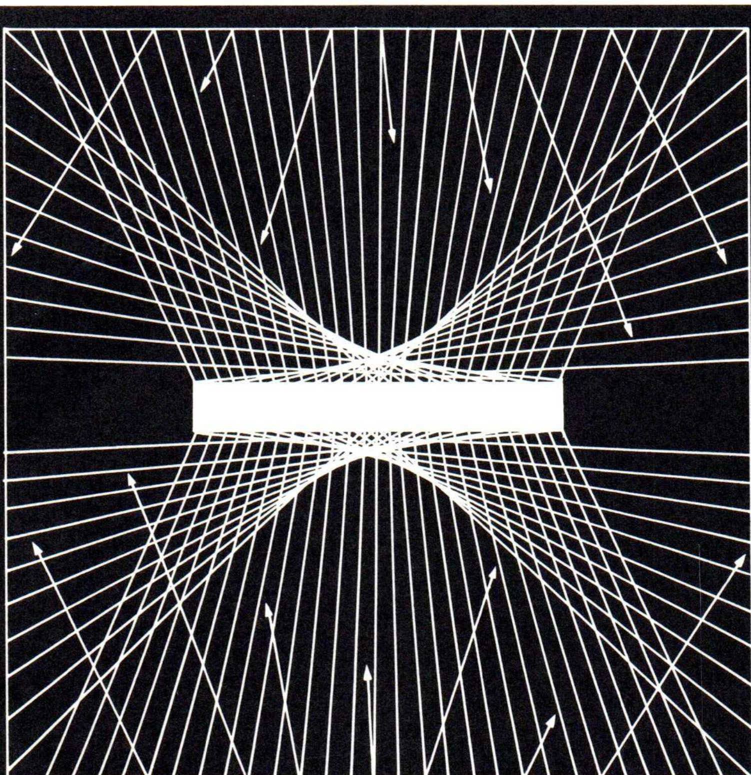
EG&G INC.



# XENON FLASHTUBES



EG&G Xenon flashtubes are efficient light sources which convert stored electrical energy into an intense burst of visible light and radiant energy. Their most important attribute is the ability to produce high peak light at comparatively short flash durations with consistent reproduction. Spectral quality is essentially that of daylight, encompassing the entire visible range and extending into the ultraviolet and infrared regions.

EG&G Xenon flashtubes can be obtained in a wide variety of configurations to suit the application. They can be designed for operation at flash rates of thousands of flashes per second, as intense single flash sources with light output ranging to tens of millions peak candlepower, and as short arc light sources having a flash duration on the order of one microsecond. Basic external circuit requirements are minimal and relatively simple.

From a device initially used in photographic and stroboscopic applications, the Xenon flashtube has evolved into an extremely flexible present day tool. Currently, one of its principal applications is for laser stimulation. EG&G is engaged in a continuing program of research and development to meet the rapidly expanding requirements for Xenon flashtubes in a multitude of applications.

**APPLICATIONS:** The versatility of Xenon flashtubes is evidenced by the fact that they are used in equipment whose environment ranges from ultimate ocean depth to outer space. Their use in scientific, engineering, industrial and military areas is expanding, and the list of diversified applications given below only partially illustrates their flexibility.

Laser Stimulation ▪ Flash Photolysis ▪ Medical Research ▪ Fluor Stimulation ▪ Semiconductor Research ▪ Ballistic Studies ▪ Satellite Flashers ▪ Marine Beacons ▪ Aircraft and Airport Beacons ▪ Visual Signal Devices ▪ Warning Lights ▪ Night Aerial Photography ▪ Underwater Photography ▪ Production Control ▪ High Speed Photographic Strobe ▪ Sensitometry ▪ Microscopic Illumination ▪ Film & Paper Timing ▪ Photographic Reproduction ▪ Typesetting ▪ Readout ▪ Training Devices ▪ Photoetching ▪ Ignition Timers ▪ Visual Strobes

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*For assistance with your application or for information concerning special configurations, please contact Edgerton, Germeshausen & Grier, Inc., Products Division, 160 Brookline Avenue, Boston, Massachusetts 02215. Phone: 617-267-9700. TWX: 617-262-9317.*

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# Spectra of Pulsed and Continuous Xenon Discharges*

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(Received 29 June 1965)

Spectral distributions over the range 0.35 to 1.1 μ were measured for representative pulsed and continuous-burning xenon arc lamps. Optical conversion efficiencies were computed for several spectral regions. Measurements were taken at different current densities ranging from 37 A/cm² for the dc lamps to 5300 A/cm² for the pulsed. Color and brightness temperatures ranged from 5000°K to 40 000°K. At high current densities the xenon arc has a higher efficiency (up to 65%) and a continuum which masks its line structure.

INDEX HEADINGS: Color; Colorimetry; Emissivity; Infrared; Plasmas; Spectroradiometry; Ultraviolet; Xenon.

## INTRODUCTION

THE xenon arc has long been used as a powerful source of light. More often than not, however, it has been used without an accurate knowledge of its spectral distribution. In photography, xenon arc lamps have been used as daylight-equivalent sources; the spectral match is close enough to take color pictures without color-correcting filters. Only recently, however, have researchers shown interest in a more precise duplication of the spectral qualities of the sun and sky.[1] Laser technology has employed xenon-arc lamps as pumping sources without a knowledge of their spectral efficiencies within the pumping bands of the various laser materials. The published information that exists covers only a small portion of the spectrum[2] or a specific operating condition.[3] Little is known or has been published about changes in the spectral output of lamps with different operating conditions or about optimum conditions for a given application.

Often, spectral data found in the literature are given in terms of radiance which is defined only over an infinitesimal region and is not necessarily constant over the spatial extent of the source. The scientist, who is interested in the spectral qualities of the light available to his apparatus, wishes to know the total flux emitted by the source. In practice the total flux is most easily found if the source emits either isotropically or with some well-known profile. Then the irradiance on a surface at some distance can be measured and integrated analytically over a sphere surrounding the source.

An instrument[4] has recently been developed that is capable of making spectral irradiance measurements whose calibrations are traceable to the National Bureau of Standards (NBS). With the use of this instrument, spectral measurements were made of the radiant output of four representative xenon-lamp types: a continuously burning arc and three flashtubes. The resulting spectrograms were graphed in such a way as to exemplify the change in spectral distribution and efficiency with current density. CIE color coordinates were generated from the spectra, and color temperatures were assigned. In addition, in one specific instance, brightness temperatures were also calculated.

## EXPERIMENT

In the experiment, each lamp was positioned facing the radiometer at distances which were large compared to the size of the lamp (see Fig. 1). The source-to-detector distance should be at least 10 times the largest source dimension. This condition must be met in order for the irradiance, as measured by the detector, to be proportional to the total emitted flux. For instance, the two-turn helical lamp shown in Fig. 2 emits almost isotropically at large distances, while the other lamps behave as terminated linear sources whose intensity varies as the sine of the angle between the direction to the viewer and the axis of the source.

The current from the vacuum photodiode detector was amplified by a high-feedback amplifier with a stable gain. In the case of the dc sources, the amplified current was read directly on a precision meter. With flashtubes, the amplified current charged a capacitor, and the meter reading then represented the time integral of the photocurrent, i.e., the charge, which was proportional to the radiant energy in the pulse. In evaluation of the lamps, the monochromator slit widths were set to correspond to 10 mμ and measurements were taken at adjacent or overlapping intervals.

The EG&G model 585 spectroradiometer used in the experiment has a measurement range from 1.2 μ in the infrared through 0.35 μ in the ultraviolet and, with some modification, measurements can be extended further

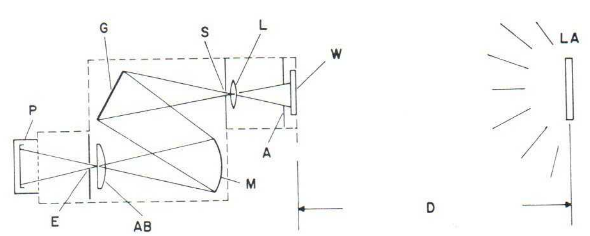


FIG. 1. Test arrangement sketch. G—grating; S—entrance slit; L—lens; W—diffusing window; A—aperture; M—mirror; AB—aberration correcting lens; E—exit slit; P—planar vacuum photodiode; LA—lamp; D—distance large compared to lamp dimensions.

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* This work was supported by the Aeronautical Systems Division, Air Force Systems Command.

[1] Deane B. Judd *et al.*, J. Opt. Soc. Am. **54**, 1031 (1964).

[2] W. H. Parkinson and E. M. Reeves, Proc. Roy. Soc. (London) **262A**, 409 (1961).

[3] W. J. Tomlinson, J. Opt. Soc. Am. **52**, 339 (1962).

[4] EG&G model 585 spectroradiometer.

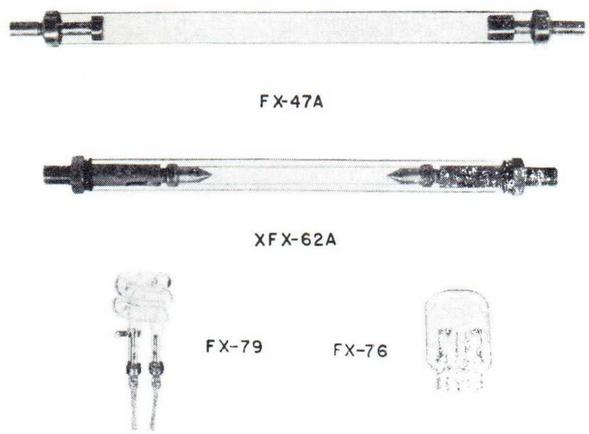



FIG. 2. Examples of tubes similar to those evaluated.

into the ultraviolet. The instrument has sufficient resolution to identify and measure the energy content of the strong, broad emission lines usually found in high-pressure arc spectra; it is particularly useful for measuring sources with strong continua.

A lens rigidly attached to the frame of the instrument collects radiant energy from a diffusing window and directs it through the entrance slit onto the grating of a Bausch & Lomb high intensity, one-quarter meter monochromator. The widths of the adjustable entrance and exit slits are set according to manufacturer's information, to give a triangle transmission function with 10-mμ bandwidth between one-half peak transmission wavelengths. A planar vacuum photodiode (with an S-1 photosurface) subtends the entire exit beam. In operation, the photocurrent from this detector gives a measurement of the spectral radiance of the diffusing window which, in turn, is proportional to the spectral irradiance on the window from the source.

Calibration of the instrument was accomplished by comparing its response to the certified spectral radiances of a NBS standard lamp[5] (a General Electric T4Q/1CL, 200-W quartz iodine lamp). The National Bureau of Standards assigns 5% uncertainty to the certification at 350 mμ. This decreases to 3% for wavelengths longer than 500 mμ. Other sources of error are the uncertainty in setting the wavelength dial, the variable entrance and exit slits of the monochromator, and the drift in the response of the photocell. Of these, the latter was the greatest. In the course of the experiments, four calibrations were made to determine its magnitude. The relative response from wavelength to wavelength was found to vary little, while the absolute response varied somewhat more. The combined sources of error place the over-all uncertainty of the intensity measurements at 10% for the shortest wavelengths and 8% for wavelengths longer than 500 mμ.

The experimental lamps were of four representative

[5] R. Stair, W. Schneider, and J. K. Jackson, Appl. Opt. 2, 1151 (1963).

TABLE I. Physical and electrical parameters for all lamps.

| | Tube type | Arc length | Bore | Fill pressure | Electrical parameters | Discharge time | Spectral efficiency 0.35–0.5 microns | 0.5–0.7 microns | 0.7–0.9 microns | 0.9–1.1 microns | 0.35–1.1 Total | Color coordinates | Color temperature |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Continuously burning | Experimental | 3.8 cm | 1.1 cm | 1.7 atm Xe | 35 A @ 30 V 37 A/cm² | Cont. | 1.7% | 2.4% | 7.0% | 4.6% | 15.7% | | 5200°K |
| | | | | 1.7 atm Ar | 35 A @ 30 V 37 A/cm² | Cont. | 0.6% | 0.6% | 3.1% | 0.7% | 5.0% | | |
| | | | | 0.41 atm Ar 0.71 atm Xe | 45 A @ 31 V 47 A/cm² | Cont. | 1.7% | 2.4% | 5.2% | 3.8% | 13.1% | | |
| | | | | 0.21 atm Ar 0.33 atm Ne 0.41 atm Xe | 45 A @ 31 V 47 A/cm² | Cont. | | | | | 9.2% | | |
| | XFX-62A | 7.6 cm | 0.7 cm | 1 atm Xe | 35 A @ 80 V 91 A/cm² | Cont. | | | | | 29.2% | 0.3407 0.3432 | 5000°K |
| Flashtubes | FX-79[a] | 15.2 cm Helical wound | 0.4 cm | 0.26 atm Xe | 1125 μF (Electrolytic) 900 V, 360 A peak 2870 A/cm², peak | 1.9 msec | 11.5% | 12.8% | 13.1% | 10.7% | 48.1% | 0.3083 0.3156 | 7100°K |
| | FX-76 | 0.8 cm | Unconfined arc | 0.71 atm Xe 0.12 atm $H_2$ | 10 μF 1 kV 2500 A peak | 10 μsec, ringing | 2.7% | 1.5% | 1.1% | 0.7% | 6.0% | 0.2430 0.2476 | 40 000°K |
| | FX-47A | 16.5 cm | 1.3 cm | 0.4 atm Xe | 1700 A/cm² [b] 1 kJ | 0.75 msec | 18.4% | 18.4% | 16.3% | 11.5% | 64.6% | 0.3057 0.3075 | 7000°K |
| | FX-47A | 16.5 cm | 1.3 cm | 0.4 atm Xe | 5300 A/cm² [b] 5 kJ | 0.75 msec | 27.3% | 20.2% | 11.2% | 6.1% | 64.8% | 0.2843 0.2927 | 9400°K |

[a] Nearly isotropic source; all other lamps are line sources.
[b] Two section pulse forming network, total capacity = 960 μF.

types. The first were continuously burning dc xenon arcs similar to those used for photography or in projectors. They consist of a straight quartz tube with an electrode sealed in at each end, and in these experiments they were water cooled. They resemble in construction the XFX-62A shown in Fig. 2.

The second lamp (FX-76) was a low-energy flashtube of a type that has become popular for stroboscopy and stop-motion photography. This lamp is unlike most xenon flashtubes in that the arc is not confined by the glass envelope. Generally, unconfined xenon arcs are not stable, but this lamp employs a number of trigger probes which initiate the arc in the same place with each flash. The flash itself is usually of such short duration that convection currents that would displace the arc do not form. The energy of the flash is usually limited to a few joules.

The third lamp tested (FX-79) was a small two-turn helix also made from quartz tubing. This lamp differs from the others in that it has long arc length, 15.2 cm, in relation to its bore, 0.4 cm. It is also noteworthy in that it is a fairly uniform isotropic source. Characteristically this lamp discharges several hundred joules per flash.

The fourth lamp (FX-47A) is typical of the high-energy xenon flashtubes usually used for pumping laser crystals or for flash photolysis. Like the dc lamps, they consist of a quartz tube with an electrode sealed in at each end. Generally these lamps discharge hundreds or thousands of joules. Table I lists the physical and electrical parameters for all of the lamps.

## DATA

Each datum was multiplied by the instrument calibration factor. The corrected readings represent the flux (or energy in the case of flashtubes) incident on the diffusing window as a function of wavelength. The total flux emitted in all directions as a function of wavelength was then calculated by multiplying the sampled flux by a constant appropriate for the type of source being observed. The following constants were used for the isotropic and line sources:

$$P(\lambda)=\int_s H(\lambda)dS \begin{cases} =4\pi d^2 H(\lambda) & \text{for an isotropic source}^6 \\ =\pi^2 d^2 H(\lambda) & \text{for a line source,}^{6,7} \end{cases}$$

where $P(\lambda)$ is the total flux emitted in all directions as a function of wavelength and $H(\lambda)$ is the irradiance measured perpendicular to the source axis at a distance $d$. The use of these constants introduces an additional error in the computed total flux, but this error does not exceed 10%.

[6] Parry H. Moon, *The Scientific Basis of Illuminating Engineering* (Dover Publications, Inc., New York, 1961), p. 229.

[7] Moon gives total flux $P=\pi^2 I_{\max}$. The above equation follows since $d^2H(\lambda)=I_{\max}$.

The spectral radiant flux for each lamp was then divided by its input electrical power and plotted as a function of wavelength. The area under each of these plots thus represents the fraction of electrical energy converted to radiant energy. The conversion efficiencies for several spectral bands and for a number of lamps and operating conditions were then computed mechanically. These results are given in Table I.

## RESULTS

The normalized spectral distributions of the various xenon lamps are presented in Figs. 3 through 8. They are arranged in order of increasing current density, which ranged from 37 A/cm² for the dc lamps to 5300 A/cm² for the high-energy flashtube. Figures 3 through 5 are the spectral distributions for the dc lamps with xenon (Fig. 3), argon (Fig. 4), and xenon–argon (Fig. 5). Figures 6 through 8 give the spectral distributions for the xenon flashtubes.

As can be seen, the dc lamp produces a very strong broadened line structure in the infrared. Table I shows that this lamp is most efficient over spectral regions which include the strong infrared lines and that it has a total efficiency of ~18% over the spectral range 0.35–1.1 μ. Lamps with longer arcs and smaller bores like the FX-62A have even higher efficiencies, approaching 30%.

The spectral distribution for the same lamp with an argon-gas fill is similar to that for xenon, with strong

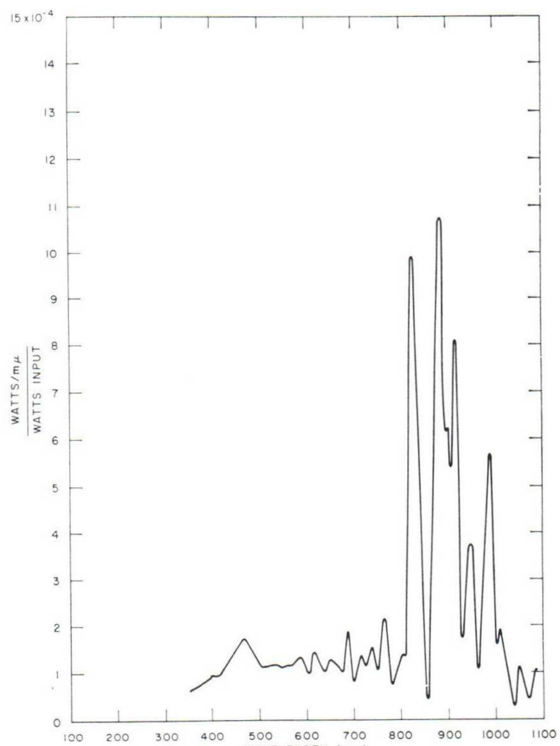



Fig. 3. Spectral emission, experimental dc lamp (1.7-atm Xe; 37 A/cm²), see also Table I. Spectral bandwidth equal to 10 mμ.

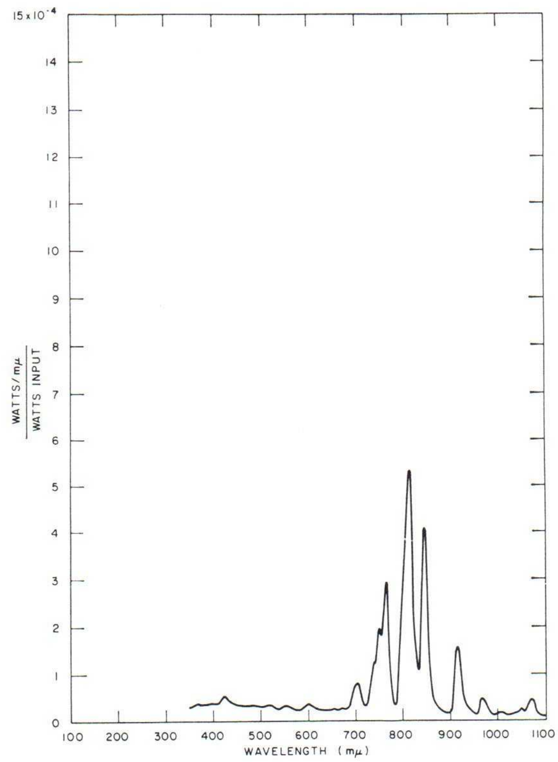



FIG. 4. Spectral emission, experimental dc lamp (1.7-atm Ar; 37 A/cm²), see also Table I. Spectral bandwidth equal to 10 mμ.

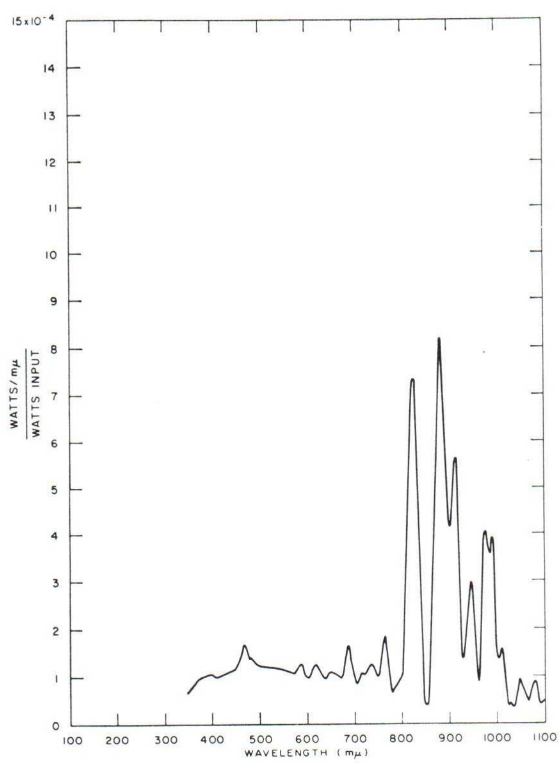



FIG. 5. Spectral emission, experimental dc lamp (0.71-atm Xe, 0.41-atm Ar; 47 A/cm²), see also Table I. Spectral bandwidth equal to 10 mμ.

broad lines in the infrared, but it is less intense at all wavelengths. The same tube with an argon–xenon mixture (Fig. 5) and with neon–argon–xenon mixtures (not shown) also evidenced similar spectral distributions but again, intensities were much less than those with pure xenon, even when the xenon was present in large amounts.

The emission spectrum of an EG&G FX-76 [the unconfined arc (Fig. 6)] shows a strong continuum which does not obscure the line structure. This flashtube has the highest color temperature (≈40 000°K) and is the least efficient of the xenon filled lamps.

In the case of the flashtubes, the relatively small-bore (0.4 cm) EG&G FX-79 shows a spectrum (Fig. 7) with

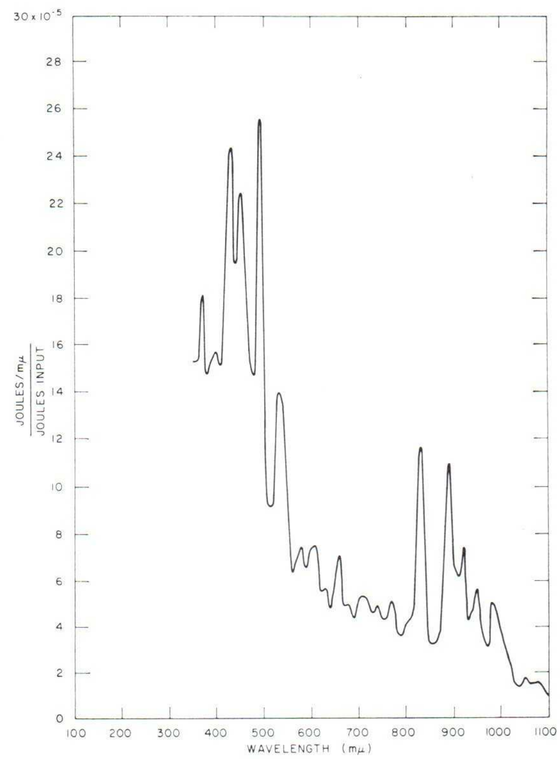



FIG. 6. Spectral emission, FX-76 unconfined arc flashtube (0.71-atm Xe, 0.12 atm $H_2$; 2500 A, peak), see also Table I. Spectral bandwidth equal to 10 mμ.

essentially the same xenon lines as the dc lamps but a much stronger continuum. At the 2870 A/cm² level, the continuum has increased considerably in the blue and resembles a blackbody radiation distribution. This lamp, like most capillary flashtubes, has an inherently higher efficiency than the continuously burning lamps.

The fourth lamp, the EG&G Type FX-47A, was tested (Fig. 8) at two different current densities. Unlike the other flashtubes which were excited by simple capacitor discharges, this tube was driven by nearly rectangular 0.75-msec current pulses from a two-section pulse-forming network. At a current density of 1700 A/cm², the line structure is still noticeable throughout the spectrum. However, at 5300 A/cm², the lines—which were quite strong at low current densities—are almost completely obscured by the continuum which has increased much more in the blue than in the infrared. The dashed lines in Fig. 8 show the spectral emission at wavelengths below 0.35 $\mu$. Because of calibration difficulties in the ultraviolet, these measurements do not have the same accuracy and precision as the measurements made at longer wavelengths. This tube had the highest current density of the lamps tested and was also the most efficient. Sixty-five percent of the input energy was converted to radiant energy in the spectral range between 0.35 and 1.1 $\mu$. Heat-transfer measurements have confirmed this efficiency. By measuring the heat

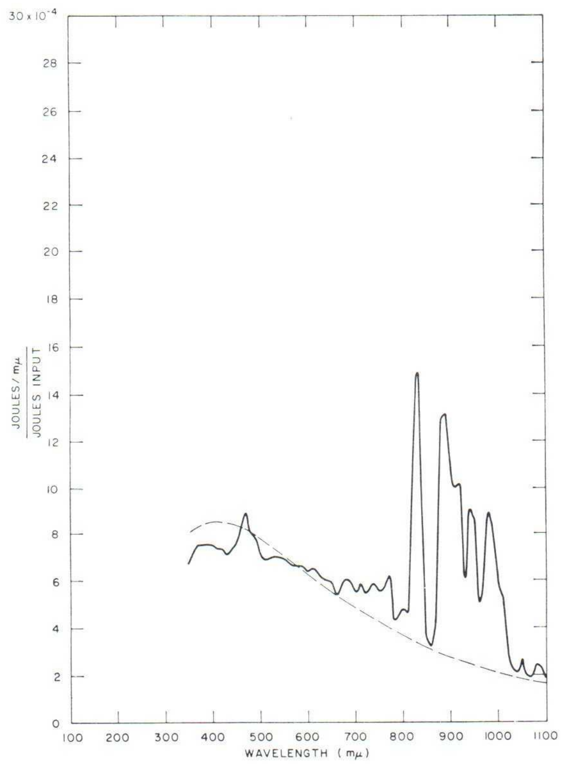



Fig. 7. Spectral emission, FX-79 helical flashtube (0.26-atm Xe; 2870 A/cm², peak), see also Table I. Spectral bandwidth equal to 10 m$\mu$. Broken line is relative spectral emission of a blackbody at 7100°K.

absorbed by water flowing over the external electrode leads and the envelope while the lamp is flashing repeatedly, the remaining fraction of the input electrical energy can be accounted for.

CIE color coordinates for each of the spectra in the figures were computed. The weighted ordinate method was used since most of the measurements were taken at equal wavelength intervals.[8] These coordinates were plotted directly on the CIE chromaticity diagram (Fig. 9) where they were compared directly with chromatici-

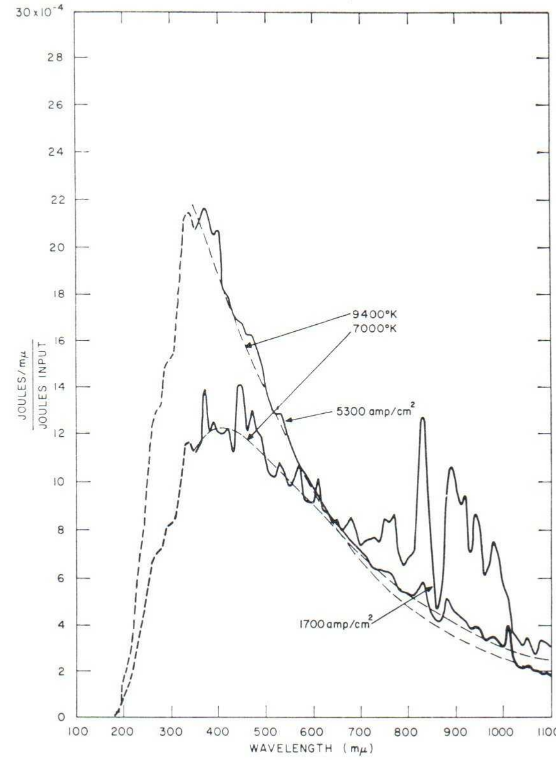



Fig. 8. Spectral emission, FX-47A flashtube at two current densities (0.4-atm Xe; 1700 and 5300 A/cm²), see also Table I. Spectral bandwidth equal to 10 m$\mu$. Coarse broken lines are relative spectral emission of blackbodies at 7000° and 9400°K. Fine broken lines represent measurements made in the ultraviolet and are not as accurate as those made in the visible and infrared.

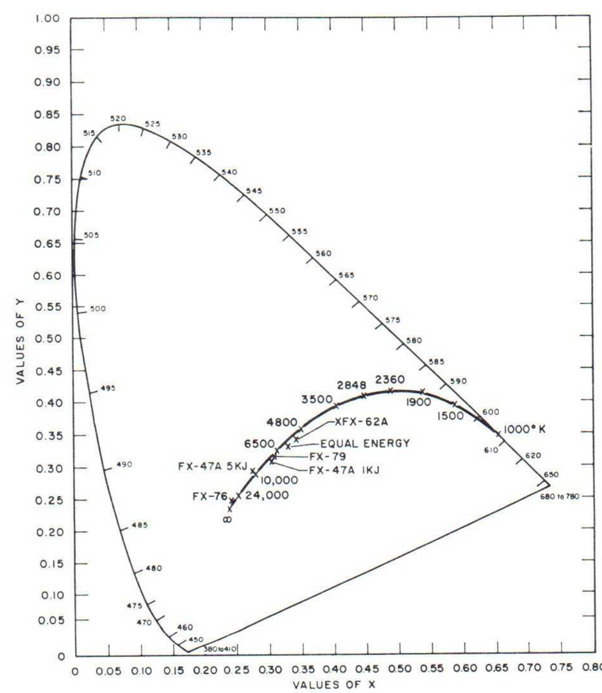



Fig. 9. CIE chromaticity diagram showing lamp color points. See also Table I.

[8] Arthur C. Hardy, *Handbook of Colorimetry* (The Technology Press, Cambridge, Mass., 1936), 1959 ed.

ties of blackbody radiators. The proximity of the points to the locus of blackbody radiators permits assignment of a color temperature to each lamp for each operating condition. Relative blackbody radiation distributions were then drawn on the original spectra (Figs. 7 and 8) normalized at points near 600 m$\mu$.

The brightness temperature was computed by assuming the emissivity of the plasma to be unity for the FX-47A at 5300 A/cm$^2$. At 0.4 $\mu$ the brightness temperature was 12 000°K; at 0.64 $\mu$ it was 14 000°K; and at 0.98 $\mu$ it was 18 000°K. These data indicate that the true emissivity of the plasma is not constant with wavelength and that the actual plasma temperature must be considerably higher than the measured color temperature.

## CONCLUSIONS

To a great extent, the current density controls the spectral distribution of the emitted energy in a xenon arc. When current density is increased from a few tens of amperes per square centimeter to a few thousand, the intensity in the blue increases far more rapidly than does the intensity in the red and infrared. In addition, the line structure, which is quite strong in the infrared at low current densities, becomes almost completely masked at high current densities.

The color temperature is also affected by increased current density. At low current density the color temperature is near 5000°K, but it increases at high current density to near 10 000°K. In the particular case of the unconfined arc (the FX-76), the color temperature was as high as 40 000°K. The CIE color coordinates of the arcs tested were particularly close to the Planckian locus with the continua resembling those of blackbodies. Within approximately reasonable limits the color coordinates are those of the coordinates of daylight reported by Judd.[1] For most color matching applications, the xenon arc (in one of its forms) could be used as a direct substitute for daylight.

The over-all efficiency of the xenon arc, which also increases with current density, is relatively high. Up to 65% of the input energy is converted to radiant energy in the spectral region between 0.35 and 1.1 $\mu$ in the FX-47A operated at 1700 to 5300 A/cm$^2$.

