Photomultiplier Tube

RADIO CORPORATION OF AMERICA

[Diagram showing pin connections and specifications]

14-Stage, 1-in., Flattop Faceplate Type Tube

- Spectral Response
- Cathode, Semitransparent
- Shape: Circular, minimum area
- Minimum diameter: 2.2 sq. in.
- Window: Corning No. 0080, or equivalent
- Index of refraction: 1.03
- Direct Interelectrode Capacitances:
  - Anode to dynode No. 1: 110.14 ± 2.8 pf
  - Anode to all other electrodes: 6.0 pf
- Maximum Overall Length: 7.5 in.
- Seated length: 6.69 ± 0.19 in.
- Maximum Diameter: 2.38 in.
- Operating Position: Any
- Weight (Approx.): 8 oz.
- Envelope: JEDEC TB-16

TERMINAL DIAGRAM (Bottom View)

Pin 1 - No Connection
Pin 2 - Cathode No. 1
Pin 3 - Dynode No. 3
Pin 4 - Dynode No. 5
Pin 5 - Dynode No. 6
Pin 6 - Dynode No. 7
Pin 7 - Dynode No. 9
Pin 8 - Dynode No. 11
Pin 9 - Dynode No. 12
Pin 10 - Dynode No. 14
Pin 11 - Dynode No. 16
Pin 12 - Photocathode Metal Contact II
VERY-LOW-LIGHT-LEVEL, LOW-NOISE, HIGH-GAIN SERVICE

Absolute-Maximum Ratings

Under conditions with dc supply voltage (E) across a voltage divider providing electrode voltages shown in Table 1 - Column A. The focusing-electrode and accelerating-electrode voltages are adjusted to these values which provide maximum anode current.

DC Supply Voltage
Between Anode and Cathode, 2400 V
Between Dynode No.1 and Anode 400 V
Between Consecutive Dynodes 500 V
Between Dynode No.1 and Cathode 400 V
Between Focusing Electrode and Cathode 400 V
Between Accelerating Electrode and Dynode No.13 1500 V
Average Anode Current 2 mA
Ambient Temperature 75 °C

Characteristics Range Values

With E = 2000 V (except as noted)

<table>
<thead>
<tr>
<th>Sensitivity</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radiant at 4000 angstroms</td>
<td>2.4 x 10^-5</td>
<td>A/m</td>
<td></td>
</tr>
<tr>
<td>Cathode radiant at 4000 angstroms</td>
<td>0.056</td>
<td>A/m</td>
<td></td>
</tr>
<tr>
<td>Luminous: At D c/s</td>
<td>400</td>
<td>3050</td>
<td>2 x 10^-6</td>
</tr>
<tr>
<td>With dynode No.14 as output electrode</td>
<td>2.1 x 10^-5</td>
<td>A/Im</td>
<td></td>
</tr>
<tr>
<td>Cathode luminous: With tungsten light source</td>
<td>5 x 10^-6</td>
<td>7 x 10^-6</td>
<td>A/Im</td>
</tr>
<tr>
<td>With blue light source</td>
<td>5 x 10^-6</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>Current Amplification: Equivalent Anode-Dark-Current Input:</td>
<td>4 x 10^-7</td>
<td>Im</td>
<td></td>
</tr>
<tr>
<td>At luminous sensitivity of 2000 A/Im</td>
<td>5 x 10^-10</td>
<td>1.5 x 10^-9</td>
<td>Im</td>
</tr>
</tbody>
</table>

Equivalent Noise Input: 3.3 x 10^-12 1.5 x 10^-11 Im

Greatest Delay Between Anode Pulses: Due to position from which electrons are simultaneously released within a circle centered on tube face having:
Diameter of 1.12 in. 1 x 10^-4 s
Diameter of 1.26 in. 3 x 10^-3 s

HIGH-OUTPUT-PULSE SERVICE

Absolute-Maximum Ratings

Under conditions with dc supply voltage (E) across a voltage divider providing electrode voltages shown in Table 1 - Column B. The focusing-electrode and accelerating-electrode voltages are adjusted to these values which provide maximum anode current.

