TPD

Preliminary and Tentative Data

RCA Developmental Type, Dev. No. C7151C C7151D C7151E *

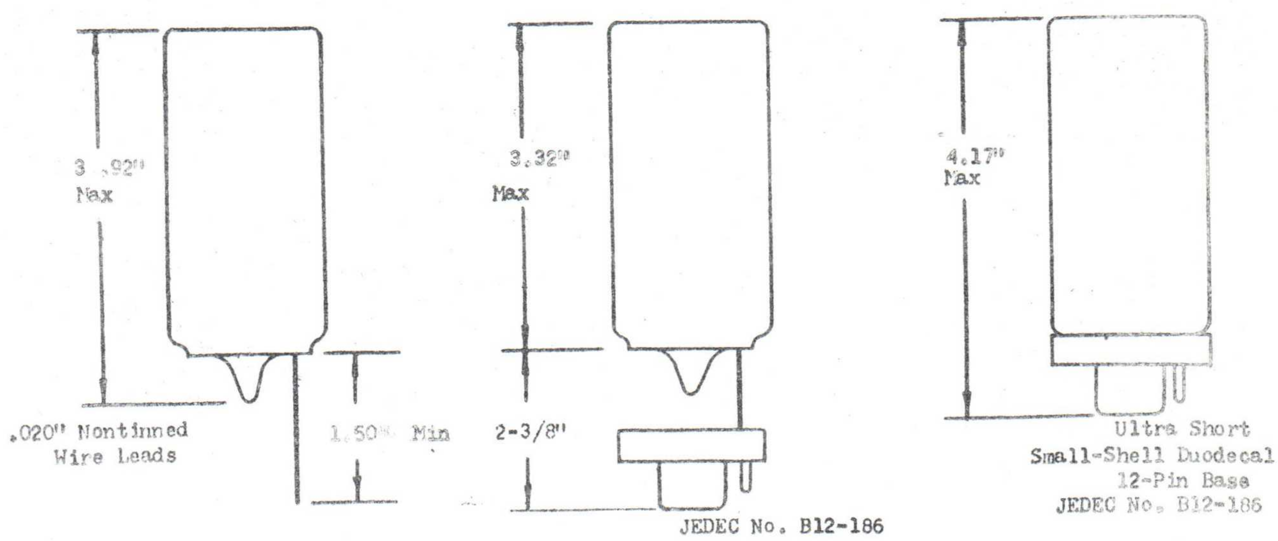
* The number identifies a particular laboratory tube design but the number and identifying data are subject to change. No obligations are assumed as to future manufacture unless otherwise arranged.
¢ Indicates a change. Place next to change item.

INDUSTRIAL TUBE PRODUCTS 10-STAGE, HEAD-ON TYPE MULTIPLIER PHOTOTUBE PHOTO

These tubes are primarily designed to withstand shock and vibration as encountered in rocketry and missile space probes.

These three tube types differ only in the base connections. The C7151C has semi-flexible leads; the C7151D has semi-flexible leads with a base attached to the ends of the leads for testing purposes, and the C7151E has a base cemented to the bulb.

DIMENSIONAL OUTLINES



Except as stated above, all data and information shown on attached 6199 bulletin applies to types C7151C, C7151D, and C7151E.

For further information or application assistance on this developmental type or other RCA tubes, please contact your field representative at the RCA District Office nearest you.

WHitehall 4-2900	HUmboldt 5-3900	RAymond 3-8361
Suite 1154 Merchandise Mart Plaza Chicago 54, Ill.	744 Broad St. Newark 2, N. J.	6355 E. Washington Blvd. Los Angeles 22, Calif.

RADIO CORPORATION OF AMERICA
ELECTRON TUBE DIVISION HARRISON, N. J.

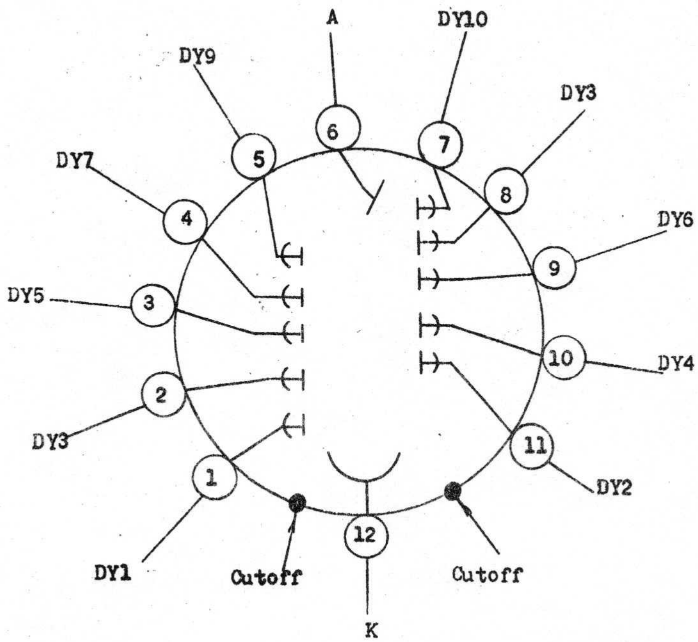
Date August 30, 1961
Supersedes 9-15-59 (GIVE DATE)

Preliminary and Tentative Data (Cont'd)

RCA Developmental Type, Dev. No. C7151C

LEAD DIAGRAM C-7151C

(For Types C-7151D and C-7151E use Base Diagram of 6199)



Lead 1 - Dynode #1	Lead 7 - Dynode #10
Lead 2 - Dynode #3	Lead 8 - Dynode #8
Lead 3 - Dynode #5	Lead 9 - Dynode #6
Lead 4 - Dynode #7	Lead 10 - Dynode #4
Lead 5 - Dynode #9	Lead 11 - Dynode #2
Lead 6 - Anode	Lead 12 - Cathode

Date August 30,1961

Supersedes

RCA

Developmental Type

Photomultiplier Tube

C31000D

Preliminary and Tentative Data

Improved Variant of Type 8575 Having Extremely High-Gain Gallium-Phosphide First Dynode.

RCA Developmental Type C31000D is a 12-stage head-on type of photomultiplier tube designed for low-light level measurement applications such as photon and low-energy scintillation counting. It features an extremely high-gain cesiated gallium-phosphide first dynode followed by high-stability copper-beryllium dynodes in the succeeding stages. It will also employ a high quantum efficiency bialkali photocathode deposited on a pyrex entrance window.

The first dynode of the C31000D provides up to an order of magnitude increase in secondary-emission ratio over conventional dynode materials. This high ratio provides a pulse height resolving capability that permits discrimination of single, double—up to seven or or more photoelectron events.

The extremely high secondary-emission ratio of the first dynode is instrumental in providing a decrease in noise induced in signal current by 18 per cent. Noise in signal due to the secondary-emission amplification mechanism of the first dynode is proportional to a factor M, where

$$M = \left[1 + \frac{B}{m-1}\right]^{1/2}$$

B = A statistical factor having a value of approximately 1.6

m = The secondary-emission ratio of the dynode, typically 5 for conventional dynode materials, 30 for gallium phosphide at 600 volts

These characteristics make the C31000D especially suited for the counting of radioactive materials releasing low-energy particles when used in conjunction with suitable scintillators.

Typical Photoelectron Pulse Height Spectrum

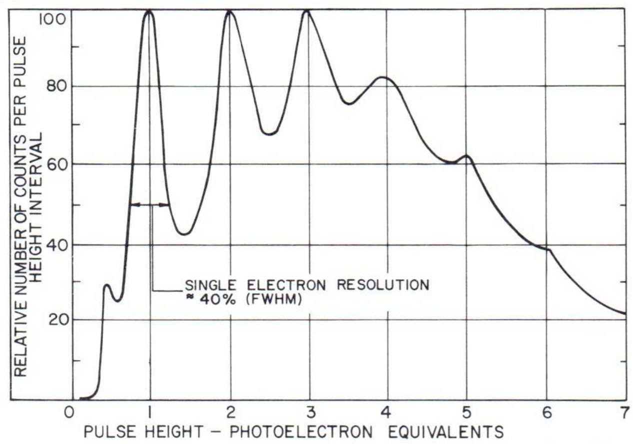


Figure 1

- **Extremely High Gain Gallium-Phosphide, GaP (Cs), First Dynode–**
  Secondary–Emission Ratio Typically 45 with 900 Volts Between Cathode and Dynode No.1
- **Extremely Low Dark Noise (Typical)**
  16 Photoelectrons
  Σ ≈ 150 Counts Per Second
  1/8 Photoelectron
- **An Order of Magnitude Improvement in Single Photoelectron Resolution**
  Typically ≈ 40% (FWHM)
- **Peak-to-Valley Ratio–**
  50 with Fe^{55} Source, Activity of 1 Microcurie and NaI (Tl) Scintillator
- **Bialkali Photocathode–**
  Quantum Efficiency, 31% Typical at 3850 Angstroms
- **Tube Envelope Material Selected for Low Residual Radioactivity**
- **Anode Transmission-Line Characteristic Impedance–50 Ohms**

For further information or application assistance on this device, contact your RCA Sales Representative or write Phototube Marketing, RCA Lancaster, PA 17604.

This developmental-type device or material is intended for engineering evaluation. The type designation and data are subject to change, unless otherwise arranged. No obligations are assumed for notice of change or future manufacture of this device or material.

RCA Electronic Components

Printed in U.S.A. | 10-68

Data

General:

Spectral Response	See **Figure 3**
Wavelength of Maximum Response	3850 ± 500 angstroms
Cathode, Semitransparent	Cesium-Potassium Antimonide (Bialkali)
Shape	Spherical Section
Minimum projected area	2.54 sq. in.
Minimum diameter	1.80 in.
Window	Pyrex, Corning[a] No.7740, or equivalent
Shape	Plano-Concave
Index of refraction at 5893 angstroms	1.47
Dynode No.1:	
Secondary Emitting Surface	Cesiated Gallium-Phosphide, GaP (Cs)
Dynode No.2 through 12:	
Secondary Emitting Surface	Beryllium-Oxide
Dynode Structure	In-Line Electrostatic Focus-Type
Direct Interelectrode Capacitances (Approx.):	
Anode to dynode No.12	5 pF
Anode to all other electrodes	6 pF
Maximum Overall Length	5.71 in
Seated Length	4.98 ± 0.08 in
Maximum Diameter	2.10 in
Bulb	T16
Base	See Base Drawing
Socket	RCA AJ2144[b] or AJ2145[b]
Magnetic Shield	See footnote (c)
Operating Position	Any
Weight (Approx.)	6 oz

Maximum and Minimum Ratings, *Absolute-Maximum Values:*[d]

DC Supply Voltage:

Between anode and cathode:

With Voltage Distribution A shown in Table I	3000 max.	V
	1300 min.	V
With Voltage Distribution B shown in Table I	3500 max.	V
	1800 min.	V
Between anode and dynode No.12	800 max.	V
Between dynode No.12 and dynode No.11	800 max.	V
Between consecutive dynodes	400 max.	V
Between dynode No.1 and cathode	1000 max.	V
	600 min.	V
Between focusing electrode and cathode	1000 max.	V
Average Anode Current[e]	0.2 max.	mA
Ambient-Temperature Range[f]	-100 to +85	°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, Column A.

With E = 2000 volts (Except as noted)

	Min.	Typical	Max.	
Anode Sensitivity:				
Radiant[g] at 3850 angstroms	–	9.7×10^5	–	A/W
Luminous[h] (2870° K)	–	8.5×10^2	–	A/lm
Current with Blue Light Source[i] (2870° K + C.S. No.5-58)	–	1.1×10^{-5}	–	A
Cathode Sensitivity:				
Radiant[k] at 3850 angstroms	–	0.097	–	A/W
Luminous (2870° K)[m]	–	8.5×10^{-5}	–	A/lm
Current with blue light source[n] (2870° K + C.S. No.5-58)	1×10^{-9}	1.1×10^{-9}	–	A
Quantum Efficiency at 3850 angstroms[p]	28	31	–	%
Current Amplification	–	1×10^7	–	
Anode Dark Current[q]	–	4×10^{-10}	3×10^{-9}	A
Equivalent-Anode-Dark-Current Input[q]	–	2×10^{-12}	1.5×10^{-11}	lm
	–	1.8×10^{-15}[r]	1.3×10^{-14}[r]	W
Single Photo-electron Pulse Height Resolution at Full-Width-Half-Maximum Point[s]	–	40	–	%
Peak-to-Valley Ratio of Pulse Height Spectrum with Fe^{55} Source[t]	–	50	–	
Dark Pulse Spectrum[u]		See **Figure 5**		
Pulse Height Resolution[v]	–	7.5	8.0	%

The following characteristics were measured with an anode-to-cathode voltage distribution of 4, 1, 1.4, 1, 1, 1, 1, 1, 1, 1, 1, 1, and 1. They are included for guidance purposes only.

With E = 1100 volts (Except as noted)

	Min.	Typical	Max.	
Pulse Height[v,w]	–	0.15	–	V
Mean Gain Deviation:[x]				
With count rate change of 1000 to 10000 cps[y]	–	1	–	%
For a period of 16 hours at a count rate of 1000 cps[z]	–	1	–	%

Anode-Pulse Rise Time[aa] at 3000 Volts	–	2.1×10^{-9}	–	s
Electron Transit Time[bb] at 3000 Volts.	–	3.1×10^{-8}	–	s

The following characteristics were measured with anode-to-cathode voltage distribution of 4, 1, 1.4, 1, 1, 1, 1, 1, 1.5, 2, 4, and 2. They are included for guidance purposes only.

With E = 3000 volts (Except as noted)

Pulse Current:				
Linear[cc].	–	0.25	–	A
Saturated[dd]. . . .	–	0.75	–	A

Table I

Voltage Distribution

Between the following Electrodes: Cathode (K), Dynode (Dy), and Anode (P)	Column A 8.06% of Dyl-P Voltage (E) Multiplied By:	Column B* 5.45% of K-P Voltage (E) Multiplied By:
K - Dy1	♦	6
Dy1 - Dy2	1	1
Dy2 - Dy3	1.4	1.4
Dy3 - Dy4	1	1
Dy4 - Dy5	1	1
Dy5 - Dy6	1	1
Dy6 - Dy7	1	1
Dy7 - Dy8	1	1
Dy8 - Dy9	1	1
Dy9 - Dy10	1	1
Dy10 - Dy11	1	1
Dy11 - Dy12	1	1
Dy12 - P	1	1
Dy1 - P	12.4	–
K - P	–	18.4

Focusing Electrode is connected to arm of potentiometer between cathode and dynode No.1. The focusing-electrode voltage is varied to give maximum anode current. Multiplier shield is operated at Dynode-No.5 potential.

♦ Cathode-to-Dynode-No.1 Voltage maintained at 660 volts.

* To take full advantage of the operating capabilities of the C31000D, it is required that the cathode-to-dynode No.1 voltage be a minimum of 600 volts.

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[a] Made by Corning Glass Works, Corning, NY 14830.

[b] The AJ2145 is designed specifically for chassis mounting. The AJ2144 is designed for use in any desired mounting arrangement. It is supplied with an unattached clamp ring which fits to either the top or bottom of its socket body to permit chassis mounting. The ring is not normally required for other mounting arrangements and can be discarded to make such arrangements more compact.

[c] Magnetic shielding material in the form of foil or tape as available from the Magnetic Shield Division, Perfection Mica Company, 1322 North Elston Avenue, Chicago, IL, 60622, or equivalent.

[d] The maximum ratings in the tabulated data are established in accordance with the following definition of the Absolute-Maximum Rating System for rating electron devices.

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron device of a specified type as defined by its published data, and should not be exceeded under the worst probable conditions.

The device manufacturer chooses these values to provide acceptable serviceability of the device, taking no responsibility for equipment variations, environment variations, and the effects of changes in operating conditions due to variations in device characteristics.

The equipment manufacturer should design so that initially and throughout life no Absolute-Maximum value for the intended service is exceeded with any device under the worst probable operating conditions with respect to supply voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in device characteristics.

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

[f] Tube operation at room temperature or below is recommended.

[g] This value is calculated from the typical anode luminous sensitivity rating using a conversion factor of 1140 lumens per watt.

