Photomultiplier Tube

14-Stage, Head-On Type
Having S-20 Spectral Response

GENERAL

Spectral Response	S-20
Wavelength of Maximum Response	4200 ± 500 Å
Cathode, Semitransparent	Potassium-Sodium Cesium-Antimony (Multialkali)
Minimum projected area	2.2 in^2 (14.2 cm^2)
Minimum diameter	1.68 in (4.2 cm)
Window	Corning[a] No.0080, or equivalent
Shape	Plano-Concave
Index of refraction at 5893 angstroms	1.512
Dynodes:	
Substrate	Copper-Beryllium
Secondary-Emitting Surface	Beryllium Oxide
Structure	In-Line Electrostatic-Focus Type
Direct Interelectrode Capacitances (Approx.):	
Anode to dynode No.14	2.8 pF
Anode to all other electrodes	6 pF
Dynode No.14 to all other electrodes	7.5 pF
Maximum Overall Length	7.5 in (19 cm)
Seated Length	6.69 in (17 cm) ± 0.19 in
Maximum Diameter	2.38 in (6 cm)
Bulb	T16
Base	Small-Shell Bidecal 20-Pin, JEDEC No.B20-102
Socket	Alden[b] Part 220FTC, or equivalent
Magnetic Shield	Millen[c] No.80802E, or equivalent
Operating Position	Any
Weight (Approx.)	8 oz (226 g)

ABSOLUTE-MAXIMUM RATINGS

DC Supply Voltage:		
Between Anode and Cathode	3000 max.	V
Between Anode and Dynode No.14	500 max.	V
Between Consecutive Dynodes	600 max.	V
Between Accelerating Electrode and Dynode No.13	±600 max.	V
Between Dynode No.1 and Cathode	500 max.	V
Between Focusing-Electrode and Cathode	500 max.	V
Average Anode Current[e]	1 max.	mA
Ambient Temperature[f]	85 max.	°C

CHARACTERISTICS RANGE VALUES

With E = 2400 volts (Except as noted)

Voltage Distribution A (See Table)

	Min.	Typical	Max.	
Anode Sensitivity:				
Radiant[g] at 4200 angstroms	—	3×10^{6}	—	A/W
Luminous[h]	8×10^{2}	7.2×10^{3}	3.3×10^{4}	A/lm
Cathode Sensitivity:				
Radiant[i] at 4200 angstroms	—	0.064	—	A/W
Luminous[k]	1×10^{-4}	1.5×10^{-4}	—	A/lm
With red light[m]	3×10^{-7}	—	—	A
With blue light[n]	5×10^{-8}	—	—	A
Cathode Quantum Efficiency at 4000 angstroms	—	19	—	%
Current Amplification	—	4.8×10^{7}	—	
Anode Dark Current[p]	—	5×10^{-8}	8×10^{-7}	A
Equivalent Anode-Dark-Current Input[p]	—	5×10^{-11}	8×10^{-10}	lm
	—	1.2×10^{-13}[q]	1.9×10^{-12}[q]	W
Equivalent Noise Input[r]	—	9×10^{-13}	—	lm
	—	2.1×10^{-15}[s]	—	W
Anode Pulse Rise Time at 3000 V[t]	—	2.7×10^{-9}	—	s
Electron Transit Time at 3000 V[u]	—	4×10^{-8}	—	s

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

[b] Made by Alden Products Co., 262 N. Main St., Brockton, Mass. 02403.

[c] Made by James Millen Manufacturing Co., 150 Exchange Street, Malden 48, Mass.

[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 428 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 0.1 microlumen is used.

[i] This value is calculated from the typical cathode luminous sensitivity rating using a conversion factor of 428 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 red filter (Corning C.S. No.2-62 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] 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.

[p] At a tube temperature of 22° C. With supply voltage adjusted to give a luminous sensitivity of 1000 amperes per lumen. Dark current caused by thermionic emission may be reduced by use of a refrigerant. Dark current is measured with incident light removed.

[q] At 4200 angstroms. This value is calculated from the EADCI value in lumens using a conversion factor of 428 lumens per watt.

[r] 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.

[s] At 4200 angstroms. This value is calculated from the ENI value in lumens using a conversion factor of 428 lumens per watt.

[t] 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.

[U] 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.

