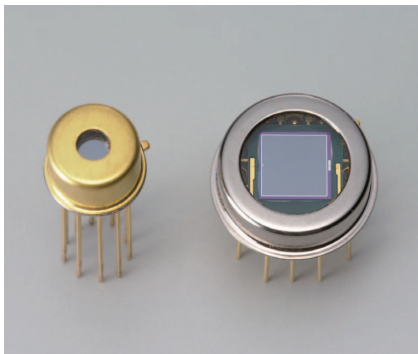


# Si photodiodes with preamp



S8745-01

S8746-01

## Photodiode and preamp integrated with feedback resistance and capacitance

The S8745-01 and S8746-01 are low-noise sensors consisting of Si photodiode, op amp, and feedback resistance and capacitance, all integrated into a small package. By simply connecting to a power supply, the S8745-01 and S8746-01 can be used in low-light-level measurement such as analytical equipment and measurement equipment. The photosensitive area of the photodiode is internally connected to the GND terminal making it highly resistant to EMC noise.

### Features

- Si photodiode for UV to near IR precision photometry
- Small metal package with quartz window  
S8745-01: TO-5  
S8746-01: TO-8
- Photosensitive area  
S8745-01: 2.4 × 2.4 mm  
S8746-01: 5.8 × 5.8 mm
- FET input operational amplifier with low power dissipation
- Built-in  $R_f=1\text{ G}\Omega$  and  $C_f=5\text{ pF}$
- Variable gain with an externally connected resistor
- Low noise and NEP
- Package with shielding effect
- Resistant to EMC noise

### Applications

- Spectrophotometry
- General-purpose optical measurement

The S8745-01 and S8746-01 may be damaged by electro static discharge, etc. Please see precautions in the last page.

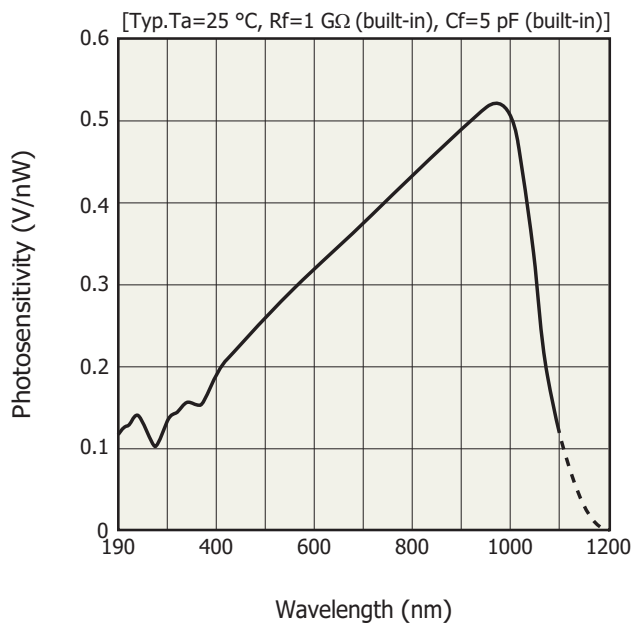
### Absolute maximum ratings (Ta=25 °C)

Parameter	Symbol	Value	Unit
Supply voltage (op amp)	Vcc	±20	V
Power dissipation	P	500	mW
Operating temperature	Topr	-20 to +60	°C
Storage temperature	Tstg	-30 to +80	°C

Note: Exceeding the absolute maximum ratings even momentarily may cause a drop in product quality. Always be sure to use the product within the absolute maximum ratings.

