



6810

6810

MULTIPLIER PHOTOTUBE

14-STAGE, HEAD-ON TYPE WITH
1-11/16" SEMITRANSSPARENT CATHODE AND S-11 RESPONSE
SHORT TIME-RESOLUTION CAPABILITY

DATA**General:**

Spectral Response	S-11
Wavelength of Maximum Response	4400 $\pm$ 500 angstroms
Cathode, Semitransparent:	
Shape	Circular
Window:	
Area	2.2 sq. in.
Minimum diameter.	1-11/16 in.
Index of refraction	1.51
Direct Interelectrode Capacitances (Approx.):	
Anode to dynode No.14	2.4 μ f
Anode to all other electrodes	5.5 μ f
Dynode No.14 to all other electrodes.	7.5 μ f
Maximum Overall Length	7-1/2"
Seated Length	6-11/16" $\pm$ 3/16"
Maximum Diameter.	2-3/8"
Mounting Position	Any
Weight (Approx.).	8 oz
Bulb.	T-16
Base.	Small-Shell Bidecal 20-Pin (JETEC No.B20-102), Non-hygroscopic

Basing Designation for BOTTOM VIEW. 20B

Pin 1-No Connec-
tion

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

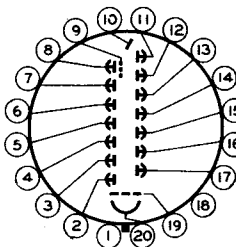
Pin 7-Dynode No.11

Pin 8-Dynode No.13

Pin 9-Grid No.2

(Accelerating
Electrode)

Pin 10-Anode



DIRECTION OF LIGHT:
INTO END OF BULB

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 Connec-
tion

Pin 19-Grid No.1

(Focusing
Electrode)

Pin 20-Photocathode

Maximum Ratings, Absolute Values:

ANODE-SUPPLY VOLTAGE (DC)	2300 max. volts
SUPPLY VOLTAGE BETWEEN DYNODE No.14 AND ANODE (DC).	400 max. volts
SUPPLY VOLTAGE BETWEEN ACCELERATING- ELECTRODE AND DYNODE No.13 (DC)	$\pm$ 500 max. volts
DYNODE-No.1 SUPPLY VOLTAGE (DC)	400 max. volts
FOCUSING-ELECTRODE SUPPLY VOLTAGE (DC).	400 max. volts
AVERAGE ANODE CURRENT [•]	2 max. ma
AMBIENT TEMPERATURE	75 max. $^{\circ}$ C

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



6810

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Characteristics Range Values for Equipment Design:

Under conditions with supply voltage (E) across a voltage divider providing electrode voltages shown in Table 1

With $E = 2000$ volts (except as noted) and Accelerating-Electrode Voltage adjusted to give maximum gain

Min. Median Max.

Sensitivity:

Radiant, at				
4400 angstroms.	-	0.6	-	amp/ μ watt
Cathode radiant;				
at 4400 angstroms . . .	-	0.048	-	μ amp/ μ watt
Luminous: $\downarrow$				
At 0 cps.	120	750	4500	amp/lumen
With dynode No.14				
as output				
electrode $\dagger$	-	525	-	amp/lumen
Cathode luminous:				
With tungsten				
light source Δ	40	60	-	μ amp/lumen
With blue light				
source $\oplus$	0.04	-	-	μ amp
Current Amplification . . .	-	12.5×10^6	-	
Equivalent Anode-Dark-				
Current Input $\#$	-	5×10^{-10}	2×10^{-9}	lumen
Equivalent Noise Input $\star$. .	-	6×10^{-12}	-	lumen
Dark Current to Any				
Electrode Except				
Anode (At 25°C).	-	-	0.75	μ amp

With $E = 2300$ volts (except as noted) and Accelerating-Electrode Voltage adjusted to give maximum gain

Min. Median Max.

