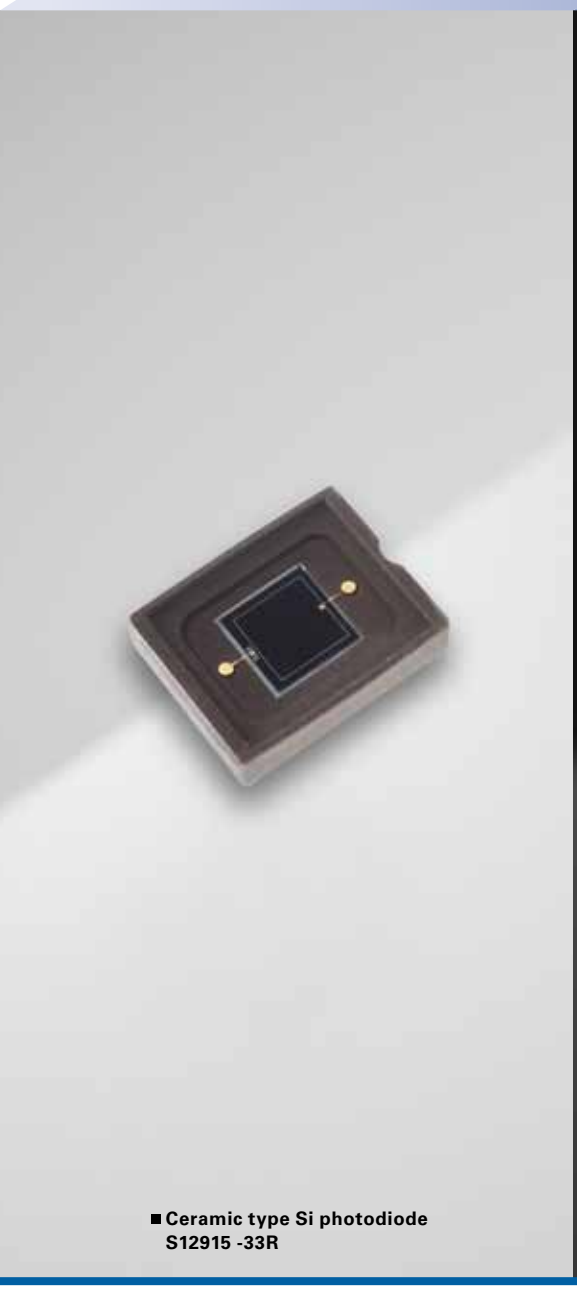
HAMAMATSU
PHOTON IS OUR BUSINESS

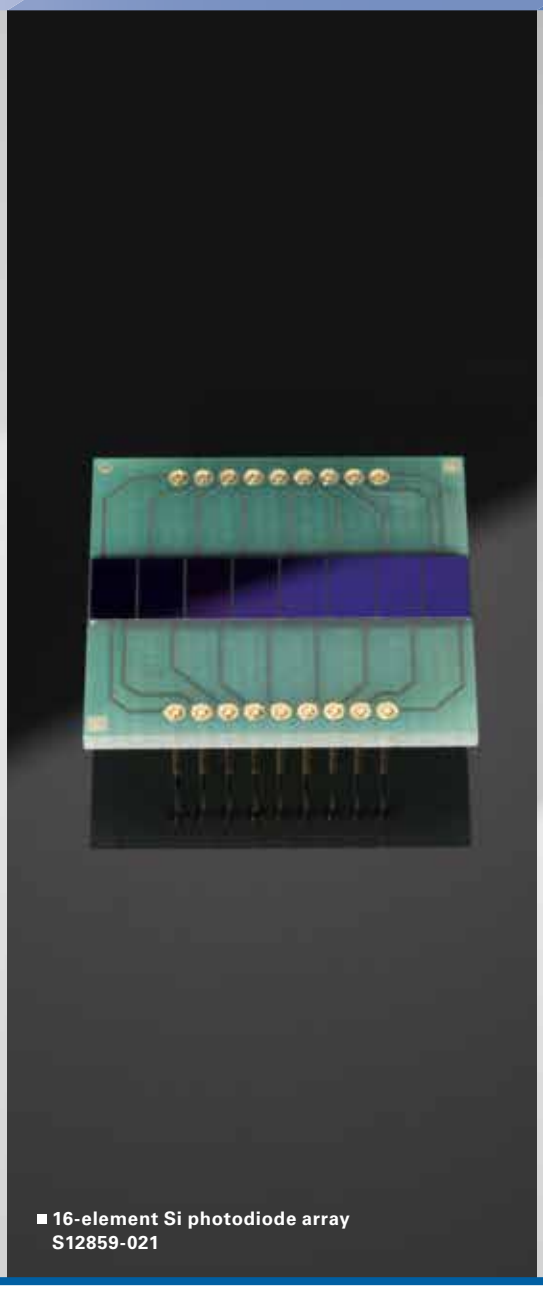
Selection guide - June 2019

Si Photodiodes

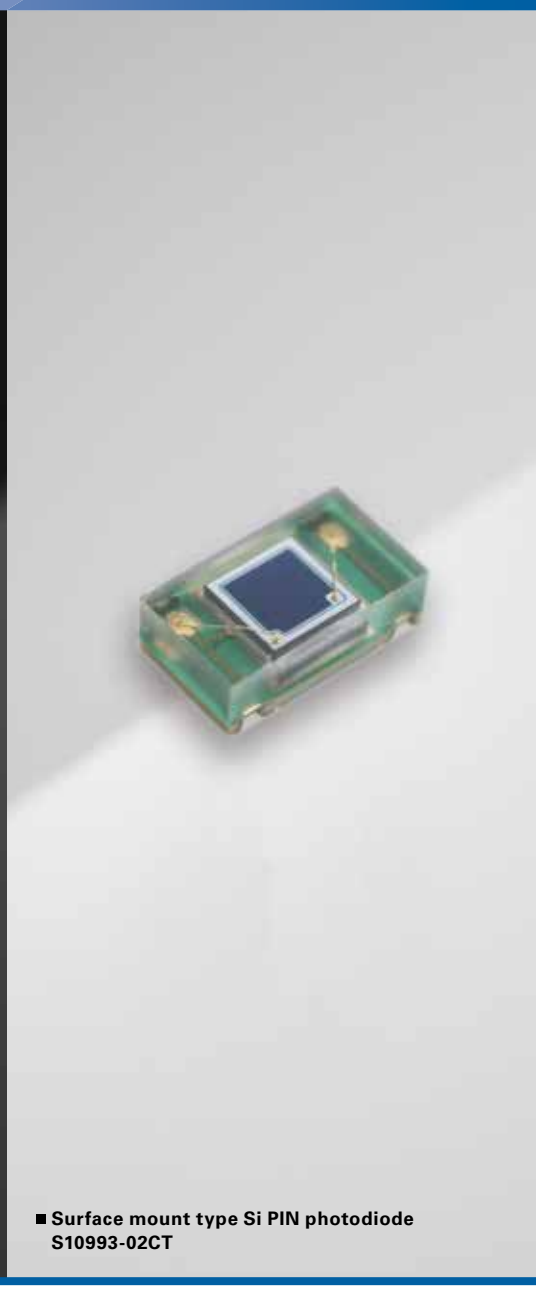
Lineup of Si photodiodes for UV to near IR, radiation



■ Ceramic type Si photodiode
S12915 -33R



■ 16-element Si photodiode array
S12859-021



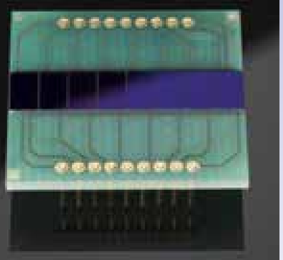
■ Surface mount type Si PIN photodiode
S10993-02CT

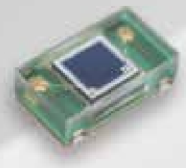
HAMAMATSU PHOTONICS K.K.

Si Photodiodes

Lineup of Si photodiodes for UV to near IR, radiation

Contents





Si photodiodes

Photodiodes are semiconductor light sensors that generate a current or voltage when the P-N junction in the semiconductor is illuminated by light. The term photodiode can be broadly defined to include even solar batteries, but it usually refers to sensors used to detect the intensity of light. Photodiodes can be classified by function and construction as follows:

- Si photodiode
- Si PIN photodiode
- Si APD (avalanche photodiode)

All of these types provide the following features and are widely used for the detection of the presence, intensity and color of light.

- Excellent linearity with respect to incident light
- Low noise
- Wide spectral response range
- Mechanically rugged
- Compact and lightweight
- Long life

Si photodiodes manufactured utilizing our unique semiconductor process technologies cover a broad spectral range from the near infrared to ultraviolet and even to high-energy regions. They also feature high-speed response, high sensitivity and low noise. Si photodiodes are used in a wide range of applications including medical and analytical fields, scientific measurements, optical communications and general electronic products. Si photodiodes are available in various packages such as metal, ceramic and plastic packages as well as in surface mount types. We also offer custom-designed devices to meet special needs.

Hamamatsu Si photodiodes

Type	Feature	Product example
Si photodiode	Featuring high sensitivity and low dark current, these Si photodiodes are specifically designed for precision photometry and general photometry/visible range.	• For UV to near IR • For visible range to near IR • For visible range • RGB color sensor • For monochromatic light detection • For VUV (vacuum ultraviolet) detection • For electron beam detector
Si PIN photodiode	Si PIN photodiodes delivering high-speed response when operated with a reverse bias are widely used for optical communications and optical disk pickup, etc.	• Cutoff frequency: 1 GHz or more • Cutoff frequency: 100 MHz to less than 1 GHz • Cutoff frequency: 10 MHz to less than 100 MHz • For YAG laser detection
Multi-element type Si photodiode	Si photodiode arrays consist of multiple elements of the same size, formed at an equal spacing in one package. These Si photodiode arrays are used in a wide range of applications such as laser beam position detection and spectrophotometry.	• Segment type • One-dimensional type
Si photodiode with preamp, TE-cooled type Si photodiode	Si photodiodes with preamp incorporate a photodiode and a pre-amplifier chip into the same package. Since TE-cooled type Si photodiodes include TE-cooler in a package, they achieve excellent S/N.	• For analytical and measurement instrument
Si photodiode for X-ray detection	These detectors are comprised of a Si photodiode coupled to a scintillator. These detectors are used for X-ray baggage inspection and non-destructive inspection.	• With scintillator • Large area Si PIN photodiodes
Si APD*	Si APDs are high-speed, high sensitivity photodiodes having an internal gain mechanism.	• Near IR type • Short wavelength type • Multi-element type
Related product of Si photodiode	Hamamatsu provides various types of Si photodiode modules.	• RGB color sensor module • Color sensor evaluation circuit • Driver circuit for Si photodiode array • Photodiode module • Signal processing unit for photodiode module • Photosensor amplifier • Charge amplifier

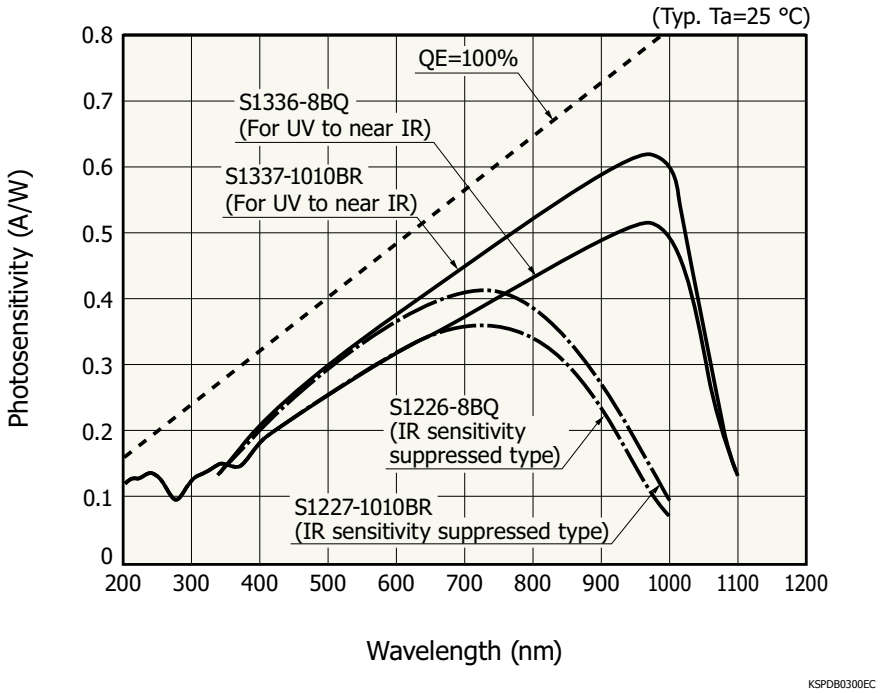
* Si APD is not listed in this catalogue.

Note: Hamamatsu also provides PSD (position sensitive detector) used to detect the position of incident light spot. PSD is a non-discrete photosensor utilizing the surface resistance of photodiodes.

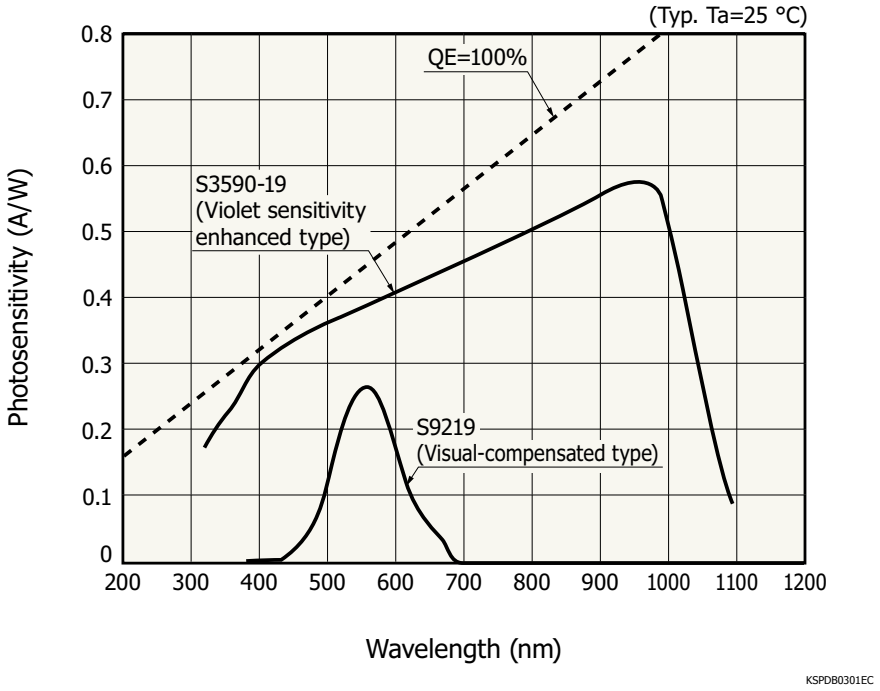
Spectral response (typical example)

Hamamatsu provides a lineup that covers a variety of spectral response ranges from 200 nm to 1200 nm.

[S1226/S1336-8BQ, S1227/S1337-1010BR]



[S3590-19, S9219]



Packages

Hamamatsu provides a wide variety of packages including metal, ceramic, and plastic.

