

**Small & Large Area Photodiodes  
Two-Color Photodiodes  
TE Cooled Photodiodes**

## Ge Photodiodes



- **Large and Small Area**
- **Wide Performance Range**
- **TE Coolers and Two-Color Sandwich**
- **Filtered Windows for High Power Available**
- **Standard and Custom Packages/Submounts**

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**GPD Optoelectronics Corp**

7 Manor Parkway

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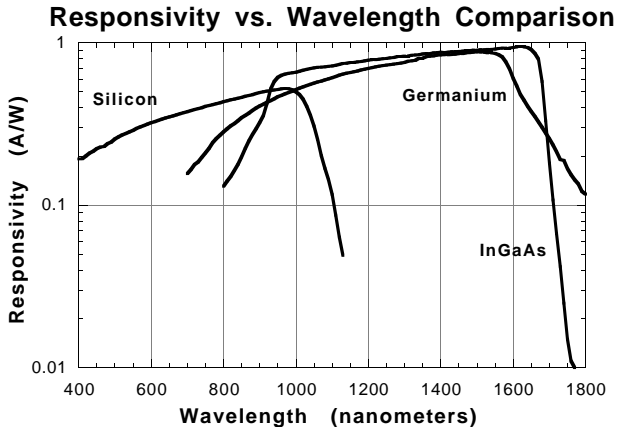
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## Introduction

GPD Optoelectronics manufactures a broad range of Ge and InGaAs photodetectors to meet the most demanding military and commercial applications. This brochure contains technical specifications for Ge, dual (Si/Ge) detectors, and TE cooled Ge photodiodes.

Custom devices and packages are also available.



Both Germanium and InGaAs are sensitive to light in the near-infrared region of the spectrum. While InGaAs detectors offer better noise performance, Ge detectors offer better linearity and cost advantages, particularly where a large detection area is required.

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## Glossary of Terms

### DARK CURRENT ( $I_D$ )

The current through a photodetector when a specified reverse bias is applied under conditions of no incident radiation.

### SHUNT RESISTANCE ( $R_{SH}$ )

The resistance of a photodetector at or near zero bias; shunt resistance values in this catalog are calculated at 10mV reverse bias.

### MAXIMUM REVERSE VOLTAGE ( $V_{RM}$ )

The maximum reverse voltage that may be applied without damaging the detector.

### RESPONSIVITY (R)

The photocurrent output per unit incident radiant power, usually at a specified wavelength.

### NOISE EQUIVALENT POWER (NEP)

The incident radiant power that creates a signal-to-noise ratio of one at the photodetector output.

### JUNCTION CAPACITANCE ( $C_J$ )

The total device capacitance, usually measured at a specified reverse bias and frequency.

### CUTOFF FREQUENCY ( $f_c$ )

The frequency at which the responsivity decreases by 3 dB from the DC responsivity value. It can be calculated from the load resistance and the junction capacitance.  $f_c = 1/(2\pi R_L C_J)$

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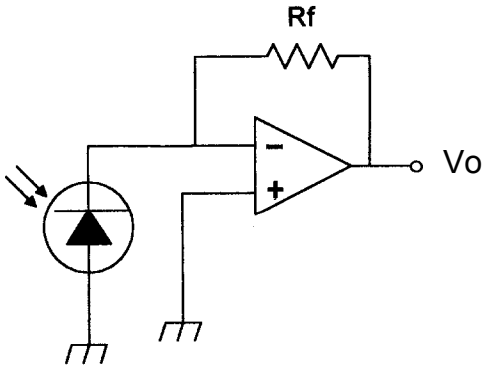
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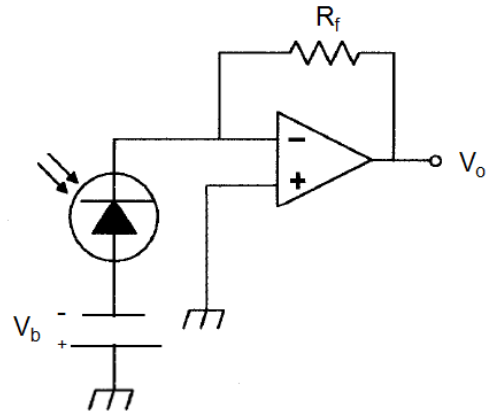
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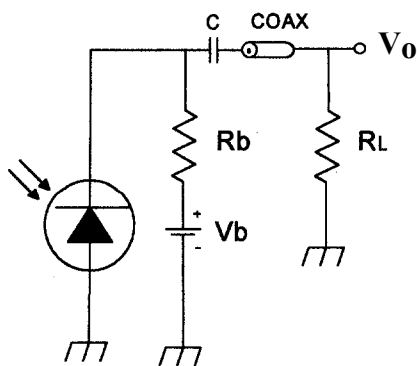
**BASIC OPERATING CIRCUIT  
(ZERO BIAS)**



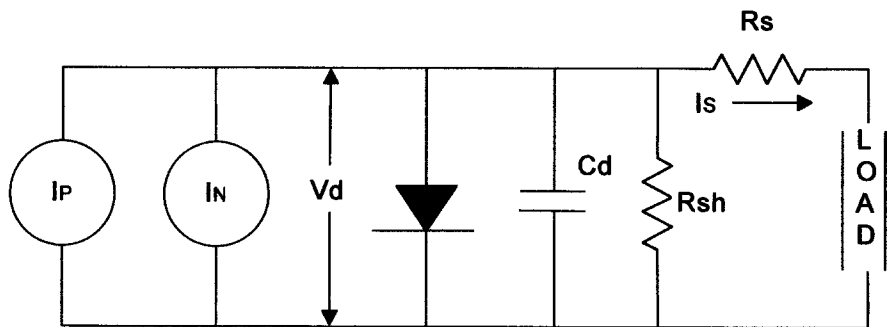
**BASIC OPERATING CIRCUIT  
(WITH BIAS)**



