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HAMAMATSU

PHOTON IS OUR BUSINESS

PHOTOMULTIPLIER TUBES
R928, R928P, R955, R955P

FEATURES

- **Wide spectral response**
  - **R928 ..... 185 nm to 900 nm**
  - **R955 ..... 160 nm to 900 nm**
- **High cathode sensitivity**
  - **Luminous ..... 250 μA/lm**
  - **Radiant at 400 nm ..... 74 mA/W**
- **High anode sensitivity**
  - **Luminous ..... 2500 A/lm**
  - **Radiant at 400 nm ..... 7.4×10^5 A/W**
- **28 mm (1-1/8 inch) multialkali side-on standard PMT**



APPLICATIONS

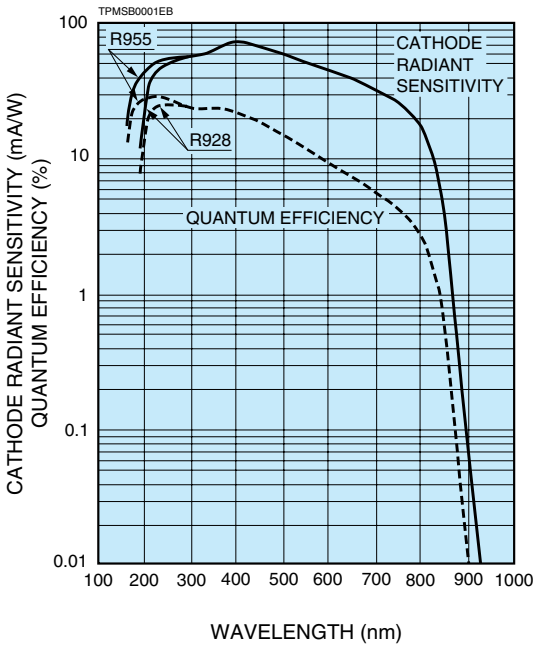
- **Spectroscopy**
- **Biofluorescence detection**
- **Laser scanning microscope**
- **Semiconductor inspection**
- **Envionmental monitoring**

SPECIFICATIONS

GENERAL

Parameter		Description / Value	Unit
Spectral response	R928	185 to 900	nm
	R955	160 to 900	nm
Wavelength of maximum response		400	nm
Photocathode	Material	Multialkali	—
	Minimum effective area	8 × 24	mm
Window material	R928	UV glass	—
	R955	Quartz	—
Dynode	Structure	Circular-cage	—
	Number of stages	9	—
Direct interelectrode capacitances	Anode to last dynode	Approx. 4	pF
	Anode to all other electrodes	Approx. 6	pF
Base		11-pin base	—
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)	

Figure 1: Typical spectral response



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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 Ⓐ		0.1	mA

CHARACTERISTICS (at 25 °C)

Parameter			R928, R928P			R955, R955P			Unit
			Min.	Typ.	Max.	Min.	Typ.	Max.	
Cathode sensitivity	Quantum efficiency (at peak wavelength)		—	25.4 (at 260 nm)	—	—	29.0 (at 220 nm)	—	%
	Luminous Ⓑ		140	250	—	140	250	—	μA/lm
	Radiant	at 194 nm	—	18	—	—	43	—	mA/W
		at 254 nm	—	52	—	—	56	—	mA/W
		at 400 nm	—	74	—	—	74	—	mA/W
		at 633 nm	—	41	—	—	41	—	mA/W
		at 852 nm	—	3.5	—	—	3.5	—	mA/W
	Red/White ratio Ⓒ		0.2	0.3	—	0.2	0.3	—	—
	Blue sensitivity index Ⓓ		—	8	—	—	8	—	—
Anode sensitivity	Luminous Ⓔ		400	2500	—	400	2500	—	A/lm
	Radiant	at 194 nm	—	1.8×10^5	—	—	4.3×10^5	—	A/W
		at 254 nm	—	5.2×10^5	—	—	5.6×10^5	—	A/W
		at 400 nm	—	7.4×10^5	—	—	7.4×10^5	—	A/W
		at 633 nm	—	4.1×10^5	—	—	4.1×10^5	—	A/W
		at 852 nm	—	3.5×10^4	—	—	3.5×10^4	—	A/W
Gain Ⓔ			—	1.0×10^7	—	—	1.0×10^7	—	—
Anode dark current Ⓔ (After 30 min storage in darkness)			—	3	50	—	3	50	nA
Anode dark count Ⓕ (for the R928P, R955P)			—	500	1000	—	500	1000	s^{-1}
ENI (Equivalent Noise Input) Ⓖ			—	1.3×10^{-16}	—	—	1.3×10^{-16}	—	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 V between the cathode and all other electrodes connected together as anode.

Ⓒ 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 Ⓑ.

Ⓓ 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 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

Ⓕ Measured at the plateau voltage.

Table 2: Voltage distribution ratio for plateau test

Electrode	K	Dy1	Dy2	Dy3	Dy4	Dy5	Dy6	Dy7	Dy8	Dy9	P
Distribution ratio	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.

