

Multiplier Phototube

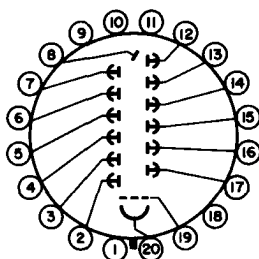
12-STAGE, HEAD-ON, SPHERICAL-FACEPLATE TYPE HAVING
ENCLOSED, IN-LINE DYNODE STRUCTURE, 1.68"-DIAMETER,
SPHERICAL, SEMITRANSSPARENT PHOTOCATHODE, S-11 RESPONSE,
HIGH CURRENT AMPLIFICATION, AND EXTREMELY SHORT RISE TIME

DATA

General:

Spectral Response.	S-11
Wavelength of Maximum Response	4400 $\pm$ 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.12.	3.8 $\mu\mu\text{f}$
Anode to all other electrodes.	5.7 $\mu\mu\text{f}$
Dynode No.12 to all other electrodes	6.8 $\mu\mu\text{f}$
Maximum Overall Length	6.31"
Seated Length.	5.50" $\pm$ 0.19"
Maximum Diameter	2.06"
Operating Position	Any
Weight (Approx.)	7 oz
Bulb	T16
Socket	Cinch No.CX-875 ^a , or equivalent
Base	Small-Shell Bidecal 20-Pin (JEDEC No. B20-102)
Basing Designation for BOTTOM VIEW	20E

- 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 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



DIRECTION OF LIGHT:
INTO END OF BULB



Maximum Ratings, Absolute-Maximum Values:

SUPPLY VOLTAGE BETWEEN ANODE AND CATHODE (DC).	2600 max.	volts
SUPPLY VOLTAGE BETWEEN DYNODE No.12 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 ^b .	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 = 2300 volts (Except as noted) and focusing-electrode voltage adjusted to give maximum current amplification

	Min.	Median	Max.	
Sensitivity:				
Radiant, at 4400 angstroms.	—	4.8×10^6	—	a/w
Cathode radiant, at 4400 angstroms.	—	0.056	—	a/w
Luminous, at 0 cps ^c .	1.4×10^3	6×10^3	50×10^3	a/lm
Cathode luminous:				
With tungsten light source ^d .	50	70	—	$\mu\text{a/lm}$
With blue light source ^{e,f} .	0.05	—	—	μa
Current Amplification.	—	8.6×10^7	—	
Equivalent Anode-Dark-Current Input ^g at luminous sensitivity of 6000 a/lm.	—	4×10^{-10}	2.5×10^{-9}	lm
Equivalent Noise Input ^h	—	3×10^{-12}	—	lm
Anode-Pulse Rise Time ^j .	—	2×10^{-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"	—	3×10^{-10k}	—	sec
1.6"	—	5×10^{-10k}	—	sec

With $E = 1800$ volts (Except as noted) and focusing-electrode voltage adjusted to give maximum current amplification

	Min.	Median	Max.	
Sensitivity:				
Radiant, at 4400 angstroms.	—	5.1×10^5	—	a/w
Cathode radiant, at 4400 angstroms. . .	—	0.056	—	a/w
Luminous, at 0 cps ^c . . .	—	640	—	a/lm
Cathode luminous:				
With tungsten light source ^d	50	70	—	μ a/lm
Current Amplification. . .	—	9.1×10^6	—	
Equivalent Anode-Dark-Current Input ^g at luminous sensitivity of 160 a/lm.	—	4×10^{-10}	—	lm
Equivalent Noise Input ^h . .	—	2.4×10^{-12}	—	lm

With $E = 1300$ volts (Except as noted) and focusing-electrode voltage adjusted to give maximum current amplification

	Min.	Median	Max.	
Sensitivity:				
Radiant, at 4400 angstroms.	—	2.9×10^4	—	a/w
Cathode radiant, at 4400 angstroms. . .	—	0.056	—	a/w
Luminous, at 0 cps ^c . . .	8	36	300	a/lm
Cathode luminous:				
With tungsten light source ^d	50	70	—	μ a/lm
Current Amplification. . .	—	5×10^5	—	
Equivalent Anode-Dark-Current Input ^g at luminous sensitivity of 9 a/lm.	—	5×10^{-10}	2×10^{-9}	lm
Equivalent Noise Input ^h . .	—	3×10^{-12}	—	lm
Pulse Height Resolution ^m . .	—	8.5	—	%

^a Made by Cinch Manufacturing Corporation, 1026 South Homan Avenue, Chicago 24, Illinois.

