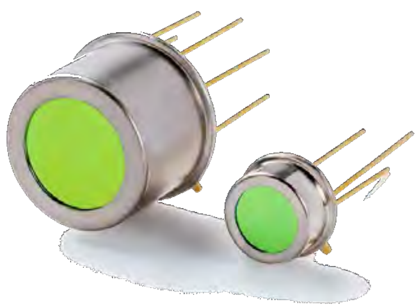
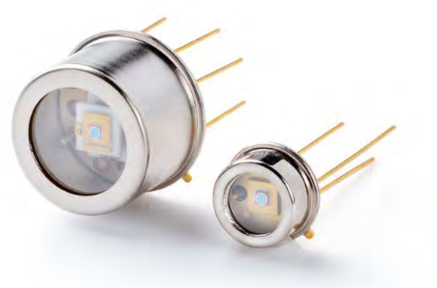
Infrared Detectors & Modules





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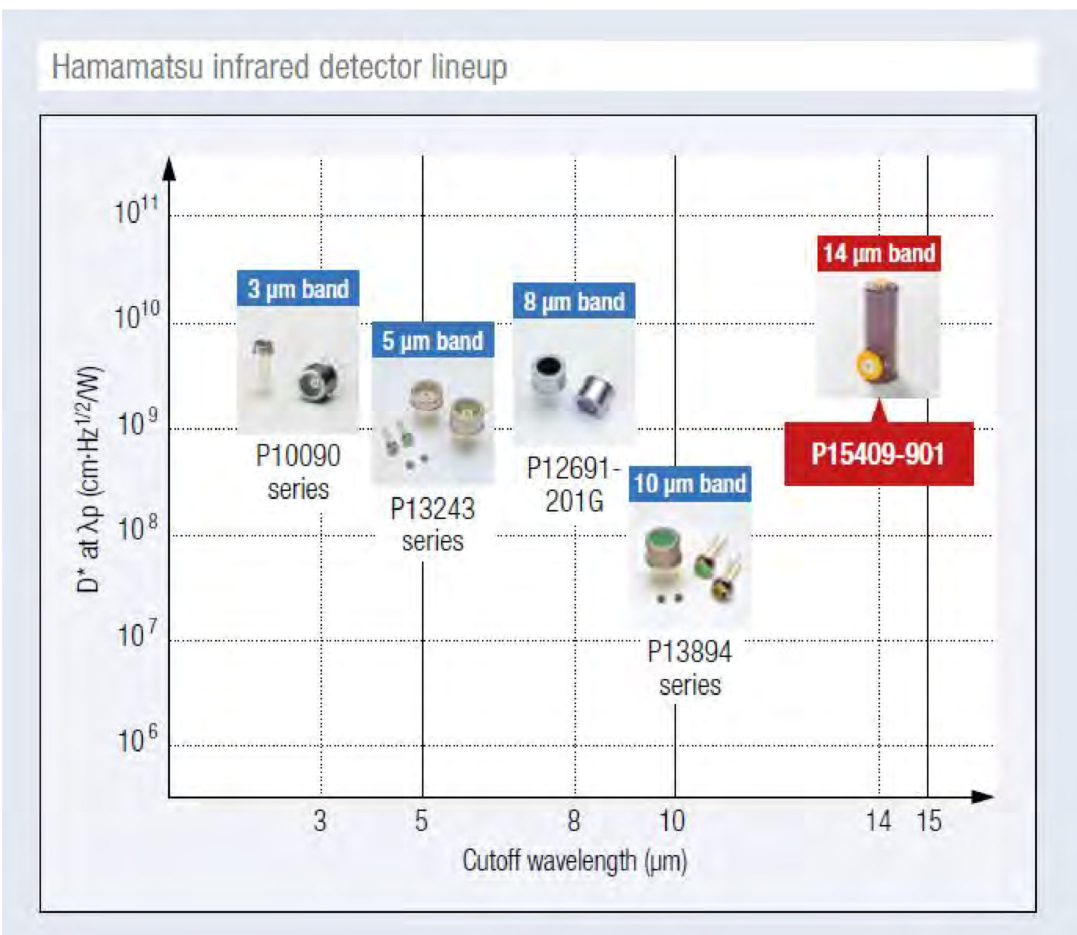
Compound semiconductor photosensors

Available from Boston Electronics

Product name	Spectral response range (μm) 0 5 10 15 20 25	Features
InAs photovoltaic detectors	1 3.8	● Covers a spectral response range close to PbS but offers higher response speed
InSb photovoltaic detectors	1 5.5	● High sensitivity in so-called atmospheric window (3 to 5 μm) ● High-speed response
InSb photoconductive detectors	1 6.7	● Detects wavelengths up to around 6.5 μm, with high sensitivity over long periods of time by thermoelectric cooling
InAsSb photovoltaic detectors	1 11	● Infrared detector with cutoff wavelength of 5 μm, 8μm or 10 μm bands ● High-speed response and high reliability
Type II superlattice infrared detector	1 14.5	● InAs and GaSb superlattice structure enables the detection up to around 14.5 μm



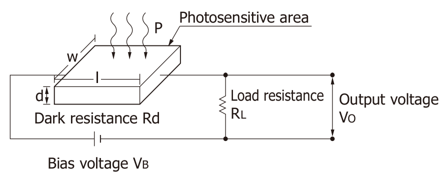
3. InSb photoconductive detectors

InSb photoconductive detectors are infrared detectors capable of detecting light up to approx. 6.5 µm. InSb photoconductive detectors are easy to handle since they are thermoelectrically cooled (liquid nitrogen not required).

3 - 1 Operating principle

When infrared light enters an InSb photoconductive detector, the number of carriers increases, causing its resistance to lower. A circuit like that shown in Figure 3-1 is used to extract the signal as a voltage, and photosensitivity is expressed in units of V/W.

[Figure 3-1] Output signal measurement circuit for photoconductive detector



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The output voltage (Vo) is expressed by equation (3-1).

$$Vo = \frac{R_L}{Rd + R_L} \cdot V_B \quad \cdots\cdots\cdots \quad (3\text{-}1)$$

The change (ΔVo) in Vo, which occurs due to a change (ΔRd) in the dark resistance (Rd) when light enters the detector, is expressed by equation (3-2).

$$\Delta Vo = - \frac{R_L \, V_B}{(Rd + R_L)^2} \cdot \Delta Rd \quad \cdots\cdots\cdots \quad (3\text{-}2)$$

ΔRd is then given by equation (3-3).

$$\Delta Rd = - Rd \, \frac{q \, (\mu_e + \mu_h)}{\sigma} \cdot \frac{\eta \, \tau \, \lambda \, P \, A}{l \, w \, d \, h \, c} \quad \cdots\cdots\cdots \quad (3\text{-}3)$$

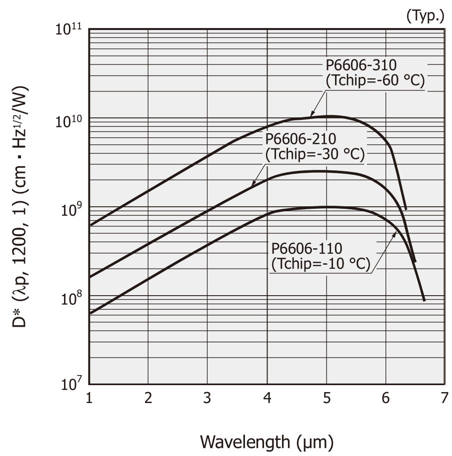
q : electron charge
μ_e: electron mobility
μ_h: hole mobility
σ : electric conductivity
η : quantum efficiency
τ : carrier lifetime
λ : wavelength
P : incident light level [W/cm^2]
A : photosensitive area [cm^2]
h : Planck's constant
c : speed of light in vacuum

3 - 2 Characteristics

Spectral response

The band gap energy in InSb photoconductive detectors has a positive temperature coefficient, so cooling the detector shifts its cutoff wavelength to the short-wavelength side. This is the same for InSb photovoltaic detectors.

[Figure 3-2] Spectral response



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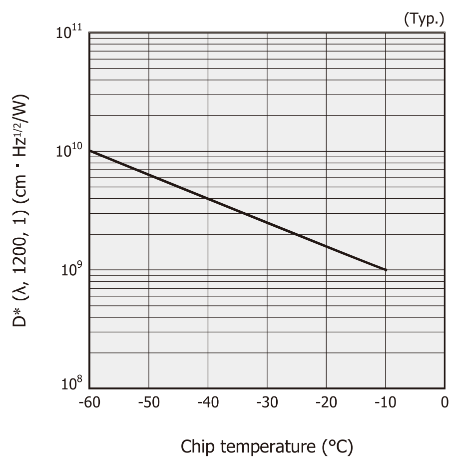
[Figure 3-3] D* vs. chip temperature (P6606-310)



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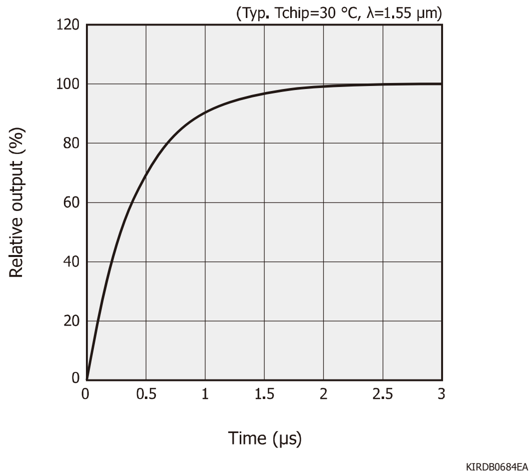
Response characteristics

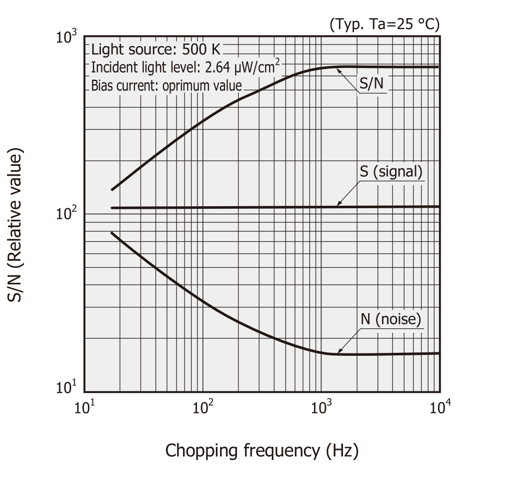
[Figure 3-4] Response characteristics (P6606-310)



Noise characteristics

Noise components in InSb photoconductive detectors include 1/f noise, g-r noise caused by electron-hole recombination, and Johnson noise. The 1/f noise is predominant at low frequencies below several hundred hertz, and the g-r noise is predominant at frequencies higher than that level. Figure 3-7 shows the relationship between the noise level and frequency for InSb photoconductive detectors. Narrowing the amplifier bandwidth will reduce the noise. Especially in low-light level measurement, the chopping frequency and bandwidth must be taken into account.

[Figure 3-7] S/N vs. chopping frequency

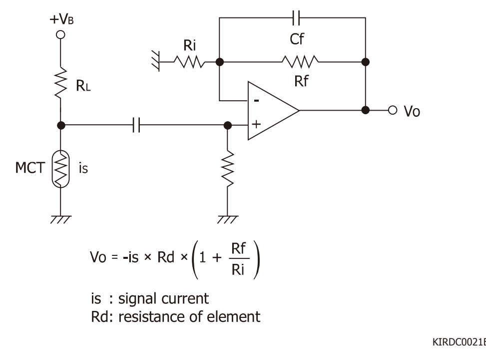


3 - 3 How to use

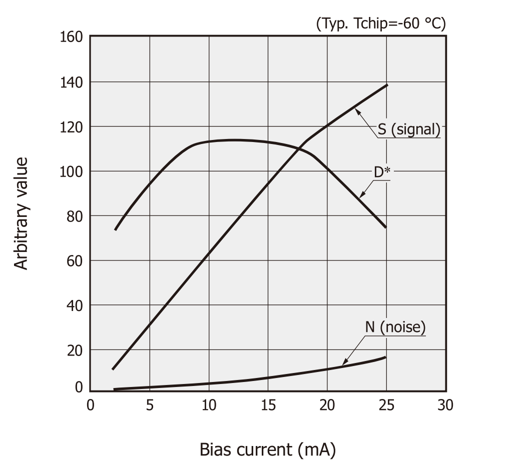
Operating circuit

Figure 3-5 shows a connection example for InSb photoconductive detectors. A power supply with low noise and ripple should be used. A load resistance (R_L) of several kilohms is generally used to make it a constant current source. As the bias current is raised, both the signal and noise increase [Figure 3-6]. But the noise begins to increase sharply after reaching a particular value, so the bias current should be used in a range where the D* becomes constant. Raising the bias current more than necessary increases the chip temperature due to Joule heat and degrades the D*. This might possibly damage the detector so it should be avoided.

[Figure 3-5] Connection example



[Figure 3-6] Signal, noise, and D* vs. bias current (P6606-310)



Temperature compensation

Since the sensitivity and dark resistance of InSb photoconductive detectors drift according to the chip temperature, some measures must be taken to control

4. InAs/InAsSb/InSb photovoltaic detectors

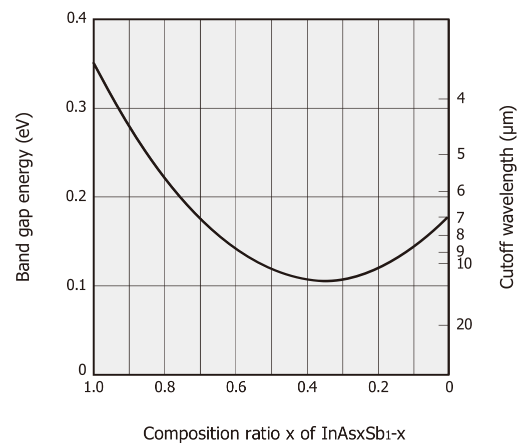
As with InGaAs PIN photodiodes, InAs/InAsSb/InSb photovoltaic detectors are infrared detectors having a PN junction. InAs photovoltaic detectors are sensitive around 3 µm, the same as PbS photoconductive detectors, while InSb photovoltaic detectors are sensitive to the 5 µm band, the same as PbSe photoconductive detectors. InAsSb photovoltaic detectors deliver high sensitivity in the 5 µm, 8 µm, or 10 µm band.

4 - 1 Characteristics

Spectral response

Controlling the composition of $InAs_xSb_{1-x}$, which is a III-V family compound semiconductor material, enables the fabrication of detectors whose cutoff wavelength at room temperature ranges from 3.3 µm (InAs) to 12 µm ($InAs_{0.38}Sb_{0.62}$).

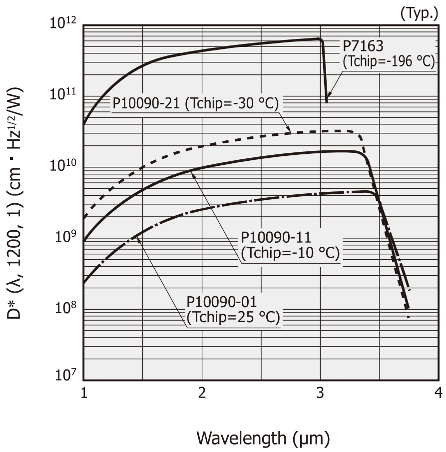
[Figure 4-1] Band gap energy and peak sensitivity wavelength vs. composition ratio x of $InAs_xSb_{1-x}$



InAs photovoltaic detectors include a non-cooled type, TE-cooled type (Tchip=-10 °C, -30 °C), and liquid nitrogen cooled type (Tchip=-196 °C) which are used for different applications. InAsSb photovoltaic detectors are available in non-cooled type and TE-cooled type (Tchip=-30 °C), and the non-cooled type includes a type with a band-pass filter and a two-element type that can detect two wavelengths. InSb photovoltaic detectors are only available as liquid nitrogen cooled types. Figure 4-2 shows spectral responses of InAs/InAsSb/InSb photovoltaic detectors. Cooling these detectors shifts their cutoff wavelengths to the shorter wavelength side.

[Figure 4-2] Spectral response

(a) InAs photovoltaic detectors



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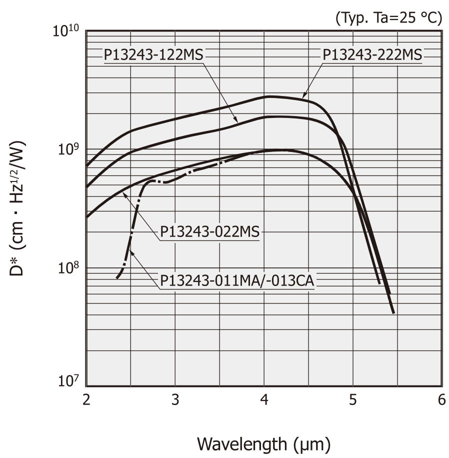
(b) InAsSb photovoltaic detectors
(cutoff wavelength: 5 μm band)



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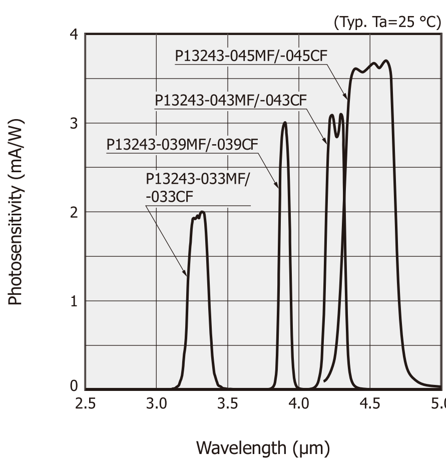
(c) InAsSb photovoltaic detectors with band-pass filter



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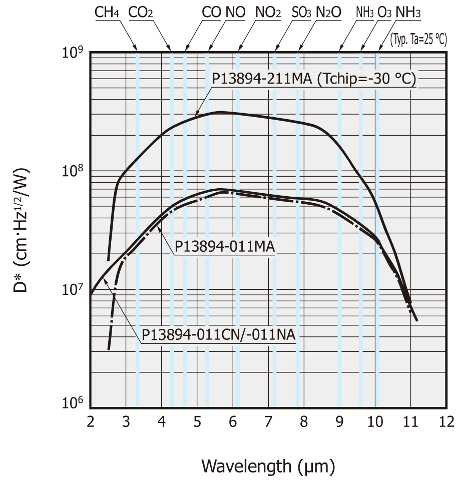
(d) InAsSb photovoltaic detectors
(cutoff wavelength: 10 μm band)



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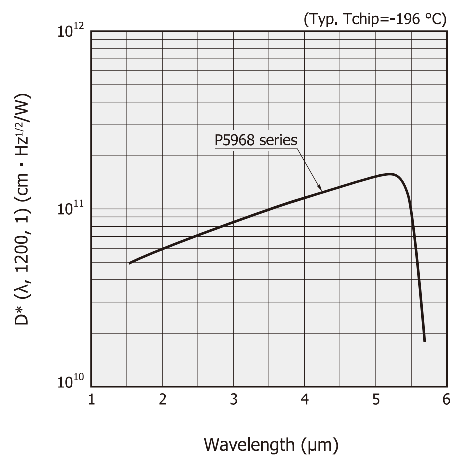
(e) InSb photovoltaic detectors



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Noise characteristics

InAs/InAsSb/InSb photovoltaic detector noise (i) results from Johnson noise (ij) and shot noise (isD) due to dark current (including photocurrent generated by background light). Each type of noise is expressed by the following equations:

$$i = \sqrt{ij^2 + isD^2} \quad \cdots\cdots\cdots\cdots\cdots \text{(4-1)}$$

$$ij = \sqrt{4k\ T\ B/Rsh} \quad \cdots\cdots\cdots\cdots \text{(4-2)}$$

$$isD = \sqrt{2q\ I_D\ B} \quad \cdots\cdots\cdots\cdots\cdots \text{(4-3)}$$

k : Boltzmann's constant
T : absolute temperature of element
B : noise bandwidth
Rsh: shunt resistance
q : electron charge
I_D : dark current

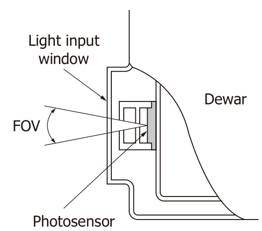
When considering the spectral response range of InSb photovoltaic detectors, background light fluctuations (background radiation noise) from the surrounding areas cannot be ignored. The D* of photovoltaic detectors is given by equation (4-4) assuming that the background radiation noise is the only noise source.

$$D^* = \frac{\lambda \sqrt{\eta}}{h\,c \sqrt{2Q}} \ [\mathrm{cm} \cdot \mathrm{Hz}^{1/2}/\mathrm{W}] \cdots\cdots\cdots (4\text{-}4)$$

λ : wavelength
η : quantum efficiency
h : Planck's constant
c : speed of light
Q: background photon flux [photons/cm^2·s]

To reduce background radiation noise, the detector's field of view (FOV) must be limited by using a cold shield or unwanted wavelengths must be eliminated by using a cooled band-pass filter. Figure 4-4 shows how the D* relates to the field of view.

[Figure 4-3] Field of view (FOV)



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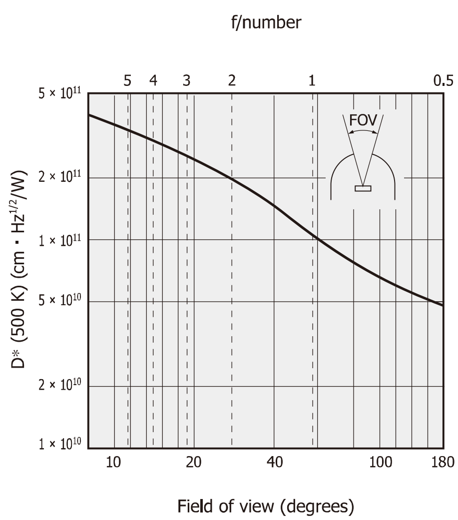
[Figure 4-4] D* vs. field of view (P5968-060, typical example)



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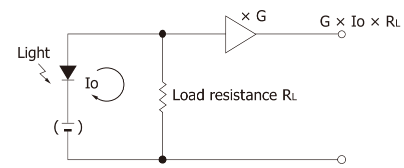
4 - 2 How to use

Operating circuit

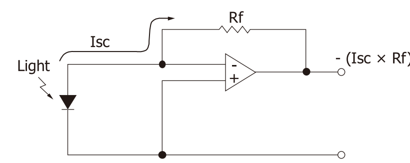
Figure 4-5 shows connection examples for InAs/InAsSb/InSb photovoltaic detectors. The photocurrent is extracted as a voltage using a load resistor or op amp. When connecting an op amp to an InAs/InAsSb photovoltaic detector with low shunt resistance, we recommend the use of an op amp with low voltage noise.

[Figure 4-5] Connection examples

(a) When load resistor is connected



(b) When op amp is connected



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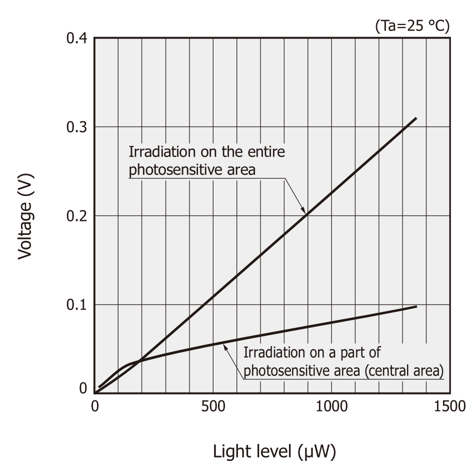
Light incidence

The P12691-201G has a lens built in the product, so it uses collimated light for light incidence. Focusing light in front of the detector may reduce the output.
When using the P13243 series or P13894 series, it is necessary to irradiate the entire photosensitive area uniformly. If you irradiate only a part of the photosensitive area, the output signal may become smaller and linearity may deteriorate [Figure 4-6].

[Figure 4-6] Linearity (P13243 series, typical example)



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Resistance measurement

Measuring the resistance of InAs/InAsSb/InSb photovoltaic detectors with a multimeter might damage the detectors. This risk is even higher at room temperature, so always cool the detector when making this measurement. In this case, the bias voltage applied to the device must be less than the value of the absolute maximum ratings.

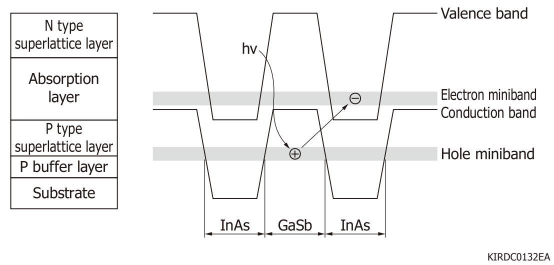
5. Type II superlattice infrared detector

Type II superlattice infrared detector is a photovoltaic 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. It is a replacement for conventional products that contain these substances.

