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Photodiode Characteristics and Applications

Silicon photodiodes are semiconductor devices responsive to high-energy particles and photons. Photodiodes operate by absorption of photons or charged particles and generate a flow of current in an external circuit, proportional to the incident power. Photodiodes can be used to detect the presence or absence of minute quantities of light and can be calibrated for extremely accurate measurements from intensities below 1 pW/cm^2 to intensities above 100 mW/cm^2. Silicon photodiodes are utilized in such diverse applications as spectroscopy, photography, analytical instrumentation, optical position sensors, beam alignment, surface characterization, laser range finders, optical communications, and medical imaging instruments.

PLANAR DIFFUSED SILICON PHOTODIODE CONSTRUCTION

Planar diffused silicon photodiodes are simply P-N junction diodes. A P-N junction can be formed by diffusing either a P-type impurity (anode), such as Boron, into a N-type bulk silicon wafer, or a N-type impurity, such as Phosphorous, into a P-type bulk silicon wafer. The diffused area defines the photodiode active area. To form an ohmic contact another impurity diffusion into the backside of the wafer is necessary. The impurity is an N-type for P-type active area and P-type for an N-type active area. The contact pads are deposited on the front active area on defined areas, and on the backside, completely covering the device. The active area is then passivated with an antireflection coating to reduce the reflection of the light for a specific predefined wavelength. The non-active area on the top is covered with a thick layer of silicon oxide. By controlling the thickness of bulk substrate, the speed and responsivity of the photodiode can be controlled. Note that the photodiodes, when biased, must be operated in the reverse bias mode, i.e. a negative voltage applied to anode and positive voltage to cathode.

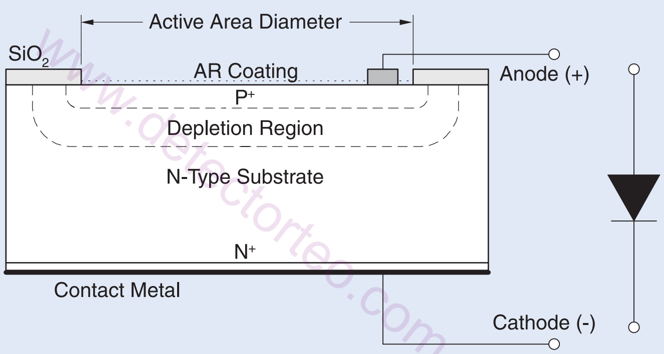

Figure 1. Planar diffused silicon photodiode

PRINCIPLE OF OPERATION

Silicon is a semiconductor with a band gap energy of 1.12 eV at room temperature. This is the gap between the valence band and the conduction band. At absolute zero temperature the valence band is completely filled and the conduction band is vacant. As the temperature increases, the electrons become excited and escalate from the valence band to the conduction band by thermal energy. The electrons can also be escalated to the conduction band by particles or photons with energies greater than 1.12eV, which corresponds to wavelengths shorter than 1100 nm. The resulting electrons in the conduction band are free to conduct current.

Due to concentration gradient, the diffusion of electrons from the N-type region to the P-type region and the diffusion of holes from the P-type region to the N-type region, develops a built-in voltage across the junction. The inter-diffusion of electrons and holes between the N and P regions across the junction results in a region with no free carriers. This is the depletion region. The built-in voltage across the depletion region results in an electric field with maximum at the junction and no field outside of the depletion region. Any applied reverse bias adds to the built in voltage and results in a wider depletion region. The electron-hole pairs generated by light are swept away by drift in the depletion region and are collected by diffusion from the undepleted region. The current generated is proportional to the incident light or radiation power. The light is absorbed exponentially with distance and is proportional to the absorption coefficient. The absorption coefficient is very high for shorter wavelengths in the UV region and is small for longer wavelengths (Figure 2). Hence, short wavelength photons such as UV, are absorbed in a thin top surface layer while silicon becomes transparent to light wavelengths longer than 1200 nm. Moreover, photons with energies smaller than the band gap are not absorbed at all.

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Penetration Depth

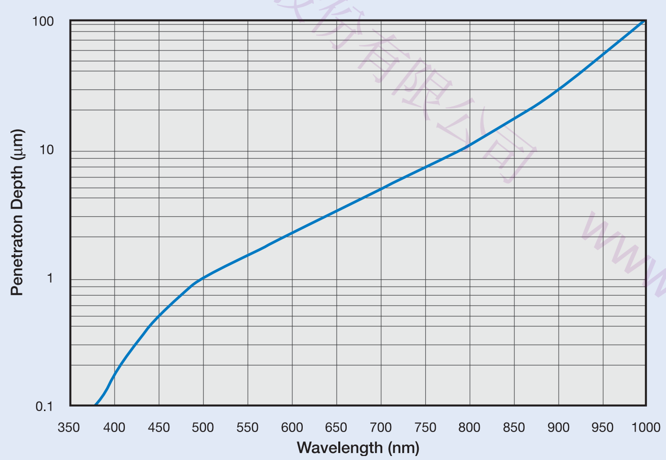

Figure 2. Penetration depth (1/e) of light into silicon substrate for various wavelengths.

ELECTRICAL CHARACTERISTICS

A silicon photodiode can be represented by a current source in parallel with an ideal diode (Figure. 3). The current source represents the current generated by the incident radiation, and the diode represents the p-n junction. In addition, a *junction capacitance* (C_j) and a *shunt resistance* (R_{SH}) are in parallel with the other components. *Series resistance* (R_S) is connected in series with all components in this model.

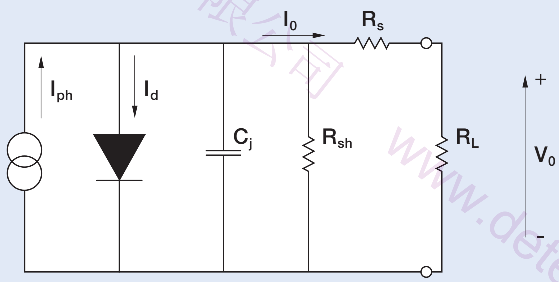

Figure 3. Equivalent Circuit for the silicon photodiode

Shunt Resistance, R_{SH}

Shunt resistance is the slope of the current-voltage curve of the photodiode at the origin, i.e. V=0. Although an ideal photodiode should have an infinite shunt resistance, actual values range from 10's to 1000's of Mega ohms. Experimentally it is obtained by applying ±10 mV, measuring the current and calculating the resistance. Shunt resistance is used to determine the noise current in the photodiode with no bias (photovoltaic mode). For best photodiode performance the highest shunt resistance is desired.

Series Resistance, R_S

Series resistance of a photodiode arises from the resistance of the contacts and the resistance of the undepleted silicon (Figure 1). It is given by:

$$R_S = \frac{(W_S - W_d)\rho}{A} + R_C \qquad (1)$$

Where W_S is the thickness of the substrate, W_d is the width of the depleted region, *A* is the diffused area of the junction, ρ is the resistivity of the substrate and R_C is the contact resistance. Series resistance is used to determine the linearity of the photodiode in photovoltaic mode (no bias, V=0). Although an ideal photodiode should have no series resistance, typical values ranging from 10 to 1000 Ω's are measured.

Junction Capacitance, C_J

The boundaries of the depletion region act as the plates of a parallel plate capacitor (Figure 1). The junction capacitance is directly proportional to the diffused area and inversely proportional to the width of the depletion region. In addition, higher resistivity substrates have lower junction capacitance. Furthermore, the capacitance is dependent on the reverse bias as follows:

$$C_J = \frac{\epsilon_{Si}\epsilon_0 A}{\sqrt{2\epsilon_{Si}\epsilon_0\mu\rho(V_A+V_{bi})}} \qquad (2)$$

$$= A\sqrt{\frac{\epsilon_{Si}\epsilon_0}{2\mu\rho(V_A+V_{bi})}}$$

$$= \frac{\epsilon_{Si}\epsilon_0 A}{W_d}$$

$$\text{Depletion Depth } W_d = \sqrt{2\epsilon_{Si}\epsilon_0\mu\rho(V_A+V_{bi})}$$

■ Typical Capacitance vs. Reverse Bias

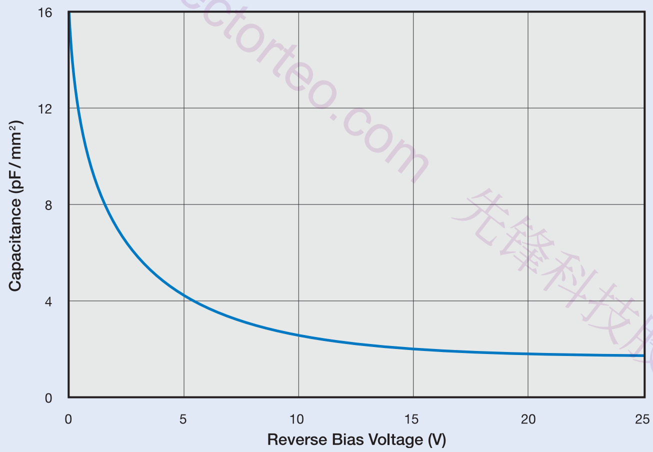

Figure 4. Capacitance of Photoconductive Devices versus Reverse Bias Voltage

where ϵ_0= 8.854x10^{-14} F/cm, is the permittivity of free space, ϵ_{Si}=11.9 is the silicon dielectric constant, μ = 1400 cm^2/Vs is the mobility of the electrons at 300 K, ρ is the resistivity of the silicon, V_{bi} is the built-in voltage of silicon and V_A is the applied bias. Figure 4 shows the dependence of the capacitance on the applied reverse bias voltage. Junction capacitance is used to determine the speed of the response of the photodiode.

Rise / Fall Time and Frequency Response, t_r / t_f / f_{3dB}

The rise time and fall time of a photodiode is defined as the time for the signal to rise or fall from 10% to 90% or 90% to 10% of the final value respectively. This parameter can be also expressed as frequency response, which is the frequency at which the photodiode output decreases by 3dB. It is roughly approximated by:

$$t_r \cong \frac{0.35}{f_{3db}} \qquad (3)$$

There are three factors defining the response time of a photodiode:

1. t_{DRIFT}, the charge collection time of the carriers in the depleted region of the photodiode.

2. $t_{DIFFUSED}$, the charge collection time of the carriers in the undepleted region of the photodiode.

3. t_{RC}, the RC time constant of the diode-circuit combination.

t_{RC} is determined by t_{RC}=2.2 RC, where R, is the sum of the diode series resistance and the load resistance (R_S + R_L), and C, is the sum of the photodiode junction and the stray capacitances (C_j+C_S). Since the junction capacitance (C_j) is dependent on the diffused area of the photodiode and the applied reverse bias (Equation 2), faster rise times are obtained with smaller diffused area photodiodes, and larger applied reverse biases. In addition, stray capacitance can be minimized by using short leads, and careful lay-out of the electronic components. The total rise time is determined by:

$$t_R = \sqrt{t_{DRIFT}^{\,2} + t_{DIFFUSED}^{\,2} + t_{RC}^{\,2}} \qquad (4)$$

Generally, in photovoltaic mode of operation (no bias), rise time is dominated by the diffusion time for diffused areas less than 5 mm^2 and by RC time constant for larger diffused areas for all wavelengths. When operated in photoconductive mode (applied reverse bias), if the photodiode is fully depleted, such as high speed series, the dominant factor is the drift time. In non-fully depleted photodiodes, however, all three factors contribute to the response time.

■ OPTICAL CHARACTERISTICS

Responsivity, R_λ

The responsivity of a silicon photodiode is a measure of the sensitivity to light, and it is defined as the ratio of the photocurrent I_P to the incident light power P at a given wavelength:

$$R_\lambda = \frac{I_P}{P} \qquad (5)$$

In other words, it is a measure of the effectiveness of the conversion of the light power into electrical current. It varies with the wavelength of the incident light (Figure 5) as well as applied reverse bias and temperature.

■ Typical Spectral Responsivity

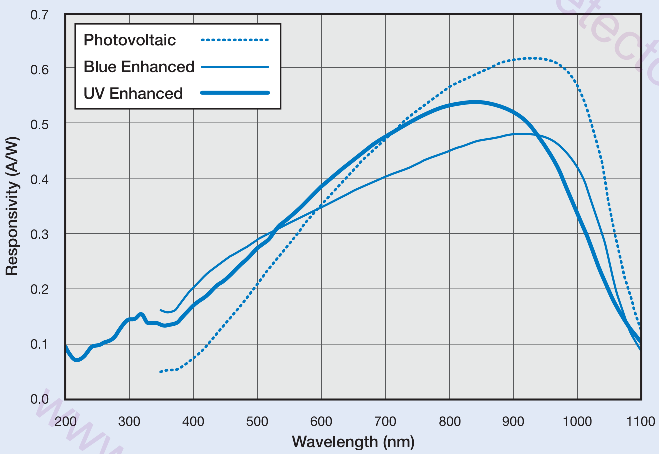

Figure 5. Typical Spectral Responsivity of Several Different Types of Planar Diffused Photodiodes

Responsivity increases slightly with applied reverse bias due to improved charge collection efficiency in the photodiode. Also there are responsivity variations due to change in temperature as shown in figure 6. This is due to decrease or increase of the band gap, because of increase or decrease in the temperature respectively. Spectral responsivity may vary from lot to lot and it is dependent on wavelength. However, the relative variations in responsivity can be reduced to less than 1% on a selected basis.

■ Temperature Dependence of Responsivity

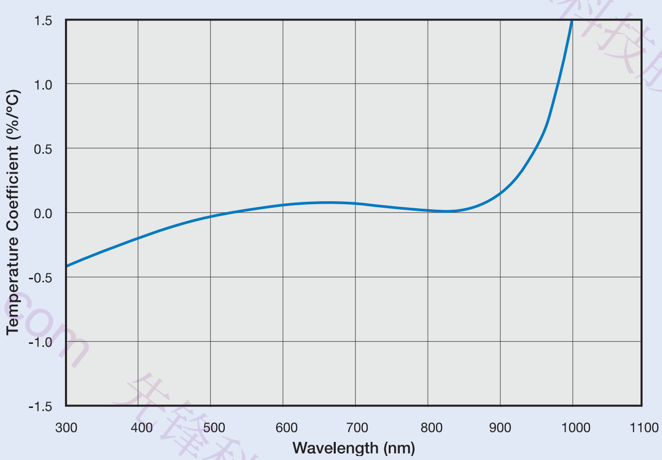

Figure 6. Typical Temperature Coefficient of Responsivity For Silicon Photodiode

Quantum Efficiency, Q.E.

Quantum efficiency is defined as the fraction of the incident photons that contribute to photocurrent. It is related to responsivity by:

$$Q.E. = \frac{R_{\lambda\ Observed}}{R_{\lambda\ Ideal}} = R_\lambda \frac{hc}{\lambda q} = 1240 \frac{R_\lambda}{\lambda} \qquad (6)$$

where h=6.63 x 10^{-34} J-s, is the Planck constant, c=3 x 10^8 m/s, is the speed of light, q=1.6 x 10^{-19} C, is the electron charge, R_λ is the responsivity in A/W and λ is the wavelength in nm.

Non-Uniformity

Non-Uniformity of response is defined as variations of responsivity observed over the surface of the photodiode active area with a small spot of light. Non-uniformity is inversely proportional to spot size, i.e. larger non-uniformity for smaller spot size.

Non-Linearity

A silicon photodiode is considered linear if the generated photocurrent increases linearly with the incident light power. Photocurrent linearity is determined by measuring the small change in photocurrent as a result of a small change in the incident light power as a function of total photocurrent or incident light power. Non-Linearity is the variation of the ratio of the change in photocurrent to the same change in light power, i.e. $\Delta I/\Delta P$. In another words, linearity exhibits the consistency of responsivity over a range of light power. Non-linearity of less than ±1% are specified over 6-9 decades for planar diffused photodiodes. The lower limit of the photocurrent linearity is determined by the noise current and the upper limit by the series resistance and the load resistance. As the photocurrent increases, first the non-linearity sets in, gradually increasing with increasing photocurrent, and finally at saturation level, the photocurrent remains constant with increasing incident light power. In general, the change in photocurrent generated for the same change in incident light power, is smaller at higher current levels, when the photodetector exhibits non-linearity. The linearity range can slightly be extended by applying a reverse bias to the photodiode.

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I-V CHARACTERISTICS

The current-voltage characteristic of a photodiode with no incident light is similar to a rectifying diode. When the photodiode is forward biased, there is an exponential increase in the current. When a reverse bias is applied, a small reverse saturation current appears. It is related to dark current as:

$$I_D = I_{SAT}\left(e^{\frac{qV_A}{k_B T}} - 1\right) \qquad (7)$$

where I_D is the photodiode dark current, I_{SAT} is the reverse saturation current, q is the electron charge, V_A is the applied bias voltage, k_B=1.38 x 10^{-23} J / K, is the Boltzmann Constant and T is the absolute temperature (273 K= 0 °C).

Photodetector I-V Curves

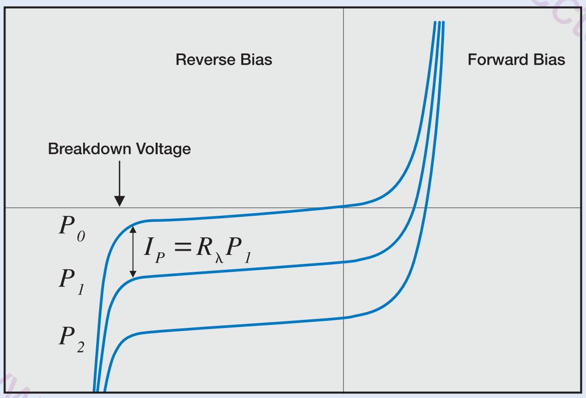

Figure 7. Characteristic I-V Curves of an OSI Optoelectronics photodiode for Photoconductive and Photovoltaic modes of operation. P_0-P_2 represent different light levels.

This relationship is shown in figure 7. From equation 7, three various states can be defined:

a) V = 0, In this state, the dark current I_P=0.
b) V = +V, In this state the current increases exponentially. This state is also known as forward bias mode.
c) V = -V, When a very large reverse bias is applied to the photodiode, the dark current becomes the reverse saturation current, I_{Sat}.

Illuminating the photodiode with optical radiation, shifts the I-V curve by the amount of photocurrent (I_P). Thus:

$$I_{TOTAL} = I_{SAT}\left(e^{\frac{qV_A}{k_B T}} - 1\right) - I_P \qquad (8)$$

where I_P is defined as the photocurrent in equation 5.

As the applied reverse bias increases, there is a sharp increase in the photodiode current. The applied reverse bias at this point is referred to as breakdown voltage. This is the maximum applied reverse bias, below which, the photodiode should be operated (also known as maximum reverse voltage). Breakdown voltage, varies from one photodiode to another and is usually measured, for small active areas, at a dark current of 10 µA.

NOISE

In a photodiode, two sources of noise can be identified; Shot noise and Johnson noise:

Shot Noise

Shot noise is related to the statistical fluctuation in both the photocurrent and the dark current. The magnitude of the shot noise is expressed as the root mean square (rms) noise current:

$$I_{sn} = \sqrt{2q(I_P + I_D)\Delta f} \qquad (9)$$

Where q=1.6x10^{-19}C, is the electron charge, I_P is the photogenerated current, I_D is the photodetector dark current and Δf is the noise measurement bandwidth. Shot noise is the dominating source when operating in photoconductive (biased) mode.

Thermal or Johnson Noise

The shunt resistance in a photodetector has a Johnson noise associated with it. This is due to the thermal generation of carriers. The magnitude of this generated noise current is:

$$I_{jn} = \sqrt{\frac{4k_B T\Delta f}{R_{SH}}} \qquad (10)$$

Where k_B=1.38 x 10^{-23} J/K, is the Boltzmann Constant, T, is the absolute temperature in degrees Kelvin (273 K= 0 °C), Δf is the noise measurement bandwidth and R_{SH} , is the shunt resistance of the photodiode. This type of noise is the dominant current noise in photovoltaic (unbiased) operation mode.

Note: All resistors have a Johnson noise associated with them, including the load resistor. This additional noise current is large and adds to the Johnson noise current caused by the photodetector shunt resistance.

Total Noise

The total noise current generated in a photodetector is determined by:

$$I_{tn} = \sqrt{I_{sn}^2 + I_{jn}^2} \qquad (11)$$

Noise Equivalent Power (NEP)

Noise Equivalent Power is the amount of incident light power on a photodetector, which generates a photocurrent equal to the noise current. NEP is defined as:

$$NEP = \frac{I_{tn}}{R_\lambda} \qquad (12)$$

Where R_λ is the responsivity in A/W and I_{tn} is the total noise of the photodetector. NEP values can vary from 10^{-11} W/√Hz for large active area photodiodes down to 10^{-15} W /√Hz for small active area photodiodes.

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TEMPERATURE EFFECTS

All photodiode characteristics are affected by changes in temperature. They include shunt resistance, dark current, breakdown voltage, responsivity and to a lesser extent other parameters such as junction capacitance.

Shunt Resistance and Dark Current:

There are two major currents in a photodiode contributing to dark current and shunt resistance. Diffusion current is the dominating factor in a photovoltaic (unbiased) mode of operation, which determines the shunt resistance. It varies as the square of the temperature. In photoconductive mode (reverse biased), however, the drift current becomes the dominant current (dark current) and varies directly with temperature. Thus, change in temperature affects the photodetector more in photovoltaic mode than in photoconductive mode of operation.

In photoconductive mode the dark current may approximately double for every 10 °C increase change in temperature. And in photovoltaic mode, shunt resistance may approximately double for every 6 °C decrease in temperature. The exact change is dependent on additional parameters such as the applied reverse bias, resistivity of the substrate as well as the thickness of the substrate.

Breakdown Voltage:

For small active area devices, by definition breakdown voltage is defined as the voltage at which the dark current becomes 10μA. Since dark current increases with temperature, therefore, breakdown voltage decreases similarly with increase in temperature.

Responsivity:

Effects of temperature on responsivity is discussed in the “Responsivity” section of these notes.

BIASING

A photodiode signal can be measured as a voltage or a current. Current measurement demonstrates far better linearity, offset, and bandwidth performance. The generated photocurrent is proportional to the incident light power and it must be converted to voltage using a transimpedance configuration. The photodiode can be operated with or without an applied reverse bias depending on the application specific requirements. They are referred to as “Photoconductive” (biased) and “Photovoltaic” (unbiased) modes.

Photoconductive Mode (PC)

Application of a reverse bias (i.e. cathode positive, anode negative) can greatly improve the speed of response and linearity of the devices. This is due to increase in the depletion region width and consequently decrease in junction capacitance. Applying a reverse bias, however, will increase the dark and noise currents. An example of low light level / high-speed response operated in photoconductive mode is shown in figure 8.

In this configuration the detector is biased to reduce junction capacitance thus reducing noise and rise time (t_r). A two stage amplification is used in this example since a high gain with a wide bandwidth is required. The two stages include a transimpedance pre-amp for current- to-voltage conversion and a non-inverting amplifier for voltage amplification. Gain and bandwidth ($f_{3dB\,Max}$) are directly determined by R_F, per equations (13) and (14) . The gain of the second stage is approximated by 1+ R1 / R2. A feedback capacitor (C_F) will limit the frequency response and avoids gain peaking.

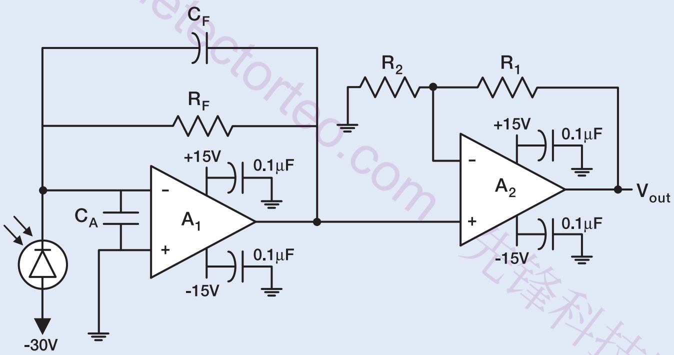

Figure 8. Photoconductive mode of operation circuit example: Low Light Level / Wide Bandwidth

$$f_{3dB\mathrm{Max}}[Hz] = \sqrt{\frac{GBP}{2\pi R_F (C_J + C_F + C_A)}} \qquad (13)$$

Where GBP is the Gain Bandwidth Product of amplifier (A_1) and C_A is the amplifier input capacitance.

$$Gain(V/W) = \frac{V_{OUT}}{P} = R_F\left(1 + \frac{R_1}{R_2}\right)R_\lambda \qquad (14)$$

In low speed applications, a large gain, e.g. >10MΩ can be achieved by introducing a large value (R_F) without the need for the second stage.

Typical components used in this configuration are:

Amplifier :	OPA-637, OPA-686, OPA-687, or similar
R_F :	1 to 10 KΩ Typical, depending on C_j
R_1 :	10 to 50 kΩ
R_2 :	0.5 to 10 kΩ
C_F :	0.2 to 2 pF

In high speed, high light level measurements, however, a different approach is preferred. The most common example is pulse width measurements of short pulse gas lasers, solid state laser diodes, or any other similar short pulse light source. The photodiode output can be either directly connected to an oscilloscope (Figure 9) or fed to a fast response amplifier. When using an oscilloscope, the bandwidth of the scope can be adjusted to the pulse width of the light source for maximum signal to noise ratio. In this application the bias voltage is large. Two opposing protection diodes should be connected to the input of the oscilloscope across the input and ground.

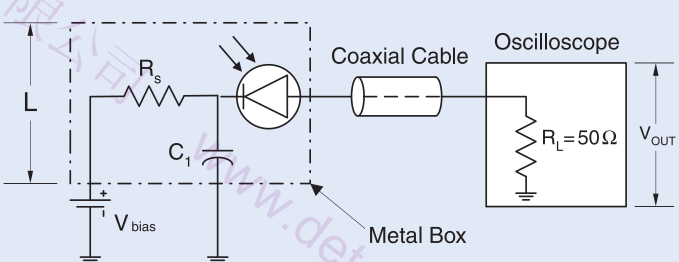

Figure 9. Photoconductive mode of operation circuit example: High Light Level / High Speed Response

(continued)

To avoid ringing in the output signal, the cable between the detector and the oscilloscope should be short (i.e. < 20cm) and terminated with a 50 ohm load resistor (R_L). The photodiode should be enclosed in a metallic box, if possible, with short leads between the detector and the capacitor, and between the detector and the coaxial cable. The metallic box should be tied through a capacitor (C1), with lead length (L) less than 2 cm, where $R_L C_1 > 10\ \tau$ (τ is the pulse width in seconds). R_S is chosen such that $R_S < V_{BIAS} / 10\ I_{PDC}$, where I_{PDC} is the DC photocurrent. Bandwidth is defined as $0.35 / \tau$. A minimum of 10V reverse bias is necessary for this application. Note that a bias larger than the photodiode maximum reverse voltage should not be applied.

Photovoltaic Mode (PV)

The photovoltaic mode of operation (unbiased) is preferred when a photodiode is used in low frequency applications (up to 350 kHz) as well as ultra low light level applications. In addition to offering a simple operational configuration, the photocurrents in this mode have less variations in responsivity with temperature. An example of an ultra low light level / low speed is shown in figure 10.

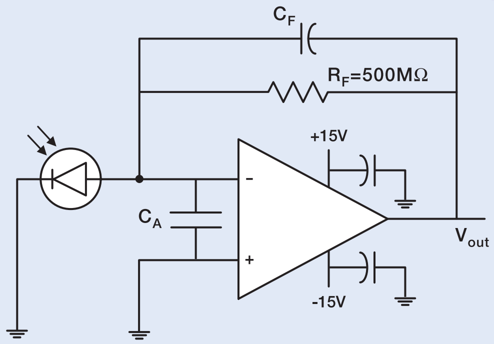

Figure 10. Photovoltaic mode of operation circuit example: Ultra low level light / low speed

In this example, a FET input operational amplifier as well as a large resistance feedback resistor (R_F) is considered. The detector is unbiased to eliminate any additional noise current. The total output is determined by equation (15) and the op-amp noise current is determined by R_F in equation (16):

$$V_{OUT} = I_P \times R_F \qquad (15)$$

$$I_N \left[\frac{A_{rms}}{\sqrt{Hz}}\right] = \sqrt{\frac{4kT}{R_F}} \qquad (16)$$

where k=1.38 x 10^{-23} J/K and T is temperature in K.

For stability, select C_F such that

$$\sqrt{\frac{GBP}{2\pi R_F (C_J + C_F + C_A)}} > \frac{1}{2\pi R_F C_F} \qquad (17)$$

Operating bandwidth, after gain peaking compensation is:

$$f_{OP}\,[Hz] = \frac{1}{2\pi R_F C_F} \qquad (18)$$

Some recommended components for this configuration are:

Amplifier :	OPA-117 or similar
R_F :	500 MΩ

These examples or any other configurations for single photodiodes can be applied to any of OSI Optoelectronics' monolithic, common substrate liner array photodiodes. The output of the first stage pre-amplifiers can be connected to a sample and hold circuit and a multiplexer. Figure 11 shows the block diagram for such configuration.

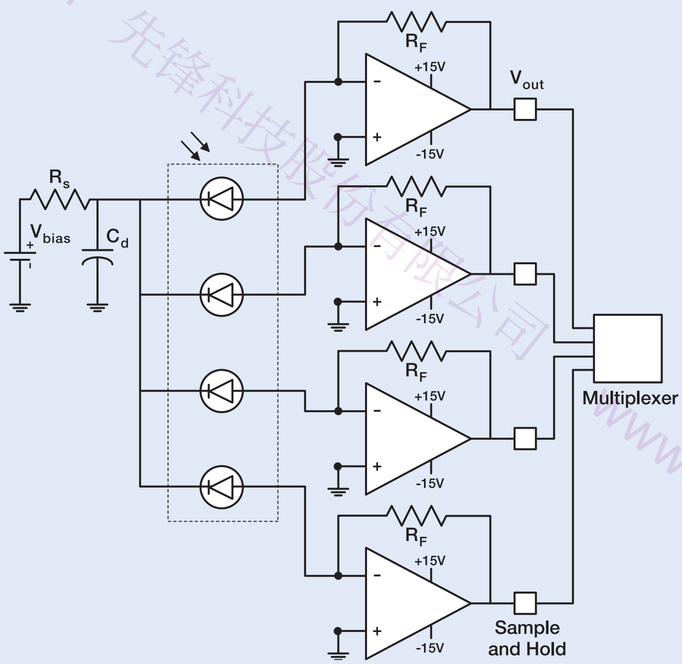

Figure 11. Circuit example for a multi-element, common cathode array

■ POSITION SENSING DETECTORS

Silicon photodetectors are commonly used for light power measurements in a wide range of applications such as bar-code readers, laser printers, medical imaging, spectroscopy and more. There is another function, however, which utilizes the photodetectors as optical position sensors. They, are widely referred to as Position Sensing Detectors or simply PSD's. The applications vary from human eye movement monitoring, 3-D modeling of human motion to laser, light source, and mirrors alignment. They are also widely used in ultra-fast, accurate auto focusing schemes for a variety of optical systems, such as microscopes, machine tool alignment, vibration analysis and more. The position of a beam within fractions of microns can be obtained using PSD's. They are divided into two families: segmented PSD's and lateral effect PSD's.

Segmented PSD's

Segmented PSD's, are common substrate photodiodes divided into either two or four segments (for one or two-dimensional measurements, respectively), separated by a gap or dead region. A symmetrical optical beam generates equal photocurrents in all segments, if positioned at the center. The relative position is obtained by simply measuring the output current of each segment. They offer position resolution better than 0.1 µm and accuracy higher than lateral effect PSD's due to superior responsivity match between the elements. Since the position resolution is not dependent on the S/N of the system, as it is in lateral effect PSD's, very low light level detection is possible. They exhibit excellent stability over time and temperature and fast response times necessary for pulsed applications. They are however, confined to certain limitations, such as the light spot has to overlap all segments at all times and it can not be smaller than the gap between the segments. It is important to have a uniform intensity distribution of the light spot for correct measurements. They are excellent devices for applications like nulling and beam centering.

Lateral Effect PSD's

Lateral effect PSD's, are continuous single element planar diffused photodiodes with no gaps or dead areas. These types of PSD's provide direct readout of a light spot displacement across the entire active area. This is achieved by providing an analog output directly proportional to both the position and intensity of a light spot present on the detector active area. A light spot present on the active area will generate a photocurrent, which flows from the point of incidence through the resistive layer to the contacts. This photocurrent is inversely proportional to the resistance between the incident light spot and the contact. When the input light spot is exactly at the device center, equal current signals are generated. By moving the light spot over the active area, the amount of current generated at the contacts will determine the exact light spot position at each instant of time. These electrical signals are proportionately related to the light spot position from the center.

The main advantage of lateral-effect diodes is their wide dynamic range. They can measure the light spot position all the way to the edge of the sensor. They are also independent of the light spot profile and intensity distribution that effects the position reading in the segmented diodes. The input light beam may be any size and shape, since the position of the centroid of the light spot is indicated and provides electrical output signals proportional to the displacement from the center. The devices can resolve positions better than 0.5 µm. The resolution is detector / circuit signal to noise ratio dependent.

OSI Optoelectronics manufactures two types of lateral effect PSD's. Duo-Lateral and Tetra-Lateral structures. Both structures are available in one and two-dimensional configurations.

In **duo-lateral PSD's**, there are two resistive layers, one at the top and the other at the bottom of the photodiode. The photocurrent is divided into two parts in each layer. This structure type can resolve light spot movements of less that 0.5 µm and have very small position detection error, all the way almost to the edge of the active area. They also exhibit excellent position linearity over the entire active area.

The **tetra-lateral PSD's**, own a single resistive layer, in which the photocurrent is divided into two or four parts for one or two dimensional sensing respectively. These devices exhibit more position non linearity at distances far away from the center, as well as larger position detection errors compared to duo-lateral types.

■ GLOSSARY OF TERMS:

Position Detection Error (PDE) or Position non-linearity is defined as the geometric variation between the actual position and the measured position of the incident light spot. It is measured over 80% of the sensing length for single dimensional PSD's and 64% of the sensing area for two-dimensional PSD's. For all calculations, the zero point is defined as the electrical center. This is the point at which $I_1 = I_2$. The error is calculated using the following equation:

$$PDE[\mu m] = \left(\frac{I_2 - I_1}{I_2 + I_1} \right) L - X \qquad (19)$$

Where I_1 and I_2 are the photocurrents at the ends of the PSD, L is the sensing area half-length in µm, and X is the actual displacement of light spot from the electrical center in µm.

Percentage Position Non-linearity is determined by dividing the position detection error by the total length of the sensing area.

Interelectrode Resistance is the resistance between the two end contacts in one axis, measured with illumination.

Position Detection Thermal Drift is the position drift with change of temperature. It is the change in position divided by the total length. It is defined within 80% of length or 64% of the area for two-dimensional PSD's.

Position Resolution is defined as the minimum detectable displacement of a spot of light on the detector active area. The resolution is limited by the signal to noise ratio of the system. It depends on light intensity, detector noise, and electronics bandwidth. Position resolutions in excess of one part in ten million have been achieved with OSI Optoelectronics lateral effect PSD's.

(continued)

■ POSITION CALCULATIONS

Segmented PSD's

Figure 12 shows a typical circuit, used with OSI Optoelectronics segmented photodiodes.

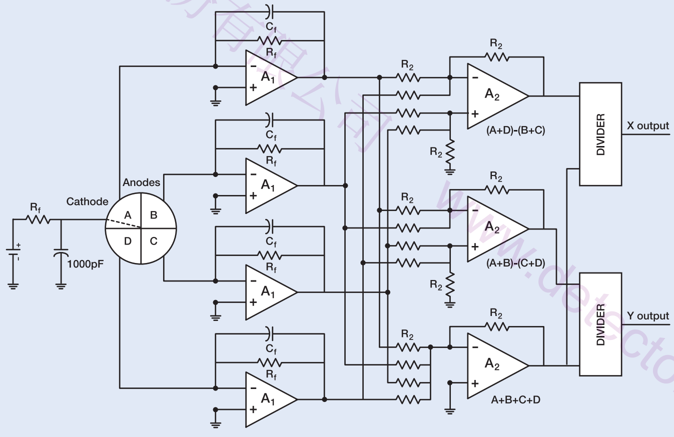

Figure 12. Typical circuit used with segmented photodiodes

The X and Y positions of the light spot with respect to the center on a quadrant photodiode is found by:

$$X = \frac{(A + D) - (B + C)}{A + B + C + D}$$

$$Y = \frac{(A + B) - (C + D)}{A + B + C + D} \quad (20)$$

Where A, B, C, and D are the photocurrents measured by each sector. The recommended components for this circuit are application specific. However, the following components are widely used in most applications:

Amplifiers A_1 and A_2 :	OPA-37 or similar
Divider:	AD-534 or similar
R_F and R_2:	10 kΩ to 10 MΩ
C_F:	$1/(2\pi R_F f)$

The same circuit can be used for one-dimensional (bi-cell) measurements.

Lateral Effect PSD's

The one dimensional lateral effect measurements are the same for duolateral and tetra-lateral structures, since they both have two contacts on top with a common contact at the bottom. In tetra-lateral devices, however, the common contact is the anode with two cathodes on top, thus making them a positive current generator. In duo-lateral devices there are two anodes on top with a common cathode at the bottom. Figure 13 shows a typical circuit set up used with one-dimensional lateral PSD's.

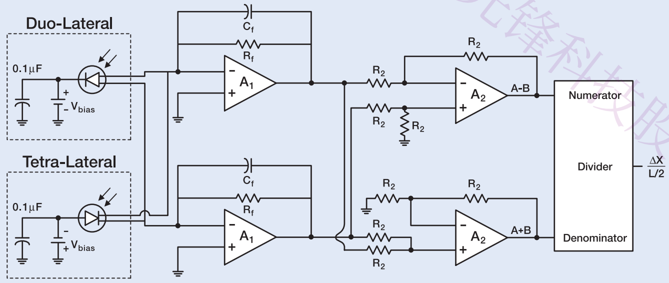

Figure 13. Typical circuit used with one dimensional lateral effect PSD's

In this configuration the outputs from the first stage are summed and subtracted in the second stage and finally divided by the divider in the final stage. The summation, subtraction and the division can be performed by software as well. The position is given as:

$$X = \frac{A - B}{A + B} \quad (21)$$

The same components as the one used in segmented photodiodes can be used with R_2 varying from 1 kΩ to 100 kΩ.

For high-speed applications, the junctions can be reverse biased with a small gain (R_F). For low frequency applications, however, the photodiode can be left unbiased and the gain (R_F), can be as high as 100 MΩ. The feedback capacitor stabilizes the frequency dependence of the gain and can vary from 1 pF to 10 µF. The gain in the first stage amplifier is I_P x R_F, and the gain of the second stage is unity.

(continued)

Two Dimensional Duo-Lateral PSD's

The two dimensional duo-lateral PSD's with two anodes on top and two cathodes on the back surface of the photodiode measure positions in two different directions, respectively. They provide a continuous position reading over the entire active area, with accuracy higher than the tetra-lateral PSD's. Figure 14 shows a typical circuit for two-dimensional duo-lateral PSD's.

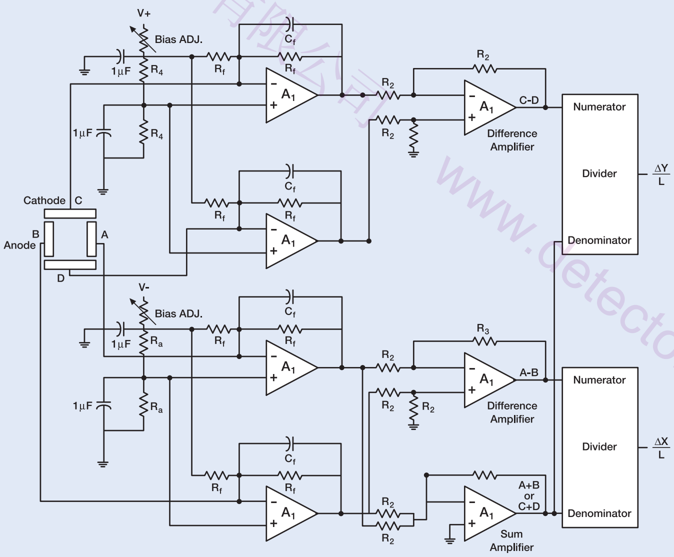

Figure 14. Typical Circuit used with two-dimensional duo-lateral PSD's

For high-speed applications, the cathodes are usually forward biased while the anodes are reverse biased. This extends the bias range that is normally limited by the maximum reverse voltage. The same components as the one-dimensional PSD's are recommended. The output is as follows:

$$X = \frac{A - B}{A + B} \qquad (22)$$

$$Y = \frac{C - D}{C + D}$$

Tetra-Lateral PSD's

In a two-dimensional tetra-lateral PSD there are four cathodes and one common anode. Similar to other PSD's, the signals from the detector are converted to voltage in the first stage and then summed and subtracted in the second stage and then finally divided in the final stage. This is shown in figure 15.

For high-speed applications, the anode is reverse biased and the feedback resistor (R_F) shall be chosen small. Additional gain can be achieved by additional stages. The recommended components and the output are similar to two-dimensional duo-lateral devices.

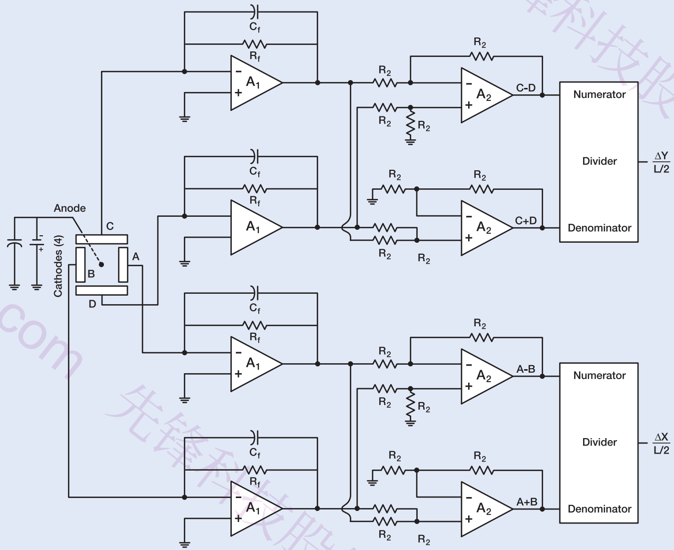

Figure 15. Typical Circuit used with two dimensional tetra-lateral PSD's

The following application notes are available for more technical information about specific uses and applications:

1. Silicon photodiodes come into their own
2. Silicon photodiodes - physics and technology (*)
3. Noise and frequency response of silicon photodiode operational amplifier combination
4. Suitability of silicon photodiodes for laser emission measurements (*)
5. Measuring LED outputs accurately
6. Radiometric and photometric concepts based on measurement techniques
7. Silicon photodiode device with 100% external quantum efficiency
8. Lateral-effect photodiodes (*)
9. Techniques for using the position sensitivity of silicon photodetectors to provide remote machine control
10. Practical electro-optics deflection measurements system
11. Non-contact optical position sensing using silicon photodetectors
12. Continuous position sensing series (LSC, SC)
13. Using photodetectors for position sensing (*)
14. High-precision, wide range, dual axis angle monitoring system
15. Real time biomechanical position sensing based on a lateral effect photodiode (*)
16. A new optical transducer to measure damped harmonic motion
17. Quantum efficiency stability of silicon photodiodes
18. Neutron hardness of photodiodes for use in passive rubidium frequency standards (*)
19. The effect of neutron irradiation on silicon photodiodes
20. Stable, high quantum efficiency, UV-enhanced silicon photodiodes by arsenic diffusion
21. Stable, high quantum efficiency silicon photodiodes for vacuum-UV applications
22. Stability and quantum efficiency performance of silicon photodiode detectors in the far ultraviolet
23. Silicon photodiodes with stable, near-theoretical quantum efficiency in the soft X-ray region

(*) These Files Are Downloadable from the OSI Optoelectronics, Inc. web site.

For any of the above documents, request them by number and write to:

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RECOMMENDED SOURCES FOR FURTHER READING:

Graeme, Jerald, Photodiode Amplifiers, McGraw Hill, New York, 1996

Dereniak, E.L., and D.G. Crowe, Optical Radiation Detectors, Wiley, New York, 1984.

Keyes, R.J., Optical and Infrared Detectors, Vol. 19, Topics in Applied Physics, Springer-Verlag, New York, 1980.

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Kruse, P.W., L.D. McGlaughlin, and R.B. McQuistan, Elements of Infrared Technology, Wiley, New York, 1963.

Sze, S.M., Physics of Semiconductor Devices, 2nd ed., Wiley-Interscience, New York, 1981.

Willardson, R.K., and A.C. Beer, Semiconductors and Semimetals, Academic Press, New York, 1977.

Wolfe, W.L. and G.J. Zissis, The Infrared Handbook, Superintendent of Documents, Washington D.C., 1979.

Standard Photodetector Products

Electro-Optical Specifications and Design Notes

In addition to our wide variety of standard photodiodes appearing in the following pages, a majority of OSI Optoelectronics' products include a broad range of custom photodiodes and custom value-added products. Our strong design and engineering group can provide services from concept to final manufactured product.

- High Reliability, Military and Aerospace Detectors per Applicable MIL-STDs.
- High Energy Particle Detectors
- Detector / Hybrid Combinations (Thick, Thin and Combifilm Ceramics)
- Detector / Filter Combinations
- Detector / Emitter Combinations
- Detector / PCB Combinations
- Detector / Scintillator Crystal Combinations
- Color Temperature Detectors
- Low Cost Lead Frame Molded Detectors
- Opto Switches and Interrupters
- Detector / Thermo-Electric Cooler Combinations
- Surface Mount Packages
- Custom Position Sensing Detectors
- Multi-Element Array (1D and 2D Configurations)

For Further Assistance
Please Call One of Our Experienced
Sales and Applications Engineers

310-978-0516

- Or -
On the Internet at

www.osioptoelectronics.com

DISCLAIMER
Information in this catalog is believed to be correct and reliable. However, no responsibility is assumed for possible inaccuracies or omission.
Specifications are subject to change without notice.

Photoconductive Series

Planar Diffused Silicon Photodiodes

The Photoconductive Detector Series are suitable for high speed and high sensitivity applications. The spectral range extends from 350 to 1100 nm, making these photodiodes ideal for visible and near IR applications, including such AC applications as detection of pulsed LASER sources, LEDs, or chopped light.

To achieve high speeds, these detectors should be reverse biased. Typical response times from 10 ns to 250 ns can be achieved with a 10V reverse bias, for example. When a reverse bias is applied, capacitance decreases (as seen in the figure below) corresponding directly to an increase in speed.

As indicated in the specification table, the reverse bias should not exceed 30 volts. Higher bias voltages will result in permanent damage to the detector.

Since a reverse bias generates additional dark current, the noise in the device will also increase with applied bias. For lower noise detectors, the Photovoltaic Series should be considered.

Refer to the Photoconductive Mode (PC) paragraph in the "Photodiode Characteristics" section of this catalog for detailed information on electronics set up.

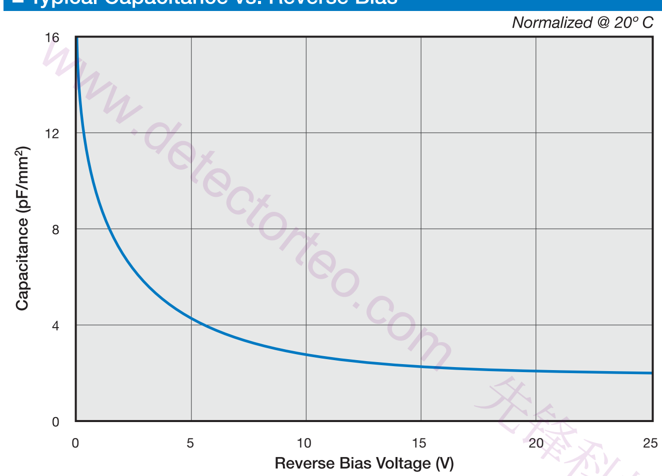
APPLICATIONS

- Pulse Detectors
- Optical Communications
- Bar Code Readers
- Optical Remote Control
- Medical Equipment
- High Speed Photometry

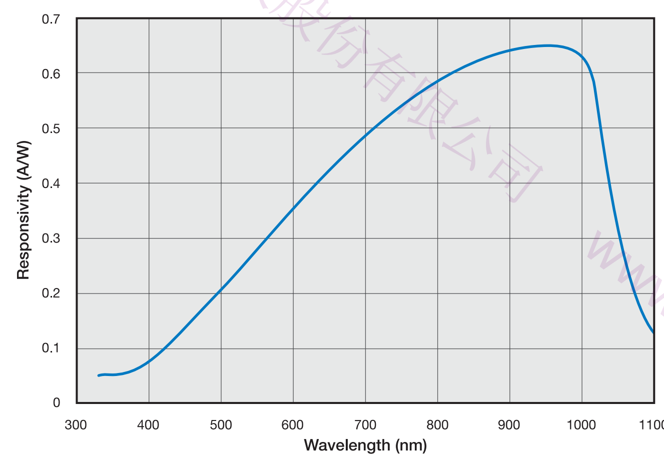
FEATURES

- High Speed Response
- Low Capacitance
- Low Dark Current
- Wide Dynamic Range
- High Responsivity

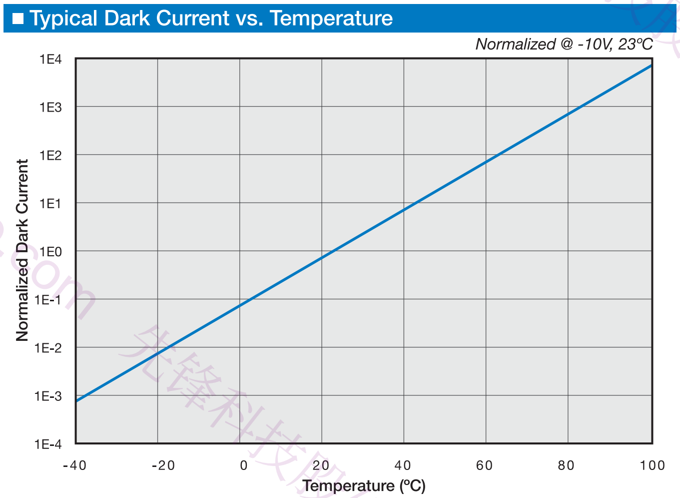
Typical Capacitance vs. Reverse Bias



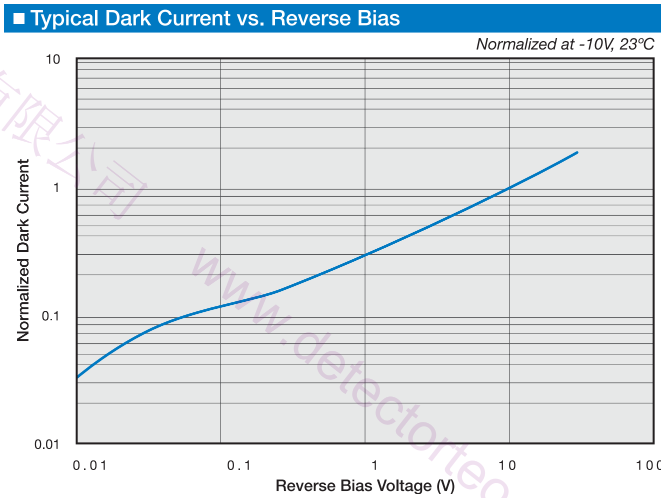
Typical Spectral Response



Typical Dark Current vs. Temperature



Typical Dark Current vs. Reverse Bias



▪ Photoconductive Series

Typical Electro-Optical Specifications at T_A=23ºC

Model Number	Active Area		Peak Responsivity Wavelength	Responsivity at λp		Capacitance (pF)		Dark Current (nA)		NEP (W/√Hz)	Reverse Voltage (V)	Rise Time (ns)	Temp.* Range (˚C)		Package Style ¶
	Area (mm²)	Dimensions (mm)	λp (nm)	(A/W)		0 V	-10 V	-10 V		-10V 970nm		-10V 632nm 50 Ω	Operating	Storage	
			typ.	min.	typ.	typ.	typ.	typ.	max.	typ.	max.	typ.			
'D' Series, Metal Package															
PIN-020A	0.20	0.51 ϕ	970	0.60	0.65	4	1	0.01	0.15	2.8 e-15	30	6	-40 ~ +100	-55 ~ +125	1 / TO-18
PIN-040A	0.81	1.02 ϕ				8	2	0.05	0.50	6.2 e-15		8			
PIN-2DI ‡	1.1	0.81 x 1.37				25	5	0.10	1.0	8.7 e-15		10			4 / TO-18
PIN-3CDI	3.2	1.27 x 2.54				45	12	0.15	2	1.1 e-14					
PIN-3CD															7 / TO-18
PIN-5DI	5.1	2.54 ϕ				85	15	0.25	3	1.4 e-14		12			2 / TO-5
PIN-5D															5 / TO-5
PIN-13DI	13	3.6 sq				225	40	0.35	6	1.6 e-14		14			2 / TO-5
PIN-13D															5 / TO-5
PIN-6DI	16.4	4.57 ϕ				330	60	0.5	10	1.9 e-14		17			3 / TO-8
PIN-6D															6 / TO-8
PIN-44DI	44	6.6 sq				700	130	1	15	2.8 e-14		24			3 / TO-8
PIN-44D															6 / TO-8
PIN-10DI	100	11.28 ϕ				1500	300	2	25	3.9 e-14		43	-10 ~ +60	-20 ~ +70	10/ Lo-Prof
PIN-10D															11 / BNC
PIN-25D	613	27.9 ϕ				9500	1800	15	1000	1.1 e-13		250			12 / BNC
'O' Series, Metal Package															
OSD1-0	1	1.0 sq	900	0.47	0.54	12	3	1	3	4.5 e-14	50	10	-25 ~ +75	-40 ~ +100	7 / TO-18
OSD5-0	5	2.5 ϕ				50	8	5	10	1.0 e-13		8			5 / TO-5
OSD15-0	15	3.8 sq				150	20	8	15	1.3 e-13		9			5 / TO-5
OSD35-0	35	5.9 sq				350	46	12	30	1.6 e-13		12			3 / TO-8
OSD60-0	58	7.6 sq				600	75	15	50	1.7 e-13		14			72/ TO-8
OSD100-0A	100	11.3 ϕ				1000	130	30	70	2.5 e-13		19			74 /Special
'D' Series, Plastic Package §															
FIL-5C	5.1	2.54 ϕ	970	0.60	0.65	85	15	0.25	3	1.4 e-14	30	12	-10 ~ +60	-20 ~ +70	14 / Plastic
FIL-20C	16.4	4.57 ϕ				330	60	0.5	10	1.9 e-14		17			
FIL-44C	44	6.6 sq				700	130	1	15	2.8 e-14		24			15 / Plastic
FIL-100C	100	11.28 ϕ				1500	300	2	25	3.9 e-14		43			
PIN-220D	200	10 x 20				3200	600	5	100	6.2 e-14		75			27 / Plastic

‡ The 'I' suffix on the model number is indicative of the photodiode chip being isolated from the package by an additional pin connected to the case.
§ The photodiode chips in "FIL" series are isolated in a low profile plastic package. They have a large field of view as well as "in line" pins.
¶ For mechanical drawings please refer to pages 58 thru 69.
* Non-condensing temperature and storage range, Non-condensing environment.

Photovoltaic Series

Planar Diffused Silicon Photodiodes

The Photovoltaic Detector series is utilized for applications requiring high sensitivity and moderate response speeds, with an additional sensitivity in the visible-blue region for the blue enhanced series. The spectral response ranges from 350 to 1100 nm, making the regular photovoltaic devices ideal for visible and near IR applications. For additional sensitivity in the 350 nm to 550 nm region, the blue enhanced devices are more suitable.

These detectors have high shunt resistance and low noise, and exhibit long term stability. Unbiased operation of these detectors offers stability under wide temperature variations in DC or low speed applications. For high light levels (greater than 10mW/cm2), the Photoconductive Series detectors should be considered for better linearity.

These detectors are not designed to be reverse biased! Very slight improvement in response time may be obtained with a slight bias. Applying a reverse bias of more than a few volts (>3V) will permanently damage the detectors. If faster response times are required, the Photoconductive Series should be considered.

Refer to the Photovoltaic Mode (PV) paragraph in the "Photodiode Characteristics" section of this catalog for detailed information on electronics set up.

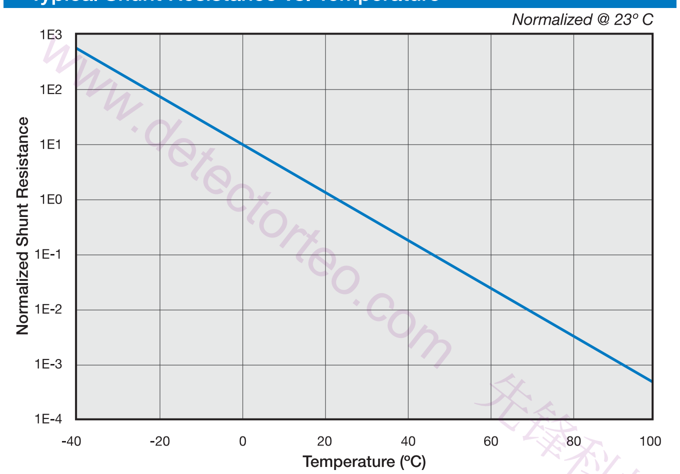
APPLICATIONS

- Colorimeters
- Photometers
- Spectroscopy Equipment
- Fluorescence

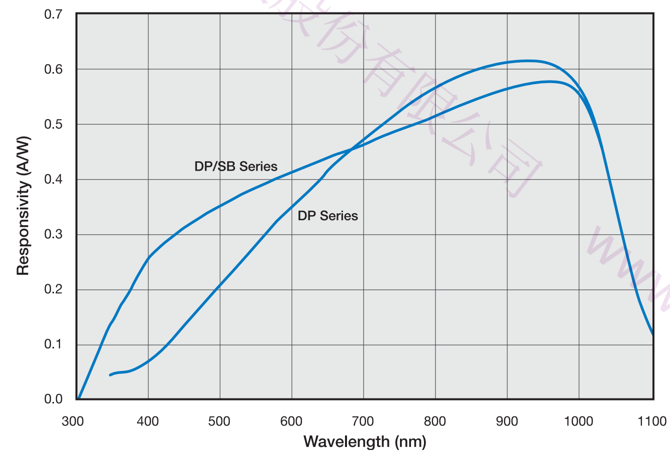
FEATURES

- Ultra Low Noise
- High Shunt Resistance
- Wide Dynamic Range
- Blue Enhanced

Typical Shunt Resistance vs. Temperature



Typical Spectral Response



Photovoltaic Series

Typical Electro-Optical Specifications at T_A=23°C

Model Number	Active Area		Peak Responsivity Wavelength	Responsivity at λp		Capacitance (pF)	Shunt Resistance (GΩ)		NEP (W/√Hz)	Rise Time (ns)	Temp.* Range (°C)		Package Style ¶
	Area (mm^2)	Dimensions (mm)	λp (nm)	(A/W)		0 V	-10 mV		0V 970 nm	0 V 632 nm 50 Ω	Operating	Storage	
			typ.	min.	typ.	max.	min.	typ.	typ.	typ.			
'DP' Series, Metal Package													
CD-1705	0.88	0.93 sq	850	0.55	0.60	70	1.0	10	2.1 e-15	2000	-40 ~ +100	-55 ~ +125	71 / Plastic
PIN-2DPI ‡	1.1	0.81 x 1.37	970			150				30			4 / TO-18
PIN-125DPL	1.6	1.27 sq.				160							8 / TO-18
PIN-3CDPI	3.2	1.27 x 2.54				320	0.5	5.0	3.0 e-15	50			4 / TO-18
PIN-3CDP													7 / TO-18
PIN-5DPI	5.1	2.54 ϕ				500	0.4	4.0	3.4 e-15	60			2 / TO-5
PIN-5DP													5 / TO-5
PIN-13DPI	13	3.6 sq				1200	0.35	3.5	3.6 e-15	150			2 / TO-5
PIN-13DP													5 / TO-5
PIN-6DPI	16.4	4.57 ϕ				2000	0.2	2.0	3.9 e-15	220			3 / TO-8
PIN-6DP													6 / TO-8
PIN-44DPI	44	6.6 sq				4300	0.1	1.0	4.8 e-15	475			3 / TO-8
PIN-44DP													6 / TO-8
PIN-10DPI	100	11.28 ϕ				9800	0.05	0.2	6.8 e-15	1000	-10 ~ +60	-20 ~ +70	10/ Lo-Prof
PIN-10DP													11 / BNC
PIN-25DP	613	27.9 ϕ				60000	0.002	0.1	3.0 e-14	6600			12 / BNC
'DP' Series, Plastic Package §													
PIN-220DP	200	10 x 20	970	0.55	0.60	20000	0.02	0.2	1.2 e-14	2200	-10 ~ +60	-20 ~ +70	27 / Plastic

Super Blue Enhanced 'DP/SB' Series, (All Specifications @ λ= 410 nm. V_{BIAS}= 0V, R_L= 50Ω)

Model No.	Active Area/Dimensions		Responsivity (A/W)		Capacitance (pF)	R_{sh} (MΩ)	NEP (W/√Hz)	Operating Current (mA)	Rise Time (μs)			Package Style ¶
	mm^2	mm	min.	typ.	typ.	min.	typ.	max.	typ.			
PIN-040DP/SB	0.81	1.02 ϕ	0.15	0.20	60	600	2.0 e-14	0.5	0.02	-10 ~ +60	-20 ~ +70	1 / TO-18
PIN-5DP/SB †	5.1	2.54 ϕ			450	150	5.2 e-14	2.0	0.2			5 / TO-5
PIN-10DP/SB	100	11.28 ϕ			8800	10	2.0 e-13	10.0	2.0			11 / BNC
PIN-10DPI/SB												10 / Metal
PIN-220DP/SB	200	10 x 20			17000	5	2.9 e-13	10.0	4.0			27 / Plastic

'5T' Series, Blue

Model No.	Active Area/Dimensions		Responsivity (A/W) 436nm		Capacitance (pF) 0V	R_{sh} (MΩ)	NEP (W/√Hz)	Dark Current (pA)	Rise Time (μs)			Package Style ¶
	mm^2	mm	min.	typ.	max	min.	typ.	max.	typ.			
OSD1-5T	1.0	1.0 sq	0.18	0.21	35	250	2.5 e-14	1.0	7	-25 ~ +75	-45 ~ +100	7 / TO-18
OSD3-5T	3.0	2.5 x 1.2			80	100	3.0 e-14	2.0	9			7 / TO-18
OSD5-5T	5.0	2.5 ϕ			130	100	3.3 e-14	2.0	9			5 / TO-5
OSD15-5T	15.0	3.8 sq			390	50	5.6 e-14	10.0	12			5 / TO-5
OSD60-5T	62.0	7.9 sq			1800	3	2.1 e-13	25.0	30			72 / TO-8
OSD100-5TA	100.0	11.3 ϕ			2500	2	2.5 e-13	30.0	45			74 / Special

‡ The 'I' suffix on the model number is indicative of the photodiode chip being isolated from the package by an additional pin connected to the case.
§ The photodiode chips in "FIL" series are isolated in a low profile plastic package. The have a large field of view as well as "in line" pins.
¶ For mechanical drawings please refer to pages 58 thru 69.
† Operating Temperature: -40 to +100 °C, Storage Temperature: -55 to +125 °C.
* Non-Condensing temperature and Storage Range, Non-Condensing Environment.

