HAMAMATSU

PHOTOMULTIPLIER TUBES
R4220
R4220P (For Photon Counting)

Very High Cathode Sensitivity with Low Noise Photocathode

FEATURES

- **Spectral Response ..... 185 nm to 710 nm**
- **High Cathode Sensitivity**
  - **Luminous ..... 100 μA/lm**
  - **Radiant at 410 nm ..... 70 mA/W**
- **High Anode Sensitivity (at 1000 V)**
  - **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

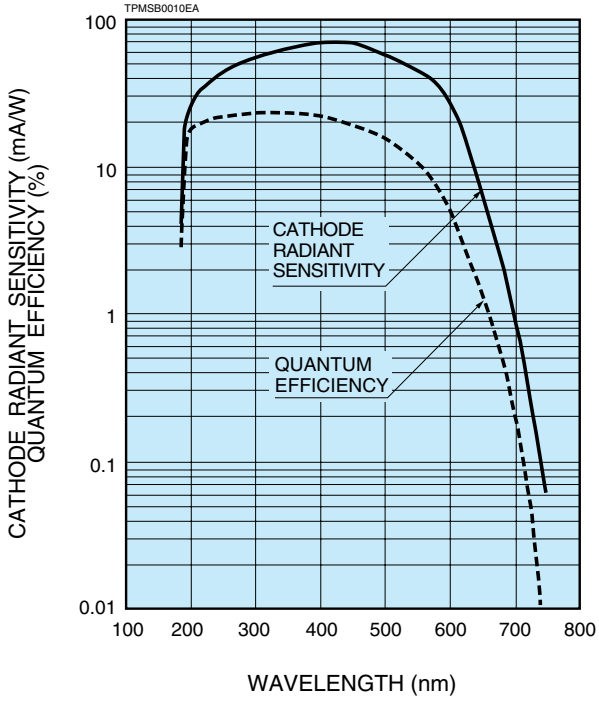
- **Fluorescence Spectrometer**
- **Chemiluminescence Detection**
- **Raman Spectroscopy**
- **Low Light Level Ditection**

SPECIFICATIONS

GENERAL

Parameter	Description / Value	Unit
Spectral Response	185 to 710	nm
Wavelength of Maximum Response	410	nm
Photocathode Material Minimum Effective Area	 Low noise bialkali 8 × 24	 – mm
Window Material	UV glass	–
Dynode Secondary Emitting Surface Structure Number of Stages	 Low noise bialkali Circular-cage 9	 – – –
Direct Interelectrode Capacitances Anode to Last Dynode Anode to All Other Electrodes	 4 6	 pF pF
Base	11-pin base JEDEC No. B11-88	–
Weight	45	g
Operating Ambient Temperature	-30 to +50	°C
Storage Temperature	-30 to +50	°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 (DC)	1250	V
Between Anode and Last Dynode (DC)	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 minutes Storage in the darkness	—	0.2	2.0	—	0.2	0.5	nA
Anode Dark Counts Ⓕ	—	—	—	—	10	50	s^{-1}
ENI(Equivalent Noise Input) Ⓖ	—	3.30×10^{-17}	—	—	3.30×10^{-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
Anode Current Stability Ⓛ							
Current Hysteresis	—	0.1	—	—	0.1	—	%
Voltage Hysteresis	—	1.0	—	—	1.0	—	%

NOTES

A: Averaged over any interval of 30 seconds maximum.

B: The light source is a tungsten filament lamp operated at a distribution temperature of 2856 K. Supply voltage is 150 volts between the cathode and all other electrodes connected together as anode.

C: 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 B.

D: Measured with the same light source as Note B and with the anode-to-cathode supply voltage and voltage distribution ratio shown in Table 1 below.

E: Measured with the same supply voltage and voltage distribution ratio as Note D after removal of light.

F: Measured at the plateau voltage.