5 - 1 Structure

By stacking thin films of InAs and GaSb alternately, energy bands (minibands) which are not found in bulk crystals are formed. The position of the miniband can be controlled by changing its thickness and composition.

[Figure 5-1] Cross-sectional structure and energy levels

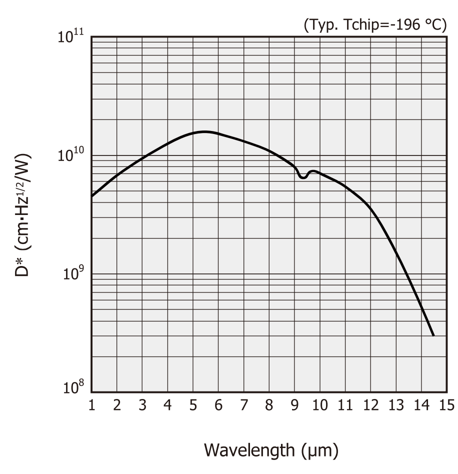


5 - 2 Characteristics

Spectral response

Type II superlattice infrared detector is liquid nitrogen cooled type. Figure 5-2 shows spectral response.

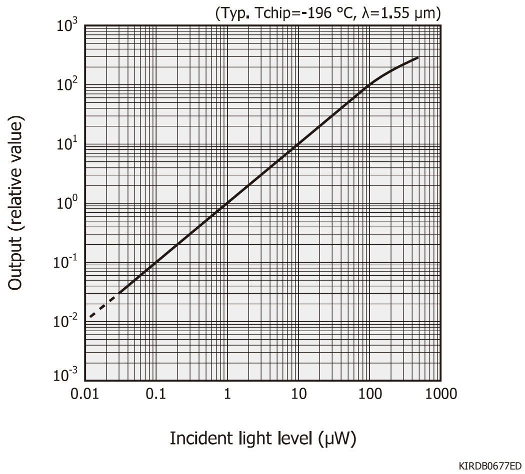
[Figure 5-2] Spectral response



Linearity

The linearity of type II superlattice infrared detectors is about two orders of magnitude better than a conventional MCT photoconductive detector.

[Figure 5-3] Linearity



5 - 3 How to use

Operating circuit

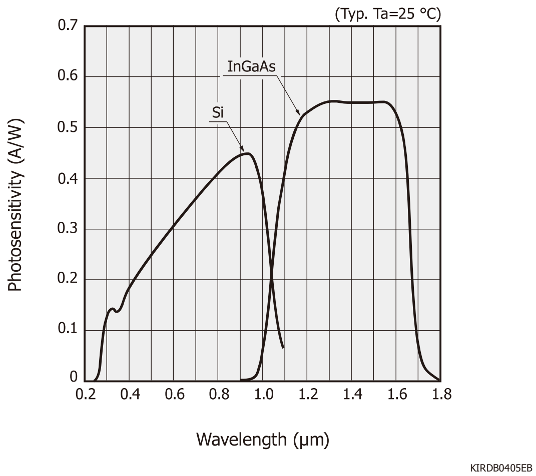
Using an op amp, the photocurrent is converted into voltage and then the converted voltage is output. For details, see “1. InGaAs PIN photodiodes | 1-2 How to use (P.8)”.

Background radiation

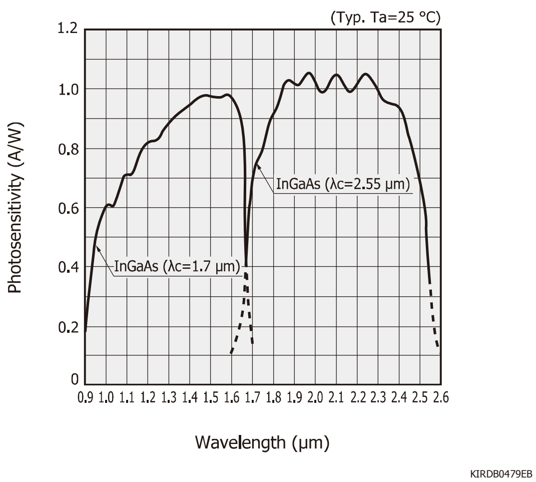
In infrared measurement, background radiation that is not the signal light affects the measurement. Use a cold shield to set the proper FOV, so as to avoid detecting background radiation.

[Figure 6-2] Spectral response

(a) Si + InGaAs



(b) Standard type InGaAs + long wavelength type InGaAs

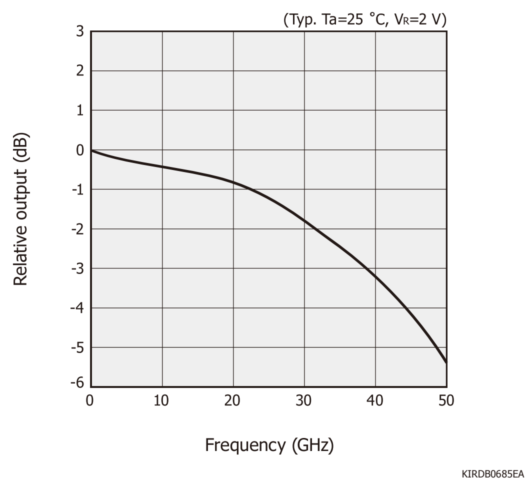


7. New approaches

7 - 1 Ultra high-speed InGaAs PIN photodiodes

As ultra high-speed response photosensors, the product demand for higher-speed photodiodes is on the rise in addition to 25 Gbps and 50 Gbps photodiodes. In this case, it is essential to keep the cost of the system itself from rising, so low power consumption and ease of assembling are required. To ensure the S/N, reduction in sensitivity from previous products is not acceptable. The photodiodes must maintain the present photosensitivity as much as possible and operate at high speed under a low reverse voltage. At the same time, the manufacturing process must integrate optical techniques to guide as much light as possible into a small photosensitive area. We have produced an ultra high-speed InGaAs PIN photodiode that operates from a low reverse voltage and verified its operation on transmission bands up to 64 Gbps at V_R=2 V in combination with an optimum preamp. We are currently working to achieve even higher speeds.

[Figure 7-1] Frequency characteristics



9. Applications

9 - 5 Radiation thermometers

Any object higher than absolute zero degrees radiates infrared light matching its own temperature. The quantity of infrared light actually emitted from an object is not directly determined just by the object temperature but must be corrected according to the object's emissivity (e).
Figure 9-5 shows the radiant energy from a black body. The black body is e=1. Figure 9-6 shows the emissivity of various objects. The emissivity varies depending on temperature and wavelength.
The noise equivalent temperature difference (NEΔT) is used as one measure for indicating the temperature resolution. NEΔT is defined in equation (9-1).

$$NE\Delta T = \frac{L_N}{\left.\frac{dL}{dT}\right|_{T=T_1}} \quad \cdots\cdots\cdots (9\text{-}1)$$

L_N: noise equivalent luminance
T_1: temperature of object

Noise equivalent luminance (L_N) relates to the detector NEP as shown in equation (9-2).

$$NEP = To\, L_N\, \Omega\, Ao / \gamma \quad \cdots\cdots\cdots (9\text{-}2)$$

To : optical system loss
Ω : solid angle from optical system toward measurement area
Ao: aperture area of optical system
γ : circuit system loss

$\left.\frac{dL}{dT}\right|_{T=T_1}$ in equation (9-1) represents the temperature coefficient of radiant luminance (L) from an object at temperature T_1. The radiant luminance can be obtained by integrating the spectral radiant exitance over the wavelength range (λ_1 to λ_2) being observed.

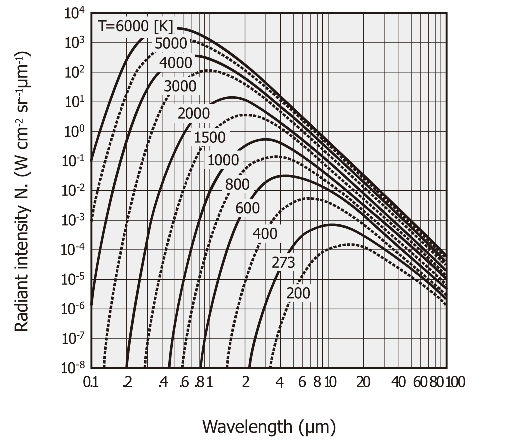
$$L = \int_{\lambda_1}^{\lambda_2} \frac{1}{\pi} M_\lambda \, d\lambda \quad \cdots\cdots\cdots (9\text{-}3)$$

M_λ: spectral radiant exitance

Radiation thermometers offer the following features compared to other temperature measurement methods.

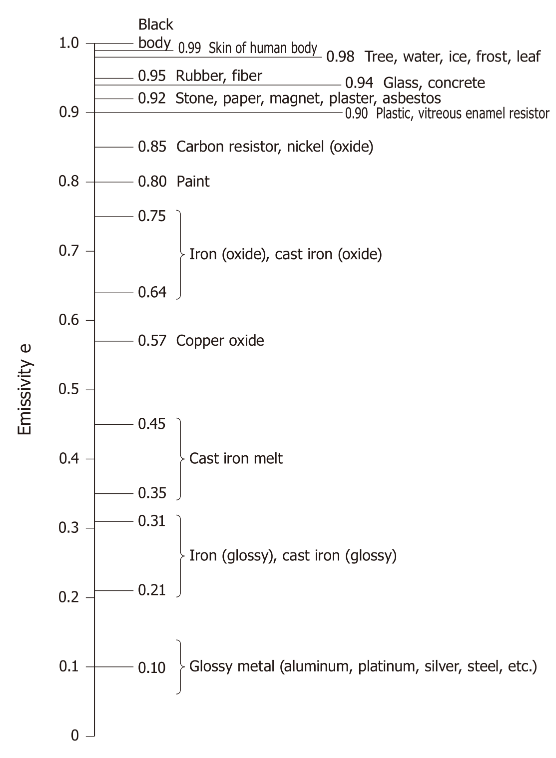
- Non-contact measurement avoids direct contact with object.
- High-speed response
- Easy to make pattern measurements

[Figure 9-5] Black body radiation law (Planck's law)



Infrared detectors for radiation thermometers should be selected according to the temperature and material of the object to be measured. For example, peak emissivity wavelength occurs at around 5 μm in glass materials and around 3.4 μm or 8 μm in plastic films, so a detector sensitive to these wavelength regions must be selected.
Infrared detectors combined with an infrared fiber now make it possible to measure the temperature of objects in hazardous locations such as complex internal structures, and objects in a hot, vacuum, or in high-pressure gases.

[Figure 9-6] Emissivity of various objects



9 - 12 FTIR

The FTIR (Fourier transform infrared spectrometer) is an instrument that acquires a light spectrum by Fourier-transforming interference signals obtained with a double-beam interferometer. It has the following features:

· High power of light due to non-dispersive method (simultaneous measurement of multiple spectral elements yields high S/N)
· High wavelength accuracy

The following specifications are required for infrared detectors that form the core of the FTIR.

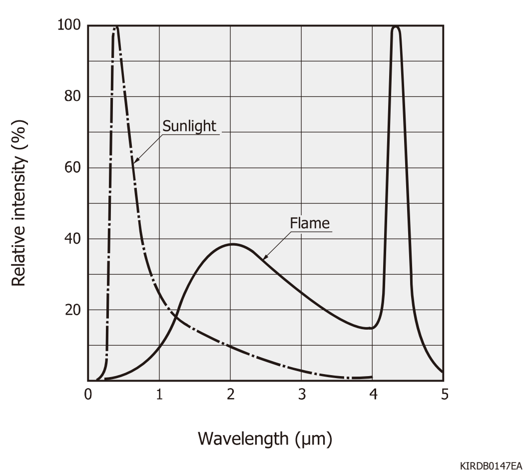
· Wide spectral response range
· High sensitivity
· Photosensitive area size matching the optical system
· Wide frequency bandwidth
· Excellent linearity versus incident light level

Thermal type detectors are generally used over a wide spectral range from 2.5 µm to 25 µm. Quantum type detectors such as InAs, InAsSb, and InSb are used in high-sensitivity and high-speed measurements.

9 - 7 Flame eyes (flame monitors)

Flame eyes detect light emitted from flames to monitor the flame burning state. Radiant wavelengths from flames cover a broad spectrum from the ultraviolet to infrared region as shown in Figure 9-9. Flame detection methods include detecting a wide spectrum of light from ultraviolet to infrared using a two-color detector, and detecting near infrared region or light with 4.3 µm wavelength using an InAsSb photovoltaic detector.

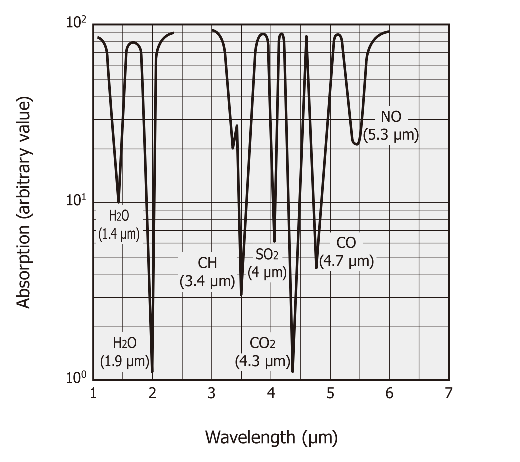
[Figure 9-9] Radiant spectrum from flame



9 - 9 Gas analyzers

Gas analyzers measure gas concentrations by making use of the fact that gases absorb specific wavelengths of light in the infrared region. Gas analyzers basically utilize two methods: a dispersive method and a non-dispersive method. The dispersive method disperses infrared light from a light source into a spectrum and measures the absorption amount at each wavelength to determine the constituents and quantities of the sample. The non-dispersive method measures the absorption amounts only at particular wavelengths. The non-dispersive method is currently the method mainly used for gas analysis. Non-dispersive method gas analyzers are used for measuring automobile exhaust gases (CO, CH, CO_2) and exhaled respiratory gas components (CO_2), as well as for regulating fuel exhaust gases (COx, SOx, NOx) and detecting fuel leaks (CH_4, C_2H_6). Further applications include CO_2 (4.3 µm) measurements in carbonated beverages (soft drinks, beer, etc.) and sugar content (3.9 µm) measurement. Figure 9-10 shows absorption spectra of various gases.
Hamamatsu provides InGaAs, InAs, InAsSb, InSb, and the like. as sensors to measure the various light wavelengths. Quantum cascade lasers (QCL; middle infrared semiconductor lasers) are also available for use in gas analyzers. There is a lineup of products with specific oscillation wavelength in the middle infrared region (4 to 10 µm).

[Figure 9-10] Gas absorption spectra



Infrared detector modules with preamp

Non-cooled and thermoelectrically cooled types

Easy-to-use detector modules with built-in preamps

Infrared detector modules operate just by connecting to DC power supplies. Low noise thermoelectric cooled types using InGaAs, InAs, InSb or InAsSb elements are available. We welcome requests for custom devices that suit your application.

Features

- **High S/N**
- **Compact size**
- **Easy to use**
  Operates just by connecting to DC power supply
- **Circuit design optimized for detector characteristics**
- **Built-in temperature control circuit (TE-cooled type)**

Applications

- **Infrared detection**

Accessories

- **4-conductor cable for non-cooled type (for DC power supply): 2 m (with one side connector)**
  A4372-02: C12494-011LH
- **6-conductor cable for TE-cooled type (for DC power supply): 2 m (with one side connector)**
  A4372-07: C12485-210, C12486-210, C12483-250, C12492-210, C12494-210S/-210M/-211L
- **Instruction manual**

Structure

Type no.	Detector element	Cooling	Window material	Photosensitive area (mm)	Supply voltage Vcc*1 (V)	Supply voltage Vp*1 (V)
C12483-250	InGaAs (G12180-250A)	Two-stage TE-cooled	AR coated (1.55 μm peak) borosilicate glass	ϕ5	±15 ± 0.5	$+2.5^{+0.5}_{-0.1}$
C12485-210	InGaAs (G12182-210K)	Two-stage TE-cooled	Borosilicate glass	ϕ1		$+2.5^{+0.5}_{-0.1}$
C12486-210	InGaAs (G12183-210K)					
C12492-210	InAs (P10090-21)	Two-stage TE-cooled	Sapphire glass	ϕ1		$+2.5^{+0.5}_{-0.1}$
C12494-210S	InAsSb (P11120-201)	Two-stage TE-cooled	Sapphire glass	ϕ1		$+2.5^{+0.5}_{-0.1}$
C12494-210M	InAsSb (P12691-201G)		AR coated Ge			
C12494-011LH	InAsSb (P13894-011NA)	Non-cooled	None	1 × 1	±2.5 ± 0.2	-
C12494-211L	InAsSb (P13894-211MA)	Two-stage TE-cooled	AR coated Ge		±15 ± 0.5	$+2.5^{+0.5}_{-0.1}$

*1: Vcc=power supply for circuit, Vp=power supply for cooling

Absolute maximum ratings

Type no.	Incident light level (μW)	Supply voltage Vcc (V)	Supply voltage Vp (V)	Operating temperature*2 Topr (°C)	Storage temperature*2 Tstg (°C)
C12483-250	0.2	±18	+5	0 to +40	-20 to +50
C12485-210	0.06				
C12486-210	0.07				
C12492-210	2.6				
C12494-210S	26		+5		
C12494-210M					
C12494-011LH	50 mW	±2.7	-		
C12494-211L	28 mW	±18	+5		

*2: No dew condensation
When there is a temperature difference between a product and the surrounding area in high humidity environments, dew condensation may occur on the product surface. Dew condensation on the product may cause deterioration in characteristics and reliability.
Note: Exceeding the absolute maximum ratings even momentarily may cause a drop in product quality. Always be sure to use the product within the absolute maximum ratings.

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

Type no.	Chip temperature at rated supply voltage Tchip (°C)	Peak sensitivity wavelength λp (μm)	Cutoff wavelength λc (μm)	Photosensitivity*3 S λ=λp Min. (V/W)	Photosensitivity*3 S λ=λp Typ. (V/W)	Noise equivalent power NEP λ=λp Typ. ($W/Hz^{1/2}$)	Noise equivalent power NEP λ=λp Max. ($W/Hz^{1/2}$)
C12483-250	-15	1.55	1.66	3.3×10^{7}	5×10^{7}	7×10^{-14}	7×10^{-13}
C12485-210		1.95	2.05	1.1×10^{8}	1.8×10^{8}	1×10^{-13}	3×10^{-12}
C12486-210		2.3	2.56	1×10^{8}	2×10^{8}	4×10^{-13}	6×10^{-12}
C12492-210	-28	3.25	3.45	0.8×10^{7}	1×10^{7}	6×10^{-12}	1×10^{-11}
C12494-210S	-28	4.9	5.9	5×10^{5}	7.5×10^{5}	1×10^{-10}	3×10^{-10}
C12494-210M		6.7	8.3				
C12494-011LH	25	5.6	11	24*4	40*4	5×10^{-9}	9×10^{-9}
C12494-211L	-28		10.2	2.5×10^{2}*4	3.5×10^{2}*4	1.5×10^{-9}	4.5×10^{-9}

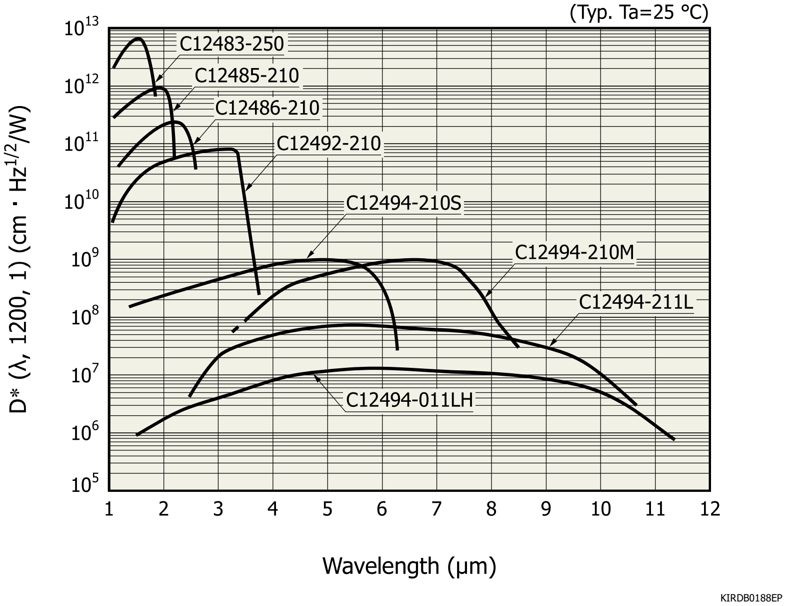
*3: f=100 Hz (C12485-210, C12486-210, C12483-250), f=1.2 kHz (C12492-210, C12494-210S/-210M/-011LH/-211L)
*4: Uniform irradiation on the entire photosensitive area.

