# 4802

# Photomultiplier Tube

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

- **Typical Current Amplification: 4 x $10^6$**
- **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 | – | $2.4\times10^{5}$ | – | A/W |
| Luminous[h] (2854° K) | 100 | 300 | 3500 | A/lm |
| Cathode Sensitivity: | | | | |
| Radiant[j] at 440 nanometers | – | $6\times10^{-2}$ | – | A/W |
| Luminous[k] (2854° K) | $5\times10^{-5}$ | $7.5\times10^{-5}$ | – | A/lm |
| Blue response[m] (2854° K + C.S. No.5-58, 1/2 stock thickness) | $5\times10^{-6}$ | $7.5\times10^{-6}$ | – | A/incident lm |
| Quantum efficiency at 440 nanometers | – | 17 | – | % |
| Current Amplification | – | $4\times10^{6}$ | – | |
| Anode Dark Current[n] at 200 A/lm | – | $5\times10^{-8}$ | $5\times10^{-7}$ | A |
| Equivalent Anode Dark Current Input[n] at 200 A/lm | –<br>– | $2.5\times10^{-10}$<br>$3.1\times10^{-13}$[p] | $2.5\times10^{-9}$<br>$3.1\times10^{-12}$[p] | lm<br>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 microlumen 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 $1 \times 10^{-12}$ 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.

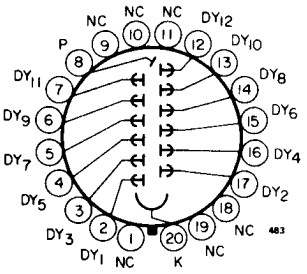
**Ambient Atmosphere**

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.

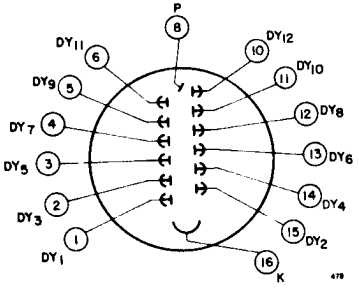
## Basing Diagram – Bottom View (With Temporary Base)




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

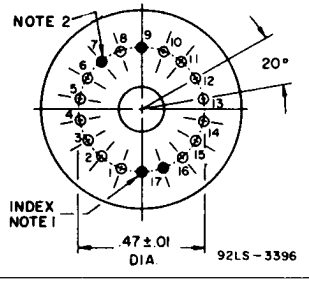
## Lead Connections – Bottom View (With Base Removed)