**Electrical and optical characteristics (Typ. Ta=25 °C, Vcc=±15 V, RL=1 MΩ, unless otherwise noted)**

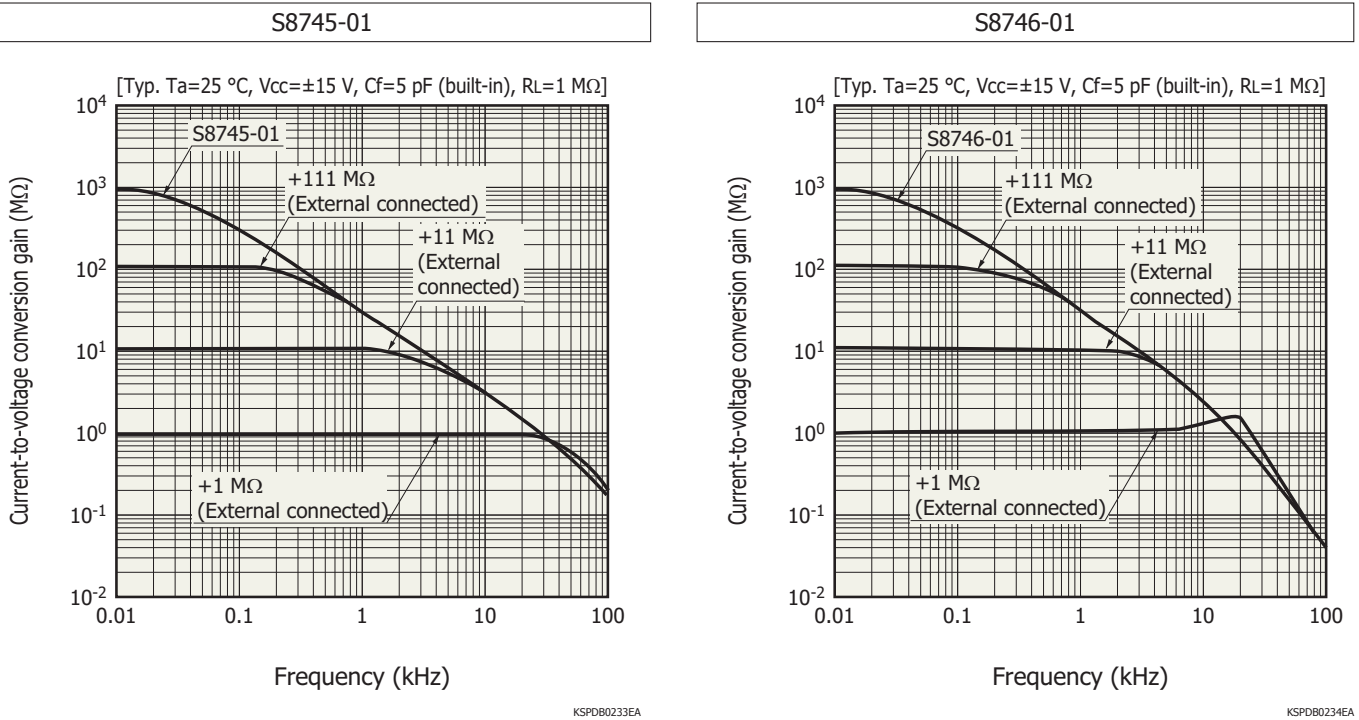
Parameter	Symbol	Condition	S8745-01	S8746-01	Unit
Spectral response range	$\lambda$		190 to 1100		nm
Peak sensitivity wavelength	$\lambda_p$		960		nm
Feedback resistance (built-in)	Rf		1		GΩ
Feedback capacitance (built-in)	Cf		5		pF
Photosensitivity	S	$\lambda=200$ nm	0.12		V/nW
		$\lambda=\lambda_p$	0.52		
Output noise voltage	Vn	Dark state, f=10 Hz	6	7	$\mu\text{V rms/Hz}^{1/2}$
		Dark state, f=20 Hz	5	6	
Noise equivalent power	NEP	$\lambda=\lambda_p$ , f=10 Hz	11	15	$\text{fW/Hz}^{1/2}$
		$\lambda=\lambda_p$ , f=20 Hz	11	15	
Output offset voltage	Vos	Dark state	±4		mV
Cutoff frequency	fc	-3 dB	32		Hz
Output voltage swing	Vo		13		V
Supply current	Icc	Dark state	0.3		mA

**[Figure 1] Spectral response**


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The built-in feedback resistance and capacitance of the S8745-01 and S8746-01 are 1 GΩ and 5 pF, respectively. This combination provides a sensitivity of about 0.1 to 0.5 V/nW in the wavelength range of 190 to 1100 nm.

