Si Photodiodes

Lineup of Si photodiodes for UV to near IR, radiation

- Ceramic type Si photodiode
  S12915-33R

- 16-element Si photodiode array
  S12859-021

- Surface mount type Si PIN photodiode
  S10993-02CT
Si Photodiodes

Lineup of Si photodiodes for UV to near IR, radiation
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Si photodiodes

Photodiodes are semiconductor light sensors that generate a current or voltage when the P-N junction in the semiconductor is illuminated by light. The term photodiode can be broadly defined to include even solar batteries, but it usually refers to sensors used to detect the intensity of light. Photodiodes can be classified by function and construction as follows:

- Si photodiode
- Si PIN photodiode
- Si APD (avalanche photodiode)

All of these types provide the following features and are widely used for the detection of the presence, intensity and color of light.

- Excellent linearity with respect to incident light
- Low noise
- Wide spectral response range
- Mechanically rugged
- Compact and lightweight
- Long life

Si photodiodes manufactured utilizing our unique semiconductor process technologies cover a broad spectral range from the near infrared to ultraviolet and even to high-energy regions. They also feature high-speed response, high sensitivity and low noise. Si photodiodes are used in a wide range of applications including medical and analytical fields, scientific measurements, optical communications and general electronic products. Si photodiodes are available in various packages such as metal, ceramic and plastic packages as well as in surface mount types. We also offer custom-designed devices to meet special needs.

Hamamatsu Si photodiodes

<table>
<thead>
<tr>
<th>Type</th>
<th>Feature</th>
<th>Product example</th>
</tr>
</thead>
</table>
| Si photodiode                  | Featuring high sensitivity and low dark current, these Si photodiodes are specifically designed for precision photometry and general photometry/visible range. | • For UV to near IR
• For visible range to near IR
• For visible range
• RGB color sensor
• For monochromatic light detection
• For VUV (vacuum ultraviolet) detection
• For electron beam detector
• Infrared sensitivity enhanced type |
| Si PIN photodiode              | Si PIN photodiodes delivering high-speed response when operated with a reverse bias are widely used for optical communications and optical disk pickup, etc. | • Cutoff frequency: 1 GHz or more
• Cutoff frequency: 100 MHz to less than 1 GHz
• Cutoff frequency: 10 MHz to less than 100 MHz
• For YAG laser detection |
| Multi-element type Si photodiode | Si photodiode arrays consist of multiple elements of the same size, formed at an equal spacing in one package. These Si photodiode arrays are used in a wide range of applications such as laser beam position detection and spectrophotometry. | • Segment type
• One-dimensional type |
| Si photodiode with preamp, TE-cooled type Si photodiode | Si photodiodes with preamp incorporate a photodiode and a pre-amplifier chip into the same package. Since TE-cooled type Si photodiodes include TE-cooler in a package, they achieve excellent S/N. | • For analytical and measurement instrument |
| Si photodiode for X-ray detection | These detectors are comprised of a Si photodiode coupled to a scintillator. These detectors are used for X-ray baggage inspection and non-destructive inspection. | • With scintillator
• Large area Si PIN photodiodes |
| Si APD*                        | Si APDs are high-speed, high sensitivity photodiodes having an internal gain mechanism. | • Near IR type
• Short wavelength type
• Multi-element type |
| Related product of Si photodiode | Hamamatsu provides various types of Si photodiode modules. | • RGB color sensor module
• Color sensor evaluation circuit
• Driver circuit for Si photodiode array
• Photodiode module
• Signal processing unit for photodiode module
• Photosensor amplifier
• Charge amplifier |

*Si APD is not listed in this catalogue.

Note: Hamamatsu also provides PSD (position sensitive detector) used to detect the position of incident light spot. PSD is a non-discrete photosensor utilizing the surface resistance of photodiodes.
Hamamatsu provides a lineup that covers a variety of spectral response ranges from 200 nm to 1200 nm.

[S1226/S1336-8BQ, S1227/S1337-1010BR]

[S3590-19, S11499, S9219]
Hamamatsu provides a wide variety of packages including metal, ceramic, and plastic.

### Si photodiodes for precision photometry

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<th>Metal</th>
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### Si photodiodes for general photometry/visible range

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### High-speed response Si PIN photodiodes

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<td>Cutoff frequency: 1 GHz or more</td>
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<td>Cutoff frequency: 100 MHz to less than 1 GHz</td>
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<td>S10783, S10784</td>
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<td>Cutoff frequency: 10 MHz to less than 100 MHz</td>
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<td>S5821/S1223 series S3071, S3072, S12271</td>
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### Multi-element type Si photodiodes

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<td>One-dimensional photodiode array</td>
<td>S4111/S4114 series</td>
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<td>S12858/S12859/S11212/S11299/S12362/S12363-021</td>
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### Surface mount type Si photodiodes

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<td>High-speed response Si PIN photodiode</td>
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### Si photodiodes with preamp, TE-cooled type Si photodiodes

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<td>Si photodiode with preamp for measurement</td>
<td>S8745-01, S8746-01, S9295 series</td>
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### Si photodiodes for X-ray detection

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### Special application Si photodiodes

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<td>RGB color sensor</td>
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<td>For YAG laser detection</td>
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Hamamatsu offers a diverse selection of package types to meet different customer needs. Metal packages are widely used in applications requiring high reliability. Ceramic packages are used for general applications and plastic packages are used in applications where the main need is low cost. Other types are also available including those with BNC connector, which facilitates connection to coaxial cable, surface mount types that support reflow soldering, and those with scintillator, which converts X-rays and radiation to visible light.

#### Mount technology

At the Solid State Division of Hamamatsu Photonics, we are constantly at work designing and developing our own mount technology to offer unique semiconductor devices having special features. Now we will take a brief look at our mount technology for Si photodiodes.

##### Flip chip bonding

Mounting technology for opto-semiconductors includes not only the two-stage chip die-bonding and wire-bonding but also the flip chip bonding as shown in Figure 1. Parasitic capacitance and inductance can be a problem when extracting opto-semiconductor device signals from a wire. Flip-chip bonding can prevent this problem and help in downsizing since it utilizes bumps to directly join the chip to the package or an IC chip, etc.

#### CSP (chip size package)

In CSP type photodiodes, the chip and substrate are connected by bump electrodes so there is minimal dead area on the package surface area. This allows utilizing the photosensitive area more effectively. Also multiple devices can be densely arrayed and used in a tile format. There is no wiring so coupling to the scintillator is easy.

![Cross section of CSP type photodiode](image-url)
Here, we will introduce several applications of our Si photodiodes.

### Optical power meters

![Large area Si PIN photodiode](image)

Large area type Si PIN photodiodes are used to measure the light levels of various light sources such as laser diodes and LEDs.

### LCD backlight color adjustment

![RGB color sensor](image)

The RGB color sensor detects the white balance of LCD backlight optical waveguides and controls the light level of each RGB LED to stabilize the LCD backlight color.

### Sunlight sensors

![Si PIN photodiode](image)

Si photodiodes are used to detect the amount of sunshine to control the volume of air flow for automotive air conditioners.

### Spectrophotometers

![Si photodiode array](image)

Si photodiode arrays are used to detect light that has been divided into wavelengths through a diffraction grating in spectrophotometers.

### Radiation detectors

![Si PIN photodiode with scintillator](image)

Si PIN photodiodes with scintillators are used in detectors that measure radiation levels of γ rays and other rays.

### Baggage inspection equipment

![Dryer image example](image)

Si PIN photodiodes with scintillators are used in dual energy imaging of baggage inspection equipment to obtain information about an object such as its type and thickness.
Si photodiodes for precision photometry

These Si photodiodes have sensitivity in the UV to near IR range. They are suitable for low-light-level detection in analysis and the like. (Typ. Ta=25 °C)

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Spectral response range (nm)</th>
<th>Photosensitivity (A/W)</th>
<th>Dark current VR=10 mV max. (pA)</th>
<th>Terminal capacitance Vf=10 kHz (pF)</th>
<th>Photosensitive area size (mm)</th>
<th>Package</th>
<th>Photo</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1336-18BQ*</td>
<td>190 to 1100</td>
<td>0.12</td>
<td>20</td>
<td>1.1 x 1.1</td>
<td>TO-18</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S1336-18BK</td>
<td>320 to 1100</td>
<td>-</td>
<td>20</td>
<td>1.1 x 1.1</td>
<td>TO-18</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S1336-6BQ*</td>
<td>190 to 1100</td>
<td>0.12</td>
<td>30</td>
<td>2.4 x 2.4</td>
<td>TO-5</td>
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<td></td>
</tr>
<tr>
<td>S1336-6BK</td>
<td>320 to 1100</td>
<td>-</td>
<td>30</td>
<td>2.4 x 2.4</td>
<td>TO-5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S1336-44BQ*</td>
<td>190 to 1100</td>
<td>0.12</td>
<td>50</td>
<td>3.6 x 3.6</td>
<td>TO-8</td>
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<td></td>
</tr>
<tr>
<td>S1336-44BK</td>
<td>320 to 1100</td>
<td>-</td>
<td>50</td>
<td>3.6 x 3.6</td>
<td>TO-8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S1336-8BQ*</td>
<td>190 to 1100</td>
<td>0.12</td>
<td>100</td>
<td>5.8 x 5.8</td>
<td>TO-8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S1336-8BK</td>
<td>320 to 1100</td>
<td>-</td>
<td>100</td>
<td>5.8 x 5.8</td>
<td>TO-8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S1337-16BQ*</td>
<td>190 to 1100</td>
<td>0.12</td>
<td>0.5</td>
<td>1.1 x 5.9</td>
<td>TO-18</td>
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</tr>
<tr>
<td>S1337-16BR</td>
<td>340 to 1100</td>
<td>-</td>
<td>50</td>
<td>1.1 x 5.9</td>
<td>TO-18</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S1337-33BQ*</td>
<td>190 to 1100</td>
<td>0.12</td>
<td>30</td>
<td>2.4 x 2.4</td>
<td>TO-5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S1337-33BR</td>
<td>340 to 1100</td>
<td>-</td>
<td>30</td>
<td>2.4 x 2.4</td>
<td>TO-5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S1337-66BQ*</td>
<td>190 to 1100</td>
<td>0.12</td>
<td>100</td>
<td>5.8 x 5.8</td>
<td>TO-8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S1337-66BR</td>
<td>340 to 1100</td>
<td>-</td>
<td>100</td>
<td>5.8 x 5.8</td>
<td>TO-8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S1337-1010BQ*</td>
<td>190 to 1100</td>
<td>0.12</td>
<td>200</td>
<td>10 x 10</td>
<td>TO-18</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S1337-1010BR</td>
<td>340 to 1100</td>
<td>-</td>
<td>200</td>
<td>10 x 10</td>
<td>TO-18</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*1: Refer to “Precautions against UV light exposure” (P.43).

### Spectral response

**[S1336-BQ, S1337-BQ]**

**[S1336-BK, S1337-BR]**

### Dark current vs. reverse voltage

**[S1336 series]**

**[S1337 series]**

For UV to near IR
## Si photodiodes for precision photometry

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Spectral response range (nm)</th>
<th>Photosensitivity (A/W)</th>
<th>Dark current VR=10 mV max. (pA)</th>
<th>Terminal capacitance VR=0 V f=10 kHz (pF)</th>
<th>Photosensitive area size (mm)</th>
<th>Package</th>
<th>Photo</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1337-21*2</td>
<td>190 to 1100</td>
<td>0.13</td>
<td>0.52</td>
<td>500</td>
<td>4000</td>
<td>18 x 18</td>
<td>Ceramic (unsealed)</td>
</tr>
<tr>
<td>S2551</td>
<td>340 to 1060</td>
<td>-</td>
<td>0.57 (λ=920 nm)</td>
<td>1000</td>
<td>350</td>
<td>1.2 x 29.1</td>
<td>Ceramic</td>
</tr>
<tr>
<td>S2281*2 *3</td>
<td>190 to 1100</td>
<td>0.12</td>
<td>0.5</td>
<td>500</td>
<td>1300</td>
<td>φ11.3</td>
<td>With BNC connector</td>
</tr>
<tr>
<td>S2281-04*2 *3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>φ7.98</td>
<td></td>
</tr>
</tbody>
</table>

*2: Refer to “Precautions against UV light exposure” (P.43).