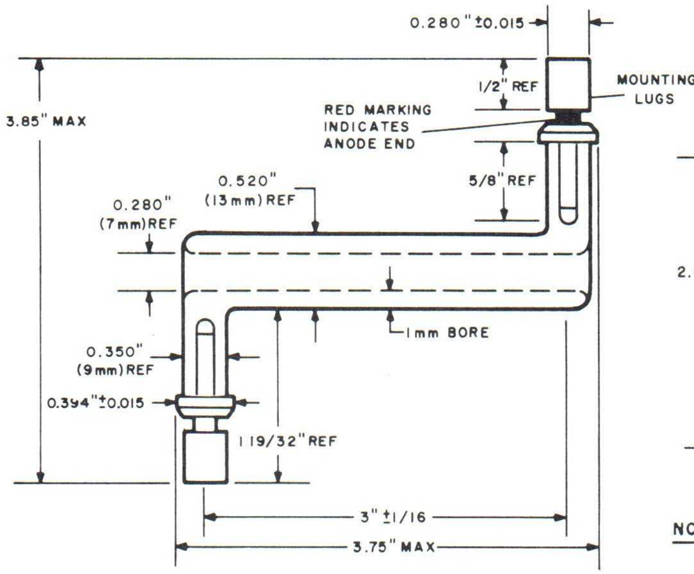
EG&G
ELECTRONIC PRODUCTS DIVISION

FX-53 -3, FX-53Z -3
FLASHTUBES

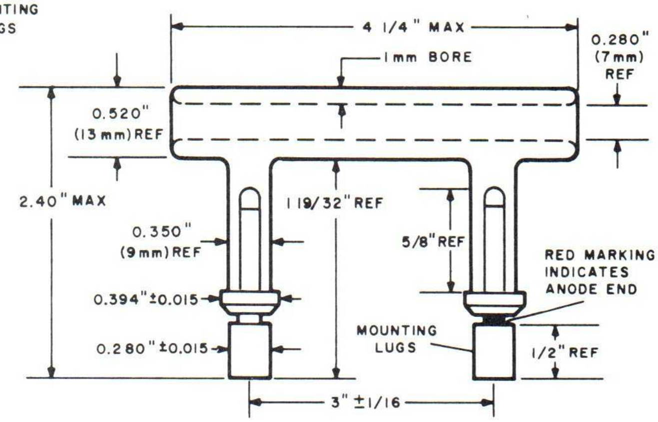
DATA SHEET 1007-3

TECHNICAL DATA

# FX-53-3, FX-53Z-3 ANNULAR XENON FLASHTUBES




FX-53-3



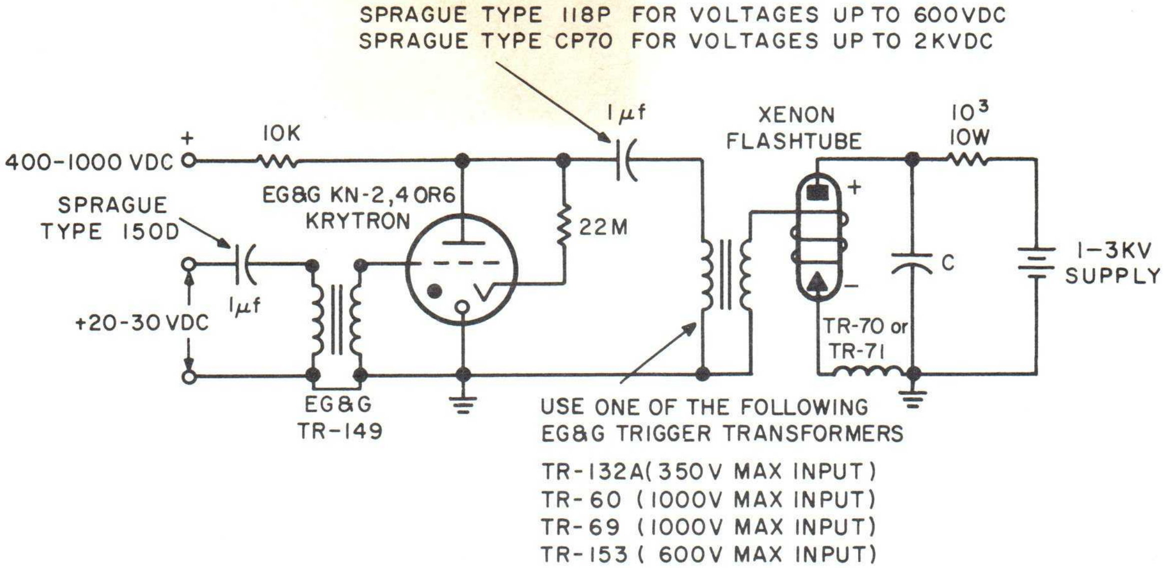

NOTE: A 1/4" ROD MUST PASS THROUGH THE INNER TUBING WITHOUT INTERFERENCE

FX-53Z-3

## TENTATIVE SPECIFICATIONS

| | | |
|---|---|---|
| TUBE DESIGNATION-ORDERING CODE | | FX-53-3 or FX-53Z-3 |
| Discharge Envelope | | 7mm I.D., 13mm O.D. |
| Arc Length (inches) | | 3 |
| ELECTRICAL CHARACTERISTICS | | |
| Maximum Energy Input per Flash, Watt-Seconds (Watts-Seconds (Joules) = $1/2\ CV^2$) | | 800 |
| Test Conditions | Voltage, V (KVDC) | 1 |
| | Capacitance, C ($\mu$fd) | 400 |
| | Inductance, L ($\mu$hy) | 180 |
| | Arc Resistance (ohms) during discharge at Maximum Energy Input | 0.4 |
| Minimum Operating Voltage (KVDC) | | 1 |
| Maximum Operating Voltage (KVDC) | | 2 |
| Typical Trigger Voltage Range (kv) | | 25-30 |
| Recommended Triggering Method or | | EG&G Trigger Module |
| Recommended EG&G Trigger Transformer | | TR-60 |
| Recommended EG&G Series Inductance | | TR-70 or TR-71 |

## TYPICAL FLASHTUBE CIRCUIT

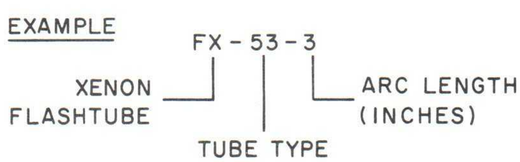



USING EXTERNAL TRIGGERING

## APPLICATION

The annular flashtube was developed primarily for optical pumping of laser crystals. This configuration permits the user to place the crystal rod in such a position that the gas discharge plasma concentrically surrounds it. The outer circumference of the annular flashtube can then be easily wrapped with aluminum (or silver) foil, which serves both as reflector and trigger electrode. A high-quality, 3 in. long by 1/4 in. diameter ruby rod was observed to have a threshold of 180 joules when aluminum foil was wrapped around the outer circumference of the flashtube and the rod and flashtube operated at the Test Conditions shown above.

## ORDERING INFORMATION



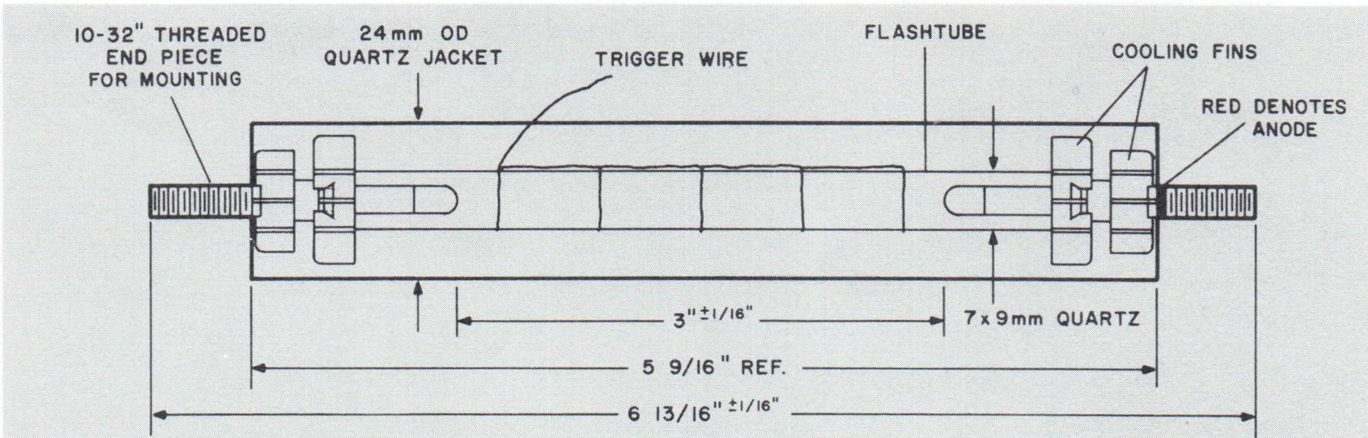

When ordering an annular flashtube, please use the coding system shown in the example above. The FX-53 and FX-53Z tube types can be supplied with various arc lengths, electrode position, and annular diameters. When changes other than arc length are desired, please enclose a sketch indicating the necessary modifications. In addition, please indicate a special tube by placing an X in front of the FX designation (Example XFX-53Z-3).

*All Data and Specifications Subject to Change Without Notice*

EG&G
ELECTRONIC PRODUCTS DIVISION



# FX-52C-3, FX-55C-6 LINEAR AIR COOLED XENON FLASHTUBES



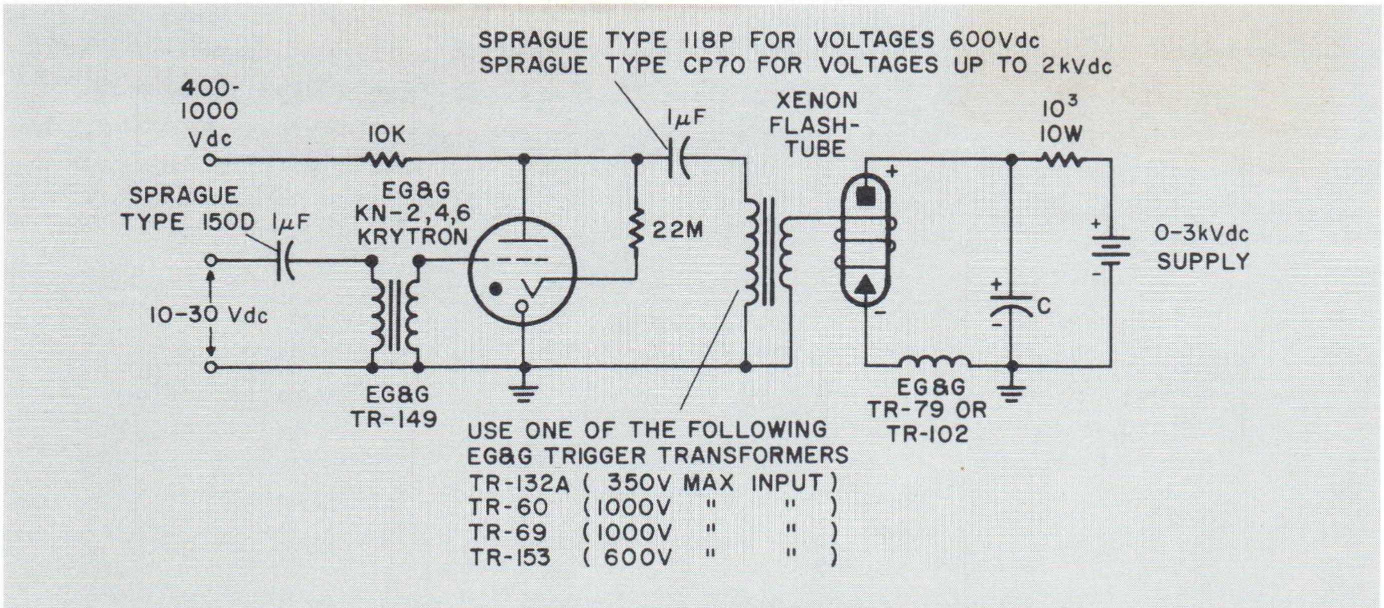

NOTE: LINEAR DIMENSIONS SHOWN ARE FOR FX-52C-3. ADD 3" FOR DIMENSIONS OF FX-55C-6.

## SPECIFICATIONS

| TUBE DESIGNATION – ORDERING CODE | | FX-52C-3 | FX-55C-6 | |
|---|---|---|---|---|
| Flashtube Envelope OD | | 9mm | 9mm | |
| Arc Length (inches) | | 3 | 6 | |
| ELECTRICAL CHARACTERISTICS | | Operation I | Operation I | II |
| Maximum Long Term Average Power Input, W (Watts = 1/2 $CV^2$ x flash rate) Note 1 | | 600 | 1000 | 1000 |
| Maximum Energy Input per Flash, Ws (Watts-Seconds (joules) = 1/2 $CV^2$) | | 600 | 2000 | 250 |
| Test Conditions | Voltage, V (kVdc) | 1.7 | 2.0 | 1.6 |
| | Capacitance, C (μF) | 400 | 1000 | 2000 |
| | Series Inductance, L (μH) | 300 | 300 | 300 |
| | Arc Resistance (ohms) During Discharge at Maximum Energy Input | 0.3 | 0.6 | 0.6 |
| Typical Light Output per Flash at Maximum Energy Input (Horizontal Candlepower Seconds, HCPS) | | 2500 | 7500 | 700 |
| Typical Flash Duration at Maximum Energy Input (Microseconds Measured at 1/3 Peak Amplitude) | | 1000 | 1000 | 600 |
| Typical Life (No. of flashes to 50% light output at test conditions) | | $2 \times 10^4$ | $2 \times 10^3$ | $1 \times 10^5$ |
| Minimum Operating Voltage (kVdc) | | 1.0 | 1.1 | 1.1 |
| Maximum Operating Voltage (kVdc) | | 3.0 | 3.0 | 3.0 |
| Typical Trigger Voltage Range (kV) | | 15 - 20 | 15 - 20 | 15 - 20 |
| Recommended Triggering Method | | EG&G Trigger Module TM-11 | | |
| or EG&G Trigger Transformer | | TR-60 or TR-69 | TR-60 or TR-69 | |
| Recommended EG&G Series Inductance | | TR-79 or TR-102 | TR-79 or TR-102 | |
| Recommended Air Flow (linear ft/s) Note 1 | | 40 | 40 | |

1. Power ratings based on use of Recommended Air Flow. Direction of air flow should be from anode to cathode.

## TYPICAL CIRCUIT




TYPICAL CIRCUIT USING EXTERNAL TRIGGERING

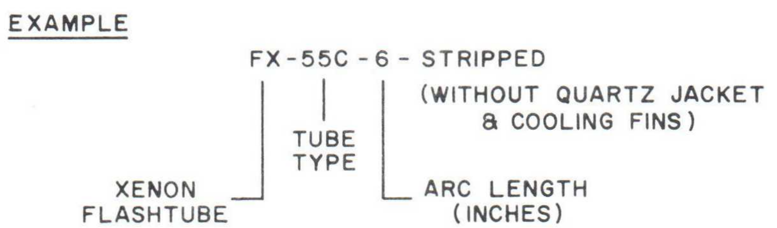
## FEATURES

- High Average Power Output
- High Flash Repetition Rate
- Heat Dissipating Fins on Seals & Terminals
- Quick Change Replaceable Flashtube
- Heavy Duty Electrodes
- Quartz Outer Jacket

## APPLICATIONS

- Laser Stimulation
- Flash Photolysis
- Fluor Stimulation
- Optical Systems
- Medical Research
- High Intensity Illumination

## ORDERING INFORMATION




The FX-52C-3 and the FX-55C-6 are also available without the outer quartz jacket and cooling fins (stripped). When ordering please indicate whether the tubes should be "complete" or "stripped".

Air cooled flashtubes with arc lengths other than shown are available upon request. When ordering please use the entire ordering code including the arc length.

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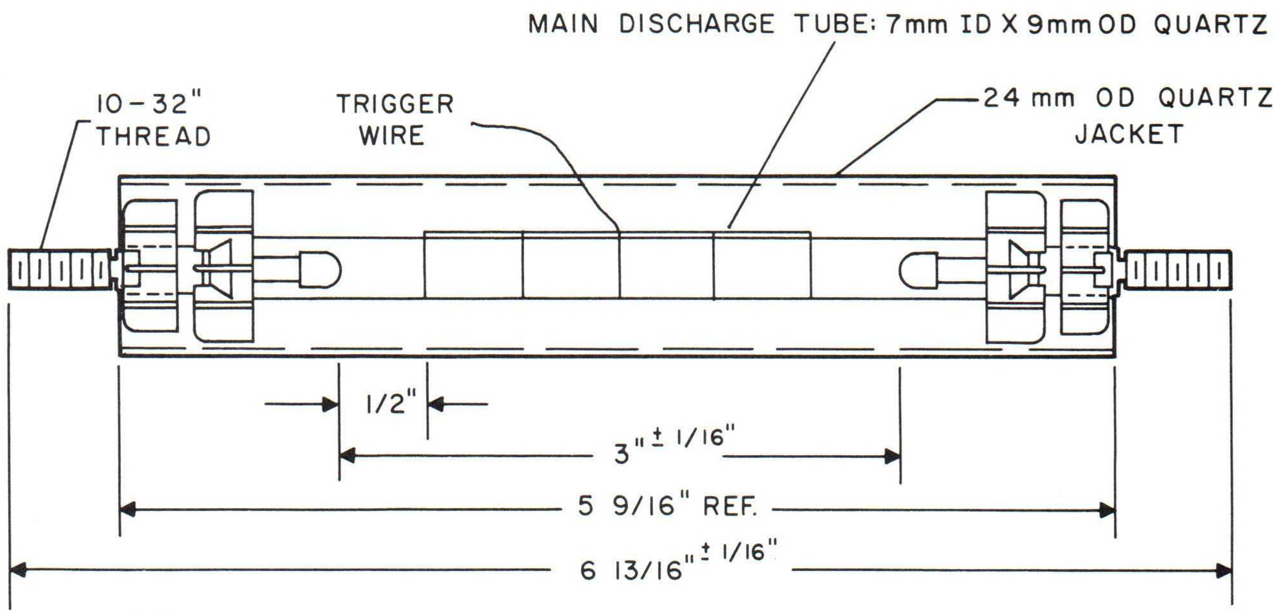
EDGERTON, GERMESHAUSEN & GRIER, INC.



# XENON FLASHTUBES FX-52, FX-55




NOTE:
FX-52 HAS A 3" ARC LENGTH, FX-55 HAS A 6" ARC LENGTH

## FEATURES:

- High Average Power Output
- High Flash Repetition Rate
- Heavy Duty Electrodes
- Air Cooled
- Cooling Fins on Seals and Terminals
- Quartz Outer Jacket

The FX-52 and FX-53 differ from EG&G's FX-42 and FX-45 in that they have heavier duty electrodes, cooling fins on the seals and terminals and a quartz outer jacket to provide air cooling from an inexpensive blower. These basic design features allow the FX-52 and FX-55 to operate at higher flash repetition rates and higher average power with only a nominal increase in tube size.

The FX-52 and FX-55 are available "stripped", i. e., without quartz jacket and cooling fins. When ordering, please specify whether the tubes should be "complete" or "stripped".

## PERFORMANCE DATA

| Characteristics | FX-52 | FX-55 Performance Data Under Two Operating Conditions | |
|---|---|---|---|
| Maximum Long Term Average Power Input (Watts) (1) | 600 | 1000 | 1000 |
| Maximum Energy Input per Flash (watt-sec) at Specified Condition | 600 @ 400 μfd, 1.7 KV, 300 μh (2) | 2000 @ 1000 μfd, 2.0 KV, 300 μh (2) | 250 @ 2000 μfd, 1.6 KV, 300 μh (2) |
| Nominal Light Output at Maximum Energy Input (horizontal candlepower seconds - HCPS) | 2500 | 7500 | 700 |
| Nominal Flash Duration at Maximum Energy (μsec) (1/3 peak) | 600 | 1000 | 600 |
| Maximum Flash Repetition Rate at Maximum Energy (3) | 1 per sec | 1 per 2 sec | 4 per sec |
| Nominal Life at Maximum Energy Input (flashes) | 5000 | 1000 | 100,000 |
| Minimum Operating Voltage (V) | 1000 | 1100 | 1100 |
| Maximum Operating Voltage (V) | 3000 | 3000 | 3000 |
| Typical Trigger Voltage Range (kv) (4) | 15 - 20 | 15 - 20 | 15 - 20 |
| Arc Resistance During Discharge (ohms) | 0.3 | 0.6 | 0.6 |

NOTES:

1. Power is based upon the flow of room temperature air over the tube envelope and cooling fins at a minimum velocity of 40 linear ft per sec. Air flow input should be in one direction only - from the anode to the cathode.
2. EG&G TR-102 Choke is recommended. The characteristics of the TR-102 are: L=300 microhenries, R=0.25 ohm. Dimensions are the same as EG&G TR-79 and TR-80 Chokes.
3. Reduced energy input per flash required at high flash repetition rates.
4. EG&G TR-60 or TR-69 is recommended to supply necessary trigger voltage.

For more information on this or other EG&G flashtubes, contact EG&G's Products Department.

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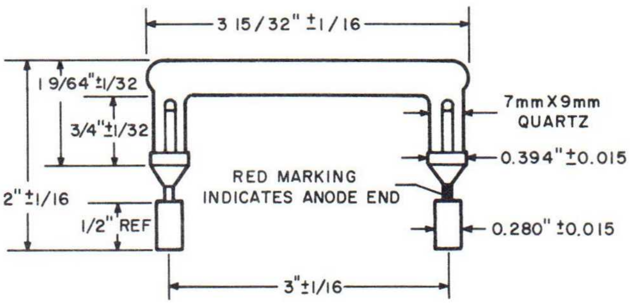
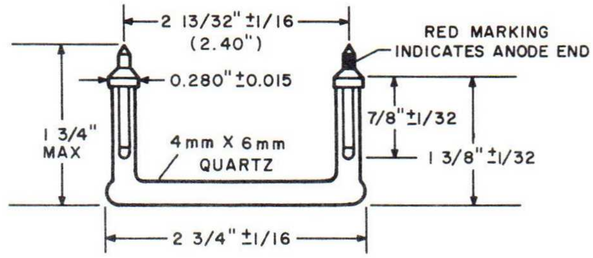
# FX-51-3, FX-100-2.4 PI-SHAPED XENON FLASHTUBES




FX-51-3

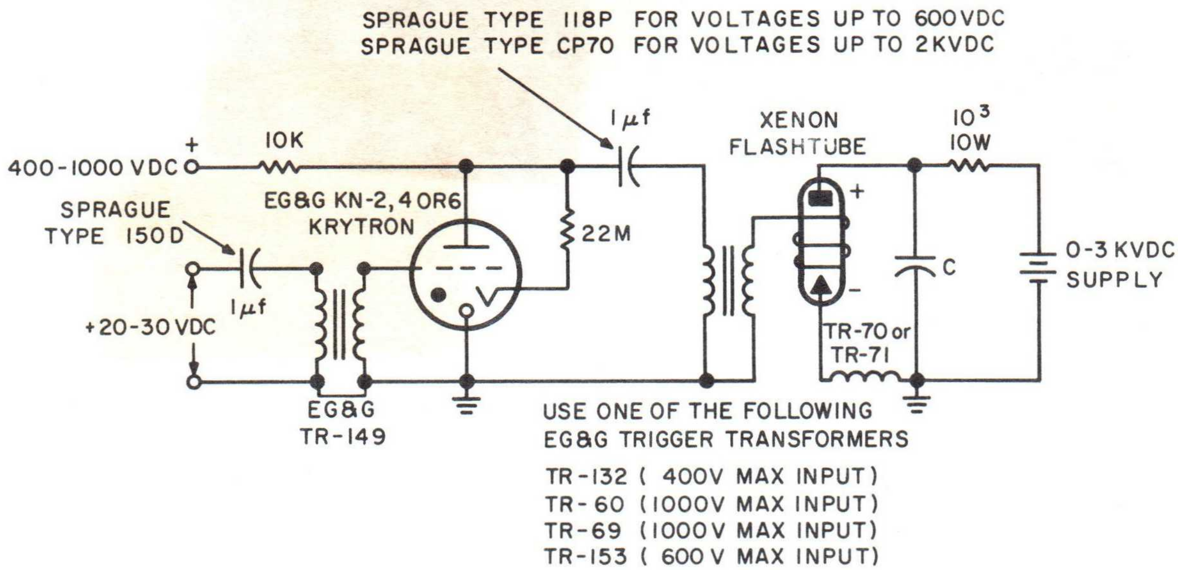



FX-100-2.4

## SPECIFICATIONS

| TUBE DESIGNATION-ORDERING CODE | FX-51-3 | FX-100-2.4 |
|---|---|---|
| Flashtube Envelope O.D. | 9mm | 6mm |
| Arc Length (inches) | 3 | 2.4 |
| ELECTRICAL CHARACTERISTICS | | |
| Maximum Energy Input per Flash, Watt-Seconds (Watts-Seconds (Joules) = $\frac{1}{2}CV^2$) | 600 | 100 |
| Maximum Long Term Average Power Input, Watts (Watts = $\frac{1}{2}CV^2$ x flash rate) | 60 | 20 |
| Test Conditions: Voltage V (KVDC) | 1.7 | 1.4 |
| Test Conditions: Capacitance, C($\mu$fd) | 400 | 100 |
| Test Conditions: Inductance, L ($\mu$hy) | 300 | — |
| Test Conditions: Arc Resistance (ohms) during discharge at Maximum Energy Input | 0.35 | 0.9 |
| Typical Light Output per Flash at Maximum Energy Input, HCPS (Horizontal Candlepower Seconds) | 2500 | 250 |
| Typical Flash Duration at Maximum Energy Input (Microseconds measured at 1/3 peak amplitude) | 1000 | 80 |
| Typical Life in free air at Test Conditions (No. of Flashes to 50% light output) | $5 \times 10^3$ | $5 \times 10^3$ |
| Minimum Operating Voltage, (KVDC) | 1 | 0.6 |
| Maximum Operating Voltage, (KVDC) | 3 | 2.5 |
| Typical Trigger Voltage Range (kv) | 15-20 | 15-20 |
| Recommended Triggering Method or | EG&G Trigger Module TM-11 | |
| Recommended EG&G Trigger Transformer | TR-132 | TR-132 |
| Recommended EG&G Series Inductance | TR-70 or TR-71 | To extend Tube Life use TR-70 or TR-71 |

## TYPICAL FLASHTUBE CIRCUIT




USING EXTERNAL TRIGGERING

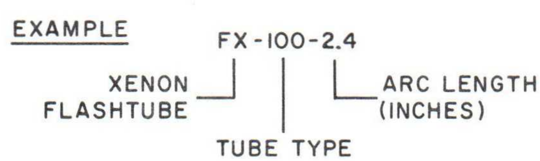
## FEATURES

- High Energy Output
- Long Life
- Heavy Duty Electrodes
- Quality Construction

## APPLICATIONS

- Laser Stimulation
- Photo Reproduction
- Satellite Flashers
- Flash Photolysis
- Medical Research
- Semiconductor Research

## ORDERING INFORMATION




When ordering Xenon flashtubes, please use the coding system shown in the example above. The FX-51 and FX-100 tube types can be supplied with various arc lengths, electrode positions, and tube diameters. When changes other than arc length are desired, please enclose a sketch with the order showing the necessary modifications. In addition, please indicate that it is a special tube by placing an X in front of the FX designation. (Example XFX-51-3)

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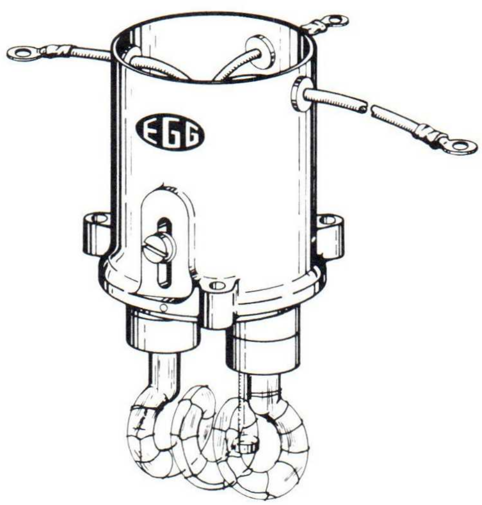
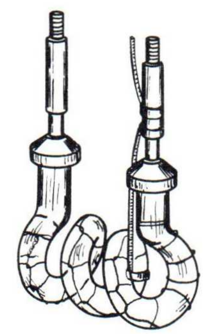
# FX-46, FX-239A XENON FLASHTUBES

EG&G INC.






FX-239A



FX-46

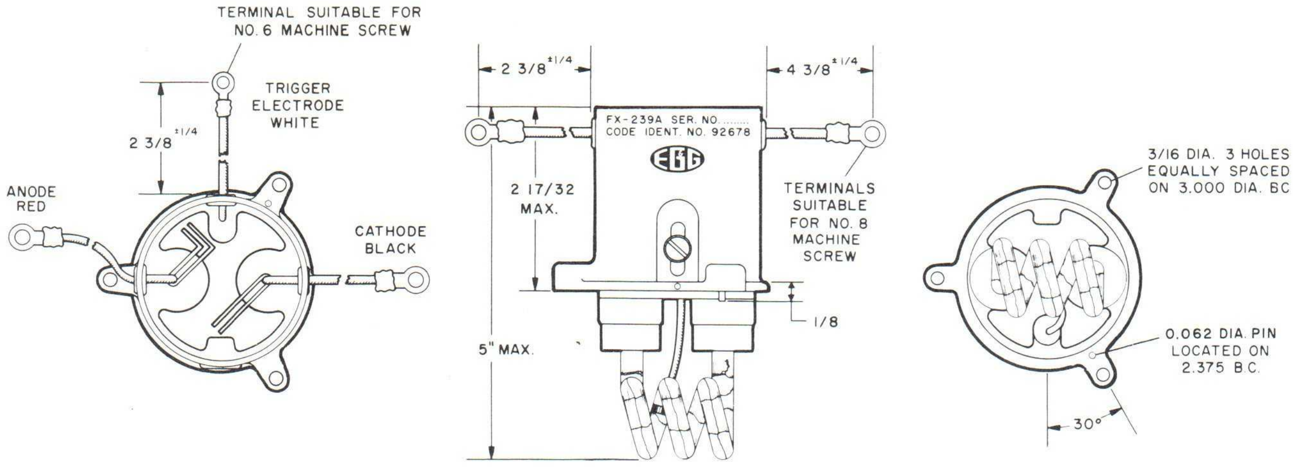
The FX-239A is a helical flashtube designed to operate in the 1.5 to 2.6 KV range. Operation in this range permits the use of paper-Mylar capacitors (or similar types of capacitors) in the associated charging circuit. Such capacitors must be used if the environmental requirements of present military specifications are to be met.

The helical configuration concentrates the light source and permits high-efficiency modified-parabolic reflectors to be used for beam forming. The FX-239A has been successfully used with such a reflector in an application requiring a beam angle of 43°. For this application the flashtube was prefocused; that is, the location of the helix with respect to the flashtube mounting surface was adjusted in a standard optical setup, and fixed at the factory. However, the beam angle that can be obtained with this particular flashtube-reflector configuration ranges from 35 to 55 degrees.

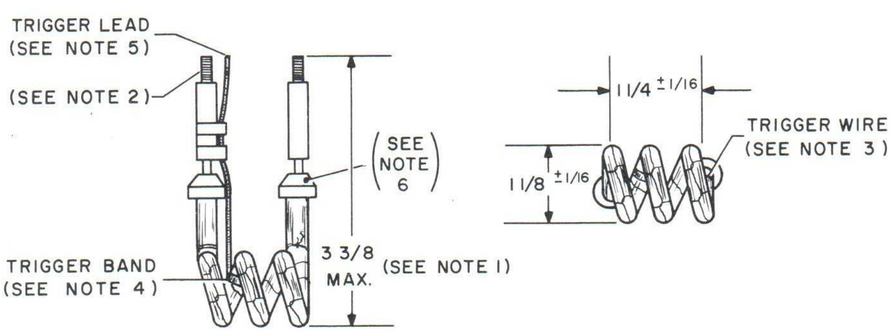
The FX-46 and FX-239A are the same flashtube type. The only difference is that the FX-239A comes equipped with a mounting bracket.

## OPERATING CONDITIONS

| | |
|---|---|
| Minimum Starting Voltage (V)<br>(The minimum main electrode voltage at which the tube can be triggered) | 1500 |
| Maximum Operating Voltage (V) | 2600 |
| Self-Flash Voltage (V)<br>(The minimum main electrode voltage at which the tube will self-flash) | 4000 |
| Typical Trigger Voltage Range (KV) | 20-25 |




**FX-239A**




**FX-46**

NOTES:

1. THESE DIMENSIONS DO NOT INCLUDE TRIGGER WIRE DIAMETER.
2. TUBE TO BE MOUNTED BY 10/32 THREADED LUGS.
3. TRIGGER WIRE IS 0.010 NICKEL. IT IS WRAPPED WITH 18-20 HALF HITCH TURNS APPROXIMATELY EQUALLY SPACED WITH TWO TURN ON THE ANODE END. (23-25 TURNS FOR FX-239A)
4. TRIGGER BAND IS 0.005 X 1/8 STAINLESS STEEL TAPE TO WHICH IS WELDED THE TRIGGER WIRE AND THE TRIGGER LEAD. THE TRIGGER BAND IS ON THE CATHODE END.
5. TRIGGER LEAD IS NO. 20 TEFLON-INSULATED (5 KV) WIRE. TENSOLITE NO. 20001-A1
6. ANODE END MARKED IN THIS AREA WITH RED PAINT.
7. HELIX IS RIGHT-HANDED.

## SPECIFICATIONS

| | |
|---|---|
| Maximum Long-Term Average Power Input (Watts) with air blast of 50 cfm (inlet temperature 68°F at Sea Level Pressure) | 676 |
| Maximum Energy Input (Watt-Seconds) (at 200 μfd, 2.6 KV) | 676 |
| $\left(WS = \frac{CV^2}{2}\right)$ per flash, at stated capacitance and voltage | |
| Flash Duration (Microseconds) | 500 |
| (1/3 peak at Specified Conditions)(1) (at 192 μfd, 2.2 KV, and 180 μhy) | |
| Typical Flash Rate (PPS)(2) | 1.6 |
| Minimum Life in Flashes(3) | 4000 |

(1) Flash duration — Flash duration depends on the operating conditions; therefore, value given is for specified conditions only.

(2) Typical flash rate — The flashing rate may be varied considerably from the typical value shown, provided that the long-term average power rating is not exceeded and suitable circuitry is provided.

(3) Life conditions — Flash Rate 1.6 pps, E-E 1.67 KV — 200 μfd with air cooling — 600 flash bursts with 5-minute cooling between bursts.

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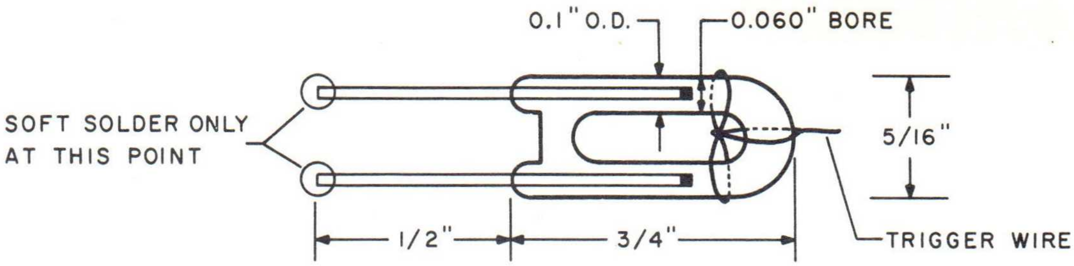
EG&G INC.