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

Type no.	Frequency response -3 dB (Hz) FcL Typ.	Frequency response -3 dB (Hz) FcH Min.	Frequency response -3 dB (Hz) FcH Typ.	Output impedance (Ω)	Maximum output voltage RL=1 kΩ (V)	Current consumption*5 Vcc Typ. (mA)	Current consumption*5 Vcc Max. (mA)	Current consumption*5 Vp Typ. (mA)	Current consumption*5 Vp Max. (mA)
C12483-250	DC	900	1.1 k	50	+10	+30, -22	+50, -30	+500	+1100
C12485-210	DC	1.5 k	2.2 k			+30, -13	+60, -30		
C12486-210	DC	2.1 k	3 k			+30, -14	+60, -30		
C12492-210	5	40 k	50 k		±13	+30, -20	+80, -30	+600	
C12494-210S	5	80 k	100 k		±13	+30, -20	+80, -30	+600	
C12494-210M									
C12494-011LH	DC	40 M	50 M		±2	±35	±45	-	-
C12494-211L		750 k	1 M		+10	+30, -20	+80, -30	+500	+1100

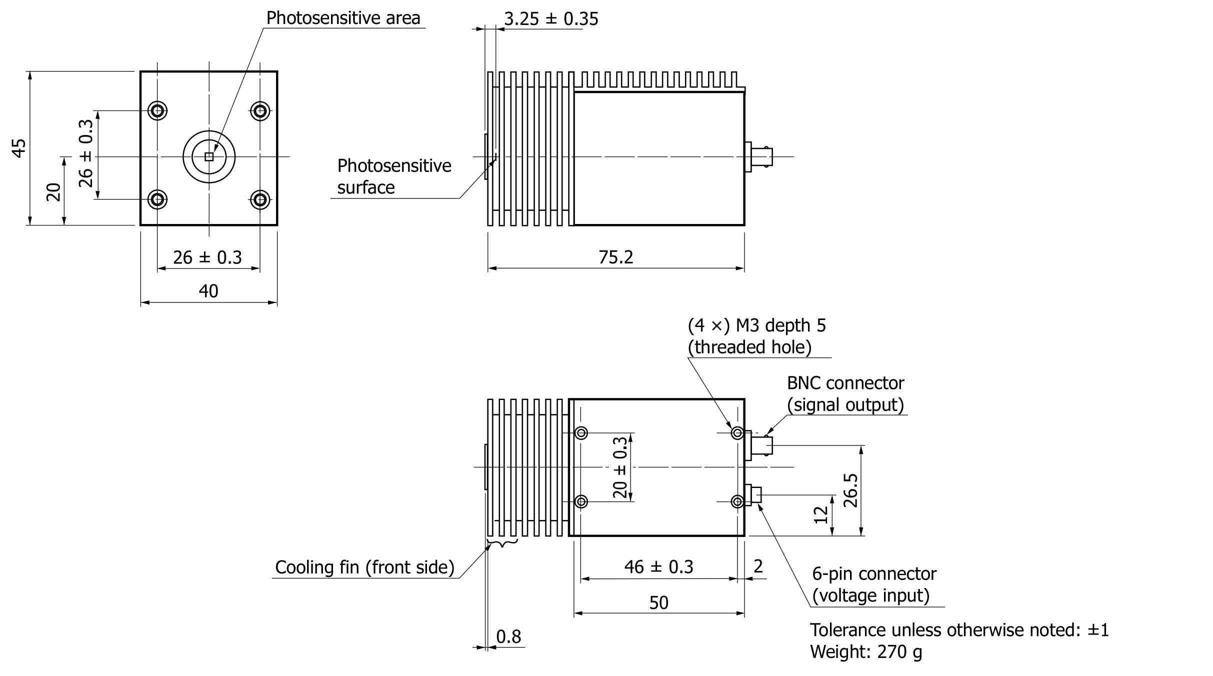
*5: Vcc=±15 V, Vp=2.5 V (C12485-210, C12486-210, C12483-250, C12492-210, C12494-210S/-210M/-211L), Vcc=±2.5 V (C12494-011LH)
Recommended DC power supply (analog power supply): PW18-1.3ATS (TEXIO Technology), E3630A (Keysight Technologies)
Current capacity: More than 1.5 times the maximum current consumption
Ripple noise: 5 mVp-p or less (±15 V, +2.5 V, +4.5 V power supply)

Spectral response

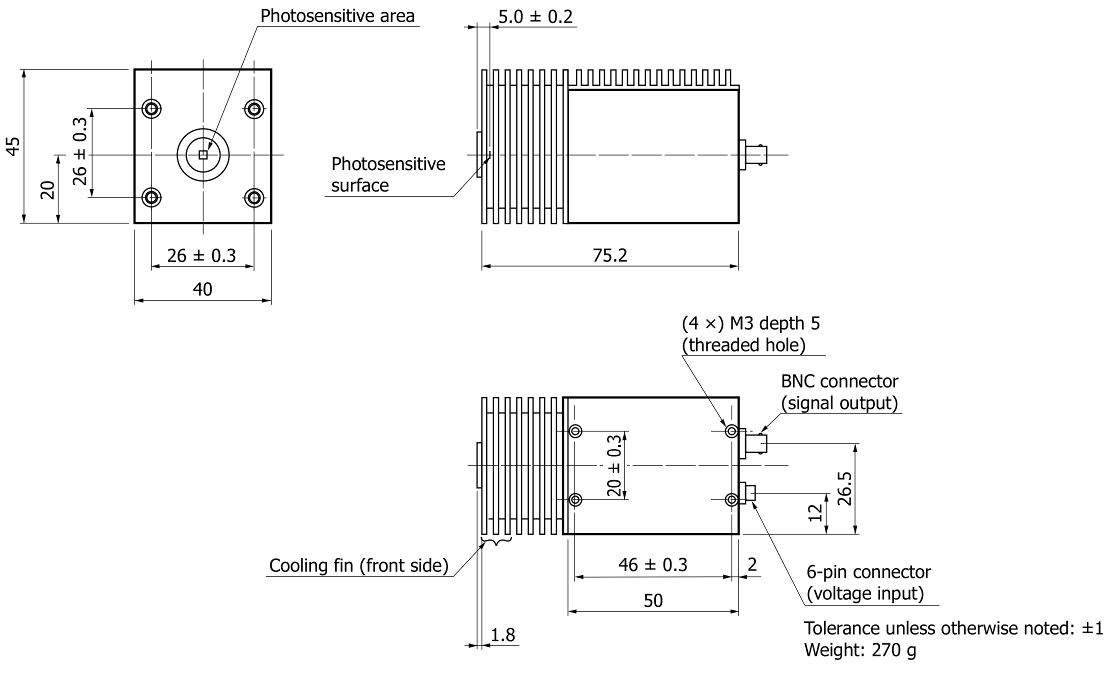


Dimensional outlines (unit: mm)

C12485-210, C12486-210, C12483-250, C12492-210, C12494-210S/-211L

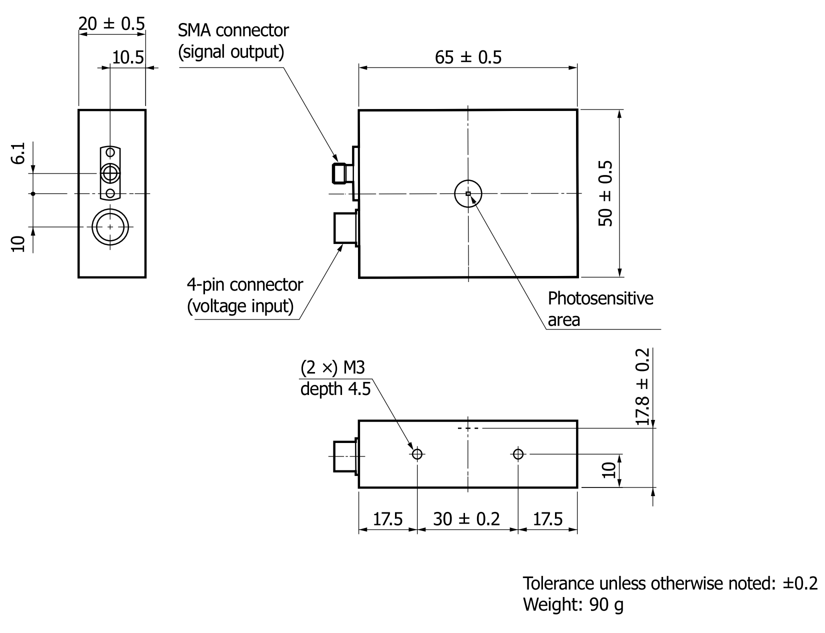


C12494-210M

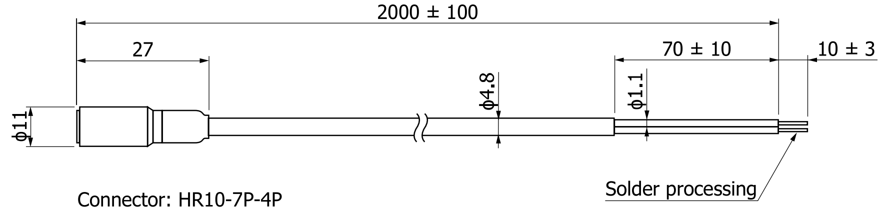


Note: The cooling fin (front side) is removable.

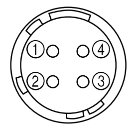
C12494-011LH



4-conductor cable (for DC power supply) A4372-02



Connector: HR10-7P-4P
(made by Hirose Electric)



Connector end

Pin no.	Pin connection	Lead color
①	+15 V or +2.5 V	White
②	GND	Black/white/blue stranded wire
③	GND	
④	-15 V or -2.5 V	Blue

Tolerance unless otherwise noted: ±1

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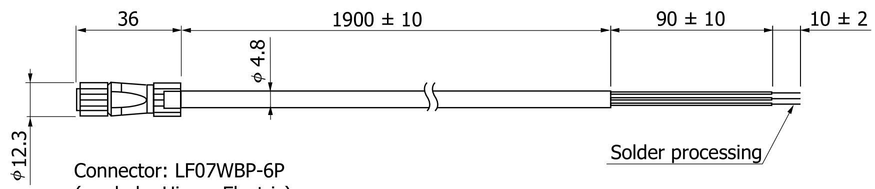
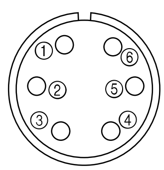
6-conductor cable (for DC power supply) A4372-07



Connector: LF07WBP-6P
(made by Hirose Electric)



Connector

Pin no.	Pin connection	Lead color
①	+2.5 V or +4.5 V Power supply for cooling controller	Red
②	GND Power supply for cooling controller	Blue
③	Output for temperature monitor	Light green
④	+15 V	Yellow
⑤	-15 V	White
⑥	GND	Black

Note: The bare wire is for GND of the case.

Tolerance unless otherwise noted: ±1

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Precautions

- Always use a dual-polarity ±15 V or ±2.5 V power supply to operate this detector. Never use a single-polarity power supply. Using a single-polarity power supply may cause the amplifier in the detector module to break down.
- Regarding TE-cooled type, always supply +2.5 V or +4.5 V to cool the detector element.
- Be careful not to apply excessive force to the detector surface. Applying excessive force may damage the light input window. Do not directly touch the light input window with bare hands. If dust or dirt gets on the window, wipe it gently using ethyl alcohol.
- The C12494-011LH has an unsealed detector. Be sure to see the "Unsealed products / Precautions" the related information before use.
- Do not drop this product or do not apply excessive shock to it.

Related information

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

■ Precautions
- Disclaimer
- Safety consideration
- Unsealed products
- Compound opto-semiconductors (photosensors, light emitters)

■ Technical information
- Compound semiconductor photosensors / Technical note

Information described in this material is current as of February 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.

HAMAMATSU

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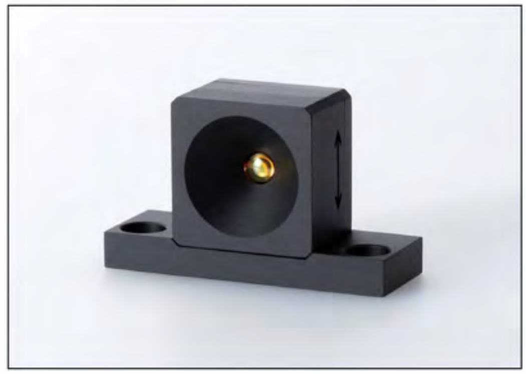
Quantum Cascade Photodetector
P16309-01

■ Features

- Ultrafast MIR photodetector with over 20 GHz response
- Response frequency range (-3 dB): DC to 20 GHz
- Peak sensitive wavelength: 4.65 μm
- Photosensitivity: 1 mA/W (Typ.)
- No cooling, and no operation bias are required



■ Applications

- Heterodyne detection
- High frequency/high time resolved measurement

■ Outline

This is a ultrafast mid-infrared photodetector with a response bandwidth of 20 GHz (-3 dB). It operates bias free with no cooling required, so no external power supplies are needed. Setup happens in two simple steps: connecting the SMA fitting to measuring instruments (oscilloscope etc.), and directing light incidence to the internal focusing lens.

■ General ratings

Parameter	Description	Unit
Connector type	SMA	—
Cooling	Non-cooled	—
Lens	Focusing lens *1	—
Aperture	ϕ4.5	mm
Polarizing direction	Marked in the body *2	—

*1 Incident light have to be colimated.
*2 See "Figure 4"

■ Absolute maximum ratings

Parameter	Symbol	Value	Unit
Opearting temperature *1	T_{opr}	-10 to +50	°C
Storage temperature *1	T_{stg}	-10 to +50	°C
Incident light level	P_{max}	1	W/cm²

*1 No condensation
* No bias is required for the operation.
* Ambient temperature: T_a=25 °C

■ Electrical and optical characteristics

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Peak sensitive wavelength	λ_p	—	4.60	4.65	4.70	μm
Photosensitivity	S	$\lambda=\lambda_p$, f_0=800 Hz, Δf=1 Hz	0.5	1.0	—	mA/W
Detectivity	D*	$\lambda=\lambda_p$, f_0=800 Hz, Δf=1 Hz	8.0×10^8	1.5×10^9	—	$cm \cdot Hz^{1/2}/W$
Noise equivalent power	NEP	$\lambda=\lambda_p$, f_0=800 Hz	—	3.0×10^{-10}	1.0×10^{-9}	$W/Hz^{1/2}$
Cut-off frequency	f_c	-3 dB down, Zi=50 Ω	18	20	—	GHz
Terminal capacitance	C_t	f=1 MHz	—	1.1	1.5	pF
Shunt resistance	R_{sh}	V_{meas}=10 mV	70	90	110	kΩ

* Ambient temperature: T_a=25 °C

Quantum Cascade Photodetector P16309-01

Figure 1: Spectral response (example)

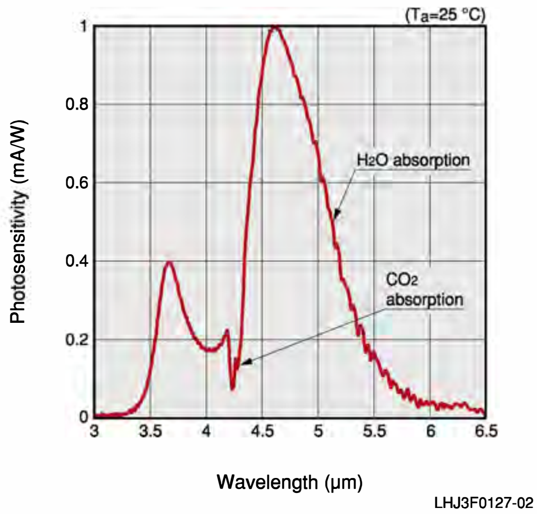


Figure 2: Response frequency (example)

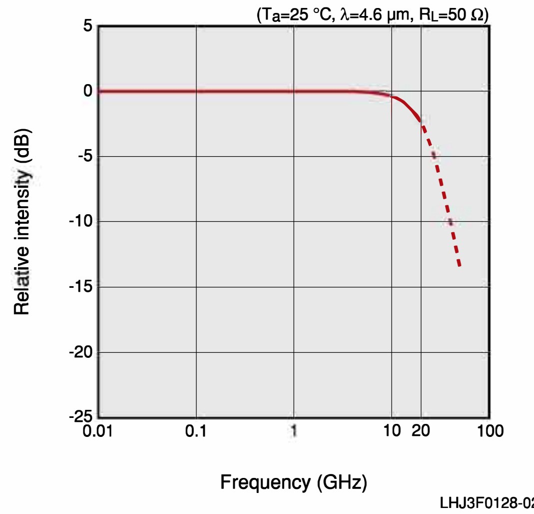
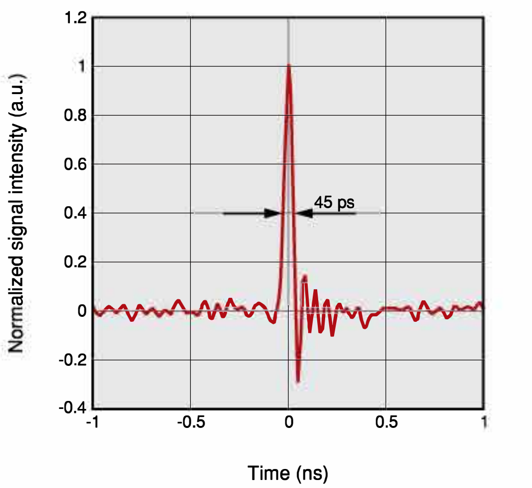
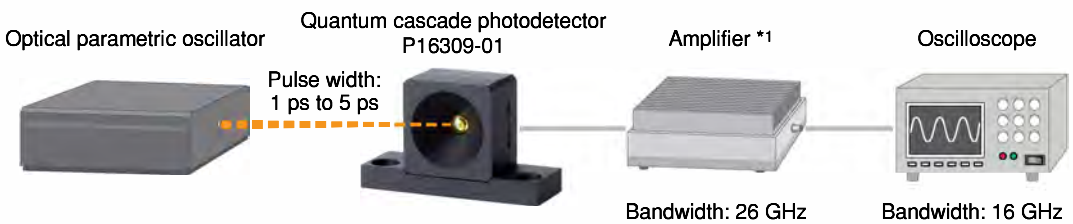


Figure 3: Ultrashort pulse waveform measurement

●Measurement example

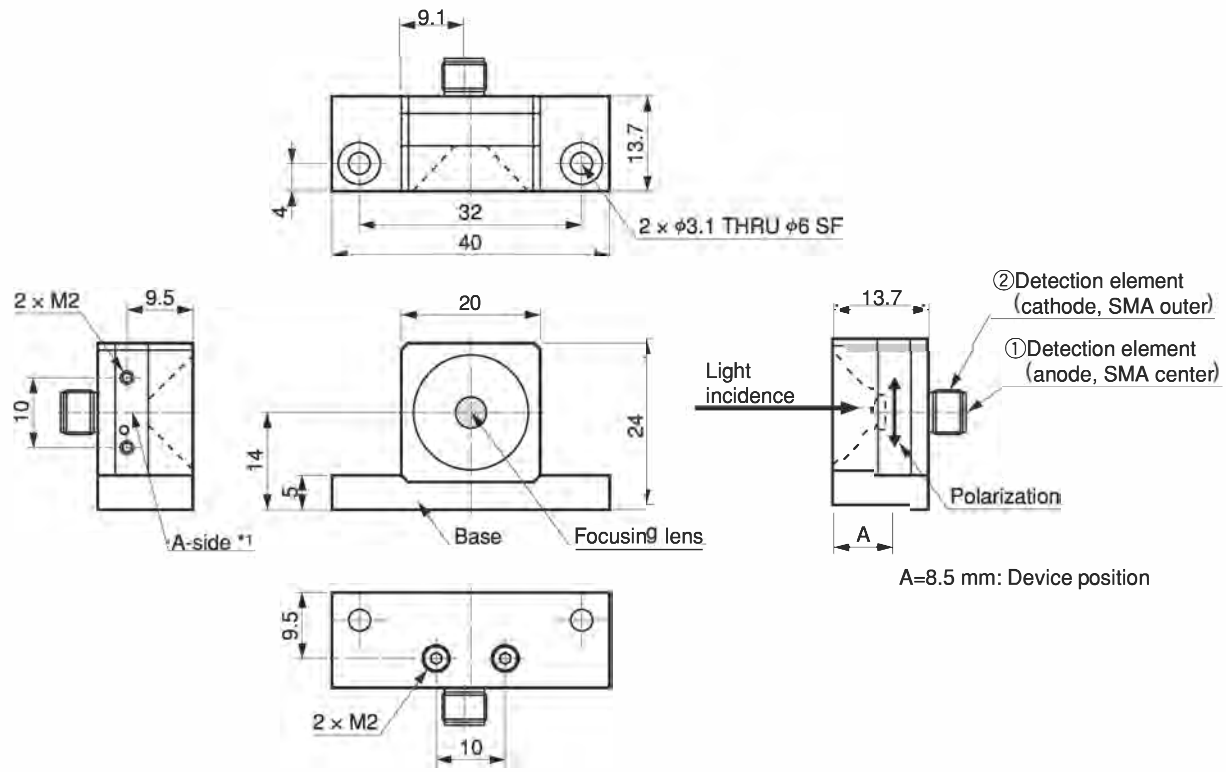


●Measurement configuration



*1 An example: Keysight technologies, 83006A

Figure 4: Dimensions (unit: mm)

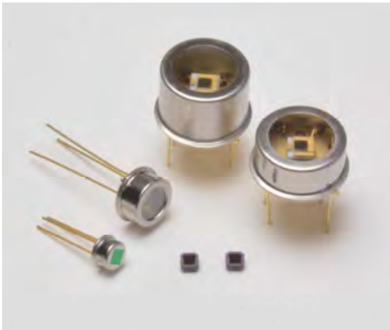


*1 A-side can be fixed on the base as the bottom aspect.
* Tolerances: ±0.3 mm (dimension without an indication)
* Both of ① and ② are electrically insulated from the package.

LHJ3F0111-02

InAsSb photovoltaic detectors

P13243 series



High sensitivity, high-speed response infrared detector up to 5 µm band.

The P13424 series are photovoltaic type detectors that have high sensitivity in the spectral band up to 5 µm. This high sensitivity has been achieved due to Hamamatsu's unique crystal growth technology and process technology. These products are environmentally friendly as they do not use lead, mercury, or cadmium which are substances restricted by the RoHS Directive. Therefore, they are replacements for previous products that contain these substances. The non-cooled types offer easy handing and include the surface mount ceramic type which compatible with lead-free solder reflow. The surface mount ceramic type is compact and suitable for automated mounting. The series also includes the TE-cooled type with a large photosensitive area which delivers stable, high S/N measurement.

Features

- High sensitivity
- High-speed response
- High shunt resistance
- Compact, surface mount type ceramic package (P13243-013CA)
- Compatible with lead-free solder reflow (P13243-013CA)
- TE-cooled type (P13243-122MS/-222MS)
- RoHS compliant (lead, mercury, cadmium free)

Applications

- Gas detection (CH_4, CO_2, CO, etc.)
- Radiation thermometers
- Flame detection (CO_2 resonance radiation)

Options (sold separately)

- 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 infrared detector — C4159-01

Structure

Type no.	Photosensitive area (mm)	Package	Window material	Cooling	Field of view FOV (degrees)
P13243-011MA	0.7 × 0.7	TO-46	Si with AR coating*1	Non-cooled	90
P13243-013CA		Ceramic			102
P13243-022MS	2 × 2	TO-5	Sapphire	Non-cooled	97
P13243-122MS		TO-8		One-stage TE-cooled	134
P13243-222MS				Two-stage TE-cooled	113

*1: Refer to the spectral transmittance of window materials (P.3).

Absolute maximum ratings

Type no.	TE-cooler allowable current (A)	Thermistor power dissipation (mW)	Reverse voltage VR (V)	Operating temperature Topr*2 (°C)	Storage temperature Tstg*2 (°C)	Maximum incident light level (W/cm²)	Soldering temperature Tsol (°C)
P13243-011MA	-	-	1	-40 to +85	-40 to +85	1	-
P13243-013CA	-	-					240 (once)*3
P13243-022MS	-	-					-
P13243-122MS	1.5	0.2		-40 to +60	-40 to +60		-
P13243-222MS	1.0						

*2: No dew condensation
When there is a temperature difference between a product and the surrounding area in high humidity environments, dew condensation may occur on the product surface. Dew condensation on the product may cause deterioration in characteristics and reliability.
*3: Reflow soldering, JEDEC J-STD-020 MSL2, see P.9
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.

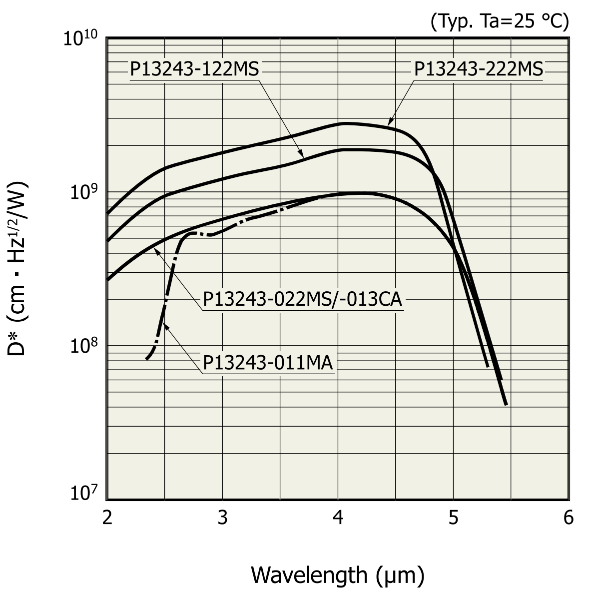
Electrical and optical characteristics (Typ. Ta=25 °C, unless otherwise noted)

Type no.	Chip temperature Tchip (°C)	Peak sensitivity wavelength λp (μm)	Cutoff wavelength λc (μm)	Photosensitivity S*4 λ=λp (mA/W)	Shunt resistance Rsh VR=10mV (kΩ)	Detectivity D* (λp, 1200, 1) Min. (cm·Hz$^{1/2}$/W)	Detectivity D* Typ. (cm·Hz$^{1/2}$/W)	Noise equivalent power NEP λ=λp Typ. (W/Hz$^{1/2}$)	NEP Max. (W/Hz$^{1/2}$)	Rise time tr*5 (ns)	Terminal capacitance Ct*6 (pF)
P13243-011MA	25	4.1	5.3	4.5	300	8.0×10^{8}	1.0×10^{9}	7.0×10^{-11}	8.8×10^{-11}	15	0.7
P13243-013CA											
P13243-022MS	25		5.3	8.0	7	8.0×10^{8}	1.0×10^{9}	2.0×10^{-10}	2.5×10^{-10}	100	20
P13243-122MS	-10		5.2	8.6	19	1.0×10^{9}	1.9×10^{9}	1.0×10^{-10}	2.0×10^{-10}	100	
P13243-222MS	-30		5.1	8.8	33	1.6×10^{9}	2.8×10^{9}	0.7×10^{-10}	1.3×10^{-10}		

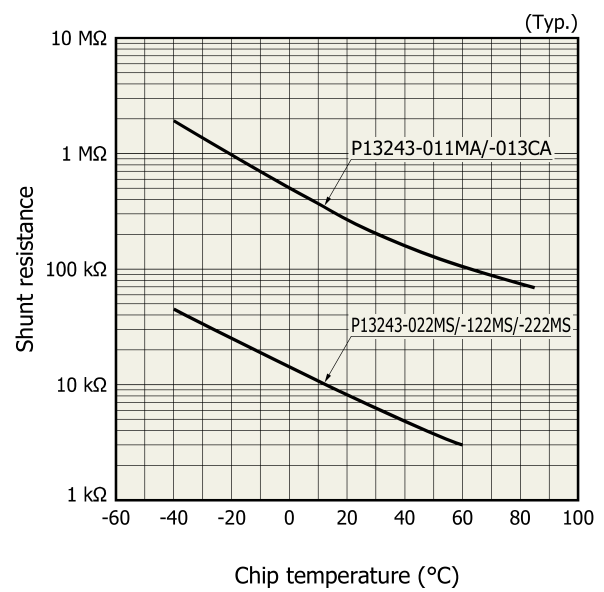
*4: Uniform irradiation on the entire photosensitive area
*5: VR=0 V, RL=50 Ω, 10 to 90%, λ=1.55 μm
*6: VR=0 V, f=1 MHz

Note: Uniform irradiation must be applied to the entire photosensitive area during use.