Si photodiodes for precision photometry

Type	Type no.	Page	Metal	Ceramic	Plastic	Glass epoxy	With BNC connector	Remarks
For UV to near IR	S1336 series	9	Yes					
	S1337 series (excluding S1337-21)	9		Yes				
	S1337-21	10		Yes				Unsealed
	S2551	10		Yes				
	S2281 series	10					Yes	
For UV to near IR (IR sensitivity suppressed type)	S1226 series	11	Yes					
	S1227 series	11		Yes				
	S2281-01	11					Yes	
For UV monitor	S12698 series	12	Yes					
For visible range to near IR	S2386 series	13	Yes					
	S12915 series	14		Yes				

Si photodiodes for general photometry/visible range

Type		Type no.	Page	Metal	Ceramic	Plastic	Glass epoxy	With BNC connector	Remarks
For visible range	Visual-sensitive compensated	S1087, S1133, S8265	15		Yes				
		S1787-04	15			Yes			
	CIE standard luminous efficiency approximation	S9219	15					Yes	
		S9219-01	15	Yes					
		S7686	15		Yes				
For visible range to near IR		S1787-12, S4797-01 S4011-06DS S1787-08, S2833-01	16			Yes			
		S1133-14, S1087-01 S1133-01	16		Yes				

High-speed response Si PIN photodiodes

Type	Type no.	Page	Metal	Ceramic	Plastic	Glass epoxy	With BNC connector	Remarks
Cutoff frequency: 1 GHz or more	S5973/S9055 series	17	Yes					
Cutoff frequency: 100 MHz to less than 1 GHz	S5971, S3399 S3883, S5972	18	Yes					
	S10783, S10784	18			Yes			
Cutoff frequency: 10 MHz to less than 100 MHz	S6775/S8385/ S8729/S2506 series S6967, S4707-01 S6801-01	19			Yes			
	S5821/S1223 series S3071, S3072 S12271	20	Yes					

Multi-element type Si photodiodes

Type	Type no.	Page	Metal	Ceramic	Plastic	Glass epoxy	With BNC connector	Remarks
Segmented type Si PIN photodiode	S3096-02, S4204, S9345	21			Yes			
	S4349	21	Yes					
One-dimensional photodiode array	S4111/S4114 series	22		Yes				
	S12858/S12859/ S11212/S11299/ S12362/S12363-021	22				Yes		Unsealed

Surface mount type Si photodiodes

Type	Type no.	Page	Metal	Ceramic	Plastic	Glass epoxy	With BNC connector	Remarks
High-speed response Si PIN photodiode	S5106, S5107 S7509, S7510	23		Yes				Surface mount type
Segmented type Si photodiode	S5980, S5981 S5870, S8558	23		Yes				Surface mount type
Small package type Si photodiode	S9674 S10625-01CT	24				Yes		Surface mount type
Small package type Si PIN photodiode	S13773 S10993-02CT S12158-01CT	24				Yes		Surface mount type

Si photodiodes with preamp, TE-cooled type Si photodiodes

Type	Type no.	Page	Metal	Ceramic	Plastic	Glass epoxy	With BNC connector	Remarks
Si photodiode with preamp for measurement	S8745-01, S8746-01 S9295 series	25	Yes					
	S9269, S9270	25		Yes				
TE-cooled type Si photodiode	S2592/S3477 series	26	Yes					

Si photodiodes for X-ray detection

Type	Type no.	Page	Metal	Ceramic	Plastic	Glass epoxy	With BNC connector	Remarks
Si photodiode with scintillator	S8559, S8193	27		Yes				With scintillator
	S12858/S12859/ S11299/S11212/ S12362/S12363 series	27				Yes		With scintillator
Large area type Si PIN photodiode	S3590 series S8650	29		Yes				
	S2744/S3204/ S3584/S3588 series	30		Yes				

Special application Si photodiodes

Type	Type no.	Page	Metal	Ceramic	Plastic	Glass epoxy	With BNC connector	Remarks
RGB color sensor	S7505-01, S9032-02 S9702	31			Yes			Surface mount type
	S10917-35GT S10942-01CT	31				Yes		Surface mount type
	S6428-01, S6429-01 S6430-01	32			Yes			
Violet/blue sensitivity enhanced type	S5973-02, S9195	33	Yes					
	S3994-01	33		Yes				
For VUV (vacuum ultraviolet) monitor	S8552, S8553	34		Yes				Unsealed
For VUV detection (high reliability type)	S10043	34		Yes				Unsealed
For monochromatic light detection	S12742-254	35	Yes					
For YAG laser detection	S3759	35	Yes					
For electron beam detector	S11141-10, S11142-10	36		Yes				Unsealed
PWB package with leads type	S12497, S12498	36				Yes		Unsealed
CSP type	S13955-01, S13956-01 S13957-01, S13620-02	37				Yes		Unsealed

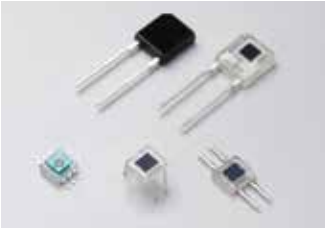
Variety of package types

Hamamatsu offers a diverse selection of package types to meet different customer needs. Metal packages are widely used in applications requiring high reliability. Ceramic packages are used for general applications and plastic packages are used in applications where the main need is low cost.
Other types are also available including those with BNC connector, which facilitates connection to coaxial cable, surface mount types that support reflow soldering, and those with scintillator, which converts X-rays and radiation to visible light.

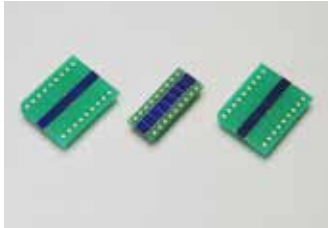
[Metal]

[Ceramic]

[Plastic]

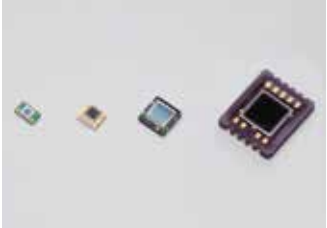


[Glass epoxy]

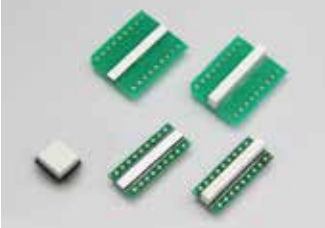


[With BNC connector]

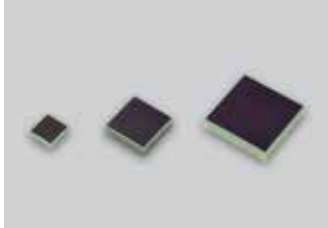
[Surface mount type]



[With scintillator]



[CSP]



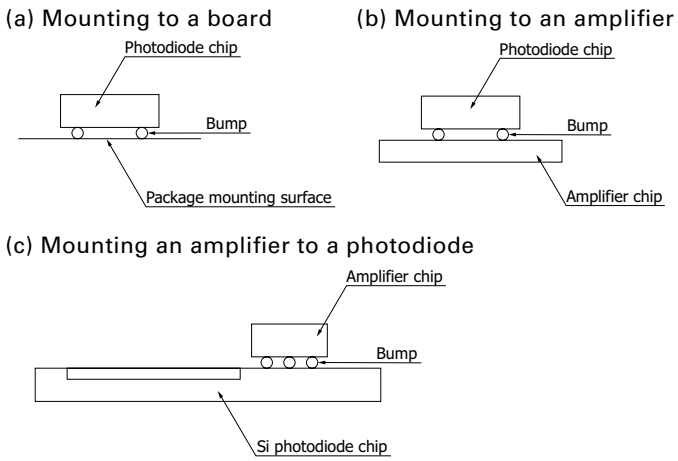
Mount technology

At the Solid State Division of Hamamatsu Photonics, we are constantly at work designing and developing our own mount technology to offer unique semiconductor devices having special features.
Now we will take a brief look at our mount technology for Si photodiodes.

Flip chip bonding

Mounting technology for opto-semiconductors includes not only the two-stage chip die-bonding and wire-bonding but also the flip chip bonding as shown in Figure 1.
Parasitic capacitance and inductance can be a problem when extracting opto-semiconductor device signals from a wire. Flip-chip bonding can prevent this problem and help in downsizing since it utilizes bumps to directly join the chip to the package or an IC chip, etc.

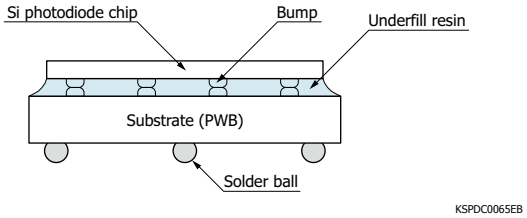
Figure 1 Example of flip chip bonding



CSP (chip size package)

In CSP type photodiodes, the chip and substrate are connected by bump electrodes so there is minimal dead area on the package surface area. This allows utilizing the photosensitive area more effectively. Also multiple devices can be densely arrayed and used in a tile format. There is no wiring so coupling to the scintillator is easy.

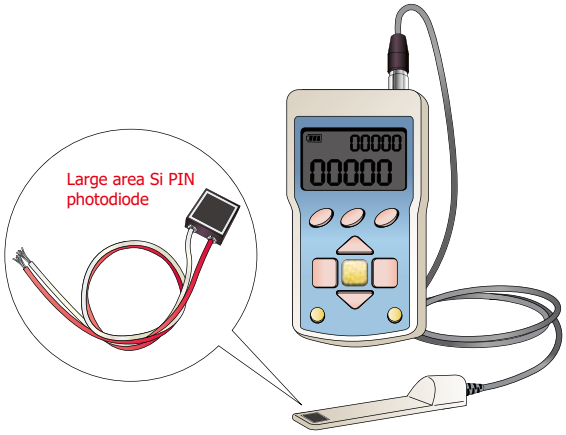
Figure 2 Cross section of CSP type photodiode



Application examples

Here, we will introduce several applications of our Si photodiodes.

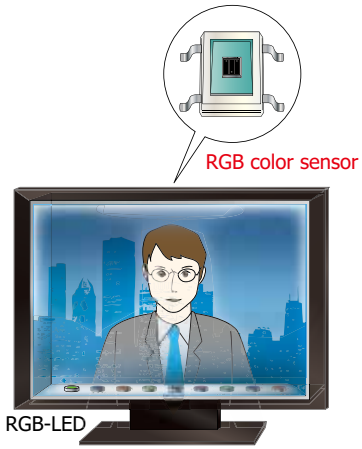
Optical power meters



KSPDC0082EA

Large area type Si PIN photodiodes are used to measure the light levels of various light sources such as laser diodes and LEDs.

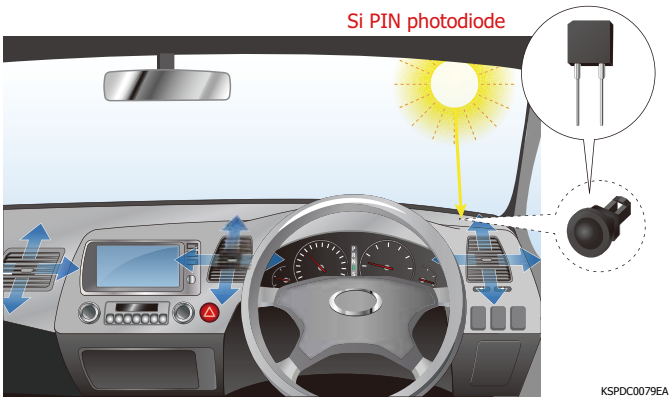
LCD backlight color adjustment



KSPDC0077EA

The RGB color sensor detects the white balance of LCD backlight optical waveguides and controls the light level of each RGB LED to stabilize the LCD backlight color.

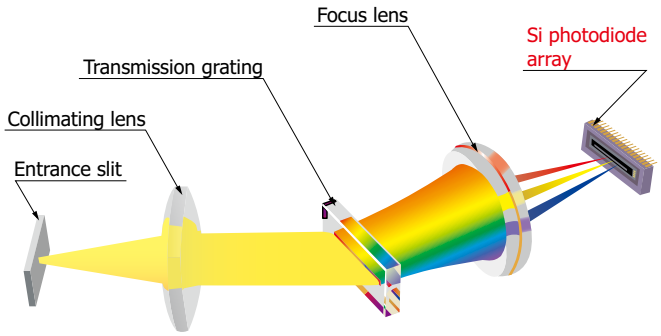
Sunlight sensors



KSPDC0079EA

Si photodiodes are used to detect the amount of sunshine to control the volume of air flow for automotive air conditioners.

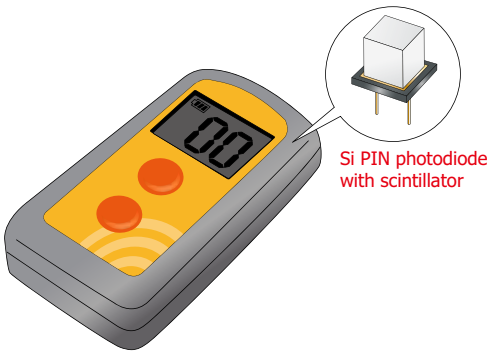
Spectrophotometers



KSPDC0080EA

Si photodiode arrays are used to detect light that has been divided into wavelengths through a diffraction grating in spectrophotometers.

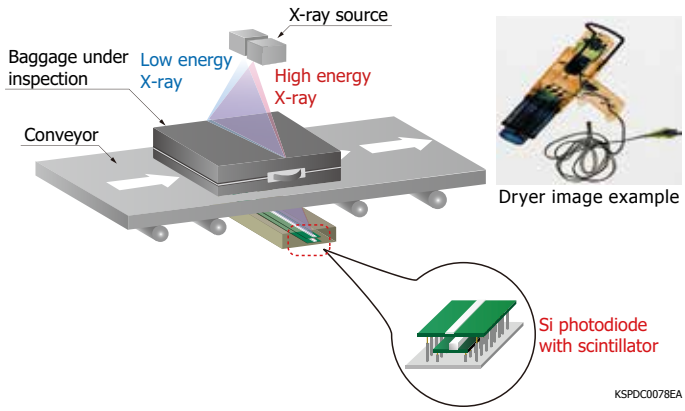
Radiation detectors



KSPDC0081EA

Si PIN photodiodes with scintillators are used in detectors that measure radiation levels of γ rays and other rays.

Baggage inspection equipment



KSPDC0078EA

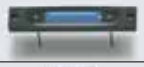
Si PIN photodiodes with scintillators are used in dual energy imaging of baggage inspection equipment to obtain information about an object such as its type and thickness.

Si photodiodes for precision photometry

For UV to near IR

These Si photodiodes have sensitivity in the UV to near IR range. They are suitable for low-light-level detection in analysis and the like.

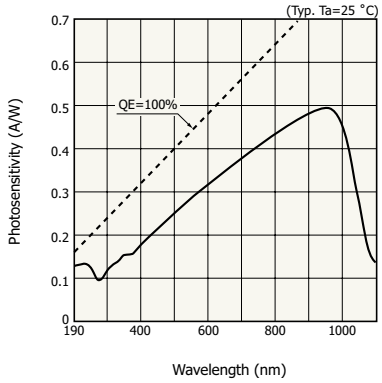
(Typ. Ta=25 °C)

Type no.	Spectral response range (nm)	Photosensitivity (A/W) λ=200 nm	Photosensitivity (A/W) λ=960 nm	Dark current VR=10 mV max. (pA)	Terminal capacitance VR=0 V f=10 kHz (pF)	Photosensitive area size (mm)	Package	Photo
S1336-18BQ*1	190 to 1100	0.12	0.5	20	20	1.1 × 1.1	TO-18	
S1336-18BK	320 to 1100	-						
S1336-5BQ*1	190 to 1100	0.12		30	65	2.4 × 2.4	TO-5	
S1336-5BK	320 to 1100	-						
S1336-44BQ*1	190 to 1100	0.12		50	150	3.6 × 3.6		
S1336-44BK	320 to 1100	-						
S1336-8BQ*1	190 to 1100	0.12		100	380	5.8 × 5.8	TO-8	
S1336-8BK	320 to 1100	-						
S1337-16BQ*1	190 to 1100	0.12	0.5	50	65	1.1 × 5.9	Ceramic	
S1337-16BR	340 to 1100	-	0.62					
S1337-33BQ*1	190 to 1100	0.12	0.5	30		2.4 × 2.4		
S1337-33BR	340 to 1100	-	0.62					
S1337-66BQ*1	190 to 1100	0.12	0.5	100	380	5.8 × 5.8		
S1337-66BR	340 to 1100	-	0.62					
S1337-1010BQ*1	190 to 1100	0.12	0.5	200	1100	10 × 10		
S1337-1010BR	340 to 1100	-	0.62					

*1: Refer to "Precautions against UV light exposure" (P.43).

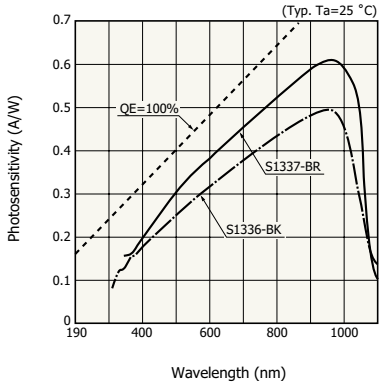
Spectral response

[S1336-BQ, S1337-BQ]



KSPDB0262EF

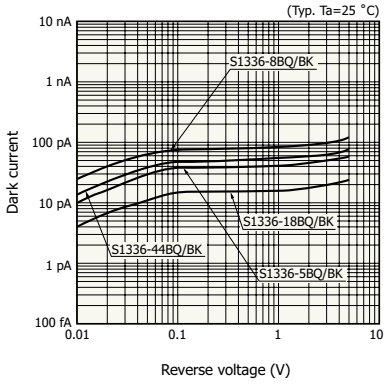
[S1336-BK, S1337-BR]



KSPDB0309EA

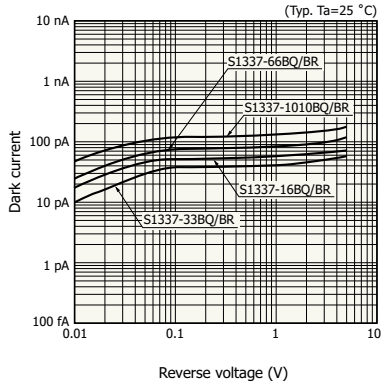
Dark current vs. reverse voltage

[S1336 series]



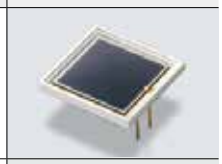
KSPDB0100EB

[S1337 series]



KSPDB0104EB

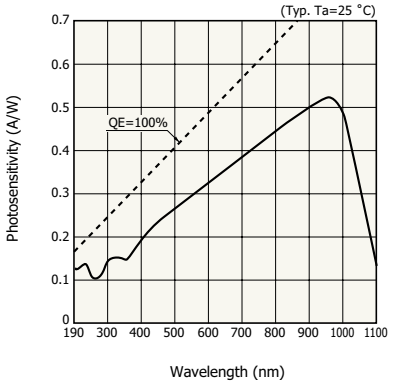
(Typ. Ta=25 °C)

Type no.	Spectral response range (nm)	Photosensitivity (A/W) λ=200 nm	Photosensitivity (A/W) λ=960 nm	Dark current VR=10 mV max. (pA)	Terminal capacitance VR=0 V f=10 kHz (pF)	Photosensitive area size (mm)	Package	Photo
S1337-21*2	190 to 1100	0.13	0.52	500	4000	18 × 18	Ceramic (unsealed)	
S2551	340 to 1060	-	0.57 (λ=920 nm)	1000	350	1.2 × 29.1	Ceramic	
S2281*2 *3	190 to 1100	0.12	0.5	500	1300	ϕ11.3	With BNC connector	
S2281-04*2 *3						ϕ7.98		

*2: Refer to "Precautions against UV light exposure" (P.43).
*3: Connecting a photodiode to the C9329 photosensor amplifier (using a BNC-BNC coaxial cable E2573) allows amplifying the photodiode's weak photocurrent with low noise.

