GENERAL OPERATIONAL RECOMMENDATIONS

GENERAL

Mullard electronic flash tubes have been designed to cover a wide range of uses in industry, in research on the study of high-speed phenomena, and in commercial photography. The tubes are characterised by a high luminous efficiency, ease of triggering and short flash duration. They are capable of producing several thousand flashes without deterioration in the quality and intensity of the light output. The spectrum of the emitted light approximates closely to that of daylight and they may thus be used in colour photography (see curves following the general operational recommendations).

The time delay between application of the trigger pulse and production of the light flash is less than 50 microseconds, and since the duration of the flash itself is usually much less than 1 millisecond, a flash tube is capable of "freezing" movement for photographic purposes.

OPERATION OF FLASH TUBES

Connections

For reliable operation it is recommended that the anode be maintained at earth potential, the cathode being alive. The trigger electrode should be tied to the anode via the trigger transformer. Failure to do this may result in spontaneous breakdown.

Energy of Discharge

The energy dissipated in the tube must not exceed the maximum value given in the data sheet. If it is intended to use the tube at the maximum rated energy discharge, a high grade voltmeter should be used to measure the voltage across the discharge capacitor ; it is not sufficient to rely upon the nominal output rating of the transformer employed, since the energy is proportional to the square of the voltage ($E=\frac{1}{2}CV^2$). The time between flashes must not be less than the minimum value given in the data sheet for each tube. Failure to observe these points will reduce the life of the tube.

The effective resistance of a flash tube during discharge is very low. The leads connecting the discharge capacitor to the anode and cathode should therefore be as short and as thick as possible to ensure maximum delivery of energy to the tube.

Trigger Voltage

The trigger voltage specified in the data sheet is the peak pulse voltage obtained from a damped oscillatory transient and must be such that it is positive with respect to the other electrodes over the first half cycle of its waveform, otherwise satisfactory operation of the tube may not be ensured. A practical method of obtaining this voltage is to discharge a 0.5μF capacitor through the primary of a transformer, the secondary of which is connected between trigger and anode. A typical trigger voltage waveform is shown in the accompanying curve. The faster the initial voltage rise, the smaller will be the delay time between the onset of the trigger voltage and the start of the flash.

Triggers for Linear Tubes

The type of trigger recommended for linear tubes is a helix of bare wire stretched along the tube from anode to cathode. The pitch of the turns is not critical—a figure of 3.5 to 5 cm is suggested. For reliable operation at the recommended trigger voltage it is necessary that the first turn should start not more than 2 cm from the cathode. Values of trigger voltage given in the data sheets are based on measurements using a trigger of this type.

Covered or enamelled wire should not be used, as permanent glass discoloration may result.

Ventilation

In no circumstances should the hole in the base of the tube be completely enclosed, as the expansion of air due to the heat developed within the dome of the tube may then fracture the envelope.

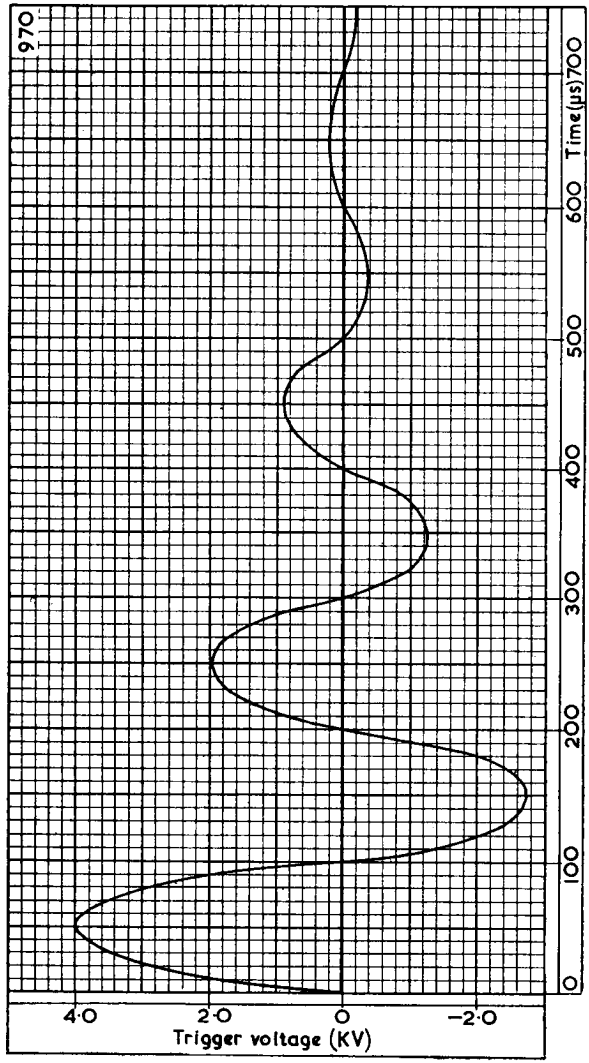
High Voltage Precautions

It is essential that the tube base be kept clean so as to prevent surface leakage between the pins. Soldering should be neat and sharp points avoided to prevent sparking in air.

