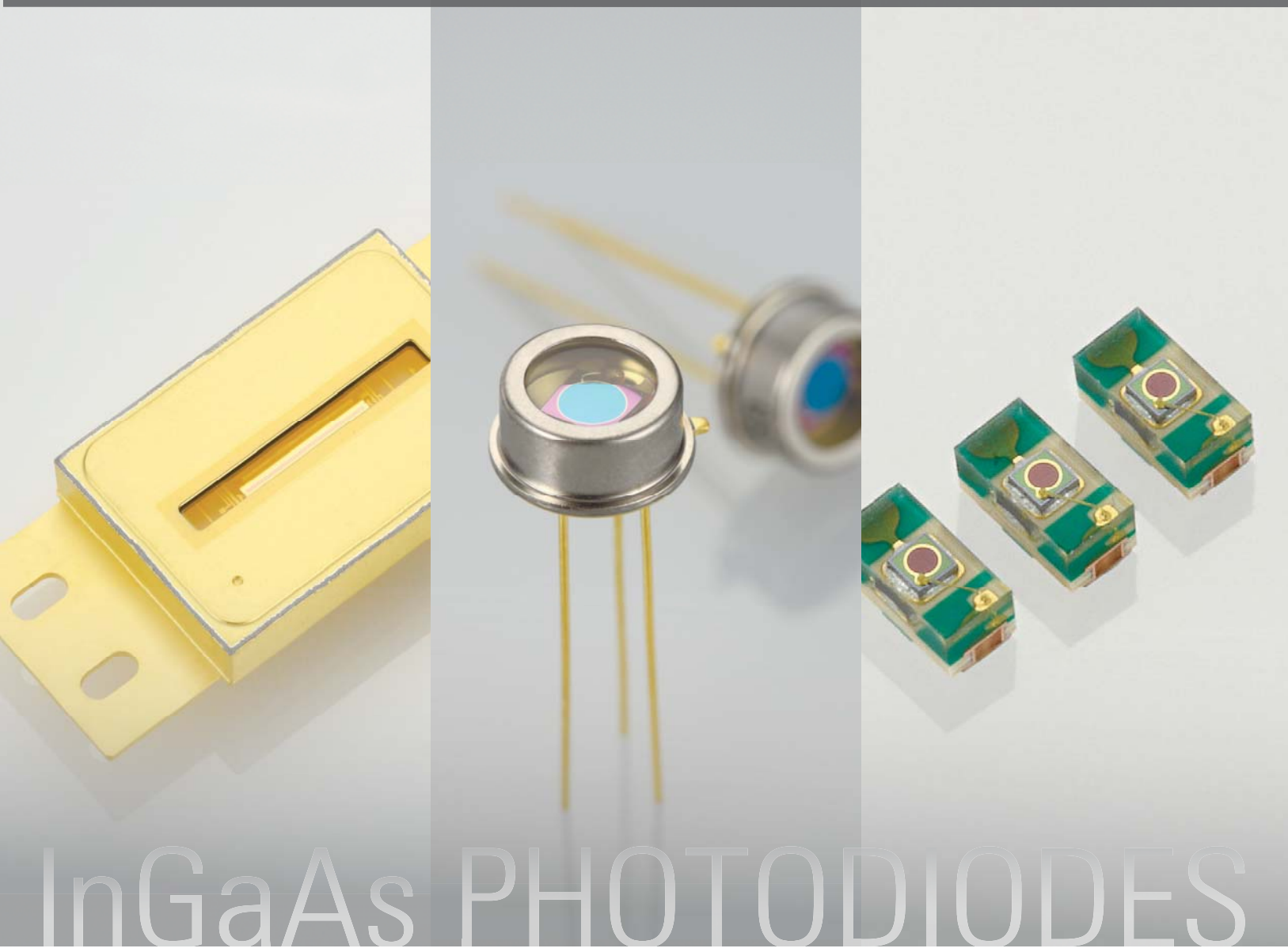


InGaAs photodiodes

Near infrared detectors with low noise and superb frequency characteristics



InGaAs PHOTODIODES

InGaAs Photodiodes

Based on unique, in-house compound semiconductor process technology, HAMAMATSU has designed and developed advanced InGaAs photodiodes that feature high speed, high sensitivity, and low noise over a spectral range from 0.5 μm to 2.6 μm . InGaAs photodiodes are used in a wide variety of applications ranging from optical communications to chemical analysis and measurement fields. HAMAMATSU provides a wide range of products in different packages including metal, ceramic and surface mount packages as well as linear and area image sensors, and infrared detector modules with built-in preamplifiers.

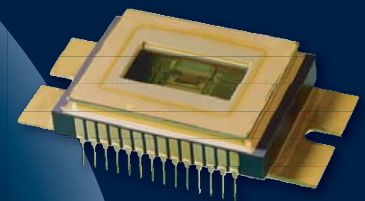
We also manufacture custom products to meet your specific requirements. Please feel free to contact us.

Topic A HAMAMATSU InGaAs linear image sensor was installed in the asteroid explorer "HAYABUSA".



Courtesy of JAXA (Japan Aerospace Exploration Agency)

The asteroid explorer "HAYABUSA," an unmanned spacecraft, returned to Earth after its long trouble-filled journey carrying particles from the surface of the asteroid "Itokawa" that was nearly 300 million kilometers away from Earth at the time. The near infrared spectrometer (NIRS) in the HAYABUSA used a HAMAMATSU InGaAs linear image sensor which is highly rated for its outstanding reliability and durability as well as high sensitivity in the near infrared region. This near infrared spectrometer is an instrument that analyzes the types of minerals on the asteroid surface and asteroid contour by detecting the light spectrum of infrared rays from the sun reflecting from the asteroid surface. Measuring this 0.8 to 2.1 μm light spectrum reflected from the surface of "Itokawa" showed that reflectance dropped in the vicinity of 1 μm and 2 μm , which revealed that minerals on the surface contained olivine and pyroxene.



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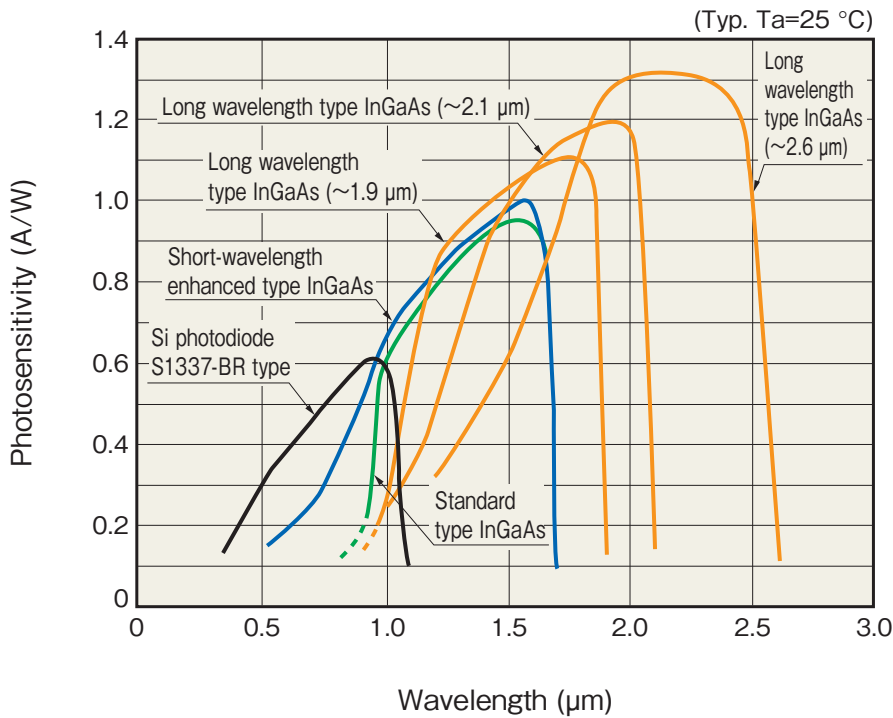
Selection guide



