

## Multiplier Phototube

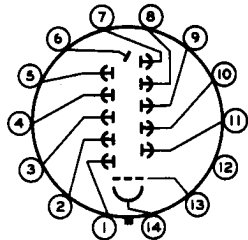
10-STAGE, HEAD-ON, SPHERICAL-FACEPLATE TYPE HAVING ENCLOSED, IN-LINE DYNODE STRUCTURE, 1.68"-DIAMETER, SPHERICAL, SEMITRANSSPARENT PHOTOCATHODE, S-11 RESPONSE, AND VERY SHORT TIME-RESOLUTION CAPABILITY

## DATA

## General:

Spectral Response . . . . .	S-11	
Wavelength of Maximum Response . . . . .	4400 ± 500 angstroms	
Cathode, Semitransparent:		
Shape . . . . .	Spherical	
Window:		
Area (Projected) . . . . .	2.2	sq. in.
Minimum diameter . . . . .	1.68	in.
Index of refraction . . . . .	1.51	
Direct Interelectrode Capacitances		
(Approx.):		
Anode to dynode No.10 . . . . .	3.8	μμf
Anode to all other electrodes . . . . .	5	μμf
Dynode No.10 to all other electrodes . . . . .	6.5	μμf
Maximum Overall Length . . . . .	6.12"	
Seated Length . . . . .	5.18" ± 0.19"	
Maximum Diameter . . . . .	2.31"	
Operating Position . . . . .	Any	
Weight (Approx.) . . . . .	6 oz	
Bulb . . . . .	T16	
Socket . . . . .	Cinch No.3M14, or equivalent	
Base . . . . .	Medium-Shell Diheptal 14-Pin (JEDEC Group 5, No.B14-38)	
Basing Designation for BOTTOM VIEW . . . . .	14AV	

- 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 - Internal Connection—  
 Do Not Use  
 Pin 13 - Focusing Electrode  
 Pin 14 - Photocathode



DIRECTION OF LIGHT:  
INTO END OF BULB

## Maximum Ratings, Absolute-Maximum Values:

SUPPLY VOLTAGE BETWEEN ANODE AND CATHODE (DC) . . . . .	2500 max. volts
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SUPPLY VOLTAGE BETWEEN DYNODE No.10 AND ANODE (DC) . . . . .	400 max.	volts
SUPPLY VOLTAGE BETWEEN CONSECUTIVE DYNODES (DC) . . . . .	300 max.	volts
SUPPLY VOLTAGE BETWEEN DYNODE No.1 AND CATHODE (DC) . . . . .	600 max.	volts
SUPPLY VOLTAGE BETWEEN FOCUSING ELECTRODE AND CATHODE (DC) . . . . .	600 max.	volts
AVERAGE ANODE CURRENT <sup>▲</sup> . . . . .	2 max.	ma
AMBIENT TEMPERATURE . . . . .	75 max.	°C

### Characteristics Range Values for Equipment Design:

Under conditions with dc supply voltage (E) across a voltage divider providing electrode voltages shown in Table I

*With E = 2000 volts (Except as noted) and focusing-electrode voltage adjusted to give maximum current amplification*

	Min.	Median	Max.	
Sensitivity:				
Radiant, at 4400 angstroms . . . . .	-	$9.6 \times 10^5$	-	amp/watt
Cathode radiant, at 4400 angstroms . . . . .	-	0.056	-	amp/watt
Luminous, at 0 cps <sup>●</sup> . . . . .	200	1200	6000	amp/lumen
Cathode luminous:				
With tungsten light source* . . . . .				
light source* . . . . .	50	70	-	μa/lumen
With blue light source♦ . . . . .				
light source♦ . . . . .	0.05	-	-	μa
Current Amplification . . . . .	-	$1.7 \times 10^7$	-	
Equivalent Anode-Dark-Current Input <sup>●</sup> at luminous sensitivity of 230 amperes/lumen . . . . .				
Equivalent Noise Input♦ . . . . .	-	$9 \times 10^{-10}$	$3.5 \times 10^{-9}$	lumen
Anode-Pulse Rise Time <sup>▲</sup> . . . . .	-	$6 \times 10^{-12}$	-	lumen
Anode-Pulse Rise Time <sup>▲</sup> . . . . .	-	$2 \times 10^{-9}$	-	sec
Greatest Delay Between Anode Pulses:				
Due to position from which electrons are simultaneously released within a circle centered on tube face having a diameter of—				
1.4" . . . . .	-	$3 \times 10^{-10}$ <sup>Ⓢ</sup>	-	sec
1.6" . . . . .	-	$5 \times 10^{-10}$ <sup>Ⓢ</sup>	-	sec

