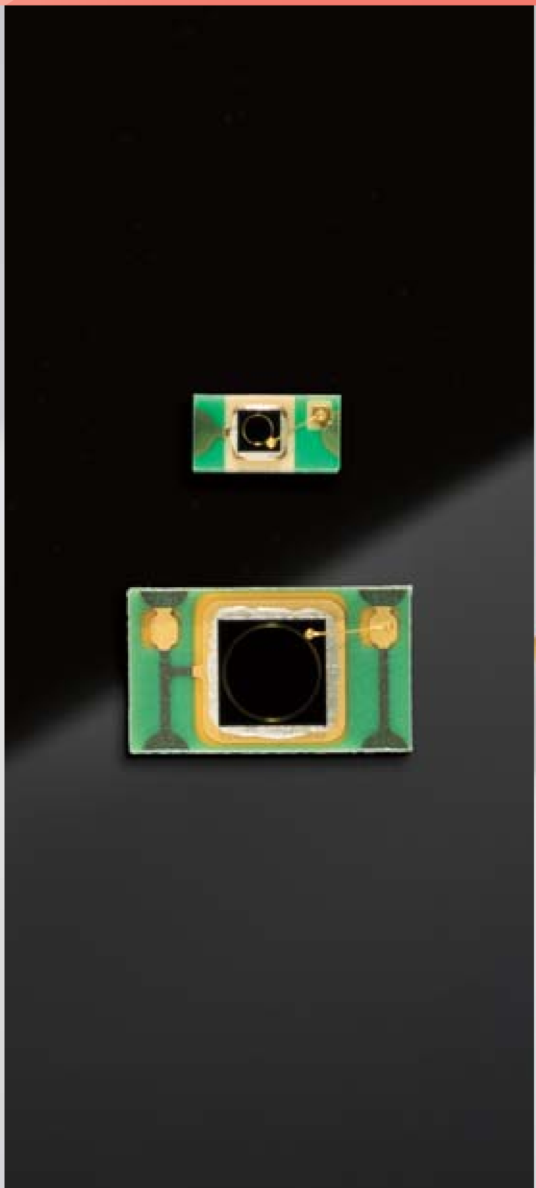
HAMAMATSU
PHOTON IS OUR BUSINESS

Selection guide - March 2018

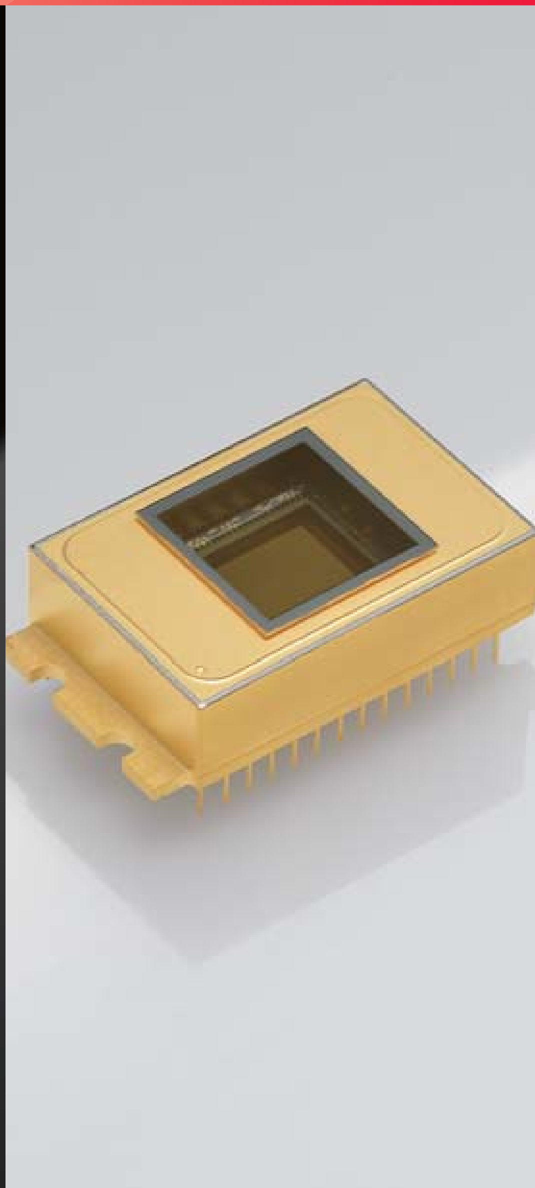
Infrared Detectors

Covering a broad spectral range in the infrared region

■ InAsSb photovoltaic detector
P11120-201



■ InGaAs PIN photodiode (surface mount type)
G13176-003P/-010P



■ InGaAs area image sensor
G13393-0909W

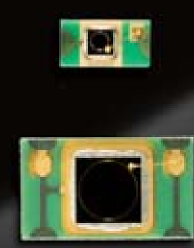
HAMAMATSU PHOTONICS K.K.

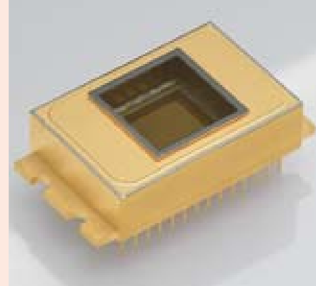
Infrared detectors

Infrared detectors are widely used in diverse field 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.

Contents

- InGaAs PIN photodiodes · · · · · 5
  - · Short wavelength enhanced type · · · · · 5
  - · Standard type · · · · · 5
  - · Long wavelength type · · · · · 7
  - · Infrared detector modules with preamp · · · · · 9
  - · InGaAs PIN photodiode arrays · · · · · 10
- InGaAs image sensors · · · · · 11
  - · InGaAs linear image sensors for spectrometry · · · · · 11
  - · High-speed type InGaAs linear image sensors · · · · · 12
  - · InGaAs area image sensors · · · · · 13
- InAs/InAsSb/InSb photovoltaic detectors, InSb photoconductive detectors · · · · · 14
  - · InAs photovoltaic detectors · · · · · 14
  - · InAsSb photovoltaic detectors · · · · · 14
  - · InSb photovoltaic detectors · · · · · 15
  - · InSb photoconductive detectors · · · · · 16
  - · Infrared detector modules with preamp · · · · · 16
- Thermopile detectors (Si thermal detectors) · · · · · 17
  - · Single-element type · · · · · 17
  - · Dual-element type · · · · · 17
- Two-color detectors · · · · · 18
- Photon drag detectors · · · · · 20
  - · Non-cooled type · · · · · 20
- Accessories for infrared detectors · · · · · 21
  - · Temperature controllers C1103 series · · · · · 22
  - · Valve operator for metal dewar A3515 · · · · · 22
  - · Heatsinks for TE-cooled detectors (TO-8, TO-3 package) A3179 series · · 23
  - · Chopper C4696 · · · · · 24
  - · Amplifiers for infrared detectors C4159 series, C5158-02 · · 25
- Description of terms · · · · · 27





Infrared detectors

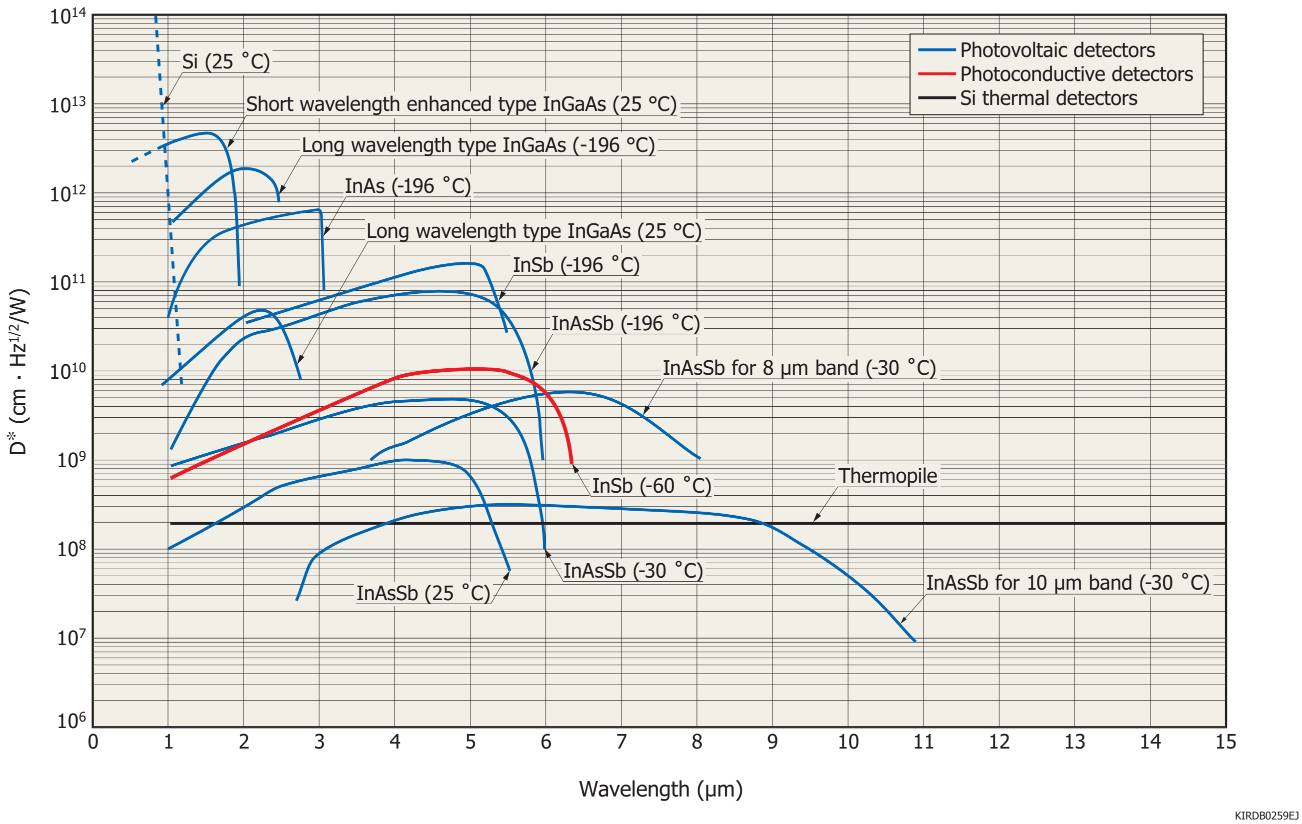
Hamamatsu infrared detectors

Product name	Spectral response range (μm)	Features	Page
InGaAs PIN photodiodes	0.5 – 1.7	• Short wavelength enhanced type • Can detect light from 0.5 μm	5
	0.9 – 1.7	• Standard type • High-speed response, high sensitivity, low dark current • Available with various photosensitive areas, arrays, and packages	5, 6, 10
	0.9 – 1.9	• For optical measurement around 1.7 μm • TE-cooled type available	7
	0.9 – 2.1	• For optical measurement in the band of water content absorption (1.9 μm) • TE-cooled type available	7
	0.9 – 2.6	• For NIR spectroscopy • TE-cooled type available	8
InGaAs linear image sensors	0.5 – 2.55	• Timing generator incorporated • Gain switching • Available with various photosensitive areas, spectral response ranges, numbers of pixels, TE-coolers, and packages • TE-cooled type available	11, 12
InGaAs area image sensors	0.9 – 2.15	• Timing generator incorporated • TE-cooled type • Low-density pixel (64x64) to high-density pixel (VGA) formats available	13