G: 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.

$$ENI = \frac{\sqrt{2q \cdot Idb \cdot G \cdot f}}{S}$$

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

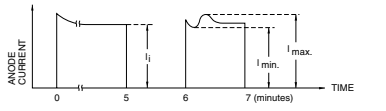
H: The rise time is the time for the output pulse to rise from 10% to 90% of the peak amplitude when the entire photocathode is illuminated by a delta function light pulse.

J: 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.

K: 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.

L: Hysteresis is temporary instability in anode current after light and voltage are applied.

$$\text{Hysteresis} = \frac{I_{max.} - I_{min.}}{I_i} \times 100(\%)$$



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(1)Current Hysteresis
The tube is operated at 750 volts with an anode current of 1 micro-ampere for 5 minutes. The light is then removed from the tube for a minute. The tube is then re-illuminated by the previous light level for a minute to measure the variation.

(2)Voltage Hysteresis
The tube is operated at 300 volts with an anode current of 0.1 micro-ampere for 5 minutes. The light is then removed from the tube and the supply voltage is quickly increased to 800 volts. After a minute, the supply voltage is then reduced to the previous value and the tube is re-illuminated for a minute to measure the variation.

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	

Supply Voltage : 1000 V (DC)
K : Cathode, Dy : Dynode, P : Anode

Figure 2: Typical Gain and Anode Dark Current

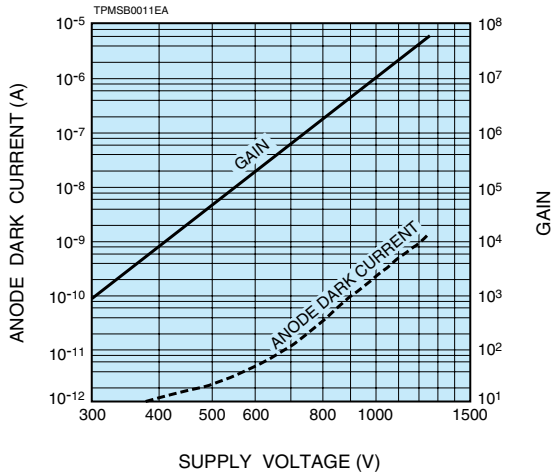


Figure 3: Typical Time Response

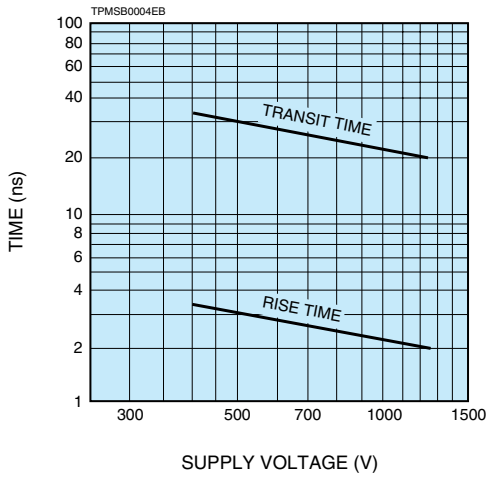


Figure 4: Typical ENI vs. Wavelength

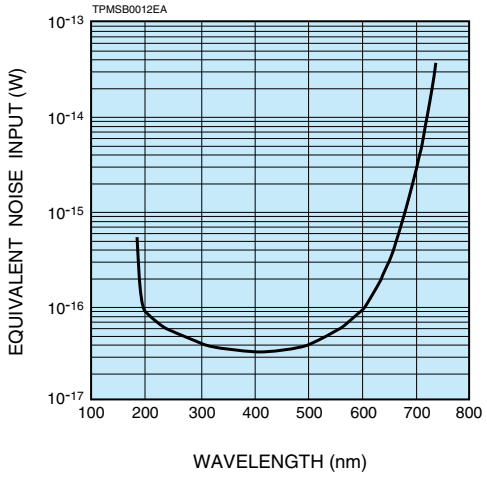
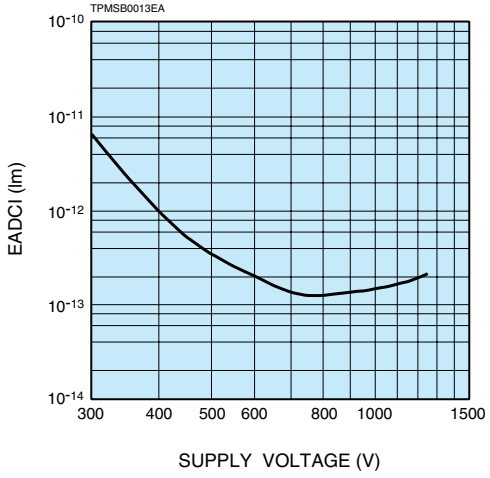


Figure 5: Typical EADCI (Equivalent Anode Dark Current Input) vs. Supply Voltage



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

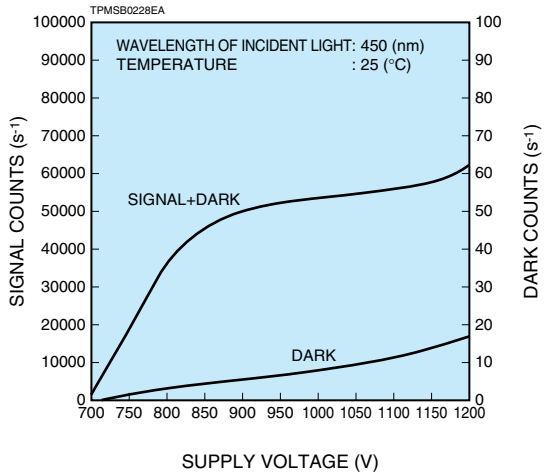


Figure 7: Typical Temperature Characteristics of Dark Count for R4220P

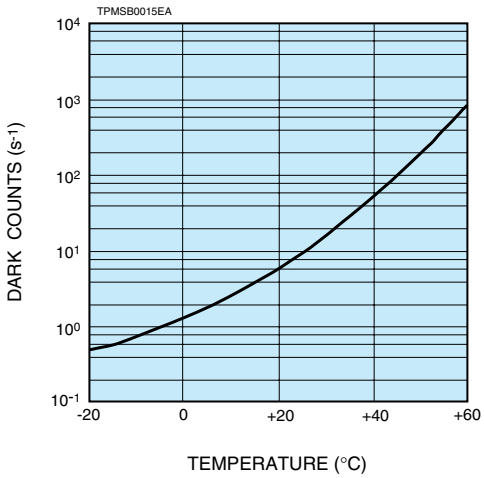


Figure 8: Dimensional Outline and Basing Diagram (Unit: mm)

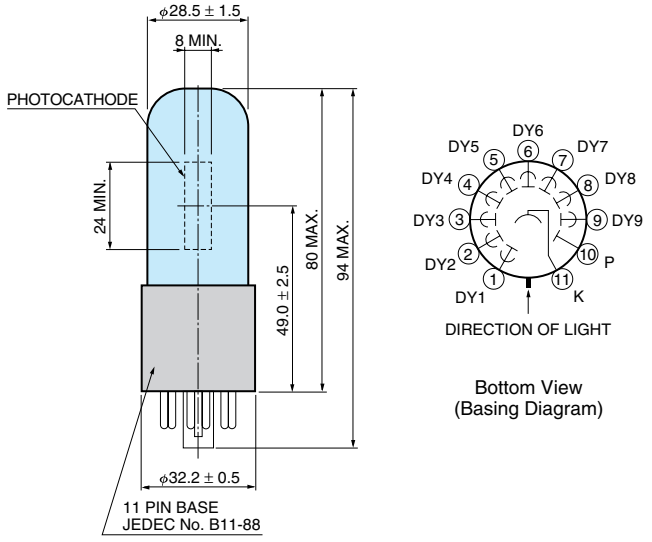


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Figure 9: Socket E678-11A (Sold Separately)

