Photomultiplier Tube

10-STAGE, HEAD-ON, FLAT-FACEPLATE TYPE HAVING S-11 RESPONSE
1.24-INCH MINIMUM DIAMETER FLAT PHOTOCATHODE

For Detection and Measurement of Nuclear Radiation and Other
Low-Level Light Sources in Portable Scintillation Counters

GENERAL

Spectral Response ........................................ S-11
Wavelength of Maximum Response ........ 4400 ± 500 angstroms
Cathode, Semitransparent ................ Cs-Sb
Shape ........................................ Flat, Circular
Minimum area ........................................ 1.2 sq in
Minimum diameter .................................... 1.24 in
Window ............................................... Lime Glass, Corning® No.0080, or equivalent
Shape ............................................... Plano-Plano
Index of refraction at 5893 angstroms .... 1.51

Dynodes

Substrate ............................................... Ni
Secondary-emitting surface ................. Cs-Sb
Structure ............................................. Circular-Cage

Direct Inter electrode Capacitances (Approx.)

Anode to dynode No.10 ......................... 4.0 pF
Anode to all other electrodes ............... 7.0 pF
Maximum Overall Length ....................... 4.57 in
Seated Length ....................................... 3.88 ± 0.19 in
Maximum Diameter .................................. 1.56 in
Operating Position .................................. Any
Weight (Approx.) ..................................... 2.2 oz
Envelope ............................................. JEDEC T12
Base .................................................. Small-Shell Duodecal 12-Pin, (JEDEC No.B12-43),
Non-hygrosopic
Socket ............................................... Eby® No.9058, or equivalent
Magnetic Shield .................................. Millen® Part No.80802C, or equivalent

TERMINAL DIAGRAM (Bottom View)

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

DY1
DY2
DY3
DY4
DY5
DY6
DY7
DY8
DY9
DY10
P

K

DIRECTION OF RADIATION:
INTO END OF BULB
12AE

Indicates a change.
ABSOLUTE-MAXIMUM RATINGS

DC Supply Voltage
- Between anode and cathode: 1250 V
- Between dynode No.10 and anode: 250 V
- Between consecutive dynodes: 200 V
- Between dynode No.1 and cathode: 300 V
- Average Anode Current: 0.75 mA
- Ambient Temperature: 75°C

CHARACTERISTICS RANGE VALUES

Under conditions with supply voltage (E) across 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.

With E = 1000 V (Except as noted)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensitivity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Radiant at 4400 angstroms</td>
<td>3.6x10^4</td>
<td></td>
<td>A/W</td>
</tr>
<tr>
<td>Cathode radiant at 4400 angstroms</td>
<td>0.036</td>
<td></td>
<td>A/W</td>
</tr>
<tr>
<td>Luminous</td>
<td>10</td>
<td>45</td>
<td>300 A/1m</td>
</tr>
<tr>
<td>Cathode luminous: With tungsten light source</td>
<td>3x10^-5</td>
<td>4.5x10^-5</td>
<td>A/1m</td>
</tr>
<tr>
<td>With blue light source</td>
<td>2.8x10^-8</td>
<td></td>
<td>A</td>
</tr>
<tr>
<td>Quantum Efficiency at 4200 angstroms</td>
<td>10</td>
<td></td>
<td>A/1m</td>
</tr>
<tr>
<td>Current Amplification</td>
<td>1x10^6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equivalent Anode-Dark-Current Input</td>
<td>2.3x10^-10</td>
<td>2.5x10^-9</td>
<td>1m</td>
</tr>
<tr>
<td>Anode Dark Current</td>
<td>2.8x10^-13</td>
<td>3.1x10^-12</td>
<td>W</td>
</tr>
<tr>
<td>Dark Current to Any Electrode Except Anode (at 22°C)</td>
<td>4.5x10^-9</td>
<td></td>
<td>A</td>
</tr>
<tr>
<td>Equivalent Noise Input</td>
<td>5x10^-15</td>
<td>2.1x10^-14</td>
<td>W</td>
</tr>
<tr>
<td>Anode-Pulse Rise Time</td>
<td>2.8x10^-9</td>
<td></td>
<td>s</td>
</tr>
<tr>
<td>Electron-Transit Time</td>
<td>3.3x10^-8</td>
<td></td>
<td>s</td>
</tr>
</tbody>
</table>

a Made by Corning Glass Works, Corning, New York.
b Made by Hugh H. Eby Company, 4701 Germantown Avenue, Philadelphia 44, Pennsylvania.
c Made by James Milken Manufacturing Company, 150 Exchange Street, Walden 48, Massachusetts.
d Averaged over any interval of 30 seconds maximum.
e Tube operation at room temperature or below is recommended.
f This value is calculated from the typical value for luminous sensitivity using a conversion factor of 804 lumens per watt.
g This value is calculated from the typical value for cathode luminous sensitivity using a conversion factor of 604 lumens per watt.

Indicates a change.

DATA 1
RADIO CORPORATION OF AMERICA
Electronic Components and Devices
Harrison, N. J.
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.

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 167 volts are applied between cathode and all other electrodes connected to anode.

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—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 167 volts are applied between cathode and all other electrodes connected as anode.