Product name		Spectral response range (μm)	Features	Page
InAs photovoltaic detectors		1 – 3.8	• Covers a spectral response range close to PbS but offers higher response speed	14
InAsSb photovoltaic detectors		1 – 11	• Infrared detectors in the 5 μm, 8 μm, or 10 μm spectral band • High-speed response • High reliability	14
InSb photovoltaic detectors		1 – 5.5	• High-speed and high sensitivity in so-called atmospheric window (3 to 5 μm)	15
InSb photoconductive detectors		1 – 6.7	• Detects wavelengths up to around 6.5 μm, with high sensitivity over long periods by thermoelectric cooling	16
Thermopile detectors		1 – 25	• Sensors that generate thermoelectromotive force in proportion to the energy level of incident infrared light	17
Two-color detectors	Si + InAsSb	0.32 – 5.3	• Wide spectral response range from UV to IR • Uses two detectors with different spectral response ranges, mounted one over the other along the same optical axis	18, 19
	Si + InGaAs	0.32 – 2.6		
	InGaAs + InGaAs	0.9 – 2.55		
Photon drag detector		10	• High-speed detector with high sensitivity in 10 μm band (for CO_2 laser detection) • Room temperature operation with high-speed response	20

For detailed information on the products listed in this catalog, see their datasheets that are available from our website **www.hamamatsu.com**

Spectral response of Hamamatsu infrared detectors (typical example)



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

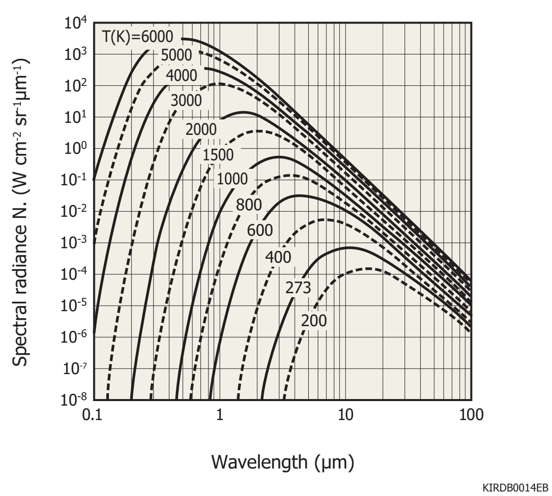
Besides easy-to-use photosensors designed for room temperature, Hamamatsu provides various types of sensors that are cooled with thermoelectric coolers, cryogenic dewars (for liquid nitrogen cooling).

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 λp (μm) and the absolute temperature T (K).

$\lambda p \cdot T = 2897.9$

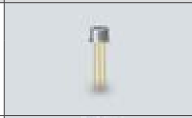
Law of black body radiation (Planck's law)



InGaAs PIN photodiodes

Short wavelength enhanced type

(Typ. Ta=25 °C)

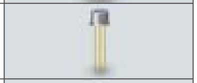
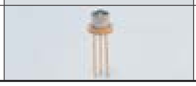
Type no.	Cooling	Photosensitive area (mm)	Spectral response range λ (μm)	Peak sensitivity wavelength λp (μm)	Cutoff frequency fc VR=1 V (MHz)	Package	Photo	Option (sold separately)
G10899-003K	Non-cooled	ϕ0.3	0.5 to 1.7	1.55	300	TO-18		C4159-03 (P.25)
G10899-005K		ϕ0.5			150			
G10899-01K		ϕ1			45			
G10899-02K		ϕ2			10	TO-5		
G10899-03K		ϕ3			5			

Standard type

Metal package

Various photosensitive area sizes are available.

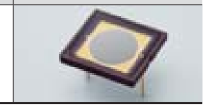
(Typ. Ta=25 °C, unless otherwise noted)

Type no.	Cooling	Photosensitive area (mm)	Spectral response range λ (μm)	Peak sensitivity wavelength λp (μm)	Cutoff frequency fc (MHz)	Package	Photo	Option (sold separately)
G12180-003A	Non-cooled	ϕ0.3	0.9 to 1.7	1.55	600 (VR=5 V)	TO-18		C4159-03 (P.25)
G12180-005A		ϕ0.5			200 (VR=5 V)			
G12180-010A		ϕ1			60 (VR=5 V)			
G12180-020A		ϕ2			13 (VR=1 V)	TO-5		
G12180-030A		ϕ3			7 (VR=1 V)			
G12180-050A		ϕ5			3 (VR=1 V)	TO-8		
G8370-81*		ϕ1			35 (VR=1 V)	TO-18		
G8370-82*		ϕ2			4 (VR=1 V)	TO-5		
G8370-83*		ϕ3			2 (VR=1 V)			
G8370-85*		ϕ5			0.6 (VR=1 V)	TO-8		
G12180-110A	One-stage TE-cooled (Tchip=-10 °C)	ϕ1	0.9 to 1.67		40 (VR=1 V)	TO-8		C4159-03 (P.25) A3179 (P.23) C1103-04 (P.22)
G12180-120A		ϕ2			13 (VR=1 V)			
G12180-130A		ϕ3			7 (VR=1 V)			
G12180-150A		ϕ5			3 (VR=1 V)			
G12180-210A	Two-stage TE-cooled (Tchip=-20 °C)	ϕ1	0.9 to 1.65		40 (VR=1 V)			C4159-03 (P.25) A3179-01 (P.23) C1103-04 (P.22)
G12180-220A		ϕ2			13 (VR=1 V)			
G12180-230A		ϕ3			7 (VR=1 V)			
G12180-250A		ϕ5			3 (VR=1 V)			
G6854-01	Non-cooled	ϕ0.08	0.9 to 1.7		2000 (VR=5 V)	TO-18 with CD lens		—

* Low PDL (polarization dependent loss) type

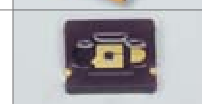
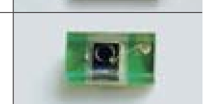
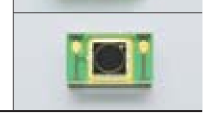
Ceramic package

(Typ. Ta=25 °C)

Type no.	Photosensitive area (mm)	Spectral response range λ (µm)	Peak sensitivity wavelength λp (µm)	Photosensitivity S λ=λp (A/W)	Cutoff frequency fc VR=0 V (MHz)	Photo
G8370-10	ϕ10	0.9 to 1.7	1.55	1.0	0.1	

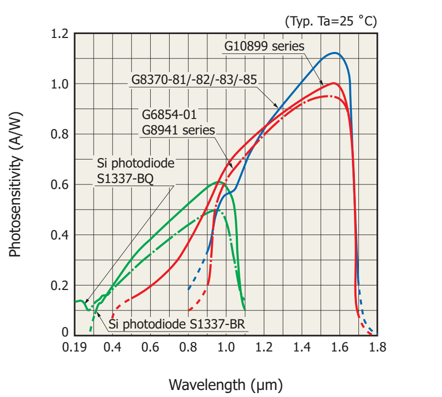
Surface mount type

(Typ. Ta=25 °C)

Type no.	Photosensitive area (mm)	Spectral response range λ (µm)	Peak sensitivity wavelength λp (µm)	Cutoff frequency fc VR=5 V (MHz)	Package	Photo
G8941-01	ϕ1	0.9 to 1.7	1.55	35	Ceramic (non-sealed)	
G8941-02	ϕ0.5			200		
G8941-03	ϕ0.3			400		
G11193-02R	ϕ0.2			1000	Ceramic	
G11193-03R	ϕ0.3			500		
G11193-10R	ϕ1			60		
G13176-003P	ϕ0.3			600	Plastic COB	
G13176-010P	ϕ1			60		

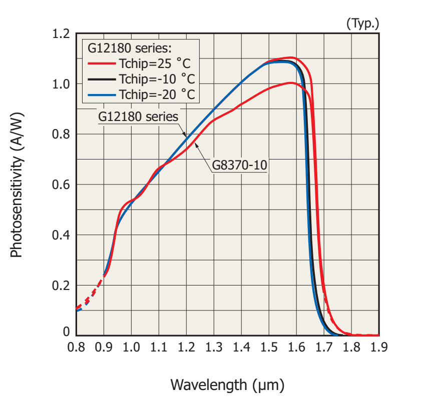
Spectral response

[G10899 series, etc.]



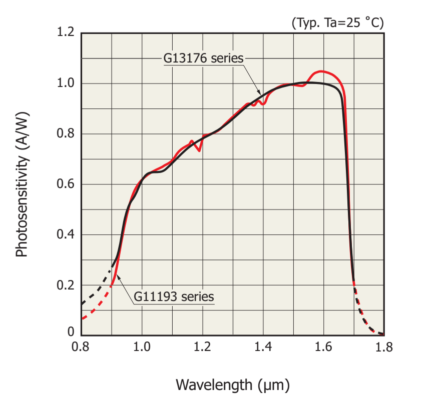
KIRDB0444EE

[G12180 series, G8370-10]



KIRDB0644EA

[G11193/G13176 series]



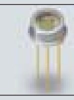
KIRDB0646EA

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)

Type no.	Cooling	Photosensitive area (mm)	Spectral response range λ (μm)	Peak sensitivity wavelength λp (μm)	Cutoff frequency fc VR=0 V (MHz)	Package	Photo	Option (sold separately)
G12181-003K	Non-cooled	ϕ0.3	0.9 to 1.9	1.75	90	TO-18		C4159-03 (P.25)
G12181-005K		ϕ0.5			35			
G12181-010K		ϕ1			10			
G12181-020K		ϕ2			2.5	TO-5		
G12181-030K		ϕ3			1.5			
G12181-103K	One-stage TE-cooled (Tchip=-10 °C)	ϕ0.3	0.9 to 1.87		140	TO-8		C4159-03 (P.25) A3179 (P.23) C1103-04 (P.22)
G12181-105K		ϕ0.5			50			
G12181-110K		ϕ1			16			
G12181-120K		ϕ2			3.5			
G12181-130K		ϕ3			1.8			
G12181-203K	Two-stage TE-cooled (Tchip=-20 °C)	ϕ0.3	0.9 to 1.85		150	TO-8		C4159-03 (P.25) A3179-01 (P.23) C1103-04 (P.22)
G12181-205K		ϕ0.5			53			
G12181-210K		ϕ1			17			
G12181-220K		ϕ2			3.7			
G12181-230K		ϕ3			1.9			

Peak sensitivity wavelength: 1.95 μm

These are suitable for optical measurement in the 1.9 μm band such as water absorption.

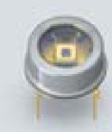
(Typ. Ta=25 °C, unless otherwise noted)

Type no.	Cooling	Photosensitive area (mm)	Spectral response range λ (μm)	Peak sensitivity wavelength λp (μm)	Cutoff frequency fc VR=0 V (MHz)	Package	Photo	Option (sold separately)
G12182-003K	Non-cooled	ϕ0.3	0.9 to 2.1	1.95	90	TO-18		C4159-03 (P.25)
G12182-005K		ϕ0.5			35			
G12182-010K		ϕ1			10			
G12182-020K		ϕ2			2.5	TO-5		
G12182-030K		ϕ3			1.5			
G12182-103K	One-stage TE-cooled (Tchip=-10 °C)	ϕ0.3	0.9 to 2.07		140	TO-8		C4159-03 (P.25) A3179 (P.23) C1103-04 (P.22)
G12182-105K		ϕ0.5			50			
G12182-110K		ϕ1			16			
G12182-120K		ϕ2			3.5			
G12182-130K		ϕ3			1.8			
G12182-203K	Two-stage TE-cooled (Tchip=-20 °C)	ϕ0.3	0.9 to 2.05		150	TO-8		C4159-03 (P.25) A3179-01 (P.23) C1103-04 (P.22)
G12182-205K		ϕ0.5			53			
G12182-210K		ϕ1			17			
G12182-220K		ϕ2			3.7			
G12182-230K		ϕ3			1.9			

Peak sensitivity wavelength: 2.3 μm

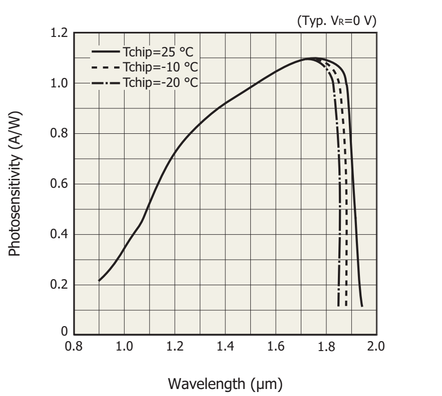
These are suitable for use in NIR (near infrared) spectroscopy.

