

HAMAMATSU

TECHNICAL DATA SHEET

931B

PHOTOMULTIPLIER TUB

High Anode Sensitivity, Low Anode Current Drift Bialkali Photocathode, 300 to 650 nm Response 1-1/8" (28mm) Diameter, 9 Stage, Side-On

The Hamamatsu 931B is a 1-1/8" (28 mm) diameter, 9 stage, side-on type photomultiplier tube with a bialkali photocathode and a borosilicate glass bulb, the combination of which allows higher sensitivity than standard S-4 response. This tube also features low anode current drift and low dark current.

FEATURES:

(Typical Values)

- High Sensitivity
 - Cathode Luminous 55 $\mu\text{A/lm}$
 - Anode Luminous 400 $\mu\text{A/lm}$ at 1000 V
- Low Anode Current Drift 0.5 %
- Low Dark Current 10 nA at 1000 V
- Hysteresis Free 1.0 % Max.

APPLICATIONS:

- Near UV to Visible Spectrophotometers
- Emission Spectrophotometers
- Fluorescent Spectrophotometers
- Chromatography
- Dust Meters
- Film Readers

GENERAL:

Spectral Response	300 ~ 650 nm (see Figure 1)
Wavelength of Maximum Response	400 nm
Photocathode	
Material	Bialkali (opaque)
Minimum Useful Size	8 x 24 mm
Window Material	Borosilicate glass
Dynode	
Secondary Emitting Surface	Bialkali
Structure	Circular-cage
Number of Stages	9 stages
Direct Interelectrode Capacitances (approx.)	
Anode to Last Dynode	4 pF
Anode to All Other Electrodes	6 pF
Base	JEDEC No. B11-88
Weight	45 g
Suitable Socket	Hamamatsu E678-11A (option)
Suitable Socket Assembly	Hamamatsu E717-05 (option)

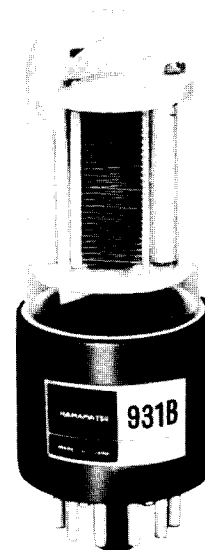
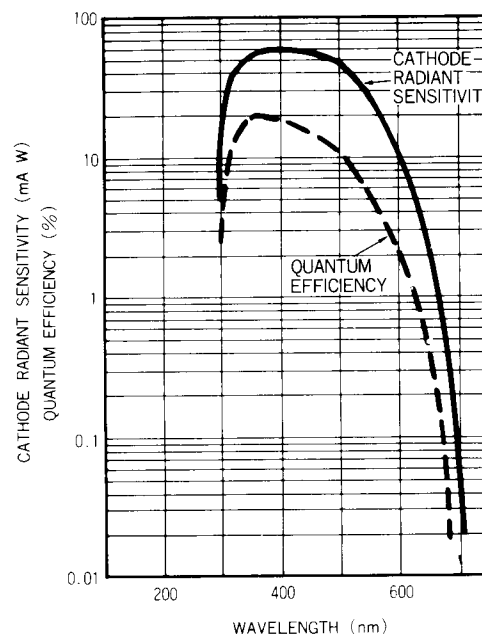


FIGURE 1
Typical Spectral Response



MAXIMUM RATINGS (Absolute Maximum Values):

Supply Voltage

Between Anode and Cathode	1250 Vdc
Between Anode and Last Dynode	250 Vdc
Between Successive Dynodes	250 Vdc
Between First Dynode and Cathode	250 Vdc
Average Anode Current (Note 1)	0.1 mA
Ambient Temperature	-80 ~ +50°C

CHARACTERISTICS (at 25°C):

	Min.	Typ.	Max.	Units
Anode Sensitivity (Note 2)				
Luminous (Note 3)	50	400	1200	A/lm
Radiant at 400 nm	—	4.4 x 10 ⁵	—	A/W
633 nm	—	2.8 x 10 ⁴	—	A/W
Cathode Sensitivity				
Luminous (Note 4)	25	55	—	μA/lm
Radiant at 400 nm	—	60	—	mA/W
633 nm	—	3.9	—	mA/W
Quantum Efficiency at 360 nm	—	20	—	%
Red/White Ratio (Note 5)	—	0.002	—	
Current Amplification (Note 2)	—	7.3 x 10 ⁶	—	
Anode Dark Current (Note 2)				
(A) After 15 hour storage				
in the dark	—	5	—	nA
(B) After 5 second storage				
in the dark	—	10	50	nA
ENI (Equivalent Noise Input)				
(Note 6)	—	2.5 x 10 ⁻¹⁶	—	W
Time Response				
Anode Pulse Rise Time				
(Note 2, 7)	—	2.2	—	ns
Electron Transit Time				
(Note 2, 8)	—	22	—	ns
Anode Current Stability				
Current Hysteresis (Note 9)	—	—	1.0	%
Drift (Note 10)	—	0.5	2	%

