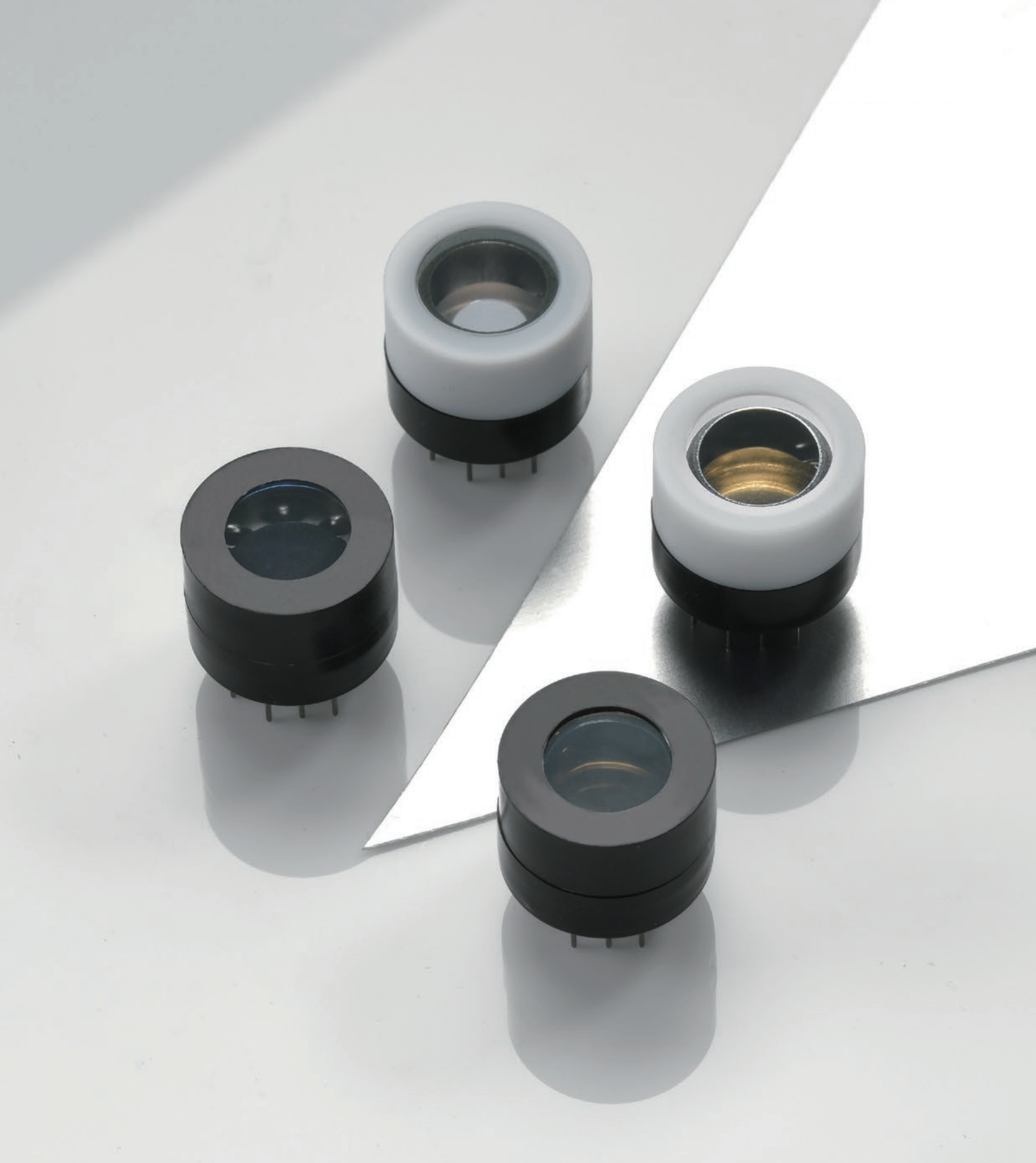
HAMAMATSU

PHOTON IS OUR BUSINESS

Phototubes



Features and applications

Features

High sensitivity and high stability	High sensitivity and high stability make phototubes very useful in chemical and medical analytical instruments which require high reliability.
Wide dynamic range	Phototubes feature a wide dynamic range from several picoamperes to several microamperes, providing signal output with excellent linearity.
Superior temperature stability	Phototubes show virtually no fluctuation with changes in the ambient temperature.
Large photosensitive area	Compared to semiconductor sensors, phototubes offer larger photosensitive area.
Low voltage operation	Phototubes are designed to operate at a low voltage.