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

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.

Ⓗ 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.

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Figure 2: Anode luminous sensitivity and gain characteristics

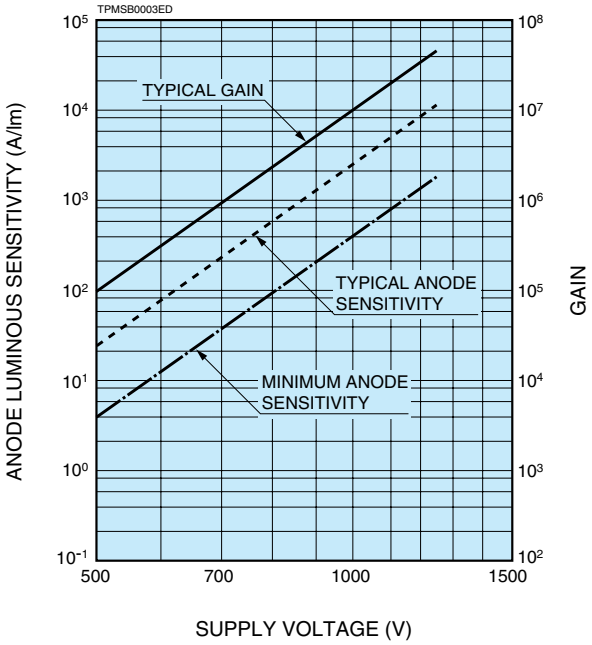


Figure 3: Typical time response

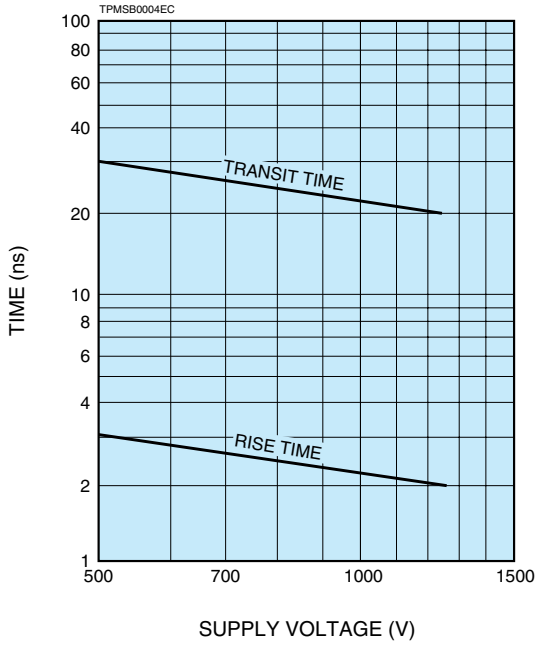


Figure 4: Typical temperature coefficient of anode sensitivity

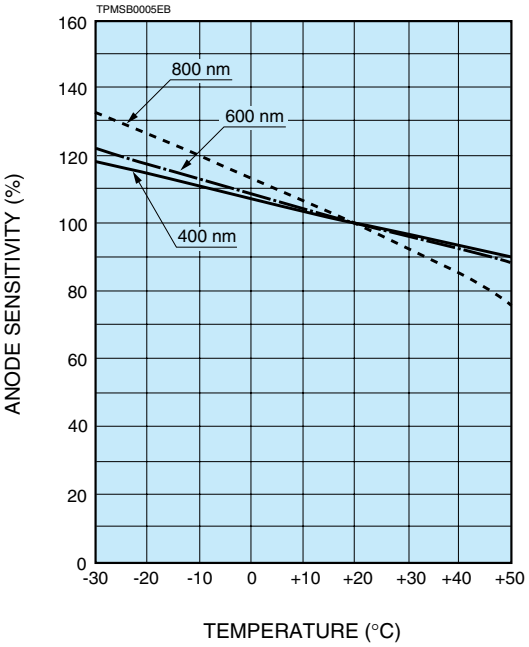
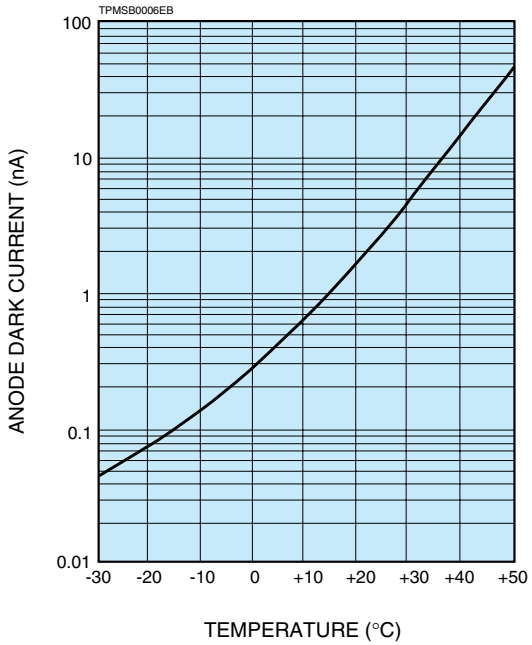
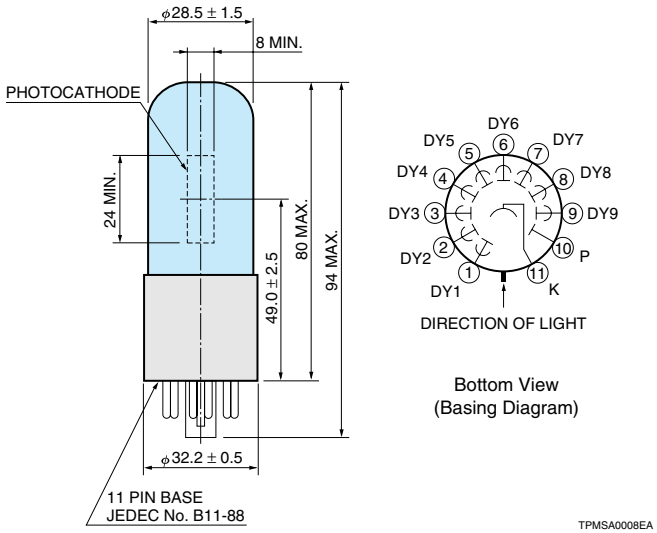


