

Ignition Voltage (starting voltage, striking voltage)

The minimum voltage which must be applied between the anode and cathode of a tube in order to initiate a glow discharge.

Burning Voltage (maintaining voltage)

The voltage between anode and cathode when a glow discharge has been established and the tube is passing current within its specified limits.

Regulation Voltage

The change in the burning voltage when the current is changed from the maximum to the minimum value.

Incremental Resistance

The slope of the burning voltage against burning current characteristic at some specified tube current.

Temperature Coefficient of Burning Voltage

The rate of change of burning voltage with tube ambient temperature for a fixed tube current.

Stability

The change in burning voltage with life caused by changes in tube characteristics. This excludes changes due to variations in tube current, temperature, etc.



STABILISER AND REFERENCE TUBES

GENERAL OPERATIONAL RECOMMENDATIONS

1. INTRODUCTION

A VOLTAGE STABILISER tube is a glow discharge tube designed to have a maintaining voltage which is substantially constant over the current operating range.

A VOLTAGE REFERENCE tube is a glow discharge tube designed to have a constant maintaining voltage at fixed values of current and temperature.

2. DATA PRESENTATION

In general, the data is presented under the following four main headings: (a) quick reference data, (b) characteristics and range values for equipment design (c) absolute maximum rating system (d) life information. The data given under each heading is described below and more detailed information is given in the later sections. Specific information is also given in the data sheets for the different tubes.

2.1 QUICK REFERENCE DATA

This section contains the nominal values of the main characteristics of the tubes to allow rapid comparison with the characteristics of other tubes. The items usually given for quick reference are: anode maintaining voltage, cathode current range and any special features.

2.2. CHARACTERISTICS AND RANGE VALUES FOR EQUIPMENT DESIGN

Information given in this section is intended as a basis for circuit design and normally indicates the range over which the tube will operate both initially and during life. No allowance is made for supply voltage and component variations. There is no objection to operation outside the stated ranges.

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provided no absolute maximum rating is thereby exceeded but no guarantee is given on the performance of the tube in a circuit under these conditions. However, once the tube is again operated within the stipulated range values, the performance is again guaranteed.

2.3 ABSOLUTE MAXIMUM RATINGS

This section states the absolute maximum ratings as defined by the I.E.C. as follows:

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

These values are chosen by the tube manufacturer to provide acceptable serviceability of the tube, taking no responsibility for equipment variations, environmental conditions due to variations in the characteristics of the tube under consideration and all other electron devices in the equipment. The equipment manufacturer should design so that initially and throughout life no absolute maximum value

the equipment.

2.4 LIFE INFORMATION

In this section, the general pattern of life behaviour is given when the life behaviour is of particular interest, the pattern is described fully.

STABILISER AND REFERENCE TUBES

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3. TERMINOLOGY

3.1. MINIMUM VOLTAGE FOR IGNITION

The ignition voltage is the lowest d.c. potential which when applied initiates a self-sustaining discharge.

The data normally states the minimum voltage for ignition. Although some tubes may ignite at a somewhat lower voltage, the specified voltage should always be applied to ensure ignition of all tubes.

3.2. IGNITION DELAY TIME

The ignition delay time is the interval between the application of the ignition voltage across the anode-cathode gap and the establishment of a self-sustaining discharge in that gap.

Certain tubes may be affected by ambient light and in darkness the delay time may increase.

3.3. MAINTAINING VOLTAGE

The maintaining voltage is the d.c. voltage between the anode and cathode with the tube conducting. It is measured under the conditions stated in the data and will vary with current, temperature and time. When a noise signal is present the average value of the composite voltage is taken.

3.4. TEMPERATURE COEFFICIENT OF MAINTAINING VOLTAGE

The temperature coefficient is the change in maintaining voltage at a specified current that occurs for 1°C change in bulb temperature. The value quoted is normally an average value which applies over the temperature range stated.

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3.5. REGULATION VOLTAGE

The regulation voltage is the difference between the maintaining voltages at two different cathode currents and is normally measured over the full current range of the tube, at the temperature specified.

3.6 INCREMENTAL RESISTANCE

The incremental resistance is the slope of the characteristic of anode maintaining voltage plotted against cathode current and is measured at a specified current and temperature.

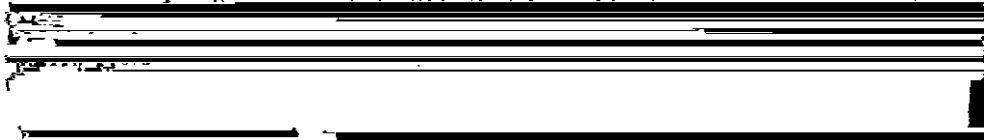
3.7 NOISE ON MAINTAINING VOLTAGE

Noise voltages arise from several different sources, and are defined as follows:

3.7.1. Random noise

A voltage random in nature and similar to thermal noise. It is normally quoted as r.m.s. voltage measured over a specific frequency range.

3.7.2. Oscillation noise



Where this information is given it is for guidance only and it is not recommended that the tube be operated under these conditions for long periods.

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3.7.4. Microphonic noise

A voltage caused by mechanical excitation due to a single blow.

3.8. VOLTAGE JUMPS

A voltage jump is an abrupt change or discontinuity in maintaining voltage during operation and is not due to a negative incremental resistance. The jump may occur either during life under constant operating conditions or as the current or temperature is varied over the operating range.

3.9. NEGATIVE ANODE VOLTAGE

Under no circumstances should reference tubes or stabilisers be allowed to pass reverse current. To ensure this, the specified maximum inverse peak voltage applied to the tube should never be exceeded.

3.10. CATHODE CURRENT

3.10.1 Maximum cathode current for continuous operation

The maximum value of cathode current for a tube is that instantaneous value which should not be exceeded during the normal operation of the tube. When the tube is initially switched on, this value may be exceeded (see maximum surge current).

3.10.2 Maximum surge current (starting current)

The maximum surge current is the peak current which may safely be passed through the tube. The maximum permissible value, together with duration and frequency of occurrence, is normally given. When a value is not given, the current should be restricted to 2.5 times the maximum continuous

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current and should not be allowed to occur for more than approximately 30 seconds in each 8 hours use. The surge current should be limited as much as possible where maximum stability is required.

3.10.3 Minimum cathode current

The minimum cathode current is the continuous current below which satisfactory operation of the tube is not guaranteed. Operation below this current may also result in deterioration of the subsequent performance of the tube.

3.10.4 Preferred operating current

For reference tubes a preferred operating current is also quoted. Wherever possible this value of current should be adopted and maintained constant because it represents a condition which is not only free from discontinuities in characteristics but also has maximum stability during life. If the current is changed during life and then returned to its original value, the high order of stability may be impaired for some time.

3.11. BULB TEMPERATURE

The bulb temperature is taken as the temperature caused by internal or external effects of the hottest part of the tube envelope.

To maintain a reliable performance the bulb temperature should be kept as close to the room temperature as possible.

4. MECHANICAL CONSIDERATIONS

4.1. MOUNTING POSITION

Unless otherwise stated in the published data, tubes can be mounted in any position.

4.2. TUBE SOCKETS

Detailed drawings of pin spacing, diameter and length are given in BS448: 1953 "Electronic-Valve Bases, Caps and Holders".

When a tube holder is wired for a tube having a glass base integral with the glass envelope, a metallic dummy base should be fitted to prevent the displacement of the contacts, otherwise possible displacement can cause damage to the pins when the tube is inserted. Pins marked I.C. on the base diagram in the data sheet may have been used for connections within the tube. The corresponding contacts on the tube holder must be left free and not used as anchoring points for wiring.

4.3. TUBES WITH FLEXIBLE LEADS

Tubes with flexible leads do not normally employ plug-in tube sockets. Usually the tube is held in position by a form of clamp or strap fitted round the envelope. If the tube is mounted in this way, it is important that:

- a) Undue stress should not be placed on the flexible leads.
- b) The bulb temperature should not exceed the specified value.
- c) If the tube is secured by means of a metal clamp the clamp should be isolated.

Direct soldered connections to the leads must be at least 5mm from the seal and any bending of the leads must be at least the

GENERAL OPERATIONAL RECOMMENDATIONS

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specified distance from the seal. Care should be taken during soldering to ensure that the glass temperature at the seal is not allowed to rise excessively. One simple precaution is to clamp a thermal shunt on the wire between the glass and the point being soldered.

4.4. DIMENSIONS

Only the dimensions given on the data sheets should be used in the design of equipment. Dimensions taken from individual tubes should never be used for this purpose.

5. CIRCUIT CONSIDERATIONS

5.1. BASIC CIRCUIT

A simple circuit is shown in Fig.1. To ensure that the tube will ignite and operate under the correct current conditions, the following conditions must be satisfied:

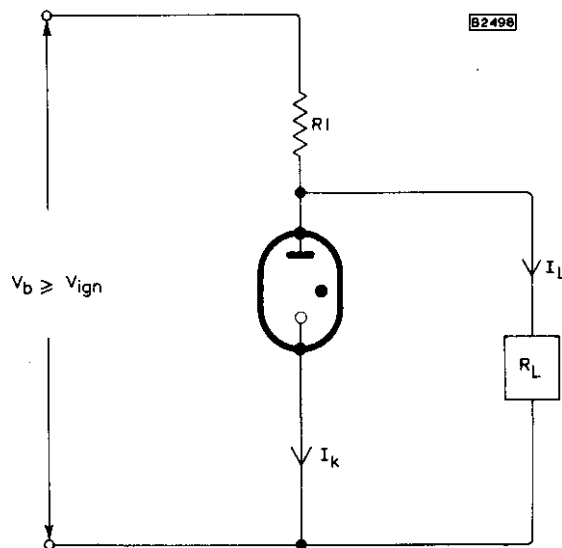


FIG.1

STABILISER AND
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$$R_1 < \frac{V_b \text{ min} - V_m \text{ max}}{I_k \text{ min} + I_L \text{ max}} \cdot \frac{1}{1 + \frac{p}{100}}$$

$$R_1 > \frac{V_b \text{ max} - V_m \text{ min}}{I_k \text{ max} + I_L \text{ min}} \cdot \frac{1}{1 - \frac{p}{100}}$$

$$R_1 < R_L \left(\frac{V_b \text{ min}}{V_{\text{ign}} \text{ max}} - 1 \right) \cdot \frac{1}{1 + \frac{p}{100}}$$

Where I_k = tube current.
 V_b = applied supply I_L = load current.

5.2 SERIES OPERATION

It is possible to operate several tubes of this class in a series configuration providing the current range falls within the limits of all tubes.

The circuit shown in Fig. 2 illustrates one method of ensuring that all tubes ignite. With this arrangement the voltage necessary for ignition is equal to $V_{\text{ign}}(V1) + V_m(V2) + V_m(V3)$ where

V_{ign} = ignition voltage of the associated tube.

V_m = maintaining voltage of the associated tube.



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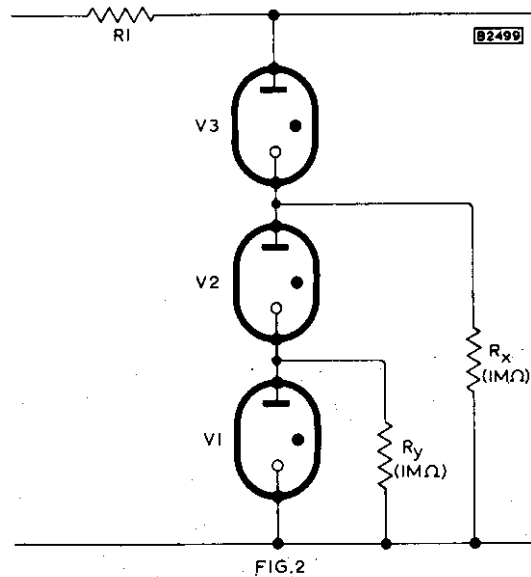


FIG. 2

If the resistors R_y and R_x cannot be considered as being large compared to the tube load, the conditions applied to each tube must be considered in its own merits as an extension of the basic circuit given in 5.1.

5.3. PARALLEL OPERATION

It is not advisable to operate stabilisers in parallel with each other because of the difficulty of providing the correct current distribution.

5.4. SHUNT CAPACITOR

The impedance of stabiliser and reference tubes is low at zero frequency (d.c.), but rises as the frequency approaches the upper end of the audio frequency range. However, the output impedance can be maintained at a constant value by a capacitor connected in parallel with the tube. Both the value and the

STABILISER AND REFERENCE TUBES

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circuit position of the capacitor are important design factors determined primarily by the function of the tube.

Stabilising tubes may have voltage jumps in the current range and it is essential that a capacitor is connected directly across the tube, otherwise it is possible for voltage jumps to generate oscillations.

In reference tubes operated at the preferred working current, voltage jumps are either very small or non-existent. When a capacitor is connected across the tube a resistor must be connected in series with the capacitor if effects due to the resonance of the capacitor with the effective inductance of the tube are to be avoided.

The value of the resistor should approximately equal the incremental resistance of the tube. The value of the capacitor should be such that the impedance of the capacitor and resistor in series approximately equals the effective impedance of the tube at the frequency at which the effective tube impedance is 1.4 times the d.c. value. This combination will maintain the effective output impedance of the tube reasonably constant up to the frequency at which the capacitor becomes predominantly inductive.

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These general notes include definitions and general test procedures. They should be read in conjunction with the data sheets for Special Quality Tubes. Where reference should be made to a specific note, this is indicated on the data sheet by an index number, e.g. Group Quality Level⁷.

1. *Limiting Values.* The limiting values quoted on the data sheets are absolute ratings. Absolute maximum ratings are limiting values of operating and environmental conditions applicable to any tube of a specified type as defined by its published data, and should not be exceeded under the worst probable conditions.

These values are chosen by the tube manufacturer to provide acceptable serviceability of the tube, taking no responsibility for equipment variations, environmental variations, and the effects of change in operating conditions due to variations in the characteristics of the tube under consideration, and of all other electron devices in the equipment.

The equipment manufacturer should design so that initially and throughout life no absolute maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply variations, equipment control adjustment, load variations, signal variation, environmental conditions and variations in characteristics of the valve under consideration and of all other devices in the equipment.

The life expectancy of a tube may be appreciably reduced if the maximum ratings are exceeded. Furthermore, in gas-filled tubes certain limiting values, such as the minimum voltage necessary for ignition must be met completely or the tube may show a total failure to operate at any time after installation.

In the interests of reliability the bulb temperature should always be kept as low as possible.

2. *The A.Q.L. (Acceptable quality level)* is the limit below which the average level of defectives is controlled.
3. *Maximum and minimum values for the individuals* are the limits to which tubes are tested.

GENERAL NOTES

SPECIAL QUALITY VOLTAGE STABILISER AND REFERENCE TUBES

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4. *Maximum and minimum for lot average* are the limits between which the average value of the characteristic of a lot or batch is controlled.
 5. *Lot standard deviation* is the standard deviation of a lot or batch.
 6. *Bogey value* is the target value.
 7. *Group quality level*. This is the A.Q.L. over a whole group of tests.
Sub-group quality level. The A.Q.L. over a number of tests which do not constitute a complete group.
 8. *Glass envelope strain test*.
 - (A) This test is carried out on a sampling basis and consists of completely submerging the tubes in boiling water at a temperature between 97 and 100°C for 15 seconds and then immediately plunging them in ice cold water for 5 seconds. The tubes are then examined for glass cracks.
 - (B) This test is carried out on a sampling basis and consists of completely submerging the tubes in boiling water not less than 85°C for 15 seconds and then immediately plunging them in ice cold water not more than 5°C for 5 seconds. The tubes are then examined for glass cracks.
 9. *Base strain test*. This test is carried out on a sampling basis and

freely suspended from the lead under test. The tubes are inclined slowly so as to bend the weighted lead through 45°, back to 45° in the other direction, back to 45° in the first direction and finally back to the vertical, the entire action taking place in one vertical plane. The tubes are examined for cracks and broken leads.

SPECIAL QUALITY VOLTAGE
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- (B) This test is carried out on a sampling basis and consists of holding the tubes vertically and having a 1-lb weight freely suspended from the lead under test. The tubes are inclined slowly so as to bend the weighted lead through 90° and return it to the vertical, the entire action taking place in one vertical plane. This cycle is repeated for the

13. *Inoperatives*. An inoperative is defined as a tube having an open or short circuit electrode, an air leak or a broken pin.



**SPECIAL QUALITY
VOLTAGE REFERENCE TUBE**

M8098

85V gas-filled reference tube for use in equipment where mechanical vibration and shocks are unavoidable.

This data should be read in conjunction with the GENERAL OPERATIONAL RECOMMENDATIONS – VOLTAGE STABILISER AND REFERENCE TUBES and the GENERAL NOTES – SPECIAL QUALITY VOLTAGE STABILISER AND REFERENCE TUBES which precede this section of the handbook; the index numbers are used to indicate where reference should be made to a specific note.

LIMITING VALUES¹ (absolute ratings)

Minimum voltage necessary for ignition (Note 1)	115	V
Cathode current		
Maximum	10	mA
Minimum	1.0	mA
Maximum bulb temperature (Note 2)		
During operation (Note 3)	90	°C
During storage and stand by	70	°C
Minimum ambient temperature	-55	°C
Maximum negative anode voltage	75	V
Maximum starting current (Note 4)	40	mA
Maximum vibrational acceleration	}	For details see Test specification
Maximum shock (short duration)		

PREFERRED OPERATING CONDITION

Cathode current	6.0	mA
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CHARACTERISTICS (at preferred operating condition, 20 to 30°C, Note 5)

Initial values

Maintaining voltage (variation from tube to tube)	83 to 87	V
Maximum jump voltage (1 to 10mA)	100	mV
Typical noise voltage (30c/s to 10kc/s)	60	μ V (pk) (r.m.s.)
Incremental resistance		
Maximum	450	Ω

Life performance



M8098

SPECIAL QUALITY VOLTAGE REFERENCE TUBE

SHORT-TERM STABILITY

Maximum short-term variation of maintaining voltage for any 8 hour period after the first 100 hours life will be better than 0.01% provided there is an initial warming-up period of 3 minutes.

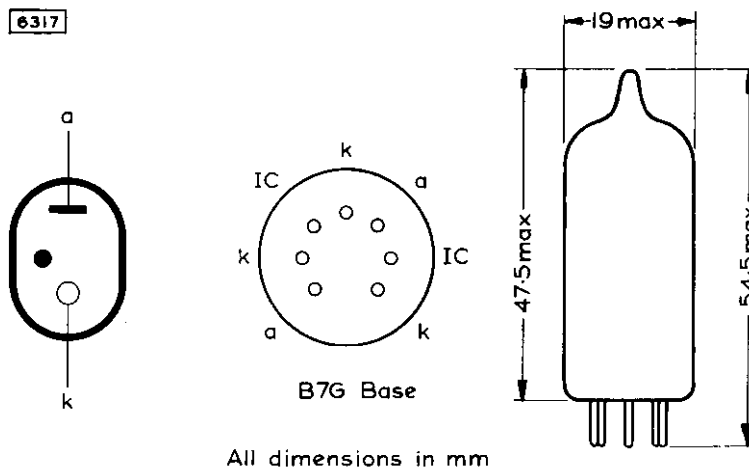
Maximum short-term (100 hours max.) variation of maintaining voltage after the first 300 hours of life is 0.1%.

