HAMAMATSU

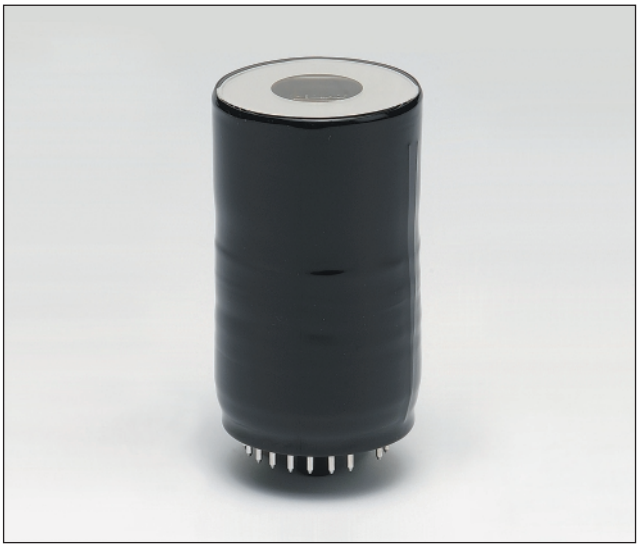
PHOTON IS OUR BUSINESS

PHOTOMULTIPLIER TUBE
R943-02

GaAs (Cs) Photocathode, Wide Spectral Response, 51 mm (2") Diameter Head-on Type for Photon Counting, Low Dark Counts, Excellent P.H.D.

FEATURES

- **Wide Spectral Response ..... 160 nm to 930 nm**
- **High Quantum Efficiency in Near IR ... 14 % at 632.8 nm**
- **Fast Rise Time ..... 3.0 ns at 1500 V**
- **Excellent Single Photoelectron Pulse Height Distribution ..... Peak to Valley Ratio 2.3 (at -20 °C)**
- **Low Dark Counts ..... 20 s^{-1} Typ. (at -20 °C)**



APPLICATIONS

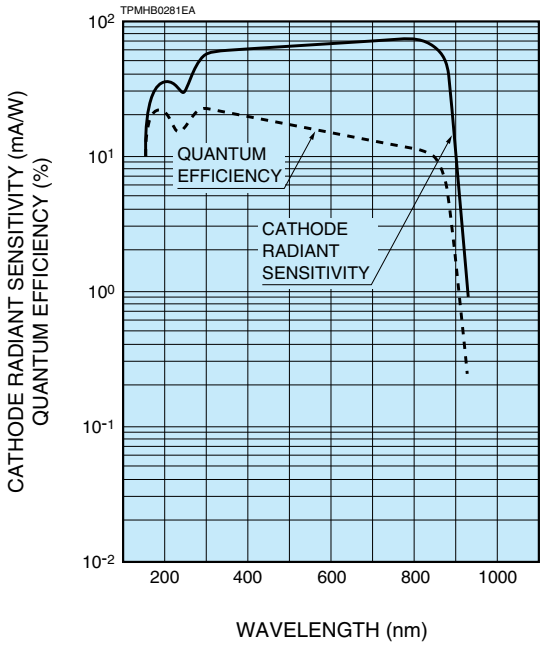
- **Raman Spectroscopy**
- **Fluorescent Spectroscopy**
- **Astrophysical Measurement**
- **Laser Detection**

Hamamatsu R943-02 is a 51 mm (2") diameter head-on type photomultiplier tube having GaAs (Cs) photocathode and synthetic silica window. The combination of the GaAs photocathode and the synthetic silica window allows high sensitivity over a wide spectral range from UV to IR (160 nm to 930 nm).
The R943-02 is selected for photon counting and features low dark counts and excellent pulse height distribution (PHD) of single photoelectrons.

GENERAL

Parameter	Description / Value	Unit
Spectral Response	160 to 930	nm
Wavelength of Maximum Response	300 to 800	nm
Photocathode		
Material	GaAs(Cs)	—
Minimum Effective Area	10 × 10	mm
Mode	Opaque	—
Window Material	Synthetic silica glass	—
Dynode		
Secondary Emitting Surface	Cu-BeO	—
Structure	Linear focused	—
Number of Stages	10	—
Direct Interelectrode Capacitances		
Anode to Last Dynode	Approx. 2.7	pF
Anode to All Other Electrodes	Approx. 5.0	pF
Base	21-pin glass base	—
Suitable Socket	E678–21C (supplied)	—
Weight	93	g
Operating Ambient Temperature	-30 to +50	°C
Storage Temperature	-80 to +50	°C

