

High Sensitivity and Lower Dark Current, Lower Dark Count
Wide Spectral Range with Low ENI

FEATURES

- Low Dark Current 5 nA (after 30 minutes)
- Low Dark Counts (R9110P) 500 s⁻¹
- Wide Spectral Response 185 nm to 900 nm
- High Cathode Sensitivity
 - Luminous 525 μA/lm
 - Radiant at 450 nm 90 mA/W
 - QE at 450 nm 24.8 %
- High Anode Sensitivity (at 1000 V)
 - Luminous 10 000 A/lm
- High Signal to Noise Ratio

The R9110 is 28 mm (1-1/8 inch) diameter, 9-stage, side-on type photomultiplier tube having an extended red multialkali photocathode same as the R3896. The R9110 features very low dark current, extremely high quantum efficiency, high gain, good S/N ratio and wide spectral response from UV to near infrared.

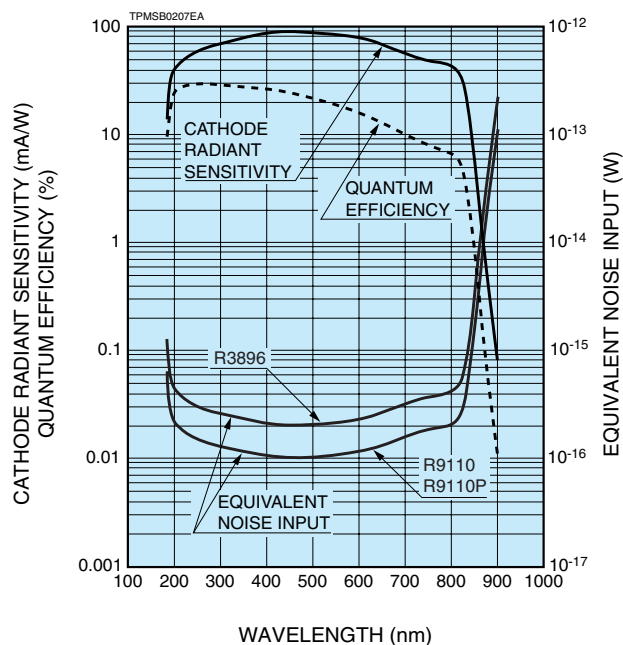
The R9110P is a photon counting version of the R9110 with low dark counts.



GENERAL

| Parameter | Description / Value | Unit |
|------------------------------------|---------------------------------|------|
| Spectral Response | 185 to 900 | nm |
| Wavelength of Maximum Response | 450 | nm |
| Photocathode | | |
| Material | Multialkali | — |
| Minimum Effective Area | 8 × 6 | 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 | 46 | 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 and Equivalent Noise Input



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PHOTOMULTIPLIER TUBES

R9110, R9110P (For Photon Counting)

MAXIMUM RATINGS (Absolute Maximum Values at 25 °C)

| 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 254 nm | — | 29.3 | — | % |
| at 450 nm | — | 24.8 | — | % |
| at 633 nm | — | 14.3 | — | % |
| at 852 nm | — | 0.73 | — | % |
| Luminous ^(B) | 400 | 525 | — | μA/lm |
| Radiant | | | | |
| at 254 nm | — | 60 | — | mA/W |
| at 450 nm | — | 90 | — | mA/W |
| at 633 nm | — | 73 | — | mA/W |
| at 852 nm | — | 5.0 | — | mA/W |
| Red / White Ratio ^(C) | 0.2 | 0.4 | — | — |
| Blue Sensitivity Index ^(D) | — | 15 | — | — |
| Anode Sensitivity | | | | |
| Luminous ^(E) | 4000 | 10 000 | — | A/lm |
| Gain ^(E) | — | 1.9×10^7 | — | — |
| Anode Dark Current ^(F) (After 30 min Storage in Darkness) | — | 5 | 15 | nA |
| Anode Dark Counts ^(F) (for the R9110P) | — | 500 | 1000 | s ⁻¹ |
| ENI (Equivalent Noise Input) ^(G) | — | 1.0×10^{-16} | — | W |
| Time Response | | | | |
| Anode Pulse Rise Time ^(H) | — | 2.2 | — | ns |
| Electron Transit Time ^(I) | — | 22 | — | ns |
| Transit Time Spread (TTS) ^(J) | — | 1.2 | — | 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 volts 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