In order to avoid voltage variations due to temperature fluctuations it will in general be sufficient to draught shield the tube.

NOTES

1. This value holds good over life in light or darkness. In total darkness an ignition delay of up to approx. 5 seconds may occur.
2. During conduction the bulb temperature is approximately 10°C above ambient temperature.
3. If the tube is to be operated with a bulb temperature above 70°C the cathode current should not be less than 6.0mA.
4. To be restricted for long life to 60 seconds once or twice in every 8 hours use.
5. Equilibrium conditions are reached within 3 minutes.

6317



All dimensions in mm

The bulb and base dimensions of this tube are in accordance with BS448, Section B7G.

**SPECIAL QUALITY VOLTAGE
REFERENCE TUBE**

M8098

TEST CONDITIONS (unless otherwise specified)

R_{lum} (k Ω) 5.0
 $I_{burning}$ (mA) 6.0
 After initial warming-up period of 3 min

TESTS

GROUP A

- Ignition voltage. Illumination 5 to 50 ft. cd. ...
- Maintaining voltage ...
- Change in maintaining voltage for burning current ...
- Voltage jumps. Burning current varies from 1 to 10 mA
- Oscillation. Burning current varies from 1 to 10 mA
- Microphonic noise. $R_a = 500\Omega$...
- Leakage current. Supply voltage = 55V, $R_a = 1M$

†This test is carried out on a 100% basis.

GROUP B

- Ignition voltage in darkness, after 24 hours in darkness
- Change in maintaining voltage for burning current

	A.Q.L. ² (%)	Individuals ³		Units
		Min.	Max.	
...	†	—	115	mV
...	†	83	87	V
... mA	†	—	180	mV
...	†	—	100	mV (pk-pk)
...	†	—	5	mV (pk-pk)
...	†	—	15	mV (pk-pk)
...	†	—	5	μ A



M8098

SPECIAL QUALITY VOLTAGE REFERENCE TUBE

TESTS	A.Q.L. ³ (%)		Individuals ³ Min. Max.	
	Min.	Max.	Min.	Max.
GROUP C				
Glass strain test ^{8A} . No applied voltage	6.5	—	—	—
Base strain test ⁹ . No applied voltage	6.5	—	—	—
Resonance search				
Vibrated at 2g over frequency range specified.				
25 to 500c/s .. .. .	..	..	..	..
500 to 2500c/s .. .. .	..	..	..	..
	2.5	2.5	5	15
			(r.m.s.)	(r.m.s.)
			mV	mV
Fatigue¹¹				
No applied voltage, 5g min. peak acceleration, f = 170c/s for 33 hours in each of 3 mutually perpendicular planes				
Post fatigue tests				
Change in maintaining voltage .. .. .	..	..	..	..
Microphonic noise as in Group A .. .. .	..	..	..	..
Sub-group quality level ⁷ .. .. .	..	..	..	..
	2.5	2.5	±0.7	30
			V	mV
				(pk-pk)
Shock¹²				
No applied voltage, 500g				
Post shock tests				
Change in maintaining voltage .. .. .	..	..	..	..
Microphonic noise as in Group A .. .. .	..	..	..	..
Sub-group quality level ⁷
	2.5	2.5	±0.7	30
			V	mV
				(pk-pk)
	4.0	4.0	—	—



**SPECIAL QUALITY VOLTAGE
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M8098

GROUP D

Life test^{1,1}

Burning current = 6mA continuous

Life test end points, 1000 hours

Inoperatives ^{1,3} .. .. .	.. .. .	.. .. .	.. .. .	.. .. .	2.5	—	—
Ignition voltage .. .. .	.. .. .	.. .. .	.. .. .	.. .. .	2.5	—	115 V
Change in maintaining voltage .. .. .	.. .. .	.. .. .	.. .. .	.. .. .	2.5	—	±0.4 V
Change in maintaining voltage for burning current change from 5.8 to 6.2mA .. .. .	.. .. .	.. .. .	.. .. .	.. .. .	2.5	—	180 mV

GROUP E

Tubes are held for 28 days and retested for

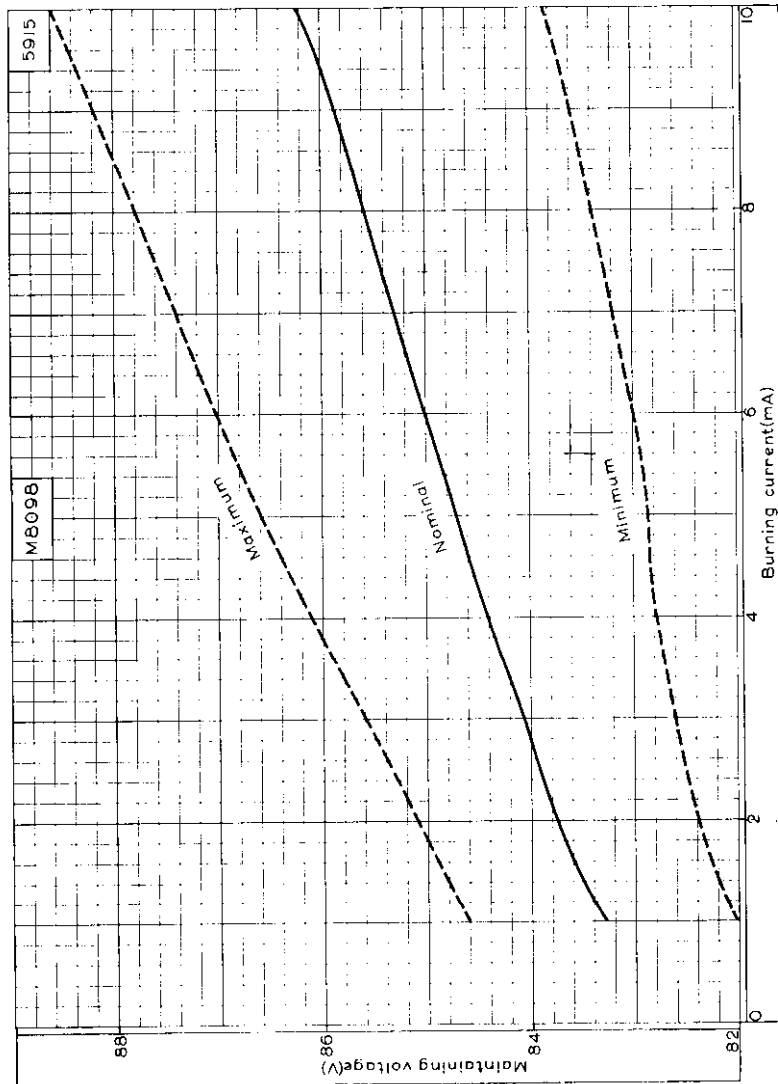
Inoperatives ^{1,3} .. .. .	.. .. .	.. .. .	.. .. .	.. .. .	0.5	—	—
Ignition voltage .. .. .	.. .. .	.. .. .	.. .. .	.. .. .	0.5	—	115 V
Maintaining voltage .. .. .	.. .. .	.. .. .	.. .. .	.. .. .	0.5	83	87 V
Change in maintaining voltage for burning current change from 5.8 to 6.2mA .. .. .	.. .. .	.. .. .	.. .. .	.. .. .	0.5	—	180 mV





SPECIAL QUALITY VOLTAGE
REFERENCE TUBE

M8098



MAINTAINING VOLTAGE PLOTTED AGAINST BURNING CURRENT





**SPECIAL QUALITY
VOLTAGE REFERENCE TUBE**

M8142

85V gas-filled voltage reference tube with flying leads, for use in equipment where mechanical vibration and shocks are unavoidable.

This data should be read in conjunction with the GENERAL OPERATIONAL RECOMMENDATIONS - VOLTAGE STABILISER AND REFERENCE TUBES and the GENERAL NOTES - SPECIAL QUALITY VOLTAGE STABILISER AND REFERENCE TUBES which precede this section of the handbook; the index numbers are used to indicate where reference should be made to a specific note.

LIMITING VALUES¹ (absolute ratings)

Minimum voltage necessary for ignition (Note 1)	115	V
Cathode current		
Maximum	10	mA
Minimum	1.0	mA
Maximum bulb temperature (Note 2)		
During operation (Note 3)	90	°C
During storage and stand by	70	°C
Minimum ambient temperature	-55	°C
Maximum negative anode voltage	75	V
Maximum starting current (Note 4)	40	mA
Maximum vibrational acceleration	}	For details see Test specification
Maximum shock (short duration)		

PREFERRED OPERATING CONDITION

Cathode current	6.0	mA
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CHARACTERISTICS (at preferred operating condition, 20 to 30°C, Note 5)

Initial values

Maintaining voltage (variation from tube to tube)	83 to 87	V
Maximum jump voltage (1 to 10mA)	100	mV
Typical noise voltage (30c/s to 10kc/s)	60	(pk) μV (r.m.s.)
Incremental resistance		
Maximum	450	Ω

Life performance

Maximum variation of maintaining voltage at 25°C		
For continuous operation at preferred current		
0 to 300 hours	0.26	V
300 to 1000 hours	0.17	V





**SPECIAL QUALITY VOLTAGE
REFERENCE TUBE**

M8142

(unless otherwise specified)

I_{burning}
(mA)
6.0

warming-up period of 3 minutes at burning current of 6mA.

	A.Q.L. ² (%)	Individuals ³ Min. / Max.
... †	— 115 V
... †	83 87 V
... †	— 180 mV
... †	— 100 mV (pk-pk)
... †	— 5 mV (pk-pk)
... †	— 15 mV (pk-pk)
... †	— 5 μ A

† on a 100% basis.

... ..	.. 2.5	— 115 V
... ..	.. 2.5	— 4.0 V



M8142

SPECIAL QUALITY VOLTAGE REFERENCE TUBE

SHORT-TERM STABILITY

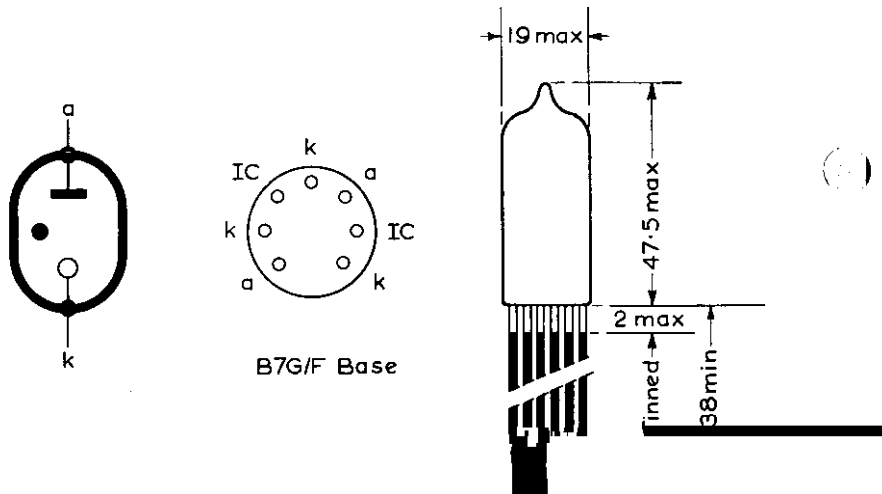
Maximum short-term variation of maintaining voltage for any 8 hour period after the first 100 hours life will be better than 0.01% provided there is an initial warming-up period of 3 minutes.

Maximum short-term (100 hours max.) variation of maintaining voltage after the first 300 hours of life is 0.1%.

In order to avoid voltage variations due to temperature fluctuations it will in general be sufficient to draught shield the tube.

NOTES

1. This value holds good over life in light or darkness. In total darkness an ignition delay of up to approx. 5 seconds may occur.
2. During conduction the bulb temperature is approximately 10°C above ambient temperature.
3. If the tube is to be operated with a bulb temperature above 70°C the cathode current should not be less than 6.0mA.
4. To be restricted for long life to 60 seconds once or twice in every 8 hours use.
5. Equilibrium conditions are reached within 3 minutes.



**SPECIAL QUALITY VOLTAGE
REFERENCE TUBE**

M8142

GROUP D

*Life test*¹¹

Burning current = mA continuous

Life test end points, 000 hours

Inoperatives ¹³ .. .. .	..	..	..	..	2.5	—	—
Ignition voltage .. .. .	..	..	..	..	2.5	—	115 V
Change in maintaining voltage .. .. .	..	..	..	..	2.5	—	±0.4 V
Change in maintaining voltage for burning .. .. .	..	..	..	..	2.5	—	180 mV

current change from 5.8 to 6.2mA

GROUP E

Tubes are held for 28 ays and retested for

Inoperatives ¹³ .. .. .	..	..	..	..	0.5	—	—
Ignition voltage .. .. .	..	..	..	..	0.5	—	115 V
Maintaining voltage .. .. .	..	..	..	..	0.5	83	87 V
Change in maintaining voltage for burning .. .. .	..	..	..	..	0.5	—	180 mV

urrent change from 5.8 to 6.2mA



M8142

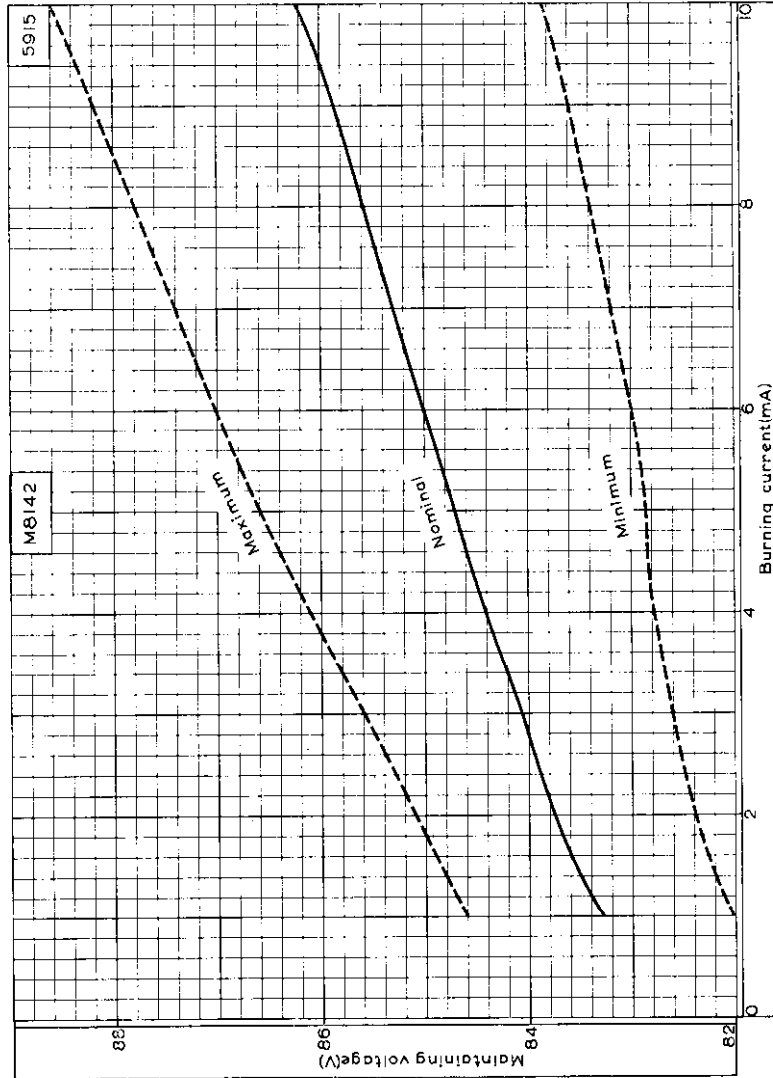
SPECIAL QUALITY VOLTAGE REFERENCE TUBE

TESTS	A.Q.L. ²		Individuals ³	
	(%)		Min.	Max.
GROUP C	6.5	6.5	—	—
Glass strain test ^{8A} , No applied voltage				
Lead fragility test ^{10A} , No applied voltage				
Resonance search				
Vibrated at 2g over frequency range specified.				
25 to 500c/s .. .. .	..	..	..	..
500 to 2500 c/s .. .. .	..	..	..	..
Fatigue¹¹				
No applied voltage, 5g min. peak acceleration, f = 170c/s for 33 hours in each of 3 mutually perpendicular planes				
Post fatigue tests				
Change in maintaining voltage .. .. .	..	..	..	..
Microphonic noise as in Group A .. .. .	..	..	..	..
Sub-group quality level ⁷ .. .. .	..	..	..	..
Shock¹²				
No applied voltage, 500g				
Post shock tests				
Change in maintaining voltage .. .. .	..	..	..	..
Microphonic noise as in Group A .. .. .	..	..	..	..
Sub-group quality level ⁷ .. .. .	..	..	..	..
	2.5	2.5	±0.7	V
	2.5	2.5	30	mV
	4.0	4.0	—	(pk-pk)
	2.5	2.5	—	±0.7
	2.5	2.5	—	30
	4.0	4.0	—	mV
			—	(pk-pk)



SPECIAL QUALITY VOLTAGE
REFERENCE TUBE

M8142



MAINTAINING VOLTAGE PLOTTED AGAINST BURNING CURRENT





SPECIAL QUALITY SUBMINIATURE VOLTAGE REFERENCE TUBE

M8190

Special quality 85V subminiature gas-filled voltage reference tube for use in equipment where mechanical vibration and shocks are unavoidable and where statistically controlled major electrical characteristics are required.

This data should be read in conjunction with the GENERAL NOTES—SPECIAL QUALITY VOLTAGE STABILISER & REFERENCE TUBES which precede this section of the handbook, and the index numbers are used to indicate where reference should be made to a specific note.

ABSOLUTE MAXIMUM RATINGS¹

*Minimum voltage necessary for ignition	125	V
Cathode current		
Maximum	3.5	mA
Minimum	0.5	mA
Maximum negative anode voltage	75	V
Minimum ambient temperature	-55	°C
Maximum bulb temperature	+90	°C

*This value covers operation in daylight and complete darkness.

PREFERRED OPERATING CONDITION

Cathode current	2.0	mA
-----------------	-----	----

CHARACTERISTICS

Measured at preferred operating condition and $T_{amb} = 25^{\circ}\text{C}$

Maintaining voltage (variation from tube to tube)	84 to 88	V
Maximum maintaining voltage difference over current range 0.5 to 3.5mA	3.0	V
Maximum incremental resistance	1.0	k Ω
Variation of maintaining voltage during the first 1000 hours of life		
Maximum	± 1.0	%
Typical	± 0.5	%

OPERATING NOTES

A steady maintaining voltage is reached within 3 min.

The greatest constancy of maintaining voltage is obtained if the tube is operated at the preferred current.