**HIGH SPEED CIRCUIT**



**EQUIVALENT CIRCUIT**



$I_p$ : Photocurrent

$I_N$ : Noise Current

$V_D$ : Voltage across diode

$V_b$ : Bias Voltage

$I_s$ : Output Current

$C_d$ : Photodiode Capacitance

$R_{sh}$ : Shunt Resistance

$R_s$ : Series Resistance

$R_f$ : Feedback Resistance

$V_o$ : Output Voltage ( $I_s \times R_f$ )

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# Ge Photodiodes TE Cooled Photodiodes

| TYPE                             | ACTIVE DIA.<br>(mm.) | SHUNT RES. @<br>$V_r=10\text{mV}$ (K $\Omega$ ) |      | DARK CURRENT<br>@ $V_r=V_{\text{test}}$<br>( $\mu\text{A}$ MAX) | TEST REVERSE BIAS<br>(Volts) | MAX REVERSE VOLTS | CAPACITANCE<br>@ $V_r$ MAX (pF) | NEP<br>(pW/ $\sqrt{\text{Hz}}$ ) | CUT-OFF FREQ.<br>@ $V_r$ , $50\Omega R_L$<br>(MHz) |
|----------------------------------|----------------------|---|------|---|------------------------------|-------------------|---------------------------------|----------------------------------|--|
|                                  |                      | MIN.  | TYP. |   |                              |                   |                                 |                                  |  |
| GM2<br>GM2HS<br>GM2VHS<br>GM2VHR | 0.5 SQ               | 30  | 60   | 2.0   | 10                           | 15                | 27                              | 1.0                              | 120  |
|                                  |                      | 100   | 150  | 1.0   | 3.0                          | 5.0               | 110                             | 0.3                              | 30   |
|                                  |                      | 250   | 350  | 0.7   | 0.3                          | 0.5               | 300                             | 0.2                              | 10   |
|                                  |                      | 550   | 900  | 0.5   | 0.3                          | 0.5               | 300                             | 0.1                              | 10   |
| GM3<br>GM3HS<br>GM3VHS<br>GM3VHR | 0.1                  | 120   | 180  | 1.0   | 10                           | 15                | 1                               | 0.3                              | 3000   |
|                                  |                      | 350   | 500  | 0.3   | 3.0                          | 5.0               | 6                               | 0.1                              | 500  |
|                                  |                      | 1500  | 2500 | 0.1   | 0.3                          | 0.5               | 21                              | 0.1                              | 150  |
|                                  |                      | 2000  | 3000 | 0.1   | 0.3                          | 0.5               | 21                              | 0.1                              | 150  |
| GM4<br>GM4HS<br>GM4VHS<br>GM4VHR | 0.3                  | 60  | 80   | 1.5   | 10                           | 15                | 10                              | 0.6                              | 300  |
|                                  |                      | 250   | 400  | 0.4   | 3.0                          | 5.0               | 50                              | 0.3                              | 60   |
|                                  |                      | 400   | 650  | 0.2   | 0.3                          | 0.5               | 200                             | 0.2                              | 16   |
|                                  |                      | 900   | 1600 | 0.2   | 0.3                          | 0.5               | 200                             | 0.15                             | 16   |
| GM5<br>GM5HS<br>GM5VHS<br>GM5VHR | 1.0                  | 20  | 40   | 3.0   | 10                           | 15                | 85                              | 1.5                              | 35   |
|                                  |                      | 60  | 100  | 1.5   | 2.0                          | 3.0               | 300                             | 0.5                              | 10   |
|                                  |                      | 200   | 280  | 0.5   | 0.3                          | 0.5               | 1450                            | 0.3                              | 2.0  |
|                                  |                      | 330   | 450  | 0.5   | 0.3                          | 0.5               | 1450                            | 0.3                              | 2.0  |
| GM6<br>GM6HS<br>GM6VHS<br>GM6VHR | 2.0                  | 6   | 12   | 10  | 10                           | 15                | 300                             | 2.0                              | 17   |
|                                  |                      | 30  | 60   | 3.0   | 2.0                          | 3.0               | 1200                            | 0.8                              | 1.0  |
|                                  |                      | 80  | 120  | 1.0   | 0.3                          | 0.5               | 9000                            | 0.4                              | 0.6  |
|                                  |                      | 120   | 200  | 1.0   | 0.3                          | 0.5               | 9000                            | 0.4                              | 0.6  |
| GM7<br>GM7HS<br>GM7VHS<br>GM7VHR | 3.0                  | 4   | 8    | 30  | 5.0                          | 10                | 800                             | 3.0                              | 4.0  |
|                                  |                      | 25  | 35   | 4.0   | 1.0                          | 3.0               | 4000                            | 1.0                              | 0.7  |
|                                  |                      | 40  | 65   | 3.0   | 0.25                         | 0.5               | 13000                           | 0.6                              | 0.2  |
|                                  |                      | 65  | 90   | 2.0   | 0.25                         | 0.5               | 13000                           | 0.6                              | 0.2  |
| GM8<br>GM8HS<br>GM8VHS<br>GM8VHR | 5.0                  | 2   | 4    | 40  | 3.0                          | 5.0               | 3000                            | 4.0                              | 1.6  |
|                                  |                      | 10  | 15   | 15  | 1.0                          | 3.0               | 6000                            | 2.0                              | 0.5  |
|                                  |                      | 15  | 20   | 5   | 0.1                          | 0.3               | 35000                           | 1.0                              | 0.1  |
|                                  |                      | 20  | 30   | 5   | 0.1                          | 0.3               | 35000                           | 1.0                              | 0.1  |
| GM10HS                           | 10 SQ.               | 2.0   | 3.5  | 50  | 0.5                          | 1.0               | 30000                           | 4.0                              | 0.1  |
| GM13HS                           | 13                   | 1.0   | 2.0  | 100   | 0.5                          | 1.0               | 50000                           | 8.0                              | 0.05   |
| GM5TEC1                          | 1.0                  |   | 300  | 0.2   | 5.0                          | 7.0               | 85                              | 0.4                              | 55   |
| GM8TEC2                          | 5.0                  |   | 60   | 1.0   | 1.0                          | 2.0               | 3000                            | 1.0                              | 1.6  |

VHS series: Designed for zero reverse bias applications requiring high shunt resistance.  
VHR series: Designed for zero reverse bias applications.  
HS series: Designed for < 5V reverse bias applications.  
GM series: Designed for high speed applications with reverse bias > 10V.  
TEC series: Mounted on a one- or two-stage thermoelectric cooler for low-noise applications.