- Measured at a tube temperature of 22°C. Dark current may be reduced by use of a refrigerant.
- Measured with supply voltage (E) adjusted to give a luminous sensitivity of 20 amperes per lumen. Dark current is measured with no incident light on tube.
- At 4400 angstroms. This value is calculated from the rating in lumen using a conversion factor of 804 lumens per watt.
- Under the following conditions: Supply voltage (E) is as shown, 22°C tube temperature, 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.
- 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.

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.

**Typical Effect of Magnetic Field on Anode Current**

<table>
<thead>
<tr>
<th>MAGNETIC FIELD INTENSITY—GAUSS</th>
<th>RELATIVE ANODE CURRENT</th>
<th>VOLTS PER STAGE = 100</th>
</tr>
</thead>
<tbody>
<tr>
<td>-2</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>-1</td>
<td>8</td>
<td>1</td>
</tr>
<tr>
<td>0</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>1</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

**UNIFORM MAGNETIC FIELD IS PARALLEL TO DYNODE-CAGE AXIS. POSITIVE VALUES ARE FOR LINES OF FORCE FROM LEFT TO RIGHT WITH BASE DOWN AND BASE KEY TOWARD OBSERVER.**
TYPICAL VOLTAGE DIVIDER ARRANGEMENT

Note: Adjustable between approximately 500 and 1250 volts dc.

C1, C2: 0.01 \( \mu \)F, non-inductive type, 400 volts (dc working) — Values dependent on amplitude and duration of pulse.

R1: 91,000 ohms, 2 watts
R2 through R11: 47,000 ohms, 1 watt
DIMENSIONAL OUTLINE

PHOTOCATHODE DIAMETER
1.24 MIN.
(SEE NOTE)

FACEPLATE

1.56 MAX. DIA.

3.88 ± .19

4.57 MAX.

T12 BULB

BASE
JEDEC No. BI2-43

92CS-777OR5

DIMENSIONS IN INCHES

Note: Deviation from flatness within the 1.24-inch diameter area will not exceed 0.010 inch from peak to valley. 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 Sensitivity and Current Amplification Characteristics

Supply voltage (E) across 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.

Sensitivity—Amperes/lumen (color temp 2870° K)

Current amplification

Supply volts (E) between anode and cathode

92LM-1480

Data 3

Radio Corporation of America
Electronic Components and Devices
Harrison, N. J.
Typical Anode Characteristics

DIYNOE No.1-TO-CATHODE VOLTS = 167
EACH-SUCCEEDING-DIYNOE-STAGE VOLTS = 83
LIGHT SOURCE IS A TUNGSTEN-FILAMENT LAMP OPERATED
AT COLOR TEMPERATURE OF 2870° K.

VOLTS BETWEEN ANODE AND DIYNOE No.10

ANODE CURRENT—MILLIAMPERES

RADIO CORPORATION OF AMERICA
Electronic Components and Devices
Harrison, N. J.

DATA 4
10-66
Typical Dark Current and EADCI Characteristics

LUMINOUS SENSITIVITY IS VARIED BY ADJUSTING THE SUPPLY VOLTAGE (E) ACROSS VOLTAGE DIVIDER WHICH PROVIDES 1/6 OF E BETWEEN CATHODE AND DYNOYE No.1; 1/12 OF E FOR EACH SUCCEEDING DYNOYE STAGE; AND 1/2 OF E BETWEEN DYNOYE No.10 AND ANODE.

TUBE TEMPERATURE = 22°C
LIGHT SOURCE IS A TUNGSTEN-FILAMENT LAMP OPERATED AT A COLOR TEMPERATURE OF 2870° K.

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DATA 4
RADIO CORPORATION OF AMERICA
Electronic Components and Devices
Harrison, N. J.
Typical Time-Resolution Characteristics

Supply voltage (E) across 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. Photocathode is fully illuminated.

Typical ENI Characteristics

Dynode No. 1 - to - cathode volts = 167
Each succeeding - dynode - stage volts = 83
Bandwidth = 1 Hz
Light source: Tungsten at 2870° K interrupted at 90 Hz to produce pulses alternating between zero and flux value shown for any given tube temperature: "ON" period of pulse equal to "OFF" period: RMS signal current = RMS noise current.
External shield volts relative to anode volts = -1000
Spectral Energy Distribution of 2870°K Light Source After Passing Through Blue Filter

<table>
<thead>
<tr>
<th>RELATIVE ENERGY DISTRIBUTION</th>
<th>WAVELENGTH—ANGSTROMS</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>3000</td>
</tr>
<tr>
<td>2</td>
<td>3500</td>
</tr>
<tr>
<td>10</td>
<td>4000</td>
</tr>
<tr>
<td>10</td>
<td>4500</td>
</tr>
<tr>
<td>1</td>
<td>5000</td>
</tr>
</tbody>
</table>

SPECTRAL CHARACTERISTIC OF LIGHT FROM 2870°K SOURCE AFTER PASSING THROUGH BLUE FILTER (CORNING C.S. No.5—58 POLISHED TO 1/2 STOCK THICKNESS). MAXIMUM FILTER TRANSMISSION OCCURS AT 4300 ANGSTROMS AND IS 60 PER CENT.