*With E = 1500 volts (Except as noted) and focusing-electrode voltage adjusted to give maximum current amplification*

	Min.	Median	Max.	
Sensitivity:				
Radiant, at 4400 angstroms . . . . .	-	$1 \times 10^5$	-	amp/watt
Cathode radiant, at 4400 angstroms . . . . .	-	0.056	-	amp/watt
Luminous, at 0 cps <sup>●</sup> . . . . .	23	130	680	amp/lumen



	Min.	Median	Max.	
Cathode luminous:				
With tungsten				
light source* . . .	50	70	-	$\mu\text{a/lumen}$
Current Amplification .	-	$1.8 \times 10^6$	-	
Equivalent Anode-Dark-				
Current Input $\downarrow$ at				
luminous sensitivity				
of 20 amperes/lumen .	-	$8 \times 10^{-10}$	$2.5 \times 10^{-9}$	lumen
Equivalent Noise Input $\blacklozenge$	-	$4 \times 10^{-12}$	$1 \times 10^{-11}$	lumen
Pulse Height Resolution $\spadesuit$	-	8.5	9	%

With  $E = 1000$  volts (Except as noted) and focusing-electrode voltage adjusted to give maximum current amplification

	Min.	Median	Max.	
Sensitivity:				
Radiant, at 4400				
angstroms . . . . .	-	$4.8 \times 10^3$	-	amp/watt
Cathode radiant,				
at 4400 angstroms .	-	0.056	-	amp/watt
Luminous, at 0 cps $\bullet$ .	1	6	30	amp/lumen
Cathode luminous:				
With tungsten				
light source* . . .	50	70	-	$\mu\text{a/lumen}$
Current Amplification .	-	$8.6 \times 10^4$	-	
Equivalent Anode-Dark-				
Current Input $\downarrow$ at				
luminous sensitivity				
of 6 amperes/lumen .	-	$5 \times 10^{-10}$	-	lumen
Equivalent Noise Input $\blacklozenge$	-	$5 \times 10^{-12}$	-	lumen

$\blacktriangle$  Averaged over any interval of 30 seconds maximum.

$\bullet$  Under the following conditions: The light source is a tungsten-filament lamp operated at a color temperature of  $2870^\circ\text{K}$ . A light input of 0.1 microlumen is used.

$\star$  Under the following conditions: The light source is a tungsten-filament lamp operated at a color temperature of  $2870^\circ\text{K}$ . The value of light flux is 0.01 lumen and 200 volts are applied between cathode and all other electrodes connected together as anode.

$\blacklozenge$  Under the following conditions: Light incident on the cathode is transmitted through a blue filter (Corning No. C.S. 5-58, Glass Code No. 5113 polished to 1/2 stock thickness) from a tungsten-filament lamp operated at a color temperature of  $2870^\circ\text{K}$ . The value of light flux on the filter is 0.01 lumen. A voltage of 200 volts is applied between cathode and all other electrodes connected together as anode.

$\spadesuit$  For spectral characteristic of this source, see sheet SPECTRAL CHARACTERISTIC OF  $2870^\circ\text{K}$  LIGHT SOURCE AND SPECTRAL CHARACTERISTIC OF LIGHT FROM  $2870^\circ\text{K}$  SOURCE AFTER PASSING THROUGH INDICATED BLUE FILTER at front of this section.