DC Supply Voltage
Between Anode and Cathode 2600 V

RADIO CORPORATION OF AMERICA
Electronic Components and Devices
DC Supply Voltage (Cont'd)
- Between Dynode No. 14 and Anode: 400 V
- Between Consecutive Dynodes: 500 V
- Between Dynode No. 1 and Cathode: 400 V
- Between Focusing Electrode and Cathode: 400 V
- Between Accelerating Electrode and Dynode No. 13: 1500 V

Average Anode Current: 2 nA
Ambient Temperature: 75 °C

Characteristics Range Values

<table>
<thead>
<tr>
<th></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>-</td>
<td>2.1x10^6</td>
<td>-</td>
</tr>
<tr>
<td>Cathode radiant at 4400 angstroms</td>
<td>-</td>
<td>0.056</td>
<td>-</td>
</tr>
<tr>
<td>Luminous:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>At c/s^2</td>
<td>3050</td>
<td>-</td>
<td>-1m</td>
</tr>
<tr>
<td>With dynode No. 14 as output electrode</td>
<td>-</td>
<td>2.1x10^3</td>
<td>-</td>
</tr>
<tr>
<td>Cathode luminous:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>With tungsten light source</td>
<td>5x10^-5</td>
<td>7x10^-5</td>
<td>-</td>
</tr>
<tr>
<td>With blue light source</td>
<td>5x10^-8</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Current Amplification</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>4.9x10^7</td>
<td>-</td>
</tr>
<tr>
<td>Equivalent Anode-Dark-Current Input</td>
<td>1.1x10^-9</td>
<td>-1m</td>
<td>-</td>
</tr>
<tr>
<td>At luminous sensitivity of 2000 A/m^2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equivalent Noise Input (A)</td>
<td>4.6x10^-12</td>
<td>-1m</td>
<td>-</td>
</tr>
</tbody>
</table>

- Made by Corning Glass Works, Corning, New York.
- Made by Cineh Manufacturing Co., Inc., 1026 South 110th Street, Chicago 21, Illinois.
- Made by James Millen Manufacturing Co., 150 Exchange Street, Malden 18, Massachusetts.
- Averaged over any interval of 30 seconds maximum.
- Under the following conditions: The light source is a tungsten-filament lamp having a fine-glass envelope. It is operated at a color temperature of 2950 K and a light output of 0.1 microlumens is used.
- 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 element and the dynode serves only as a collector. The curves shown under Typical Characteristics do not apply when dynode No. 14 is used as the output electrode.
- Under the following conditions: The light source is a tungsten-filament lamp having a fine-glass envelope. It is operated at a color temperature of 2950 K. The value of light flux 1.0x10^-6 fume 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 C.S. No. 8-20, Glass Code No. 3113 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 2950 K. The value of light flux incident on the filter is 1.0x10^-6 fume and 200 volts are applied between cathode and all other electrodes connected as anode.
- At a tube temperature of 25 °C. Dark current may be reduced by use of a refrigerant.
- For maximum signal-to-noise ratio, operation with a supply voltage (E) before 2000 volts is recommended.

6810A
RADIO CORPORATION OF AMERICA
Electronic Components and Devices
Harrison, N.J.
OPERATING CONSIDERATIONS

An increase in current amplification may be obtained under conditions with a dc supply voltage (E) across a voltage divider providing 1/8 of E between cathode and dynode No. 1, 1/16 of E for each succeeding dynode stage, and 1/16 of E between dynode No. 16 and anode.

TABLE I

<table>
<thead>
<tr>
<th>Voltage to Be Provided by Divider</th>
<th>Column A</th>
<th>Column B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cathode and Focusing Electrode</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cathode and Dynode No. 1</td>
<td>5.4% of Supply Voltage (E) multiplied by</td>
<td>2.75% of Supply Voltage (E) multiplied by</td>
</tr>
<tr>
<td>Focusing Electrode and Dynode No. 1</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Dynode No. 1 and Dynode No. 2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Dynode No. 2 and Dynode No. 3</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Dynode No. 3 and Dynode No. 4</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Dynode No. 4 and Dynode No. 5</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Dynode No. 5 and Dynode No. 6</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Dynode No. 6 and Dynode No. 7</td>
<td>1</td>
<td>1.2</td>
</tr>
<tr>
<td>Dynode No. 7 and Dynode No. 8</td>
<td>1</td>
<td>1.5</td>
</tr>
<tr>
<td>Dynode No. 8 and Dynode No. 9</td>
<td>1</td>
<td>1.9</td>
</tr>
<tr>
<td>Dynode No. 9 and Dynode No. 10</td>
<td>1</td>
<td>2.4</td>
</tr>
<tr>
<td>Dynode No. 10 and Dynode No. 11</td>
<td>1</td>
<td>3.0</td>
</tr>
<tr>
<td>Dynode No. 11 and Dynode No. 12</td>
<td>1.25</td>
<td>3.8</td>
</tr>
<tr>
<td>Dynode No. 12 and Dynode No. 13</td>
<td>1.5</td>
<td>4.8</td>
</tr>
<tr>
<td>Dynode No. 13 and Dynode No. 14</td>
<td>1.75</td>
<td>5.0</td>
</tr>
<tr>
<td>Dynode No. 14 and Anode</td>
<td>2</td>
<td>4.8</td>
</tr>
<tr>
<td>Anode and Cathode</td>
<td>16.5</td>
<td>36.4</td>
</tr>
</tbody>
</table>

