Photomultiplier Tubes

Sturdy, 10-Stage, S-11, Head-On Types for Use Under Adverse Environmental Conditions

The 4439 differs from the 4438 in that it is supplied with a small-shell duodecal base attached to semi-flexible leads to facilitate testing prior to installation. After testing, the attached base should be removed.

GENERAL

Spectral Response	S-11
Wavelength of Maximum Response	4400 ± 500 Å
Cathode, Semitransparent	Cesium-Antimony
Minimum area	1.2 in^2 (7.7 cm^2)
Minimum diameter	1.24 in (3.1 cm)
Window	Corning[a] No.0080, or equivalent
Shape	Plane-Plano
Index of refraction at 4360 angstroms	1.523
Dynodes:	
Substrate	Nickel
Secondary-Emitting Surface	Cesium-Antimony
Structure	Circular-Cage Electrostatic-Focus Type
Direct Interelectrode Capacitances (Approx.):	
Anode to dynode No.10	4 pF
Anode to all other electrodes	5.5 pF
Maximum Overall Length (Excluding Semiflexible Leads)	3.91 in (9.9 cm)
Maximum Diameter	1.56 in (3.9 cm)
Bulb	T-12
Base (Temporary for 4439 only)	Small-Shell Duodecal 12-Pin (JEDEC No.B12-43), Non-hygroscopic
Socket	Eby[b] No.9058, or equivalent
Magnetic Shield	See footnote c
Operating Position	Any
Weight (Approx.)	2 oz

MAXIMUM RATINGS, *Absolute-Maximum Values:*

DC Supply Voltage:		
Between anode and cathode	1250 max.	V
Between anode and dynode No.10	250 max.	V
Between consecutive dynodes	200 max.	V
Between dynode No.1 and cathode	300 max.	V

Average Anode Current[e]	0.75 max. mA
Ambient Temperature[f]	75 max. °C

CHARACTERISTICS RANGE VALUES

Under conditions with dc supply voltage (E) across a voltage divider providing electrode voltages as shown in Table I, except as noted.

With E = 1000 volts (Except as noted)

	Min.	Typical	Max.	
Anode Sensitivity:				
Radiant[g] at 4400 angstroms	–	2.2×10^{4}	–	A/W
Luminous[h]	10	27	300	A/lm
Cathode Sensitivity:				
Radiant[i] at 4400 angstroms	–	3.6×10^{-2}	–	A/W
Luminous[k]	3×10^{-5}	4.5×10^{-5}	–	A/lm
With blue light[m]	2.8×10^{-8}	–	–	A
Quantum Efficiency at 4200 angstroms	–	10.5	–	%
Current Amplification	–	6×10^{5}	–	
Anode Dark Current[n]	–	1.6×10^{-8}	5×10^{-8}	A
Equivalent Anode Dark Current Input[n]	–	8×10^{-10}	2.5×10^{-9}	lm
	–	1×10^{-12}[p]	–	W
Equivalent Noise Input[q]	–	6.5×10^{-12}	–	lm
Anode-Pulse Rise Time[r,s] at 1250 V.	–	2.5×10^{-9}	–	s
Electron Transit Time[r,t] at 1250 V.	–	2.9×10^{-8}	–	s

[a] Made by Corning Glass Works, Corning, New York 14830.

[b] Made by Hugh H. Eby Company, 4701 Germantown Avenue, Philadelphia, Pa. 19144.

[c] Magnetic shielding material in the form of foil or tape as available from the Magnetic Shield Division, Perfection Mica Company, 1322 N. Elston Avenue, Chicago, Ill., 60622, or equivalent.

[e] Averaged over any interval of 30 seconds maximum.

[f] Tube operation at room temperature or below is recommended.

→ *Indicates additions or changes.*

[g] This value is calculated from the typical anode luminous sensitivity rating using a conversion factor of 804 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 2870° K and a light input of 10 microlumens is used.