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

Type no.	Cooling	Photosensitive area (mm)	Spectral response range λ (μm)	Peak sensitivity wavelength λp (μm)	Cutoff frequency fc V_R=0 V (MHz)	Package	Photo	Option (sold separately)
G12183-003K	Non-cooled	ϕ0.3	0.9 to 2.6	2.3	50	TO-18		C4159-03 (P.25)
G12183-005K		ϕ0.5			20			
G12183-010K		ϕ1			6			
G12183-020K		ϕ2			1.5	TO-5		
G12183-030K		ϕ3			0.8			
G12183-103K	One-stage TE-cooled (Tchip=-10 °C)	ϕ0.3	0.9 to 2.57		70	TO-8		C4159-03 (P.25) A3179 (P.23) C1103-04 (P.22)
G12183-105K		ϕ0.5			25			
G12183-110K		ϕ1			7			
G12183-120K		ϕ2			2			
G12183-130K		ϕ3			0.9			
G12183-203K	Two-stage TE-cooled (Tchip=-20 °C)	ϕ0.3	0.9 to 2.55		75	TO-8		C4159-03 (P.25) A3179-01 (P.23) C1103-04 (P.22)
G12183-205K		ϕ0.5			28			
G12183-210K		ϕ1			8			
G12183-220K		ϕ2			2.3			
G12183-230K		ϕ3			1			

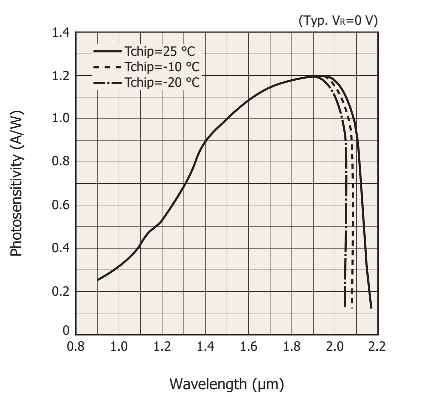
Spectral response

[G12181 series]



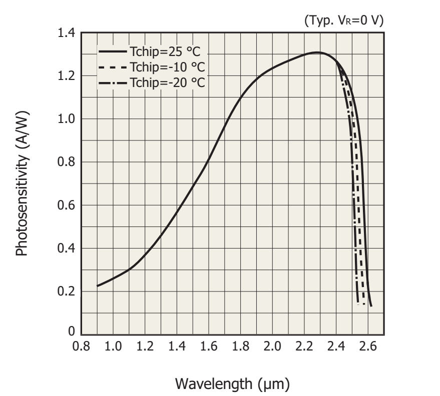
KIRDB0483ED

[G12182 series]



KIRDB0487ED

[G12183 series]



KIRDB0491ED

Infrared detector modules with preamp

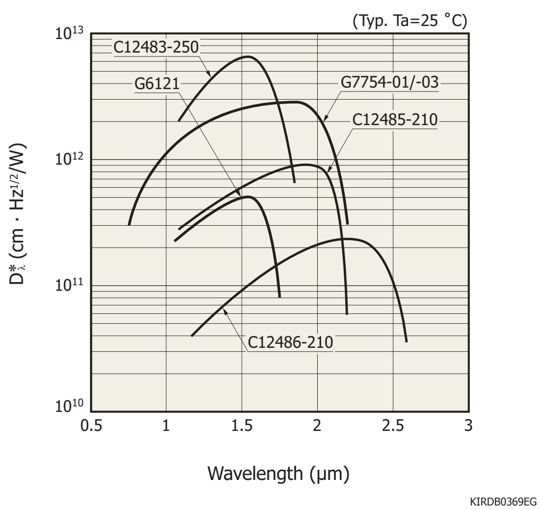
These modules consist of the InGaAs PIN photodiode assembled with matched preamplifier, and operate by connecting a DC power supply.

(Typ.)

Type no.	Detector	Cooling (Measurement condition)	Photosensitive area (mm)	Cutoff wavelength λc (μm)	Peak sensitivity wavelength λp (μm)	Photosensitivity S λ=λp (V/W)	Photo
G6121	G8370-05	Non-cooled (Ta=25 °C)	ϕ5	1.7	1.55	1×10^6	
C12483-250	G12180-250A	TE-cooled (Tchip=-15 °C)	ϕ5	1.66	1.55	5×10^7	
C12485-210	G12182-210K		ϕ1	2.05	1.95	1.8×10^8	
C12486-210	G12183-210K			2.56	2.3	2×10^8	
G7754-01	G12183-010 (chip)	Liquid nitrogen (Tchip=-196 °C)	ϕ1	2.4	2.0	2×10^9	
G7754-03	G12183-030 (chip)		ϕ3			5×10^8	

Note: Supplied with a power supply cable

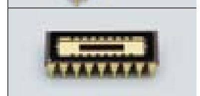
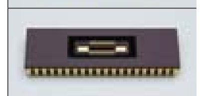
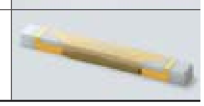
Spectral response



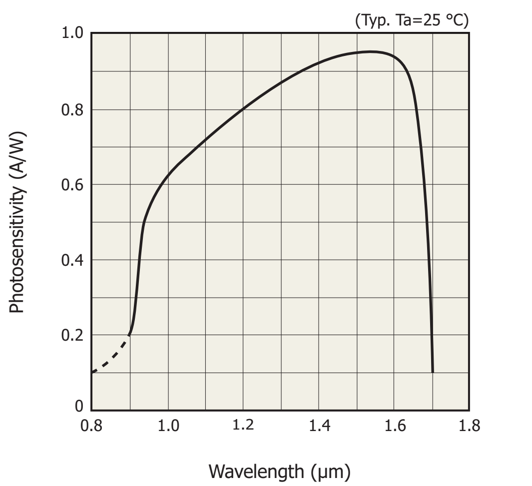
Hamamatsu also provides the C10439-10/-11 photodiode modules that integrate an InGaAs photodiode and a current-to-voltage conversion amplifier.

InGaAs PIN photodiode arrays

(Typ. Ta=25 °C)

<table>
<tr><th>Type no.</th><th>Photosensitive area
(mm)</th><th>Spectral response range
λ
(μm)</th><th>Peak sensitivity wavelength
λp
(μm)</th><th>Package</th><th>Photo</th></tr>
<tr><td>G6849-01</td><td>ϕ1
(Quadrant element)</td><td rowspan="7">0.9 to 1.7</td><td rowspan="7">1.55</td><td rowspan="2">TO-5</td><td></td></tr>
<tr><td>G6849</td><td>ϕ2
(Quadrant element)</td><td></td></tr>
<tr><td>G7151-16</td><td>0.08 × 0.2
(16-element)</td><td rowspan="4">Ceramic</td><td></td></tr>
<tr><td>G12430-016D</td><td>0.45 × 1.0
(16-element)</td><td></td></tr>
<tr><td>G12430-032D</td><td>0.2 × 1.0
(32-element)</td><td></td></tr>
<tr><td>G12430-046D</td><td>0.2 × 1.0
(46-element)</td><td></td></tr>
<tr><td>G8909-01</td><td>ϕ0.08
(40-element)</td><td>Ceramic
(Non-sealed)</td><td></td></tr>
</table>

Spectral response

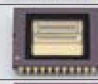
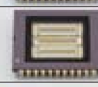
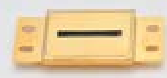


KIRDB0002EB

InGaAs image sensors

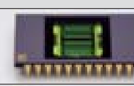
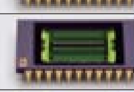
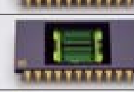
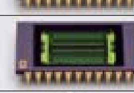
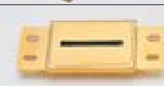
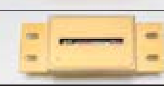
InGaAs linear image sensors for spectrometry

Front-illuminated type

Type no.	Cooling	Pixel height (μm)	Pixel pitch (μm)	Number of pixels	Line rate (lines/s)	Spectral response range λ (μm)	Defective pixels	Photo	Dedicated driver circuit
G9203-256D	Non-cooled	500	50	256	1910	0.9 to 1.7	0		–
G9204-512D			25	512	960*1				
G11608-256DA			50	256	17200	0.5 to 1.7	1% max.		–
G11608-512DA			25	512	9150*1				
G11508-256SA	One-stage TE-cooled (Tchip=-10 °C)	500	50	256	17200	0.9 to 1.67	0		–
G11508-512SA			25	512	9150*1				
G11475-256WB	Two-stage TE-cooled (Tchip=-20 °C)	250	50	256	17200	0.9 to 1.85	5% max.		–
G11476-256WB						0.9 to 2.05			
G11477-256WB						0.9 to 2.15			
G11478-256WB						0.9 to 2.55			
G11475-512WB			25	512	9150*1	0.9 to 1.85	4% max.		
G11477-512WB						0.9 to 2.15			
G11478-512WB						0.9 to 2.55			
NEW G14237-512WA		500	25	512	9150*1	0.85 to 1.4	1% max.		–

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

Back-illuminated type

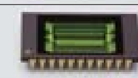
Type no.	Cooling	Pixel height (μm)	Pixel pitch (μm)	Number of pixels	Line rate (lines/s)	Spectral response range λ (μm)	Defective pixels	Photo	Dedicated driver circuit*2
G11620-128DA	Non-cooled	500	50	128	30800	0.95 to 1.7	1% max.		C11513
G11620-256DA				256	17200				
G11620-256DF			25	256	17200				
G11620-512DA				512	9150				
NEW G13913-128FB		250	50	128	13600				–
NEW G13913-256FG			25	256	7290				
G11620-256SA	One-stage TE-cooled (Tchip=-10 °C)	500	50	256	17200	0.95 to 1.67	1% max.		–
G11620-512SA			25	512	9150				
G12230-512WB	Two-stage TE-cooled (Tchip=-20 °C)	250	25	512	9150	0.95 to 2.15	2% max.		–

*2: Sold separately

High-speed type InGaAs linear image sensors

Front-illuminated type

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

Type no.	Cooling	Pixel height (μm)	Pixel pitch (μm)	Number of pixels	Line rate (lines/s)	Spectral response range λ (μm)	Defective pixels	Photo	Dedicated driver circuit*3
G9494-256D	Non-cooled	50	50	256	7100	0.9 to 1.7	1% max.		C10820
G9494-512D		25	25	512	3720*4				

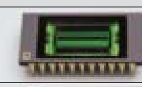
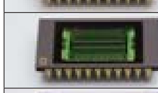
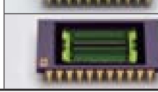
*3: Sold separately
*4: When two video lines are used for readout, the line rate is equal to that for 256 channels.

The G10768 series is a high-speed infrared image sensor with 1024 pixels designed for applications such as foreign object screening and medical diagnostic equipment where a multichannel high-speed line rate is required.

Type no.	Cooling	Pixel height (μm)	Pixel pitch (μm)	Number of pixels	Line rate (lines/s)	Spectral response range λ (μm)	Defective pixels	Photo	Dedicated driver circuit*5
G10768-1024D	Non-cooled	100	25	1024	39000	0.9 to 1.7	1% max.		C10854
G10768-1024DB		25							

Back-illuminated type

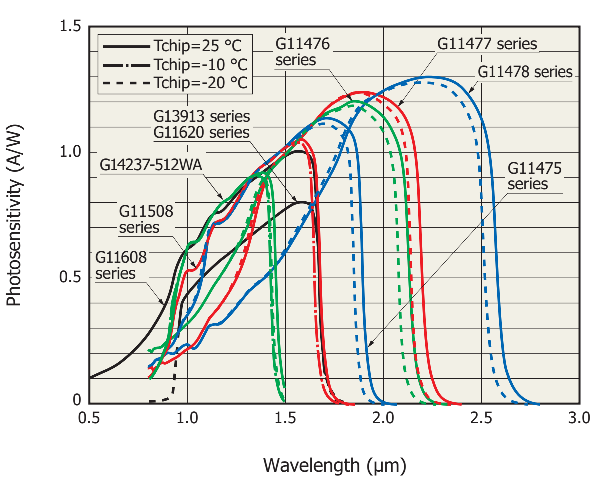
The back-illuminated InGaAs photodiode and CMOS-ROIC are bump bonded to provide a single output terminal.