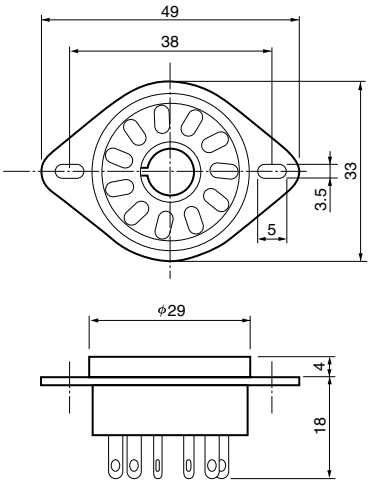

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Figure 10: D Type Socket Assembly E717-63 (Sold Separately)

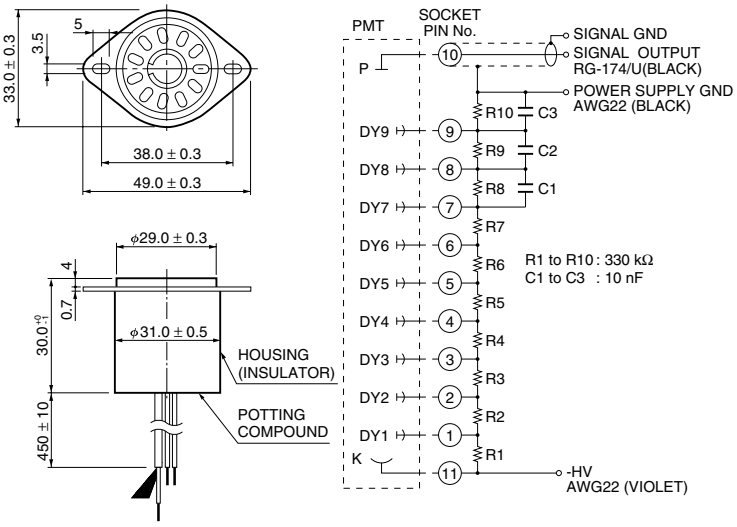

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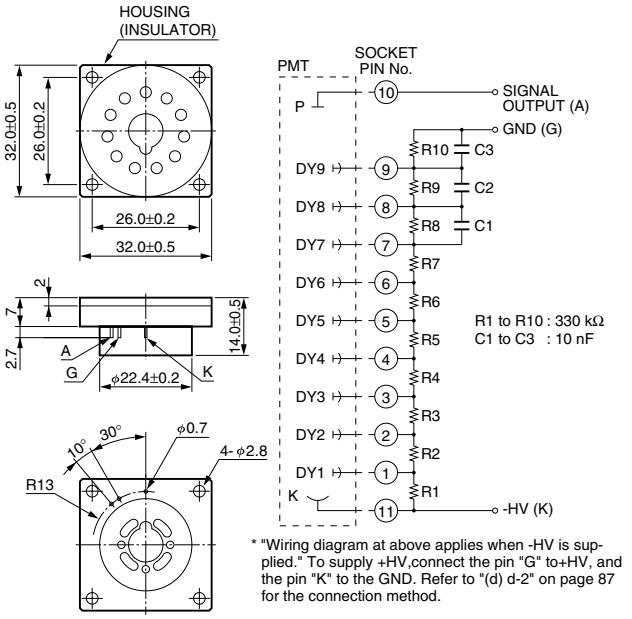
Figure 11: D Type Socket Assembly E717-74 (Sold Separately)



* "Wiring diagram at above applies when -HV is supplied." To supply +HV,connect the pin "G" to+HV, and the pin "K" to the GND. Refer to "(d) d-2" on page 87 for the connection method.

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* Hamamatsu also provides C4900 series compact high voltage power supplies and C6270 series 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.

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