Mullard **VOLUME 3 (Part 1)**

Cathode Ray Tubes

Photoconductive Cells

Photoemissive Cells

Camera Tubes

Photomultiplier Tubes

Image Converter Tubes

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Mullard Technical Handbook

GENERAL INDEX
TO VOLUMES 3 AND 3A

This index of Mullard valves, tubes and microwave components will be reissued periodically to incorporate the latest information.

Data sheets for types starred thus (*) have not yet been published but will be issued when they become available. A guarantee that these valves and tubes will become available is not implied by their inclusion in this list.

The issue number or date given against each type shows the latest information published and should correspond to that given on the data sheets at the bottom left-hand corner of each page.

Mullard Technical Handbook

GENERAL INDEX
TO VOLUMES 3 AND 3A

Mullard Technical Handbook

GENERAL INDEX
TO VOLUMES 3 AND 3A

GENERAL INDEX
TO VOLUMES 3 AND 3A

GENERAL INDEX TO VOLUMES 3 AND 3A

Mullard Technical Handbook

GENERAL INDEX TO VOLUMES 3 AND 3A

Communications Magnetrons—cont.

Issue No. or Date	*Type No.*	*Pages*
Oct 63	JP9–80 JP9–80A	D1–D5
Mar 60	,,	C1–C2
May 60	JP9–180	D1–D3
May 60	,,	C1–C2
May 60	JP9–250 Series	D1–D3
May 60	,, ,,	C1–C2
Apr 63	JP35–30	D1–D2
Feb 61	,,	D3–D4
Apr 63	,,	C1–C2
Apr 62	JPG8–01 JPG8–01B JPT8–01 JPT8–01B	D1–D5
Apr 62	,,	C1–C2
Feb 63	JPG8–01E JPG9–01B	D1–D3
Feb 63	,,	C1–C2
Jan 63	JPG8–02B JPG9–02B	D1–D3
Jan 63	,,	C1
Apr 62	JPG9–01 JPT9–01	D1–D5
Apr 62	,,	C1–C2
Oct 65	,,	C3
Apr 62	JPG9–02 JPT9–02	D1–D5
Apr 62	,,	C1–C2
Feb 63	JPG9–02C	D1–D3
Feb 63	,,	C1
Mar 68	JPT9–01K	D1–D4
May 62	JPT9–60	D1–D5
May 62	,,	C1–C4
Dec 67	YJ1010	D1–D5
Dec 67	,,	C1
*	YJ1021	
Nov 64	YJ1030	D1–D5
Nov 64	,,	C1

Communications Magnetrons—cont.

Issue No. or Date	*Type No.*	*Pages*
Apr 65	YJ1040	D1–D5
Aug 67	YJ1050	D1–D4
Aug 67	,,	C1
Sept 63	YJ1060	D1–D6
Sept 63	,,	C1
*	YJ1070	
Feb 66	YJ1071	D1–D4
Feb 66	,,	C1–C3
Oct 64	YJ1090 YJ1091	D1–D3
Oct 64	YJ1100 YJ1101	D1–D5
Feb 66	YJ1110 YJ1111	D1–D5
Feb 66	,,	C1–C3
Feb 66	YJ1120	D1–D4
Feb 66	,,	C1
Jan 66	YJ1121	D1–D5
May 67	YJ1180 YJ1181	D1–D5
May 67	,,	C1
May 68	YJ1200 YJ1201	4
Dec 67	YJ1220	D1–D3
Jan 68	YJ1250	D1–D4
July 64	2J42	D1–D5
Mar 63	,,	C1
Nov 67	2J55	D1–D4
Nov 67	,,	C1
Dec 67	2J56	D1–D4
Dec 67	,,	C1

Industrial Magnetrons

Issue No. or Date	*Type No.*	*Pages*
Feb 64	General Operational Recommendations—Industrial Magnetrons	D1–D7

Mullard Technical Handbook

GENERAL INDEX
TO VOLUMES 3 AND 3A

Mullard Technical Handbook

GENERAL INDEX TO VOLUMES 3 AND 3A

PREFACE

In order that you may obtain the maximum benefit from your Mullard Technical Handbook, we ask you to read carefully this short description of the Handbook Service and how it is organised.

By following the simple suggestions given you will ensure that your Handbook is always up to date, and will avoid much unnecessary correspondence and work both at your end and ours.

THE HANDBOOK

The Mullard Technical Handbook is published in seven volumes plus a general index.

You may possess the complete Handbook, or only one or more of the volumes. Should you wish to obtain any volumes not in your possession, please write to Mullard Central Technical Services for subscription terms, quoting the serial number of your existing Handbook.

KEEPING THE HANDBOOK UP TO DATE

Each volume has a separate index, and is sent out complete with section dividers and all current data sheets in their correct positions. As new or revised sheets are issued, copies are sent to all subscribers, together with a list indicating the position in which each sheet should be filed.

ACKNOWLEDGMENT OF RECEIPT OF HANDBOOK

In order to ensure that these sheets reach the correct individual you are earnestly requested, immediately upon receipt of your Handbook, to detach and mail to us the "Acknowledgment of Receipt Card" which you will find just inside the cover. Please make sure that the name and full address to which supplements should be sent are clearly given in the space provided.

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Any change in the name or address should be notified in a similar way by using the "Change of Address or Ownership Card" also included at the front of each Handbook.

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The prompt use of these postcards will ensure that, as far as is humanly possible, our mailing records and your Handbook are maintained up to date. This can be achieved, however, only with the co-operation of Handbook owners, not only by notifying us of change of address but by filing new data sheets as soon as they are received and removing obsolete sheets.

Neglect of this simple task may lead to loss of data sheets, and an incomplete Handbook congested with out-of-date information.

We occasionally receive letters from Handbook subscribers who have allowed their Handbooks to become disorganised, asking whether they may return them to us to be made up to date. **Please note that we cannot undertake this service.** What we can do, however, is to send you a copy of the latest index so that you can check the contents of your Handbook. We will then send you, free of charge, copies of sheets which may be missing.

CORRESPONDENCE

Correspondence concerning the Handbook Service should be addressed to:

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When writing, please quote the SERIAL NUMBER which is given on the introduction page of each Handbook. This number links up with our records and mailing system, and is repeated in the address on every set of supplementary sheets issued. By quoting this number you will save us a great deal of work and avoid delays in answering your letters.

CONTENTS

Part IV

Semiconductor diodes
Photodiodes and phototransistors

Part V

Rectifier diodes
Rectifier diode stacks

Part VI

Thyristors
Thyristor stacks

Volume 5

Fixed capacitors
Variable capacitors
Fixed resistors
Variable resistors
Non-linear resistors
Electromechanical components
Ultra-high vacuum devices
Tuners
Piezoxide components

Volume 6

Part I

Permanent magnets
Wound ferrite assemblies
Magnetic recorder heads
Ferroxcube multi-aperture devices
Ferroxcube storage cores
Ferroxcube switch cores
Memory systems

Part II

Ferroxcube rods, tubes and beads
Ferroxcube U-cores and yokes
Ferroxcube toroids
Ferroxcube transformer cores
Ferroxcube pot cores

Part III

Vinkors
High frequency vinkors

Part IV

IEC size vinkors
IEC size transformer pot cores

Volume 7

Integrated circuits

Made and printed in England by Wightman & Co. Ltd., 1-3 Brixton Road, London, S.W.9

LIST OF SYMBOLS

These symbols are based on British Standard Specification No. 1409 : 1950, " Letter Symbols for Electronic Valves ".

1. SYMBOLS FOR ELECTRODES

Anode	a	Fluorescent Screen or Target...	t
Cathode	k	External Metallisation	M
Grid	g	Internal Metallisation	m
Heater	h	Deflector Electrodes	x or y
Filament	f	Internal Shield	s
Beam Plates	bp	Resonator	Res ←

NOTE 1. In valves having more than one grid, the grids are distinguished by numbers—g_1, g_2, etc., g_1 being the grid nearest the cathode

NOTE 2. In multiple valves, electrodes of the different sections may be distinguished by adding one of the following letters:

Diode	d	Hexode	h
Triode...	t	Heptode	h
Tetrode	q	Octode	h
Pentode	p	Rectifier	r

Thus, the grid of the triode section of a triode-hexode is denoted by g_t.

NOTE 3. Two or more similar electrodes which cannot be distinguished by any of the above means may be denoted by adding one or more primes to indicate to which electrode system the electrode forms a part.
Thus, the anode of the first diode in a double diode valve is denoted a′.

2. SYMBOLS FOR ELECTRIC MAGNITUDES

Voltages		Current	
Direct Voltage	V	Direct Current	I
Alternating Voltage (r.m.s.)	$V_{r.m.s.}$	Alternating Current (r.m.s.)	$I_{r.m.s.}$
Alternating Voltage (mean)	V_{av}	Alternating Current (mean)	I_{av}
Alternating Voltage (peak)	v_{pk}	Alternating Current (peak)	i_{pk}
Peak Inverse Voltage ...	P.I.V.	No Signal Current	I_o

Miscellaneous

Frequency	f	Anode Efficiency	η
Amplification Factor ...	μ	Sensitivity	S
Mutual Conductance ...	g_m	Brightness	B
Conversion Conductance...	g_c	Temperature	T
Distortion	D	Time	t

	Inside Valve	Outside Valve
Resistance	r	R
Reactance	x	X
Impedance	z	Z
Admittance	y	Y
Mutual Inductance	m	M
Capacitance	c	C
Capacitance at Working Temperature	c_w	
Power	p	P

3. AUXILIARY SYMBOLS

Battery or other source of supply	b
Inverse (Voltage or Current)	inv
Ignition (Voltage)	ign
Extinction (Voltage)	ext
No Signal	o
Input	in
Output	out
Total	tot
Centre Tap	ct

4. COMPLEX SYMBOLS

Symbols in Sections 1 and 3 above may be used as subscripts to symbols in Section 2, to denote such magnitudes as Anode Current, Grid Volts, etc., e.g.:—

Anode Voltage ...	V_a	Anode Current (A.C. r.m.s.)	$I_{a(r.m.s.)}$
Control-Grid Voltage	V_{g1}	No Signal Anode Current ...	$I_{a(o)}$
Anode Supply Voltage	$V_{a(b)}$	Control-Grid Current ...	I_{g1}
Filament Voltage ...	V_f	Total Distortion	D_{tot}
Heater Voltage ...	V_h	3rd Harmonic Distortion ...	D_3
Anode Dissipation ...	p_a	Equivalent Noise Resistance	R_{eq}
Output Power ...	P_{out}	Limiting Resistor	R_{lim}
Drive Power	P_{drive}	Cathode Bias Resistor	R_k
Anode Current (D.C.)	I_a		

	Internal	External
Anode Resistance	r_a	R_a
Insulation Resistance (heater to cathode)	r_{h-k}	
Resistance between Control-Grid and Cathode ...	r_{g1-k}	R_{g1-k}
Capacitance (cold)—		
Anode to all other electrodes		c_{a-all}
Anode to control-grid		c_{a-g1}
Control-grid to cathode at working temperature		$c_{g1-k(w)}$
Control-grid to all other electrodes except anode (Input Capacitance)		c_{in}
Anode to all other electrodes except control-grid (Output Capacitance)		c_{out}
Inner Amplification Factor		μ_{g1-g2}

TYPE NOMENCLATURE

A new comprehensive type nomenclature system for transmitting and industrial valves and tubes has recently been introduced. In general, new Mullard devices will have type numbers in the 'new system', earlier devices will retain numbers in one of the 'old systems'.

NEW SYSTEM

The type number for valves or tubes used primarily in 'professional' applications (e.g. transmitters, navigation or communication equipment, industrial applications) consists of two letters followed by four figures. This system does not apply to receiving-type valves.

The first letter indicates a fundamental characteristic of the device:

X—photosensitive tube
Y—vacuum valve or tube (except photodevices)
Z—gasfilled valve or tube (except photodevices)

The second letter indicates the construction or application of the device :

A—diode
C—trigger tube
D—triode or double triode
G—miscellaneous
H—travelling wave tube
J—magnetron
K—klystron
L—tetrode, pentode, double tetrode or double pentode
M—cold cathode indicator or counter tube
P—photomultiplier tube or radiation counter tube
Q—camera tube
T—thyratron
X—ignitron, image intensifier or image converter
Y—rectifier
Z—voltage stabiliser or reference tube

The group of four figures is a serial number. The last figure is 0 for basic types; variants of the basic type are indicated by the figures 1 to 9.

Example

YL1030 Transmitting double tetrode

Receiving-type valves

The type number of receiving valves used primarily in 'professional' applications is similar to that for normal receiving valves except that there are four figures instead of two or three. The letters and first figure have the same significance as in the receiving valve type numbering system.

Example

EC1000 Triode for professional applications, special base, 6.3V heater

OLD SYSTEMS

Transmitting and large industrial valves and tubes

The type number generally consists of two or more letters followed by two sets of figures. These symbols provide information concerning the principal uses and ratings of the valves according to the following code.

The first letter indicates the general functional class of valve:

B—backward wave tube
J—magnetron
K—klystron
L—travelling wave tube
M—l.f. amplifying or modulator triode
P—r.f. power pentode
Q—r.f. power tetrode
R—power rectifier
T—r.f. power triode
X—large thyratron. (All hydrogen thyratrons and other thyratrons having max. mean anode current of 500mA or more.)

Note.—For valves having dual electrode systems, the code letters for both systems are used, e.g. 'QQ' for a double tetrode.

The second letter indicates some structural property in each class of valve:

(a) For transmitting valves and vacuum rectifiers, the type of cathode.
(b) For thyratrons and gasfilled rectifiers, the type of gas present.
(c) For microwave devices, a basic structural feature.

A—outputs up to 1W } In backward wave and travelling wave tubes
B—outputs of 1W and over } In backward wave and travelling wave tubes
D—disc-seal construction
G—mercury-vapour filled
H—hydrogen-filled
N—external magnet required (in magnetrons)
P—packaged construction (in magnetrons)
R—inert-gas filled
S—reflex (single resonator) construction (in klystrons)
T—multiple resonator construction (in klystrons)
V—indirectly heated oxide-coated cathode
X—directly heated tungsten filament
Y—directly heated thoriated-tungsten filament
Z—directly heated oxide-coated filament

The third letter

Transmitting valves with a silica envelope have a third letter 'S'.
Thyratrons with a shield grid (tetrode construction) have a third letter 'Q'.
Microwave devices that are tunable have a third letter 'T'.

The first group of figures, immediately following the letters, indicates:

(a) The approximate anode voltage in kV for transmitting valves and rectifiers:

Thus 05 represents 0.5kV = 500V
2 represents 2kV = 2000V

For valves intended for pulse operation this figure is the peak anode voltage in kV.

(b) The approximate peak inverse voltage in kV for thyratrons.

(c) The approximate frequency of operation in Gc/s for magnetrons, klystrons, backward wave tubes and travelling wave tubes:

Thus 9 represents 9Gc/s = 9000Mc/s.

The second group of figures indicates:

(a) For transmitting valves, the maximum permissible anode dissipation in W. For dissipations of 10kW or more the dissipation in kW is given.

(b) For transmitting valves primarily intended for pulse operation this group is prefixed by the letter 'P' and the figures indicate the maximum peak current in amps.

(c) For backward wave and travelling wave tubes, the output power in mW or W depending on the second letter ('A' or 'B').

(d) For magnetrons, the pulse power output in kW.

(e) For klystrons, the power output in mW.

(f) For rectifiers, the approximate rectifier output current in mA.

(g) For thyratrons, the approximate maximum permissible mean anode current in mA. This group consists of at least three digits, the first one being 0 if the current is between 10 and 100mA. For currents of 10A or more the current in amps is given.

Thus 045 represents 45mA
6400 represents 6400mA = 6.4A
12 represents 12A

A final letter occasionally follows the second group of figures. This is usually a serial letter to denote a particular design or development. Types designed for water cooling are indicated by the letter 'W' and if these types also have a forced air-cooled version this is indicated by the letter 'A'.

Examples

JP9-7	Magnetron with packaged construction for operation at a frequency of approximately 9000Mc/s with pulse power output of 7kW.
KS9-20	Klystron of reflex construction for operation at a frequency of approximately 9000Mc/s with a power output of 20mW.
LA4-250	Travelling wave tube for operation at a frequency of approximately 4000Mc/s with an output of 250mW.

QQV03-10 Double beam tetrode with indirectly heated oxide-coated cathode. Rated to work at 300V and to dissipate 10W continuously (5W at each anode).

QV20-P18 R.F. power tetrode with indirectly heated oxide-coated cathode. Designed for pulse operation with maximum peak anode voltage of 20kV and maximum peak anode current of 18A.

RG3-250 Mercury-vapour rectifier rated to work at 3kV and to give a maximum rectified output of 250mA.

XG5-500 Mercury-vapour thyratron having a rated peak inverse voltage of approximately 5kV and a maximum permissible mean anode current of approximately 500mA.

Cold cathode tubes

The type number for cold cathode tubes (excluding photocells and stabilisers) consists of one letter followed by a group of three figures which are followed by a second letter.

The first letter is always Z, indicating a cold cathode gasfilled tube.

The first figure indicates the type of base, the significance of the figure being the same as for Mullard receiving valves.

The second and third figures are serial numbers indicating a particular design or development.

The second letter indicates the function of the tube:

A—amplifier tube (continuous operation)
B—binary counter of switching tube
C—multistage counter tube
E—electrometer trigger or amplifier tube
G—gating tube
M—indicator (metering) tube
S—multistage switching tube
T—3-electrode trigger tube
U—4-electrode trigger tube
W—5-electrode trigger tube

Example

Z803U 4-electrode cold cathode trigger tube with B9A base.

CATHODE RAY TUBES

TUBE TYPE NOMENCLATURE

Mullard cathode ray tubes are normally registered with Pro-Electron. The type number consists of a single letter followed by two sets of figures ending with one or two letters.

The first letter indicates the primary application of the tube:

A — television display tube for domestic applications.
D — oscilloscope tube—single trace.
E — oscilloscope tube—multiple trace.
F — radar display tube—direct viewing.
L — display storage tube.
M — professional television or display tube (except radar) —direct viewing.
P — professional display tube—projection.
Q — flying spot scanner.

The first group of figures indicates the diameter or diagonal of the luminescent screen in cm:

Thus 7 represents a 7cm (3in) screen.
13 represents a 13cm (5in) screen.
47 represents a 47cm (19in) screen.
59 represents a 59cm (23in) screen.

The second group of figures is a two- or three-figure serial number indicating a particular design or development.

The second group of letters indicates the properties of the phosphor screen.

The first letter denotes the colour of the fluorescence (or phosphorescence in the case of long or very long afterglow screens) according to the regions of the Kelly Chart of Colour Designations for Lights, where applicable:

A — Reddish-purple, purple, bluish-purple.
B — Purplish-blue, blue, greenish-blue.
D — Blue-green.
G — Bluish-green, green, yellowish-green.
K — Yellow-green.
L — Orange, orange-pink.
R — Reddish-orange, red, pink, purplish-pink, purplish-red, red-purple.
W — White.
X — Tri-colour screen.
Y — Greenish-yellow, yellow, yellowish-orange.

The second letter is a serial letter to denote particular phosphors. For the 'standard' television picture tube phosphors, the letters 'W' and 'X' are used without a second letter. The current Mullard phosphors are listed overleaf.

An **internal graticule** is indicated by a two-figure suffix separated from the final letter by an oblique stroke, for example, D13-450GH/01.

Examples:

A47-26W Domestic television picture tube with 47cm (19in) screen.
D7-190GH Single trace oscilloscope tube having 7cm screen with phosphor 'GH'.

OLD SYSTEM

Some earlier cathode ray tubes have type numbers consisting of two letters followed by two sets of figures.

The first letter indicates the method of deflection and focusing:

A — Electrostatic focusing, magnetic deflection.
D — Electrostatic focusing and deflection.
M — Magnetic focusing and deflection.

The second letter indicates a particular phosphor. Letters in use are listed below.

The first group of figures immediately following the letters, indicates the diameter or diagonal of the luminescent screen in cm.

The second group of figures is a serial number indicating a particular design or development.

Examples:

AW53-88 Cathode ray tube of 53cm screen diagonal having a 'W' phosphor and employing magnetic deflection and electrostatic focusing.

DH3-91 Cathode ray tube of 3cm screen diameter having an 'H' phosphor and employing electrostatic deflection and focusing.

DESIGNATION OF MULLARD PHOSPHORS

Pro-Electron designation	*Old system*	*Fluorescent colour*	*Phosphorescent colour*	*Persistence*	*Equivalent JEDEC designation*
BA	C	Purplish-blue	—	Very short	—
BC	V	Purplish-blue	—	Killed	—
BD	A	Blue	—	Very short	—
BE	B	Blue	Blue	Medium short	P11
BF	U	Blue	—	Medium short	—
GB	M	Purplish-blue	Yellowish-green	Long	P32
GE	K	Green	Green	Short	P24
GH	H	Green	Green	Medium short	P31
GJ	G	Yellowish-green	Yellowish-green	Medium	P1
GK	G*	Yellowish-green	Yellowish-green	Medium	—
GL	N	Yellowish-green	Yellowish-green	Medium short	P2
GM	P	Purplish-blue	Yellowish-green	Long	P7
GN	J	Blue	Green (Infra-red excited)	Medium short (fluorescence)	—
GP	—	Bluish-green	Green	Medium short	P2
KA	—	Yellow-green	Yellow-green	Medium	P20
LA	D	Orange	Orange	Medium	—
LB	E	Orange	Orange	Long	—
LC	F	Orange	Orange	Very Long	—
LD	L	Orange	Orange	Very Long	P33
W	W	White	—	—	P4
X	X	Tri-colour screen	—	—	P22
YA	Y	Yellowish-orange	Yellowish-orange	Medium	—

*Used in projection tubes.

The following recommendations should be interpreted in conjunction with British Standard Code of Practice No. CP1005: Parts 1 and 2: 1954, "The Use of Electronic Valves", upon which these notes have, in part, been based.

LIMITING VALUES

The operating limits quoted on data sheets for individual tubes should on no account be exceeded. Two methods of specifying limiting values are used, the 'absolute' and 'design centre' systems, and these should be interpreted as follows:—

Absolute Ratings

The equipment designer must ensure that these ratings are never exceeded and in arriving at the actual tube operating conditions such variations as mains fluctuations, component tolerances and switching surges must be taken into account.

Design Centre Ratings

With a set of nominal valves inserted in an equipment connected to the highest permitted nominal supply voltage within a given tapping range, and in which all components have their nominal value, the tube ratings may at no time exceed the published maximum design centre value.

The phrase 'at no time' in the above paragraph means that increases in the tube working conditions, due to operating changes in equipment (e.g. a.g.c., switching, etc.) should be taken into account by the equipment designer. Normally encountered mains voltage variations (of up to $\pm 10\%$) are allowed for in the tube ratings, provided normal good practice is followed in the design of the receiver. In television receiver design, the above definition of design centre ratings applies when the timebases are synchronised. When the timebases are not synchronised it is permissible for the final anode voltage of the cathode ray tube to rise by not more than 10%.

HEATER

Parallel Operation

The heater voltage must be within $\pm 7\%$ of the rated value when the supply voltage is at its nominal rated value, and when a tube having the published heater characteristics is employed.

This figure is permissible only if the voltage variation is dependent upon more than one factor. In these circumstances the total tolerance may be taken as the square root of the sum of the squares of the individual deviations arising from the effect of the tolerances of the separate factors, providing no one of these deviations exceeds $\pm 5\%$. Should the voltage variation depend on one factor only, the voltage variation must not exceed $\pm 5\%$.

Series Operation

The heater current must be within ±5% of the rated value when the supply voltage is at its nominal rated value, and a tube having the published heater characteristics is employed.

This figure is permissible only if the current variation is dependent upon more than one factor. In these circumstances, the total tolerance may be taken as the square root of the sum of the squares of the individual deviations arising from the effects of the tolerances of the separate factors, providing no one of these deviations exceeds ±3.5%. Should the total current variation depend upon one factor only, the current variation must not exceed ±3.5%.

When calculating the tolerances of associated components, the ratio of the change of heater voltage to the change of heater current in a typical series chain including a cathode ray tube is taken as 1.8, both deviations being expressed as percentages.

With certain combinations of valves and tube, differences in the thermal inertia may result in particular heaters being run at exceedingly high temperature during the warming-up period. During this period, unless otherwise stated in the published data, it is permissible for the heater voltage of the tube to rise to a maximum value of 50% in excess of the nominal rated value when using a tube with the published heater characteristics. A surge limiting device may be necessary in order to meet this requirement. When measuring the surge value of heater voltage, it is important to employ a peak reading device, such as an oscilloscope.

In addition to the tolerances quoted above, fluctuations in the mains supply voltage not exceeding ±10% are permissible. These conditions are, however, the worst which are acceptable and it is better practice to maintain the heater as close to its published ratings as is possible, particularly in television equipment where changes in valve characteristics can have an appreciable effect upon the picture. Furthermore, in all types of equipment closer adjustment of heater voltage or current will react favourably upon valve and tube life and performance.

CATHODE

The potential difference between cathode and heater should be as low as possible and in any case must not exceed the limiting value given on the data sheets for individual tubes. Operation with the heater positive with respect to cathode is not recommended. In order to avoid excessive hum the a.c. component of the heater-to-cathode voltage should be as low as possible, e.g. less than $20V_{r.m.s.}$

When the heater is in a series chain or earthed, the 50c/s impedance between heater and cathode should not exceed 100kΩ. If the heater is supplied from a separate transformer winding the resistance between heater and cathode must not exceed 1MΩ.

INTERMEDIATE ELECTRODES (between cathode and final anode)

In no circumstances should the tube be operated without a d.c. connection between each electrode and the cathode. The total effective impedance between any electrode and the cathode should be as low as possible and must never be allowed to exceed the published maximum value.

Grid (Modulator electrode)

Television and Radar Tubes

The value of grid bias must not be allowed to become positive with respect to the cathode, except during the period immediately after switching the receiver on or off when it may be allowed to rise to +1V.

The maximum positive grid excursion of the video signal under normal operating conditions is permitted to reach 2V and at this voltage the grid current may be expected to be approximately 2mA.

Instrument Tubes

The tube should normally be operated so that the instantaneous grid voltage is not more positive than –1V.

Grid cut-off voltages

Curves showing the limits of grid cut-off voltage for specific values of first anode voltage are included in the data for individual tubes. The brightness control should be arranged so that it can handle any tube within the limits shown, at the appropriate first anode voltage (which is measured with respect to cathode).

LUMINESCENT SCREEN

To prevent permanent damage to the screen material, tubes should not be operated with a stationary or slowly moving spot, except at low beam current density. It is desirable that the scanning voltages are applied before cathode current is drawn from the tube.

Some television tubes have the face plate made of grey tinted glass in order to improve the contrast. The proportion of light transmitted through these screens is given on the data sheets for individual tubes. For a clear glass screen, approximately 90% of the light is transmitted.

Stray light falling upon the screen will result in loss of contrast. If it is difficult to shade the screen, the use of a suitable filter will improve the contrast.

Some types of screen material fluoresce under ultra-violet excitation, and where necessary, should be protected by an appropriate filter.

EXTERNAL CONDUCTIVE COATING

With those tubes having an external conductive coating, the capacitance of this to the final anode may be used to provide smoothing for the e.h.t. supply, and in all cases it must be earthed.

This coating is not a perfect conductor and in order to reduce radiation from the line timebase it may be necessary to make two separate connections to the coating on opposite sides of the bulb.

METAL CONE

Some tubes have a metal cone and where this cone and the glass face are operated at a high voltage any material in contact with the cone or the face must have insulating properties adequate for this voltage.

The metal cone must not come in contact with a magnet which would result in it becoming permanently magnetised. This would cause picture distortion.

HANDLING

The precautions taken in manufacture reduce the possibility of spontaneous implosion to a minimum but any additional stress due to mishandling considerably increases the risk of implosion; such an implosion may occur immediately or may be delayed. Particular care should be taken not to scratch any part of the bulb, particularly the face, as this will appreciably reduce the strength of the glass and may lead to implosion, often after a delay.

Care should be taken to prevent bumping or striking the rim around the face of a tube having a metal cone as rough treatment may damage the glass-to-metal seal.

When a tube is not in its equipment or original packing it should be placed screen downwards on a soft pad of suitable material free from abrasive substances. Tubes with relatively small necks and large bulbs (9 in. diameter and larger) should be handled by the bulb end. When it is necessary to handle the tube by the neck great care should be taken to avoid sideways leverage and the bulb should be supported when possible.

Attention is called to the fact that a high voltage charge may be carried by the internal conductive coating which is connected to the final anode connector and also by the external coating if not earthed, even after a tube has been removed from equipment. Anyone handling such a tube may receive a shock, which, while generally not dangerous to the person, might cause an involuntary reaction resulting in damage to the tube, which might, for example, be dropped.

PROTECTIVE SCREEN

The viewing screen of a cathode ray tube should be protected by means of a screen of transparent material of suitable strength to withstand implosion of the tube.

MOUNTING

Unless otherwise specified on the data sheets for individual tubes there are no restrictions on the position of mounting. Circular-faced all-glass television tubes should be mounted so that the position of the final anode connector is uppermost and adjustable within 15° of the vertical. This ensures that any major glass blemishes near the edge of the screen are behind the mask.

In mounting the tube the main support should be at the end nearer the screen and so arranged that no stresses are produced in the glass.

The tube socket should not be rigidly mounted but should have flexible leads and be allowed to move freely. Tubes having all-glass bases must not be soldered directly into the wiring and the use of a wiring jig is recommended when soldering connections to the holder.

It is very desirable that tubes should not be exposed to strong electrostatic and magnetic fields. In the case of electrostatic instrument tubes operating at low anode voltages a close fitting magnetic shield is generally necessary.

DIMENSIONS

Allowance should be made in the design of the equipment for the dimensional tolerances of the tube envelope and *reliance should not be placed upon dimensions taken from individual tubes.*

REFERENCE LINE

The reference line indicated on the tube outline drawing is determined by means of a suitable gauge. Drawings of several gauges follow these general operational recommendations.

X-RADIATION

No maximum permissible dosage rate has yet been accepted as a British Standard, but from work in progress at the time of printing it seems likely that a figure of 20mr per 8-hour period when measured on the outside surface of the equipment housing will be established.

CORNER CUTTING

Corner cutting, in general, is due to a direct obstruction of the electron beam after deflection before it reaches the screen and results in a blacking-out of the picture at the edges of the raster. It may be avoided by ensuring that:—

(1) the dimensions of the picture do not exceed the published

maximum *useful* screen dimensions and (2) the deflector coil system is such that the distance of its effective centre of deflection from the reference line does not exceed the maximum value given in the outline drawing.

The centre of deflection is positioned such that electrons deflected from this point in straight lines would reach the screen without being intercepted by the neck of the tube.

The maximum deflection angle is the angle subtended at the centre of deflection by the published maximum *useful* screen diameter, or diagonal in the case of rectangular tubes. (This should not be confused with the horizontal deflection angle.)

FOCUSING OF MAGNETIC TUBES

The magnetic field of the focus unit should be axially symmetrical.

The mounting should be such that upon insertion of the tube, the focus field is coaxial with the neck, and the magnetic centre is in the recommended position as indicated in the individual tube data.

In general, if the focus unit is moved toward the screen the required focusing power decreases, the resolution at the centre of the screen improves, and that at the edge deteriorates. However, with ion-trap tubes it is strongly recommended that the focus unit should be positioned as indicated, since this ensures a minimum of interaction between the magnetic field of the focus unit and the fields of the deflector coils and ion-trap magnet.

RASTER CENTERING OF MAGNETIC TUBES

To centre the raster on the screen it is recommended that either a magnetic field just behind the deflector coils be used or a direct current be passed through the deflector coils. The magnetic field should (1) lie as much as possible in a plane perpendicular to the axis of the tube; (2) be adjustable around it; (3) be variable in strength; (4) be self-magnetised and not depend on stray fields from other components; (5) extend over as short a length of the neck as possible; (6) be as uniform as possible over the cross-section of the neck. It is desirable that the zero shift position be indicated. It is not recommended that the focus field be used to centre the raster.

Unless otherwise specified the centering device should provide a shift of $\pm 3\%$ of the overall length of the tube to allow for non-centrality of the spot with respect to the geometric centre of the screen. In addition the centering device should provide the shift needed to allow for non-centrality of the visible raster (i.e. to compensate for line blanking and also timebase non-linearity, if any).

ION TRAPS

With those tubes which incorporate an ion trap, it is necessary to provide externally a magnetic field to deflect the electron beam through the final aperture of the gun towards the luminescent screen. This magnetic field is normally provided by a permanent magnet fitted with shaped pole pieces, and an adjustable clamp arranged so that the whole assembly may be moved along and around the neck of the tube. The limits of field strength for ion-trap magnet assemblies given in individual data sheets should be carefully observed. In particular, low field strength should be avoided and the assembly must not encroach further up the tube neck than the centre of the grid plane.

At e.h.t. voltages in excess of 10kV the ion-trap assembly should be earthed.

Notes on Adjustment of Ion-Trap Magnet

An arrow is marked on the magnet assembly so that when looking along the arrow the north pole is on the right hand side. An electron beam travelling between the pole pieces, in the direction of the arrow, will be deflected away from the actual magnet, which is located on the same side of the assembly as the arrow. Conversely, when the beam travels through the pole pieces in the direction opposite to that of the arrow it will be attracted towards the magnet. Hence there are two possible ways of using an ion-trap magnet to make the beam negotiate the bend in the gun; with the arrow pointing towards the screen or towards the base. The following procedure which has been found to give the better spot size should be adopted for adjusting the position of the magnet.

(1) (a) With the voltage supplies to the tube switched off and the base socket removed; slip the magnet assembly over the tube base with the arrow pointing *away* from the screen, and diametrically *opposite* the line marked on the neck of the tube. This line will normally be approximately in line with the position reserved for Pin No. 3 on the base. Adjust the assembly so that it is slightly in advance of the tube base.

(b) Fit the socket to the tube. Switch on the voltage supplies and adjust the brightness control. If necessary, adjust the position of the ion-trap magnet until a raster is obtained. Ensure that the picture centering controls are set at zero shift.

(c) Move the magnet assembly along the neck of the tube towards the screen until the raster brightness begins to decrease. Then move the magnet back towards the base until the brightness once more begins to decrease. Return the magnet to the position of maximum brightness lying between these two extremes. The magnet should now be rotated slightly to find the midpoint of the range of rotation which gives maximum brightness.

(d) Lock the magnet in position, taking care not to alter its position.

(2) With the procedure given above more accurate centering of the beam in the final aperture can be produced if the beam diameter is increased by underfocusing.

Where there is penetration of the field of the focus unit into the ion-trap region, an adjustment of the focus control will move the electron beam in the final aperture. This movement may be sufficiently large to 'black out' the picture. Accurate centering with an underfocused beam reduces this possibility.

(3) The movement produced by the focusing field, and hence 'blacking out', may also be reduced by the following additional procedure:—

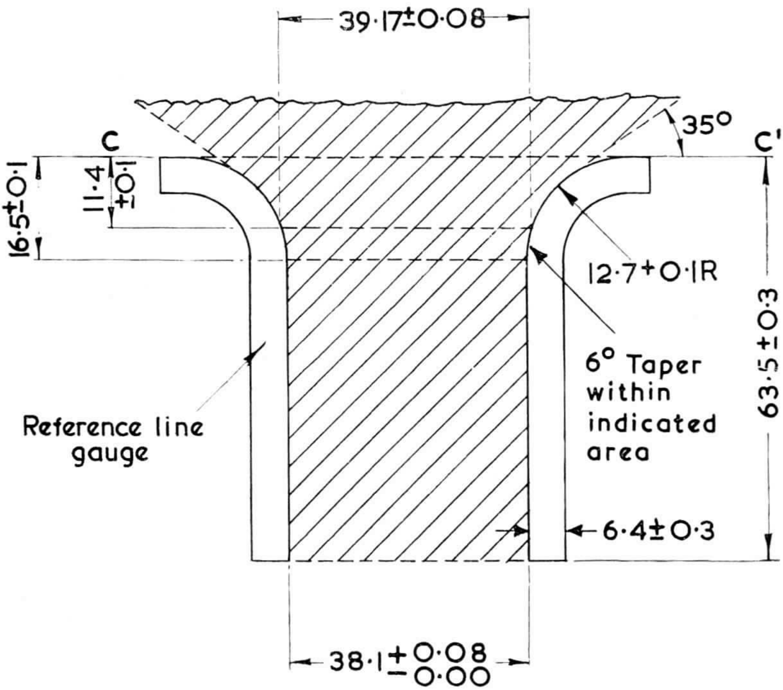
Note the angle between the centre line of the ion-trap assembly set by the procedure in (1), and the plane which passes through the bend in the gun of the cathode ray tube. If this angle is more than $\pm 10°$, rotate the magnet in a direction to reduce the angle and compensate any reduction in brightness by adjusting the angle between the focus unit and the tube neck. By successive adjustments, it will be possible to place the ion-trap magnet in line with the plane containing the bend of the gun.

ELECTROSTATIC INSTRUMENT TUBES

The e.h.t. line should be earthed, if possible, in order to avoid instability of traces due to the effects of capacitance and leakage to the screen. This is particularly important where accurate quantitative measurements are made on the screen surface of the tube. If, for other reasons, earthing the e.h.t. positive line is impracticable, as with post-deflection accelerator tubes, adequate precautions should be taken to insulate the tube from any earthed object such as the chassis.

A resistive path must be provided between each deflector plate and the anode. Its resistance should be as low as possible and must not exceed the published maximum value. If for any reason higher values are used some instability of the trace may be expected.

In order to minimise the risk of trapezoidal distortion, tubes should not normally be used with asymmetrical deflection unless specifically designed for this purpose. In general the mean deflector plate potentials should approximate to the final anode voltage in order to reduce defocusing of the beam to a minimum.



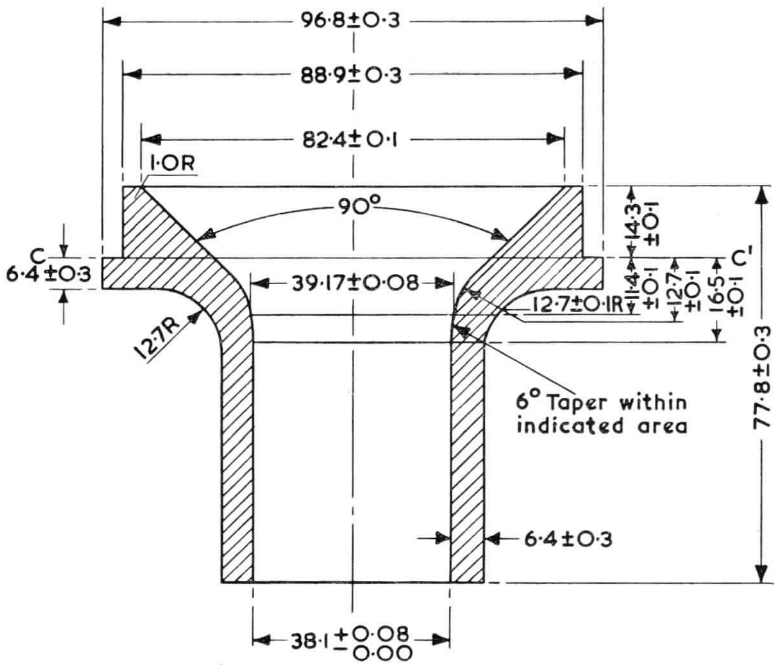
2331

All dimensions in mm

REFERENCE LINE GAUGE FOR CATHODE RAY TUBES HAVING 70 DEGREE SCANNING ANGLES

Reference Line

The reference line is determined by the plane C–C′ of the reference line gauge when the gauge is resting on the cone of the tube. To allow for dimensional tolerances the inner surface of the deflection coil must not extend into the shaded region indicated in the drawing.



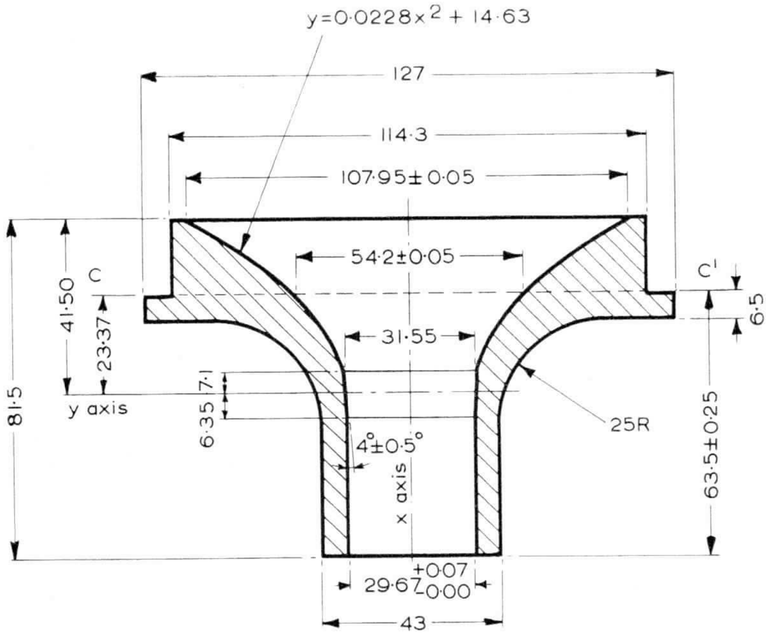
All dimensions in mm

2149

REFERENCE LINE GAUGE FOR CATHODE RAY TUBES HAVING 90 DEGREE SCANNING ANGLES

Reference Line

The reference line is determined by the plane C–C′ of the reference line gauge. For the design of deflector coils see detailed drawing of cone on individual data sheets.

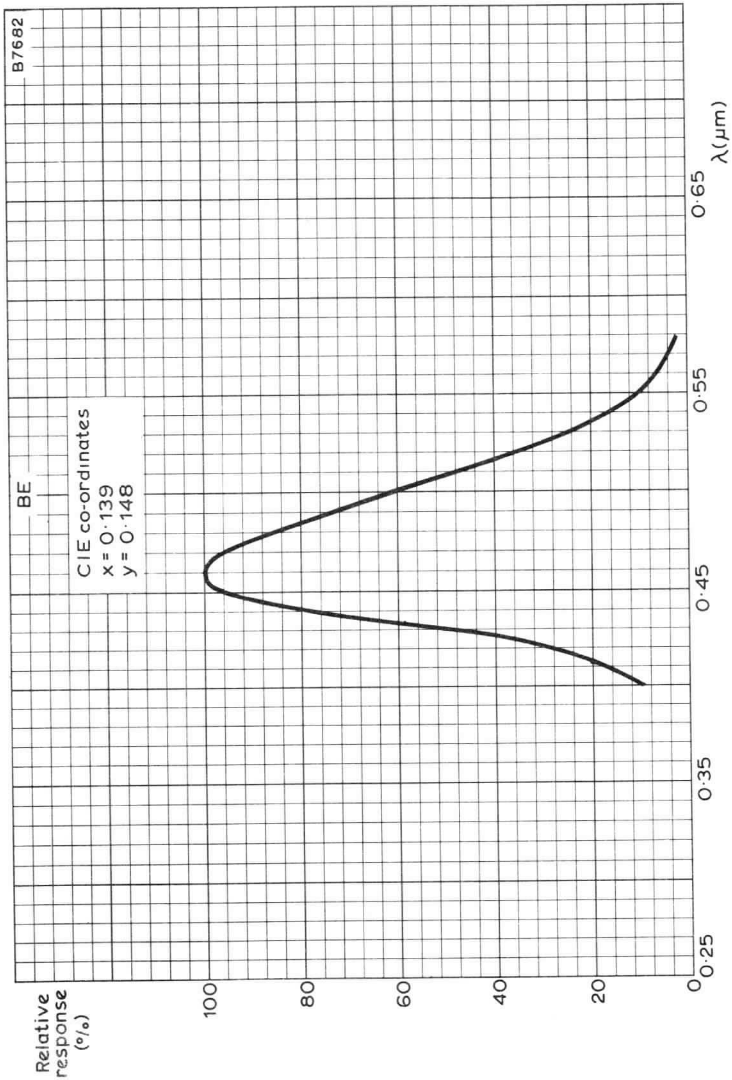


All dimensions in mm

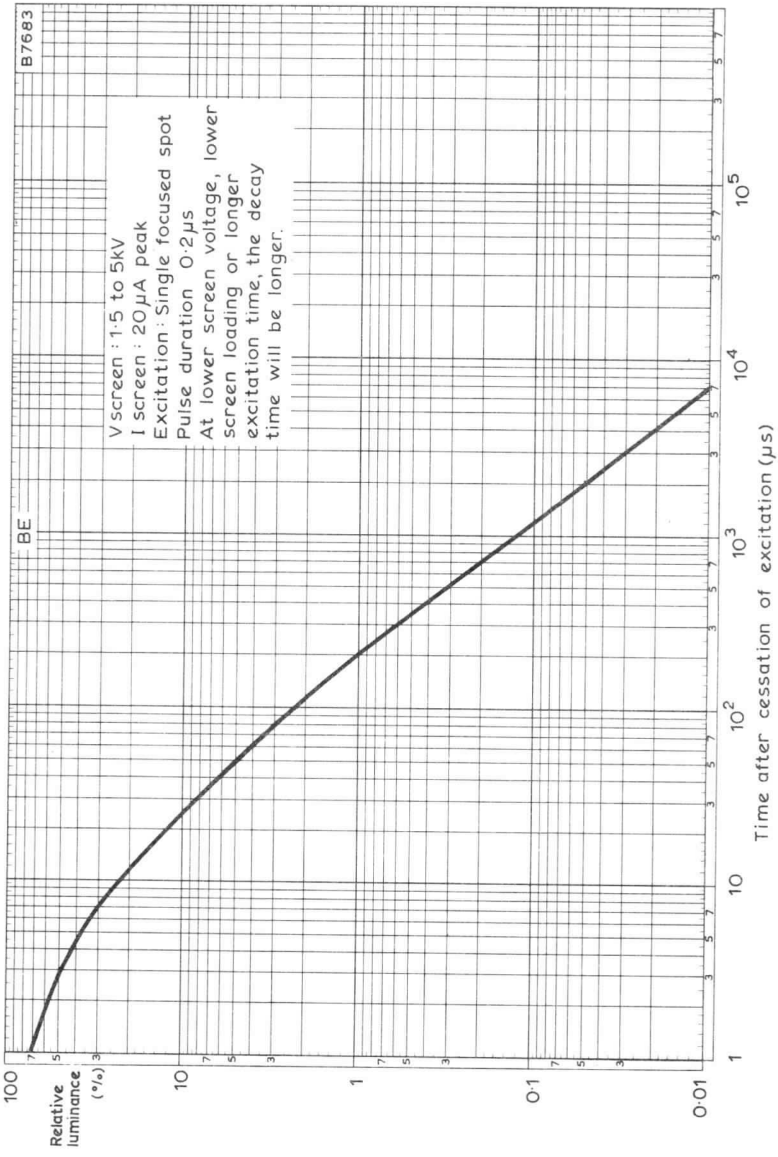
REFERENCE LINE GAUGE J.E.T.E.C. 126 FOR CATHODE RAY TUBES HAVING 110° SCANNING ANGLES

Reference Line

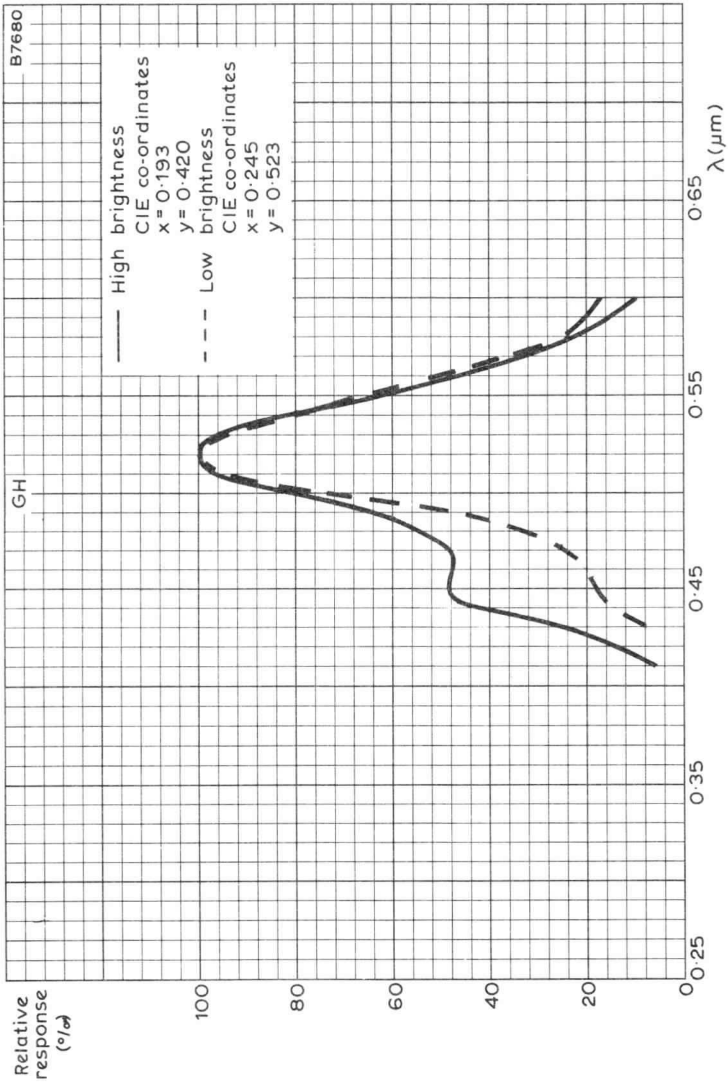
The reference line is determined by the plane C–C′ of the reference line gauge.



RELATIVE SPECTRAL ENERGY DISTRIBUTION CURVE
FOR TYPE BE LUMINESCENT SCREEN

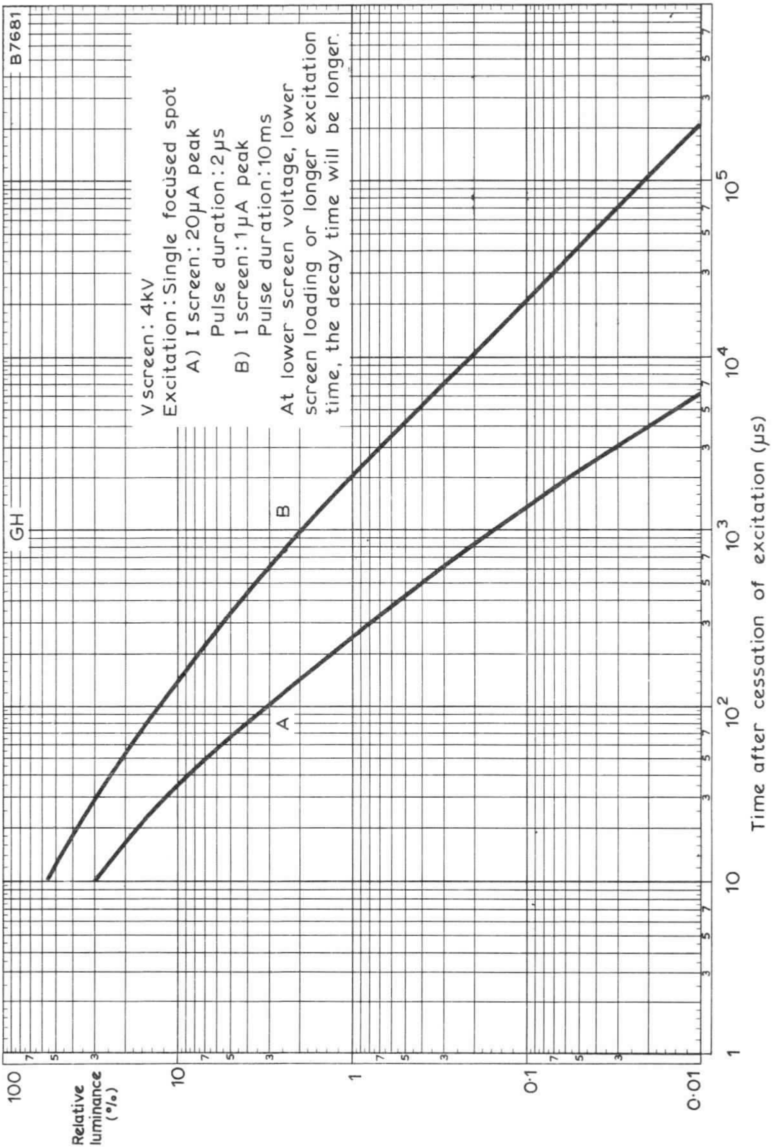


PERSISTENCE CHARACTERISTIC CURVE
FOR TYPE BE LUMINESCENT SCREEN

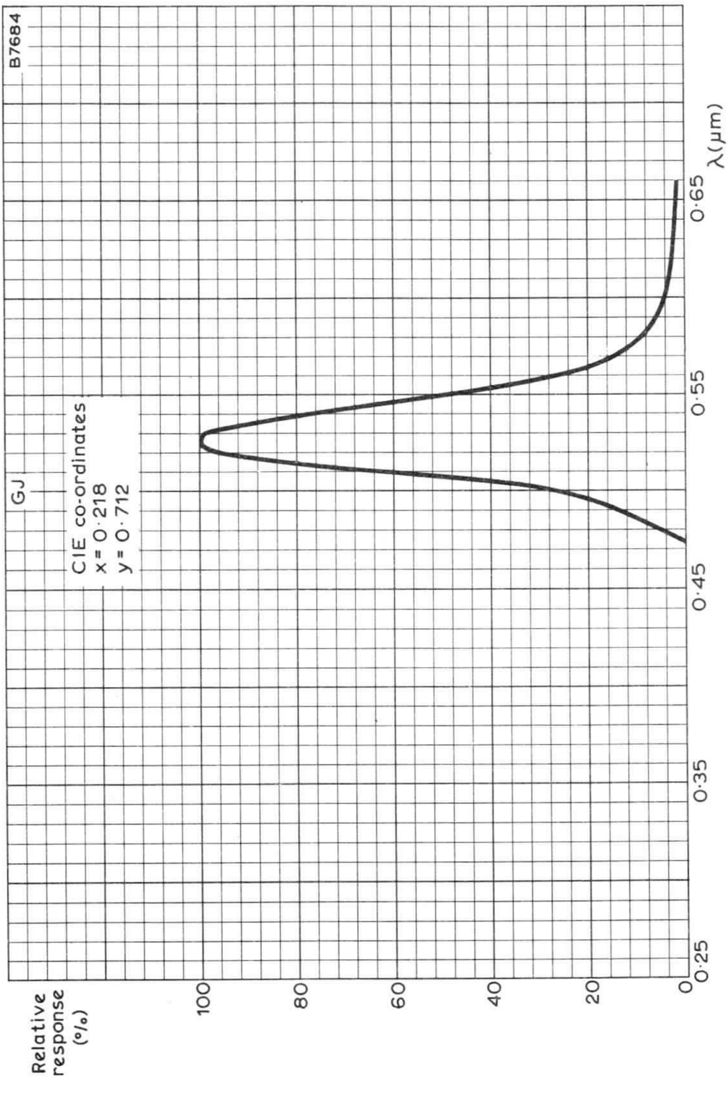


RELATIVE SPECTRAL ENERGY DISTRIBUTION CURVE
FOR TYPE GH LUMINESCENT SCREEN

CATHODE RAY TUBE
SCREEN TYPE GH(H)



PERSISTENCE CHARACTERISTIC CURVE
FOR TYPE GH LUMINESCENT SCREEN



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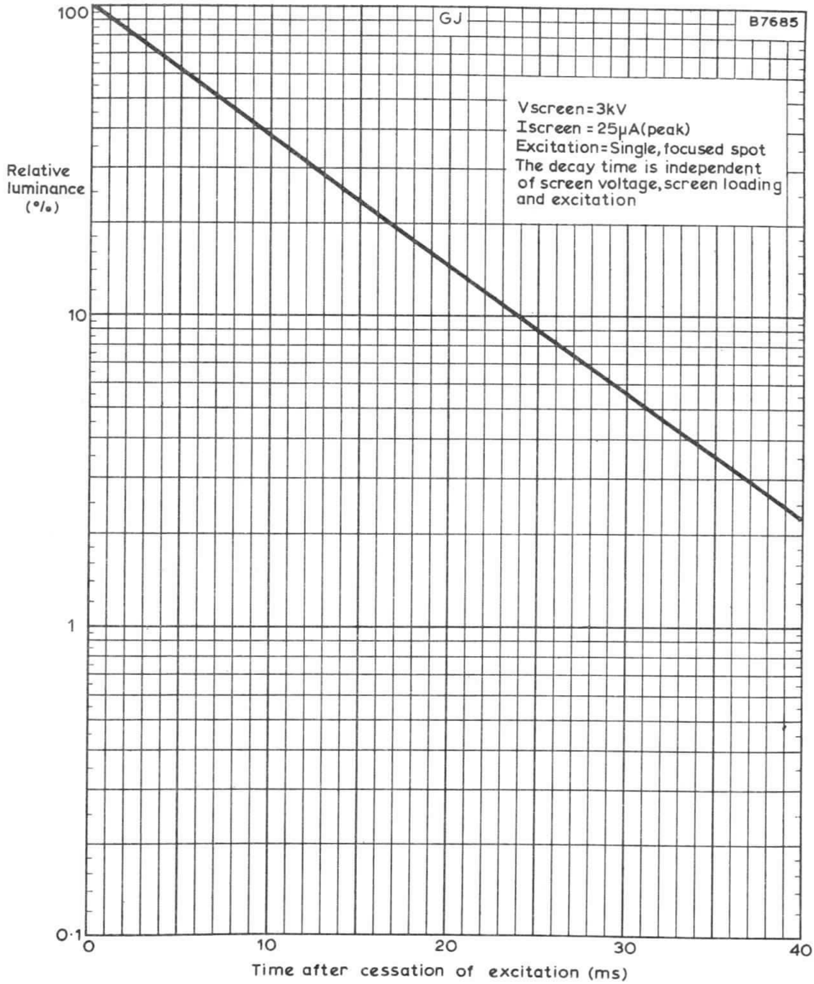
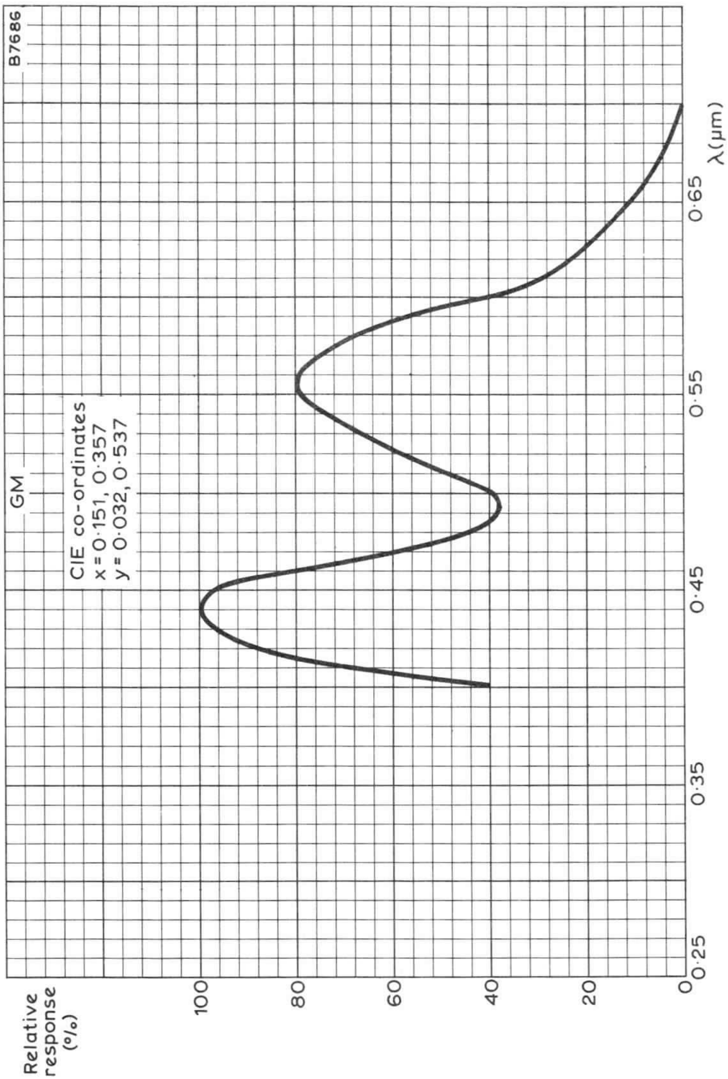
FOR TYPE GJ LUMINESCENT SCREEN

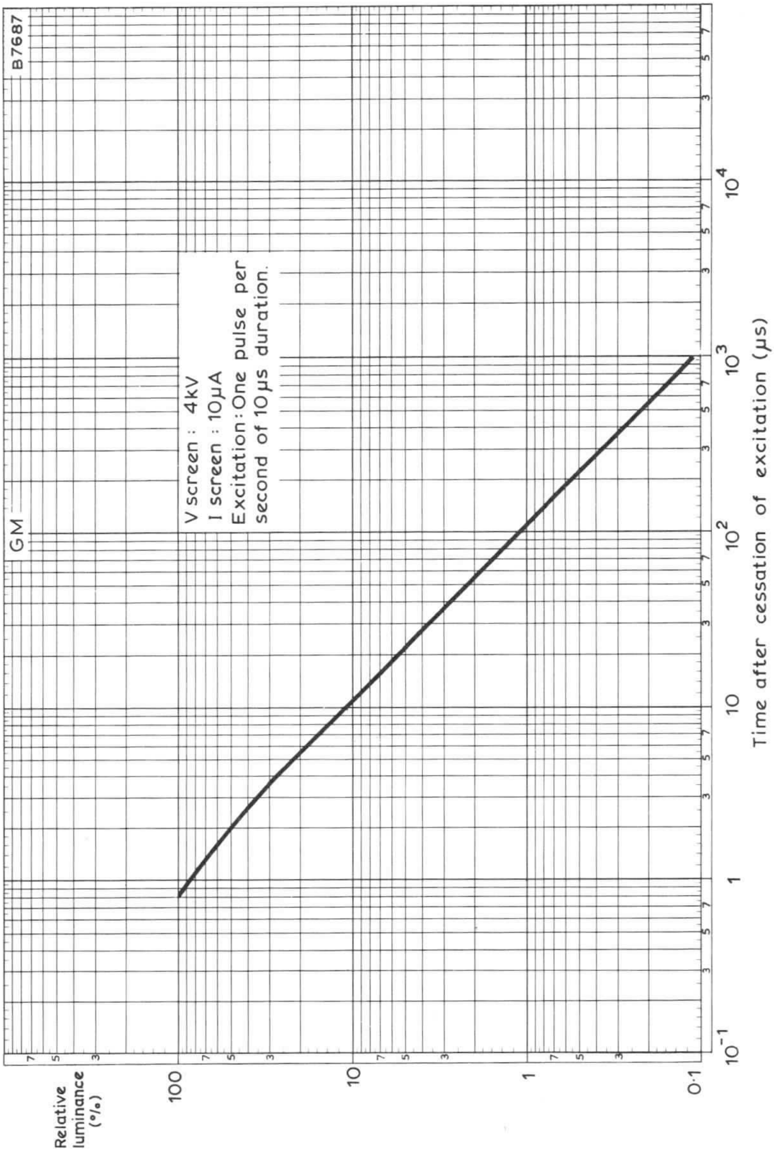


PERSISTENCE CHARACTERISTIC CURVE
FOR TYPE GJ LUMINESCENT SCREEN

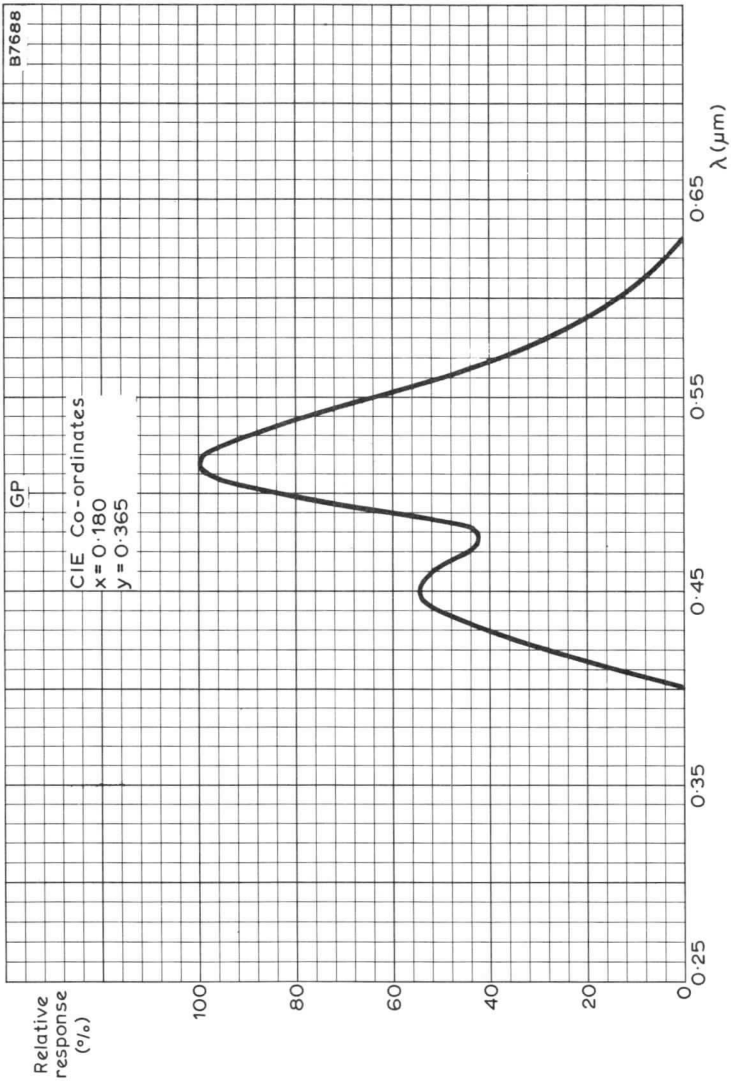


RELATIVE SPECTRAL ENERGY DISTRIBUTION CURVE
FOR TYPE GM LUMINESCENT SCREEN

CATHODE RAY TUBE
SCREEN TYPE GM(P)

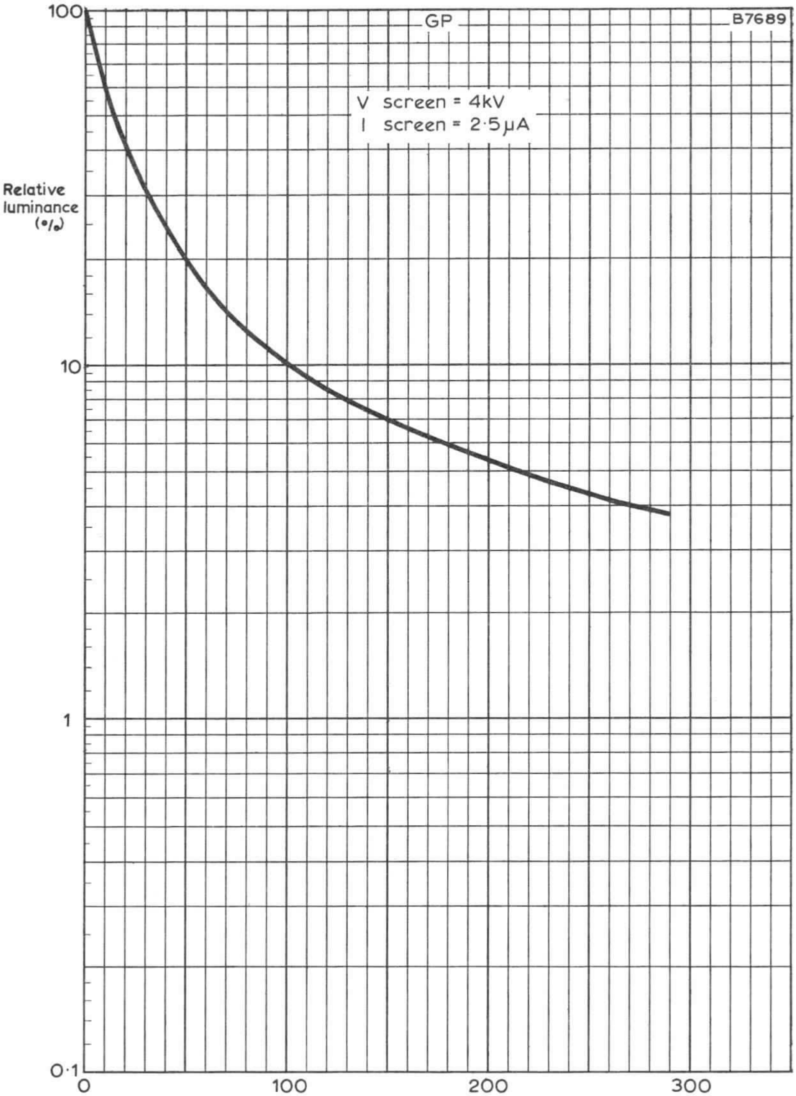


PERSISTENCE CHARACTERISTIC CURVE
FOR TYPE GM LUMINESCENT SCREEN

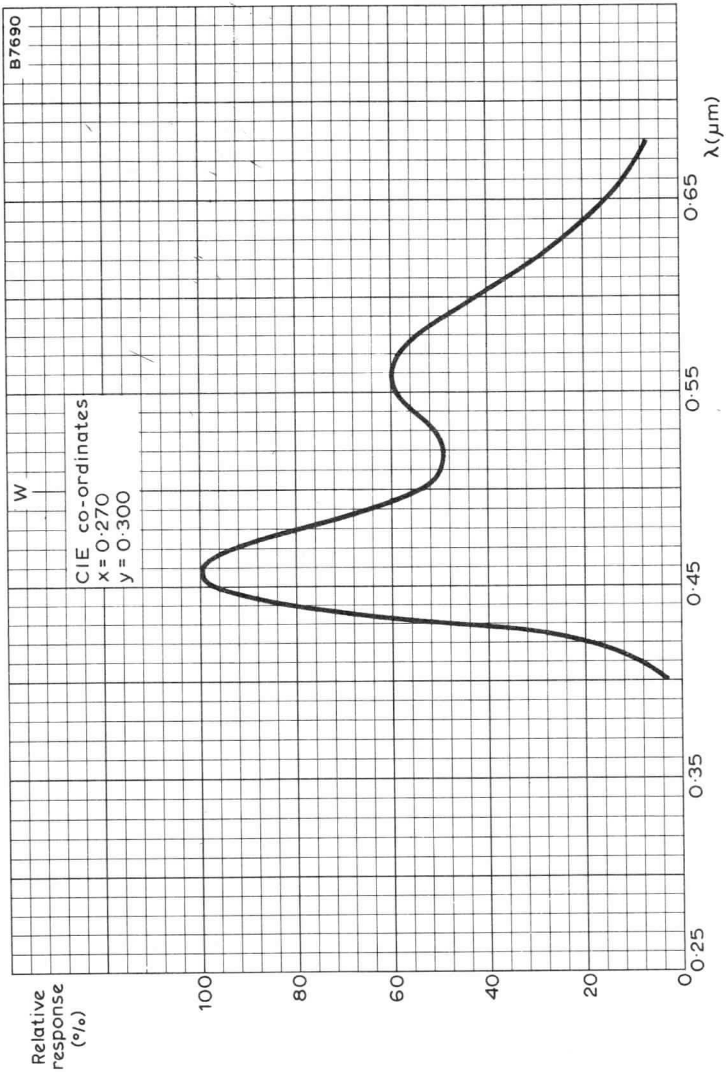


RELATIVE SPECTRAL ENERGY DISTRIBUTION CURVE
FOR TYPE GP LUMINESCENT SCREEN

CATHODE RAY TUBE
SCREEN TYPE GP



PERSISTENCE CHARACTERISTIC CURVE
FOR TYPE GP LUMINESCENT SCREEN



RELATIVE SPECTRAL ENERGY DISTRIBUTION CURVE
FOR TYPE W LUMINESCENT SCREEN

OSCILLOSCOPE TUBE D7-190GH

TENTATIVE DATA

QUICK REFERENCE DATA

7cm (3.0in) diameter, flat faced mono-accelerator oscilloscope tube, primarily intended for use in inexpensive oscilloscopes and read-out devices.

Final anode voltage	1.0	kV
Display area	50 × 60	mm
Deflection factor y	12	V/cm
Deflection factor x	29	V/cm

This data should be read in conjunction with
GENERAL OPERATIONAL RECOMMENDATIONS - CATHODE RAY TUBES

HEATER

Suitable for parallel operation only

V_h	6.3	V
I_h	300	mA

OPERATING CONDITIONS

Beam forming

Final anode and astigmatism control electrode (see note 1)	$V_{a1+a3+s1}$		1000 ± 25	V
Focus electrode	V_{a2}	approx.	150	V
Control grid (for visual cut-off)	V_g	approx.	-30	V

Line width (see note 2)

$V_{a1+a3+s1}$	1000	V
V_{a2}	adjusted for optimum line width	
$V_{y1} = V_{y2}$	1000	V
V_{x1}	300	V
V_{x2}	700	V
I_{x2}	10	μA
V_g	adjusted for I_{x2} value stated	
*Line width	0.3	mm

*Measured by the shrinking raster method in the centre of the screen.

DEFLECTION

Double electrostatic

Mean y-plate voltage	V_y mean	1000	V
Mean x-plate voltage	V_x mean	1000	V
Vertical deflection factor	S_y	12	V/cm
Horizontal deflection factor	S_x	29	V/cm
Angle between x and y deflection		90 ± 1	deg

Both x and y plates are intended for symmetrical deflection. If use is made of the full deflection capabilities of the tube the deflection plates will intercept part of the electron beam near the edge of the scan. Therefore a low impedance deflection plate drive is necessary.

Linearity of deflection

The sensitivity at a deflection of less than 75% of the useful scan will not differ from the sensitivity at a deflection of 25% of the useful scan by more than 2%.

CORRECTION POTENTIAL RANGES

Astigmatism control range	$\Delta V_{a1+a3+s1}$	±25	V

SCREEN

Phosphor	GH	
Fluorescent colour	green	
Phosphorescent colour	green	
Persistence	medium short	
Minimum useful screen diameter	64	mm
Minimum useful scan (at $V_{a1+a3+s1}$ = 1.0kV)		
$y_1 - y_2$	50	mm
$x_1 - x_2$	60	mm

The useful scan may be shifted vertically to a maximum of 4mm with respect to the geometric centre of the tube face.

RATINGS (ABSOLUTE MAXIMUM SYSTEM)

$V_{a1+a3+s1}$ max.	2.2	kV
$V_{a1+a3+s1}$ min.	0.9	kV
V_{a2} max.	2.2	kV
$-V_g$ max.	200	V
$+V_g$ max.	0	V
Grid drive (d.c. or average) max.	20	V
V_{h-k} max.	±125	V
p_t max.	3.0	mW/cm^2

CAPACITANCES (measured on a three terminal capacitance bridge)

High potential	Low potential	Earthed	Capacitance (pF)
k	all	-	5.0
g	all	-	6.0
x_1	all	x_2	4.0
x_2	all	x_1	4.0
y_1	all	y_2	3.5
y_2	all	y_1	3.5
x_1	x_2	all	2.5
y_1	y_2	all	1.5

MOUNTING POSITION

Any. The tube socket should not be rigidly mounted but should have flexible leads and be allowed to move freely.

WEIGHT

Tube alone (approx.)	260	g

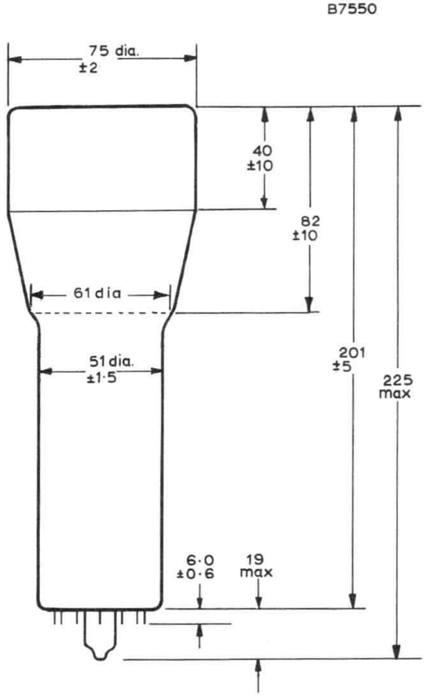
ACCESSORIES

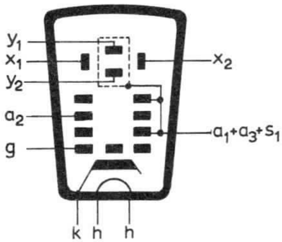
Socket (supplied with the tube)	55566
Mu-metal shield	55534

NOTES

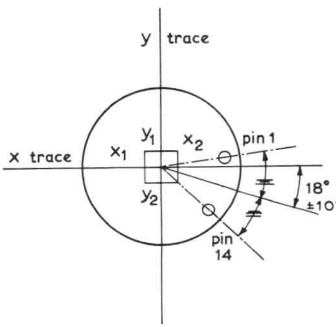
1. The astigmatism control voltage should be adjusted for optimum spot shape. The range stated will apply if the mean x and y plate potentials are equal to $V_{a1+a3+s1}$, with no astigmatism adjustment.
2. As the construction of the tube does not permit a direct measurement of the beam current, this current should be determined as follows:
   a) Under typical operating conditions display a small raster with no overscan, adjust V_g for a beam current of approximately 10μA and V_{a2} and $V_{a1+a3+s1}$ for optimum spot quality in the centre of the screen.
   b) Remove the raster and adjust the deflection plate voltages to the values stated under 'Line width', thus directing the total beam current to x2. Measure I_{x2} and adjust V_g so that $I_{x2} = 10\mu A$.
   c) Return to the conditions under (a) but without adjustment of V_g or $V_{a1+a3+s1}$. This results in a raster at a true beam current of 10μA.
   d) Adjust V_{a2} for optimum focus in the centre of the screen and measure the line width. Do not readjust $V_{a1+a3+s1}$.

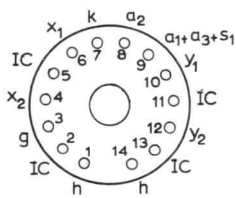
OUTLINE DRAWING OF D7-190GH





All dimensions in mm.





Orientation of axes of deflection
as viewed from screen end

As viewed from base end
Special 14 pin base

OSCILLOSCOPE TUBES

D10-11 BE GH
D10-12 GM GP

QUICK REFERENCE DATA		
10cm (4in) diameter, flat-faced oscilloscope tubes with helical p.d.a. Particularly suitable for general purpose oscilloscopes. The only difference between the D10-11 and D10-12 is the heater/cathode system; see the appropriate sections.		
Final anode voltage (p.d.a.)	4.0	kV
Display area (at $V_{a4} = 4V_{a3}$)	6 × full scan	cm
Deflection factor y	9.8	V/cm
Deflection factor x	27.5	V/cm

This data should be read in conjunction with GENERAL OPERATIONAL RECOMMENDATIONS - CATHODE RAY TUBES.

HEATER

Suitable for parallel operation only	D10-11	D10-12	
V_h	6.3	6.3	V
I_h	90	300	mA

OPERATING CONDITIONS

BEAM FORMING

Final anode + luminescent screen	V_{a4}	4.0	kV
Geometry control electrode	V_{s1}	1.0 ± 0.1	kV
Astigmatism control electrode	V_{a3}	1.0 ± 0.05	kV
Focus electrode	V_{a2}	50 to 200	V
First accelerator	V_{a1}	1.0	kV
Control grid (for visual cut-off)	V_g	-25 to -67	V

Raster distortion

A graticule, consisting of concentric rectangles 5 × 6cm and 4.84 × 5.84cm is aligned with the electrical x-axis of the tube. The edges of the raster will fall between these rectangles with optimum correction potentials applied.

Line width (GH screen)

V_{a4}	4.0	kV
V_{a3}	1.0	kV
V_{a1}	1.0	kV
I_t	10	μA
*Line width	0.35	mm

*Measured by the shrinking raster method in the centre of the screen

DEFLECTION

Double electrostatic

Mean y-plate voltage	V_y mean	1.0	kV
Mean x-plate voltage	V_x mean	1.0	kV
Vertical deflection factor	S_y	8.6 to 11	V/cm
Horizontal deflection factor	S_x	24 to 31	V/cm
Angle between x and y deflection		90 ± 1	deg

Both x and y plates are intended for symmetrical deflection.

If use is made of the full deflection capabilities of the tube the deflection plates will intercept part of the electron beam near the edge of the scan. Therefore a low impedance deflection plate drive is necessary.

Linearity of deflection

The sensitivity at a deflection of less than 75% of the useful scan will not differ from the sensitivity at a deflection of 25% of the useful scan by more than 2%.

CORRECTION POTENTIAL RANGES

Astigmatism control range	V_{a3}	950 to 1050	V
Geometry control range	V_{s1}	900 to 1100	V

SCREEN

Phosphor	BE	GH	GM	GP
Fluorescent colour	blue	green	purplish-blue	bluish-green
Phosphorescent colour	blue	green	yellowish-green	green
Persistence	medium short	medium short	long	medium short

Minimum useful screen diameter	8.5	cm
Minimum useful scan (at $V_{a4} = 4V_{a3}$)		
$y_1 - y_2$	6.0	cm
$x_1 - x_2$	full scan	

The useful scan may be shifted vertically to a maximum of 4mm with respect to the geometric centre of the tubeface.

RATINGS (ABSOLUTE MAXIMUM SYSTEM)

V_{a4} max. (p.d.a.)	5.0	kV
V_{a4} min.	1.5	kV
V_{a3} max.	2.2	kV
V_{a3} min.	900	V
V_{a2} max.	1.5	kV
V_{a1} max.	2.2	kV
V_{a1} min.	900	V
V_{s1} max.	2.2	kV
$-V_{g}$ max.	200	V
$+V_{g}$ max.	0	V
$+v_{g(pk)}$ max.	2.0	V
$v_{x-a3(pk)}$ max.	500	V
$v_{y-a3(pk)}$ max.	500	V
R_{g-k} max.	1.5	MΩ
p_{t} max.	3.0	mW/cm^2
V_{h-k} max.		
D10-11		
Cathode positive	100	V
Cathode negative	15	V
D10-12		
Cathode positive	200	V
Cathode negative	125	V
$I_{k(av)}$ max.	300	μA
R_{x-a3} max.	50	kΩ
R_{y-a3} max.	50	kΩ
Ratio V_{a4}/V_{a3} max.	4.0	

HELIX RESISTANCE

Minimum post-deflection helix resistance	50	MΩ

CAPACITANCES (measured on three terminal capacitance bridge)

High potential	Low potential	Earthed	Capacitance (pF) D10-11	Capacitance (pF) D10-12
k	all	-	3.0	3.0
g	all	-	4.5	5.0
x_1	all	x_2	3.5	4.0
x_2	all	x_1	3.5	4.0
y_1	all	y_2	2.5	3.0
y_2	all	y_1	3.0	3.0
x_1	x_2	all	2.0	2.0
y_1	y_2	all	1.7	1.7

EQUIPMENT DESIGN RANGE

Focusing electrode voltage	V_{a2}	50 to 200	V/kV of V_{a3}
Grid cut-off voltage	V_g	-25 to -67	V/kV of V_{a3}
Deflection factor ($V_{a4}=4V_{a3}$)			
Vertical	y	8.6 to 11	V/cm/kV of V_{a3}
Horizontal	x	24 to 31	V/cm/kV of V_{a3}

MOUNTING POSITION

Any. The tube socket should not be rigidly mounted but should have flexible leads and be allowed to move freely.

WEIGHT

Tube alone	approx.	1.1	lb
		480	g

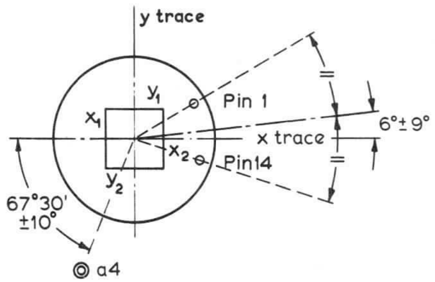
ACCESSORIES

Socket (supplied with the tube)	55566
a_4 connector (recessed ball connector CT7)	55560
Mu-metal shield	55541

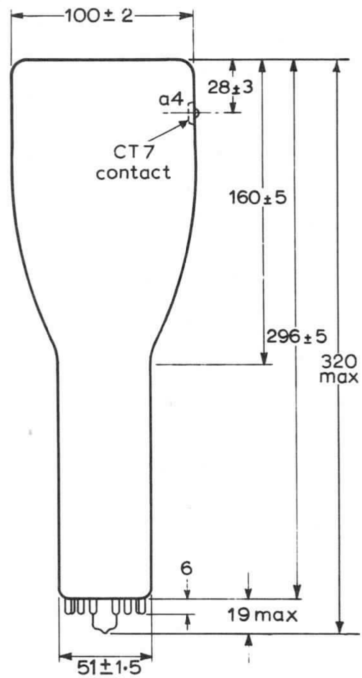
OSCILLOSCOPE TUBES

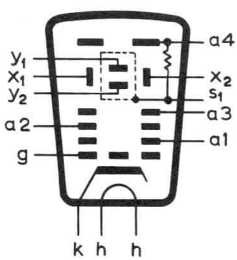
D10-11 BE GH
D10-12 GM GP

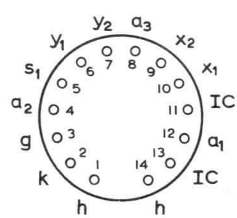
B5972



Orientation of axes of deflection as viewed from screen end







As viewed from base end
Special 14 pin base

All dimensions in mm

OSCILLOSCOPE TUBE D10-160GH

TENTATIVE DATA

QUICK REFERENCE DATA

10cm (4.0in) diameter, flat faced mono-accelerator oscilloscope tube, primarily intended for use in inexpensive oscilloscopes and read-out devices.

Final anode voltage	1.5	kV
Display area	60 × 80	mm
Deflection factor y	14.5	V/cm
Deflection factor x	33	V/cm

This data should be read in conjunction with GENERAL OPERATIONAL RECOMMENDATIONS - CATHODE RAY TUBES

HEATER

Suitable for parallel operation only

V_h	6.3	V
I_h	300	mA

OPERATING CONDITIONS

Beam forming

Final anode and astigmatism control electrode (see note 1)	$V_{a1+a3+s1}$		1500 ± 30	V
Focus electrode	V_{a2}	approx.	225	V
Control grid (for visual cut-off)	V_g	approx.	-50	V

Line width (see note 2)

$V_{a1+a3+s1}$	1.5	kV
V_{a2}	adjusted for optimum line width	
$V_{y1} = V_{y2}$	1.5	kV
V_{x1}	800	V
V_{x2}	1.2	kV
I_{x2}	10	μA
V_g	adjusted for I_{x2} value stated	
*Line width	0.3	mm

*Measured by the shrinking raster method in the centre of the screen.

DEFLECTION

Double electrostatic

Mean y-plate voltage	V_y mean	1.5	kV
Mean x-plate voltage	V_x mean	1.5	kV
Vertical deflection factor	S_y	14.5	V/cm
Horizontal deflection factor	S_x	33	V/cm
Angle between x and y deflection		90 ± 1	deg

Both x and y plates are intended for symmetrical deflection. If use is made of the full deflection capabilities of the tube the deflection plates will intercept part of the electron beam near the edge of the scan. Therefore a low impedance deflection plate drive is necessary.

Linearity of deflection

The sensitivity at a deflection of less than 75% of the useful scan will not differ from the sensitivity at a deflection of 25% of the useful scan by more than 2%.

CORRECTION POTENTIAL RANGE

Astigmatism control range	$V_{a1+a3+s1}$	±30	V

SCREEN

Phosphor	GH	
Fluorescent colour	green	
Phosphorescent colour	green	
Persistence	medium short	
Minimum useful screen diameter	85	mm
Minimum useful scan (at $V_{a1+a3+s1}$ = 1.5kV)		
$y_1 - y_2$	60	mm
$x_1 - x_2$	80	mm

The useful scan may be shifted vertically to a maximum of 5mm with respect to the geometric centre of the tube face.

RATINGS (ABSOLUTE MAXIMUM SYSTEM)

$V_{a1+a3+s1}$ max.	2.2	kV
$V_{a1+a3+s1}$ min.	1.35	kV
V_{a2} max.	2.2	kV
$-V_g$ max.	200	V
$+V_g$ max.	0	V
Grid drive (d.c. or average) max.	20	V
V_{h-k} max.	±125	V
p_t max.	3.0	mW/cm^2

CAPACITANCES (measured on a three terminal capacitance bridge)

High potential	Low potential	Earthed	Capacitance (pF)
k	all	-	5.0
g	all	-	6.0
x_1	all	x_2	4.0
x_2	all	x_1	4.0
y_1	all	y_2	3.5
y_2	all	y_1	3.5
x_1	x_2	all	2.5
y_1	y_2	all	1.5

MOUNTING POSITION

Any. The tube socket should not be rigidly mounted but should have flexible leads and be allowed to move freely.

WEIGHT

Tube alone (approx.)	400	g

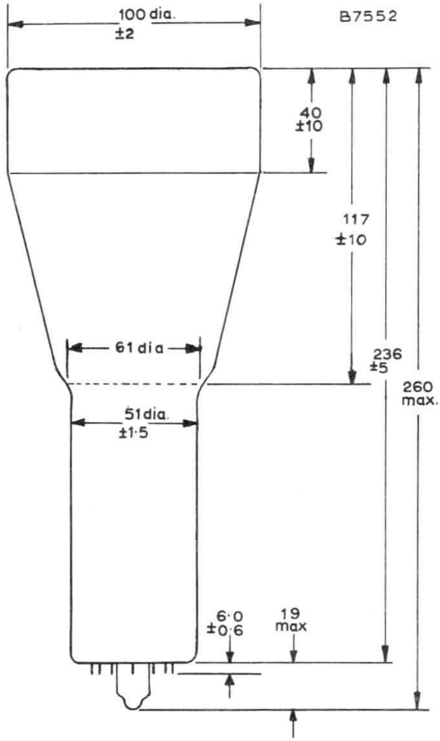
ACCESSORIES

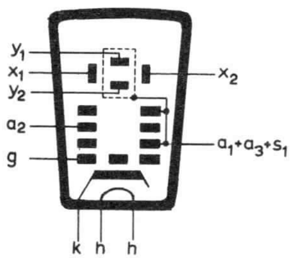
Socket (supplied with the tube)	55566
Mu-metal shield	55547

NOTES

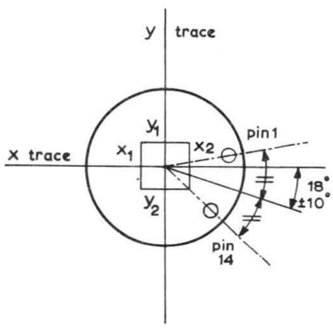
1. The astigmatism control voltage should be adjusted for optimum spot shape. The range stated will apply if the mean x and y plate potentials are equal to $V_{a1+a3+s1}$, with no astigmatism adjustment.
2. As the construction of the tube does not permit a direct measurement of the beam current, this current should be determined as follows:
   a) Under typical operating conditions display a small raster with no overscan, adjust V_g for a beam current of approximately 10μA and V_{a2} and $V_{a1+a3+s1}$ for optimum spot quality in the centre of the screen.
   b) Remove the raster and adjust the deflection plate voltages to the values stated under 'Line width', thus directing the total beam current to x2. Measure I_{x2} and adjust V_g so that $I_{x2} = 10\mu A$.
   c) Return to the conditions under (a) but without adjustment of V_g or $V_{a1+a3+s1}$. This results in a raster at a true beam current of 10μA.
   d) Adjust V_{a2} for optimum focus in the centre of the screen and measure the line width. Do not readjust $V_{a1+a3+s1}$.

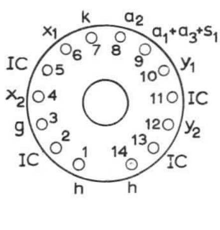
OUTLINE DRAWING OF D10-160GH





All dimensions in mm.





Orientation of axes of deflection as viewed from screen end

As viewed from base end
Special 14 pin base

OSCILLOSCOPE TUBE D10-170GH

QUICK REFERENCE DATA		
10cm (4in) diameter flat-faced oscilloscope tube with mesh, intended for use in transistorised oscilloscopes up to 30MHz.		
Final anode voltage (p.d.a.)	6.0	kV
Display area (at $V_{a4} = 6.0V_{a1+a3}$)	60 × 80	mm
Deflection factor y	3.5	V/cm
Deflection factor x	13	V/cm

This data should be read in conjunction with
GENERAL OPERATIONAL RECOMMENDATIONS - CATHODE RAY TUBES

HEATER

Suitable for parallel operation only

V_h	6.3	V
I_h	300	mA

OPERATING CONDITIONS

Beam forming

Final anode + luminescent screen	V_{a4}	6.0	kV
Geometry control electrode and interplate shield (see note 1)	V_{s2}	1000 ± 15	V
Deflection plate shield (see note 2)	V_{s1}	1000	V
Focus electrode	V_{a2}	170 to 230	V
First accelerator and astigmatism control electrode (see note 3)	V_{a1+a3}	1000 ± 30	V
Control grid (for visual cut-off)	V_g	-16 to -40	V

Raster distortion

A graticule consisting of concentric rectangles 60 × 60mm and 58.6 × 58.6mm is aligned with the electrical x-axis of the tube. The edges of a raster will fall between these rectangles with optimum correction potentials applied.

Line width

V_{a4}	6.0	kV
V_{s2}	1.0	kV
V_{s1}	1.0	kV
V_{a1+a3}	1.0	kV
I_t	10	μA
*Line width	0.42	mm

*Measured by the shrinking raster method in the centre of the screen.

DEFLECTION

Double electrostatic

Mean y-plate voltage (see note 2)	$V_{y(mean)}$		1.0	kV
Mean x-plate voltage (see note 2)	$V_{x(mean)}$		1.0	kV
Vertical deflection factor	S_y	av. 3.5,	max. 3.8	V/cm
Horizontal deflection factor	S_x	av. 13,	max. 14	V/cm
Angle between x and y traces			$90^{\circ} \pm 45'$	

Both x and y plates are intended for symmetrical deflection.

If use is made of the full deflection capabilities of the tube the deflection plates will intercept part of the electron beam near the edge of the scan. Therefore a low impedance deflection plate drive is necessary.

Linearity of deflection

The sensitivity at a deflection of less than 75% of the useful scan will not differ from the sensitivity at a deflection of 25% of the useful scan by more than 2%.

CORRECTION POTENTIAL RANGES

Astigmatism control range (see note 3)	ΔV_{a1+a3}	±30	V
Geometry control range (see note 1)	ΔV_{s2}	±15	V

SCREEN

Phosphor	GH	
Fluorescent colour	green	
Phosphorescent colour	green	
Persistence	medium short	
Minimum useful scan (at $V_{a4}=6.0V_{a1+a3}$)		
$y_1 - y_2$	60	mm
$x_1 - x_2$	80	mm

The useful scan may be shifted vertically to a maximum of 5mm with respect to the geometric centre of the tube face.

RATINGS (ABSOLUTE MAXIMUM SYSTEM)

V_{a4} max. (p.d.a.)	6.6	kV
V_{a4} min.	4.0	kV
V_{s2} max.	2.2	kV
V_{s1} max.	2.2	kV
V_{a2} max.	2.2	kV
V_{a1+a3} max.	2.2	kV
V_{a1+a3} min.	900	V
$-V_g$ max.	200	V
$+V_g$ max.	0	V
Grid drive (d.c. or average) max.	20	V
V_{h-k} max.	±125	V
$v_{x(a1+a3)pk}$ max.	500	V
$v_{y(a1+a3)pk}$ max.	500	V
p_t max.	3.0	mW/cm^2
Ratio V_{a4}/V_{a1+a3} max.	6.0	

CAPACITANCES (measured on a three terminal capacitance bridge)

High potential	Low potential	Earthed	Capacitance (pF)
k	all	-	5.0
g	all	-	6.0
x_1	all	x_2	7.0
x_2	all	x_1	7.0
y_1	all	y_2	5.0
y_2	all	y_1	5.0
x_1	x_2	all	2.5
y_1	y_2	all	1.5

MOUNTING POSITION

Any. The tube socket should not be rigidly mounted but should have flexible leads and be allowed to move freely.

WEIGHT

Tube alone (approx.)	500	g

ACCESSORIES

Socket (supplied with the tube)	55566
a4 connector (cavity connector CT8)	55563
Mu-metal shield	55548

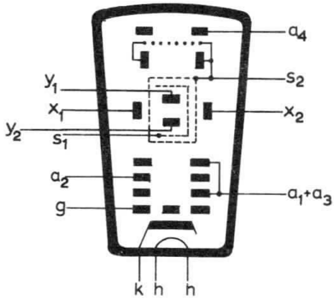
NOTES

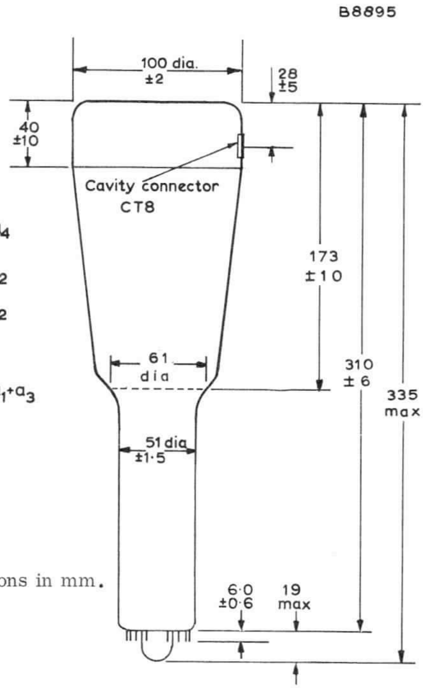
1. This tube is designed for optimum performance when operating at a ratio $V_{a4}/V_{a1+a3} \leq 6.0$. The geometry control electrode voltage (V_{s2}) should be adjusted between -15V and +15V with respect to the mean x-plate potential.
   A negative control voltage will give some pin-cushion distortion with less background light, and a positive voltage will give some barrel distortion and a slight increase in background light.

2. The deflection plate shield voltage (V_{s1}) should be equal to the mean y-plate potential. The mean x- and y-plate potentials should be equal for optimum spot quality.

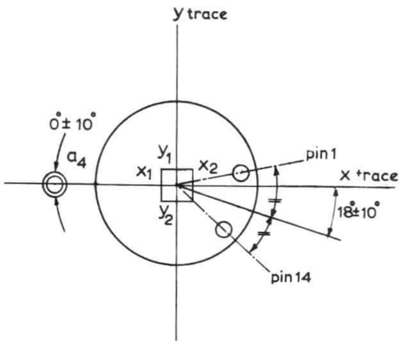
3. The astigmatism control should be adjusted within the stated range for optimum spot shape.

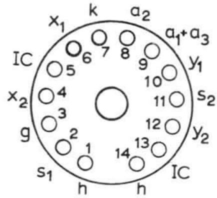
OUTLINE DRAWING OF D10-170GH





All dimensions in mm.





Orientation of axes of deflection as viewed from screen end

As viewed from base end
Special 14 pin base

QUICK REFERENCE DATA		
13cm (5in) diameter, flat faced oscilloscope tube with metal backed screen, helical p.d.a. and side connections to the x and sectioned y plates. This tube incorporates deflection blanking and is intended for high frequency, high writing speed displays.		
Final anode voltage (p.d.a.)	10	kV
Display area (at $V_{a4} = 6V_{a3}$)	6×10	cm
Deflection factor y	6.0	V/cm
Deflection factor x	<18	V/cm

This data should be read in conjunction with GENERAL OPERATIONAL RECOMMENDATIONS - CATHODE RAY TUBES.

HEATER

Suitable for parallel operation only

V_h	6.3	V
I_h	300	mA

OPERATING CONDITIONS

BEAM FORMING

Final anode + luminescent screen	V_{a4}	10	kV
Second accelerator	V_{a3}	1.67	kV
Focus electrode	V_{a2}	230 to 500	V
First accelerator	V_{a1}	1.67	kV
Geometry control electrode	V_{s3}	1.67	kV
Deflection plate shield	V_{s2}	1.67	kV
Beam centring electrode	V_{s1}	1.67	kV
Beam blanking electrode	V_{g2}	1.67	kV
Control grid (for visual cut-off)	V_{g1}	-50 to -120	V
*Beam blanking control	ΔV_{g2}	<60	V

*For visual extinction of a beam current of 10μA, the beam blanking electrode voltage change will not exceed 60 volts with respect to V_{a1}.

Raster distortion

A graticule, consisting of concentric rectangles 10 × 6cm and 9.8 × 5.82cm is aligned with the electrical x-axis of the tube. The edges of a raster will fall between these rectangles, with optimum correction potentials applied.

Line width (GH screen)

V_{a4}	10	kV
V_{a3}	1.67	kV
V_{a1}	1.67	kV
I_t	10	μA
*Line width	0.35	mm

*Measured by the shrinking raster method in the centre of the screen.

DEFLECTION

Double electrostatic

Mean y-plate voltage	V_y mean	1.67	kV
Mean x-plate voltage	V_x mean	1.67	kV
Vertical deflection factor	S_y	5.6 to 6.6	V/cm
Horizontal deflection factor	S_x	<18	V/cm
Angle between x and y deflection		90±1	deg

If use is made of the full deflection capabilities of the tube, the deflection plates will intercept part of the electron beam near the edge of the scan. Therefore a low impedance deflection plate drive is necessary.

Both x and y plates are intended for symmetrical deflection.

Linearity of deflection

The sensitivity at a deflection of less than 75% of the useful scan will not differ from the sensitivity at a deflection of 25% of the useful scan by more than 2%.

CORRECTION POTENTIAL RANGES

Astigmatism control range	V_{a3}	1.67 to 1.77	kV
Geometry control range	V_{s3}	1.67 to 1.77	kV
*Beam centring control range	V_{s1}	1.67 to 1.69	kV

*The beam centring electrode voltage should be adjusted for equal brightness in the x-direction on either side of the electrical centre of the tube.

SCREEN

Tube face diameter		13	cm
Phosphor	BE	GH	GP
Fluorescent colour	blue	green	bluish-green
Phosphorescent colour	blue	green	green
Persistence	medium short	medium short	medium short

Minimum useful screen diameter	11.4	cm
Minimum useful scan (at $V_{a4} = 6V_{a3}$)		
y1 - y2	6.0	cm
x1 - x2	10	cm

The useful scan may be shifted vertically to a maximum of 5mm with respect to the geometric centre of the tube face .

RATINGS (ABSOLUTE MAXIMUM SYSTEM)

V_{a4} max. (p.d.a.)	16	kV
V_{a4} min.	9.0	kV
V_{a3} max.	2.5	kV
V_{a2} max.	2.5	kV
V_{a1} max.	2.5	kV
V_{a1} min.	1.25	kV
Ratio of V_{a4}/V_{a3} max.	10	
Ratio of V_{a1}/V_{a3} max.	1	
V_{s3} max.	2.5	kV
V_{s2} max.	2.5	kV
V_{s1} max.	2.5	kV
V_{g2} max.	2.5	kV
$-V_{g1}$ max.	200	V
$+V_{g1}$ max.	0	V
$+v_{g(pk)}$ max.	2.0	V
$I_{k(av)}$ max.		
V_{h-k} max.		
Cathode positive	200	V
Cathode negative	125	V
R_{x-a3} max.	50	kΩ
R_{y-a3} max.	50	kΩ

RATINGS (ABSOLUTE MAXIMUM SYSTEM) (Cont'd)

R_{g-k} max.	1.5	MΩ
Maximum screen dissipation	3.0	mW/cm^2

HELIX RESISTANCE

Minimum post deflection helix resistance (a4 to s3)	300	MΩ

CAPACITANCES (measured on a three terminal capacitance bridge)

High potential	Low potential	Earthed	Capacitance (pF)
k	all	-	3.0
g1	all	-	5.0
g2	all	-	9.0
x1	all	x2	2.8
x2	all	x1	2.8
y1.1	all	(y 1.2, 1.3, 1.4) (y 2.1, 2.2, 2.3, 2.4)	1.6
y2.1	all	(y 1.1, 1.2, 1.3, 1.4) (y 2.2, 2.3, 2.4)	1.6
x1	x2	all	2.3
y1.1	y2.1	all	0.7

EQUIPMENT DESIGN RANGE

Focusing electrode voltage	V_{a2}	138 to 300	V/kV of V_{a1}
Focusing electrode current	I_{a2}	-10 to +15	μA
Grid cut-off voltage	V_{g1}	-24 to -72	V/kV of V_{a1}
Deflection factor ($V_{a4} = 6V_{a3}$)			
Vertical	y	3.4 to 4.0	V/cm/kV of V_{a3}
Horizontal	x	≤10.8	V/cm/kV of V_{a3}

MOUNTING POSITION

Any

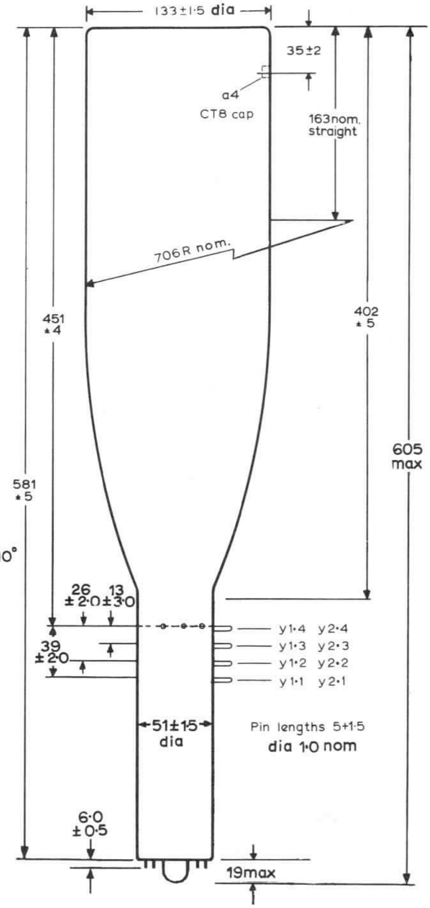
Any. The tube socket should have flexible leads and be allowed to move freely.

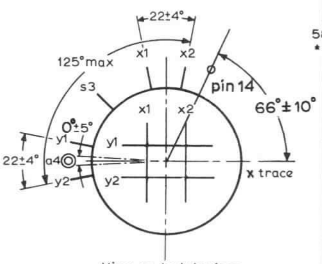
WEIGHT

Tube alone (approx.)	1.3	kg
	2.9	lb

ACCESSORIES

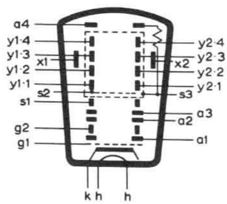
Socket (supplied with the tube)	55566
a4 connector (cavity connector CT8)	55563
Side contact connector	55561
Mu-metal shield	55554

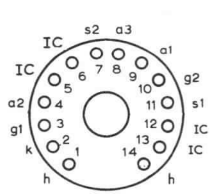




View on to tube face.

Angular tolerance to x-trace of neck pins = ±2°





View on to base pins
14 pin all glass base

All dimensions in mm

B6907

OSCILLOSCOPE TUBE D13-23GH

DEVELOPMENT SAMPLE DATA

QUICK REFERENCE DATA

13 cm (5in) diameter, flat faced oscilloscope tube with metal backed screen. The y-plates are intended for inclusion in a resonant circuit tunable to frequencies from 300 Mc/s to 900 Mc/s by means of adaptor units outside the tube. This tube is intended for high frequency narrow bandwidth displays.

Final anode voltage (p.d.a.)	6.0	kV
Display area (at Va4 = 5Va3)	5 x 10	cm
Sy	See pages D7 to D10	V/cm
Sx	<18	V/cm

This data should be read in conjunction with GENERAL OPERATIONAL RECOMMENDATIONS - CATHODE RAY TUBES.

HEATER

Suitable for series or parallel operation

Vh	6.3	V
Ih	300	mA

Note: (applies to series operation only) - the surge heater voltage must not exceed 9.5 V r.m.s. when the supply is switched on.
When used in a series heater chain a current limiting device may be necessary in the circuit to ensure that this voltage is not exceeded.

TYPICAL OPERATING CONDITIONS

BEAM FORMING

Final anode + luminescent screen	Va4	6.0	kV
Second accelerator	Va3	1.3	kV
Focus electrode	Va2	100 to 390	V
First accelerator	Va1	1.3	kV
Geometry control electrode	Vs3	1.3	kV
Inter-plate shield	Vs2	1.3	kV
Beam centring electrode	Vs1	1.3	kV
Beam blanking electrode	Vg2	1.3	kV
Control grid (for visual cut-off)	Vg1	-31 to -93	V

DEFLECTION

Double electrostatic

Mean y-plate voltage	Vy mean	1.3	kV
Mean x-plate voltage	Vx mean	1.3	kV
Vertical deflection factor	Sy	*	V/cm
Horizontal deflection factor	Sx	<14	V/cm
Angle between x and y deflection		90 ± 1	deg.

If use is made of the full deflection capabilities of the tube, the deflection plates will intercept part of the electron beam near the edge of the scan. Therefore a low impedance deflection plate drive is necessary.
Both x and y plates are intended for symmetrical deflection.

* The sensitivity in the y-direction is dependent on the frequency and the adaptors chosen.

CORRECTION POTENTIAL RANGES

Astigmatism control range	Va3	1.2 to 1.4	kV
Geometry control range	Va3	1.2 to 1.4	kV
* Beam centring control range	Vs1	1.28 to 1.32	kV
** Beam blanking control	Vg2 w.r.t.Va1	<60	V

* The beam centring electrode voltage should be adjusted for equal deflection defocusing in the x direction with respect to the electrical centre of the tube.

** For visual extinction of a beam current of 10 μA, the beam blanking electrode voltage will not exceed 60 volts with respect to Va1.

Raster distortion

A graticule, consisting of concentric rectangles 10cm x 5 cm and 9.8 cm x 4.82cm is aligned with the electrical x-axis of the tube. The edges of a raster will fall between these rectangles, with optimum correction potentials applied.

SCREEN

Faceplate diameter	13	cm
Phosphor	GH	
Fluorescent colour	green	
Persistence	medium short	

Minimum useful screen diameter	11.4	cm
Minimum useful scan (at Va4 = 6Va3)		
y1 - y2	5	cm
x1 - x2	10	cm

ABSOLUTE MAXIMUM RATINGS

Va4 max. (p.d.a.)	10	kV
Va4 min.	5.0	kV
Va3 max.	2.0	kV
Va2 max.	2.0	kV
Va1 max.	2.0	kV
Va1 min.	1.2	kV
Maximum ratio of Va4/Va3	10	
Maximum ratio of Va1/Va3	1	
Vs3 max.	2.0	kV
Vs2 max.	2.0	kV
Vs1 max.	2.0	kV
Vg2 max.	2.0	kV
- Vg1 max.	200	V
+ Vg1 max.	0	V
Ik max.	300	µA
* Vh - k		
Cathode positive		
d.c. max.	200	V
pk max.	300	V
Cathode negative		
d.c. max.	125	V
pk max.	250	V
Rg - k max.	1.5	MΩ
Maximum screen dissipation	3.0	mW/cm^2

* In order to avoid excessive hum the a.c. component of Vh - k should be as low as possible. (<20 V. r.m.s.).

During a warming up period not exceeding 45s, vh - k (pk) max. (cathode positive) is allowed to rise to 410V.

HELIX RESISTANCE

Minimum post deflection helix resistance	300	MΩ

CAPACITANCES (measured on a three terminal capacitance bridge)

High potential	Low potential	Earthed	Capacitance (pF)
k	all	-	3.5
g1	all	-	5.0
g2	all	-	9.0
x1	all	x2	2.8
x2	all	x1	2.8

EQUIPMENT DESIGN RANGE

Focusing electrode voltage	Va2	138 to 300	V/kV of Va1
Focusing electrode current	Ia2	-10 to +15	μA
Grid cut-off voltage	Vg1	-24 to -72	V/kV of Va1
Deflection factor (Va4 = 5Va3)			
Horizontal	x	<10.8	V/cm/kV of Va3

MOUNTING POSITION

Any

This tube should not be supported by the base alone and under no circumstances should the socket be allowed to support the tube.

WEIGHT

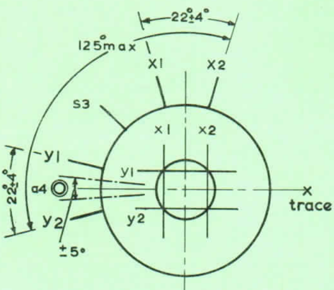
Tube alone	approx.	(2.87 (1.3	lb kg

ACCESSORIES

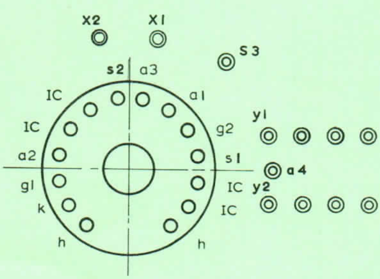
Socket	Supplied with tube	55566
a4 connector		55563
Side contact connector		55561

OSCILLOSCOPE TUBE

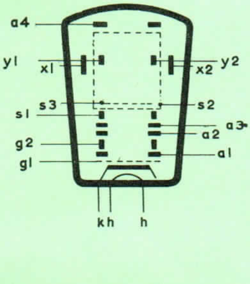
D13-23GH

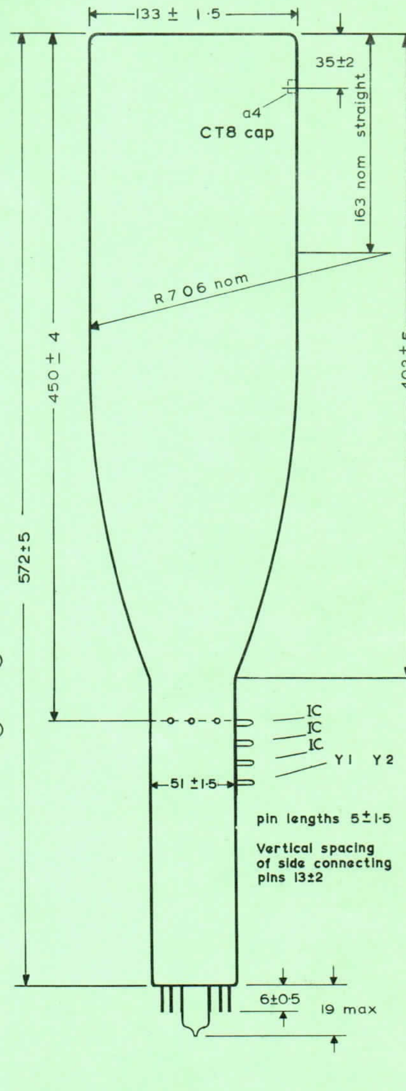


View on to tubeface



View on to base pins





All dimensions in mm.

The D13-23GH is intended for use at ultra high frequencies as a monitor of transmitter output.

To achieve the necessary sensitivity the y-deflection plates are designed to form part of a tuned circuit, resonant at the carrier frequency of the transmitter. Details of the coupling units and tuning arrangments are given below.

Mechanical construction of the coupling units.

	Unit 1 (475 to 575 Mc/s)	Unit 2 (500 to 775 Mc/s)	Unit 3 (675 to 900 Mc/s)	
Coil former				
length	20	20	18	mm
diameter	9	9	3	mm
Primary				
No. of turns	4	1.5	1.5	
Wire dia.	0.9	0.9	0.9	mm
Approx. coil length	14	10	7	mm
Secondary				
* No. of turns	4	2	2	
Wire dia.	0.5	0.5	0.9	mm
Approx. coil length	14	10	7	mm
Trimming capacitance	0.6 to 12	0.5 to 6	0.5 to 6	pF

Copper wire is used for all primary windings and enamelled copper wire is used for the secondaries.

* The secondary turns are wound between the primary turns.

The trimmer capacitors of units 1 and 2 are connected between the secondary transformer windings in order to obtain good symetry. For unit 3 the trimmer is connected between the secondary transformer windings and one connecting pin of the deflection system in order not to reduce the coupling factor.

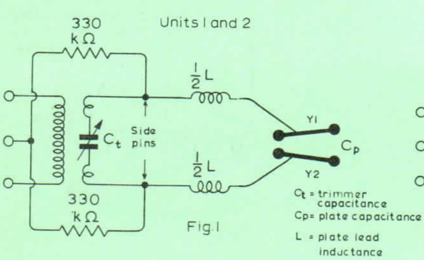


Fig. 1

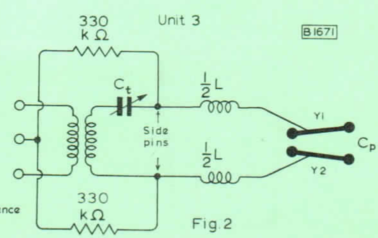


Fig. 2

Measurement of vertical sensitivity as a function of frequency.

1. Adjust the trimmer so that the trimming capacitance is a minimum, to enable resonance at the highest frequency to be obtained.
2. Change the frequency of the signal generator and adjust the trimming capacitance successively until a maximum deflection is obtained on the tubeface.

   Some care must be taken with these adjustments because several spurious resonances will be observed.
3. When the resonance frequency has been found, the input impedance of the tube must be transformed to exactly 50Ω to obtain a well defined signal voltage. For this pupose a transforming circuit is needed, as shown in fig. 3, and any reflectometer would be suitable. The impedance is matched when no reflection is measured and zero reflection can be obtained by the successive adjustment of the stubs, 1 and 2 shown in fig. 3.
4. The tube should now be connected to the generator and the output power regulated for a scan of 5 cm.
5. Replace the tube by a watt-meter to measure the output power, see fig. 4.

The signal voltage may be calculated from

$$V_{sig} = \sqrt{W \times R} = 7.07\sqrt{W}$$

The above procedure must be repeated for matching each time the operating frequency of the tube is altered.

Typical power and sensitivity values are given below for the frequency range 445 to 900 Mc/s (See page D10)

Power	30 to 400	mW
Sensitivity	1.3 to 4.5	Vrms/5cm

It should be noted that an increase in Va1 and Va3, will cause a loss of sensitivity at the lowest frequencies. At the higher frequencies this loss will partly be compensated by the decrease of the transit-time so that at 900 Mc/s the accelerating voltages can be increased to 2.0 kV without loss of sensitivity.

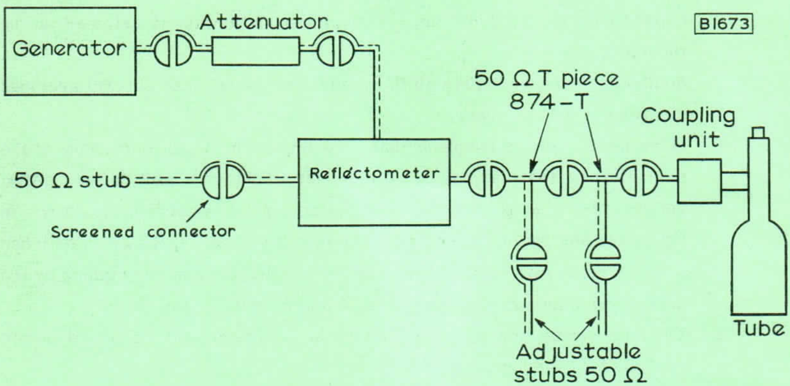


Fig. 3 Set-up for transformation to 50 Ω

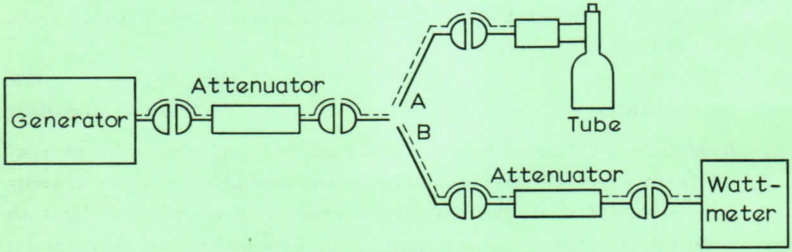
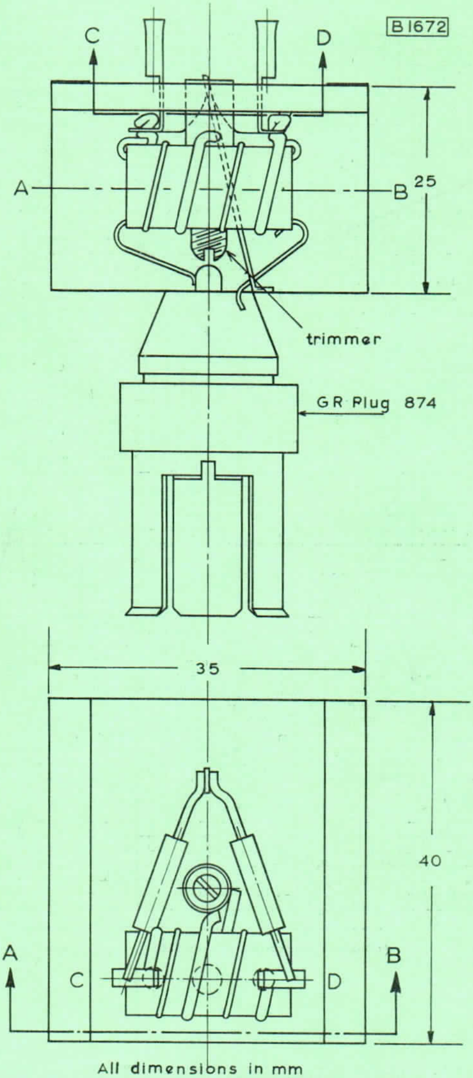
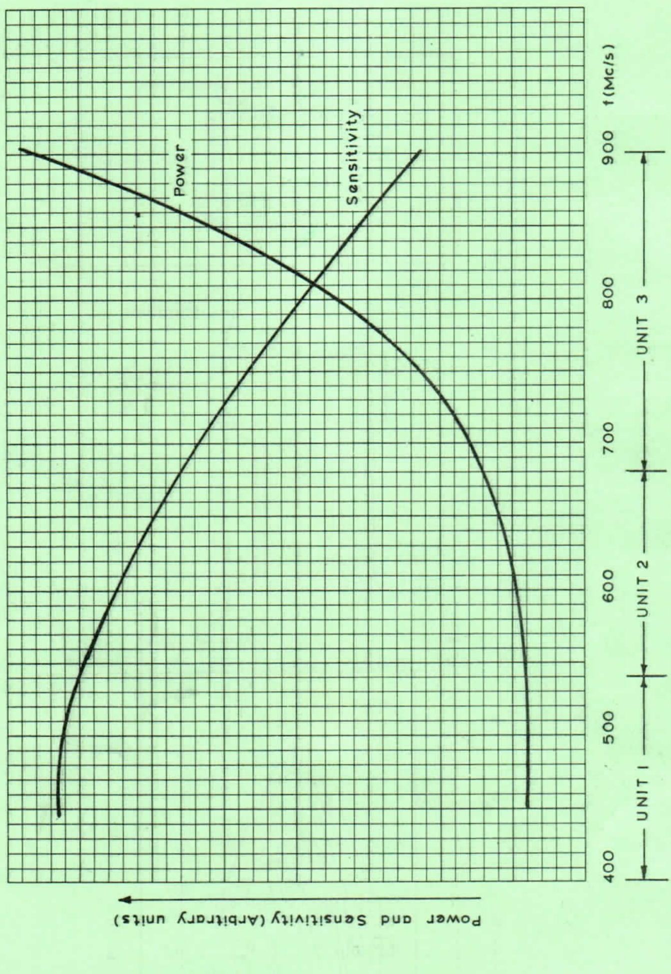


Fig. 4 A : to adjust 5 cm scan
B : to measure output



ADAPTOR UNIT



EXPECTED POWER AND SENSITIVITY CURVES AS A FUNCTION OF FREQUENCY, USING UNITS 1, 2 AND 3

QUICK REFERENCE DATA		
13cm (5in) diameter, flat-faced mesh oscilloscope tube with metal-backed screen and side connections to the deflection plates. The mesh together with the helical p.d.a. makes the tube highly sensitive and suitable for transistorised equipment.		
Final anode voltage (p.d.a.)	15	kV
Display area (at $V_{a4} = 10V_{a3}$)	6×10	cm
Deflection factor y	2.9	V/cm
Deflection factor x	11.5	V/cm

This data should be read in conjunction with GENERAL OPERATIONAL RECOMMENDATIONS-CATHODE RAY TUBES.

HEATER

Suitable for parallel operation only

V_h	6.3	V
I_h	300	mA

OPERATING CONDITIONS

Beam forming

Final anode + luminescent screen	V_{a4}	15	kV
Astigmatism control electrode (see note 1)	V_{a3}	1500 ± 70	V
Focus electrode	V_{a2}	375 to 625	V
First accelerator	V_{a1}	1500	V
Post deflection shield	V_{s4}	V_{s3} minus 12 to 18	V
Geometry control electrode (see note 2)	V_{s3}	1500 ± 70	V
Deflection plate shield	V_{s1}	1500	V
Control grid (for visual cut-off)	V_g	-40 to -90	V

Raster distortion

A graticule, consisting of concentric rectangles 10×6cm and 9.8×5.8cm is aligned with the electrical x-axis of the tube. The edges of a raster will fall between these rectangles, with optimum correction potentials applied.

Line width (GH screen)

V_{a4}	15	15	kV
V_{a3}	2.4	1.5	kV
V_{a1}	2.4	1.5	kV
I_t	10	10	μA
*Line width	0.3	0.4	mm

*Measured by the shrinking raster method in the centre of the screen.

DEFLECTION

Double electrostatic

Mean y-plate voltage	V_y mean ($= V_{s1}$)	1.5	kV
Mean x-plate voltage	V_x mean ($= V_{s1}$)	1.5	kV
Vertical deflection factor	S_y	2.3 to 3.5	V/cm
Horizontal deflection factor	S_x	9.4 to 12.5	V/cm

If use is made of the full deflection capabilities of the tube, the deflection plates will intercept part of the electron beam near the edge of the scan. Therefore a low impedance deflection plate drive is necessary.

Both x and y plates are intended for symmetrical deflection.

Linearity of deflection

The sensitivity at a deflection of less than 75% of the useful scan will not differ from the sensitivity at a deflection of 25% of the useful scan by more than 2%.

CORRECTION POTENTIAL RANGES

Astigmatism control range	V_{a3}	1.43 to 1.57	kV
Geometry control range	V_{s4}	1.43 to 1.57	kV

SCREEN

Tube face diameter		13	cm
Phosphor	GH	GP	
Fluorescent colour	green	bluish-green	
Phosphorescent colour	green	green	
Persistence	medium short	medium short	
Minimum useful scan (at $V_{a4} = 10V_{a3}$)			
y1-y2		6.0	cm
x1-x2		10	cm

RATINGS (ABSOLUTE MAXIMUM SYSTEM)

V_{a4} max.	16.5	kV
V_{a4} min.	9.0	kV
V_{a3} max.	2.5	kV
V_{a3} min.	1.35	kV
V_{a2} max.	2.5	kV
V_{a1} max.	2.5	kV
V_{a1} min.	1.35	kV
V_{s4} max.	2.5	kV
V_{s4} min.	1.35	kV
V_{s3} max.	2.5	kV
V_{s3} min.	1.35	kV
V_{s2} max.	2.5	kV
V_{s2} min.	1.35	kV
V_{s1} max.	2.5	kV
V_{s1} min.	1.35	kV
$-V_g$ max.	200	V
$+V_g$ max.	0	V
$I_{k(av)}$ max.	300	µA

V_{h-k}		
Cathode positive		
d.c. max.	200	V
pk max.	300	V
Cathode negative		
d.c. max.	125	V
pk max.	250	V
V_{x-a3} max.	500	V
V_{y-a3} max.	500	V
Ratio $\frac{V_{a4}}{V_{a3}}$ max.	10	
R_{g-k} max.	1.0	MΩ
R_{x-a3} max. = R_{y-a3} max.	50	kΩ
$\pm I_{a2}$ max.	25	μA

CAPACITANCES (measured on a three terminal capacitance bridge)

High potential	Low potential	Earthed	Capacitance (pF)
k	all	-	3.0
g	all	-	5.5
x1	all	x2	4.5
x2	all	x1	4.5
y1	all	y2	3.8
y2	all	y1	3.8
x1	x2	all	2.7
y1	y2	all	1.8

EQUIPMENT DESIGN RANGE

Focusing electrode voltage	V_{a2}	250 to 417	V/kV of V_{a3}
Grid cut-off voltage	V_g	30 to 56.7	V/kV of V_{a1}
Deflection factor (at $V_{a4} = 10V_{a3}$)			
vertical	S_y	1.53 to 2.33	V/cm/kV of V_{a3}
horizonal	S_x	6.3 to 8.4	V/cm/kV of V_{a3}

MOUNTING POSITION

Any. The tube socket should not be rigidly mounted but should have flexible leads and be allowed to move freely.

WEIGHT

Tube alone (approx.)	925	g

ACCESSORIES

Socket	55566
Anode connector	55563
Side contact connector	55561
Mu-metal shield	55555

CORRECTION COILS

The D13-26GH and D13-26GP are now provided with a coil unit consisting of a pair of coils for:

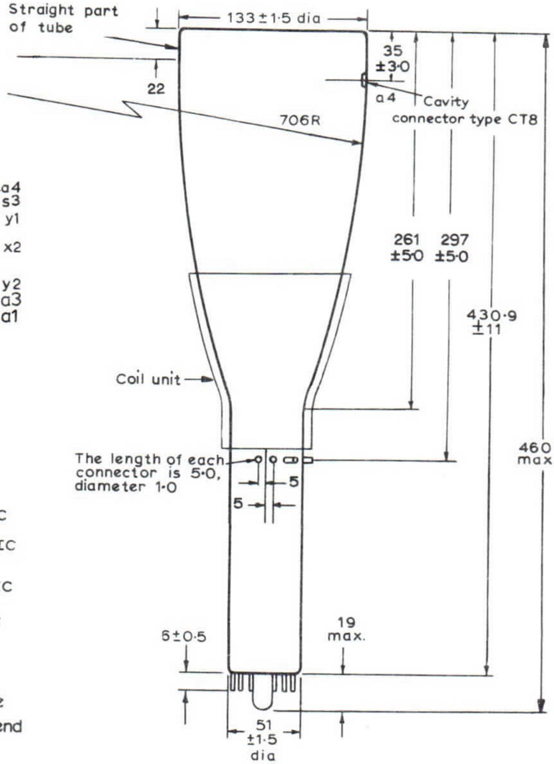
(a) correction of the orthogonality of the x and y traces (so that the angle between the x and y traces at the centre of the screen can be made exactly 90^{o}).

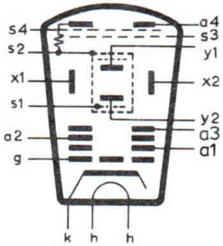
(b) vertical shift of the scanned area.

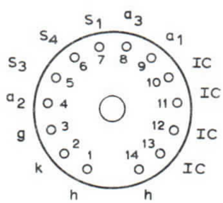
Further details of these coils can be obtained from the Industrial Electronics Division.

NOTES

1. The astigmatism control should be adjusted within the stated range for optimum spot shape.
2. This tube is designed for optimum performance when operating at the ratio $V_{a4}/V_{a3} = 10$. Operation at any other ratio may result in changes in deflection uniformity and geometry distortion. The geometry control electrode should be adjusted within the stated range for optimum performance.

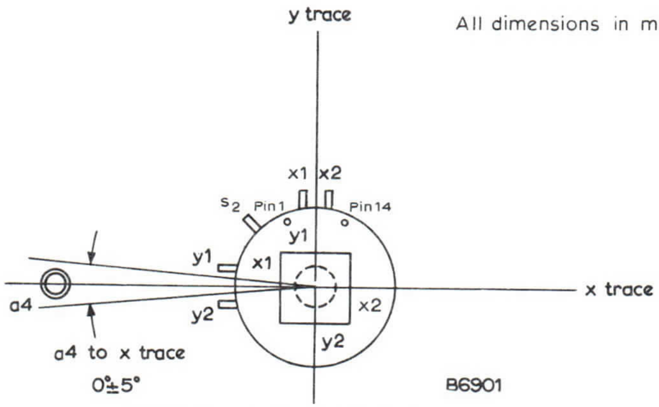






14 pin all glass base
As viewed from base end

All dimensions in mm



Orientation of axes of deflection as viewed from screen end

OSCILLOSCOPE TUBE D13-27GH

TENTATIVE DATA

QUICK REFERENCE DATA

13cm (5in) diameter, flat-faced oscilloscope tube with helical p.d.a. This tube incorporates deflection blanking and is intended for general purpose oscilloscopes.

Final anode voltage (p.d.a.)	3.0	kV
Display area (at $V_{a4} = 2V_{a3}$)	8.0 × full scan	cm
Deflection factor y	11.3	V/cm
Deflection factor x	24	V/cm

This data should be read in conjunction with GENERAL OPERATIONAL RECOMMENDATIONS - CATHODE RAY TUBES

HEATER

Suitable for parallel operation only

V_h	6.3	V
I_h	300	mA

OPERATING CONDITIONS

BEAM FORMING

Final anode + luminescent screen	V_{a4}	3.0	kV
Second accelerator	V_{a3}	1.5	kV
Focus electrode	V_{a2}	300 to 550	V
First accelerator	V_{a1}	1.5	kV
Geometry control electrode	V_{s2}	1.5	kV
Deflection plate shield	V_{s1}	1.5	kV
Beam blanking electrode	V_{g2}	1.5	kV
Control grid (for visual cut-off)	V_{g1}	-38 to -135	V
*Beam blanking control	ΔV_{g2}	<60	V
Focus electrode current	I_{a2}	-15 to +10	μA

*For visual extinction of a beam current of 10μA the beam blanking electrode voltage change will not exceed 60 volts with respect to V_{a1}.

Raster distortion

A graticule, consisting of concentric rectangles 10 × 6cm and 9.7 × 5.8cm is aligned with the electrical x-axis of the tube. The edges of a raster will fall between these rectangles, with optimum correction potentials applied.

Line width (GH screen)

V_{a4}	3.0	kV
V_{a3}	1.5	kV
V_{a1}	1.5	kV
I_t	10	μA
*Line width (at screen centre)	0.25	mm

*Measured by means of a shrinking raster.

DEFLECTION

Double electrostatic

Mean y-plate voltage	V_y mean	1.5	kV
Mean x-plate voltage	V_x mean	1.5	kV
Vertical deflection factor	S_y	9.7 to 13	V/cm
Horizontal deflection factor	S_x	21 to 27	V/cm
Angle between x and y deflection		90±1	deg

If use is made of the full deflection capabilities of the tube, the deflection plates will intercept part of the electron beam near the edge of the scan. Therefore a low impedance deflection plate drive is necessary. Both x and y plates are intended for symmetrical deflection. The useful scan may be shifted vertically 4mm max. with respect to the geometric centre of the face plate.

Linearity of deflection

The sensitivity at a deflection of less than 75% will not differ from the sensitivity at a deflection of 25% of the useful scan by more than 2%.

CORRECTION POTENTIAL RANGES

Astigmatism control range	V_{a3}	1.425 to 1.575	kV
Geometry control range	V_{s2}	1.425 to 1.575	kV

OSCILLOSCOPE TUBE D13-27GH

SCREEN

Phosphor	GH	
Fluorescent colour	green	
Phosphorescent colour	green	
Persistence	medium short	
Minimum useful screen diameter	11.4	cm
Minimum useful scan (at $V_{a4} = 2V_{a3}$)		
$y_1 - y_2$	8.0	cm
$x_1 - x_2$	full scan	

RATINGS (ABSOLUTE MAXIMUM SYSTEM)

V_{a4} max. (p.d.a.)	3.3	kV
V_{a4} min.	1.8	kV
V_{a3} max.	1.7	kV
V_{a3} min.	1.2	kV
V_{a2} max.	1.2	kV
V_{a1} max.	1.7	kV
V_{s2} max.	1.7	kV
V_{s1} max.	1.7	kV
V_{g2} max.	1.7	kV
$-V_{g1}$ max.	200	V
$+V_{g1}$ max.	0	V
$+v_{g1(pk)}$ max.	2.0	V
V_{x-a3} max.	500	V
V_{y-a3} max.	500	V
V_{h-k} max.		
Cathode positive	200	V
Cathode negative	125	V
Maximum screen dissipation	3.0	W/cm^2
Ratio V_{a4}/V_{a3} max.	2.0	
R_{g1-k} max.	1.5	MΩ
R_{x-a3} max.	1.0	MΩ
R_{y-a3} max.	1.0	MΩ

HELIX RESISTANCE

Minimum post deflection helix resistance (a4 to s2)	50	MΩ

CAPACITANCES (measured on a three terminal capacitance bridge)

High potential	Low potential	Earthed	Capacitance (pF)
k	all	-	3.5
g1	all	-	6.0
x1	all	x2	4.5
x2	all	x1	4.5
y1	all	y2	5.0
y2	all	y1	5.0
x1	x2	all	2.5
y1	y2	all	1.5

MOUNTING POSITION Any

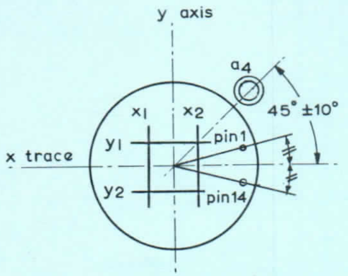
This tube should not be supported by the base alone and under no circumstances should the socket be allowed to support the tube.

ACCESSORIES

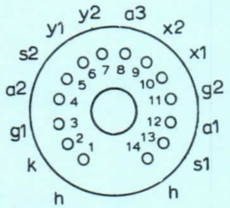
Socket (supplied with the tube)	55566
a4 connector (C.T.8)	55563
Mu-metal shield	55557

WEIGHT

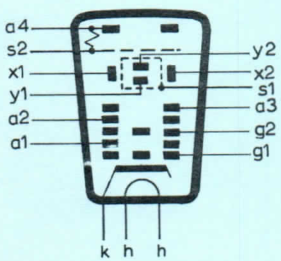
Tube alone (approx.)	680	g
	1.5	lb

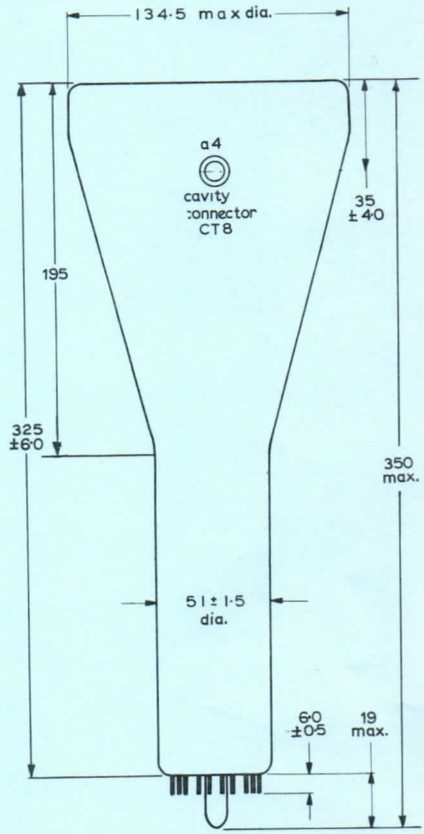


View on to tube face



14 pin all glass base
As viewed from base end





All dimensions in mm

B5580

QUICK REFERENCE DATA		
13cm (5in) diagonal rectangular flat faced oscilloscope tube with metal backed screen and mesh p.d.a. This high sensitivity tube with side connections to the x and sectional y plates is intended for use in transistorised oscilloscopes at frequencies up to 250MHz and is provided with an internal illuminated graticule.		
Final anode voltage (p.d.a.)	15	kV
Display area (at $V_{a4} = 10V_{a3}$)	60 × 100	mm
Deflection factor y	3.0	V/cm
Deflection factor x	9.9	V/cm

This data should be read in conjunction with
GENERAL OPERATIONAL RECOMMENDATIONS - CATHODE RAY TUBES

HEATER

Suitable for parallel operation only

V_h	6.3	V
I_h	300	mA

OPERATING CONDITIONS

Beam forming

Final anode + luminescent screen	V_{a4}	15	kV
Post deflection shield	V_{s4}	V_{s3} minus 12 to 18	V
Geometry control electrode (see note 1)	V_{s3}	1500 ± 70	V
Interplate shield (see note 2)	V_{s2}	1500	V
Deflection plate shield (see note 2)	V_{s1}	1500	V
Astigmatism control electrode (see note 3)	V_{a3}	1500 ± 50	V
Focus electrode	V_{a2}	400 to 550	V
First accelerator	V_{a1}	1500	V
Control grid for visual cut-off	V_g	-40 to -100	V

Raster correction

A graticule, consisting of concentric rectangles 100 × 60mm and 98 × 58.2mm is aligned with the electrical x-axis of the tube. The edges of a raster will fall between these rectangles, with optimum correction potentials applied.

Line width

V_{a4}	15	kV
V_{a3}	1.5	kV
V_{a1}	1.5	kV
I_t	10	μA
*Line width	0.4	mm

*Measured by the shrinking raster method in the centre of the screen.

DEFLECTION

Double electrostatic

Mean y-plate voltage	V_y mean		1.5	kV
Mean x-plate voltage	V_x mean		1.5	kV
Vertical deflection factor	S_y	typ.	3.0	V/cm
		max.	3.3	V/cm
Horizontal deflection factor	S_x	typ.	9.9	V/cm
		max.	11	V/cm
Angle between x and y deflection (see page 7)			90	deg

If use is made of the full deflection capabilities of the tube, the deflection plates will intercept part of the electron beam near the edge of the scan. Therefore a low impedance deflection plate drive is necessary.

Both x and y plates are intended for symmetrical deflection.

Linearity of deflection

The sensitivity at a deflection of less than 75% of the useful scan will not differ from the sensitivity at a deflection of 25% of the useful scan by more than 2%.

CORRECTION POTENTIAL RANGES

Astigmatism control range	ΔV_{a3}	±50	V
Geometry control range	ΔV_{s3}	±70	V

SCREEN

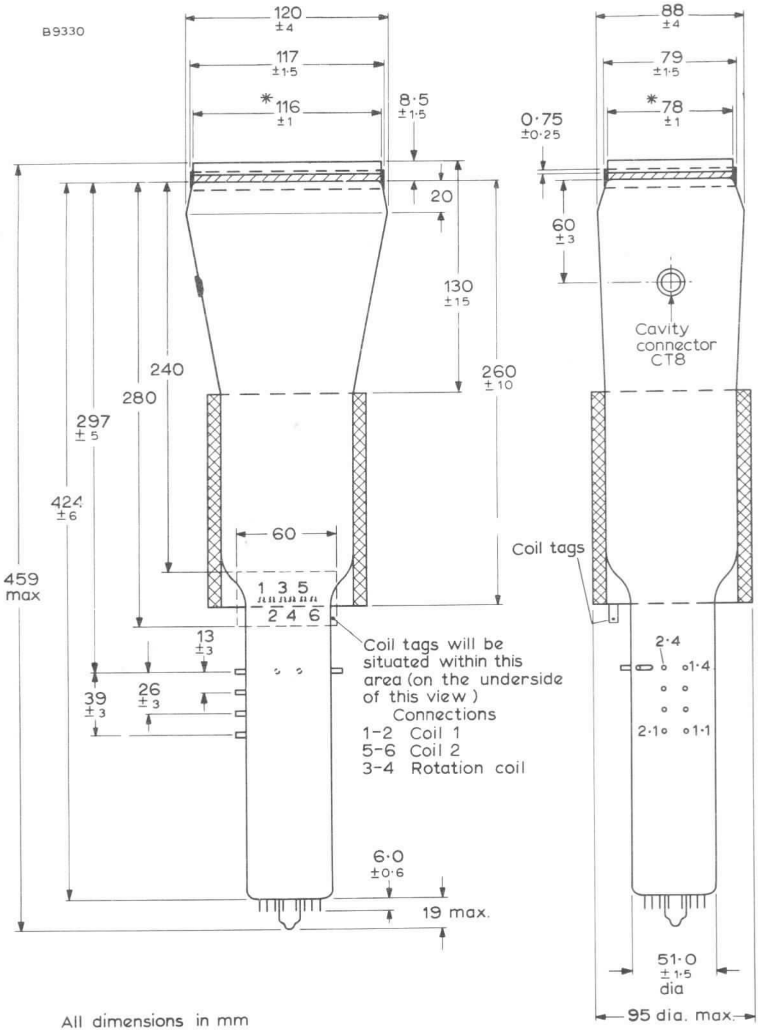
Tube face diagonal	13	cm
Phosphor	GH	
Fluorescent colour	green	
Phosphorescent colour	green	
Persistence	Medium short	
Minimum useful screen dimensions	60 × 100	mm
Minimum useful scan (at $V_{a4} = 10V_{a3}$)		
$y_1 - y_2$	60	mm
$x_1 - x_2$	100	mm

The scanned raster can be centred and aligned with the internal graticule by means of correction coils mounted on the tube (see page 7). For illumination of the internal graticule see page 9.

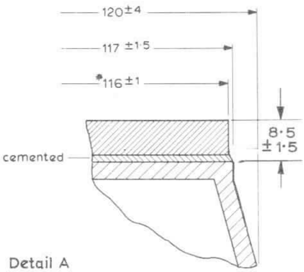
RATINGS (ABSOLUTE MAXIMUM SYSTEM)

V_{a4} max. (p.d.a.)	16.5	kV
V_{a4} min.	9.0	kV
V_{s4} max.	2.4	kV
V_{s3} max.	2.4	kV
V_{s2} max.	2.4	kV
V_{s2} min.	1.35	kV
V_{s1} max.	2.4	kV
V_{a3} max.	2.4	kV
V_{a3} min.	1.35	kV
Ratio of V_{a4}/V_{a3} max.	10	
V_{a2} max.	2.4	kV
V_{a1} max.	1.8	kV
V_{a1} min.	1.35	kV
$-V_g$ max.	200	V
$+V_g$ max.	0	V
V_{x-a3} and V_{y-a3} max.	500	V
$I_{k(av)}$ max.	300	μA
V_{h-k} max. Cathode positive	200	V
V_{h-k} max. Cathode negative	125	V
Maximum screen dissipation	3.0	mW/cm^2

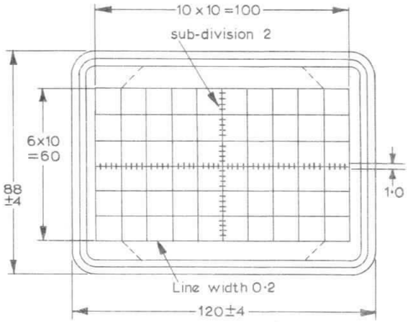
OUTLINE DRAWING
OF D13-450GH/01



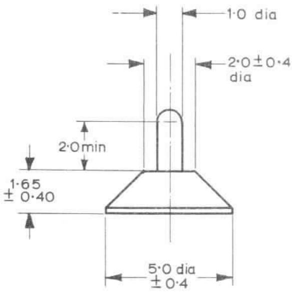
*These dimensions apply to the illumination plate which will always be within the limits 117 ± 1.5 × 79 ± 1.5mm of the tube face.



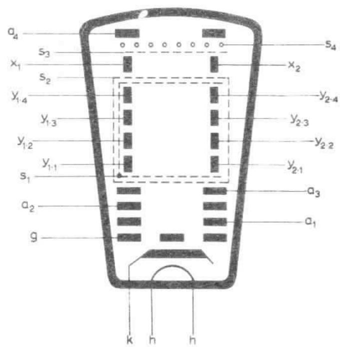
Detail A

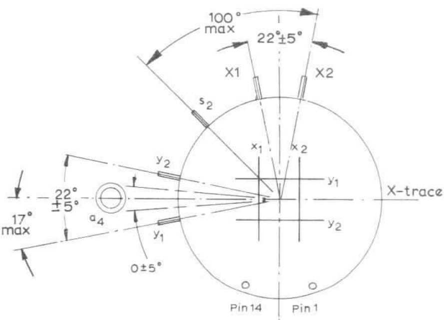


View of screen end

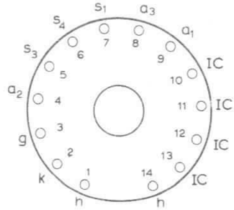


Detail of side contact





Orientation of axes of deflection as viewed from screen end.



As viewed from base end.
Special 14 pin base.

All dimensions in mm

CAPACITANCES (measured on a three terminal capacitance bridge)

High potential	Low potential	Earthed	Capacitance (pF)
k	all	-	5.0
g	all	-	6.0
x_1	all	x_2	4.8
x_2	all	x_1	4.8
$y_{1.1}$	all	$y_{2.1}$	1.2
x_1	x_2	all	2.5
$y_{1.1}$	$y_{2.1}$	all	0.8

MOUNTING POSITION

Any. The tube socket should not be rigidly mounted but should have flexible leads and be allowed to move freely.

WEIGHT

Tube alone (approx.)	1.2	kg

ACCESSORIES

Socket (supplied with tube)	55566
a_4 connector (cavity connector CT8)	55563
Side contact connector	55561
Mu-metal shield	55568

NOTES

1. This tube is designed for optimum performance when operating at a ratio $V_{a4}/V_{a3} = 10$. Operation at any other ratio may result in changes in deflection uniformity and geometry distortion. The geometry control electrode voltage should be adjusted within the stated range for optimum performance.

2. This voltage should be equal to the mean x and y plates potential.

3. The astigmatism control electrode voltage should be adjusted within the stated range for optimum spot shape.

CORRECTION COILS

The D13-450GH/01 is provided with a coil unit consisting of:

1. a pair of coils for
   (a) correction of the orthogonality of the x and y traces (so that the angle between the x and y traces at the centre of the screen can be made exactly 90°).
   (b) vertical shift of the scanned area.
2. a single coil for image rotation (aligning the x trace with the x lines of the graticule)

Orthogonality and shift

The maximum currents required under typical operating conditions are 4mA per degree of angle correction and 2mA per millimetre of shift. These values apply to a tube operating with a mu-metal shield closely surrounding the coils. If a closely fitting shield is not used the values have to be multiplied by a factor K ($1 < K < 2$), the value of which depends on the dimensions of the shield and approaches 2 for the case in which no shield is present.
The d.c. resistance of each coil is approximately 220Ω.

Image rotation

The image rotation coil is concentrically wound. Under typical operating conditions a maximum current of 45mA will be required for a maximum image rotation of 5 degrees.
The d.c. resistance of this coil is approximately 550Ω.

CIRCUIT DIAGRAMS

1. Orthogonality and shift

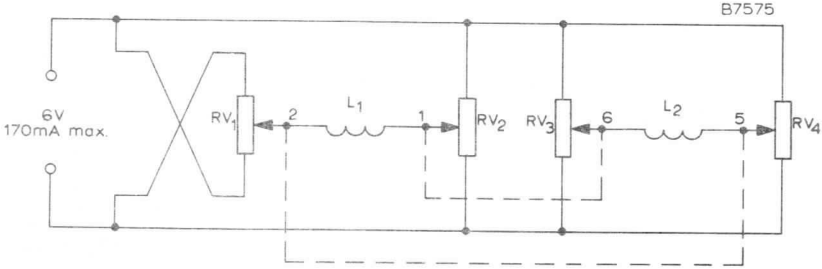


Fig.1

Potentiometers RV_1, RV_4 220Ω, 1.0W, ganged
Potentiometers RV_2, RV_3 220Ω, 1.0W, ganged

With the circuit of Fig. 1 almost independent control for shift and angle correction is achieved. This facilitates the correct adjustment to a great extent.
The dissipation in the potentiometers can be reduced considerably if the requirement of independent controls is dropped (see Fig. 2).

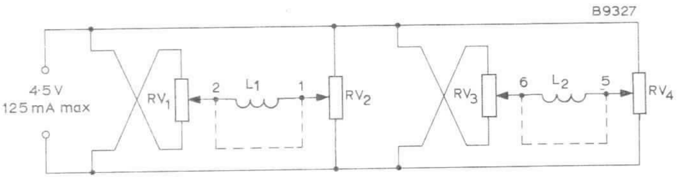


Fig. 2

Potentiometers RV_1, RV_2 220Ω, 1.0W, ganged

Potentiometers RV_3, RV_4 220Ω, 1.0W, ganged

A further reduction in the dissipation can be obtained by providing a commutator for each coil (see Fig. 3)
The procedure of adjustment will then become more complicated, but it should be kept in mind that a readjustment is necessary only when the tube has to be replaced.

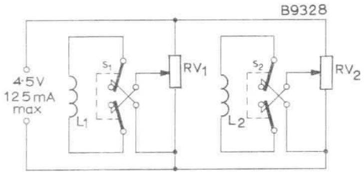


Fig. 3

Potentiometers RV_1, RV_2 220Ω, 1.0W

S_1, S_2 commutators

2. Image rotation
   A suitable circuit for the image rotating coil is given in Fig. 4.

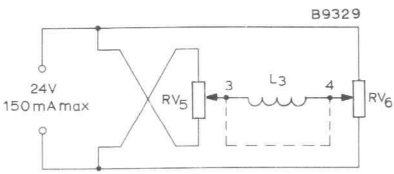


Fig. 4

Potentiometers RV_5, RV_6 500Ω, 3.0W, ganged

ADJUSTMENT PROCEDURE

a. Align the x trace with the graticule by means of the image rotating coil.

b. With the tube fully scanned in the vertical direction, the image has to be shifted so that the graticule is fully covered. With the circuit of Fig. 1 this is done by means of the ganged potentiometers RV_1 and RV_4.

c. Adjust the orthogonality by means of the ganged potentiometers RV_2 and RV_3. A slight readjustment of RV_1 and RV_4 may be necessary afterwards.

d. Readjust the image rotation if necessary.

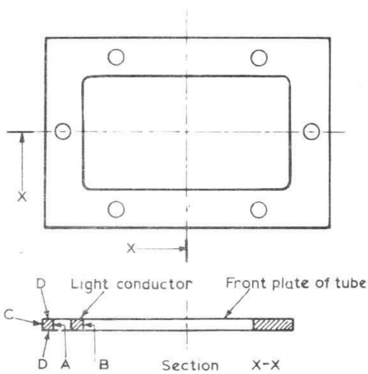
With the circuits of Fig. 2 or Fig. 3 these corrections have to be performed by means of successive adjustments of the currents in the coils.

The most convenient deflection signal is a square waveform, permitting an easy and fairly accurate visual check of orthogonality.

ILLUMINATION OF THE GRATICULE (see drawing)

To illuminate the internal graticule a light conductor (e.g. Perspex) should be used. In order to achieve the most efficient light conductance, the holes for the lamps (A) and the edges adjacent to the tube (B) should be polished, and the contact with the tube should be as close as possible. It is advisable to apply reflective material to the outer circumference (C) and, if possible, also to the upper and lower faces of the light conductor (D). The thickness of the conductor should not exceed 3mm, and its position relative to the front plate of the tube should be adjusted for optimum illumination of the graticule. It is essential that the light conductor is parallel to the front plate of the tube.

B7573



OSCILLOSCOPE TUBE D13-480GH

TENTATIVE DATA

QUICK REFERENCE DATA

13cm (5.0in) diameter, flat faced mono-accelerator oscilloscope tube, primarily intended for use in inexpensive oscilloscopes and read-out devices.