Voltage Distribution		
Between the following Electrodes: Cathode (K), Dynode (Dy), and Anode (P)	A 5.4% of Supply Voltage (E) multiplied by	B 6.06% of Supply Voltage (E) multiplied by
K - Dy1	2	♦
Dy1 - Dy2	1	1
Dy2 - Dy3	1	1
Dy3 - Dy4	1	1
Dy4 - Dy5	1	1
Dy5 - Dy6	1	1
Dy6 - Dy7	1	1
Dy7 - Dy8	1	1
Dy8 - Dy9	1	1
Dy9 - Dy10	1	1
Dy10 - Dy11	1	1
Dy11 - Dy12	1.25	1.25
Dy12 - Dy13	1.5	1.5
Dy13 - Dy14	1.75	1.75
Dy14 - P	2	2
Dy1 - P	—	16.5
K - P	18.5	—

Focusing electrode is connected to arm of potentiometer between cathode and dynode No.1; the focusing electrode voltage is varied to give maximum anode current.

The metal collar (See Dimensional Outline) is connected internally to the focusing electrode. Extreme care should be taken in the design of apparatus to prevent operating personnel from coming in contact with the collar when the circuit application is such that the collar is at high potential.

♦Cathode-to-dynode No.1 voltage is maintained at 330 volts.

OPERATING CONSIDERATIONS

The base pins of the 7265 fit a bidecal 20-contact socket, such as Alden No.220FTC or equivalent.

The socket should be made of high-grade, low-leakage material.

The operating stability of the 7265 is dependent on the magnitude of the anode current. The use of an average anode current well below the maximum rated value of 1 milliampere is recommended when stability of operation is important. When stability is of prime importance, the use of an average anode current of 1 microampere or less, commensurate with satisfactory output signal, is recommended.

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.

Accompanying voltage-divider arrangements are recommended for use with the 7265. Recommended resistance values for the voltage divider range from 10 kilohms per stage to 10 megohms per stage. The choice of resistance values for any voltage-divider network is usually a compromise. If low values of resistance per stage are utilized, the power drawn from the regulated power supply and the required power rating of the resistors increase. Phototube noise may also increase due to heating if the divider network is mounted near the photocathode. The use of high resistance values per stage may cause deviation from linearity if the voltage-divider current is not maintained at a value of at least 10 times that of the maximum value of average anode current, and may limit anode-current response to pulsed light. The latter effect may be reduced by con-

necting capacitors between the tube socket terminals for dynodes No.11 and No.12, dynodes No.12 and No.13, dynodes No.13 and No.14, and between dynode No.14 and anode return.

In addition to nonlinearity and pulse-limiting effects, the use of resistance values exceeding 10 megohms per stage make the 7265 more susceptible to leakage effects between terminals with possible resulting deviation in interstage voltage leading to a loss of current amplification.

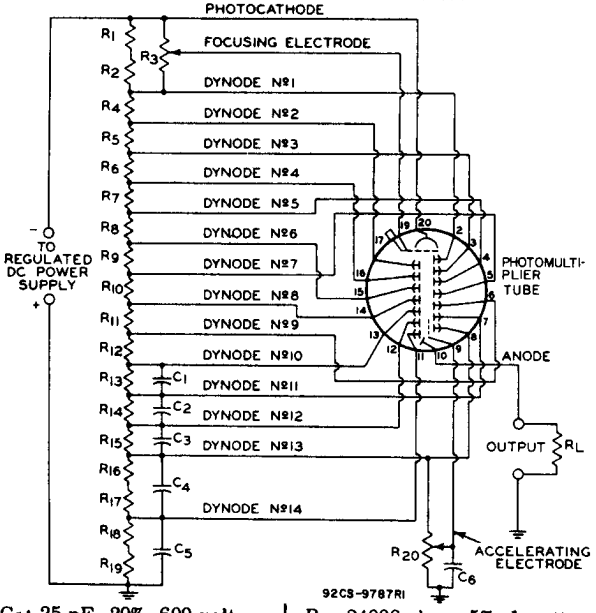
Voltage Distribution B is recommended where high dynode-No.1 gain is important, such as low light level and scintillation counting applications. Voltage Distribution B maintains the cathode to dynode-No.1 voltage constant at 330 volts; it is especially useful when the supply voltage is adjusted over a wide range to achieve large changes in anode sensitivity.

The high voltages at which the 7265 is operated are very dangerous. Care should be taken in the design of apparatus to prevent the operator from coming in contact with these high voltages. Precautions should include the enclosure of high-potential terminals and the use of interlock switches to break the primary circuit of the high-voltage power supply when access to the apparatus is required.

In the use of the 7265 as with other tubes requiring high voltages, it should always be remembered that these high voltages may appear at points in the circuit which are normally at low potential, because of defective circuit parts or incorrect circuit connections.