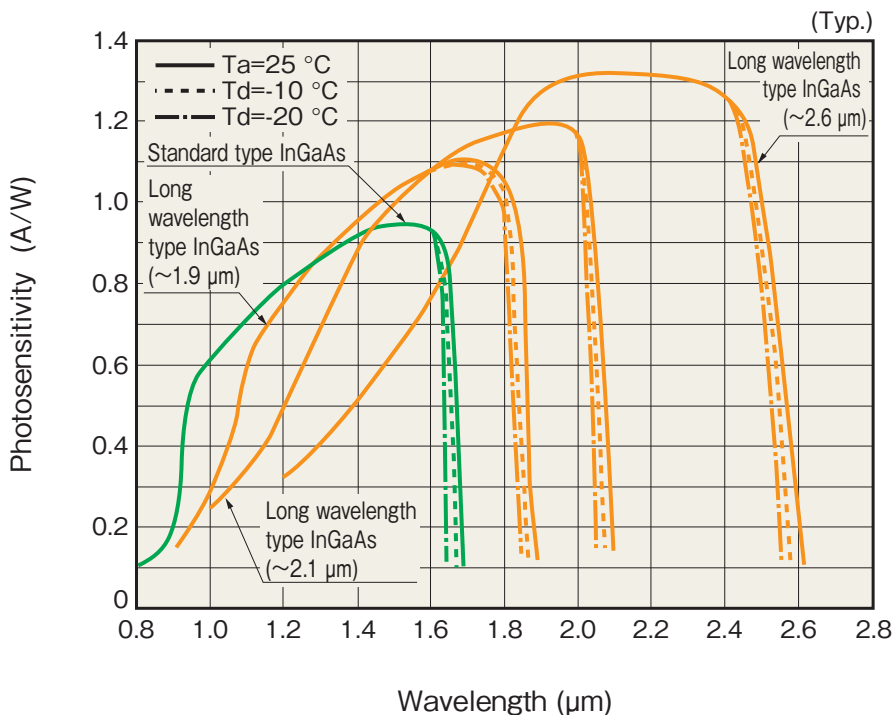
Spectral response range

HAMAMATSU provides a wide lineup of InGaAs photodiodes with different spectral response characteristics ranging from 0.5 μm to 2.6 μm .

Spectral response (typical example)



Cutoff wavelength temperature dependence (typical example)



InGaAs PIN photodiodes

Type	Type no.	Page	Spectral response range (μm)										
			0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4
Short-wavelength enhanced type	G10899 series	8	Non-cooled type (0.5 to 1.7 μm)										
	G8370/G8376 series												
Standard type	G8605 series	9	Non-cooled type (0.9 to 1.7 μm)										
	G11193 series		One-stage TE-cooled type (0.9 to 1.67 μm)										
	G8941 series		Two-stage TE-cooled type (0.9 to 1.65 μm)										
	G9230-01*1												
	COB NEW G11777-003P												
	ROSA G12072-54												
	Array G6849 series												
Long wavelength type	G7150/G7151-16	10	Non-cooled type (0.9 to 1.9 μm)										
	G8909-01		One-stage TE-cooled type (0.9 to 1.87 μm)										
	NEW G12181 series		Two-stage TE-cooled type (0.9 to 1.85 μm)										
	G5851 series		Non-cooled type (0.9 to 2.1 μm)										
	to 1.9 μm		One-stage TE-cooled type (0.9 to 2.07 μm)										
	to 2.1 μm		Two-stage TE-cooled type (0.9 to 2.05 μm)										
Long wavelength type	NEW G12182 series	10	Non-cooled type (0.9 to 2.6 μm)										
	G5852 series		One-stage TE-cooled type (0.9 to 2.57 μm)										
	to 2.1 μm		Two-stage TE-cooled type (0.9 to 2.55 μm)										
	to 2.6 μm												
Long wavelength type	NEW G12183 series	10											
	G5853 series												

*1: Back-illuminated type (Non-cooled type (0.95 to 1.7 μm))

InGaAs APD

Type	Type no.	Page	Spectral response range (μm)										
			0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4
APD	G8931 series	10	Non-cooled type (0.9 to 1.7 μm)										

InGaAs linear image sensors

Type	Type no.	Page	Spectral response range (μm)										
			0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4
Short-wavelength enhanced type	NEW G11608 series	11	Non-cooled type (0.5 to 1.7 μm)										
	G92XX series												
Standard type	G9494 series	11	Non-cooled type (0.9 to 1.7 μm)										
	G10768 series		One-stage TE-cooled type (0.9 to 1.67 μm)										
Back-illuminated type	NEW G11135 series	12	Non-cooled type (0.95 to 1.7 μm)										
	NEW G11620 series												
Long wavelength type	to 1.85 μm G9205-256W	12	Two-stage TE-cooled type (0.9 to 1.85 μm)										
	to 2.05 μm G9206-256W		Two-stage TE-cooled type (0.9 to 2.05 μm)										
	to 2.25 μm G9207-256W		Two-stage TE-cooled type (0.9 to 2.25 μm)										
	to 2.55 μm G9208-256W		Two-stage TE-cooled type (0.9 to 2.55 μm)										

InGaAs area image sensor

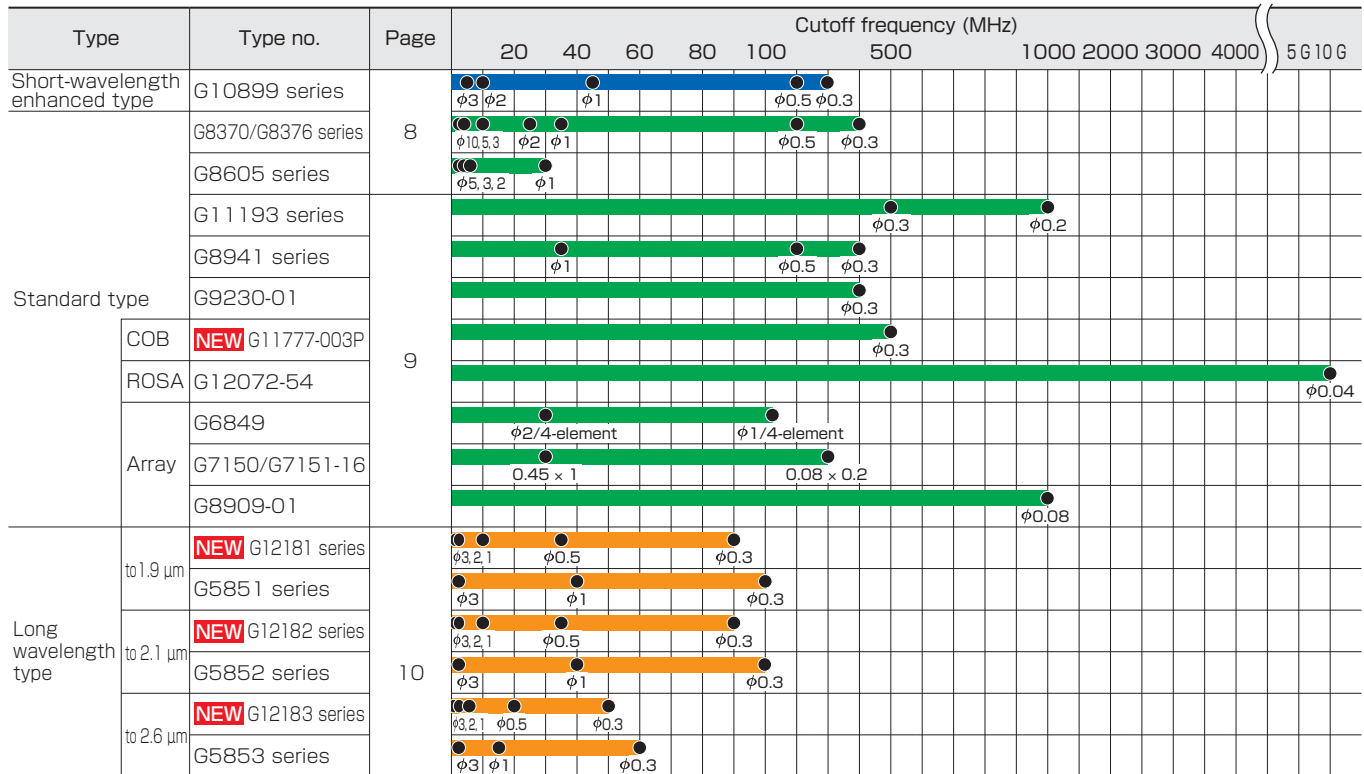
Type	Type no.	Page	Spectral response range (μm)										
			0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4
Standard type	G11097-0606S	12	One-stage TE-cooled type (0.95 to 1.67 μm)										
	NEW G11097-0707S												



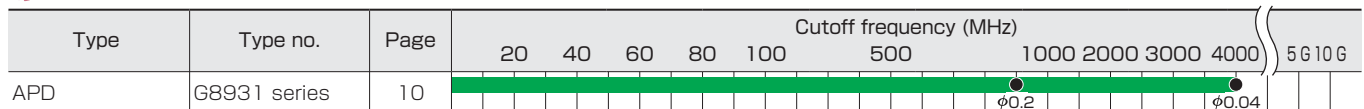
Response speed

InGaAs photodiodes with different response speeds and photosensitive areas are available to meet various applications including measurements requiring large photosensitive areas and optical communications requiring ultra-high speed.

