PHILIPS

CATHODE-RAY TUBES

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PHILIPS ELECTRON TUBE DIVISION

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This booklet contains a selection from the Philips Electron Tube Handbook and data of types which are still in the development stage. The technical data of the latter types are given as "Development Sample Data".

The data in this booklet are primarily intended for equipment design.

The fact that a type is included does not imply that it can always be supplied at short notice.

Development samples are distributed without guarantee for further supply. Development sample data represent the characteristics and ratings of development samples and are to be regarded as first indications of the ultimate performance to be achieved by the product in preparation.

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PART 1

GENERAL OPERATIONAL RECOMMENDATIONS
NOMENCLATURE
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GENERAL OPERATIONAL RECOMMENDATIONS
CATHODE-RAY TUBES

GENERAL

Unless otherwise stated the data are given for a nominal tube.

LIMITING VALUES

Unless otherwise stated the tubes are rated according to the absolute maximum rating system.

HEATER

Parallel operation

The heater voltage must be within ±7 % of the nominal value when the supply voltage is at its nominal 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 ±5 %. Should the voltage variation depend on one factor only, the voltage variation must not exceed ±5 %.

Series operation

The heater current must be within ±5 % of the nominal value when the supply voltage is at its nominal 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.

HEATER (continued)

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 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 practise to maintain the heater as close to its published ratings as possible. Furthermore in all types of equipment closer adjustment of heater voltage or current will react favourably upon 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 20 V_{rms}. When the heater is in a series chain or earthed, the 50 c/s impedance between heater and cathode should not exceed 100 kΩ. If the heater is supplied from separate transformer windings the resistance between heater and cathode must not exceed 1 MΩ.

ELECTRODES

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.

ELECTRODE VOLTAGES

Reference point for electrode voltages is the cathode. For cathode drive service the reference point is grid No.1.

Grid cut-off voltages

Values are given for the limits of grid cut-off voltage per unit of the first accelerator voltage. The brightness control voltage should be arranged so that it can handle any tube within the limits shown, at the appropriate first accelerator voltage.

First accelerator voltage

The first accelerator electrode of a so called unipotential lens provides by applying a fixed voltage independent focus and brightness controls. Care should be taken not to exceed the maximum and minimum limits for reasons of reliability and performance.

Deflection blanking electrode voltage

The mean potential of the deflection blanking electrode should be equal to that of the first accelerator.
If applicable the voltage difference (ΔV_{g_3}) given in the data should be applied to the beam blanking electrode to obtain beam blanking of a stated beam current for all tubes of the relevant type.

Focusing voltage

The focusing electrode voltage limits are given in the data. The focus voltage supply should be arranged such that it can handle these limits, so that in any tube the cross-sectional area of the electron-beam on the screen can be optimally displayed. As the focus current is very limited a high resistance series chain may be used.

Astigmatism control electrode voltage

To achieve optimum performance under all conditions it is desirable to apply a voltage for control of astigmatism (a difference in potential of this electrode and the y plates). The required range to cover any tube is given in the relevant data.

Beam centring electrode voltage

The beam centring electrode facilitates the ~~possibility to~~ centre the scan in x-direction with respect to the geometric centre of the faceplate by applying a voltage, the limits of which are given in the relevant data, to this electrode. Optimum condition is obtained when the brightness at both left and right edges of the scan are equal.

Deflection plate shield voltage

It is essential that the deflection plate shield voltage equals the mean y plates voltage.

Geometry control electrode voltage

By varying the potential of this electrode the necessary range of which is given in the relevant data the possible occurrence of pin-cushion and barrel-pattern distortion can be controlled.

Deflection voltages

For optimum performance it is essential that true symmetrical voltages are applied. It should further be noted that the mean x and y plate potentials must be equal. Moreover the deflection plate shield voltage, the mean astigmatism control voltage, if applicable the mean beam centring electrode voltage and the geometry electrode voltage should also be equal to the mean x and y plate potentials. 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.

Raster distortion and its determination

Limits of raster distortion are given for most tubes.
A graticule, consisting of concentric rectangles 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.

Measuring procedure:

a) Shift the x-trace to the centre of the graticule.

b) Align horizontal centre line of graticule with the centre line of the x-trace.

c) Shift x-trace vertically between resp. upper and lower two horizontal lines of graticule.
The centre of the x-trace now will not fall outside the area bounded by the horizontal graticule lines.

d) Without moving the graticule, switch to a vertical trace and shift this trace horizontally (resp. left and right) between the pairs of vertical lines of the graticule, and also now the centre of the y-trace will not fall outside the area bounded by the vertical graticule lines.

e) Focus and astigmatism will be adjusted for optimum performance.

f) Pattern geometry correction will be adjusted for optimum performance in the sense of minimizing simultaneously the deviation of the centre of x- respectively y-trace.

Linearity

The linearity is defined as the sensitivity at a deflection of 75 % of the useful scan with respect to differ from the sensitivity at a deflection of 25 % of the useful scan. These sensitivities will not differ by more than the indicated value.

Post deflection shield voltage

In order to optimize contrast in mesh tubes a fixed negative voltage with respect to the geometry control electrode voltage should be applied. The range is given in the data.

Helix resistance

In order to calculate the high tension supply a minimum resistance is given in the data.

Final accelerator voltage

Tubes with PDA are designed for a given final accelerator voltage to astigmatism control electrode voltage ratio. Operation at higher ratio may result in changes in deflection uniformity and pattern distortion.

High tension supply

In order to avoid damage of the screen it is important that prior to the high tension a deflection voltage e.g. the time base voltage is applied.

LINE WIDTH

Shrinking raster method. Conditions as given in the relevant data.
Focus and astigmatism potentials should be adjusted for optimum performance. Optimum performance is that adjustment which will simultaneously minimize the horizontal and vertical trace widths at the centre of the useful scan.
The raster shall be compressed until the line structure first disappears or begins to overlap or show reverse line structure.
The line width is equal to the quotient of the width of the compressed pattern transverse to the line structure divided by the number of lines which are being scanned.
In older types the line width is measured on a circle with the aid of a microscope.

CAPACITANCES

Unless otherwise stated the values given are nominal values measured on a cold tube on the tube contacts. The contacts and measuring leads or sockets being screened.

MOUNTING

Unless otherwise stated the mounting position is any. However, the tube should not be supported by the base alone and under no circumstances should the socket be allowed to support the tube.
To avoid dangerous glass strain care should be taken when installing the tube.

Shielding

The tubes must be shielded against electrical and magnetic fields.
Special attention should be paid to the mounting of transformers, coils etc.

SCREEN

To prevent screen burn stationary or slow moving spots together with high screen currents should be avoided.
If measurements are to be made under high ambient light conditions it is advisable to use a contrast improving filter and or a light hood.

TRACKING ERROR

Tracking is the ability of a multigun tube to superimpose simultaneously information from each gun.
Tracking error is the maximum allowable distance between the displays of any two guns.

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RATING SYSTEMS
(in accordance with I.E.C. publication 134)

Absolute maximum rating system

Absolute maximum ratings are limiting values of operating and environmental conditions applicable to any electronic device of a specified type as defined by its published data, which 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 electronic 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 supply voltage variation, equipment component variation, equipment control adjustment, load variations, signal variation, environmental conditions, and variations in characteristics of the device under consideration and of all other electronic devices in the equipment.

Design-maximum rating system

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

These values are chosen by the device manufacturer to provide acceptable serviceability of the device, taking responsibility for the effects of changes in operating conditions due to variations in the characteristics of the electronic device under consideration.

The equipment manufacturer should design so that, initially and throughout life, no design-maximum value for the intended service is exceeded with a bogey device under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, variation in characteristics of all other devices in the equipment, equipment control adjustment, load variation, signal variation and environmental conditions.

Design-centre rating system

Design-centre ratings are limiting values of operating and environmental conditions applicable to a bogey electronic device of a specified type as defined by its published data, and should not be exceeded under normal conditions.

These values are chosen by the device manufacturer to provide acceptable serviceability of the device in average applications, taking responsibility for normal changes in operating conditions due to rated supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of all electronic devices.

The equipment manufacturer should design so that, initially, no design-centre value for the intended service is exceeded with a bogey electronic device in equipment operating at the stated normal supply-voltage.

NOMENCLATURE

Two type nomenclature systems are currently in existance for our C.R. tubes. All future tubes will have numbers in the "new system", earlier tubes will retain numbers in the "old system".

NEW CODE SYSTEM

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 prime appplication of the tube.

A - Television display tube for domestic application

D - Oscilloscope tube - single trace

E - Oscilloscope tube - multiple trace

F - Radar display tube - direct view

L - Display storage tube

M - T.V. display tube for professional application - direct view

P - Display tube for professional application - projection

Q - Flying spot scanner

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

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

The second group of letters indicates the properties if the phosphor screen. The first letter denotes the colour of the fluorescence or phosphorescence in the case of long or very long afterglow screens.

The second letter of this group is a serial letter to denote other specific differences in screen properties.

A - Purple - reddish purple - bluish purple

B - Blue - purplish blue - greenish blue

D - Blue green

G - Green - bluish green - yellowish green

K - Yellow - green

L - Orange - Orange pink

R - Red - reddish orange - red purple - purplish red - pink - purplish pink

Y - Yellow - greenish yellow - yellowish orange

W - White screen for T.V. display tubes

X - Three-colour screen for T.V. display tubes

OLD SYSTEM

The type number consists of two letters followed by two sets of figures. The first letter indicates the method of focusing and deflection:

A - Electrostatic focusing and electromagnetic deflection

B - Electrostatic focusing and electrostatic deflection

M - Electromagnetic focusing and electromagnetic deflection

The second letter indicates the properties of the phosphor screen.

See also section "Screen Phosphors"

The first group of figures:

for round tubes: screen diameter in cm

for rectangular tubes: screen diagonal in cm

The second group of figures denotes the serial number.

LIST OF SYMBOLS

Symbols denoting electrodes and electrode connections

Heater or filament	f
Cathode	k
Grid Grids are distinguished by means of an additional numeral; the electrode nearest to the cathode having the lowest number.	g
Deflection plates intended for deflection in horizontal direction.	x_1, x_2
Deflection plates intended for deflection in vertical direction. Sectioned deflection plates are indicated by an additional decimal e.g. $y_{1.1}$ $y_{1.2}$ and $y_{2.1}$ $y_{2.2}$	y_1, y_2
External conductive coating	m
Fluorescent screen	ℓ
Tube pin which must not be connected externally	i.c.
Tube pin which may be connected externally	n.c.

Symbols denoting voltages

Symbol for voltage, followed by an index denoting the relevant electrode.	V
Heater or filament voltage	V_f
Peak value of a voltage	V_p
Peak to peak value of a voltage	V_{pp}

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Symbols denoting currents

Remark I	The positive electrical current is directed opposite to the direction of the electron current.
Remark II	The symbols quoted represent the average values of the concerning currents unless otherwise stated.

Symbol for current followed by an index denoting the relevant electrode.	I
Heater or filament current	I_f

Symbols denoting powers

Dissipation of the fluorescent screen	W_ℓ
Grid dissipation	W_g

Symbols denoting capacitances

See I.E.C. Publication 100.

Symbols denoting resistances

Symbol for resistance followed by an index for the relevant electrode pair. When only one index is given the second electrode is the cathode.	R

When R is replaced by Z the "resistance should read "impedance"

Symbols denoting various quantities

Brightness	B
Frequency	f
Magnetic field strength	H
Deflection factor	M

PART 2

INSTRUMENT CATHODE-RAY TUBES

PREFERRED TYPES

INSTRUMENT CATHODE-RAY TUBES					
Screen diameter	3 cm (1")		DH3-91		
	7 cm (3")	DB7-11 DB7-78	DH7-11 DG7-31 DG7-32 DH7-78	DN7-11 DN7-78	DP7-11 DP7-78
	10 cm (4")	D10-11BE D10-12BE E10-12BE	D10-11GH D10-12GH E10-12GH	D10-11GP D10-12GP E10-12GP	D10-11GM D10-12GM E10-12GM
	13 cm (5")	D13-16BE D13-16BE D13-17BE D13-21BE D13-24BE	D13-16GH D13-17GH D13-21GH D13-23GH D13-26GH D13-27GH	D13-16GP D13-17GP D13-21GP D13-26GP	D13-16GM D13-17GM D13-21GM
	14 cm ($5\frac{1}{2}$")		D14-10GH		

INSTRUMENT CATHODE-RAY TUBE

Oscilloscope tube with 10 cm diameter flat face-plate and post deflection acceleration by means of a helical electrode. The low heater consumption together with the high sensitivity and short overall length render this tube suitable for transistorised equipment.

QUICK REFERENCE DATA					
Final accelerator voltage		$V_{g6(\ell)}$	=	4	kV
Display area	horizontal		full scan		
	vertical		=	6	cm
Deflection factor,	horizontal	M_x	=	27.5	V/cm
	vertical	M_y	=	9.8	V/cm

SCREEN

	Colour	Persistence
D10-11BE	blue	medium short
D10-11GH	green	medium short
D10-11GM	yellowish green	long
D10-11GP	bluish green	medium short

Useful screen diameter min. 85 mm

Useful scan at $V_{g6(\ell)}/V_{g4} = 4$

horizontal	full scan		
vertical	min.	60	mm

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

HEATING

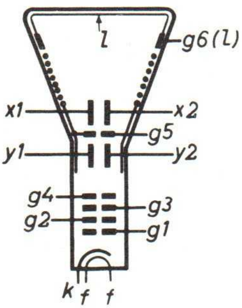
Indirect by A.C. or D.C.; parallel supply

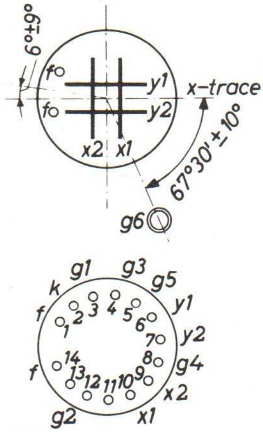
Heater voltage	V_f	=	6.3	V
Heater current	I_f	=	90	mA

7Z2 5496

MECHANICAL DATA

Dimensions in mm





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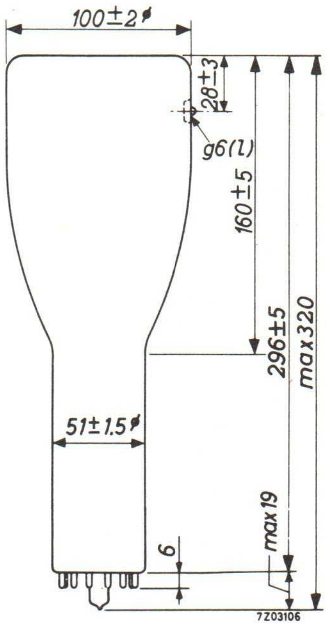

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Mounting position: any

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

Base 14 pin all glass

Dimensions and connections

Overall length (also inclusive socket type 55566)	max.	320	mm
Face diameter	max.	102	mm

Net weight	approx.	480	g

Accessories

Socket (supplied with the tube)	type	55566
Final accelerator contact connector	type	55560
Mu-metal shield	type	55541

7Z2 5497

CAPACITANCES

x_1 to all other elements except x_2	$C_{x_1(x_2)}$	=	3.5	pF
x_2 to all other elements except x_1	$C_{x_2(x_1)}$	=	3.5	pF
y_1 to all other elements except y_2	$C_{y_1(y_2)}$	=	2.5	pF
y_2 to all other elements except y_1	$C_{y_2(y_1)}$	=	3.0	pF
x_1 to x_2	$C_{x_1x_2}$	=	2.0	pF
y_1 to y_2	$C_{y_1y_2}$	=	1.7	pF
Control grid to all other elements	C_{g_1}	=	4.5	pF
Cathode to all other elements	C_k	=	3.0	pF

FOCUSING electrostatic

DEFLECTION double electrostatic

x plates symmetrical

y plates symmetrical

If use is made of the full deflection capabilities of the tube the deflection plates will intercept part of the electron beam; hence a low impedance deflection plate drive is desirable.

Angle between x and y traces $90^\circ \pm 1^\circ$

LINE WIDTH

Measured with the shrinking raster method in the centre of the screen

Final accelerator voltage	$V_{g_6(\ell)}$	=	4000	V
Astigmatism control electrode voltage	V_{g_4}	=	1000	V
First accelerator voltage	V_{g_2}	=	1000	V
Beam current	$I_{(\ell)}$	=	10	μA
Line width	l.w.	=	0.35	mm

HELIX

Post deflection accelerator helix resistance = min. 50 MΩ

7Z2 5498

TYPICAL OPERATING CONDITIONS

Final accelerator voltage	$V_{g6(\ell)}$	=	4000	V
Geometry control electrode voltage	V_{g5}	=	1000 ± 100	V [1]
Astigmatism control electrode voltage	V_{g4}	=	1000 ± 50	V [2]
Focusing electrode voltage	V_{g3}	=	50 to 200	V
First accelerator voltage	V_{g2}	=	1000	V
Control grid voltage for visual extinction of focused spot	$-V_{g1}$	=	25 to 67	V
Deflection factor				
horizontal	M_x	=	24 to 31	V/cm
vertical	M_y	=	8.6 to 11	V/cm
Deviation of linearity of deflection		=	max. 2	% [3]
Geometry distortion			See note 4	
Useful scan				
horizontal			full scan	
vertical		=	min. 60	mm

CIRCUIT DESIGN VALUES

Focusing voltage	V_{g3}	=	50 to 200	V per kV of V_{g4}
Control grid voltage for visual extinction of focused spot	$-V_{g1}$	=	25 to 67	V per kV of V_{g2}
Deflection factor at $V_{g6(\ell)}/V_{g4} = 4$				
horizontal	M_x	=	24 to 31	V/cm per kV of V_{g4}
vertical	M_y	=	8.6 to 11	V/cm per kV of V_{g4}
Control grid circuit resistance	R_{g1}	=	max. 1.5	MΩ
Focusing electrode current	I_{g3}	=	−30 to +30	μA [5]

[1] [2] [3] [4] [5] See page 5

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LIMITING VALUES (Absolute max. rating system)

Final accelerator voltage	$V_{g6(\ell)}$	= max.	5000	V
		= min.	1500	V
Geometry control electrode voltage	V_{g5}	= max.	2200	V
Astigmatism control electrode voltage	V_{g4}	= max.	2200	V
		= min.	900	V
Focusing electrode voltage	V_{g3}	= max.	1500	V
First accelerator voltage	V_{g2}	= max.	2200	V
Control grid voltage				
negative	$-V_{g1}$	= max.	200	V
positive	V_{g1}	= max.	0	V
Cathode to heater voltage				
cathode positive	$V_{+k/f-}$	= max.	100	V
cathode negative	$V_{-k/f+}$	= max.	15	V
Voltage between astigmatism control electrode and any deflection plate	$V_{g4/x}$	= max.	500	V
	$V_{g4/y}$	= max.	500	V
Cathode current, average	I_k	= max.	300	μA
Screen dissipation	W_ℓ	= max.	3	mW/cm^2
Ratio $V_{g6(\ell)}/V_{g4}$	$V_{g6(\ell)}/V_{g4}$	= max.	4	
Ratio V_{g2}/V_{g4}	V_{g2}/V_{g4}	= max.	1	
		= min.	1	

1) This tube is designed for optimum performance when operating at the ratio $V_{g6(\ell)}/V_{g4} = 4$. Operation at other ratio may result in changes in deflection uniformity and geometry distortion. The geometry control electrode voltage should be adjusted for optimum performance. For any necessary adjustment its potential will be within the stated range.

2) The astigmatism control electrode voltage should be adjusted for optimum spot shape. For any necessary adjustment its potential will be within the stated range.

3) 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 the indicated value.

4) A graticule, consisting of concentric rectangles of 50 mm x 60 mm and 48.4 mm x 58.4 mm 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.

5) Values to be taken into account for the calculation of the focus potentiometer.

7Z2 5500

INSTRUMENT CATHODE-RAY TUBE

Oscilloscope tube with 10 cm diameter flat faceplate and post deflection acceleration by means of a helical electrode. The tube is intended for small compact oscilloscopes.

QUICK REFERENCE DATA					
Final accelerator voltage		$V_{g6(\ell)}$	=	4000	V
Display area	horizontal		=	full scan	
	vertical		=	6	cm
Deflection factor,	horizontal	M_x	=	27.5	V/cm
	vertical	M_y	=	9.8	V/cm

SCREEN

	Colour	Persistence
D10-12BE	blue	medium short
D10-12GH	green	medium short
D10-12GP	bluish green	medium short
D10-12GM	yellowish green	long

Useful screen diameter min. 85 mm

Useful scan at $V_{g6(\ell)}/V_{g4} = 4$

horizontal full scan

vertical min. 60 mm

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

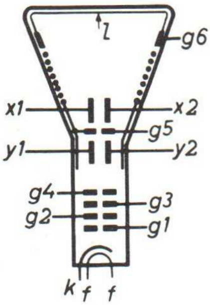
HEATING

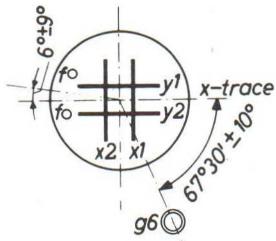
Indirect by A.C. or D.C.; parallel supply

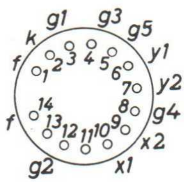
Heater voltage	V_f	=	6.3	V
Heater current	I_f	=	300	mA

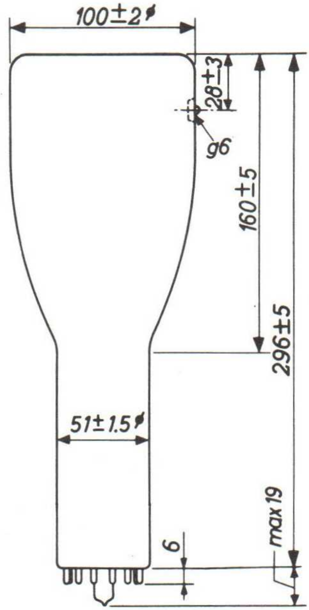
7Z2 5501

MECHANICAL DATA (Dimensions in mm)









Mounting position: any

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

Base 14 pin all glass

Dimensions and connections

Overall length (inclusive socket 55566)	max.	320	mm
Face diameter	max.	102	mm

Net weight approx. 480 g

Accessories

Socket (supplied with the tube)	type	55566
Final accelerator contact connector	type	55560
Mu-metal shield	type	55541

7Z2 5502

TYPICAL OPERATING CONDITIONS

Final accelerator voltage	$V_{g6(\ell)}$	=	4000	V
Geometry control electrode voltage	V_{g5}	=	1000 ± 100	V [1]
Astigmatism control electrode voltage	V_{g4}	=	1000 ± 50	V [2]
Focusing electrode voltage	V_{g3}	=	50 to 200	V
First accelerator voltage	V_{g2}	=	1000	V
Control grid voltage for visual extinction of focused spot	$-V_{g1}$	=	25 to 67	V
Deflection factor				
horizontal	M_x	=	24 to 31	V/cm
vertical	M_y	=	8.6 to 11	V/cm
Deviation of linearity of deflection		=	max. 2	% [3]
Geometry distortion			See note 4	
Useful scan				
horizontal		=	full scan	
vertical		=	min. 60	mm

CIRCUIT DESIGN VALUES

Focusing voltage	V_{g3}	=	50 to 200	V per kV of V_{g4}
Control grid voltage for visual extinction of focused spot	$-V_{g1}$	=	25 to 67	V per kV of V_{g2}
Deflection factor at $V_{g6(\ell)}/V_{g4} = 4$				
horizontal	M_x	=	24 to 31	V/cm per kV of V_{g4}
vertical	M_y	=	8.6 to 11	V/cm per kV of V_{g4}
Control grid circuit resistance	R_{g1}	=	max. 1.5	MΩ
Focusing electrode current	I_{g3}	=	-30 to +30	μA [5]

[1][2][3][4][5] See page 6

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CAPACITANCES

x_1 to all other elements except x_2	$C_{x_1(x_2)}$	=	4.0	pF
x_2 to all other elements except x_1	$C_{x_2(x_1)}$	=	4.0	pF
y_1 to all other elements except y_2	$C_{y_1(y_2)}$	=	3.0	pF
y_2 to all other elements except y_1	$C_{y_2(y_1)}$	=	3.0	pF
x_1 to x_2	$C_{x_1x_2}$	=	2.0	pF
y_1 to y_2	$C_{y_1y_2}$	=	1.7	pF
Control grid to all other elements	C_{g_1}	=	5.0	pF
Cathode to all other elements	C_k	=	3.0	pF

FOCUSING electrostatic

DEFLECTION double electrostatic

x plates symmetrical

y plates symmetrical

If use is made of the full deflection capabilities of the tube the deflection plates will intercept part of the electron beam; hence a low impedance deflection plate drive is desirable.

Angle between x and y traces $90^\circ \pm 1^\circ$

LINE WIDTH

Measured with the shrinking raster method in the centre of the screen

Final accelerator voltage	$V_{g_6(\ell)}$	=	4000	V
Astigmatism control electrode voltage	V_{g_4}	=	1000	V
First accelerator voltage	V_{g_2}	=	1000	V
Beam current	$I_{(\ell)}$	=	10	μA
Line width	l.w.	=	0.35	mm

HELIX

Post deflection accelerator helix resistance min. 50 MΩ

7Z2 5504

LIMITING VALUES (Absolute max. rating system)

Final accelerator voltage	$V_{g6(\ell)}$	= max.	5000	V
		= min.	1500	V
Geometry control electrode voltage	V_{g5}	= max.	2200	V
Astigmatism control electrode voltage	V_{g4}	= max.	2200	V
		= min.	900	V
Focusing electrode voltage	V_{g3}	= max.	1500	V
First accelerator voltage	V_{g2}	= max.	2200	V
Control-grid voltage				
negative	$-V_{g1}$	= max.	200	V
positive	V_{g1}	= max.	0	V
Cathode to heater voltage				
cathode positive	$V_{+k/f-}$	= max.	200	V
cathode negative	$V_{-k/f+}$	= max.	125	V
Voltage between astigmatism control electrode and any deflection plate	$V_{g4/x}$	= max.	500	V
	$V_{g4/y}$	= max.	500	V
Screen dissipation	W_{ℓ}	= max.	3	mW/cm^2
Ratio $V_{g6(\ell)}/V_{g4}$	$V_{g6(\ell)}/V_{g4}$	= max.	4	
Ratio V_{g2}/V_{g4}	V_{g2}/V_{g4}	= max.	1	
		= min.	1	

7Z2 5505

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1) This tube is designed for optimum performance when operating at the ratio $V_{g_6}(\ell)/V_{g_4} = 4$. Operation at other ratio may result in changes in deflection uniformity and geometry distortion. The geometry control electrode voltage should be adjusted for optimum performance. For any necessary adjustment its potential will be within the stated range.

2) The astigmatism control electrode voltage should be adjusted for optimum spot shape. For any necessary adjustment its potential will be within the stated range.

3) 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 the indicated value.

4) A graticule, consisting of concentric rectangles of 50 mm x 60 mm and 48.4 mm x 58.4 mm 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.

5) Values to be taken into account for the calculation of the focus potentiometer.

7Z2 5506

INSTRUMENT CATHODE-RAY TUBE

13 cm diameter flat faced oscilloscope tube with thin metal backing and post deflection acceleration by means of a helical electrode.

QUICK REFERENCE DATA				
Final accelerator voltage	$V_{g7(\ell)}$	=	4000	V
Display area		=	6x10	cm
Deflection factor, horizontal	M_x	=	22.9	V/cm
vertical	M_y	=	5.9	V/cm

SCREEN

	Colour	Persistence
D13-15BE	blue	medium short
D13-15GH	green	medium short
D13-15GP	bluish green	medium short
D13-15GM	yellowish green	long

Useful screen diameter	min.	114	mm
Useful scan at $V_{g7(\ell)}/V_{g4} = 2$			
horizontal	min.	100	mm
vertical	min.	60	mm

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

HEATING

Indirect by A.C. or D.C.; parallel supply

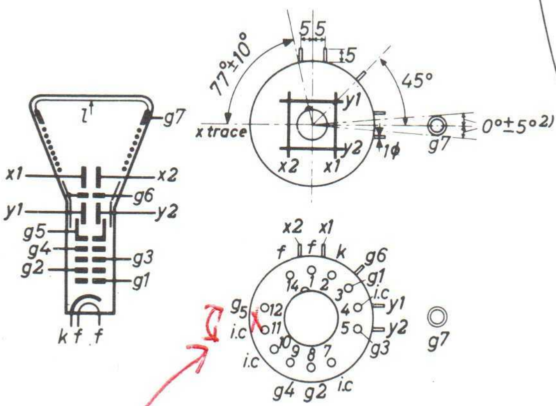
Heater voltage	V_f	=	6.3	V
Heater current	I_f	=	300	mA

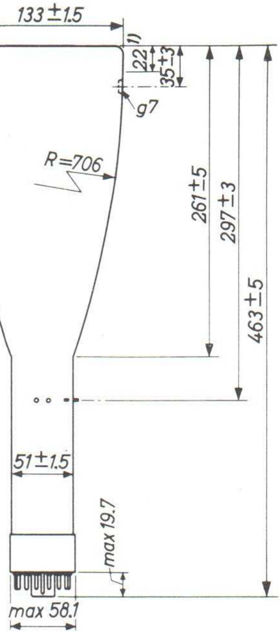
7Z2 5507

MECHANICAL DATA (Dimensions in mm)

1) Straight part of the bulb.

2) Location of the recessed cavity button contact with respect to the X-trace.





Mounting position : any

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

Base — Diheptal medium shell

Dimensions and connections

Overall length	max.	468	mm
Face diameter	max.	134.5	mm

Net weight — approx. 910 g

Accessories

Socket	type	5914/20
Final accelerator contact connector	type	55560
Side contact connector	type	55561
Mu-metal shield	type	55551

7Z2 5508

CAPACITANCES

x_1 to all other elements except x_2	$C_{x_1(x_2)}$	=	2.8	pF
x_2 to all other elements except x_1	$C_{x_2(x_1)}$	=	2.8	pF
y_1 to all other elements except y_2	$C_{y_1(y_2)}$	=	2.8	pF
y_2 to all other elements except y_1	$C_{y_2(y_1)}$	=	2.8	pF
x_1 to x_2	$C_{x_1x_2}$	=	1.9	pF
y_1 to y_2	$C_{y_1y_2}$	=	1.5	pF
Control grid to all other elements	C_{g_1}	=	5.5	pF
Cathode to all other elements	C_k	=	3.5	pF

FOCUSING electrostatic

DEFLECTION double electrostatic

x plates symmetrical

y plates symmetrical

If use is made of the full deflection capabilities of the tube the deflection plates will intercept part of the electron beam; hence a low impedance deflection plate drive is desirable.

