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S83068E
Photomultiplier Tube

28-mm (1-1/8-in) Diameter, 10-Stage, End-Window, Bialkali Photocathode Designed To Be A Direct Replacement For Hamamatsu PMT Types R268 And R268UH And Also For ETL PMT Types 9524B and 9924B

- **Direct Plug-in Replacement for Hamamatsu R268 and R268UH***
- **Direct Plug-in Replacement for ETL Types 9524B and 9924B***
- **Excellent Pulse Characteristics:**
  7.5% Typical Pulse Height Resolution
- **High Quantum Efficiency:**
  32% Typical at 380 nm
- **High Current Amplification:**
  2.4 x 10^6 Typical at 1000 Volts
  Low Anode Dark Current:
- **3 nA Typical at 1000 Volts**

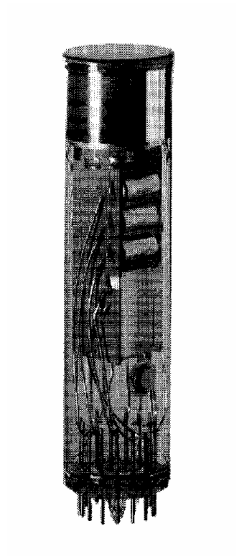
The BURLE S83068E photomultiplier is a 28-mm (1-1/8 inch) diameter, 10-stage, end-window type having a bialkali photocathode and intended for use in scintillation counters or other applications requiring the detection and measurement of low-level light. The tube features high sensitivity, high current amplification, and low dark current. The spectral response extends from 300 to 650 nanometers with peak response occurring at wavelengths which matche the emission from most popular scintillators. The S83068E features a flat faceplate design for ease of coupling to a scintillating crystal, and the excellent pulse height resolution characteristics of the S83068E make it the device of choice in the most critical of nuclear applications.

Typical applications are in bioluminescence counters, pollution monitors, electron microscopes, fluorescent spectrophotometers, radioimmunoassay systems, process control equipment, color printing, scintillation counting, and flying spot scanning equipment.

General Data

Photocathode:
Spectral Responsivity.............................. See **Figure 1**
Wavelength of Maximum Response: .... 380 nm
Composition .... Bialkali (Semitransparent)
Minimum Useful Diameter:................... 2.54 cm (1.0 in)

Faceplate Window:
Material..................... Corning No. 7056[1], or equivalent
Index of Refraction at 391.4 nm.......................... 1.500
Shape ....Plano-plano



Dynodes:
Structure .... Inline, linear-focus
Secondary Emitting Surface................ Alkali-antimonide

Direct Interelectrode Capacitances (Approx.):
Anode to Dynode No. 10 .... 3.2 pF
Anode to all Other Electrodes Combined............ 4.7 pF

Base: .... 14-pin glass

Socket: .... BURLE AJ2263B

Magnetic Shield .... BURLE AJ2246

Weight (Approx.).................................... 45 gm (1.6 oz)

Absolute Maximum Ratings[2]

DC Supply Voltage:
Between Anode and Cathode .... 1700 volts
Between Anode and Dynode No. 10............... 250 volts
Between Adjacent Dynodes .... 250 volts
Between Dynode No. 1 and Cathode.............. 400 volts

***Note** - The 10-stage S83068E is uniquely designed such that it directly plugs into the same socket that is utilized for the 11-stage Hamamatsu R268 or R268UH and the ETL Types 9524B or 9924B. This direct replacement capability assumes only that the voltage divider ratio used in the original socket is either 1:1:1 . . .1 or 2:1:1 :1 and that an overall gain adjustment in the form of applied voltage adjustment is available.

ISO 9001

BURLE

Average Anode Current[3] .... 0.20 mA

Temperature[4]:

Operating and Storage .... -80 °C to +70 °C

Perlormance Data

Under conditions with the supply voltage (E) across a voltage divider as shown in **Table 1** and at an ambient temperature of 22 °C, unless otherwise specified.

With E **=** 1000 Volts

	Min.	Typical	Max.	Units
Anode Responsivity:				
Radiant@380nm[5]	-	2.4x 1.0^{5}	-	A/W
Luminous [6]		230	-	A/lm
Blue Resonse[7]	6	21	-	A/inc lm
Cathode Responsivity:				
Radiant @ 380 nm[8]	-	99	-	mA/W
Luminous[9]	-	95	-	µA/lm
Blue Response[10]	8	11	-	µA/inc lm
Current Amplification	-	2.4 x10^{6}	-	
Anode Dark Current[11]	-	3	10	nA
Equivalent Anode Dark				
Current Input (EADCI)[12]		13[12]		lm
At 380 nm		0.013[13]		W
Rise Time[14]	-	3.2	-	nS
Transit Time[15]	-	32	-	nS
Pulse Characteristics[16]:				
Pulse Height Resolution	-	7.5	8.0	%
Pulse Height	1.8	3.8	-	V