[h] These values are calculated as shown below:

$$\text{Luminous Sensitivity (A/lm)} = \frac{\text{Anode Current (with blue light source) (A)}}{0.13 \times \text{Light Flux of } 1 \times 10^{-7} \text{ (lm)}}$$

The value of 0.13 is the average value of the ratio of the anode current measured under the conditions specified in footnote (i) to the anode current measured under the same conditions but with the blue filter removed.

[i] Under the following conditions: Light incident on the cathode is transmitted through a blue filter (Corning C.S. No.5-58, polished to 1/2 stock thickness—Manufactured by the Corning Glass Works, Corning, NY 14830) from a tungsten-filament lamp operated at a color temperature of 2870° K. The value of light flux incident on the filter is 1×10^{-7} lumen.

[k] This value is calculated from the typical cathode luminous sensitivity rating using a conversion factor of 1140 lumens per watt.

[m] These values are calculated as shown below:

$$\text{Cathode Luminous Sensitivity (A/lm)} = \frac{\text{Cathode Current (with blue light source) (A)}}{0.13 \times \text{Light Flux of } 1 \times 10^{-4} \text{ (lm)}}$$

The value of 0.13 is an average value. It is the ratio of the cathode current measured under the conditions specified in footnote (n) to the cathode current measured under the same conditions but with the blue filter removed.

n Light incident on the cathode is transmitted through a blue filter (Corning C.S. No.5-58, polished to 1/2 stock thickness) from a tungsten-filament lamp operated at a color temperature of 2870° K. The value of light flux incident on the filter is 100 microlumens and 660 volts are applied between cathode and all other electrodes connected as anode.

p Calculated from the cathode current measured with blue light source.

q At a tube temperature of 22° C. Light incident on the cathode is transmitted through a blue filter (Corning C.S. No.5-58, polished to 1/2 stock thickness). The light flux incident on the filter is 0.1 microlumen. The supply voltage E is adjusted to obtain an anode current of 2.6 microamperes. Luminous sensitivity of the tube under these conditions is approximately equivalent to 200 amperes per lumen. Dark current is measured with incident light removed.

r At 3850 angstroms. This value is calculated from the ENI value in lumens using a conversion factor of 1140 lumens per watt.

s Measured under the following conditions: The light source is a gallium-phosphide light-emitting diode having peak output at a wavelength of approximately 5600 angstroms. The diode is pulsed at a rate of 30,000 pps; pulse duration is approximately 0.4 µs; anode circuit integrating time is approximately 10 µs. The light intensity from the diode is adjusted to obtain greater or fewer registered counts in a given multielectron peak to obtain an approximately equal number of counts in the first, second, and third photoelectron peaks. A Multichannel Pulse-Height Analyzer having 256 channels is employed. Single electron resolution in per cent is defined as 100 times the ratio of the width of the single photoelectron peak at half the maximum count rate to the pulse height at maximum count rate.

t Measured using a Harshaw Type HG 0.005" beryllium window NaI (Tl) scintillator, 0.04" thick and 7/8" in diameter and an isotope of iron having an atomic mass of 55 (Fe^{55}) and an effective activity at the scintillator of one microcurie.

u Measured under the following conditions: The light source is a tungsten-filament lamp having a lime-glass envelope. It is operated at a low color temperature to assure the high probability of single photoelectron emission from the photocathode of the tube. The intensity of the light source is adjusted for approximately 50 per cent counting loss. A Nuclear Data Model No.ND-130A Multichannel Pulse-Height Analyzer is used to measure photoelectron pulse height.

v Pulse-height resolution in per cent is defined as 100 times the ratio of the width of the photopeak at half the maximum count rate in the photopeak height to the pulse height at maximum photopeak count rate under the conditions of (w).

w Pulse height is defined as the amplitude of the anode pulse voltage (referred to anode) measured across a 100 kilohm resistor and a total capacitance of 100 ± 3% pf in parallel. Under pulse conditions, the interstage voltages of the tube should not deviate more than 2% from the interstage voltage values during no-signal conditions. The 662 Kev photon from an isotope of cesium having an atomic mass of 137 (Cs^{137}) and a cylindrical 2" x 2" thallium-activated sodium-iodide scintillator [NaI (Tl)-type 3D8S50, Serial No.AJ651, or equivalent] are used. This scintillator is manufactured by the Harshaw Chemical Corporation, 1945 East 97th Street, Cleveland 6, Ohio, and is rated by the manufacturer as having a resolving capability of 8.2 per cent to 8.3 per cent. The Cs^{137} source is in direct contact with the metal end of the scintillator. The faceplate end of the crystal is coupled to the tube by a coupling fluid such as Dow Corning Corp. Type DC200 (Viscosity of 60,000 centistokes)-manufactured by the Dow Corning Corp., Midland, Michigan, or equivalent.

x Mean gain deviation is defined as the percentage change, regardless of sign, from the average pulse height for a given radiation source and scintillator over a specified time or count rate interval.

y Under the following conditions: The scintillator and Cs^{137} radiation source of (w) are employed. The radiation source is initially centered, on the major axis of the tube and the scintillator, at a point providing a pulse count rate of 1000 cps. The pulse height of the photopeak is measured under this condition. Next, the radiation source is moved rapidly, in approximately 30 seconds, to a new position that is equivalent to a count rate of 10,000 cps. The new position is also centered in the major axis of the tube. The pulse height under this condition is measured. The difference in pulse height between these two measurements is typically 1 per cent.

z Under the same conditions as (y) except the count rate position of 1,000 cps is maintained for 16 hours and the pulse height is sampled at 1 hour intervals.

aa 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.

bb 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.

cc The interstage voltages of the tube will not deviate more than 2 per cent from the recommended voltage distribution during the pulse. Capacitors are connected across the individual resistors making up the voltage-divider arrangement to insure this operating condition.

dd Maximum deviation from linearity is 2 per cent.

Operating Considerations

Cathode Current:

Peak cathode current of 1×10^{-8} ampere at a tube temperature of 22° C or 1×10^{-10} ampere at -100° C should not be exceeded. Because of the resistivity of the photocathode, the voltage drop caused by higher peak cathode currents may produce radial electric fields on the photocathode which can result in poor photoelectron collection in the first dynode. Photosurface resistivity increases with decreasing temperature.

Shielding:

Electrostatic shielding of the tube is ordinarily required. When a shield is used, it must be connected to the cathode terminal. The application of high voltage, with respect to cathode, to insulating or other materials supporting or shielding the tube at the photocathode end of the tube should not be permitted unless such materials are chosen to limit leakage current to the tube envelope to 1 x 10^{-12} ampere or less.

In addition to increasing dark current and noise output because of voltage gradients developed across the bulb wall, such high voltage may produce minute leakage current to the cathode, through the tube envelope and insulating materials, which can permanently damage the tube.

Ambient Atmosphere:

Operation or storage of this tube in environments where helium is present should be avoided. Helium permeates through the tube envelope and can lead to eventual tube destruction.

Anode Dark Current

A temporary increase is anode dark current by as much as 3 orders of magnitude may occur if the tube is exposed momentarily to high-intensity ultraviolet radiation from sources such as flourescent room lighting even though voltage is not applied to the tube. This increase in dark current may persist for a period of from 6 to 24 hours after such irradiation.

A typical tube with voltage applied in total darkness for a period of 24 hours often exhibits a lower value of Anode Dark Current than that shown under Characteristics Range Values. Dark current may be reduced by the use of a refrigerant.

Typical Secondary-Emission Ratio of First Dynode as a Function of Cathode-to-Dynode No. 1 Voltage

