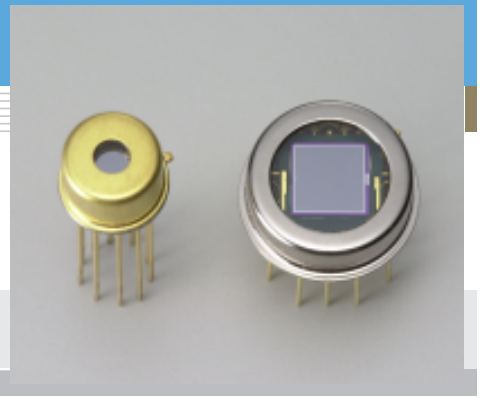


Si photodiode with preamp S8745, S8746

Photodiode and preamp integrated with feedback resistance and capacitance



S8745, S8746 are low-noise light sensors consisting of a large area Si photodiode, op amp, and feedback resistance and capacitance, all integrated into a small package. By simply connecting to a power supply, S8745 and S8746 can be used in low-light-level measurement such as spectrophotometry.

Features

- Si photodiode for UV to near IR precision photometry
- Small package with quartz window
S8745: TO-5
S8746: TO-8
- 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
- Guard ring structure for low level signal

Applications

- Spectrophotometry
- General-purpose optical measurement

General ratings / Absolute maximum ratings

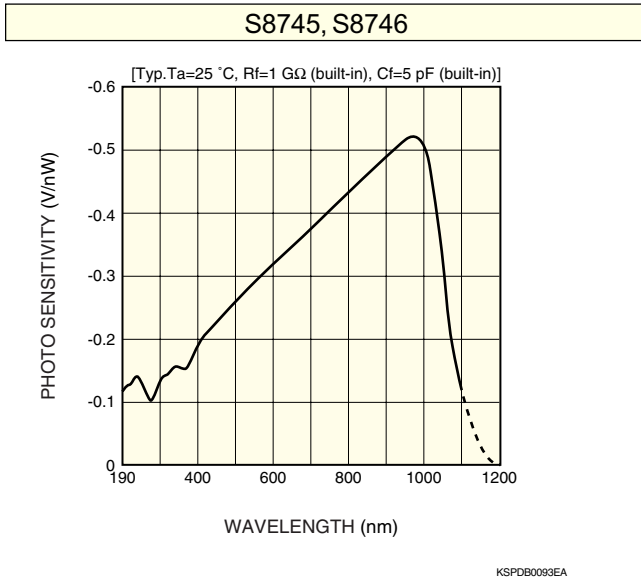
| Type No. | Dimensional outline/ Window material * | Active area size (mm) | Package | Number of terminals | Absolute maximum ratings | | | | |
|----------|---|--------------------------|---------|---------------------|---|---|--------------------------|--|--|
| | | | | | Supply voltage (op amp) V_{CC} (V) | Reverse voltage (photodiode) V_R (V) | Power dissipation P (mW) | Operating temperature T_{opr} ($^{\circ}\text{C}$) | Storage temperature T_{stg} ($^{\circ}\text{C}$) |
| S8745 | ①/Q | 2.4×2.4 | TO-5 | 10 | ± 20 | 5 | 500 | -20 to +60 | -30 to +80 |
| S8746 | ②/Q | 5.8×5.8 | TO-8 | 12 | | | | | |

Electrical and optical characteristics (Typ. $T_a=25\text{ }^{\circ}\text{C}$, $V_{CC}=\pm 15\text{ V}$, $R_L=1\text{ M}\Omega$, unless otherwise noted)

| Type No. | Spectral response range λ (nm) | Peak sensitivity wavelength λ_p (nm) | Feedback resistance R_f (built-in) ($\text{G}\Omega$) | Feedback capacitance C_f (built-in) (pF) | Photo sensitivity S (V/nW) | | Output noise voltage V_n Dark state $f=10\text{ Hz}$ ($\mu\text{Vrms}/\text{Hz}^{1/2}$) | Noise equivalent power NEP $\lambda=\lambda_p$ (fW/Hz $^{1/2}$) | | Output offset voltage V_{os} Dark state (mV) | Cut-off frequency f_c (Hz) | Supply current I_{CC} Dark state (mA) |
|----------|--|--|---|--|----------------------------|---------------------|--|--|------------------|--|---------------------------------|---|
| | | | | | $\lambda=200\text{ nm}$ | $\lambda=\lambda_p$ | | $f=10\text{ Hz}$ | $f=20\text{ Hz}$ | | | |
| | | | | | S8745 | 190 to 1100 | | 960 | 1 | | | |
| S8746 | | | | | | | 7 | 15 | 15 | | | |

