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HAMAMATSU

PHOTOMULTIPLIER TUBE R446

Multialkali Photocathode Sensitive to 870 nm
28 mm (1-1/8 Inch) Diameter, 9-Stage, Side-On Type

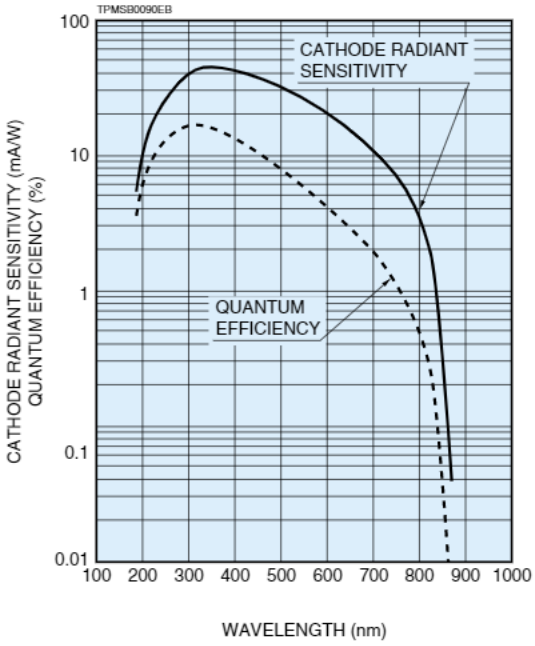
The R446 features high quantum efficiency, high current amplification, good S/N ratio and wide spectral response from UV to near infrared. The R446 employs a UV-transmitting glass envelope for UV sensitivity extension.
The R446 is well suited for use in broad-band spectrophotometers, atomic absorption spectrophotometers, chromatographs, NOx analyzers and other precision photometric instruments.



FEATURES

- **Wide Spectral Response ..... 185 nm to 870 nm**
- **Cathode Sensitivity**
  - **Luminous ..... 120 μA/lm**
  - **Radiant at 330 nm ..... 44 mA/W**
- **Anode Sensitivity (at 1000 V)**
  - **Luminous ..... 600 A/lm**
  - **Radiant at 330 nm ..... 2.2×10^5 A/W**
- **Low Drift and Hysteresis**

Figure 1: Typical Spectral Response



SPECIFICATIONS

GENERAL

Parameter		Description/Value	Unit
Spectral Response		185 to 870	nm
Wavelength of Maximum Response		330	nm
Photocathode	Material	Multialkali	—
	Minimum Effective Area	8 × 24	mm
Window Material		UV glass	—
Dynode	Secondary Emitting Surface	Multialkali	—
	Structure	Circular-cage	—
	Number of Stages	9	—
Direct Interelectrode Capacitances	Anode to Last Dynode	4	pF
	Anode to All Other Electrodes	6	pF
Base		11-pin base JEDEC No. B11-88	—
Weight		Approx. 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)	

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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 [A]		0.1	mA

CHARACTERISTICS (at 25 °C)

Parameter			Min.	Typ.	Max.	Unit
Cathode Sensitivity	Quantum Efficiency (at Peak Wavelength)		—	16.7 (at 320 nm)	—	%
	Luminous [B]		80	120	—	μA/lm
	Radiant	at 194 nm	—	9.0	—	mA/W
		at 254 nm	—	25	—	mA/W
		at 330 nm	—	44	—	mA/W
		at 633 nm	—	17	—	mA/W
		at 852 nm	—	0.25	—	mA/W
	Red/White Ratio [C]		0.1	0.25	—	—
	Blue Sensitivity Index [D]		—	6.0	—	—
Anode Sensitivity	Luminous [E]		100	600	—	A/lm
	Radiant	at 194 nm	—	4.5×10^4	—	A/W
		at 254 nm	—	1.3×10^5	—	A/W
		at 330 nm	—	2.2×10^5	—	A/W
		at 633 nm	—	8.5×10^4	—	A/W
		at 852 nm	—	1.3×10^3	—	A/W
Gain [E]			—	5.0×10^6	—	—
Anode Dark Current [F] (After 30 min Storage in Darkness)			—	3	50	nA
ENI (Equivalent Noise Input) [H]			—	3.1×10^{-16}	—	W
Time Response [E]	Anode Pulse Rise Time [I]		—	2.2	—	ns
	Electron Transit Time [J]		—	22	—	ns
Anode Current Stability [K]	Light Hysteresis		—	0.1	—	%
	Voltage Hysteresis		—	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 2856K. Supply voltage is 100 V between the cathode and all other electrodes connected together as anode.