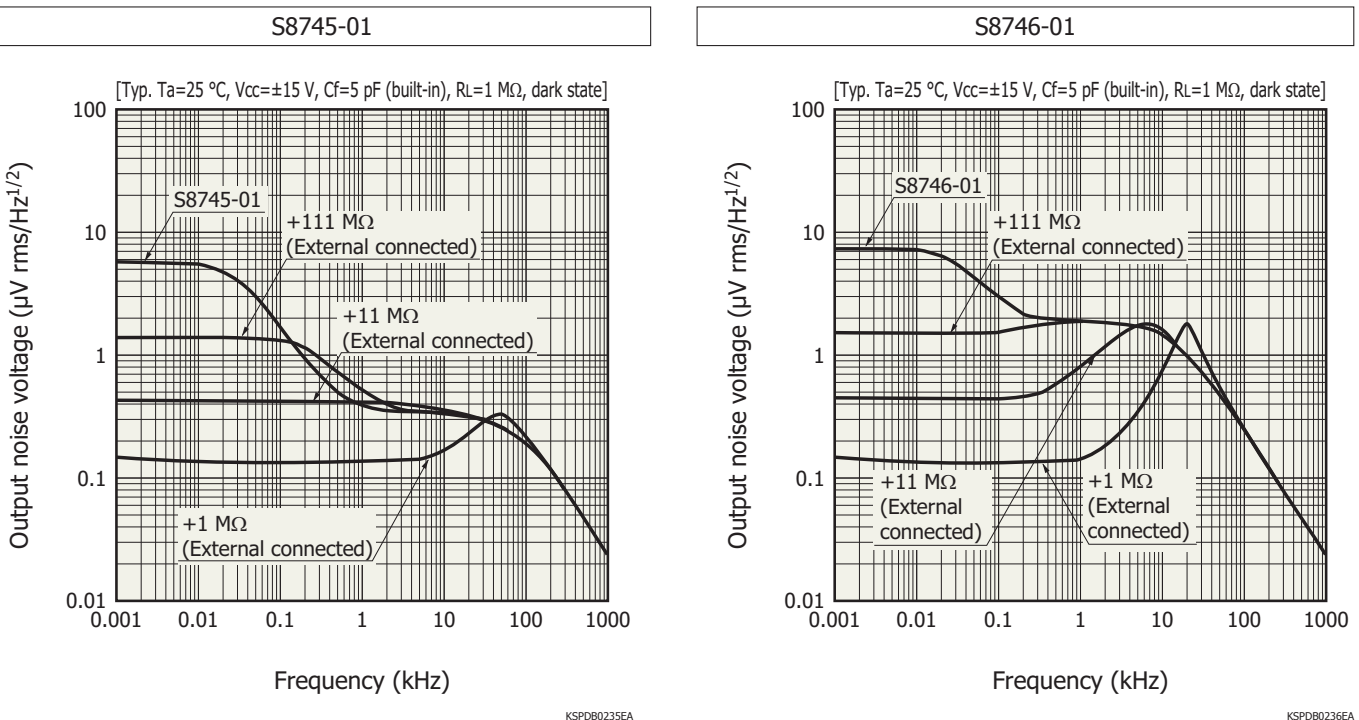
[Figure 2] Gain-frequency characteristics



The current-to-voltage conversion gain can be varied by connecting an external feedback resistor between pins 4 and 6 for the S8745-01, and between pins 9 and 12 for the S8746-01 [Figure 5]. Figure 2 shows the frequency response characteristics of the S8745-01 and S8746-01 with or without an externally connected feedback resistor. Because the S8745-01 and S8746-01 have a built-in resistor of  $1\text{ G}\Omega$ , for example the total feedback resistance will be converted to  $100\text{ M}\Omega$  by externally connecting a resistor of  $111\text{ M}\Omega$ . Choose the desired constant according to the incident light level to be detected.