Sensitivity:

Radiant, at				
4400 angstroms.	-	3.2	-	amp/ μ watt
Cathode radiant;				
at 4400 angstroms . . .	-	0.048	-	μ amp/ μ watt
Luminous: $\downarrow$				
At 0 cps.	660	4000	28000	amp/lumen
With dynode No.14				
as output				
electrode $\dagger$	-	2800	-	amp/lumen
Cathode luminous:				
With tungsten				
light source Δ	40	60	-	μ amp/lumen
With blue light				
source $\oplus$	0.04	-	-	μ amp
Current Amplification . . .	-	66×10^6	-	

$\downarrow, \dagger, \Delta, \oplus, \#, \square, \star$: See next page.



6810

6810

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TABLE I

VOLTAGE TO BE PROVIDED BY DIVIDER

Between	5.4% of Supply Voltage (E) multiplied by
Cathode and Focusing Electrode	1
Focusing Electrode and Dynode No.1	1
Dynode No.1 and Dynode No.2	1
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	1.25
Dynode No.12 and Dynode No.13	1.5
Dynode No.13 and Dynode No.14	1.75
Dynode No.14 and Anode	2
Anode and Cathode	18.5

♣ For conditions where 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. The load resistor has a value of 0.01 megohm.

† An output current of opposite polarity to that obtained at the anode may be provided by using dynode No.14 as the output electrode. With this arrangement, the load is connected in the dynode-No.14 circuit and the anode serves only as collector. The value of sensitivity at dynode No.14 is approximately 70% of that when the anode is the output electrode. Specifically, the sensitivity measured at dynode No.14 is equal to $(1-1/g)$ times the sensitivity measured at the anode, where "g" is the gain of the dynode-No.14 stage.

▲ For conditions the same as shown under (♣) except that the value of light flux is 0.01 lumen and 200 volts are applied between cathode and all other electrodes connected together as anode.

⊗ Under the following conditions: Light incident on the cathode is transmitted through a blue filter (Corning, 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. The load resistor has a value of 0.01 megohm, and 200 volts are applied between cathode and all other electrodes connected together as anode.

◆ 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.

⊕ Measured at a tube temperature of 25°C and with the supply voltage (E) adjusted to give a luminous sensitivity of 2000 amperes per lumen. Dark current caused by thermionic emission and ion feedback may be reduced by the use of a refrigerant.

■ For maximum signal-to-noise ratio, operation with a supply voltage (E) below 2000 volts is recommended.

★ Under the following conditions: Supply voltage (E) is 2000 volts, 25°C tube temperature, external shield potential of -2000 volts, ac-amplifier bandwidth of 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.



6810

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OPERATING CONSIDERATIONS

The *operating stability* of the 6810 is dependent on the magnitude of the anode current and its duration. When the 6810 is operated at high 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 6810 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 anode current should not exceed 250 microamperes.

Electrostatic and/or *magnetic shielding* of the 6810 may be necessary.

The *material* of which the dynodes of the 6810 are made has stable, high-current carrying capabilities and permits the use of a tube manufacturing process which minimizes regenerative effects such as afterpulses. The relative freedom of the 6810 from afterpulses and its small spread in electron transit time make it particularly useful for fast coincidence scintillation counting.

Because the 6810 offers the advantage of small spread in electron transit time, it has a fast pulse rise time. As a result, the 6810 has very short time-resolution capability, i.e., in the order of 1 or 2 millimicroseconds. For an input pulse having a duration of 1 millimicrosecond or less, the time spread of the pulse at the anode is about 9 millimicroseconds measured at 50 per cent of the maximum pulse height, when the supply voltage is 2000 volts and the focusing electrode is connected to dynode No.1.