UV Enhanced Series

Inversion Layers and Planar Diffused Silicon Photodiodes

OSI Optoelectronics offers two distinct families of UV enhanced silicon photodiodes. Inversion channel series and planar diffused series. Both families of devices are especially designed for low noise detection in the UV region of electromagnetic spectrum.

Inversion layer structure UV enhanced photodiodes exhibit 100% internal quantum efficiency and are well suited for low intensity light measurements. They have high shunt resistance, low noise and high breakdown voltages. The response uniformity across the surface and quantum efficiency improves with 5 to 10 volts applied reverse bias. In photovoltaic mode (unbiased), the capacitance is higher than diffused devices but decreases rapidly with an applied reverse bias. Photocurrent non-linearity sets in at lower photocurrents for inversion layer devices compared to the diffused ones. Below 700nm, their responsivities vary little with temperature.

Planar diffused structure (UV-D Series) UV enhanced photodiodes show significant advantages over inversion layer devices, such as lower capacitance and higher response time. These devices exhibit linearity of photocurrent up to higher light input power compared to inversion layer devices.

They have relatively lower responsivities and quantum efficiencies compared to inversion layer devices. There are two types of planar diffused UV enhanced photodiodes available: UVD and UVE. Both series have almost similar electro-optical characteristics, except in the UVE series, where the near IR responses of the devices are suppressed. This is especially desirable if blocking the near IR region of the spectrum is necessary. UVD devices peak at 970 nm and UVE devices at 720 nm (see graph). Both series may be biased for lower capacitance, faster response and wider dynamic range. Or they may be operated in the photovoltaic (unbiased) mode for applications requiring low drift with temperature variations. The UVE devices have a higher shunt resistance than their counterparts of UVD devices, but have a higher capacitance.

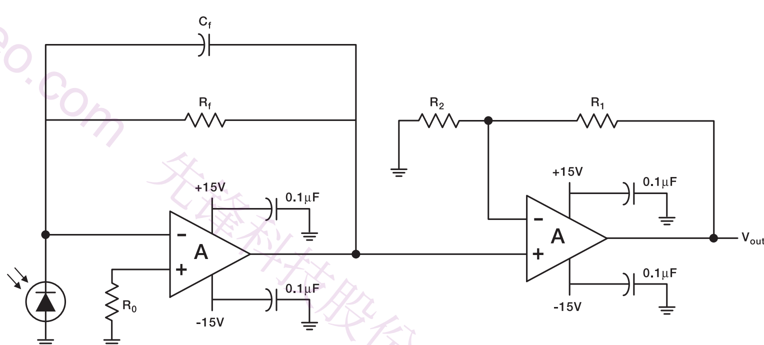
These detectors are ideal for coupling to an OP-AMP in the current mode configuration as shown below.

▪ APPLICATIONS

- Pollution Monitoring
- Medical Instrumentation
- UV Exposure Meters
- Spectroscopy
- Water Purification
- Fluorescence

▪ FEATURES

- Inversion series:
  100% Internal QE
- Ultra High R_{SH}
- Planar Diffused Series:
  IR Suppressed
  High Speed Response
  High Stability
- Excellent UV response



Inversion Layer UV Enhanced Photodiodes

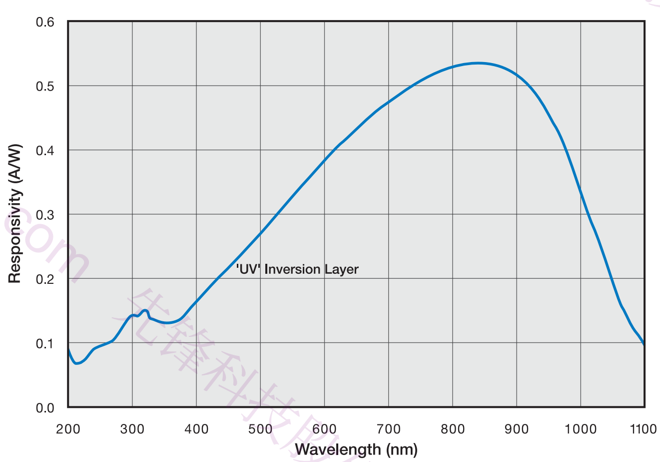
Typical Electro-Optical Specifications at T_A=23ºC

Model Number	Active Area		Responsivity (A/W)		Capacitance (pF)	Shunt Resistance (MΩ)		NEP (W/√Hz)	Reverse Voltage (V)	Rise Time (μs)	Operating Current (mA)	Temp.* Range (˚C)		Package Style ¶
	Area (mm²)	Dimensions (mm)	254 nm		0 V	-10 mV		0V 254 nm		0 V 254 nm 50 Ω	0 V	Operating	Storage	
			min.	typ.	max.	min.	typ.	typ.	max.	typ.	typ.			
'UV Enhanced' Series, Inversion Layer, Metal Package §														
UV-001	0.8	1.0 ϕ			60	250	500	6.4 e-14		0.2				
UV-005	5.1	2.54 ϕ			300	80	200	1.0 e-13		0.9		-20 ~ +60	-55 ~ +80	5 / TO-5
UV-015	15	3.05 x 3.81			800	30	100	1.4 e-13		2.0				
UV-20	20	5.08 ϕ			1000	25	50	2.0 e-13		2.0				6 / TO-8
UV-35	35	6.60 x 5.33	0.09	0.14	1600	20	30	1.7 e-13	5	3.0	0.1			
UV-50	50	7.87 ϕ			2500	10	20	2.6 e-13		3.5		-10 ~ +60	-20 ~ +70	11 / BNC
UV-50L ‡														10 / Lo-Prof
UV-100	100	11.28 ϕ			4500	5	10	4.5 e-13		5.9				11 / BNC
UV-100L														10 / Lo-Prof
'UV Enhanced' Series, Inversion Layer, Plastic Package §														
FIL-UV005	5.1	2.54 ϕ			300	50	100	9.2 e-14		0.9				14 / Plastic
FIL-UV20	20	5.08 ϕ			1000	20	50	1.3 e-13		2.0				
UV-35P	35	6.60 x 5.33	0.09	0.14	1600	15	30	1.7 e-13	5	3.0	0.1	-10 ~ +60	-20 ~ +70	25 / Plastic
FIL-UV50	50	7.87 ϕ			2500	10	20	2.1 e-13		3.5				15 / Plastic
FIL-UV100	100	11.28 ϕ			4500	5	10	2.9 e-13		5.9				

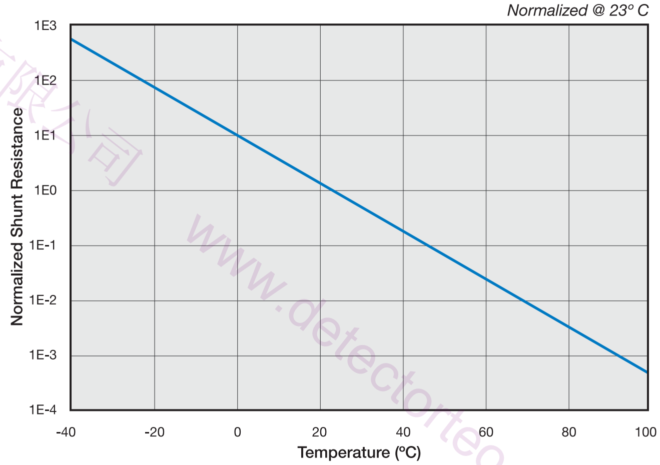
Model Number	Active Area		Responsivity (A/W)		Capacitance (pF)	Shunt Resistance (GΩ)		NEP (W/√Hz)	Reverse Voltage (V)	Rise Time (μs)	Dark Current (pA)	Temp.* Range (˚C)		Package Style ¶
	Area (mm²)	Dimensions (mm)	254 nm		0 V	-10 mV		0V 254 nm		0 V 254 nm 1kΩ	Vr=10mV	Operating	Storage	
			min.	typ.	max.	min.	typ.	typ.	max.	typ.	typ.			
'7' Series, Super UV														
OSD1.2-7U	1.2	1.1 sq	0.08	0.10	40	0.5	5.0	1.5 e-14		0.1	2			7 / TO-18
OSD1.2-7Q	1.2	1.1 sq	0.10	0.12	40	0.5	5.0	1.5 e-14		0.1	2			7 / TO-18
OSD5.8-7U	5.8	2.4 sq	0.08	0.10	180	0.5	3.0	2.0 e-14		0.4	3	-25 ~ +70	-40 ~ +100	5 / TO-5
OSD5.8-7Q	5.8	2.4 sq	0.10	0.12	180	0.5	3.0	2.0 e-14	5	0.4	3			5 / TO-5
OSD35-7Q	33.6	5.8 sq	0.10	0.12	1000	0.1	0.5	6.0 e-14		2.0	20			3 / TO-8
OSD35-7CO	33.6	5.8 sq	0.11	0.13	1000	0.1	0.5	6.0 e-14		2.0	20			25 / Ceramic

‡ The 'I' or 'L' suffix on the model number is indicative of the photodiode chip being isolated from the package by an additional pin connected to the case.
§ The photodiode chips in "FIL" series are isolated in a low profile plastic package. They have a large field of view as well as in line pins.
¶ For mechanical drawings please refer to pages 58 thru 69.
* Non-Condensing temperature and Storage Range, Non-Condensing Environment.

Typical Spectral Response



Typical Shunt Resistance vs. Temperature



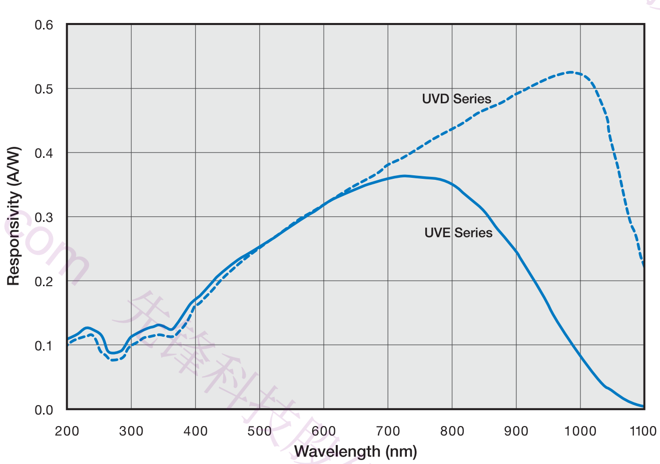
Planar Diffused UV Enhanced Photodiodes

Typical Electro-Optical Specifications at T_A=23ºC

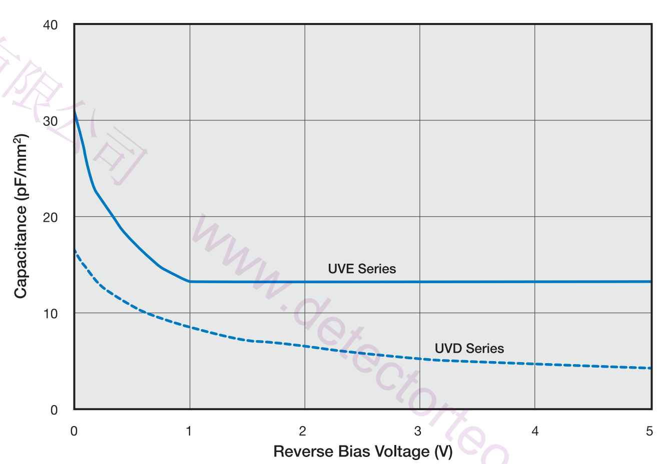
Model Number	Active Area: Area (mm²)	Active Area: Dimension (mm)	Peak Wavelength λ_P (nm)	Responsivity (A/W) 254 nm typ.	Responsivity (A/W) 633 nm typ.	Responsivity (A/W) 930 nm typ.	Capacitance (pF) 0 V typ.	Shunt Resistance (GΩ) -10 mV min.	Shunt Resistance (GΩ) -10 mV typ.	NEP (W/√Hz) 0V 254 nm typ.	Reverse Voltage (V) max.	Rise Time (μs) 0 V 254 nm 50 Ω typ.	Temp.* Range (°C) Operating	Temp.* Range (°C) Storage	Package Style ¶
'UVD' Series Planar Diffused, Metal Package															
UV-005D	5.7	2.4 sq	970	0.10	0.33	0.50	100	0.30	4	2.0 e -14	5	0.10	-20 ~ +60	-55 ~ +80	5 / TO-5
UV-013D	13	3.6 sq					225	0.20	2	2.8 e -14		0.20			
UV-035D	34	5.8 sq					550	0.10	0.50	5.6 e -14		0.40			6 / TO-8
'UVD' Series Planar Diffused, Ceramic Package															
UV-005DC	5.7	2.4 sq	970	0.10	0.33	0.50	100	0.30	4	2.0 e -14	5	0.10	-20 ~ +60	-20 ~ +80	25 / Ceramic
UV-035DC	34	5.8 sq					550	0.10	0.5	5.6 e -14		0.20			
UV-100DC	100	10 sq					1750	0.04	0.20	9.1 e -14		1.00			
'UVE' Series Planar Diffused, Metal Package															
UV-005E	5.7	2.4 sq	720	0.10	0.33	0.17	200	0.50	10	1.3 e -14	5	0.15	-20 ~ +60	-55 ~ +80	5 / TO-5
UV-013E	13	3.6 sq					400	0.40	5	1.8 e -14		0.30			
UV-035E	34	5.8 sq					1000	0.20	1	4.1 e -14		0.80			6 / TO-8
'UVE' Series Planar Diffused, Ceramic Package															
UV-005EC	5.7	2.4 sq	720	0.10	0.33	0.17	200	0.50	10	1.3 e -15	5	0.15	-20 ~ +60	-20 ~ +80	25 / Ceramic
UV-035EC	34	5.8 sq					1000	0.20	1	4.1 e -14		0.80			
UV-100EC	100	10 sq					2500	0.10	0.50	5.8 e -14		1.00			

¶ For mechanical specifications please refer to pages 58 thru 69.
* Non-Condensing temperature and Storage Range, Non-Condensing Environment.

Typical Spectral Response

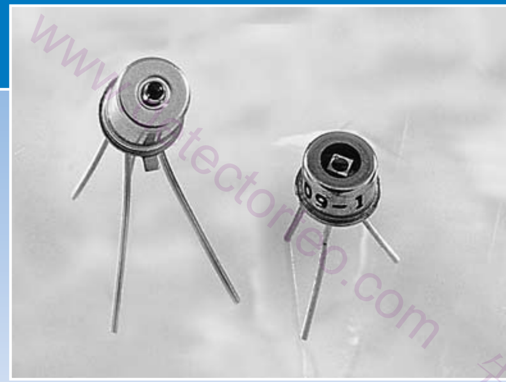


Typical Capacitance vs. Reverse Bias



High Speed Silicon Photodiodes

High Speed Silicon Series



OSI Optoelectronics High Speed Silicon series are small area devices optimized for fast response time or High bandwidth applications. The BPX-65 complements the rest of the high speed group with an industry standard.

The spectral range for these devices goes from 350 nm to 1100 nm. The responsivity and response time are optimized such that the HR series exhibit a peak responsivity of 0.50 A/W at 800 nm and typical response times of a few hundred pico seconds at -5V.

Note that for all high-speed photodetectors, a reverse bias is required to achieve the fastest response times. However, the reverse bias should be limited to maximum reverse voltage specified to avoid damage to the detector. Output signals can be measured directly with an oscilloscope or coupled to high frequency amplifiers as shown in figure 10 of the Photodiode Characteristics section of the catalog. All parts in the High-Speed silicon series are available with a flat window or ball lens (L).

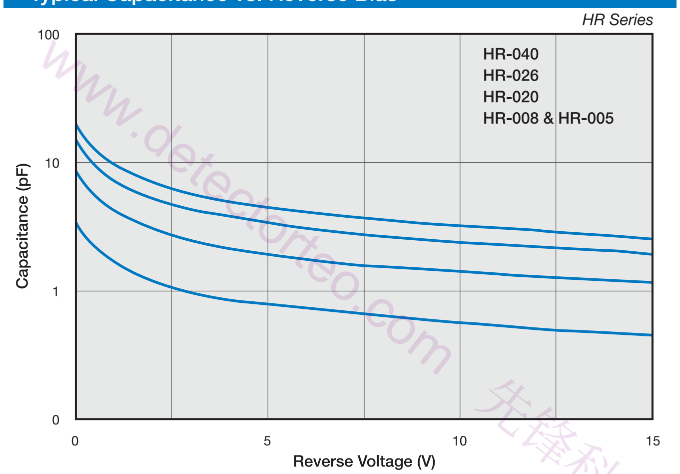
APPLICATIONS

- Video Systems
- Computers and Peripherals
- Industrial Control
- Guidance Systems
- Laser Monitoring

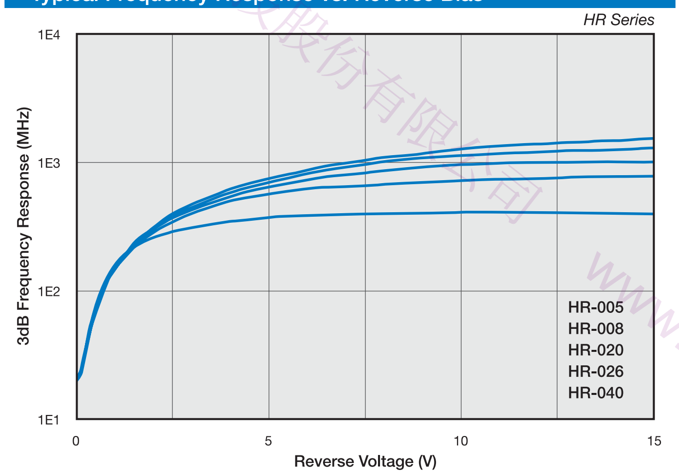
FEATURES

- Low Dark Current
- Low Capacitance
- TO-46 Package
- w/Lensed Cap
- Sub ns Response

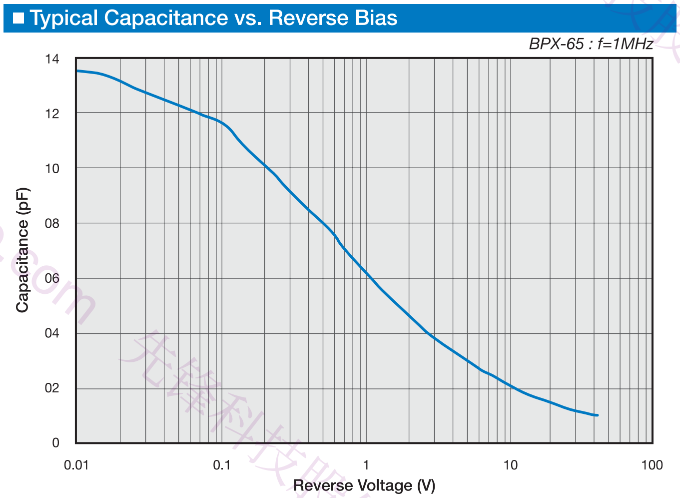
Typical Capacitance vs. Reverse Bias



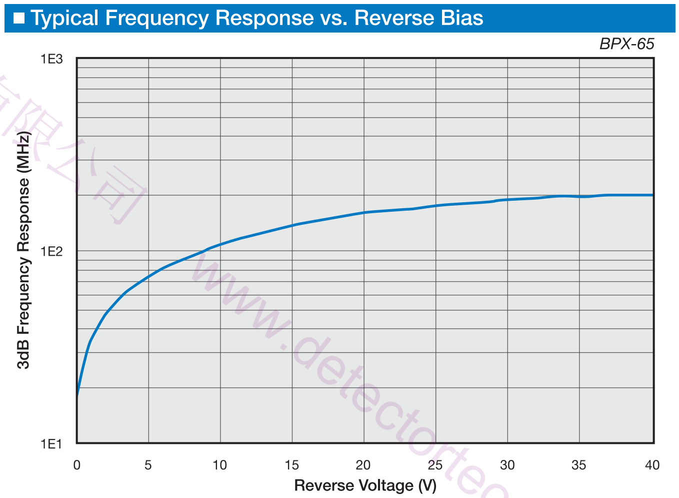
Typical Frequency Response vs. Reverse Bias



Typical Capacitance vs. Reverse Bias



Typical Frequency Response vs. Reverse Bias



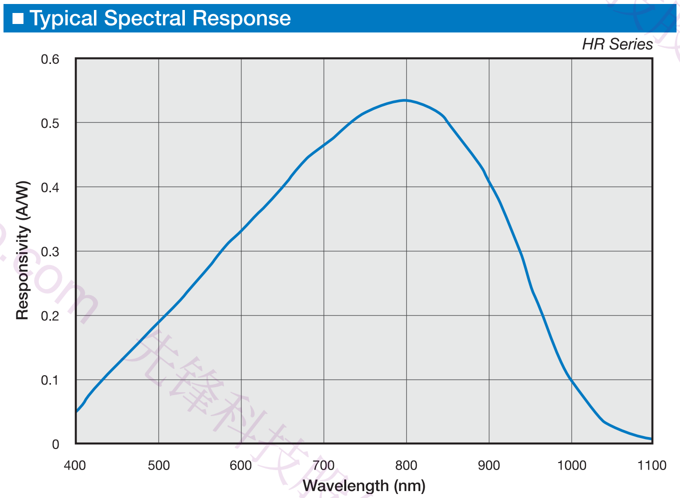
Typical Electro-Optical Specifications at T_A=23°C

Model Number	Active Area Area (mm²)	Active Area Dimensions (mm)	Peak Wavelength (nm)	Responsivity (A/W) 830 nm min.	Responsivity (A/W) 830 nm typ.	Capacitance (pF) ‡ typ.	Dark Current (nA) ‡ typ.	Dark Current (nA) ‡ max.	NEP (W/√Hz) 830 nm typ.	Reverse Voltage (V) max.	Rise Time § (ns) ‡ 830 nm 50 Ω typ.	Temp.** Range (˚C) Operating	Temp.** Range (˚C) Storage	Package Style ¶
High Responsivity Series (V_{BIAS}=-5 V)														
PIN-HR005 PIN-HR005L*	0.01	0.127 ϕ				0.8	0.03	0.8	5.0 e-15		0.60			
PIN-HR008 PIN-HR008L*	0.04	0.203 sq				0.8	0.03	0.8	5.0 e-15		0.60			
PIN-HR020 PIN-HR020L*	0.02	0.508 ϕ	800	0.45*	0.50*	1.8	0.06	1.0	7.1 e-15	15	0.80	-25 ~ +85	-40 ~ +100	9 / TO-18 16 / TO-18 (L - Ball Lens Cap)
PIN-HR026 PIN-HR026L*	0.34	0.660 ϕ				2.6	0.1	1.5	1.0 e-14		0.90			
PIN-HR040 PIN-HR040L*	0.77	0.991 ϕ				4.9	0.3	2.0	1.9 e-14		1.0			
BPX-65 (V_{BIAS}=-20 V)														
BPX-65	1.0	1.0 sq	900	0.45	0.5	3.0	0.5	5.0	2.3 e-14	50	2.0			7 / TO-18

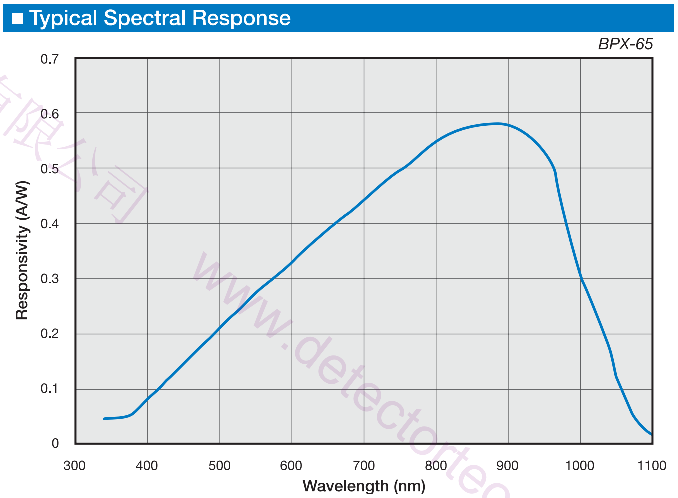
Model Number	Active Area Area (mm²)	Active Area Dimensions (mm)	Peak Wavelength (nm)	Responsivity (A/W) 900 nm min.	Responsivity (A/W) 900 nm typ.	Capacitance (pF) ‡ typ.	Dark Current (nA) ‡ typ.	Dark Current (nA) ‡ max.	NEP (W/√Hz) 900 nm typ.	Reverse Voltage (V) max.	Rise Time § (ns) ‡ 820 nm typ.	Temp.** Range (˚C) Operating	Temp.** Range (˚C) Storage	Package Style ¶
BPX-65R (V_{BIAS}=-20 V)														
BPX-65R	1.0	1.0 sq	850	0.52	0.55	3.5	1.0	5.0	3.3 e-14	30	3.5	-40 ~ +80	-55 ~ +100	4 / TO-18

¶ For mechanical drawing, please refer to pages 58 thru 69.
* Responsivities are measured for Flat window devices. L- Refers to devices with a Ball-type lens cap.
Chip centering is within +/- 0.005" wrt OD of the Header.
** Non-Condensing temperature and Storage Range, Non-Condensing Environment.
Cathode on BPX-65R is connected to the case.

■ Typical Spectral Response



■ Typical Spectral Response



Soft X-Ray, Deep UV Enhanced Series

Inversion Layer Silicon Photodiodes

OSI Optoelectronics' 1990 R&D 100 award winning X-UV detector series are a unique class of silicon photodiodes designed for additional sensitivity in the X-Ray region of the electromagnetic spectrum without use of any scintillator crystals or screens. Over a wide range of sensitivity from 200 nm to 0.07 nm (6 eV to 17,600 eV), one electron-hole pair is created per 3.63eV of incident energy which corresponds to extremely high stable quantum efficiencies predicted by Eph/3.63eV (See graph below). For measurement of radiation energies above 17.6 keV, refer to the "Fully Depleted High Speed and High Energy Radiation Detectors" section.

A reverse bias can be applied to reduce the capacitance and increase speed of response. In the unbiased mode, these detectors can be used for applications requiring low noise and low drift. These detectors are also excellent choices for detecting light wavelengths between 350 to 1100 nm.

The detectors can be coupled to a charge sensitive preamplifier or low-noise op-amp as shown in the circuit on the opposite page.

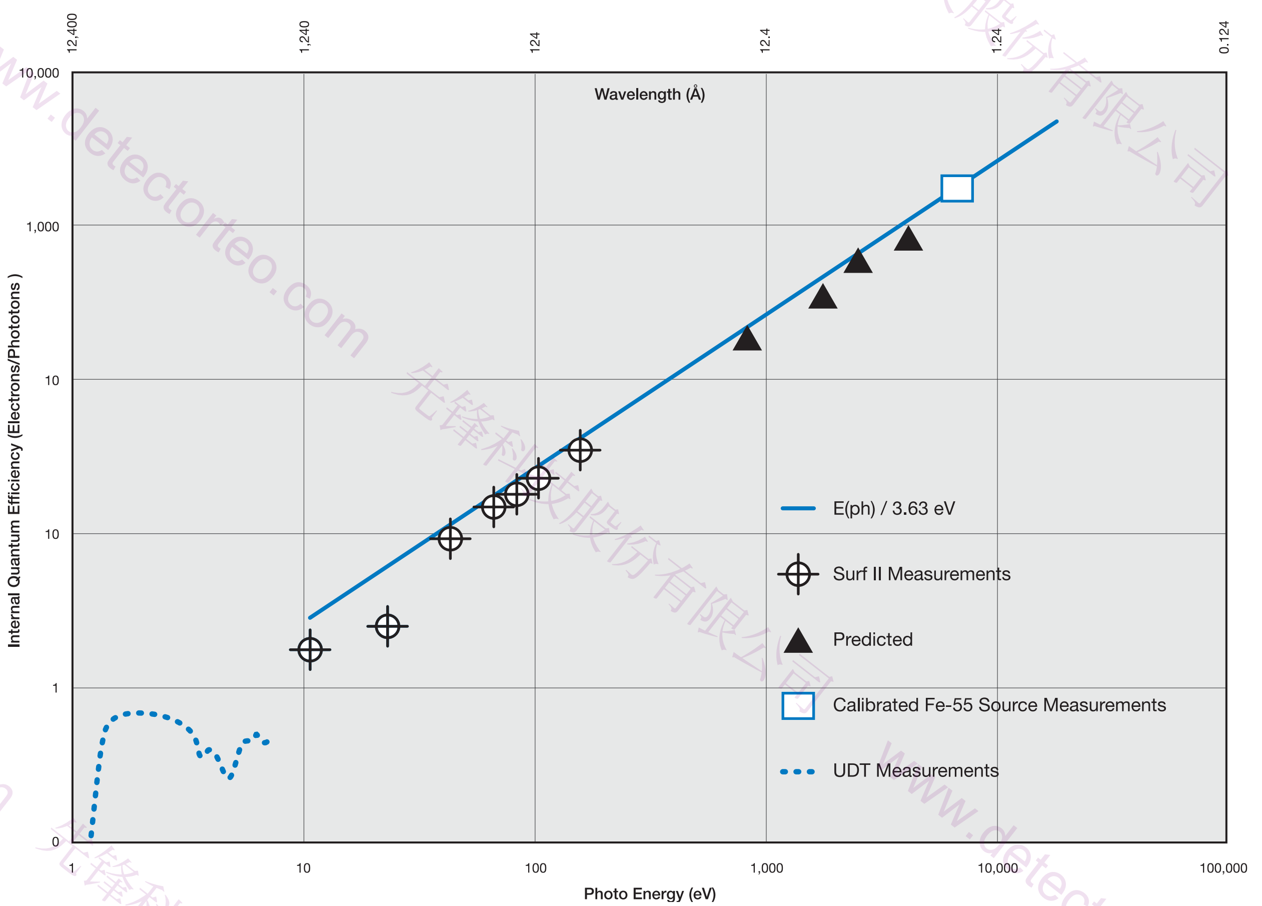
APPLICATIONS

- Electron Detection
- Medical Instrumentation
- Dosimetry
- Radiation Monitoring
- X-ray Spectroscopy
- Charged Particle Detection

FEATURES

- Direct Detection
- No Bias Needed
- High Quantum Efficiency
- Low Noise
- High Vacuum Compatible
- Cryogenically Compatible
- 0.070 nm to 1100 nm Wavelength Range

Typical Quantum Efficiency



Typical Electro-Optical Specifications at T_A=23°C

Model Number	Active Area		Capacitance (nF)		Shunt Resistance (MΩ)		NEP (W/√Hz)		Temp. Range* (°C)		Package Style ¶
	Area (mm²)	Dimension (mm)	0 V		-10 mV		0V 200 nm		Operating	Storage	
			typ.	max.	min.	typ.	typ.	max.			
'XUV' Series Metal Package											
XUV-005	5	2.57 ϕ	0.3	0.5	200	2000	2.9 e -15	9.1 e -15	-20 ~ +60	-20 ~ +80	22 / TO-5
XUV-020	20	5.00 ϕ	1.2	1.6	50	500	5.8 e -15	1.8 e -14			23 / TO-8
XUV-035	35	6.78 x 5.59	2	3	30	300	7.4 e -15	2.3 e -14			
XUV-100	100	11.33 ϕ	6	8	10	100	1.3 e -14	4.1 e -14			28 / BNC
'XUV' Series Ceramic Package											
XUV-50C	50	8.02 ϕ	2	3	20	200	9.1 e -15	2.9 e -14	-20 ~ +60	-20 ~ +80	25 / Ceramic
XUV-100C	100	10.00 sq	6	8	10	100	1.3 e -14	4.1 e -14			

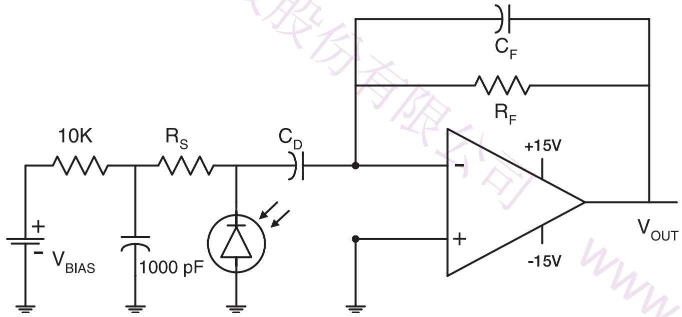
¶ For mechanical drawings please refer to pages 58 thru 69.
All XUV devices are supplied with removable windows.
* Non-Condensing temperature and Storage Range, Non-Condensing Environment.

In this circuit example, the pre-amplifier is a FET input op-amp or a commercial charge sensitive preamplifier. They can be followed by one or more amplification stages, if necessary. The counting efficiency is directly proportional to the incident radiation power. The reverse bias voltage must be selected so that the best signal-to-noise ratio is achieved.

For low noise applications, all components should be enclosed in a metal box. Also, the bias supply should be either simple batteries or a very low ripple DC supply.

Amplifier: OPA-637, OPA-27 or similar
R_F : 10 MΩ to 10 GΩ
R_S : 1 MΩ; Smaller for High Counting Rates
C_F: 1pF
C_D : 1pF to 10 µF

OUTPUT V_{OUT} = Q / C_F
Where Q is the Charge Created By One Photon or One Particle



High Breakdown Voltage, Fully Depleted Series

Large Active Area Photodiodes

The Large Active Area High Speed Detectors can be fully depleted to achieve the lowest possible junction capacitance for fast response times. They may be operated at a higher reverse voltage, up to the maximum allowable value, for achieving even faster response times in nano seconds. The high reverse bias at this point, increases the effective electric field across the junction, hence increasing the charge collection time in the depleted region. Note that this is achieved without the sacrifice for the high responsivity as well as active area.

The Large Active Area Radiation Detectors can also be fully depleted for applications measuring high energy X-rays, γ-rays as well as high energy particles such as electrons, alpha rays and heavy ions. These types of radiation can be measured with two different methods. Indirect and direct.

Indirect High Energy Radiation Measurement:

In this method, the detectors are coupled to a scintillator crystal for converting high energy radiation into a detectable visible wavelength. The devices are mounted on a ceramic and covered with a clear layer of an epoxy resin for an excellent optical coupling to the scintillator. This method is widely used in detection of high energy gamma rays and electrons. This is where the X-UV devices fail to measure energies higher than 17.6 keV. The type and size of the scintillator can be selected based on radiation type and magnitude.

Direct High Energy Radiation Measurement:

APPLICATIONS

Large Active Area
High Speed Detectors
- Laser Guided Missiles
- Laser Warning
- Laser Range Finder
- Laser Alignment
- Control Systems

Large Active Area
Radiation Detectors
- Electron Detection
- Medical Instrumentation
- High Energy Spectroscopy
- Charged Particle Detection
- High Energy Physics
- Nuclear Physics

FEATURES

Large Active Area
High Speed Detectors
- Large Active Area
- Fully Depleteable
- Fast Response
- Ultra Low Dark Current
- Low Capacitance

Large Active Area
Radiation Detectors
- Large Active Area
- Scintillator Mountable
- Fully Depleteable
- Ultra Low Dark Current
- Low Capacitance
- High Breakdown Voltage

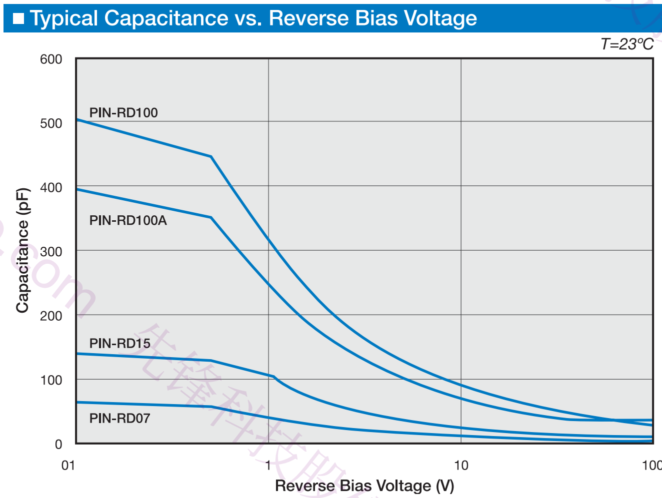
Both PIN-RD100 and PIN-RD100A, can also be used without any epoxy resin or glass window for direct measurement of high energy radiation such as alpha rays and heavy ions. The radiation exhibits loss of energy along a linear line deep into the silicon after incident on the active area.

The amount of loss and the penetration depth is determined by the type and magnitude of the radiation. In order to measure completely the amount of radiation, the depletion layer should be deep enough to cover the whole track from the incident point to the stop point. This requires a high bias application to fully deplete the detector. In spite of the large active area as well as high bias voltage applications, the devices exhibit super low dark currents, low capacitances and low series resistances.

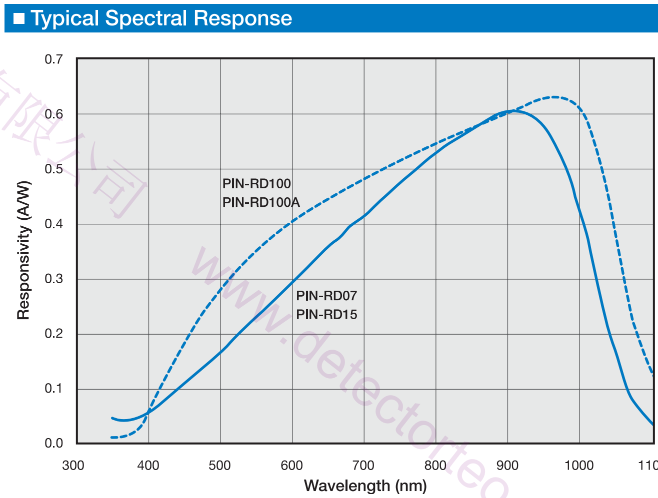
In addition to their use in high energy particle detection, the PIN-RD100 and PIN-RD100A are also excellent choices for detection in the range between 350 to 1100 nm in applications where a large active area and high speed is desired.

These detectors can be coupled to a charge sensitive preamplifier or lownoise op-amp as shown in the opposite page. The configuration for indirect measurement is also shown with a scintillator crystal.

Typical Capacitance vs. Reverse Bias Voltage



Typical Spectral Response



Fully Depleted Photodiodes

Typical Electro-Optical Specifications at T_A=23ºC

Model Number	Active Area: Area (mm²)	Active Area: Dimensions (mm)	Peak Responsivity Wavelength (nm)	Responsivity (A/W) 900 nm typ.	Depletion Voltage V typ.	Dark Current (nA) -100 V typ.	Dark Current (nA) -100 V max.	Capacitance (pF) -100 V typ.	Capacitance (pF) -100 V max.	Rise Time (ns) 900 nm -100 V 50Ω typ.	NEP (W/√Hz) 900nm -100V typ.	Reverse Voltage (V) 10 µA max.	Temp.* Range (˚C) Operating	Temp.* Range (˚C) Storage	Package Style ¶
Large Active Area, High Speed															
PIN-RD07	7.1	3.00 ϕ	900	0.55	48	0.2	5.0	8.0	9.0	1.5	1.2 e-14	135	-40 ~ +100	-55 ~ +125	26 / TO-8
PIN-RD15	14.9	4.35 ϕ		0.58	55	1.0	30	14	16	3.0	2.5 e-14	140			
PIN-RD100	100	10 Sq	950	0.60	75	2 †	10 †	50 †	60 †	---	3.2 e-14	120	-20 ~ +60	-20 ~ +80	25 / Ceramic
PIN-RD100A	100	10 Sq			35	2	10	40	45	---	3.4 e-14	70			

Model Number	Active Area: Area (mm²)	Active Area: Dimensions (mm)	Peak Responsivity Wavelength (nm)	Responsivity 900 nm A/W typ.	Capacitance (pF) 0 V typ.	Shunt Resistance (GΩ) -10 V min.	Shunt Resistance (GΩ) -10 V typ.	NEP (W/√Hz) 900 nm typ.	Rise Time (ns) 0 V 632nm 50Ω typ.	Temp.* Range (˚C) Operating	Temp.* Range (˚C) Storage	Package Style ¶
OSD35-LR Series												
OSD35-LR-A	34.2	5.8 x 5.9	830	0.54	1300	2	3	5.6 e-15	---	-25 ~+75	-45 ~ +100	25 / Ceramic
OSD35-LR-D	34.2	5.8 x 5.9	830	0.54	1300	0.1	0.3	1.8 3-14	---			

OSD-35-LR's ceramic packages come without window, instead the optically clear epoxy is used.
† Measured at Vbias = -50V
¶ For mechanical drawings please refer to pages 58 thru 69.
* Non-Condensing temperature and Storage Range, Non-Condensing Environment.

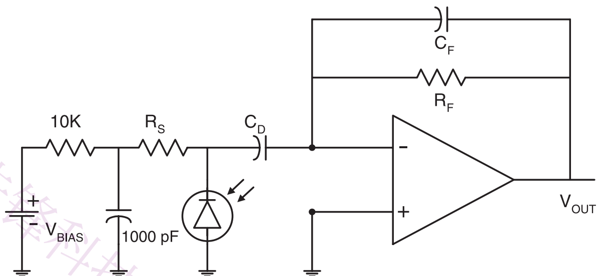
DIRECT DETECTION

For direct detection of high-energy particles, the pre-amplifier is a FET input op-amp, followed by one or more amplification stages, if necessary, or a commercial charge sensitive preamplifier. The counting efficiency is directly proportional to the incident radiation power. The reverse bias voltage must be selected as such to achieve the best signal-to-noise ratio. For low noise applications, all components should be enclosed in a metal box. Also, the bias supply should be either simple batteries or a very low ripple DC supply. The detector should also be operated in the photovoltaic mode.

Amplifier: OPA-637, OPA-27 or similar
R_F : 10 MΩ to 10 GΩ
R_S : 1 MΩ; Smaller for High Counting Rates
C_F: 1pF
C_D : 1pF to 10 µF

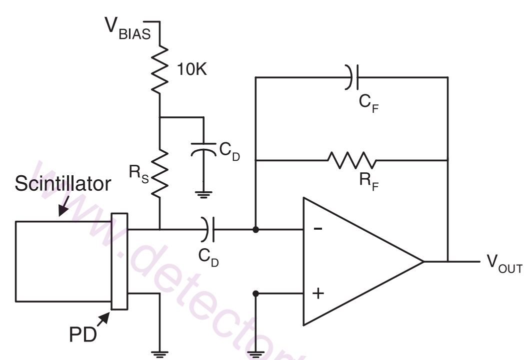
OUTPUT V_{OUT} = Q / C_F

Where Q is the Charge Created By One Photon or One Particle



INDIRECT DETECTION (WITH SCINTILLATOR CRYSTAL)

The circuit is very similar to the direct detection circuit except that the photodiode is coupled to a scintillator. The scintillator converts the high-energy X-rays and/or X-rays into visible light. Suitable scintillators include CsI(TL), CdWO4, BGO and NaI(TL). The amplifier should be a FET input op-amp, followed by one or more amplification stages, or a commercial charge sensitive preamplifier. The output voltage depends primarily on the scintillator efficiency and should be calibrated by using radioactive sources.



Multi-Channel X-Ray Detector Series

Scintillator Compatible Photodiode Arrays

This series consists of 16-element arrays: the individual elements are grouped together and mounted on PCB.

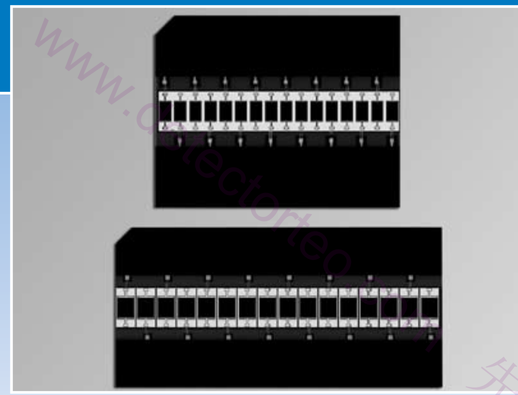
For X-ray or Gamma-ray application, these multi-channel detectors offer scintillator-mounting options: BGO, $CdWO_4$ or CsI(TI).

BGO (Bismuth Germanate) acts as an ideal energy absorber: it is widely accepted in high-energy detection applications.

$CdWO_4$ (Cadmium Tungstate) exhibits sufficiently high light output, helping improve Spectrometry results.

CsI (Cesium Iodide) is another high energy absorber, providing adequate resistance against mechanical shock and thermal stress.

When coupled to scintillator, these Si arrays map any medium or high radiation energy over to visible spectrum via scattering effect. Also, their specially designed PCB allows end-to-end connectivity. Multiple arrays can be deployed in situation that calls for larger scale assembly.



APPLICATIONS

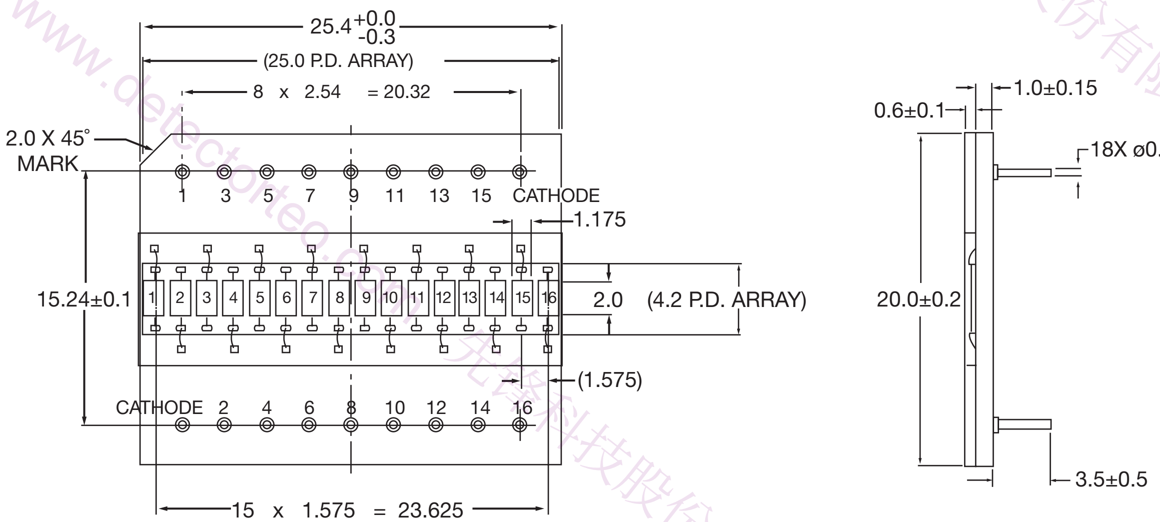
- Position Sensors
- Multi-channel Gamma counting
- X-ray Security Systems

FEATURES

- Scintillator Platform
- 5 Volt Bias
- Channel spacing variety

Mechanical Specifications (All units in mm)

A200C

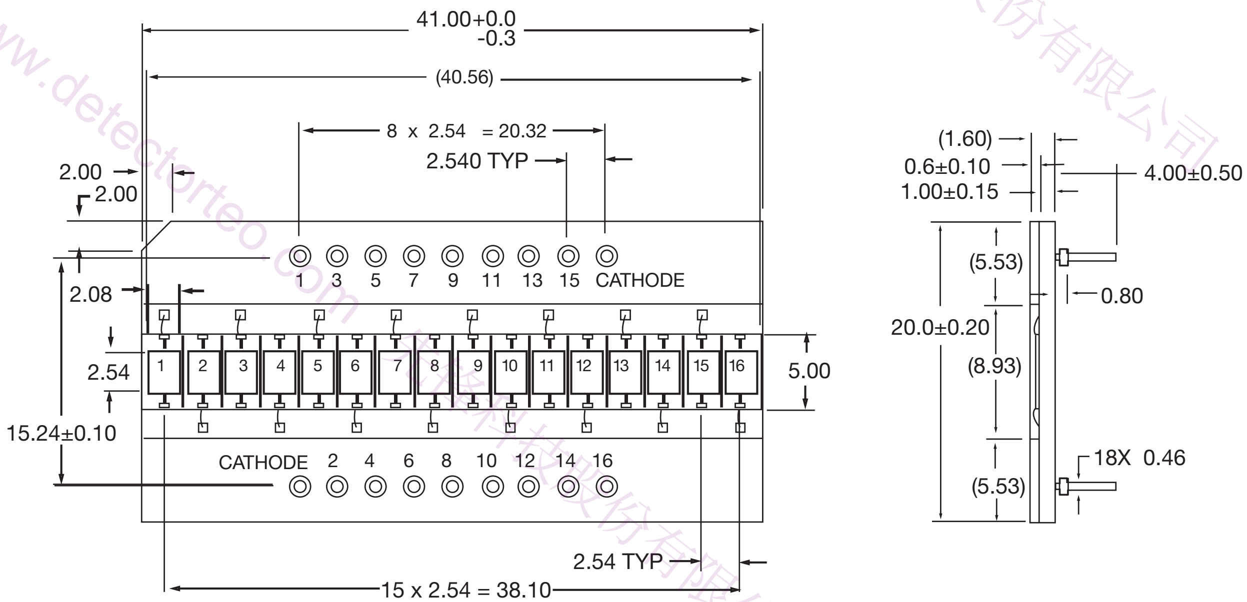


▪ Multi-Channel X-Ray Detector Series

Typical Electro-Optical Specifications at T_A=23°C

Model Number	Number of Elements	Active Area Per Element		Pitch (mm)	Responsivity (A/W)		Dark Current (pA)	Terminal Capacitance (pF)	Rise Time (μs)	Reverse Bias (V)	NEP (W/√Hz)	Temp. Range (°C)	
					540 nm	930 nm	-10 mV	0V, 10 KHz	0V, 1KΩ		-10mV 930nm	Operating	Storage
		Area (mm²)	Dimensions (mm)		typ.	typ.	typ.	typ.	typ.	max.	typ.		
Photoconductive Arrays													
A200C	16	2.35	2.00 x 1.18	1.57	0.31	0.59	5	28	0.1	5	5.30 e-15	-10 ~ +60	-20 ~ +70
A500C	16	5.28	2.54 x 2.08	2.54	0.31	0.59	10	70	0.1	5	7.50 e-15	-10 ~ +60	-20 ~ +70

A500C



▪ YAG Series

Nd:YAG Optimized Photodetectors

The YAG Series of photo detectors are optimized for high response at 1060 nm, the YAG laser light wavelength, and low capacitance, for high speed operation and low noise. These detectors can be used for sensing low light intensities, such as the light reflected from objects illuminated by a YAG laser beam for ranging applications. The SPOT Series of quadrant detectors are well suited for aiming and pointing applications. These are all N on P devices.

These detectors can be used in the photovoltaic mode, for low speed applications requiring low noise, or in the photoconductive mode, with an applied reverse bias, for high speed applications.

▪ APPLICATIONS

- Nd:YAG Pointing
- Laser Pointing & Positioning
- Position Measurement
- Surface Profiling
- Guidance Systems

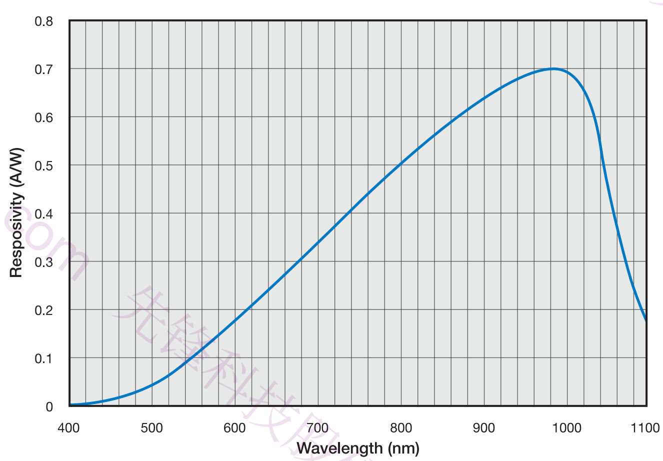
▪ FEATURES

- Nd:YAG Sensitivity
- High Breakdown Voltage
- Large Area
- High Speed
- High Accuracy

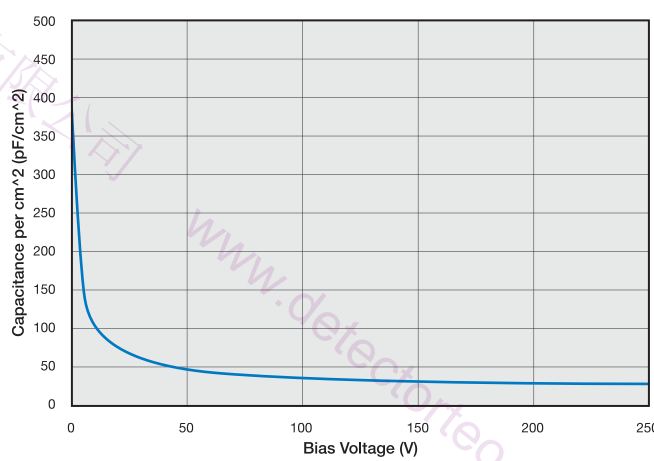
Model Number	Active Area Per Element		Peak Responsivity Wavelength	Responsivity (A/W)	Element Gap	Dark Current (nA)		Capacitance (pF)		Rise Time (ns)	NEP (W/√Hz)	Reverse Voltage (V)	Temp Range (°C)		Package Style ¶
	Area (mm^2)	Dimension (mm)	λ_p nm	1000nm	mm	-180 V		-180 V		1064 nm -180 V 50 Ω	1064 nm -180V	100 µA	Operating	Storage	
			typ.	typ.	typ.	typ.	max.	typ.	max.	typ.	typ.	max.			
Nd:YAG Optimized Single Element															
PIN-5-YAG	5.1	2.54 ϕ	1000	0.6	-	50	-	5	-	5	1.2 e-14	200	-40 ~ +100	-55 ~ +125	2 / TO-5
PIN-100-YAG	100	11.28 ϕ				75	1000	25	-	30	2.5 e-14				20 / Metal
Nd:YAG Optimized Quadrant Photodetectors**															
SPOT-9-YAG	19.6	10 ϕ	1000	0.6	0.1	35	250	8	15	7	3.2 e-14	200	-20 ~ +60	-20 ~ +80	20 / Metal
SPOT-15-YAG	38.5	14.0 ϕ			0.2	1000	3000	15	30	8	3.4 e-14				

† Measured at Vbias = -180V, T=23°C
¶ For mechanical drawings please refer to pages 58 thru 69.
** Specifications are per element

▪ Typical YAG Series Responsivity



▪ Typical Capacitance per Unit Area vs. Bias Voltage



Photops™

Photodiode-Amplifier Hybrids

The Photop™ Series, combines a photodiode with an operational amplifier in the same package. Photops™ general-purpose detectors have a spectral range from either 350 nm to 1100 nm or 200 nm to 1100nm. They have an integrated package ensuring low noise output under a variety of operating conditions. These op-amps are specifically selected by OSI Optoelectronics engineers for compatibility to our photodiodes.

Among many of these specific parameters are low noise, low drift and capability of supporting a variety of gains and bandwidths determined by the external feedback components. Operation from DC level to several MHz is possible in an either unbiased configuration for low speed, low drift applications or biased for faster response time. LN-Series Photops™ are to be used with OV-bias.

Any modification of the above devices is possible. The modifications can be simply adding a bandpass optical filter, integration of additional chip (hybrid) components inside the same package, utilizing a different op-amp, photodetector replacement, modified package design and / or mount on PCB or ceramic. For your specific requirements, contact one of our Applications Engineers.

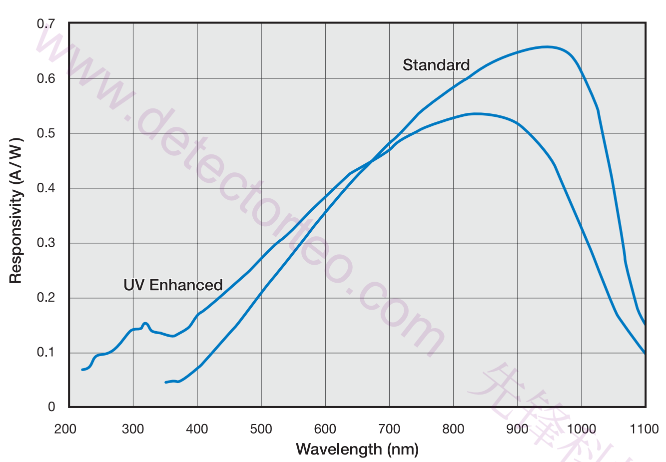
APPLICATIONS

- General Purpose Light Detection
- Laser Power Monitoring
- Medical Analysis
- Laser Communications
- Bar Code Readers
- Industrial Control Sensors
- Pollution Monitoring
- Guidance Systems
- Colorimeter

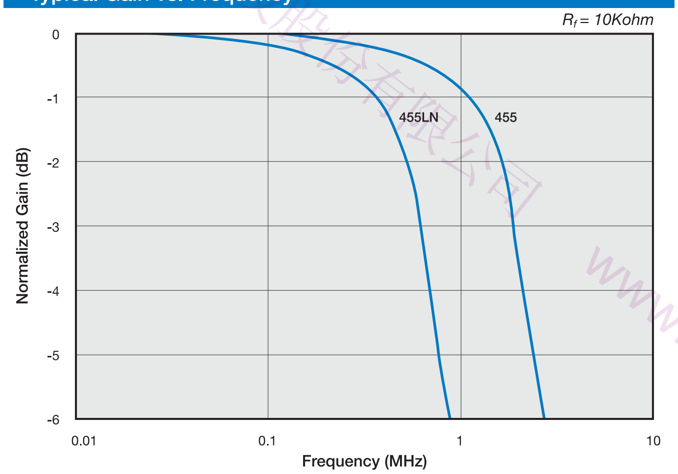
FEATURES

- Detector/Amplifier Combined
- Adjustable Gain/Bandwidth
- Low Noise
- Wide Bandwidth
- DIP Package
- Large Active Area

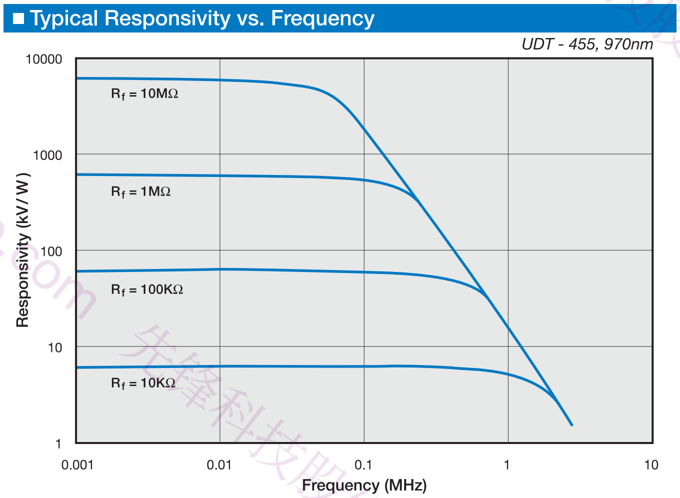
Typical Spectral Response



Typical Gain vs. Frequency



Typical Responsivity vs. Frequency



Photops™ (Photodiode Specifications)

Typical Electro-Optical Specifications at T_A=23°C

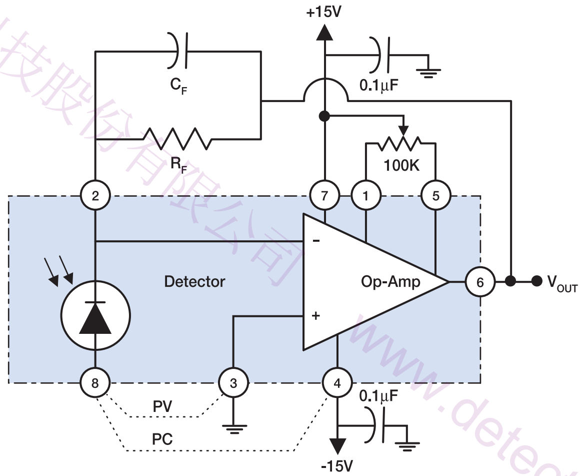
Model Number	Active Area		Responsivity (A/W)				Capacitance (pF)		Dark Current (nA)		Shunt Resistance (MΩ)	NEP (W/√Hz)		Reverse Voltage	Temp.* Range (°C)		Package Style
			254 nm		970 nm		0 V	-10 V	-10 V		-10 mV	0 V 254 nm	-10 V 970 nm	V			
	Area (mm²)	Dimension (mm)	min.	typ.	min.	typ.	typ.	typ.	typ.	max.	typ.	typ.	typ.	max.	Operating	Storage	
350-1100 nm Spectral Range																	
UDT-451	5.1	2.54 ϕ	---		0.60	0.65	85	15	0.25	3	---		1.4 e -14	30**	0 ~ +70	-30 ~ +100	29 / DIP
UDT-455																	30 / TO-5
UDT-455LN**																	
OSI-515#																	
UDT-020D	16	4.57 ϕ					330	60	0.5	10			1.9 e -14				31 / TO-8
UDT555D	100	11.3 ϕ					1500	300	2	25			3.9 e -14				32 / Special
200-1100 nm Spectral Range																	
UDT-455UV	5.1	2.54 ϕ	0.10	0.14	---		300	---			100	9.2 e -14	---	5**			30 / TO-5
UDT-455UV/LN**																	
UDT-020UV	16	4.57 ϕ					1000				50	1.3 e -13					31 / TO-8
UDT-055UV	50	7.98 ϕ					2500				20	2.1 e -13					32 / Special
UDT-555UV	100	11.3 ϕ					4500				10	2.9 e -13					32 / Special
UDT-555UV/LN**																	

Operational Amplifier Specifications

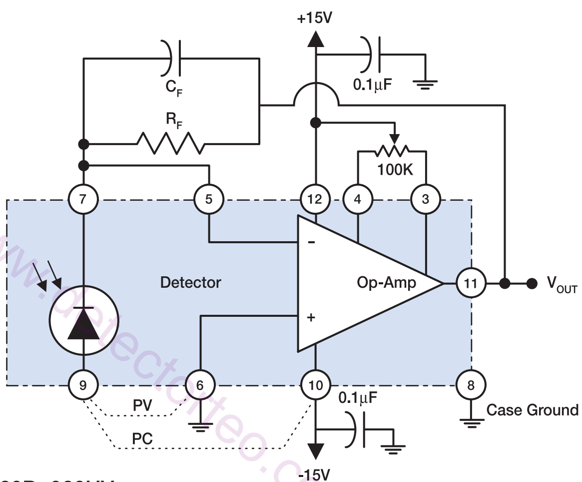
Electro-Optical Specifications at T_A=23 °C

Model Number	Supply Voltage			Quiescent Supply Current (mA)		Input Offset Voltage		Temp. Coefficient Input Offset Voltage		Input Bias Current		Gain Bandwidth Product		Slew Rate		Open Loop Gain, DC		Input Noise Voltage		Input Noise Current
																		100 Hz	1 kHz	1 kHz
				± 15 V		mV		µV / °C		pA		MHz		V / µs		V /mV		nV/ √Hz		fA/ √Hz
	min.	typ.	max.	typ.	max.	typ.	max.	typ.	max.	typ.	max.	min.	typ.	min.	typ.	min.	typ.	typ.	typ.	typ.
UDT-451	---	±15	±18	1.4	2.5	3.0	6.0	10	---	30	200	---	4.0	---	13	50	150	---	18	10
UDT-455	---	±15	±18	2.8	5.0	0.5	3	4	30	±80	±400	3.0	5.4	5	9	50	200	20	15	10
UDT-455UV																				
UDT-020D																				
UDT-020UV																				
OSI-515#	---	±15	±18	6.5	7.2	1	3	10	---	±15	±40	23	26	125	140	3	6.3	---	12	10
UDT-455LN**	±5	±15	±18	0.9	1.8	0.26	1	---	20	0.15	0.3	0.5	1	0.5	3	50	2500	78	27	0.22
UDT-455UV/LN**																				
UDT-055UV	---	±15	±22	2.7	4.0	0.4	1	3	10	±40	±200	3.5	5.7	7.5	11	75	220	20	15	10
UDT-555D																				
UDT-555UV																				

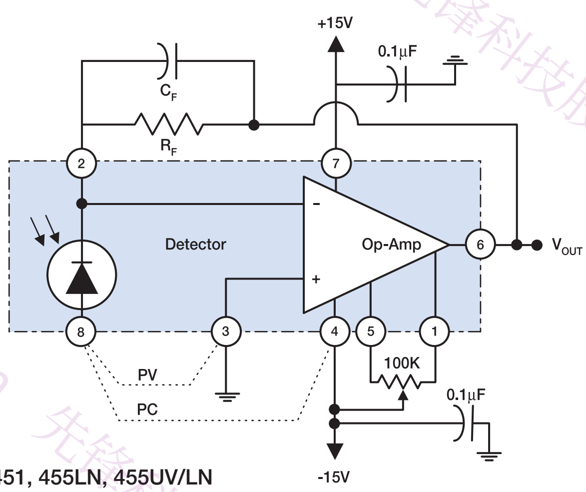
¶ For mechanical drawings please refer to pages 58 thru 69.
** LN – Series Devices are to be used with a 0V Bias.
* Non-Condensing temperature and Storage Range, Non-Condensing Environment.
# OSI-515 replaces UDT-455HS



UDT-455,
UDT-555D, 555UV, 055UV
OSI-515: pin 1 & 5 are N/C
(No offset adjustment needed).