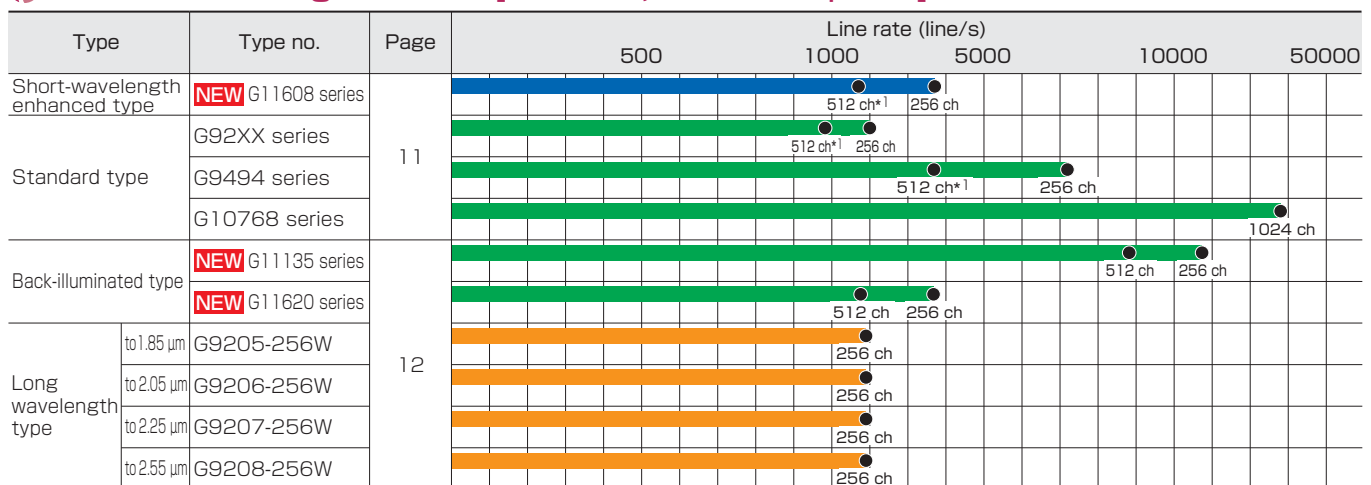
InGaAs PIN photodiodes [Cutoff frequency, Photosensitive area (unit: mm)]



InGaAs APD [Cutoff frequency, Photosensitive area (unit: mm)]

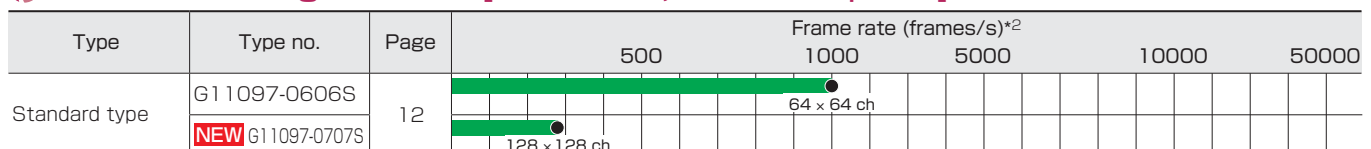


InGaAs linear image sensors [Line rate, Number of pixels]



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

InGaAs area image sensors [Frame rate, Number of pixels]



*2: Integration time 1 μs



Packages

A wide variety of packages are provided ranging from surface mount types to highly reliable metal types.

InGaAs PIN photodiodes

Type	Type no.	Page	Metal			Ceramic	Surface mount type	
			Non-cooled type	One-stage TE-cooled type	Two-stage TE-cooled type			
Short-wavelength enhanced type	G10899 series	8	1 2					
	G8370/G8376 series		1			3		
	G8605 series			4	4			
	G11193 series						5	
	G8941 series						6	
Standard type	G9230-01	9					7	
	COB NEW G11777-003P						8	
	ROSA G12072-54		9					
	Array		G6849 series	10				
			G7150/G7151-16				11	
G8909-01						12		
Long wavelength type	to 1.9 μm NEW G12181 series	10	1					
	G5851 series			4	4			
	to 2.1 μm NEW G12182 series		1					
	G5852 series			4	4			
	to 2.6 μm NEW G12183 series		1					
G5853 series			4	4				

InGaAs APD

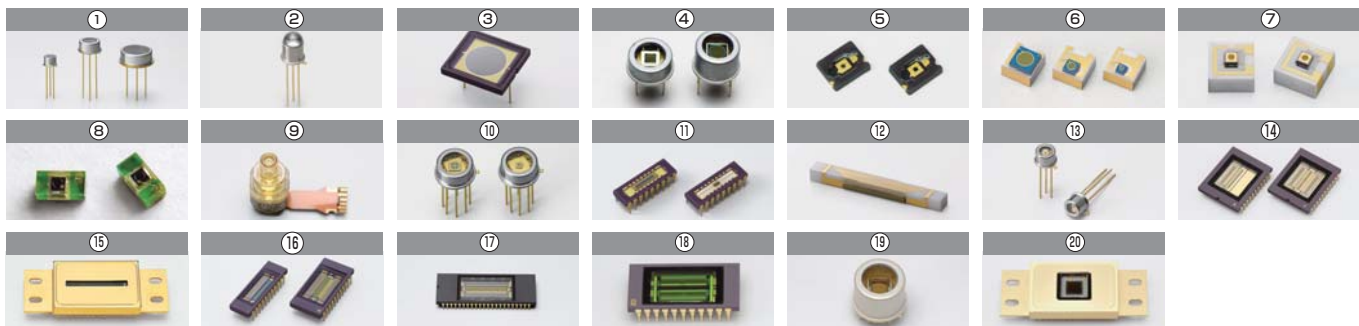
Type	Type no.	Page	Metal			Ceramic	Surface mount type
			Non-cooled type	One-stage TE-cooled type	Two-stage TE-cooled type		
APD	G8931 series	10	13				

InGaAs linear image sensors

Type	Type no.	Page	Metal			Ceramic	
			Non-cooled type	One-stage TE-cooled type	Two-stage TE-cooled type		
Short-wavelength enhanced type	NEW G11608 series	11				14	
Standard type	G92XX series			15			16
	G9494 series						16
	G10768 series						17
Back-illuminated type	NEW G11135 series	12				18	
	NEW G11620 series					18	
Long wavelength type	to 1.85 μm G9205-256W					15	
	to 2.05 μm G9206-256W					15	
	to 2.25 μm G9207-256W				15		
	to 2.55 μm G9208-256W				15		

InGaAs area image sensors

Type	Type no.	Page	Metal			Ceramic
			Non-cooled type	One-stage TE-cooled type	Two-stage TE-cooled type	
Standard type	G11097-0606S	12		19		
	NEW G11097-0707S			20		





Application examples

Here are some typical applications of HAMAMATSU InGaAs photodiodes.

InGaAs PIN photodiodes

Type	Type no.	Page	Radiation thermometer	Moisture meter	Gas analysis	Spectrophotometry	Laser monitor	DWDM monitor	Optical power meter	Optical communication	Distance measurement		
Short-wavelength enhanced type	G10899 series	8				●							
	G8370/G8376 series		●	●			●		●	●			
	G8605 series		●	●		●			●				
	G11193 series								●				
Standard type	G8941 series	9					●		●				
	G9230-01						●		●	●			
	COB NEW G11777-003P							●		●			
	ROSA G12072-54										●		
	Array		G6849 series							●			
			G7150/G7151-16					●					
	G8909-01						●						
Long wavelength type	to 1.9 μm NEW G12181 series	10	●	●	●	●			●				
	G5851 series		●	●	●	●			●				
	to 2.1 μm NEW G12182 series		●	●	●	●			●				
	G5852 series		●	●	●	●			●				
	to 2.6 μm NEW G12183 series		●	●	●	●			●				
	G5853 series		●	●	●	●			●				

InGaAs APD

Type	Type no.	Page	Radiation thermometer	Moisture meter	Gas analysis	Spectrophotometry	Laser monitor	DWDM monitor	Optical power meter	Optical communication	Distance measurement
APD	G8931 series	10								●	●

InGaAs linear image sensors

Type	Type no.	Page	Thermometer	Multichannel spectrophotometry	Non-destructive inspection	Foreign object screening	DWDM monitor	OCT	Optical spectrum analyzer	
Short-wavelength enhanced type	NEW G11608 series	11		●	●	●				
	G92XX series		●	●	●		●		●	
Standard type	G9494 series				●	●				
	G10768 series				●	●			●	
Back-illuminated type	NEW G11135 series	12			●	●				
	NEW G11620 series		●	●	●				●	
Long wavelength type	to 1.85 μm G9205-256W		●	●	●					
	to 2.05 μm G9206-256W		●	●	●					
	to 2.25 μm G9207-256W	●	●	●						
	to 2.55 μm G9208-256W	●	●	●						