[i] This value is calculated from the typical cathode luminous sensitivity rating using a conversion factor of 804 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 2870° 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, polished to 1/2 stock thickness -- Manufactured by the Corning Glass Works, Corning, New York) from a tungsten-filament lamp operated at a color temperature of 2870° 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] At a tube temperature of 22° C. With supply voltage adjusted to give a luminous sensitivity of 20 amperes per lumen.

[p] At 4400 angstroms. This value is calculated from the EADCI value in lumens using a conversion factor of 804 lumens per watt.

[q] Under the following conditions: Tube temperature 22° C, external shield connected to cathode, bandwidth 1 Hz, tungsten-light source at a color temperature of 2870° K interrupted at a low audio frequency to produce incident radiation pulses alternating between zero and the value stated. The "on" period of the pulse is equal to the "off" period.

[r] Under conditions with dc supply voltage (E) across a voltage divider providing 1/6 of E between cathode and dynode No.1; 1/12 of E for each succeeding dynode stage; and 1/12 of E between dynode No.10 and anode.

[s] Measured between 10 per cent and 90 per cent of 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.

[t] The electron transit time is the time 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.

Table I

Typical Potential Distribution

Between	8.13% of Supply Voltage (E) multiplied by
Cathode and Dynode No.1	1.7
Dynode No.1 and Dynode No.2	1.3
Dynode No.2 and Dynode No.3	1.3
Dynode No.3 and Dynode No.4	1.0
Dynode No.4 and Dynode No.5	1.0
Dynode No.5 and Dynode No.6	1.0
Dynode No.6 and Dynode No.7	1.0
Dynode No.7 and Dynode No.8	1.0
Dynode No.8 and Dynode No.9	1.0
Dynode No.9 and Dynode No.10	1.0
Dynode No.10 and Anode	1.0
Anode and Cathode	12.3

OPERATING CONSIDERATIONS

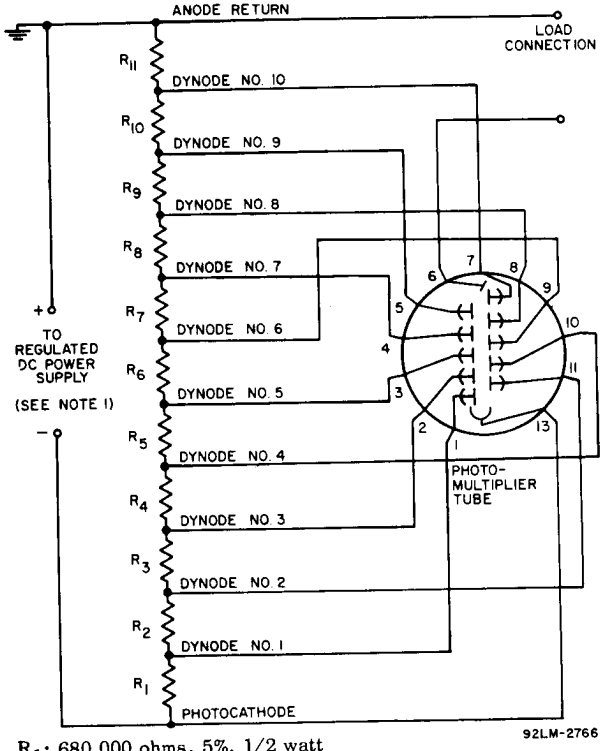
SHIELDING:

Electrostatic shielding of these tubes 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 these tubes at the photocathode end of the tubes should not be permitted unless such materials are chosen to limit leakage current to the tube envelope to 1×10^{-12} ampere or less.

HIGH VOLTAGE WARNING:

The high voltages at which these tubes are operated are very dangerous. Before any part of the circuit is touched, the power-supply switch should be turned off and both terminals of any capacitors grounded.