Note: If the external feedback resistor is  $1\text{ M}\Omega$  or less, gain peaking may occur in the frequency response. Therefore, be sure to connect a matched feedback capacitor for phase compensation.

[Figure 3] Output noise voltage vs. frequency



Output noise voltage and NEP (noise equivalent power) characteristics allow you to check whether the device can detect the low-level light you want to measure. Since NEP is given by the equation (1) as shown at the right, NEP at wavelengths other than  $\lambda_p$  can be easily calculated from Figure 1 and Figures 4.

Note: When the S8745-01 and S8746-01 are used only with the internal current-to-voltage gain, it is recommended that the "-IN" lead (pin 6 for the S8745-01; pin 9 for the S8746-01) be cut off to a short length in order to reduce the influence of external noise as much as possible.

$$\text{NEP}(f, \lambda) = \frac{V_n(f)}{G_{I-V}(f) \cdot S_{Si}(\lambda)} = \frac{\text{NEP}(f, \lambda_p) \cdot S(\lambda_p)}{S(\lambda)} \dots (1)$$

$\text{NEP}(f, \lambda)$  : NEP at frequency and wavelength to be detected

$\text{NEP}(f, \lambda_p)$ : NEP at peak wavelength [Figure 4]

$G_{I-V}(f)$  : Current-to-voltage conversion gain [Figure 2]

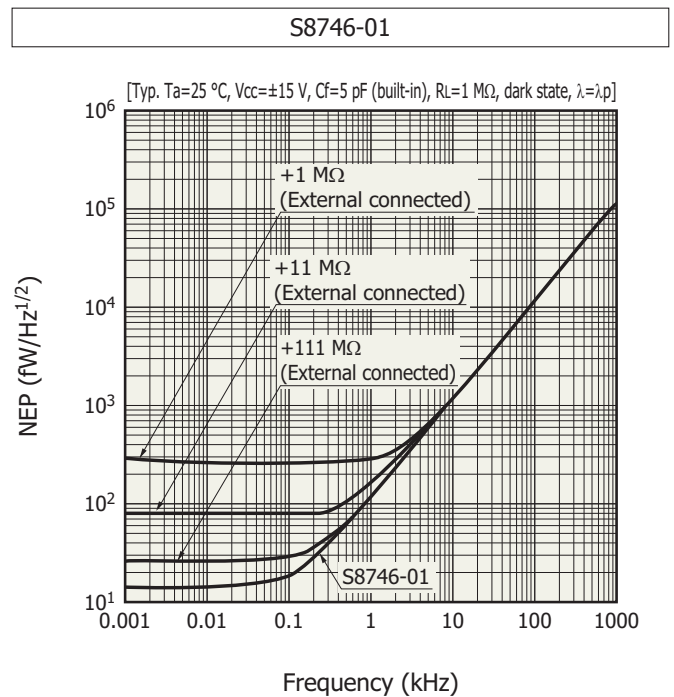
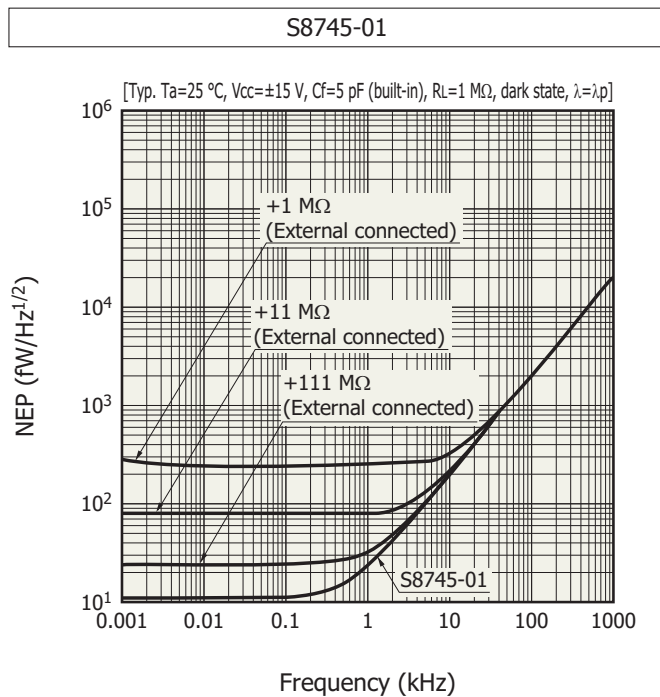
$S_{Si}(\lambda)$  : Sensitivity of Si photodiode