Type no.	Cooling	Pixel height (μm)	Pixel pitch (μm)	Number of pixels	Line rate (lines/s)	Spectral response range λ (μm)	Defective pixels	Photo	Dedicated driver circuit*5
G11135-256DD	Non-cooled	50	50	256	14000	0.95 to 1.7	1% max.		C11514
G11135-512DE		25	25	512	8150				
NEW G14006-512DE		25	25	512	8150	1.12 to 1.9			

*5: Sold separately

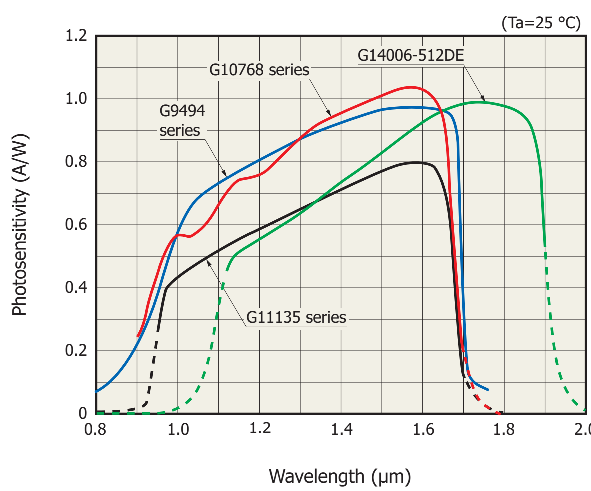
Spectral response

[InGaAs linear image sensors for spectrometry]



KMIRB0068EH

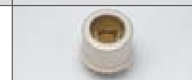
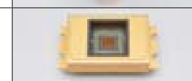
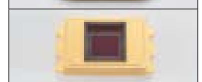
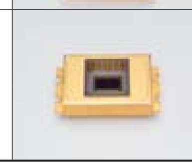
[High-speed type InGaAs linear image sensors]



KMIRB0112EA

InGaAs area image sensors

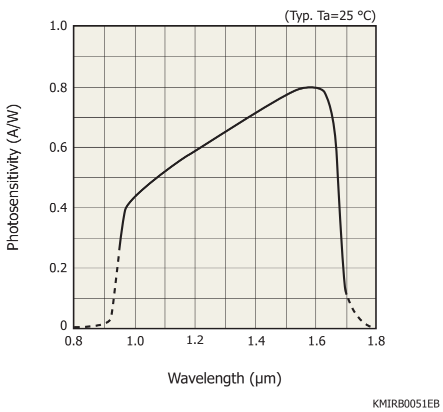
The InGaAs area image sensors have a hybrid structure consisting of a CMOS readout circuit (ROIC: readout integrated circuit) and back-illuminated InGaAs photodiodes.

Type no.	Cooling	Pixel height (μm)	Pixel pitch (μm)	Number of pixels	Frame rate*1 (frames/s)	Spectral response range λ (μm)	Defective pixels	Photo	Dedicated driver circuit*2
G11097-0606S	One-stage TE-cooled (Tchip=25 °C)	50	50	64 × 64	1025	0.95 to 1.7	1% max.		C11512
G12460-0606S	One-stage TE-cooled (Tchip=0 °C)					1.12 to 1.9			
G12242-0707W	Two-stage TE-cooled (Tchip=15 °C)	20	20	128 × 128	258	0.95 to 1.7	1% max.		C11512-02
G13393-0808W				320 × 256	228		0.37% max.		–
G13393-0909W				640 × 512	62				
G13544-01	Two-stage TE-cooled (Tchip=-10 °C)	50	50	192 × 96	867	1.12 to 1.9	1% max.		
G13441-01	Two-stage TE-cooled (Tchip=-20 °C)					1.3 to 2.15			

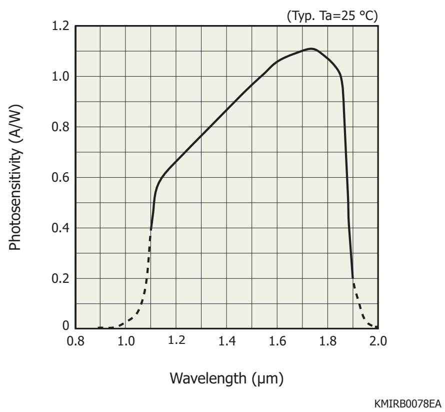
*1: Integration time 1 μs (min.)
*2: Sold separately

Spectral response

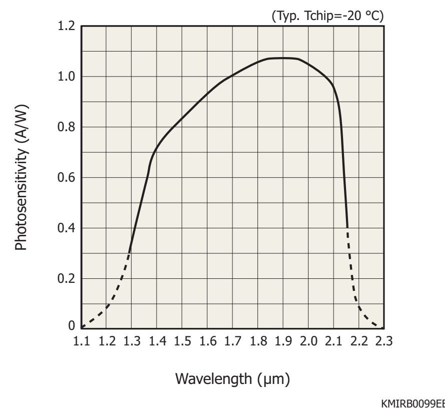
[G11097-0606S, G12242-0707W, G13393 series]



[G12460-0606S, G13544-01]



[G13441-01]



InAs/InAsSb/InSb photovoltaic detectors, InSb photoconductive detectors

InAs photovoltaic detectors are capable of detecting infrared light up to approx. 3.5 µm. InSb photovoltaic detector can sense infrared light up to approx. 5.5 µm, and InSb photoconductive detectors infrared light up to approx. 6 µm. InAsSb photovoltaic detectors also delivers high sensitivity in the 5 µm, 8 µm, or 10 µm band. InSb photoconductive detectors are available in multi-element arrays (custom-made product). InAs, InAsSb and InSb photovoltaic detectors cover a spectral response range equivalent to PbS and PbSe photoconductive detectors, respectively, and feature higher response speed and better S/N.

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.)

Type no.	Cooling	Photosensitive area (mm)	Cutoff wavelength λc (µm)	Peak sensitivity wavelength (µm)	Package	Photo	Option (sold separately)
P10090-01	Non-cooled	ϕ1	3.65	3.35	TO-5		C4159-07 (P.25)
P10090-11	One-stage TE-cooled (Tchip=-10 °C)		3.55	3.30	TO-8		A3179-01 (P.23) C1103-04 (P.22) C4159-06 (P.25)
P10090-21	Two-stage TE-cooled (Tchip=-30 °C)		3.45	3.25			A3179-01 (P.23) C1103-04 (P.22) C4159-06 (P.25)
P7163	Liquid nitrogen (Tchip=-196 °C)		3.10	3.00	Metal dewar		C4159-05 (P.25)

InAsSb photovoltaic detectors

InAsSb photovoltaic detectors have high infrared sensitivity with a cutoff wavelength in the 5 µm, 8 µm or 10 µm band. A small surface-mount package type (P13243-013CA) is also provided.

(Typ.)

Type no.	Cooling	Photosensitive area (mm)	Cutoff wavelength λc (µm)	Peak sensitivity wavelength (µm)	Package	Photo	Option (sold separately)
P11120-901	Liquid nitrogen (Tchip=-196 °C)	ϕ1	5.8	4.8	Metal dewar		C4159-01 (P.25)
P11120-201	Two-stage TE-cooled (Tchip=-30 °C)		5.9	4.9	TO-8		A3179-01 (P.23) C1103-04 (P.22) C4159-07 (P.25)
P13243-011MA	Non-cooled	0.7 × 0.7	5.3	3.5	TO-46		C4159-01 (P.25)
NEW P13243-013CA					Cramic		
NEW P13243-122MS	One-stage TE-cooled (Tchip=-10 °C)	2 × 2	5.2	4.1	TO-8		A3179 (P.23) C1103-04 (P.22) C4159-01 (P.25)
NEW P13243-222MS	Two-stage TE-cooled (Tchip=-30 °C)		5.1				A3179-01 (P.23) C1103-04 (P.22) C4159-01 (P.25)
P12691-201	Two-stage TE-cooled (Tchip=-30 °C)	ϕ1	8.3	6.7	TO-8		A3179-01 (P.23) C1103-04 (P.22) C4159-07 (P.25)
P13894-011MA	Non-cooled	1 × 1	11.0	5.6	TO-5		C4159-01 (P.25)
P13894-211MA	Two-stage TE-cooled (Tchip=-30 °C)		10.2		TO-8		A3179-01 (P.23) C1103-04 (P.22) C4159-01 (P.25)

InSb photovoltaic detectors

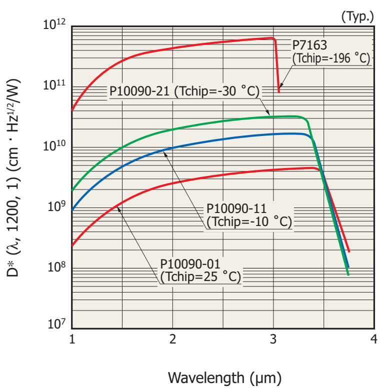
InSb photovoltaic detectors are high-speed, low-noise infrared detectors that deliver high sensitivity in the so-called atmospheric window between 3 and 5 µm. The infrared light in the 5 µm band can be detected with peak sensitivity and high response speed. A metal dewar type cooled with liquid nitrogen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

(Typ.)

Type no.	Cooling	Photosensitive area (mm)	Cutoff wavelength λc (µm)	Peak sensitivity wavelength λp (µm)	Package	Photo	Dedicated amplifier (sold separately)
P5968-060	Liquid nitrogen (Tchip=-196 °C)	ϕ0.6	5.5	5.3	Metal dewar		C4159-01 (P.25)
P5968-100		ϕ1					
P5968-200		ϕ2					C4159-04 (P.25)
P5968-300		ϕ3					Custom-made product
P4247-16		0.25 × 1.4 (1 × 16-element)					C4159-01 (P.25)
P4247-44		0.45 × 0.45 (4 × 4-element)					

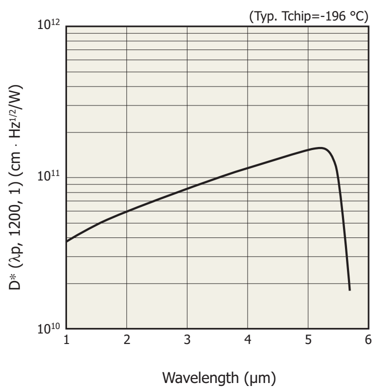
Spectral response

[InAs photovoltaic detectors]



KIRDB0356EE

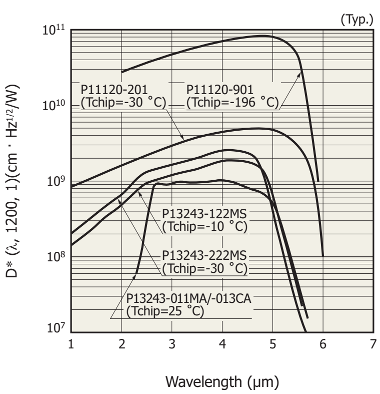
[InSb photovoltaic detectors]



KIRDB0063EF

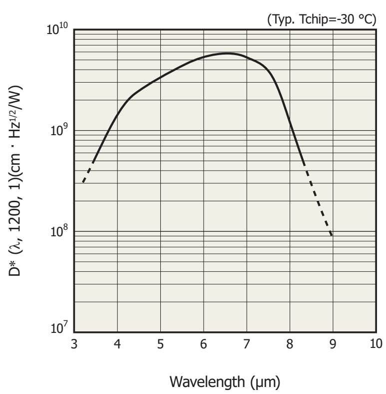
[InAsSb photovoltaic detectors]

P11120/P13243 series



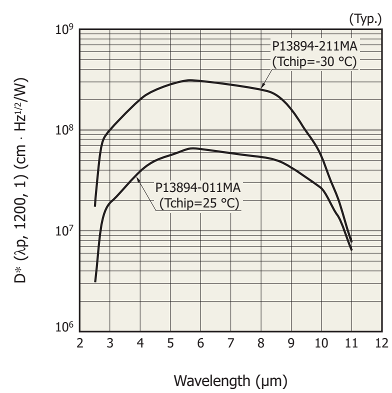
KIRDB0430EI

P12691-201



KIRDB0592EB

P13894 series



KIRDB0626EA

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.