UDT-020D, 020UV



UDT-451, 455LN, 455UV/LN
UDT-555UV/LN

The output voltage is proportional to the light intensity of the light and is given by:

$$V_{OUT} = I_P \times R_F = (P \times R_\lambda) \times R_F \quad (1)$$

Frequency Response (Photodiode/Amplifier Combination)

The frequency response of the photodiode / amplifier combination is determined by the characteristics of the photodetector, pre-amplifier as well as the feedback resistor (R_F) and feedback capacitor (C_F). For a known gain, (R_F), the 3dB frequency response of the detector/pre-amp combination is given by:

$$f_{3dB} = \frac{1}{2\pi C_F R_F} \quad (2)$$

However, the desired frequency response is limited by the Gain Bandwidth Product (GBP) of the op-amp. In order to have a stable output, the values of the R_F and C_F must be chosen such that the 3dB frequency response of the detector / pre-amp combination, be less than the maximum frequency of the op-amp, i.e. $f_{3dB} \le f_{max}$.

$$f_{max} = \sqrt{\frac{GBP}{2\pi R_F (C_F + C_J + C_A)}} \quad (3)$$

where C_A is the amplifier input capacitance.

In conclusion, an example for frequency response calculations, is given below. For a gain of 10^8, an operating frequency of 100 Hz, and an op-amp with GBP of 5 MHz:

$$C_F = \frac{1}{2\pi f_{3dB} R_F} = 15.9pF \quad (4)$$

Thus, for C_F = 15.9 pF, C_J = 15 pF and C_A = 7 pF, f_{max} is about 14.5 kHz. Hence, the circuit is stable since $f_{3dB} \le f_{max}$.

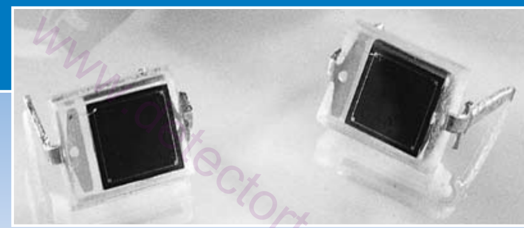
For more detailed application specific discussions and further reading, refer to the APPLICATION NOTES INDEX in the catalog.

Note: The shaded boxes represent the Photop™ components and their connections. The components outside the boxes are typical recommended connections and components.

BPW-34

Plastic Molded - Industry Standard

BPW-34 series are a family of high quality and reliability plastic encapsulated photodiodes. The devices in this series, exhibit similar electrical characteristics, but vary in optical response. BPW-34B has an excellent response in the blue region of the spectrum. They are excellent for mounting on PCB and hand held devices in harsh environments.



APPLICATIONS

- IR Sensors
- Bar Code Scanners
- Color Analysis
- Smoke Detectors

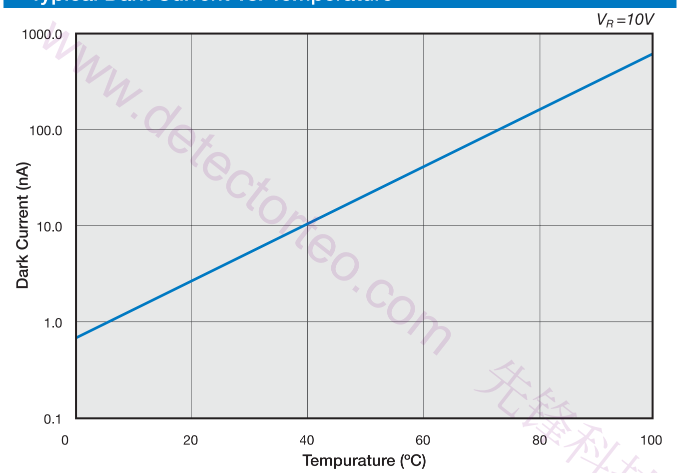
FEATURES

- High Reliability
- High Density Package
- Rugged Resin Mold
- High Speed and Low Dark Current

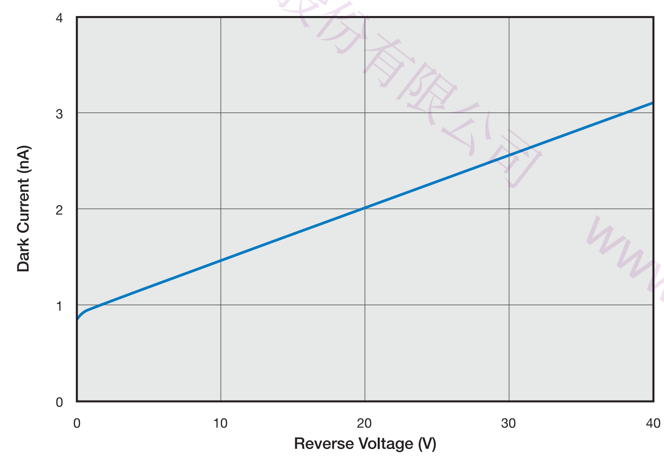
Model Number	Active Area		Peak Responsivity Wavelength	Responsivity at λp		Capacitance (pF)		Dark Current (nA)		NEP (W/√Hz)	Reverse Voltage (V)	Rise Time (ns)	Temp.* Range (°C)		Package Style ¶
	Area (mm^2)	Dimension (mm)	λp (nm)	(A/W)		0 V 1 MHz	-10V 1MHz	-10 V		-10V 970 nm		-10 V 830 nm 50 Ω	Operating	Storage	
			typ.	min.	typ.	typ.	typ.	typ.	max.	typ.	max.	typ.			
BPW 34 Series															
BPW-34	7.25	2.69 sq.	970	0.55	0.60	65	12	2	30	4.2 e -14	40	20	-25 ~ +85	-40 ~ +100	19 / Plastic Molded
BPW-34B				0.15**	0.20**					1.3 e −13**					

¶ For mechanical drawings please refer to pages 58 thru 69.
* Non-condensing temperature and storage range, Non-condensing environment.
** Responsivity and NEP values for the BPW-34B are given at 410nm.

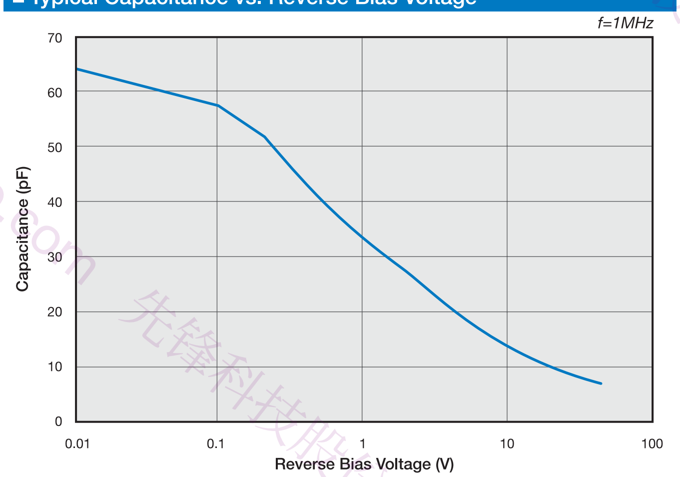
Typical Dark Current vs. Temperature



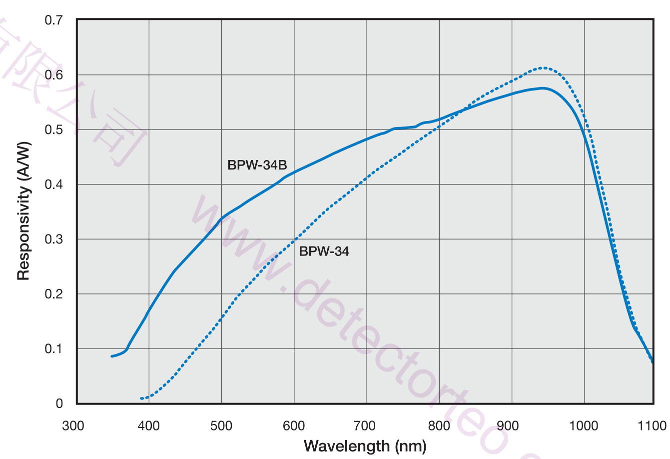
Typical Dark Current vs. Reverse Bias



Typical Capacitance vs. Reverse Bias Voltage



Typical Spectral Response



Plastic Encapsulated Series

Lead Frame Molded Photodiodes

OSI Optoelectronics offers a line of high quality and reliability plastic encapsulated photodiodes. These molded devices are available in a variety of shapes and sizes of photodetectors and packages, including industry standard T1 and T13/4, flat and lensed side lookers as well as a surface mount version (SOT- 23). They are excellent for mounting on PCB and hand held devices in harsh environments.

They have an excellent response in the NIR spectrum and are also available with visible blocking compounds, transmitting only in the 700-1100 nm range. They offer fast switching time, low capacitance as well as low dark current. They can be utilized in both photoconductive and photovoltaic modes of operation.

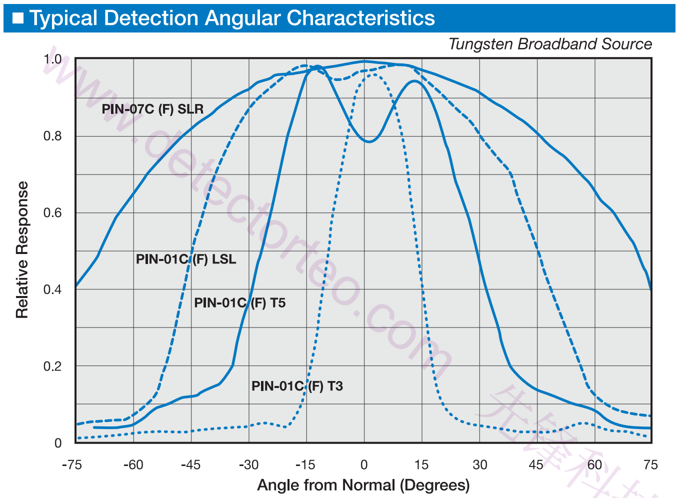
APPLICATIONS

- Bar Code Readers
- Industrial Counters
- Measurement and Control
- IR Remote Control
- Reflective Switches

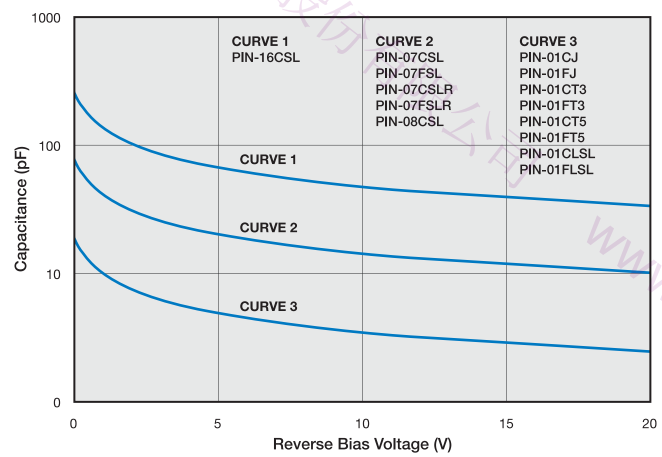
FEATURES

- High Density Package
- Rugged Molded Package
- Low Capacitance
- Low Dark Current
- Lead Frame Standard
- SMT
- Molded Lens Feature
- Side Lookers
- Filter on Chip (700nm Cutoff)

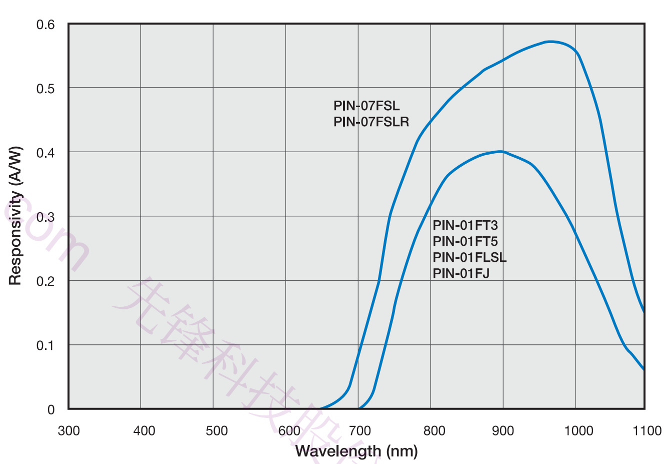
Typical Detection Angular Characteristics



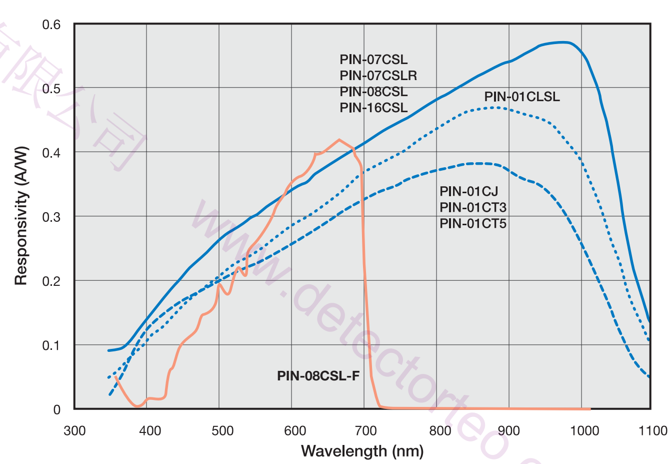
Typical Capacitance vs. Reverse Bias Voltage



Typical Spectral Response



Typical Spectral Response



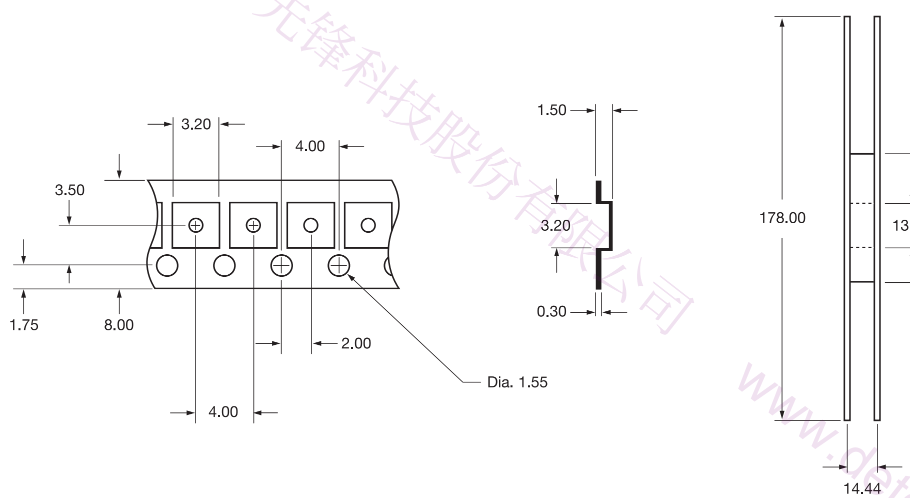
▪ Plastic Encapsulated Series

Typical Electro-Optical Specifications at T_A=23°C

<table>
<tr><th rowspan="3">Model Number</th><th colspan="2">Active Area</th><th rowspan="3">Spectral Range (nm)</th><th>Responsivity I_p=970nm</th><th colspan="2">Capacitance (pF) 1 MHz</th><th colspan="2">Dark Current (nA)</th><th rowspan="2">Reverse Voltage (V)</th><th>Rise Time (ns)</th><th colspan="2">Temp.* Range (˚C)</th><th rowspan="3">Package Style ¶</th></tr>
<tr><th rowspan="2">Area (mm²)</th><th rowspan="2">Dimensions (mm)</th><th>(A/W)</th><th>0 V</th><th>-10 V</th><th colspan="2">-10 V</th><th>-10 V peak λ 50 Ω</th><th rowspan="2">Operating</th><th rowspan="2">Storage</th></tr>
<tr><th>typ.</th><th>typ.</th><th>typ.</th><th>typ.</th><th>max.</th><th>max.</th><th>typ.</th></tr>
<tr><td>PIN-01-CJ</td><td rowspan="2">0.2</td><td rowspan="2">0.4 Sq</td><td>350-1100</td><td rowspan="6">0.40</td><td rowspan="8">21</td><td rowspan="8">4</td><td rowspan="10">2</td><td rowspan="16">30</td><td rowspan="20">20</td><td rowspan="12">11</td><td rowspan="20">-25 ~ +85</td><td rowspan="20">-40 ~ 100</td><td rowspan="2">59 / Resin Molded</td></tr>
<tr><td>PIN-01-FJ</td><td>700-1100</td></tr>
<tr><td>PIN-01-CT3</td><td rowspan="2">0.2</td><td rowspan="2">0.4 Sq</td><td>350-1100</td><td rowspan="4">58 / Resin Molded</td></tr>
<tr><td>PIN-01-FT3</td><td>700-1100</td></tr>
<tr><td>PIN-01-CT5</td><td rowspan="2">0.2</td><td rowspan="2">0.4 Sq</td><td>350-1100</td></tr>
<tr><td>PIN-01-FT5</td><td>700-1100</td></tr>
<tr><td>PIN-01-CLSL</td><td rowspan="2">0.2</td><td rowspan="2">0.4 Sq</td><td>350-1100</td><td>0.45</td><td rowspan="2">61 / Resin Molded</td></tr>
<tr><td>PIN-01-FLSL</td><td>700-1100</td><td>0.40</td></tr>
<tr><td>PIN-0.81-LLS</td><td rowspan="2">0.81</td><td rowspan="2">1.02</td><td rowspan="2">350-1100</td><td rowspan="8">0.55</td><td rowspan="2">10</td><td rowspan="2">2</td><td>62 / Leadless Ceramic</td></tr>
<tr><td>PIN-0.81-CSL</td><td>60 / Resin Molded</td></tr>
<tr><td>PIN-4.0-LLS</td><td rowspan="2">3.9</td><td rowspan="2">2.31x1.68</td><td rowspan="2">350-1100</td><td rowspan="2">60</td><td rowspan="2">10</td><td rowspan="6">5</td><td>62 / Leadless Ceramic</td></tr>
<tr><td>PIN-4.0-CSL</td><td>60 / Resin Molded</td></tr>
<tr><td>PIN-07-CSL</td><td rowspan="2">8.1</td><td rowspan="2">2.84 Sq</td><td>350-1100</td><td rowspan="4">85</td><td rowspan="4">15</td><td rowspan="4">50</td><td rowspan="2">57 / Resin Molded</td></tr>
<tr><td>PIN-07-FSL</td><td>700-1100</td></tr>
<tr><td>PIN-07-CSLR</td><td rowspan="2">8.1</td><td rowspan="2">2.84 Sq</td><td>350-1100</td><td rowspan="2">56 / Resin Molded</td></tr>
<tr><td>PIN-07-FSLR</td><td>700-1100</td></tr>
<tr><td>PIN-08-CSL-F</td><td>8.4</td><td>2.90 Sq</td><td>350-720</td><td>0.43@660nm</td><td>..</td><td>25</td><td>..</td><td>10</td><td>75</td><td>60 / Resin Molded</td></tr>
<tr><td>PIN-8.0-LLS</td><td rowspan="2">8.4</td><td rowspan="2">2.90 Sq</td><td rowspan="3">350-1100</td><td rowspan="3">0.55</td><td rowspan="2">100</td><td rowspan="2">25</td><td rowspan="2">10</td><td rowspan="3">30</td><td rowspan="2">50</td><td>62 / Leadless Ceramic</td></tr>
<tr><td>PIN-8.0-CSL</td><td rowspan="2">60 / Resin Molded</td></tr>
<tr><td>PIN-16-CSL</td><td>16</td><td>4.00 Sq</td><td>330</td><td>55</td><td>5</td><td>100</td></tr>
</table>

¶ For mechanical drawings please refer to pages 58 thru 69.
* Non-Condensing temperature and Storage Range, Non-Condensing Environment.
The "CSL-F" series ishomogeneous silicon photodiode and optical filter combination device. The filter coating is directly deposited onto the chip during wafer process.

Tape and Reel Specifications for Surface Mount PIN-01(C)J and PIN-01(F)J



▪ Detector-Filter Combination Series

Planar Diffused Silicon Photodiodes

The Detector-Filter combination series incorporates a filter with a photodiode to achieve a tailored spectral response. OSI Optoelectronics offers a multitude of standard and custom combinations. Upon request, all detector-filter combinations can be provided with a NIST traceable calibration data specified in terms of Amps/Watt, Amps/lumen, Amps/lux or Amps/ footcandle.

Among many possible custom combinations, following are a few detector-filter combinations available as standard parts.

PIN-10DF - is a 1 cm^2 active area, BNC package detector-filter combination, optimized to achieve a flat responsivity, from 450 to 950 nm. This is the spectral response required for radiometric measurements. This type of detector has several advantages over thermopile, such as sensitivity, which is about a thousand times higher, as well as 10 times more stability.

PIN-10AP - is a 1 cm^2 active area, BNC package detector- filter combination which duplicates the response of the most commonly available optical aid; the human eye. The eye senses both brightness and color, with response varying as a function of the wavelength. This response curve is commonly known as the CIE curve. The AP filters accurately match the CIE curve to within 4% of area.

▪ APPLICATIONS

- Analytical Chemistry
- Spectrophotometry
- Densitometers
- Photometry/Radiometry
- Spectroradiometry
- Medical Instrumentation
- Liquid Chromatography

▪ FEATURES

- CIE Match (AP series)
- Flat Band Response (DF)
- 254 Narrow Bandpass
- w/ Amplifier Hybrid
- BNC Packages

PIN-555AP - has the same optical characteristics as the PIN 10-AP, with an additional operational amplifier in the same package. The package and the opamp combination is identical to UDT-555D detector-amplifier combination (Photops™).

PIN-005E-550F - uses a low cost broad bandpass filter with peak transmission at 550nm to mimic the CIE curve for photometric applications. The pass band is similar to the CIE curve, but the actual slope of the spectral response curve is quite different. This device can also be used to block the near IR portion of the spectral range, 700 nm and above.

PIN-005D-254F - is a 6 mm^2 active area, UV enhanced photodiode-filter combination which utilizes a narrow bandpass filter peaking at 254 nm.

CUSTOMIZED CAPABILITIES

Current existing standard photodiodes can be modified by adding various optical filter(s), to match your specific spectral requirements. The filters can either replace the standard glass windows or be used in conjunction with the glass window, depending on the specific requirement and / or nature of the filter. Customer furnished optical filters can also be incorporated in the package. The following are among a few of the optical filter types available. These colored glass filters are grouped into four major categories: Shortpass Filters, Longpass Filters, Bandpass Filters, and Neutral Density Filters. Windows are also available with **Custom Thin Film, Anti-reflective**, **Cut-on and Cut-off Filter Coatings**.

ALL PHOTODIODES WITH OR WITHOUT FILTERS CAN BE CALIBRATED IN HOUSE FOR RESPONSIVITY FROM 200 NM TO 1100 NM IN 10 NM STEPS AS WELL AS SINGLE POINT CALIBRATION. ALL OPTICAL CALIBRATIONS ARE NIST TRACEABLE.

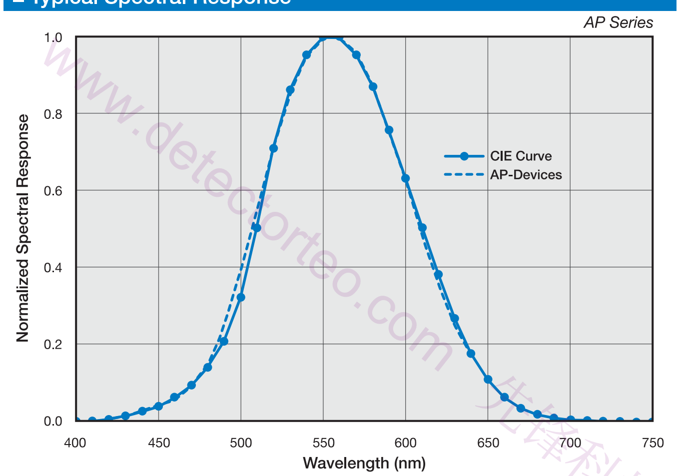
■ Detector-Filter Combination Series

Typical Electro-Optical Specifications at T_A=23ºC

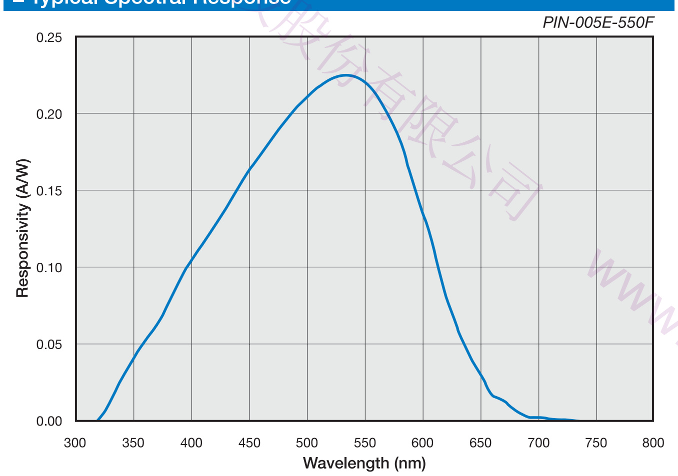
Model Number	Active Area: Area (mm²)	Active Area: Dimensions (mm)	Spectral Match: λp (nm) typ.	Responsivity at 550nm: (A/W) typ.	Responsivity at 550nm: mA/Lum typ.	Capacitance (pF): 0 V typ.	Shunt Resistance (MΩ): -10 mV typ.	NEP (W/√Hz): -10mV 550 nm typ.	Rise Time (µs): 0 V 550 nm 50 Ω typ.	Temp. Range (˚C): Operating	Temp. Range (˚C): Storage	Package Style ¶
Detector Filter Combination Series												
PIN-10DF	100	11.28 φ	± 7% ‡	0.15	---	1500	20	1.9 e-13	1.0	0 ~ +70	-25 ~ +85	13 / BNC
PIN-10AP			4%***	0.27	0.4			1.1 e-13	0.15			
PIN-555AP§									0.1*			33 / Special
PIN-005E-550F	5.7	2.4 sq.	---	0.23	---	200	500	2.5 e-14				5 / TO-5
PIN-005D-254F				0.025*		100	300	3.0 3-13*				18 / TO-5

‡ Point by point from 450nm to 950nm.
§ PIN-555AP is a Detector / Operational Amplifier hybrid. For Op-Amp specifications, please see p.29.
¶ For mechanical drawings please refer to pages 58 thru 69.
* λ=254nm
** Non-condensing temperature and storage range, Non-condensing environment.
*** Area within CIE Curve

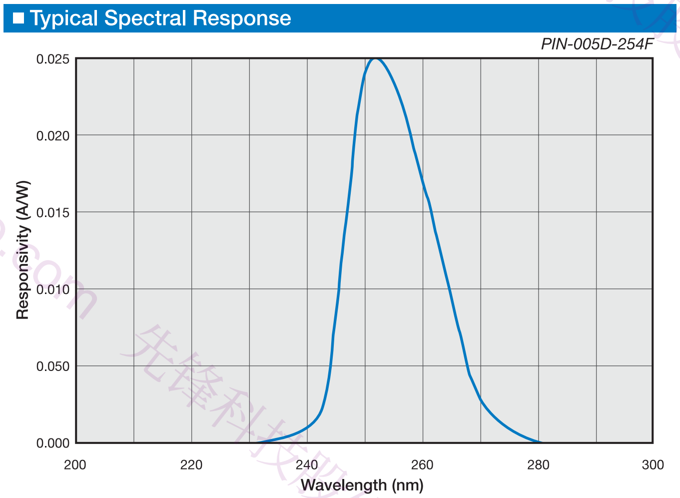
■ Typical Spectral Response



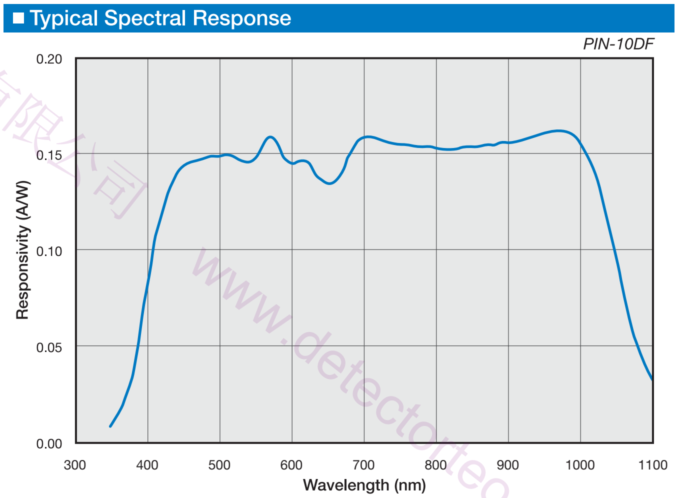
■ Typical Spectral Response



■ Typical Spectral Response



■ Typical Spectral Response



▪ Series E

Eye Response Detectors

Series E photodiodes are Blue-enhanced detectors with high quality color-correcting filters. The resulting spectral response approximates that of the human eye.

In addition to the Series E photodiodes listed, OSI Optoelectronics can provide other photodiodes in this catalog with a variety of optical filters.

▪ APPLICATIONS

- Photometry/Radiometry
- Medical Instrumentation
- Analytical Chemistry

▪ FEATURES

- Human Eye Response
- TO Can Packages

Model Number	Active Area		Responsivity nA Lux^{-1}		Dark Current (nA)		NEP (WHz$^{-1/2}$) 550 nm VR=0	Capacitance (pF)		Shunt Resistance Megaohms**		Reverse Voltage (DC)	Spectral Curve	Temp. Range (˚C)		Package Style ¶
	Area (mm²)	Dimensions (mm)	min.	typ.	max.	typ.	typ.	Vr=0V max.	Vr=12V max.	min.	typ.	max.		Operating	Storage	
OSD-E Series																
OSD1-E	1	1.0 x 1.0	1	2.2	1	0.2	1.5 x 10^{-14}	35	7	250	1000	15	1	-25 ~ +85	-40 ~ +120	7 / TO-18
OSD3-E	3	2.5 x 1.2	3	6.6	2	0.5	1.8 x 10^{-14}	80	20	100	700		1			7 / TO-18
OSD5-E	5	2.5 dia.	5	11	2	0.5	1.9 x 10^{-14}	130	35	100	600		1			5 / TO-5
OSD15-E	15	3.8 x 3.8	15	33	10	2	5.2 x 10^{-14}	390	80	50	80		1			5 / TO-5
OSD60-E	100	11.3 dia.	30	56	30	8	1.2 x 10^{-13}	2500	520	2	10		2			72 / TO-8

Characteristics measured at 22° C (±2) and a reverse bias of 12 volts unless otherwise stated.
** Shunt Resistance measured at +/- 10mV.
¶ For mechanical drawings please refer to pages 58 thru 69.

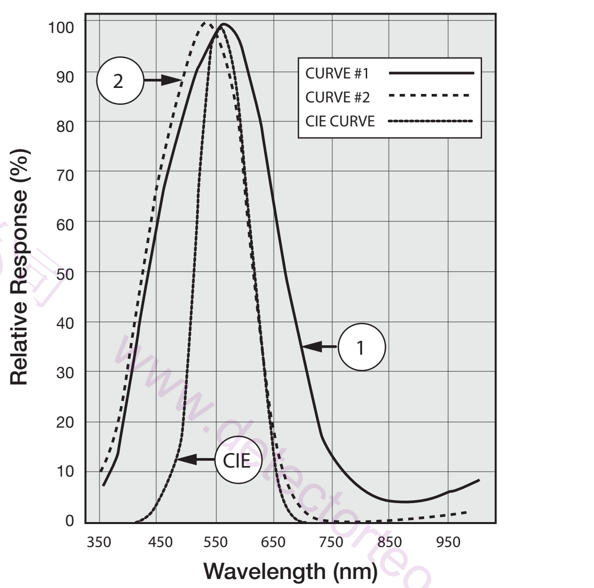
Unit Conversion Table for Illuminance

The Series E photodiodes have been color corrected to provide a phototopic eye response. These devices can be used as low illuminance monitors, i.e. visible light measurement instruments and adjusting brightness of visible display.

Lux lx (lm/m²)	Phot Ph (lm/cm²)	Foot-candle fc (lm/ft²)	Watt per square cm* W/cm²
1	1.000 x 10^{-4}	9.290 x 10^{-2}	5.0 x 10^{-6}
1.000 x 10^{4}	1	9.290 x 10^{2}	9.290 x 10^{-2}
1.076 x 10^{1}	1.076 x 10^{-3}	1	5.0 x 10^{-5}
2.0 x 10^{5}	1.0 x 10^{1}	1.9 x 10^{4}	1

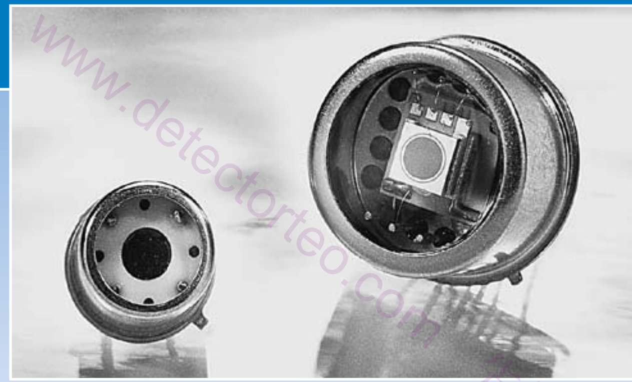
*Total irradiance (measured value) by the CIE standard light source "A".

▪ CIE Curve vs. E Type Parts



▪ Dual Sandwich Detector Series

Two Color Photodiodes



Dual Sandwich Detectors or Two Color Detectors are mostly employed for remote temperature measurements. The temperature is measured by taking the ratio of radiation intensities of two adjacent wavelengths and comparing them with the standard black body radiation curves. The advantages of optical remote measurement have definitely made these devices the perfect match for this type of measurements. They are independent of emissivity and unaffected by contaminants in the field of view or moving targets. In addition, measurements of targets out of the direct line of sight and the ability to function from outside RF/EMI interference or vacuum areas are possible. They also have the advantages of overcoming obstructed target views, blockages from sight tubes, channels or screens, atmospheric smoke, steam, or dust, dirty windows as well as targets smaller than field of view and/or moving within the field of view. These detectors can also be used in applications where wide wavelength range of detection is needed.

▪ APPLICATIONS

- Flame Temperature sensing
- Spectrophotometer
- Dual-wavelength detection
- IR Thermometers for Heat Treating, induction heating, and other metal parts processing

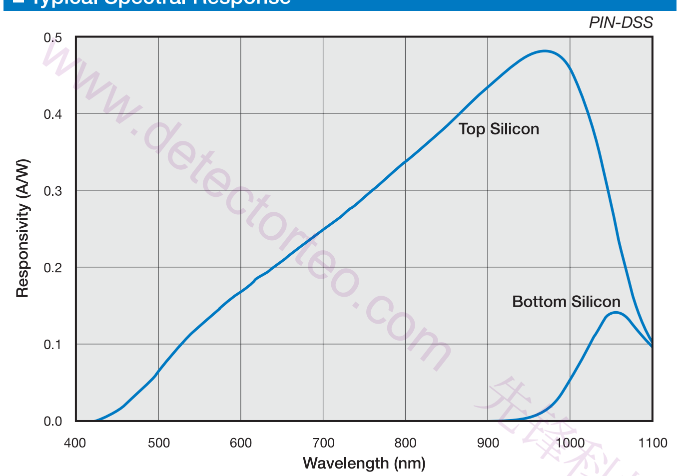
▪ FEATURES

- Compact
- Hermetically Sealed
- Low Noise
- Wide Wavelength Range
- Remote Measurements
- w/ TEC

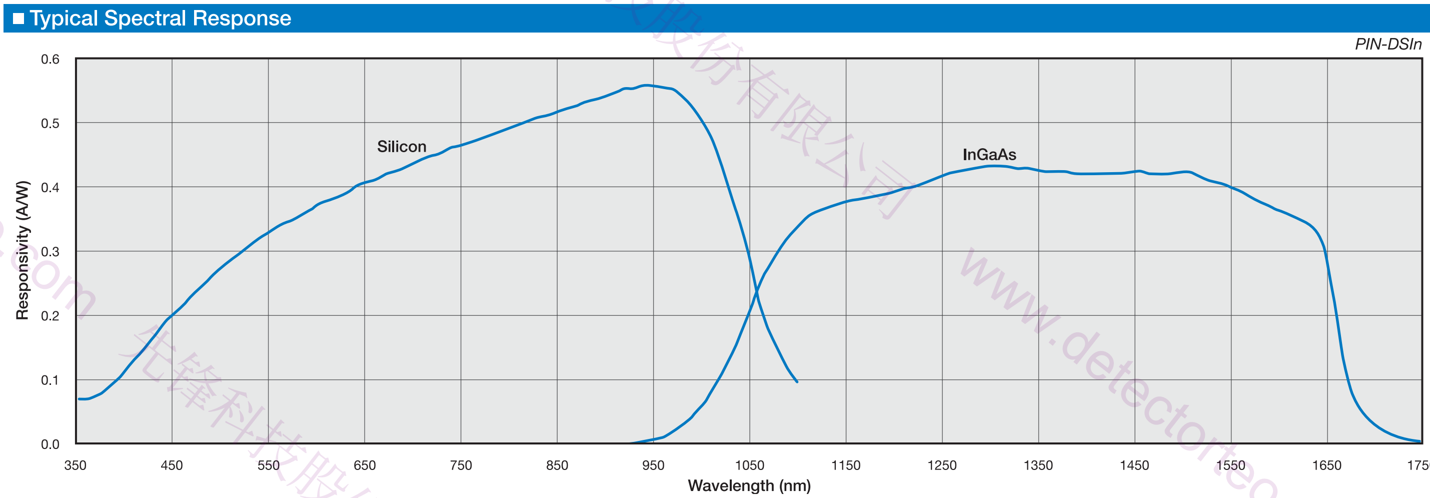
OSI Optoelectronics offers three types of dual sandwich detectors. The Silicon- Silicon sandwich, in which one silicon photodiode is placed on top of the other, with the photons of shorter wavelengths absorbed in the top silicon and the photons of longer wavelengths penetrating deeper, absorbed by the bottom photodiode. For applications requiring a wider range of wavelength beyond 1.1 µm, an InGaAs photodiode replaces the bottom photodiode. The Silicon-InGaAs version is also available with a two stage thermo-electric cooler for more accurate measurements by stabilizing the temperature of the InGaAs detector.

All devices are designed for photovoltaic operation (no bias), however, they may be biased if needed, to the maximum reverse voltage specified. They are ideal for coupling to an operational amplifier in the current mode. For further details refer to the "Photodiode Characteristics" section of this catalog.

▪ Typical Spectral Response



▪ Typical Spectral Response



Typical Electro-Optical Specifications at T_A=23°C

Model Number	Detector Element	Active Area	Spectral Range (nm)	Peak Wavelength	Responsivity	Capacitance	Shunt Resistance		NEP	D* @ peak	Reverse Voltage	Rise Time (μs)	Temp* Range (°C)		Package Style ¶
		Dimension (mm)			λ_P	0 V	-10 mV		0V, λ_P	0V, λ_P		0 V 50 Ω λ_P	Operating	Storage	
				nm	A/W	pF	MΩ		(W/√Hz)	(cm√Hz/W)	V				
				typ.	typ.	typ.	min.	typ.	typ.	typ.	max.	typ.			
Non-Cooled															
PIN-DSS	**Si (top)**	2.54 ϕ	400-1100	950	0.45	70	50	500	1.3 e -14	1.7 e +13	5	10	-40 ~ +100	-55 ~ +125	17 / TO-5
	Si		950-1100	1060	0.12				4.8 e -14	4.7 e +12		150			
PIN-DSIn	**Si (top)**	2.54 ϕ	400-1100	950	0.55 §	450	150		1.9 e -14 §	1.2 e +13 §	5	4			
	InGaAs	1.50 ϕ	1000-1800	1300	0.60	300	1.0		2.1 e -13	8.4 e +11	2	4			
Two Stage Thermoelectrically Cooled ‡															
PIN-DSIn-TEC	**Si (top)**	2.54 ϕ	400-1100	950	0.55 §	450	150		1.9 e -14 §	1.2 e +13 §	5	4	-40 ~ +100	-55 ~ +125	24 / TO-8
	InGaAs	1.5 ϕ	1000-1800	1300	0.60	300	1.0		2.1 e -13	8.4 e +11	2	4			

§ @ 870 nm
‡ Thermo-Electric Cooler and Thermistor Specifications are specified in the tables below.
¶ For mechanical drawings please refer to pages 58 thru 69.
* Non-Condensing temperature and Storage Range, Non-Condensing Environment.

Thermistor Specifications

PARAMETER	CONDITION	SPECIFICATION
Temperature Range	---	-100 ºC to +100 ºC
Nominal Resistance	---	1.25 KW @ 25 ºC
Accuracy	-100 ºC to -25 ºC	± 6.5 ºC
	-25 ºC to +50 ºC	± 3.5 ºC
	@ 25 ºC	± 1.5 ºC
	+50 ºC to +100 ºC	± 6.7 ºC

Two Stage Thermo-electric Cooler Specifications

PARAMETER	SYMBOL	CONDITION		SPECIFICATION
Maximum Achievable Temperature Difference	ΔT_{MAX} (°C)	I = I_{MAX} QC = 0	Vacuum	91
			Dry N2	83
Maximum Amount Of Heat Absorbed At The Cold Face	Q_{MAX} (W)	I = I_{MAX}, ΔT= 0		0.92
Input Current Resulting In Greatest ΔT_{MAX}	I_{MAX} (A)	---		1.4
Voltage At ΔT_{MAX}	V_{MAX} (V)	---		2.0

Multi-Element Array Series

Planar Diffused Silicon Photodiodes

Multichannel array photodetectors consist of a number of single element photodiodes laid adjacent to each other forming a one-dimensional sensing area on a common cathode substrate. They can perform simultaneous measurements of a moving beam or beams of many wavelengths. They feature low electrical cross talk and super high uniformity between adjacent elements allowing very high precision measurements. Arrays offer a low cost alternative when a large number of detectors are required. The detectors are optimized for either UV, visible or near IR range.

They can be either operated in photoconductive mode (reverse biased) to decrease the response time, or in photovoltaic mode (unbiased) for low drift applications. A2V-16 can be coupled to any scintillator crystal for measuring high-energy photons in the X-ray and g-ray region of electromagnetic spectrum. In addition, they have been mechanically designed, so that several of them can be mounted end to end to each other in applications where more than 16 elements are needed.

Figure 11 in the "Photodiode Characteristics" section of this catalog provides a detailed circuit example for the arrays.

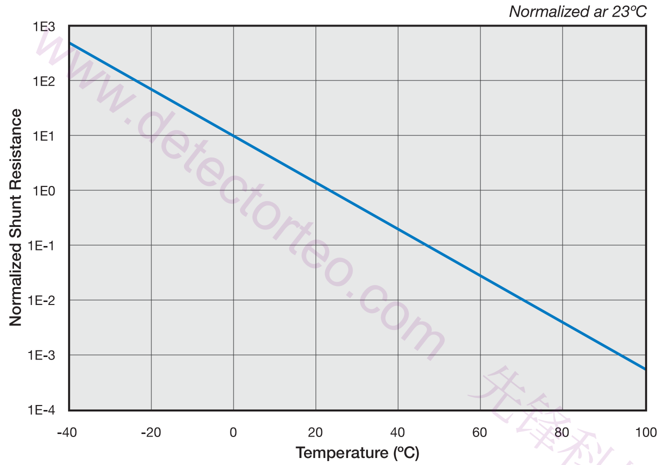
APPLICATIONS

- Level Meters
- Optical Spectroscopy
- Medical Equipment
- High Speed Photometry
- Computed Tomography Scanners
- Position Sensors

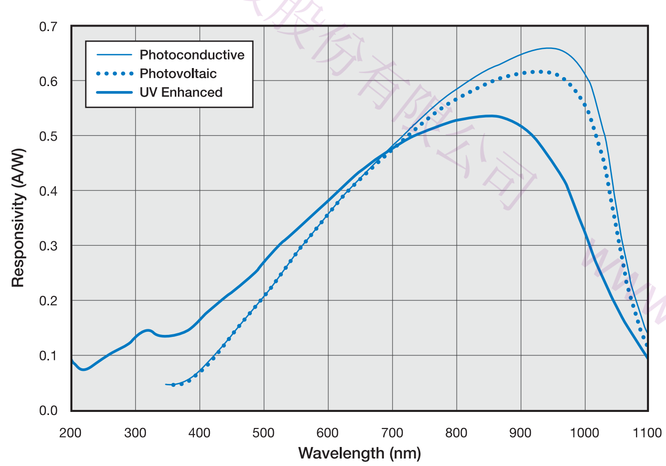
FEATURES

- Common Substrate Array
- Ultra Low Cross Talk
- UV Enhanced (A5V-35UV)
- Low Dark Current
- Low Capacitance
- Solderable

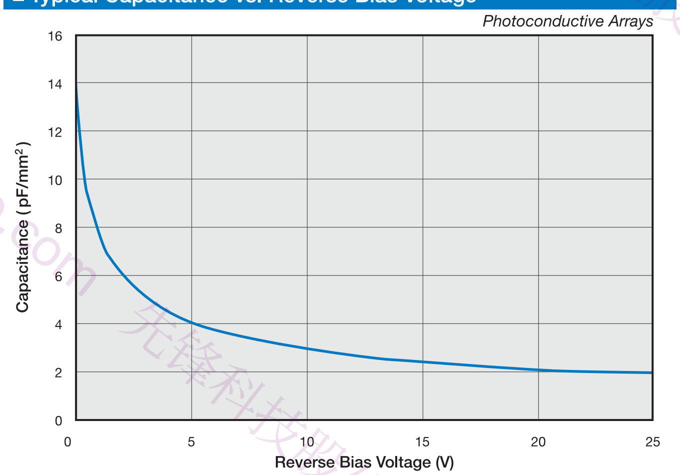
Typical Shunt Resistance vs. Temperature



Typical Spectral Response



Typical Capacitance vs. Reverse Bias Voltage



Multi-Element Array Series

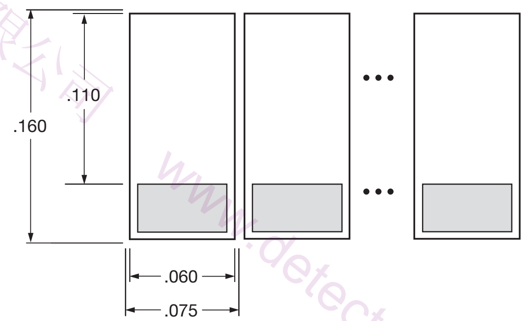
Typical Electro-Optical Specifications at T_A=23°C

Model Number	Number of Elements	Active Area Per Element: Area (mm²)	Active Area Per Element: Dimensions (mm)	Pitch (mm)	Responsivity (A/W) 970nm typ.	Shunt Resistance (MΩ) -10 mV typ.	Dark Current (pF) -10 V typ.	Capacitance (pF) 0 V typ.	Capacitance (pF) -10 V typ.	NEP (W / √Hz) 0 V 970nm min.	NEP (W / √Hz) -10 V 970nm typ.	Temp. Range (°C) Operating	Temp. Range (°C) Storage	Package Style ¶
Photoconductive Arrays														
A5C-35	35	3.9	4.39 x 0.89	0.99	0.65	---	0.05	---	12	---	6.2 e-15	-30 ~ +85	-40 ~ +125	54 / 40 pin DIP
A5C-38	38													
Photovoltaic Arrays														
A2V-16	16	1.92	1.57 x 1.22	1.59	0.60	1000	---	170	---	4.8 e-15	---			53 / PCB
A5V-35	35	3.9	4.39 x 0.89	0.99	0.60	1000	---	340	---	4.8 e-15	---			54 / 40 pin DIP
A5V-38	38													
A2V-76	76	1.8	6.45 x 0.28	0.31	0.50	500	---	160	---	8.2 e-15	---			52 / Ceramic
UV Enhanced Array (All Specifications @ λ =254 nm, V_{BIAS}= -10V)														
A5V-35UV	35	3.9	4.39 x 0.89	0.99	0.06**	500	---	340	---	6.8 e-14	---			54 / 40 pin DIP

Model Number	Number of Elements	Element Size mm (inches)	Active Area per Element (mm²) (inches²)	Pitch mm (inches)	Responsivity (A/W) 970nm typ.	Open Circuit Voltage/Element (mV) 10 mW/cm2 2850 °K typ.	Shunt Resistance (MΩ) -10 mV typ.	Capacitance (pF) 0 V typ.
Monolithic Solderable Chip Arrays (Typical Electro-Optical Specifications at T_A=23°C)								
A4V-2	2	1.52 x 2.79 (0.06 x 0.110)	4.24 (0.007)	1.90 (0.075)	0.6	500	1000	500
A4V-4	4							
A4V-6	6							
A4V-8	8							
A4V-10	10							
A4V-12	12							

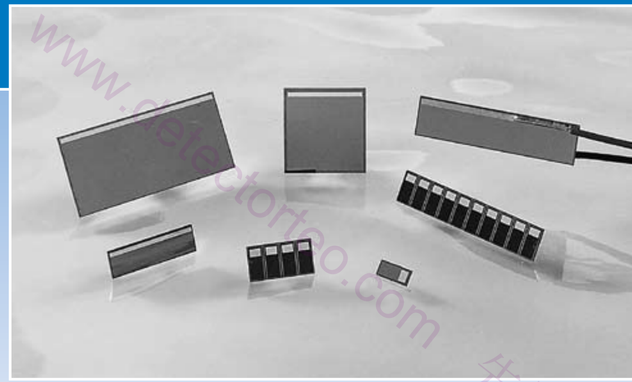
The chips are equipped with 2" long bare tinned leads soldered to all anodes and the common cathode.
'V' suffix indicates the device is optimized for 'photovoltaic' operation.
'C' suffix indicates the device is optimized for 'photoconductive' operation.
¶ For mechanical drawings please refer to pages 58 thru 69.
* Non-Condensing temperature and Storage Range, Non-Condensing Environment.
** λ = 254 nm

A4V-X



Solderable Chip Series

Planar Diffused Silicon Photodiodes



The Solderable photodiode chip series offer a low cost approach to applications requiring large active area photodetectors with or without flying leads for ease of assembly and / or situations where the detector is considered “disposable”. They have low capacitance, moderate dark currents, wide dynamic ranges and high open circuit voltages. These detectors are available with two 3" long leads soldered to the front (anode) and back (cathode). There are two types of photodiode chips available. “Photoconductive” series, (SXXCL) for low capacitance and fast response and “Photovoltaic” series (SXXVL) for low noise applications.

All of the devices are also available in chip form without any leads. For ordering subtract suffix ‘L’ from the model number, e.g. S-100C.

For large signal outputs, the detectors can be connected directly to a current meter or across a resistor for voltage measurements. Alternately, the output can be measured directly with an oscilloscope or with an amplifier. Please refer to the “Photodiode Characteristics” section for further details.

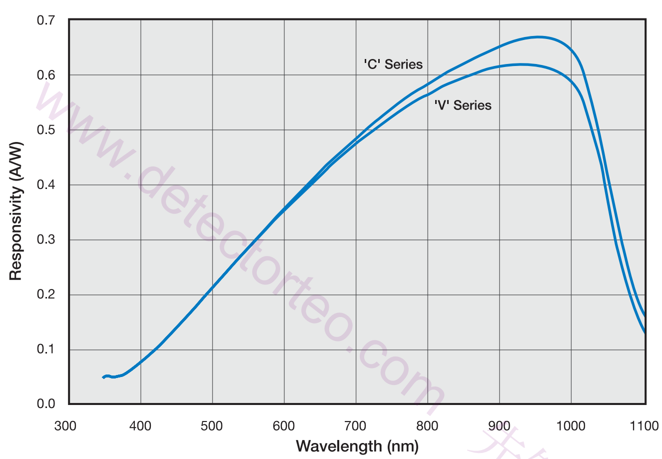
APPLICATIONS

- Solar Cells
- Low Cost Light Monitoring
- Diode Laser Monitoring
- Low Capacitance

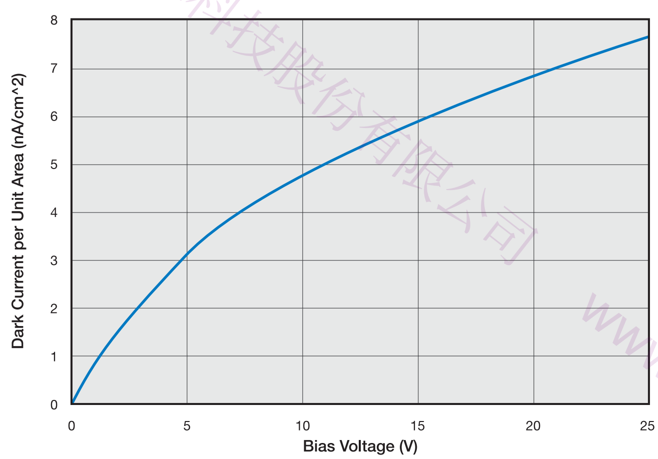
FEATURES

- Large Active Areas
- Various Sizes
- High Shunt Resistance
- With or Without Leads

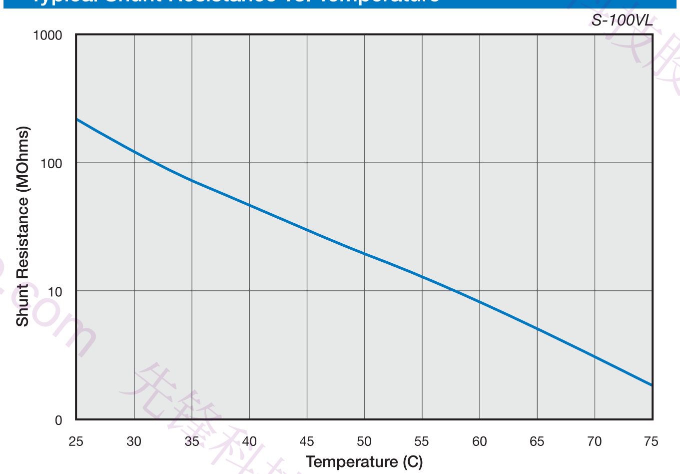
Typical Spectral Response



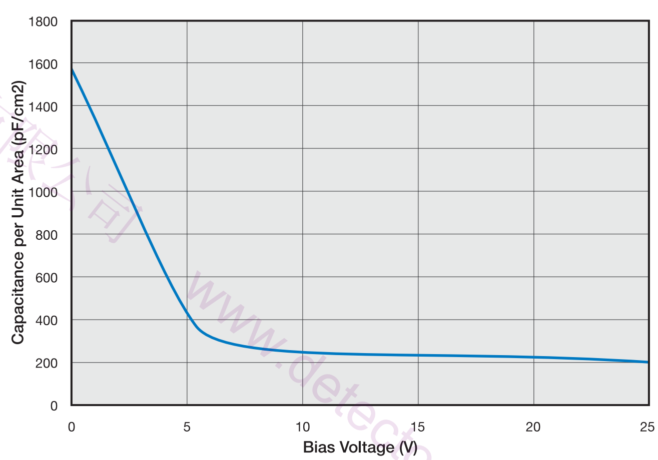
Typical Dark Current per Unit Area vs. Bias Voltage



Typical Shunt Resistance vs. Temperature



Typical Capacitance per Unit Area vs. Bias Voltage

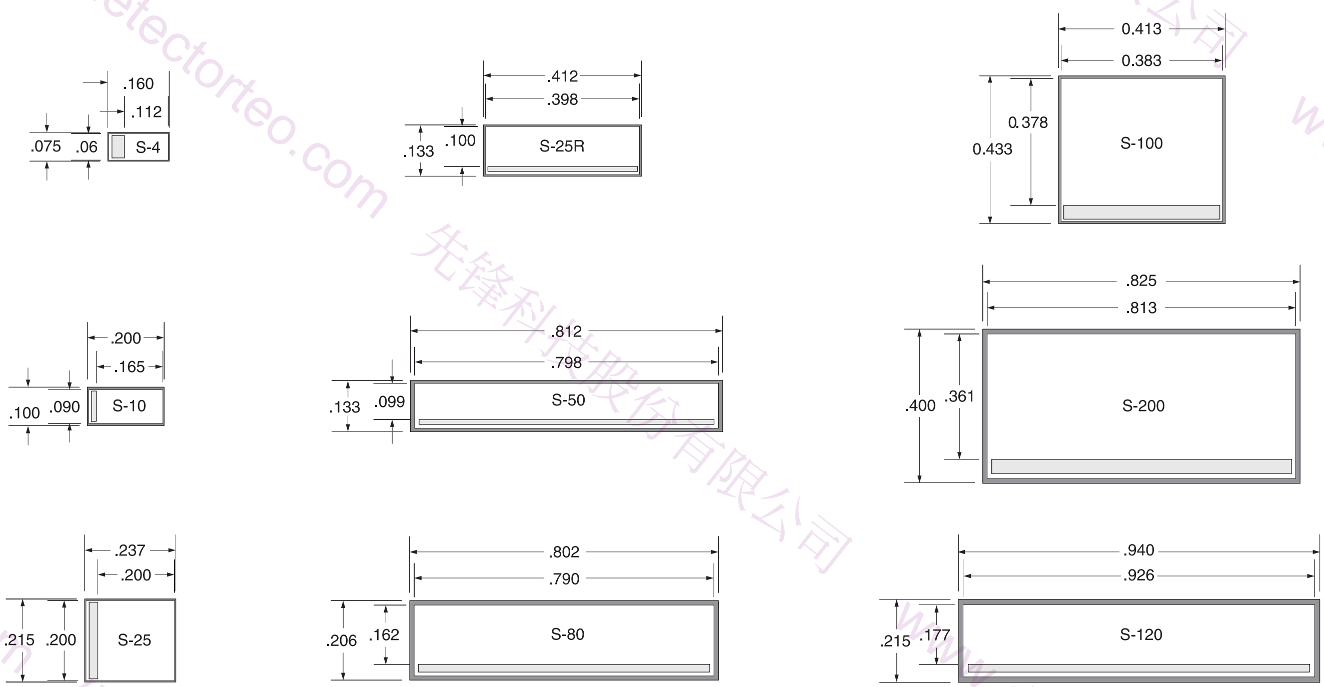


▪ Solderable Chip Series

Typical Electro-Optical Specifications at T_A=23ºC

Model Number	Active Area Area mm² (inches²)	Active Area Dimensions mm (inches)	Chip size mm (inches)	Peak Responsivity Wavelength λp (nm)	Responsivity at λp A/W min.	Responsivity at λp A/W typ.	Shunt Resistance (MΩ) -10 mV min.	Dark Current (nA) -5 V max.	Capacitance (pF) 0 V typ.	Capacitance (pF) -5 V typ.
S-4CL §	4.7 (0.007)	1.7 x 2.8 (0.07 x 0.11)	1.9 x 4.1 (0.08 x 0.16)	970	0.60	0.65	---	20	---	15
S-4VL							10	---	370	---
S-10CL	9.6 (0.015)	2.3 x 4.2 (0.09 x 0.17)	2.5 x 5.1 (0.10 x 0.20)				---	40	---	30
S-10VL							8	---	750	---
S-25CL	25.8 (0.04)	5.1 x 5.1 (0.20 x 0.20)	5.5 x 6.0 (0.22 x 0.24)				---	100	---	95
S-25VL							5	---	2100	---
S-25CRL	25.4 (0.039)	2.5 x 10.1 (0.10 x 0.40)	3.4 x 10.5 (0.13 x 0.41)				---	100	---	95
S-25VRL							5	---	2100	---
S-50CL	51.0 (0.079)	2.5 x 20.3 (0.10 x 0.80)	3.4 x 20.6 (0.13 x 0.81)				---	300	---	200
S-50VL							3	---	4000	---
S-80CL	82.6 (0.128)	4.1 x 20.1 (0.16 x 0.79)	5.2 x 20.4 (0.21 x 0.80)				---	500	---	300
S-80VL							2	---	6000	---
S-100CL	93.4 (0.145)	9.7 x 9.7 (0.38 x 0.38)	10.5 x 11.00 (0.42 x 0.43)				---	600	---	375
S-100VL							1.0	---	8500	---
S-120CL	105.7 (0.164)	4.5 x 23.5 (0.18 x 0.93)	5.5 x 23.9 (0.22 x 0.94)				---	800	---	450
S-120VL							0.5	---	10000	---
S-200CL	189.0 (0.293)	9.2 x 20.7 (0.36 x 0.81)	10.2 x 21.0 (0.40 x 0.83)				---	1200	---	750
S-200VL							0.2	---	17000	---

§ All of the above bare chips are provided with two 3" long 29-30 AWG insulated color coded leads attached to the front for anode (RED) and to the back for Cathode (BLACK). They are also available in chip form only (Leadless). For Ordering subtract Suffix 'L' from the Model Number, i.e. S-100C.



