

FEATURES

- Spectral response 185 nm to 710 nm
- High cathode sensitivity
 - Luminous 100 $\mu\text{A/lm}$
 - Radiant at 410 nm 70 mA/W
- High anode sensitivity
 - Luminous 1200 A/lm
 - Radiant at 410 nm 8.4×10^5 A/W
- Low dark current 0.2 nA
- Low dark counts (R4220P) 10 s^{-1}

APPLICATIONS

- Fluorescence spectrometer
- Chemiluminescence detection
- Raman spectroscopy
- Low light level detection

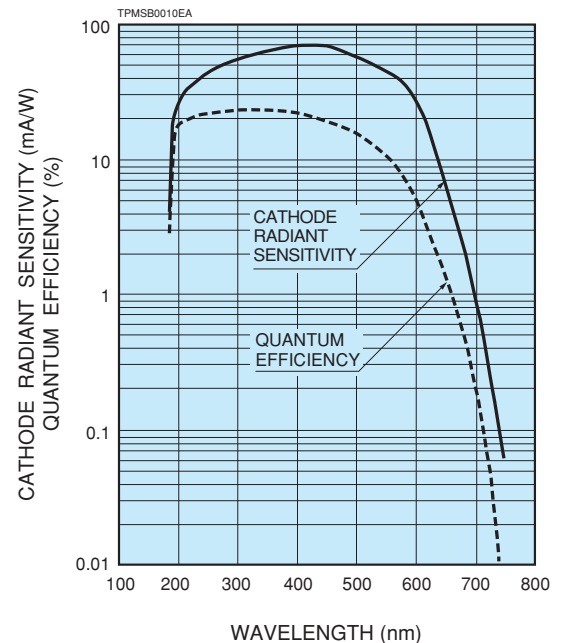


SPECIFICATIONS

GENERAL

Parameter	Description / Value	Unit
Spectral response	185 to 710	nm
Wavelength of maximum response	410	nm
Photocathode	Material	Low noise bialkali
	Minimum effective area	8×24
Window material	UV glass	—
Dynode	Structure	Circular-cage
	Number of stages	9
Direct interelectrode capacitances	Anode to last dynode	4
	Anode to all other electrode	6
Base	11-pin base	—
Weight	Approx. 45	g
Operating ambient temperature	-30 to +50	$^{\circ}\text{C}$
Storage temperature	-30 to +50	$^{\circ}\text{C}$
Suitable socket	E678-11A (sold separately)	—
Suitable socket assembly	E717-63 (sold separately)	—
	E717-74 (sold separately)	—

Figure 1: Typical spectral response



PHOTOMULTIPLIER TUBES

R4220, R4220P (For Photon Counting)

MAXIMUM RATINGS (Absolute maximum values)

Parameter		Value	Unit
Supply voltage	Between anode and cathode	1250	V
	Between anode and last dynode	250	V
Average anode current [Ⓐ]		0.1	mA

CHARACTERISTICS (at 25 °C)

Parameter		R4220 for general purpose			R4220P for photon counting			Unit
		Min.	Typ.	Max.	Min.	Typ.	Max.	
Cathode sensitivity	Quantum efficiency (at peak wavelength)	—	23	—	—	23	—	%
	Luminous [Ⓑ]	80	100	—	80	100	—	μA/lm
	Radiant (at peak wavelength)	—	70	—	—	70	—	mA/W
	Blue sensitivity index [Ⓒ]	—	8	—	—	8	—	—
Anode sensitivity	Luminous [Ⓓ]	1000	1200	—	1000	1200	—	A/lm
	Radiant at 400 nm	—	8.4 × 10 ⁵	—	—	8.4 × 10 ⁵	—	A/W
Gain [Ⓓ]		—	1.2 × 10 ⁷	—	—	1.2 × 10 ⁷	—	—
Anode dark current [Ⓔ] (After 30 min storage in the darkness)		—	0.2	2.0	—	0.2	0.5	nA
Anode dark counts [Ⓕ]		—	—	—	—	10	50	s ⁻¹
ENI (Equivalent Noise Input) [Ⓖ]		—	3.3 × 10 ⁻¹⁷	—	—	3.3 × 10 ⁻¹⁷	—	W
Time response [Ⓔ]	Anode pulse rise time [Ⓗ]	—	2.2	—	—	2.2	—	ns
	Electron transit time [Ⓘ]	—	22	—	—	22	—	ns
	Transit time spread (TTS) [Ⓣ]	—	1.2	—	—	1.2	—	ns

NOTES

- Ⓐ Averaged over any interval of 30 seconds maximum.
- Ⓑ The light source is a tungsten filament lamp operated at a distribution temperature of 2856 K. Supply voltage is 100 volts between the cathode and all other electrodes connected together as anode.
- Ⓒ The value is cathode output current when a blue filter(Corning CS-5-58 polished to 1/2 stock thickness) is interposed between the light source and the tube under the same condition as Note Ⓑ.
- Ⓓ Measured with the same light source as Note Ⓑ and with the cathode supply voltage and voltage distribution ratio shown in Table 1 below.