| Electrodes | 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

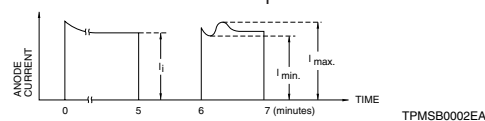
- F: Measured at the voltage producing the gain of 1×10^6 and the voltage distribution ratio shown in table 1 below.
 G: ENI is an indication of the photon-limited signal-to-noise ratio. It refers to the amount of light in watts to produce a signal-to-noise ratio of unity in the output of a photomultiplier tube.

$$ENI = \frac{\sqrt{2q \cdot I_{db} \cdot G \cdot f}}{S} \quad (W)$$

- where q = Electronic charge. (1.60×10^{-19} coulomb)
 I_{db} = Anode dark current (after 30 minute storage) in amperes.
 G = Gain.
 f = Bandwidth of the system in hertz. (usually 1 hertz)
 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.
 I: 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.
 J: Also called transit time jitter. This is the fluctuation in electron transit time between individual pulses in the single photoelectron mode, and may be defined as the FWHM of the frequency distribution of electron transit times.
 K: Hysteresis is temporary instability in anode current after light and voltage are applied.

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



- (1) Light Hysteresis
 The tube is operated at 750 volts with an anode current of 1 microampere 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.