M8190

SPECIAL QUALITY SUBMINIATURE VOLTAGE REFERENCE TUBE

TEST CONDITIONS (unless otherwise specified)

$R_{lim.}$ (k Ω) 30
 $I_{burning}$ (mA) 2.0

After initial warming-up period of 3 minutes at burning current of 2.0mA

TESTS

GROUP A

	A.Q.L. ² (%)	Individuals ³ Min.	Max.
Ignition voltage	†	84	125 V
Maintaining voltage	†	—	88 V
Change in maintaining voltage for burning current change from 1.9 to 2.1mA	†	—	0.2 V
Voltage jumps. Burning current varies from 1.2 to 3.5mA	†	—	25 mV
Oscillation. Burning current varies from 1.2 to 3.5mA	†	—	15 (pk-pk) mV
Microphonic noise	†	—	25 (pk-pk) mV

† This test is carried out on a 100% basis.

GROUP B

	A.Q.L. ² (%)	Individuals ³ Min.	Max.
Ignition voltage in darkness after 24 hours in darkness	2.5	—	125 V
Leakage current. Supply voltage = 50V $R_b = 1M\Omega$	2.5	—	15 μ A
Change in maintaining voltage for burning current change from 0.5 to 3.5mA	2.5	—	3.0 V
Maintaining voltage at burning current of 3.5mA	2.5	—	89 V
Group quality level ⁷	6.5	—	—

GROUP C

	A.Q.L. ² (%)	Individuals ³ Min.	Max.
Glass strain test ^{8A} . No applied voltage	6.5	—	—
Lead fragility test ^{10A} . No applied voltage	6.5	—	—
Resonance search Vibrated at 2g over frequency range specified.	2.5	—	5.0 mV (r.m.s.)
25 to 500c/s	2.5	—	15 mV (r.m.s.)
500 to 2500c/s	2.5	—	15 mV (r.m.s.)



**SPECIAL QUALITY SUBMINIATURE
VOLTAGE REFERENCE TUBE**

M8190

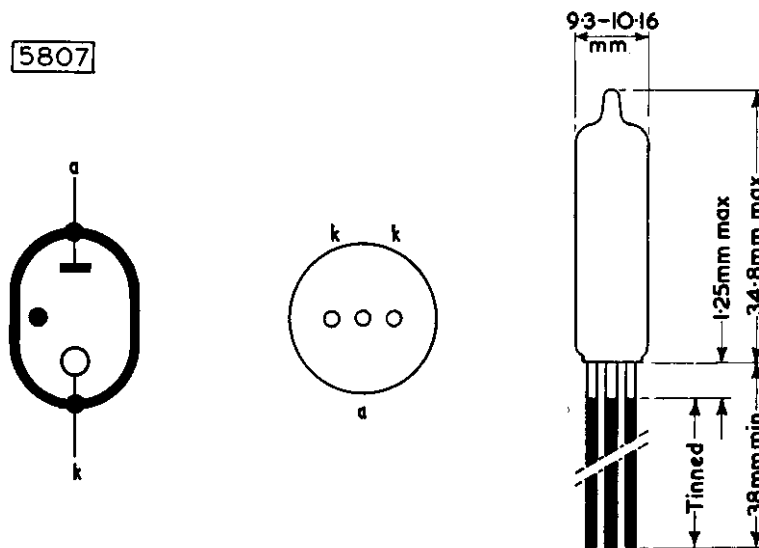
Test	Conditions	Duration	Level	Units
Fatigue¹¹ No applied voltage, of 3 mutually perpendicular vibrations	f = 170 ± 5c/s	33 hours	—	—
	—	2.5	±0.8	V
	—	2.5	50	mV (pk-pk)
Post fatigue tests	—	—	—	—
Change in maintenance Microphonic noise	—	—	—	—
Sub-group quality level	—	4.0	—	—
Shock¹² No applied voltage, of 3 mutually perpendicular vibrations	f = 170 ± 5c/s	33 hours	—	—
	—	2.5	±0.8	V
	—	2.5	50	mV (pk-pk)
Post shock tests	—	—	—	—
Change in maintenance Microphonic noise	—	—	—	—
Sub-group quality level	—	4.0	—	—
GROUP D				
Life test¹¹	Burning current =	—	—	—
	Ignition voltage	—	125	V
Life test end points.	Change in maintenance hours	2.5	±0.4	V
	Change in maintenance hours	2.5	±0.8	V
	Change in maintenance current change from 1.9 to 2.1mA	2.5	+0.2	V
	Group quality level	6.5	—	—



M8190

SPECIAL QUALITY SUBMINIATURE VOLTAGE REFERENCE TUBE

5807



The bulb dimensions of this tube are in accordance with BS448, Section B8D.

Note.—Direct soldered connections to the leads of the tube must be at least 5mm from the seal and any bending of the leads must be at least 1.5mm from the seal.

**SPECIAL QUALITY
STABILISING TUBE**

M8223

QUICK REFERENCE DATA (nominal values)

For use in equipment where mechanical vibration and shocks are unavoidable.

Maintaining voltage	150	V
Cathode current range	5 to 30	mA
Regulation voltage	3	V
Ignition delay time	10	s

This data should be read in conjunction with GENERAL OPERATIONAL RECOMMENDATIONS—VOLTAGE STABILISER AND REFERENCE LEVEL TUBES and the GENERAL NOTES—SPECIAL QUALITY VOLTAGE STABILISER AND REFERENCE TUBES which precede this section of the handbook. The index numbers are used to indicate where reference should be made to a specific note.

CHARACTERISTICS AND RANGE VALUES FOR EQUIPMENT DESIGN measured at an ambient temperature of between 20 and 30°C unless otherwise stated.

The values given state the range over which the tube will operate both initially and during life. No allowance has been made for supply voltage and component variations.

Initial values

Minimum voltage necessary for ignition (Note A)	165	V ←
Ignition delay time	See page C1	←
Maintaining voltage (all tubes) over the range 5 to 30mA		←
Maximum	154	V
Minimum	143	V
Increase in maintaining voltage as cathode current is increased from 5 to 30mA (regulation voltage)		
Maximum	5.0	V
Average	3.0	V

Life performance (Note B)

	$I_k = 20\text{mA}$ $T_{\text{bulb}} = 150^\circ\text{C}$ $t = 500\text{hrs}$	$I_k = 30\text{mA}$ $T_{\text{amb}} = 20 \text{ to } 30^\circ\text{C}$ $t = 1000\text{hrs}$	
Minimum voltage necessary for ignition (Note A)	165	165	V ←
Maintaining voltage			←
Maximum ($I_k = 30\text{mA}$)	155	156	V
Minimum ($I_k = 5.0\text{mA}$)	142	139	V

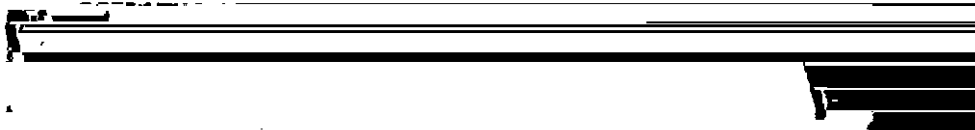


M8223

SPECIAL QUALITY STABILISING TUBE

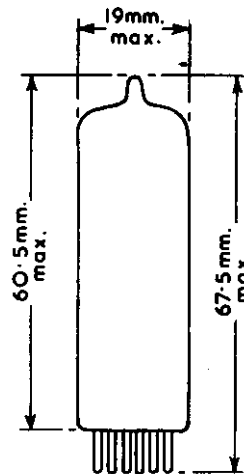
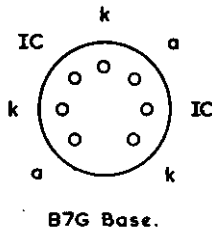
ABSOLUTE MAXIMUM RATINGS¹

Cathode current		
Maximum for continuous operation	30	mA
Maximum surge (Note C)	75	mA
Minimum	5.0	mA
Maximum negative anode voltage	125	V
Minimum bulb temperature ($I_k = 0\text{mA}$)	-55	°C
Maximum bulb temperature		
For operation	+150	°C
For storage	+100	°C ←
Maximum vibrational acceleration (page D4)	2.5	g ←
Maximum shock (short duration) page D4	900	g ←



- A. This value holds good over life in light or darkness. See graph on page C1.
 B. These figures apply only when the tube is operated continuously at the currents stated.

1616



The bulb and base dimensions of this tube are in accordance with BS448 Section B7G

M8223

SPECIAL QUALITY STABILISING TUBE

GROUP C		No applied voltage, 1000g					
Shock¹²							
Post shock tests							
Vibration	as in group B	—	—	—	—	—	—
Ignition voltage	as in group A	—	—	—	—	—	—
Maintaining voltage (1)	$I_k = 30\text{mA}$	142	142	—	—	—	—
Maintaining voltage (2)	$I_k = 5.0\text{mA}$	142	142	—	—	—	—
Regulation	$I_k = 5.0$ to 30mA	—	—	—	—	—	—
Continuity and short	..	—	—	—	—	—	—
Sub-group quality level ⁷	..	—	—	20	—	—	—
Fatigue¹¹							
		No applied voltage, 2.5g peak acceleration, $f = 50\text{c/s}$, for 32 hours in each of 3 mutually perpendicular directions					
Post fatigue tests							
Vibration	as in group B	—	—	—	—	—	—
Ignition voltage	as in group A	—	—	—	—	—	—
Maintaining voltage (1)	$I_k = 30\text{mA}$	142	142	—	—	—	—
Maintaining voltage (2)	$I_k = 5.0\text{mA}$	142	142	—	—	—	—
Regulation	$I_k = 5.0$ to 30mA	—	—	—	—	—	—
Continuity and short	..	—	—	—	—	—	—
Sub-group quality level ⁷	..	—	—	—	—	2.5	—
Base strain ⁸	..	—	—	—	—	6.5	—
Glass strain ^{8A}	..	—	—	—	—	2.5	—
GROUP D							
Stability life test							
Stability life test end point		$I_k = 20\text{mA}$, 1hr					
Change in maintaining voltage(3)		$I_k = 20\text{mA}$		..		1.0	
Survival rate life test		$I_k = 20\text{mA}$, 100hrs		..		2.0	
Survival rate life test end point		..		..		..
Continuity and short		..		..		0.65	
Change in maintaining voltage(3)		$I_k = 20\text{mA}$		..		1.0	

**SPECIAL QUALITY
STABILISING TUBE**

M8223

	Test Conditions		Permitted Rejects	Individuals ³	
	$I_k = 20\text{mA}$, T_{amb} min = 150°C, note f			Min	Max
End point tests					
..	$I_k = 5.0$ to 30mA	..	1	—	±6
..	$I_k = 30\text{mA}$	..	1	142	155
..	$I_k = 5.0\text{mA}$	..	1	142	155
..	$I_k = 20\text{mA}$	..	1	—	6
..	$I_k = 20\text{mA}$	..	1	—	165
..	as in group A	..	4	—	—
End point tests					
..	$I_k = 5.0$ to 30mA	..	2	—	±5
..	$I_k = 30\text{mA}$	..	2	140	158
..	$I_k = 5.0\text{mA}$	..	2	140	158
..	$I_k = 20\text{mA}$	..	2	—	8
..	$I_k = 20\text{mA}$	..	2	—	165
..	as in group A	..	5	—	—

With a specified hammer and the output observed on a meter of specified dynamic response, conducting and in total darkness for the 24 hours immediately prior to the test. The tube is then switched off for one minute. The tube is then operated at the specified cathode current for one minute, and the maintaining voltage off cycle is repeated a minimum of five times and the maximum difference in maintaining voltage (3) as in group A.

During vibration for 60 seconds in each of two lateral directions and the output voltage on 20 tubes per lot.



(1)

(2)

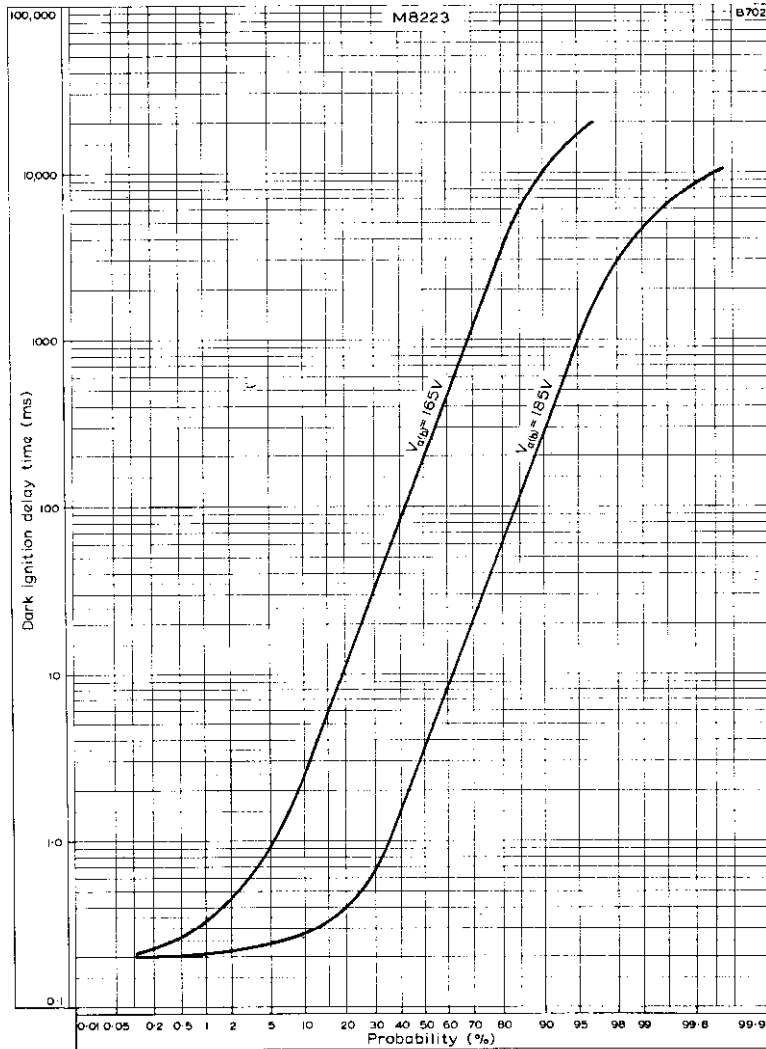
(3)

(4)

(5) ■

**SPECIAL QUALITY
STABILISING TUBE**

M8223

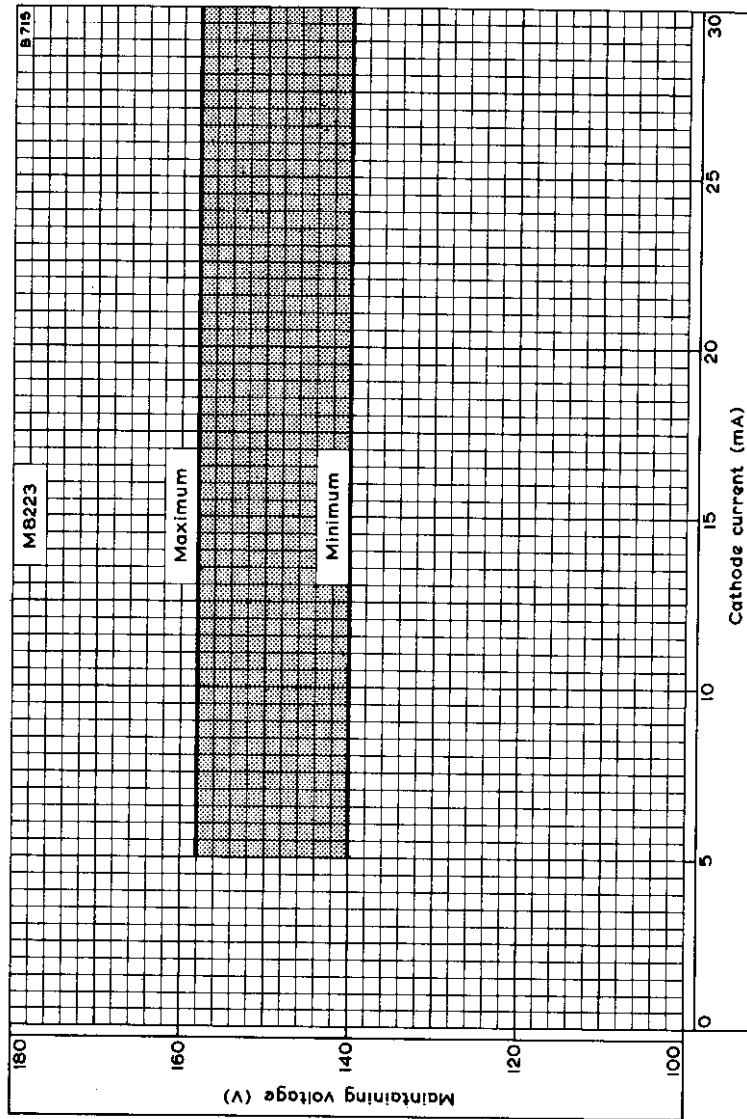


CUMULATIVE DISTRIBUTION OF DARK IGNITION DELAY TIME
 These curves show the probability that a tube will ignite in less than the time shown. This will be to some extent dependent on the supply voltage. In general an increase in the supply voltage will reduce the ignition delay time.



M8223

SPECIAL QUALITY
STABILISING TUBE



MAXIMUM VARIATION OF MAINTAINING VOLTAGE WITH CATHODE CURRENT (All tubes over life)



**SPECIAL QUALITY
STABILISING TUBE**

M8224

QUICK REFERENCE DATA (nominal values)

For use in equipment where mechanical vibration and shocks are unavoidable and where statistically controlled major electrical characteristics are required.

Maintaining voltage	108	V
Cathode current range	5.0 to 30	mA
Regulation voltage	1.5	V
Ignition delay time	1.3	s

This data should be read in conjunction with GENERAL OPERATIONAL RECOMMENDATIONS—VOLTAGE STABILISER AND REFERENCE LEVEL TUBES and the GENERAL NOTES—SPECIAL QUALITY VOLTAGE STABILISER AND REFERENCE TUBES which precede this section of the handbook. The index numbers are used to indicate where reference should be made to a specific note.

CHARACTERISTICS AND RANGE VALUES FOR EQUIPMENT DESIGN measured at an ambient temperature of between 20 and 30°C unless otherwise stated.

The values given state the range over which the tube will operate both initially and during life. No allowance has been made for supply voltage and component variations.