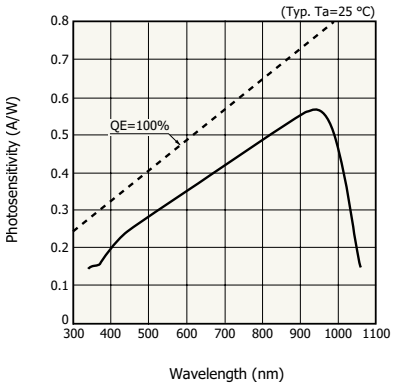
Spectral response

[S1337-21]



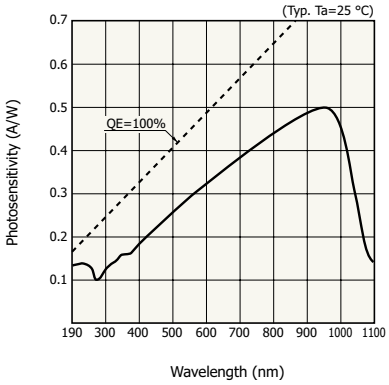
KSPDB0304EA

[S2551]



KSPDB0173EB

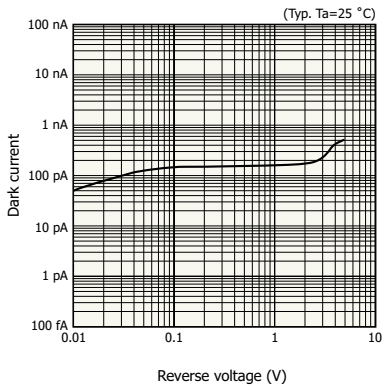
[S2281, S2281-04]



KSPDB0270EA

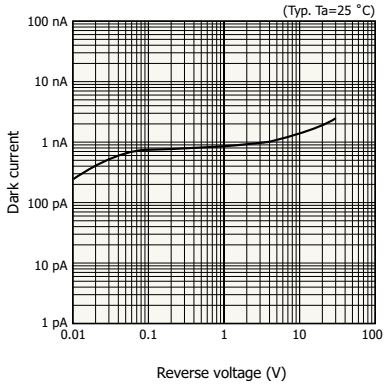
Dark current vs. reverse voltage

[S1337-21]



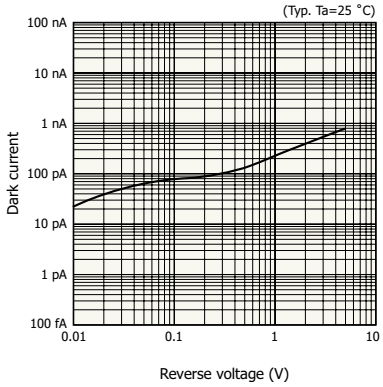
KSPDB0305EA

[S2551]



KSPDB0175EB

[S2281, S2281-04]



KSPDB0271EB

For UV to near IR (IR sensitivity suppressed type)

These Si photodiodes have suppressed IR sensitivity. They are suitable for low-light-level detection in analysis and the like.

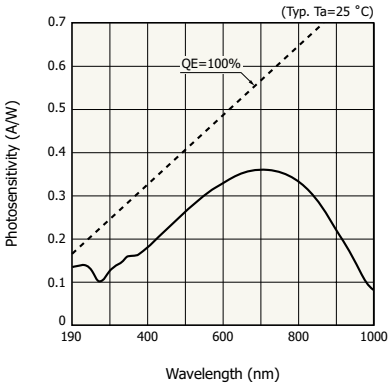
(Typ. Ta=25 °C)

Type no.	Spectral response range (nm)	Photosensitivity (A/W) λ=200 nm	Photosensitivity (A/W) λ=720 nm	Dark current VR=10 mV max. (pA)	Terminal capacitance VR=0 V f=10 kHz (pF)	Photosensitive area size (mm)	Package	Photo
S1226-18BQ*1	190 to 1000	0.12	0.36	2	35	1.1 × 1.1	TO-18	
S1226-18BK	320 to 1000	-						
S1226-5BQ*1	190 to 1000	0.12		5	160	2.4 × 2.4	TO-5	
S1226-5BK	320 to 1000	-						
S1226-44BQ*1	190 to 1000	0.12		10	500	3.6 × 3.6		
S1226-44BK	320 to 1000	-						
S1226-8BQ*1	190 to 1000	0.12		20	1200	5.8 × 5.8	TO-8	
S1226-8BK	320 to 1000	-						
S1227-16BQ*1	190 to 1000	0.12	0.36	5	170	1.1 × 5.9	Ceramic	
S1227-16BR	340 to 1000	-	0.43					
S1227-33BQ*1	190 to 1000	0.12	0.36		160	2.4 × 2.4		
S1227-33BR	340 to 1000	-	0.43					
S1227-66BQ*1	190 to 1000	0.12	0.36	20	950	5.8 × 5.8		
S1227-66BR	340 to 1000	-	0.43					
S1227-1010BQ*1	190 to 1000	0.12	0.36	50	3000	10 × 10		
S1227-1010BR	340 to 1000	-	0.43					
S2281-01*1	190 to 1000	0.12	0.36	300	3200	ϕ11.3	With BNC connector	

*1: Refer to "Precautions against UV light exposure" (P.43).

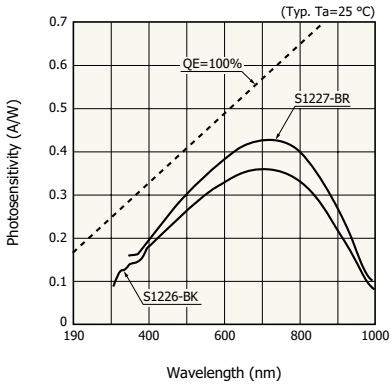
Spectral response

[S1226-BQ, S1227-BQ]



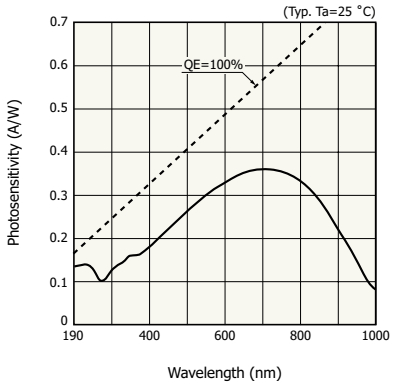
KSPDB0263EF

[S1226-BK, S1227-BR]



KSPDB0308EA

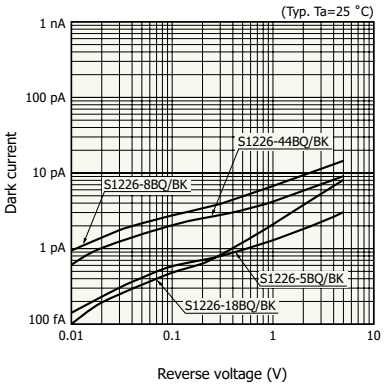
[S2281-01]



KSPDB0320EA

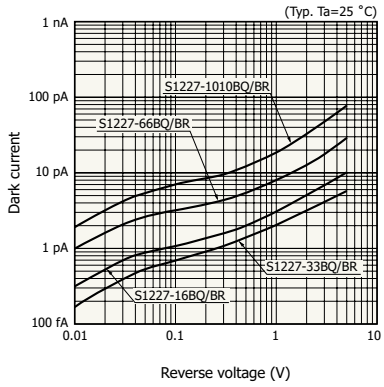
Dark current vs. reverse voltage

[S1226 series]



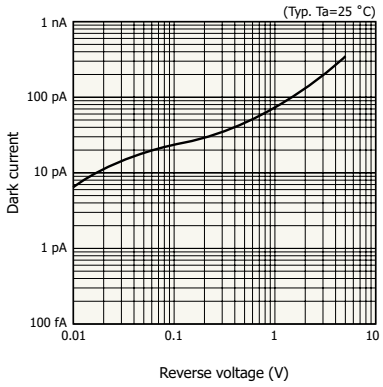
KSPDB0275EC

[S1227 series]



KSPDB0096EB

[S2281-01]



KSPDB0321EA

For UV monitor

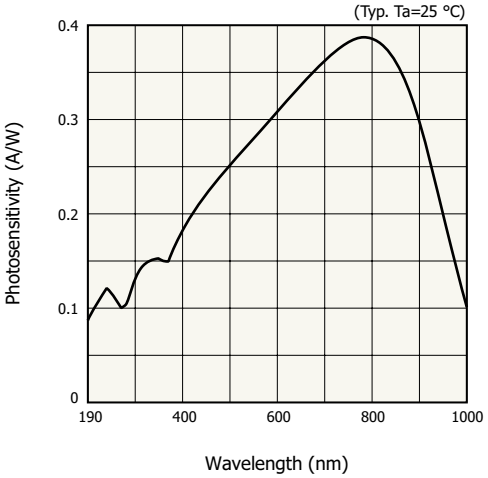
The S12698 series are Si photodiodes that have achieved high reliability for monitoring ultraviolet light by employing a structure that does not use resin. They exhibit low sensitivity deterioration under UV light irradiation and are suitable for applications such as monitoring intense UV light sources.

(Typ. Ta=25 °C)

Type no.	Photosensitivity λ=λp (A/W)	Dark current VR=10 mV max. (pA)	Photosensitive area size (mm)	Package	Photo
S12698*2	0.38	10	1.1 × 1.1	TO-18	
S12698-01*2		30	2.4 × 2.4	TO-5	
S12698-02*2		100	5.8 × 5.8	TO-8	

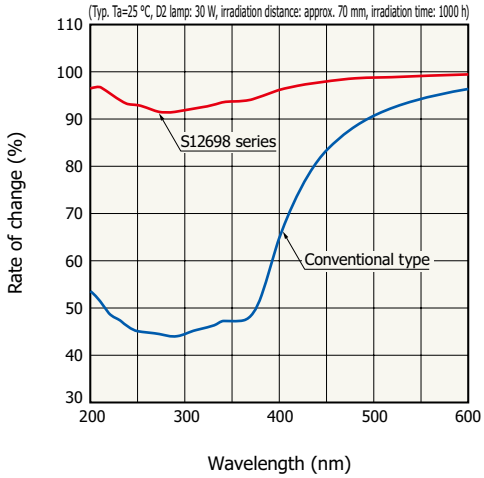
*2: Refer to "Precautions against UV light exposure ①" (P.43).

Spectral response



KSPDB0350EB

Changes in spectral response after irradiated with UV light



KSPDB0355EA

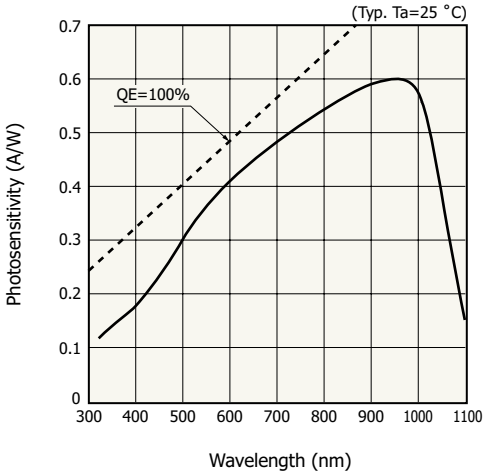
For visible range to near IR

These Si photodiodes offer enhanced sensitivity especially in the near IR range.

(Typ. Ta=25 °C)

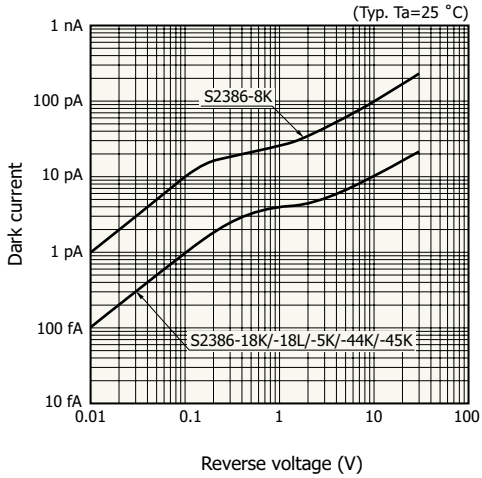
Type no.	Spectral response range (nm)	Photosensitivity λ=960 nm (A/W)	Dark current VR=10 mV max. (pA)	Terminal capacitance VR=0 V f=10 kHz (pF)	Photosensitive area size (mm)	Package	Photo
S2386-18K	320 to 1100	0.6	2	140	1.1 × 1.1	TO-18	
S2386-18L							
S2386-5K			5	730	2.4 × 2.4	TO-5	
S2386-44K			20	1600	3.6 × 3.6		
S2386-45K			30	2300	3.9 × 4.6		
S2386-8K			50	4300	5.8 × 5.8	TO-8	

Spectral response



KSPDB0272EE

Dark current vs. reverse voltage

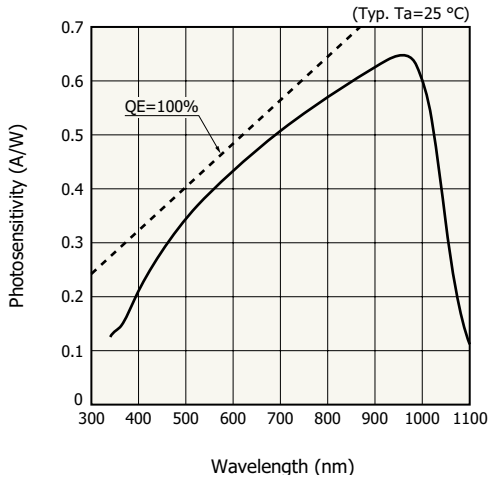


KSPDB0113EE

(Typ. Ta=25 °C)

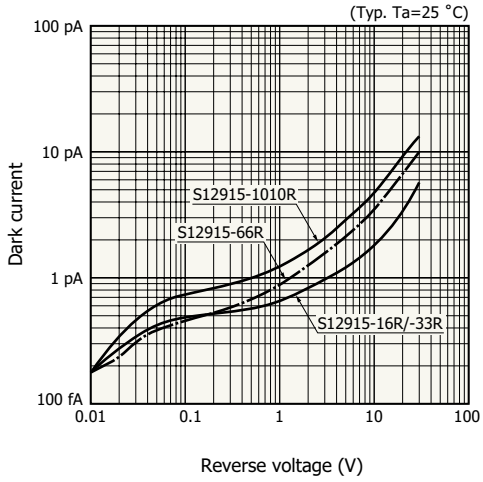
Type no.	Spectral response range (nm)	Photosensitivity λ=960 nm (A/W)	Dark current VR=10 mV max. (pA)	Terminal capacitance VR=0 V f=10 kHz (pF)	Photosensitive area size (mm)	Package	Photo
S12915-16R	340 to 1100	0.64	5	740	1.0 × 6.0	Ceramic	
S12915-33R				680	2.4 × 2.4		
S12915-66R			50	4000	5.8 × 5.8		
S12915-1010R			200	13000	10 × 10		

Spectral response



KSPDB0356EA

Dark current vs. reverse voltage



KSPDB0365EA

Si photodiodes for general photometry/visible range

For visible range

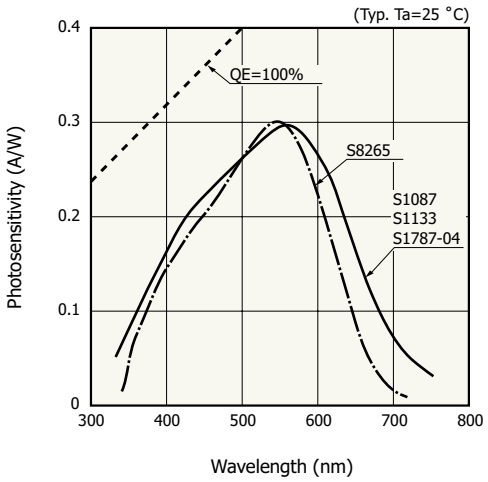
These Si photodiodes have sensitivity in the visible range.

(Typ. Ta=25 °C)

Type no.	Spectral response range (nm)	Peak sensitivity wavelength (nm)	Photosensitivity λ=λp (A/W)	Dark current VR=1 V max. (pA)	Photosensitive area size (mm)	Package	Photo
Filter type (general use)							
These are Si photodiodes with visible-compensated filters. The S8265 is a high humidity resistance type of the S1133.							
S1087	320 to 730	560	0.3	10	1.3 × 1.3	Ceramic	
S1133					2.4 × 2.8		
S8265	340 to 720	540		20	2.4 × 2.8	Ceramic	
S1787-04	320 to 730	560		10	2.4 × 2.8	Plastic	
Filter type (CIE spectral luminous efficiency approximation)							
S9219	380 to 780	550	0.24	500 (VR=10 mV)	ϕ11.3	With BNC connector	
S9219-01			0.22	50 (VR=10 mV)	3.6 × 3.6	TO-5	
S7686	480 to 660		0.38	20	2.4 × 2.8	Ceramic	

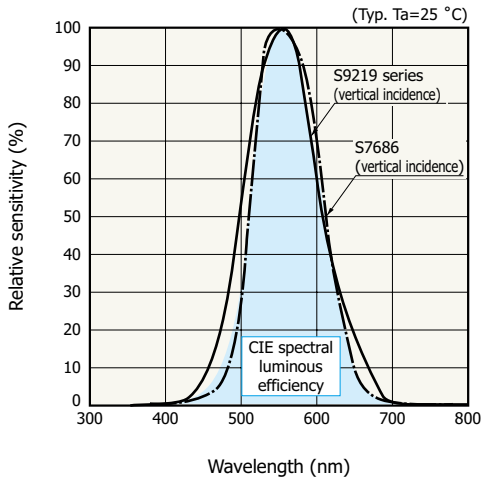
Spectral response

[S1087, S1133, S1787-04, S8265]



KSPDB0277ED

[S9219 series, S7686]



KSPDB0285EE

For visible range to near IR

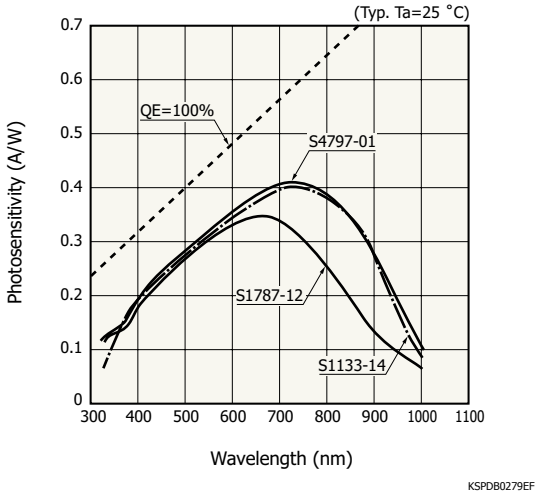
These Si photodiodes have sensitivity in the visible range to near IR.

