

Si photodiode with preamp S8745-01, S8746-01

Photodiode and preamp integrated with feedback resistance and capacitance



S8745-01, 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, S8745-01 and S8746-01 can be used in low-light-level measurement such as analytical equipment and measurement equipment. The active 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 hermetic sealed package with quartz window
S8745-01: TO-5
S8746-01: TO-8
- Active 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

S8745-01, S8746-01 may be damaged by Electro Static Discharge, etc. Please see Precautions for use in the last page.

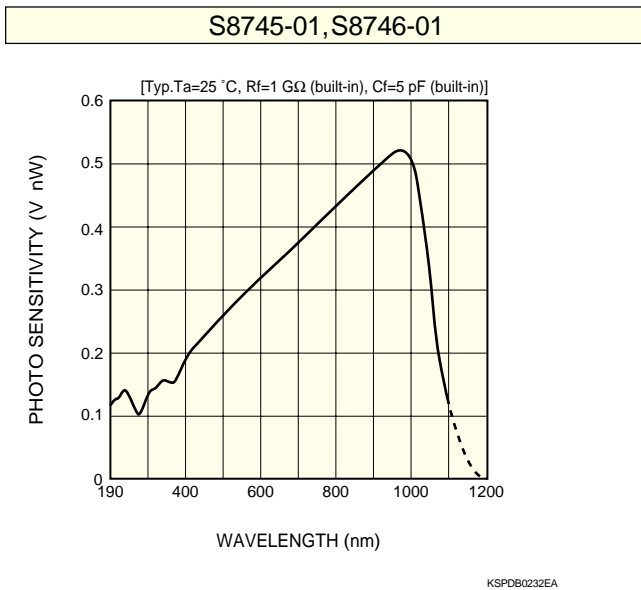
■ Absolute maximum ratings (Ta=25 °C)

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

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

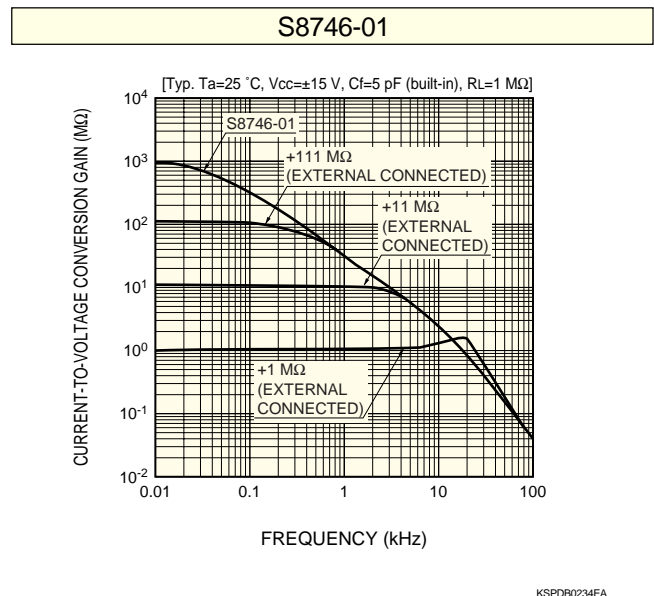
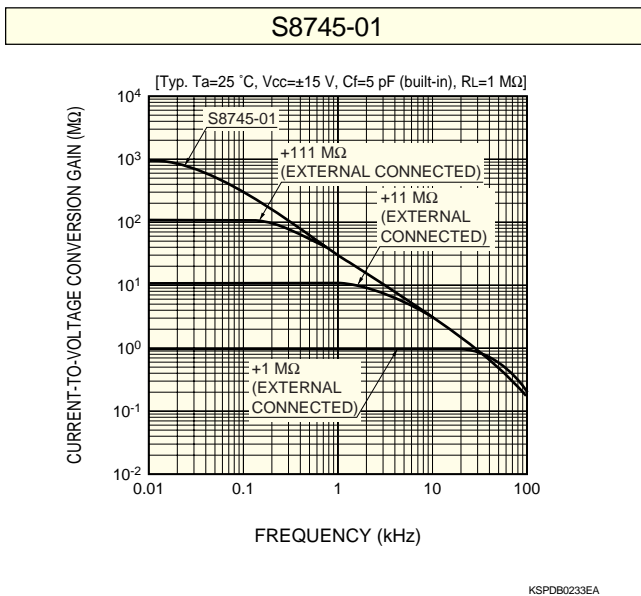
Parameter	Symbol	Condition	S8745-01	S8746-01	Unit
Spectral response range	λ		190 to 1100		nm
Peak sensitivity wavelength	λ_p		960		nm
Feedback resistance (built-in)	Rf		1		GΩ
Feedback capacitance (built-in)	Cf		5		pF
Photo sensitivity	S	$\lambda=200\text{ nm}$	0.12		V/nW
		$\lambda=\lambda_p$	0.52		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

