High-speed, high-sensitivity photodiodes having internal multiplication function

Si APD

Si avalanche photodiode

HAMAMATSU PHOTONICS K.K.

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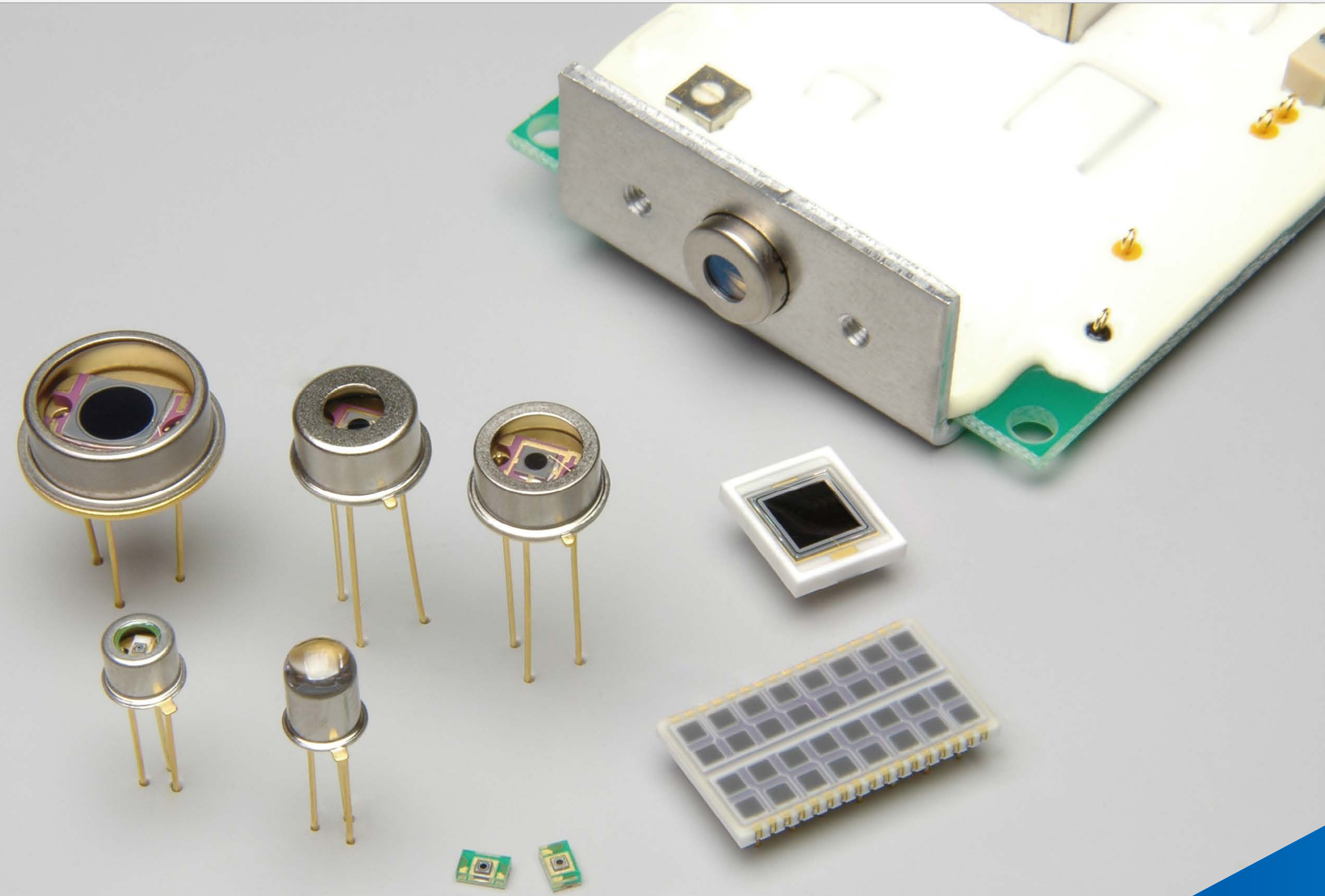
June 2025 Selection guide

High-speed, high-sensitivity photodiodes having internal multiplication function

The APD is a high-speed, high-sensitivity photodiode that internally multiplies photocurrent when reverse voltage is applied. The APD, having a signal multiplication function inside its element, achieves higher S/N than the PIN photodiode and can be used in a wide range of applications such as high-accuracy optical rangefinders and low-level light detection with a scintillator.



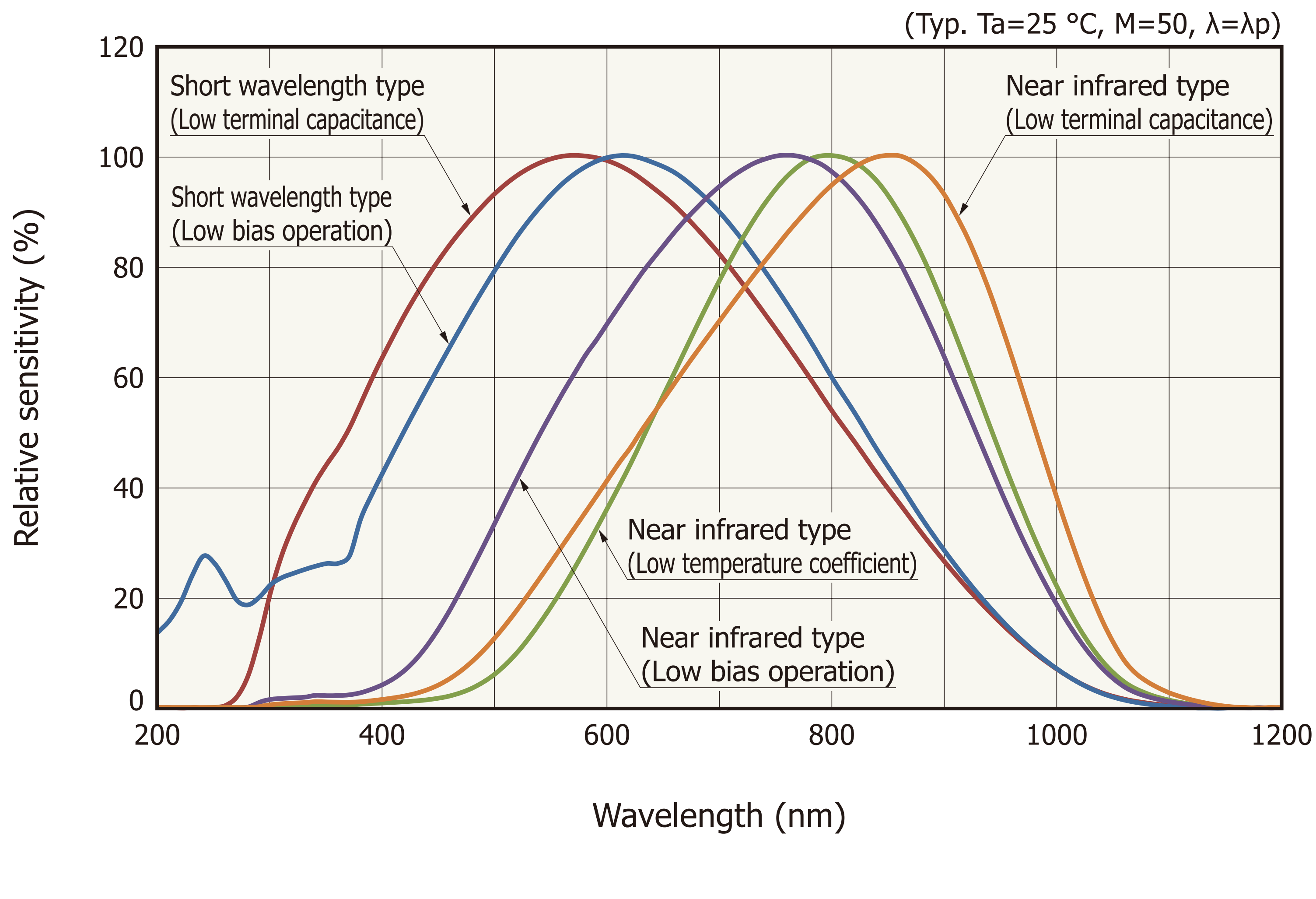
Si APD

The APD is a high-speed, high-sensitivity photodiode that internally multiplies photocurrent when reverse voltage is applied.