Therefore, 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



C_1: 25 pF, 20%, 600 volts (dc working), ceramic disc

C_2: 50 pF, 20%, 600 volts (dc working), ceramic disc

C_3: 100 pF, 20%, 600 volts (dc working), ceramic disc

C_4: 250 pF, 20%, 600 volts (dc working), ceramic disc

C_5: 500 pF, 20%, 600 volts (dc working), ceramic disc

C_6: 100 pF, 20%, 1000 volts (dc working), ceramic disc

R_1: 24000 ohms, 5%, 1 watt

R_2: 22000 ohms, 5%, 1 watt

R_3: 1 megohm, 20%, 2 watts, adjustable

R_4 through R_{13}: 22000 ohms, 5%, 1 watt

R_{14}: 27000 ohms, 5%, 2 watts

R_{15}: 33000 ohms, 5%, 2 watts

R_{16}: 22000 ohms, 5%, 2 watts

R_{17}: 18000 ohms, 5%, 2 watts

R_{18}: 22000 ohms, 5%, 2 watts

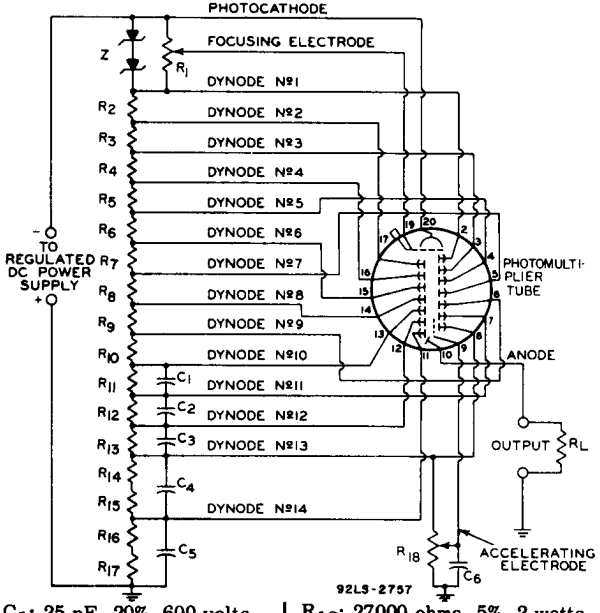
R_{19}: 22000 ohms, 5%, 2 watts

R_{20}: 10 megohms, 2 watts, adjustable

R_L: Value will depend on magnitude of peak pulse voltage desired. For a peak pulse amplitude of 100 volts, the value is approximately 300 ohms.

Note 1: Adjustable between approximately 800 and 3000 V dc.
Note 2: Component values are dependent upon nature of application and output signal desired.

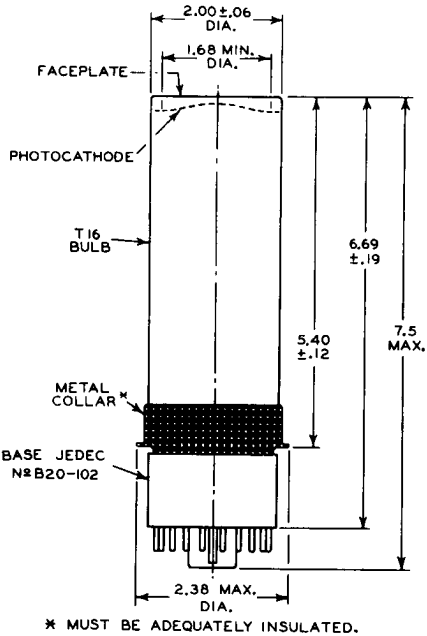
TYPICAL VOLTAGE-DIVIDER ARRANGEMENT FOR CONSTANT VOLTAGE BETWEEN CATHODE AND DYNODE No.1



C_1: 25 pF, 20%, 600 volts (dc working), ceramic disc
C_2: 50 pF, 20%, 600 volts (dc working), ceramic disc
C_3: 100 pF, 20%, 600 volts (dc working), ceramic disc
C_4: 250 pF, 20%, 600 volts (dc working), ceramic disc
C_5: 500 pF, 20%, 600 volts (dc working), ceramic disc
C_6: 100 pF, 20%, 1000 volts (dc working), ceramic disc
R_1: 5 megohms, 20%, 1/2 watt, adjustable
R_2 through R_{11}: 22000 ohms, 5%, 1 watt
R_{12}: 27000 ohms, 5%, 2 watts
R_{13}: 33000 ohms, 5%, 2 watts
R_{14}: 22000 ohms, 5%, 2 watts
R_{15}: 18000 ohms, 5%, 2 watts
R_{16}: 22000 ohms, 5%, 2 watts
R_{17}: 22000 ohms, 5%, 2 watts
R_{18}: 10 megohms, 2 watts, adjustable
R_L: Value will depend on magnitude of peak pulse voltage desired. For a peak pulse amplitude of 100 volts, the value is approximately 300 ohms.
Z: (1) - 150 V, 1 W zener diode, or equivalent
(1) - 180 V, 1 W zener diode, or equivalent

Note 1: Adjustable between approximately 800 and 3000 V dc.
Note 2: Component values are dependent upon nature of application and output signal desired.