Table 1: Voltage distribution ratio

Electrodes	K	Dy1	Dy2	Dy3	Dy4	Dy5	Dy6	Dy7	Dy8	Dy9	P
Distribution ratio	1	1	1	1	1	1	1	1	1	1	1

Supply voltage: 1000 V, K: Cathode, D: Dynode, P: Anode

- Ⓔ Measured with the same supply voltage and voltage distribution ratio shown in Table 1.
- Ⓕ Measured at the plateau voltage.

Table 2: Voltage distribution ratio for plateau test

Electrodes	K	Dy1	Dy2	Dy3	Dy4	Dy5	Dy6	Dy7	Dy8	Dy9	P
Distribution ratio	1	1	1	1	1	1	1	1	1	2	1

Supply voltage: Plateau voltage, K: Cathode, Dy: Dynode, P: Anode

- Ⓖ ENI is an indication of the photon-limited signal-to-noise ratio. It refers to the amount of light in watts to produce a signal-to-noise ratio of unity in the output of a photomultiplier tube.

$$ENI = \frac{\sqrt{2q \cdot I_{db} \cdot G \cdot \Delta f}}{S} \quad (W)$$

- where q = Electronic charge (1.60 × 10⁻¹⁹ coulomb).
 I_{db} = Anode dark current(after 30 minute storage) in amperes.
 G = Gain.
 Δf = Bandwidth of the system in hertz. 1 hertz is used.
 S = Anode radiant sensitivity in amperes per watt at the wavelength of peak response.

- Ⓗ The rise time is the time for the output pulse to rise from 10 % to 90 % of the peak amplitude when the entire photocathode is illuminated by a delta function light pulse.
- Ⓘ The electron transit time is the interval between the arrival of delta function light pulse at the entrance window of the tube and the time when the anode output reaches the peak amplitude. In measurement, the whole photocathode is illuminated.
- Ⓣ Also called transit time jitter. This is the fluctuation in electron transit time between individual pulses in the signal photoelectron mode, and may be defined as the FWHM of the frequency distribution of electron transit times.

