These are 800 nm band near-infrared Si APDs that can operate at low voltages, 200 V or less. They are suitable for applications such as FSO (free space optics) and optical rangefinders.

**Features**
- Stable operation at low bias
- High-speed response
- High sensitivity and low noise

**Applications**
- FSO
- Optical rangefinders

**Structure / Absolute maximum ratings**

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Dimensional outline/Window material*1</th>
<th>Package</th>
<th>Effective photosensitive area size*2 (mm)</th>
<th>Operating temperature Topr (°C)</th>
<th>Storage temperature Tstg (°C)</th>
<th>Soldering conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>S12023-02</td>
<td>(1)/K</td>
<td>TO-18</td>
<td>0.2</td>
<td>-20 to +85</td>
<td>-55 to +125</td>
<td>260 °C or less, within 10 s</td>
</tr>
<tr>
<td>S12023-05</td>
<td>(1)/K</td>
<td></td>
<td>0.5</td>
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</tr>
<tr>
<td>S12051</td>
<td>(2)/L</td>
<td>TO-18</td>
<td>1.0</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>S12086</td>
<td>(3)/L</td>
<td></td>
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<tr>
<td>S12023-10</td>
<td>(1)/K</td>
<td>TO-18</td>
<td>1.5</td>
<td></td>
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<tr>
<td>S12023-10A*3</td>
<td>(1)/K</td>
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<td>3.0</td>
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<tr>
<td>S3884</td>
<td>(4)/K</td>
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<tr>
<td>S2384</td>
<td>(5)/K</td>
<td>TO-8</td>
<td>3.0</td>
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<tr>
<td>S2385</td>
<td>(6)/K</td>
<td></td>
<td>5.0</td>
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</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.

*1: K=borosilicate glass, L=lens type borosilicate glass
*2: Photosensitive area in which a typical gain can be obtained
*3: This is a variant of the S12023-10 in which the device chip is light-shielded by aluminum layer except for the photosensitive area.
Electrical and optical characteristics (Typ. $T_a=25 \, ^\circ\text{C}$, 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>Photosensitivity $S_{M=1}$ $\lambda=800, \text{nm}$ (A/W)</th>
<th>Quantum efficiency $\text{QE}_{M=1}$ $\lambda=900, \text{nm}$ (%)</th>
<th>Breakdown voltage $V_{BR}$ (V)</th>
<th>Temp. coefficient of $V_{BR}$ (V/°C)</th>
<th>Dark current $I_D$ (nA)</th>
<th>Cutoff frequency $f_c$ (MHz)</th>
<th>Terminal capacitance $C_t$ (pF)</th>
<th>Excess noise figure $x_{\lambda=800, \text{nm}}$</th>
<th>Gain M $\lambda=800, \text{nm}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>S12023-02</td>
<td>400 to 1000</td>
<td>800</td>
<td>0.5</td>
<td>75</td>
<td>150</td>
<td>200</td>
<td>0.65</td>
<td>0.05</td>
<td>0.5</td>
<td>1000</td>
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<td>900</td>
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<td>6</td>
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</tbody>
</table>

*4: Values measured at a gain listed in the characteristics table
Note: Breakdown voltage can be specified by using the suffix of type number as examples shown below.
S12023-02-01: 80 to 120 V
S12023-02-02: 120 to 160 V
S12023-02-03: 160 to 200 V

Spectral response

Quantum efficiency vs. wavelength
Si APD | S12023 series, etc.

- **Dark current vs. reverse voltage**
  - (Typ. Ta=25 °C)
  - Dark current vs. reverse voltage

- **Gain vs. reverse voltage**
  - (Typ. λ=800 nm)
  - Gain vs. reverse voltage

- **Terminal capacitance vs. reverse voltage**
  - (Typ. Ta=25 °C, f=1 MHz)
  - Terminal capacitance vs. reverse voltage

- **Excess noise factor vs. gain**
  - (Typ. Ta=25 °C, f=10 kHz, B=1 Hz)
  - Excess noise factor vs. gain

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Terminal Capacitance vs. Reverse Voltage

- **S2384**
- **S3884**
- **S12023-10/-10A**
- **S12023-05, S12051**
- **S12086**

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Excess Noise Factor vs. Gain

- **M0.5**
- **M0.3**
- **M0.2**

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Dimensional outlines (unit: mm)

(1) S12023-02/-05/-10/-10A

Distance from photosensitive area center to cap center
-0.2 ≤ X ≤ +0.2
-0.2 ≤ Y ≤ +0.2

The glass window may extend a maximum of 0.2 mm above the upper surface of the cap.

(2) S12051

Distance from photosensitive area center to cap center
-0.2 ≤ X ≤ +0.2
-0.2 ≤ Y ≤ +0.2

(3) S12086

Distance from photosensitive area center to cap center
-0.2 ≤ X ≤ +0.2
-0.2 ≤ Y ≤ +0.2

(4) S3884

Distance from photosensitive area center to cap center
-0.3 ≤ X ≤ +0.3
-0.3 ≤ Y ≤ +0.3
Replacements for previous products

<table>
<thead>
<tr>
<th>Previous product (listed on the previous datasheet)*</th>
<th>Replacement (listed on this datasheet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>S2381</td>
<td>S12023-02</td>
</tr>
<tr>
<td>S2382</td>
<td>S12023-05</td>
</tr>
<tr>
<td>S5139</td>
<td>S12051</td>
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<td>S8611</td>
<td>S12086</td>
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<td>S2383</td>
<td>S12023-10</td>
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<tr>
<td>S2383-10</td>
<td>S12023-10A</td>
</tr>
</tbody>
</table>

* Products that have been removed from this datasheet
Related information
www.hamamatsu.com/sp/ssd/doc_en.html

- Precautions
- Disclaimer
- Metal, ceramic, plastic package products
- Technical information
- Si APD

Information described in this material is current as of December 2016.
Product specifications are subject to change without prior notice due to improvements or other reasons. This document has been carefully prepared and the information contained is believed to be accurate. In rare cases, however, there may be inaccuracies such as text errors. Before using these products, always contact us for the delivery specification sheet to check the latest specifications.
The product warranty is valid for one year after delivery and is limited to product repair or replacement for defects discovered and reported to us within that one year period. However, even if within the warranty period we accept absolutely no liability for any loss caused by natural disasters or improper product use.
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