HAMAMATSU
PHOTON IS OUR BUSINESS

Home   Technology   Application examples   Lineup   InGaAs linear Image sensors   InGaAs area image sensors   Related products   Technical notes

Image sensors for near infrared region

InGaAs
Image sensors

HAMAMATSU PHOTONICS K.K.
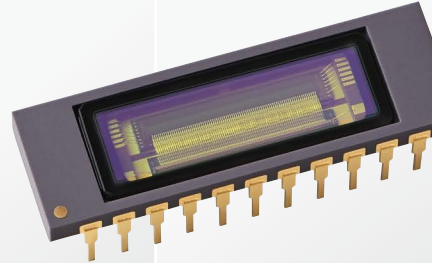
Please watch with an internet connection.   March 2024   Selection guide

InGaAs
Image sensors
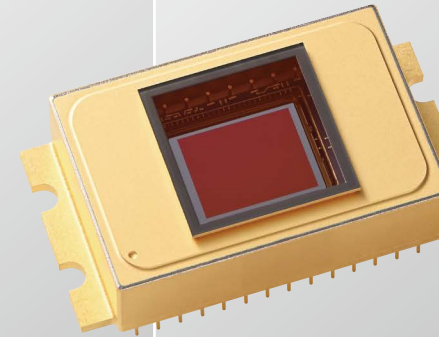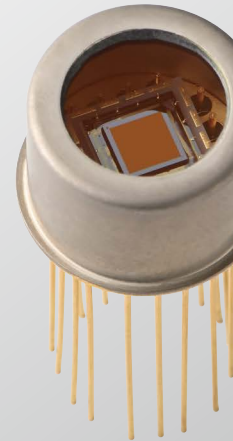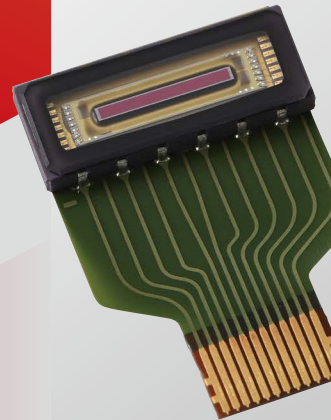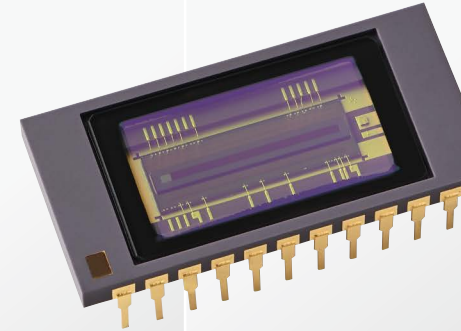
Various InGaAs linear/area image sensors for near infrared region
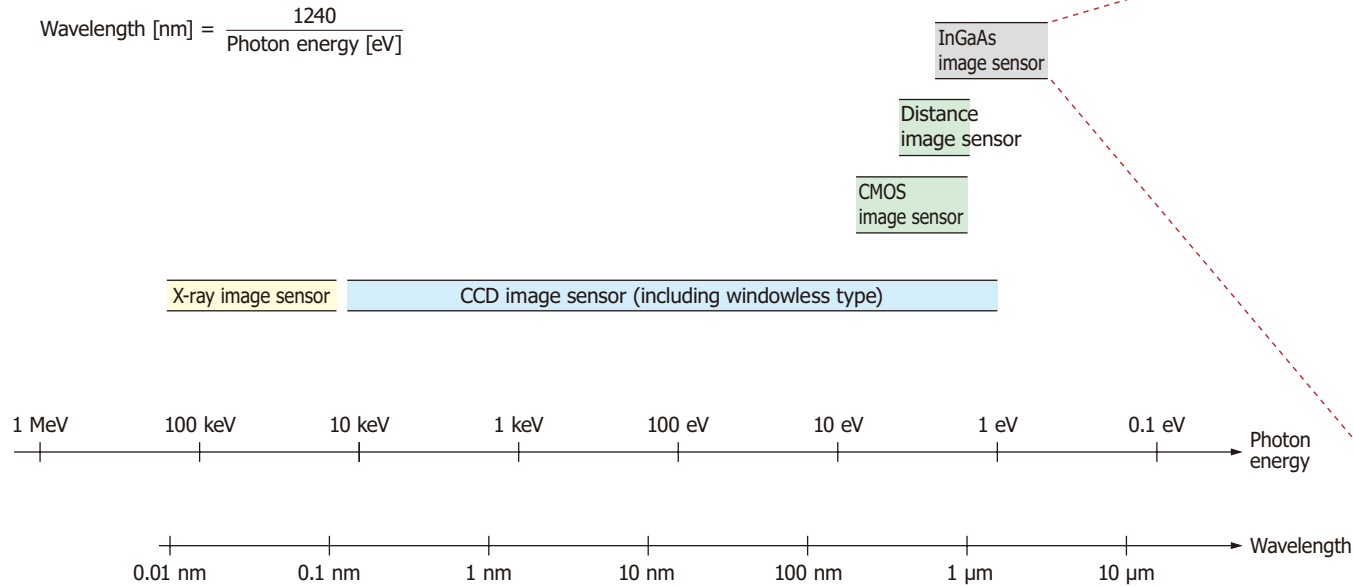
We offer a wide range of products that adopt a hybrid structure of an InGaAs array with different wavelength ranges, pixel sizes, and numbers of pixels, together with high-performance CMOS readout circuit (ROIC).
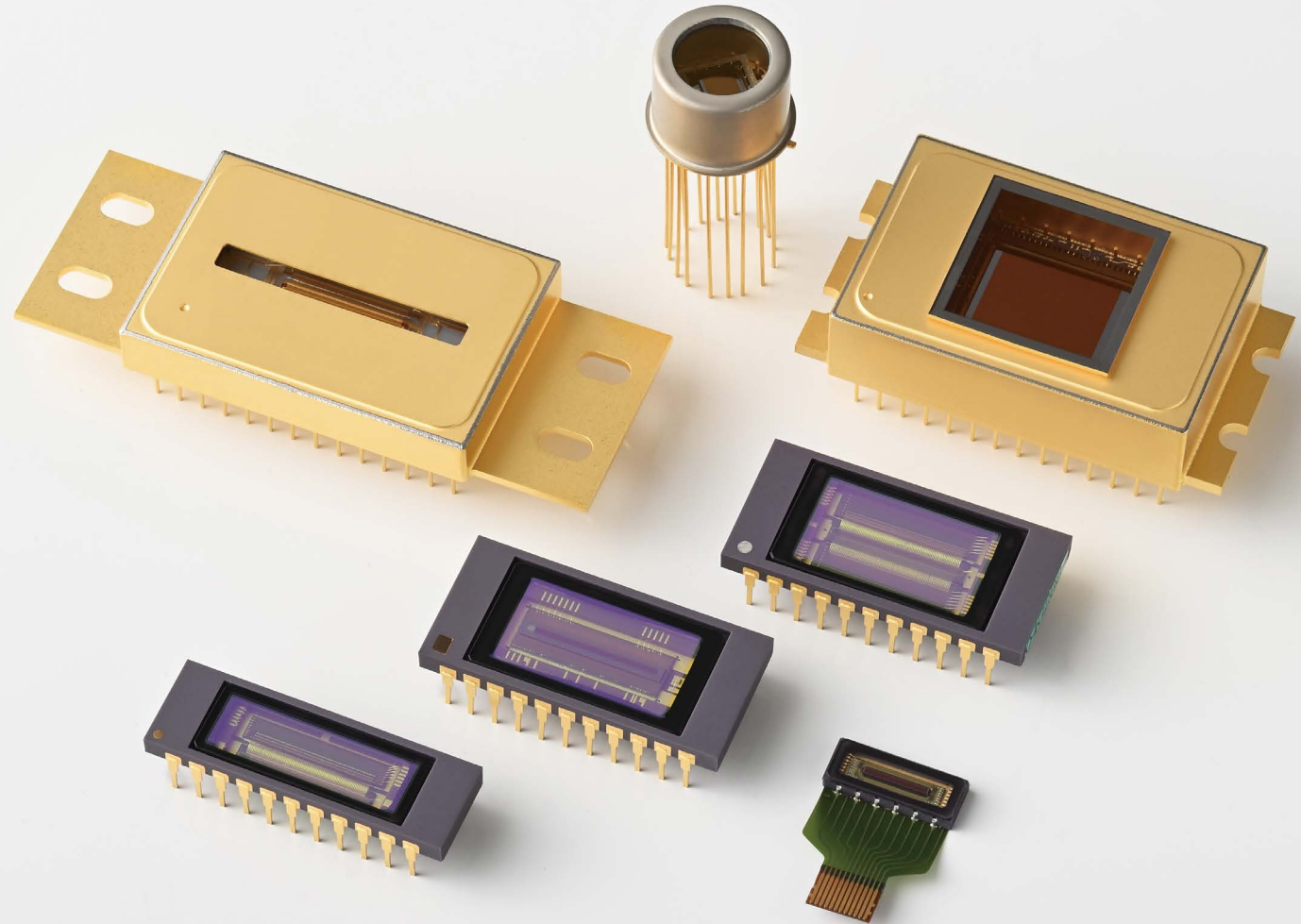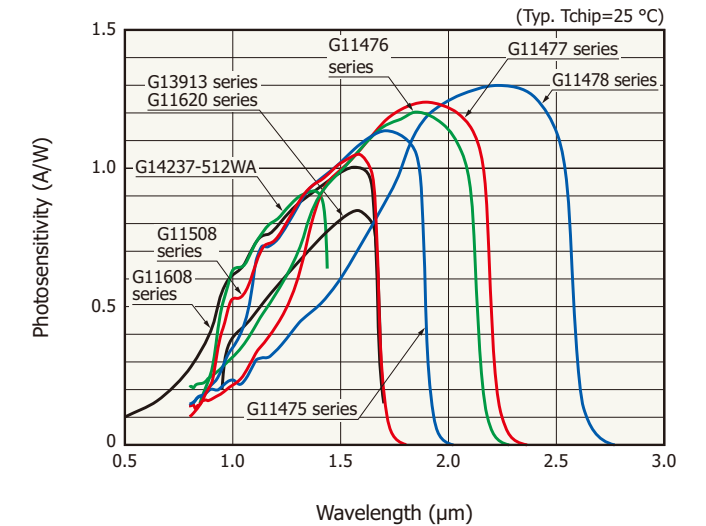
Hamamatsu image sensors