DIMENSIONAL OUTLINE – Dimensions In Inches



℄ of bulb will not deviate more than 2° in any direction from the perpendicular erected at the center of bottom of the base.

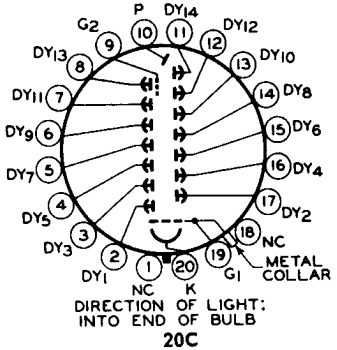
Note: Within 1.68" diameter, deviation from flatness of external surface of faceplate will not exceed 0.005" from peak to valley.

Inch Dimension Equivalents in Millimeters

Inch	mm	Inch	mm	Inch	mm
0.06	1.5	1.68	42.6	5.40	137.1
0.12	3.0	2.00	50.8	6.69	169.9
0.19	4.8	2.38	60.4	7.5	190.5

TERMINAL DIAGRAM (Bottom View)

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: Dynode No.13
Pin 9: Grid No.2 (Accelerating Electrode)
Pin 10: Anode
Pin 11: Dynode No.14
Pin 12: Dynode No.12
Pin 13: Dynode No.10
Pin 14: Dynode No.8
Pin 15: Dynode No.6
Pin 16: Dynode No.4
Pin 17: Dynode No.2
Pin 18: No Connection
Pin 19: Grid No.1 (Focusing Electrode)
Pin 20: Photocathode

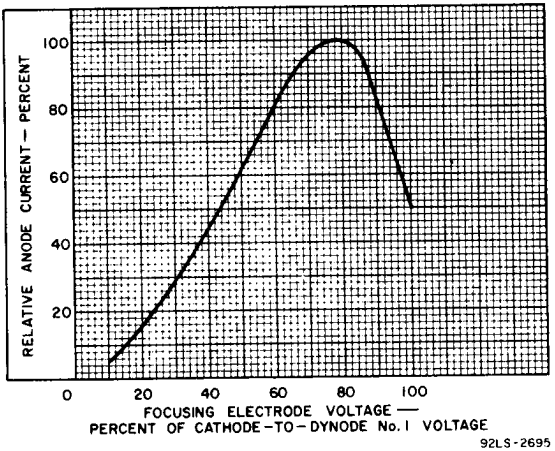


20C

Metal Collar: Connected Internally to Focusing Electrode — Do Not Make Electrical Connection to Collar.

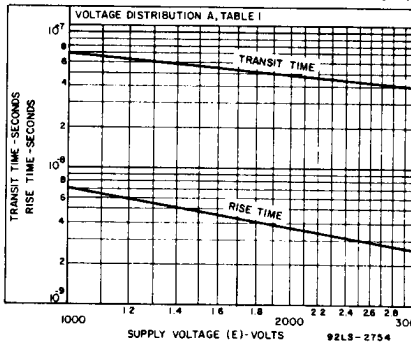
Note: The Metal Collar May be at High Potential Depending on the Circuit Application and Should be Insulated Accordingly.