^b Averaged over any interval of 30 seconds maximum.

^c Under the following conditions: The light source is a tungsten-filament lamp operated at a color temperature of 2870° K. A light input of 0.1 microlumen is used.

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

^e Under the following conditions: Light incident on the cathode is transmitted through a blue filter (Corning C.S. No. 5-58, Glass Code No. 5113 polished to 1/2 stock thickness) from a tungsten-filament lamp operated at a color temperature of 2870° 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.

^f For spectral characteristic of this source, see sheet SPECTRAL CHARACTERISTIC OF 2870° K LIGHT SOURCE AND SPECTRAL CHARACTERISTIC OF LIGHT FROM 2870° K SOURCE AFTER PASSING THROUGH INDICATED BLUE FILTER at front of this section.



- ^g Measured at a tube temperature of 25° C. Dark current may be reduced by the use of a refrigerant.
- ^h Under the following conditions: Supply voltage (E) is as shown, 25°-C tube temperature, external shield is connected to cathode, bandwidth 1 cycle per second, tungsten light source 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. The output current is measured through a filter which passes only the fundamental frequency of the pulses.
- ^j 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.
- ^k 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.
- ^m Measured with supply voltage (E) = 1100 to 1400 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 808S50, Serial No. AL281, manufactured by Harshaw Chemical Company, 1945 East 97 Street, Cleveland 6, Ohio.

TABLE I

VOLTAGE TO BE PROVIDED BY DIVIDER	
Between	6.95% 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 Dynode No.11	1
Dynode No.11 and Dynode No.12	1
Dynode No.12 and Anode	1
Anode and Cathode	14.4

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 7850 is dependent on the magnitude of the anode current and its duration. When the 7850 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 7850 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.

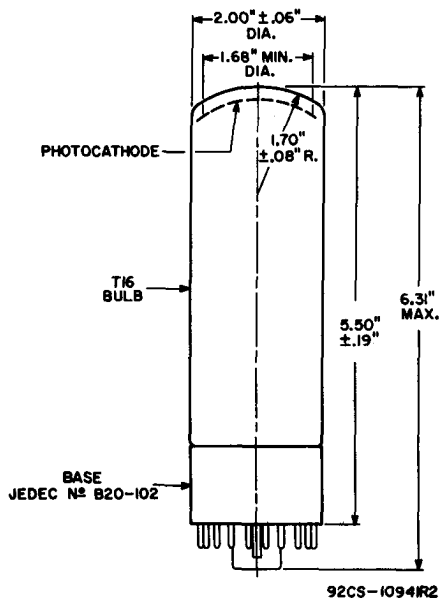
Electrostatic and/or magnetic shielding of the 7850 may be necessary.

Adequate *light shielding* should be provided to prevent extraneous light from reaching any part of the 7850—

The *high voltages at which the 7850 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-II Response
is shown at the front of this Section**

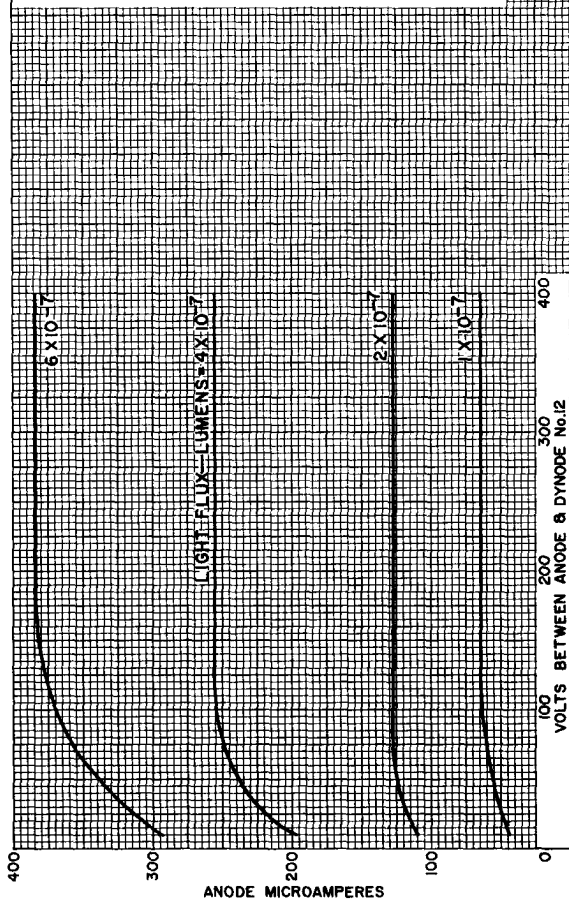




CENTER LINE OF BULB WILL NOT DEVIATE MORE THAN 2° IN ANY DIRECTION FROM THE PERPENDICULAR ERECTED AT THE CENTER OF BOTTOM OF THE BASE.

