

Photomultiplier Tube

3/4"-Diameter, 12-Stage Type Having S-11 Spectral Response and Copper-Beryllium Dynodes

- Typical Current Amplification: 4×10^6
- Typical Quantum Efficiency: 17% at 440 nm
- Tube Size: 0.78" Max. Diameter, 3.8" Max. Length
- Flat Faceplate for Mounting Scintillators

General Data

Spectral Response	See Figure 1
Wavelength of Maximum Response	440 ± 50 nm
Cathode, Semitransparent	Cesium-Antimony
Minimum projected area	0.2 in^2 (1.26 cm^2)
Minimum diameter	0.5 in (1.27 cm)
Window	Borosilicate Glass (Corning ^a No.7056), or equivalent
Shape	Plano-Concave
Index of refraction at 436 nanometers	1.523

Dynodes:

Substrate	Copper-Beryllium
Secondary-emitting surface	Beryllium-Oxide
Structure	In-Line, Electrostatic-Focus Type

Direct Interelectrode Capacitances (Approx.):

Anode to dynode No.12	2.4 pF
Anode to all other electrodes	3.2 pF

Maximum Overall Length (Excluding Semiflexible Leads)	3.8 in (96.5 mm)
Maximum Diameter	0.78 in (19.8 mm)

Base (Temporary)	Small-Shell Bidecal 20-Pin (JEDEC No.B20-102)
------------------------	--

Socket	Cinch ^b No.20-PM, or equivalent
--------------	--

Magnetic Shield	Perfection Mica ^c No.10P40, or equivalent
-----------------------	---

Operating Position	Any
--------------------------	-----

Weight (Approx.):

With temporary base removed	1 oz
-----------------------------------	------

Maximum Ratings, Absolute-Maximum Values^d**DC Supply Voltage:**

Between anode and cathode	2000	max.	V
Between anode and dynode No.12	300	max.	V
Between adjacent dynodes	200	max.	V
Between dynode No.1 and cathode	400	max.	V
Average Anode Current ^e	0.5	max.	mA
Ambient Temperature ^f	75	max.	°C

Characteristics Range Values for Equipment Design

Under conditions with a DC supply voltage (E) across a voltage divider providing the electrode voltages as shown in Table I and at an ambient temperature of 22° C, except as noted.

With E = 1500 volts (except as noted)

	Min.	Typical	Max.	
Anode Sensitivity:				
Radiant ^g at 440 nanometers	—	2.4×10^5	—	A/W
Luminous ^h (2854° K)	100	300	3500	A/lm
Cathode Sensitivity:				
Radiant ^j at 440 nanometers	—	6×10^{-2}	—	A/W
Luminous ^k (2854° K)	5×10^{-5}	7.5×10^{-5}	—	A/lm
Blue response ^m (2854° K + C.S. No.5-58, 1/2 stock thickness)	5×10^{-6}	7.5×10^{-6}	—	A/inci- dent lm
Quantum efficiency at 440 nanometers . . .	—	17	—	%
Current Amplification . . .	—	4×10^6	—	
Anode Dark Current ⁿ at 200 A/lm	—	5×10^{-8}	5×10^{-7}	A
Equivalent Anode Dark Current Input ⁿ at 200 A/lm	{	2.5×10^{-10}	2.5×10^{-9}	lm
		3.1×10^{-13p}	3.1×10^{-12p}	W

Table I	
Typical Potential Distribution	
Between:	7.1% of Supply Voltage (E) Multiplied by:
Cathode to Dynode No.1	1.2
Dynode No.1 to Dynode No.2	1.2
Dynode No.2 to Dynode No.3	1.7
Dynode No.3 to Dynode No.4	1.0
Dynode No.4 to Dynode No.5	1.0
Dynode No.5 to Dynode No.6	1.0
Dynode No.6 to Dynode No.7	1.0
Dynode No.7 to Dynode No.8	1.0
Dynode No.8 to Dynode No.9	1.0
Dynode No.9 to Dynode No.10	1.0
Dynode No.10 to Dynode No.11	1.0
Dynode No.11 to Dynode No.12	1.0
Dynode No.12 to Anode	1.0
Anode to Cathode	14.1