These values also 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 area.

Under the following conditions: Supply voltage (E) is as shown, 25°C tube temperature, external shield connected to cathode, bandwidth 1 cycle per second, tungsten-tight source at a color temperature of 2800°C, dynode current, working point of the dynode stage, and the "off" period of the exciting, alternating between zero and the value stated. The "on" period of the exciting is equal to the "off" period.

Focusing-electrode voltage is adjusted to that value which provides maximum anode current.
Center line of bulb will not deviate more than 2° in any direction from the perpendicular erected at the center of bottom of base.

Note: Within 1.68" diameter, deviation from flatness of external surface of faceplate will not exceed 0.005" from peak to valley.
Typical Anode Characteristics

CATHODE - TO - DYMODE No. 1 VOLTS = 206
GRID No. 1 - TO - DYMODE No. 1 (D1) VOLTS ADJUSTED FOR MAX. GAIN
DY1 - TO - DY2
DY2 - TO - DG1
ETC. TO
DY6 - TO - D9
VOLTS = 108
DY6 - TO - D9 VOLTS = 160
GRID No. 2 VOLTS ADJUSTED TO GIVE MAX. ANODE CURRENT
LIGHT SOURCE IS A TUNGSTEN-FLAME LAMP OPERATED AT A COLOR TEMPERATURE OF 2870° K.
Typical Sensitivity and Current Amplification Characteristics

The supply voltage (E) across voltage divider which provides voltages as follows:

<table>
<thead>
<tr>
<th>BETWEEN</th>
<th>5.4% of E MULT. BY</th>
<th>BETWEEN</th>
<th>5.4% of E MULT. BY</th>
</tr>
</thead>
<tbody>
<tr>
<td>CATHODE &amp; GRID NY</td>
<td>DI, &amp; D12</td>
<td>D13 &amp; D14</td>
<td>1.25</td>
</tr>
<tr>
<td>GRID NY &amp; DUTURE NY</td>
<td>D13 &amp; D14</td>
<td>1.25</td>
<td></td>
</tr>
<tr>
<td>ETC. THRU D20 &amp; D71</td>
<td>D13 &amp; ANODE</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

Grid #2 volts adjusted to give maximum gain.

Sensitivity vs. Voltage (Supply) between Anode and Cathode.
### The Supply Voltage (E) Across Voltage Divider Which Provides Voltages As Follows:

<table>
<thead>
<tr>
<th>Between</th>
<th>0.75% of E, Multi. By</th>
<th>Between</th>
<th>2.75% of E, Multi. By</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cathode &amp; Grid N1</td>
<td>D16 &amp; D18</td>
<td>D16 &amp; D18</td>
<td>1.0</td>
</tr>
<tr>
<td>Grid N1 &amp; Dynode N1 (Dy)</td>
<td>D16 &amp; D18</td>
<td>D16 &amp; D18</td>
<td>3.4</td>
</tr>
<tr>
<td>Dy1 &amp; Dy2 Etc. Thru</td>
<td>D16 &amp; D18</td>
<td>D16 &amp; D18</td>
<td>3.0</td>
</tr>
<tr>
<td>Dy5 &amp; Dy6</td>
<td>D16 &amp; D18</td>
<td>D16 &amp; D18</td>
<td>4.0</td>
</tr>
<tr>
<td>Dy5 &amp; Dy6</td>
<td>D16 &amp; D18</td>
<td>D16 &amp; Anode</td>
<td>6.0</td>
</tr>
<tr>
<td>Dy5 &amp; Dy6</td>
<td>D16 &amp; Anode</td>
<td>D16 &amp; Anode</td>
<td>4.0</td>
</tr>
</tbody>
</table>

