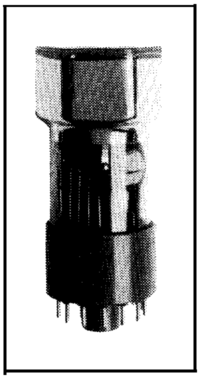
S83053F, S83053FMl Photomultipliers

60-mm (2.36 Inch) Hexagonal 8-Stage, Head-On PMTs



BURLE S83053F and S83053FMl are sixty mm hexagonal, 8-stage photomultiplier tubes. They employ potassium-cesium-antimonide (bialkali) photocathodes and electron multipliers of the box-and-grid type. The multiplier dynodes are of the alkali antimonide type and are processed in a manner that provides well-controlled overall gain.

These tubes were designed primarily for application to medical diagnostic systems of the Anger camera type. However, they are expected to be useful also in general scintillation-counting applications and in the detection and measurement of low-level light events in the blue region of the spectrum.

S83053F has a permanently-attached base; S83053FMl is supplied with a temporary base. In cases where prospective production volume justifies the necessary tooling expense, BURLE is prepared to provide devices with permanently-attached voltage divider networks as defined by customer specification.

General Data

Faceplate:

- Material .... Schott B270 Glass or Equivalent
- Cross-section .... Plano-plano
- Thickness .... 3.18 +/- 0.38 mm
- Index of refraction @ 436 nm 1.523

Photocathode:

- Type .... Semi-transparent K-Cs-Sb (Bialkali)
- Spectral response .... **See Figure** 1
- Wavelength of maximum response .... 370 nm

Dynodes:

- Number 8
- Secondary-emitting surface .... Alkali-antimonide
- Structure .... Box-and-grid

Direct Interelectrode Capacitance (approximate):

- Anode to dynode no.8 .... 6.5 pF
- Anode to all other electrodes .... 7.1 pF

Weight (approximate) .... 150 gm

Socket .... BURLE AJ2283

Absolute Maximum Ratings[1]

Limiting Values

DC Supply Voltage:

- Between anode and cathode .... 1200 V
- Between anode and dynode no. 8 .... 300 V
- Between adjacent dynodes .... 250 V
- Between dynode no.1 and cathode .... 300 V

Average Anode Current (Averaged over any 30 second interval) .... 0.1 mA

Temperature:

- Storage .... -40 to +70 °C
- Operation .... See Note 2

Test Parameters

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. Although the conditions under which these tests are performed may or may not duplicate operating conditions in particular applications, long experience has shown that a tube satisfying the criteria indicated below can be expected to perform satisfactorily in a variety of applications.

Power supply voltage (E = 800 Volts unless otherwise noted) is applied to the tube's electrodes via a Voltage Divider Network (VDN) in accordance with the distribution listed in Table 1-A. Ambient temperature during testing is approximately 22 degress C.

Test Parameter	Min.	Typ.	Max.	Units
Cathode Responsivity[3]	8.8	10.5	--	uA/inc. Im
Anode Responsivity[4]	0.75	2.0	2.7	A/inc. Im
Anode Dark Current @E = 1000Volts[5]	--	3.0	15	nA
Pulse Height[6]				
^{57}Cobalt	100	250	400	mV
Pulse Height Resolution[6]				
^{57}Cobalt	--	8.8	9.3	%
Count Rate Stability[7]	-1	-0.04	1	%

BURLE Electron Tubes

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 as presented 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 issupplied for guidance only and is not intended to supersede 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 the distribution listed in Table 1-A.