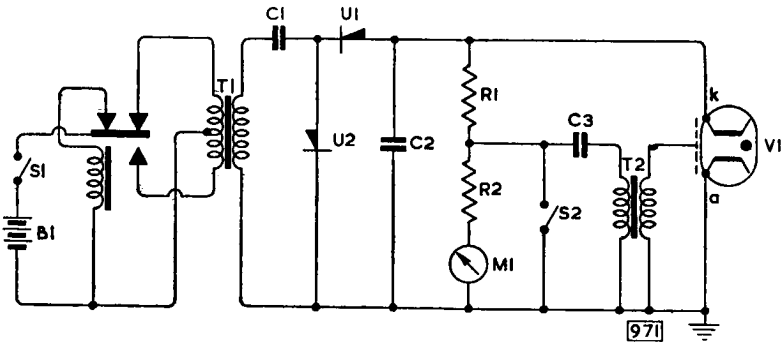
WARNING

IN VIEW OF THE HIGH VOLTAGES AND CAPACITANCES USED IN FLASH EQUIPMENT, CARE MUST BE TAKEN TO ENSURE THAT ALL PARTS WHICH ARE LIKELY TO BE HANDLED ARE ADEQUATELY INSULATED AND PROTECTED.

Flash equipment manufacturers are urged to affix warning labels on each unit pointing out that because of the dangers involved, only experienced servicemen should repair faulty equipment.



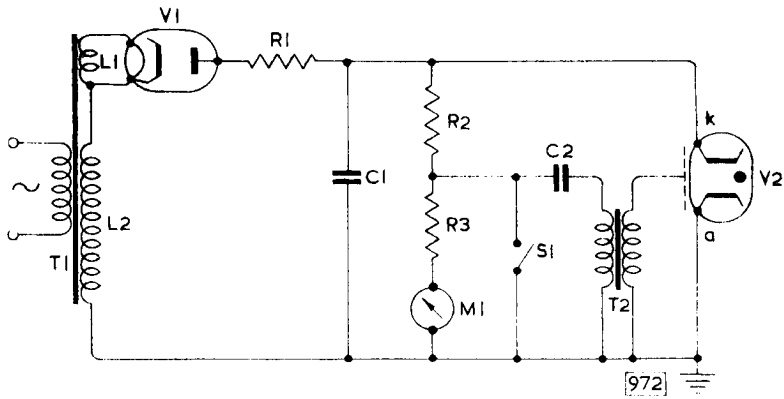
TYPICAL TRIGGER VOLTAGE WAVEFORM



BASIC CIRCUIT FOR BATTERY-OPERATED FLASH TUBE EQUIPMENT

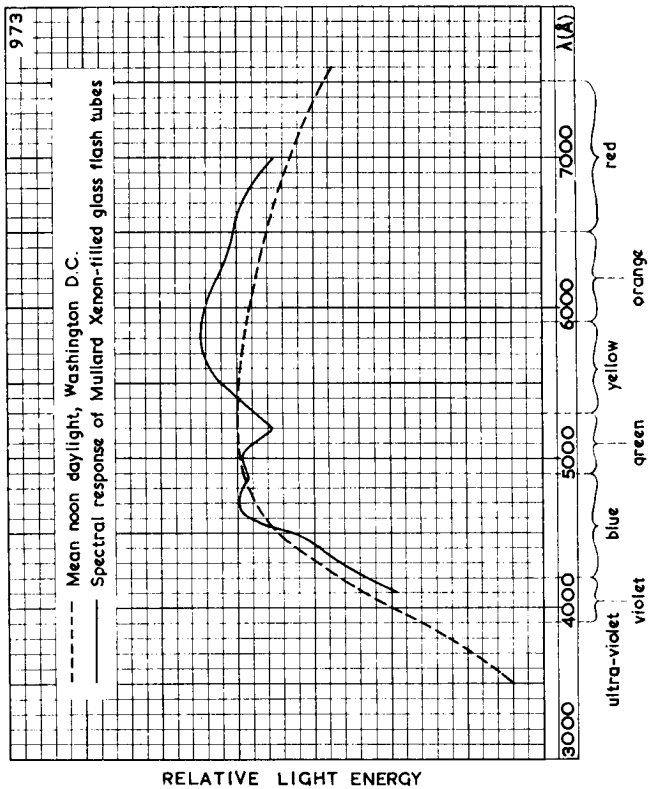
R1	10M Ω
R2	680k Ω
C1	0.05μF (1,000V working)
C2	See Flash Tube Data
C3	1.0μF (500V working)
V1	Flash Tube
M1	Micro-ammeter. 500μA full-scale deflection
*T1	Power transformer
T2	Trigger transformer
*B1	Accumulator or dry batteries
S1	Charging switch
S2	Firing switch
U1, U2	Metal rectifiers. Open circuit input voltage 900V r.m.s. Mean output current 8mA.