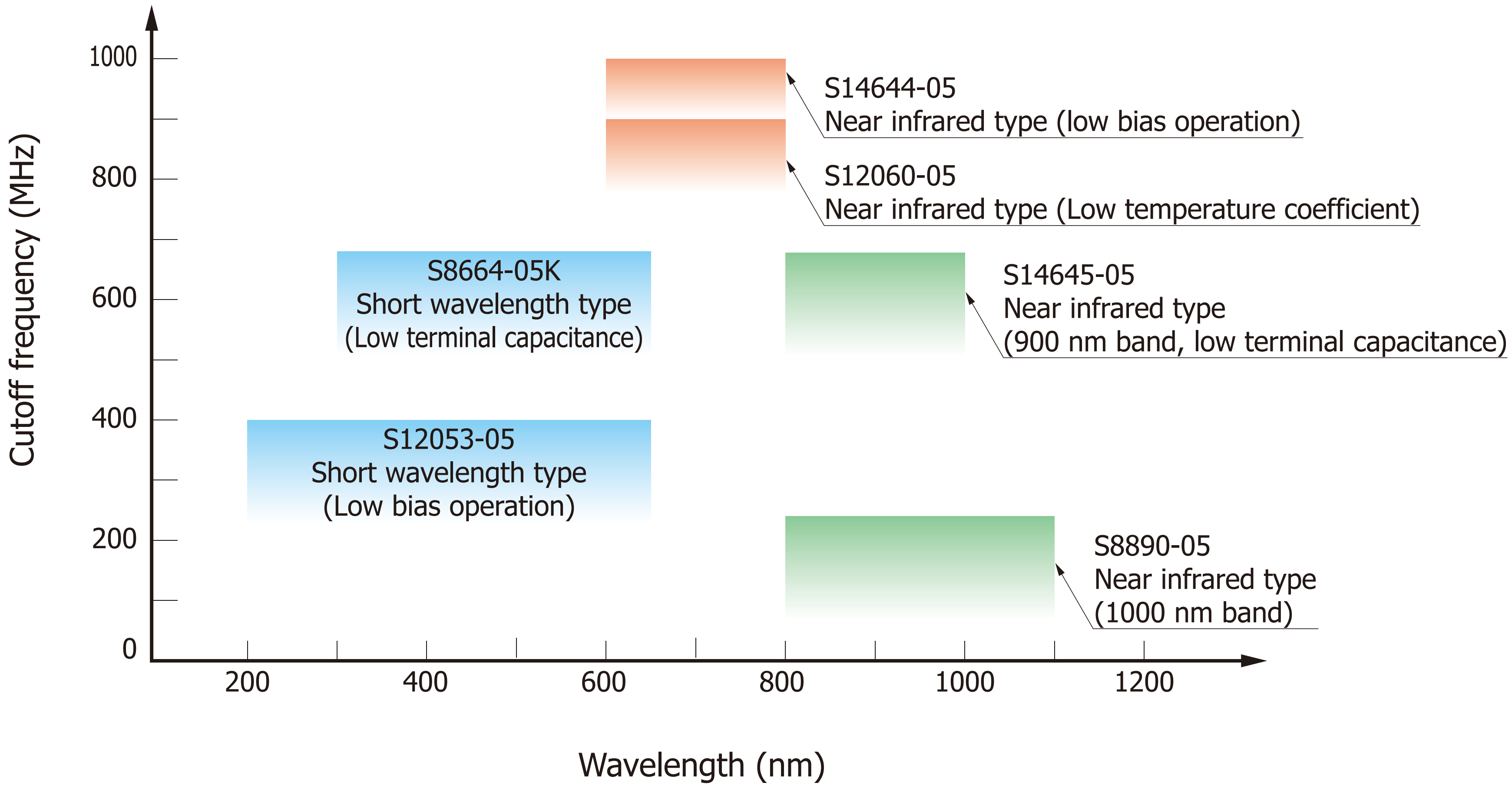
Type		Recommended spectral range (nm)	Peak sensitivity wavelength (nm)	Features	Applications
Short wavelength type	Low bias operation	200 to 650	620	Enhanced sensitivity in UV to visible region	Low-light-level detection, analytical instruments
	Low terminal capacitance	320 to 650	600		
Near infrared type	Low bias operation	700 to 900	800	Low bias voltage operation	FSO (free space optics), optical fiber communications, analytical instruments
	Low temperature coefficient	700 to 900	800	Low temperature coefficient of bias voltage, easy gain adjustment	FSO , optical fiber communications
	850 nm band	700 to 1000	840	High sensitivity in 850 nm band	FSO , optical fiber communications, analytical instruments
	900 nm band	700 to 1000	860	High sensitivity in 900 nm band	FSO , optical fiber communications, analytical instruments
	1000 nm band	800 to 1100	940	High sensitivity in 1000 nm band	FSO , analytical instruments, YAG laser light detection
	TE-cooled type	700 to 900	800	High S/N	Low-light-level detection
For LiDAR	700 nm band	600 to 800	760	Low dark current Wide operating temperature Mass production compatibility	Optical rangefinders
	800 nm band	700 to 900	800		
	900 nm band	800 to 1000	840		
		850 to 950	900		
Gain-stabilized type	700 nm band	600 to 800	760	Temperature compensation function built into the sensor	Optical rangefinders
	800 nm band	700 to 900	800		
	900 nm band	800 to 1000	840		

● Spectral response (relative value)

For the absolute sensitivity values, see the datasheets.



● Cutoff frequency vs. recommended wavelength (typical example)



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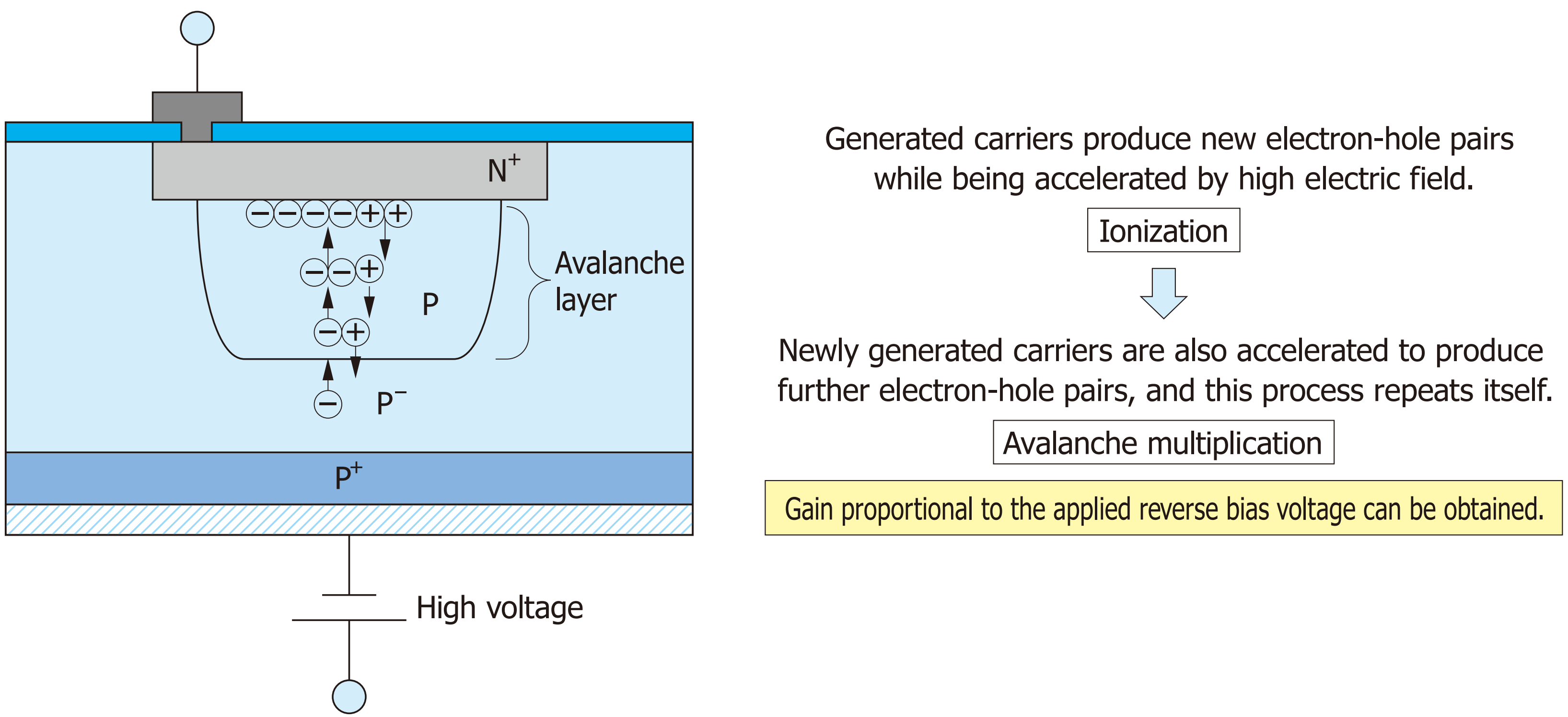
Principle of APD operation

The photocurrent generation mechanism of the APD is the same as that of a normal photodiode, but the APD is different from a photodiode in that it has a function to multiply the generated carriers.



