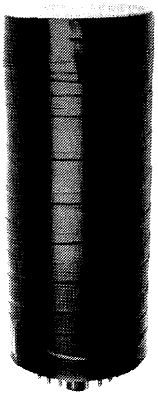
8575
Photomultiplier

51-mm (2-inch) Diameter
12-Stage, End-Window PMT



BURLE 8575 is a 2-inch diameter, 12-stage end-window photomultiplier having a bialkali (K-Cs-Sb) photocathode, a pyrex faceplate, and an in-line electrostatically-focused copper-beryllium dynode structure. This tube is intended primarily for use in pulse counting applications and features high quantum efficiency, high current amplification, low dark current, and good time characteristics.

General Data

Direct Interelectrode Capacitance (Approx.):
- Anode to dynode no.12 ..... 5.0 pF
- Anode to all other electrodes ..... 6.0 pF

Faceplate Material .... Pyrex (Corning No.7740), or Equivalent
- Index of refraction at 589.3 nm 1.47

Dynode Material:
- Substrate ..... CuBe
- Secondary-emitting surface ..... BeO
- Structure ..... In-line, Electrostatically Focused

Anode-Pulse Rise Time, 2000 V ..... 2.8 ns

Electron Transit Time, 2000 V ..... 37 ns

Socket:
- Supplied ..... BURLE AJ2145A
- Optional ..... BURLE AJ2144A

Magnetic Shield ..... BURLE AJ2252

Absolute Maximum and Minimum Ratings

DC Supply Voltage:

Between anode and cathode:

With voltage distribution of Table 1, Column A	3000 V max. / 800 V min.
With voltage distribution of Table 1, Column B	3000 V max. / 1300 V min.
With voltage distribution of Table 1, Column C	3500 V max. / 800 V min.
Between anode and dynode no.12	800 V max.
Between dynode no.12 and dynode no.11	800 V max.
Between adjacent dynodes	400 V max.
Between dynode no.1 and cathode	1000 V max. / 300 V min.
Between focusing electrode and cathode	1000 V max.

Average Anode Current (Averaged over any 30 second interval) ..... 0.2 mA

Temperature Range - Operating[1] ..... -100° to +85 ° C

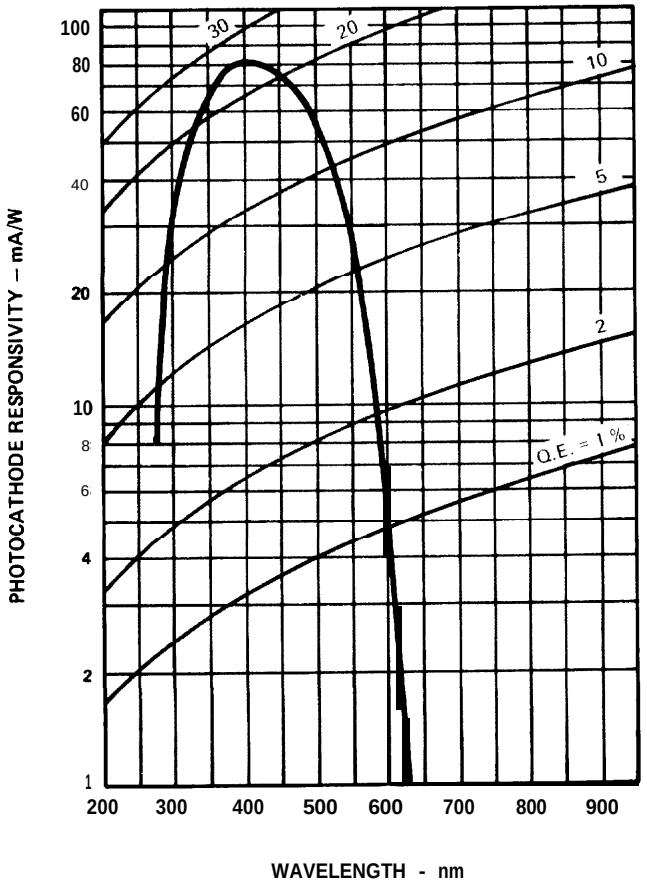


Figure 1 -Typical Photocathode Spectral Responsivity Characteristic

BURLE Electron Tubes

Performance Data

With voltage distribution of Table 1, Column A, and an ambient temperature of 22° C, unless otherwise specified.