RODUCTS DIVISION
DATA SHEET 1007-1

# FX-41 MINIATURE XENON FLASHTUBE

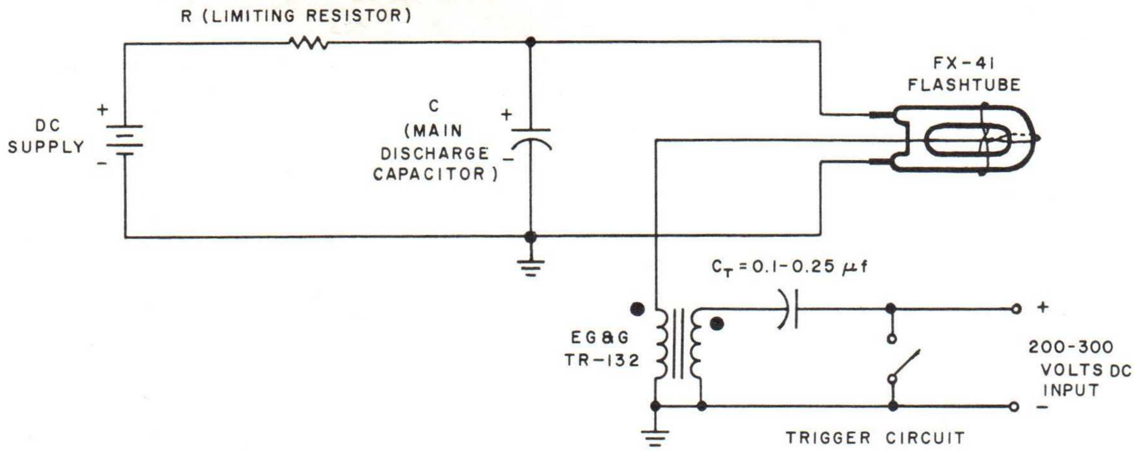



SHOWN TWICE NORMAL SIZE

## SPECIFICATIONS

| | | |
|---|---|---|
| TUBE DESIGNATION-ORDERING CODE | | FX-41 |
| Envelope O. D. | | 0.1 in. (2.5mm) |
| Arc Length | | 0.5 in. |
| ELECTRICAL CHARACTERISTICS | | |
| Maximum Energy Input Per Flash (Watt-Seconds (Joules) = $1/2\ CV^2$) | | 0.5Ws |
| Maximum Long Term Average Power Input (Watts = $1/2\ CV^2$ x Flashes/Sec.) | | 0.25W |
| Test Conditions | Voltage, V | 1.4KVDC |
| | Capacitance, C | 0.5 $\mu$fd |
| | Series Inductance, L | None |
| | Arc Resistance | 6 ohms |
| Typical Light Output Per Flash At Maximum Energy Input (Horizontal Candlepower Seconds) | | 0.30 HCPS |
| Typical Flash Duration At Maximum Energy Input (Measured at 1/3 peak amplitude) | | 3.5 $\mu$sec. |
| Typical Life in free air at Test Conditions (No. of Flashes to 50% light output) | | $5 \times 10^3$ flashes |
| Minimum Operating Voltage | | 0.9 KVDC |
| Maximum Operating Voltage | | 1.5 KVDC |
| Typical Trigger Voltage Range | | 7.5 - 10 kv |
| Recommended EG&G Trigger Transformer | | TR-132 |

## TYPICAL CIRCUIT




**PERFORMANCE** • Operating conditions listed in the specifications apply when the FX-41 is externally triggered. Self-flash will occur when a voltage greater than 2 KV is applied across the main electrodes.

**FEATURES**

- Concentrated Light Source
- Small Size - 3/4" x 5/16"
- Self-Flash or Externally Triggered

**APPLICATIONS**

- Fiducial marker
- Time marking of film
- Marking of photosensitive paper
- Reference light source
- Overvoltage operation to indicate voltage increases

**NOTES**

1. Trigger wire positioning, as supplied, should not be altered or else starting voltage may change.
2. Small concentrated arc discharge of light output can be obtained by viewing discharge end-on.
3. If self flash operation is desired for overvoltage circuit indicators, no trigger wire is required.
4. CAUTION: Do not cut, bend or apply excessive heat to electrodes since both electrodes are hollow and part of exhaust tubulation. Soft soldering leads to electrodes is permissible but only at end of electrodes as shown.

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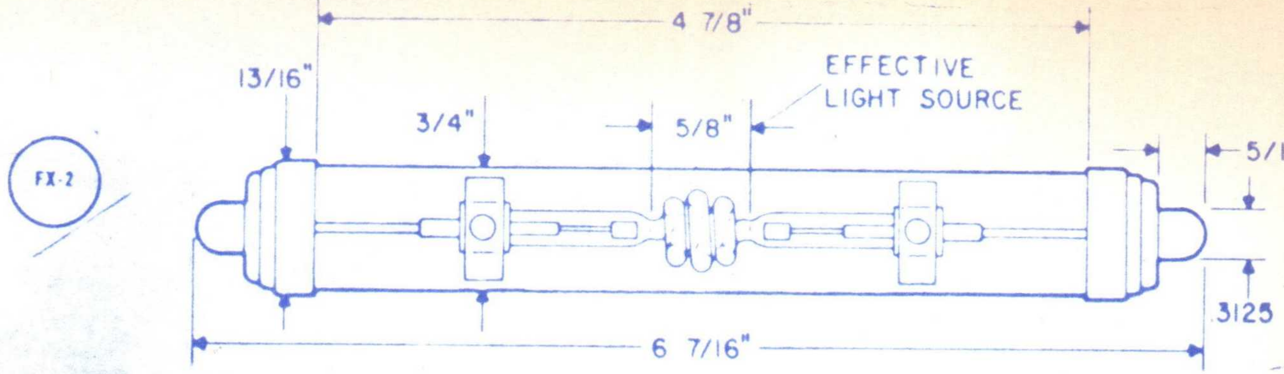
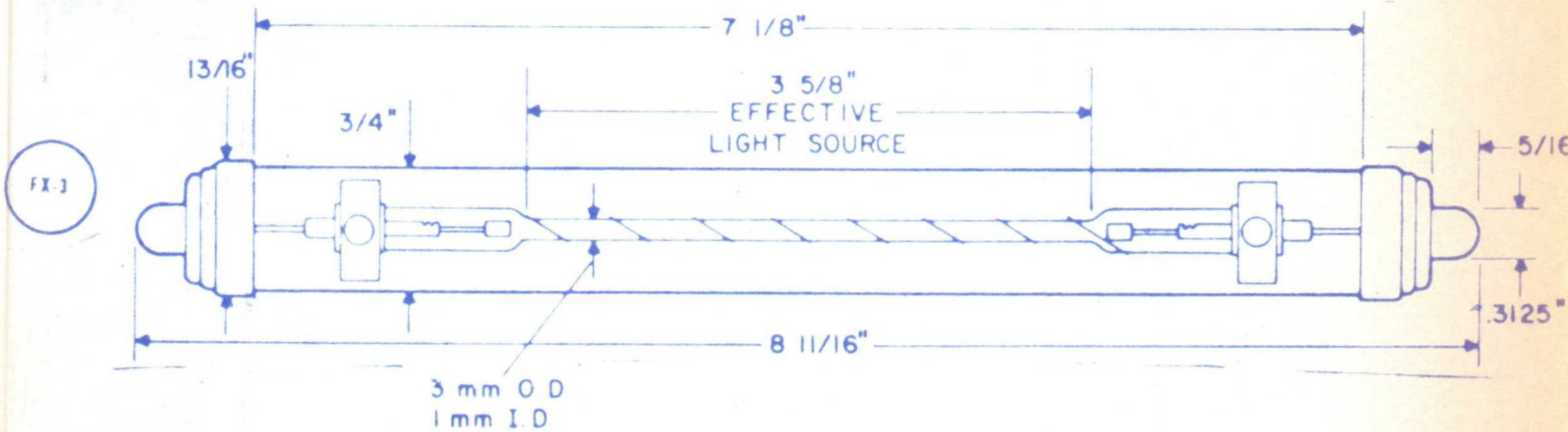
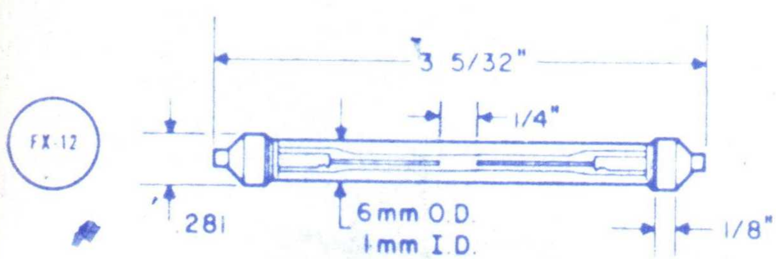
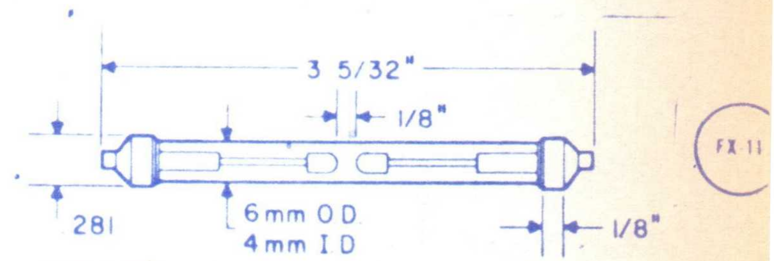
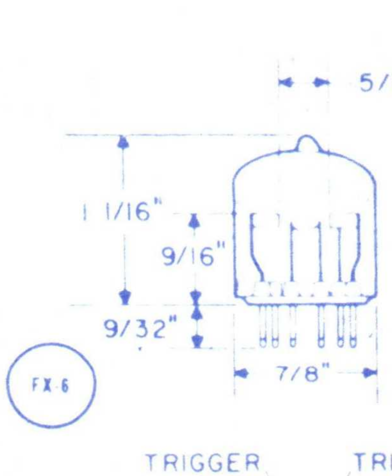
| PERFORMANCE DATA | FX-2 | FX-3 | FX-6A<br>*Fx-31* | FX-6B<br>*Fx-31B* | FX-6U<br>*Fx-31U* | FX-11 | FX-12 |
|---|---|---|---|---|---|---|---|
| Max. Long Term Average Power Input — Watts | see energy limit per burst below | | 7 | 7 | 7 | 1 | 2 |
| Max. Energy Input per Flash — Watt-Seconds or Joules | 1.25 | 1.25 | 5 | 5 | 5 | 1 | 5 |
| at Specified Conditions | 0.04 µfd, 8 kv | 0.04 µfd, 8 kv | 24 µfd, 0.65 kv | 24 µfd, 0.65 kv | 24 µfd, 0.65 kv | 2 µfd, 1 kv | 2.5 µfd, 2 kv |
| Nominal Light Output per Flash at Max. Input — Horizontal Candlepower Seconds (HCPS) | 0.6 | 0.84 | 2.5 | 2.5 | 2.5 | 1 | 2.5 |
| Nominal Flash Duration at Max. Input (⅓ peak) — microseconds | 2 | 2 | 12 | 12 | 12 | 3 | 6 |
| Typical Flash Rate | 800 per sec. Limit energy per burst to 1,500 w-s total — allow 5 min. between bursts. | | 600 pps | 1,000 pps | 600 pps | 1 per sec. | 6,000 pps |
| Nominal Life at Stated Input (in free air) — No. of Flashes | $10^5$ to $10^6$ | $10^5$ to $10^6$ | $10^9$ @ .008 w-s<br>$10^7$ @ 0.4 w-s<br>1.8 µfd, 640 v | Same as FX-6A | Same as FX-6A | 2 x $10^4$ | 6,000 at 1 w-s (0.5 µfd, 2 kv) 1.8 µfd |
| **OPERATING LIMITS** | | | | | | | |
| Min. Operating Voltage — volts | —— | —— | 400 | 500 | 400 | 600 | 400 |
| Max. Operating Voltage — volts | —— | —— | 1,500 | 1,500 | 1,500 | 3,000 | 3,000 |
| Typical Trigger Voltage Range — Kilovolts | Overvolt | Overvolt | 2.5 to 4 kv internally triggered | 4 to 6 kv internally triggered | 2.5 to 4 kv internally triggered | 10 | 15–20 |
| **OTHER CHARACTERISTICS** | | | | | | | |
| Arc Resistance During Discharge — ohms | 50 | 50 | 0.14 | 0.14 | 0.14 | 0.1 | 1 |
| Approximate Arc Length — (see illustration) | coil ⅝" wide, (3⅝" if straight) | 3⅝" | 5/16" | 5/16" | 5/16" | ⅛" | ¼" |
| Recommended Trigger Transformer — EG&G | —— | —— | TR-36A TR-76 or TR-90 | TR-90 | TR-36A TR-76 or TR-90 | TR-50 | TR-50 |
| Recommended Choke (if any) — EG&G | —— | —— | —— | —— | —— | —— | —— |
| Envelope Material | Inner envelope — quartz Outer envelope — Corning #7740 | | Corning 0080 | Corning 0080 | Corning 9823 UV glass | Quartz | Quartz |
| Mounting | —— | —— | Standard Subminiature 9 pin noval tube socket | Same as FX-6A | Same as FX-6A | Littlefuse | Littlefuse |
| Polarized Operation | No | No | Yes | Yes | Yes | No | No |

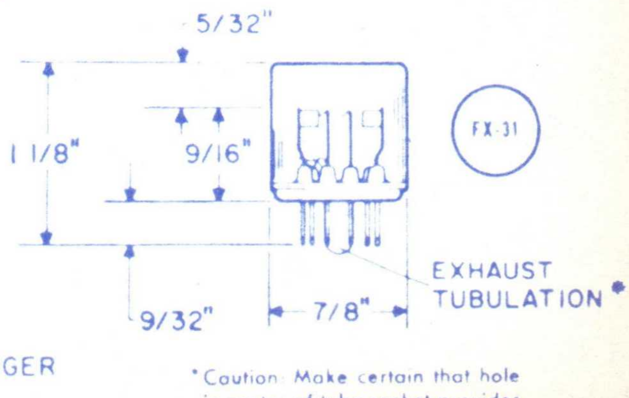


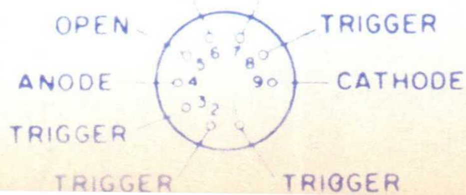




*Caution: Make certain that hole in center of tube socket provides sufficient clearance for glass exhaust tubulation in base of flash tube.

EG&G INC.

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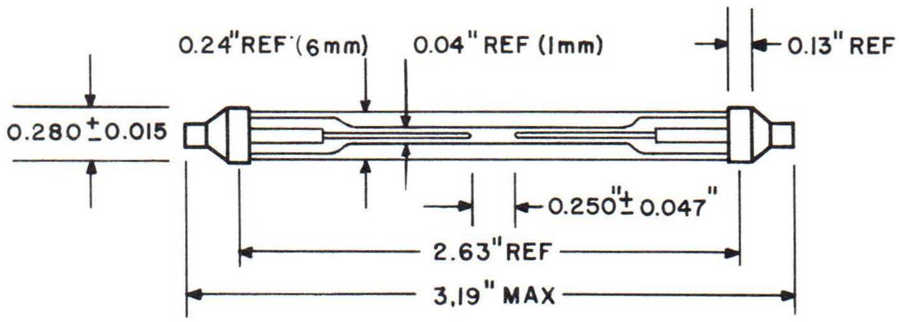
PRODUCTS DIVISION
DATA SHEET 1007-4

# LINEAR XENON FLASHTUBE FX-12-.25




## SPECIFICATIONS

| | | |
|---|---|---|
| TUBE DESIGNATION - ORDERING CODE | | FX-12-.25 |
| Flashtube Envelope O.D. | | 6 mm |
| Arc Length | | 0.25 in. |
| ELECTRICAL CHARACTERISTICS (SINGLE FLASH OPERATION)* | | |
| Maximum Energy Input Per Flash (Watt-seconds (Joules = 1/2 $CV^2$)) | | 5 Ws |
| Maximum Long Term Average Power Input (Watts = 1/2 $CV^2$ x flash rate) | | 2 Watts |
| Test Conditions (See Fig. 1) | Voltage (DC) | 1.4 KV |
| | Capacitance | 5μ fd |
| | Arc Resistance During Discharge at Maximum Energy Input | 0.25 ohms |
| Typical Light Output Per Flash at Maximum Energy Input (Horizontal Candlepower Seconds) | | 2.5 HCPS |
| Typical Flash Duration at Maximum Energy Input (Measured at 1/3 peak amplitude) | | 6μ sec |
| Typical Life in Free Air at Stated Conditions (No. of flashes to 50% light output) | | $10^4$ @ 1 WS (2μ fd, 1 KV) |
| Operating Voltage Range | | 0.4-1.4 KV |
| Typical Trigger Voltage Range | | 15-20 KV |
| Recommended Triggering Method or | | EG&G TM-11 Trigger Module |
| Recommended EG&G Trigger Transformer | | TR-132 |

*When used in EG&G's Model 501 High Speed Stroboscope, the FX-12-.25 can be operated at a flash rate of up to 1,000 pulses per second (for a 0.1 second burst) using a 0.01 μf capacitance changed to 2KV. For additional information on the use of the FX-12-.25 in high speed stroboscopic applications, see Data Sheet 501.

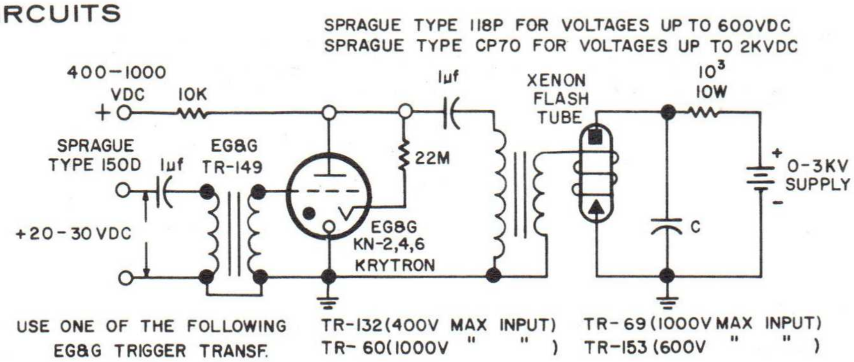
## APPLICATIONS

- High Speed Photographic Strobe
- Ballistic Studies
- Shock Wave Analysis
- Biological Research
- Schlieren Photography
- Microscopic Illumination
- Semiconductor Minority Carrier Lifetime Studies

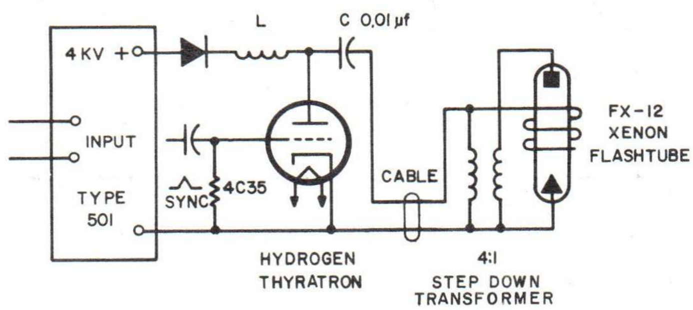
## FEATURES

- Point Light Source
- 1MM Discharge Bore
- High Pulse Rate Capability
- 7000$^{O}$K Color Temperature
- Quality Construction
- Compact Design

## TYPICAL CIRCUITS




FOR SINGLE FLASH OPERATION




FOR OPERATION AT HIGH REPETITION RATES USING EG&G 501 HIGH SPEED STROBOSCOPE

## ORDERING INFORMATION

EXAMPLE FX-12-.25

XENON FLASHTUBE — TUBE TYPE — ARC LENGTH (INCHES)

When ordering an FX-12-.25 Xenon Flashtube please use the abbreviated ordering code shown in the example above. FX-12 type flashtubes with arc lengths other than 0.25 inches are available upon request. When ordering please alter the final digits to indicate the specific arc length required.

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**EG&G INC.**

PRODUCTS DIVISION, 160 BROOKLINE AVE., BOSTON, MASS. 02215

TEL: 617-267-9700 TWX: 617-262-9317

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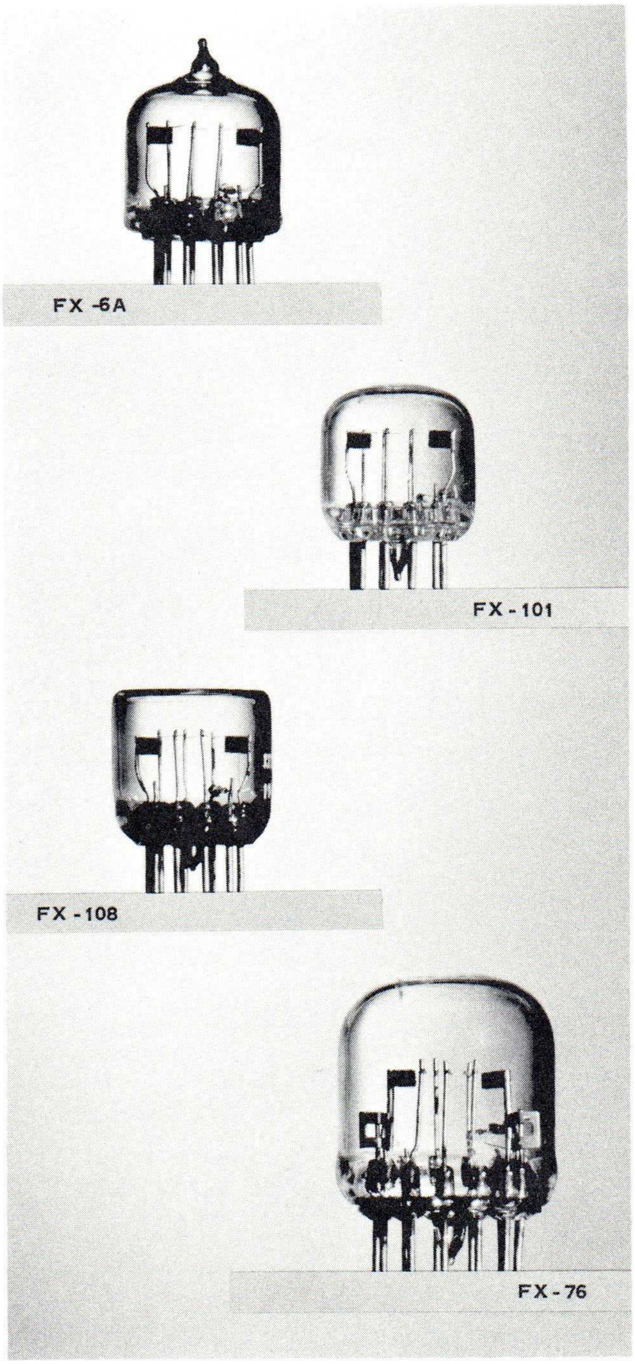
EG&G
ELECTRONIC PRODUCTS DIVISION





# BULB TYPE, PULSED XENON FLASH TUBES




## FEATURES

- LONG LIFE - UP TO $10^9$ FLASHES
- HIGH REPETITION RATES - UP TO 2500 PPS
- 5 - 10 JOULES INPUT
- 7 - 15 WATTS AVERAGE POWER
- IR, VISIBLE & UV LIGHT OUTPUT
- CONSISTENT LIGHT OUTPUT
- NON - WANDERING ARC
- SMALL SIZE
- STANDARD 9 OR 12 PIN BASES
- CHOICE OF GLASS ENVELOPE SHAPES

## APPLICATIONS

STROBOSCOPES

PHOTOTYPESETTING

OSCILLOGRAPH PAPER TIMING

PHOTOMASK PRODUCTION

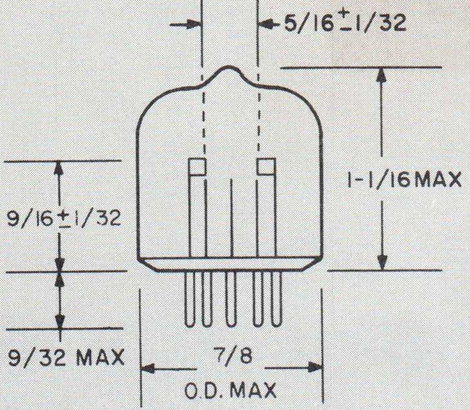
SHAFT POSITION ENCODERS

IGNITION TIMING

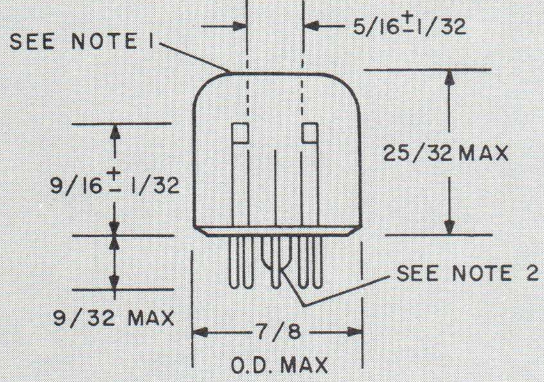
VISUAL BEACONS

DIGITAL READOUT

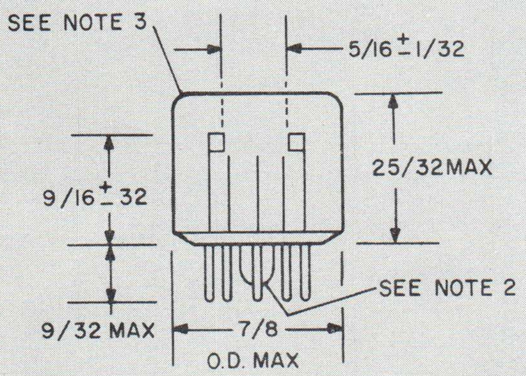
**FX-6A, 6B, 6AU, 6BU**

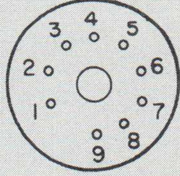



**FX-35B, 101, 101B, 102**




**FX-108, 108B, 108AU, 108BU**



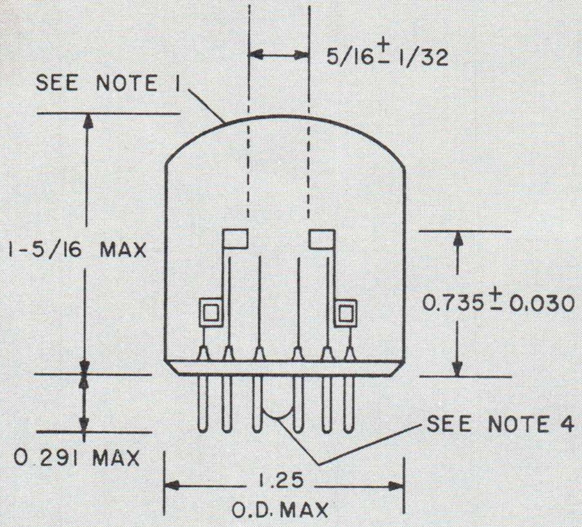



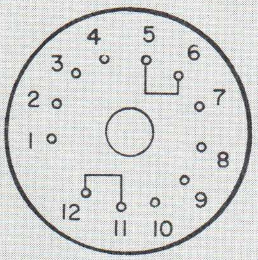

Anode pin 4
Cathode pin 9
Trigger pins 1,2,3,6,7,8
No Connection pin 5

BASE PIN CONNECTIONS

SOCKET: 9 PIN NOVAL SUBMINIATURE

**FX-76**




BASE PIN CONNECTIONS

Anode pins 11,12
Cathode pins 5,6
Trigger pins 1,2,3,4,8,9
No Connections pins 7,10

SOCKET: Cinch Jones 12CSM, Mica Filled 12 pin, Compactron socket.

NOTES:

1. 11/32 dia min area on face of envelope has minimum distortion.
2. Socket should have a center hole, drilled to accept exhaust tubulation of 0.200 long maximum and 5/32 O.D. maximum.
3. 11/32 dia min area on face of envelope is optically clear with no distortion.
4. Socket should have a center hole drilled to accept exhaust tubulation of 5/16 long maximum and 7/32 O.D. maximum
5. All dimensions in inches.

## ELECTRICAL DATA

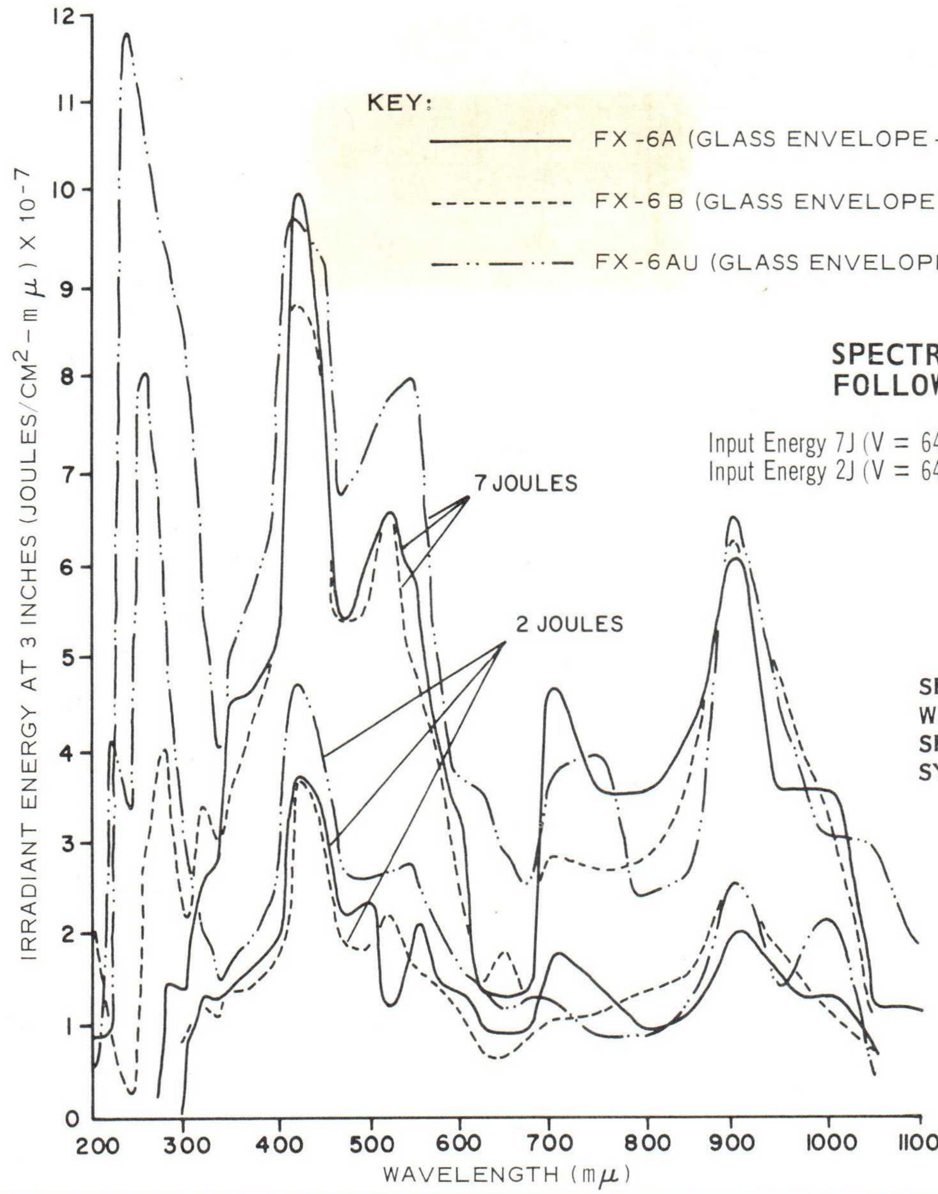
| Tube Types | | F X-6A, FX-6AU, FX-101, FX-108, FX-108 AU | | FX-6B, FX-6BU, FX-35B, FX-101B, FX-102, 108B, FX-108BU | FX-76 |
|---|---|---|---|---|---|
| Maximum Energy Input per Flash Watt-Secs (Ws) or Joules<br>Notes 1, 2 | | 5<br>(24 $\mu$F, 650 V) | | 5<br>(24 $\mu$F, 650 V) | 10<br>(20 $\mu$F, 1 kV) |
| Maximum Long Term Average Power Input (W) watts<br>Note 3 | | 7 | | 7 | 15 |
| Flash Duration at Maximum Energy Input ($\mu$s)<br>Note 4 | | 12 | | 12 | 15 |
| Typical Integrated Light Output at Maximum Energy Input (horiz cps)<br>Note 5 | | 2.5 | | 2.5 | 10 |
| Maximum Repetition Rate (pps) | | 500 | | 2500 | 2500 |
| Typical Operating Conditions | Energy Input (Ws) per Flash | 0.4 | 0.01 | 0.0013 | 1.0 |
| | Voltage (Vdc) | 650 | 650 | 600 | 1000 |
| | Capacitance ($\mu$F) | 1.8 | 0.047 | 0.007 | 2.0 |
| | Pulse Duration ($\mu$s) | 3 | 0.8 | 0.6 | 4 |
| | Pulse Rate (pps) | 10 | 420 | 1000 | 20 |
| | Life in Free Air (No. of flashes to 50% light output) | $1 \times 10^7$ | $6 \times 10^8$ | $2 \times 10^9$ | $1 \times 10^7$ |
| Minimum Operating Voltage (Vdc) | | 400 | | 500 | 900 |
| Maximum Operating Voltage (Vdc) | | 1000 | | 1000 | 1500 |
| Minimum Trigger Voltage (kV)<br>Note 6 | | 2.5 | | 4.0 | 5.0 |
| Recommended Trigger Transformer and Circuit | | EG&G<br>TR-36A, TR-76A, TR-90A or FY-5A Litepac | | EG&G<br>TR-36A, TR-90A<br>FY-5A Litepac | EG&G<br>TR-36 A<br>TR-90A |

NOTES:

1) Ws or Joules = $1/2cV^2$
2) Arc Resistance at maximum energy input is approximately 0.14 $\Omega$
3) $W = (1/2\ cV^2)$ x frequency
4) Measured at 1/3 peak amplitude
5) horiz cps = Horizontal Candle Power Seconds
6) Open Circuit, secondary Transformer voltage.

