Infrared Detectors

Covering a broad spectral range in the infrared region

- InAsSb photovoltaic detector (with band-pass filter)
  P13243-016CF

- Type II superlattice infrared detector
  P15409-901

- InGaAs PIN photodiode
  G12183-210KA-03
Infrared detectors

Infrared detectors are widely used in diverse fields including measurement, analysis, industry, communication, agriculture, medicine, physical and chemical science, astronomy and space. Based on long experience involving photonic technology, Hamamatsu provides a wide variety of infrared detectors in order to meet a large range of application needs. In addition to the standard devices listed in this catalog, custom devices are also available on request. Please feel free to contact the nearest sales office in your area.
InGaAs PIN photodiodes
- Short wavelength enhanced type
- Standard type
- Long wavelength type
- InGaAs APD
- InGaAs PIN photodiode arrays

InGaAs image sensors
- InGaAs linear image sensors for spectrometry
- High-speed type InGaAs linear image sensors
- InGaAs area image sensors

InAs photovoltaic detectors
- InAs photovoltaic detectors
- Infrared detector module with preamp

InSb photovoltaic detectors, InSb photoconductive detectors
- InSb photovoltaic detectors
- InSb photoconductive detectors
- Infrared detector modules with preamp

InAsSb photovoltaic detectors
- Standard type
- With band-pass filter
- Array
- Infrared detector modules with preamp

Type II superlattice infrared detector
- Type II superlattice infrared detector
- Infrared detector modules with preamp

Thermopile detectors (thermal detectors)
- Single-element type
- Dual-element type

Two-color detectors
- Infrared detector modules with preamp

Photon drag detectors
- Non-cooled type

Accessories for infrared detectors
- Temperature controllers C1103 series
- Valve operator for metal dewar A3515
- Heatsinks for TE-cooled detectors (TO-8, TO-3 package) A3179 series
- Chopper C4696
- Amplifiers for infrared detector C4159 series, C5158-02

Description of terms
## Hamamatsu infrared detectors

<table>
<thead>
<tr>
<th>Product name</th>
<th>Spectral response range (μm)</th>
<th>Features</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>InGaAs PIN photodiodes</td>
<td>0.5 - 1.7</td>
<td>• Short wavelength enhanced type</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Can detect light from 0.5 μm</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.9 - 1.7</td>
<td>• Standard type</td>
<td>5, 6, 10</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• High-speed response, high sensitivity, low dark current</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Available with various photosensitive areas, arrays, and packages</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.9 - 1.9</td>
<td>• For optical measurement around 1.7 μm</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• TE-cooled type available</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.9 - 2.1</td>
<td>• For optical measurement in the band of water content absorption (1.9 μm)</td>
<td>7</td>
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<tr>
<td></td>
<td></td>
<td>• TE-cooled type available</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.9 - 2.6</td>
<td>• For NIR spectroscopy</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• TE-cooled type available</td>
<td></td>
</tr>
<tr>
<td>InGaAs APD</td>
<td>0.9 - 1.7</td>
<td>• High sensitivity and low dark current</td>
<td>9</td>
</tr>
<tr>
<td>InGaAs linear image sensors</td>
<td>0.5 - 2.55</td>
<td>• Timing generator incorporated</td>
<td>11, 12</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Gain switching</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Available with various photosensitive areas, spectral response ranges, numbers of pixels, TE-coolers, and packages</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• TE-cooled type available</td>
<td></td>
</tr>
<tr>
<td>InGaAs area image sensors</td>
<td>0.9 - 2.55</td>
<td>• Timing generator incorporated</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• TE-cooled type</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Low-density pixel (64x64) to high-density pixel (VGA) formats available</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Product name</th>
<th>Spectral response range (μm)</th>
<th>Features</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>InAs photovoltaic detectors</td>
<td>1 - 3.8</td>
<td>• Covers a spectral response range close to PbS but offers higher response speed</td>
<td>14</td>
</tr>
<tr>
<td>InSb photovoltaic detectors</td>
<td>1 - 5.5</td>
<td>• High-speed and high sensitivity in so-called atmospheric window (3 to 5 μm)</td>
<td>15</td>
</tr>
<tr>
<td>InSb photoconductive detectors</td>
<td>1 - 6.7</td>
<td>• Detects wavelengths up to around 6.5 μm, with high sensitivity over long periods by thermoelectric cooling</td>
<td>15</td>
</tr>
<tr>
<td>InAsSb photovoltaic detectors</td>
<td>1 - 11</td>
<td>• Infrared detectors in the 5 μm, 8 μm, or 10 μm spectral band</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• InAs and GaSb superlattice structure enables the detection up to around 14.5 μm</td>
<td></td>
</tr>
<tr>
<td>Type I superlattice infrared detector</td>
<td>1 - 14.5</td>
<td>• Sensors that generate thermoelectromotive force in proportion to the energy level of incident infrared light</td>
<td>20</td>
</tr>
<tr>
<td>Thermopile detectors</td>
<td>1 - 25</td>
<td>• Two-color detectors</td>
<td>21</td>
</tr>
<tr>
<td>Si + InGaAs</td>
<td>0.32 - 2.6</td>
<td>• Wide spectral response range</td>
<td>22, 23</td>
</tr>
<tr>
<td>Si + InAsSb</td>
<td>0.32 - 5.3</td>
<td>• Uses two detectors with different spectral response ranges, mounted one over the other along the same optical axis</td>
<td></td>
</tr>
<tr>
<td>InGaAs + InGaAs</td>
<td>0.9 - 2.55</td>
<td>• High-speed detector with high sensitivity in 10 μm band (for CO₂ laser detection)</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Room temperature operation with high-speed response</td>
<td></td>
</tr>
</tbody>
</table>

For detailed information on the products listed in this catalog, see their datasheets that are available from our website [www.hamamatsu.com](http://www.hamamatsu.com)
When using infrared detectors, the following points should be taken into consideration for making a device selection.

- **Spectral response**
  As can be seen from the figure above, Hamamatsu provides a variety of infrared detectors with different spectral response characteristics. It should be noted that cooling a detector element may affect its spectral response. For InGaAs, InAs, InSb and InAsSb detectors, the spectral response shifts to the shorter wavelength side.

- **Response speed**
  Various detectors are available with different response speeds.

- **Photosensitive area and number of elements**
  Hamamatsu photosensors are available in a wide range of photosensitive area sizes. Also available are multi-element detector arrays optimized for high-speed multichannel spectrophotometry.

- **Cooling**
  Besides easy-to-use photosensors designed for room temperature, Hamamatsu provides various types of sensors that are cooled with thermoelectric coolers, cryogenic dewars (for liquid nitrogen cooling).

- **Object temperature**
  When selecting a detector in accordance with the temperature of an object, it is necessary to consider the distribution of the energy (the wavelength dependency of the energy) radiated from the object. When the temperature of the object is changed, the distribution of the radiating energy is given by the law of black body radiation (Planck’s law), as shown in the figure at the right-hand side. The following relationship is established by the peak sensitivity wavelength \( \lambda_p \) (\( \mu m \)) and the absolute temperature \( T \) (K).

\[
\lambda_p \cdot T = 2897.9
\]
# InGaAs PIN photodiodes

## Short wavelength enhanced type

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Cooling</th>
<th>Photosensitive area (mm)</th>
<th>Spectral response range λ (μm)</th>
<th>Peak sensitivity wavelength λp (μm)</th>
<th>Cutoff frequency fc (VR=1 V MHz)</th>
<th>Package</th>
<th>Photo</th>
<th>Option</th>
</tr>
</thead>
<tbody>
<tr>
<td>G10899-003K</td>
<td>Non-cooled</td>
<td>0.3</td>
<td>0.5 to 1.7</td>
<td>1.55</td>
<td>300</td>
<td>TO-18</td>
<td>C4159-03</td>
<td>(P21)</td>
</tr>
<tr>
<td>G10899-005K</td>
<td>Non-cooled</td>
<td>0.5</td>
<td>0.5 to 1.7</td>
<td>1.55</td>
<td>150</td>
<td>TO-8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>G10899-01K</td>
<td>Non-cooled</td>
<td>1</td>
<td>0.5 to 1.7</td>
<td>1.55</td>
<td>45</td>
<td>TO-5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>G10899-02K</td>
<td>Non-cooled</td>
<td>2</td>
<td>0.5 to 1.7</td>
<td>1.55</td>
<td>10</td>
<td>TO-5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>G10899-03K</td>
<td>Non-cooled</td>
<td>3</td>
<td>0.5 to 1.7</td>
<td>1.55</td>
<td>5</td>
<td>TO-5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Standard type

### Metal package

Various photosensitive area sizes are available. (Typ. Ta=25 °C, unless otherwise noted)

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Cooling</th>
<th>Photosensitive area (mm)</th>
<th>Spectral response range λ (μm)</th>
<th>Peak sensitivity wavelength λp (μm)</th>
<th>Cutoff frequency fc (VR=1 V MHz)</th>
<th>Package</th>
<th>Photo</th>
<th>Option</th>
</tr>
</thead>
<tbody>
<tr>
<td>G12180-003A</td>
<td>Non-cooled</td>
<td>0.3</td>
<td>0.9 to 1.7</td>
<td>1.55</td>
<td>600</td>
<td>TO-18</td>
<td></td>
<td></td>
</tr>
<tr>
<td>G12180-005A</td>
<td>Non-cooled</td>
<td>0.5</td>
<td>0.9 to 1.7</td>
<td>1.55</td>
<td>600</td>
<td>TO-18</td>
<td></td>
<td></td>
</tr>
<tr>
<td>G12180-010A</td>
<td>Non-cooled</td>
<td>1</td>
<td>0.9 to 1.7</td>
<td>1.55</td>
<td>13</td>
<td>TO-5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>G12180-020A</td>
<td>Non-cooled</td>
<td>2</td>
<td>0.9 to 1.7</td>
<td>1.55</td>
<td>7</td>
<td>TO-5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>G12180-030A</td>
<td>Non-cooled</td>
<td>3</td>
<td>0.9 to 1.7</td>
<td>1.55</td>
<td>3</td>
<td>TO-8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>G12180-050A</td>
<td>Non-cooled</td>
<td>5</td>
<td>0.9 to 1.7</td>
<td>1.55</td>
<td>0.6</td>
<td>TO-8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>G8370-81*</td>
<td>Non-cooled</td>
<td>1</td>
<td>0.9 to 1.7</td>
<td>1.55</td>
<td>35</td>
<td>TO-18</td>
<td></td>
<td></td>
</tr>
<tr>
<td>G8370-82*</td>
<td>Non-cooled</td>
<td>2</td>
<td>0.9 to 1.7</td>
<td>1.55</td>
<td>4</td>
<td>TO-18</td>
<td></td>
<td></td>
</tr>
<tr>
<td>G8370-83*</td>
<td>Non-cooled</td>
<td>3</td>
<td>0.9 to 1.7</td>
<td>1.55</td>
<td>2</td>
<td>TO-18</td>
<td></td>
<td></td>
</tr>
<tr>
<td>G8370-85*</td>
<td>Non-cooled</td>
<td>5</td>
<td>0.9 to 1.7</td>
<td>1.55</td>
<td>0.6</td>
<td>TO-8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>G12180-110A</td>
<td>One-stage</td>
<td>1</td>
<td>0.9 to 1.7</td>
<td>1.55</td>
<td>40</td>
<td>TO-8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>G12180-120A</td>
<td>One-stage</td>
<td>2</td>
<td>0.9 to 1.7</td>
<td>1.55</td>
<td>13</td>
<td>TO-8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>G12180-130A</td>
<td>One-stage</td>
<td>3</td>
<td>0.9 to 1.7</td>
<td>1.55</td>
<td>3</td>
<td>TO-8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>G12180-150A</td>
<td>One-stage</td>
<td>5</td>
<td>0.9 to 1.7</td>
<td>1.55</td>
<td>40</td>
<td>TO-8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>G12180-210A</td>
<td>Two-stage</td>
<td>1</td>
<td>0.9 to 1.7</td>
<td>1.55</td>
<td>13</td>
<td>TO-8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>G12180-220A</td>
<td>Two-stage</td>
<td>2</td>
<td>0.9 to 1.7</td>
<td>1.55</td>
<td>7</td>
<td>TO-8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>G12180-230A</td>
<td>Two-stage</td>
<td>3</td>
<td>0.9 to 1.7</td>
<td>1.55</td>
<td>3</td>
<td>TO-8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>G12180-250A</td>
<td>Two-stage</td>
<td>5</td>
<td>0.9 to 1.7</td>
<td>1.55</td>
<td>3</td>
<td>TO-8</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Low PDL (polarization dependent loss) type
### Ceramic package