Spectral response range and applications

Spectral range	Photocathode	Window material	Spectral response	Typical applications	Applicable phototube Type No.
Vacuum UV region only	Cs-I	MgF_2	115 nm to 200 nm	VUV light monitor	R6800U-24
		Silica glass	160 nm to 200 nm		R6800U-14
	Diamond	MgF_2	115 nm to 220 nm	126 nm, 146 nm monitor for excimer lamp	R6800U-26
		Silica glass	160 nm to 220 nm	172 nm monitor for excimer lamp	R6800U-16
Solar blind spectral response	Au (single metal)	Silica glass	160 nm to 240 nm	185 nm monitor for sterilizing mercury lamp	R6800U-15
	Cs-Te	MgF_2	115 nm to 350 nm	VUV to UV light monitor	R6800U-21
		Silica glass	160 nm to 350 nm	185 nm, 254 nm monitor for mercury line spectrum	R6800U-11
		UV glass	185 nm to 350 nm	Ozone monitor, UV sterilization light monitor	R6800U-01
Wide spectral response from UV to visible	Bialkali	UV glass	185 nm to 650 nm	Photometer	R6800U-08
		Borosilicate	300 nm to 650 nm	Blood analyzer	R6800U-48
Wide spectral response from UV to infrared	Multialkali	UV glass	185 nm to 850 nm	Pollution monitor	R6800U-09
		UV glass	185 nm to 850 nm	Thickness measurement	R6800U-010

Glossary of terms

- **Spectral response characteristic:**
  When light (photons) enters the photocathode, it is converted into electrons emitting from the photocathode at a certain ratio. This ratio depends on the wavelength of incident light. The relationship between the ratio and the wavelength is called spectral response characteristic.

- **Peak wavelength:**
  The wavelength gives the maximum sensitivity to the photocathode. In this catalog, the peak wavelength for radiant sensitivity (A/W) is listed.

- **Absolute maximum ratings:**
  The limiting values of the operating and environmental conditions applied to a phototube. Any conditions shall not exceed these ratings even instantaneously.

- **Anode supply voltage:**
  The voltage applied across the anode and the cathode. Normally, the cathode is used at ground potential, so the anode supply voltage equals the potential difference between the anode and ground.

- **Peak cathode current:**
  The peak current that can be allowed from the cathode when it is of pulse waveform.

- **Average cathode current:**
  The average current that can be allowed from the cathode. Normally, it is the average for 30 seconds.

- **Average cathode current density:**
  The average cathode current per unit surface area on the photocathode.

- **Luminous sensitivity:**
  The ratio of photocurrent in amperes (A) flowing in the photocathode to the incident luminous flux in lumens (lm).

$$\text{Luminous sensitivity (A/lm)} = \frac{\text{Current (A)}}{\text{Luminous flux (lm)}}$$

- **Radiant sensitivity:**
  The ratio of photocurrent in amperes (A) flowing in the photocathode to the intensity of the incident light in watts (W).

$$\text{Radiant sensitivity (A/W)} = \frac{\text{Current (A)}}{\text{Light intensity (W)}}$$