Figure 1 Spectral response



The built-in feedback resistance and capacitance of S8745-01 and S8746-01 are $1\text{ G}\Omega$ 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 .

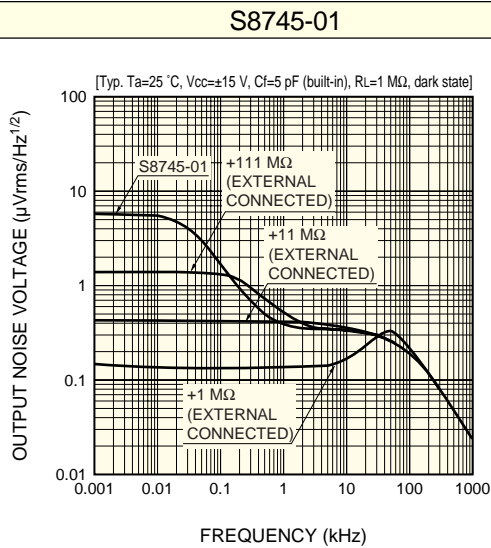
Figure 2 Gain-frequency characteristics



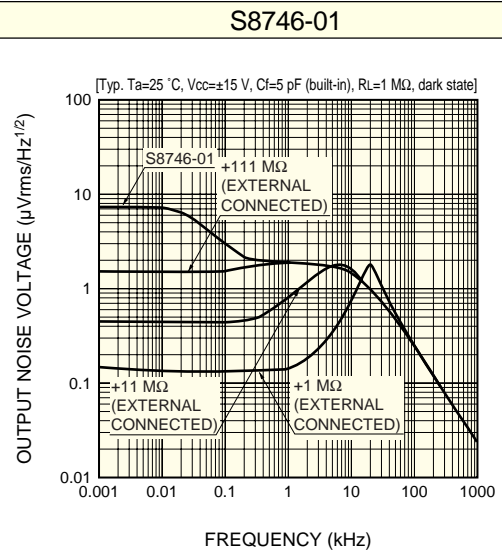
The current-to-voltage conversion gain can be varied by connecting an external feedback resistor between pins 4 and 6 for S8745-01, and between pins 9 and 12 for S8746-01 (see figure 5). Figure 2 shows the frequency response characteristics of S8745-01 and S8746-01 with or without an externally connected feedback resistor. Because 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



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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 λ_p can be easily calculated from Figure 1 and Figures 4.

Note) When 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 S8745-01; pin 9 for S8746-01) be cut off to a short length in order to reduce the influence of external noise as much as possible.

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

NEP (f, λ) : NEP at frequency and wavelength to be detected

NEP (f, λ_p): NEP at peak wavelength (See Figures 4)

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

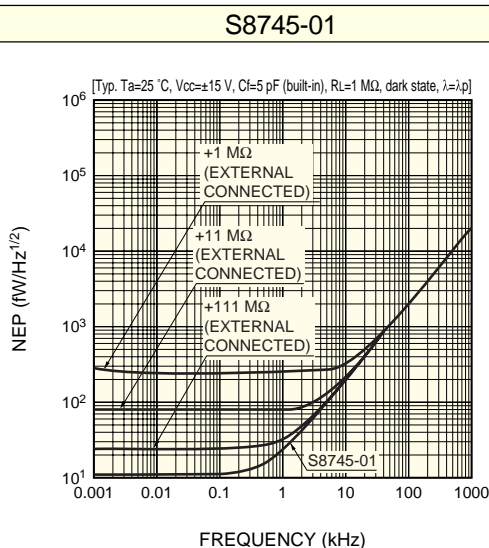
$S_{Si}(\lambda)$: Sensitivity of Si photodiode