$S(\lambda)$  : Sensitivity of S8745-01 and S8746-01 [Figure 1]

$S(\lambda_p)$  : Sensitivity of S8745-01 and S8746-01 at peak wavelength, 0.5 V/nW

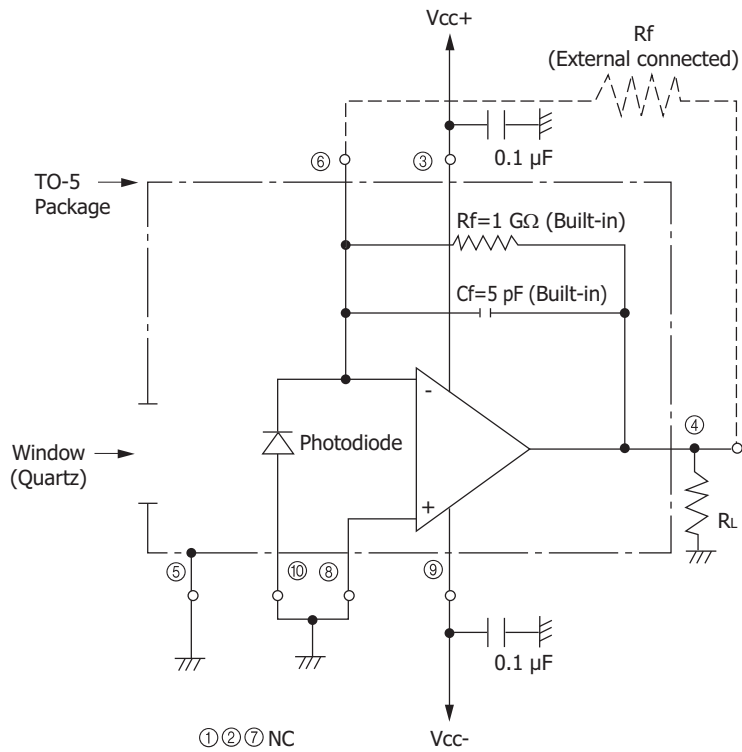
$V_n(f)$  : Output noise voltage [Figure 3]