$\blacklozenge$  Measured at a tube temperature of  $25^\circ\text{C}$ . Dark current may be reduced by the use of a refrigerant.

$\blacklozenge$  Under the following conditions: Supply voltage ( $E$ ) is as shown,  $25^\circ\text{C}$  tube temperature, external shield is connected to cathode, bandwidth 1 cycle per second, tungsten light source of  $2870^\circ\text{K}$  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. The output current is measured through a filter which passes only the fundamental frequency of the pulses.

$\blacklozenge$  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 variations in the multiplier stages and is measured under conditions with an incident-light spot approximately 1 millimeter in diameter centered on the photocathode.



- ⑥ These values represent the difference in time of transit between the photocathode and dynode No.1 for electrons simultaneously released from the center and from the periphery of the specified areas.
- \* Measured with supply voltage (E) = 1200 to 1300 volts; radiation source, an isotope of cesium having an atomic mass of 137 ( $Cs^{137}$ ); scintillation counter crystal, a cylindrical 2" x 2" thallium-activated sodium-iodide type [NaI(Tl) — type 808550, Serial No. AL281, manufactured by Harshaw Chemical Co., 1945 E. 97 Street, Cleveland 6, Ohio].

TABLE I

VOLTAGE TO BE PROVIDED BY DIVIDER	
Between	8.06% of Supply Voltage (E) multiplied by
Cathode and Dynode No.1	2
Dynode No.1 and Dynode No.2	1.4
Dynode No.2 and Dynode No.3	1
Dynode No.3 and Dynode No.4	1
Dynode No.4 and Dynode No.5	1
Dynode No.5 and Dynode No.6	1
Dynode No.6 and Dynode No.7	1
Dynode No.7 and Dynode No.8	1
Dynode No.8 and Dynode No.9	1
Dynode No.9 and Dynode No.10	1
Dynode No.10 and Anode	1
Anode and Cathode	12.4

Focusing electrode is connected to arm of potentiometer between cathode and dynode No.1. The focusing-electrode voltage is varied to give maximum current amplification.

### OPERATING CONSIDERATIONS

The *operating stability* of the 7746 is dependent on the magnitude of the anode current and its duration. When the 7746 is operated at high average values of anode current, a drop in sensitivity (sometimes called fatigue) may be expected. The extent of the drop below the tabulated sensitivity values depends on the severity of the operating conditions. After a period of idleness, the 7746 usually recovers a substantial percentage of such loss in sensitivity.

The use of an average anode current well below the maximum-rated value of 2 milliamperes is recommended when stability of operation is important. When maximum stability is required, the average anode current should not exceed 10 microamperes.

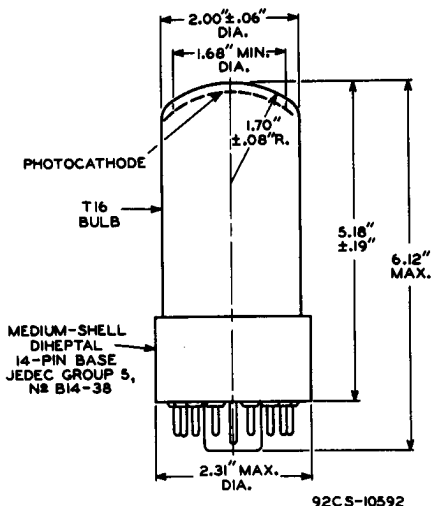
*Electrostatic* and/or *magnetic shielding* of the 7746 may be necessary.

Adequate *light shielding* should be provided to prevent extraneous light from reaching any part of the 7746.



The high voltages at which the 7746 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.