Figure 5: Typical temperature characteristic of dark current (at 1000 V, after 30 min storage in darkness)



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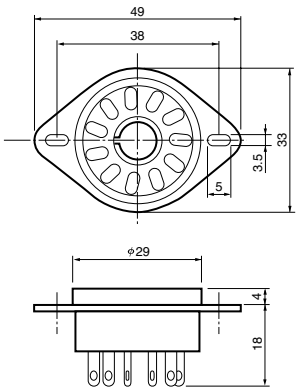
Figure 6: Dimensional outline and basing diagram (Unit: mm)



TPMSA0008EA

Figure 7: Socket (Unit: mm) Sold separately

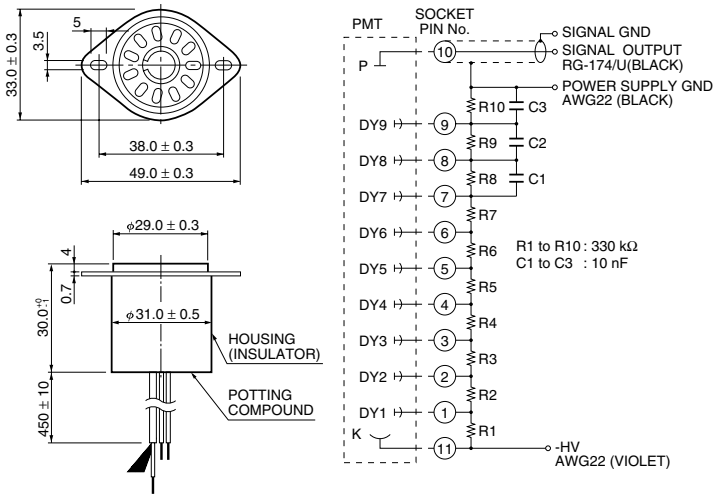
E678-11A



TACCA0064EA

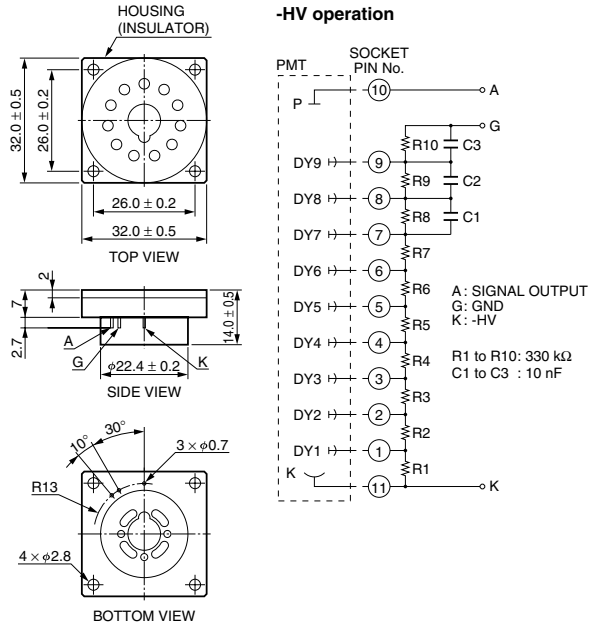
Figure 8: Accessories (Unit: mm) Sold separately

D type socket assembly E717-63



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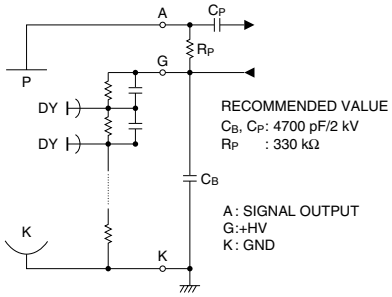
D type socket assembly E717-74



TACCA0277EC

+HV operation

CB, CP and RP must be connected as follows.



TACCA0343EA

* Hamamatsu also provides C4900 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.

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TPMS1091E02
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