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Photosensitive area (mm)</th>
<th>Spectral response range ( \lambda ) (( \mu \text{m} ))</th>
<th>Peak sensitivity wavelength ( \lambda_p ) (( \mu \text{m} ))</th>
<th>Photosensitivity ( S = \lambda_p ) (A/W)</th>
<th>Cutoff frequency ( f_c ) ( V_R=5 \text{ V} ) (MHz)</th>
</tr>
</thead>
<tbody>
<tr>
<td>G8370-10</td>
<td>( \phi 10 )</td>
<td>0.9 to 1.7</td>
<td>1.55</td>
<td>1.0</td>
<td>0.1</td>
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</table>

### Surface mount type

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Photosensitive area (mm)</th>
<th>Spectral response range ( \lambda ) (( \mu \text{m} ))</th>
<th>Peak sensitivity wavelength ( \lambda_p ) (( \mu \text{m} ))</th>
<th>Cutoff frequency ( f_c ) ( V_R=5 \text{ V} ) (MHz)</th>
<th>Package</th>
<th>Photo</th>
</tr>
</thead>
<tbody>
<tr>
<td>G15553-003C</td>
<td>( \phi 0.3 )</td>
<td></td>
<td></td>
<td></td>
<td>600</td>
<td></td>
</tr>
<tr>
<td>G15553-005C</td>
<td>( \phi 0.5 )</td>
<td></td>
<td></td>
<td></td>
<td>200</td>
<td>Ceramic (non-sealed)</td>
</tr>
<tr>
<td>G15553-010C</td>
<td>( \phi 1 )</td>
<td></td>
<td></td>
<td></td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>G11193-02R</td>
<td>( \phi 0.2 )</td>
<td></td>
<td></td>
<td></td>
<td>1000</td>
<td></td>
</tr>
<tr>
<td>G11193-03R</td>
<td>( \phi 0.3 )</td>
<td>0.9 to 1.7</td>
<td>1.55</td>
<td></td>
<td>500</td>
<td>Ceramic</td>
</tr>
<tr>
<td>G11193-10R</td>
<td>( \phi 1 )</td>
<td></td>
<td></td>
<td></td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>G13176-003P</td>
<td>( \phi 0.3 )</td>
<td></td>
<td></td>
<td></td>
<td>600</td>
<td>Plastic COB</td>
</tr>
<tr>
<td>G13176-010P</td>
<td>( \phi 1 )</td>
<td></td>
<td></td>
<td></td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>G14448-003L</td>
<td>( \phi 0.3 )</td>
<td></td>
<td></td>
<td></td>
<td>600</td>
<td>Plastic COB with lens</td>
</tr>
</tbody>
</table>

### Spectral response

- **[ G10899 series, etc. ]**
- **[ G12180 series, G8370-10 ]**
- **[ G11193/G13176 series/G14448-003L ]**
### Long wavelength type

**Peak sensitivity wavelength: 1.75 μm**

These are suitable for optical measurement around 1.7 μm. (Typ. Ta=25 °C, unless otherwise noted)

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Cooling</th>
<th>Photosensitive area (mm)</th>
<th>Spectral response range (μm)</th>
<th>Peak sensitivity wavelength λ (μm)</th>
<th>Cutoff frequency fc (MHz)</th>
<th>Package</th>
<th>Photo</th>
<th>Option (sold separately)</th>
</tr>
</thead>
<tbody>
<tr>
<td>G12181-003K</td>
<td>Non-cooled</td>
<td>ϕ0.3</td>
<td>0.9 to 1.9</td>
<td>1.75</td>
<td>90</td>
<td>TO-18</td>
<td></td>
<td>C4159-03 (P.21)</td>
</tr>
<tr>
<td>G12181-005K</td>
<td></td>
<td>ϕ0.5</td>
<td></td>
<td></td>
<td>35</td>
<td>TO-5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>G12181-010K</td>
<td></td>
<td>ϕ1</td>
<td></td>
<td></td>
<td>10</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G12181-020K</td>
<td></td>
<td>ϕ2</td>
<td></td>
<td></td>
<td>2.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G12181-030K</td>
<td></td>
<td>ϕ3</td>
<td></td>
<td></td>
<td>1.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G12181-103K</td>
<td>One-stage TE-cooled</td>
<td>ϕ0.3</td>
<td>0.9 to 1.87</td>
<td></td>
<td>140</td>
<td>TO-8</td>
<td></td>
<td>C4159-03 (P.21)</td>
</tr>
<tr>
<td>G12181-105K</td>
<td></td>
<td>ϕ0.5</td>
<td></td>
<td></td>
<td>50</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>G12181-110K</td>
<td></td>
<td>ϕ1</td>
<td></td>
<td></td>
<td>16</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G12181-120K</td>
<td></td>
<td>ϕ2</td>
<td></td>
<td></td>
<td>3.5</td>
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<tr>
<td>G12181-130K</td>
<td></td>
<td>ϕ3</td>
<td></td>
<td></td>
<td>1.8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G12181-203K</td>
<td>Two-stage TE-cooled</td>
<td>ϕ0.3</td>
<td>0.9 to 1.85</td>
<td></td>
<td>150</td>
<td>TO-8</td>
<td></td>
<td>C4159-03 (P.21)</td>
</tr>
<tr>
<td>G12181-205K</td>
<td></td>
<td>ϕ0.5</td>
<td></td>
<td></td>
<td>53</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G12181-210K</td>
<td></td>
<td>ϕ1</td>
<td></td>
<td></td>
<td>17</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>G12181-220K</td>
<td></td>
<td>ϕ2</td>
<td></td>
<td></td>
<td>3.7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G12181-230K</td>
<td></td>
<td>ϕ3</td>
<td></td>
<td></td>
<td>1.9</td>
<td></td>
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</tr>
</tbody>
</table>

**Long wavelength type**

**Peak sensitivity wavelength: 1.95 μm**

These are suitable for optical measurement in the 1.9 μm band such as water absorption. (Typ. Ta=25 °C, unless otherwise noted)

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Cooling</th>
<th>Photosensitive area (mm)</th>
<th>Spectral response range (μm)</th>
<th>Peak sensitivity wavelength λ (μm)</th>
<th>Cutoff frequency fc (MHz)</th>
<th>Package</th>
<th>Photo</th>
<th>Option (sold separately)</th>
</tr>
</thead>
<tbody>
<tr>
<td>G12182-003K</td>
<td>Non-cooled</td>
<td>ϕ0.3</td>
<td>0.9 to 2.1</td>
<td></td>
<td>90</td>
<td>TO-18</td>
<td></td>
<td>C4159-03 (P.21)</td>
</tr>
<tr>
<td>G12182-005K</td>
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<td>ϕ0.5</td>
<td></td>
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<td>35</td>
<td>TO-5</td>
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<td></td>
</tr>
<tr>
<td>G12182-010K</td>
<td></td>
<td>ϕ1</td>
<td></td>
<td></td>
<td>10</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G12182-020K</td>
<td></td>
<td>ϕ2</td>
<td></td>
<td></td>
<td>2.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G12182-030K</td>
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<td>ϕ3</td>
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<td></td>
<td>1.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G12182-103K</td>
<td>One-stage TE-cooled</td>
<td>ϕ0.3</td>
<td>0.9 to 2.07</td>
<td>1.95</td>
<td>140</td>
<td>TO-8</td>
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<td>C4159-03 (P.21)</td>
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<td>ϕ1</td>
<td></td>
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<td>G12182-120K</td>
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<td>ϕ2</td>
<td></td>
<td></td>
<td>3.5</td>
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<td></td>
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<tr>
<td>G12182-130K</td>
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<td>ϕ3</td>
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<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G12182-203K</td>
<td>Two-stage TE-cooled</td>
<td>ϕ0.3</td>
<td>0.9 to 2.05</td>
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<td>150</td>
<td>TO-8</td>
<td></td>
<td>C4159-03 (P.21)</td>
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<td>G12182-210K</td>
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<td>ϕ1</td>
<td></td>
<td></td>
<td>17</td>
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<td></td>
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<tr>
<td>G12182-220K</td>
<td></td>
<td>ϕ2</td>
<td></td>
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<td>3.7</td>
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<tr>
<td>G12182-230K</td>
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<td>ϕ3</td>
<td></td>
<td></td>
<td>1.9</td>
<td></td>
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</tr>
</tbody>
</table>
**Peak sensitivity wavelength: 2.3 μm**

These are suitable for use in NIR (near infrared) spectroscopy.

(Typ. Ta=25 °C, unless otherwise noted)

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Cooling</th>
<th>Photosensitive area (mm)</th>
<th>Spectral response range λ (μm)</th>
<th>Peak sensitivity wavelength λp (μm)</th>
<th>Cutoff frequency fc (VR=0 V MHz)</th>
<th>Package</th>
<th>Photo</th>
<th>Option (sold separately)</th>
</tr>
</thead>
<tbody>
<tr>
<td>G12183-003K</td>
<td>Non-cooled</td>
<td>φ0.3</td>
<td>0.9 to 2.6</td>
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<td></td>
<td>50</td>
<td>TO-18</td>
<td>C4159-03 (P21)</td>
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<tr>
<td>G12183-005K</td>
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<td>φ1</td>
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<tr>
<td>G12183-020K</td>
<td></td>
<td>φ2</td>
<td></td>
<td></td>
<td></td>
<td>1.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>G12183-030K</td>
<td></td>
<td>φ3</td>
<td></td>
<td></td>
<td></td>
<td>0.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>G12183-103K</td>
<td>One-stage TE-cooled (Tchip=-10 °C)</td>
<td>φ0.3</td>
<td>0.9 to 2.57</td>
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<td></td>
<td>70</td>
<td>TO-8</td>
<td>C4159-03 (P21) A3179-01 (P19) C1103-04 (P18)</td>
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<tr>
<td>G12183-105K</td>
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<td>φ0.5</td>
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<td>φ1</td>
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<tr>
<td>G12183-120K</td>
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<td>φ2</td>
<td></td>
<td></td>
<td></td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>G12183-130K</td>
<td></td>
<td>φ3</td>
<td></td>
<td></td>
<td></td>
<td>0.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>G12183-203K</td>
<td>Two-stage TE-cooled (Tchip=-20 °C)</td>
<td>φ0.3</td>
<td>0.9 to 2.55</td>
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<td></td>
<td>75</td>
<td>TO-8</td>
<td>C4159-03 (P21) A3179-01 (P19) C1103-04 (P18)</td>
</tr>
<tr>
<td>G12183-205K</td>
<td></td>
<td>φ0.5</td>
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<td>28</td>
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<tr>
<td>G12183-210K</td>
<td></td>
<td>φ1</td>
<td></td>
<td></td>
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<td>8</td>
<td></td>
<td></td>
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<tr>
<td>G12183-220K</td>
<td></td>
<td>φ2</td>
<td></td>
<td></td>
<td></td>
<td>2.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>G12183-230K</td>
<td></td>
<td>φ3</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>G12183-210KA-03</strong></td>
<td></td>
<td>φ1</td>
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<td>4</td>
<td>TO-66</td>
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</tr>
</tbody>
</table>

**Spectral response**

- [G12181 series](#)
- [G12182 series](#)
- [G12183 series](#)

* Excluding G12183-220KA-03
InGaAs APD

The G14858-0020A is used for distance measurement, low-light-level detection, and so on. (Typ.)