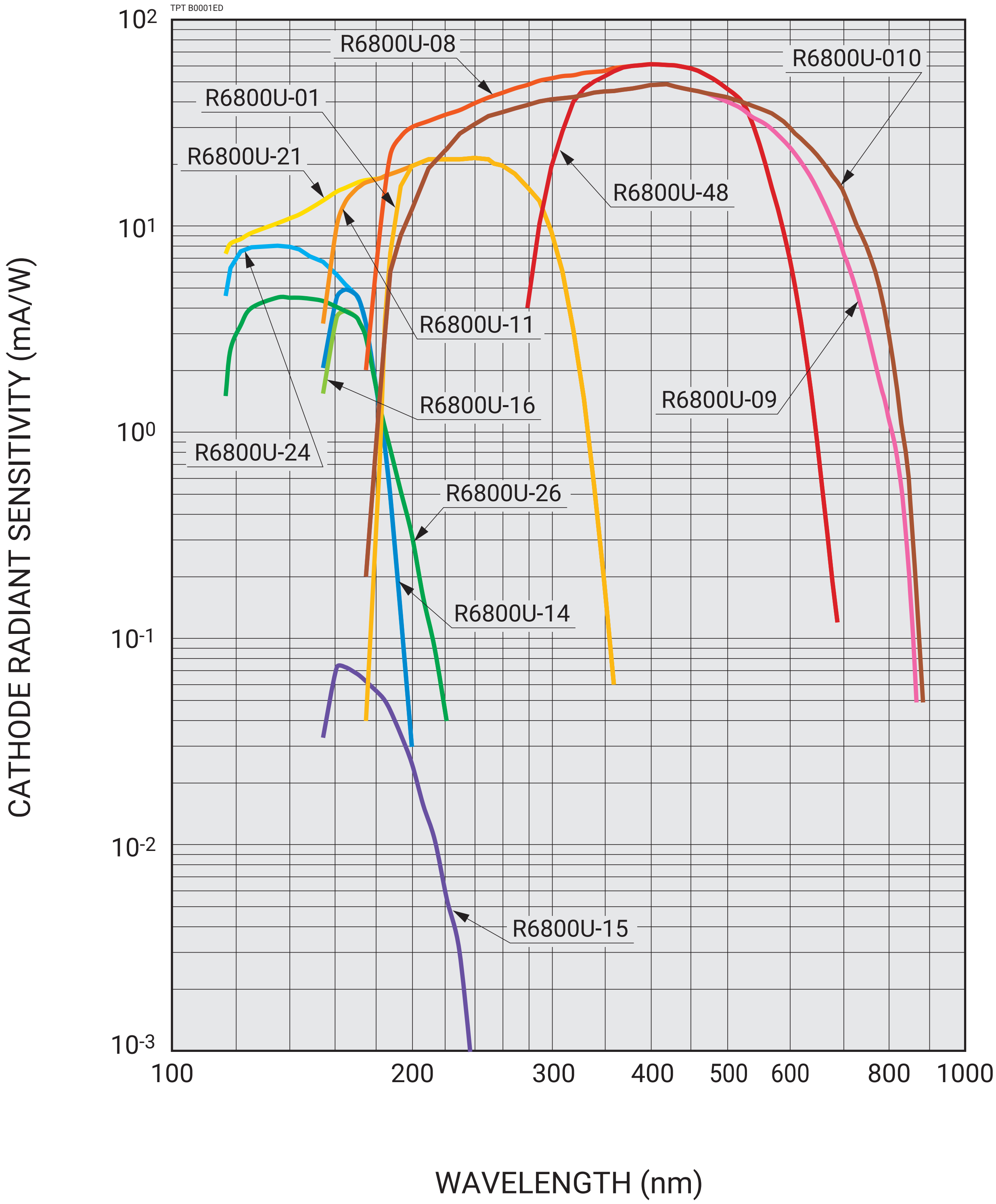
- **Dark Current:**
  The current flowing between the anode and the cathode when light is removed.

- **Interelectrode capacitance:**
  The electrostatic capacitance between the anode and the cathode.

- **Recommended operating voltage:**
  The lifetime of a phototube tends to become shortened as the supply voltage increases. The supply voltage should be made as low as possible as compared to the maximum ratings, in order to lengthen useful life. However, if the supply voltage is too low, the voltage current characteristics fall outside the saturation region, and undesirable phenomena such as hysteresis (Note 1) may occur. Considering these effects, the recommended operating voltage for each type of phototube is listed in this catalog.