Hamamatsu has developed and produced image sensors supporting broad wavelength regions such as near infrared, visible light, ultraviolet, vacuum ultraviolet (VUV), soft X-rays, and hard X-rays.

● Example of detectable energy and spectral response range

$$\text{Wavelength [nm]} = \frac{1240}{\text{Photon energy [eV]}}$$

InGaAs image sensor

Distance image sensor

CMOS image sensor

X-ray image sensor

CCD image sensor (including windowless type)

| 1 MeV | 100 keV | 10 keV | 1 keV | 100 eV | 10 eV | 1 eV | 0.1 eV | Photon energy |

| 0.01 nm | 0.1 nm | 1 nm | 10 nm | 100 nm | 1 µm | 10 µm | Wavelength |

KMPDC1014EA

● Spectral response

[InGaAs linear image sensors]

(Typ. Tchip=25 °C)

G11476 series
G11477 series
G13913 series
G11620 series
G11478 series
G14237-512WA
G11508 series
G11608 series
G11475 series

Photosensitivity (A/W)

Wavelength (µm)

KMIRB0109EB

InGaAs image sensors achieve high sensitivity at wavelengths from 0.5 to 2.55 µm.

Technology

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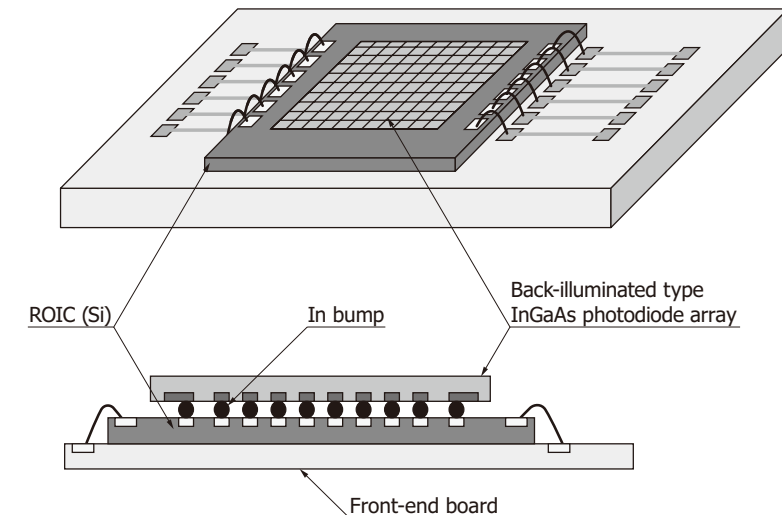# CMOS technology, Hybrid technology

CMOS technology

Hamamatsu has made CMOS signal processing circuits with various analog and digital functions using our unique process technology, and realized high-performance, multi-functional image sensors.

