PSD (position sensitive detector)

- Surface mount type
  one-dimensional PSD
  S14241

- Two-dimensional PSD
  S2044

- PSD module
  C10443-02
PSD (position sensitive detector)
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Various methods are available for detecting the position of incident light, including methods using an array of many small detectors and a multi-element detector (e.g., image sensor). In contrast to these, the PSD is a monolithic device designed to detect the position of incident light. Since the PSD is a non-segmented photosensor that makes use of the surface resistance of the photodiode, it provides continuous electrical signals and offers excellent position resolution, fast response, and high reliability. Hamamatsu PSDs are fabricated using our unique semiconductor process technology and have the following features:

- Excellent position resolution
- Wide spectral response range
- High-speed response
- Simultaneously detection light level and center-of-gravity position of light spot
- High reliability

The PSD is used in a wide range of fields such as measurements of position, angles, distortion, vibration, and lens reflection/refraction. Applications also include precision measurement such as laser displacement meters, as well as optical remote control devices, distance sensors, and optical switches.

**Schematic of PSD cross section**

![Schematic of PSD cross section](image)

- Conversion formula for light spot incident position

\[
\frac{I_{X2} - I_{X1}}{I_{X1} + I_{X2}} = \frac{2x}{L_x}
\]

**Principle of triangulation**

With the optical system shown in the figure on the right, the distance between the light receiving position of the PSD and the object is related to the following equation from the principle of triangulation. This allows obtaining the distance from the PSD output value.

\[
L = B \times \frac{f}{d}
\]

- \(L\): distance to the object
- \(B\): distance between lens optical axes
- \(f\): distance between lens and PSD
- \(d\): PSD light receiving position

**Application examples**

- **Auto-focus**: The PSD measures the distance to the screen to autofocus the image.
- **Obstacle detection**: The PSD measures distance to avoid obstacles.
### One-dimensional PSD

These PSDs have a belt-like photosensitive area and detect the position along the longer direction.

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Photosensitive area (mm)</th>
<th>Resistance length (mm)</th>
<th>Inter electrode resistance $V_b=0.1\text{ V}$ (kΩ)</th>
<th>Spectral response range (nm)</th>
<th>Package</th>
<th>Photo</th>
</tr>
</thead>
<tbody>
<tr>
<td>S4583-04</td>
<td>1 x 3</td>
<td>3</td>
<td>140</td>
<td>760 to 1100</td>
<td>Plastic</td>
<td></td>
</tr>
<tr>
<td>S4584-04</td>
<td>1 x 3.5</td>
<td>3.5</td>
<td>140</td>
<td>760 to 1100</td>
<td>Plastic</td>
<td></td>
</tr>
<tr>
<td>S4584-06</td>
<td>1 x 3.5</td>
<td>3.5</td>
<td>140</td>
<td>320 to 1100</td>
<td>Plastic</td>
<td></td>
</tr>
<tr>
<td>S3274-05</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S7105-04</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Plastic</td>
<td></td>
</tr>
<tr>
<td>S7105-06</td>
<td>1 x 4.2</td>
<td>4.2</td>
<td>140</td>
<td>320 to 1100</td>
<td>Plastic</td>
<td></td>
</tr>
<tr>
<td>S7105-16</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Glass epoxy</td>
<td></td>
</tr>
<tr>
<td>S7105-05</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Plastic</td>
<td></td>
</tr>
<tr>
<td>S15430-01CT</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S15430-02CT</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Glass epoxy</td>
<td></td>
</tr>
<tr>
<td>S15430-03CT</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S3931</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Ceramic</td>
<td></td>
</tr>
<tr>
<td>S3932</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Ceramic</td>
<td></td>
</tr>
<tr>
<td>S14241</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Glass epoxy</td>
<td></td>
</tr>
<tr>
<td>S8543</td>
<td>0.7 x 24</td>
<td>24</td>
<td>140</td>
<td>320 to 1100</td>
<td>Ceramic</td>
<td></td>
</tr>
</tbody>
</table>
Two-dimensional PSD

These PSDs detect two-dimensional positions.