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

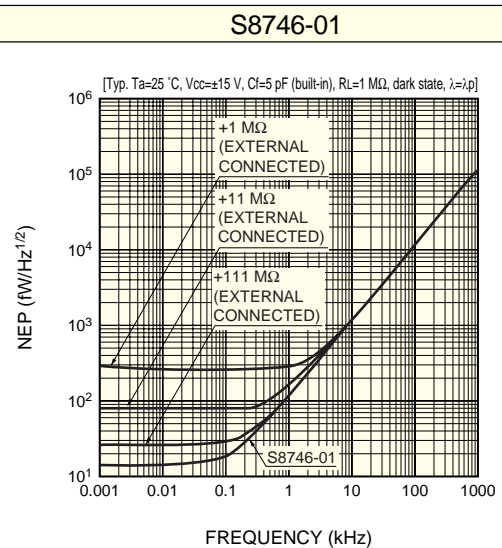
$S(\lambda_p)$: Sensitivity of S8745-01 and S8746-01 at peak wavelength, 0.5 V/nW

$V_n(f)$: Output noise voltage (See Figure 3)

Figure 4 NEP vs. frequency

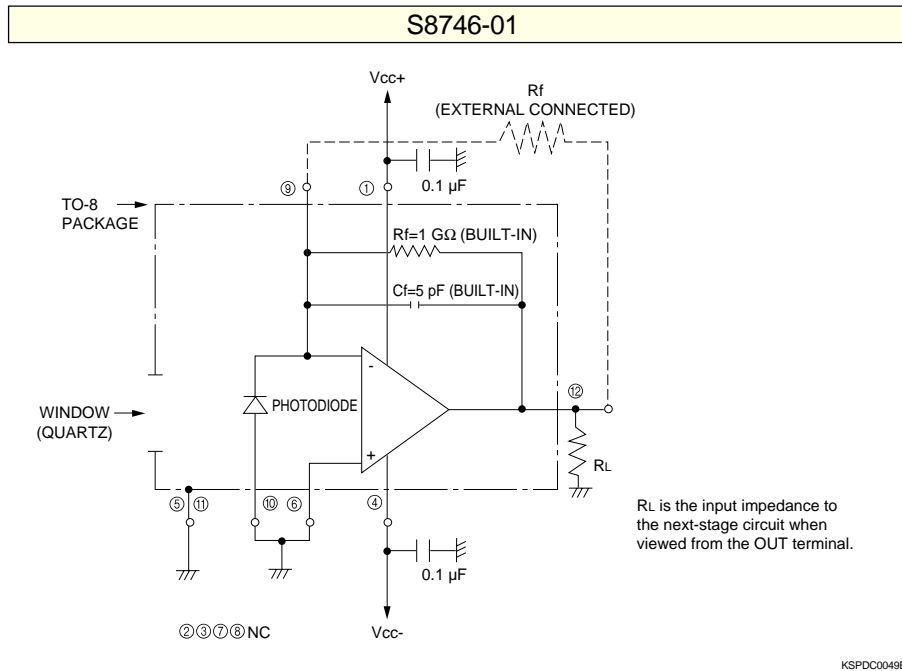
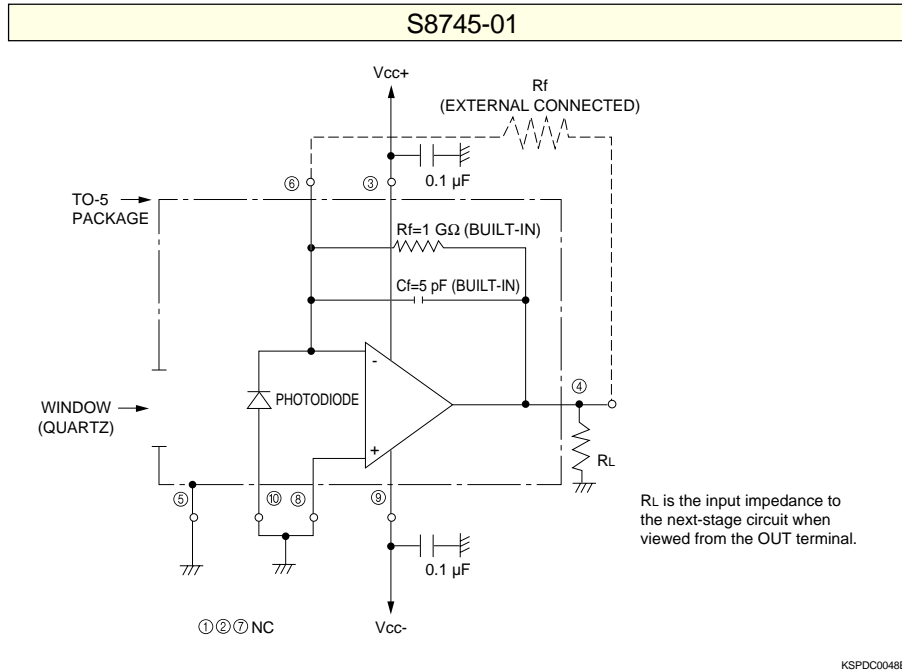