TYPICAL FOCUSING ELECTRODE CHARACTERISTIC

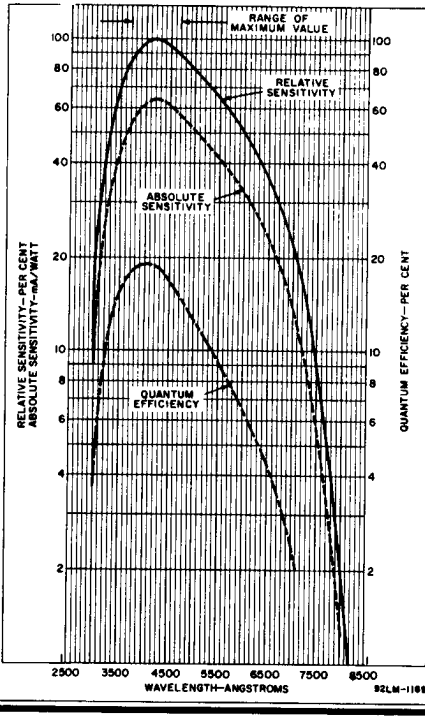


92LS-2695

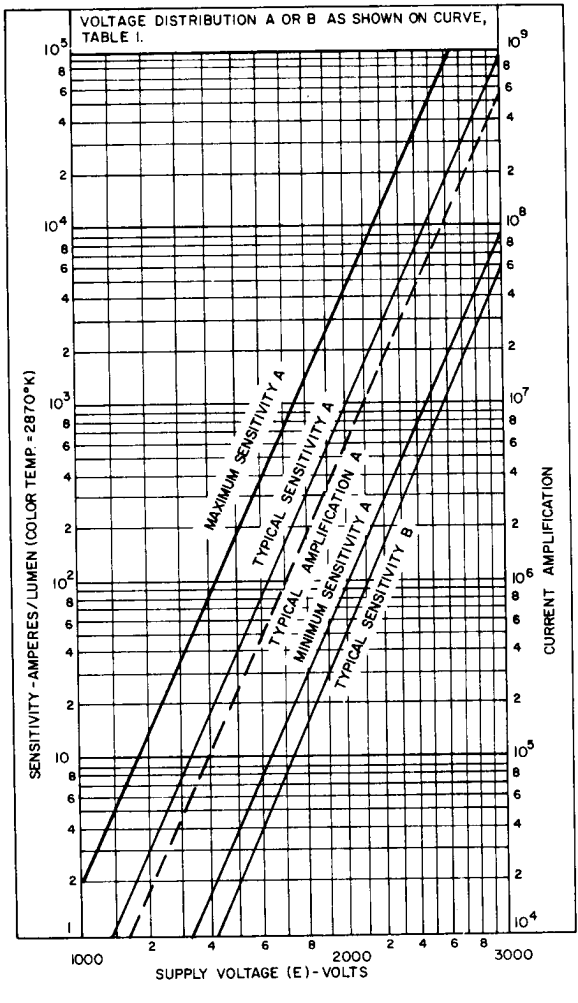
TYPICAL TIME-RESOLUTION CHARACTERISTICS



TYPICAL SPECTRAL RESPONSE CHARACTERISTICS



SENSITIVITY AND CURRENT AMPLIFICATION CHARACTERISTICS

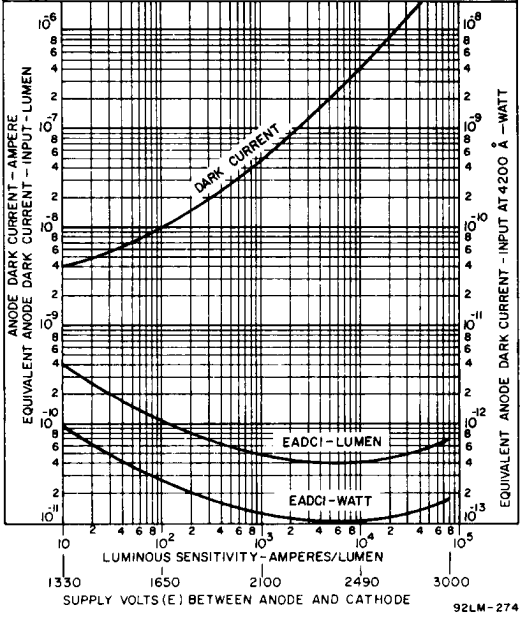


TYPICAL EADCI AND ANODE DARK CURRENT CHARACTERISTICS

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

BETWEEN	5.4% OF E MULTIPLIED BY
CATHODE & FOCUSING ELECTRODE	1.6
CATHODE & DYNODE No.1 (DY_1)	2
DY_1 & DY_2	1
DY_2 & DY_3	1
DY_3 & DY_4	1
DY_4 & DY_5	1
DY_5 & DY_6	1
DY_6 & DY_7	1
DY_7 & DY_8	1
DY_8 & DY_9	1
DY_9 & DY_{10}	1
DY_{10} & DY_{11}	1
DY_{11} & DY_{12}	1.25
DY_{12} & DY_{13}	1.5
DY_{13} & DY_{14}	1.75
DY_{14} & ANODE	2
ANODE & CATHODE	18.5

GRID-No.2 VOLTS ADJUSTED TO GIVE MAXIMUM ANODE CURRENT.
LIGHT SOURCE IS A TUNGSTEN-FILAMENT LAMP OPERATED AT A COLOR TEMPERATURE OF 2870°K.
TUBE TEMPERATURE = 22°C



TYPICAL ANODE CHARACTERISTICS