· Supports photosensitive areas of various specifications (compound semiconductor, one- and two-dimensional array, large area)
· High function (high-speed, partial readout, built-in A/D converter, global shutter, etc.)
· Flexible customization

Hybrid technology (three-dimensional mounting)

InGaAs image sensors employ a hybrid structure, in which the photodiode array used as the photosensitive area and CMOS signal processing circuit are implemented in separate chips and three-dimensionally mounted by using bumps. This construction is advantageous in that the shape of the photosensitive area, spectral response, and the like can easily be modified.

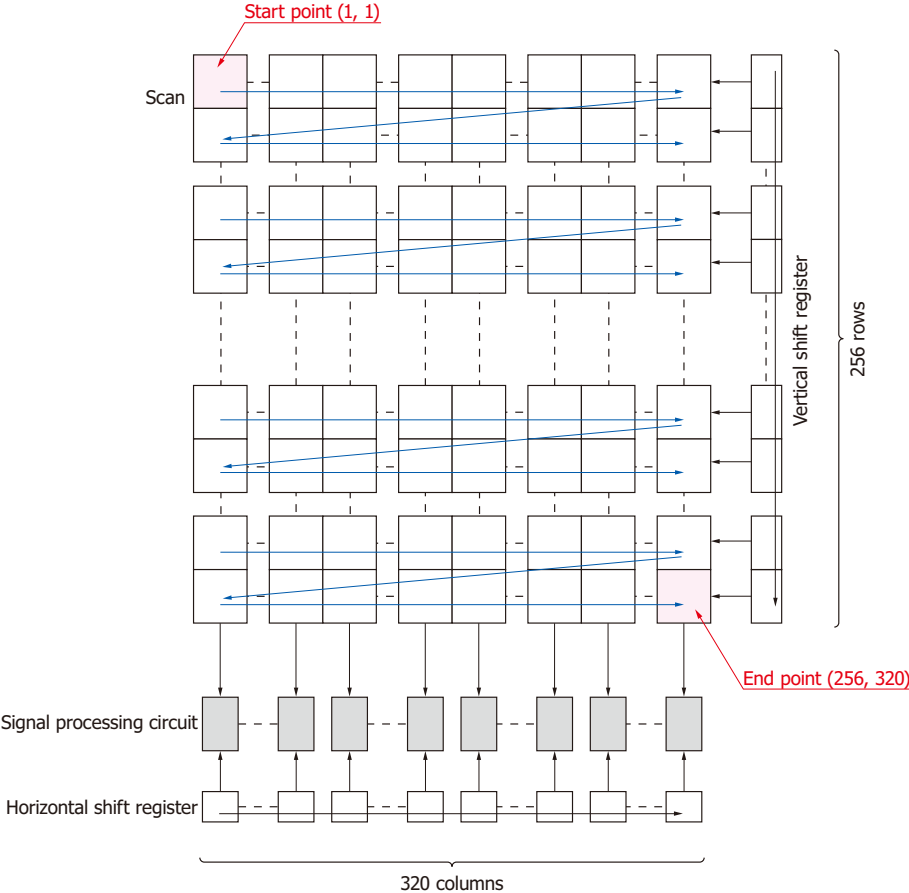● Schematic of InGaAs area image sensor using fine-pitch bumps

ROIC (Si) In bump Back-illuminated type InGaAs photodiode array

Front-end board

KMIRC0036EB

CMOS & Hybrid | Partial readout function | Multi-line readout mode

Technology

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Partial readout function

The InGaAs area image sensors (G14671 to G14674-0808W) can partially read out pixels by specifying the start point coordinates and end point coordinates of the readout region. The partial readout function (for only one region) can be used for one-port readout.
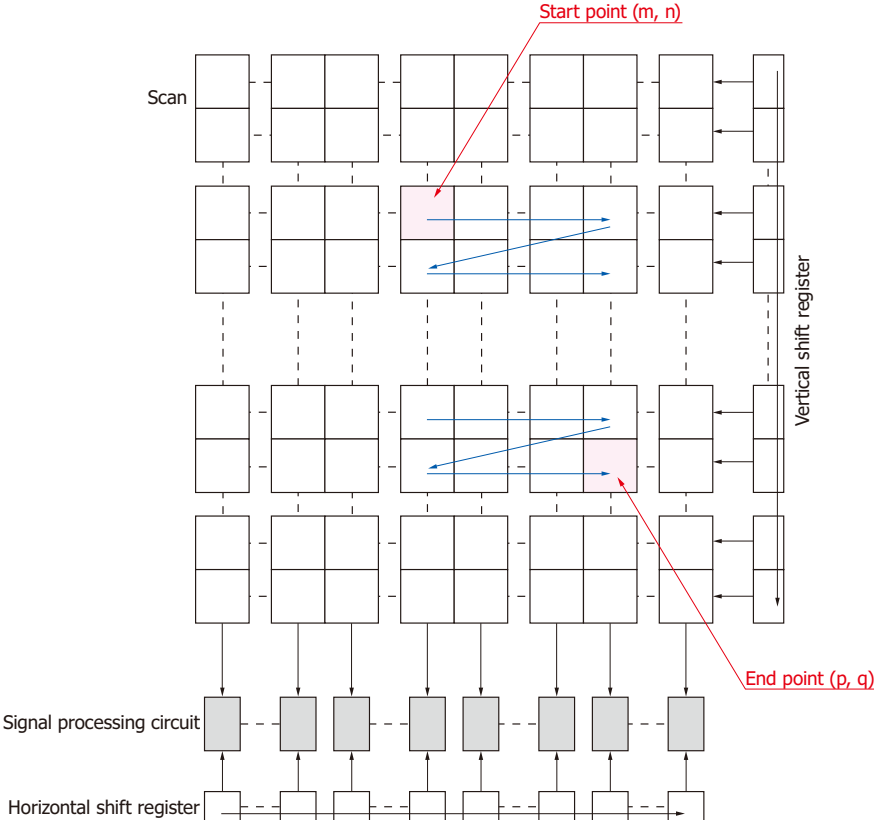
● All-pixel readout