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Low bias operation

Enhanced sensitivity in the UV to visible region

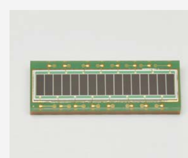
Type no.	Effective photosensitive area[*1] (mm)	Spectral response range (nm)	Breakdown voltage max. ID=100 μA (V)	Temperature coefficient of breakdown voltage (V/°C)	Cutoff frequency[*2] RL=50 Ω (MHz)	Terminal capacitance[*2] (pF)	Gain λ=650 nm	Package	
S12053-02	ϕ0.2	200 to 1000	200	0.14	900	2	50	TO-18	
S12053-05	ϕ0.5				400	5			
S12053-10	ϕ1.0				250	15			
S9075	ϕ1.5				100	30		TO-5	
S5344	ϕ3.0				25	120			
S5345	ϕ5.0				8	320		TO-8	

*1: Area in which a typical gain can be obtained
*2: Value obtained when operated at the gain indicated in the table

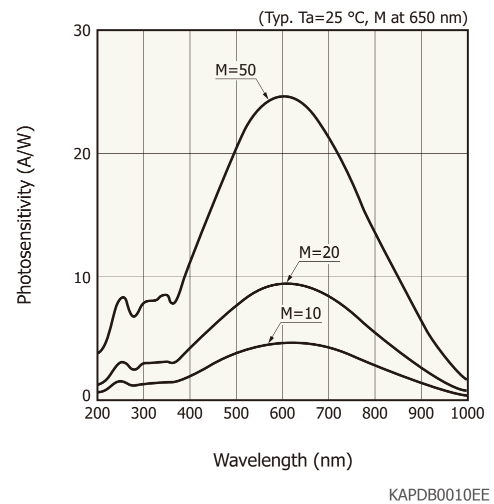
Si APD array S15249

● Surface mount type 16-element Si APD array

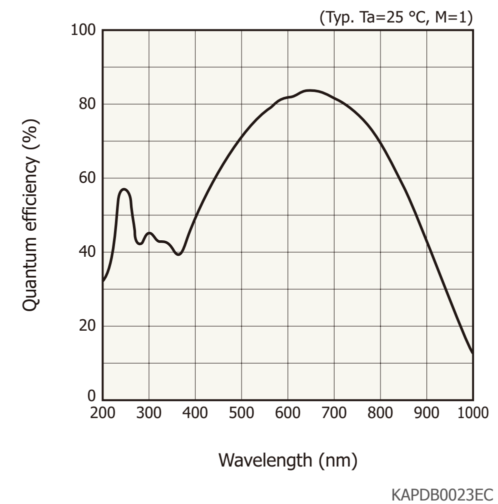
The S15249 is a surface mount type 16-element Si APD array with high sensitivity in the short wavelength range and low-bias operation. It realizes uniform gain and small crosstalk between elements.



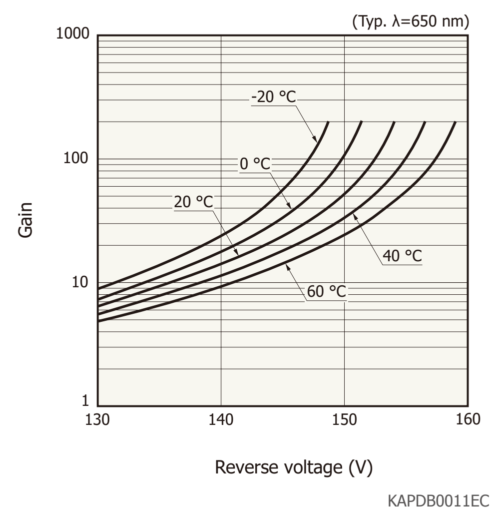
● Spectral response



● Quantum efficiency vs. wavelength

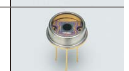
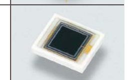
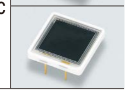


● Gain vs. reverse voltage

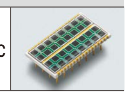


Low terminal capacitance

Enhanced sensitivity in the UV to visible region

Type no.	Effective photosensitive area*1 (mm)	Spectral response range (nm)	Breakdown voltage max. I_D=100 µA (V)	Temperature coefficient of breakdown voltage (V/°C)	Cutoff frequency*2 R_L=50 Ω (MHz)	Terminal capacitance*2 (pF)	Gain λ=420 nm	Package	
S8664-02K	ϕ0.2	320 to 1000	500	0.78	700	0.8	50	TO-5	
S8664-05K	ϕ0.5				680	1.6			
S8664-10K	ϕ1.0				530	4			
S8664-20K	ϕ2.0				280	11			
S8664-30K	ϕ3.0				140	22		TO-8	
S8664-50K	ϕ5.0				60	55			
S8664-55	5 × 5				40	80		Ceramic	
S8664-1010	10 × 10				11	270			

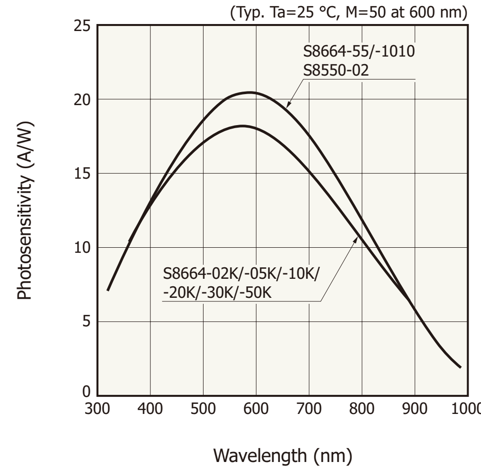
4 × 8 element array

Type no.	Effective photosensitive area*1 (mm)	Spectral response range (nm)	Breakdown voltage max. (V)	Temperature coefficient of breakdown voltage (V/°C)	Cutoff frequency*2 R_L=50 Ω (MHz)	Terminal capacitance*2 (pF)	Gain λ=420 nm	Package	
S8550-02	1.6 × 1.6 (× 32 elements)	320 to 1000	500	0.78	250	9 (per element)	50	Ceramic	

*1: Area in which a typical gain can be obtained

*2: Value obtained when operated at the gain indicated in the table

● Spectral response



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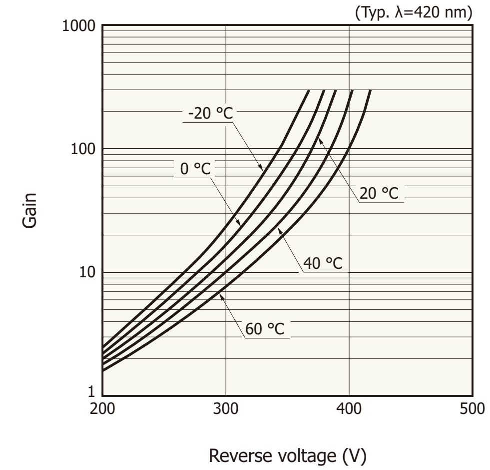
● Gain vs. reverse voltage



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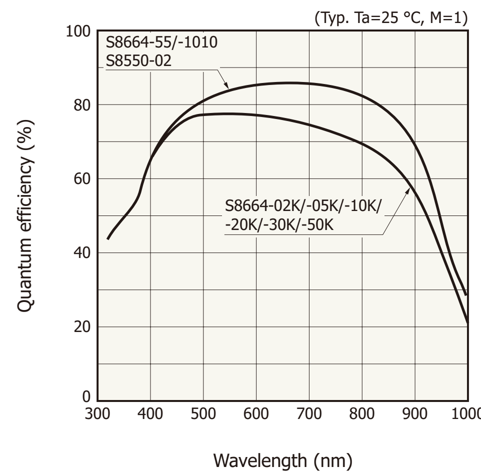
● Quantum efficiency vs. wavelength



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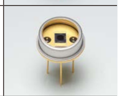
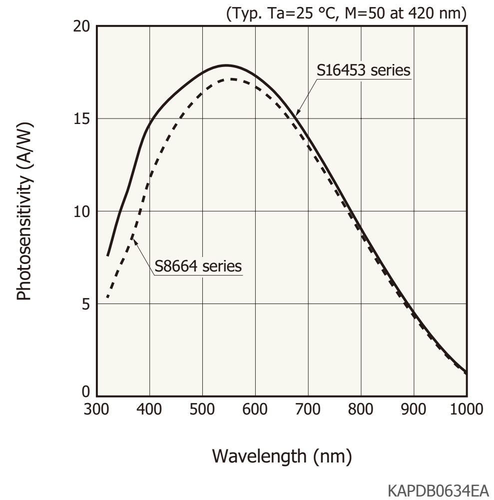
Low terminal capacitance

This type has significantly improved sensitivity at short wavelengths compared to the same size product of the S8664 series (a product with lower speed than the S8664 series is available).

