One-dimensional PSD

Hamamatsu provides various types of one-dimensional PSD (position sensitive detectors) designed for precision distance measurement such as displacement meters. The S3931 and S3932 have a photosensitive area of 1 × 6 mm and 1 × 12 mm respectively, and are mounted on a compact ceramic package with a transparent resin window. Variant types (S3931-01, S3932-01) with a visible-cut resin window are also available.

**Features**
- Superior position detection ability
- High reliability
- S3931, S3932: Easy to use 4-pin small ceramic package

**Applications**
- Displacement sensing
- Distance measurement
- Proximity switching

**Structure / Absolute maximum ratings**

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Package</th>
<th>Window material</th>
<th>Photosensitive area size (mm)</th>
<th>Absolute maximum ratings</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Reverse voltage $V_R$ max (V)</td>
</tr>
<tr>
<td>S3931</td>
<td>Ceramic</td>
<td>Epoxy resin</td>
<td>1 × 6</td>
<td>20</td>
</tr>
<tr>
<td>S3932</td>
<td></td>
<td></td>
<td>1 × 12</td>
<td></td>
</tr>
</tbody>
</table>

$^*$1: No dew condensation
When there is a temperature difference between a product and the surrounding area in high humidity environments, dew condensation may occur on the product surface. Dew condensation on the product may cause deterioration in characteristics and reliability.

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 (Typ. $T_a$=25 °C, unless otherwise noted)**

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Spectral response range $\lambda$ (nm)</th>
<th>Peak sensitivity wavelength $\lambda_p$ (nm)</th>
<th>Photo sensitivity $S$, $\lambda=\lambda_p$ (A/W)</th>
<th>Interelectrode resistance $R_{ie}$ $V_B=0.1$ V</th>
<th>Position detection error $^2$</th>
<th>Saturation photocurrent $^3$ $V_R=5$ V $V_{R}=5$ V $R_L=1$ kΩ</th>
<th>Dark current $I_D$ $V_R=5$ V $R_L=1$ kΩ</th>
<th>Temperature coefficient of $I_D$ $T_{CID}$ (times/°C)</th>
<th>Rise time $t_r$ $V_R=5$ V $R_L=1$ kΩ</th>
<th>Terminal capacitance $C_T$ $V_R=5$ V $f=10$ kHz (pF)</th>
<th>Position resolution $^4$ (µm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>S3931</td>
<td>320 to 1100</td>
<td>920</td>
<td>0.55</td>
<td>30</td>
<td>50</td>
<td>80</td>
<td>100</td>
<td>0.15</td>
<td>1.15</td>
<td>1.5</td>
<td>40</td>
</tr>
<tr>
<td>S3932</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

$^2$: A range of 75% of that from the center of the photosensitive surface to the edge
$^3$: The upper limit of linearity of photocurrent in response to the quantity of light is defined as the point where the linearity deviates by 10%.
$^4$: Position resolution
This is the minimum detectable light spot displacement. The detection limit is indicated by the 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: ϕ200 µm
- Frequency range: 1 kHz
- Photocurrent: 1 µA
- Circuit system input noise: 1 µV (1 kHz)
**Spectral response**

(Typ. Ta=25 °C)

Photosensitivity vs. Wavelength (nm)

**Photosensitivity temperature characteristics**

(Typ.)

Temperature coefficient vs. Wavelength (nm)

**Dark current vs. reverse voltage**

(Typ. Ta=25 °C)

Dark current vs. Reverse voltage (V)

**Terminal capacitance vs. reverse voltage**

(Typ. Ta=25 °C, f=10 kHz)

Terminal capacitance vs. Reverse voltage (V)
Examples of position detectability (Ta=25 °C, λ=900 nm, light spot size: ϕ0.2 mm)

<table>
<thead>
<tr>
<th>S3931</th>
<th>S3932</th>
</tr>
</thead>
</table>

Position on PSD (mm)

Position detection error (µm)

Conversion formula of spot light position on the PSD

If output signals (photocurrent) $I_1$ and $I_2$ are obtained from electrodes $X_1$ and $X_2$, then the light spot position ($x$) on the PSD can be found by the following formula.

\[
\frac{I_2 - I_1}{I_1 + I_2} = \frac{2x}{L}
\]

Correction of position detection error

If the light spot position calculated by the above conversion formula is corrected by the least squares method, position detection error can be reduced.

Example of position detection error correction (S3931)

Before correction: ±120 µm max.

After correction: ±9 µm max.
One-dimensional PSD | S3931, S3932

Dimensional outlines (unit: mm)

S3931

Photosensitive area

9.2 ± 0.2

4.8 ± 0.2

Photosensitive surface

(4 x) 0.4

0.7

X

5.08 ± 0.2

S3932

Photosensitive area

15.2 ± 0.2

4.8 ± 0.2

Photosensitive surface

(4 x) 0.4

0.7

X

5.08 ± 0.2

Recommended soldering condition

Solder temperature: 260 °C (5 s or less, once), Keep at least 2 mm away from the root of the lead

Note: When you set soldering conditions, check that problems do not occur in the product by testing out the conditions in advance.

Related information

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

- Precautions
  - Disclaimer
  - Metal, ceramic, plastic package products

- Technical information
  - PSD

Information described in this material is current as of July 2020.

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