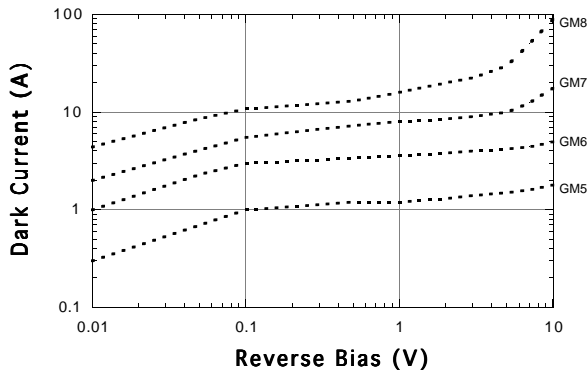
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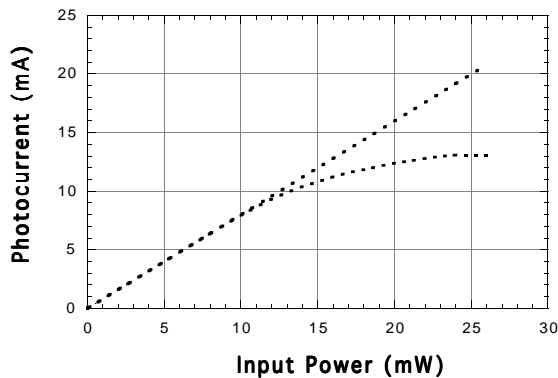


## Electrical Specifications

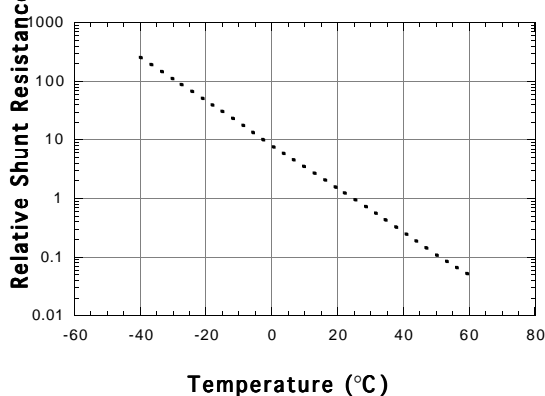
### Dark Current vs. Reverse Bias



### Linearity of Response



### Shunt Resistance vs. Temperature

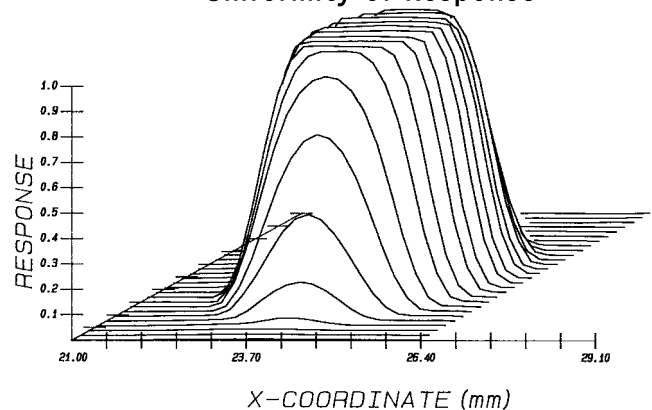


## Optical Specifications

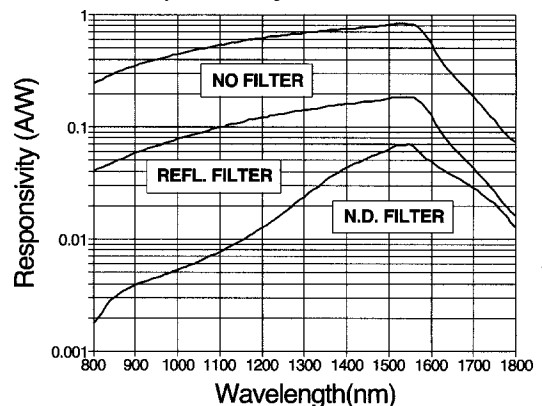
### Responsivity vs. Wavelength

| Series | WAVELENGTH |      |      |      |      |      |
|--------|------------|------|------|------|------|------|
|        | 850        |      | 1300 |      | 1550 |      |
|        | min.       | typ. | min. | typ. | min. | typ. |
| GM     | .20        | .26  | .60  | .65  | .75  | .85  |
| GMHS   | .20        | .26  | .60  | .70  | .75  | .85  |
| GMVHS  | .20        | .26  | .60  | .70  | .80  | .85  |
| GMVHR  | .26        | .32  | .70  | .80  | .82  | .87  |

### Uniformity of Response



### Responsivity of Filtered Units



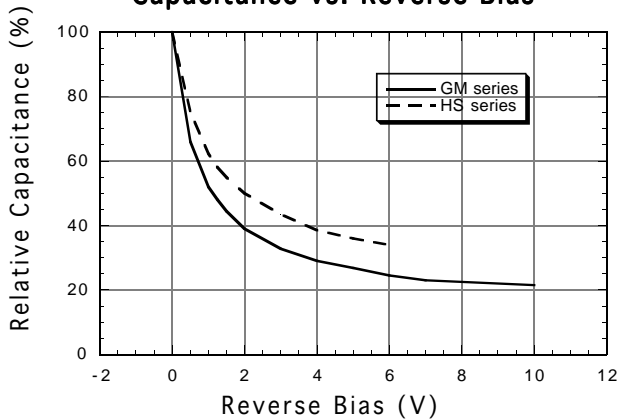
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# Two-Color Photodiodes