	Min.	Typ.	Max.	Units
With E = 2000 volts (except as noted)				
Anode Responsivity:				
Radiant, at 400 nm	-	2.2×10^6	-	A/W
Luminous [2]	-	1780	-	A/lm
Blue response [3]	25	250	700	A/Blm
Cathode Responsivity:				
Radiant, at 400 nm	-	0.081	-	A/W
Luminous [4]	-	66	-	μA/lm
Blue response [5]	7.2	9.2	-	μA/Blm
Current Amplification (Gain)	-	2.7×10^7	-	-
Anode Dark Current [6]	-	1	4.6	nA
Dark Pulse Summation [7]	-	667	1000	cps
With E = 1100 volts				
Pulse Heights [8]	-	0.200	-	V
		2.0×10^{-11}	-	C
Pulse Height Resolution [9]	-	7	-	%
With E = 3000 volts				
Pulse Current: [10]				
Linear [11]	-	0.15	-	A
Space-charge limited (Saturated)	-	0.50	-	A

Footnotes

1 Operation of the tube at room temperature or below is recommended. **Warning:** Operation of the tube at temperatures below -50°C using sockets having teflon bodies such as the BURLE AJ2144A or BURLE AJ2145A can destroy the tube. If such operation is desired, the electrical circuit connections should be made directly to the pin contacts that are supplied as part of the socket and the teflon body should be discarded.

2 This value is calculated as shown below:

$$\text{Anode Luminous Responsivity (A/lm)} = \frac{\text{Anode Blue Response (A/inc. lm)}}{0.14}$$

The value 0.14 is the average value of the ratio of the anode current measured under the conditions specified in footnote (3) to the anode current measured under the same conditions but with the blue filter removed.

3 Under the following conditions: A blue filter (Corning C.S.No.5-58, polished to 1/2 stock thickness) is interposed between a tungsten-filament lamp operating at a color temperature of 2856° K and the tube photocathode. The value of the light flux incident on the filter is 1×10^{-7} lumen.

4 This value is calculated as shown below:

$$\text{Cathode Luminous Responsivity (A/lm)} = \frac{\text{Cathode Blue Response (A/inc. lm)}}{0.14}$$

The value 0.14 is the average value of the ratio of the cathode current measured under the conditions specified in the footnote (5) to the cathode current measured under the same conditions but with the blue filter removed.

5 Under the following conditions: A blue filter (Corning C.S. No.5-58, polished to 1/2 stock thickness) is interposed between a tungsten-filament lamp operating at a color temperature of 2856° K and the tube photocathode. The value of the light flux incident on the filter is 1×10^{-4} lumen and 500 volts are applied between cathode and all other electrodes connected as anode.

6 Under the following conditions: A blue filter (Corning C.S. No.5-58, polished to 1/2 stock thickness) is interposed between a tungsten-filament lamp operating at a color temperature of 2856° K and the tube photocathode. The light flux incident on the filter is 1×10^{-7} lumen. The supply voltage is adjusted to obtain an anode current of 2.6 microamperes. Luminous responsivity of the tube under these conditions is approximately equivalent to 185 amperes per lumen. Dark current is measured with the incident light removed.

7 Measured with E = 2500 volts and a load resistance of 100-kilohms in parallel with 285 ± 10% picofarads. The tube is operated in complete darkness. The pulse height for the single photoelectron equivalent is determined by using a light source operated at a low color temperature to assure the high probability of single photoelectron emission from the photocathode of the tube. The intensity of the light source is adjusted for approximately 1×10^4 photons per second. The light is removed before the dark pulse summation is measured.

8 Pulse height is defined as the amplitude of the anode pulse voltage (referred to anode) measured across a 33-kilohm resistor in parallel with a total capacitance of 285 ± 10% picofarads. The 662 keV photon from a 1 microcurie Cs137 source and a cylindrical 2"x2" thallium-activated sodium-iodide scintillator (BURLE No. 2006, or equivalent) are used. The Cs137 is in direct contact with the metal end of the scintillator. The faceplate end of the crystal is coupled to the tube by a coupling fluid such as mineral oil, or equivalent.

Table 1

Voltages To Be Provided By Divider			
Between the Following Electrodes: Cathode (K), Dynode (Dy), and Anode (P)	**Column A** 6.1% of Supply Voltage (E) Multiplied by	**Column B** 8.06% of Dy1 - P Voltage (E) Multiplied by	**Column C** 4.6% of Supply Voltage (E) Multiplied by
K - Dy1	4.0	■	4.0
Dy1 - Dy2	1.0	1.0	1.0
Dy2 - Dy3	1.4	1.4	1.4
Dy3 - Dy4	1.0	1.0	1.0
Dy4 - Dy5	1.0	1.0	1.0
Dy5 - Dy6	1.0	1.0	1.0
Dy6 - Dy7	1.0	1.0	1.0
Dy7 - Dy8	1.0	1.0	1.0
Dy8 - Dy9	1.0	1.0	1.0
Dy9 - Dy10	1.0	1.0	1.5
Dy10 - Dy11	1.0	1.0	2.0
Dy11 - Dy12	1.0	1.0	4.0
Dy12 - P	1.0	1.0	2.0
Dy1 -P		12.4	-
K - P	16.4		21.9

Focusing electrode (pin 17) connected to dynode no.1 potential.

Electron multiplier shield (pin 10) connected to dynode no.5 potential.

■ Cathode-to-dynode-no.1 voltage maintained at 660 volts.