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Photosensitive area (mm)</th>
<th>Resistance length (mm)</th>
<th>Interelectrode resistance $V_b=0.1\ V$ (kΩ)</th>
<th>Spectral response range (nm)</th>
<th>Package</th>
<th>Photo</th>
</tr>
</thead>
<tbody>
<tr>
<td>S2044*</td>
<td>4.7 × 4.7</td>
<td>5.7</td>
<td>10</td>
<td>320 to 1060</td>
<td>Metal</td>
<td>[Image]</td>
</tr>
<tr>
<td>S5990-01</td>
<td>4 × 4</td>
<td>4.5</td>
<td>7</td>
<td>320 to 1100</td>
<td>Ceramic chip carrier</td>
<td>[Image]</td>
</tr>
<tr>
<td>S5991-01</td>
<td>9 × 9</td>
<td>10</td>
<td></td>
<td></td>
<td></td>
<td>[Image]</td>
</tr>
</tbody>
</table>

*1: Corresponds to small spot light

Examples of position detectability

[Ta=25 °C, $\lambda=900\ nm$ (S2044), $\lambda=830\ nm$ (S5990-01, S5991-01), light spot size: $\phi 0.2\ mm$]

[ S2044 ]

Line interval: 0.5 mm

[ S5990-01 ]

Line interval: 0.4 mm

[ S5991-01 ]

Line interval: 1 mm
Applied products of PSD

PSD signal processing circuits

DC type

These are signal processing circuits for DC light detection.

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Compatible PSD</th>
<th>Output</th>
<th>Dimensions (mm)</th>
<th>Photo</th>
</tr>
</thead>
<tbody>
<tr>
<td>C3683-02</td>
<td>One-dimensional PSD</td>
<td>Analog</td>
<td>66 × 56 × 15</td>
<td></td>
</tr>
<tr>
<td>C9068</td>
<td></td>
<td>Digital (RS-232C)</td>
<td>110 × 75 × 15</td>
<td></td>
</tr>
<tr>
<td>C4674-01</td>
<td>Two-dimensional PSD</td>
<td>Analog</td>
<td>90 × 65 × 15</td>
<td></td>
</tr>
<tr>
<td>C9069</td>
<td></td>
<td>Digital (RS-232C)</td>
<td>110 × 75 × 15</td>
<td></td>
</tr>
</tbody>
</table>

PSD modules

The high-precision analog output position detectors combine a PSD for precision photometry with a low-noise amplifier.

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Built-in PSD</th>
<th>Photosensitive area (mm)</th>
<th>Peak sensitivity wavelength (nm)</th>
<th>Photosensitivity$^1$ (mV/µW)</th>
<th>Output noise voltage $V_n$ Dark state (mVp-p)</th>
<th>Cutoff frequency $f_c$ -3 dB (kHz)</th>
<th>Photo</th>
</tr>
</thead>
<tbody>
<tr>
<td>C10443-01</td>
<td>Two-dimensional PSD</td>
<td>4 × 4</td>
<td>960</td>
<td>-60</td>
<td>1</td>
<td>DC 16</td>
<td></td>
</tr>
<tr>
<td>C10443-02</td>
<td></td>
<td>9 × 9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

$^1$: $\lambda = \lambda_p$

Signal processing unit for PSD module

The product converts the output of the PSD module into position signals and outputs in analog and digital form.

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Compatible PSD module</th>
<th>Analog output (V)</th>
<th>Digital output</th>
<th>Minimum measurement time interval (ms)</th>
<th>Dimensions (mm)</th>
<th>Photo</th>
</tr>
</thead>
<tbody>
<tr>
<td>C10460</td>
<td>C10443-01/-02</td>
<td>-10 to +10</td>
<td>Conforms to RS-232C (16-bit)</td>
<td>2</td>
<td>150 × 30 × 100</td>
<td></td>
</tr>
</tbody>
</table>
Main Products

Opto-semiconductors
- Si photodiodes
- APD
- MPCC
- Photo IC
- Image sensors
- PSD
- Infrared detectors
- LED
- Optical communication devices
- Automotive devices
- X-ray flat panel sensors
- MEMS devices
- Mini-spectrometers
- Opto-semiconductor modules

Electron Tubes
- Photomultiplier tubes
- Photomultiplier tube modules
- Microchannel plates
- Image intensifiers
- Xenon lamps / Mercury-xenon lamps
- Deuterium lamps
- Light source applied products
- Laser applied products
- Microfocus X-ray sources
- X-ray imaging devices

Imaging and Processing Systems
- Scientific cameras
- Spectroscopic and optical measurement systems
- Ultrafast photometry systems
- Life science systems
- Medical systems
- Non-destructive inspection products
- Semiconductor manufacturing support systems
- Material research systems

Laser Products
- Single chip laser diodes
- Laser diode bar modules
- Quantum cascade lasers
- Applied products of semiconductor lasers
- Solid state lasers
- Laser related products

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