(Typ. Ta=25 °C)

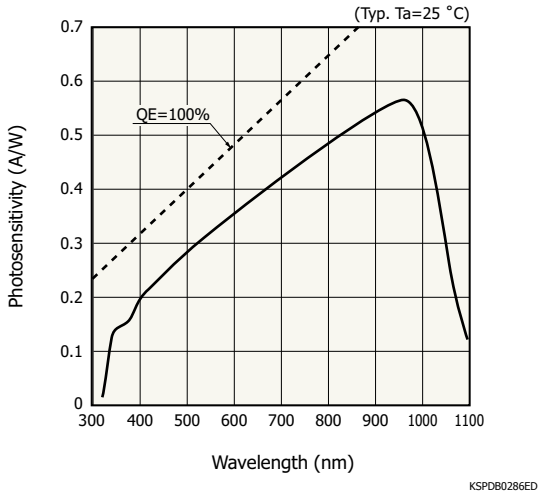
Type no.	Spectral response range (mm)	Peak sensitivity wavelength (mm)	Photosensitivity λ=λp (mm)	Dark current VR=1 V max. (pA)	Photosnsitive area size (mm)	Package	Photo
S1787-12	320 to 1000	650	0.35	20	2.4 × 2.8	Plastic	
S4797-01		720	0.4		1.3 × 1.3		
S1133-14					2.4 × 2.8	Ceramic	
S4011-06DS	320 to 1100	960	0.58	10	1.3 × 1.3	Plastic	
S1787-08					2.4 × 2.8		
S2833-01							
S1087-01					1.3 × 1.3	Ceramic	
S1133-01					2.4 × 2.8		

Spectral response

[S1787-12, S4797-01, S1133-14]



[S4011-06DS, S1787-08, S2833-01, S1087-01, S1133-01]



High-speed response Si PIN photodiodes

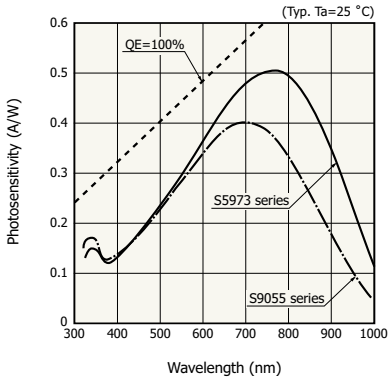
Cutoff frequency: 1 GHz or more

These Si PIN photodiodes deliver a wide bandwidth even with a low bias, making them suitable for high-speed photometry as well as optical communications.

(Typ. Ta=25 °C)

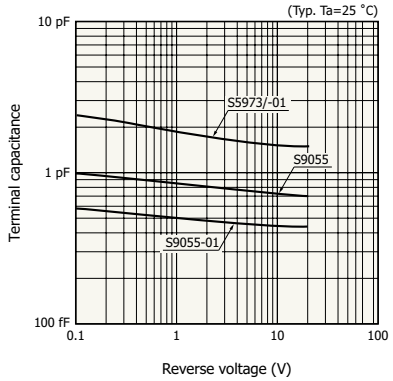
Type no.	Cutoff frequency (GHz)	Photosensitive area size (mm)	Photosensitivity (A/W) λ=780 nm	Photosensitivity (A/W) λ=830 nm	Terminal capacitance f=1 MHz (pF)	Package	Photo
S5973	1 (V_R=3.3 V)	ϕ0.4	0.51	0.47	1.6 (V_R=3.3 V)	TO-18	
S5973-01							
S9055	1.5 (V_R=2 V)	ϕ0.2	0.35	0.25	0.8 (V_R=2 V)		
S9055-01	2 (V_R=2 V)	ϕ0.1			0.5 (V_R=2 V)		

Spectral response



KPINB0326EB

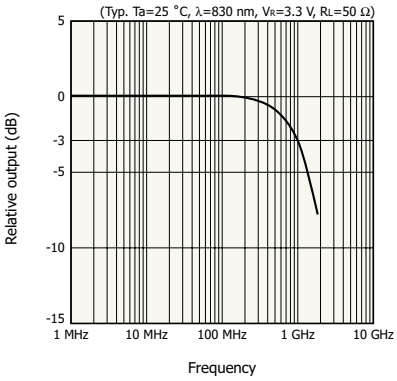
Terminal capacitance vs. reverse voltage



KPINB0332EA

Frequency response

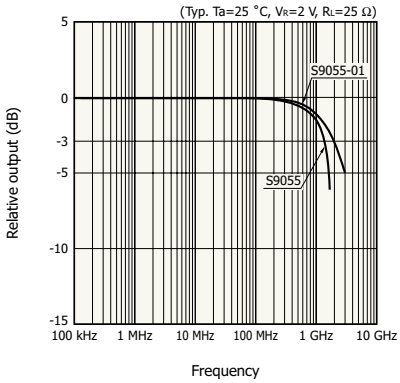
[S5973, S5973-01]



KPINB0298EA

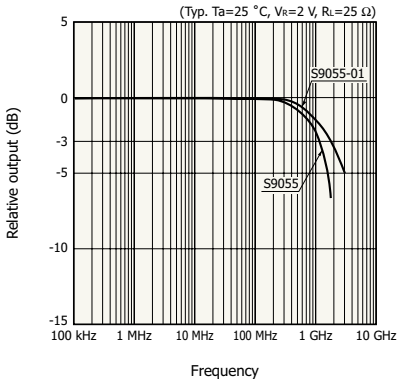
[S9055 series]

λ=410 nm



KPINB0277EB

λ=830 nm



KPINB0278EB

Cutoff frequency: 100 MHz to less than 1 GHz

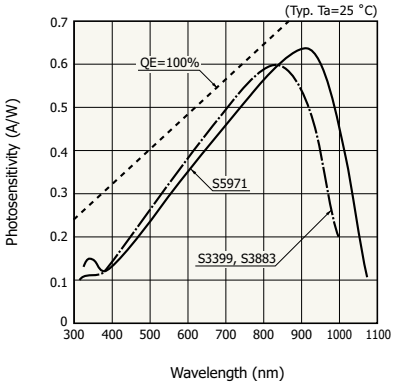
These Si PIN photodiodes have a large photosensitive area (ϕ0.8 to ϕ3 mm) yet deliver excellent frequency response characteristics.

(Typ. Ta=25 °C)

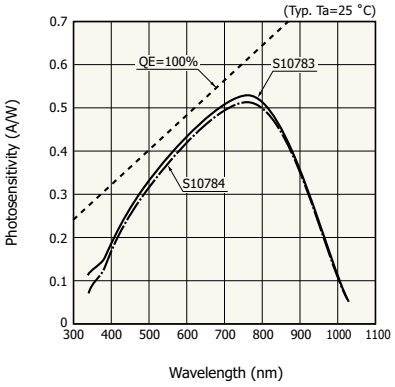
Type no.	Cutoff frequency (MHz)	Photosensitive area size (mm)	Photosensitivity (A/W) λ=660 nm	Photosensitivity (A/W) λ=780 nm	Terminal capacitance f=1 MHz (pF)	Package	Photo
S5971	100 (V_R=10 V)	ϕ1.2	0.44	0.55	3 (V_R=10 V)	TO-18	
S3399		ϕ3	0.45	0.58	20 (V_R=10 V)	TO-5	
S3883	300 (V_R=20 V)	ϕ1.5			6 (V_R=20 V)		
S10783	300 (V_R=2.5 V)	ϕ0.8	0.46	0.52	4.5 (V_R=2.5 V)	Plastic	
S10784		ϕ3	0.45	0.51		Plastic with lens	
S5972	500 (V_R=10 V)	ϕ0.8	0.44	0.55	3 (V_R=10 V)	TO-18	

Spectral response

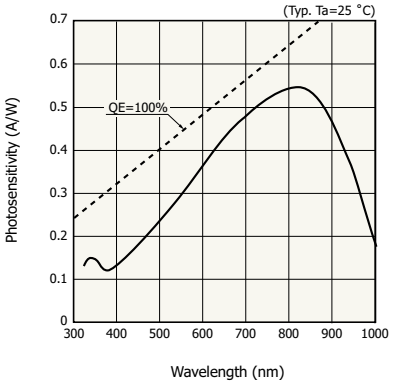
[S5971, S3399, S3883]



[S10783, S10784]

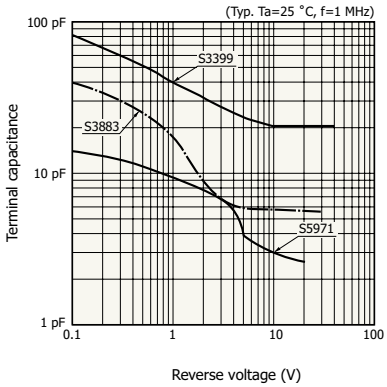


[S5972]

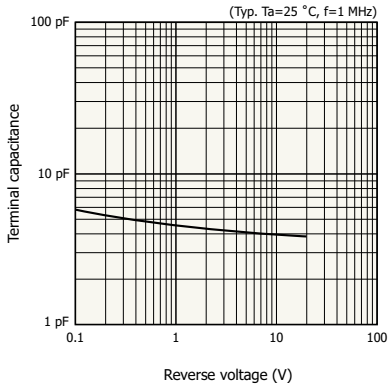


Terminal capacitance vs. reverse voltage

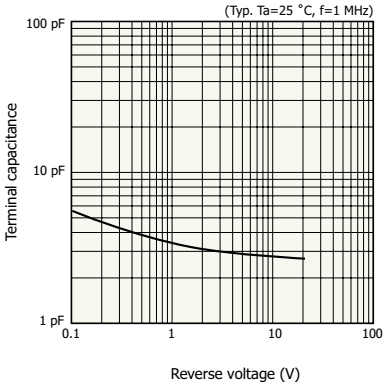
[S5971, S3399, S3883]



[S10783, S10784]



[S5972]



Cutoff frequency: 10 MHz to less than 100 MHz

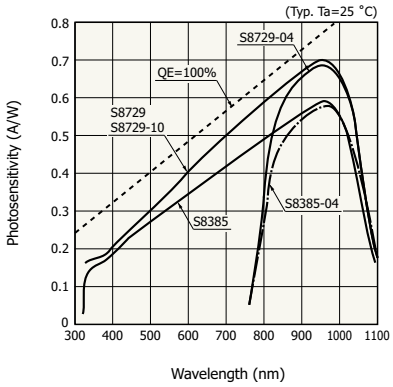
A wide variety of types are provided including a low-cost plastic package type and visible-cut type.

(Typ. Ta=25 °C)

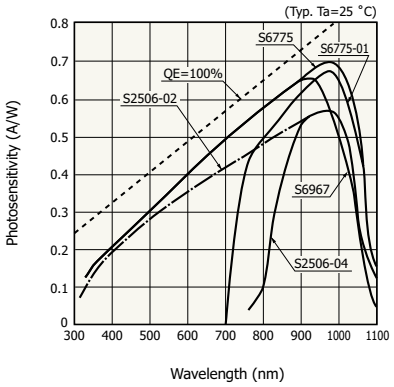
Type no.	Cutoff frequency (MHz)	Photosensitive area size (mm)	Photosensitivity (A/W) λ=660 nm	Photosensitivity (A/W) λ=780 nm	Terminal capacitance f=1 MHz (pF)	Package	Photo
S6775	15 (VR=10 V)	5.5 × 4.8	0.45	0.55	40 (VR=10 V)	Plastic	
S6967	50 (VR=10 V)				50 (VR=10 V)		
S6775-01	15 (VR=10 V)		0.54 (λ=830 nm)	0.68 (λ=λp)	40 (VR=10 V)		
S8385	25 (VR=5 V)	2 × 2	0.4	0.48	12 (VR=5 V)		
S8385-04			0.44 (λ=830 nm)	0.56 (λ=λp)			
S8729		2 × 3.3	0.45	0.55	16 (VR=5 V)		
S8729-04			0.52 (λ=830 nm)	0.68 (λ=λp)			
S8729-10			0.45	0.55			
S2506-02	25 (VR=12 V)	2.77 × 2.77	0.4	0.48	15 (VR=12 V)		
S2506-04			0.25 (λ=830 nm)	0.56 (λ=λp)			
S4707-01	20 (VR=10 V)	2.4 × 2.8	0.4	0.48	14 (VR=10 V)		
S6801-01	15 (VR=10 V)	ϕ14 (lens diameter)	0.52 (λ=830 nm)	0.65 (λ=λp)	50 (VR=10 V)	Plastic with ϕ14 mm lens	

Spectral response

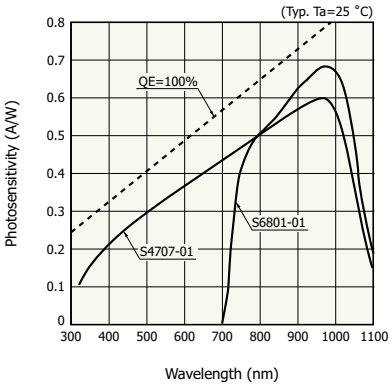
[S8385/S8729 series]



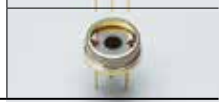
[S6775/S6967/S2506 series]



[S4707-01, S6801-01]



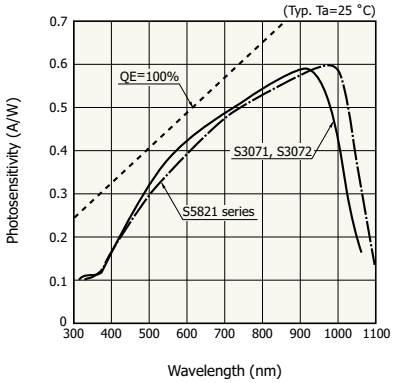
(Typ. Ta=25 °C)

Type no.	Cutoff frequency (MHz)	Photosensitive area size (mm)	Photosensitivity (A/W) λ=660 nm	Photosensitivity (A/W) λ=780 nm	Terminal capacitance f=1 MHz (pF)	Package	Photo
S5821	25 (VR=10 V)	ϕ1.2	0.45	0.52	3 (VR=10 V)	TO-18	
S5821-02							
S5821-01		ϕ4.65 (lens diameter)					
S5821-03							
S1223	30 (VR=20 V)	2.4 × 2.8	0.45	0.52	10 (VR=20 V)	TO-5	
S1223-01	20 (VR=20 V)	3.6 × 3.6			20 (VR=20 V)		
S3072	45 (VR=24 V)	ϕ3	0.47	0.54	7 (VR=24 V)		
S3071	40 (VR=24 V)	ϕ5			18 (VR=24 V)	TO-8	
S12271*	60 (VR=100 V)	ϕ4.1	0.5 (λ=960 nm)		10 (VR=100 V)		

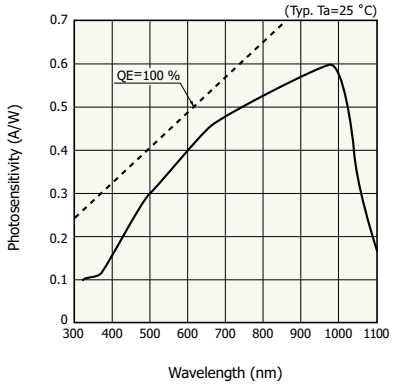
* Refer to "Precautions against UV light exposure" (P.43).

Spectral response

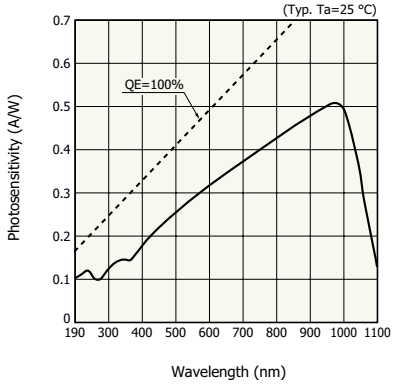
[S5821 series, S3071, S3072]



[S1223 series]

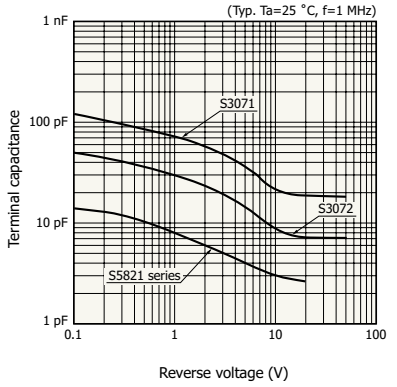


[S12271]

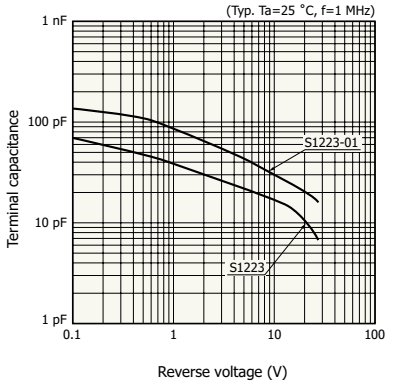


Terminal capacitance vs. reverse voltage

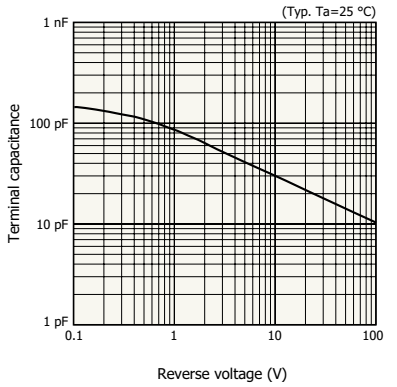
[S5821 series, S3071, S3072]



[S1223 series]



[S12271]

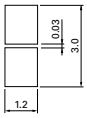
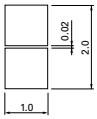
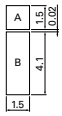
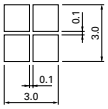


Multi-element type Si photodiodes

Segmented type Si PIN photodiodes

These Si PIN photodiode arrays consist of 2 or 4 elements having sensitivity in the UV to near IR range.