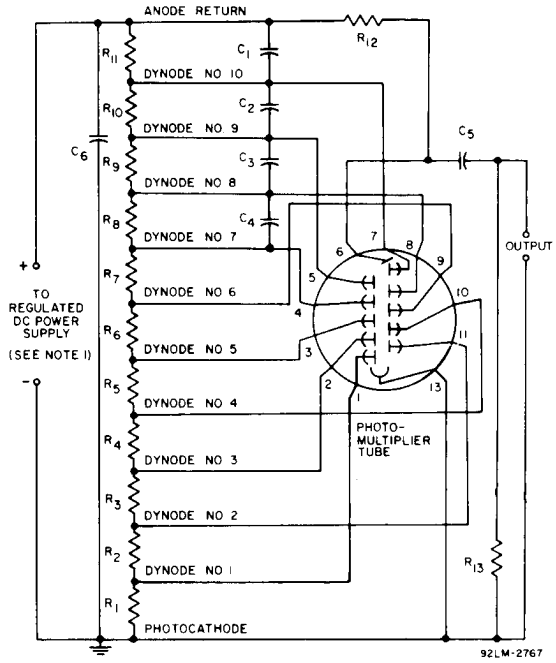
TYPICAL VOLTAGE-DIVIDER ARRANGEMENT WHICH PERMITS DIRECT COUPLING TO THE ANODE



R_1: 680,000 ohms, 5%, 1/2 watt
R_2 and R_3: 510,000 ohms, 5%, 1/2 watt
R_4 through R_{11}: 390,000 ohms, 5%, 1/2 watt

Note 1: Adjustable between approximately 500 and 1250 volts dc.

TYPICAL VOLTAGE-DIVIDER ARRANGEMENT FOR USE IN SCINTILLATION-COUNTING APPLICATIONS



C_1: 0.05 μF, 20%, 500 volts, ceramic disc
C_2: 0.02 μF, 20%, 500 volts, ceramic disc
C_3: 0.01 μF, 20%, 500 volts, ceramic disc
C_4: 0.005 μF, 20%, 500 volts, ceramic disc
C_5 and C_6: 0.005 μF, 20%, 3000 volts, ceramic disc
R_1: 680,000 ohms, 5%, 1/2 watt
R_2 and R_3: 510,000 ohms, 5%, 1/2 watt
R_4 through R_{11}: 390,000 ohms, 5%, 1/2 watt
R_{12}: 1 megohm, 5%, 1/2 watt
R_{13}: 100,000 ohms, 5%, 1/2 watt

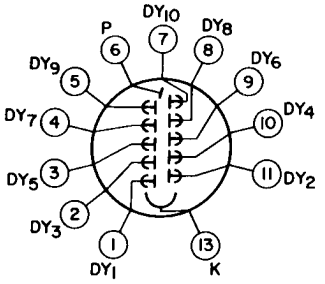
Note 1: Adjustable between approximately 500 and 1250 volts dc.

Note 2: Capacitors C_1 through C_6 should be connected at tube socket for optimum high-frequency performance.

LEAD CONNECTIONS

Bottom View

(With Base Removed)



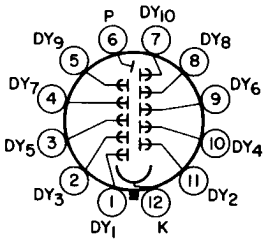
DIRECTION OF LIGHT:
INTO END OF BULB

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: Anode
Lead 7: Dynode No.10
Lead 8: Dynode No.8
Lead 9: Dynode No.6
Lead 10: Dynode No.4
Lead 11: Dynode No.2
Lead 13: Photocathode