**SPECTRAL-SENSITIVITY CHARACTERISTIC**  
of Phototube having S-11 Response  
is shown at front of this Section

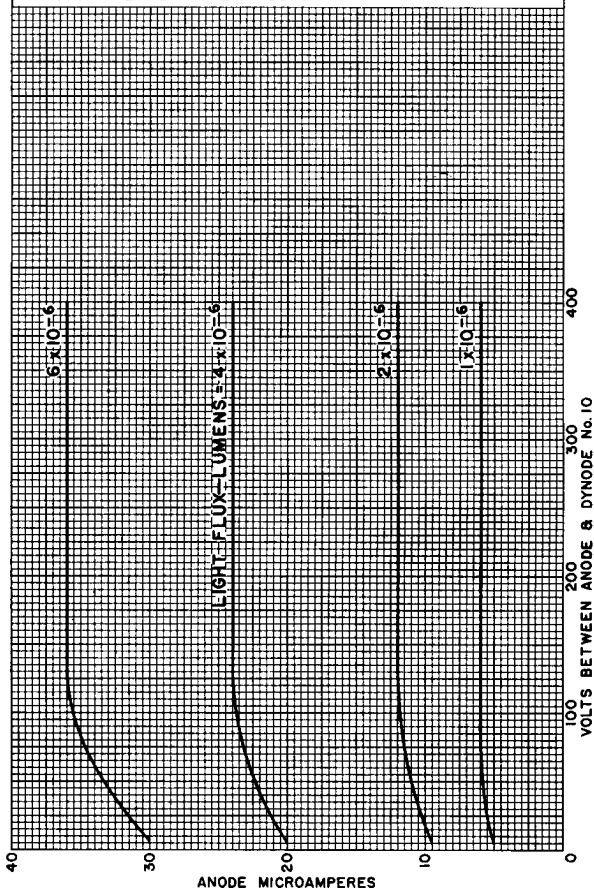


CENTER LINE OF BULB WILL NOT DEVIATE MORE THAN  $2^\circ$  IN ANY DIRECTION FROM THE PERPENDICULAR ERECTED AT THE CENTER OF BOTTOM OF THE BASE.



## TYPICAL ANODE CHARACTERISTICS

DYNODE - No.1 - TO - CATHODE VOLTS = 160  
 DYNODE - No.1 - TO - DYNODE - No.2 VOLTS = 110  
 EACH SUCCEEDING - DYNODE - STAGE VOLTS = 80  
 FOCUSING - ELECTRODE VOLTAGE ADJUSTED FOR MAXIMUM  
 CURRENT AMPLIFICATION.  
 LIGHT SOURCE IS A TUNGSTEN - FILAMENT LAMP OPERATED AT A  
 COLOR TEMPERATURE OF 2870° K.



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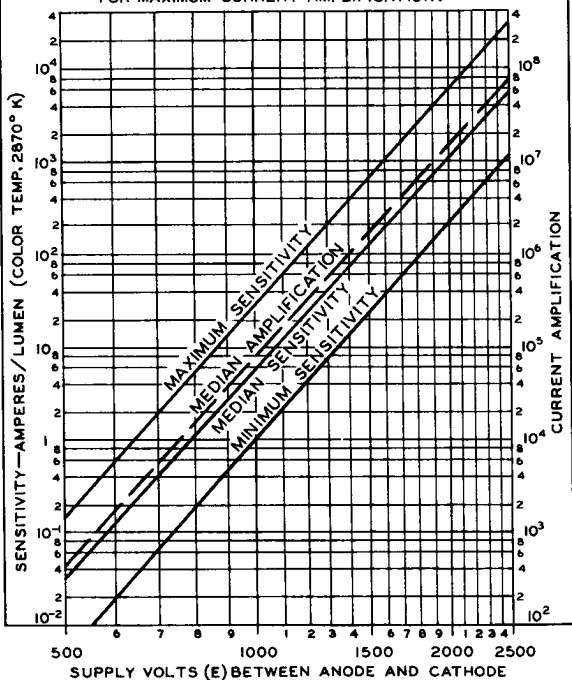


