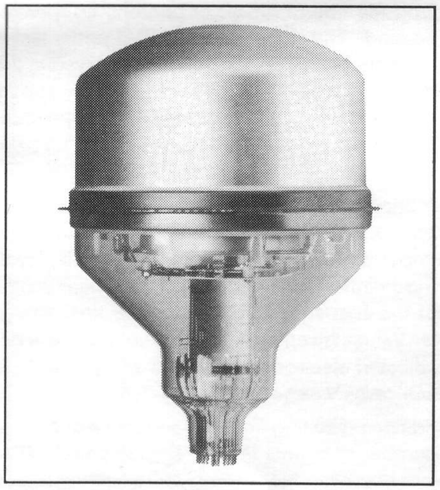
C83061E Photomultiplier



260-mm (10.4-inch) Diameter 12-Stage, End Window Quantacon® PMT

- **Low Dark Noise**
- **High Gain**
- **Low-Light Level Applications**
- **High Photon Counting Efficiency**
- **High-Stability Dynodes**

BURLE C83061E is a developmental 12-stage, end-window, 260-mm (10.4-inch) Quantacon photomultiplier employing a semi-transparent bialkali photocathode and an extremely high-gain gallium-phosphide first dynode followed by high-stability copper-beryllium dynodes in the succeeding stages. Originally designed for use in large-scale Cerenkov detector systems, the C83061E is expected to find application to other extremely low-light level measurement systems in the blue region of the spectrum.

The first dynode of these Quantacon photomultipliers provides up to an order of magnitude increase in secondary-emission ratio over conventional dynode materials. This high ratio permits excellent discrimination of single photoelectron events.

The latest methods of electron-optics design were used to arrive at the highly efficient photoelectron collection system of the C83061E, leading to a device eminently well suited to photon-counting applications.

General Data

Faceplate:
- Material .... Schott 8250 or Equivalent
- Cross-section .... Spherical Section
- Thickness .... 5.8 ± 1.8 mm (.23 ± .07 in)
- Index of refraction @ 587.6 nm 1.487

Photocathode:
- Minimum useful diameter .... 235 mm (9.25 in)
- Minimum projected area .... 434 sq cm (67.2 sq in)
- Material .... Potassium-Cesium-Antominide (Bialkali)
- Spectral response .... See **Figure 1**
- Wavelength of maximum response .... 380 nm

Dynodes:
- Number 12
- Structure .... In-line electrostatic focus type
- Dynode No.1, secondary emitting surface .... Gallium-phosphide
- Dynode Nos.2-12, secondary emitting surface .... Beryllium-oxide

Direct Interelectrode Capacitance (Approximate):
- Anode to dynode No.12 .... 8.0 pF
- Anode to all other electrodes .... 8.7 pF

Socket .... BURLE Types AJ2145A (supplied), AJ2144A (optional)

Operating Position .... Any

Weight (Approximate) .... 4.4 kg (9.76 lb)

BURLE Electron Tubes

Absolute Maximum Ratings - Limiting Values[1]

DC Supply Voltage:

Between anode and cathode	2500	V
Between anode and dynode No.12	600	V
Between consecutive dynodes	400	V
Between dynode No.1 and cathode	1000	V
Between focusing electrode No.1 and cathode	1000	V
Between focusing electrode No.2 and dynode No.1	1000	V

Temperature:

Operating and storage	-30 to +50	°C

Test Parameters and Limits

In order to insure that BURLE photomultipliers consistently meet exacting performance standards, each device is subjected to a series of tests that verify that its operating parameters conform to normal expectations for the tube type. The conditions under which these tests are performed may or may not duplicate operating conditions in particular applications. In any case, long experience has shown that a tube satisfying the criteria indicated below can be expected to perform satisfactorily in applications to which it is suited.

Unless otherwise noted, power supply voltage is applied to the tube's electrodes via a Voltage Divider Network (VDN) in accordance with **Figure 3**. Ambient temperature during testing is approximately 22 °C.