- a Made by Corning Glass Works, Corning, NY 14830.
- b Made by Cinch Manufacturing Company, 1501 Morse Avenue, Elk Grove Village, IL 60007.
- c Made by Magnetic Shield Division, Perfection Mica Company, 1322 N. Elston Avenue, Chicago 22, IL 60622.
- d A description of the Absolute Maximum Rating is given in the General Section, titled Rating Systems for Electron Tubes.
- e Averaged over any interval of 30 seconds maximum.
- f Tube operation at room temperature or below is recommended.
- g This value is calculated from the typical anode luminous sensitivity rating using a conversion factor of 803 lumens per watt.
- h Under the following conditions: The light source is a tungsten-filament lamp having a lime-glass envelope. It is operated at a color temperature of 2854° K and a light input of 1 micro-lumen is used.
- j This value is calculated from the typical cathode luminous sensitivity rating using a conversion factor of 803 lumens per watt.
- k Under the following conditions: The light source is a tungsten-filament lamp having a lime-glass envelope. It is operated at a color temperature of 2854° K. The value of light flux is 0.01 lumen and 200 volts are applied between cathode and all other electrodes connected as anode.
- m Under the following conditions: Light incident on the cathode is transmitted through a blue filter (Corning C.S. No.5-58, pol-

ished to 1/2 stock thickness — Manufactured by the Corning Glass Works, Corning, NY 14830) from a tungsten-filament lamp operated at a color temperature of 2854° K. The value of light flux incident on the filter is 0.01 lumen and 200 volts are applied between cathode and all other electrodes connected as anode.

- n With supply voltage adjusted to give a luminous sensitivity of 200 amperes per lumen. Dark current caused by thermionic emission may be reduced by use of a refrigerant.
- P At 440 nanometers. These values are calculated from the EADCI values in lumens using a conversion factor of 803 lumens per watt.

Operating Considerations

Shielding

Electrostatic shielding of the tube is ordinarily required. When a shield is used, it must be connected to the cathode terminal. 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 1×10^{-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.

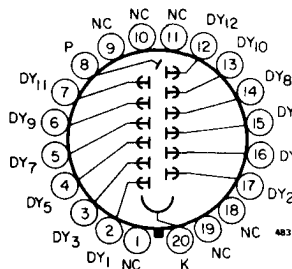
Ambient Atmosphere

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

Lead Connections

The semiflexible leads of the tube may be soldered or welded into the associated circuit. Care must be exercised when making such connections to prevent tube destruction due to thermal stress of the glass-metal seals. A heat sink placed in contact with the semiflexible leads between the point being soldered, or welded, and the protective shell is recommended. Excessive bending of the leads is to be avoided.

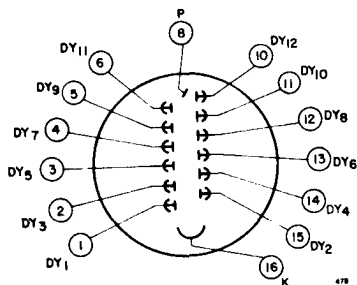
Basing Diagram – Bottom View (With Temporary Base)



- Pin 13: Dynode No. 10
 Pin 14: Dynode No. 8
 Pin 15: Dynode No. 6
 Pin 16: Dynode No. 4

- Pin 1: No Connection
 Pin 2: Dynode No. 1
 Pin 3: Dynode No. 3
 Pin 4: Dynode No. 5
 Pin 5: Dynode No. 7
 Pin 6: Dynode No. 9
 Pin 7: Dynode No. 11
 Pin 8: Anode
 Pin 9: No Connection
 Pin 10: No Connection
 Pin 11: No Connection
 Pin 12: Dynode No. 12
 Pin 17: Dynode No. 2
 Pin 18: No Connection
 Pin 19: No Connection
 Pin 20: Photocathode

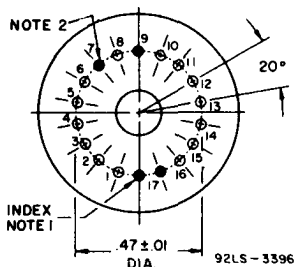
Lead Connections – Bottom View (With Base Removed)



Lead 15: Dynode No. 2

- Lead 1: Dynode No. 1
 Lead 2: Dynode No. 3
 Lead 3: Dynode No. 5
 Lead 4: Dynode No. 7
 Lead 5: Dynode No. 9
 Lead 6: Dynode No. 11
 Lead 8: Anode
 Lead 10: Dynode No. 12
 Lead 11: Dynode No. 10
 Lead 12: Dynode No. 8
 Lead 13: Dynode No. 6
 Lead 14: Dynode No. 4
 Lead 16: Photocathode