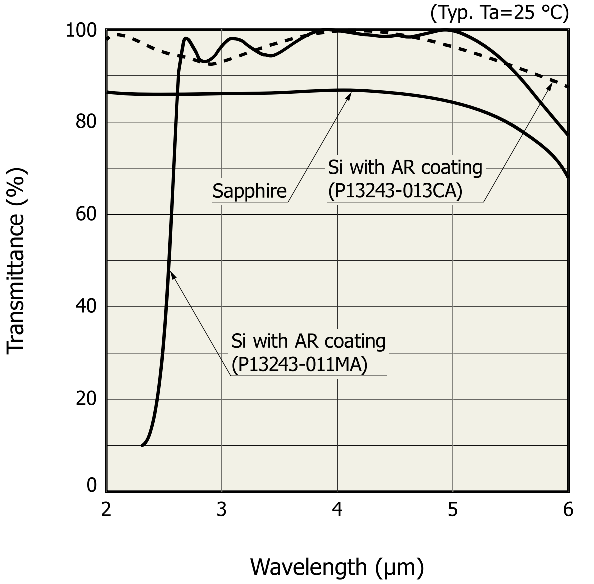
Spectral response (D*)



Shunt resistance vs. chip temperature



Spectral transmittance of window materials



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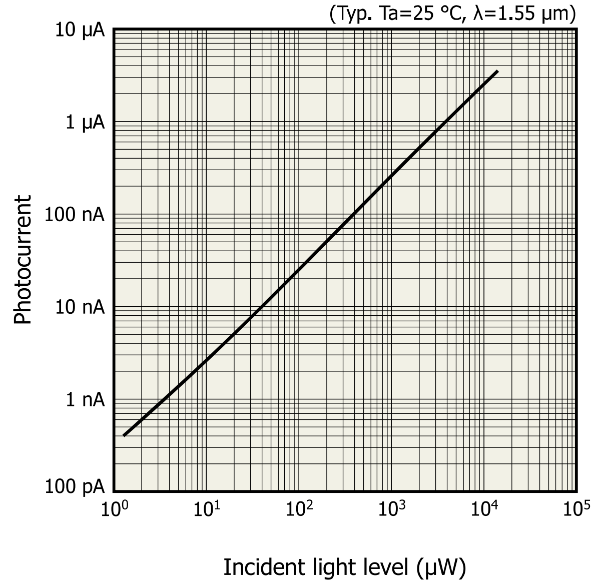
Linearity



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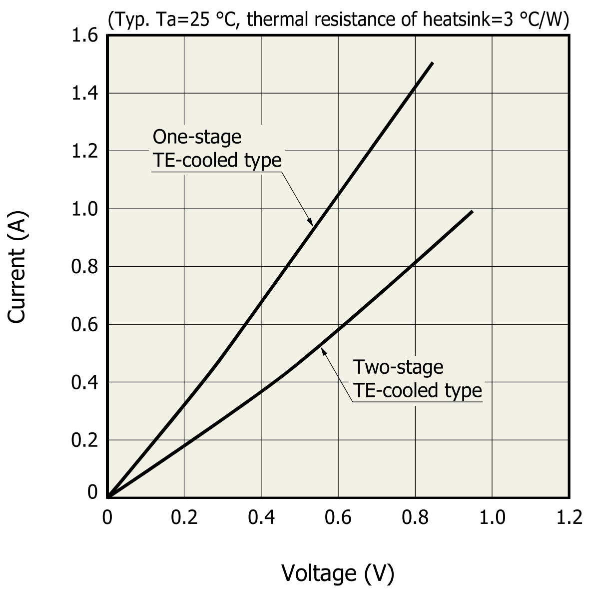
TE-cooler specifications (Ta=25 °C, unless otherwise noted)

Parameter	Condition	Symbol	Min.	Typ.	Max.	Unit
TE-cooler allowable current	One-stage TE-cooled	Ic max	-	-	1.5	A
	Two-stage TE-cooled		-	-	1.0	
TE-cooler allowable voltage	One-stage TE-cooled	Vc max	-	-	1.0	V
	Two-stage TE-cooled		-	-	1.2	
Thermistor resistance		Rth	-	9	-	kΩ
Thermistor B constant	T_1=25 °C, T_2=-20 °C	B	-	3300	-	K
Thermistor power dissipation		Pth	-	-	0.2	mW

Current vs. voltage characteristics of TE-cooler



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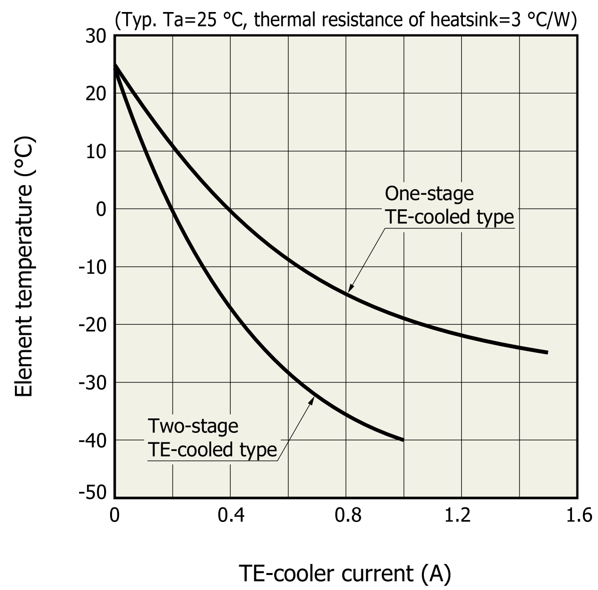
Cooling characteristics of TE-cooler



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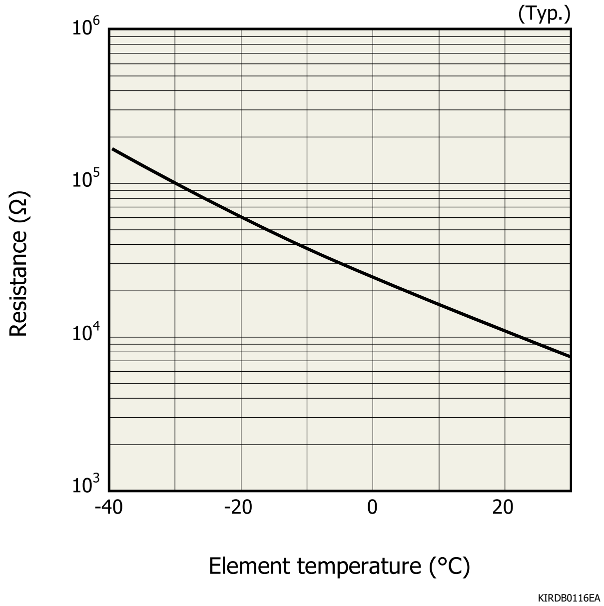
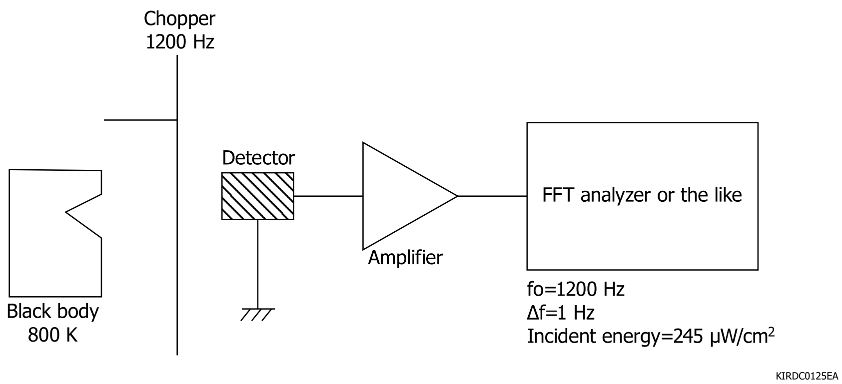
Thermistor temperature characteristics

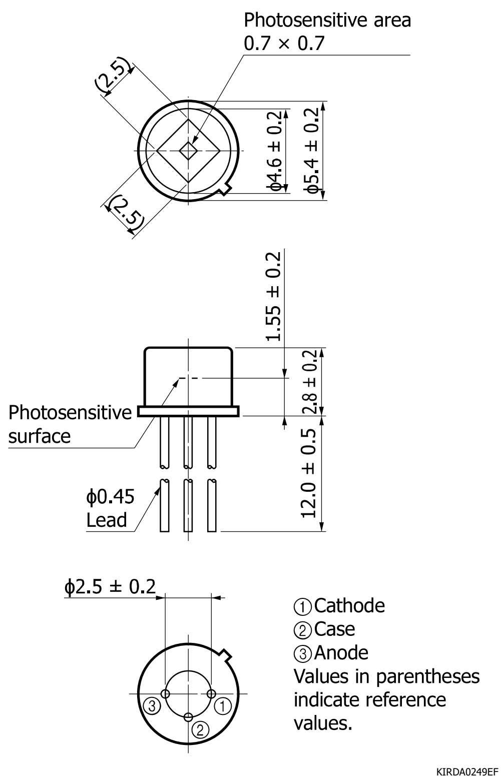


Block diagram for characteristic measurement

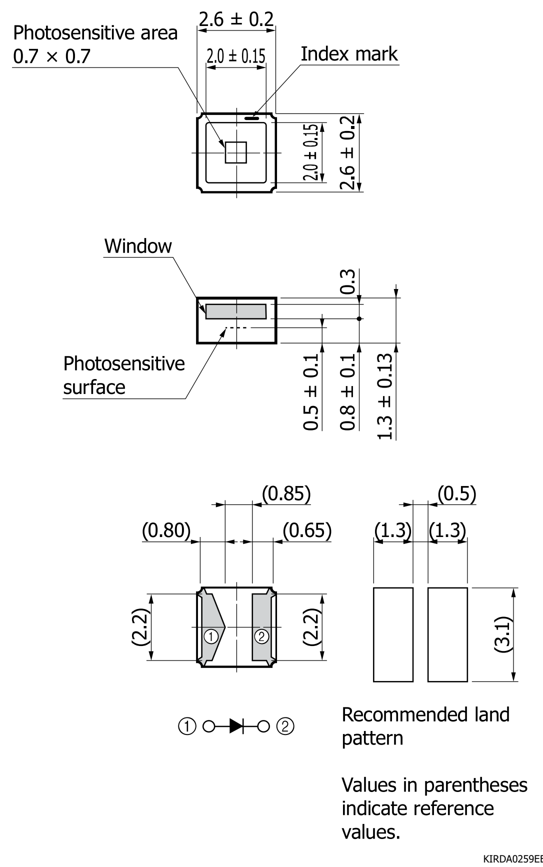


Dimensional outlines (unit: mm)

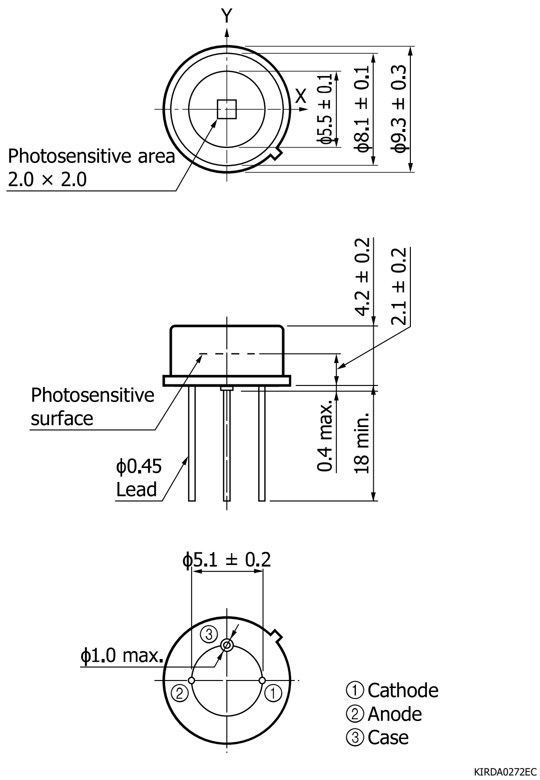
P13243-011MA



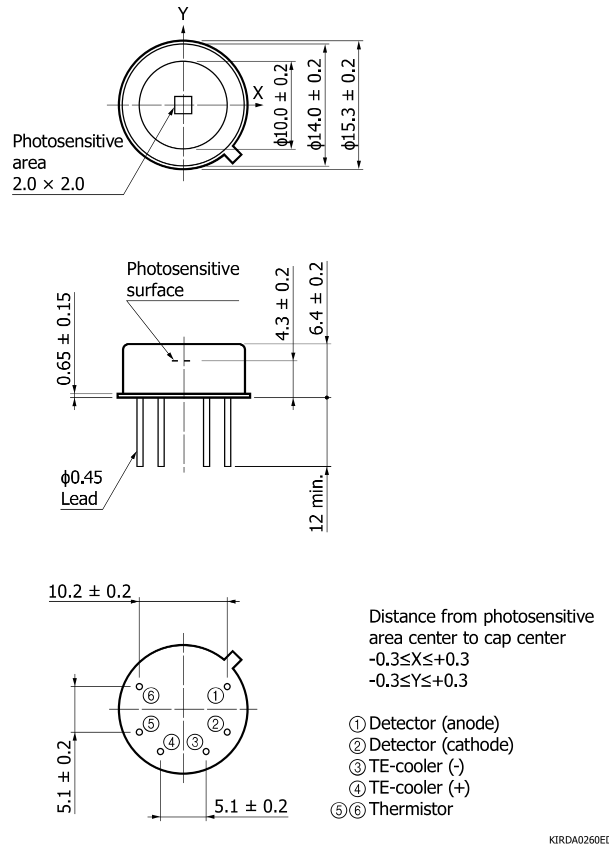
P13243-013CA



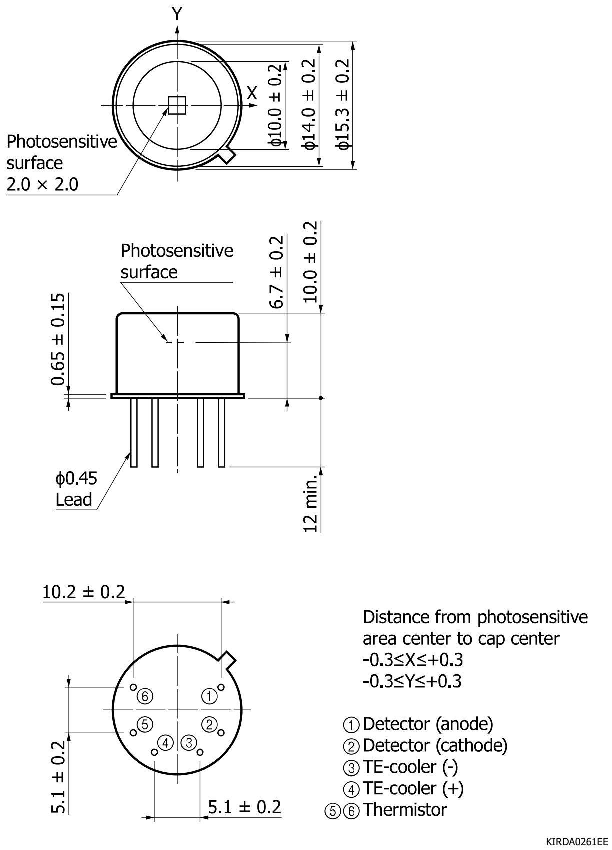
P13243-022MS



P13243-122MS



P13243-222MS



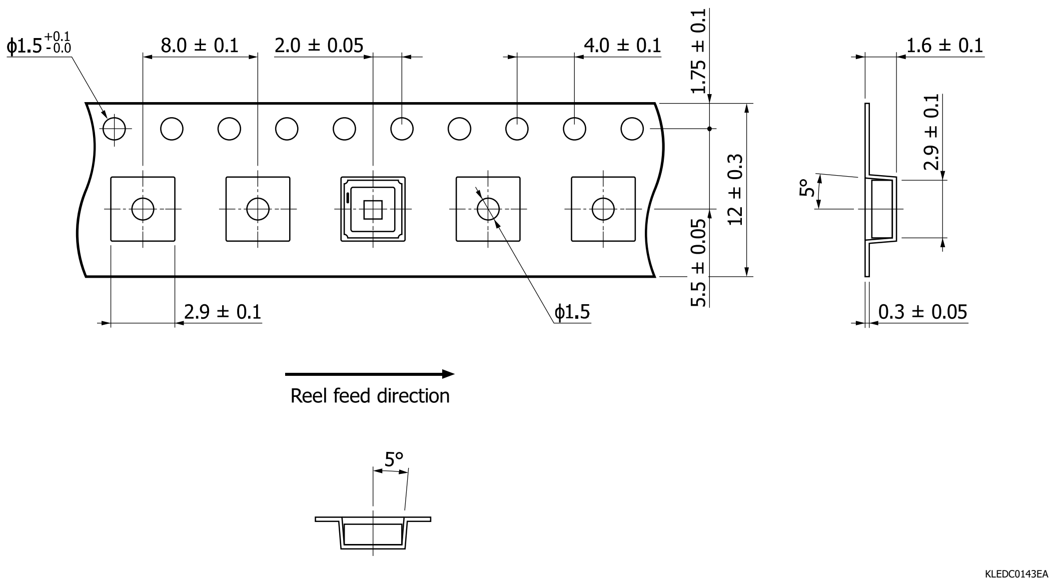
Standard packing specifications

P13243-013CA

■ Reel (conforms to JEITA ET-7200)

Outer diameter	Hub diameter	Tape width	Material	Electrostatic characteristics
ϕ180 mm	ϕ60 mm	12 mm	PS	Conductive

■ Embossed tape (unit: mm, material: PS, conductive)



■ Packing quantity
500 pcs/reel

■ Packing state
Reel and desiccant in moisture-proof packaging (vacuum-sealed)

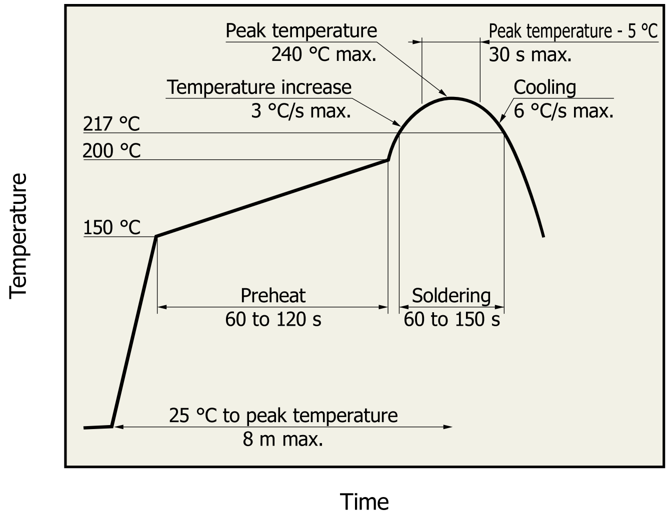
Recommended soldering conditions

P13243-011MA/-022MS/-122MS/-222MS

· Solder temperature: 260 °C (10 s or less, once)
Solder the leads at a point at least 1 mm away from the package body.

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

P13243-013CA

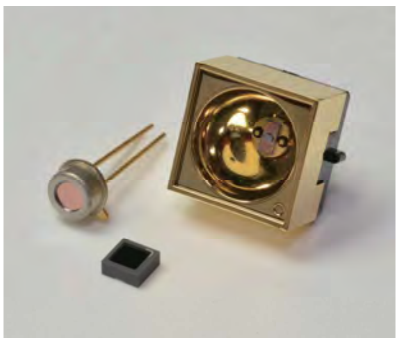


KSPDB0418EA

- After unpacking, store the device in an environment at a temperature range of 5 to 30 °C and a humidity of 60% or less, and perform reflow soldering within 1 year.
- The effect that the product receives during reflow soldering varies depending on the circuit board and reflow oven that are used. When you set reflow soldering conditions, check that problems do not occur in the product by testing out the conditions in advance.

Related products

Mid infrared LED L15893/L15894/L15895 series



Hamamatsu's unique crystal growth and process technologies enable mid infrared LEDs with peak emission wavelengths of 3.3 μm, 3.9 μm, and 4.3 μm.

Type no.	Package
L15893-0330C, L15894-0390C, L15895-0430C	Ceramic
L15893-0330M, L15894-0390M, L15895-0430M	TO-46
L15893-0330ML, L15894-0390ML, L15895-0430ML	TO-46 with reflector

Related information

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

■ Precautions

· Disclaimer

· Compound opto-semiconductors (photosensors, light emitters)

■ Technical information

· Compound semiconductor photosensors / Technical note

Information described in this material is current as of December 2021.

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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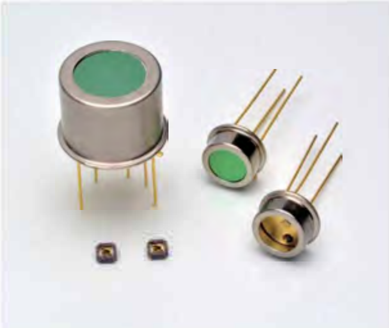
North Europe: Hamamatsu Photonics Norden AB: Torshamnsgatan 35 16440 Kista, Sweden, Telephone: (46)8-509 031 00, Fax: (46)8-509 031 01, E-mail: info@hamamatsu.se
Italy: Hamamatsu Photonics Italia S.r.l.: Strada della Moia, 1 int. 6, 20044 Arese (Milano), Italy, Telephone: (39)02-93 58 17 33, Fax: (39)02-93 58 17 41, E-mail: info@hamamatsu.it
China: Hamamatsu Photonics (China) Co., Ltd.: 1201 Tower B, Jiaming Center, 27 Dongsanhuan Beilu, Chaoyang District, 100020 Beijing, P.R.China, Telephone: (86)10-6586-6006, Fax: (86)10-6586-2866, E-mail: hpc@hamamatsu.com.cn
Taiwan: Hamamatsu Photonics Taiwan Co., Ltd.: 8F-3, No. 158, Section2, Gongdao 5th Road, East District, Hsinchu, 300, Taiwan R.O.C. Telephone: (886)3-659-0080, Fax: (886)3-659-0081, E-mail: info@hamamatsu.com.tw

Cat. No. KIRD1130E13 Dec. 2021 DN



InAsSb photovoltaic detectors

P13894 series

High-speed response and high sensitivity in the spectral band up to 11 μm, infrared detectors

The P13894 series are photovoltaic type detectors that have achieved high sensitivity in the spectral range up to 11 μm using Hamamatsu unique crystal growth technology and process technology. These products are environmentally friendly infrared detectors and do not use mercury or cadmium, which are substances restricted by the RoHS Directive. They are replacements for previous products that contain these substances. A compact surface mount type has been added to the easily handled non-cooling type.