InGaAs area image sensors

Type	Type no.	Page	Thermal image monitor	Laser beam profiler	Near infrared image detection	Foreign object screening
Standard type	G11097-0606S	12	●	●	●	●
	NEW G11097-0707S		●	●	●	●

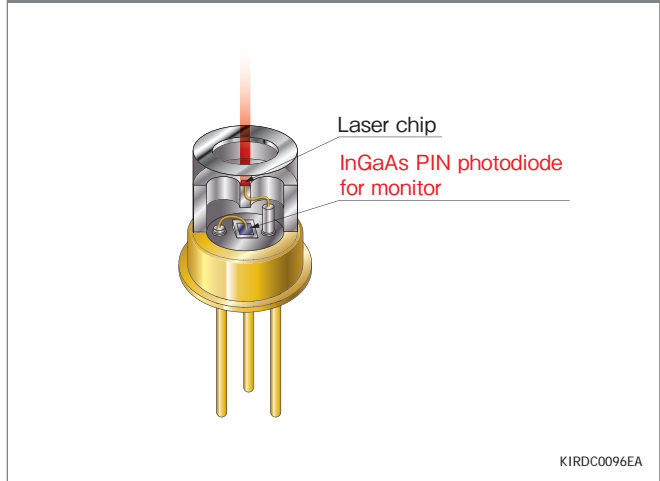
Application examples of InGaAs photodiodes

Induction heating



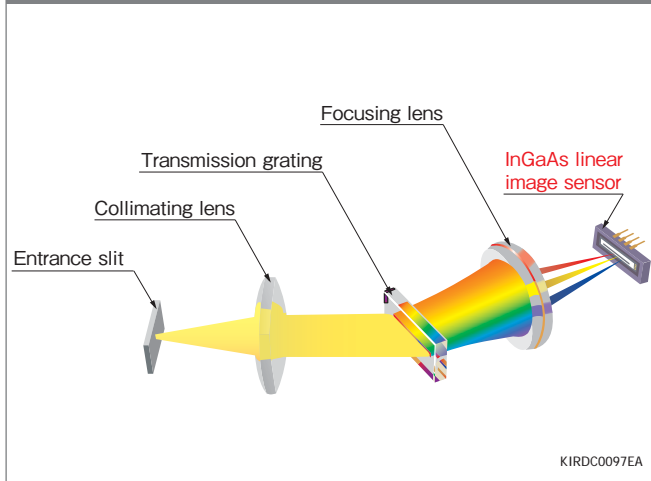
InGaAs PIN photodiode detects the temperature at the bottom of a frying pan.

Laser diode monitor



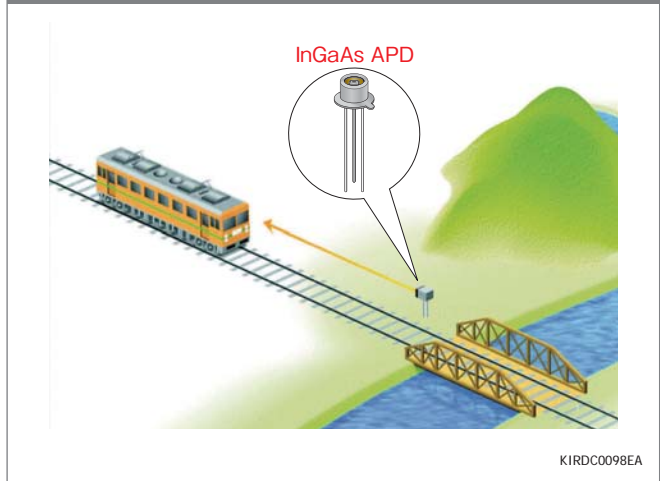
InGaAs PIN photodiode in laser diode package is used to monitor and control the light level emitted from the laser chip.

Mini-spectrometer



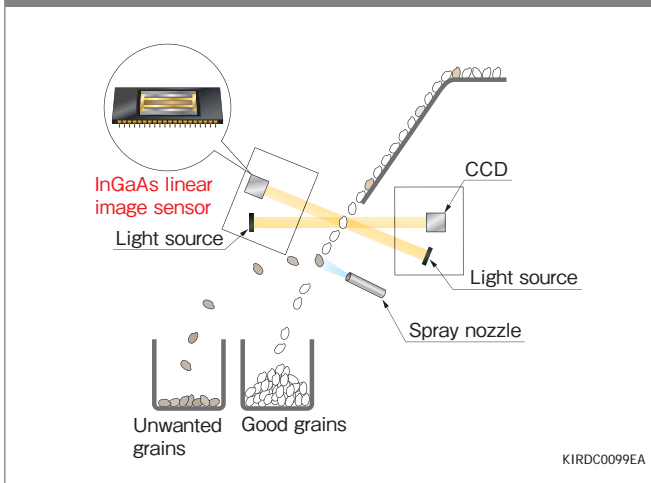
InGaAs linear image sensor is used in some of our mini-spectrometers.

Rangefinder



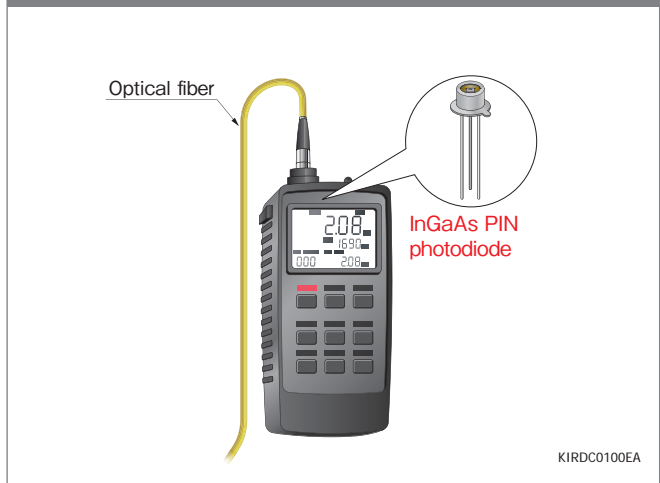
InGaAs APD detects the distance to an object with high speed and accuracy.

Grain sorter



Grain sorters irradiate light onto the falling grains and detect the transmitted light to sort out unwanted grains from good ones. (InGaAs linear image sensor detects near infrared light, and CCD detects visible light.)

Optical power meter

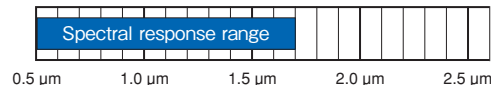


InGaAs PIN photodiode is used to detect the level of near infrared light passing through an optical fiber, etc.

InGaAs PIN photodiodes, InGaAs APD



Short-wavelength enhanced type InGaAs PIN photodiodes



The G10899 series is an InGaAs PIN photodiode that covers a wide spectral response range from 0.5 μm to 1.7 μm . While standard InGaAs PIN photodiodes have spectral response ranging from 0.9 μm to 1.7 μm , the G10899 series has sensitivity extending to 0.5 μm on the shorter wavelength side. A wide spectral range can be detected with a single detector.

Features

- Wide spectral response range
- Low noise, low dark current
- Large photosensitive area available

Applications

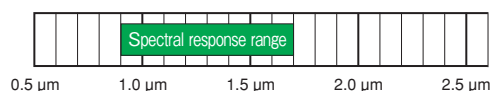
- Spectrophotometry
- Radiation thermometers

(Typ. $T_a=25^\circ\text{C}$)

Type no.	Cooling	Photosensitive area (mm)	Spectral response range λ (μm)	Peak sensitivity wavelength λ_p (μm)	Photosensitivity S		Dark current I_D $V_R=1\text{ V}$ (nA)	Cutoff frequency f_c $V_R=1\text{ V}$ (MHz)	Package	Photo	Option (sold separately)
					$\lambda=0.65\text{ }\mu\text{m}$ (A/W)	$\lambda=\lambda_p$ (A/W)					
G10899-003K	Non-cooled	$\phi 0.3$	0.5 to 1.7	1.55	0.15	0.85	0.3	300	TO-18		C4159-03
G10899-005K		$\phi 0.5$					0.5	150			
G10899-01K		$\phi 1$					1	45			
G10899-02K		$\phi 2$					5	10	TO-5		
G10899-03K		$\phi 3$					15	5			



Standard type InGaAs PIN photodiodes



InGaAs PIN photodiodes have large shunt resistance and low noise. A wide variety of packages are available including highly reliable metal types and surface mount types.

Features

- Low noise, low dark current
- Various photosensitive areas available

Applications

- Laser monitor
- Optical measurement instruments
- Optical communications







(Typ.)