Final anode voltage	2.0	kV
Display area	80 × 100	mm
Deflection factor y	15	V/cm
Deflection factor x	31	V/cm

This data should be read in conjunction with
GENERAL OPERATIONAL RECOMMENDATIONS - CATHODE RAY TUBES

HEATER

Suitable for parallel operation only

V_h	6.3	V
I_h	300	mA

OPERATING CONDITIONS

Beam forming

Final anode and astigmatism control electrode (see note 1)	$V_{a1+a3+s1}$		2000 ± 50	V
Focus electrode	V_{a2}	approx.	300	V
Control grid (for visual cut-off)	V_g	approx.	-65	V

Line width (see note 2)

$V_{a1+a3+s1}$	2.0	kV
V_{a2}	adjusted for optimum line width	
$V_{y1} = V_{y2}$	2.0	kV
V_{x1}	1.3	kV
V_{x2}	1.7	kV
I_{x2}	10	μA
V_g	adjusted for I_{x2} value stated	
*Line width	0.3	mm

*Measured by the shrinking raster method in the centre of the screen.

DEFLECTION

Double electrostatic

Mean y-plate voltage	V_y mean	2.0	kV
Mean x-plate voltage	V_x mean	2.0	kV
Vertical deflection factor	S_y	15	V/cm
Horizontal deflection factor	S_x	31	V/cm
Angle between x and y deflection		90 ± 1	deg

Both x and y plates are intended for symmetrical deflection. If use is made of the full deflection capabilities of the tube the deflection plates will intercept part of the electron beam near the edge of the scan. Therefore a low impedance deflection plate drive is necessary.

Linearity of deflection

The sensitivity at a deflection of less than 75% of the useful scan will not differ from the sensitivity at a deflection of 25% of the useful scan by more than 2%.

CORRECTION POTENTIAL RANGES

Astigmatism control range	$\Delta V_{a1+a3+s1}$	±50	V

SCREEN

Phosphor	GH	
Fluorescent colour	green	
Phosphorescent colour	green	
Persistence	medium short	
Minimum useful screen diameter	114	mm
Minimum useful scan (at $V_{a1+a3+s1}$ = 2.0kV)		
y_1-y_2	80	mm
x_1-x_2	100	mm

The useful scan may be shifted vertically to a maximum of 6mm with respect to the geometric centre of the tube face.

RATINGS (ABSOLUTE MAXIMUM SYSTEM)

$V_{a1+a3+s1}$ max.	2.2	kV
$V_{a1+a3+s1}$ min.	1.5	kV
V_{a2} max.	2.2	kV
$-V_g$ max.	200	V
$+V_g$ max.	0	V
Grid drive (d.c. or average) max.	20	V
V_{h-k} max.	±125	V
p_t max.	3.0	mW/cm^2

CAPACITANCES (measured on a three terminal capacitance bridge)

High potential	Low potential	Earthed	Capacitance (pF)
k	all	-	5.0
g	all	-	6.0
x_1	all	x_2	4.0
x_2	all	x_1	4.0
y_1	all	y_2	3.5
y_2	all	y_1	3.5
x_1	x_2	all	2.5
y_1	y_2	all	1.5

MOUNTING POSITION

Any. The tube socket should not be rigidly mounted but should have flexible leads and be allowed to move freely.

WEIGHT

Tube alone (approx.)	650	g

ACCESSORIES

Socket (supplied with tube)	55566
Mu-metal shield	55580

NOTES

1. The astigmatism control voltage should be adjusted for optimum spot shape. The range stated will apply if the mean x and y plate potentials are equal to $V_{a1+a3+s1}$, with no astigmatism adjustment.

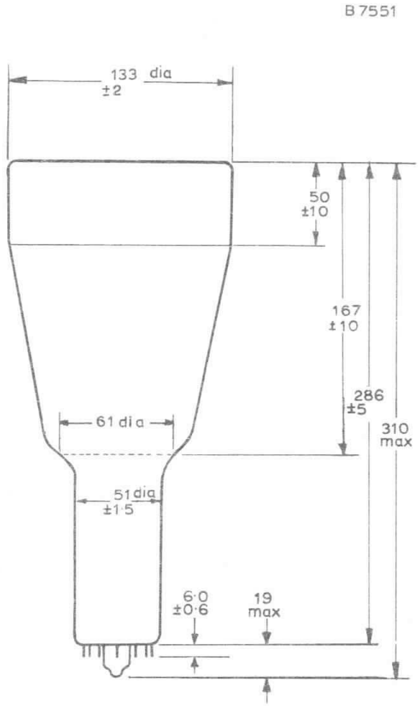
2. As the construction of the tube does not permit a direct measurement of the beam current, this current should be determined as follows:

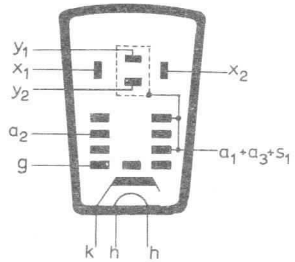
   a) Under typical operating conditions display a small raster with no overscan, adjust V_g for a beam current of approximately 10μA and V_{a2} and $V_{a1+a3+s1}$ for optimum spot quality in the centre of the screen.

   b) Remove the raster and adjust the deflection plate voltages to the values stated under 'Line width', thus directing the total beam current to x2. Measure I_{x2} and adjust V_g so that $I_{x2} = 10\mu A$.

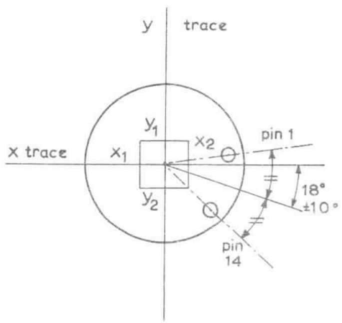
   c) Return to the conditions under (a) but without adjustment of V_g or $V_{a1+a3+s1}$. This results in a raster at a true beam current of 10μA.

   d) Adjust V_{a2} for optimum focus in the centre of the screen and measure the line width. Do not readjust $V_{a1+a3+s1}$.

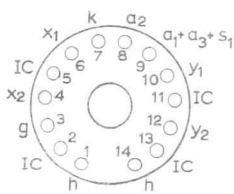




All dimensions in mm



Orientation of axes of deflection
as viewed from screen end



As viewed from base end
Special 14 pin base

TENTATIVE DATA

QUICK REFERENCE DATA

13cm (5in) diagonal rectangular flat faced ultra wideband oscilloscope tube for observation and measurement of high frequency phenomena. This very high sensitivity tube features a mesh p.d.a. system enhanced by scan magnification. The bandwidth of 800MHz is achieved by use of a delay-line system of vertical deflection. The metal backed screen is provided with an internal illuminated graticule.

Final anode voltage (p.d.a.)	15	kV
Display area (at $V_{a9} = 6.0V_{a1}$)	60 × 100	mm
Deflection factor y	2.0	V/cm
Deflection factor x	15	V/cm

This data should be read in conjunction with

GENERAL OPERATIONAL RECOMMENDATIONS - CATHODE RAY TUBES

HEATER

Suitable for parallel operation only

V_h	6.3	V
I_h	300	mA

OPERATING CONDITIONS

Beam forming

Final anode + luminescent screen	V_{a9}	15	kV
Post deflection shield	V_{s3}	V_{s2} minus 9 to 15	V
Geometry control electrode (see note 1)	V_{s2}	2500 ± 100	V
Interplate shield (see note 2)	V_{s1}	2500	V
Scan magnification electrode (see note 3)	V_{a8}	V_{a1} minus 250 to 375	V
Correction electrode (see note 4)	V_{a7}	V_{a1} plus 200	V
Horizontal beam centring electrode (see note 5)	V_{a6}	2500 ± 50	V
Second focus electrode (see note 6)	V_{a5}	V_{a1} minus 400 to 600	V
Vertical beam centring electrode (see note 7)	V_{a4}	2500 ± 50	V
First focus electrode (see note 6)	V_{a3}	V_{a1} minus 600 to 800	V
Spot correction electrode (see note 8)	V_{a2}	2500 ± 50	V
First accelerator	V_{a1}	2500	V
Control grid(for visual cut-off)	V_g	-50 to -150	V

Raster distortion

A rectangle of 98 × 58.2mm is concentrically aligned with the internal graticule of the tube. The edges of a raster will fall between this rectangle and the boundary lines of the internal graticule with correction potentials applied.

Line width

V_{a9}		15	kV
V_{a1} and V_{s1}		2.5	kV
I_t		10	μA
*Line width	approx.	0.35	mm

*Measured by the shrinking raster method in the centre of the screen, adjusted for optimum spot size and a scan magnification factor of approximately 1.9. See also note 3.

DEFLECTION

Double electrostatic
The x plates are intended for symmetrical deflection.
The y deflection system consists of a symmetrical delay line system.

Characteristic impedance	2 × 150	Ω
Bandwidth (for vertical deflection sensitivity 3dB lower than at d.c.)	800	MHz
Rise time (see page 3)	0.45	ns

DEFLECTION (cont'd)

Rise time is defined as the time interval between 10% and 90% of the final value of deflection when an ideal step function signal is applied to the vertical deflection system. The displayed rise time (t_0), the display rise time of the tube for an ideal signal (t_1) and the true value of rise time for an input signal (t_2) are linked by the equation

$$t_0 = \sqrt{t_1^2 + t_2^2}$$

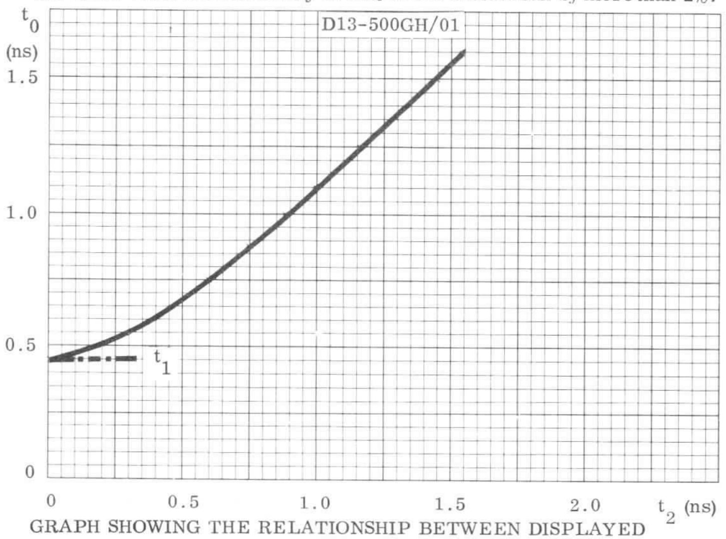
as shown by the graph below. Orthogonality should be corrected by means of the correction coils before measurement. (see page 13)

Mean y-deflection system voltage	V_y mean	2.5	kV
Mean x plate voltage	V_x mean	2.5	kV
Vertical deflection factor (see note 9)	S_y approx.	2.0	V/cm
Horizontal deflection factor	S_x approx.	15	V/cm
Angle between x and y deflection (see page 13)		90	deg

If use is made of the full deflection capabilities of the tube, the deflection plates will intercept part of the electron beam near the edge of the scan. Therefore a low impedance deflection plate drive is necessary.

Linearity of deflection

The sensitivity at a deflection of less than 75% of the useful scan will not differ from the sensitivity at 25% of the useful scan by more than 2%.



GRAPH SHOWING THE RELATIONSHIP BETWEEN DISPLAYED RISE TIME (t_0) AND SIGNAL RISE TIME (t_2)

DEFLECTION (cont'd)

The vertical deflection system

For the vertical deflection, a delay-line system is used so that transit-time effects are practically eliminated. The system consists of two flattened helices to which a symmetrical deflection signal should be applied. Under these conditions the characteristic impedance of each helix is 150Ω. The input and output terminals are connected to the beginning of the helices by means of a matched, internal two-wire transmission line. The output of the deflection system should be properly terminated in order to avoid signal reflections.

With the typical operating conditions, the bandwidth of the deflection system, that is, the frequency at which the sensitivity is 3dB below its value at d.c., is about 800MHz. Even above this frequency, the response decreases only gradually so that, for narrow-band applications, the tube can be used with reduced vertical sensitivity up to about 2000MHz.

If the tube is to be used without an amplifier in order to make use of its full bandwidth capabilities, care should be taken to ensure good symmetry of the input signal.

Fig.1 shows how the tube can be connected to a 50Ω co-axial input. A matched power divider is used to deliver two identical output signals. One of these is inverted by means of a pulse inverter. An additional length of 50Ω cable should be included in the path of the non-inverted signal, having the same delay time as the pulse inverter, so that the two signals arrive at the input of the deflection system at the same time. The 75Ω shunt resistors serve to obtain a correct termination of the 50Ω lines.

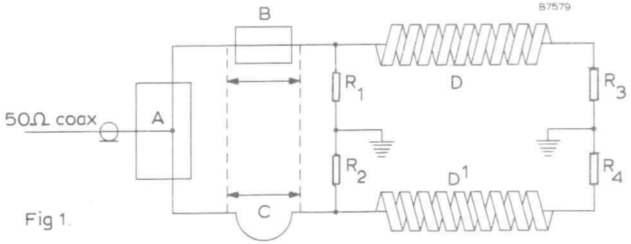


Fig 1.

A	Power divider	R_1, R_2	75Ω resistors
B	Inverter	R_3, R_4	150Ω resistors
C	Cable	D, D^1	Deflection system

Note: Delay times of B and C are equal.

Scan magnifying and focusing system (see Fig.2)

The vertical scan is magnified by means of an electrostatic quadrupole lens, that is, an electron lens which has two mutually perpendicular planes of symmetry, divergent in one plane and convergent in the other. This lens is inserted between the vertical deflection system and the horizontal deflection plates, with its plane of divergence in the vertical direction. Therefore it magnifies the vertical deflection without affecting the horizontal deflection.

DEFLECTION (cont'd)

Because of the astigmatic properties of such a lens, a conventional focusing lens cannot be used. Instead, three quadrupole lenses are incorporated, with alternating orientation of their planes of convergence and divergence.

The strength of the scan magnifier is controlled by applying to a_8 a negative voltage with respect to a_1. For a scan magnification factor, M_{sc}, between 1.8 and 2.0, the lens system will yield an approximately circular spot at moderate beam currents. (At high beam currents, where space-charge repulsion causes an increase in spot size, the width of vertical lines will be less than that of horizontal lines.)

Within this range, line width at a fixed value of screen current, and screen current at a fixed value of grid voltage, are increasing functions of the scan magnification factor. The graphs on page 6 show these functions relative to their values at $M_{sc}=1.9$, which is generally the most suitable compromise.

For minimum defocusing of vertical lines near the upper and lower edge of the display area, a_7 should be kept about 200V positive with respect to a_1. As this voltage has some effect on M_{sc}, both a_7 and a_8 should be connected to a_1 when the deviation without scan magnification is being measured.

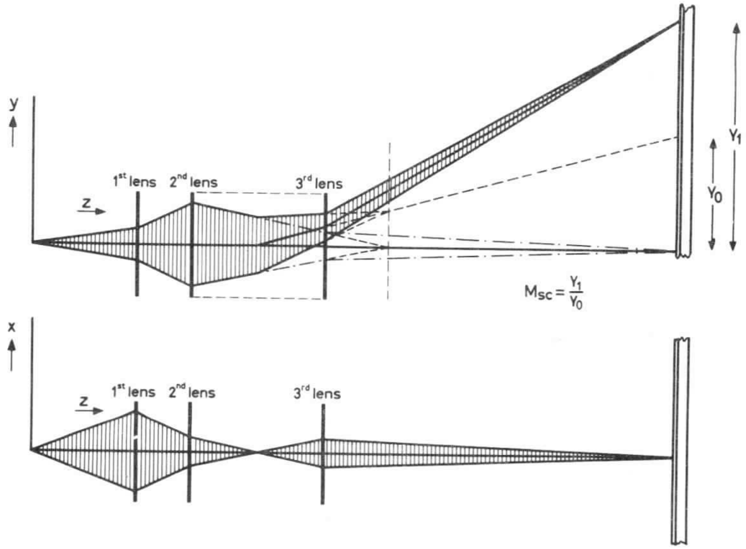
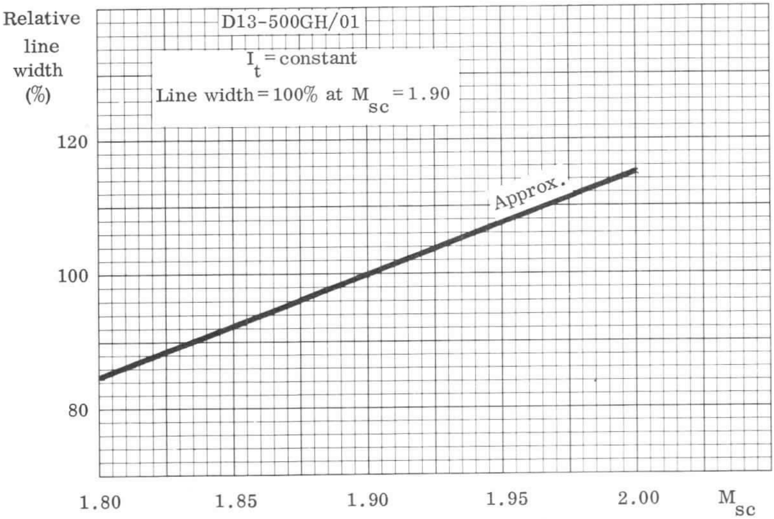
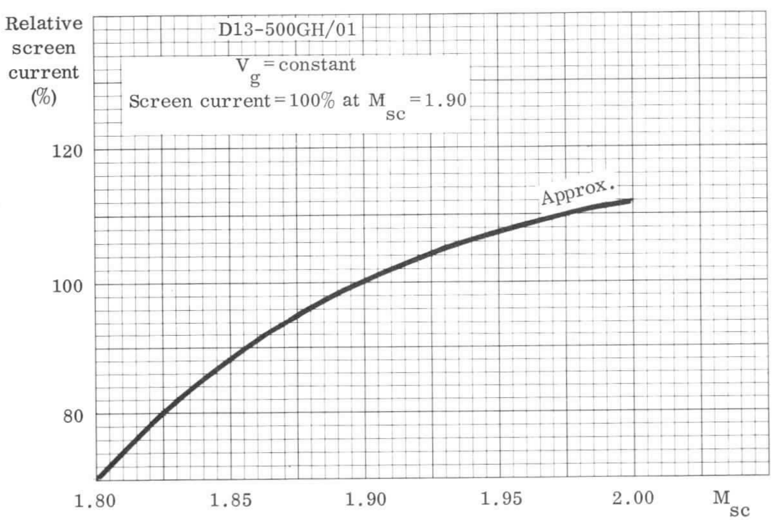


Fig.2



RELATIVE LINE WIDTH AS A FUNCTION OF
SCAN MAGNIFICATION FACTOR



RELATIVE SCREEN CURRENT AS A FUNCTION OF
SCAN MAGNIFICATION FACTOR

Adjustment of the scan magnification factor

The following procedure is recommended for the adjustment of the scan magnification factor:

a. Set V_{a7} and V_{a8} equal to V_{a1}.

b. Display a timebase line and adjust V_{a5} so that the line appears sharply focused.

c. Apply a square wave signal to the vertical deflection system (the vertical parts of the trace will be out of focus, but this is immaterial) and adjust the amplitude so that the height of the display has a convenient value, e.g. 30mm.

d. Set V_{a7} and V_{a8} to the appropriate values and readjust V_{a5} so that the horizontal parts of the trace are again in focus.

e. Check the height of the display (e.g. for $M_{sc}=1.9$ this height should now be 57mm if it was 30mm high previously)

f. If necessary, readjust V_{a8} until the desired value of M_{sc} is obtained.

Adjustment of the focusing and correction electrode voltages

Focusing is controlled by means of V_{a3} and V_{a4}. Having two focus controls is not, in fact, an extra complication, as a separate astigmatism control is not required. The voltages on electrodes a4 and a6 can be used to centre the beam with respect to the vertical and horizontal deflection systems.
The voltages of the focusing and correction electrodes can be adjusted as follows:

a. Display a square wave signal on the screen so that both horizontal and vertical traces are visible.

b. Adjust V_{a5} so that the horizontal parts of the display are in focus. The vertical parts will, in general, be out of focus.

c. Adjust V_{a3} so that the vertical traces are brought into focus. This will de-focus the horizontal parts of the display.

d. Repeat (b) and (c) successively until both vertical and horizontal traces are simultaneously in focus.

e. Adjust V_{a2} for minimum width of a horizontal line. If necessary readjust V_{a3} and V_{a5}.

f. Adjust V_{a6} for equal brightness at the left-hand and right-hand edges of the display area. If necessary, readjust the focus by means of V_{a5}.

g. Adjust V_{a4} so that the position of a horizontal trace not deflected in the vertical direction is at the centre of the vertical useful scan. If necessary, readjust the focus by means of V_{a3}.
If the graticule is not fully covered by the scanned area the image should be shifted by adjusting the correction coil current (see page 15) before the adjustment of V_{a4} is made.

The procedure for the adjustment of the scan magnification factor and for focusing, as described above, seems to be rather complicated. However, in practice it will be sufficient to adjust V_{a8} to its nominal value without determining the scan magnification factor for each individual tube. As to focusing, the user can, with some experience, achieve the best setting with very few adjustments.

Post-deflection acceleration

The use of a mesh p.d.a. shield ensures a high deflection sensitivity. The geometry control electrode, s2, serves for the correction of pin cushion or barrel distortion. In order to suppress background illumination due to secondary electrons originating from the p.d.a. shield, this shield should be kept about 12V negative with respect to s2, whereas the voltage of the interplate shield, s1, should be equal to the mean x-plate potential.

SCREEN

Tube face diagonal	13	cm
Phosphor	GH	
Fluorescent colour	green	
Phosphorescent colour	green	
Persistence	Medium short	
Minimum useful screen dimensions	60 x 100	mm
Minimum useful scan (at $V_{a9} = 6.0V_{a1}$)		
$y_1 - y_2$	60	mm
$x_1 - x_2$	100	mm

The scanned raster can be centred and aligned with the internal graticule by means of correction coils mounted on the tube (see page 13). For illumination of the internal graticule see page 15.

RATINGS (ABSOLUTE MAXIMUM SYSTEM)

V_{a9} max. (p.d.a.)	20	kV
V_{a9} min.	9.0	kV
V_{s3} max.	3.1	kV
V_{s2} max.	3.1	kV
V_{s1} max.	3.1	kV
V_{a8} max.	3.0	kV
V_{a7} max.	3.2	kV
V_{a6} max.	3.1	kV
V_{a5} max.	3.0	kV
V_{a4} max.	3.1	kV
V_{a3} max.	3.0	kV
V_{a2} max.	3.1	kV
V_{a1} max.	3.0	kV

RATINGS (cont'd)

V_{a1} min.	2.0	kV
Ratio of V_{a9}/V_{a1} max.	10	
V_{a1} minus V_{a5} max.	1.0	kV
V_{a1} minus V_{a3} max.	1.0	kV
V_{x-a1} and V_{y-a1} max.	500	V
$-V_g$ max.	200	V
$+V_g$ max.	0	V
$I_{k(av)}$ max.	300	μA
V_{h-k} max.	±125	V
Maximum screen dissipation	3.0	mW/cm^2

CAPACITANCES (measured on a three terminal capacitance bridge)

High potential	Low potential	Earthed	Capacitance (pF)
k	all	-	5.0
g	all	-	6.0
x_1	all	x_2	4.5
x_2	all	x_1	4.5
x_1	x_2	all	2.7

MOUNTING POSITION

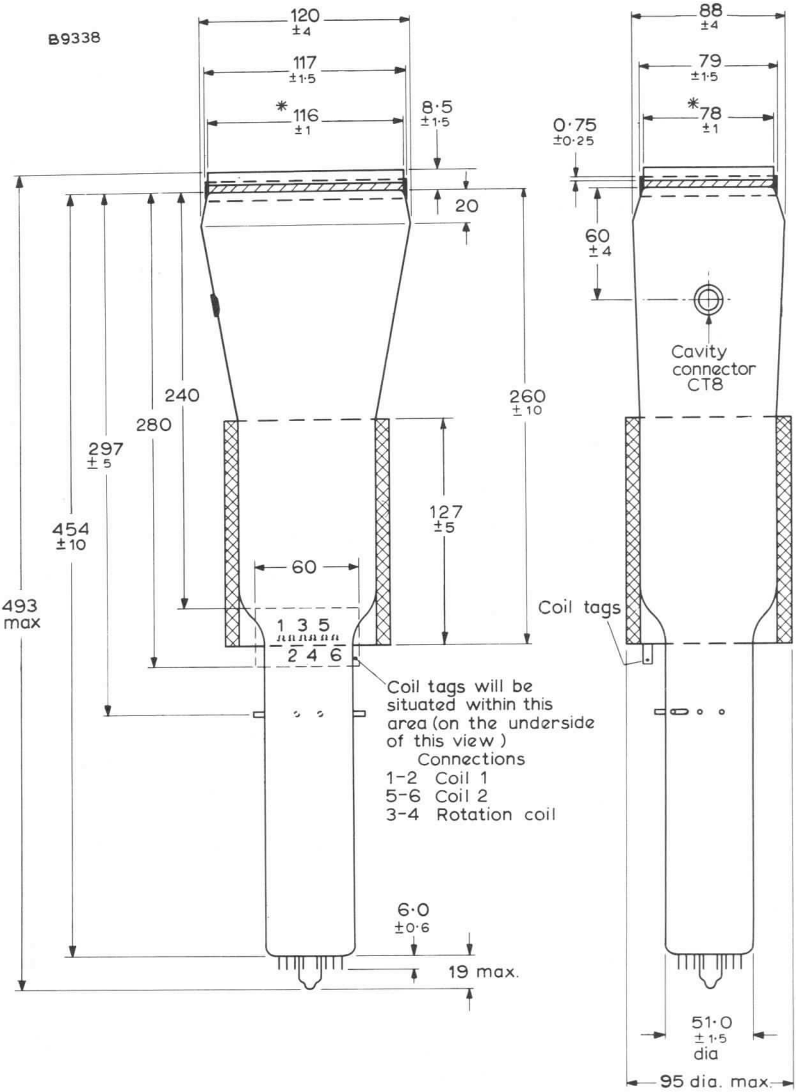
Any. The tube socket should have flexible leads and be allowed to move freely.

WEIGHT

Tube alone (approx.)	1.3	kg

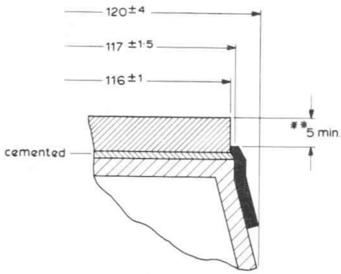
ACCESSORIES

Socket (supplied with tube)	55566
a9 connector (cavity connector CT8)	55563
Side contact connector	55561
Mu-metal shield	55582

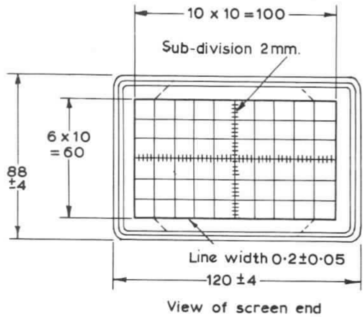


All dimensions in mm

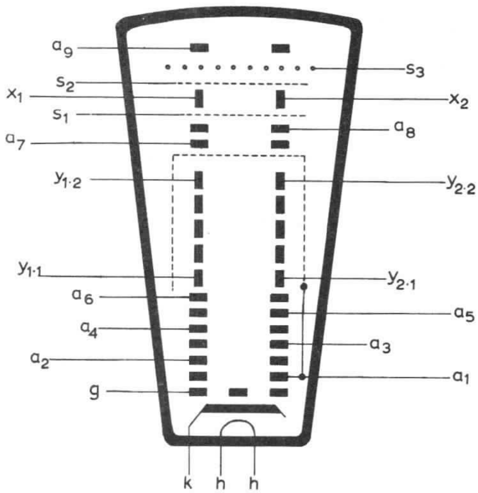
*These dimensions apply to the illumination plate which will always be within the limits 117 ± 1.5 × 79 ± 1.5mm of the tube face.



**Clear area for light conductor



All dimensions in mm



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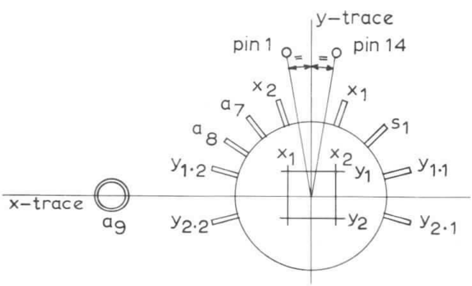
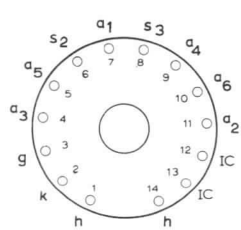


Orientation of axes of deflection
as viewed from screen end



As viewed from base end
Special 14-pin base

NOTES

1. This voltage should be adjusted for optimum picture geometry.
2. This voltage should be equal to the mean x-plate potential.
3. The range indicated corresponds to a scan magnification factor, M_{sc}, (the ratio by which the vertical deviation on the screen is increased) in the approximate range 1.8 to 2.0. Within this range, line width and screen current at a fixed value of control grid voltage are increasing functions of M_{sc}. The best compromise between brightness and line width is usually found at $M_{sc} \simeq 1.9$, which corresponds to $V_{a8-a1} \simeq 310V$.
4. For minimum defocusing of vertical lines near the upper and lower edges of the scanned area this voltage should be adjusted approximately to the value indicated. Since the value of V_{a7-a1} has some effect on the scan magnification factor, both a7 and a8 should be connected to a1 when the deviation without scan magnification is to be measured.
5. This voltage should be adjusted for equal brightness in the x-direction with respect to the electrical centre of the tube.
6. These voltages should be stabilised to within ±1V.
7. By adjusting this voltage a spot which is not deflected in the vertical direction may be centred with respect to the vertical useful scan.
8. This voltage should be adjusted for minimum width of a horizontal line.
9. For a scan magnification factor, $M_{sc} = 1.9$. In the above-mentioned range of V_{a8-a1} the vertical deflection will vary by approximately ±5%.

CORRECTION COILS

The D13-500GH/01 is provided with a coil unit consisting of:

1. a pair of coils for
   (a) correction of the orthogonality of the x and y traces (so that the angle between the x and y traces at the centre of the screen can be made exactly 90^o).
   (b) vertical shift of the scanned area.

2. a single coil for image rotation (aligning the x trace with the x lines of the graticule).

Orthogonality and shift

The change in angle between the traces will be proportional to the algebraic sum of the currents in the two coils, and the vertical shift of the scanned area will be proportional to the algebraic difference.

The maximum currents required under typical operating conditions are 5mA per degree of angle correction and 2mA per millimetre of shift. These values apply to a tube operating with a mu-metal shield closely surrounding the coils. If a close fitting shield is not used the values have to be multiplied by a factor K ($1 < K < 2$), the value of which depends on the dimensions of the shield and approaches 2 for the case in which no shield is present.
The d.c. resistance of each coil is approximately 220Ω. The supply circuits should be designed so that a maximum current of 20mA, with either polarity, can be produced in each coil.

Image rotation

The image rotation coil is concentrically wound. Under typical operating conditions a maximum current of 45mA will be required for the alignment. The d.c. resistance of this coil is approximately 550Ω.

CIRCUIT DIAGRAMS

1. Orthogonality and shift

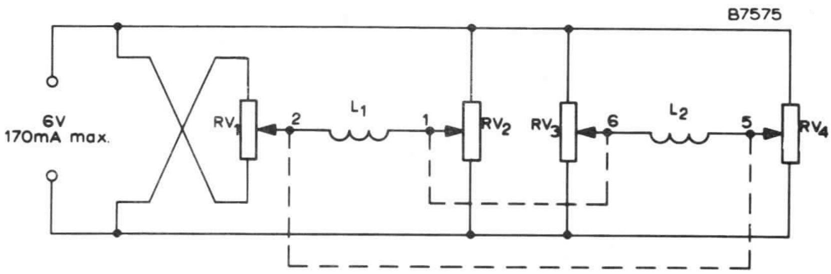


Fig.1

Potentiometers RV_1, RV_4 220Ω, 1.0W, ganged

Potentiometers RV_2, RV_3 220Ω, 1.0W, ganged

With the circuit of Fig.1 almost independent control for shift and angle correction is achieved. This facilitates the correct adjustment to a great extent.
The dissipation in the potentiometers can be reduced considerably if the requirement of independent controls is dropped (see Fig.2).

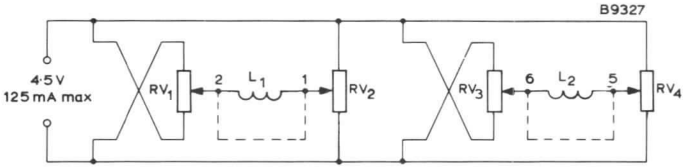


Fig.2

Potentiometers RV_1, RV_2 220Ω, 1.0W, ganged

Potentiometers RV_3, RV_4 220Ω, 1.0W, ganged

A further reduction in the dissipation can be obtained by providing a commutator for each coil (see Fig.3).
The procedure of adjustment will then become more complicated, but it should be kept in mind that a readjustment is necessary only when the tube has to be replaced.

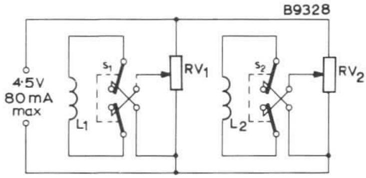


Fig.3

Potentiometers RV_1, RV_2 220Ω, 1.0W

S_1, S_2 commutators

2. Image rotation

A suitable circuit for the image rotation coil is given in Fig.4

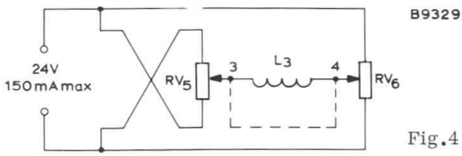


Fig.4

Potentiometers RV_5, RV_6 500Ω, 3.0W, ganged

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ADJUSTMENT PROCEDURE

a. Align the x trace with the graticule by means of the image rotating coil.

b. With the tube fully scanned in the vertical direction, the image has to be shifted so that the graticule is fully covered. With the circuit of Fig.1 this is done by means of the ganged potentiometers RV_1 and RV_4.

c. Adjust the orthogonality by means of the ganged potentiometers RV_2 and RV_3. A slight readjustment of RV_1 and RV_4 may be necessary afterwards.

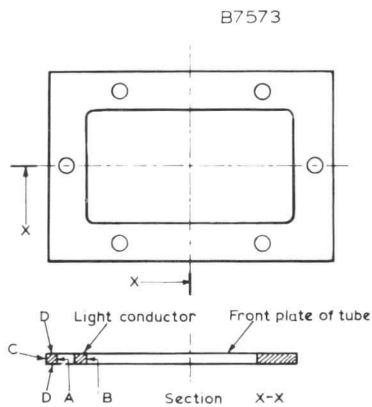
d. Readjust the image rotation if necessary.

With the circuits of Fig.2 or Fig.3 these corrections have to be performed by means of successive adjustments of the currents in the coils.

The most convenient deflection signal is a square waveform, permitting an easy and fairly accurate visual check of orthogonality.

ILLUMINATION OF THE GRATICULE (see drawing)

To illuminate the internal graticule a light conductor (e.g. Perspex) should be used. In order to achieve the most efficient light conductance, the holes for the lamps (A) and the edges adjacent to the tube (B) should be polished, and the contact with the tube should be as close as possible. It is advisable to apply reflective material to the outer circumference (C) and, if possible, also to the upper and lower faces of the light conductor (D). The thickness of the conductor should not exceed 3mm, and its position relative to the front plate of the tube should be adjusted for optimum illumination of the graticule. It is essential that the light conductor is parallel to the front plate of the tube.



OSCILLOSCOPE TUBE D14-120GH

QUICK REFERENCE DATA		
12 × 10cm (4.7 × 4.0in) flat-faced oscilloscope tube with mesh and metal backed screen. Primarily intended for use in 25 to 30MHz transistorised oscilloscopes.		
Final anode voltage (p.d.a.)	10	kV
Display area (at $V_{a4} = 6.7V_{a1+a3}$)	80 × 100	mm
Deflection factor y	4.2	V/cm
Deflection factor x	15.5	V/cm

This data should be read in conjunction with
GENERAL OPERATIONAL RECOMMENDATIONS - CATHODE RAY TUBES

HEATER

Suitable for parallel operation only

V_h	6.3	V
I_h	300	mA

OPERATING CONDITIONS

Beam forming

Final anode + luminescent screen	V_{a4}	10	kV
Geometry control electrode and interplate shield (see note 1)	V_{s2}	1500 ± 15	V
Deflection plate shield (see note 2)	V_{s1}	1500	V
Focus electrode	V_{a2}	250 to 350	V
First accelerator and astigmatism control electrode (see note 3)	V_{a1+a3}	1500 ± 50	V
Control grid (for visual cut-off)	V_g	-20 to -60	V
Average grid drive ($I_t = 10\mu A$)	ΔV_g	12	V

Line width

V_{a4}		10	kV
V_{s2}		1.5	kV
V_{s1}		1.5	kV
V_{a1+a3}		1.5	kV
I_t		10	μA
*Line width	approx.	0.4	mm

*Measured by the shrinking raster method in the centre of the screen.

Raster distortion

A graticule consisting of concentric rectangles 95 × 75mm and 92.8 × 73.6mm is aligned with the electrical x-axis of the tube. The edges of a raster will fall between these rectangles, with optimum correction potentials applied.

DEFLECTION

Double electrostatic

Mean y-plate voltage (see note 2)	$V_{y(mean)}$		1.5	kV
Mean x-plate voltage (see note 2)	$V_{x(mean)}$		1.5	kV
Vertical deflection factor	S_y	av.	4.2	V/cm
		max.	4.6	V/cm
Horizontal deflection factor	S_x	av.	15.5	V/cm
		max.	16	V/cm
Angle between x and y traces			90 ± 1	deg
Angle between x trace and horizontal axis of tube face (max.) (see note 4)			5	deg

Both x and y plates are intended for symmetrical deflection.

If use is made of the full deflection capabilities of the tube the deflection plates will intercept part of the electron beam near the edge of the scan. Therefore a low impedance deflection plate drive is necessary.

Linearity of deflection

The sensitivity at a deflection of less than 75% of the useful scan will not differ from the sensitivity at a deflection of 25% of the useful scan by more than 2%.

CORRECTION POTENTIAL RANGES

Astigmatism control range (see note 3)	ΔV_{a1+a3}	±50	V
Geometry control range (see note 1)	ΔV_{s2}	±15	V

SCREEN

Phosphor	GH	
Fluorescent colour	green	
Phosphorescent colour	green	
Persistence	medium short	
Minimum useful scan (at $V_{a4} = 6.7V_{a1+a3}$)		
$y_1 - y_2$	80	mm
$x_1 - x_2$	100	mm

The useful scan may be shifted vertically and horizontally to a maximum of 6.0mm with respect to the geometric centre of the tube face.

RATINGS (ABSOLUTE MAXIMUM SYSTEM)

V_{a4} max. (p.d.a.)	11	kV
V_{a4} min.	9.0	kV
V_{s2} max.	2.2	kV
V_{s1} max.	2.2	kV
V_{a2} max.	2.2	kV
V_{a1+a3} max.	2.2	kV
V_{a1+a3} min.	1.35	kV
$-V_g$ max.	200	V
$+V_g$ max.	0	V
Grid drive (d.c. or average) max.	20	V
V_{h-k} max.	±125	V
$v_{x-(a1+a3)pk}$ max.	500	V
$v_{y-(a1+a3)pk}$ max.	500	V
p_t max.	3.0	mW/cm^2
Ratio V_{a4}/V_{a1+a3} max.	6.7	

CAPACITANCES (measured on a three terminal capacitance bridge)

High potential	Low potential	Earthed	Capacitance (pF)
k	all	-	4.5
g	all	-	5.5
x_1	all	x_2	6.5
x_2	all	x_1	6.5
y_1	all	y_2	5.0
y_2	all	y_1	5.0
x_1	x_2	all	2.2
y_1	y_2	all	1.7

MOUNTING POSITION

Any. The tube socket should not be rigidly mounted but should have flexible leads and be allowed to move freely.

WEIGHT

Tube alone (approx.)	900	g

ACCESSORIES

Socket (supplied with the tube)	55566
a4 connector (cavity connector CT8)	55563
Mu-metal shield	55581

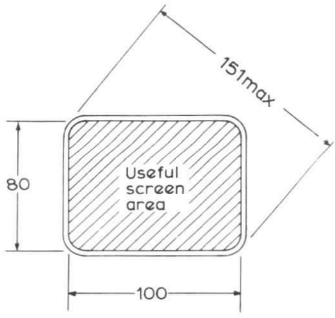
NOTES

1. This tube is designed for optimum performance when operating at a ratio $V_{a4}/V_{a1+a3} \leq 6.7$. The geometry control electrode voltage (V_{s2}) should be adjusted between -15V and +15V with respect to the mean x-plate potential.
   A negative control voltage will give some pin-cushion distortion with less background light, and a positive voltage will give some barrel distortion and a slight increase in background light.

2. The deflection plate shield voltage (V_{s1}) should be equal to the mean y-plate potential. The mean x- and y-plate potentials should be equal for optimum spot quality.

3. The astigmatism control should be adjusted within the stated range for optimum spot shape.

4. In order to align the x trace with the horizontal axis of the screen, the whole picture can be rotated by means of a rotation coil. This coil will require 50 ampere-turns for the maximum image rotation of 5 degrees, and should be positioned as shown on the outline drawing.



OUTLINE DRAWING OF D14-120GH

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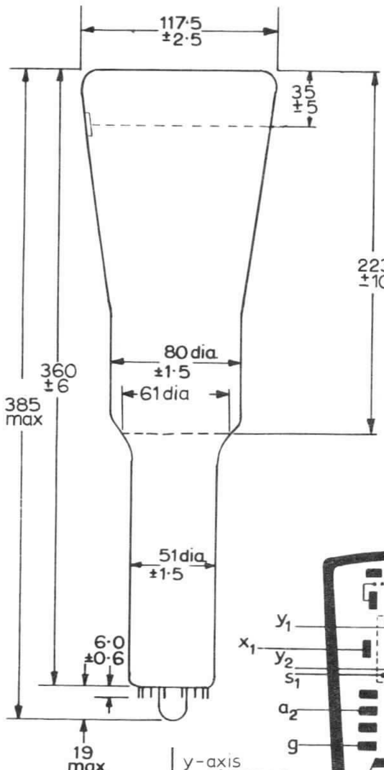
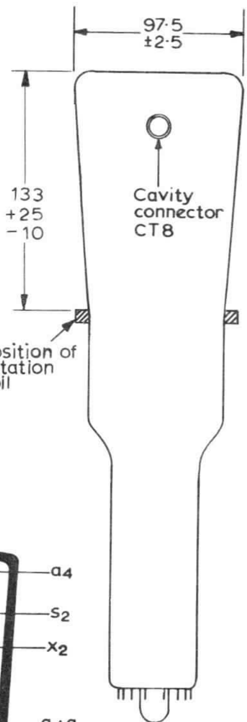
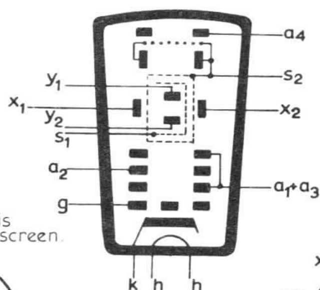
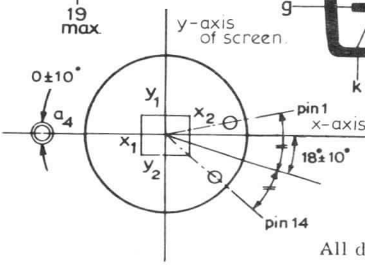
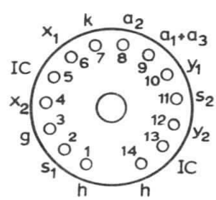










All dimensions in mm

Orientation of axes of deflection
as viewed from screen end

As viewed from base end
Special 14 pin base

OSCILLOSCOPE TUBE D14-121GH

QUICK REFERENCE DATA		
12 × 10cm (4.7 × 4.0in) flat-faced oscilloscope tube with mesh and metal backed screen. Side connections to the x and y plates. For use in transistorised oscilloscopes up to 50MHz.		
Final anode voltage (p.d.a.)	10	kV
Display area ($V_{a4} = 6.7V_{a1+a3}$)	80 × 100	mm
Deflection factor y	4.2	V/cm
Deflection factor x	15.5	V/cm

This data should be read in conjunction with
GENERAL OPERATIONAL RECOMMENDATIONS - CATHODE RAY TUBES

HEATER

Suitable for parallel operation only

V_h	6.3	V
I_h	300	mA

OPERATING CONDITIONS

Beam forming

Final anode + luminescent screen	V_{a4}	10	kV
Geometry control electrode (see note 1)	V_{s3}	1500±100	V
Interplate shield (see note 1)	V_{s2}	1500±15	V
Deflection plate shield (see note 2)	V_{s1}	1500	V
Focus electrode	V_{a2}	250 to 350	V
First accelerator and astigmatism control electrode (see note 3)	V_{a1+a3}	1500±50	V
Control grid (for visual cut-off)	V_g	-20 to -60	V
Average grid drive for $I_t = 10\mu A$	ΔV_g	12	V

Line width

V_{a4}		10	kV
V_{s2}		1.5	kV
V_{s1}		1.5	kV
V_{a1+a3}		1.5	kV
I_t		10	μA
*Line width	approx.	0.4	mm

*Measured by the shrinking raster method in the centre of the screen.

DEFLECTION

Double electrostatic

Mean y-plate voltage (see note 2)	$V_{y(mean)}$		1.5	kV
Mean x-plate voltage (see note 2)	$V_{x(mean)}$		1.5	kV
Vertical deflection factor	S_y	av.	4.2	V/cm
		max.	4.6	V/cm
Horizontal deflection factor	S_x	av.	15.5	V/cm
		max.	16	V/cm
Angle between x and y traces			90±1	deg
Angle between x trace and horizontal axis of tube face (see note 4)		max.	5	deg

Both x and y plates are intended for symmetrical deflection.

If use is made of the full deflection capabilities of the tube the deflection plates will intercept part of the electron beam near the edge of the scan. Therefore a low impedance deflection plate drive is necessary.

CORRECTION POTENTIAL RANGES

Astigmatism control range	ΔV_{a1+a3}	±50	V
Geometry control range (see note 1)	ΔV_{s3}	±100	V
Interplate shield control range (see note 1)	ΔV_{s2}	±15	V

SCREEN

Phosphor	GH	
Fluorescent colour	green	
Phosphorescent colour	green	
Persistence	medium short	
Minimum useful scan (at $V_{a4} = 6.7V_{a1+a3}$)		
$y_1 - y_2$	80	mm
$x_1 - x_2$	100	mm

The useful scan may be shifted vertically and horizontally to a maximum of 6.0mm with respect to the geometric centre of the tube face.

RATINGS (ABSOLUTE MAXIMUM SYSTEM)

V_{a4} max. (p.d.a.)	11	kV
V_{a4} min.	9.0	kV
V_{s3} max.	2.2	kV
V_{s2} max.	2.2	kV
V_{s1} max.	2.2	kV
V_{a2} max.	2.2	kV
V_{a1+a3} max.	2.2	kV
V_{a1+a3} min.	1.35	kV
$-V_g$ max.	200	V
$+V_g$ max.	0	V
Grid drive (d.c. or average) max.	20	V
V_{h-k} max.	±125	V
$v_{x-(a1+a3)pk}$ max.	500	V
$v_{y-(a1+a3)pk}$ max.	500	V
p_t max.	3.0	mW/cm^2
Ratio V_{a4}/V_{a1+a3} max.	6.7	

CAPACITANCES (measured on three terminal capacitance bridge)

High Potential	Low Potential	Earthed	Capacitance (pF)
k	all	-	4.5
g	all	-	5.5
x_1	all	x_2	5.5
x_2	all	x_1	5.5
y_1	all	y_2	4.0
y_2	all	y_1	4.0
x_1	x_2	all	2.2
y_1	y_2	all	1.7

MOUNTING POSITION

Any. The tube socket should not be rigidly mounted but should have flexible leads and be allowed to move freely.

WEIGHT

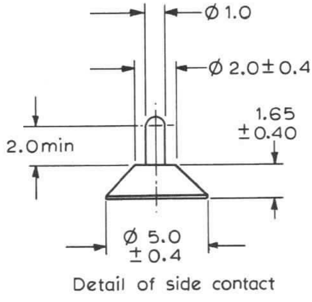
Tube alone (approx.)	900	g

ACCESSORIES

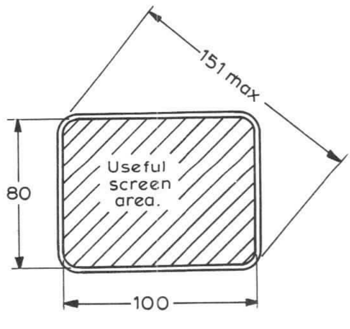
Socket (supplied with tube)	55566
a4 connector (cavity connector CT8)	55563
Side contact connector	55561
Mu-metal shield	55581A

NOTES

1. The tube is designed for optimum performance when operating at a ratio $V_{a4}/V_{a1+a3} \leq 6.7$. The geometry control electrode voltage (V_{s3}) should be adjusted between -100V and +100V with respect to the mean x plate potential.
   A negative voltage on s_2, also with respect to the mean x plate potential, will cause some pin-cushion distortion with less background light, and a positive voltage will give some barrel distortion and a slight increase of background light.
   By varying V_{s2} and V_{s3} it is possible to find a compromise between background light and raster distortion.
2. The deflection plate shield voltage (V_{s1}) should be equal to the mean y-plate potential. The mean x- and y-plate potentials should be equal for optimum spot quality.
3. The astigmatism control should be adjusted within the stated range for optimum spot shape.
4. In order to align the x trace with the horizontal axis of the screen, the whole picture can be rotated by means of a rotation coil. This coil will require 50 ampere-turns for the maximum image rotation of 5 degrees, and should be positioned as shown on the outline drawing.

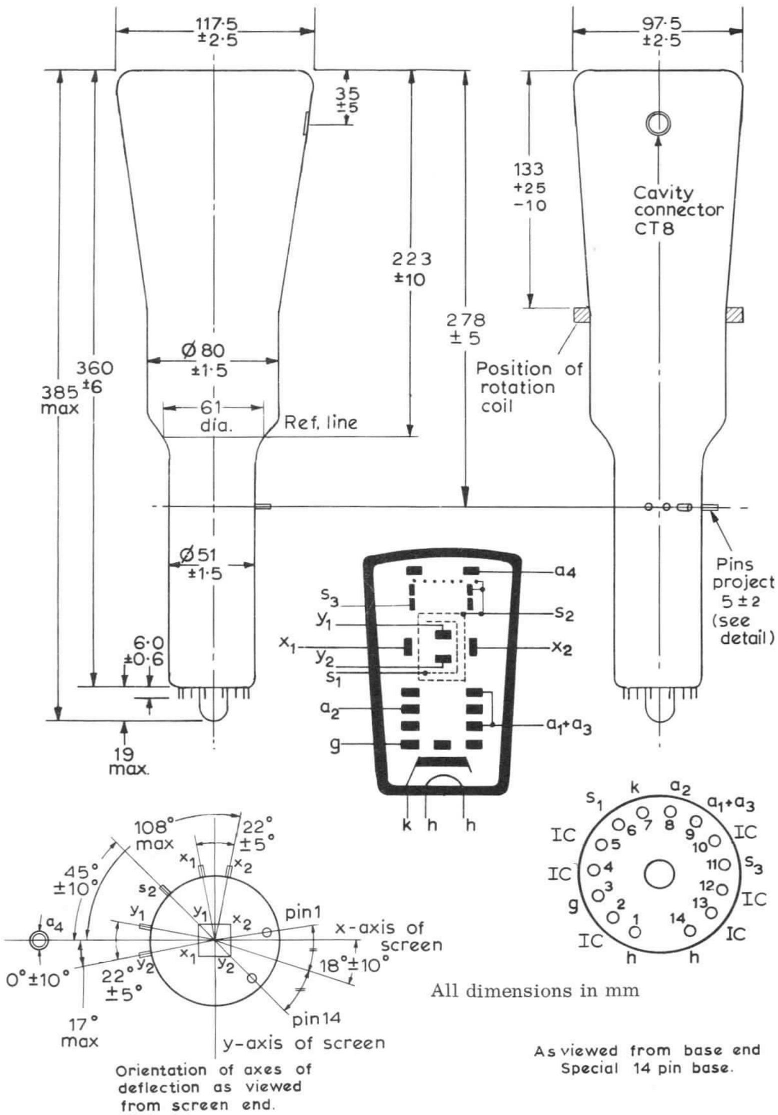


Detail of side contact



Tube face

OUTLINE DRAWING OF D14-121GH



All dimensions in mm

QUICK REFERENCE DATA

3-in. diameter flat-faced oscilloscope tube with helical post-deflection accelerator. Primarily intended for use in transistor oscilloscopes.

Final anode voltage (p.d.a.)	1.2	kV
Display area ($V_{a4} = 4V_{a3}$)	4.5×6.0	cm
S_y	4	V/cm
S_x	11	V/cm

This data should be read in conjunction with GENERAL OPERATIONAL RECOMMENDATIONS – CATHODE RAY TUBES, which precede this section of the handbook.

HEATER

Suitable for parallel operation only.

V_h	6.3	V
I_h	88	mA

SCREEN

Phosphor	*B*	*H*	*N*	*P*
Fluorescent colour	blue	green	yellow-green	purple-blue
Persistence	medium short	medium short	medium short	long (yellow-green)

Minimum useful screen diameter	6.8	cm
Minimum useful scan (with $V_{a4} = 4V_{a3}$)		
y_1–y_2	4.5	cm
x_1–x_2	6.0	cm

TYPICAL OPERATING CONDITIONS

V_{a4} (p.d.a.)	1.2	kV
V_{a3}	285 to 340	V
V_{a2} (focus electrode control range)	20 to 150	V
V_{a1} (first accelerator)	1.2	kV
V_{s1} (inter-plate shield)	270 to 330	V
V_g (for visual extinction of focused spot)	–30 to –80	V
S_y	3.2 to 4.1	V/cm
S_x	9.4 to 12	V/cm

CAPACITANCES

High potential	Low potential	Earthed	Capacitance (pF)
k	all	–	3.0
g	all	–	5.7
y_1	all	y_2	3.5
y_2	all	y_1	3.5
x_1	all	x_2	4.0
x_2	all	x_1	4.0
y_1	y_2	all	1.7
x_1	x_2	all	1.9

LINE WIDTH

V_{a4}	1.2	kV
V_{a3}	300	V
V_{a1}	1.2	kV
I_t	10	μA
*Line width	0.65	mm

*Measured by means of a shrinking raster.

FOCUSING

Electrostatic

DEFLECTION

Double electrostatic

Both x and y plates are intended for a symmetrical deflection.

Angle between x and y deflection $90 \pm 1°$

Linearity of deflection

The sensitivity at a deflection of less than 75% of the useful scan will not differ from the sensitivity at a deflection of 25% of the useful scan by more than 2.0%

Raster distortion

With a raster pattern the size of which is adjusted so that the widest points of the raster just touch the sides of a square of 4.08cm side, no point of these raster sides will be within a concentric square of 3.92cm.

Spot position

With the tube shielded, the undeflected focused spot will be within a circle of 4mm radius centred with respect to the geometric centre of the face plate.

Deflection plates x_1, x_2 and y_1, y_2

If use is made of the full deflection capabilities of the tube, the deflection plates will intercept part of the beam near the edge of the scan. Therefore, a low impedance voltage source is necessary to drive the deflection plates.

MOUNTING POSITION

Any

This tube should not be supported by the base alone and under no circumstances should the socket be allowed to support the tube.

EQUIPMENT DESIGN RANGE

Grid cut-off voltage ($V_{a4} = V_{a1}$)	V_g	−30	to	−80	V/kV of V_{a1}
Deflection factor ($V_{a4} = V_{a1}$)	y	6.9	to	8.8	V/cm/kV of V_{a1}
	x	17.9	to	22.8	V/cm/kV of V_{a1}
($V_{a4} = 4V_{a1}$)	y	10.7	to	13.7	V/cm/kV of V_{a3}
	x	31.3	to	40.0	V/cm/kV of V_{a3}
Focusing electrode current	I_{a2}	−15	to	+10	μA

ABSOLUTE MAXIMUM RATINGS

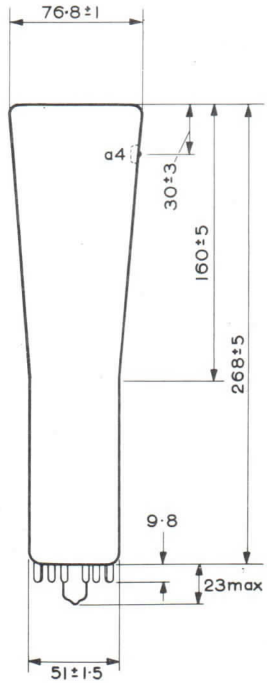
V_{a4} max. (p.d.a.)	2.5	kV
V_{a4} min.	1.2	kV
V_{a3} max.	2.2	kV
V_{a2} max.	1.0	kV
V_{a1} max.	1.6	kV
V_{a1} min.	800	V
V_{s1} max.	2.2	kV
$-V_g$ max.	200	V
$+V_g$ max.	0	V
Maximum ratio V_{a4}/V_{a3}	4	
$v_{x-a3(pk)}$ max.	500	V
$v_{y-a3(pk)}$ max.	500	V
V_{h-k} max.		
Cathode positive	100	V
Cathode negative	15	V
I_k max.	200	μA
p_l max.	3	mW/cm²
Min. post-deflection helix resistance	40	MΩ

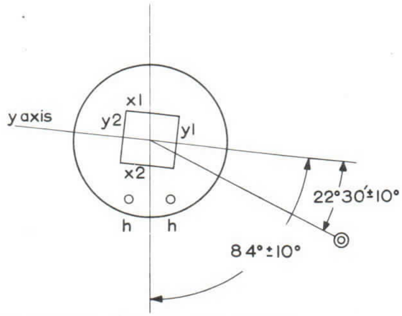
WEIGHT

Tube alone	0.82	lb
	370	g

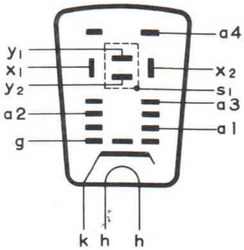
ACCESSORIES

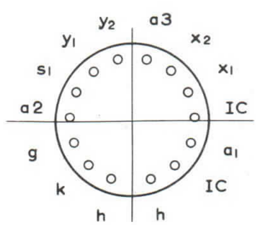
Socket 40467





Orientation of axes of deflection as viewed from screen end





Special 14 pin base

All dimensions in mm

B831

QUICK REFERENCE DATA		
7cm (3in.) diameter, flat-faced oscilloscope tube with helical p.d.a. intended for small service oscilloscopes.		
Final anode voltage (p.d.a.)	1.2	kV
Display area (at $V_{a4} = 4V_{a3}$)	4.5 × 6	cm
Deflection factor y	3.65	V/cm
Deflection factor x	10.7	V/cm

This data should be read in conjunction with GENERAL OPERATIONAL RECOMMENDATIONS - CATHODE RAY TUBES

HEATER

Suitable for parallel operation only

V_h	6.3	V
I_h	300	mA

OPERATING CONDITIONS

BEAM FORMING

Final anode + luminescent screen	V_{a4}	1.2	4.0	kV
Geometry control electrode	V_{s1}	300 ± 30	1000 ± 100	V
Astigmatism control electrode	V_{a3}	300 ± 40	1000 ± 50	V
Focus electrode	V_{a2}	20 to 150	35 to 165	V
First accelerator	V_{a1}	1.2	1.0	kV
Control grid (for visual cut-off)	V_g	-36 to -72	-30 to -60	V

Raster distortion

A graticule, consisting of concentric rectangles 4.08 × 4.08cm and 3.92 × 3.92cm is aligned with the electrical x-axis of the tube. The edges of the raster will fall between these rectangles with optimum correction potentials applied.

Line width

V_{a4}	1.2	kV
V_{a3}	300	V
V_{a1}	1.2	kV
I_t	10	μA
*Line width	0.65	mm

*Measured by the shrinking raster method in the centre of the screen.

DEFLECTION

Double electrostatic

Mean y-plate voltage	V_y mean	300	1000	V
Mean x-plate voltage	V_x mean	300	1000	V
Vertical deflection factor	S_y	3.2 to 4.1	10.7 to 13.7	V/cm
Horizontal deflection factor	S_x	9.4 to 12	31.3 to 40	V/cm
Angle between x and y deflection			90 ± 1	deg

Both x and y plates are intended for symmetrical deflection.

If use is made of the full deflection capabilities of the tube the deflection plates will intercept part of the electron beam near the edge of the scan. Therefore a low impedance deflection plate drive is necessary.

Linearity of deflection

The sensitivity at a deflection of less than 75% of the useful scan will not differ from the sensitivity at a deflection of 25% of the useful scan by more than 2%.

CORRECTION POTENTIAL RANGES

Astigmatism control range	V_{a3}	260 to 340	950 to 1050	V
Geometry control range	V_{s1}	270 to 330	900 to 1100	V

SCREEN

Phosphor	B	H	N	P
Fluorescent colour	blue	green	yellowish-green	purplish-blue
Phosphorescent colour	blue	green	yellowish-green	yellowish-green
Persistence	medium short	medium short	medium short	long

Minimum useful screen diameter	6.8	cm
Minimum useful scan (at $V_{a4}=4V_{a3}$)		
$y_1 - y_2$	4.5	cm
$x_1 - x_2$	6.0	cm

The useful scan may be shifted vertically to a maximum of 4mm with respect to the geometric centre of the tube face.

RATINGS (ABSOLUTE MAXIMUM SYSTEM)

V_{a4} max. (p.d.a.)	5.0	kV
V_{a4} min.	1.2	kV
V_{s1} max.	2.2	kV
V_{a3} max.	2.1	kV
V_{a3} min.	300	V
V_{a2} max.	1.0	kV
V_{a1} max.	1.6	kV
V_{a1} min.	800	V
$-V_g$ max.	200	V
$+V_g$ max.	0	V
$+v_{g(pk)}$ max.	2.0	V
$v_{x-a3(pk)}$ max.	500	V
$v_{y-a3(pk)}$ max.	500	V
R_{g-k} max.	1.5	MΩ
p_t max.	3.0	mW/cm^2
V_{h-k} max.		
cathode positive	200	V
cathode negative	125	V
$I_{k(av.)}$ max.	300	μA
R_{x-a3} max.	50	kΩ
R_{y-a3} max.	50	kΩ
Ratio V_{a4}/V_{a3} max.	5.0	

HELIX RESISTANCE

Minimum post-deflection helix resistance	40	MΩ

CAPACITANCES (measured on three terminal capacitance bridge)

High potential	Low potential	Earthed	Capacitance (pF)
k	all	-	2.6
g	all	-	3.5
x_1	all	x_2	3.5
x_2	all	x_1	3.5
y_1	all	y_2	3.0
y_2	all	y_1	3.0
x_1	x_2	all	1.7
y_1	y_2	all	1.6

EQUIPMENT DESIGN RANGE

Focusing electrode voltage	V_{a2}	35 to 165	V/kV of V_{a3}
Grid cut-off voltage	V_g	30 to 60	V/kV of V_{a1}
Deflection factor ($V_{a4}=4V_{a3}$)			
Vertical	y	10.7 to 13.7	V/cm/kV of V_{a3}
Horizontal	x	31.3 to 40	V/cm/kV of V_{a3}

MOUNTING POSITION

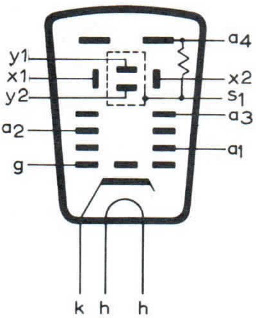
Any. The tube socket should not be rigidly mounted but should have flexible leads and be allowed to move freely.

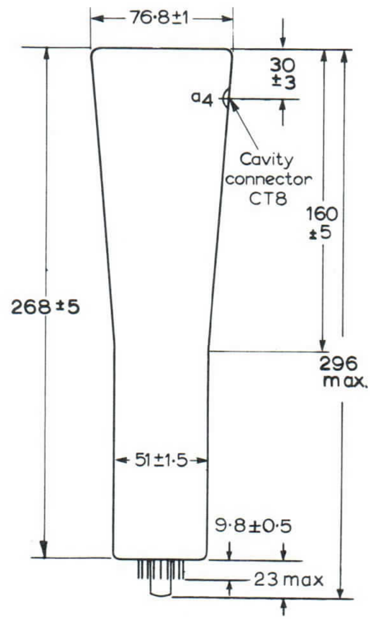
WEIGHT

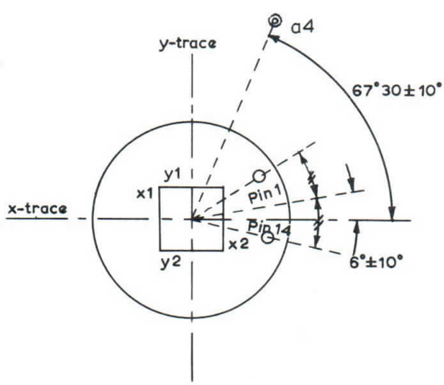
Tube alone	approx.	0.8	lb
		370	g

ACCESSORIES

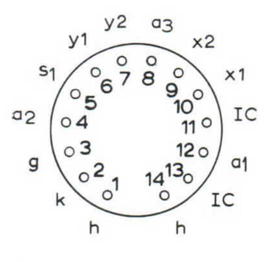
Socket (supplied with the tube)	40467
a_4 connector (cavity connector CT8)	55563
Mu-metal shield	55532







Orientation of axes of deflection as viewed from screen end

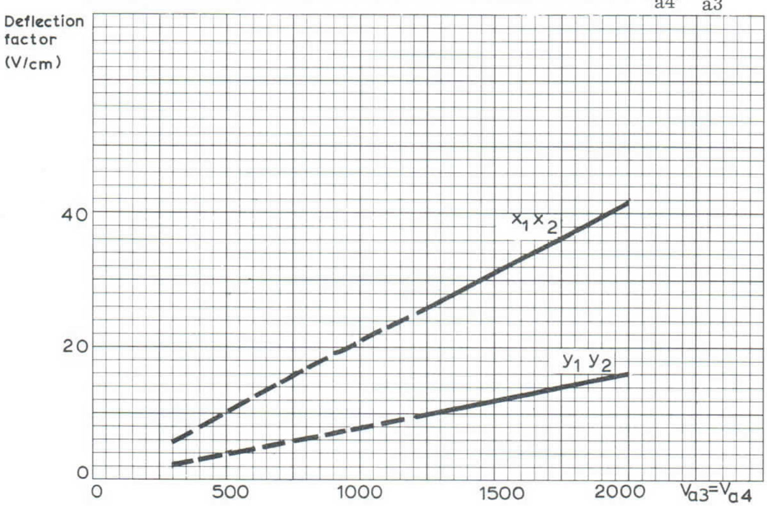


As viewed from base end
Special 14 pin base

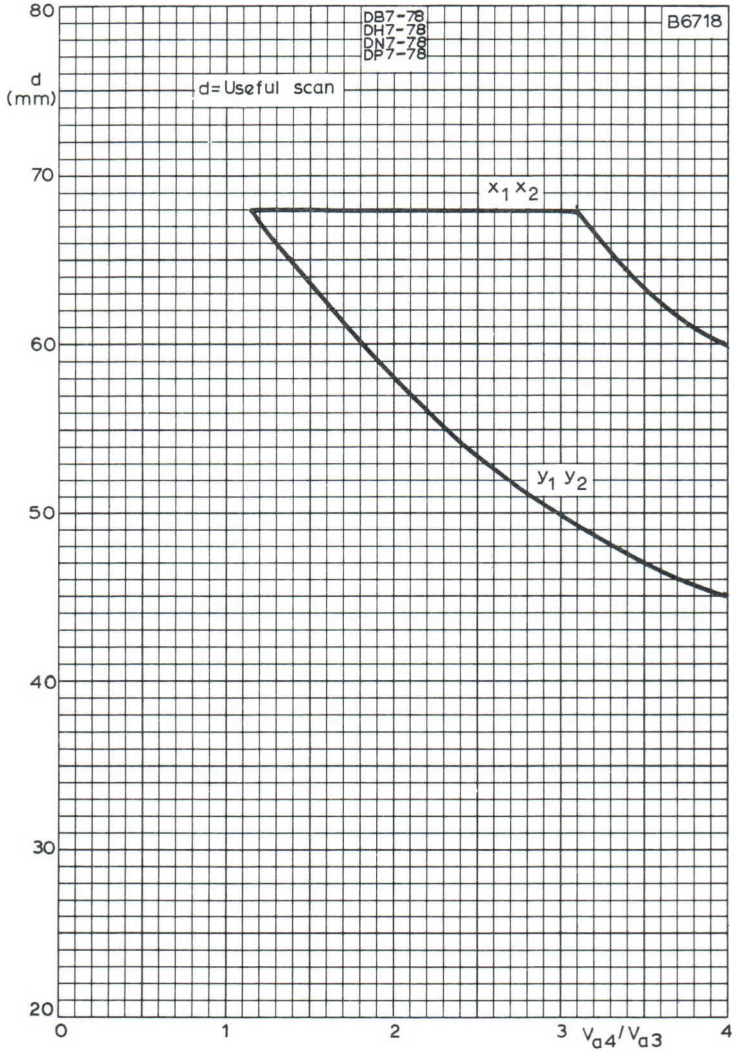
B6795

All dimensions in mm

RELATIVE DEFLECTION FACTOR PLOTTED AGAINST V_{a4}/V_{a3}



DEFLECTION FACTOR PLOTTED AGAINST $V_{a3} = V_{a4}$



USEFUL SCAN PLOTTED AGAINST V_{a4}/V_{a3}

OSCILLOSCOPE TUBES

DG7-31
DG7-32

QUICK REFERENCE DATA		
7cm (3in) diameter low voltage oscilloscope tubes for monitoring purposes. DG7-31 has asymmetrical x-deflection whereas DG7-32 has symmetrical x-deflection. Both types have symmetrical y-deflection.		
Final anode voltage	500	V
Display area	Full scan in both directions	
Deflection factor y	approx. 21	V/cm
Deflection factor x	approx. 37	V/cm

Unless otherwise stated, data is applicable to both types

This data should be read in conjunction with
GENERAL OPERATIONAL RECOMMENDATIONS - CATHODE RAY TUBES

TYPE NOMENCLATURE

Following the introduction of the suffixes /01, /02 etc.to type numbers denoting various internal graticules, it has been found necessary to cancel some of the older type numbers which used similar suffixes. The following list relating the old and new type numbers also includes the equivalent CV numbers.

Old Mullard Type Number	New Mullard Type Number	CV Number
DG7-31	-	CV5418
DG7-31/01	DG7-31	CV8330
DG7-32	-	CV2431
DG7-32/01	DG7-32	CV8959

HEATER

Suitable for parallel operation only

V_h	6.3	V
I_h	300	mA

OPERATING CONDITIONS

Beam forming

Final anode	V_{a1+a3}	500	V
Focus electrode	V_{a2}	0 to 120	V
Control grid (for visual cut-off)	V_g	-50 to -100	V
Focusing electrode current	I_{a2}	-15 to + 10	μA

Raster distortion

A graticule, consisting of concentric rectangles 4.0 × 4.0cm and 4.32 × 4.32cm is aligned with the electrical x axis of the tube; the edges of a raster will fall between these rectangles with optimum correction potentials applied.

Note:

A contrast improving transparent conductive coating connected to a_1+a_3 is present between the glass and the fluorescent layer. This makes possible the application of a high potential to a_1+a_3 with respect to earth, without the risk of picture distortion if the face plate is touched.

Line width

V_{a1+a3}	500	V
I_t	0.5	μA
*Line width	0.4	mm

*Measured on a circle of 5cm diameter

DEFLECTION

Double electrostatic

Mean y-plate voltage	V_y mean	500	V
Mean x-plate voltage	V_x mean	500	V
Vertical deflection factor	S_y	18.8 to 23.2	V/cm
Horizontal deflection factor	S_x	33.3 to 41.5	V/cm
Angle between x and y deflection		90 ± 1.5	deg

DG7 - 31

The x-plates are intended for asymmetrical deflection.
The y-plates are intended for symmetrical deflection.

DG7 - 32

Both x - and y - plates are intended for symmetrical deflection.

SCREEN

Phosphor	G(GJ)	
Fluorescent colour	yellowish - green	
Phosphorescent colour	yellowish - green	
Persistence	medium	
Minimum useful screen diameter	6.5	cm
Minimum useful scan (at V_{a1+a3} = 500V)		
$y_1 - y_2$	Full scan	
$x_1 - x_2$	Full scan	

RATINGS (ABSOLUTE MAXIMUM SYSTEM)

V_{a1+a3} max.		800	V
V_{a1+a3} min.		400	V
V_{a2} max.		200	V
$-V_g$ max.		200	V
$+V_g$ max.		0	V
$+v_{g(pk)}$ max.		2.0	V
V_{h-k} max.	Cathode positive	200	V
	Cathode negative	125	V
p_t max.		3.0	mW/cm^2
R_{g-k} max.		500	kΩ
$R_{x-(a1+a3)}$ max.		5.0	MΩ
$R_{y-(a1+a3)}$ max.		5.0	MΩ

CAPACITANCES (measured on a three terminal capacitance bridge)

High potential	Low potential	Earthed	Capacitance (pF)
k	all	-	3.2
g	all	-	7.6
x_1	all	x_2	3.7
x_2	all	x_1	3.0
y_1	all	y_2	2.5
y_2	all	y_1	2.5
x_1	x_2	all	1.7
y_1	y_2	all	1.0

EQUIPMENT DESIGN RANGE

Focusing electrode voltage	V_{a2}	0 to 240	V/kV of V_{a1+a3}
Grid cut-off voltage	V_g	-100 to -200	V/kV of V_{a1+a3}
Deflection factor			
vertical	S_y	37.6 to 46.4	V/cm/kV of V_{a1+a3}
horizontal	S_x	67 to 83	V/cm/kV of V_{a1+a3}

MOUNTING POSITION

Any. The tube socket should not be rigidly mounted but should have flexible leads and be allowed to move freely.

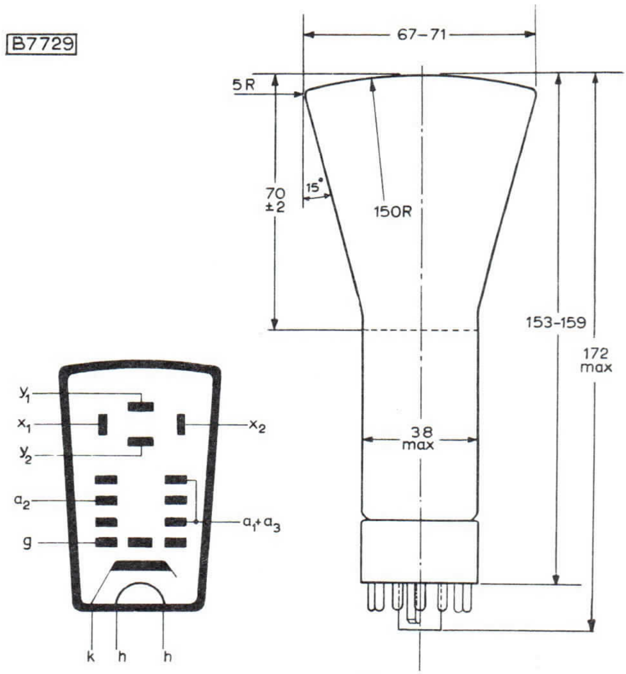
WEIGHT

Tube alone (approx.)	120	g

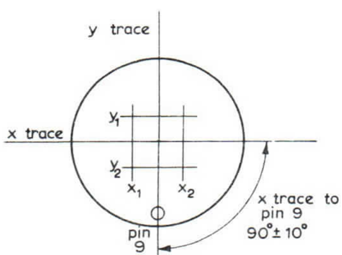
ACCESSORIES

Socket	5912/20
Mu-metal shield	55530

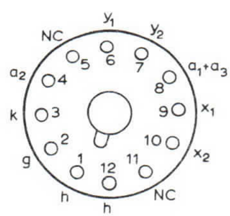
OUTLINE DRAWING OF DG7-31 AND DG7-32



All dimensions in mm



Orientation of axes of deflection as viewed from screen end



As viewed from base end
B12A base

OSCILLOSCOPE TUBE DH3-91

QUICK REFERENCE DATA		
3 cm (1 in) dia. simple oscilloscope tube for low voltage applications.		
Anode voltage	500	V
Display area	full scan	
Deflection factor y	45.5	V/cm
Deflection factor x	52.5	V/cm

This data should be read in conjunction with GENERAL OPERATIONAL RECOMMENDATIONS - CATHODE RAY TUBES.

HEATER

Suitable for parallel operation only

V_h	6.3	V
I_h	300	mA ←

OPERATING CONDITIONS

Final anode	$V_{a1+a3+y2}$	500	V
*Control grid (for visual cut-off)	V_{g1}	-8.0 to -27	V

Line width

$V_{a1+a3+y2}$	500	V
I_t	0.5	μA
**Line width	0.6	mm

*In no circumstances must the grid be allowed to become positive.

**Measured on a circle of 25mm diameter.

DEFLECTION

Double electrostatic

Vertical deflection factor	S_y	35 to 63	V/cm
Horizontal deflection factor	S_x	41 to 72	V/cm
Angle between x and y deflection		90 ± 5.0	deg

The x plates are intended for symmetrical deflection.

The y plates are intended for asymmetrical deflection.

For optimum focus with symmetrical operation the average potential of the x plates and $V_{a1+a3+y2}$ should be equal. With asymmetrical operation the potential on any one deflection plate should not differ from $V_{a1+a3+y2}$ by more than the deflection voltage.

SCREEN

Phosphor	H	
Fluorescent colour	green	
Persistence	medium short	
Minimum useful screen diameter	2.8	cm
Minimum useful scan		
$y_1 - y_2$	full scan	
$x_1 - x_2$	full scan	

RATINGS (ABSOLUTE MAXIMUM SYSTEM)

$V_{a1+a3+y2}$ max.	1.0	kV
$V_{a1+a3+y2}$ min.	350	V
$-V_{g1}$ max.	200	V
$+V_{g1}$ max.	0	V
$+v_{g1(pk)}$ max.	2.0	V
V_{h-k} (cathode positive) d.c. max.	200	V ←
V_{h-k} (cathode negative) d.c. max.	125	V ←
P_t max.	3.0	mW/cm^2
R_{g-k} max.	1.0	MΩ
R_{y-a3} max.	5.0	MΩ
R_{x-a3} max.	5.0	MΩ

CAPACITANCES (measured on a three terminal capacitance bridge) ←

High potential	Low potential	Earthed	Capacitance (pF)
g	all	-	5.6
x_1	all	x_2	4.5
x_2	all	x_1	4.5
y_1	all	a_1, a_3, y_2	3.5
x_1	x_2	all	1.0

EQUIPMENT DESIGN RANGE

Grid cut-off voltage	V_g	-16 to -54	V/kV of $V_{a1+a3+y2}$
Deflection factor			
vertical	y	38.5 to 52.5	V/cm/kV of $V_{a1+a3+y2}$
horizontal	x	90 to 120	V/cm/kV of $V_{a1+a3+y2}$

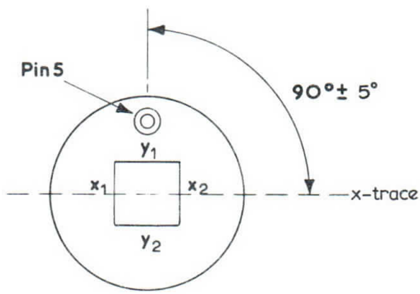
MOUNTING POSITION

Any. This tube may be supported by the base alone but care must be taken to minimise the effects of sudden acceleration and shock.

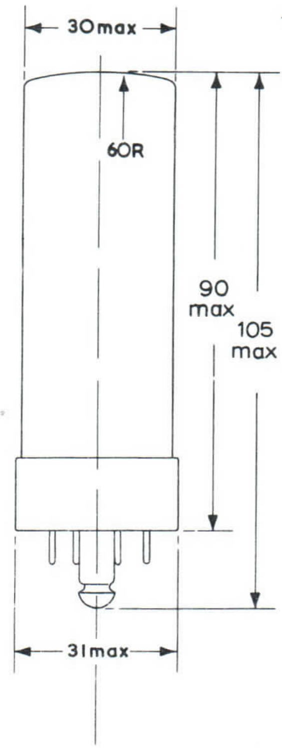
WEIGHT

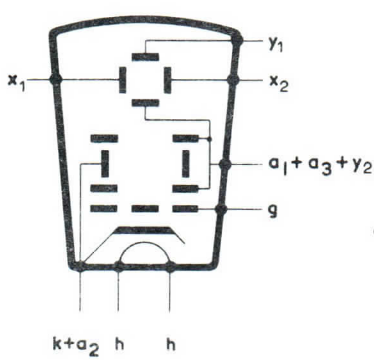
Tube alone (approx.)	39	g
	1.4	oz

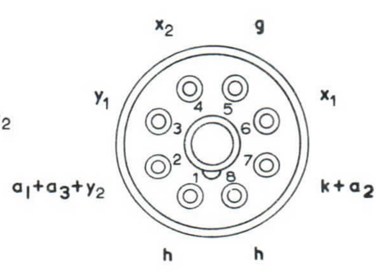
B6910



Orientation of axes of deflection as viewed from screen end.







B8G Base

All dimensions in mm

CIRCUIT NOTES FOR DH3-91

In view of the simplicity of the operating requirements no additional supplies may be required when the tube is incorporated in some equipment. An arrangement suitable for use in such a case is shown in Fig.1. Fixed bias is provided by the cathode resistor R3 which may be by-passed if necessary by a 0.5μF capacitor. Although tubes may not be identical in respect of their 'brightness-grid voltage' characteristic this method of auto-bias produces almost constant brilliance in changing from tube to tube.

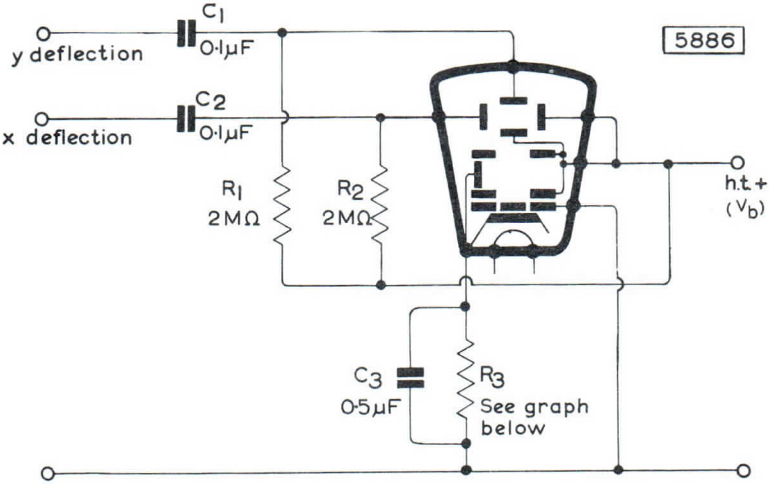
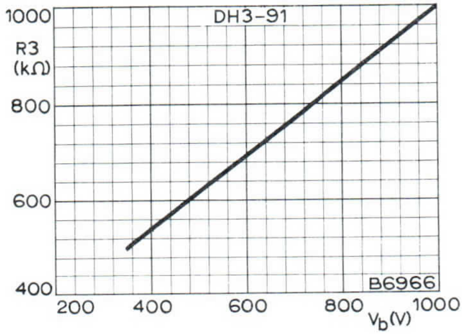


Fig. 1



Owing to the presence of a transparent conducting film connected to anode between the screen of the tube and the glass, the tube may be operated with its cathode at earth potential without any oscillogram distortion when an earthed body is brought near the screen.

Depending on the individual application, the simple arrangement shown may be unsuitable for a variety of reasons. Two of the commonest drawbacks, with suggestions for overcoming them, are:

1. If various patterns are to be displayed on the same tube it is probable that different beam currents will be required to produce the same brightness on each oscillogram. A modified variable brilliance control can be provided merely by using a variable cathode bias resistor. Alternatively, if it is required to 'black-out' the trace a combination of tube current and bleed can be used. In either case it is desirable to incorporate a limiting resistor in order to prevent excessive beam current being drawn.

2. Since the deflector plates are essentially at h.t. potential it is not normally possible to incorporate d.c. coupling to them. Should this be required it is necessary to run the tube anode at the mean potential of the deflector plates, which usually involves tapping the anode across the h.t. supply. If there is no point from which the d.c. signal can be taken which allows the necessary minimum h.t. to be obtained, it is recommended that a negative supply be utilised. This may already be incorporated in the apparatus.

Note-If it is required to run the y plate only from a d.c. signal the anode tap can be used as a centring device.

Fig.2 shows the two modifications listed above. In it the y plates are shown d.c. connected and the x plates a.c. connected. No x shift network is included. V1 is the actual working voltage of the tube.

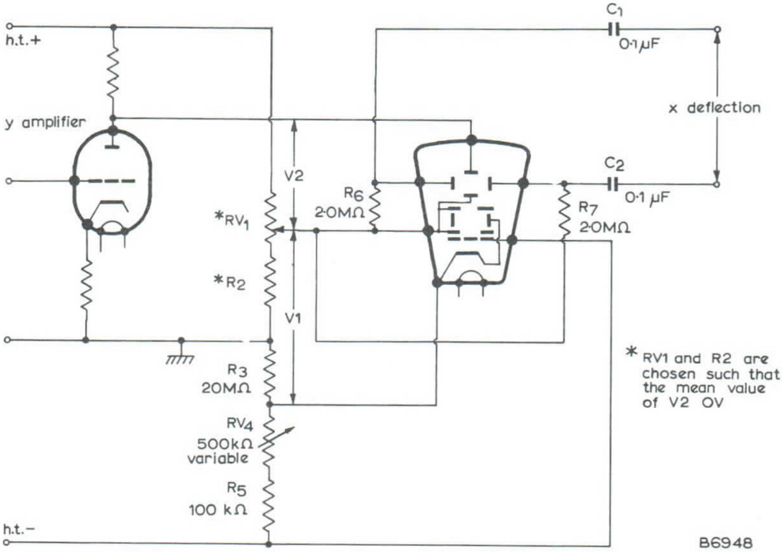


Fig. 2

DUAL TRACE OSCILLOSCOPE TUBE

(E13-10GH)

DHM13-10

Direct viewing dual trace oscilloscope tube with 5-in. diameter flat screen and distributed p.d.a. system. This tube has two independent y signal traces with common x plates, the deflection plates being brought out to side connections.

ADVANCE DATA FOR USE WITH DEVELOPMENT SAMPLES

ADVANCE DATA

This data should be read in conjunction with 'GENERAL OPERATIONAL RECOMMENDATIONS - CATHODE RAY TUBES', which precede this section of the handbook.

HEATER

Suitable for parallel operation only

Vh	6.3	V
Ih	300 or 550	mA

CAPACITANCES

cg-all	7.0	pF
ck-all	5.0	pF
cx1-all (x2 earthed)	5.0	pF
cx2-all (x1 earthed)	5.0	pF
cy1"-all (y1' earthed)	6.0	pF
cy2'-all (y2" earthed)	6.0	pF
cy1'-all (y1" earthed)	4.0	pF
cy2"-all (y2' earthed)	4.0	pF
cx1-x2	3.0	pF
cy1'-y1"	1.0	pF
cy2'-y2"	1.0	pF
cy1'+y1"-y2'+y2" max.	0.2	pF

SCREEN

Fluorescent colour	blue-green	
Persistence	medium	
Minimum useful screen dimensions (Va4=4Va1)		
y (each beam)	60	mm
x (each beam)	100	mm
overlap	50	mm

ISSUE 1
3.62

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Technical Information Department

Mullard

FOCUSING

Electrostatic

DEFLECTION

Double electrostatic

Both x and y plates are intended for symmetrical deflection.

Angle between the x and y axes for each trace 90±1 deg.

The angle between the two electrical y axes with the beams superimposed is within ±1.5 deg.

Deviation of linearity of scan

The linearity of the scan is ±2%.

Raster distortion

With a raster of size 45mm by 75mm, the total raster distortion will be ±2% for each beam and ±2.5% for both beams when they are superimposed.

Spot centrality

When all the deflector plates are connected to the third anode, both beams will coincide within a rectangle 12mm by 20mm symmetrically placed about the geometric centre of the tube face and there will be no displacement between the spots in the x direction when adjusted for optimum centre focus.

The useful screen area may be offset from the geometric screen centre by a maximum of 3mm.

MOUNTING POSITION

This tube should not be supported by the base alone. The socket should under no circumstances be used to support the tube .

TYPICAL OPERATING CONDITIONS

V_{a4}	6.0	kV
V_{a3}	1.5	kV
V_{a2}	200 to 450	V
V_{a1}	1.0	kV
V_g for visual cut-off	-45 to -90	V
S_x	18	V/cm
$S_{y'}$	13	V/cm
$S_{y''}$	13	V/cm

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ABSOLUTE MAXIMUM RATINGS

Va4 max. (p.d.a.)	8.0	kV
Va4 min.	1.5	kV
Va3 max.	3.0	kV
Va3 min.	800	V
Va2 max.	1.5	kV
Va1 max.	1.2	kV
Va1 min.	600	V
-Vg max.	200	V
-Vg min.	1.0	V
Vx-a3 max.	500	V
Vy-a3 max.	250	V
vh-k(pk) max.	150	V
Rx-a3 max.	1.0	MΩ
Ry-a3 max.	100	kΩ
Rg-k max.	1.0	MΩ
ra4-a3 min.	50	MΩ

WEIGHT

Tube alone	approx.	(2 lb	10oz
		(1.2	kg

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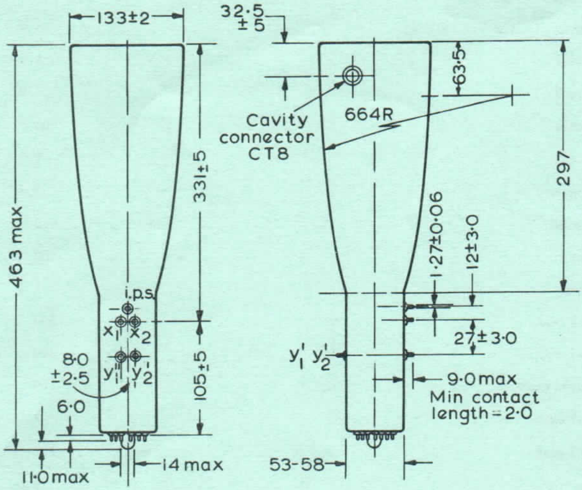
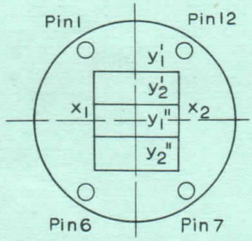
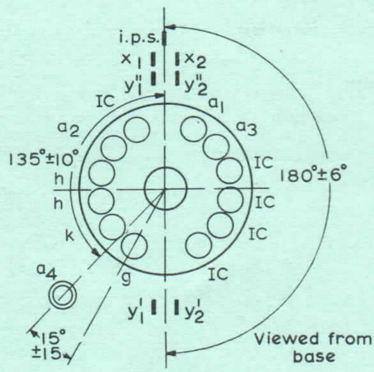
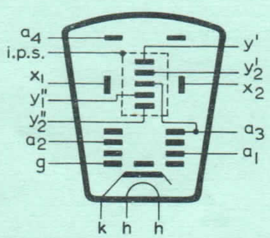




Orientation of axes of deflection as viewed from screen end.



B12F Base



All dimensions in mm

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PRELIMINARY DATA

QUICK REFERENCE DATA

4-in. diameter, flat-faced double gun oscilloscope tube with helical p.d.a. and side connections to the x and y plates. Each gun incorporates beam blanking and is suitable for separate deflection.

Final anode voltage (p.d.a.)	3.0	kV
Display area (each gun) at $V_{a4} = 3V_{a3}$	7×8.5	cm
S_y	< 8	V/cm
S_x	< 20	V/cm

This data should be read in conjunction with GENERAL OPERATIONAL RECOMMENDATIONS – CATHODE RAY TUBES which precede this section of the handbook.

TYPICAL OPERATING CONDITIONS (each gun)

V_{a4} (p.d.a.)	3.0	kV
V_{a3} (astigmatism correction)	1.0	kV
V_{a2} (focus electrode control range)	100 to 300	V
V_{a1}	1.0	kV
V_{s3} (second inter-gun shield)	1.0	kV
V_{s2} (inter-plate shield)	1.0	kV
V_{s1} (first inter-gun shield)	1.0	kV
V_{g2} (beam blanking) w.r.t. a_1	40	V
V_{g1} (for visual extinction of focused spot)	–25 to –90	V
S_y	<8	V/cm
S_x	<20	V/cm

CORRECTION POTENTIALS

Astigmatism correction (each gun)

The average potentials of the deflection plates and a_3 should normally be equal. For astigmatism correction it may be necessary to vary V_{a3} so that a small potential difference (max. $\pm 10\%$ of V_{a3}) between the mean y plate potential and a_3 exists.

Raster distortion (each gun)

Raster distortion correction is provided by adjustment (max. ± 100V) of the interplate shield and second intergun shield voltages with respect to the mean x plate potential.

E10-12 BE GH GM GP

OSCILLOSCOPE TUBES

EQUIPMENT DESIGN RANGE

Focusing voltage	V_{a2}	100 to 300	V/kV of V_{a1}
Grid cut-off voltage	V_{g1}	–25 to –90	V/kV of V_{a1}
Deflection factor ($V_{a4} = 3V_{a3}$)			
Vertical	y	<8	V/cm/kV of V_{a3}
Horizontal	x	<20	V/cm/kV of V_{a3}

SCREEN

Phosphor	BE	GH	GM	GP
Fluorescent colour	blue	green	purple-blue	blue-green
Persistence	medium-short	medium-short	long	medium-short

Minimum useful screen diameter	8.5	cm
Minimum useful scan (each gun) at $V_{a4} = 3V_{a3}$		
$y_1–y_2$	7.0	cm
$x_1–x_2$	8.5	cm

The useful scan may be shifted vertically to a maximum of 5mm with respect to the geometric centre of the faceplate with $V_{a4} = 3V_{a3}$.

ABSOLUTE MAXIMUM RATINGS (each gun if applicable)

V_{a4} max.	3.3	kV
V_{a4} min.	2.7	kV
V_{a3} max.	1.2	kV
V_{a3} min.	0.8	kV
V_{a2} max.	1.2	kV
V_{a1} max.	1.2	kV
V_{a1} min.	0.8	kV
V_{s3} max.	1.2	kV
V_{s2} max.	1.2	kV
V_{s1} max.	1.2	kV
V_{g2} max.	1.2	kV
$-V_{g1}$ max.	200	V
Max. ratio V_{a4}/V_{a3}	3	
V_{h-k} max.		
Cathode positive	200	V
Cathode negative	125	V
P_t max.	3	mW/cm^2
I_k max.	300	µA
Minimum post-deflection helix resistance	100	MΩ

HEATER (each gun)

Suitable for series or parallel operation

V_h	6.3	V
I_h	300	mA

Note: (applies to series operation only) – the surge heater voltage must not exceed $9.5V_{r.m.s.}$ when the supply is switched on. When used in a series heater chain a current limiting device may be necessary in the circuit to ensure that this voltage is not exceeded.

LINE WIDTH (each beam)

V_{a4}	3.0	kV
V_{a3}	1.0	kV
V_{a1}	1.0	kV
I_t	10	μA
*Line width	0.5	mm

*Measured by means of a shrinking raster.

CAPACITANCES

High potential	*Low potential*	*Earthed*	*Capacitance (pF)*
k	all	–	5.0
g_1	all	–	6.0
x_1	all	x_2	3.0
x_2	all	x_1	4.5
y_1	all	y_2	3.5
y_2	all	y_1	3.5
x_1	x_2	all	2.0
y_1	y_2	all	1.5
$y_{1'}+y_{1''}$	$y_{2'}+y_{1''}$	all	0.002
$y_{1'}+y_{1''}$	$y_{2'}+y_{2''}$	all	0.008

FOCUSING

Electrostatic.

DEFLECTION

Double electrostatic

Deflection plates x_1, x_2 and y_1, y_2

All x and y plates are intended for symmetrical deflection.

The corresponding trace of each gun will align within 1.5°.

If use is made of the full deflection capabilities of the tube, the deflection plates will intercept part of the beam near the edge of the scan. Therefore a low impedance voltage source is desirable to drive the deflection plates.

Linearity of deflection

The sensitivity (for both x_1, x_2 and y_1, y_2 plate pairs separately) for a deflection of less than 75% of the useful scan will not differ from the sensitivity for a deflection of less than 25% of the useful scan by more than 2%.

Interaction

The deflection of one beam, when balanced d.c. voltages are applied to the deflection plates of the other beam, is less than 2×10^{-3}mm/V.

Tracking error

With 5cm vertical traces superimposed at the centre of the tubeface and deflected horizontally $\pm$4cm by voltages proportional to the relative deflection factors, horizontal separation of the corresponding points of the traces is not greater than 1.5mm.

GEOMETRY

Raster distortion

A focused raster pattern, the size of which is adjusted so that the widest points just touch a square of side 6cm, will have no point within a concentric square, of side 5.70cm, with no correction applied.

Angle between x and y deflection (each gun).	$90 \pm 1°$

Beam blanking

The beam blanking voltage (V_{g2}) is applied with respect to a_1 and will blank beam currents up to 10μA. It may be necessary to increase V_{g2} above the stated value for blanking higher currents.

MOUNTING POSITION

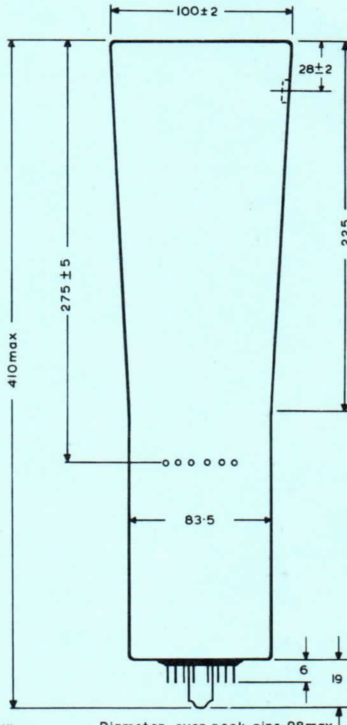
Any

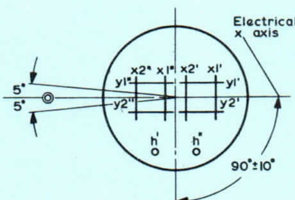
This tube should not be supported by the base alone and under no circumstances should the socket be allowed to support the tube.

ACCESSORIES

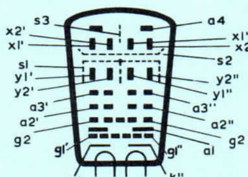
Socket (supplied with tube)	55566

E10-12 BE GH GM GP





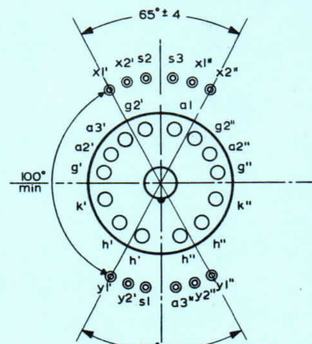
Orientation of axes of deflection as viewed from screen end.



s1–First intergun shield

s2–Inter-plate shield

s3–Second intergun shield



All dimensions in mm

TELEVISION MONITOR TUBE

M17-140W

QUICK REFERENCE DATA		
17cm (7in) flat-faced rectangular direct viewing television tube with metal backed screen, primarily intended for use as a viewfinder in television cameras.		
Deflection angle	70	deg
Focusing	Electrostatic	
Resolution	>1100	lines
Maximum overall length	234	mm

This data should be read in conjunction with
GENERAL OPERATIONAL RECOMMENDATIONS - CATHODE RAY TUBES

HEATER

Suitable for parallel operation only

V_h	6.3	V
I_h	300	mA

OPERATING CONDITIONS

V_{a2+a4}	14	kV
V_{a3} (focus electrode control range)	0 to 400	V
V_{a1}	400	V
V_g for visual extinction of focused raster	-30 to -62	V

SCREEN

Metal backed

Fluorescent colour	White
Useful screen area	See page 5

RESOLUTION

Resolution at screen centre (see note 1)	>1000	>1100	lines
Measured at:			
V_{a2+a4}	14	16	kV
V_{a1}	400	600	V
I_t	50	50	μA
Brightress	500	600	cd/m^2 (nits)

FOCUSING

Electrostatic

The range of focus voltage shown in 'OPERATING CONDITIONS' results in optimum overall focus at a beam current of $50\mu A$.

DEFLECTION

Magnetic

Diagonal deflection angle	70	deg

The deflection coils should be designed so that their internal contour is in accordance with the reference line gauge shown on page 6.

CAPACITANCES

c_{g-all}	7.0	pF
c_{k-all}	5.0	pF
$c_{a2+a4-M}$	300	pF

EXTERNAL CONDUCTIVE COATING

This tube has an external conductive coating, M, which must be connected to chassis, and the capacitance of this coating to the final anode is used to provide smoothing for the e.h.t. supply. The electrical connection to this coating must be made within the area specified on the tube outline drawing.

REFERENCE LINE GAUGE See page 6

MOUNTING POSITION

Any.

The tube socket should not be rigidly mounted but should have flexible leads and be allowed to move freely.
The tube is fitted with a pin protector in order to avoid damage to the glass base due to bending of the pins whilst handling the tube. It is advisable to keep this pin protector on the base until it can be replaced by the socket after the installation of the tube in any equipment.

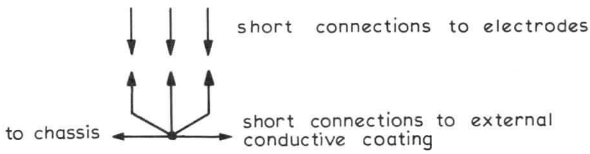
RATINGS (ABSOLUTE MAXIMUM SYSTEM)

V_{a2+a4} max. (at $I_{a2+a4}=0$) (see note 2)	16	kV
V_{a2+a4} min.	12	kV
$+V_{a3}$ max.	1.0	kV
$-V_{a3}$ max.	500	V
V_{a1} max.	800	V
V_{a1} min.	300	V
V_{h-k} (cathode positive)		
d.c. max.	250	V
pk max. (see note 3)	300	V
V_{h-k} (cathode negative)		
d.c. max.	135	V
pk max.	180	V

NOTES

1. Measured by the shrinking raster method. If necessary the resolution can be improved by the use of a beam centring magnet. This magnet can be supplied on request, together with instructions for its use.

2. With the high voltage used with this tube high voltage flashovers may occur, which may destroy the cathode. Therefore it is necessary to provide protective circuits using spark gaps. The spark gaps must be connected as follows:



No other connections between external conductive coating and chassis are permissible.

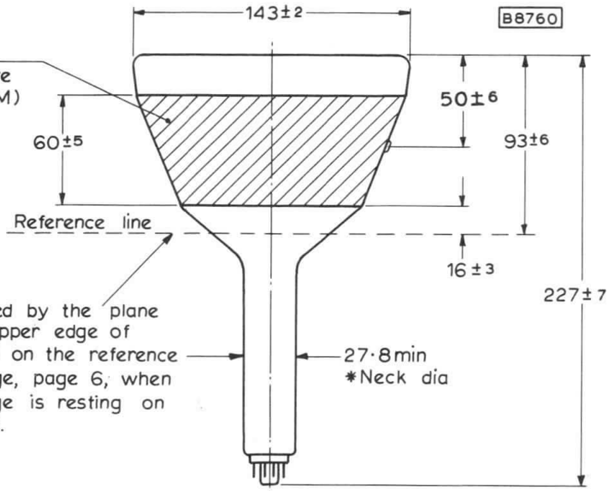
3. During a warm-up period not exceeding 15 seconds the heater may be 410V negative with respect to the cathode.

WARNING

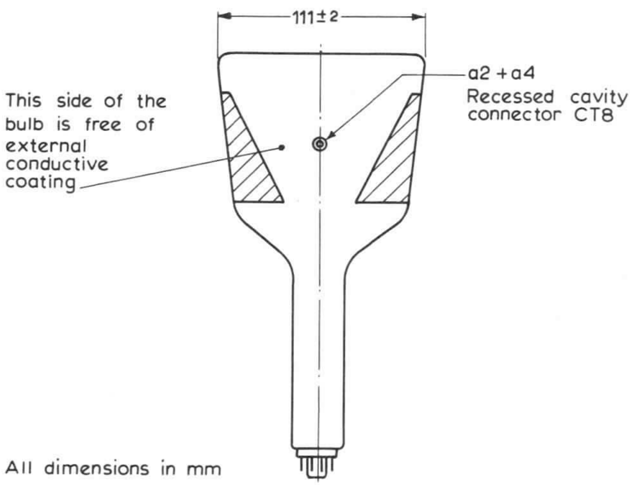
X-ray shielding is advisable to give protection against possible danger of personal injury arising from prolonged exposure at close range to this tube when operating above 14kV.

ACCESSORIES

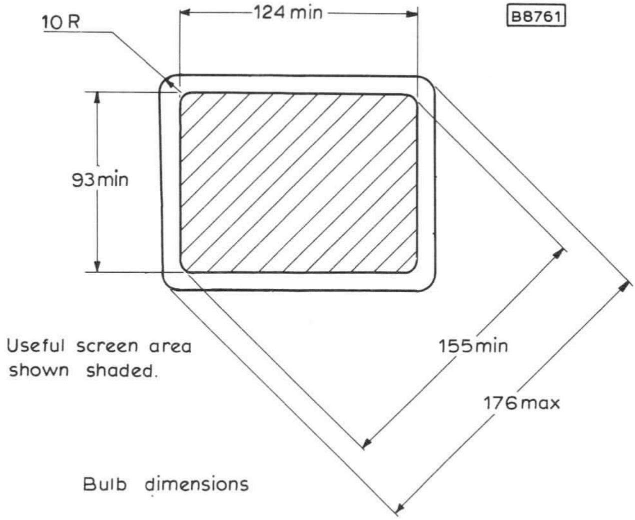
Final accelerator connector (CT8 cavity connector)	55563
Beam centring magnet	3322 142 11401

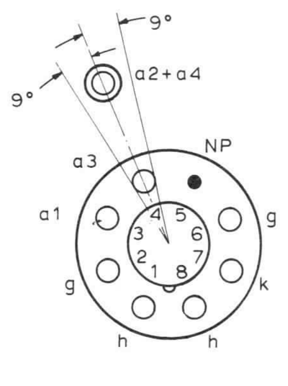


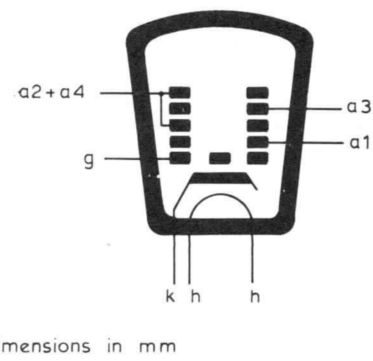
* The maximum dimension is determined by the reference line gauge.



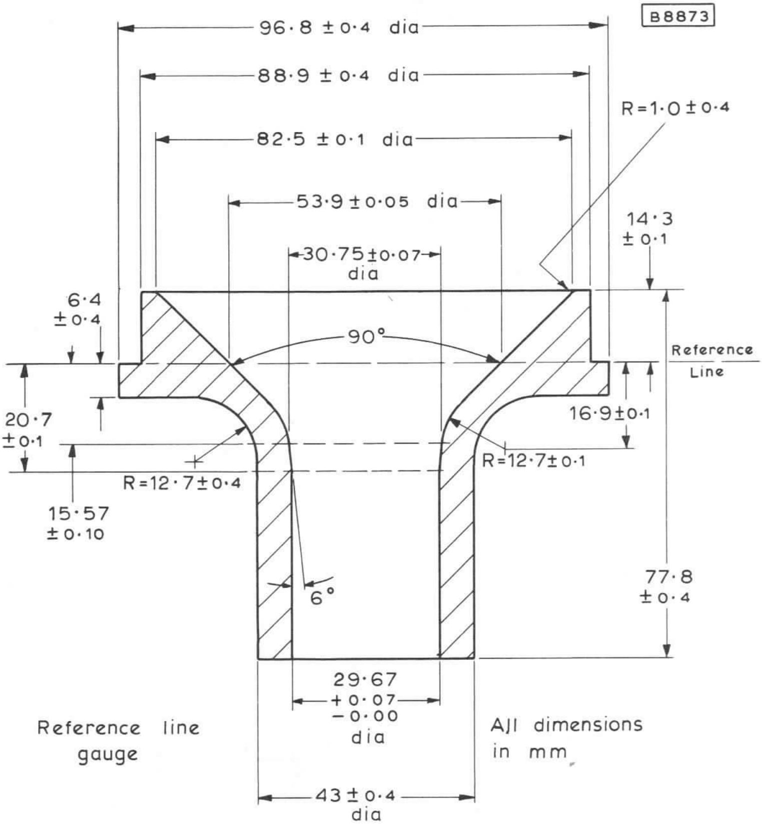
All dimensions in mm







All dimensions in mm


B8873
96·8 ±0·4 dia
88·9 ±0·4 dia
82·5 ±0·1 dia
53·9±0·05 dia
30·75±0·07 dia
R=1·0±0·4
14·3 ±0·1
6·4 ±0·4
90°
Reference Line
20·7 ±0·1
16·9±0·1
R=12·7±0·1
R=12·7±0·4
15·57 ±0·10
77·8 ±0·4
6°
29·67 +0·07 −0·00 dia
Reference line gauge
All dimensions in mm
43±0·4 dia

TELEVISION MONITOR TUBE

M17-141W

QUICK REFERENCE DATA		
17cm (7in) flat-faced rectangular direct viewing television tube with metal backed screen, primarily intended for use as a viewfinder in television cameras. This tube is provided with a bonded faceplate and a metal mounting band.		
Deflection angle	70	deg
Focusing	Electrostatic	
Resolution	>1100	lines
Maximum overall length	240	mm

This data should be read in conjunction with
GENERAL OPERATIONAL RECOMMENDATIONS - CATHODE RAY TUBES

HEATER

Suitable for parallel operation only

V_h	6.3	V
I_h	300	mA

OPERATING CONDITIONS

V_{a2+a4}	14	16	kV
V_{a3} (focus electrode control range)	0 to 400	0 to 400	V
V_{a1}	400	600	V
V_g for visual extinction of focused raster	-30 to -62	-40 to -90	V

SCREEN

Metal backed

Fluorescent colour	White
Useful screen area	See page 5

RESOLUTION

Resolution at screen centre (see note 1)	>1000	>1100	lines
Measured at :			
V_{a2+a4}	14	16	kV
V_{a1}	400	600	V
I_t	50	50	μA
Brightness	500	600	cd/m^2 (nits)

FOCUSING

Electrostatic
The range of focus voltage shown in 'OPERATING CONDITIONS' results in optimum overall focus at a beam current of 50μA.

DEFLECTION

Magnetic

Diagonal deflection angle	70	deg

The deflection coils should be designed so that their internal contour is in accordance with the reference line gauge shown on page 6.

CAPACITANCES

c_{g-all}	7.0	pF
c_{k-all}	5.0	pF
$c_{a2+a4-M}$	240	pF
$c_{a2+a4-B}$	135	pF

EXTERNAL CONDUCTIVE COATING

This tube has an external conductive coating, M, which must be connected to chassis, and the capacitance of this coating to the final anode is used to provide smoothing for the e.h.t. supply. The electrical connection to this coating must be made within the area specified on the tube outline drawing.

REFERENCE LINE GAUGE See page 6

MOUNTING POSITION

Any.

The tube socket should not be rigidly mounted but should have flexible leads and be allowed to move freely.
The tube is fitted with a pin protector in order to avoid damage to the glass base due to bending of the pins whilst handling the tube. It is advisable to keep this pin protector on the base until it can be replaced by the socket after the installation of the tube in any equipment.

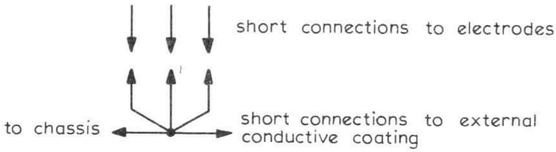
RATINGS (ABSOLUTE MAXIMUM SYSTEM)

V_{a2+a4} max. (at $I_{a2+a4}=0$) (see note 2)	18	kV
V_{a2+a4} min.	12	kV
$+V_{a3}$ max.	1.0	kV
$-V_{a3}$ max.	500	V
V_{a1} max.	800	V
V_{a1} min.	300	V
V_{h-k} (cathode positive)		
d.c. max.	250	V
pk max. (see note 3)	300	V
V_{h-k} (cathode negative)		
d.c. max.	135	V
pk max.	180	V

NOTES

1. Measured by the shrinking raster method. If necessary the resolution can be improved by the use of a beam centring magnet. This magnet can be supplied on request, together with instructions for its use.

2. With the high voltage used with this tube high voltage flashovers may occur, which may destroy the cathode. Therefore it is necessary to provide protective circuits using spark gaps. The spark gaps must be connected as follows:



No other connections between external conductive coating and chassis are permissible.

3. During a warm-up period not exceeding 15 seconds the heater may be 410V negative with respect to the cathode.

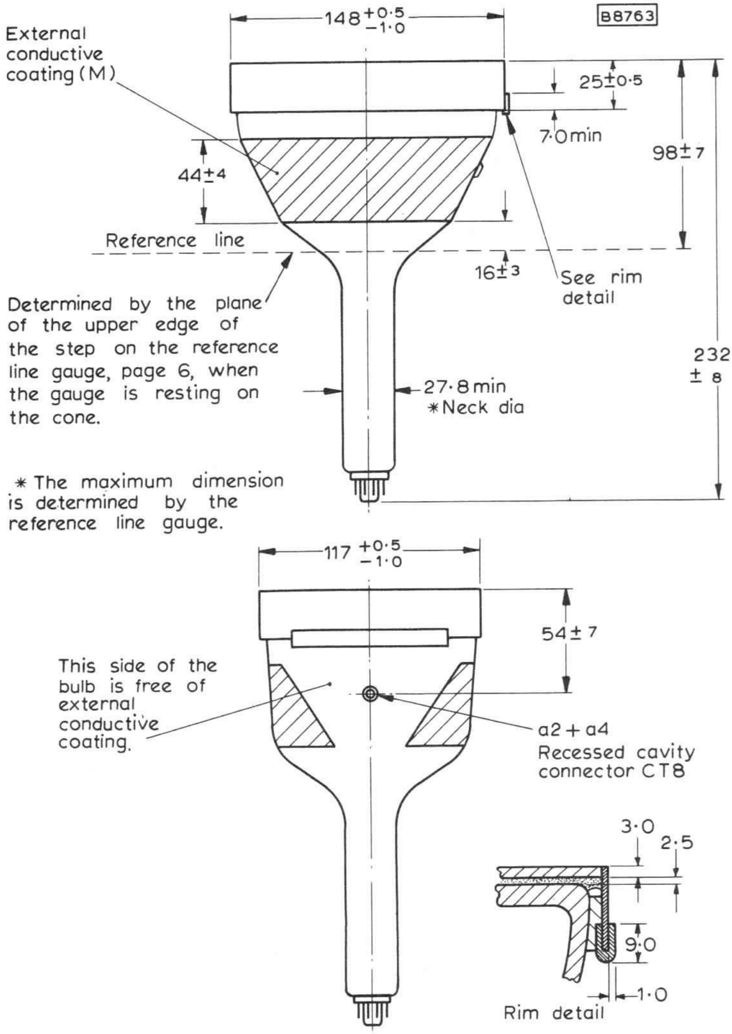
4. The metal band (B) must be connected directly to the chassis by, for example, a spring contact.

WARNING

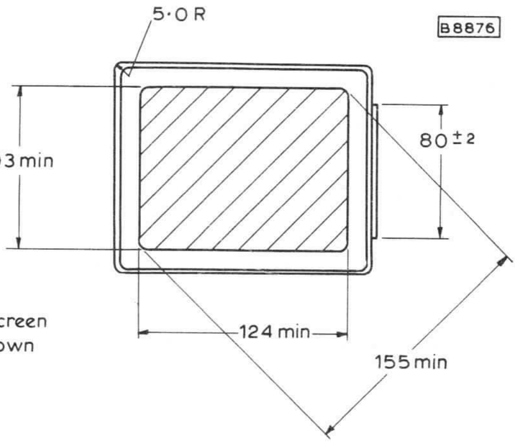
X-ray shielding is advisable to give protection against possible danger of personal injury arising from prolonged exposure at close range to this tube when operating above 14kV.

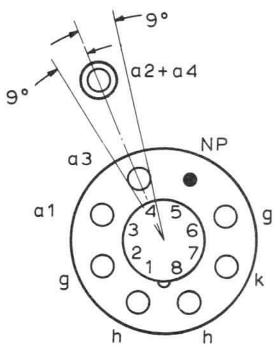
ACCESSORIES

Final accelerator connector (CT8 cavity connector)	55563
Beam centring magnet	3322 142 11401

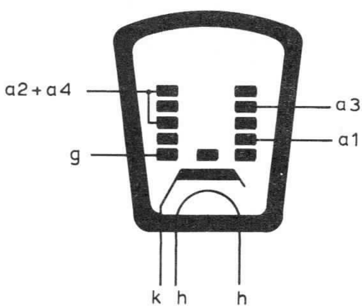


All dimensions in mm

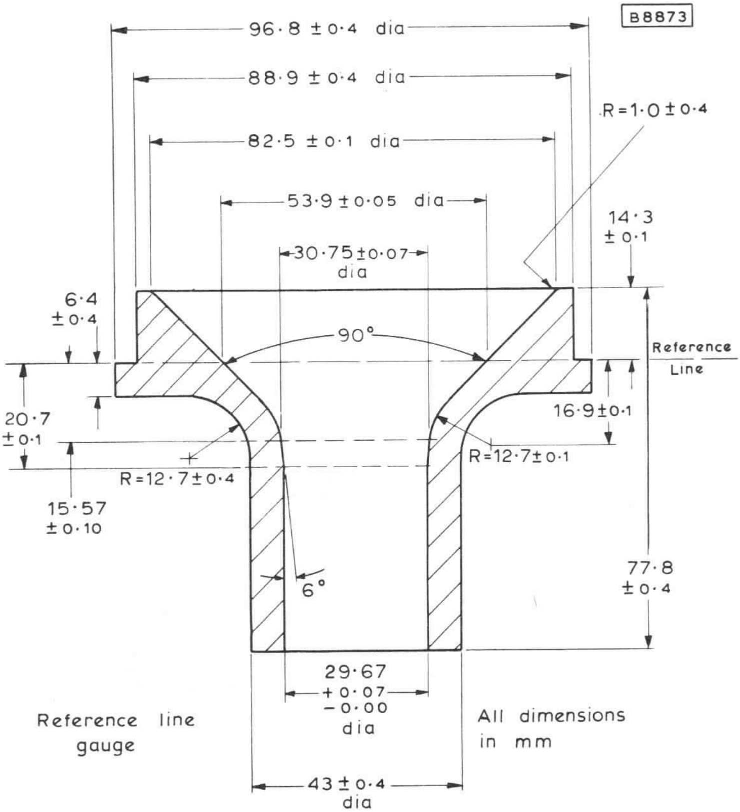




B8H Base



All dimensions in mm


B8873
96·8 ±0·4 dia
88·9 ±0·4 dia
R=1·0 ±0·4
82·5 ±0·1 dia
53·9 ±0·05 dia
14·3 ±0·1
30·75 ±0·07 dia
6·4 ±0·4
90°
Reference Line
20·7 ±0·1
16·9 ±0·1
R=12·7 ±0·1
R=12·7 ±0·4
15·57 ±0·10
77·8 ±0·4
6°
29·67 +0·07 −0·00 dia
Reference line gauge
All dimensions in mm
43 ±0·4 dia

TELEVISION MONITOR TUBE

M21-11W

QUICK REFERENCE DATA		
21cm (8.5in) rectangular television tube with metal backed screen, primarily intended for use as a precision monitor.		
Deflection angle	90	deg
Focusing	Electrostatic	
Resolution	> 650	lines
Maximum overall length	221.5	mm

This data should be read in conjunction with
GENERAL OPERATIONAL RECOMMENDATIONS - CATHODE RAY TUBES

HEATER ←

Suitable for parallel operation only

V_h	11 ± 10%	V
I_h	70	mA

OPERATING CONDITIONS

V_{a2+a4}	12	kV
V_{a3} (focus electrode control range)	0 to 400	V
V_{a1}	400	V
V_g for visual extinction of focused raster	-32 to -69	V
*V_k for visual extinction of focused raster	29 to 62	V

*For cathode modulation, all voltages are measured with respect to the grid.

SCREEN

Metal backed

Fluorescent colour	White
Useful screen area	See page 6

RESOLUTION

Resolution at screen centre	> 650	lines
Measured at:		
V_{a2+a4}	12	kV
V_{a1}	400	V

The tube will resolve 650 lines measured at a brightness of 340cd/m^2 (nits) based on a picture height of 135mm.
The focus voltage is adjusted to obtain the smallest roundest spot. For optimum overall resolution an external centring magnet may be required.

FOCUSING

Electrostatic
The range of focus voltage shown in 'OPERATING CONDITIONS' results in optimum overall focus at a beam current of 100μA.

DEFLECTION

Magnetic

Diagonal deflection angle	90	deg

The deflection coils should be designed so that their internal contour is in accordance with the reference line gauge shown on page 7.

CAPACITANCES

c_{g-all}	9.0	pF
c_{k-all}	5.0	pF
$c_{a2+a4-M}$	375	pF

EXTERNAL CONDUCTIVE COATING

This tube has an external conductive coating, M, which must be connected to chassis, and the capacitance of this coating to the final anode is used to provide smoothing for the e.h.t. supply. The electrical connection to this coating must be made within the area specified on the tube outline drawing.

RASTER CENTRING

See notes under this heading in 'General Operational Recommendations - Cathode Ray Tubes'.

Centring magnet field intensity	0 to 800	A/m

Adjustment of the centring magnet should not be such that a general reduction in brightness of the raster occurs.

REFERENCE LINE GAUGE See page 7

MOUNTING POSITION

The tube may be mounted in any position except vertical with the screen downwards, the axis of the tube making an angle of less than 20^{o} with the vertical.
The tube socket should not be rigidly mounted but should have flexible leads and be allowed to move freely.

RATINGS (ABSOLUTE MAXIMUM SYSTEM)

V_{a2+a4} max. (see note 1)	16	kV
V_{a2+a4} min.	9.0	kV
$+V_{a3}$ max.	1.0	kV
$-V_{a3}$ max.	500	V
V_{a1} max.	800	V
$+V_{g}$ max.	0	V
$+v_{g(pk)}$ max. (see note 2)	2.0	V
$-V_{g}$ max.	180	V
V_{h-k} max. (cathode positive)	80	V
$v_{h-k(pk)}$ max. (cathode positive)	130	V
$\pm I_{a3}$ max.	25	µA
$\pm I_{a1}$ max.	5.0	µA
R_{h-k} max.	1.0	MΩ
Z_{h-k} max. (f=50Hz)	500	kΩ ←
Z_{k-e} max. (f=50Hz)	100	kΩ
R_{g-k} max.	1.5	MΩ
Z_{g-k} max. (f=50Hz)	500	kΩ
R_{a1-k} max.	1.0	MΩ ←
R_{a3-k} max.	3.0	MΩ ←

NOTES

1. Adequate precautions should be taken to ensure that the receiver is protected from damage which may be caused by a possible high voltage flashover within the cathode ray tube.

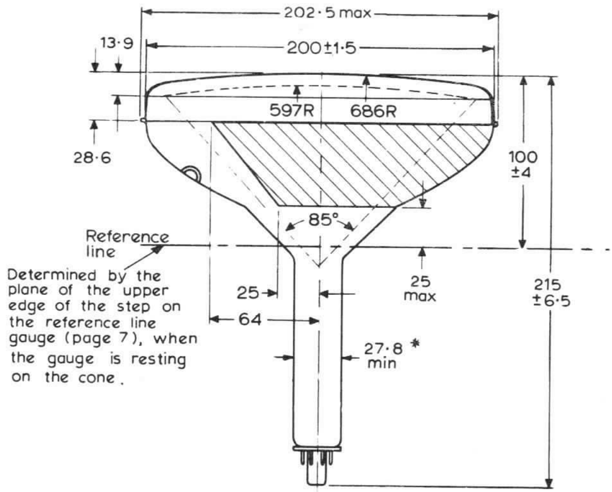
2. The d.c. value of bias must not be such as to allow the grid to become positive with respect to the cathode, except during the period immediately after switching the receiver on or off when it may be allowed to rise to +1V. The maximum positive excursion of the video signal must not exceed +2V; at this voltage the grid current may be expected to be approximately 2mA.

WARNING

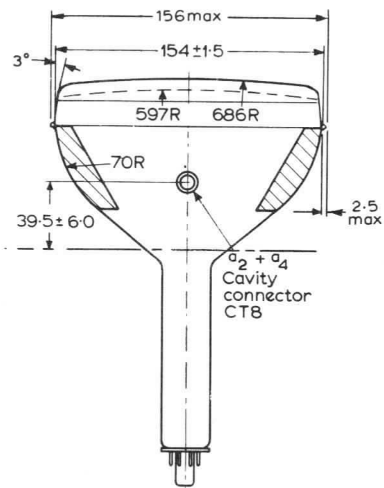
X-ray shielding is advisable to give protection against possible danger of personal injury arising from prolonged exposure at close range to this tube when operated above 16kV.

WEIGHT

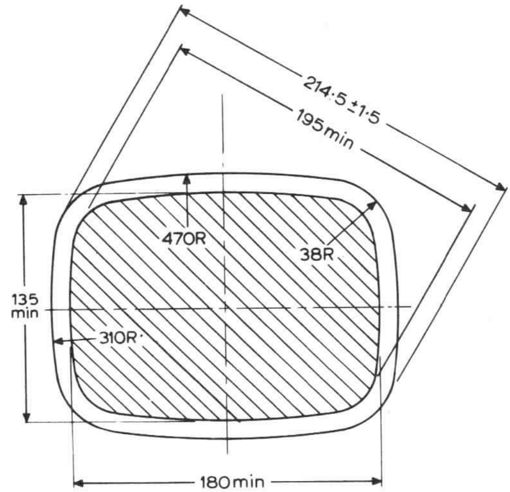
Tube alone (approx.)	1.25	kg



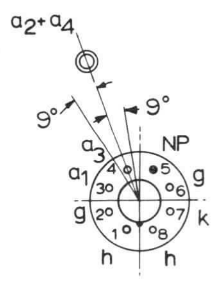
*The maximum dimension is determined by the reference line gauge.

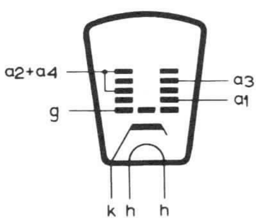


All dimensions in mm



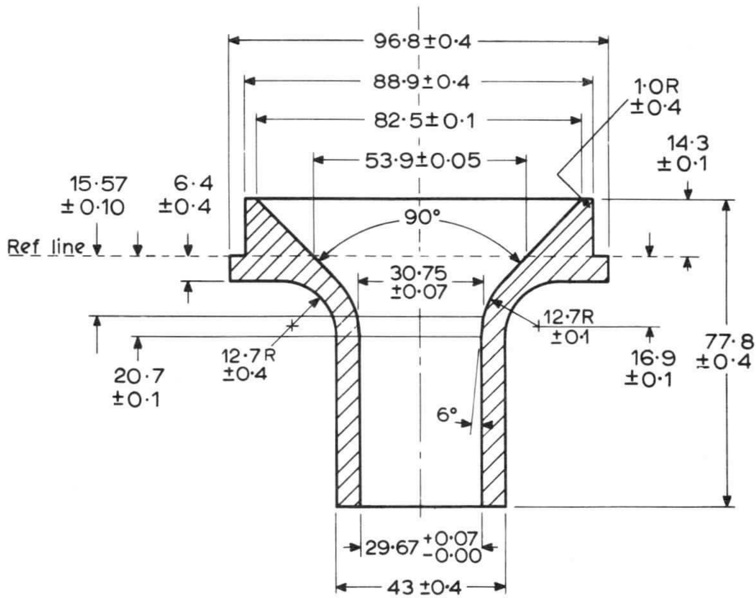
Useful screen area shown shaded.
All dimensions in mm





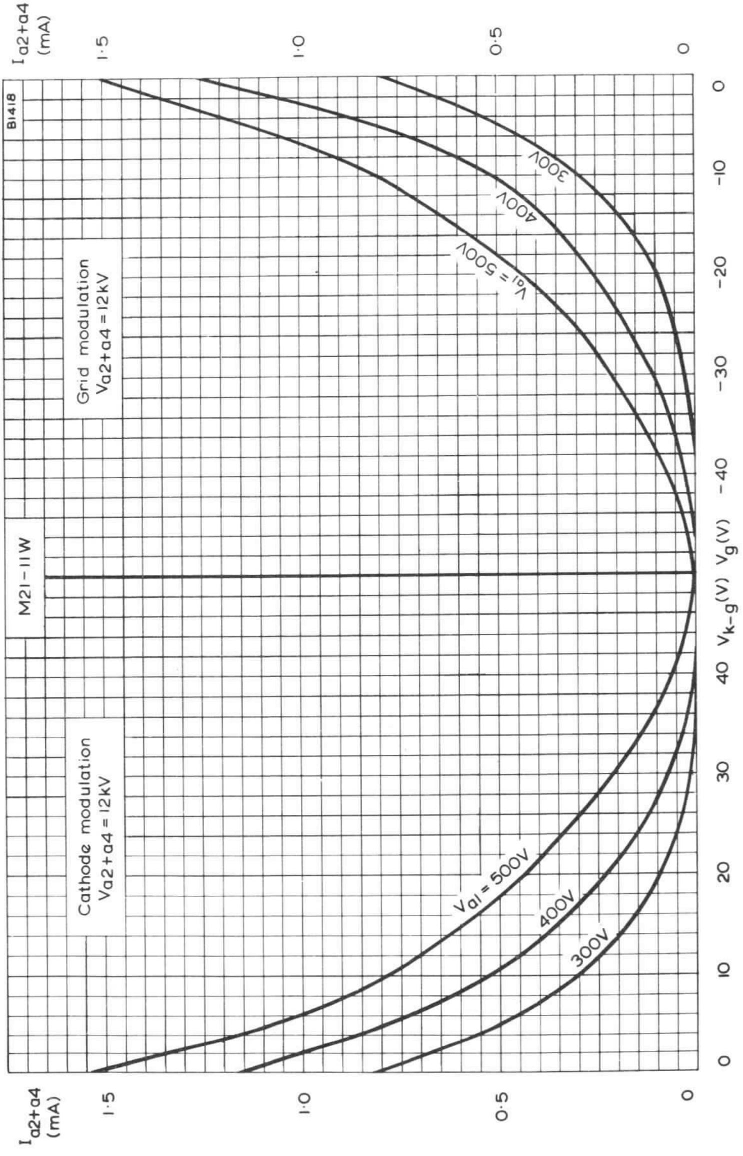
B8H Base

REFERENCE LINE GAUGE



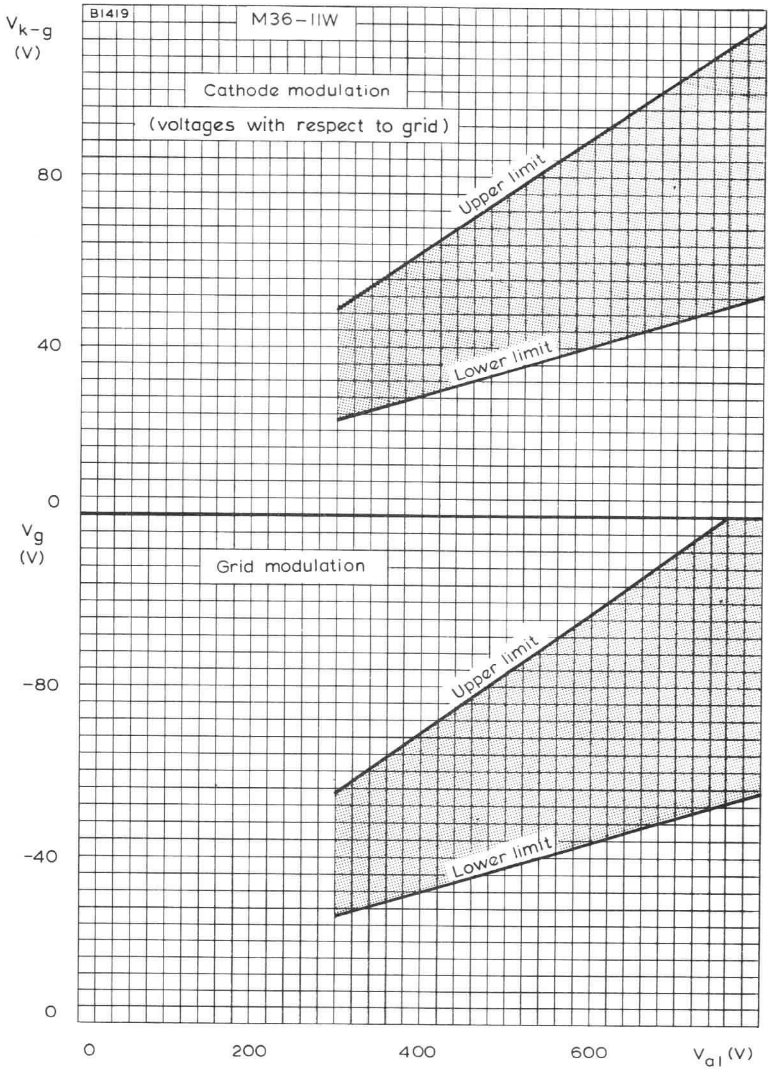
All dimensions in mm

B4431



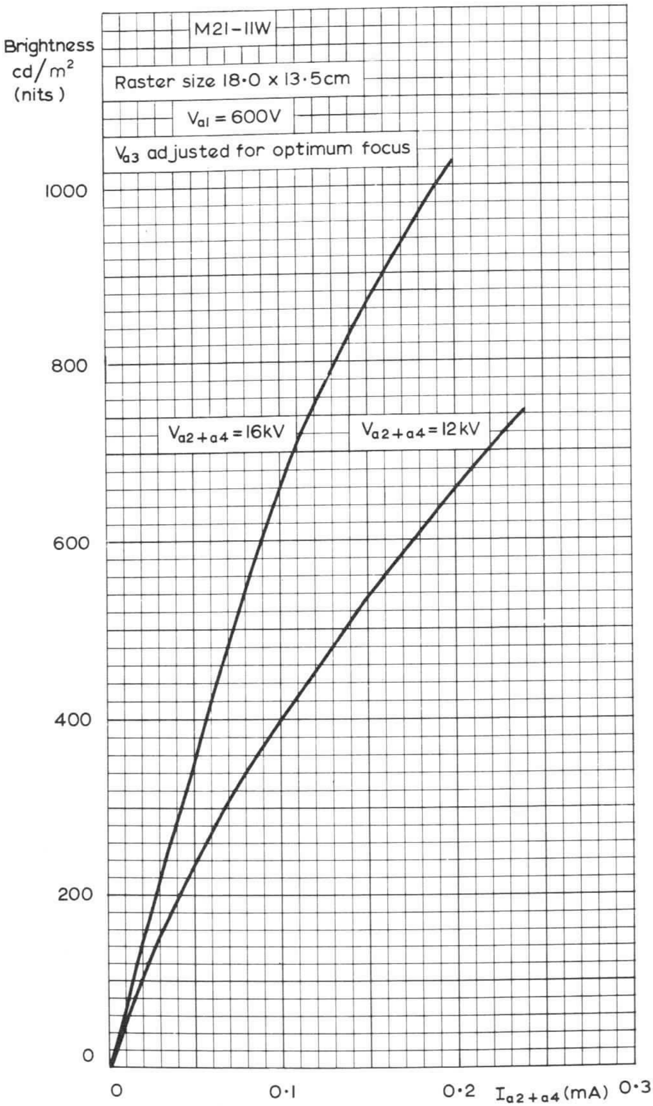
FINAL ANODE CURRENT PLOTTED AGAINST GRID VOLTAGE.
GRID MODULATION.

FINAL ANODE CURRENT PLOTTED AGAINST CATHODE-TO-GRID VOLTAGE. CATHODE MODULATION.



LIMITS OF CATHODE-TO-GRID CUT-OFF VOLTAGE PLOTTED AGAINST FIRST ANODE-TO-GRID VOLTAGE. CATHODE MODULATION.

LIMITS OF GRID CUT-OFF VOLTAGE PLOTTED AGAINST FIRST ANODE VOLTAGE. GRID MODULATION.



SCREEN BRIGHTNESS PLOTTED AGAINST FINAL ANODE CURRENT

TELEVISION MONITOR TUBE

M21-12W

QUICK REFERENCE DATA		
21cm (8.5in) rectangular television tube with metal-backed grey glass screen primarily intended for use as a picture monitor.		
Deflection angle	110	deg
Focusing	low voltage electrostatic	
Resolution	> 625	lines
Maximum overall length	205	mm

This data should be read in conjunction with GENERAL OPERATIONAL RECOMMENDATIONS - CATHODE RAY TUBES.

HEATER

Suitable for series or parallel operation

V_h	6.3	V
I_h	300	mA

Note - (applies to series operation only) - The surge heater voltage must not exceed 9.5 V r.m.s. when the supply is switched on. When used in a series heater chain a current limiting device may be necessary in the circuit to ensure that this voltage is not exceeded.

OPERATING CONDITIONS

V_{a2+a4}	16	kV
* V_{a3}	0 to 400	V
V_{a1}	300	V
V_g (for visual extinction of focused raster)	-35 to -72	V

* With the small change in focus spot size with variation of focus voltage, the limit of 0 to 400 V is such that an acceptable focus quality is obtained within this range. If it is required to pass through the point of focus, a voltage of at least -100V to +500V will be required.

SCREEN

Metal backed

Fluorescent colour	white	
Light transmission	approx. 80	%

Minimum useful screen area see drawing on page D6

RESOLUTION

Resolution at screen centre	625	lines
V_{a2+a4}	16	kV
V_{a1}	300	V

BRIGHTNESS

*Brightness	450	nits
V_{a2+a4}	16	kV
$I_{a2=a4}$	100	μA

* Measured with raster 18 x 13.5 cm.

FOCUSING

Low voltage electrostatic
The range of focus voltage shown in typical operation conditions results in optimum focus at a beam current of 100μA.

REFERENCE LINE GAUGE

JEDEC 126.For details see "General Operational Recommendations - Cathode Ray Tubes".

DEFLECTION

Double magnetic
The deflection coils should be designed so that their internal contour is in accordance with JEDEC gauge 126 and should provide a pull back of 4mm on a nominal tube.

CAPACITANCES

c_{g-all}	7.0	pF
c_{k-all}	4.0	pF
$c_{a2+a4-M}$	250	pF

RASTER CENTRING

See notes under this heading in 'General operational Recommendations - Cathode Ray Tubes'.

Centring magnet field intensity 0 to 10 Gs ←

Adjustment of the centring magnet should not be such that a general reduction in brightness or shading of the raster occurs.

EXTERNAL CONDUCTIVE COATING

This tube has an external conductive coating, M, which must be earthed and the capacitance of this to the final anode is used to provide additional smoothing for the e.h.t. supply. The tube marking and warning labels are on the side of the cone opposite the final anode connector and this side should not be used for making contact to the external conductive coating.

RATINGS (ABSOLUTE MAXIMUM SYSTEM)

** V_{a2+a4} max.	20	kV
V_{a2+a4} min.	13	kV
+ V_{a3} max.	1.0	kV
$-V_{a3}$ max.	500	V
V_{a1} max.	450	V
V_{a1} min.	200	V
$-V_g$ max.	150	V
* $-v_{g\,(pk)}$ max.	400	V
$\pm I_{a3}$ max.	25	µA
$\pm I_{a1}$ max.	5	µA
‡ V_{h-k}		
Cathode positive		
d.c. max.	200	V
pk max.	300	V
Cathode negative		
d.c. max.	125	V
pk max.	250	V
R_{h-k} max.	1.0	MΩ
Z_{k-e} max. (f = 50 c/s)	100	kΩ
R_{g-k} max.	1.5	MΩ
Z_{g-k} max. (f = 50 c/s)	500	kΩ

** Adequate precautions should be taken to ensure that the associated equipment is protected from damage, which may be caused by a possible high voltage flashover within the cathode ray tube. For details see Mullard Technical Communications, Volume 6, Number 51, September 1961 pp. 2 to 6)

* Duty factor 22% max. t_p max. = 1.5ms. The d.c. value of bias must not be such as to allow the grid to become positive with respect to the cathode, except during the period immediately after switching the receiver on or off when it may be allowed to rise to +1V. The maximum positive excursion of the video signal must not exceed +2V and at this voltage the grid current may be expected to be approximately 2mA.

‡ In order to avoid excessive hum the a.c. component of V_{h-k} should be as low as possible and must not exceed 20 V r.m.s.
During a warming up period not exceeding 15s, $v_{h-k(pk)}$ max. (cathode positive) is allowed to rise to 410V.

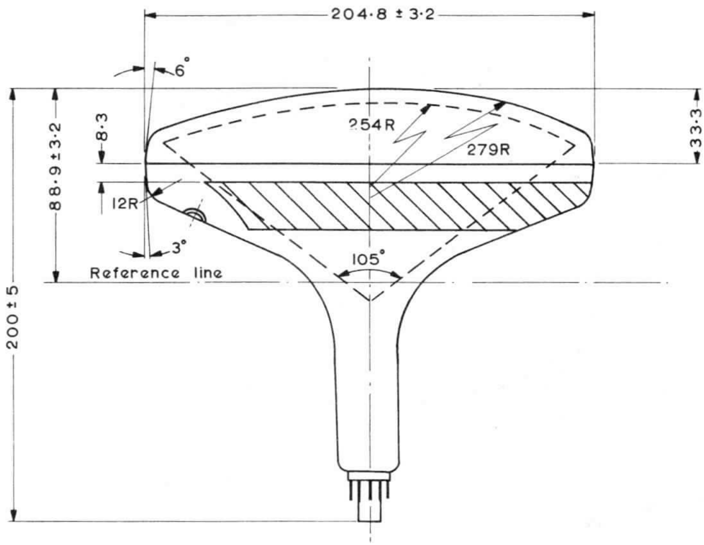
WARNING

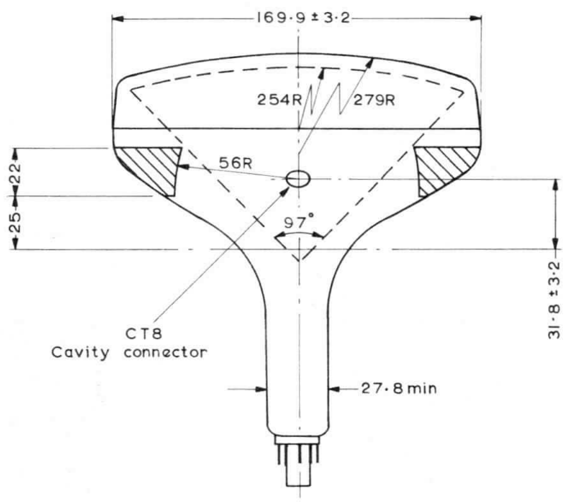
X-ray shielding is advisable to give protection against possible danger of personal injury arising from prolonged exposure at close range to this tube when operated above 16kV.

MOUNTING POSITION ←

Any, except vertical with screen downwards and the axis of the tube making an angle of less than 20° with the vertical.
The tube socket should not be rigidly mounted but should have flexible leads and be allowed to move freely.

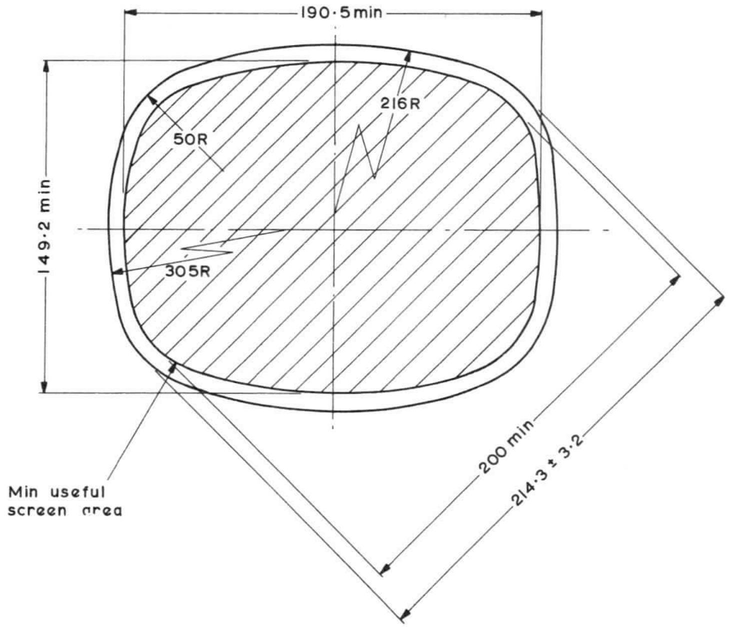
WEIGHT	2.25	lb ←
	≏1	kg

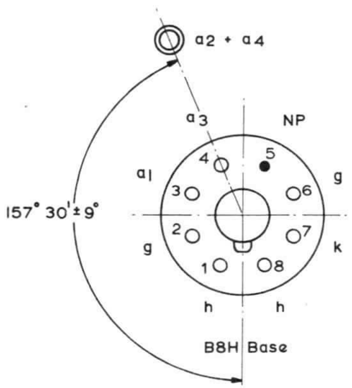


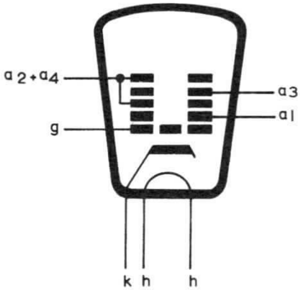


All dimensions in mm

B2372







All dimensions in mm

B2371

TELEVISION
MONITOR TUBE

M28-12W

QUICK REFERENCE DATA		
28cm (11in) rectangular direct viewing television tube with metal backed screen and reinforced envelope. A separate safety screen is not required. Intended for use as a precision picture monitor.		
Deflection angle	90	deg
Focusing	Electrostatic	
Resolution	> 850	lines
Maximum overall length	250	mm

This data should be read in conjunction with
GENERAL OPERATIONAL RECOMMENDATIONS - CATHODE RAY TUBES

HEATER

Suitable for parallel operation only

V_h	11	V
I_h	68	mA

OPERATING CONDITIONS

V_{a2+a4}	11	13	kV
V_{a3} (focus electrode control range)	0 to 350	50 to 400	V
V_{a1}	250	350	V
V_g for visual extinction of focused raster	-35 to -69	-46 to -91	V
*V_k for visual extinction of focused raster	approx. 45	44 to 80	V

*For cathode modulation, all voltages are measured with respect to the grid.

SCREEN (metal backed)

Fluorescent colour	White	
Light transmission (approx.)	50	% ←
Useful screen area	see page 7	

RESOLUTION

Resolution at V_{a2+a4} = 13kV	>850	lines

BRIGHTNESS

Brightness (at V_{a2+a4} = 13kV)	approx.	400	cd/m^2 (nits)
Brightness (at V_{a2+a4} = 11kV)	approx.	350	cd/m^2 (nits)
I_{a2+a4}		30	μA
Raster size		70 × 70	mm

FOCUSING (Electrostatic)

The range of focus voltages shown in 'OPERATING CONDITIONS' results in optimum overall focus at a beam current of 100μA.

DEFLECTION (Magnetic) ←

Diagonal deflection angle	90	deg
Horizontal deflection angle	80	deg
Vertical deflection angle	63	deg

The deflection coils should be designed so that their internal contour is in accordance with the reference line gauge shown on page 10.

CAPACITANCES

c_{g-all}	7.0	pF
c_{k-all}	3.0	pF
$c_{a2+a4-M}$	550 to 850	pF
$c_{a2+a4-B}$	150	pF

EXTERNAL CONDUCTIVE COATING

This tube has an external conductive coating, M, which must be connected to chassis, and the capacitance of this coating to the final anode is used to provide smoothing for the e.h.t. supply. The electrical connection to this coating must be made within the area specified on the tube outline drawing.

RASTER CENTRING

See notes under this heading in 'General Operational Recommendations - Cathode Ray Tubes'.

Centring magnet field intensity	0 to 800	A/m
Maximum distance of centre of centring field from reference line	55	mm

Adjustment of the centring magnet should not be such that a general reduction in brightness of the raster occurs.

REFERENCE LINE GAUGE see page 10

MOUNTING POSITION Any

The tube socket should not be rigidly mounted but should have flexible leads and be allowed to move freely.

This tube is fitted with a pin protector in order to avoid damage to the glass base due to bending of the base pins whilst handling the tube.

It is advisable to keep this pin protector on the base until it can be replaced by the socket after the installation of the tube in any equipment.

RATINGS (ABSOLUTE MAXIMUM SYSTEM)

V_{a2+a4} max. (at $I_{a2+a4} = 0$) (see note 1)	14	kV
V_{a2+a4} min.	7.5	kV
$+V_{a3}$ max.	500	V
$-V_{a3}$ max.	50	V
V_{a1} max.	350	V
V_{a1} min.	200	V
$-v_{g(pk)}$ max. (see note 2)	350	V
$-V_{g}$ max. (see note 3)	100	V
$\pm I_{a3}$ max.	25	μA
$\pm I_{a1}$ max.	5.0	μA
V_{h-k}		
d.c. max.	110	V
pk max.	130	V
R_{h-k} max.	1.0	MΩ
Z_{k-e} max. (f = 50Hz)	100	kΩ
R_{g-k} max.	1.5	MΩ
Z_{g-k} max. (f = 50Hz)	500	kΩ
R_{M-B} max.	2.0	MΩ

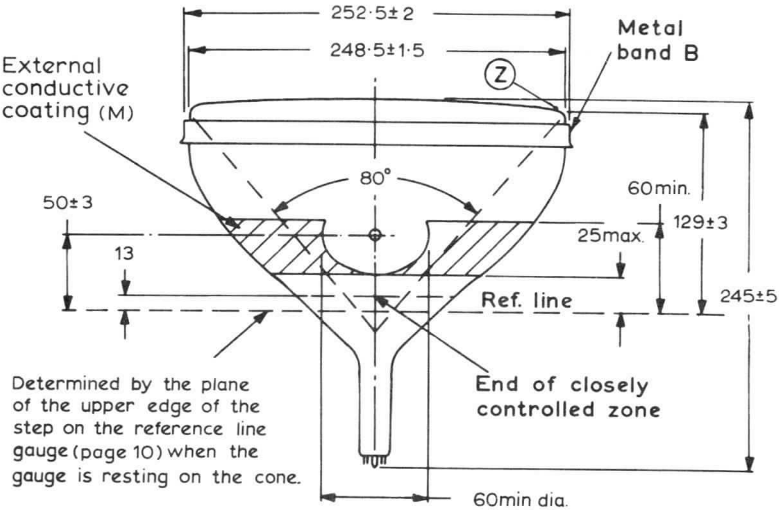
Notes

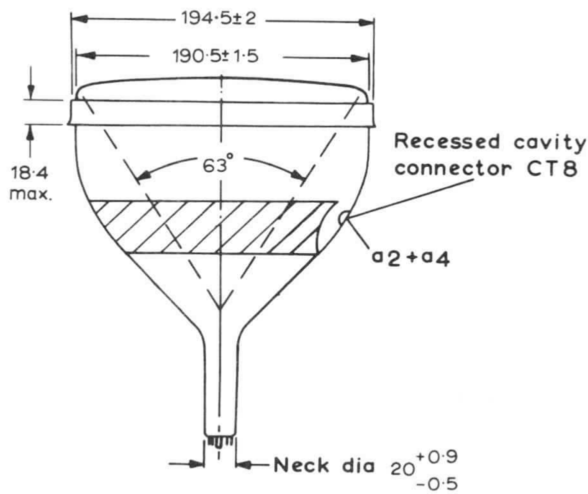
1. Adequate precautions should be taken to ensure that the receiver is protected from damage which may be caused by a possible high voltage flashover within the tube.
2. Maximum pulse duration 22% of one cycle with a maximum of 1.5ms.

3. The d.c. value of bias must not be such as to allow the grid to become positive with respect to the cathode, except during the period immediately after switching the receiver on or off when it may be allowed to rise to +1.0V. It is advisable to limit the positive excursion of the video signal to +5V (pk) max. This may be achieved automatically by the series connection of a 10kΩ resistor.

WEIGHT

Tube alone (approx.)	2.2	kg

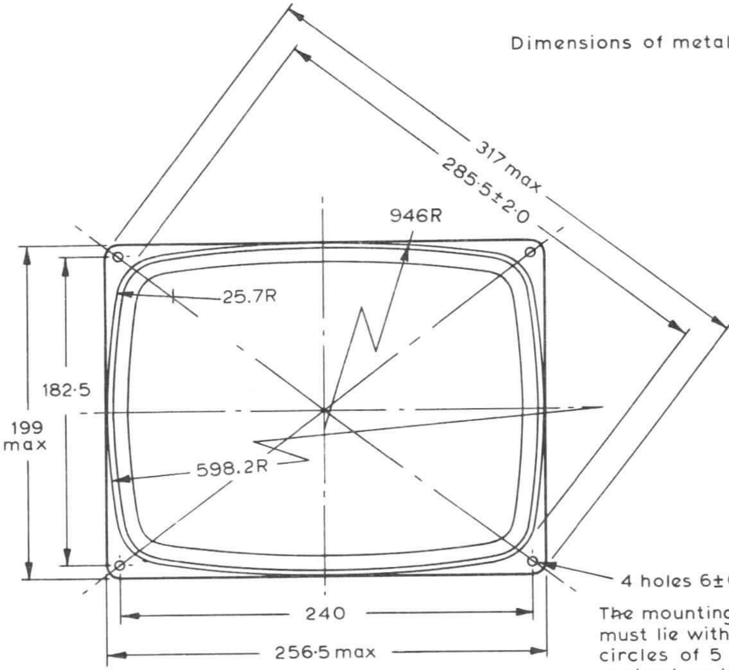




All dimensions in mm

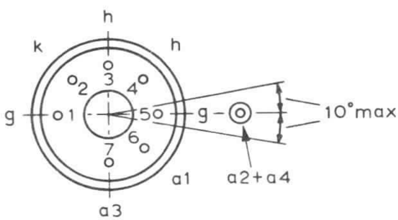
B7707

Dimensions of metal band



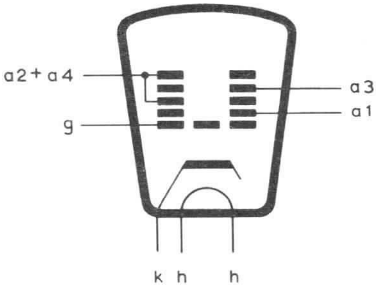
4 holes 6±0·3 dia

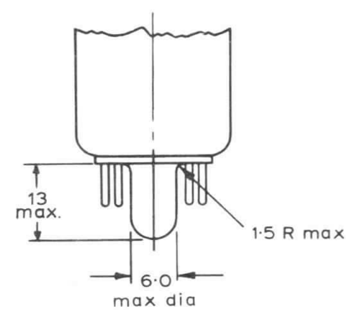
The mounting bolts must lie within circles of 5 dia. centred on the true geometric position of these holes.