Type no.	Effective photosensitive area*1 (mm)	Spectral response range (nm)	Breakdown voltage max. ID=100 μA (V)	Temperature coefficient of breakdown voltage (V/°C)	Cutoff frequency*2 RL=50 Ω (MHz)	Terminal capacitance*2 (pF)	Gain	Package	
S16453-02K	ϕ0.2	320 to 1000	500	0.78	700	0.8	50 (λ=420 nm)	TO-5	
S16453-05K	ϕ0.5				680	1.6			
S16453-10K	ϕ1.0				470	4			
S16453-20K	ϕ2.0				165	11			
S16453-30K	ϕ3.0				75	22		TO-8	
S16453-50K	ϕ5.0				30	55			
S14124-20	ϕ2.0	266	500	0.78	250	11 (M=50)	50 to 400 (λ=266 nm)	TO-8	

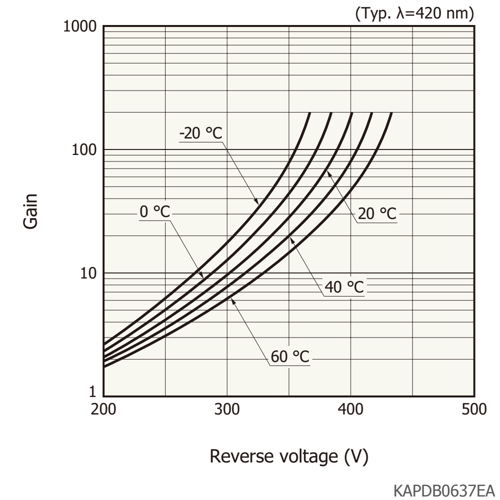
*1: Area in which a typical gain can be obtained
*2: Value obtained when operated at the gain indicated in the table

● Spectral response



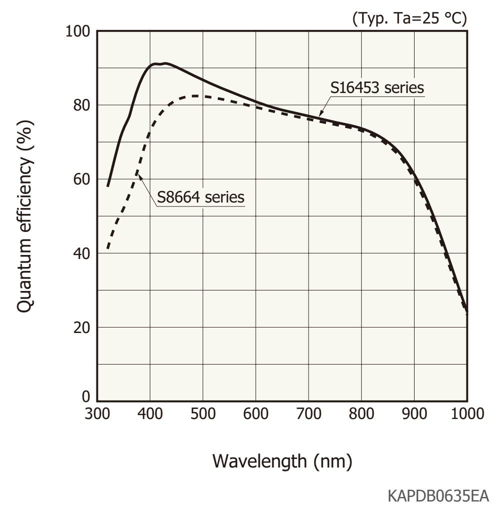
● Gain vs. reverse voltage

[S16453 series]

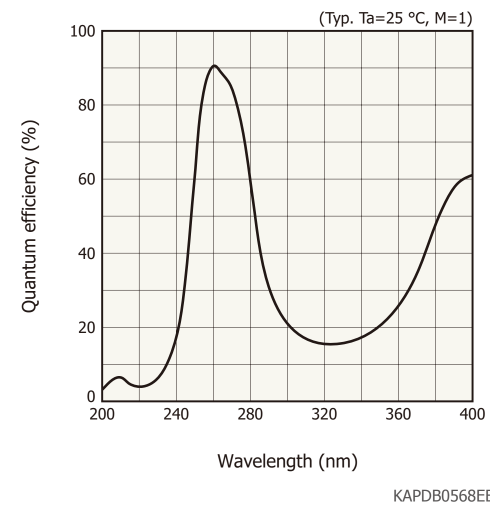


● Quantum efficiency vs. wavelength

[S16453 series]

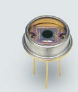


[S14124-20]



Low terminal capacitance

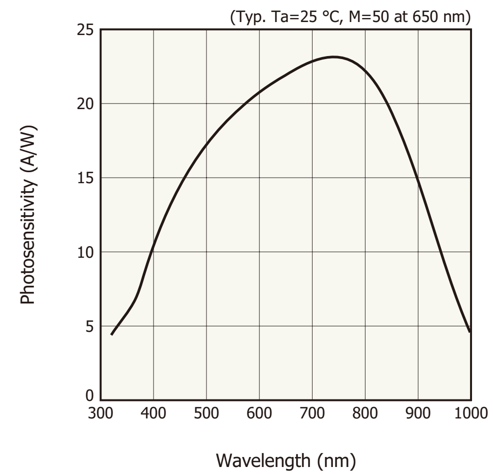
Enhanced sensitivity in the UV to 800 nm.

Type no.	Effective photosensitive area*1 (mm)	Spectral response range (nm)	Breakdown voltage max. ID=100 µA (V)	Temperature coefficient of breakdown voltage (V/°C)	Cutoff frequency*2 RL=50 Ω (MHz)	Terminal capacitance*2 (pF)	Gain λ=650 nm	Package	
S17353-02K NEW	ϕ0.2	320 to 1000	500	0.55	1000	1	50	TO-5	
S17353-05K NEW	ϕ0.5				900	2.2			
S17353-10K NEW	ϕ1.0				500	5.5			
S17353-20K NEW	ϕ2.0				200	15			
S17353-30K NEW	ϕ3.0				90	35		TO-8	
S17353-50K NEW	ϕ5.0				35	85			

*1: Area in which a typical gain can be obtained

*2: Value obtained when operated at the gain indicated in the table

● Spectral response



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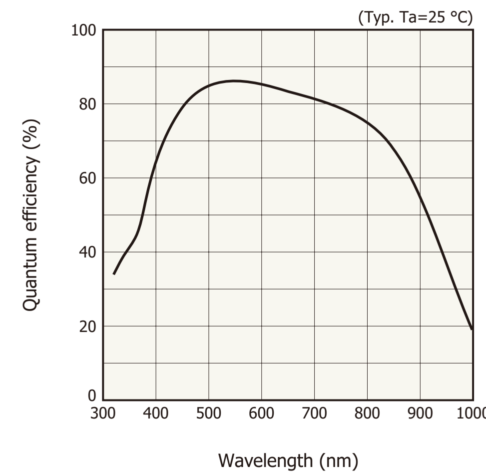
● Quantum efficiency vs. wavelength



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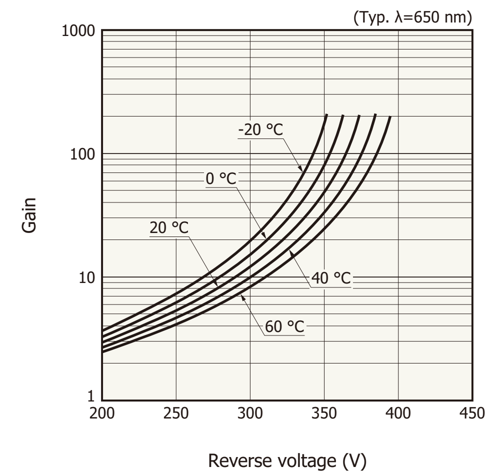
● Gain vs. reverse voltage



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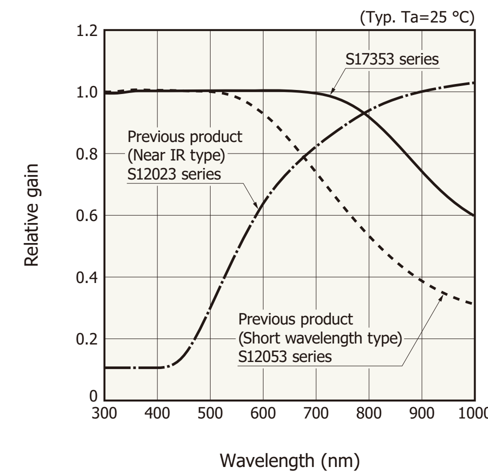
● Gain wavelength dependence