*3: Connecting a photodiode to the C9329 photosensor amplifier (using a BNC-BNC coaxial cable E2573) allows amplifying the photodiode’s weak photocurrent with low noise.

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### Spectral response

#### [ S1337-21 ]

![Spectral response S1337-21](KSPDB0304EA)

#### [ S2551 ]

![Spectral response S2551](KSPDB0173EB)

#### [ S2281, S2281-04 ]

![Spectral response S2281, S2281-04](KSPDB0270EA)

### Dark current vs. reverse voltage

#### [ S1337-21 ]

![Dark current vs. reverse voltage S1337-21](KSPDB0303EA)

#### [ S2551 ]

![Dark current vs. reverse voltage S2551](KSPDB00173EB)

#### [ S2281, S2281-04 ]

![Dark current vs. reverse voltage S2281, S2281-04](KSPDB0173EB)
These Si photodiodes have suppressed IR sensitivity. They are suitable for low-light-level detection in analysis and the like. (Typ. Ta=25 °C)

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Spectral response range (nm)</th>
<th>Photosensitivity (A/W)</th>
<th>Dark current (max. pA)</th>
<th>Terminal capacitance (pF)</th>
<th>Photosensitive area size (mm)</th>
<th>Package</th>
<th>Photo</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1226-18BQ</td>
<td>190 to 1000</td>
<td>0.12</td>
<td>2</td>
<td>35</td>
<td>1.1 × 1.1</td>
<td>TO-18</td>
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</tr>
<tr>
<td>S1226-18BK</td>
<td>320 to 1000</td>
<td>-</td>
<td>5</td>
<td>160</td>
<td>2.4 × 2.4</td>
<td>TO-5</td>
<td></td>
</tr>
<tr>
<td>S1226-5BQ</td>
<td>190 to 1000</td>
<td>0.12</td>
<td>10</td>
<td>500</td>
<td>3.6 × 3.6</td>
<td>TO-8</td>
<td></td>
</tr>
<tr>
<td>S1226-44BQ</td>
<td>320 to 1000</td>
<td>-</td>
<td>20</td>
<td>1200</td>
<td>5.8 × 5.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S1226-8BQ</td>
<td>190 to 1000</td>
<td>0.12</td>
<td>20</td>
<td>1200</td>
<td>5.8 × 5.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S1226-18BK</td>
<td>320 to 1000</td>
<td>-</td>
<td>20</td>
<td>1200</td>
<td>5.8 × 5.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S1227-16BQ</td>
<td>190 to 1000</td>
<td>0.12</td>
<td>5</td>
<td>170</td>
<td>1.1 × 5.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S1227-16BR</td>
<td>340 to 1000</td>
<td>-</td>
<td>160</td>
<td>2.4 × 2.4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S1227-33BQ</td>
<td>190 to 1000</td>
<td>0.12</td>
<td>160</td>
<td>2.4 × 2.4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S1227-33BR</td>
<td>340 to 1000</td>
<td>-</td>
<td>160</td>
<td>2.4 × 2.4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S1227-66BQ</td>
<td>190 to 1000</td>
<td>0.12</td>
<td>20</td>
<td>950</td>
<td>5.8 × 5.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S1227-66BR</td>
<td>340 to 1000</td>
<td>-</td>
<td>20</td>
<td>950</td>
<td>5.8 × 5.8</td>
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</tr>
<tr>
<td>S1227-1010BQ</td>
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<td>0.12</td>
<td>50</td>
<td>3000</td>
<td>10 × 10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S1227-1010BR</td>
<td>340 to 1000</td>
<td>-</td>
<td>50</td>
<td>3000</td>
<td>10 × 10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S12281-01</td>
<td>190 to 1000</td>
<td>0.12</td>
<td>300</td>
<td>3200</td>
<td>φ11.3</td>
<td>With BNC connector</td>
<td></td>
</tr>
</tbody>
</table>

*1: Refer to “Precautions against UV light exposure” (P.43).

### Spectral response

![S1226-BQ, S1227-BQ](image1)

![S1226-BK, S1227-BR](image2)

![S2281-01](image3)

### Dark current vs. reverse voltage

![S1226 series](image4)

![S1227 series](image5)

![S2281-01](image6)
Si photodiodes for precision photometry

For UV monitor

The S12698 series are Si photodiodes that have achieved high reliability for monitoring ultraviolet light by employing a structure that does not use resin. They exhibit low sensitivity deterioration under UV light irradiation and are suitable for applications such as monitoring intense UV light sources. (Typ. Ta=25 °C)

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Photosensitivity λ=λp (A/W)</th>
<th>Dark current Vth=10 mV max. (pA)</th>
<th>Photosensitive area size (mm)</th>
<th>Package</th>
<th>Photo</th>
</tr>
</thead>
<tbody>
<tr>
<td>S12698**2</td>
<td>0.38</td>
<td>10</td>
<td>1.1 x 1.1</td>
<td>TO-18</td>
<td></td>
</tr>
<tr>
<td>S12698-01**2</td>
<td></td>
<td>30</td>
<td>2.4 x 2.4</td>
<td>TO-5</td>
<td></td>
</tr>
<tr>
<td>S12698-02**2</td>
<td></td>
<td>100</td>
<td>5.8 x 5.8</td>
<td>TO-8</td>
<td></td>
</tr>
</tbody>
</table>

*2: Refer to “Precautions against UV light exposure ☼” (P.43).

**Spectral response**

Changes in spectral response after irradiated with UV light

![Spectral response graph](image1)

![Changes in spectral response graph](image2)
These Si photodiodes offer enhanced sensitivity especially in the near IR range. (Typ. Ta=25 °C)

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Spectral response range (nm)</th>
<th>Photosensitivity λ=960 nm (A/W)</th>
<th>Dark current VR=10 mV max. (pA)</th>
<th>Terminal capacitance VR=0 V f=10 kHz (pF)</th>
<th>Photosensitive area size (mm)</th>
<th>Package</th>
<th>Photo</th>
</tr>
</thead>
<tbody>
<tr>
<td>S2386-18K</td>
<td>320 to 1100</td>
<td>2</td>
<td>140</td>
<td>1.1 x 1.1</td>
<td>TO-18</td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>S2386-5K</td>
<td>320 to 1100</td>
<td>5</td>
<td>730</td>
<td>2.4 x 2.4</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>S2386-44K</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>TO-8</td>
<td></td>
</tr>
</tbody>
</table>

**Spectral response**

![Spectral response graph](image)

**Dark current vs. reverse voltage**

![Dark current vs. reverse voltage graph](image)
<table>
<thead>
<tr>
<th>Type no.</th>
<th>Spectral response range (nm)</th>
<th>Photosensitivity λ=960 nm (A/W)</th>
<th>Dark current Vr=10 mV max. (pA)</th>
<th>Terminal capacitance Vr=0 V f=10 kHz (pF)</th>
<th>Photosensitive area size (mm)</th>
<th>Package</th>
<th>Photo</th>
</tr>
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<tbody>
<tr>
<td>S12915-16R</td>
<td>340 to 1100</td>
<td>0.64</td>
<td>5</td>
<td>740</td>
<td>1.0 × 6.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S12915-33R</td>
<td></td>
<td></td>
<td></td>
<td>680</td>
<td>2.4 × 2.4</td>
<td>Ceramic</td>
<td></td>
</tr>
<tr>
<td>S12915-66R</td>
<td></td>
<td></td>
<td>50</td>
<td>4000</td>
<td>5.8 × 5.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S12915-1010R</td>
<td></td>
<td></td>
<td>200</td>
<td>13000</td>
<td>10 × 10</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Spectral response**

![Spectral response graph](image1)

**Dark current vs. reverse voltage**

![Dark current vs. reverse voltage graph](image2)
Si photodiodes for general photometry/visible range

For visible range
These Si photodiodes have sensitivity in the visible range. (Typ. Ta=25 °C)

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Spectral response range (nm)</th>
<th>Peak sensitivity wavelength (nm)</th>
<th>Photosensitivity $\lambda_s=\lambda_p$ (A/W)</th>
<th>Dark current $Va=1$ V max. (pA)</th>
<th>Photosensitive area size (mm)</th>
<th>Package</th>
<th>Photo</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1087</td>
<td>320 to 730</td>
<td>560</td>
<td>10</td>
<td>1.3 × 1.3</td>
<td>Ceramic</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S1133</td>
<td>340 to 720</td>
<td>540</td>
<td>0.3</td>
<td>2.4 × 2.8</td>
<td>Ceramic</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S8265</td>
<td>320 to 730</td>
<td>560</td>
<td>20</td>
<td>2.4 × 2.8</td>
<td>Ceramic</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S1787-04</td>
<td>320 to 730</td>
<td>560</td>
<td>10</td>
<td>2.4 × 2.8</td>
<td>Plastic</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Filter type (general use)
These are Si photodiodes with visible-compensated filters. The S8265 is a high humidity resistance type of the S1133.

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Spectral response range (nm)</th>
<th>Peak sensitivity wavelength (nm)</th>
<th>Photosensitivity $\lambda_s=\lambda_p$ (A/W)</th>
<th>Dark current $Va=1$ V max. (pA)</th>
<th>Photosensitive area size (mm)</th>
<th>Package</th>
<th>Photo</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1087</td>
<td>320 to 730</td>
<td>560</td>
<td>10</td>
<td>1.3 × 1.3</td>
<td>Ceramic</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S1133</td>
<td>340 to 720</td>
<td>540</td>
<td>0.3</td>
<td>2.4 × 2.8</td>
<td>Ceramic</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S8265</td>
<td>340 to 720</td>
<td>540</td>
<td>20</td>
<td>2.4 × 2.8</td>
<td>Ceramic</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S1787-04</td>
<td>320 to 730</td>
<td>560</td>
<td>10</td>
<td>2.4 × 2.8</td>
<td>Plastic</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Filter type (CIE spectral luminous efficiency approximation)

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Spectral response range (nm)</th>
<th>Peak sensitivity wavelength (nm)</th>
<th>Photosensitivity $\lambda_s=\lambda_p$ (A/W)</th>
<th>Dark current $Va=1$ V max. (pA)</th>
<th>Photosensitive area size (mm)</th>
<th>Package</th>
<th>Photo</th>
</tr>
</thead>
<tbody>
<tr>
<td>S9219</td>
<td>380 to 780</td>
<td>550</td>
<td>0.24</td>
<td>500 (VR=10 mV)</td>
<td>φ11.3</td>
<td>With BNC connector</td>
<td></td>
</tr>
<tr>
<td>S9219-01</td>
<td>380 to 780</td>
<td>550</td>
<td>0.22</td>
<td>50 (VR=10 mV)</td>
<td>3.6 × 3.6</td>
<td>TO-5</td>
<td></td>
</tr>
<tr>
<td>S7686</td>
<td>480 to 660</td>
<td>0.38</td>
<td>20</td>
<td>2.4 × 2.8</td>
<td>Ceramic</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Spectral response

[ S1087, S1133, S1787-04, S8265 ]

[ S9219 series, S7686 ]
These Si photodiodes have sensitivity in the visible range to near IR. (Typ. Ta=25 °C)