All tubes have a 5/16 inch arc length; 1/8 inch arc length tubes are available upon request. Except for the 'U' type tubes, the glass envelope material is Corning 0080. 'U' types are constructed with 9823 UV transmitting glass to increase UV output.

## SPECTRAL DATA

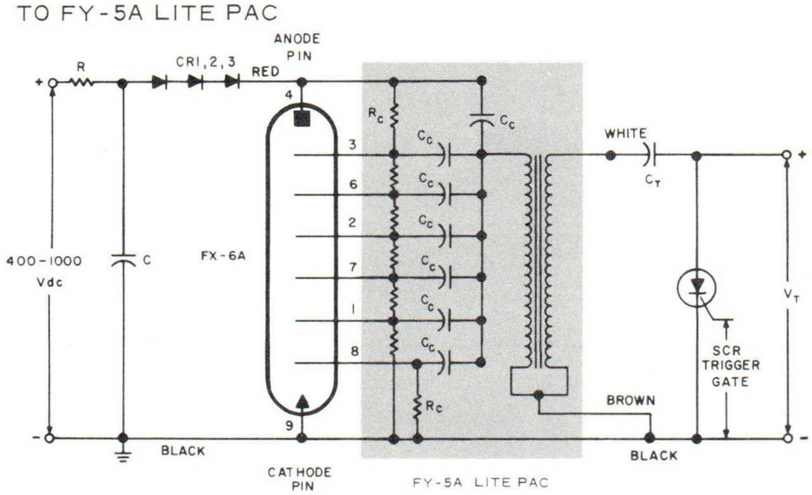



### SPECTRAL DATA AT THE FOLLOWING CONDITIONS

Input Energy 7J (V = 640 Vdc, C = 35 $\mu$F, 27 $\mu$s pulse width)
Input Energy 2J (V = 640 Vdc, C = 10 $\mu$F, 9 $\mu$s pulse width)

**SPECTRAL DATA TAKEN WITH EG&G 580/585 SPECTRORADIOMETER SYSTEM.**

COLORED LEADS REFER TO FY-5A LITE PAC




| | LOW VOLTAGE | HIGH VOLTAGE |
|---|---|---|
| $V_T$ | 40 Vdc | 200 Vdc |
| $C_T$ | 1.0 $\mu$F | 0.047 $\mu$F |
| SCR | 2N1595 | 2N1777A |

CR 1, 2, 3 T.I. 1N2071 or EDAL B3G5 up to 2 watt-seconds and GE 1N4530 for 2-5 watt-seconds

R = 10K - 200 K
C = DETERMINED BY MAX RATINGS
$R_C$ = 4.7 MEG, 1/2W
$C_C$ = 22 PF - SPRAGUE NO. 30 GA - 022

**FX-6A BASIC CIRCUIT FOR LOW OR HIGH VOLTAGE TRIGGERING USING FY-5A LITEPAC**

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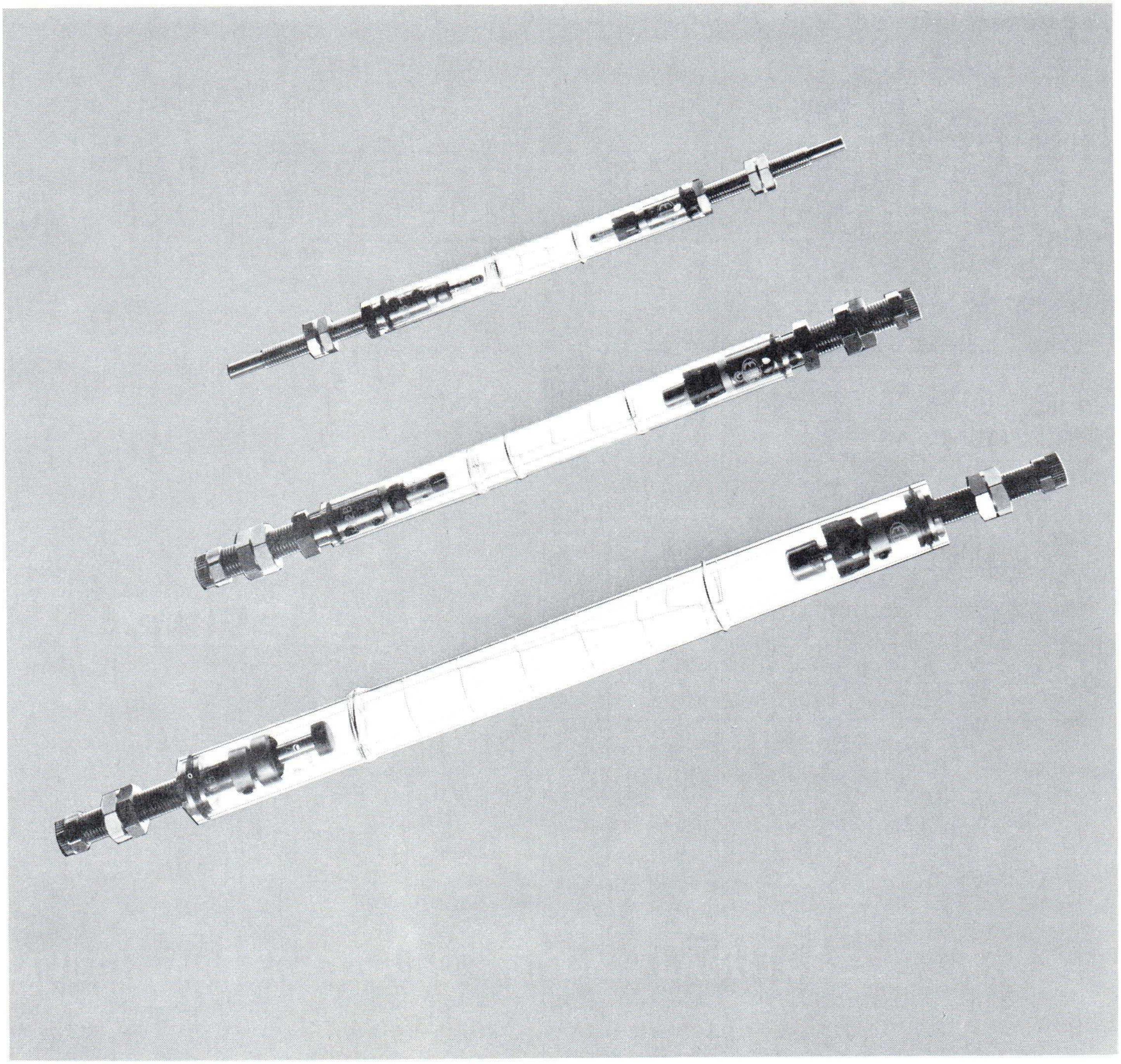
PRODUCTS DIVISION
DATA SHEET 1004

EG&G INC.



# LINEAR WATER-COOLED XENON FLASHTUBES



## FEATURES AND APPLICATIONS

Figure 1 below shows the outstanding features of EG&G's line of Q-C (Quick Change) Water-Cooled Xenon Flashtubes. Because of their unique design, the flashtubes can be quickly and easily removed from the outer quartz water jacket. Thus at the end of life only the flashtube itself need be replaced. (See Ordering Information for correct replacement.)

Efficient cooling of the flashtubes is provided by EG&G's heavy duty electrodes and special anode heat dissipator. Threaded end pieces and quality fittings allow for easy mounting and quick connection to cooling unit. Water is fed through threaded end pieces for maximum cooling of the flash-tube.

Because of the unique cooling design, EG&G's flashtubes are able to dissipate up to 10,000 watts of long term average power. As a result these flashtubes are ideally suited for applications such as optical pumping of high energy lasers, projection cameras, and other optical and illumination systems where high intensity sources are required.

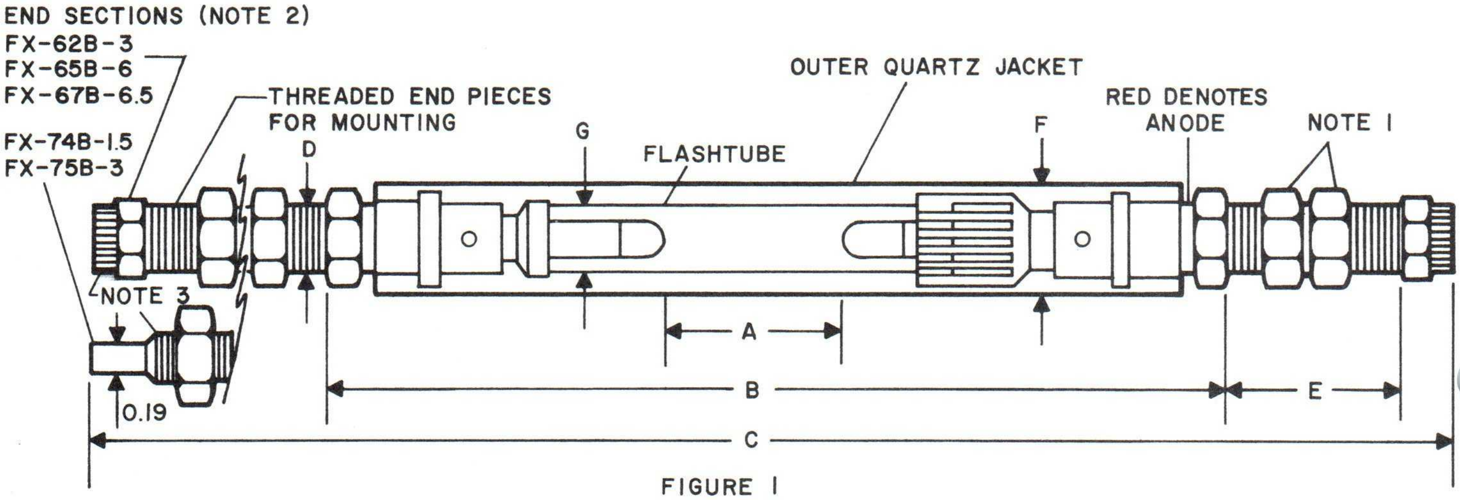



FIGURE 1

DIMENSIONS (inches except where noted)

| Tube Type | A(±.063) | B(±.125) | C(REF) | D(REF) | E(REF) | F(REF) | G(REF) |
|---|---|---|---|---|---|---|---|
| FX-74B-1.5 | 1.500 | 4.750 | 8.56 | 1/4-28UNF | 1.38 | 0.47 (12mm) | 0.24 (6mm) |
| FX-75B-3 | 3.000 | 6.250 | 10.06 | 1/4-28UNF | 1.38 | 0.47 (12mm) | 0.24 (6mm) |
| FX-62B-3 | 3.000 | 7.125 | 9.88 | 3/8-24NF | 0.91 | 0.59 (15mm) | 0.35 (9mm) |
| FX-65B-6 | 6.000 | 10.125 | 12.88 | 3/8-24NF | 0.91 | 0.59 (15mm) | 0.35 (9mm) |
| FX-67B-6.5 | 6.500 | 10.625 | 14.25 | 3/8-24NF | 1.35 | 0.87 (22mm) | 0.59 (15mm) |

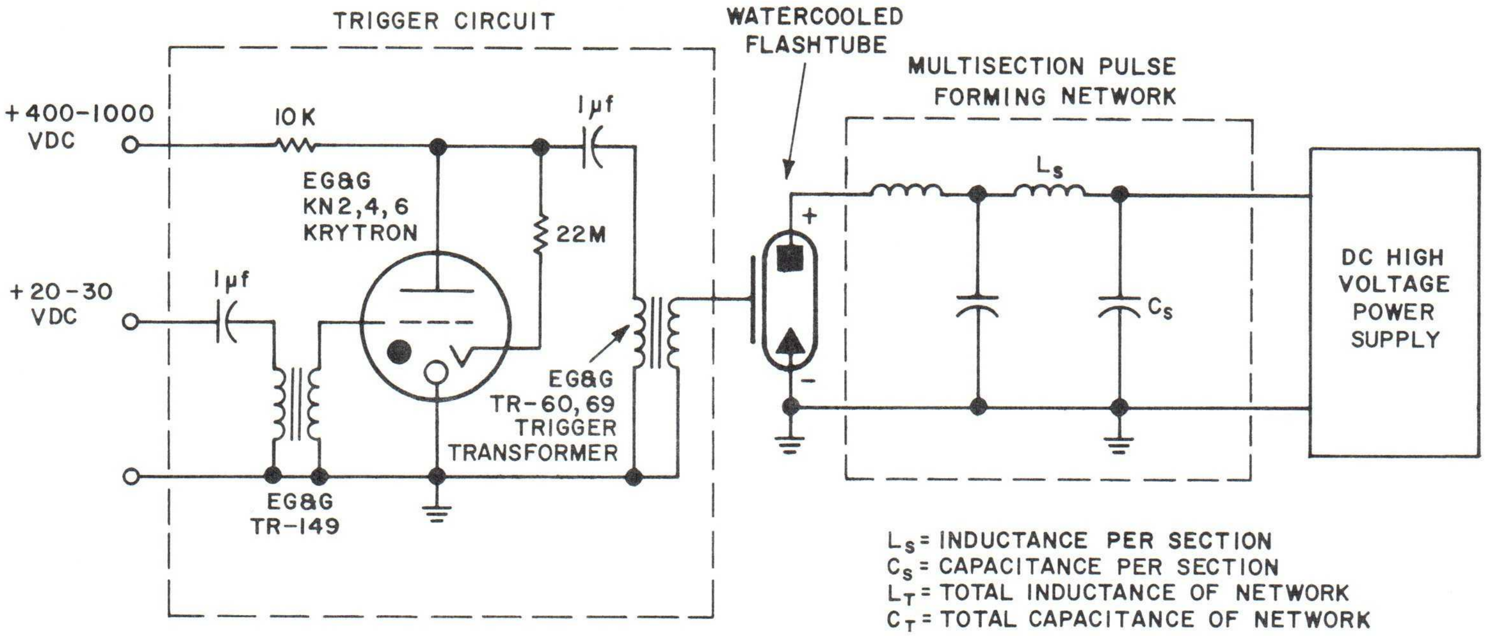
NOTES:
1. Electrical connections should be made between these two jam nuts. (CAUTION: Do not tighten outer two jam nuts against the innermost nut.)
2. Imperial Eastman Poly-Flo Nut (261 P x 1/4) and Imperial Eastman Poly Sleeve are used on FX-62B-3, FX-65B-6, and FX-67B-6.5. End section of FX-74B-1.5 and FX-75B-3 consists of hollow copper tube 1/2" long and 3/16" O.D.
3. Recommended connecting tubing and clamps

| | |
|---|---|
| FX-62B-3<br>FX-65B-6<br>FX-67B-6.5 | Imperial Eastman 44-P, 44-PP, 44-SN or equivalent polyethelene, polypropylene, or nylon tubing. |
| FX-74B-1.5<br>FX-75B-3 | Imperial Eastman C403 tubing or equivalent and Emperial Eastman Sherman No. 4-3/8 clamps. |

## TENTATIVE SPECIFICATIONS

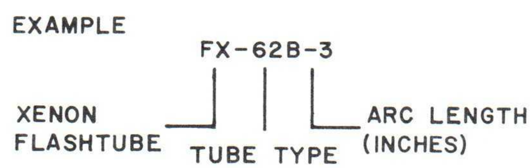
| TUBE DESIGNATION-ORDERING CODE | | FX-74B-1.5 | FX-75B-3 | FX-62B-3 | FX-65B-6 | FX-67B-6.5 |
|---|---|---|---|---|---|---|
| Flashtube Envelope O. D. | | 6mm | | 9mm | | 15mm |
| Arc Length (inches) | | 1.5 | 3 | 3 | 6 | 6.5 |
| ELECTRICAL CHARACTERISTICS | | | | | | |
| Maximum Long Term Average Power Input, Watts (Watts = $1/2\ CV^2$ x flash rate) | | 500 | 1000 | 4000 | 8000 | 10,000 |
| Maximum Energy Input per Flash, Watt-Seconds (Watt-Seconds (Joules) = $1/2\ CV^2$) | | 100 | 400 | 600 | 2000 | 4000 |
| Average Life at Test Conditions (No. of flashes to 50% light output) | | $3 \times 10^5$ | $3 \times 10^5$ | $3 \times 10^5$ | $1 \times 10^6$ Note 2 | $150 \times 10^3$ Note 2 |
| Test Conditions | Energy Input (WS) | 50 | 180 | 200 | 500 | 2000 |
| | Flash Rate (pps) | 10 | 5.6 | 20 | 16 | 5 |
| | Flash Duration (ms) | 0.20 | 0.20 | 0.34 | 0.38 | 1.20 |
| | Voltage V(KVDC) | 1.4 | 1.5 | 1.4 | 1.45 | 1.45 |
| | Total Capacitance, $C_T$ | 50 | 160 | 200 Note 1 | 480 Note 1 | 1920 Note 1 |
| | Total Series Inductance, $L_T$ | 100 | 30 | 172 Note 1 | 57 Note 1 | 124 Note 1 |
| | Arc Resistance (ohms) during discharge at maximum energy input | 0.4 | 0.6 | 0.4 | 0.6 | 0.3 |
| Minimum Operating Voltage (KVDC) | | 1.2 | 1.2 | 1.5 | 1.5 | 1.7 |
| Maximum Operating Voltage (KVDC) | | 1.8 | 2.5 | 2.5 | 2.5 | 3.0 |
| Typical Trigger Voltage Range (kv) Note 5 | | 25-30 | 25-30 | 25-30 | 25-30 | 25-30 |
| Recommended Water Flow (gpm) Notes 3, 4 | | 1.0 | 1.0 | 1.0 | 1.2 | 1.2 |
| Recommended Water Pressure (psi, gauge) Note 4 | | 25 | 25 | 25 | 25 | 25 |

NOTES:
1. Capacitance and inductance shown are total values used in multisection pulse forming network.
2. Operated in 6 inch I. D. cavity with no absorber.
3. It is recommended that demineralized or deionized water be used for cooling purposes.
4. Flow of water should be adjusted so that temperature rise will not exceed 25°C. Water pressure should not exceed 30 psi (gauge).
5. Flashtube may be triggered using external or series injection triggering. For pulsing high energy tubes in a cavity, it is recommended that a water-cooled trigger bar be used in close proximity to flashtube. Example: 3/16" O. D. nickel tubing.




TYPICAL WATER-COOLED FLASHTUBE CIRCUIT WITH EXTERNAL TRIGGERING

## FLASHTUBE ORDERING INFORMATION




When ordering a water-cooled flashtube please use the entire ordering code including arc length. The data and specifications on this sheet apply only to those specific tube types listed. Standard tubes with arc lengths other than those listed are available upon request. When ordering please alter the final digits of the code to correspond with the arc length desired.

When a replacement flashtube is required please determine the proper tube to be ordered by referring to the chart below.

| Original Flashtube Unit | Replacement Tube |
|---|---|
| FX-74B-1.5 | FX-84-1.5 |
| FX-75B-3 | FX-85-3 |
| FX-62B-3 | FX-42A-3 |
| FX-65B-6 | FX-45A-6 |
| FX-67B-6.5 | FX-47B-6.5 |

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# WHY LASERS FAIL AND WHAT TO DO ABOUT IT

***Glenn A. Hardway***
*General Manager*
*Applied Lasers, Inc.*
*Stoneham, Mass.*

Now that the laser is more a commodity than a curio, reliable, repeatable performance is as important as output power. Failure in ruby and glass lasers can often be traced to one or more of the following:

- Flash lamps.
- The laser rod.
- Cavity material.
- Excessive heat in the lamp and rod.
- Dirt in the cavity or on components.

The designer who takes pains to control these critical factors can build a laser that will maintain performance, even at high repetition rates. Such a non-Q-switched, solid-state laser can give up to 500,000 discharges.

We shall consider the danger areas one by one.

**Two types of flash lamps**

The greatest present limitation on non-Q-switched system life is the flash lamp. The two types of flash lamps usually specified are linear or helical xenon-arc lamps. They vary in over-all length from 2 in. to 2 meters. Bore diameters range from 4 to 30 mm; inputs from 100 to 100,000 Joules.

Helical lamps withstand higher input voltages than linear units, but today, are less-efficient pumps, since energy reflected from the cavity walls is lost in the lamp. The higher efficiency of the linear tube in an elliptical cavity has made it the designer's usual choice.

In early flash-lamp tests, lifetimes ranged from 25 to 1000 discharges, but today with conservative design, lives of 100,000 discharges are not unusual. To attain this level of performance, the following requirements must be met:

- End seals must be protected against outgassing.
- Reverse current must be avoided.
- Peak current must be tailored to the limits of the lamp.
- Current rise time must not be faster than the lamp can withstand.
- Cooling must fully dissipate the heat generated in the lamp.

**End-seal protection**

End seals are usually soldered or of graded quartz-to-metal construction. Both types have their limitations, but the soldered seal has proved more useful at high repetition rates, since it allows conduction cooling of the electrodes.

Solder's low melting point is a drawback, however, and it is necessary to design the system so that the seals are outside the cavity, to light-shield the seals and to water-cool them.

Seals can be damaged by pump light itself, or because they absorb heat from the electrode. End seals also outgas slightly when pumped at higher energies unless adequately cooled. Water cooling usually eliminates such breakdown.

**Specifying current**

Since the cathode is more emissive than the anode, flash lamps are polarized and will pass current in only one direction without damage. Current reversal is one of the quickest ways to damage a lamp, but it can be prevented completely by impedance-matching the lamp to and pulse-forming network/energy-storage unit.

Optimal energy transfer in an elliptical cavity occurs with the smallest possible lamp diameter. Highest-possible energy input is also desirable in most applications. Unfortunately the two parameters are not compatible, since a small bore means a low explosion rating (as shown in Fig. 1).

The linear flash lamps most often used have relatively short arc lengths and therefore require more current than equivalent helical lamps. As much as 4000 to 6000 A are sometimes desired for 6- to 13-in. lamps. This can be well above the explosion current for the quartz tubes used in some standard lamps.

The life expectancy of a flash lamp begins to deteriorate rapidly when peak current exceeds 60% of explosion current. Above 60%, the lamp's life is usually limited to less than 10,000 discharges, even if all other parameters are optimized. At the 80% level, explosion can occur on any discharge.

CONTINUED

The first step in arriving at a safe current level is selection of the desired pulse duration. The application usually determines this; shorter pulses are used in Q-switching and metal-removal applications than in welding or heating applications. For this example, assume a 1-msec pulse. Also assume that an EG&G FX-47C-6.5 flash lamp is to be used.

Fig. 1 shows that the FX-47C-6.5's quartz tube explodes at a 1msec energy input of 1300 Joules/in, or 8450 Joules for this 6.5-in lamp. Sixty percent of this is 5070 Joules. Rounding this to 5000 Joules adds an additional safety factor.

Now specify the pulse forming network. With pulse duration ($t$) known, the parameters of the network can be selected using

$$t = 2\sqrt{LC} \quad (1)$$

where $L$ = total inductance, and
$C$ = total capacitance of the pulse-forming network.

The impedance of the ($Z_o$) pulse-forming network is found through

$$Z_o = \sqrt{L/C} \quad (2)$$

The required storage capacitance ($C_s$) can now be computed using

$$C = \frac{t}{2\,Z_o} \quad (3)$$

in this case, about 1600 x $10^{-6}$ farads.

Now, with $C_s$ and $E$ (5000 Joules) known, the necessary voltage is found with

$$V = \sqrt{\frac{2E}{C_s}}. \quad (4)$$

The requirement is approximately 2500 V. Peak current ($I_p$) can now be found with

$$I_p = \frac{V}{Z_o + R_c} \quad (5)$$

where $R_c$ = flash-lamp impedance at time of peak current.

Thus, the safe, 60% current level is found to be about 4200 A.

Experiments have shown that current rise times of 50 msec (10-90%) can sputter electrodes, craze the flash tube, or cause "buck-shotting" within the quartz. To overcome these, simply design the pulse-forming network for a minimum rise time of at least 100 msec. If overvoltage triggering is used, however, a scheme is needed to prevent such triggering from distorting the network's output waveshape. A "safe" pulse is shown in Fig. 2.

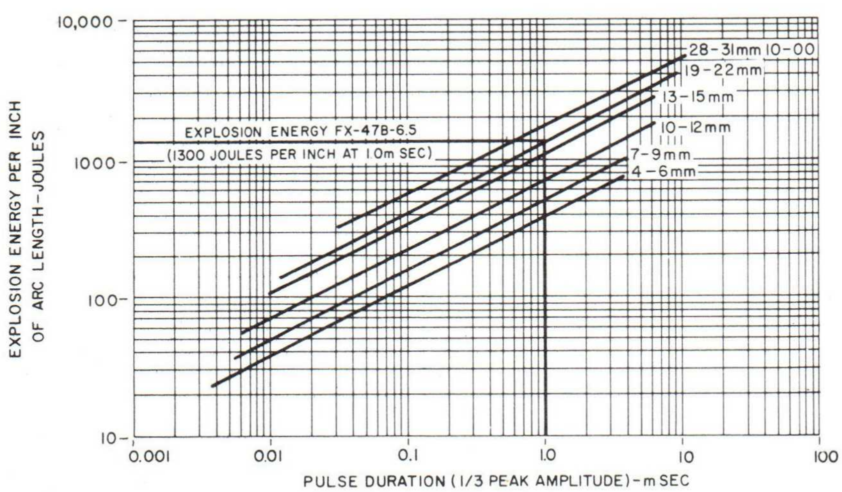


**Fig. 1. When flash lamps explode.** Chart gives explosion energies of flash lamps in terms of inner and outer diameter of quartz tube. The FX-47C-6.5, used in text as example, has 13-mm ID, 15-mm OD. Energy per unit time is quoted for one inch arc length. Graph courtesy EG&G.

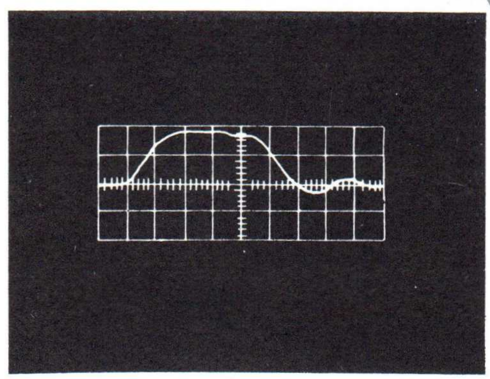

**Fig. 2. A safe pulse for flash lamps.** Scope photo shows a pulse of approximately 4000 A, 150 $\mu$sec rise time, 850 $\mu$sec duration. Pulse amplitude is less than 60% of flash lamp's explosion rating; relatively slow rise time protects tube against crazing and "buck-shotting." The waveshape is also free of tube-damaging reverse current.

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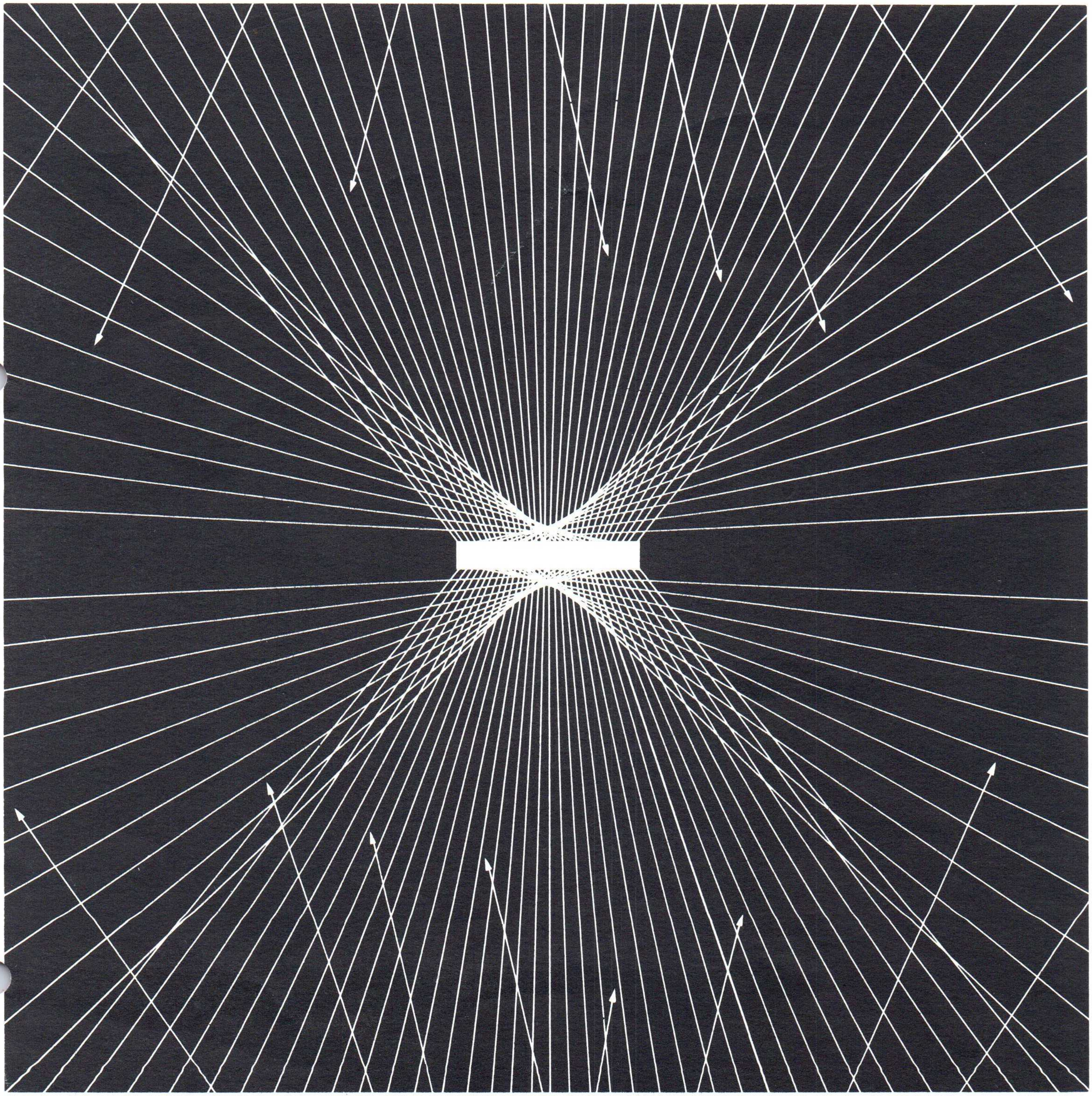
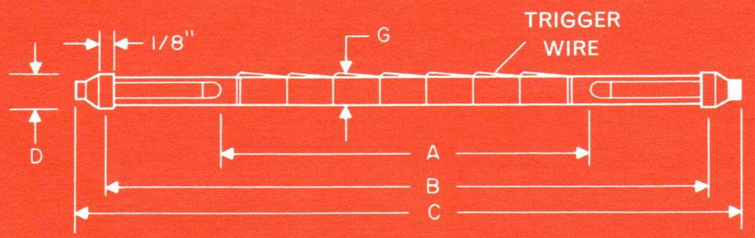
EG&G INC.

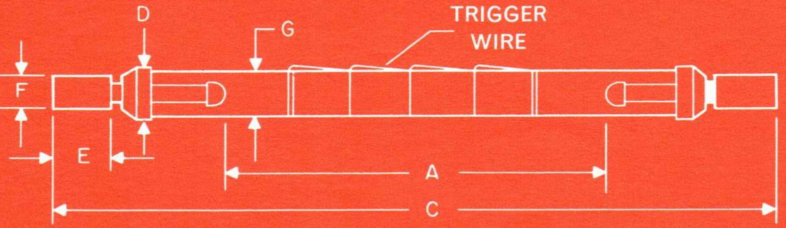
# LINEAR XENON FLASHTUBES



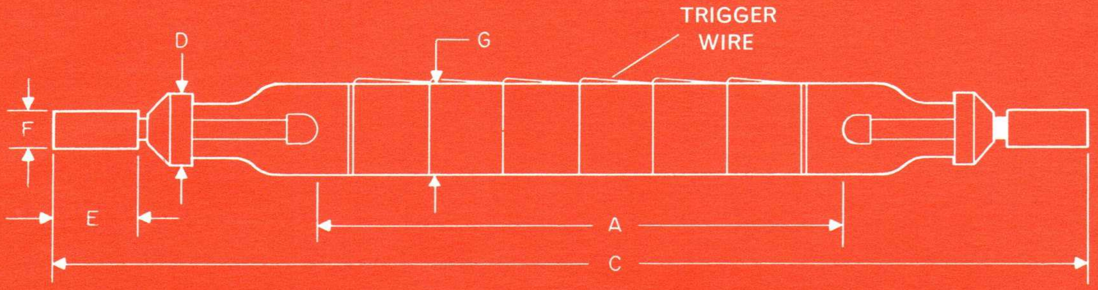
| TUBE TYPE | FX-1 | FX-5 | FX-11A | FX-33 | FX-38A | FX-42 | FX-45 | FX-81 | FX-47B | FX-77 | FX-56 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| OUTLINE DWG. NO. | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 3 |
| TOLERANCES | DIMENSIONS (INCHES) | | | | | | | | | | |
| A (±1/16) | 6 | 9 | 1/8 | 1 1/2 | 3 | 3 | 6 | 8 | 6 1/2 | 13 | 6 1/2 |
| B (Ref) | 7 7/8 | 10 7/8 | 2 5/8 | 2 5/8 | 4 7/8 | — | — | — | — | — | — |
| C (Max.) | 8 5/8 | 11 1/2 | 3 13/32 | 3 13/32 | 5 3/4 | 5 7/8 | 8 7/8 | 10 5/8 | 9 13/16 | 17 15/16 | 12 15/16 |
| D (± .015) | 0.271 | 0.271 | 0.271 | 0.271 | 0.271 | 0.385 | 0.385 | 0.515 | 0.642 | 0.935 | 0.642 |
| E (Ref) | — | — | — | — | — | 1/2 | 1/2 | 1/2 | 1/2 | 1 | 1 |
| F | — | — | — | — | — | 0.280 ±0.005 | 0.280 ±0.005 | 0.280 ±0.005 | 0.280 ±0.005 | 0.5 ±0.010 | 0.5 ±0.010 |
| G (Ref) (millimeters) | 6 | 6 | 6 | 6 | 6 | 9 | 9 | 12 | 15 | 22 | 31 |




(1)




(2)




(3)

**NOTES:**

(1) Quartz Envelopes on all Tubes

(2) FX-47B, FX-56, FX-77, and FX-81 supplied with 0.010 inch dia. silver clad nickel trigger wire. All other tubes supplied with 0.010 inch dia. nickel trigger wire.