[Figure 4] NEP vs. frequency



[Figure 5] Application circuit examples

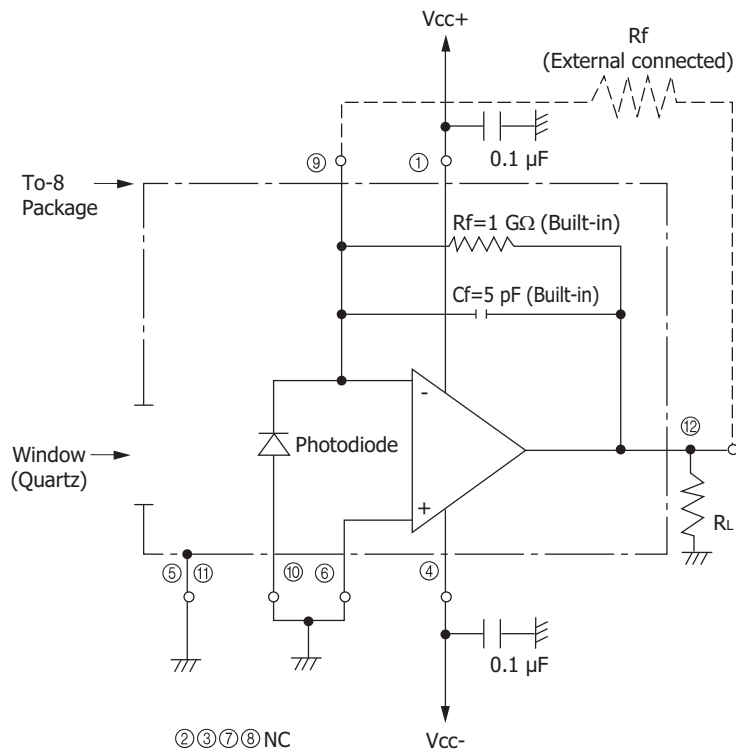
S8745-01



R<sub>L</sub> is the input impedance to the next-stage circuit when viewed from the OUT terminal.

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S8746-01



R<sub>L</sub> is the input impedance to the next-stage circuit when viewed from the OUT terminal.

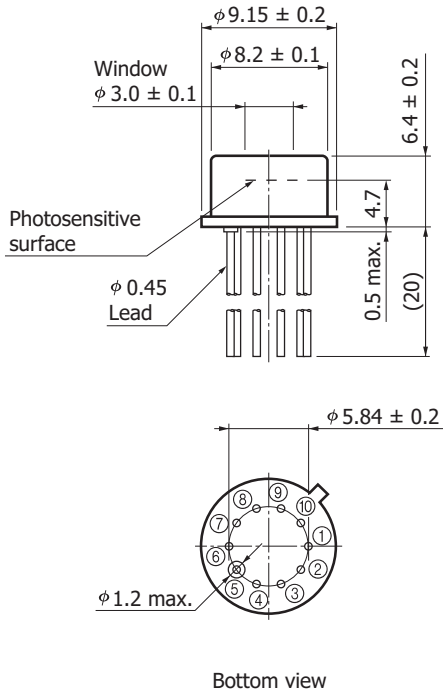
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The S8745-01 and S8746-01 use a package with the guard ring effect provided. To make it effective during measurement, the package leads (pin 5 for the S8745-01; pins 5 and 11 for the S8746-01) should be connected to the ground line. When a feedback resistor is externally connected, it is necessary to provide a guard ring on the circuit board or to provide a teflon standoff for the leads.

Note: A tantalum or ceramic capacitor of 0.1 to 10  $\mu\text{F}$  must be connected to the supply voltage leads (pins 3 and 9 for the S8745-01; pins 1 and 4 for the S8746-01) as a bypass capacitor used to prevent the device from oscillation.

[Figure 6] Dimensional outlines (unit: mm)