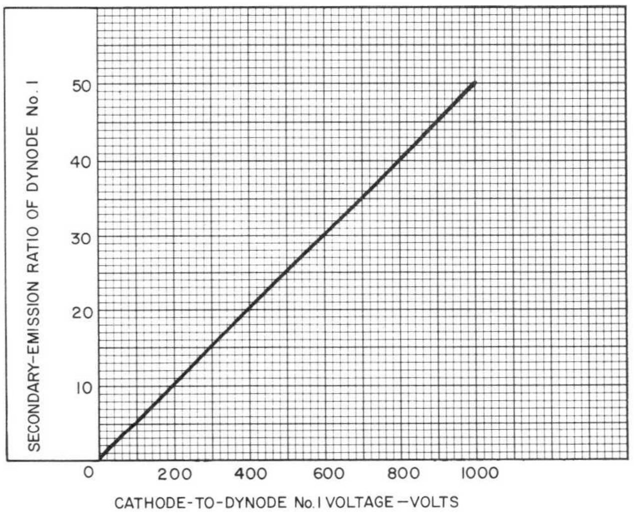


Figure 2

Spectral Response Characteristics

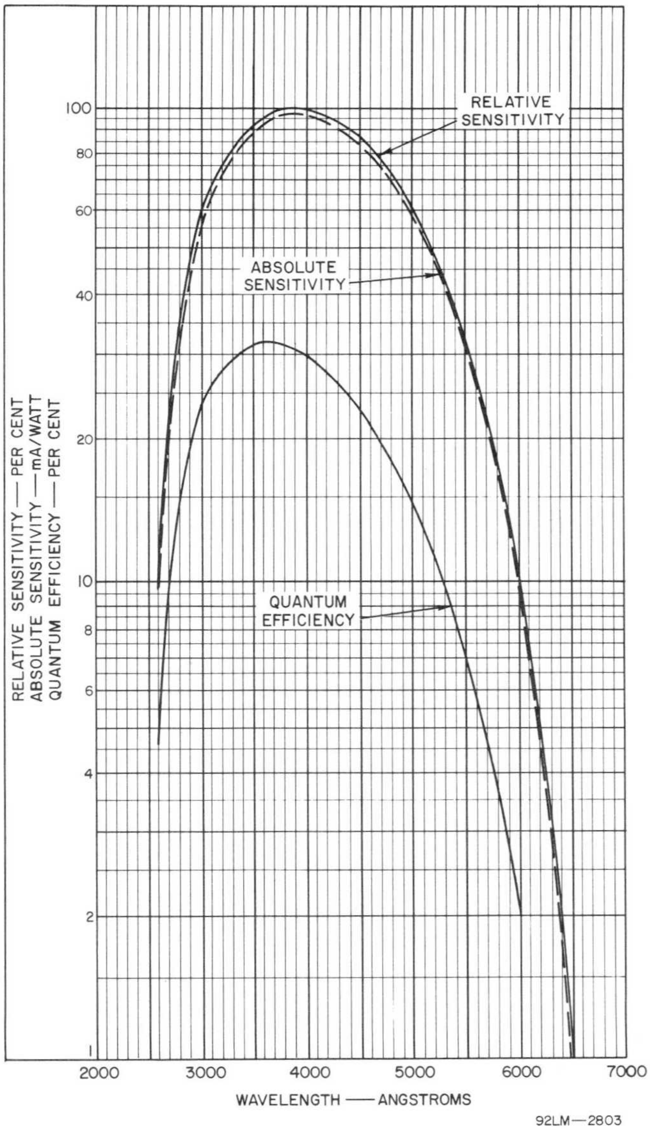


Figure 3

Differential Fe^{55} Spectrum

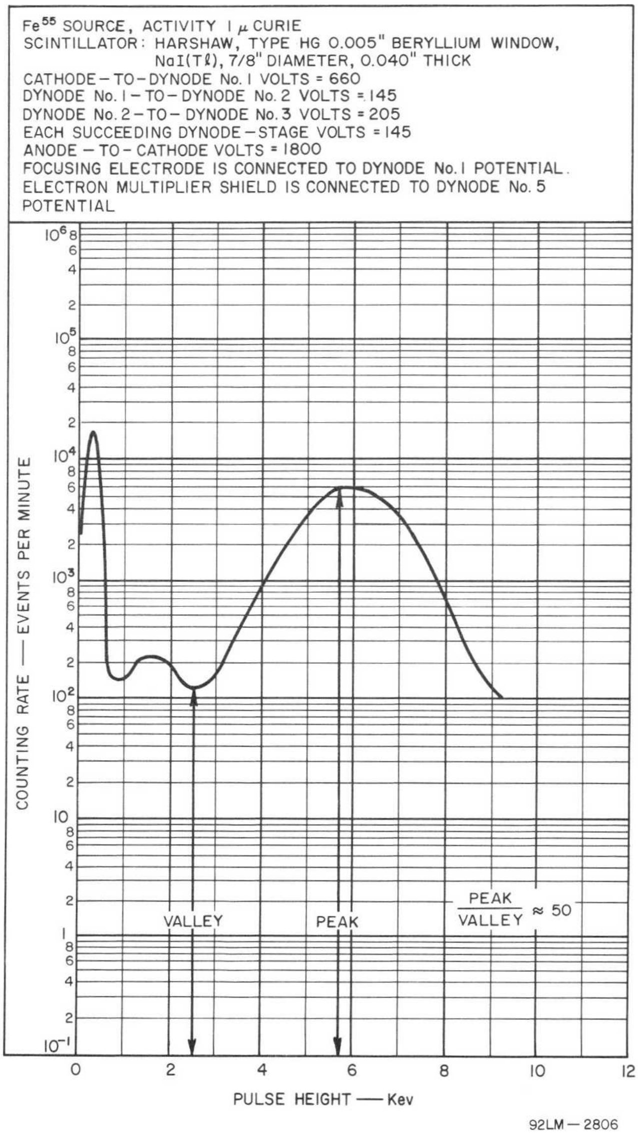


Figure 4

Typical Dark-Pulse Spectrum

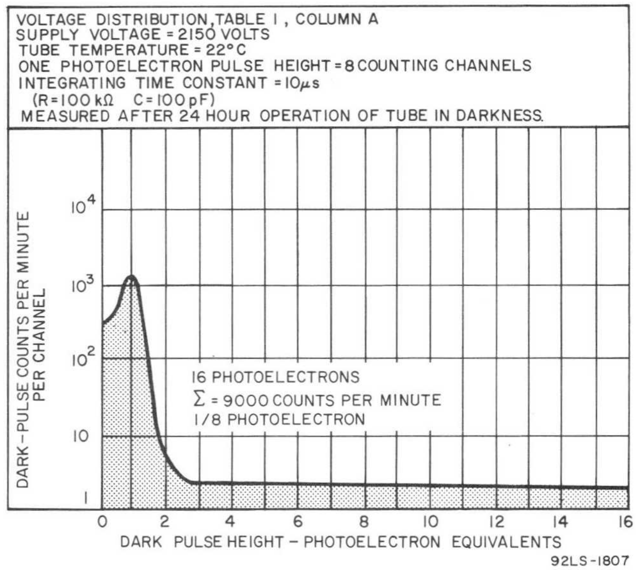


Figure 5

Typical Sensitivity and Current Amplification Characteristics

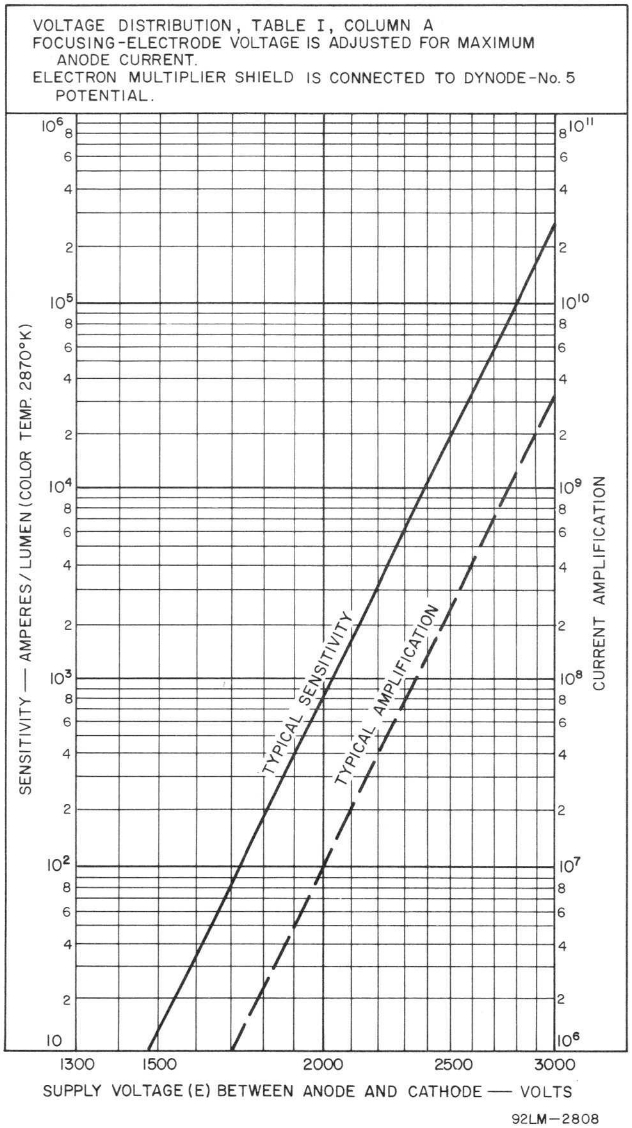


Figure 6

Typical Anode Dark Current and EADCI Characteristics

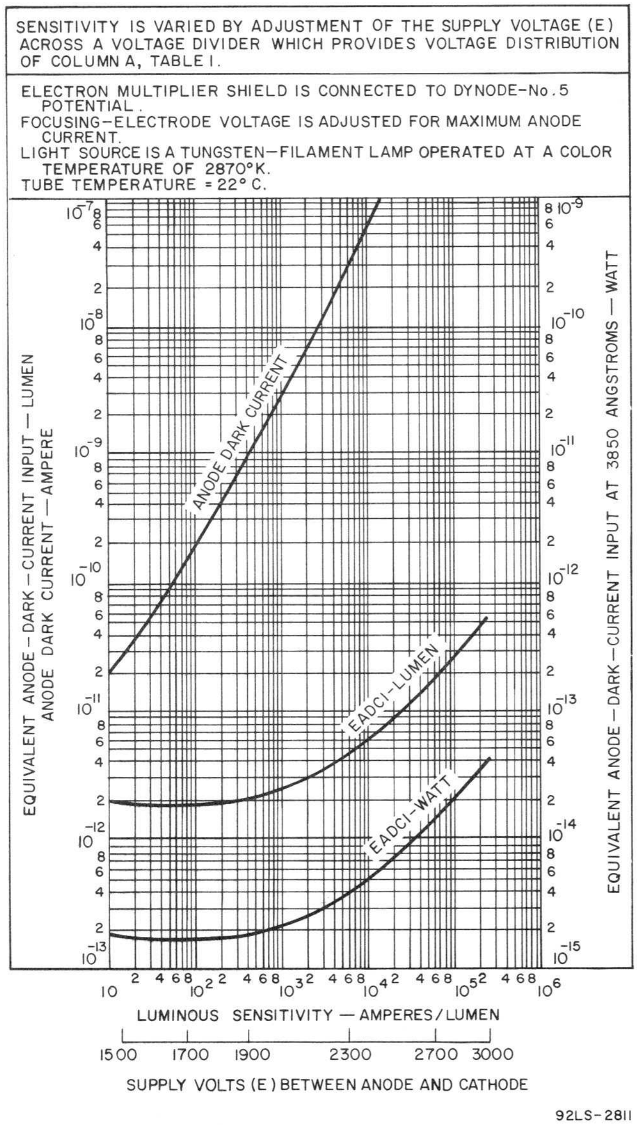


Figure 7

The following characteristics are intended for guidance only. These characteristics were taken with an anode-to-cathode voltage distribution of 4, 1, 1.4, 1, 1, 1, 1, 1, 1, 1, 1, 1, and 1 This. distribution should not normally be used unless cathode-to-dynode No.1 voltage is at least 600 volts. To take full advantage of the performance capabilities of the C31000D, either Voltage Distribution A or B of Table I should be employed.

Typical Time-Resolution Characteristics

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

BETWEEN	6.1% OF E MULTIPLIED BY
CATHODE AND DYNODE No. I	4.0
DYNODE No. I AND DYNODE No. 2	1.0
DYNODE No. 2 AND DYNODE No. 3	1.4
EACH SUCCEEDING DYNODE-STAGE VOLTS	1.0
ANODE AND CATHODE	16.4

FOCUSING ELECTRODE IS CONNECTED TO DYNODE-No. I POTENTIAL.
ELECTRON MULTIPLIER SHIELD IS CONNECTED TO DYNODE-No. 5 POTENTIAL.
PHOTOCATHODE IS FULLY ILLUMINATED.

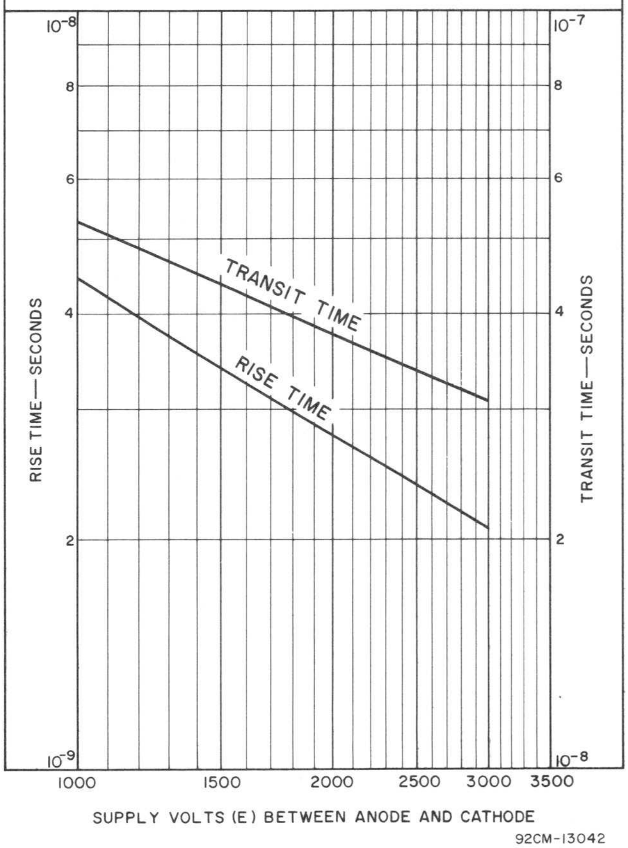


Figure 8

Typical Effect of Magnetic Field on Anode Current

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

BETWEEN	6.1% OF E MULTIPLIED BY
CATHODE AND DYNODE No. I	4.0
DYNODE No. I AND DYNODE No. 2	1.0
DYNODE No. 2 AND DYNODE No. 3	1.4
EACH SUCCEEDING DYNODE-STAGE VOLTS	1.0
ANODE AND CATHODE	16.4

FOCUSING ELECTRODE IS CONNECTED TO DYNODE-No. I POTENTIAL.
ELECTRON MULTIPLIER SHIELD IS CONNECTED TO DYNODE-No. 5 POTENTIAL.
PHOTOCATHODE IS FULLY ILLUMINATED.

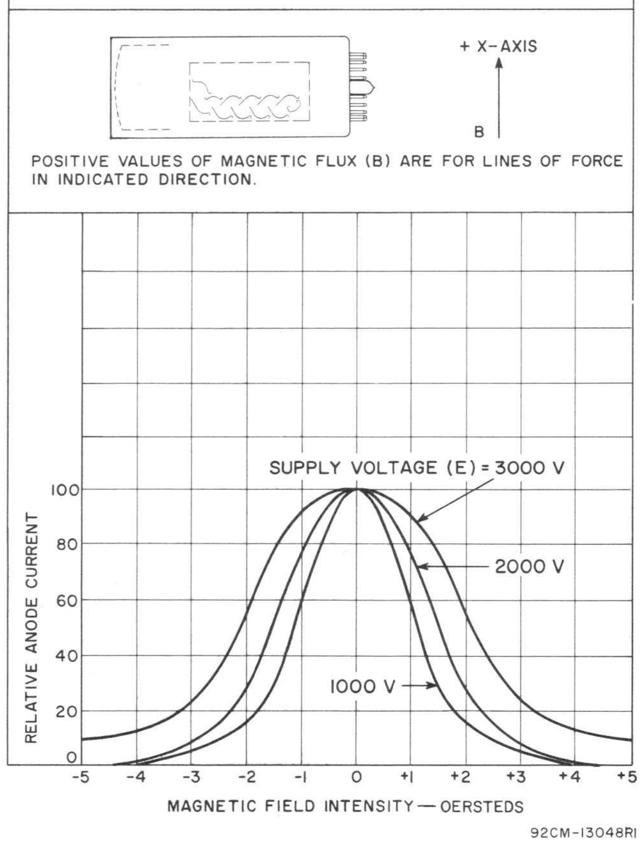


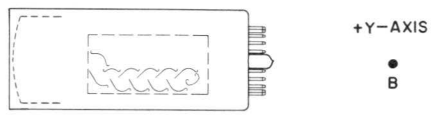
Figure 9

Typical Effect of Magnetic Field on Anode Current

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

BETWEEN	6.1% OF E MULTIPLIED BY
CATHODE AND DYNODE No. I	4.0
DYNODE No. I AND DYNODE No. 2	1.0
DYNODE No.2 AND DYNODE No. 3	1.4
EACH SUCCEEDING DYNODE-STAGE VOLTS	1.0
ANODE AND CATHODE	16.4

FOCUSING ELECTRODE IS CONNECTED TO DYNODE-No. I POTENTIAL.
ELECTRON MULTIPLIER SHIELD IS CONNECTED TO DYNODE-No. 5 POTENTIAL.
PHOTOCATHODE IS FULLY ILLUMINATED.



POSITIVE VALUES OF MAGNETIC FLUX (B) ARE FOR LINES OF FORCE OUT OF PAPER.

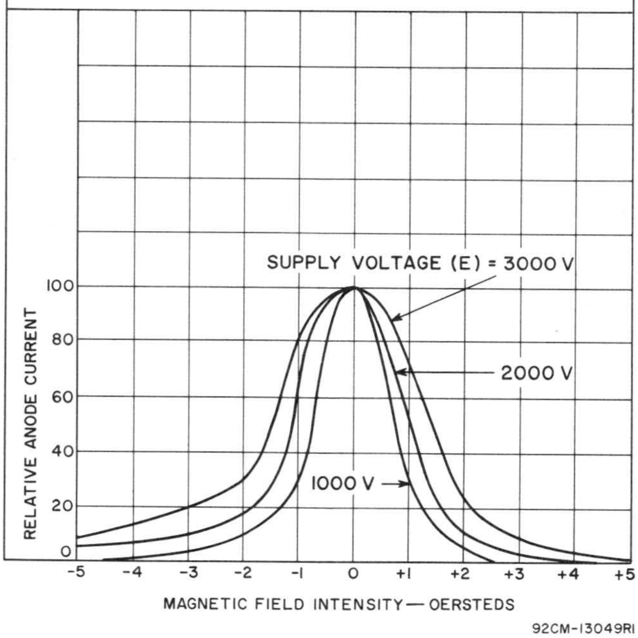
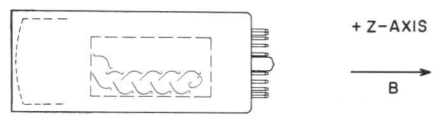


Figure 10

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

BETWEEN	6.1% OF E MULTIPLIED BY
CATHODE AND DYNODE No. I	4.0
DYNODE No. I AND DYNODE No. 2	1.0
DYNODE No.2 AND DYNODE No. 3	1.4
EACH SUCCEEDING DYNODE-STAGE VOLTS	1.0
ANODE AND CATHODE	16.4

FOCUSING ELECTRODE IS CONNECTED TO DYNODE-No. I POTENTIAL.
ELECTRON MULTIPLIER SHIELD IS CONNECTED TO DYNODE-No. 5 POTENTIAL.
PHOTOCATHODE IS FULLY ILLUMINATED.



POSITIVE VALUES OF MAGNETIC FLUX (B) ARE FOR LINES OF FORCE TOWARD TUBE BASE.