Features

- High sensitivity
- High-speed response
- High shunt resistance
- Non-cooled (P13894-011CN/-011NA/-011MA)
- Compact, surface mount ceramic package (P13894-011CN)
- Compatible with lead-free reflow soldering (P13894-011CN)

Applications

- Gas detection (CH_4, CO_2, CO, NH_3, O3, etc.)
- Radiation thermometers

Options (sold separately)

- Heatsink for two-stage TE-cooled type A3179-01
- Temperature controller for TE-cooled type C1103-04
- Amplifier for infrared detector C4159-01

Structure

Parameter	NEW P13894-011CN	P13894-011NA	P13894-011MA	P13894-211MA	Unit
Window material	None	None	Ge with AR coating	Ge with AR coating	-
Package	Ceramic	TO-5		TO-8	-
Cooling	Non-cooled			Two-stage TE-cooled	-
Photosensitive area	1 × 1				mm
Field of view (FOV)	102	97		113	degrees

Absolute maximum ratings

Parameter	Symbol	Condition	NEW P13894-011CN	P13894-011NA	P13894-011MA	P13894-211MA	Unit
Reverse voltage	V_R		1				V
Operating temperature	Topr	No dew condensation*1	-40 to +85		-40 to +60		°C
Storage temperature	Tstg	No dew condensation*1	-40 to +85		-40 to +60		°C
Soldering conditions			*2	260 °C or less, within 10 s			-

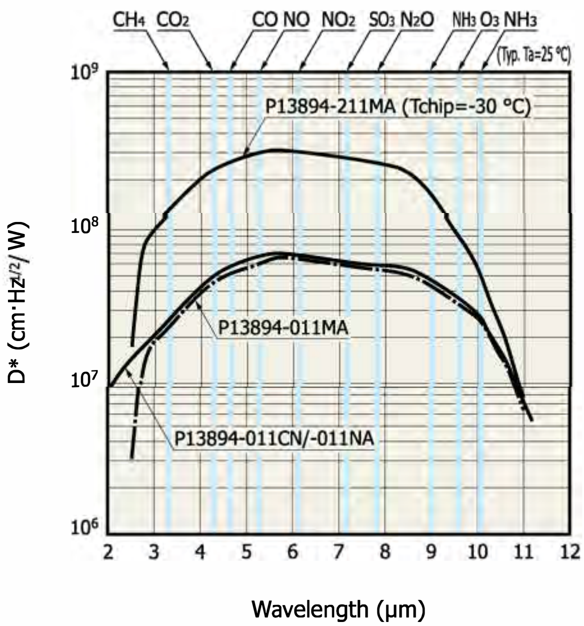
*1: When there is a temperature difference between a product and the surrounding area in high humidity environment, dew condensation may occur on the product surface. Dew condensation on the product may cause deterioration in characteristics and reliability.
*2: Peak temperature: 240 °C max. See P7. JEDEC J-STD-020 MSL 2
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 (Ta=25 °C)

Parameter	Symbol	Condition	P13894-011CN/-011NA			P13894-011MA			P13894-211MA			Unit
			Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	
Chip temperature	Tchip			25			25			-30		°C
Peak sensitivity wavelength	λp		-	5.6	-	-	5.6	-	-	5.6	-	μm
Cutoff wavelength	λc		9.7	11.0	-	9.7	11.0	-	8.9	10.2	-	μm
Photosensitivity	S	λ=λp*3	1.4	2.0	-	1.3	1.9	-	2.8	3.8	-	mA/W
Shunt resistance	Rsh	V_R=10 mV	1.5	2.0	-	1.5	2.0	-	7.5	10.0	-	kΩ
Detectivity	D*	(λp, 1200, 1)	4.0×10^7	7.0×10^7	-	3.8×10^7	6.5×10^7	-	1.8×10^8	3.2×10^8	-	cm·Hz$^{1/2}$/W
Noise equivalent power	NEP	λ=λp	-	1.4×10^{-9}	2.5×10^{-9}	-	1.5×10^{-9}	2.6×10^{-9}	-	3.1×10^{-10}	5.6×10^{-10}	W/Hz$^{1/2}$
Terminal capacitance	Ct	V_R=0 V, f=1 MHz	-	0.6	-	-	0.6	-	-	0.6	-	pF
Rise time	tr	10 to 90%, no window, λ=1.55 μm	-	3	10	-	3	10	-	3	10	ns

*3: Uniform irradiation on the entire photosensitive area
Note: Uniform irradiation must be applied to the entire photosensitive area during use.

Spectral response (D*)



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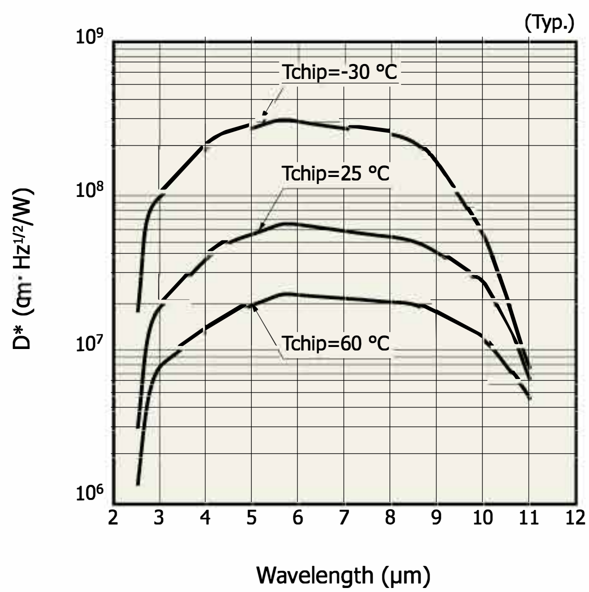
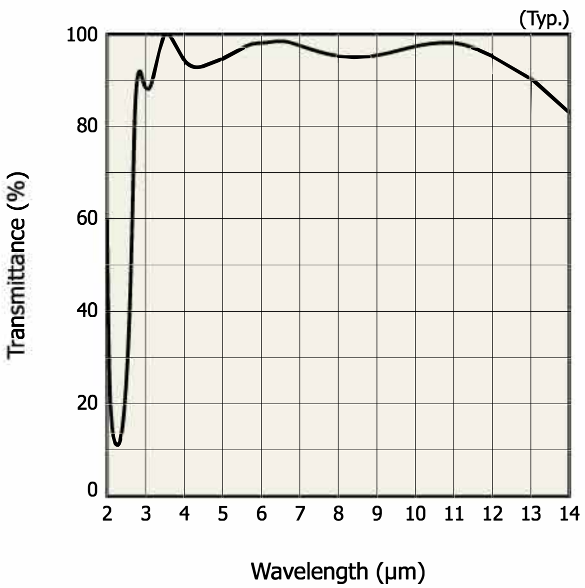
Sensitivity temperature characteristics (P13894-011MA/-211MA)



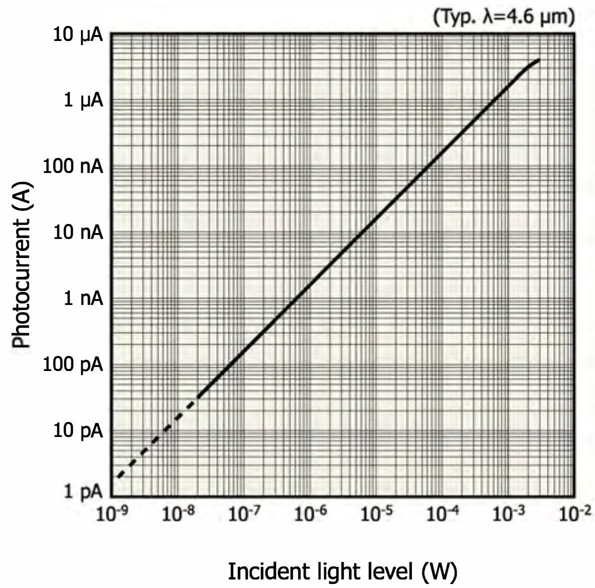
KIRDB0633EA

Spectral transmittance of window material



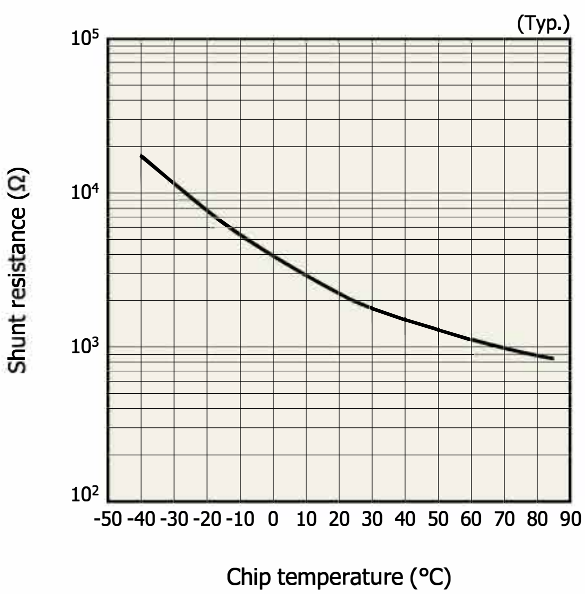
KIRDB0629EA

Linearity (P13894-011CN/-011NA)



KIRDB0630EA

Shunt resistance vs. chip temperature

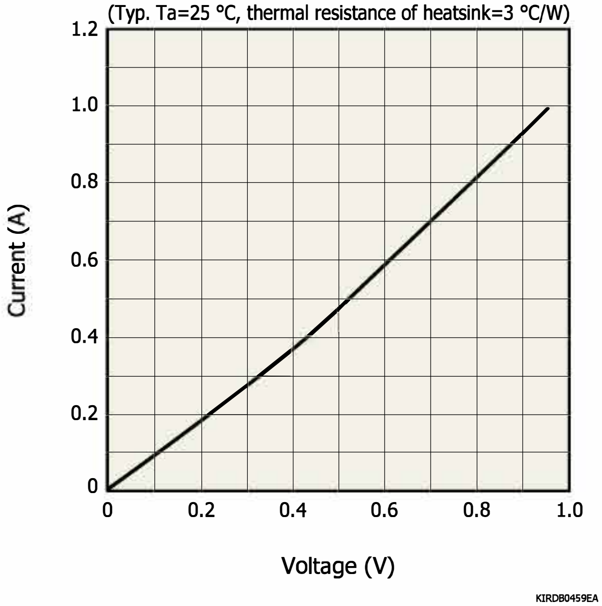


KIRDB0628EA

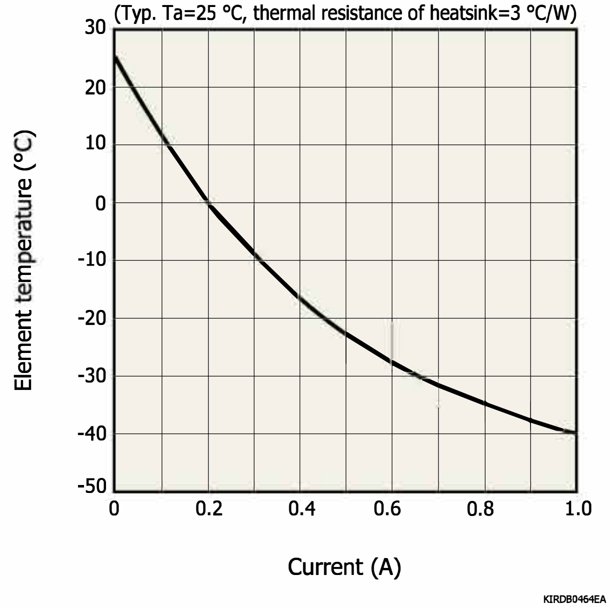
Specifications of two-stage TE-cooler (Ta=25 °C)

Parameter	Symbol	Min.	Typ.	Max.	Unit
Allowable current	Ic	-	-	1.0	A
Allowable voltage	Vc	-	-	0.95	V
Thermistor resistance	Rth	8.1	9.0	9.9	kΩ
Thermistor power dissipation	Pth	-	-	0.2	mW

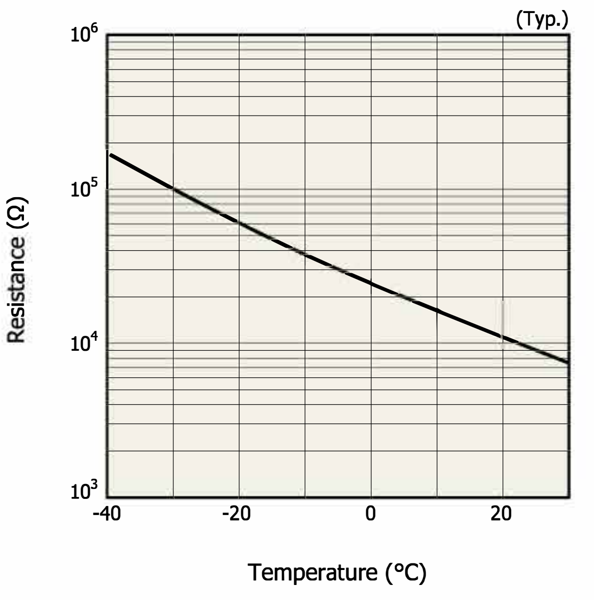
Current vs. voltage characteristics of TE-cooler



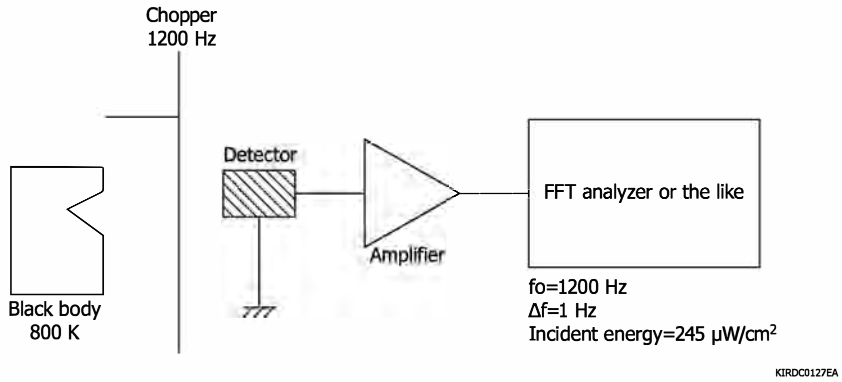
Cooling characteristics of TE-cooler



Thermistor temperature characteristics

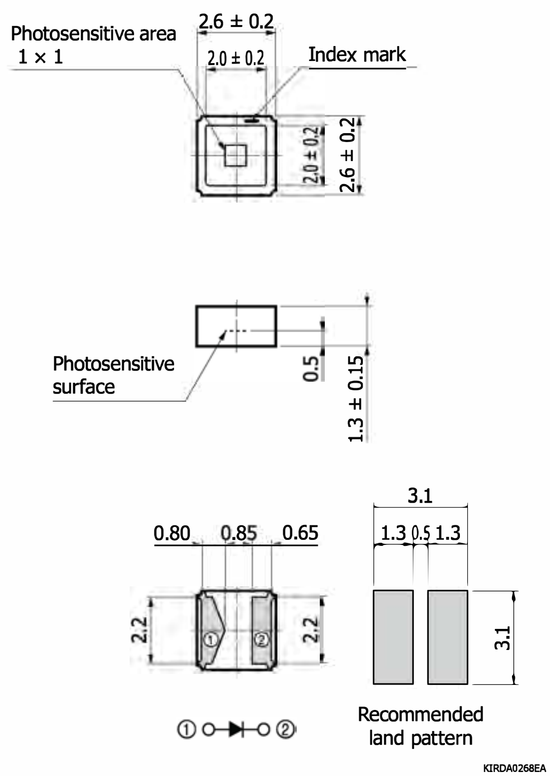


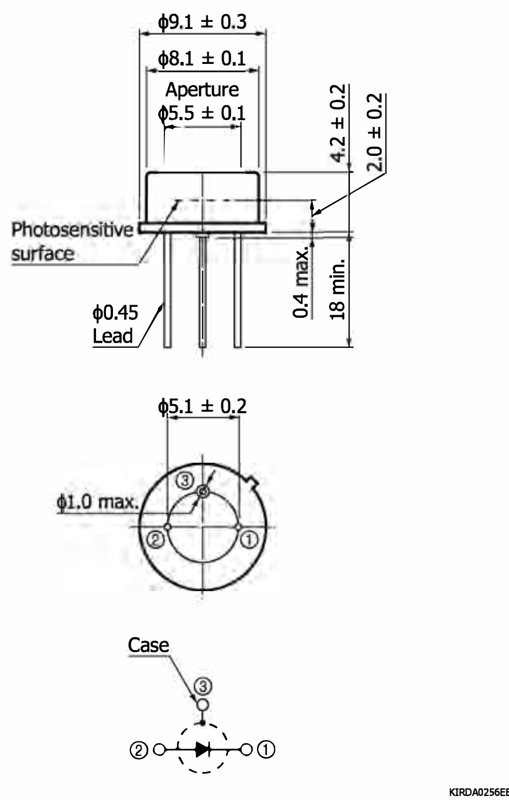
Measurement circuit example



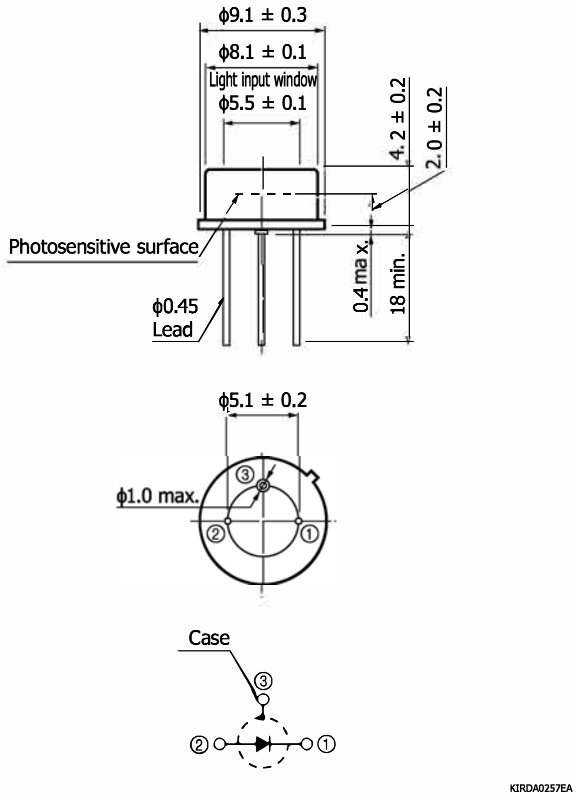
Dimensional outline (unit: mm)

P13894-011CN	P13894-011NA

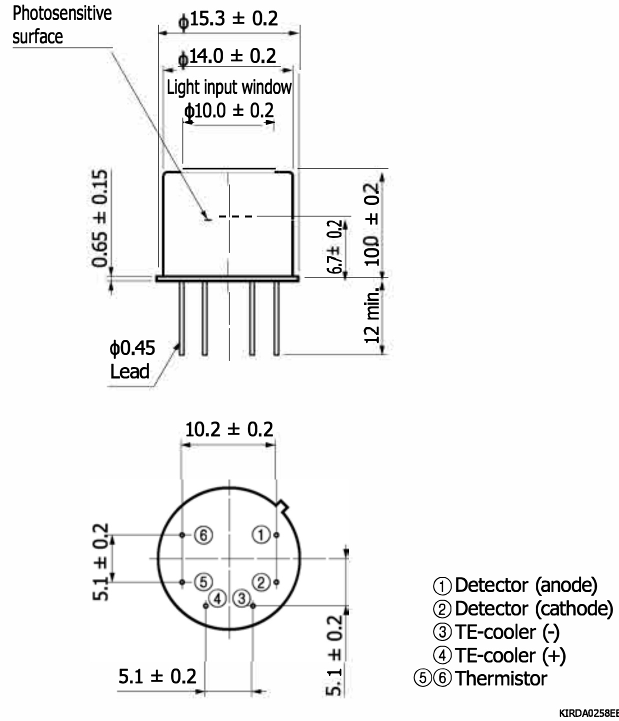




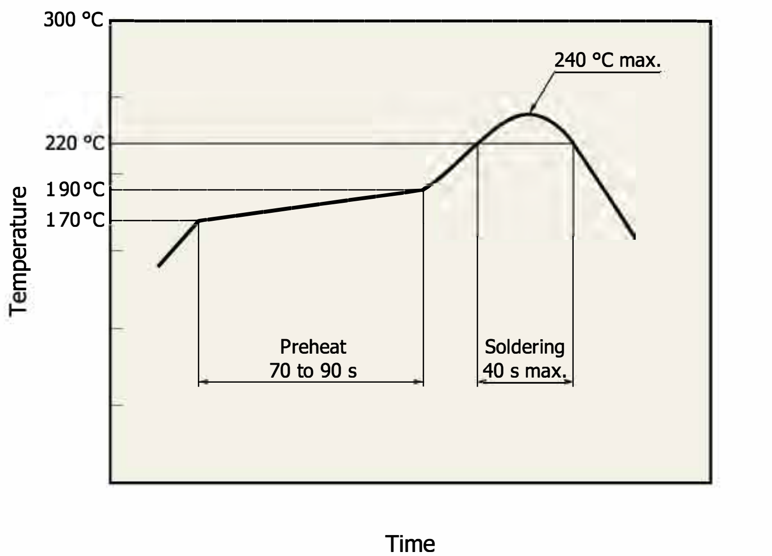
P13894-011MA



P13894-211MA



Recommended reflow soldering conditions



· After unpacking, store the device in an environment at a temperature range of 5 to 30 °C and a humidity of 60% or less, and perform reflow soldering within 1 year.
· The effect that the product receives during reflow soldering varies depending on the circuit board and reflow oven that are used.
· When you set reflow soldering conditions, check that problems do not occur in the product by testing out the conditions in advance.

Related information

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

■ Precautions
· Disclaimer

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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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InAsSb photovoltaic detector

P11120-201

High-speed response and high sensitivity in the 5 µm spectral band
Thermoelectrically cooled infrared detector with no liquid nitrogen required

The P11120-201 is an infrared detector that provides high sensitivity in the 5 µm spectral band due to our unique crystal growth technology. The InAsSb photovoltaic detector has a PN junction that ensures high-speed response and high reliability. Typical applications include gas analysis such as CO_2, SOx, CO and NOx. The P11120-201 is environmentally friendly infrared detector and do not use lead, mercury or cadmium, which are substances restricted by the RoHS Directive. They are replacements for previous products that contain these substances.