**Capacitance vs. Reverse Bias**



### Special Options

- High response at short wavelength available
- BNC connectors
- Thermoelectric coolers (1- and 2-stage)
- Neutral density filters
- Bandpass Filters
- AR-coated lenses/windows
- Custom devices including arrays
- Calibrated spectral response

## Si/Ge TWO-COLOR DETECTOR: ELECTRICAL SPECIFICATIONS

| Type           | Active Diam. (mm) | Wavelength Range (nm) | Peak Resp. (A/W) | NEP (pW/ $\sqrt{\text{Hz}}$ ) | $R_{\text{SHUNT}}$ (K $\Omega$ ) | Max Reverse Volts (V) | Leakage Current  | Forward Voltage (V) $I_{\text{PH}}=10\text{mA}$ |
|----------------|-------------------|-----------------------|------------------|-------------------------------|----------------------------------|-----------------------|------------------|---|
| (Si)<br>GM6Si5 | 5                 | 400-1000              | 0.5              | $1.0 \times 10^{-14}$         | > 1000                           | 30                    | 2 nA             | 1.1   |
| (Ge)           | 2                 | 1000-1800             | 0.6              | $1.0 \times 10^{-12}$         | 60                               | 3                     | 2 $\mu\text{A}$  | 0.45  |
| (Si)<br>GM7Si5 | 5                 | 400-1000              | 0.5              | $1.0 \times 10^{-14}$         | > 1000                           | 30                    | 2 nA             | 1.1   |
| (Ge)           | 3                 | 1000-1800             | 0.6              | $1.5 \times 10^{-12}$         | 25                               | 3                     | 3 $\mu\text{A}$  | 0.45  |
| (Si)<br>GM8Si5 | 5                 | 400-1000              | 0.5              | $1.0 \times 10^{-14}$         | > 1000                           | 30                    | 2 nA             | 1.1   |
| (Ge)           | 5                 | 1000-1800             | 0.6              | $2.0 \times 10^{-12}$         | 10                               | 1.5                   | 10 $\mu\text{A}$ | 0.45  |

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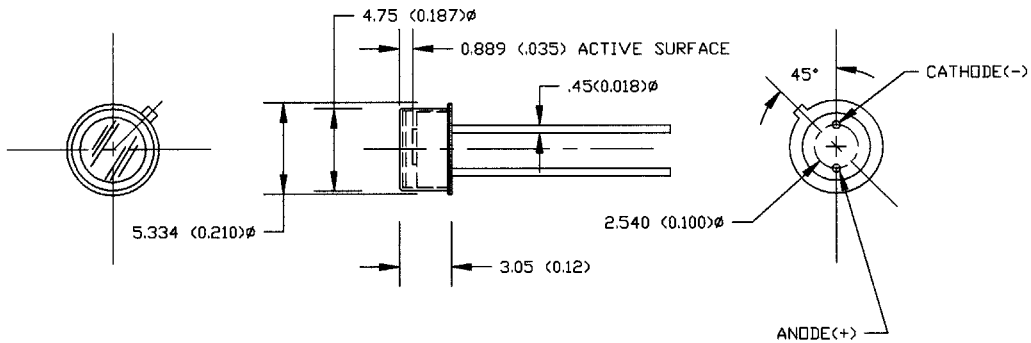
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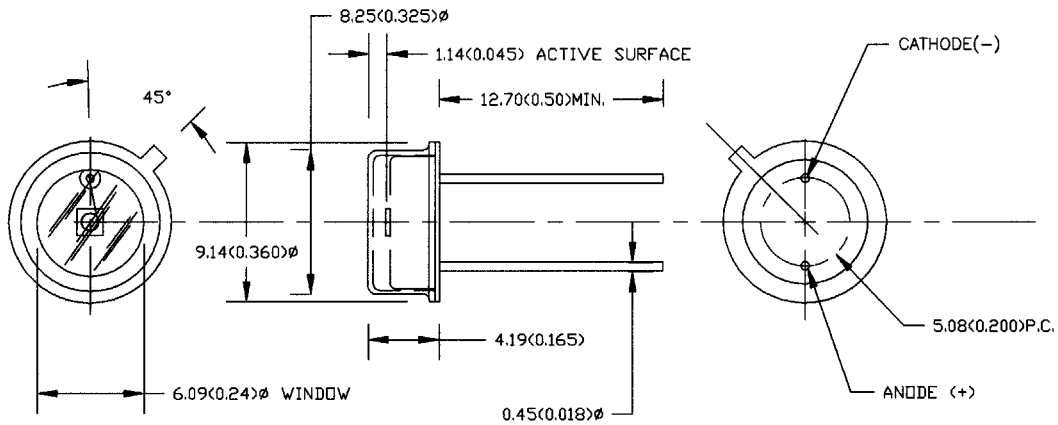


# Package Drawings

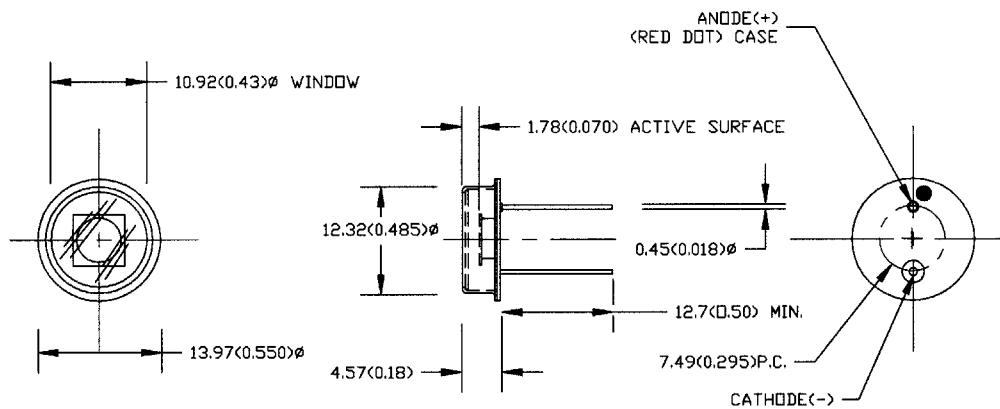
Dimensions in mm (in.) Many other packages (including lensed packages) available.