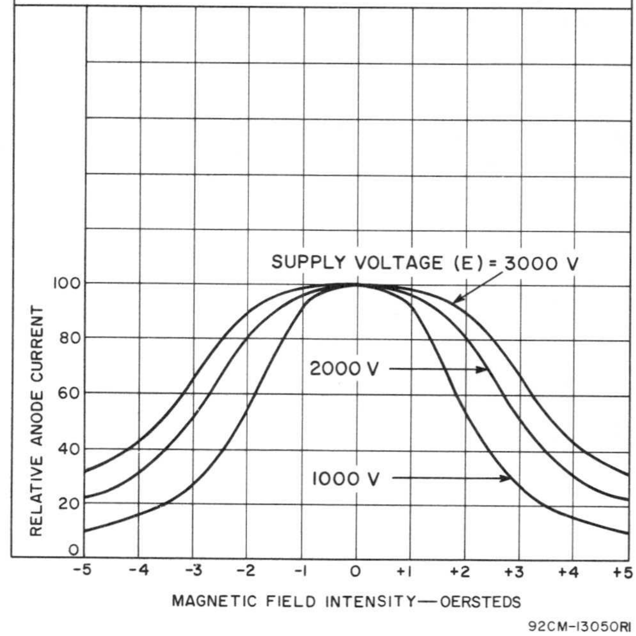


Figure 11

Typical Focusing-Electrode Characteristic

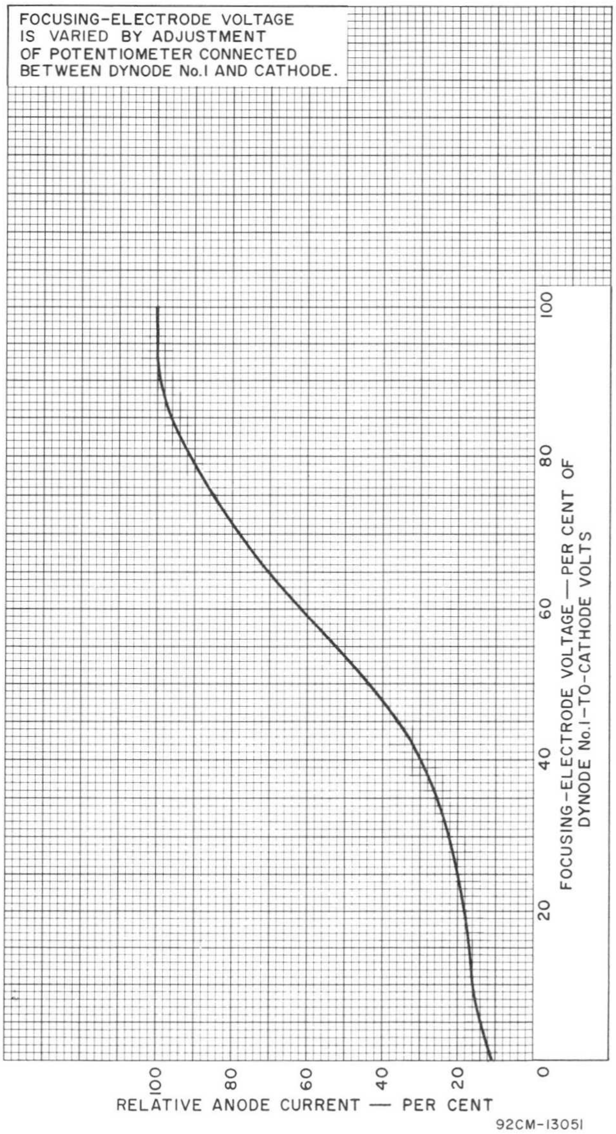


Figure 12

Typical Anode Characteristics

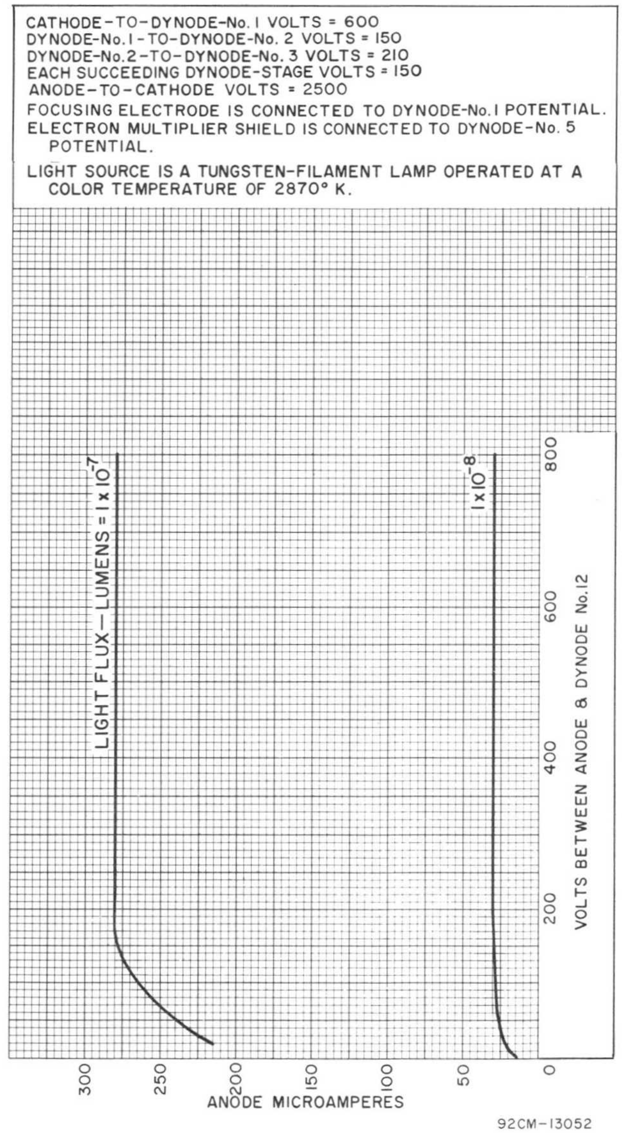
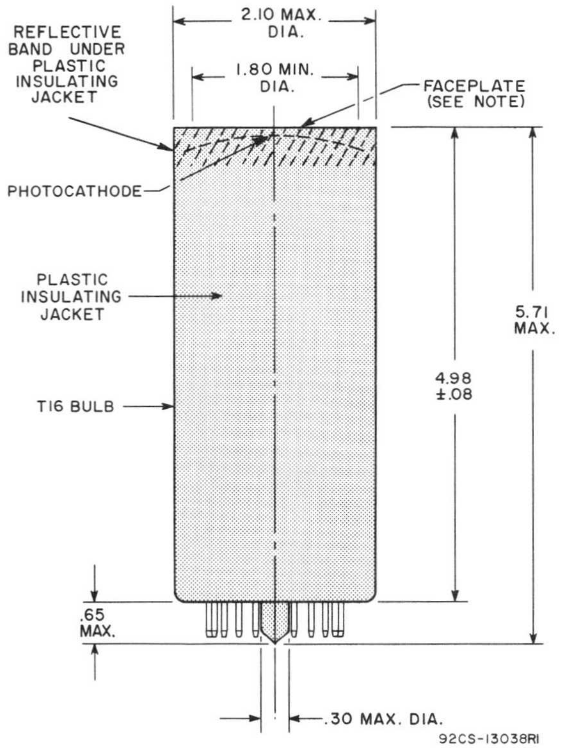


Figure 13

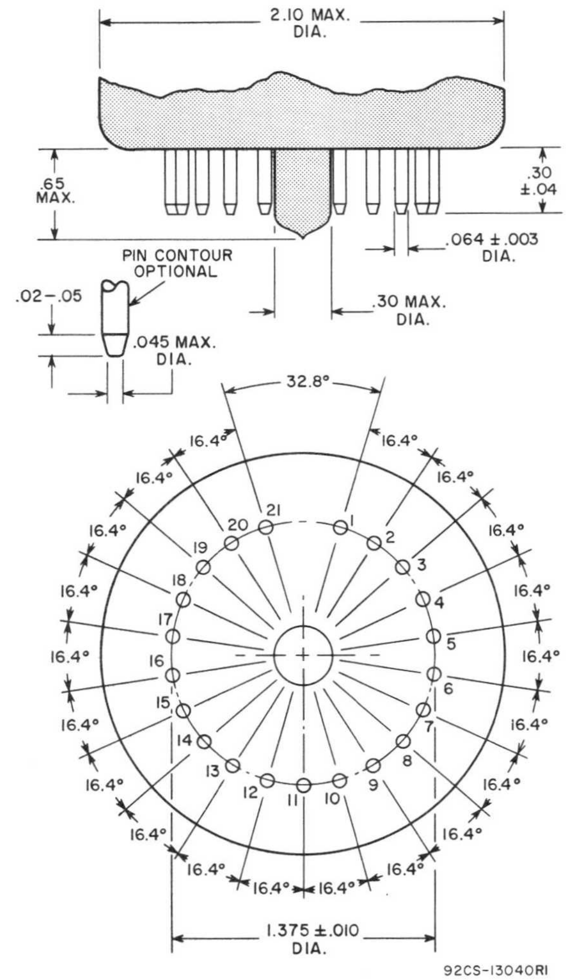
Dimensional Outline



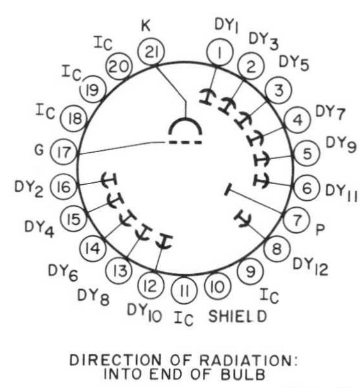
Dimensions in Inches

Note: Deviation from Flatness of External Surface of Faceplate will not exceed 0.010" from Peak to Valley.

Detail of Base Arrangement



Basing 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: Dynode No.11
Pin 7: Anode
Pin 8: Dynode No.12
Pin 9: Internal Connection, Do not use
Pin 10: Electron Multiplier Shield
Pin 11: Internal Connection, Do not use
Pin 12: Dynode No.10
Pin 13: Dynode No.8
Pin 14: Dynode No.6
Pin 15: Dynode No.4
Pin 16: Dynode No.2
Pin 17: Focusing Electrode
Pin 18: Internal Connection, Do not use
Pin 19: Internal Connection, Do not use
Pin 20: Internal Connection Do not use
Pin 21: Photocathode

Photomultiplier Tubes

RCA

Developmental Types
C31000E
C31000F

Preliminary and Tentative Data

2"-Diameter, QUANTACON Types Having Extended Red Multialkali Photocathodes and Extremely High-Gain Gallium-Phosphide First Dynodes.

RCA Developmental Types C31000E and C31000F are 2"-diameter, 12-stage, head-on QUANTACON* photomultiplier tubes employing a multialkali photocathode having extended red response and an extremely high-gain gallium-phosphide first dynode followed by high-stability copper-beryllium dynodes in the succeeding stages. The C31000E differs only in that is has a plano-concave pyrex window, while the C31000F employs a spherical section pyrex window.

These tubes are highly useful for low light level measurement applications in the red and near-infrared regions of the spectrum. Typical applications include laser detection and Raman spectroscopy.

The first dynode of these QUANTACON photomultiplier tubes provides up to an order of magnitude increase in secondary-emission ratio over conventional dynode materials. This high ratio provides a pulse height resolving capability that permits discrimination of single, double–up to five or more photoelectron events.

The extremely high secondary-emission ratio of the first dynode is instrumental in providing a decrease in noise induced in signal current by approximately 20 per cent. See Bibliography, page 4.

An important feature of the C31000E and C31000F is that the high gain of the gallium-phosphide dynode in conjunction with the excellent photoelectron collection from all parts of the photocathode provides a photon counting efficiency that is nearly equal to the quantum efficiency of the photocathode. Photon counting efficiency is equal to the ratio of the photon-originated output pulses to the number of photons incident on the faceplate.

*QUANTACON is the RCA designation for photomultiplier tubes employing group III/V compounds as secondary emitters and/or photocathodes.

- **Useful Spectral Range Extending From About 4000 to 9600 Å**
- **Typical Quantum Efficiency:**
  10% at 5500 Å
  1.4% at 8600 Å
- **1.80" Minimum Diameter Multialkali Photocathode**
- **Extremely High Gain Gallium-Phosphide, GaP, First Dynode**
- **Low Dark Current:**
  1×10^{-8} A at 30 A/lm and 22° C
  1×10^{-10} A at 30 A/lm and -76° C
- **Low Dark Noise (Typical)**
  Dark Pulse Summation

  $$\sum_{1/8 \text{ Photoelectron}}^{16 \text{ Photoelectrons}} \approx 10^4 \text{ Counts Per Second at } 22^\circ \text{ C}$$

  $$\sum_{1/8 \text{ Photoelectron}}^{16 \text{ Photoelectrons}} \approx 50 \text{ Counts Per Second at } -76^\circ \text{ C}$$
- **An Order of Magnitude Improvement in Single Photoelectron Resolution**
  Typically ≈ 60% (FWHM)
- **Anode Transmission-Line Characteristic Impedance:**
  50 ohms
- **Time Resolution Characteristics:**
  Anode-Pulse Rise Time at 2500 V –
  2.4×10^{-9} s
  Electron Transit Time at 2500 V –
  3.4×10^{-8} s

For further information or application assistance on this device, contact your RCA Sales Representative or write Phototube Marketing, RCA Lancaster, PA 17604.

Data

General

Spectral Response	See **Figure 1**
Wavelength of Maximum Response	5750 ± 500 Å
Cathode, Semitransparent	Sodium-Potassium-Cesium-Antimony (Multialkali)
Minimum projected area	2.54 sq. in
Minimum diameter	1.80 in
Window	Pyrex, Corning[a] No.7740, or equivalent
Shape (Type C31000E)	Plano-Concave
Shape (Type C31000F)	Spherical Section
Index of refraction at 5893 angstroms	1.47
Dynode No.1:	
Secondary Emitting Surface	Gallium-Phosphide, GaP
Dynode No.2 through 12:	
Secondary Emitting Surface	Beryllium-Oxide
Dynode Structure	In-Line Electrostatic Focus-Type
Direct Interelectrode Capacitances (Approx.):	
Anode to dynode No.12	5 pF
Anode to all other electrodes	6 pF
Maximum Overall Length	5.71 in
Seated Length	4.98 ± 0.08 in
Maximum Diameter	2.10 in
Bulb	T16
Base	See Base Drawing
Socket	RCA AJ2144 or AJ2145[b]
Magnetic Shield	See footnote (c)
Operating Position	Any
Weight (Approx.)	6 oz

Maximum and Minimum Ratings, *Absolute-Maximum Values:*[d]

DC Supply Voltage:			
Between anode and cathode:			
With Voltage Distribution of Column A or B shown in Table I	2500	max.	V
	800[e]	min.	V
Between anode and dynode No.12	400	max.	V
Between dynode No.12 and dynode No.11	800	max.	V
Between consecutive dynodes	400	max.	V
Between dynode No.1 and cathode	1000	max.	V
	300[e]	min.	V
Between focusing electrode and cathode	1000	max.	V
Average Anode Current[f]	1.0	max.	mA
Ambient-Temperature Range[g]	-100 to +85		°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 = 1500 volts (Except as noted)
Voltage Distribution A, Table I

	Min.	Typical	Max.	
Anode Sensitivity:				
Radiant[h] at 5750 angstroms	–	1.8×10^{4}	–	A/W
Luminous[i] (2870° K)	30	100	600	A/lm
Cathode Sensitivity:				
Radiant[k] at 5750 angstroms	–	4.5×10^{-2}	–	A/W
Radiant[m] at 8600 angstroms	6×10^{-3}	1×10^{-2}	–	A/W
Luminous[n] (2870° K)	1.5×10^{-4}	2.5×10^{-4}	–	A/lm
Quantum Efficiency:				
At 5500 angstroms	–	10	–	%
At 8600 angstroms	–	1.4	–	%
Current Amplification	–	4×10^{5}	–	
Anode Dark Current:[p]				
At 22° C	–	1×10^{-8}	5×10^{-8}	A
At -76° C	–	1×10^{-10}	–	A
Equivalent Anode Dark Current Input at 22° C[p]	–	3.3×10^{-10}	1.7×10^{-9}	lm
	–	1.8×10^{-12}[q]	9.4×10^{-12}[q]	W
Equivalent Noise Input[r]	–	3.3×10^{-13}	–	lm
	–	1.8×10^{-15}[s]	–	W
Single Photoelectron Pulse Height Resolution at Full-Width-Half-Maximum Point[t]	–	60	–	%
Dark Pulse Summation[u] at 2000 V:				
1 to 128 channels at 22° C	–	10^{4}	–	counts per second
1 to 128 channels at -76° C	–	50	–	counts per second
See **Figure 6.**				
Anode-Pulse Rise Time[v] at 2500 V	–	2.4×10^{-9}	–	s
Electron Transit Time[w] at 2500 V	–	3.4×10^{-8}	–	s

The following characteristics were measured with anode-to-cathode voltage distribution of 4, 1, 1.4, 1, 1, 1, 1, 1, 1, 1.5, 2, 4, and 2. They are included for guidance purposes only.

With E = 3000 volts (Except as noted)

	Min.	Typical	Max.	
Pulse Current:[x]				
Space-Charge Limited (Saturated)[y]	–	0.50	–	A
Linear	–	0.15	–	A

Table I		
Voltage Distribution		
Between the following Electrodes: Cathode (K), Dynode (Dy), and Anode (P)	Column A* 5.45% of K-P Voltage (E) Multiplied By:	Column B 8.06% of Dy1-P Voltage (E) Multiplied By:
K - Dy1	6	♦
Dy1 - Dy2	1	1
Dy2 - Dy3	1.4	1.4
Dy3 - Dy4	1	1
Dy4 - Dy5	1	1
Dy5 - Dy6	1	1
Dy6 - Dy7	1	1
Dy7 - Dy8	1	1
Dy8 - Dy9	1	1
Dy9 - Dy10	1	1
Dy10 - Dy11	1	1
Dy11 - Dy12	1	1
Dy12 - P	1	1
Dy1 - P	–	12.4
K - P	18.4	–

Focusing Electrode is connected to arm of potentiometer between cathode and dynode No.1. The focusing-electrode voltage is varied to give maximum anode current. Multiplier shield is operated at Dynode No.5 potential.

♦Cathode-to-Dynode-No.1 Voltage maintained at 660 volts.

*To take full advantage of the operating capabilities of these tubes, it is required that the cathode-to-dynode No.1 voltage be a minimum of 600 volts.

---

[a] Made by Corning Glass, Corning, NY 14830.

[b] The AJ2145 is ordinarily supplied with the tube and is designed specifically for chassis mounting. The AJ2144 may be supplied as an alternate socket if requested by the user. The AJ2144 is designed for use in any desired mounting arrangement. It is supplied with an unattached clamp ring which fits to either the top or bottom of its socket body to permit chassis mounting. The ring is not normally required for other mounting arrangements and can be discarded to make such arrangements more compact.

[c] Magnetic shielding material in the form of foil or tape as available from the Magnetic Shield Division, Perfection Mica Company, 1322 North Elston Avenue, Chicago, IL, 60622, or equivalent.

[d] The maximum ratings in the tabulated data are established in accordance with the following definition of the Absolute-Maximum Rating System for rating electron devices.

Absolute-Maximum Ratings are limiting values of operating and environmental conditions applicable to any electron device of a specified type as defined by its published data, and should not be exceeded under the worst probable conditions.

The device manufacturer chooses these values to provide acceptable serviceability of the device, taking no responsibility for equipment variations, environment variations, and the effects of changes in operating conditions due to variations in device characteristics.

The equipment manufacturer should design so that initially and throughout life no Absolute Maximum value for the intended service is exceeded with any device under the worst probable operating conditions with respect to supply voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in device characteristics.

[e] To take full advantage of the performance capabilities of these tubes, tube operation at voltages above these minimum specified values should be employed.

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

[g] Operation at room temperature or below is recommended. Operation above room temperature is not recommended because of excessive thermionic emission from the photocathode.

[h] This value is calculated from the typical anode luminous sensitivity rating using a conversion factor of 180 lumens per watt.

[i] 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 0.1 microlumen is used.

[k] This value is calculated from the typical cathode luminous sensitivity rating using a conversion factor of 180 lumens per watt.

[m] Measured using a Baird-Atomic narrow bandpass filter having a peak wavelength of 8600 angstroms and a bandpass of approximately 100 angstroms blocked from infrared to X-ray wavelength.

[n] 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 0.001 lumen and 200 volts are applied between cathode and all other electrodes connected as anode.

[p] At specified tube temperature. With supply voltage adjusted to give a luminous sensitivity of 30 amperes per lumen. Dark current caused by thermionic emission may be reduced by use of a refrigerant.

