Photomultiplier Tube
10-Stage, Head-On Type Having S-1
Spectral Response

For the detection and measurement of low-level radiation extending from the visible to near-infrared region of the spectrum.

GENERAL
Spectral Response ................................................. S-1
Wavelength of Maximum Response .................. 8000 ± 1000 Å
Cathode, Semitransparent ................ Silver-Oxygen-Cesium
  Minimum area ........................................... 1.2 in² (7.7 cm²)
  Minimum diameter ...................................... 1.24 in (3.1 cm)
Window ........................................ Lime Glass (Corning® No.0080) or equivalent
Shape .................................. Plano-Plano
Index of refraction at 5893 angstroms .................. 1.512

Dynodes:
  Substrate ........................................ Copper-Beryllium
  Secondary-Emitting Surface .................. Beryllium-Oxide
  Structure ................................ Circular-Cage, Electrostatic-Focus Type

Direct Interelectrode Capacitances (Approx.):
  Anode to dynode No.10 .................. 4 pF
  Anode to all other electrodes ................. 7 pF
Maximum Overall Length .................. 4.57 in (11.6 cm)
Seated Length ........................................... 3.88 in ± 0.19 in (9.8 ± 0.48 cm)
Maximum Diameter .................................. 1.56 in
Bulb ........................................ T12
Base ............................................... Small-Shell Duodecal 12-Pin (JEDEC B12-43), Non-hygroscopic

Socket ........................................ Eby® No.9058, or equivalent
Magnetic Shield .................................. Millen® No.80802C, or equivalent
Operating Position ................................. Any
Weight (Approx.) ................................... 2.2 oz (60 g)

MAXIMUM RATINGS, Absolute-Maximum Values

DC Supply Voltage:
  Between anode and cathode .................. 1500 max. V
  Between anode and dynode No.10 ............ 250 max. V
  Between consecutive dynodes ................. 200 max. V
  Between dynode No.1 and cathode .............. 400 max. V
Average Anode Current.................. 10 max. µA
Ambient Temperature .................. 75 max. °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 = 1250 volts (Except as noted)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Min.</th>
<th>Typical</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anode Sensitivity:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Radiant(^g) at 8000 angstroms</td>
<td>–</td>
<td>6.6x10(^2)</td>
<td>– A/W</td>
</tr>
<tr>
<td>Luminous(^h) (2870(^0) K)</td>
<td>1</td>
<td>7</td>
<td>30</td>
</tr>
<tr>
<td>Cathode Sensitivity:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Radiant(^i) at 8000 angstroms</td>
<td>–</td>
<td>2.8x10(^{-3})</td>
<td>– A/W</td>
</tr>
<tr>
<td>Luminous(^j) (2870(^0)K)</td>
<td>1x10(^{-5})</td>
<td>3x10(^{-5})</td>
<td>– A/Im</td>
</tr>
<tr>
<td>Current with infrared light source(^m) (2870(^0) K + C.S. No.7-56)</td>
<td>1.2x10(^{-8})</td>
<td>4x10(^{-8})</td>
<td>– A</td>
</tr>
<tr>
<td>Quantum Efficiency at 7800 angstroms</td>
<td>–</td>
<td>0.43</td>
<td>– %</td>
</tr>
<tr>
<td>Current Amplification</td>
<td>–</td>
<td>2.3x10(^5)</td>
<td>–</td>
</tr>
<tr>
<td>Anode Dark Current(^n)</td>
<td>–</td>
<td>1.9x10(^{-6})</td>
<td>6x10(^{-6})</td>
</tr>
<tr>
<td>Equivalent Anode Dark</td>
<td>–</td>
<td>4.8x10(^{-7})</td>
<td>1.5x10(^{-6})</td>
</tr>
<tr>
<td>Current Input(^o)</td>
<td>–</td>
<td>5.1x10(^{-9})</td>
<td>1.6x10(^{-8})</td>
</tr>
<tr>
<td>Equivalent Noise Input(^q)</td>
<td>–</td>
<td>1.6x10(^{-12})</td>
<td>–</td>
</tr>
<tr>
<td>Anode-Pulse Rise Time(^s) at 1500 V</td>
<td>–</td>
<td>2.2x10(^{-9})</td>
<td>– s</td>
</tr>
<tr>
<td>Electron Transit Time(^t) at 1500 V</td>
<td>–</td>
<td>2.8x10(^{-8})</td>
<td>– s</td>
</tr>
</tbody>
</table>