All chip dimensions in inches.

Segmented Photodiodes (SPOT Series)

Position Sensing Detector (PSD)

The SPOT Series are common substrate photodetectors segmented into either two (2) or four (4) separate active areas. They are available with either a 0.005" or 0.0004" well defined gap between the adjacent elements resulting in high response uniformity between the elements. The SPOT series are ideal for very accurate nulling or centering applications. Position information can be obtained when the light spot diameter is larger than the spacing between the cells.

Spectral response range is from 350-1100nm. Notch or bandpass filters can be added to achieve specific spectral responses.

These detectors exhibit excellent stability over time and temperature, fast response times necessary for high speed or pulse operation, and position resolutions of better than 0.1 μm.

Maximum recommended power density is 10 mW / cm2 and typical uniformity of response for a 1 mm diameter spot is ±2%.

The circuit on the opposite page represents a typical biasing and detection circuit set up for both bi-cells and quad-cells. For position calculations and further details, refer to “Photodiode Characteristics” section of the catalog.

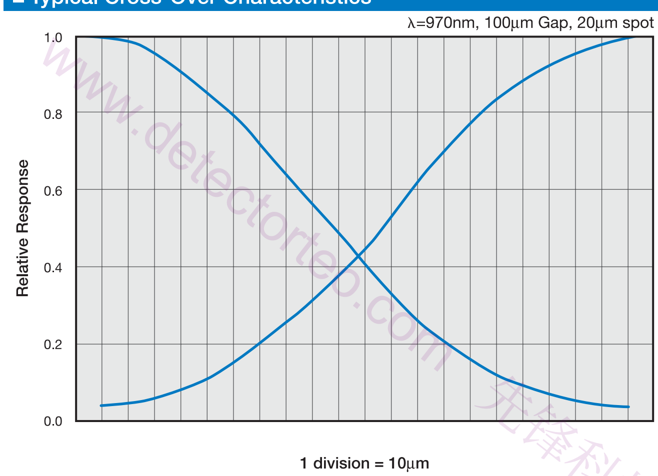
APPLICATIONS

- Machine Tool Alignment
- Position Measuring
- Beam Centering
- Surface Profiling
- Targeting
- Guidance Systems

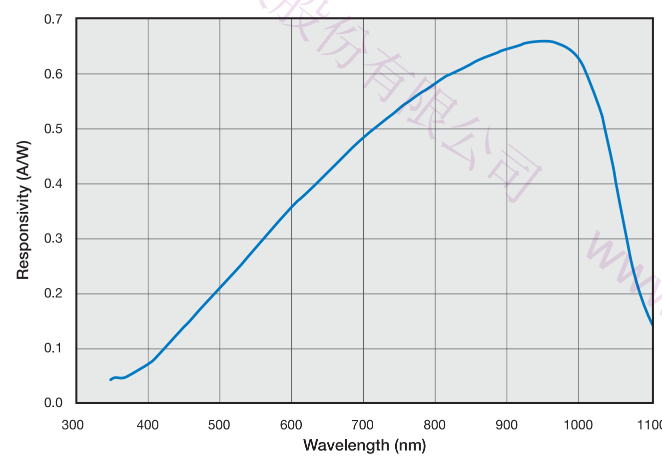
FEATURES

- High Accuracy
- Excellent Resolution
- High-Speed Response
- Ultra Low Dark Current
- Excellent Response Match
- High Stability over Time and Temperature

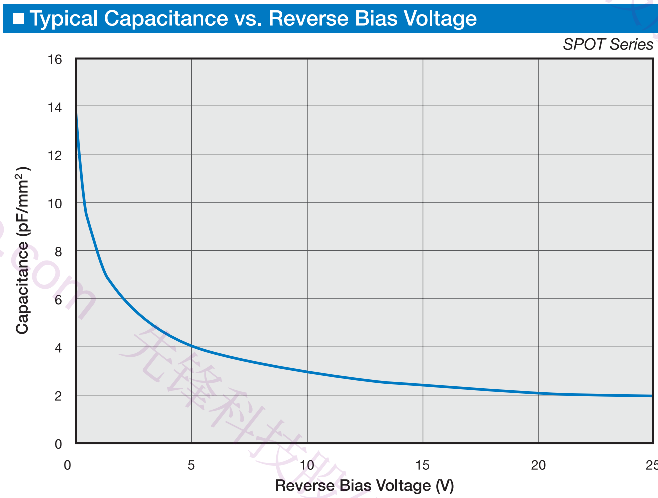
Typical Cross-Over Characteristics



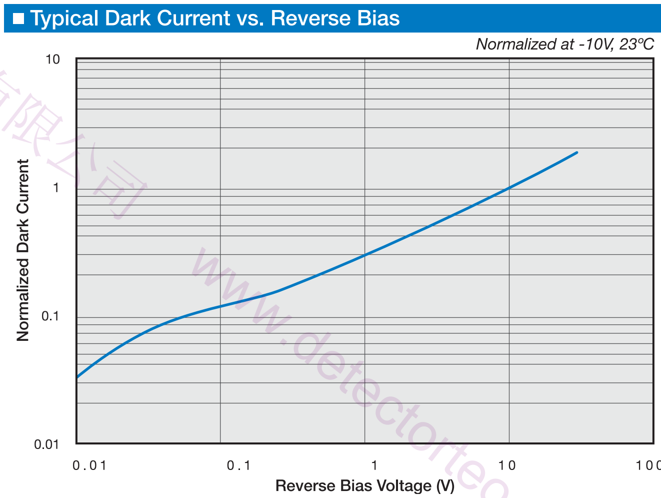
Typical Spectral Response



Typical Capacitance vs. Reverse Bias Voltage



Typical Dark Current vs. Reverse Bias



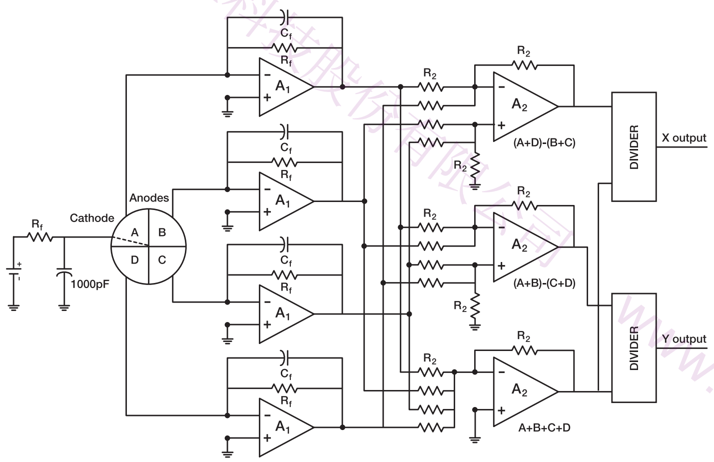
Segmented Photodiodes (SPOT Series)

Typical Electro-Optical Specifications at T_A=23ºC

Model Number	Active Area Per Element: Area (mm²)	Active Area Per Element: Dimensions (mm)	Element Gap (mm)	Responsivity (A/W) 970 nm min.	Responsivity (A/W) 970 nm typ.	Capacitance (pF) -10 V typ.	Dark Current (nA) -10 V typ.	Dark Current (nA) -10 V max.	NEP (W/√Hz) -10 V 970 nm typ.	Reverse Voltage (V) max.	Rise Time (ns) -10 V 780 nm 50 Ω typ.	Temp Range (°C) Operating	Temp Range (°C) Storage	Package Style ¶
Two-Element Series, Metal Package														
CD-25T	2.3	4.6 x 0.5	0.2	0.60	0.65	50@ -15V	20@ -15V		1.1 e-14	30	300@ -15V	-40 ~ +100	-55 ~ +125	2 / TO-5
SPOT-2D	3.3	1.3 x 2.5	0.127			11	0.15	2.0			5			41 / TO-5
SPOT-2DMI	0.7	0.6 x 1.2	0.013			3	0.05	1.0	6.2 e-15		7			40 / TO-18
SPOT-3D	2.8	0.6 x 4.6	0.025			7	0.13	2.0	9.9 e-15		4			41 / TO-5
Four Element Series, Metal Package														
SPOT-4D	1.61	1.3 sq	0.127	0.60	0.65	5	0.10	1.0	8.7 e-15	30	3	-40 ~ +100	-55 ~ +125	41 / TO-5
SPOT-4DMI	0.25	0.5 sq	0.013			1	0.01	0.5	2.8 e-15					
SPOT-9D	19.6	10 φ ‡	0.102			60	0.50	10.0	1.9 e-14					43 / LoProf
SPOT-9DMI	19.6		0.010											

Model Number	Active Area Per Element: Area (mm²)	Active Area Per Element: Dimensions (mm)	Element Gap (mm)	Responsivity 257 nm A/W min.	Responsivity 257 nm A/W typ.	Capacitance 0 V pF typ.	Shunt Resistance (MΩ) min.	Shunt Resistance (MΩ) max.	NEP (W/√Hz) typ.	Reverse Voltage (V) max.	Rise Time 0 V, 257 nm µs typ.			Package Style ¶
UV-Enhanced Four Elements, Metal Package §														
SPOT-4DUV	1.61	1.3 sq	0.127	0.08	0.10	40	100	500	1.3 e-13	5	10	-10 ~ +60	-20 ~ +70	41 / TO-5

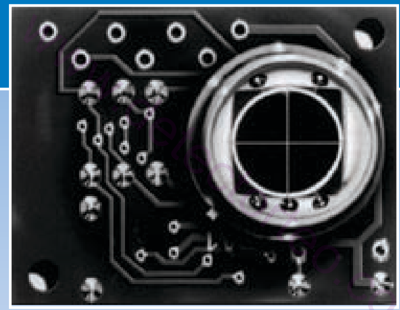
‡ Overall Diameter (All four Quads)
¶ For mechanical drawings please refer to pages 58 thru 69.
Chip centering within ±0.010".

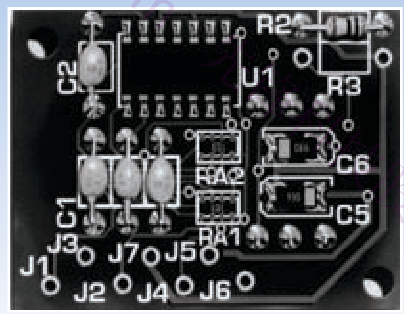


Sum and Difference Amplifier Modules

Position Sensing Modules

QD7-0-SD or QD50-0-SD are quadrant photodiode arrays with associated circuitry to provide two difference signals and a sum signal. The two difference signals are voltage analogs of the relative intensity difference of the light sensed by opposing pairs of the photodiode quadrant elements. In addition the amplified sum of all 4 quadrant elements is provided as the sum signal. This makes the QD7-0-SD or QD50-0-SD ideal for both light beam nulling and position applications. Very precise light beam alignments are possible, and the circuit can also be used for target acquisition and alignment.





APPLICATIONS
- Position Measuring
- Beam Centering
- Targeting
- Guidance Systems

FEATURES
- A 10µm gap is available for the QD50-SD Module.
- Other QD7-XX or QD50-XX are available upon request

Values given as per element unless otherwise stated

Model Number	Active Area Total: Area (mm^2)	Active Area Total: Dimensions (mm)	Element Gap (mm)	Responsivity (A/W) 900 nm: min.	Responsivity (A/W) 900 nm: typ.	Capacitance (pF) 0 V: typ.	Dark Current (nA): typ.	Dark Current (nA): max.	NEP (W/√Hz) 0 V 900 nm: typ.	Reverse Voltage (V): max.	Rise Time (ns) -30 V 900 nm 50 Ω: typ.	Temp Range (˚C): Operating	Temp Range (˚C): Storage	Package Style ¶
'O' Series														
QD7-0	7	3.0 φ	0.2	0.47	0.54	20	4.0	15.0	9.0 e-14	30	10	-40 ~ +100	-55 ~ +125	41 / TO-5
QD50-0	50	8.0 φ				125	15.0	30.0	1.3 e-13					73 / TO-8

INPUT

Power supply voltage Vcc = ±4.5V min; ±15V typical; ±18V max	
Photodiode bias voltage = (.91) x (V_{PDBIAS})	
V_{PDBIAS} = 0 TO +Vcc; Absolute maximum V_{PDBIAS} is +Vcc	
NOTE: Negative voltages applied to PDBIAS will render the QD7-0-SD or QD50-0-SD inoperative.	

ENVIRONMENTAL

Operating temperature	0 to 70° C
Theoretical noise	15 nV/$Hz^{1/2}$
Frequency response	(-3dB): 120kHz @ V_{PDBIAS}=0V;880nm 250kHz @ V_{PDBIAS}=15V;880nm
Max slew rate	10V/µs
Output current limit	25 ma

OUTPUT

Where i_x is the current from quadrant x

$V_{T-B} = -\{(i_1 + i_2) - (i_3 + i_4)\} \times (10^4)$

$V_{L-R} = -\{(i_2 + i_3) - (i_1 + i_4)\} \times (10^4)$

$V_{SUM} = -\{(i_1 + i_2 + i_3 + i_4)\} \times (10^4)$

MAXIMUM OUTPUT VOLTAGE

Positive: (+Vcc - 3V)

Negative: (- Vcc + 3V)

Duo-Lateral, Super Linear PSD's

Position Sensing Detectors (PSD)

The Super Linear Position Sensors feature state of the art duo-lateral technology to provide a continuous analog output proportional to the displacement of the centroid of a light spot from the center, on the active area. As continuous position sensors, these detectors are unparalleled; offering position accuracies of 99% over 64% of the sensing area. These accuracies are achieved by duo-lateral technology, manufacturing the detectors with two separate resistive layer, one located on the top and the other at the bottom of the chip. One or two dimensional position measurements can be obtained using these sensors.

A reverse bias should be applied to these detectors to achieve optimum current linearity at high light levels. For position calculations and further details on circuit set up, refer to the “Photodiode Characteristics” section of the catalog.

The maximum recommended power density incident on the duo lateral PSDs are 1 mW / cm^2 . For optimum performance, incident beam should be perpendicular to the active area with spot size less than 1mm in diameter.

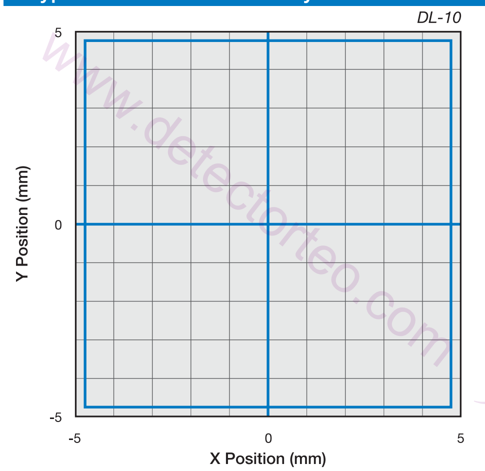
APPLICATIONS

- Beam Alignment
- Position Sensing
- Angle Measurement
- Surface Profiling
- Height Measurements
- Targeting
- Guidance System
- Motion Analysis

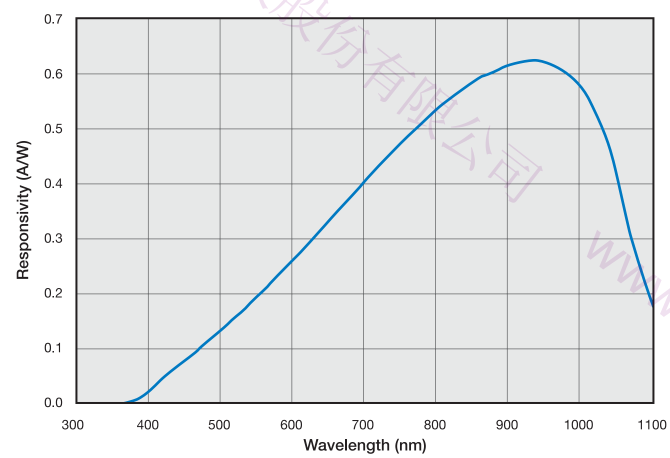
FEATURES

- Super Linear
- Ultra High Accuracy
- Wide Dynamic Range
- High Reliability
- Duo Lateral Structure

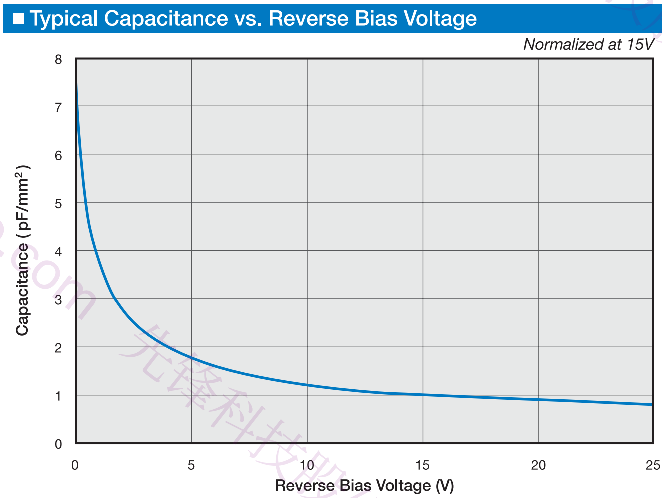
Typical Position Detectability



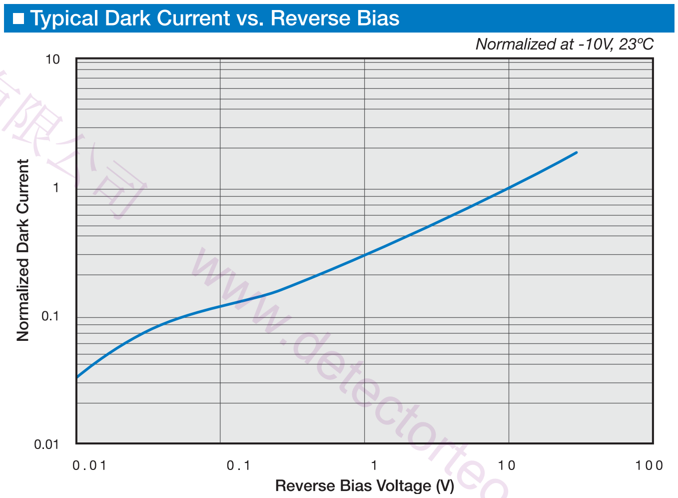
Typical Spectral Response



Typical Capacitance vs. Reverse Bias Voltage



Typical Dark Current vs. Reverse Bias



■ Duo-Lateral Super Linear PSD's

Typical Electro-Optical Specifications at T_A=23°C

Model Number	Position Sensing Area: Area (mm²)	Position Sensing Area: Dimension (mm)	Responsivity (A/W) 670 nm min.	Responsivity (A/W) 670 nm typ.	Position Detection Error (µm) Over 80% of Length 64% of Sensing Area typ.	Dark Current (nA) -15 V, SL Series -5 V, DL Series typ.	Dark Current (nA) max.	Capacitance (pF) -15 V, SL Series -5 V, DL Series typ.	Capacitance (pF) max.	Rise Time (µs) 670 nm 50 Ω typ.	Position Detection Drift † (µm / °C) typ.	Inter-electrode Resistance (kΩ) min.	Inter-electrode Resistance (kΩ) max.	Temp Range (°C) Operating	Temp Range (°C) Storage	Package Style ¶
One-Dimensional Series, Metal Package (V_{BIAS}=-15V)																
SL3-1	3	3 x 1	0.3	0.4	3	5	50	3	7	0.04	0.06	15	80	-10 ~ +60	-20 ~ +80	41 / TO-5
SL5-1	5	5 x 1			5	10	100	5	9	0.10	0.10	20	100			42 / TO-8
One-Dimensional Series, Ceramic Package (V_{BIAS}=-15V)																
SL3-2	3	3 x 1	0.3	0.4	3	5	50	3	7	0.04	0.06	15	80	-10 ~ +60	-20 ~ +80	48 / 8-pin DIP
SL5-2	5	5 x 1			5	10	100	5	9	0.10	0.10	20	100			
SL10-1	20	10 x 2			10	200	500	20	30	0.40	0.10	40	250			55 / 1 4-pin DIP
SL15	15	15 x 1			15	150	300	15	25	0.60	0.1	60	300			49 / 24-pin DIP
SL30	120	30 x 4			30	150	1000	125	150	1.0	0.6	40	80			51 / Ceramic
SL76-1	190	76 x 2.5			76	100	1000	190	250	14.0	1.4	120	600			50 / Special
Two-Dimensional Series, Metal Package § (V_{BIAS}=-5V)																
DL-2	4	2 sq	0.3	0.4	30	30	600	10	30	0.025	0.20	5	25	-10 ~ +60	-20 ~ +80	37 / TO-8
DLS-2						10	175	8	14		0.40					
DLS-2S																75 / TO-25
DL-4	16	4 sq			50	50	1000	35	60	0.08	0.25					37 / TO-8
DLS-4						25	300	30	40		0.30					
DL-10	100	10 sq			100	500	5000	175	375	0.20	0.60					34 / Special
DL-20	400	20 sq			200	2000	12000	600	1500	1.00	1.0					35 / Special
Two-Dimensional Series, Ceramic Package §‡ (V_{BIAS}=-5V)																
DLS-10	100	10 sq	0.3	0.4	100	50	400	160	200	0.20	0.70	5	25	-10 ~ +60	-20 ~ +80	36 / Ceramic
DLS-20	400	20 sq			200	100	1000	580	725	1.00	1.2					
Two-Dimensional Series, Low-Cost Ceramic Package (V_{BIAS}=-5V)																
DL-10C	100	10 sq	0.3	0.4	100	500	5000	175	375	0.20	0.60	5	25	-10 ~ +60	-20 ~ +80	38 / Ceramic
DL-20C	400	20 sq			200	2000	12000	600	1500	1.00	1.0					39 / Ceramic

† The position temperature drift specifications are for the die mounted on a copper plate without a window and the beam at the electrical center of the sensing area.
§ The DLS Series are packaged with A/R coated windows and have a lower dark current than the DL series.
‡ Also available in the same package as DL-10 or DL-20. Specify either DLS-10-1 or DLS-20-1.
¶ For mechanical drawings please refer to pages 58 thru 69.
* Non-Condensing temperature and Storage Range, Non-Condensing Environment.

NOTES:
1. DL(S) series are available with removable windows.
2. Chip centering within ± 0.010".

Tetra-Lateral PSD's

Position Sensing Detectors (PSD)

Tetra-lateral position sensing detectors are manufactured with one single resistive layer for both one and two dimensional measurements. They feature a common anode and two cathodes for one dimensional position sensing or four cathodes for two dimensional position sensing.

These detectors are best when used in applications that require measurement over a wide spacial range. They offer high response uniformity, low dark current, and good position linearity over 64% of the sensing area.

A reverse bias should be applied to these detectors to achieve optimum current linearity when large light signals are present. The circuit on the opposite page represents a typical circuit set up for two dimensional tetra-lateral PSDs.
For further details as well as the set up for one dimensional PSDs refer to the "Photodiode Characteristics" section of the catalog. Note that the maximum recommended incident power density is 10 mW / cm^2. Furthermore, typical uniformity of response for a 1 mm ϕ spot size is ± 5% for SC-25D and SC-50D and ± 2% for all other tetra-lateral devices.

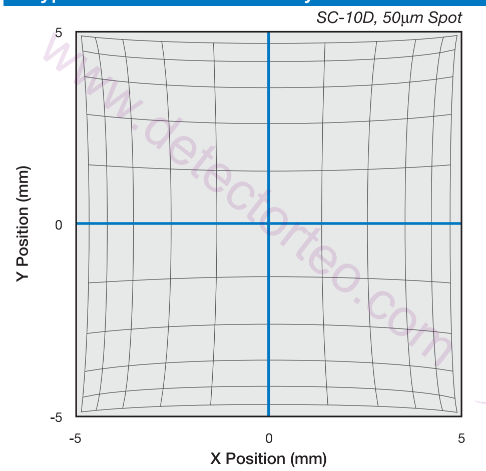
APPLICATIONS

- Tool Alignment and Control
- Leveling Measurements
- Angular Measurements
- 3 Dimensional Vision
- Position Measuring

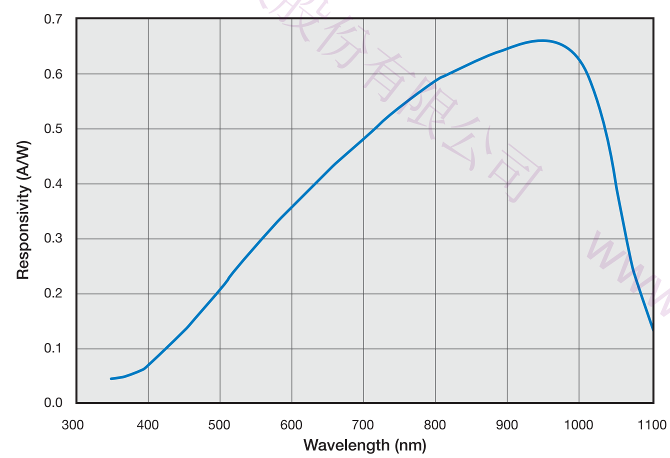
FEATURES

- Single Resistivity Layer
- High Speed Response
- High Dynamic Range
- Very High Resolution
- Spot Size & Shape Independence

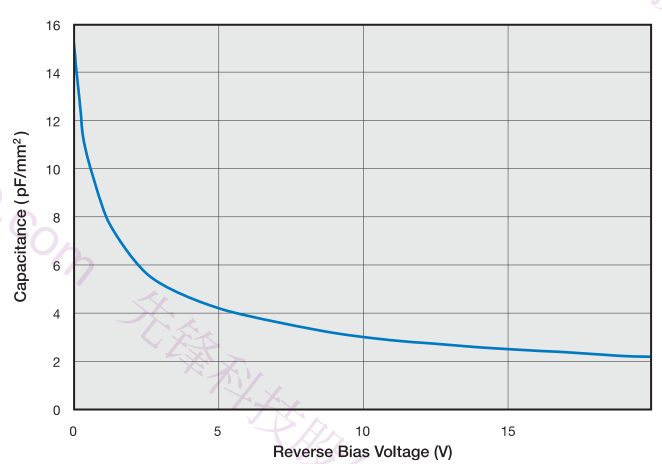
Typical Position Detectability



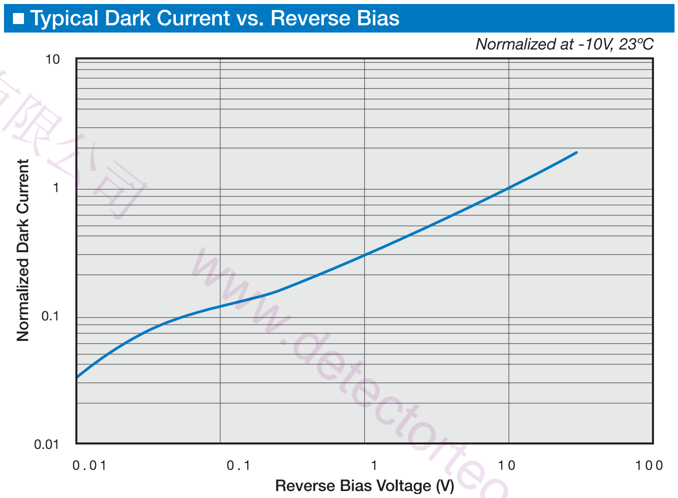
Typical Spectral Response



Typical Capacitance vs. Reverse Bias Voltage



Typical Dark Current vs. Reverse Bias



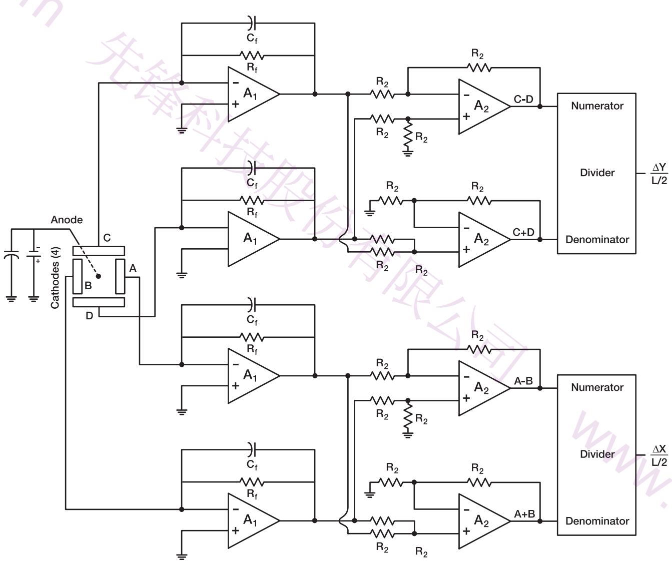
▪ Tetra-Lateral Position Sensors

Typical Electro-Optical Specifications at T_A=23ºC

Model Number	Position Sensing Area		Responsivity (A/W)		Absolute Position Detection Error (mm)	Dark Current (μA)		Capacitance (pF)	Rise Time † (μs)	Inter-electrode Resistance (kΩ)		Temp.* Range (°C)		Package Style ¶
			670 nm		Over 80% of Length 64% of Area	-15 V		-15 V	-15 V 670 nm 50Ω					
	Area (mm²)	Dimension (mm)	min.	typ.	typ.	typ.	max.	typ.	typ.	min.	max.	Operating	Storage	
One-Dimensional Series, Plastic Package														
LSC-5D	11.5	5.3 x 2.2	0.35	0.42	0.040	0.01	0.10	50	0.25	2	50	-10 ~ +60	-20 ~ +70	47 / Plastic
LSC-30D	122	30 x 4.1			0.240	0.025	0.250	300	3.00	4	100			46 / Plastic
Two-Dimensional Series, Metal Package														
SC-4D	6.45	2.54 sq	0.35	0.42	0.080	0.005	0.050	20	0.66	3	30	0 ~ +70	-20 ~ +80	41 / TO-5
SC-10D	103	10.16 sq			1.30	0.025	0.250	300	1.00					44 / Special
SC-25D	350	18.80 sq			2.5	0.10	1.0	1625	5.00					45 / Special
SC-50D	957	30.94 sq			5.0	0.25	2.5	3900	13.00					21 / Special
Two Dimensional Series, Plastic Package §														
FIL-C4DG	6.45	2.54 sq	0.35	0.42	0.080	0.005	0.050	20	0.66	3	30	-10 ~ +60	-20 ~ +70	14 / Plastic
FIL-C10DG	103	10.16 sq			1.30	0.025	0.250	300	1.00					15 / Plastic

† Rise time specifications are with a 1 mm φspot size at the center of the device.
§ The photodiode chips in "FIL" series are isolated in a low profile plastic package. They have a large field of view as well as "in line" pins.
¶ For mechanical drawings please refer to pages 58 thru 69.
* Non-Condensing temperature and Storage Range, Non-Condensing Environment.

Chip centering within ± 0.010".



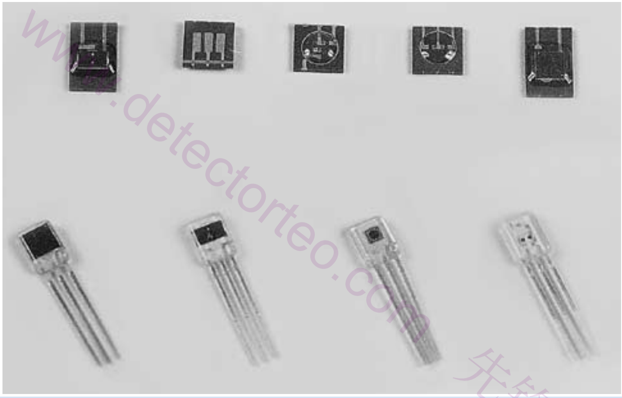
For further details, refer to the "Photodiode Characteristics" section of the catalog.

Dual Emitter / Matching Photodector Series

Molded Lead Frame and Leadless Ceramic Substrate

The Dual LED series consists of a 660nm (red) LED and a companion IR LED such as 880/ 895, 905, or 940nm. They are widely used for ratiometeric measurements such as medical analytical and monitoring devices. They can also be used in applications requiring a low cost Bi-Wavelength light source. Two types of pin configurations are available: 1.) three leads with one common anode or cathode, or 2.) two leads parallel back-to-back connection. They are available in two types of packaging. Clear lead frame molded side looker, and leadless ceramic substrate.

The matching photodectors' responses are optimized for maximum responsivity at 660nm as well as near IR wavelengths. They exhibit low capacitance and low dark currents and are available in three different active area sizes in the same two types of packaging as the dual emitters: Clear lead frame molded side looker and leadless ceramic substrate.



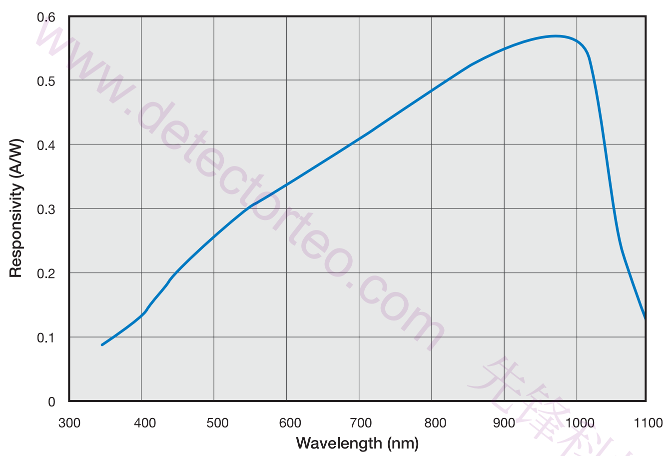
APPLICATIONS

- SpO2
- Blood analysis
- Medical Instrumentation
- Ratiometric Instruments

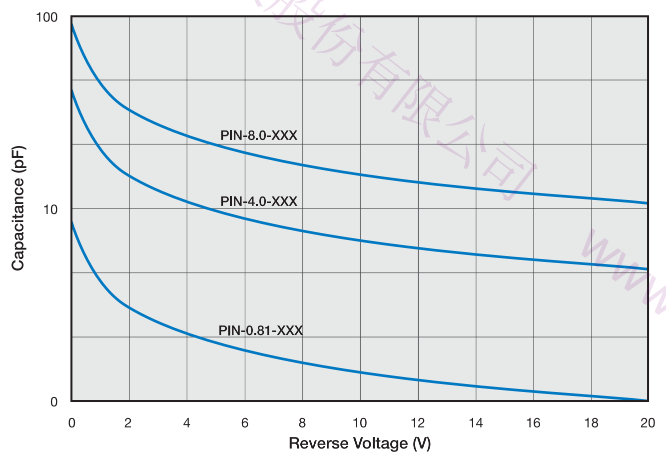
FEATURES

- Leadless ceramic Substrate
- Lead Frame Molded Packages
- Two and Three Lead Designs
- Bi-Wavelengths LEDs
- Matching Detector Response

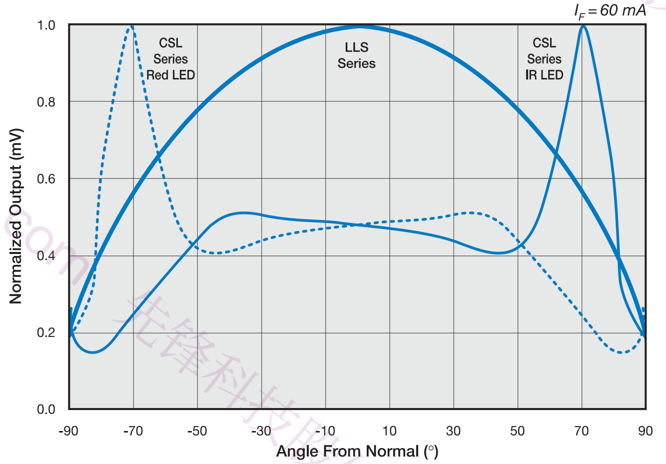
Typical Spectral Response



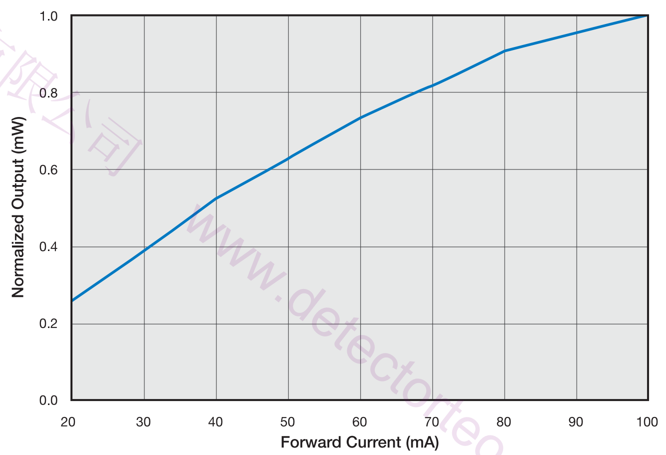
Typical Capacitance vs Reverse Voltage



Normalized LED Output vs Angular Distribution



Normalized LED Output vs Forward Current



■ Dual Emitter / Matching Photodector Series

Molded Lead Frame and Leadless Ceramic Substrate

Model Number	Active Area		Spectral Range	Responsivity		Capacitance	Dark Current (nA)	Max. Reverse Voltage	Operating Temp.	Storage Temp.	Package Style
	Area mm^2	Dimensions mm	nm	A/ W		pF	-10 V	V	°C	°C	
				660nm	900nm	-10V	typ.	10μA			

Photodiode Characteristics

Model Number	Area mm^2	Dimensions mm	Spectral Range nm	660nm	900nm	Capacitance -10V	Dark Current typ.	Max. Reverse Voltage 10μA	Operating Temp. °C	Storage Temp. °C	Package Style
PIN-0.81-LLS	0.81	1.02ϕ	350 - 1100	0.33	0.55	2.0	2	20	-25 ~ +85	-40 ~ +100C	62 / Leadless Cermic
PIN-0.81-CSL											60 / Molded Lead Frame
PIN-4.0-LLS	3.9	2.31 x 1.68				10	5				62 / Leadless Cermic
PIN-4.0-CSL											60 / Molded Lead Frame
PIN-8.0-LLS	8.4	2.9 Sq.				25	10				62 / Leadless Cermic
PIN-8.0-CSL											60 / Molded Lead Frame

For mechanical drawings and pin locations, please refer to pages 58 to 69.

Model Number	LED's Used		Package Style ¶	Pin Configuration	Operating Temperature	Storage Teperature
	nm				°C	°C

Dual Emitter Combinations

Model Number	LED's Used (nm)		Package Style ¶	Pin Configuration	Operating Temperature °C	Storage Teperature °C
DLED-660/880-LLS-2	660	880	64 / Leadless Ceramic	2 Leads / Back to Back*	-25 ~ +85	-40 ~ +80
DLED-660/895-LLS-2		895				
DLED-660/905-LLS-2		905				
DLED-660/905-LLS-3		905		3 Leads / Common Anode		
DLED-660/940-LLS-3		940				
DLED-660/880-CSL-2		880	63 / Side Locker Plastic	2 Leads / Back to Back*		
DLED-660/895-CSL-2		895				
DLED-660/905-CSL-2		905				
DLED-660/905-CSL-3		905		3 Leads / Common Anode		
DLED-660/940-CSL-3		940				

* In Back-to-Back configuration, the LED's are connected in parallel.

LED	Peak Wavelength	Radiant Flux	Spectral Bandwidth	Forward Voltage	Reverse Voltage
	nm	mW	nm	V	V
	i_f=20mA	i_f=20mA	i_f=20mA FWHM	i_f=20mA	i_f=-20mA
	typ.	typ.	typ.	max.	max.

LED Characteristics

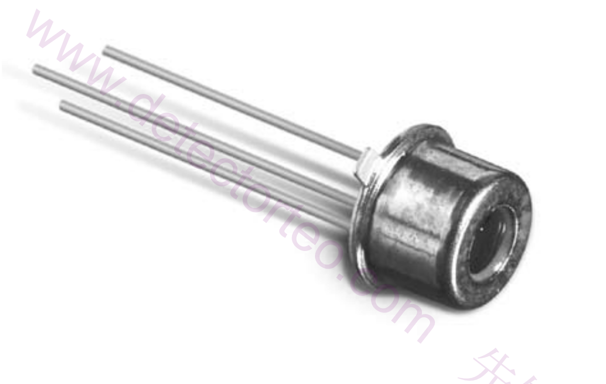
LED	Peak Wavelength (nm) typ.	Radiant Flux (mW) typ.	Spectral Bandwidth (nm) typ.	Forward Voltage (V) max.	Reverse Voltage (V) max.
660nm	660	1.8	25	2.4	5
880nm	880	1.5	80	2.0	
895nm	895	2.0	50	1.7	
905nm	905				
935nm	935	1.5		1.5	
940nm	940				

For mechanical drawings, please refer to pages 58 thru 69.

Avalanche Photodiodes

Ultra High Gain Silicon Photodetectors

Silicon Avalanche Photodiodes make use of internal multiplication to achieve gain due to impact ionization. The result is the optimized series of high Responsivity devices, exhibiting excellent sensitivity. OSI Optoelectronics offers several sizes of detectors that are available with flat windows or ball lenses for optical fiber applications.



APPLICATIONS

- High Speed Optical Communications
- Laser Range Finder
- Bar Code Readers
- Optical Remote Control
- Medical Equipment
- High Speed Photometry

FEATURES

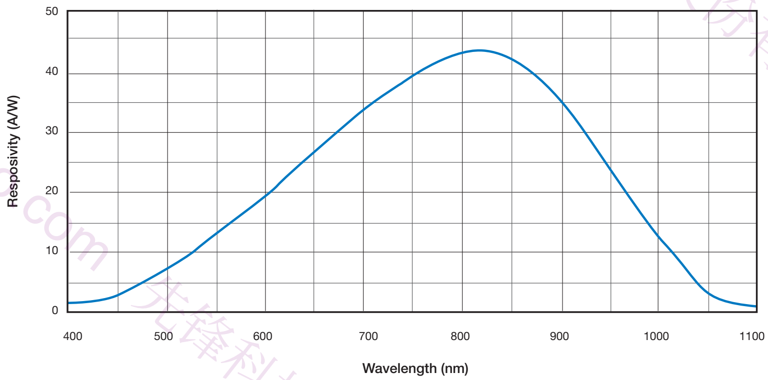
- High Responsivity
- High Bandwidth / Fast Response
- Low Noise
- Low Bias Voltage
- Hermetically Sealed TO-Packages

Model Number	Active Area: Area (mm²)	Active Area: Dimensions (mm)	Peak Responsivity Wavelength λp nm typ.	Responsivity (A/W) 850nm, G=100 typ.	Dark Current (nA) G=100 typ.	Capacitance (pF) 1MHz G=100 typ.	Rise Time (ns) 850 nm G=100 50 Ω typ.	Operating Bias Voltage Range (V) G=100	Temp. Range (˚C) Operating	Temp. Range (˚C) Storage	Package Style ¶
Silicon Avalance Photodiodes											
APD-300 APD-300L*	0.07	0.3 ϕ	820	42	1.0	1.5	0.4	130-280	-40 ~ +70	-40 ~ +85	68 / TO-18 Flat Window 69 / TO-18 Ball Lens
APD-500 APD-500L*	0.20	0.5 ϕ			1.8	2.5	0.5				
APD-900	0.64	0.9 ϕ			2.5	7	1.0				70 / TO-5
APD-1500	1.8	1.5ϕ			7.0	12	2.0				70 / TO-5
APD-3000	7.1	3.0 ϕ			15	40	5.0				70 / TO-5

¶ For mechanical drawings please refer to pages 58 thru 69.

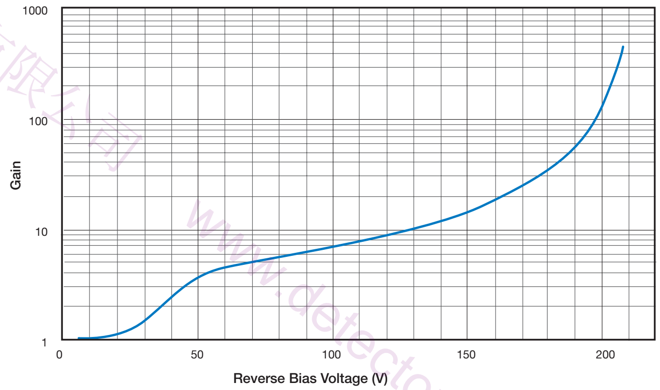
Typical Spectral Response

Conditions: Gain=100, Ta=22 °C



Typical Gain vs. Bias Voltage

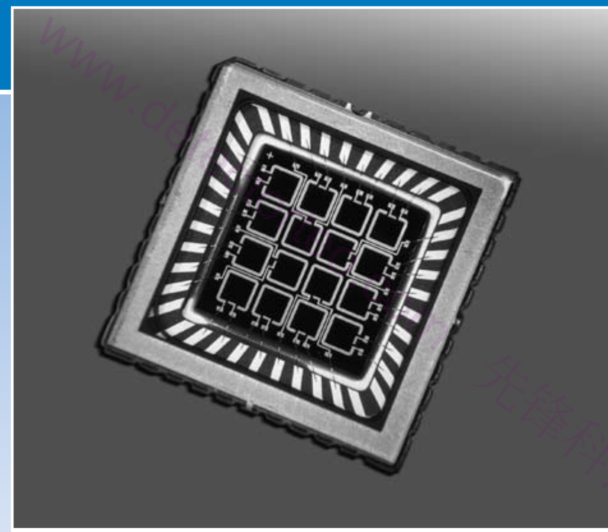
Conditions: 850nm, 500nW, Ta=22 °C



▪ UDT-4X4D

4X4 Silicon Array Detector

The UDT-4X4D is a 4 by 4 array of superblue enhanced Photodetectors. Our proprietary design provides virtually complete isolation between all of the 16 elements. The standard LCC package allows easy integration into your surface mount applications. Numerous applications include Ratio and Scattering measurements, as well as Position Sensing. For custom packages, special electro-optic requirements, or to order these parts in die form, please contact our Applications group.



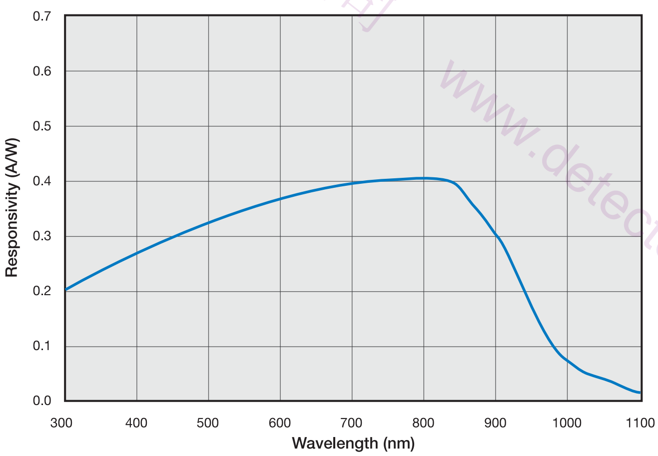
▪ APPLICATIONS

- Scattering Measurements
- Position Sensing

▪ FEATURES

- Speedy Response
- Extremely Low Cross-talk
- Surface Mount Design

▪ Typical Spectral Response

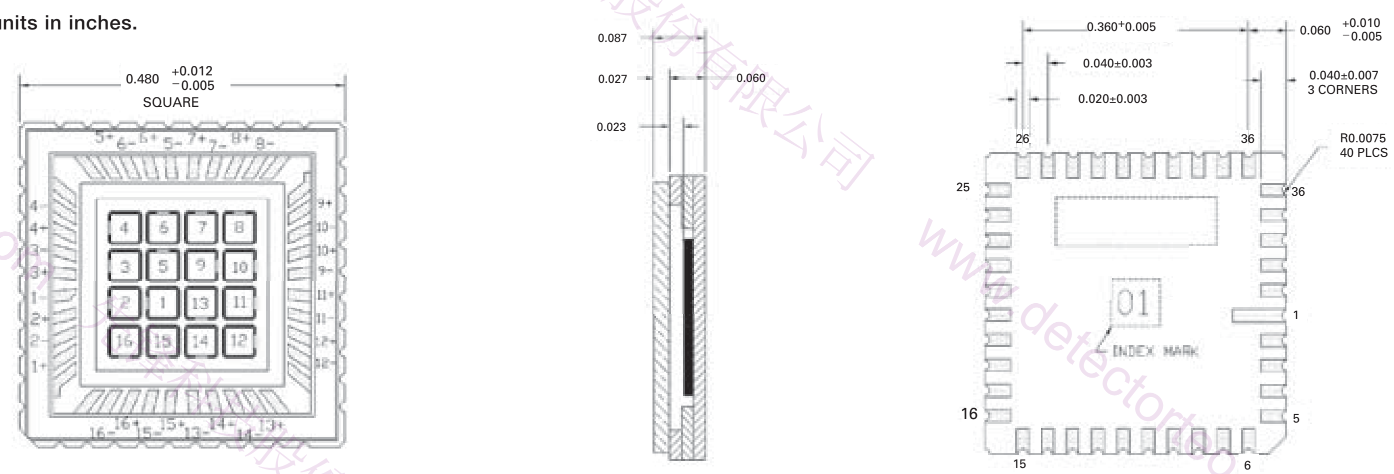


Model Number	Active Area: Area (mm²)	Active Area: Dimensions (mm)	Peak Responsivity Wavelength λp nm typ.	Responsivity (A/W) 633nm min.	Responsivity (A/W) 633nm typ.	Capacitance (pF) 0 V typ.	Shunt Resistance (GΩ) -10 mV typ.	Shunt Resistance (GΩ) -10 mV min.	NEP (W/√Hz) 0 V 810nm typ.	Crosstalk 0 V 633nm max.	Temp. Range (°C) Operating	Temp. Range (°C) Storage	Package Style ¶
4 x 4 Array Detector (Super-Blue Enhanced)													
UDT-4X4D	1.0	1.0 x 1.0	810	0.35	0.40	35pF	1.0	0.01	1.0 e-14	0.02%	-20 ~ +60	-20 ~ +80	Ceramic LCC

- Non-condensing temperature and storage range, Non-condensing environment.
- All Electro-Optical specifications are given on a per element basis.

Mechanical Specifications

All units in inches.



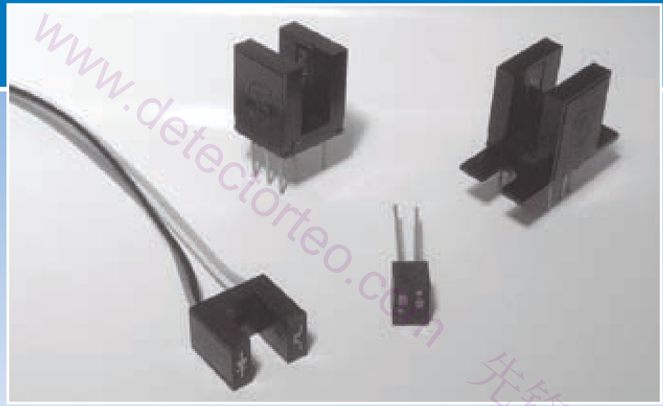
▪ Optical Switch Series

Transmissive and Reflective Photo-interrupters

Photo-interrupters are used to detect object passage and proximity presence, and they are available in two forms: transmissive and reflective.

In the transmissive group, the infared LED and phototransistor are contained in plastic molded package and mounted on opposing walls of a sensing gap. As object passes through the gap, the emitter light beam becomes interrupted and the sensor output shifts from a “closed” state to an “open” one.

As with the reflective group, user could provide a light detecting window with a visible light cut-off filter to reduce malfunctions caused by ambiant disturbance(s).



▪ APPLICATIONS

- Disk Rotation Detection
- Paper Feed Detection
- Smoke Detector (reflective)
- Proximity Detection (reflective)

▪ FEATURES

- Contactless Detection Capability
- Compact and Highly Reliable
- High Speed Response
- TTL Compatible
- Wire Contacts with OS-W200 Series

Model Number	LED Forward Voltage V_F (Volt)	LED Reverse Breakdown Voltage V_{BR} (Volt)		Sensor Breakdown Voltage V_B(Volt)	Sensor Light Current I_L (μA)	Sensor Dark Current I_D (nA)		Rise Time tr (μs)	Temp. Range (°C)		Package Style
	I_F=50mA	BV_R@IR=10μA		I_C=100μA	I_F=50mA@ 0.4inch	I_F=0mA V_{CE}=5V		V_{CC}=5V 1KΩ	Operating	Storage	
	typ.	min.	typ.	typ.	typ.	typ.	max.	typ.			
Reflective Transducer											
OS-P085	1.3	3.0	5.0	>50	100	10	100	150	-40 ~ +100		65/Plastic Molded

Model Number	LED Forward Voltage V_F (Volt)	Sensor Saturation Voltage Vsat(Volt) I_F=50mA	Sensor Breakdown Voltage V_B(Volt)	Sensor Light Current I_L (mA)	Sensor Dark Current I_D (nA)	Rise Time tr (μs)	Temp. Range (°C)		Package Style
	I_F=50mA	I_L=1.5mA	I_C=100μA	I_F=50mA V_{CE}=5V	I_F=0mA V_{CE}=5V	V_{CC}=5V	Operating	Storage	
	typ.	typ.	typ.	typ.	typ.	typ.			
Optical Interrupter									
OS-P190	1.5	0.85	>50	3	1.3	3(rise) 10(fall)	-40 ~ +85		67/Plastic Molded

Model Number	LED Forward Voltage V_F (Volt)	Sensor Saturation Voltage Vsat(Volt) I_F=35mA	Sensor Breakdown Voltage V_B(Volt)	Sensor Light Current I_L (mA)	Sensor Dark Current I_D (nA)	Rise Time tr (μs)	Temp. Range (°C)		Package Style
	I_F=20mA	V_{cc}=5V R_L=10kΩ	I_C=1mA	I_F=35mA V_{CE}=5V R_L=1kΩ	I_F=0mA V_{CE}=5V		Operating	Storage	
	typ.	typ.	typ.	typ.	typ.	typ.			
‘200’ Series, Optical Interrupter									
OS-W200A	1.2	0.12		3.2	0.25	7.5(rise) 10(fall)			66/Plastic Molded
OS-W200B	1.25	0.15	>30	2.3	0.15	10.5 (rise) 13 (fall)	-40 ~ +85		
OS-P200	1.35	0.18		2.5	0.16	12.5 (rise) 14 (fall)			76/Plastic Molded

- “OS” prefix stands for Optical Switch
- “P” or “W” denotes either Pin or Wire contacts.
- Number signifies the sensing gap distance as shown in the package schematics.
- Suffix (A, B..) differentiates electro-optical disparities.

¶ For mechanical drawings please refer to pages 58 thru 69.

Photodiode Care and Handling Instructions

AVOID DIRECT LIGHT
Since the spectral response of silicon photodiode includes the visible light region, care must be taken to avoid photodiode exposure to high ambient light levels, particularly from tungsten sources or sunlight. During shipment from OSI Optoelectronics, your photodiodes are packaged in opaque, padded containers to avoid ambient light exposure and damage due to shock from dropping or jarring.

AVOID SHARP PHYSICAL SHOCK
Photodiodes can be rendered inoperable if dropped or sharply jarred. The wire bonds are delicate and can become separated from the photodiode's bonding pads when the detector is dropped or otherwise receives a sharp physical blow.

CLEAN WINDOWS WITH OPTICAL GRADE CLOTH / TISSUE
Most windows on OSI Optoelectronics photodiodes are either silicon or quartz. They should be cleaned with isopropyl alcohol and a soft (optical grade) pad.

OBSERVE STORAGE TEMPERATURES AND HUMIDITY LEVELS
Photodiode exposure to extreme high or low storage temperatures can affect the subsequent performance of a silicon photodiode. Storage temperature guidelines are presented in the photodiode performance specifications of this catalog. Please maintain a non-condensing environment for optimum performance and lifetime.

OBSERVE ELECTROSTATIC DISCHARGE (ESD) PRECAUTIONS
OSI Optoelectronics photodiodes, especially with IC devices (e.g. Photops) are considered ESD sensitive. The photodiodes are shipped in ESD protective packaging. When unpacking and using these products, anti-ESD precautions should be observed.

DO NOT EXPOSE PHOTODIODES TO HARSH CHEMICALS
Photodiode packages and/or operation may be impaired if exposed to CHLOROTHENE, THINNER, ACETONE, or TRICHLOROETHYLENE.

INSTALL WITH CARE
Most photodiodes in this catalog are provided with wire or pin leads for installation in circuit boards or sockets. Observe the soldering temperatures and conditions specified below:

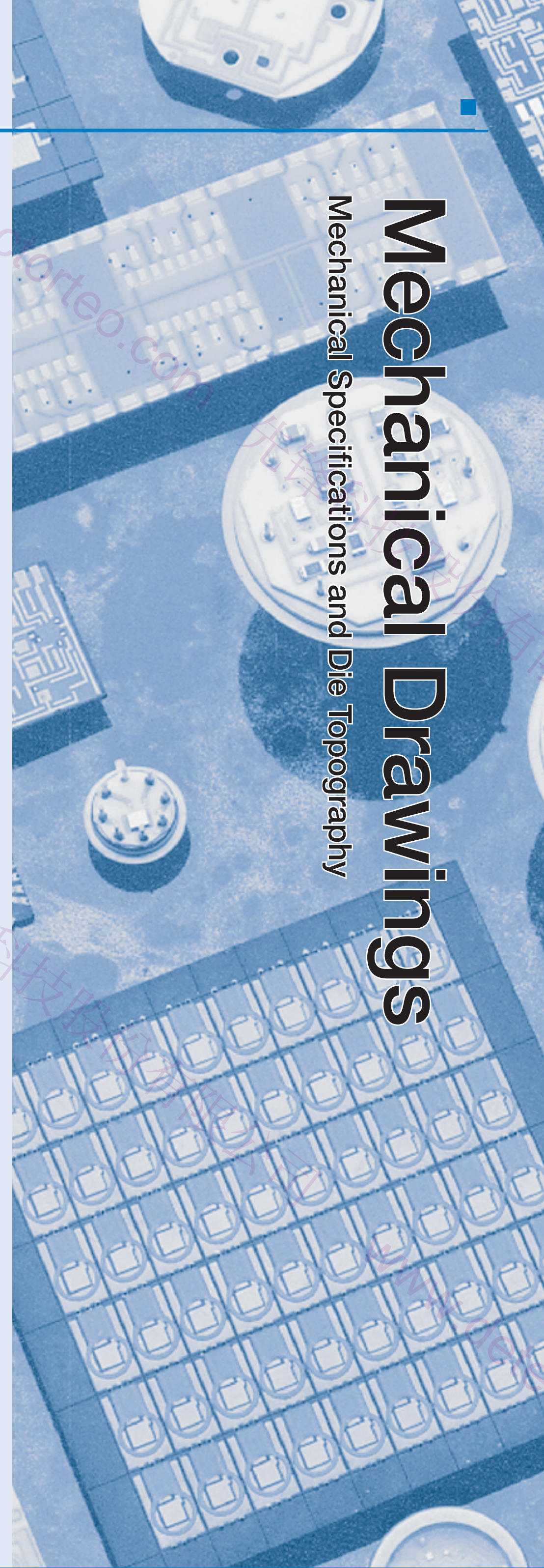
Soldering Iron:	Soldering 30 W or less Temperature at tip of iron 300°C or lower.	
Dip Soldering:	Bath Temperature: Immersion Time: Soldering Time:	260±5°C. within 5 Sec. within 3 Sec.
Vapor Phase Soldering:	DO NOT USE	
Reflow Soldering:	DO NOT USE	

Photodiodes in plastic packages should be given special care. Clear plastic packages are more sensitive to environmental stress than those of black plastic. Storing devices in high humidity can present problems when soldering. Since the rapid heating during soldering stresses the wire bonds and can cause wire to bonding pad separation, it is recommended that devices in plastic packages to be baked for 24 hours at 85°C.

The leads on the photodiode **SHOULD NOT BE FORMED**. If your application requires lead spacing modification, please contact OSI Optoelectronics Applications group at (310)978-0516 before forming a product's leads. Product warranties could be voided.