Pin dimensions as in B7G base.

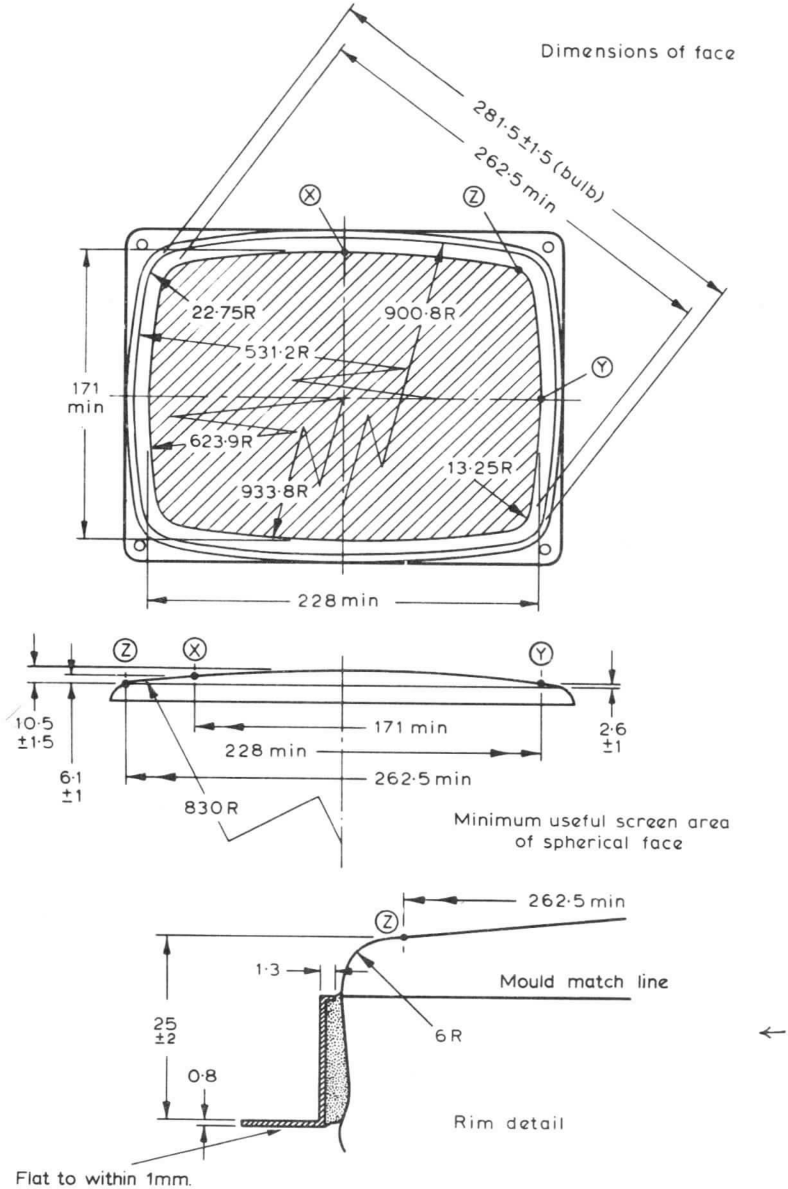
The centre of the socket must allow entry of the pump stem.





All dimensions in mm

B7708

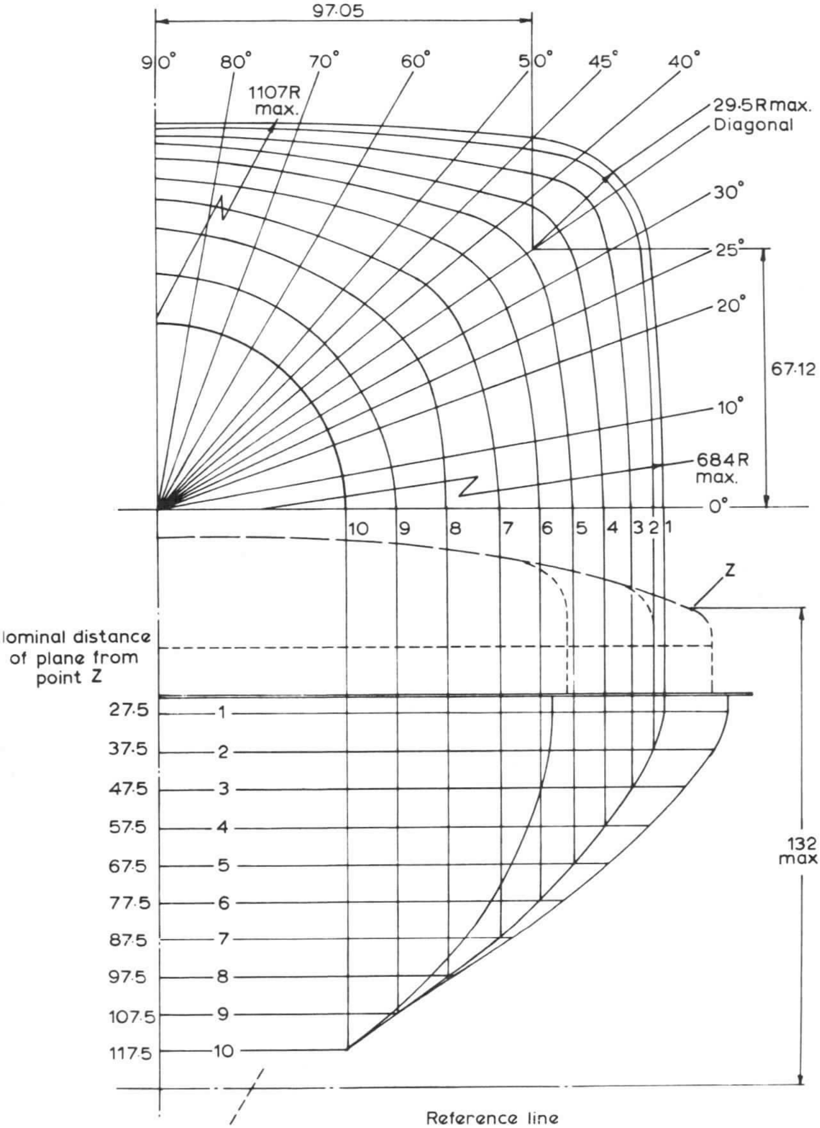


All dimensions in mm

B7709

MAXIMUM CONE CONTOURS

B5793



All dimensions in mm.

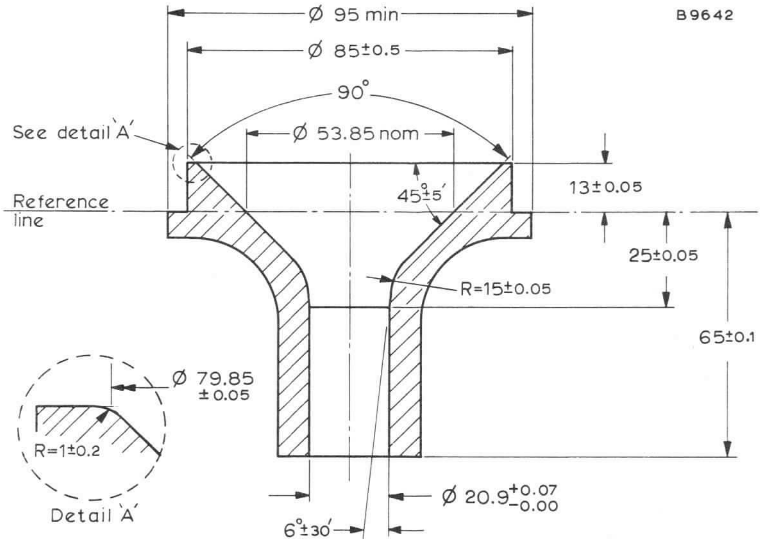
DIMENSIONS FOR MAXIMUM CONE CONTOUR DRAWING

Distance from centre

Section	0^o long	10^o	20^o	25^o	30^o	$34^o40'$ diagonal	40^o	45^o	50^o	60^o	70^o	80^o	90^o short
1	130.0	131.6	136.6	140.6	145.5	147.5	144.9	136.8	127.9	114.9	106.8	102.4	101.0
2	127.4	128.9	133.8	137.7	142.4	144.9	141.8	133.3	124.8	112.6	105.2	101.2	99.9
3	121.1	122.6	126.8	130.4	134.7	137.6	133.9	125.6	118.4	108.2	102.0	99.0	97.9
4	114.0	115.2	118.7	121.6	125.2	127.3	124.5	117.5	111.6	103.1	98.1	95.8	95.2
5	106.4	107.2	110.0	112.2	114.8	116.4	114.2	108.8	104.0	97.2	93.5	92.0	91.8
6	97.6	98.2	100.0	101.4	103.3	104.4	102.8	98.8	95.1	90.0	87.4	86.8	87.0
7	87.4	87.8	88.8	89.7	90.7	91.4	90.2	87.7	85.2	81.7	80.4	80.5	81.0
8	75.0	75.4	76.2	76.7	77.0	76.8	76.0	74.9	73.8	72.4	72.2	72.8	73.4
9	60.6	60.6	60.6	60.6	60.6	60.6	60.6	60.6	60.4	60.2	60.6	61.0	61.4
10	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0

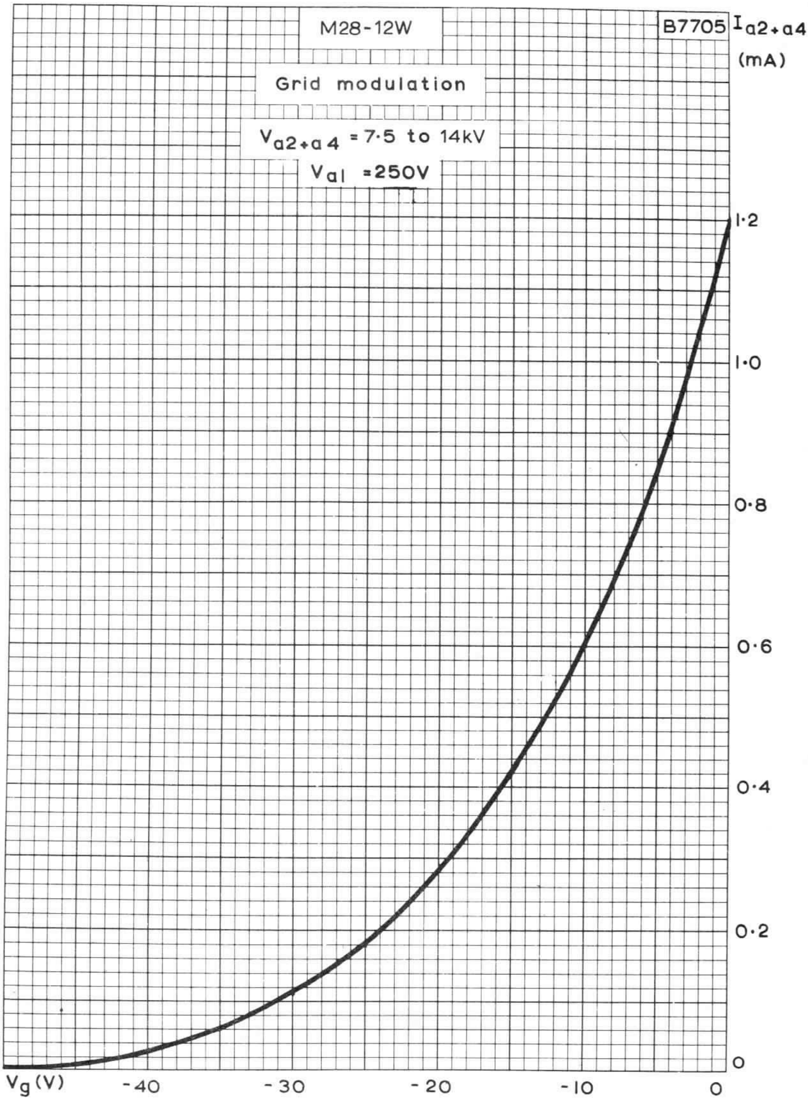
All dimensions in mm

Mullard

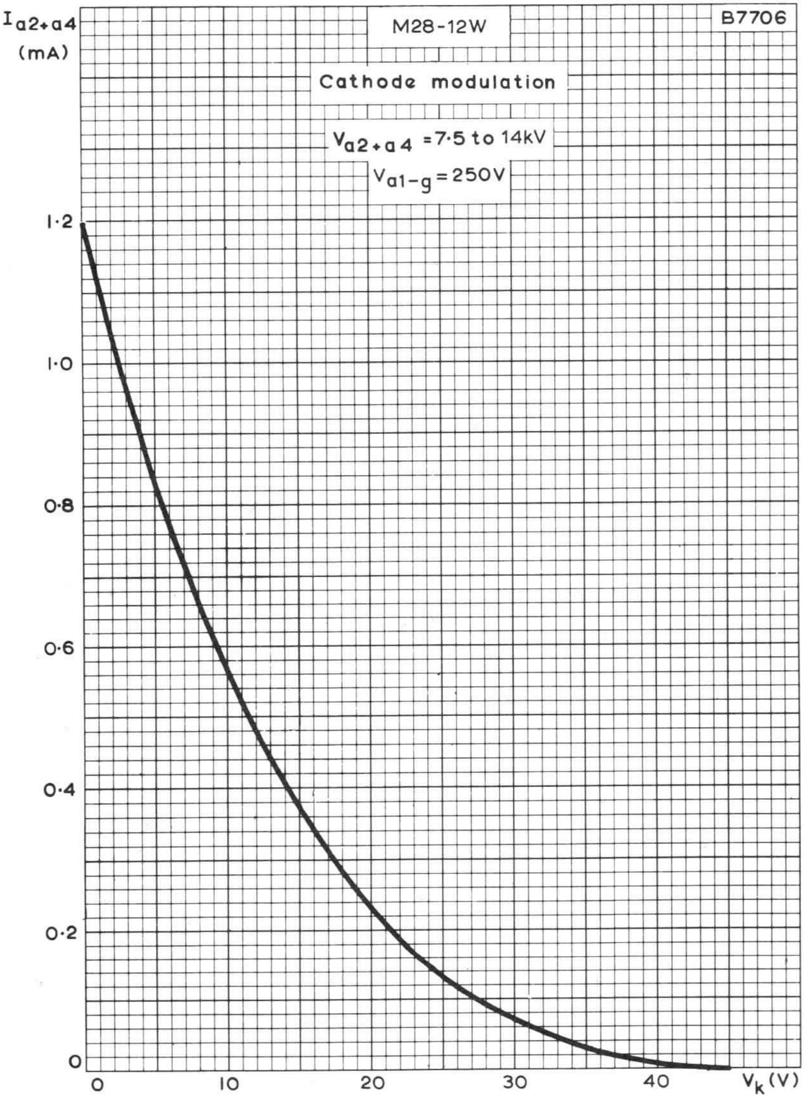


REFERENCE LINE GAUGE

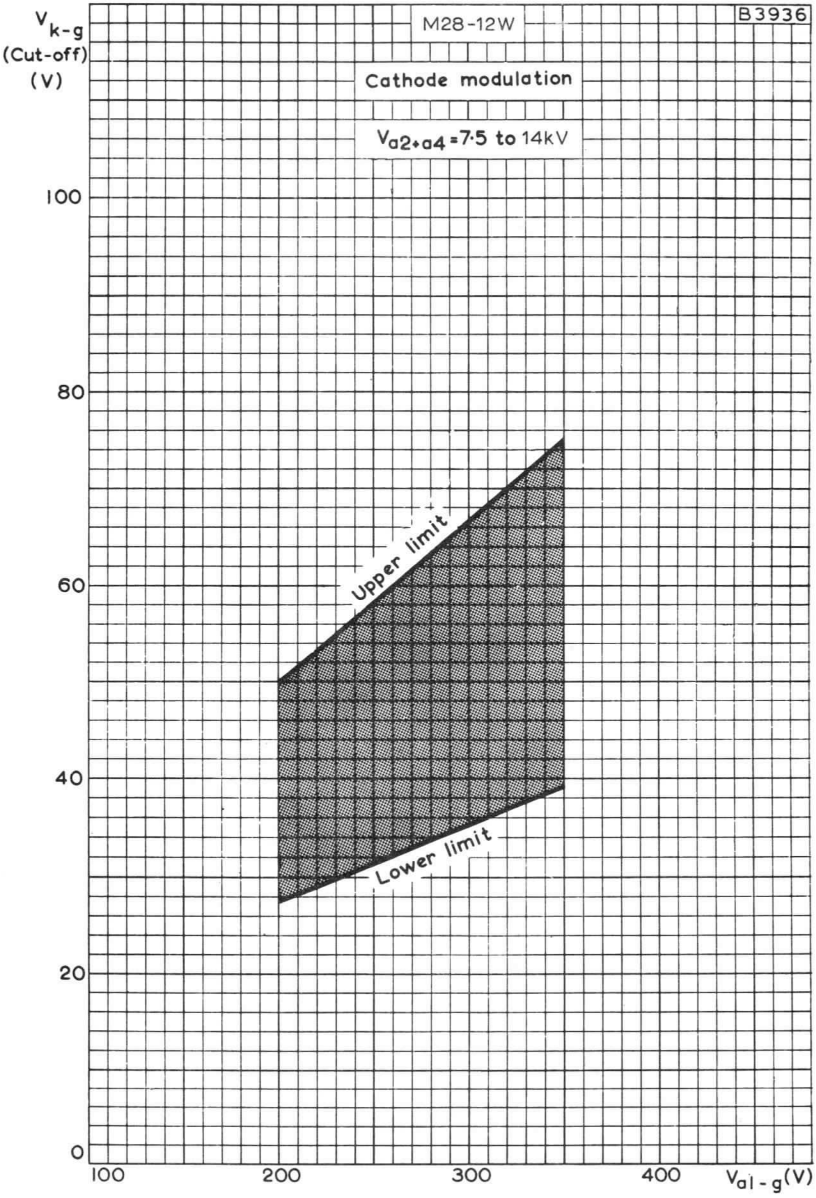
All dimensions in mm



FINAL ANODE CURRENT PLOTTED AGAINST GRID VOLTAGE.
GRID MODULATION



FINAL ANODE CURRENT PLOTTED AGAINST CATHODE-TO-GRID VOLTAGE. CATHODE MODULATION



LIMITS OF CATHODE-TO-GRID CUT-OFF VOLTAGE PLOTTED AGAINST FIRST ANODE-TO-GRID VOLTAGE. CATHODE MODULATION

TELEVISION MONITOR TUBE M36-10W.

14in. rectangular television tube with metal-backed, grey glass screen primarily intended for use as a precision monitor.

ADVANCE DATA FOR USE WITH DEVELOPMENT SAMPLES

ADVANCE DATA

HEATER

Suitable for series or parallel operation

Vh	6.3	V
Ih	300	mA

Note - (applies to series operation only). The surge heater voltage must not exceed 9.5Vr.m.s. when the supply is switched on. When used in a series heater chain a current limiting device may be necessary in the circuit to ensure that this voltage is not exceeded.

CAPACITANCES

cg-all	6.0	pF
ck-all	4.0	pF
ca2+a4-M	1000	pF

SCREEN

Metal-backed	
Fluorescent colour	white
Minimum useful screen area	see drawing on page 4

FOCUSING

Electrostatic

DEFLECTION

Double magnetic

MOUNTING POSITION

Any, except vertical with the screen downwards and the axis of the tube making an angle of less than 20° with the vertical.

TYPICAL OPERATING CONDITIONS

Va2+a4	16	kV
Va3 (focusing electrode control range)	0 to 400	V
Va1	600	V
Vg (for visual extinction of focused spot)	-35 to -85	V

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8.62.

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RESOLUTION

Resolution at centre of screen	>650	lines
With Va2+a4	16	kV
Va1	600	V

This tube will resolve a minimum of 650 lines based on a picture height of 241mm and is measured at a brightness of approximately 340 nits i.e. 100 ft.lamberts. The focus voltage is adjusted to obtain the smallest roundest spot.

ABSOLUTE MAXIMUM RATINGS

‡Va2+a4 max.	20	kV
Va2+a4 min.	12	kV
+Va3 max.	1.0	kV
-Va3 max.	500	V
Va1 max.	1.0	kV
Va1 min.	400	V
-Vg max.	150	V
*-Vg min.	0	V
+vg(pk) max.	2.0	V
‡Ia3 max.	25	μA
‡Ia1 max.	5	μA
†Vh-k max.		
Cathode positive		
d.c. max.	200	V
pk max.	300	V
Cathode negative		
d.c. max.	125	V
pk max.	250	V
Rg-k max.	1.5	MΩ
Zg-k max. (f=50c/s)	500	kΩ
Rh-k max.	see note †	

‡Adequate precautions should be taken to ensure that the associated equipment is protected from damage which may be caused by a possible high voltage flashover within the cathode ray tube. (For details see Mullard Technical Communications Volume 6, Number 51.)

*The d.c. value of grid bias must not be allowed to become positive with respect to the cathode, except during the periods immediately after switching the equipment on or off, when it may be allowed to rise to +1V. The maximum positive grid excursion may reach 2V and at this voltage the grid current may be expected to be approximately 2mA.

†In order to avoid excessive hum the a.c. component of Vh-k should be as low as possible (<20Vr.m.s.). During a warming-up period not exceeding 45s, vh-k(pk) max. (cathode positive) is allowed to rise to 410V.

When the heater is in a series chain, or earthed, Zk max. is 100kΩ, where Zk is the 50c/s impedance between earth and the cathode. When the heater is supplied from a separate transformer Rh-k max. is 1MΩ.

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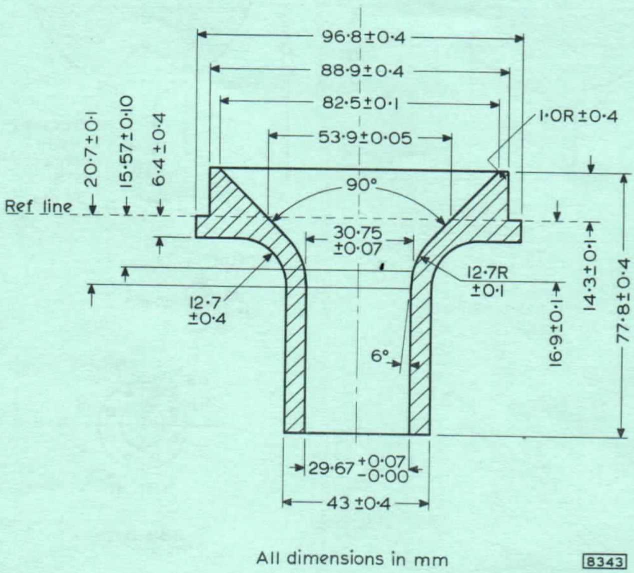
WARNING

X-ray shielding is advisable to give protection against possible danger of personal injury arising from prolonged exposure at close range to this tube when operated above 16kV.



REFERENCE LINE GAUGE

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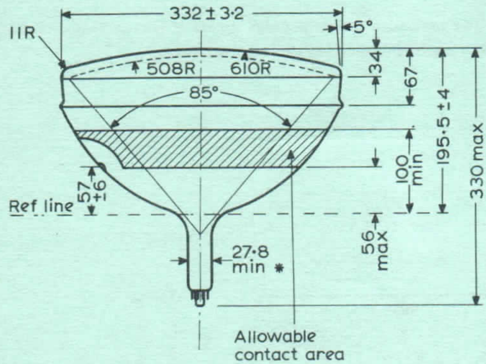
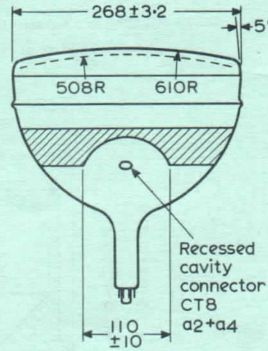
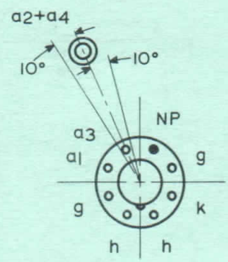
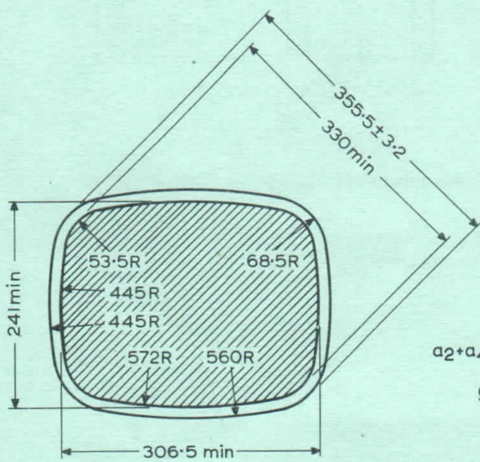


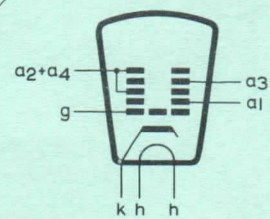


* The maximum value is determined by the reference line gauge



B8H Base





All dimensions in mm

B125

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M36-11W

QUICK REFERENCE DATA		
36cm (14in) rectangular direct viewing television tube with metal backed screen, primarily intended for use as a precision picture monitor.		
Deflection angle	90	deg
Focusing	Electrostatic	
Resolution	>650	lines
Maximum overall length	317	mm

This data should be read in conjunction with
GENERAL OPERATIONAL RECOMMENDATIONS - CATHODE RAY TUBES

HEATER

Suitable for parallel operation only ←

V_h	11±1	V
I_h	68	mA

OPERATING CONDITIONS

V_{a2+a4}	16	kV
V_{a3} (focus electrode control range)	0 to 500	V
V_{a1}	600	V
V_g for visual extinction of focused raster	-43 to -98	V
*V_k for visual extinction of focused raster	40 to 90	V

*For cathode modulation, all voltages are measured with respect to the grid.

SCREEN

Metal backed

Fluorescent colour	White
Useful screen area	See page 6

RESOLUTION

Resolution at screen centre	>650	lines
Measured at:		
V_{a2+a4}	16	kV
V_{a1}	600	V

The tube will resolve 650 lines measured at a brightness of 340cd/m^2(nits), based on a picture height of 237mm.
The focus voltage is adjusted to obtain the smallest roundest spot. For optimum overall resolution an external centring magnet may be required.

FOCUSING

Electrostatic

The range of focus voltage shown in 'OPERATING CONDITIONS' results← in optimum overall focus at a beam current of 100μA. With the small change in spot size with variation of focus voltage, the limit of 0 to 500V is such that an acceptable focus quality is obtained throughout this range. If it is required to pass through the point of focus, a voltage range of at least -100 to +600V will be necessary.

DEFLECTION

Magnetic

Diagonal deflection angle	90	deg

The deflection coils should be designed so that their internal contour is in accordance with the reference line gauge shown on page 7.

CAPACITANCES

c_{g-all}	9.0	pF
c_{k-all}	5.0	pF
$c_{a2+a4-M}$	800	pF

EXTERNAL CONDUCTIVE COATING

This tube has an external conductive coating, M, which must be connected to chassis, and the capacitance of this coating to the final anode is used to provide smoothing for the e.h.t. supply. The electrical connection to this coating must be made within the area specified on the tube outline drawing.

RASTER CENTRING

See notes under this heading in 'General Operational Recommendations - Cathode Ray Tubes.

Centring magnet field intensity	0 to 800	A/m

Adjustment of the centring magnet should not be such that a general reduction in brightness of the raster occurs.

REFERENCE LINE GAUGE

See page 7

MOUNTING POSITION

The tube may be mounted in any position except vertical with the screen downwards, the axis of the tube making an angle of less than 20^{o} with the vertical.

The tube socket should not be rigidly mounted but should have flexible leads and be allowed to move freely.

The tube is fitted with a pin protector in order to avoid damage to the glass base due to bending of the base pins whilst handling the tube. It is advisable to keep this pin protector on the base until it can be replaced by the socket after the installation of the tube in any equipment.

RATINGS (ABSOLUTE MAXIMUM SYSTEM)

V_{a2+a4} max. (at $I_{a2+a4}=0$) (see note 1)	18	kV
V_{a2+a4} min.	12	kV
$+V_{a3}$ max.	1.0	kV
$-V_{a3}$ max.	500	V
V_{a1} max.	800	V
$+V_{g}$ max. (see note 2)	0	V
$+v_{g(pk)}$ max.	2.0	V
$-V_{g}$ max.	180	V
$\pm I_{a3}$ max.	25	μA
$\pm I_{a1}$ max.	5.0	μA
V_{h-k} max.	80	V
$v_{h-k(pk)}$ max.	130	V
R_{h-k} max.	1.0	MΩ
Z_{h-k} max. (f = 50Hz)	500	kΩ
Z_{k-e} max. (f = 50Hz)	100	kΩ
R_{g-k} max.	1.5	MΩ
Z_{g-k} max. (f = 50Hz)	500	kΩ
R_{a1-k} max.	1.0	MΩ
R_{a3-k} max.	3.0	MΩ

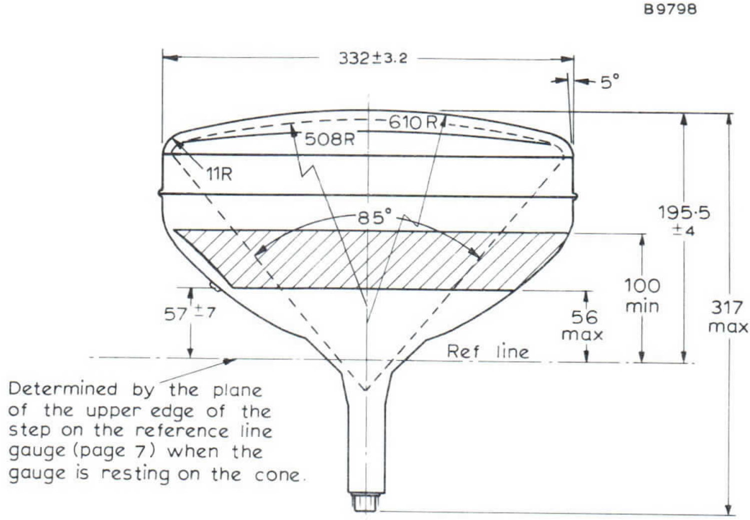
NOTES

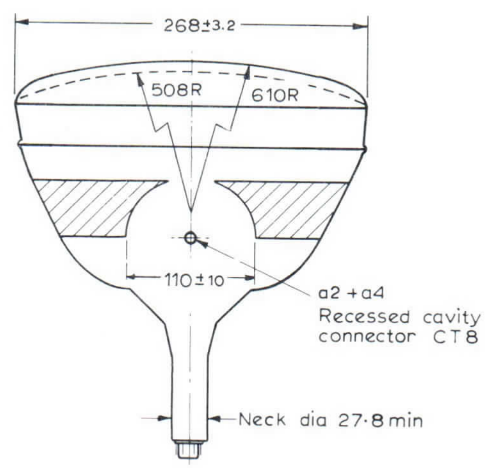
1. Adequate precautions should be taken to ensure that the receiver is protected from damage which may be caused by a possible high voltage flashover within the cathode ray tube.

2. The d.c. value of bias must not be such as to allow the grid to become positive with respect to the cathode, except during the period immediately after switching the receiver on or off when it may be allowed to rise to +1V. The maximum positive excursion of the video signal must not exceed +2V; at this voltage the grid current may be expected to be approximately 2mA.

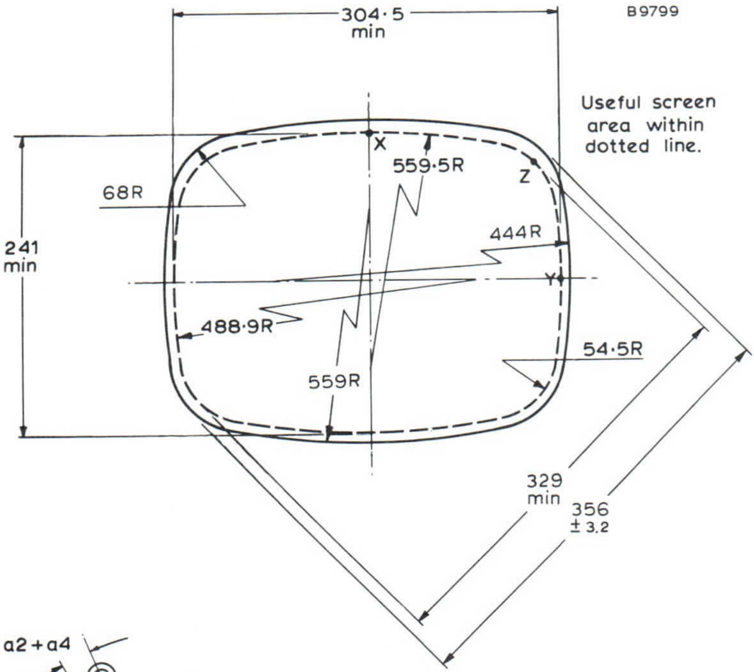
WARNING

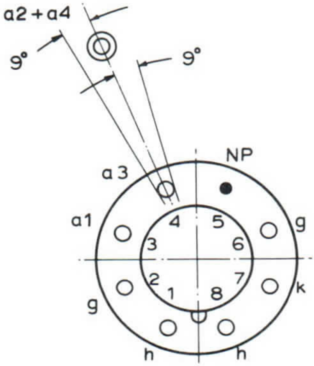
X-ray shielding is advisable to give protection against possible danger of personal injury arising from prolonged exposure at close range to this tube.



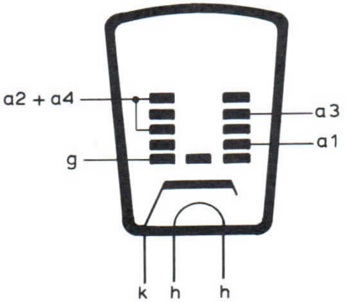


All dimensions in mm

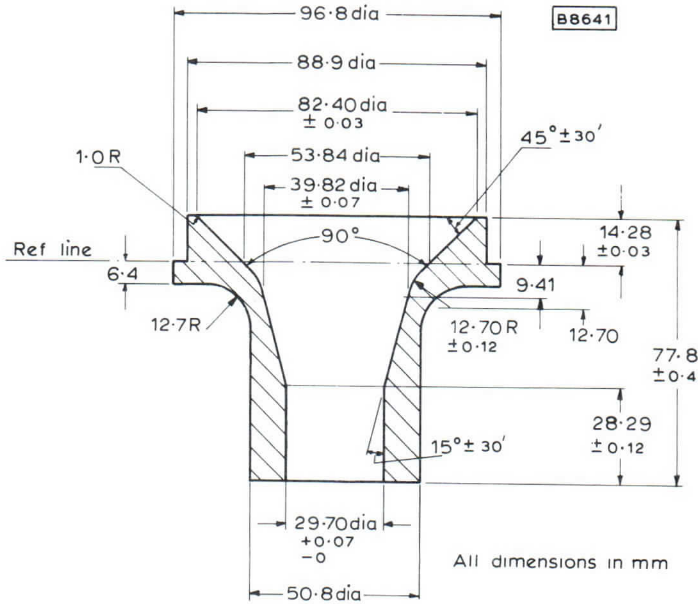




B8H Base

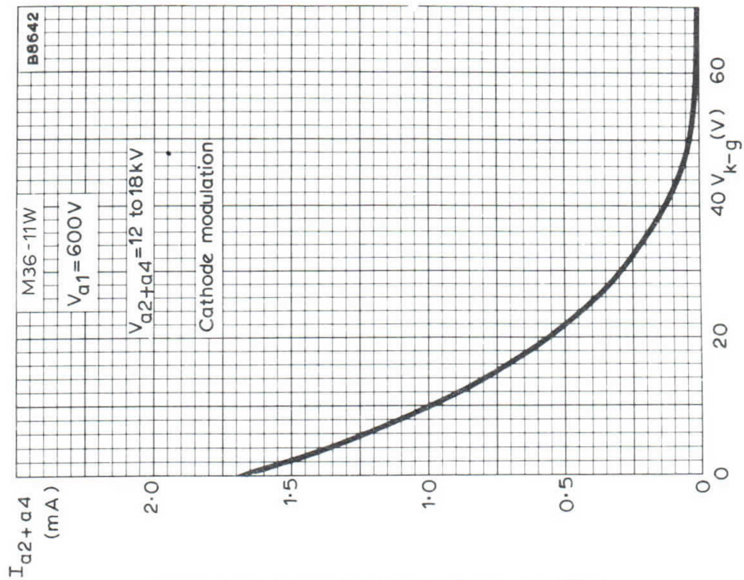


All dimensions in mm

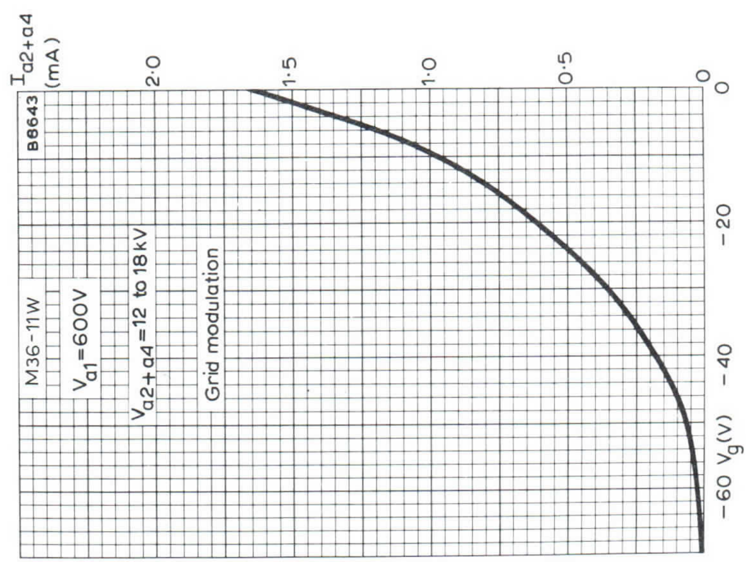


All dimensions in mm

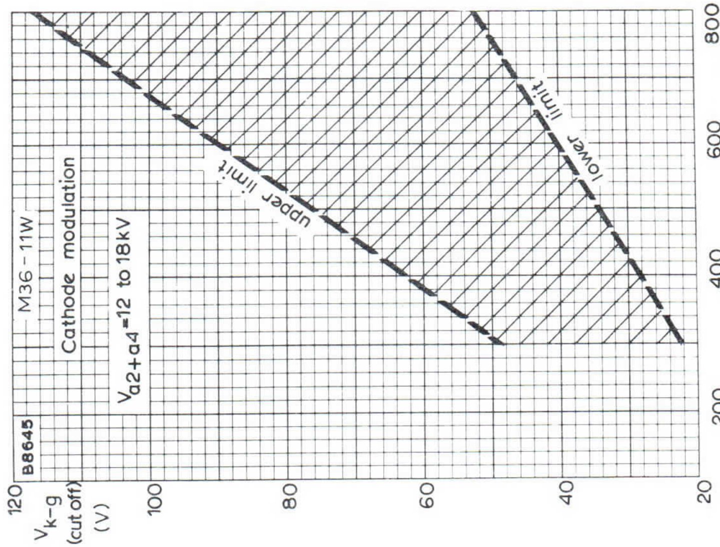
REFERENCE LINE GAUGE



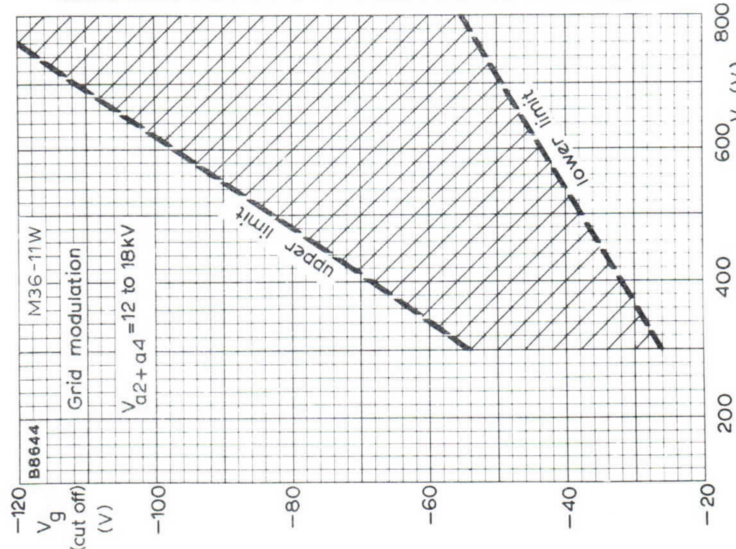
FINAL ANODE CURRENT PLOTTED AGAINST
CATHODE-TO-GRID VOLTAGE. CATHODE MODULATION



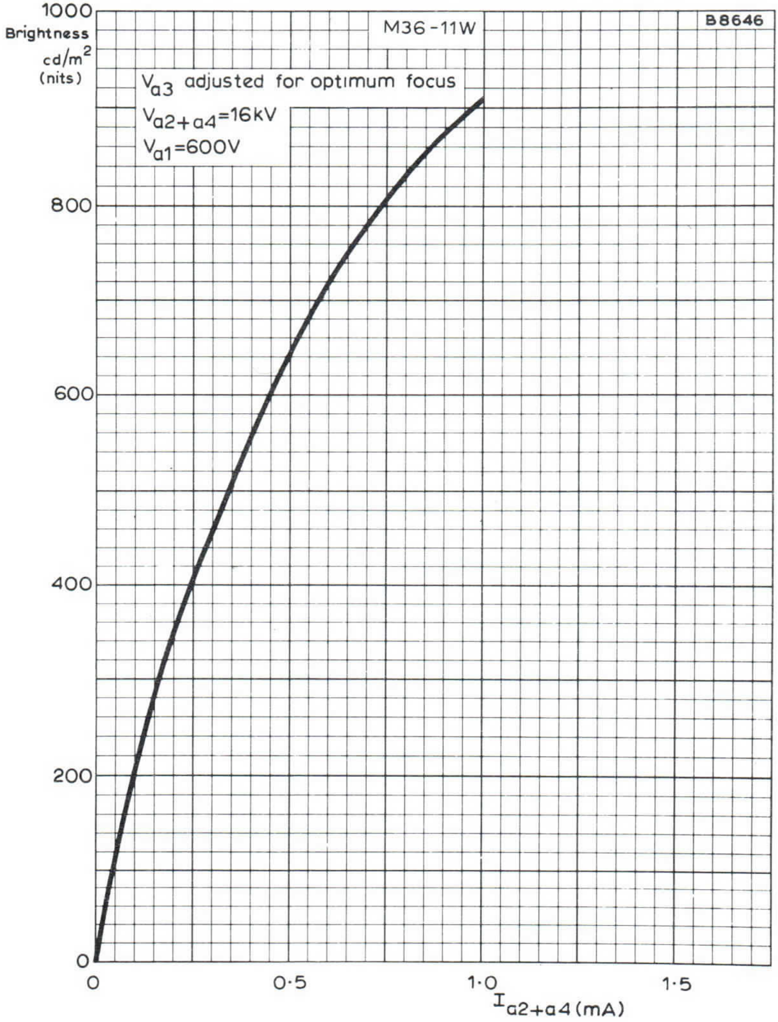
FINAL ANODE CURRENT PLOTTED AGAINST GRID VOLTAGE
GRID MODULATION



LIMITS OF CATHODE-TO-GRID CUT-OFF VOLTAGE PLOTTED AGAINST FIRST ANODE-TO-GRID VOLTAGE. CATHODE MODULATION



LIMITS OF GRID CUT-OFF VOLTAGE PLOTTED AGAINST FIRST ANODE VOLTAGE. GRID MODULATION



SCREEN BRIGHTNESS PLOTTED AGAINST FINAL ANODE CURRENT

QUICK REFERENCE DATA

5in diameter flying spot scanner tubes with metal-backed screens. The only difference between these tubes is in the screen properties.

Colour and Persistence		
C screen	blue-violet—killed	
K screen	green—very short	
Electron gun	triode—magnetically focused	
Operating voltage	25	kV
Resolution	> 1000	lines

This data should be read in conjunction with GENERAL OPERATIONAL RECOMMENDATIONS – CATHODE RAY TUBES which precede this section of the handbook.

HEATER

V_h	6.3	V
I_h	300	mA

SPARK TRAP AND EXTERNAL CONDUCTIVE COATING

This tube has an external conductive coating (M) around the neck of the tube, and the capacitance of this to the anode may be used to provide smoothing for the e.h.t. supply.

The insulating coating around the cone of the tube should not be in close proximity to any earthed metal parts.

Incorporated within the tube is a spark trap so positioned that it prevents any internal flashover taking place between the anode and the grid.

The spark trap and external conductive coating around the neck of the tube must be connected to the chassis.

CAPACITANCES

c_{g-all}	6.5	pF
c_{k-all}	6.5	pF
c_{a-M}	250 to 450	pF

SCREEN

←

	C	K
Fluorescent colour	blue-violet	green
Persistence	killed	very short
Minimum useful screen diameter	108	mm
Metal-backed		

With the C screen, the brightness is reduced to 36% (e^{-1}) of the initial peak value $<0.1\mu s$ after the excitation is removed.

FOCUSING

Magnetic

DEFLECTION

Double magnetic

MOUNTING POSITION

Any, except with screen downwards and the axis of the tube making an angle of less than 50° with the vertical.

TYPICAL OPERATING CONDITIONS

V_a	25	kV
I_a	50 to 100	μA
*V_g for cut-off	–50 to –100	V
Resolution at centre of screen	>1000	lines

DESIGN CENTRE RATINGS

V_a max.	27	kV
V_a min.	20	kV
*–V_g max.	200	V
I_k max.	150	μA
R_{g-k} max.	1.5	MΩ
Z_{g-k} max. (f = 50c/s)	500	kΩ
†V_{h-k} max. (cathode negative)	125	V
†V_{h-k} max. (cathode positive)	200	V
‡$v_{h-k(pk)}$ max. (cathode positive)	410	V
R_{h-k} max.	1.0	MΩ

*The d.c. value of grid bias must not be allowed to become positive with respect to the cathode except during the periods immediately after switching the equipment on or off, when it may be allowed to rise to +1V. The maximum positive grid excursion of the video signal may reach 2V, and at this voltage the grid current may be expected to be approximately 2mA.

†In order to avoid excessive hum, the a.c. component of V_{h-k} should be as low as possible ($<20V_{r.m.s.}$).

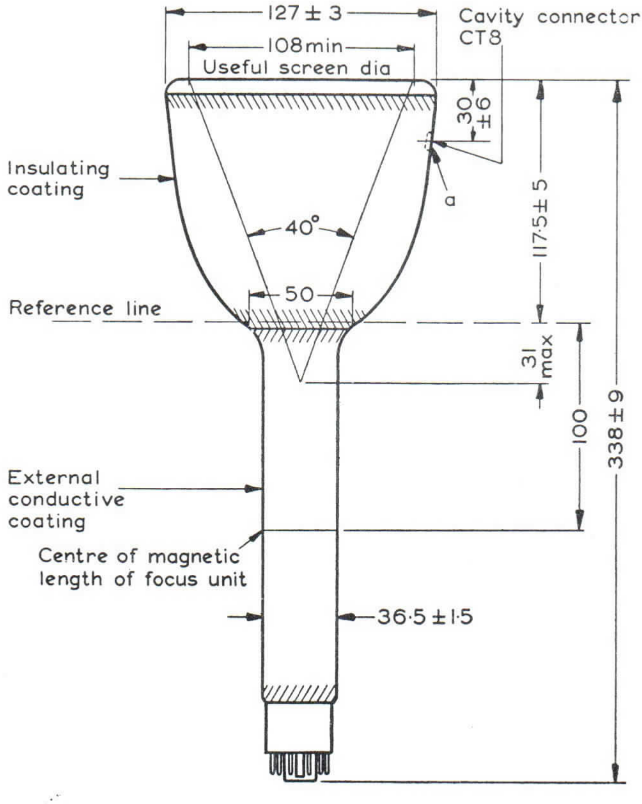
‡During a warming-up period not exceeding 45s.

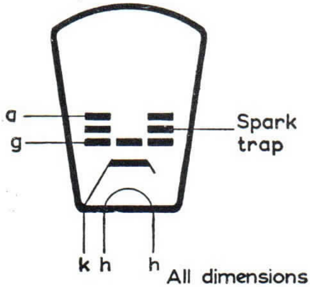
TUBE PROTECTION

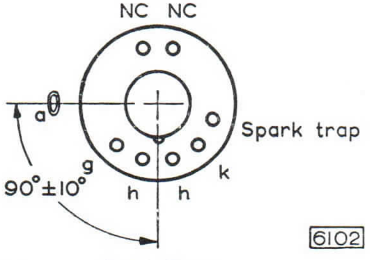
It is essential that means be provided for the instantaneous removal of the beam current in the event of a failure of either one or both of the timebases. Unless such a safety device is incorporated a failure of this type will result in the immediate destruction of the screen of the tube.

X-RADIATION PROTECTION

Shielding equivalent to a lead glass thickness of 0.5mm is required to protect the observer against X-radiation.

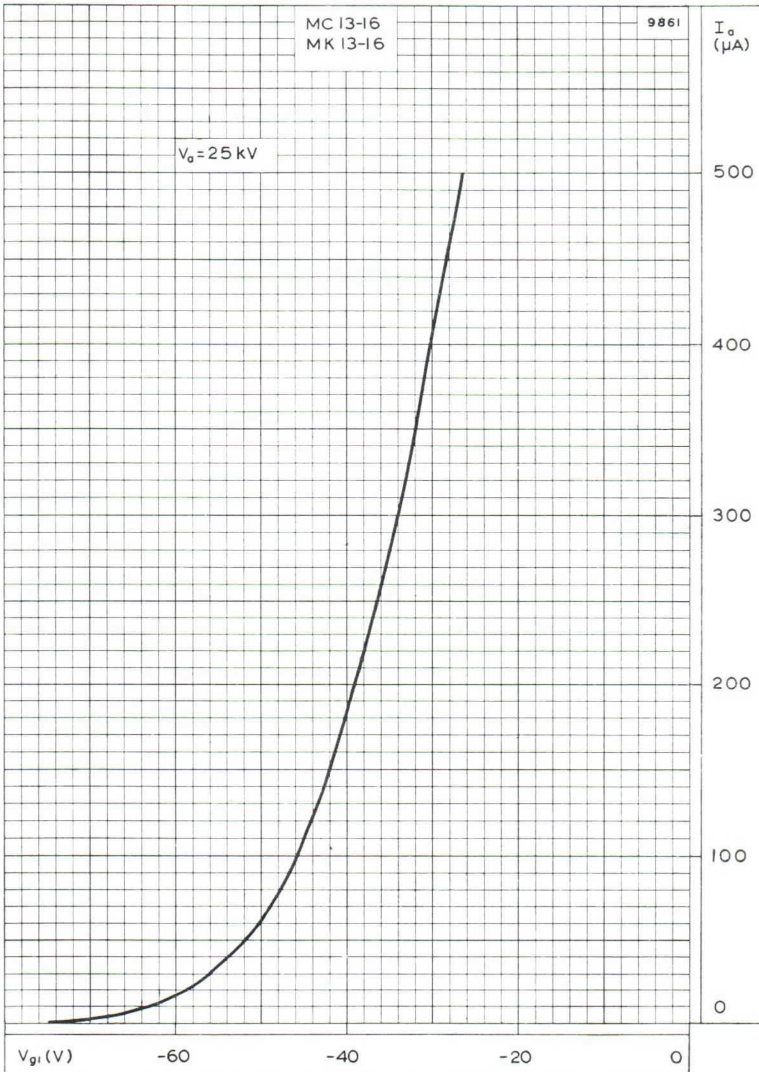






All dimensions in mm.

B12A Base.



FINAL ANODE CURRENT PLOTTED AGAINST GRID VOLTAGE

QUICK REFERENCE DATA

5in diameter projection tubes with metal-backed screens intended to provide high brightness, large area displays

	G	U	Y	W	
Colour	green	blue	yellow	white	
Light output (when used in colour projection system)	24,000	3,350	3,750	9,700	nits
Electron gun	triode—magnetically focused				
Operating voltage				50	kV

This data should be read in conjunction with GENERAL OPERATIONAL RECOMMENDATIONS – CATHODE RAY TUBES which precede this section of the handbook.

HEATER

This tube is suitable for parallel operation only.

V_h	6.3	V
I_h	660	mA

SPARK TRAP AND EXTERNAL CONDUCTIVE COATING

There is a conductive layer under the insulating coating in the region of the reference line of the tube, (see drawing) and it is therefore necessary to insulate the deflection coils from the neck of the tube.

The insulating coating around the cone of the tube and neck should not be in close proximity to earthed metal parts.

Incorporated within the tube is a spark trap, so positioned that it prevents any internal flash-over taking place between the anode and the grid.

The spark trap and external conductive coating must both be connected to the chassis.

CAPACITANCES

c_{g-all}	10	pF
c_{k-all}	9.0	pF

M(G/U/Y/W)13-38 PROJECTION TUBES

SCREEN

	MG13–38	MU13–38	MY13–38	
Fluorescent colour	green	blue	yellow	
Light output (measured at $V_a = 50kV$, $I_a = 500\mu A$ and with a raster of size $72 \times 96mm$)	24,000	3,350	16,000 or *3,750	nits
†Typical percentage values of total anode current to produce white	13	39	*48	%

†Ratios of anode current to produce white	*Minimum*	*Typical*	*Maximum*
*MY13–38 to MG13–38	2.5	3.7	5.0
*MY13–38 to MU13–38	0.6	1.2	1.8

*MY13–38 used with Wratten 25 filter.

†White is defined by the colour co-ordinates: $x = 0.310$, $y = 0.316$.

	MW13–38	
Fluorescent colour	white	
Light output (measured at $V_a = 50kV$, $I_a = 500\mu A$ and with a raster of size $72 \times 96mm$)	9,700	nits

The raster dimensions must not be smaller than $72 \times 96mm$.

The screen should be forced-air cooled by a continuous airflow of $0.06m^3/s$ ($2.1ft^3/s$).

(1 nit = $10mcd/cm^2$ = 0.292 ft.lamberts)

FOCUSING

Magnetic

DEFLECTION

Double magnetic

MOUNTING POSITION

Any, except with screen downward and the axis of the tube making an angle of less than 50° with the vertical.

The tube socket should not be rigidly mounted but should have flexible leads and be allowed to move freely. The bottom circumference of the base shell will fall within a circle having a diameter of 50mm which is centred upon the perpendicular from the centre of the face.

TYPICAL OPERATING CONDITIONS

V_a	50	kV
$i_{a(pk)}$	2.5	mA
V_g for cut-off	−100 to −170	V

ABSOLUTE MAXIMUM RATINGS

V_a max.	55	kV
V_a min.	40	kV
$-V_{g1}$ max.	200	V
$+V_{g1}$ max.	0	V
$+v_{g1(pk)}$ max.	0	V
I_a max.	500	μA
R_{g-k} max.	1.5	MΩ
Z_{g-k} max. (f = 50c/s)	500	kΩ
$v_{h-k(pk)}$ max. (cathode positive)	100	V
$v_{h-k(pk)}$ max. (cathode negative)	50	V
R_{h-k} max.	20	kΩ
Minimum raster dimensions	72×96	mm

TUBE PROTECTION

It is essential that means be provided for the instantaneous removal of the beam current, in the event of a failure of either one or both of the time-bases. Unless such a safety device is incorporated, a failure of this type will result in the immediate destruction of the screen of the tube.

X-RADIATION PROTECTION

Shielding equivalent to a lead thickness of 1mm is required to protect the observer against X-radiation.

OPERATING NOTES

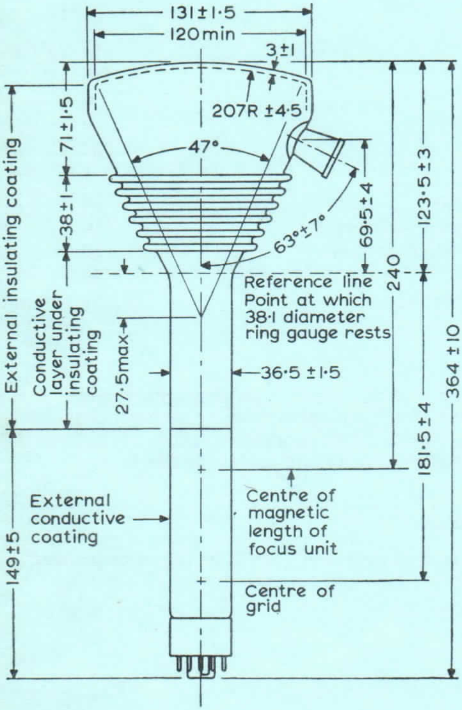
1. Before removing the tube from an equipment the screen and cone should be discharged.
2. A 50kΩ resistor should be included in the e.h.t. lead in order to avoid damage to the tube due to a momentary internal arc.
3. It is recommended that the connection to the final anode be made with the e.h.t. connector supplied with the tube.
4. In order to prevent the possible occurrence of a cracked tube face when operating with localised high brightness areas the mean anode current must be less than 500μA. For stationary raster patterns the maximum peak anode current is 500μA.

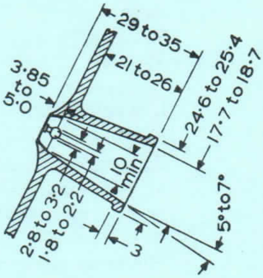
WEIGHT

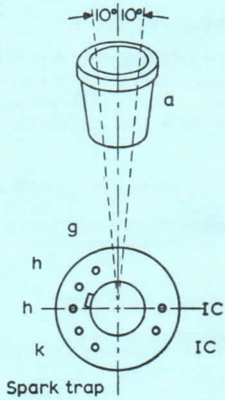
Tube alone	2	lb
	950	g
Shipping weight	3 lb 12	oz
	1.7	kg

MGUYW 13-38

PROJECTION TUBES

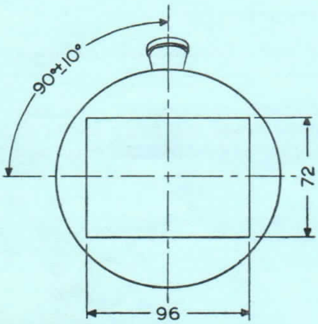




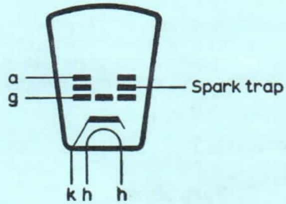


B12A Base

All dimensions in mm



Useful screen dimensions



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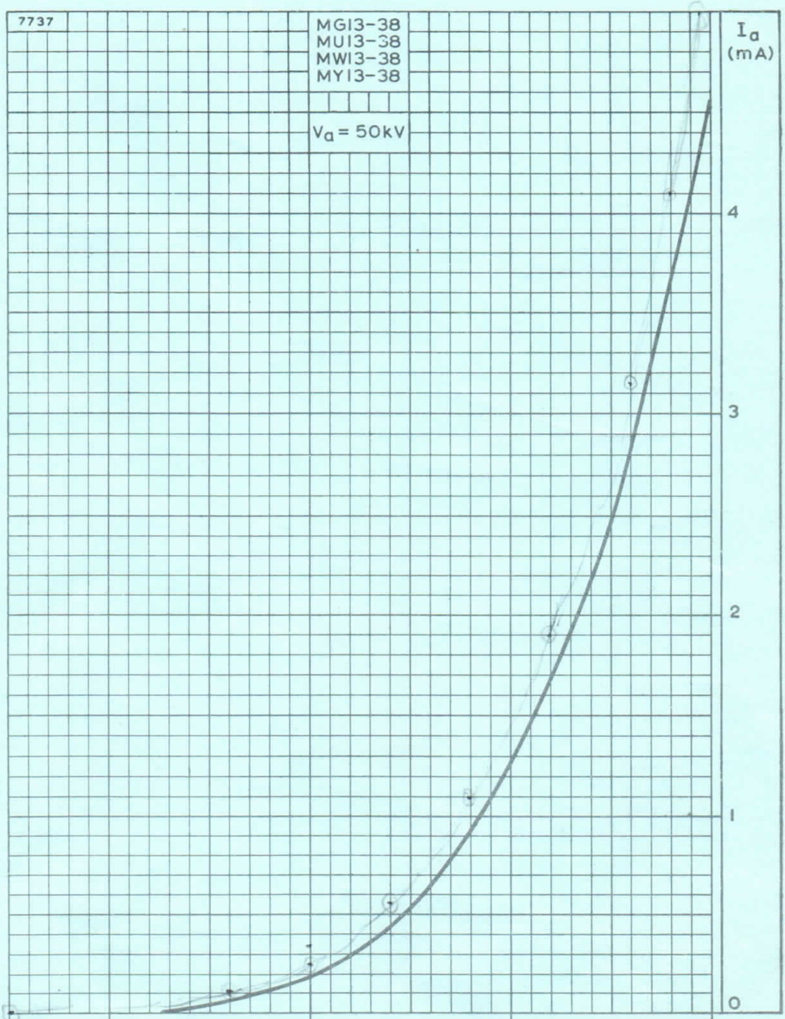


ANODE CURRENT PLOTTED AGAINST GRID VOLTAGE

PHOTOCONDUCTIVE CELLS

GENERAL EXPLANATORY NOTES

1. DESCRIPTION

Cadmium sulphide (CdS) cells are two-terminal light-sensitive resistors enclosed in a protective envelope of glass or plastic. They are made by sintering photoconductive cadmium sulphide powder into ceramic-like tablets of the required shape. Cadmium sulphide, when suitably prepared, is an insulator in the dark, but becomes a conductor when light falls upon it, due to the release of electrons within the material. The resistance varies roughly in inverse proportion to the illumination, and its range may cover up to six decades.

Electrodes are deposited upon the tablet surface, and are made of materials which give an ohmic contact, but with low resistance compared with that of the cadmium sulphide. The electrodes are usually inter-digital, i.e. in the form of interlinked fingers or combs. The design of the electrode system affects the resistance and voltage rating of the cell, so that different resistances and voltage ratings can be achieved on a tablet of given size. A device with a small number of widely spaced electrodes will have a higher resistance and voltage rating than a device using the same tablet with a large number of closely spaced electrodes.

2. DATA PRESENTATION

In general the data is divided into four main sections: quick reference data, cell characteristics, ratings and shock and vibration resistance.

2.1 Quick reference data

This section contains the main characteristics of the cell to allow rapid comparison with other cells. The information for circuit design should be obtained from the succeeding sections of the data. The characteristics usually given in the quick reference data are: maximum power dissipation at an ambient temperature of 25°C, maximum cell voltage, nominal cell resistance at 50 lux illumination, sensitive area of the cell, maximum overall dimensions and any special features.

2.2 Cell characteristics

The electrical properties of cadmium sulphide cells are dependent on many factors, such as illumination, colour temperature of the source, cell voltage and current, temperature, time of operation in the circuit, and operation during the 24 hours prior to measurement. The characteristics given in the data are therefore only checkpoints of the electrical properties, measured under specified conditions and at start of life. They are based on the device being uniformly illuminated by a tungsten lamp operated at a specified colour temperature, usually 2700°K. An explanation of colour temperature is given in section 6.2.

The cell resistance at a fixed level of illumination is affected by the colour temperature or colour content of the illumination. A curve of the spectral response of Mullard cadmium sulphide cells is given on page 8 of these notes.

More detailed information on cell characteristics is given in section 3.

2.3 Ratings

The ratings of Mullard cadmium sulphide cells are given according to the absolute maximum system, as defined below:

2.3.1 I.E.C. definition (International Electrotechnical Commission)

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

These values are chosen by the device manufacturer to provide acceptable serviceability of the device, taking no responsibility for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the device under consideration and of all other 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 device under the worst probable operating conditions with respect to variation in supply voltage, environment, equipment components, equipment control adjustment, load, signal or characteristics of the device under consideration and of all other devices in the equipment.

2.3.2 Absolute maximum cell surge voltage

The absolute maximum cell surge voltage is, unless otherwise stated, twice the absolute maximum cell voltage given in the data. A surge is defined as an occasional over-voltage due to supply transients.

2.3.3 Maximum power dissipation

The value of maximum power dissipation given in the data applies to uniform illumination of the cell. If only part of the tablet is illuminated the maximum power should be reduced in proportion to the area used. Therefore it is generally preferable to reduce the illumination on the cell by interposing a filter, instead of reducing the illuminated area by means of an iris or shutter.

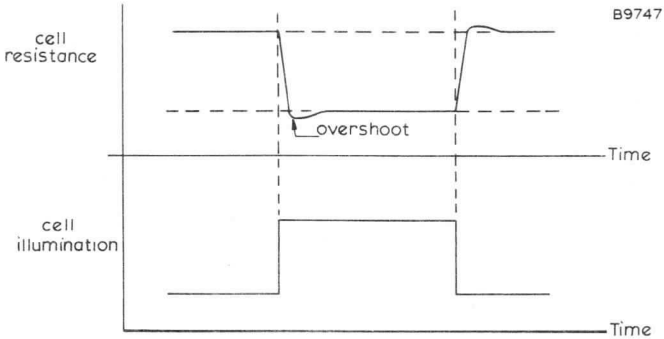
2.4 Shock and vibration resistance

The conditions for shock and vibration given in the data sheets are intended only to give an indication of the mechanical quality of the cells. It is not advisable to subject a cell to such conditions.

3. CELL CHARACTERISTICS

3.1 Illuminated resistance

When the illumination incident on a cell is changed the resistance changes to a value which is a function of the new illumination. The change is not immediate, and the resistance may overshoot as shown below:



3.2 Illuminated resistance (a.c. operation)

When a cell is operated from an a.c. supply the effective resistance measured as $|V/I|$ is usually greater than the resistance measured under d.c. conditions. Where a.c. resistance characteristics are not fully described, the a.c. resistance values at 50Hz are approximately 1 to 1.3 times those for d.c.

When using h.f. supplies there will be some change in impedance accompanied by a phase shift between the applied voltage and the cell current.

3.3 Definitions

The following terms are used in the data:

Illuminated resistance - the resistance of the cell when illuminated.

Initial illuminated resistance - the first virtually constant value of illuminated resistance after a change in illumination, usually after a change following 16 hours in complete darkness. (After 16 hours in darkness, changes in the cadmium sulphide material are still occurring, but have an insignificant effect on subsequent measurements.)

Equilibrium illuminated resistance - the illuminated resistance after such a time that the rate of change of illuminated resistance is less than 0.2% per minute.

Illuminated current - the current which flows when a specified voltage is applied to the illuminated cell.

Initial illuminated current - the first virtually constant value of illuminated current after a change of illumination, usually after a change following 16 hours in complete darkness.

Equilibrium illuminated current - the illuminated current after such a time that the rate of change of illuminated current is less than 0.2% per minute.

Dark resistance - the resistance of the cell in complete darkness.

Initial dark resistance - the dark resistance at a specified time after a specified history.

Equilibrium dark resistance - the dark resistance after such a time that the rate of change of dark resistance is less than 0.2% per minute.

Dark current - the current which flows when a specified voltage is applied to the cell in complete darkness.

Initial dark current - the dark current at a specified time after a specified history.

Equilibrium dark current - the dark current after such a time that the rate of change of dark current is less than 0.2% per minute.

Resistance rise time - the time taken for the resistance of the cell to rise to a specified value after switching off a specified illumination after a specified history.

Resistance decay time - the time taken for the resistance of the cell to fall to a specified value, measured from the instant of switching on a specified illumination after a specified history.

Current decay time - the time taken for the current through the cell to fall to 10% of its value at the instant of switching off a specified illumination after a specified history.

Current rise time - the time taken for the current through the cell to rise to 90% of its initial illuminated current, measured from the instant of switching on a specified illumination after a specified history.

Illumination sensitivity - the illuminated current divided by the incident illumination.

Temperature coefficient of illuminated resistance (current) - the relationship between illuminated resistance (current) and variation of ambient temperature, under conditions of constant illumination and applied voltage. Within the normal operating range of the cells the temperature coefficient of illuminated resistance is typically -0.2% per degC.

Initial drift - the difference between the equilibrium and initial illuminated current, expressed as a percentage of the initial illuminated current.

Illumination response - the relationship between the initial illuminated resistance (R) and the illumination (E), defined as $\frac{\Delta \log R(\text{initial})}{\Delta \log E}$

Gamma - the relationship between change in resistance and corresponding change in illumination, defined as $\frac{\log R1/R2}{\log E2/E1}$ where R1 = resistance at illumination E1 and R2 = resistance at illumination E2.

4. THERMAL DATA

4.1 Ambient temperature

The ambient temperature is the temperature of the air surrounding the cell in its practical situation, which means that all other devices in the same space or apparatus must have their normal maximum dissipation and the normal apparatus envelope must be used.

The ambient temperature can normally be measured by means of a mercury thermometer with a blackened bulb, placed 5mm from the cell in the horizontal plane through the centre of the effective area of the cadmium sulphide tablet. The thermometer should be exposed to substantially the same radiant energy as that incident on the cadmium sulphide tablet.

4.2 Thermal resistance

The thermal resistance of a cell is defined as the temperature difference between the hottest point of the cell and the dissipating medium, divided by the power dissipated in the device.

5. MECHANICAL CONSIDERATIONS

5.1 Mounting position

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

5.2 Soldering and wiring recommendations

Most photoconductive cells can be soldered directly into the circuit, as indicated in the published data. Heat conducted to the seals should be kept to a minimum by the use of a thermal shunt. Unless otherwise stated, cells may be dip-soldered at a solder temperature of $240^{\circ}C$ for a maximum of 10 seconds up to a point 5mm from the seals. Care should be taken not to bend the leads nearer than 1.5mm from the seals.

5.3 Storage

It is recommended that cells are stored in the dark. In any case direct sunlight should be avoided.

5.4 Outline drawings

All dimensions are given in millimetres.

6. CELL ILLUMINATION

6.1 Light units

Cadmium sulphide cells are sensitive mainly in the visible region of the spectrum, so units associated with visible light are used in the data sheets. The four preferred units are defined below.

Cadmium sulphide data is usually given in terms of the illumination on the cell.

6.1.1 Luminous intensity - candela (cd)

Luminous intensity is the term used to express the light giving power of a source.

The candela is 1/60th of the luminous intensity, in a direction normal to the surface, of one square centimetre of a black body at the temperature of solidification of platinum.

6.1.2 Luminous flux - lumen (lm)

Luminous flux is the term used to express the total amount of light emitted or received by a given surface, or passing through a given area.

The lumen is the luminous flux radiating from a point source of uniform luminous intensity 1 candela, and contained within a solid angle of 1 steradian.

A steradian is the solid angle subtended at the centre of a sphere of radius r by an area r^2 on the surface of the sphere. As the surface area of a sphere is $4\pi r^2$, a complete sphere comprises 4π steradians, so the total luminous flux from a point source of 1 candela is 4π lumens.

6.1.3 Illumination - lux (lx)

Illumination is the term used to express the amount of luminous flux falling on a given surface.

The lux is the illumination produced when 1 lumen of flux falls on a surface of area 1 square metre. It will be seen that an illumination of 1 lux is produced on an area of 1 square metre at a distance of 1 metre from a point source of 1 candela.

6.1.4 Luminance - candela/square metre (cd/m^2)

Luminance is a measure of the brightness of a surface whether illuminated or self-luminous.

The preferred unit is the candela per square metre, previously known as the nit.

6.2 Colour temperature

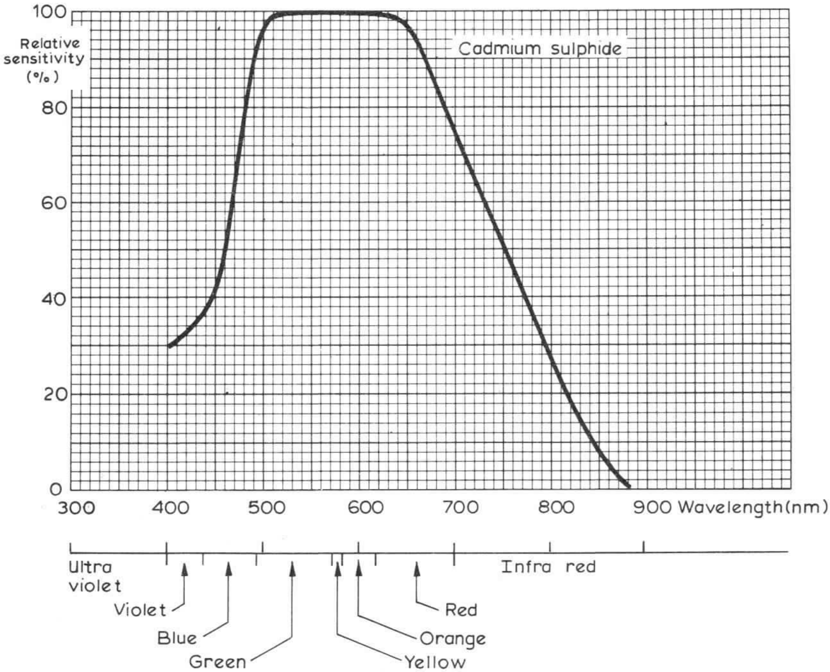
The normal way of specifying the colour of a light source is by means of its colour temperature. This is the temperature to which a black body would have to be raised to give a similar colour sensation to that produced by the light source under examination. Certain light sources (e.g. the sky) have a colour which cannot in practice be obtained by heating a black body, and to quote equivalent colour temperatures in these cases involves theoretical extrapolations. The colour temperature of the sky may be as high as 20 000^{o}K, but it is possible to simulate the colour source by the use of conventional tungsten lamps in conjunction with filters.

6.2.1 C.I.E. Standard (Commission Internationale de l'Eclairage)

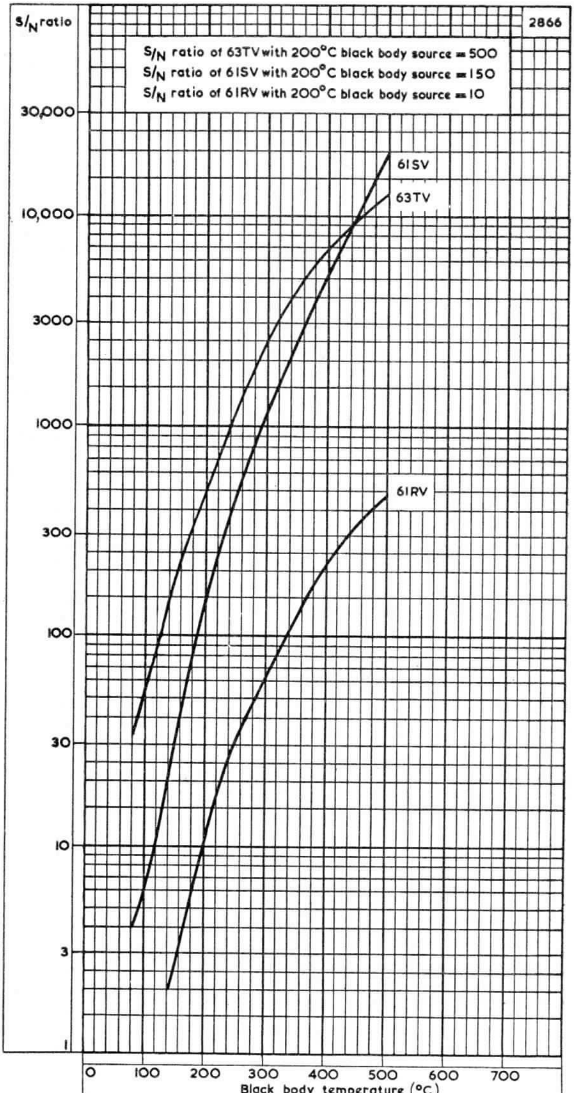
The C.I.E. standard illumination source A has a colour temperature of 2854^{o}K. To obtain a good test lamp stability, Mullard cadmium sulphide cells are normally measured at the slightly lower colour temperature of 2700^{o}K, and the published characteristics are given for this illumination. The cell resistance with an illumination of 2854^{o}K is approximately 5% higher than the resistance at 2700^{o}K. For other light sources the cell resistance should be multiplied by the following approximate factors:

Source of illumination	Factor
Incandescent radiation at colour temperature of:	
1500^{o}K	1/2
*2000^{o}K	2/3
Sunlight	4/3
White fluorescent light	2

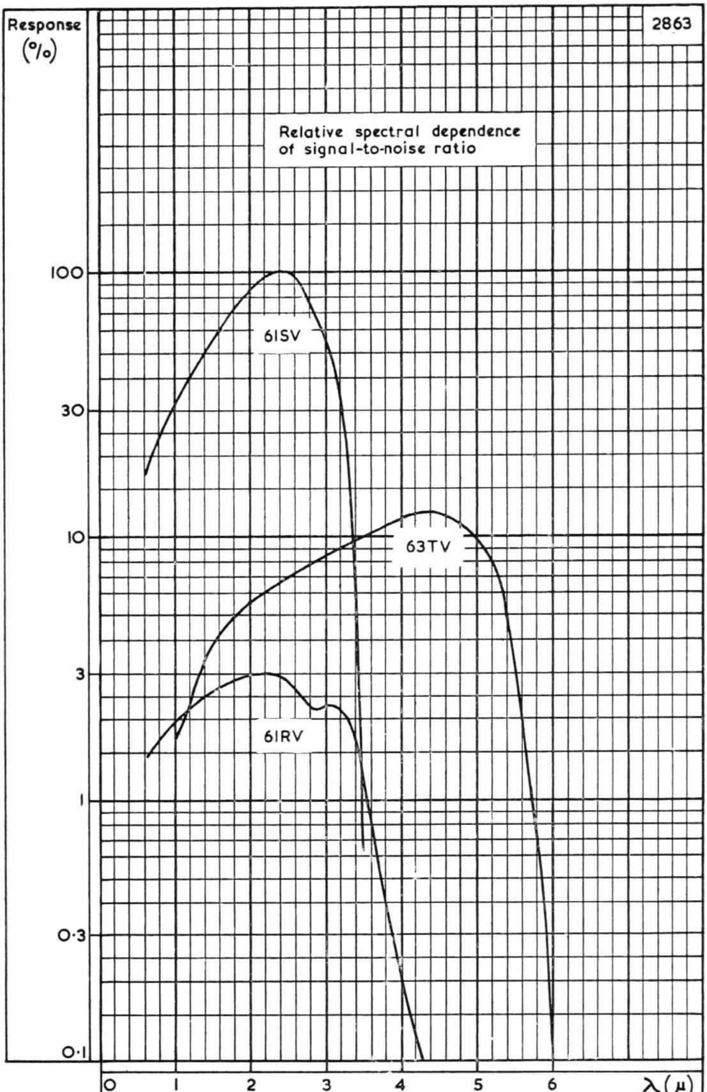
*2000^{o}K corresponds to light from an oil fired burner flame (yellow flame).



RELATIVE SPECTRAL SENSITIVITY OF CADMIUM SULPHIDE PHOTOCONDUCTIVE CELLS



SIGNAL-TO-NOISE RATIO PLOTTED AGAINST BLACK BODY TEMPERATURE



RELATIVE SPECTRAL DEPENDENCE OF SIGNAL-TO-NOISE RATIO

PHOTOCONDUCTIVE CELL ORP10

QUICK REFERENCE DATA

Indium antimonide photoconductive element mounted on a copper heat sink. Recommended for operation at a temperature of 20°C. Sensitive to infra-red radiation extending to 7.5μm and intended for use with modulated or pulsed radiation.

Peak spectral response	6.0 to 6.3	μm
Operating temperature	20	°C
Typical D* (6.0μm, 800, 1)	2.0×10^{8}	$cm(c/s)^{\frac{1}{2}}/W$
Element dimensions	6.0×0.5	mm
Time constant	approx. 0.1	μs

CHARACTERISTICS (at 20°C)

SPECTRAL RESPONSE

Peak spectral response	6.0 to 6.3	μm
Spectral response range	visible to 7.5	μm

A typical response curve is shown on page C1.

Cell resistance max.	120	Ω
min.	30	Ω
Time constant	approx. 0.1	μs
Dimensions of sensitive element	6.0×0.5	mm

MONOCHROMATIC PERFORMANCE (see notes 1 and 2)

Responsitivity (to 6.0μm radiation)	min.	0.4	μV/μW
	typ.	1.0	μV/μW
D* (6.0μm, 800, 1)	min.	8.5×10^{7}	$cm(c/s)^{\frac{1}{2}}/W$
	typ.	2.0×10^{8}	$cm(c/s)^{\frac{1}{2}}/W$
N.E.P. (6.0μm, 800, 1)	typ.	8.6×10^{-10}	(r.m.s.)W
	max.	2.0×10^{-9}	(r.m.s.)W

BLACK BODY PERFORMANCE (see notes 1 and 2)

Responsivity (to 500°K radiation)	typ.	0.3	μV/μW
D* (500°K, 800, 1)	typ.	6.0×10^{7}	$cm(c/s)^{\frac{1}{2}}/W$
N.E.P. (500°K, 800, 1)	typ.	2.5×10^{-9}	(r.m.s.)W

RATINGS (ABSOLUTE MAXIMUM SYSTEM)

Maximum bias current (at 20°C)		100	mA
Maximum operating ambient temperature		+70	°C
Storage temperature	max.	+70	°C
	min.	-50	°C

NOTES

1. Test conditions

The detector is attached to a heat sink which is maintained at a temperature of 20°C and a bias current of 50mA is applied. A parallel beam of monochromatic radiation of wavelength 4.4μm, which would produce a steady irradiance of $68\mu W/cm^2$ at the sensitive element, is square wave modulated at 800c/s. The actual r.m.s. power at the element is therefore reduced to

$$\frac{68}{2.2} = 31\mu W/cm^2$$

Measurements of the detector output are made with an amplifier tuned to 800c/s and with a bandwidth of 50c/s, and are referred to open circuit conditions i.e. correction is made for the shunting effects of the bias supply impedance and the amplifier input impedance. Under these test conditions, the ORP10 will exhibit a minimum signal-to-noise ratio of 45 and typical of 105. The detectivities quoted at the wavelength of peak response and under black body conditions are calculated from these measurements, assuming the detector to have a typical response curve.

2. N.E.P. and D*

These are figures of merit for the materials of detectors and are fully discussed in most textbooks on infra-red e.g. 'Infra-Red Physics' by J.T. Houghton and S.D. Smith (O.U.P. 1966) and 'Elements of Infra-Red Technology' by Kruse, McGlauchlin and McQuistan (John Wiley, New York 1962). D* is defined in the expression

$$D^* = \frac{\frac{V_s}{V_n} \times \left[A(\Delta f)\right]^{\frac{1}{2}}}{W}$$

where
V_s = Signal voltage across detector terminals
V_n = Noise voltage across detector terminals
A = Detector area
(Δf) = Bandwidth of measuring amplifier
W = Radiation power incident on detector sensitive element in r.m.s. watts.

The figures in brackets which follow D* refer to the test conditions e.g. D* (5.3μm, 800, 1) denotes monochromatic radiation incident on the detector of wavelength 5.3μm, modulation frequency 800c/s, an electronic bandwidth of 1c/s.
The Noise Equivalent Power (N.E.P.) is related to D* by the expression:

$$N.E.P. = \frac{(A)^{\frac{1}{2}}}{D^*}$$

3. Variation of performance with bias current.

Both signal and noise vary with bias current in this type of cell. Typical curves are shown on page C2. At high currents the noise increases more rapidly than the signal, and therefore the signal-to-noise ratio has a peak value at some optimum current, which will vary slightly from cell to cell. A typical value is 50mA. In addition the ohmic heating caused by bias currents above 60mA causes the temperature of the element to become significantly greater than the substrate so that the signal decreases as described in note 4.

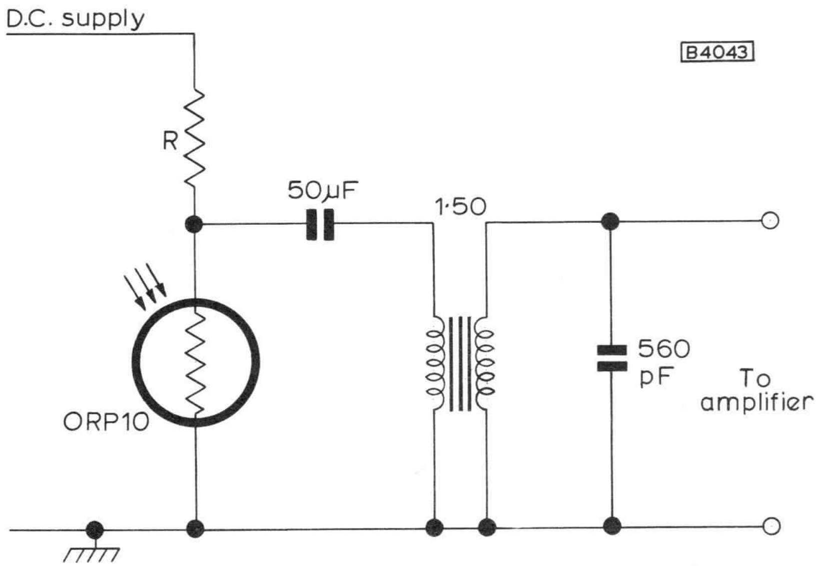
4. Variation of performance with element temperature.

As with all semiconductor photocells, the performance depends on the temperature of the sensitive element. In the case of the ORP10 this is influenced by the ambient temperature and ohmic heating caused by the d.c. bias current. To minimise fluctuations, the element is mounted on a copper base from which it is insulated by a layer of aluminium oxide, and can readily be attached to a large heat sink.
A typical variation of performance with temperature is given on page C4. The curve on page C2 shows the decrease in signal caused by the high current raising the temperature of the element.
On cooling, indium antimonide exhibits improved detectivity and increased resistance. Below 15°C this is impractical with the ORP10 unless special precautions are taken to prevent condensation and icing on the exposed element. Detectors designed for low temperature operation, such as the ORP13, are therefore contained in an evacuated dewar vessel and fitted with a sapphire window.

5. Warning

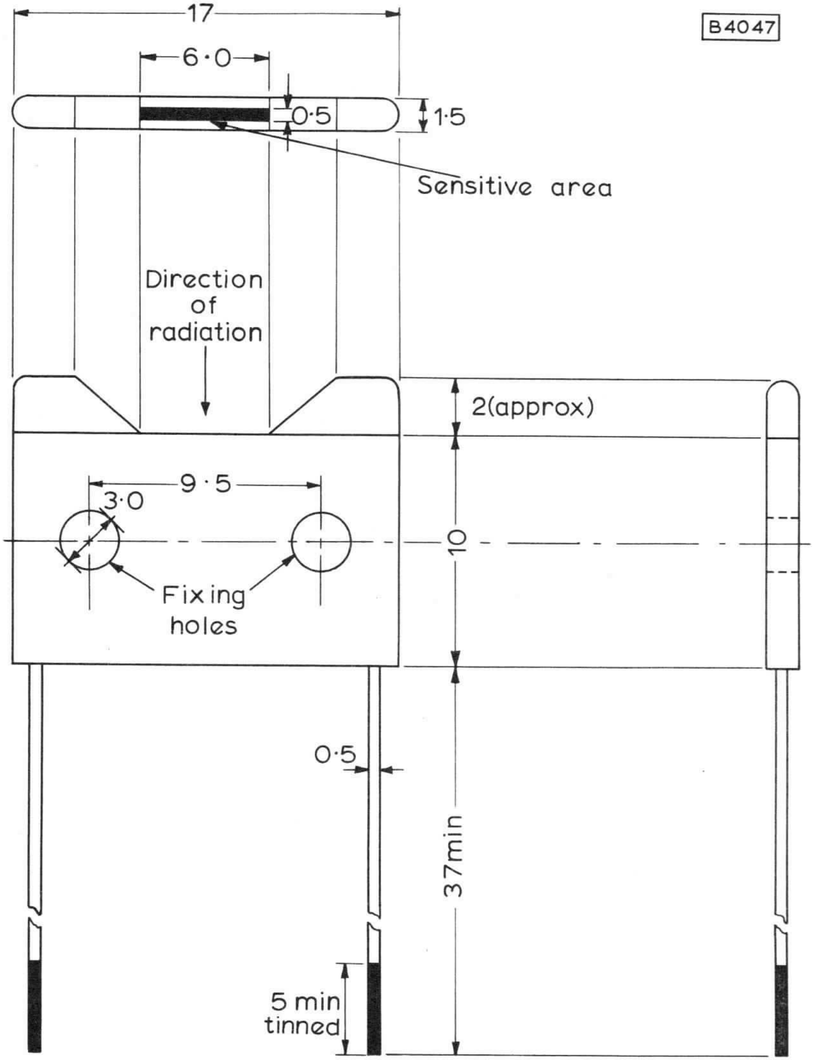
The sensitive surface is unprotected and should not be touched. It is stable in normal atmospheres but should not be exposed to high concentrations of the vapours of organic solvents. Care should be taken to avoid strain when attaching cells to heat sinks.

Recommended circuit for use with radiation chopped at 800c/s.

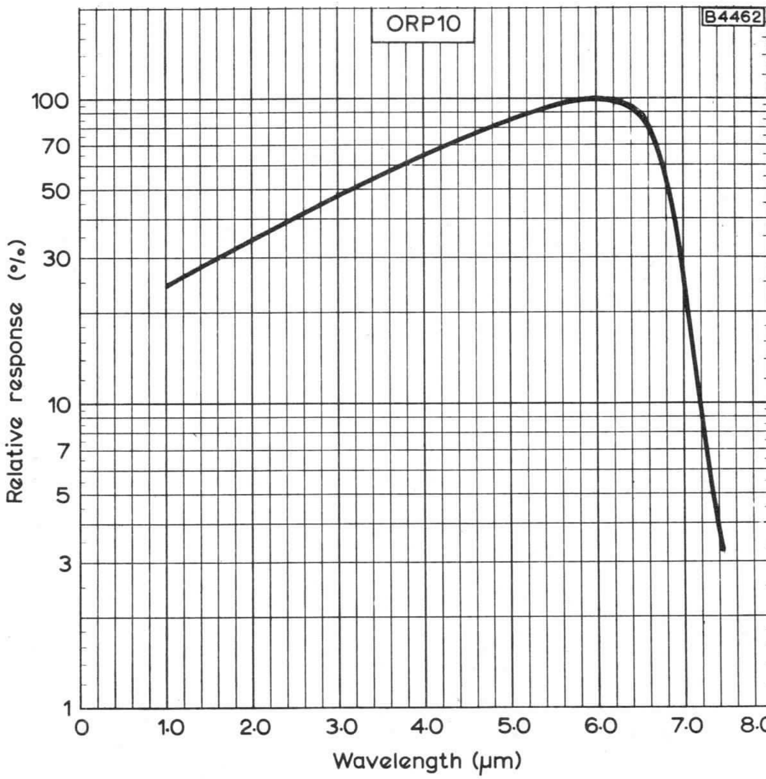


Circuit notes.

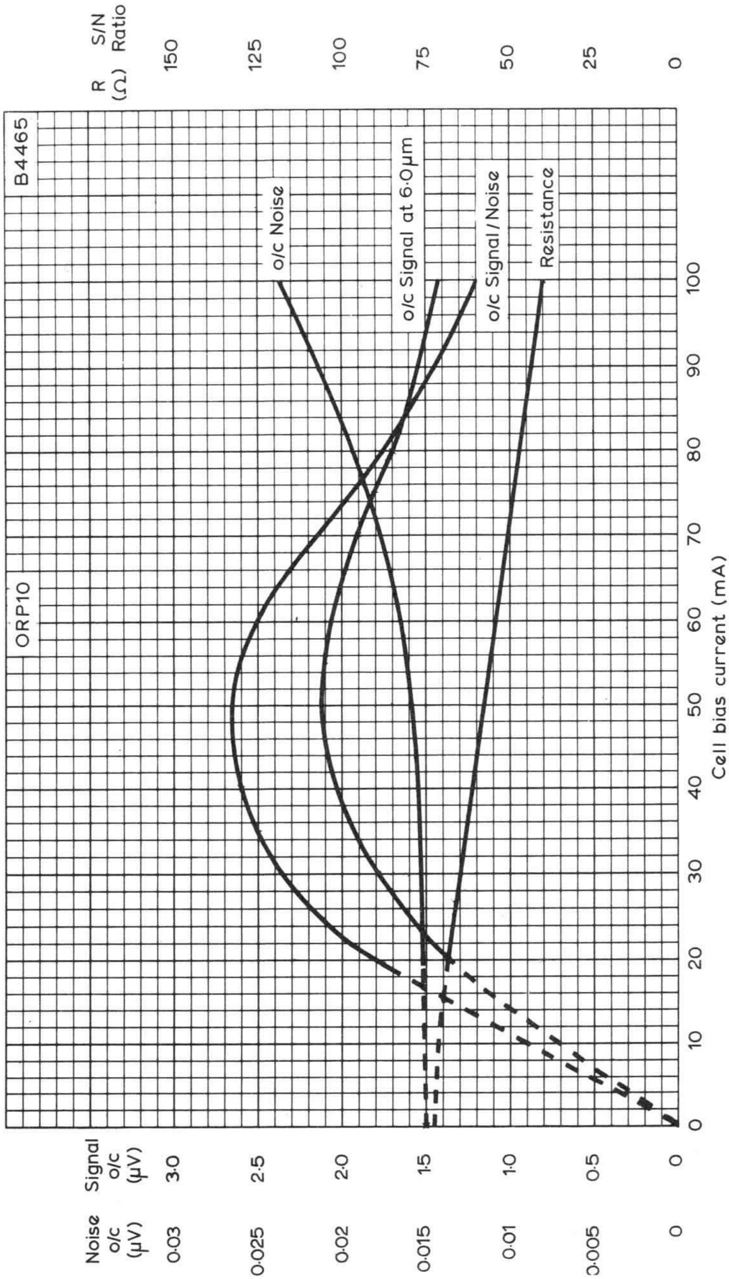
Transformer - Fortiphone type MM634. This component should be adequately screened to prevent stray pick-up.
The resistor R should be wire wound to minimise noise. It must be substantially larger than the cell resistance and its actual value will depend upon the supply voltage and the cell currents required.
The 560pF capacitor tunes the secondary to approximately 800c/s but since the 'Q' is low, the actual value is not highly critical.



All dimensions in mm

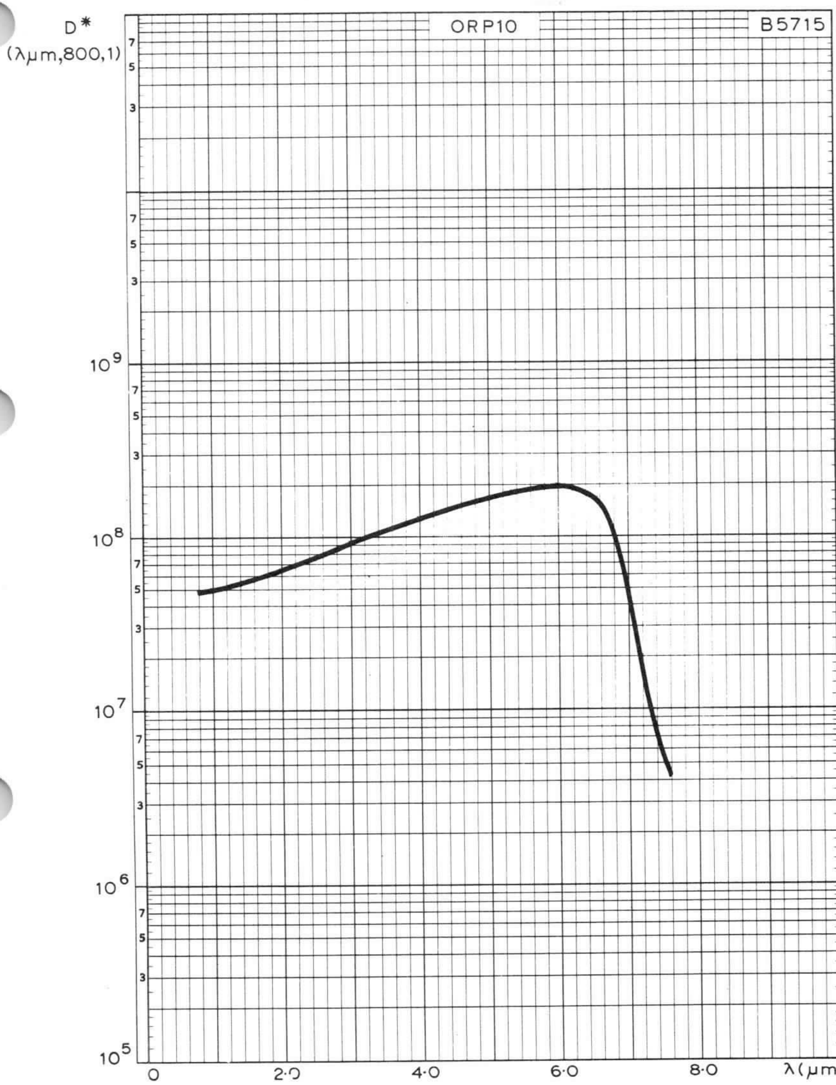


SPECTRAL RESPONSE CURVE

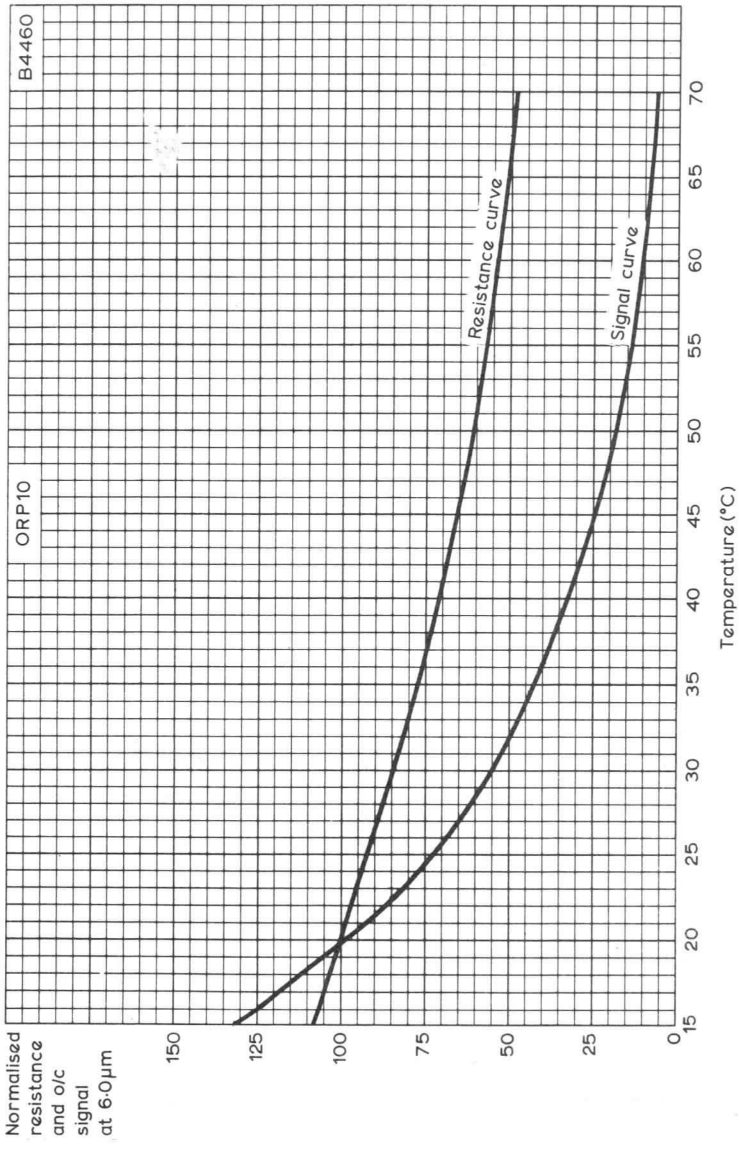


ORP10 PARAMETERS PLOTTED AGAINST BIAS CURRENT

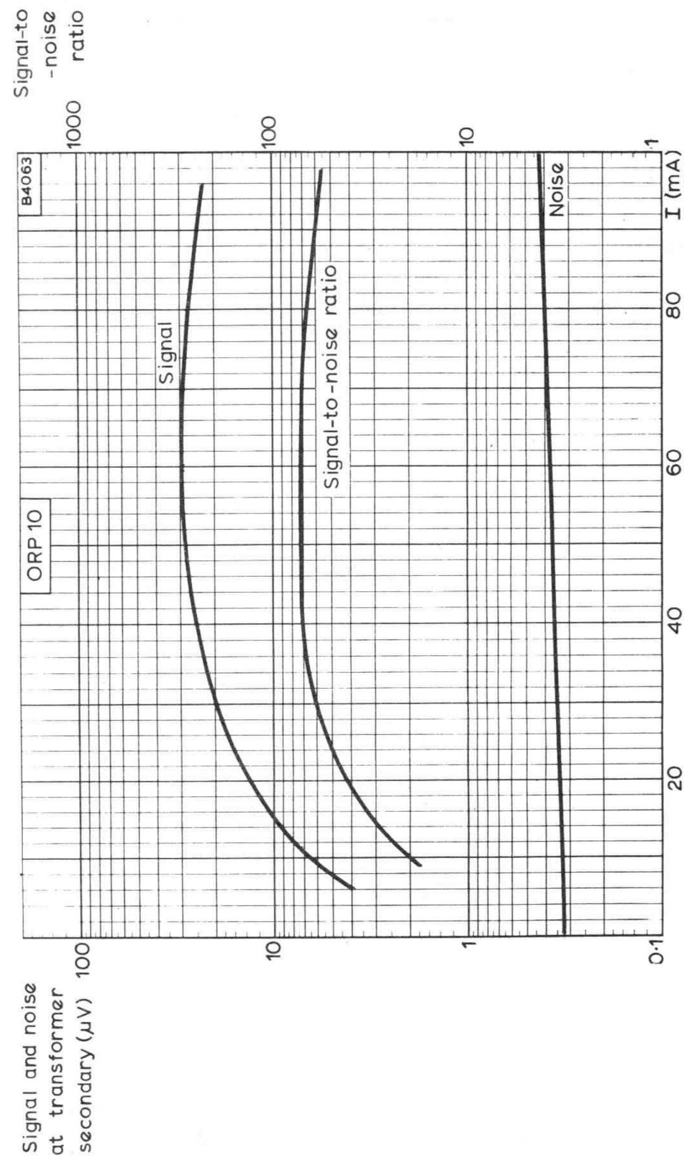
PHOTOCONDUCTIVE CELL ORP10



TYPICAL VARIATION OF D* WITH WAVELENGTH



NORMALISED RESISTANCE AND OPEN-CIRCUIT SIGNAL AT 6.0μm
PLOTTED AGAINST TEMPERATURE OF ORP10



SIGNAL-TO-NOISE RATIO, NOISE AND SIGNAL PLOTTED AGAINST BIAS CURRENT (See circuit on page D4)

PHOTOCONDUCTIVE CELL ORP11

QUICK REFERENCE DATA

Cadmium sulphide photoconductive cell for end-on incidence of illumination. Intended for flame failure, smoke detection and general industrial applications.

Maximum power dissipation (T_{amb} = 25°C)	400	mW
Absolute maximum cell voltage		
a.c. (r.m.s.)	210	V
d.c.	300	V
Cell resistance (at 50 lux)	1.7	kΩ
Sensitive area	1.25	cm^2

This data should be read in conjunction with 'OPERATING NOTES' given on page D2.

CHARACTERISTICS

(measured under d.c. conditions, at start of life, with T_{amb} = 25°C)

Cell resistance at 10V d.c., 50 lux and lamp colour temperature 2700°K		
*Initial		
Maximum	3.0	kΩ
Nominal	1.5	kΩ
Minimum	750	Ω
Equilibrium		
Nominal	1.7	kΩ
Minimum ultimate dark resistance at 300V d.c.	8.0	MΩ

(see pages C4 and C5)

*This is the first virtually constant value of resistance when illuminated shortly after 16 hours storage in complete darkness.

ABSOLUTE MAXIMUM RATINGS

V_{cell} max. (d.c. or a.c. pk)	300	V
P_{cell} max. with uniform illumination (see curve on page C3) at T_{amb} = 25°C	400	mW
T_{amb}		
Maximum (<1 lux illumination)	+50	°C
Maximum (≥1 lux illumination)	+70	°C
Minimum	-40	°C

OPERATING NOTES

1. This data is based on the device being uniformly illuminated.

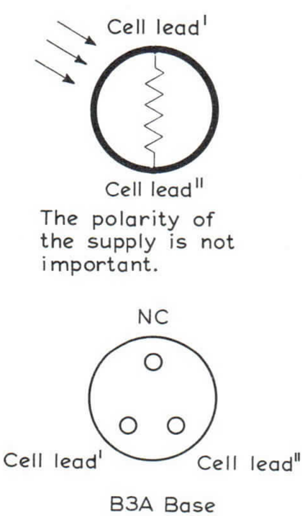
2. For sources of illumination other than a lamp of colour temperature 2700°K, the cell resistance should be multiplied by the following approximate factors.

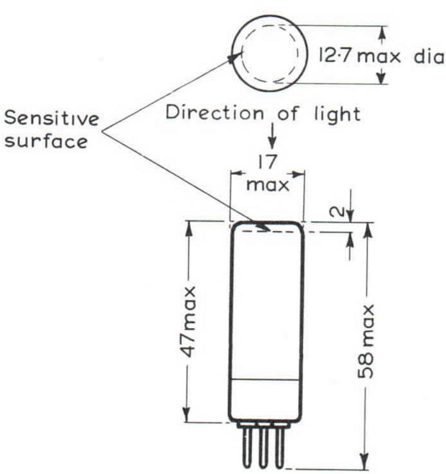
Source of illumination	Factor
Incandescent radiation at colour temperature of:	
1500°K	1/2
2000°K	2/3
Sunlight	4/3
White fluorescent	2

3. For a.c. conditions, the nominal and limit resistance values are approximately 1.1 times those for d.c.

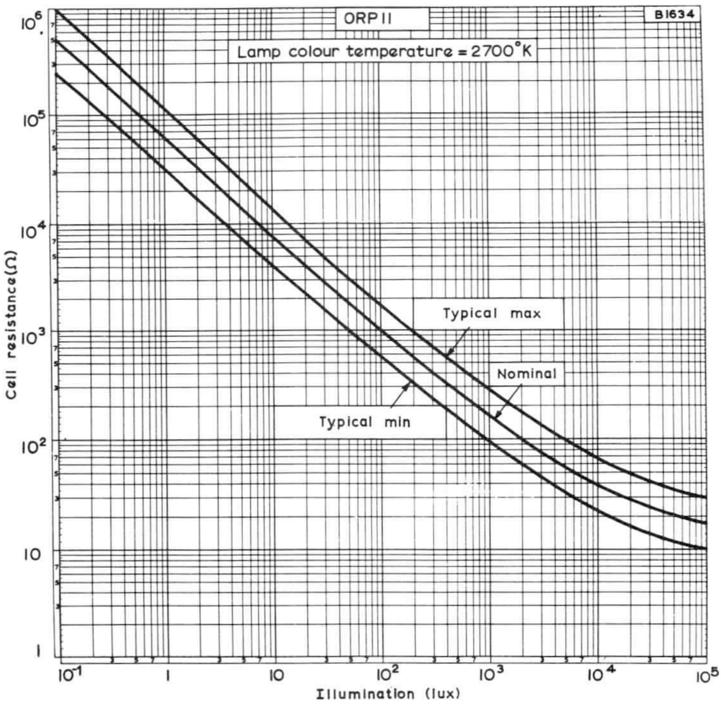
4. When the cell illumination is changed the cell resistance changes to a transient value and then, over a period of approximately 10 minutes assumes an equilibrium value. The transient usually overshoots the final equilibrium resistance.

5. The cell should not be subjected to high relative humidity at ambient temperatures above 50°C.

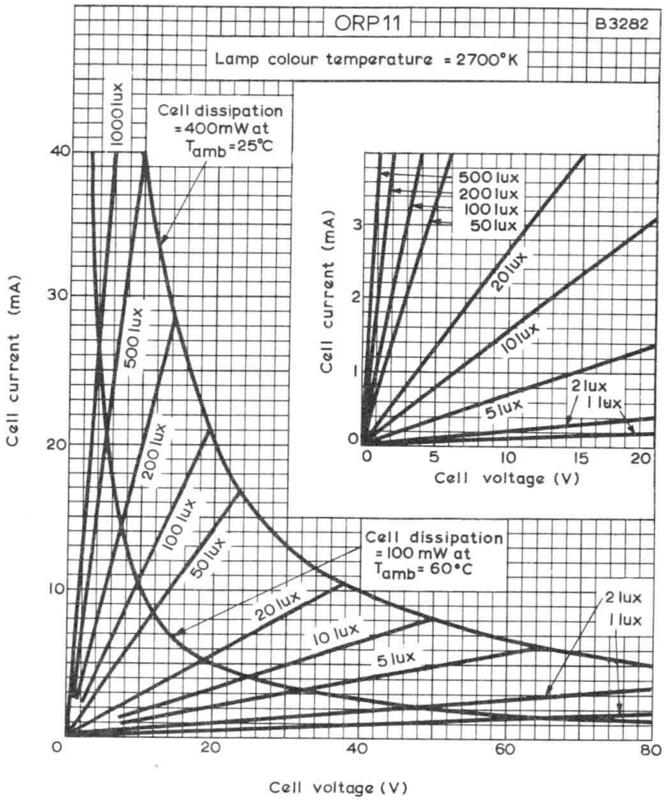




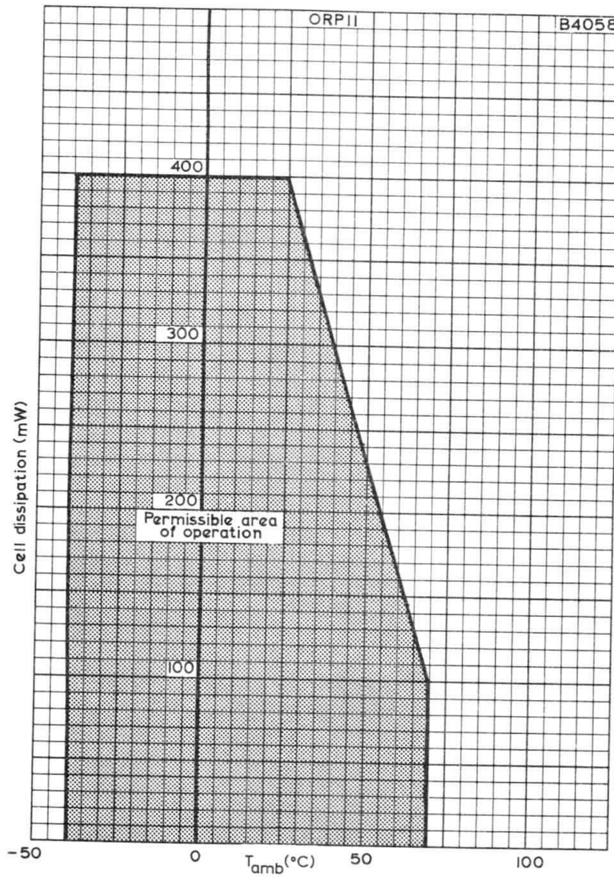
All dimensions in mm



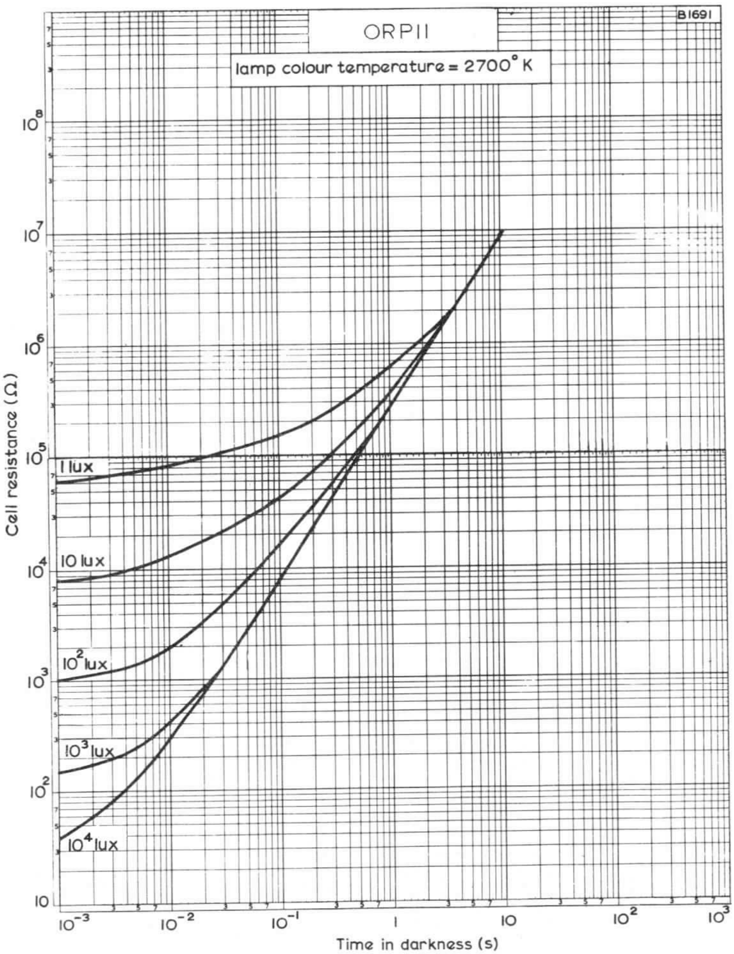
EQUILIBRIUM CELL RESISTANCE PLOTTED AGAINST ILLUMINATION WITH TYPICAL SPREAD



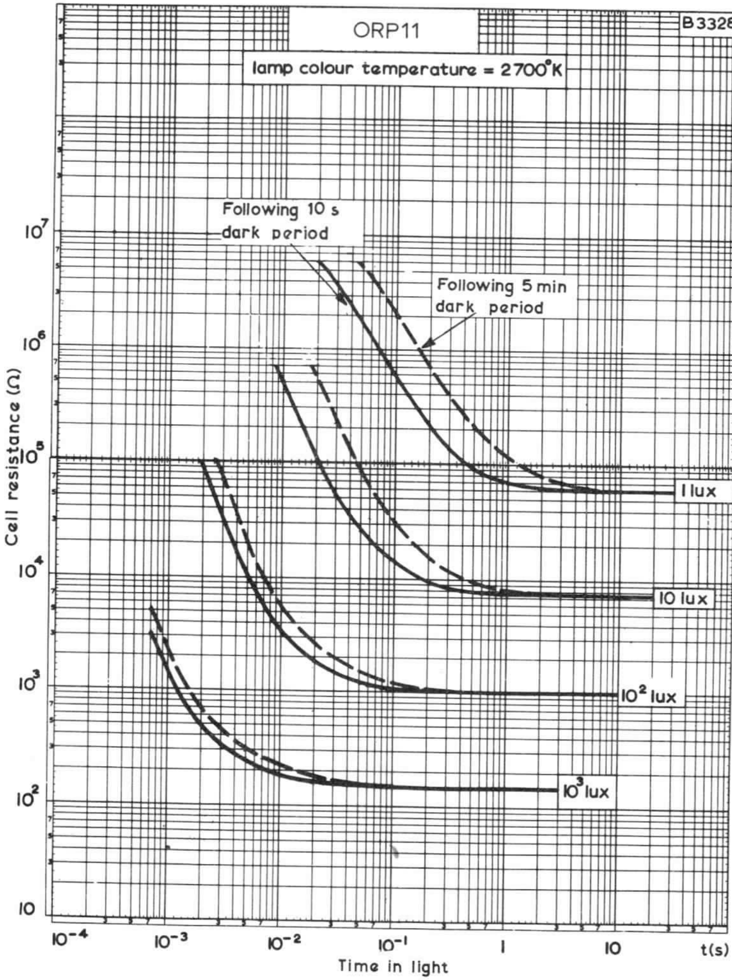
INITIAL CELL CURRENT PLOTTED AGAINST CELL VOLTAGE WITH ILLUMINATION AS PARAMETER



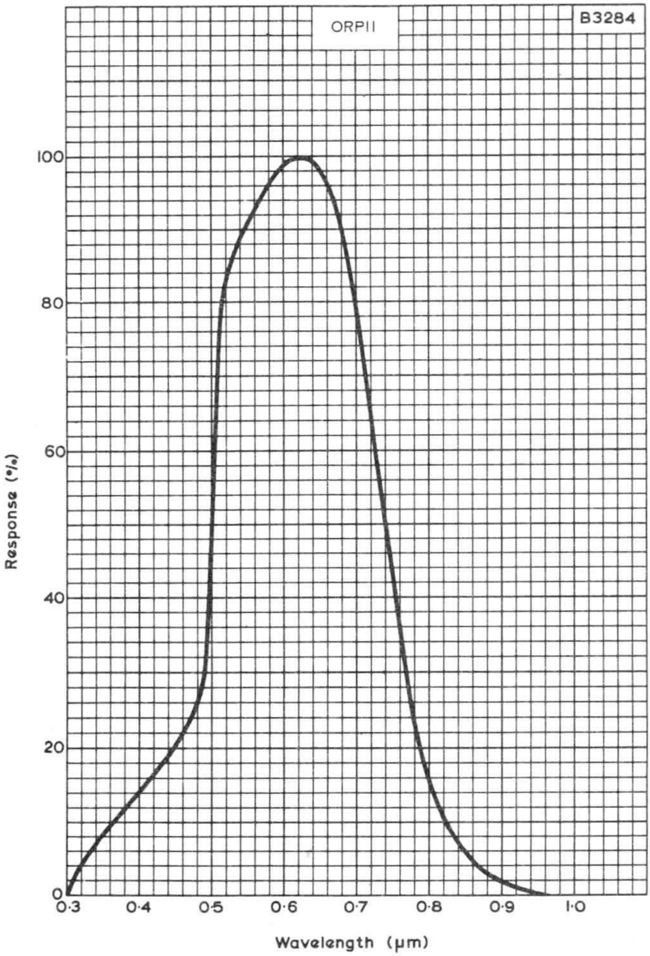
MAXIMUM CELL DISSIPATION PLOTTED AGAINST AMBIENT TEMPERATURE



NOMINAL RESISTANCE RISE-TIME CURVES WITH
ILLUMINATION AS PARAMETER



NOMINAL RESISTANCE FALL-TIME CURVES FROM DARKNESS WITH ILLUMINATION AS PARAMETER



SPECTRAL RESPONSE CURVE

QUICK REFERENCE DATA

Cadmium sulphide photoconductive cell for end-on incidence of illumination. Intended for general purpose applications and automatic contrast and brightness control of television receivers.

Maximum power dissipation (T_{amb} = 25°C)	200	mW
Absolute maximum cell voltage	110	V
Cell resistance (at 50 lux)	2.4	kΩ
Sensitive area	0.6	cm^2

This data should be read in conjunction with 'OPERATING NOTES' given on page D2.

CHARACTERISTICS

(measured under d.c. conditions, at start of life, with T_{amb} = 25°C)

Cell resistance at 1000 lux and lamp colour temperature 2700°K		
Typical	75 to 300	Ω
Minimum ultimate dark resistance at 110V d.c. (see pages C2 and C3)	10	MΩ
*Nominal resistance rise time	75	ms
**Nominal resistance fall time	350	ms

*When an illumination of 50 lux is removed, the resistance rise time is the time taken for the cell resistance to rise to 24kΩ.

**When an illumination of 50 lux is applied to a cell that was in the dark the resistance fall time is the time taken for the resistance to fall from its dark value to 5.3kΩ.

ABSOLUTE MAXIMUM RATINGS

V_{cell} max. (d.c. or a.c. pk)	110	V
p_{cell} max. with uniform illumination (see curve on page C4)		
at T_{amb} = 25°C	200	mW
T_{amb}		
Maximum	+60	°C
Minimum	-10	°C

OPERATING NOTES

1. This data is based on the device being uniformly illuminated.

2. For sources of illumination other than a lamp of colour temperature 2700°K, the cell resistance should be multiplied by the following approximate factors.

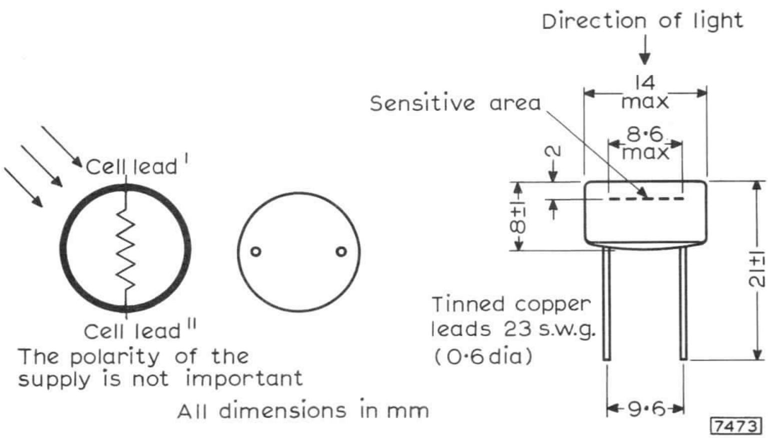
Source of illumination	Factor
Incandescent radiation at colour temperature of:	
1500°K	1/2
2000°K	2/3
Sunlight	4/3
White fluorescent	2

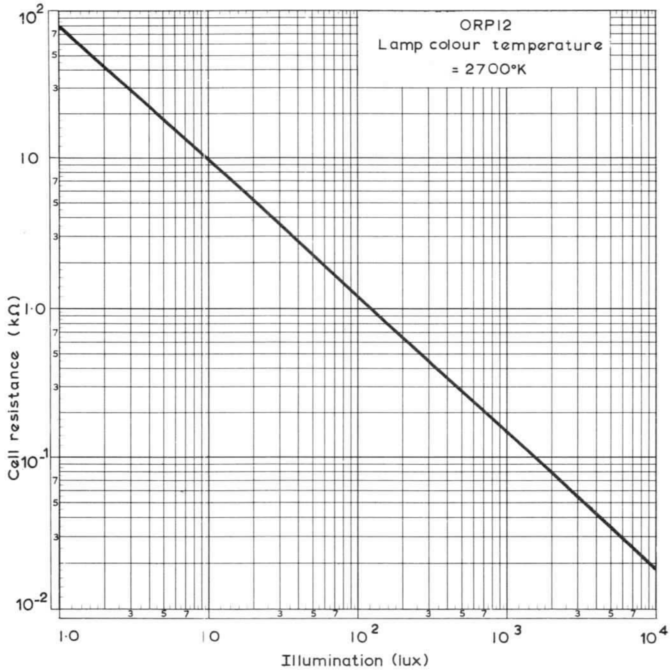
3. Care should be taken not to bend the leads nearer than 1.5mm to the seal.

4. When the cell illumination is changed the cell resistance changes to a transient value and then over a period of approximately 10 minutes assumes an equilibrium value. The transient usually overshoots the final equilibrium resistance.

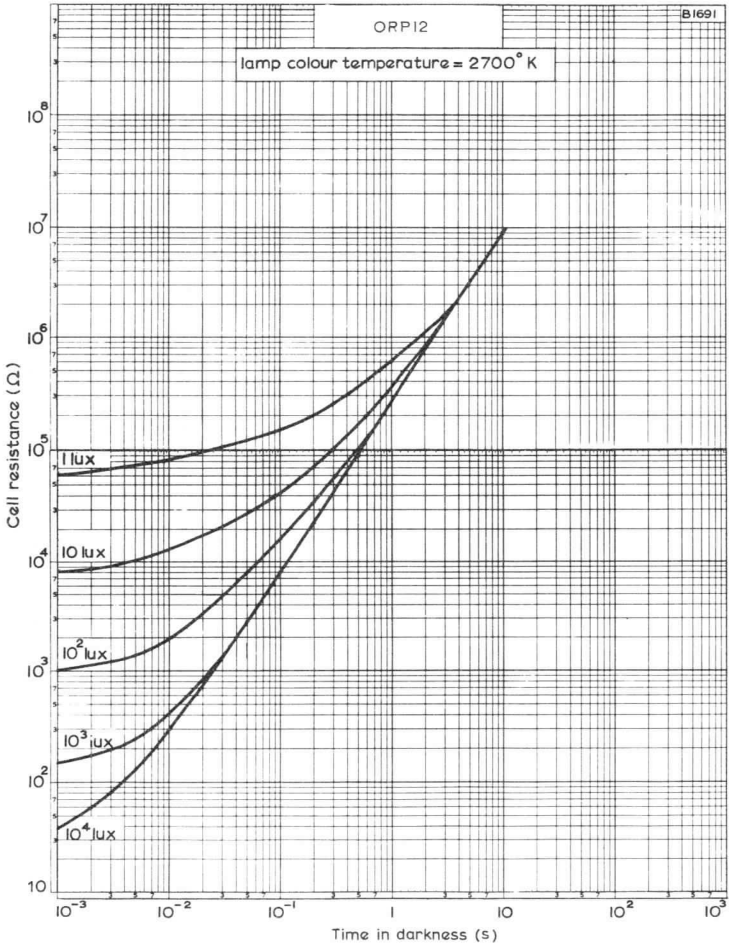
5. The cell should not be subjected to high relative humidity at ambient temperatures above 50°C.

6. The cell may be soldered directly into the circuit but heat conducted to the cell body should be kept to a minimum by the use of a thermal shunt.

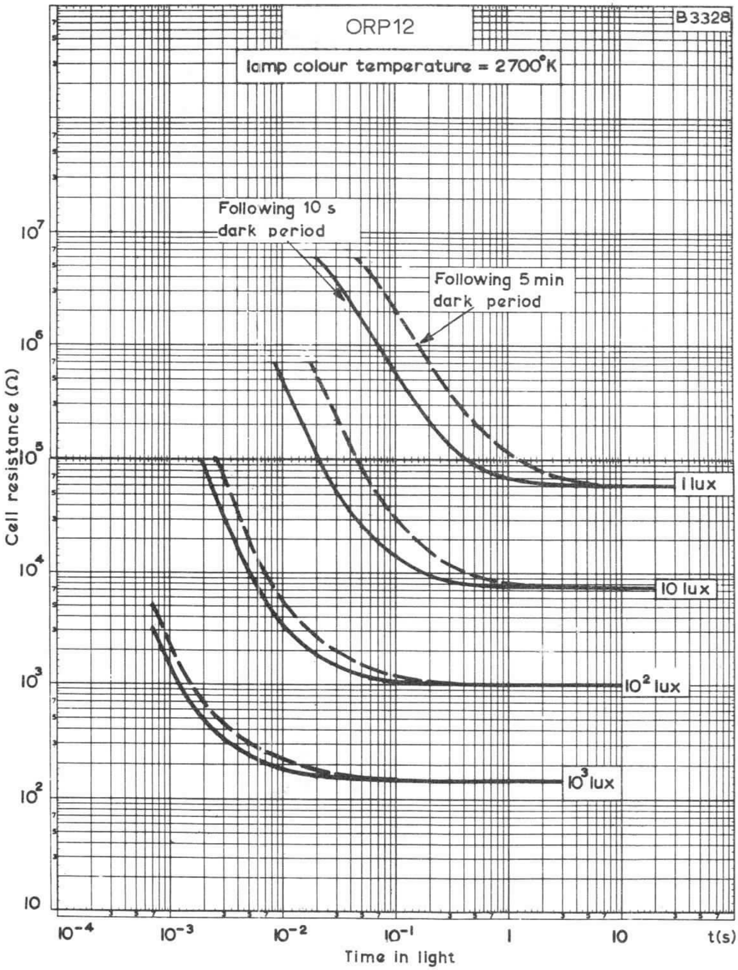




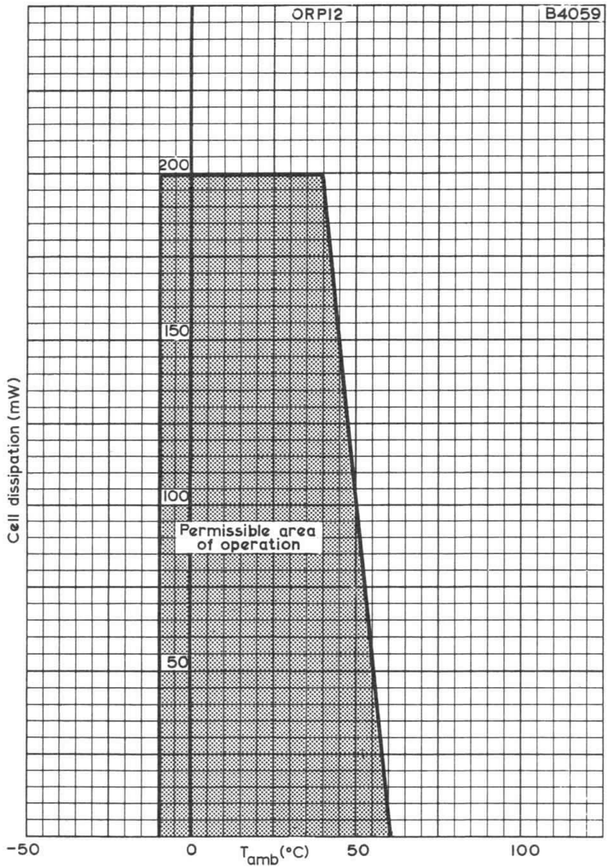
CELL RESISTANCE PLOTTED AGAINST ILLUMINATION



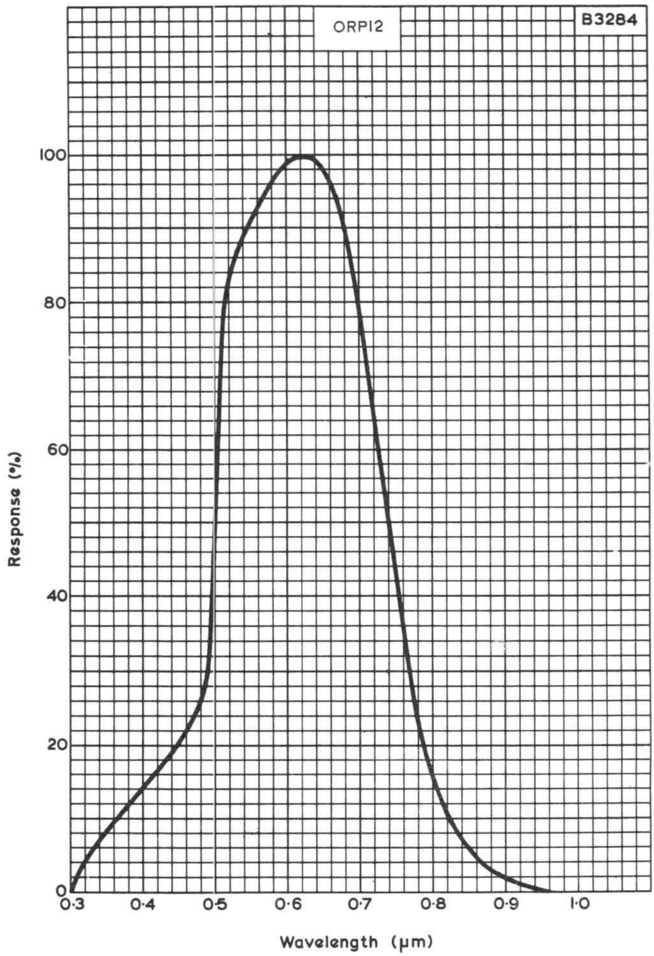
NOMINAL RESISTANCE RISE-TIME CURVES WITH ILLUMINATION AS PARAMETER



NOMINAL RESISTANCE FALL-TIME CURVES FROM DARKNESS WITH ILLUMINATION AS PARAMETER



MAXIMUM CELL DISSIPATION PLOTTED AGAINST AMBIENT TEMPERATURE



SPECTRAL RESPONSE CURVE

QUICK REFERENCE DATA

Indium antimonide photoconductive element mounted in a glass dewar vessel and cooled by liquid nitrogen. Sensitive to infra-red radiation extending to 5.6μm and intended for use with modulated or pulsed radiation.

Peak spectral response	5.3	μm
Operating temperature	77	^oK
Typical D* (5.3μm, 800, 1)	4.5×10^{10}	$cm(cps)^{\frac{1}{2}}/W$
Element dimensions	6.0 x 0.5	mm
Time constant	approx. 5	μs

CHARACTERISTICS (cooled to 77^oK)

SPECTRAL RESPONSE

Peak spectral response	5.3	μm
Spectral response range	visible to 5.6	μm

A typical response curve is shown on page C1.

Cell resistance max.	60	kΩ
min.	20	kΩ
Time constant (see note 5)	approx. 5	μs
Dimensions of sensitive element (see note 8)	6.0 x 0.5	mm
Dwell time of liquid nitrogen	>40	min.

MONOCHROMATIC PERFORMANCE (see notes 1 and 2)

Responsivity (to 5.3μm radiation)	min.	12	mV/μW
	typ.	24	mV/μW
D* (5.3μm, 800, 1)	min.	2.6×10^{10}	$cm(cps)^{\frac{1}{2}}/W$
	typ.	4.5×10^{10}	$cm(cps)^{\frac{1}{2}}/W$
N.E.P (5.3μm, 800, 1)	typ.	3.8×10^{-12}	(r.m.s.) W
	max.	6.6×10^{-12}	(r.m.s.) W

BLACK BODY PERFORMANCE (see notes 1 and 2)

Responsitivity (to 500°K radiation)	typ.	4.5	mV/μW
D* (500°K, 800, 1)	typ.	8.0×10^{9}	$cm(cps)^{\frac{1}{2}}/W$
N.E.P. (500°K, 800, 1)	typ.	2.2×10^{-11}	W

RATINGS (ABSOLUTE MAXIMUM SYSTEM)

Maximum bias current (at 77°K)		5.0	mA
Storage temperature	max.	+55	°C
	min.	-55	°C

NOTES

1. Test conditions.

The detector is cooled to 77°K by filling the dewar vessel with liquid nitrogen and a bias current of 250μA is applied. A parallel beam of monochromatic radiation of wavelength 4.4μm, which would produce a steady irradiance of $7.6\mu W/cm^2$ at the sensitive element, is square wave modulated at 800c/s. The actual r.m.s. power at the element is therefore reduced to $\frac{7.6}{2.2} = 3.45\mu W/cm^2$

Measurements of the detector output are made with an amplifier tuned to 800c/s and with a bandwidth of 50c/s, and are referred to open circuit conditions i.e. correction is made for the shunting effects of the bias supply impedance and the amplifier input impedance. Under these test conditions, the ORP13 will exhibit a minimum signal to noise ratio of 1650 and typical of 3270.

The detectivities quoted at the wavelength of peak response and under black body conditions are calculated from these measurements, assuming the detector to have a typical response curve.

2. N.E.P. and D*

These are figures of merit for the materials of detectors and are fully discussed in most textbooks on infra-red e.g. 'Infra-Red Physics' by J.T. Houghton and S.D. Smith (O.U.P. 1966) and 'Elements of Infra-Red Technology' by Kruse, McGlauchlin and McQuistan (John Wiley, New York 1962). D* is defined in the expression:

$$D^* = \frac{\frac{V_s}{V_n} \times [A(\Delta f)]^{\frac{1}{2}}}{W}$$

where V_s = Signal voltage across detector terminals

V_n = Noise voltage across detector terminals

A = Detector area

(Δf) = Bandwidth of measuring amplifier

W = Radiation power incident on detector sensitive element in r.m.s. watts.

The figures in brackets which follow D* refer to the test conditions e.g. D* (5.3μm, 800, 1) denotes monochromatic radiation incident on the detector of wavelength 5.3μm, modulation frequency 800c/s, an electronic bandwidth of 1 c/s.
The Noise Equivalent Power (N.E.P.) is related to D* by the expression:

$$N.E.P. = \frac{(A)^{\frac{1}{2}}}{D^*}$$

3. Variation of performance with bias current.

Both signal and noise vary with bias current in this type of cell. Typical curves are shown on page C2 . At high currents the noise increases more rapidly than the signal, and therefore the signal to noise ratio has a peak value at some optimum current, which will vary slightly from cell to cell. A typical value is 250μA.

4. Effect of ambient radiation.

Care should be taken to avoid the incidence on the cell of appreciable radiation in the visible range. Such radiation will cause a decrease in the cell resistance and signal as long as the cell is kept cool. Normal daylight can cause this effect if seen for more than a few minutes. Precautions should be taken to prevent visible light reaching the sensitive element via the liquid nitrogen compartment.

5. Time constant.

The time constant of the ORP13 may be as high as 10μs. For applications where speed of response is critical, a specially constructed ORP13 with a time constant of less than 1μs is available. This has the type number RPY36.

6. Warning.

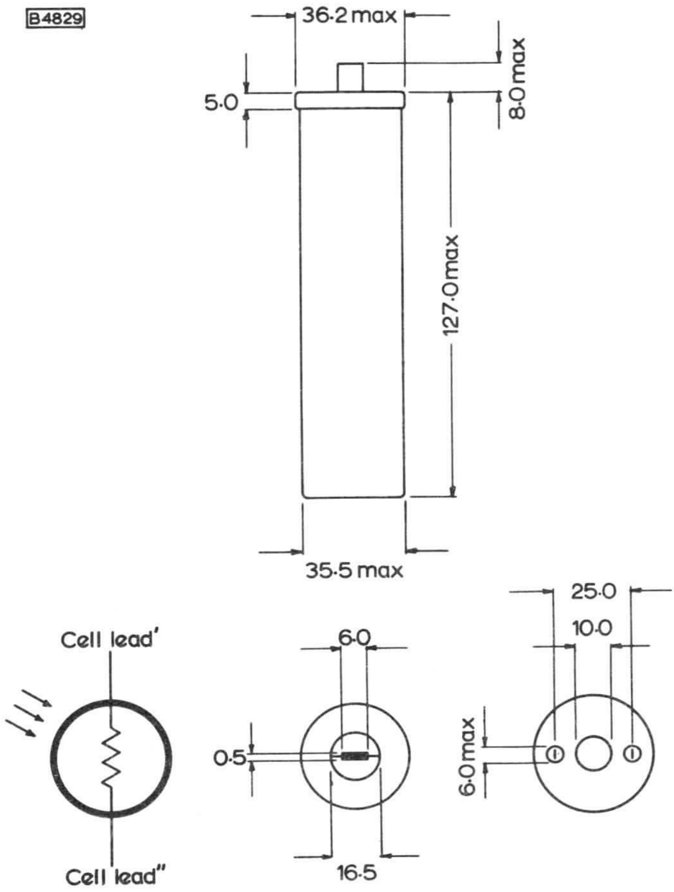
Care should be taken to ensure that the device is not allowed to reach room temperature while still biased.

7. Warning

The dewar vessel must always be completely dry before being refilled with liquid nitrogen. In very humid conditions, water vapour may condense at the top of the dewar vessel. Should this occur, the remaining liquid nitrogen should be allowed to boil off, the ice should be removed and precautions taken to avoid a recurrence.

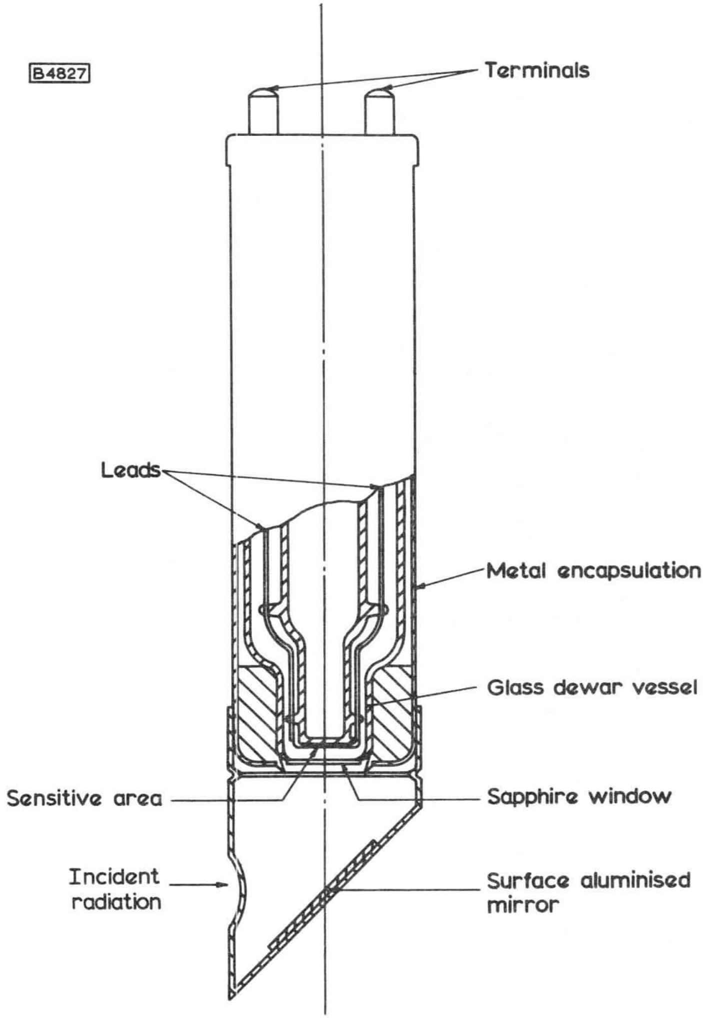
8. Element dimensions.

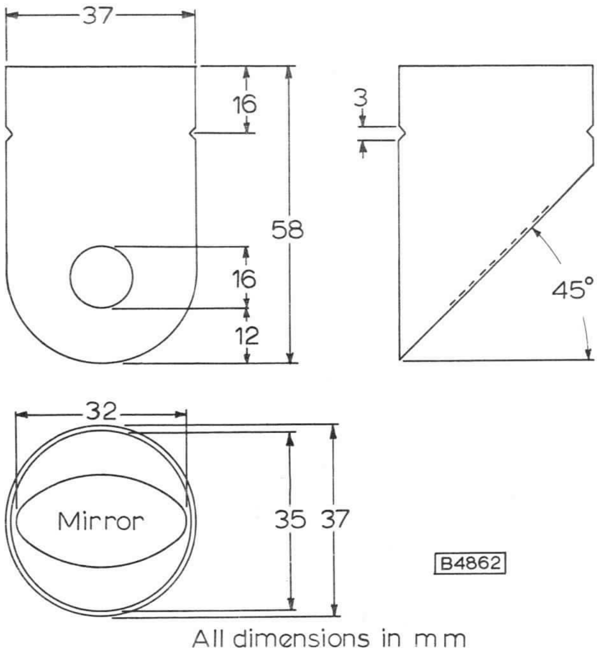
Elements of dimensions other than those stated are available to special order in the same dewar vessel. Multi-element detectors can also be specially constructed.



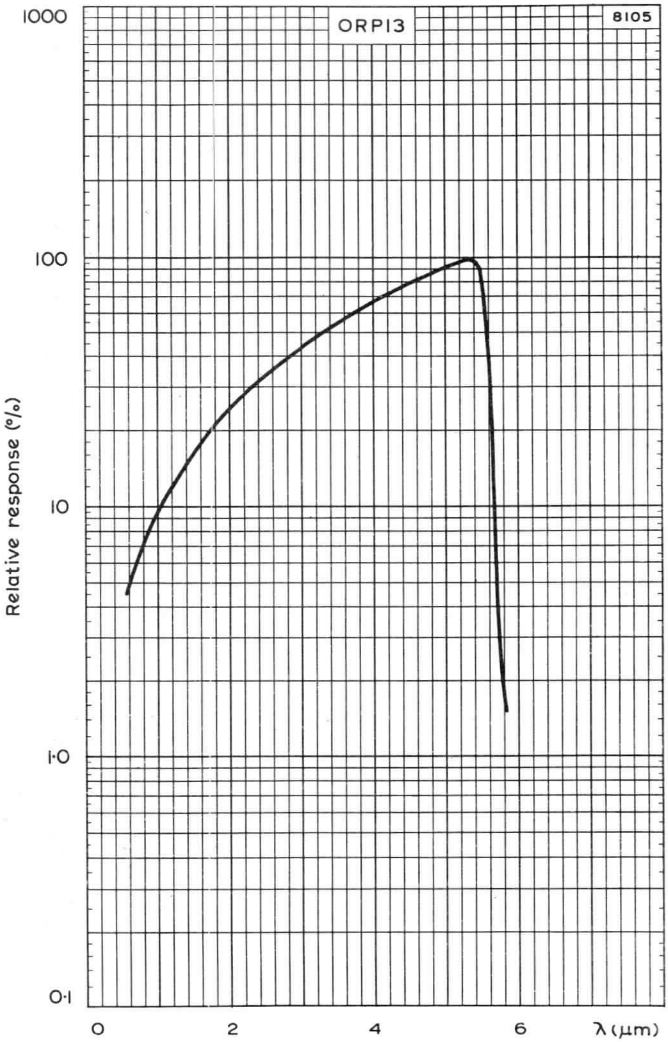
The polarity of the supply is not important

All dimensions in mm.

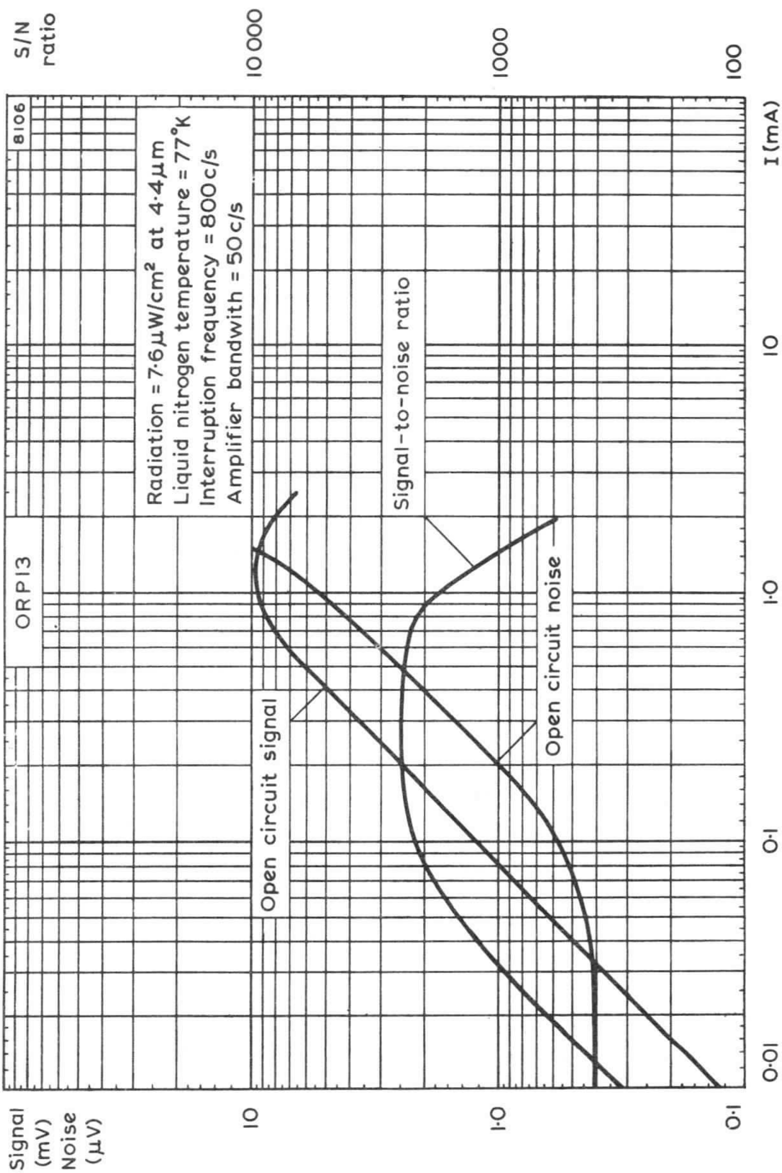

B4827
Terminals
Leads
Metal encapsulation
Glass dewar vessel
Sensitive area
Sapphire window
Incident radiation
Surface aluminised mirror



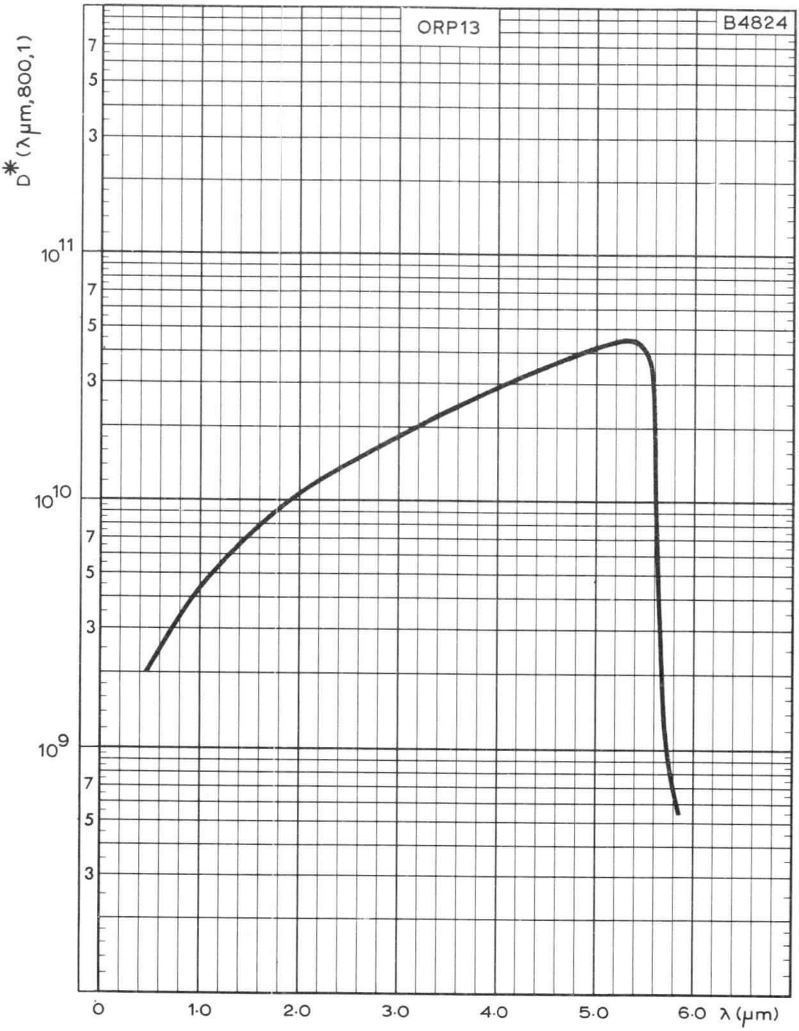
MIRROR ATTACHMENT



SPECTRAL RESPONSE CURVE



SIGNAL-TO-NOISE RATIO, NOISE AND SIGNAL PLOTTED AGAINST BIAS CURRENT



TYPICAL VARIATION OF D* WITH WAVELENGTH

PHOTOCONDUCTIVE CELL ORP50

QUICK REFERENCE DATA

A miniature flying lead cadmium sulphide photoconductive cell with top and side sensitivity.

Maximum power dissipation ($T_{amb} = 25°C$)	400	mW
Absolute maximum cell voltage		
a.c. (r.m.s.)	210	V
d.c.	300	V
Cell resistance (at 50 lux)	2.5	kΩ
Sensitive area	1.1	cm^2

This data should be read in conjunction with the 'OPERATING NOTES' given on page D3.

CHARACTERISTICS (measured under d.c. conditions, at start of life, with $T_{amb} = 25°C$)

Cell resistance at 20Vd.c., 50 lux (4.6 lm/ft^2) and lamp colour temperature 2700°K		
*Initial		
Maximum	6.2	kΩ
Nominal	2.7	kΩ
Minimum	1.3	kΩ
Equilibrium		
Nominal	3.4	kΩ
Minimum ultimate dark resistance at 300V max.	8.0	MΩ ←
**Nominal resistance rise time	75	ms
***Nominal resistance fall time	350	ms

*This is the first virtually constant value of resistance when illuminated shortly after 16 hours storage in complete darkness.

**When an illumination of 50 lux is removed, the resistance rise time is the time taken for the cell resistance to rise to 25kΩ.

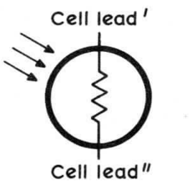
***When an illumination of 50 lux is applied to a cell that was in the dark, the resistance fall time is the time taken for the resistance to fall from its dark value to 7kΩ.