9 Measured under the conditions of footnote (8). Pulse height resolution in per cent is defined as 100 times the ratio of the width of the photopeak at half the maximum count rate in the photopeak height (A) to the pulse height at maximum photopeak count rate (C). Refer to **Diagram 1** below.

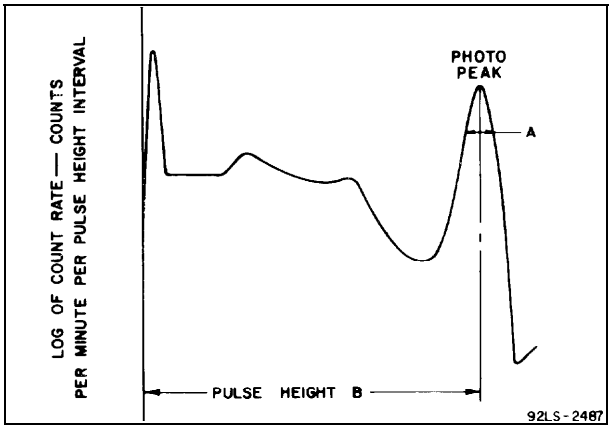


Diagram 1

10 Using a pulsed light source having a pulse duration of 0.2 microsecond and a repetition rate of 1000 pulses per second. The interstage voltages of the tube should not deviate more than 2 per cent from the recommended voltage distribution of **Table 1,** Column C.

11 Maximum deviation from linearity is 5 per cent.

Operating Considerations

Anode Current

The operating stability of the tube is dependent on the magnitude of the average anode current. The use of an average anode current well below the maximum rated value of 200 microamperes is recommended when stability of operation is important. When maximum stability is required, the average anode current should not exceed 1 microampere.

Cathode Current

A peak cathode current of $1x10^{-9}$ ampere at a temperature of 22° C or $1x10^{-11}$ ampere at -100° C should not be exceeded. Because of the resistivity of the photocathode, the voltage drop caused by higher peak cathode currents may produce radial electric fields on the photocathode which can result in poor photoelectron collection by the first dynode. Photocathode resistivity increases with decreasing temperature.

Leakage Current

The application of high voltage, with respect to cathode, to insulating or other materials supporting or shielding the tube at the photocathode end should not be permitted unless such materials are chosen to limit leakage current to the tube envelope to $1x10^{-12}$ 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.

Ambient Atmosphere

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

Anode Dark Current

The tube is intended for use in systems requiring very low dark current. Accordingly, the base of the tube and its socket should never be allowed to become contaminated by handling. Such contamination produces leakage and dark current. It is recommended that if the tube base or its socket is handled that it be washed with a solution of alkaline soap cleaner and de-ionized or distilled water having a temperature not exceeding 60° C. Careful scrubbing between pins or socket contacts is useful, but not usually required. The base of the tube and its socket should then be rinsed in de-ionized or distilled water for several minutes and then air-blown dry.

A temporary increase in anode dark current by as much as 3 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 voltage is not applied to the tube. The increase in dark current may persist for a period up to 48 hours following such irradiation.

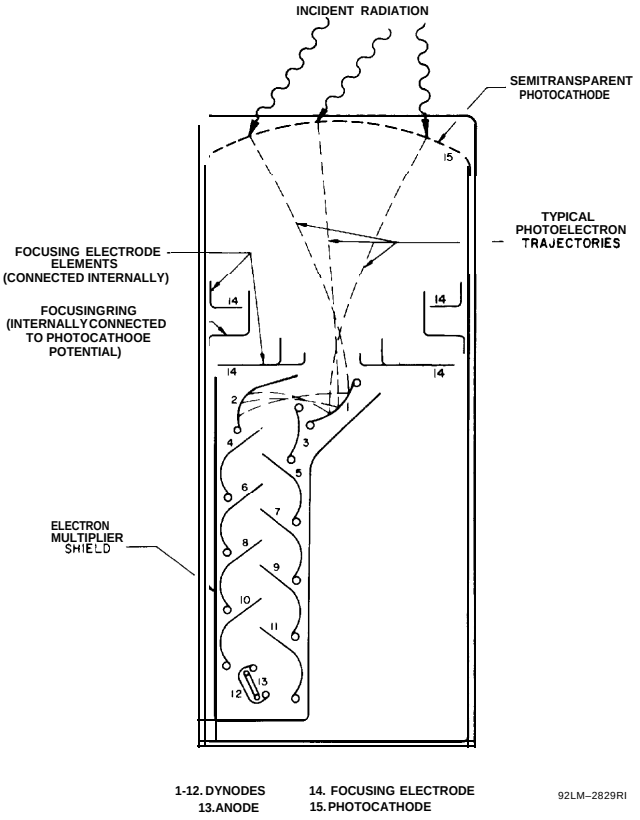
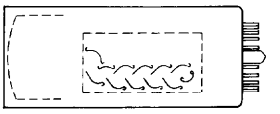


Figure 2 - Schematic Arrangement of Tube Structure Showing Typical Electron Trajectories