(Typ.)

Type no.	Cooling	Photosensitive area (mm)	Cutoff wavelength λc (μm)	Peak sensitivity wavelength λp (μm)	Package	Photo	Option (sold separately)
P6606-110	One-stage TE-cooled (Tchip=-10 °C)	1 × 1	6.7	5.5	TO-8		A3179-01 (P.23) C1103-07 (P.22) C5185-02 (P.26)
P6606-210	Two-stage TE-cooled (Tchip=-30 °C)		6.5				A3179-01 (P.23) C1103-07 (P.22) C5185-02 (P.26)
P6606-305	Three-stage TE-cooled (Tchip=-60 °C)	0.5 × 0.5	6.3		TO-3		A3179-04 (P.23) C1103-05 (P.22) C5185-02 (P.26)
P6606-310		1 × 1					
P6606-320		2 × 2					

Infrared detector modules with preamp

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

(Typ.)

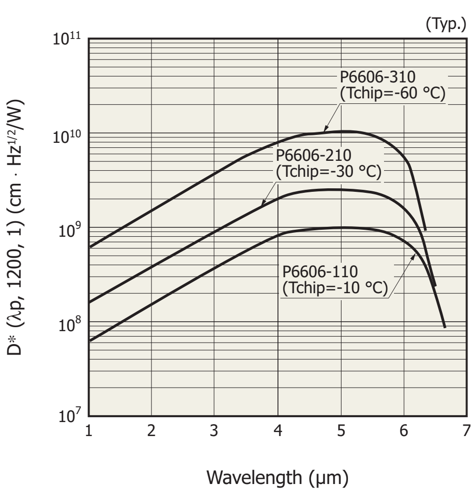
Type no.	Detector	Photosensitive area (mm)	Cooling	Measurement condition Chip temperature (°C)	Cutoff wavelength λc (μm)	Peak sensitivity wavelength λp (μm)	Photo
P4631-03	InSb (P6606-310)	1 × 1	TE-cooled	-58	6.1	5.5	
P7751-01*	InSb (P5968-060)	ϕ0.6	Liquid nitrogen	-196	5.5	5.3	
P7751-02*	InSb (P5968-200)	ϕ2					
C12492-210	InAs (P10090-21)	ϕ1	TE-cooled	-28	3.45	3.25	
C12494-210S	InAsSb (P11120-201)				5.9	4.9	
C12494-210M	InAsSb (P12691-201)				8.3	6.7	

* FOV=60°

Note: Supplied with a power supply cable

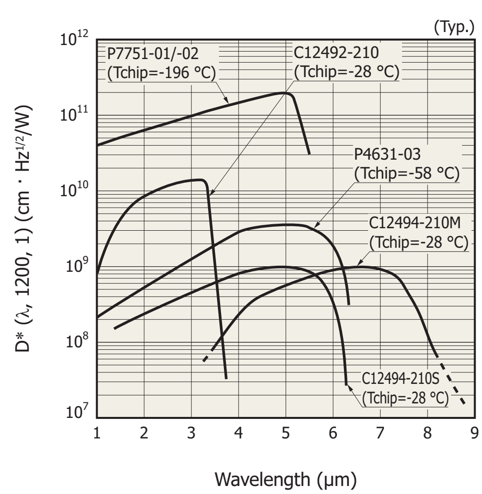
Spectral response

[InSb photoconductive detectors]



KIRDB0166ED

[Infrared detector module with preamp]



KIRDB0371EI

Hamamatsu also provides the C10439-14 photodiode module that integrates an InAsSb photovoltaic detector and a current-to-voltage conversion amplifier.

Thermopile detectors (Si thermal detectors)

Single-element type

Hamamatsu provides high-sensitivity 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 T11262-06 is suitable for flame detection and the T11361-05 for CO_2 concentration measurement.

Type no.	Package	Number of elements	Photosensitive area (mm)	Window	Spectral response (μm)	Photo
T11262-01	TO-18	1	1.2 × 1.2	AR-coated Si	3 to 5	
T11361-01*						
T11262-06				Band-pass filter	4.45	
T11361-05*					4.3	

* Built-in thermistor

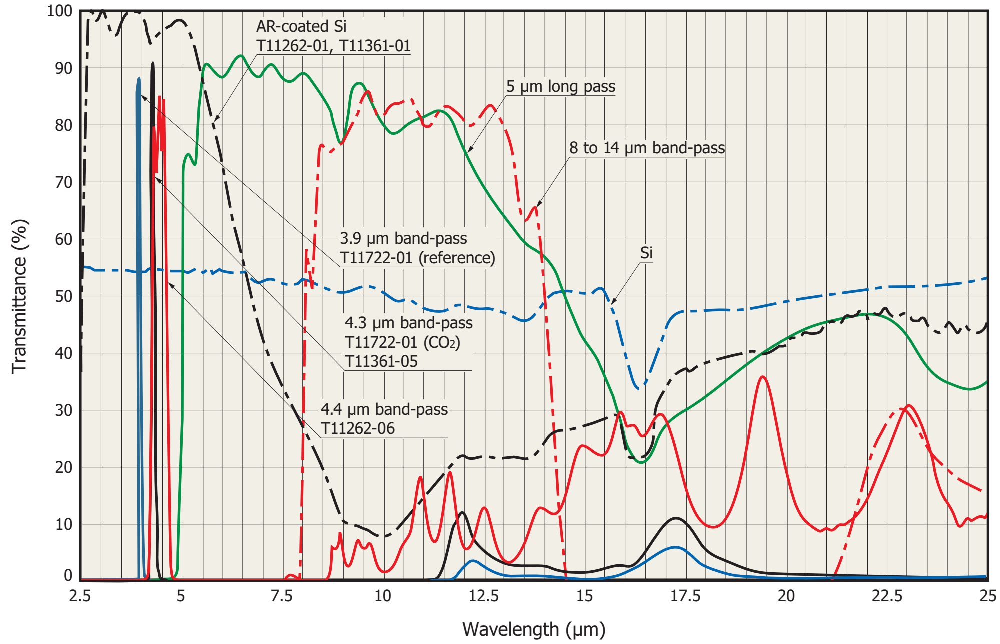
Dual-element type

The T11722-01 is a dual-element type thermopile detector designed to detect CO_2 concentrations with a high accuracy. It consists of a high sensitivity dual-element thermopile detector and two band-pass filters for sensing two wavelengths (reference: 3.9 μm, CO_2: 4.3 μm) simultaneously.

Type no.	Package	Number of elements	Photosensitive area (mm)	Window	Spectral response (μm)	Photo
T11722-01	TO-5	2	1.2 × 1.2 (per 1 element)	Band-pass filter	Reference: 3.9 CO_2: 4.3	

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.



KIRDB0512EC

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.

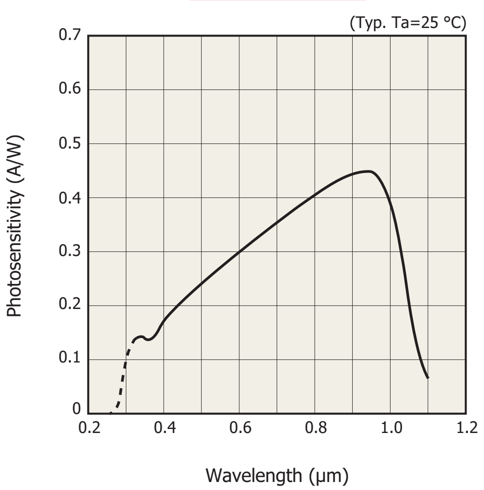
(Typ.)

Type no.	Cooling	Detector	Photosensitive area (mm)	Spectral response range λ (μm)	Peak sensitivity wavelength λp (μm)	Photo-sensitivity S (A/W)	Package	Photo	Option (sold separately)
K1713-003	Non-cooled	Si	2.4 × 2.4	0.32 to 5.3	0.94	0.45	TO-5		C9329 C4159-01 (P.26)
		InAsSb	0.7 × 0.7		4.0	0.0039			
K1713-05		Si	2.4 × 2.4	0.32 to 1.7	0.94	0.45			C9329 C4159-03 (P.25)
		InGaAs	ϕ0.5		1.55	0.55			
K1713-08		Si	2.4 × 2.4	0.32 to 2.6	0.94	0.45			
		InGaAs	ϕ1		2.3	0.60			
K1713-09		Si	2.4 × 2.4	0.32 to 1.7	0.94	0.45			
		InGaAs	ϕ1		1.55	0.55			
K11908-010K		InGaAs	2.4 × 2.4	0.9 to 2.55	1.55	0.95			C4159-03 (P.25)
		InGaAs	ϕ1		2.1	1.0			
K3413-05	One-stage TE-cooled (Tchip=-10 °C)	Si	2.4 × 2.4	0.32 to 1.67	0.94	0.45	TO-8		C9329 C4159-03 (P.25) A3179-03 (P.23) C1103-04 (P.22)
		InGaAs	ϕ0.5		1.55	0.55			
K3413-08		Si	2.4 × 2.4	0.32 to 2.57	0.94	0.45			
		InGaAs	ϕ1		2.3	0.60			
K3413-09		Si	2.4 × 2.4	0.32 to 1.67	0.94	0.45			
		InGaAs	ϕ1		1.55	0.55			
K12728-010K	Non-cooled	Si	2.4 × 2.4	0.32 to 1.7	0.96	0.45	Ceramic		C9329 C4159-03 (P.25)
		InGaAs	ϕ1		1.55	0.55			
K12729-010K		InGaAs	2.4 × 2.4	0.9 to 2.55	1.55	0.95			
		InGaAs	ϕ1		2.1	1.0			

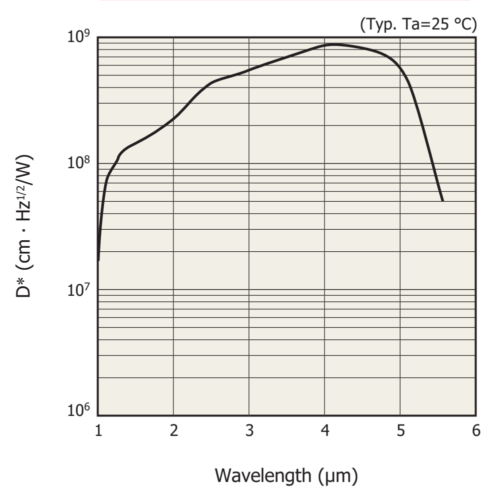
Spectral response

[K1713-003]