Features

- **High-speed response**
- **High sensitivity**
- **High reliability**
- **RoHS compliant**

Applications

- **Gas analysis**
- **Radiation thermometers**
- **Thermal imaging**
- **Remote sensing**
- **FTIR**
- **Spectrophotometry**

Options (sold separately)

- **Heatsink for two-stage TE-cooled type** **A3179-01**
- **Temperature controller** **C1103-04**
- **Amplifier for infrared detector** **C4159-07**
- **Infrared detector module with preamp** **C12494-210S**

Structure

Parameter	Specification	Unit
Window material	Sapphire	-
Package	TO-8	-
Cooling	Two-stage TE-cooled	-
Photosensitive area	ϕ1.0	mm

Absolute maximum ratings

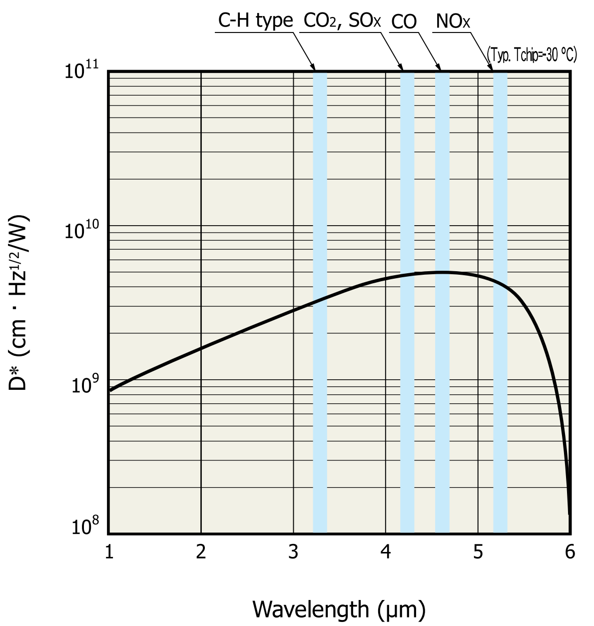
Parameter	Symbol	Value	Unit
Thermistor power dissipation	-	0.2	mW
Reverse voltage	V_R	0.1	V
Operating temperature*1 *2	Topr	-40 to +60	°C
Storage temperature*1	Tstg	-55 to +60	°C

*1: No dew condensation
When there is a temperature difference between a product and the surounding area in high humidity environment, dew condensation may occur on the product surface. Dew condensation on the product may cause deterioration in charactaristics and relaiablity.
*2: Chip temperature and package temperature
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 (Tchip=-30 °C)

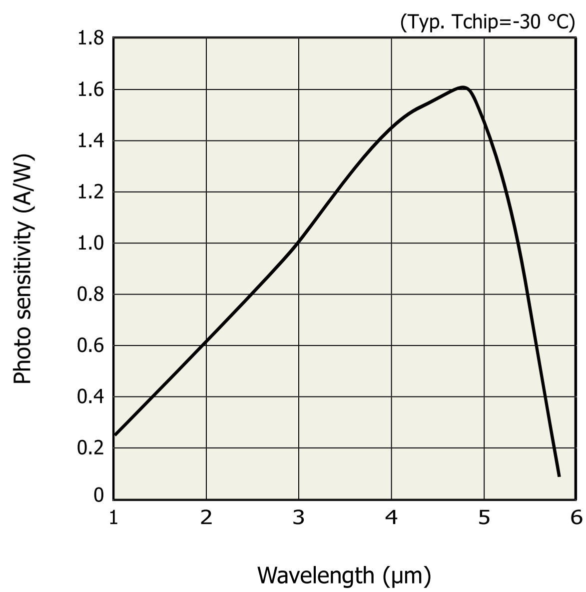
Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Peak sensitivity wavelength	λp		4.0	4.9	-	μm
Cutoff wavelength	λc		5.6	5.9	-	μm
Photo sensitivity	S	λ=λp	0.8	1.6	-	A/W
Shunt resistance	Rsh	V_R=10 mV	10	13	-	Ω
Detectivity	D*	(λp, 1200, 1)	3.5×10^9	5.0×10^9	-	cm·Hz$^{1/2}$/W
Noise equivalent power	NEP	λ=λp	-	1.8×10^{-11}	2.5×10^{-11}	W/Hz$^{1/2}$
Rise time	tr	V_R=0 V, R_L=50 Ω 0 to 63%	-	0.4	-	μs

Spectral response (D*)



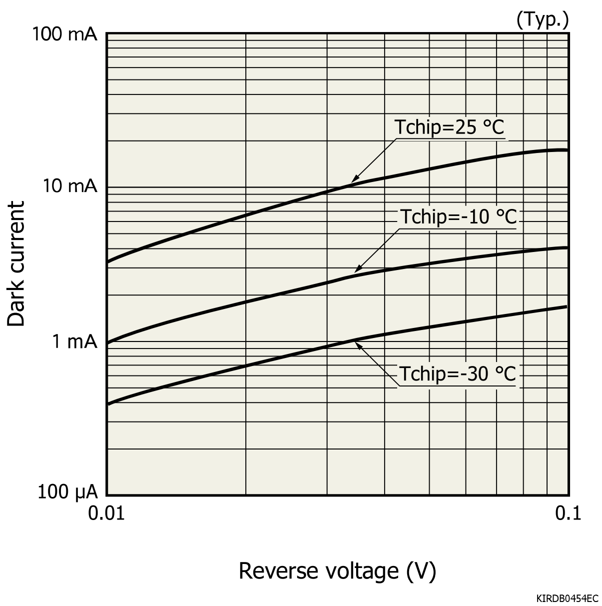
KIRDB0452EB

Spectral response

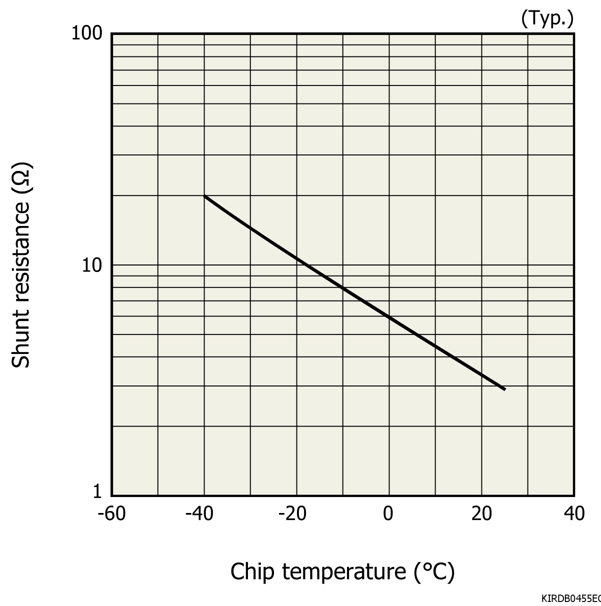


KIRDB0453EB

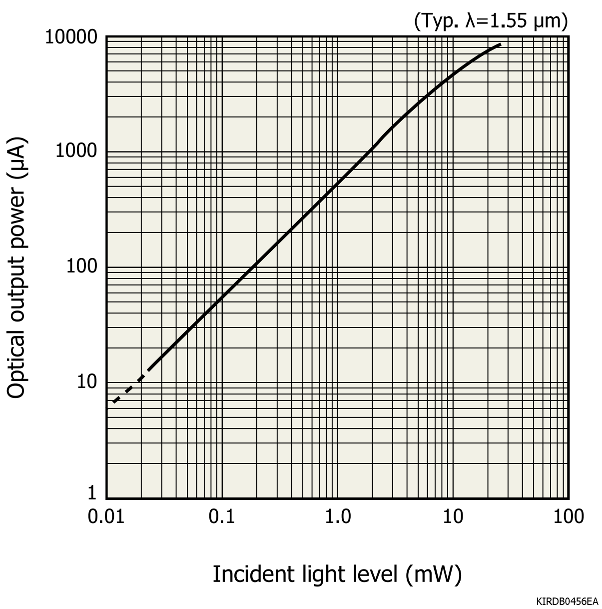
Dark current vs. reverse voltage



Shunt resistance vs. chip temperature



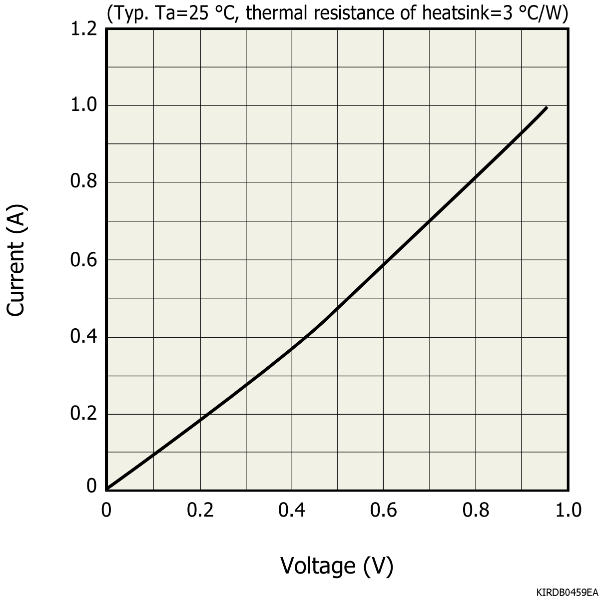
Linearity



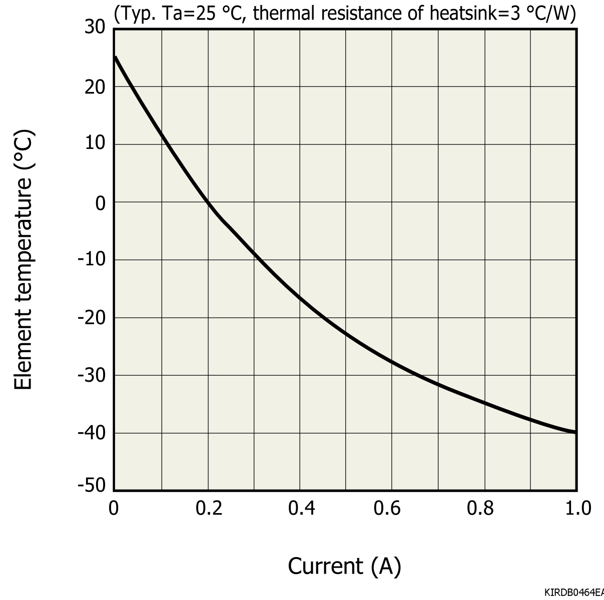
Specifications of two-stage TE-cooler (Ta=25 °C)

Parameter	Symbol	Min.	Typ.	Max.	Unit
Allowable current	Ic	-	-	1.0	A
Allowable voltage	Vc	-	-	0.95	V
Thermistor resistance	Rth	8.1	9.0	9.9	kΩ
Thermistor power dissipation	Pth	-	-	0.2	mW

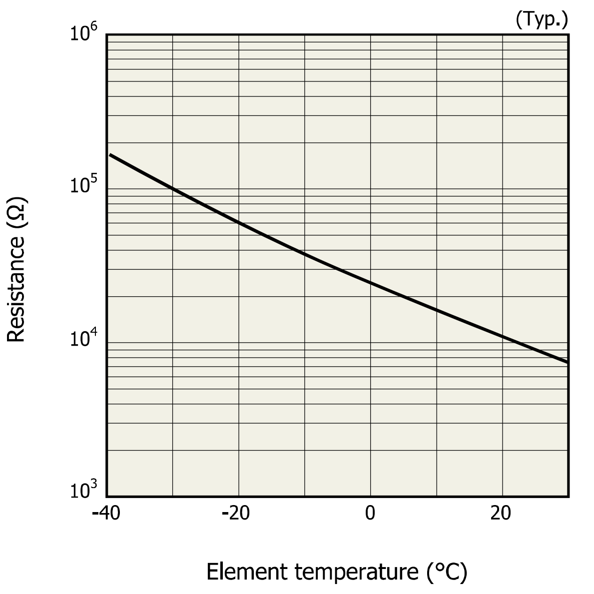
Current vs. voltage of TE-cooled type



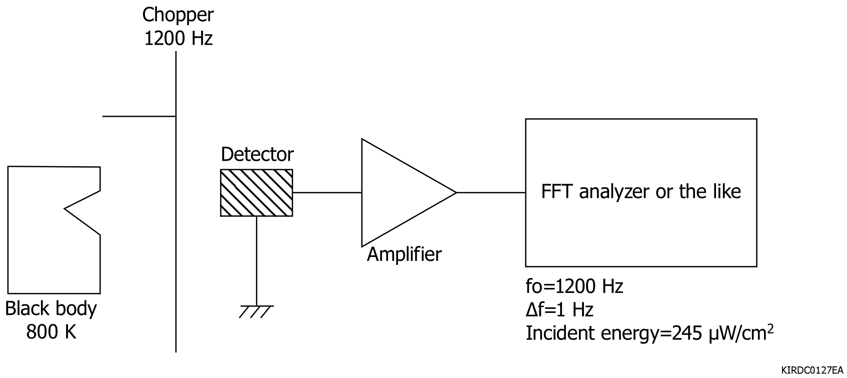
Cooling characteristics of TE-cooled type



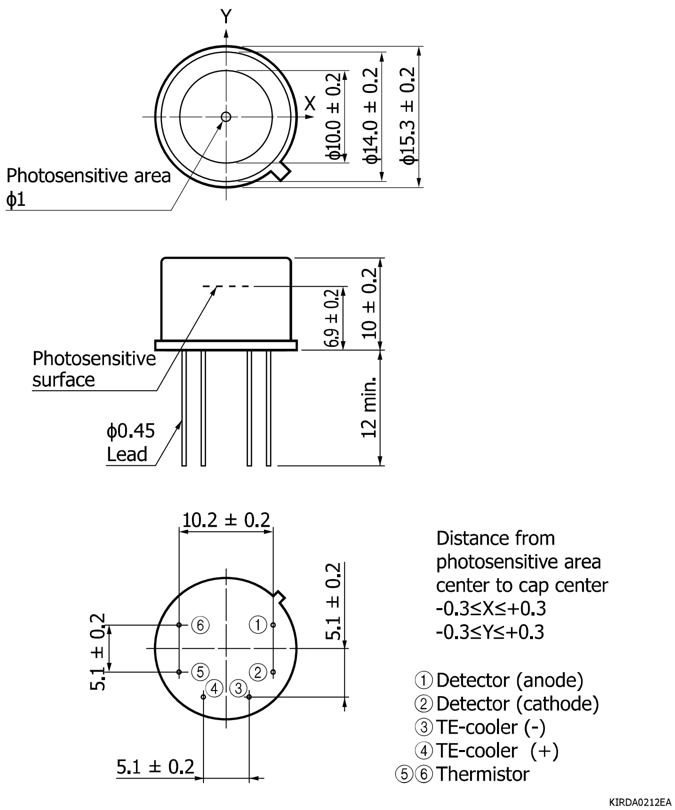
Thermistor temperature characteristic



Measurement circuit example



Dimensional outline (unit: mm)



Recommended soldering conditions

· Solder temperature: 260 °C (10 s or less, once)

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

Related information

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

■ Precautions
· Dislaimer
· Compound opto-semiconductors

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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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Taiwan: Hamamatsu Photonics Taiwan Co., Ltd.: 8F-3, No. 158, Section2, Gongdao 5th Road, East District, Hsinchu, 300, Taiwan R.O.C. Telephone: (886)3-659-0080, Fax: (886)3-659-0081, E-mail: info@hamamatsu.com.tw

HAMAMATSU
PHOTON IS OUR BUSINESS

InAsSb photovoltaic detector

P12691-201G

High-speed response and high sensitivity in the 8 µm spectral band
Thermoelectrically cooled infrared detector with no liquid nitrogen required

The P12691-201G is an infrared detector that provides high sensitivity in the 8 µm spectral band by employing our unique crystal growth technology, back-illuminated structure and integrating a lens. The InAsSb photovoltaic detector has a PN junction that ensures high-speed response and high reliability. Typical applications include gas analysis such as NO, NO_2, SO_2, and H_2S. The P12691-201G is easy to use as it uses a compact package (TO-8) not requiring liquid nitrogen.

Features

- **High-speed response**
- **High sensitivity**
- **High reliability**
- **Compact, thermoelectrically cooled TO-8 package**
- **RoHS compliant**
- **Can be assembled in a module with QCL**

Applications

- **Gas analysis**
- **Radiation thermometers**
- **Thermal imaging**
- **Remote sensing**
- **FTIR**
- **Spectrophotometers**

Options (sold separately)

- **Heatsink for two-stage TE-cooled type** **A3179-01**
- **Temperature controller** **C1103-04**
- **Infrared detector module with preamp** **C4159-07**

Structure

Parameter	Specification	Unit
Window material	Ge with AR coating	-
Package	TO-8	-
Cooling	Two-stage TE cooler	-
Photosensitive area	ϕ1.0	mm

Absolute maximum ratings

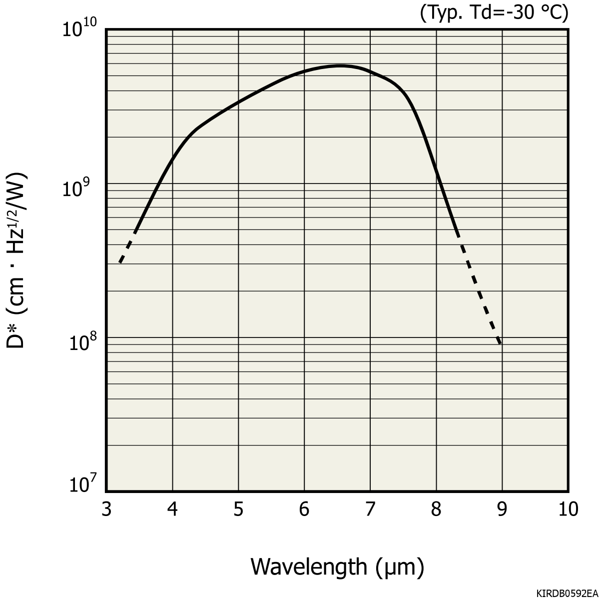
Parameter	Symbol	Value	Unit
Thermistor power dissipation	Pd_th	0.2	mW
TE-cooler allowable current	ITE max.	1	A
Reverse voltage	V_R	0.1	V
Operating temperature	Topr	-40 to +60	°C
Storage temperature	Tstg	-55 to +60	°C

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.

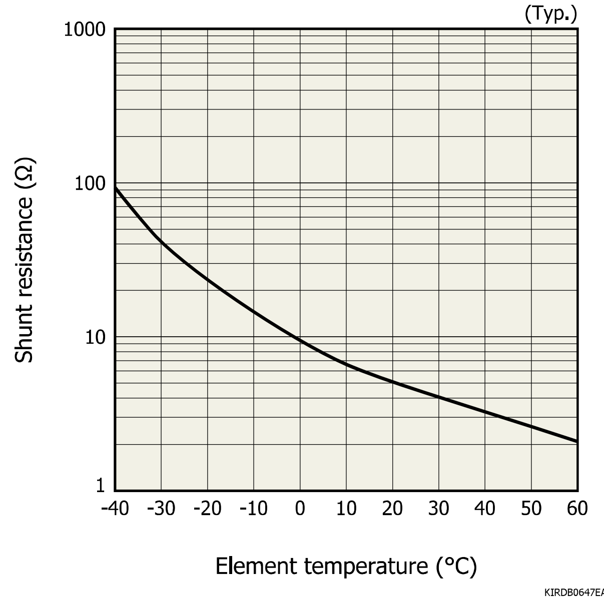
Electrical and optical characteristics (Td=-30 °C)

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Peak sensitivity wavelength	λp		-	6.7	-	μm
Cutoff wavelength	λc		8.2	8.3	-	μm
Photosensitivity	S	λ=λp	0.8	1.2	-	A/W
Shunt resistance	Rsh	V_R=10 mV	13	40	-	Ω
Detectivity	D*	(λp, 1200, 1)	4.0×10^9	6.0×10^9	-	$cm \cdot Hz^{1/2}/W$
Noise equivalent power	NEP	λ=λp	-	1.5×10^{-11}	2.3×10^{-11}	$W/Hz^{1/2}$
Rise time	tr	V_R=0 V, R_L=50 Ω 0 to 63%	-	-	10	ns

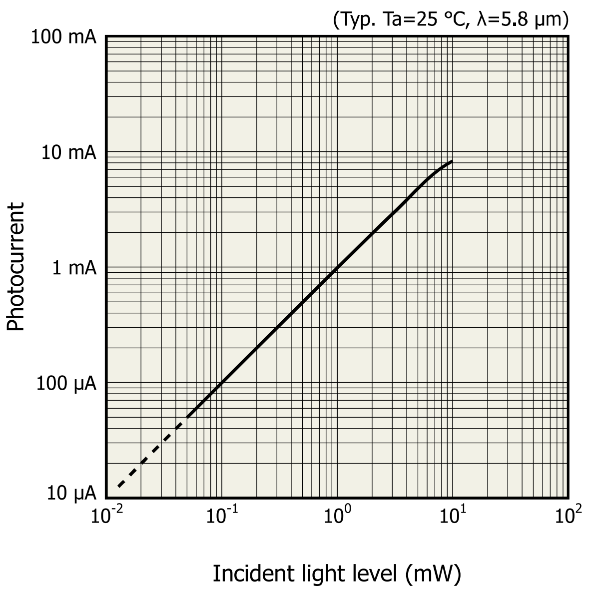
Spectral response (D*)



Shunt resistance vs. element temperature



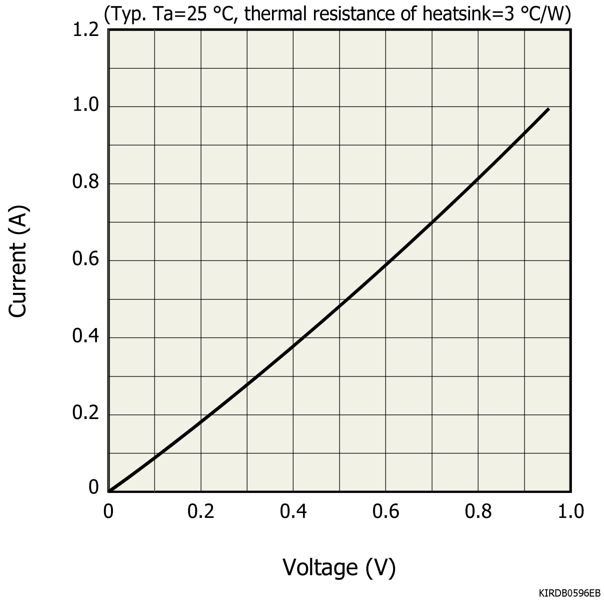
Linearity



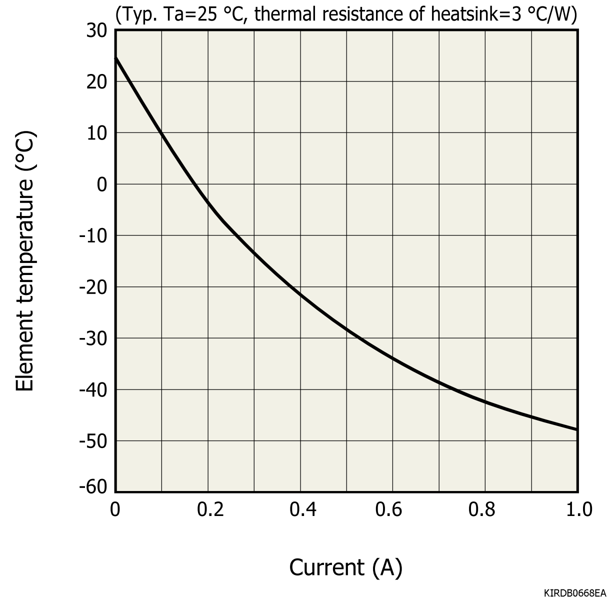
Specifications of two-stage TE-cooler (Ta=25 °C)

Parameter	Symbol	Min.	Typ.	Max.	Unit
TE cooler allowable current	ITE max.	-	-	1.0	A
TE cooler allowable voltage	VTE max.	-	-	0.95	V
Thermistor resistance	Rth	8.1	9.0	9.9	kΩ
Thermistor power dissipation	Pd_th	-	-	0.2	mW

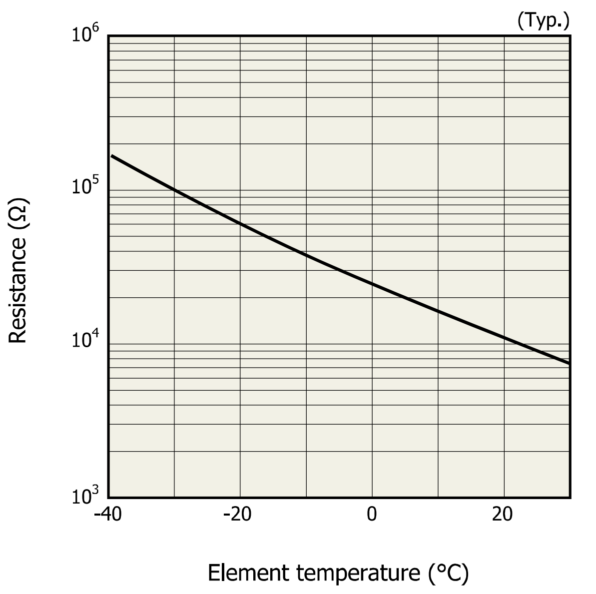
Current vs. voltage characteristics of TE-cooler



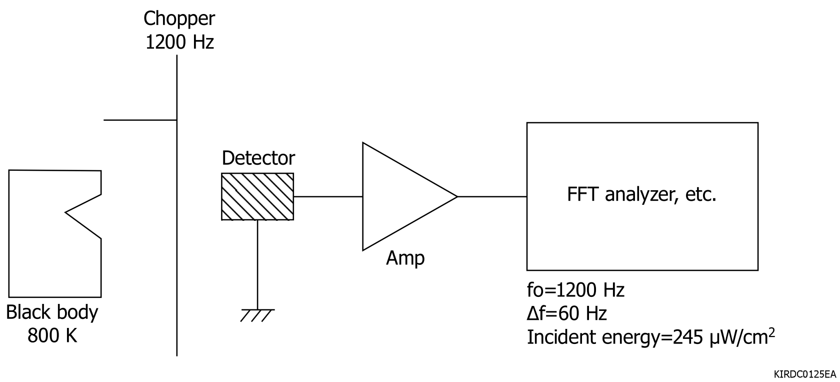
Cooling characteristics of TE-cooler



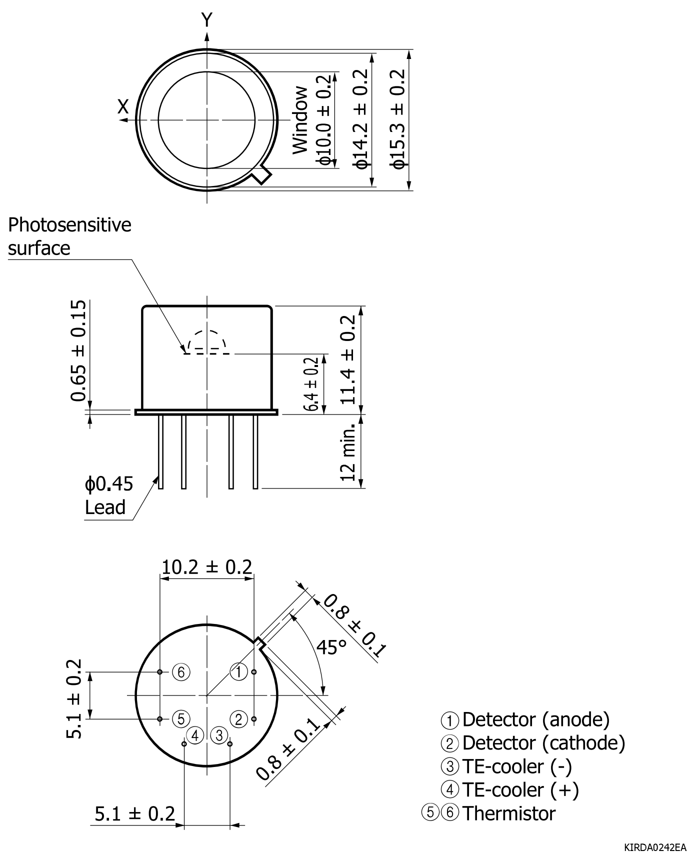
Thermistor temperature characteristics



Measurement circuit example



Dimensional outline (unit: mm)



Related information

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

■ Precautions
- Notice
- Metal, ceramic, plastic products

■ Technical information
- Infrared detector / Technical information

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Cat. No. KIRD1136E01 Aug. 2018 DN

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InAsSb photovoltaic detectors

With band-pass filter | P13243 series

Infrared detectors with band-pass filter (3.3 μm, 3.9 μm, 4.26 μm, 4.45 μm)

These are InAsSb photovoltaic detectors that use a band-pass filter for the window. Types using a band-pass filter with a center wavelength of 3.3 μm, 3.9 μm, or 4.26 μm are suitable for gas measurement, and a type using a band-pass filter of 4.45 μm is suitable for flame monitoring. These are environmentally friendly infrared detectors and do not use lead, mercury, or cadmium, which are substances restricted by the RoHS Directive. They are replacements for conventional products containing these substances. A two-element type that can detect two wavelength is also available.