Initial values

Minimum voltage necessary for ignition (Note A)	130	V←
Ignition delay time	See page C1	←
Maintaining voltage		
Maximum ($I_k = 30\text{mA}$)	112	V
Minimum ($I_k = 5.0\text{mA}$)	105	V
Increase in maintaining voltage as cathode current is increased from 5 to 30mA (regulation voltage)		
Maximum	3.5	V
Average	1.5	V

Life performance (Note B)

Minimum voltage necessary for ignition (Note A)	133	V←←
Increase in maintaining voltage as cathode current is increased from 5.0 to 30mA		
Maximum	3.5	V
Typical	1.5	V
Typical percentage variation of maintaining voltage at 20mA during 500 hrs life at $T_{\text{bulb}} = 150^\circ\text{C}$	± 2.0	%
Maximum altitude	60,000	ft



M8224

SPECIAL QUALITY STABILISING TUBE

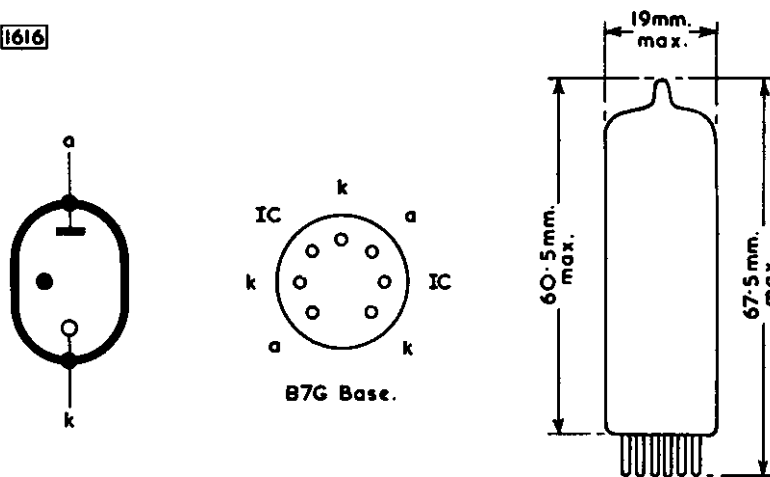
ABSOLUTE MAXIMUM RATINGS¹

Cathode current		
Maximum for continuous operation	30	mA
Maximum surge (note C)	75	mA
Minimum	5.0	mA
Maximum negative anode voltage	75	V
Minimum bulb temperature ($I_k = 0\text{mA}$)	-55	°C
Maximum bulb temperature		
For operation	+150	°C
For storage	+70	°C
Maximum vibrational acceleration (page D5)	2.5	g
Maximum shock (short duration) page D5	450	g

OPERATING NOTES

- This value holds good over life in light or darkness. See graph on page C1.
- These figures apply only when the tube is operated continuously at the currents stated.
- To be restricted for long life to approximately 30 seconds in each 8 hours use.

1616



The bulb and base dimensions of this tube are in accordance with BS448,
Section B7G

**SPECIAL QUALITY
STABILISING TUBE**

M8224

	A.G.L. ² (%)		Individuals ³ Bogey ⁶		Lot average ⁴		Lot standard deviation ⁵ Max.	V
	Min.	Max.	Min.	Max.	Min.	Max.		
illumination 5 to 50ft.cd.	0.65	—	—	130	—	—	—	V
= 30mA	{ 0.65	108.5	—	111	—	109.5	0.87	V
= 5.0mA	{ 0.65	107.5	105	—	106.5	—	0.87	V
Operating voltage for cathode from 5.0 to 30mA	0.65	—	—	3.0	—	—	—	V
I_{77}	1.0	—	—	—	—	—	—	V
Life	0.4	—	—	—	—	—	—	mV
Cathode	2.5	—	—	5.0	—	—	—	mV
100mV, cathode from 5.0 to 30mA	2.5	—	—	—	—	—	—	V
Complete darkness, after darkness	6.5	—	—	210	—	—	—	V
$V_a = 50V, R_a = 3.0k\Omega$	6.5	—	—	5.0	—	—	—	μA

with a specified hammer and the output observed on a meter of specified dynamic response.



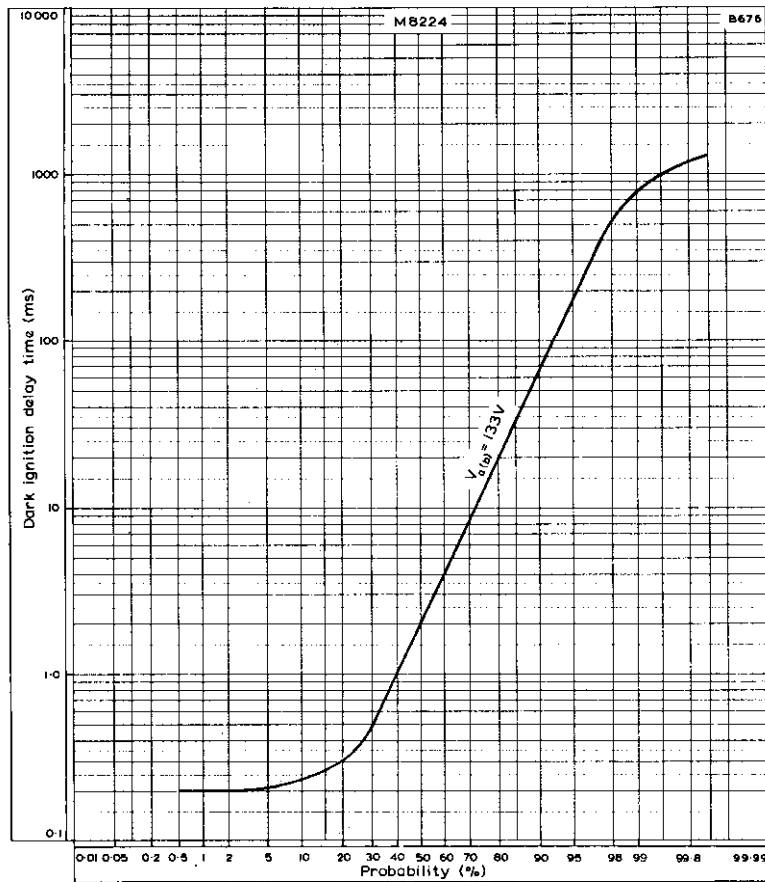
**SPECIAL QUALITY
STABILISING TUBE**

M8224

	A.Q.L. ²		Individuals ³		Lot average ⁴		Lot standard deviation ⁵ Max.
	(%)	Bogey ⁶	Min.	Max.	Min.	Max.	
GROUP D							
<i>Intermittent life test</i>							
Cathode current = 20mA							
T _{bulb} = 150°C							
Intermittent life test end points 500 hours							
Change in maintaining voltage for current change from 5.0 to 30mA	—	—	—	4.0	—	—	V
Maintaining voltage							
Cathode current = 30mA	—	—	—	113	—	—	V
Cathode current = 5.0mA	—	—	103	—	—	—	V
Ignition voltage as in group A	—	—	—	133	—	—	V
Change in maintaining voltage							
Cathode current = 30mA	—	—	—	—	—	2.0	%
Cathode current = 5.0mA	—	—	—	—	—	2.0	%
GROUP E							
Valves are held for 28 days and tested for Inoperatives							
	0.5	—	—	—	—	—	—





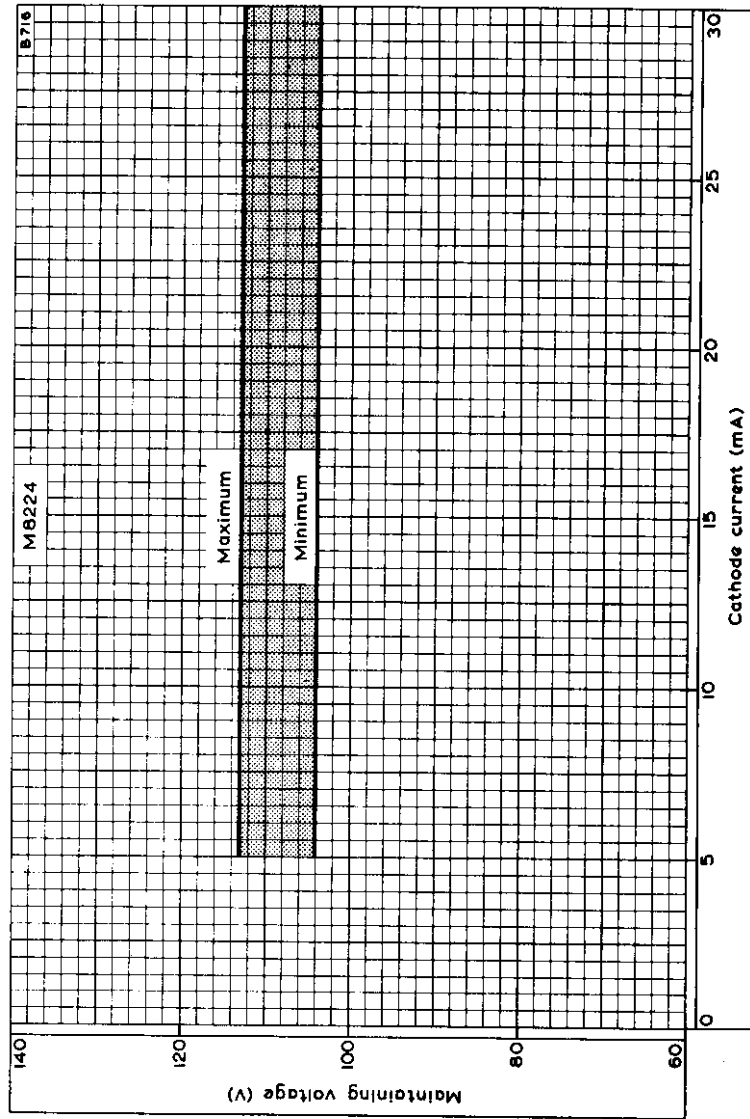


CUMULATIVE DISTRIBUTION OF DARK IGNITION DELAY TIME

This curve shows the probability that a tube will ignite in less than the time shown. This will be to some extent dependent on the supply voltage. In general an increase in the supply voltage will reduce the ignition delay time.

M8224

SPECIAL QUALITY
STABILISING TUBE



MAXIMUM VARIATION OF MAINTAINING VOLTAGE WITH CATHODE CURRENT (All tubes over life)



**SPECIAL QUALITY
STABILISING TUBE**

M8225

QUICK REFERENCE DATA (nominal values)

For use in equipment where mechanical vibration and shocks are unavoidable.

Maintaining voltage	78	V
Cathode current range	2 to 60	mA
Regulation voltage	5	V
Ignition delay time	10	ms

This data should be read in conjunction with GENERAL OPERATIONAL RECOMMENDATIONS—VOLTAGE STABILISER AND REFERENCE LEVEL TUBES and the GENERAL NOTES—SPECIAL QUALITY VOLTAGE STABILISER AND REFERENCE TUBES which precede this section of the handbook. The index numbers are used to indicate where reference should be made to a specific note.

CHARACTERISTICS AND RANGE VALUES FOR EQUIPMENT DESIGN measured at an ambient temperature of between 20 and 30°C unless otherwise stated.

The values given state the range over which the tube will operate both initially and during life. No allowance has been made for supply voltage and component variations. (Note A)

Initial values

Minimum voltage necessary for ignition (Note B)	110	V ←
Ignition delay time	See page C1	←
Maintaining voltage at 30mA		
Maximum	81	V
Minimum	75	V
Increase in maintaining voltage as cathode current is increased from 2 to 60mA (regulation voltage)		
Note C		
Maximum	8.0	V
Average	5	V
Temperature coefficient of maintaining voltage	See page C2	←
Typical maximum voltage jumps in the current range		←
2 to 20mA	100	mV
20 to 60mA	15	mV
Cathode current above which the incremental resistance is positive	7	mA
Incremental resistance in the current range 10 to 60mA (approx.) Note C	130	Ω



M8225

SPECIAL QUALITY STABILISING TUBE

Life performance (Note D)

	$I_k = 30\text{mA}$	$I_k = 60\text{mA}$	
Minimum voltage necessary for ignition (Note B)	115	115	V
Typical maximum percentage variation of maintaining voltage at cathode current (room temperature)			
In 1,000 hrs	-0.2 to +0.9	-0.7 to +0.2	%
In 10,000 hrs	-0.2 to +1.0	-0.7 to +1.4	%
In 30,000 hrs	-0.2 to +1.2	-0.7 to +2.0	%
Typical maximum increase in maintaining voltage as cathode current is increased over the range 2 to 60mA (Note C)	6.5	6.5	V

ABSOLUTE MAXIMUM RATINGS¹

Cathode current		
Maximum for continuous operation	60	mA
Maximum surge (Note E)	100	mA
Minimum	2.0	mA
Maximum negative anode voltage	50	V
Minimum bulb temperature ($I_k = 0\text{mA}$)	-55	°C
Maximum ambient temperature		
For operation (Note F)	+90	°C
For storage	+70	°C
Maximum vibrational acceleration (page D5)	2.5	$g \leftarrow$
Maximum shock (short duration) page D5	450	$g \leftarrow$

OPERATING NOTES

- A. Thermal equilibrium is reached within 3 minutes of igniting the tube.
- B. This value holds good over life in light or darkness. See graph on page C1. ←

**SPECIAL QUALITY
STABILISING TUBE**

M8225

TEST CONDITIONS (unless otherwise specified)

R_{lim} (k Ω) 1.0
 I_k (mA) 30

After an initial warming-up period of 3 minutes at a cathode current of 30mA.

GROUP A

Ignition voltage. Illumination 5 to 50ft. cd.
Maintaining voltage
Change in maintaining voltage for cathode current change of 2 to 60mA
Voltage jumps. Cathode current varied from 2 to 10mA
10 to 60mA
Oscillation. Cathode current varied from 2 to 60mA

†This test is carried out on a 100% basis.

GROUP B

Ignition voltage in darkness after 24 hours in darkness
Leakage current. Supply voltage = 55V, R_{lim} = 1M Ω
Microphonic noise
Group quality level†

GROUP C

Base strain test⁹. No applied voltage
Glass strain test^{8A}. No applied voltage

	AGL ² (%)	Individuals ³ Min.	Individuals ³ Max.
Ignition voltage. Illumination 5 to 50ft. cd.	†	75	110 V
Maintaining voltage	†	—	81 V
Change in maintaining voltage for cathode current change of 2 to 60mA	†	—	8.0 V
Voltage jumps. Cathode current varied from 2 to 10mA	†	—	300 mV
10 to 60mA	†	—	100 (pk-pk) mV
Oscillation. Cathode current varied from 2 to 60mA	†	—	20 (pk-pk) mV
Ignition voltage in darkness after 24 hours in darkness	2.5	—	110 V
Leakage current. Supply voltage = 55V, R_{lim} = 1M Ω	2.5	—	10 μ A
Microphonic noise	2.5	—	5.0 mV
Group quality level†	6.5	—	(pk-pk)
Base strain test ⁹ . No applied voltage	6.5	—	—
Glass strain test ^{8A} . No applied voltage	6.5	—	—



M8225

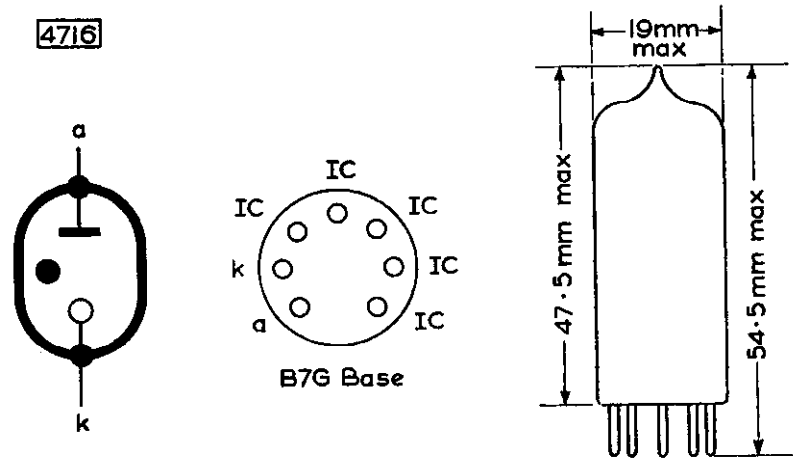
SPECIAL QUALITY STABILISING TUBE

GROUP D	2.5	5.0
Resonance search		
Vibrated at 2g over the frequency range 25 to 500c/s,		
Output voltage at $R_{lim} = 27k\Omega$, $I_k = 10mA$		5.0 mV (r.m.s.)
GROUP E		
Fatigue¹¹		
No applied voltage, 5g min. peak acceleration, $f = 170c/s \pm 5c/s$ for 33 hours in each of three mutually perpendicular planes.		
Post fatigue tests		
Ignition voltage as in group A	2.5	110 V
Change in maintaining voltage	2.5	± 1.0 V
Microphonic noise	2.5	10 mV (pk-pk)
Sub-group quality level ⁷	6.5	—
Shock test¹²		
No applied voltage, 500g		
Post shock tests		
Ignition voltage as in group A	2.5	110 V
Change in maintaining voltage	2.5	± 1.0 V
Microphonic noise	2.5	10 mV (pk-pk)
Sub-group quality level ⁷	6.5	—
GROUP F		
Life test 500 hours		
Ignition voltage as in group A	2.5	110 V
Change in maintaining voltage from 0 to 500 hours	2.5	± 1.5 V
Change in maintaining voltage for cathode current change from 2 to 60mA	2.5	8.0 V
Inoperatives ¹³	2.5	—
Group quality level ⁷	6.5	—

**SPECIAL QUALITY
STABILISING TUBE**

M8225

GROUP G	AQL ² (%)	Individuals ³		V
		Min.	Max.	
Valves held for 28 days and retested for				
Inoperatives ¹³	0.5	—	—	
Ignition voltage as in group A	0.5	—	110	
Maintaining voltage	0.5	75	81	



The bulb and base dimensions of this tube are in accordance with BS448, Section B7G.