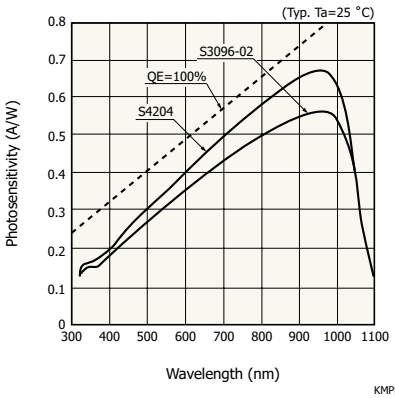
(Typ. Ta=25 °C)

Type no.	Number of elements	Photosensitive area size (mm)		Photosensitivity (A/W)	Cutoff frequency VR=10 V RL=50 Ω (MHz)	Dark current VR=10 V max. (nA)	Terminal capacitance VR=10 V f=1 MHz (pF)		Package	Photo
S3096-02	2	1.2 × 3 /2-segment		0.39 (λ=650 nm)	25	0.5*1	5		Plastic	
S4204		1 × 2 /2-segment		0.45 (λ=650 nm)	30	1*1	3			
S9345		1.5 × 1.5 + 1.5 × 4.1		0.45 (λ=650 nm)	15	5*1	4 (Photodiode A)	10 (Photodiode B)		
S4349*2	4	3 × 3 /4-segment		0.45 (λ=720 nm)	20 (VR=5 V)	0.2 (VR=5 V)	25 (VR=5 V)		TO-5	

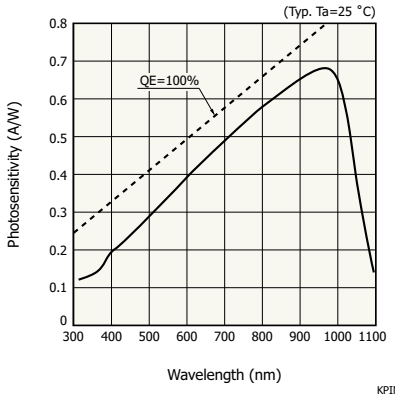
*1: Total number of elements
*2: Refer to "Precautions against UV light exposure" (P.43).

Spectral response

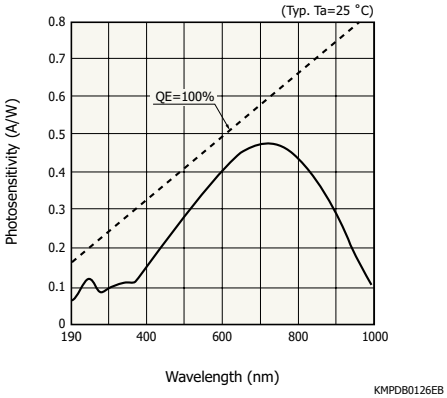
[S3096-02, S4204]



[S9345]

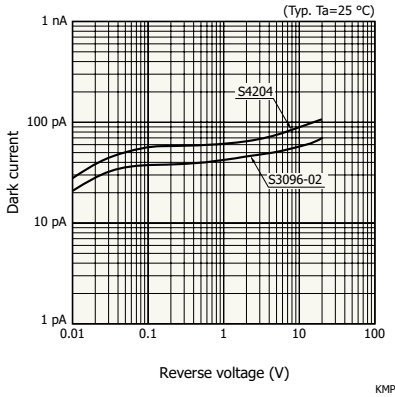


[S4349]

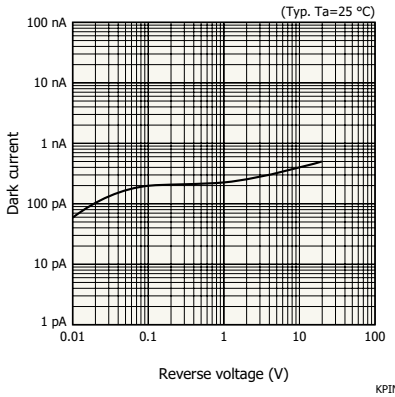


Dark current vs. reverse voltage

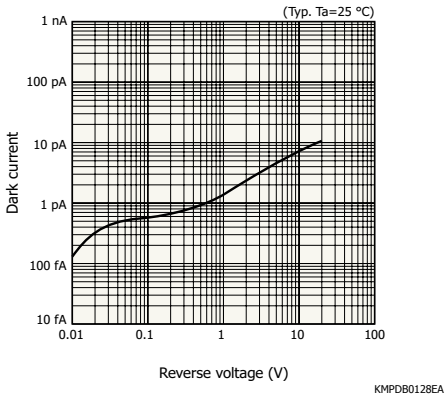
[S3096-02, S4204]



[S9345]



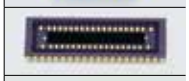
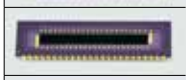
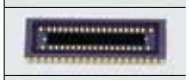
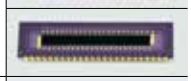
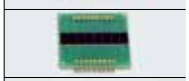
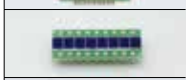
[S4349]



One-dimensional photodiode arrays (UV to near IR: UV sensitivity enhanced type)

These are Si photodiode linear arrays having rectangular elements equally spaced at a pitch of about 1 mm.

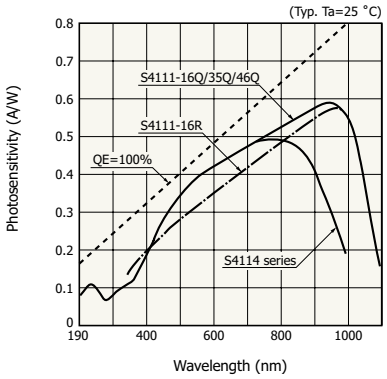
(Typ. Ta=25 °C)

Type no.	Number of elements	Element pitch (mm)	Element size W × H (mm)	Spectral response range (nm)	Photosensitivity λ=960 nm (A/W)	Dark current VR=10 mV max. (pA)	Terminal capacitance VR=0 V f=10 kHz (pF)	Package	Photo
S4111-16Q*2	16	1.0	0.9 × 1.45	190 to 1100	0.58	5	200	Ceramic	
S4111-16R				340 to 1100					
S4111-35Q*2	35		0.9 × 4.4	190 to 1100		10	550		
S4111-46Q*2	46								
S4114-35Q*2	35			190 to 1000	0.50 (λ=800 nm)	60	35		
S4114-46Q*2	46								
S12858-021	16	1.17	0.77 × 2.5	340 to 1100	0.61 (λ=920 nm)	30	30	Glass epoxy (unsealed)	
S12859-021									
S11299-021		1.575	1.175 × 2.0			30	40		
S11212-021									
S12362-021		2.5	2.2 × 2.7			50	75		
S12363-021									

*2: Refer to "Precautions against UV light exposure" (P.43).

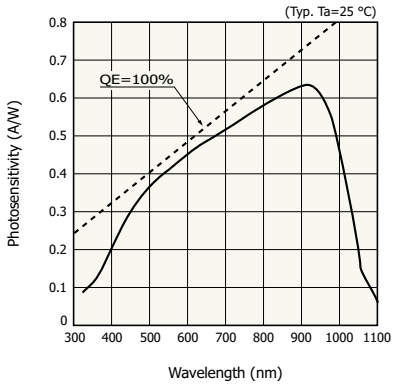
Spectral response

[S4111/S4114 series]



KMPDB0112EC

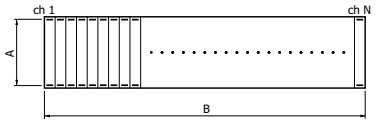
[S12858/S12859/S12362/S12363/S11212/S11299-021]



KMPDB0357EB

Structure of photosensitive area (unit: mm)

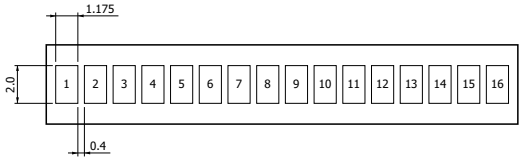
[S4111/S4114 series]



Type no.	A	B	N
S4111-16R/-16Q	1.45	15.9	16
S4111/S4114-35Q	4.4	34.9	35
S4111/S4114-46Q	4.4	45.9	46

KMPDA0227EC

[S11212/S11299-021]



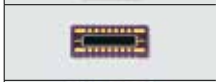
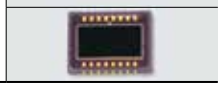
KMPDA0228EC

Surface mount type Si photodiodes

High-speed response Si PIN photodiodes

These are photodiodes sealed in a chip carrier package suitable for surface mounting and allowed solder reflow mounting on PC boards for automated processes.

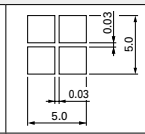
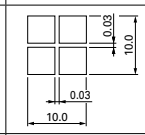
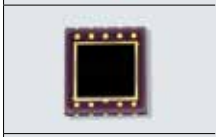
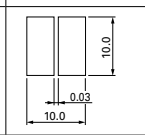
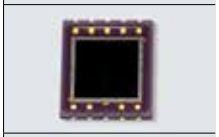
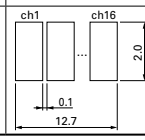
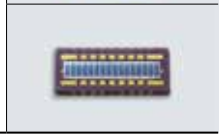
(Typ. Ta=25 °C)

Type no.	Cutoff frequency VR=10 V (MHz)	Photosensitive area size (mm)	Spectral response range (nm)	Photosensitivity λ=960 nm (A/W)	Terminal capacitance VR=10 V f=1 MHz (pF)	Package	Photo
S5106	20	5 × 5	320 to 1100	0.72	40	Ceramic	
S5107	10	10 × 10			150		
S7509	20	2 × 10			40		
S7510	15	6 × 11			80		

Segmented type Si photodiodes

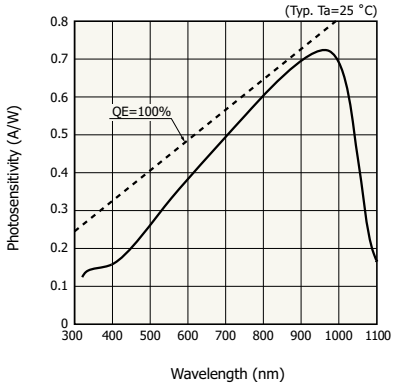
These Si photodiodes consist of 2, 4 or 16 elements and are integrated into a chip carrier package.

(Typ. Ta=25 °C)

Type no.	Number of elements	Photosensitive area size (mm)		Spectral response range (nm)	Photosensitivity λ=960 nm (A/W)	Cutoff frequency VR=10 V (MHz)	Terminal capacitance VR=10 V f=1 MHz (pF)	Package	Photo
S5980	4	5 × 5 /4-segment		320 to 1100	0.72	25	10	Ceramic	
S5981		10 × 10 /4-segment				20	35		
S5870	2	10 × 10 /2-segment				10	50		
S8558	16	2 × 12.7 /16-segment				25	5		

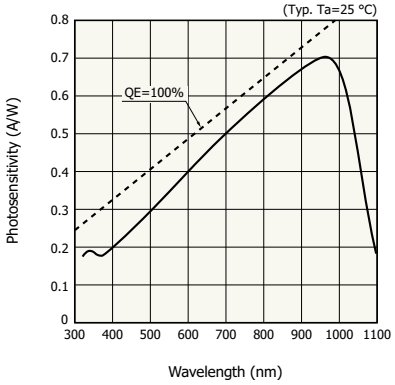
Spectral response

[S5106, S5107, S7509, S7510, S5980, S5981, S5870]



KPINB0165EB

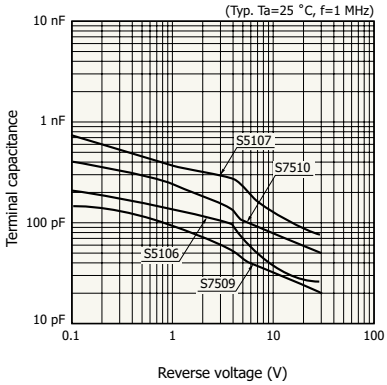
[S8558]



KMPDB0193EB

Terminal capacitance vs. reverse voltage

[S5106, S5107, S7509, S7510]



KPINB0128EA

Small package type Si photodiodes

These surface mount type Si photodiodes are mounted on small packages. They are tape packaged and allows solder reflow mounting.

(Typ. Ta=25 °C)

Type no.	Photosensitive area size (nm)	Spectral response range (nm)	Photosensitivity λ=960 nm (nm)	Terminal capacitance VR=0 V f=10 kHz (pF)	Package	Photo
S9674	2 × 2	320 to 1100	0.7	500	Glass epoxy	
S10625-01CT	1.3 × 1.3		0.54 (λ=940 nm)	200		

Small package type Si PIN photodiodes

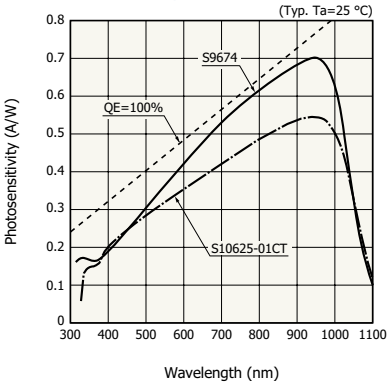
These surface mount type Si PIN photodiodes are mounted on small packages. They are tape packaged and allows solder reflow mounting.

(Typ. Ta=25 °C)

Type no.	Photosensitive area size (mm)	Spectral response range (nm)	Photosensitivity λ=960 nm (A/W)	Terminal capacitance f=1 MHz (pF)	Package	Photo
S13773	ϕ0.8	380 to 1000	0.54 (λ=800 nm)	3 (VR=10 V f=10 kHz)	Glass epoxy	
S10993-02CT	1.06 × 1.06	380 to 1100	0.6	6 (VR=2.5 V)		
S12158-01CT	2.77 × 2.77	320 to 1100	0.7	15 (VR=12 V)		

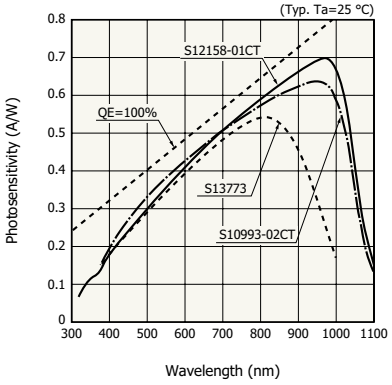
Spectral response

[S9674, S10625-01CT]



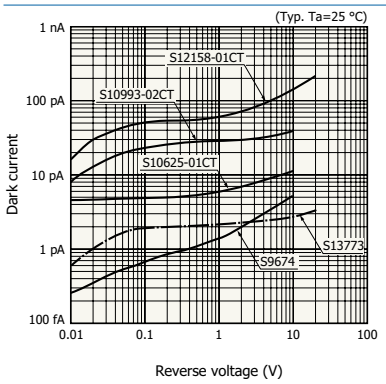
KSPDB0315EB

[S13773, S10993-02CT, S12158-01CT]



KSPDB0318EC

Dark current vs. reverse voltage



KSPDB0316EE

Si photodiodes with preamp, TE-cooled type Si photodiodes

Si photodiodes with preamp for measurement

These are low noise photosensors incorporating a large area Si photodiode, op amp and feedback capacitance.

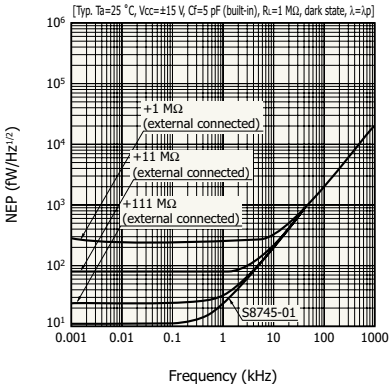
(Typ. Ta=25 °C)

Type no.	Cooling temperature ΔT (°C)	Photosensitive area size (mm)	Spectral response range (nm)	Photosensitivity (V/nW) λ=200 nm	Photosensitivity (V/nW) λ=960 nm	NEP λ=λp, f=10 Hz (fW/Hz$^{1/2}$)	Built-in feedback resistance (GΩ)	Package	Photo
S8745-01*	Non-cooled	2.4 × 2.4	190 to 1100	0.12	0.52	11	1	Metal	
S8746-01*		5.8 × 5.8				15			
S9295*	50	10 × 10		0.9	5.1	4	10		
S9295-01*	30					5			
S9269	Non-cooled	5.8 × 5.8	340 to 1100	-	0.62	12	1	Ceramic	
S9270		10 × 10				16			

* Refer to "Precautions against UV light exposure" (P.43).