[q] At 5750 angstroms. These values are calculated from the EADCI values in lumens using a conversion factor of 180 lumens per watt.

[r] Under the following conditions: Tube temperature 22° C, external shield connected to cathode, an equivalent bandwidth of 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.

s At 5750 angstroms. This value is calculated from the ENI value in lumens using a conversion factor of 180 lumens per watt.

t Measured under the following conditions: Dark noise is eliminated by use of a coincidence circuit. As a result, most of the low energy pulses below one photoelectron are not counted. The light source is a gallium-phosphide light-emitting diode having peak output at a wavelength of approximately 5600 angstroms. The diode is pulsed at a rate of 30,000 pps; pulse duration is approximately 0.4 µs; anode circuit integrating time is approximately 10 µs. The light intensity from the diode is adjusted to obtain greater or fewer registered counts in a given multielectron peak to obtain an approximately equal number of counts in the first, and second photoelectron peaks. A Multichannel Pulse-Height Analyzer having 256 channels is employed. Single electron resolution in per cent is defined as 100 times the ratio of the width of the single photoelectron peak at half the maximum count rate to the pulse height at maximum count rate.

u Measured under the following conditions: The light source is a tungsten-filament lamp having a lime-glass envelope. It is operated at a low color temperature to assure the high probability of single photoelectron emission from the photocathode of the tube. The intensity of the light source is adjusted for approximately 10^4 photons per second.

v 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.

w 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.

x The interstage voltages of the tube should not deviate more than 2 per cent from the specified voltage distribution. Capacitors are connected across the individual resistors making up the voltage-divider arrangement to insure the operating condition.

y Maximum deviation from linearity is 2 per cent.

Operating Considerations

Shielding

Electrostatic shielding of the tube is ordinarily required. When a shield is used, it must be connected to the cathode terminal. The application of high voltage, with respect to cathode, to insulating or other materials supporting or shielding the tube at the photocathode end should not be permitted unless such materials are chosed to limit leakage current to the tube envelope to 1×10^{-12} ampere or less.

In addition to increasing dark current and noise output because of voltage gradients developed across the bulb wall, such high voltage may produce minute leakage current to the cathode, through the tube envelope and insulating materials, which can permanently damage the tube.

Ambient Atmosphere

Operation or storage of this tube in environments where helium is present should be avoided. Helium may permeate through the tube envelope and may lead to eventual tube destruction.

Bibliography

Secondary Electron Emission, R. E. Simon and B. F. Williams, IEEE Transactions on Nuclear Science, June 1968.

The Performance of High-Gain First Dynode Photomultipliers, G. A. Morton, H. M. Smith, and H. R. Krall, Paper presented at 15th IEEE Nuclear Science Symposium, Montreal, Canada, October 23-25, 1968.

New High-Gain Dynode for Photomultipliers, R. E. Simon, A. H. Sommer, J. J. Tietjen, and B. F. Williams, Applied Physics Letters, Vol. 13, No.10, 15 November 1968.

Pulse Height Resolution of High-Gain First Dynode Photomultipliers, G. A. Morton, H. M. Smith, and H. R. Krall, Applied Physics Letters, Vol. 13, No.10, 15 November 1968.

Typical Spectral Response Characteristics

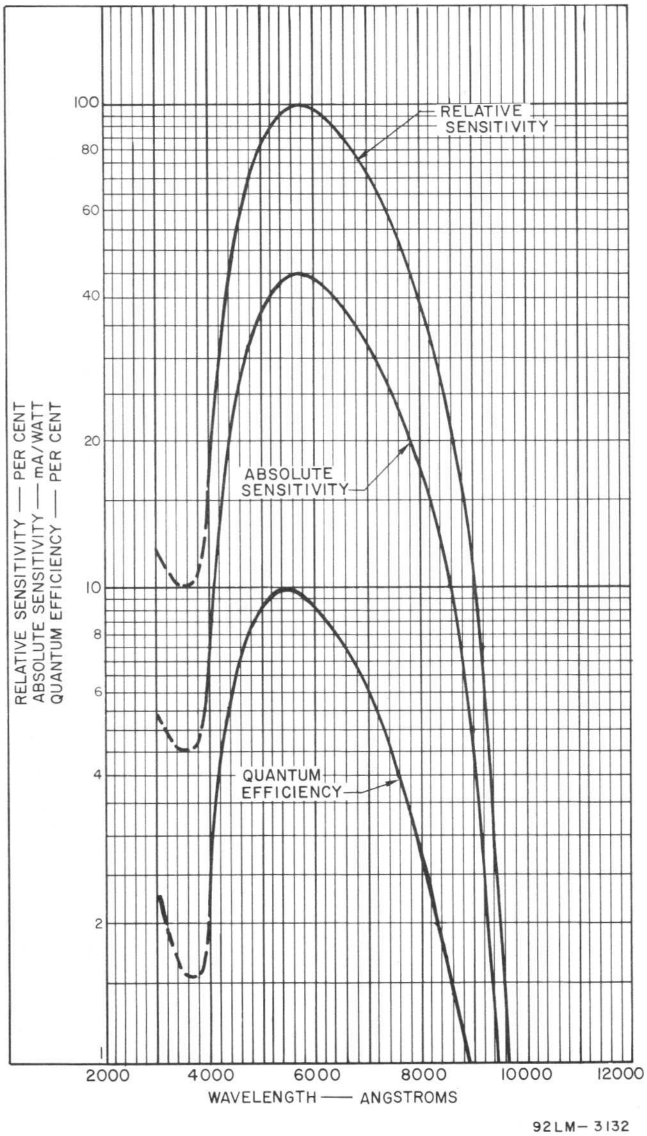


Figure 1

Typical Photoelectron Pulse Height Spectrum

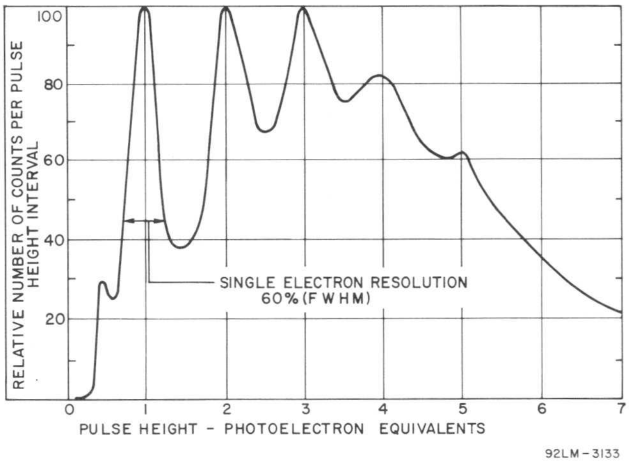


Figure 2

Typical Time-Resolution Characteristics

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

BETWEEN:	5.45% OF E MULTIPLIED BY
CATHODE AND DYNODE No.1	6.0
DYNODE No.1 AND DYNODE No.2	1.0
DYNODE No.2 AND DYNODE No.3	1.4
EACH SUCCEEDING DYNODE-STAGE	1.0
ANODE AND CATHODE	18.4

FOCUSING ELECTRODE IS CONNECTED TO DYNODE-No.1 POTENTIAL.
ELECTRON MULTIPLIER SHIELD IS CONNECTED TO DYNODE-No.5 POTENTIAL.
PHOTOCATHODE IS FULLY ILLUMINATED.

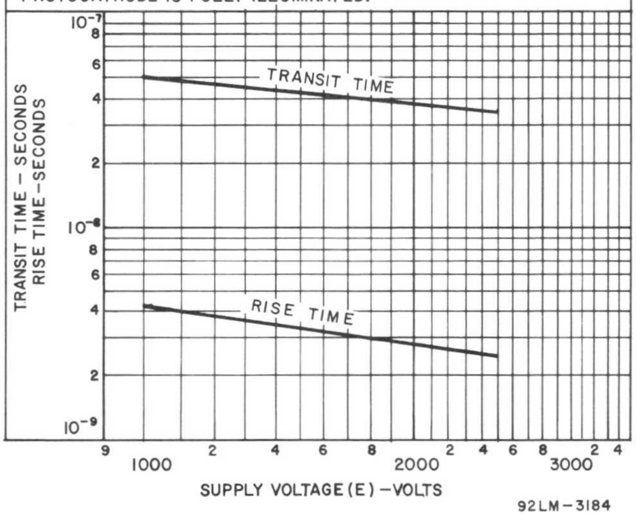


Figure 3

Schematic Arrangement of Tube Structures Showing Typical Electron Trajectories

Type C31000F

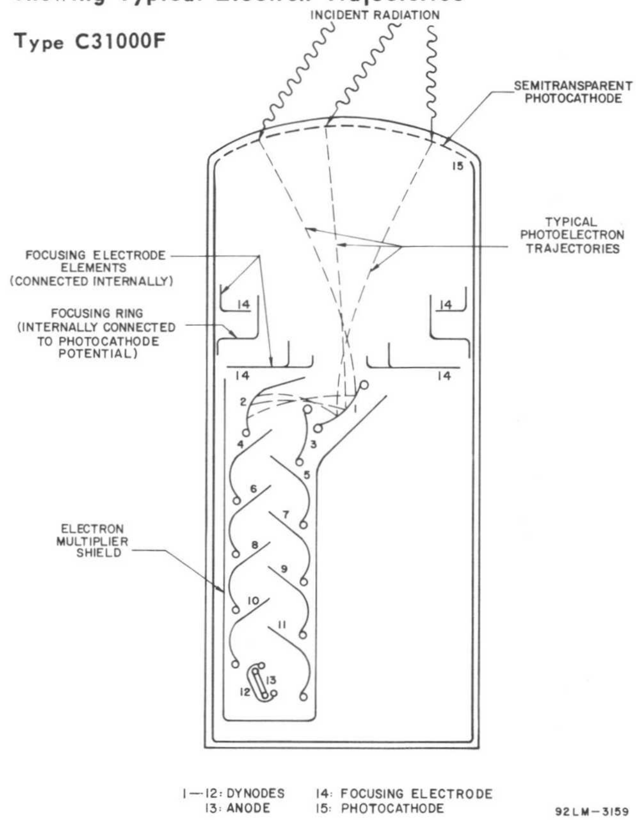


Figure 4a

Type C31000E

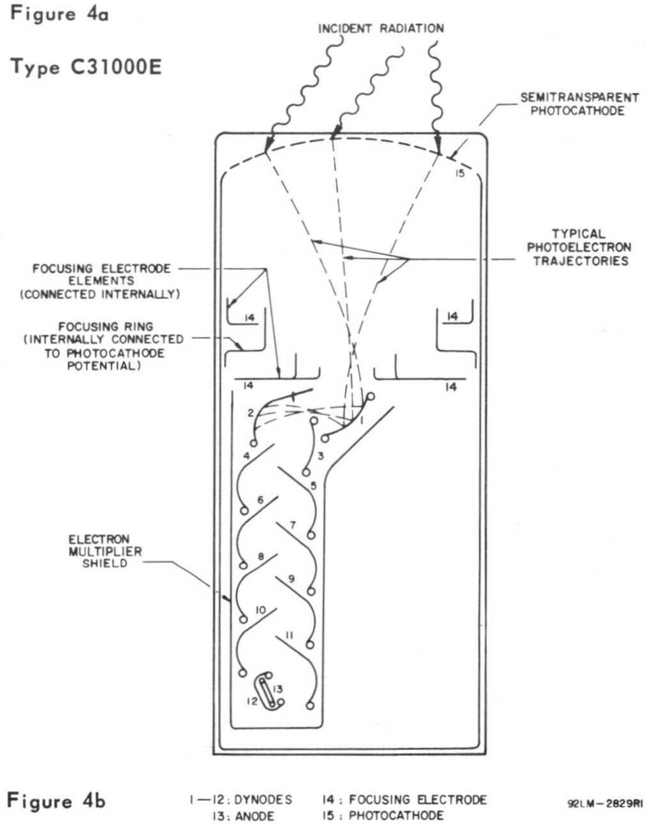


Figure 4b

Typical Secondary-Emission Ratio of First Dynode as a Function of Cathode-to-Dynode No. 1 Voltage