ORP50

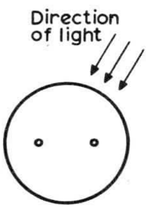
PHOTOCONDUCTIVE CELL

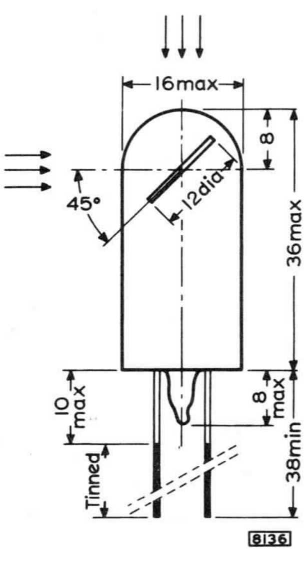
ABSOLUTE MAXIMUM RATINGS

V_{cell} max. (d.c. or a.c.$_{pk}$)	300	V ←
p_{cell} max.		
$T_{amb} = 25°C$	400	mW
$T_{amb} = 70°C$	100	mW
T_{amb}		
Maximum (<1 lux illumination)	+50	°C
Maximum (⩾1 lux illumination)	+70	°C
Minimum	−40	°C



The polarity of the supply is not important





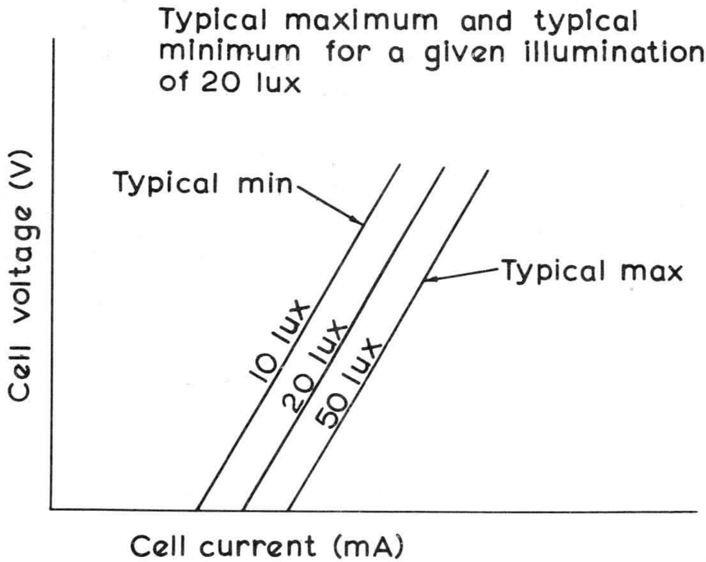
All dimensions in mm

OPERATING NOTES

1. The data is based on the device being uniformly illuminated.
2. For other sources of illumination, the cell resistance should be multiplied by the following approximate factors:

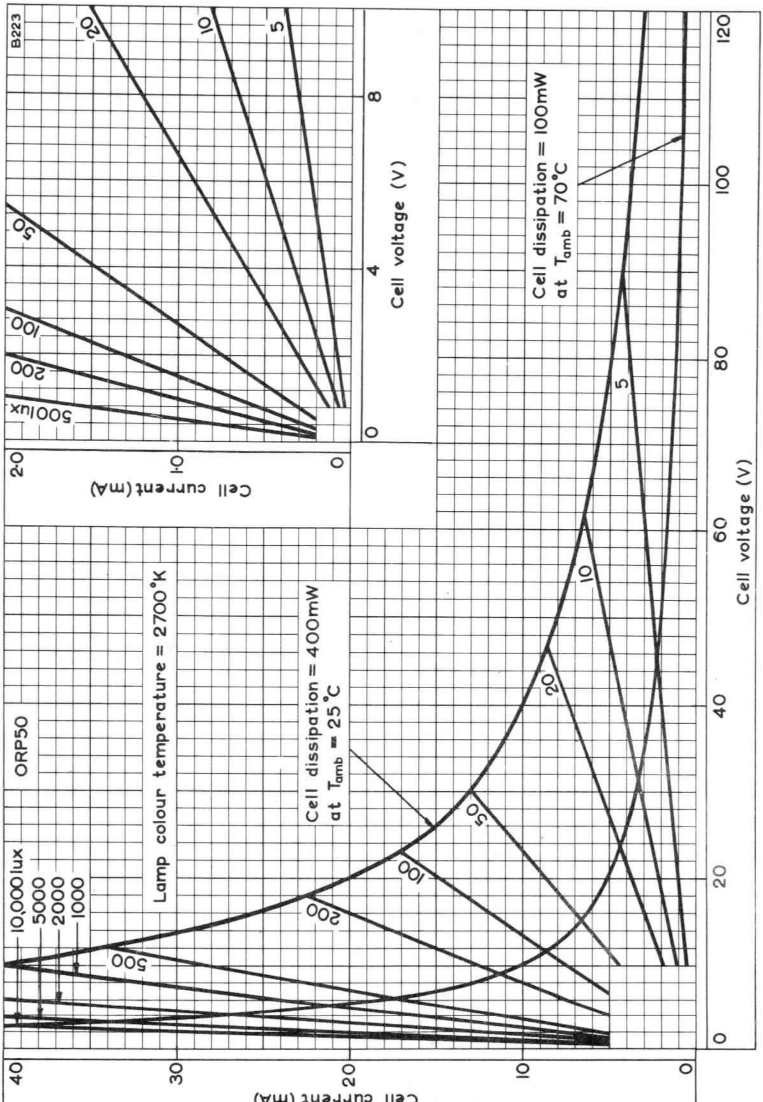
Source of illumination	Factor
Incandescent radiation at colour temperature of:	
1500°K	1/2
2000°K	2/3
Sunlight	4/3
White fluorescent	2

3. Within the range 10 to 5,000 lux on the current/voltage curves, the typical maximum and minimum limits of distribution for a given illumination are approximately represented by the lines of constant illumination immediately adjacent to the given line.



B214

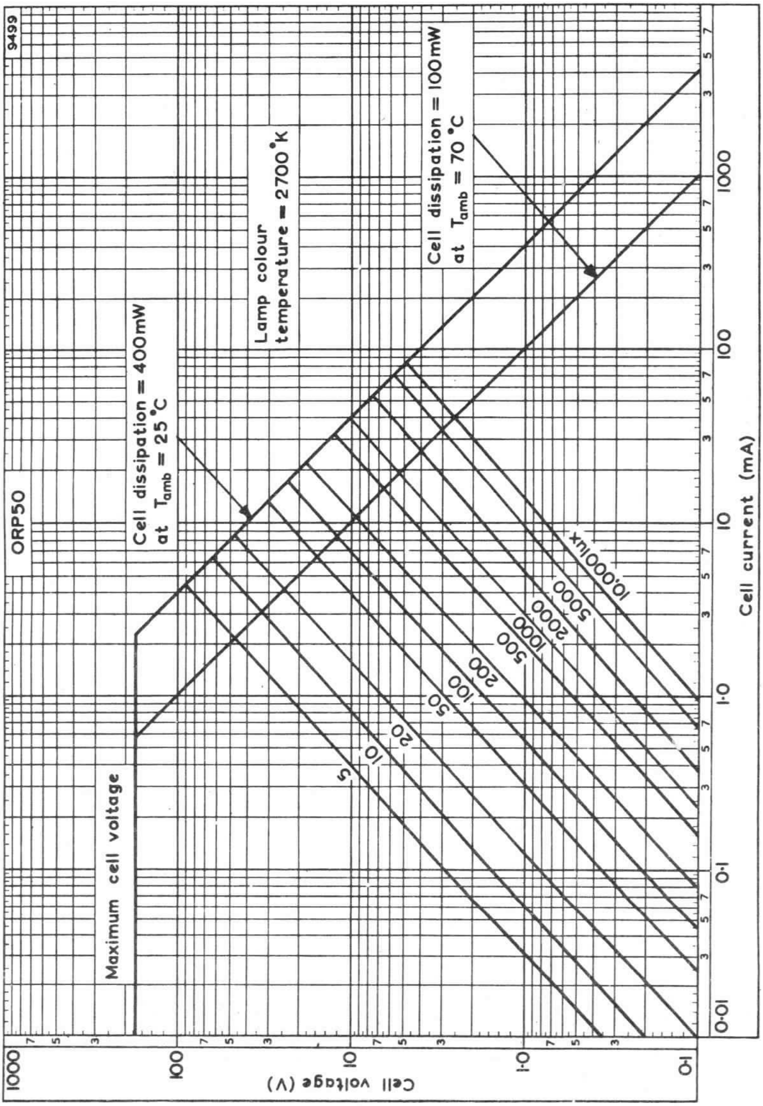
4. When a cell is subjected to a change of operating conditions, there may be a transient change of resistance which is in excess of the resistance change due to the difference between the equilibrium illumination resistances. After dark storage the sensitivity normally settles to a stable value corresponding to the illumination within one hour. The transient will be greater if the dark storage is at a high ambient temperature.



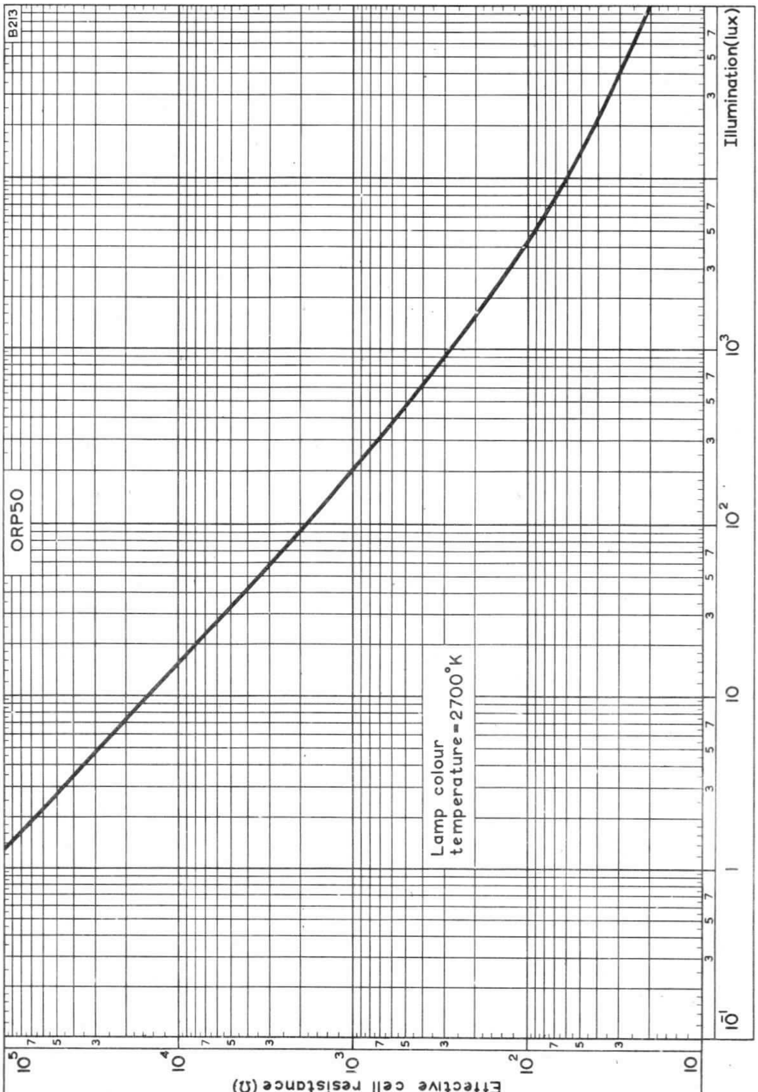
INITIAL CELL CURRENT PLOTTED AGAINST CELL VOLTAGE WITH LUMINOUS INTENSITY AS PARAMETER

ORP50

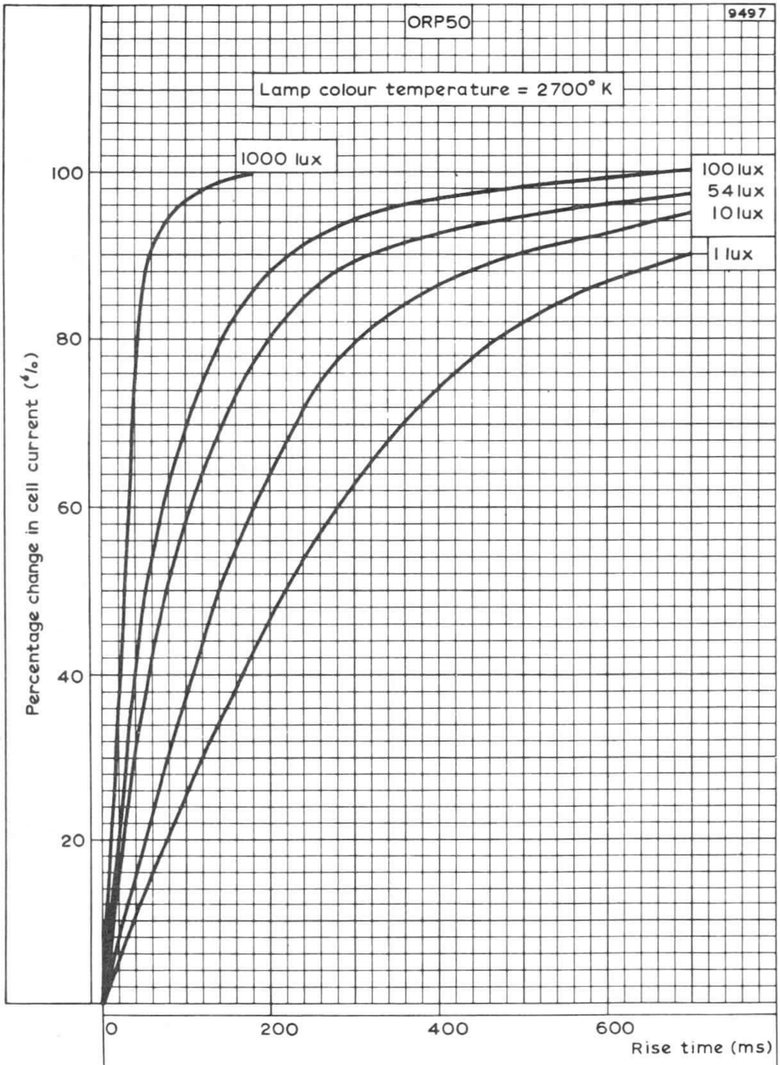
PHOTOCONDUCTIVE CELL



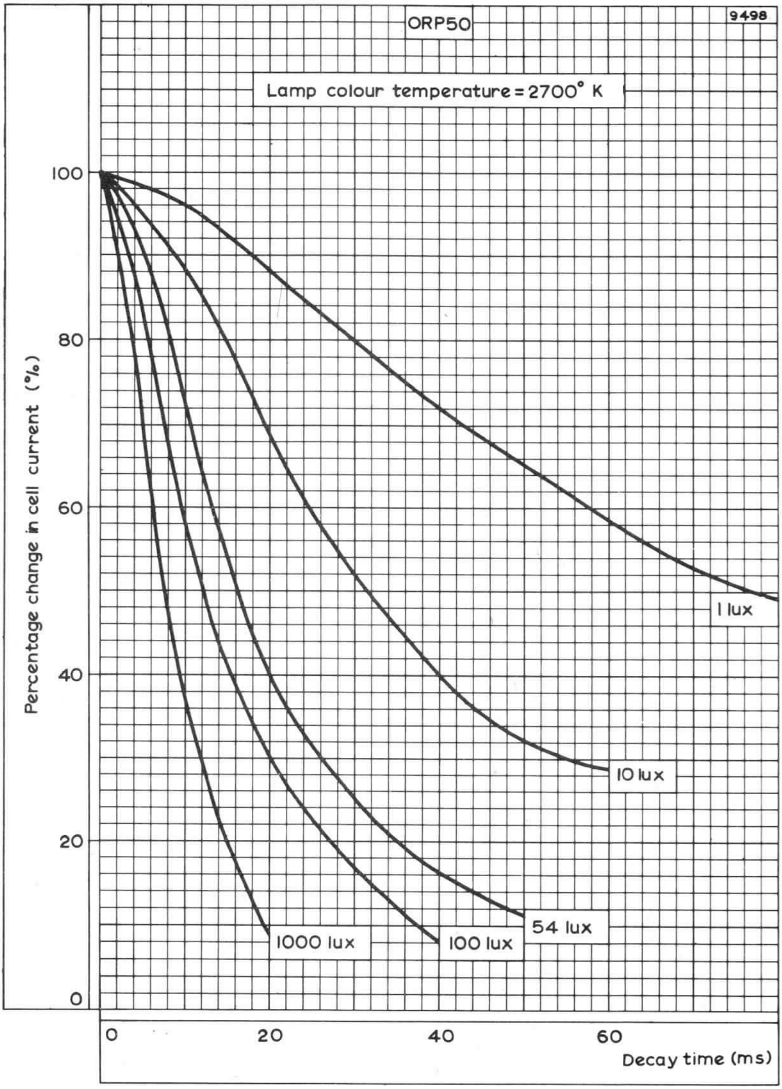
CELL VOLTAGE PLOTTED AGAINST INITIAL CELL CURRENT WITH LUMINOUS INTENSITY AS PARAMETER



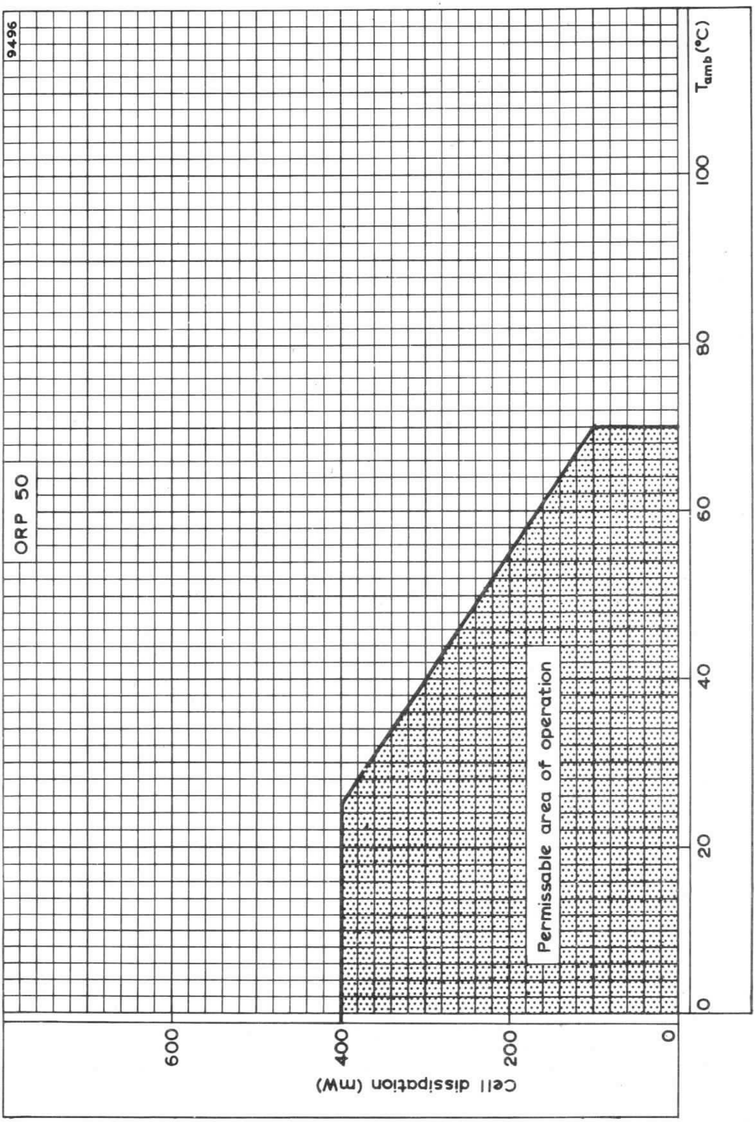
EFFECTIVE INITIAL CELL RESISTANCE PLOTTED AGAINST ILLUMINATION



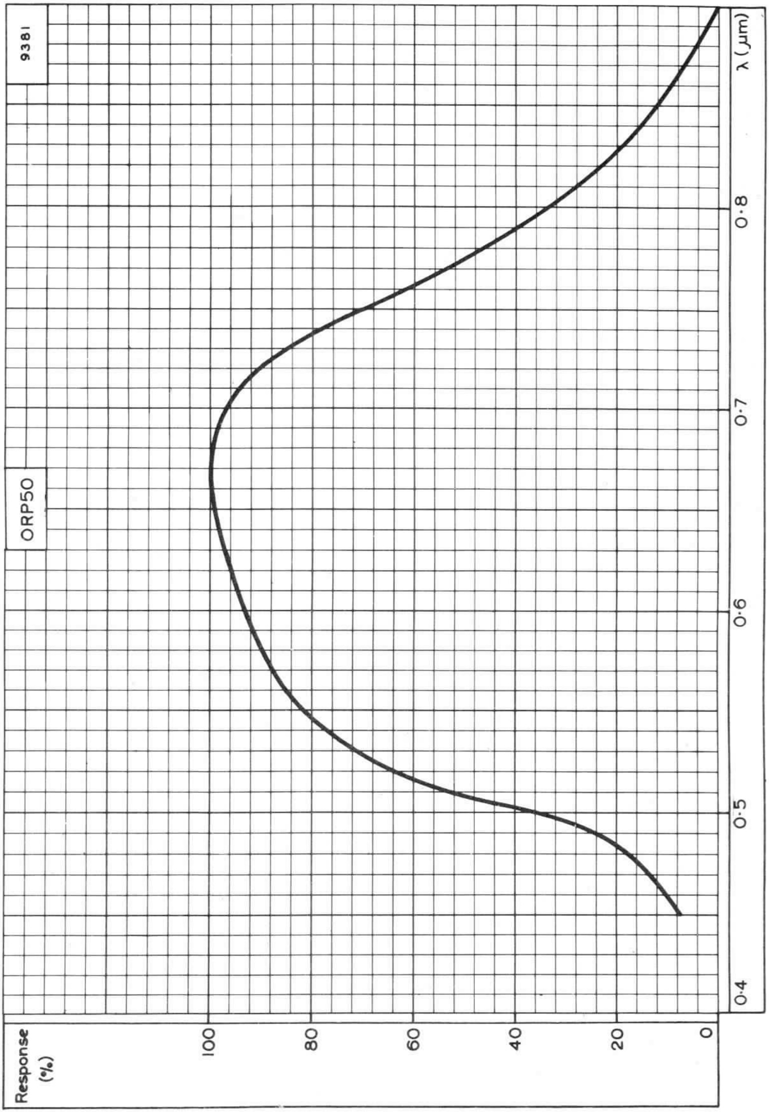
PERCENTAGE CHANGE IN CELL CURRENT PLOTTED AGAINST RISE TIME WITH ILLUMINATION AS PARAMETER



PERCENTAGE CHANGE IN CELL CURRENT PLOTTED AGAINST DECAY TIME WITH ILLUMINATION AS PARAMETER



MAXIMUM CELL DISSIPATION PLOTTED AGAINST AMBIENT TEMPERATURE



SPECTRAL RESPONSE CURVE

PHOTOCONDUCTIVE CELL ORP52

QUICK REFERENCE DATA

Cadmium sulphide photoconductive cell for end-on or side incidence, intended for use in industrial on-off applications such as flame failure equipment. The cell is tropic proof, shock and vibration resistant.

Maximum power dissipation (T_{amb} = 25 °C)	400	mW
Maximum cell voltage (d.c. and repetitive peak)	200	V
Cell resistance (at 50 lux, 2700 °K colour temperature)	1.2	kΩ
Maximum overall dimensions	44 × 15.9 dia	mm

This data should be read in conjunction with GENERAL EXPLANATORY NOTES-CADMIUM SULPHIDE PHOTOCONDUCTIVE CELLS

GENERAL

The electrical properties of cadmium sulphide cells are dependent on many factors, such as illumination, colour temperature of the source, cell voltage and current, temperature, time of operation in the circuit, and operation during the 24 hours prior to measurement. The following characteristics are therefore only checkpoints of the electrical properties, measured under specified conditions and at start of life.

CHARACTERISTICS (measured under d.c. conditions, at start of life, with T_{amb} = 25 °C illumination colour temperature = 2700 °K)

	Min.	Typ.	Max.	
Dark resistance (200V applied in series with 1MΩ) (see note 1)				
after 20s in darkness	4.0	-	-	MΩ
after 30min in darkness	100	-	-	MΩ
Illuminated resistance (50 lux illumination, 10V applied voltage)				
initially after 16h in darkness (see note 2)	0.75	1.2	3.0	kΩ
after 15min under the measuring conditions	0.75	1.5	4.1	kΩ
Current rise time (time to reach 90% of the max. value, measured from the instant of switching on 50 lux illumination after 16h in darkness, 10V applied voltage)	-	-	1.5	s
Current decay time (time to reach 10% of the max. value, measured from the instant of switching off the illumination, after 16h in darkness and 10s at 50 lux, 10V applied voltage)	-	-	0.15	s

CHARACTERISTICS (Continued)

	Typ.	Max.	
Sensitivity (50 lux illumination, 10V applied voltage)	0.17	-	mA/lux
Temperature coefficient of illuminated resistance	-0.2	-0.5	%/degC
$\frac{\text{Resistance with 0.5V applied voltage}}{\text{Resistance with 10V applied voltage}}$	1.05	-	

THERMAL CHARACTERISTIC

Thermal resistance from cadmium sulphide tablet to ambient device free in air	150	degC/W

RATINGS (ABSOLUTE MAXIMUM SYSTEM)

V_{cell} max. (d.c. and repetitive peak)	200	V
$V_{cell(pulse)}$ max. (maximum period 5ms, maximum repetition frequency 1pulse/min)	500	V
p_{cell} max.	See page 4	
$p_{cell(pulse)}$ max.	$5 \times p_{cell}$ max.	
I_{cell} max. (d.c. and repetitive peak)	100	mA
Maximum illumination	50 000	lux
T_{tablet} max.	+85	^{o}C
T_{amb} max. (storage) (see note 3)	+50	^{o}C
T_{amb} max. (operating) (see note 3)	+70	^{o}C
T_{amb} min. (storage and operating)	-40	^{o}C

DESIGN CONSIDERATIONS

Apparatus using cadmium sulphide cells should designed so that changes in resistance of the cells during life from -30% to +70% do not impair the circuit performance. Direct sunlight should be avoided.

SHOCK AND VIBRATION

Samples taken from normal production are submitted to shock and vibration tests as below. More than 95% of the devices pass these tests without perceptible damage.

Shock

25 g (peak), 10 000 shocks in one of the three positions of the cell.

Vibration

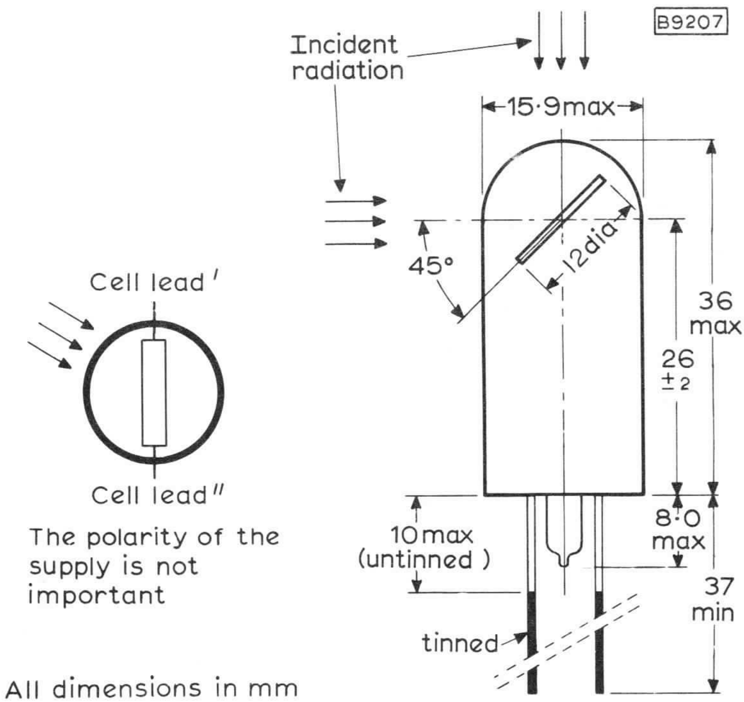
2.5 g (peak), 50Hz, 32 hours in each of the three positions of the cell.

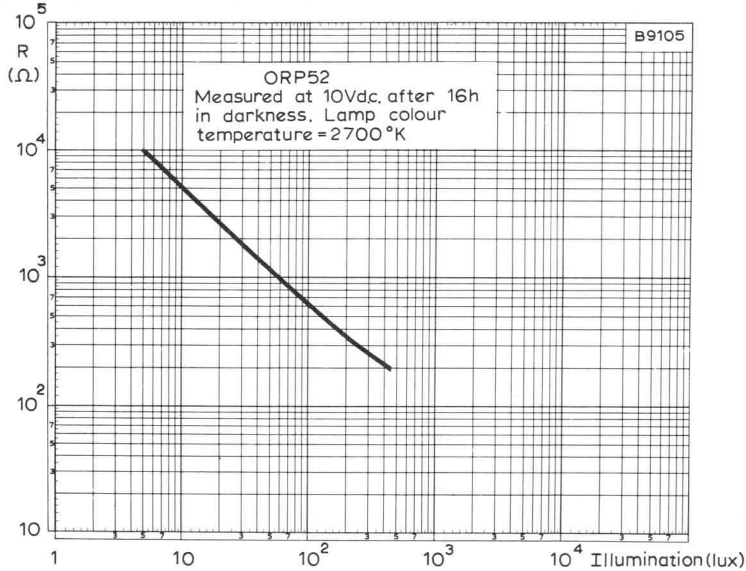
PHOTOCONDUCTIVE CELL ORP52

NOTES

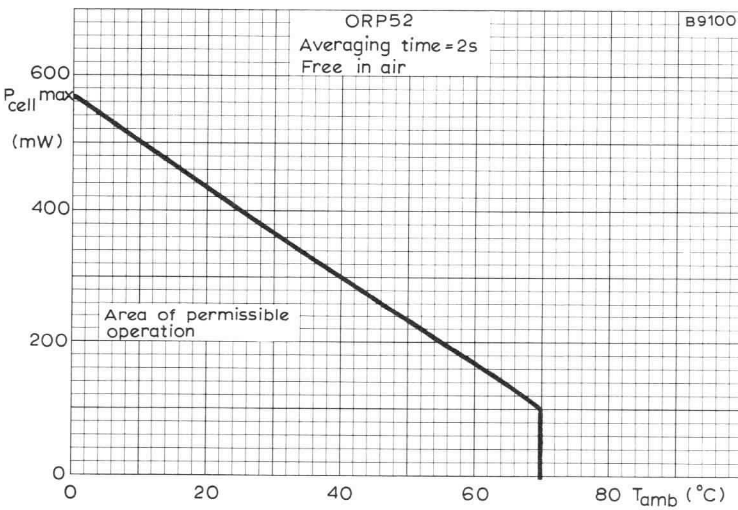
1. The spread of dark resistance is large, and values higher than 100MΩ and 10 000 MΩ are possible for the initial and equilibrium dark resistance respectively.
2. After 16 hours in darkness changes in the cadmium sulphide material are still occurring, but have an insignificant effect on the illuminated resistance and the resistance decay time.
3. Operation of the cell counteracts the deteriorating effect of long periods at high temperature. The maximum operating temperature is therefore higher than the maximum storage temperature.
4. The cell may be soldered directly into the circuit, but heat conducted to the tablet should be kept to a minimum by the use of a thermal shunt.
5. The cell may be dip-soldered at a solder temperature of 240^{o}C for a maximum of 10 seconds up to a point 10mm from the seals.
6. Care should be taken not to bend the leads nearer than 1.5mm from the seals.

OUTLINE AND DIMENSIONS





INITIAL CELL RESISTANCE PLOTTED AGAINST ILLUMINATION



MAXIMUM POWER DISSIPATION
PLOTTED AGAINST AMBIENT TEMPERATURE

PHOTOCONDUCTIVE CELLS ORP60 ORP61

QUICK REFERENCE DATA		
Cadmium sulphide photoconductive cells intended for use in flame control and other industrial applications, and for automatic brightness and contrast control in television receivers. The cells are shock and vibration resistant. ORP60 is for end-on incidence, ORP61 is for side incidence.		
Maximum power dissipation ($T_{amb}=25^{o}C$)	70	mW
Maximum cell voltage (d.c. and repetitive peak)	350	V
Cell resistance (at 50lux, $2700^{o}K$ colour temperature)	60	kΩ
Maximum overall dimensions	16.5 × 6.0dia	mm

Unless otherwise stated, data is applicable to both types

This data should be read in conjunction with GENERAL EXPLANATORY NOTES - CADMIUM SULPHIDE PHOTOCONDUCTIVE CELLS

GENERAL

The electrical properties of cadmium sulphide cells are dependent on many factors, such as illumination, colour temperature of the source, cell voltage and current, temperature, time of operation in the circuit, and operation during the 24 hours prior to measurement. The following characteristics are therefore only checkpoints of the electrical properties, measured under specified conditions and at start of life.

CHARACTERISTICS (Measured under d.c. conditions, at start of life, with $T_{amb}=25^{o}C$, illumination colour temperature $=2700^{o}K$, unless otherwise stated)

	Min.	Typ.	Max.	
Initial dark current (300V applied in series with 1MΩ, after 20s in darkness)	-	-	1.5	μA
Initial illuminated current (30V applied voltage, 50lux illumination after 16h in darkness) (see note 1)	200	500	800	μA
Sensitivity (50lux illumination, 30V applied voltage)	-	10	-	μA/lux

END OF LIFE CHARACTERISTICS (Measured under d.c. conditions, with $T_{amb} = 25^oC$, illumination colour temperature = 2700^oK)

None of the following end of life characteristics are expected to be reached before 2500 operating hours under the following conditions:

Illumination = 50 to 100lux

Colour temperature ≏ 2500^oK

Power dissipation = 60mW

$T_{amb} = 35^oC$

Initial dark current (300V applied voltage, after 20s in darkness)	≤3.0	μA
Change of intial illuminated current during life (30V applied voltage, 50lux illumination, after 16h in darkness)	≤60	%

RATINGS (ABSOLUTE MAXIMUM SYSTEM)

V_{cell} max. (d.c. and repetitive peak)	350	V
P_{cell} max.	See page 4	
I_{cell} max. (d.c. and repetitive peak)	7.5	nA
T_{amb} max. (storage) (see note 2)	+50	^oC
T_{amb} max. (operating) (see note 2)	+70	^oC
T_{amb} min. (storage and operating)	-40	^oC

SHOCK AND VIBRATION

Samples taken from normal production are submitted to shock and vibration tests as below. More than 95% of the devices pass these tests without perceptible damage.

Shock

25g (peak), 3000 shocks in one of the three positions of the cell.

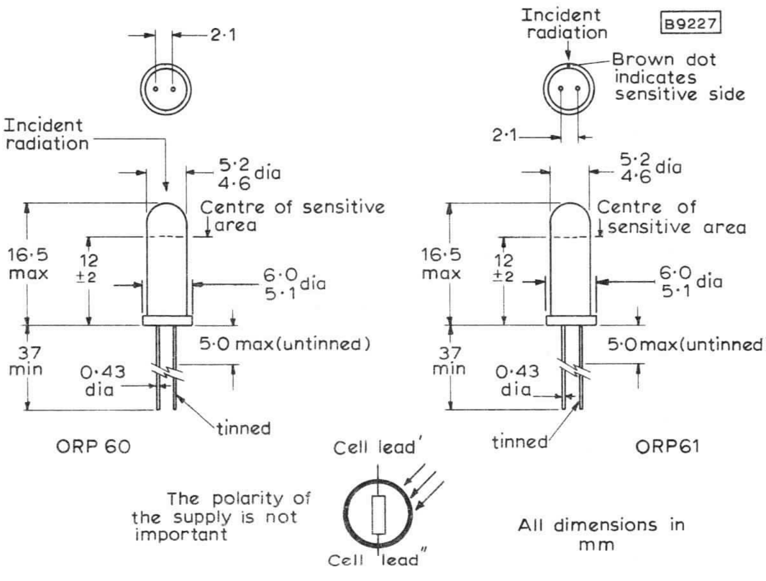
Vibration

2.5g (peak), 50Hz, 32 hours in each of the three positions of the cell.

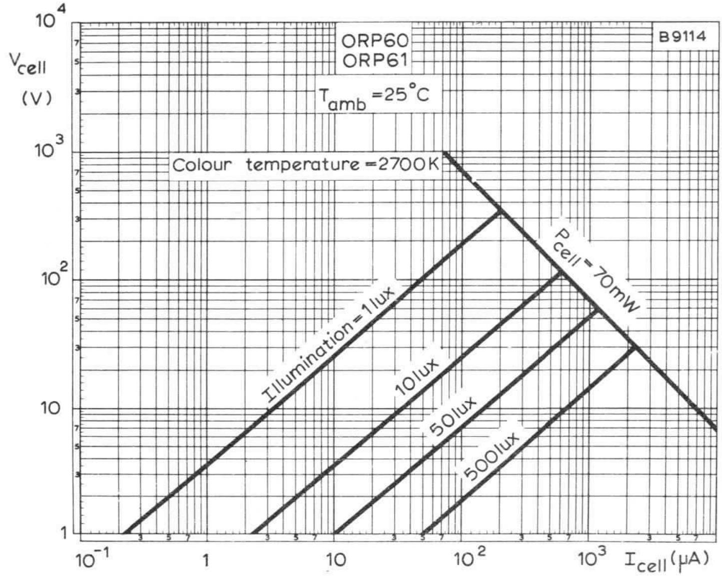
NOTES

1. After 16 hours in darkness changes in the cadmium sulphide material are still occurring, but have an insignificant effect on the illuminated resistance and the resistance decay time.
2. Operation of the cell counteracts the deteriorating effect of long periods at high temperature. The maximum operating temperature is therefore higher than the maximum storage temperature.
3. The cell may be soldered directly into the circuit, but heat conducted to the tablet should be kept to a minimum by the use of a thermal shunt.
4. The cell may be dip-soldered at a solder temperature of 240^{o}C for a maximum of 10 seconds up to a point 5mm from the seals.
5. Care should be taken not to bend the leads nearer than 1.5mm from the seals.

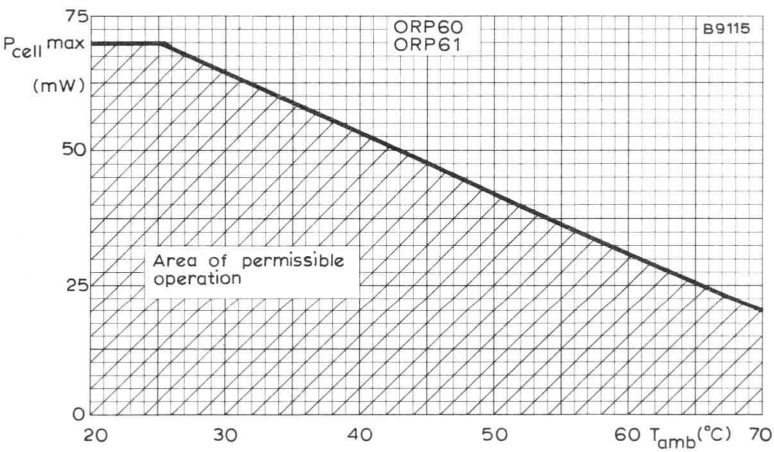
OUTLINE AND DIMENSIONS ←



Sensitive area = 0.25mm^2



CELL VOLTAGE PLOTTED AGAINST CELL CURRENT
WITH ILLUMINATION AS PARAMETER



MAXIMUM POWER DISSIPATION PLOTTED AGAINST
AMBIENT TEMPERATURE

PHOTOCONDUCTIVE CELL ORP62

QUICK REFERENCE DATA

Cadmium sulphide photoconductive cell for side incidence intended for use in industrial on-off applications such as flame failure circuits. The cell is tropic proof, shock and vibration resistant.

Maximum power dissipation (T_{amb} = 25 °C)	100	mW
Maximum cell voltage (d.c. and repetitive peak)	350	V
Cell resistance (at 50 lux, 2700 °K colour temperature)	45	kΩ
Maximum overall dimensions	16.5 x 6.0 dia.	mm

This data should be read in conjunction with GENERAL EXPLANATORY NOTES - CADMIUM SULPHIDE PHOTOCONDUCTIVE CELLS

GENERAL

The electrical properties of cadmium sulphide cells are dependent on many factors, such as illumination, colour temperature of the source, cell voltage and current, temperature, time of operation in the circuit, and operation during the 24 hours prior to measurement. The following characteristics are therefore only checkpoints of the electrical properties, measured under specified conditions and at start of life.

CHARACTERISTICS (measured under d.c. conditions, at start of life, with T_{amb} = 25 °C, illumination colour temperature = 2700 °K)

	Min.	Typ.	Max.	
Initial dark resistance (300V applied in series with 1MΩ, after 20s in darkness) (see note 1)	150	-	-	MΩ
Illuminated resistance (30V applied voltage, 50 lux illumination)				
initially after 16h in darkness (see note 2)	30	45	100	kΩ
after 15min under the measuring conditions	30	60	170	kΩ
Current rise time	See page 5			
Current decay time	See page 5			
Sensitivity (50 lux illumination, 30V applied voltage)	-	13	-	μA/lux
Temperature coefficient of illuminated resistance	-	-0.2	-0.5	%/degC
Resistance with 0.5V applied voltage / Resistance with 30V applied voltage	-	1.4	-	

THERMAL CHARACTERISTIC

Thermal resistance from cadmium sulphide tablet to ambient, device free in air	600	degC/W

RATINGS (ABSOLUTE MAXIMUM SYSTEM)

V_{cell} max. (d.c. and repetitive peak)	350	V
$V_{cell(pulse)}$ max. (maximum period 5ms, maximum repetition frequency 1 pulse/min)	1.0	kV
p_{cell} max.	See page 4	
$p_{cell(pulse)}$ max.	5 x p_{cell} max.	
T_{tablet} max.	+85	^{o}C
T_{amb} max. (storage) (see note 3)	+50	^{o}C
T_{amb} max. (operating) (see note 3)	+70	^{o}C
T_{amb} min. (storage and operating)	-40	^{o}C

DESIGN CONSIDERATIONS

Apparatus using cadmium sulphide cells should be designed so that changes in resistance of the cells during life from -30% to +70% do not impair the circuit performance. Direct sunlight should be avoided.

SHOCK AND VIBRATION

Samples taken from normal production are submitted to shock and vibration tests as below. More than 95% of the devices pass these tests without perceptible damage.

Shock

25g (peak), 10 000 shocks in one of the three positions of the cell.

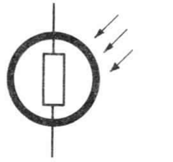
Vibration

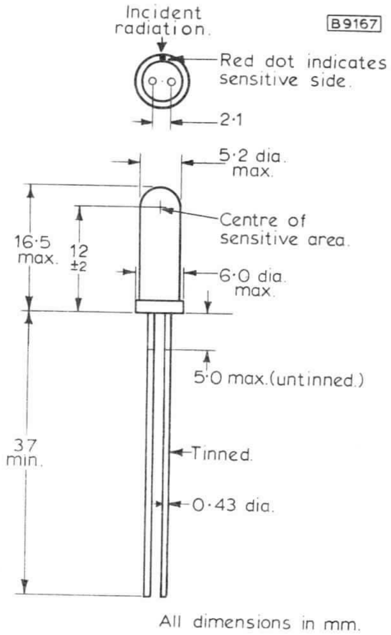
2.5 g (peak), 50Hz, 32 hours in each of the three positions of the cell.

NOTES

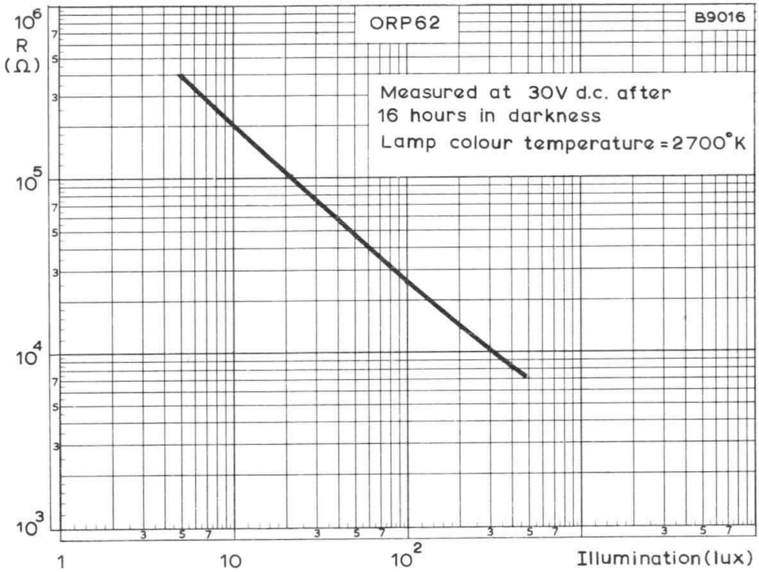
1. The spread of dark resistance is large, and values higher than 1000MΩ are possible for the initial dark resistance.
2. After 16 hours in darkness changes in the cadmium sulphide material are still occurring, but have an insignificant effect on the illuminated resistance and the current rise time.
3. Operation of the cell counteracts the deteriorating effect of long periods at high temperature. The maximum operating temperature is therefore higher than the maximum storage temperature.
4. The cell may be soldered directly into the circuit, but heat conducted to the tablet should be kept to a minimum by the use of a thermal shunt.
5. The cell may be dip-soldered at a solder temperature of 240°C for a maximum of 10 seconds up to a point 5mm from the seals.
6. Care should be taken not to bend the leads nearer than 1.5mm from the seals.

OUTLINE AND DIMENSIONS

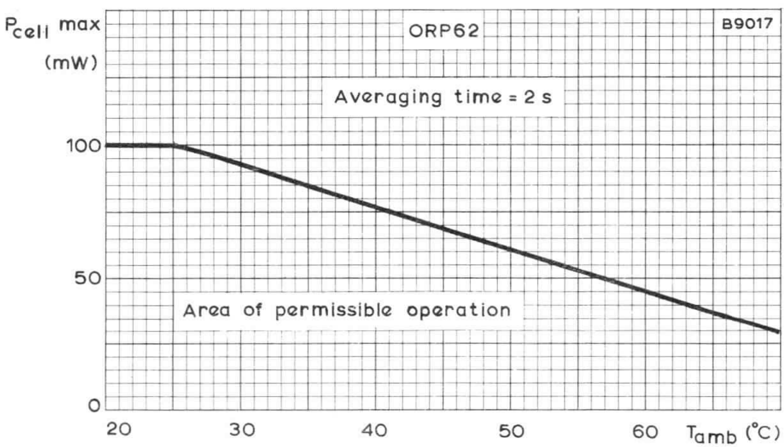




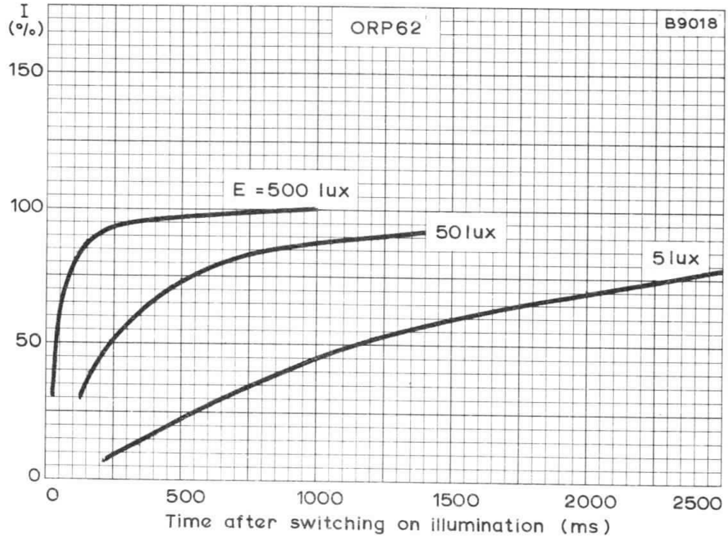
Sensitive area = 2mm × 2.5mm



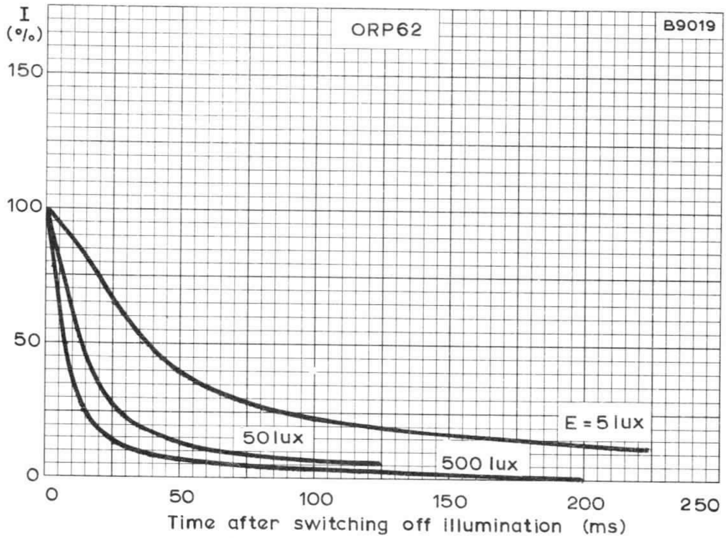
INITIAL ILLUMINATED RESISTANCE PLOTTED AGAINST ILLUMINATION



MAXIMUM POWER DISSIPATION PLOTTED AGAINST
AMBIENT TEMPERATURE



CURRENT RISE TIME WITH ILLUMINATION AS PARAMETER



CURRENT DECAY TIME WITH ILLUMINATION AS PARAMETER

PHOTOCONDUCTIVE CELL ORP69

QUICK REFERENCE DATA

Cadmium sulphide photoconductive cell for end-on or side incidence intended for use in industrial on-off applications such as flame failure circuits. The cell is tropic proof, shock and vibration resistant.

Maximum power dissipation ($T_{amb} = 25^{o}C$)	100	mW
Maximum cell voltage (d.c. and repetitive peak)	350	V
Cell resistance (at 50 lux, $2700^{o}K$ colour temperature)	30	kΩ
Maximum overall dimensions	6.0 dia. × 16.5	mm

This data should be read in conjunction with GENERAL EXPLANATORY NOTES - CADMIUM SULPHIDE PHOTOCONDUCTIVE CELLS

GENERAL

The electrical properties of cadmium sulphide cells are dependent on many factors, such as illumination, colour temperature of the source, cell voltage and current, temperature, time of operation in the circuit, and operation during the 24 hours prior to measurement. The following characteristics are therefore only checkpoints of the electrical properties, measured under specified conditions and at start of life.

CHARACTERISTICS (measured under d.c. conditions, at start of life, with $T_{amb} = 25^{o}C$, illumination colour temperature = 2700K)

	Min.	Typ.	Max.	
Initial dark resistance (300V applied in series with 1MΩ after 20s in darkness) (see note 1)	100	-	-	MΩ
Illuminated resistance (30V applied voltage, 50 lux illumination)				
initially after 16h in darkness (see notes 2 and 3)	20	30	60	kΩ
after 15min under the measuring conditions (see note 3)	27	46	115	kΩ
Resistance with side incidence / Resistance with end-on incidence	0.7	1.0	1.8	
Current rise time	See page 5			
Current decay time	See page 5			
Sensitivity (50 lux illumination, 30V applied voltage) (see note 3)	-	17	-	μA/lux
Temperature coefficient of illuminated resistance	-	-0.2	-0.5	%/degC
Resistance with 0.5V applied voltage / Resistance with 30V applied voltage	-	1.4	-	

THERMAL CHARACTERISTIC

Thermal resistance from cadmium sulphide tablet to ambient, device free in air	600	degC/W

RATINGS (ABSOLUTE MAXIMUM SYSTEM)

V_{cell} max. (d.c. and repetitive peak)	350	V
$V_{cell\ (pulse)}$ max. (maximum period 5ms, maximum repetition frequency 1 pulse/min.)	700	V
p_{cell} max.	See page 4	
$p_{cell\ (pulse)}$ max.	$5 \times p_{cell}$ max.	
T_{tablet} max.	+85	^{o}C
T_{amb} max. (storage) (see note 4)	+50	^{o}C
T_{amb} max. (operating) (see note 4)	+70	^{o}C
T_{amb} min. (storage and operating)	-40	^{o}C

DESIGN CONSIDERATIONS

Apparatus using cadmium sulphide cells should be designed so that changes in resistance of the cells during life from -30% to +70% do not impair the circuit performance. Direct sunlight should be avoided.

SHOCK AND VIBRATION

Samples taken from normal production are submitted to shock and vibration tests as below. More than 95% of the devices pass these tests without perceptible damage.

Shock

25g (peak), 10 000 shocks in one of the three positions of the cell.

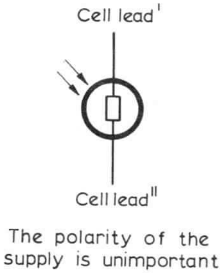
Vibration

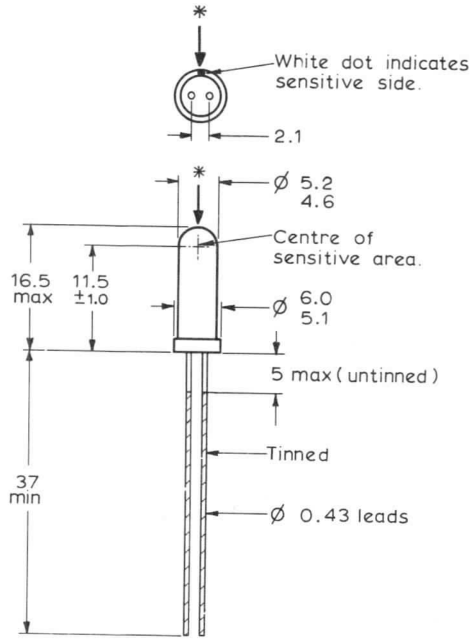
2.5g (peak), 50Hz, 32 hours in each of the three positions of the cell.

NOTES

1. The spread of dark resistance is large, and values higher than 1000MΩ are possible for the initial dark resistance.
2. After 16 hours in darkness changes in the cadmium sulphide material are still occurring, but have an insignificant effect on the illuminated resistance and the current rise time.
3. Measured with end-on incidence.
4. Operation of the cell counteracts the deteriorating effect of long periods at high temperature. The maximum operating temperature is therefore higher than the maximum storage temperature.
5. The cell may be soldered directly into the circuit, but heat conducted to the tablet should be kept to a minimum by the use of a thermal shunt.
6. The cell may be dip-soldered at a solder temperature of 240^{o}C for a maximum of 10 seconds up to a point 5mm from the seals.
7. Care should be taken not to bend the leads nearer than 1.5mm from the seals.

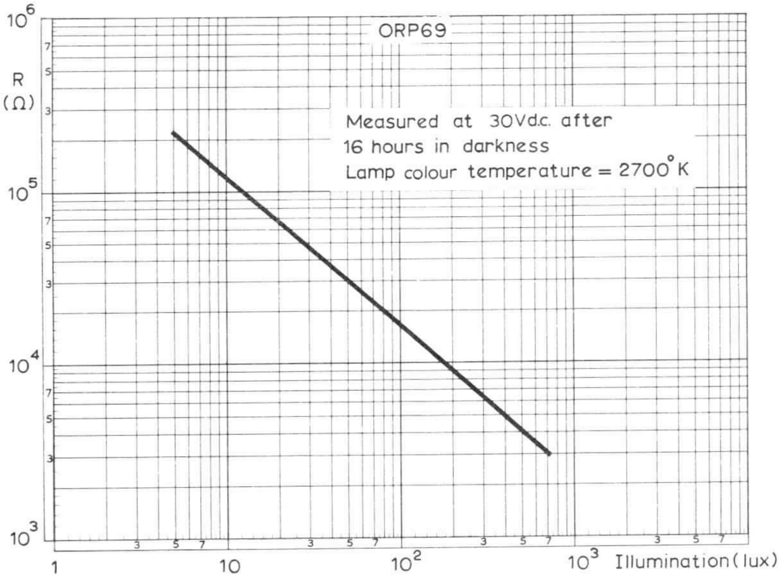
OUTLINE AND DIMENSIONS



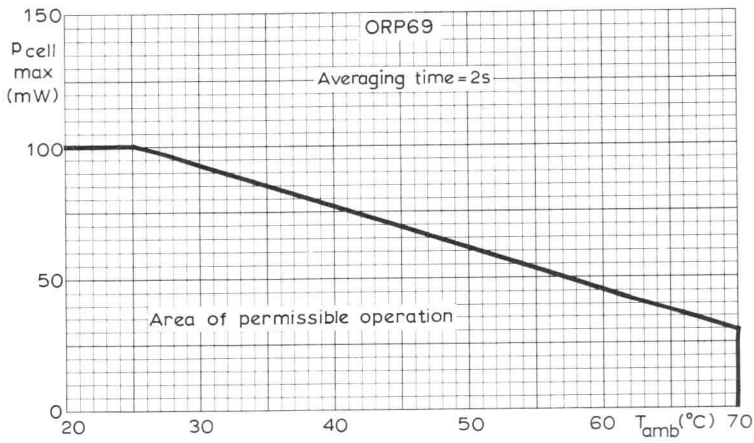


* Alternative directions for incident radiation

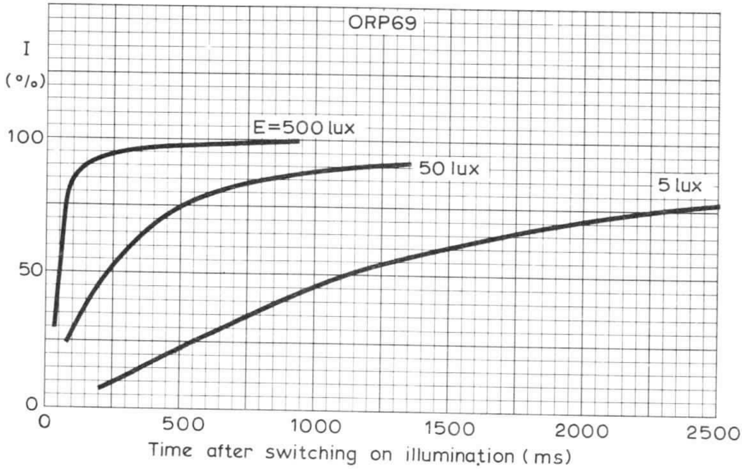
All dimensions in mm



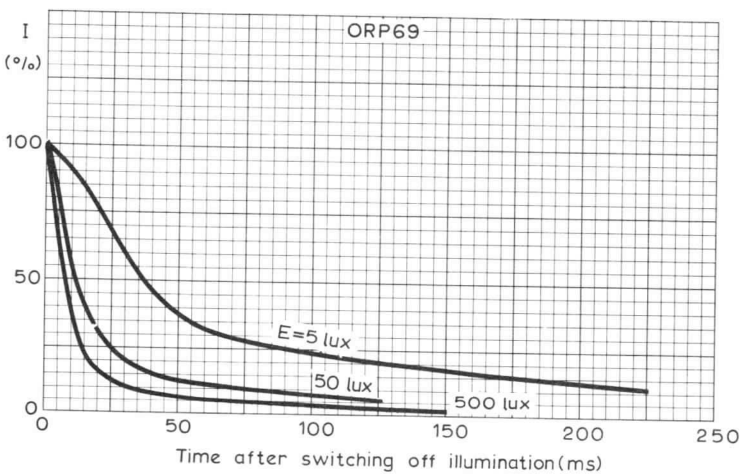
INITIAL ILLUMINATED RESISTANCE PLOTTED AGAINST ILLUMINATION



MAXIMUM POWER DISSIPATION PLOTTED AGAINST AMBIENT TEMPERATURE



CURRENT RISE TIME WITH ILLUMINATION AS PARAMETER



CURRENT DECAY TIME WITH ILLUMINATION AS PARAMETER

PHOTOCONDUCTIVE CELL ORP90

QUICK REFERENCE DATA

B7G based cadmium sulphide photoconductive cell for side incidence, intended for use in flame control, smoke detection and industrial on-off switching applications. The cell is shock and vibration resistant.

Maximum power dissipation ($T_{amb} = 25^{\circ}C$)	1.0	W
Maximum cell voltage (d.c. and repetitive peak)	350	V
Cell resistance (at 50lux, 2700°K colour temperature)	1.0	kΩ
Sensitive area	11 × 29	mm
Maximum overall dimensions	60.3 × 19dia.	mm

This data should be read in conjunction with GENERAL EXPLANATORY NOTES - CADMIUM SULPHIDE PHOTOCONDUCTIVE CELLS

GENERAL

The electrical properties of cadmium sulphide cells are dependent on many factors, such as illumination, colour temperature of the source, cell voltage and current, temperature, time of operation in the circuit, and operation during the 24 hours prior to measurement. The following characteristics are therefore only checkpoints of the electrical properties, measured under specified conditions and at start of life.

CHARACTERISTICS (Measured under d.c. conditions, at start of life, with $T_{amb} = 25^{\circ}C$, illumination colour temperature = 2700°K, unless otherwise stated)

	Min.	Typ.	Max.	
Dark current (300V applied in series with 1MΩ)				
after 20s in darkness	-	-	70	μA
after 15min in darkness	-	-	2.5	μA
Initial illuminated current (50lux illumination, 10V applied voltage, after 16h in darkness) (see note 1)				
at 2700°K colour temperature	3.0	10	15	mA
at 1500°K colour temperature	6.0	20	31	mA
Sensitivity (50lux illumination, 10V applied voltage)	-	0.2	-	mA/lux
Current rise time		See page 4		
Current fall time		See page 4		

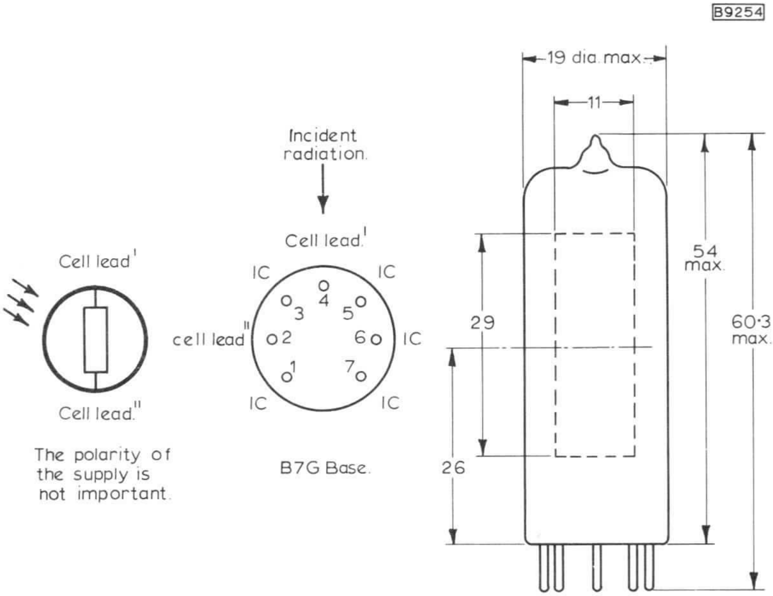
RATINGS (ABSOLUTE MAXIMUM SYSTEM)

V_{cell} max. (d.c. and repetitive peak)	350	V
p_{cell} max.	See page 3	
T_{amb} max. (storage) (see note 2)	+50	^{o}C
T_{amb} max. (operating) (see note 2)	+70	^{o}C
T_{amb} min. (storage and operating)	-40	^{o}C

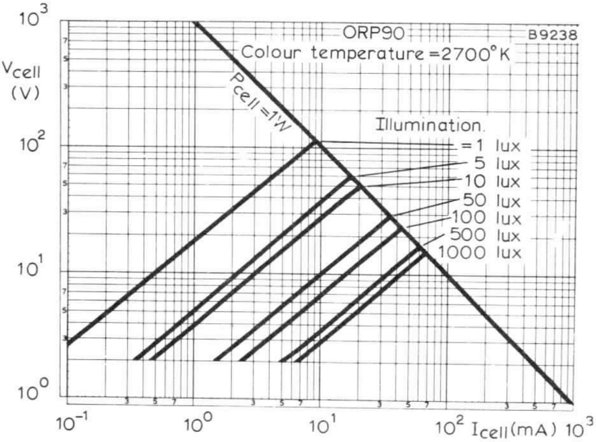
NOTES

1. After 16 hours in darkness changes in the cadmium sulphide material are still occurring, but have an insignificant effect on the illuminated resistance and the resistance decay time.
2. Operation of the cell counteracts the deteriorating effect of long periods at high temperature. The maximum operating temperature is therefore higher than the maximum storage temperature.

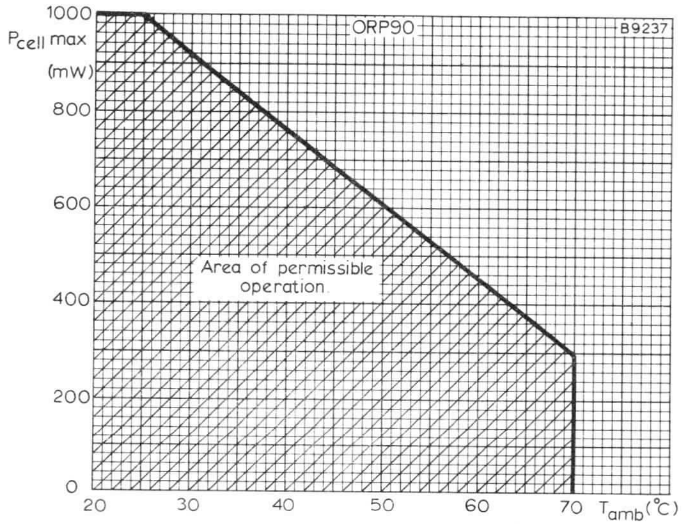
OUTLINE AND DIMENSIONS



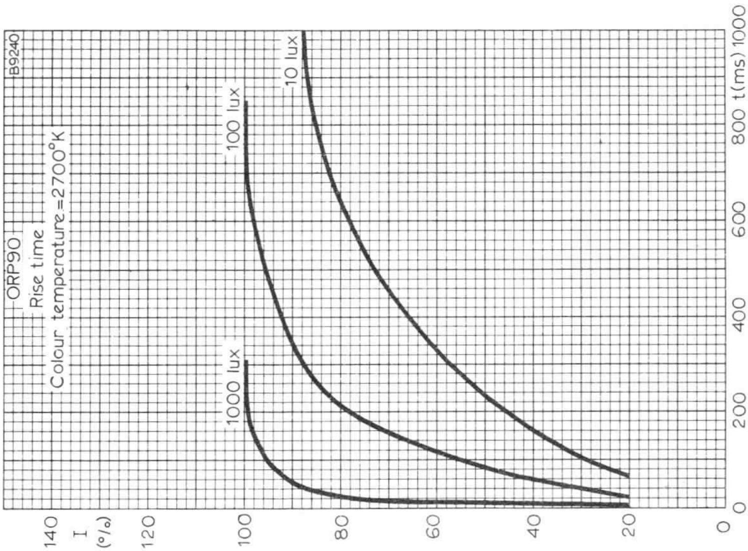
All dimensions in mm.

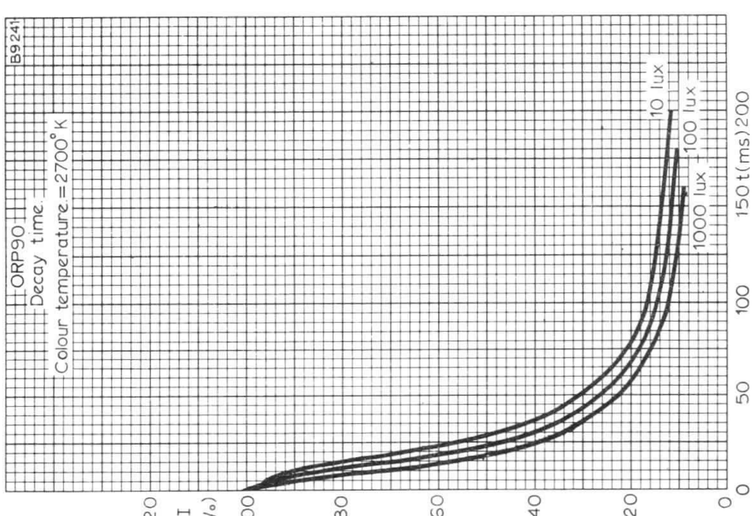


CELL VOLTAGE PLOTTED AGAINST CELL CURRENT WITH ILLUMINATION AS PARAMETER



MAXIMUM POWER DISSIPATION PLOTTED AGAINST AMBIENT TEMPERATURE





CURRENT RISE AND DECAY TIME CURVES
WITH ILLUMINATION AS PARAMETER

QUICK REFERENCE DATA

Cadmium sulphide photoconductive cell on B7G base, for side-on incidence of illumination. Intended for use in flame failure, smoke detection and general industrial applications.

Maximum power dissipation (T_{amb} = 25°C)	1.0	W
Absolute maximum cell voltage		
a.c. (r.m.s.)	280	V
d.c.	400	V
Cell resistance (at 50 lux)	1.7	kΩ
Sensitive area	2.5	cm^2

This data should be read in conjunction with 'OPERATING NOTES' given on page D2.

CHARACTERISTICS

(measured under d.c. conditions, at start of life, with T_{amb} = 25°C)

Cell resistance at 10V d.c., 50 lux and lamp colour temperature 2700°K		
*Initial		
Maximum	3.0	kΩ
Nominal	1.5	kΩ
Minimum	750	Ω
Equilibrium		
Nominal	1.7	kΩ
Minimum ultimate dark resistance at 400V d.c.	5.0	MΩ

(see pages C4 and C5)

*This is the first virtually constant value of resistance when illuminated shortly after 16 hours storage in complete darkness.

ABSOLUTE MAXIMUM RATINGS

V_{cell} max. (d.c. or a.c. pk)	400	V
p_{cell} max. with uniform illumination (see curve on page C3)		
at T_{amb} = 25°C	1.0	W
T_{amb}		
Maximum (<1 lux illumination)	+50	°C
Maximum (≥1 lux illumination)	+70	°C
Minimum	-40	°C

OPERATING NOTES

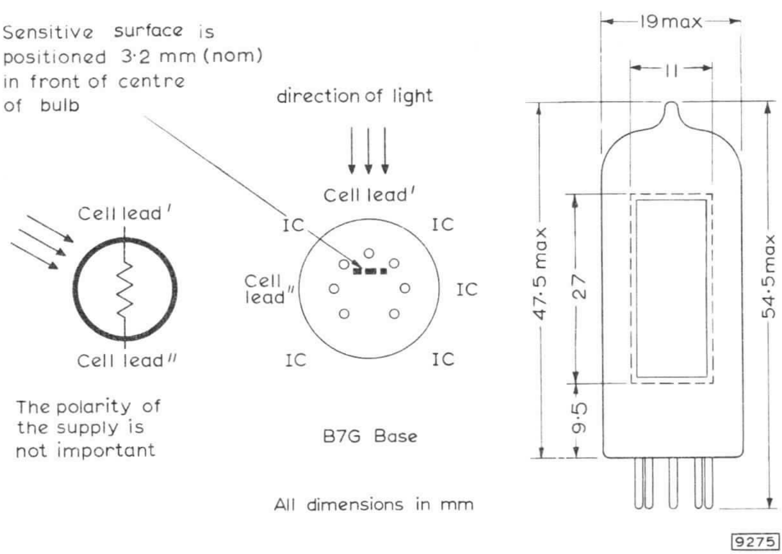
1. This data is based on the device being uniformly illuminated.

2. For sources of illumination other than a lamp of colour temperature 2700°K, the cell resistance should be multiplied by the following approximate factors.

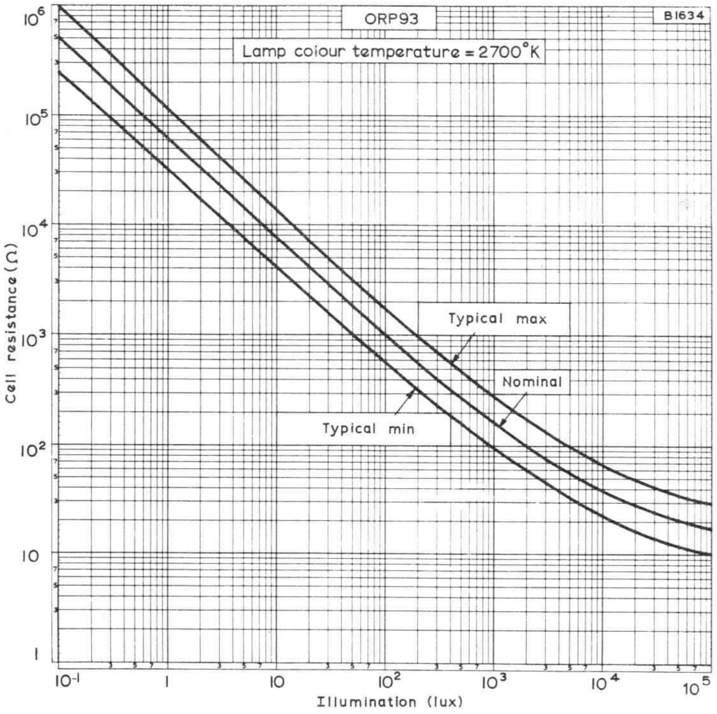
Source of illumination	Factor
Incandescent radiation at colour temperature of:	
1500°K	1/2
2000°K	2/3
Sunlight	4/3
White fluorescent	2

3. For a.c. conditions, the nominal and limit resistance values are approximately 1.1 times those for d.c.

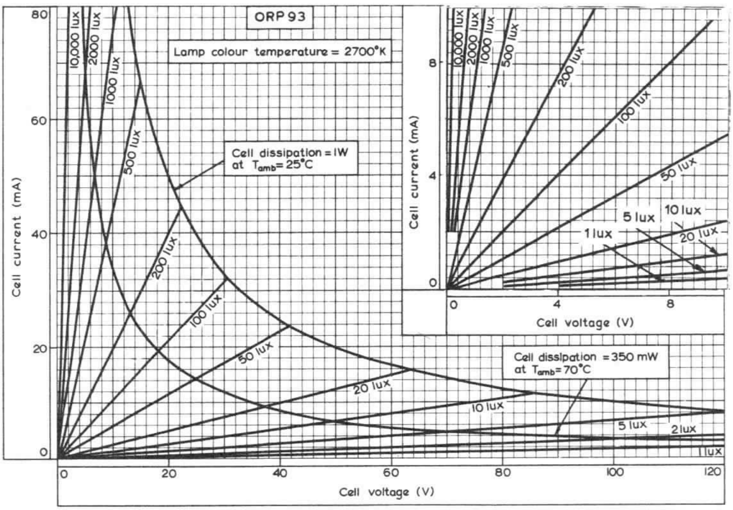
4. When the cell illumination is changed the cell resistance changes to a transient value and then, over a period of approximately 10 minutes assumes an equilibrium value. The transient usually overshoots the final equilibrium resistance.



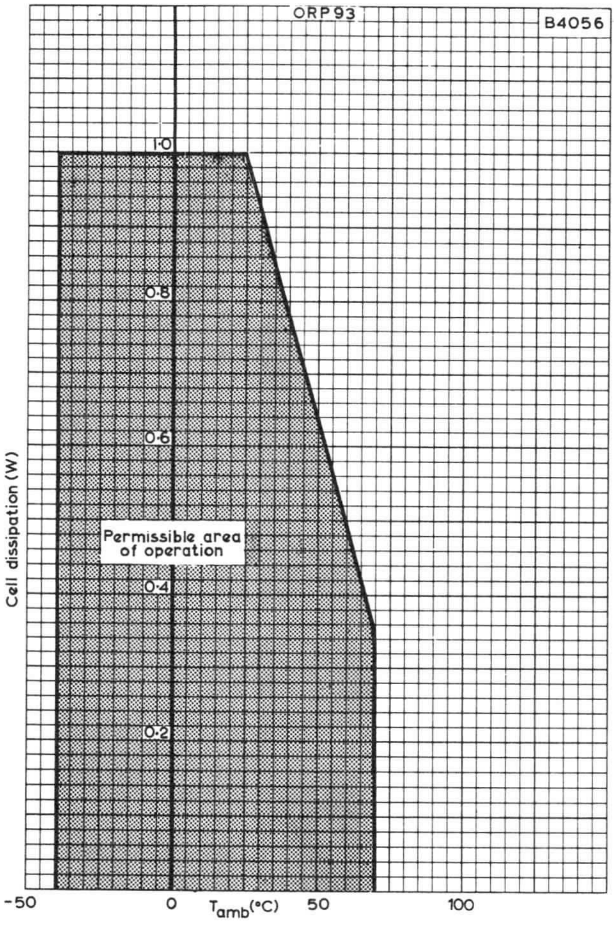
The sensitive surface to be illuminated (nominally 10 x 25) is located within the indicated area 11 x 27



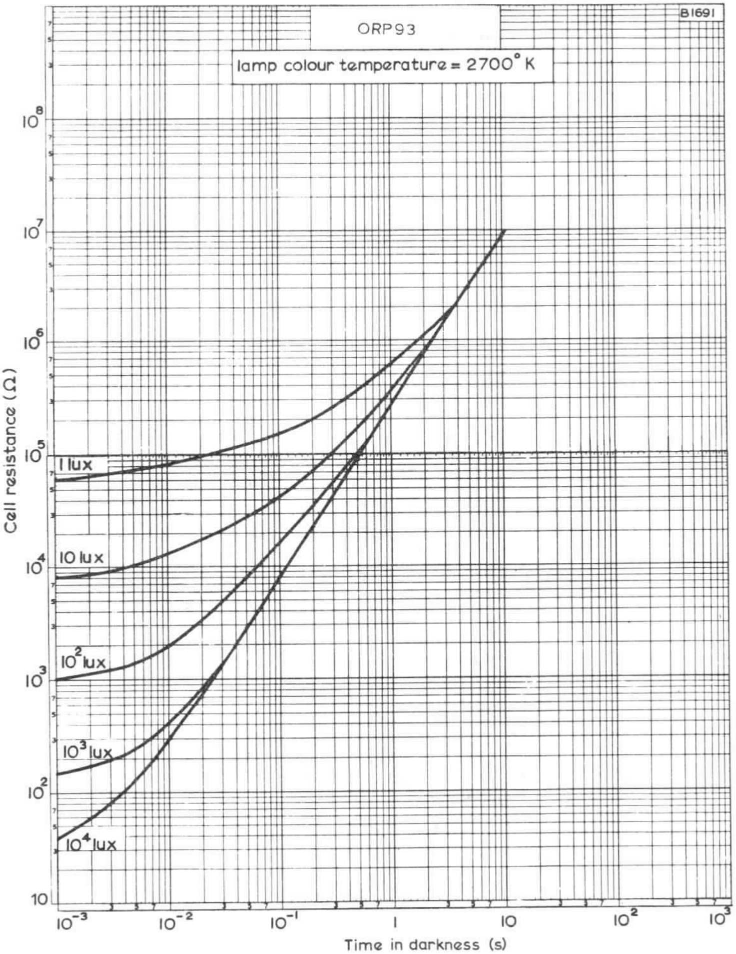
EQUILIBRIUM CELL RESISTANCE PLOTTED AGAINST ILLUMINATION WITH TYPICAL SPREAD



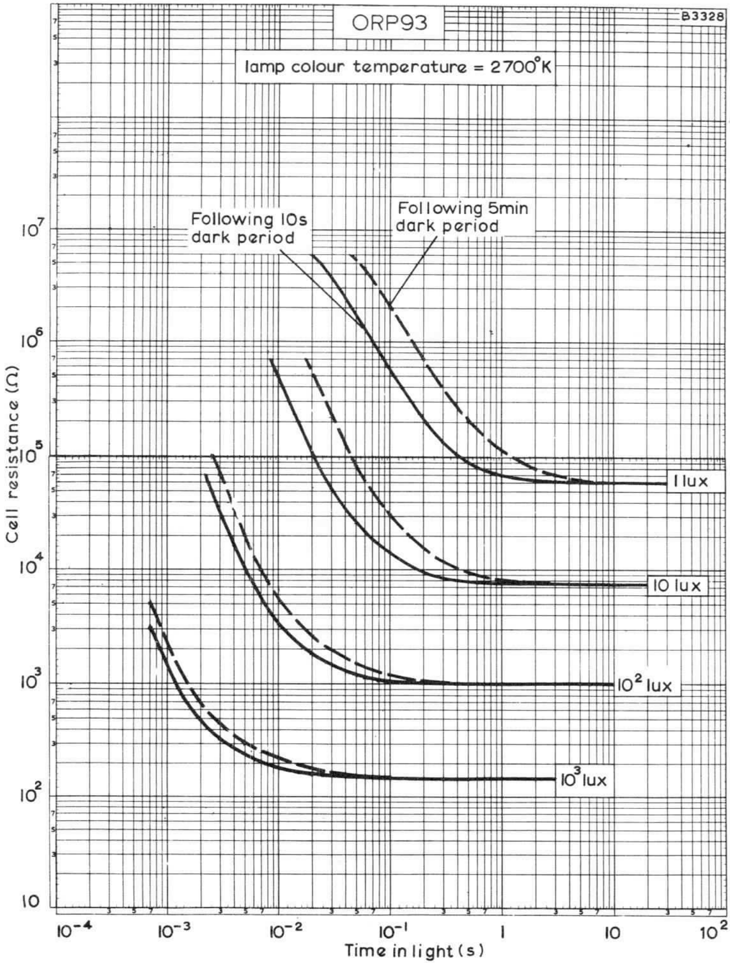
INITIAL CELL CURRENT PLOTTED AGAINST CELL VOLTAGE
WITH ILLUMINATION AS PARAMETER



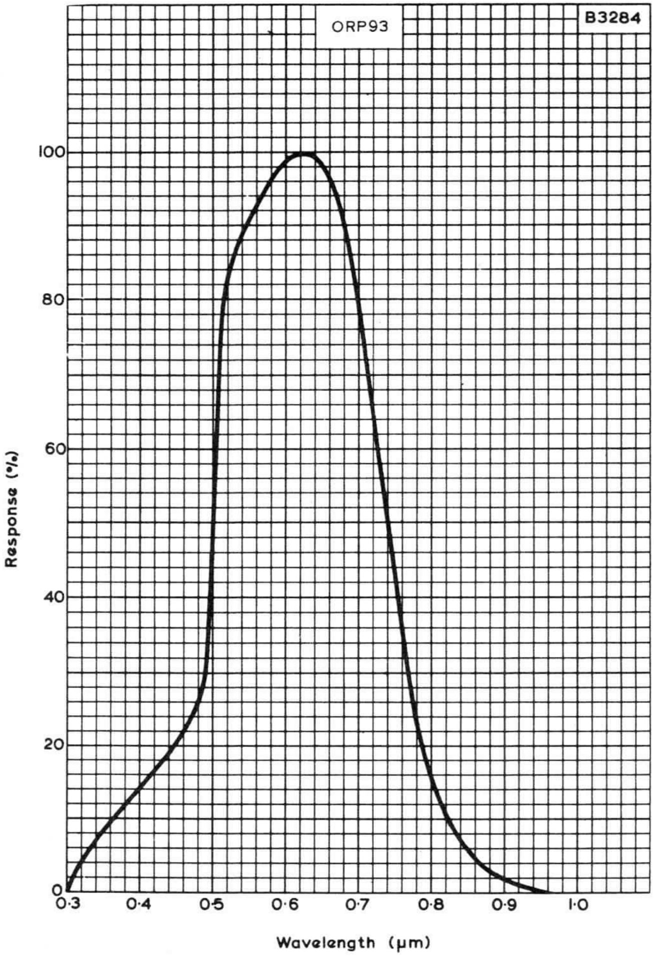
MAXIMUM CELL DISSIPATION PLOTTED AGAINST AMBIENT TEMPERATURE



NOMINAL RESISTANCE RISE-TIME CURVES WITH ILLUMINATION AS PARAMETER



NOMINAL RESISTANCE FALL-TIME CURVES FROM DARKNESS WITH ILLUMINATION AS PARAMETER



SPECTRAL RESPONSE CURVE

PHOTOCONDUCTIVE CELL RPY18

QUICK REFERENCE DATA

Flat cadmium sulphide photoconductive cell for side incidence intended for use in general control circuits. The cell is tropic proof, shock and vibration resistant.

Maximum power dissipation (T_{amb} = 25°C)	0.5	W
Maximum cell voltage (d.c. and repetitive peak)	100	V
Cell resistance (at 50 lux, 2700°K colour temperature)	500	Ω
Sensitive area	10 x 15	mm
Maximum overall dimensions	27 x 16.3 x 6.0	mm

This data should be read in conjunction with GENERAL EXPLANATORY NOTES - CADMIUM SULPHIDE PHOTOCONDUCTIVE CELLS

GENERAL

The electrical properties of cadmium sulphide cells are dependent on many factors, such as illumination, colour temperature of the source, cell voltage and current, temperature, time of operation in the circuit, and operation during the 24 hours prior to measurement. The following characteristics are therefore only checkpoints of the electrical properties, measured under specified conditions and at start of life.

CHARACTERISTICS (measured under d.c conditions, at start of life, with T_{amb} = 25°C, illumination colour temperature = 2700°K)

	Min.	Typ.	Max.	
Dark resistance (100V applied in series with 1MΩ) (see note 1)				
after 20s in darkness	5.6	-	-	MΩ
after 30min in darkness	50	-	-	MΩ
Initial illuminated resistance (after 16h in darkness) (see note 2)				
at 50 lux, 10V applied voltage	235	400	1200	Ω
at 5000 lux, 1V applied voltage (see note 3)	-	25	35	Ω
Equilibrium illuminated resistance (after 15min under the measuring conditions)				
at 50 lux, 10V applied voltage	235	480	1560	Ω
at 5000 lux, 1V applied voltage (see note 3)	-	-	35	Ω

CHARACTERISTICS (Continued)	Typ.	Max.	
Resistance decay time (time to reach 50Ω, measured from the instant of switching on 5000 lux illumination after 16h in darkness)	5.0	25	ms
Resistance rise time (time to reach 2kΩ, measured from the instant of switching off 5000 lux illumination after 5min or more illumination)	40	200	ms
Sensitivity (50 lux illumination, 10V applied voltage)	0.5	-	mA/lux
Temperature coefficient of illuminated resistance	-0.2	-0.5	%/degC
$\frac{\text{Resistance with 0.5V applied voltage}}{\text{Resistance with 10V applied voltage}}$	1.1	-	

THERMAL CHARACTERISTIC

Thermal resistance from cadmium sulphide tablet to ambient, device free in air	120	degC/W

RATINGS (ABSOLUTE MAXIMUM SYSTEM)

V_{cell} max. (d.c. and repetitive peak)	100	V
$V_{cell\ (pulse)}$ max. (maximum period 5ms, maximum repetition frequency 1pulse/min)	250	V
p_{cell} max.	See page 5	
$p_{cell(pulse)}$ max.	5 x p_{cell} max.	
I_{cell} max. (d.c. and repetitive peak)	250	mA
Maximum illumination	50 000	lux
T_{tablet} max. (see note 4)	+85	^{o}C
T_{amb} max. (storage) (see note 5)	+50	^{o}C
T_{amb} max. (operating) (see note 5)	+70	^{o}C
T_{amb} min. (storage and operating)	-40	^{o}C

DESIGN CONSIDERATIONS

Apparatus using cadmium sulphide cells should be designed so that changes in resistance of the cells during life from -30% to +70% do not impair the circuit performance. Direct sunlight should be avoided.

SHOCK AND VIBRATION

Samples taken from normal production are submitted to shock and vibration tests as below. More than 95% of the devices pass these tests without perceptible damage.

Shock

25 g (peak), 10 000 shocks in one of the three positions of the cell.

Vibration

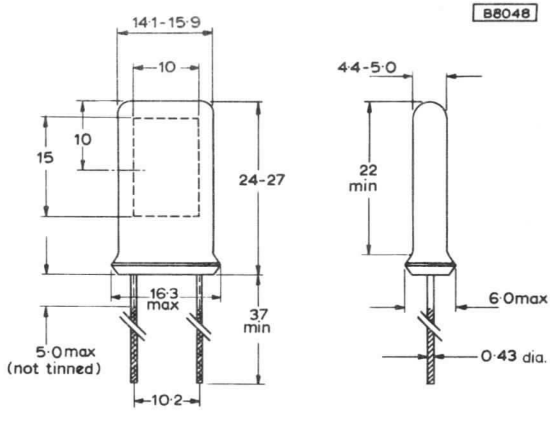
2.5 g (peak), 50Hz, 32 hours in each of the three positions of the cell.

PHOTOCONDUCTIVE CELL RPY18

NOTES.

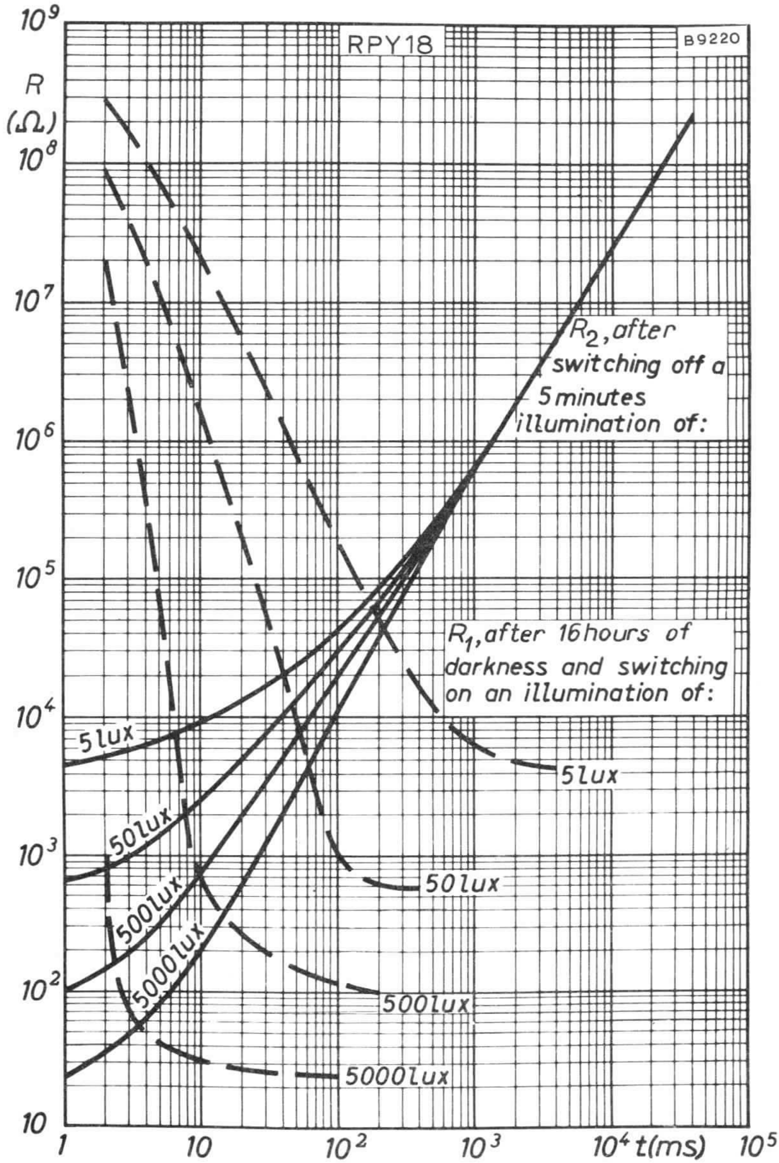
1. The spread of dark resistance is large, and values higher than 15MΩ and 2000MΩ are possible for the initial and equilibrium dark resistance respectively.
2. After 16 hours in darkness, changes in the cadmium sulphide material are still occurring, but have an insignificant effect on the illuminated resistance and the resistance decay time.
3. Maximum during life 40Ω.
4. If no forced air cooling is used the envelope temperature opposite the centre of the sensitive area is about 83°C when the temperature of the cadmium sulphide tablet is 85°C. This temperature can be measured, for example, by means of a thermocouple fastened on the envelope.
5. Operation of the cell counteracts the deteriorating effect of long periods at high temperature. The maximum operating temperature is therefore higher than the maximum storage temperature.
6. The cell may be soldered directly into the circuit, but heat conducted to the tablet should be kept to a minimum by the use of a thermal shunt.
7. The cell may be dip-soldered at a solder temperature of 240°C for a maximum of 10 seconds up to a point 5mm from the seals.
8. Care should be taken not to bend the leads nearer than 1.5mm from the seals.

OUTLINE AND DIMENSIONS

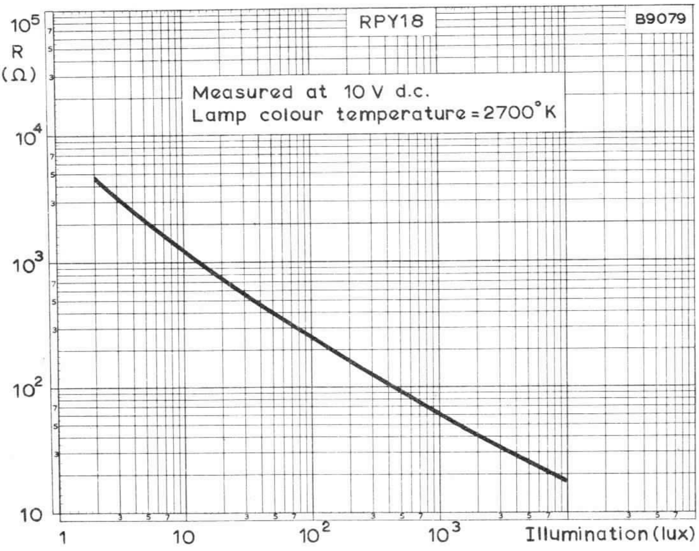


All dimensions in mm

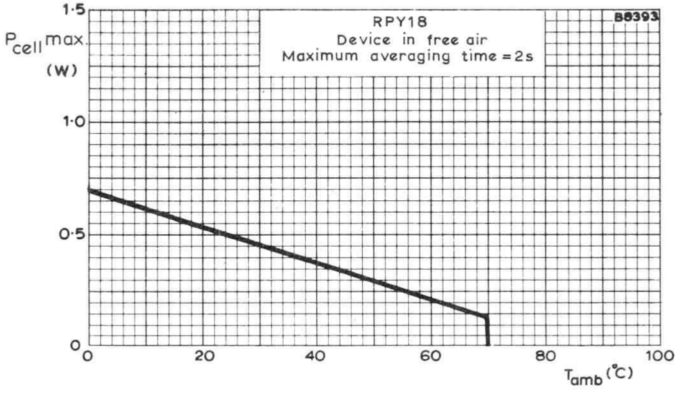
The spacing of the leads is compatible with the standard 2.54mm (0.1 in) printed wiring grid



RESISTANCE RISE AND FALL TIME CURVES
WITH ILLUMINATION AS PARAMETER



INITIAL CELL RESISTANCE PLOTTED AGAINST ILLUMINATION



MAXIMUM POWER DISSIPATION PLOTTED AGAINST AMBIENT TEMPERATURE

PHOTOCONDUCTIVE CELL RPY19

QUICK REFERENCE DATA

Flat cadmium sulphide photoconductive cell for side incidence intended for use in general control circuits. The cell is tropic proof, shock and vibration resistant.

Maximum power dissipation (T_{amb} = 25°C)	0.5	W
Maximum cell voltage (d.c. and repetitive peak)	400	V
Cell resistance (at 50 lux, 2700°K colour temperature)	3.0	kΩ
Sensitive area	10 x 15	mm
Maximum overall dimensions	27 x 16.3 x 6.0	mm

This data should be read in conjunction with GENERAL EXPLANATORY NOTES- CADMIUM SULPHIDE PHOTOCONDUCTIVE CELLS

GENERAL

The electrical properties of cadmium sulphide cells are dependent on many factors, such as illumination, colour temperature of the source, cell voltage and current, temperature, time of operation in the circuit, and operation during the 24 hours prior to measurement. The following characteristics are therefore only checkpoints of the electrical properties, measured under specified conditions and at start of life.

CHARACTERISTICS (measured under d.c. conditions, at start of life, with T_{amb} = 25°C, illumination colour temperature = 2700°K)

	Min.	Typ.	Max.	
Dark resistance (300V applied in series with 1MΩ) (see note 1)				
after 20s in darkness	10	-	-	MΩ
after 30min in darkness	200	-	-	MΩ
Illuminated resistance (50 lux illumination, 10V applied voltage)				
initially after 16h in darkness (see note 2)	1.4	3.0	6.6	kΩ
after 15min under the measuring conditions	1.4	3.8	9.0	kΩ
Resistance decay time (time to reach 20kΩ, measured from the instant of switching on 50 lux illumination after 16h in darkness, 10V applied voltage)	-	-	0.2	s
Resistance rise time (time to reach 1MΩ, measured from the instant of switching off 50 lux illumination, after 5min or more illumination, 10V applied voltage)	-	0.6	1.25	s

CHARACTERISTICS (Continued)

	Typ.	Max.	
Sensitivity	0.07	-	mA/lux
Temperature coefficient of illuminated resistance	-0.2	-0.5	%/degC
$\frac{\text{Resistance with 0.5V applied voltage}}{\text{Resistance with 10V applied voltage}}$	1.1	-	

THERMAL CHARACTERISTIC

Thermal resistance from cadmium sulphide tablet to ambient,device free in air	120	degC/W

RATINGS (ABSOLUTE MAXIMUM SYSTEM)

V_{cell} max. (d.c. and repetitive peak)	400	V
$V_{cell(pulse)}$ max. (maximum period 5ms, maximum repetition frequency 1 pulse/min)	1.0	kV
p_{cell} max.	See page 5	
$p_{cell(pulse)}$ max.	$5 \times p_{cell}$ max.	
I_{cell} max. (d.c. and repetitive peak)	250	mA
Maximum illumination	50 000	lux
T_{tablet} max. (see note 3)	+85	^{o}C
T_{amb} max. (storage) (see note 4)	+50	^{o}C
T_{amb} max. (operating) (see note 4)	+70	^{o}C
T_{amb} min. (storage and operating)	-40	^{o}C

DESIGN CONSIDERATIONS

Apparatus using cadmium sulphide cells should be designed so that changes in resistance of the cells during life from -30% to +70% do not impair the circuit performance. Direct sunlight should be avoided.

SHOCK AND VIBRATION

Samples taken from normal production are submitted to shock and vibration tests as below. More than 95% of the devices pass these tests without perceptible damage.

Shock

25 g (peak), 10 000 shocks in one of the three positions of the cell.

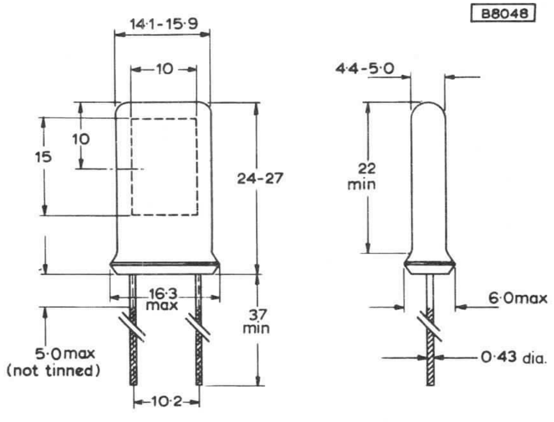
Vibration

2.5 g (peak), 50Hz, 32 hours in each of the three positions of the cell.

NOTES

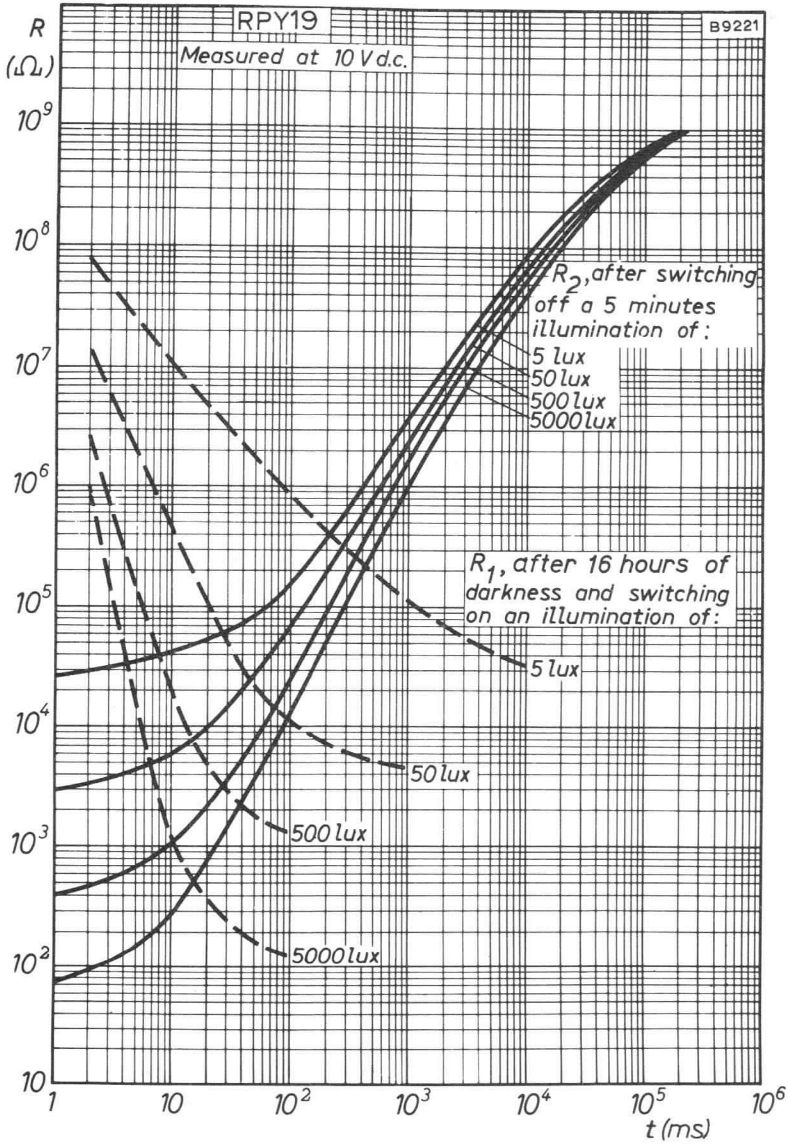
1. The spread of dark resistance is large, and values higher than 100MΩ and 10 000MΩ are possible for the initial and equilibrium dark resistance respectively.
2. After 16 hours in darkness, changes in the cadmium sulphide material are still occurring, but have an insignificant effect on the illuminated resistance and the resistance decay time.
3. If no forced air cooling is used the envelope temperature opposite the centre of the sensitive area is about 83°C when the temperature of the cadmium sulphide tablet is 85°C. This temperature can be measured, for example, by means of a thermocouple fastened on the envelope.
4. Operation of the cell counteracts the deteriorating effect of long periods at high temperature. The maximum operating temperature is therefore higher than the maximum storage temperature.
5. The cell may be soldered directly into the circuit, but heat conducted to the tablet should be kept to a minimum by the use of a thermal shunt.
6. The cell may be dip-soldered at a solder temperature of 240°C for a maximum of 10 seconds up to a point 5mm from the seals.
7. Care should be taken not to bend the leads nearer than 1.5mm from the seals.

OUTLINE AND DIMENSIONS

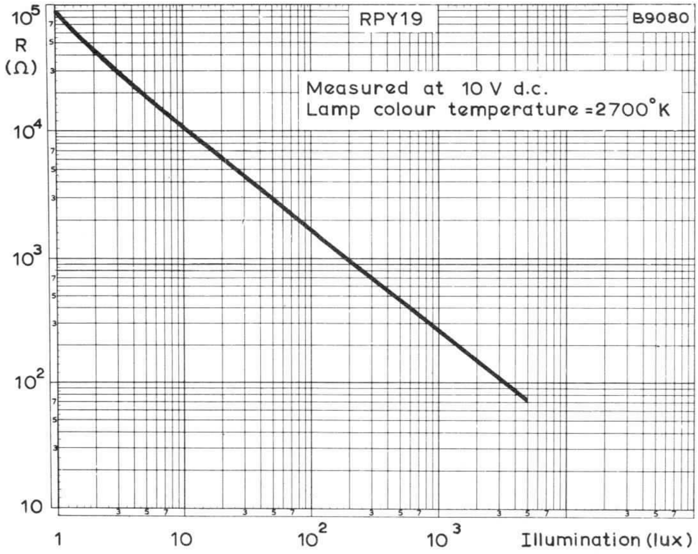


All dimensions in mm

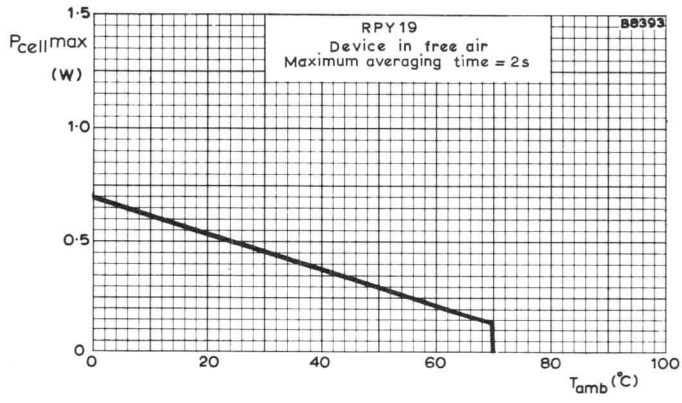
The spacing of the leads is compatible with the standard 2.54mm (0.1 in) printed wiring grid



RESISTANCE RISE AND FALL TIME CURVES
WITH ILLUMINATION AS PARAMETER



INITIAL CELL RESISTANCE PLOTTED AGAINST ILLUMINATION



MAXIMUM POWER DISSIPATION PLOTTED AGAINST AMBIENT TEMPERATURE

PHOTOCONDUCTIVE CELL RPY20

QUICK REFERENCE DATA

Flat cadmium sulphide photoconductive cell for use in general control applications such as twilight switches and flame failure equipment. The cell is tropic proof, shock and vibration resistant.

Maximum power dissipation ($T_{amb} = 25^oC$)	1.0	W
Maximum cell voltage (d.c. and repetitive peak)	400	V
Cell resistance (at 50lux, 2700°K colour temperature)	1.5	kΩ
Sensitive area	3.2	cm^2

This data should be read in conjunction with GENERAL EXPLANATORY NOTES-CADMIUM SULPHIDE PHOTOCONDUCTIVE CELLS

GENERAL

The electrical properties of cadmium sulphide cells are dependent on many factors, such as illumination, colour temperature of the source, cell voltage and current, temperature, time of operation in the circuit, and operation during the 24 hours prior to measurement. The following characteristics are therefore only checkpoints of the electrical properties, measured under specified conditions and at start of life.

CHARACTERISTICS

(measured under d.c. conditions, at start of life, with $T_{amb} = 25^oC$, lamp colour temperature = 2700°K)

	Min.	Typ.	Max.	
Dark resistance (300V applied in series with 1MΩ) See note 1				
after 20s in darkness	6.5	-	-	MΩ
after 30min in darkness	120	-	-	MΩ
Illuminated resistance (50lux illumination, 10V applied voltage)				
initially after 16h darkness (See note 2)	0.7	1.5	3.3	kΩ
after 15min illumination	0.7	1.9	4.5	kΩ
Resistance decay time (time to reach 10kΩ, measured from the instant of applying 50lux illumination after 16h darkness, 10V applied voltage)	-	-	0.2	s
Resistance rise time (time to reach 1MΩ, measured from the instant of switching off 50lux illumination after 5min or more illumination, 10V applied voltage)	-	0.9	1.5	s

CHARACTERISTICS (Continued)

	Typ.	Max.	
Sensitivity (50lux illumination, 10V applied voltage)	0.15	-	mA/lux
Temperature coefficient of illuminated resistance	-0.2	-0.5	%per degC
$\frac{\text{Resistance with 0.5V applied voltage}}{\text{Resistance with 10V applied voltage}}$	1.05	-	

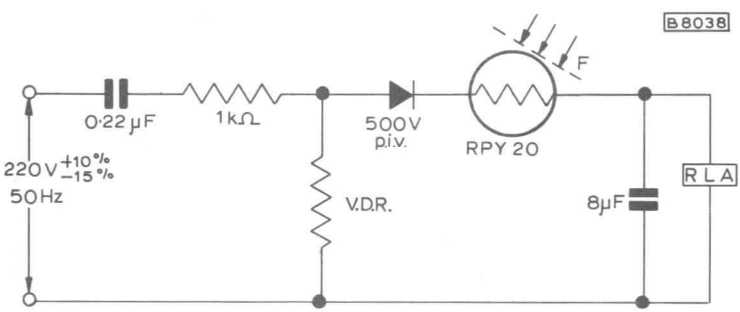
THERMAL CHARACTERISTIC

Thermal resistance from cadmium sulphide tablet to ambient, device free in air	60	degC/W

RATINGS (ABSOLUTE MAXIMUM SYSTEM)

V_{cell} max. (d.c. and repetitive peak)	400	V
I_{cell} max. (d.c. and repetitive peak)	500	mA
P_{cell} max.		See page C2
Maximum illumination	50 000	lux
Maximum temperature of cadmium sulphide tablet (see note 3)	+85	^{o}C
T_{amb} max. (storage) (see note 4)	+50	^{o}C
T_{amb} max. (operating) (see note 4)	+70	^{o}C
T_{amb} min. (storage and operating)	-40	^{o}C

TYPICAL TWILIGHT SWITCHING CIRCUIT



V.D.R.	Voltage dependent resistor, 10mA at 180V, 2W.
F	Absorption filter to be used to correct circuit spreads and to adjust the switching level (10 to 70lux). Light transmission 5 to 20%.
RLA	D.C. relay, 20kΩ, ratio I_{on}/I_{off} <2.7 (e.g. I_{on} = 2mA, I_{off} = 0.8mA).

DESIGN CONSIDERATIONS

Apparatus with cadmium sulphide cells should be designed so that changes in resistance of the cells during life from -30% to +70% do not impair the circuit performance. Direct sunlight should be avoided.

SHOCK AND VIBRATION

Samples taken from normal production are submitted to shock and vibration tests as below. More than 95% of the devices pass these tests without perceptible damage.

Shock

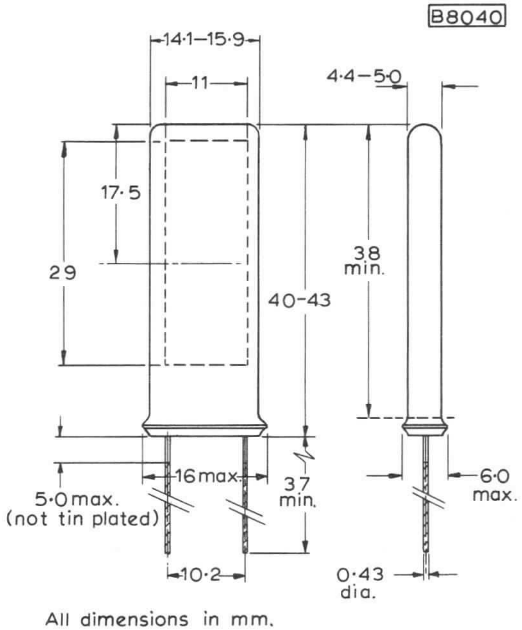
25g (peak), 10 000 shocks in one of the three positions of the cell.

Vibration

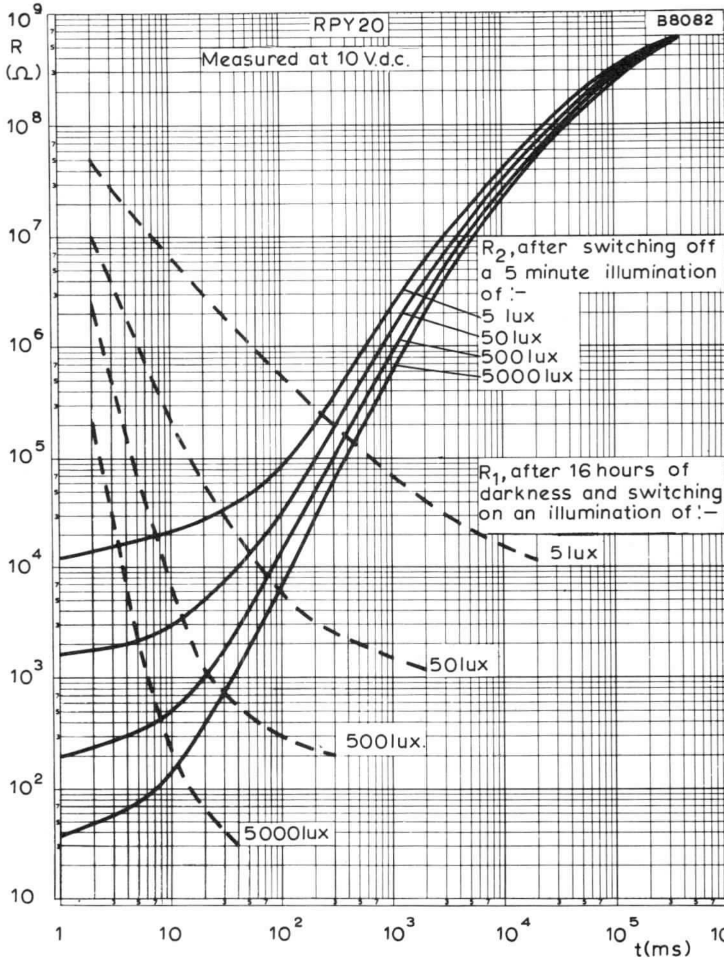
2.5g (peak), 50Hz, 32 hours in each of the three positions of the cell.

NOTES

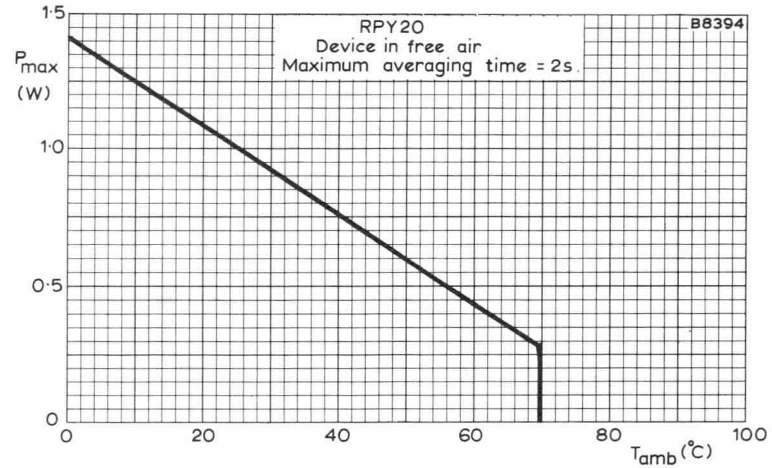
1. The spread of dark resistance is large, and values higher than 100MΩ and 10 000MΩ are possible for the initial and equilibrium dark resistance respectively.
2. After 16 hours in darkness changes in the cadmium sulphide material are still occurring, but have an insignificant effect on the illumination resistance and the resistance decay time.
3. If no forced air cooling is used, the envelope temperature opposite the centre of the sensitive area is about 83°C when the temperature of the cadmium sulphide tablet is 85°C. This temperature can be measured, for example, by means of a thermocouple fastened on the envelope.
4. Operation of the cell counteracts the deteriorating effect of long periods at high temperature. The maximum operating temperature is therefore higher than the maximum storage temperature.
5. The cell may be soldered directly into the circuit, but heat conducted to the tablet should be kept to a minimum by the use of a thermal shunt.
6. The cell may be dip-soldered at a solder temperature of 240°C for a maximum of 10 seconds up to a point 5mm from the seals.
7. Care should be taken not to bend the leads nearer than 1.5mm from the seals.



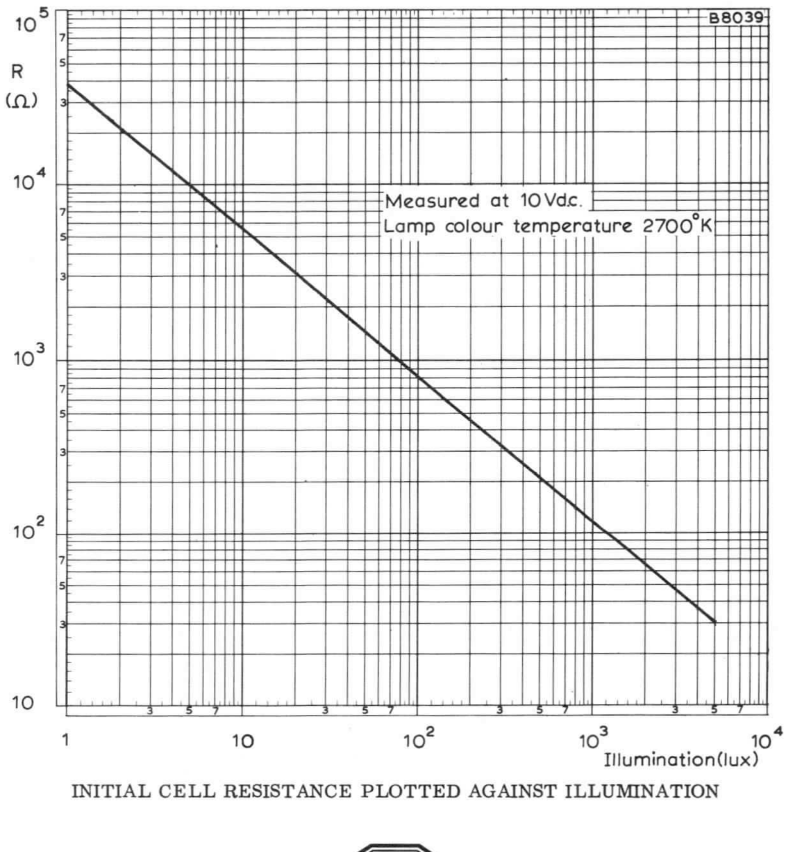
The spacing of the leads is compatible with
the standard printed wiring grid 2.54mm (0.1in)



RESISTANCE RISE AND FALL TIME CURVES
WITH ILLUMINATION AS PARAMETER



MAXIMUM POWER DISSIPATION PLOTTED AGAINST AMBIENT TEMPERATURE



INITIAL CELL RESISTANCE PLOTTED AGAINST ILLUMINATION

PHOTOCONDUCTIVE CELL RPY30

TENTATIVE DATA

QUICK REFERENCE DATA

A flat cadmium sulphide photoconductive cell in a plastic encapsulation.

Maximum power dissipation (T_{amb} = 25°C)	200	mW
Absolute maximum cell voltage (pk)	150	V
Cell resistance (at 50 lux)	1.6	kΩ
Sensitive area	0.6	cm^2

This data should be read in conjunction with OPERATING NOTES, given on page D2.

CHARACTERISTICS

(measured under d.c. conditions, at start of life with T_{amb} = 25°C)

Cell resistance at 1000 lux
and lamp colour temperature 2700°K

Typical	75 to 300	Ω
Minimum ultimate dark resistance	10	MΩ

RATINGS (ABSOLUTE MAXIMUM SYSTEM)

V_{cell} max. (pk)	150	V
P_{cell} max. with uniform illumination at T_{amb} = 25°C	200	mW
T_{amb}		
Maximum	+60	°C
Minimum	-30	°C

OPERATING NOTES

1. The data is based on the device being uniformly illuminated.

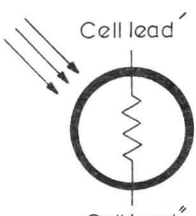
2. For sources of illumination other than a lamp of colour temperature 2700°K, the cell resistance should be multiplied by the following approximate factors.

Source of illumination	factor
Incandescent radiation at colour temperature of:	
1500°K	$^1/_2$
2000°K	$^2/_3$
Sunlight	$^4/_3$
White fluorescent	2

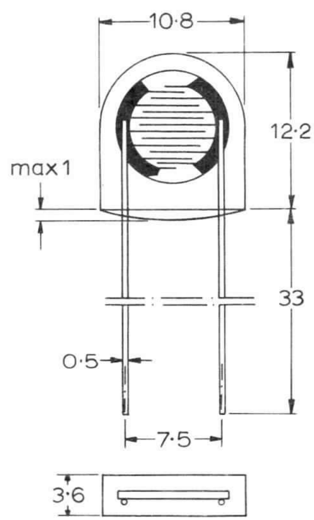
3. When the cell illumination is changed the cell resistance changes to a transient value and then, over a period of approximately 10 minutes assumes an equilibrium value. The transient usually overshoots the final equilibrium resistance.

4. The cell may be soldered directly into the circuit but heat conducted to the encapsulation should be kept to a minimum by the use of a thermal shunt.

5. Care should be taken not to bend the tags nearer than 1.5 mm to the seal.



The polarity of the supply is not important



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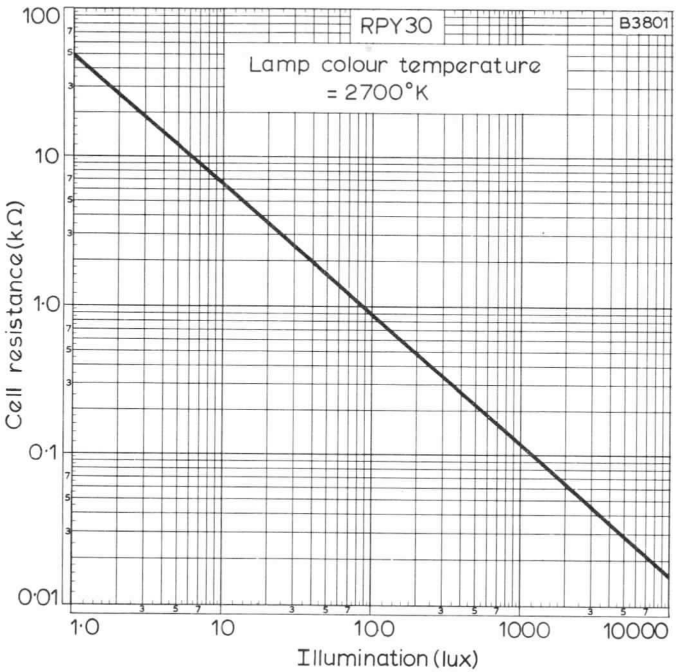
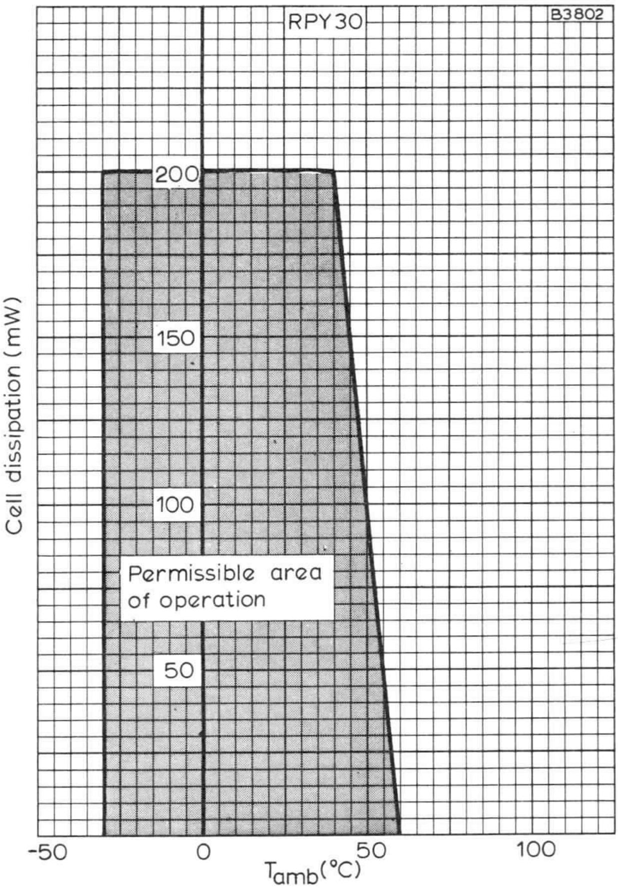
All dimensions in mm



TYPICAL CELL RESISTANCE PLOTTED AGAINST ILLUMINATION



MAXIMUM CELL DISSIPATION PLOTTED AGAINST AMBIENT TEMPERATURE

PHOTOCONDUCTIVE CELL RPY33

TENTATIVE DATA

QUICK REFERENCE DATA

Cadmium sulpho-selenide photoconductive cell for end-on incidence intended for use in exposure meters, light control equipment and for general industrial use. The cell is tropic proof, shock and vibration resistant. The envelope is hermetically sealed and has a plane glass window.

Maximum power dissipation	as a measuring device	10	mW
	for general use	75	mW
Maximum cell voltage (d.c. and repetitive peak)		50	V
Cell resistance (at 25 lux, 2854°K colour temperature)		2.5	kΩ
Sensitive area		4.9 × 3	mm
Maximum overall dimensions		9.4 dia. × 3.4	mm

This data should be read in conjunction with GENERAL EXPLANATORY NOTES-CADMIUM SULPHIDE PHOTOCONDUCTIVE CELLS

CHARACTERISTICS (measured under d.c. conditions, at start of life, with $T_{amb} = 25^{o}C$)

The cell is pre-conditioned for at least 1 hour with 300 lux illumination (fluorescent light)

	Min.	Typ	Max.	
Initial dark resistance (50V applied voltage, 20s after switching off an illumination of 25.6 lux)	100	-	-	kΩ
Initial illuminated resistance (25.6 lux illumination, 2854°K colour temperature, 1V applied voltage)	1.33	-	4.4	kΩ
Current decay time (time to reach 10% of the current at the instant of switching off 5 lux illumination)	-	3.0	-	s
Gamma over the illumination range 0.4 to 25.6 lux (see note 1)	0.63	0.75	0.87	
Illuminated current drift (over 10min period, 50 lux illumination)	-	-	10	%
Pre-conditioning factor (see note 2)	0.9	-	1.2	
$\frac{\text{Illumination at 2700°K}}{\text{Illumination at 4700°K}}$ (for the same cell resistance)	-	0.9	-	

Mullard

RATINGS (ABSOLUTE MAXIMUM SYSTEM)

V_{cell} max.	(d.c. and repetitive peak)	50	V
p_{cell} max.	for use as a measuring device	10	mW
	for general use	75	mW
T_{amb} max.		+60	^{o}C
T_{amb} min.		−40	^{o}C

SHOCK AND VIBRATION

Samples taken from normal production are submitted to shock and vibration tests as below. More than 95% of the devices pass these tests without perceptible damage.

Shock

50 g (peak), 5 shocks in each of the three positions of the cell.

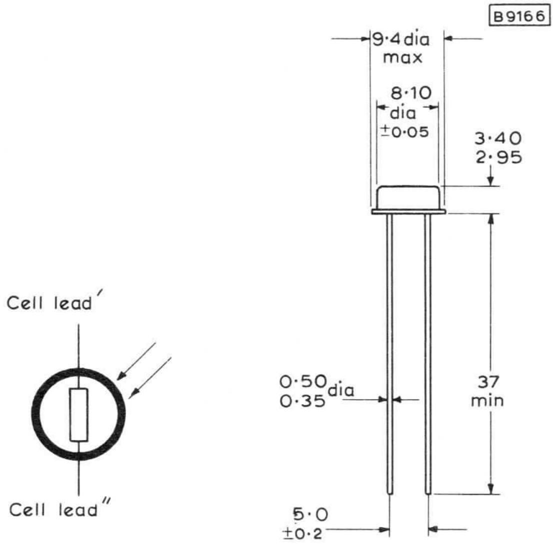
Vibration

2.5 g (peak), 50Hz, 32 hours in each of the three positions of the cell.

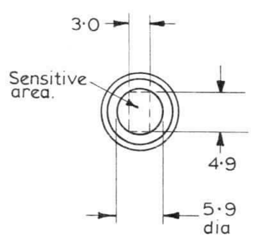
NOTES

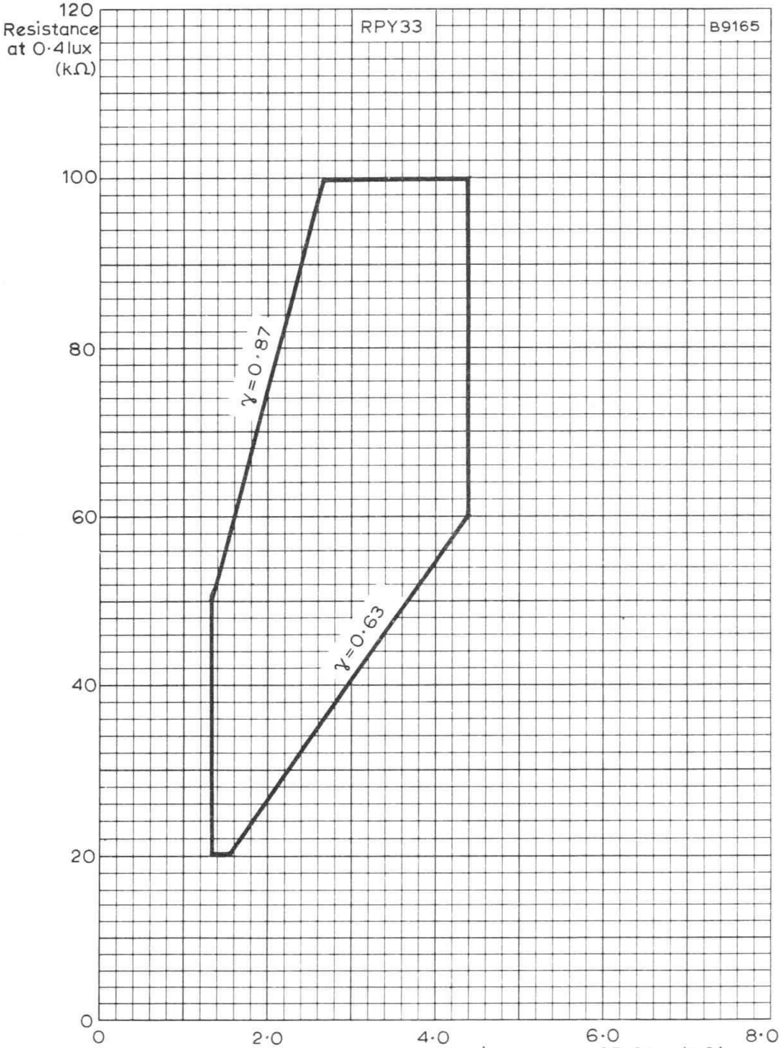
1. $\text{Gamma} = \dfrac{\log R1/R2}{\log E2/E1}$ where R1 = resistance at illumination E1 and R2 = resistance at illumination E2
2. $\text{Pre-conditioning factor} = \dfrac{\text{Cell current at 0.4 lux after 3 days in darkness}}{\text{Cell current at 0.4 lux after 1 hour preconditioning at 300 lux (fluorescent light)}}$
3. The cell may be soldered directly into the circuit, but heat conducted to the tablet should be kept to a minimum by the use of a thermal shunt.
4. The cell may be dip-soldered at a solder temperature of 245^{o}C for a maximum of 10 seconds up to a point 5mm from the seals, or for a maximum of 3 seconds up to a point 1.5mm from the seals.
   At a solder temperature between 245 and 400^{o}C the maximum soldering time is 5 seconds up to a point 5mm from the seals.
5. Care should be taken not to bend the leads nearer than 1.5mm from the seals.

OUTLINE AND DIMENSIONS



All dimensions in mm





RELATIONSHIP BETWEEN RESISTANCE AT 0.4 LUX AND 25.6 LUX
SHOWING POSSIBLE RANGE OF VALUES

PHOTOCONDUCTIVE CELL RPY43

QUICK REFERENCE DATA

Flat cadmium sulphide photoconductive cell for side incidence. The device satisfies I. E. C. Test C (damp heat test-long term exposure), as given in I. E. C. publication 68-2.

Maximum power dissipation ($T_{amb} = 25^{o}C$)	0.75	W
Maximum cell voltage (d. c. and repetitive peak)	400	V
Cell resistance (at 50 lux, 2700^{o}K colour temperature)	1.5	kΩ
Maximum overall dimensions	30.5×13.5×2.0	mm

This data should be read in conjunction with GENERAL EXPLANATORY NOTES-CADMIUM SULPHIDE PHOTOCONDUCTIVE CELLS

GENERAL

The electrical properties of cadmium sulphide cells are dependent on many factors, such as illumination, colour temperature of the source, cell voltage and current, temperature, time of operation in the circuit, and operation during the 24 hours prior to measurement. The following characteristics are therefore only checkpoints of the electrical properties, measured under specified conditions and at start of life.

CHARACTERISTICS (measured under d. c. conditions, at start of life, with $T_{amb} = 25^{o}C$, illumination colour temperature = 2700^{o}K)

	Min.	Typ.	Max.	
Dark resistance (300V applied in series with 1MΩ) (see note 1)				
after 20s in darkness	10	-	-	MΩ
after 30min in darkness	200	-	-	MΩ
Illuminated resistance (50 lux illumination, 10V applied voltage)				
initially after 16h in darkness (see note 2)	0.7	1.5	3.3	kΩ
after 15min under the measuring conditions	0.7	1.9	4.5	kΩ
Resistance decay time (time to reach 10kΩ, measured from the instant of switching on 50 lux illumination after 16h in darkness, 10V applied voltage)	-	-	0.2	s
Resistance rise time (time to reach 1MΩ, measured from the instant of switching off 50 lux illumination, after 5min or more illumination, 10V applied voltage)	-	0.9	1.5	s

CHARACTERISTICS (Continued)

Sensitivity (50 lux illumination, 10V applied voltage)	0.15	-	mA/lux
Temperature coefficient of illuminated resistance	0.2	0.5	%/degC
$\frac{\text{Resistance with 0.5V applied voltage}}{\text{Resistance with 10V applied voltage}}$	1.05	-	

CLIMATIC EFFECTS

The device satisfies test C (damp heat test-long term exposure), severity 4 (56 days at 40 2°C, 90 to 95% humidity) given in publication 68-2 of the International Electrotechnical Commission (I. E. C.)

RATINGS (ABSOLUTE MAXIMUM SYSTEM)

V_{cell} max. (d.c. and repetitive peak)	400	V
$V_{cell(pulse)}$ max. (maximum period 5ms, maximum repetition frequency 1pulse/min)	1.0	kV
p_{cell} max.	See page 5	
$p_{cell(pulse)}$ max.	5 x p_{cell} max.	
I_{cell} max. (d.c. and repetitive peak)	500	mA
Maximum illumination	50 000	lux
T_{tablet} max. (see note 3)	+85	°C
T_{amb} max. (storage) (see note 4)	+50	°C
T_{amb} max. (operating) (see note 4)	+70	°C
T_{amb} min. (storage and operating)	-40	°C

DESIGN CONSIDERATIONS

Apparatus using cadmium sulphide cells should be designed so that changes in resistance of the cells during life from -30% to +70% do not impair the circuit performance. Direct sunlight should be avoided.

SHOCK AND VIBRATION

Samples taken from normal production are submitted to shock and vibration tests as below. More than 95% of the devices pass these tests without perceptible damage.

Shock

25 g (peak), 10 000 shocks in one of the three positions of the cell.

Vibration

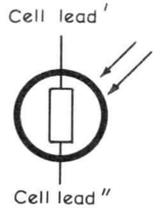
2.5 g (peak), 50Hz, 32 hours in each of the three positions of the cell.

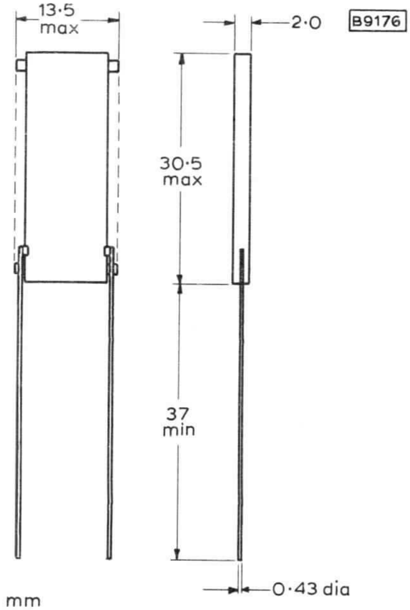
PHOTOCONDUCTIVE CELL RPY43

NOTES

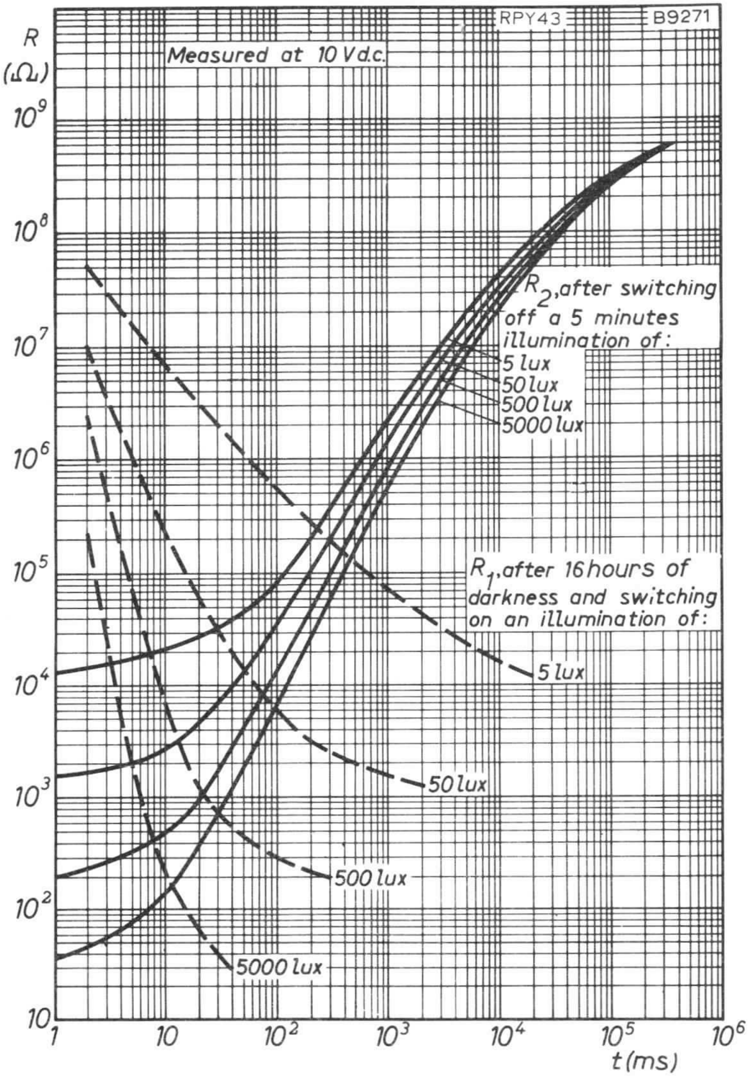
1. The spread of dark resistance is large, and values higher than 100MΩ and 10 000MΩ are possible for the initial and equilibrium dark resistance respectively.
2. After 16 hours in darkness changes in the cadmium sulphide material are still occurring, but have an insignificant effect on the illuminated resistance and the resistance decay time.
3. Operation of the cell counteracts the deteriorating effect of long periods at high temperature. The maximum operating temperature is therefore higher than the maximum storage temperature.
4. The cell may be soldered directly into the circuit, but heat conducted to the tablet should be kept to a minimum by the use of a thermal shunt.
5. The cell may be dip-soldered at a solder temperature of 240°C for a maximum of 10 seconds up to a point 5mm from the seals.
6. Care should be taken not to bend the leads nearer than 1.5mm from the seals.

OUTLINE AND DIMENSIONS

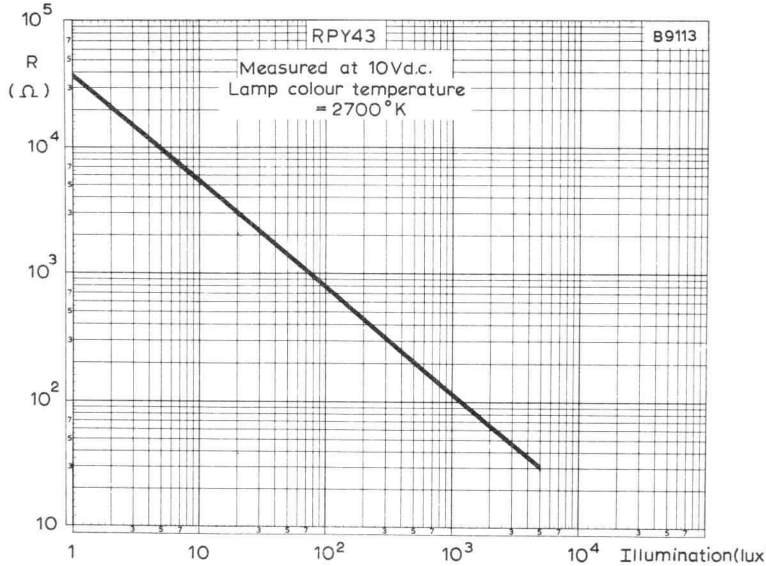




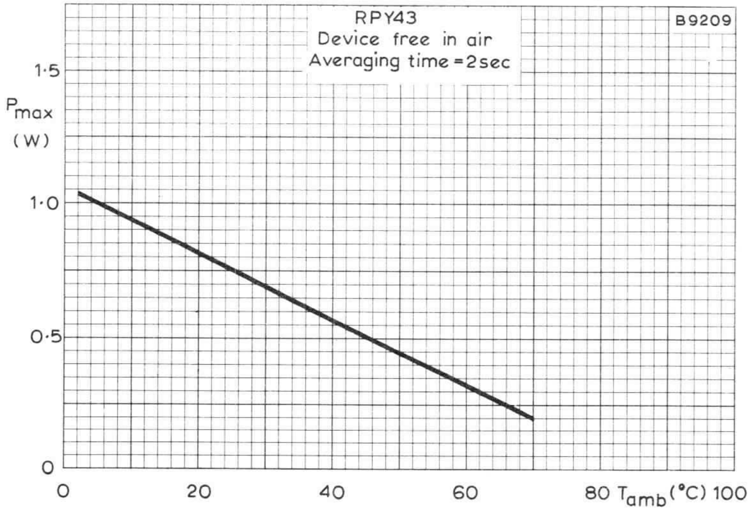
All dimensions in mm



RESISTANCE RISE AND FALL TIME CURVES
WITH ILLUMINATION AS PARAMETER



INITIAL CELL RESISTANCE PLOTTED AGAINST ILLUMINATION



MAXIMUM POWER DISSIPATION PLOTTED AGAINST AMBIENT TEMPERATURE

PHOTOCONDUCTIVE CELL RPY54

QUICK REFERENCE DATA		
Cadmium sulphide photoconductive cell intended for use in industrial on-off applications such as flame failure circuits. The cell is tropic proof, shock and vibration resistant.		
Maximum power dissipation ($T_{amb} = 25^{o}C$)	0.5	W
Maximum cell voltage (d.c.and repetitive peak)	200	V
Cell resistance (at 50lux, $2700^{o}K$ colour temperature)	1.5	kΩ
Sensitive area	1.5	cm^2

This data should be read in conjunction with GENERAL EXPLANATORY NOTES-CADMIUM SULPHIDE PHOTOCONDUCTIVE CELLS

GENERAL

The electrical properties of cadmium sulphide cells are dependent on many factors, such as illumination, colour temperature of the source, cell voltage and current, temperature, time of operation in the circuit, and operation during the 24 hours prior to measurement. The following characteristics are therefore only checkpoints of the electrical properties, measured under specified conditions and at start of life.

CHARACTERISTICS

(measured under d.c. conditions, at start of life, with $T_{amb} = 25^{o}C$, lamp colour temperature = $2700^{o}K$)

	Min.	Typ.	Max.	
Dark resistance (200V applied in series with 1MΩ) See note 1				
after 20s in darkness	6.5	-	-	MΩ
after 30min in darkness	120	-	-	MΩ
Illuminated resistance (50lux illumination, 10V applied voltage)				
initially after 16h darkness (see note 2)	0.7	1.5	3.3	kΩ
after 15min illumination	0.7	1.9	4.5	kΩ
Resistance decay time (time to reach 10kΩ, measured from the instant of applying 50lux illumination after 16h darkness, 10V applied voltage)	-	-	0.2	s
Resistance rise time (time to reach 1MΩ, measured from the instant of switching off 50lux illumination after 5min or more illumination, 10V applied voltage)	-	0.9	1.5	s

CHARACTERISTICS (Continued)

	Typ.	Max.	
Sensitivity (50lux illumination, 10V applied voltage)	0.15	-	mA/lux
Temperature coefficient of illuminated resistance	-0.2	-0.5	%per degC
Resistance with 0.5V applied voltage / Resistance with 10V applied voltage	1.1	-	

THERMAL CHARACTERISTIC

Thermal resistance from cadmium sulphide tablet to ambient, device free in air	120	degC/W

RATINGS (ABSOLUTE MAXIMUM SYSTEM)

V_{cell} max. (d.c. and repetitive peak)	200	V
I_{cell} max. (d.c. and repetitive peak)	250	mA
p_{cell} max.		See page C2
Maximum illumination	50 000	lux
Maximum temperature of cadmium sulphide tablet (see note 3)	+85	^{o}C
T_{amb} max. (storage) (see note 4)	+50	^{o}C
T_{amb} max. (operating) (see note 4)	+70	^{o}C
T_{amb} min. (storage and operating)	-40	^{o}C

DESIGN CONSIDERATIONS

Apparatus with cadmium sulphide cells should be designed so that changes in resistance of the cells during life from -30% to +70% do not impair the circuit performance. Direct sunlight should be avoided.

SHOCK AND VIBRATION

Samples taken from normal production are submitted to shock and vibration tests as below. More than 95% of the devices pass these tests without perceptible damage.

Shock

25g (peak), 10 000 shocks in one of the three positions of the cell.

Vibration

2.5g (peak), 50Hz, 32 hours in each of the three positions of the cell.

NOTES

1. The spread of dark resistance is large, and values higher than 100MΩ and 10 000MΩ are possible for the initial and equilibrium dark resistance respectively.
2. After 16 hours in darkness changes in the cadmium sulphide material are still occurring, but have an insignificant effect on the illumination resistance and the resistance decay time.

3. If no forced air cooling is used, the envelope temperature opposite the centre of the sensitive area is about 83°C when the temperature of the cadmium sulphide tablet is 85°C. This temperature can be measured, for example, by means of a thermocouple fastened on the envelope.

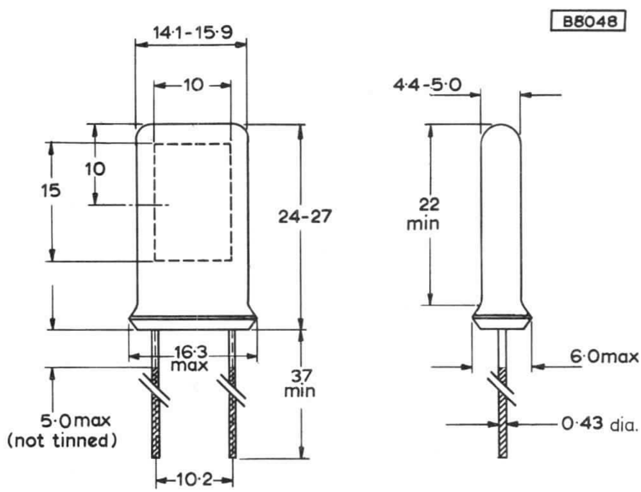
4. Operation of the cell counteracts the deteriorating effect of long periods at high temperature. The maximum operating temperature is therefore higher than the maximum storage temperature.

5. The cell may be soldered directly into the circuit, but heat conducted to the tablet should be kept to a minimum by the use of a thermal shunt.

6. The cell may be dip-soldered at a solder temperature of 240°C for a maximum of 10 seconds up to a point 5mm from the seals.

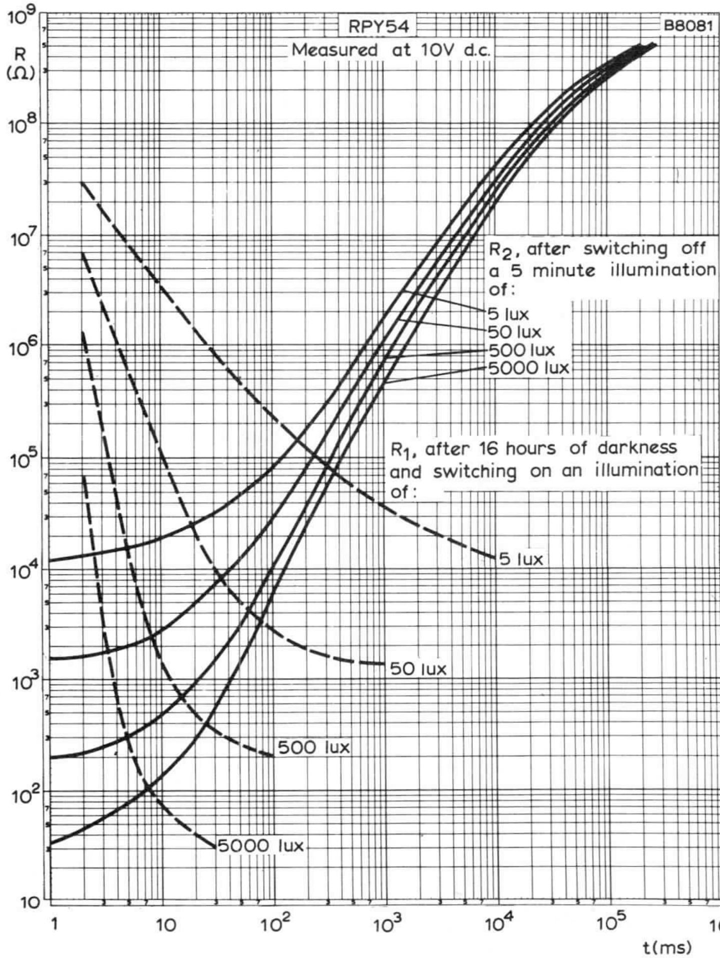
7. Care should be taken not to bend the leads nearer than 1.5mm from the seals.

OUTLINE AND DIMENSIONS

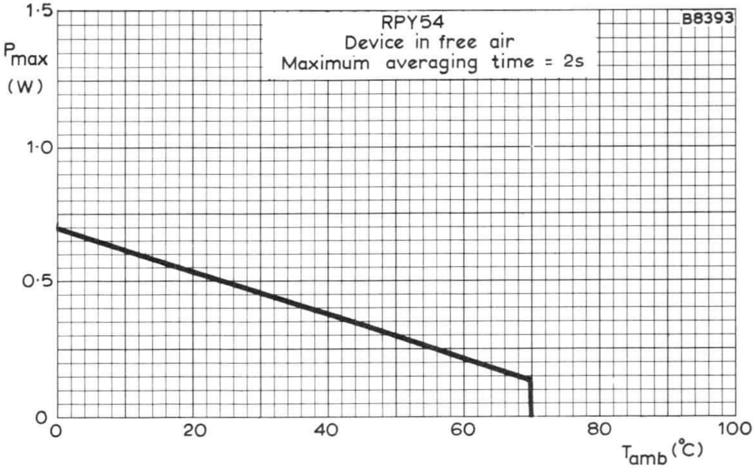


All dimensions in mm.

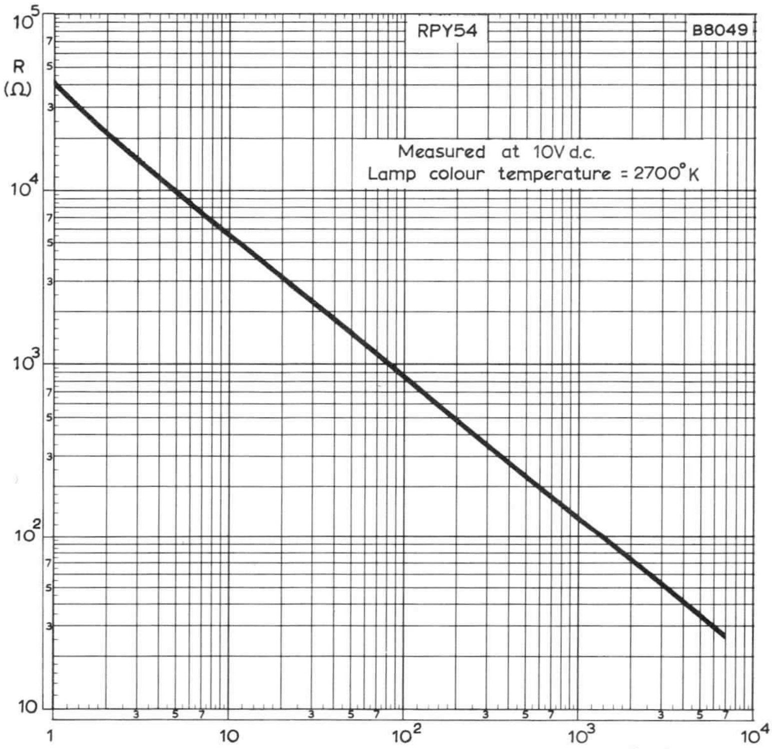
The spacing of the leads is compatible with the standard printed wiring grid 2.54mm (0.1in)



RESISTANCE RISE AND FALL TIME CURVES
WITH ILLUMINATION AS PARAMETER



MAXIMUM POWER DISSIPATION PLOTTED AGAINST AMBIENT TEMPERATURE



INITIAL CELL RESISTANCE PLOTTED AGAINST ILLUMINATION

PHOTOCONDUCTIVE CELL RPY55

QUICK REFERENCE DATA		
Cadmium sulphide photoconductive cell for end-on incidence, intended for use in general control circuits, such as twilight switches and flame failure equipment. The cell is tropic proof, shock and vibration resistant.		
Maximum power dissipation ($T_{amb} = 25^{o}C$)	1.0	W
Maximum cell voltage (d.c. and repetitive peak)	200	V
Cell resistance (at 50 lux, $2700^{o}K$ colour temperature)	420	Ω
Maximum overall dimensions	7.6 x 32 dia.	mm

This data should be read in conjunction with GENERAL EXPLANATORY NOTES - CADMIUM SULPHIDE PHOTOCONDUCTIVE CELLS

GENERAL

The electrical properties of cadmium sulphide cells are dependent on many factors, such as illumination, colour temperature of the source, cell voltage and current, temperature, time of operation in the circuit, and operation during the 24 hours prior to measurement. The following characteristics are therefore only checkpoints of the electrical properties, measured under specified conditions and at start of life.

CHARACTERISTICS (measured under d.c. conditions, at start of life, with $T_{amb} = 25^{o}C$, illumination colour temperature = $2700^{o}K$)

	Min.	Typ.	Max.	
Dark resistance (200V applied in series with 1MΩ) (see note 1)				
after 20s in darkness	3.0	-	-	MΩ
after 30min in darkness	50	-	-	MΩ
Illuminated resistance (50 lux illumination, 10V applied voltage)				
initially after 16h in darkness (see note 2)	250	420	1250	Ω
after 15min under the measuring conditions	250	530	1700	Ω
Resistance decay time (time to reach 5.0kΩ, measured from the instant of switching on 50 lux illumination after 16h in darkness, 10V applied voltage)	-	-	0.3	s
Resistance rise time (time to reach 1MΩ, measured from the instant of switching off 50 lux illumination, after 5min or more illumination, 10V applied voltage)	-	-	2.0	s

CHARACTERISTICS (continued)

	Typ.	Max.	
Sensitivity (50 lux illumination, 10V applied voltage)	0.5	-	mA/lux
Temperature coefficient of illuminated resistance	−0.2	−0.5	%/degC
$\frac{\text{Resistance with 0.5V applied voltage}}{\text{Resistance with 10V applied voltage}}$	1.05	-	

THERMAL CHARACTERISTIC

Thermal resistance from cadmium sulphide tablet to ambient, device free in air	60	degC/W

RATINGS (ABSOLUTE MAXIMUM SYSTEM)

V_{cell} max. (d.c. and repetitive peak)	200	V
$V_{cell(pulse)}$ max. (maximum period 5ms, maximum repetition frequency 1pulse/min)	500	V
p_{cell} max.	See page 4	
$p_{cell(pulse)}$ max.	5 x p_{cell} max.	
I_{cell} max. (d.c. and repetitive peak)	250	mA
Maximum illumination	50 000	lux
T_{tablet} max.	+85	^{o}C
T_{amb} max. (storage) (see note 3)	+50	^{o}C
T_{amb} max. (operating) (see note 3)	+70	^{o}C
T_{amb} min. (storage and operating)	-40	^{o}C

DESIGN CONSIDERATIONS

Apparatus using cadmium sulphide cells should be designed so that changes in resistance of the cells during life from -30% to +70% do not impair the circuit performance. Direct sunlight should be avoided.

SHOCK AND VIBRATION

Samples taken from normal production are submitted to shock and vibration tests as below. More than 95% of the devices pass these tests without perceptible damage.

Shock

25 g (peak), 10 000 shocks in one of the three positions of the cell.

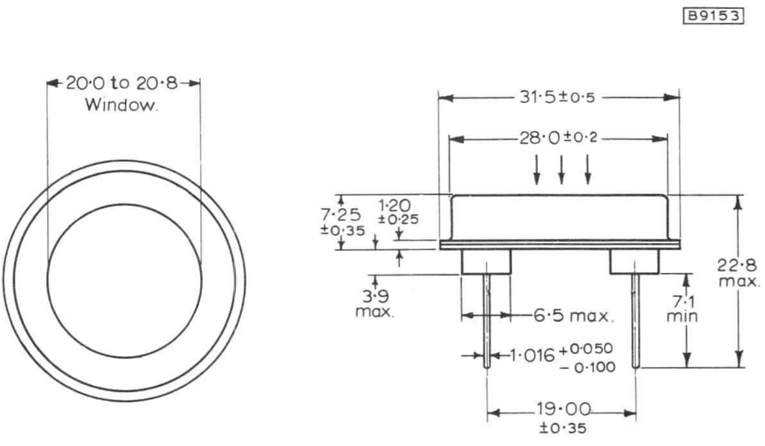
Vibration

2.5 g (peak), 50Hz, 32 hours in each of the three positions of the cell.