Figure 1: Typical Spectral Response



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MAXIMUM RATINGS (Absolute Maximum Values)

Parameter	Value	Unit
Supply Voltage		
Between Anode and Cathode	2200	V
Between Anode and Last Dynode	250	V
Average Anode Current Ⓐ	1	μA
Average Pulse Count Rate Ⓑ	6×10^6	s^{-1}
Average Cathode Current Ⓒ	1	nA

CHARACTERISTICS (at 25 °C)

Parameter	Min.	Typ.	Max.	Unit
Cathode Sensitivity Ⓓ				
Quantum Efficiency				
at 253.7 nm (Hg-Line)	—	15	—	%
at 632.8 nm (He-Ne Laser)	—	14	—	%
Luminous Ⓔ	300	600	—	μA/lm
Radiant at 253.7 nm (Hg-Line)	—	30	—	mA/W
at 632.8 nm (He-Ne Laser)	—	70	—	mA/W
at 700 nm	—	71	—	mA/W
at 852.1 nm (Cs-Line)	—	65	—	mA/W
Red/White Ratio Ⓕ	—	0.58	—	
Anode Sensitivity Ⓖ				
Luminous Ⓔ	150	300	—	A/lm
Radiant at 253.7 nm (Hg-Line)	—	1.5×10^4	—	A/W
at 632.8 nm (He-Ne Laser)	—	3.5×10^4	—	A/W
at 700 nm	—	3.6×10^4	—	A/W
at 852.1 nm (Cs-Line)	—	3.3×10^4	—	A/W
Gain Ⓖ	—	5×10^5	—	—
Equivalent Anode Dark Current Ⓗ	—	1	10	nA
Anode Dark Counts Ⓙ	—	20	50	s^{-1}
Single Photoelectron PHD (Peak to Valley Ratio)	—	2.3	—	—
Time Response Ⓖ				
Anode Pulse Rise Time Ⓚ	—	3.0	—	ns
Electron Transit Time Ⓛ	—	23	—	ns

NOTES

Ⓐ Averaged over any interval of 30 seconds maximum.

Ⓑ Measured at single photoelectron level. The discriminator level is set at valley point.

Ⓒ In practical operation, the cathode current should be lower than 0.1 nA to prevent shortening the life of the photocathode.

Ⓓ Supply voltage is 150 volts between the cathode and all other electrodes.

Ⓔ The light source is a tungsten filament lamp operated at a distribution temperature of 2856 K.

Ⓕ The quotient of the cathode sensitivity measured with the light source is the same as Note Ⓓ passing through a red filter (Toshiba R-68) divided by the cathode luminous sensitivity without the red filter.

Ⓖ Measured with supply voltage and voltage distribution ratio in Table 1.

Ⓗ Measured with supply voltage to provide the anode luminous sensitivity of 200 (A/lm) and the voltage distribution ratio in Table 1 after 30 minute storage in the darkness.

Ⓙ Measured with supply voltage that gives 2×10^6 gain and with the voltage distribution ratio shown in Table 1 after one hour storage in the cooler set at -20 °C.
The discriminator is set at 1/3 of a single photoelectron level.

Ⓚ The rise time is the time it takes 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 a delta function light pulse at the entrance window of the tube and the time when the output pulse reaches the peak amplitude. In measurement the entire photocathode is illuminated.

Table 1: Voltage Distribution Ratio

Electrode	K	Dy1	Dy2	Dy3	Dy4	Dy5	Dy6	Dy7	Dy8	Dy9	Dy10	P
Distribution Ratio	3	1.5	1	1	1	1	1	1	1	1	1	1

Supply Voltage : 1500 V, K : Cathode, Dy : Dynode, P : Anode

Replacement Information

The R943-02 is similar to the Burle C31034 series photomultiplier tube. The base and voltage divider are different.

Warning–Personal Safety Hazards
Electrical Shock — Operating voltages applied to this device present a shock hazard.