THE SUPPLY VOLTAGE(E) IS ACROSS A VOLTAGE DIVIDER WHICH PROVIDES VOLTAGES AS FOLLOWS

BETWEEN	6.1%, OF E MULTIPLIED BY
CATHODE AND DYNODE No. 1	4.0
DYNODE No. 1 AND DYNODE No. 2	1.0
DYNODE No. 2 AND DYNODE No. 3	1.4
EACH SUCCEEDING DYNODE STAGE	1.0
ANODE AND CATHODE	16.4

FOCUSING ELECTRODE IS CONNECTED TO DYNODE-No.1 POTENTIAL.
ELECTRON MULTIPLIER SHIELD ISCONNECTED TO DYNODE-No. 5 POTENTIAL.
PHOTOCATHODE IS FULLY ILLUMINATED.



POSITIVE VALUE OF H IN DIRECTION SHOWN:

(1) * ● (2) ↑ OR (3) →

*DIRECTION (1) IS OUT OF PAPER

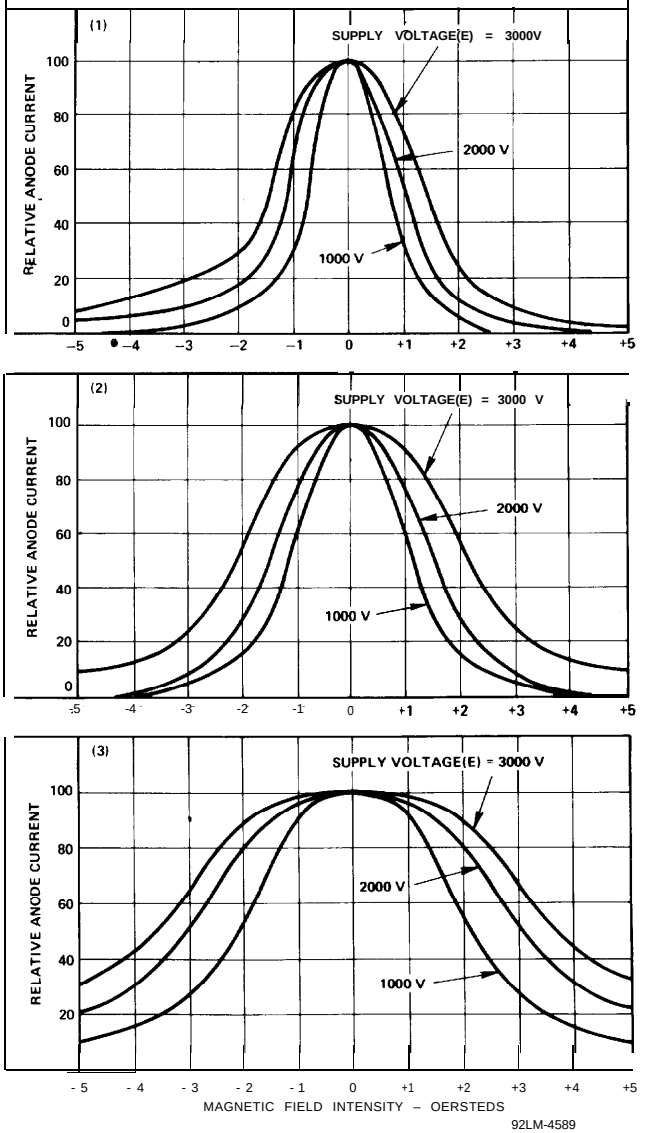


Figure 3 -Typical Effect of Magnetic Field on Anode Current

THE SUPPLY VOLTAGE (E) IS ACROSS A VOLTAGE DIVIDER WHICH PROVIDES VOLTAGES AS FOLLOWS:

BETWEEN	6.1% OF E MULTIPLIED BY
CATHODE AND DYNODE No. 1	4.0
DYNODE No.1 AND DYNODE No. 2	1.0
DYNODE No.2 AND DYNODE No. 3	1.4
EACH SUCCEEDING DYNODE-STAGE VOLTS	1.0
ANODE AND CATHODE	16.4

FOCUSING ELECTRODE IS CONNECTED TO DYNODE-No.1 POTENTIAL.
ELECTRON MULTIPLIER SHIELD IS CONNECTED TO DYNODE-No. 5 POTENTIAL.
PHOTOCATHODE IS FULLY ILLUMINATED.