Parameter	**Typ.**	**Units**
Cathode Responsivity @ 380 nm	100	mA/W
Cathode Quantum Efficiency @ 380 nm	32.6	%
Multiplier Gain @E = 800 V [8]	190000	-
Gain Exponent[9]	5.8	-
Gain versus E	**See Figure 5**	-
Anode Dark Current versus E[10]	**See Figure 6**	-
Sensitivity to External [11]	12	%
Anode Pulse:[12]		
Rise time	13	ns
Fall time	29	ns
FWHM	25	ns
Transit Time	69	ns
Transit time spread [13]	1	ns
Peak Linear Anode Current: [14]		
VDN per Table 1-A	8	mA
	14	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 In general, these types can be operated successfully over the temperature range specified for storage. However, the user should be aware that photocathode resistivity increases at reduced temperature, resulting in possible loss of effective photocathode responsivity, as shown in **Figure** 2. Also, anode dark current tends to increase with operating temperature, as shown in **Figure 3.**

3 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

4 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 (Coring C.S. No. 5-58, polished to 1/2stock thickness).The value of flux incident on the filter is 10 microlumen and test voltage (E) is 800 volts.

Anode Responsivity = Anode Current / Incident Flux

5 Anode dark current is measured at an ambienttemperature of 22 degress C. The tube under test is held in essentially complete darkness for a minimum of 30 minutes prior to the test, which is conducted in complete darkness. Test voltage (E) is 1000 volts. A second test is conducted with E = 1200 volts. Under this condition, Anode Dark Current shall not exceed five times the value recorded with E = 1000 V.

6 Power supply voltage during this test is 800 volts. The test is conducted with a gamma-ray source of sufficient intensity to produce between 5K and 15K counts per second from the device under test when positioned on the back side of the scintillator and along its principle axis. The scintillator is an encapsulated 2" long x 2" diameter NaI(Tl) crystal identified as BURLE No 2010 or equivalent. The faceplate end of the scintillator is coupled to the faceplate of the photomultiplier by a coupling fluid such as clear mineral oil or equivalent. The anode of the photomultiplier is connected to a shunt RC network whose time constant is 10 + / - 2 micro-seconds and to the input of a charge-sensitive preamplifier, Nuclear Data Model 520 or equivalent. A multi-channel analyzer (MCA) characterizes scintillation events in terms of an amplitude histogram as illustrated in **Figure** 4, on which are defined Pulse Height and Pulse Height Resolution. Pulse Height is given in millivolts developed across a hypothetical load consisting of **a** capacitance of 100 picofarads shunted by a resistance of 100 kilohms.

7 A light-emitting diode (LED) is employed as a light source. The LED is driven by a suitable pulse generator so as to produce an anode pulse equivalent in amplitude and shape to that due to ^{57}Cobalt excitation of BURLE scintillator No. 2010 or equivalent. Following operation for at least 10 seconds at a LED pulse rate of 4000 Hertz, pulse height is measured and recorded as PHi. The LED pulse rate is changed to 40000 Hertz and pulse height is immediately measured and recorded as PHf. Count Rate Stability is defined as follows:

CRS = 100 x (PHf - PHi)/PHi

Note - This test is conducted on a periodic sampling basis.

8 Gain (Current Amplification) is defined as:

Gain = Anode Responsivity / Cathode Responsivity

9 The relationship between multiplier gain and power supply voltage (E) may be expressed as follows:

$$\text{Gain} = C \times E^{\alpha}$$

where C = a constant

α = the gain exponent

10 Anode dark current is measured at an ambient temperature of 22 degress C. The tube under test is held in essentially complete darkness for a minimum of 30 minutes prior to the test, which is conducted in complete darkness.

11 A magnetic field of 0.7 Gauss (approximating the earth's magnetic field), with flux lines perpendicular to the long axis of the unshielded tube under test, is rotated about the tube axis in increments of 30 degrees. Using an appropriate light stimulus, the anode signal from the tube is recorded at each magnetic field orientation. Magnetic sensitivity is defined as follows:

MFS = (Max. Signal - Min. Signal) / (Mean Signal)