\(^a\) Made by Corning Glass Works, Corning, NY 14830.
\(^b\) Made by Hugh H. Eby Company, 4701 Germantown Avenue, Philadelphia, PA 19144.
\(^c\) Made by James Millen Manufacturing Company, 150 Exchange Street, Malden, MA 02148.
\(^e\) Averaged over any interval of 30 seconds maximum. When stability of operation is important, the use of an average anode current well below the maximum rated value of 10 microamperes is recommended. This maximum rating should never be exceeded because operation at higher average output currents may cause a permanent decrease in infrared sensitivity and a consequent decrease in the tube life.
\(^f\) Tube operation at room temperature or below is recommended.

Indicates a change or addition.
This value is calculated from the typical anode luminous sensitivity rating using a conversion factor of 94 lumens per watt.

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 $2870^\circ$ K and a light input of 10 micro-lumens is used.

This value is calculated from the typical cathode luminous sensitivity rating using a conversion factor of 94 lumens per watt.

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 $2870^\circ$ K. The value of light flux is 0.01 lumen and 250 volts are applied between cathode and all other electrodes connected as anode.

Under the following conditions: Light incident on the cathode is transmitted through an infrared filter (C.S. No.7-56, manufactured by Corning Glass Works, Corning, NY 14830) from a tungsten-filament lamp operated at a color temperature of $2870^\circ$ K. The value of light flux incident on the filter is 0.01 lumen, and 250 volts are applied between cathode and all other electrodes connected as anode.

At a tube temperature of $22^\circ$ C. With supply voltage adjusted to give a luminous sensitivity of 4 amperes per lumen. Dark current caused by thermionic emission may be reduced by use of a refrigerant.

At 8000 angstroms. These values are calculated from the EADC1 values in lumens using a conversion factor of 94 lumens per watt.

Under the following conditions: Tube temperature $22^\circ$ C, external shield connected to cathode, bandwidth 1 Hz, tungsten-light source at a color temperature of $2870^\circ$ 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.

At 8000 angstroms. This value is calculated from the EN1 value in lumens using a conversion factor of 94 lumens per watt.

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 reached a specified intensity.
reaches peak amplitude. The transit time is measured under conditions with the incident light fully illuminating the photocathode.

TERMINAL CONNECTIONS

The base pins of the 7102 fit a duodecal 12-contact socket, such as Eby No.9058, or equivalent. The basing arrangement is such that the voltage between anode pin and adjacent pins is not more than twice the voltage per stage. As a result, external leakage between anode pin and adjacent pins is kept low.

ANODE CURRENT

The operating stability of the 7102 is dependent on the magnitude of the anode current. The use of an average anode current well below the maximum rated value of 10 microamperes is recommended when stability of operation is important. This maximum rating should never be exceeded because operation at higher average output currents may cause a permanent decrease in infrared sensitivity and a consequent decrease in the tube life.

SHIELDING

Electrostatic and/or magnetic shielding of the 7102 may be necessary.

SCHEMATIC ARRANGEMENT OF STRUCTURE
TYPICAL VOLTAGE-DIVIDER ARRANGEMENT

C₁: 0.02 μF, 20%, 500 volts (dc working), ceramic disc
C₂: 0.01 μF, 20%, 500 volts (dc working), ceramic disc
R₁: 910,000 ohms, 2 watts
R₂ through R₁₁: 470,000 ohms, 1 watt

Note 1: Adjustable between approximately 500 and 1500 volts dc.

Note 2: Capacitors C₁ and C₂ should be connected at tube socket for optimum high-frequency performance.

Note 3: Component values are dependent upon nature of application and output signal desired.
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

DIRECTION OF RADIATION:
INTO END OF BULB
12AE

DIMENSIONAL OUTLINE

Note: Deviation from flatness will not exceed 0.010" from peak to valley.