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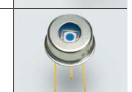
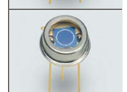
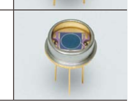
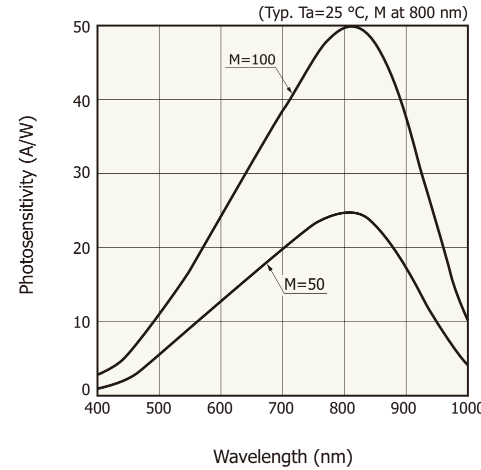
Low bias operation

They can obtain high gain with a bias voltage of 200 V or less, so they are suitable for FSO, optical fiber communications, etc.

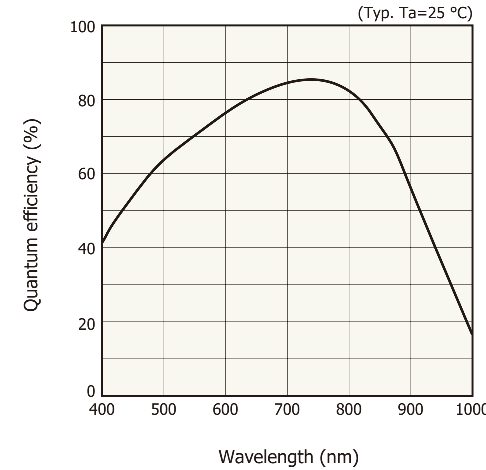
Type no.	Effective photosensitive area[*1] (mm)	Spectral response range (nm)	Breakdown voltage max. ID=100 μA (V)	Temperature coefficient of breakdown voltage (V/°C)	Cutoff frequency[*2] RL=50 Ω (MHz)	Terminal capacitance[*2] (pF)	Gain λ=800 nm	Package	
S12023-02	ϕ0.2	400 to 1000	200	0.65	1000	1	100	TO-18	
S12023-05	ϕ0.5				900	2			
S12051	ϕ0.5				900	2		TO-18	
S12086									
S12023-10	ϕ1.0				600	6			
S12023-10A									
S3884	ϕ1.5				400	10	100	TO-5	
S2384	ϕ3.0				120	40	60		
S2385	ϕ5.0				40	95	40	TO-8	

*1: Area in which a typical gain can be obtained
*2: Value obtained when operated at the gain indicated in the table

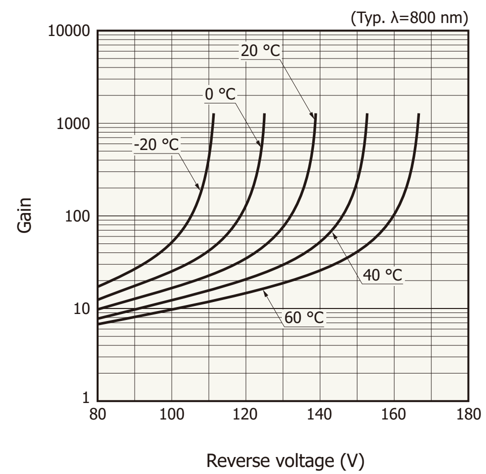
● Spectral response



● Quantum efficiency vs. wavelength

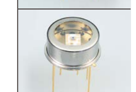
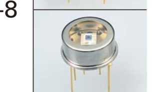
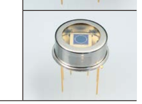


● Gain vs. reverse voltage



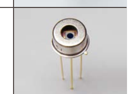
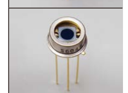
TE-cooled type

They are TE-cooled type APDs with low-bias operation, capable of high accuracy detection.

Type no.	Built-in APD	Package	
S4315	S12023-02	TO-8	
S4315-01	S12023-05		
S4315-02	S12023-10		
S4315-04	S2384		

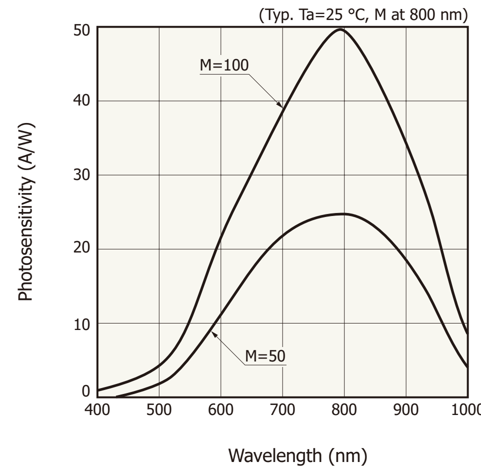
Low temperature coefficient

They produce stable gain over a wide temperature range. They are suitable for FSO, optical fiber communications, etc.

Type no.	Effective photosensitive area[*1] (mm)	Spectral response range (nm)	Breakdown voltage max. ID=100 μA (V)	Temperature coefficient of breakdown voltage (V/°C)	Cutoff frequency[*2] RL=50 Ω (MHz)	Terminal capacitance[*2] (pF)	Gain λ=800 nm	Package	
S12060-02	ϕ0.2	400 to 1000	300	0.4	1000	1.5	100	TO-18	
S12060-05	ϕ0.5				900	2.5			
S12060-10	ϕ1.0				600	6			
S6045-04	ϕ1.5				350	12	100	TO-5	
S6045-05	ϕ3.0				80	50	60		
S6045-06	ϕ5.0				35	120	40	TO-8	

*1: Area in which a typical gain can be obtained
*2: Value obtained when operated at the gain indicated in the table

● Spectral response



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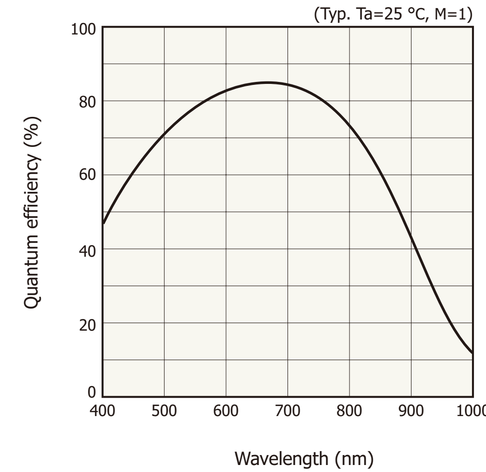
● Quantum efficiency vs. wavelength



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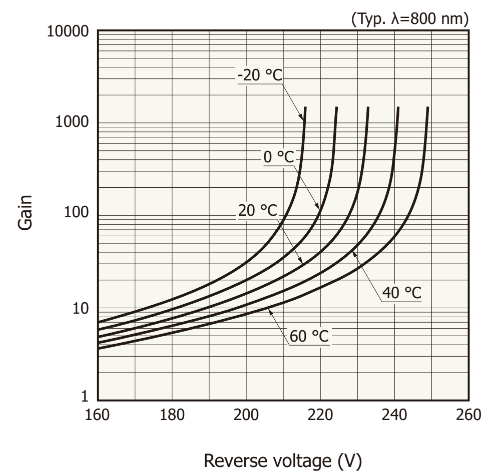
● Gain vs. reverse voltage



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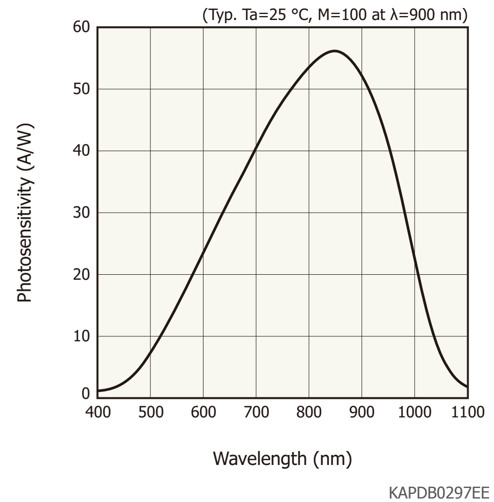
850 nm band

These are Si APDs that offer enhanced 850 nm band near-infrared sensitivity. They are suitable for FSO, optical fiber communications, and analytical instruments, etc.