**TO-18**  
(Chip Diameter to 1 mm)



**TO-5**  
(Chip Diameter to 3 mm)



**TO-8 (5 mm chip)**

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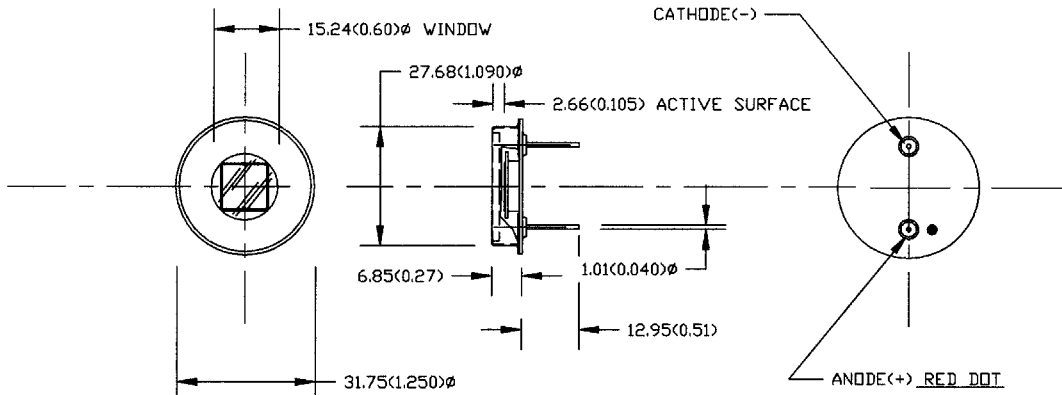
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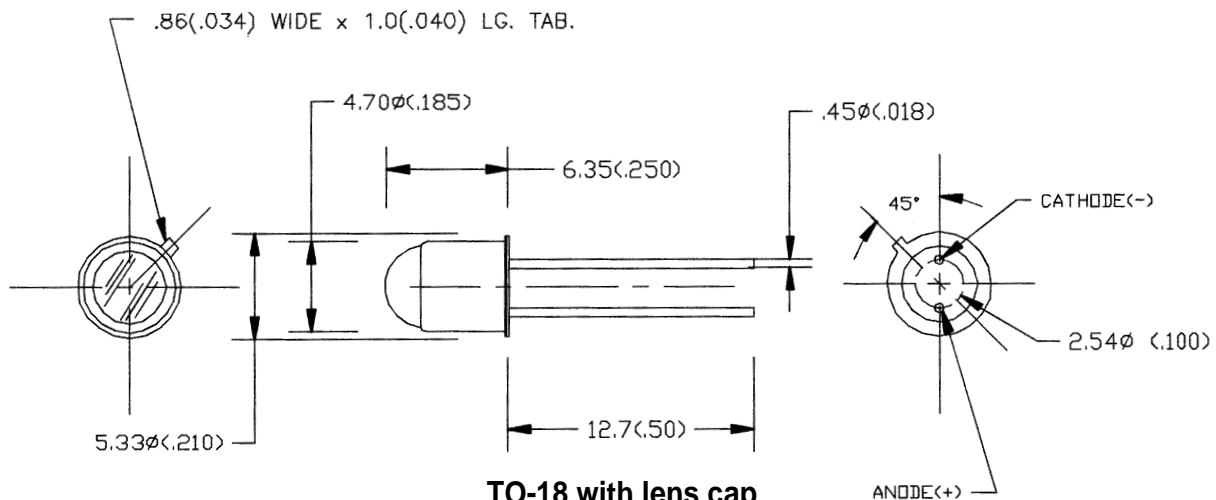


# Package Drawings

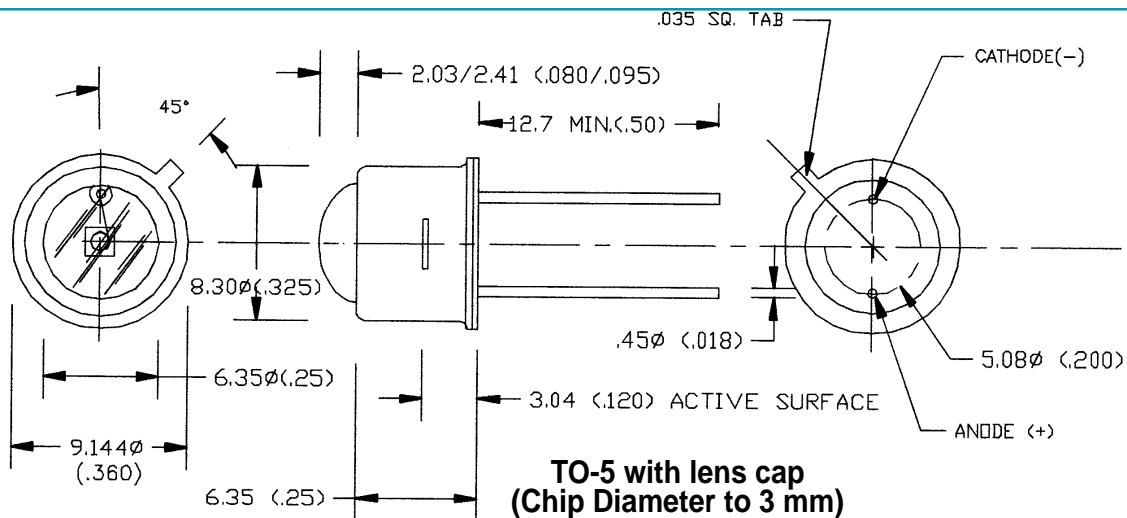
Dimensions in mm (in.) Many other packages (including lensed packages) available.