## CHARACTERISTICS

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

BETWEEN	8.06% OF E MULTIPLIED BY
CATHODE & DY <sub>1</sub>	2
DY <sub>1</sub> & DY <sub>2</sub>	1.4
DY <sub>2</sub> & DY <sub>3</sub>	—
DY <sub>3</sub> & DY <sub>4</sub>	—
DY <sub>4</sub> & DY <sub>5</sub>	—
DY <sub>5</sub> & DY <sub>6</sub>	—
DY <sub>6</sub> & DY <sub>7</sub>	—
DY <sub>7</sub> & DY <sub>8</sub>	—
DY <sub>8</sub> & DY <sub>9</sub>	—
DY <sub>9</sub> & DY <sub>10</sub>	—
DY <sub>10</sub> & ANODE	—
ANODE & CATHODE	12.4

FOCUSING-ELECTRODE VOLTAGE IS ADJUSTED FOR MAXIMUM CURRENT AMPLIFICATION.



92CM-10597R1



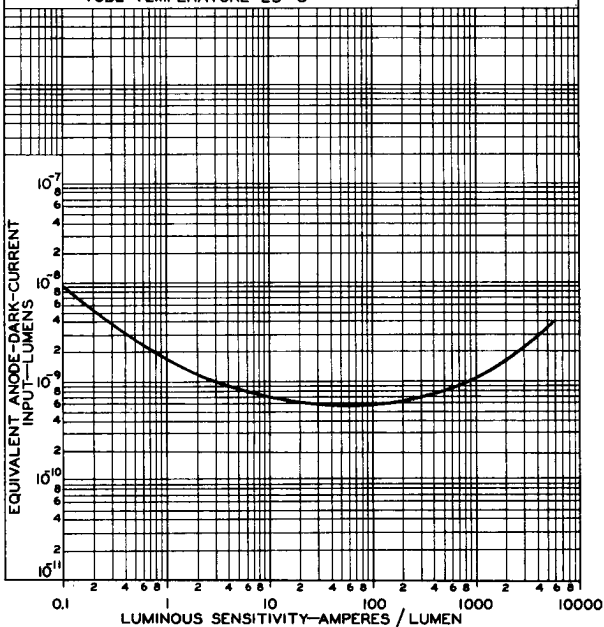
## TYPICAL ANODE-DARK-CURRENT CHARACTERISTIC

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

BETWEEN	8.06% OF E MULTIPLIED BY
CATHODE & DY <sub>1</sub>	2
DY <sub>1</sub> & DY <sub>2</sub>	1.4
DY <sub>2</sub> & DY <sub>3</sub>	1
DY <sub>3</sub> & DY <sub>4</sub>	1
DY <sub>4</sub> & DY <sub>5</sub>	1
DY <sub>5</sub> & DY <sub>6</sub>	1
DY <sub>6</sub> & DY <sub>7</sub>	1
DY <sub>7</sub> & DY <sub>8</sub>	1
DY <sub>8</sub> & DY <sub>9</sub>	1
DY <sub>9</sub> & DY <sub>10</sub>	1
DY <sub>10</sub> & ANODE	1
ANODE & CATHODE	12.4

FOCUSING-ELECTRODE VOLTAGE IS ADJUSTED FOR MAXIMUM CURRENT AMPLIFICATION.