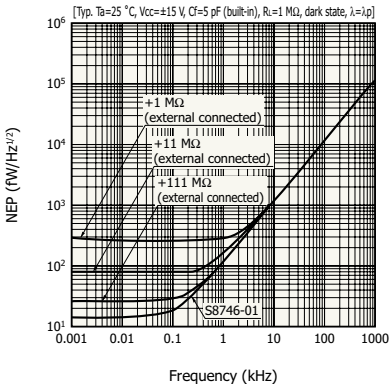
NEP (noise equivalent power) vs. frequency

[S8745-01]



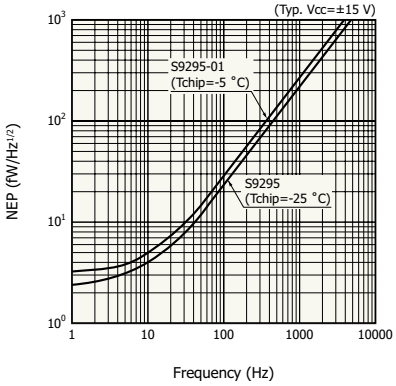
KSPDB0237EA

[S8746-01]



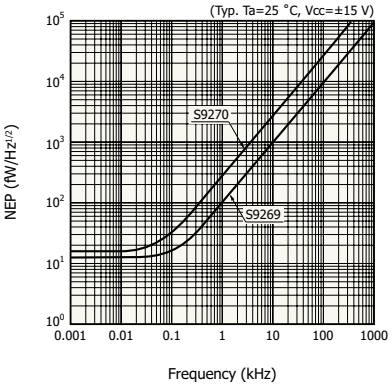
KSPDB0238EA

[S9295 series]



KSPDB0230EC

[S9269, S9270]



KSPDB0241EA

TE-cooled type Si photodiodes

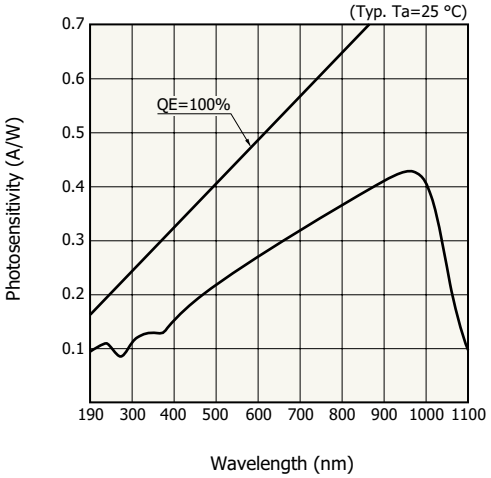
These photosensors combine a UV to near infrared Si photodiode with a TE-cooler and deliver low dark current.

(Typ. Ta=25 °C)

Type no.	Cooling temperature ΔT (°C)	Photosensitive area size (mm)	Spectral response range (nm)	Peak sensitivity wavelength (nm)	Dark current VR=10 mV (pA)	NEP (W/Hz$^{1/2}$)	Package	Photo
S2592-03*	35	2.4 × 2.4	190 to 1100	960	10	8.1×10^{-15}	TO-8	
S2592-04*		5.8 × 5.8			25	1.3×10^{-14}		
S3477-03*		2.4 × 2.4			10	8.1×10^{-15}	TO-66	
S3477-04*		5.8 × 5.8			25	1.3×10^{-14}		

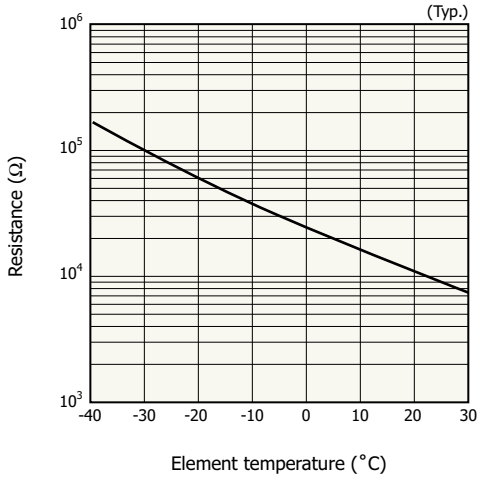
* Refer to "Precautions against UV light exposure" (P.43).

Spectral response



KSPDB0182EC

Thermistor temperature characteristics



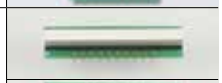
KIRDB0116EA

Si photodiodes for X-ray detection

Si photodiodes with scintillator

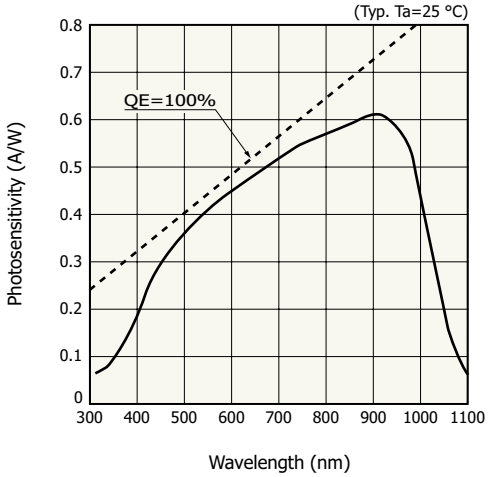
These detectors are comprised of a Si photodiode coupled to a scintillator. Ceramic scintillators have sensitivity to X-rays about 1.2 times higher than CWO and offer high reliability. CsI scintillators also have high sensitivity and are low-cost.
The S11212 and S11299 series photodiode arrays have a back-illuminated structure. They realize superb spectral response and sensitivity uniformity compared to our previous products.

(Typ. Ta=25 °C)

Type no.	Scintillator	Number of elements	Element pitch (mm)	Element size W × H (mm)	Dark current max. V_R=10 mV (pA)	X-ray sensitivity* (nA)	Package	Photo
S8559	CsI(Tl)	1	-	5.8 × 5.8	50	52	Ceramic	
S8193	GOS ceramic					30		
S12858-122	CsI(Tl)	16	1.17	0.77 × 2.5	30	5.0	Glass epoxy	
S12859-122								
S12858-324	GOS ceramic					2.5		
S12859-324								
S12858-422	Phosphor sheet					2.2		
S12859-422								
S11299-121	CsI(Tl)	16	1.575	1.175 × 2.0	30	6.0	Glass epoxy	
S11212-121								
S11299-321	GOS ceramic					3.5		
S11212-321								
S11299-422	Phosphor sheet					3.0		
S11212-422								
S12362-121	CsI(Tl)	16	2.5	2.2 × 2.7	50	12.5	Glass epoxy	
S12363-121								
S12362-321	GOS ceramic					7.2		
S12363-321								
S12362-421	Phosphor sheet					6.0		
S12363-421								

* These are for reference (X-ray tube voltage: 120 kV, tube current: 1.0 mA, aluminum filter t=6 mm, distance: 830 mm), X-ray sensitivity depends on the X-ray equipment operating and setup conditions.

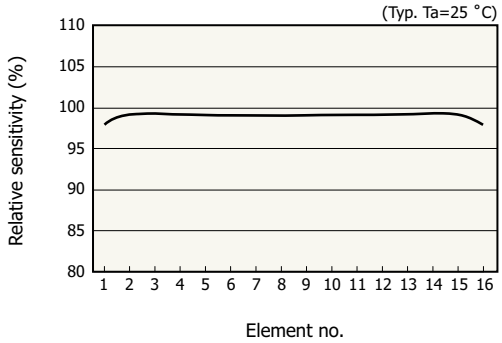
Spectral response (S12858/S12859/S11212/S11299/S12362/S12363 series)



* The characteristics exclude the scintillator but include the transmittance and reflectance of the adhesive resin used to bond a scintillator.

KMPDB0360ED

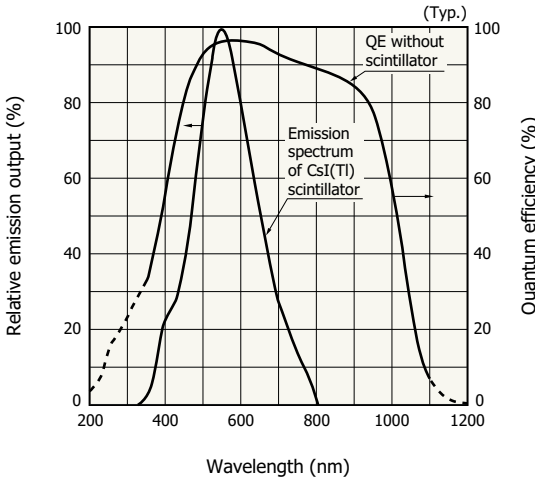
Uniformity (S11212/S11299 series)



KMPDB0361EC

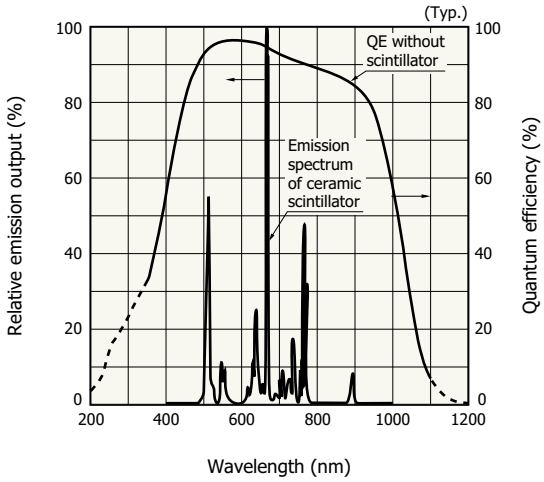
Emission spectrum of scintillator and spectral response

[S11212/S11299-121 [CsI(Tl)]]



KSPDB0282EE

[S11212/S11299-321 (GOS ceramic)]



KSPDB0281EE

Typical scintillator characteristics

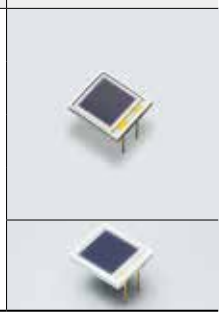
Parameter	Condition	CsI(Tl)	GOS ceramic	Unit
Peak emission wavelength		560	512	nm
X-ray absorption coefficient	100 keV	10	7	cm^{-1}
Refractive index	λ=λp	1.7	2.2	-
Decay constant		1	3	μs
Afterglow	100 ms after X-ray turn off	0.3	0.01	%
Density		4.51	7.34	g/cm^3
Color		Transparent	Light yellow-green	-
Sensitivity nonuniformity		±10	±5	%

Large area Si PIN photodiodes

These Si PIN photodiodes, mounted on a white ceramic base, are specifically developed for applications in high energy physics and are mainly used being coupled to a scintillator. Because of high resistance to high voltages, these Si PIN photodiodes operate at high reverse voltages allowing a high-speed response despite the large photosensitive areas.

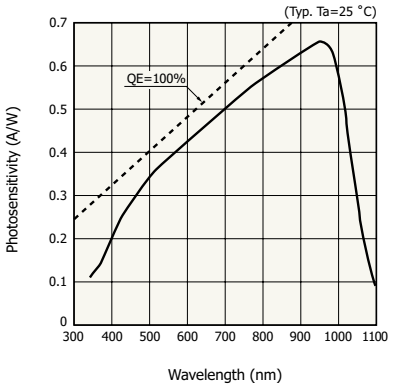
The S3590-18/-19 are violet sensitivity enhanced type and the S3590-19 is an unsealed type. To improve photodiode-to-scintillator coupling efficiency, we also offer the S8650 with epoxy resin coating window processed to have a flat surface.

(Typ. Ta=25 °C)

Type no.	Window	Photosensitive area size (mm)	Depletion layer thickness VR=70 V (mm)	Spectral response range (nm)	Photosensitivity λ=960 nm (A/W)	Dark current max. VR=70 V (nA)	Terminal capacitance VR=70 V f=1 MHz (pF)	Package	Photo
S3590-08	Epoxy resin	10 × 10	0.3	340 to 1100	0.66	6	40	Ceramic	
S3590-09	Unsealed								
S3590-18	Epoxy resin				0.65	10			
S3590-19	Unsealed				0.58				
S8650	Epoxy resin				0.66	6			

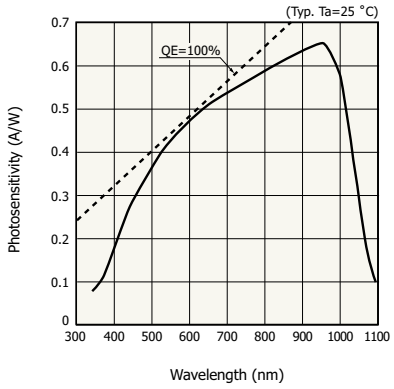
Spectral response

[S3590-08, S8650]



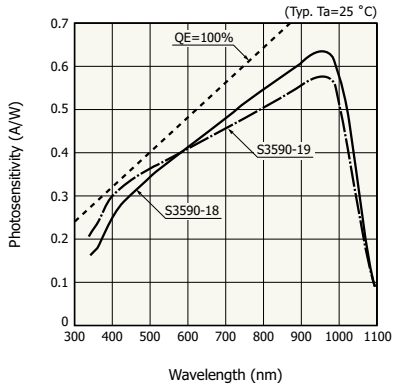
KPINB0347ED

[S3590-09]



KPINB0263EB

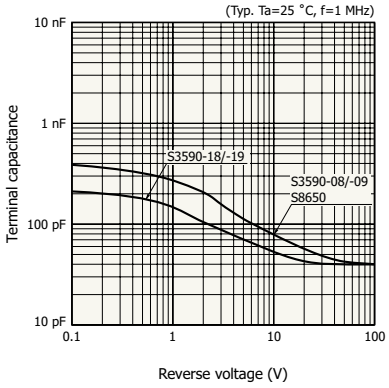
[S3590-18/-19]



KPINB0322EC

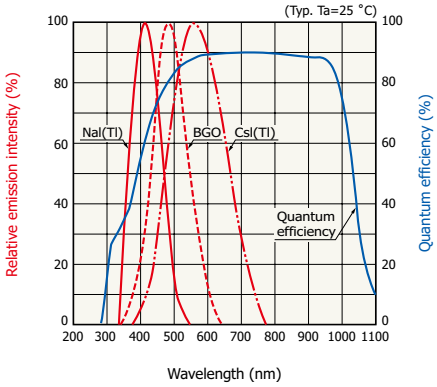
Terminal capacitance vs. reverse voltage

[S3590 series, S8650]



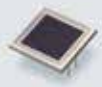
KPINB0331EC

Emission spectrum of scintillators and spectral response (S3590-08)



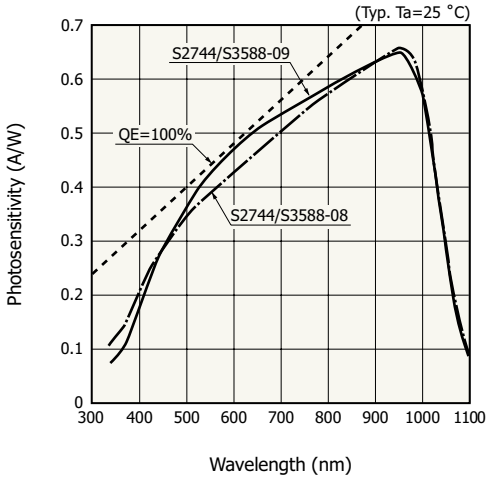
KPINB0017EE

(Typ. Ta=25 °C)

Type no.	Window	Photosensitive area size (mm)	Depletion layer thickness VR=70 V (mm)	Spectral response range (nm)	Photosensitivity λ=960 nm (A/W)	Dark current max. VR=70 V (nA)	Terminal capacitance VR=70 V f=1 MHz (pF)	Package	Photo
S2744-08	Epoxy resin	10 × 20	0.3	340 to 1100	0.66	10	85	Ceramic	
S2744-09	Unsealed								
S3204-08	Epoxy resin	18 × 18				20	130		
S3204-09	Unsealed								
S3584-08	Epoxy resin	28 × 28				30	300		
S3584-09	Unsealed								
S3588-08	Epoxy resin	3 × 30				10	40		
S3588-09	Unsealed								

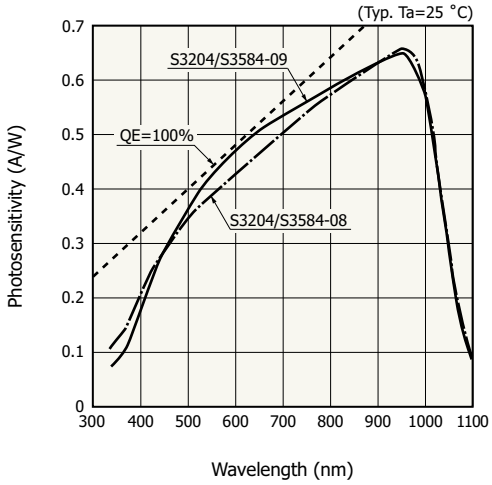
Spectral response

[S2744/S3588 series]



KPINB0265EE

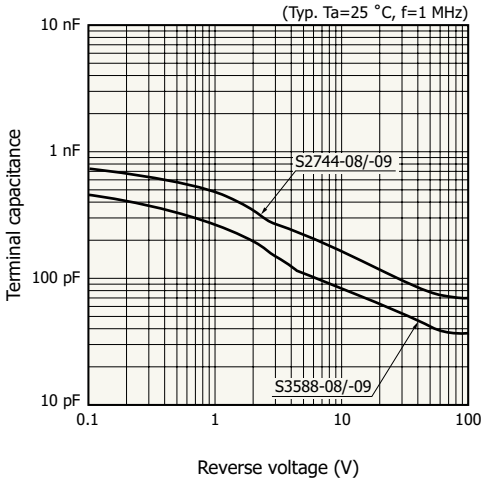
[S3204/S3584 series]



KPINB0277EC

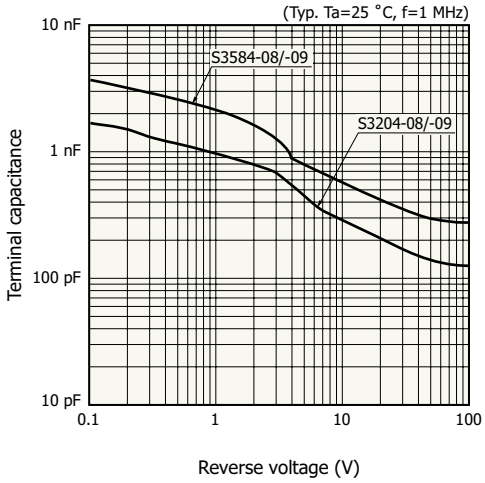
Terminal capacitance vs. reverse voltage

[S2744/S3588 series]



KPINB0222EA

[S3204/S3584 series]



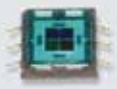
KPINB0230EC

Special application Si photodiodes

RGB color sensors

These photosensors are color sensors using a 3-element photodiode with color sensitivity, assembled in one package.