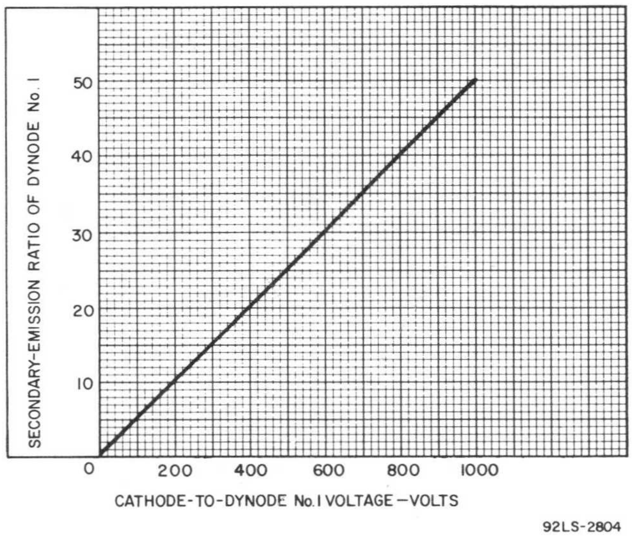


Figure 5

Typical Differential Dark-Pulse Spectrum

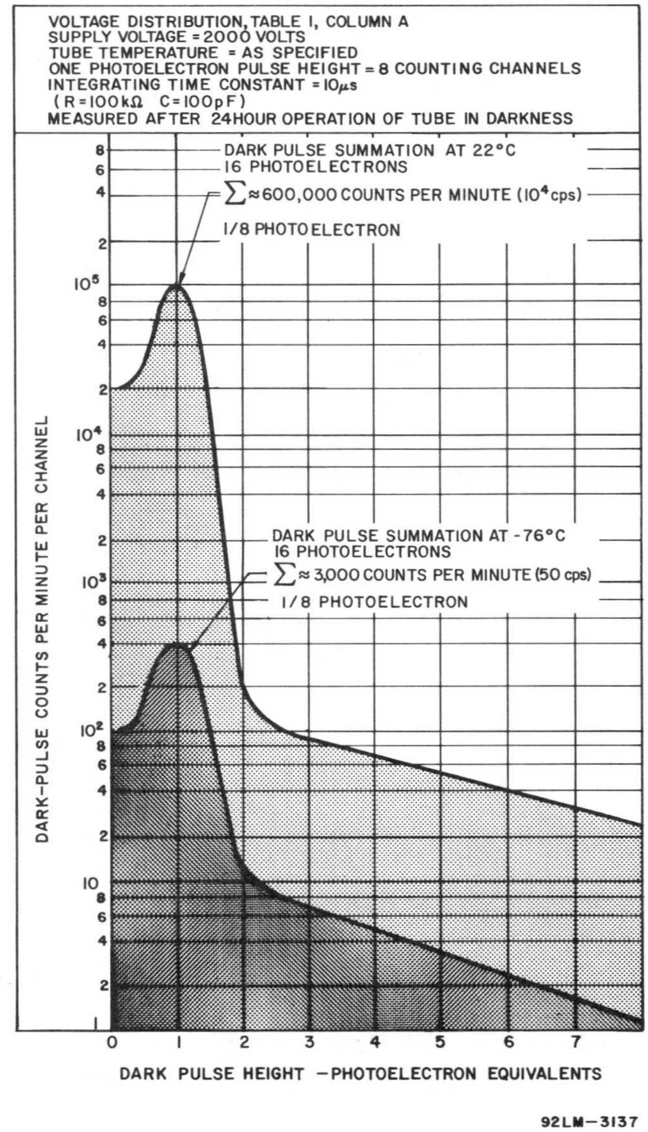


Figure 6

Typical Sensitivity and Current Amplification Characteristics

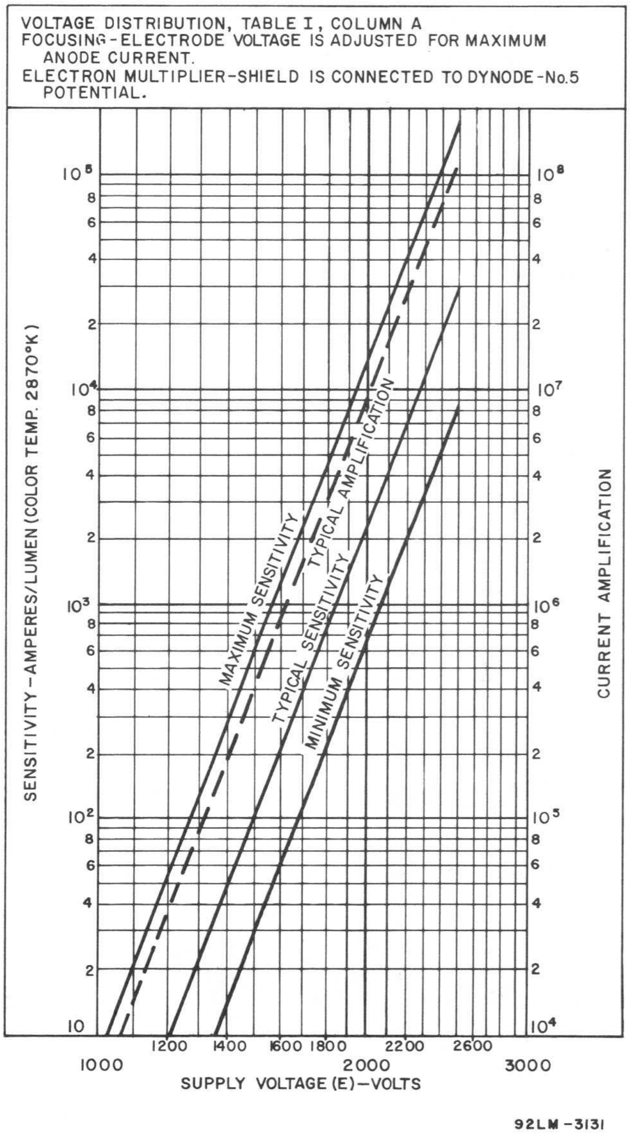


Figure 7

Typical Anode Dark Current and EADCI Characteristics

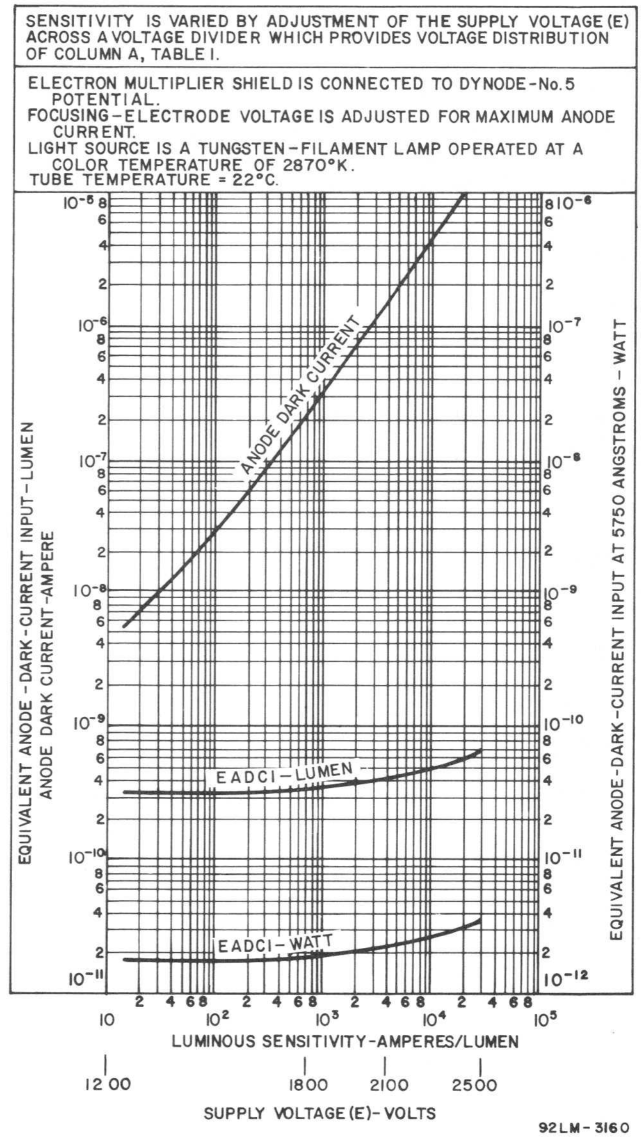
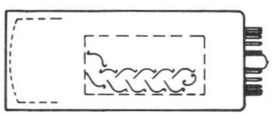


Figure 8

Typical Effect of Magnetic Field on Anode Current

THE SUPPLY VOLTAGE (E) IS ACROSS A VOLTAGE DIVIDER WHICH PROVIDES VOLTAGES AS FOLLOWS:	
BETWEEN:	6.1 % OF E MULTIPLIED BY
CATHODE AND DYNODE No.1	4.0
DYNODE No.1 AND DYNODE No.2	1.0
DYNODE No.2 AND DYNODE No.3	1.4
EACH SUCCEEDING DYNODE STAGE	1.0
ANODE AND CATHODE	16.4

FOCUSING ELECTRODE IS CONNECTED TO DYNODE-No.1 POTENTIAL.
ELECTRON MULTIPLIER SHIELD IS CONNECTED TO DYNODE-No.5 POTENTIAL.
PHOTOCATHODE IS FULLY ILLUMINATED.



POSITIVE VALUE OF H IN DIRECTION SHOWN: (1)*•, (2)↑ OR (3)⟶

*DIRECTION (1) IS OUT OF PAPER

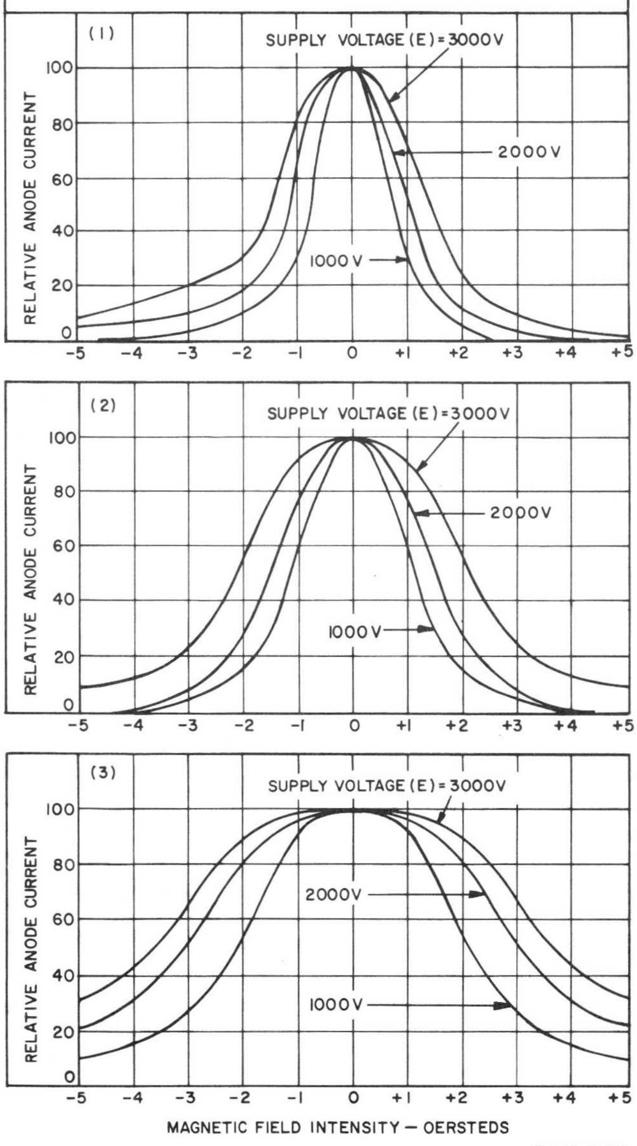


Figure 9

Typical Focusing-Electrode Characteristic

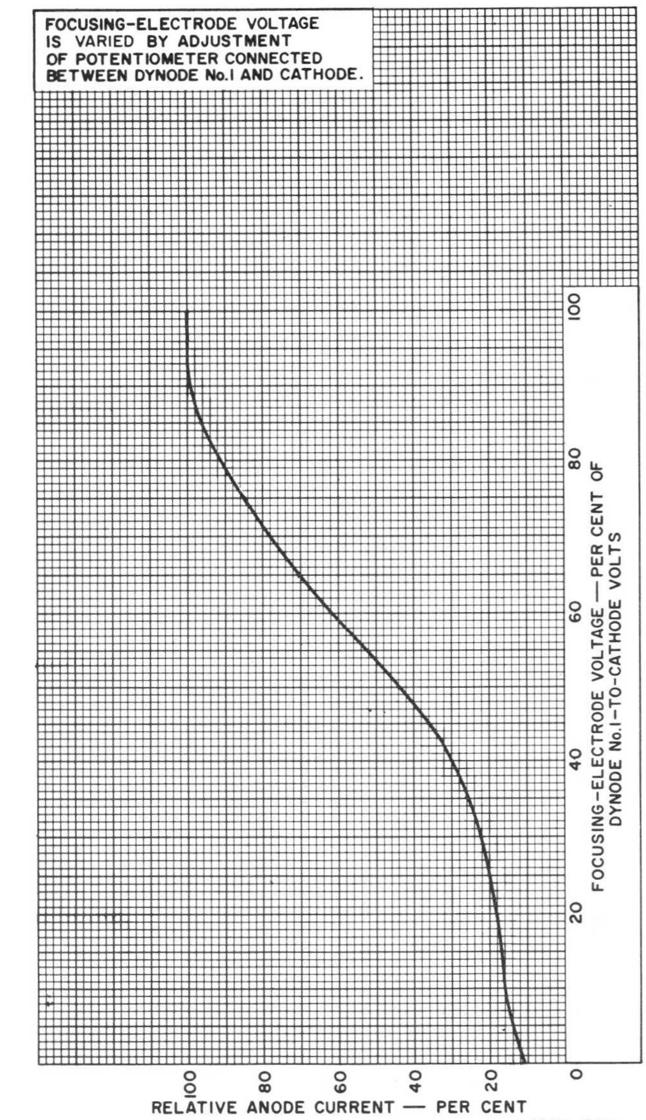


Figure 10

Typical Anode Characteristics

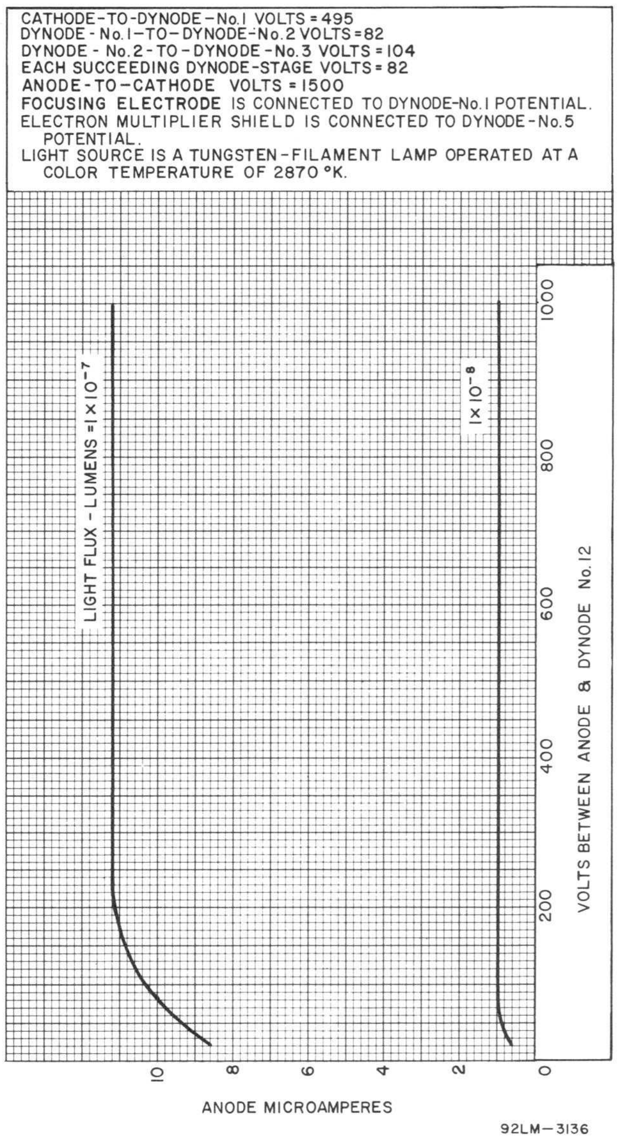


Figure 11

Typical Circuit Arrangement for Fast Pulse Response

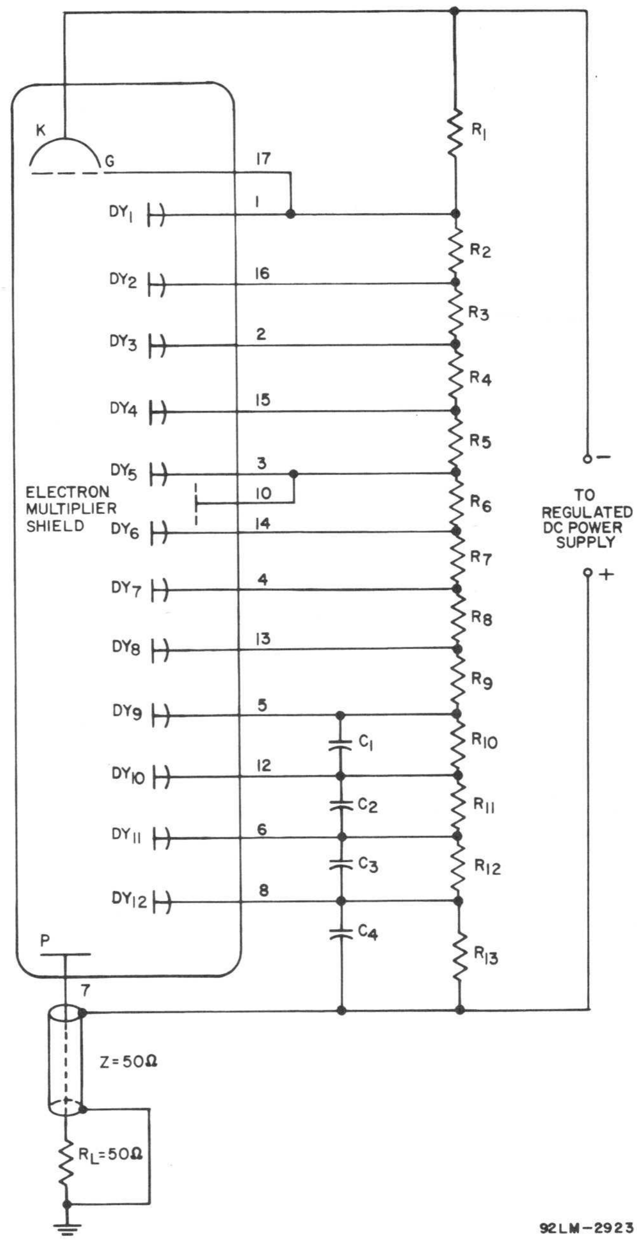


Figure 12

Fast Pulse Response Applications, to 2500 V (Typical circuit values)

- C_1: 0.005 μF, 20%, Ceramic Disc, 500 V dc
- C_2: 0.01 μF, 20%, Ceramic Disc, 500 V dc
- C_3: 0.02 μF, 20%, Ceramic Disc, 500 V dc
- C_4: 0.05 μF, 20%, Ceramic Disc, 500 V dc

R_1: 6 MΩ, (6-1 MΩ, 5%, 1/2 W in series)
R_2: 1 MΩ, 5%, 1/2 W
R_3: 1.3 MΩ, 5%, 1/2 W
R_4 through R_{13}: 1 MΩ, 5%, 1/2 W

•Leads to all capacitors should be as short as possible to minimize inductance effects. The location and spacing of capacitors is critical and may require adjustment for optimum results.