Readout region: All pixels [320 (H) × 256 (V)]

Start point (1, 1)

Scan

Vertical shift register

256 rows

End point (256, 320)

Signal processing circuit

Horizontal shift register

320 columns

KMIRC0123EA

● Partial readout

Readout region: Column n to q (H), rows m to p (V)

Start point (m, n)

Scan

Vertical shift register

End point (p, q)

Signal processing circuit

Horizontal shift register

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CMOS & Hybrid   Partial readout function   Multi-line readout mode

Technology

Home   Technology   Application examples   Lineup   InGaAs linear Image sensors   InGaAs area image sensors   Related products   Technical notes
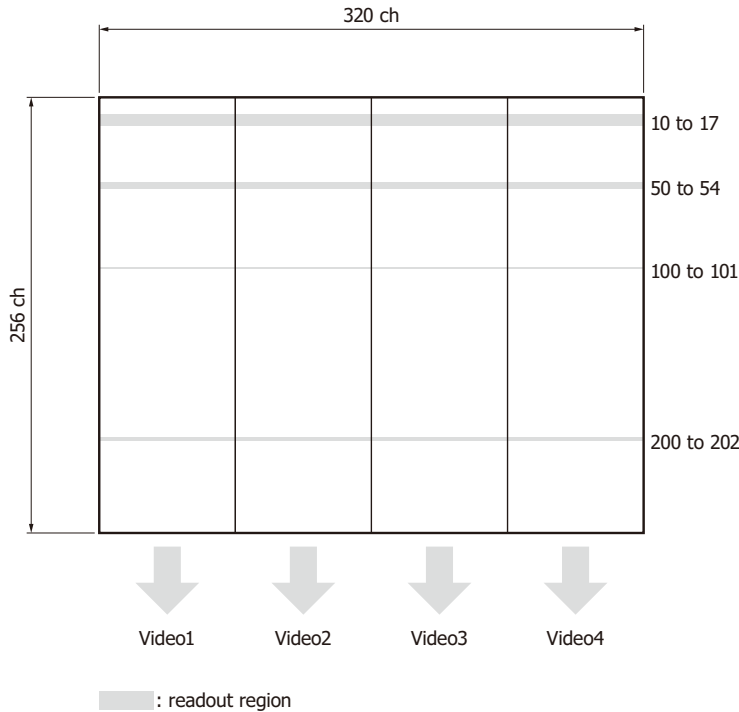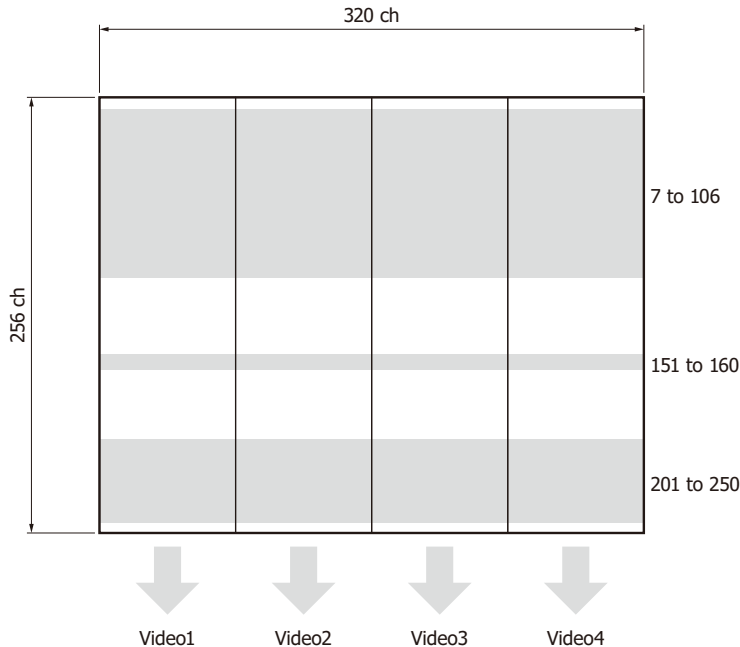
Multi-line readout mode

G16561 to G16564-0808T can be set to multi-line readout mode in addition to normal readout mode (all-line readout mode). By setting to the multi-line readout mode, it is possible to freely read any row (multi-line readout mode). To set the readout row, it is necessary to input an external signal to the specified terminal (ADR, ENadr). For details, see (multi-line readout mode timing chart).

● Multi-line readout mode readout example

(a) Selected rows 10 to 17, 50 to 54, 100 to 101, 200 to 202 (total 18 rows)

(b) Selected rows 7 to 106, 151 to 160, 201 to 250 (total 160 rows)

320 ch

256 ch

10 to 17

50 to 54

100 to 101

200 to 202

Video1   Video2   Video3   Video4

▭ : readout region

320 ch

256 ch

7 to 106

151 to 160

201 to 250

Video1   Video2   Video3   Video4

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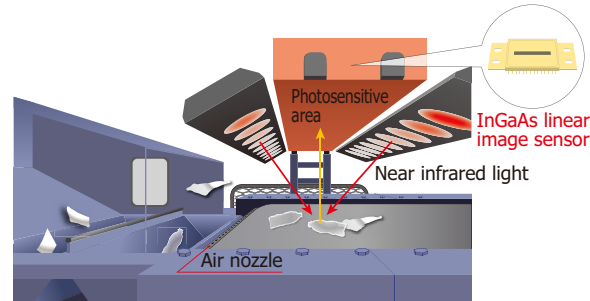CMOS & Hybrid   Partial readout function   Multi-line readout mode