LIGHT SOURCE IS A TUNGSTEN-FILAMENT LAMP OPERATED AT A COLOR TEMPERATURE OF 2870° K.  
TUBE TEMPERATURE=25° C



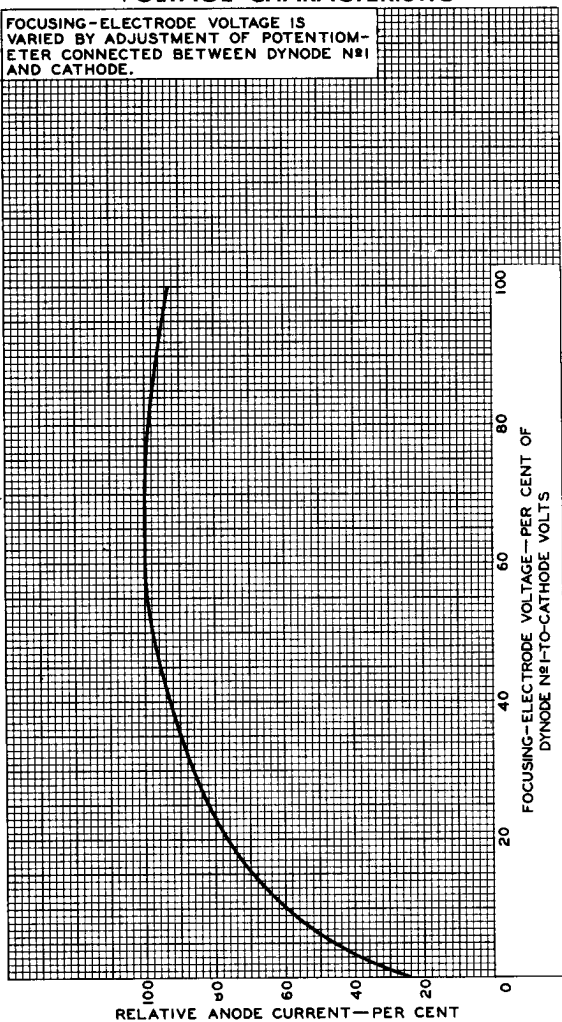
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## AVERAGE FOCUSING-ELECTRODE-VOLTAGE CHARACTERISTIC

FOCUSING-ELECTRODE VOLTAGE IS VARIED BY ADJUSTMENT OF POTENTIOMETER CONNECTED BETWEEN DYNODE NO. 1 AND CATHODE.

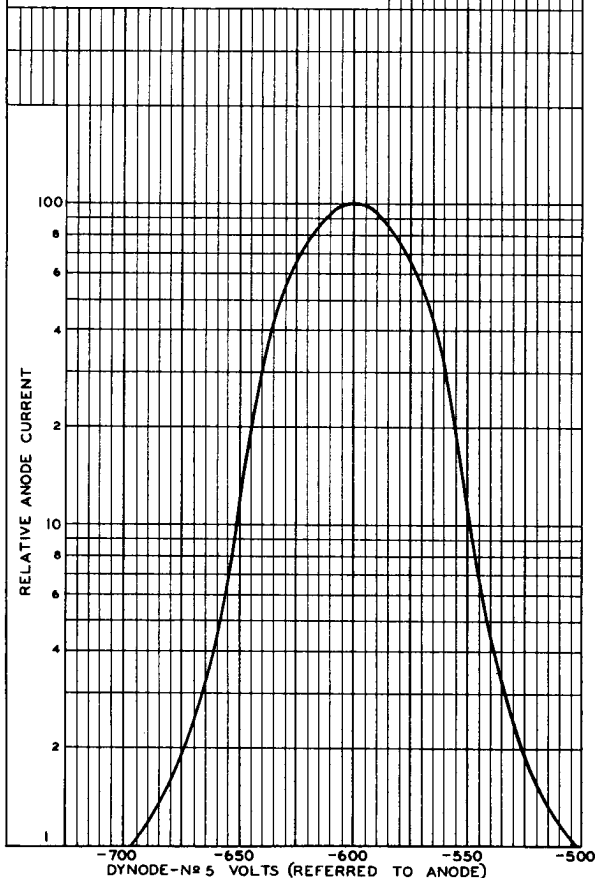


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## TYPICAL ANODE-CURRENT CHARACTERISTIC

DYNODE-Nº1-TO-CATHODE VOLTS=200  
 DYNODE-Nº1-TO-DYNODE-Nº2 VOLTS=140  
 VOLTS PER SUCCEEDING DYNODE STAGE  
 EXCEPT FOR DYNODE-Nº5 STAGE=100  
 FOCUSING-ELECTRODE VOLTAGE ADJUSTED  
 FOR MAXIMUM CURRENT AMPLIFICATION.  
 ANODE IS AT GROUND POTENTIAL.



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