Type no.	Cooling (measurement condition)	Photosensitive area (mm)	Spectral response range λ (μm)	Peak sensitivity wavelength λ_p (μm)	Photosensitivity S $\lambda=\lambda_p$ (A/W)	Dark current I_D $V_R=1\text{ V}$ (nA)	Cutoff frequency f_c (MHz)	Package	Photo	Option (sold separately)	
G8376-03	Non-cooled ($T_a=25^\circ\text{C}$)	$\phi 0.3$	0.9 to 1.7	1.55	0.95	0.3 ^{*1}	400 ($V_R=5\text{ V}$)	TO-18		C4159-03	
G8376-05		$\phi 0.5$				0.5 ^{*1}	200 ($V_R=5\text{ V}$)				
G8370-01		$\phi 1$				1 ^{*1}	35 ($V_R=5\text{ V}$)				
G8370-02		$\phi 2$				5	4 ($V_R=1\text{ V}$)	TO-5			
G8370-03		$\phi 3$				15	2 ($V_R=1\text{ V}$)				
G8370-05		$\phi 5$				25	0.6 ($V_R=1\text{ V}$)	TO-8			
G8370-81 ^{*3}		$\phi 1$				1	35 ($V_R=1\text{ V}$)	TO-18			
G8370-82 ^{*3}		$\phi 2$				5	4 ($V_R=1\text{ V}$)	TO-5			
G8370-83 ^{*3}		$\phi 3$				15	2 ($V_R=1\text{ V}$)				
G8370-85 ^{*3}		$\phi 5$				25 ^{*4}	0.6 ($V_R=0\text{ V}$)	TO-8			
G8605-11	One-stage TE-cooled ($T_d=-10^\circ\text{C}$)	$\phi 1$	0.9 to 1.67			0.07	18 ($V_R=1\text{ V}$)	TO-8		C4159-03 A3179 C1103-04	
G8605-12		$\phi 2$				0.3	4 ($V_R=1\text{ V}$)				
G8605-13		$\phi 3$				1	2 ($V_R=1\text{ V}$)				
G8605-15		$\phi 5$				2.5	0.6 ($V_R=1\text{ V}$)				
G8605-21	Two-stage TE-cooled ($T_d=-20^\circ\text{C}$)	$\phi 1$	0.9 to 1.65			0.03	18 ($V_R=1\text{ V}$)	TO-8		C4159-03 A3179-01 C1103-04	
G8605-22		$\phi 2$				0.15	4 ($V_R=1\text{ V}$)				
G8605-23		$\phi 3$				0.5	2 ($V_R=1\text{ V}$)				
G8605-25		$\phi 5$				1.2	0.6 ($V_R=1\text{ V}$)				

*1: $V_R=5\text{ V}$ *2: Element temperature *3: Low PDL (polarization dependence loss) type *4: $V_R=0.1\text{ V}$


Ceramic package

(Typ. Ta=25 °C)

Type no.	Photosensitive area (mm)	Spectral response range λ (μm)	Peak sensitivity wavelength λ_p (μm)	Photosensitivity S $\lambda=\lambda_p$ (A/W)	Dark current I _D V _R =5 V (nA)	Cutoff frequency f _c V _R =5 V (MHz)	Package	Photo
G8370-10	$\phi 10$	0.9 to 1.7	1.55	0.95	200 (V _R =10 mV)	0.1 (V _R =0 V)	-	
G11193-02R	$\phi 0.2$			1	0.04	1000	Surface mount type	
G11193-03R	$\phi 0.3$				0.1	500		
G8941-01	$\phi 1$	0.9 to 1.7	1.55	0.95	1	35	Surface mount type	
G8941-02	$\phi 0.5$				0.5	200		
G8941-03	$\phi 0.3$				0.95 to 1.7	0.3		400
G9230-01								


COB (chip on board) package

(Typ. Ta=25 °C)

Type no.	Photosensitive area (mm)	Spectral response range λ (μm)	Peak sensitivity wavelength λ_p (μm)	Photosensitivity S $\lambda=\lambda_p$ (A/W)	Dark current I _D V _R =5 V (nA)	Cutoff frequency f _c V _R =5 V (MHz)	Package	Photo
NEW G11777-003P	$\phi 0.3$	0.9 to 1.7	1.55	0.95	0.1	500	Surface mount type (Ultra-compact type)	






ROSA

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

Type no.	Wavelength band (μm)	Responsivity R (A/W)	Data rate (Gbps)	Minimum receivable sensitivity P _{min} (dBm)	Maximum receivable sensitivity P _{max} (dBm)	Transimpedance T _z (k Ω)	Optical return loss ORL min. (dB)	Photo
G12072-54	1.3	0.8	8.5 to 11.3	-19.5	+5	2.25	12	

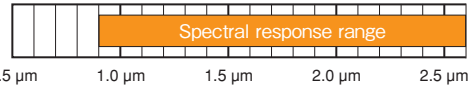
Photodiode arrays

(Typ. Ta=25 °C)

Type no.	Photosensitive area (mm)	Spectral response range λ (μm)	Peak sensitivity wavelength λ_p (μm)	Photosensitivity S $\lambda=1.55 \mu\text{m}$ (A/W)	Dark current I _D per element (nA)	Cutoff frequency f _c V _R =1 V (MHz)	Package	Photo
G6849	$\phi 2$ (quadrant)	0.9 to 1.7	1.55	0.95	0.5 (V _R =1 V)	30	TO-5	
G6849-01	$\phi 1$ (quadrant)				0.15 (V _R =1 V)	120		
G7150-16	0.45 × 1.0 (× 16-element)				5 (V _R =1 V)	30	DIP	
G7151-16	0.08 × 0.2 (× 16-element)				0.2 (V _R =1 V)	300		
G8909-01	$\phi 0.08$ (× 40-element)				0.02 (V _R =5 V)	1000 (V _R =5 V)	Ceramic	



Long wavelength type InGaAs PIN photodiodes



These are InGaAs PIN photodiodes whose spectral response range extends up to 2.6 μm . Three groups are available with different peak sensitivity wavelengths of 1.75 μm , 1.95 μm , and 2.3 μm . Thermoelectrically cooled, low noise types are also available.

Peak sensitivity wavelength 1.75 μm

(Typ.)

Type no.	Cooling (measurement condition)	Photosensitive area (mm)	Spectral response range λ (μm)	Peak sensitivity wavelength λ_p (μm)	Photosensitivity $S_{\lambda=\lambda_p}$ (A/W)	Dark current I_D $V_R=0.5\text{ V}$ (nA)	Cutoff frequency f_c $V_R=0\text{ V}$ (MHz)	Package	Photo	Option (sold separately)
NEW G12181-003K	Non-cooled (Ta=25 °C)	$\phi 0.3$	0.9 to 1.9	1.75	1.1	1	90	TO-18		C4159-03
NEW G12181-005K		$\phi 0.5$				3	35			
NEW G12181-010K		$\phi 1$				10	10			
NEW G12181-020K		$\phi 2$				50	2.5	TO-5		
NEW G12181-030K		$\phi 3$				100	1.5			
G5851-103	One-stage TE-cooled (Td=-10 °C)	$\phi 0.3$	0.9 to 1.87	1.75	1.1	3*	100*	TO-8		C4159-03
G5851-11		$\phi 1$				10*	40*			A3179
G5851-13		$\phi 3$				200*	3*			C1103-04
G5851-203	Two-stage TE-cooled (Td=-20 °C)	$\phi 0.3$	0.9 to 1.85	1.75	1.1	1.5*	100*	TO-8		C4159-03
G5851-21		$\phi 1$				5*	40*			A3179-01
G5851-23		$\phi 3$				100*	3*			C1103-04

Peak sensitivity wavelength 1.95 μm

(Typ.)

Type no.	Cooling (measurement condition)	Photosensitive area (mm)	Spectral response range λ (μm)	Peak sensitivity wavelength λ_p (μm)	Photosensitivity $S_{\lambda=\lambda_p}$ (A/W)	Dark current I_D $V_R=0.5\text{ V}$ (nA)	Cutoff frequency f_c $V_R=0\text{ V}$ (MHz)	Package	Photo	Option (sold separately)
NEW G12182-003K	Non-cooled (Ta=25 °C)	$\phi 0.3$	0.9 to 2.1	1.95	1.2	10	90	TO-18		C4159-03
NEW G12182-005K		$\phi 0.5$				20	35			
NEW G12182-010K		$\phi 1$				100	10			
NEW G12182-020K		$\phi 2$				500	2.5	TO-5		
NEW G12182-030K		$\phi 3$				1000	1.5			
G5852-103	One-stage TE-cooled (Td=-10 °C)	$\phi 0.3$	0.9 to 2.07	1.95	1.2	5.5*	100*	TO-8		C4159-03
G5852-11		$\phi 1$				50*	40*			A3179
G5852-13		$\phi 3$				500*	3*			C1103-04
G5852-203	Two-stage TE-cooled (Td=-20 °C)	$\phi 0.3$	0.9 to 2.05	1.95	1.2	3*	100*	TO-8		C4159-03
G5852-21		$\phi 1$				25*	40*			A3179-01
G5852-23		$\phi 3$				250*	3*			C1103-04

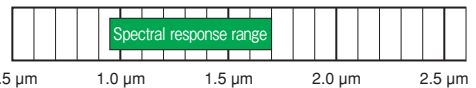
Peak sensitivity wavelength 2.3 μm

(Typ.)

