MPPC® (multi-pixel photon counter)

S13360 series

MPPCs for precision measurement

MPPC is a type of device called SiPM (silicon photomultipliers). It is a new type of photon counting device that consists of multiple Geiger mode APD (avalanche photodiode) pixels. It is an opto-semiconductor with outstanding photon counting capability and low operating voltage and is immune to the effects of magnetic fields.

The S13360 series are MPPCs for precision measurement. The MPPCs inherit the superb low afterpulse characteristics of previous products and further provide lower crosstalk and lower dark count. They are suitable for precision measurement, such as flow cytometry, DNA sequencer, laser microscope, and fluorescence measurement, that requires low noise characteristics.

Features

- Reduced crosstalk and dark count (compared to previous products)
- Outstanding photon counting capability (outstanding photon detection efficiency versus numbers of incident photons)
- Compact
- Operates at room temperature
- Low voltage (VBR=53 V typ.) operation
- High gain: $10^5$ to $10^6$
- Excellent time resolution
- Immune to the effects of magnetic fields
- Operates with simple readout circuit
- MPPC module also available (sold separately)

Applications

- Fluorescence measurement
- Laser microscopes
- Flow cytometry
- DNA sequencers
- Environmental analysis
- Various academic research

Lower noise

When an MPPC detects photons, the output may contain spurious pulses, namely afterpulse and crosstalk, that are separate from the output pulses of the incident photons. Afterpulses are output later than the timing at which the incident light is received. Crosstalk is output from other pixels at the same time as the detection of light.

Previous products achieved lower afterpulse through the improvement of material and wafer process technology, but with the S13360 series, low crosstalk has been achieved in addition to low afterpulse.

Pulse waveform comparison (typical example)

<table>
<thead>
<tr>
<th>Previous product</th>
<th>Improved product (reference data: S13360-3050PE series)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(M=1.25 × 10^6)</td>
<td>(M=1.25 × 10^6)</td>
</tr>
<tr>
<td>50 mV</td>
<td>50 mV</td>
</tr>
<tr>
<td>10 ns</td>
<td>10 ns</td>
</tr>
</tbody>
</table>

www.hamamatsu.com
**Selection guide**

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Pixel pitch (µm)</th>
<th>Effective photosensitive area (mm)</th>
<th>Number of pixels</th>
<th>Package</th>
<th>Fill factor (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>S13360-1325PE</td>
<td>25</td>
<td>1.3 × 1.3</td>
<td>2668</td>
<td>Glass epoxy</td>
<td></td>
</tr>
<tr>
<td>S13360-3025CS</td>
<td></td>
<td>3.0 × 3.0</td>
<td>14400</td>
<td>Ceramic</td>
<td></td>
</tr>
<tr>
<td>S13360-3025PE</td>
<td></td>
<td>6.0 × 6.0</td>
<td>57600</td>
<td>Glass epoxy</td>
<td></td>
</tr>
<tr>
<td>S13360-6025CS</td>
<td></td>
<td>1.3 × 1.3</td>
<td>667</td>
<td>Ceramic</td>
<td></td>
</tr>
<tr>
<td>S13360-6025PE</td>
<td></td>
<td>3.0 × 3.0</td>
<td>3600</td>
<td>Glass epoxy</td>
<td></td>
</tr>
<tr>
<td>S13360-6025PE</td>
<td></td>
<td>6.0 × 6.0</td>
<td>14400</td>
<td>Glass epoxy</td>
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<tr>
<td>S13360-1350PE</td>
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<td>50</td>
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<td></td>
<td>74</td>
</tr>
<tr>
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<td>1.3 × 1.3</td>
<td>667</td>
<td>Ceramic</td>
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<td>Glass epoxy</td>
<td></td>
</tr>
<tr>
<td>S13360-6050PE</td>
<td></td>
<td>1.3 × 1.3</td>
<td>285</td>
<td>Ceramic</td>
<td></td>
</tr>
<tr>
<td>S13360-6050PE</td>
<td></td>
<td>3.0 × 3.0</td>
<td>1600</td>
<td>Glass epoxy</td>
<td></td>
</tr>
<tr>
<td>S13360-6075CS</td>
<td></td>
<td>6.0 × 6.0</td>
<td>6400</td>
<td>Ceramic</td>
<td></td>
</tr>
</tbody>
</table>

**Structure / Absolute maximum ratings**

<table>
<thead>
<tr>
<th>Type no. (package)</th>
<th>Window material</th>
<th>Refractive index of window material</th>
<th>Absolute maximum ratings</th>
</tr>
</thead>
<tbody>
<tr>
<td>S13360-****CS</td>
<td>Silicone resin</td>
<td>1.41</td>
<td>Operating temperature: -20 to +60 °C, Storage temperature: -20 to +80 °C, Soldering temperature: 350 °C, Reflow soldering temperature: 350 °C</td>
</tr>
<tr>
<td>S13360-****PE</td>
<td>Epoxy resin</td>
<td>1.55</td>
<td>- Peak temperature: 240 °C</td>
</tr>
</tbody>
</table>

*1: No 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 may cause deterioration in characteristics and reliability.