The capacitor values will depend upon the shape of the output pulse, the amplitude of the anode-current pulse, and the time duration of the pulse, or train of pulses. When the output pulse is assumed to be rectangular in shape, the following formula applies:

$$C = 100 \frac{i \cdot t}{V}$$

where C is in farads
i is the amplitude of anode current in amperes
V is the voltage across the capacitor in volts
and t is the time duration of the pulse in seconds

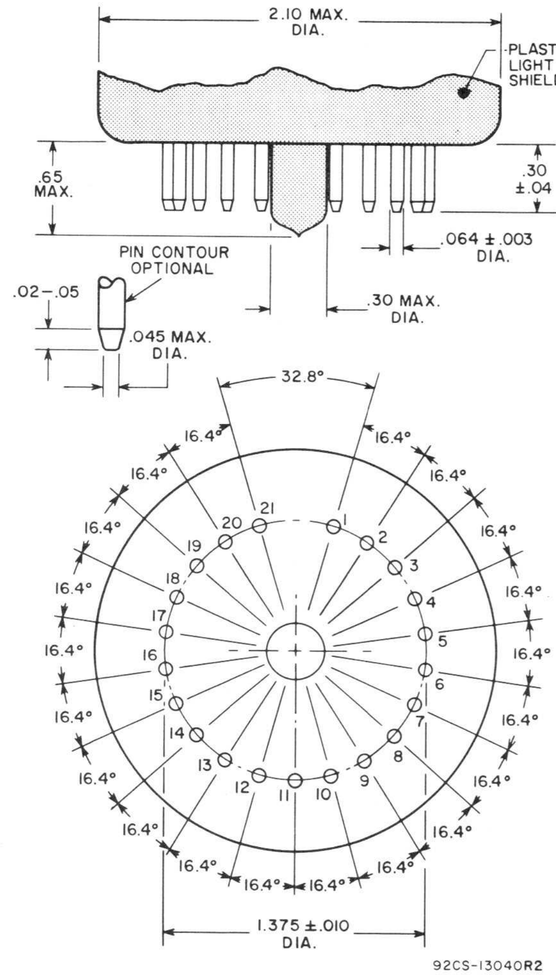
This formula applies for the anode-to-final dynode capacitor. The factor 100 is used to limit the voltage change across the capacitor to 1% maximum during a pulse. Capacitor values for preceding stages should take into account the smaller values of dynode currents in these stages. Conservatively a factor of 2 per stage is used. Capacitors are not required across those dynode stages where the dynode current is less than 1/10 of the current through the voltage-divider network.

For other shaped pulses or for a train of pulses, the total charge q should be substituted for (i·t) and the following formula applies:

$$C = 100 \frac{q}{V}$$

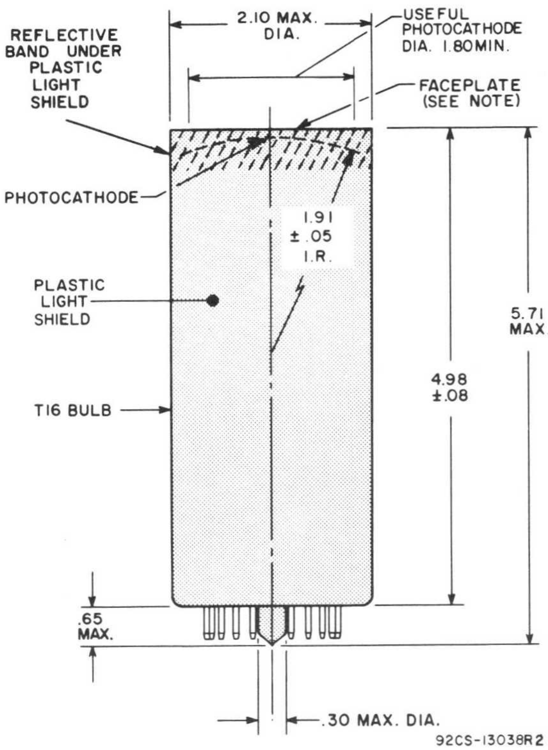
where $q = \int i(t)\, dt$ coulombs

Detail of Base Arrangement for Both Types



Dimensions in Inches

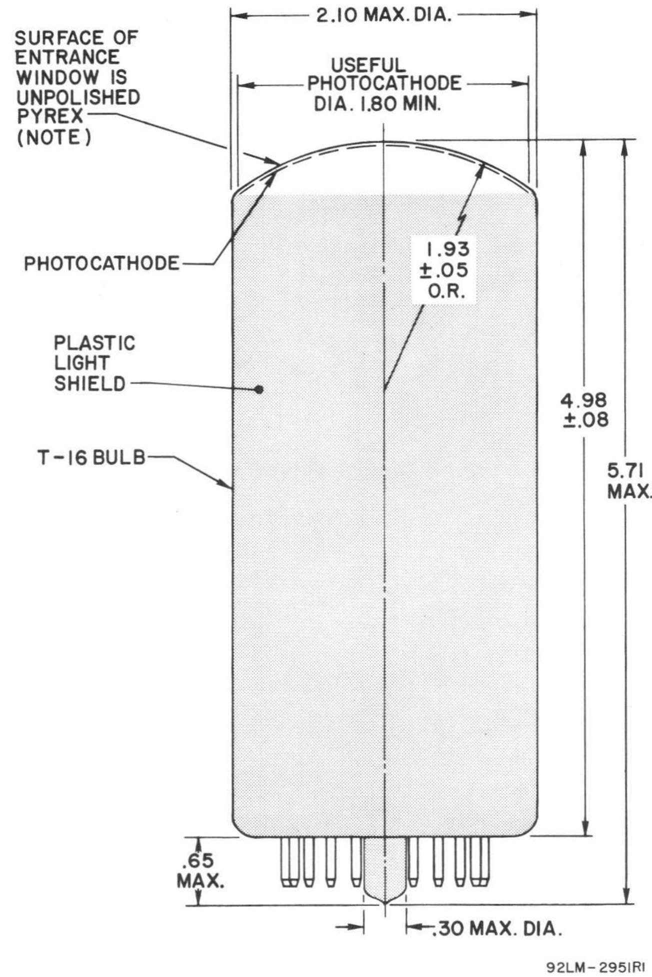
Dimensional Outline for Type C31000E



Dimensions in Inches

Note: Deviation from Flatness of External Surface of Faceplate will not exceed 0.010" from Peak to Valley.

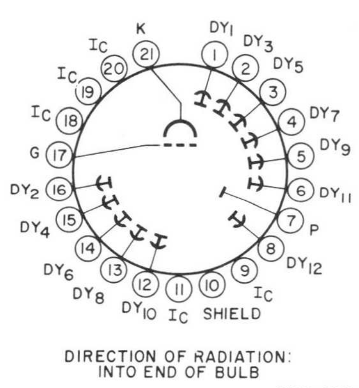
Dimensional Outline for Type C31000F



Dimensions in Inches

Note: Caution must be employed when handling this tube because of the thinness of the entrance window.

Basing Diagram for Both Types
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: Dynode No.11
Pin 7: Anode
Pin 8: Dynode No.12
Pin 9: Internal Connection, Do not use
Pin 10: Electron Multiplier Shield
Pin 11: Internal Connection Do not use
Pin 12: Dynode No.10
Pin 13: Dynode No.8
Pin 14: Dynode No.6
Pin 15: Dynode No.4
Pin 16: Dynode No.2
Pin 17: Focusing Electrode
Pin 18: Internal Connection, Do not use
Pin 19: Internal Connection Do not use
Pin 20: Internal Connection, Do not use
Pin 21: Photocathode

For your Information
RCA International Division
Licensee Service Harrison, N.J.

T.P.D.

Preliminary and Tentative Data

RCA Developmental Type, Dev. No. C74313 § now 4412 *

* The number identifies a particular laboratory tube design but the number and identifying data are subject to change. No obligations are assumed as to future manufacture unless otherwise arranged.
¢ Indicates a change. Place next to change item.

§ The C74313 has been assigned commercial number 4412.

The C74313 is a 10" display storage tube having one write gun with electrostatic focus and deflection. This tube presents a bright visual display of electrically stored information, including half tones, on an efficient phosphor for relatively long periods. With proper operating conditions the display has exceptional brightness and good contrast. The writing and viewing guns are mounted in a single neck with the viewing gun on the tube axis. The tube is encapsulated in a magnetic shield to reduce the effects of extraneous magnetic fields and to facilitate mounting. Voltages are applied to tube electrodes through potted leads equipped with connectors to make possible operation at high altitudes and conditions of high humidity.

This tube has been designed to withstand severe environmental conditions of temperature, humidity, altitude, vibration and shock.

GENERAL DATA

	Each Gun Writing Section	Viewing Section	
Heater, for Unipotential Cathode			
Voltage (AC or DC)	6.3 ± 10%	6.3 ± 10%	volts
Current, at 6.3 volts	0.6	0.6	amps
Focusing Method	Electrostatic		
Deflection Method	Electrostatic		
Deflecting Electrode Arrangement	See Outline Drawing, Sheet		

Phosphor, High-Visual-Efficiency, Aluminized P20 Type		
Fluorescence	Yellow	
Phosphorescence	Yellow	
Overall Length	20.75 max	inches
Tube Diameter	10.88 max	inches
Cables and Leads	See Outline Drawing	
Mounting Position	Any	
Weight	30 max	lbs

For further information or application assistance on this developmental type or other RCA tubes, please contact your field representative at the RCA District Office nearest you.

WHitehall 4-2900
Suite 1154
Merchandise Mart Plaza
Chicago 54, Ill.

HUmboldt 5-3900
744 Broad St.
Newark 2, N. J.

RAymond 3-8361
6355 E. Washington Blvd.
Los Angeles 22, Calif.

Maximum and Minimum Ratings - Absolute-Maximum Values (a)

To prevent possible damage to the tube, the viewing gun beam current should reach normal operating value and should be collimated to flood the stored surface before the writing gun beam current is turned on.

	Min.	Max.	
Altitude		60000	feet
Temperature Range			
Storage	-65	+85	°C
Operating	-55	+85	°C
Screen Voltage (DC)		10000	volts
Screen Voltage (Peak)		13000	volts
Backing Electrode Voltage (DC)	-30	10	volts
Backing Electrode Voltage (Peak)		15	volts
View Grid No. 5 Voltage	0	250	volts
View Grid No. 4 Voltage	0	200	volts
View Grid No. 3 Voltage	10	100	volts
View Grid No. 2 and Write Grids No. 2 and 4 Voltage (b)	0	250	volts
View Grid No. 1 Voltage	-200	0	volts
Voltage between View Heater and View Cathode	-200	200	volts
Voltage between Write Grid No. 4 and No. 2 and any Deflecting Electrode		1000	volts
Write Grid No. 3 Voltage with respect to write cathode	0	1200	volts
Write Grid No. 1 Voltage with respect to Write Cathode	-200	(c)	volts
Write Cathode Voltage	-2750	250	volts
Voltage between Write Heater and Write Cathode	-200	200	volts
Series Current-Limiting Resistance (un-bypassed) in screen circuit	1.0		megohm
Series Current Limiting Resistance (un-bypassed) in view Grid No. 5 Circuit	0.005		megohms

(a) All voltages are with respect to view cathode unless otherwise specified.

(b) View Grid No. 2 and write grids No. 2 and 4 are connected together within the tube.

(c) Write Grid No. 1 should not be more positive than is necessary to write the display to saturated brightness at the particular scanning and drive conditions used. In no case should write Grid No. 1 voltage be more positive than 0.

Preliminary and Tentative Data (Cont'd)

RCA Developmental Type, Dev. No. C74313

Recommended Operating Conditions (d)

View Gun Electrodes	Optimum Viewing Durations	Optimum Brightness	
Screen Voltage	9000	9000	volts
Backing Electrode	2	2	volts
View Grid No. 5 Voltage	150	200	volts
View Grid No. 4 Voltage (e)	40 to 110	80 to 130	volts
View Grid No. 3 Voltage (e)	10 to 60	10 to 60	volts
View Grid No. 2 Voltage (f)	125	125	volts
View Grid No. 1 Voltage (e)	-60 to 0	-60 to 0	volts

Write Gun Electrodes

Average Voltage of Deflection Plates (g)	95 to 125	volts
Write Grid No. 3 Voltage (g)	-1900 to -1600	volts
Write Grid No. 1 Voltage	(h)	volts
Write Cathode	-2500	volts

Circuit Values

Grid No. 1 Circuit Resistance (either gun)	1.0	max. megohm
Backing Electrode Circuit Resistance	0.005	max. megohm
Resistance of any Deflecting Electrode Circuit	0.01 (i)	max. megohms

(d) All voltages are with respect to view cathode unless otherwise specified

(e) Adjust for brightest, most uniform, full size pattern.

(f) View Grid No. 2 and Write Grid No. 2 and 4 are connected together within the tube.

(g) Adjust for smallest most circular spot.

(h) Adjust; Grid No. 1 bias voltage for cut off of writing beam is -60 to -120 volts with respect to write cathode.

(i) This is a recommended value for negligible distortion due to flood beam collection by deflection plates. In applications not having strict accuracy or uniformity requirements, this value can be as high as 0.1 max. megohms. For best performance, the four deflection plate impedances should be approximately equal.

Preliminary and Tentative Data (Cont'd)

RCA Developmental Type, Dev. No. C74313

Performance Characteristics at Recommended Operating Conditions.

	Note	Min	Median	Max	Units
View Gun					
At conditions for Optimum Brightness					
Useful viewing area	1		(See Note)		
Erase uniformity	2		0.3	0.4	
Brightness	3	50	200		fl
Viewing Duration	4	30	90		sec
Erase time	5		80	200	millisec.
At conditions for Optimum Viewing Duration					
Useful viewing area	1		(See Note)		
Erase uniformity	2		0.3	0.4	
Brightness	3		130		fl
Viewing Duration	4		120		sec
Erase time	5		80		milli-sec
Write Gun					
Deflection Factors					
D1 and D2		45	55	65	v/inch
D3 and D4		45	55	65	v/inch
Writing Speed	6	30000			in/sec.
Modulation	6		24	45	volts
Stored Spot Size at center of tube face	7		.023	.040	in
Undeflected Spot Position	8			12	mm

NOTES:

1. The minimum useful viewing area is that area enclosed by an 8.0 min. inch circle centered on the tube face; however the tube face is painted opaque over all areas except within the 5.6 x 6.4 inch rectangle shown on the outline drawing.

2. With no erase pulse, overscan the backplate with writing beam to obtain maximum brightness of pattern. Cutoff writing beam and apply rectangular erase pulse to the backplate. With amplitude of 8 to 10 volts (optimum viewing duration conditions) or 10 to 12 volts (optimum brightness conditions) and prf = 1 to 2 pps, adjust erase pulse duration to obtain complete erase in approximately 10 seconds.

   Determine:

   a) T1 - Time, or number of pulses, measured from start of erase to the instant of initial cutoff (definitely black) of any area .15 in. in diameter or larger, or to the instant when cut-off area becomes .15 in. in diameter or larger, within the 8.0 inch useful viewing area.

NOTES:

2. (Cont'd)

   b) T2 - Total time, or number of pulses, measured from start of erase to the instant of complete cutoff of the viewing beam (definitely black over a 8.0 inch diameter screen area). Erase uniformity is the ratio (T2-T1)/T2.

3. Measured with entire display written to saturated brightness and with writing and erasing turned off.

4. The time required for any 1.5 inch diameter area of the useful viewing area to spontaneously (no writing or erasing) rise in brightness from just dark (viewing beam cutoff) to 10% of saturated brightness.

5. A single erase pulse of 10 volts amplitude (optimum viewing duration) or 12 volts amplitude (optimum brightness) is applied to the Backing Electrode. Erase time is defined as the shortest duration of such a pulse that will completely erase the display.

6. With the scanning speed of the writing gun adjusted to be 30,000 inches per second, the voltage on Grid No. 1 of the writing gun required to write from just zero brightness (viewing beam cutoff) to 50% of staturated brightness (measured by shrinking raster technique) is defined to be the modulation voltage, and is expressed as the difference between the required Grid No. 1 voltage and the measured cutoff voltage of the tube.

7. Measured by the shrinking raster technique at a scanning speed of 30,000 inches per second and with the raster written from just zero brightness (viewing beam cutoff) to 50% of saturated brightness in one scan.

8. Spot position must be within circle of radius indicated centered with respect to the center of the tube face.

Preliminary and Tentative Data (Cont'd)

RCA Developmental Type, Dev. No. C74313

Environmental Data

Type C74313 was designed to withstand the following environmental tests.