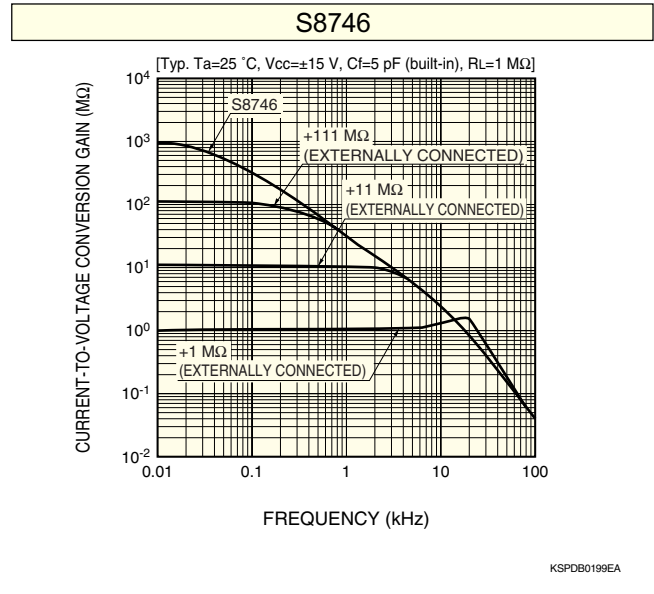
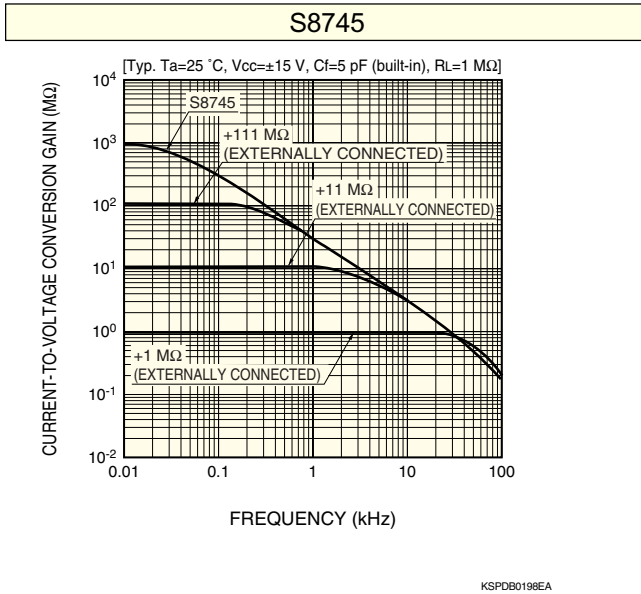
* Window material Q: quartz glass

Figure 1 Spectral response



The built-in feedback resistance and capacitance of S8745 and S8746 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.