C: Red/White ratio is the quotient of the cathode current measured using a red filter (Toshiba R-68) interposed between the light source and the tube by the cathode current measured with the filter removed under the same conditions as Note B.

D: 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.

E: Measured with the same light source as Note B and with the voltage distribution ratio shown in Table 1 below.

Table 1: Voltage Distribution Ratio

Electrode	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, K: Cathode, Dy: Dynode, P: Anode

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

G: Measured at a supply voltage adjusted to provide an anode sensitivity of 100 A/lm.

H: 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.

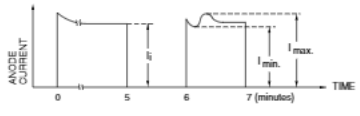
$$ENI = \frac{\sqrt{2q \cdot Idb \cdot G \cdot \Delta f}}{S}$$

where q = Electronic charge (1.60×10^{-19} coulomb).
Idb = 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.

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



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

(1)Light Hysteresis
The tube is operated at 750 V with an anode current of 1 µA 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 V with an anode current of 0.1 µA for 5 minutes. The light is then removed from the tube and the supply voltage is quickly increased to 800 V. 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.

Figure 2: Anode Luminous Sensitivity and Gain Characteristics

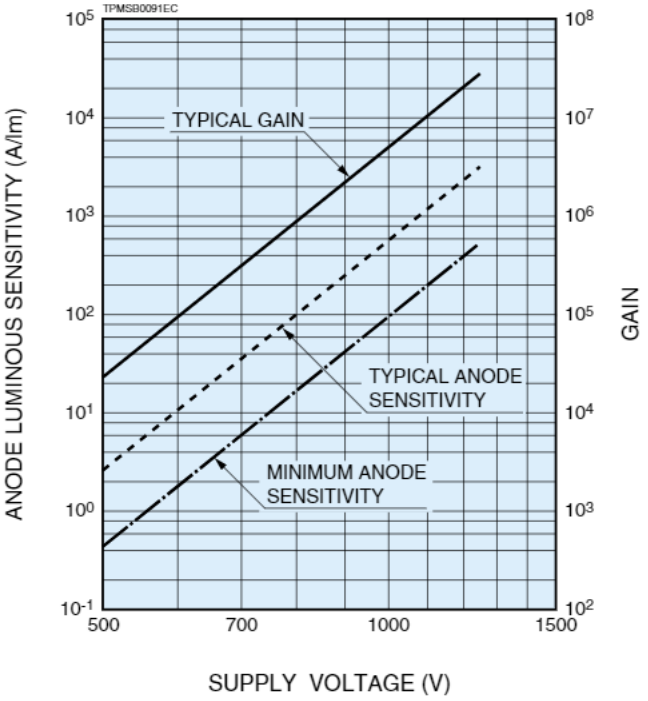


Figure 3: Typical Time Response

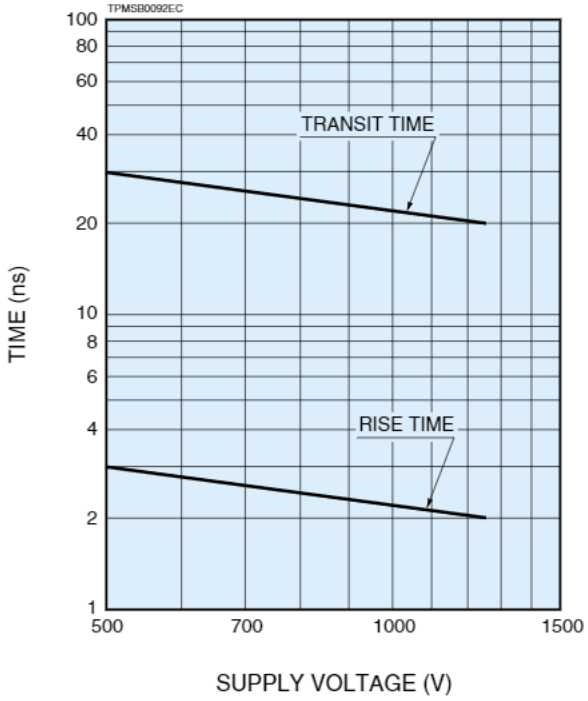


Figure 4: Typical Temperature Coefficient of Anode Sensitivity

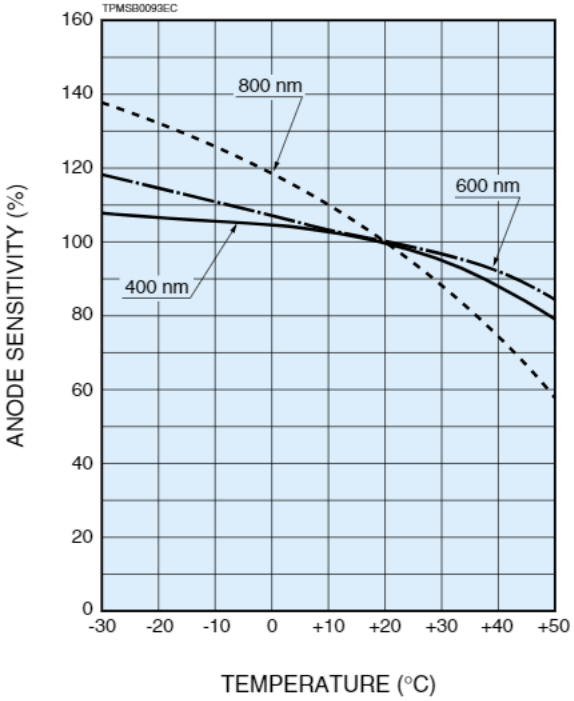


Figure 5: Typical Temperature Characteristic of Dark Current (at 1000 V, after 30 min strage in darkness)

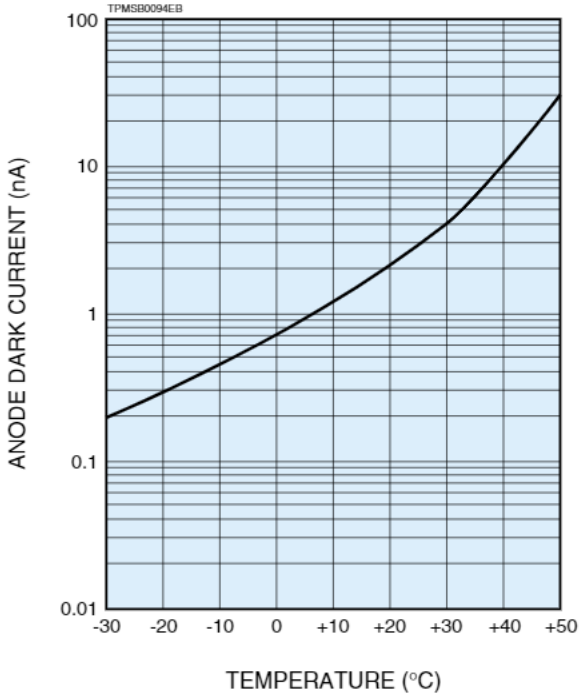
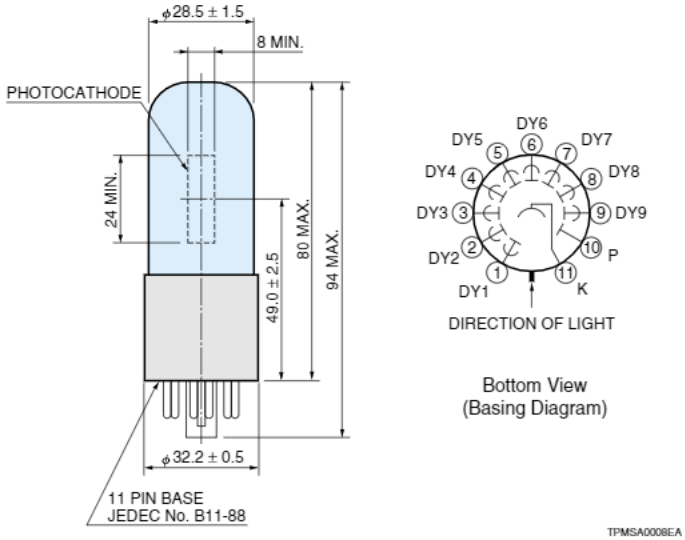