*Values should be chosen to provide the required voltage across C2.



BASIC CIRCUIT FOR MAINS-OPERATED FLASH TUBE EQUIPMENT

R1	45 k Ω
R2	10 M Ω
R3	680 k Ω
C1	See Flash Tube Data
C2	1.0μF (500V working)
V1	HVR2
V2	Flash Tube
M1	Micro-ammeter. 500μA full-scale deflection
T1	Mains Transformer { L1 = 4.0V, 0.8A; L2 = Value chosen to provide required voltage across C1
T2	Trigger Transformer
S1	Firing Switch



LIGHT ENERGY DISTRIBUTION CURVE FOR XENON-FILLED GLASS TUBES

PHOTOGRAPHIC FLASH TUBE

LSD3

Cold cathode xenon-filled discharge tube for use in studio or portable photo-flash equipment.

MOUNTING POSITION

Any.

CHARACTERISTICS

Min. anode–to–cathode breakdown voltage	3,000	volts
Following measured at V_a=2,500 volts and energy discharge=100 joules		
*Flash duration	100	μ secs
Peak light output	35	Megalumens
Total light output	3,000	Lumen–secs.
Luminous efficiency	30	Lumens/watt
Effective tube resistance (approx.)	3	ohms

*Time taken between rise and fall to 1/*e* (36%) of the peak light output

OPERATING CONDITIONS

Anode voltage (V)	Capacitance (μF)	Energy discharge (joules)
2,700	27	100
2,500	32	100
2,000	50	100

LIMITING VALUES (Absolute ratings)

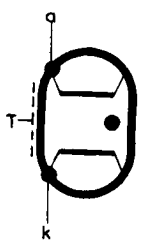
Max. energy discharge	100	joules
Anode voltage limits	2,000 to 2,700	volts
Peak trigger voltage limits	4,000 to 8,000	volts
Min. time between flashes at 100 joules	10	secs.

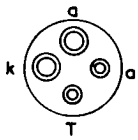
LSD3

PHOTOGRAPHIC FLASH TUBE

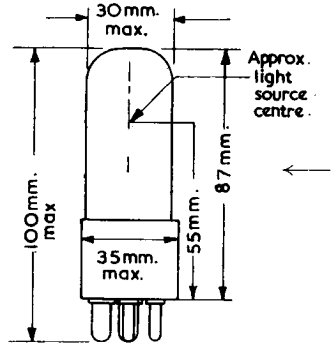
Cold cathode xenon-filled discharge tube for use in studio or portable photo-flash equipment.

1530





4–pin UX base



PHOTOGRAPHIC FLASH TUBE

LSD5

Cold cathode Xenon-filled discharge tube for use in studio photography. A modelling lamp may be inserted within the envelope for use while posing the subject.

MOUNTING POSITION

Any.

CHARACTERISTICS

Min. anode–to–cathode breakdown voltage	3,000	V
Following measured at V_a=2,500 volts and energy discharge 1,000 joules		
*Flash duration	500	μ secs.
Peak light output	80	Megalumens
Total light output	40×10^3	Lumen–secs.
Luminous efficiency	40	Lumens/watt
Effective tube resistance (approx.)	1.5	ohms

*Time taken between rise and fall to 1/e (36%) of the peak light output.

OPERATING CONDITIONS

Anode voltage (V)	Capacitance (μF)	Energy discharge (joules)
2,700	275	1,000
2,500	320	1,000
2,000	500	1,000
2,700	110	400
2,500	128	400
2,000	200	400

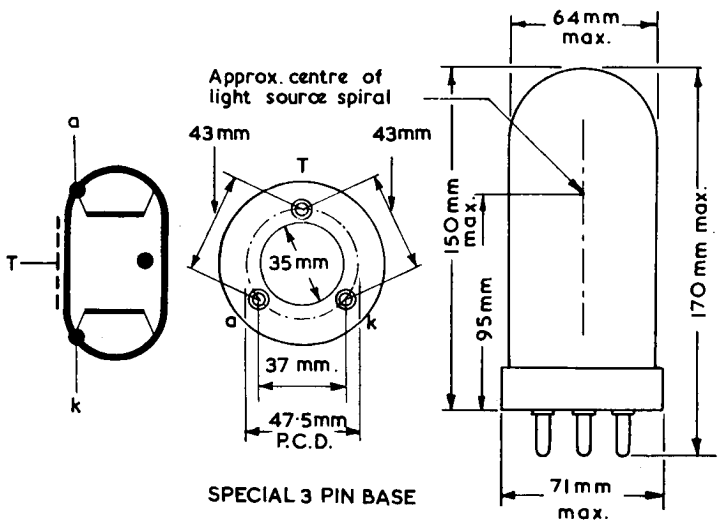
LIMITING VALUES (Absolute ratings)

Max. energy discharge	1,000	joules
Anode voltage limits	2,000 to 2,700	volts
Peak trigger voltage limits	6,000 to 12,000	volts
Min. time between flashes at 1,000 joules	30	secs.