Figure 2: Typical gain and anode dark current

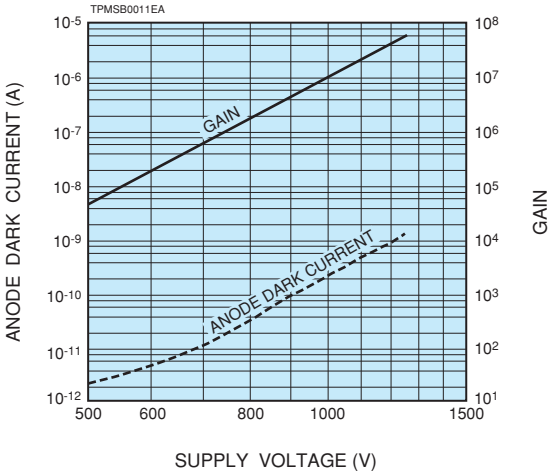


Figure 3: Typical time response

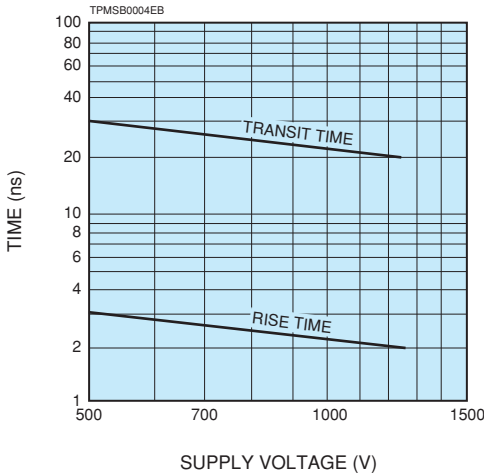


Figure 4: Typical ENI vs. wavelength

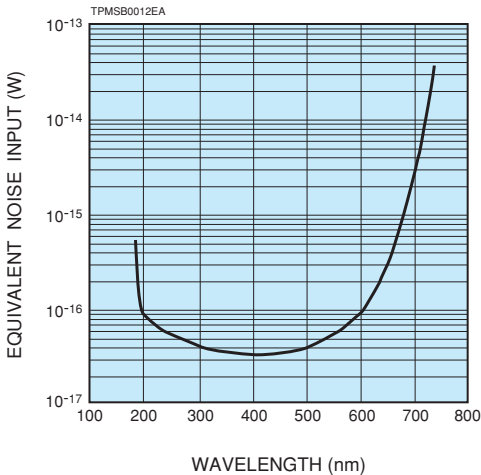
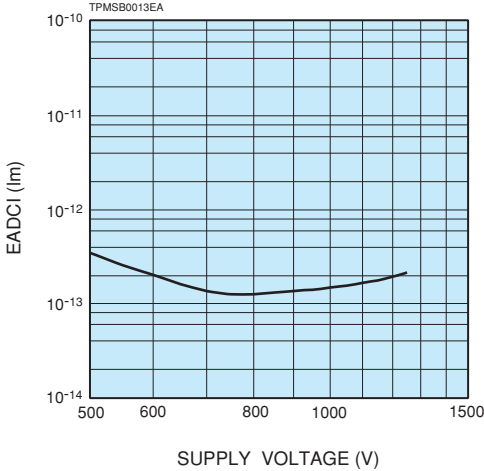


Figure 5: Typical EADCI (Equivalent Anode Dark Current Input) vs. supply voltage



Data shown here, which is given from a relation among supply voltage, anode sensitivity and dark current, serves as a good reference in order to determine the most suitable supply voltage or its range.

Figure 6: Typical plateau data for R4220P

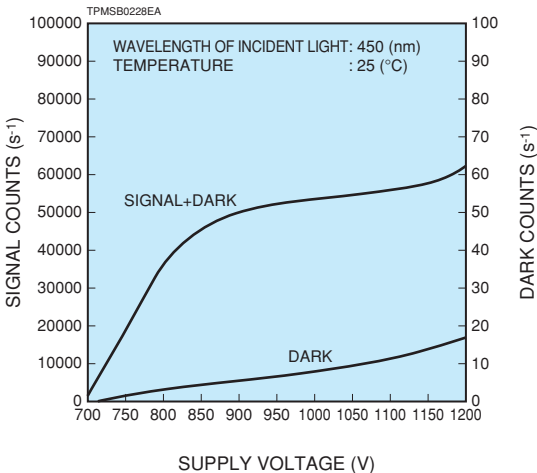
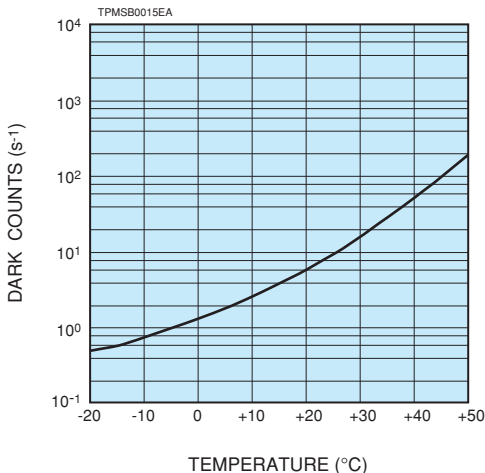
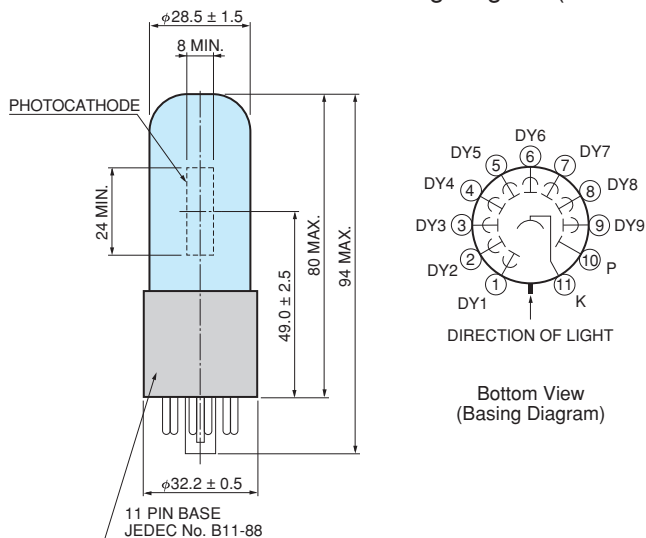