Mechanical Drawings

Mechanical Specifications and Die Topography



1. Parameter Definitions:

A = Distance from top of chip to top of glass.
a = Photodiode Anode.
B = Distance from top of glass to bottom of case.
c = Photodiode Cathode
(Note: cathode is common to case in metal package products unless otherwise noted).
W = Window Diameter.
F.O.V. = Filed of View (see definition below).

2. Dimensions are in inches (1 inch = 25.4 mm).

3. Pin diameters are 0.018 ± 0.002" unless otherwise specified.

4. Tolerances (unless otherwise noted)

General: 0.XX ±0.01"
0.XXX ±0.005"
Chip Centering: ±0.010"
Dimension ‘A’: ±0.015"

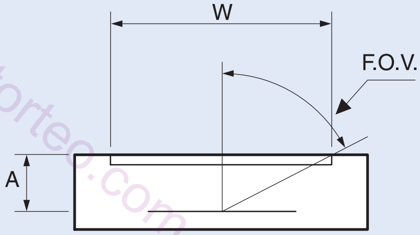
5. Windows

All **‘UV’** Enhanced products are provided with QUARTZ glass windows, 0.027 ± 0.002" thick.

All **‘XUV’** products are provided with removable windows.

All **‘DLS’** PSD products are provided with A/R coated glass windows.

All **‘FIL’** photoconductive and photovoltaic products are epoxy filled instead of glass windows.



$$F.O.V. = \tan^{-1}\left(\frac{W}{2A}\right)$$

For Further Assistance
Please Call One of Our Experienced
Sales and Applications Engineers

310-978-0516

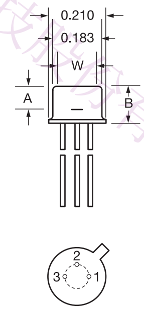
- Or -
On the Internet at

www.osioptoelectronics.com

Mechanical Specifications

All units in inches. Pinouts are bottom view.

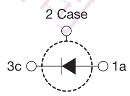
1 TO-18



Pin Circle Dia.=0.100

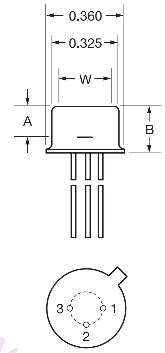
Products:

PIN-020A
PIN-040A
PIN-040-DP/SB



P/N	A	B	W
PIN-020A	0.075	0.200	0.155
PIN-040A	0.075	0.200	0.155

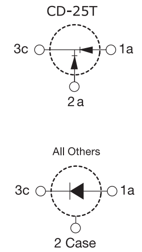
2 TO-5



Pin Circle Dia.=0.200

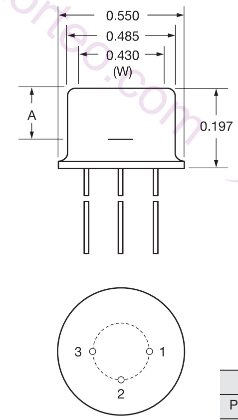
Products:

PIN-5DI
PIN-5DPI
PIN-13DI
PIN-13DPI
PIN-5-YAG
CD-25T



P/N	A	B	W
All Others	0.094	0.180	0.240
CD-25T	0.050	0.130	0.23

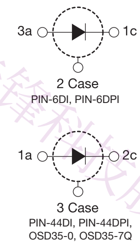
3 TO-8



Pin Circle Dia.=0.295

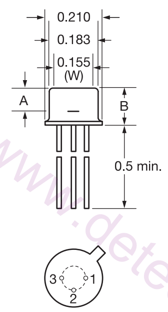
Products:

PIN-6DI
PIN-6DPI
PIN-44DI
PIN-44DPI
OSD35-0
OSD35-7Q



P/N	A
PIN-6DI/6DPI	0.115
PIN-44DI/44DPI	0.125
OSD35-0	0.130
OSD35-7Q	0.130 Quartz Window

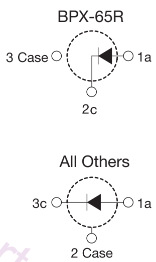
4 TO-18



Pin Circle Dia.=0.100

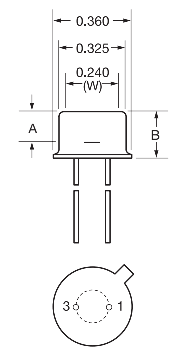
Products:

PIN-2DI
PIN-2DPI
PIN-3CDP
PIN-3CDPI
BPX-65R



P/N	A	B
BPX-65R	0.070	0.200
All Others	0.090	0.150

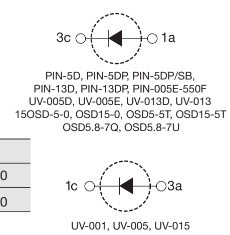
5 TO-5



Pin Circle Dia.=0.200

Products:

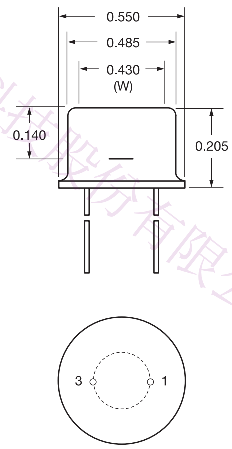
PIN-5D
PIN-5DP
PIN-5DP/SB
PIN-13D
PIN-13DP
PIN-005E-550F
UV-001
UV-005
UV-005D
UV-005E
UV-013D
UV-013E
UV-015
OSD-5-0
OSD15-0
OSD5-5T
OSD15-5T
OSD5.8-7Q
OSD5.8-7U



P/N	A	B
OSD-Prefix Devices	0.050	0.130
All Others	0.102	0.180

Quartz Window: OSD5.8-7Q
UV Transmissive Window: OSD5.8-7U

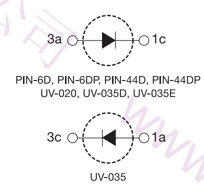
6 TO-8



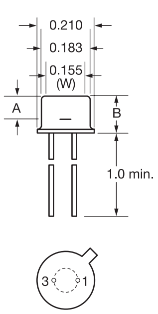
Pin Circle Dia.=0.295

Products:

PIN-6D
PIN-6DP
PIN-44D
PIN-44DP
UV-020
UV-035D
UV-035E
UV-035



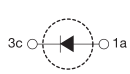
7 TO-18



Pin Circle Dia.=0.100

Products:

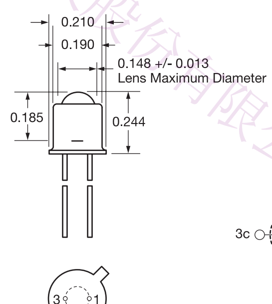
PIN-3CD
PIN-3CDP
BPX-65
OSD1-0
OSD1-5T
OSD3-5T
OSD1.2-7Q
OSD1.2-7U



P/N	A	B
PIN-3CD / 3CDP	0.087	0.146
BPX-65	0.075	0.200
OSD-Prefix Devices	0.080	0.200

Quartz Window: OSD1.2-7Q
UV Transmissive Window: OSD1.2-7U

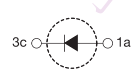
8 TO-18



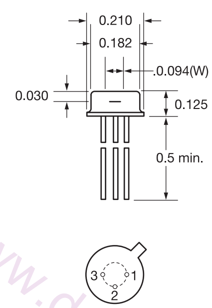
Pin Circle Dia.=0.100

Products:

PIN-125DPL



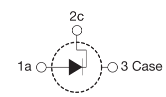
9 TO-18



Pin Circle Dia.=0.100

Products:

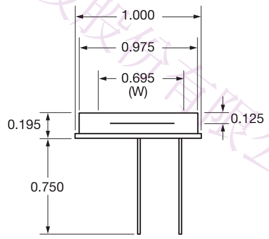
PIN-HR005
PIN-HR008
PIN-HR020
PIN-HR026
PIN-HR040

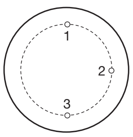


All units in inches. Pinouts are bottom view.

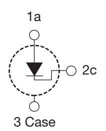
10 Low Profile

Products:
PIN-10DI
PIN-10DPI
PIN-10DPI/SB
UV-50L
UV-100L



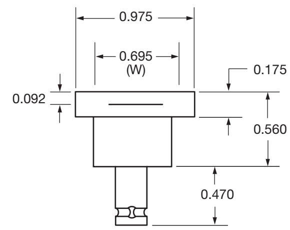


Pin Circle Dia.=0.73



11 BNC

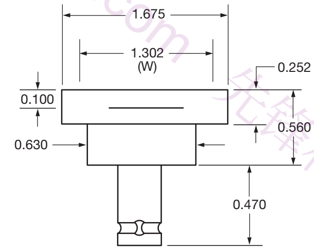
Products:
PIN-10D
PIN-10DP
PIN-10DP/SB
UV-50
UV-100



Outer Contact — Anode	PIN-10D, PIN-10DP, PIN-10DP/SB
Outer Contact — Cathode	UV-50, UV-100

12 BNC

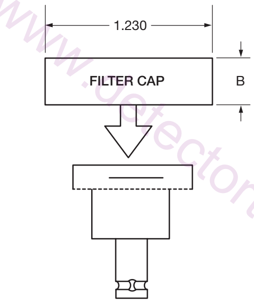
Products:
PIN-25D
PIN-25DP

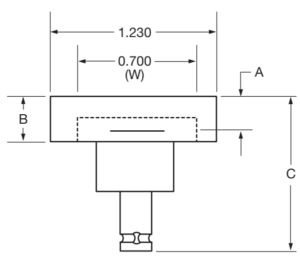


Outer Contact — Anode

13 Special BNC

Products:
PIN-10AP
PIN-10DF



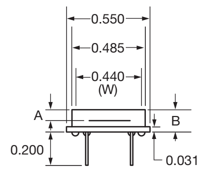


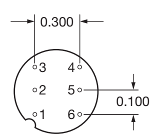
Dimensions

P/N	A	B	C
PIN-10DF	0.217	0.330	1.020
PIN-10AP	0.386	0.550	1.415

14 Special Plastic

Products:
FIL-5C
FIL-20C
FIL-UV20
FIL-C4DG





Dimensions

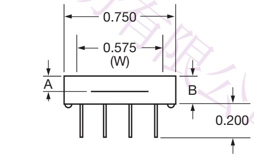
P/N	A	B
FIL-5C FIL-20C	0.060	0.130
FIL-UV005 FIL-UV20 FIL-C4DG	0.087	0.152

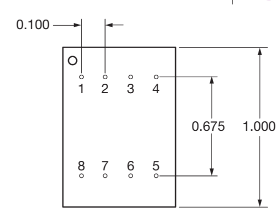
Pinouts

P/N	1	2	3	4	5	6
FIL-5C FIL-20C FIL-UV005	a	-	c	a	-	c
FIL-UV20	c	-	a	c	-	a
FIL-C4DG	c	a	c	c	a	c

15 Special Plastic

Products:
FIL-44C
FIL-100C
FIL-UV50
FIL-UV100
FIL-C10DG





Dimensions

P/N	A	B
FIL-44C FIL-100C	0.052	0.130
FIL-UV50 FIL-UV100	0.090	0.155
FIL-C10DG	0.082	0.155

Pinouts

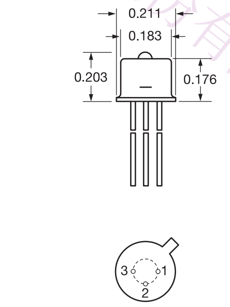
P/N	1	2	3	4	5	6	7	8
FIL-44C FIL-100C	a	-	-	c	a	-	-	c
FIL-UV50 FIL-UV100	c	-	-	a	c	-	-	a
FIL-C10DG	c	a	a	c	c	a	a	c

Mechanical Specifications

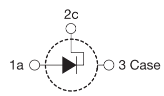
All units in inches. Pinouts are bottom view.

16 TO-18 Lensed Cap

Products:
PIN-HR005L
PIN-HR008L
PIN-HR020L
PIN-HR026L
PIN-HR040L

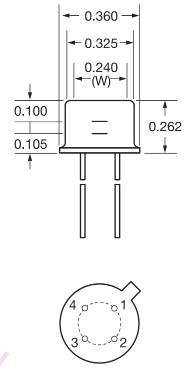


Pin Circle Dia.=0.100

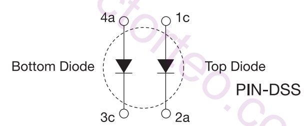


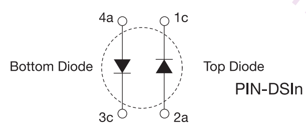
17 TO-5

Products:
PIN-DSS
PIN-DSIn



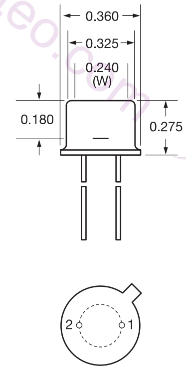
Pin Circle Dia.=0.220



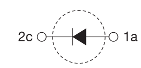


18 TO-5

Products:
PIN-005D-245F

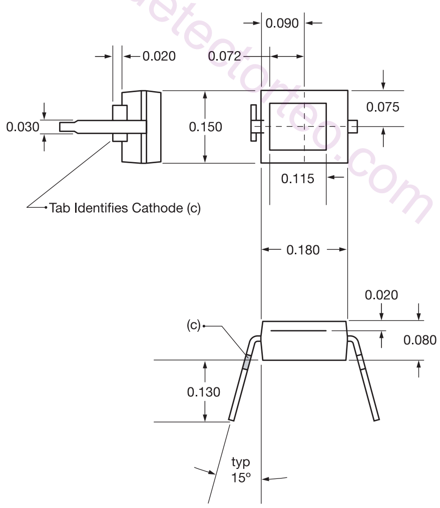


Pin Circle Dia.=0.215



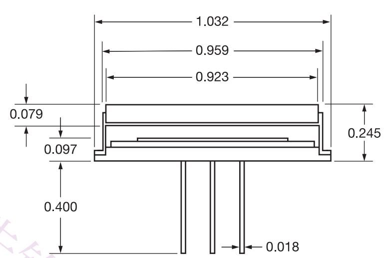
19 Plastic Mold

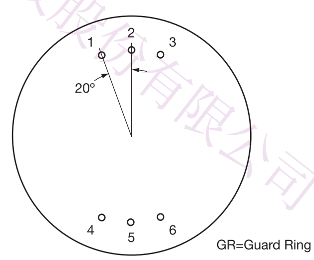
Products:
BPW34
BPW34B



20 Special Metal

Products:
SPOT-15-YAG
SPOT-9-YAG
PIN-100-YAG





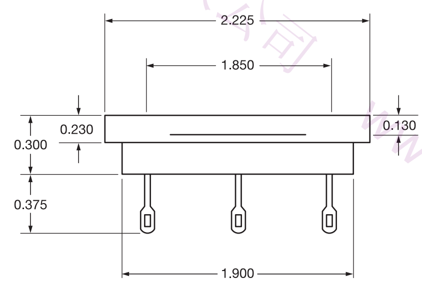
Pin Circle Dia.=0.750

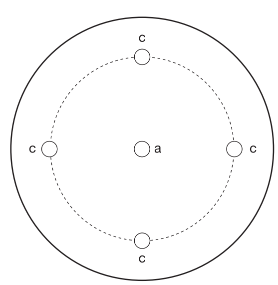
Pinouts

P/N	1	2	3	4	5	6
SPOT-15-YAG	C1	GR	C4	C2	A	C3
SPOT-9-YAG	C1	GR	C4	C2	A	C3
PIN-100-YAG	--	C	--	--	A	--

21 Special Metal

Products:
SC-50D





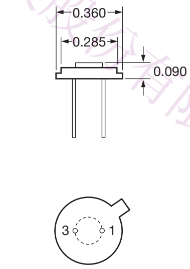
Pin Circle Dia.=1.110

All units in inches. Pinouts are bottom view.

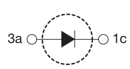
22 TO-5

Products:

XUV-005



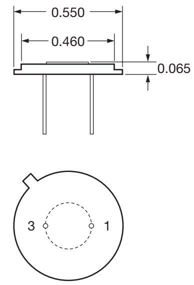
Pin Circle Dia.=0.200



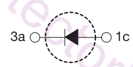
23 TO-8

Products:

XUV-020
XUV-035



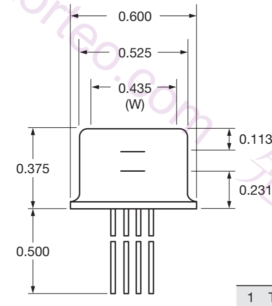
Pin Circle Dia.=0.295

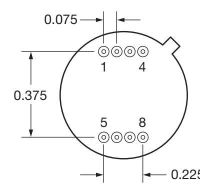


24 TO-8

Products:

PIN-DSIn-TEC





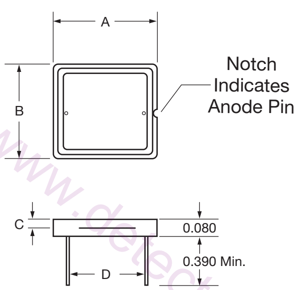
Pinout

1	TEC (-)
2	Thermistor
3	Thermistor
4	TEC (+)
5	Bottom InGaAs, Cathode
6	Bottom InGaAs, Anode
7	Top Silicon, Anode
8	Top Silicon, Cathode

25 Special Ceramic / Plastic

Products:

RD-100
RD-100A
UV-35P
UV-005EC
UV-035EC
UV-100EC
UV-005DC
UV-035DC
UV-100DC
XUV-50C
XUV-100C
OSD35-7CO
OSD35-LR-A
OSD35-LR-D



Dimensions

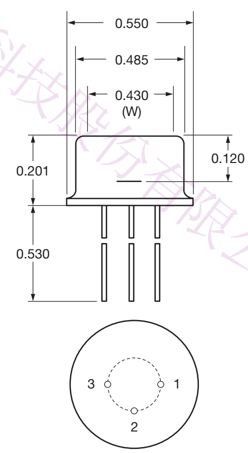
P/N	A	B	C	D
UV-005EC	0.400	0.350	0.030	0.280
UV-035EC	0.400	0.350	0.030	0.290
UV-100EC	0.650	0.590	0.048	0.500
UV-005DC	0.400	0.350	0.030	0.280
UV-035DC	0.400	0.350	0.030	0.290
UV-100DC	0.650	0.590	0.053	0.500
XUV-50C	0.650	0.590	0.027	0.490
XUV-100C	0.650	0.590	0.027	0.490
RD-100	0.650	0.590	0.027	0.490
RD-100A	0.650	0.590	0.027	0.490
UV-35P	0.390	0.345	0.050	0.275
OSD35-7CO	0.390	0.350	---	0.290
OSD35-LR-A	0.390	0.350	---	0.290
OSD35-LR-D	0.390	0.350	---	0.290

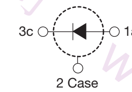
Note: OSD35-prefix packages come with 0.31" (min.) leads

26 TO-8

Products:

PIN-RD07
PIN-RD15



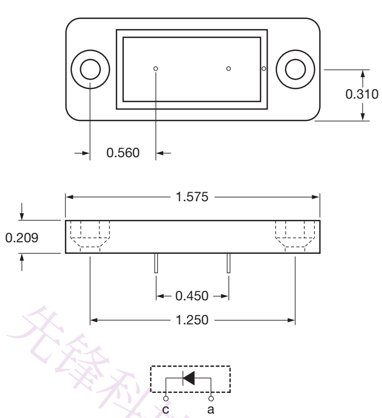


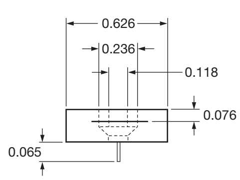
Pin Circle Dia.=0.295

27 Special Plastic

Products:

PIN-220D
PIN-220DP
PIN-220DP/SB



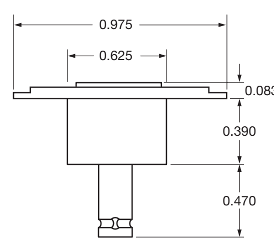


Pin Diameter=0.040

28 BNC

Products:

XUV-100



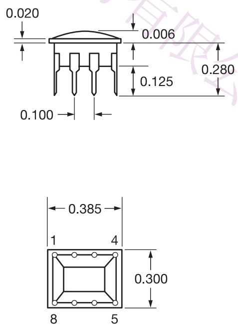
BNC Connector
Outer Contact = Cathode

Mechanical Specifications

All units in inches. Pinouts are bottom view.

29 8 PIN DIP

Products: UDT-451

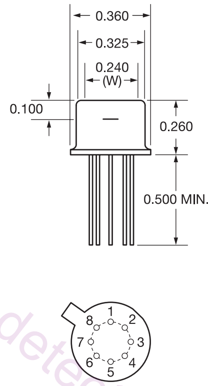


Pinout

1	Offset Null
2	Inverting Input Detector Cathode
3	Noninverting Input
4	V (-)
5	Offset Null
6	Output
7	V (+)
8	Detector Anode

30 TO-5

Products: UDT-455, UDT-455LN, UDT-455UV, UDT-455UV/LN, OSI-515



Pin Circle Dia.=0.23

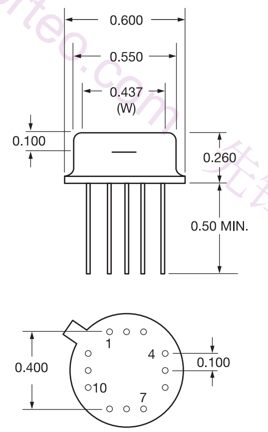
Pinout

1	Offset Null
2	Inverting Input Detector Cathode
3	Noninverting Input
4	V (-)
5	Offset Null
6	Output
7	V (+)
8	Detector Anode

OSI-515 pin 1 & 5 are N/C

31 TO-8

Products: UDT-020D, UDT-020UV



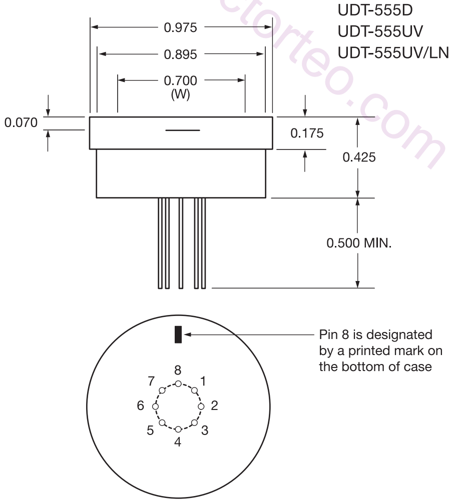
Pin Circle Dia.=0.295

Pinout

1	Not Used
2	Not Used
3	Offset Null
4	Offset Null
5	Inverting Input
6	Noninverting Input
7	Detector Cathode
8	Case Ground
9	Detector Anode
10	V (-)
11	Output
12	V (+)

32 Special

Products: UDT-055UV, UDT-555D, UDT-555UV, UDT-555UV/LN



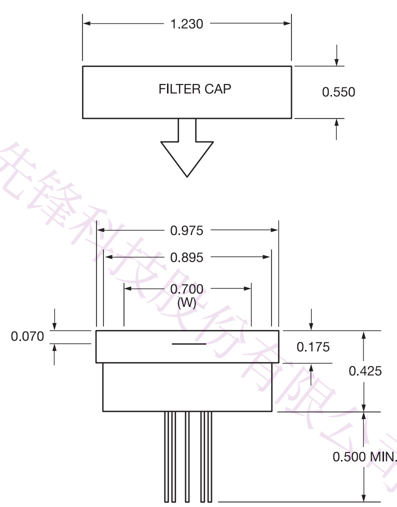
Pin Circle Dia.=0.230

Pinout

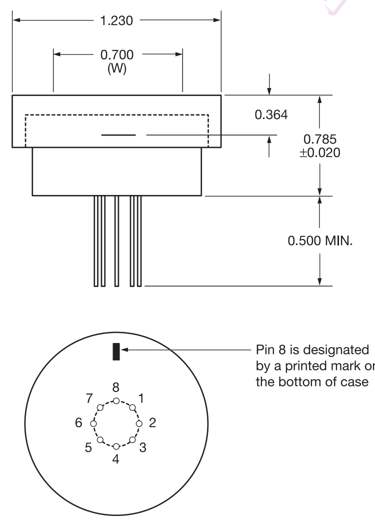
1	Offset Null
2	Inverting Input Detector Cathode
3	Noninverting Input
4	V (-)
5	Offset Null
6	Output
7	V (+)
8	Detector Anode and Case

33 Special

Products: PIN-555AP



UDT-555D



Pin Circle Dia.=0.230

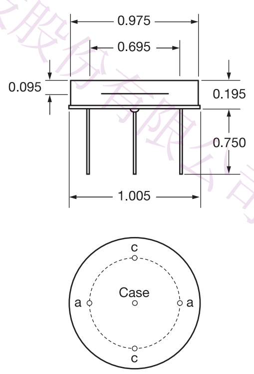
Pinout

1	Offset Null
2	Inverting Input Detector Cathode
3	Noninverting Input
4	V (-)
5	Offset Null
6	Output
7	V (+)
8	Detector Anode and Case

All units in inches. Pinouts are bottom view.

34 Special

Products: DL-10

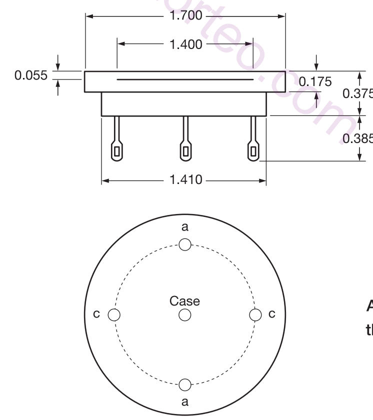


Pin Circle Dia.=0.730
Bottom View

Anode contacts are on the top of the detector.

35 Special

Products: DL-20

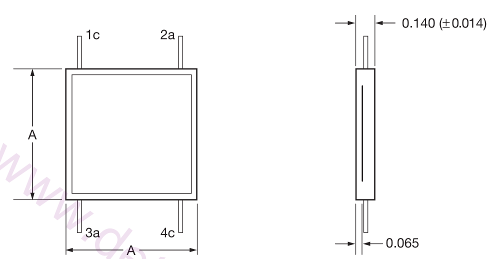


Pin Dia.=0.040
Pin Circle Dia.=1.110
Bottom View

Anode contacts are on the top of the detector.

36 Special Ceramic

Products: DLS-10, DLS-20

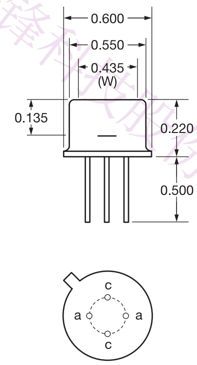


Pin Dia.=0.028 Typ.
Pin Length.=0.250 Typ.

P/N	A
DLS-10	1.000
DLS-20	1.500

37 TO-8

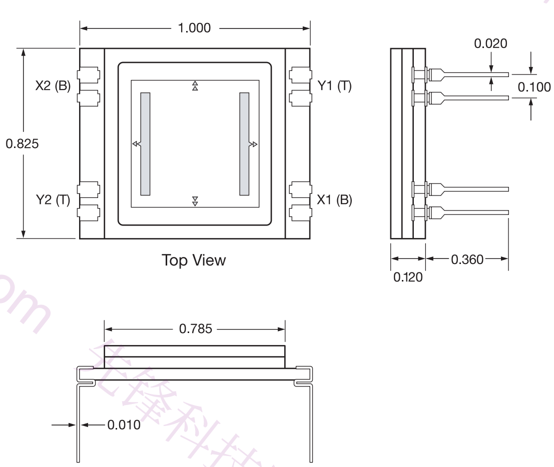
Products: DL-2, DLS-2, DL-4, DLS-4



Pin Circle Dia.=0.400
Bottom View

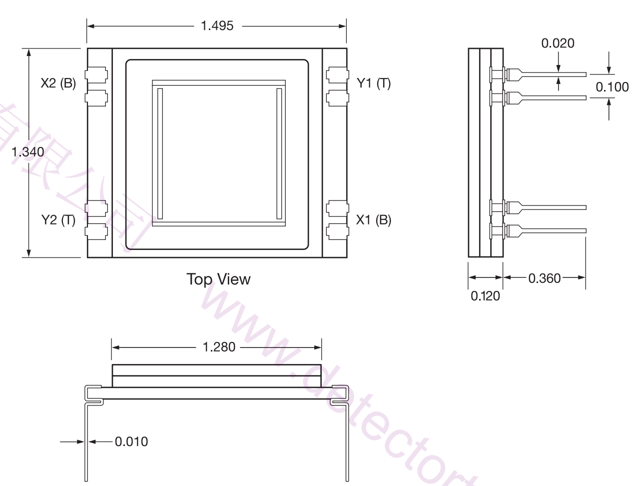
38 Low Cost Ceramic

Products: DL-10C



39 Low Cost Ceramic

Products: DL-20C



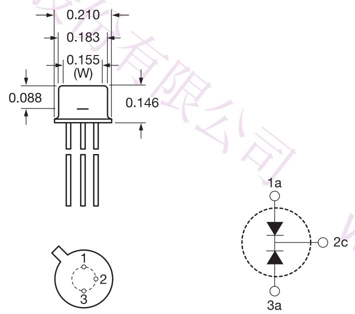
Mechanical Specifications

All units in inches. Pinouts are bottom view.

40 TO-18

Products:

SPOT-2DMI

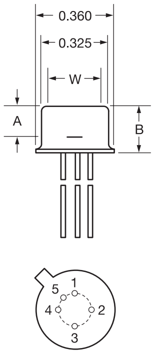


Pin Circle Dia.=0.100

41 TO-5

Products:

SC-4D
SL3-1
SPOT-2D
SPOT-3D
SPOT-4D
SPOT-4DMI
SPOT-4DUV
QD7-0



Pin Circle Dia.=0.200

Dimensions

P/N	A	B	W
SC-4D	0.071	0.142	0.240
SL3-1	0.106	0.195	0.217
SPOT-2D	0.063	0.114	0.240
SPOT-3D	0.104	0.138	0.240
SPOT-4D	0.063	0.142	0.240
SPOT-4DMI	0.063	0.142	0.240
SPOT-4DUV	0.063	0.142	0.240
QD7-0	0.050	0.130	0.230

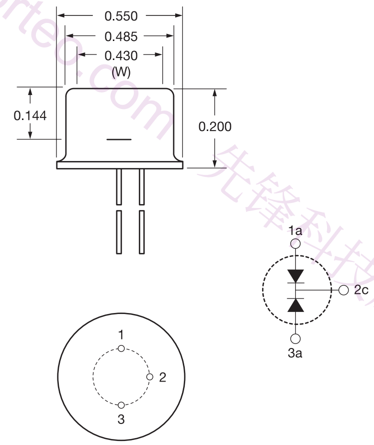
Pinouts

P/N	1	2	3	4	5
SC-4D	c	c	c	c	a
SL3-1	a	c	a	--	--
SPOT-2D	a	c	a	--	--
SPOT-3D	a	c	a	--	--
SPOT-4D	a	a	a	a	c
SPOT-4DMI	a	a	a	a	c
SPOT-4DUV	a	a	a	a	c
QD7-0	a	a	a	a	c

42 TO-8

Products:

SL5-1

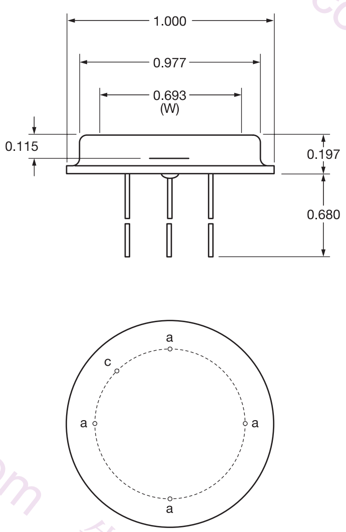


Pin Circle Dia.=0.300

43 Low Profile

Products:

SPOT-9D
SPOT-9DMI

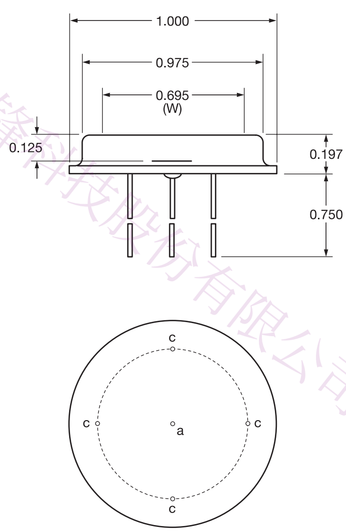


Pin Circle Dia.=0.730

44 Special

Products:

SC-10D

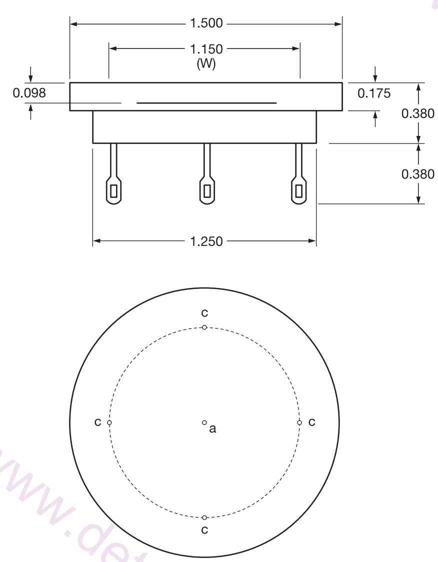


Pin Circle Dia.=0.730

45 Special

Products:

SC-25D

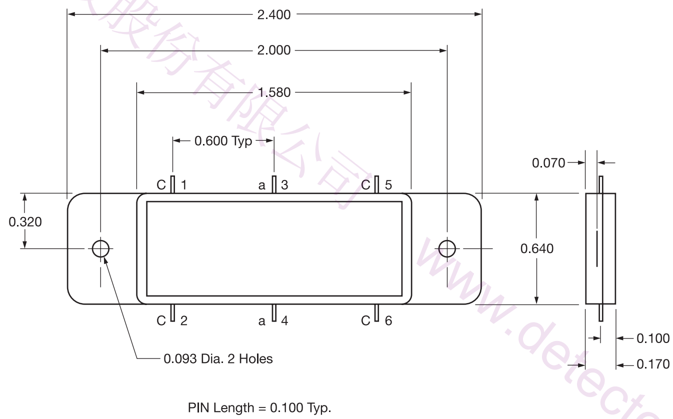


Pin Circle Dia.=0.950

All units in inches.

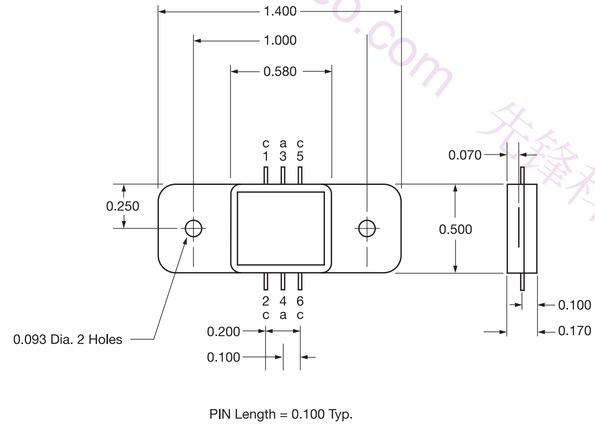
46 Plastic

Products: LSC-30D



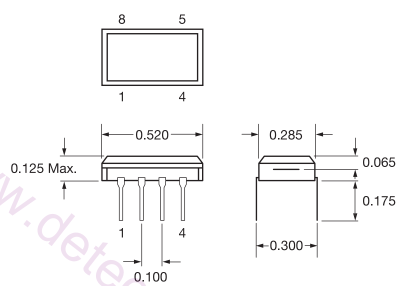
47 Plastic

Products: LSC-5D



48 8-PIN DIP

Products: SL3-2, SL5-2

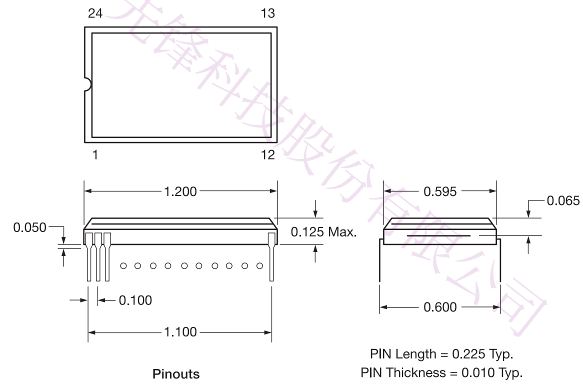


Pinouts

2, 7	Anode 1
1, 4, 5, 8	Common Cathode
3, 6	Anode 2

49 24-PIN DIP

Products: SL-15

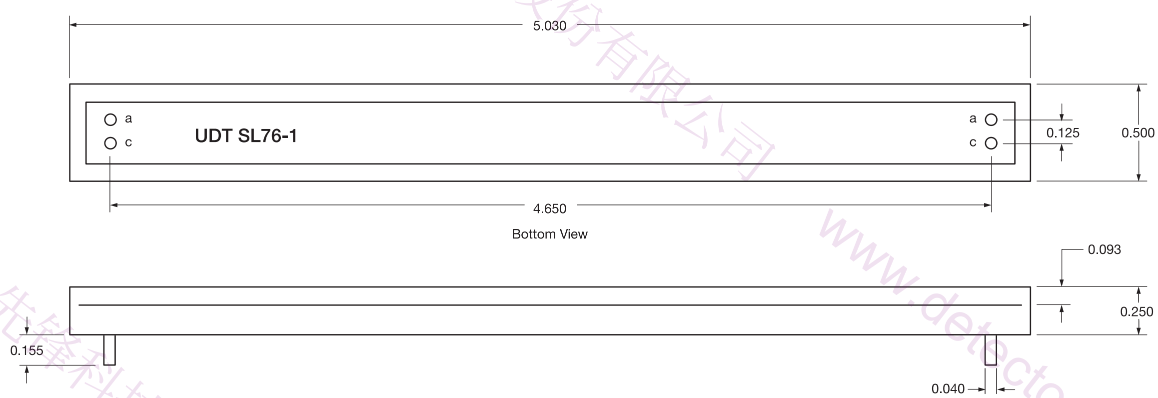


Pinouts

11	Anode 1
12, 24	Common Cathode
23	Anode 2
All Other Pins NOT CONNECTED	

50 Special

Products: SL76-1

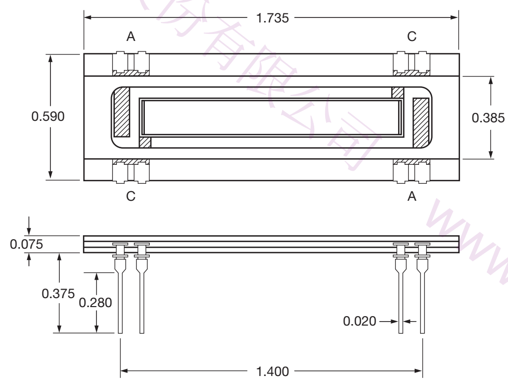


Mechanical Specifications

All units in inches. Pinouts are top view.

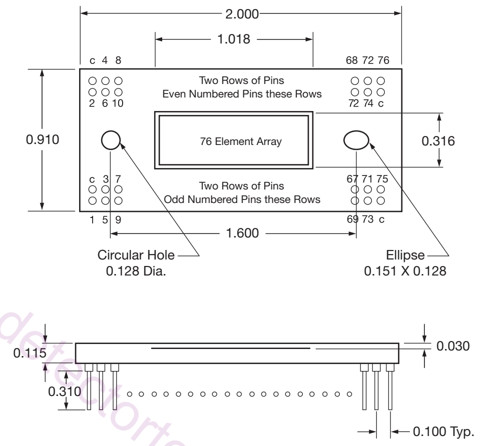
51 Low Cost Ceramic

Products: SL-30



52 Special

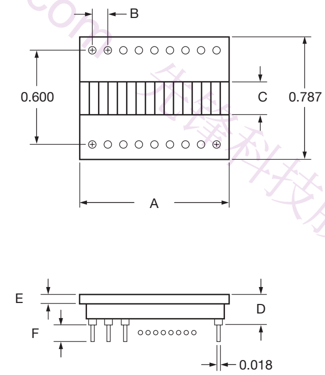
Products: A2V-76



Pin Diameter = 0.025

53 Special

Products: A2V-16



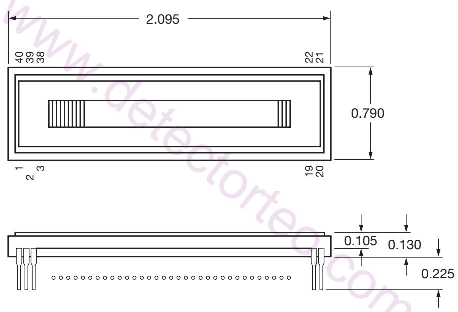
Dimensions

P/N	A	B	C	D	E	F
A2V-16	1	0.1	0.212	0.2	0.062	0.06

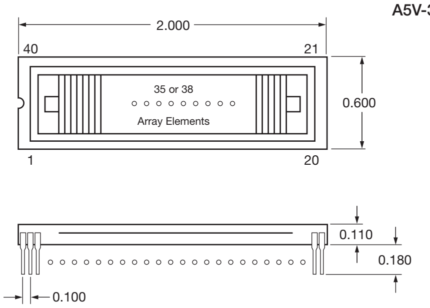
54 40-PIN-DIP

Products: A5V-35UV, A5C-35, A5C-38, A5V-35, A5V-38

A5V-35UV



A5C-35, A5C-38
A5V-35, A5V-38



35 Element Array

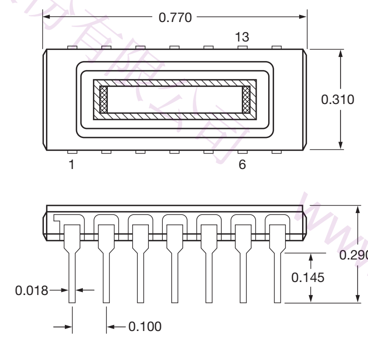
Pin Number	Element Number	Pin Number	Element Number
1	C	21	C
2	2	22	35
3	4	23	33
4	6	24	31
5	8	25	29
6	10	26	27
7	12	27	25
8	14	28	23
9	16	29	21
10	18	30	19
11	--	31	17
12	20	32	15
13	22	33	13
14	24	34	11
15	26	35	9
16	28	36	7
17	30	37	5
18	32	38	3
19	34	39	1
20	C	40	C

38 Element Array

Pin Number	Element Number	Pin Number	Element Number
1	C	21	C
2	2	22	37
3	4	23	35
4	6	24	33
5	8	25	31
6	10	26	29
7	12	27	27
8	14	28	25
9	16	29	23
10	18	30	21
11	20	31	19
12	22	32	17
13	24	33	15
14	26	34	13
15	28	35	11
16	30	36	9
17	32	37	7
18	34	38	5
19	36	39	3
20	38	40	1

55 14-PIN DIP

Products: SL-10-1

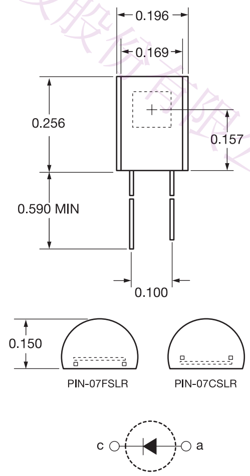


Pin 1 = Cathode
Pin 6, 13 = Anode

All units in inches.

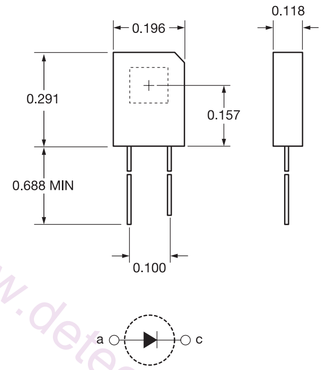
56 Lead Frame Molded

Products:
PIN-07SLR
PIN-07FSLR



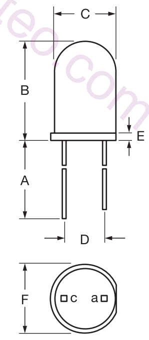
57 Lead Frame Molded

Products:
PIN-07CSL
PIN-07FSL



58 Lead Frame Molded

Products:
PIN-01CT3
PIN-01FT3
PIN-01CT5
PIN-01FT5

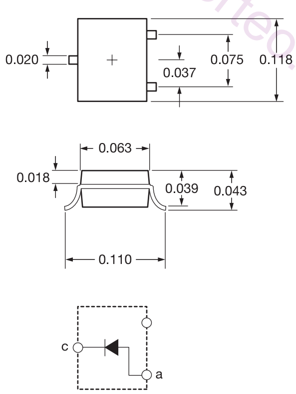


Dimensions

P/N	A	B	C	D	E	F
PIN-01CT3 PIN-01FT3	0.650	0.213	0.118	0.090	0.031	0.154
PIN-01CT5 PIN-01FT5	1.040	0.343	0.197	0.100	0.039	0.228

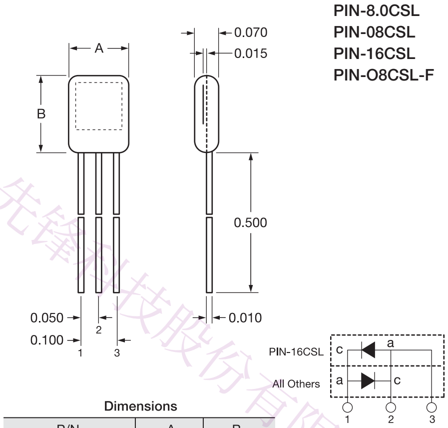
59 Lead Frame Molded

Products:
PIN-0.1CJ
PIN-01FJ



60 Lead Frame Molded

Products:
PIN-0.81CSL
PIN-4.0CSL
PIN-8.0CSL
PIN-08CSL
PIN-16CSL
PIN-O8CSL-F

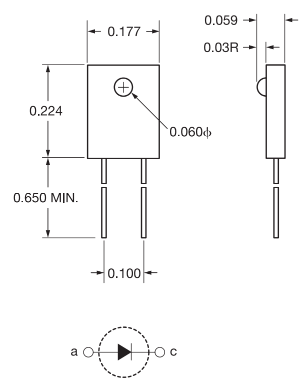


Dimensions

P/N	A	B
PIN-16CSL	0.215	0.264
All Others	0.170	0.220

61 Lead Frame Molded

Products:
PIN-01CLSL
PIN-01FLSL



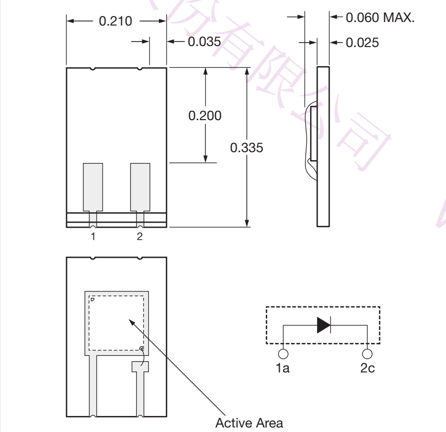
Mechanical Specifications

All units in inches.

62 Leadless Ceramic

Products:

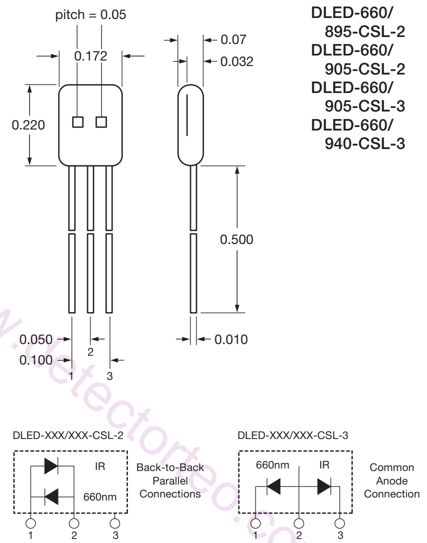
PIN-0.81-LLS
PIN-4.0-LLS
PIN-8.0-LLS



63 Lead Frame Molded

Products:

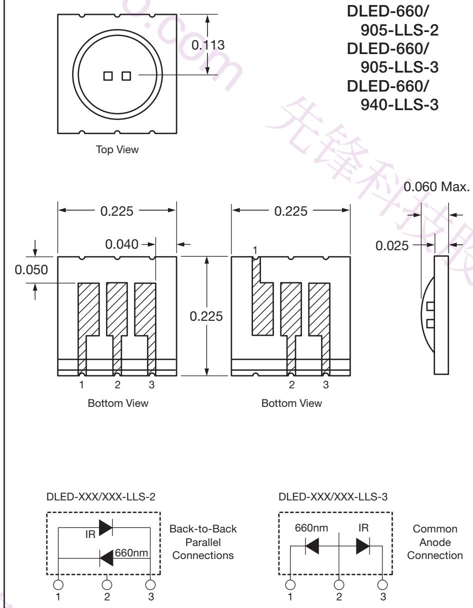
DLED-660/
880-CSL-2
DLED-660/
895-CSL-2
DLED-660/
905-CSL-2
DLED-660/
905-CSL-3
DLED-660/
940-CSL-3



64 Leadless Ceramic

Products:

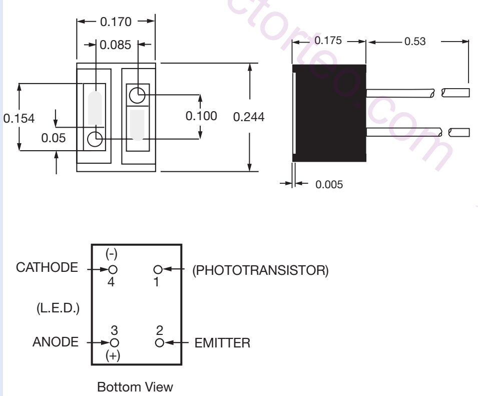
DLED-660/
880-LLS-2
DLED-660/
895-LLS-2
DLED-660/
905-LLS-2
DLED-660/
905-LLS-3
DLED-660/
940-LLS-3



65 Plastic Molded

Products:

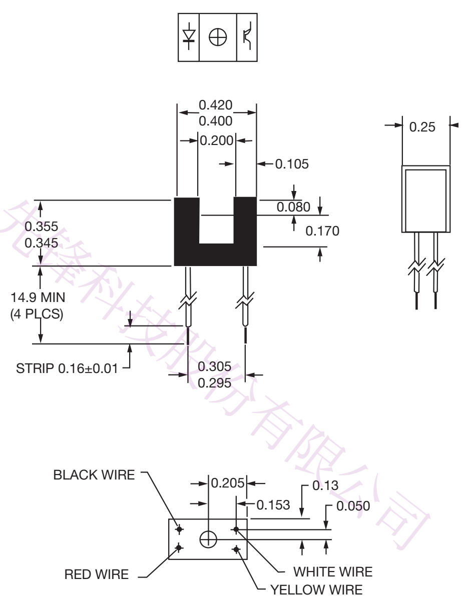
OS-P085



66 Plastic Molded

Products:

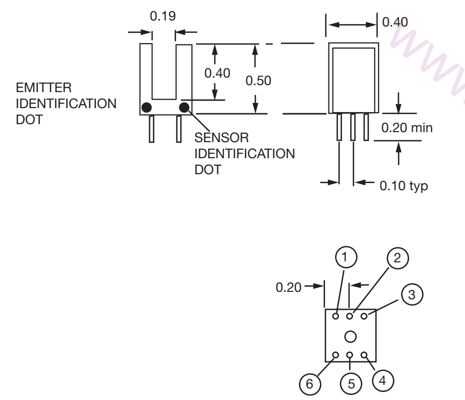
OS-W200A
OS-W200B



67 Plastic Molded

Products:

OS-P-190



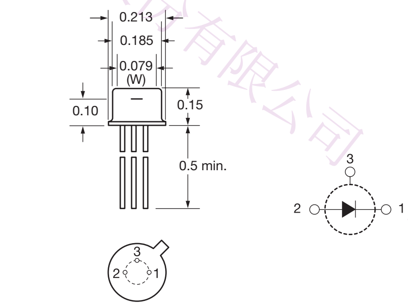
Pinout

PIN	Description
1	Emitter Cathode
2	Emitter Anode
3	Emitter Anode
4	Phototransistor Collector
5	Phototransistor Emitter
6	Phototransistor Emitter

All units in inches. Pinouts are bottom view.

68 TO-18

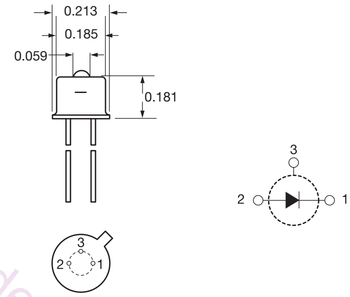
Products:
APD-300
APD-500



Pin Circle Dia.=0.100

69 TO-18

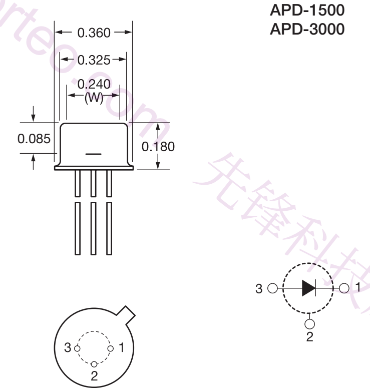
Products:
APD-300L
APD-500L



Pin Circle Dia.=0.100

70 TO-5

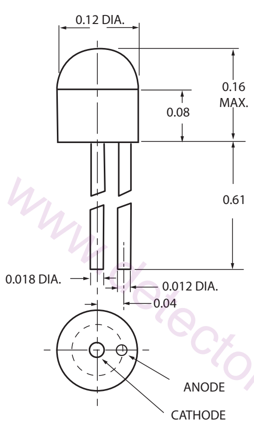
Products:
APD-900
APD-1500
APD-3000



Pin Circle Dia.=0.200

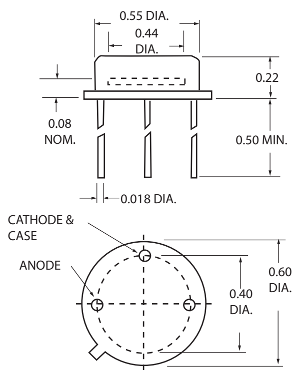
71 Plastic

Products:
CD-1705



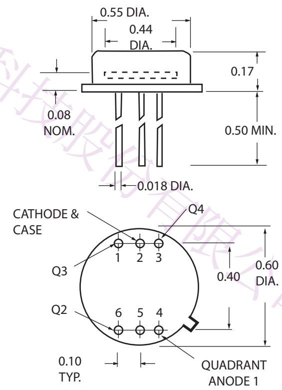
72 TO-8

Products:
OSD60-0
OSD60-5T



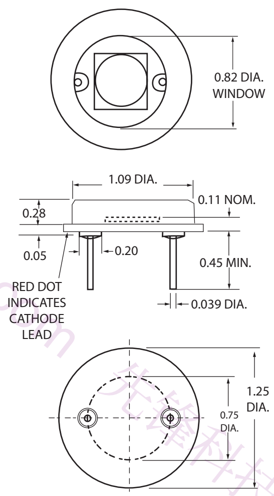
73 TO-8

Products:
QD50-0



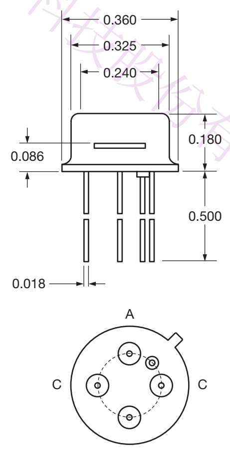
74 Special

Products:
OSD100-0A
OSD100-5TA



75 TO-5

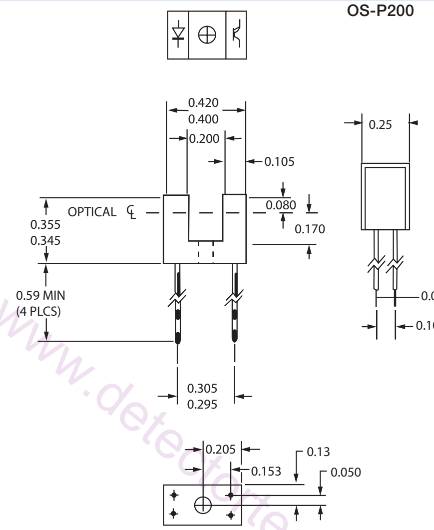
Products:
DLS-2S



Pin Circle Dia.= 0.200
Bottom View

76 Plastic Molded

Products:
OS-P200

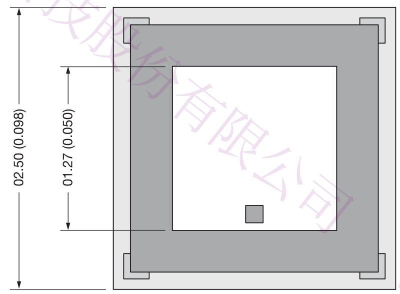


Die Topography

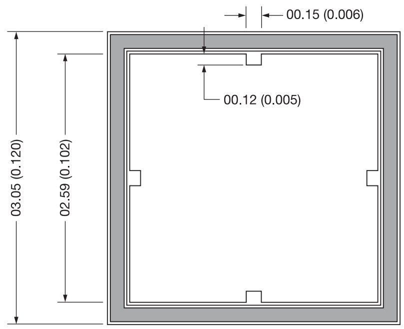
The following die topographies are for reference only. They shall not be used for any design purposes. Consult an Applications Engineer for further details and accurate dimensions.

All chip dimension are in millimeters (inches in parentheses).

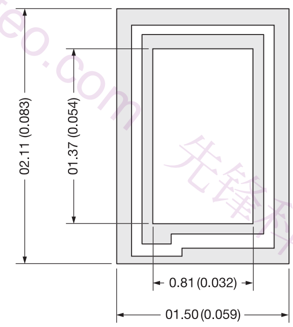
PIN-125DP / 125DPL



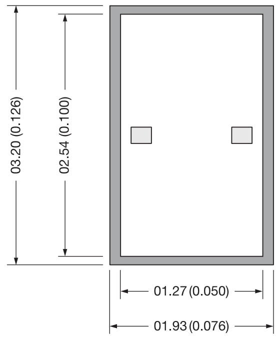
BPW-34



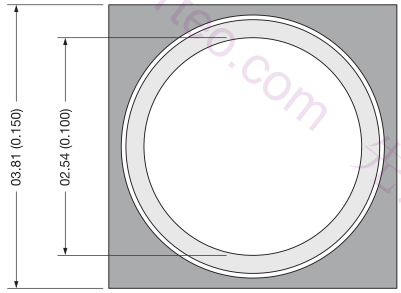
PIN-2DI / DPI



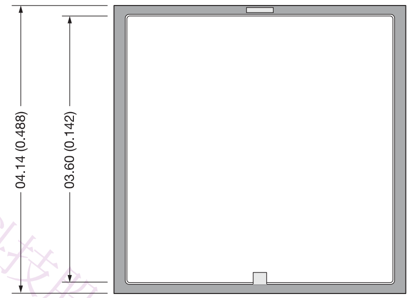
PIN-3CD / DP



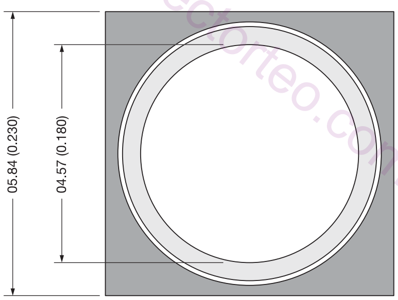
PIN-5D / DP — UV-005



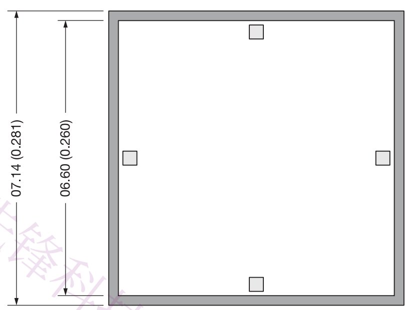
PIN-13D / DP — UV-013D / E



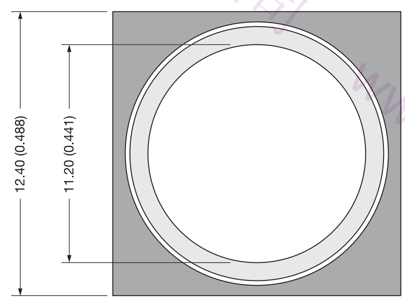
PIN-6D / DP



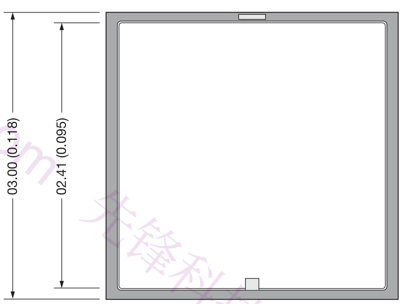
PIN-44D / DP



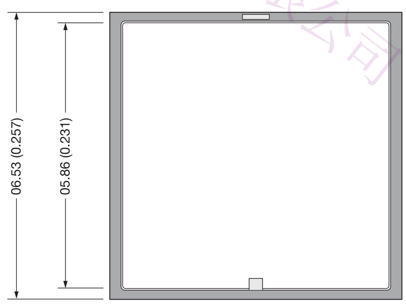
PIN-10D / DP



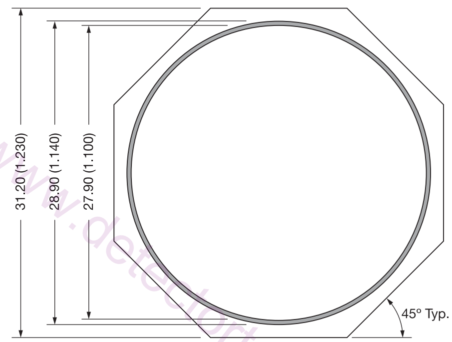
UV-005D / E



UV-035D / E



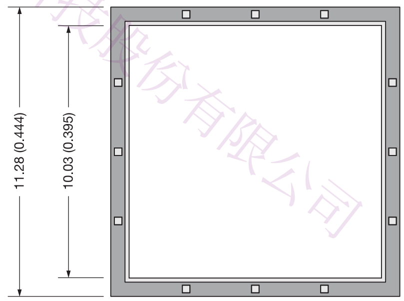
PIN-25DP



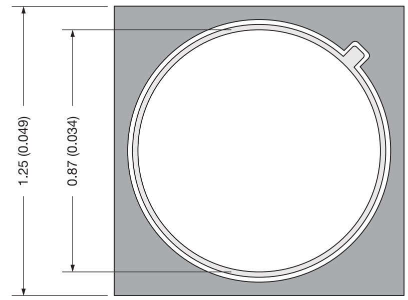
Die Topography

All chip dimension are in millimeters (inches in parentheses).