①

②

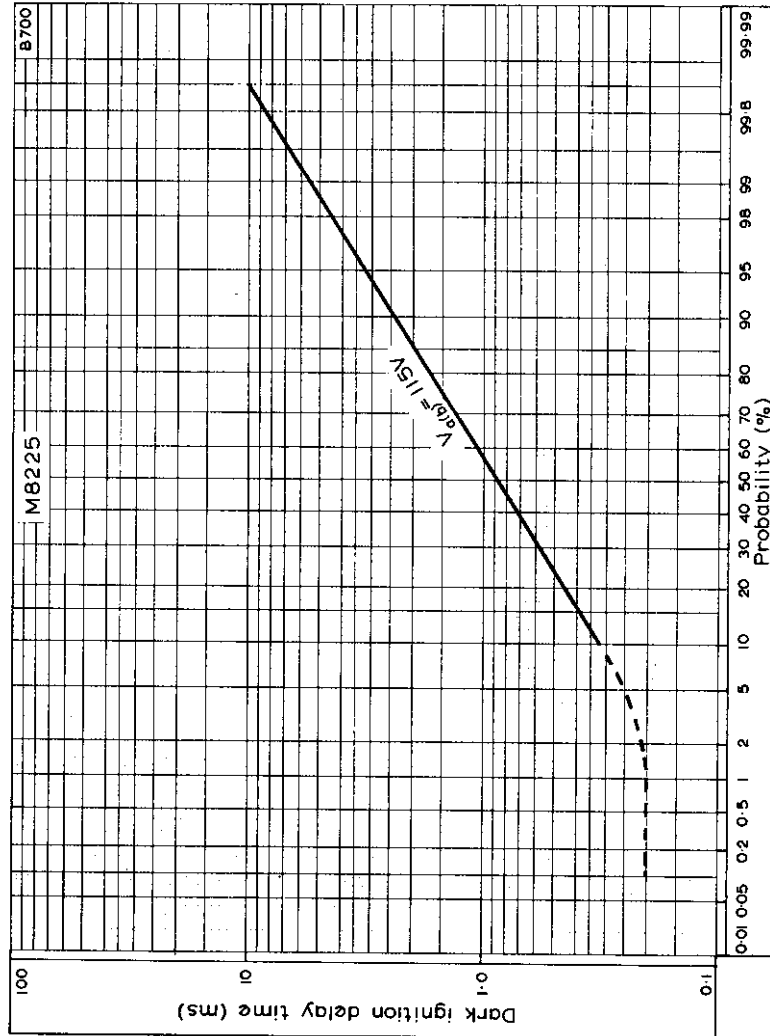
③

④

■

**SPECIAL QUALITY
STABILISING TUBE**

M8225

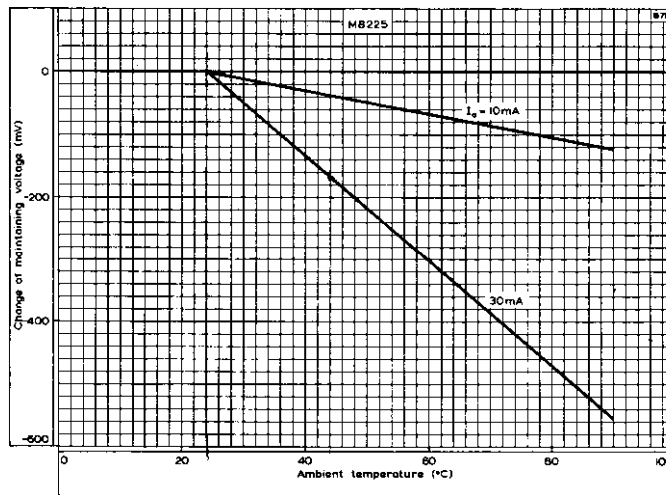


CUMULATIVE DISTRIBUTION OF DARK IGNITION DELAY TIME

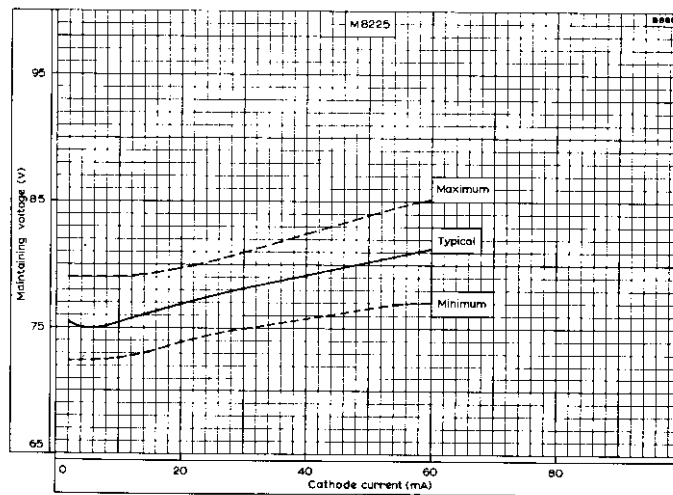
These curves show the probability that a tube will ignite in less than the time shown. This will be to some extent dependent on the supply voltage. In general an increase in the supply voltage will reduce the ignition delay time.

M8225

SPECIAL QUALITY STABILISING TUBE



AVERAGE VARIATION OF MAINTAINING VOLTAGE
WITH AMBIENT TEMPERATURE



MAXIMUM VARIATION OF MAINTAINING VOLTAGE
WITH CATHODE CURRENT (Initial values)

**SUBMINIATURE
VOLTAGE REFERENCE TUBE**

ZZ1000

QUICK REFERENCE DATA

81V gas-filled voltage reference tube. Shock and vibration resistant.

Preferred cathode current	3.2	mA
Maintaining voltage	81	V
Incremental resistance	200	Ω
Temperature coefficient of maintaining voltage		
averaged over the range +20 to +125°C	-1.2	mV/degC
averaged over the range -55 to +20°C	-3.2	mV/degC

This data should be read in conjunction with GENERAL OPERATIONAL
RECOMMENDATIONS - STABILISER AND REFERENCE TUBES

CHARACTERISTICS AND RANGE VALUES FOR EQUIPMENT DESIGN

Typical limits (initial values)

Maximum voltage jump at $I_k = 2.0$ to 4.0 mA (see note 2)	100	mV
Maximum ignition delay in darkness at $V_b = 115$ V	5.0	ms
Maximum tube impedance at $I_k = 2.7$ to 3.7 mA, 50 Hz sinusoidal variation	400	Ω
Maximum r.m.s. noise voltage (oscillation + random) at $I_k = 2.0$ to 4.0 mA, frequency band = 10 Hz to 10 kHz	1.0	mV
Maximum vibration noise voltage at $I_k = 3.2$ mA, 2.5 g peak acceleration, $f = 10$ to 50 Hz, frequency band = 1 to 100 Hz	100	mV



CHARACTERISTICS AND RANGE VALUES FOR EQUIPMENT DESIGN (cont'd)

Temperature coefficient of maintaining
voltage at $I_k = 3.2\text{mA}$

averaged over the range +20 to +125°C	max.	-2.0	mV/degC
	typ.	-1.2	mV/degC
averaged over the range -55 to +20°C	max.	-4.0	mV/degC
	typ.	-3.2	mV/degC

Life performance

Typical maximum variation in maintaining voltage

Continuous operation at preferred current; $T_{\text{bulb}} = 45^\circ\text{C}$

0 to 100 hours	0.3	V
0 to 2000 hours	0.7	V

Storage and standby; $T_{\text{bulb}} = 25^\circ\text{C}$

0 to 2000 hours	0.3	V
-----------------	-----	---

RATINGS (ABSOLUTE MAXIMUM SYSTEM)

I_k max. (see note 3)	4.0	mA
I_k min.	2.0	mA
$i_{k(pk)}$ max. (starting) for 20s max.	20	mA
$-v_a(pk)$ max.	100	V
T_{bulb} max. during operation	+125	°C
T_{bulb} max. during storage and standby	+100	°C
T_{bulb} min.	-55	°C

CIRCUIT DESIGN VALUES

Minimum voltage to ensure ignition	120	V
Maximum value of shunt capacitor	30	nF

SHOCK AND VIBRATION RESISTANCE

These conditions are used solely to assess the mechanical quality of the tube. The tube should not be continuously operated under these conditions.

Shock resistance

500g, using a NRL impact machine for electronic devices. 5 blows of the hammer lifted over an angle of 30° in each of four positions of the tube.

Vibration resistance

2.5g (peak). 32 hours at a frequency of 50Hz in each of three directions of the tube.

NOTES

1. Thermal equilibrium is reached within two minutes of igniting the tube.
2. To avoid voltage jumps over life, current variations around the preferred current should be limited to 0.3mA.
3. For use as a stabiliser tube, I_k max. = 8.0mA. At cathode currents between 2.0 and 8.0mA voltage jumps of 0.5V may occur.



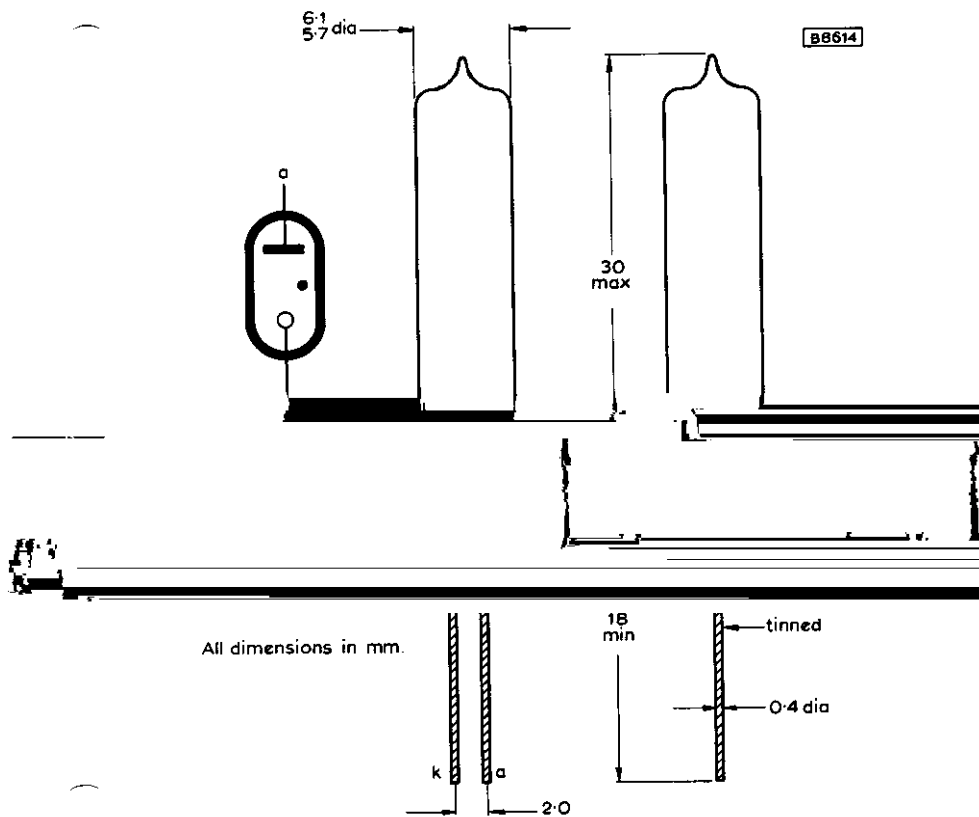
SUBMINIATURE VOLTAGE REFERENCE TUBE

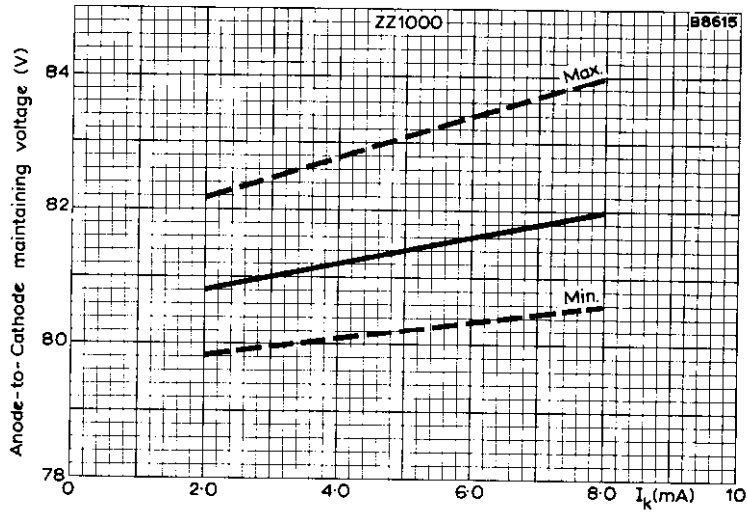
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NOTES (cont'd)

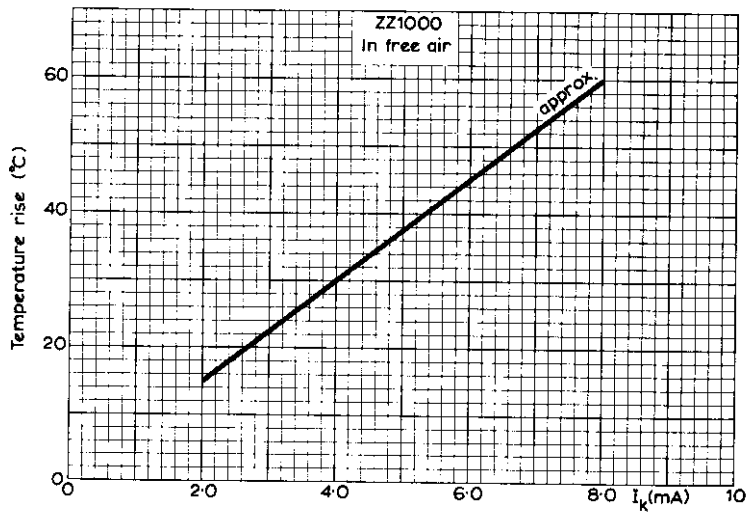
4. The tube may be soldered directly into the circuit, but heat conducted to the glass-to-metal seals should be kept to a minimum by the use of a thermal shunt.
5. The tube may be dip-soldered at a maximum solder temperature of 240°C for a maximum of ten seconds up to a point 5mm from the seal.
6. Care should be taken not to bend the leads nearer than 1.5mm from the seal.

OUTLINE AND DIMENSIONS





ANODE-TO-CATHODE MAINTAINING VOLTAGE PLOTTED AGAINST CATHODE CURRENT



APPROXIMATE TEMPERATURE RISE OF BULB PLOTTED AGAINST CATHODE CURRENT

STABILISING TUBE

75CI

QUICK REFERENCE DATA (nominal values)

Maintaining voltage	78	V
Cathode current range	2 to 60	mA
Regulation voltage	5	V
Ignition delay time	10	ms

This data should be read in conjunction with GENERAL OPERATIONAL RECOMMENDATIONS—VOLTAGE STABILISER AND REFERENCE LEVEL TUBES which precede this section of the handbook.

CHARACTERISTICS AND RANGE VALUES FOR EQUIPMENT DESIGN measured at an ambient temperature of between 20 and 30°C unless otherwise stated.

The values given state the range over which the tube will operate both initially and during life. No allowance has been made for supply voltage and component variations. (note 1)

Initial values

Minimum voltage necessary for ignition (note 2)	115	V
Ignition delay time	See page C1	←
Maintaining voltage at 30mA		
Maximum	81	V
Minimum	75	V
Increase in maintaining voltage as cathode current is increased from 2 to 60mA (regulation voltage) note 3		
Maximum	8.0	V
Average	5	V
Temperature coefficient of maintaining voltage	See page C2	←
Typical maximum voltage jumps in the current range		←
2 to 20mA	100	mV
20 to 60mA	15	mV
Cathode current above which the incremental resistance is positive	7	mA
Incremental resistance in the current range 10 to 60mA (approx.) note 3	130	Ω

Life performance (note 4)

	$I_k = 30\text{mA}$	$I_k = 60\text{mA}$	
Minimum voltage necessary for ignition note 2	115	115	V
Typical maximum percentage variation of maintaining voltage (room temperature)			
In 1,000 hrs	-0.2 to +0.9	-0.7 to +0.2	%
In 10,000 hrs	-0.2 to +1.0	-0.7 to +1.4	%
In 30,000 hrs	-0.2 to +1.2	-0.7 to +2.0	%
Typical maximum increase in maintaining voltage as cathode current is increased over the range 2 to 60mA (note 3)	6.5	6.5	V



75C1

STABILISING TUBE

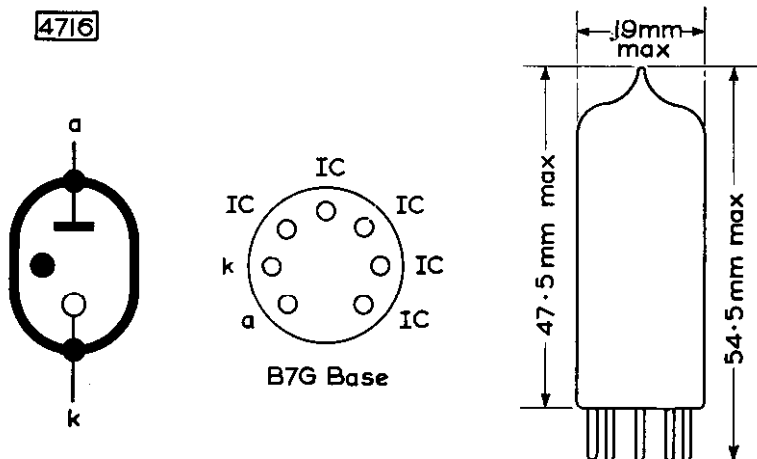
ABSOLUTE MAXIMUM RATINGS

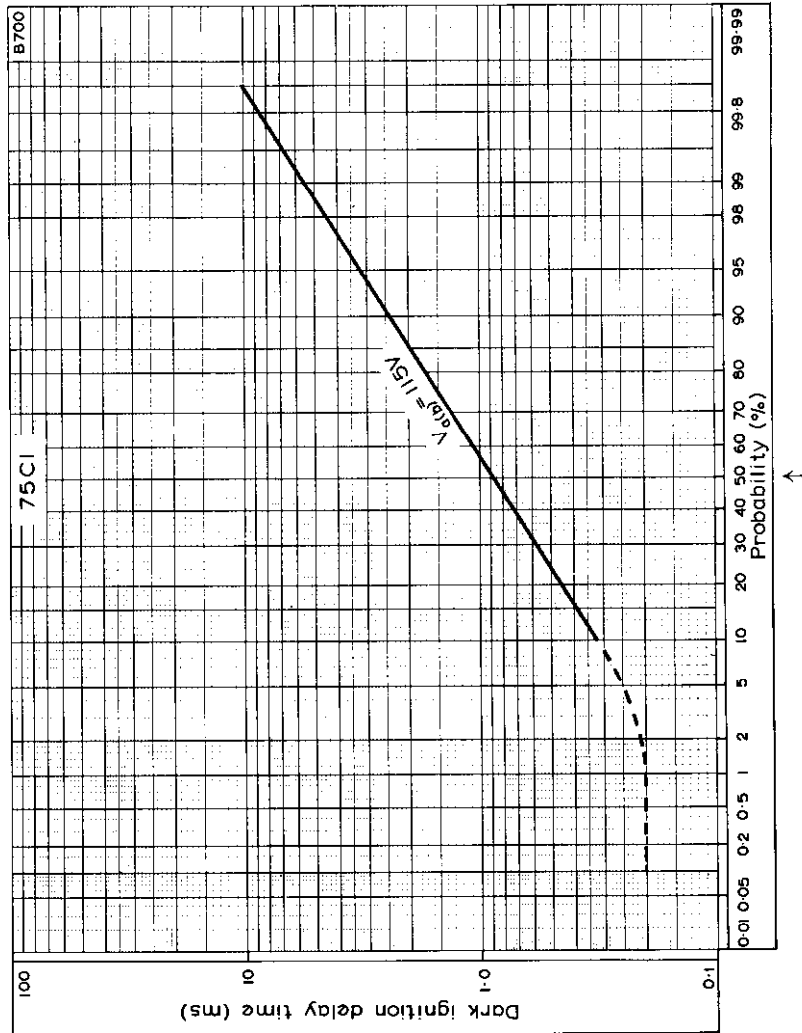
Cathode current		
Maximum for continuous operation	60	mA
Maximum surge (note 5)	100	mA
Minimum	2.0	mA
Maximum negative anode voltage	50	V
Minimum bulb temperature ($I_k = 0\text{mA}$)	-55	°C
Maximum ambient temperature		
For operation (note 6)	+90	°C
For storage	+70	°C

OPERATING NOTES

1. Thermal equilibrium is reached within 3 minutes of igniting the tube.
2. This value holds good over life in light or darkness. See graph on page C1. ←
3. Following a sudden large change in the tube current the change in maintaining voltage may be up to 2.5 volts greater than that given until tube thermal equilibrium is re-established (within 3 minutes).
4. These figures apply only when the tube is operated continuously at the currents stated.
5. To be restricted for long life to approximately 30 seconds in each 8 hours use.
6. This tube will operate satisfactorily at ambient temperatures up to 90°C, provided the tube is not used at either extreme of the current range.

