Non-discrete position sensors utilizing photodiode surface resistance

PSD (position sensitive detector) is an optoelectronic position sensor utilizing photodiode surface resistance. Unlike discrete element detectors such as CCD, PSD provides continuous position data and features high position resolution and high-speed response.

Features

- High position resolution
- Wide spectral response range
- High-speed response
- Simultaneous measurements of position and intensity
- Position is measured independent of light spot size.
- High reliability

Applications

- Optical position and angle sensing
- Remote optical control systems
- Automatic range finder systems
- Displacement and vibration monitors
- Laser beam alignment
- Medical equipment

Structure / Absolute maximum ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>S1880</th>
<th>S2044</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Package</td>
<td>-</td>
<td>Ceramic</td>
<td>Metal</td>
<td>-</td>
</tr>
<tr>
<td>Photosensitive area size</td>
<td>-</td>
<td>12 × 12</td>
<td>4.7 × 4.7</td>
<td>mm</td>
</tr>
<tr>
<td>Reverse voltage</td>
<td>Vt max</td>
<td>20</td>
<td>-</td>
<td>V</td>
</tr>
<tr>
<td>Operating temperature</td>
<td>Topr</td>
<td>-10 to +60</td>
<td>-</td>
<td>°C</td>
</tr>
<tr>
<td>Storage temperature</td>
<td>Tstg</td>
<td>-20 to +80</td>
<td>-</td>
<td>°C</td>
</tr>
</tbody>
</table>

Note: Exceeding the absolute maximum ratings even momentarily may cause a drop in product quality. Always be sure to use the product within the absolute maximum ratings.
## Electrical and optical characteristics (Ta=25 °C unless otherwise noted)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Condition</th>
<th>S1880</th>
<th>S2044</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spectral response range</td>
<td>$\lambda$</td>
<td></td>
<td>Min.</td>
<td>Typ.</td>
<td>Max.</td>
</tr>
<tr>
<td>Peak sensitivity wavelength</td>
<td>$\lambda_p$</td>
<td></td>
<td>-</td>
<td>320 to 1060</td>
<td>-</td>
</tr>
<tr>
<td>Photosensitivity</td>
<td>$S$</td>
<td>$\lambda=\lambda_p$</td>
<td>-</td>
<td>920</td>
<td>-</td>
</tr>
<tr>
<td>Interelectrode resistance*1</td>
<td>$R_{ie}$</td>
<td>$V_b=0.1$ V</td>
<td>5</td>
<td>10</td>
<td>15</td>
</tr>
<tr>
<td>Position detection error*2</td>
<td>$E$</td>
<td></td>
<td>-</td>
<td>$\pm80$</td>
<td>$\pm150$</td>
</tr>
<tr>
<td>Saturation current</td>
<td>$I_{st}$</td>
<td>$V_a=5$ V, $R_L=1$ k$\Omega$</td>
<td>-</td>
<td>0.5</td>
<td>-</td>
</tr>
<tr>
<td>Dark current</td>
<td>$I_D$</td>
<td>$V_a=5$ V</td>
<td>-</td>
<td>1.0</td>
<td>500</td>
</tr>
<tr>
<td>Temperature coefficient of $I_D$</td>
<td>$T_{CID}$</td>
<td></td>
<td>-</td>
<td>1.15</td>
<td>-</td>
</tr>
<tr>
<td>Rise time</td>
<td>$T_r$</td>
<td>$V_a=5$ V, $R_L=1$ k$\Omega$</td>
<td>-</td>
<td>1.5</td>
<td>-</td>
</tr>
<tr>
<td>Terminal capacitance</td>
<td>$C_T$</td>
<td>$f=10$ kHz</td>
<td>-</td>
<td>300</td>
<td>-</td>
</tr>
<tr>
<td>Position resolution*3</td>
<td></td>
<td></td>
<td>-</td>
<td>1.5</td>
<td>-</td>
</tr>
</tbody>
</table>

*1: Measured between two output terminals opposite to each other, and the other terminals are open-circuited on measurement.  
*2: The radius of Zones A and B depend on the product type. They are determined as follows:

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Zone A (mm)</th>
<th>Zone B (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1880</td>
<td>2.5</td>
<td>5</td>
</tr>
<tr>
<td>S2044</td>
<td>0.9</td>
<td>4 x 4 (quadrate)</td>
</tr>
</tbody>
</table>

*3: Position resolution  
This is the minimum detectable light spot displacement. The detection limit is indicated by distance on the photosensitive surface. The numerical value of the resolution of a position sensor using a PSD is proportional to both the length of the PSD and the noise of the measuring system (resolution deteriorates) and inversely proportional to the photocurrent (incident energy) of the PSD (resolution improves).  
- Light source: LED (900 nm)  
- Light spot size: $\phi$200 $\mu$m  
- Frequency range: 1 kHz  
- Photocurrent: 1 $\mu$A  
- Circuit system input noise: 1 $\mu$V (1 kHz)  
- Interelectrode resistance: Typical value (Refer to specification table.)

## Spectral response

![Spectral response graph](Typ. Ta=25 °C)  
QE=100%  
QE=50%

## Photosensitivity temperature characteristics

![Photosensitivity temperature characteristics graph](Typ.)  
Temperature coefficient (%/°C)
Terminal capacitance vs. reverse voltage

Examples of position detectability (Ta=25 °C, λ=900 nm, light spot size: φ200 μm)
**Example of DC-operating circuit**

- $R_1 - R_{24}$: same value
- $R_f$: depends on input level
- $U_1 - U_4$: low drift head amplifier, TL071, etc.
- $U_{12}, U_{13}$: analog divider, AD538 (Analog Devices), etc.

**Example of AC-operating circuit**

- $R_1 - R_{25}$: same value
- $R_f$: depends on input level
- $U_1 - U_4$: low drift head amplifier, TL071, etc.
- $U_{12}, U_{13}$: analog divider, AD538 (Analog Devices), etc.
Two-dimensional PSD

S1880, S2044

**Dimensional outlines (unit: mm)**

<table>
<thead>
<tr>
<th>S1880</th>
<th>S2044</th>
</tr>
</thead>
<tbody>
<tr>
<td>Photosensitive area 12 × 12</td>
<td>Photosensitive area 4.7 × 4.7</td>
</tr>
<tr>
<td>Photosensitive surface</td>
<td>Photosensitive surface</td>
</tr>
<tr>
<td>0.7 t glass</td>
<td>0.5 max.</td>
</tr>
<tr>
<td>φ0.75 lead</td>
<td>φ1.2 max.</td>
</tr>
</tbody>
</table>

1. Anode (Y1)
2. Anode (X1)
3. Anode (Y2)
4. Anode (X2)
5. Cathode (common)

**Photosensitive area chart**

- Photosensitive area is specified at the inscribed square.

**Position conversion formula**

\[
\begin{align*}
(Ix2 + Iy2) - (Ix1 + Iy1) &= \frac{2x}{Lx} \\
(Ix2 + Iy2) - (Ix1 + Iy1) &= \frac{2y}{Ly}
\end{align*}
\]

- S1880: Lx=14 mm
- Ly=14 mm
- S2044: Lx=5.7 mm
- Ly=5.7 mm
Two-dimensional PSD

S1880, S2044

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

Precautions
- Disclaimer
- Metal, ceramic, plastic package products
- Surface mount type products

Technical note
- PSD

Information described in this material is current as of December 2017.
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