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Spectral response range (mm)</th>
<th>Peak sensitivity wavelength (mm)</th>
<th>Photosensitivity λ=λp (mm)</th>
<th>Dark current VR=1 V max. (pA)</th>
<th>Photosensitive area size (mm)</th>
<th>Package</th>
<th>Photo</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1787-12</td>
<td>320 to 1000</td>
<td>650</td>
<td>0.35</td>
<td></td>
<td>2.4 × 2.8</td>
<td>Plastic</td>
<td></td>
</tr>
<tr>
<td>S4797-01</td>
<td>320 to 1000</td>
<td>720</td>
<td>0.4</td>
<td>20</td>
<td>1.3 × 1.3</td>
<td>Ceramic</td>
<td></td>
</tr>
<tr>
<td>S1133-14</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2.4 × 2.8</td>
<td>Ceramic</td>
<td></td>
</tr>
<tr>
<td>S4011-06DS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.3 × 1.3</td>
<td>Plastic</td>
<td></td>
</tr>
<tr>
<td>S1787-08</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2.4 × 2.8</td>
<td>Plastic</td>
<td></td>
</tr>
<tr>
<td>S2833-01</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.3 × 1.3</td>
<td>Ceramic</td>
<td></td>
</tr>
<tr>
<td>S1087-01</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.3 × 1.3</td>
<td>Ceramic</td>
<td></td>
</tr>
<tr>
<td>S1133-01</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2.4 × 2.8</td>
<td>Ceramic</td>
<td></td>
</tr>
</tbody>
</table>

Spectral response

[ S1787-12, S4797-01, S1133-14 ]

[ S4011-06DS, S1787-08, S2833-01, S1087-01, S1133-01 ]
High-speed response Si PIN photodiodes

These Si PIN photodiodes deliver a wide bandwidth even with a low bias, making them suitable for high-speed photometry as well as optical communications. (Typ. Ta=25 °C)

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Cutoff frequency (GHz)</th>
<th>Photosensitive area size (mm)</th>
<th>Photosensitivity (A/W)</th>
<th>Terminal capacitance f=1 MHz (pF)</th>
<th>Package</th>
<th>Photo</th>
</tr>
</thead>
<tbody>
<tr>
<td>S5973</td>
<td>1</td>
<td>Φ0.4</td>
<td>0.51</td>
<td>1.6 (VR=3.3 V)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S5973-01</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>TO-18</td>
<td></td>
</tr>
<tr>
<td>S9055</td>
<td>1.5</td>
<td>Φ0.2</td>
<td>0.35</td>
<td>0.8 (VR=2 V)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S9055-01</td>
<td>2</td>
<td>Φ0.1</td>
<td>0.25</td>
<td>0.5 (VR=2 V)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Spectral response**

**Terminal capacitance vs. reverse voltage**

**Frequency response**

[S5973, S5973-01] λ=410 nm  
[S9055 series] λ=830 nm
High-speed response Si PIN photodiodes

These Si PIN photodiodes have a large photosensitive area (φ0.8 to φ3 mm) yet deliver excellent frequency response characteristics.

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Cutoff frequency (MHz)</th>
<th>Photosensitive area size (mm)</th>
<th>Photosensitivity (A/W)</th>
<th>Terminal capacitance f=1 MHz (pF)</th>
<th>Package</th>
<th>Photo</th>
</tr>
</thead>
<tbody>
<tr>
<td>S5971</td>
<td>100 (VR=10 V)</td>
<td>φ1.2</td>
<td>0.44, 0.55</td>
<td>3 (VR=10 V)</td>
<td>TO-18</td>
<td></td>
</tr>
<tr>
<td>S3399</td>
<td>300 (VR=20 V)</td>
<td>φ3</td>
<td>0.45, 0.58</td>
<td>20 (VR=10 V)</td>
<td>TO-5</td>
<td></td>
</tr>
<tr>
<td>S3883</td>
<td>300 (VR=20 V)</td>
<td>φ1.5</td>
<td>0.45, 0.58</td>
<td>6 (VR=20 V)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S10783</td>
<td>300 (VR=2.5 V)</td>
<td>φ0.8</td>
<td>0.46, 0.52</td>
<td>4.5 (VR=2.5 V)</td>
<td>Plastic</td>
<td></td>
</tr>
<tr>
<td>S10784</td>
<td>φ3</td>
<td></td>
<td>0.45, 0.51</td>
<td>100 pF</td>
<td>Plastic with lens</td>
<td></td>
</tr>
<tr>
<td>S5972</td>
<td>500 (VR=10 V)</td>
<td>φ0.8</td>
<td>0.44, 0.55</td>
<td>3 (VR=10 V)</td>
<td>TO-18</td>
<td></td>
</tr>
</tbody>
</table>

Spectral response

Terminal capacitance vs. reverse voltage
A wide variety of types are provided including a low-cost plastic package type and visible-cut type. (Typ. T_a=25 °C)

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Cutoff frequency (MHz)</th>
<th>Photosensitive area size (mm)</th>
<th>Photosensitivity (A/W)</th>
<th>Terminal capacitance f=1 MHz (pF)</th>
<th>Package</th>
<th>Photo</th>
</tr>
</thead>
<tbody>
<tr>
<td>S6775</td>
<td>15 (V_R=10 V)</td>
<td>5.5 x 4.8</td>
<td>( \lambda=660 \text{ nm} ) ( \lambda=780 \text{ nm} )</td>
<td>40 (V_R=10 V)</td>
<td>Plastic</td>
<td></td>
</tr>
<tr>
<td>S6967</td>
<td>50 (V_R=10 V)</td>
<td></td>
<td></td>
<td>50 (V_R=10 V)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S6775-01</td>
<td>15 (V_R=10 V)</td>
<td></td>
<td>( \lambda=830 \text{ nm} ) ( \lambda=\lambda_p )</td>
<td>40 (V_R=10 V)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S8385</td>
<td>2 x 2</td>
<td></td>
<td>0.4</td>
<td>12 (V_R=5 V)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S8385-04</td>
<td></td>
<td></td>
<td>0.44 ( \lambda=830 \text{ nm} ) ( \lambda=\lambda_p )</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S8729</td>
<td>25 (V_R=5 V)</td>
<td></td>
<td>0.45</td>
<td>16 (V_R=5 V)</td>
<td>Plastic</td>
<td></td>
</tr>
<tr>
<td>S8729-04</td>
<td>2 x 3.3</td>
<td></td>
<td>0.52 ( \lambda=830 \text{ nm} ) ( \lambda=\lambda_p )</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S8729-10</td>
<td></td>
<td></td>
<td>0.45</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S2506-02</td>
<td>25 (V_R=12 V)</td>
<td>2.77 x 2.77</td>
<td>0.4</td>
<td>15 (V_R=12 V)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S2506-04</td>
<td></td>
<td></td>
<td>0.25 ( \lambda=830 \text{ nm} ) ( \lambda=\lambda_p )</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S4707-01</td>
<td>20 (V_R=10 V)</td>
<td>2.4 x 2.8</td>
<td>0.4</td>
<td>14 (V_R=10 V)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S6801-01</td>
<td>15 (V_R=10 V)</td>
<td>( \phi=14 \text{ mm lens diameter} )</td>
<td>0.52 ( \lambda=830 \text{ nm} ) ( \lambda=\lambda_p )</td>
<td>50 (V_R=10 V)</td>
<td>Plastic with ( \phi=14 \text{ mm lens} )</td>
<td></td>
</tr>
</tbody>
</table>

**Spectral response**

| [ S8385/S8729 series ] | [ S6775/S6967/S2506 series ] | [ S4707-01, S6801-01 ] |

---

Type no. Cutoff frequency (MHz) Photosensitive area size (mm) Photosensitivity (A/W) Terminal capacitance f=1 MHz (pF) Package Photo
S6775 15 (V_R=10 V) 5.5 x 4.8 \( \lambda=660 \text{ nm} \) \( \lambda=780 \text{ nm} \) 40 (V_R=10 V) Plastic
S6967 50 (V_R=10 V) \( \lambda=660 \text{ nm} \) \( \lambda=780 \text{ nm} \) 50 (V_R=10 V) Plastic
S6775-01 15 (V_R=10 V) \( \lambda=830 \text{ nm} \) \( \lambda=\lambda_p \) 40 (V_R=10 V) Plastic
S8385 2 x 2 0.4 0.48 12 (V_R=5 V) Plastic
S8385-04 \( \lambda=830 \text{ nm} \) \( \lambda=\lambda_p \) Plastic
S8729 25 (V_R=5 V) 0.45 0.55 Plastic
S8729-04 2 x 3.3 0.52 \( \lambda=830 \text{ nm} \) \( \lambda=\lambda_p \) Plastic
S8729-10 0.45 0.55 Plastic
S2506-02 25 (V_R=12 V) 0.4 0.48 15 (V_R=12 V) Plastic
S2506-04 2.77 x 2.77 0.25 \( \lambda=830 \text{ nm} \) \( \lambda=\lambda_p \) Plastic
S4707-01 20 (V_R=10 V) 2.4 x 2.8 0.4 0.48 14 (V_R=10 V) Plastic
S6801-01 15 (V_R=10 V) \( \phi=14 \text{ mm lens} \) 0.52 \( \lambda=830 \text{ nm} \) \( \lambda=\lambda_p \) 50 (V_R=10 V) Plastic with \( \phi=14 \text{ mm lens} \)
### High-speed response Si PIN photodiodes

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Cutoff frequency (MHz)</th>
<th>Photosensitive area size (mm)</th>
<th>Photosensitivity (A/W)</th>
<th>Terminal capacitance (pF)</th>
<th>Package</th>
<th>Photo</th>
</tr>
</thead>
<tbody>
<tr>
<td>S5821</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S5821-02</td>
<td>25 (VR=10 V)</td>
<td>φ1.2</td>
<td>0.45</td>
<td>3 (VR=10 V)</td>
<td>TO-18</td>
<td></td>
</tr>
<tr>
<td>S5821-01</td>
<td></td>
<td>φ4.65 (lens diameter)</td>
<td>0.52</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S5821-03</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S1223</td>
<td>30 (VR=20 V)</td>
<td>2.4 × 2.8</td>
<td>0.45</td>
<td>10 (VR=20 V)</td>
<td>TO-5</td>
<td></td>
</tr>
<tr>
<td>S1223-01</td>
<td>20 (VR=20 V)</td>
<td>3.6 × 3.6</td>
<td>0.45</td>
<td>20 (VR=20 V)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S3072</td>
<td>45 (VR=24 V)</td>
<td>φ3</td>
<td>0.47</td>
<td>7 (VR=24 V)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S3071</td>
<td>40 (VR=24 V)</td>
<td>φ5</td>
<td>0.54</td>
<td>18 (VR=24 V)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S12271*</td>
<td>60 (VR=100 V)</td>
<td>φ4.1</td>
<td>0.5</td>
<td>10 (VR=100 V)</td>
<td>TO-8</td>
<td></td>
</tr>
</tbody>
</table>

* Refer to “Precautions against UV light exposure” (P.43).

