

Modified R928, 8 mm × 6 mm Photocathode Size Low Dark Counts, Extended Red Multialkali, High Sensitivity For Photon Counting Applications

The R2949 is a 28mm (1-1/8 inch) diameter, 9-stage, side-on type photomultiplier tube having the same extended red multialkali photocathode as the R928. The R2949 features very low dark counts, extremely high quantum efficiency, high gain, good S/N ratio and wide spectral response from UV to near infrared.

The R2949 is well suited for use in various low-level photometries such as general single photon counting applications and fluorescence life time measurement.

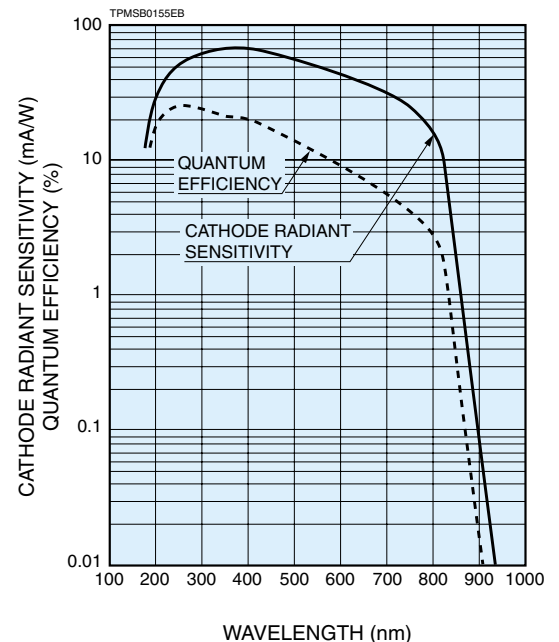
The R2949 is directly interchangeable with the R928.

FEATURES

- Low Dark Counts 300 s⁻¹ (at 25 °C)
- Low Dark Current 2 nA (after 30 min storage in darkness)
- Wide Spectral Response 185 nm to 900 nm
- High Cathode Sensitivity
 - Luminous 200 μA/lm
 - Radiant at 400 nm 68 mA/W
- High Anode Sensitivity (at 1000 V)
 - Luminous 2000 A/lm
 - Radiant at 400 nm 6.8 × 10⁵ A/W
- Low Drift and Hysteresis



Figure 1: Typical Spectral Response



SPECIFICATIONS

GENERAL

| Parameter | Description/Value | Unit |
|------------------------------------|-------------------------------|---------------|
| Spectral Response | 185 to 900 | nm |
| Wavelength of Maximum Response | 400 | nm |
| Photocathode | Material | Multialkali |
| | Minimum Effective Area | 8 × 6 |
| Window Material | UV glass | — |
| Dynode | Secondary Emitting Surface | Multialkali |
| | Structure | Circular-cage |
| | Number of Stages | 9 |
| Direct Interelectrode Capacitances | Anode to Last Dynode | 4 |
| | Anode to All Other Electrodes | 6 |
| 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) | — |