(3) Red marking identifies anode end and denotes polarized operation.

(4) Tube mounting can be made by using Littlefuse Co. fuse clip holders Type 101001 or equal for the 6 mm. O.D. tubes. For larger diameter tubes, where the peak currents can be in the order of several thousand amperes, mounting material should be carefully selected. Drilling holes in end lugs or soldering leads to end caps or end lugs is not recommended.

3

# LINEAR PULSED-XENON FLASHTUBES

| | 6mm. O.D. Types | | | | | | |
|---|---|---|---|---|---|---|---|
| **TUBE TYPE DESIGNATION** | **FX-1** | **FX-5** | **FX-11** | **FX-33** | **FX-38A** | | |
| ARC LENGTH (INCHES) | 6 | 9 | 0.125 | 1.5 | 3 | | |
| **ELECTRICAL CHARACTERISTICS** | | | | | Operation I | Operation II | Operation III |
| MAXIMUM ENERGY INPUT PER FLASH (Watt Seconds, (WS) or Joules = $\frac{1}{2}CV^2$) | 400 | 600 | 1 | 100 | 1,000 | 400 | 200 |
| TEST CONDITIONS Capacitance, C ($\mu$fds) | 200 | 200 | 2 | 100 | 22,500 | 400 | 200 |
| Voltage, V(KVDC) | 2 | 2.45 | 1 | 1.4 | 0.350 | 1.4 | 1.4 |
| Series Inductance, L($\mu$hy) | 0 | 0 | 0 | 0 | 8,000 | 600 | 0 |
| MAXIMUM LONG TERM AVERAGE POWER INPUT Watts = $\frac{1}{2}CV^2$ times flash rate) | 40 | 40 | 1 | 10 | 20 | 20 | 20 |
| TYPICAL LIGHT OUTPUT PER FLASH at Maximum Energy Input (Horizontal Candlepower Seconds, HCPS) | 2,000 | 2,200 | 1 | 200 | 2,000 | 1,000 | 600 |
| TYPICAL FLASH DURATION at Maximum Energy Input measured at ⅓ peak amplitude point (microsecond) | 250 | 300 | 5 | 100 @ 265$\mu$fd, 0.9KV | 40,000 | 1,000 | 130 |
| AVERAGE LIFE (No. of Flashes in free air at Test Conditions Above or at Stated Conditions) | $10^5$ @ 200WS (100$\mu$f, 2KV) | $10^6$ @ 200WS (100$\mu$f, 2KV) | 2 x $10^4$ | $10^3$ | 7.5 x $10^3$ | $10^5$ @ 200WS (400$\mu$f, 1KV 600$\mu$hy) | 5 x $10^3$ |
| MINIMUM OPERATING VOLTAGE (KVDC) | 0.7 | 1.2 | 0.6 | 0.5 | 0.35 | 0.7 | 0.7 |
| MAXIMUM OPERATING VOLTAGE (KVDC) | 3 | 3 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 |
| TYPICAL TRIGGER VOLTAGE RANGE (kv) | 15-20 | 15-20 | 10-15 | 15-20 | 15-20 | 15-20 | 15-20 |
| ARC RESISTANCE during discharge at Maximum Energy Input (OHMS) | 2 | 3 | 0.1 | 0.25 | 2 | 1.0 | 0.6 |
| | EG&G TM | | | | | | |
| TRIGGERING METHOD or RECOMMENDED TRIGGER TRANSFORMER EG&G Type | TR-60 or TR-132 | | | | TR-136 | TR-6 | |
| RECOMMENDED SERIES INDUCTANCE (if any) — EG&G Type | — | — | — | — | TR-80 or TR-81 | TR-70 or TR-71 | — |

NOTE 1 Operated in a 2-inch I. D. Cavity with no Absorber NOTE 2 Use air cooling at a flow rate of 10-15 cu. ft./min. NOTE 3 Use DRY NITROGEN cooled to —196°C a

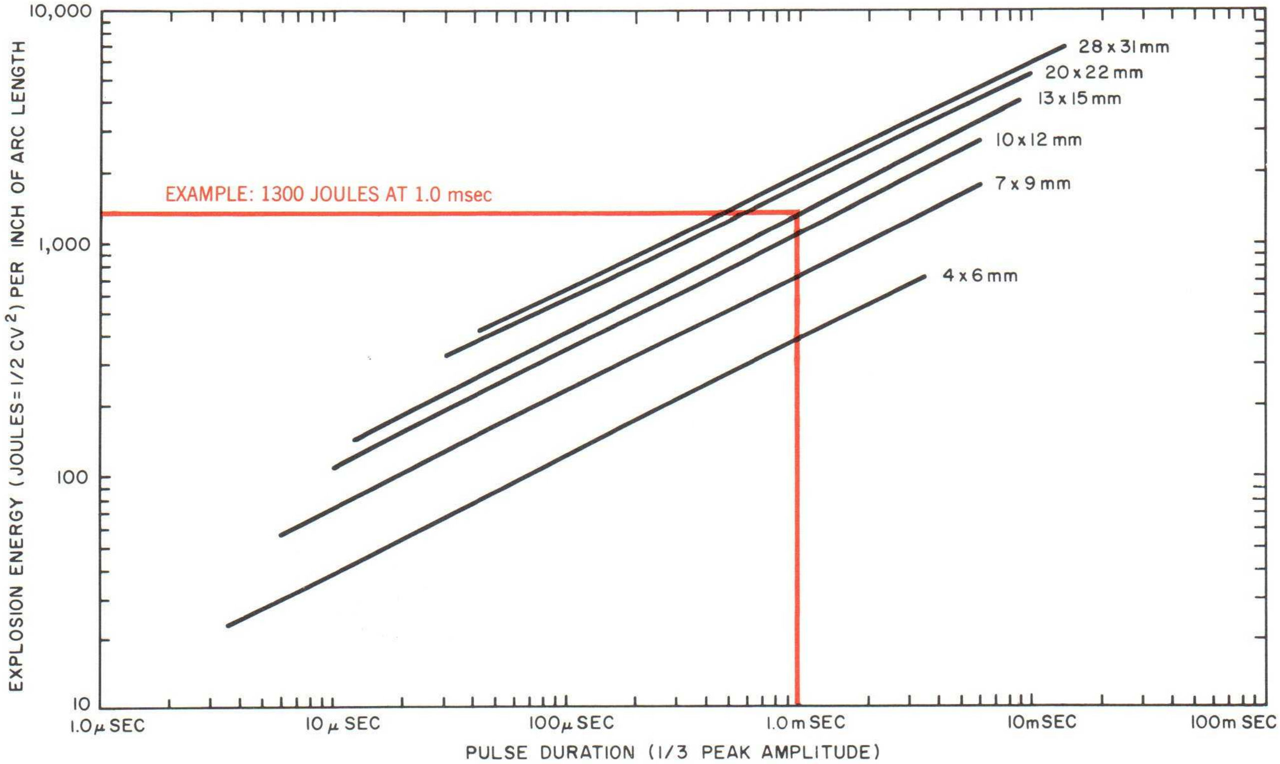
| 9mm. O.D. Types | | 12mm. O.D. Types | 15mm. O.D. Types | | | 22mm. O.D. Types | 31mm. O.D. Types |
|---|---|---|---|---|---|---|---|
| FX-42 | FX-45 | FX-81 | FX-47B | | | FX-77 | FX-56 |
| 3 | 6 | 8 | 6.5 | | | 13 | 6.5 |
| | | | Operation I | Operation II | Operation III | | |
| 600 | 2,000 | 6,000 | 4,000 | 5,000 | 10,000 | 25,000 | 20,000 |
| 400 | 2,250 | 2,585 | 2,250 | 2,250 | 2,585 | 2,400 | 3,840 |
| 1.7 | 1.34 | 2.15 | 1.9 | 2.11 | 2.78 | 4.5 | 3,300 |
| 300 | 122 | 850 | 122 | 122 | 850 | 400 | 550 |
| 60 | 60 | 80 | 80 | 80 | 100 | 125 | 150 |
| 2,500 | 7,500 | 18,000 | 16,000 | 20,000 | 40,000 | 100,000 | 80,000 |
| 1,000 | 1,400 | 1,300 | 1,400 | 1,400 | 3,800 | 3,300 | 3,500 |
| 5 x $10^3$ | $10^3$ | $10^3$ | 100 (See Notes 1, 2) | 300 (See Notes 1, 3) | 300 (See Note 2) | 50 (See Note 2) | 50 (See Note 2) |
| 1 | 1.1 | 1 | 1 | 1 | 1 | 1 | 1.5 |
| 3 | 3 | 3 | 3 | 3 | 3 | 3 | 4.0 |
| 15-20 | 15-20 | 20-25 | 20-25 | 20-25 | 20-25 | 30-35 | 30-35 |
| 0.3 | 0.6 | 0.5 | 0.25 | 0.23 | 0.25 | .28 | 0.09 |

11 TRIGGER MODULE (See Note 4)

| | |
|---|---|
| r TR-132 | TR-60, 69 or 153 |
| TR-70 or TR-71 | TR-80 or TR-81 |

ow rate of 6 cu.ft./min. NOTE 4 EG&G TM-11 Trigger Module package can be used to trigger all EG&G externally triggered Flash Tubes. TM-11 is operated with 110V AC input and puts out a 30kv trigger pulse that is generated by remote or pushbutton control.

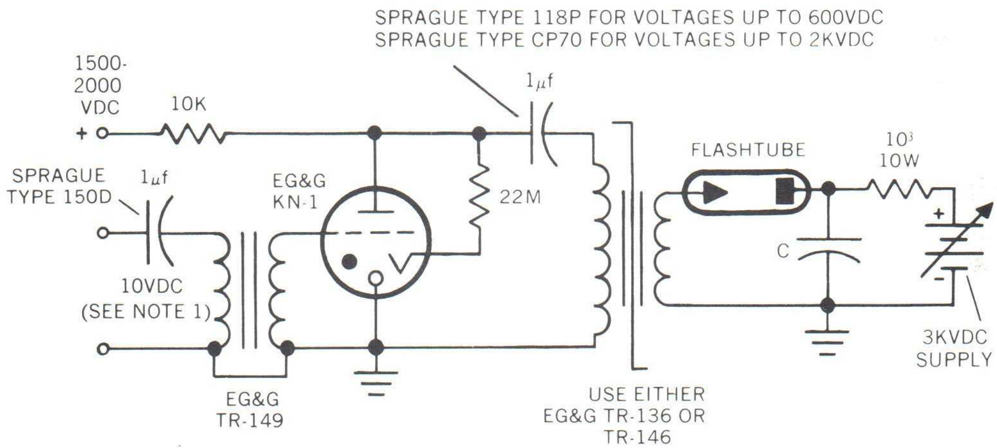
## LOADING (JOULES PER INCH) AT WHICH LINEAR (QUARTZ ENVELOPE) FLASHTUBES EXPLODE



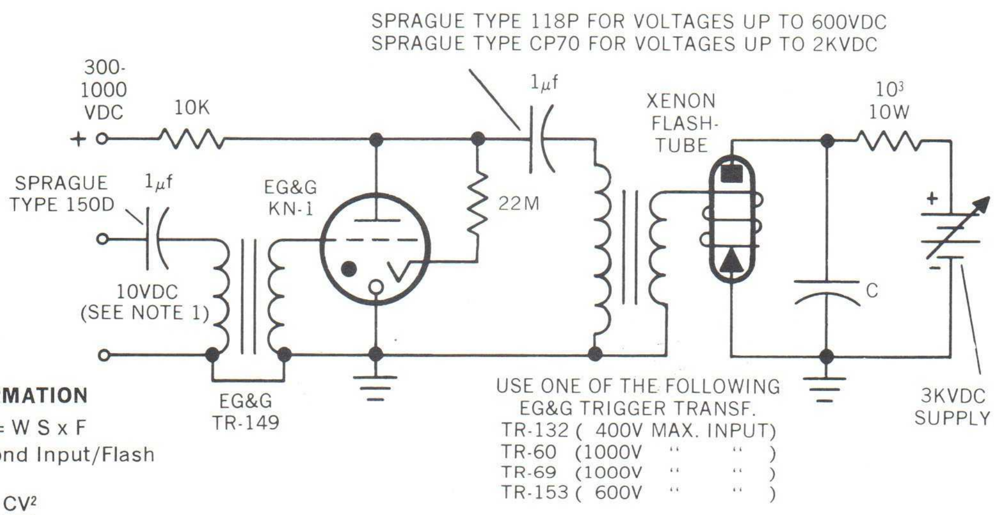

**EXAMPLE:** An FX-47B flashtube (13 x 15 mm. quartz tubing with a 6.5 inch arc length) pulsed at 1.0 millisecond pulse duration will explode within 10 shots with 8,450 joules input (1300 joules x 6.5 inches). For Free Air operation and reliable life, use 70% of this value or 5,915 joules input. For Cavity operation, use 40% of this value or 3,380 joules input.

Flashtube life can be improved by cooling the tube with a flow of air, dry nitrogen, deionized or demineralized water.

## TYPICAL FLASHTUBE CIRCUIT SHOWING SERIES INJECTION TRIGGERING




## TYPICAL FLASHTUBE CIRCUIT SHOWING OPERATION WITH EXTERNAL TRIGGERING




**GENERAL INFORMATION**

Average Power = W S x F
W S = Watt Second Input/Flash
f = Flashes/Sec.

$$\text{Watt-Seconds} = \frac{CV^2}{2}$$

C(μf) = Value of Energy Storage Capacitor
V(KV) = Voltage to which C is charged

NOTE 1: A 50Ω, 10 VOLT INPUT SIGNAL CAN BE APPLIED FOR REMOTE TRIGGERING BY ELIMINATING 1μf CAPACITOR


**EDGERTON, GERMESHAUSEN & GRIER, INC.**

Products Division 160 Brookline Ave. Boston, Mass. 02215
Phone: 617-267-9700 TWX: 617-262-9317



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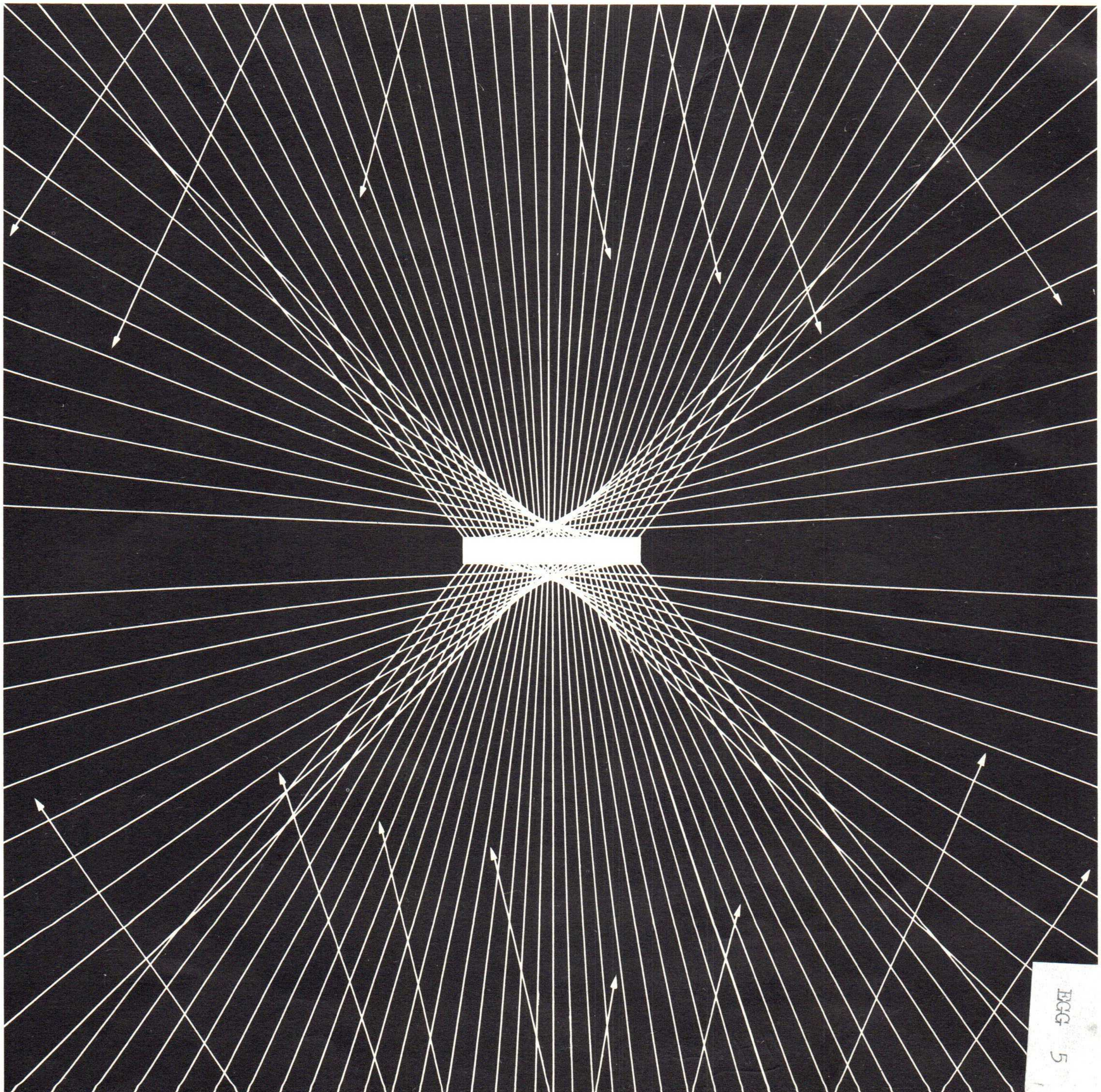
January, 1965 NP

Data Sheet 1002-B

EG&G INC.

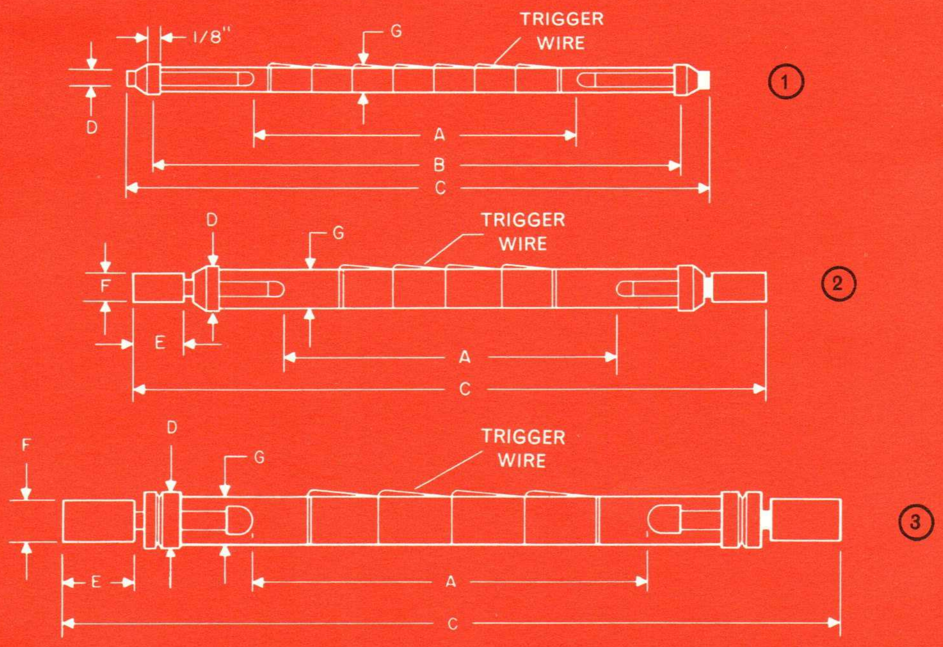
# LINEAR XENON FLASHTUBES



# DIMENSIONS

**(INCHES EXCEPT WHERE NOTED)**

| TUBE TYPE | Outline Drawing | Arc Length A (±.063) | Mounting Length B (Ref) | Overall Tube Length C (Max.) | End Cap Diameter D (±.015) | End Lug Length E (Ref) | End Lug Diameter F | O. D. Quartz Envelope G (Ref) |
|---|---|---|---|---|---|---|---|---|
| FX-1A-6 | 1 | 6.000 | 7.88 | 8.44 | 0.280 | — | — | 0.24(6mm) |
| FX-5A-9 | 1 | 9.000 | 10.88 | 11.44 | 0.280 | — | — | 0.24(6mm) |
| FX-11-.125 | 1 | 0.125 | 2.63 | 3.19 | 0.280 | — | — | 0.24(6mm) |
| FX-33-1.5 | 1 | 1.500 | 2.63 | 3.19 | 0.280 | — | — | 0.24(6mm) |
| FX-38A-3 | 1 | 3.000 | 4.88 | 5.56 | 0.280 | — | — | 0.24(6mm) |
| FX-98-3 | 1 | 3.000 | 4.88 | 5.56 | 0.280 | — | — | 0.28(7mm) |
| FX-42C-3 | 3 | 3.000 | — | 5.88 | 0.394 | 0.5 | 0.280 (±0.005) | 0.35(9mm) |
| FX-45C-6 | 3 | 6.000 | — | 8.88 | 0.394 | 0.5 | 0.280 (±0.005) | 0.35(9mm) |
| FX-81-4 | 2 | 4.000 | — | 6.88 | 0.515 | 0.5 | 0.280 (±0.005) | 0.47(12mm) |
| FX-81-8 | 2 | 8.000 | — | 10.88 | 0.515 | 0.5 | 0.280 (±0.005) | 0.47(12mm) |
| FX-47C-3 | 3 | 3.000 | — | 6.31 | 0.642 | 0.5 | 0.280 (±0.005) | 0.59(15mm) |
| FX-47C-6.5 | 3 | 6.500 | — | 9.81 | 0.642 | 0.5 | 0.280 (±0.005) | 0.59(15mm) |
| FX-47C-12 | 3 | 12.000 | — | 15.31 | 0.642 | 0.5 | 0.280 (±0.005) | 0.59(15mm) |
| FX-77-4 | 2 | 4.000 | — | 8.94 | 0.928 | 1.0 | 0.500 (±0.010) | 0.87(22mm) |
| FX-77-8 | 2 | 8.000 | — | 12.94 | 0.928 | 1.0 | 0.500 (±0.010) | 0.87(22mm) |
| FX-77-13 | 2 | 13.000 | — | 17.94 | 0.928 | 1.0 | 0.500 (±0.010) | 0.87(22mm) |




**NOTES:**

(1) Quartz Envelopes on all Tubes

(2) FX-47C-3, FX-47C-6.5, FX-47C-12, FX-77-4, FX-77-8, FX-77-13, FX-81-4, and FX-81-8 supplied with 0.010 inch dia. silver clad nickel trigger wire. All other tubes supplied with 0.010 inch dia. nickel trigger wire.

(3) Red marking identifies anode end and denotes polarized operation.

(4) Tube mounting can be made by using Littlefuse Co. fuse clip holders Type 101001 or equal for the 6 mm. O.D. tubes. For larger diameter tubes, where the peak currents can be in the order of several thousand amperes, mounting material should be carefully selected. Drilling holes in end lugs or soldering leads to end caps or end lugs is not recommended.

# LINEAR PULSED XENON FLASHTUBES

## FEATURES:

- Quality Workmanship
- Rugged Construction
- High Quality Quartz Envelope
- Heavy Duty Electrodes
- Reliable Operation
- Long life

## TYPICAL APPLICATIONS:

- Laser Stimulation
- Medical Research
- Semiconductor Research
- Satellite Flashers
- Photo Reproduction
- Lighthouse Beacons

# ORDERIN

**EXAMPLE:**

The example above
used in ordering EG
the tube is a xenor
specific tube type a
digits indicates that
as a direct replacem
luminous arc length
The flashtubes (a
up EG&G's standard
ing a standard tube
arc length. If a stan
length) is desired, p
length required. Exa

| TUBE DESIGNATION — ORDERING CODE | FX-1A-6 | FX-5A-9 | FX-11-.125 | FX-33-1.5 | FX-38A-3 | | FX-98-3 |
|---|---|---|---|---|---|---|---|
| QUARTZ ENVELOPE O.D. | 6mm | | | | | | 7mm |
| ARC LENGTH (INCHES) | 6 | 9 | 0.125 | 1.5 | 3 | | 3 |
| **ELECTRICAL CHARACTERISTICS:** | | | | | Operation I | Operation II | |
| MAXIMUM ENERGY INPUT PER FLASH, WS (Watt Seconds, (WS) or Joules = ½CV²) | 400 | 600 | 1 | 100 | 200 | 400 | 400 |
| MAXIMUM LONG TERM AVERAGE POWER INPUT, WATTS (Watts = ½CV² times flash rate) | 40 | 40 | 1 | 10 | 20 | 20 | 20 |
| TEST CONDITIONS (SEE NOTE 4): VOLTAGE, V(KVDC) | 2 | 2.45 | 1 | 1.4 | 1.4 | 1.4 | 1.4 |
| TEST CONDITIONS (SEE NOTE 4): CAPACITANCE, C(μfd) | 200 | 200 | 2 | 100 | 200 | 400 | 400 |
| TEST CONDITIONS (SEE NOTE 4): INDUCTANCE, L(μhy) | 0 | 0 | 0 | 0 | 0 | 600 | 0 |
| TEST CONDITIONS (SEE NOTE 4): ARC RESISTANCE (OHMS) during discharge at Maximum Energy Input | 2 | 3 | 0.1 | 0.25 | 0.6 | 1.0 | 0.6 |
| TYPICAL LIGHT OUTPUT PER FLASH at Maximum Energy Input (Horizontal Candlepower Seconds, HCPS) | 2,000 | 2,200 | 1 | 350 | 600 | 1,000 | 1000 |
| TYPICAL FLASH DURATION at Maximum Energy Input (microseconds measured at ⅓ peak amplitude) | 250 | 300 | 5 | 100 @ 265μfd, 0.9KV | 130 | 1,000 | 240 |
| AVERAGE LIFE (No. of flashes to 50% light output) In free air at Test Conditions (above) or at Stated Conditions. (NOTE 6) | $10^5$ @ 200WS (100μf, 2KV) | $10^6$ @ 200WS (100μf, 2KV) | 2 x $10^4$ | $10^3$ | 5 x $10^3$ | $10^5$ @ 200WS (400μf, 1KV 600μhy) | $10^5$@ 200 WS (400 μfd, IKV 600 μhy) |
| MINIMUM OPERATING VOLTAGE (KVDC) | 0.7 | 1.2 | 0.6 | 0.5 | 0.7 | 0.7 | 0.8 |
| MAXIMUM OPERATING VOLTAGE (KVDC) | 3 | 3 | 2.5 | 2.0 | 2.5 | 2.5 | 3.0 |
| TYPICAL TRIGGER VOLTAGE RANGE (kv) | 15-20 | 15-20 | 10-15 | 15-20 | 15-20 | 15-20 | 15-20 |
| RECOMMENDED TRIGGERING METHOD or EG&G TRIGGER TRANSFORMER | EG&G TM-11 TR / TR-60, TR-69, TR-132A, or TR-180 | | | | | | |
| RECOMMENDED EG&G SERIES INDUCTANCE (NOTE 5) | — | — | — | — | — | TR-70, | |

NOTES: 1. Operated in a 2-inch I.D. Cavity with no Absorber.
2. Use air cooling at a flow rate of 10-15 cu. ft./min.
3. EG&G TM-11 Trigger Module package can be used to trigger all EG&G externally triggered Flash Tubes. TM-11 is operated with 110V AC input and puts out a 30kv trigger pulse that is generated by remote or pushbutton control.

## IG INFORMATION

FX-38A-3

Xenon Flashtube — Tube Type — Luminous Arc Length (inches)

demonstrates the abbreviated code which should be
&G Pulsed-Xenon Flashtubes. The FX designates that
ı flashtube. The hyphenated digits (38) indicate the
nd linear configuration. The letter A following these
't is an improved version of the tube and may be used
ıent for the earlier tubes. The final digits specify the
of the tube in inches.
ıd their specifications) listed in the table below make
line of Linear Pulsed-Xenon Flashtubes. When order-
type please use the entire ordering code including the
dard tube with a non-standard arc length (e.g. 5″ arc
lease alter the final digit's to correspond with the arc
mple FX-38A-5.

If changes other than arc length are required (e.g. special end lugs, different gas fill such as argon, etc.) please submit a drawing or state the specific changes requested. When ordering a special tube of this type please indicate that it is a special by placing an X in front of the FX. Example XFX-38A-3.

Please note that the specifications listed in the table below apply only to standard tube types. No guarantee is made on the specifications of non-standard tubes.

Prices shown on published price sheets apply only to the standard tube type listed below. Prices on non-standard tube types are available upon request.

| FX-42C-3 | FX-45C-6 | FX-81-4 | FX-81-8 | FX-47C-3 | FX-47C-6.5 | FX-47C-12 | FX-77-4 | FX-77-8 | FX-77-13 |
|---|---|---|---|---|---|---|---|---|---|
| 9mm | | 12mm | | 15mm | | | 22 mm | | |
| 3 | 6 | 4 | 8 | 3 | 6.5 | 12 | 4 | 8 | 13 |
| | | | | | | | | | |
| 600 | 2,000 | 3,000 | 6,000 | 2,250 | 4.000 | 9,200 | 7,700 | 15,400 | 25,000 |
| 60 | 60 | 80 | 80 | 80 | 80 | 80 | 125 | 125 | 125 |
| 1.7 | 1.34 | 1.65 | 2.15 | 3.00 | 1.90 | 2.86 | 1.2 | 3.58 | 4.5 |
| 400 | 2,250 | 2,250 | 2,585 | 500 | 2,250 | 2.250 | 10,000 | 2,400 | 2,400 |
| 300 | 122 | 122 | 850 | 300 | 122 | 122 | 100 | 400 | 400 |
| 0.3 | 0.6 | 0.20 | 0.5 | 0.11 | 0.25 | 0.43 | 0.09 | 0.17 | 0.28 |
| 2,500 | 7,500 | 10,500 | 21,000 | 9,200 | 16,000 | 37,000 | 31,000 | 61,500 | 100,000 |
| 1,000 | 1,400 | 1,400 | 3,800 | 1,000 | 1,400 | 1.400 | 3,300 | 3,300 | 3,300 |
| 2 x $10^4$ | 2 x $10^3$ | $10^3$@ 1900 WS (2,250 μfd, 1.3 KV 122 μhy) | $10^3$ | $10^3$@ 1700 WS (500 μfd, 2.6 KV 300 μhy) | 500 (See Notes 1, 2) | $10^3$@ 7000 WS (2250 μfd 2.5 KV 122 μhy) | 50 (See Note 2) | 50 (See Note 2) | 50 (See Note 2) |
| 1 | 1.1 | 1 | 1 | 1.0 | 1.0 | 1.6 | 1.0 | 1.2 | 1.5 |
| 3 | 3 | 3.0 | 3 | 3.0 | 3.0 | 3 | 3.0 | 4.0 | 5 |
| 15-20 | 15-20 | 25-30 | 25-30 | 25-30 | 25-30 | 25-30 | 25-30 | 25-30 | 30-35 |

GGER MODULE (See Note 4)

| | |
|---|---|
| | TR-60, TR-69, or TR-153 |
| or TR-71 | TR-79, or TR-80 |

4. Typical Flashtube Circuits using External and Series Injection Triggering shown on page 6. For Flashtubes with high energy per flash ratings, the capacitance and inductance values given are total values used in a multi-section pulse forming network.

5. Special chokes available upon request.

6. Flashtube life may be increased by use of rectangular pulses generated by multisection pulse forming networks.

# FLASHTUBE LOADING

The graph below shows the loading (in joules per inch of arc length) at which linear quartz flashtubes will explode. For a flashtube with a specific bore size and arc length, the explosion point is a function not only of the energy input per flash, but also flash duration.

For optimum performance in free air, at room ambient conditions, it is recommended that, for a specific pulse duration, the energy input (per inch of arc length) not exceed 70% of the explosion energy. Below 70% of the explosion energy the life of the tube is substantially increased.

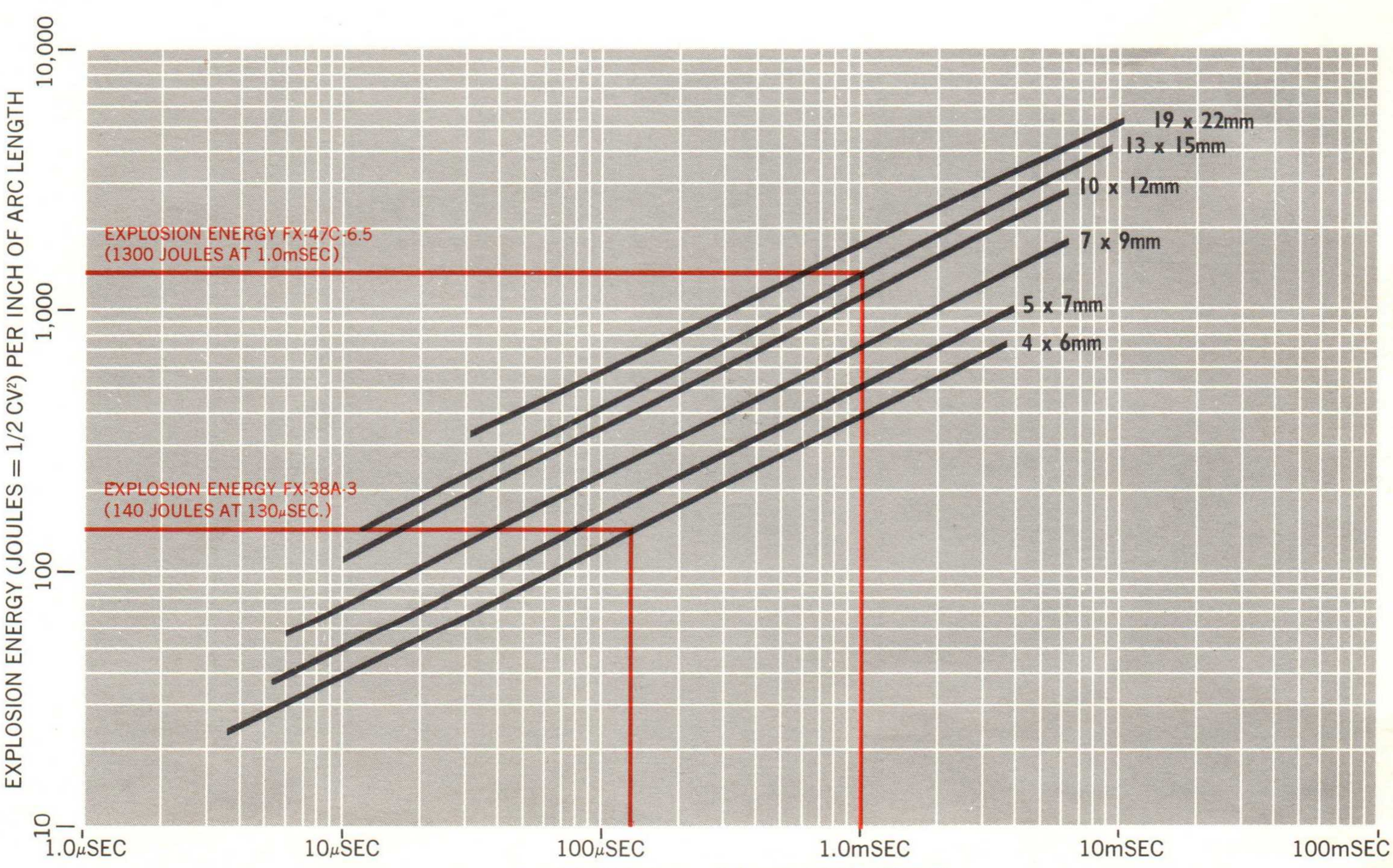
**EXAMPLE:** An FX-38A-3 flashtube (4 x 6 mm. quartz, 3 inch arc length) will explode within 10 flashes when operated with 420 joules energy input (140 joules per inch) and a flash duration of 130 microseconds. The same tube operated in free air at 50% of explosion energy (70 joules per inch) will have an expected life of approximately 5 x $10^3$ flashes.