Figure 2: Anode Luminous Sensitivity and Gain Characteristics

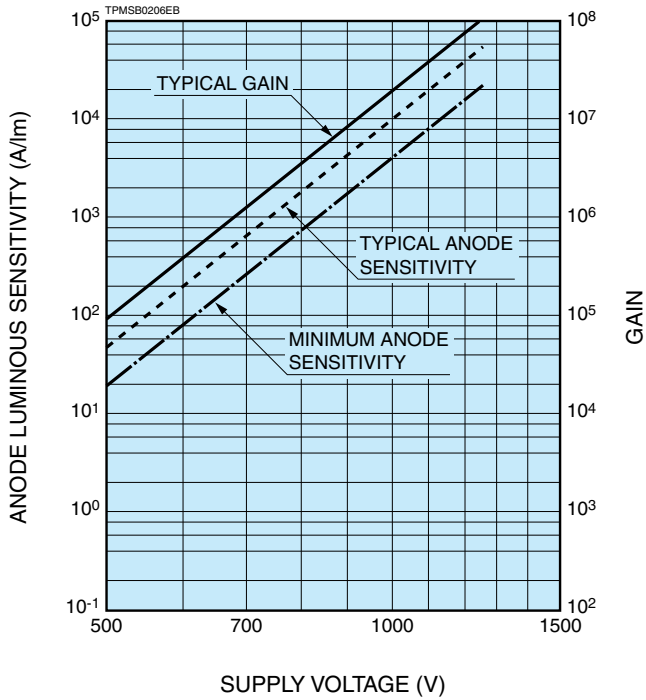


Figure 3: Typical Time Response

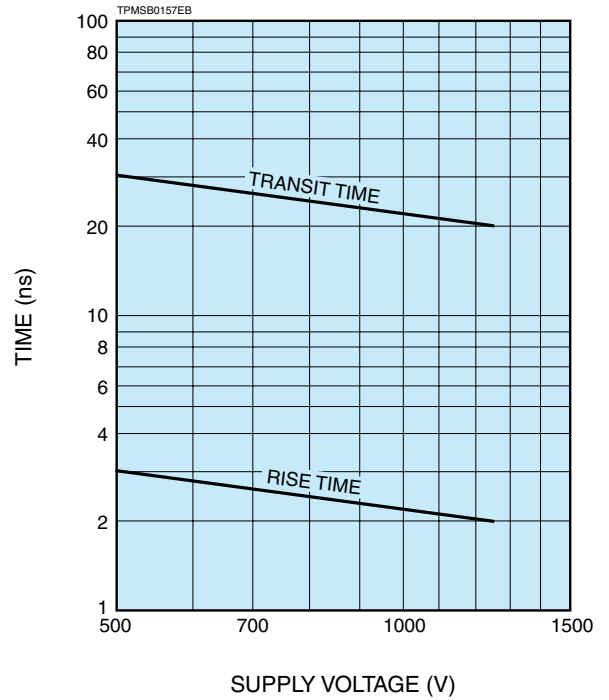


Figure 4: Typical Temperature Characteristics of Dark Current (R9110) (at 1000 V, after 30 min storage)

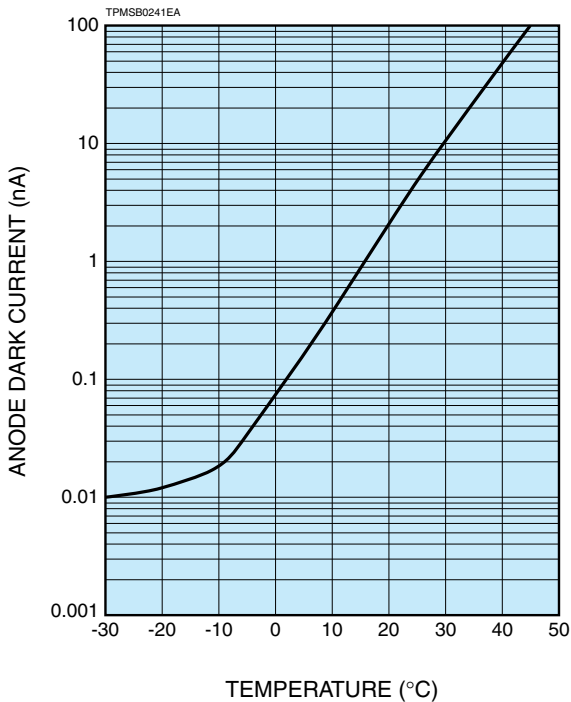
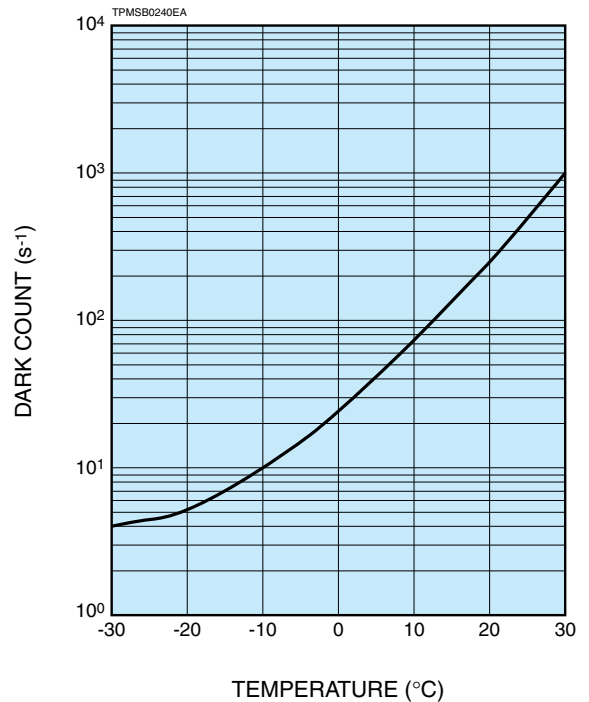