Si photodiode

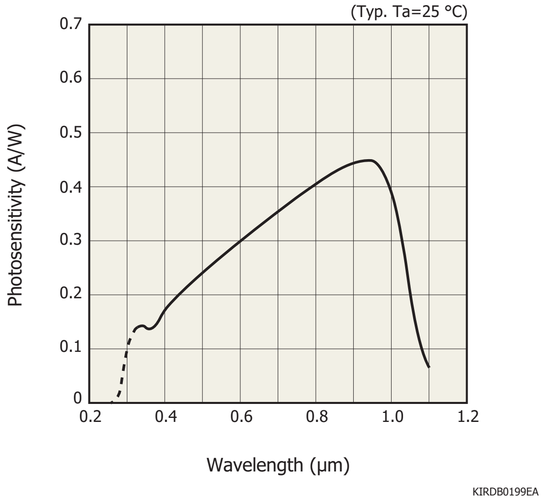


InAsSb photovoltaic detector

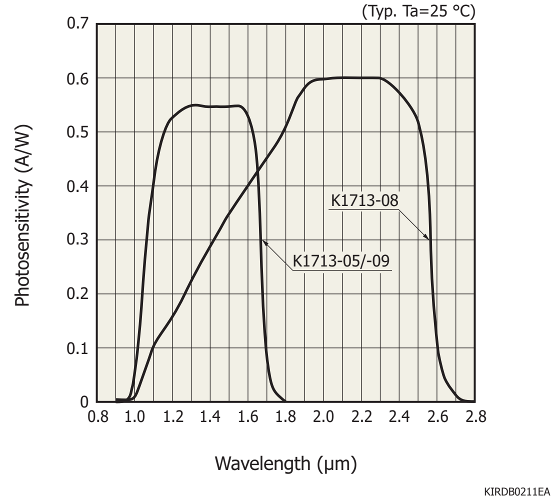


[K1713-05/-08/-09]

Si photodiode

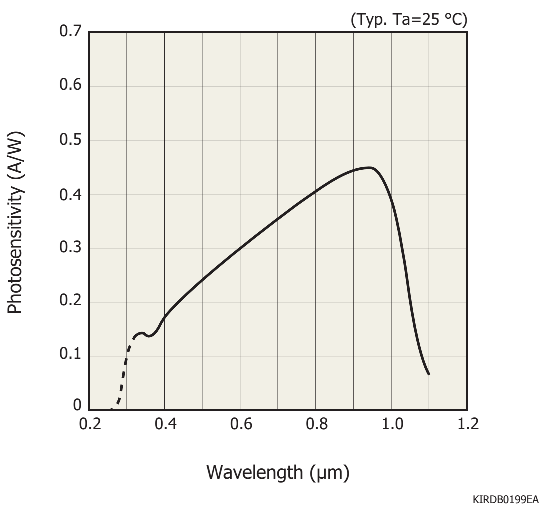


InGaAs PIN photodiode

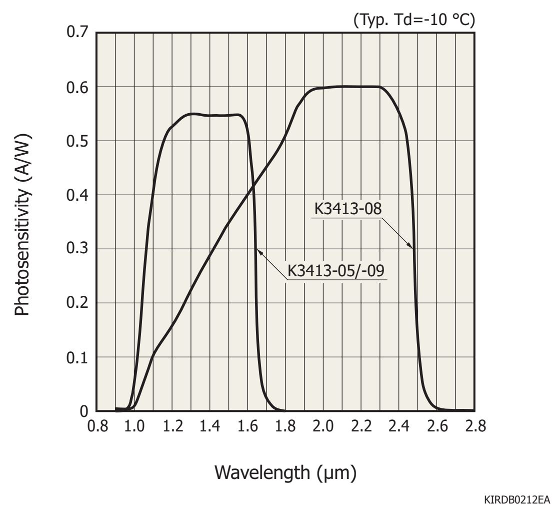


[K3413-05/-08/-09]

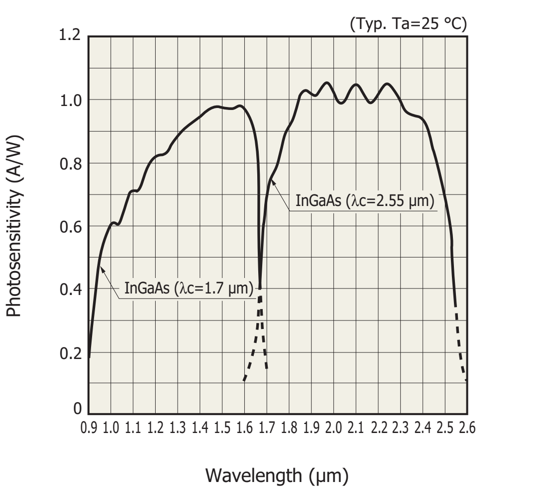
Si photodiode



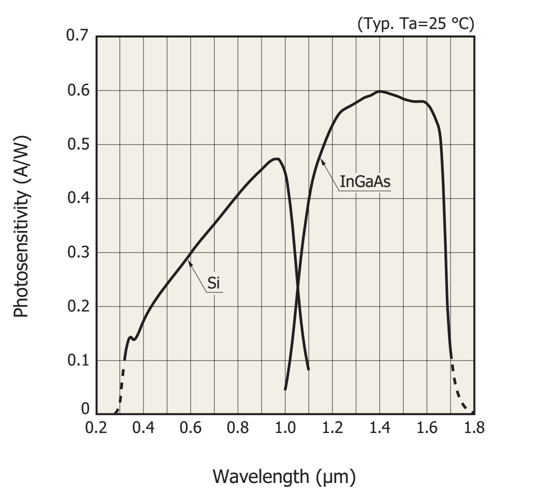
InGaAs PIN photodiode



[K11908-010K, K12729-010K]



[K12728-010K]



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 CO_2 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.

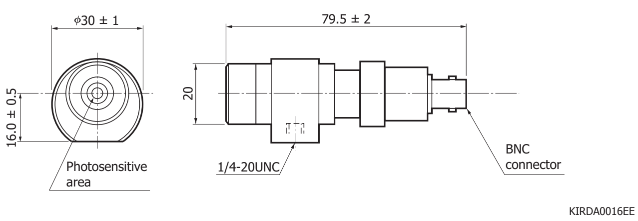
Non-cooled type

(Typ.)

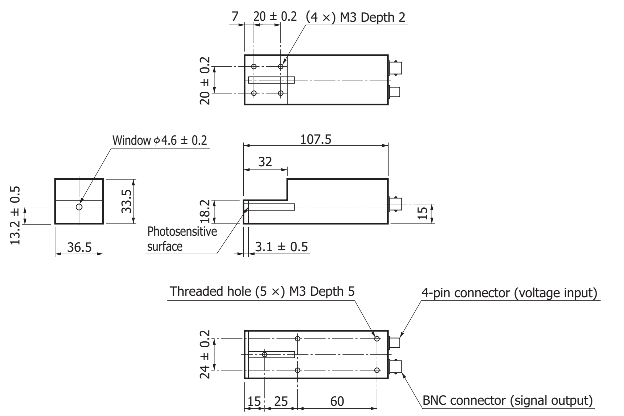
Type no.	Cooling	Photosensitive area (mm)	Peak sensitivity wavelength λp (µm)	Photosensitivity S λ=10.6 µm (V/W)	Photo	Magnet stand (sold separately)
B749	Non-cooled	ϕ5.0	10.6	1.2×10^{-6}		A1447
C12496-046		ϕ4.6		1.3×10^{-2}		-

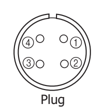
Dimensional outlines (unit: mm, tolerance unless otherwise noted: ±1)

[B749]



[C12496-046]



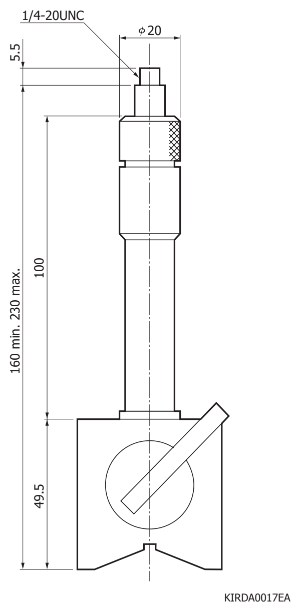


Pin no.	Pin connection	Lead color
①	Vcc=+15 V	White
②	GND	Blue/white stranded wire
③	GND	
④	Vcc=-15 V	Blue

Tolerance unless otherwise noted: ±1

KIRDA0231EB

[Magnet stand A1447]



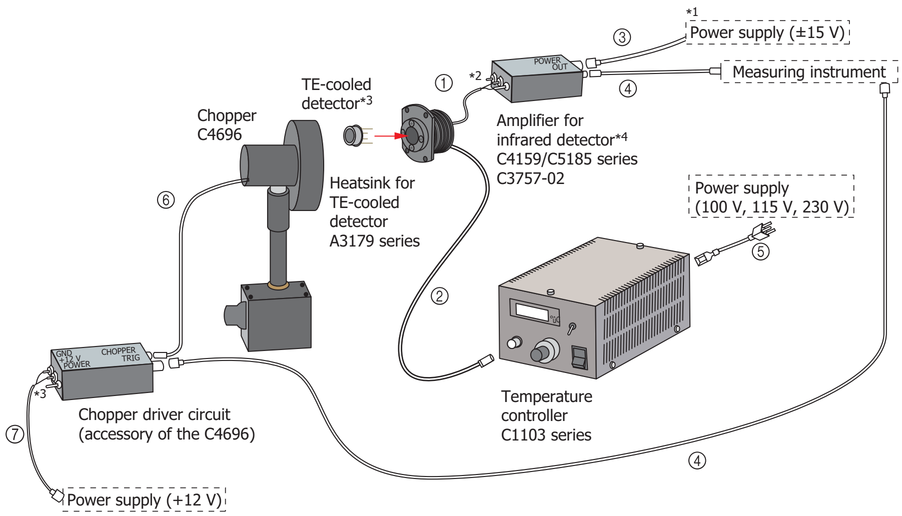
Accessories for infrared detectors

Hamamatsu provides following accessories for infrared detectors.

· Temperature controllers (P.22)
· Heatsinks for TE-cooled detector (P.23)
· Chopper (P.24)
· Amplifiers for infrared detectors (P.25)

A connection example is shown below.

Connection example



KACCC0321ED

Cable no.	Cable	Length approx.	Note
①	Coaxial cable (for signal)	2 m	Supplied with heatsink A3179 series. When using this cable, make it as short as possible (preferably approx. 10 cm).
②	4-conductor cable (with a connector) A4372-05	3 m	Supplied with temperature controller C1103 series. This cable is also sold separately.
③	4-conductor cable (with a connector) A4372-02	2 m	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 "infrared detector modules with preamps (TE-cooled type)", is also sold separately.
④	BNC connector cable E2573	1 m	Option
⑤	Power supply cable (for temperature controller)	1.9 m	Supplied with temperature controller C1103 series
⑥	Chopper driver cable (connected to chopper)	2 m	Connected to chopper driver circuit
⑦	2-conductor cable or coaxial cable (for chopper power supply)	2 m or less	Prepared by user

*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.

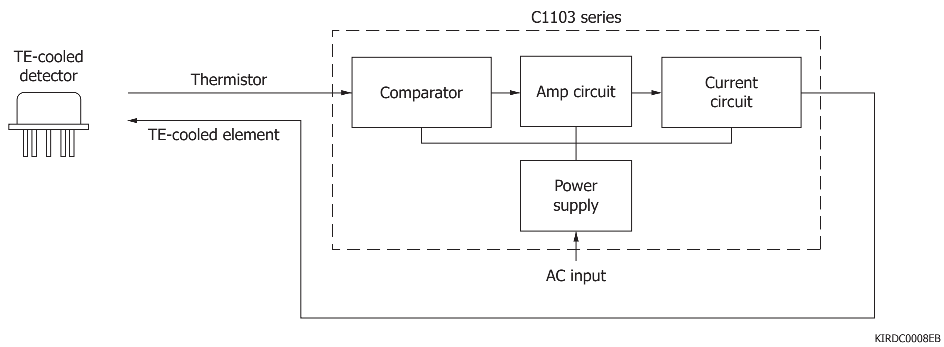
Temperature controllers C1103 series

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.