Figure 2: Typical Single Photoelectron Pulse Height Distribution

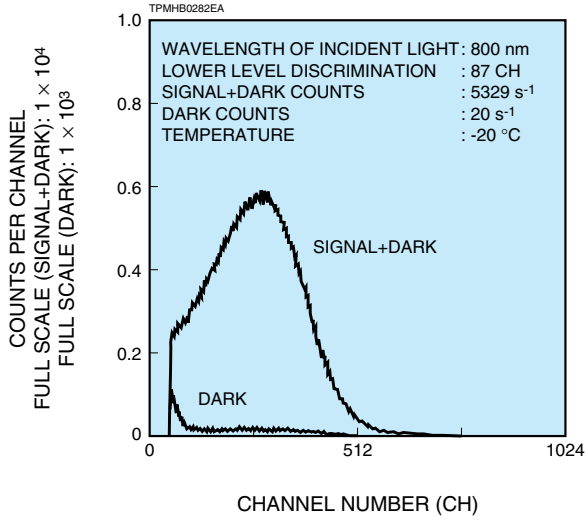


Figure 3: Typical Gain

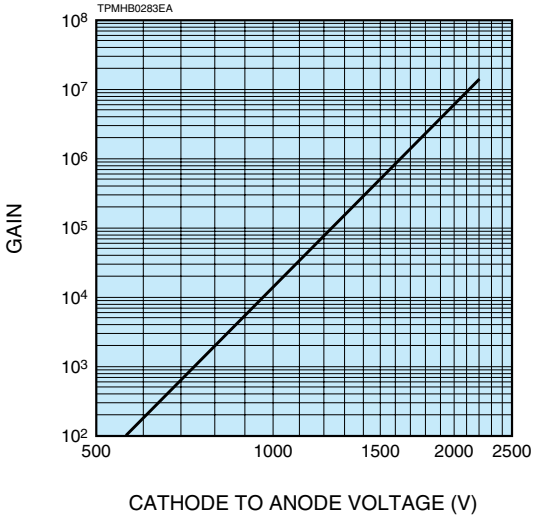


Figure 4: Typical Time Response

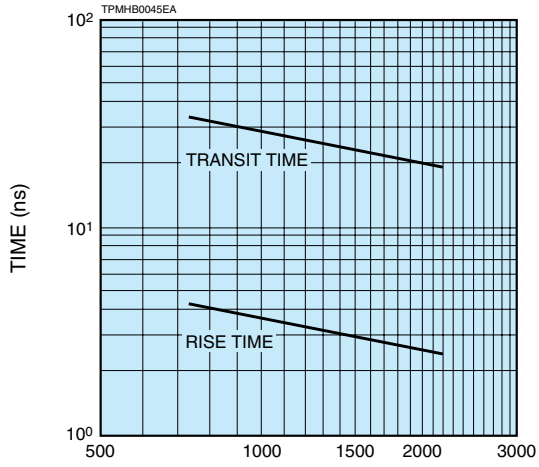


Figure 5: Typical Temperature Coefficient of Quantum Efficiency

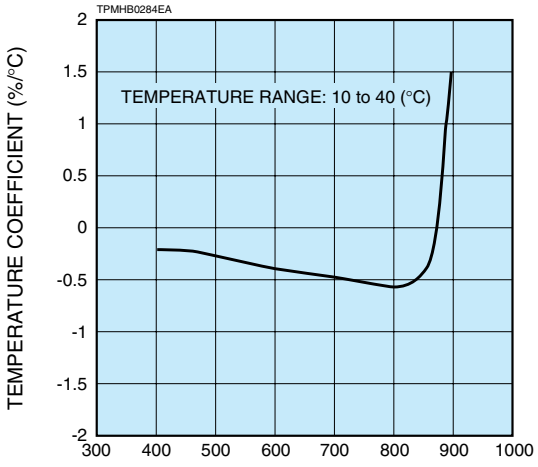
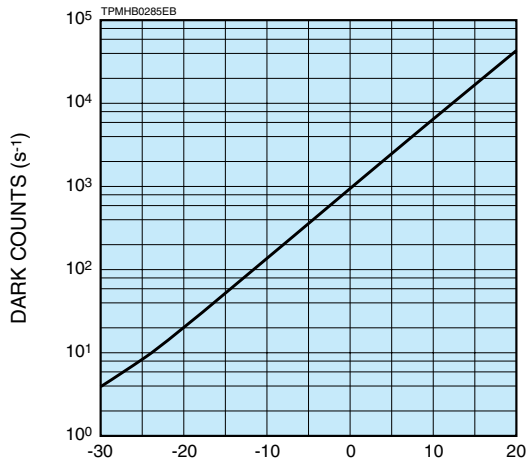