Angle between x and y traces $90^o \pm 1^o$

LINE WIDTH

Measured with the shrinking raster method in the centre of the screen

Final accelerator voltage	$V_{g7(\ell)}$	=	4000	V
Astigmatism control electrode voltage	V_{g_4}	=	2000	V
First accelerator voltage	V_{g_2}	=	2000	V
Beam current	$I_{(\ell)}$	=	10	μA
Line width	l.w.	=	0.5	mm

HELIX

Post deflection accelerator helix resistance min. 300 MΩ

7Z2 5509

TYPICAL OPERATING CONDITIONS

Final accelerator voltage	$V_{g_7(\ell)}$	=	4000	V
Geometry control electrode voltage	V_{g_6}	=	2000 ± 200	V [1]
Deflection plate shield voltage	V_{g_5}	=	2000	V [2]
Astigmatism control electrode voltage	V_{g_4}	=	2000 ± 100	V [3]
Focusing electrode voltage	V_{g_3}	=	220 to 710	V
First accelerator voltage	V_{g_2}	=	2000	V
Control grid voltage for visual extinction of focused spot	$-V_{g_1}$	=	60 to 96	V
Deflection factor				
horizontal	M_x	=	19.8 to 26.5	V/cm
vertical	M_y	=	5.1 to 6.7	V/cm
Deviation of linearity of deflection		=	max. 2	% [4]
Geometry distortion			See note 5	
Useful scan				
horizontal		=	min. 100	mm
vertical		=	min. 60	mm

CIRCUIT DESIGN VALUES

Focusing voltage	V_{g_3}	=	110 to 355	V per kV of V_{g_4}
Control grid voltage for visual extinction of focused spot	$-V_{g_1}$	=	30 to 48	V per kV of V_{g_2}
Deflection factor at $V_{g_7(\ell)}/V_{g_4} = 2$				
horizontal	M_x	=	11.9 to 15.6	V/cm per kV of V_{g_4}
vertical	M_y	=	3.3 to 4.0	V/cm per kV of V_{g_4}
Control grid circuit resistance	R_{g_1}	=	max. 1.5	MΩ
Deflection plate circuit resistance	R_x, R_y	=	max. 5	MΩ
Focusing electrode current	I_{g_3}	=	-15 to +10	μA [6]

[1][2][3][4][5][6] See page 6

7Z2 5510

LIMITING VALUES (Absolute max. rating system)

Final accelerator voltage	$V_{g7(\ell)}$	= max.	8800	V
		= min.	2500	V
Geometry control electrode voltage	V_{g6}	= max.	2200	V
Deflection plate shield voltage	V_{g5}	= max.	2200	V
Astigmatism control electrode voltage	V_{g4}	= max.	2200	V
		= min.	1000	V
Focusing electrode voltage	V_{g3}	= max.	1500	V
First accelerator voltage	V_{g2}	= max.	2200	V
Control grid voltage				
negative	$-V_{g1}$	= max.	200	V
positive	V_{g1}	= max.	0	V
positive peak	V_{g1p}	= max.	2	V
Cathode to heater voltage				
cathode positive	$V_{+k/f-}$	= max.	200	V
cathode negative	$V_{-k/f+}$	= max.	125	V
Voltage between astigmatism control electrode and any deflection plate	V_{g}/x	= max.	500	V
	V_{g}/y	= max.	500	V
Screen dissipation	W_{ℓ}	= max.	3	mW/cm^2
Ratio $V_{g7(\ell)}/V_{g4}$	$V_{g7(\ell)}/V_{g4}$	= max.	4	
Ratio V_{g2}/V_{g4}	V_{g2}/V_{g4}	= max.	1	

7Z2 5511

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1) This tube is designed for optimum performance when operating at the ratio $V_{g7(\ell)}/V_{g2}$ = 2. Operation at higher ratio may result in changes in deflection uniformity and geometry distortion. The geometry control electrode voltage should be adjusted for optimum performance. For any necessary adjustment its potential will be within the stated range.

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

3) The astigmatism control electrode voltage should be adjusted for optimum spot shape. For any necessary adjustment its potential will be within the stated range.

4) 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 the indicated value.

5) A graticule, consisting of concentric rectangles of 60 mm x 100 mm and 58.5 mm x 98 mm is aligned with the electrical x axis of the tube. The edges of a raster will fall between these ractangles with optimum correction potentials applied.

6) Values to be taken into account for the calculation of the focus potentiometer.

7Z2 5512

INSTRUMENT CATHODE-RAY TUBE

Oscilloscope tube with flat 13 cm diameter face, post deflection acceleration by means of a helical electrode, metal backed screen, deflection blanking and sectioned y deflector plates. The tube is designed to display high frequencies combined with a high writing speed.

QUICK REFERENCE DATA				
Final accelerator voltage	$V_{g9(\ell)}$	=	10	kV
Display area		=	6x10	cm
Deflection factor, horizontal	M_x	= max.	18	V/cm
vertical	M_y	=	6	V/cm

SCREEN

	Colour	Persistence
D13-16BE	blue	medium short
D13-16GH	green	medium short
D13-16GP	bluish green	medium short

Useful screen diameter	min.	114	mm
Useful scan at $V_{g9(\ell)}/V_{g5} = 6$			
horizontal	min.	100	mm
vertical	min.	60	mm

The useful scan may be shifted vertically to a max. of 5 mm with respect to the geometric centre of the faceplate.

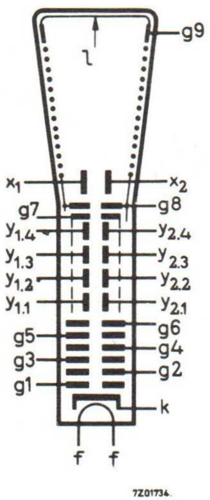
HEATING

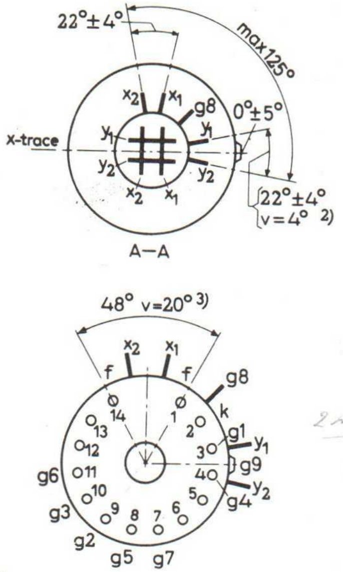
Indirect by A.C. or D.C.; parallel supply

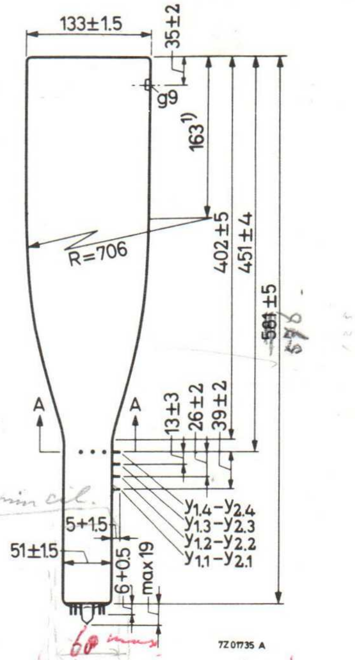
Heater voltage	V_f	=	6.3	V
Heater current	I_f	=	300	mA

7Z2 6032

MECHANICAL DATA Dimensions in mm







Mounting position: any

The socket should under no circumstances be used to support the tube.

Base	14 pin all glass		
Dimensions and connections			
Overall length (inclusive socket 55566)	max.	600	mm
Face diameter	max.	134.5	mm
Net weight:	approx.	1300	g
Accessories			
Socket (supplied with tube)	type	55566	
Final accelerator contact connector	type	55563	
Side contact connector	type	55561	
Mu-metal shield	type	55554	

1) Straight part

2) The tolerance of the position of the neck pins with respect to the x-trace is ± 2°.

3) The tolerance of the position of the base pins with respect to the x-trace is ± 10°.

7Z2 6033

CAPACITANCES

x_1 to all other elements except x_2	$C_{x_1(x_2)}$	= 2.8 pF
x_2 to all other elements except x_1	$C_{x_2(x_1)}$	= 2.8 pF
$y_{1.1}$ to all other elements except $y_2, y_{1.2}, y_{1.3}, y_{1.4}$	$C_{y_{1.1}(y_2, y_{1.2}, y_{1.3}, y_{1.4})}$	= 1.6 pF
$y_{2.1}$ to all other elements except $y_1, y_{2.2}, y_{2.3}, y_{2.4}$	$C_{y_{2.1}(y_1, y_{2.2}, y_{2.3}, y_{2.4})}$	= 1.6 pF
x_1 to x_2	$C_{x_1 x_2}$	= 2.3 pF
$y_{1.1}$ to $y_{2.1}$	$C_{y_{1.1}, y_{2.1}}$	= 0.7 pF
Control grid to all other elements	C_{g_1}	= 5.0 pF
Cathode to all other elements	C_k	= 3.0 pF
g_3 to all other elements	C_{g_3}	= 9 pF

FOCUSING electrostatic

DEFLECTION double electrostatic

x plates symmetrical

y plates symmetrical

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, hence a low impedance deflection plate drive is desirable.

Angle between x and y traces $90^{\circ} \pm 1^{\circ}$

LINE WIDTH

Measured with the shrinking raster method in the centre of the screen

Final accelerator voltage	$V_{g_9(\ell)}$	=	10 000	V
Astigmatism control electrode voltage	V_{g_5}	=	1670	V
First accelerator voltage	V_{g_2}	=	1670	V
Beam current	$I_{g_9(\ell)}$	=	10	μA
Line width	l.w.	=	0.35	mm

HELIX

Post deflection acc. helix resistance min. 300 MΩ

The helix is connected between $g_9(\ell)$ and g_8

7Z2 6034

TYPICAL OPERATING CONDITIONS

Final accelerator voltage	$V_{g_9(\ell)}$	=	10 000	V
Geometry control electrode voltage	V_{g_8}	=	1670 ± 100	V [1]
Deflection plate shield voltage	V_{g_7}	=	1670	V [2]
Beam centring electrode voltage	V_{g_6}	=	1670 + 20	V [3]
Astigmatism control electrode voltage	V_{g_5}	=	1670 + 100	V [4]
Focusing electrode voltage	V_{g_4}	=	230 to 500	V
Deflection blanking electrode voltage	V_{g_3}	=	1670	V
Deflection blanking control voltage	ΔV_{g_3}	=	max. 60	V [5]
First accelerator voltage	V_{g_2}	=	1670	V
Control grid voltage for visual extinction of focused spot	$-V_{g_1}$	=	50 to 120	V
Deflection factor				
horizontal	M_x	=	max. 18	V/cm
vertical	M_y	=	5.6 to 6.6	V/cm
Deviation of linearity of deflection		=	max. 2	% [6]
Geometry distortion	See note 7			
Useful scan				
horizontal		=	100	mm
vertical		=	60	mm

[1] [2] [3] [4] [5] [6] [7] See page

7Z2 6035

LIMITING VALUES (Absolute limits)

Final accelerator voltage	$V_{g9(\ell)}$	= max.	16000	V
		= min.	9000	V
Geometry control electrode voltage	V_{g8}	= max.	2500	V
Deflection plate shield voltage	V_{g7}	= max.	2500	V
Beam centring electrode voltage	V_{g6}	= max.	2500	V
Astigmatism control electrode voltage	V_{g5}	= max.	2500	V
Focusing electrode voltage	V_{g4}	= max.	2500	V
Deflection blanking electrode voltage	V_{g3}	= max.	2500	V
First accelerator voltage	V_{g2}	= max.	2500	V
		= min.	1250	V
Control grid voltage				
negative	$-V_{g1}$	= max.	200	V
positive	V_{g1}	= max.	0	V
positive peak	V_{g1p}	= max.	2	V
Voltage between cathode and heater				
cathode positive	$V_{+k/f-}$	= max.	200	V
cathode negative	$V_{-k/f+}$	= max.	125	V
Ratio $V_{g9(\ell)}/V_{g5}$	$V_{g9(\ell)}/V_{g5}$	= max.	10	
Ratio V_{g2}/V_{g5}	V_{g2}/V_{g5}	= max.	1	
Screen dissipation	W_{ℓ}	= max.	3	mW/cm^2
Average cathode current	I_k	= max.	300	μA

CIRCUIT DESIGN VALUES

Focusing electrode voltage	V_{g4}	= 138 to 300	V per kV of V_{g2}
Control grid voltage for visual extinction of focused spot	$-V_{g1}$	= 24 to 72	V per kV of V_{g2}
Deflection factor at $V_{g9(\ell)}/V_{g5} = 6$			
horizontal	M_x	= max. 10.8	V/cm per kV of V_{g5}
vertical	M_y	= 3.4 to 4.0	V/cm per kV of V_{g5}
Focusing electrode current	I_{g4}	= −10 to +15	μA
Control grid circuit resistance	R_{g1}	= max. 1.5	MΩ
Deflection plate circuit resistance		= max.	kΩ

7Z2 6102

1) This tube is designed for optimum performance when operating at the ratio $V_{g_9}(\ell)/V_{g_5} = 6$.
Operation at other ratio may result in changes in deflection uniformity and geometry distortion.
The geometry control electrode voltage should be adjusted for optimum performance. For any necessary adjustment its potential will be within the stated range.

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

3) The beam centring electrode voltage should be adjusted for equal brightness in the x direction with respect to the electrical centre of the tube.

4) The astigmatism control electrode voltage should be adjusted for optimum spot shape. For any necessary adjustment its potential will be within the stated range.

5) For beam blanking of a beam current $I_{g_9}(\ell)$ of 10 μA.

6) 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 the indicated value.

7) A graticule, consisting of concentric rectangles of 100 mm x 60 mm and 98 mm x 58.2 mm 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.

7Z2 6103

INSTRUMENT CATHODE-RAY TUBE

Oscilloscope tube with flat 13 cm diameter face, post deflection acceleration by means of a helical electrode, metal backed screen, deflection blanking and sectioned y deflector plates. The tube is designed to display high frequencies combined with a high writing speed.

QUICK REFERENCE DATA					
Final accelerator voltage	$V_{g9(\ell)}$	=		10	kV
Display area		=		4x10	cm
Deflection factor, horizontal	M_x	=	max.	18	V/cm
vertical	M_y	=		5	V/cm

SCREEN

	colour	persistence
D13-17BE	blue	medium short
D13-17GH	green	medium short
D13-17GP	bluish green	medium short

Useful screen diameter min. 114 mm

Useful scan at $V_{g9(\ell)}/V_{g5} = 6$

horizontal min. 100 mm

vertical min. 40 mm

The useful scan may be shifted vertically to a max. of 5 mm with respect to the geometric centre of the faceplate.

HEATING

Indirect by A.C. or D.C.; parallel supply

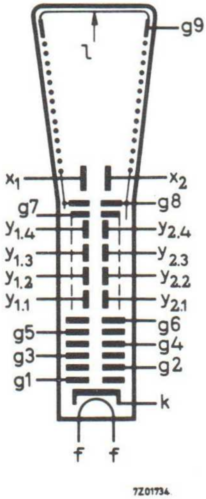
Heater voltage V_f = 6.3 V

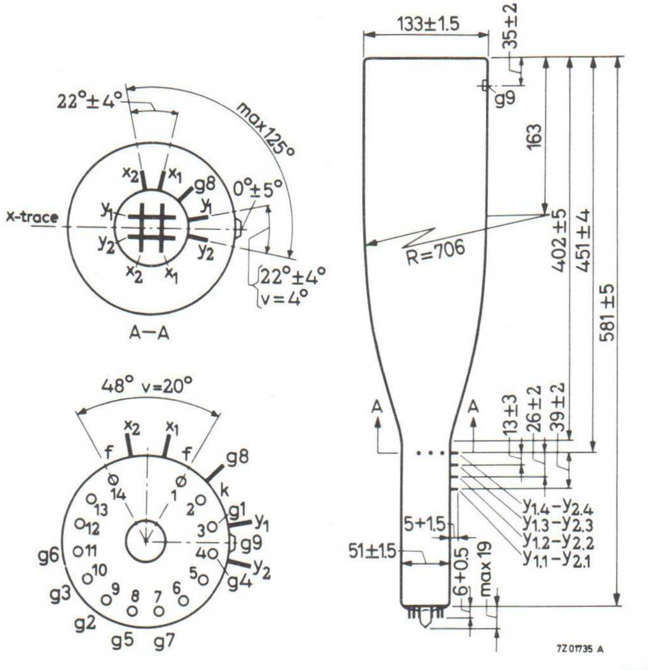
Heater current I_f = 300 mA

7Z2 5513

obsolescent.

MECHANICAL DATA Dimensions in mm





ab D13-16.

Mounting position: any

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

Base	14 pin all glass		
Dimensions and connections			
Overall length (inclusive socket 55566)	max.	600	mm
Face diameter	max.	134.5	mm
Net weight:	approx.	1300	g
Accessories			
Socket (supplied with tube)	type	55566	
Final accelerator contact connector	type	55563	
Side contact connector	type	55561	
Mu-metal shield	type	55554	

7Z2 5514

CAPACITANCES

x_1 to all other elements except x_2	$C_{x_1(x_2)}$	=	2.8 pF
x_2 to all other elements except x_1	$C_{x_2(x_1)}$	=	2.8 pF
$y_{1.1}$ to all other elements except $y_2, y_{1.2}, y_{1.3}, y_{1.4}$	$C_{y_{1.1}(y_2, y_{1.2}, y_{1.3}, y_{1.4})}$	=	1.7 pF
$y_{2.1}$ to all other elements except $y_1, y_{2.2}, y_{2.3}, y_{2.4}$	$C_{y_{2.1}(y_1, y_{2.2}, y_{2.3}, y_{2.4})}$	=	1.7 pF
x_1 to x_2	$C_{x_1 x_2}$	=	2.3 pF
$y_{1.1}$ to $y_{2.1}$	$C_{y_{1.1}, y_{2.1}}$	=	0.7 pF
Control grid to all other elements	C_{g_1}	=	5.0 pF
Cathode to all other elements	C_k	=	3.0 pF
g_3 to all other elements	C_{g_3}	=	9 pF

FOCUSING electrostatic

DEFLECTION double electrostatic

x plates symmetrical

y plates symmetrical

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, hence a low impedance deflection plate drive is desirable.

Angle between x and y traces $90^\circ \pm 1^\circ$

LINE WIDTH

Measured with the shrinking raster method in the centre of the screen

Final accelerator voltage	$V_{g_9(\ell)}$	=	10 000 V
Astigmatism control electrode voltage	V_{g_5}	=	1670 V
First accelerator voltage	V_{g_2}	=	1670 V
Beam current	$I_{g_9(\ell)}$	=	10 µA
Line width	l.w.	=	0.4 mm

HELIX

Post deflection acc. helix resistance min. 300 MΩ

The helix is connected between $g_9(\ell)$ and g_8

7Z2 5515

TYPICAL OPERATING CONDITIONS

Final accelerator voltage	$V_{g9(\ell)}$	=	10 000	V	
Geometry control electrode voltage	V_{g8}	=	1670 ± 100	V	1)
Deflection plate shield voltage	V_{g7}	=	1670	V	2)
Beam centring electrode voltage	V_{g6}	=	1670 ± 20	V	3)
Astigmatism electrode voltage	V_{g5}	=	1670 ± 100	V	4)
Focusing electrode voltage	V_{g4}	=	230 to 500	V	
Deflection blanking electrode voltage	V_{g3}	=	1670	V	
Deflection blanking control voltage	ΔV_{g3}	=	max. 60	V	5)
First accelerator voltage	V_{g2}	=	1670	V	
Control grid voltage for visual extinction of focused spot	$-V_{g1}$	=	50 to 120	V	
Deflection factor					
horizontal	M_x	=	max. 18	V/cm	
vertical	M_y	=	4.5 to 5.5	V/cm	
Deviation of linearity of deflection		=	max. 2	%	6)
Geometry distortion			See note 7		
Useful scan					
horizontal		=	100	mm	
vertical		=	40	mm	

CIRCUIT DESIGN VALUES

Focusing electrode voltage	V_{g4}	=	138 to 300	V per kV of V_{g2}
Control grid voltage for visual extinction of focused spot	$-V_{g1}$	=	24 to 72	V per kV of V_{g2}
Deflection factor at $V_{g9(\ell)}/V_{g5} = 6$				
horizontal	M_x	=	max. 10.8	V/cm per kV of V_{g5}
vertical	M_y	=	2.7 to 3.3	V/cm per kV of V_{g5}
Focusing electrode current	I_{g4}	=	−10 to +15	μA
Control grid circuit resistance	R_{g1}	=	max. 1.5	MΩ
Deflection plate circuit resistance		=	max. 50	kΩ

1)2)3)4)5)6)7) See page 6.

7Z2 5516

LIMITING VALUES (Absolute max. rating system)

Final accelerator voltage	$V_{g9(\ell)}$	=	max.	16000	V
		=	min.	9000	V
Geometry control electrode voltage	V_{g8}	=	max.	2500	V
Deflection plate shield voltage	V_{g7}	=	max.	2500	V
Beam centring electrode voltage	V_{g6}	=	max.	2500	V
Astigmatism control electrode voltage	V_{g5}	=	max.	2500	V
Focusing electrode voltage	V_{g4}	=	max.	2500	V
Deflection blanking electrode voltage	V_{g3}	=	max.	2500	V
First accelerator voltage	V_{g2}	=	max.	2500	V
		=	min.	1250	V
Control grid voltage					
negative	$-V_{g1}$	=	max.	200	V
positive	V_{g1}	=	max.	0	V
positive peak	V_{g1p}	=	max.	2	V
Voltage between cathode and heater					
cathode positive	$V_{+k/f-}$	=	max.	200	V
cathode negative	$V_{-k/f+}$	=	max.	125	V
Ratio $V_{g9(\ell)}/V_{g5}$	$V_{g9(\ell)}/V_{g5}$	=	max.	10	
Ratio V_{g2}/V_{g5}	V_{g2}/V_{g5}	=	max.	1	
Screen dissipation	W_{ℓ}	=	max.	3	mW/cm^2
Cathode current, average	I_k	=	max.	300	μA

7Z2 5517

1) This tube is designed for optimum performance when operating at the ratio $V_{g9(\ell)}/V_{g5} = 6$. Operation at other ratio may result in changes in deflection uniformity and geometry distortion. The geometry control electrode voltage should be adjusted for optimum performance. For any necessary adjustment its potential will be within the stated range.

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

3) The beam centring electrode voltage should be adjusted for equal brightness in the x direction with respect to the electrical centre of the tube.

4) The astigmatism control electrode voltage should be adjusted for optimum spot shape. For any necessary adjustment its potential will be within the stated range.

5) For beam blanking of a beam current $I_{g9(\ell)}$ of 10 μA.

6) 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 the indicated value.

7) A graticule, consisting of concentric rectangles of 100 mm x 40 mm and 98 mm x 38.8 mm 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.

7Z2 5518

INSTRUMENT CATHODE-RAY TUBE

Oscilloscope tube with flat face post deflection acceleration by means of a helical electrode, side contacts, metal backed screen, 6 cm scan for high frequency and high writing speed applications.

QUICK REFERENCE DATA					
Final accelerator voltage		$V_{g_7}(\ell)$	=	10	kV
Display area			=	6 x 10	cm
Deflection factor,	horizontal	M_x	=	30	V/cm
	vertical	M_y	=	10.9	V/cm

SCREEN

	colour	persistence
D13-19BE	blue	medium short
D13-19GH	green	medium short
D13-19GP	bluish green	medium short
D13-19GM	yellowish green	long

Useful screen diameter min. 114 mm

Useful scan at $V_{g_7}(\ell)/V_{g_4} = 6$

horizontal min. 100 mm

vertical min. 60 mm

The useful scan may be shifted vertically to a max. of 3 mm with respect to the geometric centre of the faceplate.

HEATING

Indirect by A.C. or D.C.; parallel supply

Heater voltage	V_f	=	6.3	V
Heater current	I_f	=	300	mA

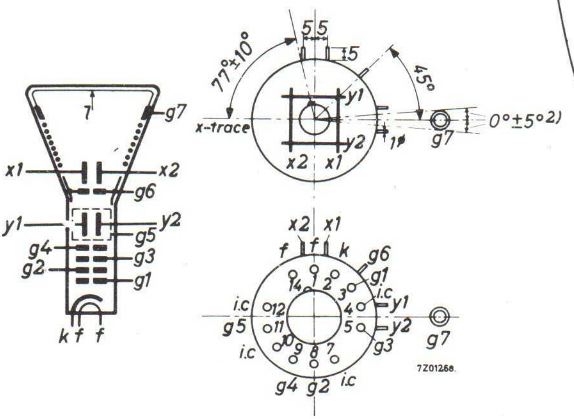
7Z2 5519

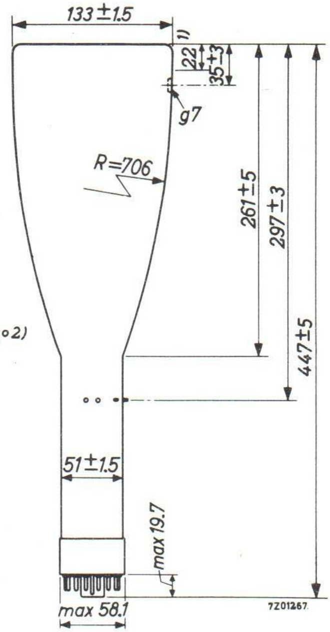
Maint.

MECHANICAL DATA

Dimensions in mm

1) Straight part of the bulb
2) Location of the recessed cavity button contact with respect to the X-trace.





Mounting position: any

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

Base Diheptal

Dimensions and connections

See also outline drawing

Overall length	max.	452	mm
Face diameter	max.	134.5	mm

Net weight:	approx.	910	g

Accessories

Socket	type	5914/20
Final accelerator contact connector	type	55563
Side contact connector	type	55561
Mu-metal shield	type	55551

7Z2 5520

CAPACITANCES

x_1 to all other elements except x_2	C_{x_1} (x_2)	=	3.0	pF
x_2 to all other elements except x_1	C_{x_2} (x_1)	=	3.0	pF
y_1 to all other elements except y_2	C_{y_1} (y_2)	=	3.0	pF
y_2 to all other elements except y_1	C_{y_2} (y_1)	=	3.0	pF
x_1 to x_2	$C_{x_1x_2}$	=	1.9	pF
y_1 to y_2	$C_{y_1y_2}$	=	1.0	pF
Control grid to all other elements	C_{g_1}	=	6.0	pF
Cathode to all other elements	C_k	=	3.5	pF

FOCUSING electrostatic

DEFLECTION double electrostatic

x plates symmetrical

y plates symmetrical

If use is made of the full deflection capabilities of the tube the deflection plates will intercept part of the electron beam; hence a low impedance deflection plate drive is desirable.

Angle between x and y traces. $90^\circ \pm 1^\circ$

LINE WIDTH

Measured with the shrinking raster method in the centre of the screen.

Final accelerator voltage	$V_{g_7(\ell)}$	=	10	kV
Astigmatism control electrode voltage	V_{g_4}	=	1670	V
First accelerator voltage	V_{g_2}	=	1670	V
Beam current	$I_{(\ell)}$	=	10	μA
Line width	l.w.	=	0.4	mm

HELIX

Post deflection accelerator helix resistance = min. 200 MΩ

7Z2 5521

TYPICAL OPERATING CONDITIONS

Final accelerator voltage	$V_{g7(\ell)}$	=	10	kV
Geometry control electrode voltage	V_{g6}	=	1670 ± 170	V [1]
Deflection plate shield voltage	V_{g5}	=	1670 ± 85	V [2]
Astigmatism control electrode voltage	V_{g4}	=	1670 ± 85	V [3]
Focusing electrode voltage	V_{g3}	=	320 to 500	V
First accelerator voltage	V_{g2}	=	1670	V
Control grid voltage for visual extinction of focused spot	$-V_{g1}$	=	53 to 82	V
Deflection factor, horizontal	M_x	=	27 to 33	V/cm
vertical	M_y	=	9.5 to 12.4	V/cm
Deviation of linearity of deflection		=	max. 2	% [4]
Geometry distortion			See note [5]	
Useful scan, horizontal		=	min. 100	mm
vertical		=	min. 60	mm

CIRCUIT DESIGN VALUES

Focusing voltage	V_{g3}	=	190 to 300	V per kV of V_{g4}
Control grid voltage for visual extinction of focused spot	$-V_{g1}$	=	32 to 49	V per kV of V_{g2}
Deflection factor at $V_{g7(\ell)}/V_{g4} = 6$				
horizontal	M_x	=	16 to 20	V/cm per kV of V_{g4}
vertical	M_y	=	5.7 to 7.4	V/cm per kV of V_{g4}
Control grid circuit resistance	R_{g1}	=	max. 1.5	MΩ
Deflection plate circuit resistance	R_x, R_y	=	max. 1	MΩ
Focusing electrode current	I_{g3}	=	−15 to +10	μA [6]

[1][2][3][4][5][6] See page 6

7Z2 5522

LIMITING VALUES (Absolute max. rating system)

Final accelerator voltage	$V_{g7(\ell)}$	= max.	12	kV
		= min.	6	kV
Geometry control electrode voltage	V_{g6}	= max.	2200	V
Deflection plate shield voltage	V_{g5}	= max.	2100	V
Astigmatism control electrode voltage	V_{g4}	= max.	2100	V
		= min.	1000	V
Focusing electrode voltage	V_{g3}	= max.	1500	V
First accelerator voltage	V_{g2}	= max.	2100	V
		= min.	1000	V
Control grid voltage				
negative	$-V_{g1}$	= max.	200	V
positive	V_{g1}	= max.	0	V
positive peak	V_{g1p}	= max.	2	V
Cathode to heater voltage				
cathode positive	$V_{+k/f-}$	= max.	200	V
cathode negative	$V_{-k/f+}$	= max.	125	V
Voltage between astigmatism control electrode and any deflection plate	$V_{g4/x}$	= max.	500	V
	$V_{g4/y}$	= max.	500	V
Screen dissipation	W_{ℓ}	= max.	3	mW/cm^2
Ratio $V_{g7(\ell)}/V_{g4}$	$V_{g7(\ell)}/V_{g4}$	= max.	6	

7Z2 5523

1) This tube is designed for optimum performance when operating at the ratio $V_{g_7(\ell)}/V_{g_4} = 6$. Operation at other ratio may result in changes in deflection uniformity and geometry distortion. The geometry control electrode voltage should be adjusted for optimum performance. For any necessary adjustment its potential will be within the stated range.

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

3) The astigmatism control electrode voltage should be adjusted for optimum spot shape. For any necessary adjustment its potential will be within the stated range.

4) 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 the indicated value.

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

6) Values to be taken into account for the calculation of the focus potentiometer.

7Z2 5524

INSTRUMENT CATHODE-RAY TUBE

Oscilloscope tube with flat face, 24 kV post deflection acceleration voltage, side contacts, metal backed screen for high frequency and high writing-speed applications

QUICK REFERENCE DATA				
Final accelerator voltage	$V_{g7}(\ell)$	=	24	kV
Display area		=	4x8	cm
Deflection factor, horizontal	M_x	=	73.5	V/cm
vertical	M_y	=	16	V/cm

SCREEN

	Colour	Persistence
D13-20BE	blue	medium short

Useful screen diameter min. 114 mm

Useful scan at $V_{g7}(\ell)/V_{g4,g2} = 6$

horizontal	min.	80	mm
vertical	min.	40	mm

The useful scan may be shifted vertically to a max. of 3 mm with respect to the geometric centre of the faceplate

HEATING

Indirect by A.C. or D.C.; parallel supply

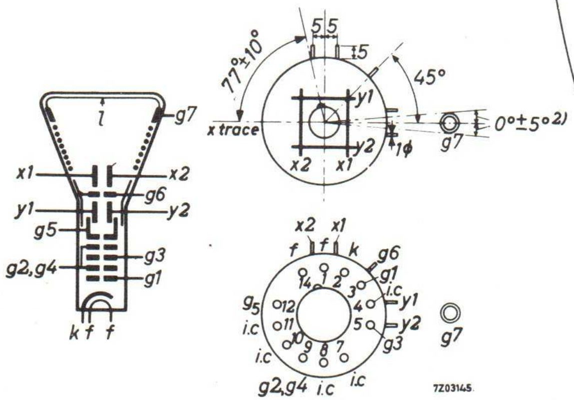
Heater voltage	V_f	=	6.3	V
Heater current	I_f	=	300	mA

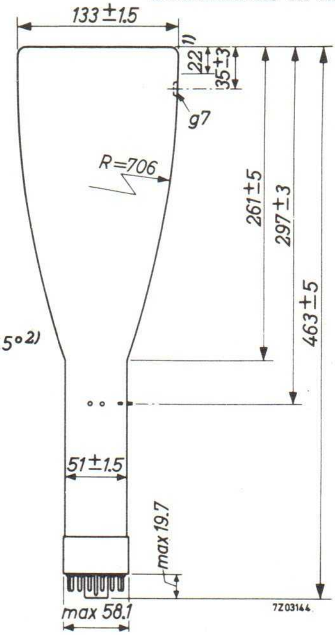
7Z2 5525

MECHANICAL DATA

Dimensions in mm

1) Straight part of the bulb.
2) Location of the recessed cavity button contact with respect to the X-trace.