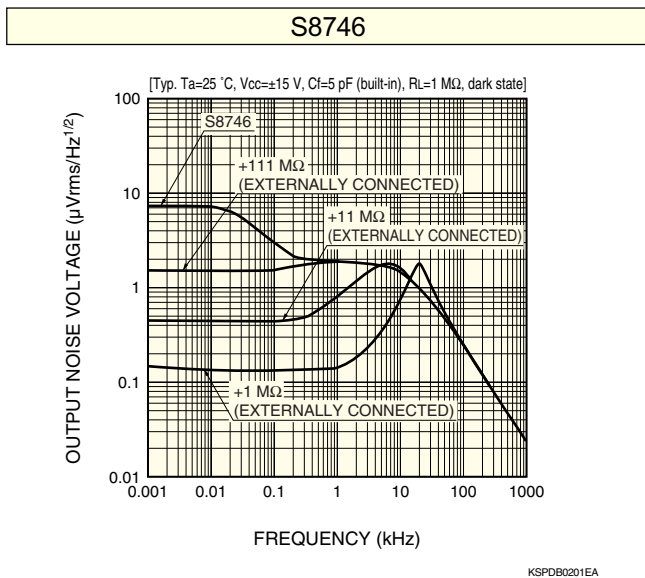
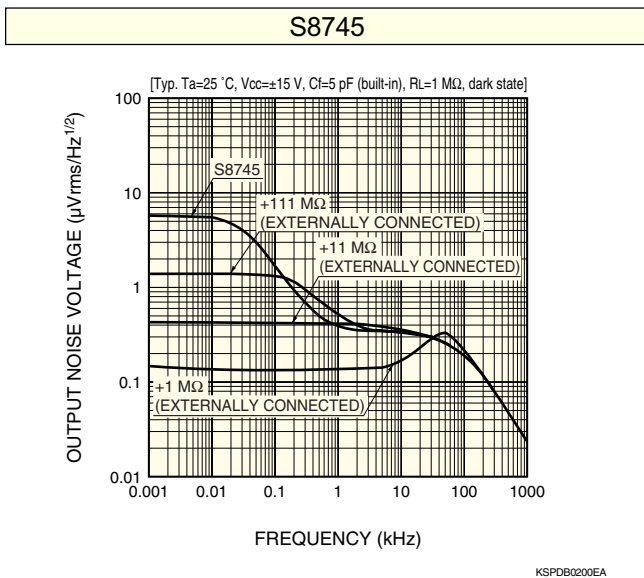
Figure 2 Gain-frequency characteristics



The current-to-voltage conversion gain can be varied by connecting an external feedback resistor between pins 4 and 6 for S8745, and between pins 9 and 12 for S8746 (see figure 5). Figure 2 shows the frequency response characteristics of S8745 and S8746 with or without an externally connected feedback resistor. Because S8745 and S8746 have a built-in resistor of 1 GΩ, for example the total feedback resistance will be converted to 100 MΩ by externally connecting a resistor of 111 MΩ. Choose the desired constant according to the incident light level to be detected.

Note) If the external feedback resistor is 1 MΩ 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 λ_p can be easily calculated from Figure 1 and Figures 4.

Note) When S8745 and S8746 are used only with the internal current-to-voltage gain, it is recommended that the "-IN" lead (pin 6 for S8745; pin 9 for S8746) 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 and S8746 (See Figure 1.)
- $S(\lambda_p)$: Sensitivity of S8745 and S8746 at peak wavelength, 0.5 V/nW
- $V_n(f)$: Output noise voltage (See Figure 3)