**TO-9**  
(Chip Diameter to 13 mm)



**TO-18 with lens cap**  
(Chip Diameter to 1 mm)



**TO-5 with lens cap**  
(Chip Diameter to 3 mm)

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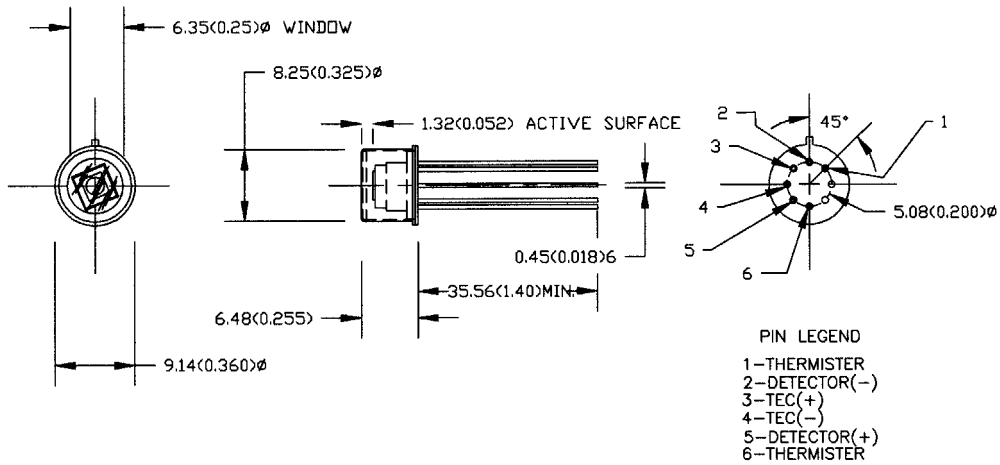
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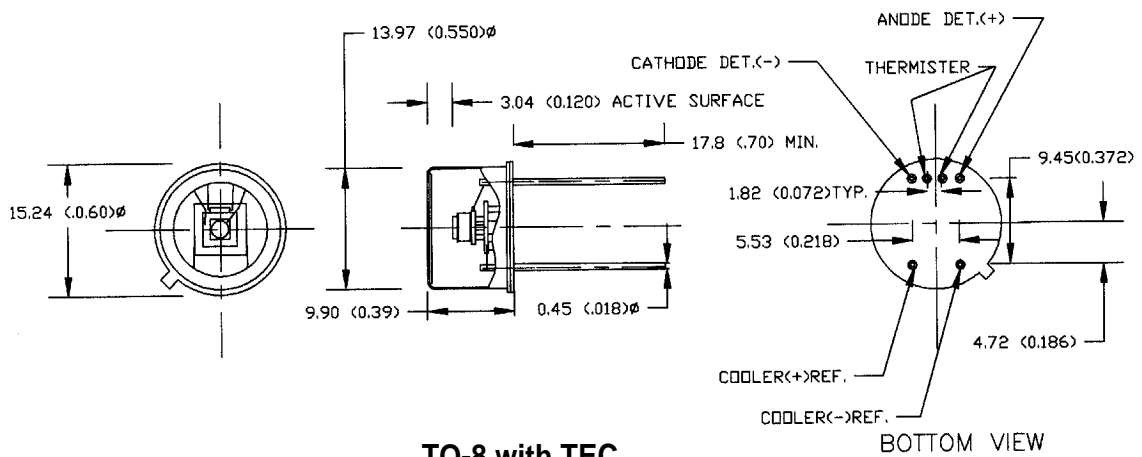


# Package Drawings

Dimensions in mm (in.) Many other packages (including lensed packages) available.



**TO-5 with TEC  
(Chip Diameter to 3 mm)**



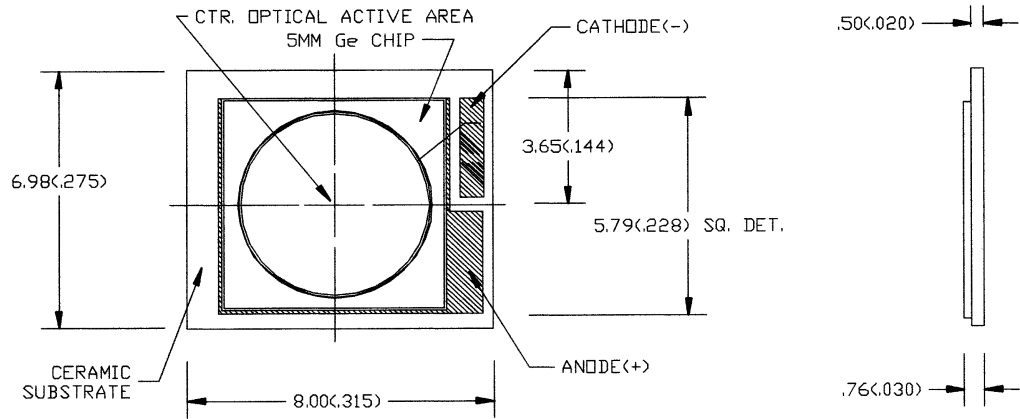
**TO-8 with TEC  
(Chip Diameter to 5 mm)**