Features

- **High sensitivity**
- **High-speed response**
- **High shunt resistance**
- **Compact, surface mount ceramic package**
- **Compatible with lead-free solder reflow (ceramic package)**

Applications

- **Gas measurement (CH_4, CO_2)**
- **Flame monitors (CO_2 resonance radiation)**

Option (sold separately)

- **Amplifier for infrared detector** **C4159-01**

Structure

Type no.	Window material*1	Package	Cooling	Photosensitive area (mm)	Field of view FOV (degrees)
P13243-033CF	BPF (3.3 μm)	Ceramic	Non-cooled	0.7 × 0.7	90
P13243-033MF	BPF (3.3 μm)	TO-46			82
P13243-039CF	BPF (3.9 μm)	Ceramic			90
P13243-039MF	BPF (3.9 μm)	TO-46			82
P13243-043CF	BPF (4.26 μm)	Ceramic			90
P13243-043MF	BPF (4.26 μm)	TO-46			82
P13243-045CF	BPF (4.45 μm)	Ceramic			90
P13243-045MF	BPF (4.45 μm)	TO-46			82
P13243-015CF	BPF (3.3 μm)	Ceramic			90
	BPF (3.9 μm)				
P13243-016CF	BPF (4.26 μm)				
	BPF (3.9 μm)				

*1: BPF: Band-pass filter

Absolute maximum ratings

Type no.	Reverse voltage V_R (V)	Operating temperature Topr*2 (°C)	Storage temperature Tstg*2 (°C)	Incident light level (W/cm²)	Soldering temperature Tsol (°C)
P13243-033CF	1	-40 to +85	-40 to +85	1	240 (once)*3
P13243-033MF					-
P13243-039CF					240 (once)*3
P13243-039MF					-
P13243-043CF					240 (once)*3
P13243-043MF					-
P13243-045CF					240 (once)*3
P13243-045MF					-
P13243-015CF					240 (once)*3
P13243-016CF					

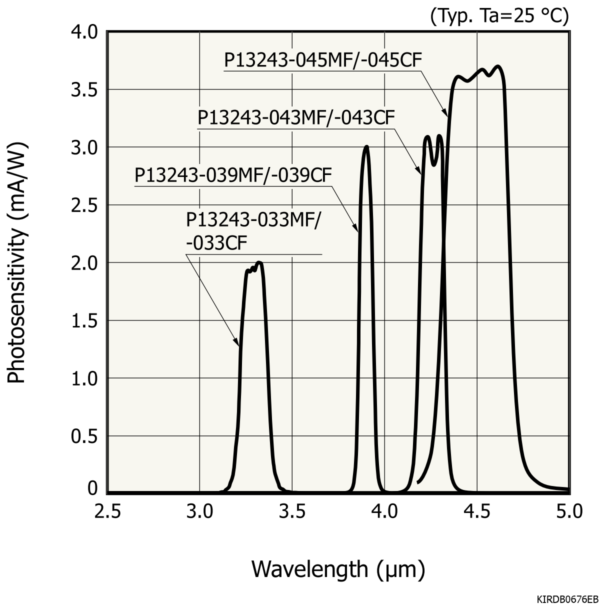
*2: No dew condensation
When there is a temperature difference between a product and the surrounding area in high humidity environments, dew condensation may occur on the product surface. Dew condensation may cause deterioration in characteristics and reliability.
*3: Reflow soldering, JEDEC J-STD-020 MSL 2, see P.5
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)

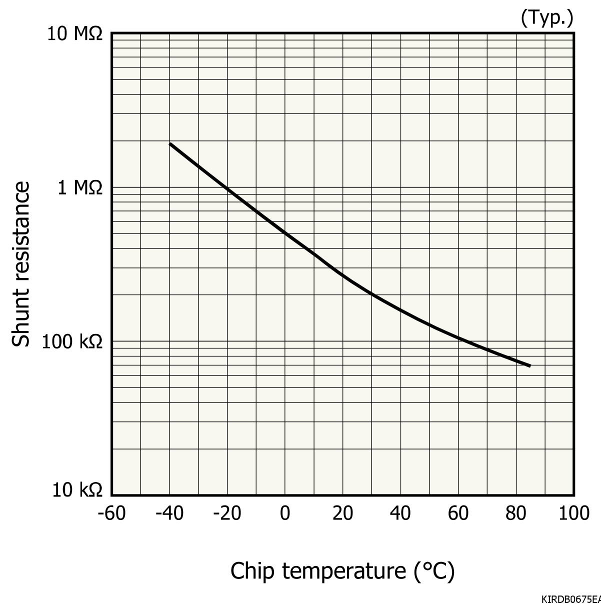
Type no.	Center wavelength CWL			Spectral response half width FWHM		Photosensitivity S*4 λ=CWL	Shunt resistance Rsh V_R=10 mV	Detectivity D* (CWL, 1200, 1)		Noise equivalent power NEP λ=CWL		Rise time tr*5	Terminal capacitance Ct*6
	Min. (nm)	Typ. (nm)	Max. (nm)	Typ. (nm)	Max. (nm)	(mA/W)	(kΩ)	Min. (cm·Hz$^{1/2}$/W)	Typ. (cm·Hz$^{1/2}$/W)	Typ. (W/Hz$^{1/2}$)	Max. (W/Hz$^{1/2}$)	(ns)	(pF)
P13243-033CF P13243-033MF	3270	3300	3330	160	180	2.3	300	4.1×10^{8}	5.1×10^{8}	1.4×10^{-10}	1.7×10^{-10}	15	0.7
P13243-039CF P13243-039MF	3820	3900	3980	90	110	3.0		5.2×10^{8}	6.5×10^{8}	1.1×10^{-10}	1.3×10^{-10}		
P13243-043CF P13243-043MF	4217	4260	4303	140	160	3.1		5.5×10^{8}	6.9×10^{8}	1.0×10^{-10}	1.3×10^{-10}		
P13243-045CF P13243-045MF	4400	4450	4500	350	400	3.7		6.5×10^{8}	8.2×10^{8}	8.5×10^{-11}	1.1×10^{-10}		
P13243-015CF	3270	3300	3330	160	180	2.3		4.1×10^{8}	5.1×10^{8}	1.4×10^{-10}	1.7×10^{-10}		
	3820	3900	3980	90	110	3.0		5.2×10^{8}	6.5×10^{8}	1.1×10^{-10}	1.3×10^{-10}		
P13243-016CF	4217	4260	4303	140	160	3.1		5.5×10^{8}	6.9×10^{8}	1.0×10^{-10}	1.3×10^{-10}		
	3820	3900	3980	90	110	3.0		5.2×10^{8}	6.5×10^{8}	1.1×10^{-10}	1.3×10^{-10}		

*4: Uniform irradiation on the entire photosensitive area
*5: V=0 V, R_L=50 Ω, 10 to 90%, λ=1.55 µm
*6: V_R=0 V, f=1 MHz
Note: Uniform irradiation must be applied to the entire photosensitive area during use.

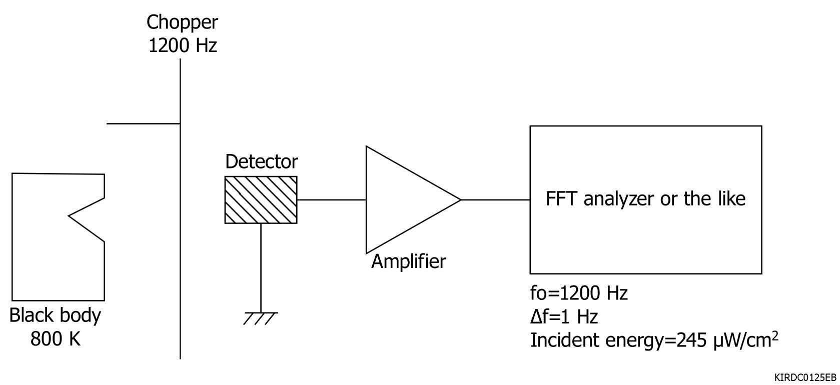
Spectral response



Shunt resistance vs. chip temperature

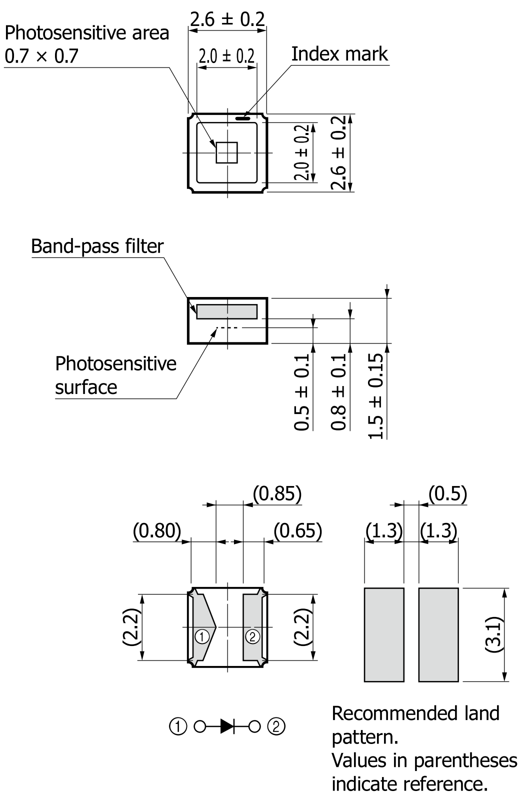


Measurement circuit example



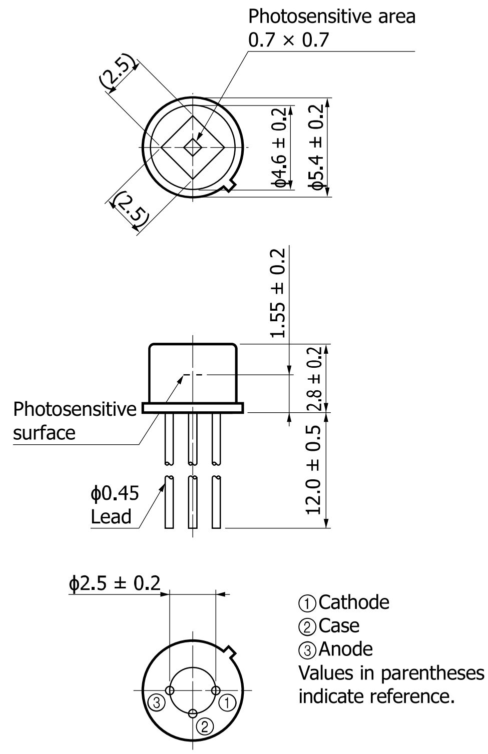
Dimensional outlines (unit: mm)

P13243-033CF/-039CF/-043CF/-045CF



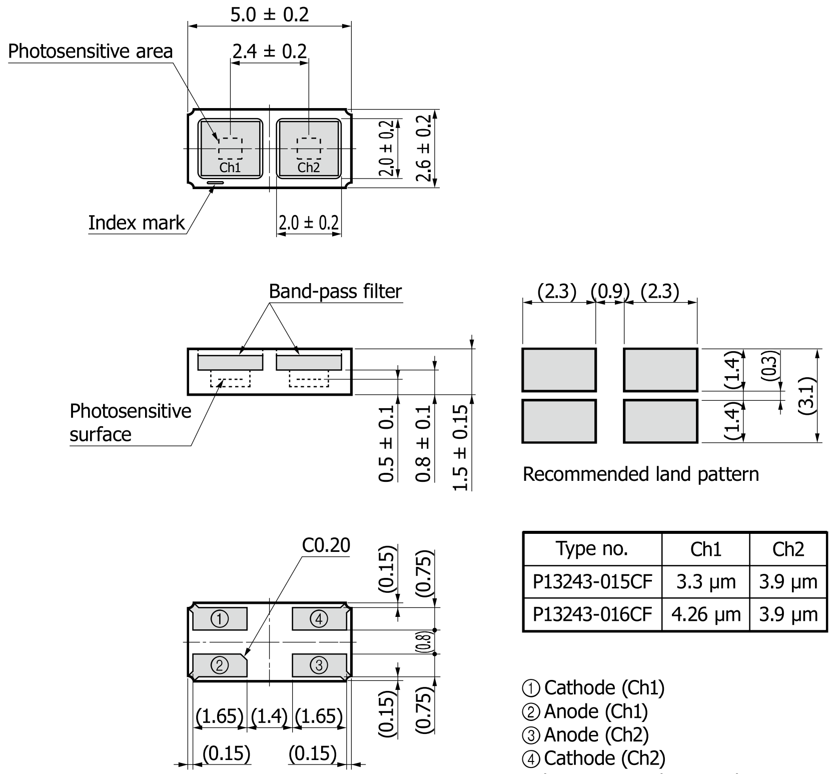
KIRDA0266EC

P13243-033MF/-039MF/-043MF/-045MF



KIRDA0249EF

P13243-015CF/-016CF



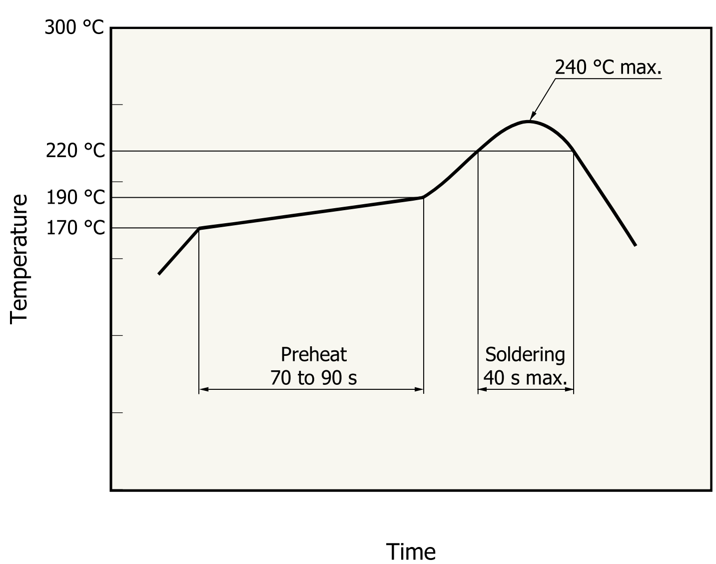
Type no.	Ch1	Ch2
P13243-015CF	3.3 µm	3.9 µm
P13243-016CF	4.26 µm	3.9 µm

① Cathode (Ch1)
② Anode (Ch1)
③ Anode (Ch2)
④ Cathode (Ch2)
Values in parentheses indicate reference values.

KIRDA0267ED

Recommended soldering conditions

P13243-033CF/-039CF/-043CF/-045CF/-015CF/-016CF



KIRDB0648EB

- After unpacking, store the device in an environment at a temperature range of 5 to 30 °C and a humidity of 60% or less, and perform reflow soldering within 1 year.
- The effect that the product receives during reflow soldering varies depending on the circuit board and reflow oven that are used. When you set reflow soldering conditions, check that problems do not occur in the product by testing out the conditions in advance.

P13243-033MF/-039MF/-043MF/-045MF

· Solder temperature: 240 °C max. (10 s or less, once)
Solder the leads at a point at least 1 mm away from the package body.
Note: When you set soldering condition, check that problems do not occur in the product by testing out the condition in advance.

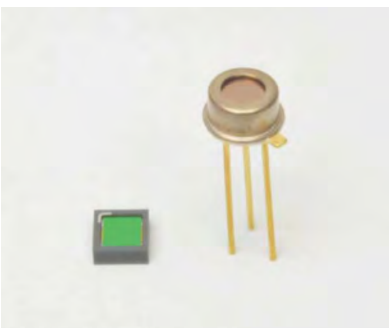
Related information

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

■ Precautions
· Disclaimer
· Metal, ceramic, plastic package products
· Compound opto-semiconductors (photosensors, light emitters)

■ Technical information
· Compound semiconductor photosensors / Technical note

[Related products] Mid infrared LEDs L15893/L15894/L15895 series



The L15893/L15894/L15895 series are mid infrared LEDs with the peak emission wavelength of 3.3 μm, 3.9 μm, and 4.3 μm respectively, manufactured using Hamamatsu unique crystal growth and process technologies.

Type no.	Package
L15893-0330C, L15894-0390C, L15895-0430C	Ceramic
L15893-0330M, L15894-0390M, L15895-0430M	Metal

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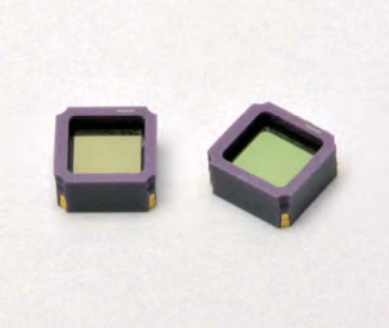
InAsSb photovoltaic detector



P16612-011CA

Back-illuminated type infrared detector up to 5 μm band

The P16612-011CA is an infrared detector that has high sensitivity in the spectral band up to 5 μm. This high sensitivity has been achieved due to Hamamatsu's unique crystal growth technology and process technology. By using a back-illuminated structure, we greatly improved the sensitivity temperature coefficient compared to the front-illuminated type (P13243-013CA). This product is an environmentally friendly infrared detector and does not use lead, mercury, or cadmium, which are substances restricted by the RoHS directive. It is a replacement for conventional products that contain these substances.

Features

- **High sensitivity**
- **High-speed response**
- **High shunt resistance**
- **Compact, surface mount type ceramic package**
- **Compatible with lead-free solder reflow**
- **RoHS compliant (lead, mercury, cadmium free)**

Applications

- **Gas detection (CH_4, CO_2, CO, etc.)**
- **Radiation thermometers**
- **Flame detection (CO_2 resonance radiation)**

Option (sold separately)

- **Amplifier for infrared detector** **C4159-01**

Structure

Parameter	Specification	Unit
Window material	Si with AR coating	-
Package	Ceramic	-
Photosensitive area	0.7 × 0.7	mm
Field of view	86	degree

Absolute maximum rating

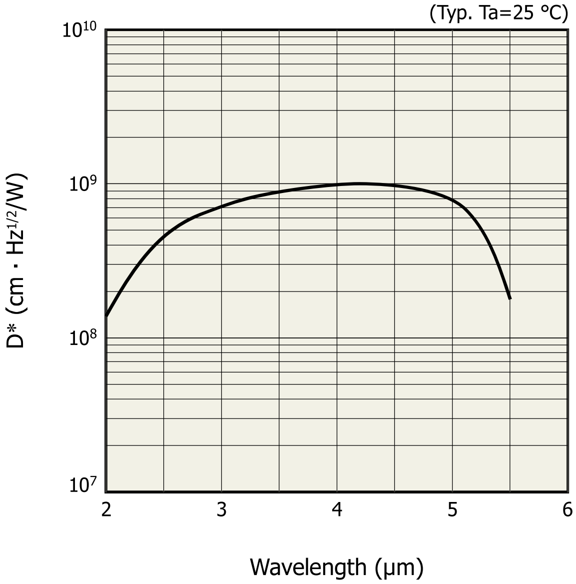
Parameter	Symbol	Value	Unit
Reverse voltage	V_R	1	V
Operating temperature*1	Topr	-40 to +85	°C
Storage temperature*1	Tstg	-40 to +85	°C
Soldering temperature	Tsol	240 (once)*2	°C

*1: No dew condensation
When there is a temperature difference between a product and the surrounding area in high humidity environments, dew condensation may occur on the product surface. Dew condensation on the product may cause deterioration in characteristics and reliability.
*2: Reflow soldering, JEDEC J-STD-020 MLS 2, see P.5
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 (Ta=25 °C)

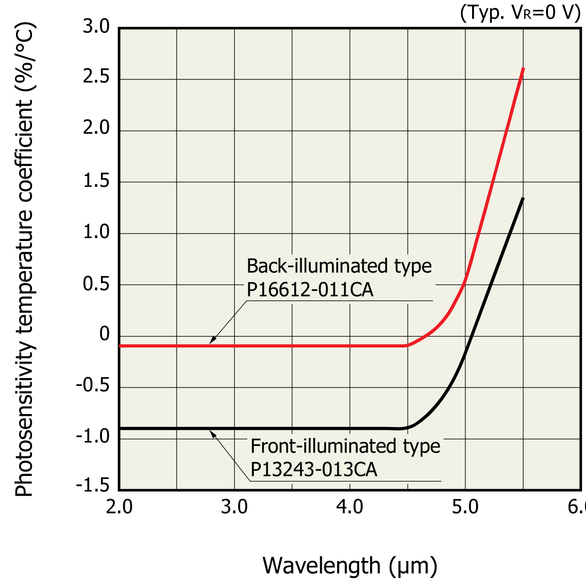
Parameter	Symbol	Condition	Min	Typ	Max	Unit
Peak sensitivity wavelength	λp		-	4.1	-	μm
Cutoff wavelength	λc		5	5.3	-	μm
Photosensitibity	S	λ=λp	3.5	4.5	-	mA/W
Shunt resistance	Rsh	V_R=10 mV	80	180	-	kΩ
Terminal capacitance	Ct	V_R=0 V, f=1 MHz	-	0.5	-	pF
Detectivity	D*	(λp, 1200, 1)	7.4×10^8	1.0×10^9	-	$cm \cdot Hz^{1/2}/W$
Noise equivalent power	NEP	λ=λp	-	4.3×10^{-11}	6.5×10^{-11}	$W/Hz^{1/2}$
Rise time	tr	V_R=0 V, R_L=50 Ω, 10 to 90%	-	15	25	ns

Spectral response (D*)