TERMINAL DIAGRAM

Bottom View

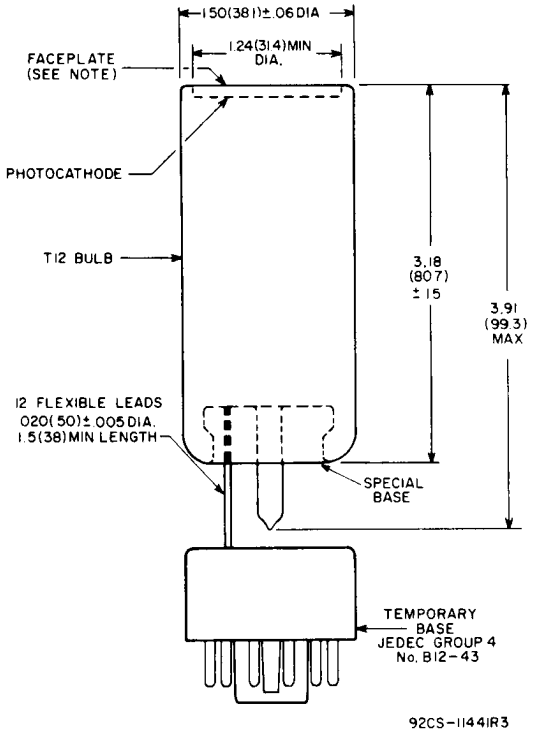
(With Temporary Base)



DIRECTION OF LIGHT:
INTO END OF BULB

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: Anode
Pin 7: Dynode No.10
Pin 8: Dynode No.8
Pin 9: Dynode No.6
Pin 10: Dynode No.4
Pin 11: Dynode No.2
Pin 12: Photocathode

DIMENSIONAL OUTLINE

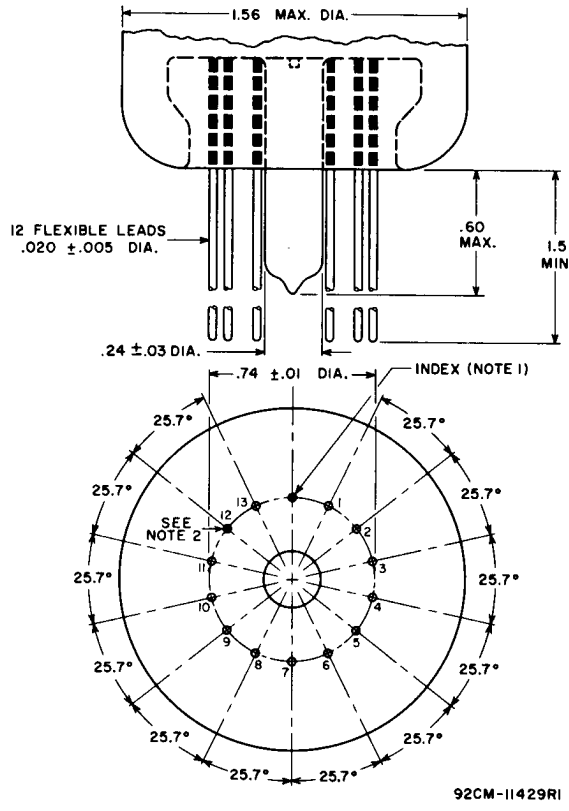


Dimensions are in inches unless otherwise stated. Dimensions in parentheses are in millimeters and are derived from the basic inch dimensions (1 inch = 25.4 mm).

Note: Within 1.24" diameter, deviation from flatness of external surface of faceplate will not exceed 0.010" from peak to valley.

Note: Type 4438 is supplied without temporary B12-43 base.