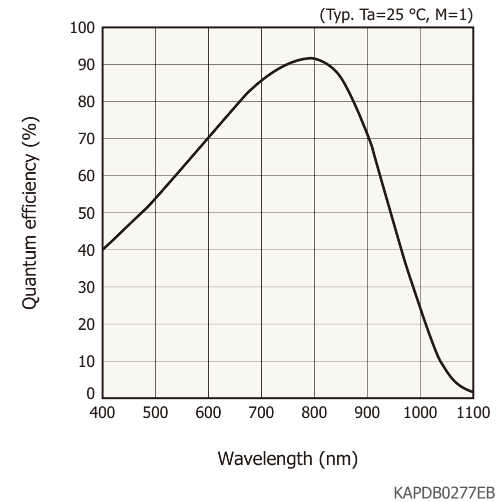
Type no.	Effective photosensitive area*1 (mm)	Spectral response range (nm)	Breakdown voltage max. I_D=100 µA (V)	Temperature coefficient of breakdown voltage (V/°C)	Cutoff frequency*2 R_L=50 Ω (MHz)	Terminal capacitance*2 (pF)	Gain λ=900 nm	Package	
S12426-02	ϕ0.2	400 to 1100	200	1.1	650	0.5	100	TO-18	
S12426-05	ϕ0.5				600	1.1			

*1: Area in which a typical gain can be obtained
*2: Value obtained when operated at the gain indicated in the table

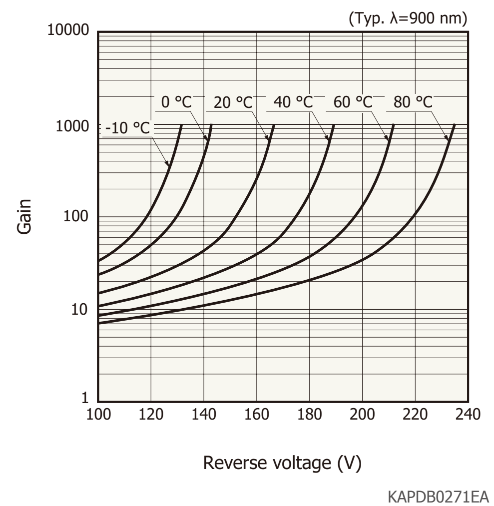
● Spectral response



● Quantum efficiency vs. wavelength

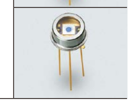


● Gain vs. reverse voltage



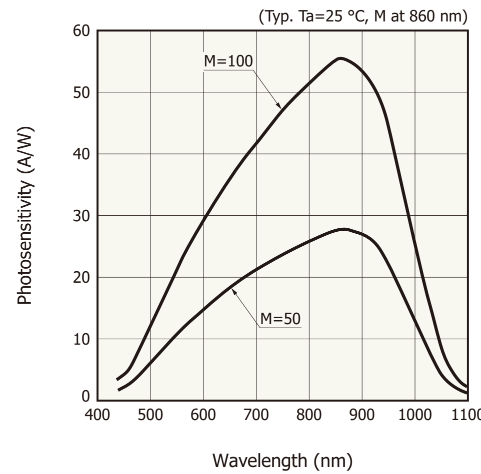
900 nm band

These are Si APDs that realize high sensitivity in the Near-infrared region of 900 nm band. They are suitable for FSO, optical fiber communications, and analytical instruments, etc.

Type no.	Effective photosensitive area*1 (mm)	Spectral response range (nm)	Breakdown voltage max. ID=100 µA (V)	Temperature coefficient of breakdown voltage (V/°C)	Cutoff frequency*2 RL=50 Ω (MHz)	Terminal capacitance*2 (pF)	Gain λ=900 nm	Package	
S12092-02	ϕ0.2	440 to 1100	350	1.85	400	0.4	100	TO-18	
S12092-05	ϕ0.5					0.7			
S9251-10	ϕ1.0				380	1.9		TO-5	
S9251-15	ϕ1.5				350	3.6			

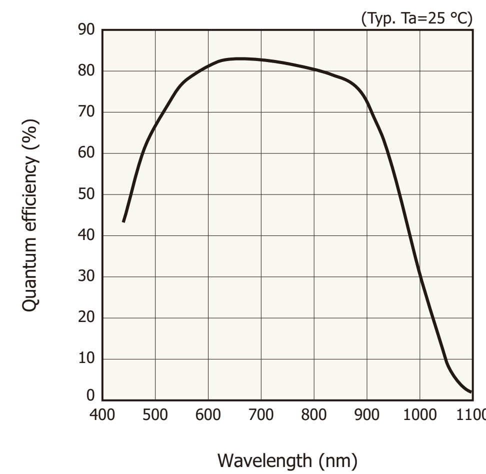
*1: Area in which a typical gain can be obtained
*2: Value obtained when operated at the gain indicated in the table

● Spectral response



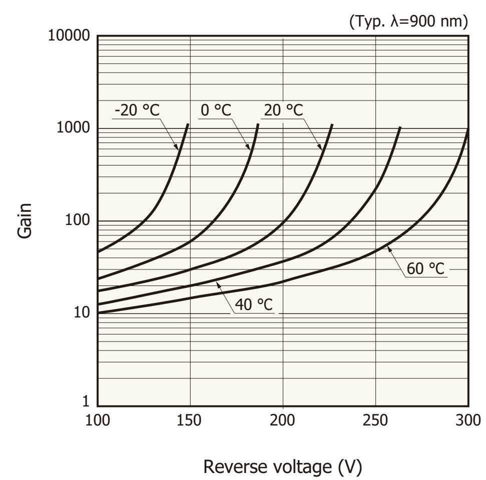
KAPDB0606EA

● Quantum efficiency vs. wavelength



KAPDB0607EA

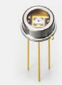
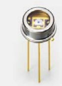
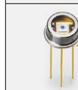
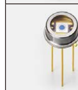
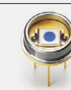
● Gain vs. reverse voltage



KAPDB0082EA

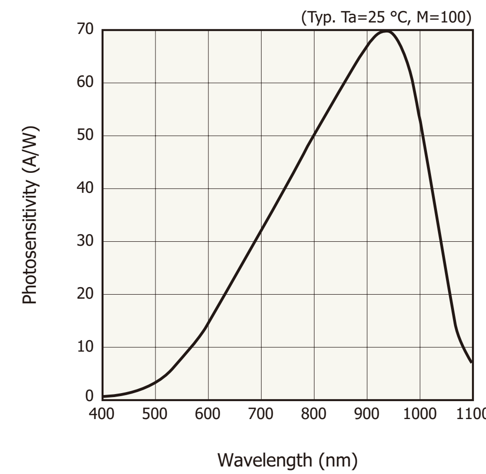
1000 nm band

These are Si APDs that realize high sensitivity in the Near-infrared region of 1000 nm band. They are suitable for FSO, optical fiber communications, and analytical instruments, etc.

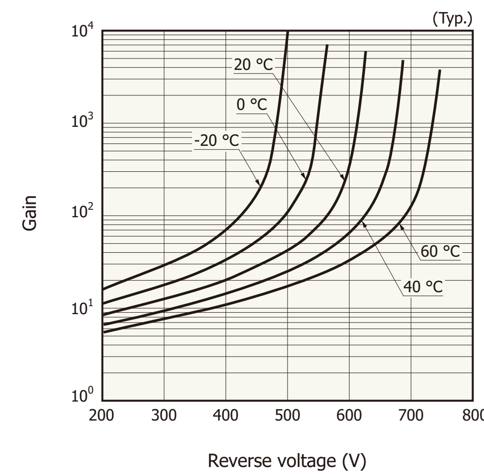
Type no.	Effective photosensitive area*1 (mm)	Spectral response range (nm)	Breakdown voltage max. ID=100 μA (V)	Temperature coefficient of breakdown voltage (V/°C)	Cutoff frequency*2 RL=50 Ω (MHz)	Terminal capacitance*2 (pF)	Gain λ=900 nm	Package	
S8890-02	ϕ0.2	400 to 1100	800	3.5	280	0.2	100	TO-5	
S8890-05	ϕ0.5				240	0.5			
S8890-10	ϕ1.0				230	1.5			
S8890-15	ϕ1.5				220	2.5			
S8890-30	ϕ3.0				220	8.0		TO-8	

*1: Area in which a typical gain can be obtained
*2: Value obtained when operated at the gain indicated in the table

Spectral response

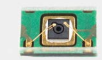
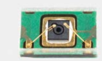
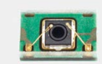
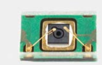
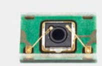


Gain vs. reverse voltage



Si APD for LiDAR

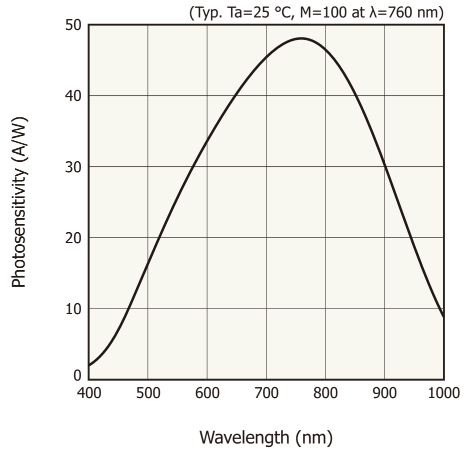
These are Si APDs with reduced variation in breakdown voltage, reduced dark current, and expanded operating temperatures.