1. Made by Corning Glass Works, Corning, NY 14930.
2. In accordance with the Absolute Maximum rating system as defined by the Electronic Industries Association Standard RS 239A, formulated by the JEDEC Electron Tube Council.
3. Averaged over any interval of 30 seconds maximum.
4. The use or storage of these tubes with attached teflon sockets, such as the AJ2263A, at temperatures below -50 °C can destroy the tube. When tube operation below -50 °C is desired, the teflon body of the socket should be removed and only socket-contact to circuit-element connections should be used.
5. This value is calculated from the typical anode luminous responsivity rating using a conversion factor of 1042 lumens per watt.
6. This value is calculated as shown below:

$$\text{Anode Luminous Response (A/LM)} = \frac{\text{Anode Blue Response (A/inc.lm)}}{0.116}$$

   The value of 0.116 is an average value. It is the ratio of the anode current measured under the conditions specified in footnote (7) to the anode current measured under the same conditions but with the blue filter removed.

7. Under the following conditions: Light incident on the photocathode is transmitted through a blue filter (Corning C.S. No. 5-58, polished to 1/2 stock thickness) from a tungsten-filament lamp operated at 2856 K. The value of the light flux incident on the filter is 1 x 10^{-7} lumens.
8. This value is calculated from the typical photocathode luminous responsivity rating using a conversion factor of 1042 lumens per watt.
9. This value is calculated as shown below:

$$\text{Cathode Luminous Response } (\mu A/inc.lm) = \frac{\text{Cathode Blue Response } \mu A/inc.lm}{0.116}$$

   The value of 0.116 is an average value. It is the ratio of the photocathode current measured under the conditions specified in footnote (10) to the photocathode current measured under the same conditions but with the blue filter removed.

10. Under the following conditions: Light incident on the photocathode is transmitted through a blue filter (Corning C.S. No. 5-58, polished to 1/2 stock thickness) from a tungsten-filament lamp operated at a color temperature of 2856 K. The value of the light flux incident on the filter is 1 x 10^{-3} lumens and 200 volts are applied between cathode and all other electrodes connected as anode.
11. Dark current is measured with the incident light removed and the supply voltage (E) set at 1000 volts.
12. Equivalent Anode Dark Current Input (EADCI) is defined as the input flux in lumens which results in an increase in the anode current of the photomultiplier tube just equal to the anode dark current.
13. EADCI in watts at 380 nanometers is calculated from the EADCI value in lumens using a conversion factor of 1042 lumens per watt.
14. Measured between 10% and 90% of the maximum anode-pulse height. This anode-pulse rise time is primarily a function of transit time variation and is measured under conditions with the incident light fully illuminating the photocathode.
15. 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 at which the output pulse at the anode terminal reaches peak amplitude. The transit time is measured under conditions with the incident light fully illuminating the photocathode.
16. Tested with a supply voltage (E) of 1000 volts and a 137Cs gamma ray source of sufficient intensity to produce approximately 10000 cps under the photopeak from the photomultiplier tube under test when positioned on the back side of a 1-inch diameter x l-inch high Nal(Tl) scintillator.

    The faceplate end of the scintillator is coupled to the faceplate of the PMT with mineral oil. The ^{137}Cs source is centered with respect to the scintillator which, in turn, is centered on the faceplate of the PMT. The anode of the PMT is connected to a charge sensitive preamplier, spectroscopy amplifier, and a multichannel analyzer. Pulse height resolution is defined as the ratio of the full-width-half-maximum of the 0.662 MeV photopeak divided by the pulse height of the photopeak and expressed in terms of percent. Pulse height is determined as the anode signal in volts developed by the photopeak at the output of the test circuit shown in Figure 5.

Table 1

Typical Voltage Distribution	
Between	**8.3% of Supply Voltage (E) Multiplied By:**
Cathode and Dynode No. 1	2
Dynode No. 1 & Dynode No. 2	1
Dynode No. 2 & Dynode No. 3	1
Dynode No. 3 & Dynode No. 4	1
Dynode No. 4 & Dynode No. 5	1
Dynode No. 5 & Dynode No. 6	1
Dynode No. 6 & Dynode No. 7	1
Dynode No. 7 & Dynode No. 8	1
Dynode No. 8 & Dynode No. 9	1
Dynode No. 9 & Dynode No. 10	1
Dynode No. 10 & Anode	1
Anode and Cathode	12

Operating Considerations

Average Anode Current

The operating stability of the tube is dependent on the magnitude of the average anode current. The use of an average current well below the rated maximum of 0.20 milliampere is recommended when stability of operation is most important. When maximum stability is required, the average anode current should not exceed 1 microampere.