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Photosensitive area (mm)</th>
<th>Spectral response range (μm)</th>
<th>Breakdown voltage max. $V_{br}$=100 μA (V)</th>
<th>Temperature coefficient of breakdown voltage (V/°C)</th>
<th>Cutoff frequency $f_c$=50 Ω (MHz)</th>
<th>Terminal capacitance (pF)</th>
<th>Gain $\lambda=1.55 \mu m$</th>
<th>Photo</th>
</tr>
</thead>
<tbody>
<tr>
<td>G14858-0020AA</td>
<td>φ0.2</td>
<td>0.95 to 1.7</td>
<td>80</td>
<td>0.1</td>
<td>900</td>
<td>2.0</td>
<td>30</td>
<td></td>
</tr>
</tbody>
</table>

Infrared detector modules with preamp

These modules consist of the InGaAs PIN photodiode assembled with matched preamplifier, and operate by connecting a DC power supply. (Typ.)

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Detector</th>
<th>Cooling (Measurement condition)</th>
<th>Photosensitive area (mm)</th>
<th>Cutoff wavelength $\lambda_c$ (μm)</th>
<th>Peak sensitivity wavelength $\lambda_p$ (μm)</th>
<th>Photosensitivity $S=\lambda=\lambda_p$ (V/W)</th>
<th>Photo</th>
</tr>
</thead>
<tbody>
<tr>
<td>C10439-10</td>
<td>G10899-01K</td>
<td>Non-cooled (Ta=25 °C)</td>
<td>φ1</td>
<td>1.70</td>
<td>1.55</td>
<td>$1 \times 10^6$</td>
<td></td>
</tr>
<tr>
<td>C10439-11</td>
<td>G10899-03K</td>
<td></td>
<td>φ3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C12483-250</td>
<td>G12180-250A</td>
<td>TE-cooled (Tchip=-15 °C)</td>
<td>φ5</td>
<td>1.66</td>
<td>1.55</td>
<td>$5 \times 10^7$</td>
<td></td>
</tr>
<tr>
<td>C12485-210</td>
<td>G12182-210K</td>
<td></td>
<td>φ1</td>
<td>2.05</td>
<td>1.95</td>
<td>$1.8 \times 10^8$</td>
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</tr>
<tr>
<td>C12486-210</td>
<td>G12183-210K</td>
<td></td>
<td>φ1</td>
<td>2.56</td>
<td>2.3</td>
<td>$2 \times 10^8$</td>
<td></td>
</tr>
<tr>
<td>G7754-01</td>
<td>G12183-010 (chip)</td>
<td>Liquid nitrogen (Tchip=-196 °C)</td>
<td>φ1</td>
<td>2.4</td>
<td>2.0</td>
<td>$2 \times 10^9$</td>
<td></td>
</tr>
<tr>
<td>G7754-03</td>
<td>G12183-030 (chip)</td>
<td></td>
<td>φ3</td>
<td></td>
<td></td>
<td>$5 \times 10^9$</td>
<td></td>
</tr>
</tbody>
</table>

Note: A power supply cable is included

Spectral response

[ G14858-0020AA ]  [ C10439-10/-11 ]  [ C12483-250, C12485-210, C12486-210, G7754-01/-03 ]
InGaAs PIN photodiode arrays

4 segmented type and 16-element, 32-element, 40-element, and 46-element arrays are available. (Typ. Ta=25 °C)

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Photosensitive area (mm)</th>
<th>Spectral response range λ (μm)</th>
<th>Peak sensitivity wavelength λ_p (μm)</th>
<th>Package</th>
<th>Photo</th>
</tr>
</thead>
<tbody>
<tr>
<td>G6849-01</td>
<td>φ1 (Quadrant element)</td>
<td></td>
<td></td>
<td>TO-5</td>
<td>[Image]</td>
</tr>
<tr>
<td>G6849</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>[Image]</td>
</tr>
<tr>
<td>G7151-16</td>
<td>0.08 × 0.2 (16-element)</td>
<td></td>
<td>0.9 to 1.7</td>
<td>Ceramic</td>
<td>[Image]</td>
</tr>
<tr>
<td>G12430-016D</td>
<td>0.45 × 1.0 (16-element)</td>
<td>0.9 to 1.7</td>
<td>1.55</td>
<td>Ceramic</td>
<td>[Image]</td>
</tr>
<tr>
<td>G12430-032D</td>
<td>0.2 × 1.0 (32-element)</td>
<td></td>
<td></td>
<td>Ceramic</td>
<td>[Image]</td>
</tr>
<tr>
<td>G12430-046D</td>
<td>0.2 × 1.0 (46-element)</td>
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<td></td>
<td>Ceramic</td>
<td>[Image]</td>
</tr>
<tr>
<td>G8909-01</td>
<td>φ0.08 (40-element)</td>
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<td></td>
<td>Ceramic (Non-sealed)</td>
<td>[Image]</td>
</tr>
</tbody>
</table>

**Spectral response**

[InGaAs photodiode arrays]
# InGaAs image sensors

## InGaAs linear image sensors for spectrometry

### Front-illuminated type

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Cooling</th>
<th>Pixel height (μm)</th>
<th>Pixel pitch (μm)</th>
<th>Number of pixels</th>
<th>Line rate (lines/s)</th>
<th>Spectral response range λ (μm)</th>
<th>Defective pixels</th>
<th>Photo</th>
<th>Dedicated driver circuit*&lt;sup&gt;1&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>G9203-256D</td>
<td>Non-cooled</td>
<td>500</td>
<td>50</td>
<td>256</td>
<td>1910</td>
<td>0.9 to 1.7</td>
<td>0</td>
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<td></td>
</tr>
<tr>
<td>G9204-512D</td>
<td></td>
<td>25</td>
<td>512</td>
<td>256</td>
<td>960&lt;sup&gt;2&lt;/sup&gt;</td>
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<tr>
<td>G11608-256DA</td>
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<td>50</td>
<td>50</td>
<td>256</td>
<td>17200</td>
<td>0.5 to 1.7</td>
<td>1% max.</td>
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<tr>
<td>G11608-512DA</td>
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<td>25</td>
<td>512</td>
<td>256</td>
<td>9150&lt;sup&gt;2&lt;/sup&gt;</td>
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</tr>
<tr>
<td>G11508-256SA</td>
<td>One-stage TE-cooled (Tchip=-10 °C)</td>
<td>500</td>
<td>50</td>
<td>256</td>
<td>17200</td>
<td>0.9 to 1.67</td>
<td>0</td>
<td>C16091-08&lt;sup&gt;3&lt;/sup&gt;</td>
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</tr>
<tr>
<td>G11508-512SA</td>
<td></td>
<td>25</td>
<td>512</td>
<td>256</td>
<td>9150&lt;sup&gt;2&lt;/sup&gt;</td>
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<td></td>
<td>C16091-09&lt;sup&gt;3&lt;/sup&gt;</td>
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<td>256</td>
<td>17200</td>
<td>0.9 to 1.67</td>
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<td>G11476-256WB</td>
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<td>512</td>
<td>256</td>
<td>9150&lt;sup&gt;2&lt;/sup&gt;</td>
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<tr>
<td>G11475-512WB</td>
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<td>25</td>
<td>512</td>
<td>512</td>
<td>9150&lt;sup&gt;2&lt;/sup&gt;</td>
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<td>256</td>
<td>17200</td>
<td>0.9 to 1.67</td>
<td>0</td>
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</table>

### Back-illuminated type

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Cooling</th>
<th>Pixel height (μm)</th>
<th>Pixel pitch (μm)</th>
<th>Number of pixels</th>
<th>Line rate (lines/s)</th>
<th>Spectral response range λ (μm)</th>
<th>Defective pixels</th>
<th>Photo</th>
<th>Dedicated driver circuit*&lt;sup&gt;1&lt;/sup&gt;</th>
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<tbody>
<tr>
<td>G11620-128DA</td>
<td>Non-cooled</td>
<td>500</td>
<td>50</td>
<td>128</td>
<td>30800</td>
<td>0.95 to 1.7</td>
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<td>500</td>
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<td>256</td>
<td>17200</td>
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<td></td>
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<td>256</td>
<td>17200</td>
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<td>250</td>
<td>50</td>
<td>128</td>
<td>13600</td>
<td>0.95 to 1.7</td>
<td>1% max.</td>
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<td>256</td>
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<tr>
<td>G11620-256SA</td>
<td>One-stage TE-cooled (Tchip=-10 °C)</td>
<td>500</td>
<td>50</td>
<td>256</td>
<td>17200</td>
<td>0.95 to 1.67</td>
<td>1% max.</td>
<td>C16091-11&lt;sup&gt;3&lt;/sup&gt;</td>
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</tr>
<tr>
<td>G11620-512SA</td>
<td></td>
<td>25</td>
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<td>9150</td>
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<td>C16091-12&lt;sup&gt;3&lt;/sup&gt;</td>
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<tr>
<td>G12230-512WB</td>
<td>Two-stage TE-cooled (Tchip=20 °C)</td>
<td>250</td>
<td>25</td>
<td>512</td>
<td>9150</td>
<td>0.95 to 2.15</td>
<td>2% max.</td>
<td>C16091-13&lt;sup&gt;3&lt;/sup&gt;</td>
<td></td>
</tr>
</tbody>
</table>

---

*1: Sold separately  
*2: When two video lines are used for readout, the line rate is equal to that for 256 channels.  
*3: With sensor
InGaAs image sensors

Front-illuminated type
These are linear image sensors with high-speed data rate designed for industrial measuring instruments.

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Cooling</th>
<th>Pixel height (μm)</th>
<th>Pixel pitch (μm)</th>
<th>Number of pixels</th>
<th>Line rate (lines/s)</th>
<th>Spectral response range λ (μm)</th>
<th>Defective pixels</th>
<th>Photo</th>
<th>Dedicated driver circuit*</th>
</tr>
</thead>
<tbody>
<tr>
<td>G9494-256D</td>
<td>Non-cooled</td>
<td>50</td>
<td>50</td>
<td>256</td>
<td>7100</td>
<td>0.9 to 1.7</td>
<td>1% max.</td>
<td></td>
<td>C10820</td>
</tr>
<tr>
<td>G9494-512D</td>
<td>Non-cooled</td>
<td>25</td>
<td>25</td>
<td>512</td>
<td>3720*5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

This is a 1024-pixel, high-speed linear image sensor designed for foreign object screening and medical diagnosis equipment where a multichannel high-speed line rate is required.