(Note 1) Hysteresis: The temporary instability in output signal when light is applied to a phototube, showing "overshoot" or "undershoot" without being proportional to light input.

Spectral response characteristics



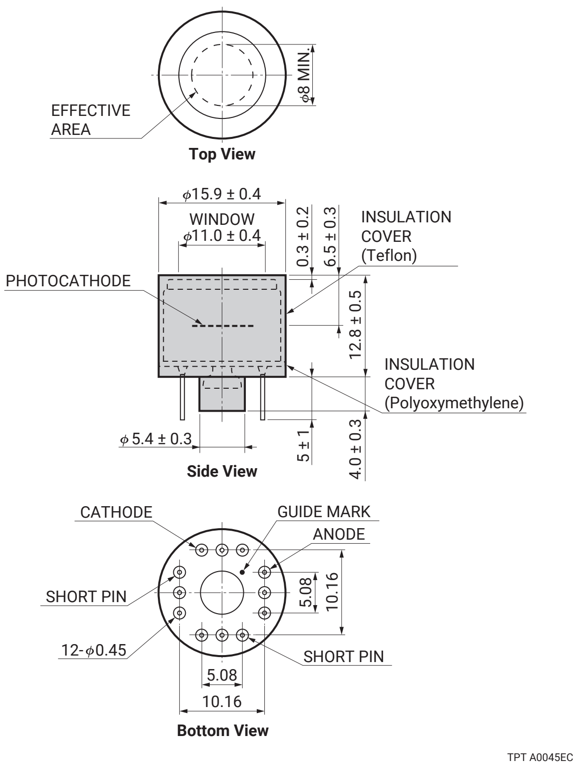
Characteristics

Type No.	Ⓐ Spectral response (nm)	Peak wave-length (nm)	Outline diagram No.	Tube diameter (mm)	Photocathode area Min. (mm)	Input window material	Absolute maximum ratings: Anode supply voltage (V)	Absolute maximum ratings: Peak cathode current (μA)	Absolute maximum ratings: Average cathode current density (μA/cm^2)	Absolute maximum ratings: Ⓑ Average cathode current (μA)
For vacuum UV (Cs-I photocathode)										
R6800U-24	115 to 200	130	❶	ϕ16	ϕ8	MgF_2	100	1	0.5	0.1
R6800U-14	160 to 200	165	❶	ϕ16	ϕ8	Silica glass	100	1	0.5	0.1
For vacuum UV (Diamond photocathode)										
R6800U-26	115 to 220	135	❷	ϕ16	ϕ6	MgF_2	100	1.2	5	0.4
R6800U-16	160 to 220	165	❷	ϕ16	ϕ6	Silica glass	100	10	50	4
For UV / High power (Au single metal photocathode)										
R6800U-15	160 to 240	165	❶	ϕ16	ϕ8	Silica glass	100	1.2	5	0.4
For UV / General purpose (Cs-Te photocathode)										
R6800U-21	115 to 350	240	❶	ϕ16	ϕ8	MgF_2	100	1.2	5	0.4
R6800U-11	160 to 350	240	❶	ϕ16	ϕ8	Silica glass	100	1.2	5	0.4
R6800U-01	185 to 350	240	❸	ϕ16	ϕ8	UV glass	100	1.2	5	0.4
For UV to visible (Bialkali)										
R6800U-08	185 to 650	400	❸	ϕ16	ϕ8	UV glass	100	2	5	0.5
R6800U-48	300 to 650	400	❸	ϕ16	ϕ8	Borosilicate glass	100	2	5	0.5
For UV to Near-infrared (Multialkali)										
R6800U-09	185 to 850	420	❸	ϕ16	ϕ8	UV glass	100	1.2	1	0.5
R6800U-010	185 to 850	420	❹	ϕ16	ϕ8	UV glass	100	1	0.5	0.25