12 The photocathode is fully illuminated by a delta-function light pulse of approximately 1 nanosecond duration and of intensity sufficient to create an anode current pulse of approximately 6 milliamperes (peak value). Power Supply Voltage during the test is 1200 volts. Rise and Fall Times, the FWHM value, and Transit Time are as defined in **Figure 7.** For estimating the effect of power supply voltage on these parameters, the following approximate relationship may be used:

$$\text{Parameter value} = C \times E^{\beta}$$

$$\beta = -0.5 \text{ to } -0.7$$

13

14 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 values are associated with approximately 5% deviation from linearity and apply to the following power supply voltages:

For VDN per Table 1-A, E = 1000 V

For VDN per Table 1-B, E = 1100 V

For estimating Peak Linear Anode Currents (PLAC) at other power supply voltages, the following approximate relationship may be used:

$$\text{PLAC} = C \times E^{\gamma}$$

where C = a constant

$$\gamma = 1.4$$

In designing a voltage divider network in accordance with either Column A or Column B of Table 1, precautions must be taken to maintain the appropriate voltage distribution in the presence of high average and/or high peak anode current values. This subject is treated in the BURLE Photomultiplier Tube Handbook (PMT-62) under the section titled “Photomultiplier Applications - Applied Voltage Considerations”.

Table 1

	A	B
Voltage Distribution	**11% of Supply Voltage (E) Multiplied By:**	**8.9% of Supply Voltage (E) Multiplied By:**
Cathode and Focus Electrode	1	1
Focus Electrode and Dynode No. 1	1	1
Dynode No. 1 and Dynode No. 2	1	1
Dynode No. 2 and Dynode No. 3	1	1
Dynode No. 3 and Dynode No. 4	1	1
Dynode No. 4 and Dynode No. 5	1	1
Dynode No. 5 and Dynode No. 6	1	1
Dynode No. 6 and Dynode No. 7	1	1.125
Dynode No. 7 and Dynode No. 8	1	2.00
Dynode No. 8 and Anode	1	1.125
Anode and Cathode	10	11.25

