PbSe photoconductive detectors

Infrared detectors with fast response and high sensitivity in 5 μm wavelength band

Compared to other detectors used in the same wavelength regions, PbSe photoconductive detectors have faster response and can operate at room temperature, making them widely used in gas analyzers, etc. Cooling these detectors increases the sensitivity and improves the S/N. So cooled type PbSe photoconductive detectors are widely used in high-precision photometry such as for analytical instruments.

**Features**

- High-speed response
- Room temperature type and TE-cooled type available
- Lower temperature detection limit: approx. 50 °C
- With bandpass filter: P3207-08

**Applications**

- Gas analyzer (CH₄, CO, CO₂)
- Radiation thermometer
- Flame detector
- Film thickness gauge

**Accessories (options)**

- Heatsink for one-stage TE-cooled type A3179
- Heatsink for two-stage TE-cooled type A3179-01
- Temperature controller for TE-cooled type C1103-04
- Amplifier for PbS/PbSe photoconductive detector C3757-02
- Infrared detector module with preamp Non-cooled type P4245
  Cooled type P4639

**Specifications / Absolute maximum ratings**

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Dimensional outline*¹</th>
<th>Package</th>
<th>Cooling</th>
<th>Photocative area (mm)</th>
<th>Thermistor power dissipation*² (mW)</th>
<th>TE-cooler voltage consumption (V)</th>
<th>TE-cooler current consumption (A)</th>
<th>Incident light level Pin (W/cm²)</th>
<th>Supply voltage Vs (V)</th>
<th>Operating temperature Topr (°C)</th>
<th>Storage temperature Tstg (°C)</th>
<th>Soldering conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>P9696-02</td>
<td>(1)/S</td>
<td>TO-5</td>
<td>Non-cooled</td>
<td>2 × 2</td>
<td>3 × 3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1 × 10⁻³</td>
<td>-30 to +50</td>
<td>-55 to +60</td>
<td>260 °C or less, within 10 seconds</td>
</tr>
<tr>
<td>P9696-03</td>
<td>(2)/S</td>
<td>TO-5*² (with filter)</td>
<td>2 × 2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1 × 10⁻³</td>
<td>100</td>
<td>-30 to +50</td>
<td>-55 to +60</td>
<td>260 °C or less, within 10 seconds</td>
</tr>
<tr>
<td>P3207-08</td>
<td>(3)/S</td>
<td>TO-8</td>
<td>One-stage TE-cooled</td>
<td>2 × 2</td>
<td>0.2</td>
<td>0.85</td>
<td>1.5</td>
<td>-</td>
<td>-</td>
<td>-30 to +50</td>
<td>-55 to +60</td>
<td>260 °C or less, within 10 seconds</td>
</tr>
<tr>
<td>P9696-102</td>
<td>(3)/S</td>
<td>TO-8</td>
<td>Two-stage TE-cooled</td>
<td>2 × 2</td>
<td>0.95</td>
<td>1.0</td>
<td>-</td>
<td>-</td>
<td>-30 to +50</td>
<td>-55 to +60</td>
<td>260 °C or less, within 10 seconds</td>
<td></td>
</tr>
<tr>
<td>P9696-103</td>
<td>(4)/S</td>
<td>TO-8</td>
<td>Dual-stage TE-cooled</td>
<td>2 × 2</td>
<td>0.95</td>
<td>1.0</td>
<td>-</td>
<td>-</td>
<td>-30 to +50</td>
<td>-55 to +60</td>
<td>260 °C or less, within 10 seconds</td>
<td></td>
</tr>
<tr>
<td>P9696-202</td>
<td>(4)/S</td>
<td>TO-8</td>
<td>Dual-stage TE-cooled</td>
<td>2 × 2</td>
<td>0.95</td>
<td>1.0</td>
<td>-</td>
<td>-</td>
<td>-30 to +50</td>
<td>-55 to +60</td>
<td>260 °C or less, within 10 seconds</td>
<td></td>
</tr>
<tr>
<td>P9696-203</td>
<td>(4)/S</td>
<td>TO-8</td>
<td>Dual-stage TE-cooled</td>
<td>2 × 2</td>
<td>0.95</td>
<td>1.0</td>
<td>-</td>
<td>-</td>
<td>-30 to +50</td>
<td>-55 to +60</td>
<td>260 °C or less, within 10 seconds</td>
<td></td>
</tr>
</tbody>
</table>

*¹: S=Sapphire glass
*²: Thermistor recommended power dissipation=0.03 mW max.
*³: Voltage applied to a PbSe detector through a load resistor
*⁴: Half width=140 nm

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.
**PbSe photoconductive detectors**