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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 255 nm | — | 25.3 | — | % | |
| | Luminous ^B | 140 | 200 | — | μA/lm | |
| | Radiant | at 194 nm | — | 18 | — | mA/W |
| | | at 254 nm | — | 52 | — | mA/W |
| | | at 400 nm | — | 68 | — | mA/W |
| | | at 633 nm | — | 41 | — | mA/W |
| | | at 852 nm | — | 3.5 | — | mA/W |
| Red/White Ratio ^C | 0.1 | 0.3 | — | — | | |
| Blue Sensitivity Index ^D | — | 7.5 | — | — | | |
| Anode Sensitivity | Luminous ^E | 1000 | 2000 | — | A/lm | |
| | Radiant | at 194 nm | — | 1.8 × 10 ⁵ | — | A/W |
| | | at 254 nm | — | 5.2 × 10 ⁵ | — | A/W |
| | | at 400 nm | — | 6.8 × 10 ⁵ | — | A/W |
| | | at 633 nm | — | 4.1 × 10 ⁵ | — | A/W |
| | | at 852 nm | — | 3.5 × 10 ⁴ | — | A/W |
| Gain ^E | — | 1.0 × 10 ⁷ | — | — | | |
| Anode Dark Count ^F | at +25 °C | — | 300 | 500 | s ⁻¹ | |
| | at -20 °C | — | 3 | — | s ⁻¹ | |
| Anode Dark Current ^F (After 30 min Storage in Darkness) | | — | 2 | 25 | nA | |
| ENI (Equivalent Noise Input) ^G | | — | 1.2 × 10 ⁻¹⁶ | — | W | |
| Time Response ^E | Anode Pulse Rise Time ^H | — | 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 anode-to-cathode supply voltage and voltage distribution ratio shown in Table 1.

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 30 minute storage in darkness.
 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.

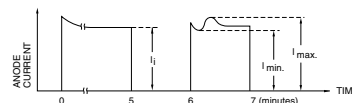
$$ENI = \frac{\sqrt{2q \cdot I_{db} \cdot G \cdot \Delta f}}{S}$$

- 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.

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: 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