For cavity operation, it is recommended that the energy input (per inch of arc length) for a specific flash duration, not exceed 40% of the explosion energy.

**EXAMPLE:** The FX-47C-6.5 flashtube (13 x 15 mm quartz, 6.5 inch arc length) has an explosion point of 8450 joules (1300 joules per inch) at a 1.0 millisecond pulse duration. In a cavity with a 2-inch I.D. the maximum energy input (per flash) should not exceed 3380 joules (520 joules per inch).

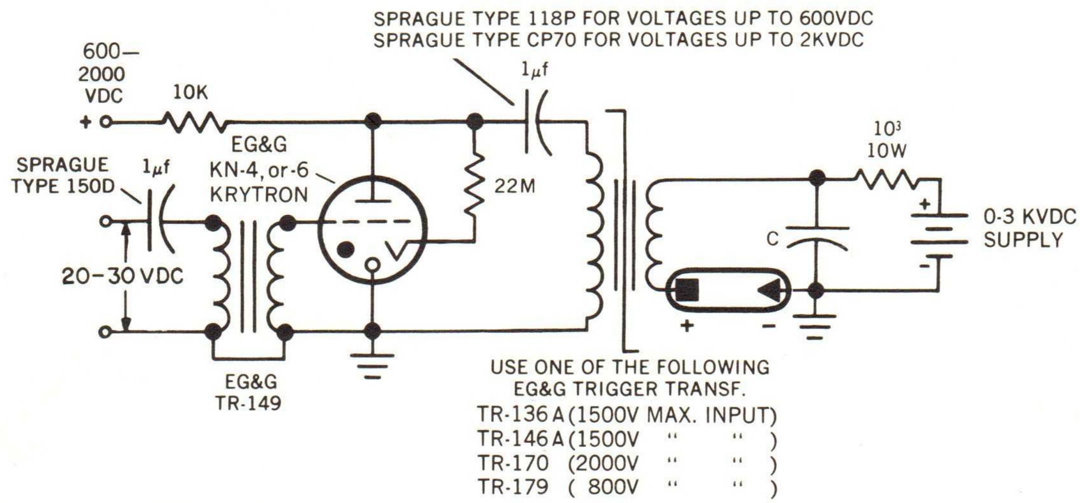
In addition to lowering energy input per flash, flashtube life can also be extended by cooling the flashtube with air, dry nitrogen, or demineralized water. See notes on page 3, or Data Sheets 1003 and 1004 for additional information on EG&G's air and watercooled flashtubes.

## LOADING (JOULES PER INCH) AT WHICH LINEAR (QUARTZ ENVELOPE) FLASHTUBES EXPLODE

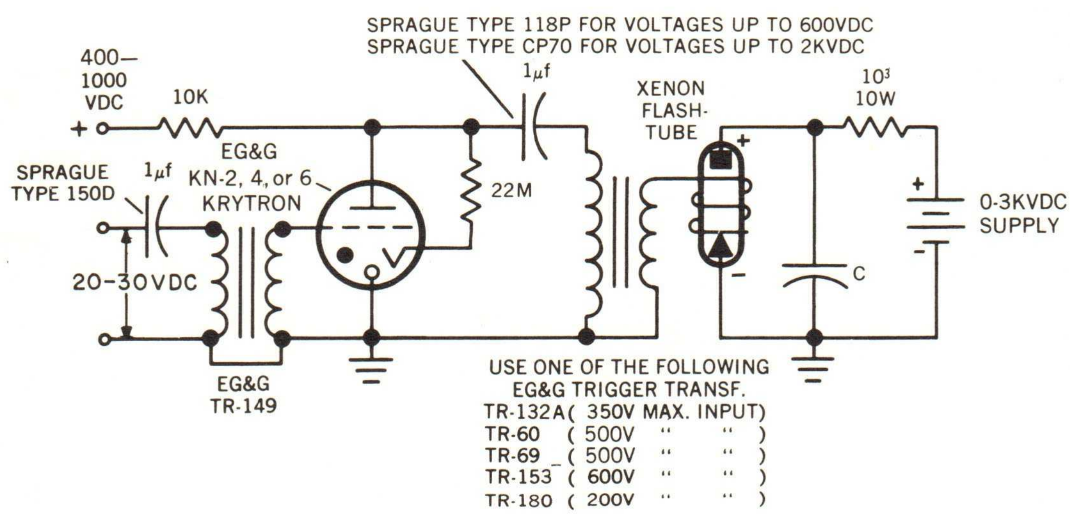



LOADING (JOULES PER INCH) AT WHICH LINEAR (QUARTZ ENVELOPE) FLASHTUBES EXPLODE

# TYPICAL FLASHTUBE CIRCUITS




## USING SERIES INJECTION TRIGGERING




## USING EXTERNAL TRIGGERING

**EG&G INC.**

PRODUCTS DIVISION, 160 BROOKLINE AVE., BOSTON, MASS. 02215

TEL: 617-267-9700 TWX: 617-262-9317

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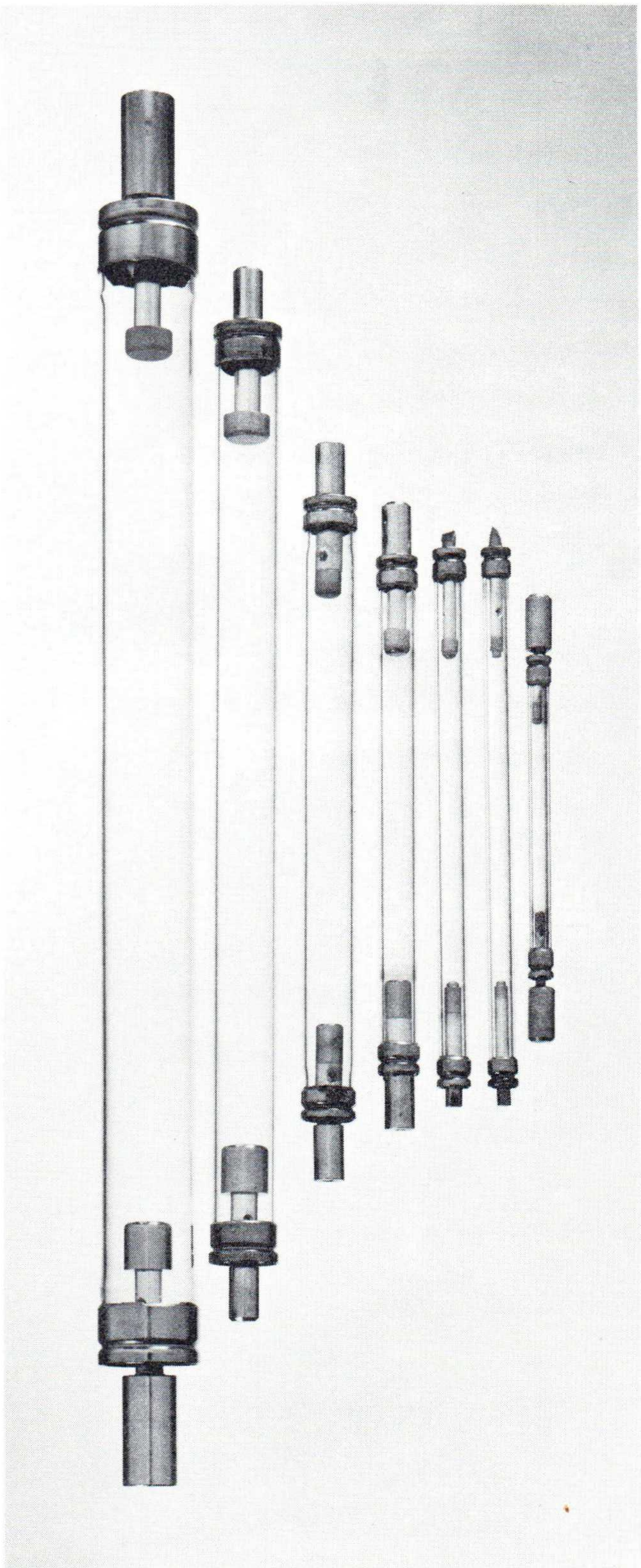
EG&G
ELECTRO-OPTICS DIVISION





# LINEAR XENON FLASHTUBES
# QUARTZ ENVELOPE



## FEATURES

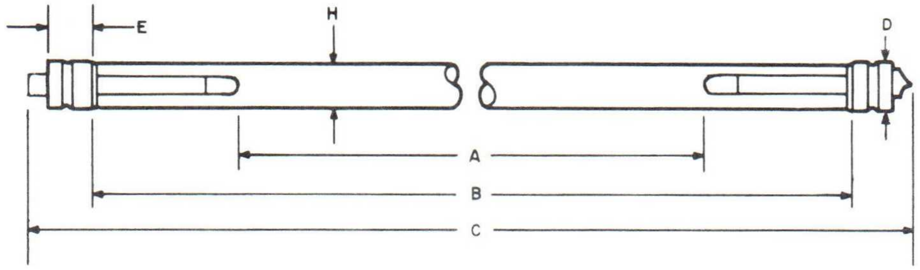
- QUALITY CONTROL
- QUALITY QUARTZ MATERIAL
- LONG LIFE ELECTRODES
- RELIABLE TRIGGERING
- BORE SIZES UP TO 19MM
- ARC LENGTHS UP TO 72 INCHES
- RUGGED CONSTRUCTION
- REPRODUCIBLE PRODUCTION QUALITY
- XENON OR KRYPTON GAS FILL
- UV, VISIBLE AND IR OUTPUT
- EASILY ADAPTABLE FOR WATER COOLING
- LONG SHELF LIFE

## APPLICATIONS

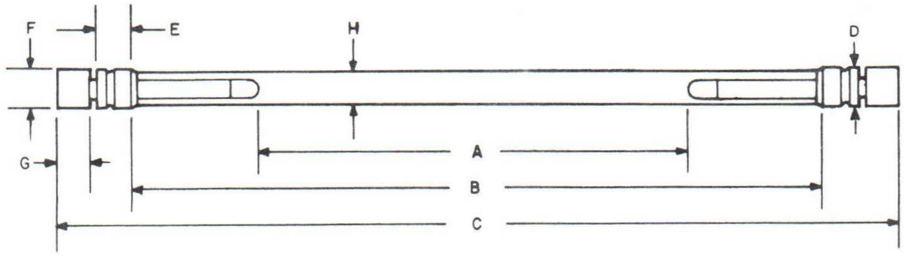
- OPTICAL PUMPS FOR SOLID STATE AND DYE LIQUID LASERS
- PHOTOCOPY EXPOSURE
- PHOTOCOPY FUSING
- PHOTORESIST EXPOSURE
- FLASH PHOTOLYSIS
- MICROFILM, LABEL AND COMPUTER PRINTING
- NAVIGATIONAL, SATELLITE AND AVOIDANCE COLLISION BEACONS
- AERIAL PHOTOGRAPHY ILLUMINATION

# OUTLINE DRAWINGS

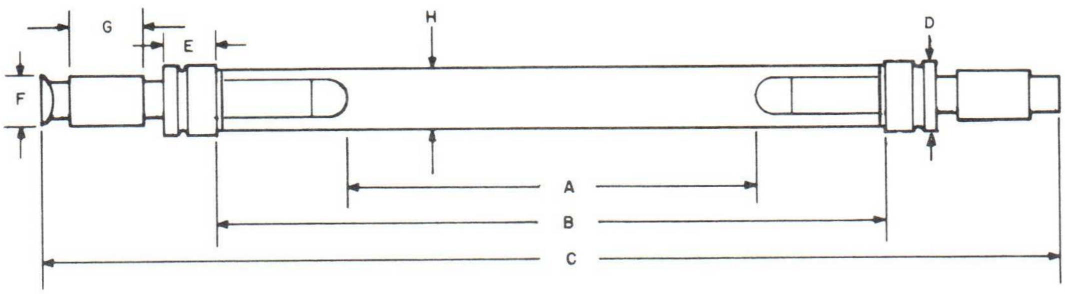
①



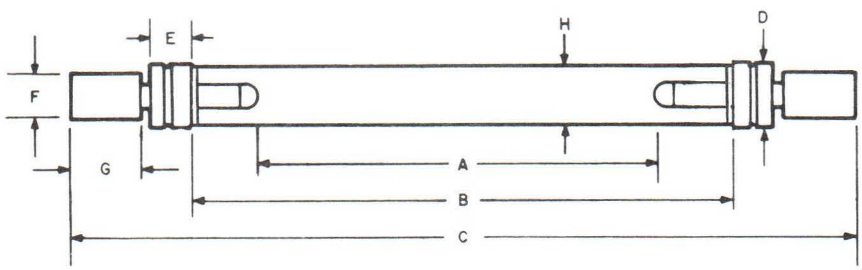

②



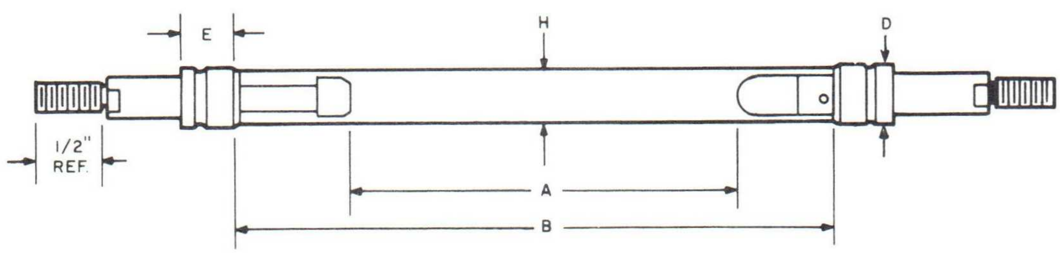

③



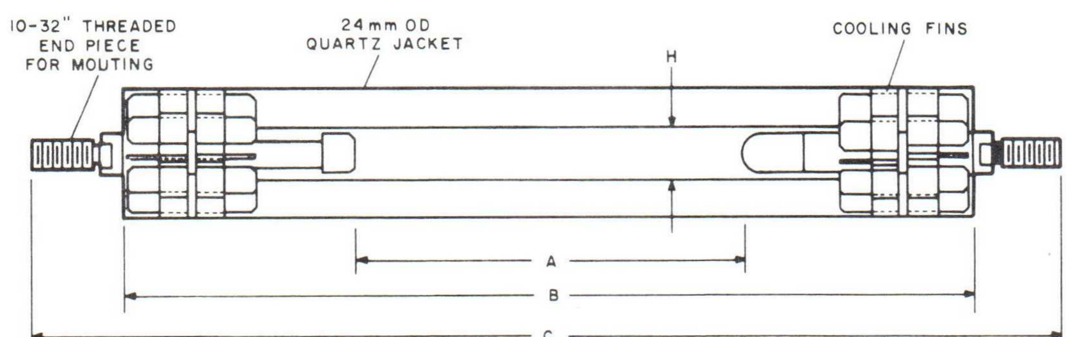

④




⑤




⑥




NOTE:
ANODE END MARKED RED OR PLUS (+) SIGN

# MECHANICAL DIMENSIONS
## (inches/millimeters)

| TUBE TYPE | Outline Drawing | Arc Length A(±0.063)* | Quartz Length B (Ref) | Overall Length C (Max.) | End Cap Diameter D(±0.015) | End Cap Length E (Ref) | End Lug Diameter F(±0.005) | End Lug Length G (Ref) | Quartz Envelope H (ID x OD mm) |
|---|---|---|---|---|---|---|---|---|---|
| FX-147C-2 | 4 | 2/51 | 2.78/71 | 4.5/114 | 0.24/6 | 0.25/6 | 0.25/6 | 0.5/13 | 3 x 5 |
| FX-1C-6 | 1 | 6/152 | 7.49/190 | 8.44/214 | 0.282/7 | 0.25/6 | - | - | 4 x 6 |
| FX-5C-9 | 1 | 9/229 | 10.49/266 | 11.44/291 | 0.282/7 | 0.25/6 | - | - | 4 x 6 |
| FX-33C-1.5 | 1 | 1.5/38 | 2.28/58 | 3.25/82 | 0.282/7 | 0.25/6 | - | - | 4 x 6 |
| FX-33C-2 | 1 | 2/51 | 2.78/71 | 3.75/95 | 0.282/7 | 0.25/6 | - | - | 4 x 6 |
| FX-38C-2 | 1 | 2/51 | 3.49/89 | 4.5/114 | 0.282/7 | 0.25/6 | - | - | 4 x 6 |
| FX-38C-3 | 1 | 3/76 | 4.49/114 | 5.5/140 | 0.282/7 | 0.25/6 | - | - | 4 x 6 |
| FX-84C-1.5 | 3 | 1.5/38 | 2.28/58 | 3.94/100 | 0.282/7 | 0.25/6 | 0.186/5 | 0.25/6 | 4 x 6 |
| FX-85C-3 | 3 | 3/76 | 3.78/96 | 5.44/138 | 0.282/7 | 0.25/6 | 0.186/5 | 0.25/6 | 4 x 6 |
| FX-103C-2 | 2 | 2/51 | 3.49/89 | 4.81/122 | 0.282/7 | 0.25/6 | 0.280/7 | 0.25/6 | 4 x 6 |
| FX-103C-3 | 2 | 3/76 | 4.49/114 | 5.81/148 | 0.282/7 | 0.25/6 | 0.280/7 | 0.25/6 | 4 x 6 |
| FX-98C-3 | 1 | 3/76 | 4.49/114 | 5.5/140 | 0.320/8 | 0.25/6 | - | - | 5 x 7 |
| FX-42C-3 | 4 | 3/76 | 4.24/108 | 5.88/149 | 0.394/10 | 0.25/6 | 0.280/7 | 0.5/13 | 7 x 9 |
| FX-45C-6 | 4 | 6/152 | 7.24/183 | 8.88/226 | 0.394/10 | 0.25/6 | 0.280/7 | 0.5/13 | 7 x 9 |
| FX-52C-3S** | 5 | 3/76 | 4.24/108 | 6.88/175 | 0.394/10 | 0.25/6 | Mounted by long, 10-32" threaded end lugs | 0.5/13 | 7 x 9 |
| FX-52C-3C*** | 6 | 3/76 | 5.56/141 | 6.88/175 | 0.394/10 | 0.25/6 | - | - | 7 x 9 |
| FX-55C-6S** | 5 | 6/152 | 7.24/184 | 9.88/251 | 0.394/10 | 0.25/6 | - | - | 7 x 9 |
| FX-55C-6C*** | 6 | 6/152 | 8.56/217 | 9.88/251 | 0.394/10 | 0.25/6 | - | - | 7 x 9 |
| FX-81C-4 | 4 | 4/102 | 5.24/133 | 6.88/175 | 0.507/13 | 0.25/6 | 0.280/7 | 0.5/13 | 10 x 12 |
| FX-81C-6.5 | 4 | 6.5/165 | 7.74/197 | 9.38/238 | 0.507/13 | 0.25/6 | 0.280/7 | 0.5/13 | 10 x 12 |
| FX-81C-8 | 4 | 8/203 | 9.24/235 | 10.88/276 | 0.507/13 | 0.25/6 | 0.280/7 | 0.5/13 | 10 x 12 |
| FX-47C-3 | 4 | 3/76 | 4.45/113 | 6.31/160 | 0.642/16 | 0.38/10 | 0.280/7 | 0.5/13 | 13 x 15 |
| FX-47C-4 | 4 | 4/102 | 5.45/138 | 7.31/186 | 0.642/16 | 0.38/10 | 0.280/7 | 0.5/13 | 13 x 15 |
| FX-47C-4.5 | 4 | 4.5/114 | 5.95/151 | 7.81/198 | 0.642/16 | 0.38/10 | 0.280/7 | 0.5/13 | 13 x 15 |
| FX-47C-6.5 | 4 | 6.5/165 | 7.95/202 | 9.81/249 | 0.642/16 | 0.38/10 | 0.280/7 | 0.5/13 | 13 x 15 |
| FX-47C-12 | 4 | 12/304 | 13.45/342 | 15.31/389 | 0.642/16 | 0.38/10 | 0.280/7 | 0.5/13 | 13 x 15 |
| FX-47C-18 | 4 | 18/457 | 19.45/494 | 21.31/541 | 0.642/16 | 0.38/10 | 0.280/7 | 0.5/13 | 13 x 15 |
| FX-77C-4* | 4 | 4/102 | 5.56/141 | 8.94/227 | 0.926/24 | 0.54/14 | 0.50/13 | 1.0/25 | 19 x 22 |
| FX-77C-4.25 | 4 | 4.25/108 | 5.81/148 | 9.19/233 | 0.926/24 | 0.54/14 | 0.50/13 | 1.0/25 | 19 x 22 |
| FX-77C-8 | 4 | 8/203 | 9.56/243 | 12.94/329 | 0.926/24 | 0.54/14 | 0.50/13 | 1.0/25 | 19 x 22 |
| FX-77C-9 | 4 | 9/229 | 10.56/268 | 13.94/354 | 0.926/24 | 0.54/14 | 0.50/13 | 1.0/25 | 19 x 22 |
| FX-77C-11.5 | 4 | 11.5/292 | 13.06/332 | 15.44/392 | 0.926/24 | 0.54/14 | 0.50/13 | 1.0/25 | 19 x 22 |
| FX-77C-13 | 4 | 13/330 | 14.56/370 | 16.94/430 | 0.926/24 | 0.54/14 | 0.50/13 | 1.0/25 | 19 x 22 |

*FX-77C Arc Length Tolerance ± 0.093.

**Stripped Tube.

***Complete Tube-Designed for Air Cooled Operation.

# FLASHTUBE LOADING

The graph Figure 1 below shows the loading in joules/inch of arc length at which linear flashtubes explode. This data is useful from 10 microsecond to 10 millisecond pulse durations. For a flashtube with a specific bore size and arc length, the explosion point is a function of the energy input per flash and the pulse duration. For useful life, tubes should not be operated in excess of 70% of the explosion energy in free air and 40% in a laser cavity. Flashtube life is proportional to the percent of explosion energy. See graph, Figure 2 for flashtube life approximation.

EXAMPLE 1: An FX-38C-3 (3 inch arc length, quartz tube with 4mm I. D. and 6mm O. D.) can withstand higher energy per inch as the pulse duration increases. For example, at 100 microsecond duration, this tube will explode in 10 flashes at 360 joules (120 joules/inch); at 1 millisecond duration, this tube will explode in 10 flashes at 1200 joules (400 joules/inch). For useful flashtube life, tube should be operated in the 10% - 40% range of explosion.

EXAMPLE 2: An FX-47C-6.5 (6.5 inch arc length, quartz tube with 13mm I. D. and 15mm O. D.) will explode with 8450 joules (1300 joules/inch x 6.5 inches) at 1 millisecond duration. Useful flashtube life can be obtained if operated between 845 to 3380 joules or 10% to 40% of explosion.

In addition to lower energy input per flash and/or increasing pulse duration, flashtube life can be extended by cooling tube with forced air, dry nitrogen or demineralized water. See EG&G/Data Sheet No. F1004 for water cooled flashtube data.

## LOADING (JOULES PER INCH) AT WHICH LINEAR (QUARTZ ENVELOPE) FLASHTUBES EXPLODE

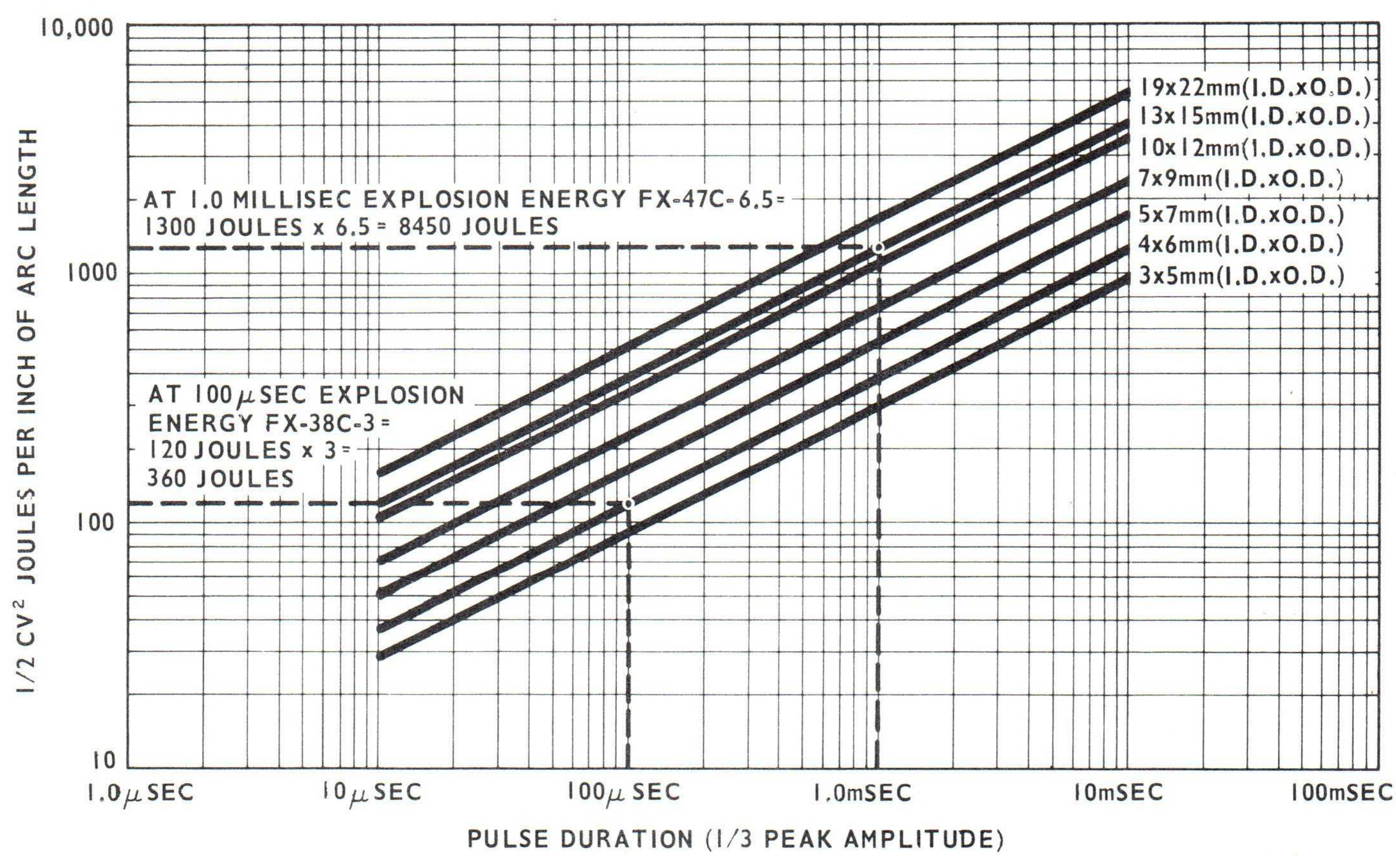



**Fig. 1**

## LIFE APPROXIMATION FOR QUARTZ LINEAR FLASHTUBES

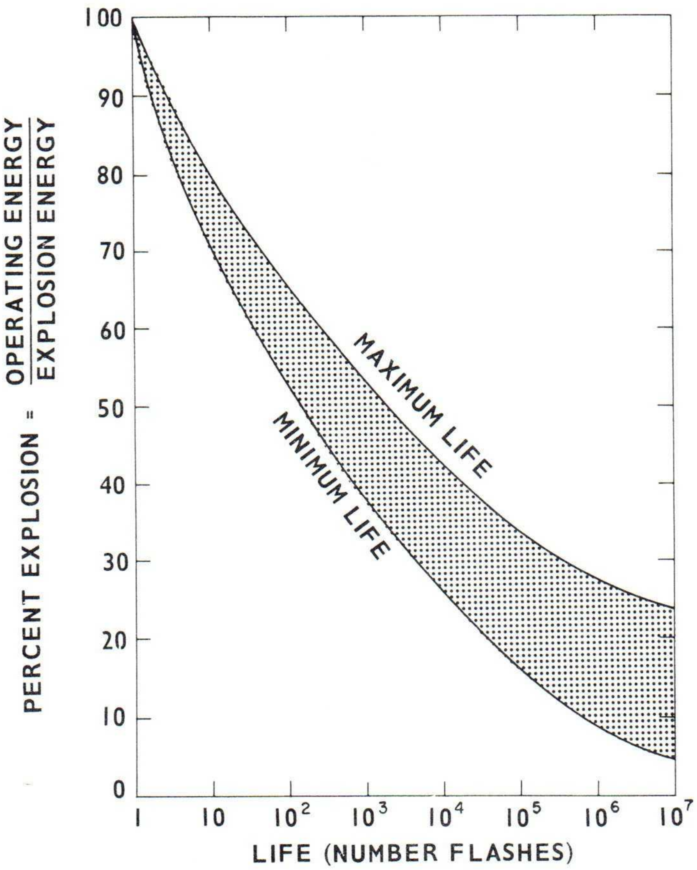
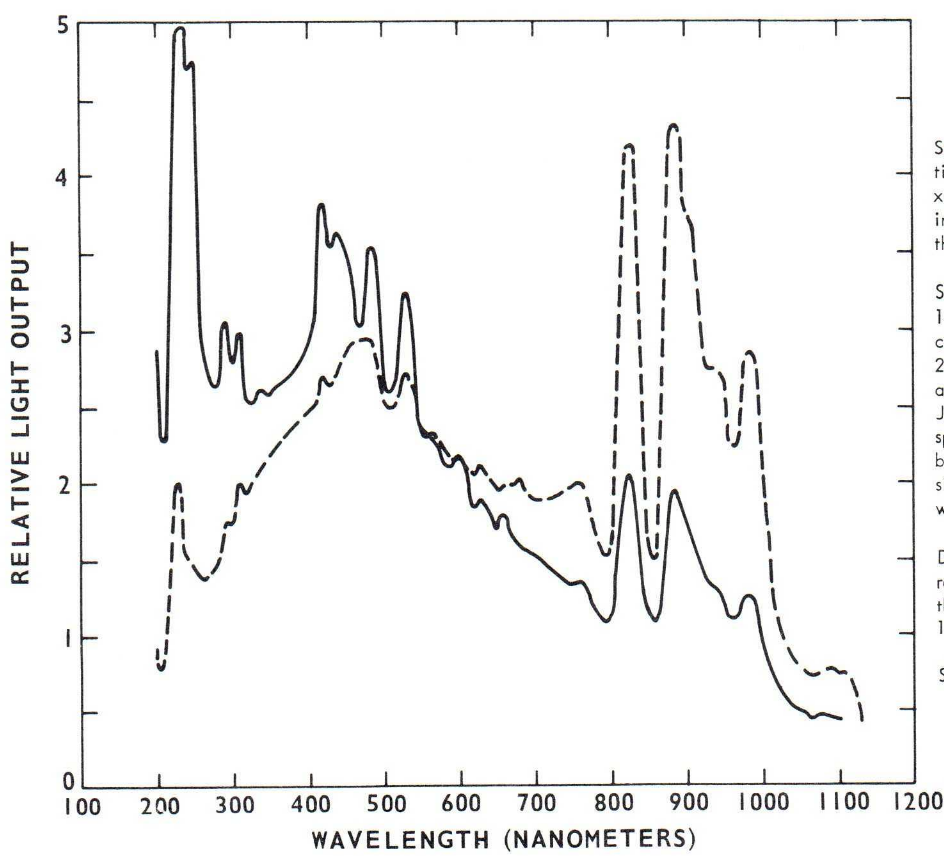



**Fig. 2**

1. Life test conditions were performed at ambient temperature of 25°C.

2. End of life is determined when light output decreases to 50% of initial value.

## XENON FLASHTUBE SPECTRAL OUTPUT DATA




Spectral data curves show the effect of operating the FX-38C-3 (4mm I. D., 3 inch arc length, xenon filled - 400 torr) flashtube at 50 joules input at low and high voltage to enhance either the IR or the UV output.

Solid line curve shows data at 50 joules input or 1400 VDC, 51 μF, 0 inductance. Dotted line curve shows data at 50 joules input or 700 VDC, 205 μF, 0 inductance. Shifts in spectral data are primarily due to changes in current density, J, amps/cm$^2$. Higher current density, J, shifts spectral output toward the shorter wavelengths or blue region, UV. Conversely lower current density, J, shifts spectral output toward the longer wavelengths or red region, IR.