Application examples

Optical channel monitors
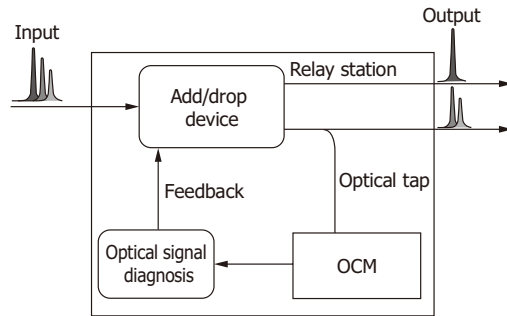
KMIRC0038EA

The InGaAs linear image sensor is used for the optical channel monitor in optical communication.
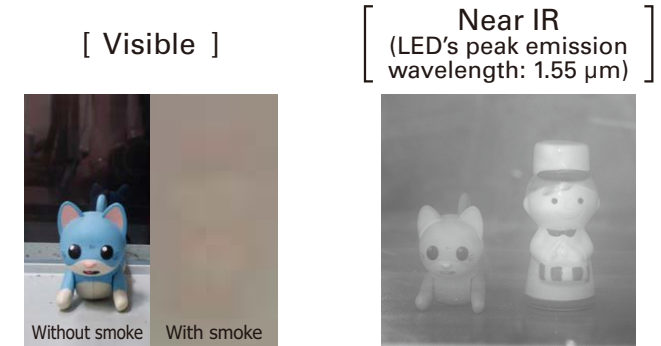
Farm product inspection
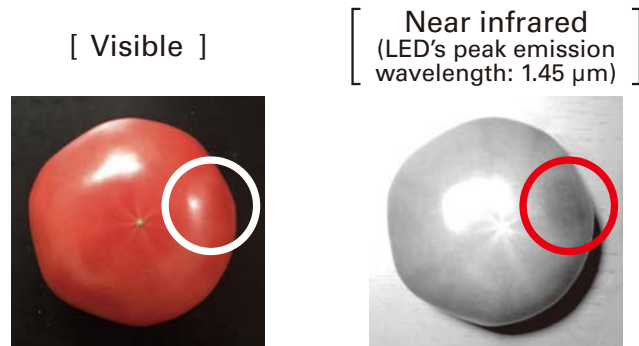
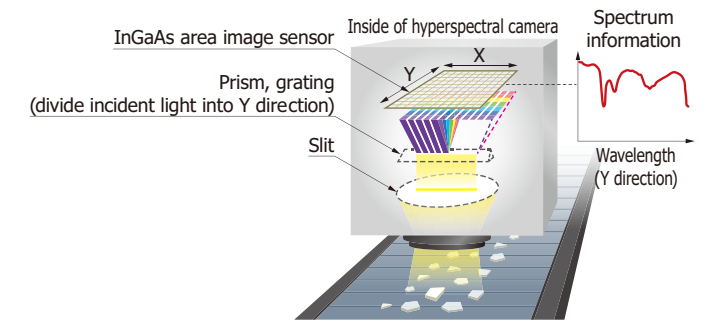[Visible]

[Near infrared (LED's peak emission wavelength: 1.45 µm)]

The InGaAs area image sensor is used to detect damaged areas (high moisture content) caused by pushing the tomato.

Plastic screening

Photosensitive area

InGaAs linear image sensor

Near infrared light

Air nozzle

KACCC1123EB

Plastic screening is performed by using the fact that when near infrared light is directed at plastic, the wavelengths that are absorbed varies depending on the material.

Semiconductor inspection

[Visible]

[Near infrared (LED's peak emission wavelength: 1.2 µm)]
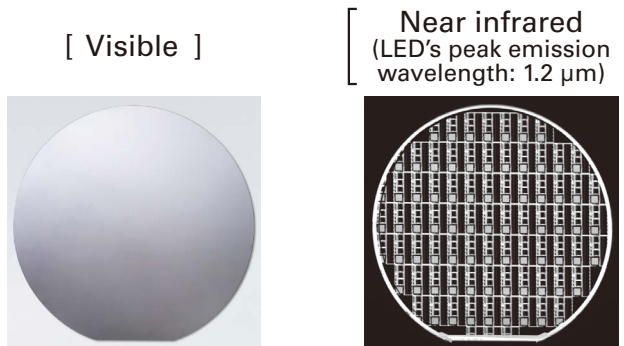
The InGaAs area image sensor is used to detect the patterns of silicon wafers.

Security

[Visible]

[Near IR (LED's peak emission wavelength: 1.55 µm)]

Without smoke   With smoke

InGaAs area image sensors are used in monitoring cameras, etc. because they can easily capture near infrared images even when there is fog or smoke.

Hyperspectral imaging

InGaAs area image sensor

Inside of hyperspectral camera

Spectrum information

Prism, grating (divide incident light into Y direction)

Slit

Wavelength (Y direction)

KMIRC0133EA

It can do high accuracy identification by acquiring spectral information using the InGaAs area image sensor.
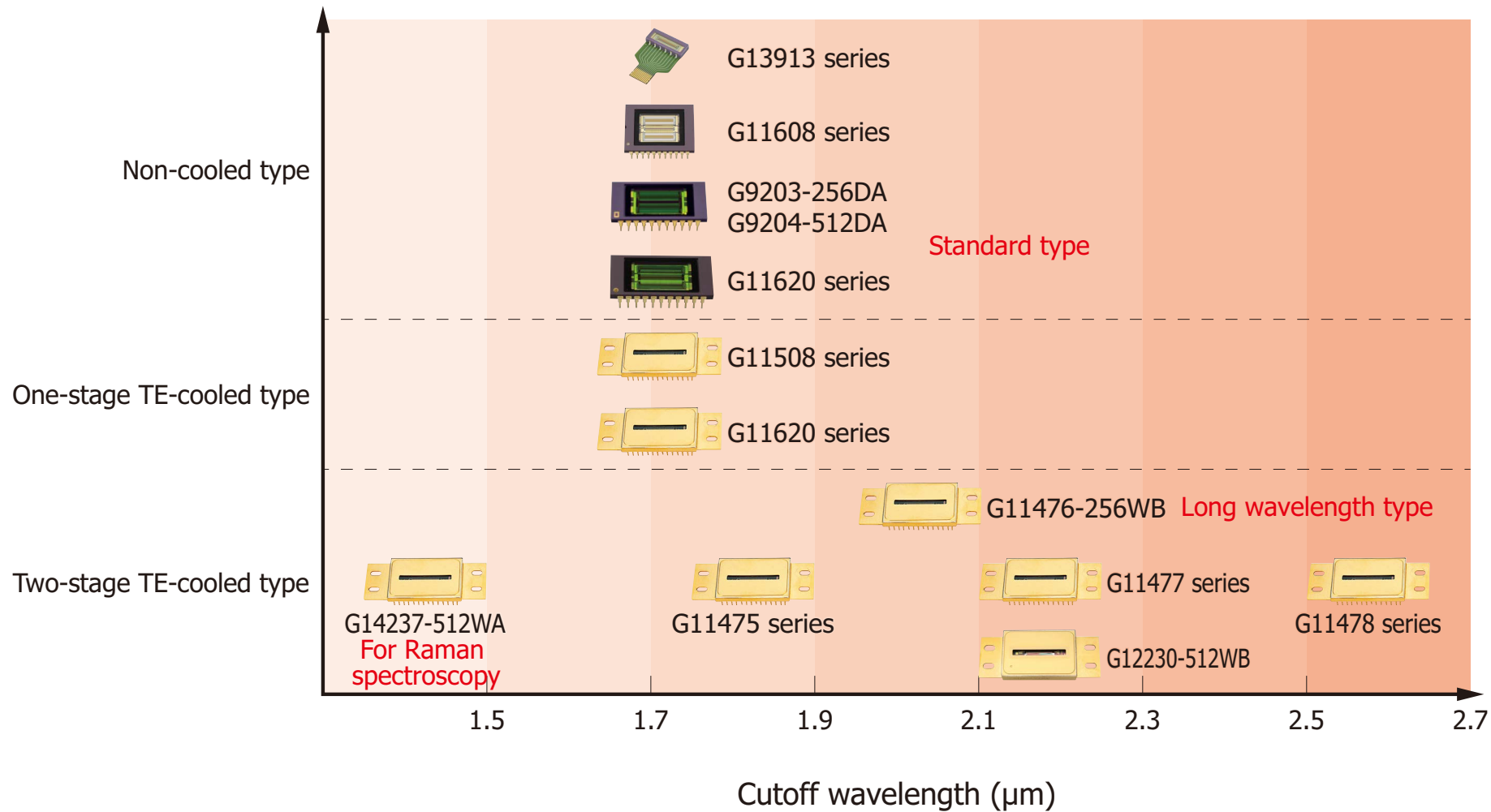
Lineup