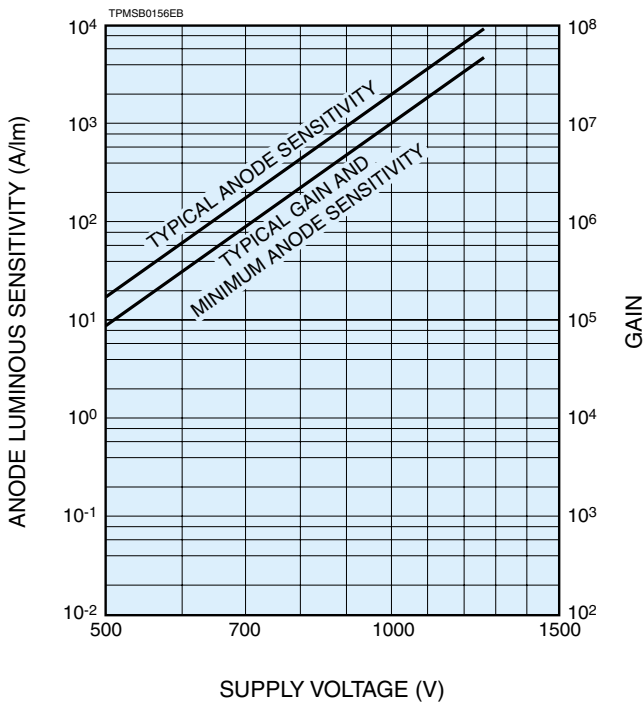


Figure 3: Typical Time Response

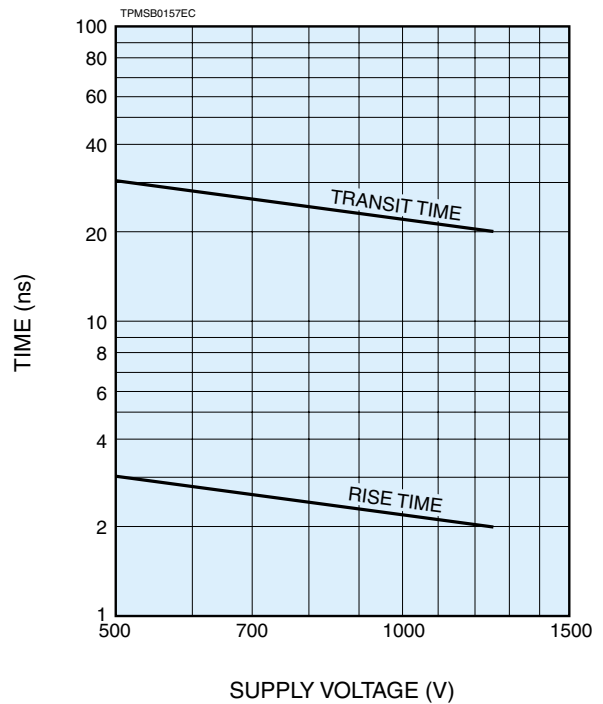


Figure 4: Typical Temperature Coefficient of Anode Sensitivity

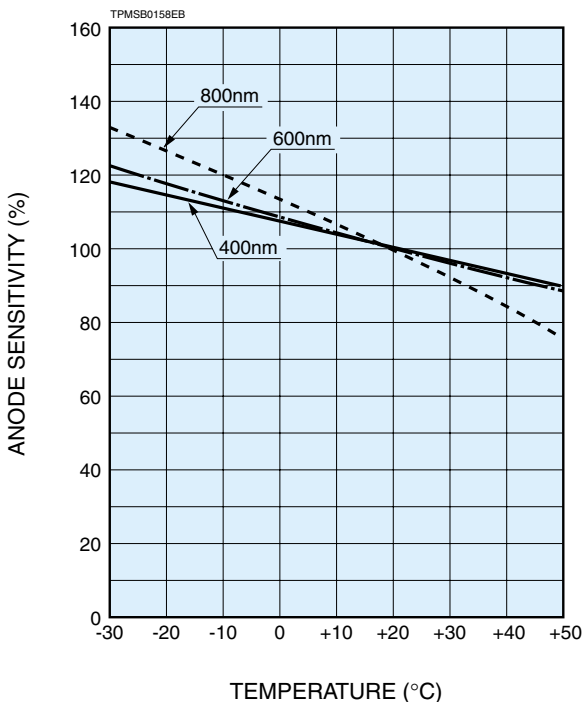
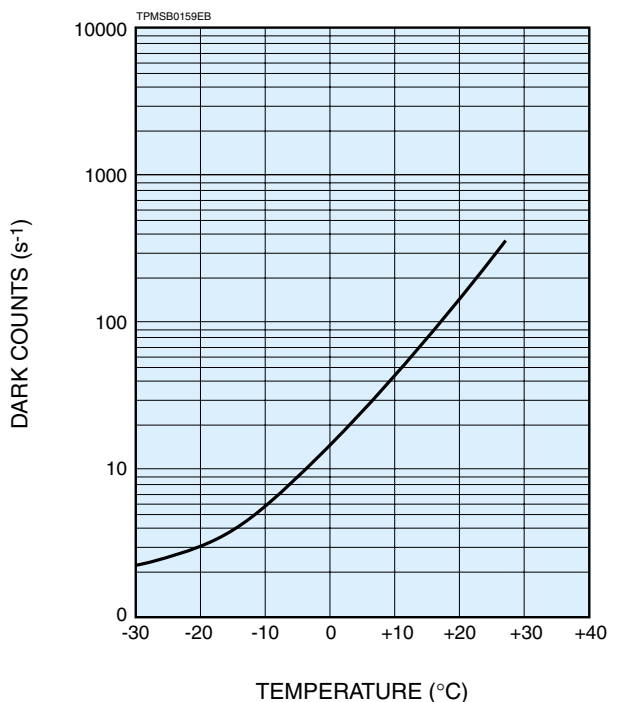
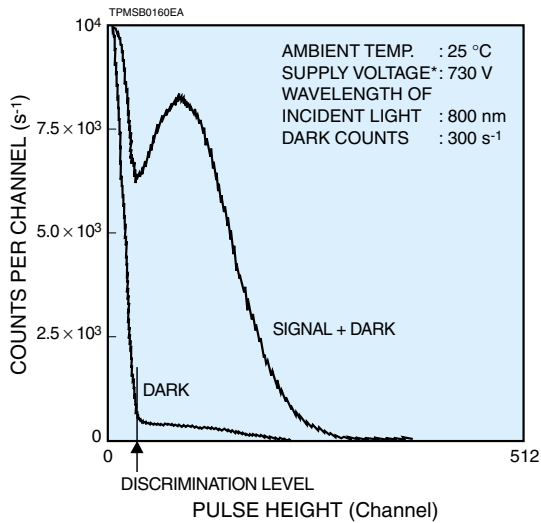