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Cooling</th>
<th>Pixel height (μm)</th>
<th>Pixel pitch (μm)</th>
<th>Number of pixels</th>
<th>Line rate (lines/s)</th>
<th>Spectral response range λ (μm)</th>
<th>Defective pixels</th>
<th>Photo</th>
<th>Dedicated driver circuit*</th>
</tr>
</thead>
<tbody>
<tr>
<td>G10768-1024D</td>
<td>Non-cooled</td>
<td>100</td>
<td>25</td>
<td>1024</td>
<td>39000</td>
<td>0.9 to 1.7</td>
<td>1% max.</td>
<td></td>
<td>C10854</td>
</tr>
<tr>
<td>G10768-1024DB</td>
<td>Non-cooled</td>
<td>25</td>
<td>25</td>
<td>512</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Back-illuminated type
The back-illuminated InGaAs photodiode and CMOS-ROIC are bump bonded to provide a single output terminal.

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Cooling</th>
<th>Pixel height (μm)</th>
<th>Pixel pitch (μm)</th>
<th>Number of pixels</th>
<th>Line rate (lines/s)</th>
<th>Spectral response range λ (μm)</th>
<th>Defective pixels</th>
<th>Photo</th>
<th>Dedicated driver circuit*</th>
</tr>
</thead>
<tbody>
<tr>
<td>G11135-256DD</td>
<td>Non-cooled</td>
<td>50</td>
<td>50</td>
<td>256</td>
<td>14000</td>
<td>0.95 to 1.7</td>
<td>1% max.</td>
<td></td>
<td>C11514</td>
</tr>
<tr>
<td>G11135-512DE</td>
<td>Non-cooled</td>
<td>25</td>
<td>25</td>
<td>512</td>
<td>8150</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G14006-512DE</td>
<td>25</td>
<td>25</td>
<td>512</td>
<td>8150</td>
<td>1.12 to 1.9</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*4: Sold separately
*5: When two video lines are used for readout, the line rate is equal to that for 256 channels.

These are high-speed line rate, back-illuminated type InGaAs linear imaging sensors with multiple output terminals.

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Cooling</th>
<th>Pixel height (μm)</th>
<th>Pixel pitch (μm)</th>
<th>Number of pixels</th>
<th>Line rate (lines/s)</th>
<th>Spectral response range λ (μm)</th>
<th>Defective pixels</th>
<th>Photo</th>
<th>Dedicated driver circuit</th>
</tr>
</thead>
<tbody>
<tr>
<td>G14714-512DE</td>
<td>Non-cooled</td>
<td>25</td>
<td>25</td>
<td>512</td>
<td>40000</td>
<td>0.95 to 1.7</td>
<td>1% max.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>G14714-1024DK</td>
<td>Non-cooled</td>
<td>12.5</td>
<td>12.5</td>
<td>1024</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Spectral response

[ InGaAs linear image sensors for spectrometry ]

[ High-speed type InGaAs linear image sensors ]
InGaAs area image sensors

The InGaAs area image sensors have a hybrid structure consisting of a CMOS readout circuit (ROIC: readout integrated circuit) and back-illuminated InGaAs photodiodes.

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Cooling</th>
<th>Pixel size (μm)</th>
<th>Pixel pitch (μm)</th>
<th>Number of pixels</th>
<th>Frame rate*1 (frames/s)</th>
<th>Spectral response range*1 (μm)</th>
<th>Defective pixels</th>
<th>Photo</th>
<th>Dedicated driver circuit*2</th>
</tr>
</thead>
<tbody>
<tr>
<td>G11097-0606S</td>
<td>One-stage TE-cooled (Tchip=25 °C)</td>
<td>50 × 50</td>
<td>50</td>
<td>64 × 64</td>
<td>1025</td>
<td>0.95 to 1.7</td>
<td>1% max.</td>
<td>C11512</td>
<td></td>
</tr>
<tr>
<td>G12460-0606S</td>
<td>One-stage TE-cooled (Tchip=0 °C)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G12242-0707W</td>
<td>Two-stage TE-cooled (Tchip=15 °C)</td>
<td>20 × 20</td>
<td>20</td>
<td>128 × 128</td>
<td>258</td>
<td>0.95 to 1.7</td>
<td>0.37% max.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>G13393-0808W</td>
<td>Two-stage TE-cooled (Tchip=15 °C)</td>
<td></td>
<td></td>
<td>320 × 256</td>
<td>228</td>
<td>0.95 to 1.7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G13393-0909W</td>
<td>Two-stage TE-cooled (Tchip=-20 °C)</td>
<td>640 × 512</td>
<td></td>
<td>62</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G13544-01</td>
<td>Two-stage TE-cooled (Tchip=-10 °C)</td>
<td>50 × 50</td>
<td>50</td>
<td>192 × 96</td>
<td>867</td>
<td>1.12 to 1.9</td>
<td>1% max.</td>
<td>C16090-01*3</td>
<td></td>
</tr>
<tr>
<td>G13441-01</td>
<td>Two-stage TE-cooled (Tchip=-20 °C)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G14671-0808W</td>
<td>Two-stage TE-cooled (Tchip=15 °C)</td>
<td>20 × 20</td>
<td>20</td>
<td>320 × 256</td>
<td>509</td>
<td>0.95 to 1.7</td>
<td>0.37% max.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>G14672-0808W</td>
<td>Two-stage TE-cooled (Tchip=15 °C)</td>
<td>20 × 20</td>
<td>20</td>
<td>320 × 256</td>
<td>509</td>
<td>0.95 to 1.7</td>
<td>0.37% max.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>G14673-0808W</td>
<td>Two-stage TE-cooled (Tchip=-20 °C)</td>
<td>20 × 20</td>
<td>20</td>
<td>320 × 256</td>
<td>509</td>
<td>0.95 to 1.7</td>
<td>0.37% max.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>G14674-0808W</td>
<td>Two-stage TE-cooled (Tchip=-20 °C)</td>
<td>20 × 20</td>
<td>20</td>
<td>320 × 256</td>
<td>509</td>
<td>0.95 to 1.7</td>
<td>0.37% max.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*1: Integration time 1 μs (min.)
*2: Sold separately
*3: With sensor

Spectral response

[ G11097-0606S, G12242-0707W, G13393 series, G14671-0808W ]

![Graph](image1)

[ G12460-0606S, G13544-01, G14672-0808W ]

![Graph](image2)

[ G13441-01, G14673-0808W ]

![Graph](image3)

[ G14674-0808W ]

![Graph](image4)
InAs photovoltaic detectors

InAs photovoltaic detectors are high-speed, low-noise infrared detectors capable of detecting infrared light up to approx. 3.5 μm. (Typ.)

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Cooling</th>
<th>Photosensitive area (mm)</th>
<th>Cutoff wavelength λ_c (μm)</th>
<th>Peak sensitivity wavelength λ_p (μm)</th>
<th>Package</th>
<th>Photo</th>
<th>Option (sold separately)</th>
</tr>
</thead>
<tbody>
<tr>
<td>P10090-01</td>
<td>Non-cooled</td>
<td>φ1</td>
<td>3.65</td>
<td>3.35</td>
<td>TO-5</td>
<td>C4159-07 (P21)</td>
<td></td>
</tr>
<tr>
<td>P10090-11</td>
<td>One-stage TE-cooled (Tchip=-10 °C)</td>
<td></td>
<td>3.55</td>
<td>3.30</td>
<td>TO-8</td>
<td>A3179-01 (P19) C1103-04 (P18) C4159-06 (P21)</td>
<td></td>
</tr>
<tr>
<td>P10090-21</td>
<td>Two-stage TE-cooled (Tchip=-30 °C)</td>
<td></td>
<td>3.45</td>
<td>3.25</td>
<td></td>
<td>A3179-01 (P19) C1103-04 (P18) C4159-06 (P21)</td>
<td></td>
</tr>
<tr>
<td>P7163</td>
<td>Liquid nitrogen (Tchip=-196 °C)</td>
<td></td>
<td>3.10</td>
<td>3.00</td>
<td>Metal dewar</td>
<td>C4159-05 (P21)</td>
<td></td>
</tr>
</tbody>
</table>

Infrared detector module with preamp

This is an amplifier-integrated module that can detect infrared light simply by a DC power supply. (Typ.)

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Detector</th>
<th>Photosensitive area (mm)</th>
<th>Cooling</th>
<th>Measurement condition</th>
<th>Cutoff wavelength λ_c (μm)</th>
<th>Peak sensitivity wavelength λ_p (μm)</th>
<th>Photo</th>
</tr>
</thead>
<tbody>
<tr>
<td>C12492-210</td>
<td>InAs (P10090-21)</td>
<td>φ1</td>
<td>TE-cooled</td>
<td>-28</td>
<td>3.45</td>
<td>3.25</td>
<td></td>
</tr>
</tbody>
</table>

Note: A power supply cable is included.

Spectral response

[ InAs photovoltaic detectors ]

[ C12492-210 ]
InSb photovoltaic detectors

InSb photovoltaic detectors are high-speed, low-noise infrared detectors that deliver high sensitivity in the so-called atmospheric window between 3 and 5 μm. The infrared light in the 5 μm band can be detected with peak sensitivity and high response speed. A metal dewar type cooled with liquid nitrogen is also available.

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Cooling</th>
<th>Photosensitive area (mm)</th>
<th>Cutoff wavelength $\lambda_c$ (μm)</th>
<th>Peak sensitivity wavelength $\lambda_p$ (μm)</th>
<th>Package</th>
<th>Photo</th>
<th>Dedicated amplifier (sold separately)</th>
</tr>
</thead>
<tbody>
<tr>
<td>P5968-060</td>
<td>Liquid nitrogen (Tchip=-196 °C)</td>
<td>$\phi0.6$</td>
<td>5.5</td>
<td>5.3</td>
<td>Metal dewar</td>
<td></td>
<td>C4159-01 (P21)</td>
</tr>
<tr>
<td>P5968-100</td>
<td>Liquid nitrogen (Tchip=-196 °C)</td>
<td>$\phi1$</td>
<td>5.5</td>
<td>5.3</td>
<td></td>
<td></td>
<td>C4159-04 (P21)</td>
</tr>
<tr>
<td>P5968-200</td>
<td>Liquid nitrogen (Tchip=-196 °C)</td>
<td>$\phi2$</td>
<td></td>
<td></td>
<td></td>
<td>C4159-07 (P21)</td>
<td>Custom-made product</td>
</tr>
<tr>
<td>P5968-300</td>
<td>Liquid nitrogen (Tchip=-196 °C)</td>
<td>$\phi3$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>C4159-01 (P21)</td>
</tr>
<tr>
<td>P4247-16</td>
<td></td>
<td>$0.25 \times 1.4$ (1 × 16-element)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P4247-44</td>
<td></td>
<td>$0.45 \times 0.45$ (4 × 4-element)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

InSb photoconductive detectors

Thermoelectrically cooled InSb photoconductive detectors are capable of detecting infrared light up to around 6 μm with high sensitivity and high speed.