*2: Separate by at least 1 mm from the lead root. 3 seconds or less, once

*3: See reflow soldering conditions (P.10). up to twice, JEDEC J-STD-020 MSL 5a

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. Ta=25 °C, unless otherwise noted)

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Measurement conditions</th>
<th>Spectral response range λ</th>
<th>Peak sensitivity wavelength λp</th>
<th>Photon detection efficiency PDE (%)</th>
<th>Dark count*5</th>
<th>Terminal capacitance Ct (pF)</th>
<th>Gain M</th>
<th>Breakdown voltage VBR (V)</th>
<th>Crosstalk probability (%)</th>
<th>Recommended operating voltage Vop (V)</th>
<th>Temperature coefficient at recommended operating voltage ΔTVop (mV/°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>S13360-1325PE</td>
<td>Vover =5 V</td>
<td>320 to 900</td>
<td>450</td>
<td>25</td>
<td>70</td>
<td>210</td>
<td>60</td>
<td>7.0 × 10^5</td>
<td>1</td>
<td>VBR + 5</td>
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<tr>
<td>S13360-3025CS</td>
<td></td>
<td>270 to 900</td>
<td></td>
<td></td>
<td>400</td>
<td>1200</td>
<td>320</td>
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</tr>
<tr>
<td>S13360-1350PE</td>
<td>Vover =3 V</td>
<td>320 to 900</td>
<td></td>
<td>40</td>
<td>90</td>
<td>270</td>
<td>60</td>
<td>1.7 × 10^6</td>
<td>3</td>
<td>VBR + 3</td>
<td>54</td>
</tr>
<tr>
<td>S13360-3050CS</td>
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<td>270 to 900</td>
<td></td>
<td></td>
<td>500</td>
<td>1500</td>
<td>320</td>
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<td>320 to 900</td>
<td></td>
<td>50</td>
<td>90</td>
<td>270</td>
<td>60</td>
<td>4.0 × 10^6</td>
<td>7</td>
<td>VBR + 3</td>
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</table>

*4: Photon detection efficiency does not include crosstalk or afterpulses.

*5: Threshold=0.5 p.e.

Note: The above characteristics were measured at the operating voltage that yields the listed gain. (See the data attached to each product.)

### Connection example

![Connection diagram](image)
Photon detection efficiency vs. wavelength (typical example)

**Pixel pitch: 25 µm**

- **S13360-**25PE
- **S13360-**25CS

**Pixel pitch: 50 µm**

- **S13360-**50PE
- **S13360-**50CS

**Pixel pitch: 75 µm**

- **S13360-**75PE
- **S13360-**75CS

Photon detection efficiency does not include crosstalk or afterpulses.
- **Overvoltage specifications of gain, crosstalk probability, photon detection efficiency (typical example)**

Pixel pitch: 25 µm

![Graph](image1)

Pixel pitch: 50 µm

![Graph](image2)
MPPC characteristics vary with the operating voltage. Although increasing the operating voltage improves the photon detection efficiency and time resolution, it also increases the dark count and crosstalk at the same time, so an optimum operating voltage must be selected to match the application.
Dimensional outlines (unit: mm)

<table>
<thead>
<tr>
<th>S13360-3025CS/-3050CS/-3075CS</th>
</tr>
</thead>
</table>

Photosensitive area: 3.0 × 3.0

Silicone resin

Lead material: Oxygen-free copper
Lead processing: Au plating
Tolerance unless otherwise noted: ±0.2
Chip position accuracy:
-0.25 ≤ X ≤ 0.25
-0.53 ≤ Y ≤ 0.13
The coating resin may extend a maximum of 0.1 mm above the upper surface of the package.

* Metal electrodes connecting to the internal electrodes are exposed on the sides of the ceramic package. To avoid short circuits, never allow other conductors to come in contact with these metal electrodes.
MPPC (multi-pixel photon counter)  
S13360 series

S13360-6025CS/-6050CS/-6075CS

Photosensitive area
6.0 × 6.0

Silicone resin
Lead

Lead material: Fe-Ni-Co alloy
Lead processing: Au plating
Tolerance unless otherwise noted: ±0.2
Chip position accuracy:
X, Y ≤ ±0.3 with respect to package center
The coating resin may extend a maximum of 0.1 mm above the upper surface of the package.

Index mark:
Cathode

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MPPC (multi-pixel photon counter)  |  S13360 series

S13360-6025PE/-6050PE/-6075PE

Photosensitive area
6.0 × 6.0

Epoxy resin
Photosensitive surface

NC
Anode
Cathode
NC

Index mark

(4×) Ø1.0
(Au pattern)

Tolerance unless otherwise noted: ±0.1
* Distance from chip center to package center

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Temperature profile measurement example using our experimental hot-air reflow oven (S13360-1350PE)

- This surface mount type package product supports lead-free soldering. After unpacking, store it in an environment at a temperature of 25 °C or less and a humidity of 60% or less, and perform soldering within 24 hours.
- The effect that the product is subject to during reflow soldering varies depending on the circuit board and reflow furnace that are used. Before actual reflow soldering, check for any problems by testing out the reflow soldering methods in advance.
**Baking**

If more than 3 months have passed in the unopened state or storage conditions are exceeded after opening the package, baking is required to remove moisture before reflow soldering. For the baking method, refer to the precautions "Surface mount type products".

- **Recommended baking conditions**
  - Temperature: 150 °C, 3 hours, up to twice

  Note: Before setting the baking conditions, perform experiments to confirm that no problems occur with the products.

**Precautions**

- If necessary, incorporate appropriate protective circuits in power supplies, devices, and measuring instruments to prevent overvoltage and overcurrent.

**Related information**

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

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

- **Technical note**
  - MPPC

MPPC is a registered trademark of Hamamatsu Photonics K.K.

Information described in this material is current as of October 2022. 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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