Data was taken with EG&G 580/585 Spectroradiometer system. Spectral resolution 10 nm in the 200 - 700 nm region; and 20 nm in the 700 - 1200 nm region.

See Figure 3.

**Fig. 3**

# XENON QUARTZ (FUSED SILICA) ENVELOPE LINEAR FLASHTUBE RATINGS

| TUBE DESCRIPTION | FX-147C-2 | FX-IC-6 | FX-5C-9 | FX-33C-1.5<br>FX-84C-1.5 | FX-33C-2<br>FX-38C-2<br>FX-103C-2 | FX-38C-3<br>FX-85C-3<br>FX-103C-3 | FX-98C-3 | FX-42C-3<br>FX-52C-3 | FX-45C-6<br>FX-55C-6 | FX-81C-4 | FX-81C-6.5 | FX81C-8 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Quartz Envelope (ID x OD mm) | 3 x 5 | 4 x 6 | 4 x 6 | 4 x 6 | 4 x 6 | 4 x 6 | 5 x 7 | 7 x 9 | 7 x 9 | 10 x 12 | 10 x 12 | 10 x 12 |
| ARC Length (inches/millimeters) | 2/51 | 6/152 | 9/229 | 1.5/38 | 2/51 | 3/76 | 3/76 | 3/76 | 6/152 | 4/102 | 6.5/165 | 8/203 |
| ELECTRICAL CHARACTERISTICS | | | | | | | | | | | | |
| Minimum Starting Voltage, V (kV dc) | 0.5 | 0.7 | 1.2 | 0.5 | 0.6 | 0.7 | 0.8 | 1.0 | 1.1 | 1.0 | 1.0 | 1.0 |
| Minimum Trigger Voltage (1) $V_T$ (kV) | 15 | 20 | 20 | 15 | 15 | 15 | 15 | 20 | 20 | 25 | 25 | 25 |
| AT $\tau = 100\,\mu s$ FLASH DURATION (2) | | | | | | | | | | | | |
| Maximum Energy Input, E (3) (joules) | 133 | 546 | 819 | 137 | 182 | 273 | 360 | 462 | 924 | 980 | 1592 | 1960 |
| Voltage, V (kVdc) | 2.1 | 5.5 | 8.2 | 1.4 | 1.8 | 1.8 | 1.6 | 2.1 | 2.4 | 2.4 | 3.9 | 4.9 |
| Inductance, L ($\mu$H) | 28 | 45 | 68 | 13 | 15 | 23 | 15 | 8 | 15 | 5 | 8 | 10 |
| Capacitance, C ($\mu$F) | 58 | 36 | 24 | 128 | 106 | 71 | 106 | 212 | 106 | 320 | 212 | 160 |
| Tube Impedance, $R_T$ ($\Omega$) (5) | 1.1 | 1.8 | 2.7 | 0.5 | 0.6 | 0.9 | 0.6 | 0.3 | 0.6 | 0.2 | 0.3 | 0.4 |
| AT $\tau = 1000\,\mu s$ FLASH DURATION (2) | | | | | | | | | | | | |
| Maximum Energy Input, E (3) (joules) | 420 | 1680 | 2520 | 420 | 560 | 840 | 1050 | 1490 | 2980 | 3080 | 5000 | 6160 |
| Voltage, V (kVdc) | 1.35 | 2.8 | 5.3 | 0.89 | 1.2 | 1.8 | 1.6 | 1.36 | 2.7 | 1.7 | 2.5 | 3.1 |
| Inductance, L ($\mu$H) | 350 | 600 | 900 | 150 | 200 | 300 | 200 | 100 | 200 | 75 | 100 | 125 |
| Capacitance, C ($\mu$F) | 460 | 265 | 177 | 107 | 800 | 535 | 800 | 1600 | 800 | 2120 | 1600 | 1280 |
| Tube Impedance, $R_T$ ($\Omega$) (5) | 1.4 | 2.4 | 3.6 | 0.6 | 0.8 | 1.2 | 0.8 | 0.4 | 0.8 | 0.3 | 0.4 | 0.5 |
| MAXIMUM AVERAGE POWER (watts) (4) | | | | | | | | | | | | |
| Convection (25°C Ambient) | 15 | 40 | 50 | 10 | 15 | 20 | 30 | 60 | 80 | 80 | 90 | 100 |
| Forced Air (10-15 cu ft/min) | 120 | 320 | 400 | 80 | 120 | 160 | 240 | 480 | 640 | 640 | 720 | 800 |
| Water (1 gpm at 25°C) | 900 | 2400 | 3000 | 500 | 900 | 1000 | 1800 | 4000 | 8000 | 8000 | 9000 | 10,000 |
| LIFE IN NUMBER OF FLASHES | See Life Chart Figure 2 | | | | | | | | | | | |

## NOTES:

(1) Trigger voltage is measured at unloaded secondary of Trigger Transformer. See EG&G data sheets on Trigger Transformers, Chokes, and Trigger Modules.

(2) Circuit constants are based on RLC, single mesh, critically damped conditions, and pulse width, at 1/3 peak amplitude of current pulse.

$$R_T = \frac{\rho \ell}{A} = \frac{4\rho \ell}{\pi D^2}$$

$R_T$ = tube impedance
$\rho$ = resistivity - ohm-cm
$\ell$ = arc length-inches
D = bore of tube - cm

$$R_T = \frac{0.048\,\ell}{D^2} \quad (\rho = 0.015 \text{ for } \tau \le 100\ \mu s)$$ [Formula includes the conversion of inches to cm.]

$$R_T = \frac{0.065\,\ell}{D^2} \quad (\rho = 0.020 \text{ for } \tau > 100\ \mu s \text{ and } \le 1000\ \mu s)$$

$$R_T = \frac{0.082\,\ell}{D^2} \quad (\rho = 0.025 \text{ for } \tau > 1000\ \mu s)$$

$$\tau = 2.5 \quad LC\ ;$$

$$L = \frac{R_T \tau}{4}\ ; \quad C = \frac{0.64\tau}{R_T}\ ; \quad V = \sqrt{2\frac{E}{C}}\ ; \quad E = \frac{1}{2} CV^2$$

(3) Energy ratings are based on 70% of Explosion, $E = 1/2\ CV^2$ (see Figure 1).

(4) Temperature at end caps to quartz seals should not exceed 200°C. Average power = joules x flash rate. Higher temperature seals available on request.

(5) Tube impedance calculations are close approximation due to bore (I. D.) of quartz envelope and can vary by as much as 20%.

(6) For arc lengths not indicated in chart above, ratings for energy and tube impedance vary on a linear basis.

| FX-47C-3 | FX-47C-4 | FX-47C-4.5 | FX-47C-6.5 | FX-47C-12 | FX-47C-18 | FX-77C-4 | FX-77C-4.25 | FX-77C-8 | FX-77C-9 | FX-77C-11.5 | FX-77C-13 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 13 x 15 | 13 x 15 | 13 x 15 | 13 x 15 | 13 x 15 | 13 x 15 | 19 x 22 | 19 x 22 | 19 x 22 | 19 x 22 | 19 x 22 | 19 x 22 |
| 3/76 | 4/102 | 4.5/114 | 6.5/165 | 12/304 | 18/457 | 4/102 | 4.25/108 | 8/203 | 9/229 | 11.5/292 | 13/330 |
| 1 | 1 | 1 | 1 | 1.3 | 1.6 | 1.0 | 1.0 | 1.2 | 1.2 | 1.3 | 1.5 |
| 20 | 20 | 20 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 |
| 860 | 1150 | 1300 | 1865 | 3400 | 5160 | 1624 | 1827 | 3428 | 3650 | 4670 | 5278 |
| 1.5 | 2.0 | 2.3 | 3.3 | 6.0 | 9.0 | 1.6 | 1.7 | 3.4 | 3.7 | 4.7 | 5.3 |
| 2 | 2.8 | 3.3 | 4.8 | 8.5 | 1.3 | 1.3 | 1.3 | 2.8 | 3 | 3.8 | 4.2 |
| 710 | 580 | 490 | 336 | 188 | 128 | 1280 | 1280 | 580 | 530 | 425 | 380 |
| 0.09 | 0.11 | 0.13 | 0.19 | 0.34 | 0.5 | 0.05 | 0.05 | 0.11 | 0.12 | 0.15 | 0.17 |
| 2040 | 2720 | 3100 | 5500 | 8160 | 12,240 | 5040 | 5355 | 10,000 | 11,340 | 14,500 | 16,400 |
| 1.2 | 1.1 | 1.3 | 2.1 | 4.2 | 5.1 | 1.1 | 1.1 | 2.1 | 2.4 | 3.1 | 3.5 |
| 30 | 40 | 42 | 63 | 115 | 175 | 175 | 20 | 35 | 40 | 53 | 58 |
| 5300 | 4000 | 3750 | 2560 | 1400 | 915 | 9150 | 8000 | 4570 | 4000 | 3050 | 2750 |
| 0.12 | 0.16 | 0.17 | 0.25 | 0.46 | 0.70 | 0.07 | 0.08 | 0.14 | 0.16 | 0.21 | 0.23 |
| 75 | 85 | 90 | 100 | 125 | 135 | 125 | 125 | 150 | 150 | 200 | 220 |
| 600 | 700 | 720 | 800 | 1000 | 1080 | 1000 | 1000 | 1200 | 1200 | 1600 | 1760 |
| 7500 | 8500 | 9000 | 10,000 | 12,500 | 13,500 | 12,500 | 12,500 | 15,000 | 15,000 | 20,000 | 22,000 |

## ORDERING INFORMATION

EG&G letter and number designations specify standard tube types.

Example:

F X 42C 3

- F — Flashtube
- X — Xenon
- 42C — Basic End Cap Design
- 3 — Arc Length in inches

QUARTZ ENVELOPE: Unless otherwise specified, all tubes are supplied with quartz (fused silica) envelopes.

UV INHIBITING QUARTZ: Tubes can be supplied with envelope material which cuts off spectral output in the ultra violet region eliminating Ozone. This material has the same energy loading characteristics as the standard quartz and should be ordered by specifying the letter G e.g., FXG-42C-3.

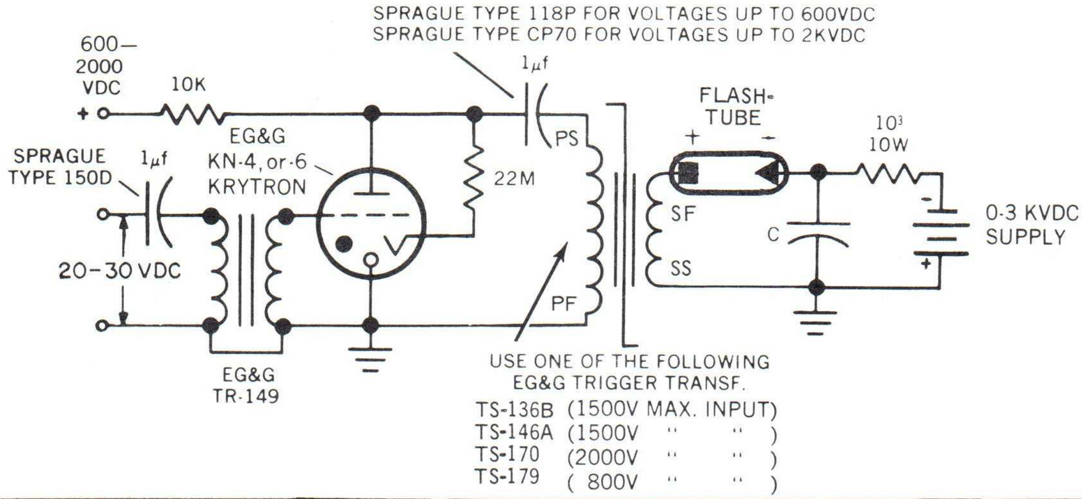
GAS FILL: Xenon is the gas used for most standard tube types. Krypton, argon or mixtures of these gases are also available. For krypton fill tubes, specify the letter K e.g., FK-42C-3.

PRESSURE FILL: Standard tubes are supplied with pressure fills between 200 - 500 torr xenon. Pressure fills up to 4 atmospheres are available upon request in either xenon or krypton.

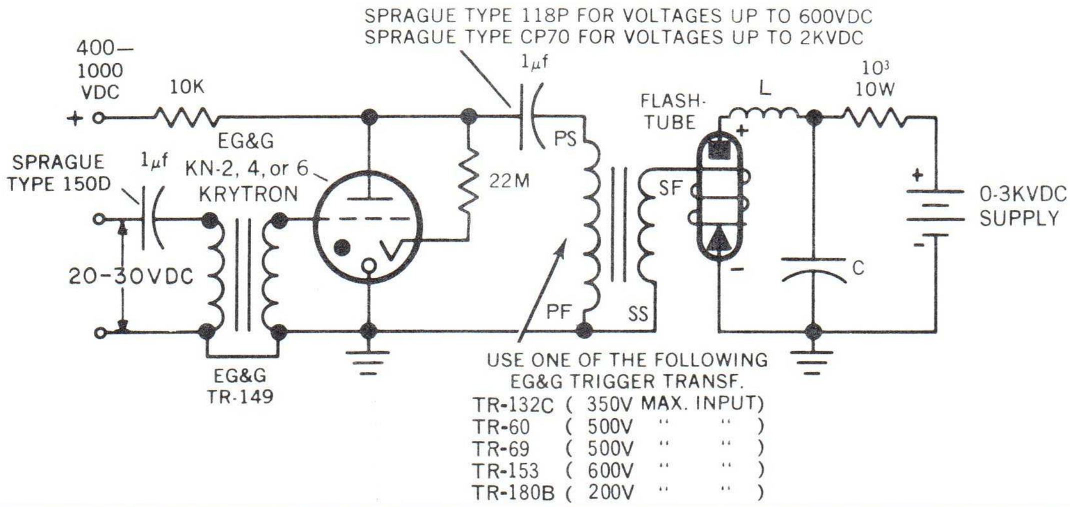
SPECIAL DESIGNS: Custom design tubes are available with arc lengths up to 72 inches. Changes in quartz dimensions and configurations, flexible leads and special mounting hardware are readily available upon request.

# FLASHTUBE CIRCUITS

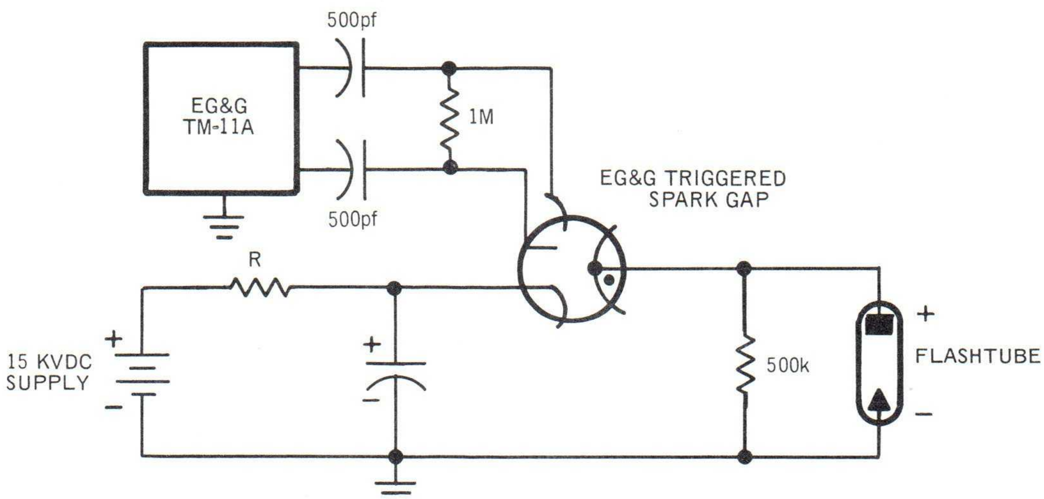
## SERIES INJECTION TRIGGERING (circuit 1)




## EXTERNAL TRIGGERING (circuit 2)




## OVERVOLTAGE FLASHTUBE OPERATION USING TRIGGERED SPARK GAP (circuit 3)




USED FOR LASER STIMULATION WHERE SHORT FLASH DURATION (1-10μs) AT 10-15KVDC IS DESIRED.



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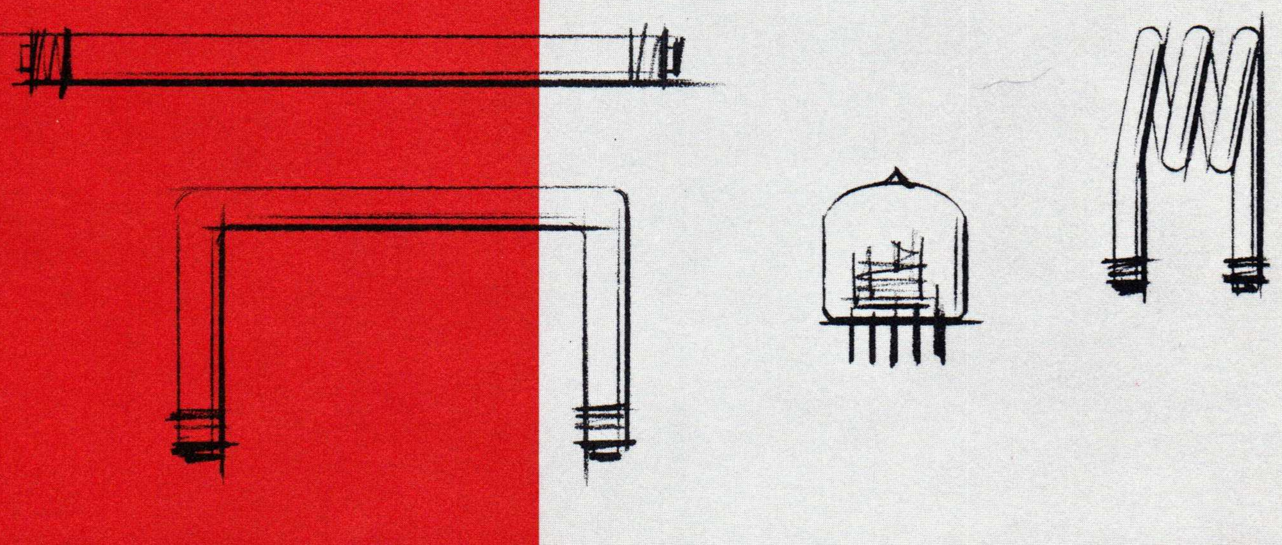
# XENON FLASH TUBES
# TRIGGER TRANSFORMERS
# CHOKES



**EDGERTON, GERMESHAUSEN & GRIER, INC.**
160 Brookline Avenue, Boston 15, Massachusetts

Xenon flashtubes are efficient light sources which convert stored electrical energy into an intense burst of visible light and radiant energy in the ultraviolet and infrared regions. Their most important attribute is the ability to produce high peak light at comparatively short flash durations. Spectral quality is essentially that of daylight, encompassing the entire visible range, extending as well into the UV and IR.

Xenon flashtubes can be obtained in a wide variety of configurations to suit the application. They can be designed for operation at flash rates of thousands of flashes per second, as intense single flash sources with light output ranging to tens of millions peak candlepower, and as short arc light sources having a flash duration on the order of one microsecond. Basic external circuit requirements are minimal and relatively simple.

From a device initially used in photographic and stroboscopic applications, the xenon flashtube has evolved into an extremely flexible present day tool. Guided by the pioneering efforts of Dr. Harold E. Edgerton, EG&G has been engaged from the beginning in a continuing program of research and development to meet the rapidly expanding utilization of xenon flashtubes in a multitude of applications.

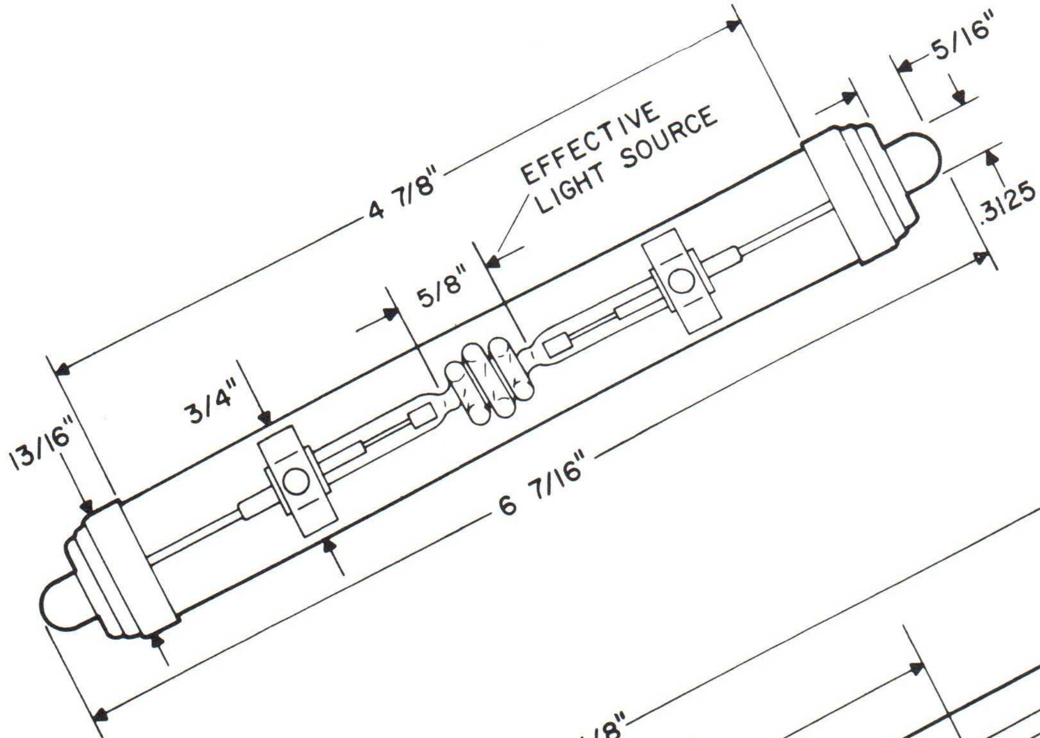
## APPLICATIONS

The versatility of xenon flashtubes is evidenced by the fact that they are used in equipment whose environment ranges from ultimate ocean depth to outer space. Their use in scientific, engineering, industrial and military areas is expanding, and the list of diversified applications given below partially illustrates their flexibility.

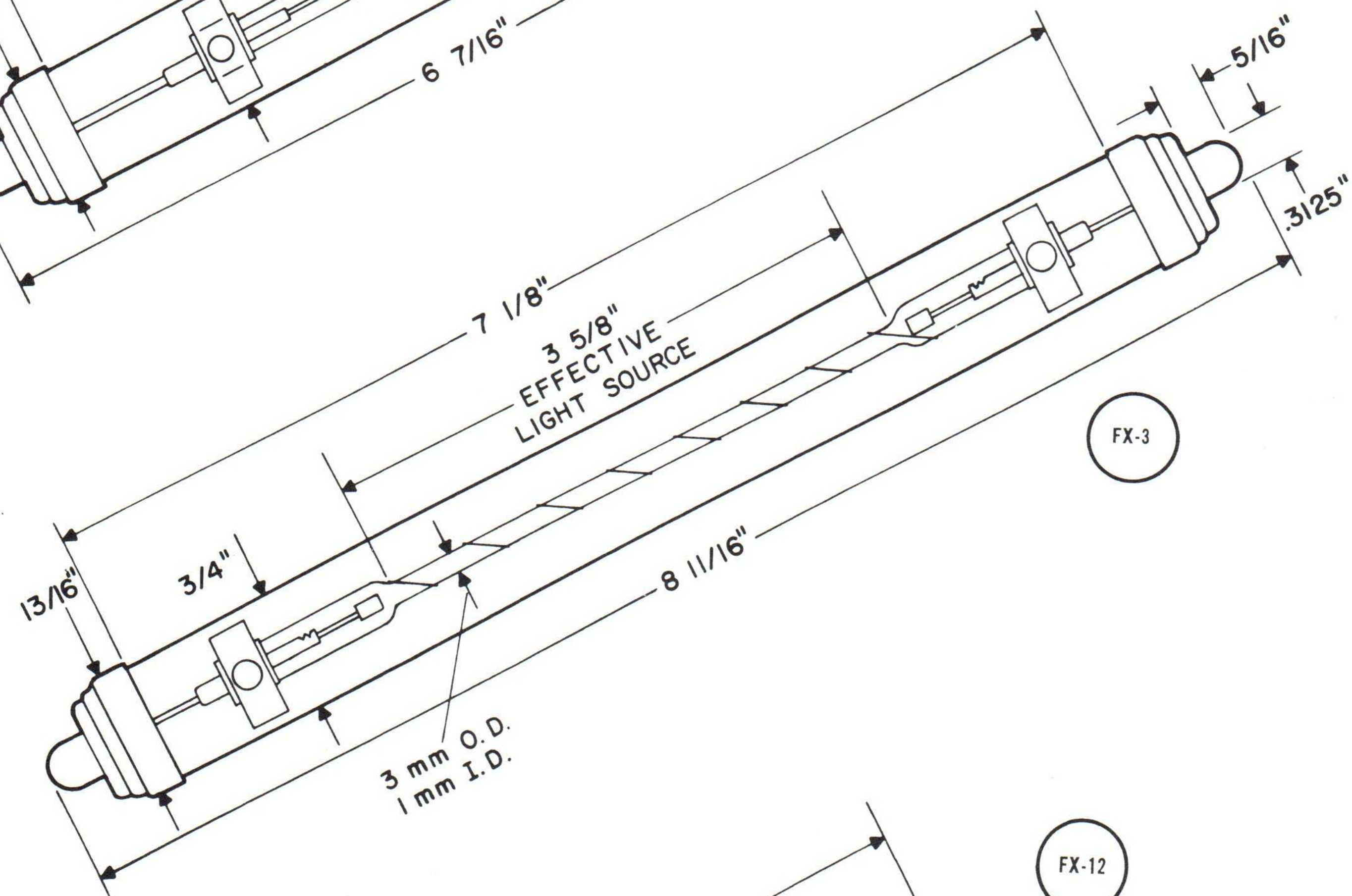
- Laser Stimulation
- Flash Photolysis
- Medical Research
- Fluor Stimulation
- Semiconductor Research
- Ballistic Studies
- Satellite Flashers
- Marine Beacons
- Aircraft & Airport Beacons
- Visual Signal Devices
- Warning Lights
- Night Aerial Photography
- Underwater Photography
- Sensitometry
- High Speed Photographic Strobe
- Microscopic Illumination
- Film & Paper Timing
- Photographic Reproduction
- Typesetting
- Readout
- Training Devices
- Printed Circuits
- Ignition Timers
- Visual Strobes

For assistance with your application or for information concerning special configurations, please contact EG&G Application Engineering Group.

| PERFORMANCE DATA | FX-1 | FX-2 | FX-3 | FX-6A | FX-6B | FX-6U |
|---|---|---|---|---|---|---|
| Max. Long Term Average Power Input — Watts | 40 | see energy limit per burst below | | 7 | 7 | 7 |
| Max. Energy Input per Flash — Watt-Seconds or Joules | 400 | 1.25 | 1.25 | 5 | 5 | 5 |
| at Specified Conditions | 200 $\mu$fd, 2 kv | 0.04 $\mu$fd, 8 kv | 0.04 $\mu$fd, 8 kv | 24 $\mu$fd, 0.65 kv | 24 $\mu$fd, 0.65 kv | 24 $\mu$fd, 0.65 kv |
| Nominal Light Output per Flash at Max. Input — Horizontal Candlepower Seconds (HCPS) | 2,000 | 0.6 | 0.84 | 2.5 | 2.5 | 2.5 |
| Nominal Flash Duration at Max. Input (⅓ peak) — microseconds | 250 | 2 | 2 | 12 | 12 | 12 |
| Typical Flash Rate | 1 per 10 seconds | 800 per sec. Limit energy per burst to 1,500 w-s total — allow 5 min. between bursts. | | 600 pps | 1,000 pps | 600 pps |
| Nominal Life at Stated Input (in free air) — No. of Flashes | $10^5$ at 200 w-s, (100 $\mu$fd, 2 kv) | $10^5$ to $10^6$ | $10^5$ to $10^6$ | $10^9$ @ .008 w-s $10^7$ @ 0.4 w-s 1.8 $\mu$fd, 640 v | Same as FX-6A | Same as FX-6A |
| **OPERATING LIMITS** | | | | | | |
| Min. Operating Voltage — volts | 700 | — — | — — | 400 | 500 | 400 |
| Max. Operating Voltage — volts | 3,000 | — — | — — | 1,500 | 1,500 | 1,500 |
| Typical Trigger Voltage Range — Kilovolts | 15–20 | Overvolt | Overvolt | 2.5 to 4 kv internally triggered | 4 to 6 kv internally triggered | 2.5 to 4 kv internally triggered |
| **OTHER CHARACTERISTICS** | | | | | | |
| Arc Resistance During Discharge — ohms | 2 | 50 | 50 | 0.14 | 0.14 | 0.14 |
| Approximate Arc Length — (see illustration) | 6″ | coil ⅝″ wide, (3⅝″ if straight) | 3⅝″ | 5/16″ | 5/16″ | 5/16″ |
| Recommended Trigger Transformer — EG&G | TR-50 | — — | — — | TR-36, TR-76 or TR-90 | TR-90 | TR-36, TR-76 or TR-90 |
| Recommended Choke (if any) — EG&G | — — | — — | — — | — — | — — | — — |
| Envelope Material | Quartz | Inner envelope — quartz Outer envelope — Corning #7740 | | Corning 0080 | Corning 0080 | Corning 9823 UV glass |
| Mounting | Littlefuse clips #101001 | — — | — — | Standard Sub-miniature 9 pin noval tube socket | Same as FX-6A | Same as FX-6A |
| Polarized Operation | No | No | No | Yes | Yes | Yes |