### Spectral response

<table>
<thead>
<tr>
<th>[S5821 series, S3071, S3072]</th>
<th>[S1223 series]</th>
<th>[S12271]</th>
</tr>
</thead>
</table>

### Terminal capacitance vs. reverse voltage

<table>
<thead>
<tr>
<th>[S5821 series, S3071, S3072]</th>
<th>[S1223 series]</th>
<th>[S12271]</th>
</tr>
</thead>
</table>
**Multi-element type Si photodiodes**

These Si PIN photodiode arrays consist of 2 or 4 elements having sensitivity in the UV to near IR range. (Typ. Ta=25 °C)

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Number of elements</th>
<th>Photosensitive area size (mm)</th>
<th>Photosensitivity A/W</th>
<th>Cutoff frequency VR=10 V RL=50 Ω (MHz)</th>
<th>Dark current max. VR=10 V (nA)</th>
<th>Terminal capacitance VR=10 V f=1 MHz (pF)</th>
<th>Package</th>
<th>Photo</th>
</tr>
</thead>
<tbody>
<tr>
<td>S3096-02</td>
<td>2/seg-ment</td>
<td>1.2 × 3</td>
<td>0.39 (λ=650 nm)</td>
<td>25</td>
<td>0.5*1</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S4204</td>
<td></td>
<td>1 × 2</td>
<td>0.45 (λ=650 nm)</td>
<td>30</td>
<td>1*1</td>
<td>3 Plastic</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S9345</td>
<td></td>
<td>1.5 × 1.5 + 1.5 × 4.1</td>
<td>0.45 (λ=650 nm)</td>
<td>15</td>
<td>5*1</td>
<td>4 Photo-diode A 10 Photo-diode B</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S4349**2</td>
<td>4/seg-ment</td>
<td>3 × 3</td>
<td>0.45 (λ=720 nm)</td>
<td>20 (VR=5 V)</td>
<td>0.2</td>
<td>25 (VR=5 V) TO-5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*1: Total number of elements
*2: Refer to “Precautions against UV light exposure” (P.43).

**Spectral response**

- [ S3096-02, S4204 ]
  ![Spectral response S3096-02, S4204](image)
  ![Spectral response S4204](image)

- [ S9345 ]
  ![Spectral response S9345](image)

- [ S4349 ]
  ![Spectral response S4349](image)

**Dark current vs. reverse voltage**

- [ S3096-02, S4204 ]
  ![Dark current vs. reverse voltage S3096-02, S4204](image)
  ![Dark current vs. reverse voltage S4204](image)

- [ S9345 ]
  ![Dark current vs. reverse voltage S9345](image)

- [ S4349 ]
  ![Dark current vs. reverse voltage S4349](image)
One-dimensional photodiode arrays (UV to near IR: UV sensitivity enhanced type)

These are Si photodiode linear arrays having rectangular elements equally spaced at a pitch of about 1 mm. (Typ. Ta=25 °C)

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Number of elements</th>
<th>Element pitch (mm)</th>
<th>Element size W × H (mm)</th>
<th>Spectral response range (nm)</th>
<th>Photosensitivity λ=960 nm (A/W)</th>
<th>Dark current V&lt;sub&gt;r&lt;/sub&gt;=10 mV max. (pA)</th>
<th>Terminal capacitance V&lt;sub&gt;r&lt;/sub&gt;=0 V f=10 kHz (pF)</th>
<th>Package</th>
<th>Photo</th>
</tr>
</thead>
<tbody>
<tr>
<td>S4111-16Q*2</td>
<td>16</td>
<td>0.9 × 1.45</td>
<td>190 to 1100</td>
<td>340 to 1100</td>
<td>0.58</td>
<td>5</td>
<td>200</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S4111-16R</td>
<td>16</td>
<td>1.0</td>
<td>190 to 1100</td>
<td></td>
<td></td>
<td>10</td>
<td>550</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S4111-35Q*2</td>
<td>35</td>
<td>0.9 × 4.4</td>
<td>190 to 1000</td>
<td></td>
<td>0.50 (λ=800 nm)</td>
<td>60</td>
<td>35</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S4111-46Q*2</td>
<td>46</td>
<td>1.0</td>
<td>190 to 1000</td>
<td></td>
<td></td>
<td>10</td>
<td>550</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S4114-35Q*2</td>
<td>35</td>
<td>0.9 × 4.4</td>
<td>190 to 1000</td>
<td></td>
<td>0.50 (λ=800 nm)</td>
<td>60</td>
<td>35</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S4114-46Q*2</td>
<td>46</td>
<td>1.0</td>
<td>190 to 1000</td>
<td></td>
<td></td>
<td>10</td>
<td>550</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S12858-021</td>
<td>16</td>
<td>1.17</td>
<td>0.77 × 2.5</td>
<td></td>
<td></td>
<td>30</td>
<td>30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S12859-021</td>
<td>16</td>
<td>1.575</td>
<td>1.175 × 2.0</td>
<td>340 to 1100</td>
<td>0.61 (λ=920 nm)</td>
<td>30</td>
<td>40</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S11299-021</td>
<td>16</td>
<td>1.575</td>
<td>1.175 × 2.0</td>
<td>340 to 1100</td>
<td>0.40 (λ=900 nm)</td>
<td>30</td>
<td>40</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S11212-021</td>
<td>16</td>
<td>1.575</td>
<td>1.175 × 2.0</td>
<td>340 to 1100</td>
<td>0.61 (λ=990 nm)</td>
<td>30</td>
<td>40</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S12362-021</td>
<td>16</td>
<td>2.5</td>
<td>2.2 × 2.7</td>
<td></td>
<td></td>
<td>50</td>
<td>75</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S12363-021</td>
<td>16</td>
<td>2.5</td>
<td>2.2 × 2.7</td>
<td></td>
<td></td>
<td>50</td>
<td>75</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*2: Refer to ‘Precautions against UV light exposure’ (P.43).

**Spectral response**

[S4111/S4114 series] [S12858/S12859/S12362/S12363/S11212/S11299-021]

**Structure of photosensitive area (unit: mm)**

[S4111/S4114 series] [S11212/S11299-021]
Surface mount type Si photodiodes

### High-speed response Si PIN photodiodes

These are photodiodes sealed in a chip carrier package suitable for surface mounting and allowed solder reflow mounting on PC boards for automated processes. (Typ. Ta=25 °C)

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Cutoff frequency VR=10 V (MHz)</th>
<th>Photosensitive area size (mm)</th>
<th>Spectral response range (nm)</th>
<th>Photosensitivity λ=960 nm (A/W)</th>
<th>Terminal capacitance VR=10 V f=1 MHz (pF)</th>
<th>Package</th>
<th>Photo</th>
</tr>
</thead>
<tbody>
<tr>
<td>S5106</td>
<td>20</td>
<td>5 x 5</td>
<td>320 to 1100</td>
<td>0.72</td>
<td>40</td>
<td>Ceramic</td>
<td></td>
</tr>
<tr>
<td>S5107</td>
<td>10</td>
<td>10 x 10</td>
<td></td>
<td></td>
<td>150</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S7509</td>
<td>20</td>
<td>2 x 10</td>
<td></td>
<td></td>
<td>40</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S7510</td>
<td>15</td>
<td>6 x 11</td>
<td></td>
<td></td>
<td>80</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Segmented type Si photodiodes

These Si photodiodes consist of 2, 4 or 16 elements and are integrated into a chip carrier package. (Typ. Ta=25 °C)

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Number of elements</th>
<th>Photosensitive area size (mm)</th>
<th>Spectral response range (nm)</th>
<th>Photosensitivity λ=960 nm (A/W)</th>
<th>Cutoff frequency VR=10 V (MHz)</th>
<th>Terminal capacitance VR=10 V f=1 MHz (pF)</th>
<th>Package</th>
<th>Photo</th>
</tr>
</thead>
<tbody>
<tr>
<td>S5980</td>
<td>4</td>
<td>5 x 5 /4-segment</td>
<td></td>
<td></td>
<td>25</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S5981</td>
<td>10</td>
<td>10 x 10 /4-segment</td>
<td></td>
<td></td>
<td>20</td>
<td>35</td>
<td>Ceramic</td>
<td></td>
</tr>
<tr>
<td>S5870</td>
<td>2</td>
<td>10 x 10 /2-segment</td>
<td>320 to 1100</td>
<td>0.72</td>
<td>10</td>
<td>50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S8558</td>
<td>16</td>
<td>2 x 12.7 /16-segment</td>
<td></td>
<td></td>
<td>25</td>
<td>5</td>
<td>Ceramic</td>
<td></td>
</tr>
</tbody>
</table>

### Spectral response

[ S5106, S5107, S7509, S7510, S5980, S5981, S5870 ]

[ S8558 ]

### Terminal capacitance vs. reverse voltage

[ S5106, S5107, S7509, S7510 ]

[ S8558 ]
Surface mount type Si photodiodes

These surface mount type Si photodiodes are mounted on small packages. They are tape packaged and allows solder reflow mounting. (Typ. Ta=25 °C)

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Photosensitive area size (mm)</th>
<th>Spectral response range (nm)</th>
<th>Photosensitivity λ=960 nm (A/W)</th>
<th>Terminal capacitance Vr=0 V f=10 kHz (pF)</th>
<th>Package</th>
<th>Photo</th>
</tr>
</thead>
<tbody>
<tr>
<td>S9674</td>
<td>2 × 2</td>
<td>320 to 1100</td>
<td>0.7</td>
<td>500</td>
<td>Glass epoxy</td>
<td><img src="image1.png" alt="Photo1" /></td>
</tr>
<tr>
<td>S10625-01CT</td>
<td>1.3 × 1.3</td>
<td></td>
<td>0.54 (λ=940 nm)</td>
<td>200</td>
<td>Glass epoxy</td>
<td><img src="image2.png" alt="Photo2" /></td>
</tr>
</tbody>
</table>

Small package type Si PIN photodiodes

These surface mount type Si PIN photodiodes are mounted on small packages. They are tape packaged and allows solder reflow mounting. (Typ. Ta=25 °C)

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Photosensitive area size (mm)</th>
<th>Spectral response range (nm)</th>
<th>Photosensitivity λ=960 nm (A/W)</th>
<th>Terminal capacitance Vr=0 V f=10 kHz (pF)</th>
<th>Package</th>
<th>Photo</th>
</tr>
</thead>
<tbody>
<tr>
<td>S13773</td>
<td>φ0.8</td>
<td>380 to 1000</td>
<td>0.54 (λ=800 nm)</td>
<td>3 (Vr=10 V)</td>
<td>Glass epoxy</td>
<td><img src="image3.png" alt="Photo3" /></td>
</tr>
<tr>
<td>S10993-02CT</td>
<td>1.06 × 1.06</td>
<td>380 to 1100</td>
<td>0.6</td>
<td>6 (Vr=2.5 V)</td>
<td>Glass epoxy</td>
<td><img src="image4.png" alt="Photo4" /></td>
</tr>
<tr>
<td>S12158-01CT</td>
<td>2.77 × 2.77</td>
<td>320 to 1100</td>
<td>0.7</td>
<td>15 (Vr=12 V)</td>
<td>Glass epoxy</td>
<td><img src="image5.png" alt="Photo5" /></td>
</tr>
</tbody>
</table>

Spectral response

[S9674, S10625-01CT] (Typ. Ta=25 °C)

Dark current vs. reverse voltage

[KSPDB0315EB](image6.png)

[KSPDB0318EC](image7.png)
Si photodiodes with preamp, TE-cooled type Si photodiodes

These are low noise photosensors incorporating a large area Si photodiode, op amp and feedback capacitance. (Typ. Ta=25 °C)

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Cooling temperature AT (°C)</th>
<th>Photosensitive area size (mm)</th>
<th>Spectral response range (nm)</th>
<th>Photosensitivity (V/nW) λ=200 nm</th>
<th>Photosensitivity (V/nW) λ=960 nm</th>
<th>NEP λ=λp, f=10 Hz (fW/Hz 1/2)</th>
<th>Built-in feedback resistance (GΩ)</th>
<th>Package</th>
<th>Photo</th>
</tr>
</thead>
<tbody>
<tr>
<td>S8745-01*</td>
<td>Non-cooled</td>
<td>2.4 x 2.4</td>
<td>190 to 1100</td>
<td>0.12</td>
<td>0.52</td>
<td>11</td>
<td>1</td>
<td>Metal</td>
<td></td>
</tr>
<tr>
<td>S8746-01*</td>
<td>Non-cooled</td>
<td>5.8 x 5.8</td>
<td>340 to 1100</td>
<td>0.9</td>
<td>5.1</td>
<td>15</td>
<td>1</td>
<td>Metal</td>
<td></td>
</tr>
<tr>
<td>S9269</td>
<td>50</td>
<td>10 x 10</td>
<td>0.9</td>
<td>5.1</td>
<td>-</td>
<td>12</td>
<td>1</td>
<td>Ceramic</td>
<td></td>
</tr>
<tr>
<td>S9270</td>
<td>Non-cooled</td>
<td>10 x 10</td>
<td>0.62</td>
<td>-</td>
<td>-</td>
<td>16</td>
<td>1</td>
<td>Ceramic</td>
<td></td>
</tr>
</tbody>
</table>

* Refer to “Precautions against UV light exposure” (P.43).

