

Extended Red, High Sensitivity, Multialkali Photocathode 28 mm (1-1/8 Inch) Diameter, 9-Stage, Side-On Type

The R928 and R955 feature extremely high quantum efficiency, high current amplification, good S/N ratio and wide spectral response from UV to near infrared. The R928 employs a UV glass envelope and the R955 has a fused silica envelope for UV sensitivity extension. The R928 and R955 are well suited for use in broad-band spectrophotometers, atomic absorption spectrophotometers, emission spectrophotometers and other precision photometric instruments.

FEATURES

- Wide Spectral Response
 - R928 185 nm to 900 nm
 - R955 160 nm to 900 nm
- High Cathode Sensitivity
 - Luminous 250 $\mu\text{A/lm}$
 - Radiant at 400 nm 74 mA/W
- High Anode Sensitivity (at 1000 V)
 - Luminous 2500 A/lm
 - Radiant at 400 nm $7.4 \times 10^5 \text{ A/W}$
- Low Drift and Hysteresis

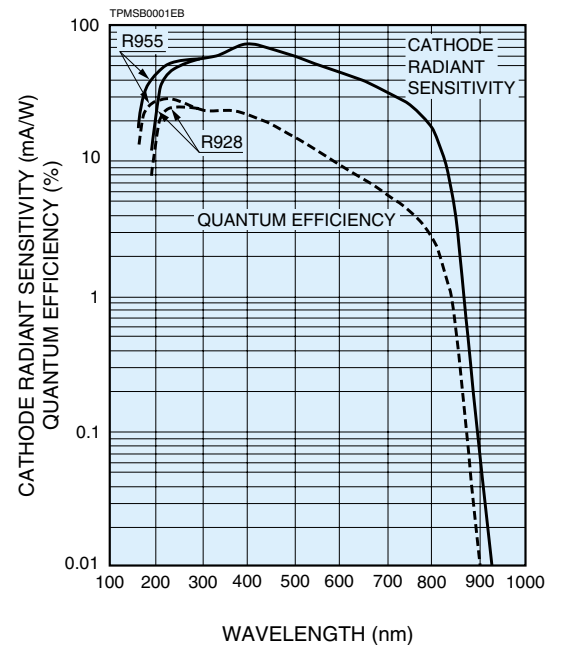


SPECIFICATIONS

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 | Fused silica | — |
| 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 | $^{\circ}\text{C}$ |
| 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



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PHOTOMULTIPLIER TUBES R928, R955

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 | | R928 | | | R955 | | | 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 ^B | 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 ^C | 0.2 | 0.3 | — | 0.2 | 0.3 | — | — | | |
| Blue Sensitivity Index ^D | — | 8 | — | — | 8 | — | — | | |
| Anode Sensitivity | Luminous ^E | 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 ^E | — | 1.0 × 10 ⁷ | — | — | 1.0 × 10 ⁷ | — | — | | |
| Anode Dark Current ^F (After 30 min Storage in Darkness) | | — | 3 | 50 | — | 3 | 50 | nA | |
| ENI (Equivalent Noise Input) ^H | | — | 1.3 × 10 ⁻¹⁶ | — | — | 1.3 × 10 ⁻¹⁶ | — | W | |
| Time Response ^E | Anode Pulse Rise Time ^I | — | 2.2 | — | — | 2.2 | — | ns | |
| | Electron Transit Time ^J | — | 22 | — | — | 22 | — | ns | |
| | Transit Time Spread (TTS) ^K | — | 1.2 | — | — | 1.2 | — | ns | |
| Anode Current Stability ^L | Light 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 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 | 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.

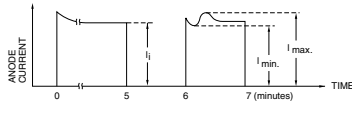
- H: ENI is an indication of the photon-limited signal-to-noise ratio. It refers to the amount of light in watts to produce a signal-to-noise ratio of unity in the output of a photomultiplier tube.

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

- 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.

- 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: 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.