Lead 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 15: Dynode No. 2

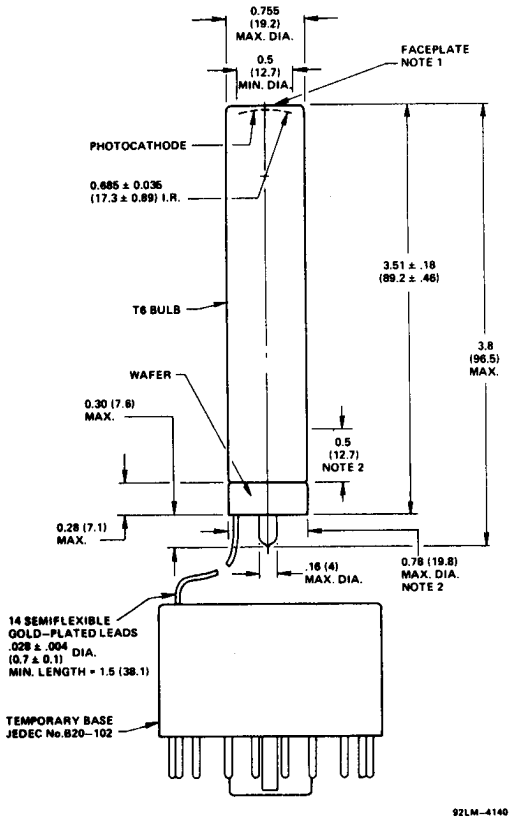
## Lead Orientation, Bottom View




**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




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

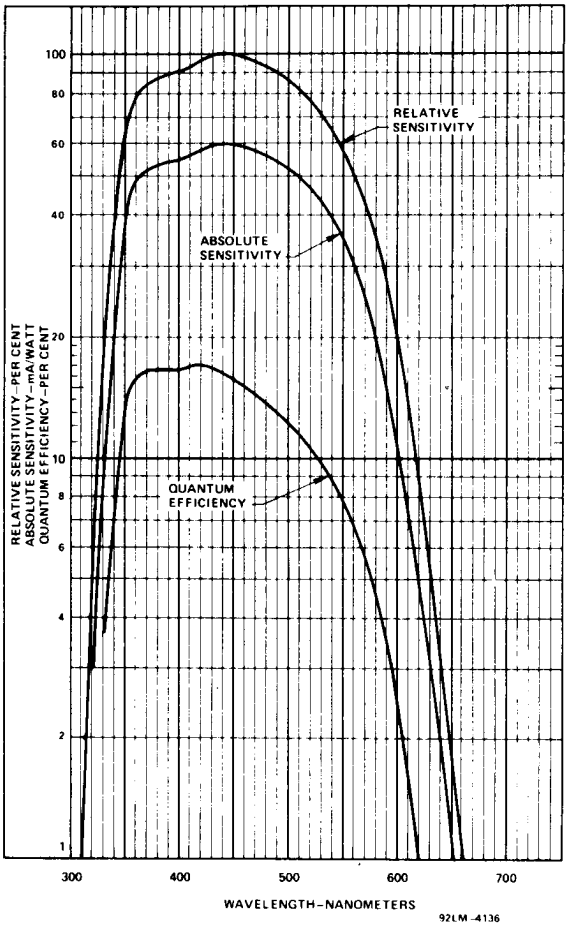



**Figure 1**

## Sensitivity and Current Amplification Characteristics

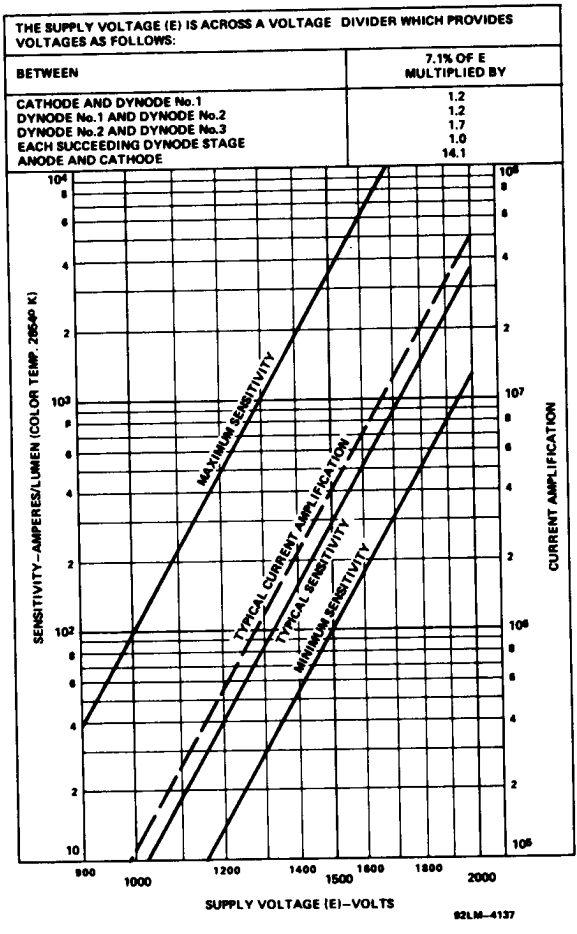



Figure 2

## Typical EADCI and Anode Dark Current Characteristics

LUMINOUS SENSITIVITY IS VARIED BY ADJUSTMENT OF THE SUPPLY VOLTAGE (E) ACROSS A VOLTAGE DIVIDER WHICH PROVIDES VOLTAGES AS FOLLOWS:

| BETWEEN | 7.1% OF E MULTIPLIED BY |
|---|---|
| CATHODE AND DYNODE No.1 | 1.2 |
| DYNODE No.1 AND DYNODE No.2 | 1.2 |
| DYNODE No.2 AND DYNODE No.3 | 1.7 |
| EACH SUCCEEDING DYNODE STAGE | 1.0 |
| ANODE AND CATHODE | 14.1 |