Type no.	Cooling (measurement condition)	Photosensitive area (mm)	Spectral response range λ (μm)	Peak sensitivity wavelength λ_p (μm)	Photosensitivity $S_{\lambda=\lambda_p}$ (A/W)	Dark current I_D $V_R=0.5\text{ V}$ (μA)	Cutoff frequency f_c $V_R=0\text{ V}$ (MHz)	Package	Photo	Option (sold separately)
NEW G12183-003K	Non-cooled (Ta=25 °C)	$\phi 0.3$	0.9 to 2.6	2.3	1.3	0.4	50	TO-18		C4159-03
NEW G12183-005K		$\phi 0.5$				1	20			
NEW G12183-010K		$\phi 1$				3	6			
NEW G12183-020K		$\phi 2$				10	1.5	TO-5		
NEW G12183-030K		$\phi 3$				30	0.8			
G5853-103	One-stage TE-cooled (Td=-10 °C)	$\phi 0.3$	0.9 to 2.57	2.3	1.3	0.2*	60*	TO-8		C4159-03
G5853-11		$\phi 1$				1.5*	15*			A3179
G5853-13		$\phi 3$				15*	1.5*			C1103-04
G5853-203	Two-stage TE-cooled (Td=-20 °C)	$\phi 0.3$	0.9 to 2.55	2.3	1.3	0.1*	60*	TO-8		C4159-03
G5853-21		$\phi 1$				0.8*	15*			A3179-01
G5853-23		$\phi 3$				7.5*	1.5*			C1103-04

* $V_R=1\text{ V}$ 

InGaAs APD



(Typ. Ta=25 °C)

Type no.	Cooling	Photosensitive area (mm)	Spectral response range λ (μm)	Peak sensitivity wavelength λ_p (μm)	Photosensitivity $S_{\lambda=1.55\text{ }\mu\text{m}}$ $M=1$ (A/W)	Dark current I_D $V_R=V_{BR} \times 0.9$ (nA)	Cutoff frequency f_c $M=10$ (GHz)	Package	Photo
G8931-04	Non-cooled	$\phi 0.04$	0.95 to 1.7	1.55	0.9	40	4	TO-18	
G8931-20		$\phi 0.2$				150	0.9		

InGaAs image sensors

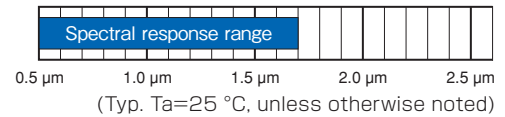




InGaAs linear image sensors

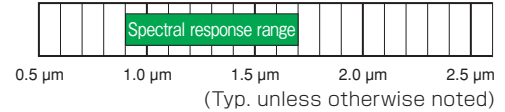
InGaAs linear image sensors are comprised of an InGaAs photodiode array with high sensitivity in the near infrared region, charge amplifier arrays, an offset compensation circuit, a shift register, and a timing generator. The signal from each pixel is read out in charge integration mode. The G11135/G11620 series use a back-illuminated structure to allow signal readout from a single video line.

Short-wavelength enhanced type










These InGaAs linear image sensors cover a wide spectral response range from the visible to near infrared region (0.5 to 1.7 μm).



Type no.	Cooling	Pixel pitch (μm)	Number of pixels	Photosensitive area (mm \times mm)	Spectral response range λ (μm)	Photo-sensitivity $S_{\lambda=\lambda_p}$ (A/W)	Dark current I_D (pA)	Defective pixels max. (%)	Photo	Applicable driver circuit (sold separately)
NEW G11608-256DA	Non-cooled	50	256	12.8 \times 0.5	0.5 to 1.7	1	± 5	1		-
NEW G11608-512DA		25	512							

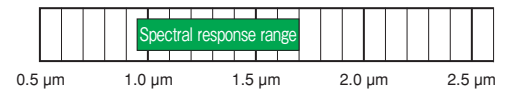


Standard type

Type no.	Cooling (measurement condition)	Pixel pitch (μm)	Number of pixels	Photosensitive area (mm \times mm)	Spectral response range λ (μm)	Photo-sensitivity $S_{\lambda=\lambda_p}$ (A/W)	Dark current I_D $T_a=25^\circ\text{C}$ (pA)	Defective pixels max. (%)	Photo	Applicable driver circuit (sold separately)
G9201-256S	One-stage TE-cooled ($T_d=-10^\circ\text{C}$)	50	256	12.8 \times 0.25	0.9 to 1.67		2			C8061-01
G9202-512S		25	512				1			
G9203-256D	Non-cooled ($T_a=25^\circ\text{C}$)	50	256	12.8 \times 0.5	0.9 to 1.7	0.95	4	0		-
G9203-256S	One-stage TE-cooled ($T_d=-10^\circ\text{C}$)									C8061-01
G9204-512D	Non-cooled ($T_a=25^\circ\text{C}$)	25	512	12.8 \times 0.5	0.9 to 1.7		1			-
G9204-512S	One-stage TE-cooled ($T_d=-10^\circ\text{C}$)									C8061-01
G9211-256S	One-stage TE-cooled ($T_d=-10^\circ\text{C}$)	50	256	12.8 \times 0.25	0.9 to 1.67	0.95	2	1		C8061-01
G9212-512S		25	512				1			
G9213-256S		50	256	12.8 \times 0.5			4			
G9214-512S		25	512				1			
G9494-256D	Non-cooled ($T_a=25^\circ\text{C}$)	50	256	12.8 \times 0.05	0.9 to 1.7	0.95	4	1		C10820
G9494-512D		25	512	12.8 \times 0.025			1			
G10768-1024D	Non-cooled ($T_d=25^\circ\text{C}$)	25	1024	25.6 \times 0.1	0.9 to 1.7	0.95	± 1	1		C10854
G10768-1024DB				25.6 \times 0.025						

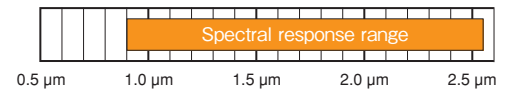
Back-illuminated type

These linear image sensors use a back-illuminated type InGaAs photodiode array that is bump-connected to a CMOS-ROIC with a single output terminal.



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

Type no.	Cooling	Pixel pitch (μm)	Number of pixels	Photosensitive area (mm × mm)	Spectral response range λ (μm)	Photo-sensitivity S λ=λp (A/W)	Dark current ID (pA)	Defective pixels max. (%)	Photo	Applicable driver circuit (sold separately)
NEW G11135-256DD	Non-cooled	50	256	12.8 × 0.05	0.95 to 1.7	0.8	2	1		C11514
NEW G11135-512DE		25	512	12.8 × 0.025			0.5			
NEW G11620-256DA		50	256	12.8 × 0.5			±5			C11513
NEW G11620-512DA		25	512							



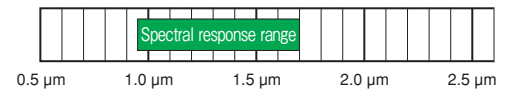
(Typ., unless otherwise noted)

Long wavelength type

Type no.	Cooling (measurement condition)	Pixel pitch (μm)	Number of pixels	Photosensitive area (mm × mm)	Spectral response range λ (μm)	Photo-sensitivity S λ=λp (A/W)	Dark current ID (pA)	Defective pixels max. (%)	Photo	Applicable driver circuit (sold separately)
G9205-256W	Two-stage TE-cooled (Td=-20 °C)	50	256	12.8 × 0.25	0.9 to 1.85	1.1	15	5		C8062-01
G9206-256W					0.9 to 2.05	1.2	30			
G9207-256W					0.9 to 2.25	1.3	200			
G9208-256W					0.9 to 2.55	1.3	500			



InGaAs area image sensors



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

(Typ., unless otherwise noted)

Type no.	Cooling (measurement condition)	Pixel pitch (μm)	Number of pixels	Photosensitive area (mm × mm)	Spectral response range λ (μm)	Photo-sensitivity S λ=λp (A/W)	Dark current ID Td=25 °C (pA)	Defective pixels max. (%)	Photo	Applicable driver circuit (sold separately)
G11097-0606S	One-stage TE-cooled (Td=-10 °C)	50	64 × 64	3.2 × 3.2	0.95 to 1.67	0.8	2	1		C11512
NEW G11097-0707S			128 × 128	6.4 × 6.4						C11512-01

Related products



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. As the combination of two light sensors, an infrared-transmitting Si photodiode and an InGaAs PIN photodiode (standard type or long wavelength type) or an infrared-transmitting InGaAs PIN photodiode (standard type) and an InGaAs PIN photodiode (long wavelength type) are available. 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.