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Cooling</th>
<th>Photosensitive area (mm)</th>
<th>Cutoff wavelength $\lambda_c$ (μm)</th>
<th>Peak sensitivity wavelength $\lambda_p$ (μm)</th>
<th>Package</th>
<th>Photo</th>
<th>Option (sold separately)</th>
</tr>
</thead>
<tbody>
<tr>
<td>P6606-110</td>
<td>One-stage TE-cooled (Tchip=-10 °C)</td>
<td>$1 \times 1$</td>
<td>6.7</td>
<td>5.5</td>
<td>TO-8</td>
<td></td>
<td>A3179-01 (P19) C1103-07 (P18) C5185-02 (P22)</td>
</tr>
<tr>
<td>P6606-210</td>
<td>Two-stage TE-cooled (Tchip=-30 °C)</td>
<td>$0.5 \times 0.5$</td>
<td>6.5</td>
<td></td>
<td>TO-3</td>
<td></td>
<td>A3179-04 (P19) C1103-05 (P18) C5185-02 (P22)</td>
</tr>
<tr>
<td>P6606-305</td>
<td>Three-stage TE-cooled (Tchip=-60 °C)</td>
<td>$1 \times 1$</td>
<td>6.3</td>
<td></td>
<td></td>
<td></td>
<td>A3179-01 (P19) C1103-07 (P18) C5185-02 (P22)</td>
</tr>
<tr>
<td>P6606-310</td>
<td>Three-stage TE-cooled (Tchip=-60 °C)</td>
<td>$2 \times 2$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>A3179-04 (P19) C1103-05 (P18) C5185-02 (P22)</td>
</tr>
<tr>
<td>P6606-320</td>
<td>Three-stage TE-cooled (Tchip=-60 °C)</td>
<td>$2 \times 2$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>A3179-04 (P19) C1103-05 (P18) C5185-02 (P22)</td>
</tr>
</tbody>
</table>

Spectral response

[ InSb photovoltaic detectors ]

[ InSb photoconductive detectors ]
InSb photovoltaic detectors, InSb photoconductive detectors

These modules consist of the detector assembled with the matched preamplifier, and operate by connecting a DC power supply. (Typ.)

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Detector</th>
<th>Photosensitive area (mm)</th>
<th>Cooling</th>
<th>Measurement condition</th>
<th>Cutoff wavelength λ_c (μm)</th>
<th>Peak sensitivity wavelength λ_p (μm)</th>
<th>Photo</th>
</tr>
</thead>
<tbody>
<tr>
<td>P4631-03</td>
<td>InSb (P6606-310)</td>
<td>1 x 1</td>
<td>TE-cooled</td>
<td>-58</td>
<td>6.1</td>
<td>5.5</td>
<td></td>
</tr>
<tr>
<td>P7751-01*</td>
<td>InSb (P5968-060)</td>
<td>φ0.6</td>
<td>Liquid nitrogen</td>
<td>-196</td>
<td>5.5</td>
<td>5.3</td>
<td></td>
</tr>
<tr>
<td>P7751-02*</td>
<td>InSb (P5968-200)</td>
<td>φ2</td>
<td>Liquid nitrogen</td>
<td>-196</td>
<td>5.5</td>
<td>5.3</td>
<td></td>
</tr>
</tbody>
</table>

* FOV=60°
Note: A power supply cable is included

Spectral response

![Spectral response graph](image)
These sensors deliver high-sensitivity in the wavelength 5 μm, 8 μm, and 10 μm bands using our unique crystal technology. A small surface mount package P13243-013CA is also available.

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Cooling</th>
<th>Photosensitive area (mm)</th>
<th>Cutoff wavelength λc (μm)</th>
<th>Peak sensitivity wavelength λp (μm)</th>
<th>Package</th>
<th>Photo</th>
<th>Options (sold separately)</th>
</tr>
</thead>
<tbody>
<tr>
<td>P11120-201</td>
<td>Two-stage TE-cooled</td>
<td>φ1</td>
<td>5.9</td>
<td>4.9</td>
<td>TO-8</td>
<td>A3179-01 (P.28) C1103-04 (P.27) C4159-07 (P.30)</td>
<td></td>
</tr>
<tr>
<td>P13243-013CA</td>
<td>Non-cooled</td>
<td>0.7 × 0.7</td>
<td>5.3</td>
<td>3.5</td>
<td>Ceramic</td>
<td>C4159-01 (P.30)</td>
<td></td>
</tr>
<tr>
<td>P13243-011MA</td>
<td>Non-cooled</td>
<td>0.7 × 0.7</td>
<td>5.3</td>
<td>3.5</td>
<td>Ceramic</td>
<td>C4159-01 (P.30)</td>
<td></td>
</tr>
<tr>
<td>P13243-122MS</td>
<td>One-stage TE-cooled</td>
<td>2 × 2</td>
<td>5.2</td>
<td>4.1</td>
<td>TO-8</td>
<td>A3179 (P.26) C1103-04 (P.27) C4159-01 (P.30)</td>
<td></td>
</tr>
<tr>
<td>P13243-222MS</td>
<td>Two-stage TE-cooled</td>
<td>2 × 2</td>
<td>5.1</td>
<td>4.1</td>
<td>TO-8</td>
<td>A3179-01 (P.28) C1103-04 (P.27) C4159-01 (P.30)</td>
<td></td>
</tr>
<tr>
<td>P12691-201G</td>
<td>Two-stage TE-cooled</td>
<td>φ1</td>
<td>8.3</td>
<td>6.7</td>
<td>TO-8</td>
<td>A3179-01 (P.28) C1103-04 (P.27) C4159-01 (P.30)</td>
<td></td>
</tr>
<tr>
<td>P13894-011CN</td>
<td>Non-cooled</td>
<td>1 × 1</td>
<td>11.0</td>
<td>5.6</td>
<td>TO-5</td>
<td>C4159-01 (P.30)</td>
<td></td>
</tr>
<tr>
<td>P13894-011NA</td>
<td>Non-cooled</td>
<td>1 × 1</td>
<td>11.0</td>
<td>5.6</td>
<td>TO-5</td>
<td>C4159-01 (P.30)</td>
<td></td>
</tr>
<tr>
<td>P13894-011MA</td>
<td>Non-cooled</td>
<td>1 × 1</td>
<td>11.0</td>
<td>5.6</td>
<td>TO-5</td>
<td>C4159-01 (P.30)</td>
<td></td>
</tr>
<tr>
<td>P13894-211CA</td>
<td>Two-stage TE-cooled</td>
<td>φ1</td>
<td>10.2</td>
<td>6.7</td>
<td>TO-8</td>
<td>A3179-01 (P.28) C1103-04 (P.27) C4159-01 (P.30)</td>
<td></td>
</tr>
</tbody>
</table>

### Spectral response

#### [P11120-201, P13243 series]

#### [P12691-201G]

#### [P13894 series]
These are InAsSb photovoltaic detectors that use a band-pass filter (center wavelength: 3.3 μm, 3.9 μm, 4.26 μm, 4.45 μm) for the window material. It is suitable for measurement of gases (CH₄, CO₂).

**With band-pass filter**

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Cooling</th>
<th>Photosensitive area (mm)</th>
<th>Window material*1</th>
<th>Package</th>
<th>Photo</th>
<th>Dedicated amplifier (Sold separately)</th>
</tr>
</thead>
<tbody>
<tr>
<td>P13243-033CF</td>
<td>Non-cooled</td>
<td>0.7 × 0.7</td>
<td>BPF (3.3 μm)</td>
<td>Ceramic</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P13243-033MF</td>
<td>Non-cooled</td>
<td></td>
<td></td>
<td>TO-46</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P13243-039CF</td>
<td>Non-cooled</td>
<td></td>
<td>BPF (3.9 μm)</td>
<td>Ceramic</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P13243-039MF</td>
<td>Non-cooled</td>
<td></td>
<td></td>
<td>TO-46</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P13243-043CF</td>
<td>Non-cooled</td>
<td></td>
<td>BPF (4.26 μm)</td>
<td>Ceramic</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P13243-043MF</td>
<td>Non-cooled</td>
<td></td>
<td></td>
<td>TO-46</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P13243-045CF</td>
<td>Non-cooled</td>
<td></td>
<td>BPF (4.45 μm)</td>
<td>Ceramic</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P13243-045MF</td>
<td>Non-cooled</td>
<td></td>
<td></td>
<td>TO-46</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P13243-015CF</td>
<td>Non-cooled</td>
<td>0.7 × 0.7 (2 elements)</td>
<td>BPF (3.3 μm)</td>
<td>Ceramic</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P13243-016CF</td>
<td>Non-cooled</td>
<td></td>
<td>BPF (3.9 μm)</td>
<td>Ceramic</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>BPF (4.26 μm)</td>
<td>Ceramic</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*1: BPF: Band-pass filter

**Array**

These are InAsSb photodiode arrays in a ceramic DIP. Simultaneous measurement and wide range measurement are possible.

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Cooling</th>
<th>Photosensitive area (mm)</th>
<th>Cutoff wavelength λc (μm)</th>
<th>Peak sensitivity wavelength λp (μm)</th>
<th>Package</th>
<th>Photo</th>
<th>Dedicated amplifier (sold separately)</th>
</tr>
</thead>
<tbody>
<tr>
<td>P15742-016DS</td>
<td>Non-cooled</td>
<td>0.45 × 0.7 (16 elements)</td>
<td>5.3</td>
<td>3.5</td>
<td>Ceramic</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P15742-046DS</td>
<td>Non-cooled</td>
<td>0.2 × 0.7 (46 elements)</td>
<td></td>
<td></td>
<td>Ceramic</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Spectral response**

![Spectral response graph](image)

-Typ.: Ta=25 °C

[ P13243 series ]

[ P15742 series ]
These are amplifier-integrated modules that can detect infrared light simply by connecting a DC power supply.

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Detector (P)</th>
<th>Photosensitive area (mm)</th>
<th>Cooling</th>
<th>Measurement conditions</th>
<th>Cutoff wavelength $\lambda_c$ (μm)</th>
<th>Peak sensitivity wavelength $\lambda_p$ (μm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>C10439-14</td>
<td>InAsSb (P13243-011MA)</td>
<td>0.7 × 0.7</td>
<td>Non-cooled</td>
<td>+25</td>
<td>5.3</td>
<td>4.1</td>
</tr>
<tr>
<td>C12494-011LH</td>
<td>InAsSb (P13894-011NA)</td>
<td>1 × 1</td>
<td></td>
<td></td>
<td>11</td>
<td>5.6</td>
</tr>
<tr>
<td>C12494-210S</td>
<td>InAsSb (P11120-201)</td>
<td>φf</td>
<td>TE-cooled</td>
<td>-28</td>
<td>5.9</td>
<td>4.9</td>
</tr>
<tr>
<td>C12494-210M</td>
<td>InAsSb (P12691-201G)</td>
<td></td>
<td></td>
<td></td>
<td>8.3</td>
<td>6.7</td>
</tr>
<tr>
<td>C12494-211L</td>
<td>InAsSb (P13894-211MA)</td>
<td>1 × 1</td>
<td></td>
<td>-28</td>
<td>10.6</td>
<td>5.6</td>
</tr>
</tbody>
</table>

Note: A power supply cable is included.

### Spectral response

**[C10439-14]**

High range photosensitivity (mV/nW) vs. Wavelength (μm)

Low range photosensitivity (mV/nW) vs. Wavelength (μm)

**[C12494-011LH/-210S/-210M/-211L]**

$D^*$ vs. Wavelength (μm)

Note: $KACCB0419EB$ and $KIRDB0690EB$ are used for the spectral response graphs.

Typ. Ta=25 °C
Type Ⅱ superlattice infrared detector

The P15409-901 is a Type Ⅱ superlattice infrared detector with sensitivity expanded to the 14 μm band using Hamamatsu unique crystal growth technology and process technology. This product is an environmentally friendly infrared detector and does not use mercury or cadmium, which are substances restricted by the RoHS Directive. This is a replacement for conventional products that contain these substances.

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Cooling</th>
<th>Photosensitive area (mm)</th>
<th>Cutoff wavelength*1 λc (μm)</th>
<th>Peak sensitivity wavelength λp (μm)</th>
<th>Package</th>
<th>Photo</th>
<th>Dedicated amplifier (Sold separately)</th>
</tr>
</thead>
<tbody>
<tr>
<td>P15409-901</td>
<td>Liquid nitrogen (Tchip=-196 °C)</td>
<td>φ0.1</td>
<td>14.5</td>
<td>5.4</td>
<td>Metal dewar</td>
<td>C4159-01 (P.30)</td>
<td></td>
</tr>
</tbody>
</table>

*1: Wavelength at which signal/noise=1

Infrared detector modules with preamp

This is an amplifier-integrated module that can detect infrared light simply by connecting a DC power supply.