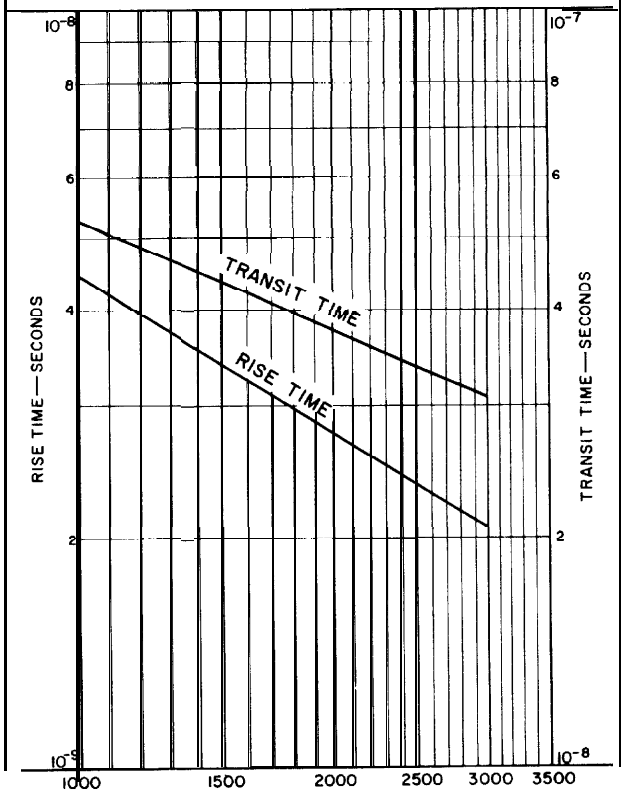


Figure 4 - Typical Time Characteristics

Measured with E = 25OO volts and a load resistanceof 100 - kiohms in parallel with 285 ± 10% picrofarads The tube IS operated in complete darkness The pulse height for the single photoelectron equivalent IS determined by using a light source operated at a low color temperature to assure the high probability of single photoelectron emission from the photocathode of the tube The intensity of the light source IS adjusted for approximately 1×10^4 photons per second The light is removed before the dark pulse summation IS measured
Focusing electrode IS connected to dynode no. 1 potential
Electron multiplier shield IS connected to dynode-no. 5 potential
Tube temperature = 22° C
One photoelectron pulse height — 8 counting channels