Figure 6: Typical Dark Counts vs. Temperature

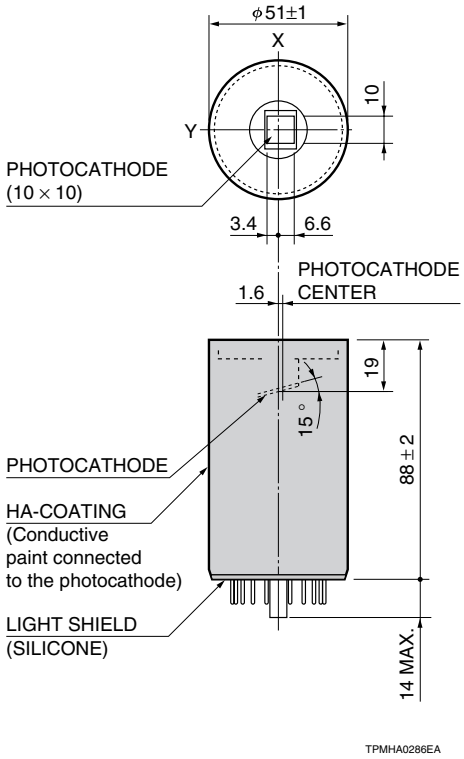


COOLING

As Figure 6 shows, the dark counts of the R943-02 decreases by cooling the tube. Therefore, when performing photon counting, it is recommended that the tube be cooled down to about -20 °C. The cooler C10372 which features temperature control from -30 °C to 0 °C is available from HAMAMATSU.

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

a)



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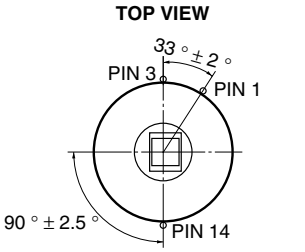
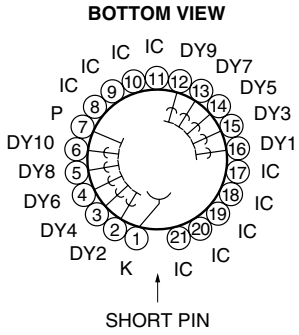
Orientation of Photocathode with respect to base pin





Dy: Dynode
K : Photocathode
P : Anode
IC : Internal Connection
(should not be used)

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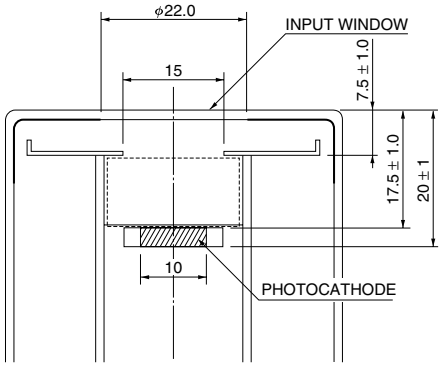
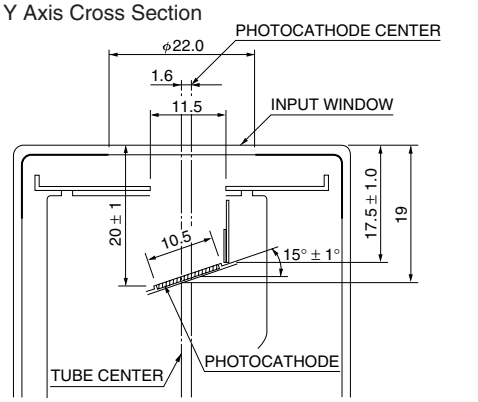
b) PHOTOCATHODE

X Axis Cross Section



Y Axis Cross Section



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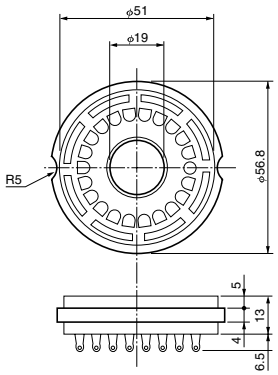
c) SOCKET(Refer to NOTES Ⓐ)

E678–21C (Supplied)



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REMARKS

- HA coating
  The R943-02 is coated with the conductive paint connected to the cathode, which is covered with an insulating material (HA coating). This method decreases noise. Care should be taken not to damage the insulating cover wrapping around the bulb.

CAUTIONS

- Use the HAMAMATSU SOCKET E678-21C.
- When soldering the voltage dividers to the socket, the PMT should be inserted in the socket.
- Helium will permeate through the silica bulb, leading to an increase in noise. Avoid operating or storing tubes in an environment where helium is present.
- As the R943-02 has a synthetic silica window, a very thin graded sealing structure is used in the bulb wall. Although it is covered with an insulating cover, extreme care should be taken in handling.

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TPMH1115E07
DEC. 2010 IP