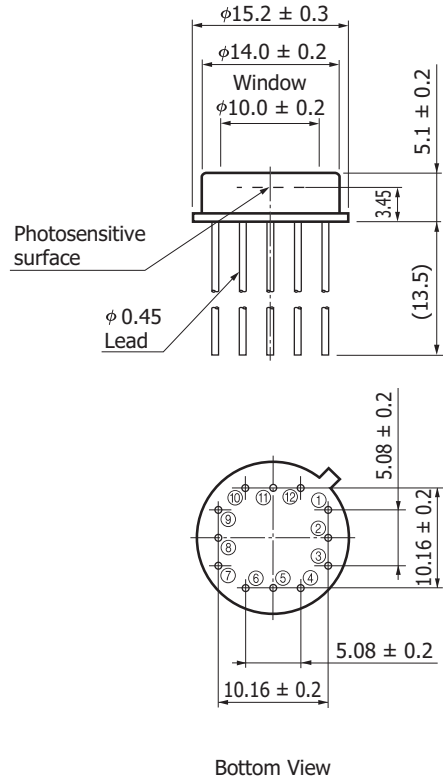
(1) S8745-01



- ① NC
- ② NC
- ③ Vcc+
- ④ OUT
- ⑤ CASE
- ⑥ -IN
- ⑦ NC
- ⑧ +IN
- ⑨ Vcc-
- ⑩ GND

KSPDA0158EA

(2) S8746-01



- ① Vcc+
- ② NC
- ③ NC
- ④ Vcc-
- ⑤ CASE
- ⑥ +IN
- ⑦ NC
- ⑧ NC
- ⑨ -IN
- ⑩ GND
- ⑪ CASE
- ⑫ OUT

KSPDA0159EA

## ⚠ Precautions

### ■ ESD

The S8745-01 and S8746-01 may be damaged or their performance may deteriorate by such factors as electro static discharge from the human body, surge voltages from measurement equipment, leakage voltages from soldering irons and packing materials. As a countermeasure against electro static discharge, the device, operator, work place and measuring jigs must all be set at the same potential. The following precautions must be observed during use:

- To protect the device from electro static discharge which accumulate on the operator or the operator's clothes, use a wrist strap or similar tools to ground the operator's body via a high impedance resistor (1 M $\Omega$ ).
- A semiconductive sheet (1 M $\Omega$  to 100 M $\Omega$ ) should be laid on both the work table and the floor in the work area.
- When soldering, use an electrically grounded soldering iron with an isolation resistance of more than 10 M $\Omega$ .
- For containers and packing, use of a conductive material or aluminum foil is effective. When using an antistatic material, use one with a resistance of 0.1 M $\Omega$ /cm<sup>2</sup> to 1 G $\Omega$ /cm<sup>2</sup>.

### ■ Wiring

If electric current or voltage is applied in reverse polarity to an electronic device such as a preamplifier, this can degrade device performance or destroy the device. Always check the wiring and dimensional outline to avoid misconnection.

### ■ Against UV light exposure

- 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.
- 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

[http://www.hamamatsu.com/sp/ssd/doc\\_en.html](http://www.hamamatsu.com/sp/ssd/doc_en.html)

### ■ Precautions

- Disclaimer
- Metal, ceramic, plastic package products

### ■ Technical information

- Si photodiode / Application circuit examples

Information described in this material is current as of October, 2015.

Product specifications are subject to change without prior notice due to improvements or other reasons. This document has been carefully prepared and the information contained is believed to be accurate. In rare cases, however, there may be inaccuracies such as text errors. Before using these products, always contact us for the delivery specification sheet to check the latest specifications.

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# HAMAMATSU

[www.hamamatsu.com](http://www.hamamatsu.com)

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

U.S.A.: Hamamatsu Corporation: 360 Foothill Road, Bridgewater, N.J. 08807, U.S.A., Telephone: (1) 908-231-0960, Fax: (1) 908-231-1218

Germany: Hamamatsu Photonics Deutschland GmbH: Arzbergerstr. 10, D-82211 Herrsching am Ammersee, Germany, Telephone: (49) 8152-375-0, Fax: (49) 8152-265-8

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

United Kingdom: Hamamatsu Photonics UK Limited: 2 Howard Court, 10 Tewin Road, Welwyn Garden City, Hertfordshire AL7 1BW, United Kingdom, Telephone: (44) 1707-294888, Fax: (44) 1707-325777

North Europe: Hamamatsu Photonics Norden AB: Torshamnsgatan 35 16440 Kista, Sweden, Telephone: (46) 8-509-031-00, Fax: (46) 8-509-031-01

Italy: Hamamatsu Photonics Italia S.r.l.: Strada della Moia, 1 int. 6, 20020 Arese (Milano), Italy, Telephone: (39) 02-93581733, Fax: (39) 02-93581741

China: Hamamatsu Photonics (China) Co., Ltd.: B1201, Jiaming Center, No.27 Dongsanhuan Beilu, Chaoyang District, Beijing 100020, China, Telephone: (86) 10-6586-6006, Fax: (86) 10-6586-2866