### Grid N2 Volts Adjusted To Give Max. Anode Current.

#### Sensitivity—Amperes/Lumen (Color Temp. 2850°K)

- **Sensitivity: Amperes/Lumen**
- **Current Amplification**

---

**Data 4**

RADIO CORPORATION OF AMERICA

Electronic Components and Devices

Harrison, N. J.
Typical Anode-Dark-Current Characteristic

Very low-light-level, low-noise, high-gain service

Luminous sensitivity is varied by adjustment of the supply voltage (E) across voltage divider which provides voltages as follows:

<table>
<thead>
<tr>
<th>Between</th>
<th>0.8% of E</th>
<th>Multiplied By</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cathode &amp; Grid 1</td>
<td>GRID N1 &amp; DYODE N1 (DY1)</td>
<td>2</td>
</tr>
<tr>
<td>Cathode &amp; Grid 2</td>
<td>DY1 &amp; DY2</td>
<td>1</td>
</tr>
<tr>
<td>Cathode &amp; Grid 3</td>
<td>DY2 &amp; DY3</td>
<td>1</td>
</tr>
<tr>
<td>Cathode &amp; Grid 4</td>
<td>DY3 &amp; DY4</td>
<td>1</td>
</tr>
<tr>
<td>Cathode &amp; Grid 5</td>
<td>DY4 &amp; DY5</td>
<td>1</td>
</tr>
<tr>
<td>Cathode &amp; Grid 6</td>
<td>DY5 &amp; DY6</td>
<td>1</td>
</tr>
<tr>
<td>Cathode &amp; Grid 7</td>
<td>DY6 &amp; DY7</td>
<td>1</td>
</tr>
<tr>
<td>Cathode &amp; Grid 8</td>
<td>DY7 &amp; DY8</td>
<td>1</td>
</tr>
<tr>
<td>Cathode &amp; Grid 9</td>
<td>DY8 &amp; DY9</td>
<td>1</td>
</tr>
<tr>
<td>Cathode &amp; Grid 10</td>
<td>DY9 &amp; DY10</td>
<td>1</td>
</tr>
<tr>
<td>Cathode &amp; Grid 11</td>
<td>DY11 &amp; DY12</td>
<td>1.2</td>
</tr>
<tr>
<td>Cathode &amp; Grid 12</td>
<td>DY12 &amp; DY13</td>
<td>1.3</td>
</tr>
<tr>
<td>Cathode &amp; Grid 13</td>
<td>DY13 &amp; DY14</td>
<td>1.7</td>
</tr>
<tr>
<td>Cathode &amp; Grid 14</td>
<td>DY14 &amp; Anode</td>
<td>2.0</td>
</tr>
<tr>
<td>Grid-Grid Volts, Adjusted to give max. anode current</td>
<td>0.5</td>
<td></td>
</tr>
</tbody>
</table>

Light source is a tungsten-filament lamp operated at a color temperature of 2800° K.
Tube temperature = 23° C
Dashed portion indicates instability.

Luminous sensitivity is measured in amperes per lumen.
LUMINOUS SENSITIVITY IS VARIED BY ADJUSTMENT OF
THE SUPPLY VOLTAGE (E) ACROSS VOLTAGE DIVIDER
WHICH PROVIDES VOLTAGES AS FOLLOWS:

<table>
<thead>
<tr>
<th>BETWEEN (V)</th>
<th>2.7% OF E</th>
<th>MULTIPLIED BY</th>
</tr>
</thead>
<tbody>
<tr>
<td>CATHODE &amp; GRID NR. 1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>GRID NR. 1 &amp; DYNOE NR. 1 (DY)</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>DY1 &amp; DY1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>DY1 &amp; DY2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>DY1 &amp; DY3</td>
<td>1.2</td>
<td>1.5</td>
</tr>
<tr>
<td>DY1 &amp; DY4</td>
<td>1.5</td>
<td>2.4</td>
</tr>
<tr>
<td>DY4 &amp; DY5</td>
<td>3.0</td>
<td>4.8</td>
</tr>
<tr>
<td>DY4 &amp; DY6</td>
<td>4.0</td>
<td>6.0</td>
</tr>
<tr>
<td>DY4 &amp; DY7</td>
<td>6.0</td>
<td>8.0</td>
</tr>
<tr>
<td>ANODE &amp; CATHODE</td>
<td>35.4</td>
<td></td>
</tr>
</tbody>
</table>

GRID NR. 2 VOLTS ADJUSTED TO GIVE MAX. ANODE CURRENT.
LIGHT SOURCE IS A TUNGSTEN-FILAMENT LAMP OPERATED
AT A COLOR TEMPERATURE OF 2870° K.
TUBE TEMPERATURE = 25°C.
DASHED PORTION INDICATES INSTABILITY.