NOTES

1. The spread of dark resistance is large, and values higher than 50MΩ and 5000MΩ are possible for the initial and equilibrium dark resistance respectively.
2. After 16 hours in darkness changes in the cadmium sulphide material are still occurring, but have an insignificant effect on the illuminated resistance and the resistance decay time.
3. Operation of the cell counteracts the deteriorating effect of long periods at high temperature. The maximum operating temperature is therefore higher than the maximum storage temperature.

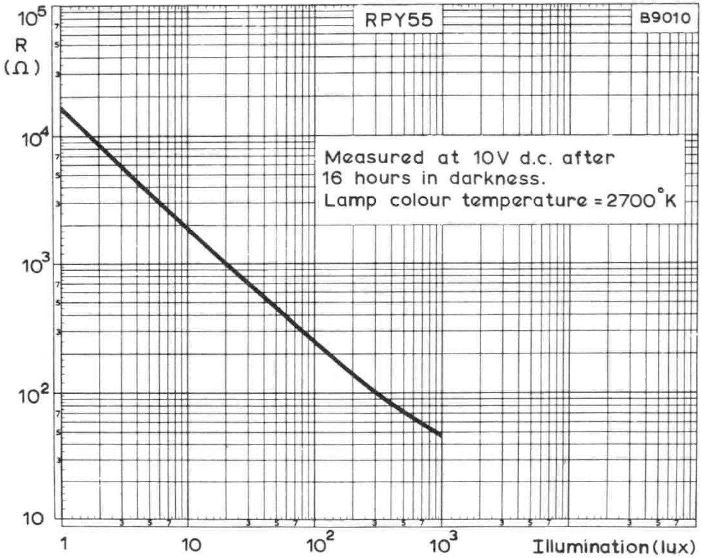
OUTLINE AND DIMENSIONS



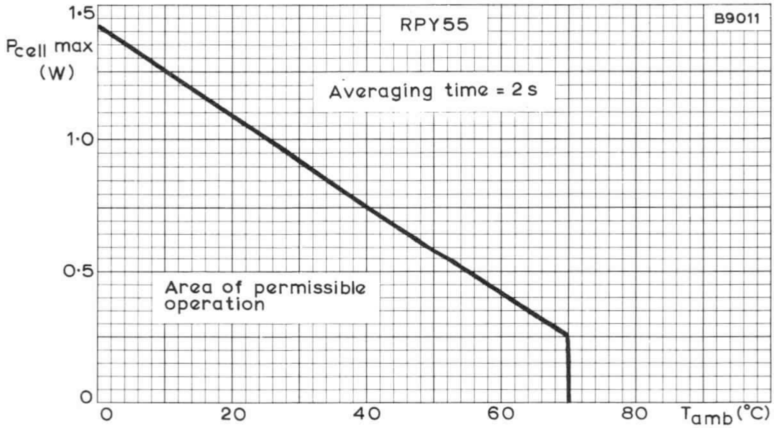
All dimensions in mm.

ACCESSORY

Pin connector 55561



INITIAL CELL RESISTANCE PLOTTED AGAINST ILLUMINATION



MAXIMUM POWER DISSIPATION
PLOTTED AGAINST AMBIENT TEMPERATURE

PHOTOCONDUCTIVE DEVICE

RPY58

TENTATIVE DATA

QUICK REFERENCE DATA		
Cadmium sulphide photoconductive device for side incidence in plastic encapsulation. The device consists of two cells connected in series, and is intended for general applications.		
Maximum power dissipation ($T_{amb} \leq 40^oC$)	200	mW
Maximum cell voltage (d.c. and repetitive peak)	50	V
Cell resistance (at 50 lux, 2700^oK colour temperature)	600	Ω
Maximum overall dimensions	$6.0 \times 6.0 \times 2.0$ mm	

This data should be read in conjunction with GENERAL EXPLANATORY NOTES - CADMIUM SULPHIDE PHOTOCONDUCTIVE CELLS

CHARACTERISTICS (measured under d.c. conditions, at start of life, with $T_{amb} = 25^oC$, illumination colour temperature $= 2700^oK$)

	Min.	Typ.	Max.	
Initial dark resistance (50V applied in series with 1MΩ, after 20s in darkness)	200	-	-	kΩ
Initial illuminated resistance (1V applied voltage, 50 lux illumination, after 16h in darkness)	0.35	0.6	1.4	kΩ
Initial drift	-	0	-	%
$\frac{\text{Resistance at } 4700^oK \text{ colour temperature}}{\text{Resistance at } 2700^oK \text{ colour temperature}}$ (at constant illumination)	-	1.2	-	

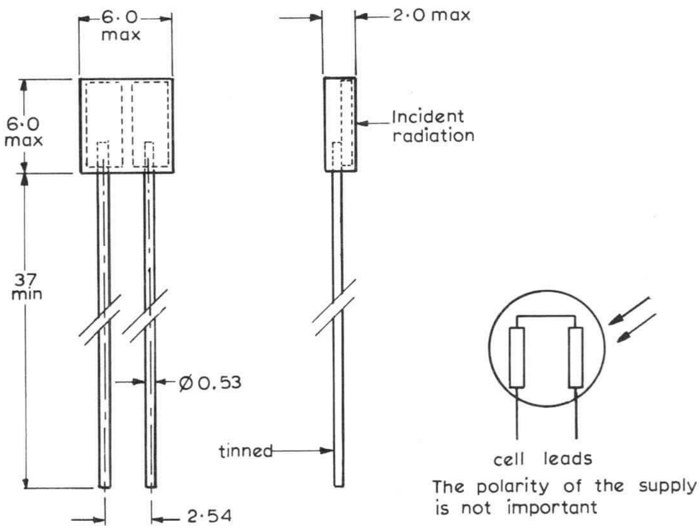
RATINGS (ABSOLUTE MAXIMUM SYSTEM)

V_{cell} max. (d.c. and repetitive peak)	50	V
$V_{cell(pulse)}$ max. (maximum period 5ms, maximum repetition frequency 1 pulse/min)	100	V
P_{cell} max.	See page 3	
I_{cell} max. (d.c. and r.m.s.)	25	mA
T_{amb} max. (storage)	+50	^oC
T_{amb} max. (operating)	+70	^oC
T_{amb} min. (storage and operating)	-40	^oC

NOTES

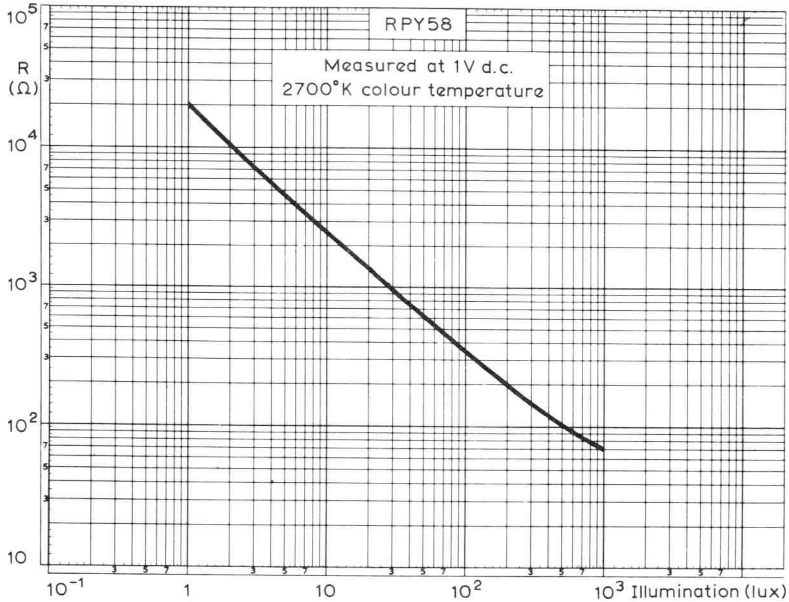
1. The device consists of two photoconductive cells connected in series. The resistance of the device is mainly governed by the resistance of the cell receiving the lower luminous flux.
   If for any application it is required to partially shade the device, the shadow line should be perpendicular to the axis of the device (i.e. horizontal if the cell is positioned as in the drawing below).
2. Since heat produced in the cell is removed mainly by conduction along the leads, short leads will improve the performance.
3. The device may be soldered directly into the circuit, but heat conducted to the tablet should be kept to a minimum by the use of a thermal shunt. It may be dip-soldered at a solder temperature of 270°C for a maximum of 2 seconds up to a point 6mm from the envelope.

OUTLINE AND DIMENSIONS

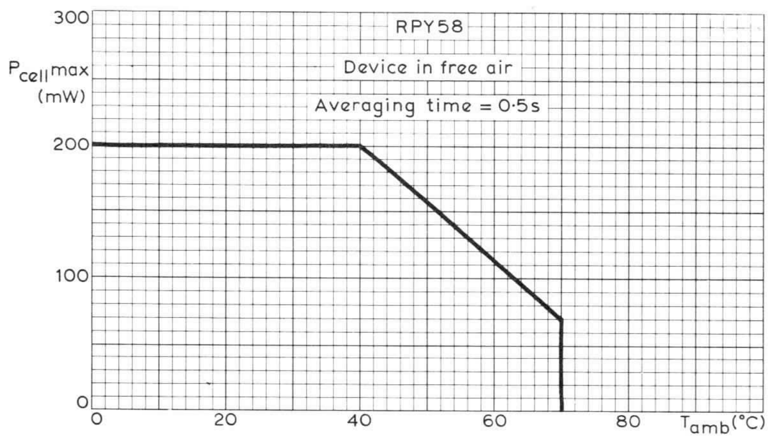


All dimensions in mm

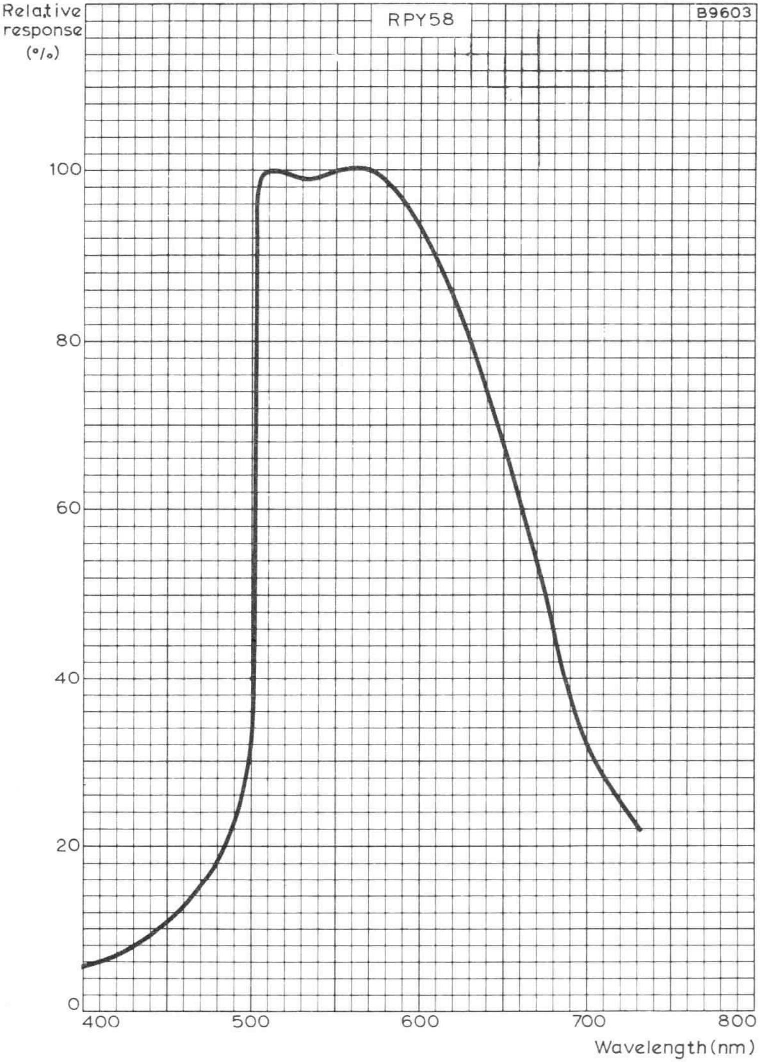
The spacing of the leads is compatible with
the standard 2.54mm (0.1in) printed wiring grid



INITIAL CELL RESISTANCE PLOTTED AGAINST ILLUMINATION



MAXIMUM CELL DISSIPATION
PLOTTED AGAINST AMBIENT TEMPERATURE



RELATIVE SPECTRAL RESPONSE

PHOTOCONDUCTIVE CELLS 61SV 62SV

QUICK REFERENCE DATA

Evaporated lead sulphide photoconductive cells with sensitive element mounted in a glass dewar. Normally encapsulated in a metal envelope for room temperature operation. Also available without metal envelope for cooled operation.
Spectral response from 0.3 to 3.5μm and intended for use with pulsed or modulated radiation.

	61SV	62SV	
Wavelength at maximum response	2.2	2.5	μm
Resistance	1.5	1.5	MΩ
Responsivity (2.0μm radiation)	8.0×10^4	1.2×10^5	V/W
D* (2.0μm, 800, 1)	4.0×10^{10}	6.0×10^{10}	$cm(Hz)^{\frac{1}{2}}/W$
Time constant	100	175	μs
Sensitive area	6.0x6.0	6.0x6.0	mm

Unless otherwise stated, data is applicable to both types

CHARACTERISTICS (at $T_{amb} = 20^{o}C$ under conditions specified in note 1)

		61SV	62SV	
Wavelength at maximum response		2.2	2.5	μm
Spectral response range (see page 5)		0.3 to 3.5	0.3 to 3.5	μm
Cell resistance	min.	1.0	1.0	MΩ
	typ.	1.5	1.5	MΩ
	max.	4.0	4.0	MΩ
Time constant (see note 2)	typ.	100	175	μs
Noise voltage (see note 3)	typ.	8.5	8.5	μV

MONOCHROMATIC PERFORMANCE (see notes 1 and 4)

		61SV	62SV	
Responsivity (to 2.0μm radiation)	typ.	8.0×10^4	1.2×10^5	V/W
D* (2.0μm, 800, 1)	typ.	4.0×10^{10}	6.0×10^{10}	$cm(Hz)^{\frac{1}{2}}/W$
N.E.P. (2.0μm, 800, 1)	typ.	1.5×10^{-11}	1.0×10^{-11}	W

BLACK BODY PERFORMANCE (see notes 1 and 4)

		61SV	62SV	
Responsivity (to 500°K radiation)	min.	2.2×10^2	1.0×10^3	V/W
	typ.	1.3×10^3	2.0×10^3	V/W
D* (500°K, 800, 1)	min.	2.2×10^8	6.0×10^8	cm(Hz)½/W
	typ.	6.5×10^8	1.0×10^9	cm(Hz)½/W
N.E.P. (500°K, 800,1)	typ.	9.2×10^{-10}	6.0×10^{-10}	W
	max.	2.7×10^{-9}	1.0×10^{-9}	W

RATINGS (ABSOLUTE MAXIMUM SYSTEM)

Electrical

V_{cell} max.	250	V
I_{cell} max.	0.5	mA

Temperature (see note 5)

T_{amb} max. (storage and operating)	+60	°C
T_{amb} min. (storage and operating)		
Encapsulated version	-55	°C
Cooled version	-80	°C

NOTES

1. TEST CONDITIONS

Characteristics are measured with the cell biased from a 200V d.c. supply in series with a 1.0MΩ load resistor. No correction is made for the loading effect of the 1.0MΩ resistor, i.e. open circuit characteristics are not given.

A monochromatic source provides a uniform field at 2.0μm wavelength so as to provide a steady irradiance of 0.86μW/cm² at the sensitive element. However the beam is modulated at 800Hz, giving an actual r.m.s. power at the element of $\frac{0.86}{2.2} \simeq 0.4\mu W/cm^2$.

Irradiation from the 500°K black body source is also square wave modulated at 800Hz, giving an actual r.m.s. power of 4.55μW/cm². Measurements of the detector output are made with an amplifier tuned to 800Hz with a bandwidth of 50Hz.

2. FREQUENCY RESPONSE

The 61SV and 62SV have typical time constants of 100μs and 175μs respectively. These figures represent the time for the output to drop to e^{-1} of its value after radiation on the cell has been cut off. Because of this, responsivity varies with the frequency of interruption of the radiation in accordance with the following relationship:

$$S = \frac{S_o}{\sqrt{1+4\pi^2 f^2 t^2}}$$

where S and S_o are the responsivities at frequencies f and zero respectively, and t is the time constant.

3. VARIATION OF PERFORMANCE WITH BIAS CURRENT

Both signal and noise vary with bias current in this type of cell. Typical curves are shown on page 6. At high currents the noise increases more rapidly than the signal, and therefore the signal-to-noise ratio has a peak value at some optimum current, which will vary slightly from cell to cell. A typical value is 20μA.

4. RESPONSIVITY

Responsivity is defined as the r.m.s. signal voltage per unit r.m.s. radiant power, expressed in volts per watt.

N.E.P. and D*

These are figures of merit for the materials of detectors and are fully discussed in most textbooks on infrared, e.g. "Infrared Physics" by J.T. Houghton and S.D. Smith (O.U.P. 1966) and "Elements of Infrared Technology" by Kruse, McGlauchin and McQuistan (John Wiley, New York 1962).

D* (detectivity) is defined by the expression

$$D^* = \frac{\frac{V_s}{V_n} \times \left[A(\Delta f)\right]^{1/2}}{W}$$

where V_s = Signal voltage across detector terminals.

V_n = Noise voltage across detector terminals.

A = Detector area

(Δf) = Bandwidth of measuring amplifier.

W = Radiation power (watts r.m.s.) incident on detector sensitive element.

The figures in brackets which follow D* and N.E.P. refer to the test conditions, e.g. D* (2.0μm, 800, 1) denotes monochromatic radiation of 2.0μm wavelength incident on the detector, modulation frequency 800Hz and an electronic bandwidth of 1.0Hz.

The Noise Equivalent Power (N.E.P.) is related to D* by the expression

$$N.E.P. = \frac{(A)^{1/2}}{D^*}$$

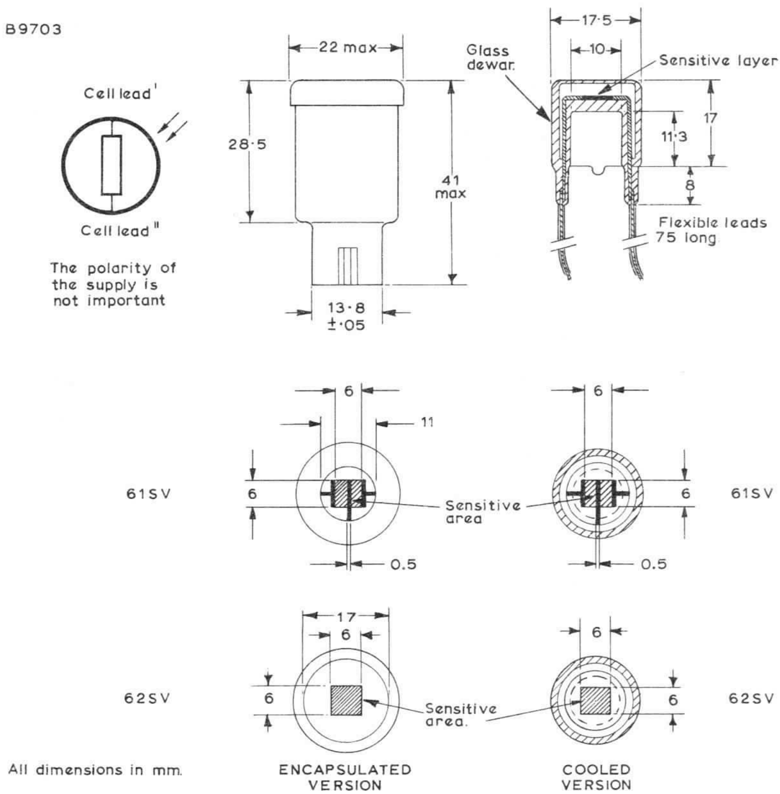
5. AMBIENT TEMPERATURE

The performance of the cell depends upon the ambient temperature. Correction factors for variation of ambient temperature are given on page 8 for resistance, detectivity and responsivity.

6. WARNING

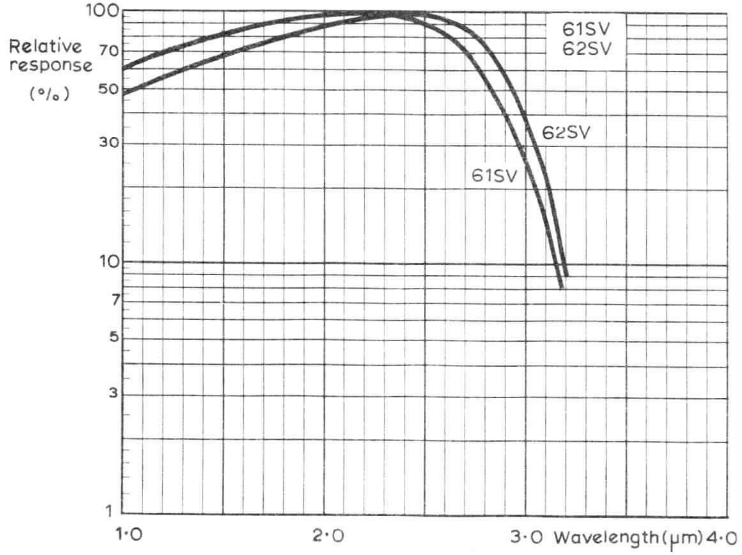
Prolonged exposure to visible radiation should be avoided.

OUTLINE DRAWING OF 61SV AND 62SV

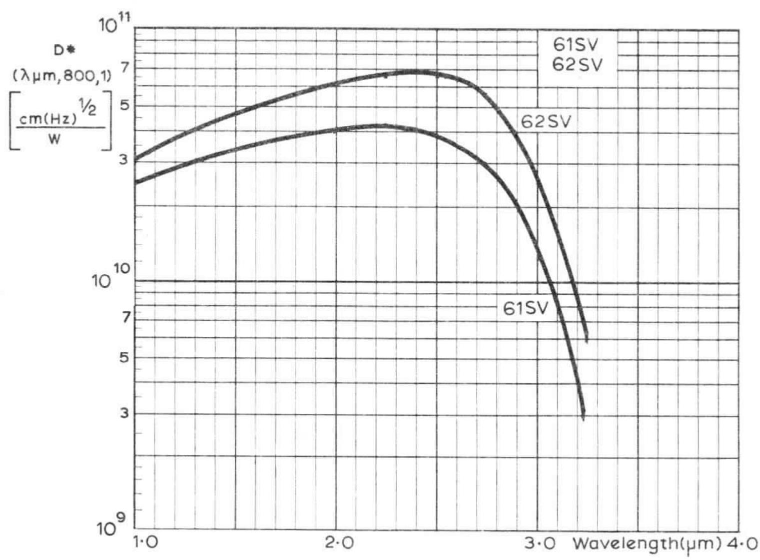


SOCKET

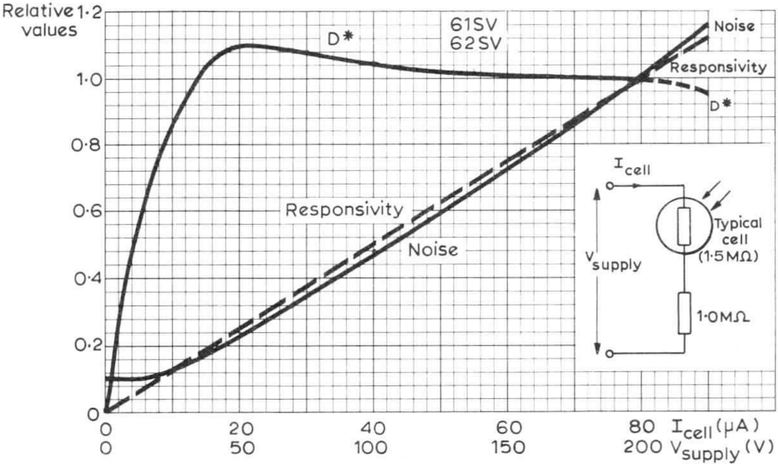
A suitable socket for the encapsulated version is Belling-Lee type 789/CS.



TYPICAL SPECTRAL RESPONSE AT 20°C

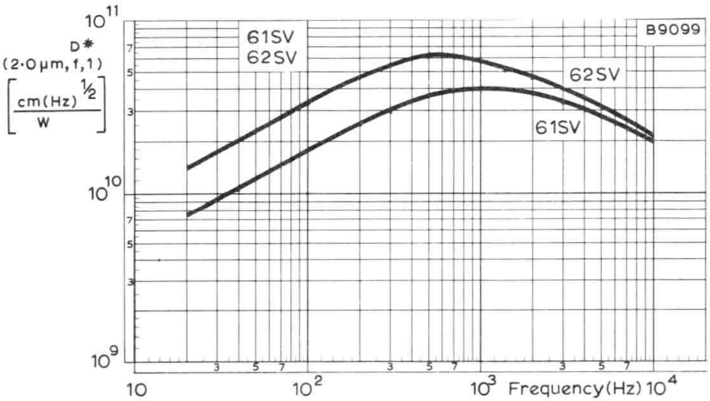


TYPICAL VARIATION OF DETECTIVITY WITH WAVELENGTH

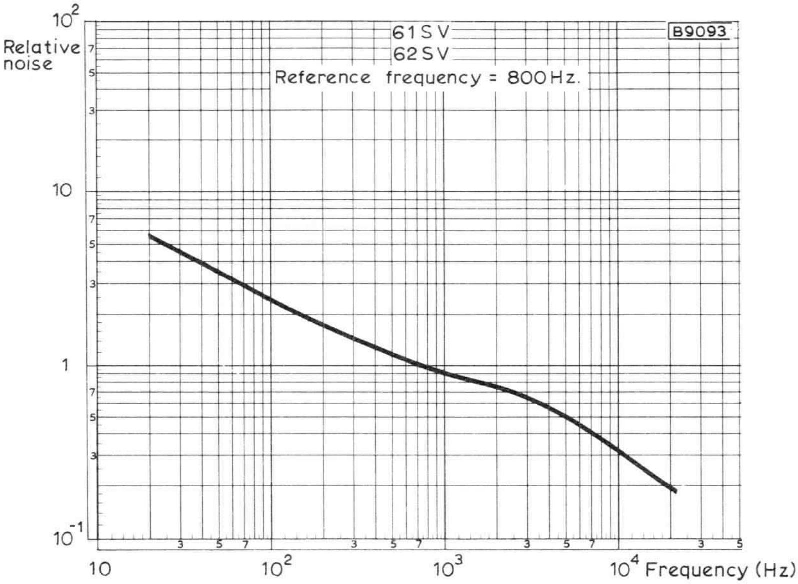


DETECTIVITY, RESPONSIVITY AND NOISE
PLOTTED AGAINST CELL CURRENT

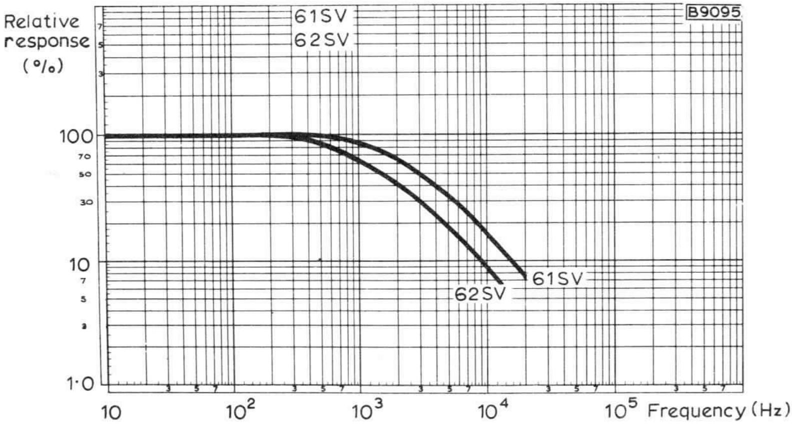
The values given are for a typical cell (1.5MΩ) in series with a 1MΩ resistor, and are relative to the values at V_{supply} = 200V, corresponding to a cell current of 80μA.



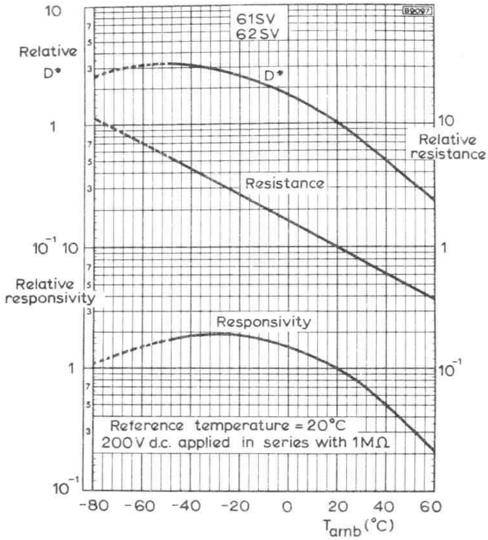
DETECTIVITY PLOTTED AGAINST FREQUENCY



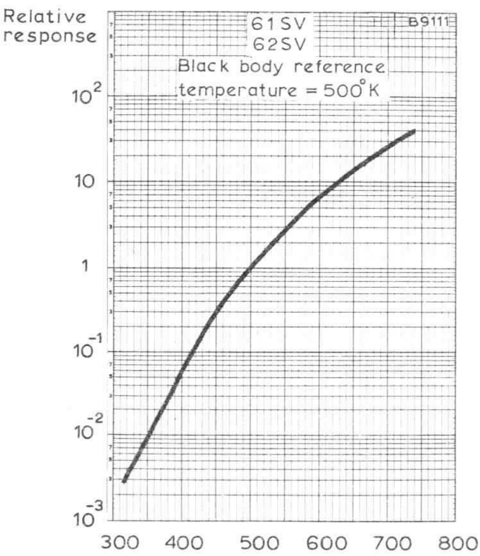
RELATIVE NOISE PLOTTED AGAINST FREQUENCY



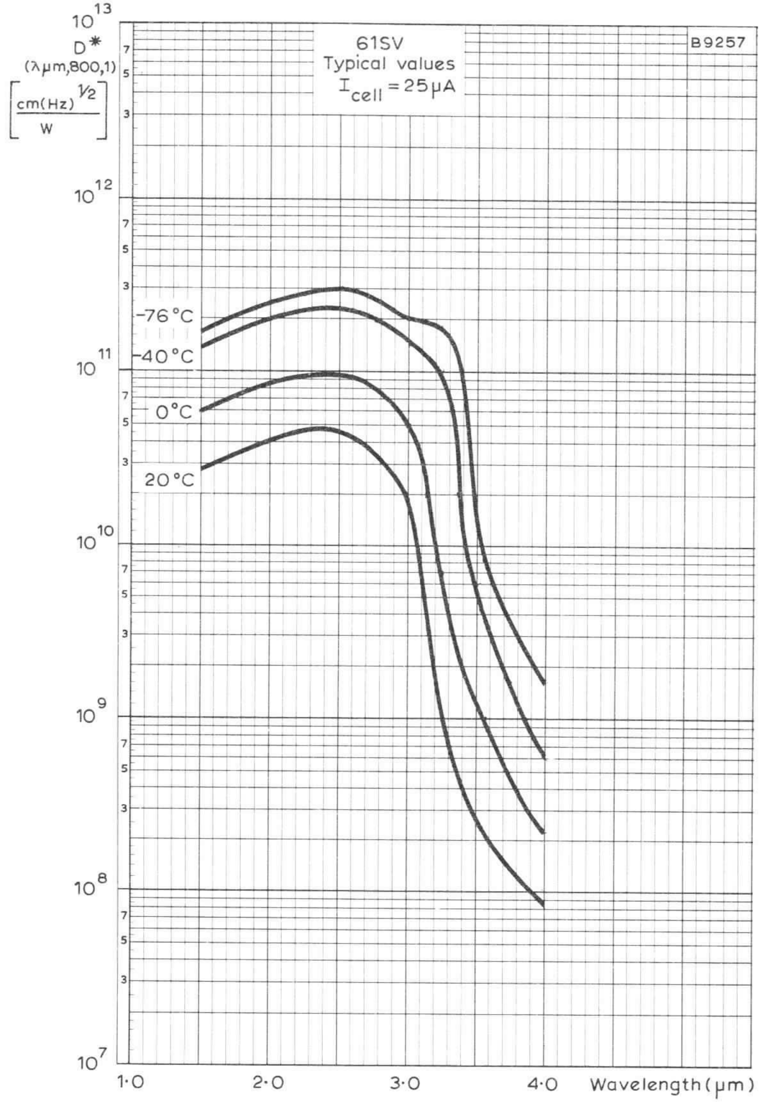
RELATIVE RESPONSE PLOTTED AGAINST FREQUENCY



RELATIVE VALUES OF DETECTIVITY, RESISTANCE AND RESPONSIVITY PLOTTED AGAINST AMBIENT TEMPERATURE



RELATIVE RESPONSE PLOTTED AGAINST BLACK BODY TEMPERATURE



DETECTIVITY PLOTTED AGAINST WAVELENGTH
WITH CELL TEMPERATURE AS A PARAMETER
FOR COOLED VERSION OF 61SV

PHOTOCONDUCTIVE CELL

63TV

Cooled lead telluride photoconductive cell having a high infra-red sensitivity at liquid air temperature.

SENSITIVE AREA

The sensitive area is 0.1 sq. cm., the two electrodes being 10mm long and 1.0mm apart.

CHARACTERISTICS (measured with the cell cooled by liquid oxygen)

Peak spectral response	4.2	μ
Spectral response range	0.6 to 6.0	μ
Sensitivity (see notes)		
Black body at 200°C	650	Vr.m.s./W (pk to pk)
Signal-to-noise ratio	>250	
Noise equivalent power (bandwidth 1c/s)	$<8\times10^{-10}$	W

(Test conditions 1.36μW of radiation falling on the cell area with 150V applied across cell and 1.0MΩ load resistor. The interruption frequency of the radiation is 800c/s and the measuring amplifier bandwidth is 50c/s.)

Cell resistance (variation from cell to cell)	1 to 50	MΩ
Time constant	10 to 100	μs
Noise equivalent power at 4μ	2.2×10^{-10}	W ←

LIMITING VALUES (absolute ratings)

*Maximum applied voltage across cell and load	250	V

*No voltage should be applied to the cell before it is cooled by liquid oxygen otherwise permanent damage may result.

NOTES

Sensitivity. The 63TV differs from the vacuum photoemissive cell in that the signal for a given irradiation energy is dependent upon the applied voltage and is linear up to about 200V across cell and load.

The 63TV has a high infra-red sensitivity and its performance is usually defined in terms of volts/(radiation source watt) across the cell load, when subjected to interrupted radiation from a black body at some specified temperature. For spectroscopic work it is of use to have the cell sensitivity at some fixed wavelength. For the 63TV this is given at 4μ.

As a limiting measure of cell sensitivity the signal-to-noise ratio for a given amount of interrupted radiation from a black body is usually given or what is the same thing, the noise equivalent power i.e. the radiation falling on the cell which will produce a signal equal to the cell noise with a test amplifier bandwidth of 1c/s.

Sensitivity of 63TV for different source temperatures. The sensitivity of the 63TV increases rapidly with the radiation source temperature. This is illustrated by the fact that if the source temperature changes from 200 to 500°C the sensitivity increases by a factor of 25.

ADDITIONAL INFORMATION

Shape of spectral response curve.

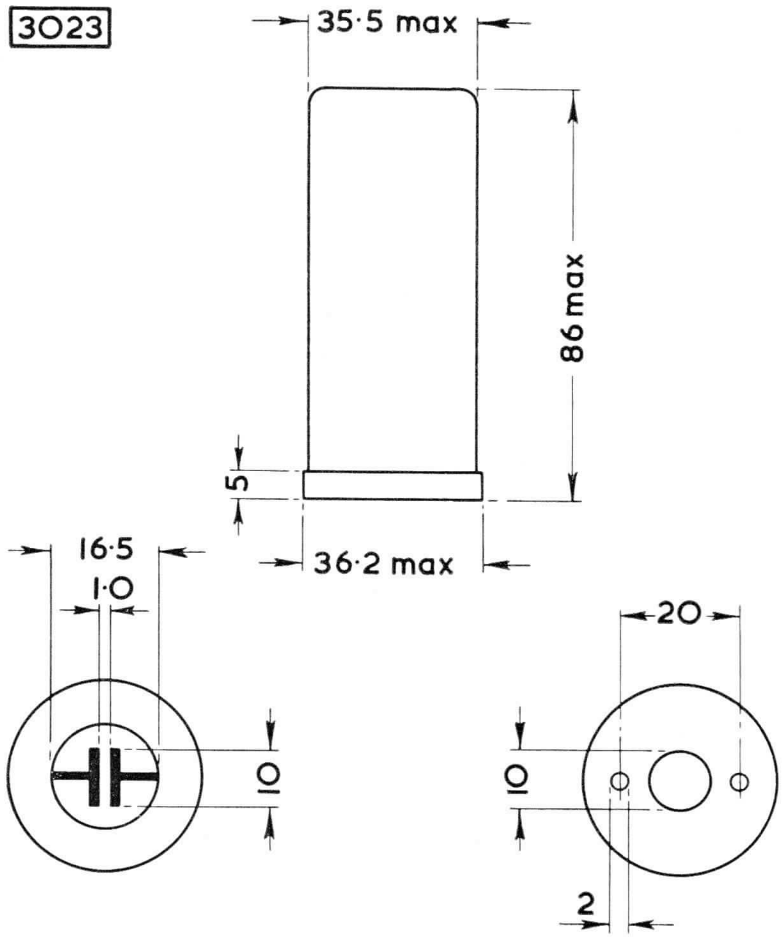
It is found that some cells have curves which have a secondary peak in the region of 2μ. The height of this peak is variable and in many cells it is completely absent.

Applications

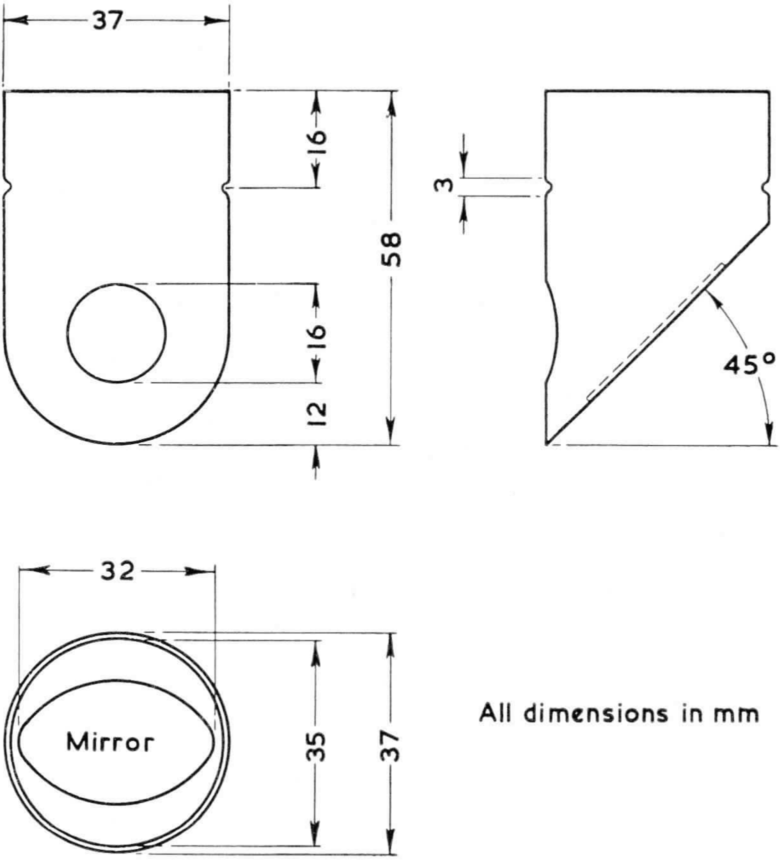
(1) Detector for spectroscopic work out to 6.0μ

(2) Rapid scanning spectrometry out to 6.0μ

(3) Gas analysis.



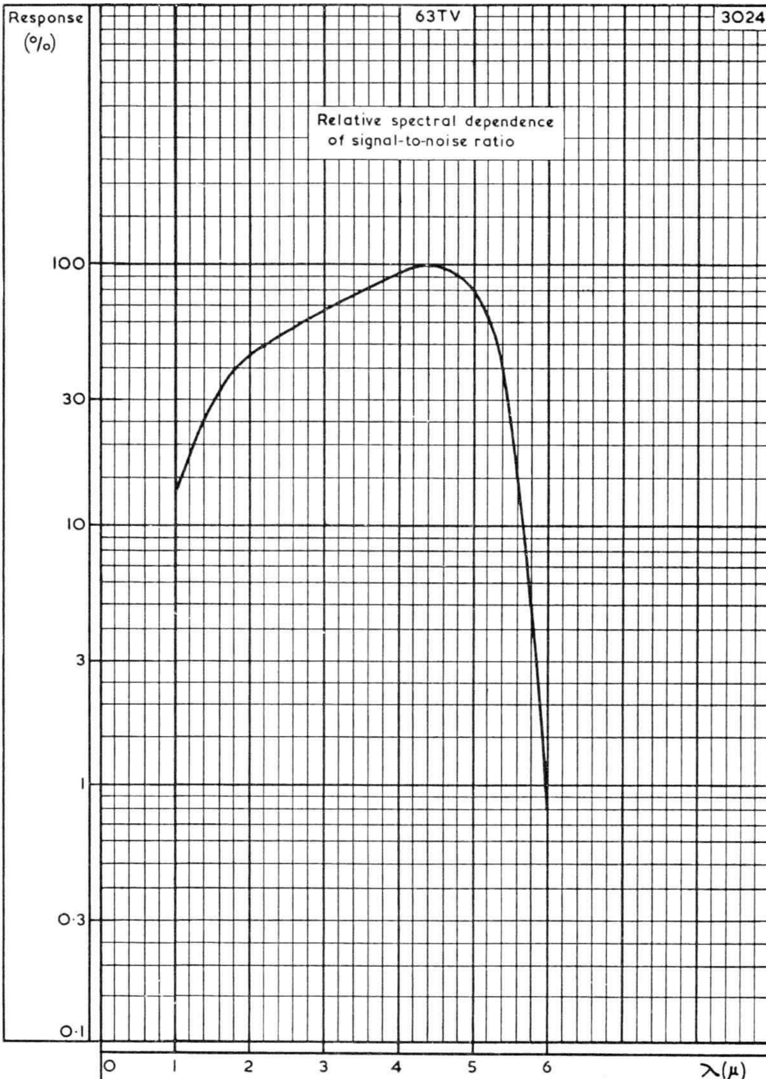
All dimensions in mm



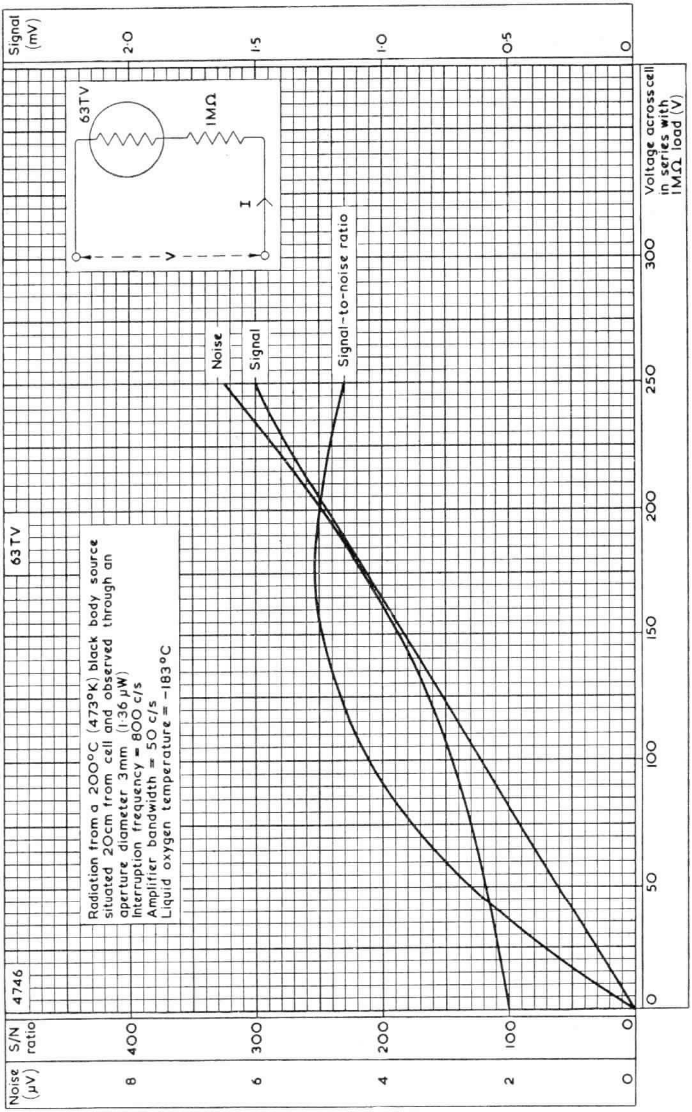
All dimensions in mm

MIRROR ATTACHMENT
FOR 63TV

3025



RELATIVE SPECTRAL DEPENDENCE OF SIGNAL-TO-NOISE RATIO



SIGNAL-TO-NOISE RATIO, NOISE AND SIGNAL PLOTTED AGAINST VOLTAGE ACROSS CELL WITH 1MΩ LOAD

PHOTOEMISSIVE CELLS

1. GENERAL

Photoemissive tubes are photoelectric devices of the emissive type, as distinct from barrier layer and photoconductive cells. They may be divided into two main groups:

a) High vacuum tubes

b) Gas-filled tubes

Each of these groups can be sub-divided into red sensitive and blue sensitive photo tubes; the spectral response depends upon the photocathode material. Blue sensitive tubes have a type 'A' or type 'U' cathode (caesium antimony), type 'U' having a quartz window to extend the response into the ultra-violet region. Red sensitive tubes have a type 'C' cathode (caesium on oxidised silver).

Spectral response curves for each type of cathode are given at the end of these notes. These curves are for guidance only, and should not be taken as exact.

2. OPERATING CHARACTERISTICS

For a vacuum photo tube the anode current at a fixed illumination is reasonably constant at voltages above a certain low value known as the "saturation voltage".

Gas-filled photo tubes contain a quantity of inert gas, the ionising potential of which is generally somewhat higher than the saturation voltage of an equivalent vacuum photo tube, so that the anode current is substantially constant between the saturation voltage and the voltage at which ionisation commences. Above this voltage range, ionisation increases, resulting in a progressive increase in anode current.

Since the gas-filled photo tube operates at a higher voltage than the ionising potential, it will have a greater sensitivity than a similar vacuum photo tube. Within the operating ranges of both groups of photo tube the anode current is directly proportional to the quantity of light incident on the cathode surface.

2.1 **Luminous sensitivity**

The response of a photo tube to light falling on its cathode is termed its luminous sensitivity; this is expressed in micro-amperes per lumen. The sensitivity of all types of photo tube is dependent upon the colour temperature of the light source and in some cases upon the portion of the cathode that is illuminated.

The sensitivity of gas-filled photo tubes, moreover, is dependent upon the anode voltage; the sensitivity of vacuum photo tubes in the "saturation region", in which region the tube mainly operates, is practically independent of the anode voltage.

2.1 **Luminous sensitivity** (cont'd)

Unless otherwise stated, the values given in the data sheets have been obtained by illuminating the total useful cathode area with an incandescent lamp having a colour temperature of $2700^{\circ}K$.

The values given for sensitivity on the data sheets are the initial values for average photo tubes. The ratio between the maximum and minimum initial sensitivity of photo tubes of a given type will not exceed 3 to 1.

2.2 **Dark current**

This is the current which flows between the photocathode and anode when the photo tube is in total darkness. The tube is in total darkness when no radiation within the spectral sensitivity curve of the photocathode is present. This current is caused mainly by electrical leakage and thermionic emission from the photocathode and will therefore increase with temperature and voltage.

2.3 **Frequency response**

The sensitivity of a vacuum photo tube is constant for frequencies of light modulation up to those generally met in practice. Only at very high frequencies, at which transit time limitations occur, the sensitivity becomes dependent upon the frequency.

The sensitivity of gas-filled photo tubes, however, decreases with increasing frequency. At a frequency of 15 000Hz this decrease is about 3dB, as shown in the accompanying curve.

3. THERMAL DATA

Ambient temperature

The temperature of the photocathode must not be too high otherwise evaporation of the emissive cathode layer may result, with consequent reduction in sensitivity and life. As it is difficult to measure this temperature the limiting value for the ambient temperature is given in the published data sheets.

It must be considered, however, that even when the ambient temperature in the immediate vicinity of the photo tube is not beyond the limit, an excessive temperature rise of the photocathode can still be caused, for example, by infra-red heat radiation. If the possibility of this radiation exists a suitable filter should be inserted in the optical path to minimise this effect.

4. OPERATIONAL NOTES

4.1 **Stability during life**

Where a gas-filled photo tube is continuously operated at its maximum rated voltage, its sensitivity may fall by as much as 50% during 500 hours.

Vacuum photo tubes on the other hand are inherently more stable.

The stability of both types of photo tube will be improved if the current density at the photocathode is reduced (for example by reducing the incident light or increasing the illuminated area of the photocathode). Particularly in the case of gas-filled photo tubes reduction of the anode voltage will improve the stability.

In the inoperative periods, also, photo tubes must not be exposed to strong radiation such as strong sunlight. A loss of sensitivity of both vacuum and gas-filled photo tubes during operation will be wholly or partially restored during inoperative periods.

4.2 **Prevention of glow discharge**

Gas-filled photo tubes must not be operated above the published maximum voltage since the glow discharge, indicated by a faint blue glow in the bulb, may occur, and this may adversely affect the good operation of the photo tube and can even result in rapid destruction of the photocathode. If accidental overrunning can be expected the anode resistance should have a value of at least 0.1MΩ. When it is necessary to approach the maximum operating voltage a stabilised supply is recommended.

5. MOUNTING

If no restrictions are made on the individual published data sheets, photo tubes may be mounted in any position.

6. STORAGE

It is necessary for photo tubes to be always stored in the dark.

7. RATINGS

The ratings of photo tubes are given according to the absolute maximum rating system.

8. OUTLINE DIMENSIONS

The outline dimensions are given in millimetres.

9. TYPE NOMENCLATURE

The type nomenclature for Mullard photoemissive tubes consists of two or three figures followed by two letters. These symbols provide information concerning the class of tube and the type of photocathode.

The figures are a serial number indicating a particular design or development.

The first letter indicates the type of spectral response (see section 1)

A - Type A (S11) response (caesium antimony)

C - Type C (S1) response (caesium on oxidised silver)

U - Type U (S13) response (caesium antimony, quartz window)

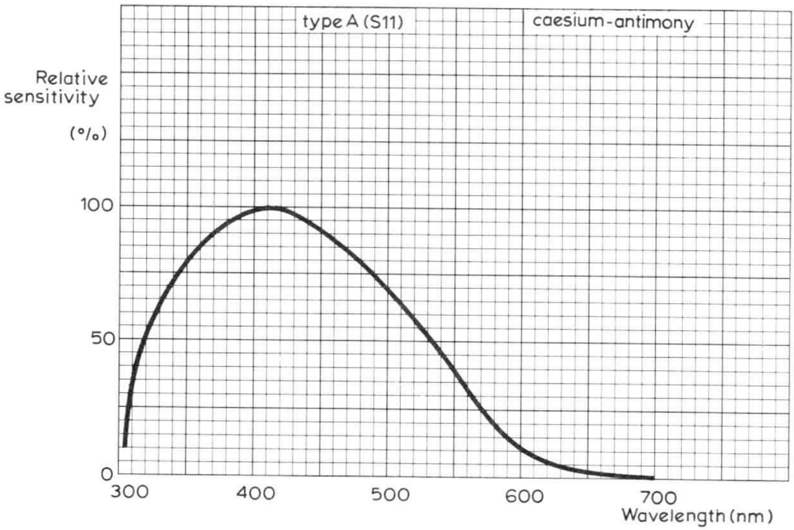
The second letter indicates the class of tube

G - Gas-filled

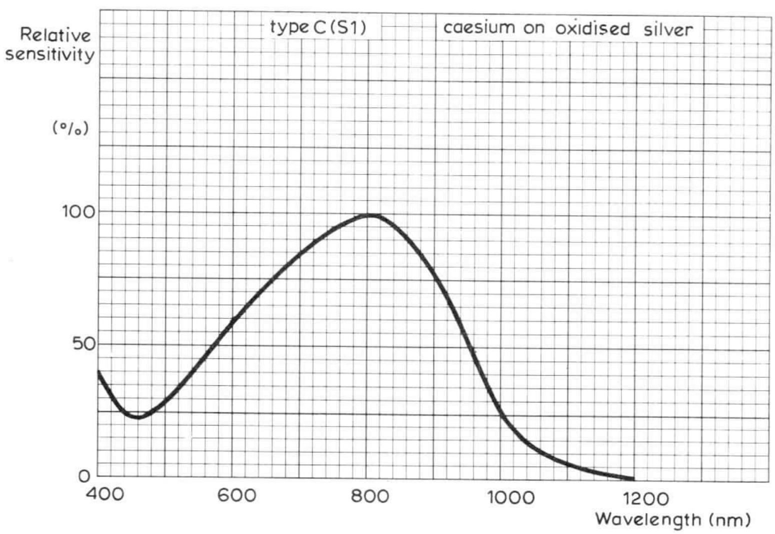
V - High vacuum

Example:- 150AV

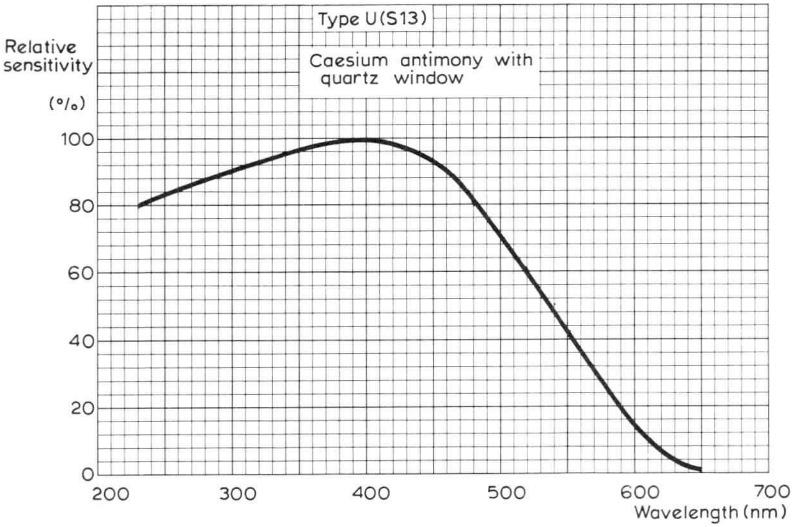
150	A	V
Serial number	Type A (S11) phtotcathode	High vacuum



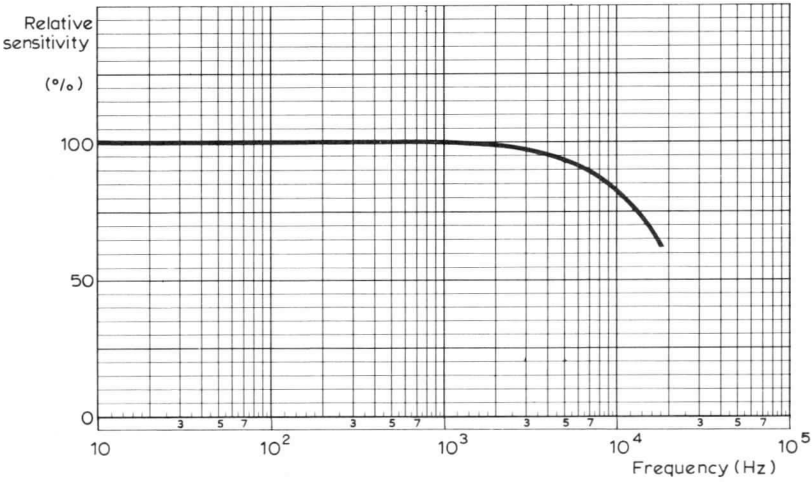
RELATIVE SPECTRAL SENSITIVITY FOR TYPE A (S11) PHOTOCATHODE



RELATIVE SPECTRAL SENSITIVITY FOR TYPE C (S1) PHOTOCATHODE

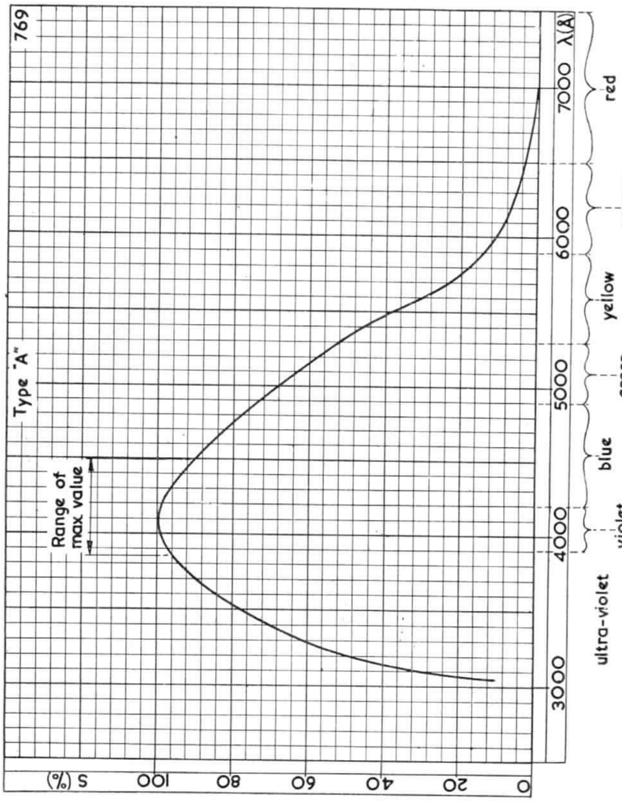


RELATIVE SPECTRAL SENSITIVITY FOR TYPE U (S13) PHOTOCATHODE

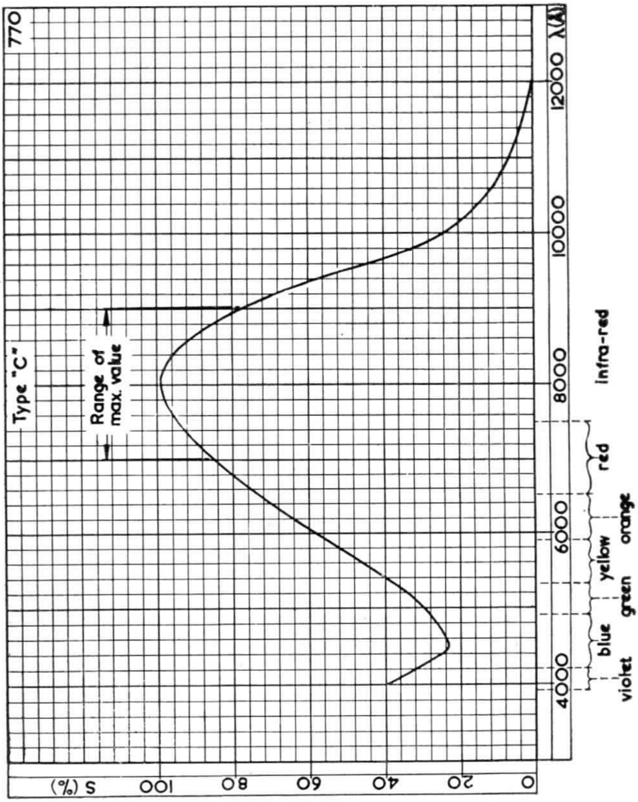


FREQUENCY RESPONSE OF GAS-FILLED PHOTOEMISSIVE TUBES

Two types of photocathodes are used in Mullard photocells and each responds to a different part of the light spectrum. Below is given the spectral response curve for the photocathode Type "A" and shows relative sensitivity plotted against wavelength of light in Angstrom units. The response curve for the photocathode Type "C" is given on the next page.



SPECTRAL RESPONSE CURVE FOR PHOTOCATHODE TYPE "A"
(Caesium—Antimony)



SPECTRAL RESPONSE CURVE FOR PHOTOCATHODE TYPE "C"

(Caesium on Oxidised Silver)

GAS-FILLED PHOTOCELL

53CG

Gas-filled photocell particularly sensitive to incandescent light sources, and to near infra-red radiation. Designed for end-on incidence of illumination and suitable for applications where space is a limiting factor or where multiple banks of photocells are required.

CATHODE

Surface	Caesium on oxidised silver
Projected Area	1·1 sq. cm

MOUNTING POSITION

Any

CAPACITANCE

c_{a-k}	3·0	pF

CHARACTERISTICS (measured at $V_a = 85V$)

I_{dark}	$<0{\cdot}1$	μA
*S	100	μA/lm
$A_g$max.	9	

* Measured with the whole cathode area illuminated by a lamp of colour temperature 2700°K and with a series resistor of 1MΩ

RECOMMENDED OPERATING CONDITIONS

$V_{a(b)}$	85	V

LIMITING VALUES (Absolute ratings)

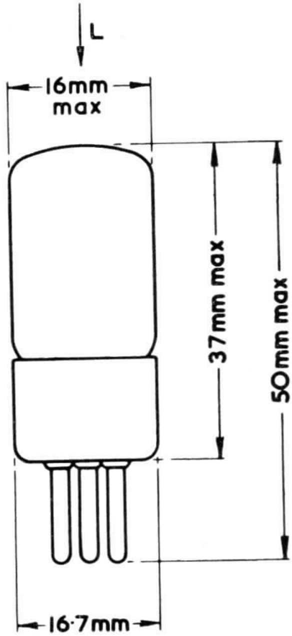
$V_{a(b)}$ max.	90	V
I_k max.	1.5	μA
$T_{ambient}$ max.	100	°C

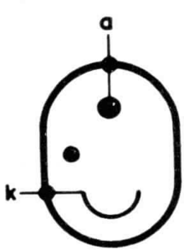
53CG

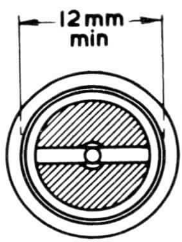
GAS-FILLED PHOTOCELL

Gas-filled photocell particularly sensitive to incandescent light sources, and to near infra-red radiation. Designed for end-on incidence of illumination and suitable for applications where space is a limiting factor or where multiple banks of photocells are required.

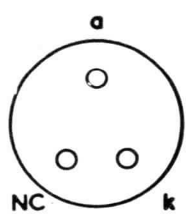
3087







Sensitive cathode area shown shaded

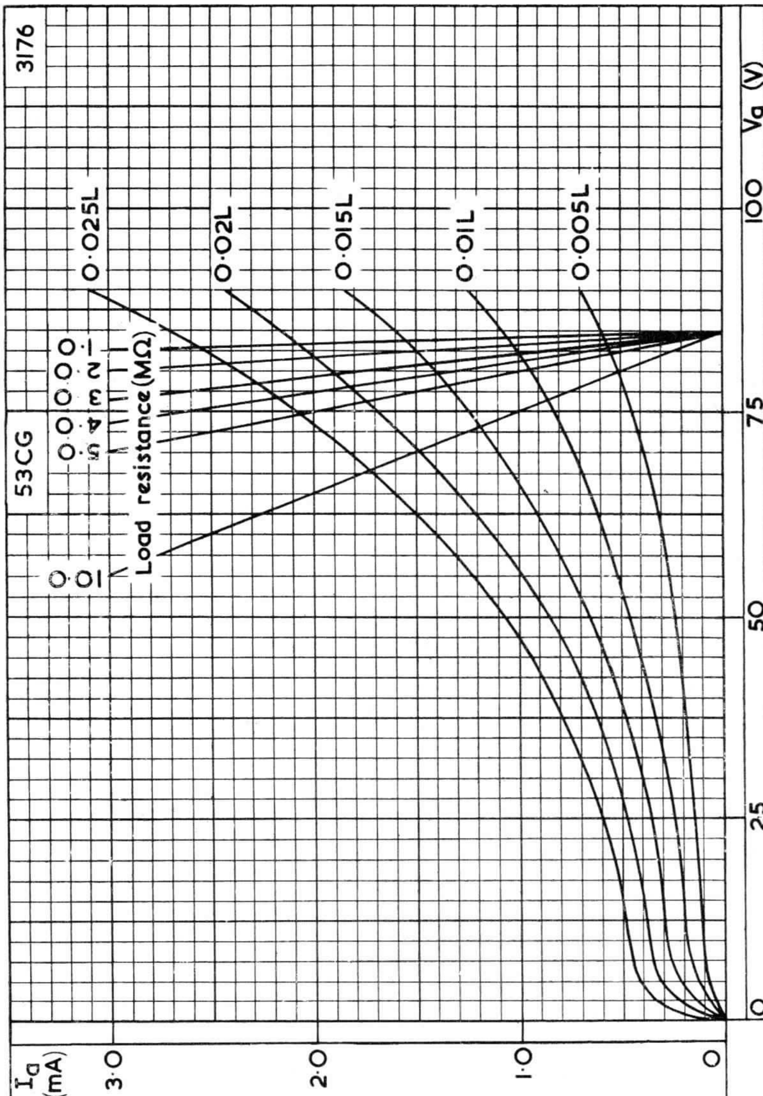


B3A Base

GAS-FILLED PHOTOCELL

53CG

Gas-filled photocell particularly sensitive to incandescent light sources, and to near infra-red radiation. Designed for end-on incidence of illumination and suitable for applications where space is a limiting factor or where multiple banks of photocells are required.



ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE
WITH TOTAL ILLUMINATION AS PARAMETER

VACUUM PHOTOCELL

53CV

Vacuum photocell particularly sensitive to incandescent light sources, and to near infra-red radiation. Designed for end-on incidence of illumination and suitable for applications where space is a limiting factor or where multiple banks of photocells are required.

CATHODE

Surface	Caesium on oxidised silver
Projected area	1.1 sq.cm

MOUNTING POSITION

Any

CAPACITANCE

c_{a-k}	3.0	pF

CHARACTERISTICS

I_{dark} (at V_a=100V)	<0.05	µA
*S (at V_a=50V)	20	µA/lm

*Measured with the whole cathode area illuminated by a lamp of colour temperature 2700°K, and with a series resistor of 1MΩ

RECOMMENDED OPERATING CONDITION

$V_{a(b)}$	50	V

LIMITING VALUES (Absolute ratings)

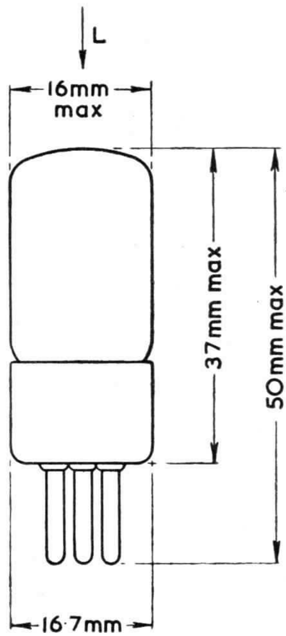
$V_{a(b)}$ max.	250	V
I_k max.	3.0	µA
$T_{ambient}$ max.	100	°C

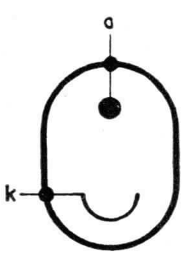
53CV

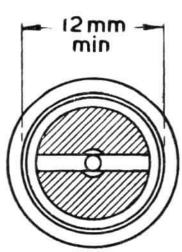
VACUUM PHOTOCELL

Vacuum photocell particularly sensitive to incandescent light sources, and to near infra-red radiation. Designed for end-on incidence of illumination and suitable for applications where space is a limiting factor or where multiple banks of photocells are required.

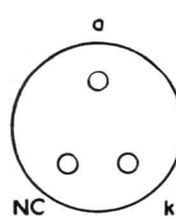
3049







Sensitive cathode area shown shaded

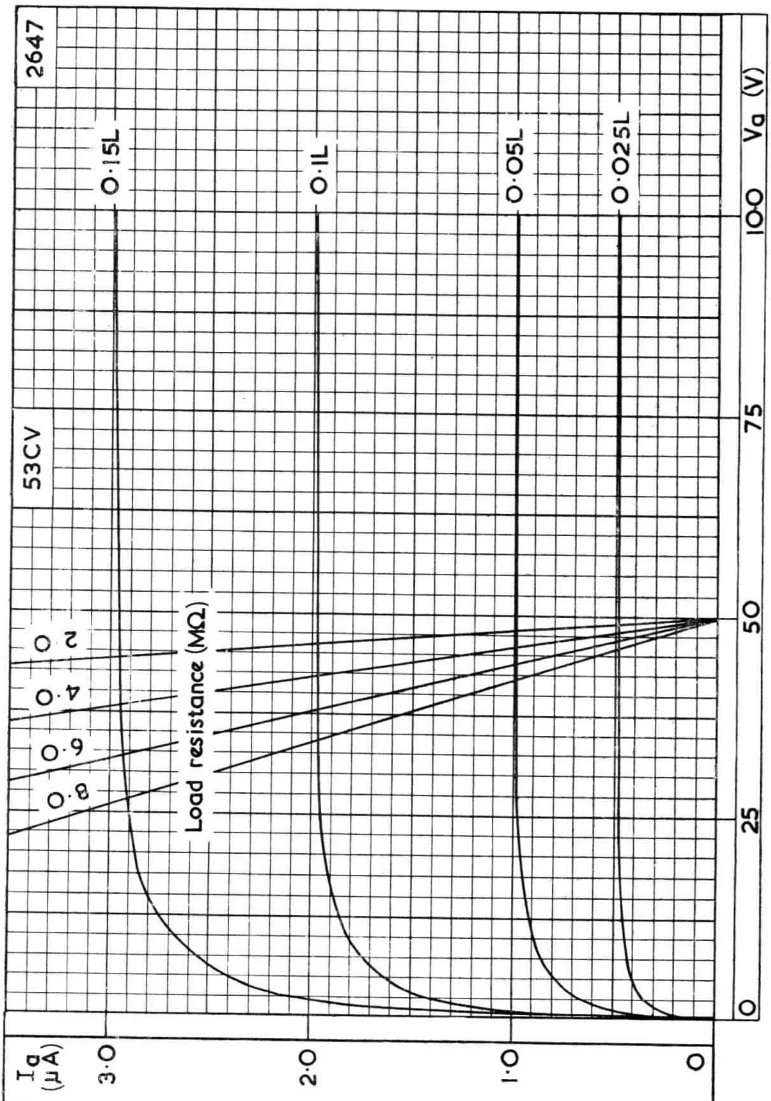


B3A Base

VACUUM PHOTOCELL

53CV

Vacuum photocell particularly sensitive to incandescent light sources, and to near infra-red radiation. Designed for end-on incidence of illumination and suitable for applications where space is a limiting factor or where multiple banks of photocells are required.



ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE
WITH TOTAL ILLUMINATION AS PARAMETER

GAS-FILLED PHOTOCELL

55CG

Gas-filled photocell, particularly sensitive to incandescent light sources and to near infra-red radiation. Its small dimensions render it suitable for use in standard 16 mm. sound film projectors.

CATHODE

Surface	Caesium on oxidised silver	
Projected area	2.2	sq. cm

MOUNTING POSITION

Any

CAPACITANCE

c_{a-k}	2.3	pF

CHARACTERISTICS (measured at 90 V)

I_{dark}	< 0.1	μA
*S	125	μA/lumen
A_g max.	10	

*Measured with the whole cathode area illuminated by a lamp of colour temperature 2700°K and with a series resistor of 1 M Ω

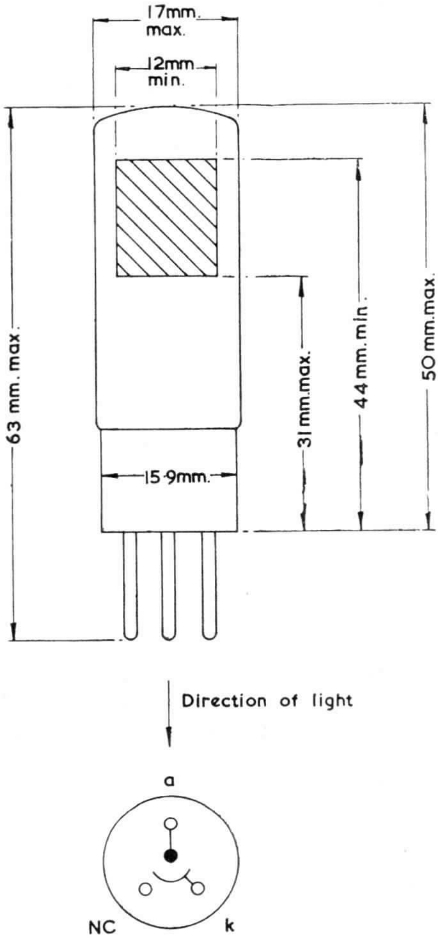
LIMITING VALUES (absolute ratings)

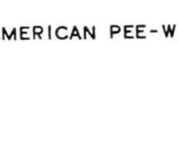
$V_{a(b)}$ max.	90	V
T_k max.	2.0	μA
$T_{ambient}$ max.	100	°C

55CG

GAS-FILLED PHOTOCELL

Gas-filled photocell, particularly sensitive to incandescent light sources and to near infra-red radiation. Its small dimensions render it suitable for use in standard 16 mm. sound film projectors.





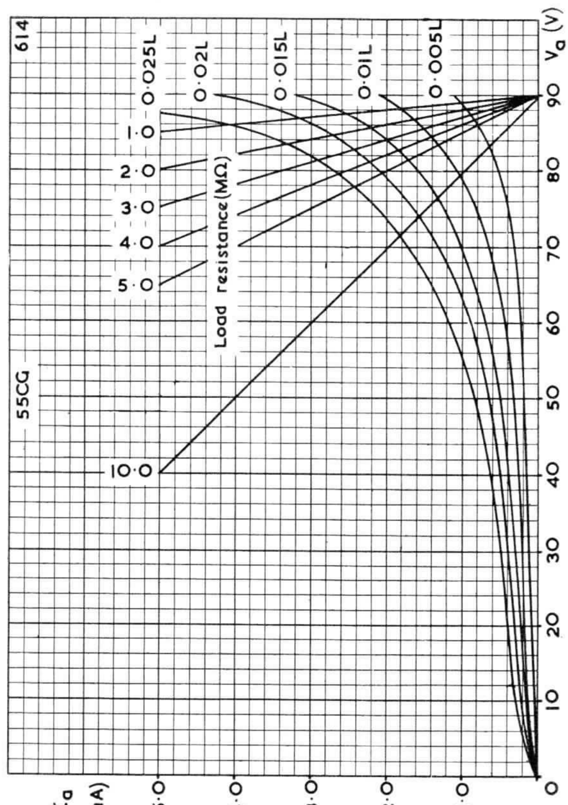
B3A (AMERICAN PEE-WEE) BASE

613

GAS-FILLED PHOTOCELL

55CG

Gas-filled photocell, particularly sensitive to incandescent light sources and to near infra-red radiation. Its small dimensions render it suitable for use in standard 16 mm. sound film projectors.



ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE
WITH TOTAL ILLUMINATION AS PARAMETER

GAS-FILLED PHOTOCELL 58CG

Gas-filled photocell particularly sensitive to incandescent light sources, and to near infra-red radiation. Designed for end-on incidence of illumination and suitable for applications where space is a limiting factor or where multiple banks of photocells are required.

CATHODE

Surface	Caesium on oxidised silver	
Projected area	1.1	sq.cm

MOUNTING POSITION — Any

CAPACITANCE

c_{a-k}	3.0	pF

CHARACTERISTICS (Measured at 85V)

I_{dark}	<0.1	µA
*S	100	µA/lm
A_g max.	9.0	

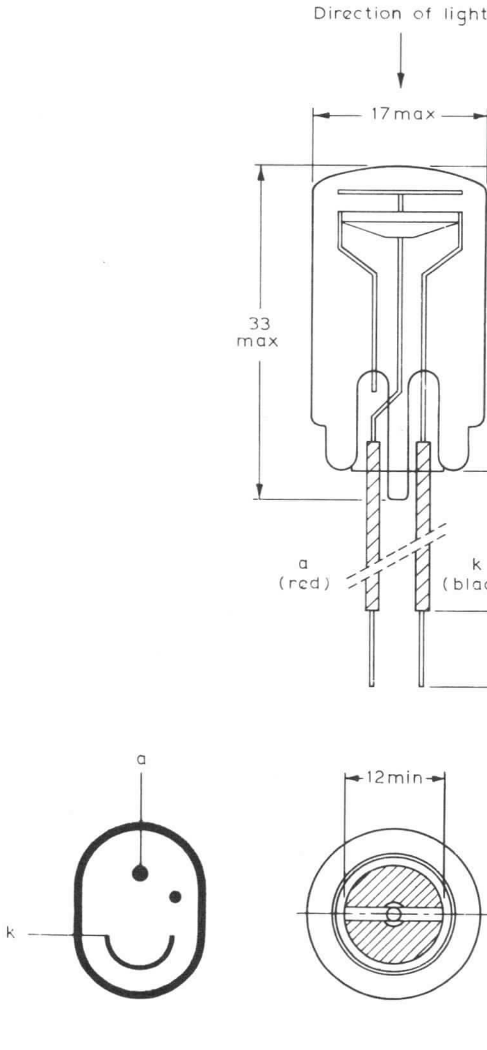
*Measured with the whole cathode area illuminated by a lamp of colour temperature 2700°K and with a series resistor of 1MΩ.

OPERATING CONDITION

$V_{a(b)}$	85	V

RATINGS (ABSOLUTE MAXIMUM SYSTEM)

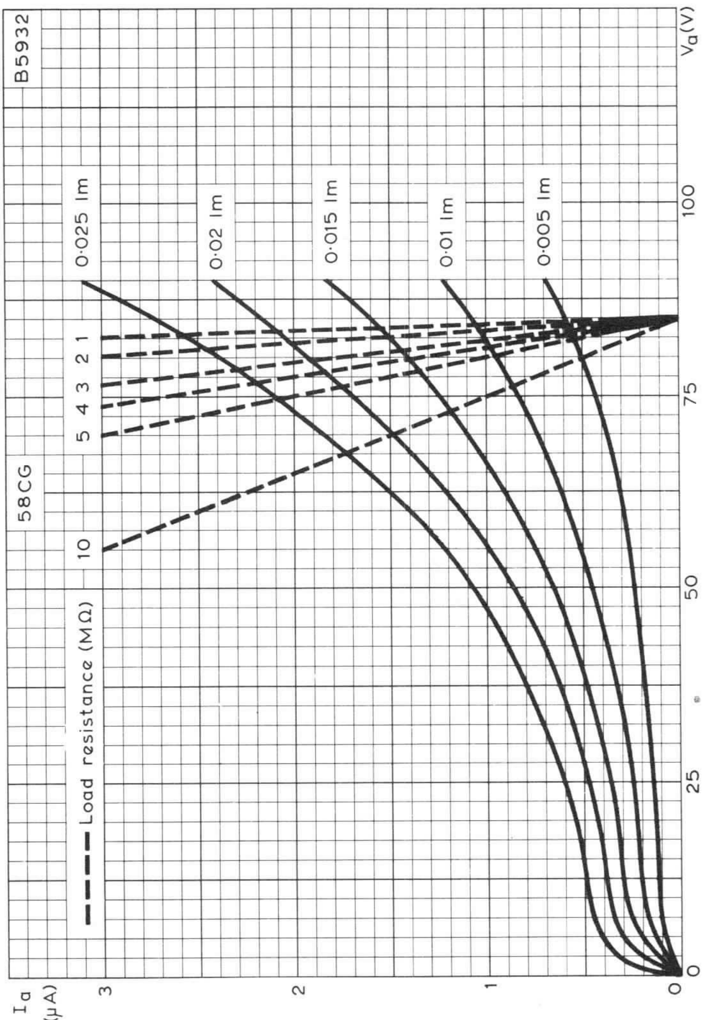
$V_{a(b)}$	90	V
I_k max.	1.5	µA
T_{amb} max.	100	°C



Sensitive cathode area shown shaded

All dimensions in mm

B5918



ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH TOTAL ILLUMINATION AS PARAMETER

VACUUM PHOTOCELL 58CV

Vacuum photocell particularly sensitive to incandescent light sources, and to near infra-red radiation. Designed for end-on incidence of illumination and suitable for applications where space is a limiting factor or where multiple banks of photocells are required.

CATHODE

Surface	Caesium on oxidised silver	
Projected area	1.1	sq.cm

MOUNTING POSITION

		Any

CAPACITANCE

c_{a-k}	3.0	pF

CHARACTERISTICS

I_{dark} (at $V_a = 100V$)	<0.05	μA
*S (at $V_a = 50V$)	20	$\mu A/lm$

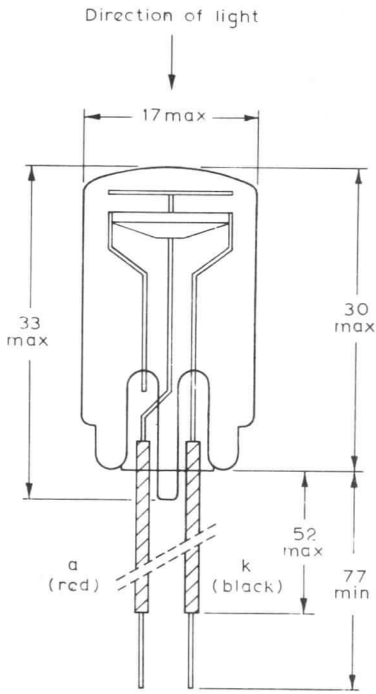
*Measured with the whole cathode area illuminated by a lamp of colour temperature 2700°K, and with a series resistor of 1MΩ.

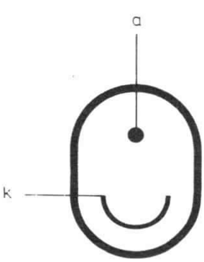
OPERATING CONDITION

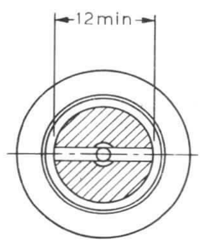
$V_{a(b)}$	50	V

RATINGS (ABSOLUTE MAXIMUM SYSTEM)

$V_{a(b)}$ max.	250	V
I_k max.	3.0	μA
T_{amb} max.	100	$^{\circ}C$



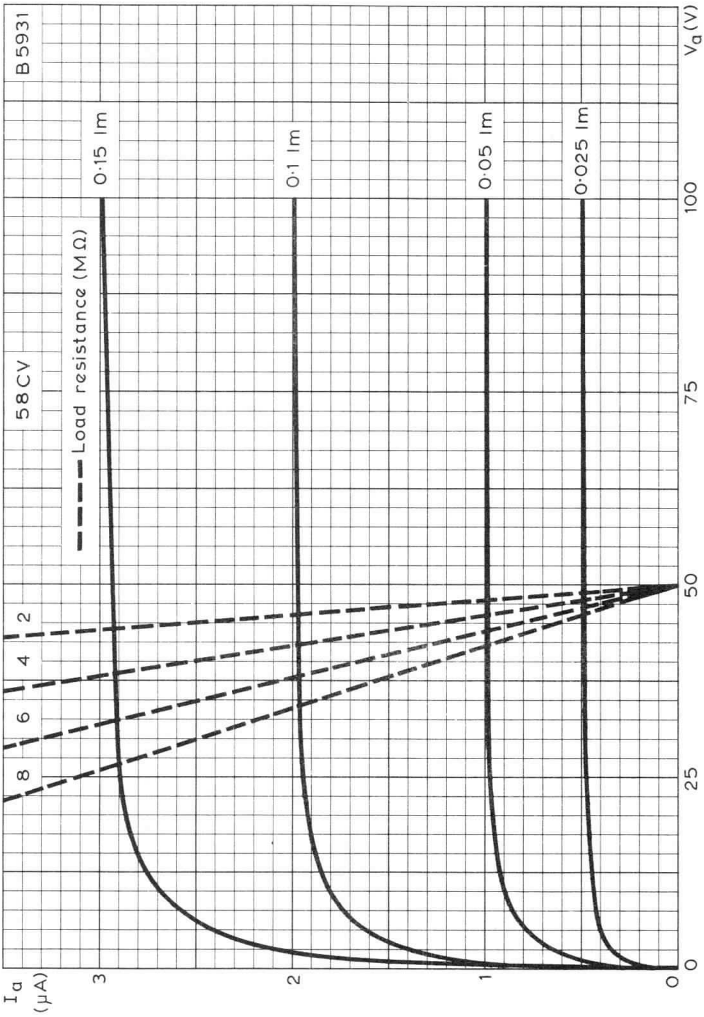




Sensitive cathode area
shown shaded

All dimensions in mm

B5942



ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH TOTAL ILLUMINATION AS PARAMETER

GAS-FILLED PHOTOCELL

90AG

Gas-filled photocell particularly sensitive to daylight and to radiation having a blue predominance. It is suitable for use in sound reproducing systems where a dye-image sound track is used in conjunction with an incandescent light source.

CATHODE

Surface	Caesium antimony	
Projected area	4.0	cm^2

MOUNTING POSITION

Any

CAPACITANCE

c_{a-k}	0.7	pF ←

CHARACTERISTICS (Measured at 85V)

I_{dark}	<0.1	μA
* S	130	μA/lumen
A_g max.	7.0	

* Measured with the whole cathode area illuminated by a lamp of colour temperature 2700°K and with a series resistor of 1MΩ.

RECOMMENDED OPERATING CONDITIONS

$V_{a(b)}$	85	V

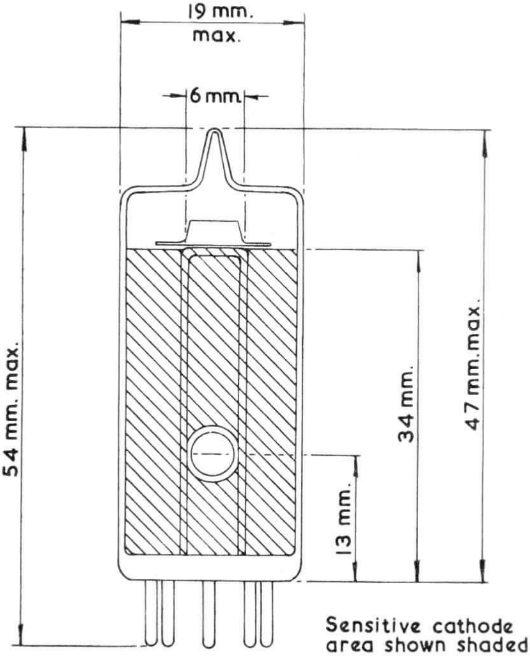
LIMITING VALUES (Absolute ratings)

$V_{a(b)}$ max.	90	V
I_k max.	2.5	μA
$T_{ambient}$ max.	70	°C

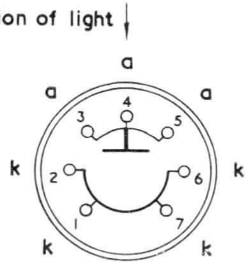
90AG

GAS-FILLED PHOTOCELL

Gas-filled photocell particularly sensitive to daylight and to radiation having a blue predominance. It is suitable for use in sound reproducing systems where a dye-image sound track is used in conjunction with an incandescent light source.



Sensitive cathode area shown shaded



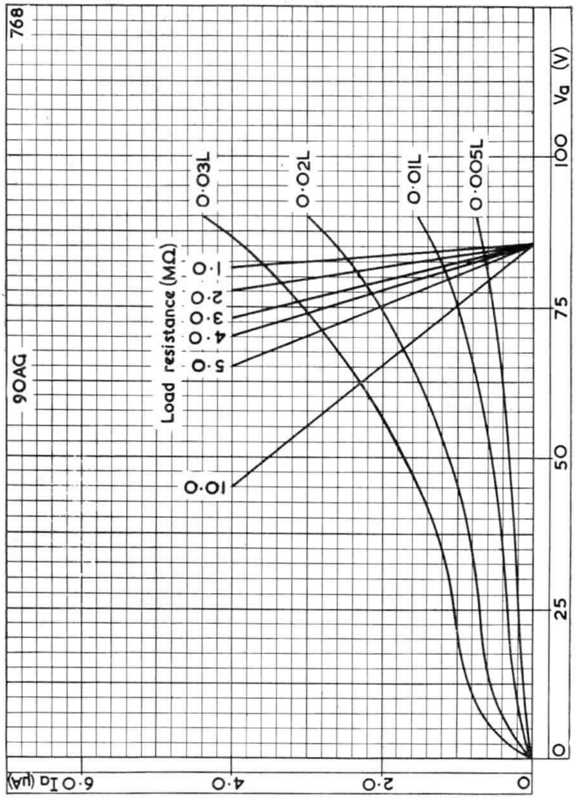
The cathode connection should be made to pins 1, 2, 6 & 7 connected together and the anode connection to pins 3, 4 & 5 connected together.

B7G BASE

GAS-FILLED PHOTOCELL

90AG

Gas-filled photocell particularly sensitive to daylight and to radiation having a blue predominance. It is suitable for use in sound reproducing systems where a dye-image sound track is used in conjunction with an incandescent light source.



ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE

VACUUM PHOTOCELL

90AV

Vacuum photocell, particularly sensitive to daylight and to light radiation with a blue predominance. The use of the B7G miniature all-glass base permits a rigid construction and maximum cathode area for a cell of this size.

CATHODE

Surface	Caesium antimony	
Projected area	4.0	cm^2

MOUNTING POSITION

Any

CAPACITANCE

c_{a-k}	0.7	pF ←

CHARACTERISTICS (measured at Va = 100V)

I_{dark}	<0.05	μA
* S	45	μA/lumen

* Measured with the whole cathode area illuminated by a lamp of colour temperature 2700°K and with a series resistor of 1MΩ

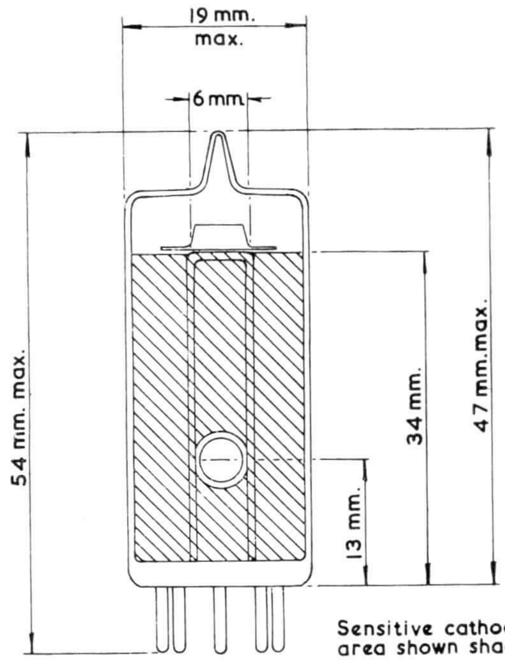
LIMITING VALUES (Absolute ratings)

$V_{a(b)}$ max.	100	V
I_k max.	5	μA
$T_{ambient}$ max.	70	°C

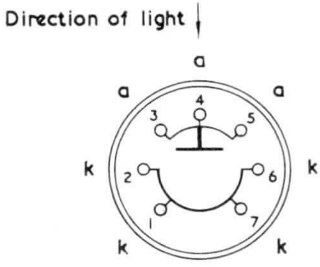
90AV

VACUUM PHOTOCELL

Vacuum photocell, particularly sensitive to daylight and to light radiation with a blue predominance. The use of the B7G miniature all-glass base permits a rigid construction and maximum cathode area for a cell of this size.



Sensitive cathode area shown shaded



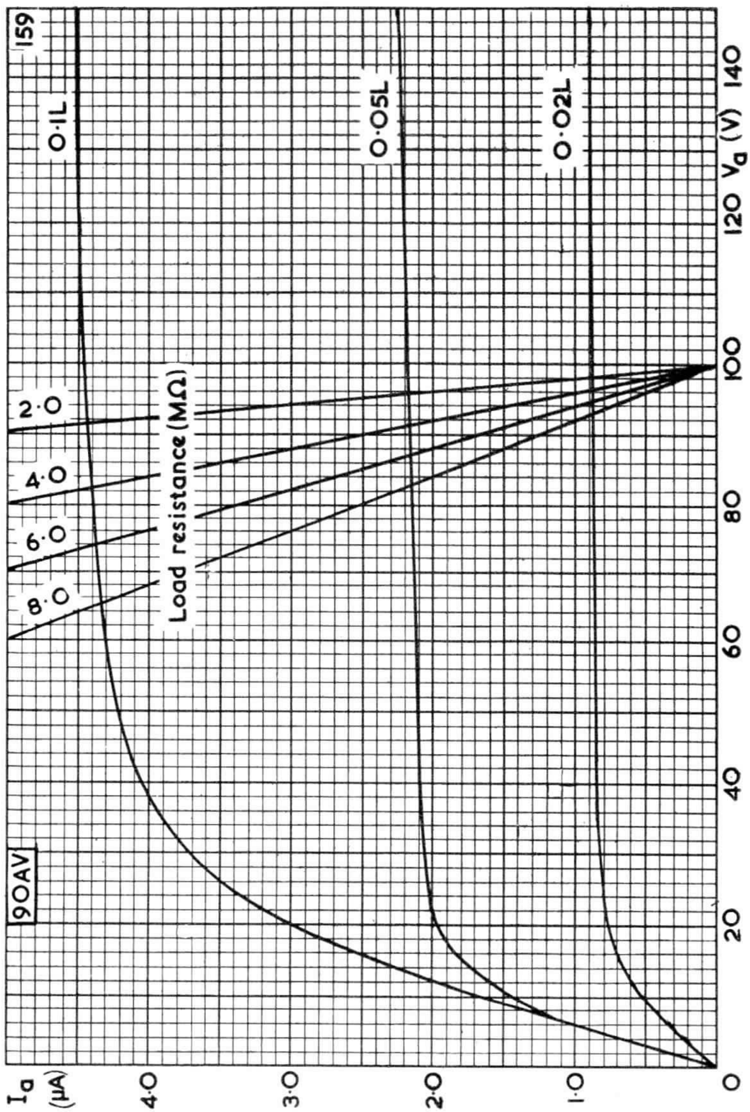
B7G BASE

The cathode connection should be made to pins 1, 2, 6 & 7 connected together and the anode connection to pins 3, 4 & 5 connected together.

VACUUM PHOTOCELL

90AV

Vacuum photocell, particularly sensitive to daylight and to light radiation with a blue predominance. The use of the B7G miniature all-glass base permits a rigid construction and maximum cathode area for a cell of this size.



ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE
WITH TOTAL ILLUMINATION AS PARAMETER

GAS-FILLED PHOTOEMISSIVE TUBE 90CG

QUICK REFERENCE DATA		
Gas-filled photoemissive tube, particularly sensitive to incandescent light sources and to near infra-red radiation.		
Anode supply voltage	90	V
Luminous sensitivity	125	μA/lm
Spectral response curve	Type C (S1)	

This data should be read in conjunction with
GENERAL EXPLANATORY NOTES - PHOTOEMISSIVE TUBES

PHOTOCATHODE

Surface	Caesium on oxidised silver	
Spectral response curve	Type C (S1)	
Projected sensitive area	3.0	cm^2

CHARACTERISTICS

Anode supply voltage	90	V
Anode series resistor	1.0	MΩ
Luminous sensitivity (measured with the whole cathode area illuminated by a lamp of colour temperature $2700^{o}K$)	125	μA/lm
Dark current	≤0.1	μA

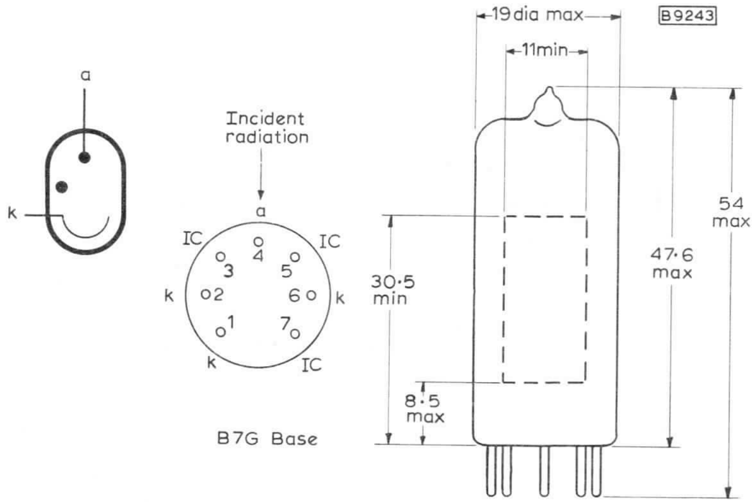
CAPACITANCE

c_{a-k}	1.1	pF

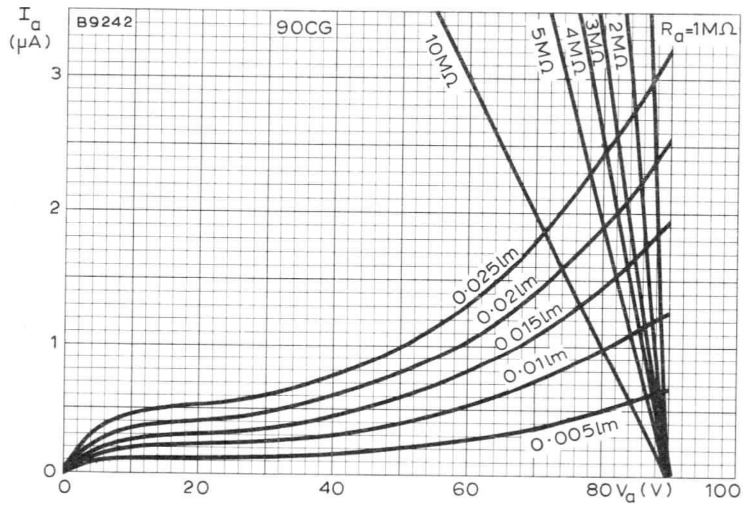
RATINGS (ABSOLUTE MAXIMUM SYSTEM)

$V_{a(b)}$ max.	90	V
I_k max.	2.0	μA
T_{amb} max.	100	^{o}C

OUTLINE AND SCHEMATIC DRAWING
OF 90CG



The cathode connection may be made to pins 1, 2, 6 and 7 connected together and the anode connection to pins 3, 4 and 5 connected together.



ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE
WITH ILLUMINATION AS PARAMETER

VACUUM PHOTOEMISSIVE TUBE 90CV

QUICK REFERENCE DATA		
Vacuum photoemissive tube, particularly sensitive to incandescent light sources and to near infra-red radiation.		
Anode supply voltage (max.)	250	V
Luminous sensitivity	20	μA/lm
Spectral response curve	Type C (S1)	

This data should be read in conjunction with
GENERAL EXPLANATORY NOTES - PHOTOEMISSIVE TUBES

PHOTOCATHODE

Surface	Caesium on oxidised silver	
Spectral response curve	Type C (S1)	
Projected sensitive area	3.0	cm^2

CHARACTERISTICS

Anode supply voltage	50	V
Anode series resistor	1.0	MΩ
Luminous sensitivity (measured with the whole cathode area illuminated by a lamp of colour temperature 2700°K)	20	μA/lm
Dark current (at $V_a = 100V$)	≤0.05	μA

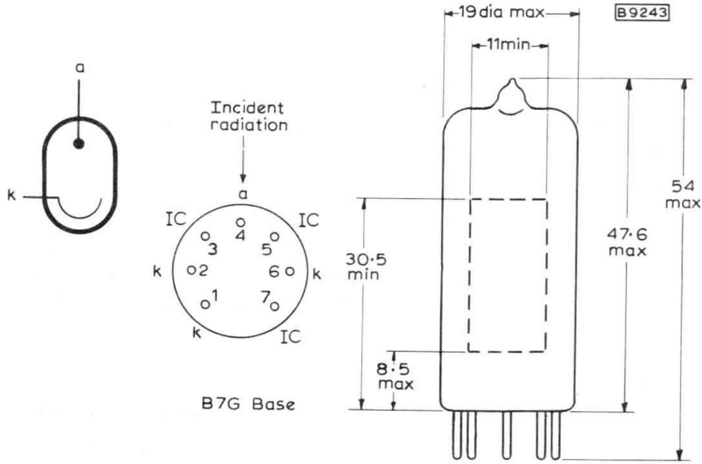
CAPACITANCE

c_{a-k}	0.8	pF

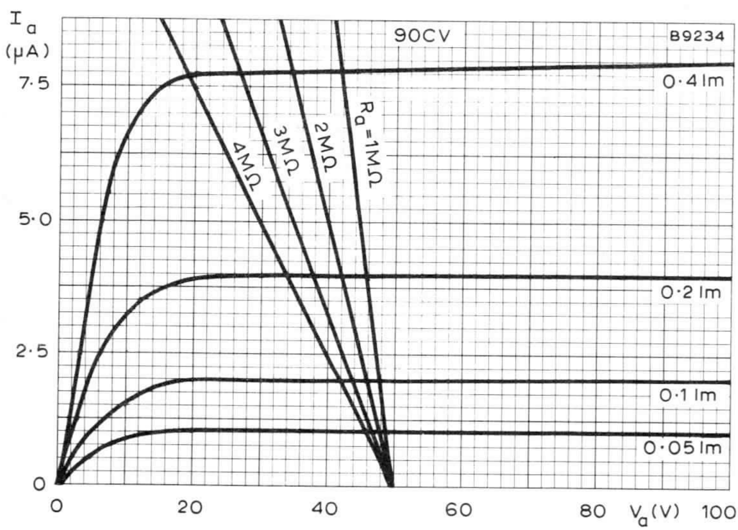
RATINGS (ABSOLUTE MAXIMUM SYSTEM)

$V_{a(b)}$ max.	250	V
I_k max.	10	μA
T_{amb} max.	100	°C

OUTLINE AND SCHEMATIC DRAWING
OF 90CV



The cathode connection may be made to pins 1, 2, 6 and 7 connected together and the anode connection to pins 3, 4 and 5 connected together.



ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE
WITH ILLUMINATION AS PARAMETER

GAS-FILLED PHOTOEMISSIVE TUBE 92AG

QUICK REFERENCE DATA		
Gas-filled photoemissive tube, particularly sensitive to daylight and to radiation having a blue predominance.		
Anode supply voltage (max.)	90	V
Luminous sensitivity	130	μA/lm
Spectral response curve	Type A (S11)	

This data should be read in conjunction with
GENERAL EXPLANATORY NOTES - PHOTOEMISSIVE TUBES

PHOTOCATHODE

Surface	Caesium antimony	
Spectral response curve	Type A (S11)	
Projected sensitive area	2.1	cm^2

CHARACTERISTICS

Anode supply voltage	85	V
Anode series resistor	1.0	MΩ
Luminous sensitivity (measured with the whole cathode area illuminated by a lamp of colour temperature 2700°K)	130	μA/lm
Dark current	≤ 0.1	μA

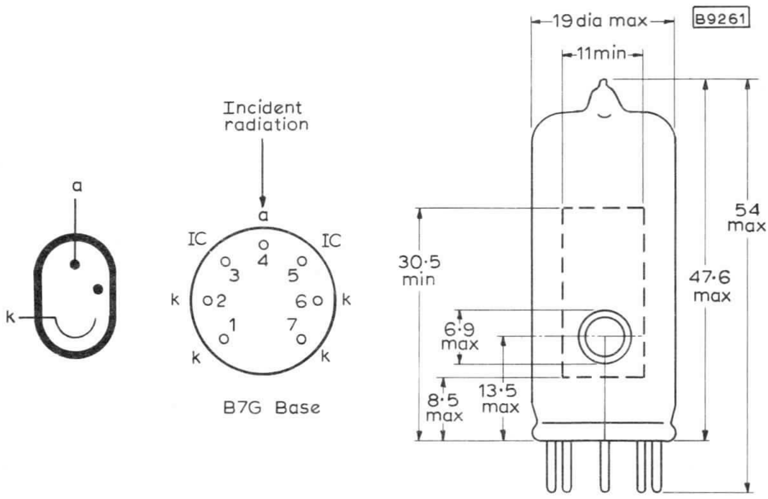
CAPACITANCE

c_{a-k}	0.9	pF

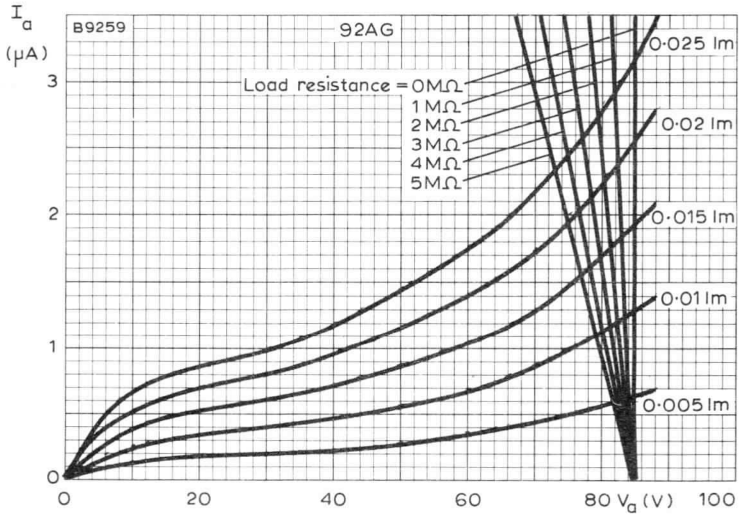
RATINGS (ABSOLUTE MAXIMUM SYSTEM)

$V_{a(b)}$ max.	90	V
I_k max.	12.5	nA/mm^2
T_{amb} max.	70	°C

OUTLINE AND SCHEMATIC DRAWINGS
OF 92AG



The cathode connection may be made to pins 1, 2, 6 and 7 connected together and the anode connection to pins 3, 4 and 5 connected together.



ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE
WITH ILLUMINATION AS PARAMETER

VACUUM PHOTOEMISSIVE TUBE 92AV

QUICK REFERENCE DATA		
Vacuum photoemissive tube, particularly sensitive to daylight and to radiation having a blue predominance.		
Anode supply voltage (max.)	100	V
Luminous sensitivity	45	μA/lm
Spectral response curve	Type A (S11)	

This data should be read in conjunction with
GENERAL EXPLANATORY NOTES - PHOTOEMISSIVE TUBES

PHOTOCATHODE

Surface	Caesium antimony	
Spectral response curve	Type A (S11)	
Projected sensitive area	2.1	cm^2

CHARACTERISTICS

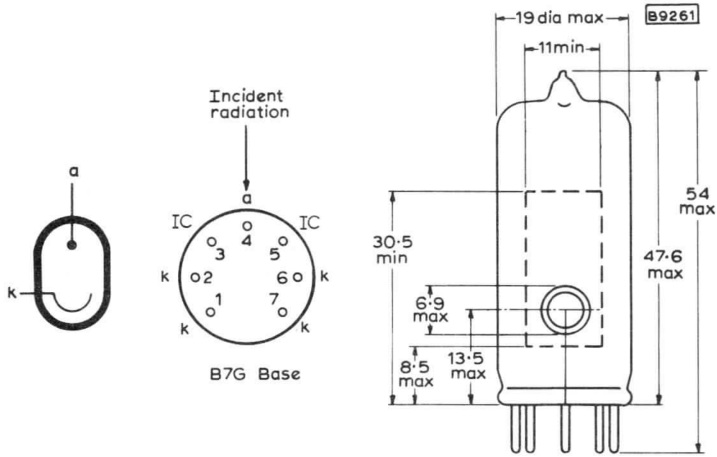
Anode supply voltage	85	V
Anode series resistor	1.0	MΩ
Luminous sensitivity (measured with the whole cathode area illuminated by a lamp of colour temperature $2700^{o}K$)	45	μA/lm
Dark current	≤ 0.05	μA

CAPACITANCE

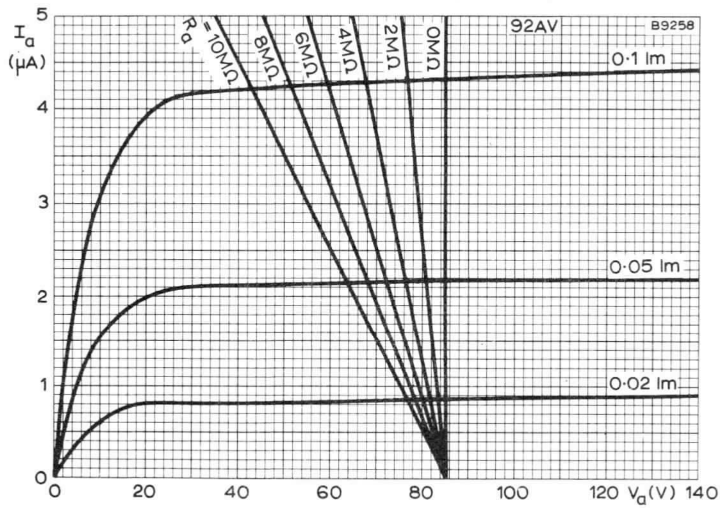
c_{a-k}	0.9	pF

RATINGS (ABSOLUTE MAXIMUM SYSTEM)

$V_{a(b)}$ max.	100	V
I_k max.	25	nA/mm^2
T_{amb} max.	70	^{o}C



The cathode connection may be made to pins 1, 2, 6 and 7 connected together and the anode connection to pins 3, 4 and 5 connected together.



ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE
WITH ILLUMINATION AS PARAMETER

VACUUM PHOTOEMISSIVE TUBES

150AV
150CV
150UV

QUICK REFERENCE DATA

Vacuum photoemissive tubes with high stability and linearity, intended for use in high precision photometry (up to 1 lux) and for measurements of quickly changing light phenomena (up to approx. 1000 lux).

The 150AV is particularly sensitive to light having a blue predominance
The 150CV is particularly sensitive to light having a red predominance
The 150UV is particularly sensitive to blue light and has a response which extends into the ultra-violet region.

	150AV	150CV	150UV	
Anode voltage	6 to 90	6 to 90	6 to 90	V
Maximum average current	50	35	50	nA
Maximum peak current	35	25	35	μA
Sensitivity	60	20	60	μA/lm
Rise time	14	14	14	ns
Spectral response curve	A (S11)	C (S1)	U (S13)	

Unless otherwise stated, data is applicable to all types
This data should be read in conjunction with
GENERAL EXPLANATORY NOTES - PHOTOEMISSIVE TUBES

PHOTOCATHODE	150AV	150CV	150UV	
*Surface	Caesium antimony	Caesium on oxidised silver	Caesium antimony	
**Spectral response curve	A (S11)	C (S1)	U (S13)	
Luminous sensitivity (Measured using a tungsten lamp of colour temperature 2850°K)				
typical	60	20	60	μA/lm
minimum	35	14	35	μA/lm

Each tube is marked with its sensitivity. An angle of 15° between the axis of the tube and the direction of the incident light decreases the sensitivity by not more than 5%.

*The cathode material is deposited on the inner surface of the window, which is optically plane and polished. This allows the luminous source to be at a close and repeatable distance from the cathode.

**The spectral response curve is a nominal one, and considerable variation between individual tubes may be expected.

CHARACTERISTICS ←

Saturation voltage		
luminous flux = 0.05 lm	< 6.0	V
luminous flux = 1.0 lm	< 70	V
Anode voltage	6 to 90	V
Dark current		
150AV, 150UV	< 1.0	pA
150CV	< 1.0	nA
*Linearity	10^{-4}	
Insulation resistance	$> 10^{15}$	Ω
Rise time	14	ns

*Tube current is proportional to luminous flux within measuring errors, provided that the anode voltage is higher than the saturation voltage.

CAPACITANCE

c_{a-k}	13	pF ←

RATINGS (ABSOLUTE MAXIMUM SYSTEM) ←

V_a max.	100	V
I_k max. (per unit area)		
peak	50	nA/mm^2
average (averaging time = 1s)	70	pA/mm^2
I_k max. (cathode uniformly illuminated)		
peak		
150AV, 150UV	35	µA
150CV	25	µA
average (averaging time = 1s)		
150AV, 150UV	50	nA
150CV	35	nA
T_{bulb} max.	+60	°C
T_{bulb} min.	-90	°C

LIFE EXPECTANCY ←

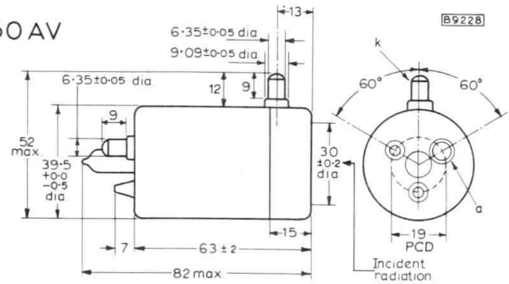
At the maximum average current the sensitivity will not decrease by more than 10% of its initial value between start of life and 500 operating hours. At lower cathode currents a higher stability may be expected.

NOTES ←

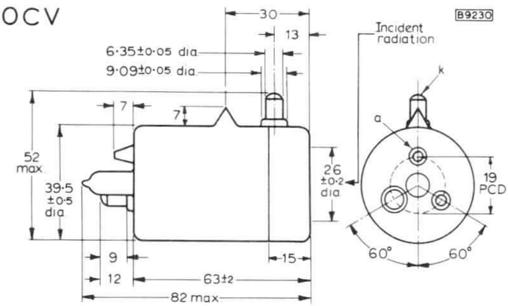
The cathode should not be exposed to direct sunlight.
In cases where low frequency noise influences the measuring results, this source of noise may be reduced by cooling the tube to -90°C.

OUTLINE DRAWINGS

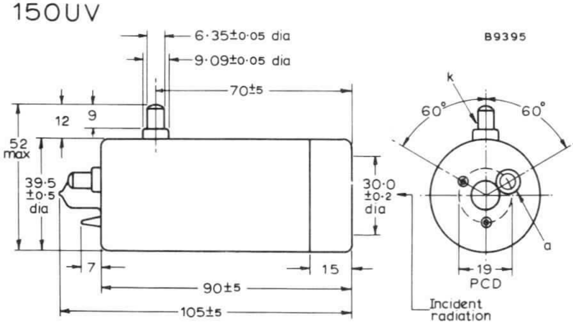
150 AV



150 CV



150 UV



Anode and cathode terminals are CT1 caps
All dimensions in millimetres

The currents allowed through this tube are so small that amplification will always be necessary. To maintain the accuracy of the signal from the tube is often the main problem. This problem may be divided into four parts.

1. **Distortion due to capacitive shunting**
The signal at the input of the amplifier is

$$v = \frac{i}{\sqrt{\frac{1}{R^2} + \omega^2 C^2}}$$

where v = signal in volts
i = current through photoemissive tube, in amps
R = series resistance across which signal is taken, in ohms
ω = $2\pi f$ (f = signal frequency in Hz)
C = total capacitance of cathode of photoemissive tube + input capacitance of amplifier + stray capacitance, in farads. The value of C will probably be at least 20pF.

Given a maximum allowable distortion, the maximum signal frequency will limit the value of R, and therefore also the value of v.

2. **Noise**

The signal level at the input to the amplifier must exceed the noise level. The three main sources of noise are:

a. **Shot noise in the photoemissive tube**, which follows the formula:

$$I_{noise} = \sqrt{2eiB} \text{ (amps r.m.s.)}$$

$$V_{noise} = RI_{noise}$$

where e = electronic charge (1.6×10^{-19} coulomb)
i = current through photoemissive tube, in amps
B = bandwidth in Hz
R = series resistance across which signal is taken, in ohms

b. **Resistance noise**, which follows the formula:

$$V_{noise} = \sqrt{4kTRB}$$

where k = Boltzmann's constant (1.38×10^{-23} Nm/degK)
T = temperature in $^{\circ}$K
R = series resistance across which signal is taken, in ohms
B = bandwidth in Hz

c. **Input noise of the amplifier**

When a thermionic valve is used in the input stage of the amplifier, the noise voltage follows the formula:

$$V_{noise} = \sqrt{\Sigma V_{eq}^2 \Delta B}$$

V_{eq} varies with frequency, and has a different value for each valve type. For frequencies above 1kHz V_{eq} does not change much with frequency, so that the formula may be approximated to:

$$V_{noise} = V_{eq}\sqrt{B}$$

APPLICATION NOTES (cont'd)

In this case V_{eq} can be approximated within a factor of 2 or 3 by:

$$V_{eq} = \frac{3 \times 10^{-9}\sqrt{I_a}}{gm}$$

where I_a = the anode current of the valve, in amps

gm = the mutual conductance in amps/volt.

3. **Amplifier input current**

The input current to the amplifier should be low compared with the signal current through the photoemissive tube.

4. **Amplifier linearity**

The amplifier should have negative feedback so that the stability of the signal is not impaired and distortion is not introduced.

If the circumstances are such that the signal-to-noise ratio cannot be kept within acceptable limits - usually where low incident light levels are combined with high frequencies, use of this type of tube should be abandoned in preference to a photomultiplier tube, in which distortion due to capacitive shunting and noise sources other than shot noise are of lower relative importance.

Circuit examples

An example of a simple circuit which is useful for many purposes of static light measurement is shown in fig. 1.

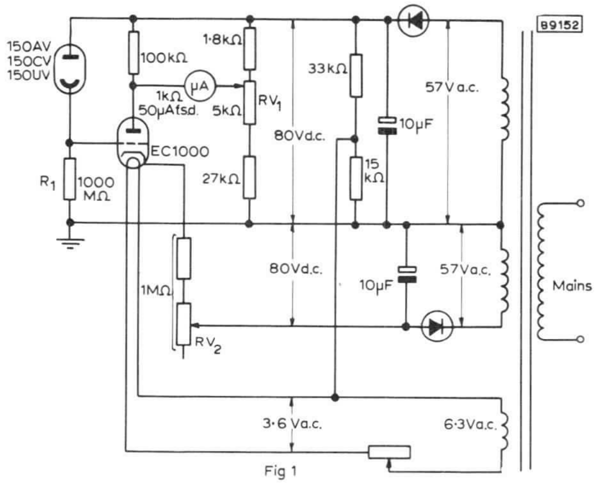


Fig 1

The 50μA meter can be calibrated in millilumens or, if the whole of the cathode is illuminated, in lux. Assuming that the pointer of the meter will not move with frequencies above 20Hz, noise level calculations may be restricted to frequencies below this. With a photoemissive tube current of 5nA, the amplifier input voltage is 5V, the shot noise is 0.1mV, the resistance noise is 10μV and the equivalent noise voltage at the amplifier is 1μV.
The negative feedback in the system is about 1000 times, so the accuracy is solely determined by the accuracy of the 50μA meter, all other inaccuracies being small. Mains voltage variations between +10% and -15% have no effect on the measured result.

The circuit of fig.1 is calibrated as follows:

Adjust RV_2 so that the total cathode series resistance of the EC1000 is $\frac{A.R_1}{50\ 000}\ \Omega$,

where R_1 is the value of the series resistor of the photoemissive tube and

A is the sensitivity of the photoemissive tube (μA/lm) as marked on the tube.

Disconnect the EC1000 grid from the photoemissive tube and connect it to earth. Connect the mains input and adjust RV_1 so that the 50μA meter reads zero. The circuit is now set up and calibrated for 0.02mlm per μA deflection on the meter. For measurements of rapidly changing phenomena the series resistor (R_1) should be chosen for an acceptable signal-to-noise ratio and acceptable distortion, and the meter should be replaced by a resistor shunted by the input to an oscilloscope. Depending on the frequency, further adaptions of the circuit may be necessary, for example, further smoothing of the direct voltages and a d.c. heater supply for the EC1000.
For extremely rapid changes, when all the circuit time constants must be reduced as far as possible, the circuit of fig.2 may be used. With this circuit laser light flashes can be recorded with a rise time of the signal at the oscilloscope of 20ns.

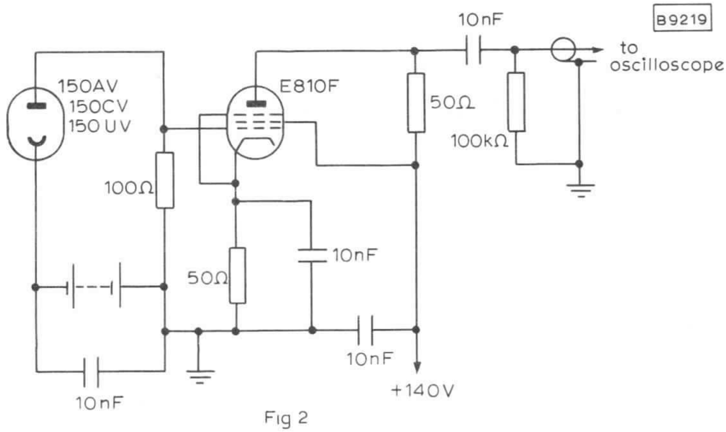


Fig 2

GAS-FILLED PHOTOEMISSIVE TUBE

155UG

QUICK REFERENCE DATA		
Gas-filled photoemissive tube with end-on incidence, sensitive to ultra-violet radiation and intended for use as an on-off device in flame failure circuits.		
Spectral response	0.20 to 0.29	μm
Supply voltage (r.m.s.)	220	V

This data should be read in conjunction with
GENERAL EXPLANATORY NOTES - PHOTOEMISSIVE TUBES

OPERATING PRINCIPLE

When photons of sufficient energy strike the cathode of the tube, electrons may be released. Provided that the tube voltage is sufficiently high, these electrons may initiate a discharge. The probability that this will occur is dependent amongst other things on the value of the supply voltage and the intensity of the ultra-violet radiation.

The discharge will cease as soon as the instantaneous value of the tube voltage falls below the maintaining voltage.

CHARACTERISTICS

Spectral response (see page 7)	0.20 to 0.29	μm
Maintaining voltage	180 to 220	V

RATINGS

T_{amb} max. (operating)		
when used in the circuit of Fig.1	+70	^{o}C
when used in the circuits Fig.2 and Fig.3	+100	^{o}C
T_{amb} min. (operating)	-25	^{o}C
T_{amb} max. (storage)	+50	^{o}C
T_{amb} min. (storage)	-50	^{o}C

No electrical ratings are given for this tube. Designers are strongly advised to use the recommended circuits. Any departure may result in an unsafe operating mode which is likely to cause an internal short circuit in the tube before its rated useful life has expired.

It should be noted that most sources of visible light (e.g. the sun, fluorescent lamps, etc.) are also sources of ultra-violet radiation. Where the level of such radiation affects circuit operation adequate shielding or filtering should be provided.

RECOMMENDED CIRCUITS

1. **Direct relay circuit** (T_{amb} max. = 70°C)

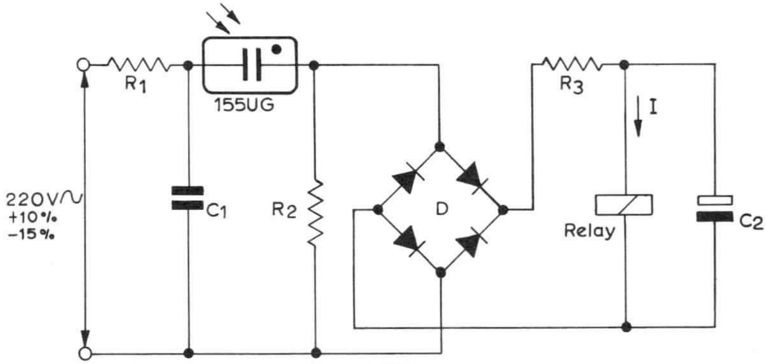


FIG.1

R_1	100Ω ± 10%	Relay:	
R_2	220kΩ ± 10%	R	12kΩ ± 10%
R_3	270Ω ± 10%	I_{on}	<3mA
D	4 diodes 800V P.I.V. e.g. BYX10	I_{off}	0.5 to 1.5mA
		P max.	>1.2W
C_1	12nF ± 15%		
C_2	25µF ± 15%		

NOTES

1. The filter R_1 C_1 reduces the effect of high voltage transients on the mains.

2. Incidental discharges of the tube will not activate the relay with the stated range of supply voltage.

SENSITIVITY

Under the worst probable conditions of supply voltage (190V), component variations and characteristic variation of the tube over 10 000 hours, the tube will activate the relay when the standard radiation source (Fig.4) is less than 50mm from the tube.

2. **Indirect relay circuit 'A'** (T_{amb} max. = 100°C)

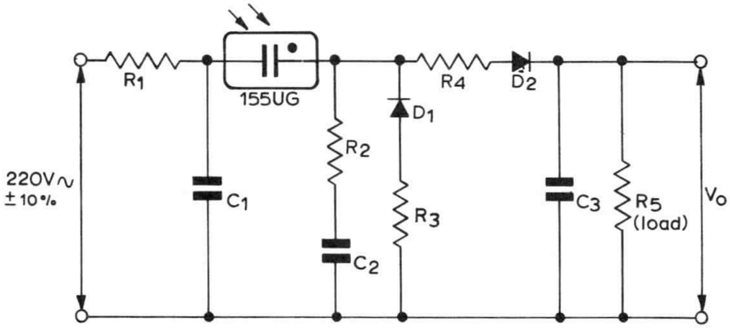


FIG.2

R_1	100Ω ± 10%		C_1	12nF ± 15%
R_2	100Ω ± 10%		C_2	12nF ± 15%
R_3	120kΩ ± 10%		C_3	2.2μF ± 15%
R_4	120kΩ ± 10%		D_1, D_2	diodes 800V P.I.V. e.g. BYX10
R_5	470kΩ ± 10%			

NOTE

The filter R_1 C_1 reduces the effect of high voltage transients on the mains.

SENSITIVITY

The curve on page 8 shows the relationship between the output voltage (V_o) and the distance between the tube and the standard radiation source (Fig.4) under the worst probable conditions of supply voltage (198V) and component variations for the least sensitive new tube.

After the first 10 000 hours of operation the sensitivity will have decreased, but in all cases will be better than indicated by the appropriate curve on page 8, provided that the radiation source is doubled (two candles as in Fig.4).

3. **Indirect relay circuit 'B'** (T_{amb} max. = 100°C)

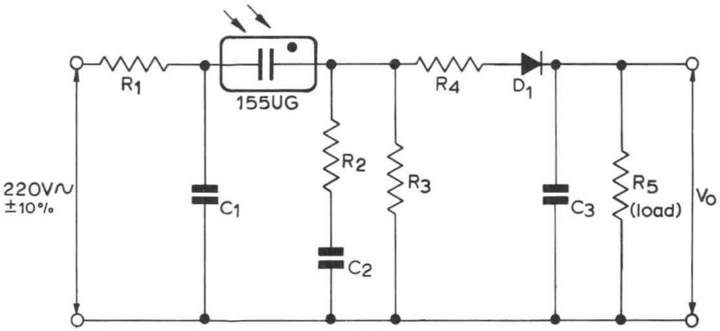


FIG.3

R_1	100Ω ± 10%	C_1	12nF ± 15%
R_2	100Ω ± 10%	C_2	12nF ± 15%
R_3	330kΩ ± 10%	C_3	2.2μF ± 15%
R_4	150kΩ ± 10%	D_1	diode 800V P.I.V. e.g. BYX10
R_5	470kΩ ± 10%		

NOTE

The filter R_1 C_1 reduces the effect of high voltage transients on the mains.

SENSITIVITY

The curve on page 8 shows the relationship between the output voltage (V_o) and the distance between the tube and the standard radiation source (Fig.4) under the worst probable conditions of supply voltage (198V) and component variations for the least sensitive new tube.

After the first 10 000 hours of operation the sensitivity will have decreased, but in all cases will be better than indicated by the appropriate curve on page 8, provided that the radiation source is doubled (two candles as in Fig.4).

APPLICATION NOTES

To ensure that the intensity of radiation incident on the tube in its equipment will be sufficient throughout its service life (10 000 hours in the case of a new tube) the following procedure should be observed:

For the circuit of Fig.1

Place a standard radiation source (Fig. 4) 50mm from the tube and measure the average voltage across the relay.
In actual operation the same tube should be mounted at a distance from the flame such that the average voltage across the relay is **at least** equal to that obtained using the standard radiation source at 50mm distance.
Care should be taken that the mains voltage is the same during both measurements. The flame used during this measurement should be the minimum flame which has to be detected. No further readjustment of the distance between tube and flame will be necessary when the tube is replaced.

For the circuits of Fig.2 and Fig.3

The output power from these circuits is too low to operate a relay directly. For effective discrimination, the voltage at the input of the amplifier must attain a certain threshold value when the ultra-violet radiation emitted by the flame reaches a certain critical intensity.
Therefore steps must be taken to ensure that the output voltage (V_o) from the recommended circuit will remain above this threshold value throughout the life of the tube. This may be done as follows:
Read from the dotted curve on the relevant graph on page 8 the distance d corresponding to the required minimum voltage V_o.
Place two standard radiation sources (Fig.4) at a distance d from the tube and measure the average output voltage with a high resistance d.c. voltmeter (this is the mean value around which the needle swings).
In actual operation the same tube should be mounted at a distance from the flame such that the average output voltage (V_o) is **at least** equal to that obtained using two standard radiation sources at a distance d.
Care should be taken that the mains voltage is the same during both measurements. The flame used during this measurement should be the minimum flame which has to be detected. No further readjustment of the distance between tube and flame will be necessary when the tube is replaced.

The above procedures do not, of course, include allowance for dirt deposited on the tube during life.

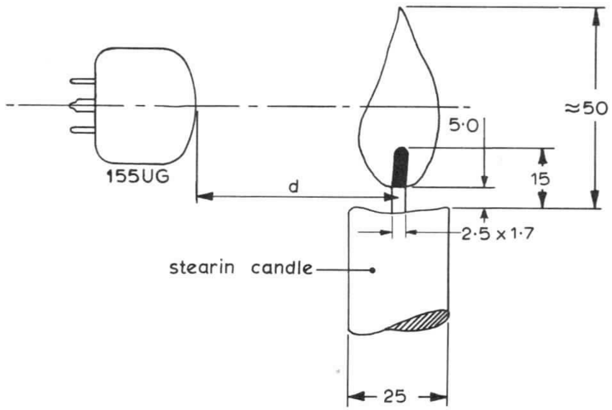
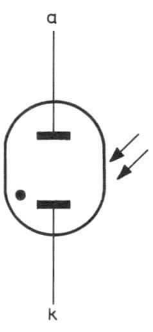
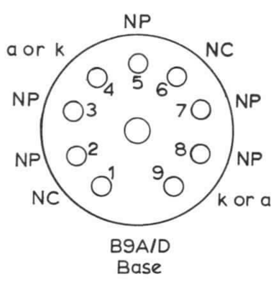
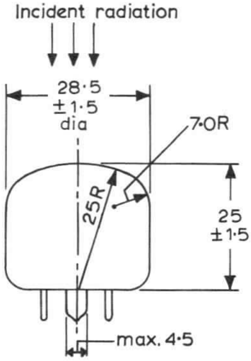


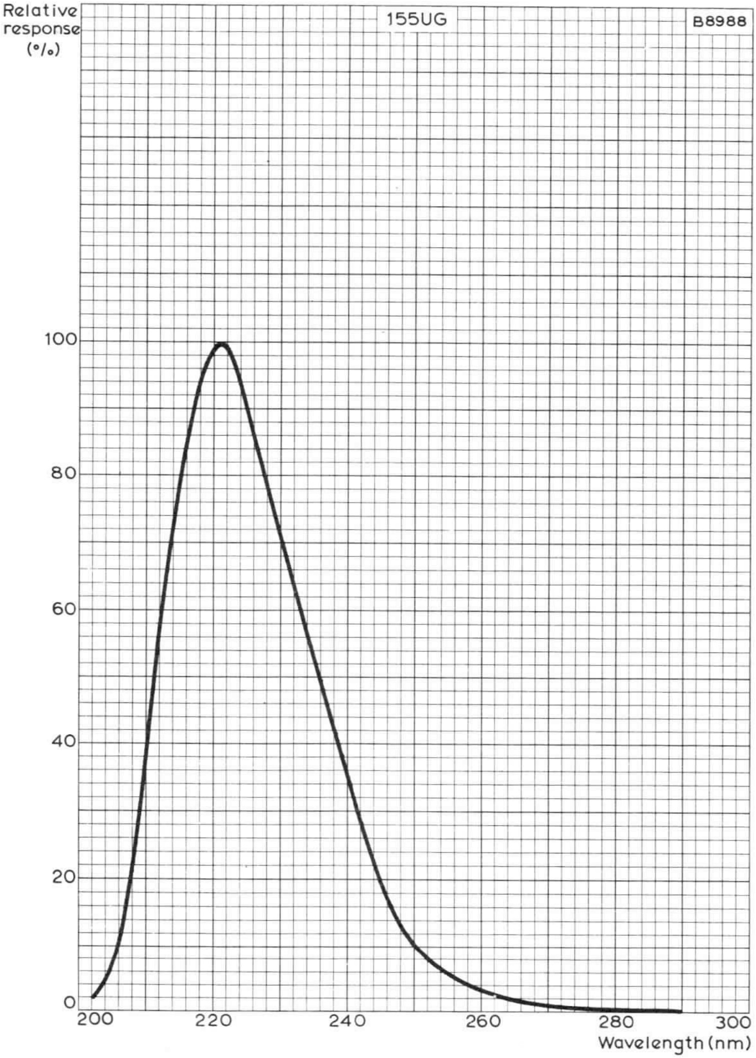
FIG. 4
Standard radiation source

DIMENSIONS AND CONNECTIONS

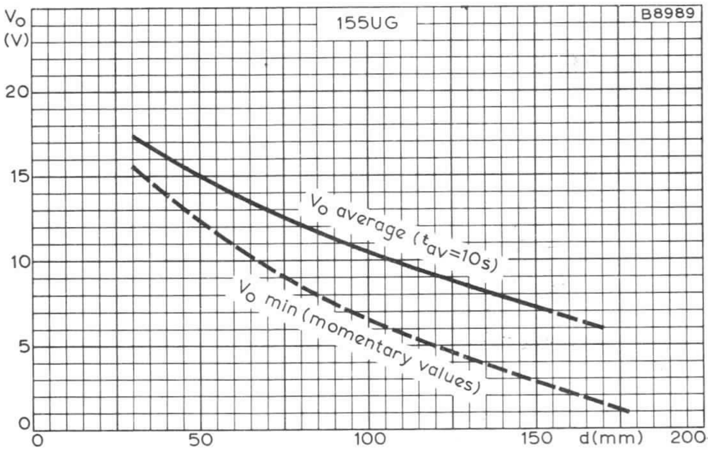




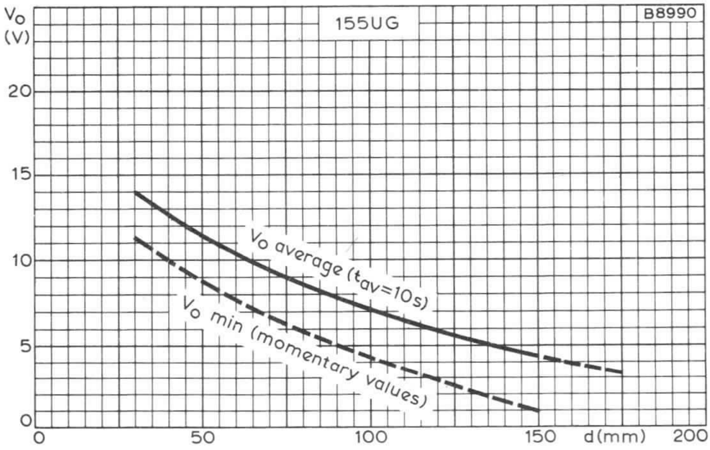




RELATIVE SPECTRAL RESPONSE



OUTPUT VOLTAGE AS A FUNCTION OF THE DISTANCE BETWEEN RADIATION SOURCE AND THE LEAST SENSITIVE TUBE IN THE CIRCUIT OF Fig. 2



OUTPUT VOLTAGE AS A FUNCTION OF THE DISTANCE BETWEEN RADIATION SOURCE AND THE LEAST SENSITIVE TUBE IN THE CIRCUIT OF Fig. 3

The curve is valid at 0 hours when the tube is irradiated by one 'standard radiation source' and at 10 000 hours when irradiated by two 'standard radiation sources'.

CAMERA TUBES

TENTATIVE DATA

Deflection assembly, consisting of deflection, focus and alignment coils, for use with Plumbicon camera tubes in colour cameras.

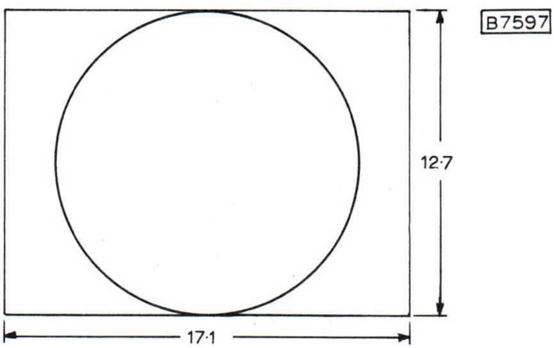
	V_{a2+a3} = 300V	V_{a2+a3} = 600V	
Line deflection current (p-p)	170	250	mA
Frame deflection current (p-p)	27	37	mA

OPERATING CONDITIONS

Plumbicon tube voltage	V_{a2+a3} = 300V	V_{a2+a3} = 600V	
Line deflection current (p-p)	170	250	mA
Frame deflection current (p-p)	27	37	mA
Focus current (L_9 and L_{10} in series)	75	100	mA
Maximum alignment currents	±5	±5	mA

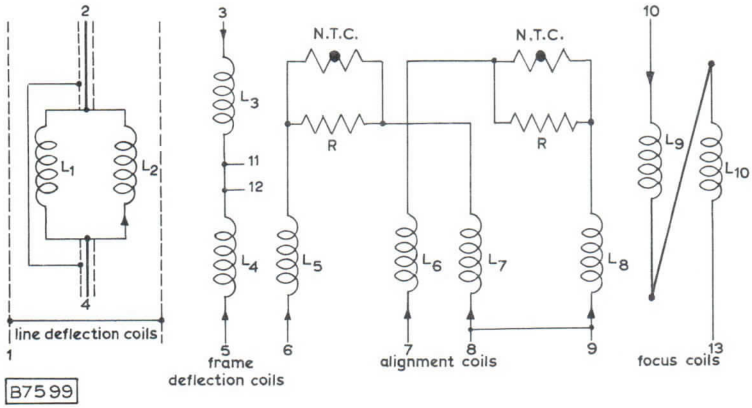
LINEARITY

Linearity inside the circle	≤0.5% of picture height
Linearity outside the circle	≤1.0% of picture height



Scanned area of tube
Dimensions in mm

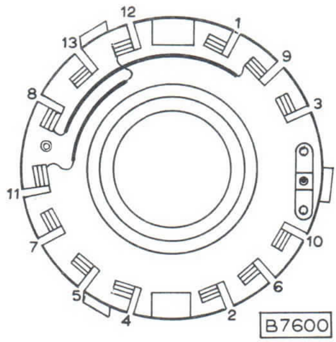
ELECTRICAL CHARACTERISTICS



N.T.C. thermistors = 1300Ω ± 20% at 25°C

R = 560Ω ± 5%

1 = black
2 = transparent (screened)
3 = brown
4 = yellow (screened)
5 = red
6 = orange
7 = yellow
8 = 9 = blue
10 = white
11 = -
12 = -
13 = grey

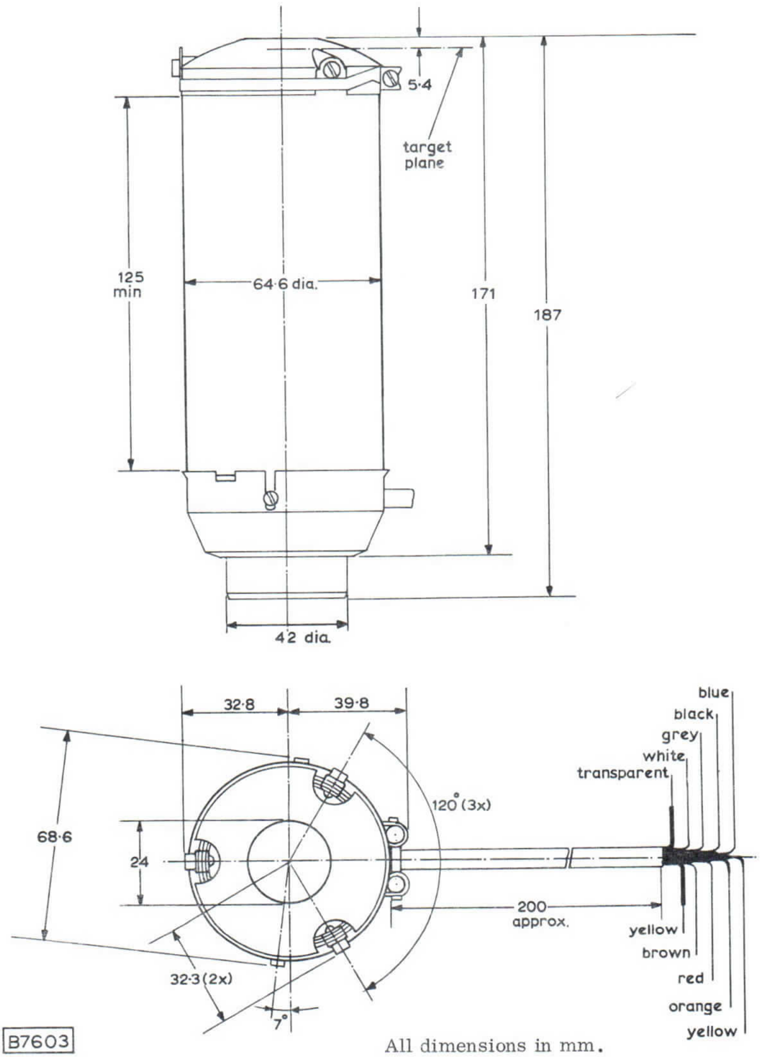


Terminating panel

Coils	Measuring points	Inductance (mH)	Resistance at 25°C (Ω)
$L_1 + L_2$	2-4	0.995 ± 3.5%	2.6 ± 10%
$L_3 + L_4$	3-5	22.1 ± 3.5%	63.8 ± 10%
$L_5 + L_7$	6-8		2143 ± 10%
$L_6 + L_8$	7-9		2143 ± 10%
$L_9 + L_{10}$	10-13		148 ± 10%
Internal shield	1		

Temperature dependence of alignment coils $L_5 + L_7$ and $L_6 + L_8$ from 25 to 60°C < 1%.

OUTLINE AND DIMENSIONS OF AT1113



B7603

All dimensions in mm.

QUICK REFERENCE DATA			
Deflection assembly, consisting of deflection, focus and alignment coils, for use with Plumbicon camera tubes in monochrome cameras.			
	$V_{a2+a3} = 300V$	$V_{a2+a3} = 600V$	
Line deflection current (p-p)	170	250	mA
Frame deflection current (p-p)	27	37	mA

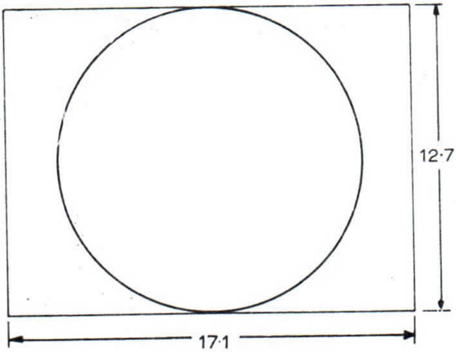
OPERATING CONDITIONS

Plumbicon tube voltage	$V_{a2+a3} = 300V$	$V_{a2+a3} = 600V$	
Line deflection current (p-p)	170	250	mA
Frame deflection current (p-p)	27	37	mA
Focus current (L_9 and L_{10} in series)	17	25	mA
Maximum alignment currents	±5	±5	mA

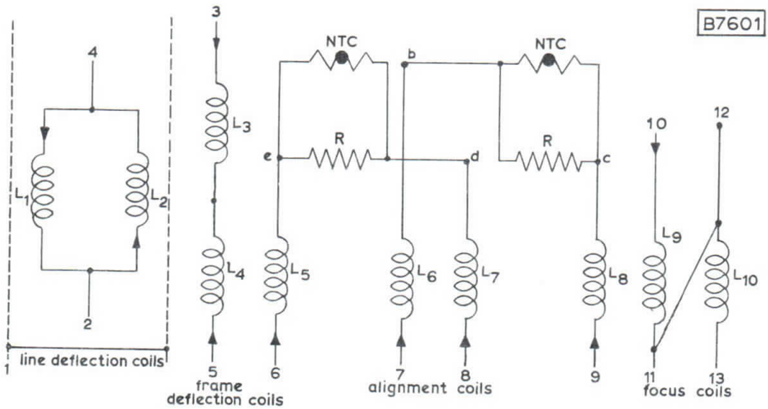
LINEARITY

Linearity inside the circle	≤0.5% of picture height
Linearity outside the circle	≤1.0% of picture height

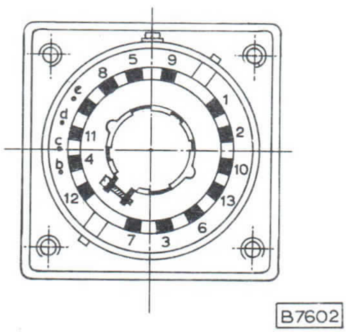
B7596



Scanned area of tube
Dimensions in mm



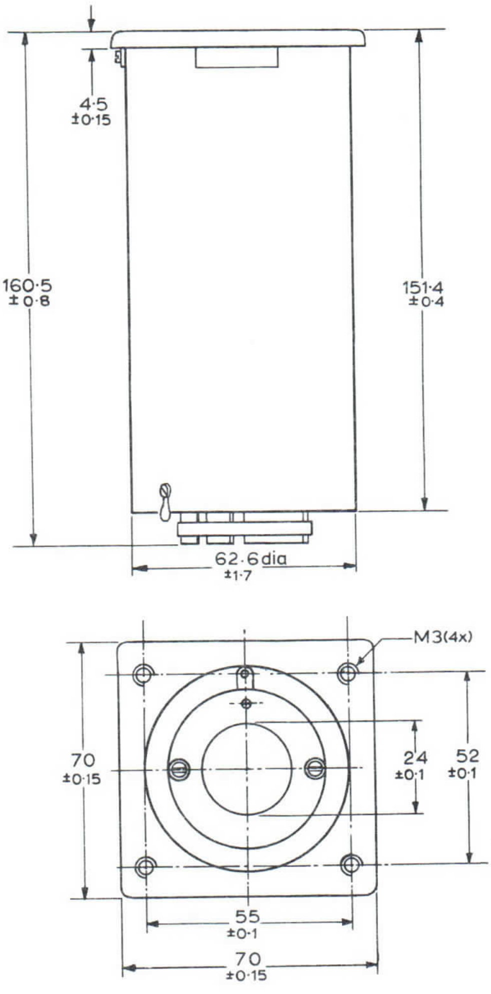
N.T.C. thermistor = 1300Ω ± 20% at 25°C
R = 560Ω ± 5%



Terminating panel

Coils	Measuring points	Inductance (mH)	Resistance (Ω)
$L_1 + L_2$	2-4	0.99	2.6
$L_3 + L_4$	3-5	22.1	63.8
$L_5 + L_7$	6-8		2390
$L_6 + L_8$	7-9		2390
L_9	12-13		1100
L_{10}	10-11		1650
Internal shield	1		

OUTLINE AND DIMENSIONS



All dimensions in mm. B7598

VIDICON TUBE XQ1010

DEVELOPMENT SAMPLE DATA

QUICK REFERENCE DATA		
2.5cm (1in) diameter ruggedised vidicon camera tube with low heater power and electrostatic focusing and deflection. Intended for use in military and other applications under limited dimensional conditions. This tube has a low power consumption and is suitable for use where vibration and shock conditions are experienced.		
Resolution capability (at picture centre)	700	lines
Spectral sensitivity is a maximum at	0.4	μm
Typical output current (8 lux illumination)	0.15	μA

This data should be read in conjunction with OPERATING NOTES on page D3.

HEATER

Indirectly heated

V_h	6.3 ± 10%	V
I_h	90	mA

OPERATING CONDITIONS AND PERFORMANCE
(for scanned area of 11.2mm × 11.2mm and a faceplate temperature of 25 to 35 °C)

Pick-up from limited motion live scenes

Conditions

All voltages with respect to cathode

V (target electrode) for dark current of 0.2μA (typical value)	40	V
V_{g5} (decelerator mesh)	275 to 325	V
V_{g4} (collector)	225	V
V_{g3} (focus)	0 to 50	V
V_{g2} (accelerator)	225	V

V_{g1} adjusted for sufficient beam current to stabilise highlights.

Performance

Average deflector plate voltage	225 to 250	V
v_{x1-x2} (sawtooth at 11.2mm)	75	Vp-p
v_{x1-y2} (sawtooth at 11.2mm)	75	Vp-p
Peak highlight target current (see note 1)	0.3	µA
Average target output current (see note 1)	0.1 to 0.2	µA
Minimum modulation depth at centre of picture for 400 t.v. lines	25	%
Average gamma of transfer characteristic	0.6	
Typical decay	10	%

Measured with 8 lux on photoconductive layer, the target voltage adjusted for a dark current of 0.2µA. Residual signal after dark pulse of 200ms.

FOCUSING

Electrostatic

DEFLECTION

Electrostatic

RATINGS (ABSOLUTE MAXIMUM SYSTEM)

When designing the circuit, variations in supply voltages, component tolerances and ambient temperature must be taken into account. The ratings given apply for the full scanned area of 11.2mm×11.2mm (see note 2).

V_{target} max.	250	V
V_{g5} max.	750	V
V_{g4} max.	750	V
V_{g3} max.	750	V
V_{g2} max.	750	V
Maximum voltage between deflection electrodes	200	V
$-V_{g1}$ max.	200	V
$+V_{g1}$ max.	0	V
Faceplate		
Maximum illumination	5000	lux
Maximum temperature	80	^{o}C
$v_{h-k(pk)}$ max.		
Cathode positive	125	V
Cathode negative	10	V
Peak dark current max.	0.2	µA
Peak target current max. (see note 1)	0.6	µA

CAPACITANCES

Target electrode to all other electrodes	4.5	pF

This capacitance, which affects the output impedance, increases by approximately 3.0pF when the tube is mounted in a shield.

ORIENTATION OF SCANNED RECTANGLE

Correct orientation is obtained when the horizontal scan is parallel to the plane passing through the axis of the tube and pin two.

MOUNTING POSITION Any

OPERATING NOTES

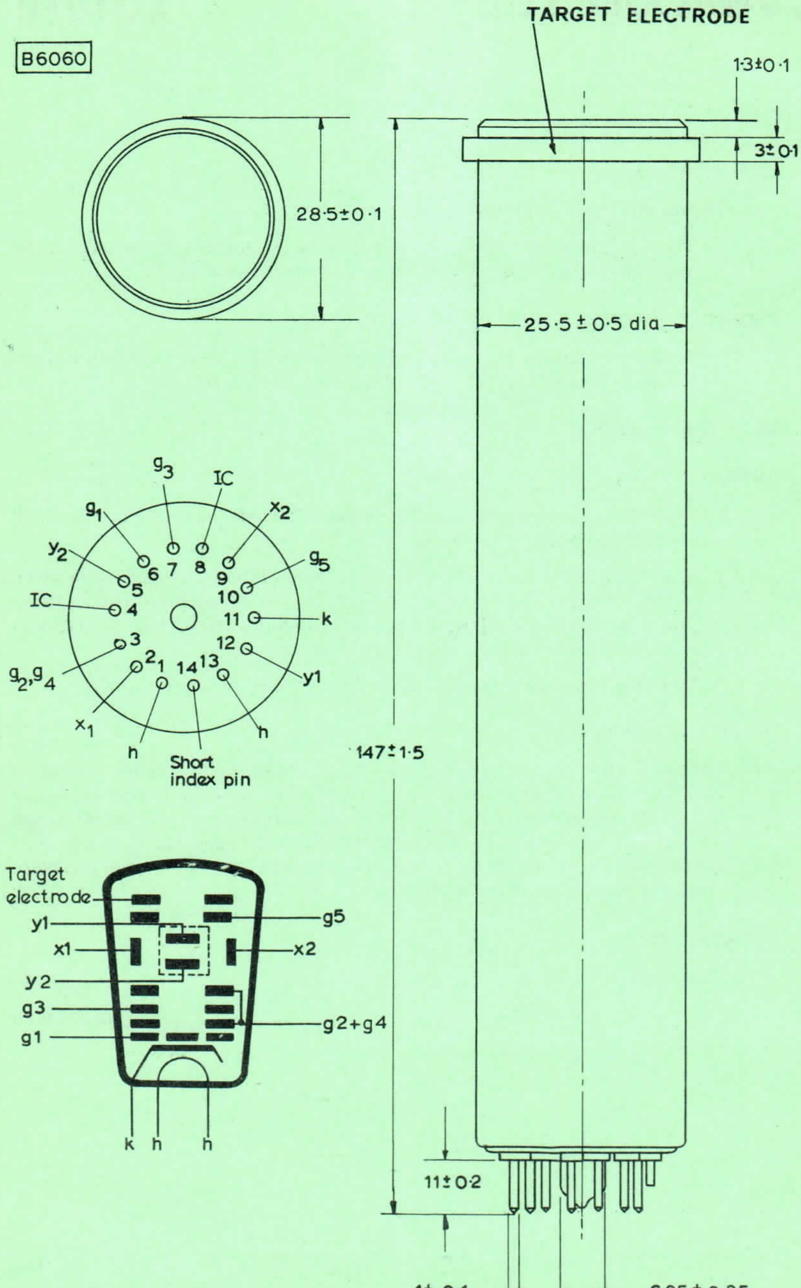
1. Defined as the component of the target electrode current after the dark current has been subtracted.
2. The entire working area (11.2mm × 11.2mm) of the photoconductive layer should always be scanned, accordingly the use of the mask having these dimensions is recommended. Scanning an area less than 11.2mm × 11.2mm may permanently damage the photoconductive layer.
3. The tube requires a mu-metal shield to exclude magnetic fields.

SHOCK AND VIBRATION

The tube will function satisfactorily when vibrated at a frequency of 25 to 500Hz with an acceleration of 20g in each of three mutually perpendicular directions one of which coincides with the axis of the tube. The rate of change of frequency to be logarithmic and such that a complete cycle occupies approximately 10 minutes. The duration of the test to be twelve complete cycles in each of its three directions.

ACCESSORIES

Valve holder	B8 700 67 (provisional)



All dimensions in mm

DEVELOPMENT SAMPLE DATA

QUICK REFERENCE DATA

3cm (1.2in) diameter*Plumbicon camera tubes with separate mesh, for sensitive, high definition pick-up in monochrome and colour broadcast cameras.

These tubes incorporate a photoconductive layer

XQ1020	-	for use in monochrome television cameras
XQ1020L	-	provides the luminance component of a colour picture
XQ1020R	-	provides the red component of a colour picture
XQ1020G	-	provides the green component of a colour picture
XQ1020B	-	provides the blue component of a colour picture

Dark current	<3.0	nA
Resolution capability	>600	T.V. lines
Transfer characteristic	linear	

GENERAL OPERATIONAL RECOMMENDATIONS AND INSTRUCTIONS FOR USE ARE GIVEN ON PAGES D7 to D9.

Unless otherwise stated, data is applicable to all types in the series

HEATER

Suitable for parallel operation only

V_h	6.3 ± 5%	V
I_h	300	mA

* Registered trade mark for television camera tubes.