NEP (noise equivalent power) vs. frequency
### TE-cooled type Si photodiodes

These photosensors combine a UV to near infrared Si photodiode with a TE-cooler and deliver low dark current. (Typ. Ta=25 °C)

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Cooling temperature ΔT (°C)</th>
<th>Photosensitive area size (mm)</th>
<th>Spectral response range (nm)</th>
<th>Peak sensitivity wavelength (nm)</th>
<th>Dark current Vθ=10 mV (pA)</th>
<th>NEP (W/Hz$^{1/2}$)</th>
<th>Package</th>
<th>Photo</th>
</tr>
</thead>
<tbody>
<tr>
<td>S2592-03*</td>
<td>35</td>
<td>2.4 × 2.4</td>
<td>190 to 1100</td>
<td>960</td>
<td>10</td>
<td>8.1 × 10^{-15}</td>
<td>TO-8</td>
<td></td>
</tr>
<tr>
<td>S2592-04*</td>
<td>35</td>
<td>5.8 × 5.8</td>
<td>190 to 1100</td>
<td>960</td>
<td>25</td>
<td>1.3 × 10^{-14}</td>
<td>TO-66</td>
<td></td>
</tr>
<tr>
<td>S3477-03*</td>
<td>35</td>
<td>2.4 × 2.4</td>
<td>190 to 1100</td>
<td>960</td>
<td>10</td>
<td>8.1 × 10^{-15}</td>
<td>TO-8</td>
<td></td>
</tr>
<tr>
<td>S3477-04*</td>
<td>35</td>
<td>5.8 × 5.8</td>
<td>190 to 1100</td>
<td>960</td>
<td>25</td>
<td>1.3 × 10^{-14}</td>
<td>TO-66</td>
<td></td>
</tr>
</tbody>
</table>

* Refer to “Precautions against UV light exposure” (P.43).

#### Spectral response

![Spectral response graph](image1)

#### Thermistor temperature characteristics

![Thermistor temperature graph](image2)
### Si photodiodes for X-ray detection

These detectors are comprised of a Si photodiode coupled to a scintillator. Ceramic scintillators have sensitivity to X-rays about 1.2 times higher than CWO and offer high reliability. CsI scintillators also have high sensitivity and are low-cost. The S11212 and S11299 series photodiode arrays have a back-illuminated structure. They realize superb spectral response and sensitivity uniformity compared to our previous products. (Typ. Ta=25 °C)

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Scintillator</th>
<th>Number of elements</th>
<th>Element pitch (mm)</th>
<th>Element size W × H (mm)</th>
<th>Dark current max. V_{R}=10 mV (pA)</th>
<th>X-ray sensitivity* (nA)</th>
<th>Package</th>
<th>Photo</th>
</tr>
</thead>
<tbody>
<tr>
<td>S8559</td>
<td>CsI(Tl)</td>
<td>1</td>
<td>-</td>
<td>5.8 × 5.8</td>
<td>50</td>
<td>52</td>
<td>Ceramic</td>
<td><img src="image1.png" alt="Photo" /></td>
</tr>
<tr>
<td>S8193</td>
<td>GOS ceramic</td>
<td>-</td>
<td>-</td>
<td>5.8 × 5.8</td>
<td>50</td>
<td>30</td>
<td>Ceramic</td>
<td><img src="image2.png" alt="Photo" /></td>
</tr>
<tr>
<td>S12858-122</td>
<td>CsI(Tl)</td>
<td>16</td>
<td>1.17</td>
<td>0.77 × 2.5</td>
<td>30</td>
<td>2.5</td>
<td>Glass epoxy</td>
<td><img src="image3.png" alt="Photo" /></td>
</tr>
<tr>
<td>S12859-122</td>
<td>GOS ceramic</td>
<td>16</td>
<td>1.17</td>
<td>0.77 × 2.5</td>
<td>30</td>
<td>2.5</td>
<td>Glass epoxy</td>
<td><img src="image4.png" alt="Photo" /></td>
</tr>
<tr>
<td>S12858-324</td>
<td>Phosphor sheet</td>
<td>16</td>
<td>1.17</td>
<td>0.77 × 2.5</td>
<td>30</td>
<td>2.5</td>
<td>Glass epoxy</td>
<td><img src="image5.png" alt="Photo" /></td>
</tr>
<tr>
<td>S12859-324</td>
<td>Phosphor sheet</td>
<td>16</td>
<td>1.575</td>
<td>1.175 × 2.0</td>
<td>30</td>
<td>3.5</td>
<td>Glass epoxy</td>
<td><img src="image6.png" alt="Photo" /></td>
</tr>
<tr>
<td>S11299-121</td>
<td>CsI(Tl)</td>
<td>16</td>
<td>1.575</td>
<td>1.175 × 2.0</td>
<td>30</td>
<td>3.5</td>
<td>Glass epoxy</td>
<td><img src="image7.png" alt="Photo" /></td>
</tr>
<tr>
<td>S11299-321</td>
<td>GOS ceramic</td>
<td>16</td>
<td>1.575</td>
<td>1.175 × 2.0</td>
<td>30</td>
<td>3.5</td>
<td>Glass epoxy</td>
<td><img src="image8.png" alt="Photo" /></td>
</tr>
<tr>
<td>S11299-422</td>
<td>Phosphor sheet</td>
<td>16</td>
<td>1.575</td>
<td>1.175 × 2.0</td>
<td>50</td>
<td>7.2</td>
<td>Glass epoxy</td>
<td><img src="image9.png" alt="Photo" /></td>
</tr>
<tr>
<td>S11299-422</td>
<td>Phosphor sheet</td>
<td>16</td>
<td>1.575</td>
<td>1.175 × 2.0</td>
<td>50</td>
<td>7.2</td>
<td>Glass epoxy</td>
<td><img src="image10.png" alt="Photo" /></td>
</tr>
</tbody>
</table>

* These are for reference (X-ray tube voltage: 120 kV, tube current: 1.0 mA, aluminum filter t=6 mm, distance: 830 mm), X-ray sensitivity depends on the X-ray equipment operating and setup conditions.
Spectral response (S12858/S12859/S11212/S11299/S12362/S12363 series)

- Photosensitivity (A/W)
  - Wave length (nm)
  - QE=100% (Typ. Ta=25 °C)

Uniformity (S11212/S11299 series)

- Relative sensitivity (%)
  - Element no.

Emission spectrum of scintillator and spectral response

- Relative emission output (%)
  - Quantum efficiency (%)
  - Wavelength (nm)

Typical scintillator characteristics

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Condition</th>
<th>CsI(Tl)</th>
<th>GOS ceramic</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak emission wavelength</td>
<td></td>
<td>560</td>
<td>512</td>
<td>nm</td>
</tr>
<tr>
<td>X-ray absorption coefficient</td>
<td>100 keV</td>
<td>10</td>
<td>7</td>
<td>cm(^{-1})</td>
</tr>
<tr>
<td>Refractive index</td>
<td>(\lambda=\lambda_p)</td>
<td>1.7</td>
<td>2.2</td>
<td>-</td>
</tr>
<tr>
<td>Decay constant</td>
<td>1 µs</td>
<td>3 µs</td>
<td></td>
<td>µs</td>
</tr>
<tr>
<td>Afterglow</td>
<td>100 ms after X-ray turn off</td>
<td>0.3</td>
<td>0.01</td>
<td>%</td>
</tr>
<tr>
<td>Density</td>
<td>4.51 g/cm(^3)</td>
<td>7.34</td>
<td></td>
<td>g/cm(^3)</td>
</tr>
<tr>
<td>Color</td>
<td>Transparent</td>
<td>Light yellow-green</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Sensitivity nonuniformity</td>
<td>±10 %</td>
<td>±5 %</td>
<td></td>
<td>%</td>
</tr>
</tbody>
</table>
Large area Si PIN photodiodes

These Si PIN photodiodes, mounted on a white ceramic base, are specifically developed for applications in high energy physics and are mainly used being coupled to a scintillator. Because of high resistance to high voltages, these Si PIN photodiodes operate at high reverse voltages allowing a high-speed response despite the large photosensitive areas.

The S3590-18/-19 are violet sensitivity enhanced type and the S3590-19 is an unsealed type. To improve photodiode-to-scintillator coupling efficiency, we also offer the S8650 with epoxy resin coating window processed to have a flat surface. (Typ. Ta=25 °C)

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Window</th>
<th>Photosensitive area size (mm)</th>
<th>Depletion layer thickness Vth=70 V (mm)</th>
<th>Spectral response range (nm)</th>
<th>Photosensitivity λ=980 nm (A/W)</th>
<th>Dark current max. Vth=70 V (nA)</th>
<th>Terminal capacitance Vth=70 V f=1 MHz (pF)</th>
<th>Package</th>
<th>Photo</th>
</tr>
</thead>
<tbody>
<tr>
<td>S3590-08</td>
<td>Epoxy resin</td>
<td>10×10</td>
<td>0.3</td>
<td>340 to 1100</td>
<td>0.66</td>
<td>6</td>
<td></td>
<td>40</td>
<td>Ceramic</td>
</tr>
<tr>
<td>S3590-09</td>
<td>Unsealed</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S3590-18</td>
<td>Epoxy resin</td>
<td></td>
<td></td>
<td></td>
<td>0.65</td>
<td>10</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S3590-19</td>
<td>Unsealed</td>
<td></td>
<td></td>
<td></td>
<td>0.58</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S8650</td>
<td>Epoxy resin</td>
<td></td>
<td></td>
<td></td>
<td>0.66</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Spectral response**

[ S3590-08, S8650 ]

[ S3590-09 ]

[ S3590-18/-19 ]

**Terminal capacitance vs. reverse voltage**

[ S3590 series, S8650 ]

**Emission spectrum of scintillators and spectral response (S3590-08)**
<table>
<thead>
<tr>
<th>Type no.</th>
<th>Window</th>
<th>Photosensitive area size (mm)</th>
<th>Depletion layer thickness Vh=70 V (mm)</th>
<th>Spectral response range (nm)</th>
<th>Photosensitivity λ=980 nm (A/W)</th>
<th>Dark current max. VR=70 V (nA)</th>
<th>Terminal capacitance VR=70 V f=1 MHz (pF)</th>
<th>Package</th>
<th>Photo</th>
</tr>
</thead>
<tbody>
<tr>
<td>S2744-08</td>
<td>Epoxy resin</td>
<td>10 × 20</td>
<td>0.3</td>
<td>340 to 1100</td>
<td>0.66</td>
<td>10</td>
<td>85</td>
<td>Ceramic</td>
<td></td>
</tr>
<tr>
<td>S2744-09</td>
<td>Unsealed</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S3204-08</td>
<td>Epoxy resin</td>
<td>18 × 18</td>
<td></td>
<td></td>
<td></td>
<td>20</td>
<td>130</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S3204-09</td>
<td>Unsealed</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S3584-08</td>
<td>Epoxy resin</td>
<td>28 × 28</td>
<td></td>
<td></td>
<td></td>
<td>30</td>
<td>300</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S3584-09</td>
<td>Unsealed</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S3588-08</td>
<td>Epoxy resin</td>
<td>3 × 30</td>
<td></td>
<td></td>
<td></td>
<td>10</td>
<td>40</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S3588-09</td>
<td>Unsealed</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Spectral response

**[S2744/S3588 series]**

![Graph: Spectral response of S2744/S3588 series](image1)

**[S3204/S3584 series]**

![Graph: Spectral response of S3204/S3584 series](image2)

### Terminal capacitance vs. reverse voltage

**[S2744/S3588 series]**

![Graph: Terminal capacitance vs. reverse voltage of S2744/S3588 series](image3)

**[S3204/S3584 series]**

![Graph: Terminal capacitance vs. reverse voltage of S3204/S3584 series](image4)
Special application Si photodiodes

These photosensors are color sensors using a 3-element photodiode with color sensitivity, assembled in one package.