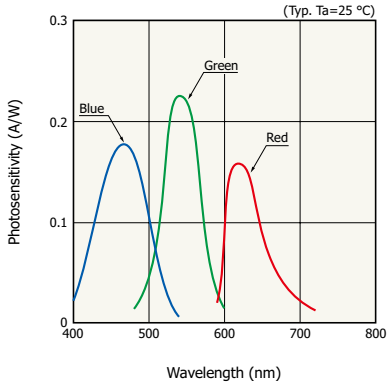
(Typ. Ta=25 °C)

Type no.	Spectral response range (nm)		Peak sensitivity wavelength (nm)	Photosensitivity λ=λp (A/W)		Dark current VR=1 V Total number of elements max. (pA)	Photosensitive area size (mm)		Package	Photo
S7505-01	Blue	400 to 540	460	Blue	0.18	200	Blue	1.5 × 1.5 (× 2)	Surface mount type plastic	
	Green	480 to 600	540	Green	0.23		Green	1.5 × 1.5		
	Red	590 to 720	620	Red	0.16		Red	1.5 × 1.5		
S9032-02*1	Blue	400 to 540	460	Blue	0.18	100	ϕ2 / 3-segment		Surface mount type plastic	
	Green	480 to 600	540	Green	0.23					
	Red	590 to 720	620	Red	0.16					
S9702*1	Blue	400 to 540	460	Blue	0.18	50	1 × 1 / 3-segment		Surface mount type, small plastic	
	Green	480 to 600	540	Green	0.23					
	Red	590 to 720	620	Red	0.16					
S10917-35GT	Blue	390 to 530	460	Blue	0.2	50	1 × 1 / 3-segment		Surface mount type, small, glass epoxy	
	Green	470 to 600	540	Green	0.23					
	Red	590 to 680	620	Red	0.17					
S10942-01CT	See the spectral response.			Blue	0.21*2	50	1 × 1 / 3-segment		Surface mount type, small glass epoxy	
				Green	0.25*2					
				Red	0.45*2					

*1: If excessive vibration is continuously applied to the glass filter, there is a risk that the filter may come off, so secure the glass filter with a holder.
*2: Blue: λ=460 nm, Green: λ=540 nm, Red: λ=640 nm

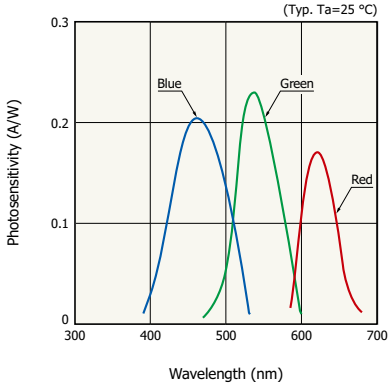
Spectral response

[S7505-01, S9032-02, S9702]



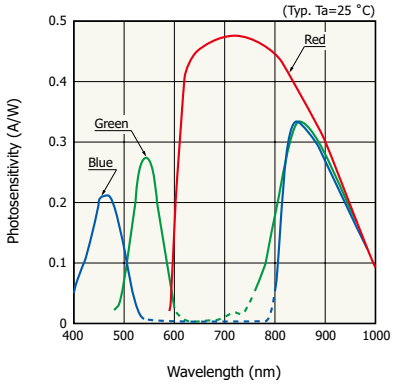
KMPDB0217EC

[S10917-35GT]



KSPDB0295EC

[S10942-01CT]



KSPDB0287EB

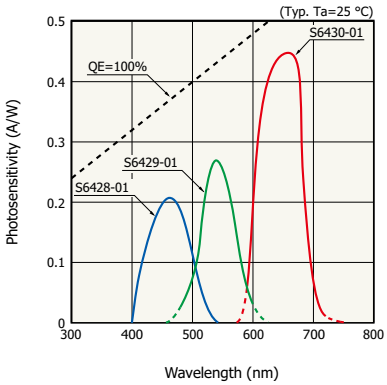
This sensor also has sensitivity in the infrared region, so cut off infrared light as needed.

The S6428-01, S6429-01 and S6430-01 are monochromatic color sensors sensitive to blue, green and red light, respectively.

(Typ. Ta=25 °C)

Type no.	Spectral response range (nm)	Peak sensitivity wavelength (nm)	Photosensitivity λ=λp (A/W)	Dark current V_R=1 V max. (pA)	Photosensitive area size (mm)	Package	Photo
S6428-01	400 to 540	460	0.22	20	2.4 × 2.8	Plastic	
S6429-01	480 to 600	540	0.27				
S6430-01	590 to 720	660	0.45				

Spectral response

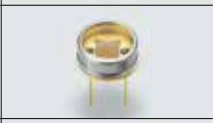


KSPDB0280EC

Violet/blue sensitivity enhanced type

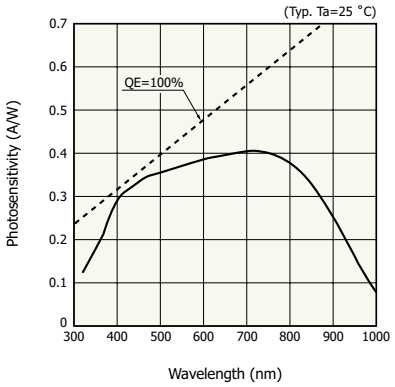
These are photodiodes for violet/blue laser diode detection.

(Typ. Ta=25 °C)

Type no.	Cutoff frequency (MHz)	Photosensitive area size (mm)	Peak sensitivity wavelength (nm)	Photo-sensitivity (A/W)	Dark current max. (nA)	Terminal capacitance f=1 MHz (pF)	Package	Photo
S5973-02	1 GHz (V_R=3.3 V)	ϕ0.4	760	0.3 (λ=410 nm)	0.1 (V_R=3.3 V)	1.6 (V_R=3.3 V)	TO-18	
S9195	50 (V_R=10 V)	5 × 5	840	0.28 (λ=405 nm)	5 (V_R=10 V)	60 (V_R=10 V)	TO-8	
S3994-01	20 (V_R=30 V)	10 × 10	960	0.25 (λ=400 nm)	10 (V_R=30 V)	40 (V_R=30 V)	Ceramic	

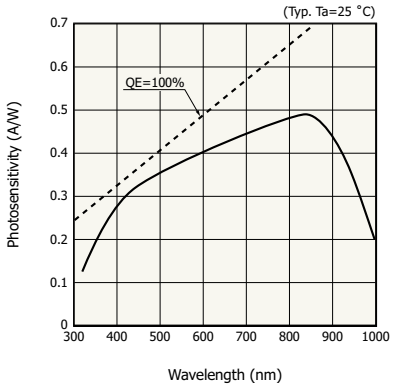
Spectral response

[S5973-02]



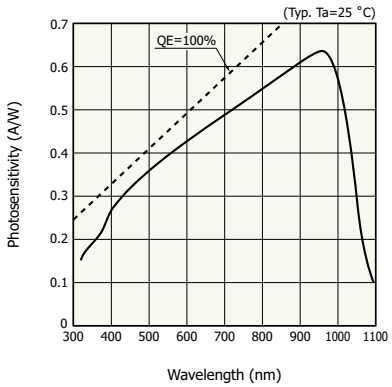
KPINB0337EC

[S9195]



KPINB0289EB

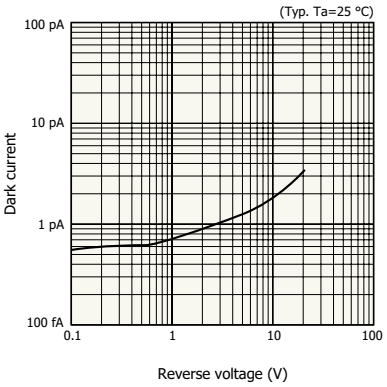
[S3994-01]



KPINB0198EB

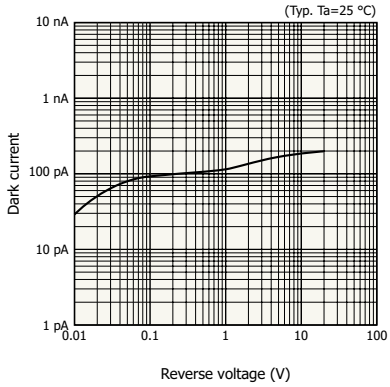
Dark current vs. reverse voltage

[S5973-02]



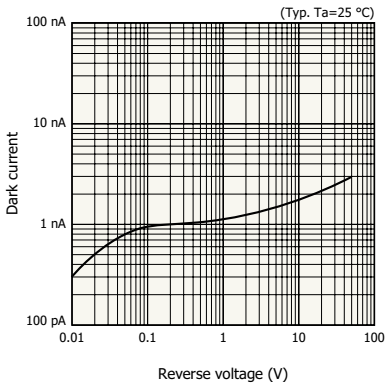
KPINB0400EA

[S9195]



KPINB0291EA

[S3994-01]

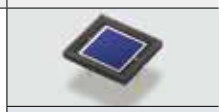
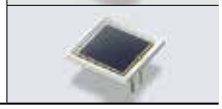


KPINB0199EA

For VUV (vacuum ultraviolet) monitor

These Si photodiodes are specially optimized for excimer laser monitor (ArF: 193 nm, KrF: 248 nm): sensitive in the vacuum UV (VUV) range.

(Typ. Ta=25 °C)

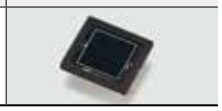
Type no.	Photosensitivity λ=193 nm (A/W)	Dark current VR=10 mV max. (nA)	Photosensitive area size (mm)	Package	Photo
S8552*	0.06	1.0	10 × 10	Ceramic (unsealed)	
S8553*		5.0	18 × 18		

* Refer to "Precautions against UV light exposure ①" (P.43).

For VUV detection (high reliability type)

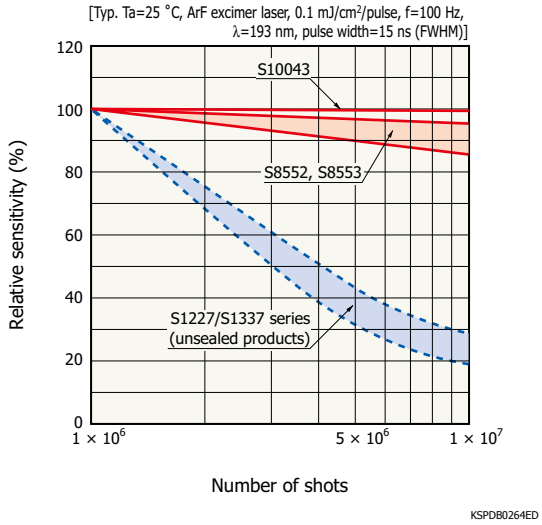
The S10043 is greatly improved in sensitivity stability even after exposure to ArF (λ=193 nm) excimer laser.

(Typ. Ta=25 °C)

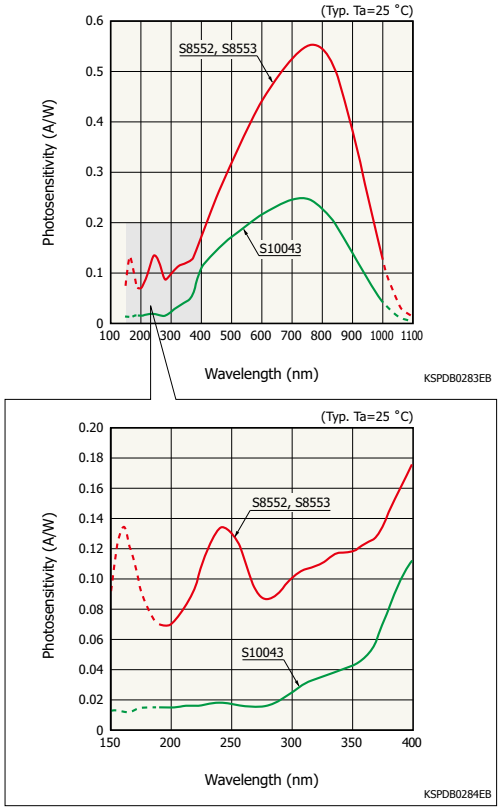
Type no.	Photosensitivity λ=193 nm (A/W)	Dark current VR=10 mV max. (nA)	Photosensitive area size (mm)	Package	Photo
S10043*	0.015	1.0	10 × 10	Ceramic (unsealed)	

* Refer to "Precautions against UV light exposure ①" (P.43).

Variation in sensitivity due to UV exposure



Spectral response



For monochromatic light detection

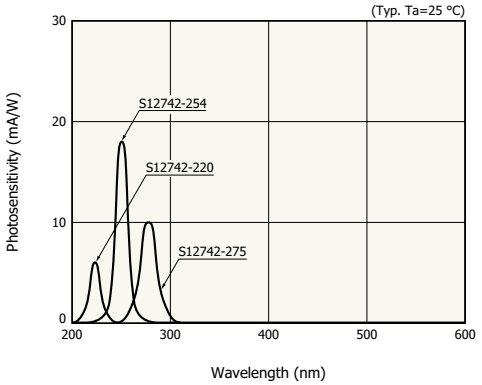
This photosensor uses an interference filter and has high sensitivity only to monochromatic light.

(Typ. Ta=25 °C)

Type no.	Peak sensitivity wavelength (nm)	Spectral response half-width (nm)	Photosensitivity λ=Center wavelength (mA/W)	Dark current VR=10 mV max. (pA)	Photosensitive area size (mm)	Package	Photo
NEW S12742-220	220	10	6	25	3.61 × 3.61	TO-5	
S12742-254*1	254		18				
NEW S12742-275	275		10				

*1: Refer to "Precautions against UV light exposure" (P.43).

Spectral response



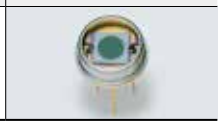
KSPDB0333EA

Note: The photosensor can be customized to support other wavelength types, including center wavelengths of 340 nm and 560 nm. (made-to-order product).

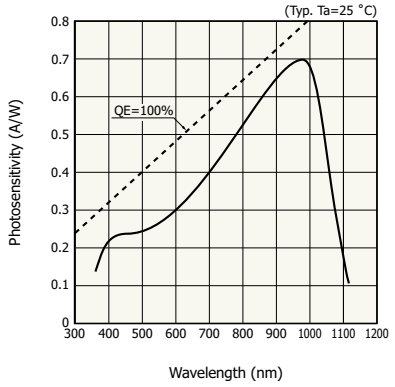
For YAG laser detection

This is a Si PIN photodiode developed to measure infrared energy emitted from YAG lasers (1.06 μm).

(Typ. Ta=25 °C)

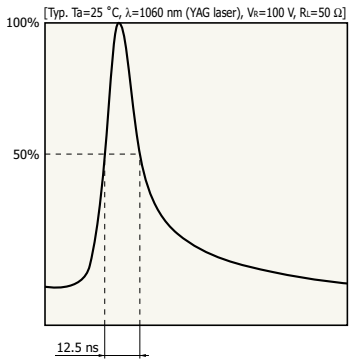
Type no.	Photosensitive area size (mm)	Spectral response range (nm)	Peak sensitivity wavelength (nm)	Photosensitivity λ=1060 nm (A/W)	Dark current VR=100 V max. (nA)	Rise time λ=1060 nm VR=100 V, RL=50 Ω (ns)	Package	Photo
S3759	ϕ5	360 to 1120	980	0.38	10	12.5	TO-8	

Spectral response



KPINB0279EB

Response waveform



KPINB0280EC

For electron beam detector

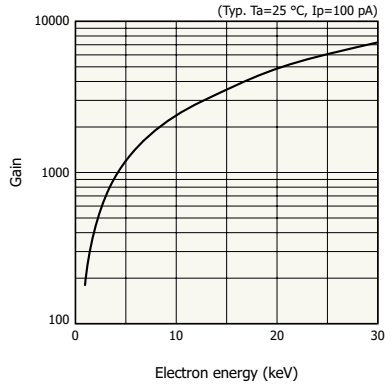
These photodiodes directly detect low energy (1 keV or more) electron beams with high sensitivity. The structure with an extremely thin dead layer (insensitive layer) makes these photodiodes ideal for backscattered electron detector for Scanning Electron Microscope (SEM).

(Typ. Ta=25°C)

Type no.	Incident electron energy range (keV)	Output current (nA)	Dark current VR=5 V max. (nA)	Terminal capacitance VR=5 V (pF)	Cutoff frequency VR=5 V (MHz)	Electron multiplying gain	Package	Photo
S11141-10	1 to 30	30 (Electron energy: 1.5 keV Ip*2=100 pA)	60	450	2.5	300 (Electron energy: 1.5 keV)	Thin ceramic (unsealed)	
S11142-10				200	5			

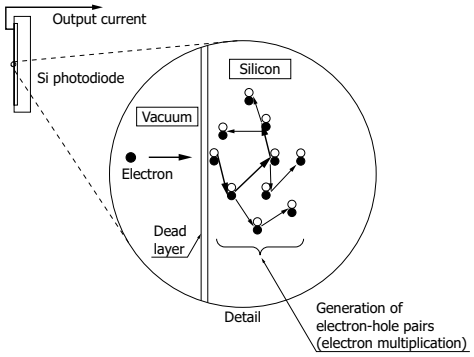
*2: Probe current

Gain vs. electron energy



KSPDB0344EA

Electron multiplication principle



Electrons generate ions as they pass through silicon. This ionization process generates a large number of electron-hole pairs that then multiply the number of electrons. The electron multiplication can boost the output current by approximately 300 times at an input electron energy of 1.5 keV (refer to "Gain vs. electron energy").