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Figure 5 Application circuit example

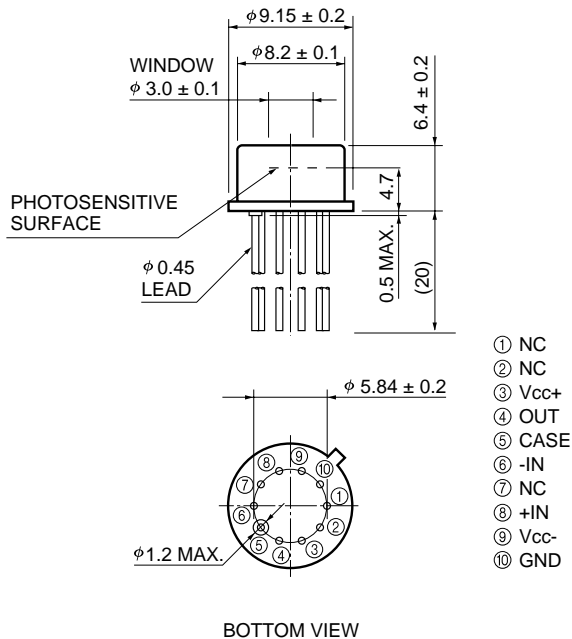


S8745-01 and S8746-01 use a package with the guard ring effect provided. To make it effective during measurement, the package leads (pin 5 for S8745-01; pins 5 and 11 for S8746-01) should be connected to the ground line. When a feedback resistor is externally connected, it is necessary to provide a guard 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 μ F must be connected to the supply voltage leads (pins 3 and 9 for S8745-01; pins 1 and 4 for S8746-01) as a bypass capacitor used to prevent the device from oscillation.

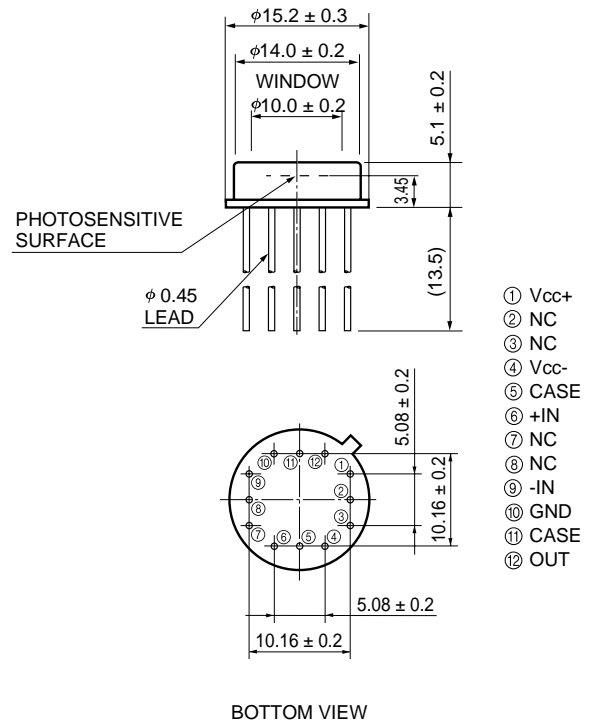
Figure 6 Dimensional outlines (unit: mm)

① S8745-01



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② S8746-01



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Precautions for Use

● ESD

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 Ω).
- A semiconductive sheet (1 M Ω to 100 M Ω) 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 Ω .
- 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 Ω /cm² to 1 G Ω /cm².

● 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.

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Cat. No. KSPD1065E01
Dec. 2004 DN