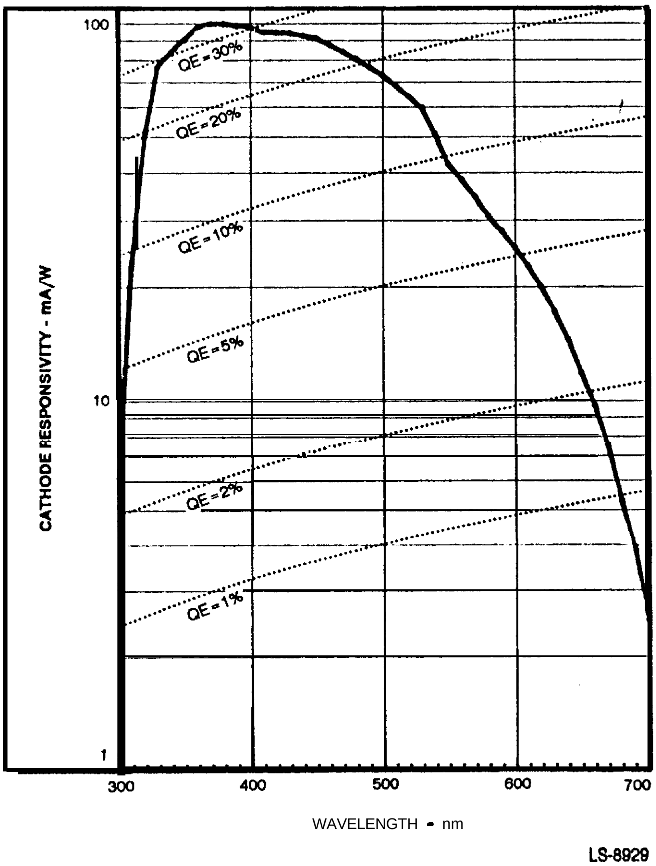


Figure 1 - Typical Photocathode Spectral Response Characteristics

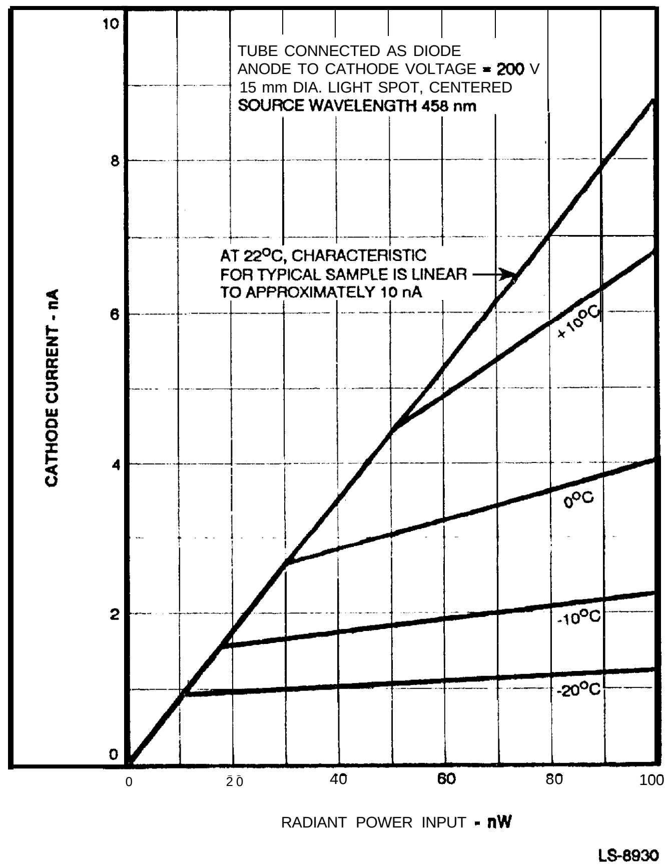


Figure 2 - Effect of Temperature on Cathode Responsivity

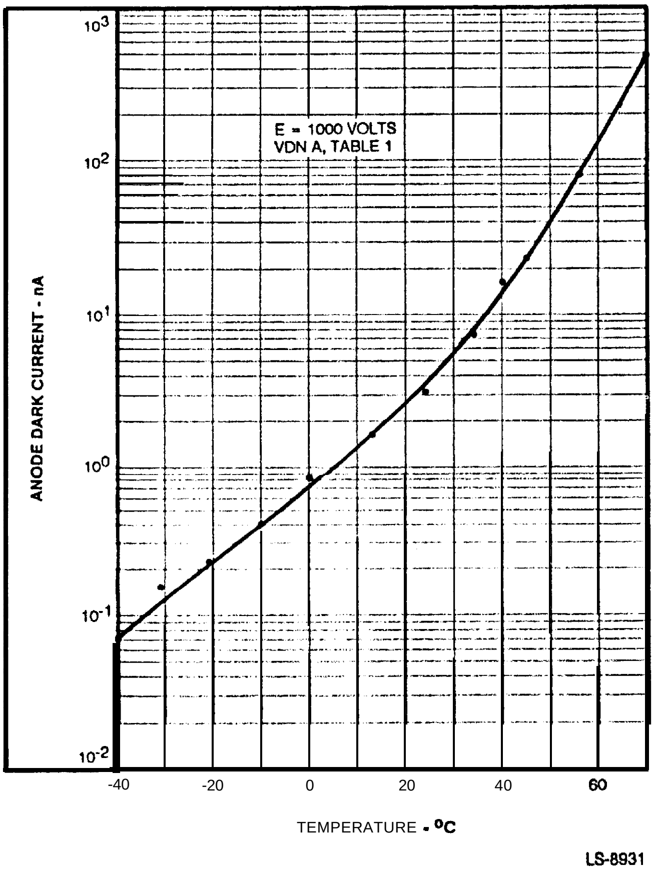


Figure 3 - Effect of Temperature on Anode Dark Current

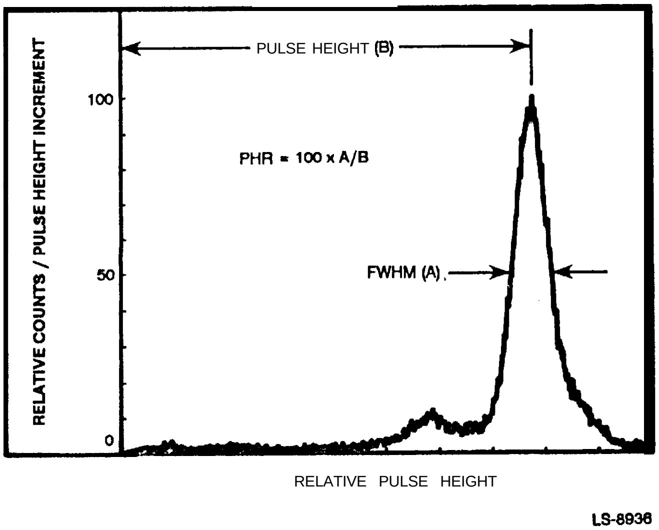


Figure 4 - MCA Display, Illustrating Definitions of Pulse Height and Pulse Height Resolution