DETAIL OF BASE STEM

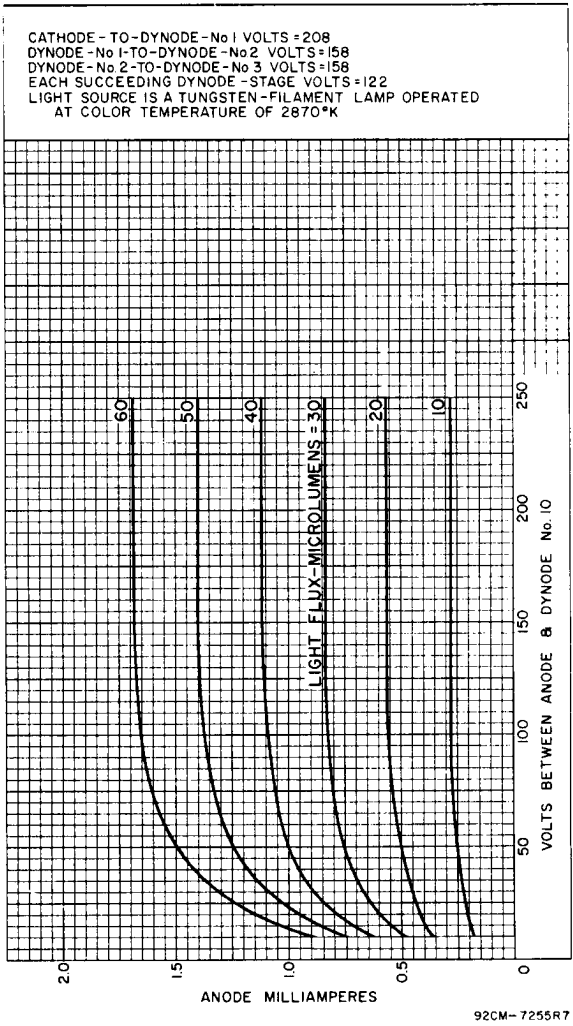


Note 1: Lead is cut off within 0.04 inch of the glass button for indexing.

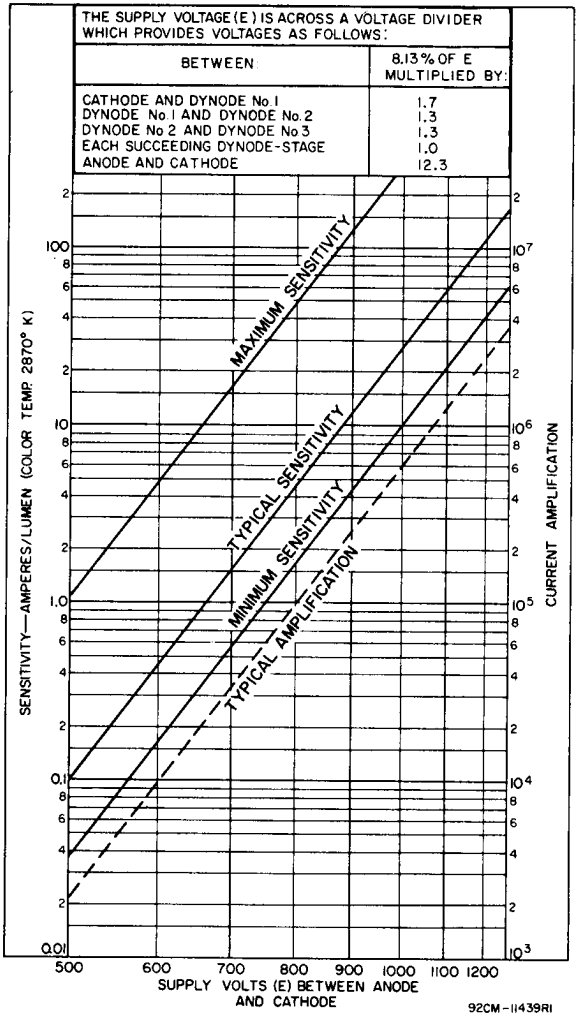
Note 2: Lead No.12 is cut off within 0.04 inch of the glass button.

See Spectral Energy Distribution Curve at Front of this Section.