KSPDC0089EA

PWB package with leads type

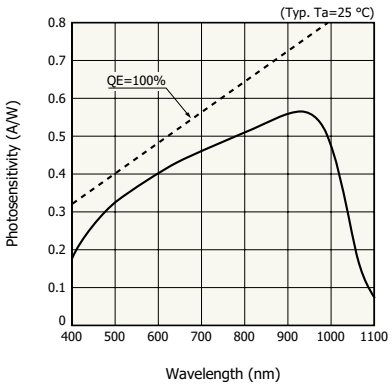
The S12497 and S12498 are Si photodiodes suitable for non-destructive inspection of baggage and the like and general industrial measurement. As they are back-illuminated photodiodes, photosensitive area does not have wires, and therefore a scintillator can be mounted directly on the photodiode.

(Typ. Ta=25 °C)

Type no.	Photosensitive area (mm)	Spectral response range (nm)	Peak sensitivity wavelength (nm)	Photo-sensitivity λ=920 nm (A/W)	Short circuit current 100 *lx*, 2856 K (μA)	Terminal capacitance VR=0 V, f=10 kHz (pF)	Photo
S12497	9.5 × 9.5	400 to 1100	920	0.57	75	950	
S12498	6 × 6				30	380	

Spectral response

[S12497, S12498]



KSPDB0360EC

CSP type

These are back-illuminated photodiodes employing a CSP (chip size package) that allows direct coupling of a scintillator on the chip. It is designed with minimal dead space around the product. This makes it possible to arrange multiple products side by side.

(Typ. Ta=25 °C)

Type no.	Photosensitive area size (mm)	Spectral response range (nm)	Peak sensitivity wavelength (nm)	Photo-sensitivity λ=920 nm (A/W)	Short circuit current 100 *lx*, 2856 K (μA)	Terminal capacitance VR=0 V, f=10 kHz (pF)	Package	Photo
S13955-01	7.37 × 7.37	400 to 1100	960	0.61	46	500	PWB (unsealed)	
S13956-01	2.5 × 2.5				5.5	60		
S13957-01	4.5 × 4.5				22	230		

CSP type 64-element Si photodiode array

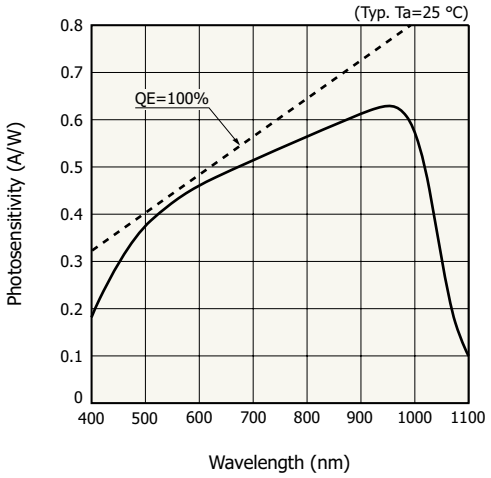
This is an 8 × 8 element Si photodiode array with a back-illuminated type structure for X-ray non-destructive inspection. A scintillator can be directly coupled on the chip. It is designed with minimal dead space around the product. This makes it possible to arrange multiple products side by side. Moreover, there is no crosstalk between channels.

(Typ. Ta=25 °C)

Type no.	Number of elements	Element pitch (mm)	Element size W × H (mm)	Spectral response range (nm)	Peak sensitivity wavelength (nm)	Photo-sensitivity λ=920 nm (A/W)	Short circuit current 100 *lx*, 2856 K (μA)	Terminal capacitance VR=0 V, f=10 kHz (pF)	Package	Photo
S13620-02	64 (8 × 8)	3.0	2.5 × 2.5	400 to 1100	960	0.61	5.5	60	PWB (unsealed)	

Spectral response

[S13955-01, S13956-01, S13957-01, S13620-02]



KSPDB0367EB

Related products of Si photodiode

RGB color sensor modules

For TFT-LCD monitor

● RGB-LED backlight monitor for TFT-LCD (liquid crystal display)

Features

- Built-in RGB color sensor (S9032-02)
  Sensitivity matches wavelengths of RGB-LED backlight for TFT-LCD.
- 3 ch current-to-voltage amplifiers
  Simultaneous output of 3 ch RGB photocurrent
- Configuration and size suitable for side mounting to TFT-LCD
- Low current consumption: 0.4 mA typ.
  (1/3 than the conventional type)
- High gain type (C9303-04)

Applications

- RGB-LED backlight monitor for TFT-LCD

(Typ. Ta=25 °C)

Type no.	Photosensitivity (V/mW)			Cutoff frequency -3 dB (kHz)	Supply voltage (V)
	λp=620 nm	λp=540 nm	λp=460 nm		
C9303-03	-14	-20	-18	16	+2.7 to +5.5
C9303-04	-108	-156	-122	2.4	

Simple color measurement

● Numerically converts RGB color information and outputs data for PCs

Features

- Measures object color information as a reflective type*
- Measures small areas using an objective optical fiber
- 12-bit digital output
- Serial connection (RS-232C) with PC
- Teaching function
- Sample software included

Applications

- Color monitoring and simple detection of color difference of opaque body (painting, printing, cosmetics, etc.)
- Teaching material for simple color measurements

(Typ. Ta=25 °C)

Type no.	Light source	Photosensor	Measurement and output cycle (ms)	Supply voltage (V)
C9315	White LED	Si photodiode	200	AC adapter (+12)

* Does not conform to CIE (International Commission on Illumination) standards

Color sensor evaluation circuit

● Color sensor evaluation circuit board

Features

- 3 ch current-to-voltage conversion amplifier for color sensor evaluation
- Color sensors that mount on C9331:
  S7505-01, S9032-02 (sold separately)

Applications

- Evaluation of Hamamatsu color sensor

(Ta=25 °C, Vcc=9.0 V, common to each RGB channel)

Type no.	Output offset voltage Zt=5.1 × 10^5 V/A [without photodiode] (mV)		Conversion impedance (V/A)	Cutoff frequency [without photodiode] -3 dB (kHz)	Supply voltage (V)
	Typ.	Max.			
C9331	±40	±50	1 × 10^5 to 5.1 × 10^5	14	+7 to +15

Driver circuit for Si photodiode array

● Driver circuit for 16-element photodiode array

Features

- High precision and high-speed measurement by simultaneous 16-channel readout
- Assembled with pulse generator (8-step adjustable oscillatory frequency)
  CLK, START, A/D conversion Trig and $\overline{EOS}$ pulse output
- Choice of gain (conversion impedance): 1×10^6 V/A or 1×10^7 V/A
- Accessory AC adapter (+12 V) operation

Type no.	Applicable sensor
C9004	Hamamatsu S4111-16 series, S11212 series photodiode arrays are directly mountable on board.

Photodiode modules

● Integrates a Si photodiode for precision photometry with low-noise amplifier.

The C10439 series is a high-precision photodetector that combines a photodiode and current-to-voltage conversion amplifier.

Features

- Easy handling
  The output from these photodiode modules is an analog voltage and can be checked with a voltmeter, etc.
- Two switchable photosensitivity ranges
  High accuracy output can be obtained by selecting a range suitable for the light level to be detected.
- Compact size
  Half the size of a business card (C10439-15: business card size) Can be mounted directly on optical bench rod (M4).

(Typ. Ta=25 °C)

Type no.	Photosensitive area size (mm)		Peak sensitivity wavelength (nm)	Photosensitivity λ=λp (mV/nW)	Conversion impedance (V/A)	Cutoff frequency -3 dB (Hz)	Supply voltage (V)	Dimensions W × D × H (mm)
C10439-01	Si	2.4 × 2.4	960	H: 500 L: 5	H: 10^9 L: 10^7	H: 10 L: 1k	External power supply ±5 to ±12	19 × 46 × 52
C10439-02		5.8 × 5.8						
C10439-03		10 × 10						
C10439-07		2.4 × 2.4		H: 0.5 L: 0.005	H: 10^6 L: 10^4	H: 1k L: 100k*1		
C10439-08		5.8 × 5.8						
C10439-09		10 × 10						
C10439-10	InGaAs	ϕ1	1550	H: 1 L: 0.01				19 × 50 × 52
C10439-11		ϕ3						
C10439-14	InAsSb	0.7 × 0.7	4100	H: 0.045*2 L: 0.0045*2	H: 10^7 L: 10^6	H: 100 L: 1k		
C10439-15	Si	2.4 × 2.4	940	H: 0.45 L: 0.045	H: 10^6 L: 10^5	H: 10k L: 100k*1		19 × 50 × 75
	InGaAs	ϕ1	2300	H: 0.6 L: 0.06				

* 1: Output amplitude: 2 Vp-p *2: Uniform irradiation on the entire photosensitive area

Signal processing unit for photodiode module

● Unit dedicated for photodiode module (C10439 series)

The C10475 converts the output from a photodiode module (C10439 series) into digital signals. Also supplies power to the photodiode module.

Features

- High-resolution digital output (16-bit)
- Data logger function

(Typ. Ta=25 °C)

Type no.	Digital output	Minimum measurement time interval (ms)	Supply voltage (V)	Dimensions W × D × H (mm)
C10475	Conforms to RS-232C (16-bit)	50	AC adapter (+12) or battery (+9)	110 × 100 × 30

Note: RS-232C cable is optional.

Photosensor amplifier

For low-light-level detection

● Digital output function, current-to-voltage conversion amplifier for amplifying very slight photocurrent with low noise

Photodiode, coaxial cable with BNC-BNC plug and RS-232C cable are optional.

Features

- Three sensitivity ranges
- Selectable operation modes (analog output / digital output)
- Serial connection (RS-232C) with PC
- Data logger function, low battery function

(Typ. Ta=25 °C)

Type no.	Range	Conversion impedance (V/A)	Cutoff frequency -3 dB (Hz)	Power supply (V)	Dimensions W × D × H (mm)
C9329	H	10^9	16	AC adapter (+12) or battery (+9)	115 × 90 × 40
	M	10^7	1600		
	L	10^5	1600		

With optical fiber

● Light-to-voltage conversion amplifier with optical fiber

Features

- Easy handling
  Built-in photodiode allows easy detection of light just by connecting to a voltmeter, etc.
- Optical fiber light input
  Measures light at a narrow detection point. Separating the amplifier from the detection point allows measurement in unusual environments and achieves low noise.
- Three sensitivity ranges

(Typ. Ta=25 °C)

Type no.	Range	Photosensitivity λ=830 nm (mV/μW)	Conversion impedance (V/A)	Cutoff frequency -3 dB (MHz)	Power supply (V)	Dimensions W × D × H (mm)
C6386-01	H	30	10^5	1	External power supply (±15) or batteries (+9) × 2	115 × 90 × 40
	M	3	10^4	3		
	L	0.3	10^3	10		

High-speed type

● Current-to-voltage conversion amplifier

Features

- C8366: for high speed Si PIN photodiode
  C8366-01: for high speed InGaAs photodiode
- Wide bandwidth: DC to 100 MHz typ. (-3 dB; varied by the photodiode used)
- Just inserting the photodiode leads makes the connection.
  (Compatible with TO-8, TO-5 and TO-18 packages)
- Adjustable response speed
  Response speed can be adjusted by a trimmer potentiometer easily.
- Compact size

(Typ. Ta=25 °C)

Type no.	Conversion impedance (V/A)	Cutoff frequency -3 dB (MHz)	Power supply (V)	Dimensions W × D × H (mm)
C8366	10^3	100	External power supply (±15)	19 × 52 × 46
C8366-01				

Compact board type

● Current-to-voltage conversion amplifier for low-level-light

Features

- Compact board type for easy assembly
- Usable with photodiodes having large terminal capacitance
- Conversion impedance: 10^8 V/A

(Typ. Ta=25 °C)

Type no.	Conversion impedance (V/A)	Cutoff frequency -3 dB (Hz)	Power supply (V)	Dimensions W × D × H (mm)
C9051	10^8	16	AC adapter (+12)	50 × 50 × 19

Charge amplifier

● For radiation and high energy particle detection

The H4083 is a low-noise hybrid charge amplifier designed for a wide range of spectrometric applications including soft X-ray and low to high energy gamma-ray spectrometry. The first stage of this amplifier uses a low-noise junction type FET, which exhibits excellent performance when used with a photodiode having a large junction capacitance. The H4083 is especially suited for use with Hamamatsu S3590/S3204 series, etc. Si PIN photodiodes. S3590 series photodiodes can be directly mounted on the backside of the H4083, so there will be no increase in stray capacitance.

Features

- Low noise
- Compact and lightweight
- Easy handling

Applications

- Detection of X-rays, radiation, high energy particles

(Typ. Ta=25 °C)

Type no.	Amplification method	Input/ output polarity	Charge gain	Noise characteristic (e^-/FWHM)	Negative feedback constant	Power supply (V)	Current consumption (mW)	Dimensions W × D × H (mm)
H4083	Charge-sensitive type	Inverted	0.5 V/pC 22 mV/MeV (Si)	550	50 MΩ//2 pF	±12	150	24 × 19 × 4

Description of terms

Spectral response

The photocurrent produced by a given level of incident light varies with the wavelength. 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

This measure of sensitivity is the ratio of photocurrent expressed in amperes (A)—or output voltage expressed in volts (V)—to the incident light expressed in watts (W). It may be represented as either an absolute sensitivity (A/W or VW unit) or as a relative sensitivity normalized for the sensitivity at the peak wavelength, usually expressed in percent (%) with respect to the peak value. At Hamamatsu, we usually use absolute sensitivity to express photosensitivity, and the spectral response range is defined as the region in which the relative sensitivity is higher than 5% or 10% of the peak value.

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 and photo sensitivity S have the following relationship at a given wavelength (nm):

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

Short circuit current: Isc

The output current that flows through the photodiode when the load resistance is 0. This is often called "white light sensitivity" with regards to the spectral response, and a tungsten lamp of 2856 K distribution temperature (color temperature) is used for the light source. At Hamamatsu, we indicate the short circuit current at 100 *lx* illuminance in the table of characteristics in our catalogues.

Open circuit voltage: Voc

The open circuit voltage is a photovoltaic voltage generated when the load resistance is infinite. The open circuit voltage depends on the light level, but for light levels higher than extremely low levels, it is nearly constant.

Dark current: I_D

The dark current is a small current which flows when a reverse voltage is applied to a photodiode even in dark state. This is a major source of noise for cases in which a reverse voltage is applied to photodiodes (PIN photodiode, etc.).

Shunt resistance: Rsh

The voltage-to-current ratio in the vicinity of 0 V in photodiodes. The shunt resistance is defined as follows: Where I_D is the dark current at V_R=10 mV.

$$Rsh\ [\Omega] = \frac{0.01\ [V]}{I_D\ [A]}$$

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

Terminal capacitance: Ct

An effective capacitor is formed at the PN junction of a photodiode. Its capacitance is termed the junction capacitance and is one of parameters that determine the response speed of the photodiode. And it probably causes a phenomenon of gain peaking in I/V converter using operational amplifier. In Hamamatsu, the terminal capacitance including this junction capacitance plus package stray capacitance is listed.

Rise time: tr

This is the measure of the time response of a photodiode to a stepped light input, and is defined as the time required for the output to change from 10% to 90% of the maximum light level (steady output level).

Cutoff frequency: fc

The frequency at which the photodiode output decreases by 3 dB from the output in the frequency region where the output is constant. The rise time (tr) has a relation with the cut-off frequency (fc) as follows:

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

NEP (noise equivalent power)

The NEP is the amount of light equivalent to the noise level of a device. It is the light level required to obtain a signal-to-noise ratio of unity. Our data sheets show the NEP values measured at the peak wavelength λp. Since the noise level is proportional to the square root of the frequency bandwidth, the NEP is measured at a bandwidth of 1 Hz.

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

Maximum reverse voltage: V_R 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 related to light and opto-semiconductors)

Constant	Symbol	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 (300 K)	eV
Energy of 1 eV	eV	1.602×10^{-19}	J
Wavelength equivalent to 1 eV in vacuum	—	1240	nm
Permittivity of vacuum	εo	8.854×10^{-12}	F/m
Relative premittivity of silicon	εsi	Approx. 12	—
Relative premittivity of silicon oxide film	εox	Approx. 4	—
Band gap energy of silicon	Eg	Approx. 1.12 (25 °C)	eV

Precautions against UV light exposure

① When UV light irradiation is applied, the product characteristics may degrade. Such examples include degradation of the product's UV sensitivity and increase in dark current. This phenomenon varies depending on the irradiation level, irradiation intensity, usage time, and ambient environment and also varies depending on the product model. Before employing the product, we recommend that you check the tolerance under the ultraviolet light environment that the product will be used in.

② Exposure to UV light may cause the characteristics to degrade due to gas released from the resin bonding the product's component materials. As such, we recommend that you avoid applying UV light directly on the resin and apply it on only the inside of the photosensitive area by using an aperture or the like.

Related information

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

- Precautions
  - Disclaimer
  - Metal, ceramic, plastic package products
  - Unsealed products
  - Surface mount type products

HAMAMATSU

PHOTON IS OUR BUSINESS

Date.

No.

HAMAMATSU

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 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

Quality, technology, and service are part of every product.

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, P.R.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, P.R.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)3-659-0080, Fax: (886)3-659-0081
E-mail: info@hamamatsu.com.tw

■ *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 Contact:
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
Transistorstraat 7, NL-1322 CJ 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. KSPD0001E14
Jun. 2019 AS
Printed in Japan