OPERATING CONDITIONS

For scanned area 12.8×17.1mm (see note 1)

Conditions

V_{a3} (see note 2)	V_{a2} plus 50 to 100	V
V_{a2}	600	V
V_{a1}	300	V
Minimum peak-to-peak blanking voltage		
when applied to grid	70	V
when applied to cathode	25	V
I_{a1} for normal beam currents	<1.0	mA
Dark current (target electrode voltage=45V)	<3.0	nA
Faceplate illumination	See note 3	

Performance

Target electrode voltage (see note 4)	45	V
V_g (for picture cut-off with no blanking applied)	-30 to -100	V
*Highlight target electrode current	0.3	μA
*Average target electrode current	approx. 0.15	μA

Beam current should be adjusted for correct stabilisation of a highlight signal current of twice the value stated in the table below.

Resolution

Modulation depth at centre of picture for 400 T.V. lines (see note 5)

	XQ1020 XQ1020L	XQ1020R	XQ1020G	XQ1020B	
Highlight target current	0.3	0.15	0.3	0.15	μA
V_{a2}=550 to 650V**, $V_{a3}=V_{a2}$+50 to 100V	40	35	40	50	%

Resolution capability	>600	T.V. lines
Signal-to-noise ratio at a signal current of 0.15μA (see note 6)	approx. 200:1	
Gamma of transfer characteristic (see note 7)	0.95±0.05	
Peak spectral response	approx. 500	nm

Decay (see note 8)

Measured with 100% signal current of 0.1μA and with a light source of colour temperature 2850°K. The appropriate filter is inserted in the light path of the XQ1020R, G, B.

	XQ1020, XQ1020L, R, G	XQ1020B	
Max. residual signal			
after dark pulse of 60ms	5.0	6.0	%
after dark pulse of 200ms	2.0	3.0	%

*Subtraction of dark current is unnecessary because of the high ratio of signal current to dark current.

**V_{a2} adjusted for optimum focus.

Sensitivity (see note 9)

XQ1020, XQ1020L	>275	μA/lm
XQ1020R	>60	μA/lm
XQ1020G	>125	μA/lm
XQ1020B	>32	μA/lm

ORIENTATION OF SCANNED RECTANGLE

The picture quality specification will hold for a quality rectangle 12.8 × 17.1mm. For correct orientation of the image on the photoconductive layer the vertical scan should be essentially parallel to the plane passing through the tube axis and the mark on the tube base.

FOCUSING AND DEFLECTION (see "Accessories")

Magnetic

Approximate values	Focus current (mA)	Line current (mA p-p)	Field current (mA p-p)
Monochrome coil assembly AT1132 V_{a2} = 600V, V_{a3} = V_{a2} plus 50 to 100V	25	235	35
Colour coil assembly AT1113 V_{a2} = 600V, V_{a3} = V_{a2} plus 50 to 100V	100	235	35

PHOTOCONDUCTIVE LAYER

Dimensions of image on photoconductive layer (aspect ratio 4:3)	12.8 × 17.1	mm

RATINGS (ABSOLUTE MAXIMUM SYSTEM)

V_{target} max.	50	V
V_{a3} max.	1000	V
V_{a2} max.	750	V
V_{a3-a2} max. (a3 positive)	350	V
V_{a1} max. (at V_k = 0V)	350	V
p_{a1} max.	1.0	W
$+V_g$ max.	0	V
$-v_{g(pk)}$ max.	125	V
$v_{h-k(pk)}$ max.		
cathode positive	50	V
cathode negative	50	V

RATINGS (continued)

Minimum warm-up time of heater to be observed before drawing cathode current	1.0	min
T_{amb} max. (storage and operation)	+50	^oC
T_{amb} min. (storage and operation)	-30	^oC
Maximum faceplate temperature (storage and operation)	+50	^oC
Minimum faceplate temperature (storage and operation)	-30	^oC
Maximum faceplate illumination (see note 10)	500	lux

CAPACITANCES

Target electrode to all other electrodes (see note 11)	3.0 to 6.0	pF

MOUNTING POSITION Any

WEIGHT

Tube alone (approx.)	100	g

ACCESSORIES

Socket	56021
Focusing and deflection coil assembly	
for XQ1020	AT1132
for XQ1020L, R, G, B	AT1113

NOTES

1. Underscanning of the specified useful target area of 12.8 × 17.1mm, or failure of scanning, should be avoided since this may cause damage to the photoconductive layer. The boundaries outside this area should preferably be covered by a mask to reduce the effects of internal reflections in the faceplate.
2. The optimum voltage difference between a3 and a2 depends on the type of focus/deflection coil unit used. For types AT1113, AT1132, a voltage difference of 50 to 100 volts is recommended.
3. Faceplate illumination level for the XQ1020 and XQ1020L typically needed to produce 0.3μA target current will be approximately 4 lux. For the colour tubes XQ1020R, G, B, the target currents stated in the table on page D2 will be obtained with an incident illumination level on the filters of approximately 10 lux, 2850°K colour temperature.
4. The target electrode voltage should be adjusted to 45V. To compete with excessive highlights in the scene to be televised the target electrode voltage may be reduced to a minimum of 25V; this, however, will result in some reduction in performance, particularly in respect of sensitivity.
5. The figures shown represent the typical horizontal amplitude responses of the tubes after correction for the faults introduced by the optical system. Horizontal amplitude response can be improved by the addition of suitable correction circuits. Such compensation, however, does not affect vertical resolution, nor does it influence the resolution capability.

6. The stated ratio represents the "visual equivalent signal-to-noise ratio". Because the noise in such a system is predominantly of the high-frequency type, the signal-to-noise ratio is taken as the ratio of the highlight video signal current to the r.m.s. noise current, multiplied by a factor of 3. An r.m.s. noise current in the pre-amplifier of 2nA, bandwidth 5MHz, is assumed.

7. Gamma is, to a certain extent, dependent on the wavelength of the illumination applied.
The use of gamma-correcting circuitry is recommended.

8. The tubes have a short persistence which makes them ideal for live studio monochrome and colour applications.

9. As measured under the following conditions:
Tubes are exposed to an illumination of 4.54 lux of colour temperature 2850°K. The appropriate filter is inserted in the light path (XQ1020R, G, B). The current obtained is a measure of the colour sensitivity, and is expressed in micro-amperes per lumen of white light before the filter.

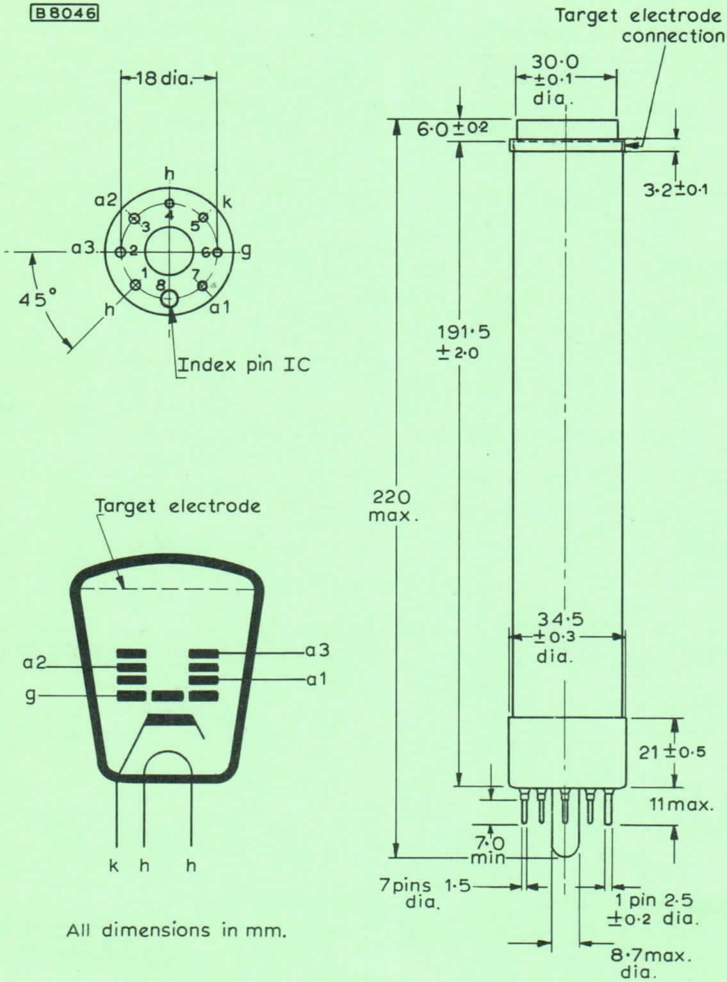
Filters used:

XQ1020R	Schott	OG2	3mm thick
XQ1020G	Schott	VG9	1mm thick
XQ1020B	Schott	BG12	3mm thick

10. For short intervals. During storage and idle periods when the camera is not in use, the tube face should be covered with the plastic hood provided, or the lens should be capped.

11. This capacitance, which is effectively the output impedance, increases when the tube is inserted into the deflection/focusing assembly.

OUTLINE DRAWING OF XQ1020 SERIES



GENERAL OPERATIONAL RECOMMENDATIONS

TRANSPORT, HANDLING AND STORAGE

During transport, handling or storage, the longitudinal axis must be in either a horizontal or vertical position. In the vertical position the faceplate of the tube must be upwards.
During long term storage the ambient temperature should preferably not exceed 30°C.

GENERAL

Base pins

The Plumbicon has been provided with tungsten base pins; accordingly, care must be taken when the tube and socket are mated.

Target electrode

Target electrode connection is made with the metallic coating at the face end of the tube by a spring-contact which is part of the focusing coil assembly.

Photoconductive layer

In some instances the properties of the photoconductive layer may slightly deteriorate during long idle periods, such as encountered between the manufacturer's last test and the first time of operation by the user. It is therefore recommended to operate the tube directly after receipt to restore the photoconductive layer. The tube should be operated for a few hours with normal voltage settings and a signal current of 0.15μA and should be adjusted to overscan an evenly illuminated target.

Light transfer

Because the light transfer characteristic has a gamma of approximately unity, it may be desirable for broadcast applications to incorporate a gamma correcting circuit in the video-amplifier system with a gamma adjustable from 0.5 to 1.0.

When designing this gamma correcting circuit, manual control should be provided for the compression of the video signal in the range 75% to 100% of normal peak white level.

This provision will prevent overloading of the video amplifier system when the tube is exposed to scenes containing small peaked highlights as caused by reflections of shiny objects.

Signal-to-noise ratio

Since the tube does not generate noise to any noticeable extent, the signal-to-noise ratio will be determined mainly by the noise factor of the video-amplifier system.

Under normal studio lighting conditions the high sensitivity of the tube produces a high signal-to-noise ratio, provided that the output of the tube is fed into a well-designed input stage of the video amplifier system. In such a system an aperture correction may be incorporated to increase the resolving power without visually impairing the signal-to-noise ratio.

OPERATING INSTRUCTIONS

1. Insert the tube into the deflection unit in such a way that the vertical scan is essentially parallel to the plane through the tube axis and the mark on the base.

2. Clean the faceplate of the tube and press the socket gently onto the base pins.

3. Cap the lens and close the iris

4. Adjust the operating conditions as follows:

   a) Grid bias control at maximum negative bias (beam cut-off)

   b) Target electrode voltage at 45V

   c) Scanning amplitudes to maximum

5. Switch on the camera and monitor equipment. Allow a few minutes for heating up.

6. Adjust the monitor to produce a faint, non-overscanned raster.

7. Direct the camera to the scene to be televised and uncap the lens.

8. Slowly adjust the grid bias control until a picture is produced on the monitor. If the picture is too faint, increase the lens aperture.

9. Adjust V_{a2} and V_{a3} (beam focus) and optical focus alternately for maximum focus.

10. Adjust the light input and V_g so that a signal current is produced as below, and the beam current is sufficient to stabilise twice this current.

XQ1020, XQ1020L, G	0.3μA
XQ1020R, B	0.15μA

Then align the beam of the Plumbicon by one of the two following methods.

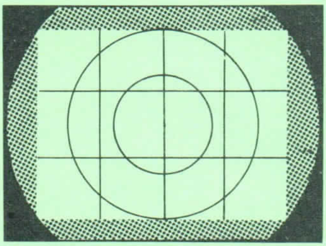
   a) Adjust the alignment fields so that the centre of the picture on the monitor does not move when V_{a2} and V_{a3} (beam focus) are varied.

   b) Reduce the target electrode voltage to a few tenths of a volt only. Adjust the alignment fields until the most uniform picture is obtained, as observed on the monitor or an oscilloscope.

   Readjust the target electrode voltage to 45V.

11. Adjust the scanning amplitudes as follows:

Direct the camera to a test chart having an aspect ratio of 4:3 and adjust the centring controls so that the target ring is just visible in the corners of the picture.



Adjust the distance from the camera to the test chart and the optical focus alternately, until the picture of the test chart is positioned on the target as indicated on the adjoining figure. (This applies to XQ1020. For types XQ1020L, R, G, B used in a colour camera, the picture of the test chart should be slightly within the circle)

Decrease both scanning amplitudes until the picture of the test chart completely fills the scanned raster on the monitor.

12. Adjust the iris for a picture of sufficient contrast.

13. **Standby condition and return-to-operation procedure**

From operation to standby-

a) Cap lens

b) Set V_g for beam cut-off

From standby to normal operation-

a) Increase beam current to normal value

b) Uncap lens

ALWAYS

- use full size (12.8×17.1mm) scanning of the target, and avoid underscanning.
- adjust sufficient beam current to stabilise the picture highlights.
- ensure that the deflection circuits are operative before turning on the beam current.
- operate a3 at a voltage equal to or more positive than V_{a2}.
- avoid focusing the camera directly into the sun.
- keep the lens capped when transporting the camera.

VIDICON TUBES

XQ1040
XQ1042
XQ1043
XQ1044

TENTATIVE DATA

QUICK REFERENCE DATA		
2.5cm (1in) diameter vidicon camera tubes with separate mesh, for industrial and broadcast applications. Suitable for use in transistorised cameras. The four types are identical except for the quality of the photoconductive layer.		
XQ1040 - For use in film scanners		
XQ1042 - For industrial and broadcast applications where a high picture quality is required		
XQ1043 - For normal industrial applications		
XQ1044 - A low cost tube for general purposes		
Focusing and deflection	Magnetic	
Resolution	Up to 1000	lines
Heater voltage	6.3	V
Heater current	90	mA

HEATER

Suitable for series or parallel operation, a.c. or d.c.

V_h	6.3±10%	V
I_h	90	mA

Note (applies to series operation only). The surge heater voltage must not exceed 9.5V r.m.s. when the supply is switched on. When used in a series heater chain, a current limiting device may be necessary in the circuit to ensure that this voltage is not exceeded.

OPERATING CONDITIONS (for scanned area 9.6 × 12.8mm)

Conditions

		Normal operation	Operation for max. resolution	
V_{a3}	Mesh voltage (see note 1)	265 to 400	575 to 850	V
V_{a2}	Focus electrode control range	250 to 300	550 to 650	V
V_{a1}	First anode voltage	300	300	V

V_g adjusted for sufficient beam current to stabilise highlights.

Minimum peak-to-peak blanking voltage			
when applied to the grid	75		V
when applied to the cathode	20		V
Field strength at centre of focusing coil (approx.) (see note 2)	40	60	Gs
Field strength of adjustable alignment coils	0 to 4	0 to 6	Gs

Performance

V_{as} Signal electrode voltage for dark current of 20nA	Min.	20	V
	Typ.	45	V
	Max.	100	V
V_g (for picture cut-off with no blanking applied)		-30 to -100	V

Typical signal current with faceplate illumination of 8 lux	150		nA
Resolution capability at centre of picture (see note 3)	750	1000	T.V. lines
Modulation depth at 400 T.V. lines at centre of picture (see note 4)	50	70	%
Typical decay (8 lux illumination, V_{as} adjusted for dark current of 20nA; residual signal after dark pulse of 200ms)	10		%
Average gamma of transfer characteristic for signal currents between 10 and 300nA	0.6		
Approx. visual equivalent signal-to-noise ratio (see note 5)	200:1		

FOCUSING

Magnetic

DEFLECTION

Magnetic

PHOTOCONDUCTIVE LAYER

Maximum useful diagonal of rectangular image (4:3 aspect ratio) (see note 6)	16	mm

RATINGS (ABSOLUTE MAXIMUM SYSTEM)

V_{as} max. (see note 7)	100	V
V_{a3} max.	1000	V
V_{a2} max.	850	V
V_{a1} max.	450	V
$-V_g$ max.	125	V
$+V_g$ max.	0	V
$i_{as(pk)}$ max. (see note 8)	0.6	μA
Maximum peak dark current	0.25	μA
$v_{h-k(pk)}$ max.		
cathode positive	125	V
cathode negative	10	V
Maximum faceplate illumination	5000	lux
Maximum faceplate temperature (see note 9)	80	^{o}C

CAPACITANCES

Signal electrode to all other electrodes	4.5	pF

This capacitance, which is effectively the output impedance, increases by approximately 3pF when the tube is inserted into the deflection and focusing coil assembly. The resistive component of the output impedance is of the order of 100MΩ.

ORIENTATION OF SCANNED RECTANGLE

The horizontal scan should be essentially parallel to the plane passing through the tube axis and the short index pin.

MOUNTING POSITION Any

WEIGHT

Tube alone (approx.)	75	g

NOTES

1. Under no circumstances should the mesh (a3) be allowed to operate at a lower voltage than the final anode (a2), since this may damage the photoconductive layer.

   The minimum voltage difference (a3 positive with respect to a2) to produce an attractive gain in resolution is 15V. The optimum value of V_{a3} for the highest resolution and the best uniformity of resolution and white level will depend on the type of coil unit used, and will be within the range 1.05 to 1.3 times V_{a2}.

2. The higher voltage operation will necessitate an increase in focusing and deflecting power. Provision should be made for adequate cooling of the tube under these conditions.

3. With a video amplifier system having a flat response to 10MHz.

4. Typical values, measured under conditions of peak signal current I_{as} = 150nA and beam current sufficient to stabilise 500nA.

5. Because the noise in such a system is predominantly of the high frequency type, the "visual equivalent signal-to-noise ratio" is taken as the ratio of the highlight video signal current to the r.m.s. noise current, multiplied by a factor of 3. An r.m.s. noise current in the pre-amplifier of 2nA, bandwidth 5MHz, is assumed.

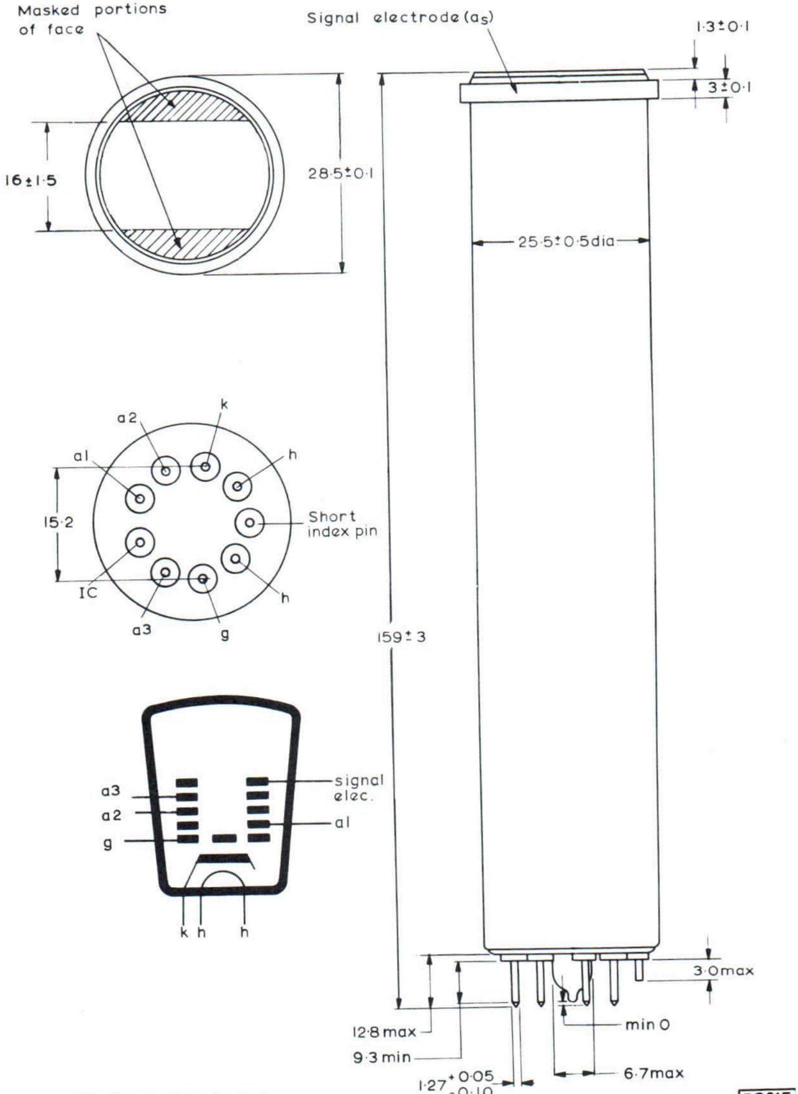
6. The entire working area (9.6 × 12.8mm) of the photoconductive layer should always be scanned. Accordingly the use of a mask having these dimensions is recommended. Scanning an area less than this may permanently damage the photoconductive layer.

7. V_{as} should never exceed 100V, either during warm-up or standby, or during operation. An excessive signal electrode voltage may permanently damage the photoconductive layer.

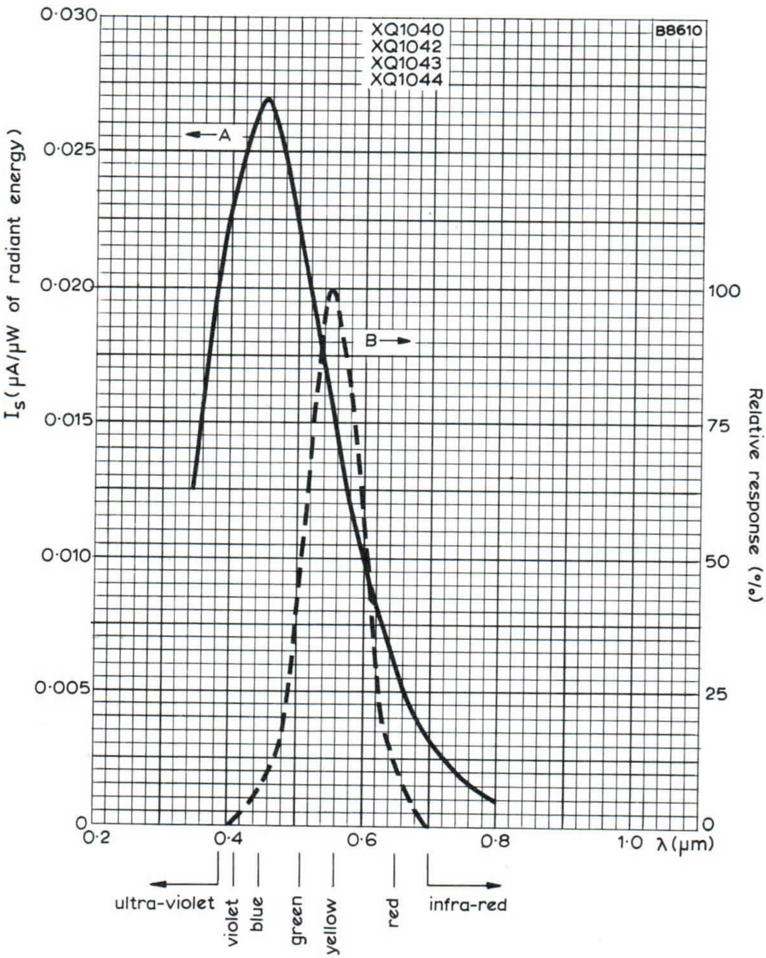
8. Video amplifiers should be capable of handling signal electrode currents of this magnitude without overload or picture distortion.

9. Absolute maximum for shelf life and operation. Under high temperature conditions a flow of cooling air directed at the faceplate is recommended. When televising flames and furnaces, appropriate infra-red filters should be used.

OUTLINE DRAWING



All dimensions in mm.



Curve A: Spectral response of XQ1040 Series

Scanned area = 12.8 × 9.6mm

Signal current = 20nA

Curve B: Relative spectral response of the human eye

SPECTRAL RESPONSE CURVES

CAMERA TUBES
PLUMBICON*

XQ1070 XQ1070/01
XQ1070L XQ1070/01L
XQ1070R XQ1070/01R
XQ1070G XQ1070/01G
XQ1070B XQ1070/01B

DEVELOPMENT SAMPLE DATA

QUICK REFERENCE DATA

25.4mm (1 in) diameter Plumbicon camera tubes with photoconductive layer and separate mesh construction for broadcast, educational and high quality industrial applications. The basic types XQ1070, L, R, G, B are provided with an anti-halation glass disc, while the types XQ1070/01, L, R, G, B are without. These tubes are mechanically interchangeable with 1 inch vidicons with separate mesh and have the same pin connections.

XQ1070 - for use in monochrome television cameras
XQ1070L - provides the luminance component of a colour picture
XQ1070R - provides the red component of a colour picture
XQ1070G - provides the green component of a colour picture
XQ1070B - provides the blue component of a colour picture

Dark current	<3	nA
Resolution capability	>600	TV lines
Transfer characteristic	linear	

GENERAL OPERATIONAL RECOMMENDATIONS AND INSTRUCTIONS FOR USE are given on pages 6 to 8.

HEATER

Suitable for parallel or series operation, a.c. or d.c.

V_h	6.3 ±10%	V
I_h	95	mA

When the tube is used in a series chain, the heater voltage must not exceed 9.5Vr.m.s. when the supply is switched on. To avoid registration errors in colour cameras, stabilisation of the heater voltage is recommended.

FOCUSING — Magnetic

DEFLECTION — Magnetic

PHOTOCONDUCTIVE LAYER

Image dimensions on photoconductive layer
3:4 aspect ratio (see note 1) — 9.6 × 12.8 mm

For correct orientation of the image on the photoconductive layer, the horizontal scan should be essentially parallel to the plane passing through the tube axis and the short index pin.

CAPACITANCE

Target electrode to all other electrodes — 4.5 ±1.0 pF

This capacitance, which is effectively the output impedance, increases when the tube is inserted in the coil assembly.

*Registered trade mark for television camera tubes

TYPICAL OPERATION

Operating conditions

V_k	0	V
V_{target}	45	V
V_{a3} (see note 2)	850	V
V_{a2} (see note 2)	600	V
V_{a1}	300	V
V_g adjusted to give the required beam current		
Scanned area	9.6 × 12.8	mm
Faceplate illumination	See note 3	
Faceplate temperature	20 to 45	^oC

	XQ1070, L, G, XQ1070/01, L, G	XQ1070R, B, XQ1070/01R, B	
Highlight signal current	200	100	nA
Beam current	400	200	nA

Typical performance

Dark current	<3	nA

Resolution

Typical modulation depth measured at centre of picture for 400 TV lines, without aperture correction but corrected for losses introduced by the optical system.

XQ1070 and /01, XQ1070L and /01L	30	%
XQ1070R, XQ1070/01R	25	%
XQ1070G, XQ1070/01G	30	%
XQ1070B, XQ1070/01B	35	%

Resolution capability	>600	TV lines
Gamma of transfer characteristic (see note 4)	0.95 ± 0.05	
Wavelength (approx.) (see page 9)		
at maximum response	500	nm
at cut-off	650	nm

Lag (see note 5)

	XQ1070, XQ1070L, R, G XQ1070/01, XQ1070/01L, R, G	XQ1070B and /01B	
Max. residual signal after dark pulse of 60ms	5	6	%
Max. residual signal after dark pulse of 200ms	2	3	%

Sensitivity (see note 6)

	Minimum	Typical	
XQ1070 and /01, XQ1070L and /01L	275	400	μA/lm
XQ1070R, XQ1070/01R	60	80	μA/lm
XQ1070G, XQ1070/01G	125	165	μA/lm
XQ1070B, XQ1070/01B	32	35	μA/lm

RATINGS (ABSOLUTE MAXIMUM SYSTEM)

V_{target} max. (see note 7)	50	V
V_{a3} max.	1100	V
V_{a2} max.	800	V
V_{a3-a2} max.	450	V
V_{a1} max.	350	V
$-V_g$ max.	125	V
$+V_g$ max.	0	V
I_k max.	3.0	mA
$v_{h-k(pk)}$ max.		
Cathode positive	125	V
Cathode negative	50	V
Maximum faceplate illumination (see note 8)	500	lux
Maximum faceplate temperature (operation and storage)	50	^oC
Minimum faceplate temperature (operation and storage)	-30	^oC
Minimum warm-up time of heater to be observed before drawing cathode current	1.0	min

EQUIPMENT DESIGN RECOMMENDATIONS

V_{target} (see note 9)	25 to 45	V
V_{a3}	820 to 880	V
V_{a2}	570 to 630	V
V_g	0 to -100	V
Minimum peak-to-peak blanking voltage		
when applied to the grid	70	V
when applied to the cathode	25	V

The current drawn by the tube from the first anode supply will not exceed 1mA.

MOUNTING POSITION

Any

WEIGHT

Tube alone (approx.)	60	g

ACCESSORIES (see separate data sheets)

Socket	Cinch no. 54A18088 or equivalent
Coil assembly	AT1102 or equivalent

NOTES

1. Underscanning of the useful target area of 9.6 × 12.8mm, or failure of scanning, should be avoided, since this may cause damage to the photoconductive layer. The boundaries outside this area should preferably be covered by a mask to reduce the effects of internal reflections in the faceplate.

2. V_{a2} and V_{a3} are adjusted for optimum beam focus. The optimum voltage V_{a3-a2} to obtain minimum beam landing errors (should be ≤2) depends on the type of coil assembly used. For the type AT1102 a ratio of 1.3:1 to 1.5:1 is recommended, and this ratio should be maintained when focusing.

3. Adjusted to give the required peak signal current. For a typical XQ1070 or XQ1070/01 the required illumination will be approximately 5 lux. The signal currents stated for the XQ1070R, G, B and XQ1070/01R, G, B will be obtained with an incident illumination of approximately 12.5 lux (2854K colour temperature), this figure being based on the use of the following filters:

   for XQ1070R and /01R Schott OG2 thickness 3mm
   XQ1070G and /01G Schott VG9 thickness 1mm
   XQ1070B and /01B Schott BG12 thickness 1mm
   Transmission curves for these filters are given on page 10.

   For a monochrome camera, the faceplate illumination is related to the scene illumination by the formula

$$B_{ph} = B_{sc} \frac{R.T}{4F^2 (m+1)^2}$$

   where B_{sc} = scene illumination
   B_{ph} = faceplate illumination
   R = scene reflectivity (average or that of the object under consideration, whichever is relevant)
   T = lens transmission factor
   F = lens aperture
   m = linear magnification from scene to target

   A similar formula may be derived for the illumination on the photoconductive layers of the R, G and B tubes, in which the effects of the various components in the complete optical system are taken into account.

4. Gamma is to a certain extent dependent on the wavelength of the incident illumination. The use of gamma-correcting circuits is recommended.

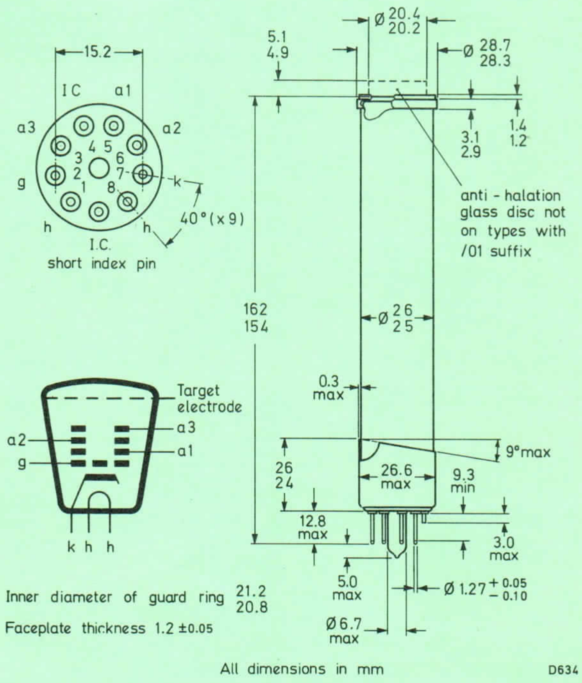
5. Measured with a 100% signal current of 100nA and with a light source of colour temperature 2854K. The appropriate filter is inserted in the light path when measuring colour tubes.

6. As measured under the following conditions:
   Tubes are exposed to an illumination of 8.15 lux at a colour temperature of 2854K. The appropriate filter is inserted in the light path. The current obtained is a measure of the colour sensitivity, and is expressed in micro-amperes per lumen of white light before the filter.

   Filters used:
   for XQ1070 and /01R Schott OG2 thickness 3mm
   XQ1070 and /01G Schott VG9 thickness 1mm
   XQ1070 and /01B Schott BG12 thickness 3mm
   Transmission curves for these filters are given on page 10.

7. Automatic sensitivity control cannot be obtained in Plumbicon tubes by regulating the target electrode voltage. Adequate control can be achieved by iris control and neutral density filters.
   When a Plumbicon tube is used in cameras originally designed for vidicon tubes, the automatic sensitivity control circuits should be made inoperative and the target electrode voltage set to 45V.
8. For short intervals. During storage the tube face should be covered with the plastic hood provided. When the camera is idle the lens should be capped.
9. The target electrode voltage should be adjusted to 45V. If the scene to be televised contains excessive highlights, the target electrode voltage may be reduced to a minimum of 25V; this, however, will result in some reduction in performance, particularly in respect of sensitivity.

OUTLINE DRAWING OF XQ1070 SERIES



The anti-halation glass disc (for types XQ1070, L, R, G, B) is located within a circle of diameter 20.6mm, concentric with the target electrode ring.
The base seal of the tube is protected by a metal sleeve, which is cut-off obliquely at the top. Rotating the tube while pulling will free the tube without damage to the centring or target-electrode springs.

GENERAL OPERATIONAL RECOMMENDATIONS

Transport, handling and storage

During transport, handling or storage, the tube should be placed so that the faceplate is not below the level of the base.

Base pins

The pins of this tube are of Kovar. Accordingly, care must be taken when the tube and socket are matched, in order to avoid damaging the pins or the glass-to-metal seals.

Target electrode

The connection to the target electrode is made at the face end of the tube by a spring contact which is part of the coil assembly.

Photoconductive layer

In some instances the properties of the photoconductive layer may slightly deteriorate during long idle periods, such as encountered between the manufacturer's last test and the first time of operation by the user. It is therefore recommended to operate the tube at approximately monthly intervals from receipt. To restore the photoconductive layer, the tube should be operated for a few hours with normal voltage settings and a signal current of 150nA, and should be adjusted to overscan an evenly illuminated target.

Light transfer

Because the light transfer characteristic has a gamma of approximately unity, it may be desirable for broadcast applications to incorporate a gamma-correcting circuit in the video system, with a gamma adjustable from 0.4 to 1.0. In addition, provision should be made for limiting the video signal above 100% of peak white level, in order to prevent overloading of the video amplifier system when the tube is exposed to scenes containing small peaked highlights as caused by reflections from shiny objects.

Signal-to-noise ratio

Since the tube does not generate noise to any noticeable extent, the signal-to-noise ratio will be determined mainly by the noise factor of the video amplifier system.

Under normal studio lighting conditions the high sensitivity of the tube produces a high signal-to-noise ratio provided that the output of the tube is fed into a well designed input stage of the video amplifier system. In such a system horizontal and vertical aperture correction may be incorporated to ensure sufficient gain in resolving power without significantly impairing the signal-to-noise ratio.

OPERATING INSTRUCTIONS

1. Clean the faceplate of the tube and insert in the coil assembly in such a way that the plane defined by the tube axis and the mark on the base is essentially parallel to the direction of the vertical scan.

2. Carefully mate the socket with the base pins.

3. Cap the lens and close the iris.

OPERATING INSTRUCTIONS (contd.)

4. Adjust the operating conditions as follows:

   (a) Grid bias control to maximum negative bias (beam cut-off)

   (b) Target electrode voltage to 45V.

   (c) Scanning amplitudes to maximum (overscanning)

5. Switch on camera and picture monitor equipment. Allow a few minutes for warming up.

6. Adjust the monitor to produce a faint, non-overscanned raster.

7. Direct the camera towards the scene to be televised and uncap the lens.

8. Slowly adjust the grid bias control until a picture is produced on the monitor. If the picture is too faint, increase the lens aperture.

9. Adjust V_{a2} control (beam focus) and optical focus alternately for optimum focus.

10. Align the beams of the Plumbicon by one of the following methods:

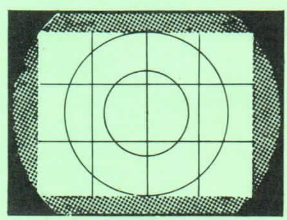
    (a) Adjust the alignment fields in such a way that the centre of the picture on the monitor does not move when V_{a2} (beam focus) is varied. This is catered for automatically in some cameras.

    (b) Reduce the target electrode voltage to a very low value. Adjust the alignment fields until the most uniform picture is obtained, as observed on the monitor or an oscilloscope.

11. Adjust the scanning amplitudes as follows:

    (a) By means of a 9.6×12.8mm mask which is in contact with and centred on the faceplate. Decrease the horizontal and vertical scanning amplitudes until the periphery of the mask is just outside the raster on the monitor. This may be facilitated by small adjustments of the centring controls.

    (b) If no mask is available, direct the camera towards a test chart having an aspect ratio of 4:3 and adjust the centring controls in such a way that the target ring is just visible in the corners of the picture. Adjust the distance from camera to test chart, and re-focus until the image of the test chart is positioned on the faceplate as indicated on the adjoining figure.



    Decrease both scanning amplitudes until the image of the test chart completely fills the scanned raster on the monitor.

12. Adjust the iris for a picture of sufficient contrast and adjust the beam current to a value at which all highlights are stabilised.

13. Check alignment, beam focus and optical focus.

14. Procedure for standby operation

From operation to standby -

(a) Cap lens

(b) Set V_g for beam cut-off

(c) Switch off heater

From standby to normal operation -

(a) Restore heater voltage to 6.3V

(b) Wait 1 minute

(c) Increase beam current to normal value

(d) Uncap lens

ALWAYS -

Use full size (9.6 × 12.8mm) scanning of the target and avoid underscanning.

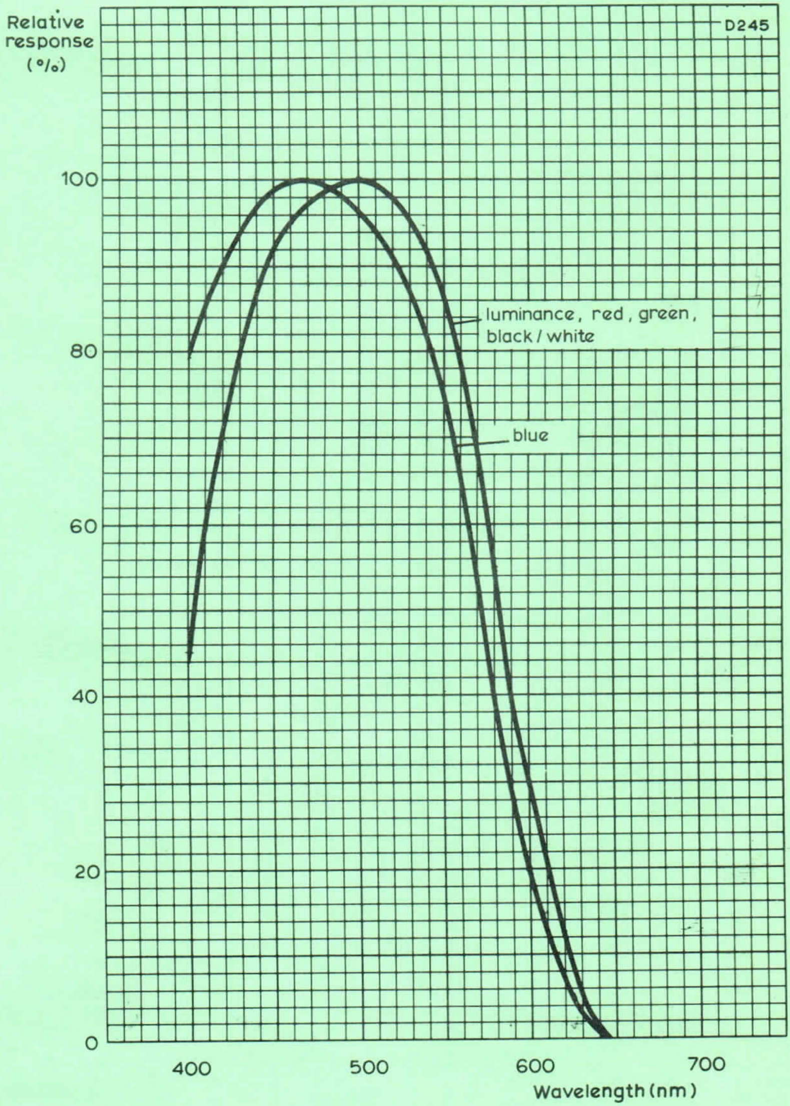
Adjust sufficient beam current to stabilise the picture highlights.

Ensure that the deflection circuits are operative before turning on the beam current.

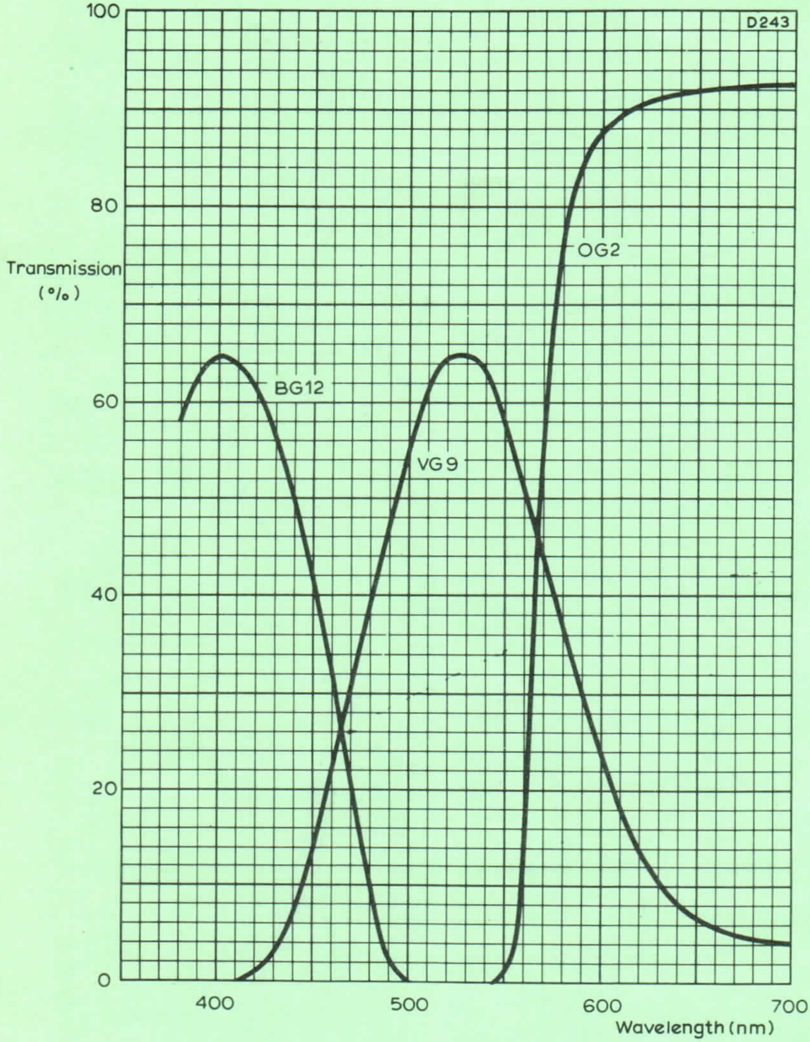
Operate a3 at a voltage equal to or more positive than a2.

Avoid pointing the camera directly into the sun.

Keep the lens capped when transporting the camera.



TYPICAL SPECTRAL RESPONSE CURVES



TRANSMISSION CURVES FOR SCHOTT FILTERS

PRELIMINARY DATA

QUICK REFERENCE DATA

2.5 cm (1 in) diameter vidicon television camera tube with low heater power. Intended for use in low-cost industrial, or experimental cameras.

Pick-up from limited motion live scenes		
Final anode voltage (focus range)	250 to 300	V
Field strength at centre of focusing coil	40	G
Resolution capability (at picture centre)	>600	lines

This data should be read in conjunction with OPERATING NOTES on pages D5 and D6

HEATER

Indirectly heated. Suitable for series or parallel operation.

V_h	6.3	V
I_h	90	mA

Note - (applies to series operation only). The surge heater voltage must not exceed 9.5 Vr.m.s. when the supply is switched on. When used in a series heater chain, a current limiting device may be necessary in the circuit to ensure that this voltage is not exceeded.

TYPICAL OPERATING CONDITIONS AND PERFORMANCE

(for scanned area of 9.6 mm x 12.8 mm and a faceplate temperature of 25 to 35°C)

Pick up from limited-motion live scenes

Conditions

V_{a2+a3} focusing electrode control range (see note 1)	250 to 300	V
V_{a1}	300	V
V_g adjusted for sufficient beam current to stabilise highlights		
Minimum peak-to-peak blanking voltage		
when applied to the grid	75	V
when applied to the cathode (see note 3)	20	V
Field strength at centre of focusing coil (see note 3) approx.	40	G
Field strength of adjustable alignment coils (see note 3)	0 to 4	G

Performance

Signal electrode voltage (for dark current of 20 nA)		
Minimum	0	V
Typical	40	V
Maximum	100	V
V_g (for picture cut-off with no blanking applied)	-20 to -110	V
Minimum signal current with faceplate illumination of 10 lux (see note 4)	75	nA
Resolution capability at centre of picture (see note 5)	> 600	lines
Typical decay (Measured with 10 lux on photoconductive layer, a peak white signal of 100 nA and rest signal after dark pulse of 200 ms.)	< 20	%
Average gamma of transfer characteristic for signal output currents between 10 and 300 nA	0.6	
Visual equivalent signal-to-noise ratio (see note 6)	300 : 1	
Spurious signals		
Shading		see note 7
Spots and blemishes		see note 8

FOCUSING

Magnetic

DEFLECTION

Magnetic

PHOTOCONDUCTIVE LAYER

Maximum useful diagonal of rectangular image (4 : 3 aspect ratio)	16	mm

ABSOLUTE MAXIMUM RATINGS

The equipment designer must ensure that the tube does not exceed these ratings. When designing the circuit, variations in supply voltages, component tolerances and ambient temperature must be taken into account.

The ratings given apply for the full scanned area of 9.6 mm x 12.8 mm (see note 9).

* Signal-electrode voltage max.	100	V
$V_{a2 + a3}$ max.	800	V
V_{a1} max.	350	V

* $-V_g$ max.	125	V
$+V_g$ max.	0	V
** Peak signal current max.	600	nA
Faceplate		
Maximum illumination	5000	lux
Maximum temperature (see note 10)	80	^oC
$V_{h-k(pk)}$ max.		
Cathode positive	125	V
Cathode negative	10	V
V_h max.	6.9	V
V_h min.	5.7	V

* An excessive signal-electrode voltage may cause permanent damage to the photoconductive layer, and the signal-electrode voltage must never exceed 100 V, during warming-up or stand-by, or during operation.

** Video amplifiers must be capable of amplifying signal-electrode currents of this magnitude without overloading the amplifier or distorting the picture.

CAPACITANCES

Signal electrode to all other electrodes 4.5 pF

This capacitance, which is effectively the output impedance, increases by approximately 3 pF when the tube is mounted in the deflection and focusing coil-assembly. The resistive component of the output impedance is approximately 100MΩ.

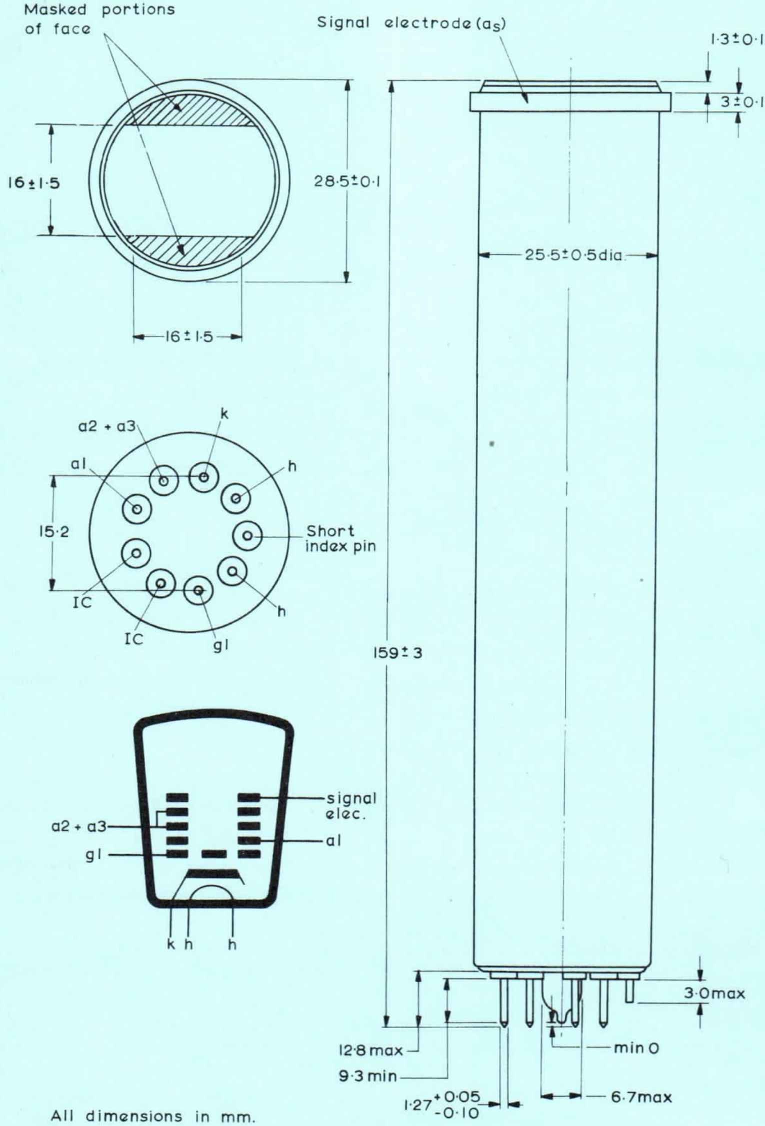
ORIENTATION OF SCANNED RECTANGLE

Correct orientation is obtained when the horizontal scan is parallel to the straight sides of the masked portions of the faceplate. The masking is only a reference for orientation and does not define the proper scanned area of the photoconductive layer.

MOUNTING POSITION Any

WEIGHT

tube alone	approx.	65	g
		2.3	oz



All dimensions in mm.

OPERATING NOTES

1. Focusing of the beam is controlled by V_{a2} and a focus coil having an average field strength of 40 G. For adjustment of focus provision must be made in the a2 circuit to allow variation of V_{a2} within the specified range Normally a2 should be operated above 250 V. Loss of both definition and uniformity of focus over the screen area occurs as V_{a2} is decreased.

2. In transistor cameras cathode blanking is preferable. The cathode impedance is in the order of 30 kΩ.

3. With an indicator placed at the image end of the focusing coil, the direction of the current passed through the coil should be such that the north seeking pole of the indicator is attracted to the image end of the coil.

   The alignment coil assembly should be located round the tube so that its axis in common with the axes of the tube, the deflection yoke and the focusing coil. The centre of the alignment coil assembly should be approximately 9.4 cm from the face of the tube.

4. Defined as the component of the signal-electrode current after the dark current has been subtracted.

5. With a video-amplifier system having 7.5 Mc/s bandwidth (-3 dB points).

   A resolution capability of approximately 900 lines can be achieved with the V_{a2+a3} adjusted to 750 V and a focusing field strength of approximately 70 G. With this mode of operation, beam-landing errors resulting in parabolic shading and dark corners increase, and the deflecting and focusing coils should be designed to eliminate these errors.

   Because higher power will be required to produce 70 G the tube temperature will increase and adequate provisions for cooling should be made.

6. Measured with a peak signal output current of 200 nA into a high-gain cascode-input type of amplifier with an internal noise current of 2 nA r.m.s. and a bandwidth of 5 Mc/s. Because the noise in such a system is predominantly of the high-frequency type, the visual equivalent signal-to-noise ratio is taken as the ratio of the highlight video-signal current to the r.m.s. noise current multiplied by a factor of 3.

7. Target voltage adjusted to obtain a dark current of 20 nA with the camera directed towards a uniformly illuminated white background and the light level adjusted to produce a signal output current (see note 4) of 200 nA.

The composite video signal when viewed as a horizontal trace on a waveform oscilloscope will have a peak-to-peak amplitude of less than 50 % of the peak signal.

8. The test for spots and blemishes is to be made under the following conditions :-

   a) Target voltage adjusted to obtain a dark current of 20 nA.

   b) The camera focused on a uniformly illuminated two-zone test pattern, the diameter of the centre zone (1) being equal to the raster height.

   c) Light level adjusted to produce a signal output current of 200 nA (see note 4).

   d) Scanning amplitude of rectangular monitor adjusted to obtain a raster with an aspect ratio of 4 : 3.

   e) Monitor set-up and contrast control adjusted for faint raster when lens of camera is capped, and for non-blooming bright raster when lens of camera is uncapped.

With the conditions as specified, the number and size of the spots visible in the monitor picture is not to exceed the limits stated below. Both black and white spots must be counted, unless the contrast ratio is 2 : 1 or less.

Spot size Percentage of raster height	Maximum number of spots Zone 1	 Zone 2
>1 %	none	none
1 - 0.6 %	1	3
0.6 - 0.2 %	4	6
<0.2 %	*	*

* Do not count spots of this size unless concentration causes a smudgy appearance.

9. The entire working area (9.6 mm x 12.8 mm) of the photoconductive layer should always be scanned, accordingly the use of a mask having these dimensions is recommended. Scanning an area less than 9.6mm x 12.8mm may permanently damage the photoconductive layer.

10. Absolute maximum for shelf-life and operation. Under difficult environmental conditions a flow of cooling air directed at the faceplate is recommended. When televising flames and furnaces appropriate infra-red filters should be used.

PRELIMINARY DATA

QUICK REFERENCE DATA

2.5cm (1 in) diameter vidicon camera tubes with the low heater power. Intended for use in industrial, medical and broadcast television systems in either black and white or colour. The 55850 has three grades, namely 55850N - for normal industrial applications. 55850S - for industrial, medical and broadcast applications in which a higher picture quality is required. 55850F for use in film scanners.

Pick-up from limited motion line scenes

Final anode voltage (focus range)	250 to 300	V
Field strength at centre of focusing coil	40	G
Resolution capability (at picture centre)	>600	lines

This data should be read in conjunction with OPERATING NOTES on pages D5 and D6.

HEATER

Indirectly heated. Suitable for series or parallel operation. (see note 10).

V_h	6.3	V
I_h	90	mA

Note - (applies to series operation only). The surge heater voltage must not exceed 9.5V r.m.s. when the supply is switched on. When used in a series heater chain, a current limiting device may be necessary in the circuit to ensure that this voltage is not exceeded.

TYPICAL OPERATING CONDITIONS AND PERFORMANCE

(for scanned area of 9.6mm x 12.8mm and a faceplate temperature of 25 to 35°C)

Pick up from limited-motion live scenes

Conditions

V_{a2+a3} focusing electrode control range (see note 1)	250 to 300	V
V_{a1}	300	V
V_g adjusted for sufficient beam current to stabilise highlights		
Minimum peak-to-peak blanking voltage		
When applied to the grid	75	V

when applied to the cathode (see note 2)	20	V
Field strength at centre of focusing coil (see note 3) approx.	40	G
Field strength of adjustable alignment coils (see note 3)	0 to 4	G

Performance

Signal electrode voltage (for dark current of 20nA)		
Minimum	0	V
Typical	40	V
Maximum	100	V
V_g (for picture cut-off with no blanking applied)	-20 to -110	V
Minimum signal current with faceplate illumination of 10 lux (see note 4)	75	nA
Resolution capability at centre of picture (see note 5)	>600	lines
Typical decay	5	%

(Measured with 10 lux on photoconductive layer, a peak white signal of 100nA and rest signal after dark pulse of 200ms.)

Average gamma of transfer characteristic for signal output currents between 10 and 300nA	0.6
Visual equivalent signal-to-noise ratio (see note 6)	300 : 1
Spurious signals (shading)	see note 7.

Pick-up from film (minimum-lag operation)

Conditions

As under 'Pick-up from limited-motion live scenes' with the exception of :

Faceplate illumination (highlight)	500	lux

Performance

As under 'Pick-up from limited-motion live scenes' with the exception of :

Signal voltage (for dark current of 5nA)		
Minimum	10	V
Maximum	20	V
Signal current	300	nA
Typical decay	1	%

(Measured at peak white signal of 300nA and rest signal after dark pulse of 200ms.)

Operation for maximum resolution

Conditions

As under 'Pick-up from limited-motion live scenes' or 'Pick-up from film', with the exception of:-

V_{a2+a3}	750	V
Field strength at centre of focusing coil approx.	70	G

Performance

As under 'Pick-up from limited-motion live scenes' or 'Pick-up from film', with the exception of :-

Resolution capability at centre of picture	approx. 900	lines

FOCUSING

Magnetic

DEFLECTION

Magnetic

PHOTOCONDUCTIVE LAYER

Maximum spectral response	0.45	μm
Maximum useful diagonal of rectangular image (4:3 aspect ratio)	16	mm

ABSOLUTE MAXIMUM RATINGS

The equipment designer must ensure that the tube does not exceed these ratings. When designing the circuit, variations in supply voltages, component tolerances and ambient temperature must be taken into account.

The ratings given apply for the full scanned area of 9.6 mm x 12.8 mm (see note 9)

* Signal-electrode voltage max.	100	V
V_{a2+a3} max.	800	V
V_{a1} max.	350	V
$-V_g$ max.	125	V
$+V_g$ max.	0	V
** Peak signal current max.	600	nA
Faceplate		
Maximum illumination	5000	lux
Maximum temperature (see note 10)	80	°C
$v_{h-k\,(pk)}$ max.		
Cathode positive	125	V

Cathode negative	10	V
V_h max.	6.9	V
V_h min.	5.7	V

* An excessive signal-electrode voltage may cause permanent damage to the photoconductive layer, and the signal-electrode voltage must never exceed 100 V, during warming-up or stand-by, or during operation.

Video amplifiers must be capable of amplifying signal-electrode currents of this magnitude without overloading the amplifier or distorting the picture.

CAPACITANCES

Signal electrode to all other electrodes	4.5	pF

This capacitance, which is effectively the output impedance, increases by approximately 3 pF when the tube is mounted in the deflection and focusing coil-assembly. The resistive component of the output impedance is approximately 100MΩ.

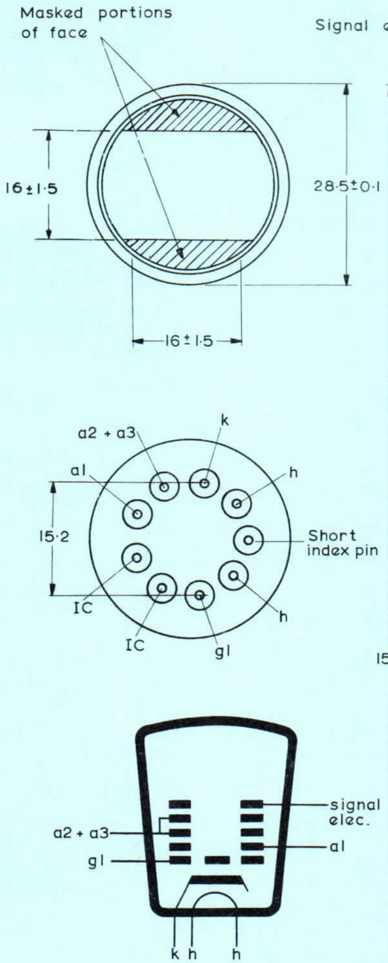
ORIENTATION OF SCANNED RECTANGLE

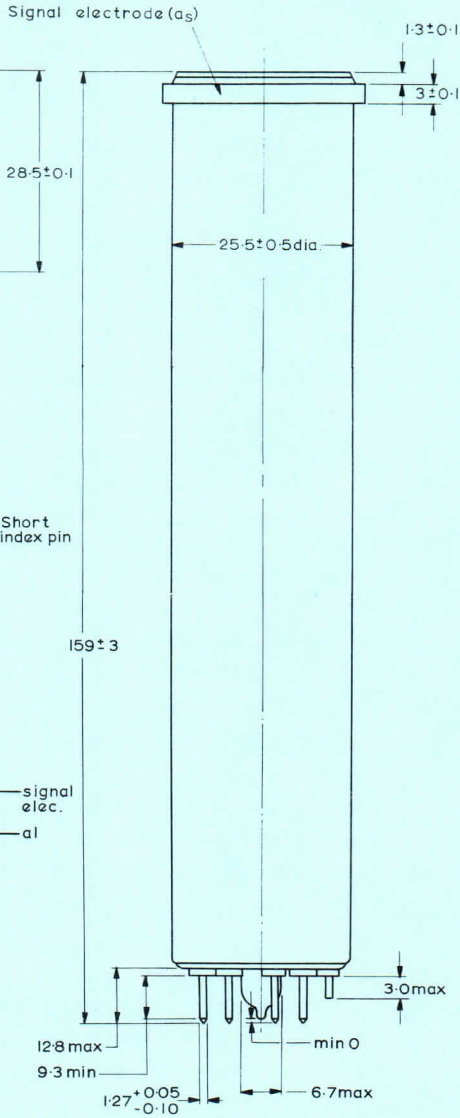
Correct orientation is obtained when the horizontal scan is parallel to the straight sides of the masked portions of the faceplate. The masking is only a reference for orientation and does not define the proper scanned area of the photoconductive layer.

MOUNTING POSITION	Any	

WEIGHT

Tube alone	approx. 65	g
	2.3	oz





All dimensions in mm.

OPERATING NOTES

1. Focusing of the beam is controlled by V_{a2} and a focus coil having an average field strength of 40G. For adjustment of focus provision must be made in the a2 circuit to allow variation of V_{a2} within the specified range Normally a2 should be operated above 250V. Loss of both definition and uniformity of focus over the screen area occurs as V_{a2} is decreased.

2. In transistor cameras cathode blanking is preferable. The cathode impedance is in the order of 30kΩ.

3. With an indicator placed at the image end of the focusing coil, the direction of the current passed through the coil should be such that the north seeking pole of the indicator is attracted to the image end of the coil.

   The alignment coil assembly should be located round the tube so that its axis in common with the axes of the tube, the deflection yoke and the focusing coil. The centre of the alignment coil assembly should be approximately 9.4cm from the face of the tube.

4. Defined as the component of the signal-electrode current after the dark current has been subtracted.

5. With a video-amplifier system having 7.5 Mc/s bandwidth (-3 dB points).

   A resolution capability of approximately 900 lines can be achieved with the $V_{a2 + a3}$ adjusted to 750 V and a focusing field strength of approximately 70 G. With this mode of operation, beam-landing errors resulting in parabolic shading and dark corners increase, and the deflecting and focusing coils should be designed to eliminate these errors.

   Because higher power will be required to produce 70 G the tube temperature will increase and adequate provisions for cooling should be made.

6. Measured with a peak-signal output current of 200nA into a high-gain cascode-input type of implifier with an internal noise current of 2nA r.m.s. and a bandwidth of 5 Mc/s. Because the noise in such a system is predominantly of the high-frequency type, the visual equivalent signal-to-noise ratio is taken as the ratio of the highlight video-signal current to the r.m.s. noise current multiplied by a factor of 3.

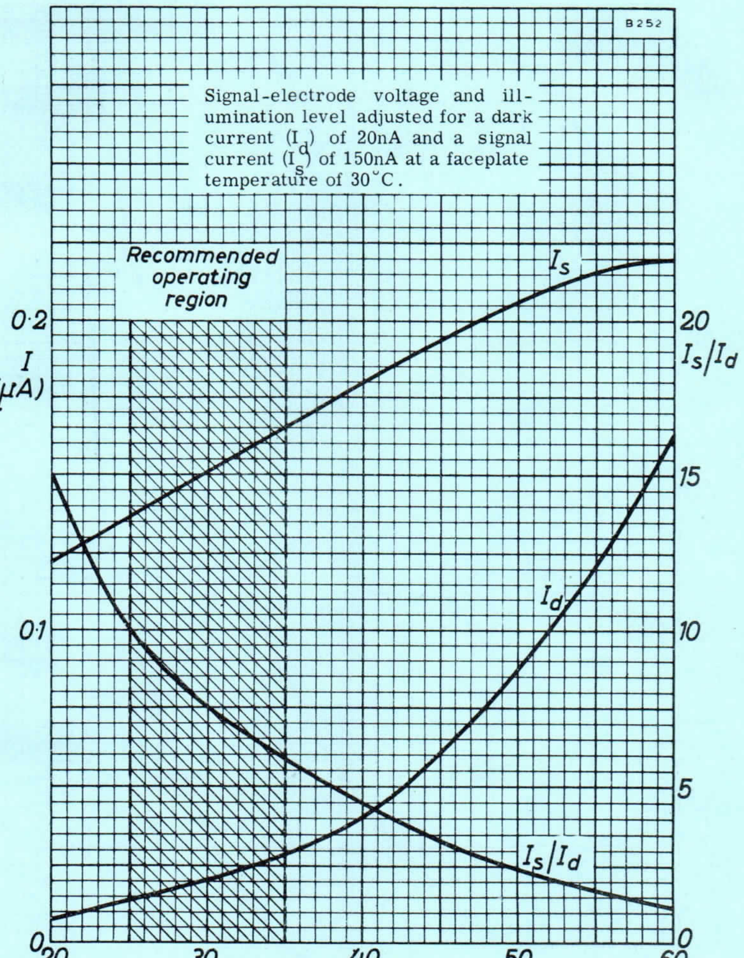
7. Target voltage adjusted to obtain a dark current of 20nA with the camera directed towards a uniformly illuminated white background and the light level adjusted to produce a signal output current (see note 4) of 100nA. The composite video signal when viewed as a horizontal trace on a waveform oscilloscope will have a peak-to-peak amplitude of less than 50% of the peak signal.

8. The entire working area (0.6 mm x 12.8 mm) of the photoconductive layer should always be scanned, accordingly the use of a mask having these dimensions is recommended. Scanning an area less than 9.6 mm x 12.8 mm may permanently damage the photoconductive layer.

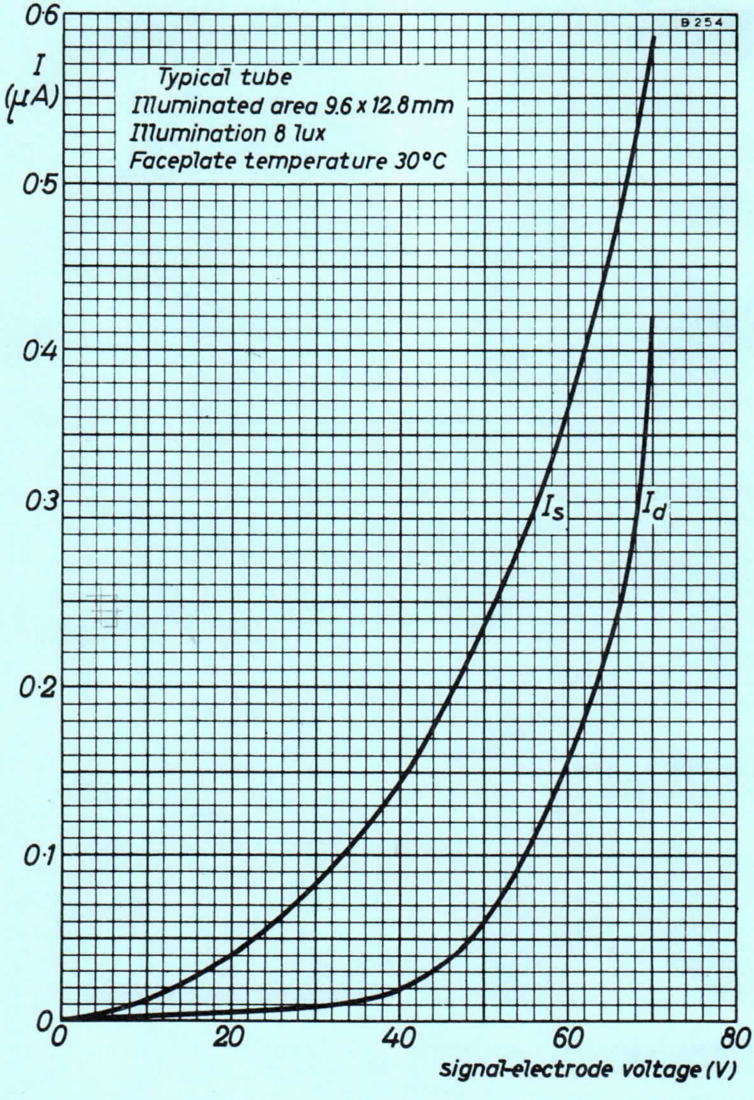
9. Absolute maximum for shelf-life and operation. Under difficult environmental conditions a flow of cooling air directed at the faceplate is recommended. When television flames and furnaces appropriate infra-red filters should be used.

10. When the 55850 vidicon is used as a replacement for types requiring a larger heater power, it is possible, because of the regulation of the heater supply, for the heater voltage limits to be exceeded.

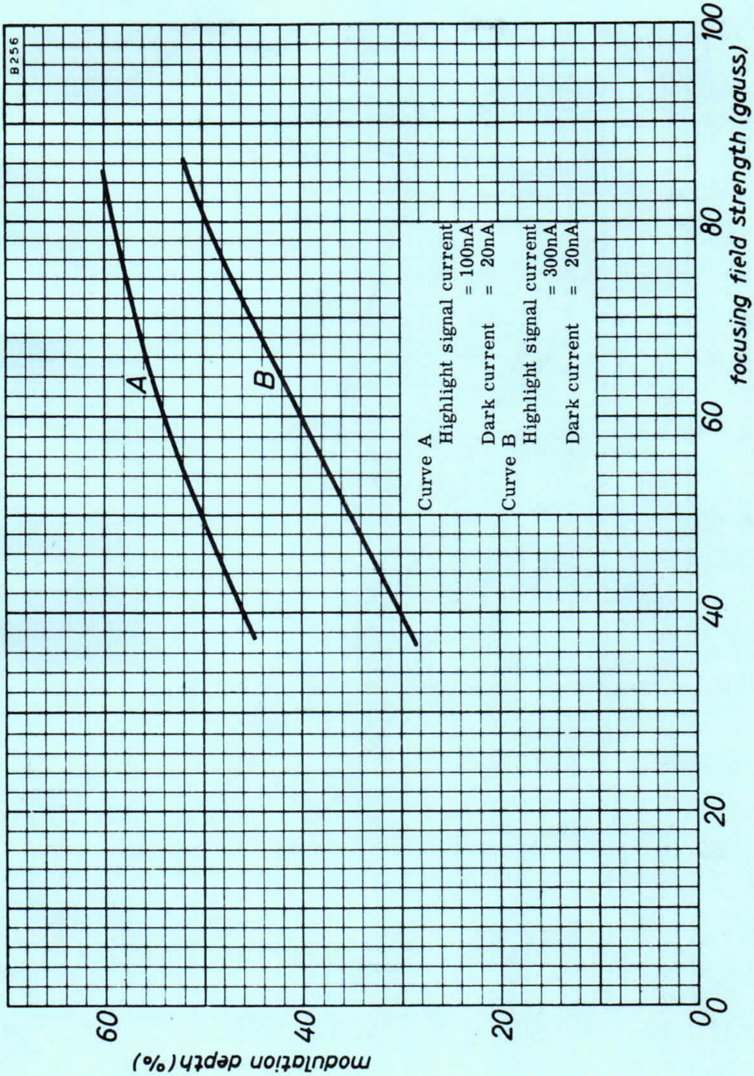
The heater voltage, measured at the base pins must therefore be checked after a substitution is carried out.



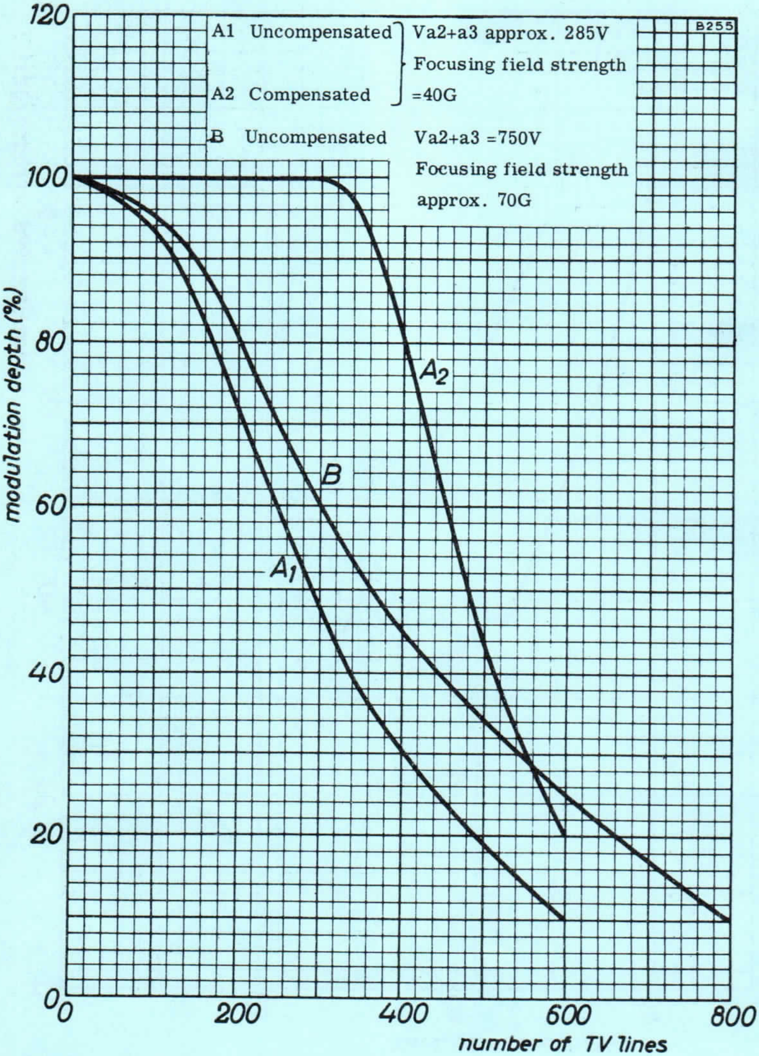
SIGNAL CURRENT, DARK CURRENT AND RATIO OF SIGNAL CURRENT TO DARK CURRENT AS A FUNCTION OF THE FACEPLATE TEMPERATURE



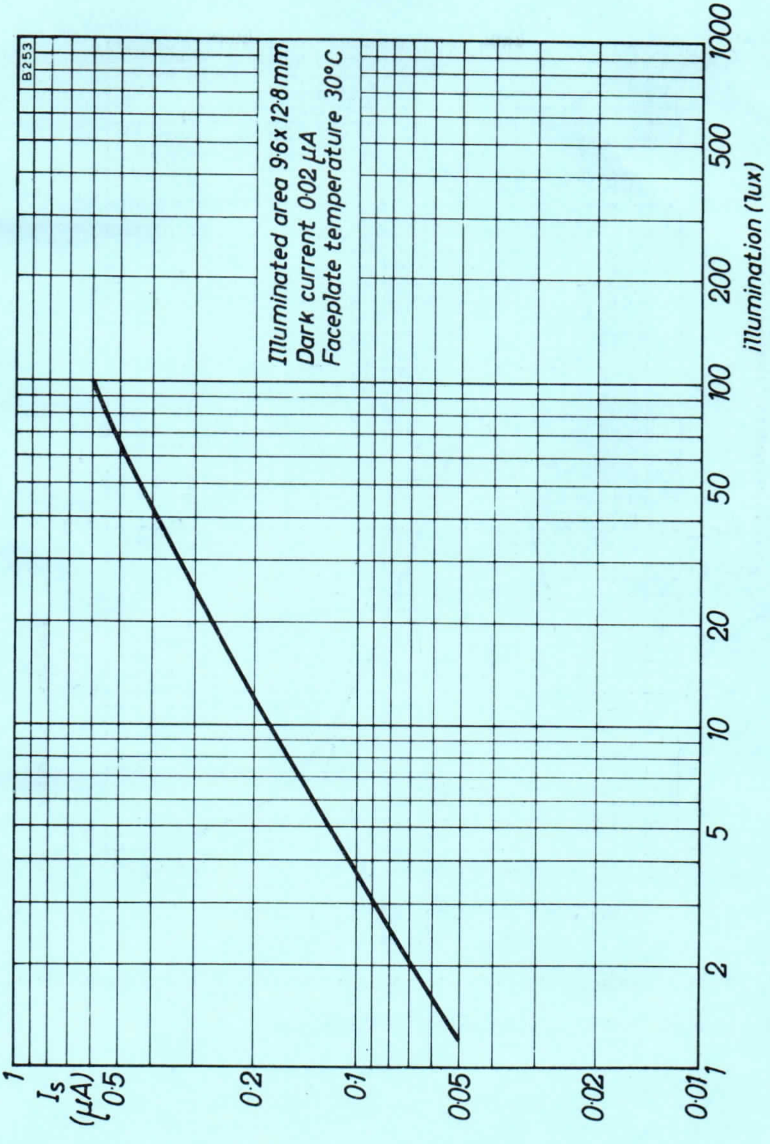
SIGNAL CURRENT AND DARK CURRENT AS A FUNCTION OF THE SIGNAL ELECTRODE VOLTAGE



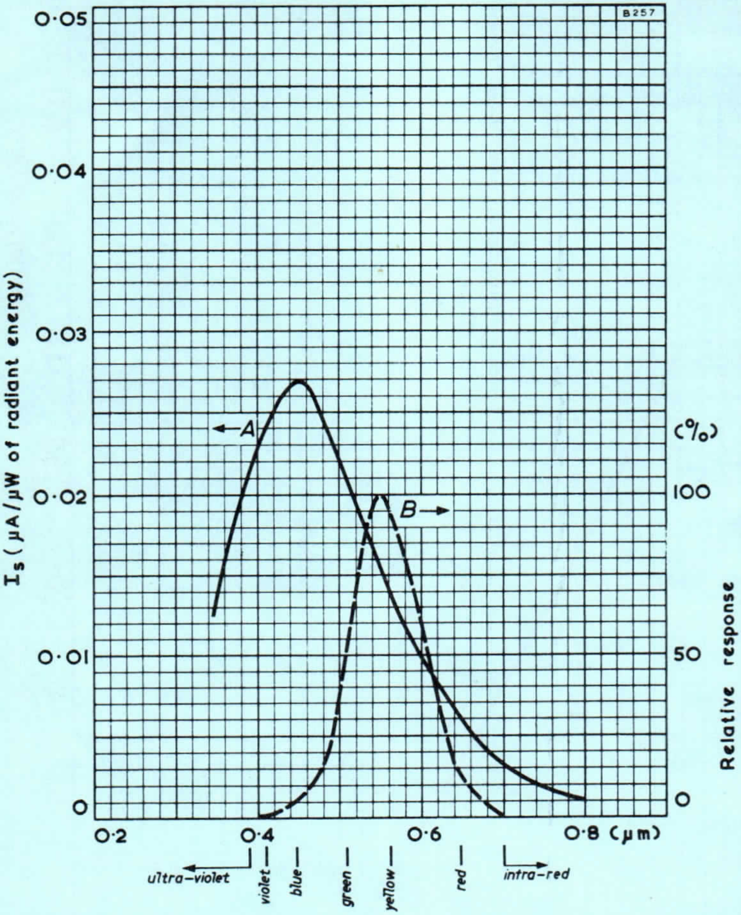
UNCOMPENSATED HORIZONTAL SQUARE-WAVE RESPONSE AT 400 TV LINES AS A FUNCTION OF THE FOCUSING MAGNET FIELD STRENGTH



HORIZONTAL SQUARE-WAVE RESPONSE IN CENTRE OF PICTURE



AVERAGE SIGNAL CURRENT AS A FUNCTION OF THE ILLUMINATION OF THE PHOTOCONDUCTIVE LAYER



A. Spectral response of 55850 Scanned area = 12.8mm x 9.6mm Signal current I = 20nA.
B. Relative spectral response of the human eye.

SPECTRAL RESPONSE CURVES

TENTATIVE DATA

QUICK REFERENCE DATA

2.5cm (1 in) diameter vidicon camera tubes with separate mesh, for industrial applications. The two types are identical, but the 55851-2-AM is a low-price tube with a slightly lower standard of blemishes on the target surface.

Final anode voltage (focus range)	200 to 300	V
Resolution capability at picture centre	up to 900	lines
Heater voltage	6.3	V
Heater current	300 to 350	mA

HEATER

Suitable for series or parallel operation, a.c. or d.c.

V_h	6.3	V
I_h	300 to 350	mA

Note (applies to series operation only). The surge heater voltage must not exceed 9.5V r.m.s. when the supply is switched on. When used in a series heater chain, a current limiting device may be necessary in the circuit to ensure that this voltage is not exceeded.

OPERATING CONDITIONS (for scanned area 9.5×12.7mm)

Conditions

V_{as}	Signal electrode voltage	30 to 70	V
V_{a3}	Mesh voltage (see note 1)	300 to 450	V
V_{a2}	Focusing electrode control range (final anode) See note 2.	200 to 300	V
V_{a1}	First anode voltage	300	V

V_g adjusted for sufficient beam current to stabilise highlights.

Minimum peak-to-peak blanking voltage		
when applied to the grid	50	V
when applied to the cathode	25	V
Field strength at centre of focusing coil (approx.)	40	Gs
Field strength of adjustable alignment coils	0 to 4	Gs

Performance

V_g (for picture cut-off with no blanking applied)	-30 to -100	V
Signal current with faceplate illumination of 10 lux (approx.) See note 3	150	nA
Resolution capability at centre of picture (see note 1)	up to 900	lines
Average slope of transfer characteristic for signal output currents between 50 and 200nA (approx.)	0.65	

FOCUSING

Magnetic

DEFLECTION

Magnetic

PHOTOCONDUCTIVE LAYER

Maximum useful diagonal of rectangular image (4:3 aspect ratio) See note 4	16	mm

RATINGS (ABSOLUTE MAXIMUM SYSTEM)

V_{as} max. (see note 5)	100	V
V_{a3} max.	1000	V
V_{a2} max.	900	V
V_{a1} max.	450	V
$-V_g$ max.	125	V
$+V_g$ max.	0	V
$v_{h-k(pk)}$ max.		
cathode positive	125	V
cathode negative	10	V
Maximum temperature of faceplate (see note 6)	70	^{o}C

CAPACITANCES

Signal electrode to all other electrodes (approx.)	5.0	pF

This capacitance, which is effectively the output impedance, increases by approximately 3pF when the tube is mounted in the deflection and focusing coil assembly. The resistive component of the output impedance is of the order of 100MΩ.

ORIENTATION OF SCANNED RECTANGLE

Preferred orientation is obtained at the point where no mesh pattern is observed.

MOUNTING POSITION Any

WEIGHT

Tube alone (approx.)	75	g

OPERATING NOTES

1. The mesh (a_3) should be operated at a higher electrical potential than that of the final anode (a_2). V_{a3} should be adjusted for optimum resolution and minimum shading. If a separate supply is not available for a_3 it should be connected to a_2.

2. Focusing of the beam is controlled by V_{a2} and a focus coil having an average field strength of 40Gs. For focus adjustment provision must be made to allow variation of V_{a2} within the specified range.

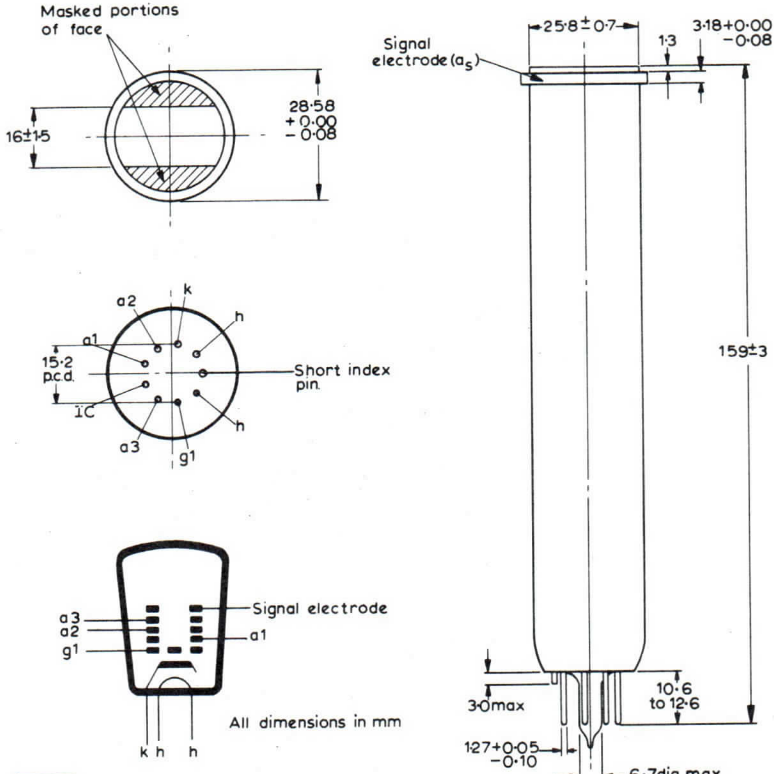
3. Defined as the component of the signal electrode current after the dark current has been subtracted.

4. The entire working area (9.5×12.7mm) of the photoconductive layer should always be scanned. Accordingly the use of a mask having these dimensions is recommended. Scanning an area less than this may permanently damage the photoconductive layer.

5. V_{as} should never exceed 100V, either during warm-up, or standby, or during operation. An excessive signal electrode voltage may permanently damage the photoconductive layer.

6. Absolute maximum for shelf-life and operation. Under high temperature conditions a flow of cooling air directed at the faceplate is recommended. When televising flames and furnaces, appropriate infra-red filters should be used.

OUTLINE DRAWING



B7891

TENTATIVE DATA

QUICK REFERENCE DATA		
3cm (1.2in) diameter plumbicon camera tubes for sensitive, high definition pick-up in monochrome and colour broadcast cameras. These tubes incorporate a photoconductive layer.		
Dark current	<3.0	nA
Resolution capability	>600	TV lines
Transfer characteristic	linear	

GENERAL OPERATIONAL RECOMMENDATIONS AND INSTRUCTIONS FOR USE given on pages D7 to D9.

HEATER

Suitable for parallel operation only

V_h	6.3 ± 5%	V
I_h	90	mA

OPERATING CONDITIONS

For scanned area of 12mm × 16mm and a faceplate temperature of 20°C to 45°C (see note 1)

Conditions

V_{a2+a3}	250 to 300	V
V_{a1}	300	V
Minimum peak to peak blanking voltage		
when applied to grid	40	V
when applied to cathode	15	V
I_{a1} for normal beam currents	<1.0	mA
Dark current (target electrode voltage = 45V)	<3.0	nA
Faceplate illumination (see note 2)		

Performance

Target electrode voltage (see note 3)	45	V
V_g (for picture cut-off with no blanking applied)	-30 to -100	V
*Highlight target electrode current	0.3	μA
*Average target electrode current	approx. 0.15	μA

Beam current (see note 4)

Resolution-

Modulation depth at centre of picture for 400 TV lines (see notes 5, 6 and 11) -

	55875	55875R	55875G	55875B	
At highlight target current	0.3	0.15	0.3	0.15	μA
V_{a2+a3} = 250V to 300V	35	30	35	45	%
V_{a2+a3} = 550 to 650V	40	35	40	50	%

Resolution capability	>600	TV lines
Signal to noise ratio at a signal current of 0.15μA (see note 7)	approx. 200:1	
Gamma of transfer characteristic (see note 8)	0.95 ± 0.05	
Peak spectral response	approx. 500	nm

Decay (see note 9)

Measured with 100% signal current of 0.1μA and with a light source with a colour temperature of 2850°K. The appropriate filter is inserted in the light path of the 55875R, G, B tubes

Max. residual signal

after dark pulse of 60ms	5.0	%
after dark pulse of 200ms	2.0	%

Persistence (see note 9)

Sensitivity (see note 10)

55875	>275	μA/lm
55875R	>60	μA/lm
55875G	>100	μA/lm
55875B	>32	μA/lm

*Subtraction of dark current is unnecessary because of the high signal current to dark current ratio.

ORIENTATION OF SCANNED RECTANGLE

The picture quality specification will hold for a 12mm × 16mm quality rectangle. For correct orientation of the image on the photoconductive layer the vertical scan should be essentially parallel to the plane passing through the tube axis and the mark on the tube base.

FOCUSING

Magnetic (see note 11)

DEFLECTION

Magnetic (see note 11)

PHOTOCONDUCTIVE LAYER

Image dimensions on photoconductive layer

3:4 aspect ratio (see note 1)	12mm × 16mm	

RATINGS (ABSOLUTE MAXIMUM SYSTEM)

V_{target} max.	50	V
V_{a2+a3} max.	750	V
V_{a1} max.	450	V
$-V_g$ max.	125	V
$+V_g$ max.	0	V
I_k max.	3.0	mA
$v_{h-k(pk)}$ max.		
cathode positive	125	V
cathode negative	10	V
Faceplate		
maximum illumination (see note 12)	500	lux
maximum temperature (operation and storage)	50	^{o}C
minimum temperature (operation and storage)	-30	^{o}C

CAPACITANCES (see note 13)

Target electrode to all other electrodes	4.0 to 6.0	pF

MOUNTING POSITION

In the normal, horizontal, stand-by position of the camera, the longitudinal axis of the tube should be approximately horizontal. During operation, deviations from this position are allowable, provided that the declination of the axis does not exceed 45 degrees.

WEIGHT

Tube alone	approx. 100	g

ACCESSORIES

Socket	56020
Focusing and deflection coil assembly	
for 55875	AT1132
for 55875R, G and B	AT1112

NOTES

1. Underscanning of the specified useful target area of 12mm × 16mm, or failure of scanning, should be avoided since this may cause damage to the photoconductive layer. The boundaries outside of this area should preferably be covered by a mask to reduce the effects of internal reflections in the faceplate.

2. Faceplate illumination level for the 55875 typically needed to produce 0.3μA target current will be approximately 5lux. The target currents specified for the colour tubes 55875R, G and B respectively will be obtained with an incident white light level (2850^{o}K) on the filter of approximately 12lux.

   These figures are based on the use of the filters described in note 10. For filter BG12, however, a thickness of 1mm is chosen.

3. At $V_k = 0$.

4. The beam current to be adjusted for current stabilization according to the highlight target currents as stated in the table.

5. The figures shown represent the typical horizontal amplitude responses of the tubes after correction for faults introduced by the optical system. Horizontal amplitude response can be improved by the application of suitable correction circuits. Such compensation, however, does not affect vertical resolution, nor does it influence the resolution capability.

6. V_{a2+a3} adjusted for optimum focus.

7. The stated ratio represents the "visual equivalent signal-to-noise ratio", which is taken as the ratio of highlight video signal current to r.m.s. noise current, multiplied by a factor of 3. (An r.m.s. noise current of the video pre-amplifier of 2nA, bandwidth 5MHz, is assumed).

8. (a) Gamma, to a certain extent, is dependent on the wavelength of the illumination applied.

   (b) The use of gamma-correcting circuitry is recommended.

9. The tube has a short persistence which makes it ideal for live studio monochrome and colour applications.

10. As measured under the following conditions:

Tubes are exposed to an illumination of 5.2lux at black body temperature of 2850°K. The appropriate filter is inserted in the light path. The current obtained is a measure of the colour sensitivity and is expressed in units of micro-amperes per lumen of white light before the filter.

Filters used:

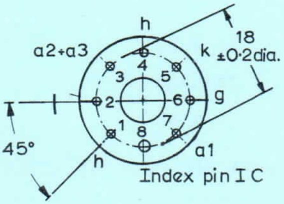
55875R	Schott	OG2	3mm thick
55875G	Schott	VG9	1mm thick
55875B	Schott	BG12	3mm thick

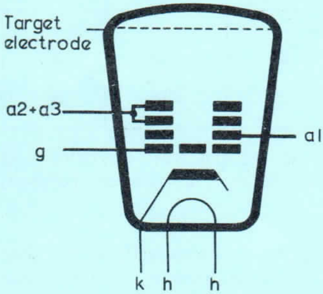
11. For focusing and deflection coil assembly see under "ACCESSORIES"

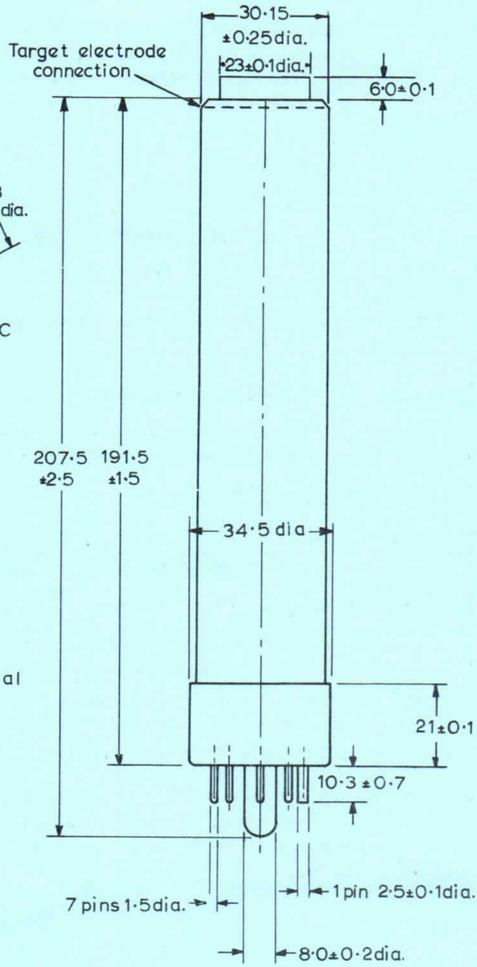
Approximate values	Focus current (mA)	Line current (mA p-p)	Field current (mA p-p)
Monochrome coil assembly AT1132			
$V_{a2+a3}=300V$	17	160	25
$V_{a2+a3}=600V$	25	235	35
Colour coil assembly AT1112			
$V_{a2+a3}=300V$	75	160	25
$V_{a3+a3}=600V$	100	235	35

12. For short intervals. During storage and idle periods when the camera is not in use the tube face should be covered with the plastic hood provided, or else the lens should be capped.

13. The capacitance existing between the target electrode and all the other electrodes, which affects the output impedance, increases by approximately 5pF when the tube is inserted into the deflecting and focusing assembly.







All dimensions in mm

GENERAL OPERATIONAL RECOMMENDATIONS

TRANSPORT, HANDLING AND STORAGE

During transport, handling or storage, the longitudinal axis must be in either a horizontal or vertical position. In the vertical position the faceplate of the tube must be upwards.

GENERAL

Base pins

The Plumbicon as described in this Tentative Data has been provided with tungsten base pins, accordingly, care must be taken when the tube and socket are mated.

Target electrode

Target electrode connection is made with the metallic coating at the face end of the tube by a spring-contact which is part of the focusing coil assembly.

Photoconductive layer

In some instances the properties of the photoconductive layer may slightly deteriorate during long idle periods, such as encountered between the manufacturer's last test and the first time of operation by the user. It is therefore recommended to operate the tube directly after receipt to restore the photoconductive layer. The tube should be operated for a few hours with normal voltage settings and a signal current of 0.15μA and should be adjusted to overscan an evenly illuminated target.

Light transfer

Because the light transfer characteristic has a gamma of approximately unity, it may be desirable for broadcast applications to incorporate a gamma correcting circuit in the video amplifier system with a gamma adjustable from 0.5 to 1.0.

When designing this gamma correcting circuit, control should be provided for the compression of the video signal in the range 75% to 100% of normal peak white level.

This provision will prevent overloading of the video amplifier system when the tube is exposed to scenes containing small peaked highlights as caused by reflections of shiny objects.

Signal-to-noise ratio

Since the tube does not generate noise to any noticeable extent, the signal-to-noise ratio will be determined mainly by the noise factor of the video-amplifier system.

Under normal studio lighting conditions the high sensitivity of the tube produces a high signal-to-noise ratio provided that the output of the tube is fed into a well-designed input state of the video amplifier system. In such a system an aperture correction may be incorporated to ensure sufficient gain in resolving power without effectively impairing the signal-to-noise ratio.

OPERATING INSTRUCTIONS

1. Insert the tube in the deflection unit in such a way that the plane defined by the mark at the base of the tube and the tube axis is essentially parallel to the direction of the field scan.

2. Carefully mate the socket with the base pins and clean the faceplate of the tube.

3. Cap the lens and close the iris.

4. Adjust the operating conditions as follows:

   a) Grid-bias control at maximum negative bias (beam cut-off).

   b) Target electrode voltage to the value as indicated on test sheet supplied with the tube.

   c) Scanning amplitudes to maximum.

5. Switch on camera and monitor equipment. Allow a few minutes for heating up.

6. Adjust the monitor to produce a faint, non-overscanned raster.

7. Direct the camera to the scene to be televised and uncap the lens.

8. Slowly adjust the grid-bias control until a picture is produced on the monitor. If the picture is too faint, increase the lens aperture.

9. Adjust V_{a2+a3} control (beam focus) and optical focus alternately for maximum focus.

10. Align the beam of the Plumbicon by either of the two following methods:

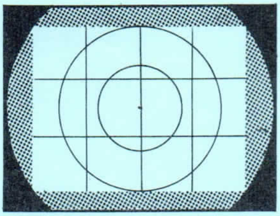
    a) Adjust the alignment fields in such a way that the centre of the picture on the monitor does not move when V_{a2+a3} (beam focus) is varied.

    b) Reduce the target electrode potential to a few tenths of a volt only.

       Adjust the alignment fields until the most uniform picture is obtained as observed on the monitor or an oscilloscope.

11. Adjust the scanning amplitudes as follows:

    a) By means of a 12mm × 16mm mask which is in contact with and centred at the faceplate. Decrease the horizontal and vertical deflecting currents until the periphery of the mask is just outside the raster on the monitor. This procedure may be facilitated by small adjustments of the centring controls.



b) If no mask is available direct the camera to a test chart having an aspect ratio of 4:3 and adjust the centring controls in such a way that the target ring is just visible in the corners of the picture. Adjust the distance from camera to test chart, and refocus until the image of the test chart is positioned on the face-plate as indicated on the adjoining figure.

Decrease both scanning amplitudes until the image of the test chart completely fills the scanned raster on the monitor.

12. Adjust the iris for a picture of sufficient contrast and adjust the beam current to a value at which all highlights are stabilized.

13. Check alignment, beam focus and optical focus.

ALWAYS

- use full size (12mm × 16mm) scanning of the target and avoid under-scanning
- adjust sufficient beam current to stabilize the picture highlights
- ensure that the deflection circuits are operative before adjusting beam current
- avoid focusing camera directly into the sun
- keep lens capped when transporting the camera

PHOTOMULTIPLIER TUBES

1. The overall supply voltage should be well stabilised, since the gain of a photomultiplier is critically dependent on the voltage. The percentage change in gain is approximately ten times the percentage change in supply voltage. Thus, to hold the gain stable to within 1% the power supply must be stabilised to within approximately 0.1%.

2. (a) High-stability carbon resistors should be used in the voltage divider chain.

   (b) The current through the resistor chain should be high compared with the anode current if the fluctuations in the latter are not to affect the gain excessively. The relative change in gain is approximately proportional to the ratio of the anode current to the divider current. For example, to maintain the gain stable to within 1% when measuring continuous luminous flux, the current in the chain should be at least 100 times the anode current.

   (c) When the tube is used for the detection of luminous pulses, as in scintillation counting, the fluctuations in gain can be restricted without the need for a high supply current by shunting each resistor in the divider chain with a capacitor, which supplies the additional current when required. Since the earlier cathodes carry a very much lower current than the later ones, it is sufficient in practice to bypass the last three or four stages only.

   The capacitors should be chosen according to the following relationship:

$$C_n \simeq dC_{n-1}$$
$$C_{n-1} \simeq dC_{n-2} \text{ etc.}$$

where C_n = capacitor across resistor feeding last cathode

C_{n-1} = capacitor across resistor feeding last cathode but one

C_{n-2} = capacitor across resistor feeding last cathode but two

d = secondary emission factor of cathodes (typically 3.5)

If the time constant RC_n is made greater than 100t, where t is the time constant of the pulses, a peak anode current of 1mA will cause a change in gain of less than 1% if the current through the voltage divider chain is 1mA.

The voltage fluctuations occurring in this arrangement are small but of long duration, so that if the counting rate is high the fluctuations due to successive pulses may be partially superimposed, resulting in an error which is a function of the counting rate. In the example just given, the duration of each fluctuation would be approximately 600t, and if overlapping were not to occur, the counting rate could not exceed 1/600t p.p.s. For a pulse length of 10μs this corresponds to a rate of approximately 1700 p.p.s.

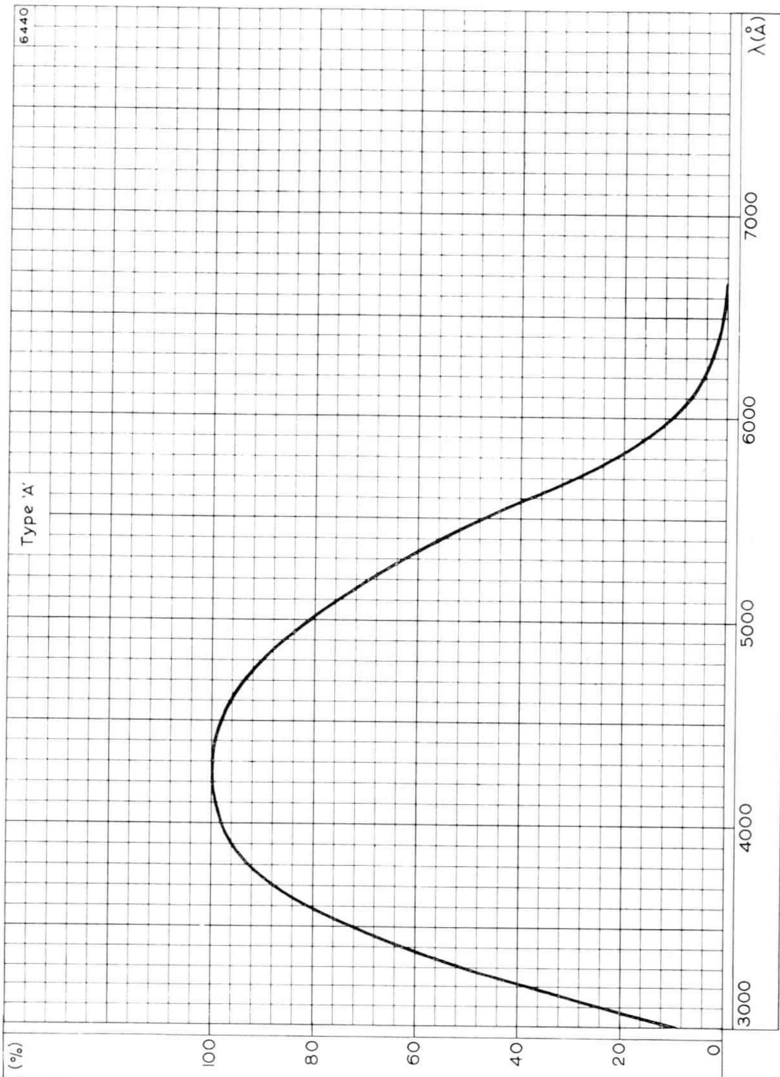
(d) Where a high current supply cannot be avoided, due to a high counting rate or the need to measure a continuous luminous flux, it is possible to employ a high current source of comparatively low voltage for the last three or four stages only, and a low current high voltage source for the remaining stages. If it is undesirable to maintain one power supply terminal at the sum of the two voltages with respect to earth, the common terminal may be earthed.

3. On no account should the tube be exposed to ambient light when the supply voltage is applied. A luminous flux of less than 10^{-5}lm is sufficient to cause the maximum permissible anode current to be exceeded. To obtain the maximum useful life from the photocathode the tube should be protected from light as far as possible even when not in use.

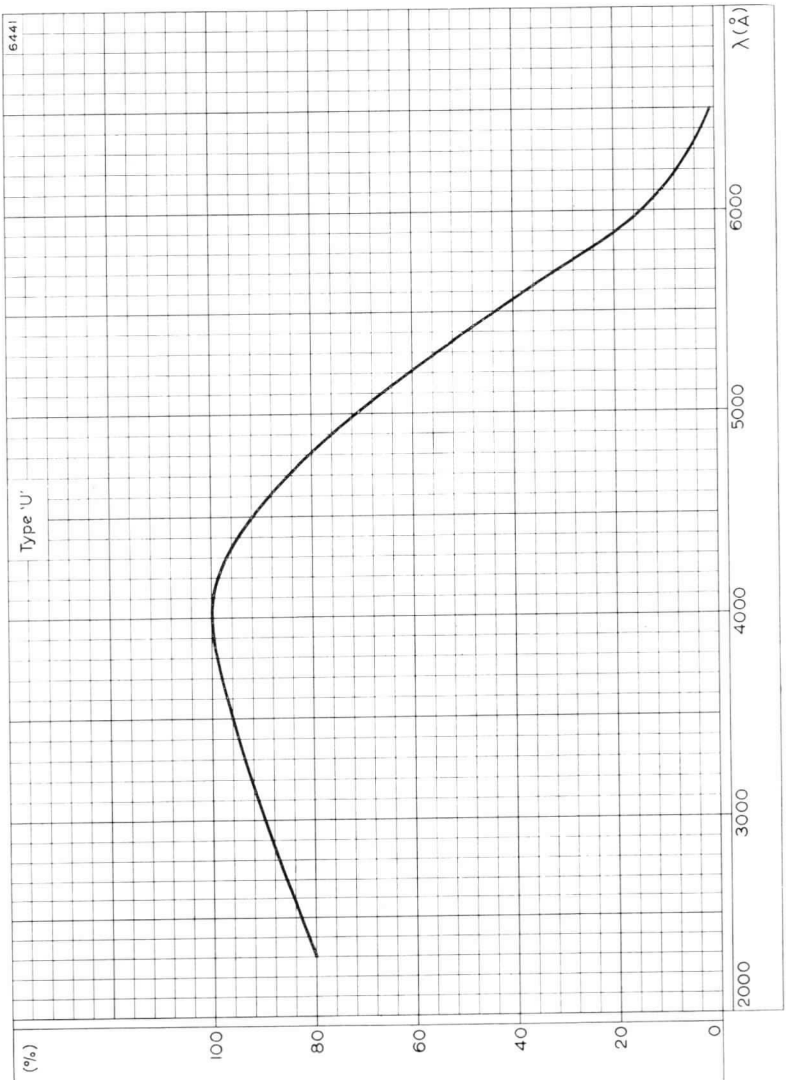
4. The dark current takes approximately 15 to 30 minutes after the application of the supply voltage to fall to a stable value. For this reason it is recommended that the equipment should be switched on half an hour before making any measurements requiring a high degree of accuracy.

The dark current may be further reduced by applying to the photocathode a jet of dry air cooled by being passed, for example, through a spiral immersed in liquid nitrogen. It is very important to ensure that no condensation occurs on the base or socket of the tube if air-cooling is adopted.

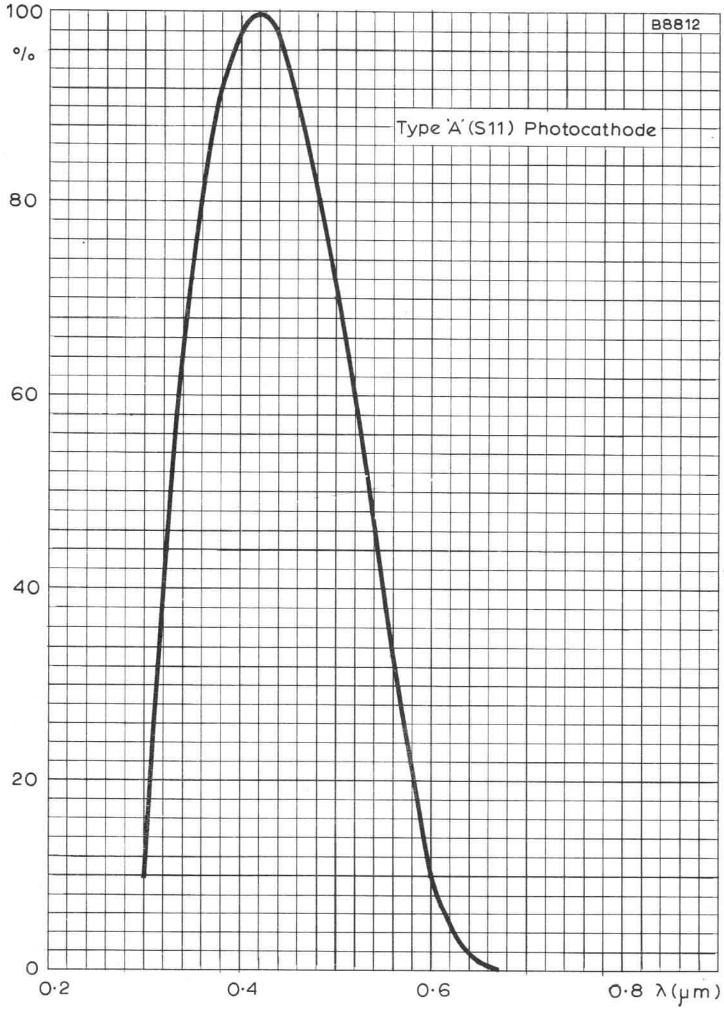
5. It is advisable to fit a mu-metal screening can round the envelope of the tube if it is used in the vicinity of magnetic fields.



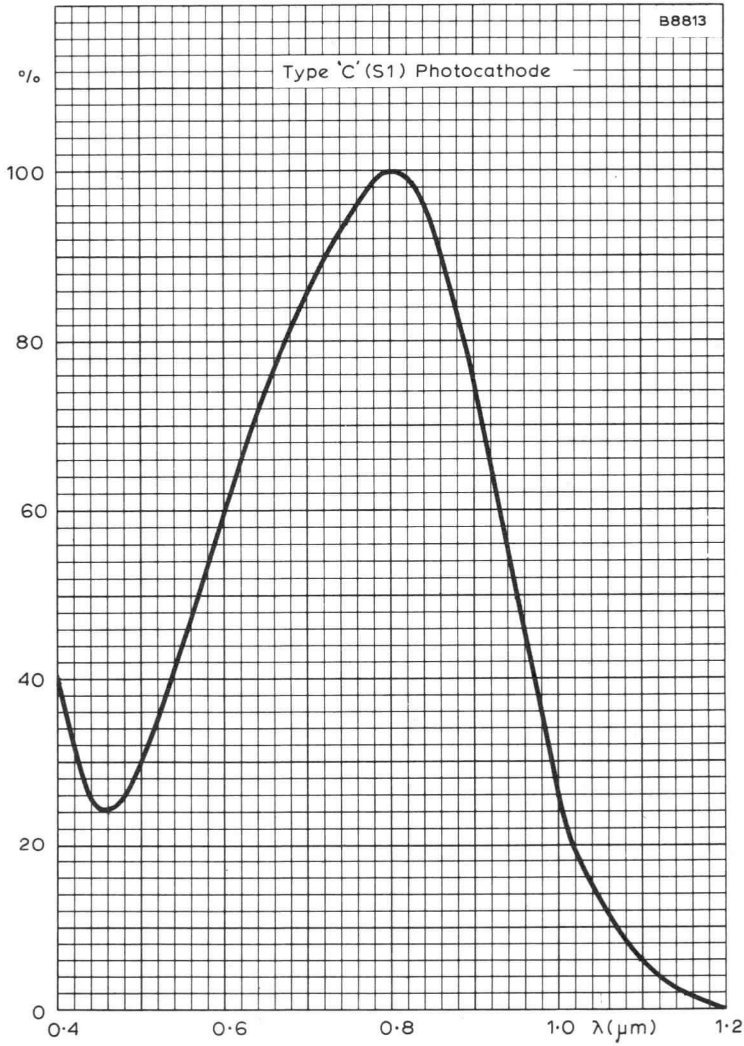
RELATIVE SPECTRAL ENERGY DISTRIBUTION CURVE
FOR TYPE "A" SCREEN



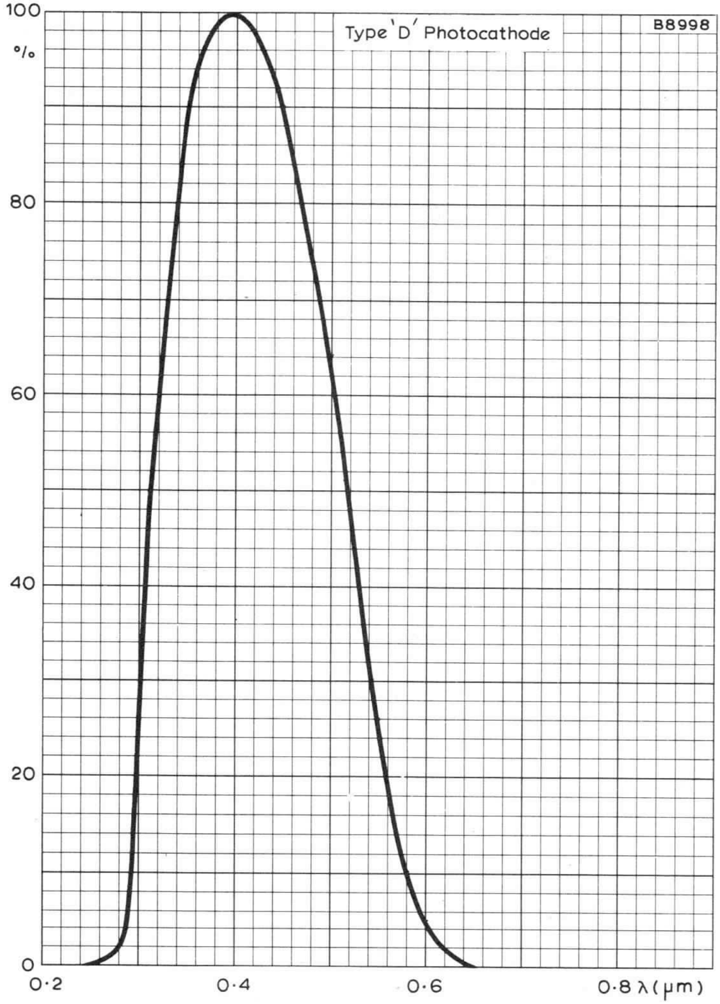
RELATIVE SPECTRAL ENERGY DISTRIBUTION CURVE
FOR TYPE " U " SCREEN



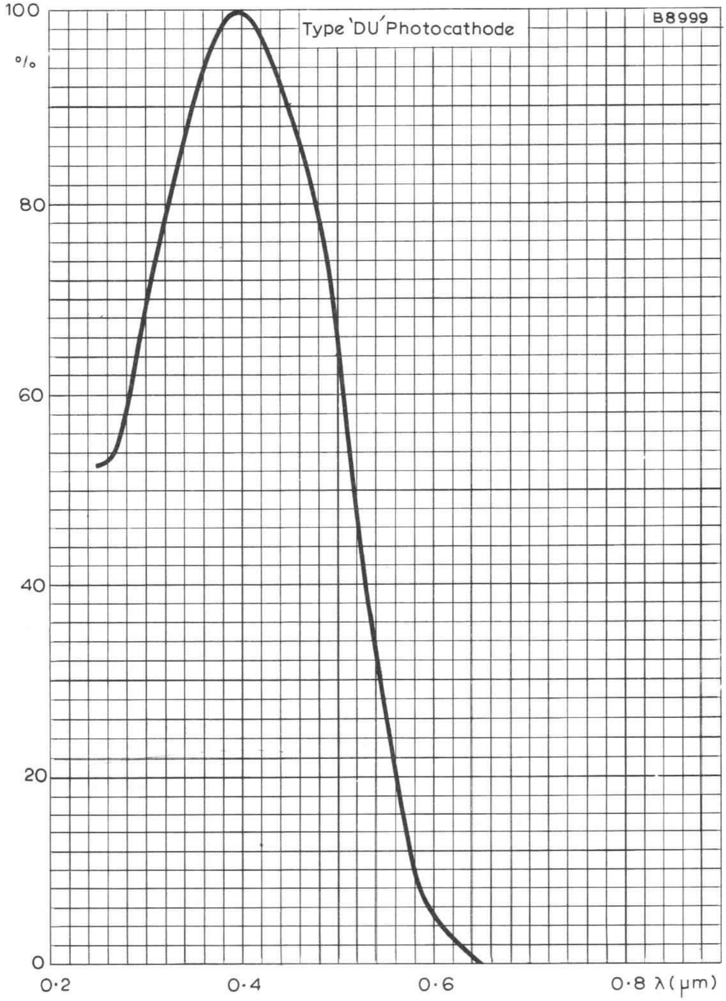
RELATIVE SPECTRAL ENERGY DISTRIBUTION CURVE
FOR TYPE 'A' (S11) PHOTOCATHODE



RELATIVE SPECTRAL ENERGY DISTRIBUTION CURVE
FOR TYPE 'C' (S1) PHOTOCATHODE

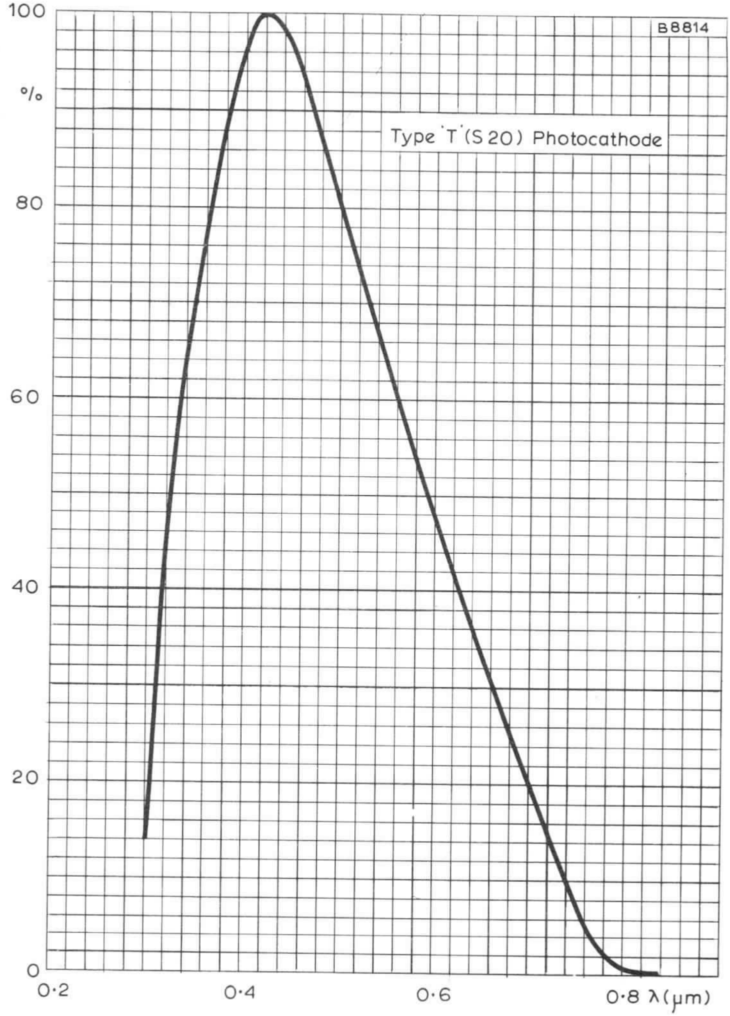


RELATIVE SPECTRAL ENERGY DISTRIBUTION CURVE
FOR TYPE 'D' PHOTOCATHODE

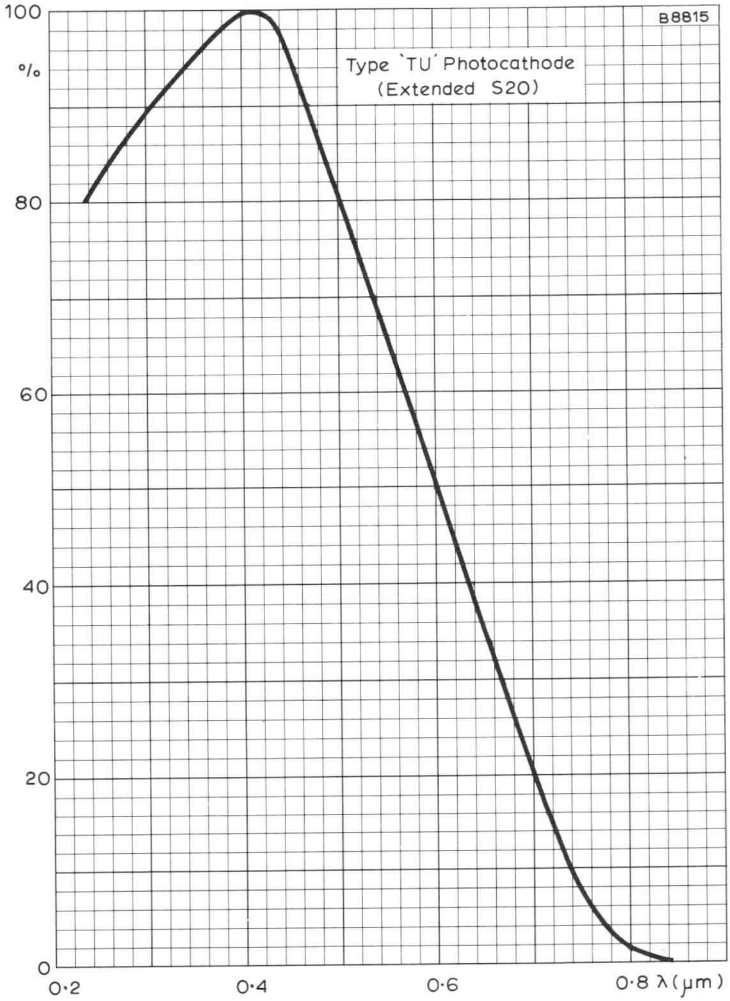


RELATIVE SPECTRAL ENERGY DISTRIBUTION CURVE
FOR TYPE 'DU' PHOTOCATHODE

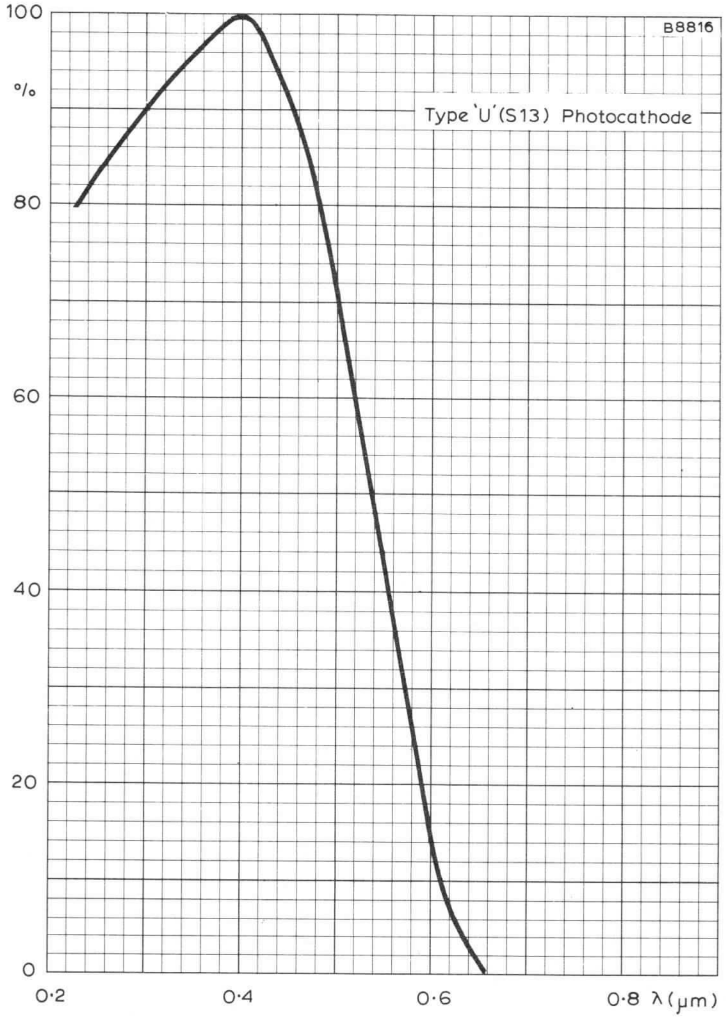
SPECTRAL RESPONSE



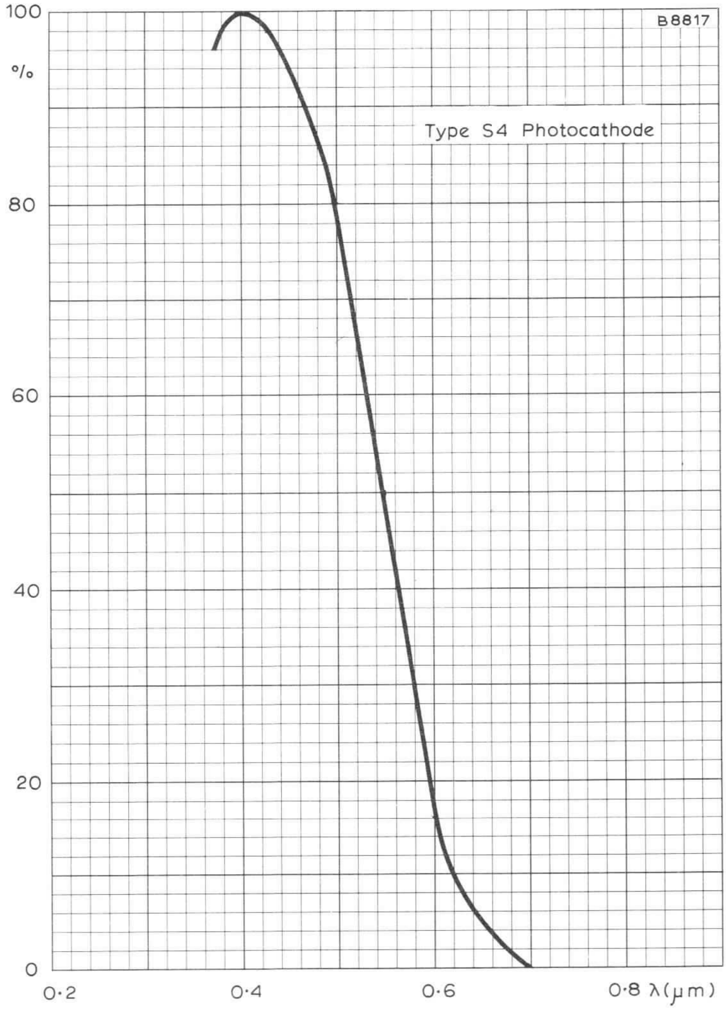
RELATIVE SPECTRAL ENERGY DISTRIBUTION CURVE
FOR TYPE 'T' (S20) PHOTOCATHODE



RELATIVE SPECTRAL ENERGY DISTRIBUTION CURVE
FOR TYPE 'TU' (EXTENDED S20) PHOTOCATHODE



RELATIVE SPECTRAL ENERGY DISTRIBUTION CURVE
FOR TYPE 'U' (S13) PHOTOCATHODE



RELATIVE SPECTRAL ENERGY DISTRIBUTION CURVE
FOR TYPE S4 PHOTOCATHODE

UNIVERSAL PHOTOSCINTILLATOR HOUSING ASSEMBLY

S5600 Series

TENTATIVE DATA

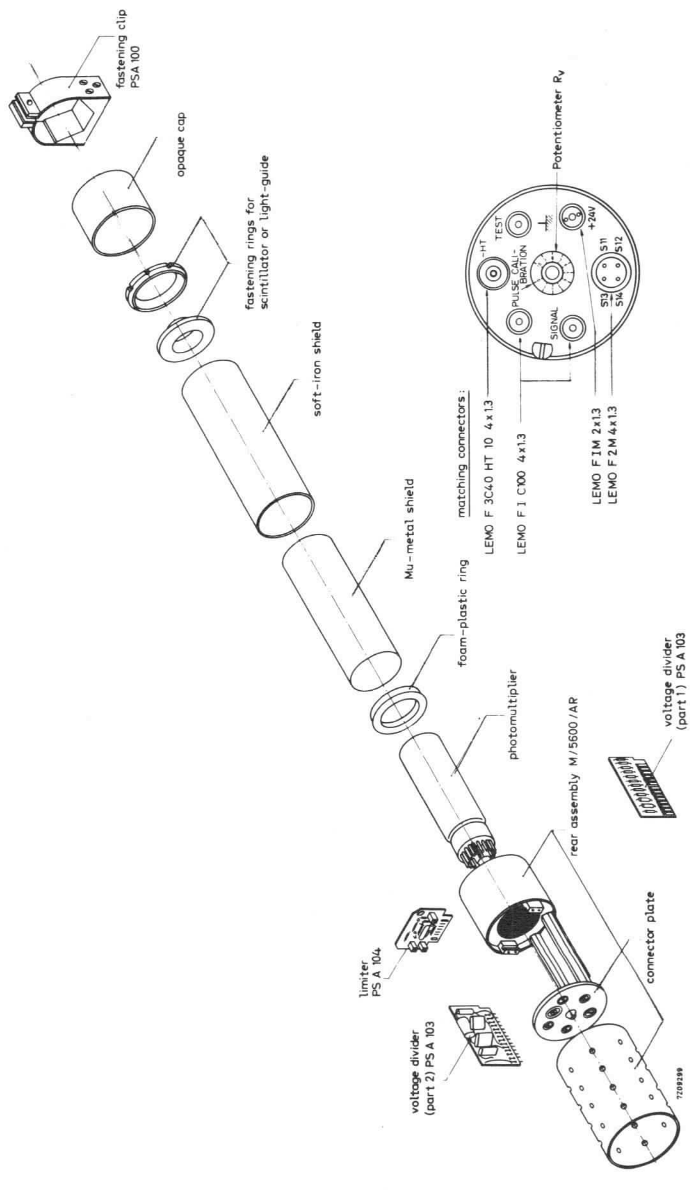
QUICK REFERENCE DATA

This assembly is essentially a probe-like mechanical system with provisions for mounting a photomultiplier tube, a voltage divider, a limiter and either a scintillator or a light guide.
Printed wiring boards carrying the limiter and voltage dividers are included, together with all necessary wiring. The photomultiplier tube and the scintillator or light guide must be ordered separately.

Maximum h.t. supply voltage for the photomultiplier tube (negative polarity)	2.5	kV
H. T. supply current	1.05 ± 10%	mA/kV
Limiter supply voltage (positive polarity)	24	V
Limiter supply current	35	mA

TYPE DESIGNATION

S5600/01	Complete assembly with mu-metal and soft-iron shields, fastening rings for light guide or scintillator, socket for photomultiplier tube, decoupling capacitors for photomultiplier tube, 2 printed circuit boards carrying the voltage divider, 1 printed circuit board carrying the limiter. Without photomultiplier tube, scintillator or light guide. This assembly is intended for use with photomultiplier tube type 56AVP, 56DVP, 56DUVP, 56TUVP, 56TVP or 56UVP.
S5600/02	As S5600/01 but for use with photomultiplier tube type 56CVP.
S5600/03	As S5600/01 but for use with photomultiplier tube type 58AVP, 58DVP, 58UVP, XP1040 or XP1041.
M/5600/01	As S5600/01 but without the printed wiring boards carrying voltage divider and limiter.
M/5600/02	As S5600/02 but without the printed wiring boards carrying voltage divider and limiter.
M/5600/03	As S5600/03 but without the printed wiring boards carrying voltage divider and limiter.
M/5600/AR	As M/5600/01 but without anti-magnetic shields and without fastening rings for light guide or scintillator.


fastening clip
PSA 100
opaque cap
fastening rings for
scintillator or light-guide
soft-iron shield
Mu-metal shield
foam-plastic ring
photomultiplier
rear assembly M/5600/AR
voltage divider
(part 1) PS A 103
limiter
PS A 104
voltage divider
(part 2) PS A 103
connector plate
7Z09299
Potentiometer R_v
-HT
TEST
PULSE CALI-
BRATION
SIGNAL
+24V
S11
S12
S13
S14
matching connectors:
LEMO F 3C40 HT 10 4x1.3
LEMO F I C100 4x1.3
LEMO F I M 2x1.3
LEMO F 2 M 4x1.3

PHOTOMULTIPLIER TUBE

The photomultiplier tube must be ordered separately. For tube data see Handbook section 'Photomultiplier tubes'.

SCINTILLATOR

The plastic scintillator must be ordered separately. Details may be obtained from the Industrial Electronics Division.

LIGHT GUIDE

The light guide must be ordered separately. The maximum diameter is 40mm, and the required length must be stated when ordering.

ACCESSORIES

The following accessories can be ordered separately:

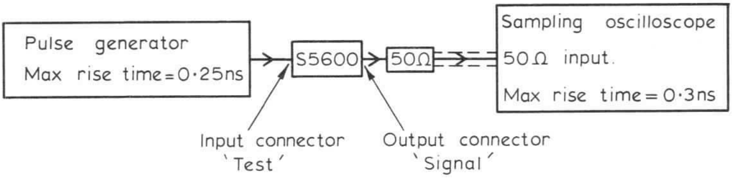
Fastening clip	PS A 100
Voltage divider for S5600/02 (2 circuits)	PS A 101
Two printed circuit boards without components, for mounting a voltage divider at choice	PS A 102
Voltage divider for S5600/01 and S5600/03 (2 circuits)	PS A 103
Limiter	PS A 104
Opaque cap	PS A 105
Fastening rings for light guide or scintillator	PS A 106
Soft iron shield	PS A 107
Foam plastic ring	PS A 108
Passive printed circuit board to replace limiter PS A 104 in case of direct connection to the anode	PS A 109
Mu-metal shield	TA 60/09

OPERATIONAL CONSIDERATIONS

The h.t. supply of the probe must have a negative polarity. The absolute maximum value of the h.t. is 2500V but, depending on the type of photomultiplier tube used, it must not exceed the value giving a gain of 10^9.
The h.t. supply current is 1.05mA/kV ± 10%.
The supply voltage of the limiter must have positive polarity. The voltage is 24V at a current of 35mA.

CHARACTERISTICS OF THE LIMITER

Measuring set-up



Output signal peak amplitude = 1.6V across 100Ω

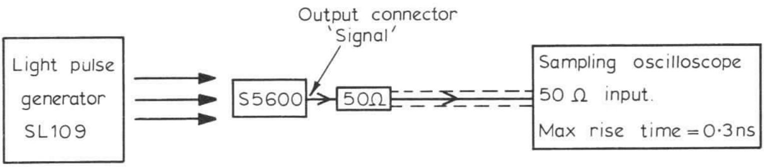
For a given output voltage the leading edge is max. $0.8V_s$
(V_s = tube interstage voltage)

Rise time from 0 to $0.75V_s$ = max. 2ns.

Maximum ambient temperature = 40^oC.

CHARACTERISTICS OF S5600
equipped with photomultiplier tube 56AVP or 56DVP

Measuring set-up



Pulse rise time = max. 0.6ns.

Width at half height = max. 0.9ns.

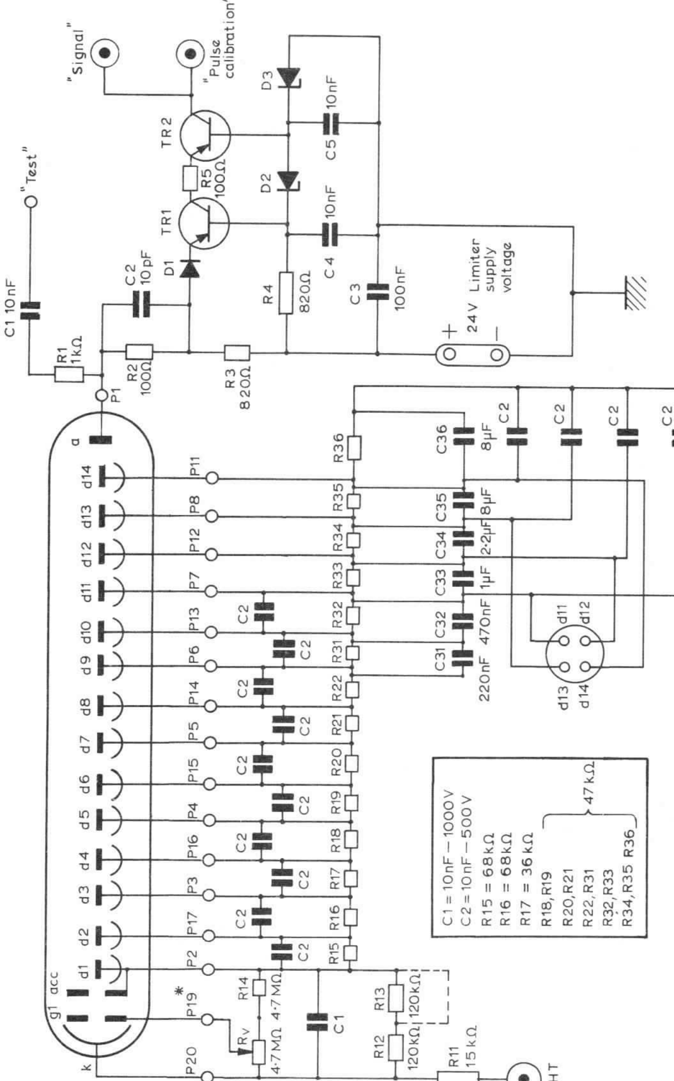
Supply voltage for gain = 10^8: see photomultiplier tube data.

Output signal peak amplitude = max. $0.8V_s$

Rise time = 4ns.

GENERAL CIRCUIT

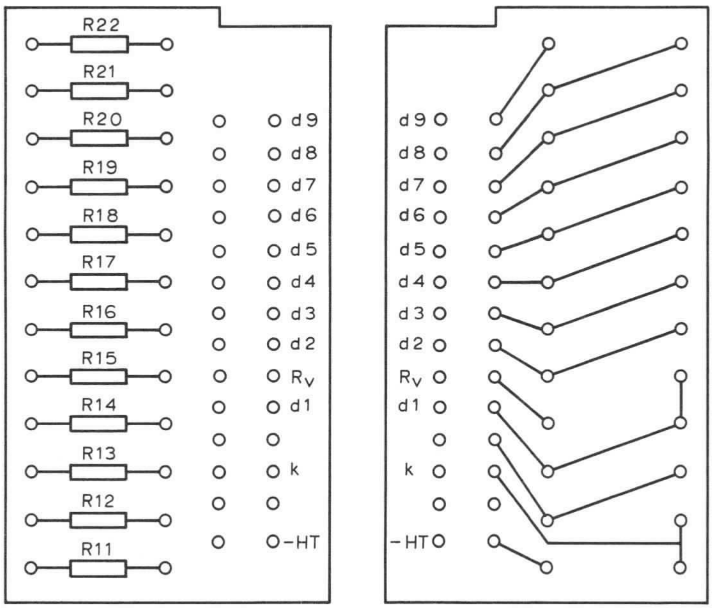
S5600/01 with 56AVP



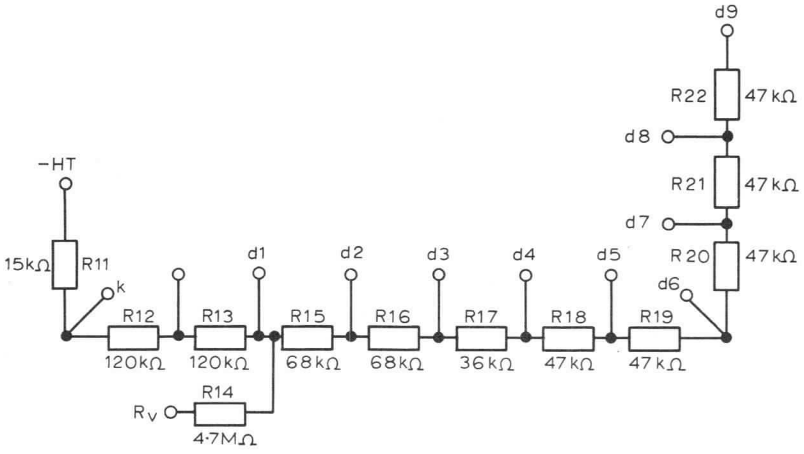
P1 to P20 (base connections 56AVP)

* P18 connected to P19 at the photomultiplier socket.

Printed circuit board 1

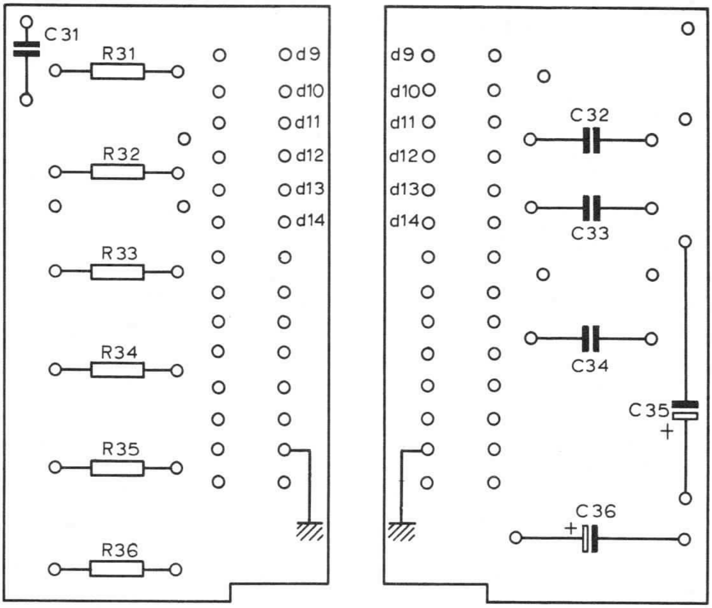


Circuit 1

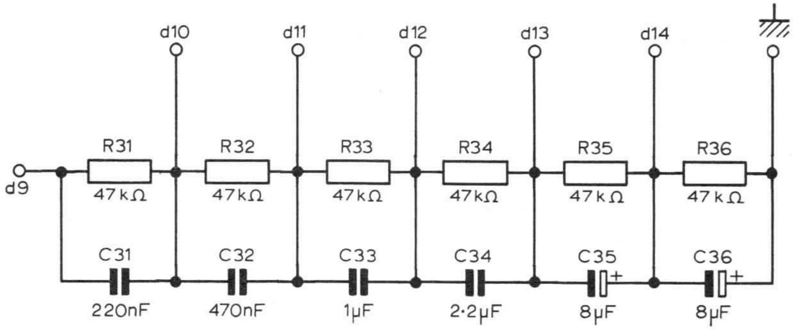


VOLTAGE DIVIDER PS A 103

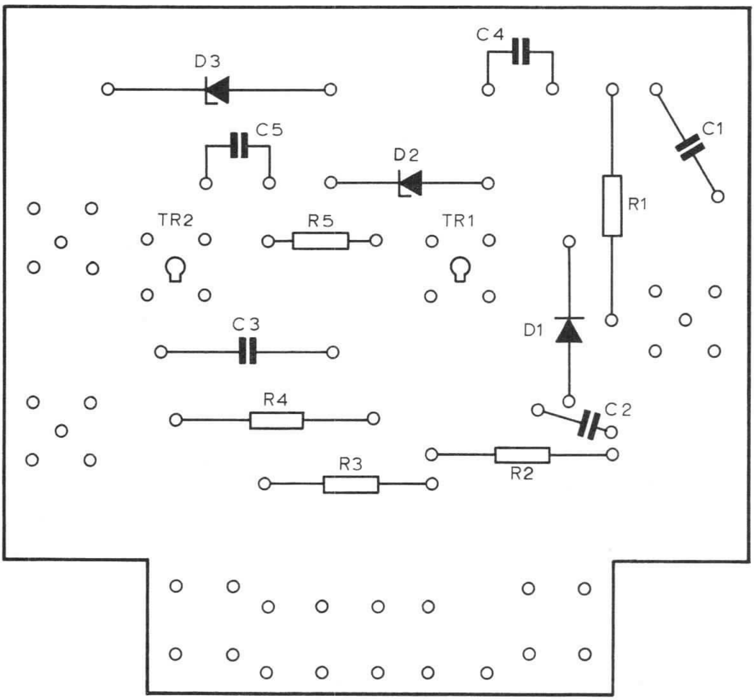
Printed circuit board 2



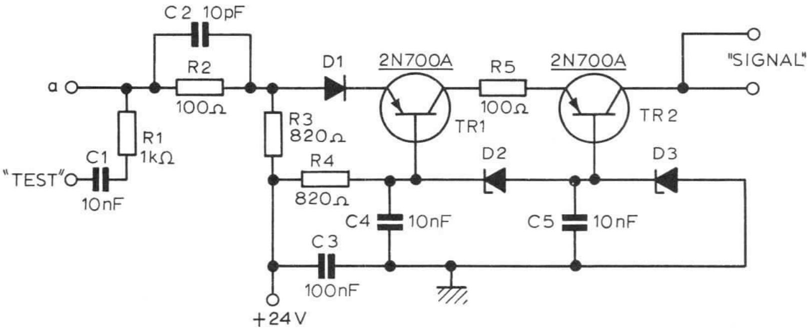
Circuit 2



Printed circuit board



Circuit



PHOTOMULTIPLIER TUBE XP1002

QUICK REFERENCE DATA		
10 stage photomultiplier tube intended for use in laser applications, working in the orange, yellow and green range.		
Spectral response curve	type T (S20)	
Photocathode useful diameter	44	mm
Anode sensitivity (at $V_b = 1.8kV$)	400	A/lm

This data should be read in conjunction with
OPERATING NOTES - PHOTOMULTIPLIER TUBES

PHOTOCATHODE

Surface	Sodium potassium caesium antimony	
Spectral response curve	type T (S20)	
Peak spectral response	420 ± 30	nm
Minimum useful diameter	44	mm
Minimum cathode area	15.2	cm^2
*Luminous sensitivity		
Average	150	µA/lm
Minimum	110	µA/lm
Average radiant sensitivity (at 420nm)	70	mA/W

*Measured using a lamp of colour temperature 2850 ^{o}K.

CHARACTERISTICS

VOLTAGE DIVIDER AS IN FIG.1

Overall sensitivity (at $V_b = 1.8kV$)		
Average	400	A/lm
Minimum	100	A/lm
Maximum dark current at S = 60A/lm	50	nA
Maximum value of anode current at which relationship between peak anode current and luminous flux is linear (at $V_b = 1.8kV$)	30	mA

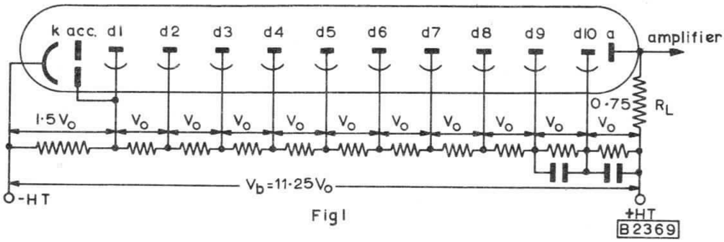


Fig 1

CAPACITANCES

c_{a-d10}	3.0	pF
c_{a-all}	5.0	pF

MOUNTING POSITION Any

RATINGS (ABSOLUTE MAXIMUM SYSTEM)

V_b max.	1.8	kV
I_a max. (continuous operation)	1.0	mA
V_{k-d1} max.	500	V
V_{k-d1} min.	180	V
*V_{a-d10} max.	300	V
*V_{a-d10} min.	80	V
$V_{d1-d2 \cdots\cdots\cdots d9-d10}$ max.	300	V
$V_{d1-d2 \cdots\cdots\cdots d9-d10}$ min.	80	V

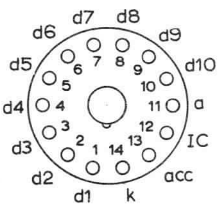
*When calculating the anode voltage, the voltage drop across the load resistance should not be overlooked.

ACCESSORIES (supplied as additional items)

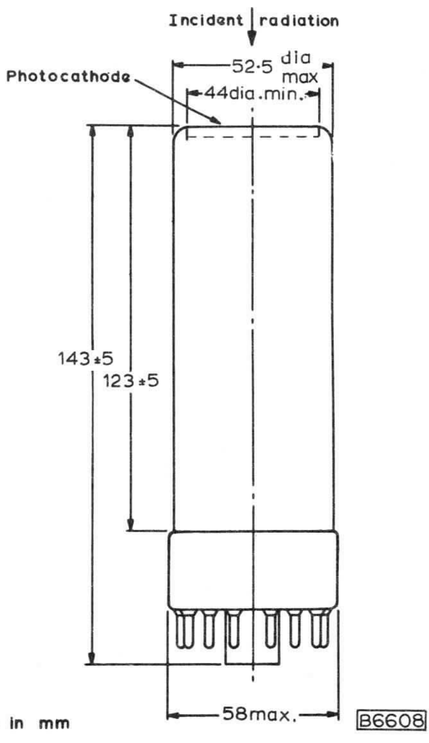
Socket	FE1001
Mu-metal shield	56128

OPERATING NOTES

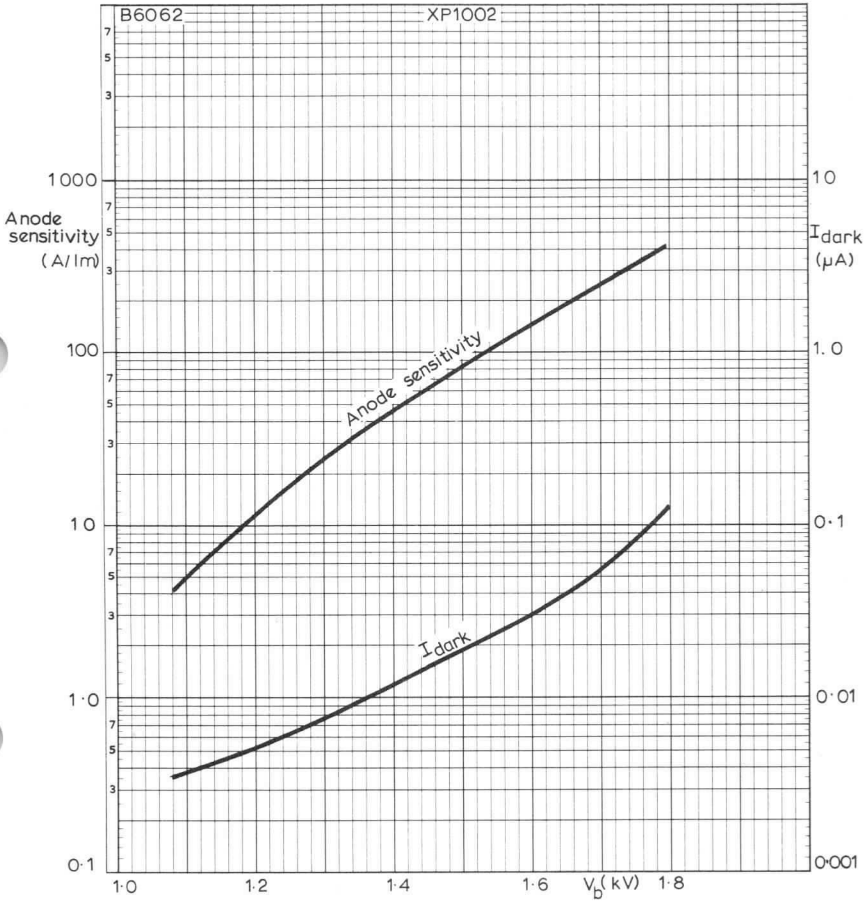
1. To achieve a stability of about 1% the ratio of the current through the voltage divider bridge to that through the heaviest loaded stage of the tube should be approximately 100.
2. For moderate intensities of radiation a bridge current of about 0.5mA will be sufficient.
3. When pulses of high amplitude are taken from the anode, it is useful to decouple the last stages as indicated in the circuit by means of capacitors of a few hundred pF, to avoid a voltage drop between these stages.
4. When the tube has been exposed to full daylight just before mounting, it will probably show an increased dark current, which will return to its normal value after several hours of operation.
5. It is advisable to screen the tube with a mu-metal cylinder against the influence of magnetic fields.



14-pin base
J.E.D.E.C. B14-38



All dimensions in mm



ANODE SENSITIVITY AND DARK CURRENT PLOTTED AGAINST TOTAL VOLTAGE

PHOTOMULTIPLIER TUBE XP1010

QUICK REFERENCE DATA		
10 stage photomultiplier tube intended for use in applications such as x and γ-ray spectrometry.		
Spectral response curve	type A (S11)	
Photocathode useful diameter	32	mm
Anode sensitivity (at V_b = 1.8kV)	700	A/lm

This data should be read in conjunction with
OPERATING NOTES - PHOTOMULTIPLIER TUBES

PHOTOCATHODE

Surface	semi-transparent, caesium antimony	
Spectral response curve	type A (S11)	
Peak spectral response	420 ± 30	nm
Minimum cathode area	8.0	cm^2
*Luminous sensitivity		
Average	80	µA/lm
Minimum	70	µA/lm
Average radiant sensitivity (at 420nm)	65	mA/W

*Measured using a tungsten lamp of colour temperature 2850°K.

CHARACTERISTICS

VOLTAGE DIVIDER AS IN FIG.1

Overall sensitivity (at V_b = 1.8kV)		
Average	700	A/lm
Minimum	400	A/lm
Maximum dark current at S = 60A/lm (measured at 25°C)	50	nA
**Minimum plateau length (Mn, K_α line 5.9keV)	70	V
**Maximum plateau slope	0.08	%/V
**Background in middle of plateau		
Average	10	Hz
Maximum	50	Hz
Maximum value of anode current at which relationship between peak anode current and luminous flux is linear with the voltage divider shown (at V_b = 1.8kV)	30	mA

**Measured with 1" × 1" NaI crystal, at a counting rate of about 2.5kHz in the middle of the plateau, and with the discriminator bias set at 0.2V.