Parameter	C1103-04	C1103-05	C1103-07
Applicable detector*4	One-stage/two-stage TE-cooled type InAsSb, InAs photovoltaic detectors, InGaAs, Si photodiodes	Two-stage/three-stage TE-cooled type InSb photoconductive detectors	One-stage TE-cooled type InSb photoconductive detectors
Setting element temperature	-30 to +20 °C	-75 to -25 °C	-30 to +20 °C
Temperature stability	Within ±0.1 °C		
Output current for temperature control	1.1 A min., 1.2 A typ., 1.3 A max.		
Power supply	100 V ± 10% · 50/60 Hz*5		
Power consumption	30 W		
Dimensions	107 (W) × 87 (H) × 190 (D) mm		
Weight	Approx. 1.9 kg		
Operating temperature	+10 to +40 °C		
Operating humidity	90% max.		
Storage temperature*6	-20 to +40 °C		
Accessories	Instruction manual 4-conductor cable (with a connector, 3 m) A4372-05*7, power supply cable		

*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

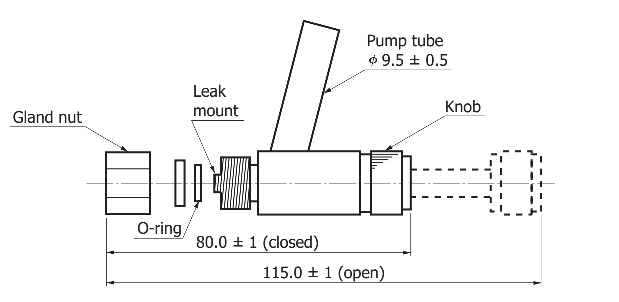


Valve operator for metal dewar A3515

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.

Vaccum pump — Valve operator — Metal dewar type infrared detector

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 (heatsink for TO-66 is available as a custom product.).

Accessories

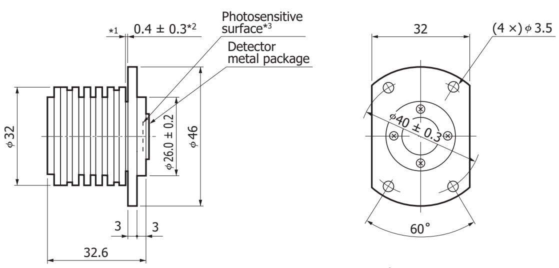
- Instruction manual
- 4-conductor cable (2 m): for TE-cooler and thermistor*1 *2
- Coaxial cable (2 m): for signal*2

*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]

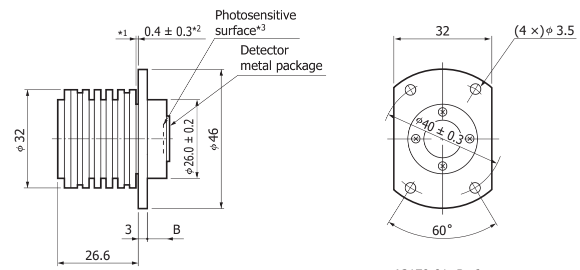


Weight: approx. 50 g

*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.

KIRDA0018EE

[A3179-01, A3179-03]

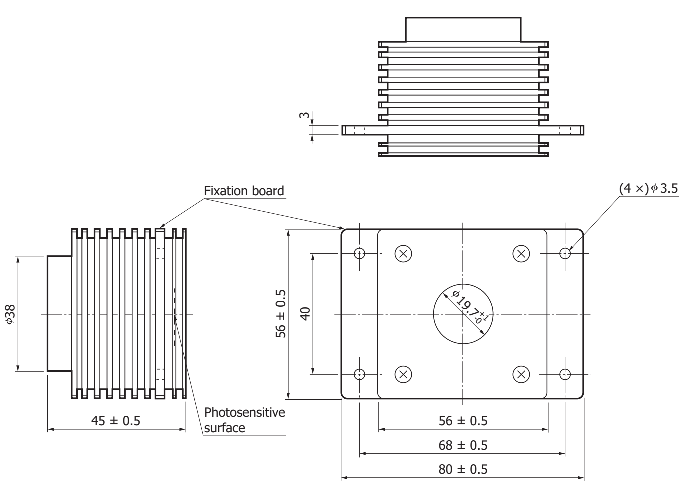


A3179-01: B=6
A3179-03: B=6.4
Weight: approx. 53 g

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

KIRDA0019EF

[A3179-04]



Weight: approx. 320 g

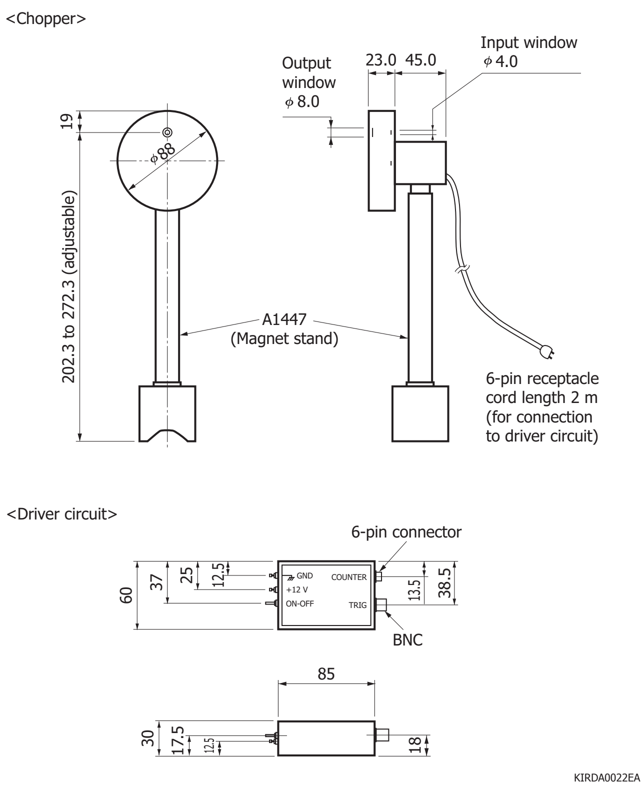
KIRDA0149ED

Chopper C4696

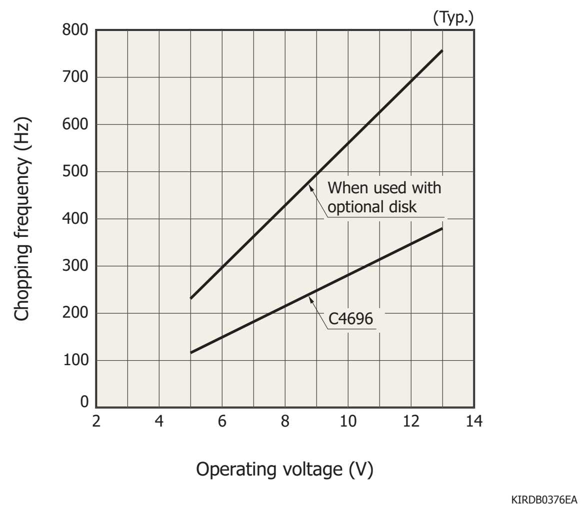
Parameter		Specification
Chopping frequency		115 to 380 Hz, 345 Hz typ.*3
Operating voltage V_D		DC 5 to 13 V, 12 V typ.
Duty ratio		1:1
Rotational stability		0.06%/°C
Sync signal V_H (high level)	Min.	V_D - 0.5 V
	Max.	V_D - 0.2 V
Operating temperature		0 to 50 °C
Maximum current consumption*4		90 mA
Accessories		Magnet stand A1447 (see P.20), driver circuit

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

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



Chopping frequency vs. operating voltage



Amplifiers for infrared detectors C4159 series, C5158-02

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: ±15 V ± 0.5
· 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)

Absolute maximum ratings (Ta=25 °C)

Parameter	Value	Unit
Operating temperature	0 to +40	°C
Storage temperature	-20 to +70	°C

Amplifiers for photovoltaic detectors (Typ.)

Parameter	C4159-01	C4159-04	C4159-05	C4159-06	C4159-07	Unit
Applicable detector*1 *2 *3	Dewar type InSb (P5968-060/-100, P4247-16/-44) Dewar type InAsSb (P11120-901) Non-cooled type InAsSb (P13243-011MA/-013CA, P13894-011MA) TE-cooled type InAsSb (P13243-122MS/-222MS, P13894-211MA)	Dewar type InSb (P5968-200)	Dewar type InAs (P7163)	TE-cooled type InAs (P10090-11/-21)	Non-cooled type InAs (P10090-01) TE-cooled type InAsSb (P11120-201, P12691-201)	-
Conversion impedance	10^8, 10^7, 10^6 (3 ranges switchable)	2 x 10^7, 2 x 10^6, 2 x 10^5 (3 ranges switchable)	10^8, 10^7, 10^6 (3 ranges switchable)	10^6, 10^5, 10^4 (3 ranges switchable)		V/A
Frequency response (amp only, -3 dB)	DC to 100 kHz*4	DC to 45 kHz	DC to 15 kHz	DC to 100 kHz		-
Output impedance	50					Ω
Maximum output voltage (1 kΩ load)	+10					V
Output offset voltage	±5		±10	±5		mV
Equivalent input noise current*5 (f=1 kHz)	0.15 (10^8, 10^7 range) 0.65 (10^6 range)	0.55	0.15 (10^8, 10^7 range) 0.65 (10^6 range)	6	10	pA/Hz$^{1/2}$
Reverse voltage	Limited to 0 V operation					-
External power supply*6	±15					V
Current consumption	+30, -10 max.			+30, -22 max.		mA

Amplifiers for InGaAs PIN photodiodes (Typ.)

Parameter	C4159-03	Unit
Applicable detector*1 *2	InGaAs	-
Conversion impedance	10^7, 10^6, 10^5 (3 ranges switchable)	V/A
Frequency response (amp only, -3 dB)	DC to 15 kHz	-
Output impedance	50	Ω
Maximum output voltage (1 kΩ load)	+10	V
Output offset voltage	±5	mV
Equivalent input noise current (f=1 kHz)	2.5	pA/Hz$^{1/2}$
Reverse voltage	Can be applied from external unit	-
External power supply*6	±15	V
Current consumption	±15 max.	mA

Note: Output noise voltage = Equivalent input noise current × Conversion impedance

*1: These amplifiers 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.
*4: When connected to a detector, frequency response becomes 60 kHz or less depending on the detector photosensitive area. (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. No ringing occurs when detecting sine-wave light. (For information on the ringing specifications, refer to the datasheet "Amplifier for infrared detector".)
*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: More than 1.5 times the maximum current consumption
Ripple noise: 5 mVp-p or less

Amplifiers for photoconductive detectors (Typ.)*7

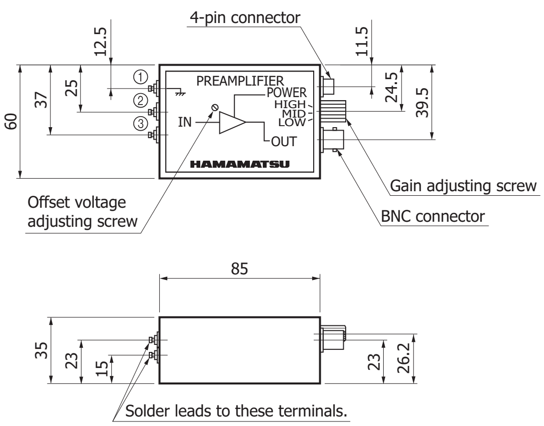
Parameter	C5185-02	Unit
Applicable detector*8 *9 *10	InSb (P6606 series)	-
Input impedance	5	kΩ
Voltage gain	66 (× 2000)	dB
Frequency response (amp only, -3 dB)	5 Hz to 250 kHz	-
Detector bias current	5 mA, 10 mA, 15 mA (3 ranges switchable)	-
Output impedance	50	Ω
Maximum output voltage (1 kΩ load)	±10	V
Equivalent input noise voltage (f=1 kHz)	2.6*11	$nV/Hz^{1/2}$
External power supply*12	±15	V
Current consumption	+100, -30 max.	mA

Note: Output noise voltage = Equivalent input noise voltage × Voltage gain

*7: Before purchasing, make sure the bias current to the detector matches the detector bias current specified in the above table.
*8: These amplifiers cannot operate multiple detectors.
*9: Consult us before purchasing if you want to use with a detector other than listed here.
*10: Consult us before purchasing if you want to use with a multi-element detector.
*11: At the maximum detector bias current
*12: Recommended DC power supply (analog power supply): ±15 V
Current capacity: More than 1.5 times the maximum current consumption
Ripple noise: 5 mVp-p or less

Dimensional outlines (unit: mm)

[C4159-01/-03/-04/-05/-06/-07]

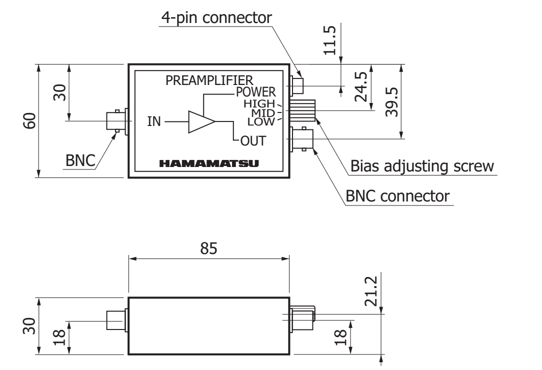


Pin connections
① GND
② Cathode
③ Anode

Tolerance unless otherwise noted: ±1
Note: Socket for lead attachment is not provided.