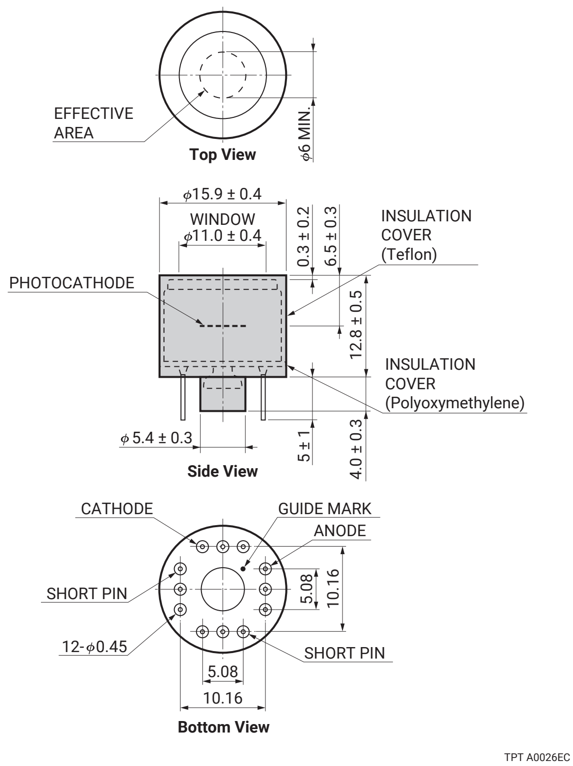
NOTE: ⒶSee spectral response characteristics on page 2.
ⒷOutput current averaged over 1 second time interval. The whole photocathode is uniformly illuminated.

Dimensional outlines (Unit: mm)