TUBE TEMPERATURE IS 22° C

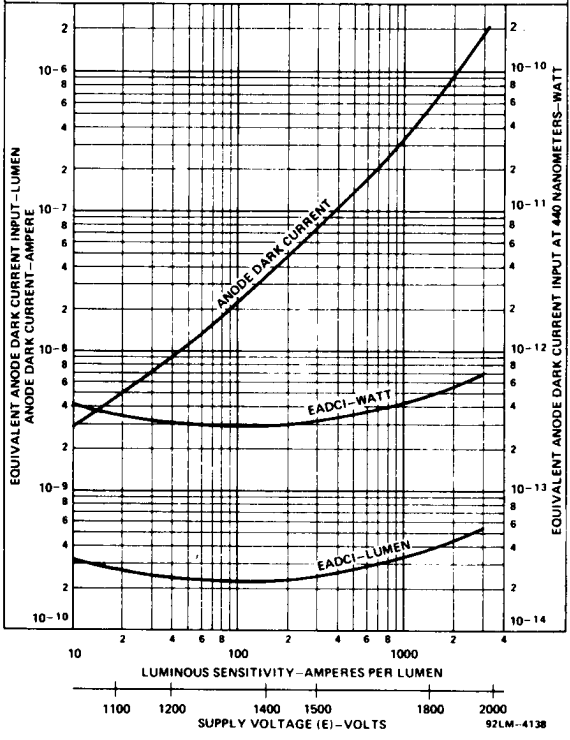
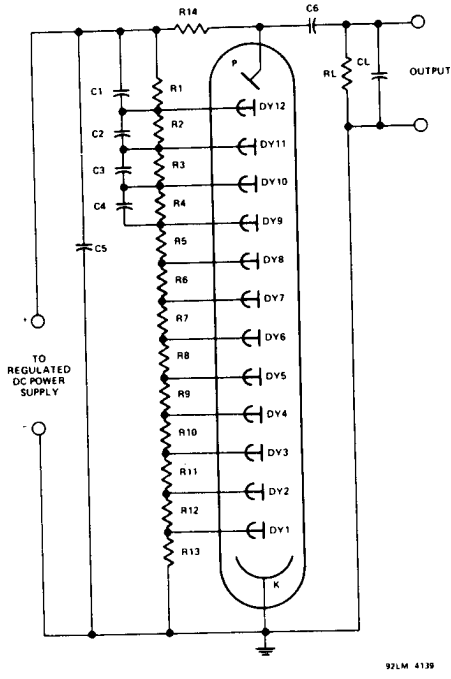



Figure 3

## Typical Circuit Arrangement for Scintillation Counting Applications




$C_1$: 0.05, 500 VDC, Ceramic Disc
$C_2$: 0.02, 500 VDC, Ceramic Disc
$C_3$: 0.01, 500 VDC, Ceramic Disc
$C_4$: 0.005, 500 VDC, Ceramic Disc
$C_5$, $C_6$: 0.005, 2500 VDC, Ceramic Disc

$R_1$ through $R_{10}$: 270 kΩ±5%, 1/2 W
$R_{11}$: 470 kΩ±5%, 1/2 W
$R_{12}$, $R_{13}$: 330 kΩ±5%, 1/2 W
$R_{14}$: 1 MΩ±5%, 1/2 W

**Note 1** — The value of the load elements $R_L$ and $C_L$, depend on the application. $R_L \times C_L$ = 10 microseconds for most applications.

**Note 2** — Tolerance of all capacitors is ± 20%.

**Figure 4**