Mounting position: any

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

Base	Diheptal 12 pins		
Dimensions and connections			
See also outline drawing			
Overall length	max.	468	mm
Face diameter	max.	134.5	mm
Net weight	approx.	910	g
Accessories			
Socket	type	5914/20	
Final accelerator contact connector	type	55563	
Side contact connector	type	55561	
Mu-metal shield	type	55551	

7Z2 5526

CAPACITANCES

x_1 to all other elements except x_2	$C_{x_1(x_2)}$	= 2.8	pF
x_2 to all other elements except x_1	$C_{x_2(x_1)}$	= 2.8	pF
y_1 to all other elements except y_2	$C_{y_1(y_2)}$	= 2.8	pF
y_2 to all other elements except y_1	$C_{y_2(y_1)}$	= 2.8	pF
x_1 to x_2	$C_{x_1x_2}$	= 1.9	pF
y_1 to y_2	$C_{y_1y_2}$	= 1.5	pF
Control grid to all other elements	C_{g_1}	= 6.0	pF
Cathode to all other elements	C_k	= 3.5	pF

FOCUSING electrostatic

DEFLECTION double electrostatic

x plates symmetrical

y plates symmetrical

If use is made of the full deflection capabilities of the tube the deflection plates will intercept part of the electron beam; hence a low impedance deflection plate drive is desirable.

Angle between x and y traces $90^o \pm 1^o$

LINE WIDTH

Measured with the shrinking raster method in the centre of the screen.

Final accelerator voltage	$V_{g_7(\ell)}$	= 24	kV
Astigmatism control electrode voltage	V_{g_4, g_2}	= 4	kV
Beam current	$I(\ell)$	= 10	μA
Line width	l.w.	= 0.2	mm

HELIX

Post deflection accelerator helix resistance min. 200 MΩ

7Z2 5527

TYPICAL OPERATING CONDITIONS

Final accelerator voltage	$V_{g_7(\ell)}$	=	24	kV
Geometry control electrode voltage	V_{g_6}	=	4000 +400 V / −200 V	[1]
Deflection plate shield voltage	V_{g_5}	=	4000	V [2]
Astigmatism control electrode voltage	V_{g_4, g_2}	=	4000 ±200	V [3]
Focusing electrode voltage	V_{g_3}	=	770 to 1200	V
Control grid voltage for visual extinction of focused spot	$-V_{g_1}$	=	120 to 192	V
Deflection factor				
horizontal	M_x	=	67 to 80	V/cm
vertical	M_y	=	13.5 to 18.5	V/cm
Deviation of linearity of deflection		=	max. 2	% [4]
Geometry distortion			See note 5	
Useful scan				
horizontal		=	min. 80	mm
vertical		=	min. 40	mm

CIRCUIT DESIGN VALUES

Focusing voltage	V_{g_3}	=	190 to 300	V per kV of V_{g_4, g_2}
Control grid voltage for visual extinction of focused spot	$-V_{g_1}$	=	30 to 48	V per kV of V_{g_4, g_2}
Deflection factor				
horizontal	M_x	=	16.7 to 20	V/cm per kV of V_{g_4, g_2}
vertical	M_y	=	3.4 to 4.6	V/cm per kV of V_{g_4, g_2}
Control grid circuit resistance	R_{g_1}	=	max. 1.5	MΩ
Deflection plate circuit resistance	R_x, R_y	=	max. 1	MΩ
Focusing electrode current	I_{g_3}	=	−15 to +10	μA [6]

[1][2][3][4][5][6] see page 6

7Z2 5528

LIMITING VALUES (Absolute max. rating system)

Final accelerator voltage	$V_{g_7(\ell)}$	=	max.	24	kV
			min.	4	kV
Geometry control electrode voltage	V_{g_6}	=	max.	4400	V
Deflection plate shield voltage	V_{g_5}	=	max.	4200	V
Astigmatism control electrode voltage	V_{g_4, g_2}	=	max.	4200	V
		=	min.	1000	V
Focusing electrode voltage	V_{g_3}	=	max.	2000	V
Control grid voltage					
negative	$-V_{g_1}$	=	max.	200	V
positive	V_{g_1}	=	max.	0	V
positive peak	$V_{g_{1p}}$	=	max.	2	V
Cathode to heater voltage					
cathode positive	$V_{+k/f-}$	=	max.	200	V
cathode negative	$V_{-k/f+}$	=	max.	125	V
Voltage between astigmatism control electrode and any deflection plate	$V_{g_4/x}$	=	max.	500	V
	$V_{g_4/y}$	=	max.	500	V
Cathode current	I_k	=	max.	1500	μA
Screen dissipation	W_ℓ	=	max.	3	mW/cm^2
Ratio $V_{g_7(\ell)}V_{g_4, g_2}$	$V_{g_7(\ell)}V_{g_4, g_2}$	=	max.	6	

X-Ray 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 16 kV.

7Z2 5529

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1) This tube is designed for optimum performance when operating at the ratio $V_{g7(\ell)}V_{g4,g2} = 6$. Operation at other ratio may result in changes in deflection uniformity and geometry distortion. The geometry control electrode voltage should be adjusted for optimum performance. For any necessary adjustment its potential will be within the stated range.

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

3) The astigmatism control electrode voltage should be adjusted for optimum spot shape. For any necessary adjustment its potential will be within the stated range.

4) 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 the indicated value.

5) A graticule, consisting of concentric rectangles of 80 mm x 40 mm and 78 mm x 39 mm 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.

6) Values to be taken into account for the calculation of the V_{g_3}-potentiometer.

7Z2 5530

INSTRUMENT CATHODE-RAY TUBE

Oscilloscope tube with flat face post deflection acceleration by means of a helical electrode, side contacts, metal backed screen, 4 cm scan for high frequency and high writing speed applications.

QUICK REFERENCE DATA				
Final accelerator voltage	$V_{g\,(\ell)}$	=	10	kV
Display area		=	4 x 10	cm
Deflection factor, horizontal	M_x	=	30	V/cm
vertical	M_y	=	6.4	V/cm

SCREEN

	colour	persistence
D13-21BE	blue	medium short
D13-21GH	green	medium short
D13-21GP	bluish green	medium short
D13-21GM	yellowish green	long

Useful screen diameter min. 114 mm

Useful scan at $V_{g_7\,(\ell)}/V_{g_4} = 6$

horizontal	min.	100	mm
vertical	min.	40	mm

The useful scan may be shifted vertically to a max. of 3 mm with respect to the geometric centre of the faceplate.

HEATING

Indirect by A.C. or D.C.; parallel supply

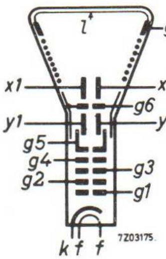
Heater voltage	V_f	=	6.3	V
Heater current	I_f	=	300	mA

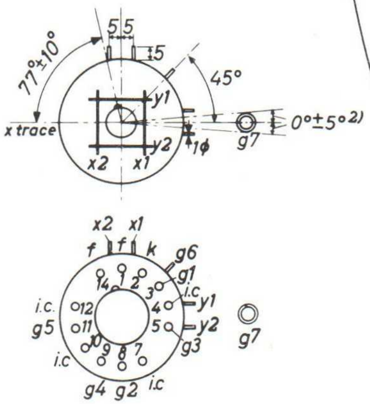
7Z2 5531

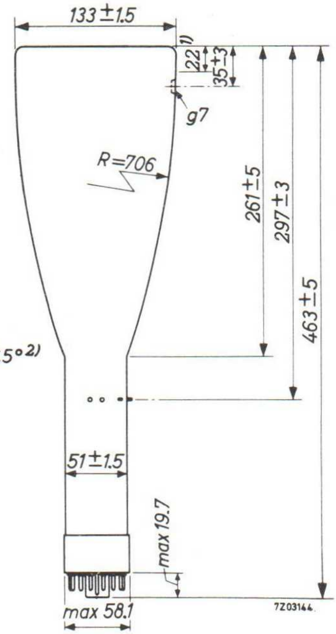
MECHANICAL DATA

Dimensions in mm

1) Straight part of the bulb.
2) Location of the recessed cavity button contact with respect to the X-trace.







Mounting position: any

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

Base Diheptal 12 pins

Dimensions and connections

See also outline drawing

Overall length	max.	468	mm
Face diameter	max.	134.5	mm

Net weight:	approx.	910	g

Accessories

Socket	type	5914/20
Final accelerator contact connector	type	55563
Side contact connector	type	55561
Mu-metal shield	type	55551

7Z2 5532

CAPACITANCES

x_1 to all other elements except x_2	$C_{x_1 (x_2)}$	=	2.8	pF
x_2 to all other elements except x_1	$C_{x_2 (x_1)}$	=	2.8	pF
y_1 to all other elements except y_2	$C_{y_1 (y_2)}$	=	2.8	pF
y_2 to all other elements except y_1	$C_{y_2 (y_1)}$	=	2.8	pF
x_1 to x_2	$C_{x_1 x_2}$	=	1.9	pF
y_1 to y_2	$C_{y_1 y_2}$	=	1.5	pF
Control grid to all other elements	C_{g_1}	=	6.0	pF
Cathode to all other elements	C_k	=	3.5	pF

FOCUSING electrostatic

DEFLECTION double electrostatic

x plates symmetrical

y plates symmetrical

If use is made of the full deflection capabilities of the tube the deflection plates will intercept part of the electron beam; hence a low impedance deflection plate drive is desirable.

Angle between x and y traces $90^o \pm 1^o$

LINE WIDTH

Measured with the shrinking raster method in the centre of the screen.

Final accelerator voltage	$V_{g_7 (\ell)}$	=	10	kV
Astigmatism control electrode voltage	V_{g_4}	=	1670	V
First accelerator voltage	V_{g_2}	=	1670	V
Beam current	$I_{(\ell)}$	=	10	μA
Line width	l.w.	=	0.4	mm

HELIX

Post deflection accelerator helix resistance = min. 200 MΩ

7Z2 5533

TYPICAL OPERATING CONDITIONS

Final accelerator voltage	$V_{g7(\ell)}$	=	10	kV
Geometry control electrode voltage	V_{g6}	=	1670 ± 170	V 1)
Deflection plate shield voltage	V_{g5}	=	1670 ± 85	V 2)
Astigmatism control electrode voltage	V_{g4}	=	1670 ± 85	V 3)
Focusing electrode voltage	V_{g3}	=	320 to 500	V
First accelerator voltage	V_{g2}	=	1670	V
Control grid voltage for visual extinction of focused spot	$-V_{g1}$	=	−50 to −80	V
Deflection factor, horizontal	M_x	=	27 to 33	V/cm
vertical	M_y	=	5.7 to 7.1	V/cm
Deviation of linearity deflection				
horizontal		=	max. 1.5	% 4)
vertical		=	max. 1.0	% 4)
Geometry distortion			See note 5	
Useful scan, horizontal		=	min. 100	mm
vertical		=	min. 40	mm

CIRCUIT DESIGN VALUES

Focusing electrode	V_g	=	190 to 300	V per kV of V_{g4}
Control grid voltage for visual extinction of focused spot	$-V_{g1}$	=	30 to 48	V per kV of V_{g2}
Deflection factor at $V_{g7(\ell)}/V_{g4} = 6$				
horizontal	M_x	=	16.2 to 19.8	V/cm per kV of V_{g4}
vertical	M_y	=	3.4 to 4.25	V/cm per kV of V_{g4}
Control grid circuit resistance	R_{g1}	=	max. 1.5	MΩ
Deflection plate circuit resistance	R_x, R_y	=	max. 1.0	MΩ
Focusing electrode current	I_g	=	−15 to +10	μA 6)

1)2)3)4)5)6) See page 6

7Z2 5534

LIMITING VALUES (Absolute max. rating system)

Final accelerator voltage	$V_{g7(\ell)}$	=	max.	12	kV
		=	min.	6	kV
Geometry control electrode voltage	V_{g6}	=	max.	2200	V
Deflection plate shield voltage	V_{g5}	=	max.	2100	V
Astigmatism control electrode voltage	V_{g4}	=	max.	2100	V
		=	min.	1000	V
Focusing electrode voltage	V_{g3}	=	max.	1500	V
First accelerator voltage	V_{g2}	=	max.	2100	V
		=	min.	1000	V
Control grid voltage					
negative	$-V_{g1}$	=	max.	200	V
positive	V_{g1}	=	max.	0	V
positive peak	V_{g1p}	=	max.	2	V
Cathode to heater voltage					
cathode positive	$V_{+k/f-}$	=	max.	200	V
cathode negative	$V_{-k/f+}$	=	max.	125	V
Voltage between astigmatism control electrode and any deflection plate	$V_{g4/x}$	=	max.	500	V
	$V_{g4/y}$	=	max.	500	V
Screen dissipation	W_{ℓ}	=	max.	3	mW/cm^2
Ratio $V_{g7(\ell)}/V_{g4}$	$V_{g7(\ell)}/V_{g4}$	=	max.	6	

7Z2 5535

1) This tube is designed for optimum performance when operating at the ratio $V_{g7(\ell)}/V_{g4} = 6$. Operation at other ratio may result in changes in deflection uniformity and geometry distortion. The geometry control electrode voltage should be adjusted for optimum performance. For any necessary adjustment its potential will be within the stated range.

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

3) The astigmatism control electrode voltage should be adjusted for optimum spot shape. For any necessary adjustment its potential will be within the stated range.

4) 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 the indicated value.

5) A graticule, consisting of concentric rectangles of 100 mm x ~~60~~ 40 mm and 98.8 mm x 39 mm 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.

6) Values to be taken into account for the calculation of the V_{g3}-potentiometer.

7Z2 5536

INSTRUMENT CATHODE-RAY TUBE

13 cm diameter flat faced oscilloscope tube with metalbacked screen, distributed p.d.a. and side connections to the deflection plates.

QUICK REFERENCE DATA			
Final accelerator voltage	$V_{g9(\ell)}$	15	kV
Display area		6 x 10	cm
Deflection factor, horizontal	M_x	12.5	V/cm
vertical	M_y	3.5	V/cm

SCREEN

	colour	persistence
D13-22BE	blue	medium short
D13-22GH	green	medium short
D13-22GP	bluish green	medium short
D13-22GM	yellowish green	long

Useful screen diameter	min.	114	mm
Useful scan at $V_{g9}(\ell)/V_{g4}$ = 10			
horizontal	min.	100	mm
vertical	min.	60	mm

The useful scan may be shifted vertically to a max. of 3 mm with respect to the geometric centre of the faceplate.

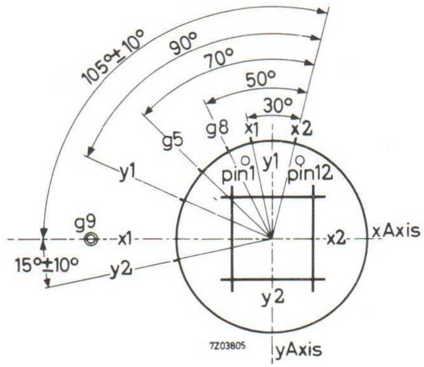
HEATING

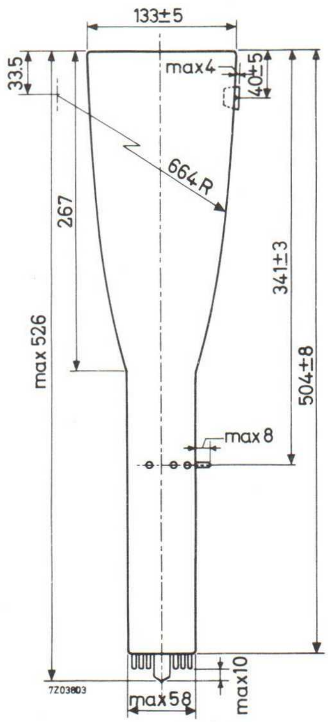
Indirect by A.C. or D.C.; parallel supply

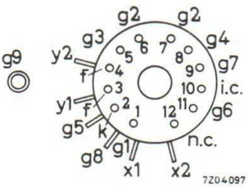
Heater voltage	V_f	6.3	V
Heater current	I_f	300	mA

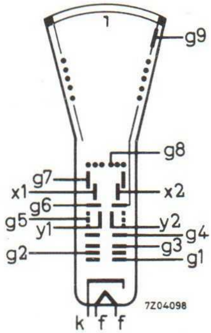
7Z2 5961

MECHANICAL DATA Dimensions in mm









Mounting position: any

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

Base	B12F		
Dimensions and connections			
Overall length	max.	526	mm
Face diameter	max.	138	mm
Net weight	approx.	1300	g
Accessories			
Socket	type	55562	
Final accelerator contact connector	type	55563	
Side contact connector	type	55561	

7Z2 5962

CAPACITANCES

x_1 to all other elements except x_2	$C_{x_1(x_2)}$	max.	6.1	pF
x_2 to all other elements except x_1	$C_{x_2(x_1)}$	max.	6.4	pF
y_1 to all other elements except y_2	$C_{y_1(y_2)}$	max.	3.9	pF
y_2 to all other elements except y_1	$C_{y_2(y_1)}$	max.	3.9	pF
x_1 to x_2	$C_{x_1x_2}$	max.	2.1	pF
y_1 to y_2	$C_{y_1y_2}$	max.	2.1	pF
Control grid to all other elements	C_{g_1}	max.	6.2	pF
Cathode to all other elements	C_k	max.	4.1	pF

FOCUSING electrostatic

DEFLECTION double electrostatic

x plates symmetrical

y plates symmetrical

If use is made of the full deflection capabilities of the tube the deflection plates will intercept part of the electron beam; hence a low impedance deflection plate drive is desirable.

Angle between x and y traces 90 ± 1^{o}

LINE WIDTH

Measured with the shrinking raster method in the centre of the screen.

Final accelerator voltage	$V_{g_9(\ell)}$	15000	V
Astigmatism control electrode voltage	V_{g_4}	1500	V
First accelerator voltage	V_{g_2}	1500	V
Beam current	$I_{(\ell)}$	25	μA
Line width	l.w.	0.6	mm

HELIX

Post deflection accelerator helix resistance min. 175 MΩ

7Z2 5963

TYPICAL OPERATING CONDITIONS

Final accelerator voltage	$V_{g_9}(\ell)$	15000	V
Post deflection shield voltage (w.r.t. V_{g_7})	V_{g_8}	-12 to -18	V
Geometry control electrode voltage	V_{g_7}	1500 ± 50	V 1)
Helix voltage lower end	V_{g_6}	1500	V
Deflection plate shield voltage	V_{g_5}	1500	V 2)
Astigmatism control electrode voltage	V_{g_4}	1500 ± 50	V 3)
Focusing electrode voltage	V_{g_3}	250 to 500	V
First accelerator voltage	V_{g_2}	1500	V
Control grid voltage for visual extinction of focused spot	$-V_{g_1}$	45 to 85	V
Deflection factor, horizontal	M_x	9.4 to 12.5	V/cm
vertical	M_y	2.3 to 3.5	V/cm
Deviation of linearity of deflection	max.	2	% 4)
Geometry distortion		see note 5	
Useful scan, horizontal	min.	100	mm
vertical	min.	60	mm

---

1) This tube is designed for optimum performance when operating at the ratio $V_{g_9}(\ell)/V_{g_4} = 10$. Operation at other ratio may result in changes in deflection uniformity and geometry distortion. The geometry control electrode voltage should be adjusted for optimum performance. For any necessary adjustment its potential will be within the stated range.

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

3) The astigmatism control electrode voltage should be adjusted for optimum spot shape. For any necessary adjustment its potential will be within the stated range.

4) 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 the indicated value.

5) A graticule, consisting of concentric rectangles of 100 mm x 60 mm and 98 mm x 58 mm 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.

7Z2 5964

LIMITING VALUES (Absolute max. rating system)

Final accelerator voltage	$V_{g_9(\ell)}$	max.	17300	V
		min.	6000	V
Post deflection shield voltage	V_{g_8}	max.	3300	V
		min.	1000	V
Geometry control electrode voltage	V_{g_7}	max.	3300	V
		min.	900	V
Helix voltage, lower end	V_{g_6}	max.	3300	V
		min.	1000	V
Deflection plate shield voltage	V_{g_5}	max.	3300	V
		min.	1000	V
Astigmatism control electrode voltage	V_{g_4}	max.	3300	V
		min.	1000	V
Focusing electrode voltage	V_{g_3}	max.	1500	V
First accelerator voltage	V_{g_2}	max.	1700	V
		min.	800	V
Control grid voltage,				
negative	$-V_{g_1}$	max.	200	V
positive	V_{g_1}	max.	0	V
Voltage between astigmatism electrode and any deflection plate	$V_{g_4/x}$	max.	500	V
	$V_{g_4/y}$	max.	500	V
Cathode to heater voltage,				
cathode positive	$V_{+k/f-}$	max.	200	V
cathode negative	$V_{-k/f+}$	max.	125	V
Screen dissipation	W_{ℓ}	max.	3	mW/cm^2
Ratio $V_{g_9(\ell)}/V_{g_4}$	$V_{g_9(\ell)}/V_{g_4}$	max.	10	

7Z2 5965

CIRCUIT DESIGN VALUES

Focusing voltage	V_{g_3}	167 to 333	V per kV of V_{g_4}
Control grid voltage for visual extinction of focused spot	$-V_{g_1}$	30 to 56.7	V per kV of V_{g_2}
Deflection factor at $V_{g_9}(\ell)/V_{g_4} = 10$			
horizontal	M_x	6.3 to 8.4	V/cm per kV of V_{g_4}
vertical	M_y	1.53 to 2.33	V/cm per kV of V_{g_4}
Control grid circuit resistance	R_{g1}	max. 1	MΩ
Deflection plate circuit resistance	R_x, R_y	max. 50	kΩ
Focusing electrode current at a beam current of max. 25 μA	I_{g_3}	-25 to +25	μA [1]

[1]) Values to be taken into account for the calculation of the focus potentiometer.

7Z2 5966

INSTRUMENT CATHODE-RAY TUBE

13 cm diameter flat faced oscilloscope tube, with metal-backed screen, helical PDA and side connections to the x and y plates. The y plates are intended to be included in a resonant circuit tunable to frequencies from 300 Mc/s to 900 Mc/s by means of adapter units outside the tube. This tube incorporates deflection blanking and is intended for high frequency, narrow bandwidth displays.

QUICK REFERENCE DATA					
Final accelerator voltage	$V_{g9(\ell)}$	=		6	kV
Display area		=		5x10	cm
Deflection factor, horizontal	M_x	=	max.	14	V/cm
vertical	M_y		See note 1		

SCREEN

	colour	persistence
D13-23GH	green	medium short

Useful screen diameter min. 114 mm

Useful scan at $V_{g9(\ell)}/V_{g5} = 5$

horizontal	min.	100	mm
vertical	min.	50	mm

The useful scan may be shifted vertically to a max. of 5 mm with respect to the geometric centre of the faceplate.

HEATING

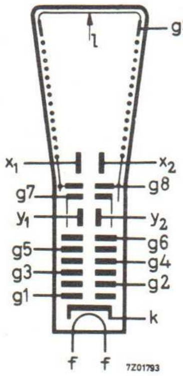
Indirect by A C. or D.C.; parallel supply

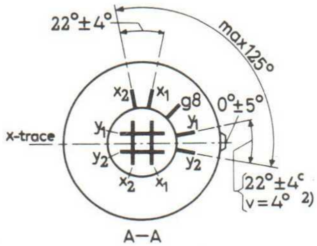
Heater voltage	V_f	=	6.3	V
Heater current	I_f	=	300	mA

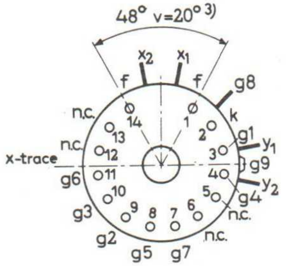
7Z2 5537

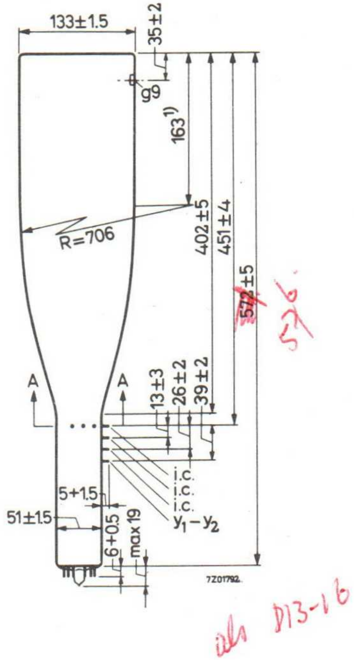
MECHANICAL DATA

Dimensions in mm









Mounting position: any

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

Base	14 pins all glass		
Dimensions and connections			
Overall length (inclusive socket 55566)	max.	600	mm
Face diameter	max.	135.5	mm
Net weight:	approx.	1300	g
Accessories:			
Socket (supplied with the tube)	type	55566	
Final accelerator contact connector	type	55563	
Side contact connector	type	55561	

1) Straight part

2) The tolerance of the position of the neck pins with respect to the x-trace is $\pm 2^{o}$.

3) The tolerance of the position of the base pins with respect to the x-trace is $\pm 10^{o}$.

7Z2 5538

CAPACITANCES

x_1 to all other elements except x_2	$C_{x_1(x_2)}$	=	2.8	pF
x_2 to all other elements except x_1	$C_{x_2(x_1)}$	=	2.8	pF
x_1 to x_2	$C_{x_1x_2}$	=	2.3	pF
Control grid to all other elements	C_{g_1}	=	5.0	pF
Cathode to all other elements	C_k	=	3.5	pF
Deflection blanking electrode to all other elements	C_{g_3}	=	9	pF

FOCUSING electrostatic

DEFLECTION double electrostatic

x plates symmetrical

y plates symmetrical

If use is made of the full deflection capabilities of the tube the deflection plates will intercept part of the electron beam; hence a low impedance deflection plate drive is desirable.

Angle between x and y plates $90^{\circ} \pm 1^{\circ}$

HELIX

Post deflection accelerator helix resistance min. 300 MΩ

CIRCUIT DESIGN VALUES

Focusing voltage	V_{g_4}	=	138 to 300	V per kV of V_{g_2}
Control grid voltage for visual extinction of focused spot	$-V_{g_1}$	=	24 to 72	V per kV of V_{g_2}
Deflection factor at $V_{g_9(\ell)}/V_{g_5} = 5$				
horizontal	M_x	=	max. 10.8	V/cm per kV of V_{g_5}
vertical	M_y		See note 1	
Control grid circuit resistance	R_{g_1}	=	max. 1.5	MΩ
Deflection plate circuit resistance	R_x, R_y	=	max. 50	kΩ
Focusing electrode current	I_{g_4}	=	+15 to −10	μA 2)

1) Depends on the frequency and the adaptors being used.

2) Values to be taken into account for the calculation of the focus potentiometer.

7Z2 5539

TYPICAL OPERATING CONDITIONS

Final accelerator voltage	$V_{g_9(\ell)}$	=		6000	V	
Geometry control electrode voltage	V_{g_8}	=	1300 ±	100	V	1)
Deflection plate shield voltage	V_{g_7}	=		1300	V	2)
Beam centring electrode voltage	V_{g_6}	=	1300 ±	20	V	3)
Astigmatism control electrode voltage	V_{g_5}	=	1300 ±	100	V	4)
Focusing electrode voltage	V_{g_4}	=	180 to	390	V	
Deflection blanking electrode voltage	V_{g_3}	=		1300	V	
Deflection blanking control voltage	ΔV_{g_3}	=	max.	60	V	5)
First accelerator voltage	V_{g_2}	=		1300	V	
Control grid voltage for visual extinction of focused spot	$-V_{g_1}$	=	31 to	93	V	
Deflection factor						
horizontal	M_x	=	max.	14	V/cm	
vertical		See note 7				
Geometry distortion		See note 6				
Useful scan						
horizontal		=	min.	100	mm	
vertical		=	min.	50	mm	

1) This tube is designed for optimum performance when operating at the ratio $V_{g_9(\ell)}/V_{g_5} = 5$. Operation at other ratio may result in changes in deflection uniformity and geometry distortion. The geometry control electrode voltage should be adjusted for optimum performance. For any necessary adjustment its potential will be within the stated range.

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

3) The beam centring electrode voltage should be adjusted for equal brightness in the x direction with respect to the electrical centre of the tube.

4) The astigmatism control electrode voltage should be adjusted for optimum spot shape. For any necessary adjustment its potential will be within the stated range.

5) For beam blanking of a beam current of 10 μA.

6) A graticule, consisting of concentric rectangles of 100 mm x 50 mm and 98 mm x 48.2 mm is aligned with the electrical x aixs of the tube. The edges of a raster will fall between these rectangles with optimum correction potentials applied.

7) Depends on the frequency and the adaptors being used.

7Z2 5540

LIMITING VALUES (Absolute max. rating system)

Final accelerator voltage	$V_{g_9(\ell)}$	=	max.	10000	V
		=	min.	5000	V
Geometry control electrode voltage	V_{g_8}	=	max.	2000	V
Deflection plate shield voltage	V_{g_7}	=	max.	2000	V
Beam centring electrode voltage	V_{g_6}	=	max.	2000	V
Astigmatism control electrode voltage	V_{g_5}	=	max.	2000	V
Focusing electrode voltage	V_{g_4}	=	max.	2000	V
Deflection blanking electrode voltage	V_{g_3}	=	max.	2000	V
First accelerator voltage	V_{g_2}	=	max.	2000	V
		=	min.	1200	V
Control grid voltage					
negative	$-V_{g_1}$	=	max.	200	V
positive	V_{g_1}	=	max.	0	V
positive peak	$V_{g_{1p}}$	=	max.	2	V
Cathode to heater voltage					
cathode positive	$V_{+k/f-}$	=	max.	200	V
cathode negative	$V_{-k/f+}$	=	max.	125	V
Voltage between astigmatism electrode	$V_{g_5/x}$	=	max.	500	V
and any deflection plate	$V_{g_5/y}$	=	max.	500	V
Cathode current (average)	I_k	=	max.	300	mA
Screen dissipation	W_ℓ	=	max.	3	mW/cm^2
Ratio $V_{g_9(\ell)}/V_{g_5}$	$V_{g_9(\ell)}/V_{g_5}$	=	max.	10	
Ratio V_{g_9}/V_{g_5}	V_{g_2}/V_{g_5}	=	max.	1	

7Z2 5541

APPLICATION DATA

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 arrangements are given below.

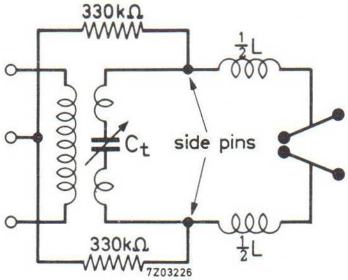
Mechanical construction of the coupling units

	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 diameter	0.9	0.9	0.9	mm
Approx. coil length	14	10	7	mm
Secondary				
No. of turns	4	2	2	
Wire diameter	0.5	1.5	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

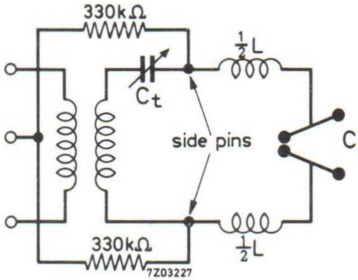
Copper wire is used for all primary windings and enamelled copper wire is used for the secondaries.
The secondary turns are wound between the primary turns.
The trimmer capacitors of units 1 and 2 are connected between the secondary transformer windings in order to obtain good symmetry.
For unit 3 the trimmer is connected between secondary transformer windings and one connecting pin of the deflection system in order not to reduce the coupling factor.