InGaAs image sensors are used in a wide variety of applications in the near infrared region. Built-in CMOS signal processing circuit allows easy handling. They use a charge amplifier method, which can integrate electric charge to increase output signal, making it suitable for very low-level light detection.

Product name	Type	Overview
InGaAs linear image sensor	For near infrared spectrophotometry	One-dimensional image sensors for visible (VIS), near infrared (NIR), and short wavelength infrared (SWIR). They feature low dark current, low readout noise, and high scan rate. They are used for spectrophotometry, sorting machines, medical imaging, etc.
	For Raman spectroscopy	
	High-speed type (for line scan camera)	
InGaAs area image sensor	For near infrared imaging, etc.	Two-dimensional image sensors for near infrared and short wavelength infrared. They are used for hyperspectral imaging, sorting machines, process inspections, and night-vision cameras, etc.

Lineup

Home   Technology   Application examples   Lineup   InGaAs linear Image sensors   InGaAs area image sensors   Related products   Technical notes

InGaAs linear image sensors

For near infrared spectrophotometry

Non-cooled type

G13913 series

G11608 series

G9203-256DA
G9204-512DA

Standard type

G11620 series

One-stage TE-cooled type

G11508 series

G11620 series

Two-stage TE-cooled type

G11476-256WB   Long wavelength type

G11477 series

G14237-512WA   G11475 series   G12230-512WB   G11478 series

For Raman spectroscopy

1.5   1.7   1.9   2.1   2.3   2.5   2.7

Cutoff wavelength (µm)

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Lineup

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InGaAs linear image sensors

High-speed type (for line scan camera)

Chart: Number of pixels vs. Cutoff wavelength (μm)

- G14714-1024DG/-1024DK — 1024 pixels, ~1.7 μm
- G10768-1024D/1024DB — ~1024 pixels, ~1.7 μm
- G14714-512DE — 512 pixels, ~1.7 μm
- G11135-512DE — 512 pixels, ~1.7 μm
- G14006-512DE — 512 pixels, ~1.9 μm
- G11135-256DD — 256 pixels, ~1.7 μm

Number of pixels (y-axis): 256, 512, 1024
Cutoff wavelength (μm) (x-axis): 1.6, 1.7, 1.8, 1.9, 2.0

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Lineup

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InGaAs area image sensors

Number of pixels (y-axis):
- 640 × 512 — G13393-0909W
- 320 × 256 — G14671-0808W / G16561-0808T, G14672-0808W / G16562-0808T, G14673-0808W / G16563-0808T, G14674-0808W / G16564-0808T
- 192 × 96 — G13544-01, G13441-01
- 128 × 128 — G12242-0707W
- 64 × 64 — G11097-0606S, G12460-0606S

Cutoff wavelength (µm): 1.7   1.9   2.1   2.3   2.5   2.7

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InGaAs linear image sensors

Home | Technology | Application examples | Lineup | **InGaAs linear Image sensors** | InGaAs area image sensors | Related products | Technical notes

For near infrared spectrophotometry

Standard type to 1.7 μm

Type no.	Cooling	Pixel height (μm)	Pixel pitch (μm)	Number of pixels	Line rate max. (lines/s)	Spectral response range (μm)	Defective pixels	Photo	Related products (sold separately)
G9203-256DA	Non-cooled	500	50	256	1910	0.9 to 1.7	0		—
G9204-512DA			25	512	960*				
G11608-256DA			50	256	17200	0.5 to 1.7	1% max.		—
G11608-512DA			25	512	9150*				
G11508-256SA	One-stage TE-cooled (Tchip=-10 °C)	500	50	256	17200	0.9 to 1.67	0		C16091 series
G11508-512SA			25	512	9150*				
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				
G13913-128FB		250	50	128	13600				—
G13913-256FG			25	256	7290				
G11620-256SA	One-stage TE-cooled (Tchip=-10 °C)	500	50	256	17200	0.95 to 1.67			C16091 series
G11620-512SA			25	512	9150				

* When reading with two video lines, the line rate is the same as 256 pixels.