Test Parameter	Typical	Units
Cathode Responsivity[2]	9.0	uA/inc lm
Power Supply Voltage for Gain = 1E7[3]	1940	V
Voltage for optimum photoelectron collection[4]		
Focusing electrode No.1	6	%
Peak to Valley Ratio[5]	2.9	-
Dark Noise Count Rate[6]	5500	Hz
Anode Dark Current[7]	15	nA

Typical Performance Characteristics

The following information is provided in order that customers may predict the typical performance of a tube of this type in an application where TEST PARAMETER data may not be directly relevant. This material has been derived from TEST PARAMETER values and from special evaluations conducted in BURLE's Application Engineering Laboratory. This information is supplied for guidance only and is not intended to supercede the limiting ranges given in the TEST PARAMETER section.

Unless otherwise indicated, the power supply voltage (E) is applied to the tube's electrodes via a Voltage Divider Network (VDN) in accordance with **Figure 3**.

Parameter	Typical	Units
Cathode Quantum Efficiency @ 380 nm	27	%
Multiplier Gain Exponent[8]	10.5	-
Multiplier Gain versus E	See **Figure 5**	
Anode Pulse due to single photoelectron event[9]:		
Rise time[10]	3.5	ns
Fall time[10]	11.0	ns
FWHM[10]	6.0	ns
Transit time[11]	83.0	ns
Transit time spread[11]	2.3	ns
Peak Linear Anode Current[12]	25	mA

1. In accordance with the Absolute Maximum rating system as defined by the Electronic Industries Association Standard RS-239A, formulated by the JEDEC Electron Tube Council.
2. Under the following conditions: Light from a tungsten filament lamp operated at a color temperature of 2856 K is transmitted to the cathode through a blue filter (Corning C.S. No. 5-58, polished to 1/2 stock thickness). The value of flux incident on the filter is 0.1 millilumen and 300 volts is applied between cathode and all other electrodes connected as anode.

   Cathode Responsivity = Cathode Current / Incident Flux
3. Under the following conditions: Light from a green-emitting LED is allowed to illuminate the full area of the photocathode. Sufficient neutral density filtering is inserted between the LED and the photocathode to limit the rate of arrival of photons to approximately 15000 per second. The signal from the PMT under test is directed to a Multi-Channel Analyzer (MCA) and displayed in the form of a pulse height histogram or spectrum. Power supply voltage is adjusted such that the "singles peak" of the spectrum appears in the MCA channel pre-calibrated to represent 1.6 picocoulombs.
4. With operating conditions resulting from Note 3, the voltages on focusing electrodes No.1 and No.2 are iteratively adjusted to maximize the number of recorded counts in the displayed "singles peak". If the channel-position of the "singles peak" shifts appreciably, repeat the sequence of Note 3 before final adjustments per this note. Values given represent the voltage between cathode and the indicated electrode, expressed as a percentage of the voltage difference between cathode and dynode No.1.
5. With operating conditions resulting from the sequence of Note 4, record the ratio (Number of counts in the "singles peak" MCA-channel)/(Number of counts in the "valley" MCA-channel). See **Figure 4.**
6. With operating conditions resulting from the sequence of Note 4, initiate repeated spectrum accumulation cycles, meanwhile re-adjusting MCA system amplifier gain to place the "singles peak" in channel 40. When this condition is established, totally eliminate photocathode illumination and initiate a noise spectrum accumulation of T seconds duration. Initiate a summation, S, of all counts displayed in channels 8 to 640 inclusive. Determine noise count rate as S/T.
7. With operating conditions resulting from the sequence of Note 6, measure and record DC dark current.
8. The relationship between multiplier gain and power supply voltage (E) may be expressed as follows:

   Gain = C x E

   where C = a constant

   = the gain exponent
9. Anode Pulse timing parameters are defined in **Figure 6**.
10. For purposes of Rise Time, Fall Time, and FWHM measurements, the delta-function stimulus of **Figure 6** is taken to represent the arrival of individual photons under conditions as described in Notes 3 and 4.
11. The photocathode is fully illuminated by a delta-function light pulse of approximately 1 nanosecond duration. Power supply voltage during this test is as established by the sequences of Notes 3 and 4. Transit Time is defined as indicated on **Figure 6**. Transit Time Spread (TTS) is defined as the full-width-half-maximum of the distribution of Transit Times about the mean Transit Time, observed over a period of time encompassing a series of illumination events.
12. The photocathode is fully illuminated by a square light pulse of approximately 100 nanoseconds duration. Introduction of appropriate optical attenuation into the input light path allows determination of the peak pulse anode current at which space charge effects cause deterioration of the normally linear light-in/current-out function. The indicated peak current value is associated with approximately 5% deviation from linearity, with 2000 volts applied to the VDN of **Figure 3**.

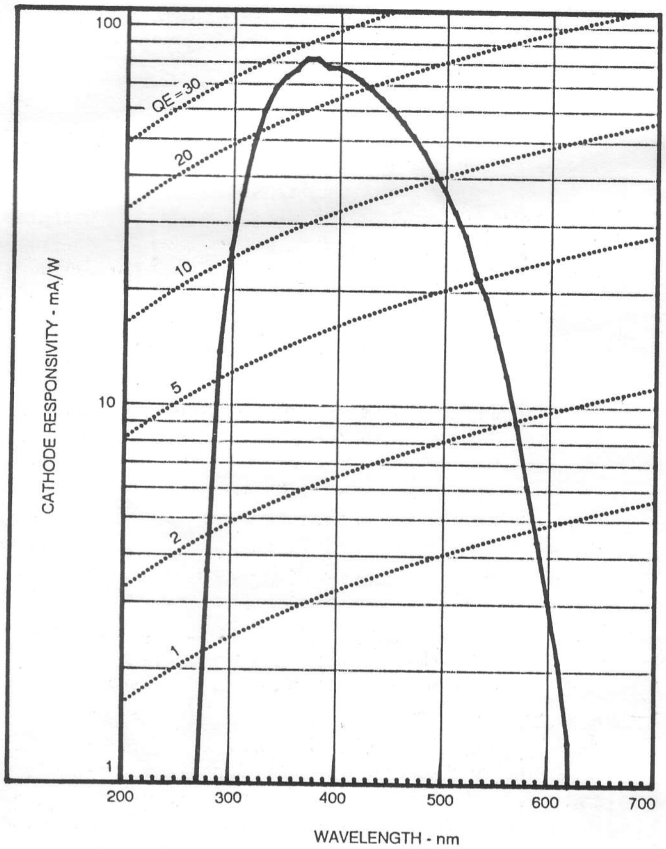


Figure 1 - Typical Photocathode Spectral Response Characteristic

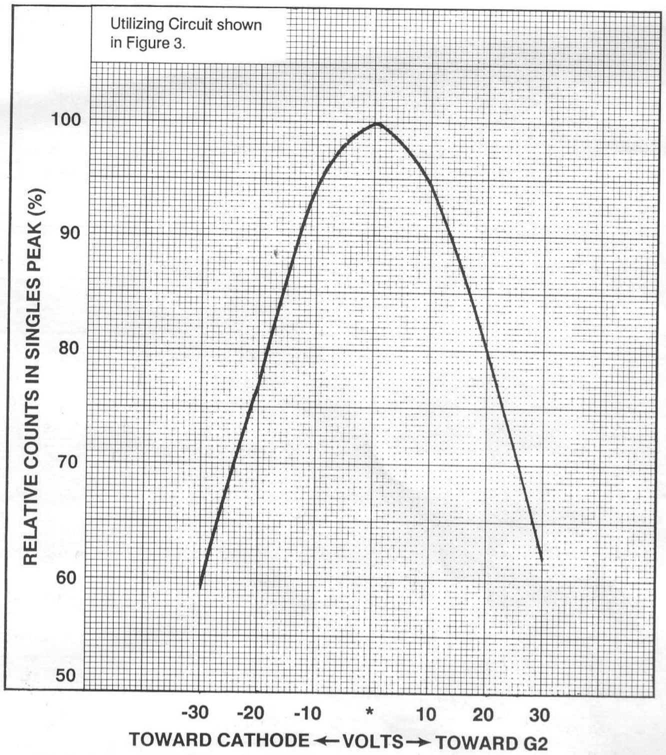
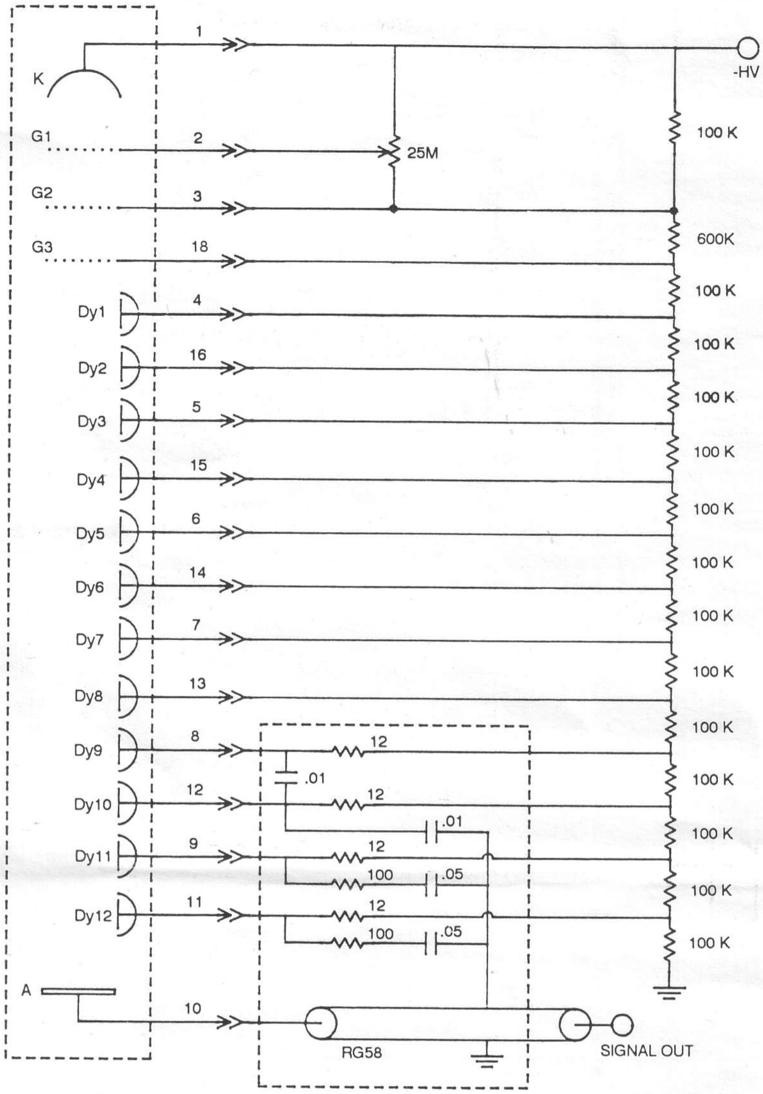


Figure 2 - Typical Effect of Grid No.1 Potential Variation on Count Rate

* Optimum potential for best collection efficiency. Optimum Grid No. 1 potential defined as that voltage that maximizes single photon counting rate with full photocathode illumination.

Warning - Personal Safety Hazard **Electrical Shock -** Operating voltages applied to this device present a shock hazard.



Note 1: Circuit components shown within the dashed lines should be mounted directly on the tube socket (AJ2144A or AJ2145A). However, care should be taken that the socket pins are free to move within their seats in the socket body. Otherwise, difficulty in tube insertion may lead to tube damage.

Note 2: This circuit arrangement includes concepts suggested by Los Alamos National Laboratory and is shown here with its permission.