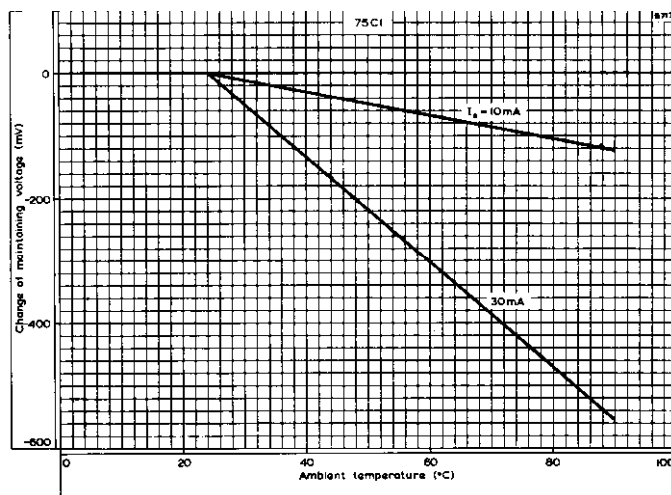
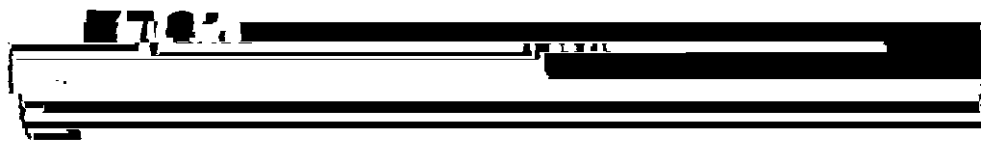
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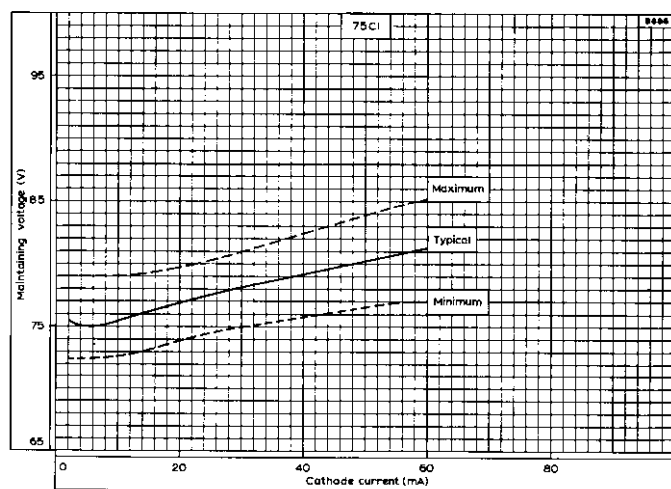


CUMULATIVE DISTRIBUTION OF DARK IGNITION DELAY TIME

This curve shows the probability that a tube will ignite in less than the time shown. This will be to some extent dependent on the supply voltage. In general an increase in the supply voltage will reduce the ignition delay time.



AVERAGE VARIATION OF MAINTAINING VOLTAGE WITH AMBIENT TEMPERATURE



MAINTAINING VOLTAGE PLOTTED AGAINST CATHODE CURRENT (Initial values)

VOLTAGE REFERENCE TUBE

83V gas-filled reference tube.

83A1

DATA FOR EQUIPMENT DESIGN

LIMITING VALUES (absolute ratings)

Minimum voltage necessary for ignition (Notes 1 and 2)	130	V
Cathode current		
Maximum	6.0	mA
Minimum	3.5	mA
Maximum bulb temperature (Note 3)		
During operation	150	°C
During storage and stand-by	100	°C
Maximum negative anode voltage	50	V
Maximum starting current (Note 4)	10	mA
Cathode current	4.5	mA

CHARACTERISTICS (Note 5) at preferred operating condition

Initial values (measured at 25 to 30°C)

Maintaining voltage (variation from tube to tube)	83.0 to 84.5	V ←
*Maximum jump voltage (3.5 to 6.0mA)	1	mV
*Typical r.m.s. noise voltage (30c/s to 10kc/s)	100	μV
*Incremental resistance		
Maximum	350	Ω
Minimum	110	Ω
*Nominal temperature coefficient (Note 7) average over the range 25 to 120°C	-0.003%/°C	(-2.5mV/°C)
*See note 6.		

Life performance

Limits of the typical variations of maintaining voltage at the temperatures shown and over the period indicated.

For continuous operation at preferred current

Bulb temperature	25	100	150	°C
Life period				
0 to 300hrs.	0 to +0.35	0 to +0.35	0 to +2	V ←
300 to 2500hrs.	0 to +0.2	0 to +0.2	-2 to +4	V
300 to 10,000hrs.	+0.05 to +0.35	+0.05 to +0.35	—	V

For storage or stand-by

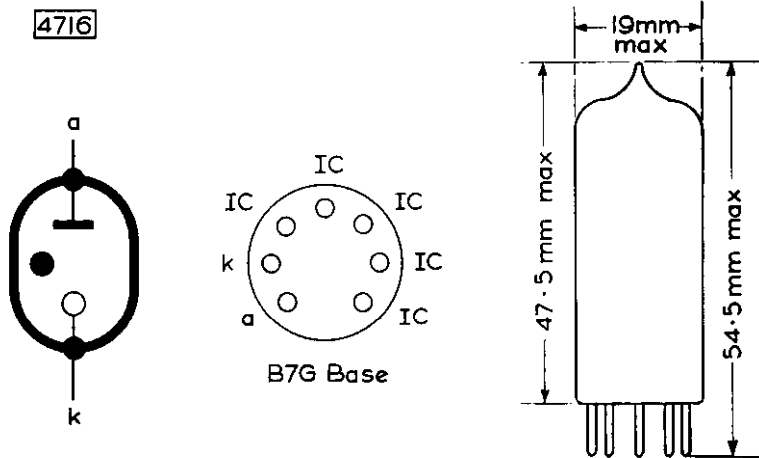
0 to 500hrs.	Negligible	<1.5 (Note 8)	—	V
0 to 3000hrs.	Negligible	<6 (Note 8)	—	V

83A1

VOLTAGE REFERENCE TUBE

NOTES

1. The effective resistance in series with the tube should never be less than $2k\Omega$.
2. This value holds good over life, in light or darkness. In total darkness an ignition delay of up to 5s may occur.
3. During conduction the bulb temperature is approximately 20°C above ambient temperature.
4. To be restricted for long life to approx. 30s once or twice in each 8hrs. use.
5. Equilibrium conditions are reached within 1min.
6. Information to date indicates that these values hold good, with little or no change, over life.
7. The characteristics curve connecting temperature coefficient and bulb temperature is continuous and repeatable. The typical tube to tube variations in maintaining voltage with temperature are shown on page C1.
8. Subsequent operation of the tube for approximately 50hrs. at 4.5mA at not more than 100°C will restore the maintaining voltage to within 0.2V of its original value.



QUALITY ACCEPTANCE TESTS AND CONTROLS**Introduction**

This voltage reference tube is produced with the processes of manufacture controlled to tolerances usually associated with special quality tubes. In order to check that all processes have been performed correctly, each batch of tubes is subjected to a standard assessment procedure which has been designed to ensure that the characteristics (electrical, mechanical and life) of the tube satisfy certain fixed quality standards. This assessment procedure has been drawn up using the British Reliable Valve Specification (CV4000 series) as a guide and it is presented on pages D5, D6, D7, D8 and D9. This supplements the normal data by showing the standard of quality to which the tube is controlled.

The tests and limits given in the assessment procedure are those applied to tubes leaving the factory. They do not represent recommended operating conditions as they are designed to protect the normal data and control the quality. The limits and test conditions given are in many cases more stringent than those in the normal data to allow for the very small changes which may occur during storage. The data on pages D1 and D2 includes an allowance (where applicable) for the changes which may occur during life under various conditions. Because of this it is important that any circuit design work and subsequent tube measurements should be performed using the ratings and conditions of the Data for Equipment Design given on page D1.

Acceptance procedure

The assessment tests are arranged in groups (A to G) which correspond to electrical tests of varying importance, mechanical tests, life tests, etc. The principal electrical tests are given in group A, and tubes which pass these tests, and have been produced in a given period, usually one month, are collected together into a 'lot'. Random samples are then taken from each lot for the tests in groups B to F inclusive. Detailed test results on all sample tests are recorded. After a storage period during which the sample tests are performed, the remaining tubes are submitted to the group G tests to ensure that no appreciable changes have occurred.

For each acceptance test an Acceptable Quality Level (A.Q.L.) is fixed and is the percentage of failures that may be allowed for a particular test. It does not represent the percentage of failures to be expected in a lot, but is the standard to which the test is controlled.

In general the percentage of tubes which fail in any given lot will be a much smaller percentage than the A.Q.L. It should be noted that a high A.Q.L. for this tube means that a small sample is used.

For all acceptance tests (i.e. all tests except those in group F2), if the A.Q.L. is not satisfied the lot is rejected. Thus every tube which is delivered comes from a lot which has satisfied all the acceptance tests.

The tests are grouped as follows:

Group A tests

These are tests of the principal electrical characteristics and are performed on every tube.



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VOLTAGE REFERENCE TUBE

Group B tests

These tests are similar or identical to those in group A. They are repeated here so that the results of measurements can be recorded and any trend towards a limit can be corrected. A large sample is used for this group of tests and the A.Q.L. is 0.65%. Tubes from the group B tests are used for the tests in groups C to F. The sample size, however, may be smaller.

Group C tests

These tests measure the secondary electrical characteristics including some outside the normal current range of the tube. In this way it has been found possible to obtain a more sensitive control of the characteristics inside the recommended operating range. The sample used is the same as that for the group B tests, but a slightly higher A.Q.L. is given.

Group D tests

The tests in this group are of characteristics which are known from experience to remain constant provided the manufacturing process is unaltered and the requirements of groups B and C are met. Because of this only a small sample is needed to confirm that these characteristics are in fact unchanged. The A.Q.L. is relatively high because only a small sample is used.

Group E tests

This group consists of mechanical tests to check that the quality of the glass envelope and base is adequate, and to ensure that the ruggedness of the electrode structure does not depart from the set standard. These tests are performed on small samples.

Group F1 tests

This group contains life and storage tests under various conditions. They are acceptance tests, and any lot which fails to satisfy these requirements is rejected.

Group F2 tests

In this group information is given as to the changes expected on long term life or storage. These tests cannot be acceptance tests as it would be impracticable to retain the tubes in store until this information on each lot had accumulated. These tests are performed on a regular basis.

Group G tests

Tubes which were not used in the sample tests are rechecked for some of their principal characteristics after one month in store. These tests ensure that no appreciable changes have occurred during storage.

Rejected lots

If the given A.Q.L. is not satisfied when performing any acceptance tests, the lot is rejected.

VOLTAGE REFERENCE TUBE

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ACCEPTANCE TESTS AND CONTROLS

Unless otherwise specified $I_k = 4.5\text{mA}$, $R_a = 10\text{k}\Omega$, $T_{\text{ambient}} = 20$ to 25°C

Test	Test conditions	A.Q.L. (%)	Notes (pp.D8/9)	Limits		
				Min.	Max.	
GROUP A (100% Tests)						
Ignition	$V_a = 118\text{V}$, Illumination 5 to 50 lm/ft ²	—	a	—	5	s
Maintaining voltage		—	—	83.2	84.3	V
Incremental resistance		—	—	125	350	Ω
Voltage jumps	$I_k = 3.5$ to 6.0mA	—	b	—	1	mV (pk-pk)
		0.65	c			
Ignition voltage	Illumination 5 to 50 lm/ft ²	—	d	—	120	V
Maintaining voltage		—	—	83.1	84.4	V
Incremental resistance		—	—	125	350	Ω
Voltage jumps	$I_k = 3.5$ to 6.0mA	—	b	—	1	mV (pk-pk)
		2.5	c			
Maintaining voltage	$I_k = 3.0\text{mA}$	—	e	—	Note e.	V
Regulation	$I_k = 3.0$ to 6.0mA	—	—	—	1.1	V
Microphony		—	f	—	30	mV (pk-pk)
GROUP D						
Ignition	$V_a = 120\text{V}$, Total darkness	6.5	a, g	—	5	s
Leakage	$V_a = 55\text{V}$, $R_{\text{lim}} = 1\text{M}\Omega$	6.5	—	—	4	μA
Temperature coefficient		6.5	h			
	$T_{\text{bulb}} = 25$ to 90°C		i	-2.0	-4.0	mV/°C
	$T_{\text{bulb}} = 90$ to 120°C		i	0	-4.0	mV/°C
A.C. impedance		6.5	h, j			
	$f = 100\text{c/s}$	—	—	110	350	Ω
	$f = 1000\text{c/s}$	—	—	—	500	Ω
	$f = 10,000\text{c/s}$	—	—	—	1500	Ω



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VOLTAGE REFERENCE TUBE

Test	Test conditions	A.Q.L. (%)	Notes (pp.D8/9)	Limits	
				Min.	Max.
GROUP E		6.5	c		
Glass strain	No applied voltage	—	k	—	—
Base strain	No applied voltage	—	l	—	—
Resonance search	Acceleration = 20g, f = 60 to 2000c/s	—	m	—	—
GROUP F1 Life Acceptance Tests					
Life test	$V_{a(b)} = 250V,$ $R_a = 37k\Omega,$ $T_{ambient} = 20 \text{ to } 25^\circ C$		n, o		
End point tests at 500 hours		6.5	h, p		
Change in maintaining voltage	0 to 500 hours	—	q	—	0.35 V
Ignition voltage	Illumination 5 to 50 lm/ft ²	—	d	—	125 V
High temperature life test					
	$V_a = 250V,$ $R_a = 37k\Omega,$ $T_{bulb} = 100^\circ C$		n, o		
End point tests at 500 hours		6.5	h, p		
Change in maintaining voltage					
voltage	0 to 500 hours	—	q	—	0.35 V
Ignition voltage	Illumination 5 to 50 lm/ft ²	—	d	—	125 V
Change in maintaining voltage	0 to 100 hours	—	q	—	0.5 V
Average change in maintaining voltage	0 to 100 hours	—	r	—	0.2 V
Ignition voltage	Illumination 5 to 50 lm/ft ²	—	d	—	125 V

VOLTAGE REFERENCE TUBE

83A1

Test	Test conditions	A.Q.L. (%)	Notes (pp.D8/9)	Limits Min. Max.		
GROUP F2 Life Information Tests						s
Room temperature life test						
	$V_a = 250V$, $R_a = 37k\Omega$, $T_{ambient} = 20 \text{ to } 25^\circ C$					n
Change in maintaining voltage	500 to 3000 hours	—	t	0	+0.2	V
Change in maintaining voltage	500 to 10,000 hours	—	t	+0.05	+0.35	V
Ignition voltage	at 10,000 hours	—	d	—	125	V
High temperature life test						
	$V_a = 250V$, $R_a = 37k\Omega$, $T_{bulb} = 100^\circ C$					n
Change in maintaining voltage	500 to 3000 hours	—	t	0	+0.2	V
Change in maintaining voltage	500 to 10,000 hours	—	t	+0.05	+0.35	V
Ignition voltage	at 10,000 hours	—	d	—	125	V
High temperature storage test						
	No applied voltage, $T_{ambient} = 100^\circ C$					n
Change in maintaining voltage	0 to 500 hours	—	t	—	1.5	V
Change in maintaining voltage	0 to 3000 hours	—	t	—	6	V
Ignition voltage	at 3000 hours	—	d	—	130	V
GROUP G Retest after 28 days storage						u
Ignition	$V_a = 120V$, Illumination 5 to 50 lm/ft ²	0.5	a	—	5	s
Maintaining voltage		0.5	—	83.1	84.4	V
Incremental resistance		0.5	—	125	350	Ω



Notes on tests

General: All results except for those on group A and group G tests are recorded.

- a. The tube must ignite within the specified time.
- b. The tube is ignited with V_a adjusted to give I_k of 3.5mA and the current is increased slowly to 6.0mA. Time of sweep = 5s.
- c. The A.Q.L. given applies separately to each test in the group.
- d. A potential of 100V is applied to the anode of the tube for a period of 2 seconds. If ignition does not occur the voltage is increased by 2V and applied for a further 2 seconds. If ignition still does not occur, the voltage is increased as before and so on until ignition occurs. If ignition occurs during a 2 second period at a fixed (numerically even) voltage, that voltage is recorded. If ignition occurs while the voltage is being increased, the intermediate (numerically odd) voltage is recorded.
- e. The value of maintaining voltage in each tube shall not be greater than that measured at 4.5mA in group B.
- f. This test is performed by tapping the tube with a standard hammer as described in the British Services Specification K1006 paragraph 4.7.5. The output is measured on a triggered oscilloscope with scan time 10ms approx.
- g. The tube is held non-conducting and in total darkness for the 24 hours immediately prior to this test.
- h. The A.Q.L. is a combined A.Q.L. for the sub-group of tests.
- i. This is the average temperature co-efficient over the stated temperature range. The tube is immersed in turn in baths of oil kept at the temperatures of the extremities of the range only, and the maintaining voltage at each temperature is measured as soon as it is stable.
- j. This is the effective a.c. impedance of the tube measured at the specified frequencies.
- k. In this glass envelope strain test the tubes are completely submerged in boiling water at a temperature between 97 and 100°C for 15 seconds and then immediately plunged into ice-cold water for 5 seconds. The tubes are then examined for glass cracks.
- l. In this base strain test, the pins of the tubes are forced over specified cones and the tubes and cones are then submerged in boiling water at a temperature between 97 and 100°C for 10 seconds. The tubes and cones are allowed to cool to room temperature before examining for glass cracks.
- m. The tube is operated during vibration at a fixed acceleration of 20g in a direction at an angle of 45° to each of the axes of the tube. The frequency is swept once through the range 60 to 2000c/s at a rate not exceeding 1 octave in 30 seconds.

N.B. – These conditions are used solely to assess the mechanical quality of the tube. The tube must not be operated under such conditions.