7Z2 5542

APPLICATION DATA (continued)



Unit 1 and 2
fig.1



Unit 3
fig.2

Ct = trimmer capacitance
Cp = plate capacitance
L = inductivity of the strips between deflection system and pins in the neck of the tube

Measurement of vertical sensitivity as a function of frequency

1. Adjust the trimmer so that the trimming capacitance is a minimum, to enaable 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 tube face. 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 50 Ω to obtain a well defined signal voltage. For this purpose 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 can be calculated from:

$$V_{RMS} = WxR = 7.07 \quad W$$

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

7Z2 5543

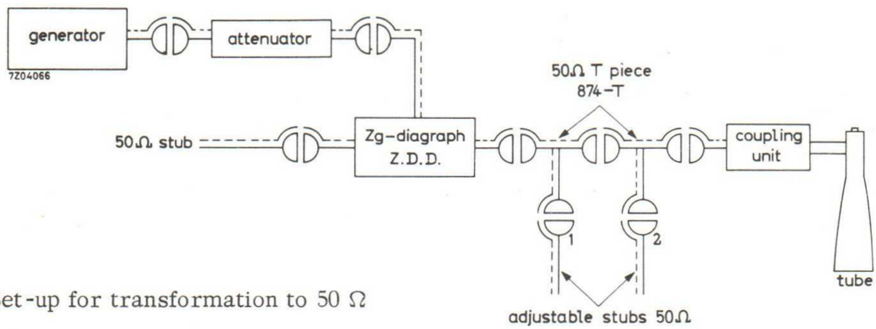
APPLICATION DATA (continued)

Typical power and sensitivity values

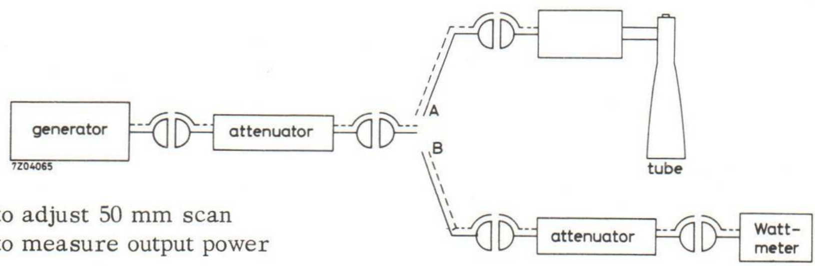
Unit	Frequency (Mc/s)	Power (mW)	Sensitivity (V_{RMS}/5 cm)
1	445	37	1.36
1	480	39	1.40
1	540	55	1.66
2	565	46	1.52
2	680	69	1.86
3	680	91	2.14
3	750	110	2.35
3	800	195	3.12
3	850	240	3.47
3	900	390	4.43

All measurements: $V_{g_{2+5}}$ = 1300 V) V_{g_9} = 6000 V) with respect to cathode

It should be noted that an increase in acceleration voltage 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 acceleration voltage can be increased to 2000 V, without changing the sensitivity.

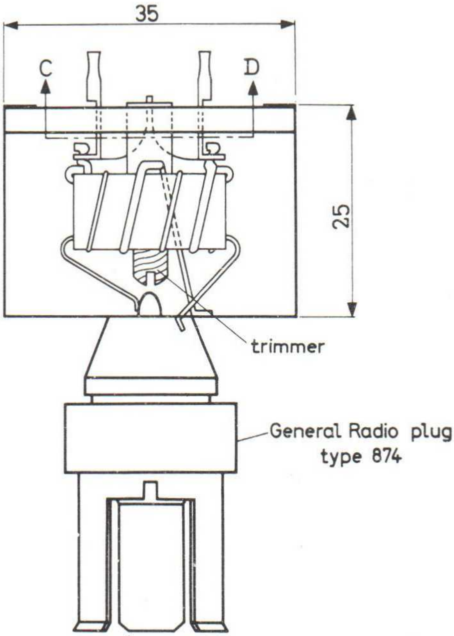


Set-up for transformation to 50 Ω

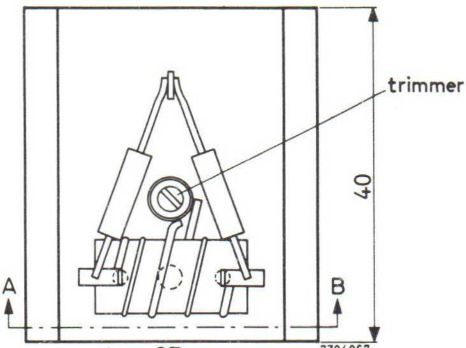


A: to adjust 50 mm scan
B: to measure output power

7Z2 5544



view AB



view CD

7Z2 6129

INSTRUMENT CATHODE-RAY TUBE

The D13-24BE is a wide-band oscilloscope tube especially designed for observation and measurement of high frequence (1000 MHz) phenomena.

QUICK REFERENCE DATA				
Final accelerator voltage	$V_{g_9}(\ell)$		24	kV
Display area			2 x 6	cm
Deflection factor, horizontal	M_x	max.	32	V/cm
vertical	M_y	max.	8	V/cm

SCREEN

	colour	persistence
D13-24BE	blue	medium short

Useful screen diameter	min.	114	mm
Useful scan at $V_{g_9}(\ell)/V_{g_5} = 8$			
horizontal	min.	60	mm
vertical	min.	20	mm

The useful scan may be shifted vertically to a max. of 10 mm with respect to the geometric centre of the faceplate. The vertical useful scan will be at least 8 mm in either direction from the position of the undeflected spot, with a total of at least 20 mm. A positive voltage on the vertical deflection system will deflect the beam towards pin no.7.

DESCRIPTION

The D13-24BE is a wide-band oscilloscope tube especially designed for observation and measurement of high frequence (1000 MHz) phenomena.
The high-frequency performance of conventional oscilloscope tubes is limited by transit-time effects and by resonance phenomena occuring in the circuit consisting of the deflection plates and their connection leads.

7Z2 6212

In order to overcome these limitations a travelling-wave deflection system is used in the D13-24BE. This deflection system consist of a metal tape wound in the shape of a flattened helix and the electron beam is deflected in the region between the flat part of the helix and a metal plate inserted into the helix. This metal plate is interconnected to the shield surrounding the system.
The mechanical dimensions of the helix have so been chosen that the signal delay per turn is equal to the electron transit-time per turn. This means that the transit-time effects are determined by the width of one turn only, where as the defelction sensitivity is determined by the sum of the deviations of the beam due to the field of all the turns.
As for the transmissions of wide band signals containing ultra-high frequencies coaxial lines are most suitable. The deflection system has been designed for asymmetrical deflection (helix and plate are connected to inner and outer conductor respectively).
For the connection between the deflection system and coaxial plugs a three strip transmission-line is used which is brought out through the tube neck by means of pins sealed into the glass. The transition to coaxial plugs is made outside the tube. The characteristic impedance of the tube is 100 Ohms, and a modified version of the well-known General Radio type 874 coaxial connector is used (The diameter of the inner conductor has been reduced so as to obtain 100 Ohm impedance). Both input and output of the deflection have been brought out through the tube neck so that it is possible to pick up the signal which is being observed at the output and to use it for other purposes, if desired.
The performance of the deflection system may be expressed in terms of bandwidth (min. 1000 MHz for 3 dB down with respect to D.C.) or in terms of rise time of the display of a step-function signal (max. 0.35 nanoseconds for 10% to 90% of the final value).
Great care has been taken in the design to avoid phase distortion which would introduce overshoot in the display of such a signal. The extent to which a constant input impedance has been realized is indicated by the voltage standing-wave ratio (maximum 1.25 up to 1000 MHz). In order to be able to shift the display in vertical direction the deflection system shield is not directly connected but capacitively be coupled to the outer connector of the coaxial plugs.
A D.C. shift voltage can be applied to the shield.
The useful vertical scan has been limited to 2 cm in order to obtain the highest possible sensitivity. This is important as in most cases the signal to be observed will be applied directly to the deflection system without any amplification.
The horizontal deflection plates giving 6 cm useful scan, are of conventional design and, of course, also brought out through the neck.

The typical acceleration voltage is 3 kV. Deviations from this value will cause detoriation of band-width and rise time, since the electron velocity will then not be equal to the velocity of signal propagation of the vertical deflection system. However this adjustment is not very critical. The electron gun features apart from astigmatism and geometry controll electrode auxialiary electrodes such as deflection blanking electrodes and a beam centring electrode. The latter can be used to center the beam with respect to the x plates.
Post deflection acceleration is achieved by a helical resistive coating in the innerside of the envelope which allows a p.d.a to acceleration electrode voltages of 10. The maximum PDA voltage is 24 kV. This high voltage, the metal-backed screen and the small linewidth (0.12 mm) assure a high writingspeed.
In order to make use of the full capabilities of this tube some precautions have to be taken in the manner the signal is applied to the tube. First, a good termination at the output of the deflection system is essential when pulse signals are to be observed, otherwise reflections from a mismatch at the output may distort the displayed wave-form.
A coaxial resistor is the most suitable termination.
For signal delays in oscilloscopes a high-quality delay-line should be used in order to avoid deterioration of performance due to band-width limitations of the delay-line.

HEATING

Indirect by A.C. or D.C.; parallel supply

Heater voltage	V_f	6.3	V
Heater current	I_f	300	mA

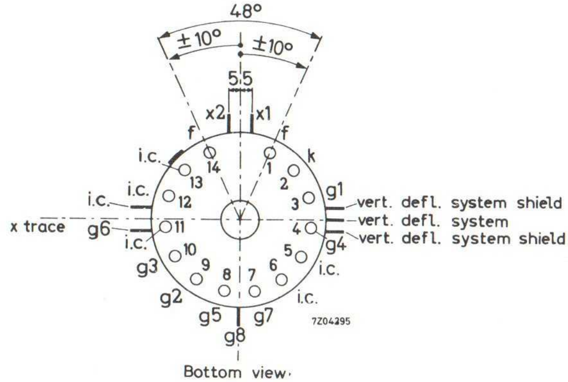
CAPACITANCES

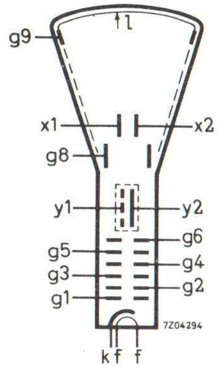
x_1 to all other elements except x_2	$C_{x_1(x_2)}$	3.0	pF
x_2 to all other elements except x_1	$C_{x_2(x_1)}$	3.0	pF
x_1 to x_2	$C_{x_1x_2}$	2.7	pF
Control grid to all other elements	C_{g_1}	5.0	pF
Cathode to all other elements	C_k	3.5	pF
Deflection blanking electrode to all other elements	C_{g_3}	9.0	pF

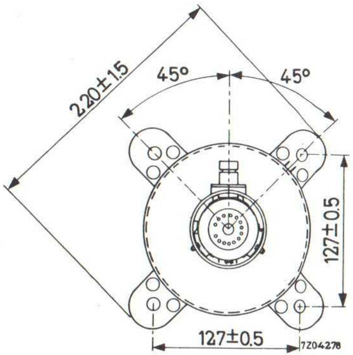
7Z2 6214

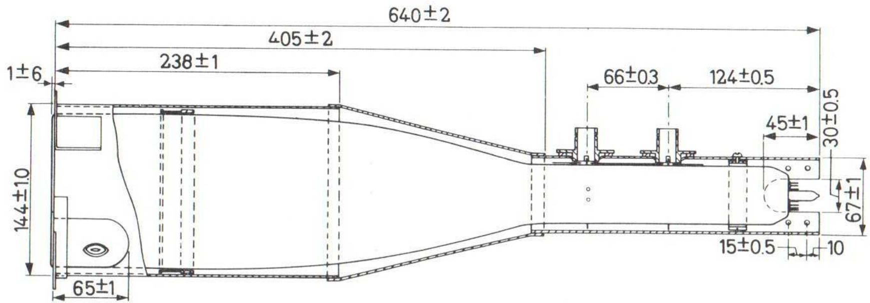
MECHANICAL DATA

Dimensions in mm









7Z2 6215

MECHANICAL DATA

Mounting position: any

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

Base	14 pin all glass	
Dimensions and connections		
Overall length (socket inclusive)	625	mm
Face diameter	max. 134.5	mm
Net weight	approx.	g
Accessories		
Socket	supplied with tube	
Final accelerator contact connector	type 55563	
Side contact connector	supplied with tube	
Mu-metal shield	supplied with tube	

FOCUSING electrostatic

DEFLECTION

Horizontal	electrostatic symmetrical		
Vertical	delay-line system, asymmetrical		
Characteristic impedance of delay-line system	100	Ω	
VSWR	max. 1.25 up to 1000	MHz	[1]
Bandwidth	1000	MHz	[2]
Rise time	0.35	nsec	[3]
Angle between x and y traces	$90 \pm 2^{\circ}$		

[1] [2] and [3] see page 8

7Z2 6216

LINE WIDTH

Measured with the shrinking raster method in the centre of the screen.

Final accelerator voltage	$V_{g_9}(\ell)$	24	V
Astigmatism control electrode voltage	V_{g_5}	3	V
First accelerator voltage	V_{g_2}	3	V
Beam current	$I(\ell)$	0.5	µA
Line width	l.w.	0.12	mm

HELIX

Post deflection accelerator helix resistance	min.	300	MΩ

TYPICAL OPERATING CONDITIONS

Final accelerator voltage	$V_{g_9}(\ell)$	24000	V
Geometry control electrode voltage	V_{g_8}	3000 ± 200	V
Vertical deflection system shield voltage	V_{g_7}	3000	V [4]
Beam centring electrode voltage	V_{g_6}	3000 ± 40	V [5]
Astigmatism control electrode voltage	V_{g_5}	3000 ± 200	V [6]
Focusing electrode voltage	V_{g_4}	400 to 900	V
Deflection blanking electrode voltage	V_{g_3}	3000	V
Deflection blanking control voltage	ΔV_{g_3}	110	V [7]
First accelerator voltage	V_{g_2}	3000	V [8]
Control grid voltage for visual extinction of focused spot	$-V_{g_1}$	60 to 250	V
Deflection factor, horizontal	M_x	32	V/cm
vertical	M_y	max. 8	V/cm
Useful scan, horizontal		min. 60	mm
vertical		min. 20	mm

[4] [5] [6] [7] and [8] see page 8

7Z2 6217

LIMITING VALUES

Final accelerator voltage	$V_{g_9(\ell)}$	max.	25000	V
		min.	10000	V
Geometry control electrode voltage	V_{g_8}	max.	4400	V
Vertical deflection system shield voltage	V_{g_7}	max.	4400	V
Beam centring electrode voltage	V_{g_6}	max.	4400	V
Astigmatism control electrode voltage	V_{g_5}	max.	4400	V
		min.	2500	V
Focusing electrode voltage	V_{g_4}	max.	1500	V
Deflection blanking electrode voltage		max.	4400	V
First accelerator voltage	V_{g_2}	max.	4400	V
Control grid voltage,				
negative	$-V_{g_1}$	max.	350	V
positive	V_{g_1}	max.	0	V
positive peak	$V_{g_{1p}}$	max.	2	V
Cathode to heater voltage				
cathode positive	$V_{+k/f-}$	max.	200	V
cathode negative	$V_{-k/f+}$	max.	125	V
Cathode current average	$I_{k_{eff}}$	max.	300	mA
Screen dissipation	W_ℓ	max.	3	W/cm^2
Ratio $V_{g_9}(\ell)/V_{g_5}$	$V_{g_9}(\ell)/V_{g_5}$	max.	10	
Ratio V_{g_2}/V_{g_5}	V_{g_2}/V_{g_5}	max.	1	

WARNING

This tube, when in operation, produces X-rays which may constitute a health hazard unless the tube is adequately shielded.

NOTES

1. Measured with coaxial 50 to 100 Ω quarter wavelength transformers with a 50 Ω coaxial precision resistance from Rohde and Schwarz, type RMD 33526/50 as reference standard.
2. The bandwidth is defined as the frequency at which the vertical sensitivity is 3 dB down with respect to that at D.C.
3. The risetime is defined to be the time interval between 10% and 90% of the final value of deflection, when a stepfunction signal is applied to the vertical deflection system.
   The signal source will be built-in step function generator of a Tektronix type 519 oscilloscope with the built-in delay-line included in the signal path and an abrupt 125 to 100 Ω transition between the output of the delay-line and the input of the oscilloscope tube. The output connector of the tube will be terminated with a 100 Ω coaxial resistor type BB 1241. In order to avoid errors due to the angle of traces, two measurements are taken using a positive going and a negative going step function of equal amplitude and the risetime will be taken to be the arithmetic mean of the two values.
4. If the external conductors of the coaxial input and output connectors are not directly connected but capacitively coupled to this electrode, a vertical shift of the display can be obtained by varying the potential of this electrode.
5. The beam centring electrode voltage should be adjusted for equal deflection defocusing and deflection linearity in the x-direction with respect to the electrical centre of the tube.
6. The astigmatism electrode voltage should be corrected for optimum spot shape.
7. For visual extinction of a beam current of 10 μA its potential will not exceed 110 V with respect to V_{g_2}.
8. The delay-line deflection system has been designed for an accelerator voltage of about 3000 V. Deviation from this value will cause deterioration of bandwidth and risetime. The potential of g2 should not vary within the duration of the brightness of the display may occur.

7Z2 6219

INSTRUMENT CATHODE-RAY TUBE

Oscilloscope tube with flat face, side connections to the deflector plates. The mesh together with the helical post deflection accelerator electrode, serves to obtain the high sensitivity which renders the tube suitable for transistorized equipment. The phosphor screen is metal backed.

QUICK REFERENCE DATA				
Final accelerator voltage	$V_{g9(\ell)}$	=	15	kV
Display area		=	6x10	cm
Deflection factor, horizontal	M_x	=	12.5	V/cm
vertical	M_y	=	3.5	V/cm

SCREEN

	Colour	Persistence
D13-26GH	green	medium short
D13-26GP	bluish green	medium short

Useful screen diameter min. 114 mm

Useful scan at $V_{g9(\ell)}/V_{g4}$ = 10

horizontal min. 100 mm

vertical min. 60 mm

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

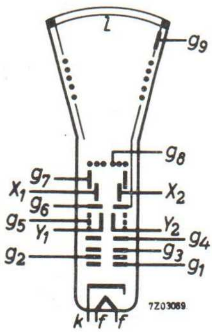
HEATING

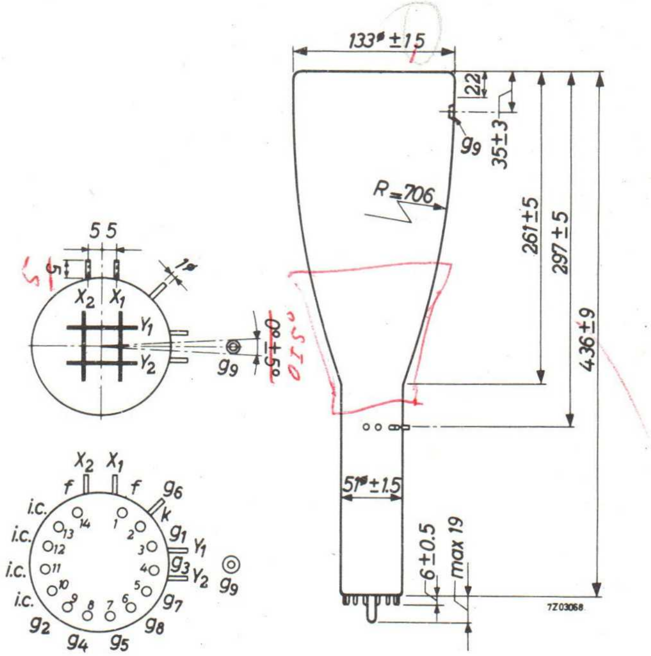
Indirect by A.C. or D.C.; parallel supply

Heater voltage	V_f	=	6.3	V
Heater current	I_f	=	300	mA

7Z2 5545

MECHANICAL DATA Dimensions in mm





Mounting position: any

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

Base	14 pin all-glass		
Dimensions and connections			
Overall length	max.	468	mm
Face diameter	max.	134.5	mm
Net weight	approx.	925	g
Accessories			
Socket	type	55566	
Final accelerator contact connector	type	55563	
Side contact connector	type	55561	
Mu-metal shield	type	55555	

7Z2 5546

CAPACITANCES

x_1 to all other elements except x_2	$C_{x_1(x_2)}$	=	4.5	pF
x_2 to all other elements except x_1	$C_{x_2(x_1)}$	=	4.5	pF
y_1 to all other elements except y_2	$C_{y_1(y_2)}$	=	3.8	pF
y_2 to all other elements except y_1	$C_{y_2(y_1)}$	=	3.8	pF
x_1 to x_2	$C_{x_1x_2}$	=	2.7	pF
y_1 to y_2	$C_{y_1y_2}$	=	1.8	pF
Control grid to all other elements	C_{g_1}	=	5.5	pF
Cathode to all other elements	C_k	=	3.0	pF

FOCUSING electrostatic

DEFLECTION double electrostatic

x plates symmetrical

y plates symmetrical

If use is made of the full deflection capabilities of the tube the deflection plates will intercept part of the electron beam; hence a low impedance deflection plate drive is desirable.

Angle between x and y traces $90^\circ \pm 1^\circ$

LINE WIDTH

Measured with the shrinking raster method in the centre of the screen

Final accelerator voltage	$V_{g9(\ell)}$	=	15 000	V
Astigmatism control electrode voltage	V_{g4}	=	1500	V
First accelerator voltage	V_{g2}	=	1500	V
Beam current	$I(\ell)$	=	10	μA
Line width	l.w.	=	0.45	mm

HELIX

Post deflection accelerator helix resistance min. 200 MΩ

7Z2 5547

TYPICAL OPERATING CONDITIONS

Final accelerator voltage	$V_{g_9(\ell)}$	=	15 000	V
Post deflection shield voltage (with respect to V_{g_7})	V_{g_8}	=	−12 to −18	V
Geometry control electrode voltage	V_{g_7}	=	1500 ±70	V [1]
Helix voltage, lower end	V_{g_6}	=	1500	V
Deflection plate shield voltage	V_{g_5}	=	1500	V [2]
Astigmatism control electrode voltage	V_{g_4}	=	1500 ±70	V [3]
Focusing electrode voltage	V_{g_3}	=	375 to 625	V
First accelerator voltage	V_{g_2}	=	1500	V
Control grid voltage for visual extinction of focused spot	$-V_{g_1}$	=	40 to 90	V
Deflection factor				
horizontal	M_x	=	9.4 to 12.5	V/cm
vertical	M_y	=	2.3 to 3.5	V/cm
Deviation of linearity of deflection		=	max. 2	% [4]
Geometry distortion			See note 5	
Useful scan				
horizontal		=	min. 100	mm
vertical		=	min. 60	mm

CIRCUIT DESIGN VALUES

Focusing voltage	V_{g_3}	=	250 to 417	V per kV of V_{g_4}
Control grid voltage for visual extinction of focused spot	$-V_{g_1}$	=	30 to 56.7	V per kV of V_{g_2}
Deflection factor at $V_{g_9(\ell)}/V_{g_4} = 10$				
horizontal	M_x	=	6.3 to 8.4	V/cm per kV of V_{g_4}
vertical	M_y	=	1.53 to 2.33	V/cm per kV of V_{g_4}
Control grid circuit resistance	R_{g_1}	=	max. 1	MΩ
Deflection plate circuit resistance	R_x, R_y	=	max. 50	kΩ
Focusing electrode current at a beam current of max. 25 µA	I_{g_3}	=	−25 to +25	µA [6]

1)2)3)4)5)6) See page 6.

7Z2 5548

LIMITING VALUES (Absolute max. rating system)

Final accelerator voltage	$V_{g9(\ell)}$	=	max.	16500	V
		=	min.	9000	V
Post deflection shield voltage	V_{g8}	=	max.	2500	V
		=	min.	1350	V
Geometry control electrode voltage	V_{g7}	=	max.	2500	V
		=	min.	1350	V
Helix voltage, lower end	V_{g6}	=	max.	2500	V
		=	min.	1350	V
Deflection plate shield voltage	V_{g5}	=	max.	2500	V
		=	min.	1350	V
Astigmatism control electrode voltage	V_{g4}	=	max.	2500	V
		=	min.	1350	V
Focusing electrode voltage	V_{g3}	=	max.	2500	V
First accelerator voltage	V_{g2}	=	max.	1800	V
		=	min.	1350	V
Control grid voltage					
negative	$-V_{g1}$	=	max.	200	V
positive	V_{g1}	=	max.	0	V
Voltage between astigmatism electrode	$V_{g4/x}$	=	max.	500	V
and any deflection plate	$V_{g4/y}$	=	max.	500	V
Cathode to heater voltage					
cathode positive	$V_{+k/f-}$	=	max.	200	V
cathode negative	$V_{-k/f+}$	=	max.	125	V
Screen dissipation	W_{ℓ}	=	max.	3	mW/cm^2
Ratio $V_{g9(\ell)}/V_{g4}$	$V_{g9(\ell)}/V_{g4}$	=	max.	10	

7Z2 5549

1) This tube is designed for optimum performance when operating at the ratio $V_{g9(\ell)}/V_{g4} = 10$. Operation at other ratio may result in changes in deflection uniformity and geometry distortion. The geometry control electrode voltage should be adjusted for optimum performance. For any necessary adjustment its potential will be within the stated range.

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

3) The astigmatism control electrode voltage should be adjusted for optimum spot shape. For any necessary adjustment its potential will be within the stated range.

4) 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 the indicated value.

5) A graticule, consisting of concentric rectangles of 100 mm x 60 mm and 98 mm x 58.2 mm 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.

6) Values to be taken into account for the calculation of the focus potentiometer.

7Z2 5550

INSTRUMENT CATHODE-RAY TUBE

13 cm diameter flat faced short oscilloscope tube (max. 35 cm) with post-deflection acceleration by means of a helical electrode. The tube is provided with deflection blanking.

QUICK REFERENCE DATA				
Final accelerator voltage	$V_{g8(\ell)}$	=	3000	V
Display area			8 cm x full scan	
Deflection factor, horizontal	M_x	=	24	V/cm
vertical	M_y	=	11.3	V/cm

SCREEN

	Colour	Persistence
D13-27GH	green	medium short

Useful screen diameter min. 114 mm

Useful scan at $V_{g8(\ell)}/V_{g5} = 2$

horizontal		full scan	
vertical	min.	80	mm

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

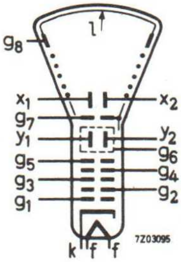
HEATING

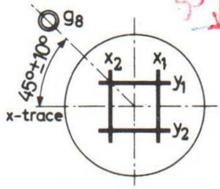
Indirect by A.C. or D.C.; parallel supply

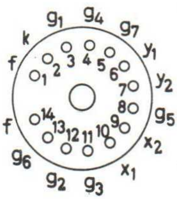
Heater voltage	V_f	=	6.3	V
Heater current	I_f	=	300	mA

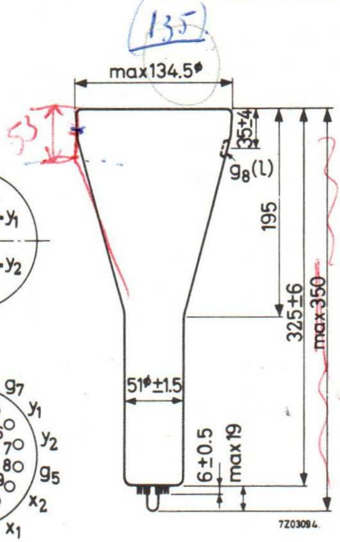
7Z2 5551

MECHANICAL DATA Dimensions in mm









Mounting position: any

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

Base 14 pin all glass

Dimensions and connections

Overall length (also with socket type 55566)	max.	350	mm
Face diameter	max.	134.5	mm

Net weight	approx.	680	g

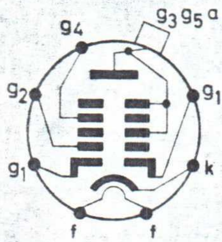
Accessories

Socket (supplied with tube)	type	55566
Final accelerator contact connector	type	55563
Mu metal shield	type	55557

7Z2 5552

Schwarzweiß-Bildröhren
M 17 - 18 W

17 cm Rechteckmonitorröhre mit 75° diagonalem Ablenkwinkel elektrostatischer Fokussierung und aluminisiertem Leuchtschirm



1. Allgemeines

Strahlsystem	Tetrode mit Einzellinse
Sockel	Miniatur-7-Stift (Spezial)
Fokussierung	elektrostatisch
Ablenkung	magnetisch
Ablenkwinkel	diagonal ca. 75° horizontal ca. 60° vertikal ca. 50°
Halsdurchmesser	20 mm

Stirnfläche:

Form	plan
Material	Klarglas
Schirm	aluminisiert
Fluoreszenzfarbe	weiß
Minimal nutzbare Abmessungen	95 mm × 125 mm Diagonale 155 mm
Gesamtlänge	max. 205 mm
Gewicht	ca. 0,7 kg

2. Betriebswerte für Kathodensteuerung ①

U_f ⑬		11 V
I_f		ca. 68 m A
U_{g3g5a}	11	11 kV
U_{g2}	200–350	250 V
U_{g4} ③	-100 . . . +300	-100 . . . + 300 V
$U_{k\ sperr}$ ④	45 ⑭	32 . . . 58 V

3. Grenzwerte ①

$U_{g3g5a\ max}$	12 kV
$U_{g3g5a\ min}$	7,5 kV
$U_{g4\ max}$	450 V
$(U_{g4})_{max}$	100 V
$(\pm I_{g4})_{max}$	25 μA
$U_{g2\ max}$	450 A
$U_{g2\ min}$	180 V
$(\pm I_{g2})_{max}$	5 μA
$U_{k\ max}$	100 V
$U_{k\ min}$	0 V
$U_{ks\ max}$ ⑦	350 V
$(-U_k)_{s\ max}$	2 V
$R_{g1\ max}$	1,5 MΩ
Z_{g1} (50 Hz) $_{max}$	0,5 MΩ
$U \pm_{f/k\ max}$	80 V
$U \pm_{f/ks\ max}$	130 V
$R_{f/k\ max}$ ⑩	1 MΩ
$Z_{f/k}$ (50 Hz) $_{max}$ ⑪	0,1 MΩ

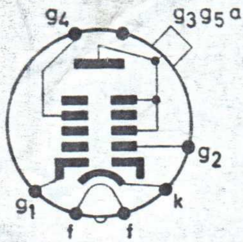
4. Kapazitäten

c_{g1}	ca. 6 pF
c_k	ca. 3 pF
$c_{g3g5a/m}$	ca. 350 pF

AW 17-69

A 17 – 69 BE / A 17 – 69 GJ / A 17 – 69 LF

Rechteckbildröhre mit aluminisiertem Leuchtschirm für Industriefernsehen



Strahlsystem	Tetrode mit Einzellinse
Sockel	Duodekal mit 7 Stiften
Fokussierung	elektrostatisch
Ablenkung	magnetisch
Ablenkwinkel	diagonal 70°
	horizontal 65°
	vertikal 50°
Stirnfläche:	
Form	plan
Material	Klarglas
Schirm	aluminisiert
Minimal nutzbare Abmessungen	96 mm × 128 mm Diagonale 170 mm
Gesamtlänge	256 ± 10 mm
Gewicht	ca. 0,7 kg

1. Allgemeines

Typ	Fluoreszenzfarbe	Nachleuchtdauer	
AW 17–69	weißlich	mittelkurz	$10^{-5} \ldots 10^{-3}$ s
A 17–69 BE	blau	mittelkurz	$10^{-5} \ldots 10^{-3}$ s
A 17–69 GJ	gelblich grün	mittel	$10^{-3} \ldots 10^{-1}$ s
A 17–69 LF	orange	lang	$10^{-1} \ldots 1$ s

2. Betriebswerte

U_f		6,3 V
I_f		0,3 A
U_{g3g5a}		14 kV
U_{g2}	300	400 V
U_{g4}		0 ... 400 V
$(-U_{g1})_{sperr}$	35 ... 75	48 ... 102

3. Grenzwerte

$U_{g3g5a\,max}$	16 kV
$U_{g4g5a\,min}$	12 kV
$U_{g4\,max}$	460 V
$U_{g2\,max}$	460 V
$U_{g2\,min}$	200 V
$U_{g1\,max}$	0 V
$(-U_{g1})_{max}$	150 V
$U_{g1\,s\,max}$	2 V
$(-U_{g1})_{s\,max}$ ⑦	400 V
$P_{lm\,max}$	10 mW/cm²

$R_{g1\,max}$	1,0 MΩ
$Z_{g1\,max}$	0,5 MΩ
$R_{f/k\,max}$ ⑩	1,0 MΩ
$Z_{f/k\,max}$ ⑪	0,1 MΩ
$U_{-f/k\,max}$ ⑨	410 V
$U_{-f/k\,max}$	250 V
$U_{-f/k\,s\,max}$	300 V
$U_{+f/k\,max}$	135 V
$U_{+f/k\,s\,max}$	180 V
$R_{g1\,min}$	150 Ω
$R_{g2\,min}$	470 Ω
$R_{g4\,min}$	470 Ω
$R_{g3g5a\,min}$	16 kΩ

4. Kapazitäten

c_{g1}	ca. 7 pF
c_k	ca. 5 pF
$c_{g3g5a/m\,min}$	400 pF
$c_{g3g5a/m\,max}$	800 pF

CAPACITANCES

x_1 to all other elements except x_2	$C_{x_1(x_2)}$	=	4.5	pF
x_2 to all other elements except x_1	$C_{x_2(x_1)}$	=	4.5	pF
y_1 to all other elements except y_2	$C_{y_1(y_2)}$	=	5	pF
y_2 to all other elements except y_1	$C_{y_2(y_1)}$	=	5	pF
x_1 to x_2	$C_{x_1x_2}$	=	2.5	pF
y_1 to y_2	$C_{y_1y_2}$	=	1.5	pF
Grid No.1 to all other elements	C_{g_1}	=	6	pF
Cathode to all other elements	C_k	=	3.5	pF

FOCUSING electrostatic

DEFLECTION double electrostatic

x plates symmetrical

y plates symmetrical

If use is made of the full deflection capabilities of the tube the deflection plates will intercept part of the electron beam; hence a low impedance deflection plate drive is desirable.