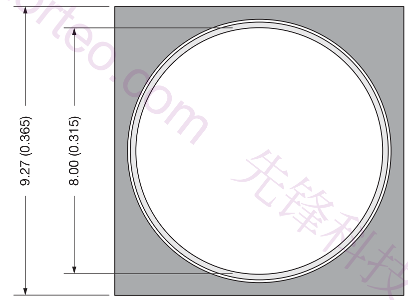
PIN-RD100(A)



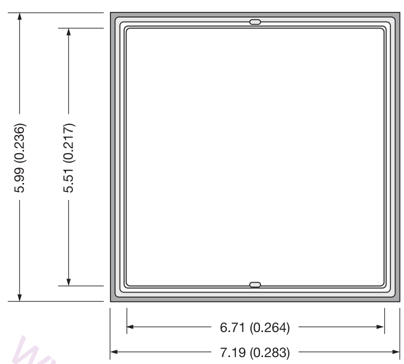
UV-001



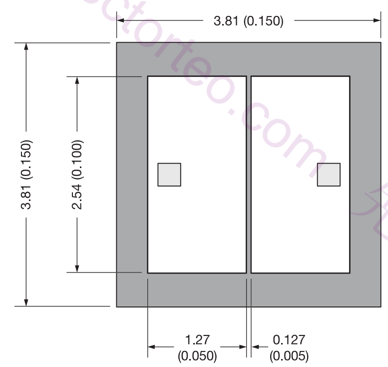
UV-50



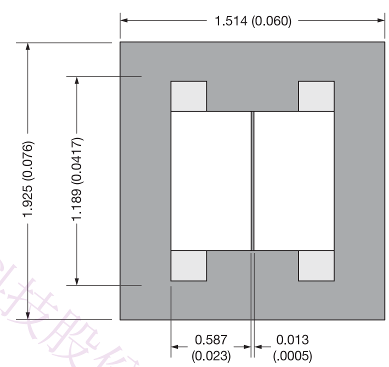
UV-35(P)



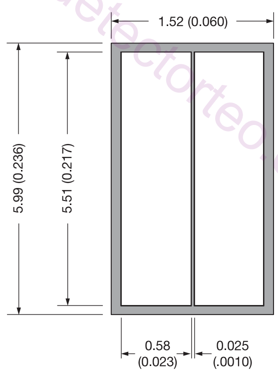
SPOT-2D



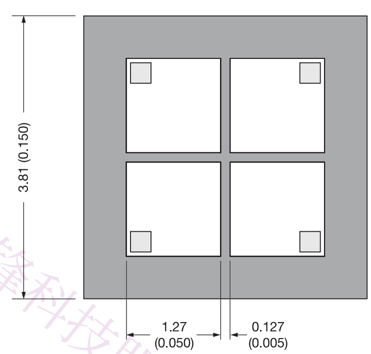
SPOT-2DM1



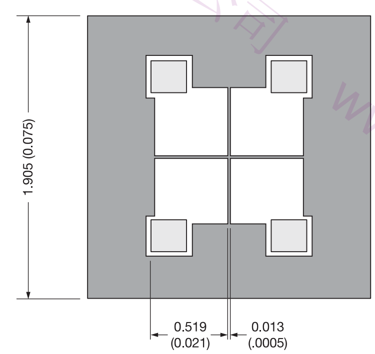
SPOT-3D



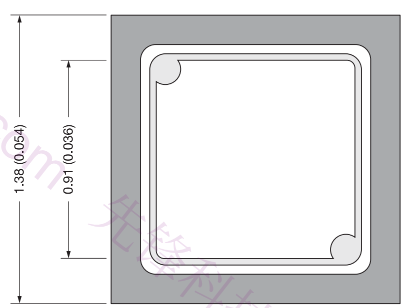
SPOT-4D



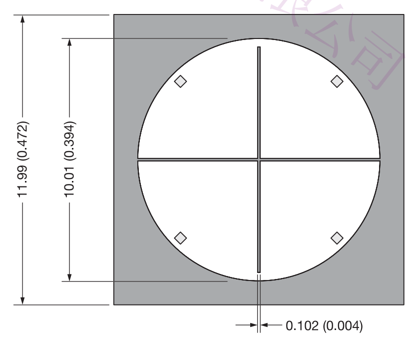
SPOT-4DM1



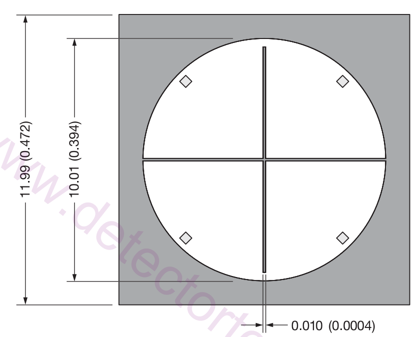
BPX-65



SPOT-9D



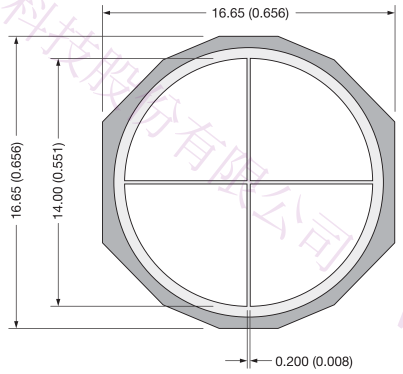
SPOT-9DMI



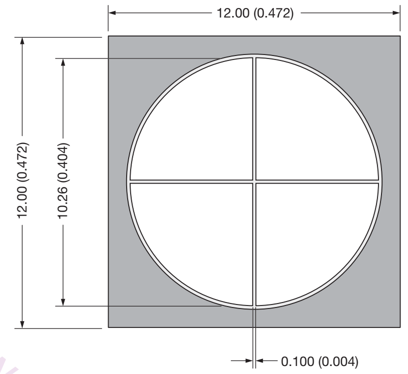
Die Topography

All chip dimension are in millimeters (inches in parentheses).

SPOT-15-YAG



SPOT-9-YAG



Custom Die Topography

Please fill out the items in the tables below in order to assist us in selecting the most appropriate item for your requirements. You may not need, or able to complete ALL items. Hence, simply fill out what you can and fax or mail the form directly to the factory or one of our sales representatives. We will return back to you with a prompt quotation.

Personal Information		Purchase Information	
Company:		Description:	
Name:		Quantity Required:	
Position:		Date Required:	
Address:		Target Price:	
State / Zip Code:		Competitor P/N:	
Telephone:		Application:	
Fax:			
E-mail:			

Photodetector Electro-Optical Specifications Per Element

Die Size:		Min. Responsivity @	
Active Area Size:		Max. Dark Current @	
Operating Wavelength:		Max. Capacitance @	
Applied Bias:		Max. Rise/Fall Time @	
Multi-Element Arrays		**Detector / Amplifier Combination**	
No. of Elements:		Operating Frequency:	
Active Area / Element:		Gain:	
Center Pitch:		Supply Voltage:	
Max. Crosstalk:		Light Power & Wavelength:	

Mechanical / Packaging Specifications

TO Metal Can:		Common Anode or Cathode:	
Ceramic Substrate:		Chip Only:	w/ Solderable Pads
Isolated Chip:			w / Wirebond Pads

Other Packaging Requirements:

Environmental Requirements, e.g. Operating Temperature, etc.:

Special Drawing or Specifications

Application Notes

OSI Optoelectronics, is a leading manufacturer of fiber optic components for communication systems. The products offer range for Silicon, GaAs and InGaAs to full turnkey solutions.

Photodiodes are semiconductor devices responsive to high energy particles and photons. Photodiodes operate by absorption of photons or charged particles and generate a flow of current in an external circuit, proportional to the incident power. Planar diffused silicon photodiodes are P-N junction diodes. A P-N junction can be formed by diffusing either a P-type impurity, such as Boron, into a N-type bulk or epitaxial silicon wafer, or a N-type impurity, such as Phosphorus, into a P-type bulk or epitaxial wafer. The diffused area defines the photodiode active area. To form an ohmic contact, another impurity diffusion into the backside of the wafer is necessary. The active area is coated with an Anti-Reflection coating to reduce the reflection of the light for a specific predefined wavelength. The P and N-sides of the junction have metal pads, which make an electrical contact through dielectric layers.

For applications within the wavelength range of 1.3μm - 1.55μm, photodiodes made on InGaAs/InP material are widely used due to the superior speed, responsivity and low noise characteristics. ***Figure 1.1*** shows the schematic cross-section of OSI Optoelectronics's InGaAs/InP photodiode.

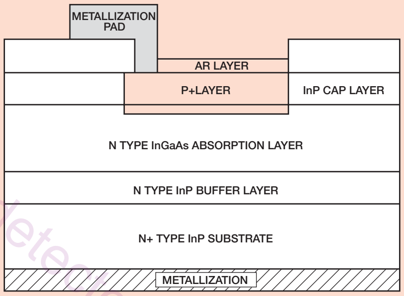


Figure 1.1

Due to the high absorption coefficient, the InGaAs absorption region is typically a few micrometers thick. The thin absorption layer enables the device to obtain high speed at a low reverse bias voltage, typically 2-5 volts. The InP window layer is transparent to 1.3μm - 1.55μm wavelengths, thus InGaAs/InP photodiodes do not have slow tail impulse response associated with the slow diffusion component from the contact layer.

Typical Spectral Responsivity (Si)

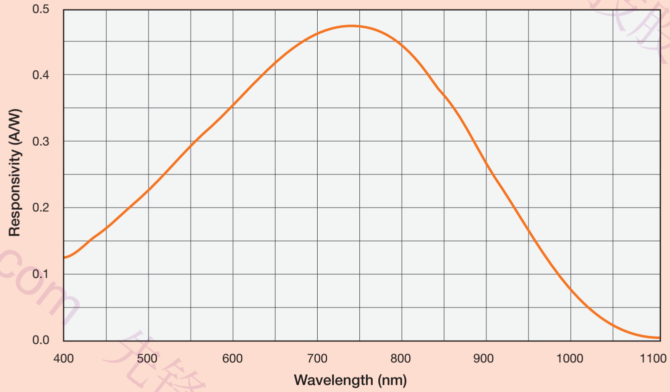


Figure 1.2

Typical Spectral Responsivity (GaAs)

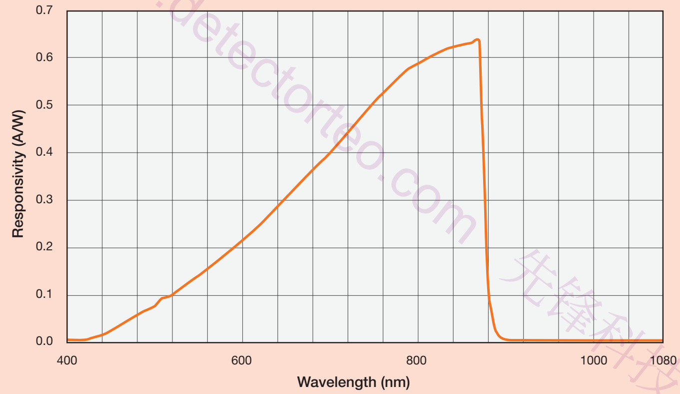


Figure 1.3

Typical Spectral Responsivity (InGaAs)

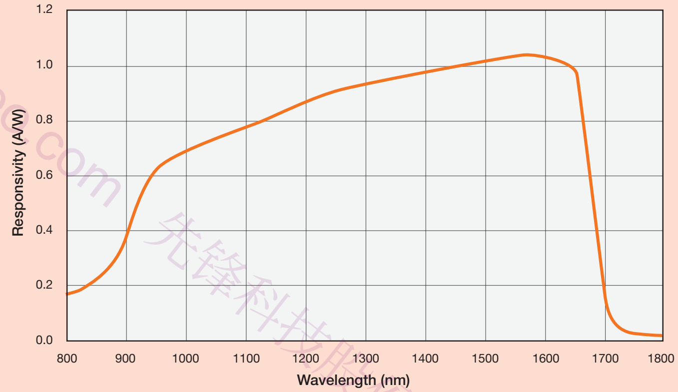


Figure 1.4

The typical spectral response curves of Silicon, GaAs, and InGaAs photodiodes are shown in Figures 1.2, 1.3, 1.4. The bandgap energies of Si, GaAs, and InGaAs are 1.12eV, 1.42eV, and 0.75eV respectively. The cutoff wavelengths of photodiodes made from these materials are 1.10μm for Si, 0.87μm for GaAs, and 1.65μm for InGaAs

OSI Optoelectronics's InGaAs/InP photodiodes are planar passivated. The dark current is low and very stable. ***Figure1.5*** shows the typical dark current of FCI-InGaAs-500 as a function of reverse bias voltage. The relationship between dark current and temperature is shown in ***Figure 1.6.***

Typical Dark Current vs. Reverse Bias Voltage (500m InGaAs in TO-package)

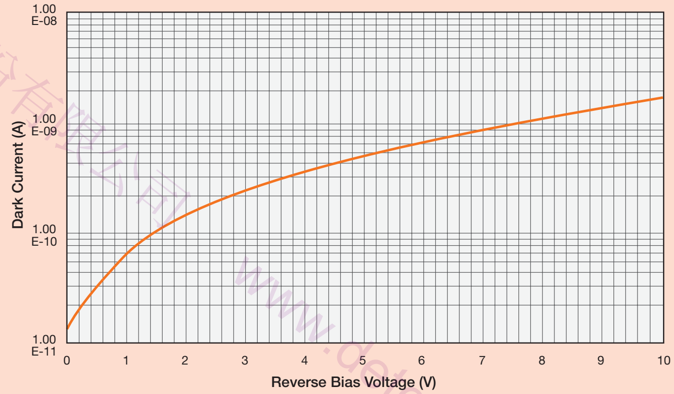


Figure 1.5

Typical Dark Current vs. Temperature (V=-5V, 500m InGaAs in TO-package)

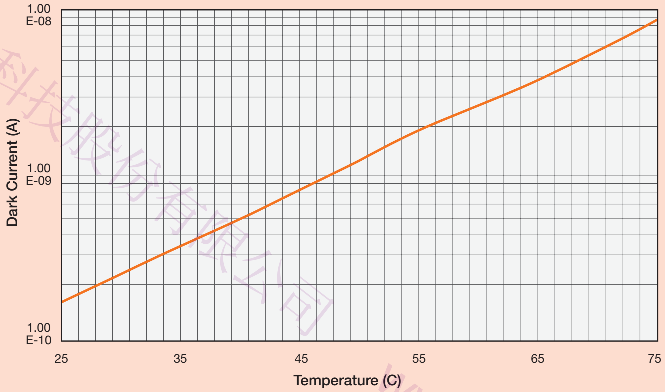


Figure 1.6

Electrical Characteristics

A p-n junction photodiode can be represented by a current source in parallel with an ideal diode ***(Figure 1.7)***. The current source represents the current generated by the incident photons, and the diode represents the p-n junction. In addition, a junction capacitance C_j and a shunt resistance R_{sh} are in parallel with the other components. Series resistance Rs is connected in series with all components in this model.

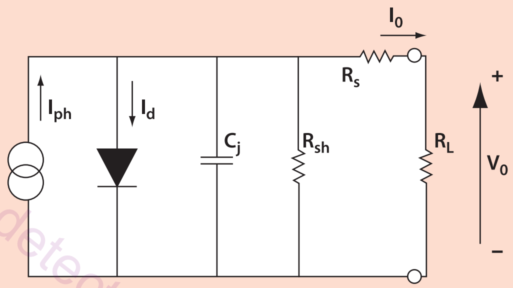


Figure 1.7

Shunt Resistance, R_{sh}

Shunt resistance is the slope of the current-voltage curve of the photodiode at the origin, i.e. V=0. Although an ideal photodiode should have a shunt resistance of infinite, actual values range from 10s to 1000s of Mega ohms. Experimentally it is usually obtained by applying ±10mV, measuring the current and calculating the resistance. Shunt resistance is used to determine the noise current in the photodiode with no bias (photovoltaic mode). For best photodiode performance the highest shunt resistance is desired.

Series Resistance, R_s

Series resistance of a photodiode arises from the resistance of the contacts and the resistance of the undepleted semiconductors. It is given by:

$$R_s = \frac{(W_s - W_d)\rho}{A} + R_c$$

Where W_s is the thickness of the substrate, W_d is the width of the depleted region, A is the diffused area of the junction, ρ is the resistivity of the substrate and R_c is the contact resistance. Series resistance is used to determine the rise time and the linearity of the photodiode.

Junction Capacitance, C_j

The boundaries of the depletion region act as the plates of a parallel plate capacitor. The junction capacitance is directly proportional to the diffused area and inversely proportional to the width of the depletion region. The capacitance is dependent on the reverse bias as follows:

$$C_J = \frac{\epsilon\ \epsilon_o A}{\sqrt{2\epsilon\ \epsilon_o \mu\rho\,(V_A + V_{bi})}}$$

Where ϵ_0 is the permittivity of free space, ϵ is the semiconductor dielectric constant, μ is the mobility of the majority carriers, ρ is the resistivity, V_{bi} is the built-in voltage of the semiconductor of the P-N junction and V_A is the applied bias. ***Figure 1.8*** shows the typical capacitance of FCI-InGaAs-500 as a function of the applied reverse bias voltage. Junction capacitance is used to determine the speed of the response of the photodiode.

Typical Capacitance vs. Reverse Bias Voltage (at f=1MHz, 500m InGaAs in TO-package)

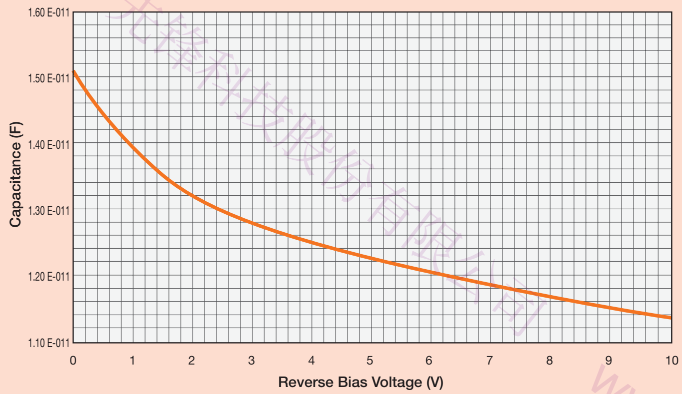


Figure 1.8

Rise/Fall time and Frequency Response, $t_r / t_f / f_{3dB}$

The rise time and fall time of a photodiode is defined as the time for the signal to rise or fall from 10% to 90% or 90% to 10% of the final value respectively. This parameter can be also expressed as frequency response, which is the frequency at which the photodiode output decreased by 3dB. It is roughly approximated by:

$$t_r = \frac{0.35}{f_{3dB}}$$

These are three factors defining the response time of a photodiode:

1. t_{DRIFT}, the drifting time of the carriers in the depleted region of the photodiode.
2. $t_{DIFFUSED}$, the charge collection time of the carriers in the undepleted region of the photodiode.
3. t_{RC}, the RC time constant of the diode-circuit combination.

t_{RC} is determined by t_{RC}=2.2RC, where R is the sum of the diode series resistance and the load resistance (R_s+R_L), and C is the sum of the photodiode junction and the stray capacitances (C_j+C_s). Since the junction capacitance (C_j) is dependent on the diffused area of the photodiode and the applied reverse bias, faster rise times are obtained with smaller diffused area photodiodes, and larger applied biases. In addition, stray capacitance can be minimized by using short leads, and careful lay-out of the electronic components. The total rise time is determined by:

$$t_r = \sqrt{t^2_{DRIFT} + t^2_{DIFFUSED} + t^2_{RC}}$$

Noise

In a photodiode two sources of noise can be identified. Shot noise and Johnson noise:

Shot Noise

Shot noise is related to the statistical fluctuation in both the photocurrent and the dark current. The magnitude of the shot noise is expressed as the root mean square (rms) noise current:

$$I_{sn} = \sqrt{2q\,(I_P + I_d)\,\Delta f}$$

Where q=1.6x10^{-19}C is the electron charge, I_p is the photogenerated current, I_d is the photodetector dark current and Δf is the noise measurement bandwidth.

Thermal or Johnson Noise

The shunt resistance in the photodetector has a Johnson noise associated with it. This is due to the thermal generation of carriers. The magnitude of the generated current noise is:

$$I_{jn} = \sqrt{\frac{4k_B T \Delta f}{R_{sh}}}$$

Where k_B=1.38x10^{-23}J/°K, is the Boltzmann Constant, T is the absolute temperature in degrees Kelvin (273°K=0°C), Δf is the noise measurement bandwidth, and R_{sh} is the shunt resistance of the photodiode. This type of noise is the dominant current noise in photovoltaic (unbias) operation mode.

Note: All resistors have a Johnson noise associated with them, including the load resistor. This additional noise current is large and adds to the Johnson noise current caused by the photodetector shunt resistance.

Total Noise

The total noise current generated in a photodetector is determined by:

$$I_{tn} = \sqrt{I^2_{sn} + I^2_{jn}}$$

Noise Equivalent Power(NEP)

Noise Equivalent Power is the amount of incident light power on a photodetector, which generates a photocurrent equal to the noise current. NEP is defined as:

$$NEP = \frac{I_{tn}}{R_\lambda}$$

Where R_λ is the responsivity in A/W and I_{tn} is the total noise of the photodetector. For InGaAs photodiodes, NEP values can vary from 10^{-14}W/√Hz for large active area down to 10^{-15}W/√Hz for small active area photodiodes.

TEMPERATURE EFFECTS

All photodiode characteristics are affected by changes in temperature. They include shunt resistance, dark current, breakdown voltage, and to a lesser extent other parameters such as junction capacitance.

Shunt Resistance and Dark Current:

There are two major currents in a photodiode contributing to dark current and shunt resistance. Diffusion current is the dominating factor in a photovoltaic (unbiased) mode of operation, which determines the shunt resistance. It varies as the square of the temperature. In photoconductive mode (reverse biased), however, the drift current becomes the dominant current (dark current) and varies directly with temperature. Thus, change in temperature affects the photodetector more in photovoltaic mode than in photoconductive mode of operation.

In photoconductive mode the dark current may approximately double for every 10ºC increase change in temperature. And in photovoltaic mode, shunt resistance may approximately double for every 6ºC decrease in temperature. The exact change is dependent on additional parameters such as the applied reverse bias, resistivity of the substrate as well as the thickness of the substrate.

Breakdown Voltage:

For small active area devices, breakdown voltage is defined as the voltage at which the dark current becomes 10μA. Since dark current increases with temperature, therefore, breakdown voltage decreases similarly with increase in temperature.

RESPONSIVITY, R_λ

The responsivity of a photodiode is a measure of the sensitivity to light, and it is defined as the ratio of the photocurrent Ip to the incident light power P at a given wavelength:

$$R_\lambda = \frac{I_P}{P}$$

In another words, it is a measure of the effectiveness of the conversion of the light power into electrical current. It varies with the wavelength of the incident light as well as applied reverse bias and temperature.

Responsivity increases slightly with applied reverse bias due to improved charge collection efficiency in photodiode. Also there are responsivity variations due to change in temperature as shown in ***Figure 1.9***. This is due to decrease or increase of the band gap, because of increase or decrease in the temperature respectively. Spectral responsivity may vary from lot to lot and it is dependent on wavelength. However, the relative variations in responsivity can be reduced to less than 1% on a selected basis.

Spectral Response vs. Temperature for InGaAs

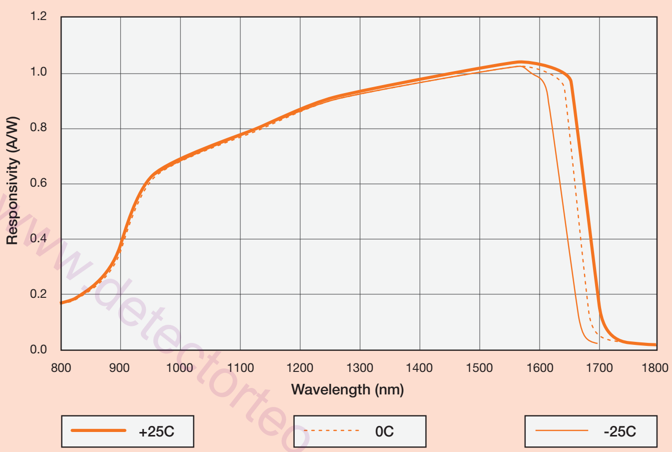


Figure 1.9. Typical Spectral Response versus Temperature for InGaAs

BIASING

A photodiode signal can be measured as a voltage or a current. Current measurement demonstrates far better linearity, offset, and bandwidth performance. The generated photocurrent is proportional to the incident light power and it must be converted to voltage using a transimpedance configuration. The photodiode can be operated with or without an applied reverse bias depending on the application specific requirements. They are referred to as "Photoconductive" (biased) and "Photovoltaic" (unbiased) modes.

Photoconductive Mode (PC)

Application of a reverse bias (i.e. cathode positive, anode negative) can greatly improve the speed of response and linearity of the devices. This is due to increase in the depletion region width and consequently decrease in junction capacitance. Applying a reverse bias, however, will increase the dark and noise currents. An example of low light level / high-speed response operated in photoconductive mode is shown in ***Figure 1.10***.

In this configuration the detector is biased to reduce junction capacitance thus reducing noise and rise time (t_r). A two stage amplification is used in this example since a high gain with a wide bandwidth is required. The two stages include a transimpedance pre-amp for current- to-voltage conversion and a non-inverting amplifier for voltage amplification. Gain and bandwidth ($f_{3dB\ Max}$) are directly determined by R_F. The gain of the second stage is approximated by $1+ R_1 / R_2$. A feedback capacitor (C_F) will limit the frequency response and avoids gain peaking.

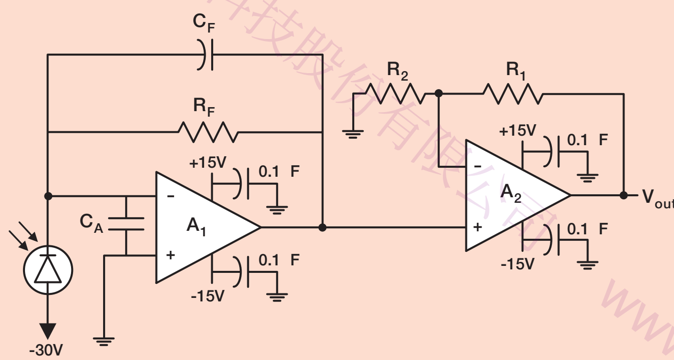


Figure 1.10. Photoconductive mode of operation circuit example: Low Light Level / Wide Bandwidth

$$f_{3dB\mathrm{Max}}[Hz] = \sqrt{\frac{GBP}{2\pi R_F (C_J + C_F + C_A)}}$$

Where GBP is the Gain Bandwidth Product of amplifier (A_1) and C_A is the amplifier input capacitance.

$$Gain(V/W) = \frac{V_{OUT}}{P} = R_F\left(1 + \frac{R_1}{R_2}\right) R_\lambda$$

In low speed applications, a large gain, e.g. >10MΩ can be achieved by introducing a large value (R_F) without the need for the second stage.

Typical components used in this configuration are:

Amplifier: CLC-425, CLC-446, OPA-637, or similiar
RF: 1 to 10 kΩ Typical, depending on C_j
R1: 10 to 50 kΩ
R2: 0.5 to 10 kΩ
CF: 0.2 to 2 pF

In high speed, high light level measurements, however, a different approach is preferred. The most common example is pulse width measurements of short pulse gas lasers, solid state laser diodes, or any other similar short pulse light source. The photodiode output can be either directly connected to an oscilloscope ***(Figure 1.11)*** or fed to a fast response amplifier. When using an oscilloscope, the bandwidth of the scope can be adjusted to the pulse width of the light source for maximum signal to noise ratio. In this application the bias voltage is large. Two opposing protection diodes should be connected to the input of the oscilloscope across the input and ground.

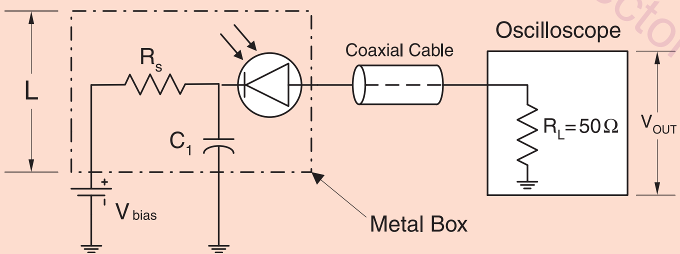


Figure 1.11. Photoconductive mode of operation circuit example: High Light Level / High Speed Response

To avoid ringing in the output signal, the cable between the detector and the oscilloscope should be short (i.e. < 20cm) and terminated with a 50 ohm load resistor (R_L). The photodiode should be enclosed in a metallic box, if possible, with short leads between the detector and the capacitor, and between the detector and the coaxial cable. The metallic box should be tied through a capacitor (C_1), with lead length (L) less than 2 cm, where R_L C_1 > 10 t (t is the pulse width in seconds). R_S is chosen such that $R_S < V_{BIAS} / 10\ I_{PDC}$, where I_{PDC} is the DC photocurrent. Bandwidth is defined as 0.35 / t. A minimum of 10V reverse bias is necessary for this application. Note that a bias larger than the photodiode maximum reverse voltage should not be applied.

Photovoltaic Mode (PV)

The photovoltaic mode of operation (unbiased) is preferred when a photodiode is used in low frequency applications (up to 350 kHz) as well as ultra low light level applications. In addition to offering a simple operational configuration, the photocurrents in this mode have less variations in responsivity with temperature. An example of an ultra low light level / low speed is shown in ***Figure 1.12.***

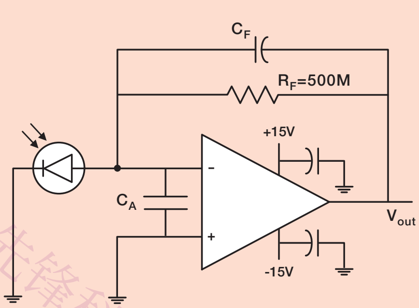


Figure 1.12. Photovoltaic mode of operation circuit example: Low Light Level / Wide Bandwidth

In this example, a FET input operational amplifier as well as a large resistance feedback resistor (R_F) is considered. The detector is unbiased to eliminate any additional noise current. The total output and the op-amp noise current are determined as follows:

$$V_{OUT} = I_P \times R_F$$

$$I_N \left[\frac{A_{rms}}{\sqrt{Hz}} \right] = \sqrt{\frac{4k_B T}{R_F}}$$

where k_B=1.38 x 10^{-23} J/°K and T is temperature in °K.

For stability, select C_F such that

$$\sqrt{\frac{GBP}{2\pi R_F (C_J + C_F + C_A)}} > \frac{1}{2\pi R_F C_F}$$

Operating bandwidth, after gain peaking compensation is:

$$f_{OP}[Hz] = \frac{1}{2\pi R_F C_F}$$

These examples or any other configurations for single photodiodes can be applied to any of OSI Optoelectronicss monolithic, common substrate linear array photodiodes. The output of the first stage pre-amplifiers can be connected to a sample and hold circuit and a multiplexer. ***Figure 1.13*** shows the block diagram for such configuration.

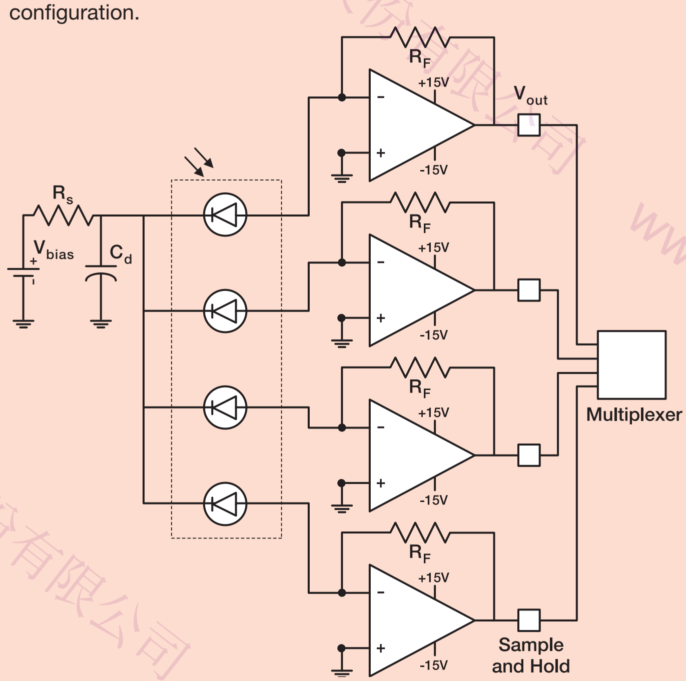


Figure1.13. Circuit example for a multi-element, common cathode array.

Photodetector with Transimpedance Amplifier

Fiberoptic Receiver Design

One of the most critical part in fiber communication system is receiver of optical signal. Optical receiver determines performance of total system because it is the lowest signal point. Optical system designer must pay special attention when developing receiver part.

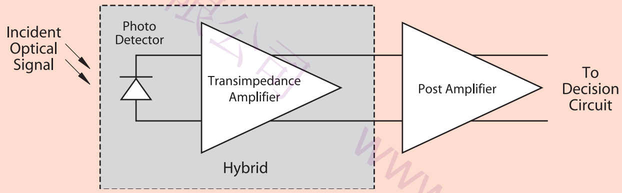


Figure 2.1. Optical Receiver. Functional Block Diagram.

As it is shown on ***Figure 2.1***, optical receiver in digital communication system typically contains of Photo Detector, Transimpedance Amplifier (TIA), and Post Amplifier then followed by decision circuit. Photo Detector (PD), typically PIN or Avalanche Photo Diode (APD), produces photocurrent proportional to the incident optical power. Transimpedance amplifier converts this current into voltage signal and then Post Amplifier bring this voltage to some standard level, so Post Amplifier output signal can be used by decision circuit.

In digital optical communication system binary data stream is transmitted by modulation of optical signal. Optical signal with non-return-to-zero (NRZ) coding may have one of two possible state of optical power level during bit time interval. Higher optical power level corresponds to logic level 1, lower level corresponds to 0. In the real system optical power does not equal to zero when transmitting logical 0. Let's assume, that 0 state power equal to P_0 and 1 - state power equal to P_1 as it is indicated on ***Figure 2.2***.

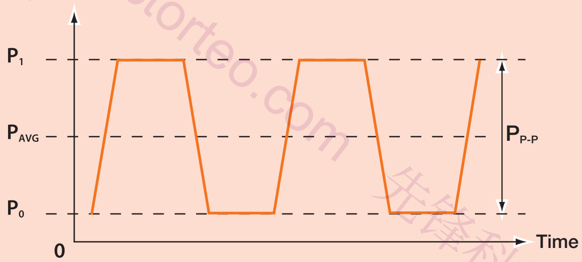


Figure 2.2. Optical Power Levels

The system can be described in terms of Average Power P_{AVG} and Optical Modulation Amplitude or Peak-to-Peak Optical Power P_{P-P}. It is very important to note that we will consider below systems with probabilities to have "one" or "zero" at the output equal to each other (50%). So we can easily determine:

$$P_{AVG} = \frac{P_0 + P_1}{2}$$

$$P_{P-P} = P_1 - P_0$$

Extinction Ratio re is the ratio between P_1 and P_0:

$$r_e = \frac{P_1}{P_0}$$

Extinction ratio can be expressed in terms of dB:

$$r_e(dB) = 10 \log \left(\frac{P_1}{P_0} \right)$$

Then, the average power in terms of peak-to-peak power and extinction ratio is:

$$P_{AVG} = \frac{1\,(r_e + 1)}{2\,(r_e - 1)} \; P_{P-P}$$

For example, if the average optical power of the incident signal is –17dBm while extinction ratio is 9dB. Then, P_{AVG}= 20 μW; r_e =7.94. Peak-to-peak power will be:

$$P_{P-P} = 2\,\frac{(r_e - 1)}{(r_e + 1)} \; P_{AVG}$$

$$P_{P-P} = 2\,\frac{(7.94 - 1)}{(7.94 + 1)} \times 20\,\mu W$$

$$= 1.55 \times 20\,\mu W = 31\,\mu W_{P-P}$$

Sensitivity and BER.

Number of errors at the output of decision circuit will determine the quality of the receiver and of course the quality of transmission system. Bit-error-rate (BER) is the ratio of detected bit errors to number of total bit transmitted. Sensitivity S of the optical receiver is determined as a minimum optical power of the incident light signal that is necessary to keep required Bit Error Rate. Sensitivity can be expressed in terms of Average Power (dBm, sometimes μW) with given Extinction Ratio (dB) or in terms of Peak-to-Peak Optical Power (μW_{P-P}). BER requirements are specified for different applications, for example some telecommunication applications specify BER to be 10^{-10} or better; for some data communications it should be equal or better than 10^{-12}.

Noise is one of the most important factors of errors. Noise of PIN Photodiode in digital high-speed application system is typically much less than noise of transimpedance amplifier. Considering thermal noise of TIA as an only noise in such a system usually gives good result for PD/TIA hybrid analysis. We can estimate error probability PE when assuming Gaussian distribution for thermal noise of amplifier:

$$PE = \frac{1}{2}\left[PE(0|1) + PE(1|0) \right]$$

where PE(0|1) and PE(1|0) probability to decide 0 instead of 1; and 1 instead of 0 correspondingly when we have equal probabilities for 0 and 1 in our system.

Probability density function D_p for Gaussian distribution is:

$$D_p(\chi) = \frac{1}{\sqrt{2\pi}\cdot\sigma}\exp\left(-\frac{(\chi-\mu)^2}{2\sigma^2}\right)$$

where χ – distribution parameter, σ – is standard deviation, and μ – is mean value. Probability density functions are shown on ***Figure 2.3*** for two levels of signal.

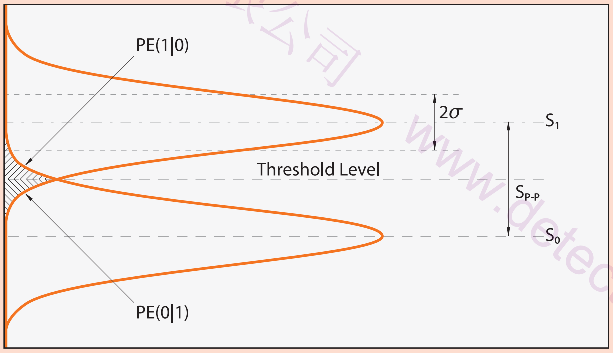


Figure 2.3. Probability Density Functions.

To estimate probability of incorrect decision, for example PE(1|0), we need to integrate density function for 0-distribution above threshold level.

$$PE(1|0) = \int_{Threshold}^{\infty} D_{Po}(\chi)\,d\chi$$

Considering symmetrical distributions (threshold is the half of peak-to-peak signal S_{P-P}):

$$PE(1|0) = \int_{S_{P-P}/2}^{\infty} \frac{1}{\sqrt{2\pi}\cdot\sigma}\exp\left(-\frac{\chi^2}{2\sigma^2}\right)d\chi$$

Then normalizing to: $t = \chi/\sigma$

$$PE(1|0) = \int_{S_{P-P}/2\sigma}^{\infty} \frac{1}{\sqrt{2\pi}}\exp\left(-\frac{t^2}{2}\right)$$

If deviations for 0 and 1 levels are equal total probability of error will be:

$$PE = erfc\,(SNR/2)$$

where erfc(x) is the complimentary error function:

$$erfc\,(x) = \frac{1}{\sqrt{2\pi}}\int_{x}^{\infty}\exp\left(\frac{-t^2}{2}\right)dt$$

and SNR – signal-to-noise ratio, where signal is in terms of peak-to-peak and noise is an RMS value. Graph of $erfc(x)$ is shown on ***Figure 2.4*** and some tabulated SNR numbers vs. BER are given

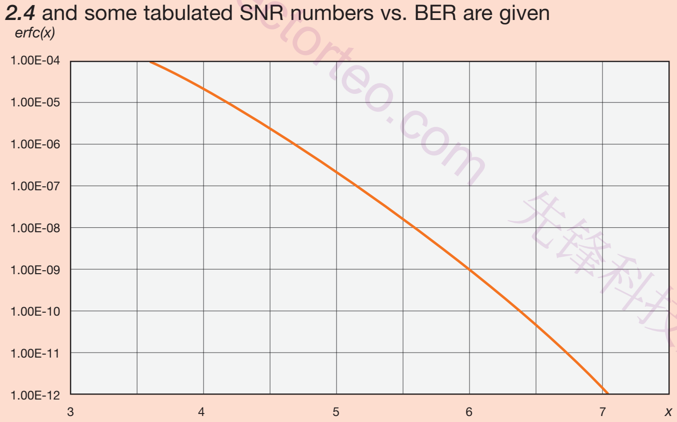


Figure 2.4 Complimentary Error Function

in the ***Table 1***. Here we assume that PE = BER, but actual Error Probability equal to BER in ideal system when time of measurements considered being infinite.

BER	10^{-08}	10^{-09}	10^{-10}	10^{-11}	10^{-12}
SNR	11.22	11.99	12.72	13.40	14.06

Table 1

So we can find peak-to-peak signal that we need to achieve required BER.

$$SNR = \frac{I_{P-P}}{I_{N,RMS}} = \frac{P_{P-P}\times R}{I_{N,RMS}}$$

where I_{P-P} is signal photocurrent, R – photodetector responsivity expressed in A/W, $I_{N,RMS}$ – input equivalent RMS noise of TIA.

$$P_{P-P} = \frac{SNR\times I_{N,RMS}}{R}$$

to estimate the sensitivity of PD/TIA at certain BER, we need to find required SNR in the ***Table 1*** and then calculate average power using equation:

$$S = P_{AVG@BER} = \frac{SNR\times I_{N,RMS}}{2R}\times\frac{(r_e+1)}{(r_e-1)}$$

where the first term is the sensitivity with an infinite extinction ratio, and the second is the correction for finite extinction ratio or extinction ratio penalty. Some numbers for extinction ratio penalty are shown in ***Table 2***.

r_e, dB	7.00	8.00	9.00	10.00	∞
r_e	5.01	6.31	7.94	10.00	∞
Power Penalty, dB	1.76	1.39	1.10	0.87	0

Table 2

To calculate total receiver sensitivity we have to consider also sensitivity of Post Amplifier or Input Threshold Voltage V_{TH}. Sensitivity of Post Amplifier should be indicated in the Post Amplifier Datasheet and it is usually expressed in peak-to peak Volts value (mV_{P-P}). To achieve the same BER we need to increase peak-to-peak current at least by value of:

$$\Delta I_{PA} = \frac{V_{TH}}{R_{TIA}}$$

where R_{TIA} is transimpedance coefficient of TIA.

Peak-to-peak optical power will be:

$$P_{P-P} = \frac{SNR \times I_{N,RMS} + \Delta I_{PA}}{R}$$

and sensitivity:

$$S = \frac{SNR \times I_{N,RMS} + \dfrac{V_{TH}}{R_{TIA}}}{2 \cdot R} \times \frac{(r_e + 1)}{(r_e - 1)}$$

Figure 2.5 shows typical sensitivity for InGaAs PD/TIA hybrid alone, typical and minimum sensitivities of the device calculated with $10mV_{P-P}$ threshold Post Amplifier, and actual measured values for the system with Post Amplifier.

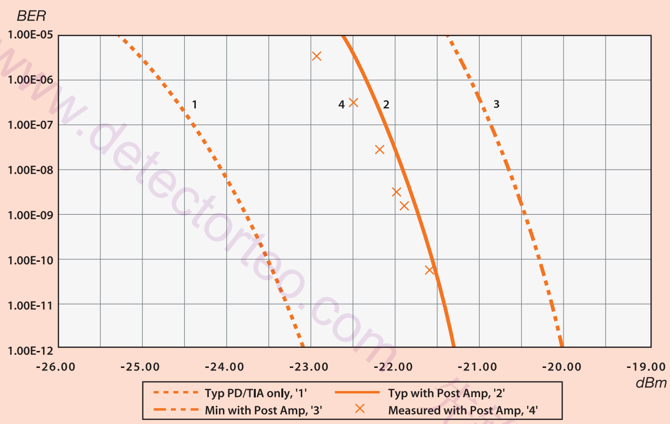


Figure 2.5. InGaAs PD/TIA hybrid: sensitivity for PD/TIA only (curve 1), calculated for PD/TIA with 10mV threshold Post Amplifier typical (curve 2) and minimum (curve 3), and actual measurements for PD/TIA-Post Amplifier system (X-points 4).

For Example, let's calculate the sensitivity for 2.5Gbps InGaAs PD/TIA hybrid at BER=10^{-10}, assuming responsivity of detector to be 0.9 A/W, input RMS noise current of the transimpedance amplifier 500nA, and the extinction ratio of the optical signal 9dB.

First, we will find SNR required to achieve BER=10^{-10} from the ***Table 1***. Therefore, SNR = 12.72. Then, we can calculate the sensitivity considering r_e = 7.94:

$$S = \frac{12.72 \times 0.5\mu A}{2 \times 0.9 A/W} \frac{(7.94 + 1)}{(7.94 - 1)} = 4.56\mu W$$

or S = -23.4 dBm

For combination of such a PD/TIA Hybrid and Post Amplifier with V_{TH} = 10 mV assuming R_{TIA} = 2.8kΩ sensitivity will be:

$$S = \frac{12.72 \times 0.5\mu A + \left(\dfrac{10mV}{2.8k\Omega}\right)}{2 \times 0.9 A/W} \times \frac{(7.94 + 1)}{(7.94 - 1)} = 7.11\mu W$$

or S = -21.5 dBm. This Post Amplifier threshold affects the sensitivity and the difference is 1.9 dB. Therefore it is very important to take performance and parameters of all discrete receiver components into consideration to analyze the sensitivity of the entire receiver system.

This application note helps to estimate optical front-end performance and to compare receivers' parameters. In the real systems, Jitter, Inter-symbol Interference and other phenomena can affect total system performance.

Actual BER may be different from Error Probability that we dealt with. When measuring actual BER, we have to make sure that large number of bits has been transmitted before obtaining the results. Sometimes, we receive "error envelope", which is a large number of bit errors for a certain short interval with a small amount of errors in previous and next intervals. It happens due to EMI, power surges, etc. that affect total system/equipment performance and measurements result.

We cannot extrapolate Sensitivity vs. BER curves using the data of ***Table 1*** for a system (or conditions) with a nonlinear transfer function, such as a limiting amplifier. We can calculate the sensitivity of a TIA in a linear range, and then modify the results for the system with a limiting amplifier for a certain BER because the threshold of post amplifier is a function of BER.

▪ 155Mbps/622Mbps/1.25Gbps/2.5Gbps

High Speed InGaAs Photodiodes

FCI-InGaAs-XXX series with active area sizes of 55µm, 70µm, 120µm, 300µm, 400µm and 500µm, exhibit the characteristics need for Datacom and Telecom applications. Low capacitance, low dark current and high responsivity from 1100nm to 1620nm make these devices ideal for high-bit rate receivers used in LAN, MAN, WAN, and other high speed communication systems. The photodiodes are packaged in 3 lead isolated TO-46 cans or in 1 pin pill packages with AR coated flat windows or micro lenses to enhance coupling efficiency. FCI-InGaAs-XXX series is also offered with FC, SC, ST and SMA receptacles.

▪ APPLICATIONS

- High Speed Optical Communications
- Single/Multi-Mode Fiber Optic Receiver
- Gigabit Ethernet/Fibre Channel
- SONET/SDH, ATM
- Optical Taps

▪ FEATURES

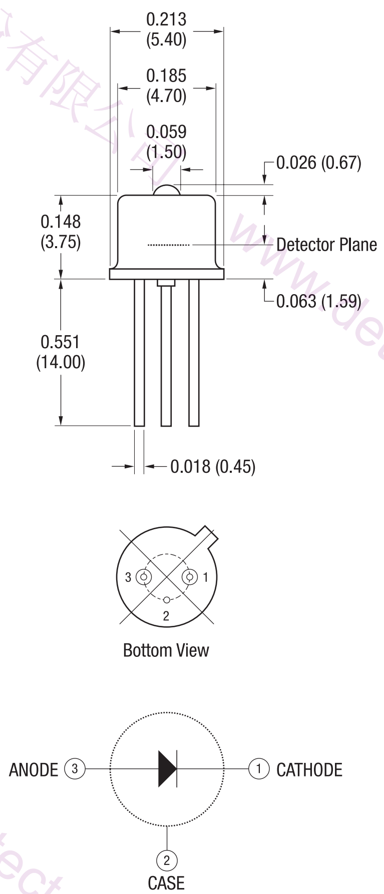
- High Speed
- High Responsivity
- Low Noise
- Spectral Range 900nm to 1700nm

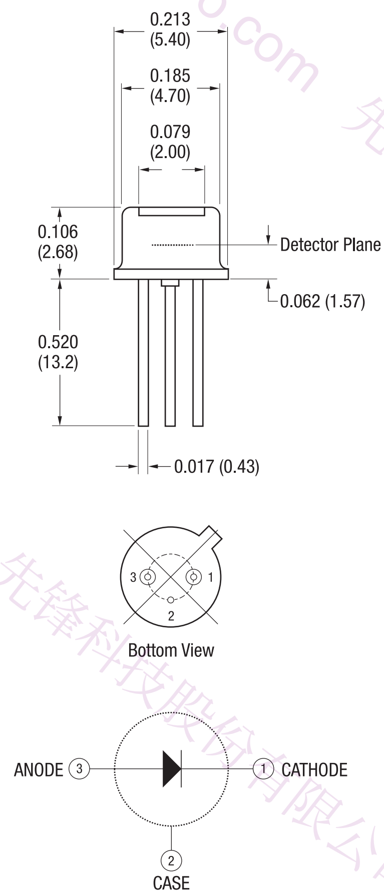
Absolute Maximum Ratings

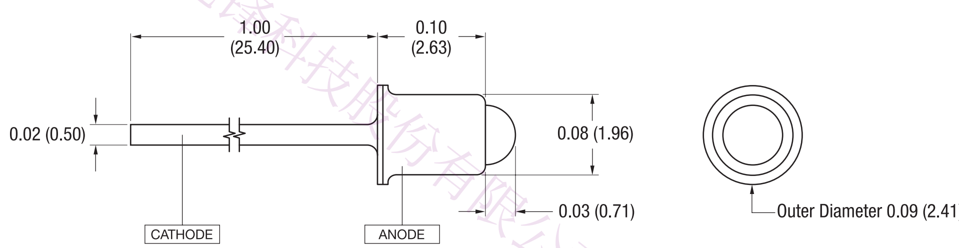
PARAMETERS	SYMBOL	MIN	MAX	UNITS
Storage Temperature	T_{stg}	-55	+125	°C
Operating Temperature	T_{op}	-40	+75	°C
Soldering Temperature	T_{sld}	---	+260	°C

Electro-Optical Characteristics T_A=23°C

PARAMETERS	SYMBOL	CONDITIONS	FCI-InGaAs-55			FCI-InGaAs-70			FCI-InGaAs-120			FCI-InGaAs-300			FCI-InGaAs-400			FCI-InGaAs-500			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
Active Area Diameter	AA_ϕ	---	---	55	---	---	70	---	---	120	---	---	300	---	---	400	---	---	500	---	µm
Responsivity (Flat Window Package)	R_λ	λ=1310nm	0.80	0.90	---	0.80	0.90	---	0.80	0.90	---	0.80	0.90	---	0.80	0.90	---	0.80	0.90	---	A/W
		λ=1550nm	0.90	0.95	---	0.90	0.95	---	0.90	0.95	---	0.90	0.95	---	0.90	0.95	---	0.90	0.95	---	
Capacitance	C_j	V_R = 5.0V	---	1.0	---	---	1.5	---	---	2.0	---	---	10.0	---	---	14.0	---	---	20.0	---	pF
Dark Current	I_d	V_R = 5.0V	---	0.02	2	---	0.03	2	---	0.05	2	---	0.30	5	---	0.40	5	---	0.50	20	nA
Rise Time/ Fall Time	t_r/t_f	V_R = 5.0V, R_L=50Ω 10% to 90%	---	---	0.20	---	---	0.20	---	---	0.30	---	---	1.5	---	---	3.0	---	---	10.0	ns
Max. Revervse Voltage	---	---	---	---	20	---	---	20	---	---	20	---	---	15	---	---	15	---	---	15	V
Max. Reverse Current	---	---	---	---	0.5	---	---	1	---	---	2	---	---	2	---	---	2	---	---	2	mA
Max. Forward Current	---	---	---	---	5	---	---	5	---	---	5	---	---	8	---	---	8	---	---	8	mA
NEP	---	---	---	2.66E-15	---	---	3.44E-15	---	---	4.50E-15	---	---	6.28E-15	---	---	7.69E-15	---	---	8.42E-15	---	W/√Hz







Notes:
- All units in inches (mm).
- All tolerances: 0.005 (0.125).
- Please specify when ordering the flat window or lens cap devices.
- The flat window devices have broadband AR coatings centered at 1310nm.
- The thickness of the flat window=0.008 (0.21).

FCI-InGaAs-XXX-X

Large Active Area InGaAs Photodiodes

FCI-InGaAs-XXX-X series with active area sizes of 1mm, 1.5mm and 3mm, are part of OSI Optoelectronics's large active area IR sensitive detectors which exhibit excellent responsivity from 1100nm to 1620nm, allowing high sensitivity to weak signals. These large active area devices are ideal for use in infrared instrumentation and monitoring applications. The photodiode chip are isolated in TO-46 or TO-5 packages with a broadband double sided AR coated flat window. FCI-InGaAs-1500-X and FCI-InGaAs-3000-X come with different shunt resistance values of 5, 10, 20, 30 and 40MΩ.

APPLICATIONS

- Optical Instrumentation
- Power Measurement
- IR Sensing
- Medical Devices

FEATURES

- High Responsivity
- Large Active Area Diameter
- Low Noise
- Spectral Range 900nm to 1700nm

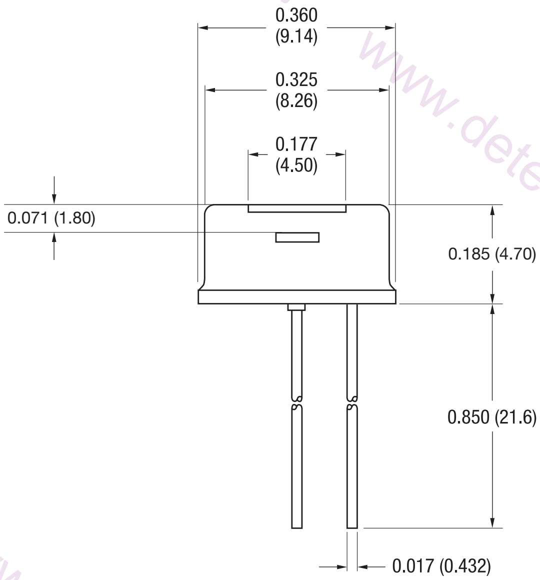
Absolute Maximum Ratings

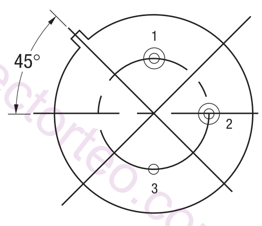
PARAMETERS	SYMBOL	MIN	MAX	UNITS
Storage Temperature	T_{stg}	-55	+125	°C
Operating Temperature	T_{op}	-40	+75	°C
Soldering Temperature	T_{sld}	---	+260	°C

Electro-Optical Characteristics T_A=23°C

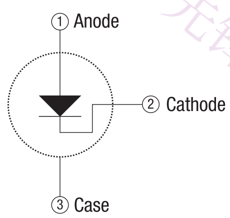
PARAMETERS	SYMBOL	CONDITIONS	FCI-InGaAs-1000			FCI-InGaAs-1500-X			FCI-InGaAs-3000-X			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
Active Area Diameter	AA_ϕ	---	---	1.0	---	---	1.5	---	---	3.0	---	mm
Responsivity	R_λ	λ=1310nm	0.80	0.90	---	0.80	0.90	---	0.80	0.90	---	A/W
		λ=1550nm	0.90	0.95	---	0.90	0.95	---	0.90	0.95	---	
Capacitance	C_j	V_R=0V	---	80	200	---	200	450	---	750	1800	pF
Shunt Resistance	R_{SH}	V_R=10mV	30	---	---	---	20	---	---	20	---	MΩ
Max. Reverse Voltage	---	---	---	---	5	---	---	2	---	---	2	V
Max. Reverse Current	---	---	---	---	1	---	---	2	---	---	2	mA
Max. Forward Current	---	---	---	---	10	---	---	10	---	---	10	mA
NEP	---	---	---	2.45E-14	---	---	3.01E-14	---	---	4.25E-14	---	W/√Hz

FCI-InGaAs-3000-X



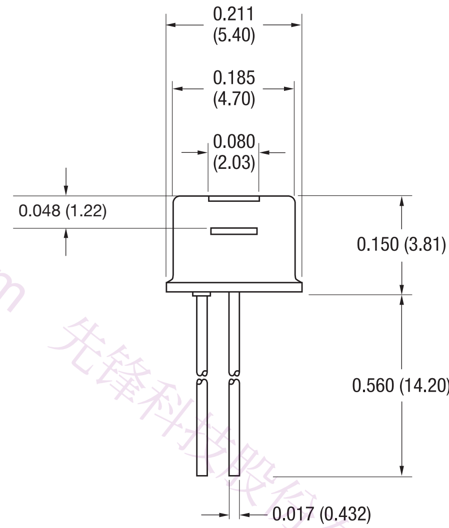


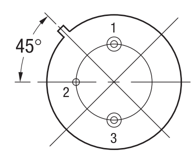
Bottom View



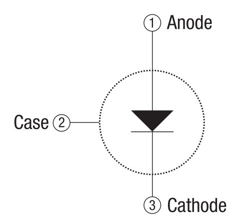
Pin Circle Diameter = 0.200 (5.08)

FCI-InGaAs-1000 & FCI-InGaAs-1500-X





Bottom View



Pin Circle Diameter = 0.100 (2.54)

Notes:
- All units in inches (mm).
- All tolerances: 0.005 (0.125)
- The flat window devices have broadband AR coatings centered at 1310nm
- The thickness of the flat window=0.008 (0.21)

FCI-InGaAs-QXXX

Large Active Area InGaAs Quadrants

FCI-InGaAs-QXXX series are large active area InGaAs photodiodes segmented into four separate active areas. These photodiodes come in 1mm and 3mm active area diameter. The InGaAs Quad series with high response uniformity and the low cross talk between the elements are ideal for accurate nulling or centering applications as well as beam profiling applications. They exhibit excellent responsivity from 1100nm to 1620nm, and are stable over time and temperature, and fast response times necessary for high speed or pulse operation. The photodiodes are packaged in isolated TO-5 or TO-8 cans with a broadband double sided AR coated flat window, and also can be mounted on ceramic substrate per request.

APPLICATIONS

- Position Sensoring
- Beam Alignment
- Beam Profiling

FEATURES

- High Responsivity
- Low Noise
- Spectral Range 900nm to 1700nm
- Low Crosstalk
- Wide Field of View

Absolute Maximum Ratings

PARAMETERS	SYMBOL	MIN	MAX	UNITS
Storage Temperature	T_{stg}	-55	+125	°C
Operating Temperature	T_{op}	-40	+75	°C
Soldering Temperature	T_{sld}	---	+260	°C

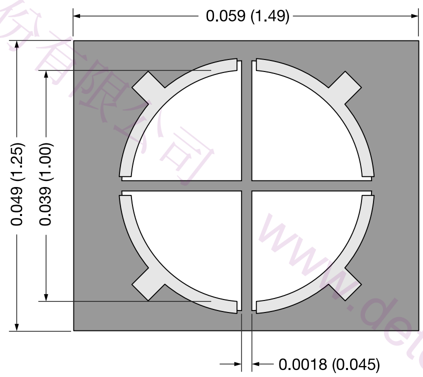
Electro-Optical Characteristics (per 1 element) T_A=23°C

PARAMETERS	SYMBOL	CONDITIONS	FCI-InGaAs-Q1000			FCI-InGaAs-Q3000			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
Active Area Diameter	AA_ϕ	---	---	1000	---	---	3000	---	µm
Responsivity	R_λ	λ=1310nm	0.85	0.90	---	0.85	0.90	---	A/W
		λ=1550nm	0.90	0.95	---	0.90	0.95	---	
Element Gap	---	---	---	0.045	---	---	0.045	---	mm
Capacitance	C_j	V_R = 5.0V	---	---	25	---	---	225	pF
Dark Current	I_d	V_R = 5.0V	---	0.5	15	---	2.0	100	nA
Rise Time/ Fall Time	t_r/t_f	V_R = 5.0V, 50Ω 10% to 90%	---	3	---	---	24	---	ns
Crosstalk	---	λ=1550nm, V_R = 5.0V	---	---	1	---	---	1	%
Max. Revervse Voltage	---	---	---	---	15	---	---	10	V
NEP	---	λ=1550nm	---	1.20E-14	---	---	2.50E-14	---	W/√Hz

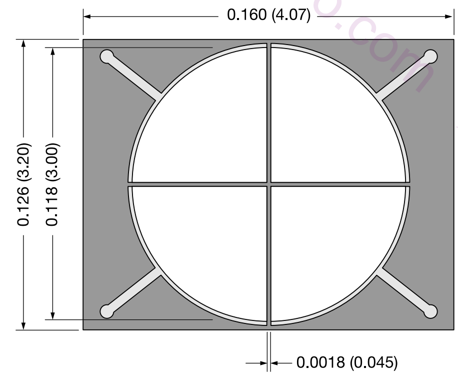
FCI-InGaAs-QXXX

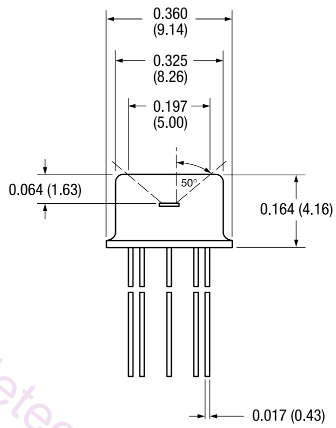
Large Active Area InGaAs Quadrants

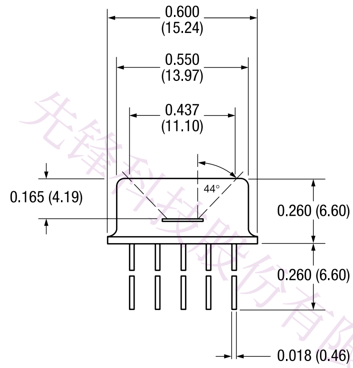
InGaAs-Q1000

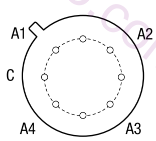


InGaAs-Q3000



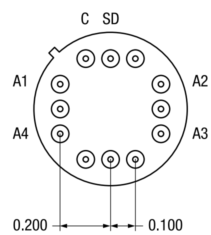






Pin Circle Dia.=0.230

Bottom View



Bottom View

Pinout

PIN	Description
A1	ANODE QUADRANT 1
A2	ANODE QUADRANT 2
A3	ANODE QUADRANT 3
A4	ANODE QUADRANT 4
C	COMMON CATHODE

Pinout

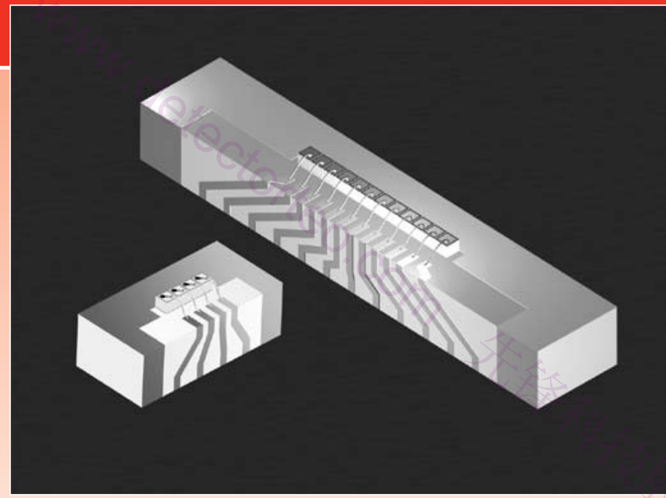
PIN	Description
A1	ANODE QUADRANT 1
A2	ANODE QUADRANT 2
A3	ANODE QUADRANT 3
A4	ANODE QUADRANT 4
C	COMMON CATHODE
SD	SUCTION DIODE

Notes:
- All units in inches (mm).