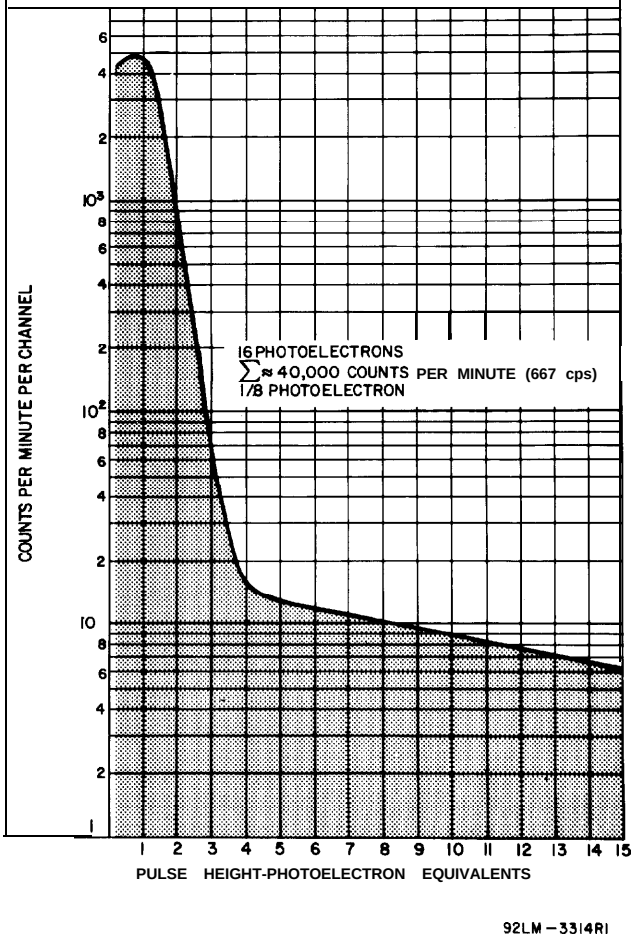


Figure 5 - Typical Dark-Pulse Spectrum

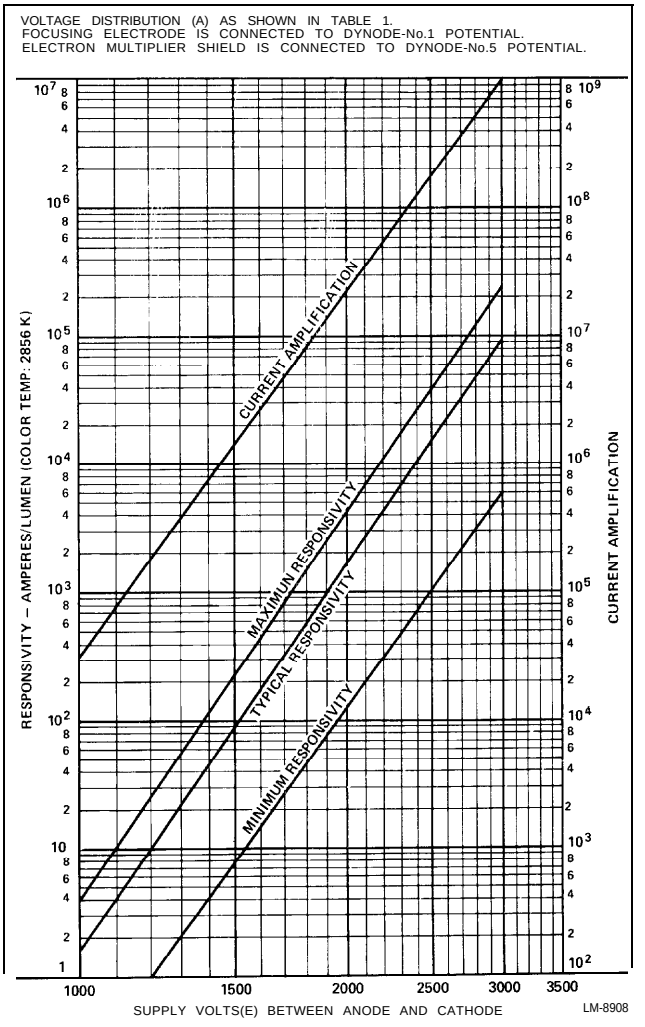


Figure 6 -Typical Responsivity and Current Amplification Characteristics

LUMINOUS RESPONSIVITY IS VARIED BY ADJUSTMENT OF THE SUPPLY VOLTAGE (EI ACROSS A VOLTAGE DIVIDER WHICH PROVIDES VOLTAGES AS FOLLOWS:

BETWEEN	6.1% OF E MULTIPLIED BY
CATHODE AND DYNODE No 1	4.0
DYNODE No.1 AND DYNODE No 2	1.0
DYNODE No.2 AND DYNODE No 3	1.4
EACH SUCCEEDING DYNODE-STAGE	1.0
VOLTS ANODE AND CATHODE	16.4

ELECTRON MULTIPLIER SHIELD IS CONNECTED TO DYNODE No.5 POTENTIAL
FOCUSING ELECTRODE IS CONNECTED TO DYNODE No.1 POTENTIAL.
LIGHT SOURCE IS A TUNGSTEN-FILAMENT LAMP OPERATED AT A COLOR TEMPERATURE OF 2856 K.
TUBE TEMPERATURE = 22 C.

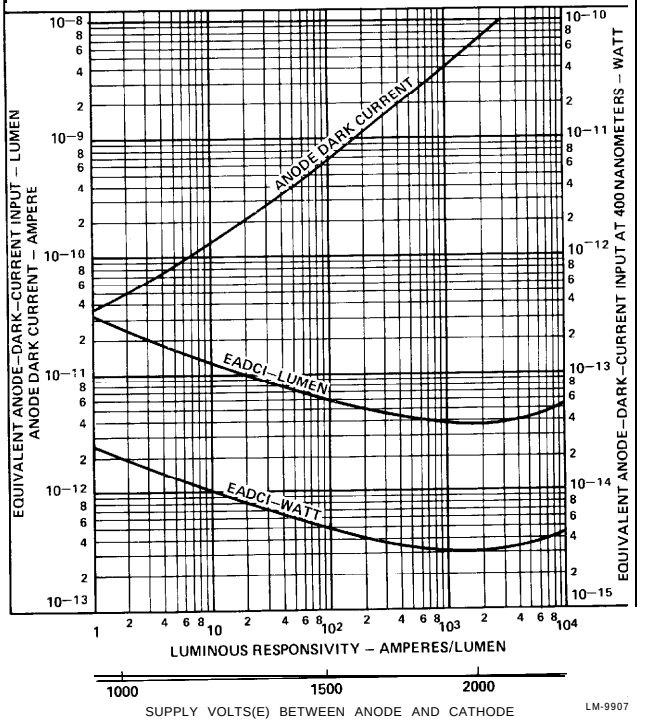
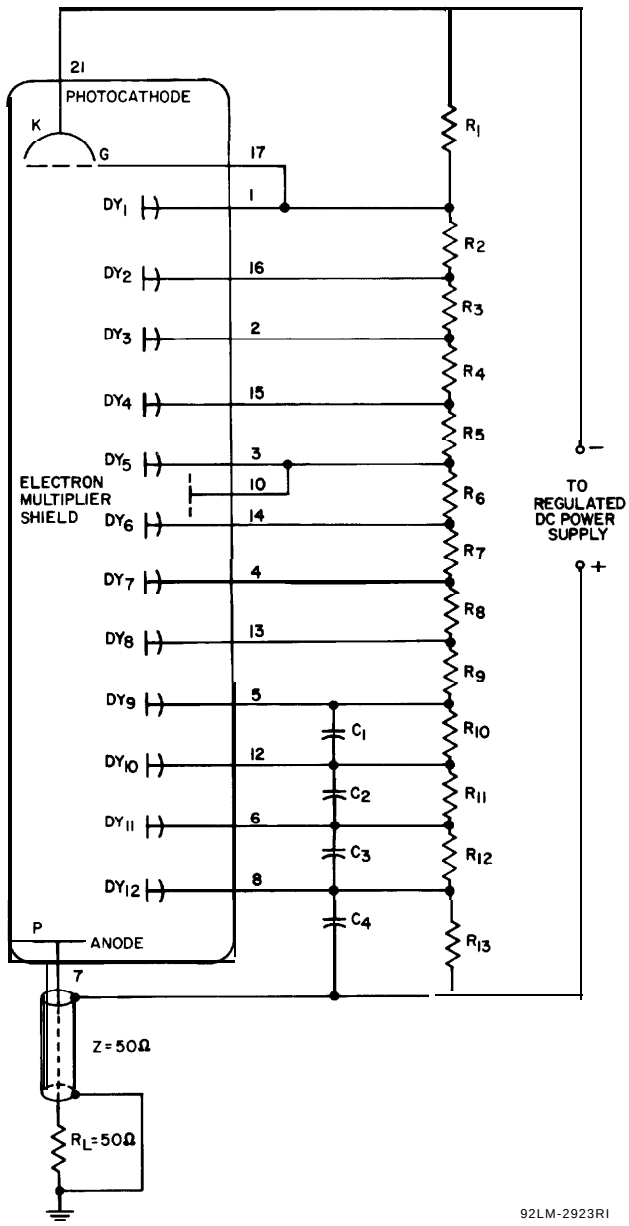