Figure 3 - Circuit Arrangement Used to Obtain Listed Data

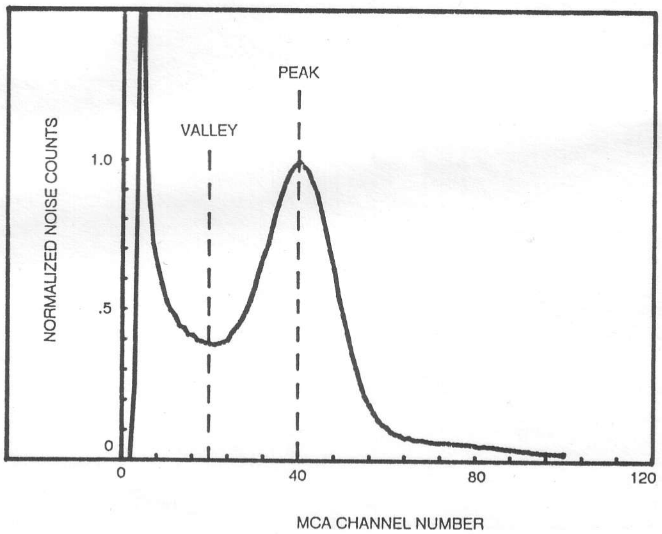


Figure 4 - Typical Single Photoelectron Spectrum

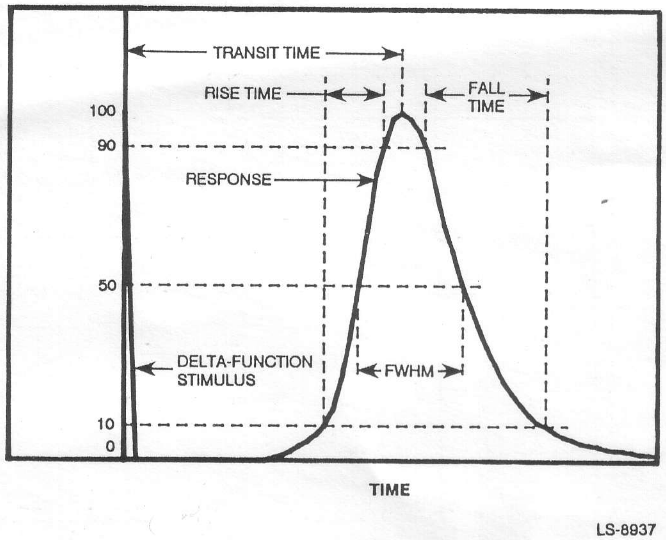