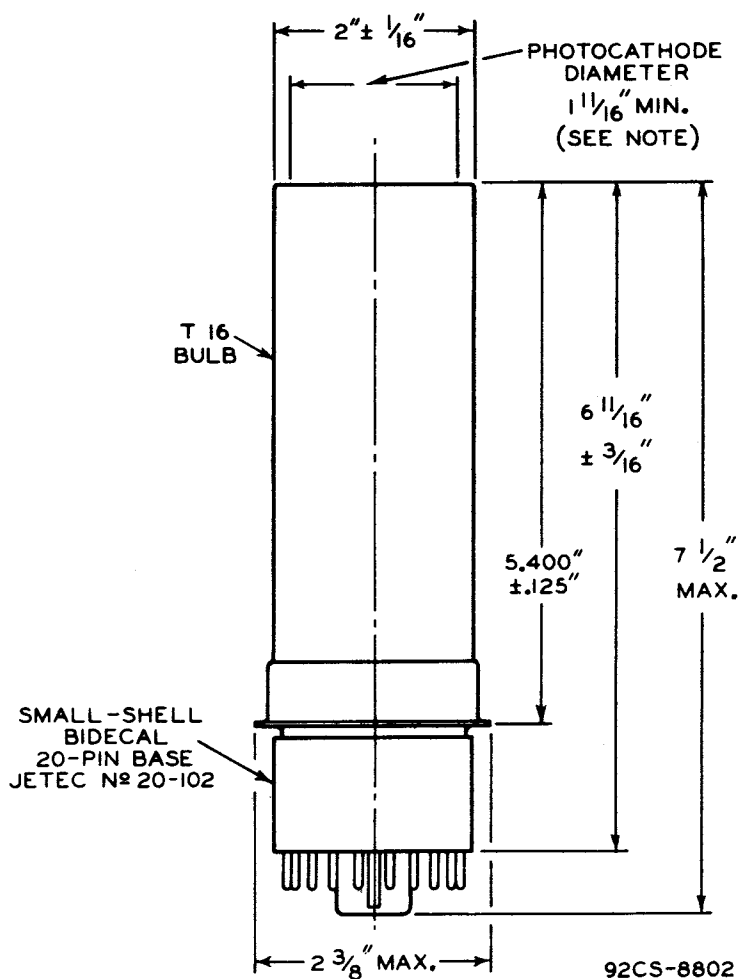
SPECTRAL-SENSITIVITY CHARACTERISTIC
of Phototube having S-11 Response
is shown at the front of this Section



6810

6810

MULTIPLIER PHOTOTUBE



☉ 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 MINIMUM DIAMETER, DEVIATION FROM FLATNESS WILL NOT EXCEED 0.010" FROM PEAK TO VALLEY.