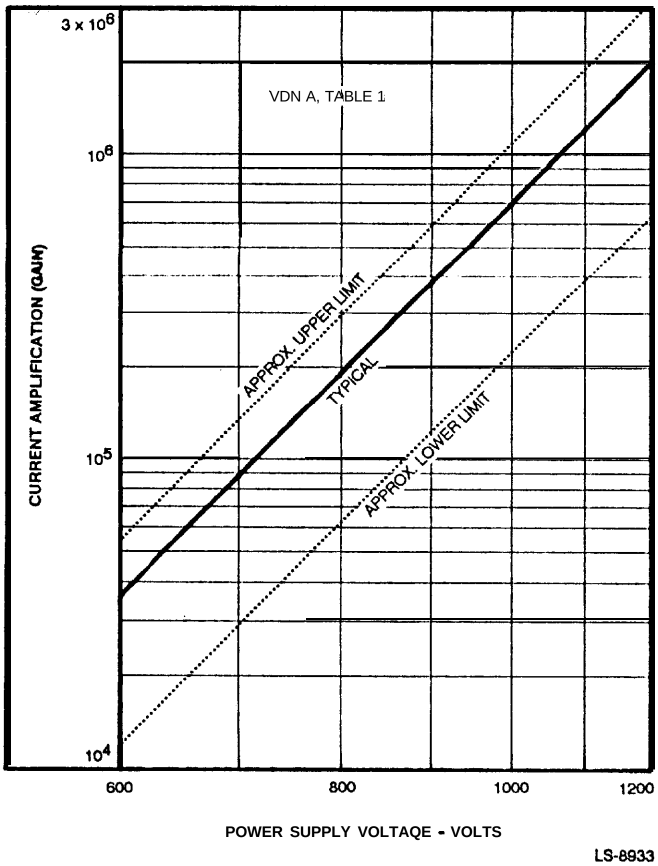


Figure 5 - Typical Current Amplification Characteristics

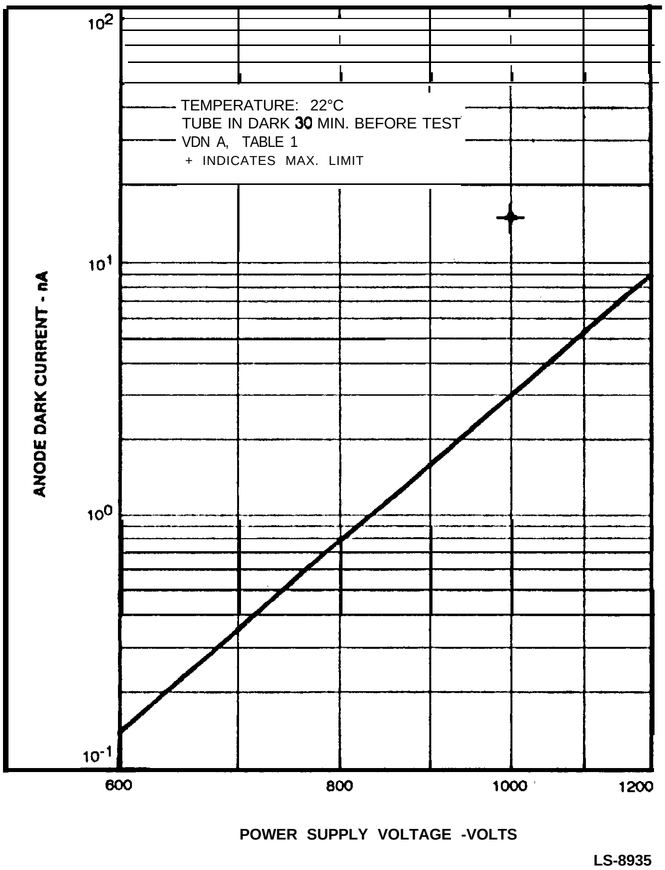