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

(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

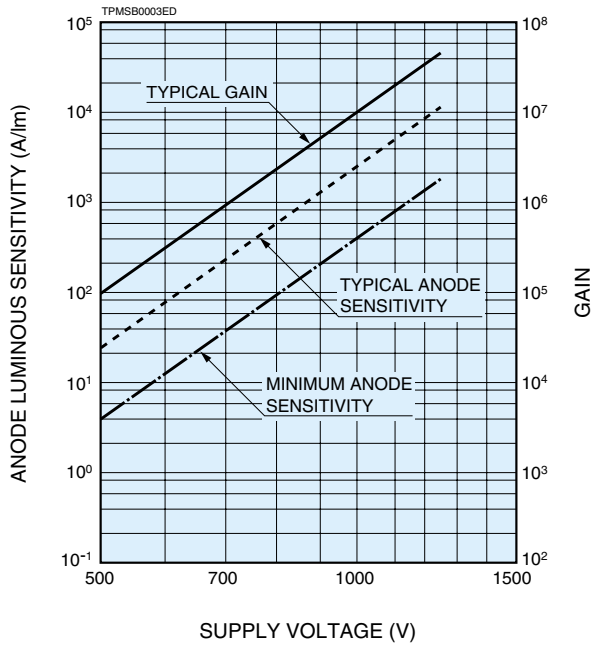


Figure 3: Typical Time Response

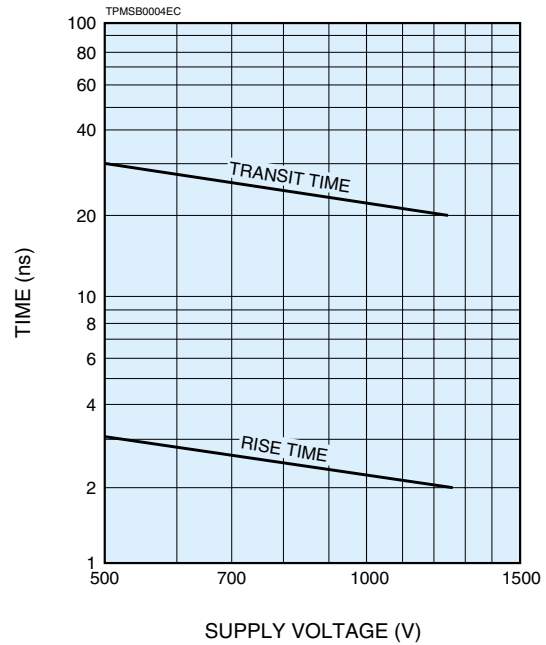


Figure 4: Typical Temperature Coefficient of Anode Sensitivity

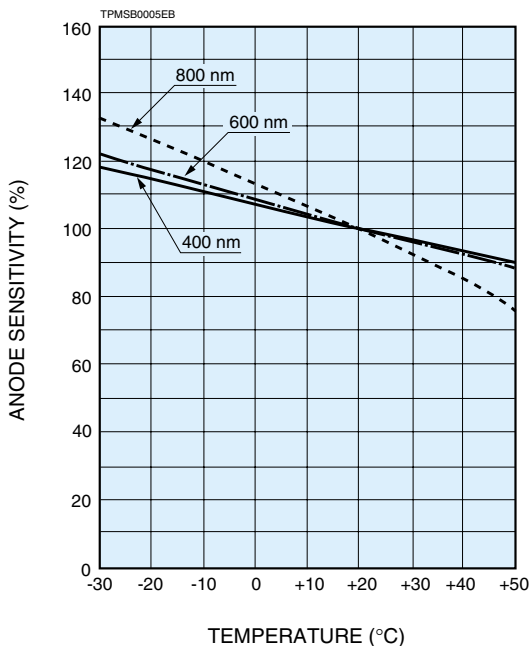
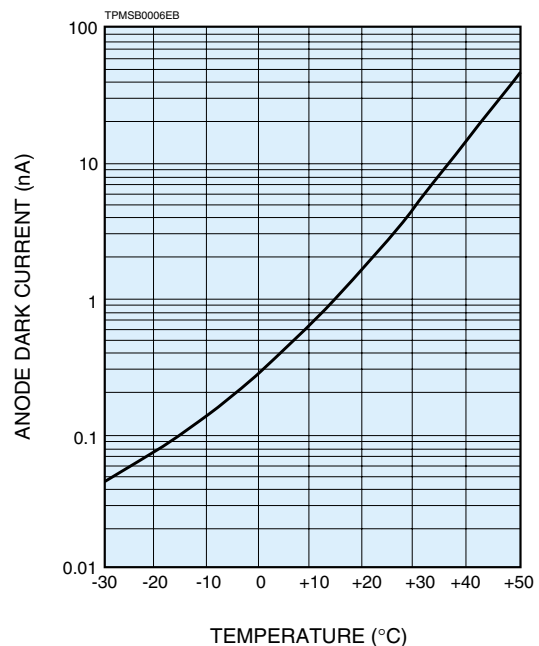
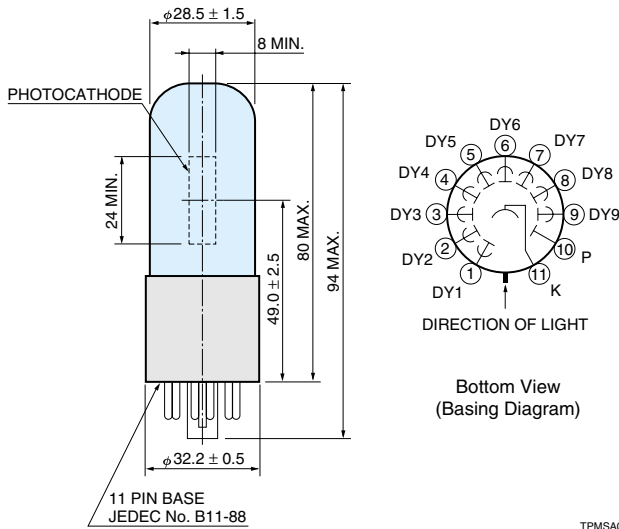