Angle between x and y traces $90^{\circ} \pm 1^{\circ}$

LINE WIDTH

Measured with the shrinking raster method in the centre of the screen.

Final accelerator voltage	$V_{g_8(\ell)}$	=	3000	V
Astigmatism control electrode voltage	V_{g_5}	=	1500	V
First accelerator voltage	V_{g_2}	=	1500	V
Beam current	$I_{g_8(\ell)}$	=	10	μA
Line width	l.w.	=	0.25	mm

HELIX

Post deflection accelerator helix resistance min. 50 MΩ
The helix is connected between $g_8(\ell)$ and g

7Z2 5553

TYPICAL OPERATING CONDITIONS

Final accelerator voltage	$V_{g_8(\ell)}$	=	3000	V
Geometry control electrode voltage	V_{g_7}	=	1500 ± 75	V [1]
Deflection plate shield voltage	V_{g_6}	=	1500	V [2]
Astigmatism control electrode voltage	V_{g_5}	=	1500 ± 75	V [3]
Focusing electrode voltage	V_{g_4}	=	300 to 550	V
Deflection blanking electrode voltage	V_{g_3}	=	1500	V
Deflection blanking control voltage	ΔV_{g_3}	=	max. 60	V [4] -60/+80.?
First accelerator voltage	V_{g_2}	=	1500	V
Control grid voltage for visual extinction of focused spot	V_{g_1}	=	−38 to −135	V
Deflection factor				
horizontal	M_x	=	21 to 27	V/cm
vertical	M_y	=	9.7 to 13	V/cm
Deviation of linearity of deflection		=	max. 2	% [5]
Geometry distortion			See note 6	
Useful scan				
horizontal			full scan	
vertical		=	min. 80	mm

CIRCUIT DESIGN VALUES

Focusing voltage	V_{g_4}	=	200 to 370	V per kV of V_{g_5}
Control grid voltage for visual extinction of focused spot	$-V_{g_1}$	=	25 to 90	V per kV of V_{g_2}
Deflection factor at $V_{g_8(\ell)}/V_{g_5} = 2$				
horizontal	M_x	=	max. 18	V/cm per kV of V_{g_5}
vertical	M_y	=	max. 8.7	V/cm per kV of V_{g_5}
Control grid circuit resistance	R_{g_1}	=	max. 1.5	MΩ
Deflection plate circuit resistance	R_x, R_y	=	max. 1	MΩ
Focusing electrode current	I_{g_4}	=	−15 to +10	μA [7]

7Z2 5554

LIMITING VALUES (Absolute max. rating system)

Final accelerator voltage	$V_{g8(\ell)}$	= max. 3300	V
		= min. 1800	V
Geometry control electrode voltage	V_{g7}	= max. 1700	V
Deflection plate shield voltage	V_{g6}	= max. 1700	V
Astigmatism control electrode voltage	V_{g5}	= max. 1700	V
		= min. 1200	V
Focusing electrode voltage	V_{g4}	= max. 1200	V
Deflection blanking electrode voltage	V_{g3}	= max. 1700	V
First accelerator voltage	V_{g2}	= max. 1700	V
Control grid voltage			
negative	$-V_{g1}$	= max. 200	V
positive	V_{g1}	= max. 0	V
positive peak	V_{g1p}	= max. 2	V
Voltage between astigmatism control electrode and any deflection plate	$V_{g5/x}$	= max. 500	V
	$V_{g5/y}$	= max. 500	V
Screen dissipation	W_{ℓ}	= max. 3	W/cm^2
Ratio $V_{g8(\ell)}/V_{g5}$	$V_{g8(\ell)}/V_{g5}$	= max. 2	

1) This tube is designed for optimum performance when operating at the ratio $V_{g8(\ell)}/V_{g5} = 2$. Operation at other ratio may result in changes in deflection uniformity and geometry distortion. The geometry control electrode voltage should be adjusted for optimum performance. For any necessary adjustment its potential will be within the stated range.

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

3) The astigmatism control electrode voltage should be adjusted for optimum spot shape. For any necessary adjustment its potential will be within the stated range.

4) For beam blanking of a beam current of 10 μA.

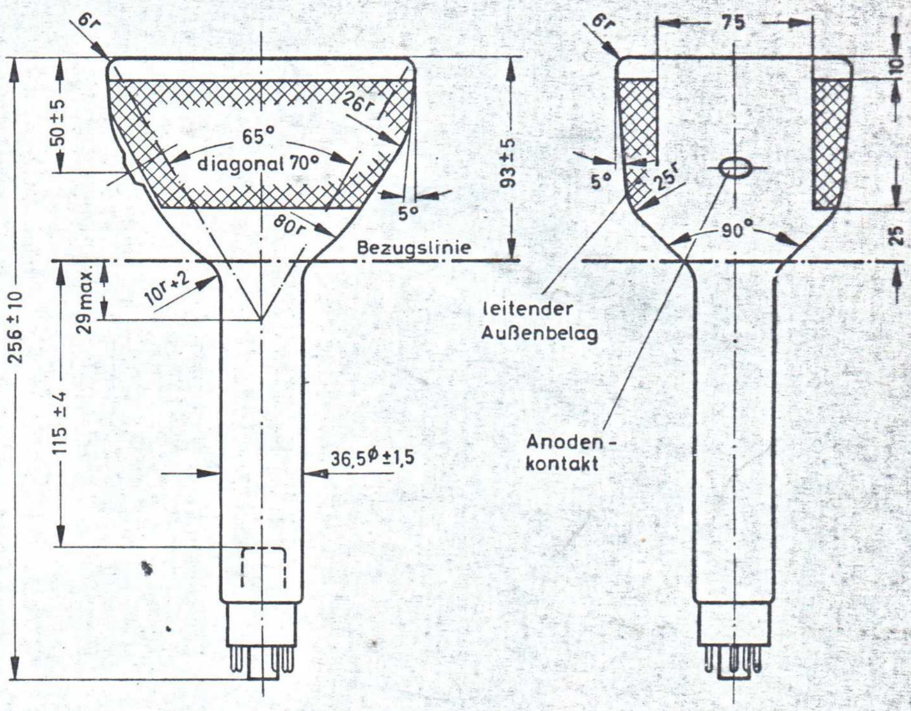
5) The sensitivity at a deflection of less than 75% of the usefull scan will not differ from the sensitivity at a deflection of 25% of the useful scan by more than the indicated value.

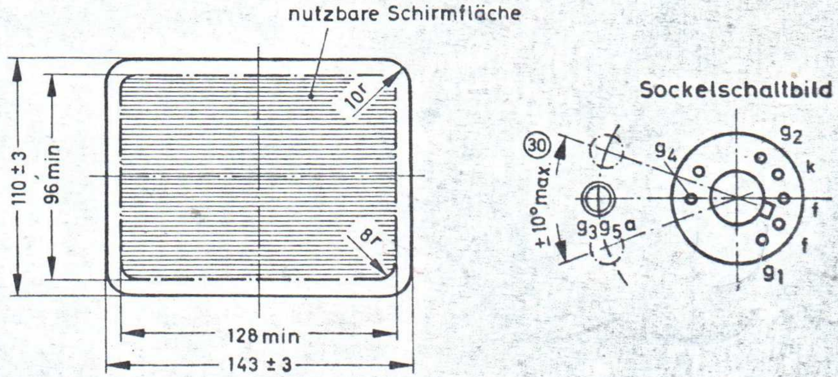
6) A graticule, consisting of concentric rectangles of 100 mm x 60 mm and 97 mm x 58 mm is aligned with the electrical x axis of the tube. The edges of a raster will fall between these rectangles with optimum correction potentials applied.

7) Values to be taken into account for the calculation of the focus potentiometer.

7Z2 5555

5. Maßzeichnungen

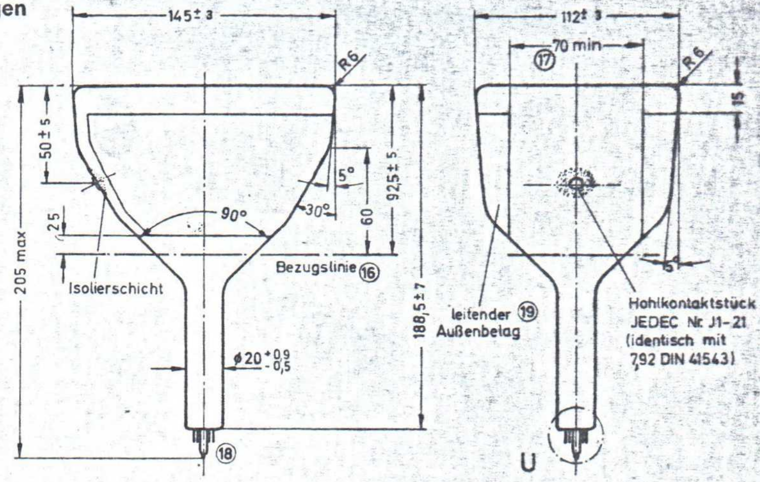


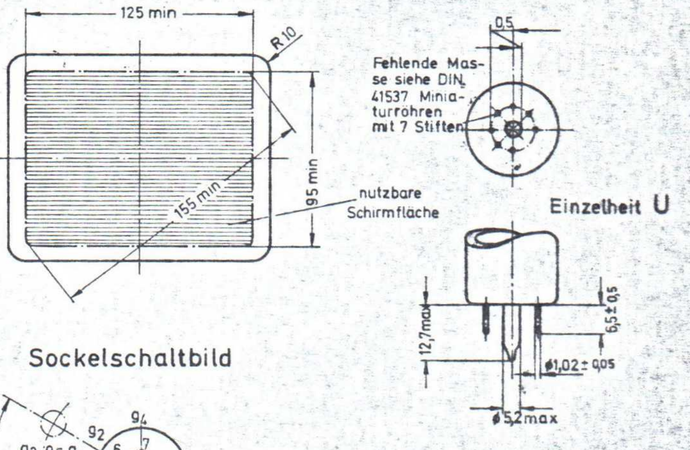


Bezuglinienlehre siehe Seite 52

O Fußnoten siehe Seite 48

5. Maßzeichnungen





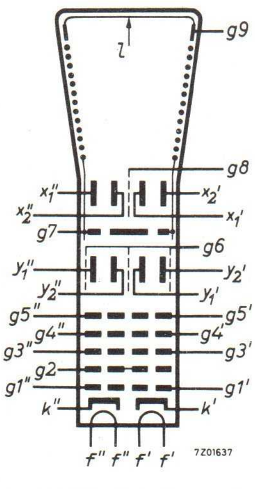
Sockelschaltbild

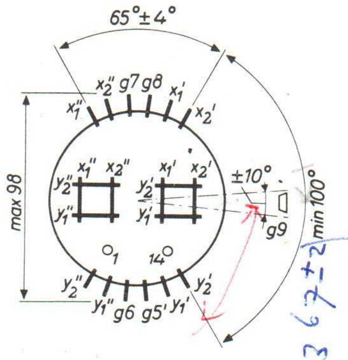
Bezugslinienlehre siehe Seite 53

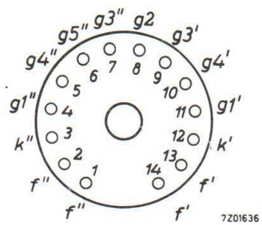
O Fußnoten siehe Seite 48

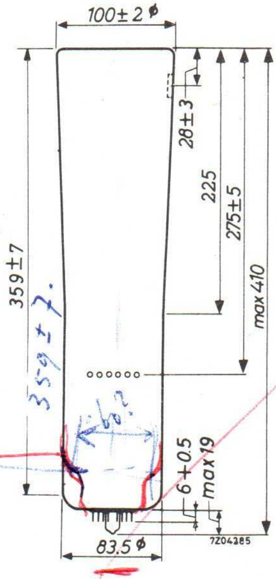
MECHANICAL DATA

Dimensions in mm









Mounting position: any

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

Base — 14 pin all glass

Dimensions and connections

Overall length	max.	410	mm
Face diameter	max.	102	mm

CAPACITANCES (each gun)

x_1 to all other elements except x_2	$C_{x_1(x_2)}$	3	pF
x_2 to all other elements except x_1	$C_{x_2(x_1)}$	4.5	pF
y_1 to all other elements except y_2	$C_{y_1(y_2)}$	3.5	pF
y_2 to all other elements except y_1	$C_{y_2(y_1)}$	3.5	pF
x_1 to x_2	$C_{x_1x_2}$	2	pF
y_1 to y_2	$C_{y_1y_2}$	1.5	pF
Grid No.1 to all other elements	C_{g_1}	6	pF
Cathode to all other elements	C_k	5	pF

FOCUSING electrostatic

DEFLECTION double electrostatic

x plates	symmetrical
y plates	symmetrical
Angle between x and y traces	$90 \pm 1^{\circ}$
Corresponding traces of each gun align within	1.5°

If use is made of the full deflection capabilities of the tube the deflection plates will intercept part of the electron beam; hence a low impedance deflection plate drive is desirable.

LINE WIDTH

Measured with the shrinking raster method in the centre of the screen.

Final accelerator voltage	$V_{g_9(\ell)}$	3000	V
Astigmatism control electrode voltage	V_{g_5}	1000	V
First accelerator voltage	V_{g_2}	1000	V
Beam current	$I_{g_9(\ell)}$	10	μA
Line width	l.w.	0.50	mm

HELIX

Post deflection accelerator helix resistance: min. 100 MΩ

7Z2 6182

TYPICAL OPERATING CONDITIONS(each gun)

Final accelerator voltage	$V_{g_9(\ell)}$	3000	V
Intergun shield voltage	V_{g_8}	1000±100	V [1])
Geometry control electrode voltage	V_{g_7}	1000±100	V [1])
Deflection plate shield voltage	V_{g_6}	1000	V [2])
Astigmatism control electrode voltage	V_{g_5}	1000±100	V [3])
Focusing electrode voltage	V_{g_4}	180 to 380	V
Deflection blanking electrode voltage	V_{g_3}	1000	V
Deflection blanking control voltage for beam blanking of a current $I_{g_9}(\ell)$ = 10 µA	ΔV_{g_3}	max. 40	V + 54 of + vernalt.
First accelerator voltage	V_{g_2}	1000	V
Control grid voltage for visual extinction of focused spot	V_{g_1}	-25 to -90	V
Deflection factor, horizontal	M_x	10 to 20	V/cm
vertical	M_y	6 to 8	V/cm
Deviation of linearity of deflection		max. 2.5	% [4])
Geometry distortion		See note 5	
Interaction factor		2.10^{-3}	mm/Vdc [6])
Tracking error		1.5	mm [7])

[1])[2])[3])[4])[5])[6])[7]) See page 6

7Z2 6183

LIMITING VALUES (each gun, if applicable) (Absolute max. rating system)

Final accelerator voltage	$V_{g_9}(\ell)$	max.	3300	V
		min.	2700	V
Intergun shield voltage	V_{g_8}	max.	1200	V
Geometry control electrode voltage	V_{g_7}	max.	1200	V
Deflection plate shield voltage	V_{g_6}	max.	1200	V
Astigmatism control electrode voltage	V_{g_5}	max.	1200	V
		min.	800	V
Focusing electrode voltage	V_{g_4}	max.	1200	V
Beam blanking electrode voltage	V_{g_3}	max.	1200	V
First accelerator voltage	V_{g_2}	max.	1200	V
		min.	200	V
Control grid voltage,				
negative	$-V_{g_1}$	max.	200	V
positive	V_{g_1}	max.	0	V
positive peak	$V_{g_{1p}}$	max.	2	V
Cathode to heater voltage,				
cathode positive	$V_{+k/f-}$	max.	200	V
cathode negative	$V_{-k/f+}$	max.	125	V
Average cathode current	I_k	max.	300	μA
Screen dissipation	W_ℓ	max.	3	mW/cm^2
Ratio $V_{g_9}(\ell)/V_{g_5}$	$V_{g_9}(\ell)/V_{g_5}$	max.	3	

7Z2 6184

CIRCUIT DESIGN VALUES (each gun, if applicable)

Focusing voltage	V_{g4}	180 to 380	V/kV of V_{g2}
Control grid voltage for visual cut-off focused spot	V_{g1}	25 to -90	V/kV of V_{g2}
Deflection factor $V_{g9}(\ell)/V_{g5} = 3$			
horizontal	M_x	10 to 20	V/cm per kV of V_{g5}
vertical	M_y	6 to 8	V/cm per kV of V_{g5}
Focusing electrode current	I_{g4}	-15 to +10	μA
Control grid circuit resistance	R_{g1}	max. 1.5	MΩ

---

1) This tube is designed for optimum performance when operating at the ratio $V_{g9}(\ell)/V_{g5} = 3$. Operation at other ratio may result in changes in deflection uniformity and geometry distortion. The geometry control electrode voltage and the intergunshield voltage should be adjusted for optimum performance. For any necessary adjustment its potential will be within the stated range.

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

3) The astigmatism control electrode voltage should be adjusted for optimum spot shape. For any necessary adjustment its potential will be within the stated range.

4) 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 the indicated value.

5) A graticule consisting of concentric rectangles of 60 mm x 60 mm and 57 mm x 57 mm is aligned with electrical x axis of the tube. The edges of a raster will fall between these rectangles with optimum potentials applied.

6) The deflection of one beam when balanced dc voltage are applied to the deflection plates of the other beam, will not be greater than the indicated value.

7) With 50 mm vertical traces superimposed at the tube face centre and deflected horizontally ± 4 cm by voltages proportional to the relative deflection factors, horizontal separation of the corresponding points of the traces shall not be greater than the indicated value.

7Z2 6185

INSTRUMENT CATHODE-RAY TUBE

Low accelerator voltage cathode-ray tube for monitoring purpose

QUICK REFERENCE DATA				
Accelerator voltage	$V_{g_4,g_2,y_2(\ell)}$	=	500	V
Display area	Both directions full scan			
Deflection factor, horizontal	M_x	=	52.5	V/cm
vertical	M_y	=	45.5	V/cm

SCREEN

	Colour	Persistence
DH3-91	green	medium short

Useful screen diameter min. 28 mm

Useful scan

horizontal full scan

vertical full scan

HEATING:

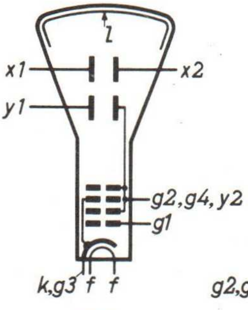
Indirect by A.C. or D.C.; parallel supply

Heater voltage V_f = 6.3 V

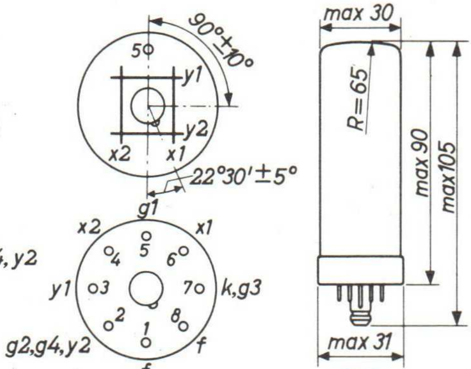
Heater current I_f = 300 mA

7Z2 5556

MECHANICAL DATA Dimensions in mm



7Z02826



7Z02825

Mounting position: any

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

Base	English Loctal 8 pins		
Dimensions and connections			
See also outline drawing			
Overall length	max.	105	mm
Face diameter	max.	30	mm
Net weight:	approx.	39	g
Accessories			
Socket	type	5902/20 or 40213	
Mu-metal shield	type	55525	

7Z2 5557

CAPACITANCES

x_1 to all other elements except x_2	$C_{x_1(x_2)}$	=	4.5	pF
x_2 to all other elements except x_1	$C_{x_2(x_1)}$	=	4.5	pF
y_1 to all other elements except y_2	$C_{y_1(y_2)}$	=	3.5	pF
x_1 to x_2	$C_{x_1 x_2}$	=	1.0	pF
Control grid to all other elements	C_{g_1}	=	5.6	pF

FOCUSING electrostatic self focusing

DEFLECTION double electrostatic

x plates symmetrical

y plates asymmetrical

LINE WIDTH

Measured on a circle of 25 mm diameter

Accelerator voltage	$V_{g_4, g_2, y_2(\ell)}$	=	500	V
Beam current	$I(\ell)$	=	0.5	μA
Line width	l.w.	=	0.6	mm

TYPICAL OPERATING CONDITIONS

Accelerator voltage	$V_{g_4, g_2, y_2(\ell)}$	=	500	V
Control grid voltage for visual extinction of focused spot	$-V_{g_1}$	=	8 to 27	V
Deflection factor				
horizontal	M_x	=	41 to 72	V/cm
vertical	M_y	=	35 to 63	V/cm
Useful scan				
horizontal			full scan	
vertical			full scan	

7Z2 5558

LIMITING VALUES (Absolute max. rating system)

Accelerator voltage	$V_{g_4, g_2, y_2(\ell)}$	= max.	1000	V
		= min.	350	V
Control grid voltage				
negative	$-V_{g_1}$	= max.	200	V
positive	V_{g_1}	= max.	0	V
positive peak	$V_{g_{1p}}$	= max.	2	V
Cathode to heater voltage				
cathode positive	$V_{+k/f-}$	= max.	200	V
cathode negative	$V_{-k/f+}$	= max.	125	V
Screen dissipation	W_ℓ	= max.	3	mW/cm^2

CIRCUIT DESIGN VALUES

Control grid voltage for visual extinction of focused spot	$-V_{g_1}$	=	16 to 54	V per kV of V_{g_4, g_2, y_2}
Deflection factor				
horizontal	M_x	=	90 to 120	V/cm per kV of V_{g_4, g_2, y_2}
vertical	M_y	=	38.5 to 52.5	V/cm per kV of V_{g_4, g_2, y_2}
Control grid circuit resistance	R_{g_1}	= max.	1	MΩ
Deflection plate circuit resistance	R_x, R_y	= max.	5	MΩ

REMARK

A contrast improving transparent conductive coating connected to the accelerator electrode is present between glass and fluorescent layer. This enables the application of a high potential with respect to earth to the accelerator electrode, without the risk of picture distortion by touching the face (electrostatic body-effect).

7Z2 5559

INSTRUMENT CATHODE-RAY TUBE

4 cm diameter cathode-ray tube for monitoring purposes.

SCREEN

	colour	persistence
DB4-1	blue	medium short
DG4-1	yellowish green	medium
DP4-1	yellowish green	long

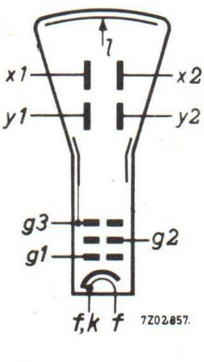
HEATING

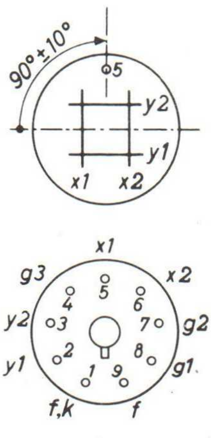
Indirect by A.C. or D.C.; parallel supply

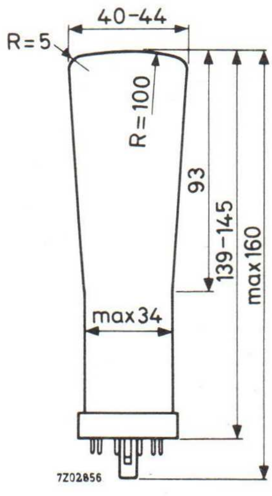
Heater voltage	V_f =	6.3 V
Heater current	I_f =	310 mA

MECHANICAL DATA

Dimensions in mm







Base English Loctal 9 pins

Socket 5906/20 or 40212

7Z2 5560

FOCUSING electrostatic

DEFLECTION double electrostatic

x plates	symmetrical
y plates	symmetrical

TYPICAL OPERATING CONDITIONS

Accelerator voltage	$V_{g_3(\ell)}$	=	800	V
Focusing electrode voltage	V_{g_2}	=	200 to 300	V
Control grid voltage for visual extinction of focused spot	$-V_{g_1}$	=	0 to 50	V
Deflection factor				
horizontal	M_x	=	62.5	V/cm
vertical	M_y	=	40	V/cm
Useful scan				
horizontal			full scan	
vertical			full scan	

LIMITING VALUES (Absolute max. rating system)

Accelerator voltage	$V_{g_3(\ell)}$	=	max. 1000	V
		=	min. 800	V
Focusing electrode voltage	V_{g_2}	=	max. 400	V
Control grid voltage				
negative	$-V_{g_1}$	=	max. 200	V
positive	V_{g_1}	=	max. 0	V
positive peak	$V_{g_{1p}}$	=	max. 2	V

7Z2 5561

INSTRUMENT CATHODE-RAY TUBE

SCREEN

	colour	persistence
DB4-2	blue	medium short
DG4-2	yellowish green	medium
DP4-2	yellowish green	long

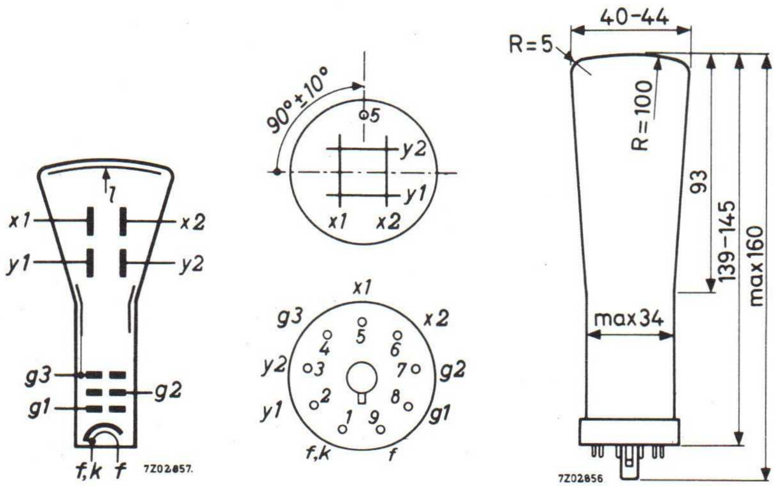
HEATING

Indirect by A.C. or D.C.; parallel supply

Heater voltage	V_f	= 6.3 V
Heater current	I_f	= 310 mA

MECHANICAL DATA

Dimensions in mm



x_1 has to be connected to the accelerator electrode. Earthing of the accelerator electrode is recommended.

Base	English Loctal 9 pins
Socket	5906/20 or 40212

7Z2 5562

FOCUSING electrostatic

DEFLECTION double electrostatic

x plates asymmetrical

y plates symmetrical

TYPICAL OPERATING CONDITIONS

Accelerator voltage	$V_{g3(\ell)}$	=	800	V
Focusing electrode voltage	V_{g2}	=	200 to 300	V
Control grid voltage for visual extinction of focused spot	$-V_{g1}$	=	0 to 50	V
Deflection factor				
horizontal	M_x	=	62.5	V/cm
vertical	M_y	=	40	V/cm
Useful scan				
horizontal			full scan	
vertical			full scan	

LIMITING VALUES (Absolute max. rating system)

Accelerator voltage	$V_{g3(\ell)}$	= max.	1000	V
		= min.	800	V
Focusing electrode voltage	V_{g2}	= max.	400	V
Control grid voltage				
negative	$-V_{g1}$	= max.	200	V
positive	V_{g1}	= max.	0	V
positive peak	V_{g1p}	= max.	2	V

7Z2 5563

INSTRUMENT CATHODE-RAY TUBE

7 cm diameter oscilloscope tube for monitoring purposes

SCREEN

	colour	persistence
DB7-1	blue	medium short
DG7-1	yellowish green	medium short

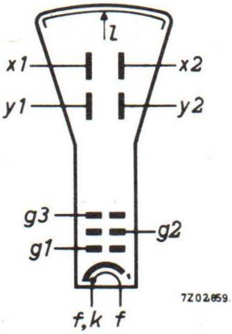
HEATING

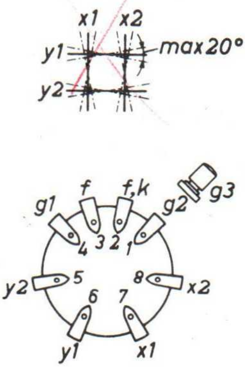
Indirect by A.C. or D.C.; parallel supply

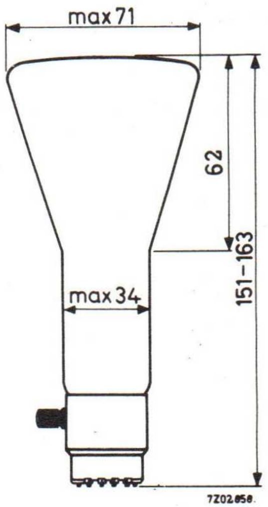
Heater voltage	V_f =	4.0 V
Heater current	I_f =	1 A

MECHANICAL DATA

Dimensions in mm







Base P

7Z2 5564

FOCUSING	electrostatic			
DEFLECTION	double electrostatic			
x plates	symmetrical			
y plates	symmetrical			

TYPICAL OPERATING CONDITIONS

Accelerator voltage	$V_{g_3(\ell)}$	=	800	V
Focusing electrode voltage	V_{g_2}	=	150 to 350	V
Control grid voltage for visual extinction of focused spot	$-V_{g_1}$	=	0 to 30	V
Deflection factor				
horizontal	M_x	=	71.5	V/cm
vertical	M_y	=	45.5	V/cm
Useful scan				
horizontal			full scan	
vertical			full scan	

LIMITING VALUES (Absolute max. rating system)

Accelerator voltage	$V_{g_3(\ell)}$	=	max. 800	V
Focusing electrode voltage	V_{g_2}	=	max. 350	V
Control grid voltage				
negative	$-V_{g_1}$	=	max. 200	V
positive	V_{g_1}	=	max. 0	V
positive peak	$V_{g_{1p}}$	=	max. 2	V

7Z2 5565

INSTRUMENT CATHODE-RAY TUBE

7 cm diameter oscilloscope tube for monitoring purposes

SCREEN

	colour	persistence
DB7-2 DG7-2	blue yellowish green	medium short medium short

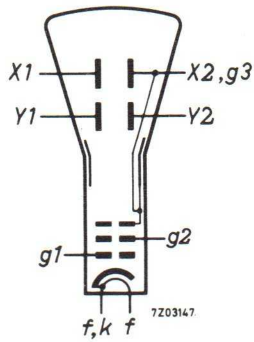
HEATING

Indirect by A.C. or D.C.; parallel supply

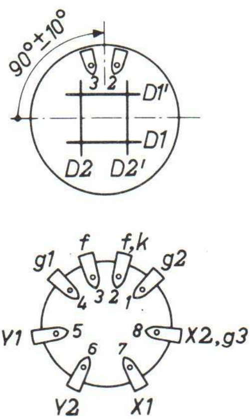
Heater voltage	V_f =	4.0 V
Heater current	I_f =	1 A

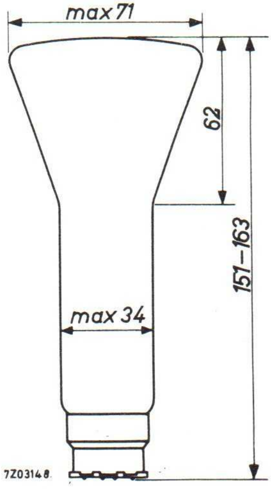
MECHANICAL DATA

Dimensions in mm



7Z03147





7Z03148

Earthing of x_2, g_3 is recommended.