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Detector</th>
<th>Photosensitive area (mm)</th>
<th>Cooling</th>
<th>Measurement conditions</th>
<th>Cutoff wavelength λc (μm)</th>
<th>Peak sensitivity wavelength λp (μm)</th>
<th>Photo</th>
</tr>
</thead>
<tbody>
<tr>
<td>C15780-401</td>
<td>Type Ⅱ superlattice (P15409-901)</td>
<td>φ0.1</td>
<td>Liquid nitrogen</td>
<td>-196 °C</td>
<td>14.5</td>
<td>5.4</td>
<td></td>
</tr>
</tbody>
</table>

Spectral response

![Spectral response graph](image)
Thermopile detectors (thermal detectors)

**Single-element type**

Hamamatsu provides high-sensitivity Si thermopile detectors suitable for gas concentration measurement, etc. Concentration of various types of gases can be measured by attaching a band-pass filter to thermopile detectors. The T15770 is suitable for flame detection and the T11361-05 for CO₂ concentration measurement.

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Package</th>
<th>Number of elements</th>
<th>Photosensitive area (mm)</th>
<th>Window</th>
<th>Spectral response (μm)</th>
<th>Photo</th>
</tr>
</thead>
<tbody>
<tr>
<td>T11262-01</td>
<td>TO-18</td>
<td>1</td>
<td>1.2 × 1.2</td>
<td>AR-coated Si</td>
<td>3 to 5</td>
<td></td>
</tr>
<tr>
<td>T11361-01*</td>
<td></td>
<td></td>
<td></td>
<td>Band-pass</td>
<td>4.45</td>
<td></td>
</tr>
<tr>
<td>T15770</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T11361-05*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4.3</td>
<td></td>
</tr>
</tbody>
</table>

* Built-in thermistor

**Dual-element type**

These are dual type thermopile detectors developed to measure the concentration of carbon dioxide and methane with high accuracy. They consist of two high sensitivity Si thermopile chips and two band-pass filters so that two wavelengths can be detected simultaneously.

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Package</th>
<th>Number of elements</th>
<th>Photosensitive area (mm)</th>
<th>Window</th>
<th>Spectral response (μm)</th>
<th>Photo</th>
</tr>
</thead>
<tbody>
<tr>
<td>NEW T11722-11</td>
<td>TO-5</td>
<td>2</td>
<td>1.2 × 1.2 (per element)</td>
<td>Band-pass</td>
<td>Reference light: 3.9</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>CO₂: 4.3</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Reference light: 3.9</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>CH₄: 3.3</td>
<td></td>
</tr>
</tbody>
</table>

**Spectral response (typical example)**

Since thermopile detectors have no wavelength dependence, their spectral response characteristics are determined only by the transmittance of the window material.

The graph below shows transmittance characteristics of typical window materials. Please contact our sales office about changing the window of a thermopile detector to the following materials.
Two-color detectors

Two-color detectors use a combination of two light sensors with different spectral response, in which one sensor is mounted over the other sensor along the same optical axis to provide a broad spectral response range. Thermoelectrically cooled two-color detectors are also provided that cool the sensors to maintain their temperatures constant, allowing high precision measurement with an improved S/N.

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Cooling</th>
<th>Detector</th>
<th>Photosensitive area (mm)</th>
<th>Spectral response range λ (μm)</th>
<th>Peak sensitivity wavelength λp (μm)</th>
<th>Photo-sensitivity S (A/W)</th>
<th>Photo</th>
<th>Option (sold separately)</th>
</tr>
</thead>
<tbody>
<tr>
<td>K1713-03</td>
<td>Non-cooled</td>
<td>Si 2.4 × 2.4</td>
<td>0.32 to 5.3</td>
<td>0.94</td>
<td>0.45</td>
<td></td>
<td></td>
<td>C9329</td>
</tr>
<tr>
<td></td>
<td></td>
<td>InAsSb 0.7 × 0.7</td>
<td></td>
<td>4.0</td>
<td>0.0039</td>
<td></td>
<td></td>
<td>C4159-01 (P21)</td>
</tr>
<tr>
<td>K1713-05</td>
<td></td>
<td>Si 2.4 × 2.4</td>
<td>0.32 to 1.7</td>
<td>0.94</td>
<td>0.45</td>
<td></td>
<td></td>
<td>C9329</td>
</tr>
<tr>
<td></td>
<td></td>
<td>InGaAs φ0.5</td>
<td></td>
<td>1.55</td>
<td>0.55</td>
<td></td>
<td></td>
<td>C4159-03 (P21)</td>
</tr>
<tr>
<td>K1713-08</td>
<td></td>
<td>Si 2.4 × 2.4</td>
<td>0.32 to 2.6</td>
<td>0.94</td>
<td>0.45</td>
<td></td>
<td></td>
<td>C4159-03 (P21)</td>
</tr>
<tr>
<td>K1713-09</td>
<td></td>
<td>Si 2.4 × 2.4</td>
<td>0.32 to 1.7</td>
<td>0.94</td>
<td>0.45</td>
<td></td>
<td></td>
<td>C4159-03 (P21)</td>
</tr>
<tr>
<td>K11908-010K</td>
<td></td>
<td>InGaAs 2.4 × 2.4</td>
<td>0.9 to 2.55</td>
<td>1.55</td>
<td>0.95</td>
<td></td>
<td></td>
<td>C4159-03 (P21)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>InGaAs φ1</td>
<td></td>
<td>2.1</td>
<td>0.10</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>K3413-05</td>
<td>One-stage TE-cooled (Tchip=-10 °C)</td>
<td>Si 2.4 × 2.4</td>
<td>0.32 to 1.67</td>
<td>0.94</td>
<td>0.45</td>
<td></td>
<td></td>
<td>C9329</td>
</tr>
<tr>
<td></td>
<td></td>
<td>InGaAs φ0.5</td>
<td></td>
<td>1.55</td>
<td>0.55</td>
<td></td>
<td></td>
<td>C4159-03 (P21)</td>
</tr>
<tr>
<td>K3413-08</td>
<td></td>
<td>Si 2.4 × 2.4</td>
<td>0.32 to 2.57</td>
<td>0.94</td>
<td>0.45</td>
<td></td>
<td></td>
<td>C9329</td>
</tr>
<tr>
<td></td>
<td></td>
<td>InGaAs φ1</td>
<td></td>
<td>2.3</td>
<td>0.60</td>
<td></td>
<td></td>
<td>A3179-01 (P19)</td>
</tr>
<tr>
<td>K3413-09</td>
<td></td>
<td>Si 2.4 × 2.4</td>
<td>0.32 to 1.67</td>
<td>0.94</td>
<td>0.45</td>
<td></td>
<td></td>
<td>C1103-04 (P18)</td>
</tr>
<tr>
<td>K12728-010K</td>
<td></td>
<td>Si 2.4 × 2.4</td>
<td>0.32 to 1.7</td>
<td>0.96</td>
<td>0.45</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>InGaAs φ1</td>
<td></td>
<td>1.55</td>
<td>0.55</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>K12729-010K</td>
<td></td>
<td>Si 2.4 × 2.4</td>
<td>0.9 to 2.55</td>
<td>1.55</td>
<td>0.95</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>InGaAs φ1</td>
<td></td>
<td>2.1</td>
<td>0.10</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Spectral response

**Si photodiode**

(K1713-003)

**InAsSb photovoltaic detector**

(K12728-010K)
Infrared detector modules with preamp

This is an amplifier-integrated module using a two-color detector. This can detect wide spectral range simply by connecting a DC power supply. (Typ.)

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Detector</th>
<th>Cooling</th>
<th>Photosensitive area (mm)</th>
<th>Spectral response range $\lambda$ (μm)</th>
<th>Peak sensitivity wavelength $\lambda_p$ (μm)</th>
<th>Photosensitivity $S^{*1}$ $\lambda=\lambda_p$ (V/W)</th>
<th>Photo</th>
</tr>
</thead>
<tbody>
<tr>
<td>C10439-15</td>
<td>K1713-08 (Si + InGaAs)</td>
<td>Non-cooled (Ta=25 °C)</td>
<td>Si: 2.4 x 2.4 InGaAs: $\phi$1</td>
<td>0.32 to 2.6</td>
<td>Si: 0.94 InGaAs: 2.3</td>
<td>Si: $4.5 \times 10^5$, InGaAs: $6.5 \times 10^5$</td>
<td></td>
</tr>
</tbody>
</table>

*1: High range

**Spectral response**

![Spectral response graph](image-url)
Photon drag detectors

The photon drag detector makes use of the "photon drag effect" in which holes created in a semiconductor by incident photons are dragged along in the direction of the photons, generating an electromotive force. Because of its sensitivity at 10.6 μm, this detector is suitable for detection of CO₂ lasers. The surface of the detector element is coated with a non-reflective material. The C12496-046 is a infrared detector module with preamp designed to detect infrared light by connecting to a DC power supply.

<table>
<thead>
<tr>
<th>Type no.</th>
<th>Cooling</th>
<th>Photosensitive area (mm)</th>
<th>Peak sensitivity wavelength λp (μm)</th>
<th>Photosensitivity $S_{\lambda=10.6\mu m}$ (V/W)</th>
<th>Photo</th>
<th>Magnet stand (sold separately)</th>
</tr>
</thead>
<tbody>
<tr>
<td>B749</td>
<td>Non-cooled</td>
<td>ϕ5.0</td>
<td>10.6</td>
<td>$1.2 \times 10^6$</td>
<td></td>
<td>A1447</td>
</tr>
<tr>
<td>C12496-046</td>
<td>Non-cooled</td>
<td>ϕ4.6</td>
<td></td>
<td>$1.3 \times 10^2$</td>
<td></td>
<td>-</td>
</tr>
</tbody>
</table>

Dimensional outlines (unit: mm, tolerance unless otherwise noted: ±1)
Hamamatsu provides following accessories for infrared detectors.  
- Temperature controllers (P.18)  
- Heatsinks for TE-cooled detector (P.19)  
- Chopper (P.20)  
- Amplifiers for infrared detectors (P.21)  

A connection example is shown below.

### Connection example

<table>
<thead>
<tr>
<th>Cable no.</th>
<th>Cable</th>
<th>Length approx.</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>①</td>
<td>Coaxial cable (for signal)</td>
<td>2 m</td>
<td>Supplied with heatsink A3179 series. When using this cable, make it as short as possible (preferably approx. 10 cm).</td>
</tr>
<tr>
<td>②</td>
<td>4-conductor cable (with a connector)</td>
<td>3 m</td>
<td>Supplied with temperature controller C1103 series. This cable is also sold separately.</td>
</tr>
<tr>
<td>③</td>
<td>4-conductor cable (with a connector)</td>
<td>2 m</td>
<td>This cable is supplied with the C4159 series, C5185-02 amplifiers for infrared detectors, and infrared detector modules with preamps (room temperature type). This cable is also sold separately. A power supply cable (with a 6-conductor connector) A4372-03 supplied with &quot;infrared detector modules with preamps (TE-cooled type)&quot;, is also sold separately.</td>
</tr>
<tr>
<td>④</td>
<td>BNC connector cable E2573</td>
<td>1 m</td>
<td>Option</td>
</tr>
<tr>
<td>⑤</td>
<td>Power supply cable (for temperature controller)</td>
<td>1.9 m</td>
<td>Supplied with temperature controller C1103 series</td>
</tr>
<tr>
<td>⑥</td>
<td>Chopper driver cable (connected to chopper)</td>
<td>2 m</td>
<td>Connected to chopper driver circuit</td>
</tr>
<tr>
<td>⑦</td>
<td>2-conductor cable or coaxial cable (for chopper power supply)</td>
<td>2 m or less</td>
<td>Prepared by user</td>
</tr>
</tbody>
</table>

*1: Attach the bare wire ends to a 3-pin or 4-pin connector or to a banana jack, and then connect them to the power supply.  
*2: Soldering is needed. When using the C5185-02 amplifier, a BNC connector (prepared by the user, example: one end of the E2573) is required.  
*3: No socket is available. Soldering is needed.  