Figure 6 - Typical Anode Dark Current Characteristic

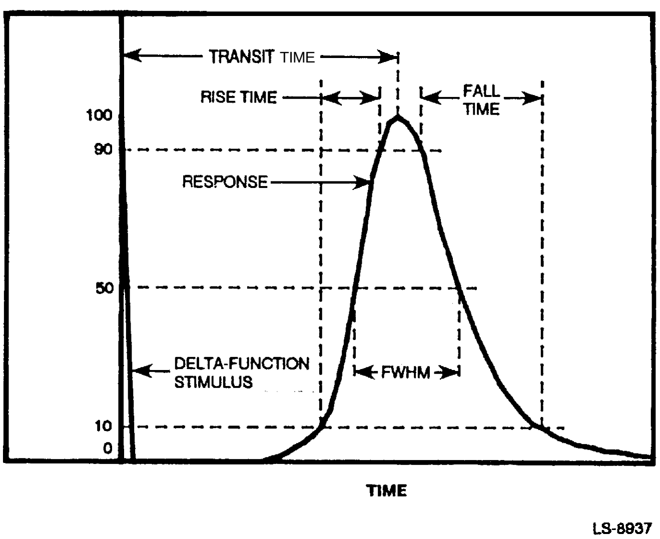
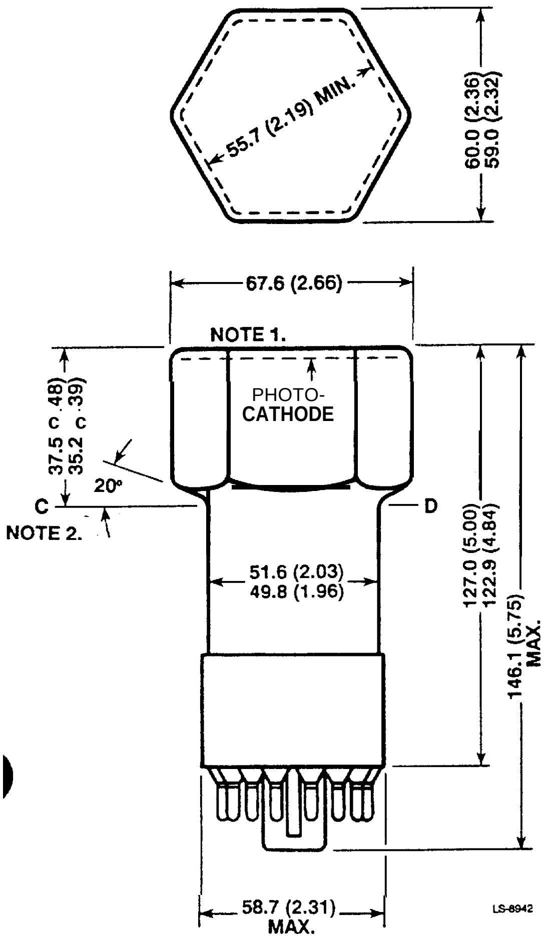
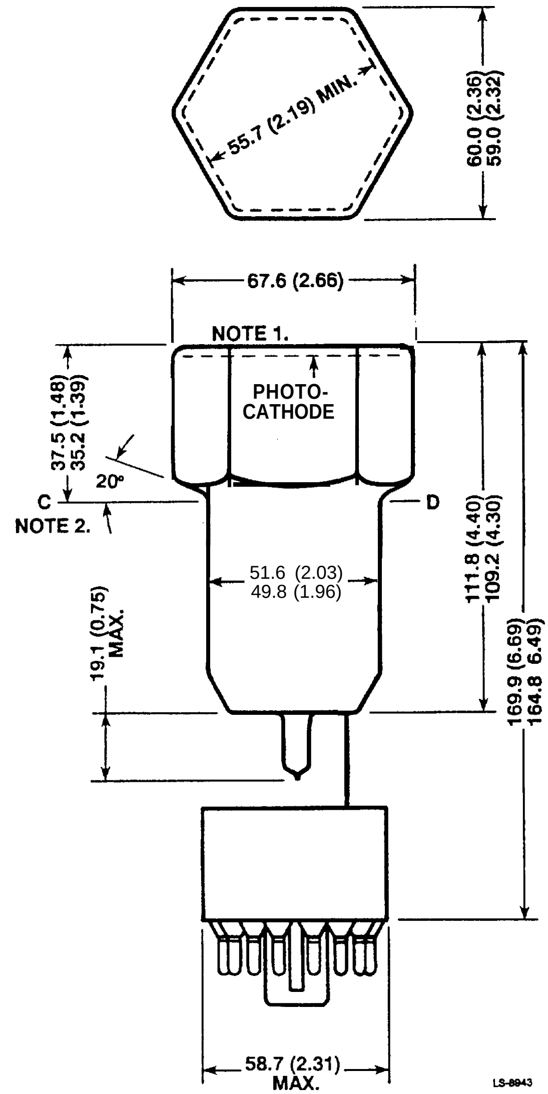