Base P

7Z2 5566

FOCUSING electrostatic

DEFLECTION double electrostatic

x plates	asymmetrical
y plates	symmetrical

TYPICAL OPERATING CONDITIONS

Accelerator voltage	$V_{g_3(\ell)}$	=	800	V
Focusing electrode voltage	V_{g_2}	=	150 to 350	V
Control grid voltage for visual extinction of focused spot	$-V_{g_1}$	=	0 to 30	V
Deflection factor				
horizontal	M_x	=	71.5	V/cm
vertical	M_y	=	45.5	V/cm
Useful scan				
horizontal			full scan	
vertical			full scan	

LIMITING VALUES (Absolute max. rating system)

Accelerator voltage	$V_{g_3(\ell)}$	=	max.	800	V
Focusing electrode voltage	V_{g_2}	=	max.	350	V
Control grid voltage					
negative	$-V_{g_1}$	=	max.	200	V
positive	V_{g_1}	=	max.	0	V
positive peak	$V_{g_{1p}}$	=	max.	2	V

7Z2 5567

INSTRUMENT CATHODE-RAY TUBE

7 cm diameter oscilloscope tube for monitoring purposes

SCREEN

	colour	persistence
DB7-3	blue	medium short
DG7-3	yellowish green	medium
DN7-3	yellowish green	medium short

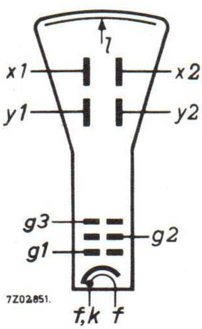
HEATING

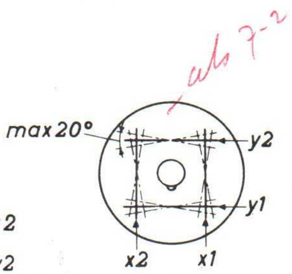
Indirect by A.C. or D.C.; parallel supply

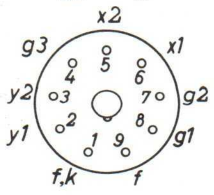
Heater voltage	V_f =	6.3 V
Heater current	I_f =	400 mA

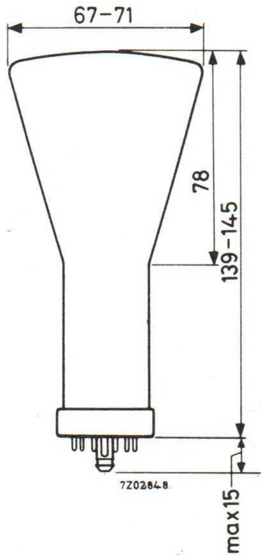
MECHANICAL DATA

Dimensions in mm









Base ENNE-AL

7Z2 5568

OBSOLETE TYPE

FOCUSING	electrostatic			
DEFLECTION	double electrostatic			
x plates	symmetrical			
y plates	symmetrical			

TYPICAL OPERATING CONDITIONS

Accelerator voltage	$V_{g_3(\ell)}$	=	800	V
Focusing electrode voltage	V_{g_2}	=	200 to 300	V
Control grid voltage for visual extinction of focused spot	$-V_{g_1}$	=	0 to 50	V
Deflection factor				
horizontal	M_x	=	62.5	V/cm
vertical	M_y	=	38.5	V/cm
Useful scan				
horizontal			full scan	
vertical			full scan	

LIMITING VALUES (Absolute max. rating system)

Accelerator voltage	$V_{g_3(\ell)}$	=	max. 1000	V
		=	min. 800	V
Focusing electrode voltage	V_{g_2}	=	max. 400	V
Control grid voltage				
negative	$-V_{g_1}$	=	max. 200	V
positive	V_{g_1}	=	max. 0	V
positive peak	$V_{g_{1p}}$	=	max. 2	V

7Z2 5569

INSTRUMENT CATHODE-RAY TUBE

7 cm diameter oscilloscope tube for monitoring purposes

SCREEN

	colour	persistence
DB7-4	blue	medium short
DG7-4	yellowish green	medium
DN7-4	yellowish green	medium short

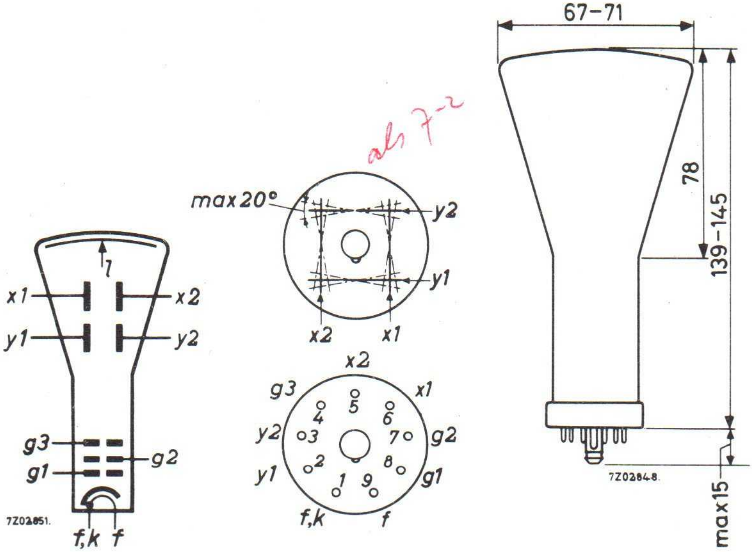
HEATING

Indirect by A.C. or D.C.; parallel supply

Heater voltage	V_f	=	6.3	V
Heater current	I_f	=	400	mA

MECHANICAL DATA

Dimensions in mm



x_2 has to be connected to the accelerator electrode. Earthing of the accelerator is recommended.

Base	ENNE-AL	7Z2 5570

FOCUSING	electrostatic
DEFLECTION	double electrostatic
x plates	asymmetrical
y plates	symmetrical

TYPICAL OPERATING CONDITIONS

Accelerator voltage	$V_{g_3(\ell)}$	=	800	V
Focusing electrode voltage	V_{g_2}	=	200 to 300	V
Control grid voltage for visual extinction of focused spot	$-V_{g_1}$	=	0 to 50	V
Deflection factor				
horizontal	M_x	=	62.5	V/cm
vertical	M_y	=	38.5	V/cm
Useful scan				
horizontal		full scan		
vertical		full scan		

LIMITING VALUES (Absolute max. rating system)

Accelerator voltage	$V_{g_3(\ell)}$	=	max. 1000	V
		=	min. 800	V
Focusing electrode voltage	V_{g_2}	=	max. 400	V
Control grid voltage				
negative	$-V_{g_1}$	=	max. 200	V
positive	V_{g_1}	=	max. 0	V
positive peak	$V_{g_{1p}}$	=	max. 2	V

7Z2 5571

INSTRUMENT CATHODE-RAY TUBE

Cathode-ray tube for monitoring purposes.

QUICK REFERENCE DATA				
Accelerator voltage	$V_{g_3(\ell)}$	=	800	V
Display area	Both directions full scan			
Deflection factor, horizontal	M_x	=	62.5	V/cm
vertical	M_y	=	40	V/cm

SCREEN

	colour	persistence
DB7-5	blue	medium short
DG7-5	yellowish green	medium short
DP7-5	yellowish green	long

Useful screen diameter — min. 65 mm

Useful scan

- horizontal — full scan
- vertical — full scan

HEATING

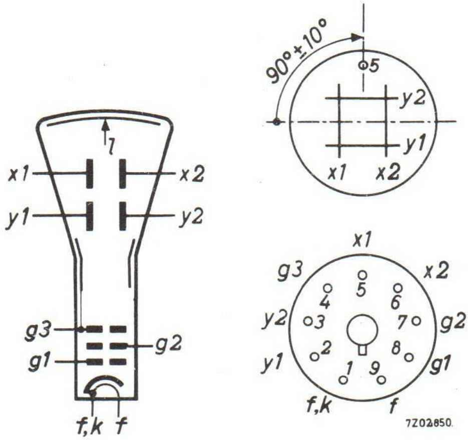
Indirect by A.C. or D.C.; parallel supply

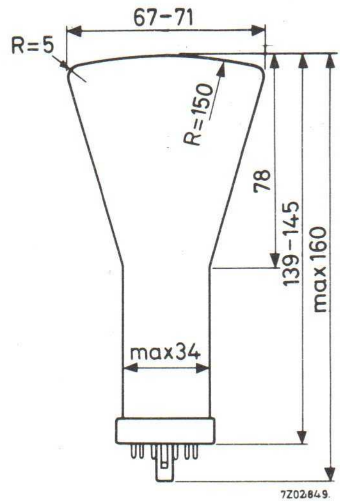
Heater voltage	V_f	=	6.3	V
Heater current	I_f	=	310	mA

7Z2 5572

MECHANICAL DATA

Dimensions in mm





Mounting position: any

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

Base English Loctal 9 pins

Dimensions and connections

See also outline drawing			
Overall length	max.	160	mm
Face diameter	max.	71	mm

Net weight:	approx.	140	g

Accessories

Socket	type	5906/20 or 40212
Mu-metal shield	type	55530

CAPACITANCES

x_1 to all other elements except x_2	$C_{x_1(x_2)}$	= 2.8 pF
x_2 to all other elements except x_1	$C_{x_2(x_1)}$	= 2.8 pF
y_1 to all other elements except y_2	$C_{y_1(y_2)}$	= 3.0 pF
y_2 to all other elements except y_1	$C_{y_2(y_1)}$	= 3.3 pF
x_1 to x_2	$C_{x_1x_2}$	= 0.8 pF
y_1 to y_2	$C_{y_1y_2}$	= 0.6 pF
Control grid to all other elements	C_{g_1}	= 7.0 pF
Cathode to all other elements	C_k	= 3.2 pF

FOCUSING electrostatic

DEFLECTION double electrostatic

x plates symmetrical

y plates symmetrical

Angle between x and y traces $90^o \pm 1.5^o$

LINE WIDTH

Measured on a circle of 50 mm diameter

Accelerator voltage	$V_{g_3(\ell)}$	= 800 V
Beam current	$I_{(\ell)}$	= 0.5 μA
Line width	l.w.	= 0.4 mm

TYPICAL OPERATING CONDITIONS

Accelerator voltage	$V_{g_3(\ell)}$	= 800 V
Focusing electrode voltage	V_{g_2}	= 200 to 300 V
Control grid voltage for visual extinction of focused spot	$-V_{g_1}$	= 0 to 50 V
Deflection factor, horizontal	M_x	= 53 to 72 V/cm
vertical	M_y	= 33 to 45 V/cm
Geometry distortion		See note 1 page 4
Useful scan, horizontal		full scan
vertical		full scan

7Z2 5574

LIMITING VALUES (Absolute max. rating system)

Accelerator voltage	$V_{g3(\ell)}$	= max.	1000	V
		= min.	800	V
Focusing electrode voltage	V_{g2}	= max.	400	V
Control grid voltage				
negative	$-V_{g1}$	= max.	200	V
positive	V_{g1}	= max.	0	V
positive peak	V_{g1p}	= max.	2	V
Cathode to heater voltage				
cathode positive	$V_{+k/f-}$	= max.	200	V
cathode negative	$V_{-k/f+}$	= max.	125	V
Voltage between accelerator electrode and any deflection plate	$V_{g3/x}$	= max.	500	V
	$V_{g3/y}$	= max.	500	V
Screen dissipation	W_{ℓ}	= max.	3	mW/cm^2

CIRCUIT DESIGN VALUES

Focusing voltage	V_{g2}	=	250 to 375	V per kV of V_{g3}
Control grid voltage for visual extinction of focused spot	$-V_{g1}$	=	0 to 62.5	V per kV of V_{g3}
Deflection factor				
horizontal	M_x	=	66 to 90	V/cm per kV of V_{g3}
vertical	M_y	=	41 to 56	V/cm per kV of V_{g3}
Control grid circuit resistance	R_{g1}	=	max. 0.5	MΩ
Deflection plate circuit resistance	R_x, R_y	=	max. 5	MΩ

---

[1]) A graticule, consisting of concentric rectangles of 43.2 mm x 43.2 mm and 40 mm x 40 mm 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.

7Z2 5575

INSTRUMENT CATHODE-RAY TUBE

Cathode-ray tube for monitoring purposes.

QUICK REFERENCE DATA				
Accelerator voltage	$V_{g3(\ell)}$	=	800	V
Display area	Both directions full scan			
Deflection factor, horizontal	M_x	=	62.5	V/cm
vertical	M_y	=	40	V/cm

SCREEN

	colour	persistence
DB7-6	blue	medium short
DG7-6	yellowish green	medium short
DP7-6	yellowish green	long

Useful screen diameter min. 65 mm

Useful scan

horizontal full scan

vertical full scan

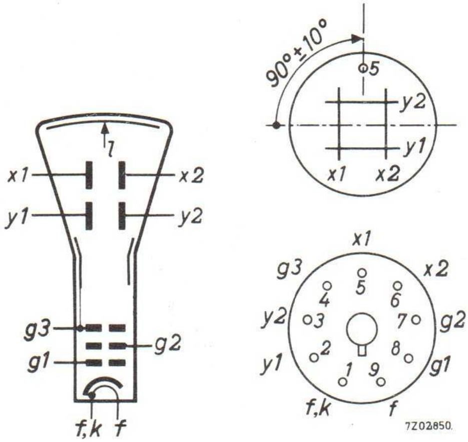
HEATING

Indirect by A.C. or D.C.; parallel supply

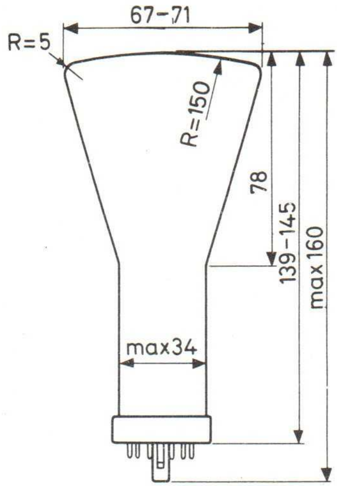
Heater voltage	V_f	=	6.3	V
Heater current	I_f	=	310	mA

7Z2 5576

MECHANICAL DATA Dimensions in mm



7Z02850



7Z02849

Mounting position: any

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

Base English Loctal 9 pins

Dimensions and connections

See also outline drawing

Overall length	max.	160	mm
Face diameter	max.	71	mm

Net weight: approx. 140 g

Accessories

Socket	type	5906/20 or 40212
Mu-metal shield	type	55530

7Z2 5573

CAPACITANCES

x_1 to all other elements except x_2	$C_{x_1(x_2)}$	=	2.8	pF
x_2 to all other elements except x_1	$C_{x_2(x_1)}$	=	2.8	pF
y_1 to all other elements except y_2	$C_{y_1(y_2)}$	=	3.0	pF
y_2 to all other elements except y_1	$C_{y_2(y_1)}$	=	3.3	pF
x_1 to x_2	$C_{x_1x_2}$	=	0.8	pF
y_1 to y_2	$C_{y_1y_2}$	=	0.6	pF
Control grid to all other elements	C_{g_1}	=	7.0	pF
Cathode to all other elements	C_k	=	3.2	pF

FOCUSING electrostatic

DEFLECTION double electrostatic

x plates asymmetrical
x_1 has to be connected to the accelerator electrode. Earthing of the accelerator electrode is recommended.

y plates symmetrical

Angle between x and y traces $90^o \pm 1.5^o$

LINE WIDTH

Measured on a circle of 50 mm diameter

Accelerator voltage	$V_{g_3(\ell)}$	=	800	V
Beam current	$I_{(\ell)}$	=	0.5	μA
Line width	l.w.	=	0.4	mm

TYPICAL OPERATING CONDITIONS

Accelerator voltage	$V_{g_3(\ell)}$	=	800	V
Focusing electrode voltage	V_{g_2}	=	200 to 300	V
Control grid voltage for visual extinction of focused spot	$-V_{g_1}$	=	0 to 50	V
Deflection factor, horizontal	M_x	=	53 to 72	V/cm
vertical	M_y	=	33 to 45	V/cm
Geometry distortion			See note 1 page 4	
Useful scan, horizontal			full scan	
vertical			full scan	

7Z2 5578

LIMITING VALUES (Absolute max. rating system)

Accelerator voltage	$V_{g_3(\ell)}$	= max.	1000	V
		= min.	800	V
Focusing electrode voltage	V_{g_2}	= max.	400	V
Control grid voltage				
negative	$-V_{g_1}$	= max.	200	V
positive	V_{g_1}	= max.	0	V
positive peak	$V_{g_{1p}}$	= max.	2	V
Cathode to heater voltage				
cathode positive	V+k/f-	= max.	200	V
cathode negative	V-k/f+	= max.	125	V
Voltage between accelerator electrode and any deflection plate	$V_{g_3/x}$	= max.	500	V
	$V_{g_3/y}$	= max.	500	V
Screen dissipation	W_ℓ	= max.	3	mW/cm^2

CIRCUIT DESIGN VALUES

Focusing voltage	V_{g_2}	= 250 to	375	V per kV of V_{g_3}
Control grid voltage for visual extinction of focused spot	$-V_{g_1}$	=	0 to 62.5	V per kV of V_{g_3}
Deflection factor				
horizontal	M_x	= 66 to	90	V/cm per kV of V_{g_3}
vertical	M_y	= 41 to	56	V/cm per kV of V_{g_3}
Control grid circuit resistance	R_{g_1}	= max.	0.5	MΩ
Deflection plate circuit resistance	R_x, R_y	= max.	5	MΩ

[1]) A graticule, consisting of concentric rectangles of 43.2 mm x 43.2 mm and 40 mm x 40 mm 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.

7Z2 5575

INSTRUMENT CATHODE-RAY TUBE

Oscilloscope tube with 7 cm diameter flat face plate and post deflection acceleration by means of a helical electrode. The low heater consumption together with the high sensitivity render this tube suitable for transistorized equipment.

QUICK REFERENCE DATA				
Final accelerator voltage	$V_{g6(\ell)}$	=	1200	V
Display area		=	4.5x6	cm
Deflection factor, horizontal	M_x	=	10.7	V/cm
vertical	M_y	=	3.65	V/cm

SCREEN

	Colour	Persistence
DB7-11	blue	medium short
DH7-11	green	medium short
DN7-11	bluish green	medium short
DP7-11	yellowish green	long

Useful screen diameter min. 68 mm

Useful scan at $V_{g6(\ell)}/V_{g4} = 4$

horizontal	min.	60	mm
vertical	min.	45	mm

HEATING

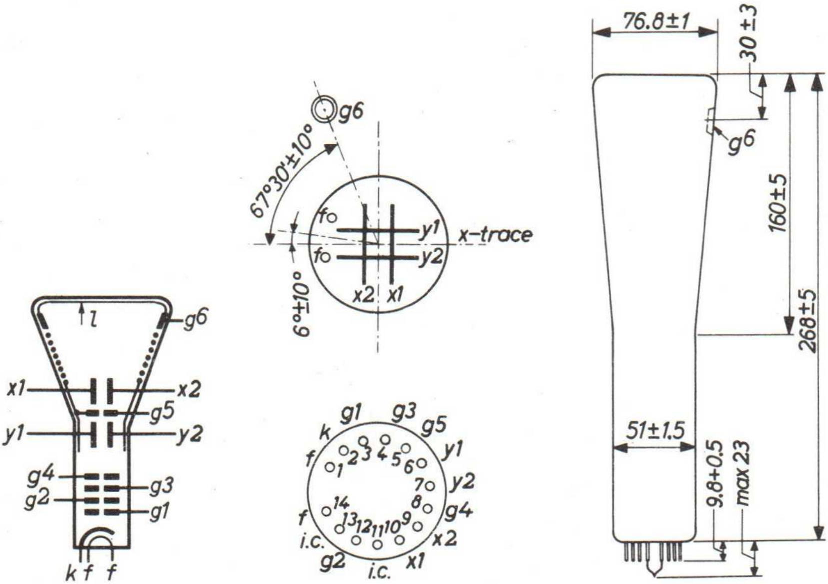
Indirect by A.C. or D.C.; parallel supply

Heater voltage	V_f	=	6.3	V
Heater current	I_f	=	95	mA

90

7Z2 5584

MECHANICAL DATA (Dimensions in mm)



Mounting position: any

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

Base 14 pins all glass

Dimensions and connections

Overall length	max.	285	mm
Face diameter	max.	77.8	mm

Net weight	approx.	370	g

Accessories

Socket (supplied with tube)	type	40467
Final accelerator contact connector	type	55563
Mu-metal shield	type	55532

7Z2 5585

CAPACITANCES

x_1 to all other elements except x_2	$C_{x_1(x_2)}$	=	4.0	pF
x_2 to all other elements except x_1	$C_{x_2(x_1)}$	=	4.0	pF
y_1 to all other elements except y_2	$C_{y_1(y_2)}$	=	3.5	pF
y_2 to all other elements except y_1	$C_{y_2(y_1)}$	=	3.5	pF
x_1 to x_2	$C_{x_1x_2}$	=	1.9	pF
y_1 to y_2	$C_{y_1y_2}$	=	1.7	pF
Control grid to all other elements	C_{g_1}	=	5.7	pF
Cathode to all other elements	C_k	=	3.0	pF

FOCUSING
electrostatic

DEFLECTION
double electrostatic

x plates — symmetrical

y plates — symmetrical

If use is made of the full deflection capabilities of the tube the deflection plates will intercept part of the electron beam; hence a low impedance deflection plate drive is desirable.

Angle between x and y traces $90^{\circ} \pm 1^{\circ}$

LINE WIDTH

Measured with the shrinking raster method in the centre of the screen.

Final accelerator voltage	$V_{g_6(\ell)}$	=	1200	V
Astigmatism control electrode voltage	V_{g_4}	=	300	V
First accelerator voltage	V_{g_2}	=	1200	V
Beam current	$I_{(\ell)}$	=	10	μA
Line width	l.w.	=	0.65	mm

HELIX

Post deflection accelerator helix resistance min. 40 MΩ

7Z2 5586

TYPICAL OPERATING CONDITIONS

Final accelerator voltage	$V_{g_6(\ell)}$	=	1200 V
Geometry control electrode voltage	V_{g_5}	=	300 ± 30 V [1]
Astigmatism control electrode voltage	V_{g_4}	=	$300 \pm {}^{40}_{15}$ V [2]
Focusing electrode voltage	V_{g_3}	=	20 to 150 V
First accelerator voltage	V_{g_2}	=	1200 V
Control grid voltage for visual extinction of focused spot	$-V_{g_1}$	=	30 to 80 V
Deflection factor			
horizontal	M_x	=	9.4 to 12 V/cm
vertical	M_y	=	3.2 to 4.1 V/cm
Deviation of linearity of deflection		=	max. 2 % [3]
Geometry distortion			See note [4]
Useful scan			
horizontal		=	min. 60 mm
vertical		=	min. 40 mm

CIRCUIT DESIGN VALUES

Focusing voltage	V_{g_3}	=	35 to 165 V per kV of V_{g_4}
Control grid voltage for visual extinction of focused spot	$-V_{g_1}$	=	30 to 60 V per kV of V_{g_2}
Deflection factor at $V_{g_6(\ell)}/V_{g_4} = 4$			
horizontal	M_x	=	31.3 to 40.0 V/cm per kV of V_{g_4}
vertical	M_y	=	10.7 to 13.7 V/cm per kV of V_{g_4}
Control grid circuit resistance	R_{g_1}	=	max. 1.5 MΩ
Deflection plate circuit resistance	R_x, R_y	=	max. 50 kΩ
Focusing electrode current	I_{g_3}	=	−15 to +10 μA [5]

[1][2][3][4][5] See page 6

7Z2 5587

LIMITING VALUES (Absolute max. rating system)

Final accelerator voltage	$V_{g6(\ell)}$	= max. 2500	V
		= min. 1200	V
Geometry control electrode voltage	V_{g5}	= max. 2200	V
Astigmatism control electrode voltage	V_{g4}	= max. 2100	V
		= min. 300	V
Focusing electrode voltage	V_{g3}	= max. 1000	V
First accelerator voltage	V_{g2}	= max. 1600	V
		= min. 800	V
Control grid voltage			
negative	$-V_{g1}$	= max. 200	V
positive	V_{g1}	= max. 0	V
positive peak	V_{g1p}	= max. 2	V
Cathode to heater voltage			
cathode positive	$V_{+k/f-}$	= max. 100	V
cathode negative	$V_{-k/f+}$	= max. 15	V
Voltage between astigmatism control electrode and any deflection plate	$V_{g4/x}$	= max. 500	V
	$V_{g4/y}$	= max. 500	V
Screen dissipation	W_{ℓ}	= max. 3	mW/cm^2
Ratio $V_{g6(\ell)}/V_{g4}$	$V_{g6(\ell)}/V_{g4}$	= max. 4	

als 7-78

7Z2 5588

1) This tube is designed for optimum performance when operating at the ratio $V_{g6(\ell)}/V_{g4} = 4$. Operation at other ratio may result in changes in deflection uniformity and geometry distortion. The geometry control electrode voltage should be adjusted for optimum performance. For any necessary adjustment its potential will be within the stated range.

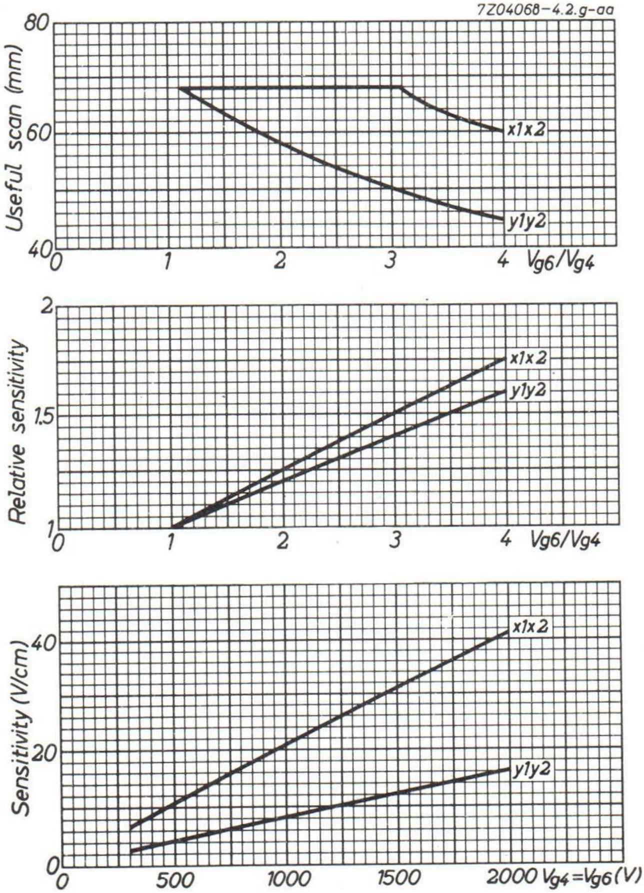
2) The astigmatism control electrode voltage should be adjusted for optimum spot shape. For any necessary adjustment its potential will be within the stated range.

3) 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 the indicated value.

4) A graticule, consisting of concentric rectangles of 40.8 mm x 40.8 mm and 39.2 mm x 39.2 mm 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.

5) Values to be taken into account for the calculation of the focus potentiometer.

7Z2 5589


7Z04068-4.2.g-aa
80
60
40
Useful scan (mm)
0
1
2
3
4
Vg6/Vg4
x1x2
y1y2
2
1.5
1
Relative sensitivity
x1x2
y1y2
40
20
0
Sensitivity (V/cm)
500
1000
1500
2000
Vg4 = Vg6 (V)
x1x2
y1y2

INSTRUMENT CATHODE-RAY TUBE

Low accelerator voltage cathode-ray tube for monitoring purposes.

QUICK REFERENCE DATA				
Final accelerator voltage	$V_{g4,g2(\ell)}$	=	500	V
Display area	Both directions full scan			
Deflection factor, horizontal	M_x	=	37	V/cm
vertical	M_y	=	21	V/cm

SCREEN

	Colour	Persistence
DG7-31	yellowish green	medium

Useful screen diameter	min. 65 mm
Useful scan	
horizontal	full scan
vertical	full scan

HEATING

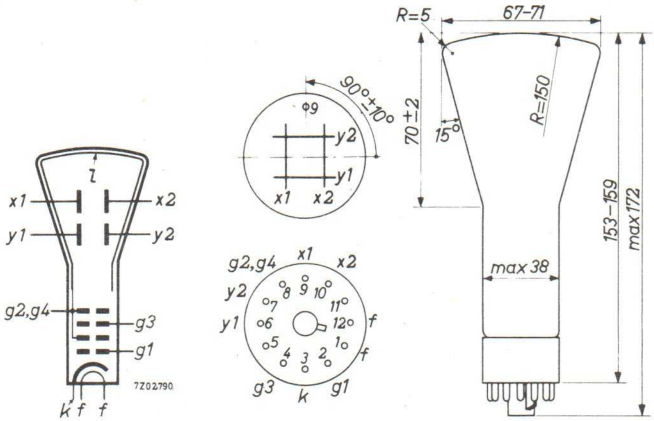
Indirect by A.C. or D.C.; parallel supply

Heater voltage	V_f	=	6.3	V
Heater current	I_f	=	300	mA

7Z2 5616

MECHANICAL DATA

Dimensions in mm



Mounting position: any

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

Base	Duodecal 12 pins		
Dimensions and connections			
See also outline drawing			
Overall length	max.	172	mm
Face diameter	max.	71	mm
Net weight:	approx.	120	g
Accessories			
Socket	type	5912/20	
Mu-metal shield	type	55530	

7Z2 5581

CAPACITANCES

x_1 to all other elements except x_2	$C_{x_1(x_2)}$	=	3.7	pF
x_2 to all other elements except x_1	$C_{x_2(x_1)}$	=	3.0	pF
y_1 to all other elements except y_2	$C_{y_1(y_2)}$	=	2.5	pF
y_2 to all other elements except y_1	$C_{y_2(y_1)}$	=	2.5	pF
x_1 to x_2	$C_{x_1x_2}$	=	1.7	pF
y_1 to y_2	$C_{y_1y_2}$	=	1.0	pF
Control grid to all other elements	C_{g_1}	=	7.6	pF
Cathode to all other elements	C_k	=	3.2	pF

FOCUSING electrostatic

DEFLECTION double electrostatic

x plates asymmetrical – X_1 earde

y plates symmetrical

Angle between x and y traces $90^o \pm 1.5^o$

LINE WIDTH

Measured on a circle of 50 mm diameter

Accelerator voltage	$V_{g_4, g_2(\ell)}$	=	500	V
Beam current	$I_{(\ell)}$	=	0.5	μA
Line width	l.w.	=	0.4	mm

TYPICAL OPERATING CONDITIONS

Accelerator voltage	$V_{g_4, g_2(\ell)}$	=	500	V
Focusing electrode voltage	V_{g_3}	=	0 to 120	V
Control grid voltage for visual extinction of focused spot	$-V_{g_1}$	=	50 to 100	V
Deflection factor, horizontal	M_x	=	33.3 to 41.5	V/cm
vertical	M_y	=	18.8 to 23.2	V/cm
Geometry distortion			See note 1 page 4	
Useful scan, horizontal			full scan	
vertical			full scan	

7Z2 5618

LIMITING VALUES (Absolute max. rating system)

Accelerator voltage	$V_{g_4,g_2(\ell)}$	= max.	800	V
		= min.	400	V
Focusing electrode voltage	V_{g_3}	= max.	200	V
Control grid voltage				
negative	$-V_{g_1}$	= max.	200	V
positive	V_{g_1}	= max.	0	V
positive peak	$V_{g_{1p}}$	= max.	2	V
Cathode to heater voltage				
cathode positive	$V_{+k/f-}$	= max.	200	V
cathode negative	$V_{-k/f+}$	= max.	125	V
Voltage between accelerator electrode and any deflection plate	$V_{g_4/x}$	= max.	500	V
	$V_{g_4/y}$	= max.	500	V
Screen dissipation	W_ℓ	= max.	3	mW/cm^2

CIRCUIT DESIGN VALUES

Focusing voltage	V_{g_3}	= 0 to 240	V per kV of V_g
Control grid voltage for visual extinction of focused spot	$-V_{g_1}$	= 100 to 200	V per kV of V_{g_2}
Deflection factor at $V_{g(\ell)}/V_g$			
horizontal	M_x	= 67 to 83	V/cm per kV of V_g
vertical	M_y	= 37.6 to 46.4	V/cm per kV of V_g
Control grid circuit resistance	R_{g_1}	= max. 0.5	MΩ
Deflection plate circuit resistance	R_x, R_y	= max. 5	MΩ
Focusing electrode current	I_g	= −15 to +10	μA 2)

1) A graticule, consisting of concentric rectangles of 43.2 mm x 43.2 mm and 40 mm x 40 mm 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.