Vibration

The tube shall be vibrated in accordance with the following schedule of inputs.

	Direction of Motion		
Frequency c.p.s.	Y along major axis (a)	X perpendicular to major axis (b)	Z perpendicular to major axis (c)
5-10	.036" D.A.	.036" D.A.	.036" D.A.
10-55	± 1.2G	± 1.2G	± 1.2G
50-130	± 2.0G	± 2.0G	± 2.0G
130-250	± 2.0G	± 1.5G	± 1.5G
250-500	± 2.0G	± 2.0G	± 2.0G

Inputs shall be measured at the attachment points of the tube with the vibration fixture and shall be adjusted so that the lowest recorded input value at any attachment point shall correspond to the above specification.

During vibration a circular trace shall be presented on the screen.

The tube shall be mounted rigidly to the vibration table and the procedure outlined below followed:

a. The tube, operating, shall be vibrated in a direction along the tube major axis with the frequency varying between 5 to 500 cycles per second at the above amplitudes. The frequency cycle may be continuous from 5 to 500 or may be in steps. However, the rate of change shall be such that the complete cycle (5 - 500 - 5) will consume approximately 15 minutes. The frequency of and and all resonant points shall be noted.

   The tube shall then be vibrated for 30 minutes at the major resonant frequency noted. If the tube has a number of resonant frequencies then the tube shall be vibrated according to the following schedule.

No. of Resonances	0	1	2	3	4
Total Vibration time at resonance	-	30 min.	1 hr.	1½ hrs.	2 hrs.
Cycling Time	3 hrs	2½ hrs.	2 hrs.	1½ hrs.	1 hrs.

In no case shall the tube be required to have a total elapsed vibration time for each axis of more than 3 hrs.

Environmental Data (Cont'd)

If more than four resonant frequencies are noted in any one plane the four most severe shall be used.

b. Repeat (a.) with the direction of vibration changed to a direction perpendicular to the major axis and parallel to one set of deflection plates of the writing gun.

c. Repeat (a.) with the direction of vibration perpendicular to the major axis and parallel to the other set of deflection plates of the writing gun.

Shock - Nondestructive

The tube shall be firmly clamped to the shock table. The tube shall be subjected to 18 impact shocks of 15G each for a duration of 11 ± 1 milliseconds each. Three of the shocks shall be applied in each direction along each of the three mutually perpendicular axis x, y, and z.

Shock - Destructive

The tube shall be firmly clamped to the shock table. The tube shall be subjected to 12 impact shocks of 30G each for a duration of 11 ± 1 milliseconds each. Two of the shocks shall be applied in each direction along each of the three mutually perpendicular axis x, y, and z. After the destructive shock test the tube need not function in any manner and any degree of internal destruction is acceptable. There shall be no cracking or destruction of the faceplate and all internal parts shall remain within the shield.

Low Temperature Storage

The tube shall be stored at -65°C for 48 hours.

High Temperature Storage

The tube shall be stored at +85°C for 48 hours.

Low Temperature Operation

The tube shall be installed in the test chamber. With the tube not operating the chamber temperature shall be reduced to -55°C. After the tube temperature has stabilized, the tube shall be turned on and off four times at 5 minute intervals.

High Temperature Operation

The tube shall be tested as under low temperature operation except that the temperature shall be +85°C instead of -55°C.

ENVIRONMENTAL DATA (Cont'd)

Temperature Shock

Temperature Shock - The tube shall be placed in the test chamber wherein a temperature of 85°C is maintained. This temperature shall be maintained for a period of not less than four hours. At the conclusion of this period and within 5 minutes, the tube shall be transferred to a chamber having an internal temperature of -40°C. The tube shall be subjected to this temperature for a period of 4 hours.

This procedure shall be repeated 2 more times for a total of 3 cycles.

Humidity

The tube shall be tested as required by paragraph 4.4 of MIL-E-5422D.

Altitude

With the voltage specified below impressed upon the tube through the normal connections and leads, no visible corona or arcing shall be evident in 15 minutes of operation at 60,000 feet and +35°C in a darkened altitude chamber.

The following circuit shall be used to apply the voltage specified to the tube and to detect corona. The screen lead shall be connected to a +11KV supply voltage through a 25 megohm resistor (nearer to the tube) and a 5.1 megohm resistor, in series. The 5.1 megohm resistor shall be shunted by a 56 kilohm resistor (nearer to the tube) and an NE51 neon bulb, in series. The write gun heater, the write gun cathode, the write gun control grid, and the write gun focus leads shall be all connected together, and shall be connected to a -2750 volt supply through a 10 megohm resistor (nearer to the tube) and a 5.1 megohm resistor, in series. The 5.1 megohm resistor shall be shunted by a 56 kilohm resistor (nearer to the tube) and an NE51 neon bulb, in series. All other tube electrodes, tube shield, and cable shields shall be grounded. The neon bulbs shall not fire. The tube voltage shall be switched off and on three times during this period.

Preliminary and Tentative Data (Cont'd)

RCA Developmental Type, Dev. No. C74313

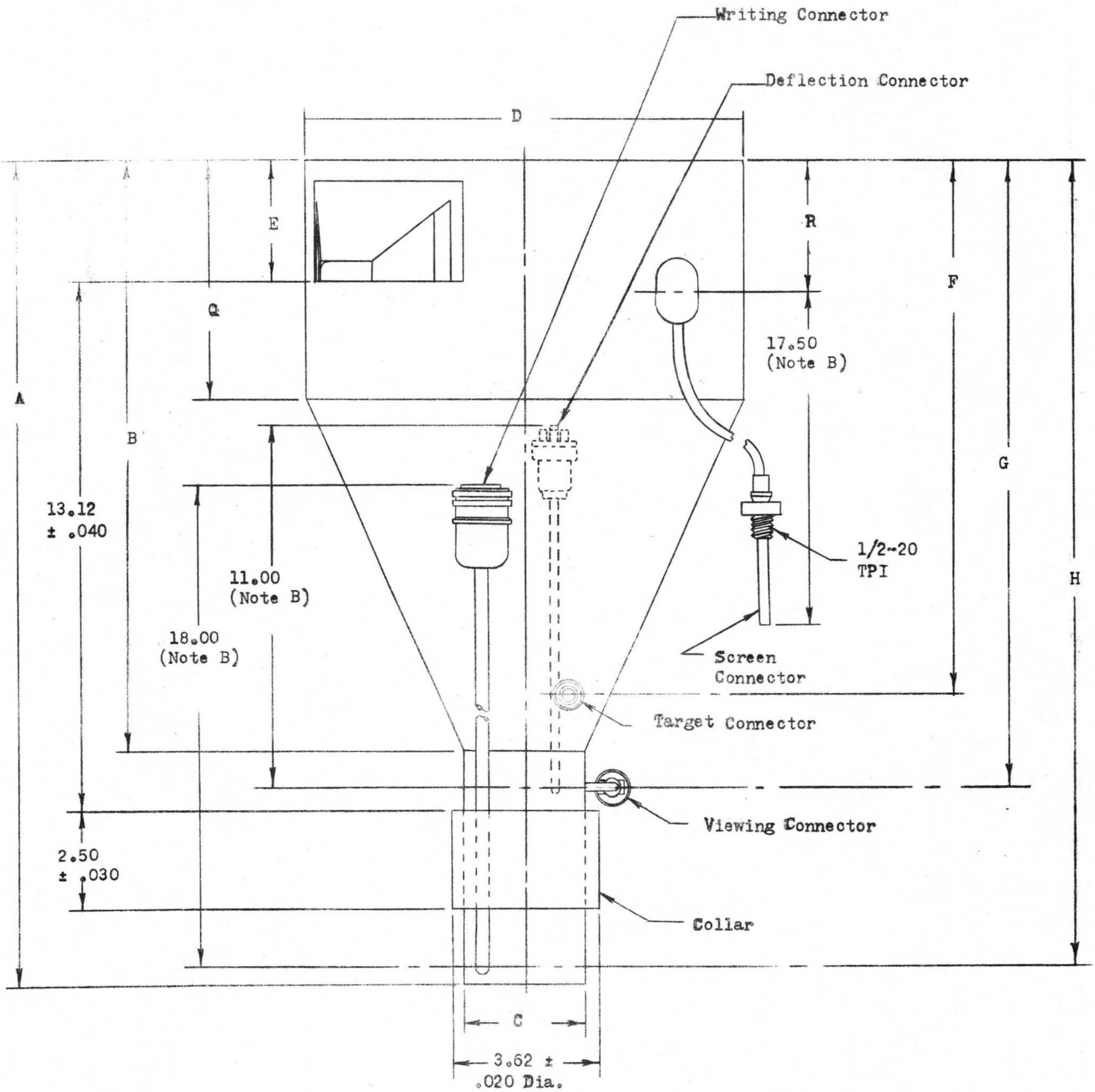
CAUTIONS

The user of this tube is advised to pay particular attention to the following items in the interest of avoiding possible tube damage.

1. Be sure to include unbypassed one megohm series screen resistor.
2. Do not exceed the maximum or minimum ratings.
3. Be sure to include unbypassed 10 kilohm series resistor in view grid No. 5.
4. Do not use excessive writing beam current.
5. Protect against scanning failure.
6. Protect against loss of writing gun bias.
7. Keep writing beam biased off until after other writing gun voltages are on.
8. Never write unless viewing beam is on.

Preliminary and Tentative Data (Cont'd)

RCA Developmental Type, Dev. No. C74313



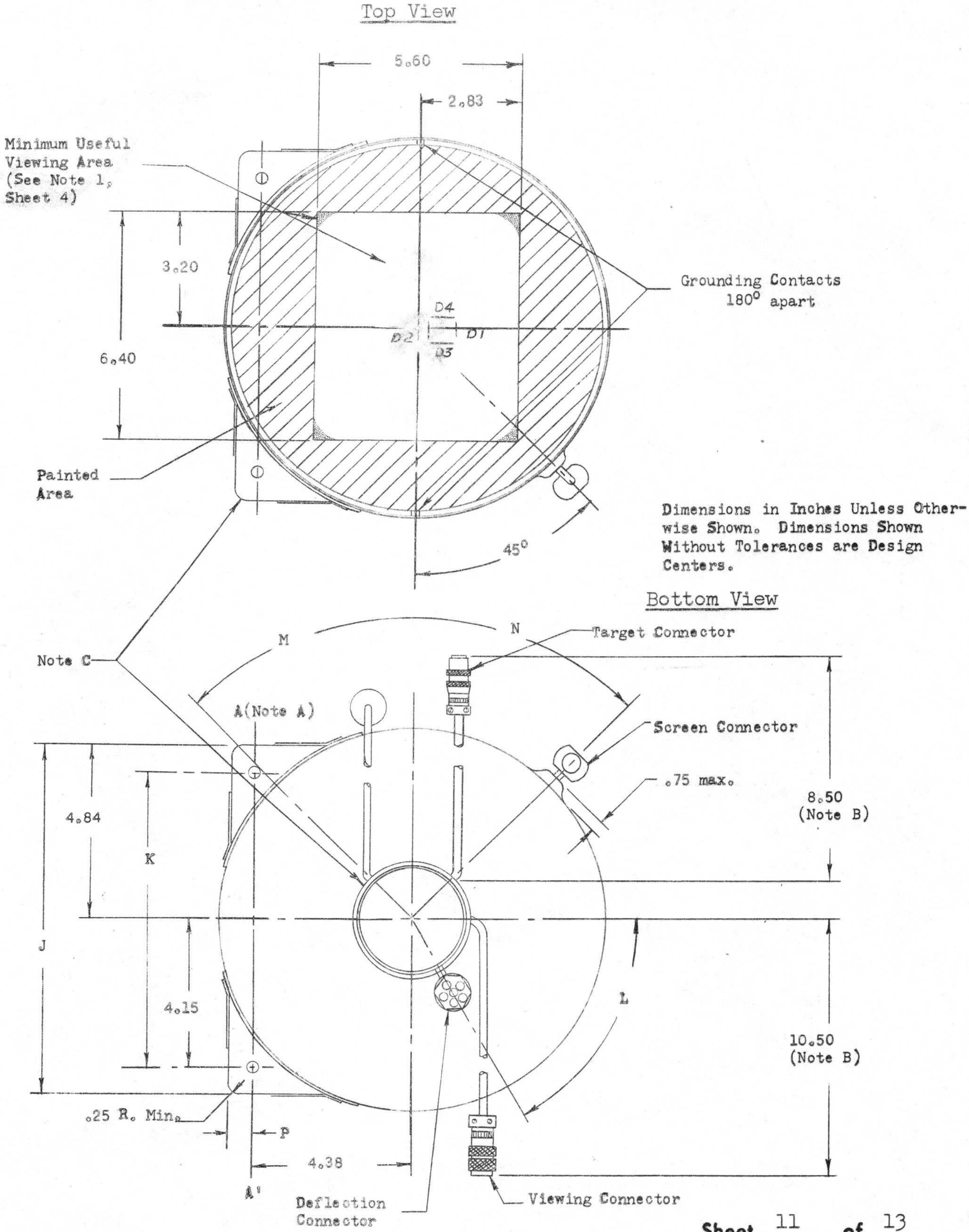
Dimensions in Inches Unless Otherwise Shown. Dimensions Shown Without Tolerances are Design Centers.

Date May 2, 1961

Supersedes .... (GIVE DATE)

Preliminary and Tentative Data (Cont'd)

RCA Developmental Type, Dev. No. C74313



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Sheet 11 of 13

Date May 2, 1961

Supersedes ....
(GIVE DATE)

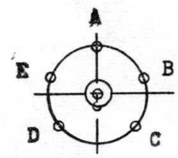
T 506-2 3/59

Wire Connection Guide

1. Screen Connector Assly - Screen   AMP No. P. O. 83C141699H46, AMP 836921 and 1/2-20TPI End Cap

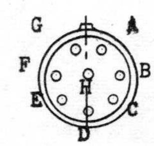
2. Writing Connector Assly. (Winchester No. PM6P/HV and Amphenol No. 97-3106A-20 (438)

   A. Write Gun Cathode
   B. Write Gun Heater
   C. Write Gun Heater
   D. Write Gun Control Grid
   E. Write Gun Focus



3. Viewing Connector Assly. (Bendix No. PT06E-12-8P(SR))

   A. View Gun Heater
   B. View Gun Cathode
   C. View Gun Grid No. 1
   D. View Gun Grid No. 2, Write Gun Grids No. 2 and No. 4
   F. View Gun Grid No. 3 (Collimator No. 1)
   G. View Gun Heater

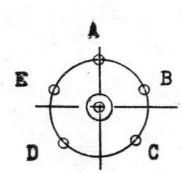


4. Target Connector Assly. (Bendix No. PT06E-8-4P (SR)

   A. Backplate (Violet Wire)
   B. View Gun Grid No. 5 (Collector)(Red Wire)
   C. View Gun Grid No. 4 (Collimator No. 2) (Green Wire)

5. Deflection Connector Assly. (Winchester No. PM6P/LS6 and No. PM6H)

   B. Deflecting Electrode No. 1 (D1)
   C. Deflecting Electrode No. 2 (D2)
   D. Deflecting Electrode No. 3 (D3)
   E. Deflecting Electrode No. 4 (D4)



Preliminary and Tentative Data (Cont'd)

RCA Developmental Type, Dev. No. C74313

TABULATED DIMENSIONS

Dim	Minimum	Bogie	Maximum
A	20.25	20.50	20.75
B	13.91	14.16	14.16
C		3.00	3.50
D		10.75	10.88
E	2.94	3.00	3.06
F	13.13	13.25	13.37
G	15.38	15.50	15.62
H	19.88	20.00	20.12
J	9.60	9.68	9.70
K	8.28	8.30	8.32
L	50°	60°	70°
M	35°	45°	55°
N	35°	45°	55°
P	.60	.63	.66
Q		5.94	
R		3.25	

NOTES:

A. Horizontal trace on tube face is parallel to horizontal centerline A-A' within $\pm 1^\circ$.

B. Tolerance on lead length is $^{+.50''}_{-.00''}$.

C. Shield neck and collar need not be concentric. Major axis of the tube is defined with respect to the collar and the holes in the mounting brackets.

Dimensions in Inches Unless Otherwise Shown. Dimensions Shown without Tolerances are Design Centers.