● Spectral response

[G9203-256DA, G9204-512DA, G11608 series]

(Typ. Tchip=25 °C)

G9203-256DA
G9204-512DA

G11608 series

Photosensitivity (A/W) vs Wavelength (μm)

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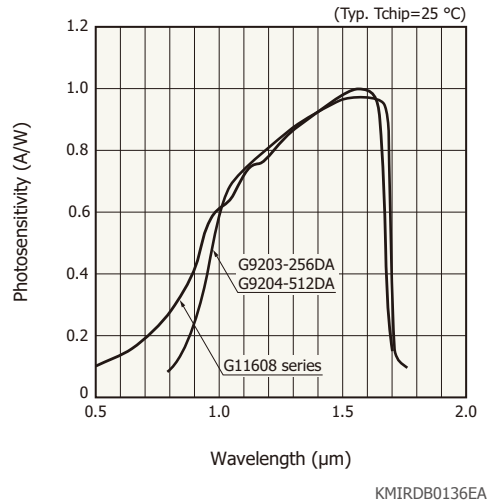
[G11508/G11620/G13913 series]

(Typ. Tchip=25 °C)

G13913 series
G11620 series

G11508 series

Photosensitivity (A/W) vs Wavelength (μm)

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InGaAs linear image sensors

Home | Technology | Application examples | Lineup | **InGaAs linear Image sensors** | InGaAs area image sensors | Related products | Technical notes
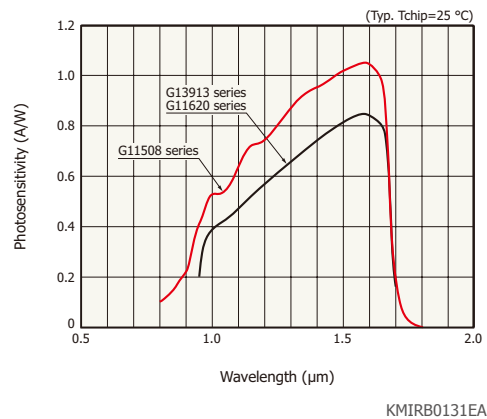
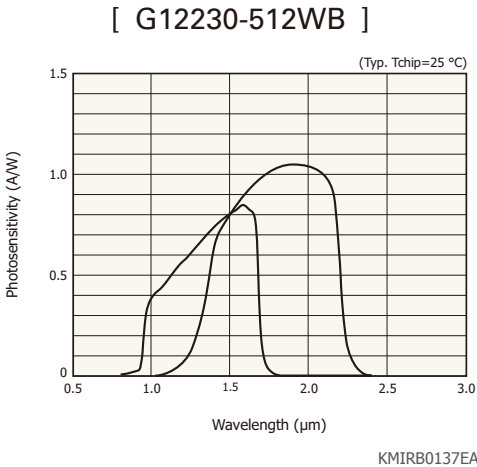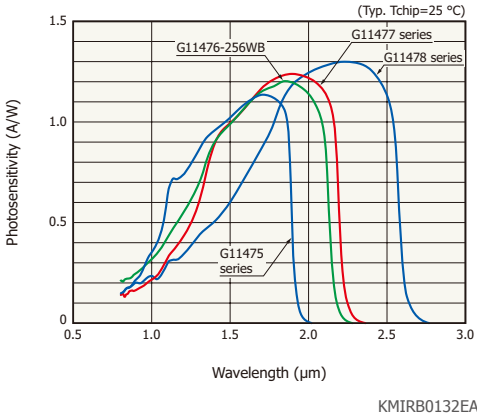# For near infrared spectrophotometry

Long wavelength type

The G11475 to G11478 series are types that extend the spectral response range from 1.85 µm to 2.55 µm. The G12230-512WB has two types of InGaAs chips in a series configuration to achieve high S/N over a wide spectral response range.

● Spectral response

[G11475/G11477/G11478 series, G11476-256WB]

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[G12230-512WB]

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Type no.	Cooling	Pixel height (µm)	Pixel pitch (µm)	Number of pixels	Line rate max. (lines/s)	Spectral response range (µm)	Defective pixels	Photo	Related products (sold separately)
G11475-256WB	Two-stage TE-cooled (Tchip=-20 °C)	250	50	256	17200	0.9 to 1.85	5% max.		C16091 series
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*	0.9 to 1.85	4% max.		
G11477-512WB						0.9 to 2.15			
G11478-512WB						0.9 to 2.55			
G12230-512WB						0.95 to 2.15	2% max.		

* When reading with two video lines, the line rate is the same as 256 pixels.

InGaAs linear image sensors

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For Raman spectroscopy

This type is designed for Raman spectroscopy using a 1064 nm laser. It achieves lower dark current than the previous product (G11508-512SA).

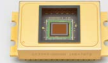| Type no.	Cooling	Pixel height (µm)	Pixel pitch (µm)	Number of pixels	Line rate max. (lines/s)	Spectral response range (µm)	Defective pixels	Photo	Related products (sold separately)
G14237-512WA	Two-stage TE-cooled (Tchip=-20 °C)	500	25	512	9150*	0.85 to 1.4	1% max.		C16091 series

* When reading with two video lines, the line rate is the same as 256 pixels.

● Spectral response

(Typ. Tchip=25 °C)

Photosensitivity (A/W) vs Wavelength (µm)

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InGaAs linear image sensors

Home   Technology   Application examples   Lineup   **InGaAs linear Image sensors**   InGaAs area image sensors   Related products   Technical notes
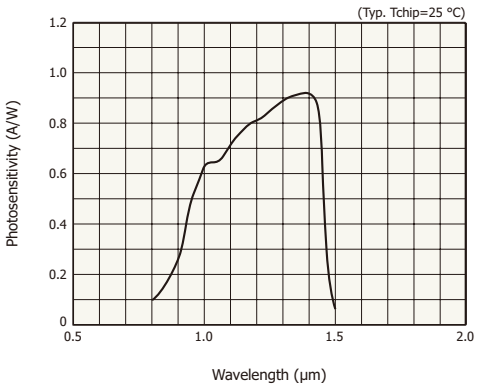
High-speed type

For line scan camera

These are high line rate types suitable for various industrial measurement instruments.

Type no.	Cooling	Pixel height (μm)	Pixel pitch (μm)	Number of pixels	Line rate max. (lines/s)	Spectral response range (μm)	Defective pixels	Photo	Related products (sold separately)
G9494-256D	Non-cooled	50	50	256	7100	0.9 to 1.7	1% max.		–
G9494-512D		25		512	3720*				
G10768-1024D		100	25	1024	39000				–
G10768-1024DB		25							
G11135-256DD		50	50	256	14000	0.95 to 1.7			
G11135-512DE		25	25	512	8150	0.95 to 1.7			C11514
G14006-512DE						1.12 to 1.9			
G14714-512DE		25	25	512	40000	0.95 to 1.7			C15853-01
G14714-1024DG		250	12.5	1024	40000				–
G14714-1024DK		12.5							C15853-02

* When reading with two video lines, the line rate is the same as 256 pixels.