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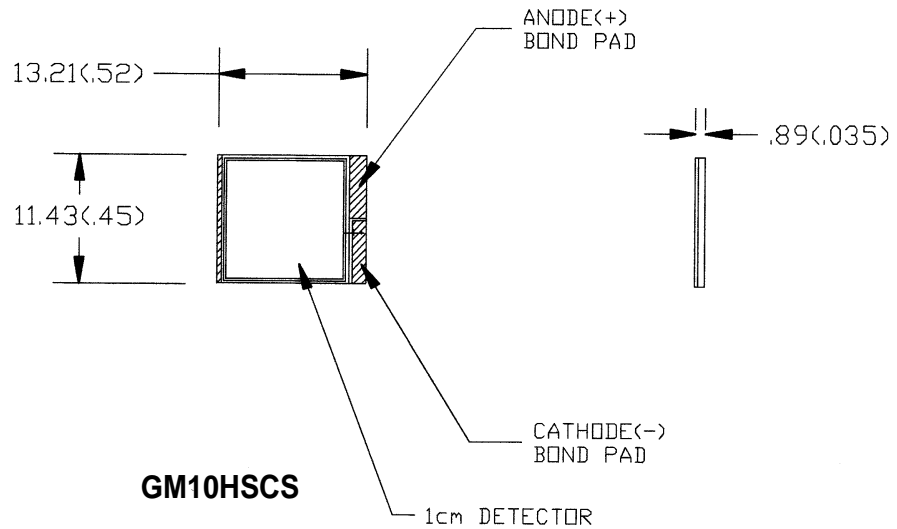
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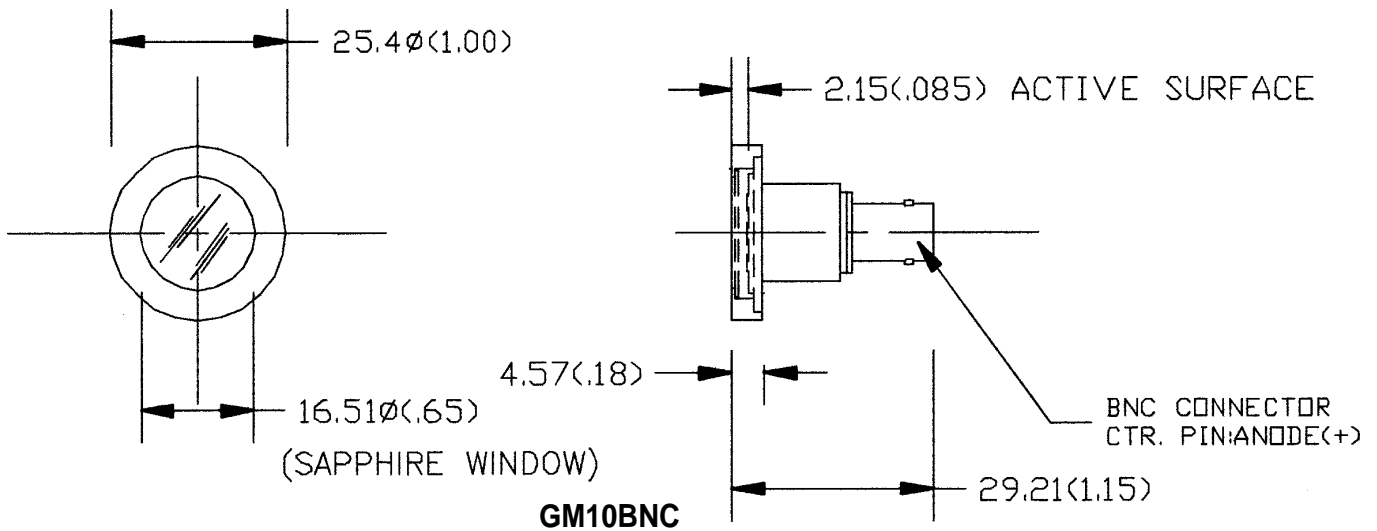
# Package Drawings



**GM8HSCS**



**GM10HSCS**



**GM10BNC**

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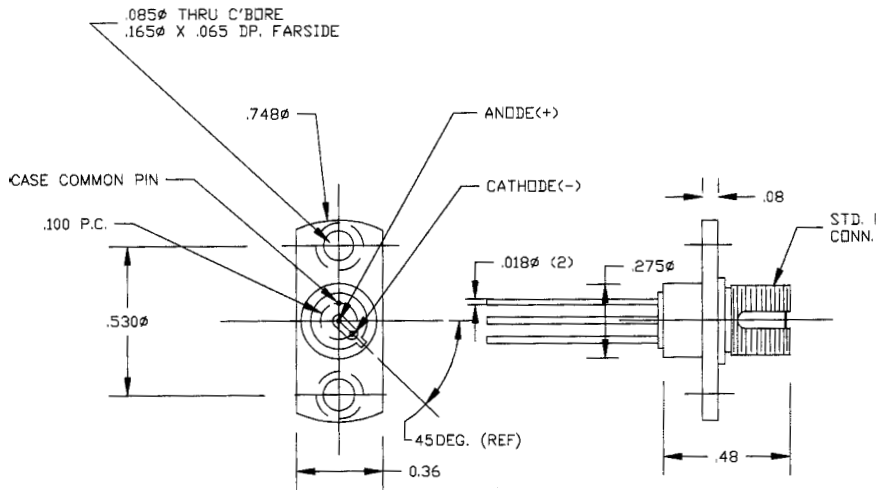
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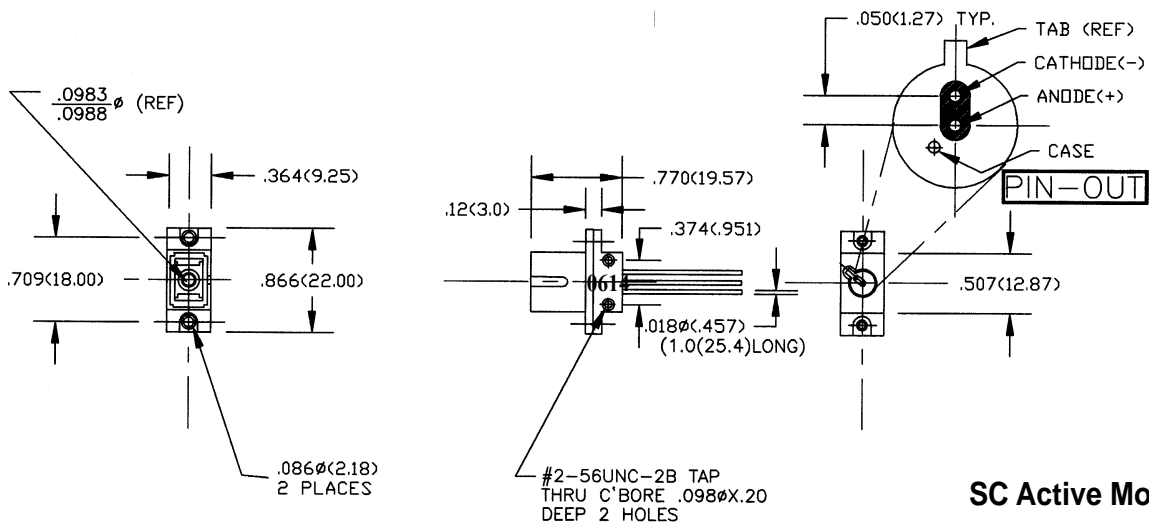
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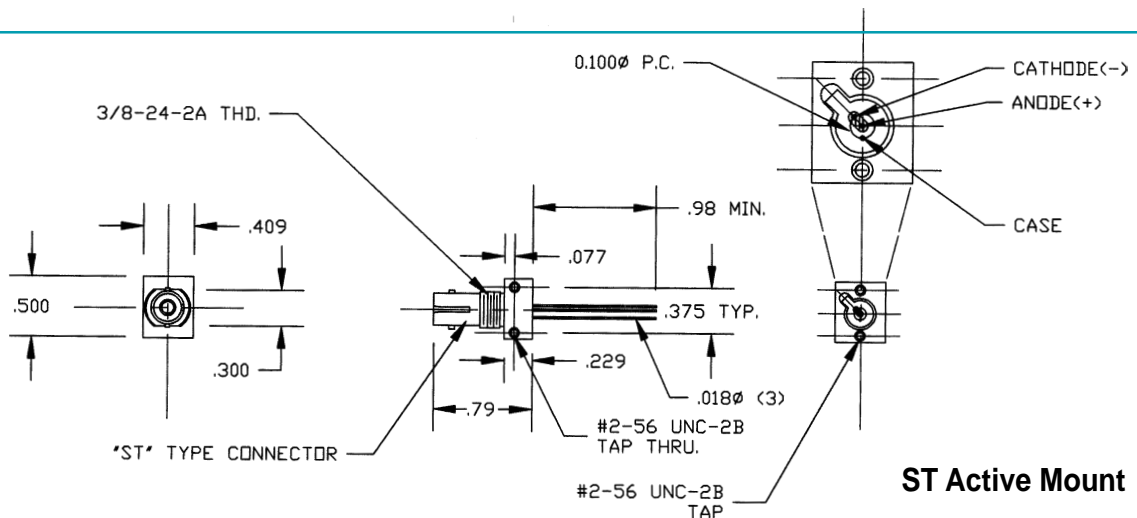
# Package Drawings