KIRDA0046EC

[C5185-02]



Tolerance unless otherwise noted: ±1

KIRDA0048EB

Description of terms

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

Dark current: I_D
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 V/W for photoconductive and in 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: λp
This is the wavelength at which the sensitivity of the detector is at maximum.

Reverse voltage (max.): V_R max, supply voltage (max.)
Applying a reverse voltage to a photovoltaic 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 (λp) 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.

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

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

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

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: Ct
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: Isc
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: λc
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 · $Hz^{1/2}$/W, and the higher the D*, the better the detector. D* is given by the following equation.

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

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 Δf 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: Rsh
This shunt resistance is the voltage-to-current ratio in the vicinity of 0 V in photovoltaic detectors and defined as follows:
Where I_D is the dark current at reverse voltage=10 mV.

$$\text{Rsh } [\Omega] = \frac{10\ [\text{mV}]}{I_D\ [\text{A}]}$$

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

Quantum efficiency: 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]:

$$\text{QE} = \frac{S \times 1240}{\lambda} \times 100\ [\%]$$

Date.

No.

PHOTON IS OUR BUSINESS

Date.

No.

Disclaimer

- Products manufactured by Hamamatsu Photonics K.K. (hereafter "Hamamatsu") are intended for use in general-use electronic devices (such as measurement equipment, office equipment, information communications equipment, household appliances, etc.). Unless an exception to the following is stated in the documentation of a specific product, Hamamatsu products are not to be used for special applications which demand extremely high reliability or safety (such as equipment for nuclear power control, aerospace equipment, medical equipment and transportation equipment that directly affect human life, or disaster prevention or safety equipment).
- Hamamatsu products should not be used in excess of their absolute maximum ratings. Attention must be paid to all documented precautions.
- Hamamatsu continually makes efforts to improve the quality and reliability of its products; however these efforts cannot ensure 100% compliance with the manufacturing specifications. Sufficient safety design (such as redundant safety, fire preventative, and malfunction preventative features) are to be implemented in the development of equipment manufactured with the Hamamatsu product so that personal injury, fire, or damage to public property or welfare does not occur in the unlikely event of a malfunction of the Hamamatsu product. A dangerous condition could be created if sufficient consideration is not given to safety design that addresses potential problems, especially in the design of equipment where the failure or malfunction of the Hamamatsu product within the equipment could result in bodily harm, life-threatening injury, or serious property damage during the use of the equipment. With such types of equipment, Hamamatsu shall not be responsible for the use of its products within the equipment in any way for not obtaining our written consent such as specification sheets beforehand.
- Appropriate descriptions of the functions, performance, and methods of operation of the Hamamatsu product and the equipment within which the Hamamatsu product is incorporated are to be provided to end-users of the equipment. All accompanying warnings and cautionary labeling are also to be provided to the end-user.
- Warranty of the Hamamatsu product is limited to the repair or replacement of a product in which a defect is discovered within 1 year of delivery of the product and notification is made to Hamamatsu within that period, otherwise certain warranty is specified. However, even within the warranty period Hamamatsu shall not be responsible for damages caused by either natural disaster or improper use of the product (such as modification of the product or any use that contravenes the operating conditions, intended applications, operating instructions, storage method, disposal method, or any other term or condition described in our products' documents). For a complete description of the warranty associated with a particular product, please contact your regional Hamamatsu sales office.
- Exportation of some Hamamatsu products must comply with individual governmental regulations pertaining to export control. Export in contravention of governmental regulations is a crime and can result in severe monetary penalties or imprisonment. While we cannot give any legal advice as to how to comply with these regulations, we can help classify the goods in order to assist the buyer in determining what regulations apply. Please contact your regional Hamamatsu sales office for further assistance.
- In our products' documents, applications are mentioned as notable examples of how the Hamamatsu product can be used. Such mentions guarantee neither the suitability of the product for specific purposes nor the success or failure of the commercial use of the product in specific applications. Some applications may be protected by patents or other proprietary rights. Hamamatsu assumes no liability for any infringing use of our products. All warranties express or implied, including any warranty of merchantability or fitness for any particular purpose are hereby excluded.
- Product specifications are subject to change without notification due to product improvements, etc. Our products' documents have been carefully prepared to ensure the accuracy of the technical information contained herein, but in rare cases there may be errors. When using the Hamamatsu product, please be sure to request the delivery specification sheets, and confirm upon delivery that it is the most recent specifications. In addition to this document, please be sure to read any accompanying technical documentation and make note of any precautions listed in the delivery specification sheets.
-

HAMAMATSU

HAMAMATSU PHOTONICS K.K., Solid State Division
1126-1, Ichino-cho, Higashi-ku, Hamamatsu City, 435-8558, Japan
Telephone: (81)53-434-3311, Fax: (81)53-434-5184

www.hamamatsu.com

Main 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
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
Semiconductor lasers
Applied products of semiconductor lasers
Solid state lasers

Sales Offices

Japan:
HAMAMATSU PHOTONICS K.K.
325-6, Sunayama-cho, Naka-ku,
Hamamatsu City, Shizuoka Pref. 430-8587, Japan
Telephone: (81)53-452-2141, Fax: (81)53-456-7889
E-mail: intl-div@hq.hpk.co.jp

China:
HAMAMATSU PHOTONICS (CHINA) Co., Ltd.
Main Office
1201 Tower B, Jiaming Center, 27 Dongsanhuan Beilu,
Chaoyang District, 100020 Beijing, China
Telephone: (86)10-6586-6006, Fax: (86)10-6586-2866
E-mail: hpc@hamamatsu.com.cn

Shanghai Branch
4905 Wheelock Square, 1717 Nanjing Road West,
Jingan District, 200040 Shanghai, China
Telephone: (86)21-6089-7018, Fax: (86)21-6089-7017

Taiwan:
HAMAMATSU PHOTONICS TAIWAN Co., Ltd.
Main Office
8F-3, No.158, Section2, Gongdao 5th Road,
East District, Hsinchu, 300, Taiwan R.O.C.
Telephone: (886)03-659-0080, Fax: (886)03-659-0081
E-mail: info@hamamatsu.com.tw

Kaohsiung Office
No.6, Central 6th Road, K.E.P.Z. Kaohsiung 806,
Taiwan R.O.C.
Telephone: (886)07-262-0736, Fax: (886)07-811-7238

U.S.A.:
HAMAMATSU CORPORATION
Main Office
360 Foothill Road, Bridgewater, NJ 08807, U.S.A.
Telephone: (1)908-231-0960, Fax: (1)908-231-1218
E-mail: usa@hamamatsu.com

California Office
2875 Moorpark Ave. San Jose, CA 95128, U.S.A.
Telephone: (1)408-261-2022, Fax: (1)408-261-2522
E-mail: usa@hamamatsu.com

Chicago Office
4711 W.Golf Road, Suite 805, Skokie, IL 60076, U.S.A.
Telephone: (1)847-825-6046, Fax: (1)847-825-2189
E-mail: usa@hamamatsu.com

Boston Office
20 Park Plaza, Suite 312, Boston, MA 02116, U.S.A.
Telephone: (1)617-536-9900, Fax: (1)617-536-9901
E-mail: usa@hamamatsu.com

United Kingdom:
HAMAMATSU PHOTONICS UK Limited
Main Office
2 Howard Court, 10 Tewin Road, Welwyn Garden City,
Hertfordshire AL7 1BW, UK
Telephone: (44)1707-294888, Fax: (44)1707-325777
E-mail: info@hamamatsu.co.uk

South Africa Office:
9 Beukes Avenue, Highway Gardens, Edenvale
1609 South Africa
Telephone/Fax: (27)11-609-0367

France, Portugal, Belgium, Switzerland, Spain:
HAMAMATSU PHOTONICS FRANCE S.A.R.L.
Main Office
19, Rue du Saule Trapu, Parc du Moulin de Massy,
91882 Massy Cedex, France
Telephone: (33)1 69 53 71 00, Fax: (33)1 69 53 71 10
E-mail: infos@hamamatsu.fr

Swiss Office
Dornacherplatz 7, 4500 Solothurn, Switzerland
Telephone: (41)32-625-60-60, Fax: (41)32-625-60-61
E-mail: swiss@hamamatsu.ch

Belgian Office
Axisparc Technology, rue Andre Dumont 7
1435 Mont-Saint-Guibert, Belgium
Telephone: (32)10 45 63 34, Fax: (32)10 45 63 67
E-mail: info@hamamatsu.be

Spanish Office
C. Argenters, 4 edif 2 Parque Tecnológico del Vallés
08290 Cerdanyola (Barcelona), Spain
Telephone: (34)93 582 44 30, Fax: (34)93 582 44 31
E-mail: infospain@hamamatsu.es

Germany, Denmark, The Netherlands, Poland:
HAMAMATSU PHOTONICS DEUTSCHLAND GmbH
Main Office
Arzbergerstr. 10, D-82211 Herrsching am Ammersee,
Germany
Telephone: (49)8152-375-0, Fax: (49)8152-265-8
E-mail: info@hamamatsu.de

Danish Office
Lautruphøj 1-3, DK-2750 Ballerup, Denmark
Telephone: (45)70 20 93 69, Fax: (45)44 20 99 10
Email: info@hamamatsu.dk

Netherlands Office
Televisieweg 2, NL-1322 AC Almere, The Netherlands
Telephone: (31)36-5405384, Fax: (31)36-5244948
E-mail: info@hamamatsu.nl

Poland Office
8 St. A. Boboli Str. PL-02-525 Warsaw, Poland
Telephone: (48)22-646-0016, Fax: (48)22-646-0018
E-mail: poland@hamamatsu.de

North Europe and CIS:
HAMAMATSU PHOTONICS NORDEN AB
Main Office
Torshamnsgatan 35 16440 Kista, Sweden
Telephone: (46)8-509 031 00, Fax: (46)8-509 031 01
E-mail: info@hamamatsu.se

Russian Office
11, Christoprudny Boulevard, Building 1, Office 114,
101000, Moscow, Russia
Telephone: (7)495 258 85 18, Fax: (7)495 258 85 19
E-mail: info@hamamatsu.ru

Italy:
HAMAMATSU PHOTONICS ITALIA S.r.l.
Main Office
Strada della Moia, 1 int. 6, 20020 Arese (Milano), Italy
Telephone: (39)02-93 58 17 33, Fax: (39)02-93 58 17 41
E-mail: info@hamamatsu.it

Rome Office
Viale Cesare Pavese, 435, 00144 Roma, Italy
Telephone: (39)06-50 51 34 54, Fax: (39)02-93 58 17 41
E-mail: inforoma@hamamatsu.it

Cat. No. KIRD0001E12
Mar. 2018 DN
Printed in Japan (2,000)