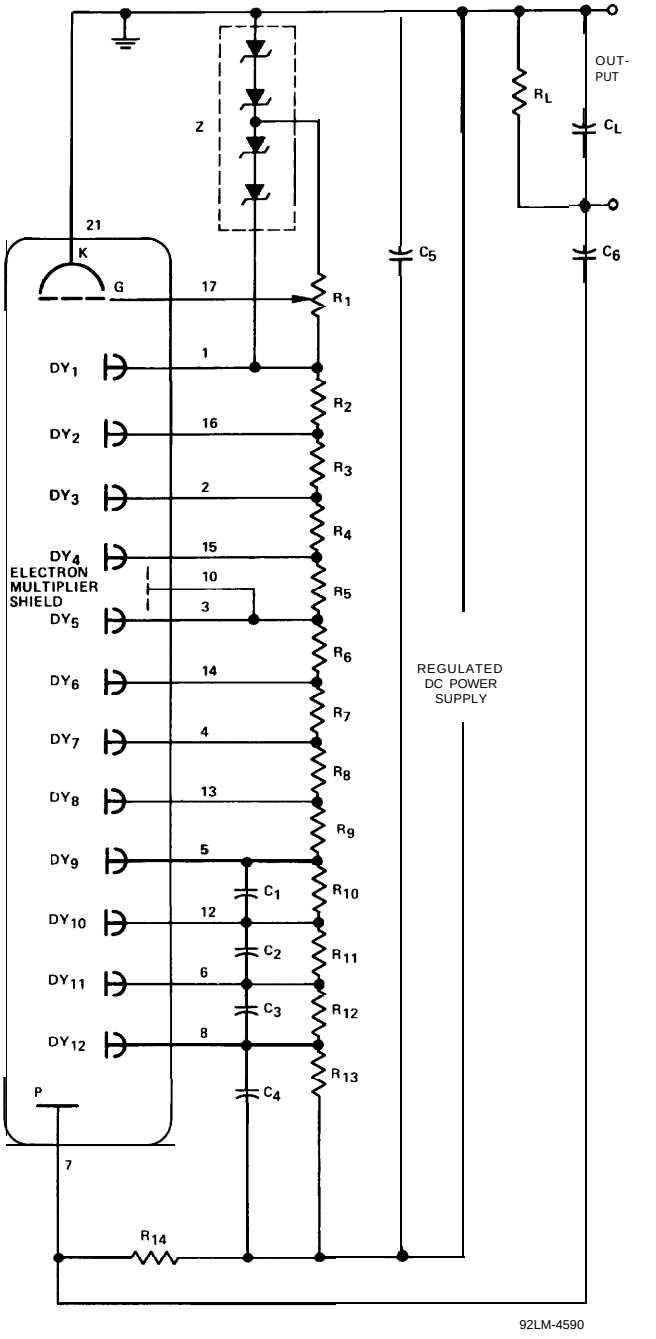
Figure 7 -Typical Anode Dark Current and EADCI Characteristics



Fast Pulse Response Applications, to 3000 V (Typical circuit values)
C_1: 0.005 µF, 20%, Ceramic Disc, 500 VDC
C_2: 0.01 µF, 20%, Ceramic Disc, 500 VDC
C_3: 0.02 µF, 20%, Ceramic Disc, 500 VDC
C_4: 0.05 µF, 20%, Ceramic Disc, 500 VDC
R_1: 400 kΩ (4-100 kΩ, 5%, 1/2 W in series)
R_2: 100 kΩ, 5%, 1/2 W
R_3: 130 kΩ, 5%, 1 W
R_4 through R_{13}: 100 kΩ, 5%, 1/2W