Note: Refer to the datasheet "Accessories for infrared detectors" for detailed information about cables.
The C1103 series is a temperature controller designed for TE-cooled infrared detectors. The C1103 series allows temperature setting for the TE-cooler mounted in an infrared detector.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>C1103-04</th>
<th>C1103-05</th>
<th>C1103-07</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applicable detector*4</td>
<td>One-stage/two-stage TE-cooled type InAsSb, InAs photovoltaic detectors, InGaAs, Si photodiodes</td>
<td>Two-stage/three-stage TE-cooled type InSb photoconductive detectors</td>
<td>One-stage TE-cooled type InSb photoconductive detectors</td>
</tr>
<tr>
<td>Setting element temperature</td>
<td>-30 to +20 °C</td>
<td>-75 to -25 °C</td>
<td>-30 to +20 °C</td>
</tr>
<tr>
<td>Temperature stability</td>
<td>Within ±0.1 °C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output current for temperature control</td>
<td>1.1 A min., 1.2 A typ., 1.3 A max.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power supply</td>
<td>100 V ± 10% · 50/60 Hz*5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power consumption</td>
<td></td>
<td>30 W</td>
<td></td>
</tr>
<tr>
<td>Dimensions</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight</td>
<td>Approx. 1.9 kg</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operating temperature</td>
<td></td>
<td>+10 to +40 °C</td>
<td></td>
</tr>
<tr>
<td>Operating humidity</td>
<td></td>
<td>90% max.</td>
<td></td>
</tr>
<tr>
<td>Storage temperature*6</td>
<td></td>
<td>-20 to +40 °C</td>
<td></td>
</tr>
<tr>
<td>Accessories</td>
<td>Instruction manual</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4-conductor cable (with a connector, 3 m) A4372-05*7, power supply cable</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*4: It does not correspond to TE-cooled type infrared detector module with preamp.

*5: Please specify power supply requirement (AC line voltage) from among 100 V, 115 V and 230 V when ordering.

*6: No dew condensation

When there is a temperature difference between a product and the surrounding area in high humidity environment, dew condensation may occur on the product surface. Dew condensation on the product may cause deterioration in characteristics and reliability.

*7: When used in combination with the A3179 series heatsink, do not use the 4-conductor cable supplied with the A3179 series, but use the A4372-05 instead.

**Block diagram**

**Valve operator for metal dewar A3515**

With this valve operator, metal dewars can be re-evacuated to maintain the desired vacuum level. Refer to the instruction manual for details. Please be aware that the detector performance is not guaranteed after re-evacuation is performed with the valve operator.

**Dimensional outline (unit: mm)**
Heatsinks for TE-cooled detectors (TO-8, TO-3 package) A3179 series

These heatsinks are designed for use with thermoelectrically cooled detector sealed in a 6-pin TO-8, TO-3 package. The cooling (heat dissipation) capacity of the A3179 and A3179-03 is approx. 35 °C relative to the ambient temperature 25 °C, the A3179-01 is approx. 40 °C, and that of the A3179-04 is approx. 85 °C. The A3179-03 is designed only for two-color detector K3413 series, the A3179 for one-stage TE-cooled TO-8, the A3179-01 for two-stage TE-cooled TO-8, the A3179-04 for TO-3.

**Accessories**

- Instruction manual
- 4-conductor cable (2 m): for TE-cooler and thermistor*1 *2
- Coaxial cable (2 m): for signal*2

*1: When used in combination with the C1103 series temperature controller, do not use the 4-conductor cable supplied with the A3179 series, but use the 4-conductor cable A4372-05 (sold separately, with a connector).
*2: No socket is supplied for connection to infrared detectors. Connect infrared detectors by soldering. Cover the soldered joints and detector pins with vinyl insulating tubes.

**Dimensional outlines (unit: mm, tolerance unless otherwise noted: ± 0.3)**

[A3179]

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

[A3179-01, A3179-03]

<p>| | |</p>
<table>
<thead>
<tr>
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<tbody>
<tr>
<td></td>
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<td></td>
<td></td>
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</tbody>
</table>

[A3179-04]

<p>| | |</p>
<table>
<thead>
<tr>
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<tbody>
<tr>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*1: Bottom surface (reference surface) of detector metal package
*2: When the detector is installed
*3: The position of the photosensitive surface differs according to the detector used.
Refer to the dimensional outline for the detector.
## Parameter Specification

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chopping frequency</td>
<td>115 to 380 Hz, 345 Hz typ.*³</td>
</tr>
<tr>
<td>Operating voltage $V_D$</td>
<td>DC 5 to 13 V, 12 V typ.</td>
</tr>
<tr>
<td>Duty ratio</td>
<td>1:1</td>
</tr>
<tr>
<td>Rotational stability</td>
<td>$0.06%/°C$</td>
</tr>
<tr>
<td>Sync signal $V_H$ (high level)</td>
<td>$V_D = 0.5 V$</td>
</tr>
<tr>
<td></td>
<td>$V_D = 0.2 V$</td>
</tr>
<tr>
<td>Operating temperature</td>
<td>0 to 50 °C</td>
</tr>
<tr>
<td>Maximum current consumption*⁴</td>
<td>90 mA</td>
</tr>
<tr>
<td>Accessories</td>
<td>Magnet stand A1447 (see P.16), driver circuit</td>
</tr>
</tbody>
</table>

*³: Chopping frequency will be 230 to 760 Hz when an optional disk is used.
*⁴: $V_D=12 \text{ V}$

### Dimensional outline (unit: mm, tolerance unless otherwise noted: ±1)

- **<Chopper>**
  - Output window ≈ 8.0
  - Input window ≈ 4.0
  - A1447 (Magnet stand)
  - 6-pin receptacle cord length 2 m (for connection to driver circuit)

- **<Driver circuit>**
  - 6-pin connector
  - BNC

### Chopping frequency vs. operating voltage

- When used with optional disk
- Chopping frequency vs. operating voltage graph
Accessories for infrared detectors

These are low noise amplifiers for InSb, InAs, InAsSb, and InGaAs detectors.

### Accessories

- Instruction manual
- Power cable A4372-02 (one end with 4-pin connector for connection to amplifier and the other end unterminated, 2 m)

### Required power supply specifications

- C4159 series, C5185-02: ±15 V ± 0.5
- Current capacity: 1.5 times or more of amplifier’s maximum current consumption
- Ripple noise: 5 mVp-p or less
- Analog power supply only

Recommended DC power supply (example): PW18-3AD (TEXIO) E3620A, E3630A (Keysight Technologies)

### Applicable detectors

<table>
<thead>
<tr>
<th>Group</th>
<th>Type no.</th>
<th>Applicable detectors(^{1,2,3})</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dewar type InSb</td>
<td>C4159-01</td>
<td>(P5968-60/100), non-cooled type InAsSb (P13243-015CF/-016CF/-011MA/033CF/032MF/-039CF/039MF/-042CF/-043MF/045MF/P13894-01CN/01MA/011NA), TE-cooled type InAsSb (P13243-122MS/222MS, P13894-211MA), dewar type II (P15495-901)</td>
</tr>
<tr>
<td>Dewar type InSb</td>
<td>C4159-04</td>
<td>(P5968-200)</td>
</tr>
<tr>
<td>Dewar type InSb</td>
<td>C4159-05</td>
<td>(P7163)</td>
</tr>
<tr>
<td>TE-cooled type InAs</td>
<td>C4159-06</td>
<td>(P10090-11/21)</td>
</tr>
<tr>
<td>Non-cooled type InAs</td>
<td>C4159-07</td>
<td>(P10090-01), TE-cooled type InAsSb (P11120-201, P12691-201G)</td>
</tr>
<tr>
<td>Non-cooled/TE-cooled type InGaAs</td>
<td>C4159-03</td>
<td>(G12180/G12181/G12182/G12183 series)</td>
</tr>
<tr>
<td>TE-cooled type InSb</td>
<td>C5185-02</td>
<td>(P6606-110/210/305/310/320)</td>
</tr>
</tbody>
</table>

*1: These products cannot operate multiple detectors.
*2: Consult us before purchasing if you want to use with a detector other than listed here.
*3: Consult us before purchasing if you want to use with a multi-element detector.

### Absolute maximum ratings (Ta=25 °C)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>±18.0 max.</td>
<td>V</td>
</tr>
<tr>
<td>Operating temperature</td>
<td>-20 to +40</td>
<td>°C</td>
</tr>
<tr>
<td>Storage temperature</td>
<td>-20 to +70</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.

### Amplifiers for photovoltaic detector (Typ.)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>C4159-01</th>
<th>C4159-04</th>
<th>C4159-05</th>
<th>C4159-06</th>
<th>C4159-07</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conversion impedance</td>
<td>10^6, 10^7, 10^8 (3 range switchable)</td>
<td>2 x 10^6, 2 x 10^7, 2 x 10^8 (3 range switchable)</td>
<td>10^6, 10^7, 10^8 (3 range switchable)</td>
<td>10^6, 10^7, 10^8 (3 range switchable)</td>
<td>10^6, 10^7, 10^8 (3 range switchable)</td>
</tr>
<tr>
<td>Frequency characteristics (amplifier only, -3 dB)</td>
<td>DC to 100 kHz(^{4})</td>
<td>DC to 45 kHz</td>
<td>DC to 15 kHz</td>
<td>DC to 100 kHz</td>
<td>DC to 100 kHz</td>
</tr>
<tr>
<td>Output impedance</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Maximum output voltage (1 kΩ load)</td>
<td>+10</td>
<td>+10</td>
<td>+10</td>
<td>+10</td>
<td>+10</td>
</tr>
<tr>
<td>Output offset voltage</td>
<td>±5</td>
<td>±5</td>
<td>±5</td>
<td>±5</td>
<td>±5</td>
</tr>
<tr>
<td>Equivalent input noise current(^{5}) (f=1 kHz)</td>
<td>0.15 (10^8, 10^7 range)</td>
<td>0.15 (10^8, 10^7 range)</td>
<td>0.15 (10^8, 10^7 range)</td>
<td>0.15 (10^8, 10^7 range)</td>
<td>0.15 (10^8, 10^7 range)</td>
</tr>
<tr>
<td>Reverse voltage</td>
<td>Limited to 0 V operation, cannot be applied from external unit</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>External power supply(^{6})</td>
<td>±15</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current consumption</td>
<td>+30, -10 max.</td>
<td>+30, -22 max.</td>
<td>mA</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(^{4}\): When connected to a detector, the frequency becomes 60 kHz or less (ϕ0.6 mm: 60 kHz or less, ϕ1 mm: 25 kHz or less). Ringing occurs in the output if the rise time tr (10 to 90%) of incident light is approximately 100 μs or less. The ringing becomes larger as the rise time becomes shorter. However, ringing does not occur for sine wave light.