6810



6810

AVERAGE ANODE CHARACTERISTICS

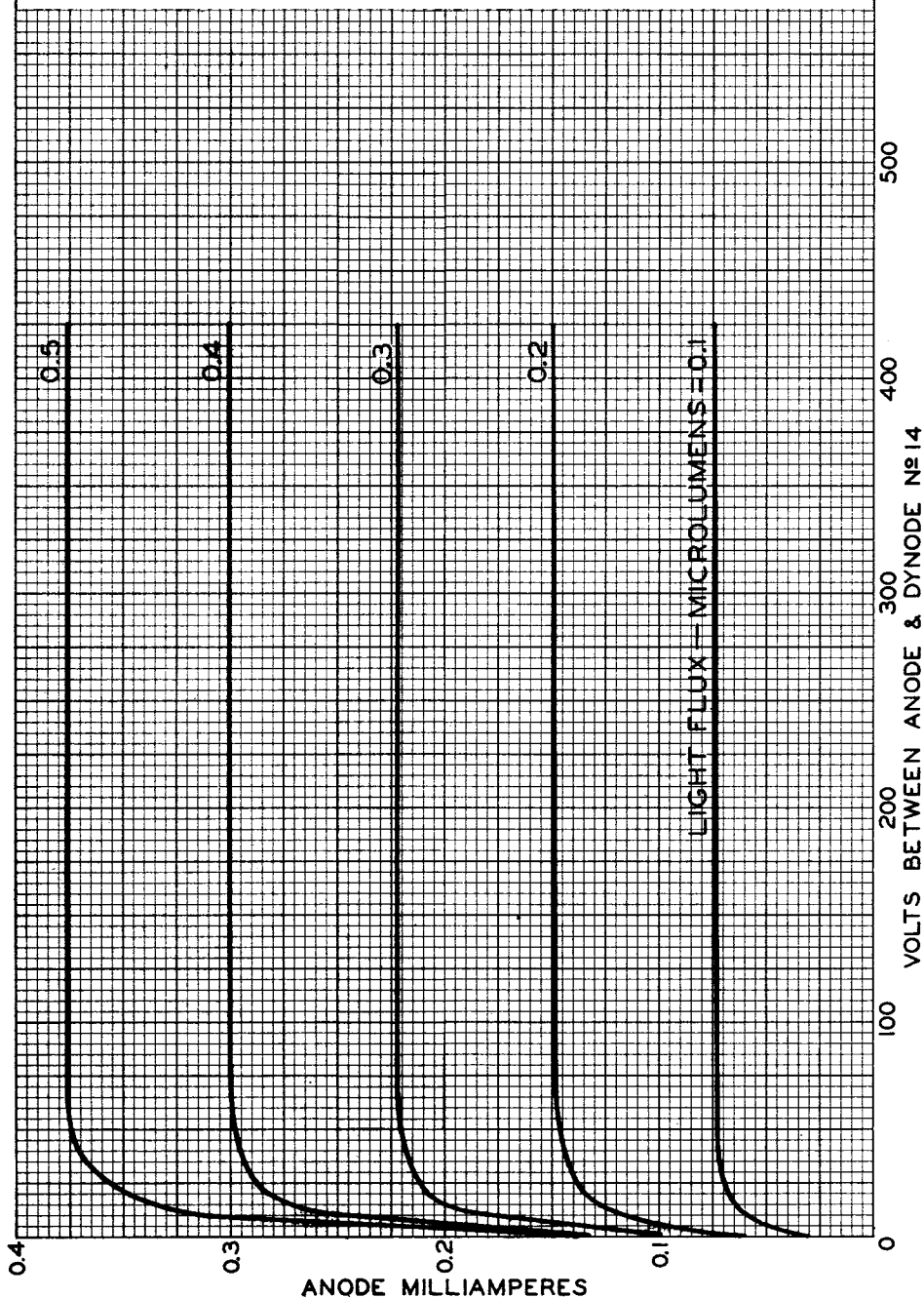
CATHODE-TO-GRID-N₂1 VOLTS = 108GRID-N₂1-TO-DYNODE N₂1 (DY₁) VOLTS = 108

DY₁ - TO - DY₂
 DY₂ - TO - DY₃
 ETC. TO
 DY₁₀ - TO - DY₁₁

VOLTS = 108

DY₁₁ - TO - DY₁₂ VOLTS = 135DY₁₂ - TO - DY₁₃ VOLTS = 160DY₁₃ - TO - DY₁₄ VOLTS = 189GRID-N₂2 VOLTS ADJUSTED TO
GIVE MAX. GAIN