● Spectral response

(Typ. Ta=25 °C)

G10768 series
G14006-512DE
G9494 series
G11135/G16215/G14714 series

Photosensitivity (A/W)
Wavelength (μm)

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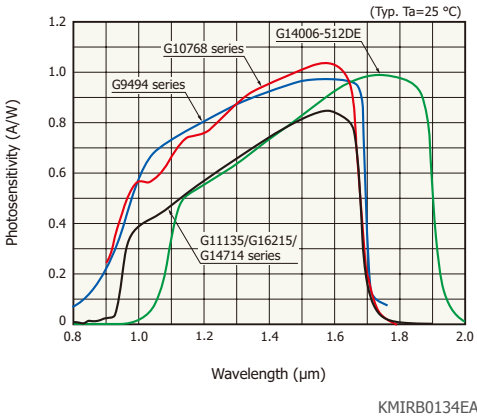
InGaAs area image sensors

These are used for near-infrared image acquisition (hyperspectral imaging, etc.), FSO (free space optics), and laser beam profilers, etc.

Type no.	Cooling	Pixel height (μm)	Pixel pitch (μm)	Number of pixels	Frame rate*1 max. (frames/s)	Spectral response range (μm)	Defective pixels	Photo	Related products (sold separately)
G11097-0606S	One-stage TE-cooled (Tchip=25 °C)	50	50	64 × 64	1025	0.95 to 1.7	1% max.		—
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.		—
G13393-0808W				320 × 256	228		0.37% max.		—
G13393-0909W				640 × 512	62				
G13441-01	Two-stage TE-cooled (Tchip=-20 °C)	50	50	192 × 96	867	1.3 to 2.15	1% max.		*2
G13544-01	Two-stage TE-cooled (Tchip=-10 °C)					1.12 to 1.9			—
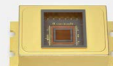
*1: Integration time 1 μs min.   *2: Dem equipment is available.

● Spectral response

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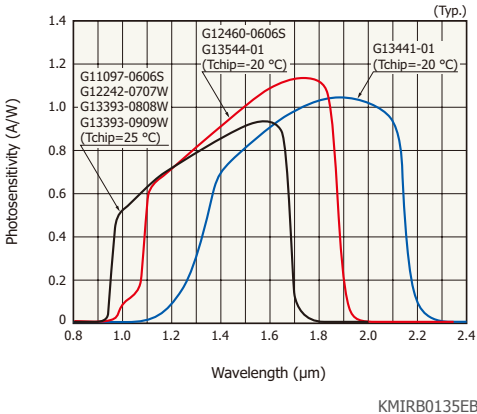
InGaAs area image sensors

These are used for near infrared non-destructive inspection (farm produce inspection, semiconductor inspection, etc.), hyperspectral imaging (food screening, etc.), and traffic monitoring, etc.

Type no.	Cooling	Pixel height (µm)	Pixel pitch (µm)	Number of pixels	Frame rate[1] max. (frames/s)	Spectral response range (µm)	Defective pixels	Photo	Related products (sold separately)
G14671-0808W[1]	Two-stage TE-cooled (Tchip=15 °C)	20	20	320 × 256	509[2]	0.95 to 1.69	0.37% max.		C16090 series
G14672-0808W[1]	Two-stage TE-cooled (Tchip=-20 °C)					1.12 to 1.85	1% max.		
G14673-0808W[1]						1.3 to 2.15			
G14674-0808W[1]						1.7 to 2.55			
G16561-0808T[3]	Three-stage TE-cooled (Tchip=15 °C)	20	20	320 × 256	503[4]	0.95 to 1.69	0.37% max.		—
G16562-0808T[3]	Three-stage TE-cooled (Tchip=-20 °C)					1.12 to 1.85	1% max.		
G16563-0808T[3]						1.3 to 2.15			
G16564-0808T[3]						1.7 to 2.55			

*1: With partial readout function
*2: Number of readout ports=4 ports, all pixels (320 × 256 ch) readout, integration time=1 µs min.
*3: With multi-line readout mode
*4: All-line readout mode, integration time=1.98 ms, in IWR operation

● Spectral response

KMIRB0146EA
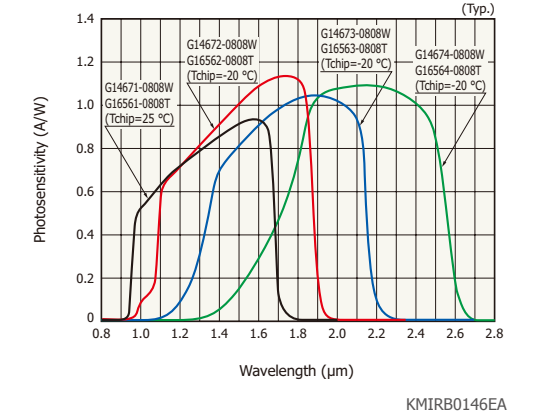
Related products

An InGaAs image sensor offers excellent performance, but it requires more complex drive electronics and signal processing than a single element. Driver circuits, multichannel detector heads, and image sensor modules compatible with our main InGaAs image sensors are available to easily evaluate and test Hamamatsu InGaAs image sensors.

Product name	Type no.	Features	Photo	Applicable sensors	
Driver circuit	C11513	USB 2.0 Interface		InGaAs linear image sensors (sold separately)	G11620-128DA/-256DA/-256DF/-512DA
	C11514	Compatible with CameraLink			G11135-256DD/-512DE, G14006-512DE
Image sensor module	C16091 series	USB 3.1 Interface		InGaAs linear image sensors (built-in)	G11508-256SA/-512SA, G11620-256SA/-512SA, G11475-G11478 series, G14237-512WA, G12230-512WB
	C15853 series				G14714-512DE/-1024DK
	C16090 series			InGaAs area image sensors (built-in)	G14671/G14672/G14673/G14674-0808W

● **Technical notes**

InGaAs linear image sensors
InGaAs area image sensors

● **Precautions**

Disclaimer
Safety consideration
Image sensors

● **Inquiries from online**

www.hamamatsu.com

● Information described in this material is current as of March 2024.
● Product specifications are subject to change without prior notice due to improvements or other reasons. Before using these products, always contact us for the delivery specification sheet to check the latest specifications.

HAMAMATSU PHOTONICS K.K.

KMIR1037E04 Mar. 2024 DN