**RGB color sensors**

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Spectral response range (nm)</th>
<th>Peak sensitivity wavelength (nm)</th>
<th>Photosensitivity $\lambda = \lambda_0$ (A/W)</th>
<th>Dark current $V_r=1$ V Total number of elements max. (pA)</th>
<th>Photosensitive area size (mm)</th>
<th>Package</th>
<th>Photo</th>
</tr>
</thead>
<tbody>
<tr>
<td>S7505-01</td>
<td>Blue 400 to 540 Blue 460</td>
<td>Blue 0.18</td>
<td>200 Blue 1.5 x 1.5 (x 2)</td>
<td></td>
<td>Surface mount type plastic</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Green 480 to 600 Green 540</td>
<td>Green 0.23</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Red 590 to 720 Red 620</td>
<td>Red 0.16</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S9032-02*1</td>
<td>Blue 400 to 540 Blue 460</td>
<td>Blue 0.18</td>
<td>100 Blue $\phi$2 / 3-segment</td>
<td></td>
<td>Surface mount type plastic</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Green 480 to 600 Green 540</td>
<td>Green 0.23</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Red 590 to 720 Red 620</td>
<td>Red 0.16</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S9702*1</td>
<td>Blue 400 to 540 Blue 460</td>
<td>Blue 0.18</td>
<td>50 1 x 1 / 3-segment</td>
<td></td>
<td>Surface mount type, small plastic</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Green 480 to 600 Green 540</td>
<td>Green 0.23</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Red 590 to 720 Red 620</td>
<td>Red 0.16</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S10917-35GT</td>
<td>Blue 390 to 530 Blue 460</td>
<td>Blue 0.2</td>
<td>50 1 x 1 / 3-segment</td>
<td></td>
<td>Surface mount type, small glass epoxy</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Green 470 to 600 Green 540</td>
<td>Green 0.23</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Red 590 to 680 Red 620</td>
<td>Red 0.17</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S10942-01CT</td>
<td>See the spectral response. Blue 0.21*2</td>
<td>50 1 x 1 / 3-segment</td>
<td></td>
<td>Surface mount type, small glass epoxy</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Green 470 to 600 Green 540</td>
<td>Green 0.25*2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Red 490 to 620 Red 640</td>
<td>Red 0.45*2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*1: If excessive vibration is continuously applied to the glass filter, there is a risk that the filter may come off, so secure the glass filter with a holder.

*2: Blue: $\lambda_0=460$ nm, Green: $\lambda_0=540$ nm, Red: $\lambda_0=640$ nm

**Spectral response**

- **[S7505-01, S9032-02, S9702]**
- **[S10917-35GT]**
- **[S10942-01CT]**

This sensor also has sensitivity in the infrared region, so cut off infrared light as needed.
The S6428-01, S6429-01 and S6430-01 are monochromatic color sensors sensitive to blue, green and red light, respectively. (Typ. Ta=25 °C)

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Spectral response range (nm)</th>
<th>Peak sensitivity wavelength (nm)</th>
<th>Photosensitivity $\lambda=\lambda_p$ (A/W)</th>
<th>Dark current $V_R=1$ V max. (pA)</th>
<th>Photosensitive area size (mm)</th>
<th>Package</th>
<th>Photo</th>
</tr>
</thead>
<tbody>
<tr>
<td>S6428-01</td>
<td>400 to 540</td>
<td>460</td>
<td>0.22</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S6429-01</td>
<td>480 to 600</td>
<td>540</td>
<td>0.27</td>
<td>20</td>
<td>2.4 x 2.8</td>
<td>Plastic</td>
<td></td>
</tr>
<tr>
<td>S6430-01</td>
<td>590 to 720</td>
<td>660</td>
<td>0.45</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Spectral response**

![Spectral response graph](image)
Violet/blue sensitivity enhanced type

These are photodiodes for violet/blue laser diode detection.  
(Typ. Ta=25 °C)

| Type no.   | Cutoff frequency (MHz) | Cutoff frequency (VR=3.3 V) | Photosensitive area size (mm) | Peak sensitivity wavelength (nm) | Peak sensitivity wavelength (λ=410 nm) | Dark current max. (nA) | Dark current max. (VR=3.3 V) | Dark current max. (VR=3.3 V) | Dark current max. (VR=3.3 V) | Dark current max. (VR=3.3 V) | Terminal capacitance (pF) | Package | Photo |
|------------|------------------------|-----------------------------|-------------------------------|---------------------------------|--------------------------------------|------------------------|-----------------------------|-----------------------------|-----------------------------|-----------------------------|---------------------------|---------|
| S5973-02   | 1 GHz (VR=3.3 V)       | ϕ0.4                        | 760                           | 0.3                             | 0.1                                  | 1.6                    | TO-18                       |                             |                             |                             |                          |         |
| S9195      | 50 (VR=10 V)           | 5 × 5                       | 840                           | 0.28                            | 5                                    | 60                     | TO-8                        |                             |                             |                             |                          |         |
| S3994-01   | 20 (VR=30 V)           | 10 × 10                     | 960                           | 0.25                            | 10                                   | 40                     | Ceramic                     |                             |                             |                             |                          |         |

Spectral response

[ S5973-02 ]

[ S9195 ]

[ S3994-01 ]

Dark current vs. reverse voltage

[ S5973-02 ]

[ S9195 ]

[ S3994-01 ]
For VUV (vacuum ultraviolet) monitor

These Si photodiodes are specially optimized for excimer laser monitor (ArF: 193 nm, KrF: 248 nm): sensitive in the vacuum UV (VUV) range.

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Photosensitivity $\lambda=193$ nm (A/W)</th>
<th>Dark current $V_{th}=10$ mV max. (nA)</th>
<th>Photosensitive area size (mm)</th>
<th>Package</th>
<th>Photo</th>
</tr>
</thead>
<tbody>
<tr>
<td>S8552*</td>
<td>0.06</td>
<td>1.0</td>
<td>10 × 10</td>
<td>Ceramic (unsealed)</td>
<td><img src="image1" alt="Image" /></td>
</tr>
<tr>
<td>S8553*</td>
<td>5.0</td>
<td>18 × 18</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Refer to “Precautions against UV light exposure” (P.43).

For VUV detection (high reliability type)

The S10043 is greatly improved in sensitivity stability even after exposure to ArF ($\lambda=193$ nm) excimer laser.

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Photosensitivity $\lambda=193$ nm (A/W)</th>
<th>Dark current $V_{th}=10$ mV max. (nA)</th>
<th>Photosensitive area size (mm)</th>
<th>Package</th>
<th>Photo</th>
</tr>
</thead>
<tbody>
<tr>
<td>S10043*</td>
<td>0.015</td>
<td>1.0</td>
<td>10 × 10</td>
<td>Ceramic (unsealed)</td>
<td><img src="image2" alt="Image" /></td>
</tr>
</tbody>
</table>

* Refer to “Precautions against UV light exposure” (P.43).

Variation in sensitivity due to UV exposure

Spectral response

![Variation in sensitivity due to UV exposure](image3)

![Spectral response](image4)
For monochromatic light detection

This photosensor uses an interference filter and has high sensitivity only to monochromatic light. (Typ. Ta=25 °C)

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Peak sensitivity wavelength (nm)</th>
<th>Spectral response half-width (nm)</th>
<th>Photosensitivity $\lambda=254$ nm (A/W)</th>
<th>Dark current $\text{VR}=10$ mV max. (pA)</th>
<th>Photosensitive area size (mm)</th>
<th>Package</th>
<th>Photo</th>
</tr>
</thead>
<tbody>
<tr>
<td>S12742-254*1</td>
<td>254</td>
<td>10</td>
<td>0.018</td>
<td>25</td>
<td>3.61 × 3.61</td>
<td>TO-5</td>
<td></td>
</tr>
</tbody>
</table>

*1: Refer to “Precautions against UV light exposure” (P.43).

**Spectral response**

![Spectral response graph]

Note: Different types compatible with wavelengths other than the 254 nm center wavelength are also available (made-to-order product).

For YAG laser detection

This is a Si PIN photodiode developed to measure infrared energy emitted from YAG lasers (1.06 μm). (Typ. Ta=25 °C)

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Photosensitive area size (mm)</th>
<th>Spectral response range (nm)</th>
<th>Peak sensitivity wavelength (nm)</th>
<th>Photosensitivity $\lambda=1060$ nm (A/W)</th>
<th>Dark current $\text{VR}=100$ V max. (nA)</th>
<th>Rise time $\lambda=1060$ nm $\text{VR}=100$ V, $\text{RL}=50$ Ω (ns)</th>
<th>Package</th>
<th>Photo</th>
</tr>
</thead>
<tbody>
<tr>
<td>S3759</td>
<td>ϕ5</td>
<td>360 to 1120</td>
<td>980</td>
<td>0.38</td>
<td>10</td>
<td>12.5</td>
<td>TO-8</td>
<td></td>
</tr>
</tbody>
</table>

**Spectral response**

![Spectral response graph]

**Response waveform**

![Response waveform graph]

Note: Different types compatible with wavelengths other than the 1060 nm center wavelength are also available (made-to-order product).
### Infrared sensitivity enhanced type

These are Si PIN photodiodes that offer enhanced near-infrared sensitivity due to a MEMS structure formed on the back side of the photodiode. (Typ. Ta=25°C)

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Photosensitive area size (mm)</th>
<th>Spectral response range (nm)</th>
<th>Photosensitivity λ=1080 nm (A/W)</th>
<th>Dark current max. (nA)</th>
<th>Terminal capacitance f=1 MHz (pF)</th>
<th>Package</th>
<th>Photo</th>
</tr>
</thead>
<tbody>
<tr>
<td>S11499</td>
<td>φ3</td>
<td>360 to 1140</td>
<td>0.6</td>
<td>5 (VR=20 V)</td>
<td>13 (VR=20 V)</td>
<td>TO-5</td>
<td><img src="image1.png" alt="Image" /></td>
</tr>
<tr>
<td>S11499-01</td>
<td>φ5</td>
<td></td>
<td>0.6</td>
<td>10 (VR=20 V)</td>
<td>33 (VR=20 V)</td>
<td>TO-8</td>
<td><img src="image2.png" alt="Image" /></td>
</tr>
<tr>
<td>S12028</td>
<td>φ1.2</td>
<td></td>
<td>0.5</td>
<td>2 (VR=10 V)</td>
<td>4 (VR=10 V)</td>
<td>TO-18</td>
<td><img src="image3.png" alt="Image" /></td>
</tr>
</tbody>
</table>

#### Spectral response

![Graph](image4.png)  

#### For electron beam detector

These photodiodes directly detect low energy (1 keV or more) electron beams with high sensitivity. The structure with an extremely thin dead layer (insensitive layer) makes these photodiodes ideal for backscattered electron detector for Scanning Electron Microscope (SEM). (Typ. Ta=25°C)

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Incident electron energy range (keV)</th>
<th>Output current (nA)</th>
<th>Dark current Vr=5 V max. (nA)</th>
<th>Terminal capacitance Vr=5 V (pF)</th>
<th>Cutoff frequency Vr=5 V (MHz)</th>
<th>Electron multiplying gain</th>
<th>Package</th>
<th>Photo</th>
</tr>
</thead>
<tbody>
<tr>
<td>S11141-10</td>
<td>1 to 30</td>
<td>30</td>
<td>60</td>
<td>450</td>
<td>2.5</td>
<td>300</td>
<td>Thin ceramic (unsealed)</td>
<td><img src="image5.png" alt="Image" /></td>
</tr>
<tr>
<td>S11142-10</td>
<td>1.5 keV</td>
<td>1.5</td>
<td>100</td>
<td>5</td>
<td>5</td>
<td>1.5 keV</td>
<td><img src="image6.png" alt="Image" /></td>
<td></td>
</tr>
</tbody>
</table>

*2: Probe current

#### Gain vs. electron energy

![Graph](image7.png)

#### Electron multiplication principle

Electrons generate ions as they pass through silicon. This ionization process generates a large number of electron-hole pairs that then multiply the number of electrons. The electron multiplication can boost the output current by approximately 300 times at an input electron energy of 1.5 keV (refer to "Gain vs. electron energy").