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



ANODE MILLIAMPERES

TUBE DIVISION

RADIO CORPORATION OF AMERICA, HARRISON, NEW JERSEY

92CM-8846



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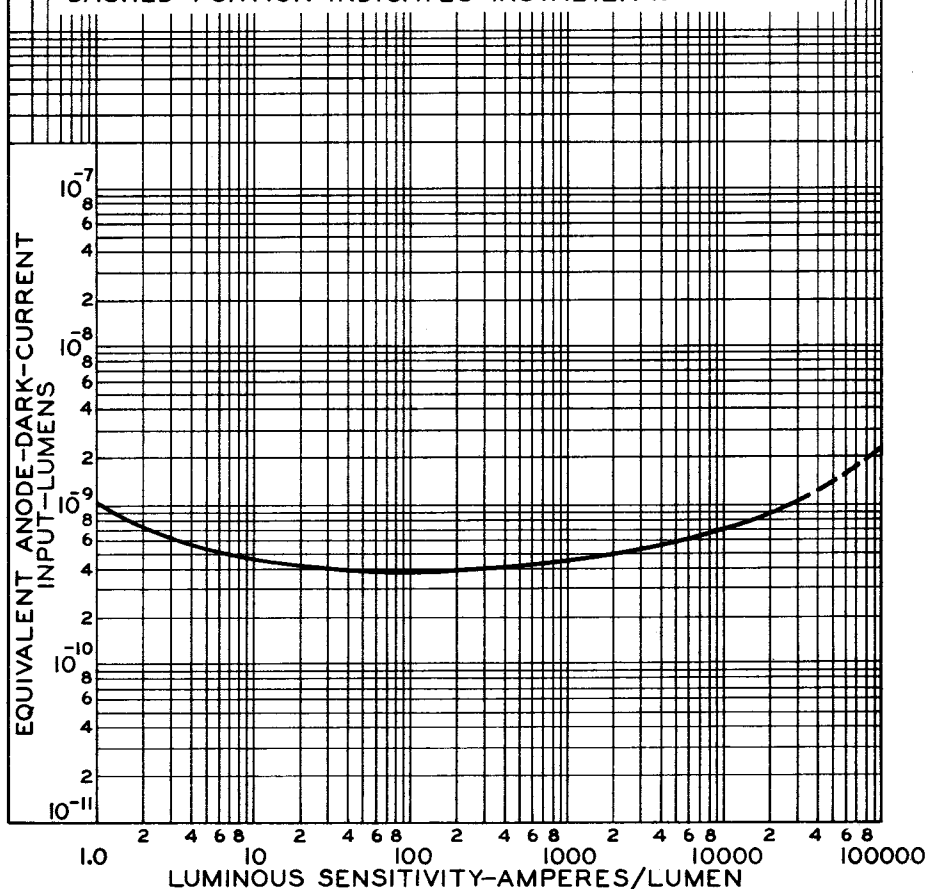
6810

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	5.4% OF E MULTIPLIED BY
CATHODE & GRID N ^o 1	
GRID N ^o 1 & DYNODE N ^o 1 (DY ₁)	
DY ₁ & DY ₂	
DY ₂ & DY ₃	
DY ₃ & DY ₄	
DY ₄ & DY ₅	
DY ₅ & DY ₆	
DY ₆ & DY ₇	
DY ₇ & DY ₈	
DY ₈ & DY ₉	
DY ₉ & DY ₁₀	
DY ₁₀ & DY ₁₁	
DY ₁₁ & DY ₁₂	1.25
DY ₁₂ & DY ₁₃	1.50
DY ₁₃ & DY ₁₄	1.75
DY ₁₄ & ANODE	2.
ANODE & CATHODE	18.5

GRID-N^o2 VOLTS ADJUSTED TO GIVE MAX. GAIN.
LIGHT SOURCE IS A TUNGSTEN-FILAMENT LAMP OPER-
ATED AT A COLOR TEMPERATURE OF 2870°K.
TUBE TEMPERATURE=25°C
DASHED PORTION INDICATES INSTABILITY.



TUBE DIVISION

92CM-8848

RADIO CORPORATION OF AMERICA, HARRISON, NEW JERSEY

6810



6810

CHARACTERISTICS

CATHODE-TO-GRID-N₂ VOLTS=108GRID-N₂-TO-DYNODE-N₂ (DY₁) VOLTS=108DY₁-TO-DY₂DY₂-TO-DY₃

ETC. TO

DY₁₀-TO-DY₁₁

VOLTS=108

DY₁₁-TO-DY₁₂ VOLTS=135DY₁₂-TO-DY₁₃ VOLTS=160DY₁₃-TO-DY₁₄ VOLTS=189DY₁₄-TO-ANODE VOLTS=216GRID-N₂ VOLTS ADJUSTED
TO GIVE MAX. GAIN