Type no.	Effective photosensitive area*1 (mm)	Spectral response range (nm)	Breakdown voltage ID=100 µA max. (V)	Temperature coefficient of breakdown voltage (V/°C)	Cutoff frequency*2 RL=50 Ω (MHz)	Terminal capacitance*2 (pF)	Gain	Package	
700 nm band									
S14643-02	ϕ0.2	400 to 1000	120	0.42	2000	0.7	100 (λ=760 nm)	Glass epoxy	
800 nm band									
S14644-02	ϕ0.2	400 to 1000	180	0.63	1200	0.6	100 (λ=800 nm)	Glass epoxy	
S14644-05	ϕ0.5				1000	1.6			
900 nm band									
S14645-02	ϕ0.2	400 to 1100	195	1.1	600	0.5	100 (λ=900 nm)	Glass epoxy	
S14645-02F*3		850 to 950							
S14645-05	ϕ0.5	400 to 1100				1			
S14645-05F*3		850 to 950							

*1: Area in which a typical gain can be obtained   *2: Value obtained when operated at the gain indicated in the table   *3: With on-chip filter

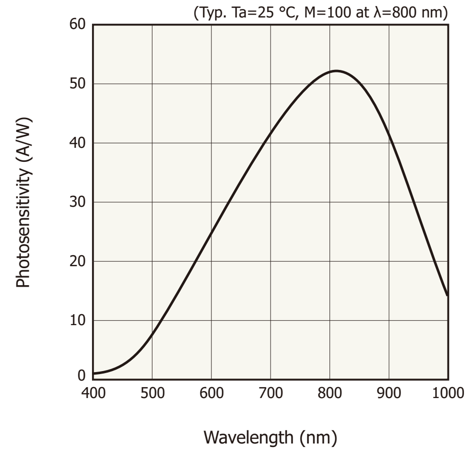
Spectral response

[S14643-02]



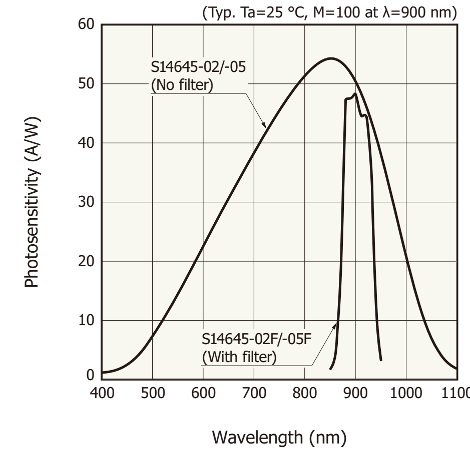
KAPDB0439EA

[S14644 series]



KAPDB0444EA

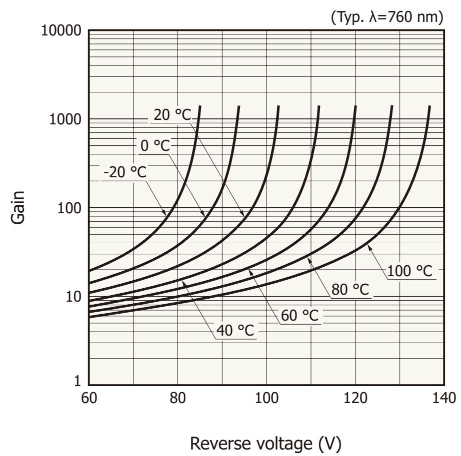
[S14645 series]



KAPDB0436EC

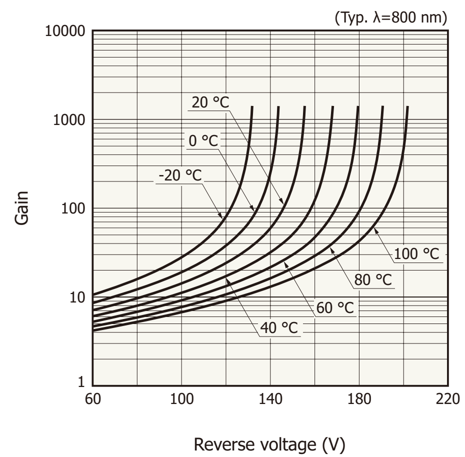
Gain vs. reverse voltage

[S14643-02]



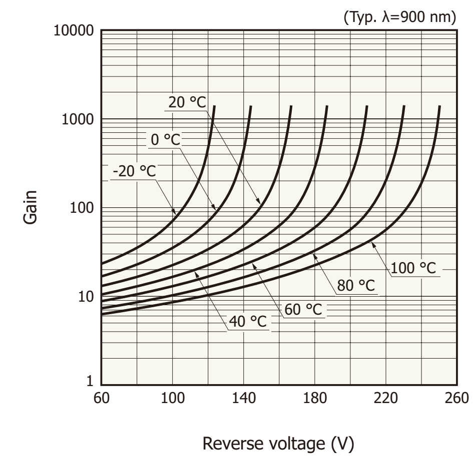
KAPDB0451EA

[S14644 series]



KAPDB0452EA

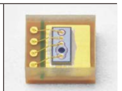
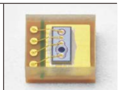
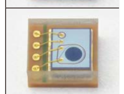
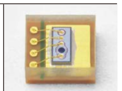
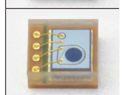
[S14645 series]



KAPDB0449EA

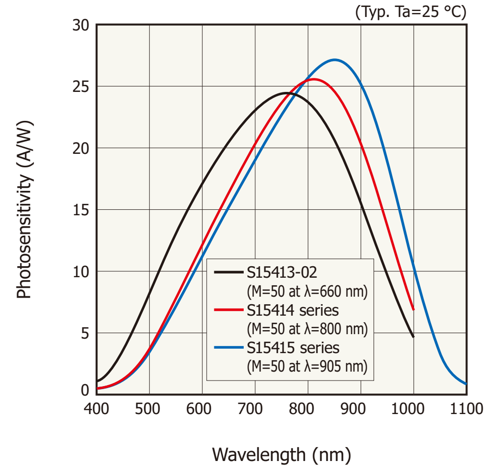
Gain-stabilized type

These are a gain-stabilized APD (GS APD) with a built-in temperature compensation function inside the sensor. This realizes constant gain without the need for temperature adjustment.