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 = 1000Vdc

K : Cathode Dy : Dynode P : Anode

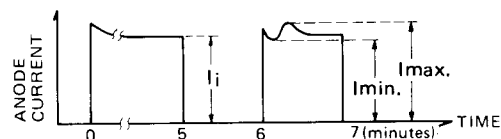
NOTES:

1. Averaged over any interval of 30 seconds maximum.
2. The voltage distribution ratio is shown in Table 1 below.
3. The light source is a tungsten filament lamp operated at a distribution temperature of 2856K. The light input is 0.1 micro-lumen.
4. Under the same conditions as Note 3 except that the light input is 10⁻² lumen and 100 volts are applied between cathode and all other electrode connected together as anode.
5. 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 4.
6. ENI is an indication of 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 = Elementary charge (1.60 x 10⁻¹⁹ coulomb)
 I_{db} = Anode dark current (after 15 hour storage) in amperes
 G = Current amplification
 Δf = Bandwidth of the system in hertz. In this catalog, 1 hertz is used.
 S = Anode radiant sensitivity in amperes per watt at the wavelength of peak response.

7. 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.
8. 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 the output pulse reaches the peak amplitude. In measurement the entire photocathode is illuminated.
9. Hysteresis is a temporary instability in anode current after light and voltage are applied.



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

The tube is operated at 750 volts with an anode current of 1 micro-ampere for 5 minutes and 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 variation.

10. The change in anode current for 12 minutes after warm-up of 30 minutes with an initial anode current of 3 micro-amperes.