**P9696 series, P3207-08**

### Electrical and optical characteristics (Typ., unless otherwise noted)

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Measurement condition</th>
<th>Peak sensitivity wavelength (\lambda_p) (µm)</th>
<th>Cut-off wavelength (\lambda_c) (µm)</th>
<th>Photosensitivity*S ((S_{\lambda=\lambda_p, V_S=15, \text{V}}))</th>
<th>Detectivity (D^*) (Typ.)</th>
<th>Rise time (t_r) (µs)</th>
<th>Thermistor resistance (R)</th>
<th>Dark resistance (R_d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>P9696-02</td>
<td>25</td>
<td>4.0</td>
<td>4.8</td>
<td>(1.5 \times 10^4)</td>
<td>(8 \times 10^8)</td>
<td>-</td>
<td>-</td>
<td>0.1 to 3</td>
</tr>
<tr>
<td>P9696-03</td>
<td>-10</td>
<td>4.1</td>
<td>5.1</td>
<td>(6.7 \times 10^3)</td>
<td>(5 \times 10^7)</td>
<td>-</td>
<td>-</td>
<td>3300</td>
</tr>
<tr>
<td>P3207-08**</td>
<td>-20</td>
<td>4.2</td>
<td>5.2</td>
<td>(6.7 \times 10^3)</td>
<td>(1 \times 10^7)</td>
<td>9.0</td>
<td>-</td>
<td>0.5 to 10</td>
</tr>
<tr>
<td>P9696-102</td>
<td>-20</td>
<td>4.2</td>
<td>5.2</td>
<td>(3 \times 10^3)</td>
<td>(5 \times 10^9)</td>
<td>10</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>P9696-103</td>
<td>-20</td>
<td>4.2</td>
<td>5.2</td>
<td>(4.7 \times 10^3)</td>
<td>(1 \times 10^7)</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

*4: Chopping frequency=600 Hz, load resistance=nearly equal to detector dark resistance
*5: Half width=140 nm

### Spectral response

#### P9696 series (Typ.)

![Spectral response graph for P9696 series](image1)

#### P3207-08 (Typ. \(T_d=25\, \text{°C}\))

![Spectral response graph for P3207-08](image2)
Spectral transmittance of window material

S/N vs. supply voltage (P9696-02)

S/N vs. chopping frequency

Photosensitivity vs. element temperature

Increasing the chopping frequency reduces the 1/f noise and results in an S/N improvement. The S/N can also be improved by narrowing the noise bandwidth using a lock-in amplifier.

Cooling the device enhances its sensitivity, but the sensitivity also depends on the load resistance in the circuit.
**PbSe photoconductive detectors**

**Dark resistance, rise time vs. element temperature**

- **Relative value** vs. **Element temperature (°C)**

- **Dark resistance**

- **Rise time**

**Element temperature (°C)**

**Linearity**

- **Relative sensitivity** vs. **Incident light level (W/cm²)**

(Typ. Ta=25 °C, fully illuminated)

**Dependent on NEP**

By making the incident light spot smaller than the photosensitive area, the upper limit of the linearity becomes lower.

**Cooling characteristics of TE-cooler**

(Typ. Ta=25 °C, Thermal resistance of heatsink=3 °C/W)

**Current vs. voltage characteristics of TE-cooler**

(Typ. Ta=25 °C, Thermal resistance of heatsink=3 °C/W)

**One-stage TE-cooled type**

**Two-stage TE-cooled type**

**KIRDB0056EA**

**KIRDB0115EC**

**KIRDB0185EB**

**KIRDB0044EC**

**KIRDB0856EA**
Thermistor temperature characteristics

<table>
<thead>
<tr>
<th>Temperature (°C)</th>
<th>Resistance (Ω)</th>
</tr>
</thead>
<tbody>
<tr>
<td>-30</td>
<td>10^6</td>
</tr>
<tr>
<td>-20</td>
<td>10^5</td>
</tr>
<tr>
<td>-10</td>
<td>10^4</td>
</tr>
<tr>
<td>0</td>
<td>10^3</td>
</tr>
<tr>
<td>10</td>
<td>10^2</td>
</tr>
<tr>
<td>20</td>
<td>10^1</td>
</tr>
<tr>
<td>30</td>
<td>10</td>
</tr>
<tr>
<td>40</td>
<td>1</td>
</tr>
<tr>
<td>50</td>
<td>0.1</td>
</tr>
</tbody>
</table>

(Typ. Thermistor power dissipation=0.03 mW max.)

Connection example (P9696-203)

- Connect the C1103-04 and power supply ground terminals together.

Diagram showing the connection of various components including:
- Power supply for amp
- Amp
- Lock-in amp or spectrum analyzer
- Temperature controller
- Signal processing circuit
- Thermistor temperature characteristics graph
- P9696-203 + A3179-01
- Detector and heatsink
- C3757-02
- C1103-04
- C4696
- Chopper
- 2-conductor shielded cable
- BNC connector cable (sold separately)
- Cable (supplied with C3757-02)
- Cable (supplied with C1103-04)
PbSe photoconductive detectors

Dimensional outlines (unit: mm)

(1) P9696-02/-03

- Window: Φ9.1 ± 0.3
- Lead: Φ0.45
- Photosensitive surface: Φ5.1 ± 0.2
- Chip position accuracy with respect to cap center: 0.2 mm max.

(2) P3207-08

- Window: Φ9.1 ± 0.3
- Filter: 5.2 × 5.2 mm, 0.5 mm thick
- Lead: Φ0.45
- Photosensitive surface: Φ5.1 ± 0.2
- Chip position accuracy with respect to cap center: 0.2 mm max.

(3) P9696-102/-103

- Window: 10 ± 0.2 mm
- Lead: 0.45
- Photosensitive surface: 10.2 ± 0.2 mm
- Chip position accuracy with respect to cap center: 0.3 mm max.

(4) P9696-202/-203

- Window: 10 ± 0.2 mm
- Lead: 0.45
- Photosensitive surface: 5.1 ± 0.2 mm
- Chip position accuracy with respect to cap center: 0.3 mm max.
PbSe photoconductive detectors

P9696 series, P3207-08

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

Precautions
- Notice
- Metal, ceramic, Plastic products/Precautions

Technical information
- infrared detector/technical information

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Type numbers of products listed in the delivery specification sheets or supplied as samples may have a suffix “(X)” which means preliminary specifications or a suffix “(Z)” which means developmental 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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