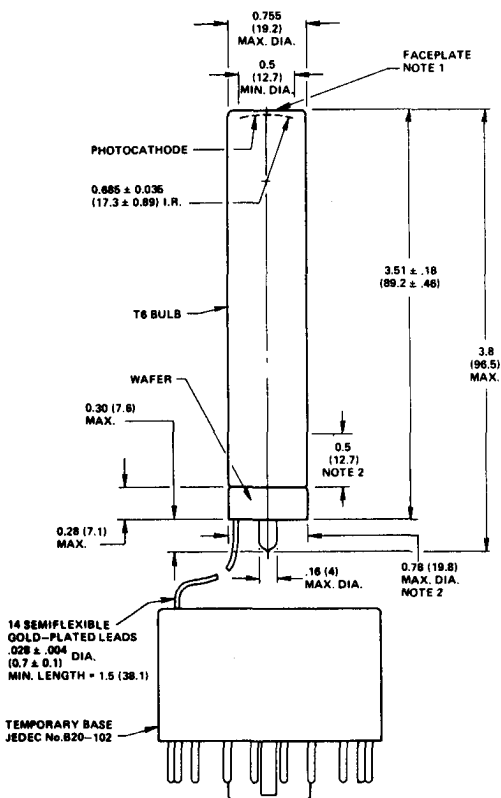
Lead Orientation, Bottom View



Note 1 – Lead is cut off within 0.12" of glass button for indexing.

Note 2 – Lead Nos. 7, 9, and 17 are cut off within 0.12" of the glass button.

Dimensional Outline



92LM-4140

Dimensions are in inches unless otherwise stated. Dimensions tabulated below are in millimeters and are derived from the basic inch dimensions (1 inch = 25.4 mm).

Note 1 — Deviation from flatness will not exceed 0.006" from peak to valley.

Note 2 — Within this length, maximum diameter of tube is 0.78".