2) Values to be taken into account for the calculation of the focus potentiometer.

Remark: A contrast improving transparent conductive coating connected to g_4, g_2 is present between glass and fluorescent layer. This enables the application of a high potential to g_4, g_2 with respect to earth, without the risk of picture distortion by touching the face (electrostatic body-effect)

7Z2 5583

INSTRUMENT CATHODE-RAY TUBE

Low accelerator voltage cathode-ray tube for monitoring purposes.

QUICK REFERENCE DATA				
Final accelerator voltage	$V_{g(\ell)}$	=	500	V
Display area	Both directions full scan			
Deflection factor, horizontal	M_x	=	37	V/cm
vertical	M_y	=	21	V/cm

SCREEN

	Colour	Persistence
DG7-32	yellowish green	medium

Useful screen diameter	min.	65	mm
Useful scan			
horizontal	full scan		
vertical	full scan		

HEATING

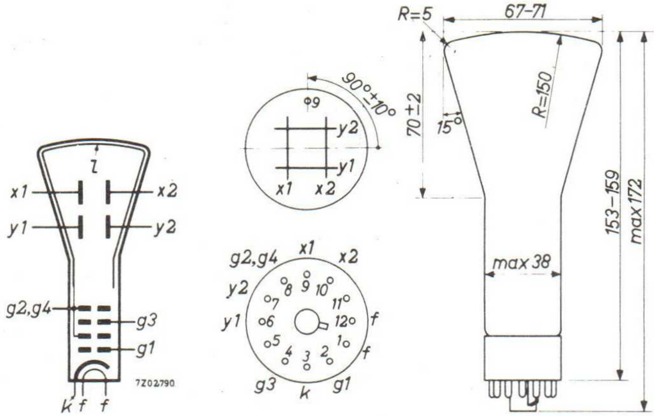
Indirect by A.C. or D.C.; parallel supply

Heater voltage	V_f	=	6.3	V
Heater current	I_f	=	300	mA

7Z2 5580

MECHANICAL DATA

Dimensions in mm



Mounting position: any

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

Base Duodecal 12 pins

Dimensions and connections

See also outline drawing

Overall length	max.	172	mm
Face diameter	max.	71	mm

Net weight:	approx.	120	g

Accessories

Socket	type	5912/20
Mu-metal shield	type	55530

7Z2 5581

CAPACITANCES

x_1 to all other elements except x_2	$C_{x_1(x_2)}$	= 3.7 pF
x_2 to all other elements except x_1	$C_{x_2(x_1)}$	= 3.0 pF
y_1 to all other elements except y_2	$C_{y_1(y_2)}$	= 2.5 pF
y_2 to all other elements except y_1	$C_{y_2(y_1)}$	= 2.5 pF
x_1 to x_2	$C_{x_1x_2}$	= 1.7 pF
y_1 to y_2	$C_{y_1y_2}$	= 1.0 pF
Control grid to all other elements	C_{g_1}	= 7.6 pF
Cathode to all other elements	C_k	= 3.2 pF

FOCUSING electrostatic

DEFLECTION double electrostatic

x plates symmetrical

y plates symmetrical

Angle between x and y traces $90^o \pm 1.5^o$

LINE WIDTH

Measured on a circle of 50 mm diameter

Accelerator voltage	$V_{g_4,g_2(\ell)}$	= 500 V
Beam current	$I_{(\ell)}$	= 0.5 μA
Line width	l.w.	= 0.4 mm

TYPICAL OPERATING CONDITIONS

Accelerator voltage	$V_{g_4,g_2(\ell)}$	= 500 V
Focusing electrode voltage	V_{g_3}	= 0 to 120 V
Control grid voltage for visual extinction of focused spot	$-V_{g_1}$	= 50 to 100 V
Deflection factor, horizontal	M_x	= 33.3 to 41.5 V/cm
vertical	M_y	= 18.8 to 23.2 V/cm
Geometry distortion		See note 1 page 4
Useful scan, horizontal		full scan
vertical		full scan

7Z2 5582

LIMITING VALUES (Absolute max. rating system)

Accelerator voltage	$V_{g4,g2(\ell)}$	= max.	800	V
		= min.	400	V
Focusing electrode voltage	V_{g3}	= max.	200	V
Control grid voltage				
negative	$-V_{g1}$	= max.	200	V
positive	V_{g1}	= max.	0	V
positive peak	V_{g1p}	= max.	2	V
Cathode to heater voltage				
cathode positive	V+k/f-	= max.	200	V
cathode negative	V-k/f+	= max.	125	V
Voltage between accelerator electrode and any deflection plate	$V_{g4/x}$	= max.	500	V
	$V_{g4/y}$	= max.	500	V
Screen dissipation	W_{ℓ}	= max.	3	mW/cm^2

CIRCUIT DESIGN VALUES

Focusing voltage	V_{g3}	= 0 to 240	V per kV of V_g
Control grid voltage for visual extinction of focused spot	$-V_{g1}$	= 100 to 200	V per kV of V_{g2}
Deflection factor at $V_{g(\ell)}/V_g$			
horizontal	M_x	= 67 to 83	V/cm per kV of V_g
vertical	M_y	= 37.6 to 46.4	V/cm per kV of V_g
Control grid circuit resistance	R_{g1}	= max. 0.5	MΩ
Deflection plate circuit resistance	R_x, R_y	= max. 5	MΩ
Focusing electrode current	I_g	= -15 to +10	μA [2])

[1]) A graticule, consisting of concentric rectangles of 43.2 mm x 43.2 mm and 40 mm x 40 mm 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.

[2]) Values to be taken into account for the calculation of the focus potentiometer.

Remark: A contrast improving transparent conductive coating connected to g_4, g_2 is present between glass and fluorescent layer. This enables the application of a high potential to g_4, g_2 with respect to earth, without the risk of picture distortion by touching the face (electrostatic body-effect)

7Z2 5583

INSTRUMENT CATHODE-RAY TUBE

Oscilloscope tube with 7 cm diameter flat face-plate. The tube is intended for small service oscilloscopes.

QUICK REFERENCE DATA				
Final accelerator voltage	$V_{g}(\ell)$	=	1500	V
Display area		=	5.7 x 6.8	cm
Deflection factor, horizontal	M_x	=	27.3	V/cm
vertical	M_y	=	18.8	V/cm

SCREEN

	Colour	Persistence
DB7-36	blue	medium short
DG7-36	yellowish green	medium
DN7-36	bluish green	medium short

Useful scan

horizontal	min.	68	mm
vertical	min.	57	mm

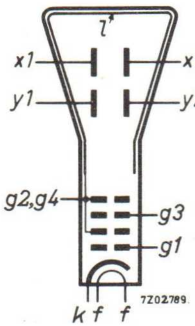
HEATING

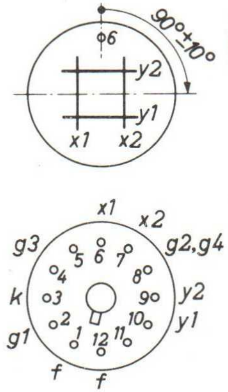
Indirect by A.C. or D.C.; parallel supply

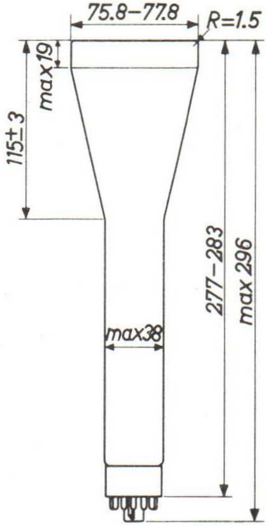
Heater voltage	V_f	=	6.3	V
Heater current	I_f	=	300	mA

7Z2 5620

MECHANICAL DATA Dimensions in mm







Mounting position: any

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

Base Duodecal 12 pins

Dimensions and connections

See also outline drawing

Overall length	max.	296	mm
Face diameter	max.	77.8	mm

Net weight:	approx.	370	g

Accessories

Socket	type	5912/20
Mu-metal shield	type	55531

7Z2 5621

CAPACITANCES

x_1 to all other elements except x_2	$C_{x_1(x_2)}$	=	6.0	pF
x_2 to all other elements except x_1	$C_{x_2(x_1)}$	=	6.0	pF
y_1 to all other elements except y_2	$C_{y_1(y_2)}$	=	4.7	pF
y_2 to all other elements except y_1	$C_{y_2(y_1)}$	=	4.7	pF
x_1 to x_2	$C_{x_1x_2}$	=	1.9	pF
y_1 to y_2	$C_{y_1y_2}$	=	1.7	pF
Control grid to all other elements	C_{g_1}	=	5.7	pF
Cathode to all other elements	C_k	=	3.3	pF

FOCUSING electrostatic

DEFLECTION double electrostatic

x plates symmetrical

y plates symmetrical

If use is made of the full deflection capabilities of the tube the deflection plates will intercept part of the electron beam; hence a low impedance deflection plate drive is desirable.

Angle between x and y traces $90^\circ \pm 1^\circ$

LINE WIDTH

Measured on a circle of 50 mm diameter

Final accelerator voltage	$V_{g_4,g_2(\ell)}$	=	1500	V
Beam current	$I_{(\ell)}$	=	0.5	μA
Line width	l.w.	=	0.4	mm

7Z2 5622

TYPICAL OPERATING CONDITIONS

Accelerator voltage	$V_{g_4, g_2(\ell)}$	= 1500	V
Focusing electrode voltage	V_{g_3}	= 247 to 397	V
Control grid voltage for visual extinction of focused spot	$-V_{g_1}$	= 40 to 80	V
Deflection factor			
horizontal	M_x	= 24.5 to 30	V/cm
vertical	M_y	= 17.0 to 20.5	V/cm
Deviation of linearity of deflection		= max. 2	% [1]
Geometry distortion		See note 2	
Useful scan			
horizontal		= min. 68	mm
vertical		= min. 57	mm

LIMITING VALUES (Absolute max. rating system)

Final accelerator voltage	$V_{g_4, g_2(\ell)}$	= max. 2500 = min. 1000	V V
Focusing electrode voltage	V_{g_3}	= max. 1000	V
Control grid voltage			
negative	$-V_{g_1}$	= max. 200	V
positive	V_{g_1}	= max. 0	V
positive peak	$V_{g_{1p}}$	= max. 2	V
Cathode to heater voltage			
cathode positive	$V_{+k/f-}$	= max. 200	V
cathode negative	$V_{-k/f+}$	= max. 125	V
Voltage between final accelerator and any deflection plate	$V_{g_4, g_2/x_p}$	= max. 500	V
	$V_{g_4, g_2/y_p}$	= max. 500	V
Screen dissipation	W_ℓ	= max. 3	mW/cm^2

[1][2]) See page 5

7Z2 5623

CIRCUIT DESIGN VALUES

Focusing voltage	V_{g3}	= 165 to 265	V per kV of $V_{g4,g2}$
Control grid voltage for visual extinction of focused spot	$-V_{g1}$	= 27 to 53	V per kV of $V_{g4,g2}$
Deflection factor			
horizontal	M_x	= 16.3 to 20.0	V/cm per kV of $V_{g4,g2}$
vertical	M_y	= 11.2 to 13.7	V/cm per kV of $V_{g4,g2}$
Control grid circuit resistance	R_{g1}	= max. 1.5	MΩ
Deflection plate circuit resistance	R_x, R_y	= max. 5	MΩ
Focusing electrode current	I_{g3}	= −15 to +10	μA [3]

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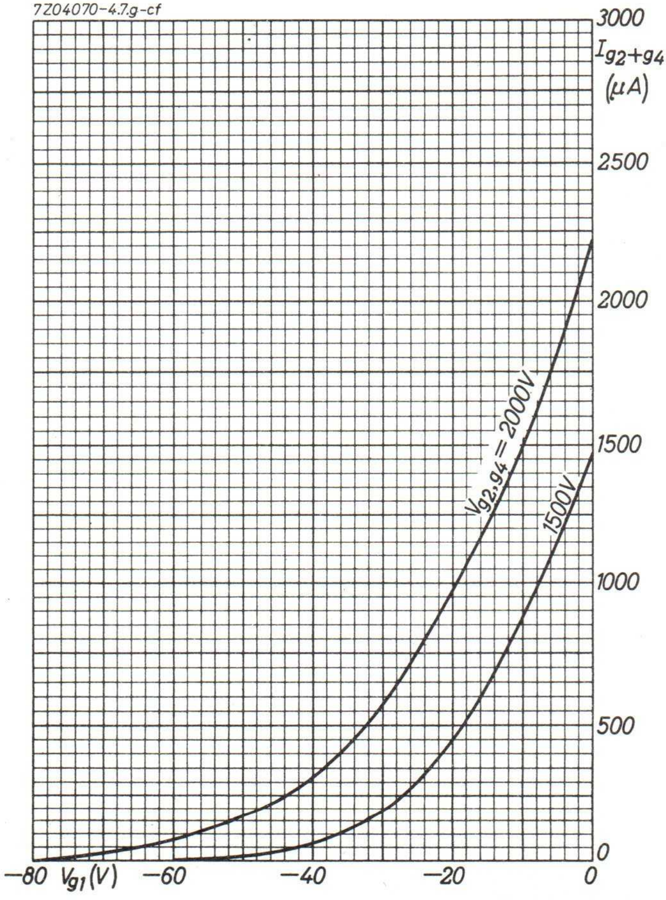
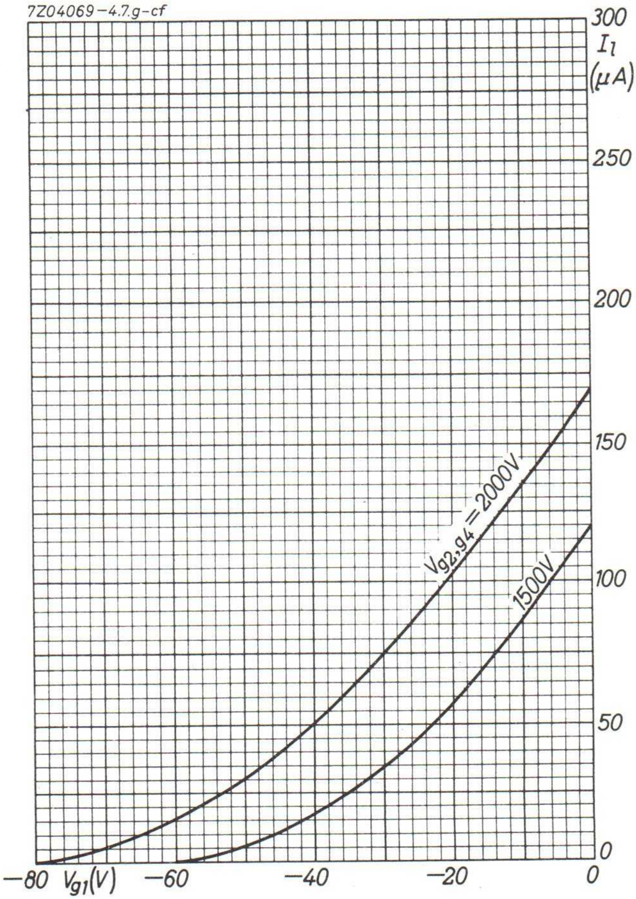
[1]) The sensitivity at a deflection of less than 75% of the useful scan will not differ from the sensitivity at a deflection of 25% of the useful scan by more than the indicated value.

[2]) A graticule, consisting of concentric rectangles of 40.8 mm x 40.8 mm and 39.2 mm x 39.2 mm 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.

[3]) Values to be taken into account for the calculation of the focus potentiometer.

7Z2 5624


7Z04070-4.7.g-cf
3000
2500
2000
1500
1000
500
0
I_{g2+g4} (µA)
$V_{g2,g4}$ = 2000V
1500V
−80
−60
−40
−20
0
V_{g1} (V)



7Z04069-4.7.g-cf
300
250
200
150
100
50
0
I_l (μA)
$V_{g2,g4}$ = 2000V
1500V
−80
V_{g1}(V)
−60
−40
−20
0

INSTRUMENT CATHODE-RAY TUBE

Oscilloscope tube with 7 cm diameter flat faceplate and post deflection acceleration by means of a helical electrode. The tube is intended for small service oscilloscopes.

QUICK REFERENCE DATA				
Final accelerator voltage	$V_{g6(\ell)}$	=	1200	V
Display area		=	4.5x6	cm
Deflection factor, horizontal	M_x	=	10.7	V/cm
vertical	M_y	=	3.65	V/cm

SCREEN

	Colour	Persistence
DB7-78	blue	medium short
DH7-78	green	medium short
DN7-78	bluish green	medium short
DP7-78	yellowish green	long

Useful screen diameter	min.	68	mm
Useful scan at $V_{g6(\ell)}/V_{g4} = 4$			
horizontal	min.	60	mm
vertical	min.	45	mm

HEATING

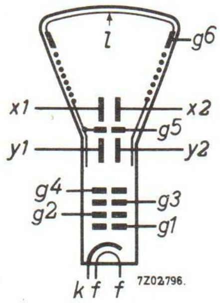
Indirect by A.C. or D.C.; parallel supply

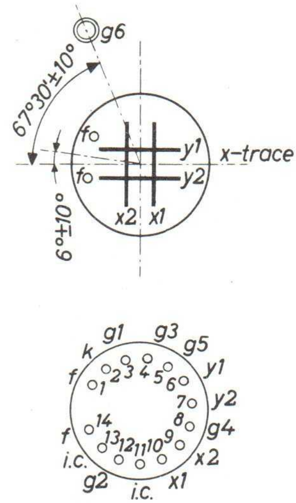
Heater voltage	V_f	=	6.3	V
Heater current	I_f	=	300	mA

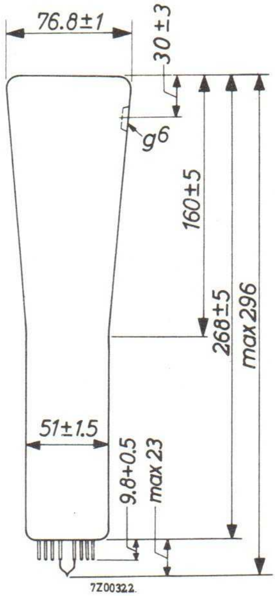
7Z2 5625

MECHANICAL DATA

Dimensions in mm







Mounting position: any

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

Base	14 pins all glass		
Dimensions and connections			
Overall length	max.	296	mm
Face diameter	max.	77.8	mm
Net weight	approx.	370	g
Accessories			
Socket (supplied with the tube)	type	40467	
Final accelerator contact connector	type	55563	
Mu-metal shield	type	55532	

7Z2 5626

CAPACITANCES

x_1 to all other elements except x_2	$C_{x_1(x_2)}$	=	3.5	pF
x_2 to all other elements except x_1	$C_{x_2(x_1)}$	=	3.5	pF
y_1 to all other elements except y_2	$C_{y_1(y_2)}$	=	3.0	pF
y_2 to all other elements except y_1	$C_{y_2(y_1)}$	=	3.0	pF
x_1 to x_2	$C_{x_1x_2}$	=	1.7	pF
y_1 to y_2	$C_{y_1y_2}$	=	1.6	pF
Control grid to all other elements	C_{g_1}	=	3.5	pF
Cathode to all other elements	C_k	=	2.6	pF

FOCUSING electrostatic

DEFLECTION double electrostatic

x plates symmetrical

y plates symmetrical

If use is made of the full deflection capabilities of the tube the deflection plates will intercept part of the electron beam; hence a low impedance deflection plate drive is desirable.

Angle between x and y traces $90 \pm 1^{\circ}$

LINE WIDTH

Measured with the shrinking raster method in the centre of the screen.

Final accelerator voltage	$V_{g_6(\ell)}$	=	1200	V
Astigmatism control electrode voltage	V_{g_4}	=	300	V
First accelerator voltage	V_{g_2}	=	1200	V
Beam current	$I(\ell)$	=	10	μA
Line width	l.w.	=	0.65	mm

HELIX

Post deflection accelerator helix resistance min. 40 MΩ

7Z2 5627

TYPICAL OPERATING CONDITIONS

Final accelerator voltage	$V_{g_6(\ell)}$	=	1200	4000	V	
Geometry control electrode voltage	V_{g_5}	=	300 ± 30	1000 ± 100	V	1)
Astigmatism control electrode voltage	V_{g_4}	=	300 ± 40	1000 ± 50	V	2)
Focusing electrode voltage	V_{g_3}	=	20 to 150^{15}	35 to 165	V	
First accelerator voltage	V_{g_2}	=	1200	1000	V	
Control grid voltage for visual extinction of focused spot	$-V_{g_1}$	=	36 to 72	30 to 60	V	
Modulation voltage for $I(\ell) = 10\ \mu A$	V_{g_1}	=	max. 25	max. 25	V	
Deflection factor						
horizontal	M_x	=	9.4 to 12	31.3 to 40.0	V/cm	
vertical	M_y	=	3.2 to 4.1	10.7 to 13.7	V/cm	
Deviation of linearity of deflection		=	max. 2	max. 2	%	3)
Geometry distortion			See note 4			
Useful scan						
horizontal		=	min. 60	60	mm	
vertical		=	min. 45	45	mm	

CIRCUIT DESIGN VALUES

Focusing voltage	V_g	=	35 to 165	V per kV of V_{g_4}
Control grid voltage for visual extinction of focused spot	$-V_{g_1}$	=	30 to 60	V per kV of V_{g_2}
Deflection factor at $V_{g_6(\ell)}/V_{g_4} = 4$				
horizontal	M_x	=	31.3 to 40.0	V/cm per kV of V_{g_4}
vertical	M_y	=	10.7 to 13.7	V/cm per kV of V_{g_4}
Control grid circuit resistance	R_{g_1}	=	max. 1.5	MΩ
Deflection plate circuit resistance	R_x, R_y	=	max. 50	kΩ
Focusing electrode current	I_{g_3}	=	−15 to +10	μA 5)

7Z2 5628

LIMITING VALUES (Absolute max. rating system)

Final accelerator voltage	$V_{g_6(\ell)}$	= max. 5000 = min. 1200	V V
Geometry control electrode voltage	V_{g_5}	= max. 2200	V
Astigmatism control electrode voltage	V_{g_4}	= max. 2100 = min. 300	V V
Focusing electrode voltage	V_{g_3}	= max. 1000	V
First accelerator voltage	V_{g_2}	= max. 1600 = min. 800	V V
Control grid voltage			
negative	$-V_{g_1}$	= max. 200	V
positive	V_{g_1}	= max. 0	V
positive peak	$V_{g_{1p}}$	= max. 2	V
Cathode to heater voltage			
cathode positive	$V_{+k/f-}$	= max. 200	V
cathode negative	$V_{-k/f+}$	= max. 125	V
Voltage between astigmatism control electrode and any deflection plate	$V_{g_4/x}$ $V_{g_4/y}$	= max. 500 = max. 500	V V
Screen dissipation	W_ℓ	= max. 3	mW/cm^2
Ratio $V_{g(\ell)}/V_g$	$V_{g(\ell)}/V_g$	= max. 4	

1) This tube is designed for optimum performance when operating at the ratio $V_{g_6(\ell)}/V_{g_4} = 4$. Operating at other ratio may result in changes in deflection uniformity and geometry distortion. The geometry control electrode voltage should be adjusted for optimum performance. For any necessary adjustment its potential will be within the stated range.

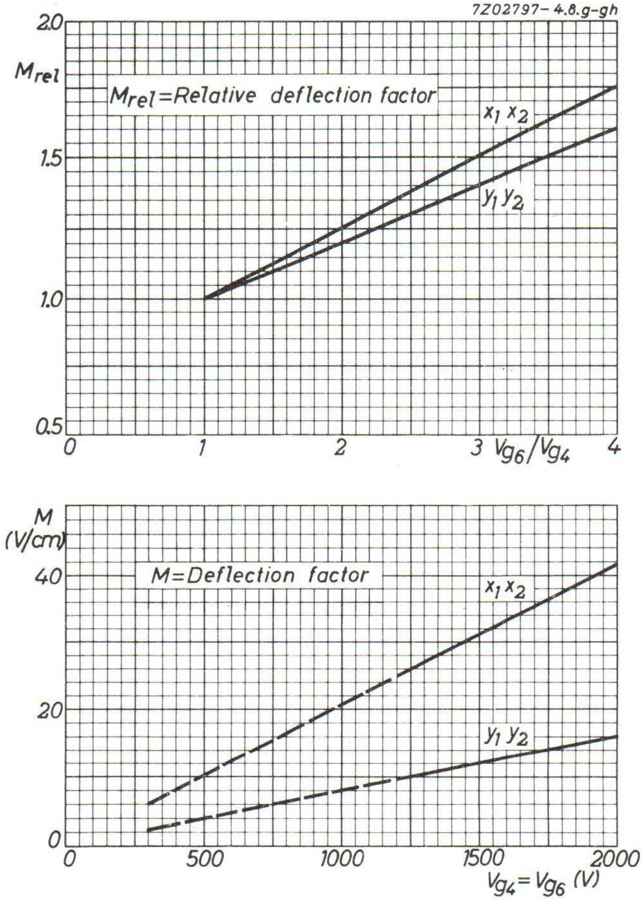
2) The astigmatism control electrode voltage should be adjusted for optimum spot shape. For any necessary adjustment its potential will be within the stated range.

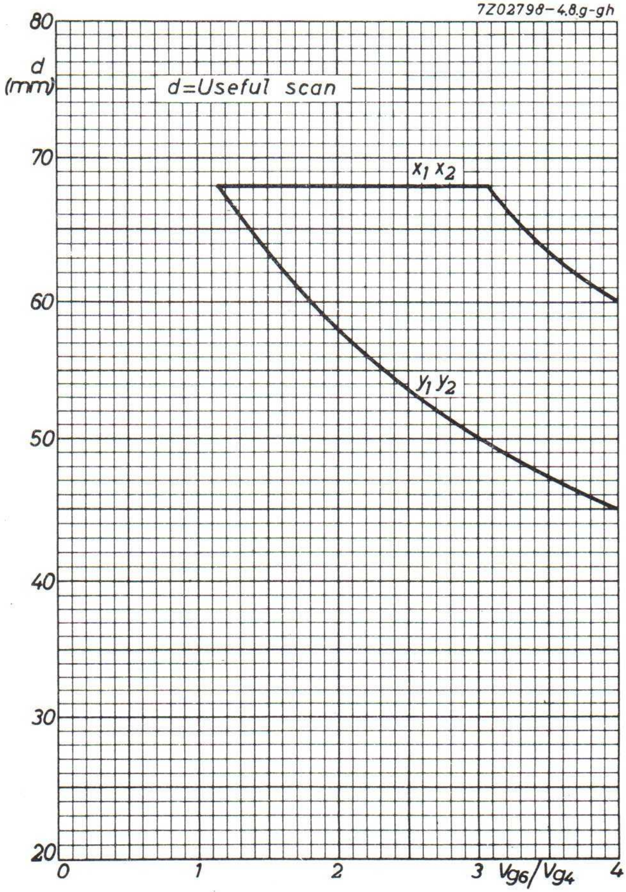
3) The sensitivity at a deflection of less than 75% of the useful scan will not differ from the sensitivity at a deflection of 25% of the useful scan by more than the indicated value.

4) A graticule, consisting of concentric rectangles of 40.8 mm x 40.8 mm and 39.2 mm x 39.2 mm 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.

5) Values to be taken into account for the calculation of the focus potentiometer.

7Z2 5629


7Z02797-4.8.g-gh
2.0
M_{rel}
M_{rel}=Relative deflection factor
x_1 x_2
1.5
y_1 y_2
1.0
0.5
0
1
2
3 V_{g6}/V_{g4}
4
M
(V/cm)
40
M=Deflection factor
x_1 x_2
20
y_1 y_2
0
0
500
1000
1500
2000
$V_{g4}=V_{g6}$ (V)


7Z02798-4.8.g-gh
80
d
(mm)
d=Useful scan
70
$x_1\,x_2$
60
$y_1\,y_2$
50
40
30
20
0
1
2
3
V_{g6}/V_{g4}
4

INSTRUMENT CATHODE-RAY TUBE

7 cm diameter oscilloscope tube for monitoring purposes

QUICK REFERENCE DATA				
Final accelerator voltage	$V_{g_4, g_2(\ell)}$	=	1000	kV
Display area	Both directions full scan			
Deflection factor, horizontal	M_x	=	20	V/cm
vertical	M_y	=	11.5	V/cm

SCREEN

	Colour	Persistence
DH7-91	green	medium short

Useful scan

horizontal	full scan
vertical	full scan

HEATING

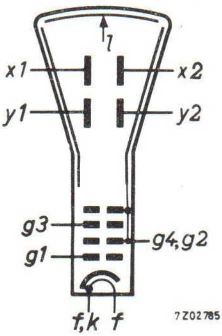
Indirect by A.C. or D.C.; parallel supply

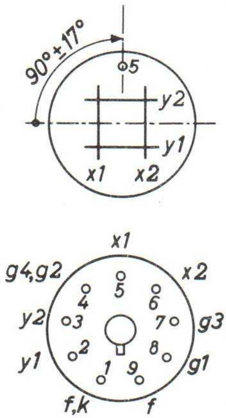
Heater voltage	V_f	=	6.3	V
Heater current	I_f	=	550	mA

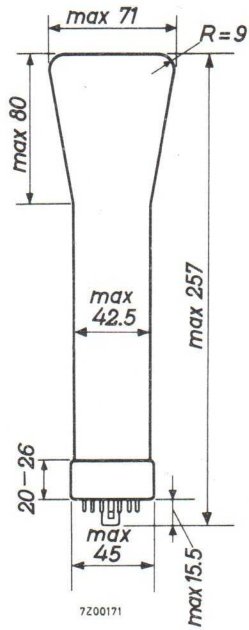
7Z2 5630

MECHANICAL DATA

Dimensions in mm







Mounting position: any

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

Base	English Loctal 9 pins
Dimensions and connections	
Overall length	max. 257 mm
Face diameter	max. 71 mm
Net weight:	approx. 225 g
Accessories	
Socket	type 5906/20 or 40212
Mu-metal shield	type 55533

7Z2 5631

CAPACITANCES

x_1 to all other elements except x_2	$C_{x_1(x_2)}$	=	5.8	pF
x_2 to all other elements except x_1	$C_{x_2(x_1)}$	=	5.8	pF
y_1 to all other elements except y_2	$C_{y_1(y_2)}$	=	3.5	pF
y_2 to all other elements except y_1	$C_{y_2(y_1)}$	=	3.5	pF
x_1 to x_2	$C_{x_1x_2}$	=	1.8	pF
y_1 to y_2	$C_{y_1y_2}$	=	2.2	pF
Control grid to all other elements	C_{g_1}	=	6.6	pF
Cathode to all other elements	C_k	=	3.0	pF

FOCUSING electrostatic

DEFLECTION double electrostatic
symmetrical or asymmetrical

For optimum focus, with symmetrical operation, the average potentials of the deflection plates and g_4, g_2 should be equal. With asymmetrical operation, the potential of anyone deflection plate should not differ from V_{g_4, g_2} by more than the deflection voltage.