LSD5

PHOTOGRAPHIC FLASH TUBE

Cold cathode Xenon-filled discharge tube for use in studio photography. A modelling lamp may be inserted within the envelope for use while posing the subject.



PHOTOGRAPHIC FLASH TUBE

LSD7

Cold cathode Xenon-filled discharge tube for use in studio or portable photo-flash equipment.

MOUNTING POSITION

Any

CHARACTERISTICS

Min. anode-to-cathode breakdown voltage	3,000	volts
Following measured at V_a=2,500 volts and energy discharge=200 joules		
*Flash duration	200	μ secs.
Peak light output	44	Megalumens
Total light output	7,000	Lumens-secs.
Luminous efficiency	35	Lumens/watt
Effective tube resistance (approx.)	3	ohms

*Time taken between rise and fall to 1/e (36%) of the peak light output.

OPERATING CONDITIONS

Anode voltage (V)	Capacitance (μF)	Energy discharge (joules)
2,700	55	200
2,500	64	200
2,000	100	200

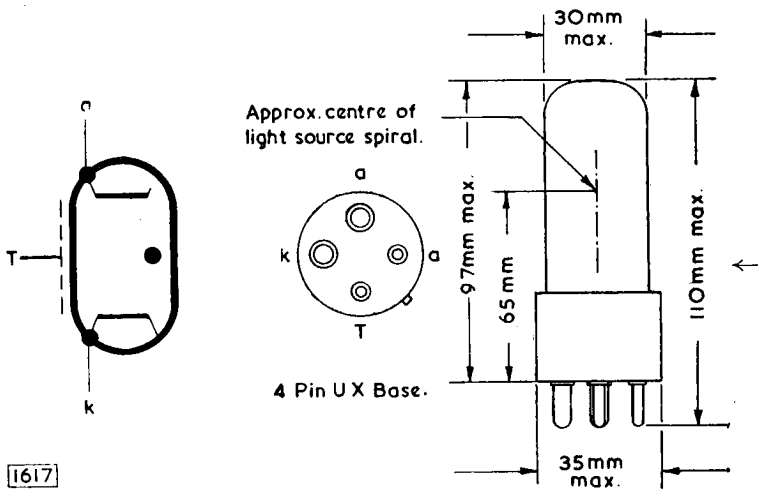
LIMITING VALUES (Absolute ratings)

Max. energy discharge	200	joules
Anode voltage limits	2,000 to 2,700	volts
Peak trigger voltage limits	5,000 to 8,000	volts
Min. time between flashes at 200 joules	30	secs.

LSD7

PHOTOGRAPHIC FLASH TUBE

Cold cathode Xenon-filled discharge tube for use in studio or portable photo-flash equipment.



PHOTOGRAPHIC FLASH TUBE

LSD24

Cold cathode Xenon-filled discharge tube for use in studio or portable photo-flash equipment. Designed for operation with an anode voltage of 1.0 kV.

MOUNTING POSITION

Any

CHARACTERISTICS

Min. anode-to-cathode breakdown voltage	1.5	kV

Following measured at V_a = 1.0 kV and energy discharge = 100 joules

*Flash duration	150	μ secs.
Peak light output	35	Megalumens
Total light output	3,800	Lumen-secs.
Luminous efficiency	38	Lumens/watt

*Time taken between rise and fall to 1/e (36%) of the peak light output.

OPERATING CONDITIONS

Anode voltage	1.0	kV
*Capacitance	200	μF
Energy discharge	100	joules

*With this type of tube, *electrolytic* capacitors are normally employed. Care should be taken in their selection in order that the maximum ratings of the tube are not exceeded.

LIMITING VALUES (Absolute ratings)

Max. energy discharge	100	joules
Anode voltage limits	0.8 to 1.1	kV
*Min. trigger voltage	6.0	kV
Min. time between flashes at 100 joules	10	secs.

*The maximum time taken to reach the first peak of the trigger voltage waveform should be 10 μ secs. Reduction in the rate of rise of this voltage will result in reduced triggering efficiency.

LSD24

PHOTOGRAPHIC FLASH TUBE

Cold cathode Xenon-filled discharge tube for use in studio or portable photo-flash equipment. Designed for operation with an anode voltage of 1.0 kV.