Typical Photocathode Spectral Response Characteristics

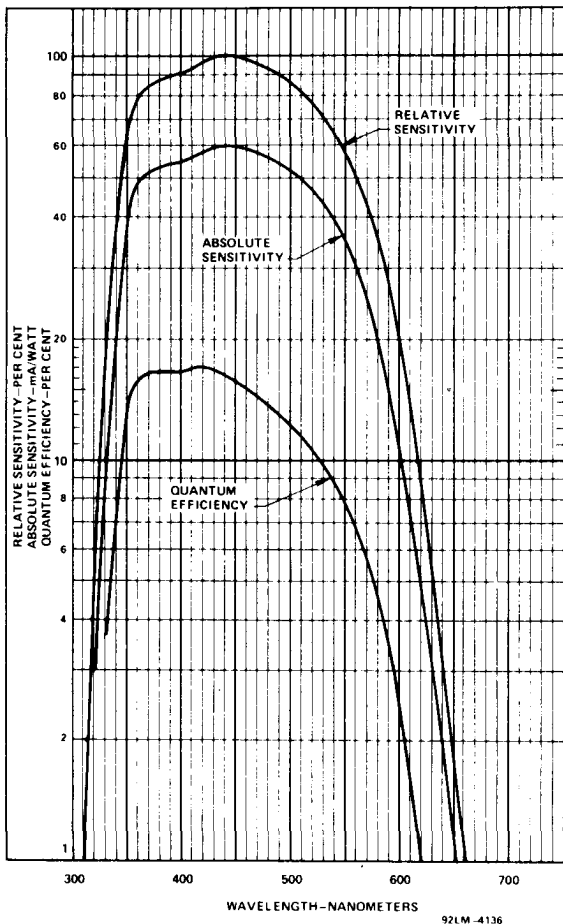


Figure 1

Sensitivity and Current Amplification Characteristics

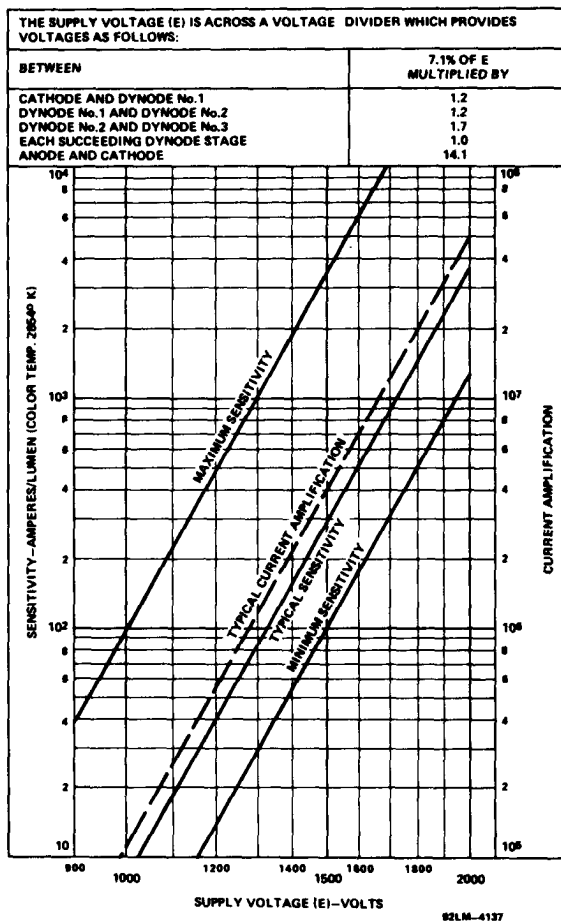


Figure 2

Typical EADCI and Anode Dark Current Characteristics

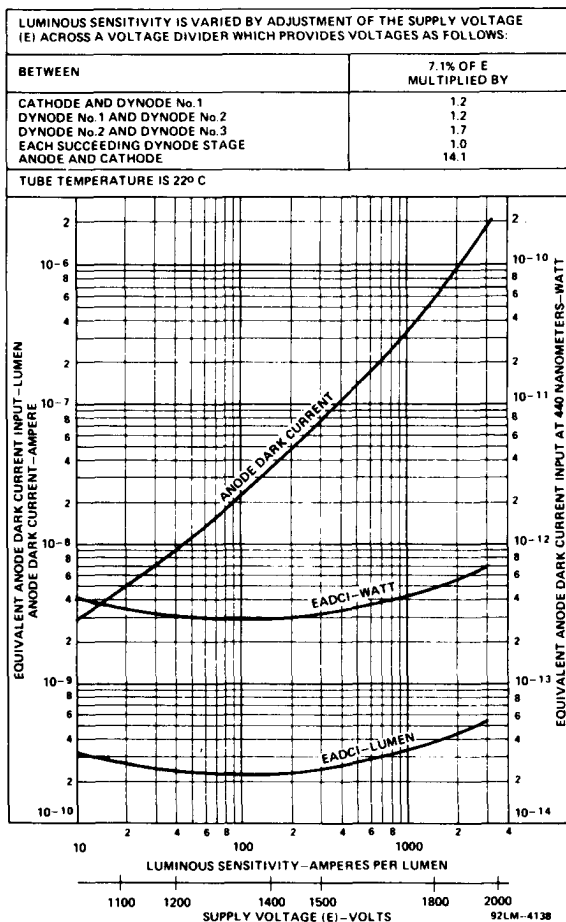
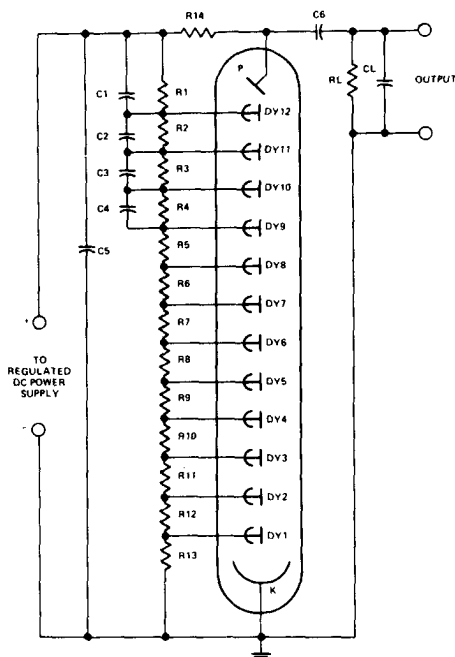


Figure 3

Typical Circuit Arrangement for Scintillation Counting Applications



92LM 4139

C₁: 0.05, 500 VDC, Ceramic Disc

C₂: 0.02, 500 VDC, Ceramic Disc

C₃: 0.01, 500 VDC, Ceramic Disc

C₄: 0.005, 500 VDC, Ceramic Disc

C₅, C₆: 0.005, 2500 VDC, Ceramic Disc

R₁ through R₁₀: 270 kΩ ± 5%, 1/2 W

R₁₁: 470 kΩ ± 5%, 1/2 W

R₁₂, R₁₃: 330 kΩ ± 5%, 1/2 W

R₁₄: 1 MΩ ± 5%, 1/2 W

Note 1 – The value of the load elements R_L and C_L, depend on the application. R_L × C_L = 10 microseconds for most applications.

Note 2 – Tolerance of all capacitors is ± 20%.

Figure 4