**FC Active Mount**



**SC Active Mount**



**ST Active Mount**

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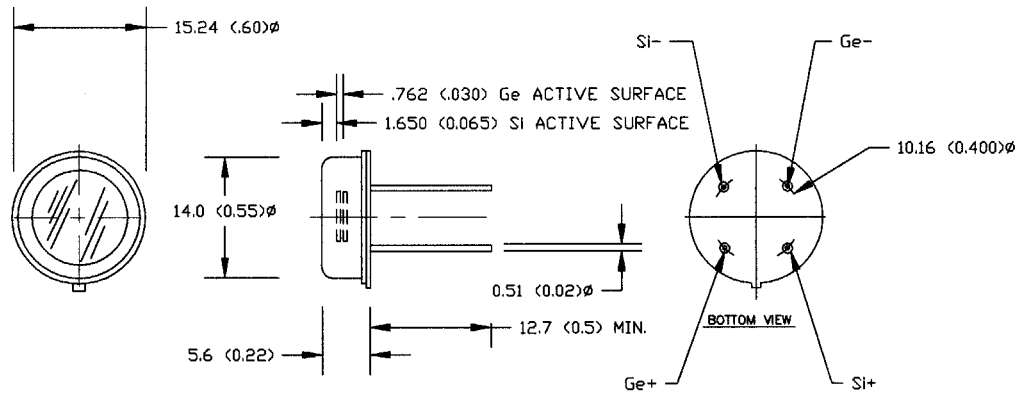
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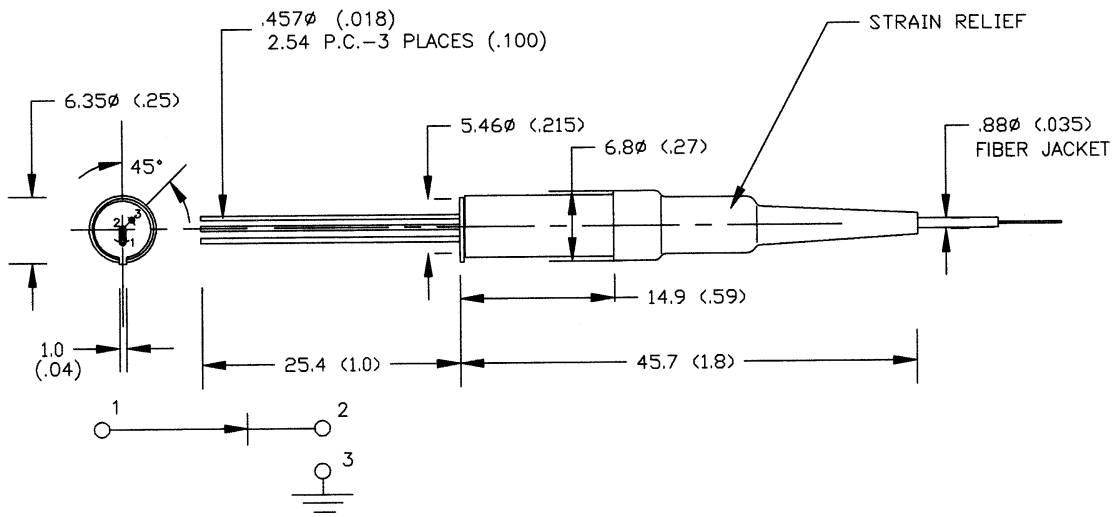
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Dimensions in mm (in.) Many other packages (including lensed packages) available.



### Si/Ge Two-color Detector



### Fiber-pigtailed Detector

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