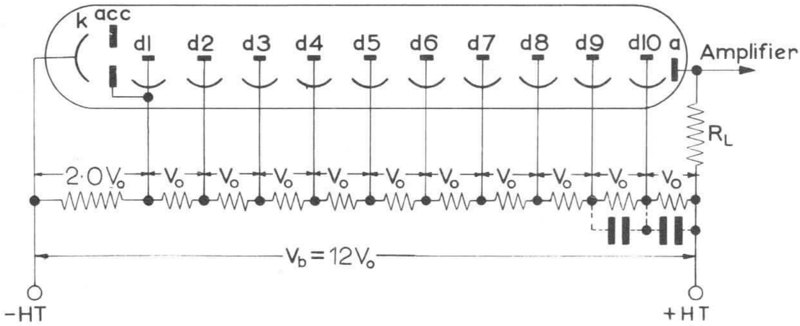


Fig. 1

CAPACITANCES

c_{a-d10}	3.0	pF
c_{a-all}	5.0	pF

MOUNTING POSITION — Any

RATINGS (ABSOLUTE MAXIMUM SYSTEM)

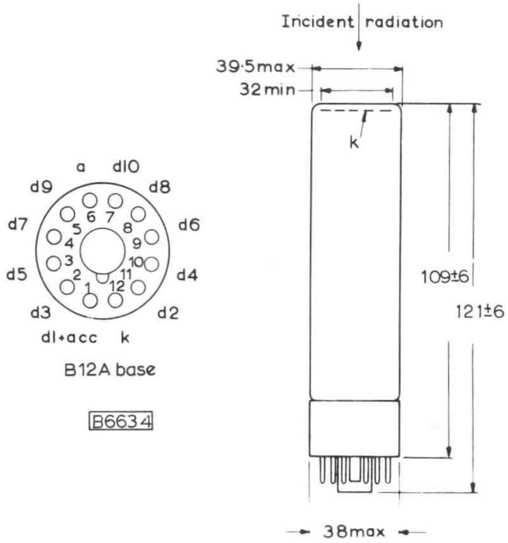
V_b max.	1.8	kV
I_a max. (continuous operation)	1.0	mA
V_{k-d1} max.	500	V
V_{k-d1} min.	120	V
$V_{d1-d2} \cdots\cdots\cdots V_{d9-d10}$ max.	300	V
$V_{d1-d2} \cdots\cdots\cdots V_{d9-d10}$ min.	80	V
***V_{a-d10} max.	300	V
***V_{a-d10} min.	80	V

***When calculating the anode voltage the voltage drop across the load resistance should not be overlooked.

ACCESSORIES (supplied as additional items)

Socket	FE1002
Mu-metal shield	56127

PHOTOMULTIPLIER TUBE XP1010



OPERATING NOTES

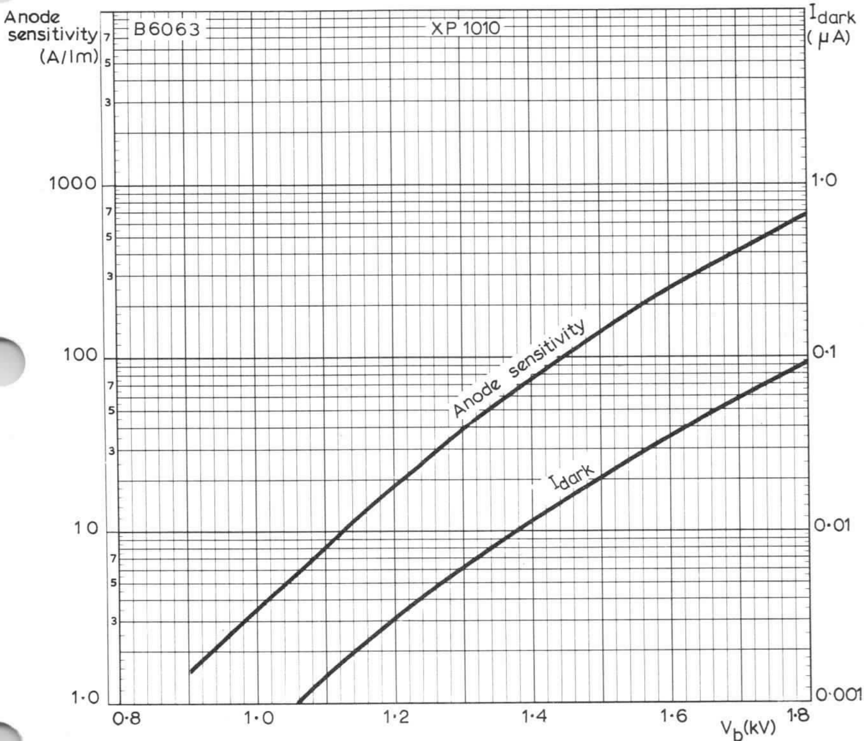
1. To achieve a stability of about 1% the ratio of the current through the voltage divider bridge to that through the heaviest loaded stage of the tube should be approximately 100.

2. For moderate intensities of radiation a bridge current of 0.5mA will be sufficient.

3. When pulses with high amplitudes are taken from the anode, it is useful to decouple the last stages as indicated in the circuit by means of capacitors of a few hundred pF, to avoid a voltage drop between these stages.

4. When a tube has been exposed to full daylight just before mounting, it will probably show an increased dark current, which will return to its normal value after several hours of operation.

5. It is advisable to screen the tube with a mu-metal cylinder against the influence of magnetic fields.



ANODE SENSITIVITY AND DARK CURRENT PLOTTED AGAINST TOTAL VOLTAGE

PHOTOMULTIPLIER TUBE

XP1030

PRELIMINARY DATA

QUICK REFERENCE DATA

10 stage photomultiplier tube intended for use in alpha detection and optical and scintillation applications in which a larger photosensitive area is required.

Overall diameter	75.5	mm
Photocathode diameter	63.5	mm
Overall sensitivity (at $V_b = 1.8kV$)	250	A/lm
Maximum dark current (at $S = 100A/lm$)	0.2	μA

This data should be read in conjunction with OPERATING NOTES—PHOTOMULTIPLIER TUBES.

PHOTOCATHODE

Surface	Caesium antimony	
Peak spectral response	0.42 ± 0.03	μm
Minimum useful diameter	63.5	mm
Minimum cathode area	31.8	cm^2
*Luminous sensitivity		
Average	60	μA/lm
Minimum	40	μA/lm
Average radiant sensitivity (at 0.42μm)	50	mA/W
Maximum dark current (at $T_{amb} = 25°C$)	2×10^{-15}	A/cm^2

*Measured using a lamp of colour temperature 2850°K.

CHARACTERISTICS

Overall sensitivity (at $V_b = 1.8kV$)		
Average	250	A/lm
Minimum	100	A/lm
Maximum dark current (at $S = 100A/lm$)	0.2	μA
Transit time for infinitely short light pulse (at $V_b = 1.4kV$)		
Width at half height of anode pulse	15	ns
Rise time of anode pulse	7	ns
Maximum transit time difference between the centre of the photocathode and the edge (at $V_b = 1.4kV$)	7	ns
Maximum value of anode current at which relationship between peak anode current and luminous flux is linear (at $V_b = 1.8kV$)		
At high gain distribution as shown in fig. 1	50	mA
At high current distribution as shown in fig. 2	100	mA

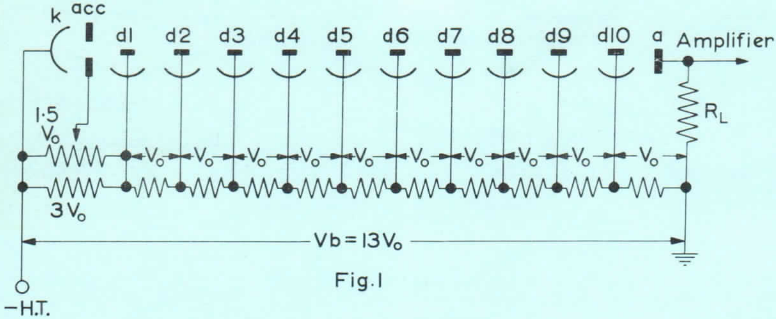


Fig. 1

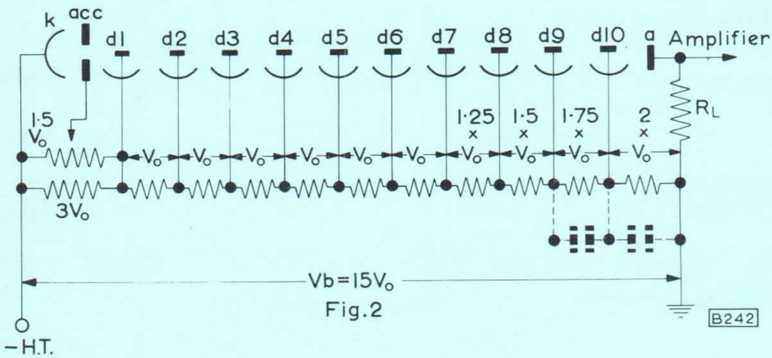


Fig. 2

CAPACITANCES

c_{a-d10}	2.5	pF
c_{a-all}	4.0	pF

MOUNTING POSITION

Any

ABSOLUTE MAXIMUM RATINGS

V_b max.	2.0	kV
I_a max. (continuous operation)	1.0	mA
p_a max.	0.5	W
V_{k-acc} max.	500	V
V_{k-d1} max.	500	V
V_{k-d1} min.	100	V
*V_{a-d10} max.	300	V
*V_{a-d10} min.	80	V
$V_{d1-d2\ \ldots\ d9-d10}$ max.	300	V
$V_{d1-d2\ \ldots\ d9-d10}$ min.	80	V

*When calculating the anode voltage, the voltage drop across the load resistance should not be overlooked.

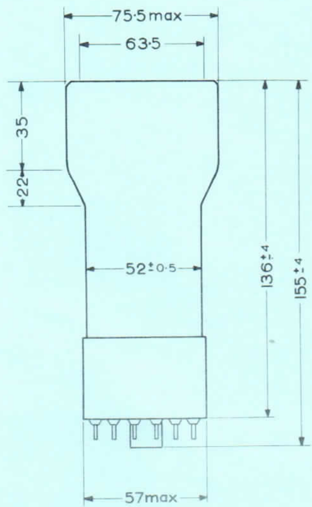
ACCESSORIES

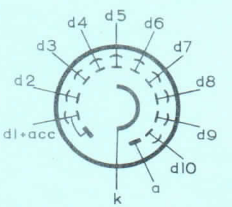
Socket B8 700 40

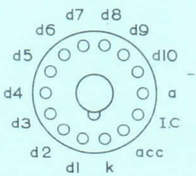
This socket is supplied with the tube. When ordering separately, the above reference number should be quoted.

WEIGHT

Tube alone	6.5	oz
	185	g



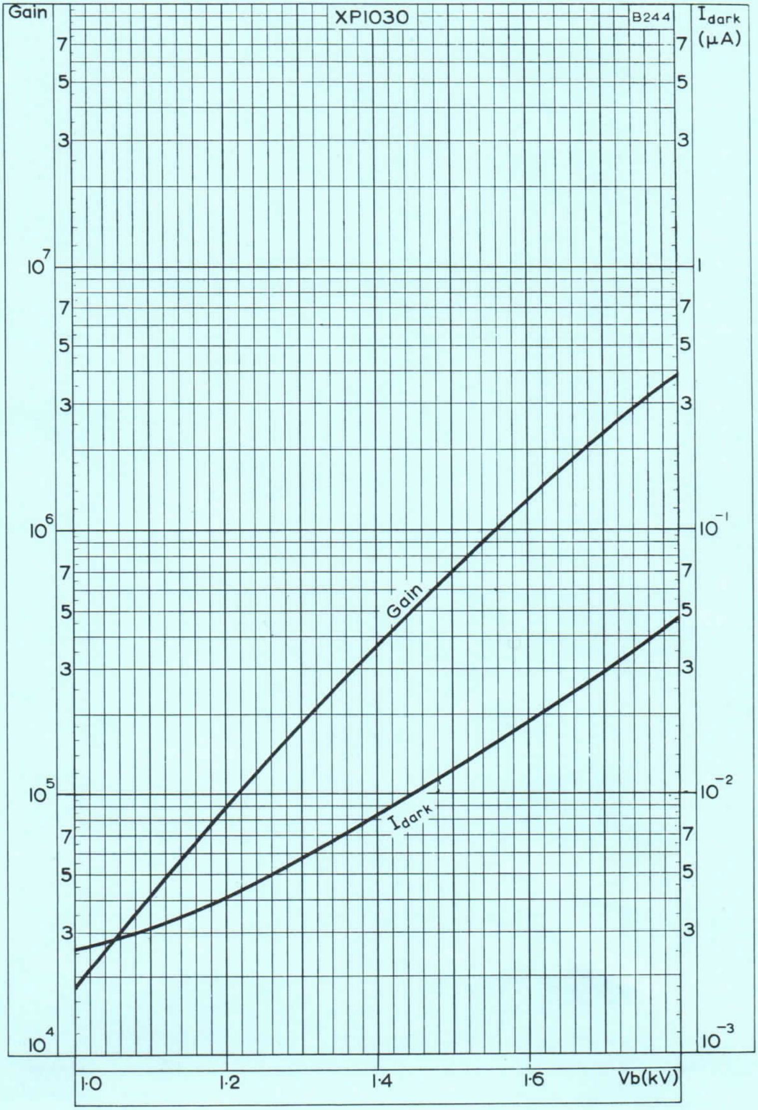




Special 14pin base

All dimensions in mm

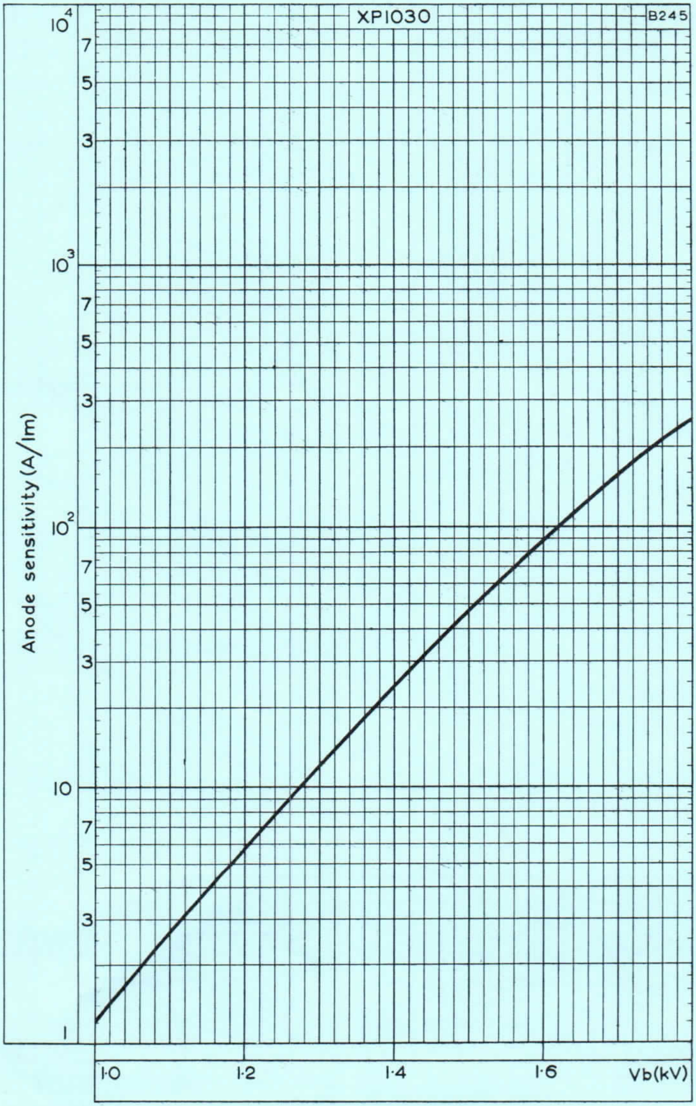
B243



GAIN AND DARK CURRENT PLOTTED AGAINST TOTAL VOLTAGE

XP1030

PHOTOMULTIPLIER TUBE



ANODE SENSITIVITY PLOTTED AGAINST TOTAL VOLTAGE

PHOTOMULTIPLIER TUBE XP1031

QUICK REFERENCE DATA		
10 stage photomultiplier tube intended for use in applications such as gamma-ray spectrometry and gamma scintillation cameras.		
Spectral response curve		Type A (S11)
Photocathode useful diameter	63.5	mm
Anode sensitivity (at $V_b = 1.8kV$)	250	A/lm
Energy resolution for 0.661MeV caesium 137 line	8.5	%

This data should be read in conjunction with
OPERATING NOTES - PHOTOMULTIPLIER TUBES

PHOTOCATHODE

Surface	semi-transparent, caesium antimony	
Minimum useful diameter	63.5	mm
Spectral response curve		Type A (S11)
Wavelength at maximum response	420±30	nm
*Luminous sensitivity		
Average	80	μA/lm
Minimum	70	μA/lm
Average radiant sensitivity at 420nm	65	mA/W

*Measured using a tungsten lamp of colour temperature 2850 $^{\circ}$K

MULTIPLIER SYSTEM

Number of stages	10
Dynode material	silver magnesium oxygen caesium

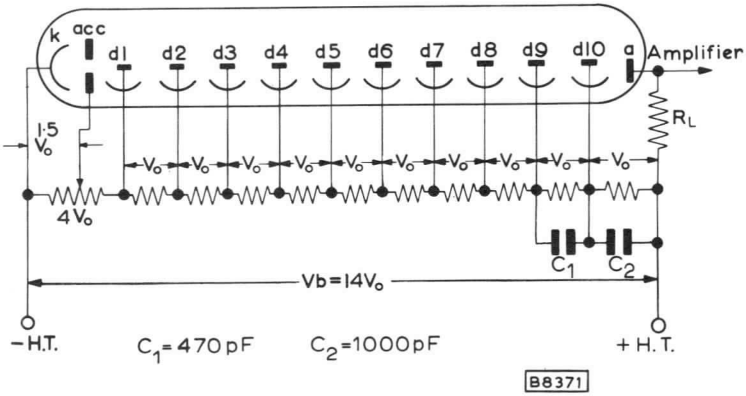
CHARACTERISTICS

Overall sensitivity at $V_b = 1.8kV$		
Average	300	A/lm
Minimum	100	A/lm
*Maximum dark current at S=100A/lm	0.2	μA
Maximum value of anode current at which relationship between peak anode current and luminous flux is linear (at $V_b = 1.8kV$)	50	mA
**Anode pulse rise time (at $V_b = 1.4kV$)	7.0	ns
Anode pulse width at half height (at $V_b = 1.4kV$)	15	ns
Transit time difference between the centre of the photocathode and the edge (at $V_b = 1.4kV$)	7.0	ns
Total transit time (at $V_b = 1.4kV$)	60	ns
***Energy resolution for 0.661MeV caesium 137 line		
Average	8.5	%
Maximum	9.0	%

*Measured at 25°C

**For an infinitely short light pulse

***Measured using a 50mm × 50mm sodium iodide crystal



CAPACITANCES

c_{a-d10}	3.0	pF
c_{a-all}	5.0	pF

RATINGS (ABSOLUTE MAXIMUM SYSTEM)

V_b max.	2.0	kV
I_a max. (continuous operation)	1.0	mA
V_{k-d1} max.	500	V
V_{k-d1} min.	100	V
V_{k-acc} max.	500	V
$V_{d1-d2 \cdots\cdots\cdots d9-d10}$ max.	300	V
$V_{d1-d2 \cdots\cdots\cdots d9-d10}$ min.	80	V
*V_{a-d10} max.	300	V
*V_{a-d10} min.	80	V

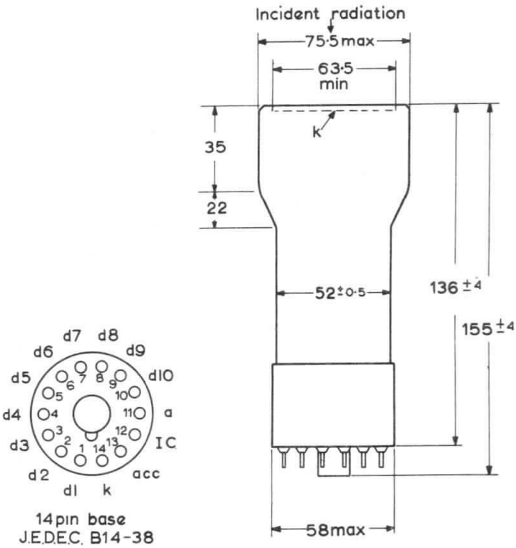
*When calculating the anode voltage, the voltage drop across the load resistance should not be overlooked.

ACCESSORIES (supplied as additional items)

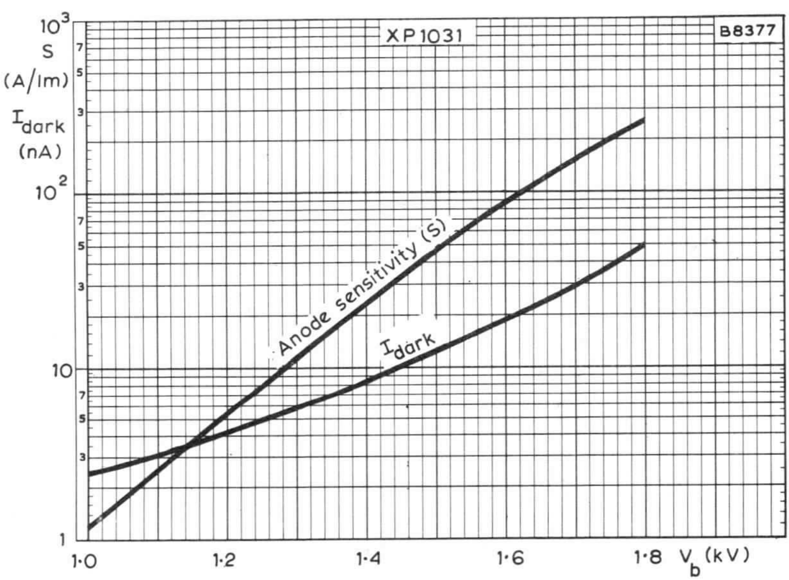
Socket	FE1001
Mu-metal shield	56135

OPERATING NOTES

1. To achieve a stability of about 1% the ratio of the current through the voltage divider bridge to that through the heaviest loaded stage of the tube should be approximately 100.
2. For moderate intensities of radiation a bridge current of about 0.5mA will be sufficient.
3. Each tube is accompanied by a sheet of characteristics, on which is indicated the voltage to be applied between the cathode and the first dynode. The best results in gamma-ray spectrometry will be achieved with this voltage, when the recommended voltage divider bridge is used.
4. When the tube has been exposed to full daylight just before mounting, it will probably show an increased dark current, which will return to its normal value after several hours of operation.
5. It is advisable to screen the tube with a mu-metal cylinder against the influence of magnetic fields.



All dimensions in mm B8368



ANODE SENSITIVITY AND DARK CURRENT
PLOTTED AGAINST TOTAL VOLTAGE

PHOTOMULTIPLIER TUBE XP1040

QUICK REFERENCE DATA

14 stage photomultiplier tube intended for use in fast coincidence circuits and Cerenkov counters where a high degree of time definition is required. This tube is similar to type 58AVP, except for the window construction.

Spectral response curve	type A (S11)	
Photocathode useful diameter	110	mm
Anode sensitivity (at V_b = 3.0kV)	7000	A/lm

This data should be read in conjunction with
OPERATING NOTES - PHOTOMULTIPLIER TUBES

PHOTOCATHODE

Surface	semi-transparent, caesium antimony	
Spectral response curve	type A (S11)	
Peak spectral response	420 ± 30	nm
Minimum useful diameter	110	mm
*Luminous sensitivity		
Average	70	μA/lm
Minimum	45	μA/lm
Average radiant sensitivity (at 420nm)	60	mA/W

*Measured using a tungsten lamp of colour temperature 2850°K.

CHARACTERISTICS

VOLTAGE DIVIDER AS IN FIG. 1.

Supply voltage for gain = 10^8		
Average	2.4	kV
Maximum	3.0	kV
**Maximum anode dark current at gain = 10^8	12	μA
Maximum value of anode current for which relationship between peak anode current and luminous flux is linear (at V_b = 3.0kV)	100	mA

**Measured at 25°C

VOLTAGE DIVIDER AS IN FIG. 2.

Maximum value of anode current for which relationship between peak anode current and luminous flux is linear (at V_b = 3.0kV)	300	mA
Rise time of anode pulse (at V_b = 3.0kV)	2.0	ns
Width at half height of anode pulse (at V_b = 3.0kV)	4.0	ns
Transit time difference between the centre of the photocathode and the edge (at V_b = 3.0kV)	1.0	ns
Total transit time (at V_b = 3.0kV)	45	ns
Maximum peak current	0.5 to 1.0	A

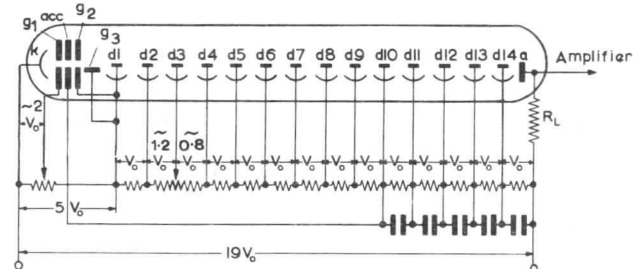


Fig.1

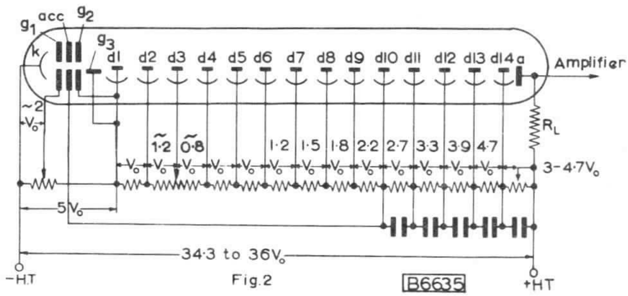


Fig.2

If cathode is connected to negative h.t., precautions should be taken to ensure adequate h.t. insulation between the aquadag shield and the metal envelope or mu-metal shield.

CAPACITANCES

c_{a-d14}	5.0	pF
c_{a-all}	7.0	pF

RATINGS (ABSOLUTE MAXIMUM SYSTEM)

*V_b max.	3.0	kV
I_a max. (continuous operation)	2.0	mA
V_{k-acc} max.	1.8	kV
V_{k-acc} min.	1.4	kV
V_{k-g1} max.	300	V
$V_{k-d1+g2}$ max.	800	V
$V_{k-d1+g2}$ min.	250	V
V_{g3-d1} max.	100	V
**V_{a-d14} max.	500	V
**V_{a-d14} min.	80	V
V_{d1-d2} .... $d13-d14$ max.	500	V
V_{d1-d2} .... $d13-d14$ min.	80	V

*Or the voltage at which the tube, when used in the circuit of FIG.1, has a gain of about 10^9, whichever is the lower.

**When calculating the anode voltage, the volt drop across the load resistance should not be overlooked.

ACCESSORIES (supplied as additional items)

Socket	FE1003
Mu-metal shield	
tube with metal container	56133
tube without metal container	56129

OPERATING NOTES

1. To achieve a stability of about 1% the ratio of the current through the voltage divider bridge to that through the heaviest loaded stage of the tube should be approximately 100.

2. For moderate intensities of radiation a bridge current of about 3mA will be sufficient.

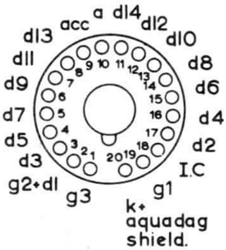
3. When pulses of high amplitude are taken from the anode, it is useful to decouple the last stages as indicated in the circuit by means of capacitors of a few hundred pF, to avoid a voltage drop between these stages.

4. When the tube has been exposed to full daylight just before mounting, it will probably show an increased dark current, which will return to its normal value after several hours of operation.

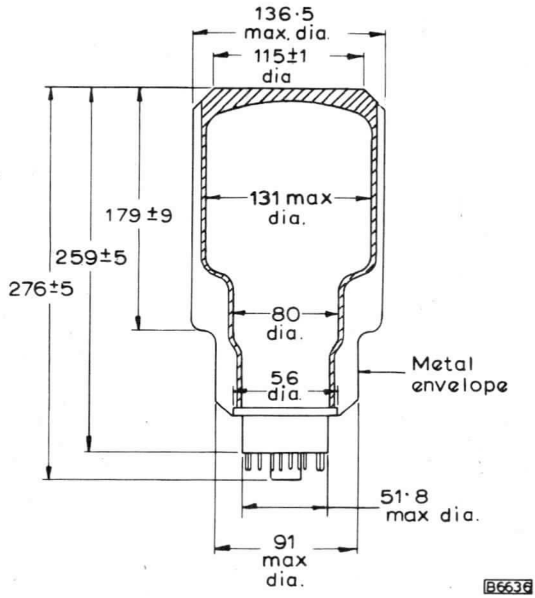
5. It is advisable to screen the tube with a mu-metal cylinder against the influence of magnetic fields.

6. In the case of high counting rates and large peak power outputs, and to avoid a high tension supply of large power it is possible to supply the first stages with a h.t. of small output current and the end stages with an average value of h.t.

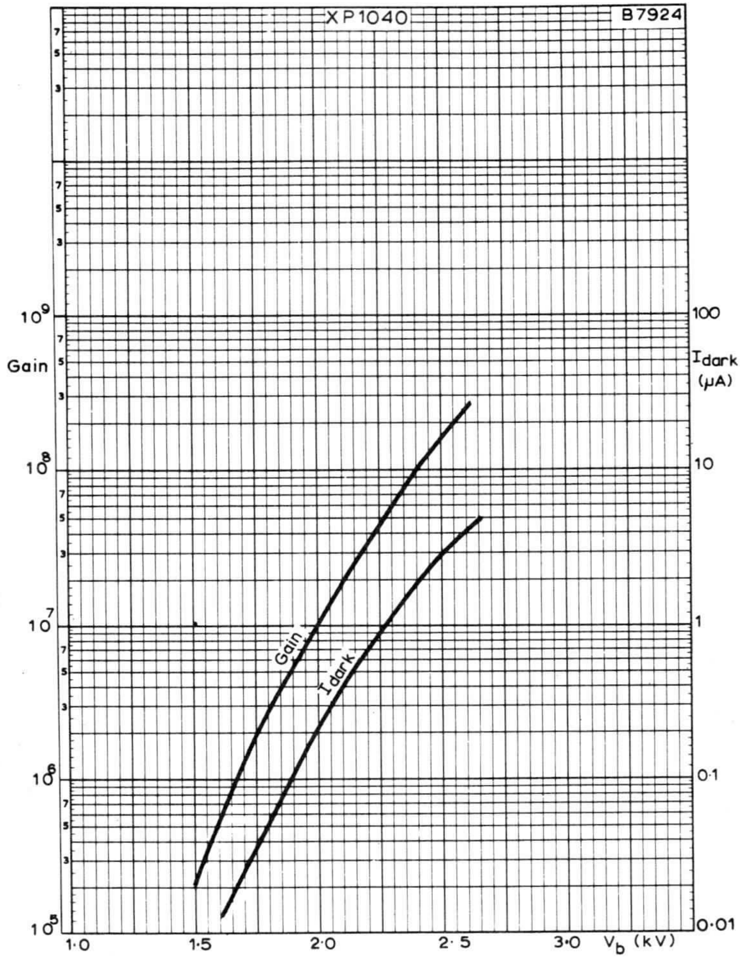
7. The voltage divider in Fig.1 has the higher gain, while a higher anode current output with better time characteristics can be obtained when the tube is connected as in Fig. 2.



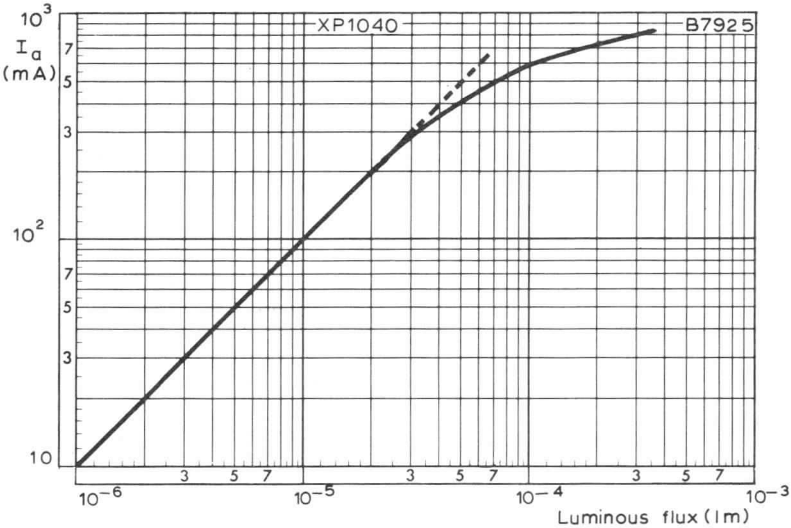
Special 20pin base



All dimensions in mm.



GAIN AND DARK CURRENT
AS A FUNCTION OF TOTAL VOLTAGE



ANODE CURRENT AS A FUNCTION OF LUMINOUS FLUX

PHOTOMULTIPLIER TUBE XP1110

QUICK REFERENCE DATA		
10 stage photomultiplier tube intended for use in applications such as scintillation counting under limited dimensional conditions and optical applications.		
Spectral response curve	type A (S11)	
Photocathode useful diameter	14	mm
Anode sensitivity (at V_b = 1.8kV)	250	A/lm

This data should be read in conjunction with
OPERATING NOTES - PHOTOMULTIPLIER TUBES

PHOTOCATHODE

Surface	semi-transparent, caesium antimony	
Minimum useful diameter	14	mm
Spectral response curve	type A (S11)	
Wavelength at maximum response	420 ±30	nm
*Luminous sensitivity		
Average	70	µA/lm
Minimum	40	µA/lm
Average radiant sensitivity at 420nm	60	mA/W

*Measured using a tungsten lamp of colour temperature 2850°K.

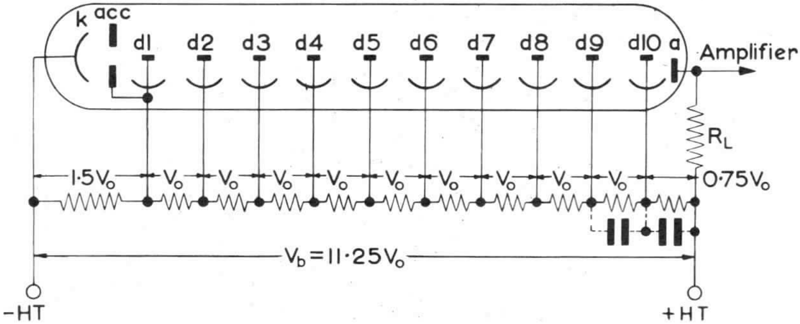
MULTIPLIER SYSTEM

Number of stages	10
Dynode material	silver magnesium oxygen caesium

CHARACTERISTICS

Overall sensitivity at V_b = 1.8kV		
Average	250	A/lm
Minimum	30	A/lm
**Maximum dark current at S= 30A/lm	100	nA
Maximum value of anode current at which relationship between peak anode current and luminous flux is linear (at V_b = 1.8kV)	10	mA

**Measured at 25°C.



CAPACITANCES

c_{a-d10}	1.5	pF
c_{a-all}	2.5	pF

RATINGS (ABSOLUTE MAXIMUM SYSTEM)

V_b max.	1.8	kV
I_a max. (continuous operation)	1.0	mA
V_{k-d1} max.	300	V
V_{k-d1} min.	120	V
V_{d1-d2} .... $_{d9-d10}$ max.	200	V
V_{d1-d2} .... $_{d9-d10}$ min.	80	V
***V_{a-d10} max.	200	V
***V_{a-d10} min.	80	V

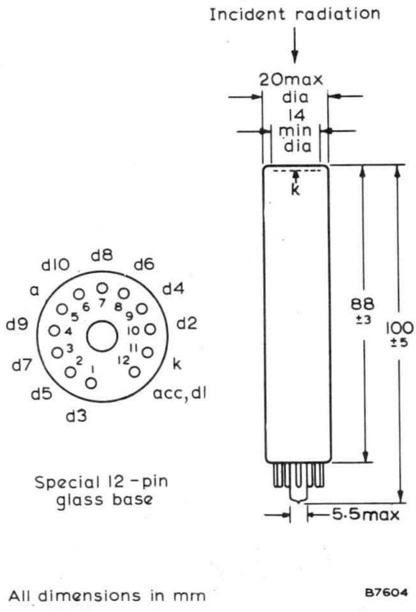
***When calculating the anode voltage, the voltage drop across the load resistance should not be overlooked.

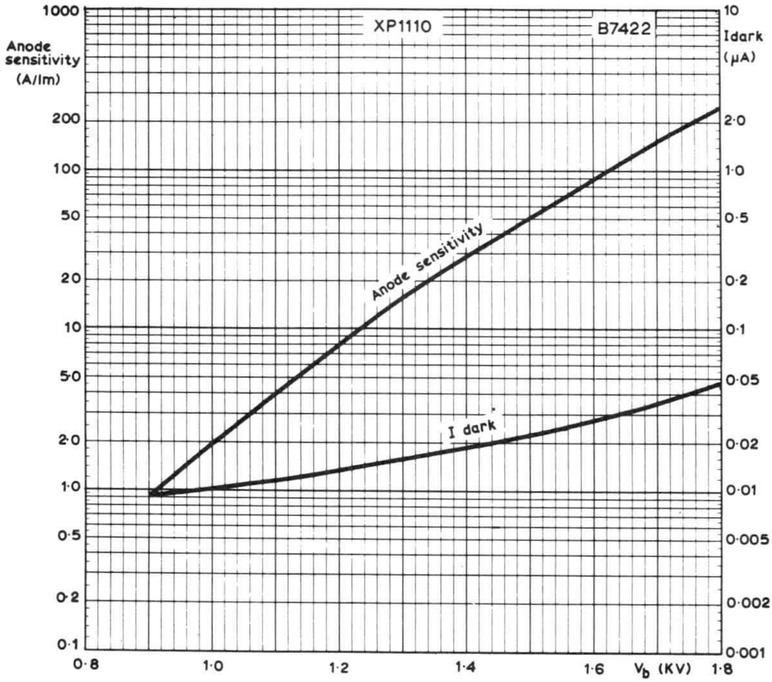
ACCESSORIES (Supplied as additional items)

Socket	56073
Mu-metal shield	56134

OPERATING NOTES

1. To achieve a stability of about 1% the ratio of the current through the voltage divider bridge to that through the heaviest loaded stage of the tube should be approximately 100.
2. For moderate intensities of radiation a bridge current of about 0.5mA will be sufficient.
3. When pulses of high amplitude are taken from the anode, it is useful to decouple the last stages as indicated in the circuit by means of capacitors of a few hundred pF, to avoid a voltage drop between these stages.
4. When the tube has been exposed to full daylight just before mounting, it will probably show an increased dark current, which will return to its normal value after several hours of operation.
5. It is advisable to screen the tube with a mu-metal cylinder against the influence of magnetic fields.





ANODE SENSITIVITY AND DARK CURRENT
PLOTTED AGAINST TOTAL VOLTAGE

PHOTOMULTIPLIER TUBE XP1113

TENTATIVE DATA

QUICK REFERENCE DATA

6 stage photomultiplier tube of small size intended for use in optical applications where relatively high light fluxes are to be measured.

Spectral response curve	type A (S11)	
Photocathode useful diameter	14	mm
Anode sensitivity (at $V_b = 1.2kV$)	0.7	A/lm

This data should be read in conjunction with
OPERATING NOTES - PHOTOMULTIPLIER TUBES

PHOTOCATHODE

Surface	semi-transparent, caesium antimony	
Minimum useful diameter	14	mm
Spectral response curve	type A (S11)	
Wavelength at maximum response	420 ± 30	nm
*Average luminous sensitivity	40	μA/lm
Average radiant sensitivity at 420nm	35	mA/W

*Measured using a tungsten lamp of colour temperature 2850^{O}K.

MULTIPLIER SYSTEM

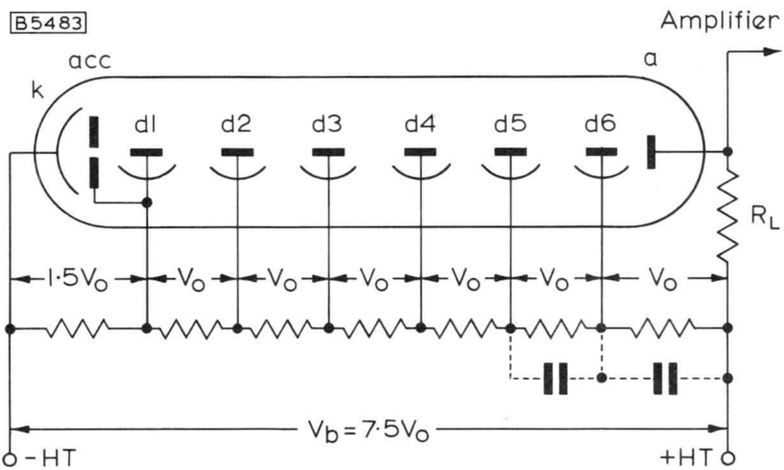
Number of stages	6
Dynode material	silver magnesium oxygen caesium

CHARACTERISTICS

Overall sensitivity at V_b = 1.2kV		
Average	0.7	A/lm
Minimum	0.2	A/lm
**Maximum dark current at S = 0.3A/lm	10	nA
Maximum value of anode current at which relationship between peak anode current and luminous flux is linear (at V_b = 1.2kV)	15	mA

**Measured at 25°C

B5483



CAPACITANCES

$c_{a\text{-}d6}$	1.6	pF
$c_{a\text{-}all}$	1.3	pF

RATINGS (ABSOLUTE MAXIMUM SYSTEM)

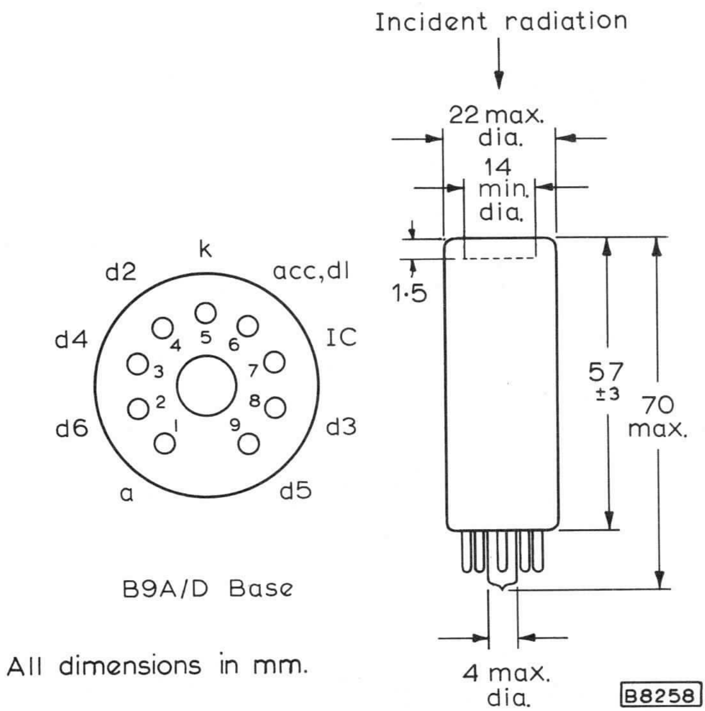
V_b max.	1.2	kV
I_a max. (continuous operation)	0.5	mA
$V_{k\text{-}d1}$ max.	200	V
$V_{d1\text{-}d2}$ .... $_{d5\text{-}d6}$ max.	200	V
$V_{d1\text{-}d2}$ .... $_{d5\text{-}d6}$ min.	80	V
***$V_{a\text{-}d6}$ max.	200	V
***$V_{a\text{-}d6}$ min.	50	V

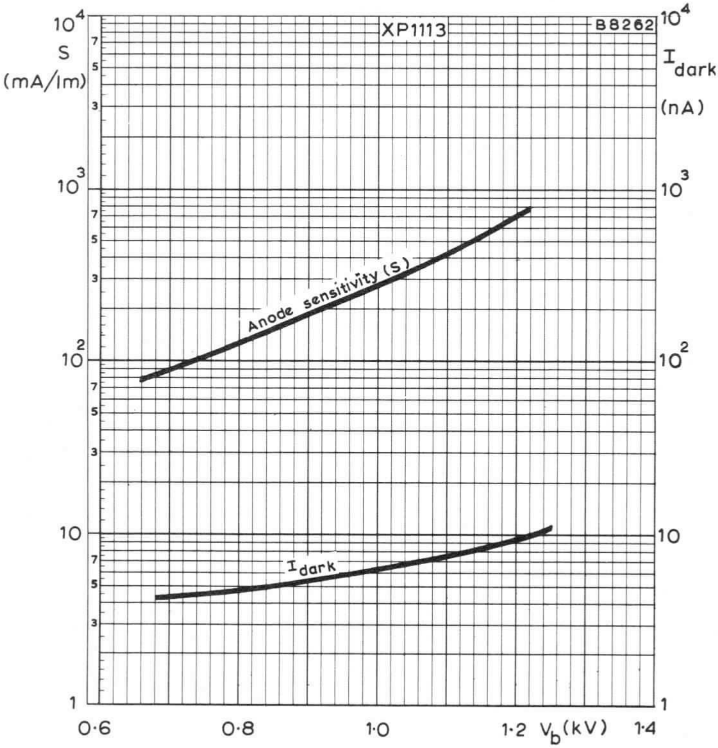
***When calculating the anode voltage, the voltage drop across the load resistance should not be overlooked.

PHOTOMULTIPLIER TUBE XP1113

OPERATING NOTES

1. To achieve a stability of about 1% the ratio of the current through the voltage divider bridge to that through the heaviest loaded stage of the tube should be approximately 100.
2. For moderate intensities of radiation a bridge current of about 0.5mA will be sufficient.
3. When pulses of high amplitude are taken from the anode, it is useful to decouple the last stages as indicated in the circuit by means of capacitors of a few hundred pF, to avoid a voltage drop between these stages.
4. When the tube has been exposed to full daylight just before mounting, it will probably show an increased dark current, which will return to its normal value after several hours of operation.
5. It is advisable to screen the tube with a mu-metal cylinder against the influence of magnetic fields.





ANODE SENSITIVITY AND DARK CURRENT PLOTTED AGAINST TOTAL VOLTAGE

PHOTOMULTIPLIER TUBE XP1114

TENTATIVE DATA

QUICK REFERENCE DATA		
4 stage photomultiplier tube of small size intended for use in optical applications where relatively high light fluxes are to be measured.		
Spectral response curve	type A (S11)	
Photocathode useful diameter	14	mm
Anode sensitivity (at $V_b = 900V$)	15	mA/lm
Maximum dark current (at 4mA/lm)	0.1	nA

This data should be read in conjunction with
OPERATING NOTES - PHOTOMULTIPLIER TUBES

PHOTOCATHODE

Surface	semi-transparent, caesium antimony	
Minimum useful diameter	14	mm
Spectral response curve	type A (S11)	
Wavelength at maximum response	420 ± 30	nm
*Average luminous sensitivity	40	μA/lm
Average radiant sensitivity at 420nm	35	mA/W

*Measured using a tungsten lamp of colour temperature $2850^{\circ}K$.

MULTIPLIER SYSTEM

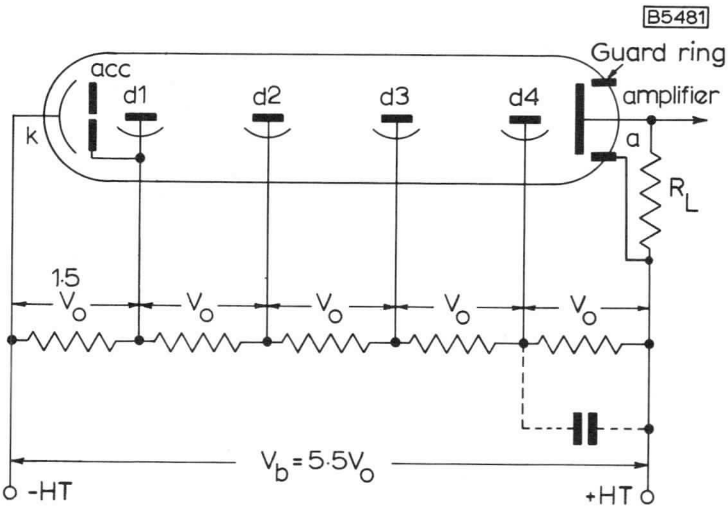
Number of stages	4
Dynode material	silver magnesium oxygen caesium

CHARACTERISTICS

Overall sensitivity at $V_b = 900V$

Average	15	mA/lm
Minimum	4.0	mA/lm
**Maximum dark current at S=4.0mA/lm	0.1	nA

**Measured at 25°C



CAPACITANCES

c_{a-d4}	1.9	pF
c_{a-all}	2.7	pF

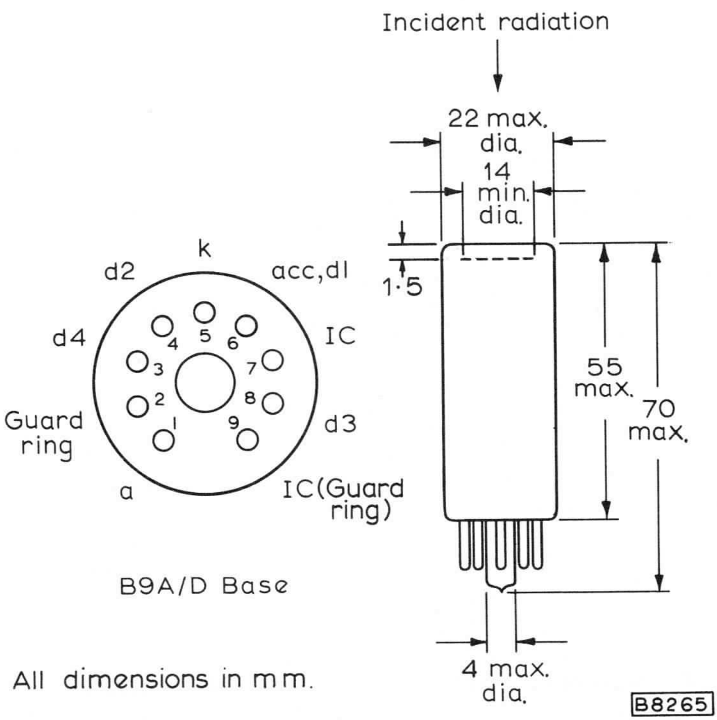
RATINGS (ABSOLUTE MAXIMUM SYSTEM)

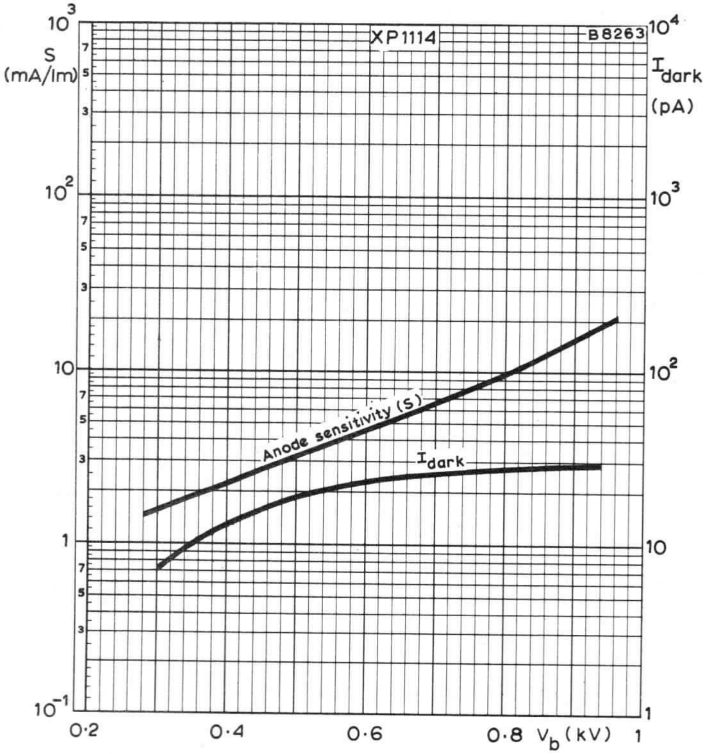
V_b max.	900	V
I_a max. (continuous operation)	0.1	mA
V_{k-d1} max.	200	V
$V_{d1-d2-d3-d4}$ max.	200	V
$V_{d1-d2-d3-d4}$ min.	80	V
***V_{a-d4} max.	200	V
***V_{a-d4} min.	50	V

***When calculating the anode voltage, the voltage drop across the load resistance should not be overlooked.

OPERATING NOTES

1. To achieve a stability of about 1% the ratio of the current through the voltage divider bridge to that through the heaviest loaded stage of the tube should be approximately 100.
2. For moderate intensities of radiation a bridge current of about 0.5mA will be sufficient.
3. When pulses of high amplitude are taken from the anode, it is useful to decouple the last stages as indicated in the circuit by means of capacitors of a few hundred pF, to avoid a voltage drop between these stages.
4. When the tube has been exposed to full daylight just before mounting, it will probably show an increased dark current, which will return to its normal value after several hours of operation.
5. It is advisable to screen the tube with a mu-metal cylinder against the influence of magnetic fields.





ANODE SENSITIVITY AND DARK CURRENT PLOTTED AGAINST TOTAL VOLTAGE

PHOTOMULTIPLIER TUBE XP1116

TENTATIVE DATA

QUICK REFERENCE DATA

10 stage photomultiplier tube intended for use in applications such as infra-red telecommunication and ranging under limited dimensional conditions.

Spectral response curve	type C(S1)	
Photocathode useful diameter	14	mm
Anode sensitivity (at $V_b = 1.8kV$)	20	A/lm

This data should be read in conjunction with
OPERATING NOTES - PHOTOMULTIPLIER TUBES

PHOTOCATHODE

Surface	semi-transparent, caesium on oxidised silver	
Minimum useful diameter	14	mm
Spectral response curve	type C(S1)	
Wavelength at maximum response	800 ± 100	nm
*Average luminous sensitivity	20	μA/lm
Average radiant sensitivity at 800nm	2.0	mA/W

*Measured using a tungsten lamp of colour temperature $2850^{o}K$.

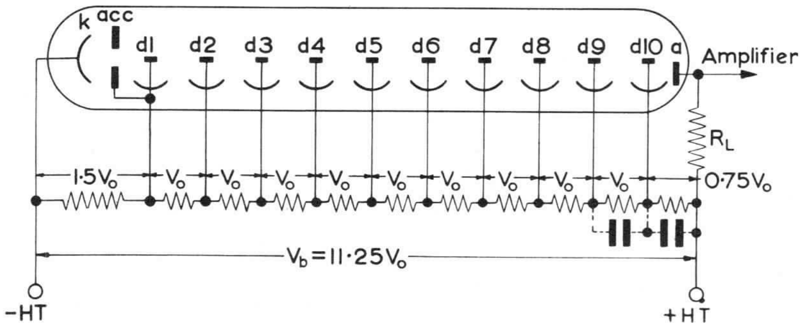
MULTIPLIER SYSTEM

Number of stages	10
Dynode material	silver magnesium oxygen caesium

CHARACTERISTICS

Average overall sensitivity at $V_b = 1.8kV$	20	A/lm
**Average dark current at S = 10A/lm	10	μA

**Measured at $25^{\circ}C$.



CAPACITANCES

c_{a-d10}	1.5	pF
c_{a-all}	2.5	pF

RATINGS (ABSOLUTE MAXIMUM SYSTEM)

V_b max.	1.8	kV
I_a max. (continuous operation)	30	μA
V_{k-d1} max.	300	V
V_{k-d1} min.	120	V
$V_{d1-d2 \cdots\cdots d9-d10}$ max.	200	V
$V_{d1-d2 \cdots\cdots d9-d10}$ min.	80	V
***V_{a-d10} max.	200	V
***V_{a-d10} min.	80	V

***When calculating the anode voltage, the voltage drop across the load resistance should not be overlooked.

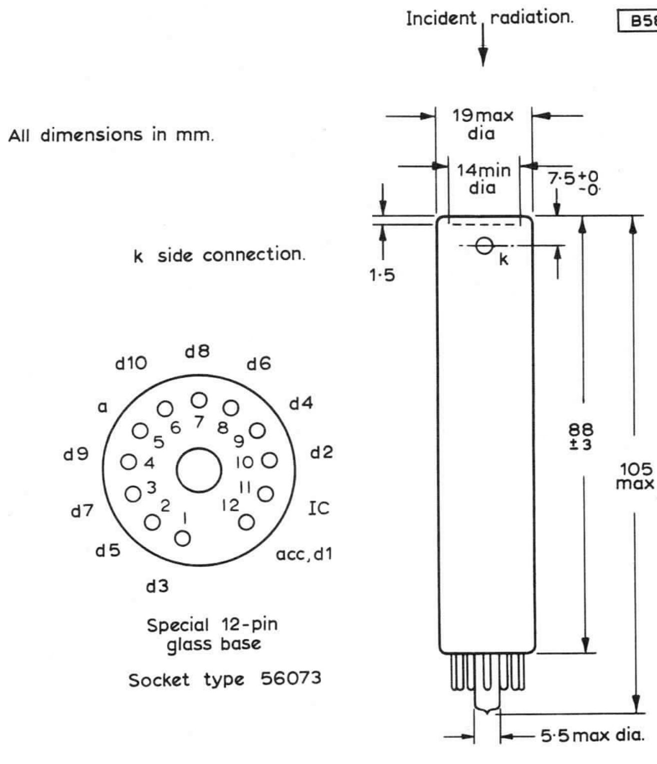
ACCESSORIES

Socket	56073
Mu-metal shield	56134

PHOTOMULTIPLIER TUBE XP1116

OPERATING NOTES

1. To achieve a stability of about 1% the ratio of the current through the voltage divider bridge to that through the heaviest loaded stage of the tube should be approximately 100.
2. For moderate intensities of radiation a bridge current of about 0.5mA will be sufficient.
3. When pulses of high amplitude are taken from the anode, it is useful to decouple the last stages as indicated in the circuit by means of capacitors of a few hundred pF, to avoid a voltage drop between these stages.
4. When the tube has been exposed to full daylight just before mounting, it will probably show an increased dark current, which will return to its normal value after several hours of operation.
5. It is advisable to screen the tube with a mu-metal cylinder against the influence of magnetic fields.



Special 12-pin glass base

Socket type 56073

PHOTOMULTIPLIER TUBE XP1117

QUICK REFERENCE DATA		
9 stage photomultiplier tube intended for use in laser techniques. It is suitable for applications where a broad spectral response is needed and under limited dimensional conditions.		
Spectral response curve	type T (S20)	
Photocathode useful diameter	14	mm
Anode sensitivity (at V_b = 1.8kV)	100	A/lm

This data should be read in conjunction with
OPERATING NOTES - PHOTOMULTIPLIER TUBES

PHOTOCATHODE

Surface	semi-transparent, sodium potassium caesium antimony	
Minimum useful diameter	14	mm
Spectral response curve	type T (S20)	
Wavelength at maximum response	420 ± 30	nm
*Average luminous sensitivity	100	μA/lm
Average radiant sensitivity at 420nm	60	mA/W

*Measured using a tungsten lamp of colour temperature 2850 ^{o}K.

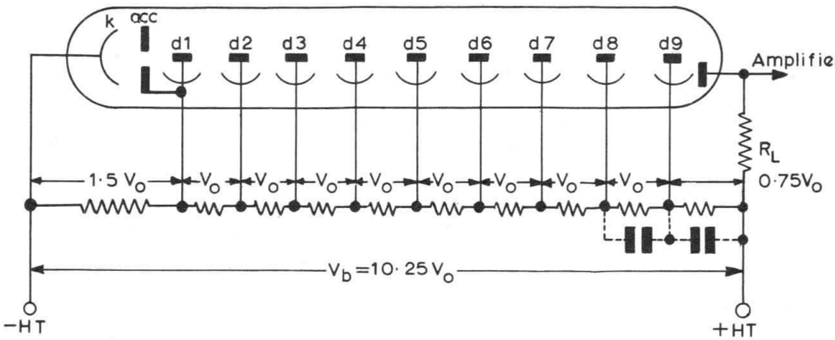
MULTIPLIER SYSTEM

Number of stages	9
Dynode material	silver magnesium oxygen caesium

CHARACTERISTICS ←

Overall sensitivity at $V_b = 1.8$kV	average	100	A/lm
	minimum	30	A/lm
**Dark current at S=30A/lm	average	0.01	μA
	maximum	0.10	μA

**Measured at 25°C



CAPACITANCES

c_{a-d9}	1.5	pF
c_{a-all}	2.5	pF

RATINGS (ABSOLUTE MAXIMUM SYSTEM)

V_b max.	1.8	kV
I_a max. (continuous operation)	1.0	mA
V_{k-d1} max.	300	V
V_{k-d1} min.	120	V
$V_{d1-d2 \cdots\cdots d8-d9}$ max.	200	V
$V_{d1-d2 \cdots\cdots d8-d9}$ min.	80	V
***V_{a-d9} max.	200	V
***V_{a-d9} min.	80	V

***When calculating the anode voltage, the voltage drop across the load resistance should not be overlooked.

ACCESSORIES

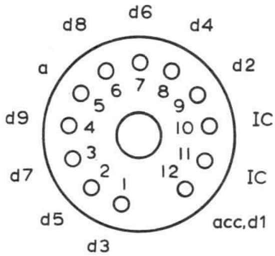
Socket	56073
Mu-metal shield	56134

OPERATING NOTES

1. To achieve a stability of about 1% the ratio of the current through the voltage divider bridge to that through the heaviest loaded stage of the tube should be approximately 100.
2. For moderate intensities of radiation a bridge current of about 0.5mA will be sufficient.
3. When pulses of high amplitude are taken from the anode, it is useful to decouple the last stages as indicated in the circuit by means of capacitors of a few hundred pF, to avoid a voltage drop between these stages.
4. When the tube has been exposed to full daylight just before mounting, it will probably show an increased dark current, which will return to its normal value after several hours of operation.
5. It is advisable to screen the tube with a mu-metal cylinder against the influence of magnetic fields.

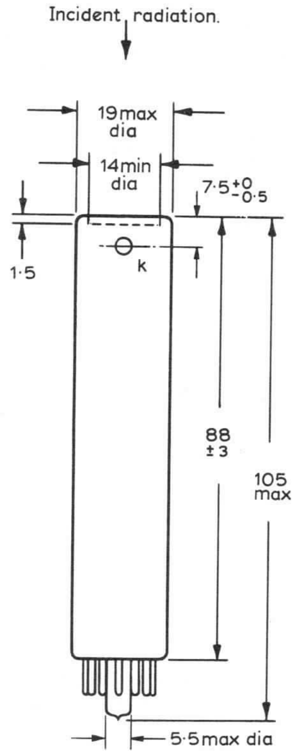
All dimensions in mm.

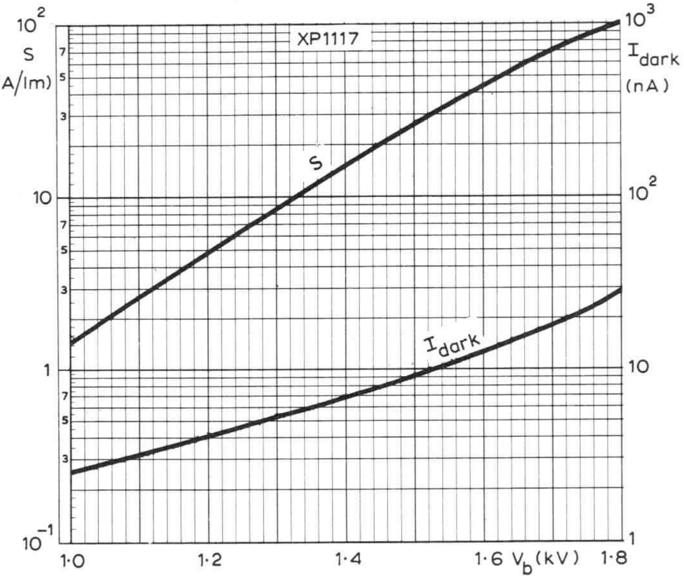
k side connection.



Special 12-pin glass base

Socket type 56073





ANODE SENSITIVITY AND DARK CURRENT PLOTTED AGAINST TOTAL VOLTAGE

PHOTOMULTIPLIER TUBE XP1140

QUICK REFERENCE DATA		
6 stage very fast high current photomultiplier tube intended for use in plasma physics where a high degree of time definition and linearity is required.		
Spectral response curve		S4
Photocathode rectangular surface area	150	mm^2
Gain (at V_b = 3.75kV)	10^4	
Maximum output current for linearity within 5%	2.0	A
Anode pulse rise time	1.7	ns
Total electron transit time	11	ns

This data should be read in conjunction with
OPERATING NOTES - PHOTOMULTIPLIER TUBES

PHOTOCATHODE

Surface	Non-transparent, caesium antimony	
Minimum useful window area	25.5 × 5.9	mm^2
Spectral response curve		S4
Wavelength at maximum response	400±50	nm
*Luminous sensitivity		
Average	45	μA/lm
Minimum	25	μA/lm
Average radiant sensitivity (at 420nm)	35	mA/W

*Measured using a tungsten lamp of colour temperature 2850°K.

MULTIPLIER SYSTEM

Number of stages	6
Dynode material	Silver magnesium oxygen caesium

CHARACTERISTICS

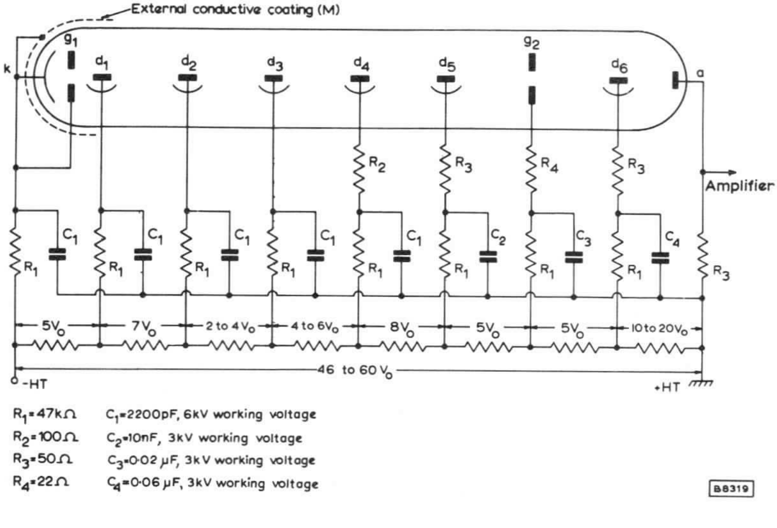
Overall voltage for gain of 10^4		
Maximum	5.0	kV
Average	3.75	kV
**Dark current at gain of 10^4		
Maximum	1.0	µA
Average	30	nA
Maximum output current for linearity within 5%	2.0	A
Overall tube voltage for 5% linearity of 2A peak anode current and input flux		
Maximum	6.5	kV
Average	6.0	kV
Response time measured at 6.5kV		
Anode pulse rise time	1.7	ns
Anode pulse width at half height	3.0	ns
Total transit time	11	ns
Maximum peak anode current	4.0	A

**Measured at 25°C

RATINGS (ABSOLUTE MAXIMUM SYSTEM)

V_b max.	7.0	kV
I_a max. (continuous operation)	2.0	mA

CIRCUIT DIAGRAM



ADJUSTMENT OF TUBE VOLTAGES FOR LINEARITY

A short light pulse is received by two photomultiplier tubes, one of which is a linear reference tube, and the other the tube to be measured. The signals of both tubes are fed in phase to an oscilloscope.

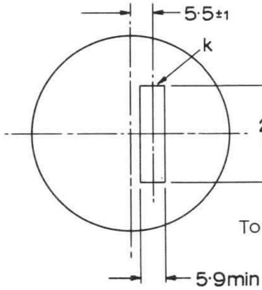
The measurements are made with a voltage divider as indicated in the suggested circuit diagram, starting with a total voltage of 4.8kV.

Observing the oscillogram and simultaneously controlling the voltages between d_2-d_3 and d_3-d_4, it is possible to find a compromise between linearity and absence of oscillation. After this, the voltage between d_6-a is increased in order to obtain a linearity as specified. The whole procedure is then repeated.

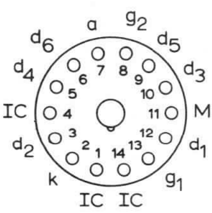
Each tube is accompanied by a test-card which indicates the voltages between d_2-d_3, d_3-d_4 and d_6-a at which a linearity (within 5%) up to 2A is obtained.

NOTES

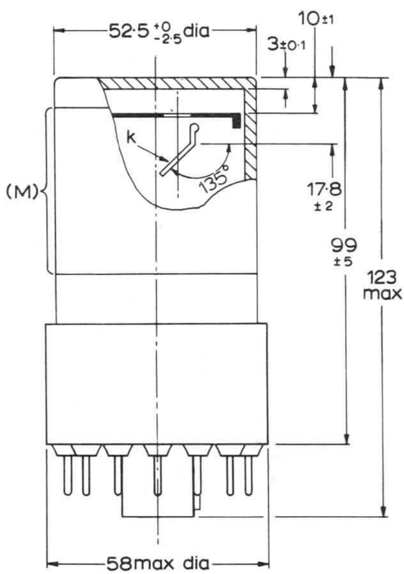
1. It is possible to obtain linearities at peak anode currents in excess of 3A by means of a more complicated procedure. Starting from the recommended voltage divider, each interstage voltage has to be adjusted independently.
2. Linearity within 5% is defined as follows: the curve showing the relationship between the output pulse and the input light pulse will not deviate more than 5% from a straight line.



Top view



14-pin base
J.E.D.E.C. B14-38

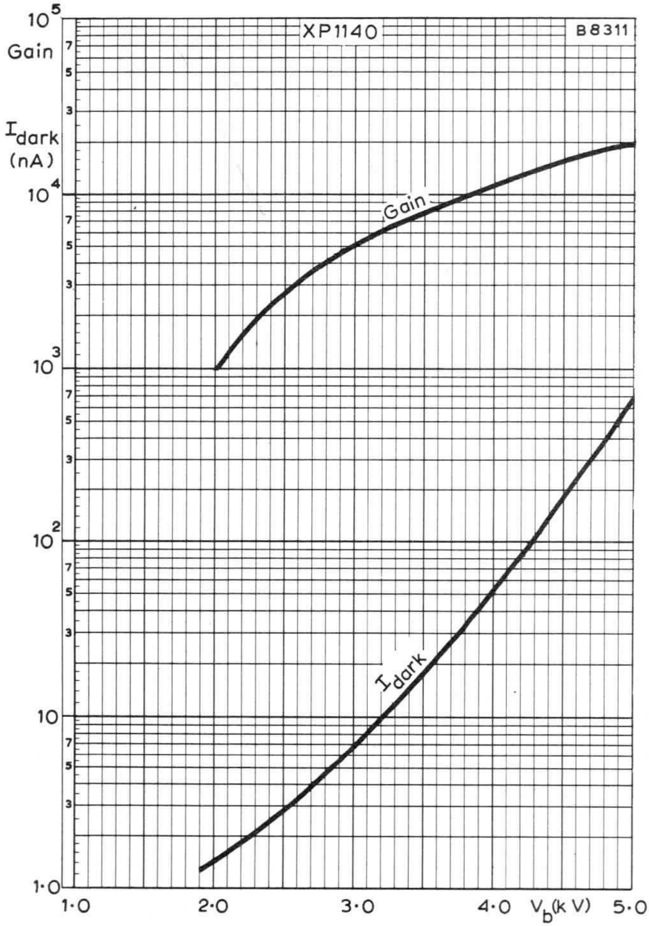


M = External conductive coating

All dimensions in mm

ACCESSORIES (supplied as additional items)

Socket	FE1001
Mu-metal shield	56128



GAIN AND DARK CURRENT PLOTTED AGAINST TOTAL VOLTAGE

PHOTOMULTIPLIER TUBE XP1141

QUICK REFERENCE DATA		
7 stage very fast high current photomultiplier tube intended for use in plasma physics where a high degree of time definition and linearity is required.		
Spectral response curve	Type A (S11)	
Photocathode diameter	42	mm
Gain (at $V_b = 3.5kV$)	10^4	
Maximum output current for linearity within 5%	1.0	A
Anode pulse rise time	1.9	ns
Total electron transit time	16	ns

This data should be read in conjunction with
OPERATING NOTES - PHOTOMULTIPLIER TUBES

PHOTOCATHODE

Surface	Semi-transparent, low resistivity, caesium antimony	
Minimum useful diameter	42	mm
Spectral response curve	Type A (S11)	
Wavelength at maximum response	420±30	nm
*Luminous sensitivity		
Average	55	μA/lm
Minimum	25	μA/lm
Average radiant sensitivity (at 420nm)	50	mA/W

*Measured using a tungsten lamp of colour temperature $2850^{o}K$

MULTIPLIER SYSTEM

Number of stages	7
Dynode material	Silver magnesium oxygen caesium

CHARACTERISTICS

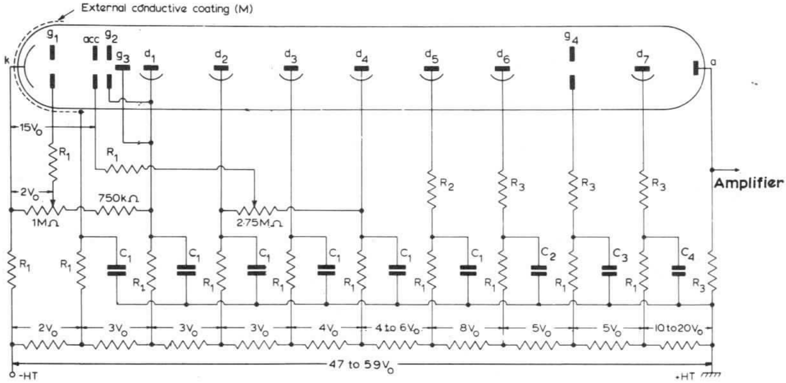
Overall voltage for gain of 10^4		
Maximum	6.5	kV
Average	3.5	kV
**Dark current at gain of 10^4		
Maximum	20	μA
Average	0.1	μA
Maximum output current for linearity within 5%	1.0	A
Overall tube voltage for 5% linearity of 1A peak anode current and input flux		
Maximum	6.5	kV
Average	6.0	kV
Response time measured at 6.5kV		
Anode pulse rise time	1,9	ns
Anode pulse width at half height	3.2	ns
Total transit time	16	ns
Maximum peak anode current	3.0	A

**Measured at 25°C.

RATINGS (ABSOLUTE MAXIMUM SYSTEM)

V_b max.	7.0	kV
I_a max. (continuous operation)	2.0	mA

CIRCUIT DIAGRAM



R_1 = 47kΩ C_1 = 2000pF, 6kV working voltage C_4 = 0·06μF, 3kV working voltage
R_2 = 100Ω C_2 = 10nF, 6kV working voltage
R_3 = 50Ω C_3 = 0·02μF, 3kV working voltage

ADJUSTMENT OF TUBE VOLTAGES FOR LINEARITY

A short light pulse is received by two photomultiplier tubes, one of which is a linear reference tube, and the other the tube to be measured. The signals of both tubes are fed in phase to an oscilloscope.

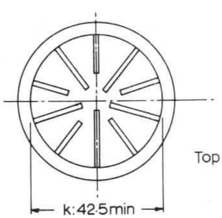
The measurements are made with a voltage divider as indicated in the suggested circuit diagram, starting with a total voltage of 4.8kV.

Observing the oscillogram and simultaneously controlling the voltages between d_4-d_5, it is possible to find a compromise between linearity and absence of oscillation. After this, the voltage between d_7-a is increased in order to obtain a linearity as specified. The whole procedure is then repeated.

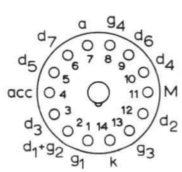
Each tube is accompanied by a test card which indicates the voltages between d_4-d_5 and d_7-a at which linearity (within 5%) up to 1A is obtained.

NOTES

1. It is possible to obtain linearities at peak anode currents in excess of 1A by means of a more complicated procedure. Starting from the recommended voltage divider, each interstage voltage has to be adjusted independently.
2. Linearity within 5% is defined as follows: the curve showing the relationship between the output pulse and the input light pulse will not deviate more than 5% from a straight line.

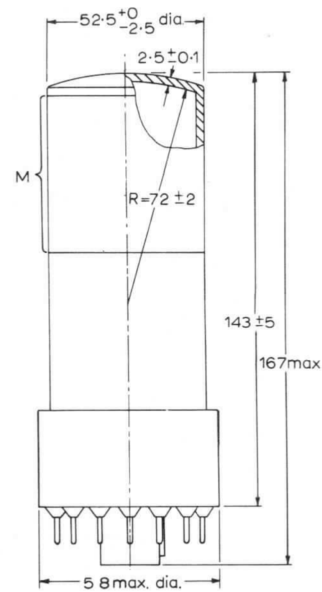


Top view



14-pin base.
J.E.D.E.C. B14-38

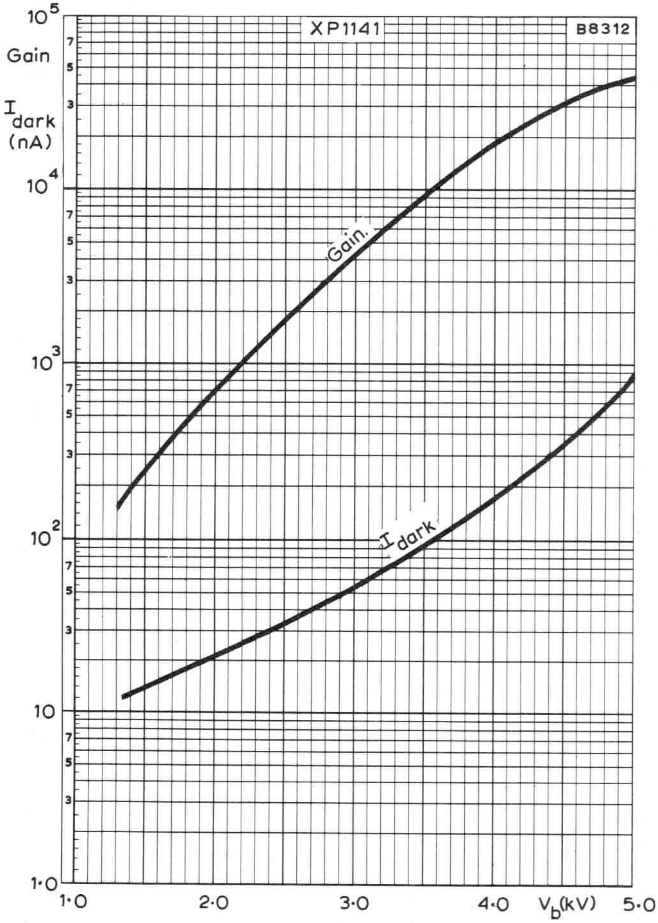
All dimensions in mm



M=External conductive coating

ACCESSORIES (supplied as additional items)

Socket	FE1001
Mu-metal shield	56130



GAIN AND DARK CURRENT PLOTTED AGAINST
TOTAL VOLTAGE

QUICK REFERENCE DATA		
6 stage photomultiplier tube intended for measuring very short light pulses having a very high luminous flux.		
Spectral response curve	Type S4	
Useful photocathode area	280	mm^2
Gain (at $V_b = 3.5kV$)	10^4	
Anode pulse rise time	< 1.0	ns
Maximum anode pulse amplitude for linearity with input light pulse	5.0	A
Coaxial outlet impedance	50	Ω

This data should be read in conjunction with
OPERATING NOTES - PHOTOMULTIPLIER TUBES

PHOTOCATHODE

Surface	Opaque, caesium antimony	
Minimum useful area	280	mm^2
Spectral response curve	Type S4	
Wavelength at maximum response	400 ± 50	nm
*Luminous sensitivity		
Average	45	μA/lm
Minimum	25	μA/lm
Average radiant sensitivity (at 400nm)	40	mA/W

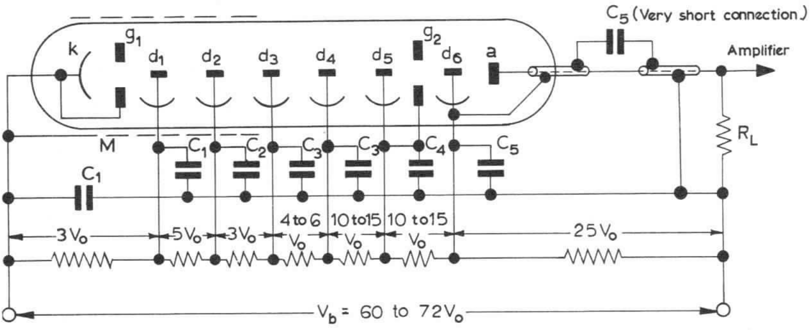
*Measured using a tungsten lamp of colour temperature 2854°K.

MULTIPLIER SYSTEM

Number of stages	6
Dynode material	silver magnesium oxygen caesium

CHARACTERISTICS using recommended voltage divider

Supply voltage for gain = 10^4		
Average	3.5	kV
Maximum	7.0	kV
Dark current at gain = 10^4		
Average	1.0	μA
Maximum	6.0	μA
Maximum output current for linearity with input light pulse (linear within 5%)	5.0	A
Supply voltage for linearity (within 5%) up to 5A		
Average	6.5	kV
Maximum	7.0	kV
Anode pulse rise time	<1.0	ns
Anode pulse width at half height	<2.0	ns
Total transit time	10	ns



$C_1 = 2.2nF, 7.5kV$
$C_2 = 2.2nF, 7.0kV$
$C_3 = 2.2nF, 6.0kV$ Low inductance ceramic capacitors
$C_4 = 30nF, 4.0kV$
$C_5 = 50nF, 3.0kV$
$R_L = 50\Omega$

CAPACITANCES

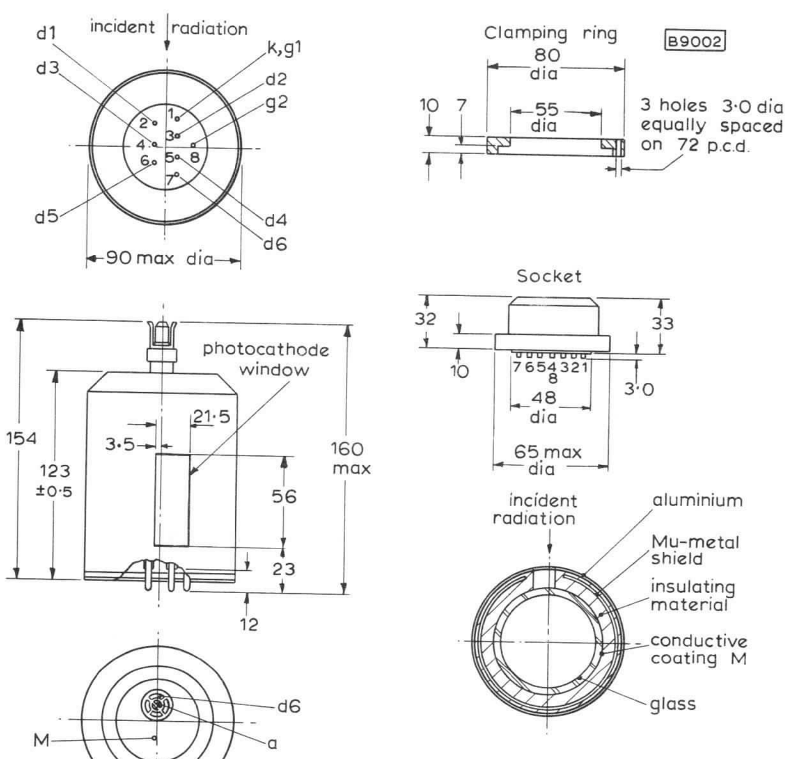
c_{a-d6} (without coaxial connector)	10	pF
c_{a-d6} (with coaxial connector)	12	pF
c_{a-all}	11	pF

RATINGS (ABSOLUTE MAXIMUM SYSTEM)

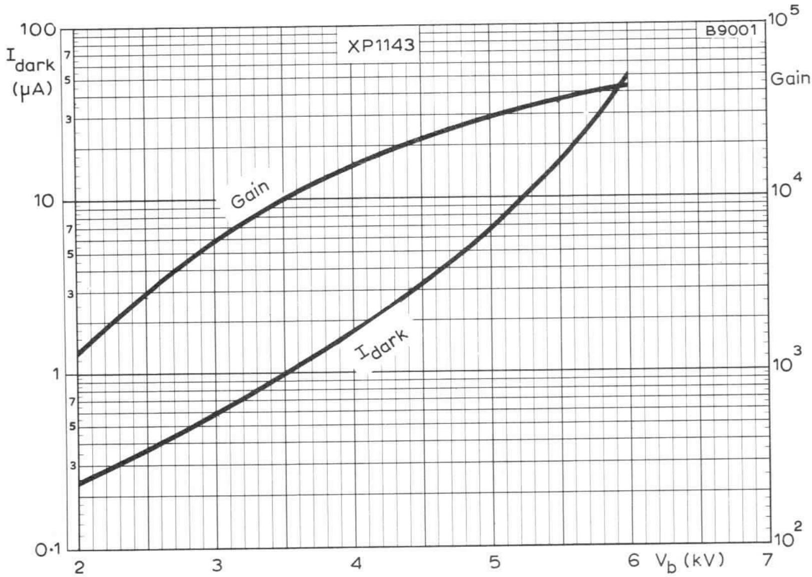
V_b max.	7.5	kV
I_a max (continuous)	2.0	mA
V_{k-d1} max.	1.0	kV
$V_{d1-d2 \ldots\ldots\ldots d5-d6}$ max.	2.0	kV
V_{a-d6} max.	2.75	kV

ACCESSORIES

Coaxial cable connector	General Radio type 874/C8A
Socket (see drawing below)	Supplied with the tube



All dimensions in mm



GAIN AND DARK CURRENT PLOTTED AGAINST TOTAL VOLTAGE

PHOTOMULTIPLIER TUBE XP1210

TENTATIVE DATA

QUICK REFERENCE DATA		
10 stage photomultiplier tube intended for use in very fast light pulse detection, life time of excited states, fast coincidence measurements, Cerenkov measurements, etc.		
Spectral response curve	Type A (S11)	
Photocathode useful diameter	42	mm
Gain (at V_b = 4.0kV)	10^7	
Maximum output current for linearity within 5%	> 75	mA
Anode pulse rise time	1.2	ns
Coaxial outlet impedance	50	Ω

This data should be read in conjunction with
OPERATING NOTES - PHOTOMULTIPLIER TUBES

PHOTOCATHODE

Surface	semi-transparent, caesium antimony	
Minimum useful diameter	42	mm
Spectral response curve	Type A (S11)	
Wavelength at maximum response	420±30	nm
*Luminous sensitivity		
Average	45	μA/lm
Minimum	25	μA/lm
Average radiant sensitivity at 420nm	45	mA/W

*Measured using a tungsten lamp of colour temperature 2854 $^{\circ}$K.

MULTIPLIER SYSTEM

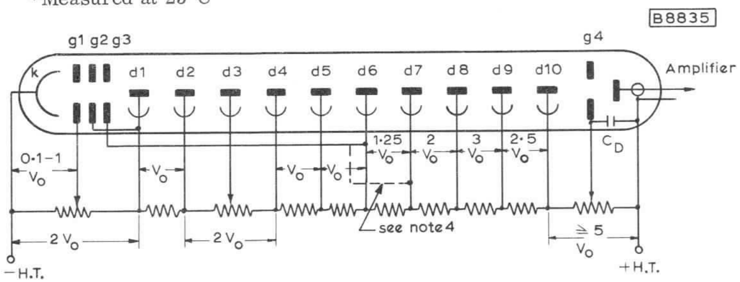
Number of stages	10
Dynode material	silver magnesium oxygen caesium

CHARACTERISTICS (see note 2)

Supply voltage for gain = 10^7		
Average	4.0	kV
Maximum	5.0	kV
*Maximum dark current at gain = 10^7	1.0	μA
Maximum anode pulse amplitude for linearity with input light pulse (linear within 5%)	>75	mA
Anode pulse rise time (at V_b = 5.0kV)	≤1.2	ns
Anode pulse width at half height (at V_b = 5.0kV)	2.2	ns
Transit time difference between the centre of the photocathode and the edge (at V_b = 5.0kV)	≤0.2	ns
Total transit time (at V_b = 5.0kV)	20	ns

Note - These time characteristics are for an infinitely short light pulse, fully illuminating the photocathode.

*Measured at 25°C



CAPACITANCES

c_{a-g4}	4.0	pF
c_{a-all}	6.0	pF
Decoupling capacitor between g4 and outside of coaxial connector (built-in)	400	pF

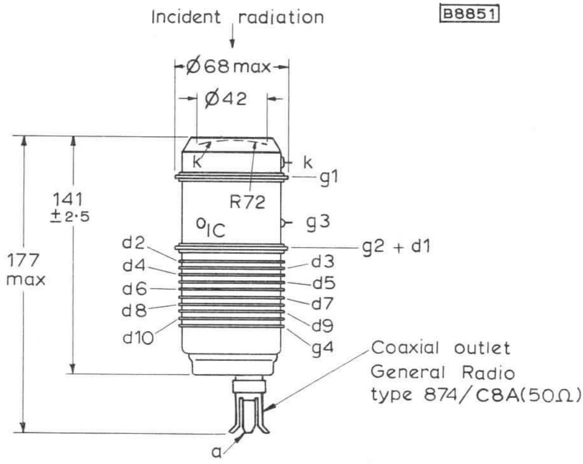
RATINGS (ABSOLUTE MAXIMUM SYSTEM)

V_b max.	5.0	kV
V_{k-d1} max.	900	V
V_{g2-g3} max.	1.75	kV
$V_{d1-d2.....d9-d10}$ max.	900	V
V_{a-g4} max.	1.5	kV

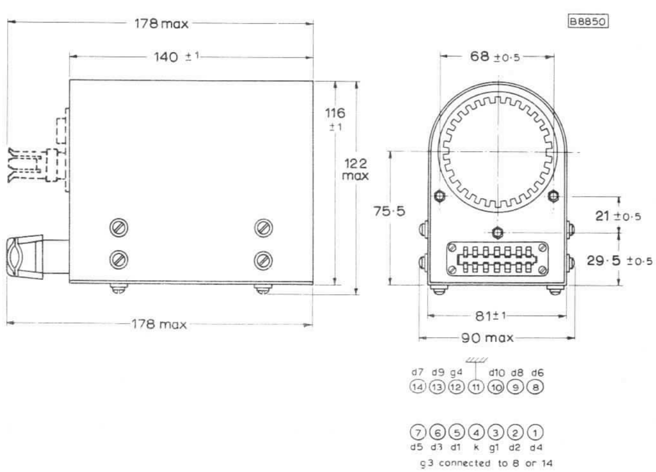
ACCESSORIES

Socket (see page 3)	56040
Coaxial cable connector	General Radio type 874/C8A

OUTLINE DRAWING OF XP1210



OUTLINE DRAWING OF 56040 SOCKET



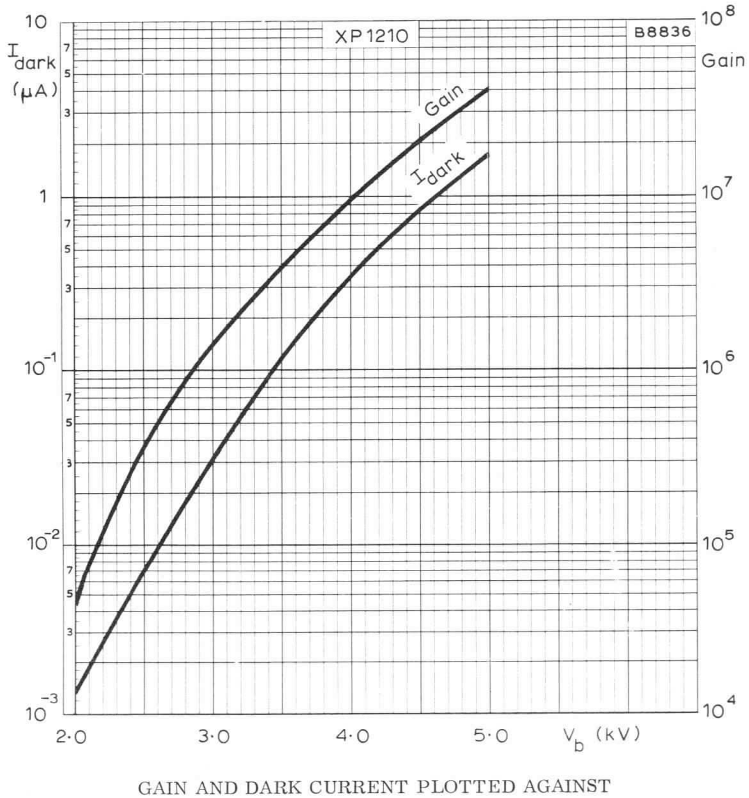
OPERATING NOTES

1. To achieve a stability of about 1% the ratio of the current through the voltage divider bridge to that through the heaviest loaded stage of the tube should be approximately 100.

2. Each tube is accompanied by a certificate showing the exact voltage divider to be used. This is designed to give optimum linearity, time characteristics and dark current at a gain of 10^7.

3. The disc-shaped dynode connections decrease the inductance of the connections and make good decoupling of the stages possible. This system results in a very rigid construction of the tube, and appreciably decreases ionic and light feedback.

4. The accelerator electrode g3 is connected to d6 or d7 inside the socket. The decoupling capacitor between g4 and the coaxial outlet is mounted inside the tube.



GAIN AND DARK CURRENT PLOTTED AGAINST TOTAL VOLTAGE

PHOTOMULTIPLIER TUBE

50AVP

Eleven stage photomultiplier tube with semi-transparent cathode, particularly sensitive to daylight and to radiation having a blue predominance. Designed for end-on incidence of illumination and with optically flat and parallel surfaces.

PHOTOCATHODE

Surface	Caesium antimony	
Peak spectral response	4200 ± 300	Å
Projected cathode area	8.0	sq. cm
Minimum useful diameter	32	mm
*S	50	μA/lm

*Measured with a lamp of colour temperature 2870°K.

MOUNTING POSITION

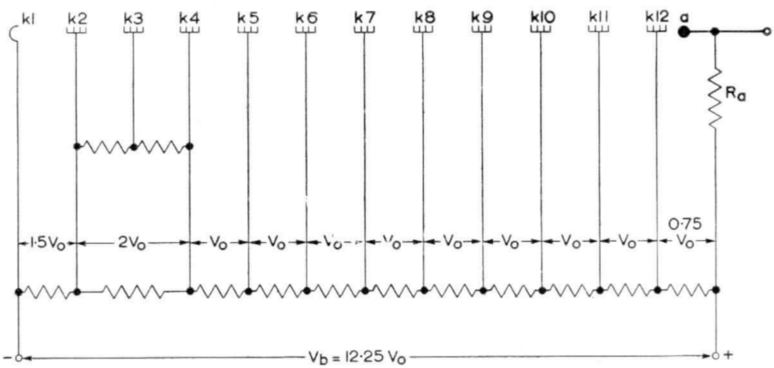
Any

CAPACITANCES

c_{a-k12}	3.0	pF
c_{a-all}	5.0	pF

CHARACTERISTICS (at $V_{a-k1(b)} = 1.8$kV) ←

S(av)	500	A/lm
S(min)	60	A/lm
Current amplification	10^7	
I_{dark} max. (S = 60A/lm)	5×10^{-8}	A
Maximum value of anode current for which relationship between peak anode current and luminous flux is linear		
At voltage distribution as shown in fig. 1	30	mA
At voltage distribution as shown in fig. 2	100	mA



6430

Fig 1

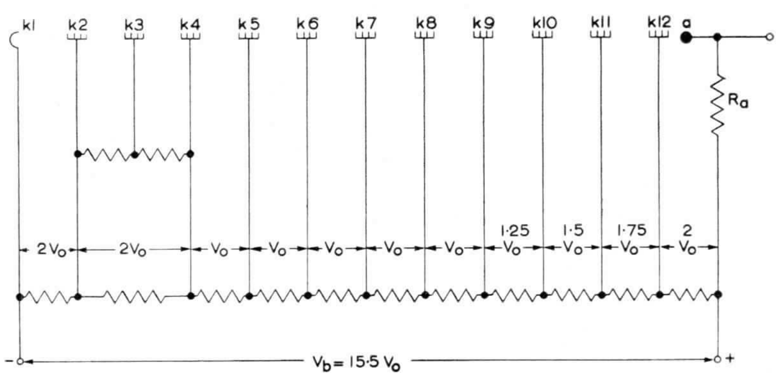


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Fig 2

OPERATING CONDITIONS

At normal voltage distribution (Fig. 1), $V_{a-k1(b)} > 1.47$kV ←

*V_{k1-k2}	$1.5 \times V_o$
V_{k2-k4}	$2.0 \times V_o$
$V_{k4-k5....k11-k12}$	V_o
V_{a-k12}	$0.75 \times V_o$
V_{a-k1}	$12.25 \times V_o$

*$2.0 \times V_o$ for gamma spectrometry

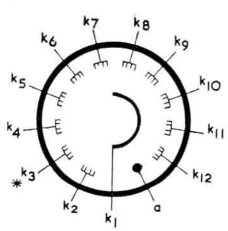
At $V_{a-k1(b)} < 1.47$kV

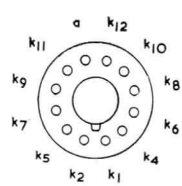
V_{k1-k2}	>130	V
V_{k2-k4}	>160	V
$V_{k4-k5....k11-k12}$	>80	V
V_{a-k12}	>80	V
V_{a-k1}	>1.06	kV

LIMITING VALUES (absolute ratings) ←

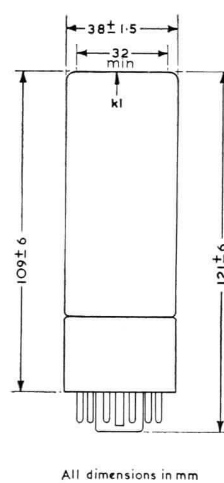
$V_{a(b)}$ max.	1.8	kV
I_a max.	1.0	mA
p_a max.	500	mW
V_{k1-k2} min.	180	V
V_{k2-k4} min.	160	V
V_{a-k12} min	80	V
Minimum voltage difference between two consecutive cathodes	80	V

6443





B12A Base



All dimensions in mm

* k_3 is not terminated at a base pin but is connected internally within the base to the junction of two 2MΩ resistors which form a potential divider between k_2 and k_4

52AVP

QUICK REFERENCE DATA

10 stage photomultiplier tube intended for use in small medical probes, portable equipment or any optical or scintillation application in which a small diameter is required.

Overall diameter	25.5	mm
Photocathode diameter	20	mm
Overall sensitivity (at $V_b = 1.8$kV)	250	A/lm
Maximum dark current (at S = 30A/lm)	0.1	μA

This data should be read in conjunction with
'OPERATING NOTES—PHOTOMULTIPLIER TUBES.'

PHOTOCATHODE

Surface	caesium antimony	
Peak spectral response	0.42 ± 0.03	μm
Minimum useful diameter	20	mm
Minimum cathode area	3.14	cm^2
*Luminous sensitivity		
Average	60	μA/lm
Minimum	35	μA/lm
Average radiant sensitivity (at 0.42μm)	50	mA/W
Maximum dark current (at $T_{amb} = 25°C$)	3×10^{-15}	A/cm^2

*Measured using a lamp of colour temperature 2850°K.

52AVP

PHOTOMULTIPLIER TUBE

CHARACTERISTICS

Overall sensitivity (at V_b = 1.8kV)		
Average	250	A/lm
Minimum	30	A/lm
Maximum dark current (at S = 30A/lm)	0.1	μA
Maximum value of anode current at which relationship between peak anode current and luminous flux is linear (at V_b = 1.8kV)		
At high gain distribution as shown in fig. 1	5	mA
At high current distribution as shown in fig. 2	10	mA

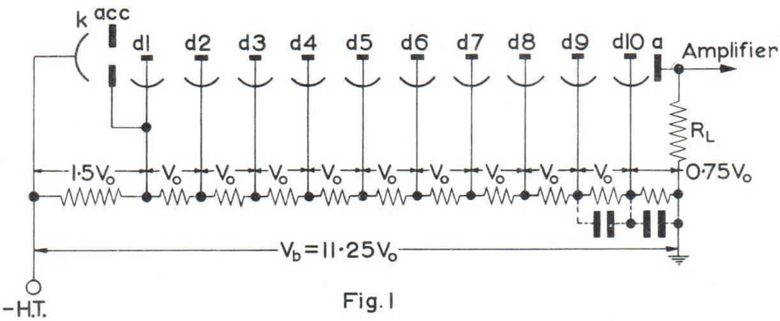


Fig. 1

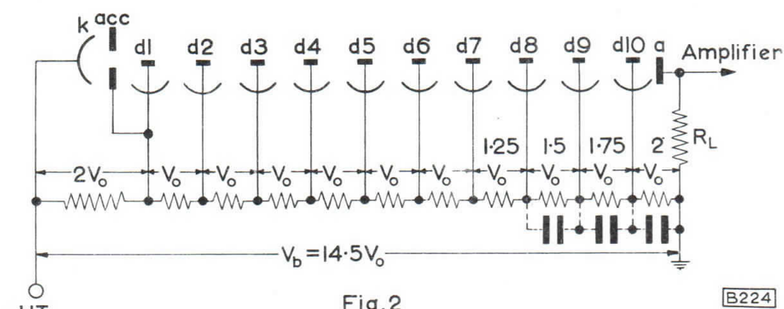


Fig. 2

B224

CAPACITANCES

c_{a-d10}	3	pF
c_{a-a11}	5	pF

MOUNTING POSITION

Any

ABSOLUTE MAXIMUM RATINGS

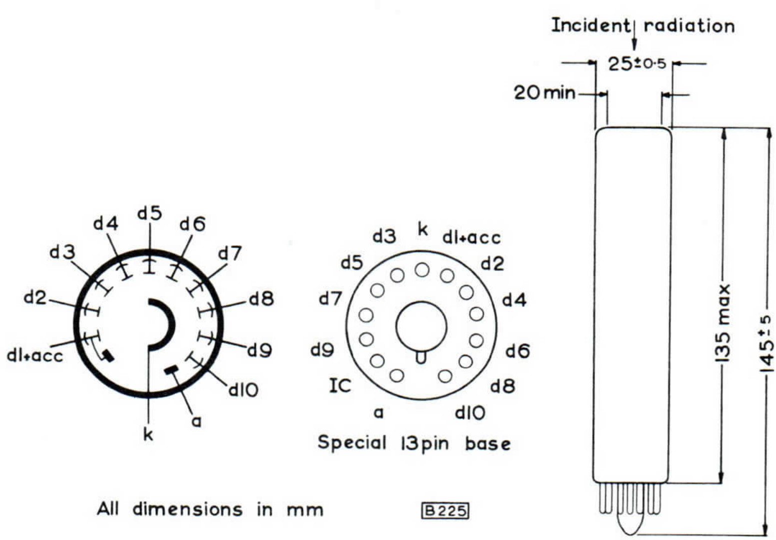
V_b max.	1.8	kV
I_a max. (continuous operation)	1.0	mA
p_a max.	0.5	W
V_{k-d1} max.	500	V
V_{k-d1} min.	120	V
*V_{a-d10} max.	300	V
*V_{a-d10} min.	80	V
$V_{d1-d2 \ldots\ldots d9-d10}$ max.	300	V
$V_{d1-d2 \ldots\ldots d9-d10}$ min.	80	V

*When calculating the anode voltage, the volt drop across the load resistance should not be overlooked.

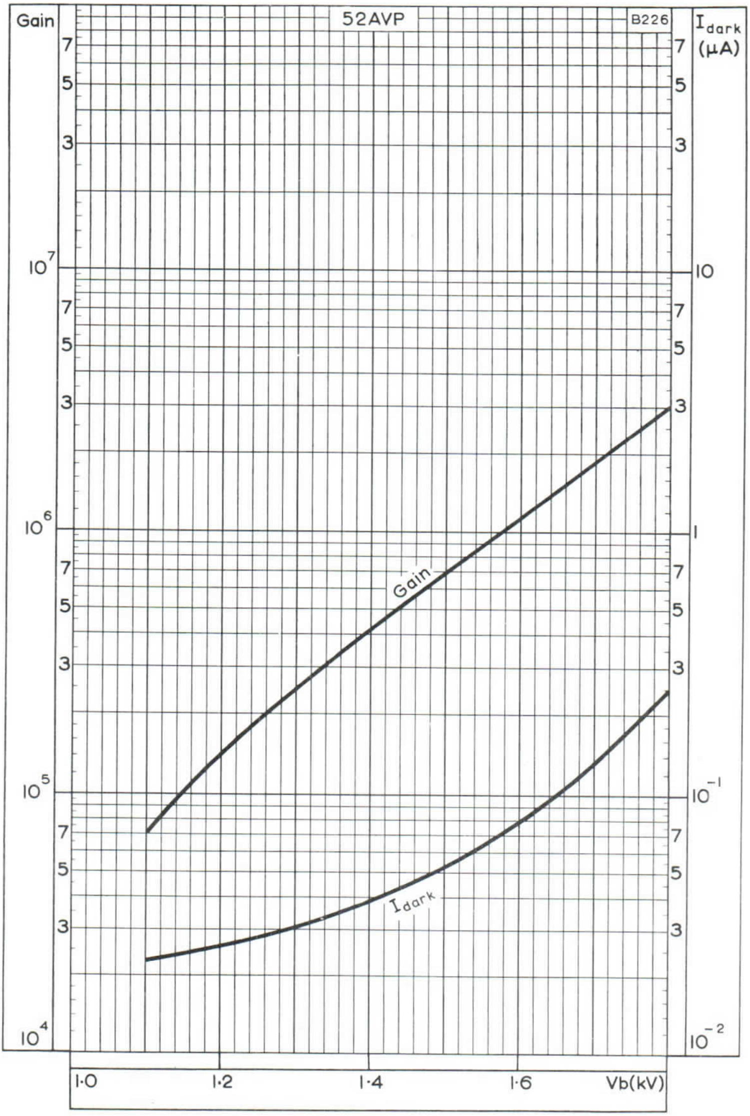
ACCESSORIES

Socket B8 700 67

This socket is supplied with the tube. When ordering separately, the above reference should be quoted.



All dimensions in mm B225



GAIN AND DARK CURRENT PLOTTED AGAINST TOTAL VOLTAGE

53AVP
53UVP

QUICK REFERENCE DATA

11 stage photomultiplier tubes intended for use in scintillation applications, flying-spot apparatus and optical spectrometry.

Overall diameter	57	mm
Photocathode diameter	44	mm
Overall sensitivity (at $V_b = 1.8kV$)	4000	A/lm
Maximum dark current (at S = 60A/lm)	0.05	μA

The 53AVP and 53UVP are identical except for spectral response. 53AVP is particularly suitable for daylight and radiation having a blue predominance. 53UVP has a quartz window and is predominantly sensitive to ultraviolet radiation.

This data should be read in conjunction with
'OPERATING NOTES – PHOTOMULTIPLIER TUBES'

PHOTOCATHODE

Surface	caesium antimony	
Peak spectral response		
53AVP	0.42 ± 0.03	μm
53UVP	0.40 ± 0.03	μm
Minimum useful diameter	44	mm
Minimum cathode area	15.2	cm^2
*Luminous sensitivity		
Average	60	μA/lm
Minimum	35	μA/lm
Average radiant sensitivity (at peak spectral response)	50	mA/W
Maximum dark current (at $T_{amb} = 25°C$)	10^{-15}	A/cm^2

*Measured using a lamp of colour temperature 2850°K.

53AVP
53UVP

PHOTOMULTIPLIER TUBES

CHARACTERISTICS

Overall sensitivity (at V_b = 1.8kV)		
Average	4000	A/lm
Minimum	100	A/lm
Maximum dark current (at S = 60A/lm)	0.05	μA
Maximum value of anode current at which relationship between peak anode current and luminous flux is linear (at V_b = 1.8kV)		
At high gain distribution as shown in fig. 1	30	mA
At high current distribution as shown in fig. 2	100	mA

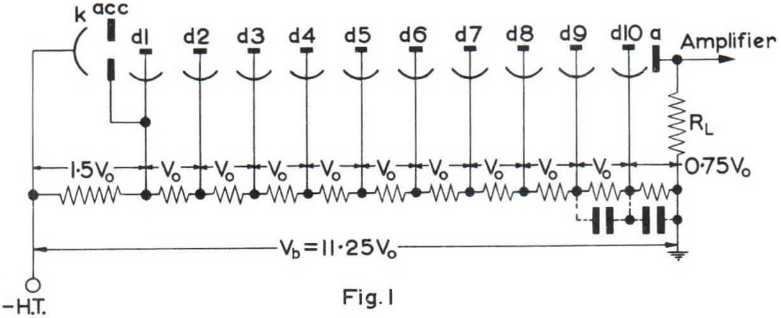


Fig. 1

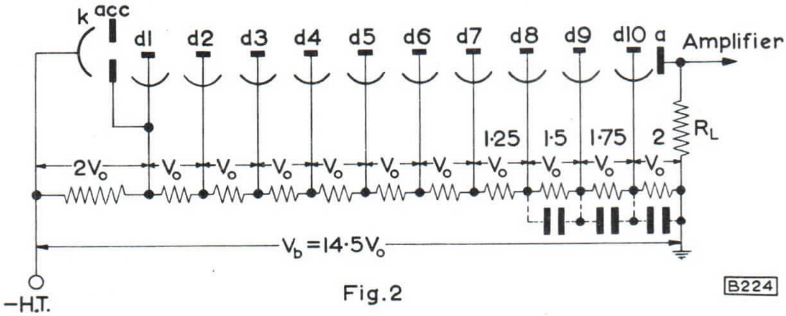


Fig. 2

B224

CAPACITANCES

c_{a-d11}	3	pF
c_{a-all}	5	pF

MOUNTING POSITION

Any

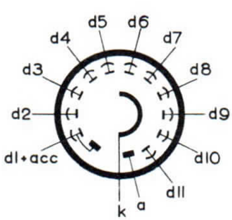
ABSOLUTE MAXIMUM RATINGS

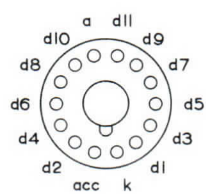
V_b max.	1.8	kV
I_a max. (continuous operation)	1.0	mA
p_a max.	0.5	W
V_{k-d1} max.	500	V
V_{k-d1} min.	120	V
*V_{a-d11} max.	300	V
*V_{a-d11} min.	80	V
$V_{d1-d2 \ldots\ldots d10-d11}$ max.	300	V
$V_{d1-d2 \ldots\ldots d10-d11}$ min.	80	V

*When calculating the anode volt the voltage drop across the load resistance should not be overlooked.

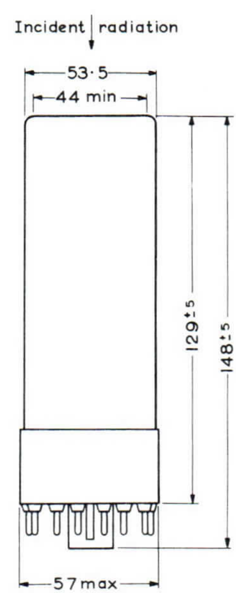
ACCESSORIES

Socket	B8 700 40
Mu-metal shield (cylindrical)	
Length 90±1mm, diameter 57^{+1}_{-0}mm	56128



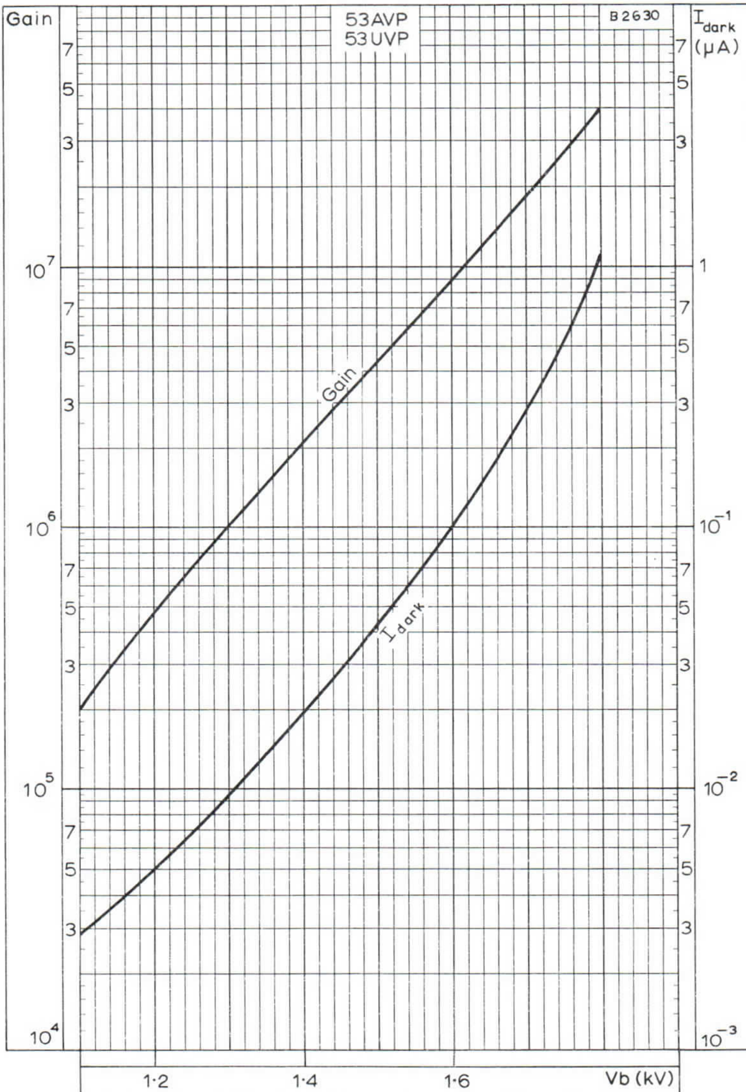


Special 14pin base

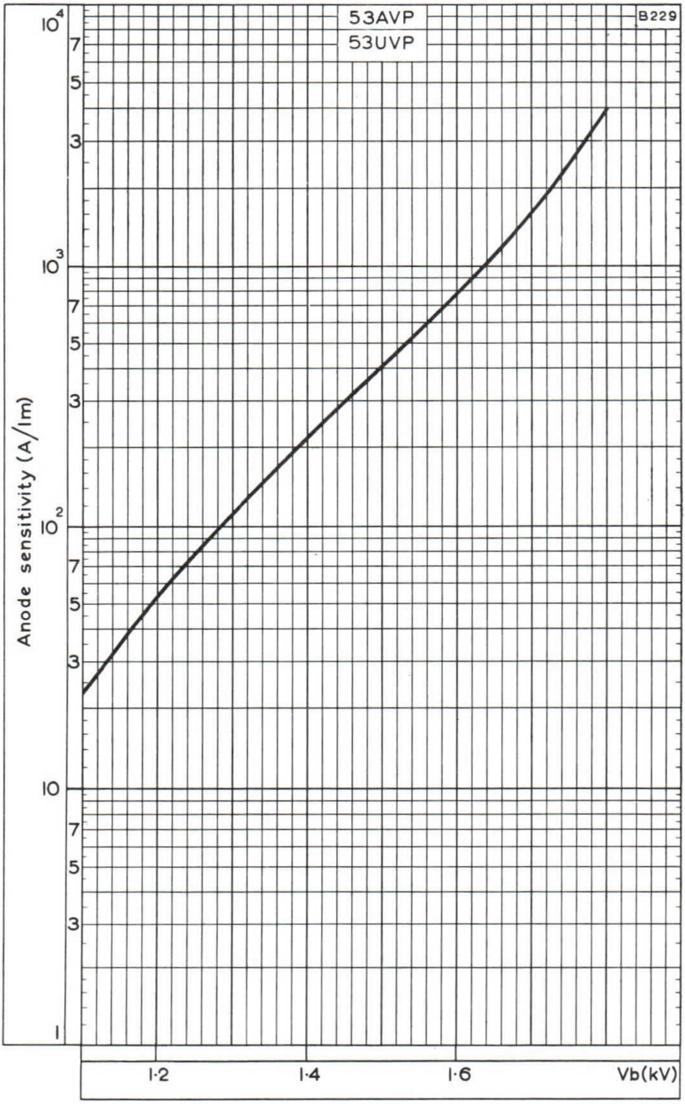


All dimensions in mm

B227



GAIN AND DARK CURRENT PLOTTED AGAINST TOTAL VOLTAGE



ANODE SENSITIVITY PLOTTED AGAINST TOTAL VOLTAGE

PHOTOMULTIPLIER TUBE 54AVP

QUICK REFERENCE DATA

11 stage photomultiplier tube intended for use in scintillation counters employing large crystals or applications in which the light is either diffused or from a distant source.

Overall diameter	130	mm
Photocathode diameter	111	mm
Overall sensitivity (at $V_b = 1.8kV$)	500	A/lm
Maximum dark current (at $S = 250A/lm$)	0.5	μA

This data should be read in conjunction with
'OPERATING NOTES—PHOTOMULTIPLIER TUBES.'

PHOTOCATHODE

Surface	caesium antimony	
Peak spectral response	0.42 ± 0.03	μm
Minimum useful diameter	111	mm
Minimum cathode area	97	cm^2
*Luminous sensitivity		
Average	60	$\mu A/lm$
Minimum	35	$\mu A/lm$
Average radiant sensitivity (at $0.42\mu m$)	50	mA/W
Maximum dark current (at $T_{amb} = 25°C$)	10^{-15}	A/cm^2

*Measured using a lamp of colour temperature 2850°K.

CHARACTERISTICS

Overall sensitivity (at V_b = 1.8kV)		
Average	500	A/lm
Minimum	100	A/lm
Maximum dark current (at S = 250 A/lm)	0.5	µA
Maximum value of anode current at which relationship between peak anode current and luminous flux is linear (at V_b = 1.8kV)		
At high gain distribution as shown in fig. 1	30	mA
At high current distribution as shown in fig. 2	100	mA

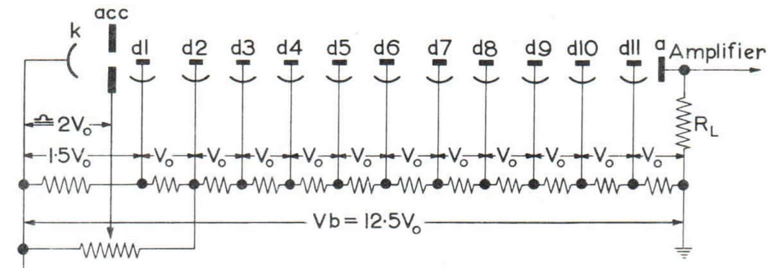


Fig. 1

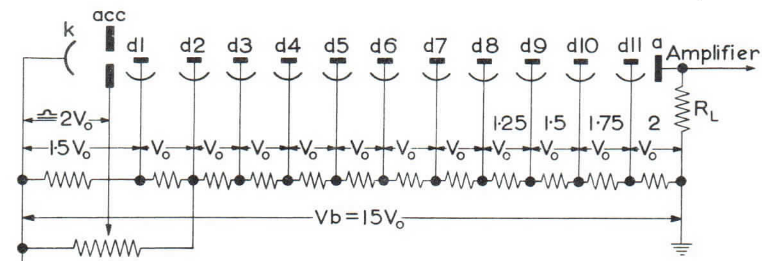


Fig. 2 B231

CAPACITANCES

C_{a-d11}	3	pF
C_{a-all}	5	pF

MOUNTING POSITION

Any

PHOTOMULTIPLIER TUBE 54AVP

ABSOLUTE MAXIMUM RATINGS

V_b max.	2.0	kV
I_a max. (continuous operation)	1.0	mA
p_a max.	0.5	W
V_{k-d1} max.	500	V
V_{k-d1} min.	120	V
*V_{a-d11} max.	300	V
*V_{a-d11} min.	80	V
$V_{d1-d2} \ldots\ldots d10-d11$ max.	300	V
$V_{d1-d2} \ldots\ldots d10-d11$ min.	80	V

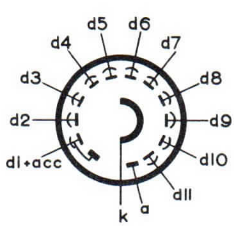
*When calculating the anode voltage, the volt drop across the load resistance should not be overlooked.

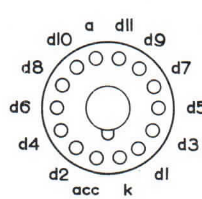
ACCESSORIES

Socket	B8	700	40
Mu-metal shield (cylindrical)			
Length 150±1mm, diameter 130±1mm	56129		

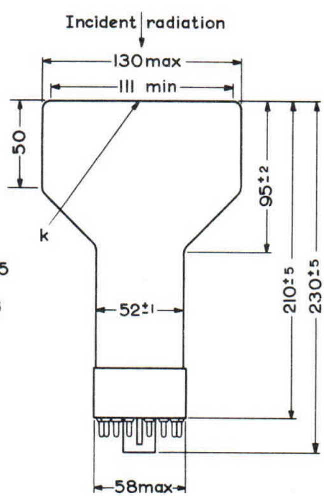
NOTES

It should be noted that the accelerating and focusing electrode has a separate external connection in order to facilitate adjustment for optimum collection of photo-electrons by the first dynode.



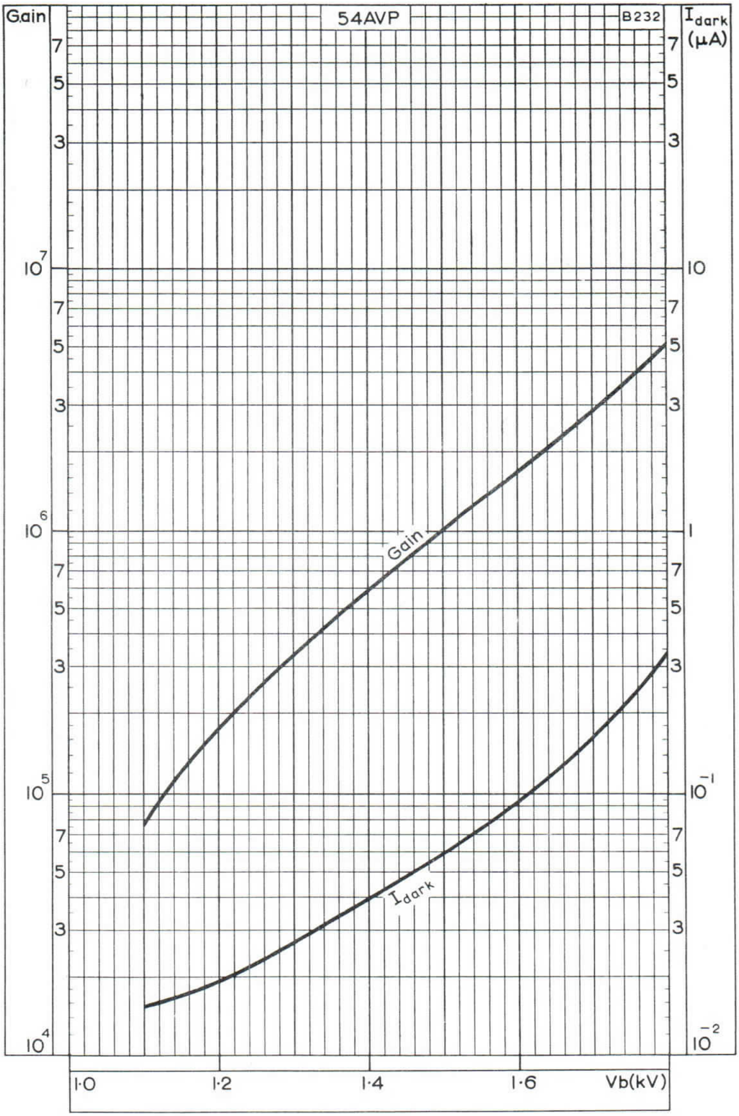


Special 14pin base



All dimensions in mm

B230



GAIN AND DARK CURRENT PLOTTED AGAINST TOTAL VOLTAGE

PHOTOMULTIPLIER TUBE 56AVP

QUICK REFERENCE DATA

14 stage photomultiplier tube for use in nuclear physics where a high degree of time definition or a high time resolution is required (fast coincidence, life of unstable particles, Cerenkov counters.)

Spectral response curve	Type A (S11)	
Photocathode useful diameter	42	mm
Gain (at V_b = 2.2kV)	10^8	
Anode pulse rise time	2.0	ns
Maximum output current for linearity with input light pulse	300	mA

This data should be read in conjunction with OPERATING NOTES-PHOTOMULTIPLIER TUBES

PHOTOCATHODE

Surface	semi-transparent, caesium antimony	
Minimum useful diameter	42	mm
Spectral response curve	Type A (S11)	
Wavelength at maximum response	420 ± 30	nm
*Luminous sensitivity		
Average	65	μA/lm ←
Minimum	45	μA/lm
Average radiant sensitivity at 420nm	55	mA/W ←

*Measured using a tungsten lamp of colour temperature 2854 °K

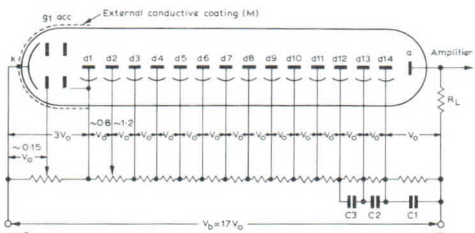
MULTIPLIER SYSTEM

Number of stages	14
Dynode material	silver magnesium oxygen caesium

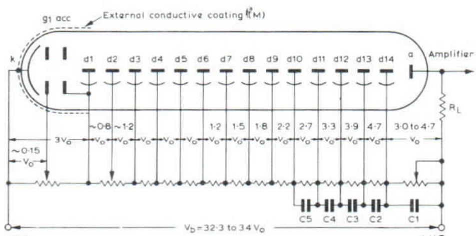
CHARACTERISTICS

With voltage divider A		
Supply voltage for gain = 10^8		←
Average	2.2	kV
Maximum	2.5	kV
Dark current at gain = 10^8 (measured at 25°C)		
Average	0.5	μA ←
Maximum	5.0	μA
Maximum output current for linearity with input light pulse	100	mA
With voltage divider B		
Maximum output current for linearity with input light pulse	300	mA
Anode pulse rise time at V_b = 2.5kV (see note 1)	2.0	ns
Anode pulse width at half height at V_b = 2.5kV (see note 1)	4.0	ns ←
Transit time difference between the centre of the photocathode and the edge at V_b = 2.5kV	$\leq$ 0.5	ns
Total transit time at V_b = 2.5kV (see note 1)	36	ns
Maximum peak current	0.5 to 1.0	A

RECOMMENDED CIRCUITS (see notes 3 to 9) ←



Voltage divider A



Voltage divider B

The voltage between the cathode and the focusing electrode (g1) should be adjusted around $0.15V_o$, the voltage between d1 and d2 should be adjusted around $0.8V_o$.

$C_1 = 100q/V_o$, $C_2 = 100q/3V_o$, $C_3 = 100q/9V_o$, $C_4 = 100q/27V_o$, etc., where q = quantity of electricity transported by the anode.

CAPACITANCES

$c_{g1-(acc+d1)}$	25	pF
c_{a-d14}	7.0	pF
c_{a-all}	9.5	pF

RATINGS (ABSOLUTE MAXIMUM SYSTEM)

V_b max. (see note 2)	2.5	kV ←
I_a max. (continuous operation)	2.0	mA
$V_{k-(acc+d1)}$ max.	800	V
$V_{k-(acc+d1)}$ min.	250	V
V_{g1-k} max.	100	V ←
$V_{d1-d2........d13-d14}$ max.	500	V
$V_{d1-d2........d13-d14}$ min.	80	V
V_{a-d14} max. (see note 3)	500	V
V_{a-d14} min. (see note 3)	80	V

ACCESSORIES (supplied as additional items)

Socket	FE1003
Mu-metal shield (see notes 4 and 10)	56131

NOTES ←

1. For an infinitely short light pulse, fully illuminating the photocathode.
2. Or the voltage at which the tube, when connected as in voltage divider A, has a gain of 10^9, whichever voltage is the lower.
3. When calculating the anode voltage, the voltage drop across the load resistor should not be overlooked.
4. To avoid electric field distortion in the electron optical system the external conductive coating (M, pin no. 18) must be connected to a point whose potential is close to that of the cathode. If the cathode is connected to negative h.t. precautions should be taken to ensure adequate high tension insulation between the external conductive coating and the mu-metal shield.
5. To achieve a stability of about 1% the ratio of the current through the voltage divider bridge to that through the heaviest loaded stage of the tube should be approximately 100. For moderate intensities of radiation a bridge current of about 3mA will be sufficient.

6. The last stages of the tube must be decoupled by means of capacitors to avoid a serious voltage drop on the dynodes. A typical value for C_1 is 2nF. In the case of high counting rates and large peak power output, and to avoid a high tension supply of high power, it is possible to supply the first stages with a high tension of low output power and the last stages with an average voltage of high output.

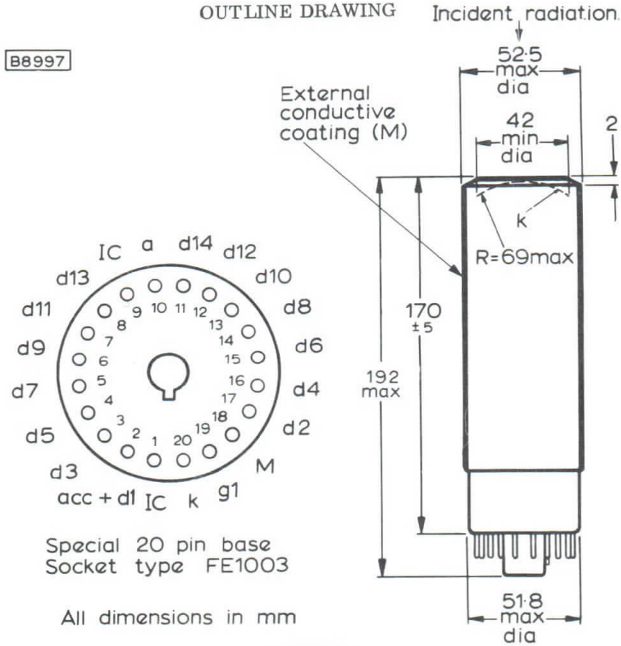
7. The tube is capable of producing very high peak output currents (up to 1A). The output time constant must be very small. Therefore it is necessary, taking into account parasitic capacitances, to use a low load resistance. It is advisable to use a resistance matched coaxial cable. Under these conditions the tube easily delivers pulses of tens of volts, thus rendering an amplifier superfluous.

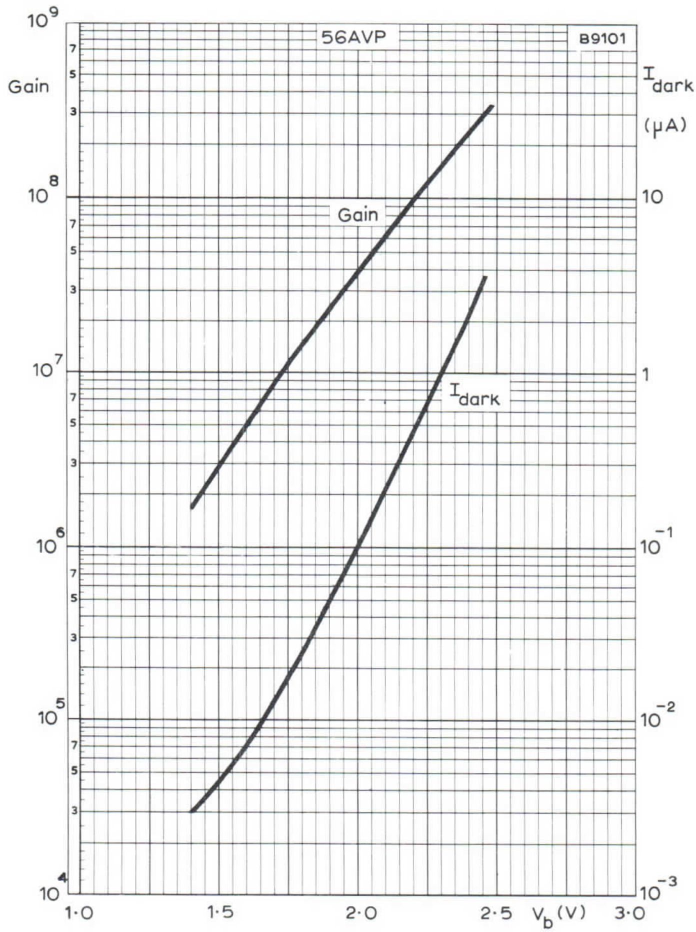
8. In a number of applications it is not necessary for the current to be proportional to the incident luminous flux; such short pulses are needed for time measurements only, and not for spectrography purposes. If, however, it is required at the same time to determine the energy of the incident radiation, it is possible to select a dynode at which the current is proportional to the incident flux. Starting from the anode, the current is divided at each stage by (d-1) where d is the secondary emission factor of the stage (approximately 3.5). It is therefore possible to locate a dynode, the current at which is lower than or equal to the saturation limit of the dynodes.

9. Care should be taken to ensure that the anode voltage is adjusted to its optimum value. It should be noted that for equal supply voltage the gain of the tube is lower for voltage divider B than for voltage divider A.

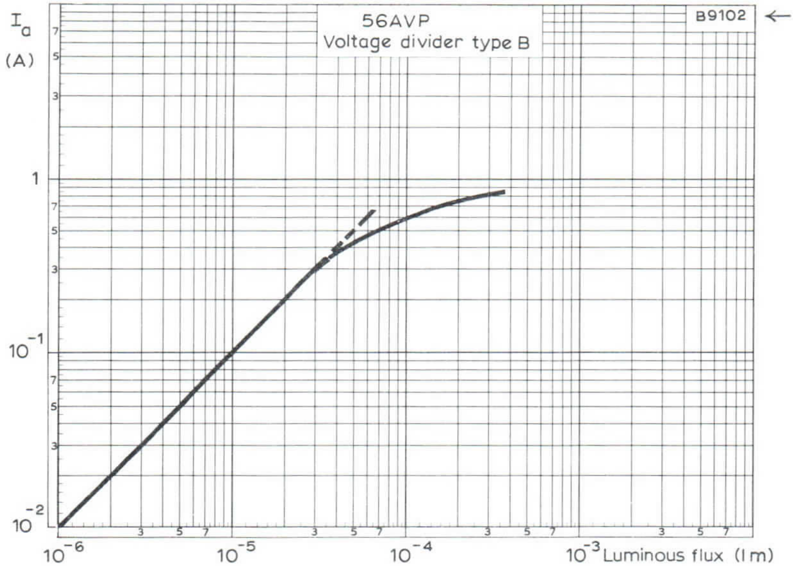
10. It is advisable to screen the tube with a mu-metal cylinder against the influence of magnetic fields.

OUTLINE DRAWING ←





GAIN AND DARK CURRENT PLOTTED AGAINST TOTAL VOLTAGE



ANODE CURRENT PLOTTED AGAINST LUMINOUS FLUX
FOR VOLTAGE DIVIDER B

PHOTOMULTIPLIER TUBE 56CVP

QUICK REFERENCE DATA		
10 stage photomultiplier tube for use in infra-red telecommunication and ranging, and in optical applications where a very fast response is required.		
Spectral response curve	Type C (S1)	
Photocathode useful diameter	42	mm
Anode sensitivity (at V_b = 2.75kV)	100	A/lm

This data should be read in conjunction with
OPERATING NOTES - PHOTOMULTIPLIER TUBES

PHOTOCATHODE

Surface	semi-transparent, caesium on oxidised silver	
Minimum useful diameter	42	mm
Spectral response curve	Type C (S1)	
Wavelength at maximum response	800±100	nm
*Luminous sensitivity		
Average	25	μA/lm
Minimum	15	μA/lm
**Infra-red luminous sensitivity		
Average	3.0	μA/lm
Minimum	1.4	μA/lm
Average radiant sensitivity at 800nm	2.0	mA/W

*Measured using a tungsten lamp of colour temperature 2850°K.

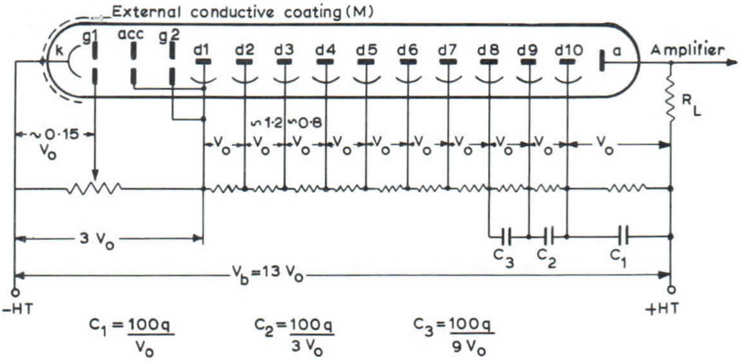
**The infra-red lumen is the flux resulting from one lumen yielded by a tungsten lamp of colour temperature 2850°K passing through an infra-red filter Corning CS94 No. 2450, fusion 1613, thickness 2.61mm.

MULTIPLIER SYSTEM

Number of stages	10
Dynode material	silver magnesium oxygen caesium

CHARACTERISTICS

Overall sensitivity at V_b=2.75kV		
Average	100	A/lm
Minimum	20	A/lm
Maximum dark current at S=20A/lm, and at 25°C.	10	μA



CAPACITANCES

c_{g1-acc}	25	pF
c_{g2-all}	7.0	pF
c_{a-d10}	7.0	pF
c_{a-all}	9.5	pF

RATINGS (ABSOLUTE MAXIMUM SYSTEM)

V_b max.	3.0	kV
I_a max. (continuous operation)	30	µA
V_{k-d1} max.	800	V
V_{k-d1} min.	250	V
V_{g1-k} max.	100	V
V_{g2-d1} max.	100	V
$V_{d1-d2 \cdots\cdots d9-d10}$ max.	500	V
$V_{d1-d2 \cdots\cdots d9-d10}$ min.	80	V
*V_{a-d10} max.	500	V
*V_{a-d10} min.	80	V

*When calculating the anode voltage, the voltage drop across the load resistance should not be overlooked.

ACCESSORIES

Socket	FE1003
Mu-metal shield	56131

OPERATING NOTES

1. To achieve a stability of about 1% the ratio of the current through the voltage divider bridge to that through the heaviest loaded stage of the tube should be approximately 100.

2. For moderate intensities of radiation a bridge current of about 3mA will be sufficient.

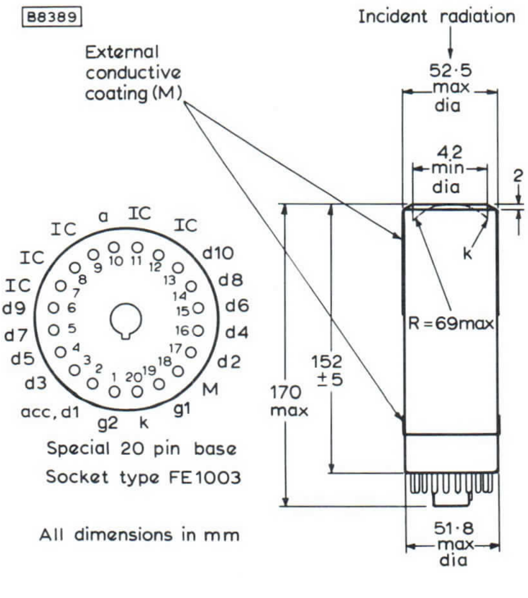
3. The last stages of the tube must be decoupled by means of capacitors to avoid a serious voltage drop on the dynodes. A typical value of C_1 is 2nF.

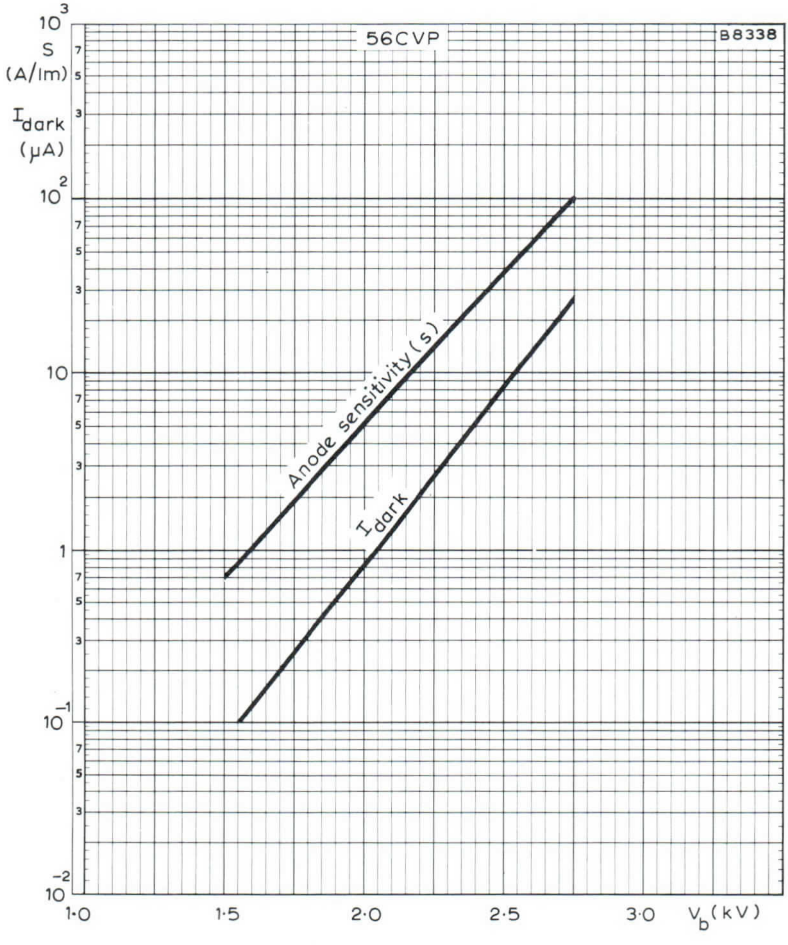
4. It is advisable to screen the tube with a mu-metal cylinder against the influence of magnetic fields.

5. In the case of high counting rates and large peak power output, and to avoid a high tension supply of high power, it is possible to supply the first stages with a high tension of low output power and the last stages with an average voltage of high output.

6. To avoid electric field distortion in the electron optical system, the external conductive coating, M (pin no. 18), must be connected to a point whose potential is close to that of the cathode.

7. If the cathode is connected to negative h.t., precautions should be taken to ensure high tension insulation between the external conductive coating and the mu-metal shield.





ANODE SENSITIVITY AND DARK CURRENT
PLOTTED AGAINST TOTAL VOLTAGE

TENTATIVE DATA

QUICK REFERENCE DATA

14 stage photomultiplier tubes for use in spectrometry and other applications where very low luminous fluxes are to be measured (single photon counting) and liquid scintillation counting of ^{14}C and ^{3}H. The tubes feature a high quantum efficiency and a very good collection efficiency. Very fast characteristics make these tubes particularly useful for fast coincidence measurements with low background noise.

56DUVP The polished optical quartz window extends the response into the ultra-violet region and guarantees a very low background because of the absence of ^{40}K radiation.

56DVP Suitable for detection of soft β-radiation.

56DVP/03 Similar to 56DVP, but features a higher efficiency for single photons.

56DVP/03A Matched pair of 56DVP/03 tubes (see note 11)

Spectral response curve	56DUVP	Type DU	
	56DVP, 56DVP/03	Type D	
Photocathode useful diameter		42	mm
Gain (at V_b = 2.1kV)		10^8	
Anode pulse rise time		2.0	ns
Quantum efficiency (at 400nm)		24	%
Efficiency for single photons (at V_b = 2.1kV)			
	56DUVP, 56DVP	15	%
	56DVP/03	≥20	%
Collection efficiency		80	%

Unless otherwise stated data is applicable to all types

This data should be read in conjunction with
OPERATING NOTES - PHOTOMULTIPLIER TUBES

PHOTOCATHODE

Surface	semi-transparent, potassium caesium antimony		
Minimum useful diameter		42	mm
Spectral response curve	56DUVP	Type DU	
	56DVP, 56DVP/03	Type D	
Wavelength at maximum response		400 ± 30	nm
*Minimum luminous sensitivity		45	μA/lm
Average radiant sensitivity at 400nm		77	mA/W
Average quantum efficiency at 400nm		24	%

*Measured using a tungsten lamp of colour temperature 2854°K

MULTIPLIER SYSTEM

Number of stages	14	
Dynode material	silver magnesium oxygen caesium	

CHARACTERISTICS

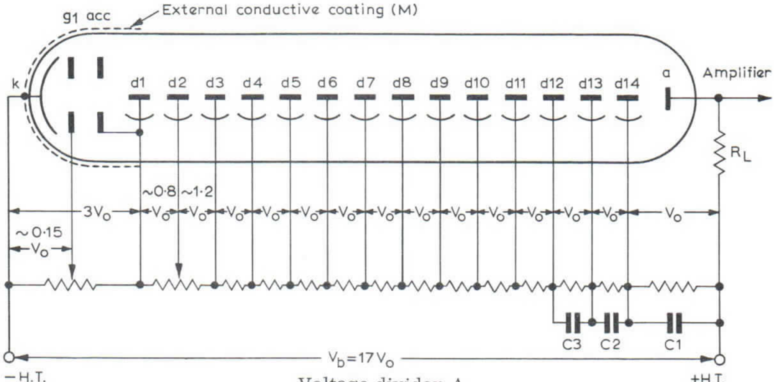
With voltage divider A

Average supply voltage for gain = 10^8		2.1	kV
Dark current at gain = 10^8 (measured at 25°C)			
Average		0.2	μA
Maximum		1.0	μA
Maximum output current for linearity with input light pulse		100	mA
Efficiency for single photons (see note 1)			
56DUVP, 56DVP	average	15	%
56DVP/03	minimum	20	%
Average supply voltage for single photon efficiency of 15% (56DUVP, 56DVP) or 20% (56DVP/03) (see note 3)		2.1	kV
Average background noise at V_b = 2.1kV (measured at 25°C) (see note 1)		600	pulse/s

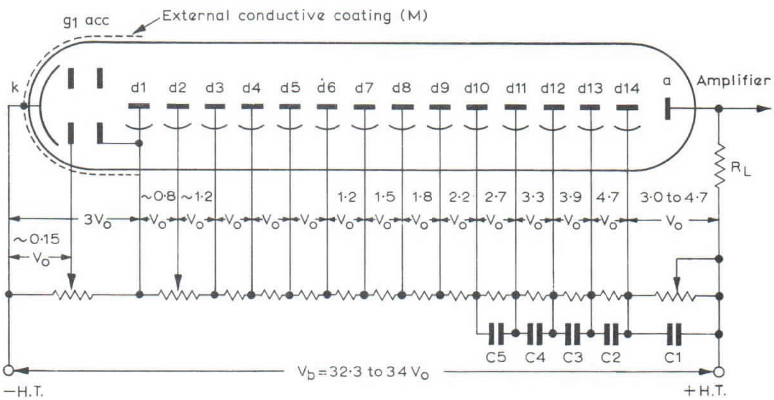
With voltage divider B

Maximum output current for linearity with input light pulse	300	mA
Anode pulse rise time at V_b = 2.5kV (see note 2)	2.0	ns
Anode pulse width at half height at V_b = 2.5kV (see note 2)	4.0	ns
Maximum transit time difference between the centre of the photocathode and the edge at V_b = 2.5kV	0.5	ns
Total transit time at V_b = 2.5kV	36	ns
Maximum peak current	0.5 to 1.0	A

RECOMMENDED CIRCUITS (see notes 4 to 10)



Voltage divider A



Voltage divider B

The voltage between the cathode and the focusing electrode (g1) should be adjusted around $0.15V_o$; the voltage between d1 and d2 should be adjusted around $0.8V_o$.

$C_1 = 100q/V_o$, $C_2 = 100q/3V_o$, $C_3 = 100q/9V_o$, $C_4 = 100q/27V_o$, etc., where

q = quantity of electricity transported by the anode.

CAPACITANCES

$c_{g1-(acc+d1)}$	25	pF
c_{a-d14}	7.0	pF
c_{a-all}	9.5	pF

RATINGS (ABSOLUTE MAXIMUM SYSTEM)

V_b max. (see note 3)	2.5	kV
I_a max. (continuous operation)	0.2	mA
$V_{k-(acc+d1)}$ max.	800	V
$V_{k-(acc+d1)}$ min.	250	V
V_{g1-k} max.	100	V
$V_{d1-d2......d13-d14}$ max.	300	V
$V_{d1-d2......d13-d14}$ min.	80	V
V_{a-d14} max. (see note 4)	500	V
V_{a-d14} min. (see note 4)	80	V

ACCESSORIES (supplied as additional items)

Socket	FE1003
Mu-metal shield (see note 5)	56131

NOTES

1. Measured under the following conditions:

   Threshold at the anode of the photomultiplier = 4.25×10^{-13}C
   Anode coupling capacitor = 10nF
   Anode load resistor = 100kΩ

2. For an infinitely short light pulse, fully illuminating the photocathode.

3. Or the voltage at which the tube, when connected as in voltage divider A, has a gain of 5×10^8, whichever voltage is the lower.

4. When calculating the anode voltage, the voltage drop across the load resistor should not be overlooked.

5. To avoid electric field distortion in the electron optical system the external conductive coating (M, pin no. 18) must be connected to a point whose potential is close to that of the cathode. If the cathode is connected to negative h.t. precautions should be taken to ensure adequate high tension insulation between the external conductive coating and the mu-metal shield.

6. To achieve a stability of about 1% the ratio of the current through the voltage divider bridge to that through the heaviest loaded stage of the tube should be approximately 100.

7. The last stages of the tube must be decoupled by means of capacitors to avoid a serious voltage drop on the dynodes. A typical value for C_1 is 2nF. In the case of large peak power output, and to avoid a high tension supply of high power, it is possible to supply the first stages with a high tension of low output power and the last stages with an average voltage of high output.

NOTES (cont'd)

8. The tube is capable of producing very high peak output currents (up to 1A). The output time constant must be very small. Therefore it is necessary, taking into account parasitic capacitances, to use a low load resistance. It is advisable to use a resistance matched coaxial cable. Under these conditions the tube easily delivers pulses of tens of volts, thus rendering an amplifier superfluous.
9. Care should be taken to ensure that the anode voltage is adjusted to its optimum value. It should be noted that for equal supply voltages the gain of the tube is lower for voltage divider B than for voltage divider A.
10. It is advisable to screen the tube with a mu-metal cylinder against the influence of magnetic fields.
11. A considerable reduction in the background noise can be achieved by means of coincidence measurements. For this purpose matched pairs of 56DVP/03 tubes are available under type number 56DVP/03A. The supply voltages of these tubes are equal within ±15V at a detection efficiency for single photons of 20%, and the product of the values of background noise of both tubes is less than 10^6 at the same voltage.

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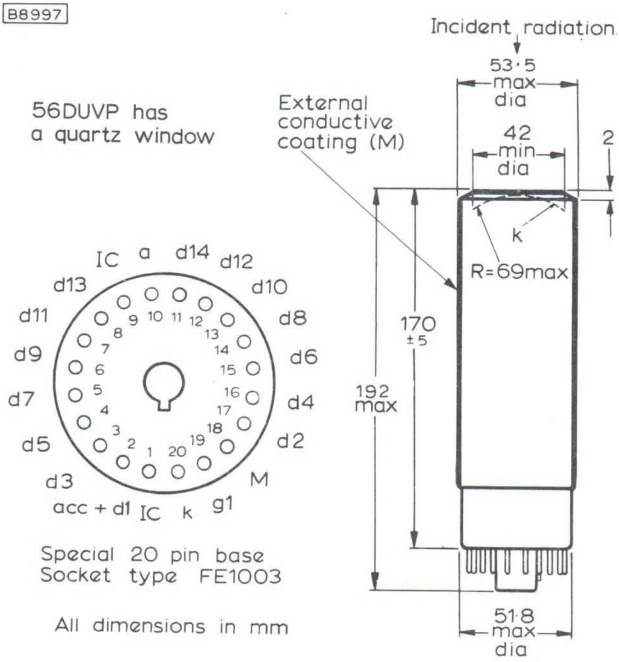
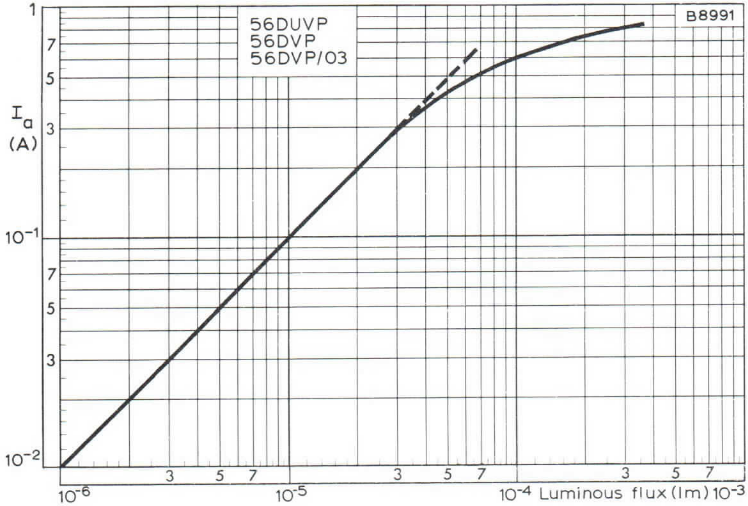
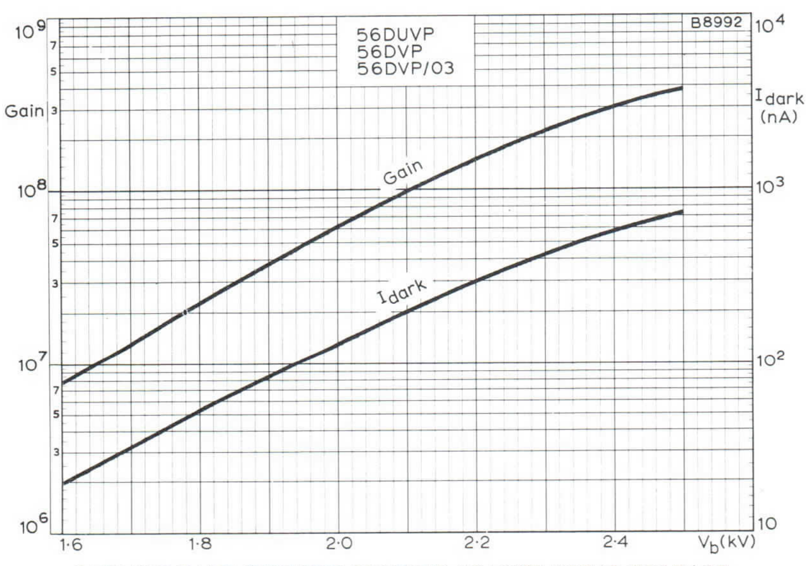


Special 20 pin base
Socket type FE1003

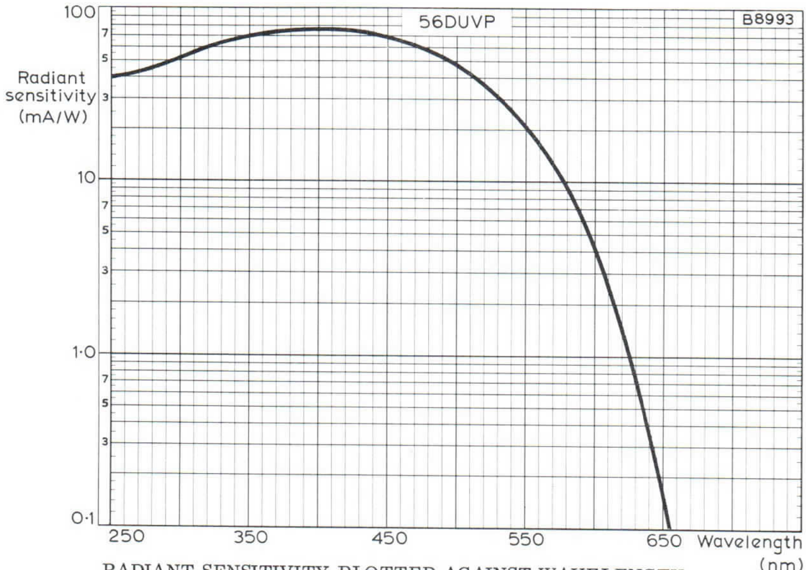
All dimensions in mm



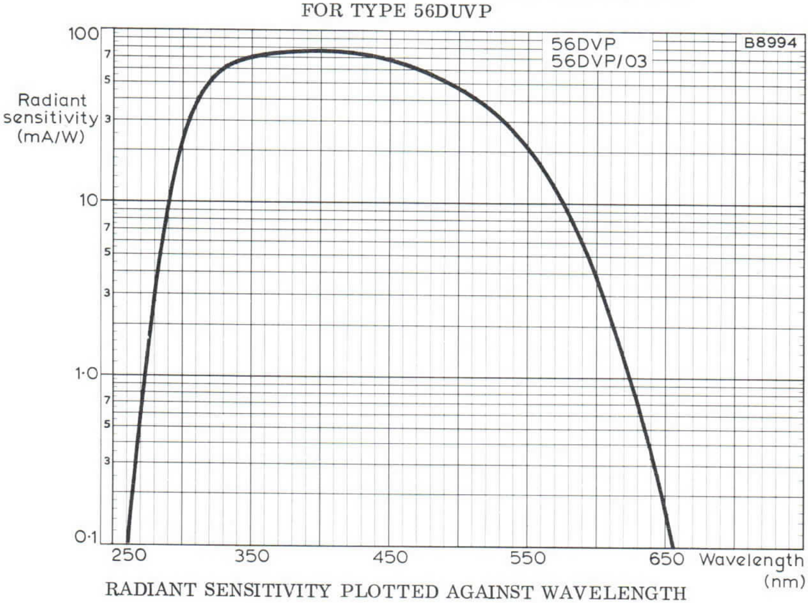
ANODE CURRENT AS A FUNCTION OF LUMINOUS FLUX
FOR VOLTAGE DIVIDER B



GAIN AND DARK CURRENT PLOTTED AGAINST TOTAL VOLTAGE



RADIANT SENSITIVITY PLOTTED AGAINST WAVELENGTH
FOR TYPE 56DUVP



RADIANT SENSITIVITY PLOTTED AGAINST WAVELENGTH
FOR TYPES 56DVP, 56DVP/03

QUICK REFERENCE DATA

56TUVP	14 stage photomultiplier tube with quartz window, intended for use in applications such as telecommunications and ranging, and in optical experiments where a high sensitivity in the whole visible and ultra-violet regions is required, combined with a high degree of time definition.		
56TVP	14 stage photomultiplier tube intended for use in laser applications, working in the orange, yellow and green range.		
Spectral response curve	56TUVP	Type TU (extended S20)	
	56TVP	Type T (S20)	
Photocathode useful diameter		42	mm
Gain (at V_b = 2.5kV)		10^8	

Unless otherwise stated, data is applicable to both types

This data should be read in conjunction with
OPERATING NOTES - PHOTOMULTIPLIER TUBES

PHOTOCATHODE

Surface		semi-transparent, sodium potassium caesium antimony	
Minimum useful diameter		42	mm
Spectral response curve	56TUVP	Type TU (extended S20)	
	56TVP	Type T (S20)	
Wavelength at maximum response		420±30	nm
*Luminous sensitivity			
Average		115	μA/lm
Minimum		90	μA/lm
Average radiant sensitivity at 420nm		65	mA/W
Average radiant sensitivity at 700nm		12	mA/W

*Measured using a tungsten lamp of colour temperature 2850°K.