Figure 6 - Response to Delta-Function Light Stimulus

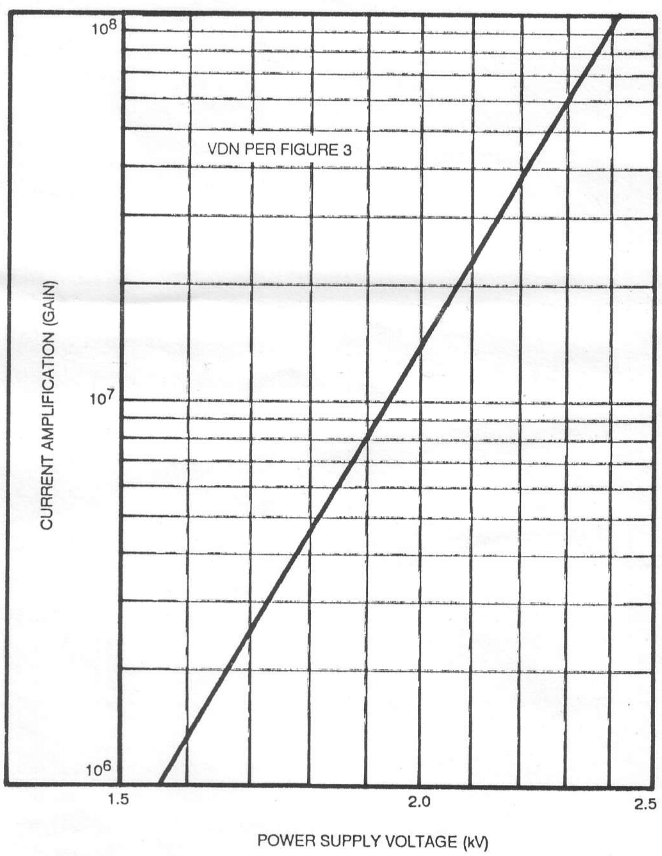
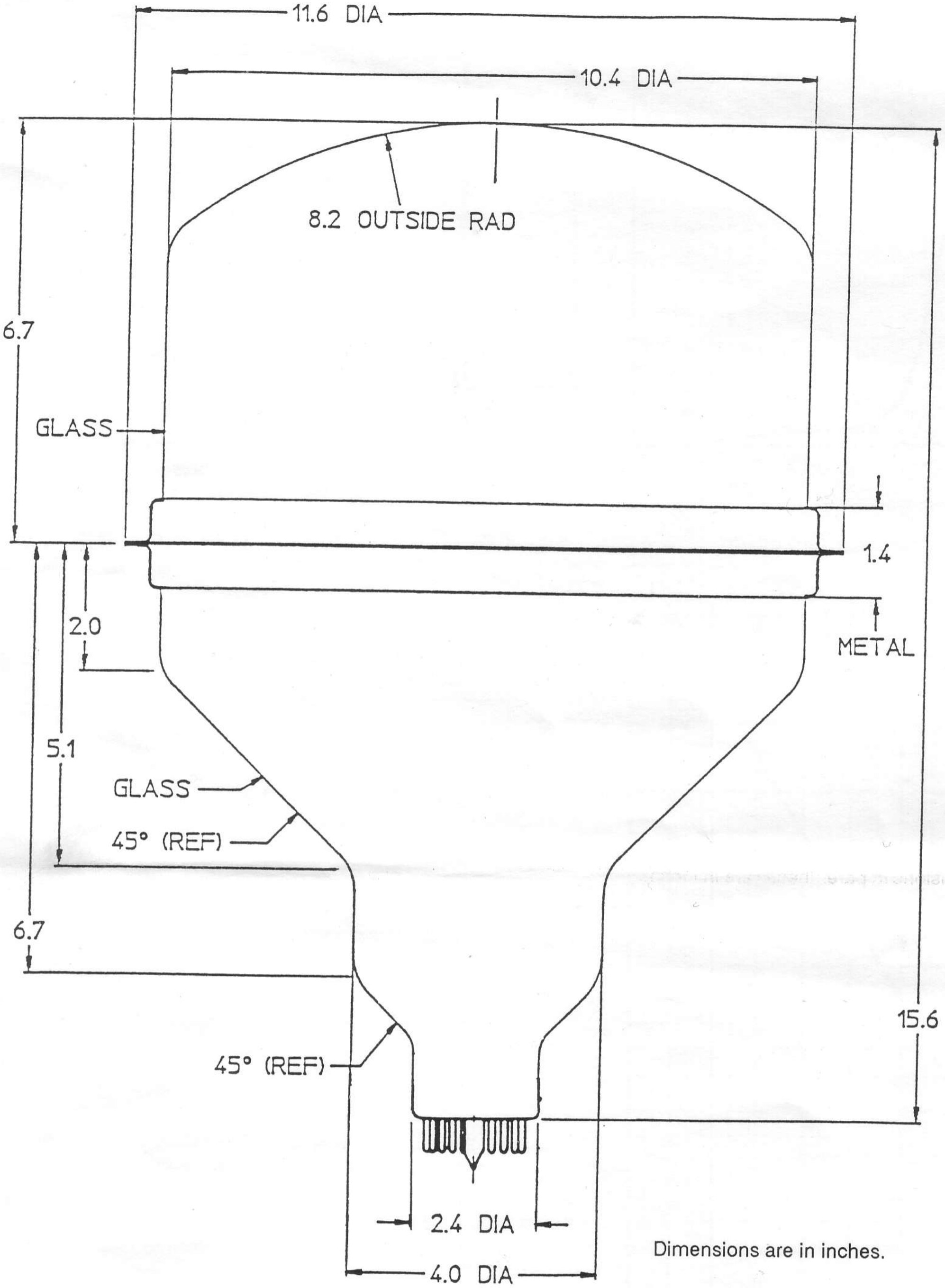
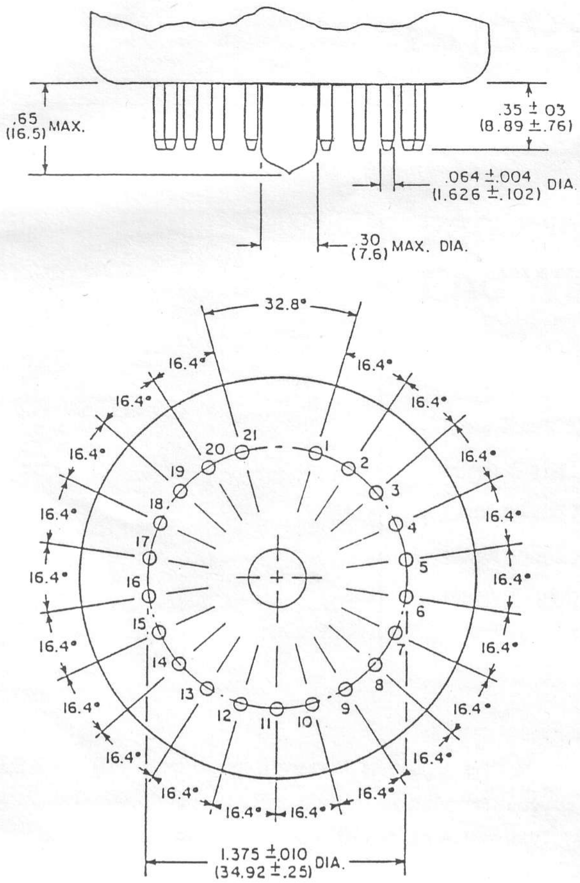