VOLTAGE REFERENCE TUBE

83A1

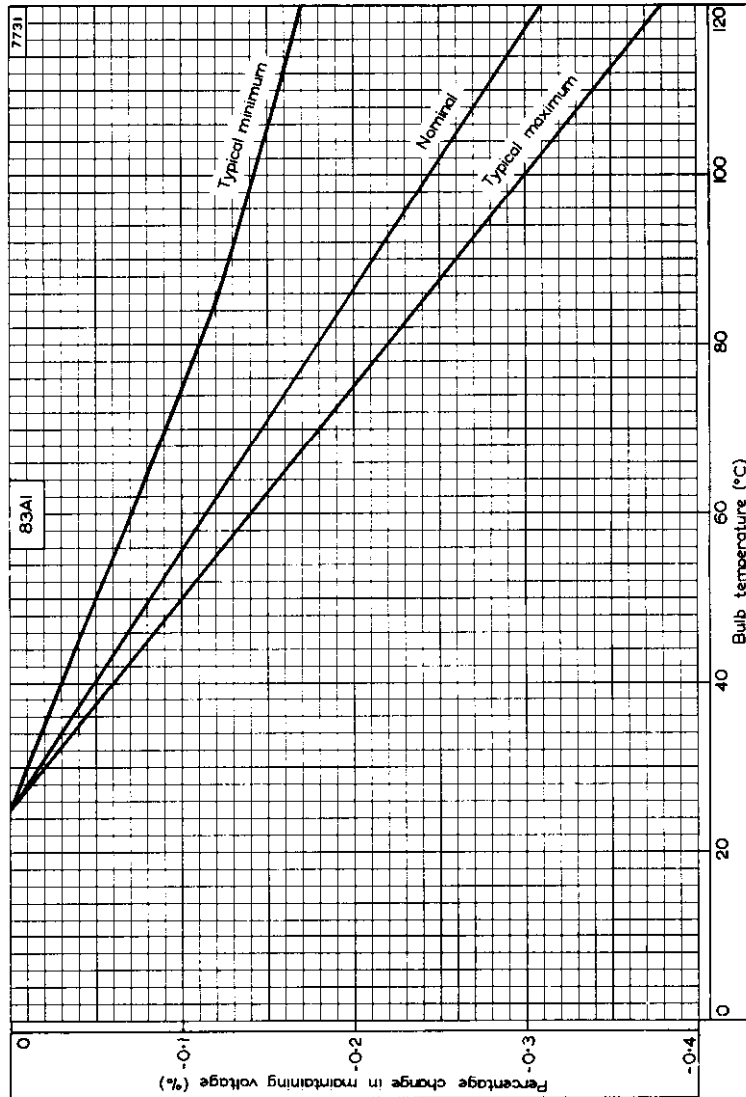
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- n. This test is run continuously under the stated conditions.
 - o. This test is performed on 15 tubes per lot.
 - p. These end point tests are acceptance tests and lots not satisfying these requirements are rejected.
 - q. This is the maximum change on the individual tubes over the stated period.
 - r. This is the average change over the complete sample of tubes, ignoring sign. The combined A.Q.L. does not apply to this test.
 - s. These control measurements are performed regularly but they are not acceptance tests on each lot.
 - t. These are limits which individual tubes are expected to satisfy over the stated period.
 - u. These tests are performed on tubes not used in sample tests, at least 28 days after the group A tests.





VOLTAGE REFERENCE TUBE

83A1



PERCENTAGE CHANGE IN MAINTAINING VOLTAGE PLOTTED AGAINST BULB TEMPERATURE





VOLTAGE REFERENCE TUBE

85A2

Gas-filled two-electrode tube intended
for use as a voltage reference.

LIMITING VALUES (Absolute Ratings)

Min. voltage necessary for ignition	115	V ←
Max. burning current	10	mA
Min. burning current	1	mA
Ambient temperature limits	-55 to +90	°C

PREFERRED OPERATING CONDITION

Burning current	6	mA
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CHARACTERISTICS

At Preferred Operating Condition

Max. ignition voltage	115	V ←
Burning voltage (variation from tube to tube)	83 to 87	V
Incremental resistance		
Average	300	Ω
Maximum	450	Ω
Temperature coefficient of burning voltage over temperature range 15 to 90°C	-4.0	mV/°C
*Max. percentage variation of burning voltage		
During the first 300 hours of life	0.3	%
During the subsequent 1,000 hours	0.2	%
Typical percentage drift of burning voltage per 1,000 hours after 1,300 hours	0.1	%

*After the initial warming-up period of 3 minutes.

DISCONTINUITIES OF THE I_a/V_a CHARACTERISTIC

Typical voltage jumps over current range 4 to 10 mA	5.0	mV
Maximum voltage jumps over current range 4 to 10 mA	50	mV

SHORT-TERM STABILITY

Maximum short-term variation of burning voltage for any 8 hour ←
period after the first 100 hours life will be better than 0.01%
provided there is an initial warming-up period of 3 minutes.

Maximum short-term (100 hours max.) variation of burning voltage
after the first 300 hours of life is 0.1%.

In order to avoid voltage variations due to temperature fluctuations
it will in general be sufficient to draught shield the tube (see
temperature coefficient of tube).

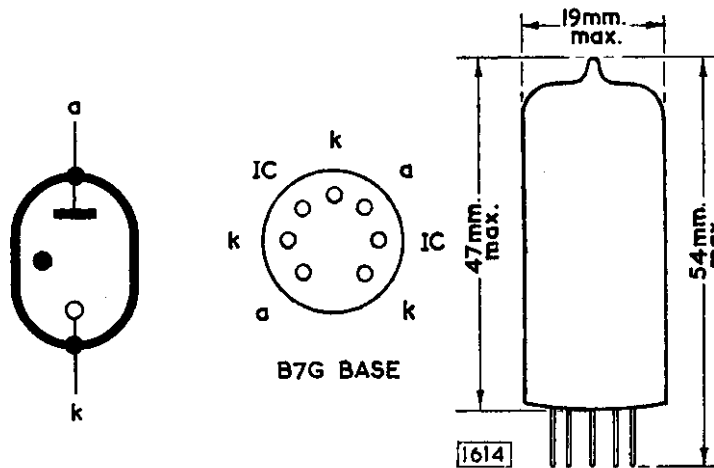
85A2

VOLTAGE REFERENCE TUBE

*Gas-filled two-electrode tube intended
for use as a voltage reference*

OPERATING NOTES

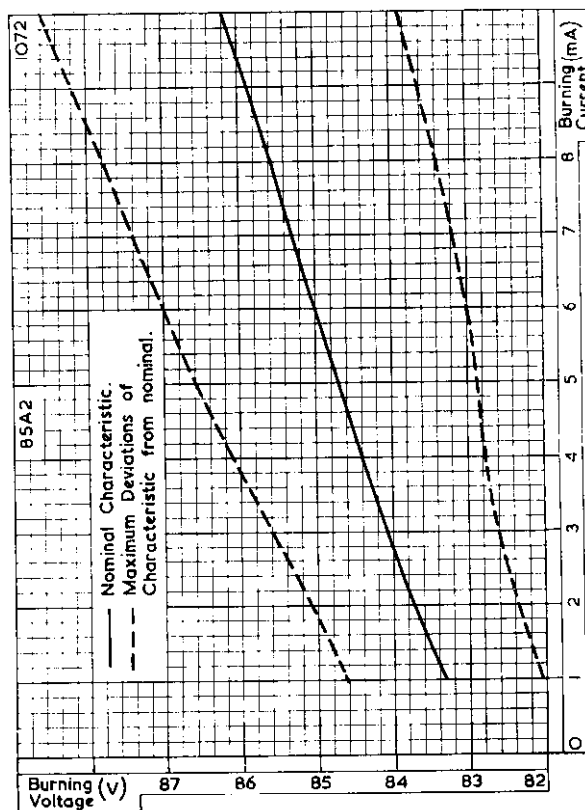
1. To obtain a good life a reverse current must not be drawn from this tube. This condition is satisfied if any inverse voltage does not exceed 75 V.
2. The maximum ignition voltage quoted is the greatest voltage which is necessary to ignite any tube in the presence of some ambient illumination. A voltage of at least this value must be available if reliability of ignition is to be obtained. In complete darkness there



VOLTAGE REFERENCE TUBE

85A2

Gas-filled two-electrode tube intended for use as a voltage reference.



BURNING VOLTAGE PLOTTED AGAINST BURNING CURRENT





STABILISING TUBE

90C1

QUICK REFERENCE DATA (nominal values)

Maintaining voltage	90	V
Cathode current range	1 to 40	mA
Regulation voltage	12	V
Ignition delay time	2	s

This data should be read in conjunction with GENERAL OPERATIONAL RECOMMENDATIONS—VOLTAGE STABILISER AND REFERENCE LEVEL TUBES which precede this section of the handbook.

CHARACTERISTICS AND RANGE VALUES FOR EQUIPMENT DESIGN

measured at an ambient temperature of between 20 and 30°C unless otherwise stated.

The values given state the range over which the tube will operate both initially and during life. No allowance has been made for supply voltage and component variations. (note 1)

Initial values

Minimum voltage necessary for ignition (note 2)	115	V	
Ignition delay time	See page C1	←	
Maintaining voltage at 20mA			
Maximum	94	V	
Minimum	86	V	
Increase in maintaining voltage as cathode current is increased from 1 to 40mA (regulation voltage)			
Note 3			
Maximum	14	V	
Average	12	V	
Cathode current above which the incremental resistance is positive	2	mA	
Typical maximum incremental resistance in the current range 1 to 40mA (note 3)	300	Ω←	
Life performance (note 4)	$i_k = 20\text{mA}$	$i_k = 40\text{mA}$	
Minimum voltage necessary for ignition (note 2)	115	115	V
Percentage variation of maintaining voltage at cathode current (room temperature)			
In 1,000 hrs (maximum)	± 1	$\frac{+5}{-1}$	0% ←
In 10,000 hrs (average)	+3.5	+5	0%
Typical maximum increase in maintaining voltage as cathode current is increased over the current range	13	15	V

90C1

STABILISING TUBE

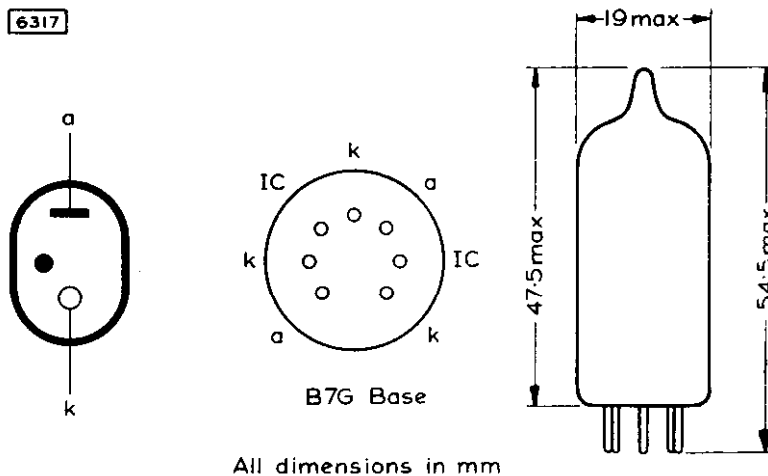
ABSOLUTE MAXIMUM RATINGS

Cathode current		
Maximum for continuous operation	40	mA
Maximum surge (note 5)	100	mA
Minimum	1.0	mA
Maximum negative anode voltage	80	V
Minimum bulb temperature ($I_k = 0\text{mA}$)	-55	°C
Maximum ambient temperature		
For operation (note 6)	+70	°C
For storage (note 7)	+70	°C

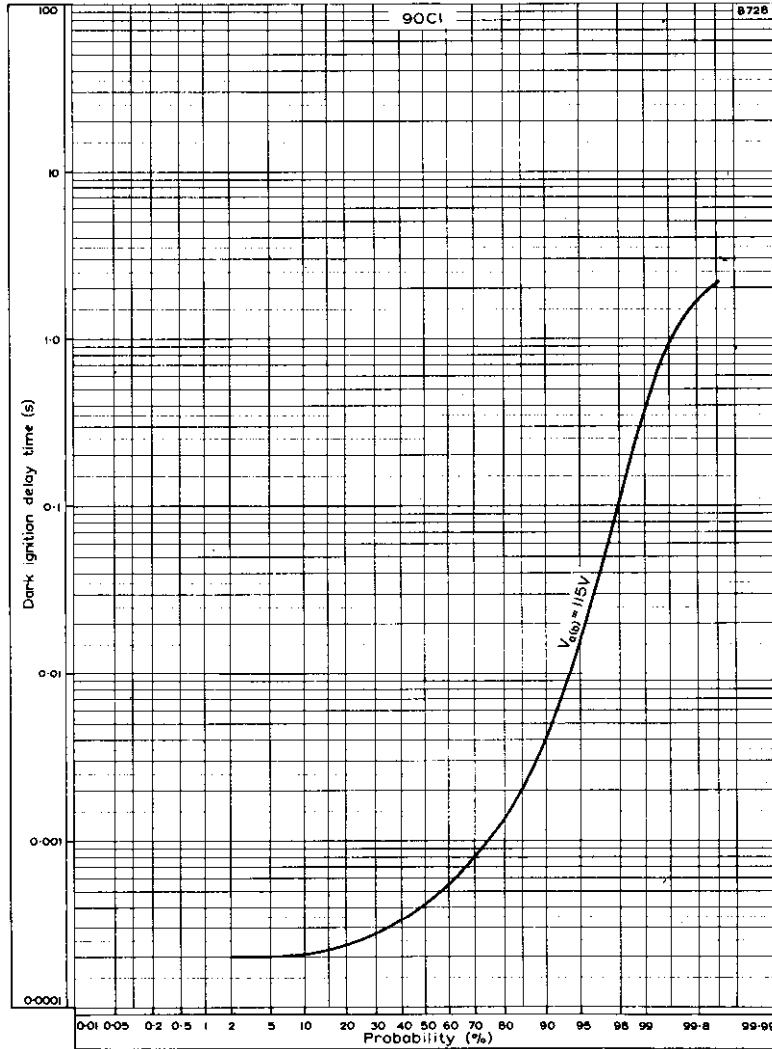
OPERATING NOTES

1. Thermal equilibrium is reached within 3 minutes of igniting the tube.
2. This value holds good over life in light or darkness. See graph on page C1.
3. Following a sudden large change in the tube current, the change in maintaining voltage may be slightly greater than that given until tube thermal equilibrium is re-established (within 3 minutes).
4. These figures apply only when the tube is operated continuously at the currents stated.
5. To be restricted for long life to approximately 30 seconds in each 8 hours use.
6. This tube will operate satisfactorily at ambient temperatures up to 70°C providing the tube is not used at the upper end of the current range.
7. The tube should not be stored for more than 4 months at this maximum temperature without intermediate operation.

6317



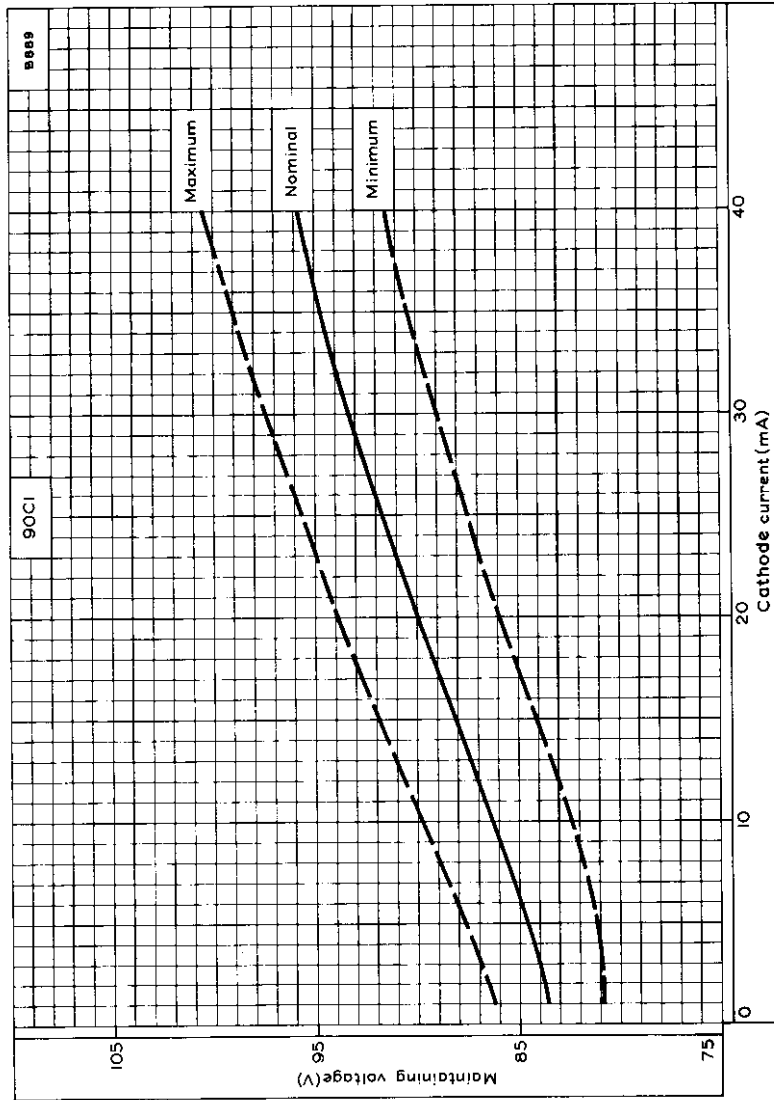
All dimensions in mm



CUMULATIVE DISTRIBUTION OF DARK IGNITION DELAY TIME
 This curve shows the probability that a tube will ignite in less than the time shown. This will be to some extent dependent on the supply voltage. In general an increase in the supply voltage will reduce the ignition delay time.

90C1

STABILISING TUBE



MAINTAINING VOLTAGE PLOTTED AGAINST CATHODE CURRENT
(Initial values)



STABILISING TUBE

I08C1

QUICK REFERENCE DATA (nominal values)

Maintaining voltage	108	V
Cathode current range	5.0 to 30	mA
Regulation voltage	1.5	V
Ignition delay time	1.3	s

This data should be read in conjunction with GENERAL OPERATIONAL RECOMMENDATIONS—VOLTAGE STABILISER AND REFERENCE LEVEL TUBES which precede this section of the handbook.

CHARACTERISTICS AND RANGE VALUES FOR EQUIPMENT DESIGN

measured at an ambient temperature of between 20 and 30°C unless otherwise stated.

The values given state the range over which the tube will operate both initially and during life. No allowance has been made for supply voltage and component variations.