Type no.	Effective photosensitive area*1 (mm)	Spectral response range (nm)	Cutoff frequency*2 RL=50 Ω (GHz)	Terminal capacitance*2 f=1 MHz (pF)	Gain*3	Package	
700 nm band							
S15413-02	ϕ0.2	400 to 1000	1.5	0.6	50 (λ=660 nm)	Glass epoxy	
800 nm band							
S15414-02	ϕ0.2	400 to 1000	1.2	0.6	50 (λ=800 nm)	Glass epoxy	
S15414-05	ϕ0.5		1.0	1.4			
900 nm band							
S15415-02	ϕ0.2	400 to 1100	0.5	0.5	50 (λ=905 nm)	Glass epoxy	
S15415-05	ϕ0.5		0.5	1.1			

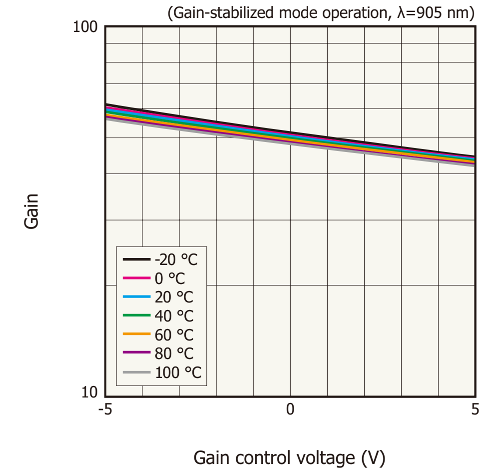
*1: Area in which a typical gain can be obtained
*2: Value obtained when operated at the gain indicated in the table
*3: Gain-stabilized mode operation

Spectral response



KAPDB0664EA

Gain vs. gain control voltage (Typical example: S15415 series)



KAPDB0647EA

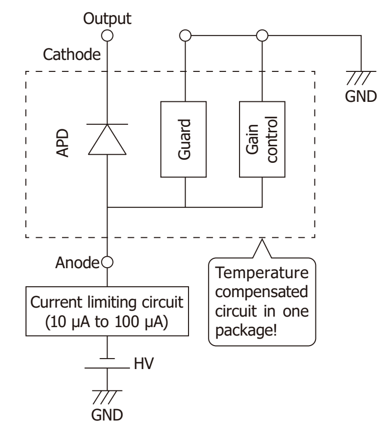
Operating principle of GS APD

The gain is kept constant by passing a current through the temperature compensation circuit built into the APD chip. It is possible to operate the APD at a constant gain without monitoring the operating temperature.

Features

- No need to adjust operating voltage due to temperature change
- No need to adjust operating voltage for APD element-to-element variations
- Adjustable gain by applying voltage to the Gain control terminal

GS APD configuration

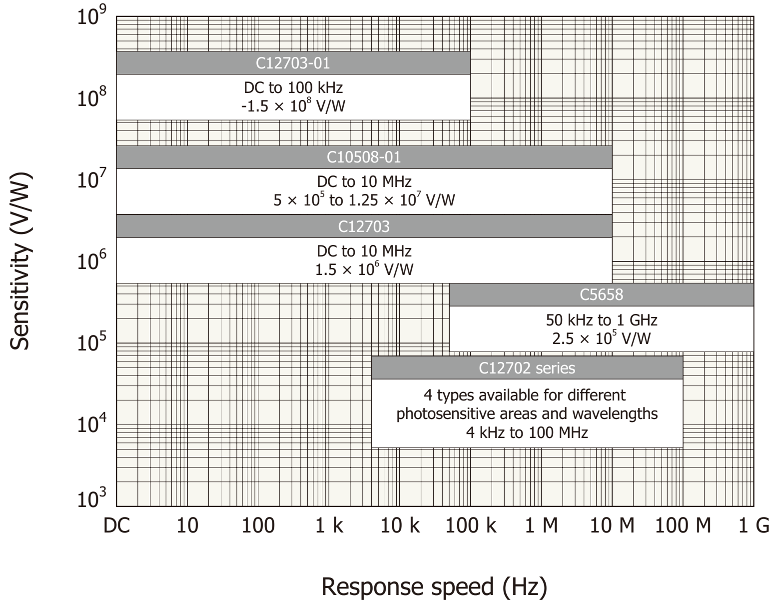


KAPDC0146EA

APD modules

Compact modules integrating APD, low noise amplifier, and bias power supply.

● Sensitivity vs. response speed



KACCB0355EB

Type	Type no.	Features
Standard type	C12702 series	Contains Near-infrared type or short wavelength type APD. FC/SMA fiber adapters are also available.
High-sensitivity type	C12703 series	High gain type for low-light-level detection
High-stability type	C10508-01	Digital temperature compensation type, high stability APD module
High-speed type	C5658	Can be used in a wide-band frequency range (up to 1 GHz)

APD modules

These modules are a compact combination of APD, a low noise amplifier, and a bias power supply.

(Typ., unless otherwise noted)

Type		Type no.	Effective photosensitive area*1 (mm)	Built-in APD	Cutoff frequency		Photoelectric conversion sensitivity (V/W)	Minimum detection limit (nW rms)	Supply voltage (V)	Photo W × D × H (mm)
					Low band	High band				
Standard	For near infrared	C12702-03	ϕ1.0	S12023-10	4 kHz	100 MHz	-6.8×10^4	3	+5	 80 × 50 × 23
		C12702-04	ϕ3.0	S2384		80 MHz	-2.3×10^4	3.6		
	For short wavelength	C12702-11	ϕ1.0	S12053-10	4 kHz	100 MHz	-2.5×10^4	5	+5	
		C12702-12	ϕ3.0	S5344		40 MHz	-1.9×10^4	6.3		
High sensitivity		C12703	ϕ1.5	S3884	DC	10 MHz	1.5×10^6	0.63	±12	 80 × 50 × 23
		C12703-01	ϕ3.0	S2384		100 kHz	-1.5×10^8	0.0063		
High stability		C10508-01	ϕ1.0	S12023-10A	DC	10 MHz	5×10^5 to 1.25×10^7*2	0.063	±5	 60 × 65.6 × 19.6
High speed		C5658	ϕ0.5	S12023-05	50 kHz	1 GHz	2.5×10^5	16	+12	 28 × 50 × 60

*1: Area in which a typical gain can be obtained
*2: Variable gain using a switch

Power supply modules

Making full use of high-voltage power supply technology we accumulated over long years of work with photomultiplier tubes (PMT), we also design high-voltage power supply modules optimized for drive of APD.

Type no.	Input voltage (V)	Max. output voltage (V)	Max. output current (mA)	Ripple / Noise peak to peak (mV)
C14478-03	+4.75 to +5.25	-250	1	10
C14478-53		+250		

- Disclaimer
- Metal, ceramic, plastic package products/Precautions
- Unsealed products/Precautions
- Surface mount type products/Precautions
- Inquiries from online

www.hamamatsu.com

- Information described in this material is current as of June 2025.
- Product specifications are subject to change without prior notice due to improvements or other reasons. Before using these products, always contact us for the delivery specification sheet to check the latest specifications.

HAMAMATSU PHOTONICS K.K.

KAPD0001E14 Jun. 2025 DN

Optical Semiconductor Sales, HAMAMATSU PHOTONICS K.K.
1126-1 Ichino-cho, Chuo-ku, Hamamatsu City, Shizuoka Pref., 435-8558 Japan, Telephone: (81)53-434-3311, Fax: (81)53-434-5184
U.S.A.: HAMAMATSU CORPORATION: 360 Foothill Road, Bridgewater, NJ 08807, U.S.A., Telephone: (1)908-231-0960, Fax: (1)908-231-1218
Germany: HAMAMATSU PHOTONICS DEUTSCHLAND GMBH: Arzbergerstr. 10, 82211 Herrsching am Ammersee, Germany, Telephone: (49)8152-375-0, Fax: (49)8152-265-8 E-mail: info@hamamatsu.de
France: HAMAMATSU PHOTONICS FRANCE S.A.R.L.: 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
United Kingdom: HAMAMATSU PHOTONICS UK LIMITED: 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
North Europe: HAMAMATSU PHOTONICS NORDEN AB: Torshamnsgatan 35, 16440 Kista, Sweden, Telephone: (46)8-509-031-00, Fax: (46)8-509-031-01 E-mail: info@hamamatsu.se
Italy: HAMAMATSU PHOTONICS ITALIA S.R.L.: Strada della Moia, 1 int. 6 20044 Arese (Milano), Italy, Telephone: (39)02-93 58 17 33, Fax: (39)02-93 58 17 41 E-mail: info@hamamatsu.it
China: HAMAMATSU PHOTONICS (CHINA) CO., LTD.: 1201, Tower B, Jiaming Center, 27 Dongsanhuan Beilu, Chaoyang District, 100020 Beijing, P.R. China, Telephone: (86)10-6586-6006, Fax: (86)10-6586-2866 E-mail: hpc@hamamatsu.com.cn
Taiwan: HAMAMATSU PHOTONICS TAIWAN CO., LTD.: 13F-1, No.101, Section 2, Gongdao 5th Road, East Dist., Hsinchu City, 300046, Taiwan(R.O.C) Telephone: (886)3-659-0080, Fax: (886)3-659-0081 E-mail: info@hamamatsu.com.tw
Korea: HAMAMATSU PHOTONICS KOREA CO., LTD.: A-912, 167, Songpa-daero, Seoul, 05855, Korea, Telephone: (82)2-2054-8202, Fax: (82)2-2054-8207 E-mail: sales@hpkr.co.kr