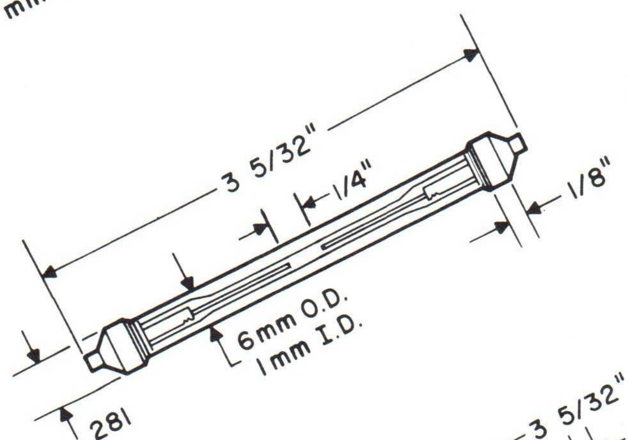


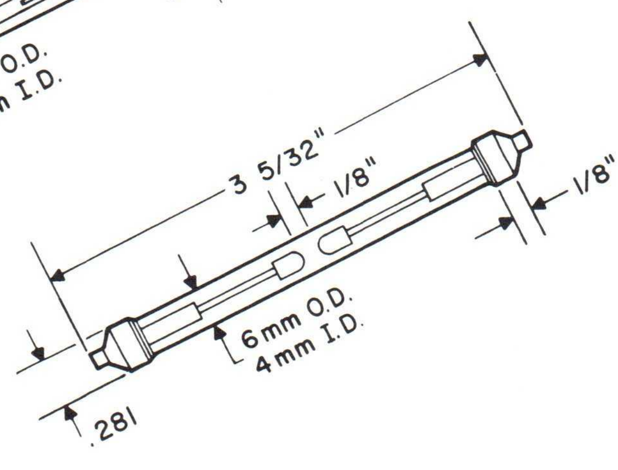

FX-2




FX-3

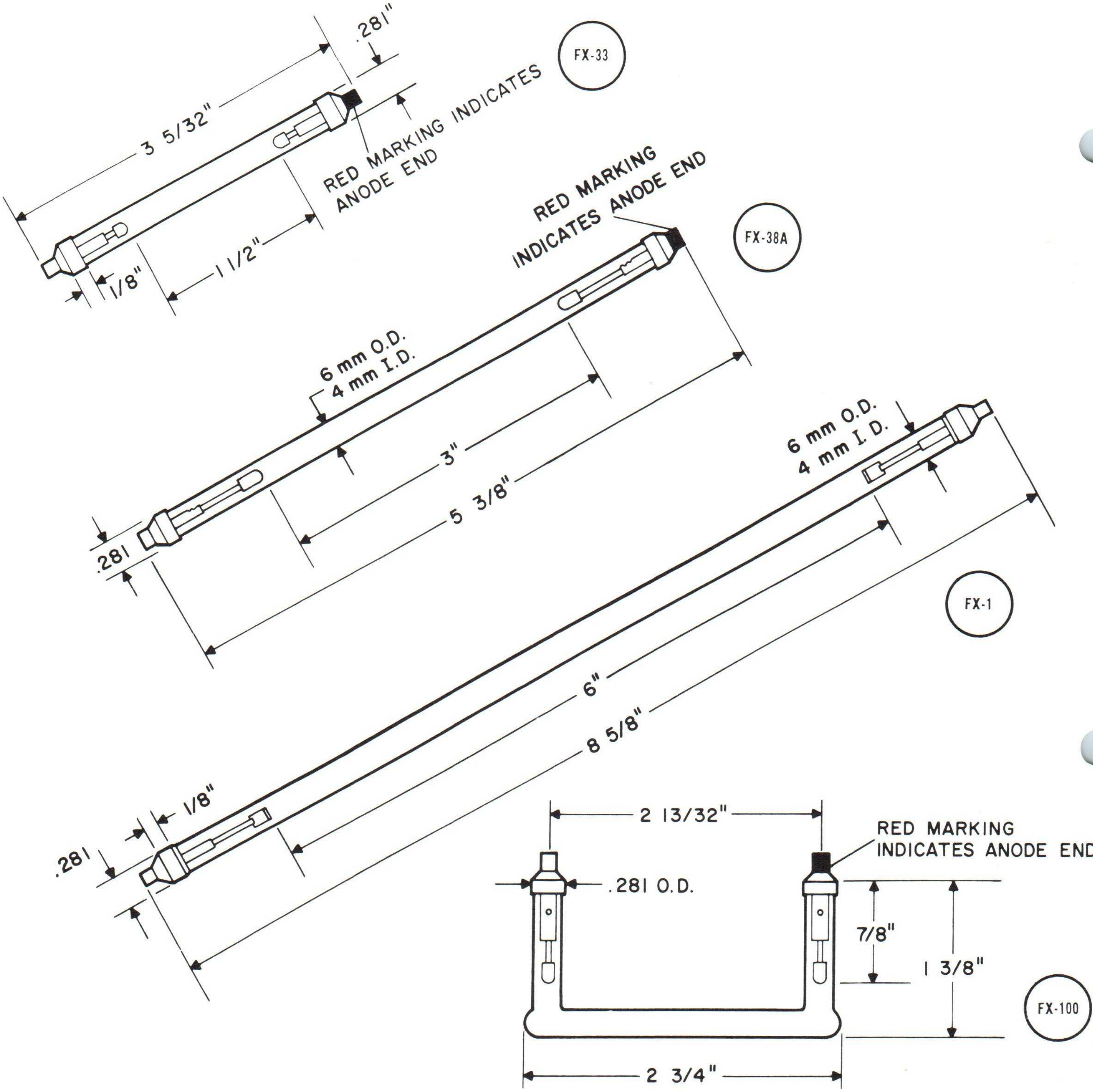
FX-12

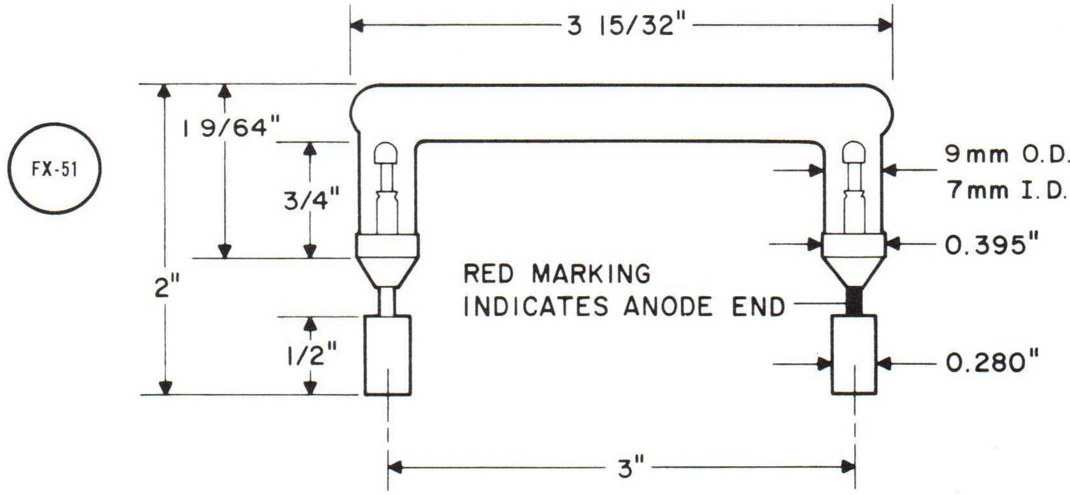


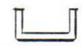



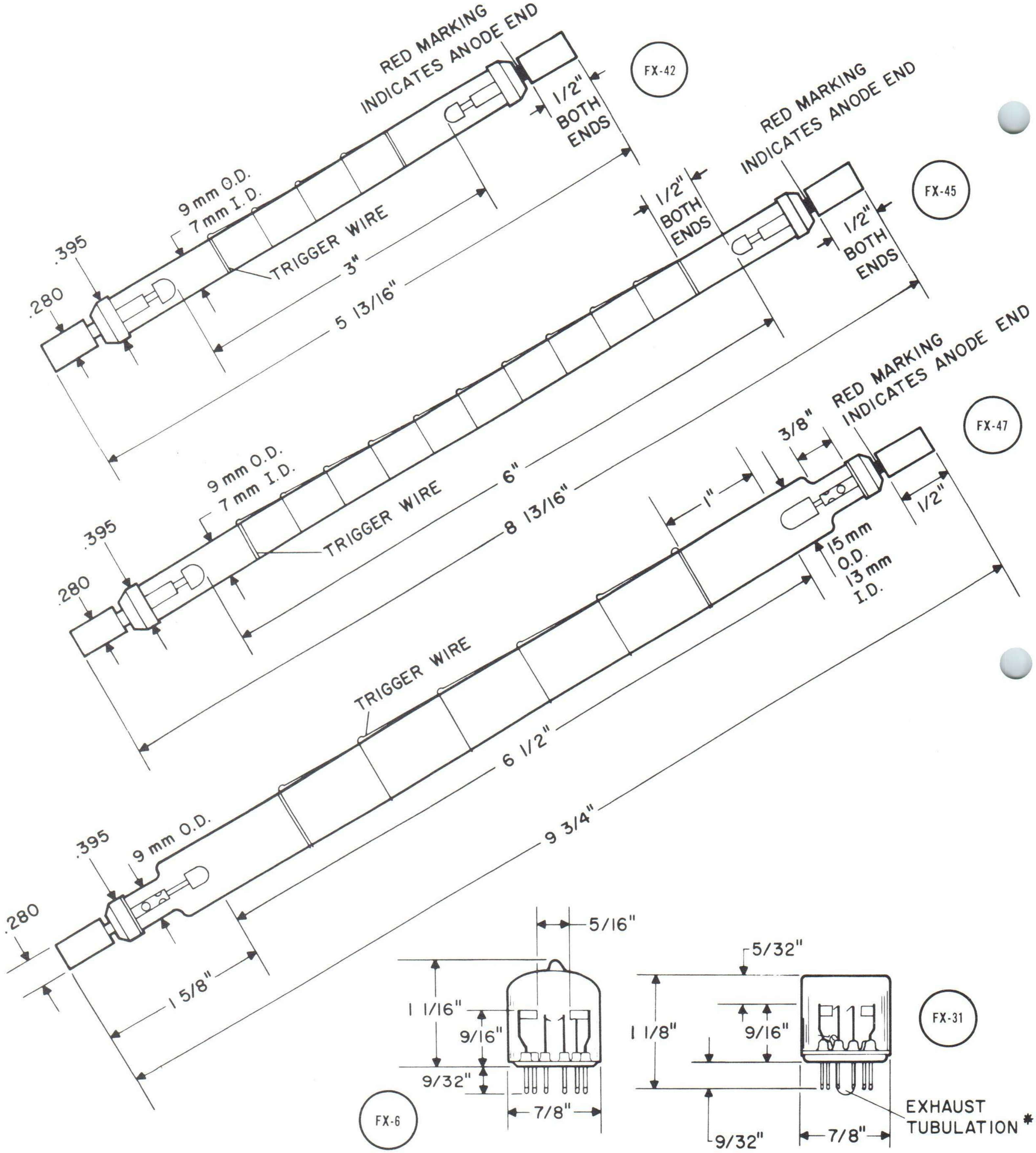

FX-11

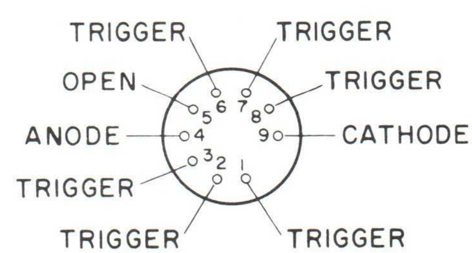
| |  |  |  |  |  | | | |
|---|---|---|---|---|---|---|---|---|
| **PERFORMANCE DATA** | **FX-11** | **FX-12** | **FX-31** | **FX-33** | **FX-38A** Performance Data Under 4 Operating Conditions | | | |
| Max. Long Term Average Power Input — Watts | 1 | 2 | 4 | 10 | 20 | 20 | 20 | 20 |
| Max. Energy Input per Flash — Watt-Seconds or Joules | 1 | 5 | 1 | 100 | 400 | 200 | 200 | 100 |
| at Specified Conditions | 2 μfd, 1 kv | 2.5 μfd, 2 kv | 5 μfd, 0.65 kv | 100 μfd, 1.4 kv | 400 μfd, 1.4 kv with 600 μh choke in series with flashtube | 500 μfd, 0.9 kv without choke | 200 μfd, 1.4 kv without choke | 100 μfd, 1.4 kv without choke |
| Nominal Light Output per Flash at Max. Input - Horizontal Candlepower Seconds (HCPS) | 1 | 2.5 | 0.5 (vertical) | 200 | 800 | 600 | 600 | 300 |
| Nominal Flash Duration at Max. Input (⅓ peak) — microseconds | 3 | 6 | 3 | 150 100 w-s 265 μd 900 v. | 1 msec | 400 | 160 | 80 |
| Typical Flash Rate | 1 per sec. | 6,000 pps | 600 pps | 1 per 10 sec. | 1 per 20 sec. | 1 per 10 sec. | 1 per 10 sec. | 1 per 5 sec. |
| Nominal Life at Stated Input (in free air) — No. of Flashes | 2 x $10^4$ | 6,000 at 1 w-s (0.5 μfd, 2 kv) 1.8 μfd | $10^9$ @ .008 w-s $10^7$ @ 0.4 w-s, 1.8 μfd, 650 v | $10^4$ @ 100 w-s, 100 μfd, 1.4 kv | $10^5$ @ 200 w-s 400 μfd 1 kv with 600 μh choke | 5 x $10^4$ at above conditions | $10^3$ at above conditions | 5 x $10^4$ at above conditions |
| **OPERATING LIMITS** | | | | | | | | |
| Min. Operating Voltage-volts | 600 | 400 | 500 | 500 | 700 | 700 | 700 | 700 |
| Max. Operating Voltage-volts | 3,000 | 3,000 | 1,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 |
| Typical Trigger Voltage Range — Kilovolts | 10 | 15-20 | 2.5-4 Internally triggered | 15-20 | 15-20 | 15-20 | 15-20 | 15-20 |
| **OTHER CHARACTERISTICS** | | | | | | | | |
| Arc Resistance During Discharge — ohms | 0.1 | 1 | 0.14 | 0.5 | 1 | 1 | 1 | 1 |
| Approximate Arc Length — (see illustration) | ⅛″ | ¼″ | 5/16″ | 1½″ | 3″ | 3″ | 3″ | 3″ |
| Recommended Trigger Transformer — EG&G | TR-50 | TR-50 | TR-36, TR-76 or TR-90 | TR-50 | TR-50 | TR-50 | TR-50 | TR-50 |
| Recommended Choke (if any) — EG&G | — | — | — | — | TR-70 or TR-71 | — | — | — |
| Envelope Material | Quartz | Quartz | Corning 0080 | Quartz | Quartz | Quartz | Quartz | Quartz |
| Mounting | Little-fuse | Little-fuse | Std. Sub-miniature 9 pin noval tube socket (socket must be open in center to allow for tip-off in base.) | Little-fuse clips #101001 | — | — | — | — |
| Polarized Operation | No | No | Yes | Yes | Yes | Yes | Yes | Yes |


FX-33
3 5/32"
.281"
RED MARKING INDICATES ANODE END
1/8"
1 1/2"
FX-38A
RED MARKING INDICATES ANODE END
6 mm O.D.
4 mm I.D.
3"
5 3/8"
.281
FX-1
6 mm O.D.
4 mm I.D.
6"
8 5/8"
1/8"
.281
2 13/32"
RED MARKING
INDICATES ANODE END
.281 O.D.
7/8"
1 3/8"
FX-100
2 3/4"


3 15/32"
FX-51
1 9/64"
3/4"
2"
1/2"
9mm O.D.
7mm I.D.
0.395"
RED MARKING
INDICATES ANODE END
0.280"
3"

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| |  |  |  | | |  |  |
| **PERFORMANCE DATA** | **FX-42** | **FX-45** | **FX-47** Performance Data Under 3 Operating Conditions | | | **FX-51** | **FX-100** |
| Max. Long Term Average Power Input — Watts | 60 | 60 | 40 | 40 | 40 | 60 | 20 |
| Max. Energy Input per Flash — Watt-Seconds or Joules | 600 | 2,000 | 10,000 (max.) | 7,500 | 5,000 | 600 | 100 |
| at Specified Conditions | 400 $\mu$fd, 1.7 kv, with 300 $\mu$h choke in series with tube | 500 $\mu$fd, 2.8 kv with 300 $\mu$h choke in series with tube | 2,200 $\mu$fd, 3.0 kv with 850 $\mu$h choke in series with tube | 2,200 $\mu$fd, 2.6 kv with 850 $\mu$h choke in series with tube | 2,200 $\mu$fd, 2.15 kv with 850 $\mu$h choke in series with tube | 400 $\mu$fd, 1.7 kv with 300 $\mu$h choke in series with tube | 100 $\mu$fd, 1.4 kv |
| Nominal Light Output per Flash at Max. Input — Horizontal Candlepower Seconds (HCPS) | 2,500 | 7,500 | 40,000 | 30,000 | 20,000 | 2,500 | 250 |
| Nominal Flash Duration at Max. Input (⅓ peak) — microseconds | 600 | 1 msec | 2.2 msec | 2.2 msec | 2.2 msec | 600 | 150 |
| Typical Flash Rate | 1 per 10 sec. | 1 per 35 sec. | 1 per 4 min. | 1 per 3 min. | 1 per 2 min. | 1 per 10 sec. | 1 per 10 sec. |
| Nominal Life at Stated Input (in free air) — No. of Flashes | 5,000 at above conditions | 1,000 @ 2,000 w-s, 1,000 $\mu$fd, 2.0 kv, with 300 $\mu$h choke in series with tube | 50 at above conditions | 1,000 at above conditions | 7,500 at above conditions | 5,000 at above conditions | $10^4$ at above conditions |
| **OPERATING LIMITS** | | | | | | | |
| Min. Operating Voltage — volts | 1,000 | 1,100 | 1,000 | 1,000 | 1,000 | 1,000 | 600 |
| Max. Operating Voltage — volts | 3,000 | 3,000 | 3,000 | 3,000 | 3,000 | 3,000 | 2,500 |
| Typical Trigger Voltage Range — Kilovolts | 15–20 | 15–20 | 25 | 25 | 25 | 15–20 | 15–20 |
| **OTHER CHARACTERISTICS** | | | | | | | |
| Arc Resistance During Discharge — ohms | 0.3 | 0.6 | 0.2 | 0.2 | 0.2 | 0.4 | 0.9 |
| Approximate Arc Length — (see illustration) | 3″ | 6″ | 6½″ | 6½″ | 6½″ | 3½″ | 2⅜″ in flat part of $\pi$ |
| Recommended Trigger Transformer — EG&G | TR-50 | TR-50 | TR-50 or TR-60 | TR-50 or TR-60 | TR-50 or TR-60 | TR-50 | TR-50 |
| Recommended Choke (if any) — EG&G | TR-70 or TR-71 | TR-70 or TR-71 | TR-79 or TR-80 | TR-79 or TR-80 | TR-79 or TR-80 | TR-70 or TR-71 | —— |
| Envelope Material | Quartz | Quartz | Quartz | Quartz | Quartz | Quartz | Quartz |
| Mounting | Fuse-clip | Fuse-clip | Little-fuse | Little-fuse | Little-fuse | Fuse-clip | Little-fuse |
| Polarized Operation | Yes | Yes | Yes | Yes | Yes | Yes | Yes |




*Caution: Make certain that hole in center of tube socket provides sufficient clearance for glass exhaust tubulation in base of flash tube.

## GENERAL INFORMATION

Average Power = w-s x f
w-s = watt second input/flash
f = flashes/sec.

$$\text{Watt-seconds} = \frac{CV^2}{2}$$

C (mfd) = value of energy storage capacitor
V (kv) = voltage to which C is charged

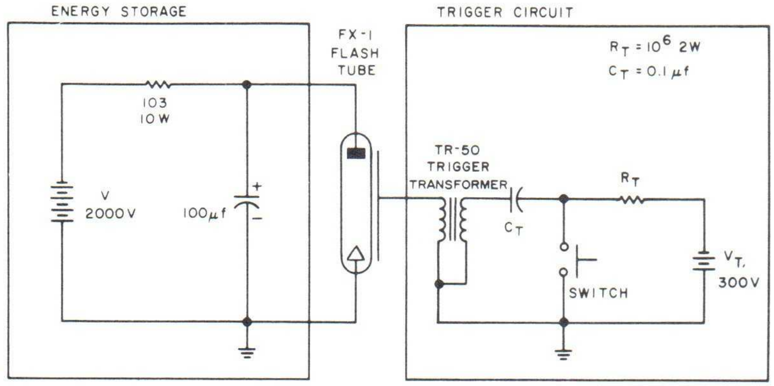



Fig. I
Typical circuit illustrating basic charging and triggering arrangement.

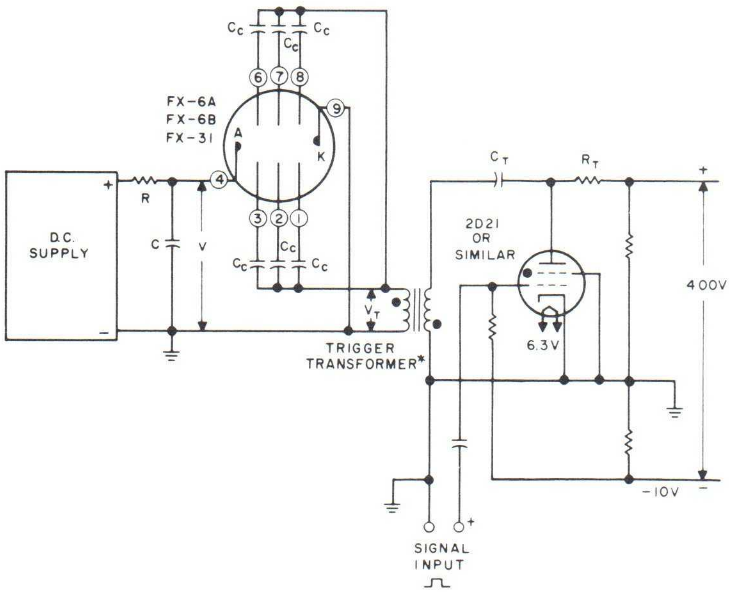



Fig. II
Typical circuit for use with FX-6A type internally triggered flashtubes.

*Trigger Transformer EG&G Type TR-36

C — Value determined by formula (w-s = 1/2 $CV^2$)

V — Value determined by formula (w-s = 1/2 $CV^2$)

$C_c$ — 4.7 µµf 3 kv (Sprague 30GAB-V47 or equivalent). Printed circuit capacitors can be used.

$V_T$ — Trigger voltage (2.5 — 4 kv)

$R_T$ — Value determined by flash repetition rate (controls time constant $R_TC_T$)

$C_T$ — Value determined by trigger transformer requirements and flash repetition rate.

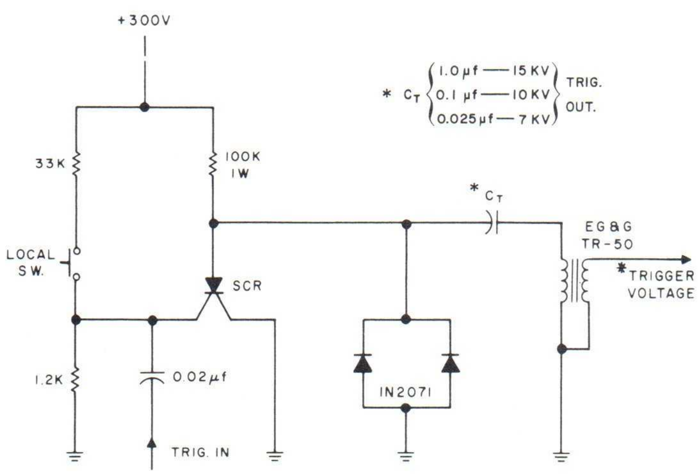



Fig. III
Typical SCR trigger circuit
SCR = Silicon control rectifier 300V-1A for single shot and low repetition rates, 300V-5A for higher repetition rates.
Note that different values of $C_T$ will provide a range of trigger voltage outputs (additional curves in trigger transformer section).

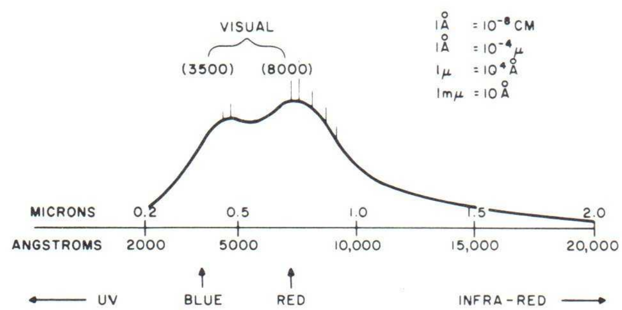
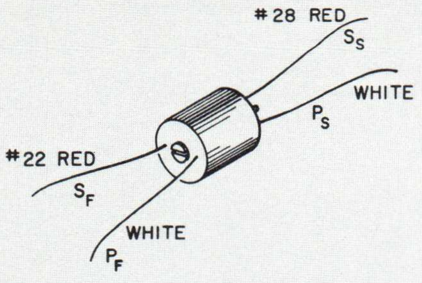
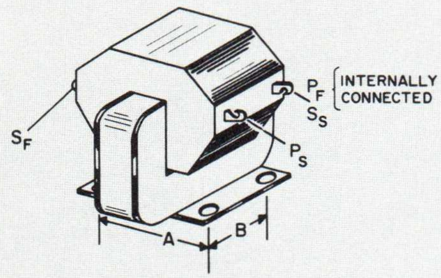


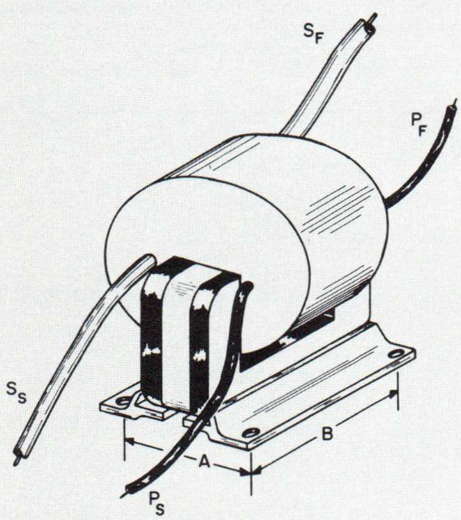

Fig. IV
Approximate spectral output of xenon flashtubes with quartz envelope (not to scale).



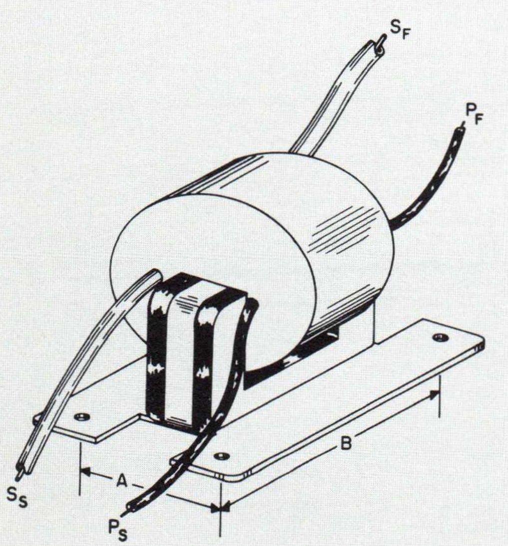

**TR-36, TR-76 & TR-90**




**TR-50**




**TR-60**




**TR-69**

# TRIGGER TRANSFORMERS

For many years EG&G has been a recognized leader in the development and operation of triggering and firing devices. From this work has evolved a complete line of related components. Among these are trigger transformers and chokes.

EG&G Trigger transformers were developed for triggering flashtubes, spark gaps, and similar devices.

The units described in this data sheet are only a few of the many types manufactured. In most cases special trigger transformer requirements can be met by either an existing design or by a custom-engineered unit. For complete information contact the EG&G Applications Group.

### SPECIFICATIONS

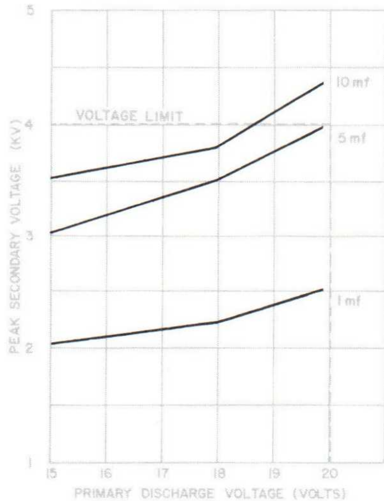
| | TR-36 | *TR-50 | TR-60 | TR-69 | TR-76 | TR-90 |
|---|---|---|---|---|---|---|
| Maximum Primary Discharge Voltage (volts dc) | 400 | 500 | 1,000 | 1,000 | 20 | 20 |
| Peak Voltage Out (KV) | 6 | 25 | 40 | 60 | 4 | 5.5 |
| Turns Ratio | 1:15 | 1:35 | 1:40 | 1:60 | 1:188 | 1:250 |
| Typical Output Pulse Duration (varies with input capacitance) ($\mu$sec) | 6 | 5 | 6 | 8 | 6 | 6 |
| Overall Dimensions (inches) | ¾ x 15/16 dia. | 2¼ x 2 7/16 x 2 high | 2⅝ x 2 9/16 x 3 high | 3 11/16 x 4 x 2⅞ high | ¾ x 15/16 dia. | ¾ x 15/16 dia. |
| Mounting Holes** (A) (inches center to center) (B) | Mounted with #6-32 screw thr. ctr. | 1 1/16<br>⅞ | 1¾<br>2 3/16 | 2½<br>3⅜ | Mounted with #6-32 screw through center | |
| Weight (lbs) | ¼ | 1 | 1¼ | 1½ | ¼ | ¼ |
| Shipping Weight (lbs) | 3 | 4 | 4 | 5 | 3 | 3 |

Notes *TR-50 is an exact replacement for Model TR-35 except that it has improved insulation.

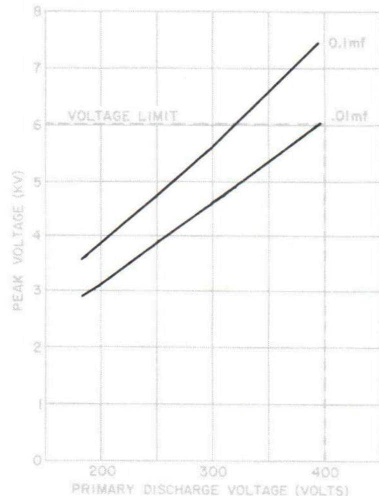
**Size of mounting holes for TR-50, TR-60 and TR-69 are 3/16" diameter.

## OPERATING DATA

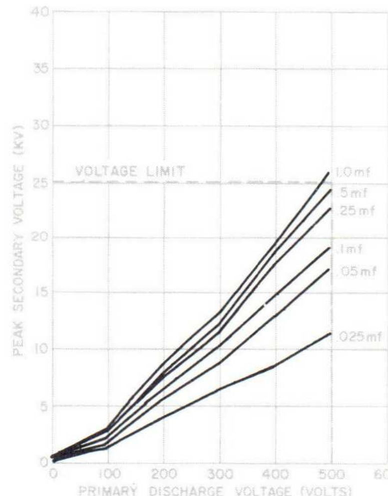
The charts below will help you select the most suitable transformer for your specific requirements. Peak voltage output is plotted against primary discharge voltage at different values of discharge capacitance.



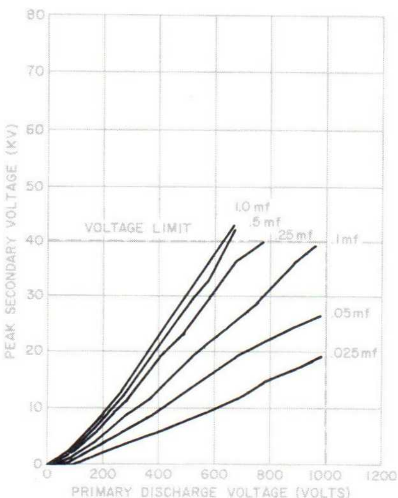

**TR-76**



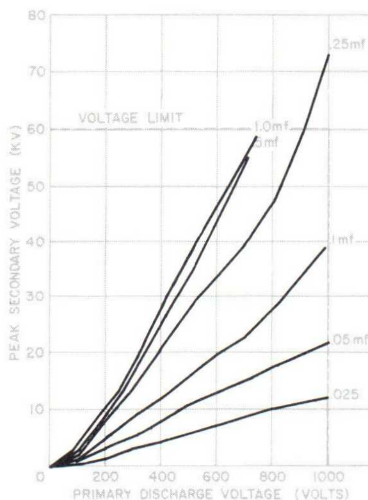

**TR-36**



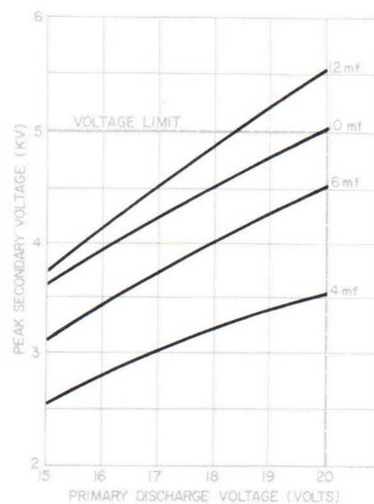

**TR-50**




**TR-60**




**TR-69**

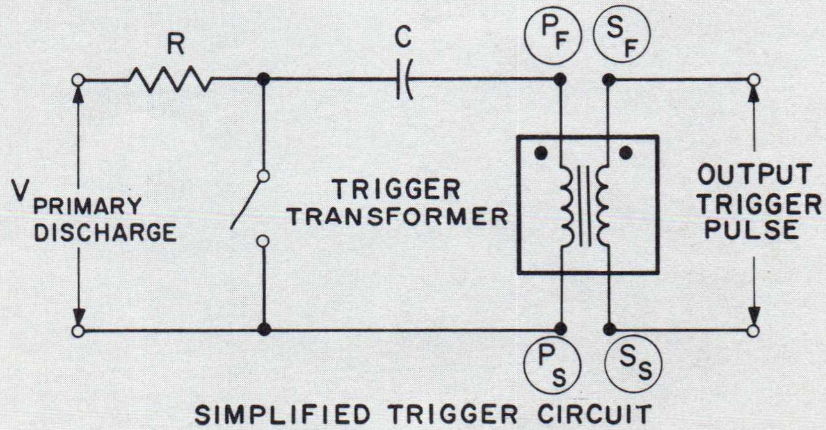



**TR-90**

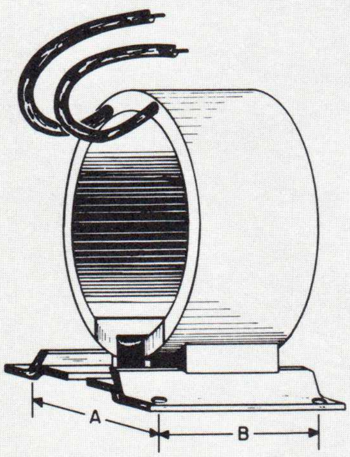
## INSTALLATION

For connecting transformers see circuit diagram, and illustrations on left side of opposite page for terminal identification.

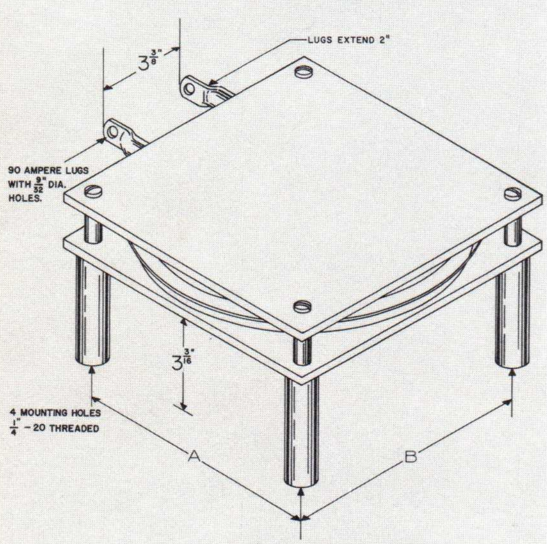
$P_s$ — Primary start
$P_f$ — Primary finish
$S_s$ — Secondary start
$S_f$ — Secondary finish
C — Discharge capacitance into primary transformer.
R — Series limiting resistance.




SIMPLIFIED TRIGGER CIRCUIT




**TR-70 & TR-71**




**TR-79 & TR-80**

# CHOKES

In order to provide designers with a complete line of accessories for electronic flash circuit applications, EG&G produces a line of chokes designed especially to meet the requirements of EG&G xenon flashtubes.

## SPECIFICATIONS

| | TR-70 | TR-71 | TR-79 | TR-80 |
|---|---|---|---|---|
| Inductance (microhenries) | 300 | 600 | 550 | 850 |
| D C Resistance (ohms) | 0.17 | 0.23 | 0.031 | 0.044 |
| Voltage (KV) | 4 | 4 | 3 | 3 |
| Maximum Peak Current for 1 Millisecond Pulse (amperes) | 2,000 | 2,000 | 5,000 | 5,000 |
| Maximum RMS Current * (amperes) | 8 | 8 | 10 | 10 |
| Dimensions (inches) | 3½ x 2⁹⁄₁₆ x 4¼ high | | 8x8x4¾ high | 9x9x4¾ high |
| Mounting Holes** (inches (A) center to center) (B) | 1¾<br>2³⁄₁₆ | 1¾<br>2³⁄₁₆ | 6½<br>6½ | 7½<br>7½ |
| Recommended for use with EG&G Flashtubes*** | FX-38<br>FX-42<br>FX-45 | FX-38<br>FX-42<br>FX-45 | FX-47 | FX-47 |
| Weight (lbs.) | ¾ | 1 | 13 | 17 |
| Shipping Weight (lbs.) | 4 | 4 | 16 | 20 |

Notes

* $I_{RMS} = \sqrt{I_{Peak} \times I_{Average}}$ where $I_{Average} = I_{Peak}$ x Duty Cycle

**Mounting holes for TR-70 & TR-71 are 3/16" diameter.

Mounting holes for TR-79 & TR-80 are ¼-20 threaded.

***Can also be used with other flashtubes having similar ratings.

MOUNTING — Due to the intense magnetic fields generated during discharge, chokes should be securely mounted away from metallic objects and components influenced by magnetic fields. Flexible leads are desirable. Magnetic coupling should be avoided when two or more chokes are used.

DATA AND SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE.

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