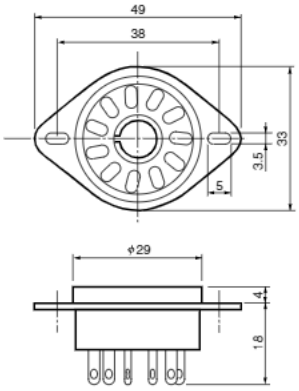
Figure 6: Dimensional Outline and Basing Diagram (Unit: mm)



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Figure 7: Socket (Unit: mm) Sold Separately

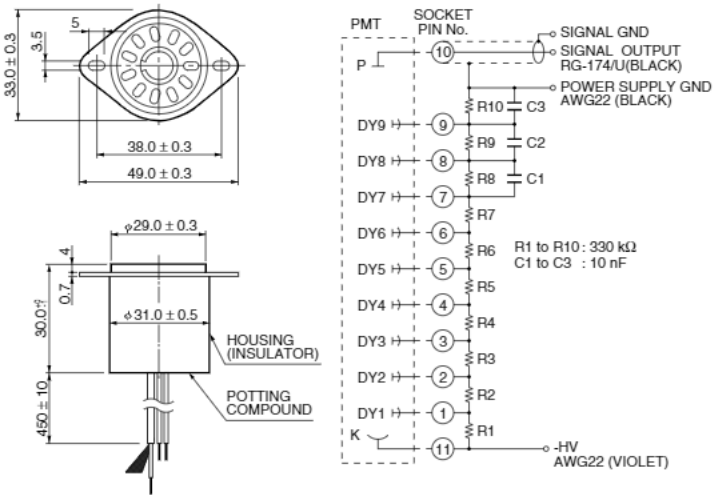
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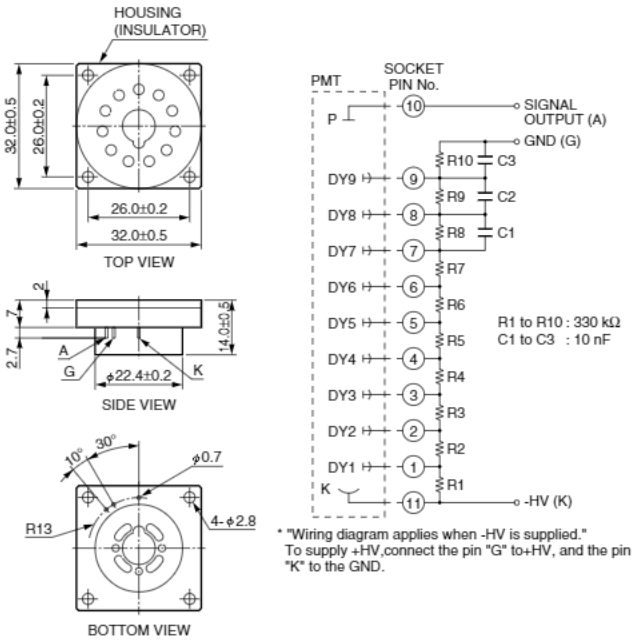
Figure 8: D Type Socket Assembly (Unit: mm) Sold Separately

E717-63



TACCA0002EH

E717-74



TACCA0277EA

* 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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