MULTIPLIER SYSTEM

Number of stages	14	
Dynode material	silver magnesium oxygen caesium	

CHARACTERISTICS

Supply voltage for gain = 10^8		
Average	2.5	kV
Maximum	2.75	kV
*Maximum dark current at gain = 10^8	5.0	μA
Maximum anode pulse amplitude for linearity with input light pulse	100	mA ←

*Measured at 25°C

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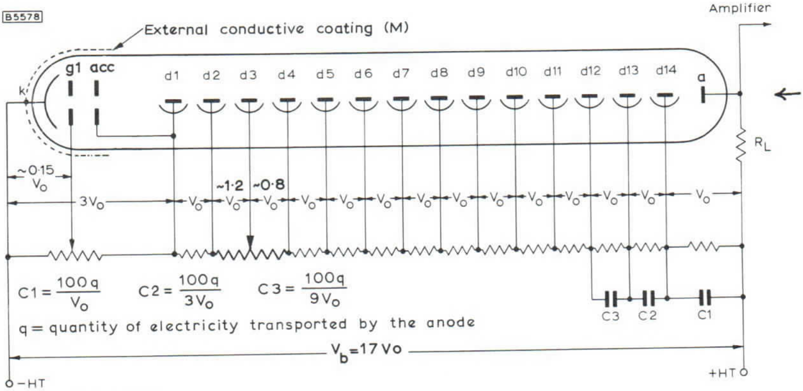


CAPACITANCES ←

$c_{g1-(acc+d1)}$	25	pF
$c_{(acc+d1)-all}$	7	pF
c_{a-d14}	7	pF
c_{a-all}	9.5	pF

RATINGS (ABSOLUTE MAXIMUM SYSTEM)

**V_b max.	2.75	kV
I_a max. (continuous operation)	2.0	mA
V_{k-d1} max.	800	V
V_{k-d1} min.	250	V
V_{k-g1} max.	100	V
V_{d1-d2} .... $_{d13-d14}$ max.	500	V
V_{d1-d2} .... $_{d13-d14}$ min.	80	V
***V_{a-d14} max.	500	V
***V_{a-d14} min.	80	V

**Or the voltage at which the tube, when used in the circuit above, has a gain of 10^9, whichever is the lower.

***When calculating the anode voltage, the voltage drop across the load resistance should not be overlooked.

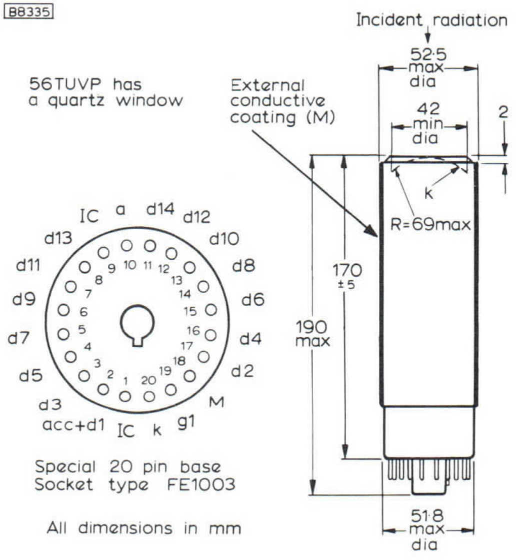
ACCESSORIES (supplied as additional items)

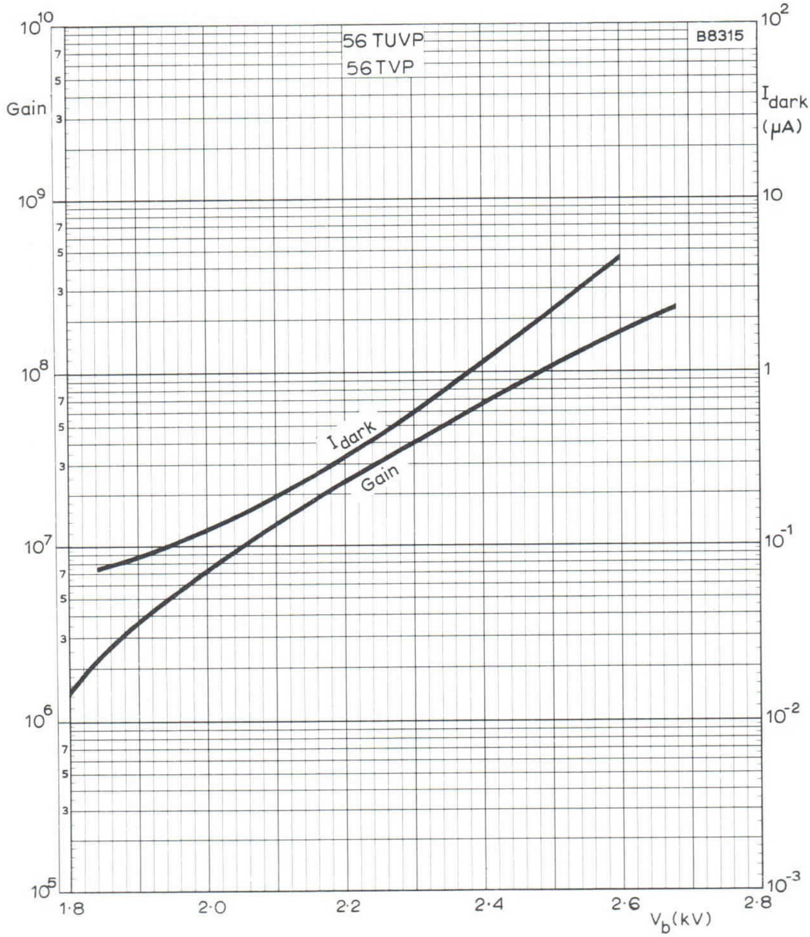
Socket	FE1003
Mu-metal shield	56131

OPERATING NOTES

1. To achieve a stability of about 1% the ratio of the current through the voltage divider bridge to that through the heaviest loaded stage of the tube should be approximately 100.
2. The last stages of the tube must be decoupled by means of capacitors to avoid a serious voltage drop on the dynodes. A typical value of C_1 is 2nF.
3. It is advisable to screen the tube with a mu-metal cylinder against the influence of magnetic fields.
4. In the case of high counting rates and large peak power output, and to avoid a high tension supply of high power, it is possible to supply the first stages with a high tension of low output power and the last stages with an average voltage of high output.
5. To avoid electric field distortion in the electron optical system, the external conductive coating, M (pin no. 18), must be connected to a point whose potential is close to that of the cathode.
6. If the cathode is connected to negative h.t., precautions should be taken to ensure high tension insulation between the external conductive coating and the mu-metal shield.

←





GAIN AND DARK CURRENT PLOTTED AGAINST TOTAL VOLTAGE

PHOTOMULTIPLIER TUBE 57AVP

QUICK REFERENCE DATA		
11 stage photomultiplier tube intended for use in applications such as total body radiation measurements, uranium prospecting with very large scintillators and Cerenkov light measurements in large transparent objects.		
Spectral response curve	type A (S11)	
Photocathode useful diameter	200	mm
Anode sensitivity (at $V_b = 1.8kV$)	250	A/lm

This data should be read in conjunction with
OPERATING NOTES - PHOTOMULTIPLIER TUBES

PHOTOCATHODE

Surface	semi-transparent, caesium antimony	
Spectral response curve	type A (S11)	
Peak spectral response	420 ± 30	nm
Minimum useful diameter	200	mm
*Luminous sensitivity		
Average	50	μA/lm
Minimum	35	μA/lm
Average radiant sensitivity at 420nm	45	mA/W

*Measured using a tungsten lamp of colour temperature 2850°K.

MULTIPLIER SYSTEM

Number of stages	11	
Dynode material	silver magnesium oxygen caesium	

CHARACTERISTICS

VOLTAGE DIVIDER AS IN FIG.1

Overall sensitivity (S) at $V_b = 1.8kV$		
Average	250	A/lm
Minimum	60	A/lm
**Maximum dark current at S = 60A/lm	1.0	μA
Maximum value of anode current at which relationship between peak anode current and luminous flux is linear (at $V_b = 1.8kV$)	30	mA

**Measured at 25°C.

VOLTAGE DIVIDER AS IN FIG.2

Maximum value of anode current at which relationship between peak anode current and luminous flux is linear (at V_b = 2.5kV)	100	mA
Rise time of anode pulse (at V_b = 2.5kV)	5.0	ns
Width at half height of anode pulse (at V_b = 2.5kV)	10	ns
Transit time difference between the centre of the photocathode and the edge (at V_b = 2.5kV)	4.0	ns
Total transit time (at V_b = 2.5kV)	50	ns

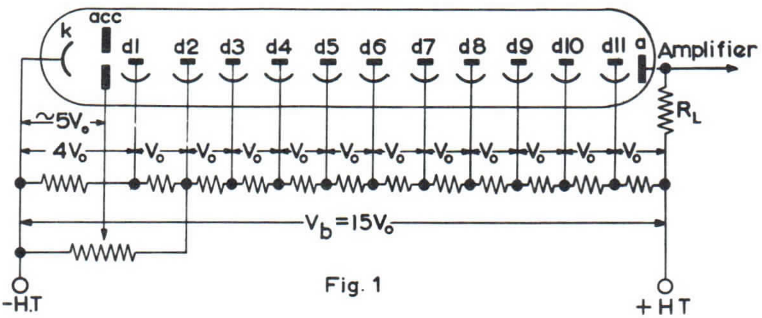


Fig. 1

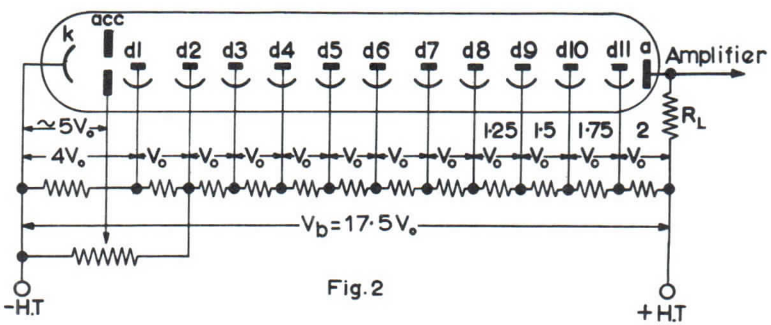


Fig. 2

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CAPACITANCES

c_{a-d11}	3.0	pF
c_{a-all}	5.0	pF

RATINGS (ABSOLUTE MAXIMUM SYSTEM)

V_b max.	2.5	kV
I_a max. (continuous operation)	1.0	mA
V_{k-acc} max.	1.0	kV
V_{k-d1} max.	1.0	kV
V_{k-d1} min.	200	V
$V_{d1-d2 \cdots\cdots\cdots d10-d11}$ max.	300	V
$V_{d1-d2 \cdots\cdots\cdots d10-d11}$ min.	80	V
***V_{a-d11} max.	300	V
***V_{a-d11} min.	80	V

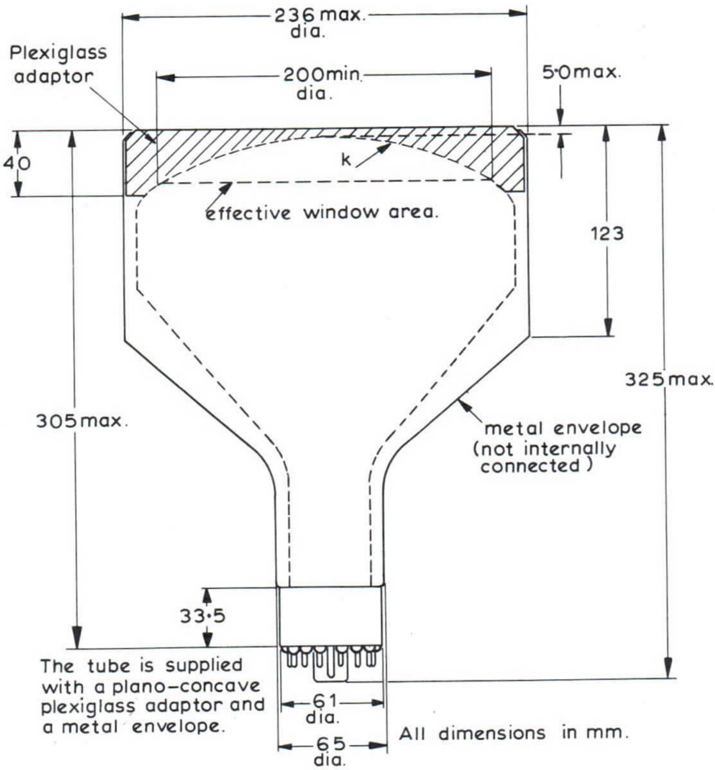
***When calculating the anode voltage, the voltage drop across the load resistance should not be overlooked.

ACCESSORIES (supplied as additional items)

Socket	FE1001
Mu-metal shield	56132

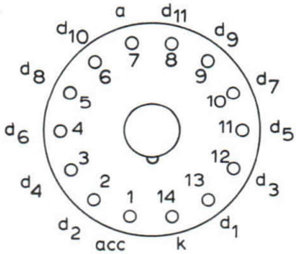
OPERATING NOTES

1. To achieve a stability of about 1% the ratio of the current through the voltage divider bridge to that through the heaviest loaded stage of the tube should be approximately 100.
2. For moderate intensities of radiation a bridge current of about 1mA will be sufficient.
3. Of the voltage dividers shown the highest gain is obtained when the tube is connected as in Fig.1. A higher anode current output with better time characteristics is obtained when the tube is connected as in Fig.2.
4. The accelerating electrode has a separate external connection to allow adjustment for optimum photoelectron collection on the first dynode.
5. In pulse techniques, such as scintillation counting, it is advisable to decouple the last two or three stages by means of capacitors of 100pF and 200pF (the highest value at the last stage).
6. When the tube has been exposed to full daylignt just before mounting it will probably show an increased dark current, which will return to its normal value after several hours of operation.
7. It is advisable to screen the tube with a mu-metal cylinder against the influence of magnetic fields.

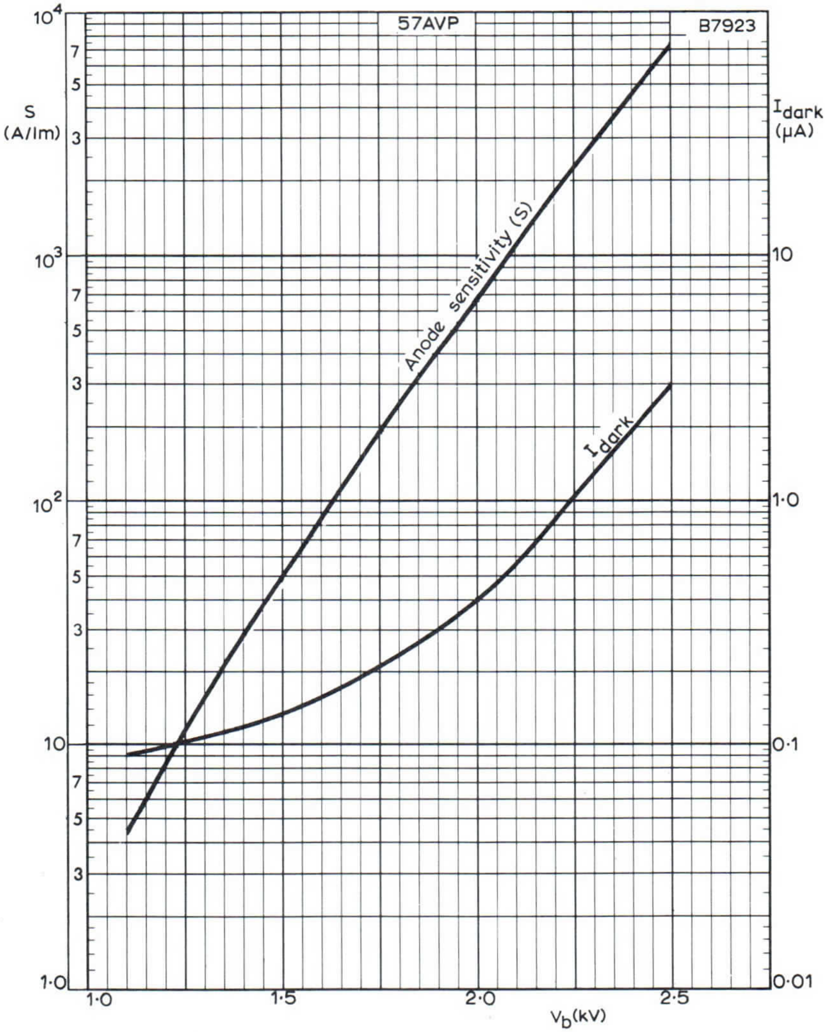


The tube is supplied with a plano-concave plexiglass adaptor and a metal envelope.

All dimensions in mm.



14 Pin base
J.E.D.E.C. B14-38



ANODE SENSITIVITY AND DARK CURRENT PLOTTED AGAINST TOTAL VOLTAGE

PHOTOMULTIPLIER TUBE 58AVP

QUICK REFERENCE DATA		
14 stage photomultiplier tube intended for use in fast coincidence circuits and Cerenkov counters where a high degree of time definition is required. This tube is similar to type XP1040, expect for the window construction.		
Spectral response curve	type A (S11)	
Photocathode useful diameter	110	mm
Anode sensitivity (at V_b = 3.0kV)	7000	A/lm

This data should be read in conjunction with
OPERATING NOTES - PHOTOMULTIPLIER TUBES

PHOTOCATHODE

Surface	semi-transparent, caesium antimony	
Spectral response curve	type A (S11)	
Peak spectral response	420 ± 30	nm
Minimum useful diameter	110	mm
*Luminous sensitivity		
Average	70	μA/lm
Minimum	45	μA/lm
Average radiant sensitivity (at 420nm)	60	mA/W

*Measured using a tungsten lamp of colour temperature 2850°K.

CHARACTERISTICS

VOLTAGE DIVIDER AS IN FIG.1.

Supply voltage for gain = 10^8		
Average	2.4	kV
Maximum	3.0	kV
**Maximum anode dark current at gain = 10^8	12	μA
Maximum value of anode current for which relationship between peak anode current and luminous flux is linear (at V_b = 3.0kV)	100	mA

**Measured at 25°C

VOLTAGE DIVIDER AS IN FIG.2

Maximum value of anode current for which relationship between peak anode current and luminous flux is linear (at $V_b = 3.0kV$)	300	mA
Rise time of anode pulse (at $V_b = 3.0kV$)	2.0	ns
Width at half height of anode pulse (at $V_b = 3.0kV$)	4.0	ns
Transit time difference between the centre of the photocathode and the edge (at $V_b = 3.0kV$)	1.0	ns
Total transit time (at $V_b = 3.0kV$)	45	ns
Maximum peak current	0.5 to 1.0	A

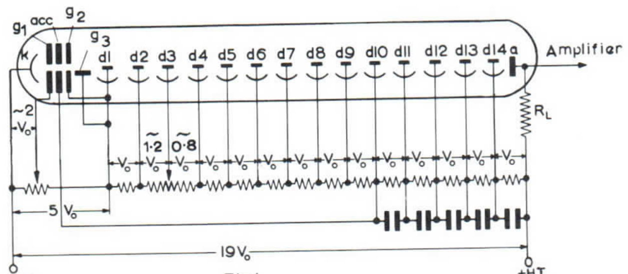


Fig.1

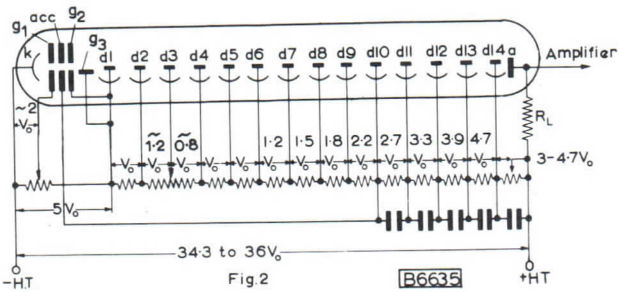


Fig.2

If cathode is connected to negative h.t., precautions should be taken to ensure adequate h.t. insulation between the aquadag shield and the metal envelope or mu-metal shield.

CAPACITANCES

c_{a-d14}	5.0	pF
c_{a-all}	7.0	pF

RATINGS (ABSOLUTE MAXIMUM SYSTEM)

*V_b max.	3.0	kV
I_a max. (continuous operation)	2.0	mA
V_{k-acc} max.	1.8	kV
V_{k-acc} min.	1.4	kV
V_{k-g1} max.	300	V
$V_{k-d1+g2}$ max.	800	V
$V_{k-d1+g2}$ min.	250	V
V_{g3-d1} max.	100	V
**V_{a-d14} max.	500	V
**V_{a-d14} min.	80	V
$V_{d1-d2 \cdots\cdots d13-d14}$ max.	500	V
$V_{d1-d2 \cdots\cdots d13-d14}$ min.	80	V

*Or the voltage at which the tube, when used in the circuit of FIG.1, has a gain of about 10^9, whichever is the lower.

**When calculating the anode voltage, the volt drop across the load resistance should not be overlooked.

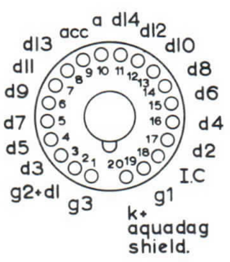
ACCESSORIES (supplied as additional items)

Socket	FE1003
Mu-metal shield	
tube with metal container	56133
tube without metal container	56129

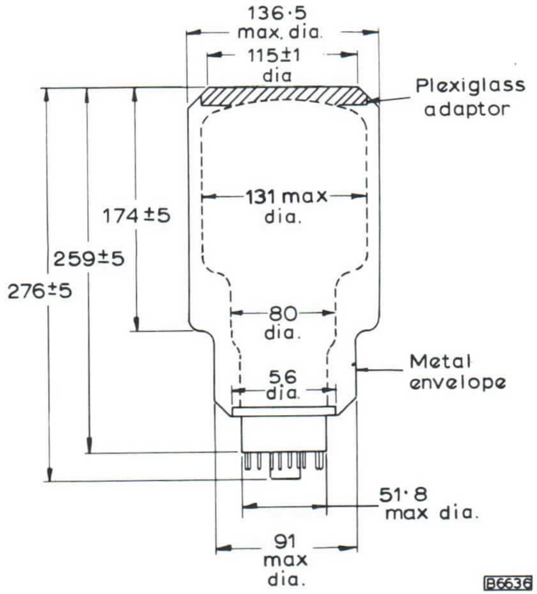
A plano-concave plexiglass adaptor is supplied with the tube for coupling to scintillators.

OPERATING NOTES

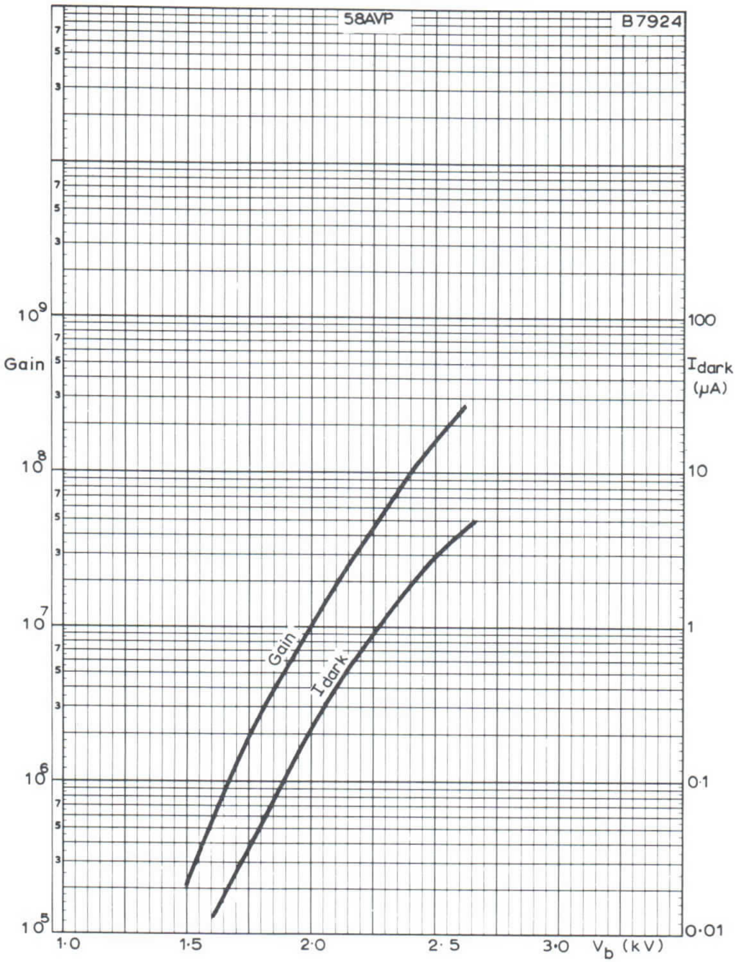
1. To achieve a stability of about 1% the ratio of the current through the voltage divider bridge to that through the heaviest loaded stage of the tube should be approximately 100.
2. For moderate intensities of radiation a bridge current of about 3mA will be sufficient.
3. When pulses of high amplitude are taken from the anode, it is useful to decouple the last stages as indicated in the circuit by means of capacitors of a few hundred pF, to avoid a voltage drop between these stages.
4. When the tube has been exposed to full daylight just before mounting, it will probably show an increased dark current, which will return to its normal value after several hours of operation.
5. It is advisable to screen the tube with a mu-metal cylinder against the influence of magnetic fields.
6. In the case of high counting rates and large peak power outputs, and to avoid a high tension supply of large power it is possible to supply the first stages with a h.t. of small output current and the end stages with an average value of h.t.
7. The voltage divider in Fig.1 has the higher gain, while a higher anode current output with better time characteristics can be obtained when the tube is connected as in Fig. 2.



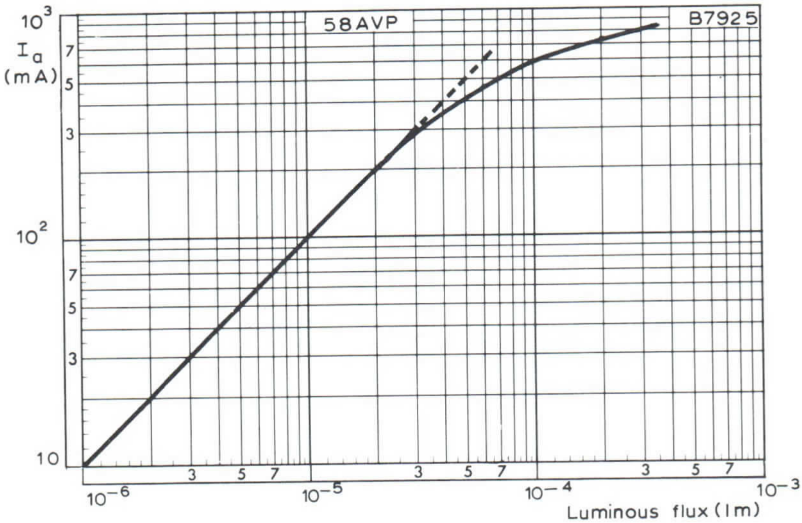
Special 20pin base



All dimensions in mm.



GAIN AND DARK CURRENT
AS A FUNCTION OF TOTAL VOLTAGE



ANODE CURRENT AS A FUNCTION OF LUMINOUS FLUX

150AVP
150UVP

QUICK REFERENCE DATA

10 stage photomultiplier tubes intended for use in scintillation counting and flying-spot scanner applications and various kinds of optical and industrial instruments.

Overall diameter	39.5	mm
Photocathode diameter	32	mm
Overall sensitivity (at $V_b = 1.8kV$)	1250	A/lm
Maximum dark current (at S = 60A/lm)	0.05	μA

The 150AVP and the 150UVP are identical except for spectral response. 150AVP is particularly suitable for daylight and radiation having a blue predominance. 150UVP has a quartz window and is predominantly sensitive to ultraviolet radiation.

This data should be read in conjunction with
'OPERATING NOTES—PHOTOMULTIPLIER TUBES.'

PHOTOCATHODE

Surface	caesium antimony	
Peak spectral response		
150AVP	0.42 ± 0.03	μm
150UVP	0.40 ± 0.03	μm
Minimum useful diameter	32	mm
Minimum cathode area	8	cm^2
*Luminous sensitivity		
Average	60	μA/lm
Minimum	35	μA/lm
Average radiant sensitivity (at peak spectral response)	50	mA/W
Maximum dark current (at $T_{amb} = 25°C$)	10^{-15}	A/cm^2

*Measured using a lamp of colour temperature 2850 °K.

150AVP
150UVP

PHOTOMULTIPLIER TUBES

CHARACTERISTICS

Overall sensitivity (at V_b = 1.8kV)		
Average	1250	A/lm
Minimum	100	A/lm
Maximum dark current (at S = 60A/lm)	0.05	μA
Maximum value of anode current at which relationship between peak anode current and luminous flux is linear (at V_b = 1.8kV)		
At high gain distribution as shown in fig. 1	30	mA
At high current distribution as shown in fig. 2	100	mA

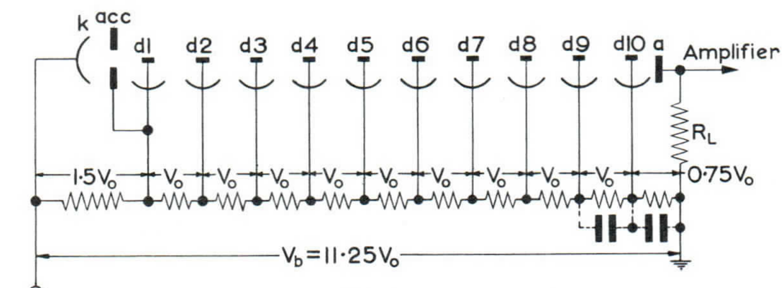


Fig. 1

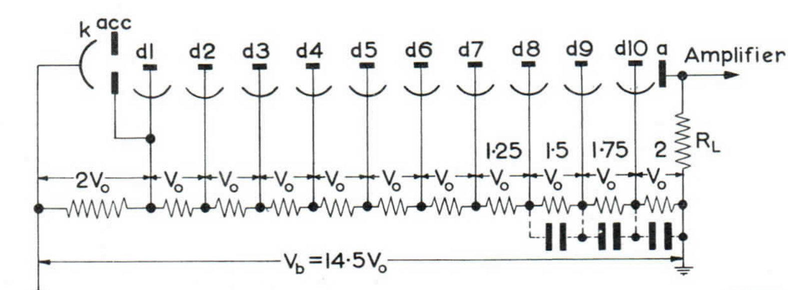


Fig. 2

CAPACITANCES

c_{a-d10}	3	pF
c_{a-a11}	5	pF

MOUNTING POSITION

Any

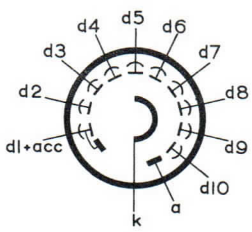
ABSOLUTE MAXIMUM RATINGS

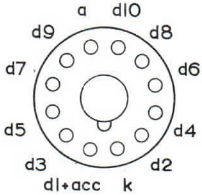
V_b max.	1.8	kV
I_a max. (continuous operation)	1.0	mA
p_a max.	0.5	W
V_{k-d1} max.	500	V
V_{k-d1} min.	120	V
*V_{a-d10} max.	300	V
*V_{a-d10} min.	80	V
$V_{d1-d2 \ldots\ldots d9-d10}$ max.	300	V
$V_{d1-d2 \ldots\ldots d9-d10}$ min.	80	V

*When calculating the anode voltage, the volt drop across the load resistance should not be overlooked.

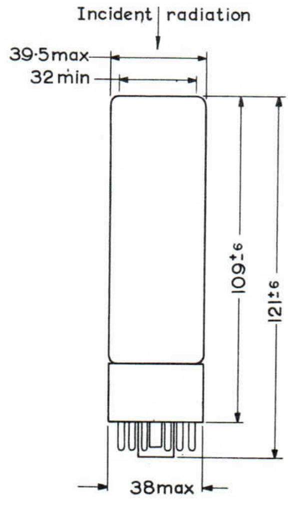
ACCESSORIES

Socket	B8 700 42
Mu-metal shield (cylindrical)	
Length 90±1mm, diameter 42^{+1}_{-0}mm	56127



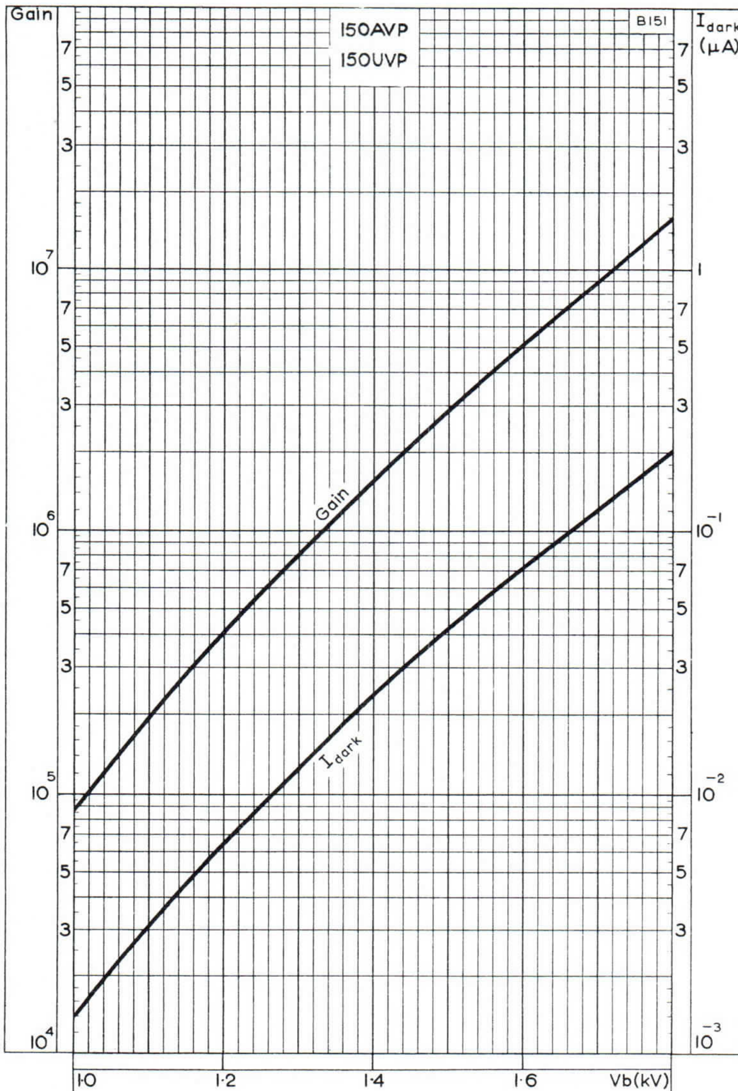


Special 12pin base

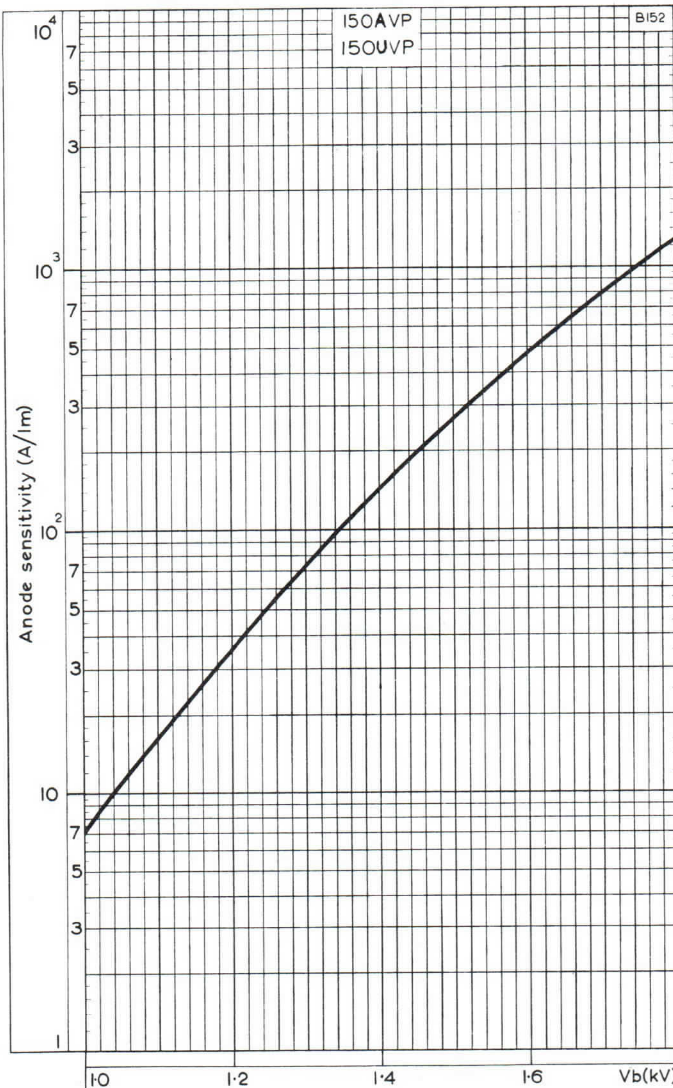


All dimensions in mm

B143



GAIN AND DARK CURRENT PLOTTED AGAINST TOTAL VOLTAGE



ANODE SENSITIVITY PLOTTED AGAINST TOTAL VOLTAGE

PHOTOMULTIPLIER TUBE 150CVP

QUICK REFERENCE DATA		
10 stage photomultiplier tube with semi-transparent cathode, particularly sensitive to daylight and to radiation having a red predominance. Designed for end-on incidence of illumination and having optically flat and parallel surfaces.		
Spectral response curve	type C (S1)	
Photocathode useful diameter	32	mm
Anode sensitivity (at 1.8kV)	100	A/lm

This data should be read in conjunction with
OPERATING NOTES - PHOTOMULTIPLIER TUBES

PHOTOCATHODE

Surface	semi-transparent, caesium on oxidised silver	
Minimum useful diameter	32	mm
Spectral response curve	type C (S1)	
Peak spectral response	800 ± 100	nm
Minimum cathode area	8.0	cm^2
*Luminous sensitivity		
Average	25	μA/lm
Minimum	15	μA/lm
Average radiant sensitivity (at 800nm)	2.5	mA/W

*Measured using a tungsten lamp of colour temperature 2850°K.

MULTIPLIER SYSTEM

Number of stages	10	
Dynode material	silver magnesium oxygen caesium	

CHARACTERISTICS

VOLTAGE DIVIDER AS IN FIG.1

Overall sensitivity at V_b = 1.8kV		
Average	100	A/lm
Minimum	20	A/lm
**Maximum dark current at S = 20A/lm	10	μA
Maximum value of anode current at which relationship between peak anode current and luminous flux is linear (at V_b = 1.8kV)	5.0	mA

**Measured at 25°C.

VOLTAGE DIVIDER AS IN FIG.2

Maximum value of anode current at which relationship between peak anode current and luminous flux is linear (at $V_b = 1.5kV$)	100	mA
Rise time of anode pulse (at $V_b = 1.5kV$)	4.0	ns
Transit time difference between the centre of the photocathode and the edge (at $V_b = 1.5kV$)	3.0	ns
Total transit time (at $V_b = 1.5kV$)	36	ns

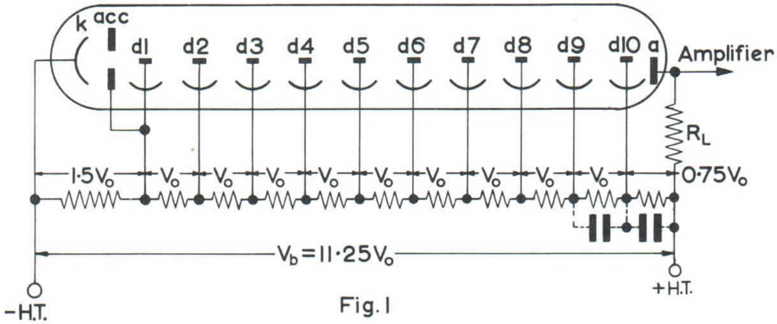


Fig.1

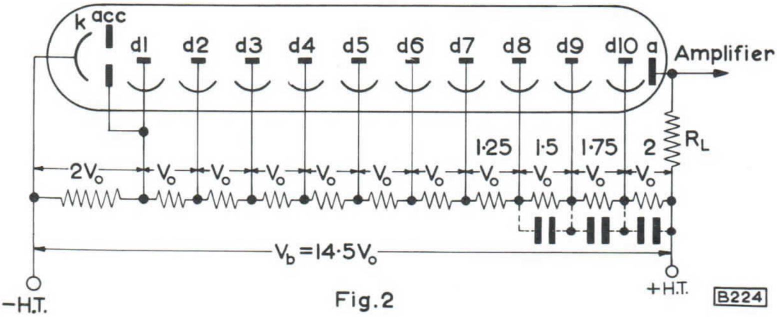


Fig.2

B224

CAPACITANCES

c_{a-d10}	3.0	pF
c_{a-all}	5.0	pF

RATINGS (ABSOLUTE MAXIMUM SYSTEM)

V_b max.	1.8	kV
I_a max. (continuous operation)	30	μA
V_{k-d1} max.	500	V
V_{k-d1} min.	120	V
$V_{d1-d2 \cdots\cdots d9-d10}$ max.	300	V
$V_{d1-d2 \cdots\cdots d9-d10}$ min.	80	V
***V_{a-d10} max.	300	V
***V_{a-d10} min.	80	V

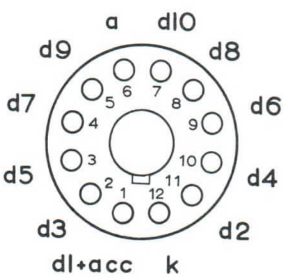
***When calculating the anode voltage, the voltage drop across the load resistance should not be overlooked.

ACCESSORIES (supplied as additional items)

Socket	FE1002
Mu-metal shield	56127

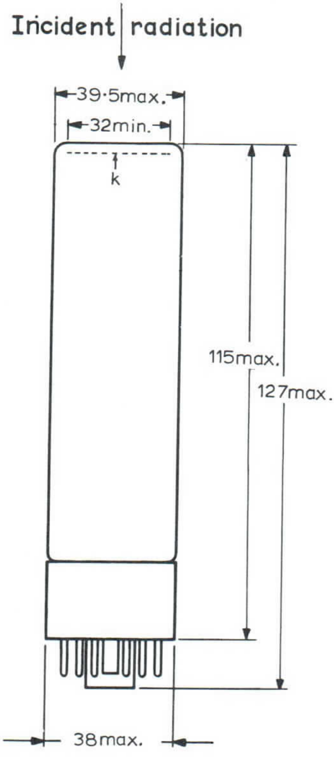
OPERATING NOTES

1. To achieve a stability of about 1% the ratio of the current through the voltage divider bridge to that through the heaviest loaded stage of the tube should be approximately 100.
2. For moderate intensities of radiation a bridge current of 0.5mA to 1.0mA will be sufficient.
3. When pulses with high amplitudes are taken from the anode, it is useful to decouple the last stages as indicated in the circuit by means of capacitors of a few hundred pF, to avoid a voltage drop between these stages.
4. When the tube has been exposed to full daylight just before mounting, it will probably show an increased dark current, which will return to its normal value after several hours of operation.
5. It is advisable to screen the tube with a mu-metal cylinder against the influence of magnetic fields.
6. Of the voltage dividers shown the highest gain is obtained at a given total voltage when the tube is connected as in FIG.1. A higher anode current output with better time characteristics is obtained when the tube is connected as in FIG.2 with the same total voltage but the overall gain is less.

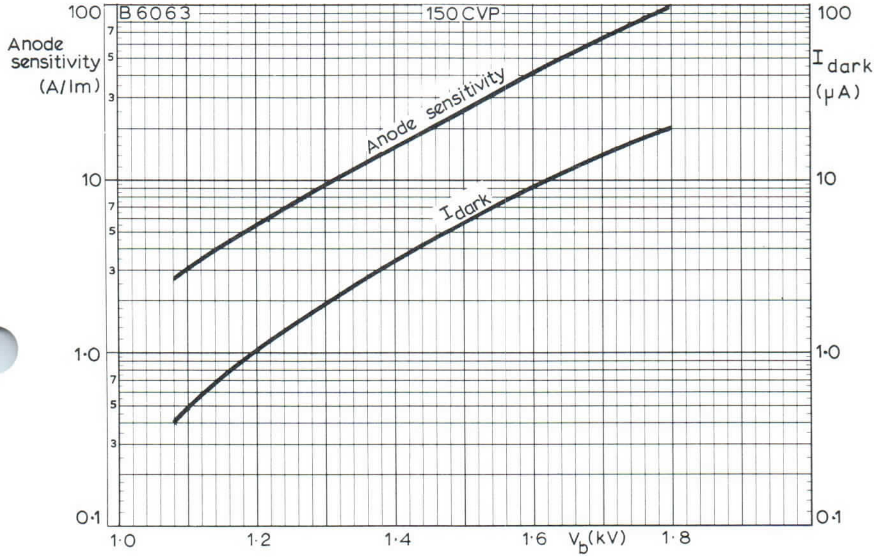


B12A base

All dimensions in mm



B6611



ANODE SENSITIVITY AND DARK CURRENT PLOTTED AGAINST TOTAL VOLTAGE

PHOTOMULTIPLIER TUBE

153AVP

QUICK REFERENCE DATA

11 stage photomultiplier tube intended for use in gamma ray spectrometry. This tube has a guaranteed energy resolution of less than 9% for 0.661MeV caesium 137 gamma radiation.

Overall diameter	57	mm
Photocathode diameter	44	mm
Overall sensitivity (at $V_b = 1.8kV$)	4500	A/lm
Maximum dark current (at S = 60A/lm)	0.05	μA

This data should be read in conjunction with
'OPERATING NOTES—PHOTOMULTIPLIER TUBES.'

PHOTOCATHODE

Surface	caesium antimony	
Peak spectral response	0.42 ± 0.03	μm
Minimum useful diameter	44	mm
Minimum cathode area	15.2	cm^2
*Luminous sensitivity		
Average	70	μA/lm
Minimum	50	μA/lm
Average radiant sensitivity (at 0.42μm)	55	mA/W
Maximum dark current (at $T_{amb} = 25°C$)	10^{-15}	A/cm^2

*Measured using a lamp of colour temperature 2850°K.

153AVP

PHOTOMULTIPLIER TUBE

CHARACTERISTICS

Overall sensitivity (at $V_b = 1.8kV$)		
Average	4500	A/lm
Minimum	100	A/lm
Maximum dark current (at $S = 60A/lm$)	0.05	µA
Resolution (for 0.661 MeV caesium 137 gamma radiation)		
Average	8.5	%
Maximum	9.0	%
Maximum value of anode current at which relationship between peak anode current and luminous flux is linear (at $V_b = 1.8kV$)		
At distribution as shown in fig. 1	30	mA

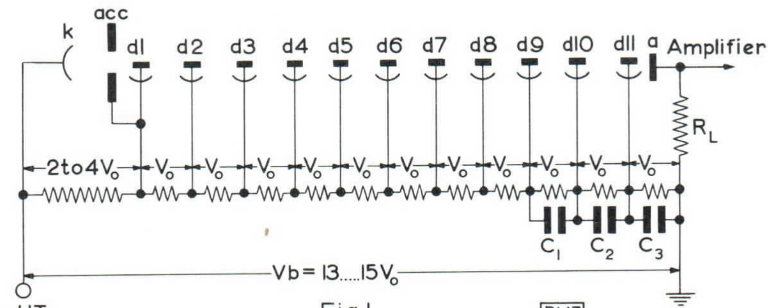


Fig.1

CAPACITANCES

c_{a-d11}	3	pF
c_{a-a11}	5	pF

MOUNTING POSITION

Any

PHOTOMULTIPLIER TUBE 153AVP

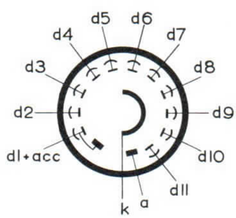
ABSOLUTE MAXIMUM RATINGS

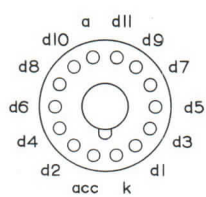
V_b max.	1.8	kV
I_a max. (continuous operation)	1.0	mA
p_a max.	0.5	W
V_{k-d1} max.	500	V
V_{k-d1} min.	200	V
*V_{a-d11} max.	300	V
*V_{a-d11} min.	80	V
$V_{d1-d2} \ldots\ldots V_{d10-d11}$ max.	300	V
$V_{d1-d2} \ldots\ldots V_{d10-d11}$ min.	80	V

*When calculating the anode voltage, the volt drop across the load resistance should not be overlooked.

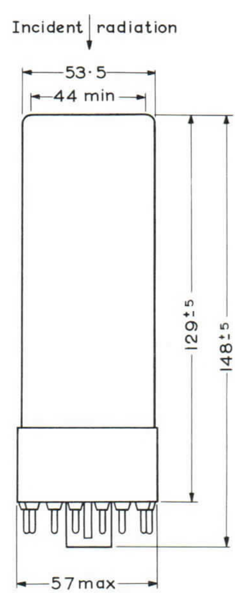
ACCESSORIES

Socket	B8 700 40
Mu-metal shield (cylindrical)	
Length 90 ± 1mm, diameter 57^{+1}_{-0}mm	56128



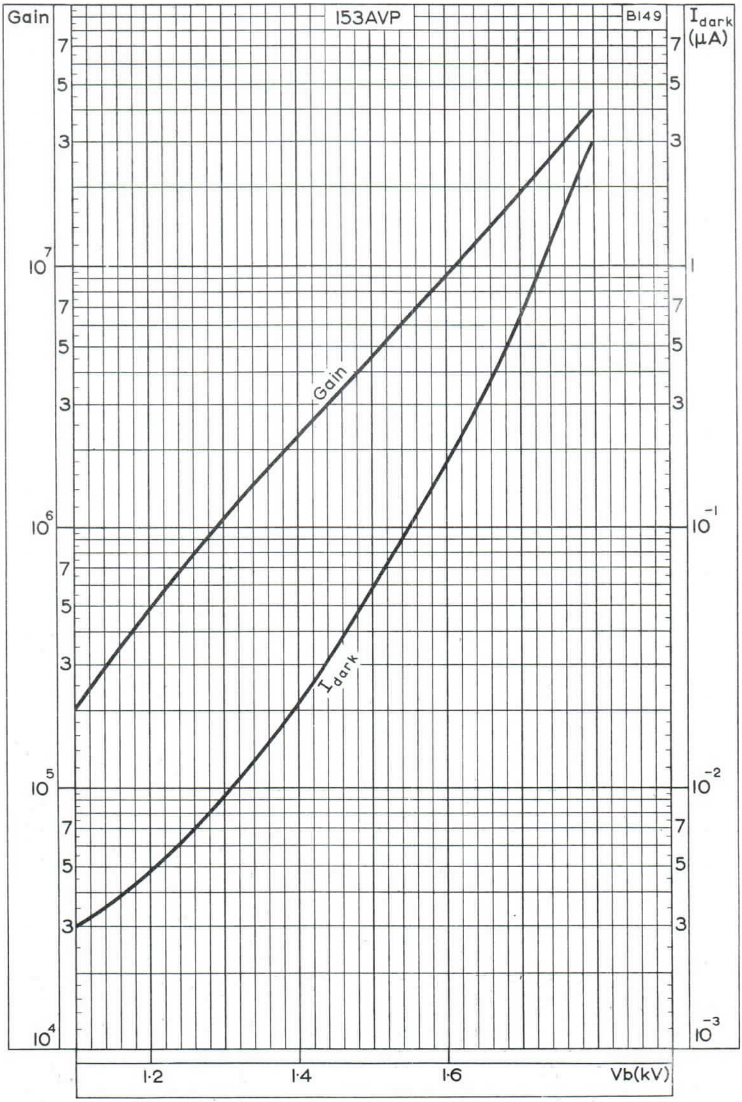


Special 14pin base

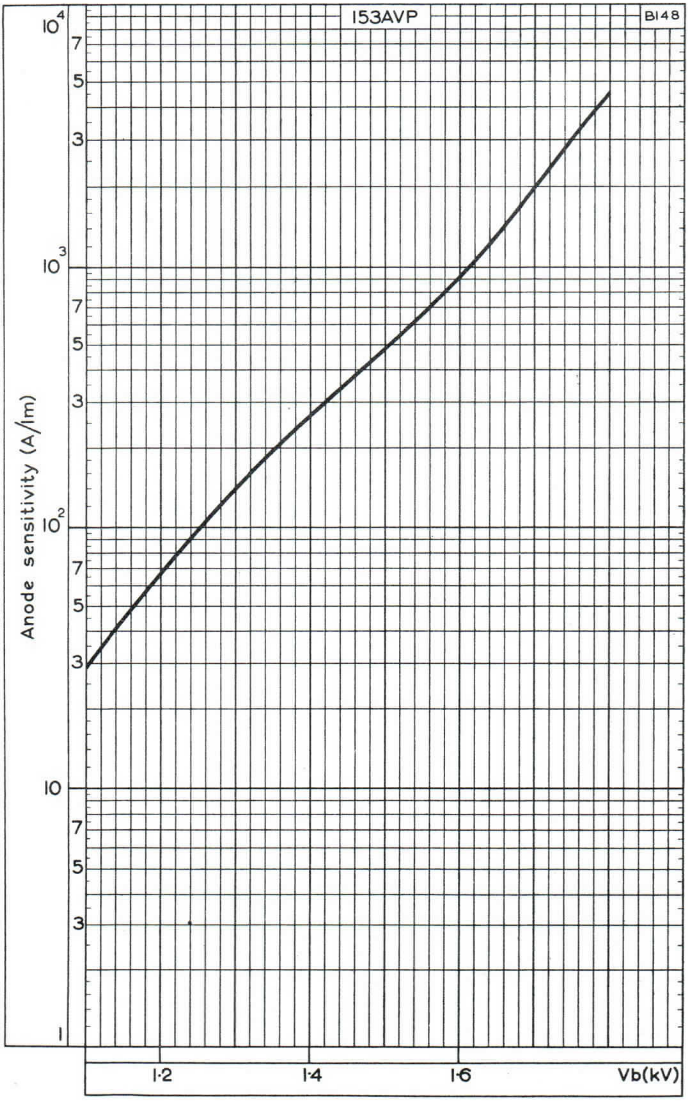


All dimensions in mm

B227



GAIN AND DARK CURRENT PLOTTED AGAINST TOTAL VOLTAGE



ANODE SENSITIVITY PLOTTED AGAINST TOTAL VOLTAGE

IMAGE CONVERTER TUBES

Diode image converter tube primarily intended for high speed sweep photography or as a diode shutter tube.

ME1200AA
ME1200AG

This data should be read in conjunction with GENERAL OPERATIONAL RECOMMENDATIONS—IMAGE CONVERTERS included in this section of the handbook.

PHOTOCATHODE

Type: Caesium antimony, blue sensitive with low resistance for pulse operation.

In tubes primarily intended for pulse operation where large peak emission currents are required, the transverse resistance of the layer must be kept low compared with the values obtained in normal semi-transparent caesium antimony types. In a high resistance cathode, sensitivities of the order of 60μA/lm can be obtained, but the inclusion of inactive conductive material lowers this figure to 20μA/lm.

The cathode sensitivities quoted are measured with a tungsten lamp of colour temperature 2700°K.

Effective photocathode diameter	30	mm

LUMINESCENT SCREEN

Two types of screen are in normal use, the type being indicated by the second letter after the type number,

Screen type	A	G	
Colour	Blue	Green	
Energy efficiency (approx.)	15	7.0	%
Decay time to 1/e (37%) after 10^{-7} second excitation	20×10^{-6}	10×10^{-3}	s
Resolution	25	25	lines/mm
Maximum screen diameter	117	117	mm

CAPACITANCE

c_{a-k}	50	pF

CHARACTERISTICS

*Photocathode sensitivity	20	μA/lm
V_a	6.0	kV
V_k	0	V
Linear magnification	2.5 to 4.0	
Focusing ampere turns for 2nd focus with specified coil	4000	
†Picture resolution	250	lines/cm

*Measured with a lamp of colour temperature 2700°K.

†A picture resolution of 250 lines/cm means that an image of 250 lines alternately black and white of equal width can be viewed in 1cm on the screen. With a linear magnification of 4 times, this means an image detail of 1000 lines/cm on the photocathode.

VARIATION OF MAGNIFICATION AND ROTATION OF IMAGE

With the specified coil, V_a = 6.0kV and 'D' = 42mm (see page D4)

Focus	Focus current (mA)	Magnification	Angle of rotation (degrees)
I	126	2.4	15
II	270	4.0	9.2

LIMITING VALUES (absolute ratings)

V_{a-k} max.	6.0	kV
*Photocathode current density max.	0.05	μA/cm^2
$T_{ambient}$ max.	50	°C

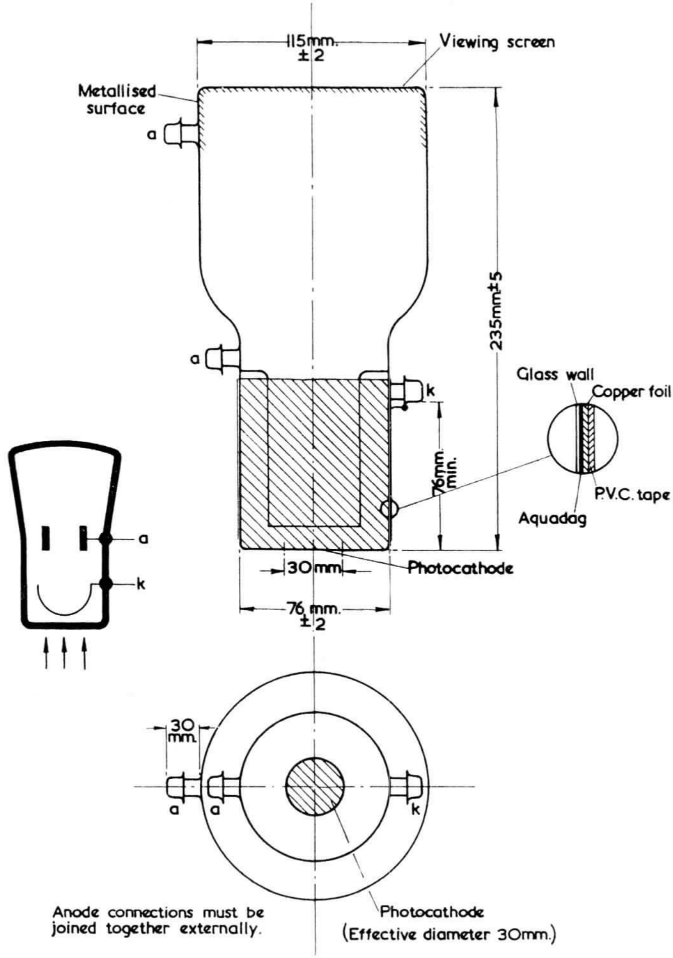
*With short pulse operation the upper limit to photo-emission current is not set by factors of damage to the cathode. If the sensitive layer suffers a slight overload, electron optical distortion will occur, but no damage to the cathode need result.

EXTERNAL CONDUCTIVE COATING

An external metallised coating connected to the cathode surrounds the outer wall of this tube. It is essential that the copper foil connection between this metallising and the cathode terminal should not be broken.

If the cathode is not operated at earth potential, care must be taken to maintain insulation of the cathode from the focusing coil.

ME1200AA
ME1200AG

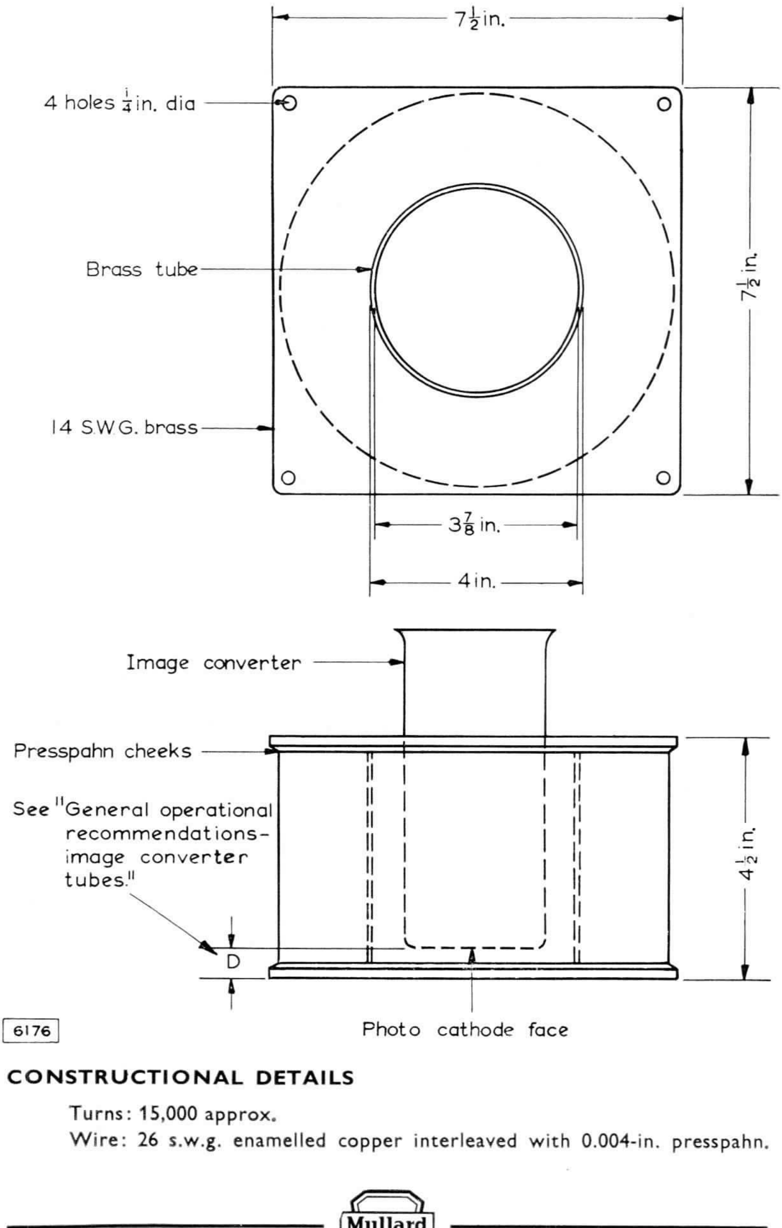


Anode connections must be joined together externally.

836

ME1200AA
ME1200AG

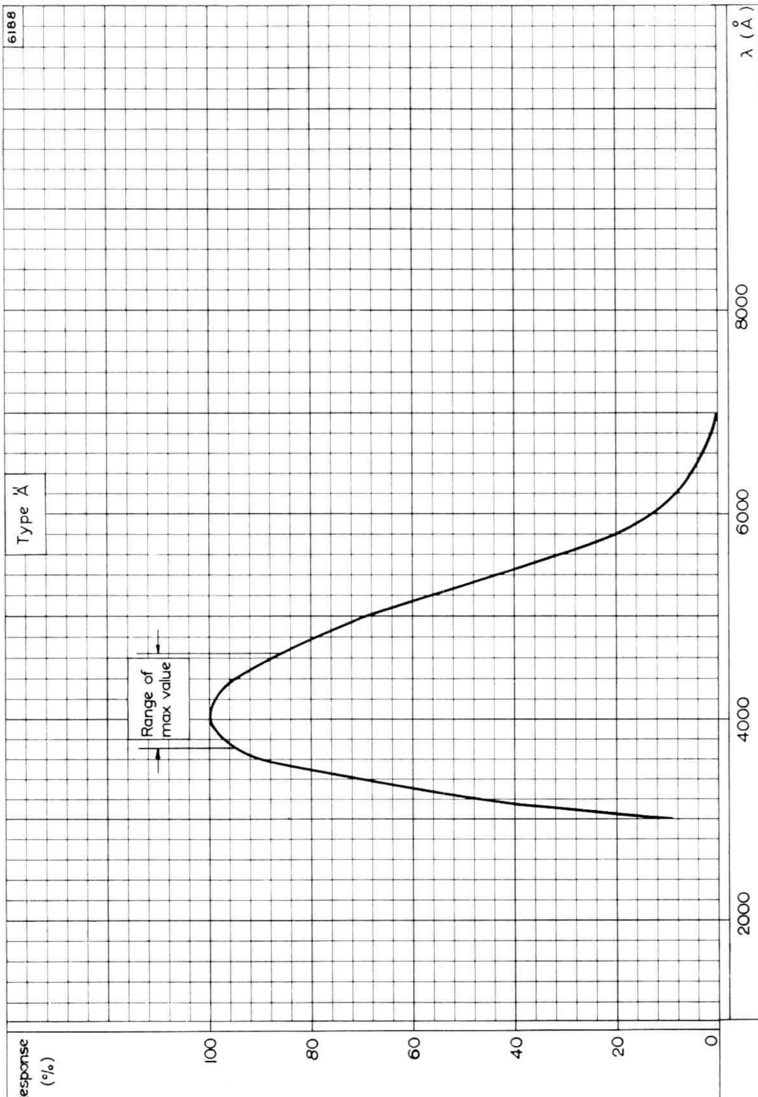
IMAGE CONVERTER TUBE



6176

CONSTRUCTIONAL DETAILS

Turns: 15,000 approx.
Wire: 26 s.w.g. enamelled copper interleaved with 0.004-in. presspahn.



RELATIVE SPECTRAL ENERGY DISTRIBUTION CURVE FOR TYPE 'A' LUMINESCENT SCREEN

IMAGE CONVERTER TUBE

ME1201AA
ME1201AG

Triode image converter tube for high speed pulse operation or as a diode shutter tube with grid and anode strapped.

This data should be read in conjunction with GENERAL OPERATIONAL RECOMMENDATIONS – IMAGE CONVERTERS included in this section of the handbook.

PHOTOCATHODE

Type A:—Caesium antimony, blue sensitive with low resistance for pulse operation.

In tubes primarily intended for pulse operation where large peak emission currents are required, the transverse resistance of the layer must be kept low compared with the values obtained in normal semi-transparent caesium antimony types. In a high resistance cathode, sensitivities of the order of 60μA/lm can be obtained, but the inclusion of inactive conductive material lowers this figure to 20μA/lm.

The cathode sensitivities quoted are measured with a tungsten lamp of colour temperature 2700°K.

Effective photocathode diameter	25	mm

LUMINESCENT SCREEN

Two types of screen are in normal use, the type being indicated by the second letter after the type number.

Screen type	A	G	
Colour	Blue	Green	
Energy efficiency (approx.)	15	7.0	%
Decay time at 1/e (37%) after 10^{-7} second excitation	20×10^{-6}	10×10^{-3}	s
Resolution	25	25	lines/mm
Maximum screen diameter	117	117	mm

CAPACITANCES

c_{a-g}	4.0	pF
c_{a-k}	3.0	pF
c_{g-k}	13	pF
c_{a+g-k}	16	pF

CHARACTERISTICS

*Photocathode sensitivity	20	μA/lm
V_a	6.0	kV
V_k	0	V
V_g max.	6.0	kV
V_g min. for reasonable picture quality	500	V
V_g for cut-off (approx.)	–20	V
Linear magnification	See page C1	
Focusing ampere turns for 2nd focus with specified coil	4000	
†Picture resolution	250	lines/cm

*Measured with a lamp of colour temperature 2700°K

†A picture resolution of 250 lines/cm means that an image of 250 lines alternately black and white of equal width can be viewed in 1cm on the screen. With a linear magnification of 2.5 times, this means an image detail of 625 lines/cm on the photocathode.

ME1201AA
ME1201AG

IMAGE CONVERTER TUBE

LIMITING VALUES (absolute ratings)

V_{a-k} max.	6.5	kV
V_{g-k} max.	6.5	kV
V_{a-g} max.: at picture extinction	6.6	kV
during exposure	6.0	kV
*Photocathode current density max.	0.05	μA/cm²
$T_{ambient}$ max.	50	°C

*With short pulse operation the upper limit to photo-emission current is not set by factors of damage to the cathode. If the sensitive layer suffers a slight overload, electron optical distortion will occur, but no damage to the cathode need result.

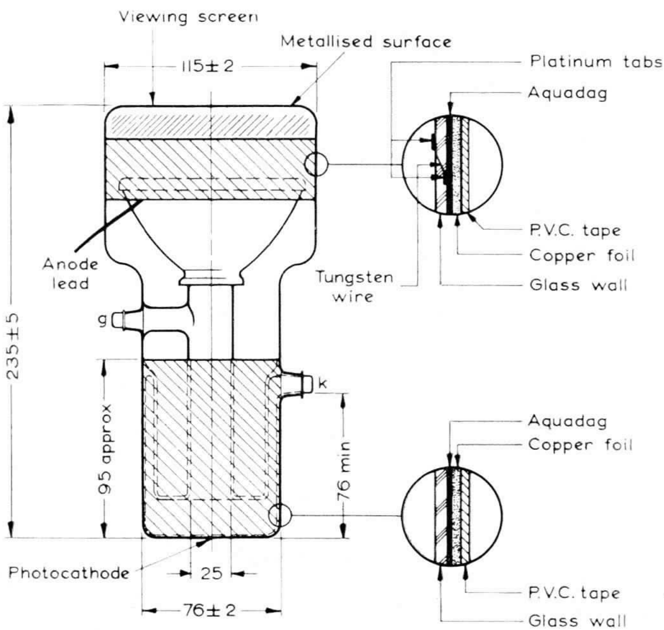
EXTERNAL CONDUCTIVE COATING

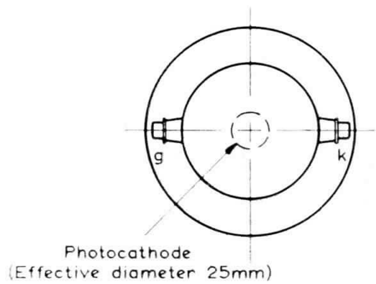
An external metallised coating, connected to the cathode, surrounds the outer wall of this tube. It is essential that the copper foil connection between the metallising and the cathode terminal should not be broken. If the cathode is not operated at earth potential, care must be taken to maintain insulation of the cathode from the focusing coil.

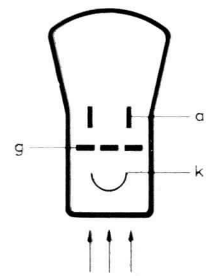
OPERATING NOTE

The grid voltage must not be allowed to exceed the anode voltage during operation especially with magnetic focusing as this mode of operation can cause serious damage to the photocathode.

ME1201AA ME1201AG



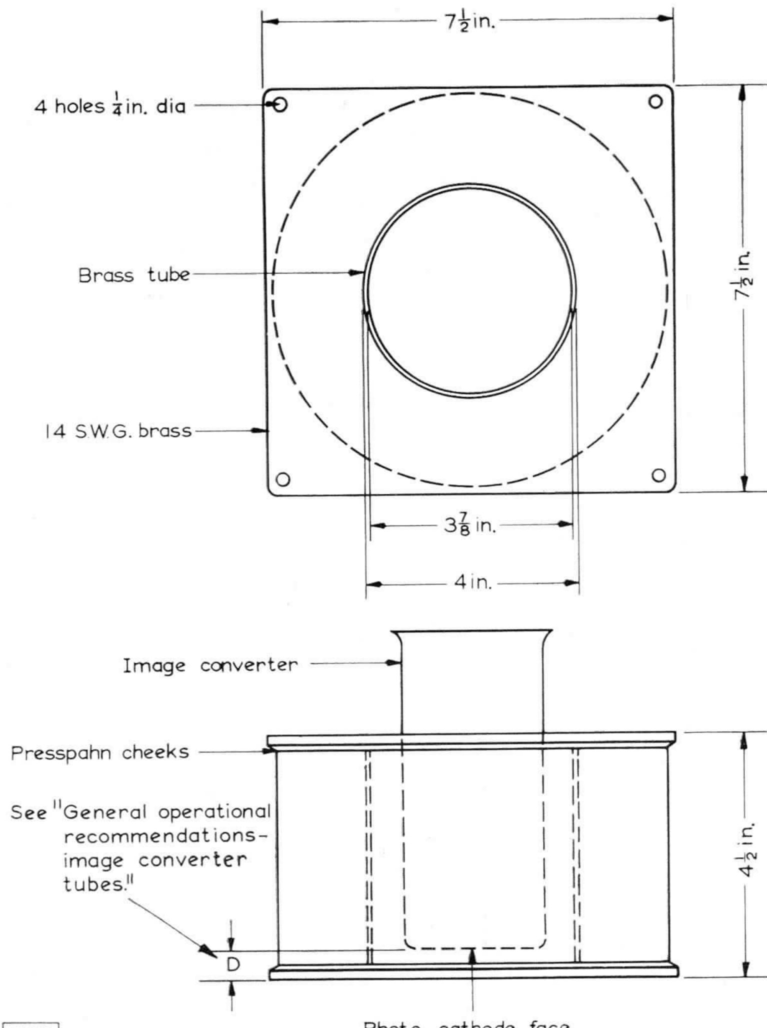




6187 All dimensions in mm

ME1201AA
ME1201AG

IMAGE CONVERTER TUBE

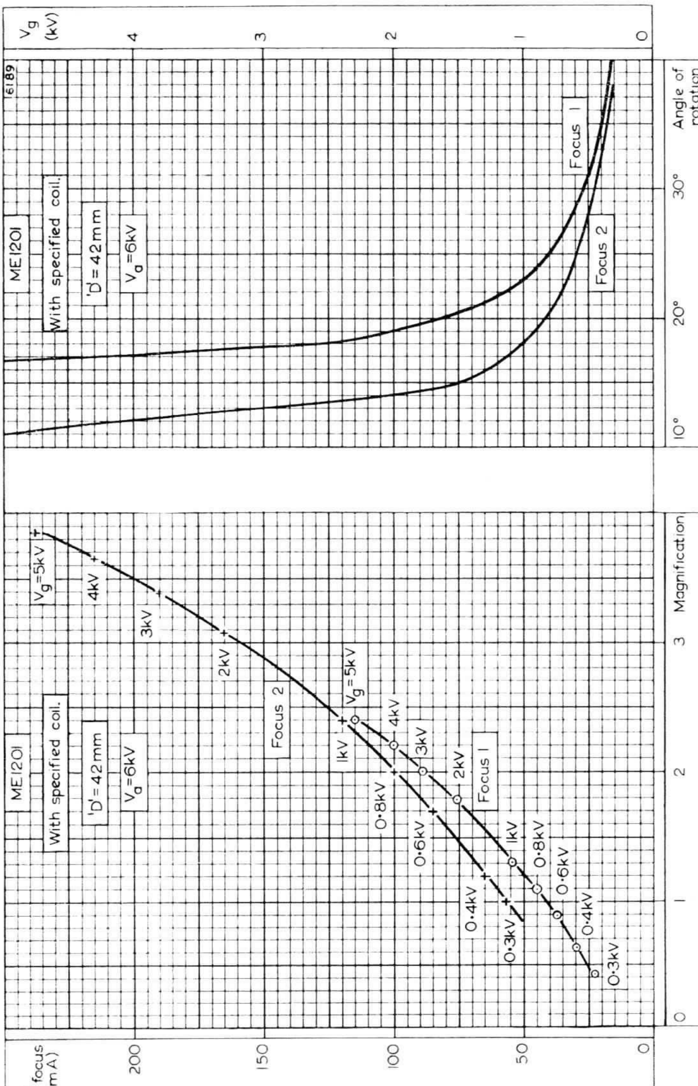


6176

CONSTRUCTIONAL DETAILS

Turns: 15,000 approx.

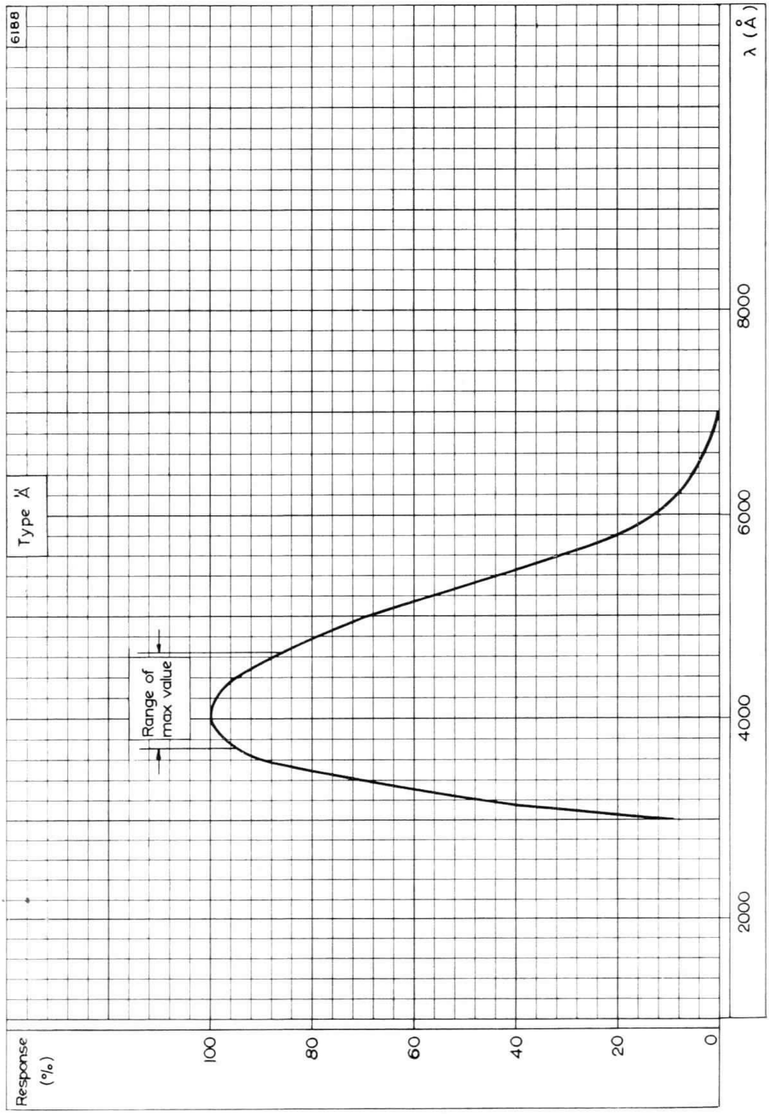
Wire: 26 s.w.g. enamelled copper interleaved with 0.004-in. presspahn.



MAGNIFICATION AND ROTATION OF IMAGE WITH DIFFERING FOCUSING CONDITIONS

ME1201AA
ME1201AG

IMAGE CONVERTER TUBE



RELATIVE SPECTRAL ENERGY DISTRIBUTION CURVE
FOR TYPE 'A' LUMINESCENT SCREEN

IMAGE INTENSIFIER TUBE XX1020

QUICK REFERENCE DATA		
Self-focusing electrostatic diode image intensifier tube with red-enhanced S20 cathode, for use in night vision applications.		
Tube voltage	16	kV
Photocathode	S20 with enhanced red response	
Useful cathode diameter	25	mm
Screen phosphor	P20	
Useful screen diameter	19	mm

To be read in conjunction with
GENERAL OPERATIONAL RECOMMENDATIONS - IMAGE CONVERTER TUBES

PHOTOCATHODE

Surface	S20 with enhanced red response	
Peak spectral response	500	nm
Cathode area	500	mm^2
Minimum useful cathode diameter	25.4	mm
External radius of curvature	60	mm

SCREEN

Aluminium-backed

Fluorescent colour: yellow-green (P20)

Persistence: medium short

The screen luminance is reduced to 36% (e^{-1}) of the initial peak value 200μs after the excitation is removed.

Minimum useful screen diameter: 19.3 mm

FOCUSING

Self-focusing electrostatic

CHARACTERISTICS (measured with V_a = 16kV at T_{amb} = 20°C)

Minimum conversion coefficient (C.C. - see note 1)	35	cd/lm
Centre magnification (see note 2)	0.76 ±0.025	
Distortion (see note 3)	8.5 to 12.5	%
Minimum centre resolution (see note 4)	60	line pairs/mm
Minimum edge resolution (see note 5)	12	line pairs/mm
Background equivalent illumination (see note 6) typ.	2.0	µlux
max.	10	µlux
Maximum dark current	0.02	µA
Maximum axial eccentricity (see note 7)	1.0	mm

OPERATING CONDITIONS

V_a (see note 8)	16	kV

Either the anode or the cathode should be earthed, depending upon the application. It is recommended that the cathode be earthed in order to obtain the lowest possible background.

RATINGS (ABSOLUTE MAXIMUM SYSTEM)

$v_{a(pk)}$ max.	18	kV
V_a max. (continuous operation)	16.5	kV
V_a min. (useful continuous operation)	10	kV
I_a max. (continuous operation)	0.1	µA
Maximum continuous photocathode illumination (see note 9)	2.0	lux
T_{amb} max.	+50	°C
T_{amb} min.	-50	°C

MOUNTING POSITION (see note 10) Any

WEIGHT

Tube alone	90	g

NOTES

1. C.C. $= \dfrac{\text{Luminous intensity (normal to the screen)}}{\text{Luminous flux incident on photocathode}} = \dfrac{\text{cd}}{\text{lm}}$
(2850°K colour temperature source)

2. Measured at the photocathode at a distance of 2.2mm from the centre.

3. Percentage distortion $= (\frac{Md}{Mc} - 1) \times 100$, where Md is the magnification at a distance 10.2mm from the centre of the photocathode and Mc is the magnification at the centre of the photocathode.

4. Measured at the photocathode within a circle of 4.3mm diameter.

5. Measured at the photocathode at a distance of 6.4mm from the centre. (Half of the useful photocathode radius).

6. This is the value of input illumination required to give an increase in screen luminance equivalent to the background luminance.

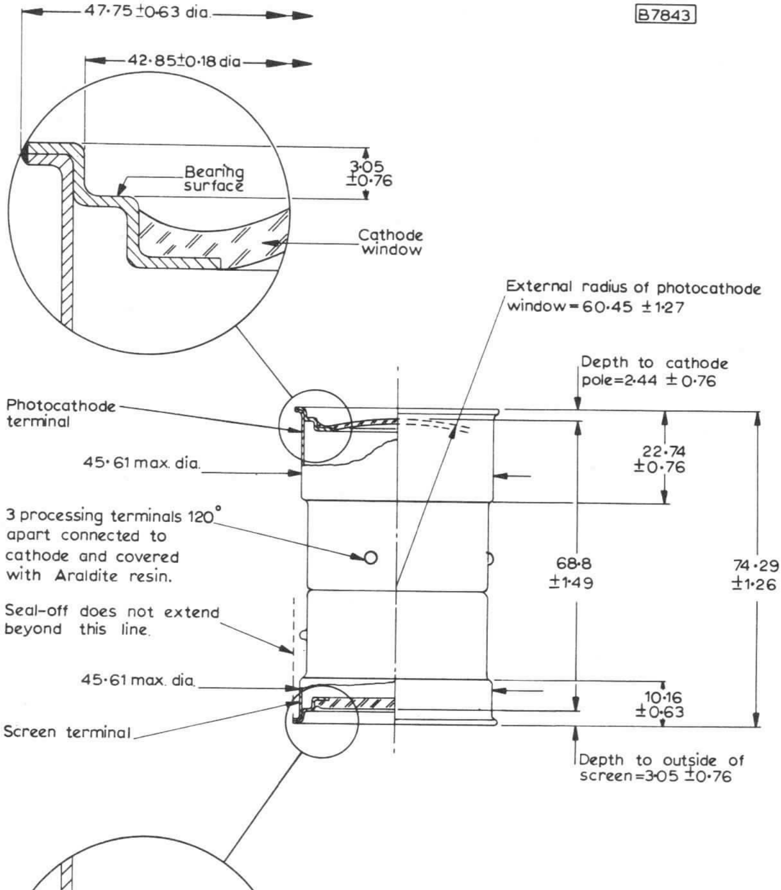
7. This is defined as the deviation of the cathode centre image from the centre of the screen, both centres being defined by the Bearing Surface Diameters (see page D4).

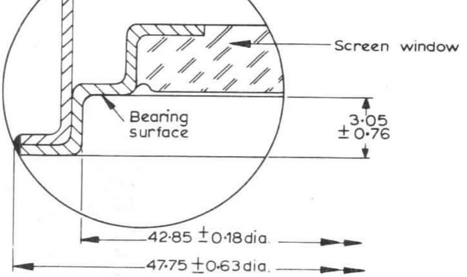
8. Permanent damage may result from temporary reversal of polarity.

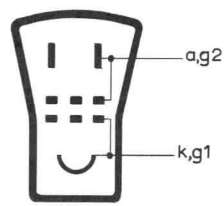
9. This figure assumes uniform irradiation of the photocathode. Permanent damage may result if the tube is exposed to radiant power so great as to cause excessive heating of the photocathode.

10. The tube should be supported on the Bearing Surfaces, which also provide the electrical connections.

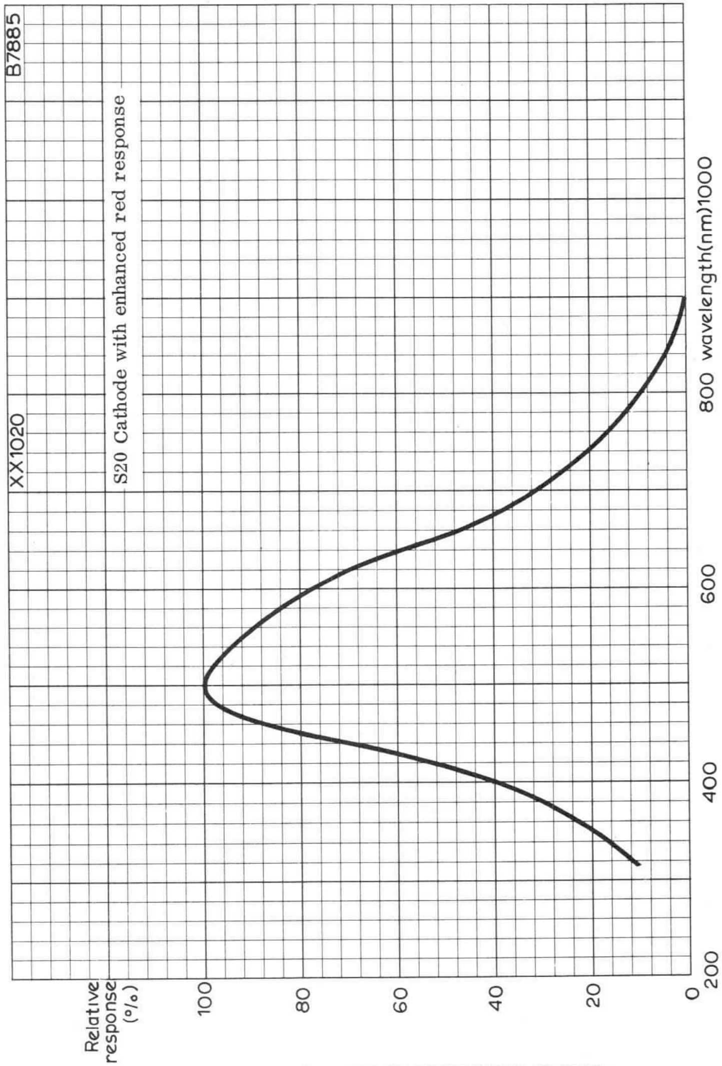
11. Magnetic fields may impair the tube's performance. In certain applications a mu-metal shield may be required.







All dimensions in mm



PHOTOCATHODE SPECTRAL RESPONSE CURVE

IMAGE INTENSIFIER TUBE XX1052

QUICK REFERENCE DATA		
Self-focusing electrostatic diode image intensifier tube with fibre-optic windows for general purpose applications.		
Minimum luminance gain	50	
Photocathode	S20 with enhanced red response	
Screen phosphor	P20	
Useful cathode and screen diameters	25	mm
Anode voltage	15	kV
Overall dimensions (approx.)	60 × 50 dia.	mm
Weight (approx.)	145	g

This data should be read in conjunction with
GENERAL EXPLANATORY NOTES - IMAGE CONVERTER TUBES

PHOTOCATHODE

Surface	S20 with enhanced red response	
Wavelength at maximum response	500	nm
Minimum useful diameter	25	mm
External surface of cathode window	Flat to within 2μm over entire diameter	

SCREEN

Surface	Metal-backed P20	
Fluorescent colour	Yellow-green	
Persistence	Medium short	

The screen luminance falls to 36% (e^{-1}) of the initial peak value 200μs after the excitation is removed.

Minimum useful diameter	25	mm
External surface of screen window	Flat to within 2μm over entire diameter	

FOCUSING

Self-focusing electrostatic with image inversion.

CHARACTERISTICS (Measured at V_a = 15kV, T_{amb} = -50 to +30°C)

Minimum luminance gain (see note 1)	50	
Minimum photocathode sensitivity (measured using a tungsten lamp of colour temperature 2850°K)	100	µA/lm
Minimum radiant sensitivity at λ = 800nm	2.0	mA/W
at λ = 850nm	0.5	mA/W
Centre magnification, M_c (see note 2)	0.935 ± 0.010	
Distortion (see note 3)	7.00 ± 1.65	%
Minimum centre resolution (see note 4)	60	line pairs/mm
Minimum edge resolution (see note 5)	50	line pairs/mm
Background equivalent illumination (see note 6)	1.0	µlux

Axial eccentricity

A point at the centre of the photocathode will form an image within a concentric circle of 1.5mm diameter on the screen.

OPERATING CONDITIONS

V_a (see note 7)	15	kV

The cathode should be connected to the instrument housing.

RATINGS (ABSOLUTE MAXIMUM SYSTEM)

V_a max.	16	kV
V_a min. (useful continuous operation)	10	kV
Maximum continuous photocathode illumination (see note 8)	2.0	lux
T_{amb} max.	+50	°C

MOUNTING POSITION	Any	
WEIGHT (approx.)	145	g

NOTES

1. Luminance gain is defined as $\frac{\pi . L_o}{E_i}$

   where L_o = luminance (cd/m^2) in a direction normal to the screen, measured with an eye-corrected photometer having an acceptance angle of less than 2 degrees.

   and E_i = illumination (lux) incident on a 19mm diameter concentric area of the cathode, produced by a tungsten lamp at a colour temperature of 2850°K.

2. This is the magnification of a 2mm diameter concentric circle on the photocathode, as measured on the screen.

3. Percentage distortion = $(\frac{M_d}{M_c} \times 100)$, where M_d is the magnification at a distance of 10mm from the centre of the photocathode and M_c is the magnification at a distance of 1mm from the centre of the photocathode.

4. Measured at the centre of the photocathode.

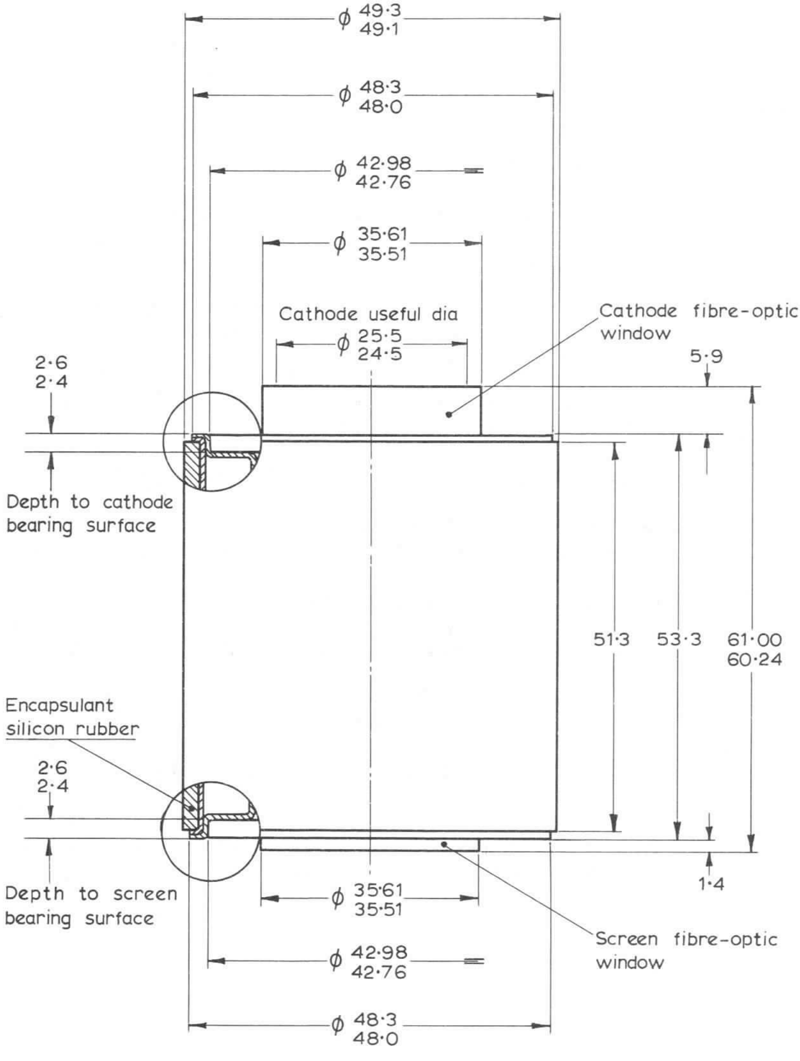
5. Measured at the photocathode at a distance of 7mm from the centre.

6. This is the value of input illumination required to give an increase in screen luminance equivalent to the background luminance.

7. Permanent damage may result from a temporary reversal of polarity.

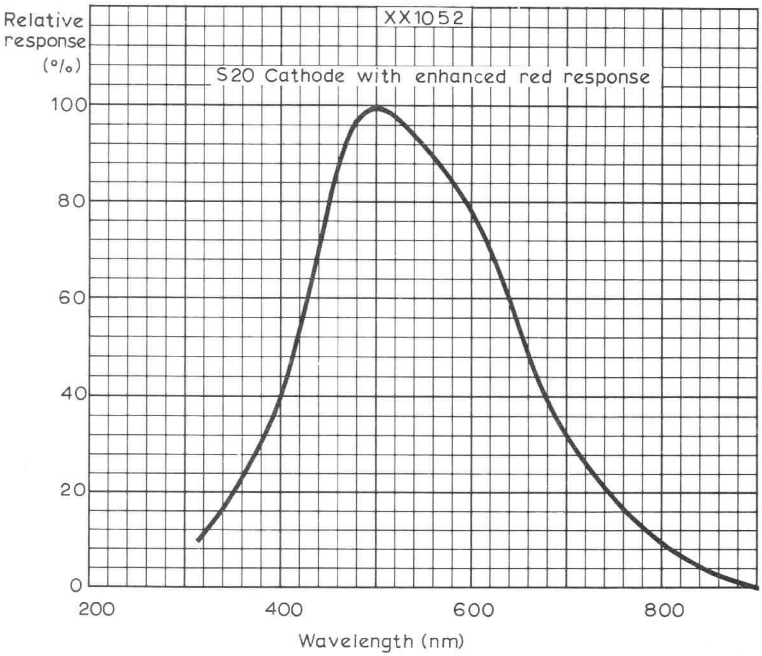
8. This figure assumes uniform illumination of the photocathode. Permanent damage may result if the tube is exposed to radiant power so great as to cause excessive heating of the photocathode.

OUTLINE DRAWING



All dimensions in mm

Contacts to cathode and screen should be made to the respective bearing surfaces. Contact rings should be kept well clear of the fibre-optic windows. Maximum contact force must not exceed 1kg.



PHOTOCATHODE SPECTRAL RESPONSE CURVE

IMAGE INTENSIFIER ASSEMBLY XX1060

QUICK REFERENCE DATA		
Very high gain self-focusing image intensifier assembly for night vision systems.		
Minimum luminance gain	35 000	
Photocathode	S20 with enhanced red response	
Screen phosphor	P20	
Useful cathode and screen diameters	25	mm
Supply voltage (p-p) at 1500Hz	2800	V
Overall dimensions (approx.)	195 × 70 dia.	mm
Weight (approx.)	880	g

This data should be read in conjunction with GENERAL EXPLANATORY NOTES - IMAGE CONVERTER TUBES

PHOTOCATHODE

Surface	S20 with enhanced red response	
Wavelength at maximum response	500	nm
Minimum useful diameter	25	mm
External surface of cathode window	Flat to within 2μm over entire diameter	

SCREEN

Surface	Metal-backed P20	
Fluorescent colour	Yellow-green	
Overall persistence	Medium	

The screen luminance falls to 36% (e^{-1}) of the initial peak value 5ms after the excitation is removed.

Minimum useful diameter	25	mm
External surface of screen window	Flat to within 2μm over entire diameter	

FOCUSING

Self-focusing electrostatic with image inversion

CHARACTERISTICS (Measured at $V_{supply(p-p)}$ = 2800V ± 0.5%, f_{supply} = 1500Hz ± 2%, T_{amb} = -50 to +30°C)

Minimum luminance gain (see note 1)	35 000	
Minimum photocathode sensitivity (measured using a tungsten lamp of colour temperature 2850°K)	175	μA/lm
Minimum radiant sensitivity at λ = 800nm	10	mA/W
at λ = 850nm	3.0	mA/W
Centre magnification, M_c (see note 2)	0.82 to 1.0	
Maximum distortion (see note 3)	25	%
Minimum centre resolution (see note 4)	25	line pairs/mm
Minimum edge resolution (see note 5)	23	line pairs/mm
Minimum contrast transfer at cathode centre		
at 2.5 line pairs/mm	80	%
at 7.5 line pairs/mm	50	%
at 16 line pairs/mm	6.0	%
Maximum background equivalent illumination (see note 6)	0.2	μlux

Axial eccentricity

A point at the centre of the photocathode will form an image within a concentric circle of 1.25mm diameter on the screen.

Maximum screen luminance ratio (see note 7)	4:1	

OPERATING CONDITIONS

$V_{supply(p-p)}$	2800	V
f_{supply}	1500	Hz
Typical cathode illumination	10	μlux
	(starlight, partly overcast sky)	

The cathode should be connected to the instrument housing.

RATINGS (ABSOLUTE MAXIMUM SYSTEM)

$V_{supply(p-p)}$ max.	2850	V
f_{supply} max.	1600	Hz
f_{supply} min.	1400	Hz
Maximum photocathode illumination (see note 8)	5.0	mlux
T_{amb} max. (for 2 hours max.)	+70	°C

MOUNTING POSITION	Any	
WEIGHT (approx)	880	g

NOTES

1. Luminance gain is defined as: $\frac{\pi . L_o}{E_i}$

   where L_o = luminance (cd/m^2) in a direction normal to the screen, measured with an eye-corrected photometer having an acceptance angle of less than 2 degrees.

   and E_i = illumination (lux) incident on a 19mm diameter concentric area of the cathode, produced by a tungsten lamp at a colour temperature of 2850^oK.

2. This is the magnification of a 2mm diameter concentric circle on the photocathode, as measured on the screen.

3. Percentage distortion = $(\frac{M_d}{M_c} \times 100)$, where M_d is the magnification at a distance of 10mm from the centre of the photocathode and M_c is the magnification at a distance of 1mm from the centre of the photocathode.

4. Measured at the centre of the photocathode.

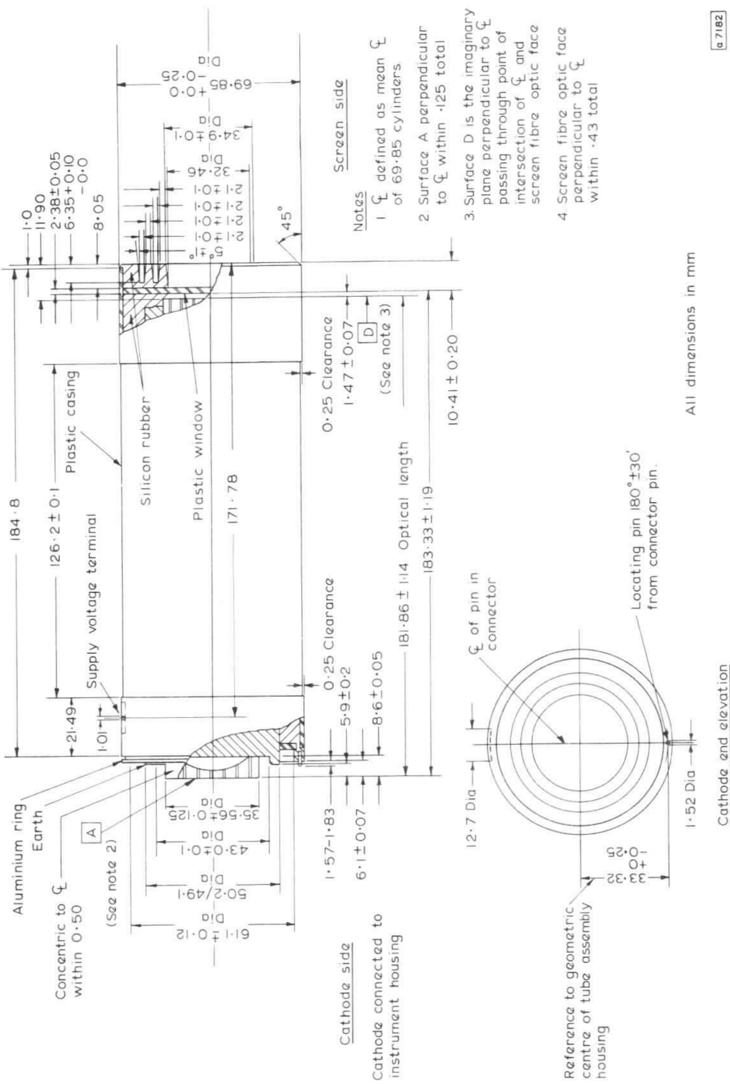
5. Measured at the photocathode at a distance of 7mm from the centre.

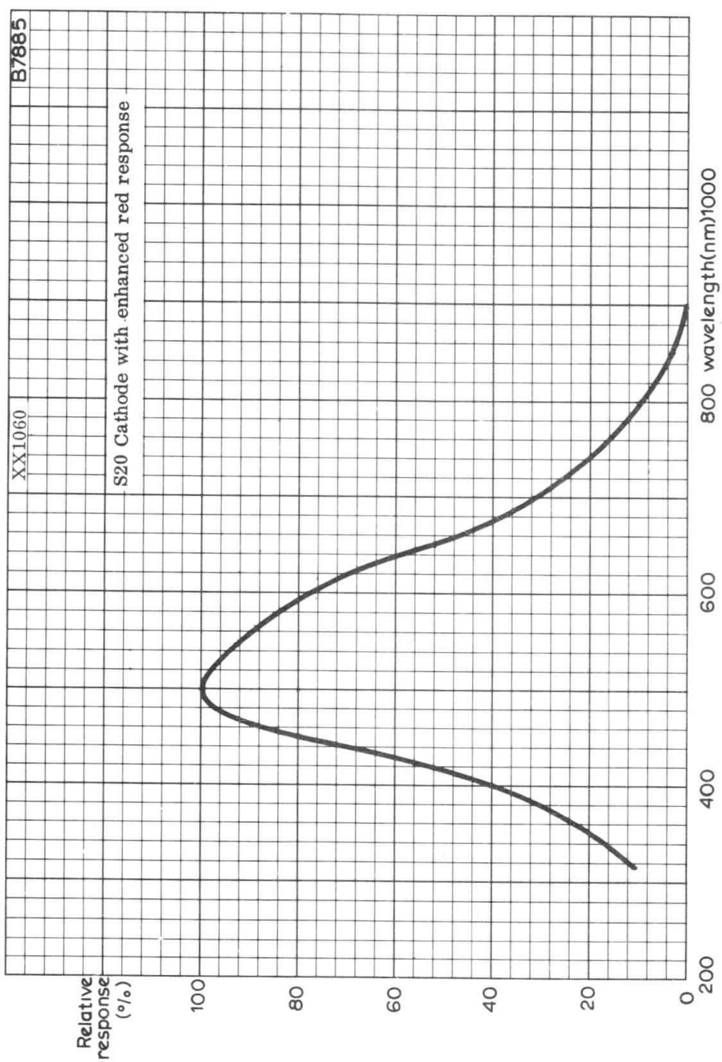
6. This is the value of input illumination required to give an increase in screen luminance equivalent to the background luminance.

7. The screen luminance ratio is defined as the ratio of the maximum and minimum screen luminance over a 20mm diameter concentric area on the screen, for uniform cathode illumination.

8. Intermittent flashes producing much higher cathode illuminations are allowed, but the tube should never be used in broad daylight.

OUTLINE DRAWING OF XX1060





PHOTOCATHODE SPECTRAL RESPONSE CURVE

IMAGE INTENSIFIER ASSEMBLY XX1061

QUICK REFERENCE DATA		
Very high gain self-focusing image intensifier assembly for night vision systems.		
Minimum luminance gain	30 000	
Photocathode	S20 with enhanced red response	
Screen phosphor	P20	
Useful cathode and screen diameters	25	mm
Supply voltage (p-p) at 1500Hz	2800	V
Overall dimensions (approx.)	195 × 70 dia.	mm
Weight (approx.)	880	g

This data should be read in conjunction with
GENERAL EXPLANATORY NOTES - IMAGE CONVERTER TUBES

PHOTOCATHODE

Surface	S20 with enhanced red response	
Wavelength at maximum response	500	nm
Minimum useful diameter	25	mm
External surface of cathode window	Flat to within 2μm over entire diameter	

SCREEN

Surface	Metal-backed P20	
Fluorescent colour	Yellow-green	
Overall persistence	Medium	

The screen luminance falls to 36% (e^{-1}) of the initial peak value 5ms after the excitation is removed.

Minimum useful diameter	25	mm
External surface of screen window	Flat to within 2μm over entire diameter	

FOCUSING

Self-focusing electrostatic with image inversion.

CHARACTERISTICS (Measured at $V_{supply(p-p)} = 2800V \pm 0.5\%$, $f_{supply} = 1500Hz \pm 2\%$, $T_{amb} = -50$ to $+30^{o}C$)

Minimum luminance gain (see note 1)	30 000	
Minimum photocathode sensitivity (measured using a tungsten lamp of colour temperature $2850^{o}K$)	150	$\mu A/lm$
Minimum radiant sensitivity at $\lambda = 800nm$	6.0	mA/W
at $\lambda = 850nm$	1.0	mA/W
Centre magnification, M_c (see note 2)	0.82 to 1.0	
Maximum distortion (see note 3)	25	%
Minimum centre resolution (see note 4)	22	line pairs/mm
Minimum edge resolution (see note 5)	18	line pairs/mm
Typical contrast transfer at cathode centre		
at 2.5 line pairs/mm	80	%
at 7.5 line pairs/mm	50	%
at 16 line pairs/mm	6.0	%
Maximum background equivalent illumination (see note 6)	0.5	μlux

Axial eccentricity

A point at the centre of the photocathode will form an image within a concentric circle of 1.25mm diameter on the screen.

Maximum screen luminance ratio (see note 7)	4:1	

OPERATING CONDITIONS

$V_{supply(p-p)}$	2800	V
f_{supply}	1500	Hz
Typical cathode illumination	10	μlux
	(starlight, partly overcast sky)	

The cathode should be connected to the instrument housing.

RATINGS (ABSOLUTE MAXIMUM SYSTEM)

$V_{supply(p-p)}$ max.	2850	V
f_{supply} max.	1600	Hz
f_{supply} min.	1400	Hz
Maximum photocathode illumination (see note 8)	5.0	mlux
T_{amb} max. (for 2 hours max.)	+70	^{o}C

MOUNTING POSITION	Any	
WEIGHT (approx.)	880	g

NOTES

1. Luminance gain is defined as: $\frac{\pi . L_o}{E_i}$

   where L_o = luminance (cd/m^2) in a direction normal to the screen, measured with an eye-corrected photometer having an acceptance angle of less than 2 degrees.

   and E_i = illumination (lux) incident on a 19mm diameter concentric area of the cathode, produced by a tungsten lamp at a colour temperature of 2850°K.

2. This is the magnification of a 2mm diameter concentric circle on the photocathode, as measured on the screen.

3. Percentage distortion = $(\frac{M_d}{M_c} \times 100)$, where M_d is the magnification at a distance of 10mm from the centre of the photocathode and M_c is the magnification at a distance of 1mm from the centre of the photocathode.

4. Measured at the centre of the photocathode.

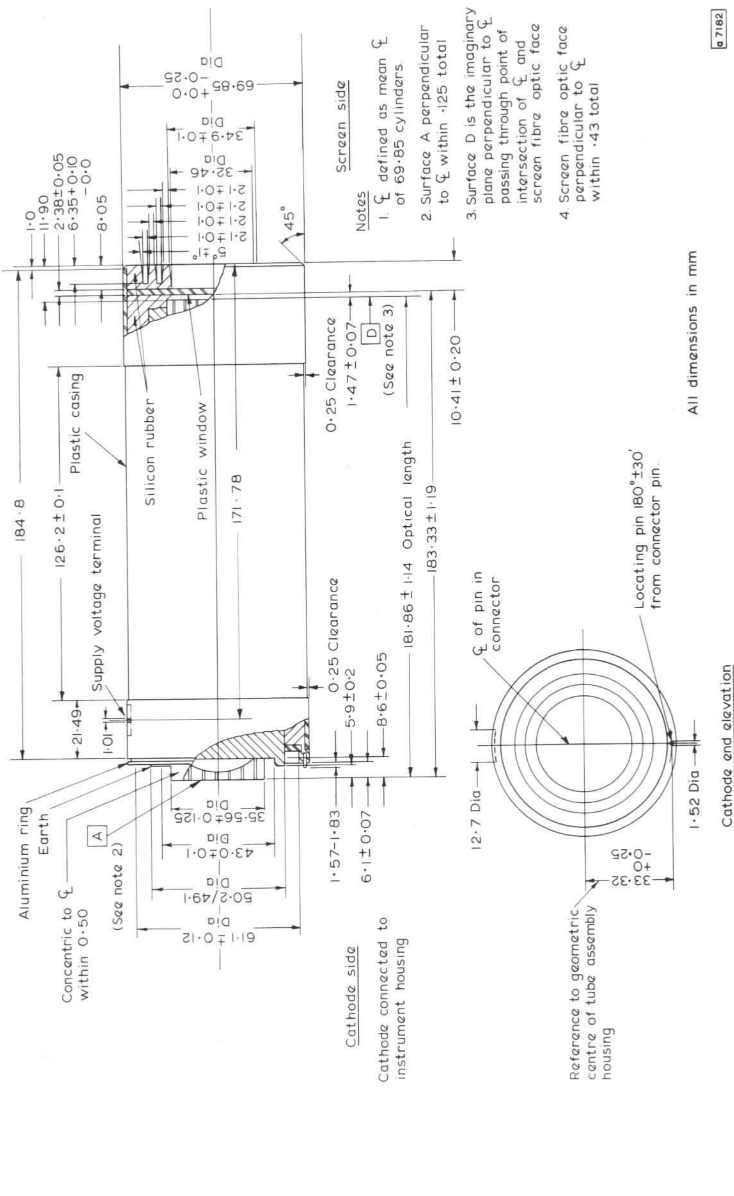
5. Measured at the photocathode at a distance of 7mm from the centre.

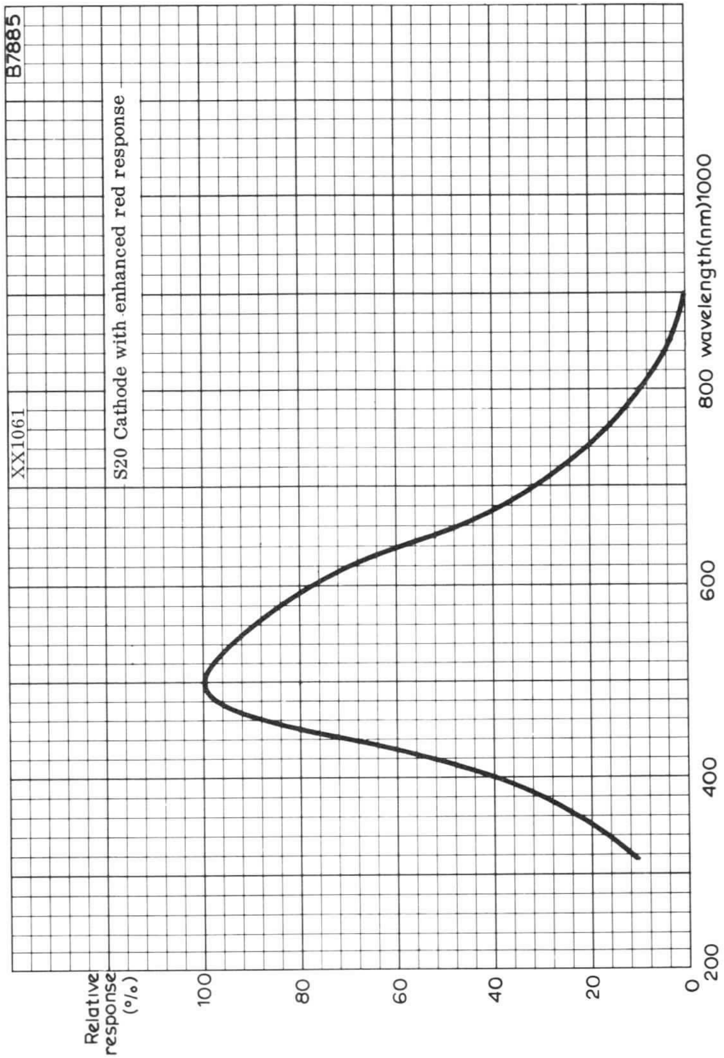
6. This is the value of input illumination required to give an increase in screen luminance equivalent to the background luminance.

7. The screen luminance ratio is defined as the ratio of the maximum and minimum screen luminance over a 20mm diameter concentric area on the screen, for uniform cathode illumination.

8. Intermittent flashes producing much higher cathode illuminations are allowed, but the tube should never be used in broad daylight.

OUTLINE DRAWING OF XX1061





PHOTOCATHODE SPECTRAL RESPONSE CURVE

IMAGE INTENSIFIER ASSEMBLY XX1062

QUICK REFERENCE DATA		
Very high gain self-focusing image intensifier assembly for night vision systems.		
Minimum luminance gain	20 000	
Photocathode	S20 with enhanced red response	
Screen phosphor	P20	
Useful cathode and screen diameters	25	mm
Supply voltage (p-p) at 1500Hz	2800	V
Overall dimensions (approx.)	195 × 70 dia.	mm
Weight (approx.)	880	g

This data should be read in conjunction with
GENERAL EXPLANATORY NOTES - IMAGE CONVERTER TUBES

PHOTOCATHODE

Surface	S20 with enhanced red response	
Wavelength at maximum response	500	nm
Minimum useful diameter	25	mm
External surface of cathode window	Flat to within 2μm over entire diameter	

SCREEN

Surface	Metal-backed P20	
Fluorescent colour	Yellow-green	
Overall persistence	Medium	

The screen luminance falls to 33% (e^{-1}) of the initial peak value 5ms after the excitation is removed.

Minimum useful diameter	25	mm
External surface of screen window	Flat to within 2μm over entire diameter	

FOCUSING

Self-focusing electrostatic with image inversion

CHARACTERISTICS (measured at $V_{supply(p-p)}$ = 2800V ± 0.5%, f_{supply} = 1500Hz ± 2%, T_{amb} = -50 to +30°C)

Minimum luminance gain (see note 1)	20 000	
Minimum photocathode sensitivity (measured using a tungsten lamp of colour temperature 2850°K)	100	μA/lm
Minimum radiant sensitivity at λ = 800nm	2.0	mA/W
at λ = 850nm	0.5	mA/W
Centre magnification, M_c (see note 2)	0.82 to 1.0	
Maximum distortion (see note 3)	25	%
Minimum centre resolution (see note 4)	20	line pairs/mm
Minimum edge resolution (see note 5)	15	line pairs/mm
Typical contrast transfer at cathode centre		
at 2.5 line pairs/mm	80	%
at 7.5 line pairs/mm	50	%
at 16 line pairs/mm	6.0	%
Maximum background equivalent illumination (see note 6)	1.0	μlux

Axial eccentricity

A point at the centre of the photocathode will form an image within a concentric circle of 1.25mm diameter on the screen.

Maximum screen luminance ratio (see note 7) 4:1

OPERATING CONDITIONS

$V_{supply(p-p)}$	2800	V
f_{supply}	1500	Hz
Typical cathode illumination	10	μlux
	(starlight, partly overcast sky)	

The cathode should be connected to the instrument housing.

RATINGS (ABSOLUTE MAXIMUM SYSTEM)

$V_{supply(p-p)}$ max.	2850	V
f_{supply} max.	1600	Hz
f_{supply} min.	1400	Hz
Maximum photocathode illumination (see note 8)	5.0	mlux
T_{amb} max. (for 2 hours max.)	+70	°C

MOUNTING POSITION Any

WEIGHT (approx.) 880 g

NOTES

1. Luminance gain is defined as: $\frac{\pi . L_o}{E_i}$

where L_o = luminance (cd/m^2) in a direction normal to the screen, measured with an eye-corrected photometer having an acceptance angle of less than 2 degrees.

and E_i = illumination (lux) incident on a 19mm diameter concentric area of the cathode, produced by a tungsten lamp at a colour temperature of 2850°K.

2. This is the magnification of a 2mm diameter concentric circle on the photocathode, as measured on the screen.

3. Percentage distortion = $(\frac{M_d}{M_c} \times 100)$, where M_d is the magnification at a distance of 10mm from the centre of the photocathode and M_c is the magnification at a distance of 1mm from the centre of the photocathode.

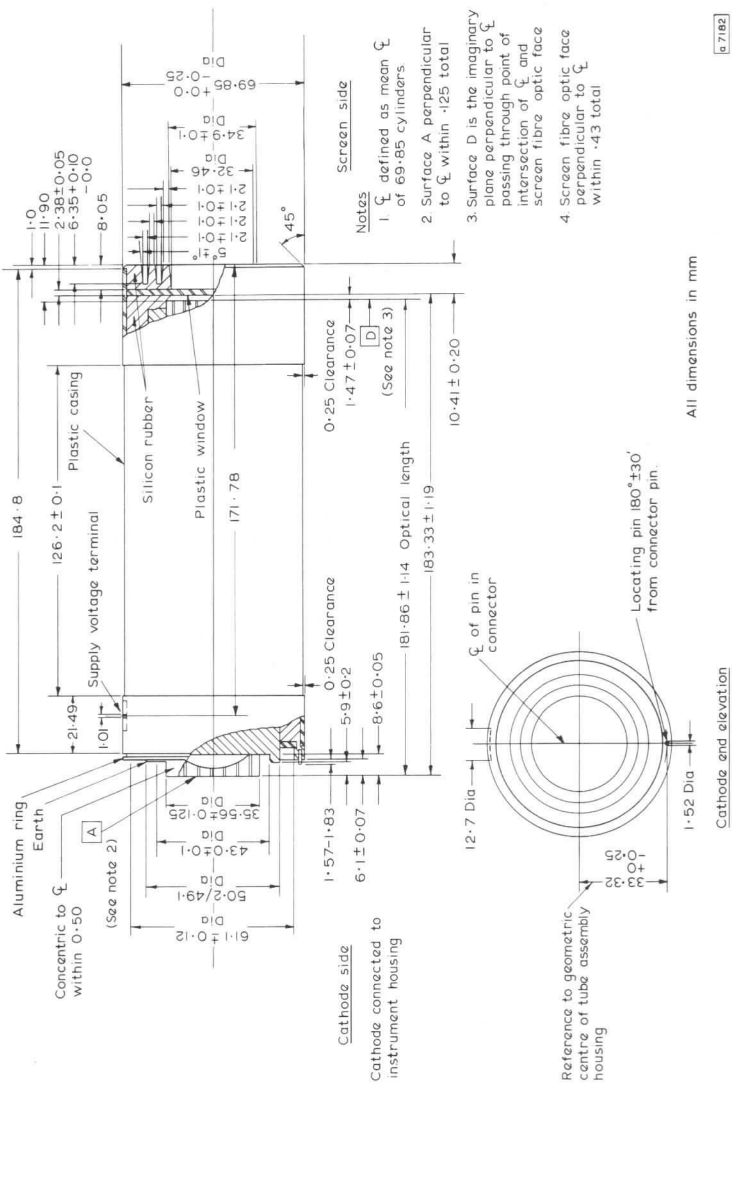
4. Measured at the centre of the photocathode.

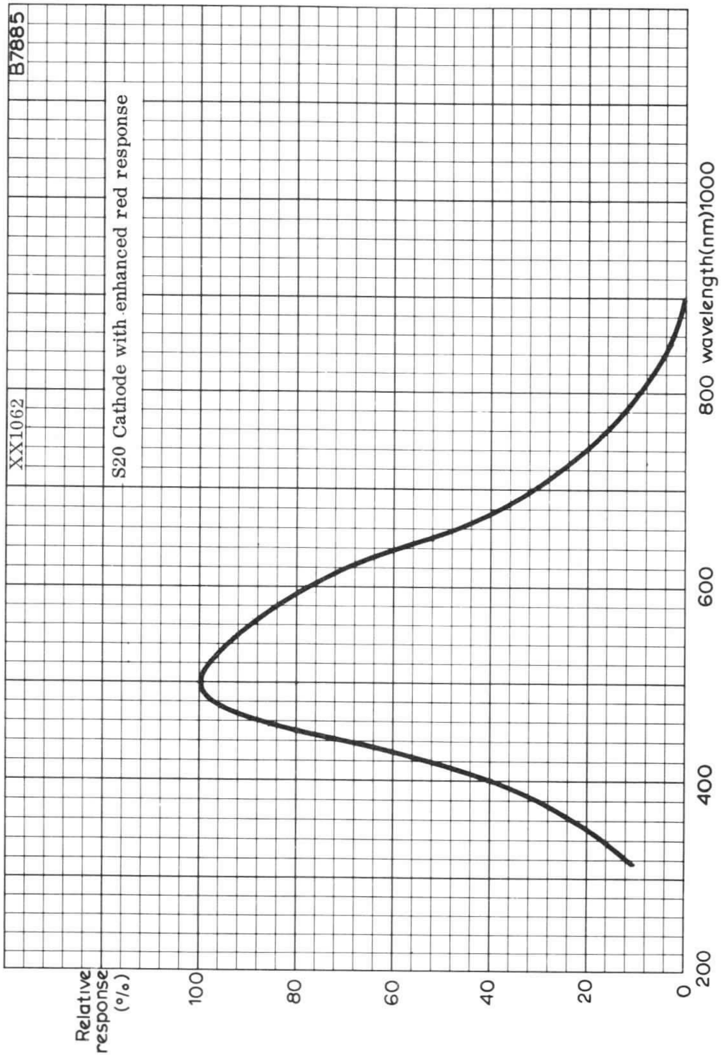
5. Measured at the photocathode at a distance of 7mm from the centre.

6. This is the value of input illumination required to give an increase in screen luminance equivalent to the background luminance.

7. The screen luminance ratio is defined as the ratio of the maximum and minimum screen luminance over a 20mm diameter concentric area on the screen, for uniform cathode illumination.

8. Intermittent flashes producing much higher cathode illuminations are allowed, but the tube should never be used in broad daylight.


Aluminium ring
Earth
Concentric to ℄ within 0·50
A (See note 2)
Supply voltage terminal
Plastic casing
Silicon rubber
Plastic window
184·8
126·2 ± 0·1
21·49
1·01
171·78
1·0
11·90
2·38±0·05
6·35+0·10 −0·0
8·05
5° ±1°
2·1 ±0·1
2·1 ±0·1
2·1 ±0·1
2·1 ±0·1
32·46 Dia
34·9±0·1 Dia
69·85 +0·0 −0·25 Dia
45°
0·25 Clearance
1·47 ± 0·07
D (See note 3)
10·41 ± 0·20
181·86 ± 1·14 Optical length
183·33 ± 1·19
0·25 Clearance
5·9 ± 0·2
8·6 ± 0·05
1·57–1·83
6·1 ± 0·07
35·56±0·125 Dia
43·0±0·1 Dia
50·2/49·1 Dia
61·1 ± 0·12 Dia
Screen side
Cathode side
Cathode connected to instrument housing
Notes
1. ℄ defined as mean ℄ of 69·85 cylinders
2. Surface A perpendicular to ℄ within ·125 total
3. Surface D is the imaginary plane perpendicular to ℄ passing through point of intersection of ℄ and screen fibre optic face
4. Screen fibre optic face perpendicular to ℄ within ·43 total
℄ of pin in connector
12·7 Dia
1·52 Dia
Locating pin 180° ± 30′ from connector pin.
33·32 +0 −0·25
Reference to geometric centre of tube assembly housing
Cathode end elevation
All dimensions in mm
a 7182



PHOTOCATHODE SPECTRAL RESPONSE CURVE

TENTATIVE DATA

QUICK REFERENCE DATA

Diode image converter tube intended for use in the near infra-red region of the spectrum.

Tube voltage	16	kV
Photocathode	S1 response	
Screen phosphor	P20 TYPE	
Minimum useful cathode diameter	25.4	mm

To be read in conjunction with
GENERAL OPERATIONAL RECOMMENDATIONS - IMAGE CONVERTER TUBES

PHOTOCATHODE

Surface	Type C, caesium on oxidised silver	
Peak spectral response	0.8 ± 0.1	μm
Cathode area	5.06	cm^2
Minimum useful cathode diameter	25.4	mm
External radius of curvature	60	mm

SCREEN

Metal-backed

Fluorescent colour: yellow-green (P20 type)

Persistence: medium short

The brightness is reduced to 36% (e^{-1}) of the initial peak value 200μs after the excitation is removed.

Minimum useful screen diameter: 19.3 mm

FOCUSING

Self-focusing electrostatic

CHARACTERISTICS (measured with V_a = 16kV at T_{amb} = 20°C)

Minimum conversion coefficient (see note 1)	0.6	cd/lm irf
Centre magnification (see note 2)	0.76 ± 0.025	
Distortion (see note 3)	8.5 to 12.5	%
Minimum centre resolution (see note 4)	50	line pairs/mm
Minimum edge resolution (see note 5)	12	line pairs/mm
Maximum background equivalent illumination (see note 6)	25×10^{-3}	lux irf
Maximum dark current	0.02	μA
Maximum axial eccentricity (see note 7)	1.0	mm

TYPICAL OPERATING CONDITIONS

V_a	16	kV
I_a	0.02	μA

Either the anode or the cathode should be earthed depending upon the application.

LIMITING VALUES

v_a (pk) max.	18	kV
V_a max. (continuous operation)	16.5	kV
V_a min. (continuous operation)	10	kV
I_a max. (continuous operation)	0.1	μA
*Photocathode illumination		
continuous	10	lux irf
**intermittent	100	lux irf
T_{amb}		
Maximum	+50	°C
Minimum	-50	°C

*Assuming uniform irradiation of the photocathode

**A duty factor of 0.3 with a maximum averaging time of 15min. applies.

MOUNTING POSITION Any

WEIGHT

Tube alone	90	g
	3.2	oz

NOTES

1. This parameter is measured with the radiation from a tungsten lamp operating at a colour temperature 2854°K. The radiation is filtered by means of a CS94 filter, (Corning type 2540, Melt No. 1613, 2.61mm thick) before falling on the photocathode. The conversion coefficient is defined as the ratio of the luminous intensity of the screen in candela and the luminous flux in lumens which would be incident on the photocathode if the infra-red filter were removed. This is indicated by "irf" (infra-red filtered).

2. Measured at 4.3mm diameter concentric circle on the cathode.

3. Percentage distortion = $(\frac{Md}{Mc} - 1) \times 100$ where Md is the magnification at a distance 10.2mm from the centre of the photocathode. Mc is the magnification at the centre of the photocathode.

4. Measured at the photocathode within a circle of 4.3mm diameter.

5. Measured at the photocathode at a distance of 6.4mm from the centre.

6. This is the value of equivalent input illumination (irf) required to give an increase of luminance on the screen equal to the background luminance.

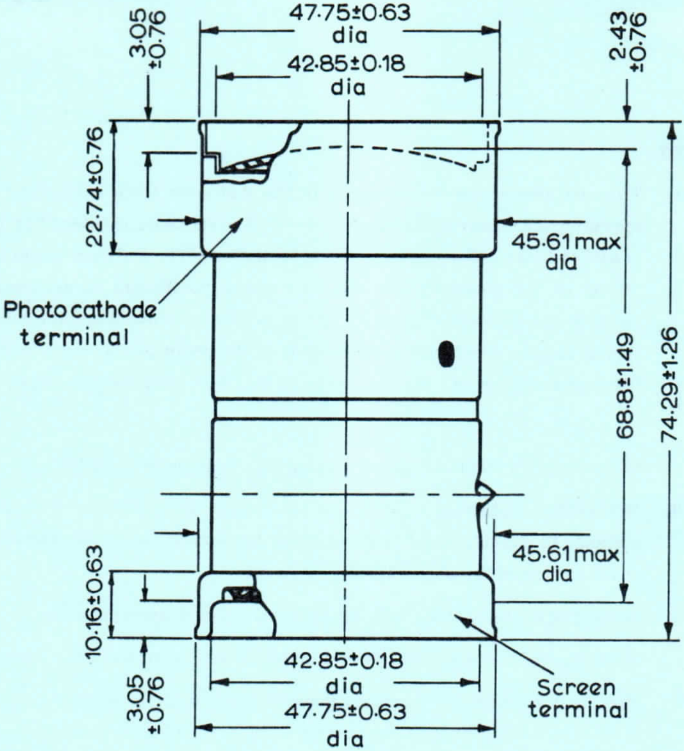
7. This is defined as the deviation of the cathode centre image from centre of the screen.

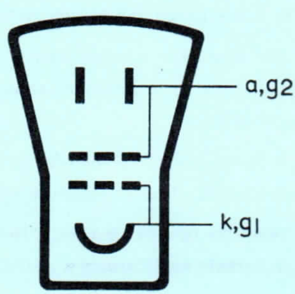
8. Permanent damage to the tube may result if it is exposed to radiant energy so great as to cause excessive heating of the photocathode.

9. Support for the tube may be provided by a simple clamp arrangement on either terminal. Only light pressure should be applied to avoid damage to the glass metal seals.

10. Connections to the terminals of the tube must not be soldered but should be made by either spring clips or simple clamps.

11. The tube is sensitive to stray magnetic fields which may impair the tube's resolution. In certain applications a μ-metal shield may be required.





All dimensions in mm

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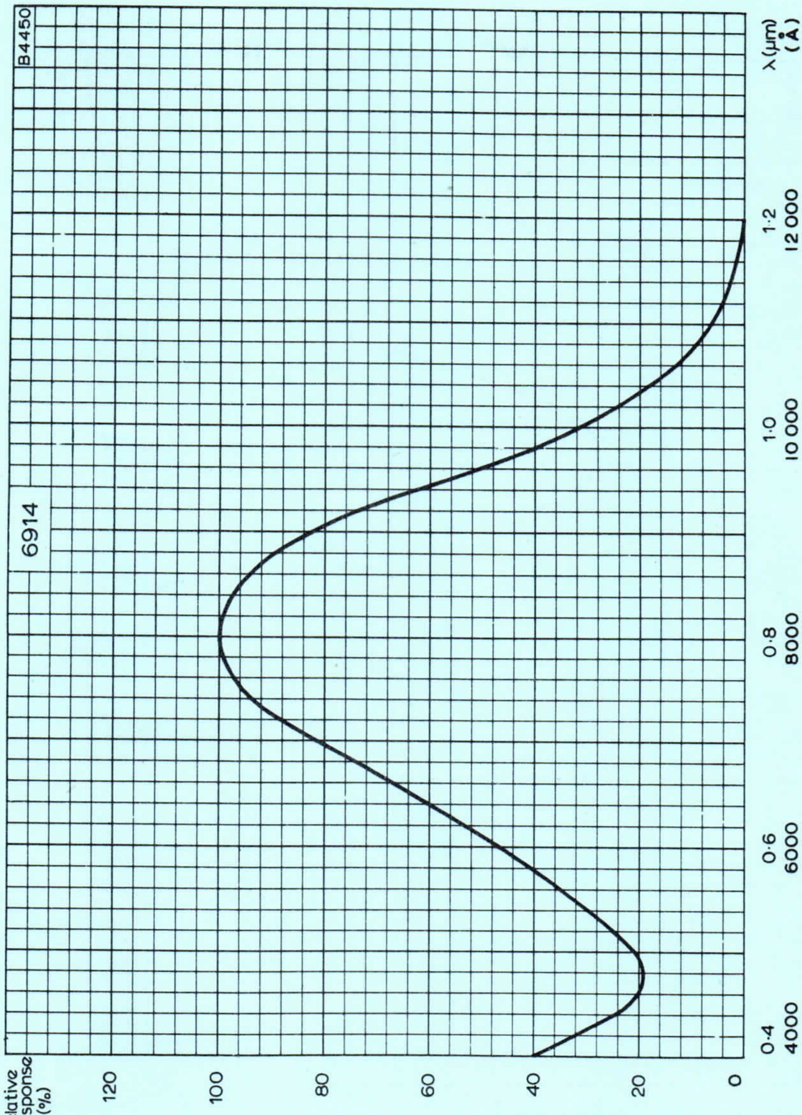


PHOTOCATHODE RELATIVE SPECTRAL EMISSIVITY CURVE

RELATIVE SPECTRAL RESPONSE OF PHOSPHOR

IMAGE CONVERTER TUBE 6929

TENTATIVE DATA

QUICK REFERENCE DATA

Diode image converter tube intended for use in the near infra-red region of the spectrum.

Tube voltage	12	kV
Photocathode	S1 response	
Screen phosphor	P20 TYPE	
Minimum useful cathode diameter	19	mm

To be read in conjunction with
GENERAL OPERATIONAL RECOMMENDATIONS - IMAGE CONVERTER TUBES

PHOTOCATHODE

Surface	Type C, caesium on oxidised silver	
Peak spectral response	0.8 ± 0.1	μm
Cathode area	2.84	cm^2
Minimum useful cathode diameter	19	mm
External radius of curvature	31	mm

SCREEN

Metal-backed

Fluorescent colour	yellow-green (P20 type)	
Persistence	medium short	

The brightness is reduced to 36% (e^{-1}) of the initial peak value 200μs after the excitation is removed.

Minimum useful screen diameter	14.5	mm

FOCUSING Self-focusing electrostatic

CHARACTERISTICS (measured with V_a = 12kV at T_{amb} = 20°C)

Minimum conversion coefficient (see note 1)	0.4	cd/lm irf
Centre magnification (see note 2)	0.74 ± 0.025	
Distortion (see note 3)	5.5 to 10	%
Minimum centre resolution (see note 4)	50	line pairs/mm
Minimum edge resolution (see note 5)	12	line pairs/mm
Maximum background equivalent illumination (see note 6)	12×10^{-3}	lux irf
Maximum dark current	0.02	μA
Maximum axial eccentricity (see note 7)	1.0	mm

TYPICAL OPERATING CONDITIONS

V_a	12	kV
I_a	0.02	μA

Either the anode or the cathode should be earthed depending upon the application.

LIMITING VALUES

v_a (pk) max.	13	kV
V_a max. (continuous operation)	12.5	kV
V_a min. (continuous operation)	9.0	kV
I_a max. (continuous operation)	0.1	μA
*Photocathode illumination		
Continuous	10	lux irf
**intermittent	100	lux irf
T_{amb}		
Maximum	+50	°C
Minimum	-50	°C

*Assuming uniform irradiation of the photocathode.

**A duty factor of 0.3 with a maximum averaging time of 15min. applies.

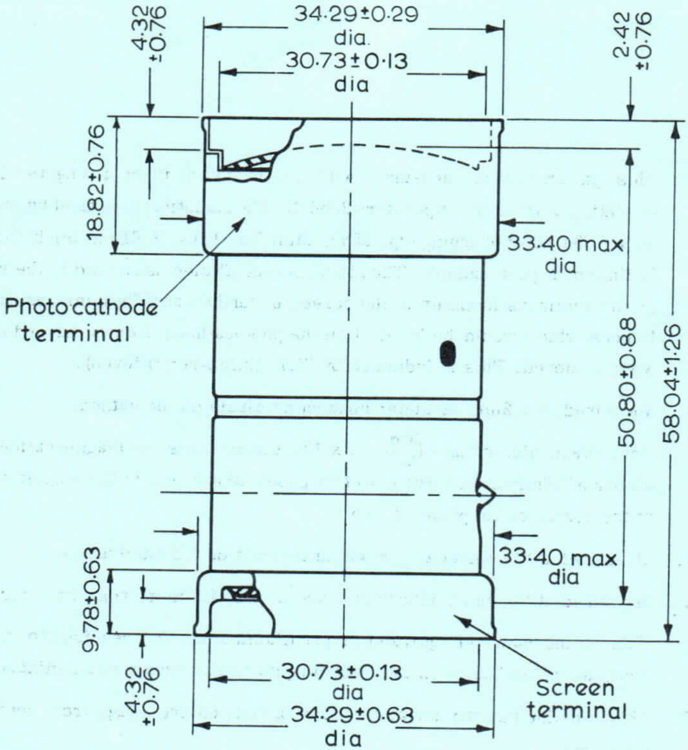
MOUNTING POSITION Any

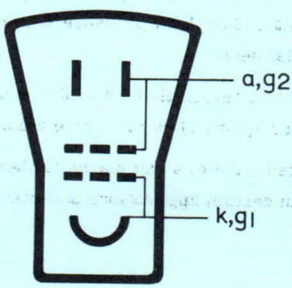
WEIGHT

Tube alone	42 1.5	g oz

NOTES

1. This parameter is measured with the radiation from a tungsten lamp operating at a colour temperature 2854°K. The radiation is filtered by means of a CS94 filter (Corning type 2540, Melt No. 1613, 2.61mm thick) before falling on the photocathode. The conversion coefficient is defined as the ratio of the luminous intensity of the screen in candela and the luminous flux in lumens which would be incident on the photocathode if the infra-red filter were removed. This is indicated by "irf" (infra-red filtered).
2. Measured at 3.2mm diameter concentric circle on the cathode.
3. Percentage distortion = $(\frac{Md}{Mc} - 1) \times 100$ where Md is the magnification at a distance 7.6mm from the centre of the photocathode. Mc is the magnification at the centre of the photocathode.
4. Measured at the photocathode within a circle of 3.2mm diameter.
5. Measured at the photocathode at a distance of 4.75mm from the centre.
6. This is the value of equivalent input illumination (irf) required to give an increase of luminance on the screen equal to the background luminance.
7. This is defined as the deviation of the cathode centre image from centre of the screen.
8. Permanent damage to the tube may result if it is exposed to radiant energy so great as to cause excessive heating of the photocathode.
9. Support for the tube may be provided by a simple clamp arrangement on either terminal. Only light pressure should be applied to avoid damage to the glass metal seals.
10. Connections to the terminals of the tube must not be soldered but should be made by either spring clips or simple clamps.
11. The tube is sensitive to stray magnetic fields which may impair the tube's resolution. In certain applications a μ-metal shield may be required.





All dimensions in mm

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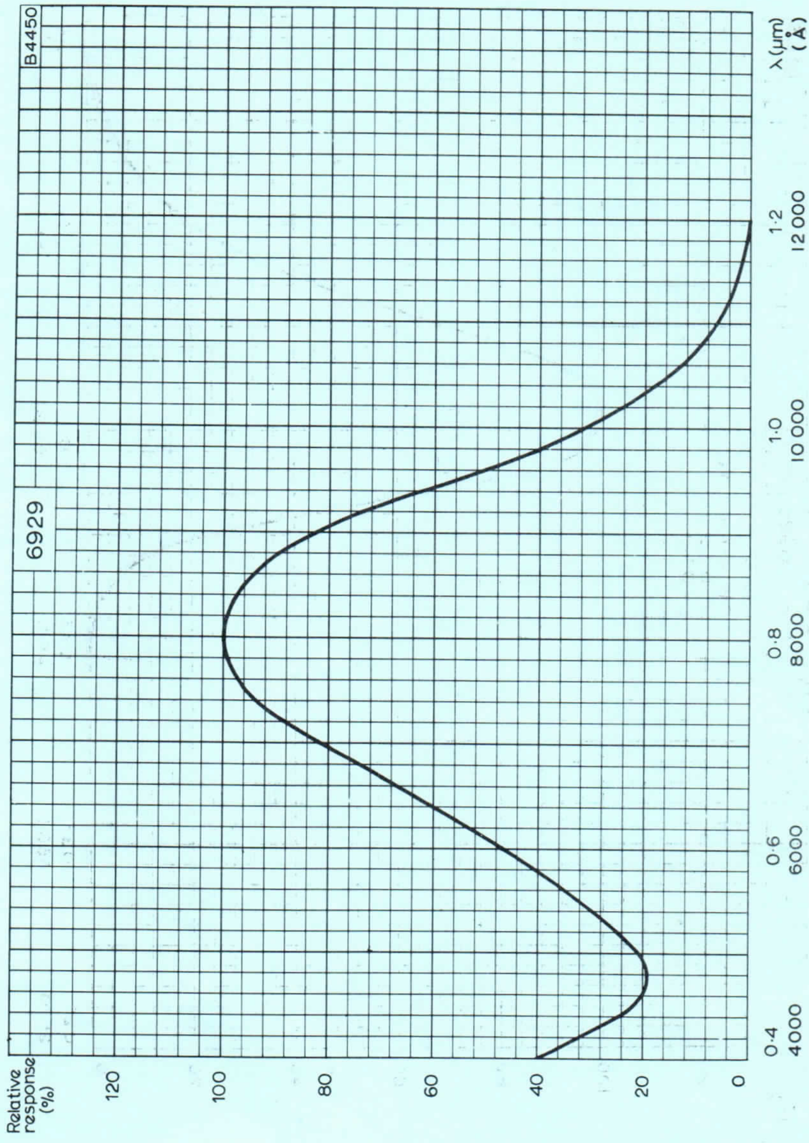
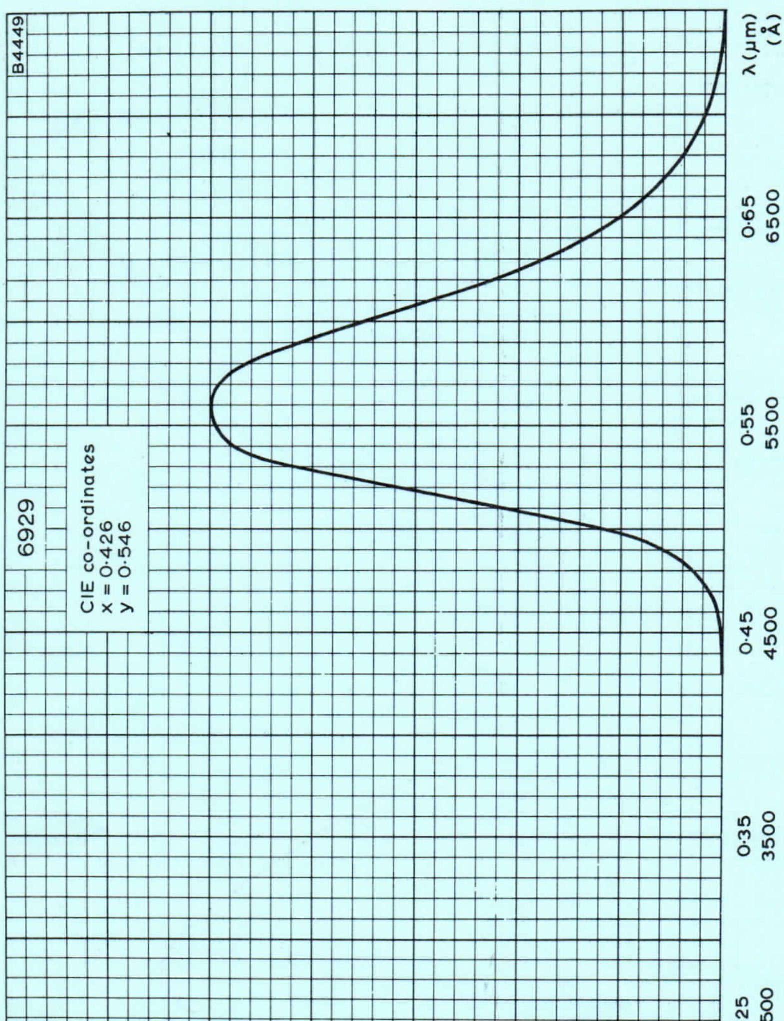


PHOTOCATHODE RELATIVE SPECTRAL EMISSIVITY CURVE



RELATIVE SPECTRAL RESPONSE OF PHOSPHOR

IMAGE CONVERTER TUBE 6929-1

TENTATIVE DATA

QUICK REFERENCE DATA

Diode image converter tube intended for use in the near infra-red region of the spectrum.

Tube voltage	**12**	**kV**
Photocathode	**S1 response**	
Screen phosphor	**P20 TYPE**	
Minimum useful cathode diameter	**19**	**mm**

To be read in conjunction with
GENERAL OPERATIONAL RECOMMENDATIONS - IMAGE CONVERTER TUBES

PHOTOCATHODE

Surface	Type C, caesium on oxidised silver	
Peak spectral response	0.8 ± 0.1	μm
Cathode area	2.84	cm^2
Minimum useful cathode diameter	19	mm
External radius of curvature	31	mm

SCREEN

Metal-backed

Fluorescent colour — yellow-green (P20 type)

Persistence — medium short

The brightness is reduced to 36% (e^{-1}) of the initial peak value 200μs after the excitation is removed.

Minimum useful screen diameter — 14.5 mm

FOCUSING

Self-focusing electrostatic

CHARACTERISTICS (measured with V_a = 12kV at T_{amb} = 20°C)

Minimum conversion coefficient (see note 1)	0.4	cd/lm irf
Centre magnification (see note 2)	0.74 ± 0.025	
Distortion (see note 3)	5.5 to 10	%
Minimum centre resolution (see note 4)	35	line pairs/mm
Minimum edge resolution (see note 5)	12	line pairs/mm
Maximum background equivalent illumination (see note 6)	25×10^{-3}	lux irf
Maximum dark current	0.02	μA
Maximum axial eccentricity (see note 7)	1.0	mm

TYPICAL OPERATING CONDITIONS

V_a	12	kV
I_a	0.02	μA

Either the anode or the cathode should be earthed depending upon the application.

LIMITING VALUES

v_a (pk) max.	12.5	kV
V_a max. (continuous operation)	12	kV
V_a min. (continuous operation)	9.0	kV
I_a max. (continuous operation)	0.1	μA
*Photocathode illumination		
Continuous	10	lux irf
T_{amb}		
Maximum	+40	°C
Minimum	-50	°C

*Assuming uniform irradiation of the photocathode.

MOUNTING POSITION Any

WEIGHT

Tube alone	42	g
	1.5	oz

NOTES

1. This parameter is measured with the radiation from a tungsten lamp operating at a colour temperature 2854°K. The radiation is filtered by means of a CS94 filter (Corning type 2540, Melt No. 1613, 2.61mm thick) before falling on the photocathode. The conversion coefficient is defined as the ratio of the luminous intensity of the screen in candela and the luminous flux in lumens which would be incident on the photocathode if the infra-red filter were removed. This is indicated by "irf" (infra-red filtered)
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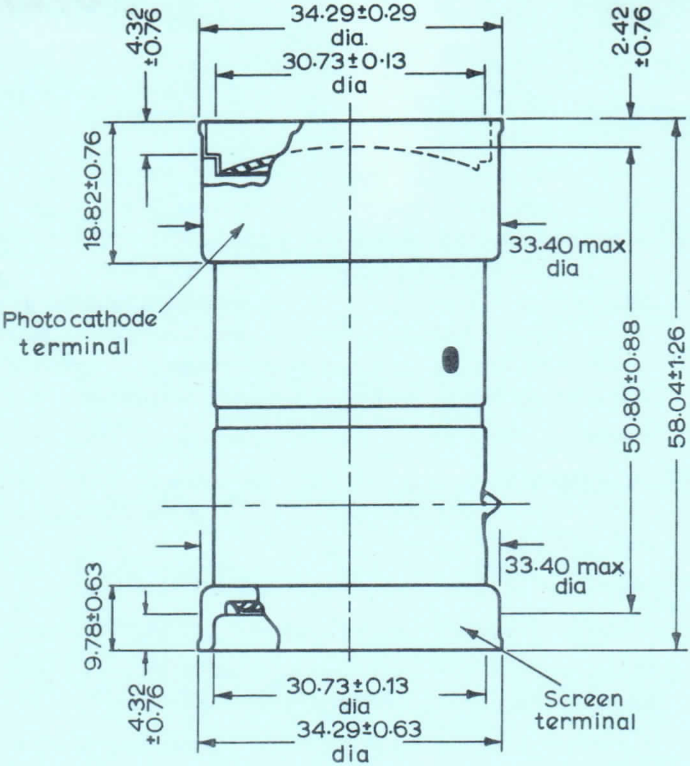

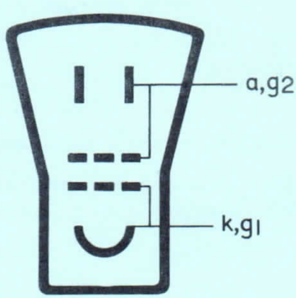

All dimensions in mm

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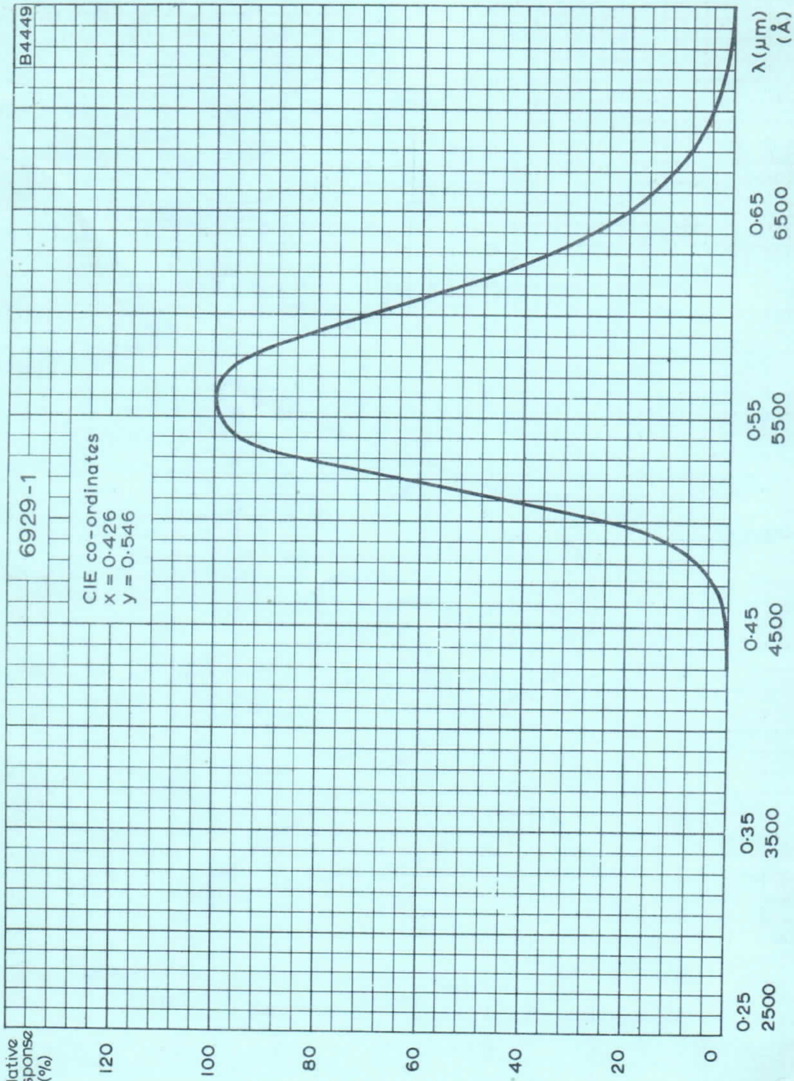
PHOTOCATHODE RELATIVE SPECTRAL EMISSIVITY CURVE



RELATIVE SPECTRAL RESPONSE OF PHOSPHOR