FCI-InGaAs-XXM

High Speed InGaAs Arrays

FCI-InGaAs-XXM series with 4, 8, 12 and 16 channels are parts of OSI Optoelectronics's high speed IR sensitive photodetector arrays. Each AR coated element is capable of 2.5Gbps data rates exhibiting high responsivity from 1100nm to 1620nm. FCI-InGaAs-XXM, which comes standard on a wraparound ceramic submount, is designed for multichannel fiber applications based on standard 250mm pitch fiber ribbon. Also, board level contacts of 500mm make it easy to connect to your circuit. Upon request, 55um active area 4 channel arrays are available.



APPLICATIONS

- High Speed Optical Communications
- Single/Multi-Mode Fiber Optic Receiver
- Gigabit Ethernet/Fibre Channel
- SONET/SDH, ATM
- Optical Taps

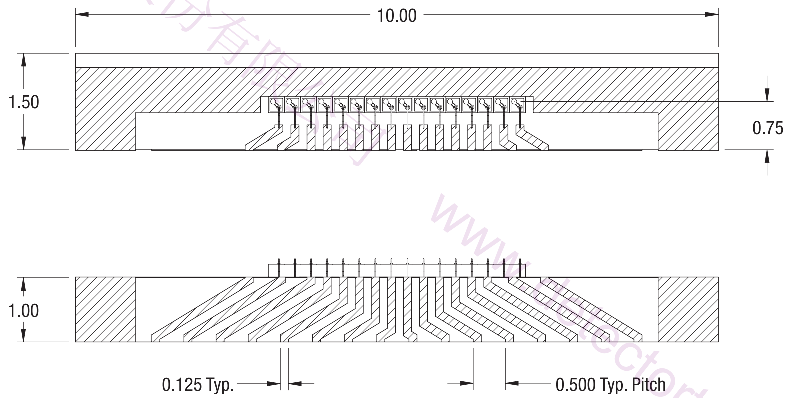
FEATURES

- High Speed
- High Responsivity
- Low Noise
- Spectral Range 900nm to 1700nm

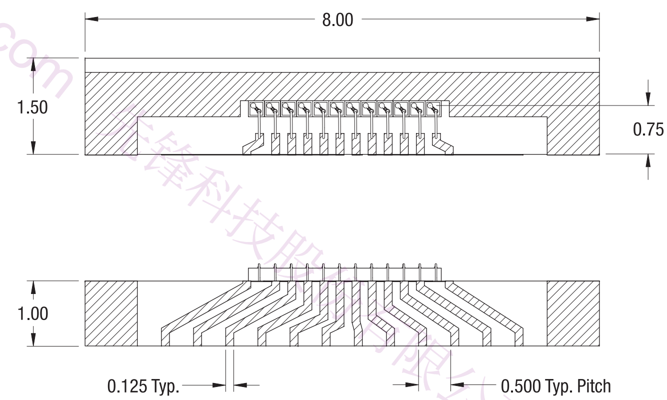
Electro-Optical Characteristics $T_A=23°C, V_R=5V$

PARAMETERS	FCI-InGaAs-4M	FCI-InGaAs-8M	FCI-InGaAs-12M	FCI-InGaAs-16M
Active Area Diameter	70µm, Pitch:250µm			
Responsivity	Typ. 0.95A/W @1550nm			
Capacitance	Typ. 0.65pF			
Dark Current	Typ. 0.03nA			
Max. Reverse Voltage	20V			
Max. Forward Current	5mA			
Bandwidth	Typ. 2.0GHz @ 1550nm			
Breakdown Voltage	Typ. 50V			
Storage Temperature Range	From −40 to 85°C			
Operating Temperature Range	From 0 to 70°C			

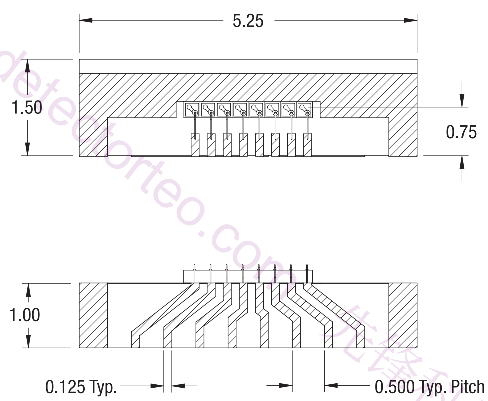
FCI-InGaAs-16M



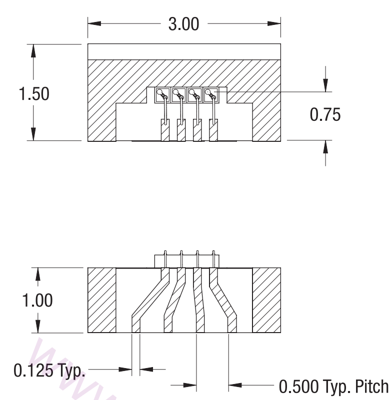
FCI-InGaAs-12M



FCI-InGaAs-8M



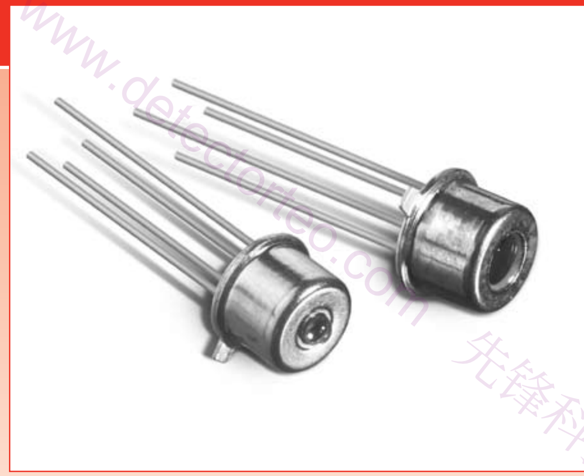
FCI-InGaAs-4M



Notes:
- All units in millimeters.
- All devices are mounted with low out gassing conductive epoxy with tolerance of ±25μm.

1.25Gbps / 2.50Gbps Hybrids

InGaAs Photodetectors / Transimpedance Amplifiers



FCI-H125/250G-InGaAs-XX series are compact and integrated high speed InGaAs photodetector with wide dynamic range transimpedance amplifier. Combining the detector with the TIA in a hermetically sealed 4 pin TO-46 package provides ideal conditions for high speed signal amplification. High speed and superior sensitivity make these devices ideal for high-bit rate receivers used in LAN, MAN, WAN, and other high speed communication systems. TO packages come standard with a lensed cap to enhance coupling efficiency, or with a broadband double sided AR coated flat window. The FCI-H125/250G-InGaAs-XX series are also offered with FC, SC, ST and SMA receptacles.

APPLICATIONS

- High Speed Optical Communications
- Gigabit Ethernet
- Fibre Channel
- ATM
- SONET OC-48 / SDH STM-16

FEATURES

- InGaAs Photodetector / Low Noise Transimpedance Amplifier
- High Bandwidth / Wide Dynamic Range
- Hermetically Sealed TO-46 Can
- Single +3.3 to +5V Power Supply
- Spectral Range 1100nm to 1650nm
- Differential Output

Absolute Maximum Ratings

PARAMETERS	SYMBOL	MIN	MAX	UNITS
Storage Temperature	T_{stg}	-40	+125	°C
Operating Temperature	T_{op}	-40	+85	°C
Supply Voltage	V_{cc}	0	+5.5	V
Input Optical Power	P_{IN}	---	+3	dBm

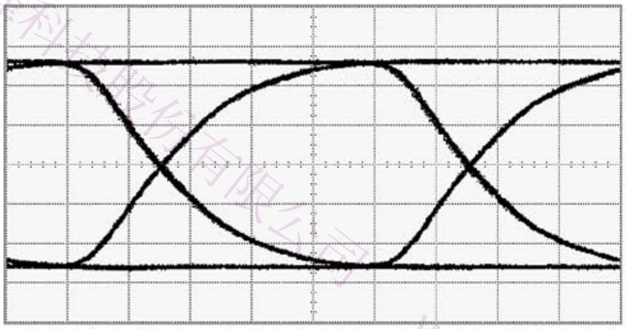
Electro-Optical Characteristics

T_A=23°C, Vcc=+3.3V, 1310nm, 100Ω Differential AC Load

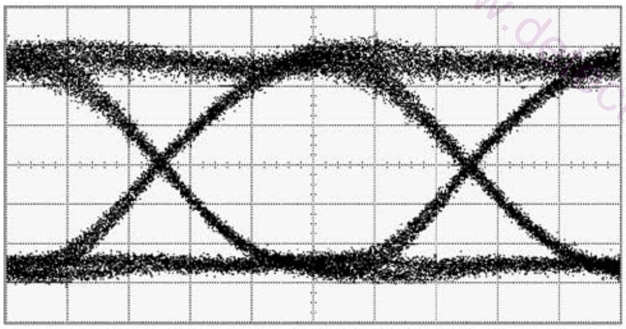
PARAMETERS	SYMBOL	CONDITIONS	FCI-H125G-InGaAs-70			FCI-H250G-InGaAs-70			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
Supply Voltage	V_{CC}	---	+3	---	+5.5	+3	---	+5.5	V
Supply Current	I_{CC}	*T_A = 0 to 70°C	---	26	*55	---	35	*65	mA
Active Area Diameter	AA_{ϕ}	---	---	70	---	---	70	---	µm
Operating Wavelength	λ	---	1100	---	1650	1100	---	1650	nm
Responsivity	R_{λ}	-17dBm, Differential	1800	2500	---	1600	2500	---	V/W
Transimpedance	---	-17dBm, Differential	---	2800	---	---	2800	---	Ω
Sensitivity	S	BER 10^{-10}, PRBS2^7-1	-24	-28	---	-20	-24	---	dBm
Optical Overload	---	---	-3	---	---	0	---	---	dBm
Bandwidth	BW	-3dB, Small Signal	---	900	---	---	1750	---	MHz
Low Frequency Cutoff	---	-3dB	---	45	---	---	30	---	kHz
Differential Output Voltage	$V_{OUT, P-P}$	-3dBm	180	250	420	200	400	600	mV_{P-P}
Output Impedance	---	---	47	50	53	47	50	53	Ω
Transimpedance Linear Range	---	<5%	30	---	---	40	---	---	μW_{P-P}

Use AC coupling and differential 100Ω load for best high-speed performance. Devices are not intended to drive DC coupled, 50Ω grounded load.

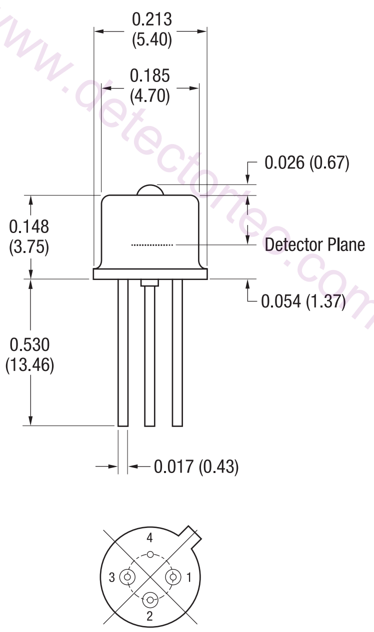
FCI-H125G-InGaAs-70



50mV / div, 160ps / div, -6dBm, 1310nm, PRBS2^7-1, Diff.



8mV / div, 160ps / div, -21dBm, 1310nm, PRBS2^7-1, Diff.

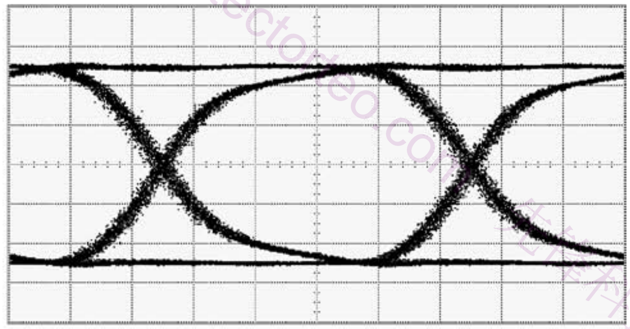


PINOUT

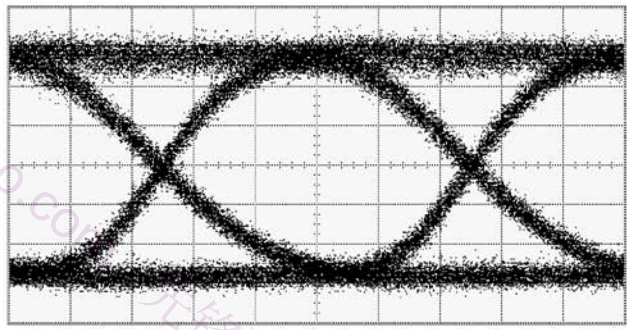
1	D_{out}
2	V_{CC}
3	$\overline{D_{out}}$
4	GND

Pin Circle Diameter = 0.100 (2.54)

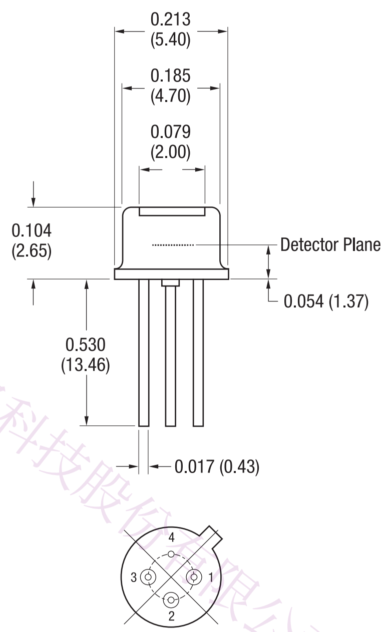
FCI-H250G-InGaAs-70



80mV / div, 80ps / div, -6dBm, 1310nm, PRBS2^7-1, Diff.



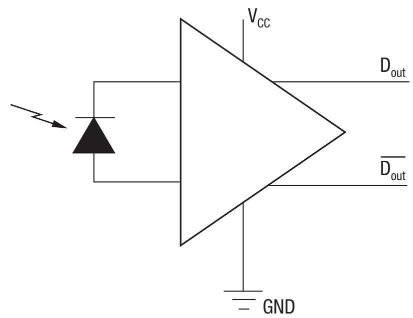
10mV / div, 80ps / div, -19dBm, 1310nm, PRBS2^7-1, Diff.



PINOUT

1	D_{out}
2	V_{CC}
3	$\overline{D_{out}}$
4	GND

Pin Circle Diameter = 0.100 (2.54)



Notes:
- All units in inches (mm).
- All tolerances: 0.005 (0.125).
- Please specify when ordering the flat window or lens cap devices.
- The flat window devices have broadband AR coatings centered at 1310nm.
- The thickness of the flat window=0.008 (0.21).

▪ 155 Mbps / 622 Mbps Hybrids

InGaAs Photodetectors / Transimpedance Amplifiers

FCI-H155/622M-InGaAs-70 series are high-speed 70µm InGaAs photodetector integrated with wide dynamic range transimpedance amplifier. Combining the detector with the TIA in a hermetically sealed 4 pin TO-46 package provides ideal conditions for high-speed signal detection and amplification. Low capacitance, low dark current and high responsivity of the detector, along with low noise characteristic of the integrated TIA, give rise to excellent sensitivity. In practice, these devices are ideal for datacom and telecom applications. Cost effective TO-46 packages come standard with a lensed cap for design simplification, or with a broadband double-sided AR coated flat window. The FCI-H155/622M-InGaAs-70 series are also offered with FC, SC, ST and SMA receptacles.

▪ APPLICATIONS

- High Speed Optical Communications
- ATM
- SONET OC-3 / OC-12
- SDH STM-1 / STM-4
- Optical Receivers

▪ FEATURES

- Low Noise Transimpedance Amplifier
- High Bandwidth / Wide Dynamic Range
- Single +3.3V Power Supply
- Spectral Range 1100nm to 1650nm
- Differential Output

Absolute Maximum Ratings

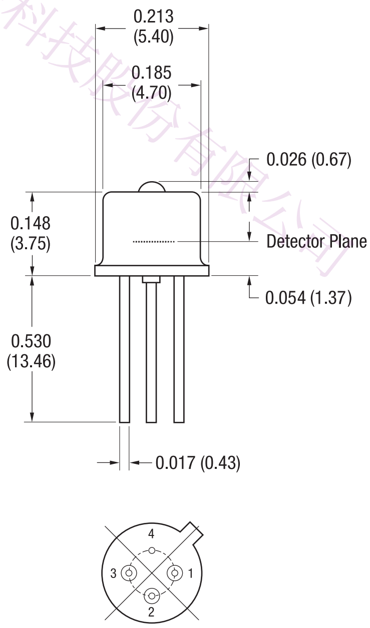
PARAMETERS	SYMBOL	MIN	MAX	UNITS
Storage Temperature	T_{stg}	-40	+125	°C
Operating Temperature	T_{op}	-40	+85	°C
Supply Voltage	V_{cc}	0	+5.5	V
Input Optical Power	P_{IN}	---	+3	dBm

Electro-Optical Characteristics

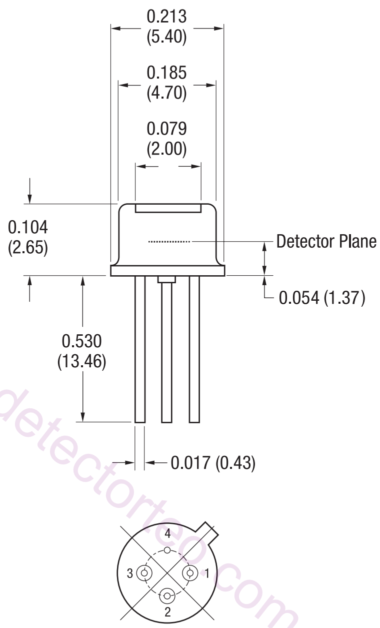
T_A=23°C, Vcc=+3.3V, 1310nm, 200Ω Differential AC at 155Mbps, 150Ω Differential AC at 622Mbps

PARAMETERS	SYMBOL	CONDITIONS	FCI-H155M-InGaAs-70			FCI-H622M-InGaAs-70			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
Supply Voltage	V_{CC}	---	+3	---	+3.6	+3	---	+3.6	V
Supply Current	I_{CC}	*T_A = 0 to 70°C	---	25	35	---	22	27	mA
Active Area Diameter	AA_{ϕ}	---	---	70	---	---	70	---	µm
Operating Wavelength	λ	---	1100	---	1650	1100	---	1650	nm
Responsivity	R_{λ}	*-37dBm, ¨-28dBm Differential	---	*48	---	---	¨16	---	V/mW
Transimpedance	---	*-37dBm, ¨-28dBm Differential	---	*54	---	---	¨18	---	kΩ
Sensitivity	S	BER 10^{-9}, PRBS2^7-1 with noise filter	---	-38	---	---	-32	---	dBm
Optical Overload	---	---	---	0	---	---	0	---	dBm
Bandwidth	BW	-3dB, Small Signal	---	110	---	---	520	---	MHz
Differential Output Voltage	$V_{OUT, P-P}$	0dBm	---	250	---	---	240	---	mV_{P-P}
Output Impedance	---	Single-ended	---	100	---	---	75	---	Ω

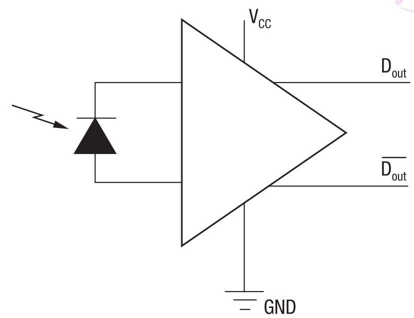
Use AC coupling and differential 200Ω/150Ω load for the best high-speed performance. Devices are not designed to drive DC coupled 200Ω/150Ω grounded load.



Bottom View



Bottom View



PINOUT

1	$\overline{D}_{out}$
2	V_{CC}
3	D_{out}
4	GND

Pin Circle Diameter = 0.100 (2.54)

PINOUT

1	$\overline{D}_{out}$
2	V_{CC}
3	D_{out}
4	GND

Pin Circle Diameter = 0.100 (2.54)

Notes:
- All units in inches (mm).
- All tolerances: 0.005 (0.125).
- Please specify when ordering the flat window or lens cap devices.
- The flat window devices have a double sided AR coated window at 1310nm.
- The thickness of the flat window=0.008 (0.21).

FCI-InGaAs-300B1XX

Back Illuminated InGaAs Photodiode / Arrays

FCI-InGaAs-300B1XX series are multifunctional backside illuminated photodiode/arrays. They come standard in a single element diode or 4- or 8- elements array with active area of 300um. These back illuminated InGaAs photodiode/arrays are designed to be flip chip mounted to an optical plane for front or back illumination. They can be traditionally mounted (active area facing up), or assembled face down minimizing the overall dimensions. These low inductance, low dark current, and low capacitance back illuminated photodiode/arrays come with or without ceramic substrates.

APPLICATIONS

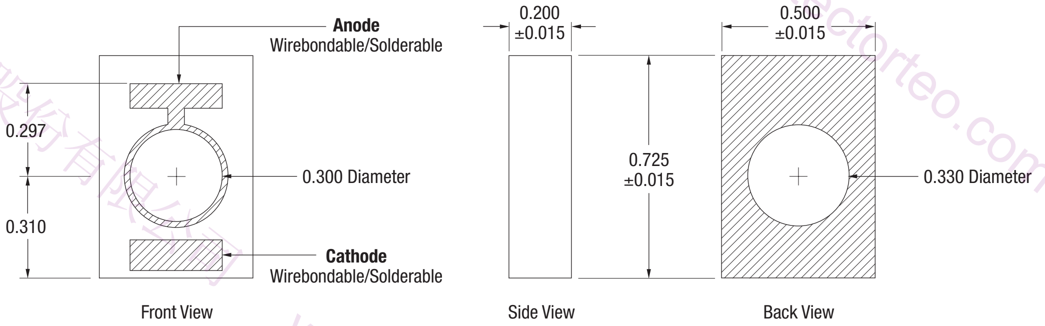
- High Speed Optical Communications
- Multichannel Fiber Optic Receiver
- Power Monitoring
- Single/Multi-Mode Fiber Optic Receiver
- Fast Ethernet, SONET/SDH OC-3/STM-1, ATM
- Instrumentation and Analog Receivers

FEATURES

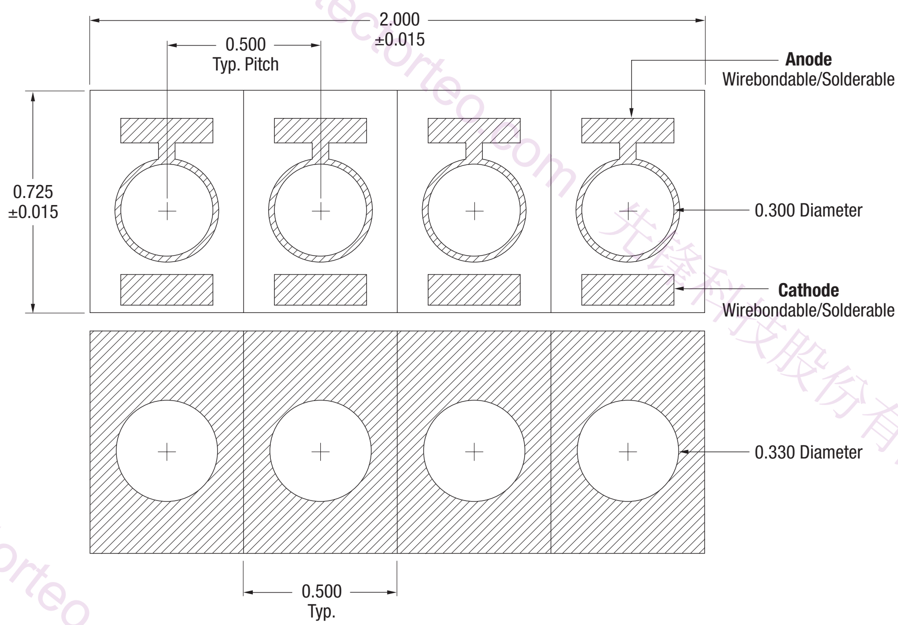
- Back Illumination
- High Responsivity on Both Front and Back
- Low Noise
- Spectral Range 900nm to 1700nm

Electro-Optical Characteristics $T_A=23°C, V_R=5V$

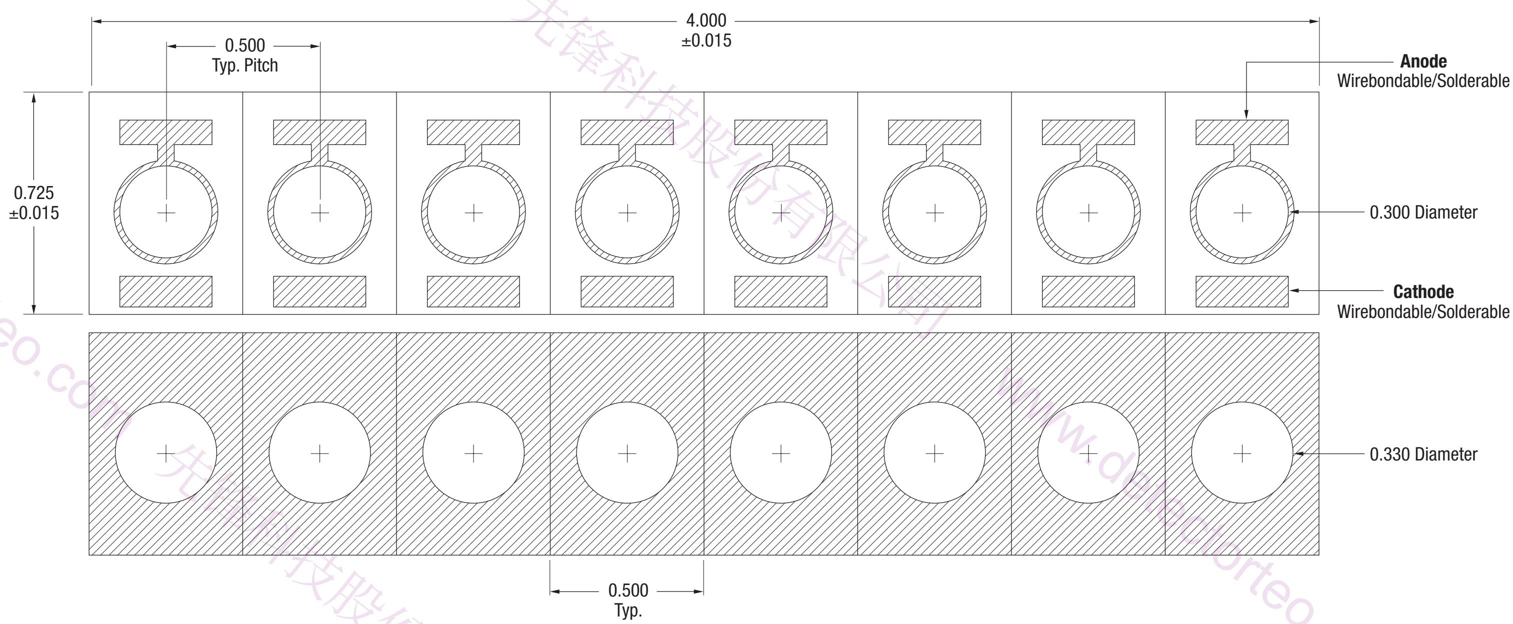
PARAMETERS	FCI-InGaAs-300B1	FCI-InGaAs-300B1X4	FCI-InGaAs-300B1X8
Active Area Diameter	300μm	300μm, Pitch:500μm	300μm, Pitch:500μm
Responsivity	Min. 0.85A/W @ 1550nm for both front and back Min. 0.80A/W @ 1310nm for both front and back		
Capacitance	Typ. 8pF, Max. 10pF @ V_R=-5V		
Dark Current	Typ. 0.05nA, Max. 5.0nA @ V_R=-5V		
Max. Reverse Voltage	15V		
Max. Reverse Current	5mA		
Max. Forward Current	25mA		
Bandwidth	Min. 100MHz		
Breakdown Voltage	Min. 10V @ 1uA		
Storage Temperature Range	From −40 to 85°C		
Operating Temperature Range	From 0 to 70°C		



Anode
Wirebondable/Solderable
0.297
0.300 Diameter
0.310
Cathode
Wirebondable/Solderable
Front View
0.200
±0.015
0.725
±0.015
Side View
0.500
±0.015
0.330 Diameter
Back View



2.000
±0.015
0.500
Typ. Pitch
Anode
Wirebondable/Solderable
0.725
±0.015
0.300 Diameter
Cathode
Wirebondable/Solderable
0.330 Diameter
0.500
Typ.

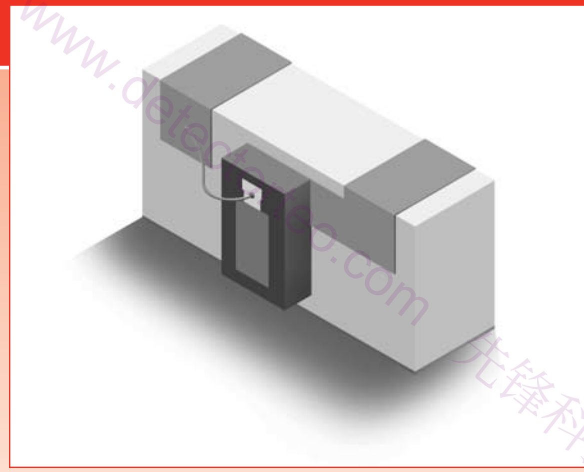


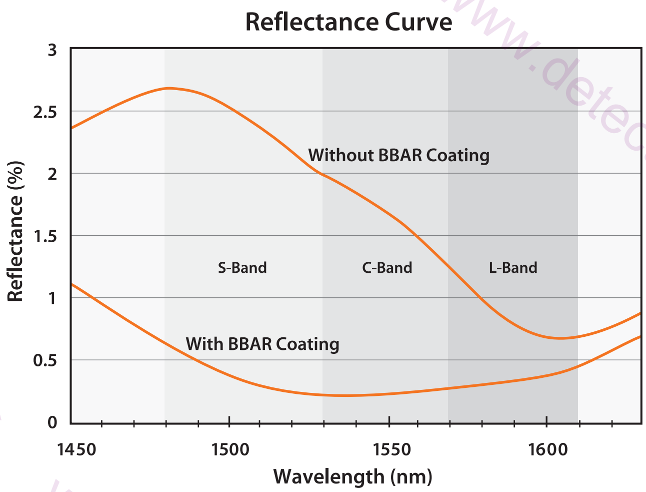
4.000
±0.015
0.500
Typ. Pitch
Anode
Wirebondable/Solderable
0.725
±0.015
0.300 Diameter
Cathode
Wirebondable/Solderable
0.330 Diameter
0.500
Typ.

▪ FCI-InGaAs-WCER-LR

Broadband Anti-Reflection Coated InGaAs Photodiodes

OSI Optoelectronics's latest product line includes a very low reflectance photodiode. Designed for telecommunication applications, the InGaAs/InP photodiode has a typical optical reflectance of less than .6% from 1520nm to 1620nm. This ultra low reflectance over the wide wavelength range was achieved by depositing a proprietary multi-layered Anti-Reflection coating directly onto the surface of the InGaAs/InP photodiode.



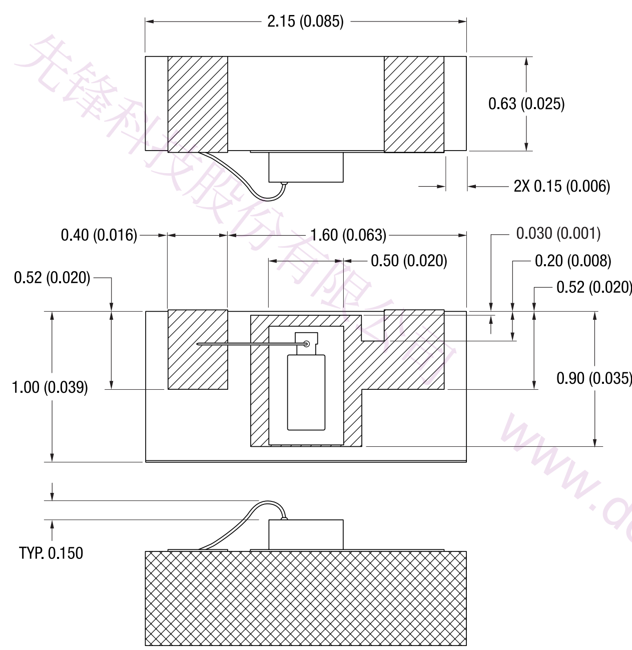


▪ APPLICATIONS

- Wavelength Locker / Wavelength Monitoring
- Lasers Back Facet Monitoring
- DWDM
- Instrumentation

▪ FEATURES

- Reflectance Less than 0.6%
- Low Noise
- High Responsivity
- High Speed
- Spectral Range 900nm to 1700nm



Absolute Maximum Ratings

PARAMETERS	SYMBOL	MIN	MAX	UNITS
Storage Temperature	T_{stg}	-40	+85	°C
Operating Temperature	T_{op}	0	+70	°C
Soldering Temperature	T_{sld}	---	+260	°C

Electro-Optical Characteristics T_A=23°C

PARAMETERS	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Active Area	AA	---	---	250X500	---	μm X μm
Responsivity	R_λ	λ = 1310nm	0.85	0.90	---	A/W
		λ = 1550nm	0.90	0.95	---	
Capacitance	C_j	V_R=5.0V	---	15	---	pF
Dark Current	I_d	V_R=5.0V	---	---	1	nA
Max. Reverse Voltage	---	---	---	---	20	V
Max. Reverse Current	---	---	---	---	2	mA
Max. Forward Current	---	---	---	---	5	mA
Reflectance	---	1520nm≤ λ ≤1620nm	---	0.5	0.6	%

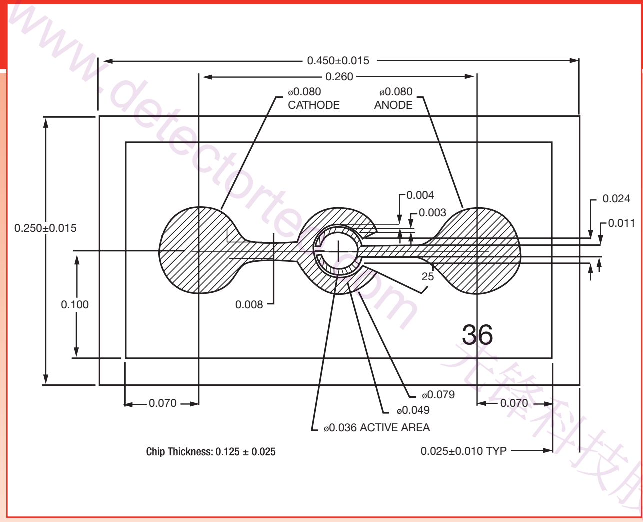
Notes:
- All units in millimeters.
- All devices are mounted with low out gassing conductive epoxy withtolerance of ±25μm. Eutectic mounting is also availabel upon request.

▪ FCI-InGaAs-36C

10Gbps InGaAs Photodiode

OSI Optoelectronics's FCI-InGaAs-36C is an OC-192 (SONET/SDH) capable photosensitive device, exhibiting low dark current and good performance stability.

Both Anode and Cathode contacts appear on the chip's top facet. And it makes ideal component in high-speed optical data transport applications at 10Gbps, responding to a spectral envelope that spans from 910nm to 1650nm.



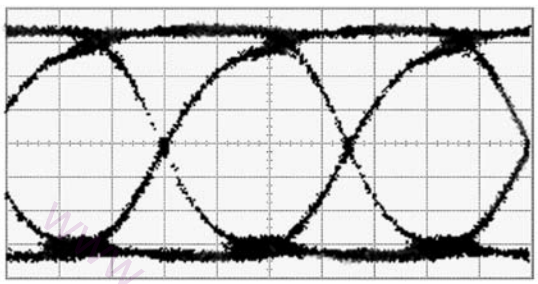
▪ APPLICATIONS

- High Speed Optical Communications
- OC-192
- Optical Networking
- Optical Measurement

▪ FEATURES

- High Speed, 10 Gbps Data Rates
- low Dark Current
- Front Illuminated
- High Responsivity, Typ. 0.8 A/W @1550nm
- Diameter of Light Sensitive area 36μm
- Low Capacitance

Typical Eye Diagram (10Gbps)(1)



Scale: Vertical 100mV/div
Horizontal 20.0 ps/div

Electro-Optical Characteristics T_A=23°C

PARAMETERS	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Sensing Area Diameter	AA_ϕ	---	---	36	---	μm
Chip Size	---	---	---	450 x 250	---	μm x μm
Responsivity	R_λ	λ=1310nm	0.8	0.85	---	A/W
		λ=1550nm	0.75	0.8	---	
Capacitance	C_j	V_R=5V	---	0.16	0.2	pF
Dark Current	I_d	V_R=5V	---	0.5	2	nA
Breakdown Voltage	V_b	I_R=1μA	20	---	---	V
Bandwidth	---	---	---	9	---	GHz

(1) Measured with a TIA. Currently FCI-InGaAs-36C is offered in die form only.

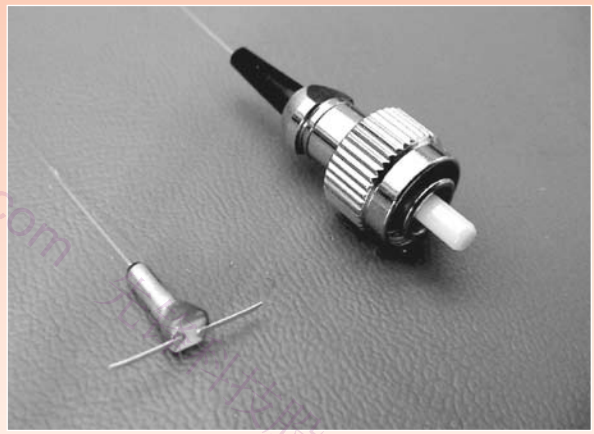
▪ FCI-InGaAs-XX-XX-XX

High Speed InGaAs Photodiodes w/Pigtail Packages

The FCI-InGaAs-XX-XX-XX with active area of 70um and 120um are part of OSI Optoelectronics's family of high speed IR sensitive detectors with fiber pigtail package. The single/multi-mode fiber is optically aligned to either the hermetically sealed InGaAs diode in TO-46 lens cap package enhancing the coupling efficiency and stability or directly to the InGaAs diode mounted on a ceramic substrate. High responsivity and low capacitance make these devices ideal for very high-bit rate receivers used in LAN, MAN, WAN and other high speed communication and monitoring/instrumentation systems. Angle polished connectors and custom packages are also available.

For a solution involving FC connector and TO-46 attachment, user(s) may consider either FCI-InGaAs-70-SM-FC or FCI-InGaAs-120-SM-FC in single-mode operation.

Similarly, the multi-mode variant is available in FCI-InGaAs-120-MM-FC using 62.5/125 fiber. The back-reflection of -30dB typical is to be experienced in multi-mode based solution.



▪ APPLICATIONS

- High Speed Optical Communications
- Gigabit Ethernet/Fibre Channel
- SONET/SDH, ATM
- Optical Power Monitoring / Instrumentation

▪ FEATURES

- High Speed
- High Responsivity
- Spectral Range 900nm to 1700nm
- Low Back Reflection

Absolute Maximum Ratings

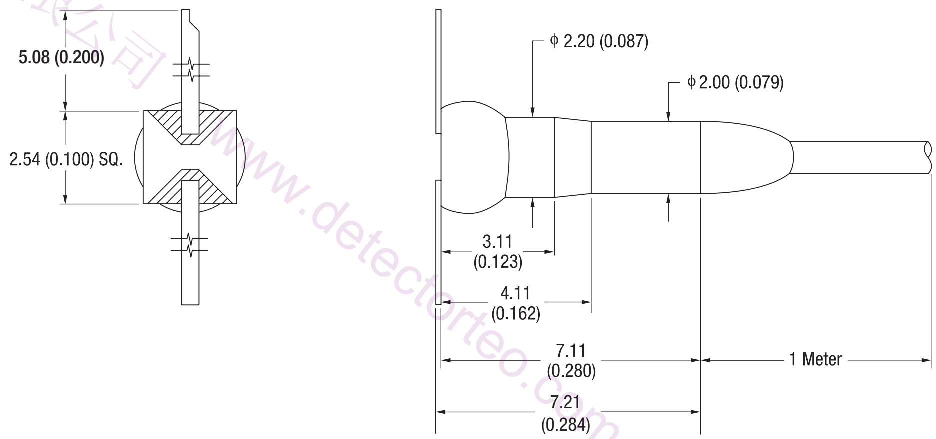
PARAMETERS	SYMBOL	MIN	MAX	UNITS
Storage Temperature	T_{stg}	-20	+90	°C
Operating Temperature	T_{op}	0	+75	°C

Electro-Optical Characteristics T_A=23°C

PARAMETERS	SYMBOL	CONDITIONS	FCI-InGaAs-70-XX-XX			FCI-InGaAs-120-XX-XX			FCI-InGaAs-70C-XX-XX			FCI-InGaAs-120C-XX-XX			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
Active Area Diameter	AA_ϕ	---	---	70	---	---	120	---	---	70	---	---	120	---	µm
Responsivity	R_λ	λ=1310nm	0.75	0.85	---	0.80	0.90	---	0.80	0.90	---	0.85	0.90	---	A/W
		λ=1550nm	0.80	0.90	---	0.85	0.95	---	0.85	0.95	---	0.90	0.95	---	
Back-Reflection*	R_L	---	---	-40	-35	---	-40	-35	---	-40	-35	---	-40	-35	dB
Capacitance	C_j	V_R = 5.0V	---	0.65	---	---	1.0	---	---	0.65	---	---	1.0	---	pF
Dark Current	I_d	V_R = 5.0V	---	0.03	2	---	0.05	2	---	0.03	2	---	0.05	2	nA
Rise Time/ Fall Time	t_r/t_f	V_R = 5.0V, R_L=50Ω 10% to 90%	---	---	0.2	---	---	0.3	---	---	0.2	---	---	0.3	ns
Max. Revervse Voltage	---	---	---	---	20	---	---	20	---	---	20	---	---	20	V
Max. Reverse Current	---	---	---	---	1	---	---	2	---	---	1	---	---	2	mA
Max. Forward Current	---	---	---	---	5	---	---	5	---	---	5	---	---	5	mA
NEP	---	---	---	3.44E-15	---	---	4.50E-15	---	---	3.44E-15	---	---	4.50E-15	---	W/√Hz

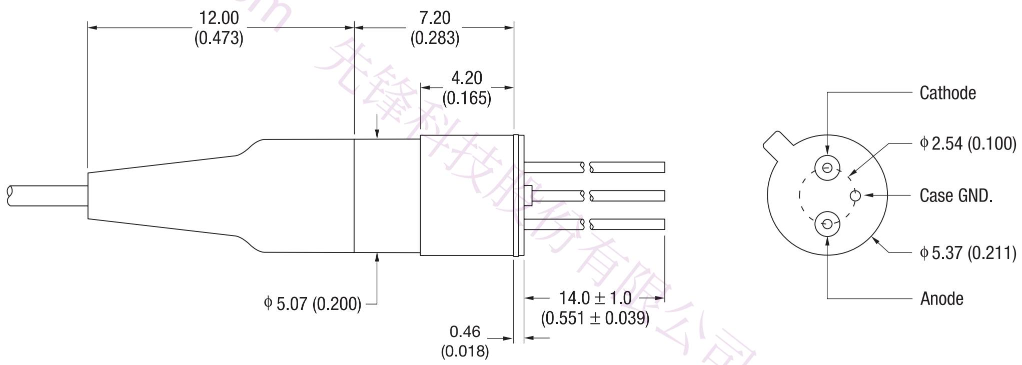
*Single Mode Fiber (SMF) only

FCI-InGaAs-70C-XX-XX & FCI-InGaAs-120C-XX-XX



All pigtail packages are available in: SM-(FC, SC or ST)
MM-(FC, SC or ST)

FCI-InGaAs-70-XX-XX & FCI-InGaAs-120-XX-XX



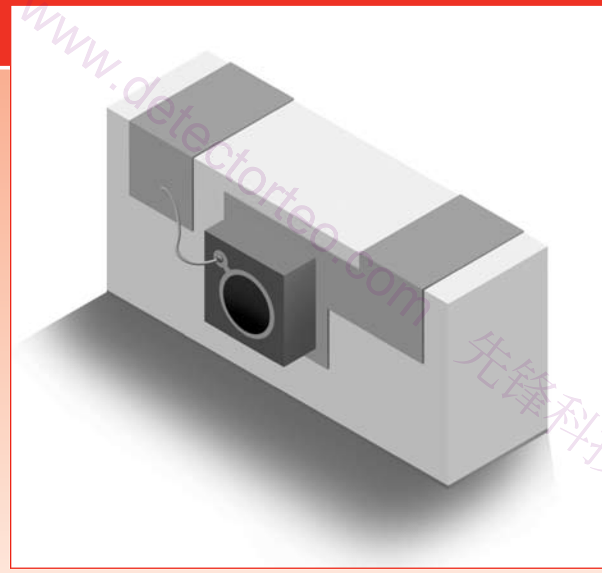
All pigtail packages are available in: SM-(FC, SC or ST)
MM-(FC, SC or ST)

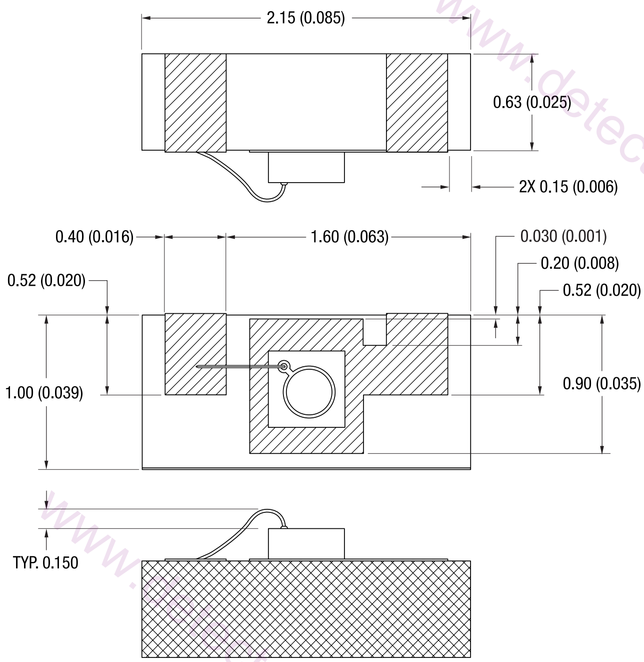
Notes:
- All units in millimeters (inches).
- All tolerances are 0.125 (0.005)

FCI-InGaAs-XXX-WCER

High Speed InGaAs Photodiodes Mounted on Wraparound Ceramic Packages

FCI-InGaAs-XXX-WCER with active area sizes of 70µm, 120µm, 300µm, 400µm and 500µm are part of a line of monitor photodiodes mounted on metallized ceramic substrates. These compact assemblies are designed for ease of integration. The chips can be epoxy or eutectic mounted onto the ceramic substrate.





Notes:
- All units in millimeters (inches).
- All devices are eutectic mounted with tolerance of ±50µm.

APPLICATIONS

- High Speed Optical Communications
- Gigabit Ethernet/Fibre Channel
- SONET / SDH, ATM
- Diode Laser Monitor
- Instrumentation

FEATURES

- Low Noise
- High Responsivity
- High Speed
- Spectral Range 900nm to 1700nm

Absolute Maximum Ratings

PARAMETERS	SYMBOL	MIN	MAX	UNITS
Storage Temperature	T_{stg}	-40	+85	°C
Operating Temperature	T_{op}	0	+70	°C
Soldering Temperature	T_{sld}	---	+260	°C

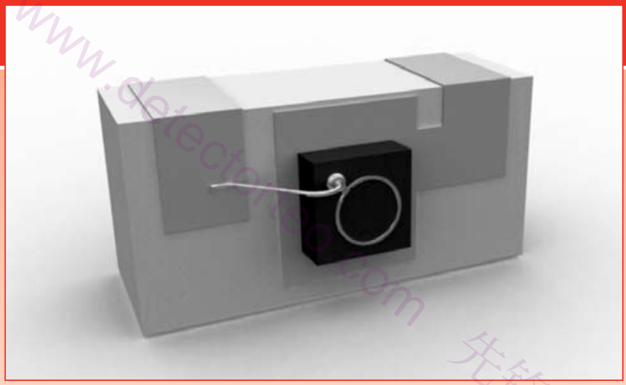
Electro-Optical Characteristics T_A=23°C

PARAMETERS	SYMBOL	CONDITIONS	FCI-InGaAs-70WCER			FCI-InGaAs-120WCER			FCI-InGaAs-300WCER			FCI-InGaAs-400WCER			FCI-InGaAs-500WCER			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
Active Area Diameter	AA_ϕ	---	---	70	---	---	120	---	---	300	---	---	400	---	---	500	---	µm
Responsivity	R_λ	λ=1310nm	0.80	0.90	---	0.80	0.90	---	0.80	0.90	---	0.80	0.90	---	0.80	0.90	---	A/W
		λ=1550nm	0.90	0.95	---	0.90	0.95	---	0.90	0.95	---	0.90	0.95	---	0.90	0.95	---	
Capacitance	C_j	V_R = 5.0V	---	0.65	---	---	1.0	---	---	10.0	---	---	14.0	---	---	20.0	---	pF
Dark Current	I_d	V_R = 5.0V	---	0.03	2	---	0.05	2	---	0.30	5	---	0.40	5	---	0.50	20	nA
Rise Time/ Fall Time	t_r/t_f	V_R = 5.0V, R_L=50Ω 10% to 90%	---	---	0.20	---	---	0.30	---	---	1.5	---	---	3.0	---	---	10.0	ns
Max. Revervse Voltage	---	---	---	---	20	---	---	20	---	---	15	---	---	15	---	---	15	V
Max. Reverse Current	---	---	---	---	1	---	---	2	---	---	2	---	---	2	---	---	2	mA
Max. Forward Current	---	---	---	---	5	---	---	5	---	---	8	---	---	8	---	---	8	mA
NEP	---	---	---	3.44E-15	---	---	4.50E-15	---	---	6.28E-15	---	---	7.69E-15	---	---	8.42E-15	---	W/√Hz

▪ FCI-InGaAs-XXX-ACER

High Speed InGaAs Photodiodes Mounted on Wedge Ceramic Packages

FCI-InGaAs-XXX-ACER with active area sizes of 70µm, 120µm, 300µm, 400µm and 500µm is part of OSI Optoelectronics's high speed IR sensitive photodiodes mounted on angled ceramic substrates. The ceramic substrate with an angled surface by 5° greatly reduces the back reflection. The chips can be epoxy/eutectic mounted onto the angled ceramic substrate.

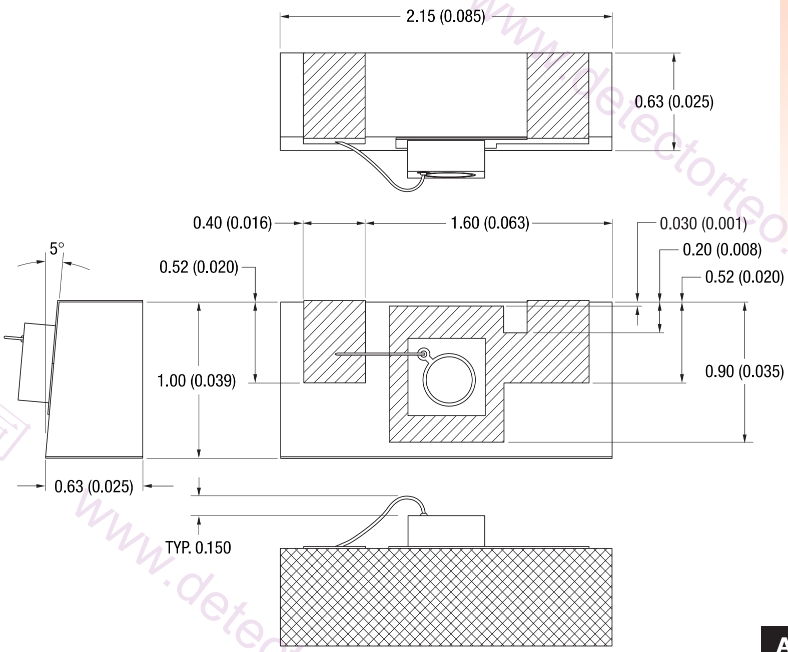


• APPLICATIONS

- High Speed Optical Communications
- Gigabit Ethernet/Fibre Channel
- SONET / SDH, ATM
- Diode Laser Monitor
- Instrumentation

• FEATURES

- 5° Angle Ceramic
- Low Noise
- High Responsivity
- High Speed
- Spectral Range 900nm to 1700nm



Notes:
- All units in millimeters (inches).
- All devices are eutectic mounted with tolerance of ±50µm.

Absolute Maximum Ratings

PARAMETERS	SYMBOL	MIN	MAX	UNITS
Storage Temperature	T_{stg}	-40	+85	°C
Operating Temperature	T_{op}	0	+70	°C
Soldering Temperature	T_{sld}	---	+260	°C

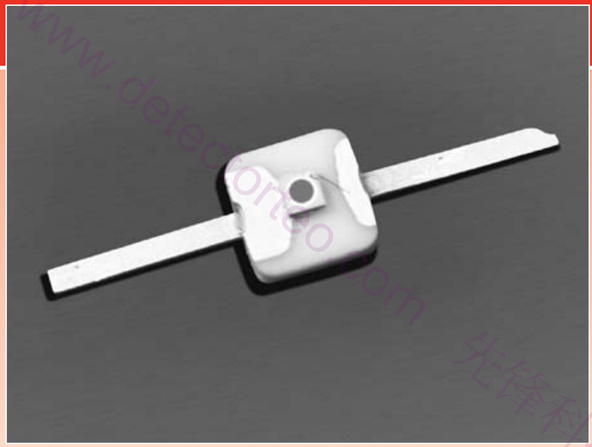
Electro-Optical Characteristics T_A=23°C

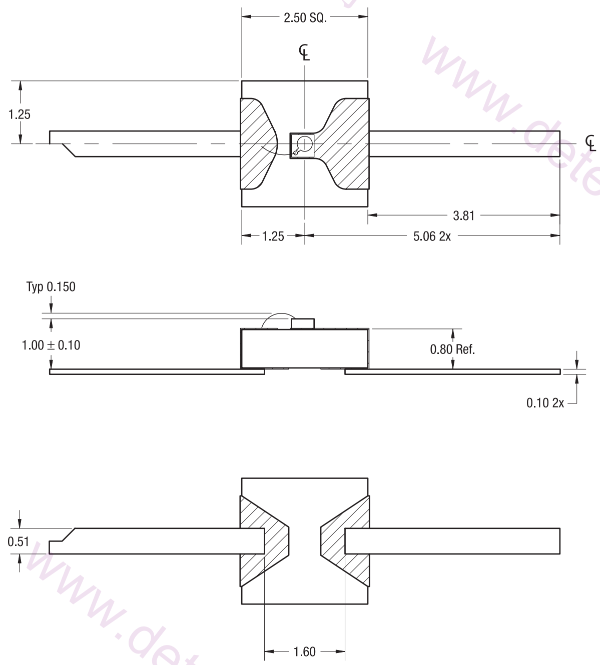
PARAMETERS	SYMBOL	CONDITIONS	FCI-InGaAs-70ACER			FCI-InGaAs-120ACER			FCI-InGaAs-300ACER			FCI-InGaAs-400ACER			FCI-InGaAs-500ACER			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
Active Area Diameter	AA_ϕ	---	---	70	---	---	120	---	---	300	---	---	400	---	---	500	---	µm
Responsivity	R_λ	λ=1310nm	0.80	0.90	---	0.80	0.90	---	0.80	0.90	---	0.80	0.90	---	0.80	0.90	---	
		λ=1550nm	0.90	0.95	---	0.90	0.95	---	0.90	0.95	---	0.90	0.95	---	0.90	0.95	---	A/W
Capacitance	C_j	V_R = 5.0V	---	0.65	---	---	1.0	---	---	10.0	---	---	14.0	---	---	20.0	---	pF
Dark Current	I_d	V_R = 5.0V	---	0.03	2	---	0.05	2	---	0.30	5	---	0.40	5	---	0.50	20	nA
Rise Time/ Fall Time	t_r/t_f	V_R = 5.0V, R_L=50Ω 10% to 90%	---	---	0.20	---	---	0.30	---	---	1.5	---	---	3.0	---	---	10.0	ns
Max. Revervse Voltage	---	---	---	---	20	---	---	20	---	---	15	---	---	15	---	---	15	V
Max. Reverse Current	---	---	---	---	1	---	---	2	---	---	2	---	---	2	---	---	2	mA
Max. Forward Current	---	---	---	---	5	---	---	5	---	---	8	---	---	8	---	---	8	mA
NEP	---	---	---	3.44E-15	---	---	4.50E-15	---	---	6.28E-15	---	---	7.69E-15	---	---	8.42E-15	---	W/√Hz

FCI-InGaAs-XXX-LCER

High Speed InGaAs Photodiodes Mounted on Ceramic Packages w/Leads

FCI-InGaAs-XXX-LCER with active area sizes of 70µm, 120µm, 300µm, 400µm and 500µm are part of OSI Optoelectronics's high speed IR sensitive photodiodes mounted on gull wing ceramic substrates. The chips can be epoxy/eutectic mounted onto the ceramic substrate.





Notes:
- All units in millimeters.
- All devices are mounted with low out gassing conductive epoxy with tolerance of ±25µm. Eutectic mounting is also available upon request.

APPLICATIONS

- High Speed Optical Communications
- Gigabit Ethernet/Fibre Channel
- SONET / SDH, ATM
- Diode Laser Monitoring
- Instrumentation

FEATURES

- Low Noise
- High Responsivity
- High Speed
- Spectral Range 900nm to 1700nm

Absolute Maximum Ratings

PARAMETERS	SYMBOL	MIN	MAX	UNITS
Storage Temperature	T_{stg}	-40	+85	°C
Operating Temperature	T_{op}	0	+70	°C
Soldering Temperature	T_{sld}	---	+260	°C

Electro-Optical Characteristics

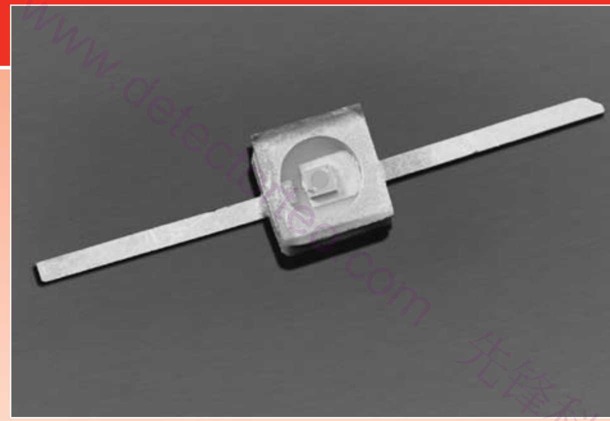
T_A=23°C

PARAMETERS	SYMBOL	CONDITIONS	FCI-InGaAs-70LCER			FCI-InGaAs-120LCER			FCI-InGaAs-300LCER			FCI-InGaAs-400LCER			FCI-InGaAs-500LCER			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
Active Area Diameter	AA_ϕ	---	---	70	---	---	120	---	---	300	---	---	400	---	---	500	---	µm
Responsivity	R_λ	λ=1310nm	0.80	0.90	---	0.80	0.90	---	0.80	0.90	---	0.80	0.90	---	0.80	0.90	---	A/W
		λ=1550nm	0.90	0.95	---	0.90	0.95	---	0.90	0.95	---	0.90	0.95	---	0.90	0.95	---	
Capacitance	C_j	V_R = 5.0V	---	0.65	---	---	1.0	---	---	10.0	---	---	14.0	---	---	20.0	---	pF
Dark Current	I_d	V_R = 5.0V	---	0.03	2	---	0.05	2	---	0.30	5	---	0.40	5	---	0.50	20	nA
Rise Time/ Fall Time	t_r/t_f	V_R = 5.0V, R_L=50Ω 10% to 90%	---	---	0.20	---	---	0.30	---	---	1.5	---	---	3.0	---	---	10.0	ns
Max. Revervse Voltage	---	---	---	---	20	---	---	20	---	---	15	---	---	15	---	---	15	V
Max. Reverse Current	---	---	---	---	1	---	---	2	---	---	2	---	---	2	---	---	2	mA
Max. Forward Current	---	---	---	---	5	---	---	5	---	---	8	---	---	8	---	---	8	mA
NEP	---	---	---	3.44E-15	---	---	4.50E-15	---	---	6.28E-15	---	---	7.69E-15	---	---	8.42E-15	---	W/√Hz

FCI-InGaAs-XXX-CCER

High Speed InGaAs Photodiodes Mounted on Cavity Ceramic Packages

FCI-InGaAs-XXX-CCER with active area sizes of 70µm, 120µm, 300µm, 400µm and 500µm are part of OSI Optoelectronics's high speed IR sensitive photodiodes mounted on gull wing ceramic substrates with glass windows. These devices have a glass window attached to the ceramic where fibers can be directly epoxy mounted onto. The chips can be epoxy or eutectic mounted onto the ceramic substrate. These devices can be provided with custom AR coated windows.