![Diagram](image8.png)
**CSP type**

These are back-illuminated photodiodes employing a CSP (chip size package) that allows direct coupling of a scintillator on the chip. It is designed with minimal dead space around the product. This makes it possible to arrange multiple products side by side. (Typ. Ta=25 °C)

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Photosensitive area size (mm)</th>
<th>Spectral response range (nm)</th>
<th>Peak sensitivity wavelength (nm)</th>
<th>Photodetector sensitivity λ=920 nm (A/W)</th>
<th>Short circuit current 100 lx, 2856 K (µA)</th>
<th>Terminal capacitance Vh=0 V, f=10 kHz (pF)</th>
<th>Package</th>
<th>Photo</th>
</tr>
</thead>
<tbody>
<tr>
<td>S13955-01</td>
<td>7.37 × 7.37</td>
<td>400 to 1100</td>
<td>960</td>
<td>0.61</td>
<td>46</td>
<td>500</td>
<td>PWB (unsealed)</td>
<td></td>
</tr>
<tr>
<td>S13956-01</td>
<td>2.5 × 2.5</td>
<td>400 to 1100</td>
<td>960</td>
<td>0.61</td>
<td>5.5</td>
<td>60</td>
<td>PWB (unsealed)</td>
<td></td>
</tr>
<tr>
<td>S13957-01</td>
<td>4.5 × 4.5</td>
<td></td>
<td></td>
<td></td>
<td>22</td>
<td>230</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**CSP type 64-element Si photodiode array**

This is an 8 × 8 element Si photodiode array with a back-illuminated type structure for X-ray non-destructive inspection. A scintillator can be directly coupled on the chip. It is designed with minimal dead space around the product. This makes it possible to arrange multiple products side by side. Moreover, there is no crosstalk between channels. (Typ. Ta=25 °C)

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Number of elements</th>
<th>Element pitch (mm)</th>
<th>Element size W × H (mm)</th>
<th>Spectral response range (nm)</th>
<th>Peak sensitivity wavelength (nm)</th>
<th>Photodetector sensitivity λ=920 nm (A/W)</th>
<th>Short circuit current 100 lx, 2856 K (µA)</th>
<th>Terminal capacitance Vh=0 V, f=10 kHz (pF)</th>
<th>Package</th>
<th>Photo</th>
</tr>
</thead>
<tbody>
<tr>
<td>S13620-02</td>
<td>64 (8 × 8)</td>
<td>3.0</td>
<td>2.5 × 2.5</td>
<td>400 to 1100</td>
<td>960</td>
<td>0.61</td>
<td>5.5</td>
<td>60</td>
<td>PWB</td>
<td></td>
</tr>
</tbody>
</table>

**PWB package with leads type**

The S12497 and S12498 are Si photodiodes suitable for non-destructive inspection of baggage and the like and general industrial measurement. As they are back-illuminated photodiodes, photosensitive area does not have wires, and therefore a scintillator can be mounted directly on the photodiode. (Typ. Ta=25 °C)

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Photosensitive area (mm)</th>
<th>Spectral response range (nm)</th>
<th>Peak sensitivity wavelength (nm)</th>
<th>Photodetector sensitivity λ=920 nm (A/W)</th>
<th>Short circuit current 100 lx, 2856 K (µA)</th>
<th>Terminal capacitance Vh=0 V, f=10 kHz (pF)</th>
<th>Photo</th>
</tr>
</thead>
<tbody>
<tr>
<td>S12497</td>
<td>9.5 × 9.5</td>
<td>400 to 1100</td>
<td>920</td>
<td>0.57</td>
<td>75</td>
<td>950</td>
<td></td>
</tr>
<tr>
<td>S12498</td>
<td>6 × 6</td>
<td></td>
<td></td>
<td></td>
<td>30</td>
<td>380</td>
<td></td>
</tr>
</tbody>
</table>

**Spectral response**

[S12497, S12498] (Typ. Ta=25 °C)

[S13955-01, S13956-01, S13957-01, S13620-02] (Typ. Ta=25 °C)
RGB color sensor modules

For TFT-LCD monitor

- RGB-LED backlight monitor for TFT-LCD (liquid crystal display)

Features

- Built-in RGB color sensor (S9032-02)
  - Sensitivity matches wavelengths of RGB-LED backlight for TFT-LCD.
- 3 ch current-to-voltage amplifiers
  - Simultaneous output of 3 ch RGB photocurrent
- Configuration and size suitable for side mounting to TFT-LCD
- Low current consumption: 0.4 mA typ.
  (1/3 than the conventional type)
- High gain type (C9303-04)

Applications

- RGB-LED backlight monitor for TFT-LCD

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Photosensitivity (V/mW)</th>
<th>Cutoff frequency (kHz)</th>
<th>Supply voltage (V)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Λp=620 nm</td>
<td>Λp=540 nm</td>
<td>Λp=460 nm</td>
</tr>
<tr>
<td>C9303-03</td>
<td>-14</td>
<td>-20</td>
<td>-18</td>
</tr>
<tr>
<td>C9303-04</td>
<td>-108</td>
<td>-156</td>
<td>-122</td>
</tr>
</tbody>
</table>

Simple color measurement

- Numerically converts RGB color information and outputs data for PCs

Features

- Measures object color information as a reflective type*
- Measures small areas using an objective optical fiber
- 12-bit digital output
- Serial connection (RS-232C) with PC
- Teaching function
- Sample software included

Applications

- Color monitoring and simple detection of color difference of opaque body (painting, printing, cosmetics, etc.)
- Teaching material for simple color measurements

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Light source</th>
<th>Photosensor</th>
<th>Measurement and output cycle (ms)</th>
<th>Supply voltage (V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>C9315</td>
<td>White LED</td>
<td>Si photodiode</td>
<td>200</td>
<td>AC adapter (+12)</td>
</tr>
</tbody>
</table>

* Does not conform to CIE (International Commission on Illumination) standards

Color sensor evaluation circuit

- Color sensor evaluation circuit board

Features

- 3 ch current-to-voltage conversion amplifier for color sensor evaluation
- Color sensors that mount on C9331:
  S7505-01, S9032-02 (sold separately)

Applications

- Evaluation of Hamamatsu color sensor

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Output offset voltage (V/A)</th>
<th>Conversion impedance (V/A)</th>
<th>Cutoff frequency (kHz)</th>
<th>Supply voltage (V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>C9331</td>
<td>±40</td>
<td>±50</td>
<td>1 x 10⁹ to 5.1 x 10⁹</td>
<td>+7 to +15</td>
</tr>
</tbody>
</table>

(Typ. Ta=25 °C, Vcc=9.0 V, common to each RGB channel)
Driver circuit for Si photodiode array

**Features**

- High precision and high-speed measurement by simultaneous 16-channel readout
- Assembled with pulse generator (8-step adjustable oscillatory frequency)
- CLK, START, A/D conversion Trig and EOS pulse output
- Choice of gain (conversion impedance): $1 \times 10^6$ V/A or $1 \times 10^7$ V/A
- Accessory AC adapter (+12 V) operation

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Applicable sensor</th>
</tr>
</thead>
<tbody>
<tr>
<td>C9004</td>
<td>Hamamatsu S4111-16 series, S11212 series photodiode arrays are directly mountable on board.</td>
</tr>
</tbody>
</table>

Photodiode modules

**Integrates a Si photodiode for precision photometry with low-noise amplifier.**

The C10439 series is a high-precision photodetector that combines a photodiode and current-to-voltage conversion amplifier.

**Features**

- Easy handling
  - The output from these photodiode modules is an analog voltage and can be checked with a voltmeter, etc.
- Two switchable photosensitivity ranges
  - High accuracy output can be obtained by selecting a range suitable for the light level to be detected.
- Compact size
  - Half the size of a business card (C10439-15: business card size) Can be mounted directly on optical bench rod (M4).

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Photosensitive area size (mm)</th>
<th>Peak sensitivity wavelength (nm)</th>
<th>Photosensitivity $\lambda=\lambda_p$ (mV/nW)</th>
<th>Conversion impedance (V/A)</th>
<th>Cutoff frequency -3 dB (Hz)</th>
<th>Supply voltage (V)</th>
<th>Dimensions W × D × H (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>C10439-01</td>
<td>Si 2.4 × 2.4</td>
<td>960</td>
<td>H: 500</td>
<td>L: 10^6</td>
<td>H: 10^10</td>
<td>C10475 Conforms to RS-232C (16-bit)</td>
<td>19 × 46 × 52</td>
</tr>
<tr>
<td>C10439-02</td>
<td>5.8 × 5.8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C10439-03</td>
<td>10 × 10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C10439-07</td>
<td>2.4 × 2.4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C10439-08</td>
<td>5.8 × 5.8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C10439-09</td>
<td>10 × 10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C10439-10</td>
<td>InGaAs 1550</td>
<td></td>
<td>H: 1</td>
<td>L: 10^4</td>
<td>H: 10^6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C10439-11</td>
<td>$\phi^1$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C10439-12</td>
<td>$\phi^3$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C10439-14</td>
<td>InAsSb 2300</td>
<td></td>
<td>H: 0.045</td>
<td>L: 0.0045*2</td>
<td>H: 10^7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C10439-15</td>
<td>2.4 × 2.4</td>
<td></td>
<td>H: 0.45</td>
<td>L: 0.045</td>
<td>H: 10^6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C10439-16</td>
<td>InGaAs 2900</td>
<td></td>
<td>H: 0.6</td>
<td>L: 0.06</td>
<td>H: 10^6</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*1: Output amplitude: 2 Vp-p  *2: Uniform irradiation on the entire photosensitive area

Signal processing unit for photodiode module

**Unit dedicated for photodiode module (C10439 series)**

The C10475 converts the output from a photodiode module (C10439 series) into digital signals. Also supplies power to the photodiode module.