TYPICAL ANODE CHARACTERISTICS



TYPICAL SENSITIVITY AND CURRENT AMPLIFICATION CHARACTERISTICS



TYPICAL DARK CURRENT AND EADCI CHARACTERISTICS

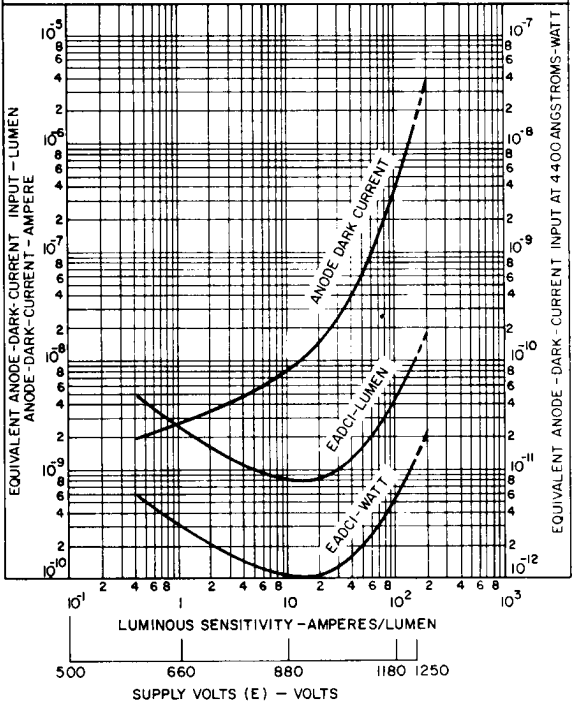
LUMINOUS SENSITIVITY IS VARIED BY ADJUSTMENT OF THE SUPPLY VOLTAGE (E) ACROSS A VOLTAGE DIVIDER WHICH PROVIDES VOLTAGES AS FOLLOWS:

BETWEEN:	8.13%OF E MULTIPLIED BY
CATHODE AND DYNODE No. 1	1.7
DYNODE No.1 AND DYNODE No.2	1.3
DYNODE No.2 AND DYNODE No.3	1.3
EACH SUCCEEDING DYNODE-STAGE	1.0
ANODE AND CATHODE	12.3

TUBE TEMPERATURE =22°C

DASHED PORTION INDICATES INSTABILITY.

LIGHT SOURCE IS A TUNGSTEN-FILAMENT LAMP OPERATED AT A COLOR TEMPERATURE OF 2870°K



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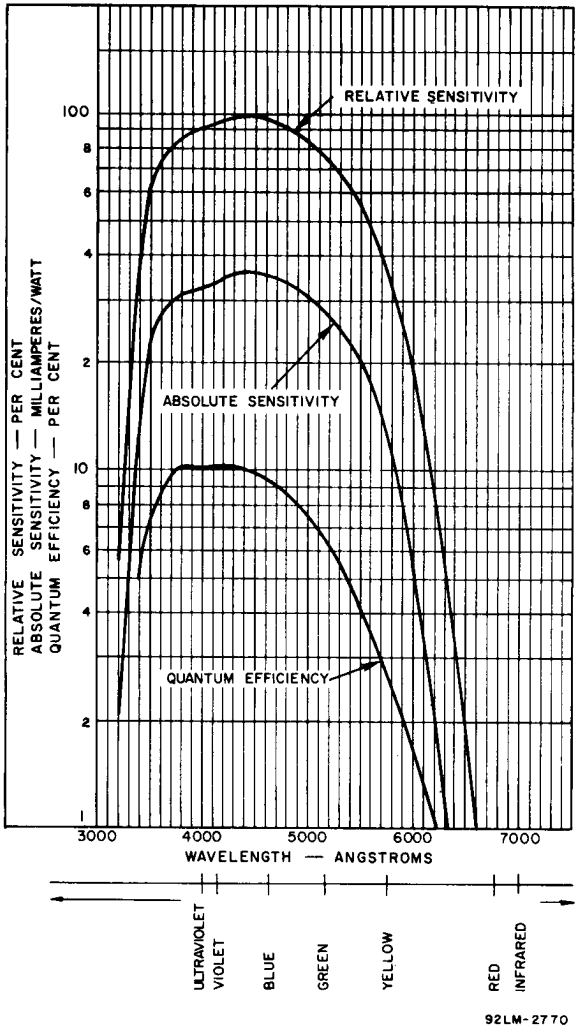
TYPICAL SPECTRAL RESPONSE CHARACTERISTICS



TYPICAL TIME RESOLUTION CHARACTERISTICS