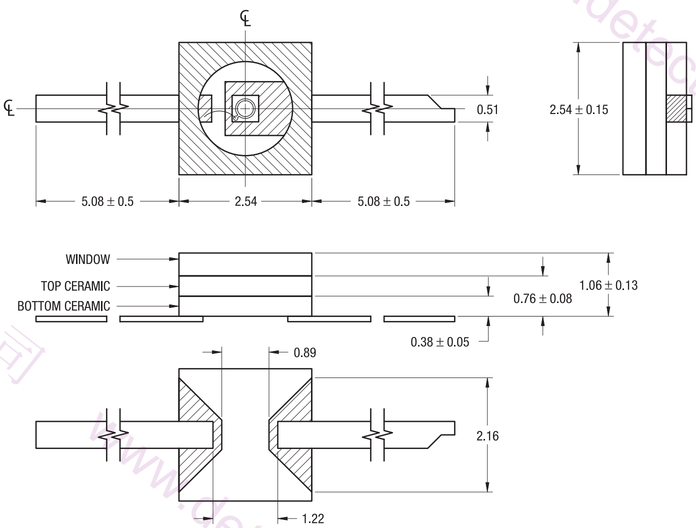


APPLICATIONS

- High Speed Optical Communications
- Gigabit Ethernet/Fibre Channel
- SONET / SDH, ATM
- Diode Laser Monitoring
- Instrumentation

FEATURES

- Low Noise
- High Responsivity
- High Speed
- Spectral Range 900nm to 1700nm



Notes:
- All units in millimeters.
- All devices are mounted with low out gassing conductive epoxy with tolerance of ±25µm. Eutectic mounting is also available upon request.

Absolute Maximum Ratings

PARAMETERS	SYMBOL	MIN	MAX	UNITS
Storage Temperature	T_{stg}	-40	+85	°C
Operating Temperature	T_{op}	0	+70	°C
Soldering Temperature	T_{sld}	---	+260	°C

Electro-Optical Characteristics

T_A=23°C

PARAMETERS	SYMBOL	CONDITIONS	FCI-InGaAs-70CCER			FCI-InGaAs-120CCER			FCI-InGaAs-300CCER			FCI-InGaAs-400CCER			FCI-InGaAs-500CCER			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
Active Area Diameter	AA_ϕ	---	---	70	---	---	120	---	---	300	---	---	400	---	---	500	---	µm
Responsivity	R_λ	λ=1310nm	0.80	0.90	---	0.80	0.90	---	0.80	0.90	---	0.80	0.90	---	0.80	0.90	---	A/W
		λ=1550nm	0.90	0.95	---	0.90	0.95	---	0.90	0.95	---	0.90	0.95	---	0.90	0.95	---	
Capacitance	C_j	V_R = 5.0V	---	0.65	---	---	1.0	---	---	10.0	---	---	14.0	---	---	20.0	---	pF
Dark Current	I_d	V_R = 5.0V	---	0.03	2	---	0.05	2	---	0.30	5	---	0.40	5	---	0.50	20	nA
Rise Time/ Fall Time	t_r/t_f	V_R = 5.0V, R_L=50Ω 10% to 90%	---	---	0.20	---	---	0.30	---	---	1.5	---	---	3.0	---	---	10.0	ns
Max. Revervse Voltage	---	---	---	---	20	---	---	20	---	---	15	---	---	15	---	---	15	V
Max. Reverse Current	---	---	---	---	1	---	---	2	---	---	2	---	---	2	---	---	2	mA
Max. Forward Current	---	---	---	---	5	---	---	5	---	---	8	---	---	8	---	---	8	mA
NEP	---	---	---	3.44E-15	---	---	4.50E-15	---	---	6.28E-15	---	---	7.69E-15	---	---	8.42E-15	---	W/√Hz

FCI-XXXA

Large Active Area 970nm Si Monitor Photodiodes

FCI-020A and FCI-040A with active area sizes of 0.5mm and 1.0mm, are parts of OSI Optoelectronics's large active area IR sensitive Silicon detectors exhibiting excellent responsivity at 970nm. These large active area devices are ideal for use in low speed infrared instrumentation and monitoring applications. The photodiode chip is isolated in a TO-18 package.

APPLICATIONS

- Optical Communications
- Power Measurement
- IR Sensing
- Medical Devices
- Optical Taps

FEATURES

- High Responsivity @ 970nm
- Large Active Area Diameter
- Spectral Range 400nm to 1100nm
- Wide Dynamic Range

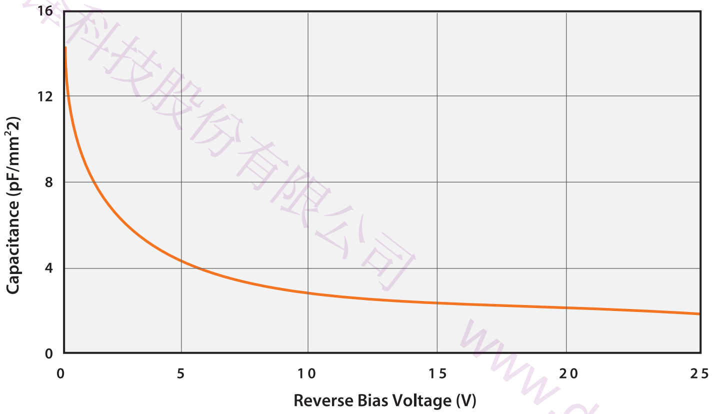
Absolute Maximum Ratings

PARAMETERS	SYMBOL	MIN	MAX	UNITS
Storage Temperature	T_{stg}	-55	+125	°C
Operating Temperature	T_{op}	-40	+75	°C
Soldering Temperature	T_{sld}	---	+260	°C

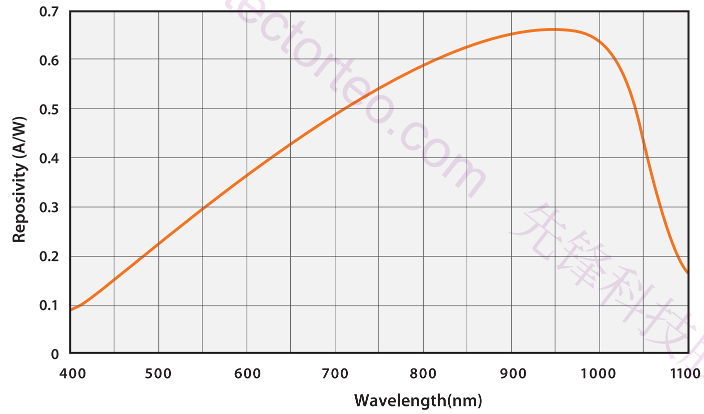
Electro-Optical Characteristics T_A=23°C

PARAMETERS	SYMBOL	CONDITIONS	FCI-020A			FCI-040A			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
Active Area Diameter	AA_ϕ	---	---	0.51	---	---	1.02	---	mm
Responsivity	R_λ	λ=400nm	0.07	0.12	---	0.07	0.12	---	A/W
		λ=632nm	0.33	0.40	---	0.33	0.40	---	
		λ=970nm	0.60	0.65	---	0.60	0.65	---	
Capacitance	C_j	V_R =0V	---	4	---	---	8	---	pF
		V_R =10V	---	1	---	---	2	---	
Dark Current	I_d	V_R =10V	---	0.01	0.15	---	0.05	0.50	nA
Reverse Voltage	---	---	---	---	30	---	---	30	V
Rise Time	t_r	V_R =10V, λ=632nm 10% to 90%, R_L=50Ω	---	26	---	---	24	---	ns
NEP	---	---	---	2.80E -15	---	---	6.20E -15	---	W/√Hz

Typical Capacitance vs. Bias Voltage

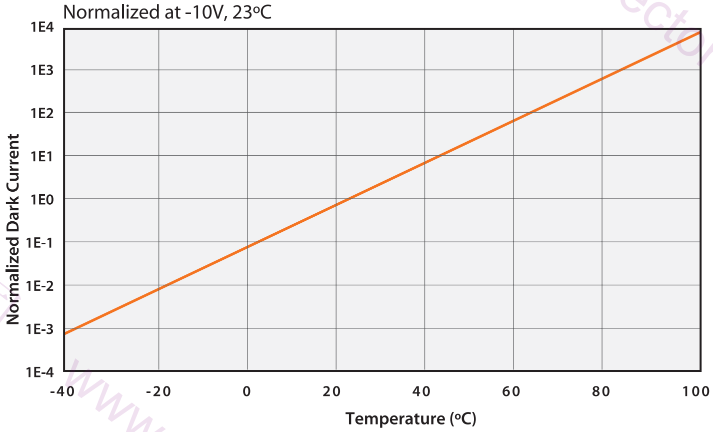


Typical Spectral Response



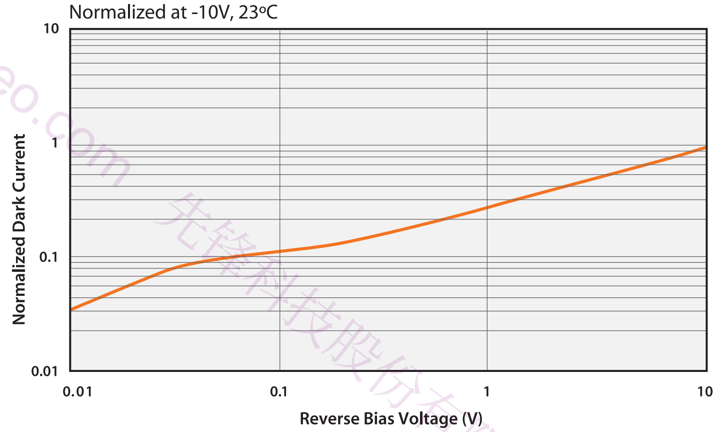
Typical Dark Current vs. Temperature

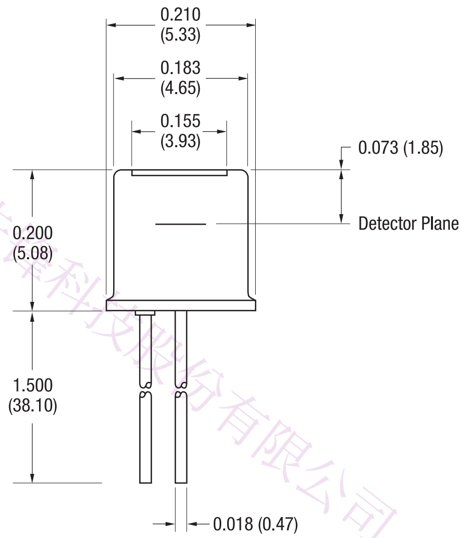
Normalized at -10V, 23ºC

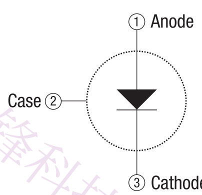


Typical Dark Current vs Bias Voltage

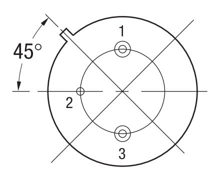
Normalized at -10V, 23ºC







Pin Circle Diameter = 0.100 (2.54)



Bottom View

Notes:
- All units in inches (mm).
- The flat window devices have broadband AR coatings centered at 850nm.

▪ 100Mbps / 155Mbps / 622Mbps

Large Active Area and High Speed Silicon Photodiodes

OSI Optoelectronics's family of large active area and high speed silicon detector series are designed to reliably support short-haul data communications applications. All exhibit low dark current and low capacitance at 3.3V bias. The base unit comes in a 3 pin TO-46 package with micro lens cap or AR coated flat window. Standard fiber optic receptacles (FC, ST, SC and SMA) allow easy integration of OSI Optoelectronics's fast silicon photodiodes into systems.

▪ APPLICATIONS

- High Speed Optical Communications
- Single/Multi-Mode Fiber Optic Receiver
- Fast Ethernet/FDDI
- SONET/SDH, ATM

▪ FEATURES

- Silicon Photodiodes
- High Responsivity
- Large Diameter Sensing Area
- Low Capacitance @ 3.3V Bias
- Low Cost

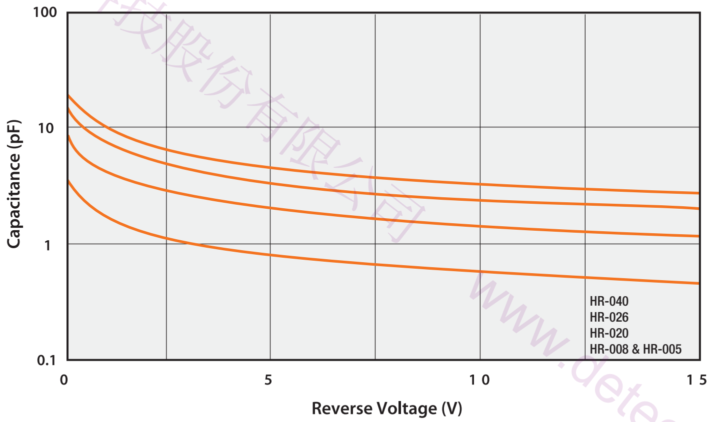
Absolute Maximum Ratings

PARAMETERS	SYMBOL	MIN	MAX	UNITS
Storage Temperature	T_{stg}	-55	+125	°C
Operating Temperature	T_{op}	-40	+75	°C
Soldering Temperature	T_{sld}	---	+260	°C

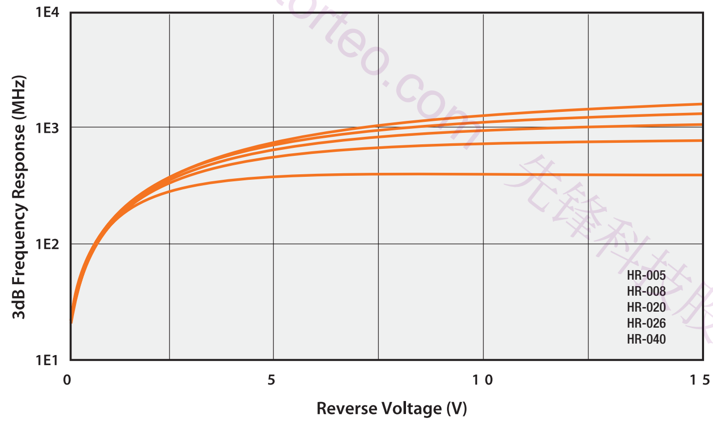
Electro-Optical Characteristics T_A=23°C

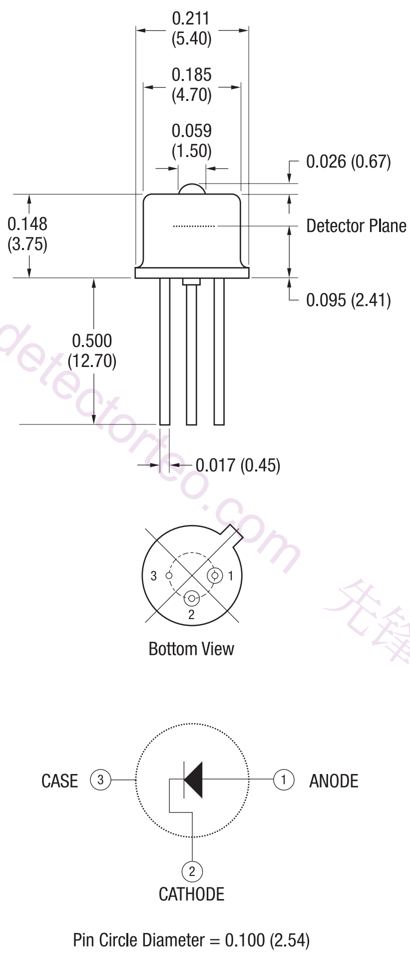
PARAMETERS	SYMBOL	CONDITIONS		FCI-HR005			FCI-HR008			FCI-HR020			FCI-HR026			FCI-HR040			UNITS
				MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
Active Area Diameter	AA_ϕ	---		---	127	---	---	203	---	---	508	---	---	660	---	---	991	---	µm
Responsivity (Flat Window Package)	R_λ	λ=850nm		---	0.50	---	---	0.50	---	---	0.50	---	---	0.50	---	---	0.50	---	A/W
Dark Current	I_d	V_R = 5.0V		---	0.02	0.80	---	0.03	0.80	---	0.06	1.00	---	0.09	1.50	---	0.30	2.00	nA
Capacitance	C_j	V_R = 3.3V		---	0.9	---	---	0.9	---	---	2.1	---	---	2.8	---	---	5.2	---	pF
		V_R = 5.0V		---	0.80	---	---	0.80	---	---	1.8	---	---	2.6	---	---	4.9	---	
Rise Time	t_r	10% to 90% R_L=50Ω λ=850nm	V_R = 3.3V	---	0.75	---	---	0.75	---	---	1.00	---	---	1.10	---	---	1.20	---	ns
			V_R = 5.0V	---	0.60	---	---	0.60	---	---	0.80	---	---	0.90	---	---	1.00	---	
Max. Reverse Voltage	---	---		---	---	20	---	---	20	---	---	20	---	---	20	---	---	20	V
NEP	---	---		---	5.95E -15	---	---	6.19E -15	---	---	8.76E -15	---	---	1.07E -14	---	---	1.96E -14	---	W/√Hz

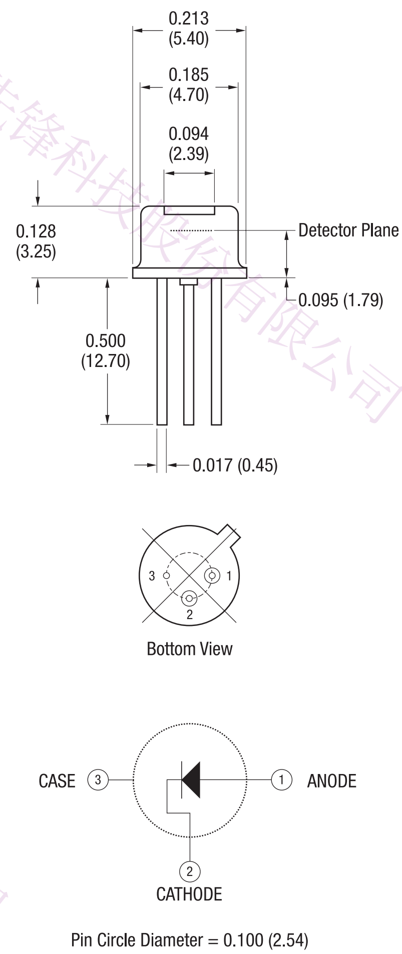
Typical Capacitance vs. Reverse Bias



Frequency Response vs. Bias Voltage







Notes:
- All units in inches (mm).
- All tolerances: 0.005 (0.125).
- Please specify when ordering the flat window or lens cap devices.
- The flat window devices have broadband AR coatings centered at 850nm.
- The thickness of the flat window=0.008 (0.21).

▪ 850nm, 1.25Gbps

Large Active Area and High Speed Silicon Photodiodes

OSI Optoelectronics's family of large active area and high speed silicon PIN photodiodes possesses a large sensing area optimized for short-haul optical data communication applications at 850nm. The photodetectors exhibit high responsivity, wide bandwidth, low dark current and low capacitance at 3.3V. They are designed to match the most widely used transimpedance amplifiers. The photodiodes can be used in all 850nm transceivers and GBICs up to 1.25Gbps applications such as Gigabit Ethernet and Fibre Channel. The chip is isolated in a 3 pin TO-46 package with options of micro lens cap or an AR coated flat window. They are also available in standard fiber receptacles such as FC, ST, SC and SMA. For availability in chip form please contact our sales department.

▪ APPLICATIONS

- High Speed Optical Communications
- Single/Multi-Mode Fiber Optic Receiver
- Gigabit Ethernet/Fibre Channel
- SONET/SDH, ATM

▪ FEATURES

- Silicon Photodiodes
- High Responsivity
- Large Diameter Sensing Area
- Low Capacitance @ 3.3V
- Low Cost

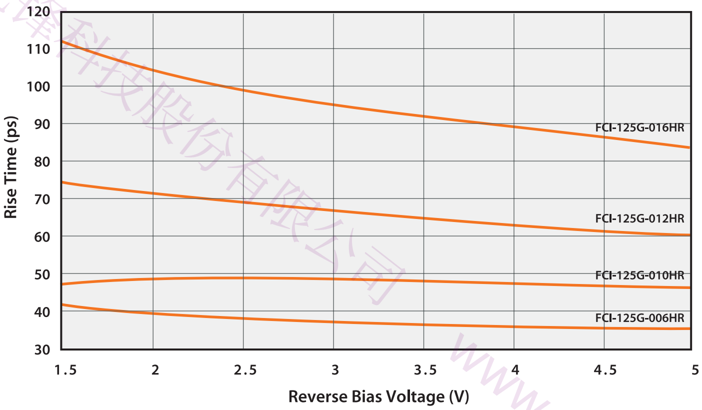
Absolute Maximum Ratings

PARAMETERS	SYMBOL	MIN	MAX	UNITS
Storage Temperature	T_{stg}	-55	+125	°C
Operating Temperature	T_{op}	-40	+75	°C
Soldering Temperature	T_{sld}	---	+260	°C

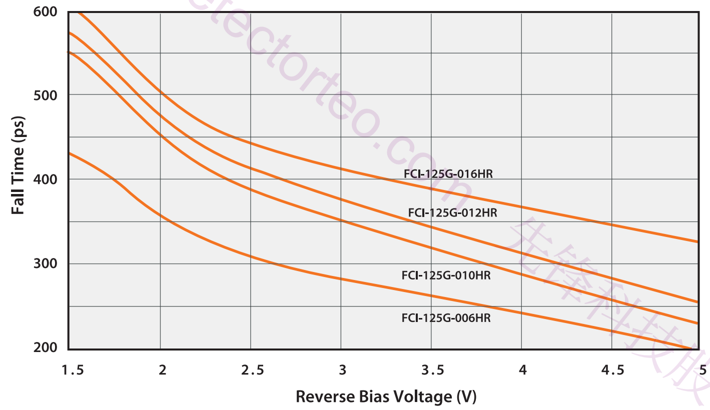
Electro-Optical Characteristics — T_A=23°C

PARAMETERS	SYMBOL	CONDITIONS		FCI-125G-006HRL			FCI-125G-010HRL			FCI-125G-012HRL			FCI-125G-016HRL			UNITS
				MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
Active Area Diameter	AA_ϕ	---		---	150	---	---	250	---	---	300	---	---	400	---	µm
Responsivity (Flat Window Package)	R_λ	λ=850nm		---	0.36	---	---	0.36	---	---	0.36	---	---	0.36	---	A/W
Dark Current	I_d	V_R = 3.3V		---	20	500	---	25	500	---	30	500	---	40	500	pA
		V_R = 5.0V		---	30	500	---	35	500	---	40	500	---	50	500	
Capacitance	C_j	V_R = 3.3V		---	0.66	---	---	0.96	---	---	1.16	---	---	1.73	---	pF
		V_R = 5.0V		---	0.65	---	---	0.94	---	---	1.13	---	---	1.70	---	
Rise Time	t_r	20% to 80% R_L=50Ω λ=850nm	V_R = 3.3V	---	38	---	---	50	---	---	69	---	---	100	---	ps
			V_R = 5.0V	---	35	---	---	47	---	---	60	---	---	84	---	
Fall Time	t_f	80% to 20% R_L=50Ω λ=850nm	V_R = 3.3V	---	313	---	---	429	---	---	436	---	---	449	---	ps
			V_R = 5.0V	---	200	---	----	246	---	---	265	---	---	329	---	
Max. Reverse Voltage	---	---		---	---	20	---	---	20	---	---	20	---	---	20	V
NEP	---	---		---	8.60E -15	---	---	9.29E -15	---	---	9.93E -15	---	---	1.11E -14	---	W/√Hz

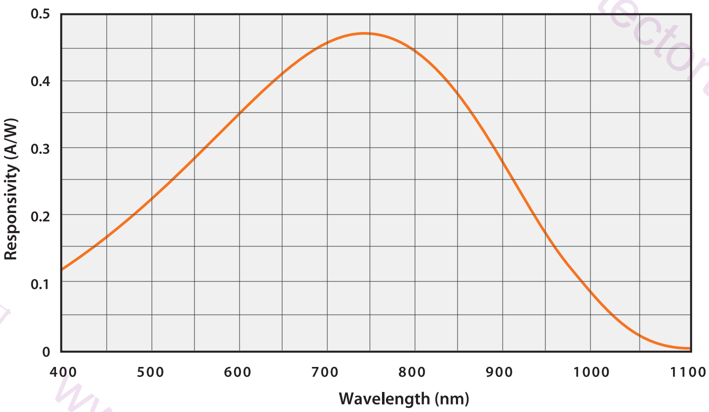
Rise Time vs. Bias Voltage



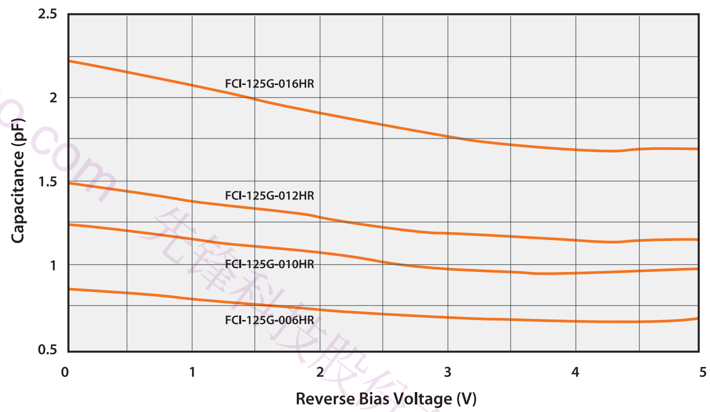
Fall Time vs. Bias Voltage

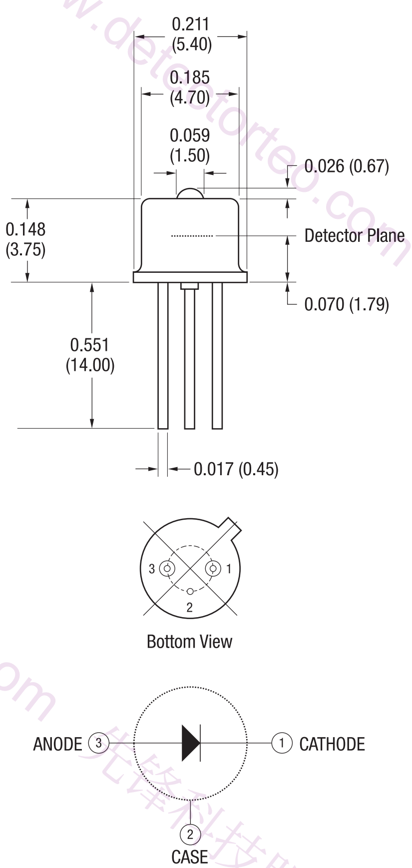


Typical Responsivity

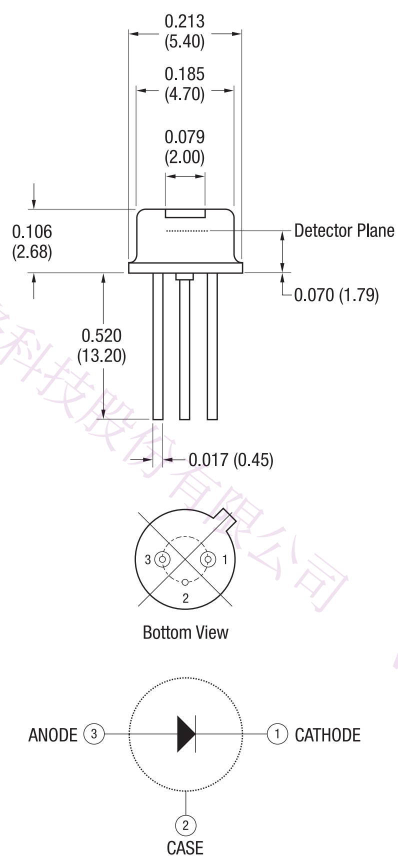


Capacitance vs. Bias Voltage





Pin Circle Diameter = 0.100 (2.54)



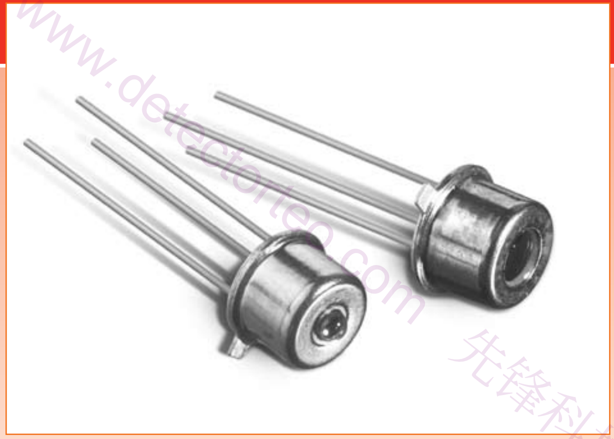
Pin Circle Diameter = 0.100 (2.54)

Notes:
- All units in inches (mm).
- All tolerances: 0.005 (0.125).
- Please specify when ordering the flat window or lens cap devices.
- The flat window devices have broadband AR coatings centered at 850nm.
- The thickness of the flat window=0.008 (0.21).

▪ FCI-H125G-010

1.25Gbps Silicon Photodetector / Transimpedance Amplifier

FCI-H125G-010 is a low noise, high bandwidth photodetector plus transimpedance amplifier designed for short wavelength (850nm) high speed fiber optic data communications. The hybrid incorporates a 250µm diameter large sensing area, high sensitivity silicon photodetector. It also includes a high gain transimpedance amplifier producing a differential output voltage for latching to post amplifiers used in electro-optical receivers and transceivers for Gigabit Ethernet and Fibre Channel applications up to 1.25Gbps over multi-mode fiber. The photodetector converts the light into an electrical signal while the output voltage increases with light input. This is achieved by a single +3.3V to +5V positive power supply. These devices are available in 4 pin TO-46 metal packages with either a double sided AR coated window cap or an integrated lens cap. The 250µm diameter sensing area eases fiber alignment for connectorization or receptacle attachment. Furthermore, the proximity of the transimpedance amplifier to the photodetector lowers the capacitance associated with long traces, therefore allowing higher bandwidth and sensitivity.



▪ APPLICATIONS

- High Speed Optical Communications
- Gigabit Ethernet
- Fibre Channel
- SONET/SDH, ATM

▪ FEATURES

- Silicon Photodetector / Low Noise Transimpedance Amplifier
- Low Cost
- Large Active Area of 250µm
- High Bandwidth / Wide Dynamic Range
- Automatic Gain Control (AGC)
- Hermetically Sealed TO-46 Can
- Single +3.3V to +5V Power Supply
- Differential Output

Absolute Maximum Ratings

PARAMETERS	SYMBOL	MIN	MAX	UNITS
Storage Temperature	T_{stg}	-55	+125	°C
Operating Temperature	T_{op}	-40	+75	°C
Supply Voltage	V_{cc}	0	+6	V
Input Optical Power	P_{IN}	---	+5	dBm

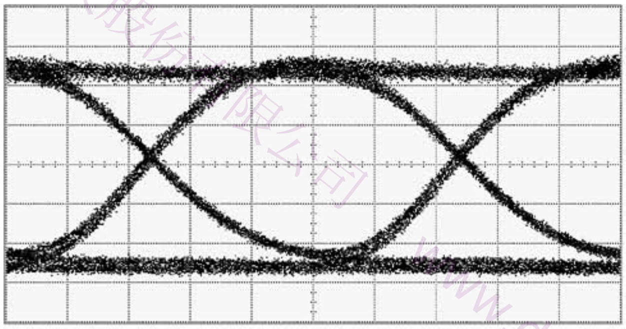
Electro-Optical Characteristics T_A=23°C, Vcc=+5.0V, 850nm, 100Ω Differential AC Load

PARAMETERS	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Supply Voltage	V_{CC}	---	+3	---	+5.5	V
Supply Current	I_{CC}	---	---	38	50	mA
Active Area Diameter	AA_{ϕ}	---	---	250	---	µm
Operating Wavelength	λ	---	---	850	---	nm
Responsivity	R_{λ}	-19dBm, Differential	---	3000	---	V/W
Transimpedance	---	-19dBm, Differential	---	8300	---	Ω
Sensitivity	S	BER 10^{-10}, PRBS2^7-1	-20	-23	---	dBm
Optical Overload	---	---	-3	0	---	dBm
Bandwidth	BW	-3dB, Small Signal	800	1000	---	MHz
Differential Output Voltage	$V_{OUT,\ P-P}$	---	---	200	---	mV_{p-p}
Output Impedance	---	---	40	50	62	Ω

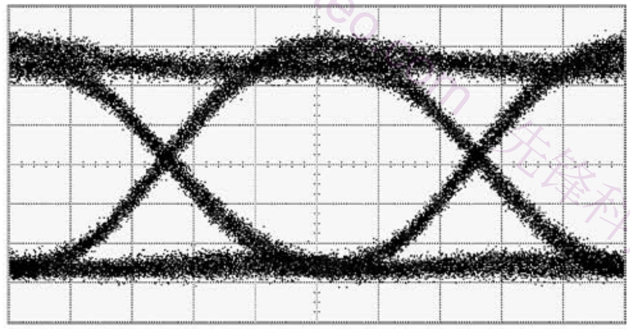
Use AC coupling and differential 100Ω load for the best high-speed performance. Devices are not intended to drive DC coupled, 50Ω grounded load.

▪ FCI-H125G-010

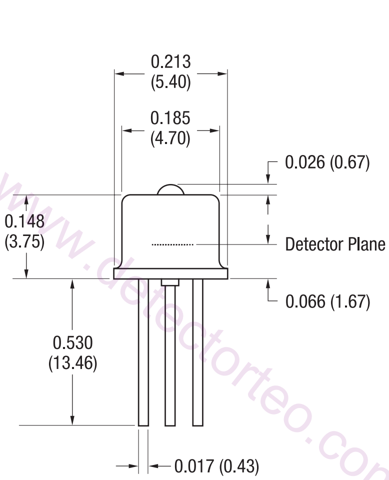
1.25Gbps Silicon Photodetector / Transimpedance Amplifier

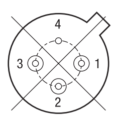


40mV / div, 160ps / div, -12dBm, 850nm, PRBS2^7-1, Diff.



20mV / div, 160ps / div, -17dBm, 850nm, PRBS2^7-1, Diff.



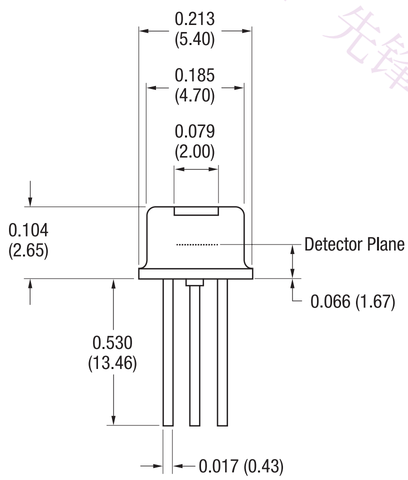


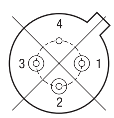
Bottom View

PINOUT

1	D_{out}
2	V_{CC}
3	$\overline{D_{out}}$
4	GND

Pin Circle Diameter = 0.100 (2.54)



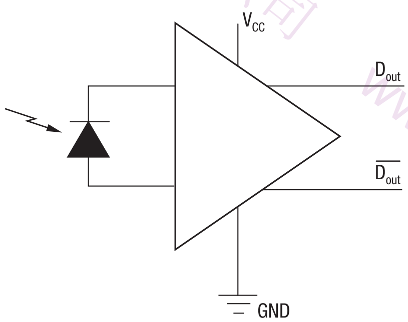


Bottom View

PINOUT

1	D_{out}
2	V_{CC}
3	$\overline{D_{out}}$
4	GND

Pin Circle Diameter = 0.100 (2.54)

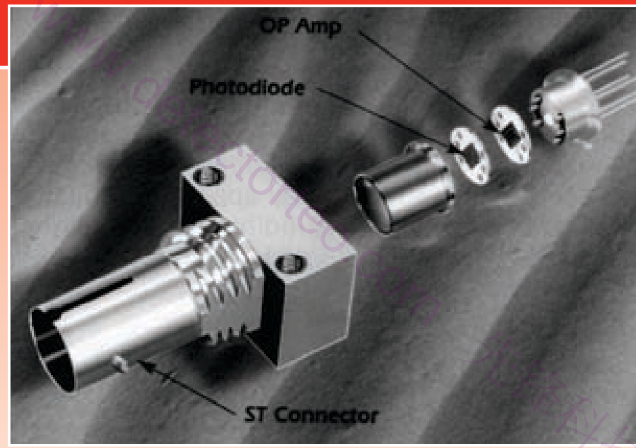


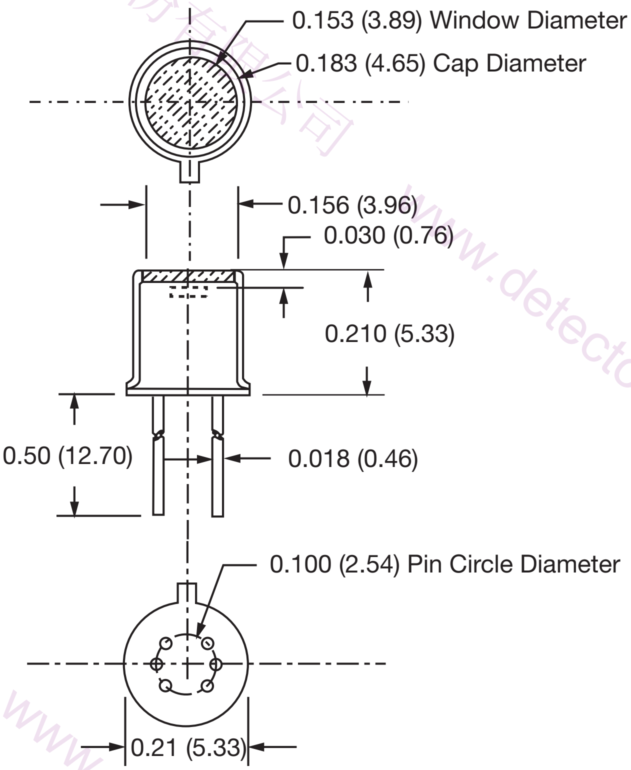
Notes:
- All units in inches (mm).
- All tolerances: 0.005 (0.125).
- Please specify when ordering the flat window or lens cap devices.
- The flat window devices have broadband AR coatings centered at 850nm.
- The thickness of the flat window=0.008 (0.21).

▪ BPX65-100

Fiberoptic Receiver

The BPX65-100 receiver contains a BPX-65 ultra high speed photodiode coupled to an NE5212 (Signetics) transimpedance amplifier. Standard products include ST aned SMA connector versions.



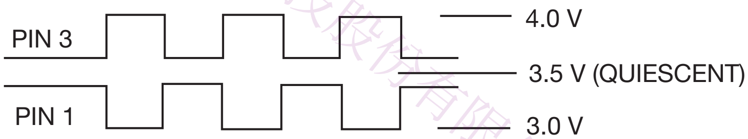


▪ APPLICATIONS

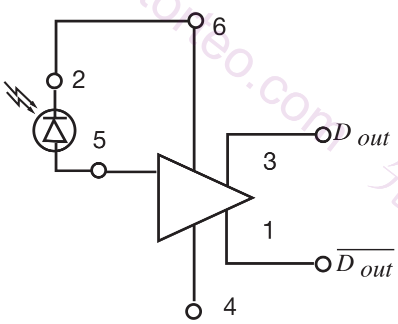
- 100Mbs Optical Communications
- Fiber Patchcord Coupling
- Silicon-based Optical Receivers

▪ FEATURES

- 140MHz Bandwidth
- 14KΩ Differential Transresistance
- 400 nm to 1000nm Spectral Range
- $2.5 \frac{pA}{\sqrt{Hz}}$ Transimpedance Amplifier



OUTPUT WAVEFORMS (NOMINAL VALUES)



Pin Designations

1 - $\overline{D}_{out}$

2 - Cathode

3 - D_{out}

4 - Ground

5 - Anode

6 - Vcc (5 V)

Absolute Maximum Ratings

	MAX	UNITS
Maximum Voltage	6	V
Operating Temp. Range	-20 to +70	°C

Receiver Data at 25°C

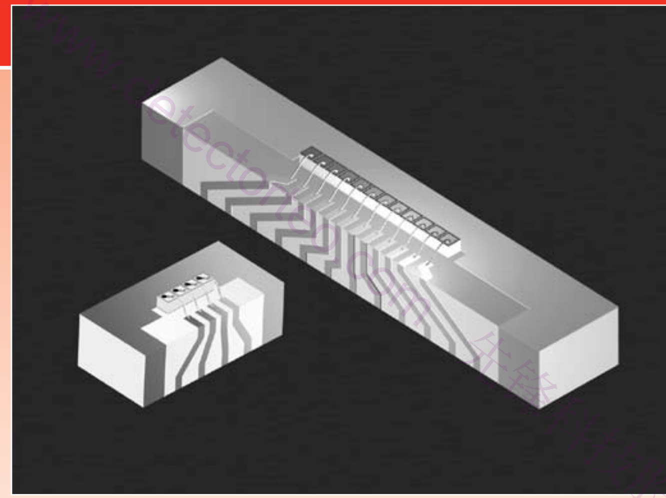
MODEL NUMBER	FIBER CONNECTOR	POWER SUPPLY	DETECTOR RESPONSIVITY λ=850nm	AMPLIFIER GAIN	MAX DATA RATE
BPX65-100	None	5V	0.5 A/W	14 KΩ	100 Mbps
BPX65-100ST	ST				
BPX65-100SMA	SMA				

FCI-GaAs-XXM

High Speed GaAs Arrays

The FCI-GaAs-XXM is a 4 or 12 element GaAs PIN photodetector array designed for high speed fiber receiver and monitoring applications. The 70µm diameter elements are capable of 2.5Gbps data rates. AR coated and sensitive to telecommunication wavelengths, this array is a perfect receiver for SM or MM fiber ribbon with a 250µm pitch. The FCI-GaAs-XXM comes standard on a wraparound ceramic submount. Board level contacts have a 0.5mm pitch.

If you need a custom array or require special testing for your OSI Optoelectronics part, please contact our Applications department.



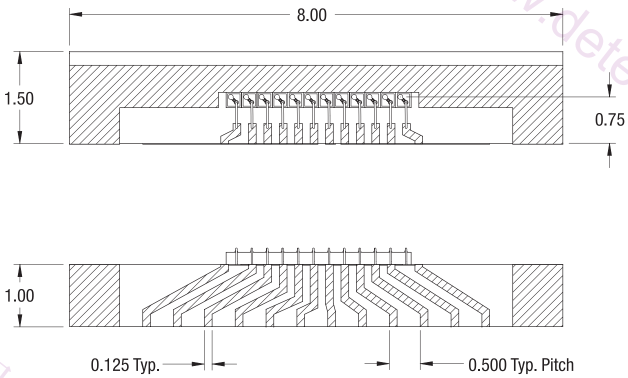
APPLICATIONS

- Fiber Optic Receiver
- DWDM Monitor
- SM or MM Fiber Ribbon
- Parallel Interconnects

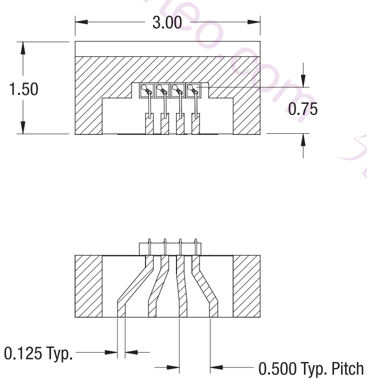
FEATURES

- High Speed
- High Responsivity
- AR Coated Elements
- Wraparound Ceramic Submount
- Spectral Range 650nm to 860nm

FCI-GaAs-12M



FCI-GaAs-4M



Notes:
- All units in millimeters.
- All devices are mounted with low out gassing conductive epoxy withtolerance of ±25µm.

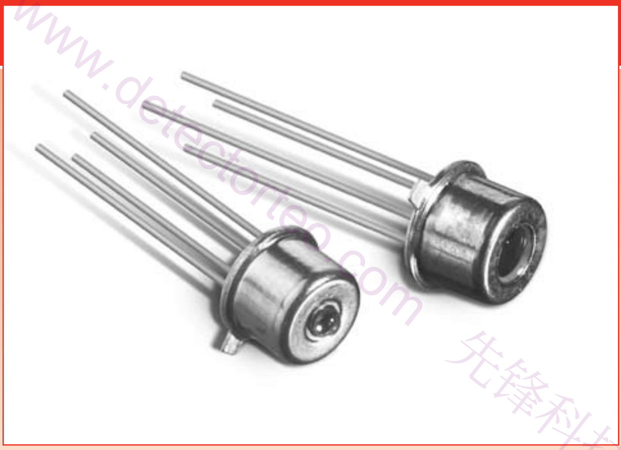
Electro-Optical Characteristics T_A=23°C, V_R=5V

PARAMETERS	FCI-GaAs-4M	FCI-GaAs-12M
Active Area Diameter	70µm, Pitch:250µm	
Responsivity	Typ. 0.63A/W @850nm	
Capacitance	Typ. 0.65pF	
Dark Current	Typ. 0.03nA	
Max. Reverse Voltage	20V	
Max. Forward Current	5mA	
Bandwidth	Typ. 2.0GHz @ 850nm	
Breakdown Voltage	Typ. 50V	
Storage Temperature Range	From −40 to 85°C	
Operating Temperature Range	From 0 to 70°C	

1.25Gbps / 2.50Gbps Hybrids

GaAs Photodetectors / Transimpedance Amplifiers

FCI-H125/250G-GaAs-100 series with active area sizes of 100μm is a compact integration of our high speed GaAs photodetector with a wide dynamic range transimpedance amplifier. Combining the detector with the TIA in a hermetically sealed 4 pin TO-46 or TO-52 package provides ideal conditions for high speed signal amplification. Low capacitance, low dark current and high responsivity from 650nm to 860nm make these devices ideal for high-bit rate receivers used in LAN, MAN, and other high speed communication systems. TO packages come standard with a lensed cap to enhance coupling efficiency, or with a broadband double sided AR coated flat window. The FCI-H125/250G-GaAs-100 series is also offered with FC, SC, ST and SMA receptacles.



APPLICATIONS

- High Speed Optical Communications
- Gigabit Ethernet
- Fibre Channel
- ATM
- SONET OC-48 / SDH STM-16

FEATURES

- GaAs Photodetector / Low Noise Transimpedance Amplifier
- High Bandwidth / Wide Dynamic Range
- Hermetically Sealed TO-46 Can
- Single +3.3V to +5V Power Supply
- Spectral Range 650nm to 850nm
- Differential Output

Absolute Maximum Ratings

PARAMETERS	SYMBOL	MIN	MAX	UNITS
Storage Temperature	T_{stg}	-40	+125	°C
Operating Temperature	T_{op}	0	+75	°C
Supply Voltage	V_{cc}	0	+6	V
Input Optical Power	P_{IN}	---	+5	dBm

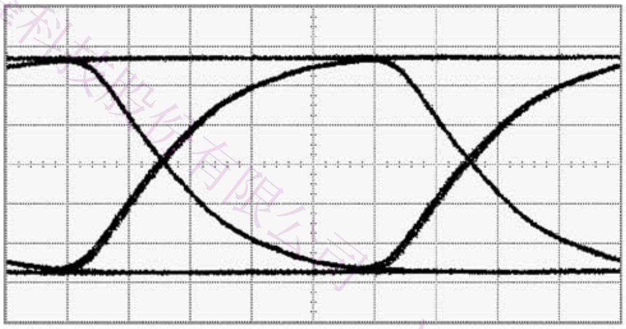
Electro-Optical Characteristics

T_A=23°C, Vcc=+3.3V, 850nm, 100Ω Differential AC Load

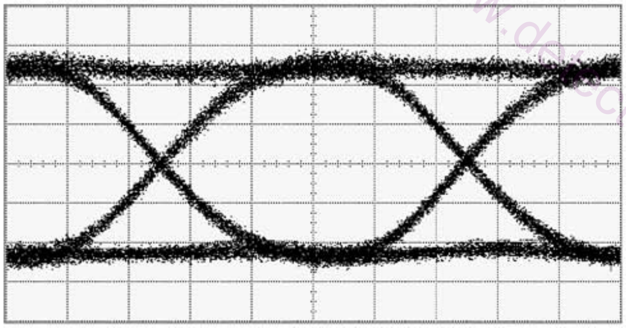
PARAMETERS	SYMBOL	CONDITIONS	FCI-H125G-GaAs-100			FCI-H250G-GaAs-100			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
Supply Voltage	V_{CC}	---	+3	---	+5.5	+3	----	+5.5	V
Supply Current	I_{CC}	*T_A = 0 to 70°C	---	26	*55	---	35	*65	mA
Active Area Diameter	AA_{ϕ}	---	---	100	---	---	100	---	μm
Operating Wavelength	λ	---	650	---	860	650	---	860	nm
Responsivity	R_{λ}	-17dBm, Differential	1000	1700	---	1000	1650	---	V/W
Transimpedance	---	-17dBm, Differential	---	2800	---	---	2800	---	Ω
Sensitivity	S	BER 10^{-10}, PRBS2^7-1	-22	-26	---	-19	-22	---	dBm
Optical Overload	---	---	0	---	---	0	---	---	dBm
Bandwidth	BW	-3dB, Small Signal	---	900	---	---	1700	---	MHz
Low Frequency Cutoff	---	-3dB	---	45	---	---	30	---	kHz
Differential Output Voltage	$V_{OUT,\ P-P}$	-3dBm	180	250	420	200	400	600	mV_{P-P}
Output Impedance	---	---	47	50	53	47	50	53	Ω
Transimpedance Linear Range	---	<5%	50	---	---	65	---	---	μW_{P-P}

Use AC coupling and differential 100Ω load for the best high-speed performance. Devices are not intended to drive DC coupled, 50Ω grounded load.

FCI-H125G-GaAs-100

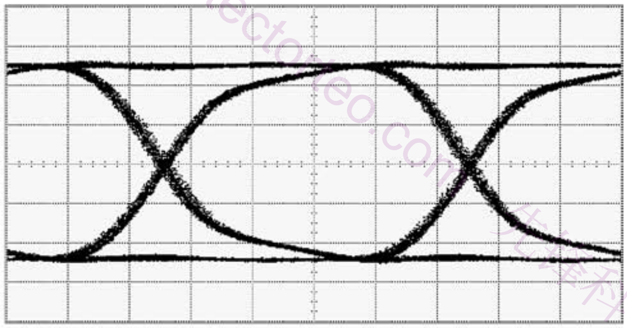


50mV / div, 160ps / div, -6dBm, 850nm, PRBS2[7]-1, Diff.

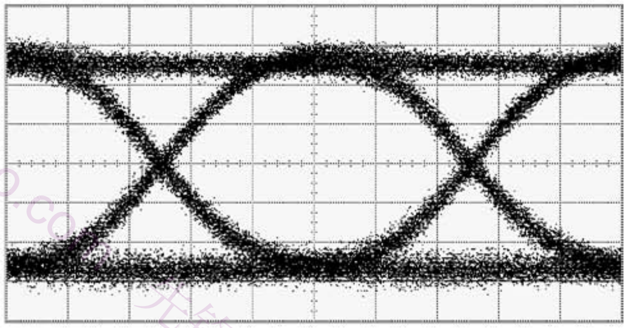


10mV / div, 160ps / div, -17dBm, 850nm, PRBS2[7]-1, Diff.

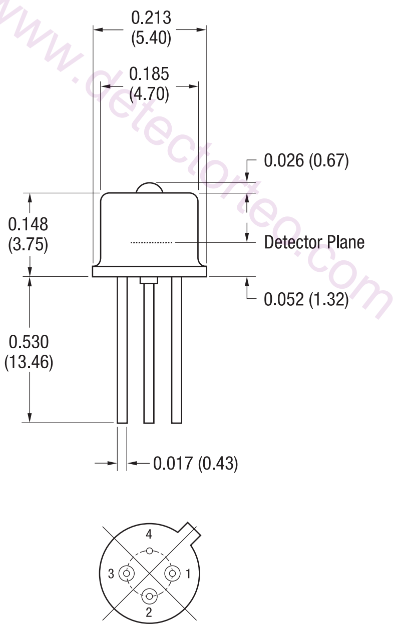
FCI-H250G-GaAs-100



80mV / div, 80ps / div, -6dBm, 850nm, PRBS2[7]-1, Diff.



10mV / div, 80ps / div, -17dBm, 850nm, PRBS2[7]-1, Diff.

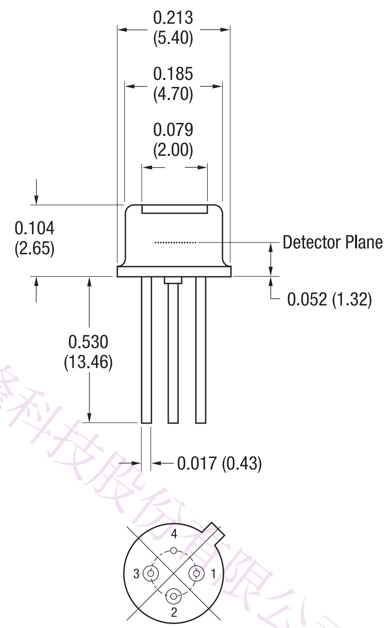


Bottom View

PINOUT

1	D_{out}
2	V_{CC}
3	$\overline{D}_{out}$
4	GND

Pin Circle Diameter = 0.100 (2.54)

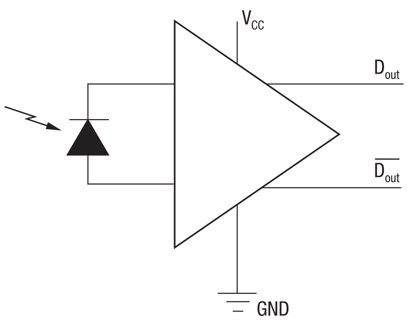


Bottom View

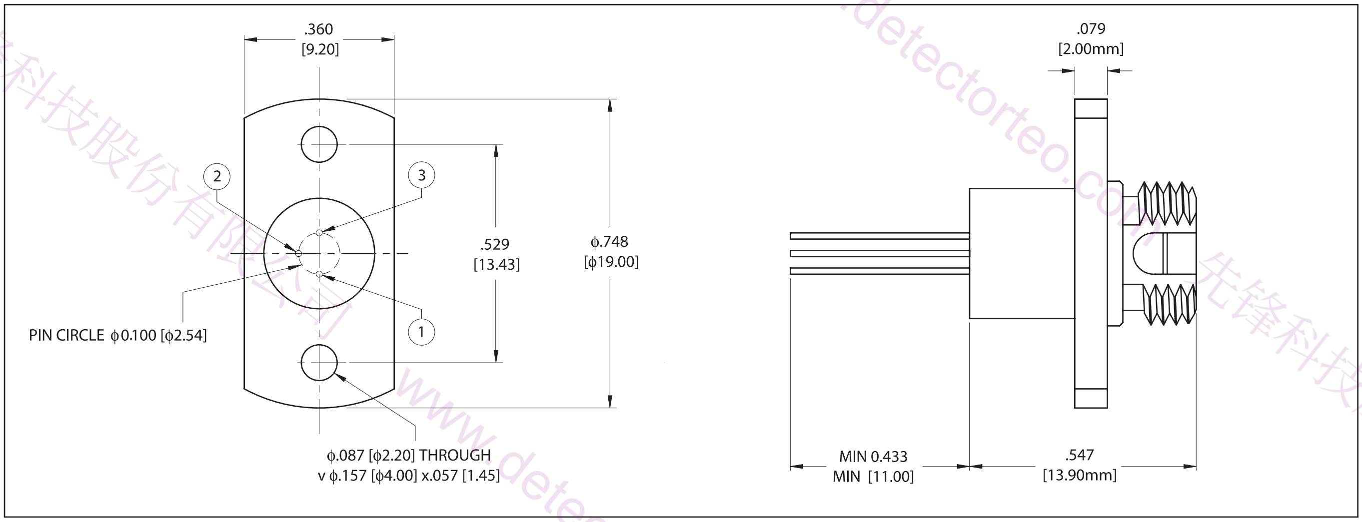
PINOUT

1	D_{out}
2	V_{CC}
3	$\overline{D}_{out}$
4	GND

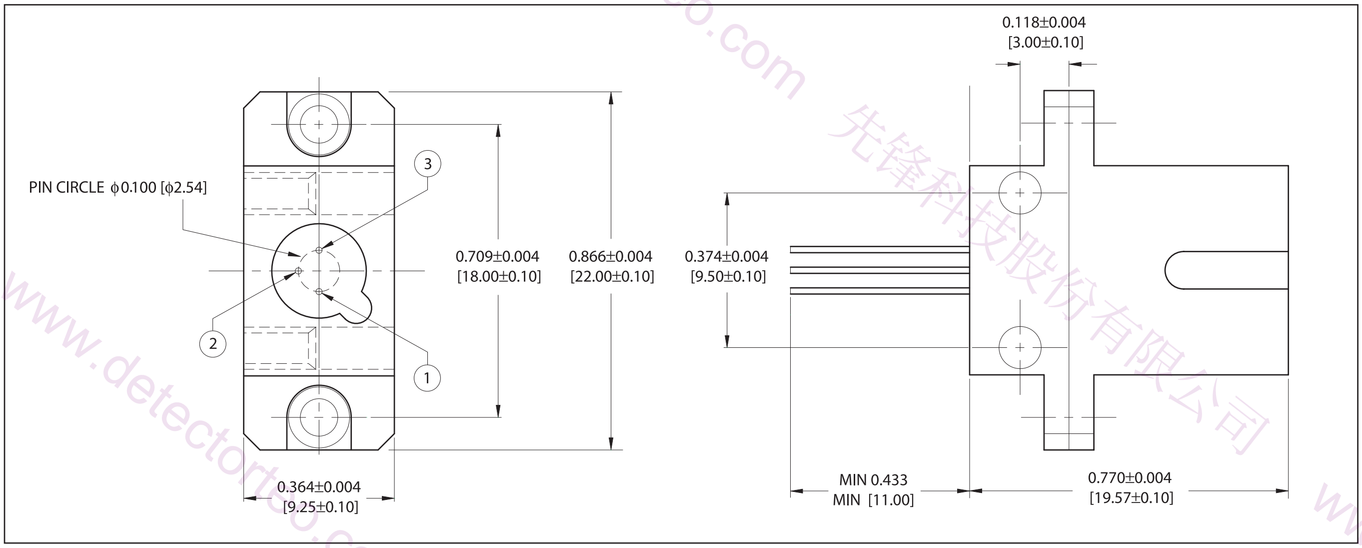
Pin Circle Diameter = 0.100 (2.54)



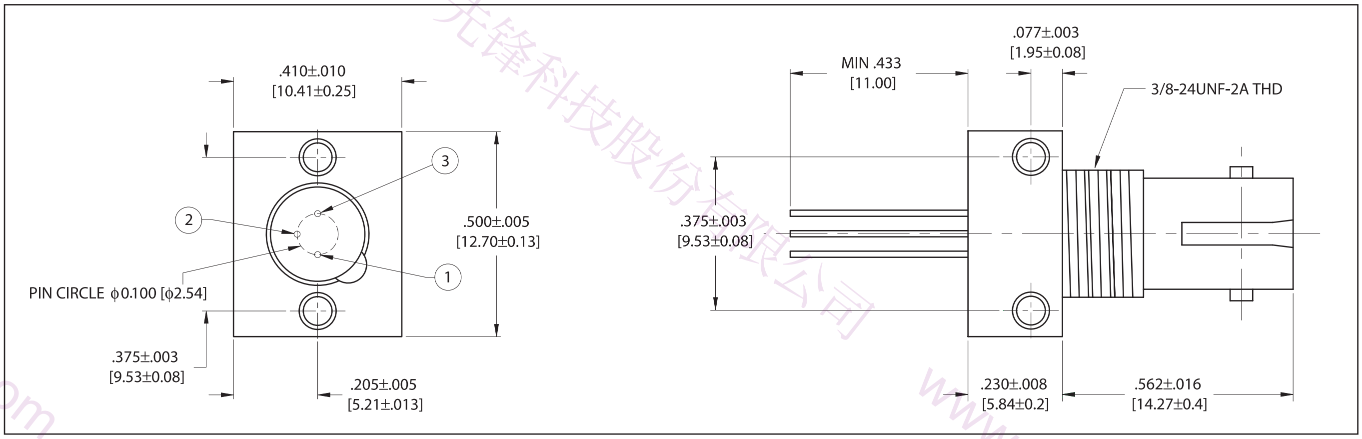
Notes:
- All units in inches (mm).
- All tolerances: 0.005 (0.125).
- Please specify when ordering the flat window or lens cap devices.
- The flat window devices have a double sided AR coated window at 850nm.
- The thickness of the flat window=0.008 (0.21).



FC Receptacles Package



SC Receptacles Package



ST Receptacles Package

Please note that all receptacle-associated photo-detectors carry an additional 0.45dB insertion loss-that is 10% loss to the incident signal power.

PIN#	FCI-HR-XXX	FCI-125G-XXXHR FCI-InGaAs-XXX
1	ANODE	CATHODE
2	CATHODE	CASE
3	CASE	ANODE