\(^{5}\): Input resistance: 1 MΩ (C4159-01/-04/05), 500 Ω (C4159-06/07)

\(^{6}\): Recommended DC power supply (analog power supply): ±15 V, current capacity: 1.5 times the maximum current consumption or more, ripple noise: 5 mVp-p or less

Note:
- Output noise voltage = Equivalent input noise current x Conversion impedance
- For information about accessories except for the amplifiers for infrared detectors, refer to the “Accessories for infrared detectors” datasheet.
Amplifier for InGaAs PIN photodiode (Typ.)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>C4159-03</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conversion impedance</td>
<td>(10^7, 10^6, 10^5) (3 range switchable)</td>
<td>V/A</td>
</tr>
<tr>
<td>Frequency characteristics (amplifier only, -3 dB)</td>
<td>DC to 15 kHz</td>
<td>-</td>
</tr>
<tr>
<td>Output impedance</td>
<td>50</td>
<td>(\Omega)</td>
</tr>
<tr>
<td>Maximum output voltage (1 k(\Omega) load)</td>
<td>+10</td>
<td>V</td>
</tr>
<tr>
<td>Output offset voltage</td>
<td>(\pm 5)</td>
<td>mV</td>
</tr>
<tr>
<td>Equivalent input noise current (f=1 kHz)</td>
<td>2.5</td>
<td>pA/Hz(^{1/2})</td>
</tr>
<tr>
<td>Reverse voltage</td>
<td>Cannot be applied from external unit</td>
<td>-</td>
</tr>
<tr>
<td>External power supply*7</td>
<td>(\pm 15)</td>
<td>V</td>
</tr>
<tr>
<td>Current consumption</td>
<td>(\pm 15) max.</td>
<td>mA</td>
</tr>
</tbody>
</table>

Amplifier for photoconductive detector (Typ.)*8

<table>
<thead>
<tr>
<th>Parameter</th>
<th>C5185-02</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input impedance</td>
<td>5</td>
<td>k(\Omega)</td>
</tr>
<tr>
<td>Voltage gain</td>
<td>66 ((\times) 2000)</td>
<td>dB</td>
</tr>
<tr>
<td>Frequency characteristics (amplifier only, -3 dB)</td>
<td>5 Hz to 250 kHz</td>
<td>-</td>
</tr>
<tr>
<td>Detector bias current</td>
<td>5 mA, 10 mA, 15 mA (3 range switchable)</td>
<td>-</td>
</tr>
<tr>
<td>Output impedance</td>
<td>50</td>
<td>(\Omega)</td>
</tr>
<tr>
<td>Maximum output voltage (1 k(\Omega) load)</td>
<td>(\pm 10)</td>
<td>V</td>
</tr>
<tr>
<td>Equivalent input noise voltage (f=1 kHz)</td>
<td>2.6*9</td>
<td>nV/Hz(^{1/2})</td>
</tr>
<tr>
<td>External power supply*7</td>
<td>(\pm 15)</td>
<td>V</td>
</tr>
<tr>
<td>Current consumption</td>
<td>(\pm 100, -30) max.</td>
<td>mA</td>
</tr>
</tbody>
</table>

*7: Recommended DC power supply (analog power supply): \(\pm 15\) V, current capacity: 1.5 times the maximum current consumption or more, ripple noise: 5 mVp-p or less
*8: Before purchasing, make sure the bias current to the detector matches the detector bias current specified in the table.
*9: At the maximum detector bias current
Note: Output noise voltage = Equivalent input noise voltage \(\times\) Voltage gain

Dimensional outlines (unit: mm)

<table>
<thead>
<tr>
<th>[ C4159-01/-03/-04/-05/-06/-07 ]</th>
<th>[ C5185-02 ]</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Dimensional outline diagram" /></td>
<td><img src="image" alt="Dimensional outline diagram" /></td>
</tr>
</tbody>
</table>

Pin connections:
1. GND
2. Cathode
3. Anode

Tolerance unless otherwise noted: \(\pm 1\)
Note: Socket for lead attachment is not provided.
Description of terms

- **Dark resistance: Rd**
  This is the resistance of a photoconductive detector in the dark state.

- **Dark current: Io**
  The dark current is the small current which flows when a reverse voltage is applied to a photovoltaic detector (InGaAs, InAs, InSb, etc.) under dark conditions. This is a factor for determining the lower limit of light detection.

- **FOV (field of view)**
  The field of view is related to the background radiation noise and greatly influences the value of $D^*$.

- **Offset voltage**
  This is DC output voltage of an amplifier when the input signal is zero.

- **Photosensitivity: S**
  This is the detector output per watt of incident light at a given wavelength. The unit is usually expressed in $\text{V/W}$ for photoconductive and in $\text{A/W}$ for photovoltaic detectors.

- **Photovoltaic detector (photodiode)**
  This is a semiconductor detector that generates electrical current or voltage when light enters its PN junction. Detector materials include InGaAs, InAs, InAsSb, and InSb.

- **Photoconductive detector**
  This is a semiconductor detector whose conductivity increases with increasing incident light.

- **Peak sensitivity wavelength: $\lambda_p$**
  This is the wavelength at which the sensitivity of the detector is at maximum.

- **Reverse voltage (max.): $V_{\text{max}}$, supply voltage (max.)**
  Applying a reverse voltage to a photoconductive detector (or applying a voltage to a photoconductive detector) triggers a breakdown at a certain voltage and causes severe deterioration of the detector performance. Therefore, the absolute maximum rating for the voltage is specified at the voltage somewhat lower than this breakdown voltage. Do not apply a voltage higher than the maximum rating.

- **Allowable current (max.)**
  This is a maximum value of current which can be used when photoconductive detectors are operated. When the supply current is higher than the maximum allowable current, the detector performance may deteriorate, therefore, excessive current must be avoided.

- **NEP (noise equivalent power)**
  This is the radiant power that produces S/N of 1 at the detector output. At Hamamatsu, we list the NEP measured at the peak sensitivity wavelength ($\lambda_p$) and the like. Since the noise level is proportional to the square root of the frequency bandwidth, the NEP is normalized to a bandwidth of 1 Hz.

\[
\text{NEP at } \lambda_p \text{ [W/Hz}^{1/2}\text{]} = \frac{\text{Noise current [A/Hz}^{1/2}\text{]}}{\text{Photosensitivity [A/W] at } \lambda_p}
\]

- **Cutoff frequency: $f_c$**
  This is the frequency at which the output decreases 3 dB from the steady state output level. The cutoff frequency ($f_c$) is related to rise time (tr: time required for the output to rise from 10% to 90% of the maximum output value) as follows:

\[
\text{tr [s]} = \frac{0.35}{f_c \text{ [Hz]}}
\]

- **Rise time: tr**
  This is the value of a detector time response to a stepped light input, and defined as the time required for transition from 10% to 90% (or 0 to 63%) of the maximum (constant) output value. The light sources used are GaAs LED (0.92 µm), laser diode (1.3 µm), etc.

- **Terminal capacitance: $C_t$**
  An effective capacitor is formed at the PN junction of a photovoltaic detector. Its capacitance is termed the junction capacitance and is one of the parameters that determine the response speed of the photovoltaic detector. And it can cause the phenomenon of gain peaking in I-V conversion circuit using op amp. In Hamamatsu, the terminal capacitance including this junction capacitance plus package stray capacitance is listed.

- **Short circuit current: $I_{\text{sc}}$**
  The short circuit current is the output current which flows when the load resistance is 0 and is nearly proportional to the device photosensitive area. This is often called “white light sensitivity” with regards to the spectral response. This value is measured with light from a tungsten lamp of 2856 K distribution temperature (color temperature), providing 100 lx illuminance.

- **Cutoff wavelength: $\lambda_c$**
  This represents the long wavelength limit of spectral response and in datasheets is listed as the wavelength at which the sensitivity becomes 10% of the value at the peak sensitivity wavelength.

- **Chopping frequency**
  In the measurement of infrared detector sensitivity, an optical chopper is often used to perform on-off operation of incident light. This is the frequency of the chopper.

- **$D^*$ (D-star: Detectivity)**
  $D^*$ is the detectivity indicating the S/N in an AC signal obtained by a detector when radiant energy of 1 W is input to the detector. $D^*$ is normalized to a detector area of 1 cm$^2$ and a noise bandwidth of 1 Hz, to allow comparing of characteristics of detector materials independent of the detector area. $D^*$ is usually represented as $D^*$ (A, B, C), in which A is the light source temperature [K] or wavelength [µm], B is the chopping frequency [Hz], and C is the noise bandwidth [Hz]. $D^*$ is expressed in units of cm$^2$ · Hz$^{1/2}$/W, and the higher the $D^*$, the better the detector. $D^*$ is given by the following equation.

\[
D^* = \frac{S/N \Delta f^{1/2}}{P A^{1/2}}
\]

where S is the signal, N is the noise, P is the incident energy in [W/cm$^2$], A is the photosensitive area in [cm$^2$] and $\Delta f$ is the noise bandwidth in [Hz]. The following relation is established by $D^*$ and NEP.

\[
D^* = \frac{A^{1/2}}{\text{NEP}}
\]

- **Noise: N**
  The noise is the output voltage (current) from a detector operated under specified conditions and 300 K background radiations.

- **Shunt resistance: $R_{sh}$**
  This shunt resistance is the voltage-to-current ratio in the vicinity of 0 V in photovoltaic detectors and defined as follows:

\[
R_{sh} \text{ [Ω]} = \frac{10 \text{ [mV]}}{I_0 \text{ [A]}}
\]

For applications where no reverse voltage is applied, noise resulting from the shunt resistance becomes predominant.

- **Quantum efficiency: $\text{QE}$**
  The quantum efficiency is the number of electrons or holes that can be detected as a photocurrent, divided by the number of incident photons. This is commonly expressed in percent [%]. The quantum efficiency QE and photosensitivity S [A/W] have the following relationship at a given wavelength [nm]:

\[
\text{QE} = \frac{S \times 1240}{\lambda} \times 100 \%]
\]
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- Si photodiodes
- APD
- MPPC®
- Photo IC
- Image sensors
- PSD
- Infrared detectors
- LED
- Optical communication devices
- Automotive devices
- X-ray flat panel sensors
- MEMS devices
- Mini-spectrometers
- Opto-semiconductor modules

Electron Tubes
- Photomultiplier tubes
- Photomultiplier tube modules
- Microchannel plates
- Image intensifiers
- Xenon lamps / Mercury-xenon lamps
- Deuterium lamps
- Light source applied products
- Laser applied products
- Microfocus X-ray sources
- X-ray imaging devices

Imaging and Processing Systems
- Cameras / Image processing measuring systems
- X-ray products
- Life science systems
- Medical systems
- Semiconductor failure analysis systems
- FPD / LED characteristic evaluation systems
- Spectroscopic and optical measurement systems

Laser Products
- Single chip laser diodes
- Laser diode bar modules
- Quantum cascade lasers
- Direct diode lasers
- Applied products of semiconductor lasers
- Solid state lasers / Fiber lasers
- Laser related products

Opto-semiconductors
- Si photodiodes
- APD
- MPPC®
- Photo IC
- Image sensors
- PSD
- Infrared detectors
- LED
- Optical communication devices
- Automotive devices
- X-ray flat panel sensors
- MEMS devices
- Mini-spectrometers
- Opto-semiconductor modules

Electron Tubes
- Photomultiplier tubes
- Photomultiplier tube modules
- Microchannel plates
- Image intensifiers
- Xenon lamps / Mercury-xenon lamps
- Deuterium lamps
- Light source applied products
- Laser applied products
- Microfocus X-ray sources
- X-ray imaging devices

Imaging and Processing Systems
- Cameras / Image processing measuring systems
- X-ray products
- Life science systems
- Medical systems
- Semiconductor failure analysis systems
- FPD / LED characteristic evaluation systems
- Spectroscopic and optical measurement systems

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- Single chip laser diodes
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