Figure 5 - Typical Current Amplification Characteristic



Dimensions are in inches.

Figure 7 - Dimensional Outline



Dimensions in millimeters. Dimensions in parentheses are in inches.

Pin No. 1: Photocathode
Pin No. 2: Focusing Electrode No.1
Pin No. 3: Focusing Electrode No.2
Pin No. 4: Dynode No.1
Pin No. 5: Dynode No.3
Pin No. 6: Dynode No.5
Pin No. 7: Dynode No.7
Pin No. 8: Dynode No.9
Pin No. 9: Dynode No.11
Pin No. 10 Anode
Pin No. 11 Dynode No.12
Pin No. 12 Dynode No.10
Pin No. 13 Dynode No.8
Pin No. 14 Dynode No.6
Pin No. 15 Dynode No.4
Pin No. 16: Dynode No.2
Pin No. 17: Internally connected - Do not use
Pin No. 18: Focusing Electrode No. 3
Pin No. 19: Internally connected - Do not use
Pin No. 20: Internally connected - Do not use
Pin No. 21: Internally connected - Do not use

Figure 8 - Detail of Tube Base

BURLE

PHOTOMULTIPLIER

TEST DATA

Ser. No. V24332

Type C83061E 16

Date 11/11/91

1E7 Gain @

2052 volts

G1 VOLTS 1989

G2 VOLTS –

D1 VOLTS –

P/V Ratio= ≥1.5

Dark I = 15 nA

2-3-89 rem

BURLE INDUSTRIES, INC., Tube Products Division
1000 New Holland Ave., Lancaster, PA 17601-5688 U.S.A.

Supersedes 12-89 Printed in U.S.A. / 1-90