High Peak Current Applications, to 3200 V (Typical circuit values)
C_1: 0.005 µF, 20%, Ceramic Disc, 500 VDC
C_2: 0.01 µF, 20%, Ceramic Disc, 500 VDC
C_3: 0.02 µF, 20%, Ceramic Disc, 1000 VDC
C_4: 0.05 µF, 20%, Ceramic Disc, 500 VDC
R_1, R_{12}: 156 kΩ (4-39 kΩ, 5%, 1 W in series)
R_2 R_4 through R_9: 39 kΩ, 5%, 1 W
R_3, R_{10}: 56 kΩ, 5%, 2 W
R_{11}, R_{13}: 78 kΩ (2-39 kΩ, 5%, 1 W, in series)

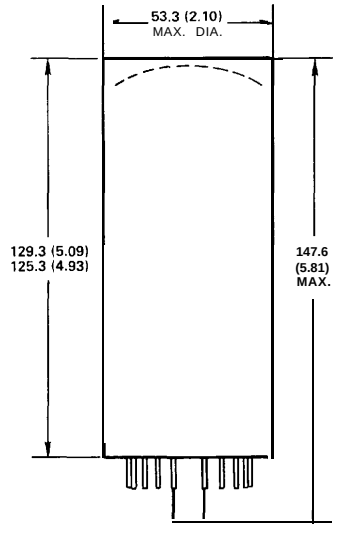
Figure 8 – Typical Circuit Arrangement For Fast Pulse Response and High Peak Current Amplifications



C_1: 0.005 µF, 20%, Ceramic Disc, 500 VDC
C_2: 0.01 µF, 20%, Ceramic Disc, 500 VDC
C_3: 0.02 µF, 20%, Ceramic Disc, 500 VDC
C_4: 0.05 µF, 20%, Ceramic Disc, 500 VDC
C_5 and C_6: 0.0047 ,µF, 20%. Ceramic Disc, 6000 VDC
R_1: 10 MΩ, 2 W, adjustable
(Not required for most applications This potentiometer is used to optimize transit time dispersion or current amplification.)
R_2, R_4 through R_{13}: 100 kΩ, 5%, 1 W
R_3: 130 kΩ, 5%, 1/2 W
R_{14}: 100 kΩ, 5%, 1/2 W
Z: (2) - 150 V, 2 W zener diodes, or equivalent
(2) - 180 V, 2 W zener diodes, or equivalent

Note: R_L and C_L depend on the application. For most applications, $R_L x C_L = 10$ microseconds. R_{14} is in parallel with R_L; consider when selecting the R_L value.

Figure 9 -Typical Circuit Arrangement For Scintillation-Counting Applications



Dimensions are in millimeters unless otherwise stated Dimensions in parentheses are in inches.

Note 1 - Minimum useful area of photocathode is 16.4 cm ^{2} (2.54 in ^{2}). Useful photocathode diameter is 45.7 mm (1.80 in).

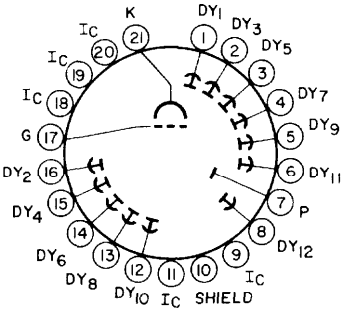
Note 2 - Deviation from flatness of external surface of faceplate will not exceed 0.25 mm (0.010') from peak to valley. Faceplate material is pyrex (Corning No.7740), or equivalent. Its index of refraction at 589.3 nm is 1.47.

Note 3 - Typical sockets for this base are BURLE AJ2144A and AJ2145A.

The AJ2145A is ordinarily supplied with the tube and is designed specifically for chassis mounting. The AJ2144A is designed for use in any desired mounting arrangement. It is supplied with an unattached clamp ring which fits to either the top or bottom of its socket body to permit chassis mounting. The ring is not normally required for other mounting arrangements and can be discarded to make such arrangements more compact.

Note 4 - Magnetic shielding of the tube is ordinarily required. A typical shield is the BURLE AJ2252.

Figure 10 - Dimensional Outline



DIRECTION OF RADIATION: INTO END OF BULB

92LS-2812

Pin 1: Dynode No.1
Pin 2: Dynode No.3
Pin 3: Dynode No.5
Pin 4: Dynode No.7
Pin 5: Dynode No.9
Pin 6: Dynode No.11
Pin 7: Anode
Pin 8: Dynode No.12
Pin 9: Internal Connection, Do Not Use
Pin 10: Electron Multiplier Shield
Pin 11: Internal Connection, Do Not Use
Pin 12: Dynode No.10
Pin 13: Dynode No.8
Pin 14: Dynode No.6
Pin 15: Dynode No.4
Pin 16: Dynode No.2
Pin 17: Focusing Electrode
Pin 18: Internal Connection, Do Not Use
Pin 19: Internal Connection, Do Not Use
Pin 20: Internal Connection, Do Not Use
Pin 21: Photocathode

Figure 11 - Basing Diagram - Bottom View

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