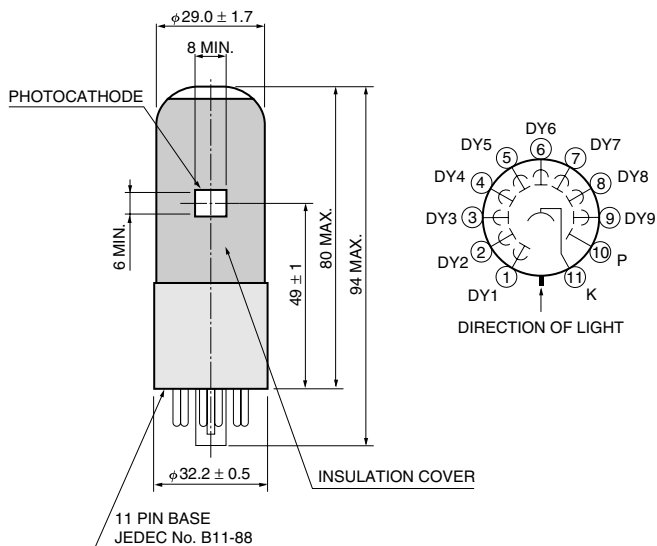
Figure 5: Typical Temperature Characteristics of Dark Count (R9110P)



PHOTOMULTIPLIER TUBES

R9110, R9110P (For Photon Counting)

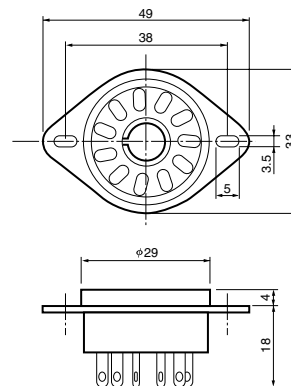
Figure 5: Dimensional Outline and Basing Diagram (Unit: mm)



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Figure 6: Socket (Unit: mm) Sold Separately

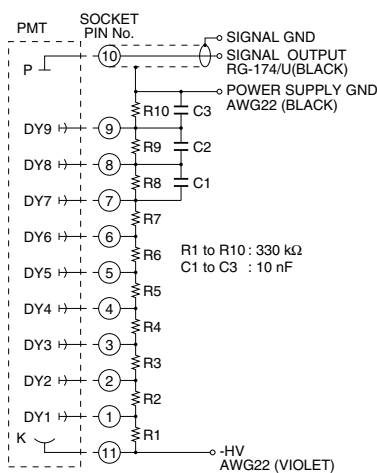
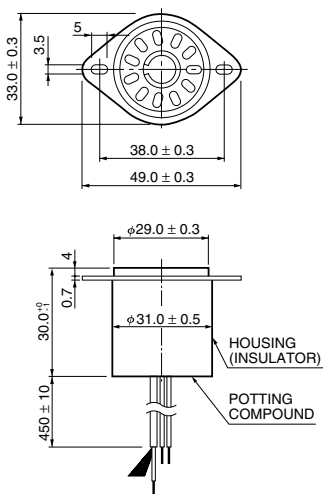
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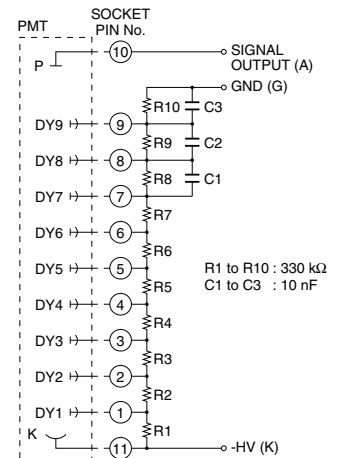
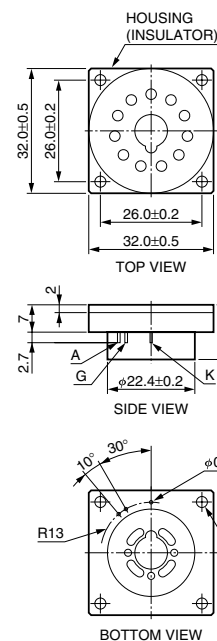
Figure 7: D Type Socket Assembly (Unit: mm) Sold Separately

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.

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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