Shielding

Electrostatic and magnetic shielding of the tube is ordinarily required. The application of negative high voltage to the cathode should be avoided unless materials outside the glass envelope and immediately surrounding the photocathode limit leakage current to 1 x 10^{-12} ampere or less. In addition to increasing dark current and noise output because of voltage gradients developed across the bulb wall, such high voltage may produce minute leakage current to the cathode, through the tube envelope and insulating materials, which can permanently damage the tube. In general, when a shield is used it is recommended that it be connected to the cathode potential.

Ambient Atmosphere

Operation or storage of this tube, in environments where helium is present, should be avoided. Helium will permeate the tube envelope and may lead to eventual tube failure.

Anode Dark Current

Typical anode dark current as a function of applied high voltage and luminous responsivity at a temperature of +22 °C is shown in Figure 3. A temporary increase in anode dark current by as much as 2 orders of magnitude may occur if the tube is exposed momentarily to high-intensity ultraviolet radiation from sources such as fluorescent room lighting even though the voltage is not applied to the tube. The increase in dark current may persist for a period of 24 to 48 hours following such irradiation.

Cooling of the tube is recommended in those applications where maximum current amplification with minimum dark current is required. The stem of the tube and its socket should never be allowed to become contaminated by handling. Such contamination produces electrical leakage and increased dark current.

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

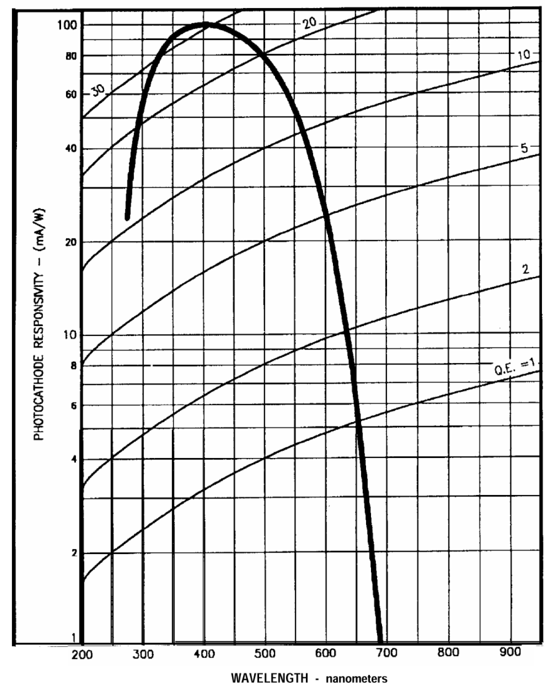


Figure 1: Typical Photocathode Spectral Response

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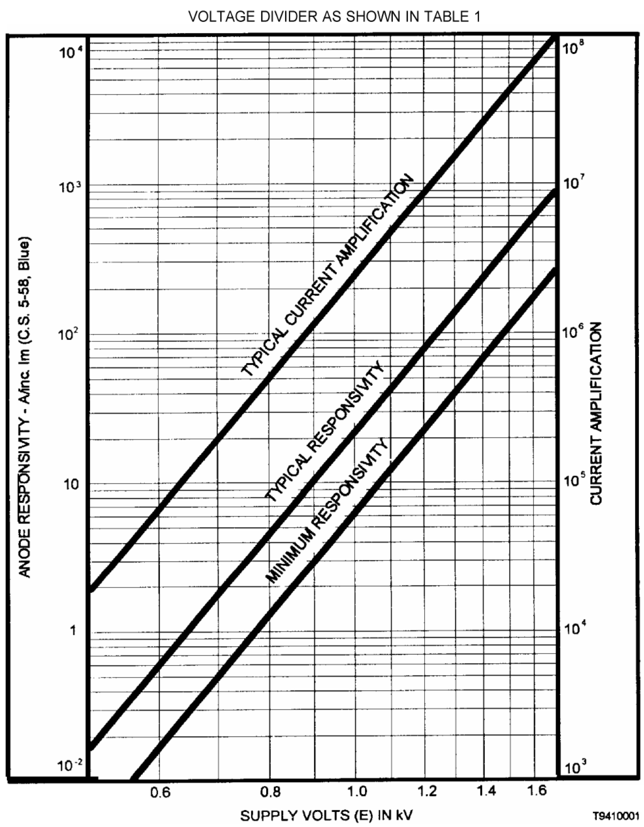