LUMINOUS SENSITIVITY IS VARY BY ADJUSTMENT OF THE SUPPLY VOLTAGE (E) ACROSS VOLTAGE DIVIDER WHICH PROVIDES VOLTAGES AS FOLLOWS:
SPECTRAL-SENSITIVITY CHARACTERISTIC
OF PHOTOTUBE HAVING
S-5 RESPONSE

FOR EQUAL VALUES OF RADIANT FLUX AT ALL WAVELENGTHS

FOR VALUE OF RADIANT SENSITIVITY
AT 100-UNIT POINT, SEE DATA SHEET
FOR SPECIFIC TYPE.

RANGE OF MAXIMUM VALUE

RELATIVE SENSITIVITY

WAVELENGTH - ANGSTROMS

ULTRA VIOLET
VIOLET
BLUE
GREEN
YELLOW
RED
INFRARED

ELEKTRON TUBE DIVISION
92CM-6814R2
LAND CORPORATION OF AMERICA, MARIPOSA, NEW YORK
SPECTRAL-SENSITIVITY CHARACTERISTIC
OF PHOTOTUBE HAVING
S-5 RESPONSE
FOR EQUAL VALUES OF RADIANT FLUX AT ALL WAVELENGTHS

FOR VALUE OF RADIANT SENSITIVITY
AT 100-UNIT POINT, SEE DATA SHEET
FOR SPECIFIC TYPE.

RANGE OF
MAXIMUM VALUE

WAVELENGTH - ANGSTROMS
1000 3000 5000 7000 9000

RELATIVE SENSITIVITY
100
80
60
40
20
0

ULTRAVIOLET
BLUE
GREEN
YELLOW
RED
INFRARED

ELECTRON TUBE DIVISION
RCA CORPORATION OF AMERICA, HUDSON, NEW JERSEY
SPECTRAL-SENSITIVITY CHARACTERISTIC OF PHOTOTUBE HAVING S-II RESPONSE

FOR EQUAL VALUES OF RADIANT FLUX AT ALL WAVELENGTHS

- FOR VALUE OF RADIANT SENSITIVITY AT 100-UNIT POINT, SEE DATA SHEET FOR SPECIFIC TYPE.

- RANGE OF MAXIMUM VALUE


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WAVELENGTH (ANGSTROMS) vs. RELATIVE SENSITIVITY

- VIOLET
- BLUE
- GREEN
- YELLOW
- RED

ELECTRON TUBE DIVISION 96CM-850IR2
SPECTRAL-SENSITIVITY CHARACTERISTIC
OF PHOTOTUBE HAVING
S-II RESPONSE

FOR EQUAL VALUES OF RADIANT FLUX AT ALL WAVELENGTHS

FOR VALUE OF RADIANT SENSITIVITY AT 100-UNIT POINT, SEE DATA SHEET FOR SPECIFIC TYPE.

RANGE OF MAXIMUM VALUE
SPECTRAL-SENSITIVITY CHARACTERISTIC
OF PHOTOTUBE HAVING
S-II RESPONSE
FOR EQUAL VALUES OF RADIANT FLUX AT ALL WAVELENGTHS

FOR VALUE OF RADIANT SENSITIVITY
AT 100-UNIT POINT, SEE DATA SHEET
FOR SPECIFIC TYPE.
SPECTRAL SENSITIVITY CHARACTERISTIC
OF PHOTOTUBE HAVING
S-II RESPONSE

FOR EQUAL VALUES OF RADIANT FLUX AT ALL WAVELENGTHS

FOR VALUE OF RADIANT SENSITIVITY AT 100-UNIT POINT, SEE DATA SHEET FOR SPECIFIC TYPE.

RANGE OF MAXIMUM VALUE

RELATIVE SENSITIVITY

WAVELENGTH—ANGSTROMS

ULTRA-VIOLET
VIOLET
BLUE
GREEN
YELLOW
RED
NIR
IR

92CM-050IR2
ELECTRON TUBE DIVISION