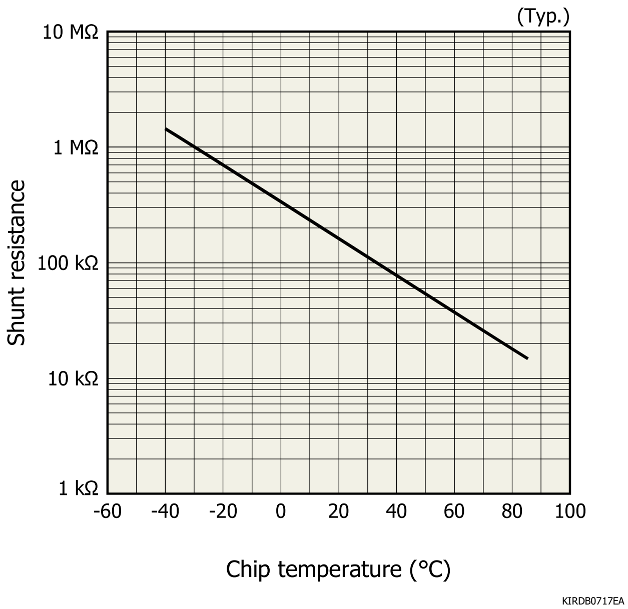
KIRDB0715EA

Photosensitivity temperature characteristics

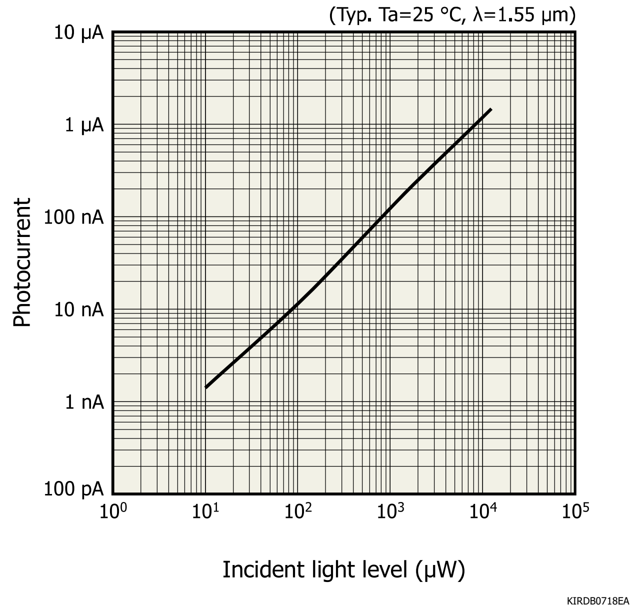


KIRDB0716EA

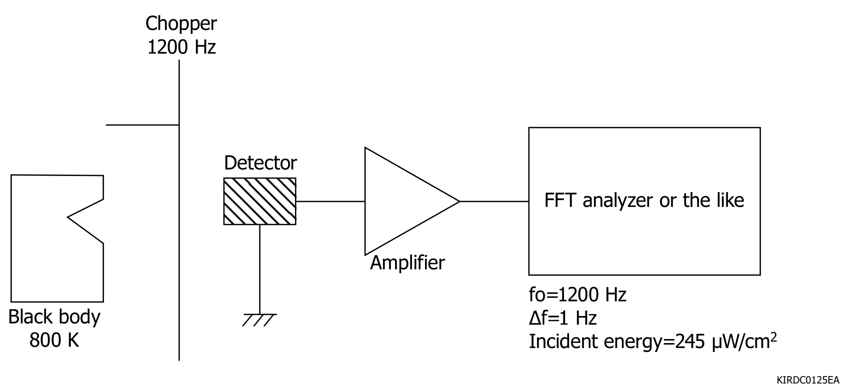
Shunt resistance vs. chip temperature



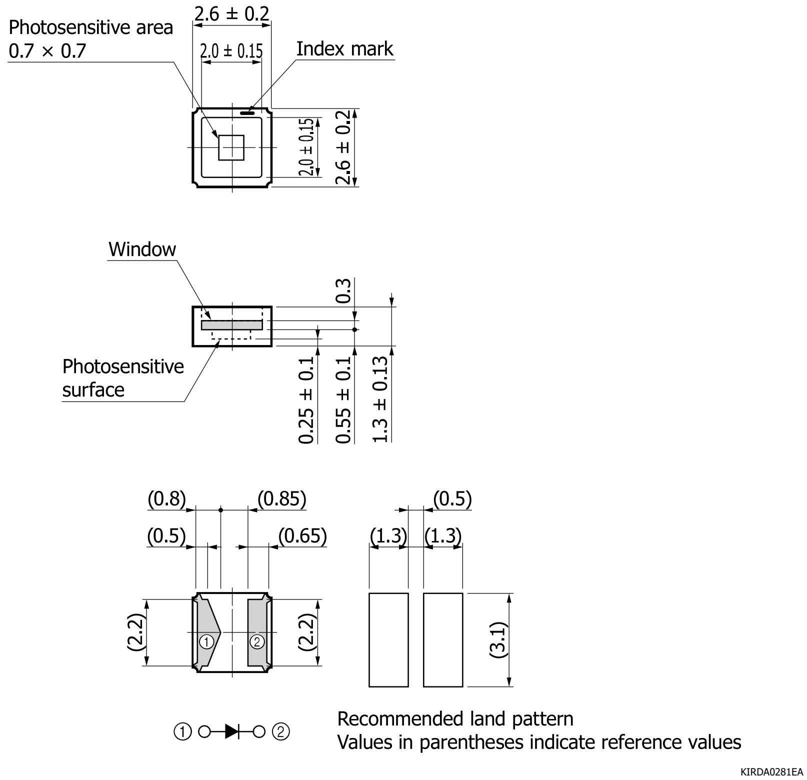
Linearity



Block diagram for characteristic measurement



Dimensional outline (unit: mm)

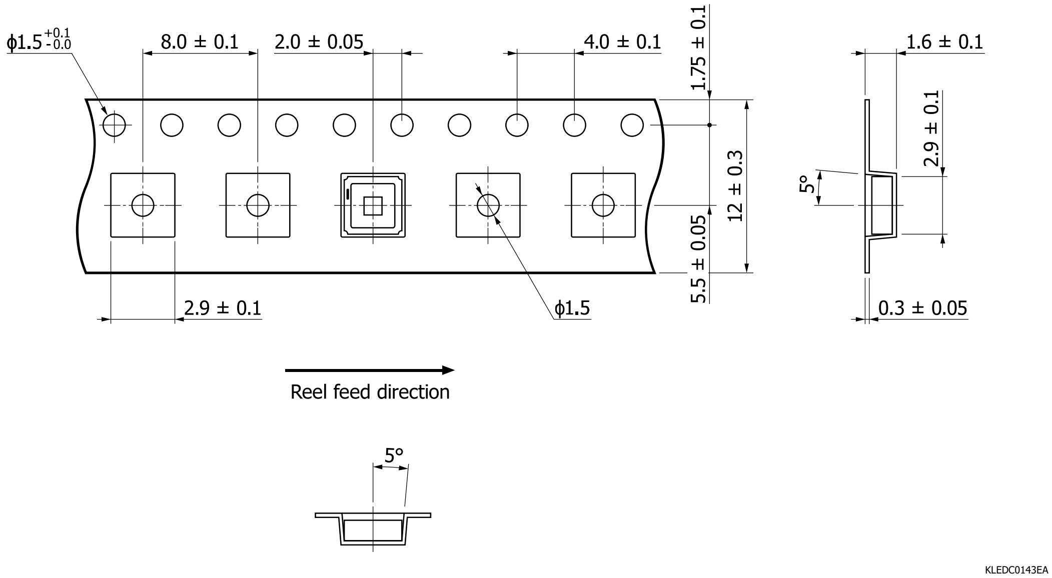


Standard packing specifications

■ Reel (conforms to JEITA ET-7200)

Outer diameter	Hub diameter	Tape width	Material	Electrostatic characteristics
ϕ180 mm	ϕ60 mm	12 mm	PS	Conductive

■ Embossed tape (unit: mm, material: PS, conductive)



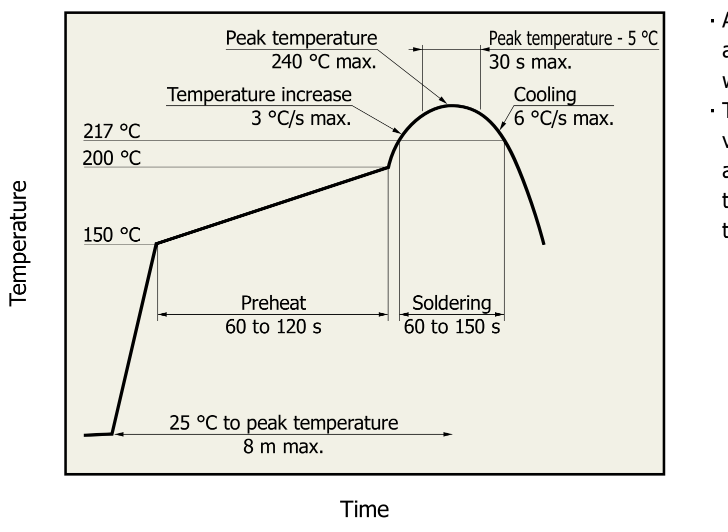
■ Packing quantity

500 pcs/reel

■ Packing state

Reel and desiccant in moisture-proof packaging (vacuum-sealed)

Recommended reflow soldering conditions

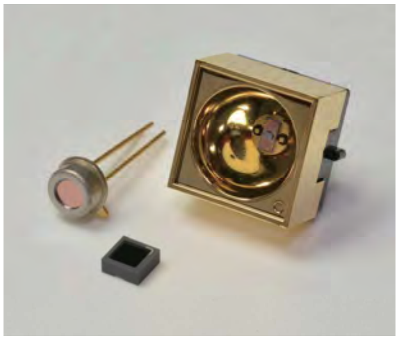


· After unpacking, keep it in an environment at 5 to 30 °C and a humidity of 60% or less, and perform soldering within 1 year.

· The effect that the product receives during reflow soldering varies depending on the circuit board and reflow oven that are used. When you set reflow soldering conditions, check that problems do not occur in the product by testing out the conditions in advance.

Related products

Mid infrared LEDs L15893/L15894/L15895 series



Hamamatsu's unique crystal growth and process technologies enable mid infrared LEDs with peak emission wavelengths of 3.3 μm, 3.9 μm, and 4.3 μm.

Type no.	Package
L15893-0330C, L15894-0390C, L15895-0430C	Ceramic
L15893-0330M, L15894-0390M, L15895-0430M	TO-46
L15893-0330ML, L15894-0390ML, L15895-0430ML	TO-46 with reflector

Related information

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

■ Precautions
- Disclaimer
- Compound opto-semiconductors (photosensors, light emitters)

■ Technical information
- Compound semiconductor photosensors / Technical note

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Cat. No. KIRD1145E01 Dec. 2021 DN

HAMAMATSU

PHOTON IS OUR BUSINESS

Infrared detector modules with preamp

Metal dewar type

High sensitivity modules of easy-to-use

These devices combine a dewar type detector with a compatible preamplifier, and easily operate to detect infrared radiation just by connecting to a DC power supply. InGaAs, InSb, and Type II superlattice detectors are provided as standard devices (liquid nitrogen cooling). Custom-designed devices with different active areas, FOV or amplifier gain, etc. are also available to meet your specific needs.

Features

- **Compact integral detector unit**
- **Optimum connections between the detector element and preamplifier allow amplified signals to be easily obtained.**

Required power supply specifications

- G7754 series, P7751 series: ±15 V (±12.0 to ±17.5 V can also be used)
- Current capacity: 1.5 times or more of each module's maximum current consumption
- Ripple noise: 5 mVp-p or less
- Analog power supply only
- Recommended DC power supplies: PW18-3AD (TEXIO)
  E3630A (Keysight Technologies)

Applications

- **Infrared detection**

Accessories

- **Cable (for DC power supply):**
  2 m (connector installed at one end) A4372-02
- **BNC-BNC coaxial cable (for signal output): 2 m**
- **Instruction manual**

Specifications / Absolute maximum ratings

Type no.	Detector element	Photo-sensitive area	External power supply*1				Absolute maximum ratings		
			Supply voltage (V)			Supply capacitance	External input voltage	Operating temperature Topr	Storage temperature Tstg
		(mm)	Min.	Typ.	Max.	(mA)	(V)	(°C)	(°C)
G7754-01	InGaAs (G12183-010 chip)	ϕ1	±12.0	±15.0	±17.5	±23	±18	0 to +40	-20 to +50
G7754-03	InGaAs (G12183-030 chip)	ϕ3							
P7751-01	InSb (P5968-060)	ϕ0.6				±30			
P7751-02	InSb (P5968-200)	ϕ2							
C15780-401	Type II superlattice (P15409-901)	ϕ0.1	±14.5	±15.0	±15.5	+45, -30			

*1: Use only an analog power supply.

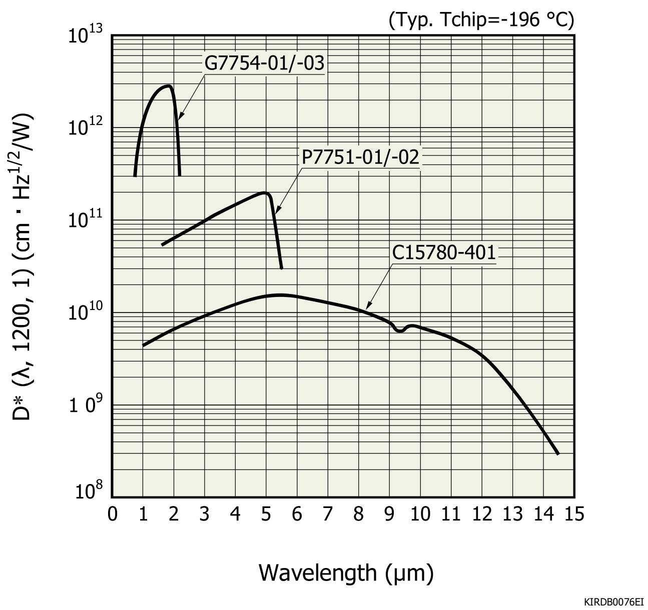
Note: Nitrogen hold time: 12 hours or more (at the time of shipment)
Exceeding the absolute maximum ratings even momentarily may cause a drop in product quality. Always be sure to use the product within the absolute maximum ratings.

Electrical and optical characteristics (Typ. Ta=25 °C)

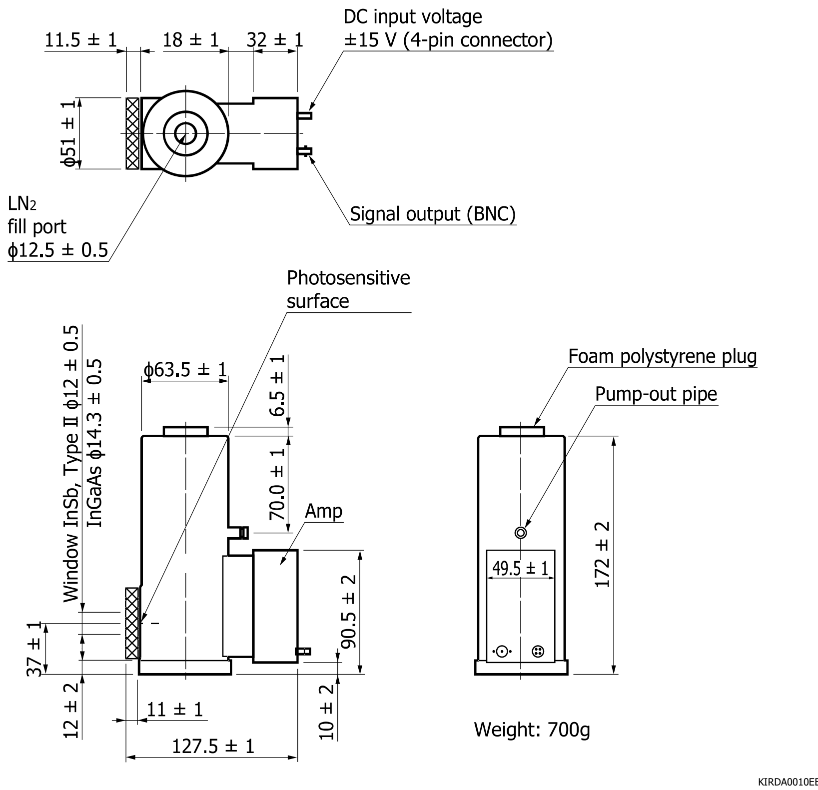
Type No.	Measurement condition Element temperature T (°C)	Peak sensitivity wavelength λp (µm)	Cutoff wavelength λc (µm)	Photo-sensitivity S λ=λp *2 (V/W)	Noise equivalent power NEP λ=λp (W/Hz$^{1/2}$)	Cutoff frequency fc (Hz)	Output impedance (Ω)	Maximum output voltage RL=1 kΩ (V)	Maximum current consumption*3 (mA)
G7754-01	-196	2.0	2.4	2×10^{9}	3×10^{-14}	2 to 500	50	±10	±15
G7754-03				5×10^{8}	1.5×10^{-13}	2 to 500		±10	±15
P7751-01*4		5.3	5.5	3×10^{8}	3×10^{-13}	5 to 10000		±10	±20
P7751-02*4				1.5×10^{8}	1×10^{-12}	5 to 12000		±10	±20
C15780-401*4		5.4	14.5	2×10^{6}	5.5×10^{-12}	7 to 100000		±14	+30, -20

*2: f=100 Hz (G7754-01, G7754-03), f=1.2 kHz (P7751-01, P7751-02, C15780-401)
*3: Vs=±15 V
*4: FOV=60°

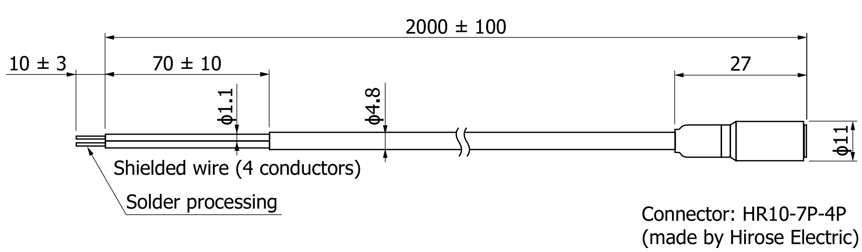
Spectral response

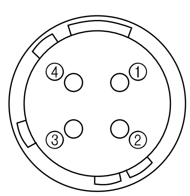


Dimensional outline (unit: mm)



Cable (for DC power supply) A4372-02





Pin no.	Pin connection	Lead color
①	-Vs	Blue
②	GND	Black/white/blue stranded wire
③	GND	
④	+Vs	White

KIRDA0196EB

Precaution for use

- The detector should not be placed horizontally during use.
- Using these detectors in an environment subjected to vibration may cause microphonic noise. Take measures to prevent vibration as needed.

Related information

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

■ Precautions
- Disclaimer
- Compound opto-semiconductors (photosensors, light emitters)

■ Technical information
- Compound semiconductor photosensors / Technical note

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Type Ⅱ superlattice infrared detector

P15409-901

High sensitivity, high-speed response infrared detector up to 14 μm band

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

Feature

- **High sensitivity**
- **High-speed response**
- **Excellent linearity**

Applications

- **FTIR**
- **Gas detection**
- **Radiation thermometers**

Option (sold separately)

- **Amplifier for infrared detector** **C4159-01**

Structure

Parameter	Specification	Unit
Window material	ZnSe	-
Package	Metal dewar	-
Cooling	Liquid nitrogen	-
Photosensitive area	ϕ0.1	mm

Absolute maximum ratings

Parameter	Symbol	Value	Unit
Reverse voltage	V_R	0.1	V
Operating temperature*1	Topr	-40 to +60	°C
Storage temperature*1	Tstg	-55 to +60	°C

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

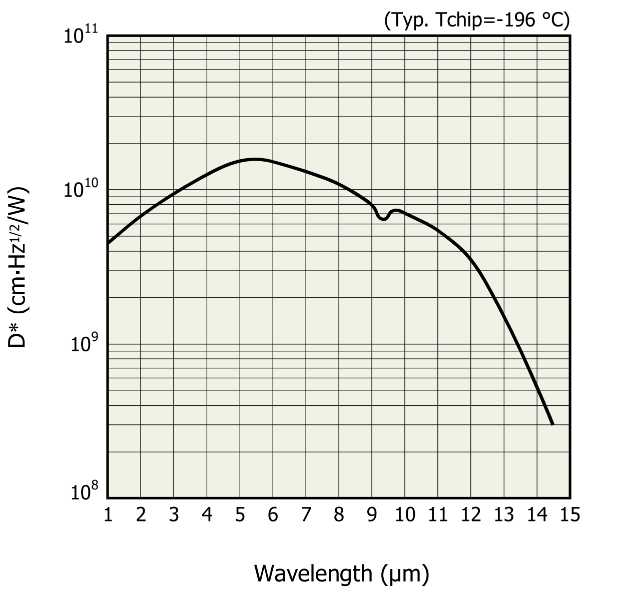
Note: Exceeding the absolute maximum ratings even momentarily may cause a drop in product quality. Always be sure to use the product within the absolute maximum ratings.

Electrical and optical characteristics (Tchip=-196 °C)

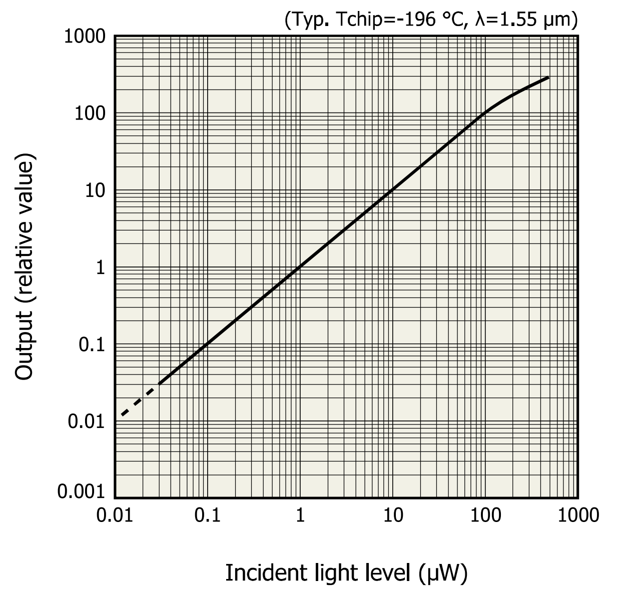
Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Peak sensitivity wavelength	λp		-	5.4	-	μm
Cutoff wavelength*2	λc		-	14.5	-	μm
Photosensitivity	S	λ=λp	-	2.6	-	A/W
Shunt resistance	Rsh	V_R=10 mV	-	2.5	-	kΩ
Terminal capacitance	Ct	V_R=0 V, f=1 MHz	-	50	-	pF
Detectivity	D*	(λp, 1200, 1)	5.0×10^9	1.6×10^{10}	-	$cm \cdot Hz^{1/2}/W$
Noise equivalent power	NEP	λ=λp	-	5.5×10^{-12}	1.8×10^{-11}	$W/Hz^{1/2}$
Rise time	tr	V_R=0 V, R_L=50 Ω, 0 to 63%	-	150	-	ns

*2: Wavelength at which signal/noise=1

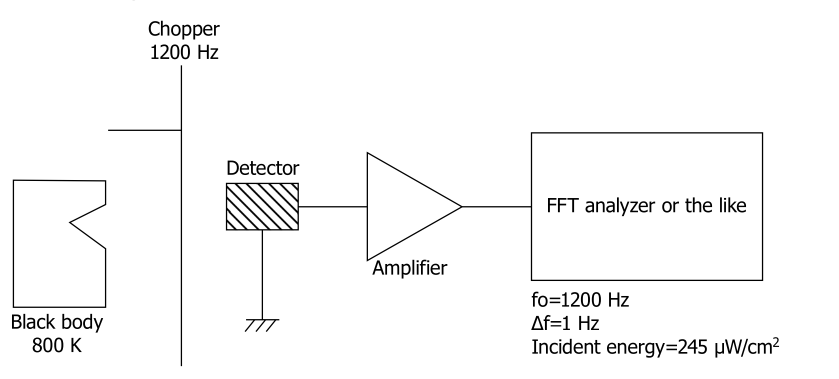
Spectral response (D*)



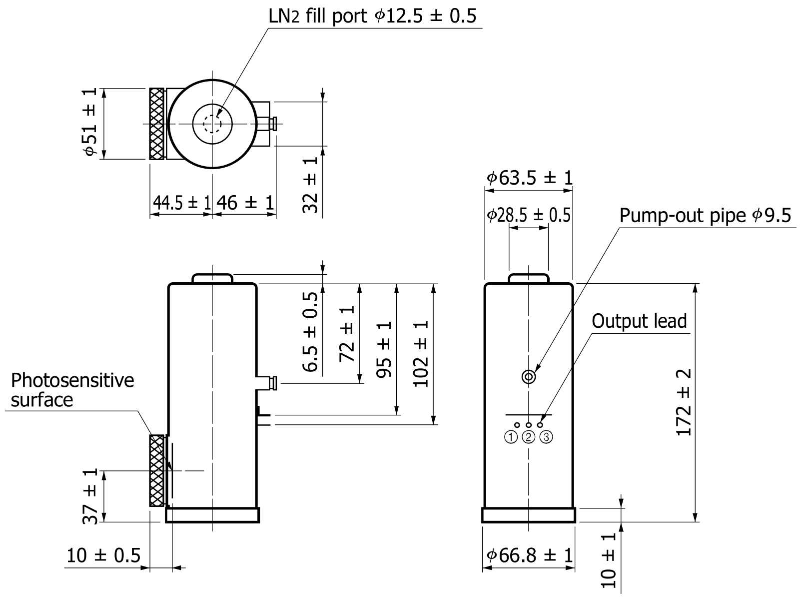
Linearity



Block diagram for characteristics measurement



Dimensional outline (unit: mm)



① Detector (anode)
② NC
③ Detector (cathode)

KIRDA0190ED

Related information

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

■ Precaution
- Disclaimer

■ Technical information
- Compound semiconductor photosensors / Technical note

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