Figure 5: Typical Temperature Characteristic of Dark Current (at 1000 V, after 30 min storage in darkness)



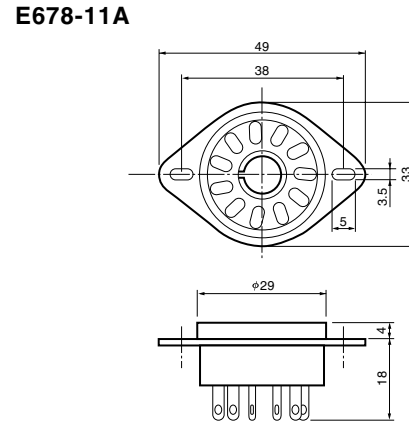
PHOTOMULTIPLIER TUBES R928, R955

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



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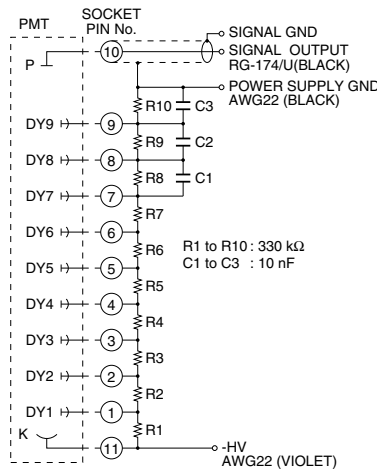
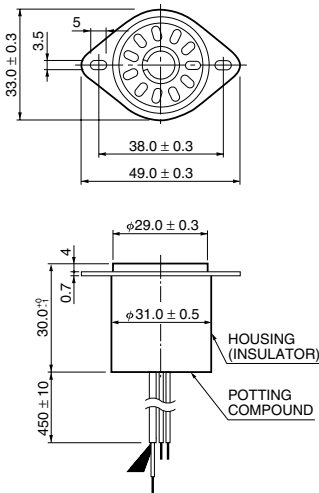
Figure 7: Socket (Unit: mm) Sold Separately



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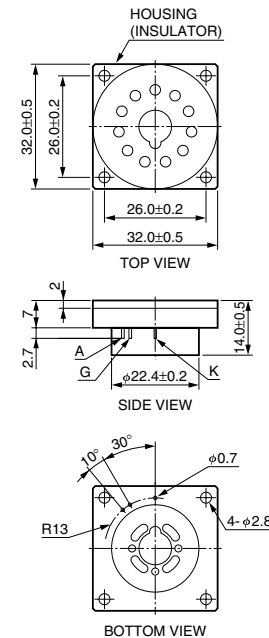
Figure 8: D Type Socket Assembly (Unit: mm) Sold Separately

E717-63



TACCA0002EH

E717-74



* "Wiring diagram applies when -HV is supplied." To supply +HV, connect the pin "G" to +HV, and the pin "K" to the GND.

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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.

HAMAMATSU

WEB SITE www.hamamatsu.com

HAMAMATSU PHOTONICS K.K., Electron Tube Division

314-5, Shimokanzo, Iwata City, Shizuoka Pref., 438-0193, Japan, Telephone: (81)539/62-5248, Fax: (81)539/62-2205

U.S.A.: Hamamatsu Corporation: 360 Foothill Road, P. O. Box 6910, Bridgewater, N.J. 08807-0910, U.S.A., Telephone: (1)908-231-0960, Fax: (1)908-231-1218 E-mail: usa@hamamatsu.com

Germany: Hamamatsu Photonics Deutschland GmbH: Arzbergerstr. 10, D-82211 Herrsching am Ammersee, Germany, Telephone: (49)8152-375-0, Fax: (49)8152-2658 E-mail: info@hamamatsu.de

France: Hamamatsu Photonics France S.A.R.L.: 19, Rue du Saule Trapu, Parc du Moulin de Massy, 91882 Massy Cedex, France, Telephone: (33)1 69 53 71 00, Fax: (33)1 69 53 71 10 E-mail: infos@hamamatsu.fr

United Kingdom: Hamamatsu Photonics UK Limited: 2 Howard Court, 10 Tewin Road Welwyn Garden City Hertfordshire AL7 1BW, United Kingdom, Telephone: 44-(0)1707-294888, Fax: 44-(0)1707-325777 E-mail: info@hamamatsu.co.uk

North Europe: Hamamatsu Photonics Norden AB: Smidesvägen 12, SE-171-41 SOLNA, Sweden, Telephone: (46)8-509-031-00, Fax: (46)8-509-031-01 E-mail: info@hamamatsu.se

Italy: Hamamatsu Photonics Italia: S.R.L.: Strada della Moia, 1/E, 20020 Arese, (Milano), Italy, Telephone: (39)02-935 81 733, Fax: (39)02-935 81 741 E-mail: info@hamamatsu.it

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