TYPICAL ANODE CHARACTERISTICS

DYNODE-NO.1-TO-CATHODE VOLTS=250
 DYNODE-NO.1-TO-DYNODE-NO.2 VOLTS=175
 EACH SUCCEEDING-DYNODE-STAGE VOLTS=125
 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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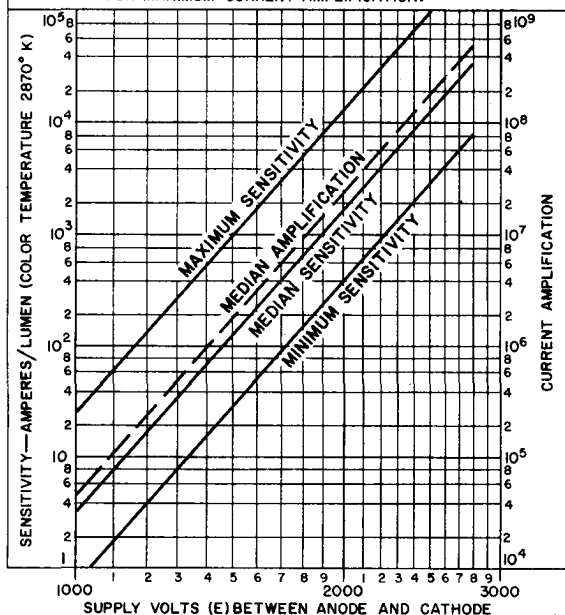


CHARACTERISTICS

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

BETWEEN	6.95% OF E MULTIPLIED BY
CATHODE & DY ₁	2
DY ₁ & DY ₂	1.4
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
DY ₁₂ & ANODE	1
ANODE & CATHODE	14.4

FOCUSING-ELECTRODE VOLTAGE IS ADJUSTED
FOR MAXIMUM CURRENT AMPLIFICATION.



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TYPICAL ANODE-DARK-CURRENT CHARACTERISTIC

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

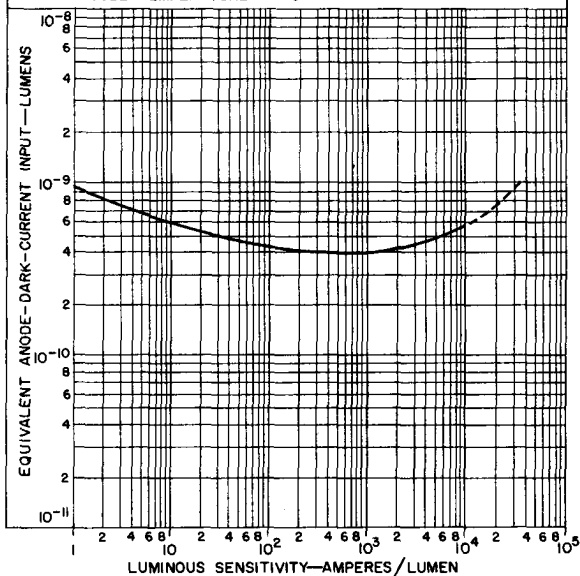
BETWEEN	6.95% OF E MULTIPLIED BY
CATHODE & DY ₁	2
DY ₁ & DY ₂	1.4
DY ₂ & DY ₃	1
DY ₃ & DY ₄	1
DY ₄ & DY ₅	1
DY ₅ & DY ₆	1
DY ₆ & DY ₇	1
DY ₇ & DY ₈	1
DY ₈ & DY ₉	1
DY ₉ & DY ₁₀	1
DY ₁₀ & DY ₁₁	1
DY ₁₁ & DY ₁₂	1
DY ₁₂ & ANODE	1
ANODE & CATHODE	14.4