**Features**

- High-resolution digital output (16-bit)
- Data logger function

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Digital output</th>
<th>Minimum measurement time interval (ms)</th>
<th>Supply voltage (V)</th>
<th>Dimensions W × D × H (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>C10475</td>
<td>Conforms to RS-232C (16-bit)</td>
<td>50</td>
<td>AC adapter (+12) or battery (+9)</td>
<td>110 × 100 × 30</td>
</tr>
</tbody>
</table>

Note: RS-232C cable is optional.
### Photosensor amplifier

#### For low-light-level detection
- Digital output function, current-to-voltage conversion amplifier for amplifying very slight photocurrent with low noise

**Features**
- Three sensitivity ranges
- Selectable operation modes (analog output / digital output)
- Serial connection (RS-232C) with PC
- Data logger function, low battery function

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Range</th>
<th>Conversion impedance (V/A)</th>
<th>Cutoff frequency -3 dB (Hz)</th>
<th>Power supply (V)</th>
<th>Dimensions W × D × H (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>C9329</td>
<td>H</td>
<td>$10^9$</td>
<td>16</td>
<td>AC adapter (+12) or battery (+9)</td>
<td>115 × 90 × 40</td>
</tr>
<tr>
<td></td>
<td>M</td>
<td>$10^7$</td>
<td>1600</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>L</td>
<td>$10^5$</td>
<td>1600</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### With optical fiber
- Light-to-voltage conversion amplifier with optical fiber

**Features**
- Easy handling
  - Built-in photodiode allows easy detection of light just by connecting to a voltmeter, etc.
- Optical fiber light input
  - Measures light at a narrow detection point. Separating the amplifier from the detection point allows measurement in unusual environments and achieves low noise.
- Three sensitivity ranges

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Range</th>
<th>Photosensitivity $\lambda=830$ nm (mV/µW)</th>
<th>Conversion impedance (V/A)</th>
<th>Cutoff frequency -3 dB (MHz)</th>
<th>Power supply (V)</th>
<th>Dimensions W × D × H (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>C6386-01</td>
<td>H</td>
<td>30</td>
<td>$10^5$</td>
<td>1</td>
<td>External power supply (+15) or batteries (+9) × 2</td>
<td>115 × 90 × 40</td>
</tr>
<tr>
<td></td>
<td>M</td>
<td>3</td>
<td>$10^4$</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>L</td>
<td>0.3</td>
<td>$10^3$</td>
<td>10</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### High-speed type
- Current-to-voltage conversion amplifier

**Features**
- C8366: for high speed Si PIN photodiode
- C8366-01: for high speed InGaAs photodiode
- Wide bandwidth: DC to 100 MHz typ. (-3 dB; varied by the photodiode used)
- Just inserting the photodiode leads makes the connection.
  - (Compatible with TO-8, TO-5 and TO-18 packages)
- Adjustable response speed
  - Response speed can be adjusted by a trimmer potentiometer easily.
- Compact size

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Conversion impedance (V/A)</th>
<th>Cutoff frequency -3 dB (MHz)</th>
<th>Power supply (V)</th>
<th>Dimensions W × D × H (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>C8366</td>
<td>$10^3$</td>
<td>100</td>
<td>External power supply (+15)</td>
<td>19 × 52 × 46</td>
</tr>
<tr>
<td>C8366-01</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Compact board type

- Current-to-voltage conversion amplifier for low-level-light

**Features**
- Compact board type for easy assembly
- Usable with photodiodes having large terminal capacitance
- Conversion impedance: $10^8$ V/A

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Conversion impedance (V/A)</th>
<th>Cutoff frequency -3 dB (Hz)</th>
<th>Power supply (V)</th>
<th>Dimensions W × D × H (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>C9051</td>
<td>$10^8$</td>
<td>16</td>
<td>AC adapter (+12)</td>
<td>50 × 50 × 19</td>
</tr>
</tbody>
</table>

Charge amplifier

- For radiation and high energy particle detection

The H4083 is a low-noise hybrid charge amplifier designed for a wide range of spectrometric applications including soft X-ray and low to high energy gamma-ray spectrometry. The first stage of this amplifier uses a low-noise junction type FET, which exhibits excellent performance when used with a photodiode having a large junction capacitance. The H4083 is especially suited for use with Hamamatsu S3590/S3204 series, etc. Si PIN photodiodes. S3590 series photodiodes can be directly mounted on the backside of the H4083, so there will be no increase in stray capacitance.

**Features**
- Low noise
- Compact and lightweight
- Easy handling

**Applications**
- Detection of X-rays, radiation, high energy particles

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Amplification method</th>
<th>Input/output polarity</th>
<th>Charge gain</th>
<th>Noise characteristic ($e^-$/FWHM)</th>
<th>Negative feedback constant</th>
<th>Power supply (V)</th>
<th>Current consumption (mW)</th>
<th>Dimensions W × D × H (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>H4083</td>
<td>Charge-sensitive type</td>
<td>Inverted</td>
<td>0.5 V/pC</td>
<td>22 mV/MeV (Si)</td>
<td>550</td>
<td>±12</td>
<td>150</td>
<td>24 × 19 × 4</td>
</tr>
</tbody>
</table>

(Typ. Ta=25 °C)
**Spectral response**

The photocurrent produced by a given level of incident light varies with the wavelength. This relation between the photoelectric sensitivity and wavelength is referred to as the spectral response characteristic and is expressed in terms of photosensitivity or quantum efficiency.

**Photosensitivity: **$S$

This measure of sensitivity is the ratio of photocurrent expressed in amperes (A)—or output voltage expressed in volts (V)—to the incident light expressed in watts (W). It may be represented as either an absolute sensitivity (A/W or VW unit) or as a relative sensitivity normalized for the sensitivity at the peak wavelength, usually expressed in percent (%) with respect to the peak value. At Hamamatsu, we usually use absolute sensitivity to express photosensitivity, and the spectral response range is defined as the region in which the relative sensitivity is higher than 5% or 10% of the peak value.

**Quantum efficiency: **$QE$

The quantum efficiency is the number of electrons or holes that can be detected as a photocurrent, divided by the number of incident photons. This is commonly expressed in percent (%). The quantum efficiency and photo sensitivity $S$ have the following relationship at a given wavelength (nm):  

$$QE = \frac{S \times 1240}{\lambda} \times 100\ [%]$$

**Short circuit current: **$I_{sc}$

The output current that flows through the photodiode when the load resistance is 0. This is often called “white light sensitivity” with regards to the spectral response, and a tungsten lamp of 2856 K distribution temperature (color temperature) is used for the light source. At Hamamatsu, we indicate the short circuit current at 100 lx illuminance in the table of characteristics in our catalogues.

**Open circuit voltage: **$V_{oc}$

The open circuit voltage is a photovoltaic voltage generated when the load resistance is infinite. The open circuit voltage depends on the light level, but for light levels higher than extremely low levels, it is nearly constant.

**Dark current: **$I_{d}$

The dark current is a small current which flows when a reverse voltage is applied to a photodiode even in dark state. This is a major source of noise for cases in which a reverse voltage is applied to photodiodes (PIN photodiode, etc.).

**Shunt resistance: **$R_{sh}$

The voltage-to-current ratio in the vicinity of 0 V in photodiodes. The shunt resistance is defined as follows: Where $I_{d}$ is the dark current at $V_R=10$ mV.

$$R_{sh} [\Omega] = \frac{0.01 [\text{V}]}{I_{d} [\text{A}]}$$

For applications where no reverse voltage is applied, noise resulting from the shunt resistance becomes predominant.

**Terminal capacitance: **$C_t$

An effective capacitor is formed at the PN junction of a photodiode. Its capacitance is termed the junction capacitance and is one of parameters that determine the response speed of the photodiode. And it probably causes a phenomenon of gain peaking in I/V converter using operational amplifier. In Hamamatsu, the terminal capacitance including this junction capacitance plus package stray capacitance is listed.

**Rise time: **$t_r$

This is the measure of the time response of a photodiode to a stepped light input, and is defined as the time required for the output to change from 10% to 90% of the maximum light level (steady output level).

**Cutoff frequency: **$f_c$

The frequency at which the photodiode output decreases by 3 dB from the output in the frequency region where the output is constant. The rise time ($t_r$) has a relation with the cut-off frequency ($f_c$) as follows:

$$t_r [\text{s}] = 0.35 \frac{f_c [\text{Hz}]}{[\text{s}]}$$

**NEP (noise equivalent power)**

The NEP is the amount of light equivalent to the noise level of a device. It is the light level required to obtain a signal-to-noise ratio of unity. Our data sheets show the NEP values measured at the peak wavelength $\lambda_p$. Since the noise level is proportional to the square root of the frequency bandwidth, the NEP is measured at a bandwidth of 1 Hz.

$$\text{NEP} [\text{W/Hz}^{1/2}] = \frac{\text{Noise current} [\text{A/Hz}^{1/2}]}{\text{Photosensitivity} [\text{A/W}] \text{ at } \lambda_p}$$

**Maximum reverse voltage: **$V_{R\ max}$

Applying a reverse voltage to a photodiode triggers a breakdown at a certain voltage and causes severe deterioration of the device performance. Therefore the absolute maximum rating is specified for reverse voltage at the voltage somewhat lower than this breakdown voltage. The reverse voltage shall not exceed the maximum rating, even instantaneously.

---

**Reference (Physical constants related to light and opto-semiconductors)**

<table>
<thead>
<tr>
<th>Constant</th>
<th>Symbol</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electron charge</td>
<td>$q$</td>
<td>$1.602 \times 10^{-19}$</td>
<td>C</td>
</tr>
<tr>
<td>Speed of light in vacuum</td>
<td>$c$</td>
<td>$2.998 \times 10^8$</td>
<td>m/s</td>
</tr>
<tr>
<td>Planck’s constant</td>
<td>$h$</td>
<td>$6.626 \times 10^{-34}$</td>
<td>J · s</td>
</tr>
<tr>
<td>Boltzmann’s constant</td>
<td>$k$</td>
<td>$1.381 \times 10^{-23}$</td>
<td>J/K</td>
</tr>
<tr>
<td>Thermal energy at room temperature</td>
<td>$kT$</td>
<td>$0.0259$ (300 K)</td>
<td>eV</td>
</tr>
<tr>
<td>Energy of 1 eV</td>
<td>$eV$</td>
<td>$1.602 \times 10^{-19}$</td>
<td>J</td>
</tr>
<tr>
<td>Wavelength equivalent to 1 eV in vacuum</td>
<td>—</td>
<td>$1240$</td>
<td>nm</td>
</tr>
<tr>
<td>Permittivity of vacuum</td>
<td>$\varepsilon_0$</td>
<td>$8.854 \times 10^{-12}$</td>
<td>F/m</td>
</tr>
<tr>
<td>Relative permittivity of silicon</td>
<td>$\varepsilon_i$</td>
<td>Approx. 12</td>
<td>—</td>
</tr>
<tr>
<td>Relative permittivity of silicon oxide film</td>
<td>$\varepsilon_{ox}$</td>
<td>Approx. 4</td>
<td>—</td>
</tr>
<tr>
<td>Band gap energy of silicon</td>
<td>$E_g$</td>
<td>Approx. 1.12 (25 °C)</td>
<td>eV</td>
</tr>
</tbody>
</table>
When UV light irradiation is applied, the product characteristics may degrade. Such examples include degradation of the product’s UV sensitivity and increase in dark current. This phenomenon varies depending on the irradiation level, irradiation intensity, usage time, and ambient environment and also varies depending on the product model. Before employing the product, we recommend that you check the tolerance under the ultraviolet light environment that the product will be used in.

Exposure to UV light may cause the characteristics to degrade due to gas released from the resin bonding the product’s component materials. As such, we recommend that you avoid applying UV light directly on the resin and apply it on only the inside of the photosensitive area by using an aperture or the like.

Related information

www.hamamatsu.com/sp/ssd/doc_en.html

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