FIGURE 2
Anode Sensitivity and Amplification Characteristics

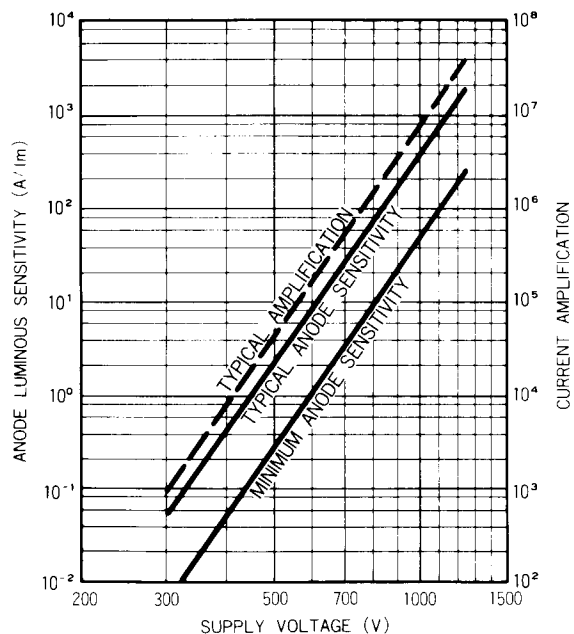


FIGURE 3
Typical Time Response

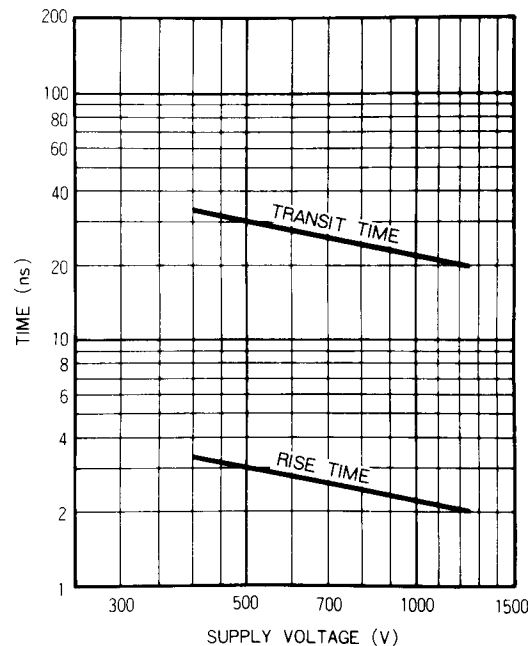


FIGURE 4
Typical Temperature Coefficient of Anode Sensitivity

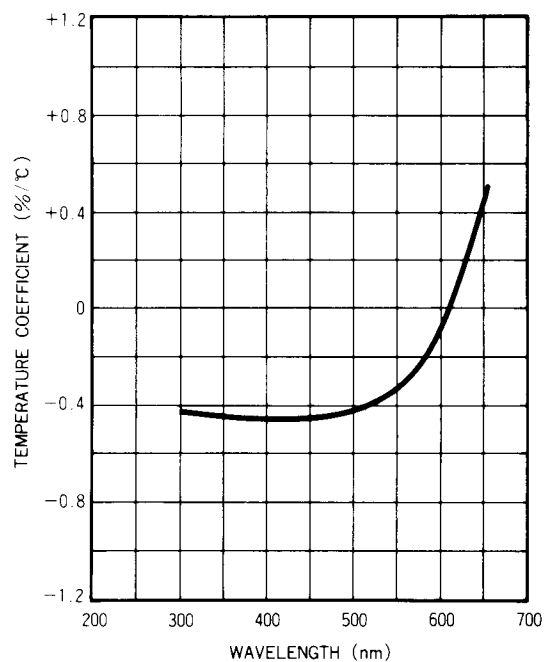
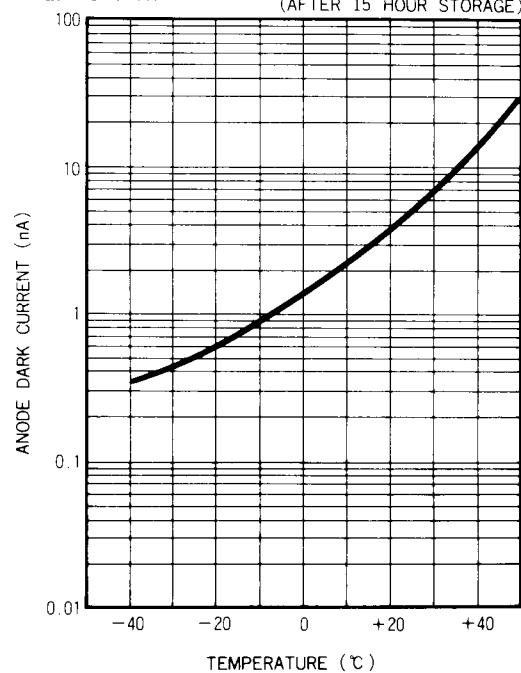
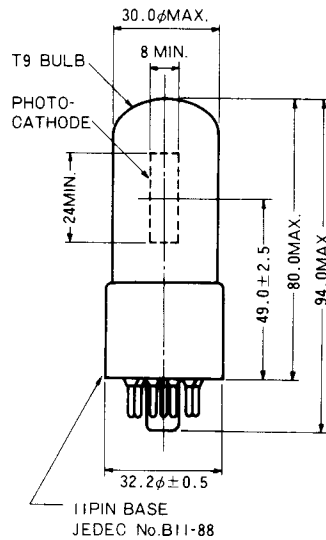


FIGURE 5
Typical Temperature Characteristic of Dark Current
(AFTER 15 HOUR STORAGE)



931B PHOTOMULTIPLIER TUBE

FIGURE 6
Dimensional Outline (Unit: mm)



Basing Diagram
(Bottom View)

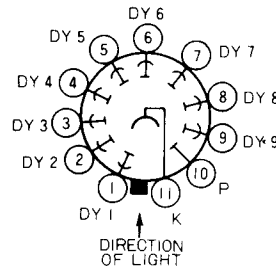
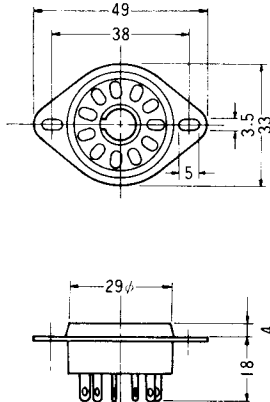
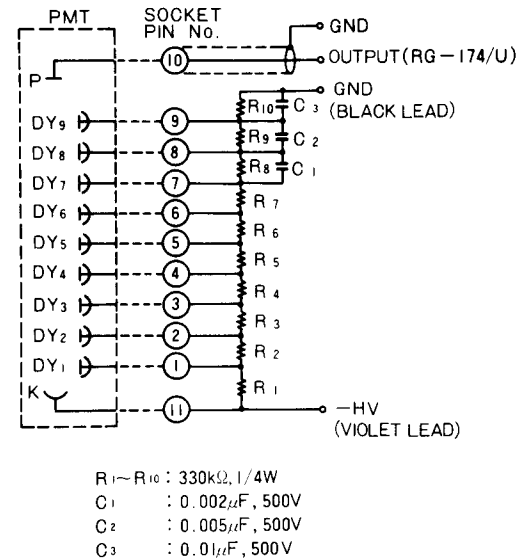
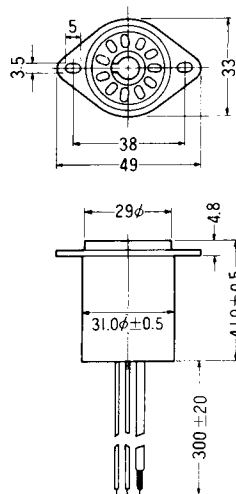


FIGURE 7
Optional Accessories (Unit: mm)

Socket E678-11A



Socket Assembly E717-05



Warning – Personal Safety Hazards

Electrical Shock – Operating voltages applied to this device present a shock hazard.

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