❶ R6800U-11, -14, -15, -21, -24



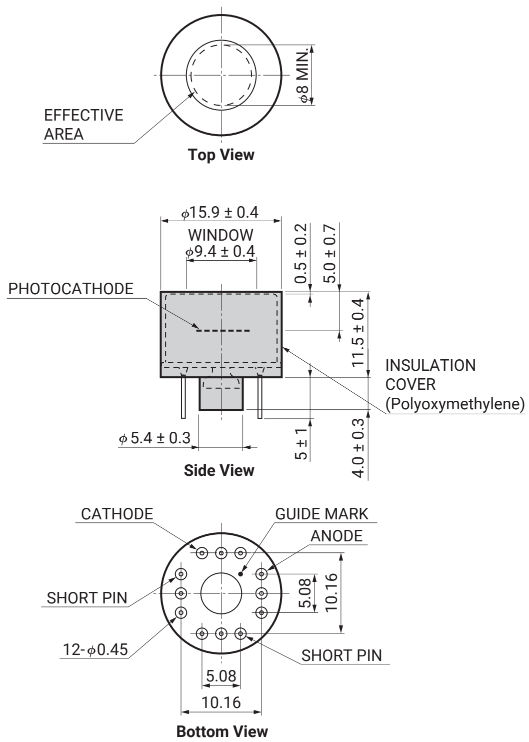
❷ R6800U-16, -26



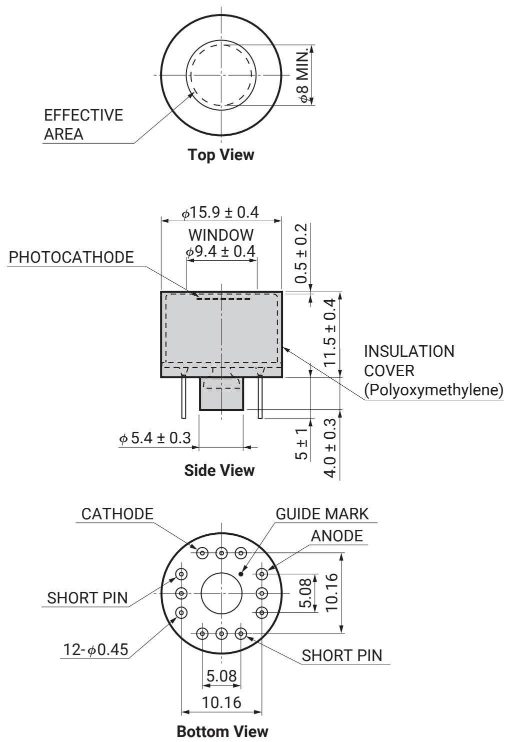
Characteristics at 25 °C							Ⓓ	
Luminous sensitivity Ⓒ		Radiant sensitivity		Dark current	Recommended operating voltage	Interelectrode capacitance	Operating ambient temperature	Type No.
Min. (µA/lm)	Typ. (µA/lm)	Min. (mA/W)	Typ. (mA/W)	Max. (pA)	(V)	(pF)	(°C)	
—		2 (at 122 nm)	8 (at 122 nm)	2	15	3	-30 to +50	R6800U-24
—		1 (at 161 nm)	5 (at 161 nm)	2	15	3	-30 to +50	R6800U-14
—		1 (at 122 nm)	3 (at 122 nm)	1	15	3	-30 to +50	R6800U-26
—		1 (at 165 nm)	3 (at 165 nm)	1	15	3	-30 to +50	R6800U-16
—		0.02 (at 185 nm)	0.05 (at 185 nm)	1	15	3	-30 to +50	R6800U-15
—		10 (at 254 nm)	20 (at 254 nm)	1	15	3	-30 to +50	R6800U-21
—		10 (at 254 nm)	20 (at 254 nm)	1	15	3	-30 to +50	R6800U-11
—		10 (at 254 nm)	20 (at 254 nm)	1	15	3	-30 to +50	R6800U-01
40	80	—		2	15	3	-30 to +50	R6800U-08
40	80	—		2	15	3	-30 to +50	R6800U-48
90	110	—		50	15	3	-30 to +50	R6800U-09
100	150	—		5	15	3	-30 to +50	R6800U-010

ⒸThe photocurrent from the photocathode per incident light flux (10^{-5} to 10^{-2} lumens) from a tungsten filament lamp operated at a distribution temperature of 2856 K. ⒹWhen a tube is operated below -30 °C see page 6, "Caution".

❸ R6800U-01, -08, -09, -48



❹ R6800U-010



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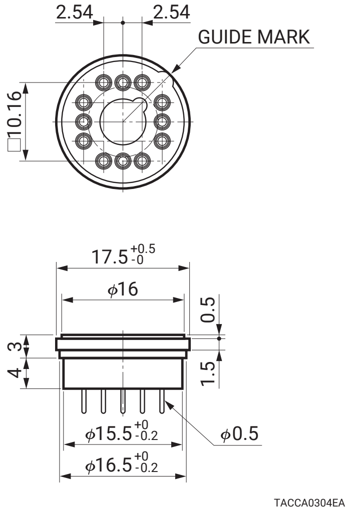
NOTE: Don't use pins excepting ANODE and CATHODE pins.

Accessories (Unit: mm) Sold separately

● **Socket E678-12-01**

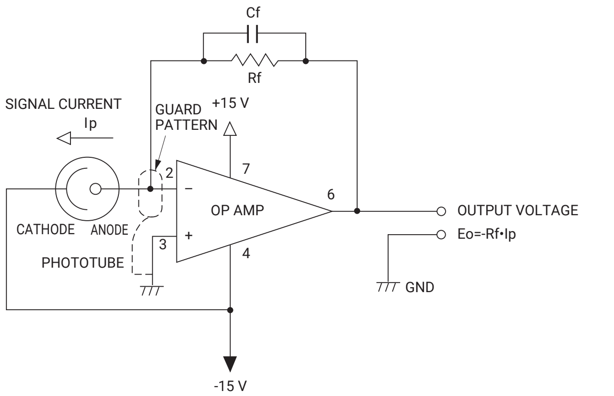


Example of operating circuits

Operating circuits for phototubes

Figure 1 shows an operating circuit example using the phototube bias voltage also for the power to an operational amplifier. The feedback resistance Rf should be chosen so that the output voltage becomes 0.1 V to 1 V. Cf must be placed for stable operation and should be between 10 pF and 100 pF. It is recommended to use a low-bias-current, low-offset-current FET input operational amplifier. For the input terminal (pin 2), a guard pattern should be provided on the printed circuit board or a stand-off terminal made of Teflon should be used.