Figure 4 NEP vs. frequency

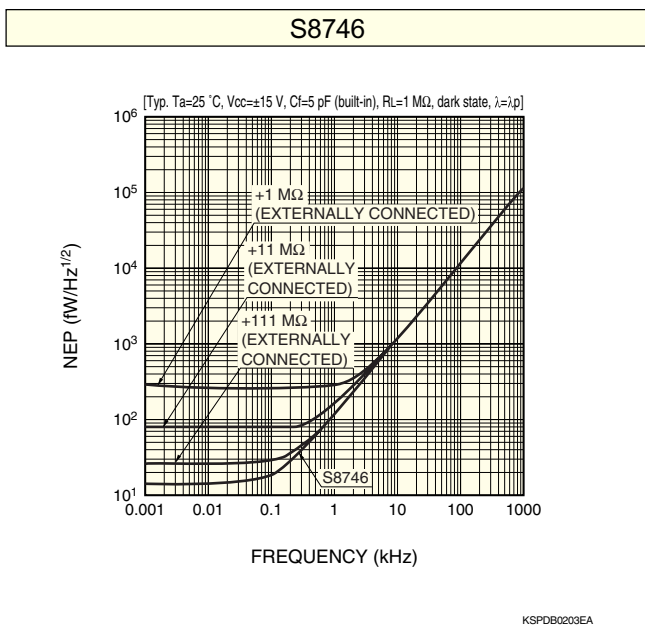
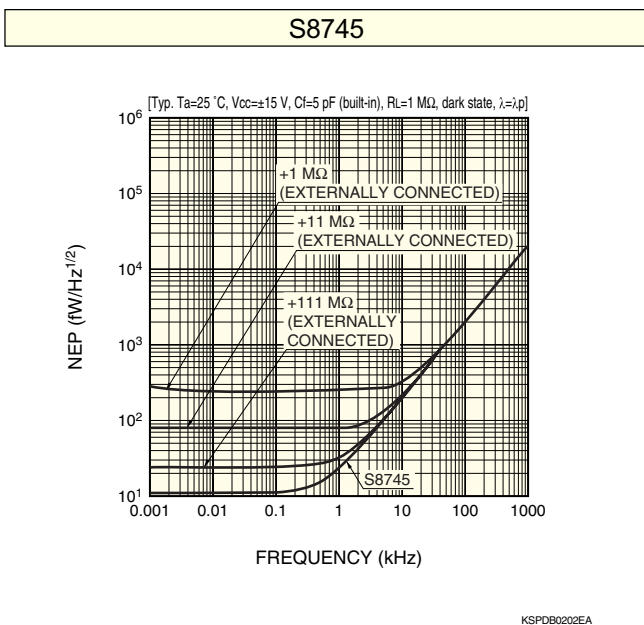
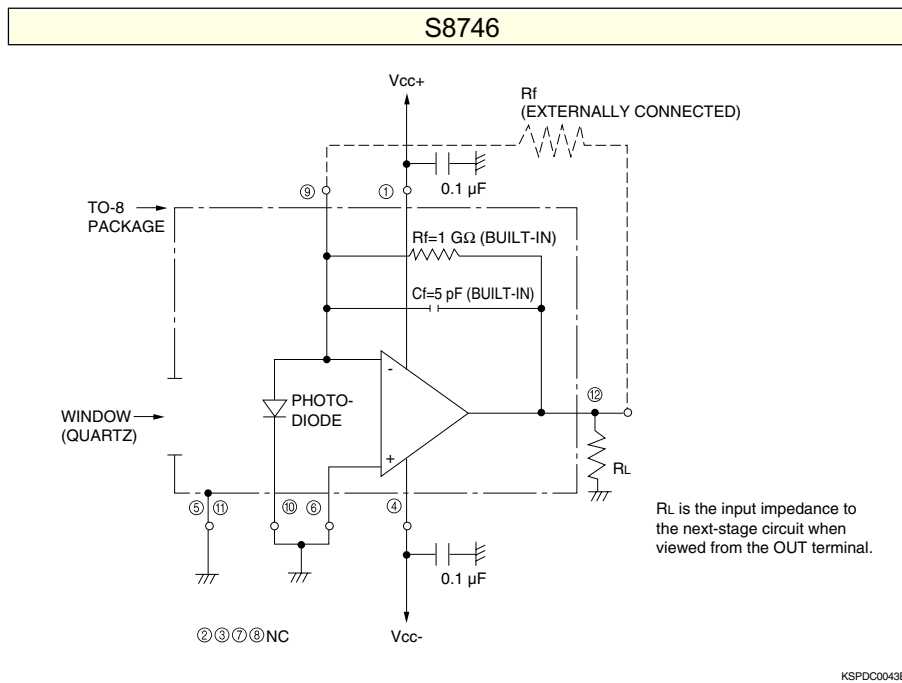
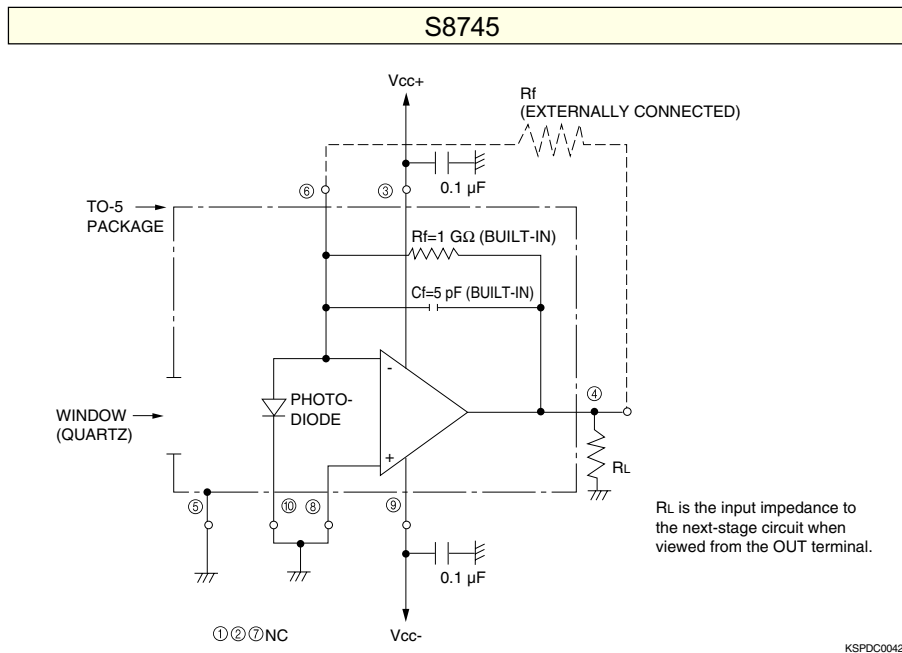