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

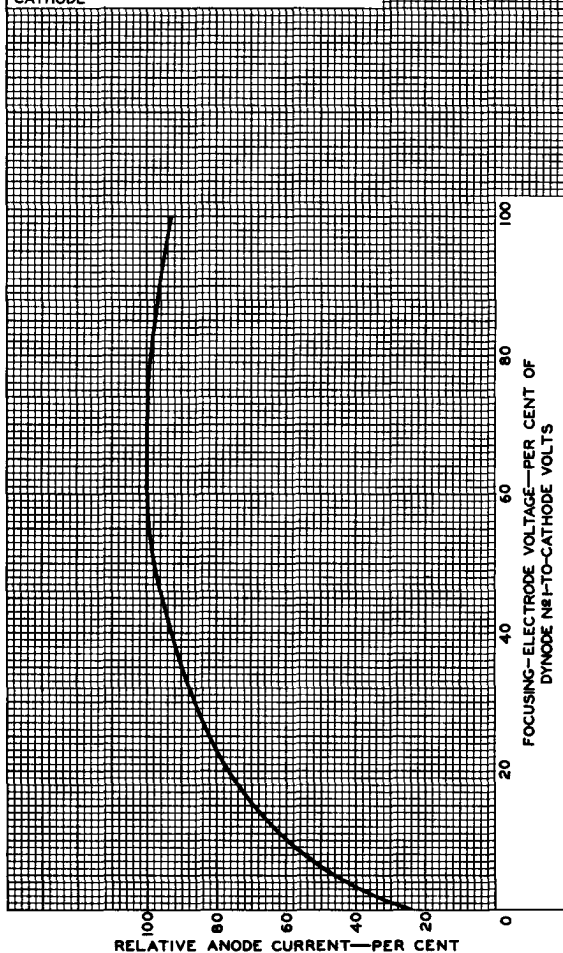


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AVERAGE FOCUSING-ELECTRODE-VOLTAGE CHARACTERISTIC

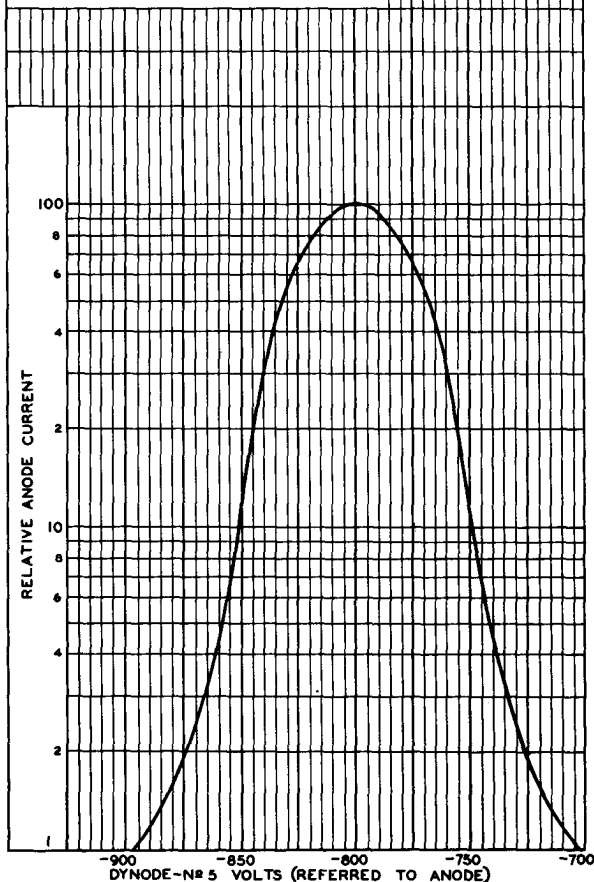
FOCUSING-ELECTRODE VOLTAGE IS
VARIED BY ADJUSTMENT OF POTENTIOM-
ETER CONNECTED BETWEEN DYNODE AND
CATHODE



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TYPICAL ANODE-CURRENT CHARACTERISTIC

DYNODE-NR1-TO-CATHODE VOLTS=200
 DYNODE-NR1-TO-DYNODE-NR2 VOLTS=140
 VOLTS PER SUCCEEDING DYNODE STAGE
 EXCEPT FOR DYNODE-NR5 STAGE=100
 FOCUSING-ELECTRODE VOLTAGE ADJUSTED
 FOR MAXIMUM CURRENT AMPLIFICATION.
 ANODE IS AT GROUND POTENTIAL.



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