Figure 1: When plus / Minus powers are available



(Inverting current-voltage conversion circuit)

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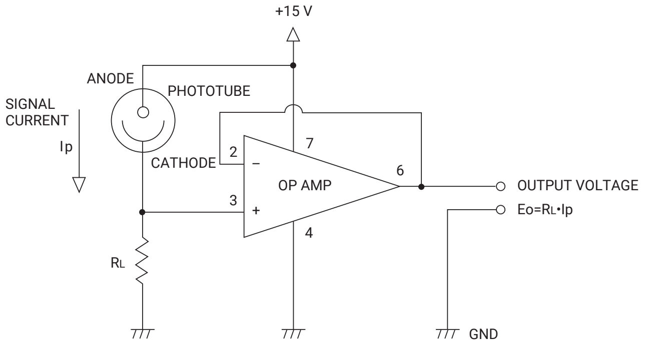
Figure 2 shows an operating circuit in which a low-impedance voltage is output from an operational amplifier after the signal current has been converted into a voltage through the load resistance RL. The operational amplifier should be a low-bias-current, low-offset-current type which can be operated on a single power.

Figure 2: Operating circuit with single power



(Impedance conversion circuit)

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NOTE: The operational amplifiers that can be used in these circuits differ in such factors as operating temperature range, bias current, phase compensation, and offset adjustment method, depending on the type used. Please refer to the catalog or data sheet available from the manufacturer.
Sample circuits listed in this catalog introduce typical applications and do not cover any guarantee of the circuit design. No patent rights are granted to any of the circuits described herein.

Cautions and warranty

⚠ Cautions

● **Maximum ratings**
Always operate the phototube within the maximum rating listed in this catalog.

● **The light input surface area should be as large as possible**
The output current available from a phototube is determined by the maximum average cathode current and maximum average cathode current density. If the light input surface area is small, even if the output current is below the maximum average cathode current, the maximum average cathode current density may be exceeded. Therefore, the light input surface area should be as large as possible to decrease the cathode current per unit surface area. This is important also, from the standpoint of photocathode uniformity (i.e., variation in sensitivity with respect to incident light position).

● **Handle tubes with extreme care**
Phototubes have evacuated glass envelopes. Allowing the glass to be scratched or to be subjected to shock can cause cracks.

● **Avoid mechanical vibration**
Mechanical vibration can cause microphonic noise (sensitivity fluctuation caused by vibration of the electrode.) and variation in sensitivity caused by displacement of the incident light position.

● **Keep input window and base clean**
Do not touch the input window and base with bare hands. Dirt and fingerprints on the input window cause loss of transmittance and dirt on the base may cause ohmic leakage. Should they become soiled, wipe it clean using alcohol.

● **Avoid direct sunlight and other high-intensity light**
Avoid subjecting the phototube to direct sunlight or other high-intensity light, as this can adversely affect the photocathode, causing not only loss of sensitivity but instability as well.

● **Be careful not to damage the hermetic seals**
Glass is used for hermetically sealing the root of each stem pin of phototubes. Bending a stem pin or applying mechanical shock to a phototube may cause cracks in the sealing glass, leading to a malfunction of the phototube. Do NOT bend the stem pins and do NOT apply mechanical shock.

● **Helium permeation through silica glass window**
Helium will permeate through the silica glass window, leading to an increase in noise. Avoid operating or storing tubes in an environment where helium is present.

Data and specifications listed in this catalog are subject to change due to product improvement and other factors. Before specifying any of the types in your production equipment, please consult our sales office.

Warranty

In general, Hamamatsu products listed in this catalog are warranted for a period of one year from time of delivery. This warranty is limited to replacement for the defective product. Note, however, that this warranty will not apply to failures caused by natural calamity or misuse.

CE marking

This catalog contains products which are subject to CE Marking of European Union Directives. For further details, please consult Hamamatsu sales offices.

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