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

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>Inches</th>
<th>mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>4.57 max.</td>
<td>116.1 max.</td>
</tr>
<tr>
<td>B</td>
<td>3.88 ± 0.19</td>
<td>98.5 ± 4.8</td>
</tr>
<tr>
<td>C</td>
<td>1.24 min. dia.</td>
<td>31.4 min. dia.</td>
</tr>
<tr>
<td>D</td>
<td>1.56 max. dia.</td>
<td>39.6 max. dia.</td>
</tr>
</tbody>
</table>
Typical Time Resolution Characteristics

<table>
<thead>
<tr>
<th>Supply Volts (E) Between Anode and Cathode</th>
<th>Transit Time</th>
<th>Rise Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>500</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>600</td>
<td>2 x 10^-6</td>
<td>2</td>
</tr>
<tr>
<td>700</td>
<td>4 x 10^-7</td>
<td>2 x 10^-6</td>
</tr>
<tr>
<td>800</td>
<td>6 x 10^-8</td>
<td>4 x 10^-7</td>
</tr>
<tr>
<td>900</td>
<td>8 x 10^-9</td>
<td>6 x 10^-8</td>
</tr>
<tr>
<td>1000</td>
<td>10^-9</td>
<td>8 x 10^-9</td>
</tr>
<tr>
<td>1100</td>
<td>2 x 10^-9</td>
<td>10^-9</td>
</tr>
<tr>
<td>1200</td>
<td>4 x 10^-10</td>
<td>2 x 10^-9</td>
</tr>
<tr>
<td>1300</td>
<td>6 x 10^-11</td>
<td>4 x 10^-10</td>
</tr>
<tr>
<td>1400</td>
<td>8 x 10^-12</td>
<td>6 x 10^-11</td>
</tr>
<tr>
<td>1500</td>
<td>10^-12</td>
<td>8 x 10^-12</td>
</tr>
</tbody>
</table>

Spectral Characteristic of Radiation from 2870°K Light Source After Passing Through Infrared Filter (Corning C.S. No. 7-56)
EQUIVALENT NOISE-INPUT CHARACTERISTICS

TYPICAL EFFECT OF MAGNETIC FIELD ON ANODE CURRENT

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.
VOLTS PER STAGE = 100
TYPICAL ANODE CHARACTERISTICS

DYNOE - No.1 - TO - CATHODE VOLTS = 208
EACH SUCCEEDING - DYNOE-STAGE VOLTS = 104
LIGHT SOURCE IS A TUNGSTEN-FILAMENT LAMP
OPERATED AT COLOR TEMPERATURE OF
2870° K.

VOLTS BETWEEN ANODE & DYNOE No. 10
150
100
50
0
250
200

LIGHT FLUX - MICROMENENS = 10

ANODE MICROAMPERES
0 50 100 150 200

92CM - 9480R3

RCA
Electronic Components
DATA 5
11-69
SENSITIVITY AND CURRENT AMPLIFICATION CHARACTERISTICS

DYNOE No.1—TO—CATHODE VOLTS = 1/6 E
EACH SUCCEEDING DYNOE—STAGE VOLTS = 1/12
ANODE—TO—DYNOE No. 10 VOLTS = 1/12 E

SENSITIVITY — AMPERES/LUMEN (COLOR TEMPERATURE 2870° K)

TYPICAL SENSITIVITY
TYPICAL AMPLIFICATION
MINIMUM SENSITIVITY
MAXIMUM SENSITIVITY

CURRENT AMPLIFICATION

SUPPLY VOLTS (E) BETWEEN ANODE AND CATHODE

92CM-12477R3
The dashed portion shown in the above curve of the spectral response is not controlled.
TYPICAL EADC1 AND ANODE DARK CURRENT CHARACTERISTICS

LUMINOUS SENSITIVITY IS VARIED BY ADJUSTMENT OF THE SUPPLY VOLTAGE (E).
DYNODE NO. 1 TO CATHODE VOLTS = 1/6 E
EACH SUCCEEDING DYNODE-STAGE VOLTS = 1/12 E
ANODE-TO-DYNODE NO. 10 VOLTS = 1/12 E
LIGHT SOURCE IS A TUNGSTEN-FILAMENT LAMP OPERATED AT A COLOR TEMPERATURE OF 2870°K.
TUBE TEMPERATURE = 22°C.