Figure 7: Typical temperature characteristics of dark count for R4220P



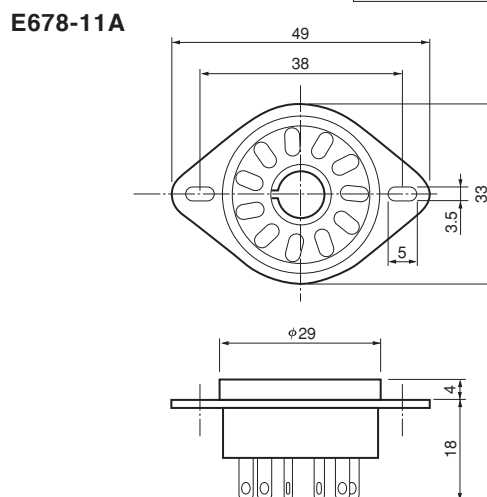
PHOTOMULTIPLIER TUBES R4220, R4220P (For Photon Counting)

Figure 8: Dimensional outline and basing diagram (Unit: mm)



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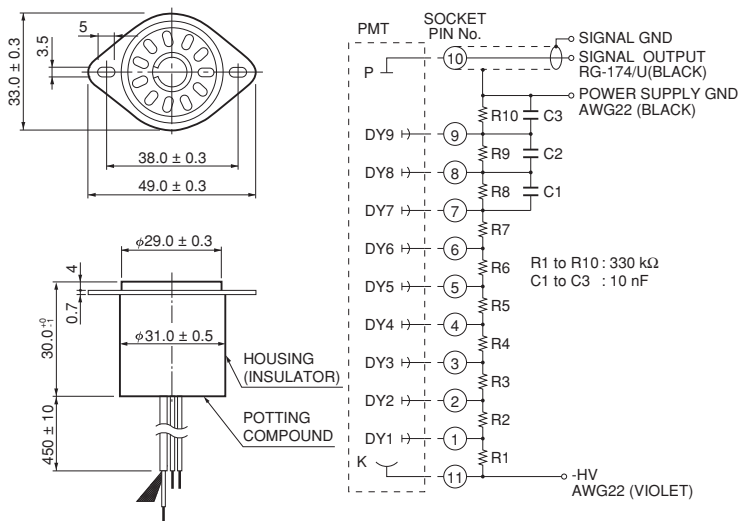
Figure 9: Socket (Unit: mm) **Sold separately**



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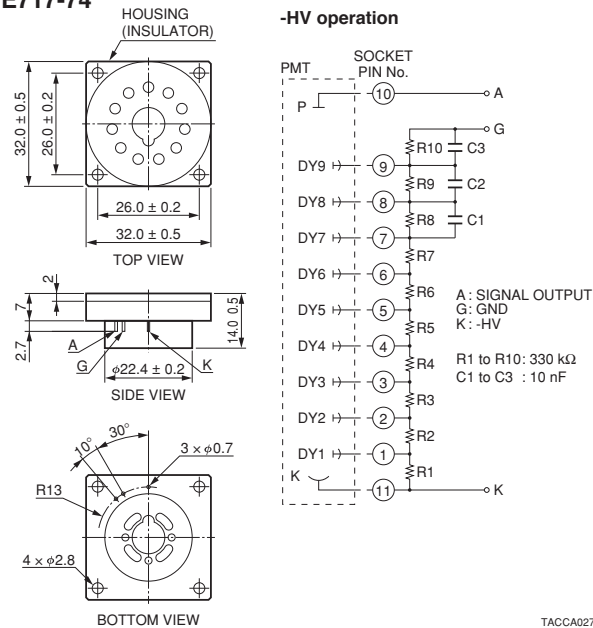
Figure 10: D type socket assembly (Unit: mm) **Sold separately**

E717-63



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E717-74



TACCA0277EC

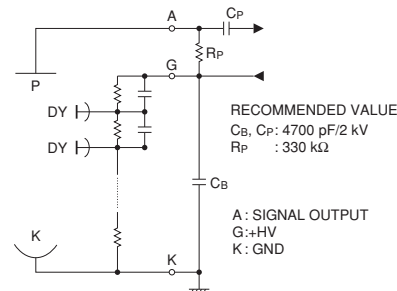
* Hamamatsu also provides C13890 series compact high voltage power supplies and C12597-01, C8991 DP type socket assemblies which incorporate a DC to DC converter type high voltage power supply.

Warning—Personal Safety Hazards

Electrical Shock—Operating voltages applied to this device present a shock hazard.

+HV operation

Cb, Cp and Rp must be connected as follows.



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