Figure 5 External connection example



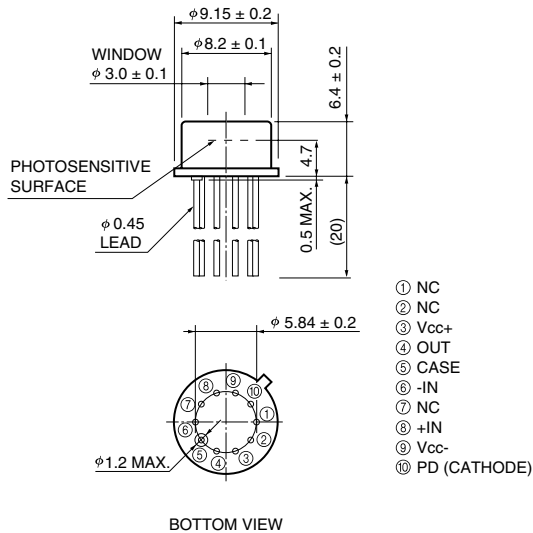
S8745 and S8746 use a package with the guard ring effect provided. To make it effective during measurement, the package leads (pin 5 for S8745; pins 5 and 11 for S8746) should be connected to the ground line.

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; pins 1 and 4 for S8746) as a bypass capacitor used to prevent the device from oscillation.

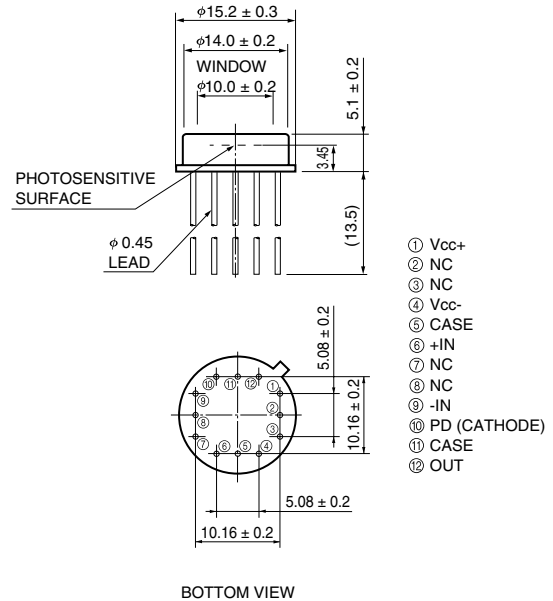
Figure 6 Dimensional outlines (unit: mm)

① S8745



KSPDA0148EA

② S8746



KSPDA0149EA

Precautions for Use

● ESD

S8745 and S8746 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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