Figure 2: Typical Current Amplification and Responsivity

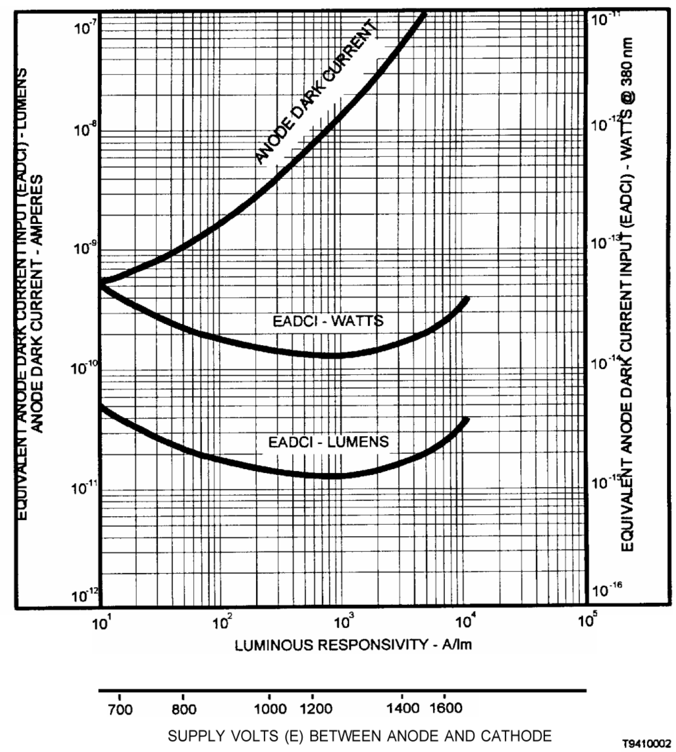


Figure 3: Typical Anode Dark Current and EADCI Characteristics

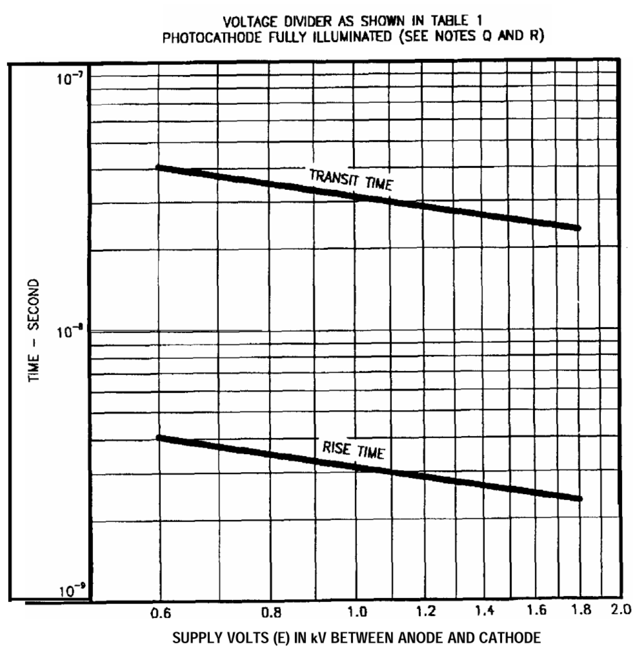
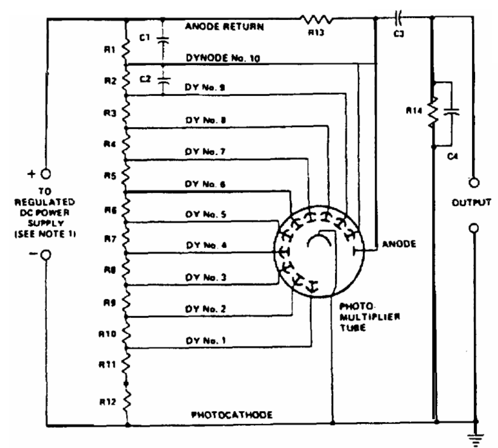


Figure 4: Typical Time Resolution Characteristics



C_1, C_2: 0.01 µF, 500 V (± 20%)
C_3: 0.005 µF, 2 kV (±20%)
C_4: 290 ± 10 pF (including cabling and strays), 200 V
R_1 through R_{12}: 27ko, 1/2W (± 5%)
R_{13}**:** 1 mo_, 1/4W(±5%)
$R_1$4: 33ko, 1/4W(±5%)

Note:1:Capacitors C^1 through C_3 should have short leads for optimum high-frequency performance.

Figure 5: Test Circuit for Pulse Height and Pulse-Height Resolution Tests

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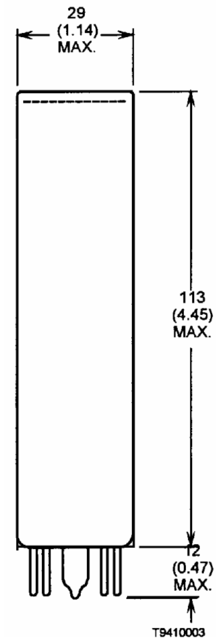

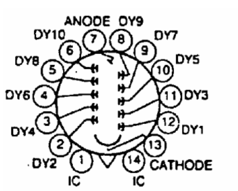

Figure 6: Dimensional Outline and Basing Diagram