Initial values

Minimum voltage necessary for ignition (note 1)	133	V←
Ignition delay time	See page C1	←
Maintaining voltage		
Maximum (at $I_k = 30\text{mA}$)	112	V
Minimum (at $I_k = 5.0\text{mA}$)	105	V
Increase in maintaining voltage as cathode current is increased from 5 to 30mA (regulation voltage)		
Maximum	3.5	V
Average	1.5	V

Life performance (note 2)

Minimum voltage necessary for ignition (note 1)	133	V←
Maintaining voltage		←
In 1000 hrs		
Maximum (at $I_k = 30\text{mA}$)	113	V
Minimum (at $I_k = 5.0\text{mA}$)	104	V
In 3000 hrs (note 3)		
Maximum (at $I_k = 30\text{mA}$)	113	V

I08C1

STABILISING TUBE

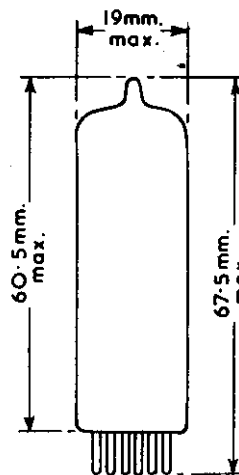
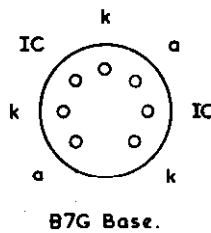
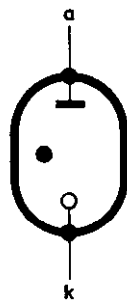
ABSOLUTE MAXIMUM RATINGS

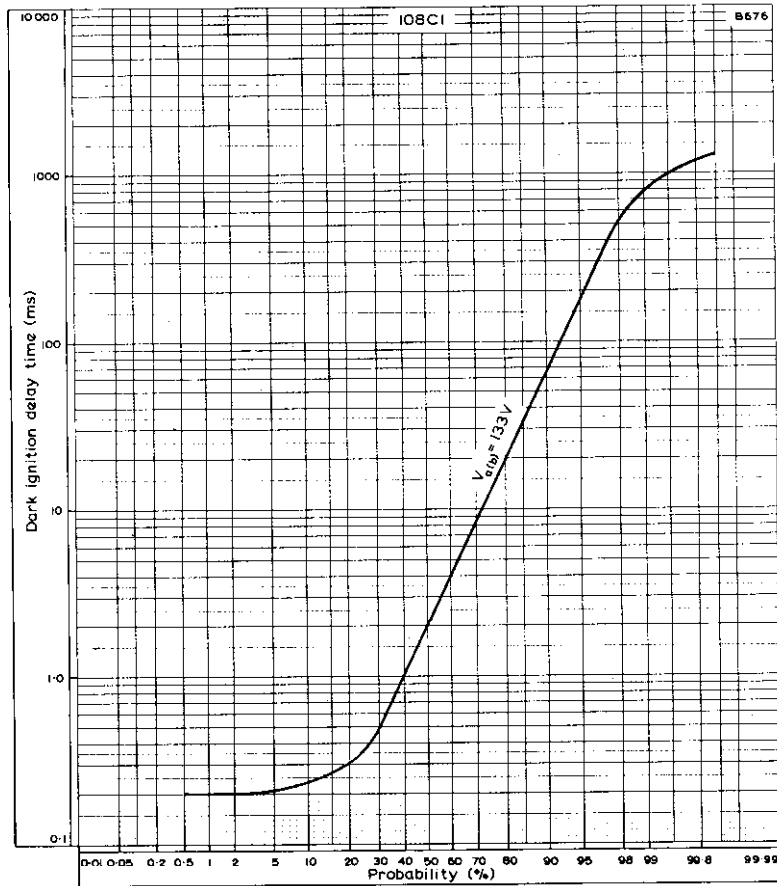
Cathode current		
Maximum for continuous operation	30	mA
Maximum surge (note 4)	75	mA
Minimum	5.0	mA
Maximum negative anode voltage	75	V
Minimum bulb temperature ($I_k = 0\text{mA}$)	-55	°C
Maximum bulb temperature		
For operation	+150	°C ←
For storage	+70	°C

OPERATING NOTES

1. This value holds good over life in light or darkness. See graph on page C1. ←
2. These figures apply only when the tube is operated continuously at the currents stated. ()
3. The maintaining voltage for all tubes will stay within the limits given and ← the change in any individual tube will not exceed +3V or -4V.
4. To be restricted for long life to approximately 30 seconds in each 8 hours' ← use.

1616





CUMULATIVE DISTRIBUTION OF DARK IGNITION DELAY TIME

This curve shows the probability that a tube will ignite in less than the time shown. This will be to some extent dependent on the supply voltage. In general an increase in the supply voltage will reduce the ignition delay time.

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STABILISING TUBE

I50B2

QUICK REFERENCE DATA (nominal values)

Maintaining voltage	150	V
Cathode current range	5 to 15	mA
Regulation voltage	4	V
Ignition delay time	250	ms

This data should be read in conjunction with GENERAL OPERATIONAL RECOMMENDATIONS—VOLTAGE STABILISER AND REFERENCE LEVEL TUBES which precede this section of the handbook.

CHARACTERISTICS AND RANGE VALUES FOR EQUIPMENT DESIGN measured at an ambient temperature of between 20 and 30°C unless otherwise stated.

The values given state the range over which the tube will operate both initially and during life. No allowance has been made for supply voltage and component variations. (note 1)

Initial values

Minimum voltage necessary for ignition (note 2)	180	V
Ignition delay time	See page C1	←
Maintaining voltage at 10mA		
Maximum	151	V←
Minimum	146	V
Increase in maintaining voltage as cathode current is increased from 5 to 15mA (regulation voltage)		
Maximum	5.0	V
Average	3.0	V←
Temperature coefficient of maintaining voltage		

Room temperature

In 1000 hrs at 10mA (maximum)	} +1 -0.5	%
In 10,000 hrs at 5 and 10mA (typical maximum)		
In 30,000 hrs at 5 and 10mA (typical maximum)	} +2 -1	%
Typical maximum increase in maintaining voltage as cathode current is increased from 5 to 15mA		
In 1000 hrs	4.0	V
In 10,000 hrs	6.0	V



I50B2

STABILISING TUBE

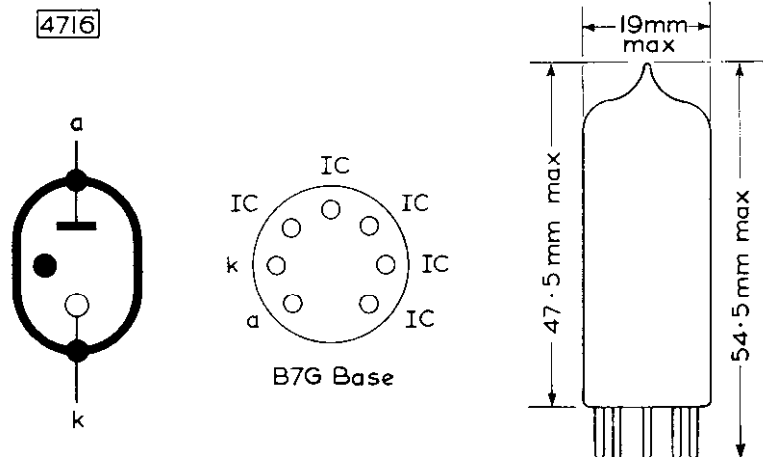
ABSOLUTE MAXIMUM RATINGS

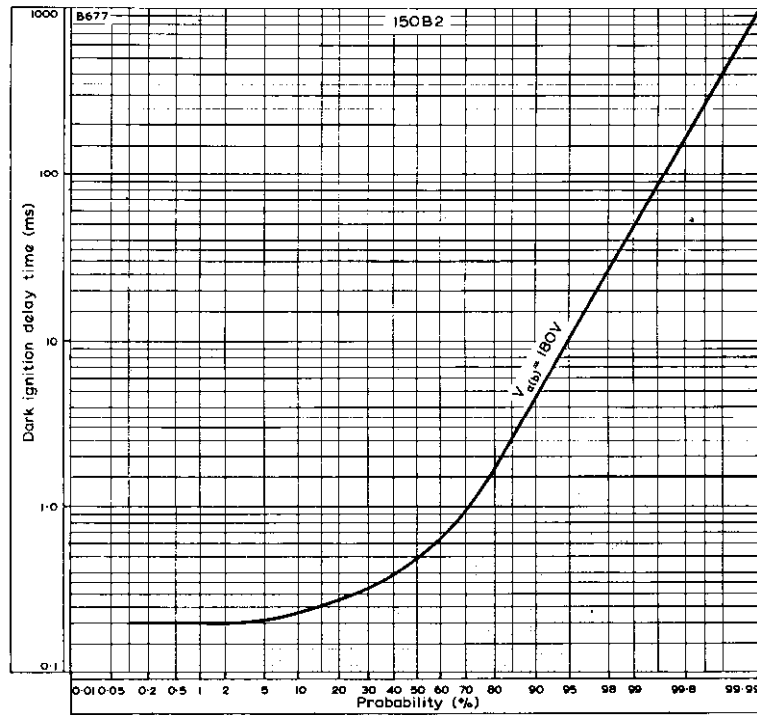
Cathode current		
Maximum for continuous operation	15	mA
Maximum surge (note 4)	40	mA
Minimum	5.0	mA
Maximum negative anode voltage	130	V
Minimum bulb temperature ($I_k = 0\text{mA}$)	-55	°C
Maximum ambient temperature		
For operation	+70	°C
For storage	+70	°C

OPERATING NOTES

1. Thermal equilibrium is reached within 3 minutes of igniting the tube.
2. This value holds good over life in light or darkness. See graph on page C1.
3. These figures apply only when the tube is operated continuously at the currents stated.
4. To be restricted for long life to approximately 30 seconds in each 8 hours' use.

B4716





CUMULATIVE DISTRIBUTION OF DARK IGNITION DELAY TIME

This curve shows the probability that a tube will ignite in less than the time shown. This will be to some extent dependent on the supply voltage. In general an increase in the supply voltage will reduce the ignition delay time.





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STABILISING TUBE

I50C4

QUICK REFERENCE DATA (nominal values)

Maintaining voltage	150	V
Cathode current range	5 to 30	mA
Regulation voltage	3	V
Ignition delay time	10	s

This data should be read in conjunction with GENERAL OPERATIONAL RECOMMENDATIONS—VOLTAGE STABILISER AND REFERENCE LEVEL TUBES which precede this section of the handbook.

CHARACTERISTICS AND RANGE VALUES FOR EQUIPMENT DESIGN

measured at an ambient temperature of between 20 and 30°C unless otherwise stated.

The values given state the range over which the tube will operate both initially and during life. No allowance has been made for supply voltage and component variations.

Initial values

Minimum voltage necessary for ignition (note 1)	185	V←
Ignition delay time	See page C1	←
Maintaining voltage (all tubes)		
Maximum (at $I_k = 30\text{mA}$)	156	V
Minimum (at $I_k = 5.0\text{mA}$)	143	V
Increase in maintaining voltage as cathode current is increased from 5 to 30mA (regulation voltage)		
Maximum	5.0	V
Average	3.0	V

Life performance (note 2)

Minimum voltage necessary for ignition (note 1)	185	V←
Maintaining voltage		
Maximum (at $I_k = 30\text{mA}$)	156	V←
Minimum (at $I_k = 5.0\text{mA}$)	139	V
Percentage variation of maintaining voltage at 30mA during 1,000 hrs life (room temperature)		←
Maximum	{ +1.5	%
Average	-5	%
Average	±1	%
Increase in maintaining voltage as cathode current is increased from 5 to 30mA		
Maximum	8.0	V
Average	3.0	V

I50C4

STABILISING TUBE

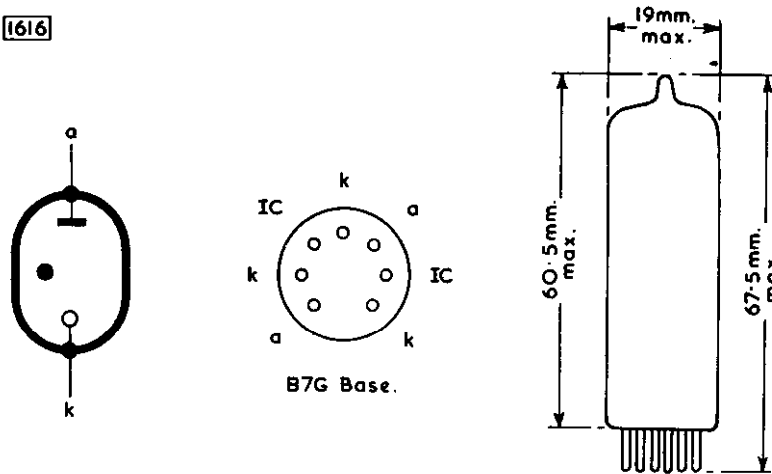
ABSOLUTE MAXIMUM RATINGS

Cathode current		
Maximum for continuous operation	30	mA
Maximum surge (note 3)	75	mA
Minimum	5.0	mA
Maximum negative anode voltage	125	V
Minimum bulb temperature ($I_k = 0\text{mA}$)	-55	°C
Maximum bulb temperature		
For operation	+150	°C
For storage	+100	°C

OPERATING NOTES

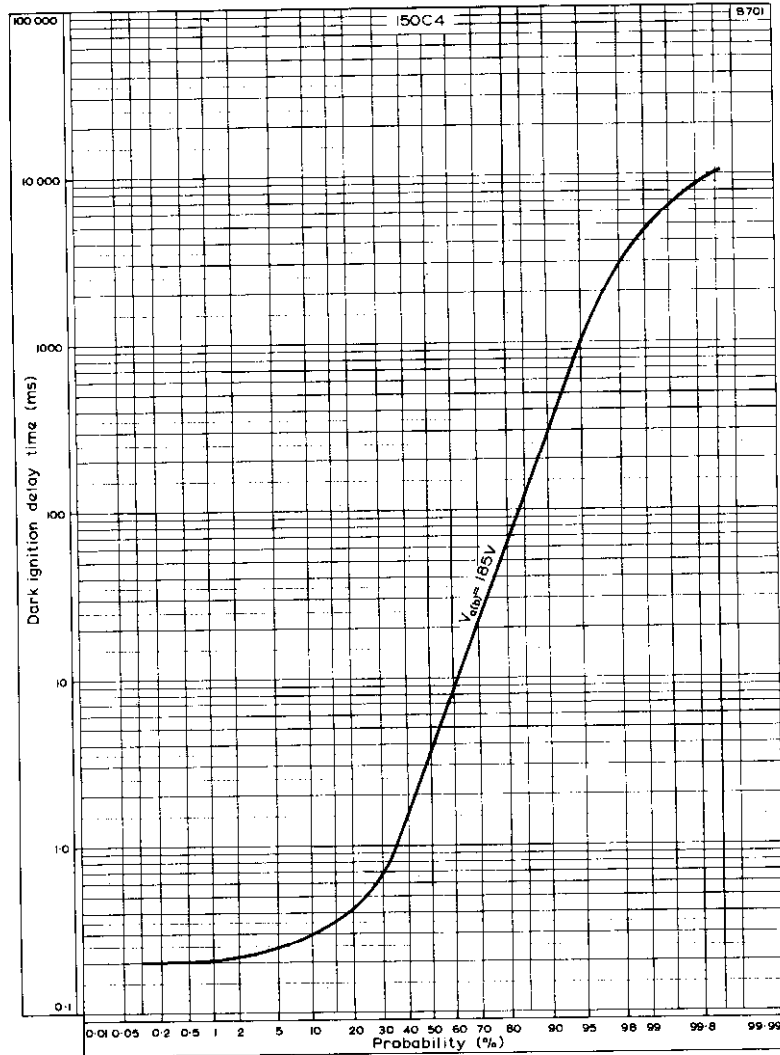
1. This value holds good over life in light or darkness. See graph on page C1.
2. These figures apply only when the tube is operated continuously at 30mA.
3. To be restricted for long life to approximately 30 seconds in each 8 hours' use.

I616



STABILISING TUBE

I50C4



CUMULATIVE DISTRIBUTION OF DARK IGNITION DELAY TIME

This curve shows the probability that a tube will ignite in less than the time shown. This will be to some extent dependent on the supply voltage. In general an increase in the supply voltage will reduce the ignition delay time.



11-11-11

(1)

(2)

(3)

(4)

11-11-11

SPECIAL QUALITY SUBMINIATURE STABILISING TUBE

5644

*Special quality subminiature gas-filled 90V voltage stabiliser
for use in equipment where mechanical vibration and shocks
are unavoidable.*

PRELIMINARY DATA

This data should be read in conjunction with GENERAL NOTES—
SPECIAL QUALITY VOLTAGE STABILISER AND REFERENCE TUBES
which precede this section of the handbook, and the index numbers are
used to indicate where reference should be made to a specific note.

LIMITING VALUES¹ (absolute ratings)

†Minimum voltage necessary for ignition		
In some ambient light	130	V
In complete darkness	175	V
Burning current		
Maximum	25	mA
Minimum	5.0	mA
Maximum starting current	60	mA
Maximum negative anode voltage	75	V
Minimum ambient temperature	-55	C
Maximum bulb temperature	*	

†These values cover life.

*Information on the performance of the tube at high bulb temperatures
(up to 220 C) can be supplied on request.

CHARACTERISTICS

Maximum maintaining voltage at 25mA (all tubes over life)	108	V
Minimum maintaining voltage at 5.0mA (all tubes over life)	82	V
Difference between maintaining voltages at 25mA and 5.0mA (individual tube)		
Maximum	5.0	V
Typical	3.0	V

5644

SPECIAL QUALITY SUBMINIATURE STABILISING TUBE

	A.Q.L. ² (%)	Individuals ⁴		V
		Min.	Max.	
.. .. .	*	—	120	V
.. .. .	*	—	105	V
.. .. .	*	85	—	V
.. .. . current change from 5.0 to 25mA	*	—	5.0	V
nA	4.0	—	15	mV
< 100kΩ	6.5	—	10	μA

er and the output observed on a meter of specified dynamic response.

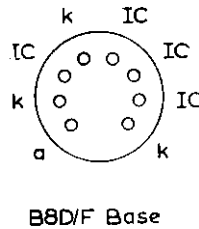
stage... .. . 4.0

eleration f = 25c/s min. 60c/s max. for
kular planes.

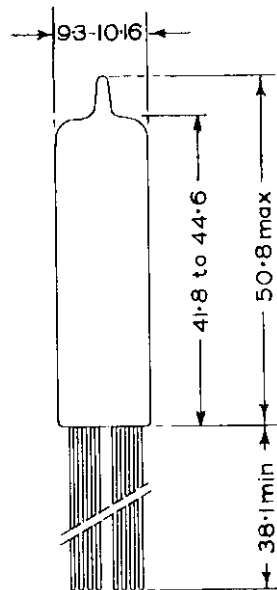
5644

SPECIAL QUALITY SUBMINIATURE STABILISING TUBE

3937



B8D/F Base



All dimensions in mm

The bulb and base dimensions of this tube are in accordance with BS448, Section B8D/F

Note: Direct soldered connections to the leads of the tube must be at least 5mm from the seal and any bending of the leads must be at least 1.5mm from the seal.