Features

- Wide spectral response range
- Simultaneously detects light of multiple wavelengths in the same optical path
- High S/N (One-stage TE-cooled type)

Applications

- Spectrophotometers
- Radiation thermometer
- Flame monitor
- Laser monitor

(Typ.)

Type no.	Cooling (measurement condition)	Detector	Photosensitive area (mm)	Spectral response range λ (μm)	Peak sensitivity wavelength λ_p (μm)	Photosensitivity S $\lambda=\lambda_p$ (A/W)	Cutoff frequency f_c $V_R=0$ V $R_L=1$ k Ω (MHz)	Package	Photo	Option (sold separately)
K1713-05	Non-cooled (Ta=25 °C)	Si	2.4 × 2.4	0.32 to 1.7	0.94	0.45	1.75	TO-5		C9329 C4159-03
		InGaAs	φ0.5			1.55	0.55			
K1713-08		Si	2.4 × 2.4	0.32 to 2.6	0.94	0.45	1.75			
		InGaAs	φ1			2.3	0.60			
K1713-09		Si	2.4 × 2.4	0.32 to 1.7	0.94	0.45	1.75			
		InGaAs	φ1			1.55	0.55			
NEW K11908-010K	InGaAs	2.4 × 2.4	0.9 to 2.55	1.55	0.95	2*1				
	InGaAs	φ1			2.1	1.0	6*1			
K3413-05	One-stage TE-cooled (Td=-10 °C)	Si	2.4 × 2.4	0.32 to 1.67	0.94	0.45	1.75	TO-8		C9329 C4159-03 A3179-03 C1103-04
		InGaAs	φ0.5			1.55	0.55			
K3413-08		Si	2.4 × 2.4	0.32 to 2.57	0.94	0.45	1.75			
		InGaAs	φ1			2.3	0.60			
K3413-09		Si	2.4 × 2.4	0.32 to 1.67	0.94	0.45	1.75			
		InGaAs	φ1			1.55	0.55			

*1: $V_R=0$ V, $R_L=50$ Ω



Infrared detector modules with preamps

These are infrared detector modules using an InGaAs PIN photodiode and a preamp integrated into a compact case. Thermoelectrically cooled types and liquid nitrogen cooled types are provided for applications requiring low noise. Custom products are also available with different spectral response ranges, time response characteristics, and gains.




Features

- Easy to use
Just connecting it to a DC power supply provides a voltage output that varies with the incident light level.
- Compact size
- Low noise, high sensitivity (TE-cooled type, liquid nitrogen cooled type)

Applications

- Various infrared detections

(Typ.)

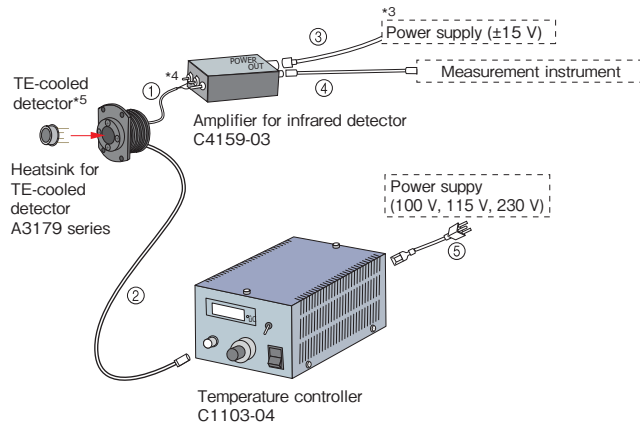
Type no.	Detector	Cooling (measurement condition)	Photosensitive area (mm)	Cutoff wavelength λ_c (μm)	Peak sensitivity wavelength λ_p (μm)	Photosensitivity S $\lambda=\lambda_p$ (V/W)	Photo
G6121	G8370-05	Non-cooled (Ta=25 °C)	φ5	1.7	1.55	1×10^6	
G6122*2	G5852-21	TE-cooled (Td=-15 °C)	φ1	2.05	1.95	1.7×10^8	
G6122-03*2	G5853-21		φ1	2.56	2.3	1.5×10^8	
G6126*2	G8605-25		φ5	1.66	1.55	5×10^7	
G7754-01	G5853-01 (Chip)	Liquid nitrogen (Td=-196 °C)	φ1	2.4	2.0	2×10^9	
G7754-03	G5853-03 (Chip)		φ3			5×10^8	

*2: The G6122, G6122-03 and G6126 conform to European EMC directives: EN 61326-1, Class B.

Options

A variety of options are provided to facilitate using InGaAs photodiodes.

Connection example



KIRDC0101EA

Cable no.	Cable	Approx. length	Note
①	Coaxial cable (for signal, no connector)	2 m	Supplied with heatsink A3179 series. When using this cable, make it as short as possible (preferably about 10 cm).
②	4-conductor cable (with a connector) A4372-05	3 m	Supplied with temperature controller C1103-04. This cable is also sold separately.
③	4-conductor cable (with a connector) A4372-02	2 m	This cable is supplied with the C4159-03 amplifier for infrared detector, and infrared detector modules with preamps (non-cooled type). This cable is also sold separately. Besides this cable, the A4372-03, which is a 6-conductor cable (with connector) supplied with infrared detector module with preamp (non-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 C1103-04

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



Amplifier for infrared detectors

For InGaAs PIN photodiode

The C4159-03 is a low noise amplifier for InGaAs PIN photodiodes.

Features

- Low noise
- 3 ranges switchable

Accessories

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

Specification

Parameter	Condition	Specification	Unit	Photo
Applicable detector*6 *7		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*8		±15	V	
Current consumption		±15 max.	mA	

- Note: A power supply is needed to use this amplifier.
 *6: These amplifiers cannot operate multiple detectors.
 *7: Consult us before purchasing if you want to use with a detector other than listed here.
 *8: 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



The C4159-03 conforms to European EMC directives EN 61326-1, Class B.



Heatsinks for TE-cooled detectors

For InGaAs PIN photodiode and two-color detector

The A3179 series heatsinks are designed specifically for thermoelectrically cooled infrared detectors. When used at an ambient temperature of 25 °C, the A3179 and A3179-03 provide a temperature difference (ΔT) of about 35 °C and the A3179-01 provides a temperature difference (ΔT) of about 45 °C.

Features

- A3179: for one-stage TE-cooled type
A3179-01: for two-stage TE-cooled type
A3179-03: for two-color detector K3413 series
- Compact size

Accessories

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



A3179-01

Note:

*1: When used in combination with the C1103-04 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.



Temperature controller

For InGaAs PIN photodiode

The C1103-04 is a temperature controller designed for TE-cooled infrared detectors. The C1103-04 allows temperature setting for the TE-cooler mounted in an infrared detector.

Accessories

- Instruction manual
- 4-conductor cable A4372-05 (with a connector, 2 m): for TE-cooler and thermistor*3
- Power supply cable

Specifications

Parameter	Specification	Photo
Applicable detector*4	One-stage /two-stage TE-cooled InGaAs PIN photodiode	
Setting element temperature	-30 to +20 °C	
Temperature stability	within ± 0.1 °C	
Output current for temperature control	1.3 A max.	
Power supply	100 V \pm 10% · 50/60 Hz*5	
Power consumption	30 W	
Dimensions	107 (W) \times 87 (H) \times 190 (D) mm	
Weight	Approx. 1.9 kg	

*3: 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.

*4: This temperature controller does not support TE-cooled infrared detector modules with preamps and cannot set temperatures on two or more TE-coolers.

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



The C1103-04 conforms to European EMC directives EN 61326-1, Class B.



Multichannel detector heads

For InGaAs image sensor

Multichannel detector heads for InGaAs linear image sensor (one-stage/two-stage TE-cooled type) C8061/C8062-01

The C8061-01 and C8062-01 are multichannel detector heads designed for use with an InGaAs linear image sensor developed for near infrared spectrophotometry. These detector heads contain a driver circuit that operates from input of simple external signals. When used in combination with the C7557-01 multichannel detector head controller and the supplied software, these multichannel detector heads can be controlled from a PC and easily acquire data.