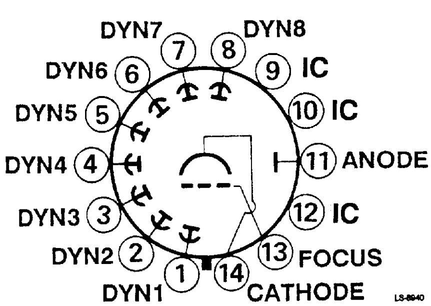
Figure 7 - Response to Delta-Function Light Stimulus

S83053F



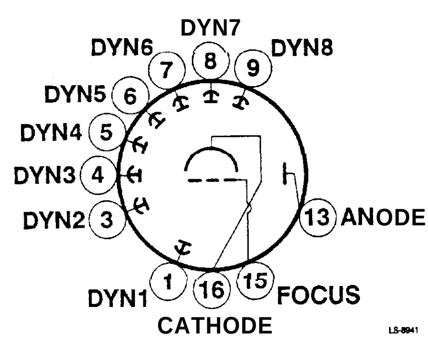
S83053FMI





IC: INTERNAL CONNECTION, DO NOT USE

Base Pin Connections



Stem Lead Identification

Dimensions are in millimeters unlessotherwise stated. Dimensions in parentheses are in inches and are derived from the basic inch dimension. (One inch = 25.4 mm).

Note 1 - Deviation from flatness not to excees 0.25 mm (0.01 inch) from peak to valleyd

Note 2 - The C-D reference line is defined by the points where a 75.2 mm (2.25 in) wide "U" gauge, held parallel to the faceplate, contacts the bulb/neck transition.

Figure 8 - Dimensional Outlines and Basing Diagrams