Figure 5: Typical Temperature Characteristic of Dark Counts



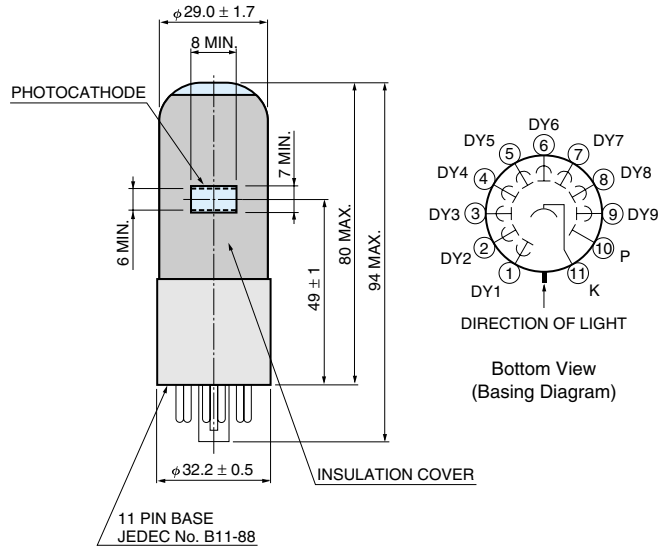
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Figure 6: Single Photon Pulse Height Distribution



* The supply voltage is set at gain to be 1×10^6

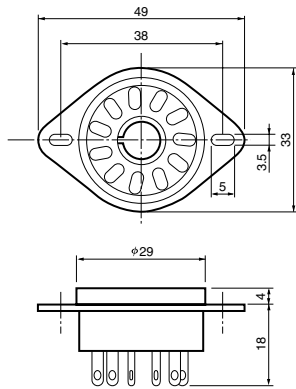
Figure 7: Dimensional Outline and Basing Diagram (Unit: mm)



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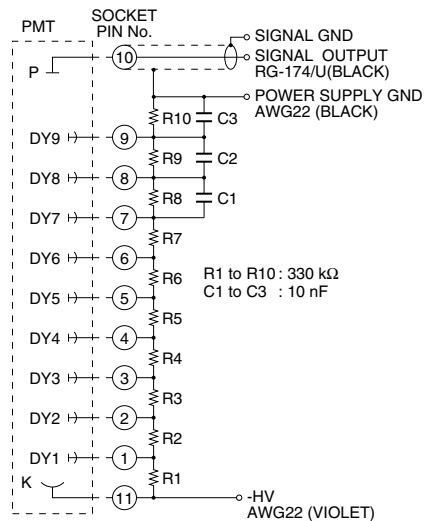
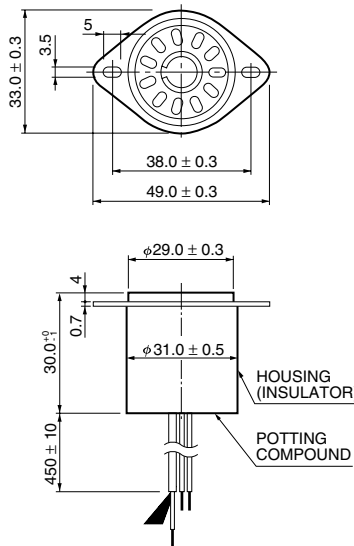
Figure 7: Accessories (Unit: mm) Sold Separately

Socket E678-11A



TACCA0064EA

D Type Socket Assembly E717-63



TACCA0002EH

* 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

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