Features

- Built-in driver circuit for InGaAs linear image sensor
C8061-01: for one-stage TE-cooled type
C8062-01: for two-stage TE-cooled type
- Highly stable temperature controller
Cooling temperature ($T_a=10$ to 30 °C)
fixed at $T_d=-10 \pm 0.1$ °C (C8061-01),
 -20 ± 0.1 °C (C8062-01)
- Simple signal input operation
- Compact size

Applications

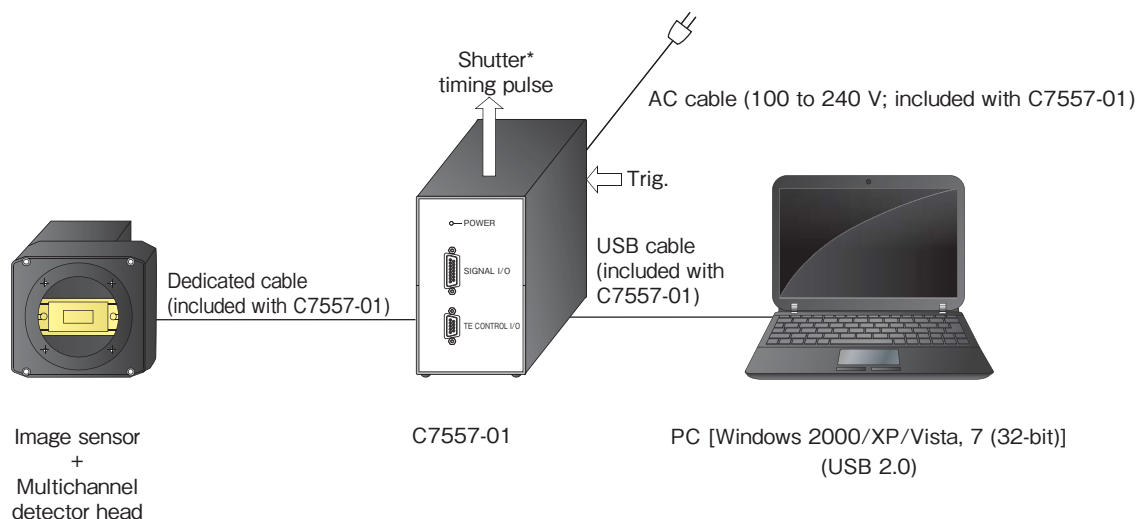
- Near infrared multichannel spectroscopy
- Radiation thermometer
- Non-destructive inspection
- Optical fiber transmittance measurement

Type no.	Output	Photo	Applicable sensor (option)
C8061-01	Analog		G9201/G9203/G9211/G9213-256S, G9202/G9204/G9212/G9214-512S
C8062-01			G9205/G9206/G9507/G9208-256W

Multichannel detector head controller

Type no.	Interface	Photo	Applicable multichannel detector head (option)
C7557-01	USB 2.0		C8061-01, C8062-01

Connection example



* Shutter, etc. are not available

KACCC0402EC

Multichannel detector head for InGaAs linear image sensor (G10768 series) C10854


The C10854 is a multichannel detector head designed for applications such as sorting machines and SD-OCT (spectral domain optical coherence tomography) where high-speed response is essential. The C10854 is optimized for use with the G10768 series InGaAs linear image sensors and controllable from a PC by using the supplied application software (C10854DCamAPL) that runs on Windows 2000/XP.

Features

- High-speed operation: 5 MHz
- Line rate: 31.25 kHz
- Supports CameraLink

Applications

- Near infrared multichannel spectroscopy
- Foreign object screening
- OCT (optical coherence tomography)

Type no.	Interface	Output	Photo	Applicable sensor (option)
C10854	CameraLink	Digital		G10768-1024D, G10768-1024DB

Multichannel detector heads for InGaAs area image sensors (G11097 series) C11512 series

The C11512 series is a multichannel detector head designed for the G11097 series InGaAs area image sensors. The C11512 series supports a variety of near infrared imaging applications and is controllable from a PC by using the supplied application software (DCam-CL) that runs on Windows XP/7 (32-bit version).

Features

- Built-in temperature control circuit
[Td=10 °C typ. (Ta=25 °C)]
- Supports CameraLink
- Compact size
- External trigger input
- Adjustable offset and gain
- Pulse output setting

Applications

- Thermal imaging
- Laser beam profiler
- Foreign object inspection

Type no.	Interface	Output	Photo	Applicable sensor (option)
NEW C11512	CameraLink	Digital		G11097-0606S
NEW C11512-01				G11097-0707S

Description of terms

Spectral response

The relation (photoelectric sensitivity) between the incident light level and resulting photocurrent differs depending on the wavelength of the incident light. This relation between the photoelectric sensitivity and wavelength is referred to as the spectral response characteristic and is expressed in terms of photosensitivity or quantum efficiency.

Photosensitivity: S

The ratio of photocurrent expressed in amperes (A) or output voltage expressed in volts (V) to the incident light level expressed in watts (W). Photosensitivity is represented as an absolute sensitivity (A/W or V/W) or as a relative sensitivity (%) to the peak wavelength sensitivity normalized to 100. We usually define the spectral response range as the range in which the relative sensitivity is higher than 5% or 10% of the peak sensitivity.

Quantum efficiency: QE

This is the number of electrons or holes that can be extracted as photocurrent divided by the number of incident photons. It is commonly expressed in percent (%). The quantum efficiency QE and photosensitivity S (unit: A/W) have the following relationship at a given wavelength (unit: nm).

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

Short circuit current: Isc

This is the output current that flows in a photodiode when load resistance is zero. This is called "white light sensitivity" to differentiate it from the spectral response, and is measured with light from a standard tungsten lamp at 2856 K distribution temperature (color temperature). Our product catalog lists the short circuit current measured under an illuminance of 100 lx.

Peak sensitivity wavelength: λ_p

This is the wavelength at which the photosensitivity of the detector is at maximum.

Cutoff wavelength: λ_c

This represents the long wavelength limit of spectral response and in datasheets is listed as the wavelength at which the sensitivity becomes 10% of the value at the peak sensitivity wavelength.

Dark current: Id

A small current which flows when a reverse voltage is applied to a photodiode even in a dark state. This current is called the dark current. Noise resulting from dark current becomes dominant when a reverse voltage is applied to photodiodes (PIN photodiodes, etc.).

Shunt resistance: Rsh

This is the voltage/current ratio of a photodiode operated in the vicinity of 0 V. In our product catalog, the shunt resistance is specified by the following equation, where the dark current (Id) is a value measured at a reverse voltage of 10 mV.

$$R_{sh} [\Omega] = \frac{0.01 \text{ [V]}}{I_d \text{ [A]}}$$

Noise generated from the shunt resistance becomes dominant in applications where a reverse voltage is not applied to the photodiode.

Terminal capacitance: Ct

In a photodiode, the PN junction can be considered as a type of capacitor. This capacitance is termed the junction capacitance and is an important parameter in determining the response speed. In current-to-voltage conversion circuits using an op amp, the junction capacitance might cause gain peaking. At HAMAMATSU, we specify the terminal capacitance including this junction capacitance plus the package stray capacitance.

Rise time: tr

The rise time is the time required for the output to rise from 10% to 90% of the maximum output value (steady-state value) in response to input of step-function light.

Cutoff frequency: fc

This is the measure used to evaluate the time response of high-speed PIN photodiodes to a sine-wave-modulated light input. It is defined as the frequency at which the photodiode output decreases by 3 dB from the output at 100 kHz. The light source used is a laser diode (1.3 μm or 1.55 μm) and the load resistance is 50 Ω . The rise time tr has a relation with the cutoff frequency fc as follows:

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

Noise equivalent power: NEP

NEP is the incident light level equivalent to the noise level of a device. In other words, it is the light level required to obtain a signal-to-noise ratio (S/N) of 1. We define the NEP value at the peak sensitivity wavelength (λ_p). Since the noise level is proportional to the square root of the frequency bandwidth, the bandwidth is normalized to 1 Hz.

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

Reverse voltage: VR max

Applying a reverse voltage to a photodiode triggers a breakdown at a certain voltage and causes severe deterioration of the device performance. Therefore the absolute maximum rating is specified for reverse voltage at the voltage somewhat lower than this breakdown voltage. The reverse voltage shall not exceed the maximum rating, even instantaneously.

Reference (Physical constants relating to light and opto-semiconductors)

Constant	Symbol	Numerical value	Unit
Electron charge	q	1.602×10^{-19}	C
Speed of light in vacuum	c	2.998×10^8	m/s
Planck's constant	h	6.626×10^{-34}	J·s
Boltzmann's constant	k	1.381×10^{-23}	J/K
Thermal energy at room temperature	kT	0.0259 (T=300 K)	eV
Energy of 1eV	eV	1.602×10^{-19}	J
Wavelength equivalent to 1 eV in vacuum	-	1240	nm
Permittivity of vacuum	ϵ_0	8.854×10^{-12}	F/m
Band gap energy of silicon	Eg	Approx. 1.12 (T=25 °C)	eV

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