Angle between x and y traces $90^\circ \pm 2^\circ$

LINE WIDTH

Measured on a circle of 40 mm diameter

Final accelerator voltage	$V_{g_4, g_2(\ell)}$	=	1000	V
Beam current	$I(\ell)$	=	1	μA
Line width	l.w.	=	0.6	mm

7Z2 5632

TYPICAL OPERATING CONDITIONS

Final accelerator voltage	$V_{g_4, g_2(\ell)}$	=	1000	V
Focusing electrode voltage	V_{g_3}	=	210 to 320	V
Control grid voltage for visual extinction of focused spot	$-V_{g_1}$	=	50	V
Deflection factor				
horizontal	M_x	=	16.4 to 24.4	V/cm
vertical	M_y	=	9.5 to 14.6	V/cm
Geometry distortion			See note 1	
Useful scan				
horizontal			full scan	
vertical			full scan	

LIMITING VALUES (Absolute max. rating system)

Final accelerator voltage	$V_{g_4, g_2(\ell)}$	=	max.	1500	V
		=	min.	700	V
Focusing electrode voltage	V_{g_3}	=	max.	500	V
Control grid voltage					
negative	$-V_{g_1}$	=	max.	200	V
positive	V_{g_1}	=	max.	0	V
positive peak	$V_{g_{1p}}$	=	max.	2	V
Screen dissipation	W_ℓ	=	max.	3	W/cm^2

[1]) The length of the edges of a raster pattern whose mean dimensions are less than 72% of the useful scan will not deviate from these mean dimensions by more than 3.5% in the case of asymmetrical operation, or 2.5% in the case of symmetrical operation.

7Z2 5633

INSTRUMENT CATHODE-RAY TUBE

9 cm diameter oscilloscope tube for monitoring purposes

SCREEN

	Colour	Persistence
DB 9-3	blue	medium short
DG9-3	yellowish green	medium
DN9-3	yellowish green	medium short

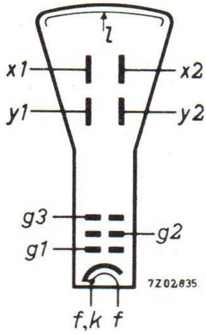
HEATING

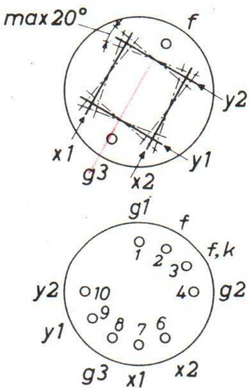
Indirect by A.C. or D.C.; parallel supply

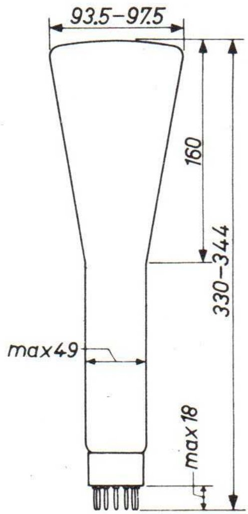
Heater voltage	V_f	= 4.0 V
Heater current	I_f	= 1000 mA

MECHANICAL DATA

Dimensions in mm







Base F7 7Z2 5634

OBSOLETE TYPE

FOCUSING	electrostatic
DEFLECTION	double electrostatic
x plates	symmetrical
y plates	asymmetrical

TYPICAL OPERATING CONDITIONS

Accelerator voltage	$V_{g_3(\ell)}$	=	1000	V
Focusing electrode voltage	V_{g_2}	=	200 to 400	V
Control grid voltage for visual extinction of focused spot	$-V_{g_1}$	=	0 to 40	V
Deflection factor				
horizontal	M_x	=	32.2	V/cm
vertical	M_y	=	25	V/cm
Useful scan				
horizontal			full scan	
vertical			full scan	

LIMITING VALUES (Absolute max. rating system)

Accelerator voltage	$V_{g_3(\ell)}$	= max.	1200	V
Focusing electrode voltage	V_{g_2}	= max.	500	V
Control grid voltage				
negative	$-V_{g_1}$	= max.	200	V
positive	V_{g_1}	= max.	0	V
positive peak	$V_{g_{1p}}$	= max.	2	V

7Z2 5635

INSTRUMENT CATHODE-RAY TUBE

9 cm diameter oscilloscope tube for monitoring purposes

SCREEN

	Colour	Persistence
DB9-4	blue	medium short
DG9-4	yellowish green	medium
DN9-4	yellowish green	medium short

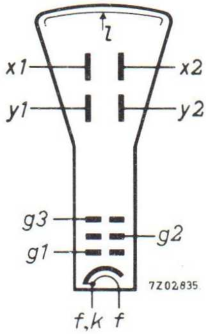
HEATING

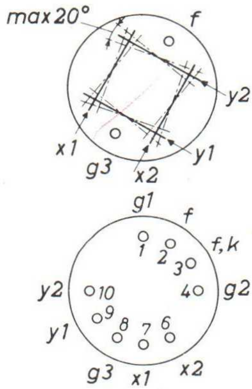
Indirect by A.C. or D.C.; parallel supply

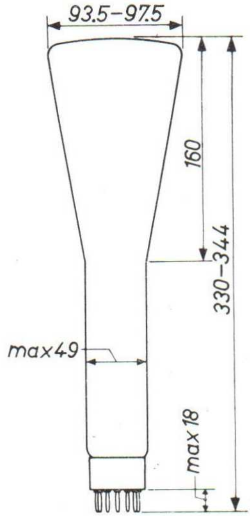
Heater voltage	V_f	=	4.0 V
Heater current	I_f	=	1000 mA

MECHANICAL DATA

Dimensions in mm







Base FJ

7Z2 5636

FOCUSING	electrostatic
DEFLECTION	double electrostatic
x plates	symmetrical
y plates	symmetrical

TYPICAL OPERATING CONDITIONS

Accelerator voltage	$V_{g_3(\ell)}$	=	1000	V
Focusing electrode voltage	V_{g_2}	=	200 to 400	V
Control grid voltage for visual extinction of focused spot	$-V_{g_1}$	=	0 to 40	V
Deflection factor				
horizontal	M_x	=	32.2	V/cm
vertical	M_y	=	25	V/cm
Useful scan				
horizontal			full scan	
vertical			full scan	

LIMITING VALUES (Absolute max. rating system)

Accelerator voltage	$V_{g_3(\ell)}$	=	max. 1200	V
Focusing electrode voltage	V_{g_2}	=	max. 500	V
Control grid voltage				
negative	$-V_{g_1}$	=	max. 200	V
positive	V_{g_1}	=	max. 0	V
positive peak	$V_{g_{1p}}$	=	max. 2	V

7Z2 5637

INSTRUMENT CATHODE-RAY TUBE

SCREEN

	Colour	Persistence
DB9-5	blue	medium short
DG9-5	yellowish green	medium
DN9-5	yellowish green	medium short

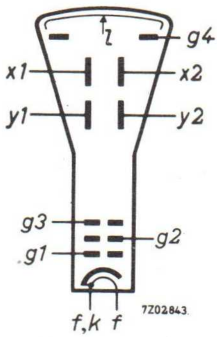
HEATING

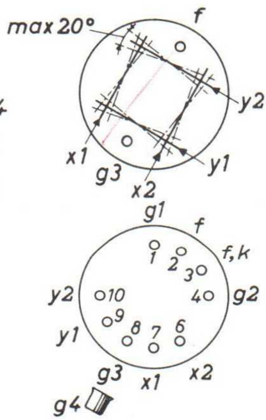
Indirect by A.C. or D.C.; parallel supply

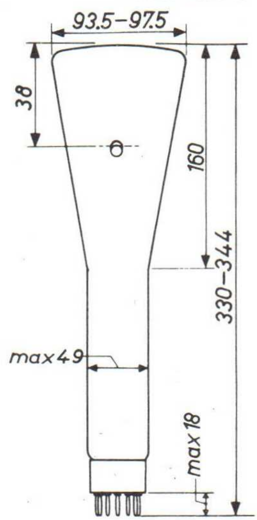
Heater voltage	V_f =	4.0 V
Heater current	I_f =	1000 mA

MECHANICAL DATA

Dimensions in mm







Base FJ

7Z2 5640

FOCUSING electrostatic

DEFLECTION double electrostatic

x plates	symmetrical
y plates	asymmetrical

TYPICAL OPERATING CONDITIONS

Final accelerator voltage	$V_{g_4(\ell)}$	=	5000	V
First accelerator voltage	V_{g_3}	=	1000	V
Focusing electrode voltage	V_{g_2}	=	230 to 430	V
Control grid voltage for visual extinction of focused spot	$-V_{g_1}$	=	0 to 40	V
Deflection factor				
horizontal	M_x	=	66.5	V/cm
vertical	M_y	=	55.5	V/cm
Useful scan				
horizontal		full scan		
vertical		full scan		

LIMITING VALUES (Absolute max. rating system)

Final accelerator voltage	$V_{g_4(\ell)}$	=	max. 5500	V
First accelerator voltage	V_{g_3}	=	max. 1200	V
Focusing electrode voltage	V_{g_2}	=	max. 500	V
Control grid voltage				
negative	$-V_{g_1}$	=	max. 200	V
positive	V_{g_1}	=	max. 0	V
positive peak	$V_{g_{1p}}$	=	max. 2	V

7Z2 5641

INSTRUMENT CATHODE-RAY TUBE

10 cm oscilloscope tube for monitoring purposes

SCREEN

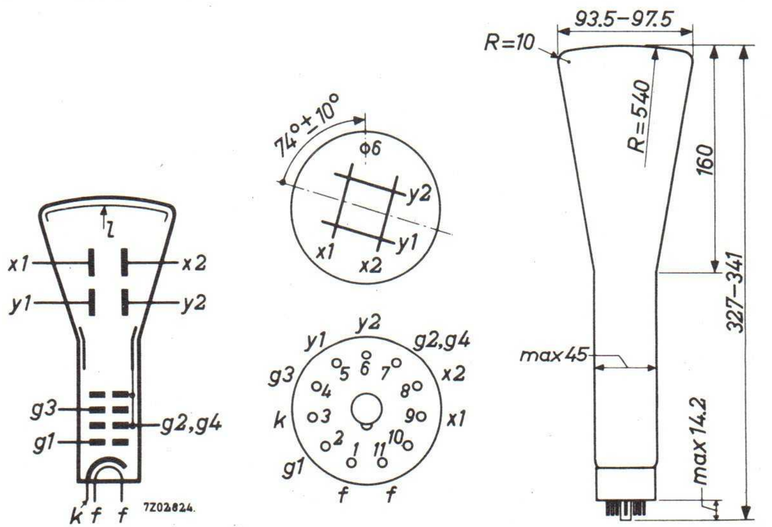
	Colour	Persistence
DB10-2	blue	medium short
DG10-2	yellowish green	medium
DP10-2	yellowish green	long

HEATING

Indirect by A.C. or D.C.; parallel supply

Heater voltage	V_f = 6.3 V	
Heater current	I_f = 300 mA	

MECHANICAL DATA Dimensions in mm



Base Magnal 11 pin

7Z2 5638

FOCUSING	electrostatic			
DEFLECTION	double electrostatic			
x plates	symmetrical			
y plates	symmetrical			

TYPICAL OPERATING CONDITIONS

Accelerator voltage	$V_{g_4, g_2(\ell)}$	=	2000	V
Focusing electrode voltage	V_{g_3}	=	400 to 720	V
Control grid voltage for visual extinction of focused spot	$-V_{g_1}$	=	45 to 100	V
Deflection factor				
horizontal	M_x	=	33.2 to 41.5	V/cm
vertical	M_y	=	26.3 to 31.2	V/cm
Useful scan				
horizontal			full scan	
vertical			full scan	

LIMITING VALUES (Absolute max. rating system)

Accelerator voltage	$V_{g_4, g_2(\ell)}$	=	max. 2500	V
Focusing electrode voltage	V_{g_3}	=	max. 1000	V
Control grid voltage				
negative	$-V_{g_1}$	=	max. 200	V
positive	V_{g_1}	=	max. 0	V
positive peak	$V_{g_{1p}}$	=	max. 2	V

7Z2 5639

INSTRUMENT CATHODE-RAY TUBE

10 cm oscilloscope tube for monitoring purposes.

SCREEN

	colour	persistence
DB 10-3	blue	medium short
DG10-3	yellowish green	medium

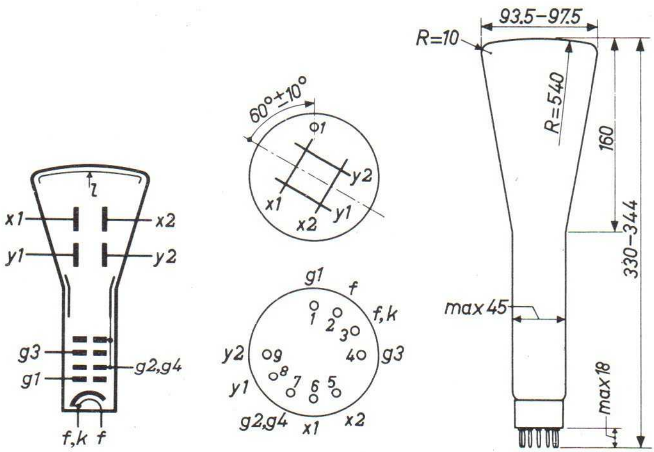
HEATING

Indirect by A.C. or D.C.; parallel supply

Heater voltage	V_f	4	V
Heater current	I_f	560	mA

MECHANICAL DATA

Dimensions in mm



x_2 has to be connected to g_2, g_4
Earthing of g_2, g_4 is recommended.

Base FJ 7Z2 6030

FOCUSING	electrostatic
DEFLECTION	double electrostatic
x plates	asymmetrical
y plates	symmetrical

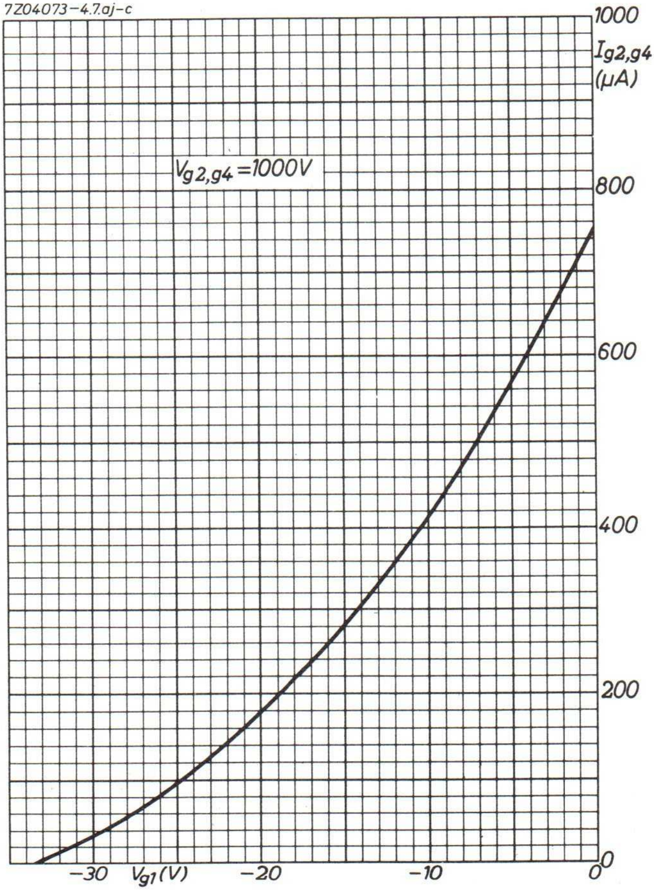
TYPICAL OPERATING CONDITIONS

Accelerator voltage	$V_{g_4,g_2(\ell)}$	1000	V
Focusing electrode voltage	V_{g_3}	200 to 340	V
Control grid voltage for visual extinction of focused spot	$-V_{g_1}$	18 to 46	V
Deflection factor, horizontal	M_x	18	V/cm
vertical	M_y	15.4	V/cm
Useful scan, horizontal		full scan	
vertical		full scan	

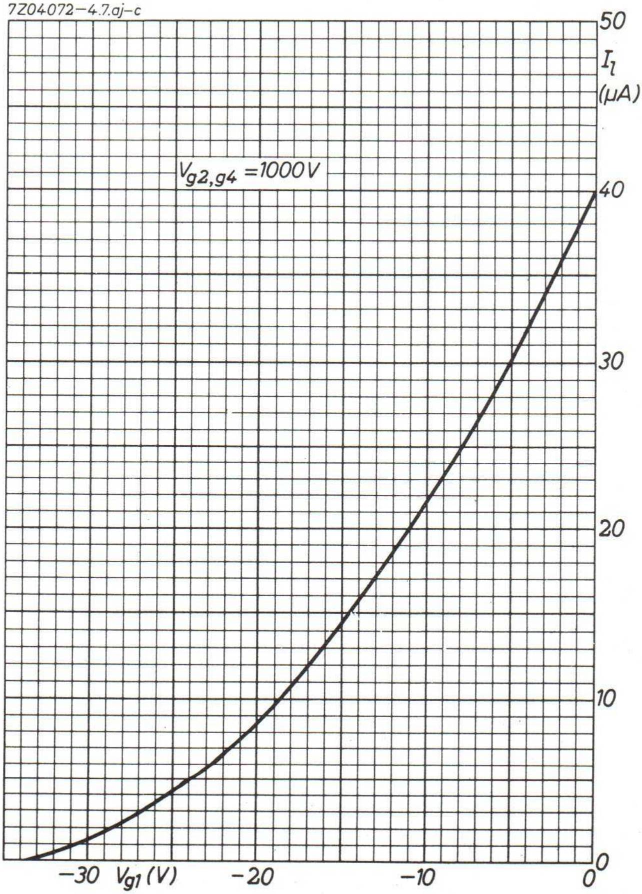
LIMITING VALUES (Absolute max. rating system)

Accelerator voltage	$V_{g_4,g_2(\ell)}$	max.	1200	V
		min.	800	V
Focusing electrode voltage	V_{g_3}	max.	500	V
Control grid voltage,				
negative	$-V_{g_1}$	max.	150	V
positive	V_{g_1}	max.	0	V
positive peak	$V_{g_{1p}}$	max.	2	V

7Z2 6031



7Z04073-4.7.aj-c
1000
$I_{g2,g4}$ (μA)
$V_{g2,g4}$=1000V
800
600
400
200
0
−30
V_{g1}(V)
−20
−10
0


7Z04072—4.7.aj-c
50
I_l
(µA)
$V_{g2,g4}$ =1000V
40
30
20
10
0
−30
V_{g1} (V)
−20
−10
0

INSTRUMENT CATHODE-RAY TUBE

10 cm oscilloscope tube for monitoring purposes

SCREEN

	Colour	Persistence
DB10-5	blue	medium short
DG10-5	yellowish green	medium

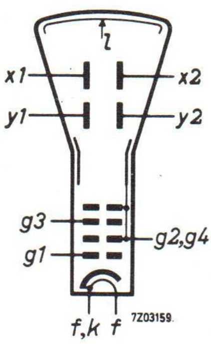
HEATING

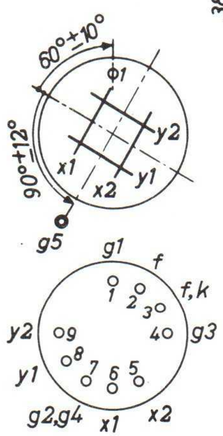
Indirect by A.C. or D.C.; parallel supply

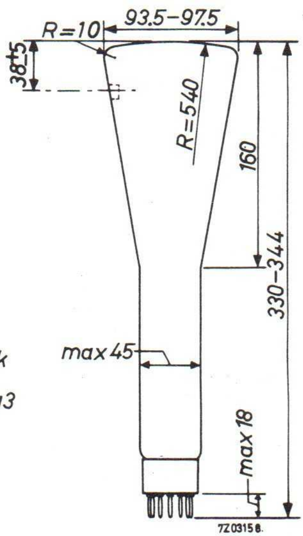
Heater voltage	V_f	=	4.0	V
Heater current	I_f	=	560	mA

MECHANICAL DATA

Dimensions in mm







Base FJ

7Z2 5642

FOCUSING	electrostatic
DEFLECTION	double electrostatic
x plates	symmetrical
y plates	asymmetrical

TYPICAL OPERATING CONDITIONS

Final accelerator voltage	$V_{g5(\ell)}$	=	2500	V
Accelerator voltage	$V_{g4,g2}$	=	1000	V
Focusing electrode voltage	V_{g3}	=	200 to 340	V
Control grid voltage for visual extinction of focused spot	$-V_{g1}$	=	18 to 46	V
Deflection factor				
horizontal	M_x	=	27	V/cm
vertical	M_y	=	21	V/cm
Useful scan				
horizontal			full scan	
vertical			full scan	

LIMITING VALUES (Absolute max. rating system)

Final accelerator voltage	$V_{g5(\ell)}$	=	max. 3000	V
Accelerator voltage	$V_{g4,g2}$	=	max. 1200	V
Focusing electrode voltage	V_{g3}	=	max. 500	V
Control grid voltage				
negative	$-V_{g1}$	=	max. 200	V
positive	V_{g1}	=	max. 0	V
positive peak	V_{g1p}	=	max. 2	V

7Z2 5643

INSTRUMENT CATHODE-RAY TUBE

10 cm diameter oscilloscope tube for monitoring purposes

QUICK REFERENCE DATA			
Final accelerator voltage	$V_{g5}(\ell)$	4	kV
Display area	Both directions full scan		
Defelction factor, horizontal	M_x	46	V/cm
vertical	M_y	36	V/cm

SCREEN

	colour	persistence
DB 10-6	blue	medium short
DG10-6	yellowish green	medium
DP 10-6	yellowish green	long

Useful scan at $V_{g5}(\ell)/V_{g4,g2} = 2$

	horizontal	full scan
	vertical	full scan

HEATING

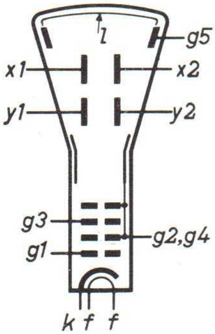
Indirect by A.C. or D.C.; parallel supply

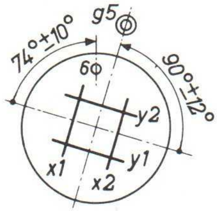
Heater voltage	V_f	6.3	V
Heater current	I_f	300	mA

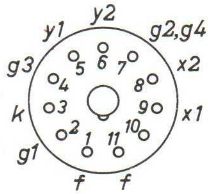
7Z2 6210

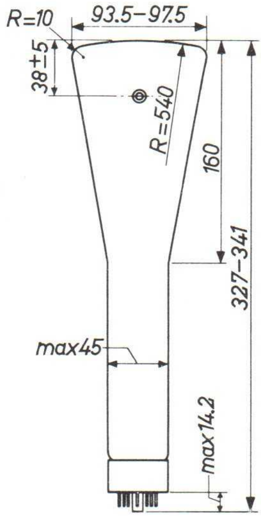
MECHANICAL DATA

Dimensions in mm









Mounting position: any

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

Base	Magnal		
Dimensions and connections			
Overall length	max.	341	mm
Face diameter	max.	97.5	mm
Accessories			
Socket	type	5911/20	
Final accelerator contact connector	type	55560	
Mu-metal shield	type	55540	

7Z2 6211

CAPACITANCES

x_1 to all other elements except x_2	$C_{x_1(x_2)}$	5.5	pF
x_2 to all other elements except x_1	$C_{x_2(x_1)}$	5.5	pF
y_1 to all other elements except y_2	$C_{y_1(y_2)}$	4.7	pF
y_2 to all other elements except y_1	$C_{y_2(y_1)}$	4.7	pF
x_1 to x_2	$C_{x_1x_2}$	2.5	pF
y_1 to y_2	$C_{y_1y_2}$	1.9	pF
Control grid to all other elements	C_{g_1}	4.6	pF
Cathode to all other elements	C_k	6.0	pF

FOCUSING electrostatic

DEFLECTION double electrostatic

x plates	symmetrical
y plates	symmetrical
Angle between x and y traces	90 + 1.5°

TYPICAL OPERATING CONDITIONS

Final accelerator voltage	$V_{g_5(\ell)}$	4000	V
First accelerator voltage	V_{g_4, g_2}	2000	V
Focusing electrode voltage	V_{g_3}	400 to 720	V
Control grid voltage for visual extinction of focused spot	$-V_{g_1}$	45 to 100	V
Deflection factor, horizontal	M_x	40 to 52.5	V/cm
vertical	M_y	32 to 40	V/cm
Useful scan, horizontal		full scan	
vertical		full scan	

7Z2 6006

LINE WIDTH

Measured on a circle of 50 mm diameter.

Final accelerator voltage	$V_{g_5}(\ell)$	4000	V
First accelerator voltage	V_{g_4,g_2}	2000	V
Beam current	$I(\ell)$	0.5	μA
Line width	l.w.	0.3	mm

LIMITING VALUES

Final accelerator voltage	$V_{g_5}(\ell)$	max.	5000	V
First accelerator voltage	V_{g_2,g_4}	max.	2500	V
Focusing electrode voltage	V_{g_3}	max.	1000	V
Control grid voltage,				
negative	$-V_{g_1}$	max.	200	V
positive	V_{g_1}	max.	0	V
positive peak	$V_{g_{1p}}$	max.	2	V
Cathode to heater voltage,				
cathode positive	$V_{+k/f-}$	max.	200	V
cathode negative	$V_{-k/f+}$	max.	125	V
Voltage between and any deflection plate	$V_{g_4/x}$	max.	500	V
	$V_{g_4/y}$	max.	500	V
Screen dissipation	W_ℓ	max.	3	mW/cm^2
Ratio $V_{g_5}(\ell)/V_{g_4,g_2}$	$V_{g_5}(\ell)/V_{g_4,g_2}$	max.	2	

7Z2 6007

INSTRUMENT CATHODE-RAY TUBE

10 cm diameter flat faced oscilloscope tube for medium class equipment.

QUICK REFERENCE DATA			
Final accelerator voltage	$V_{g_5(\ell)}$	4	kV
Display area	Both directions full scan		
Deflection factor, horizontal	M_x	46	V/cm
vertical	M_y	36	V/cm

SCREEN

	colour	persistence
DB 10-74	blue	medium short
DG10-74	yellowish green	medium
DP 10-74	yellowish green	long

Useful scan at $V_{g_5(\ell)}/V_{g_4, g_2} = 2$

horizontal	full scan
vertical	full scan

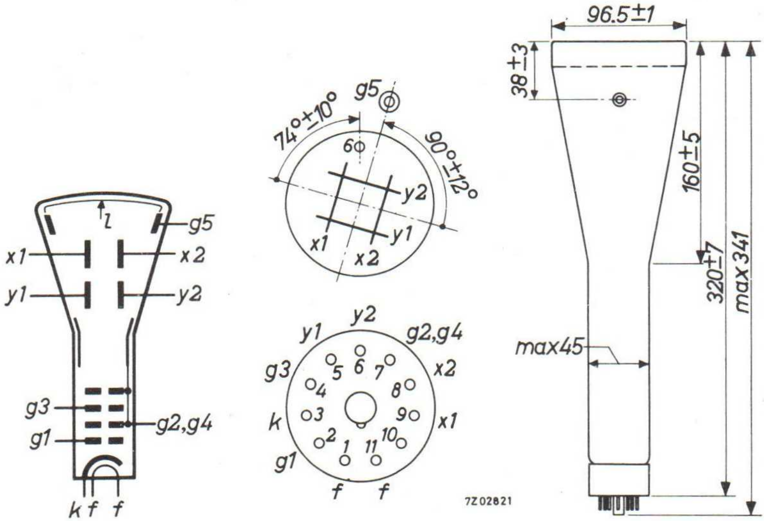
HEATING

Indirect by A.C. or D.C.; parallel supply

Heater voltage	V_f	6.3	V
Heater current	I_f	300	mA

7Z2 6004

MECHANICAL DATA Dimensions in mm



Mounting position: any

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

Base Magnal

Dimensions and connections

Overall length	max.	341	mm
Face diameter	max.	97.5	mm

Accessories

Socket	type 5911/20
Final accelerator contact connector	type 55560
Mu-metal shield	type 55540

CAPACITANCES

x_1 to all other elements except x_2	$C_{x_1(x_2)}$	5.5	pF
x_2 to all other elements except x_1	$C_{x_2(x_1)}$	5.5	pF
y_1 to all other elements except y_2	$C_{y_1(y_2)}$	4.7	pF
y_2 to all other elements except y_1	$C_{y_2(y_1)}$	4.7	pF
x_1 to x_2	$C_{x_1x_2}$	2.5	pF
y_1 to y_2	$C_{y_1y_2}$	1.9	pF
Control grid to all other elements	C_{g_1}	4.6	pF
Cathode to all other elements	C_k	6.0	pF

FOCUSING electrostatic

DEFLECTION double electrostatic

x plates	symmetrical
y plates	symmetrical
Angle between x and y traces	$90 + 1.5^o$

TYPICAL OPERATING CONDITIONS

Final accelerator voltage	$V_{g_5(\ell)}$	4000	V
First accelerator voltage	V_{g_4,g_2}	2000	V
Focusing electrode voltage	V_{g_3}	400 to 720	V
Control grid voltage for visual extinction of focused spot	$-V_{g_1}$	45 to 100	V
Deflection factor, horizontal	M_x	40 to 52.5	V/cm
vertical	M_y	32 to 40	V/cm
Useful scan, horizontal		full scan	
vertical		full scan	

7Z2 6006

LINE WIDTH

Measured on a circle of 50 mm diameter.

Final accelerator voltage	$V_{g_5}(\ell)$	4000	V
First accelerator voltage	V_{g_4, g_2}	2000	V
Beam current	$I(\ell)$	0.5	μA
Line width	l.w.	0.3	mm

LIMITING VALUES

Final accelerator voltage	$V_{g_5}(\ell)$	max.	5000	V
First accelerator voltage	V_{g_2, g_4}	max.	2500	V
Focusing electrode voltage	V_{g_3}	max.	1000	V
Control grid voltage,				
negative	$-V_{g_1}$	max.	200	V
positive	V_{g_1}	max.	0	V
positive peak	$V_{g_{1p}}$	max.	2	V
Cathode to heater voltage,				
cathode positive	$V_{+k/f-}$	max.	200	V
cathode negative	$V_{-k/f+}$	max.	125	V
Voltage between and any deflection plate	$V_{g_4/x}$	max.	500	V
	$V_{g_4/y}$	max.	500	V
Screen dissipation	W_ℓ	max.	3	mW/cm^2
Ratio $V_{g_5}(\ell)/V_{g_4, g_2}$	$V_{g_5}(\ell)/V_{g_4, g_2}$	max.	2	

7Z2 6007

INSTRUMENT CATHODE-RAY TUBE

General purpose cathode-ray tube with flat face and post deflection acceleration by means of a helical electrode.

QUICK REFERENCE DATA				
Final accelerator voltage	$V_{g(\ell)}$	=	4	kV
Display area		=	55x75	cm
Deflection factor, horizontal	M_x	=	34	V/cm
vertical	M_y	=	11	V/cm

SCREEN

	Colour	Persistence
DB10-78	blue	medium short
DH10-78	green	medium short
DN10-78	bluish green	medium short
DP10-78	yellowish green	long

Useful scan diameter min. 90 mm

Useful scan at $V_{g6(\ell)}/V_{g4,g2} = 4$

horizontal min. 75 mm

vertical min. 55 mm

HEATING

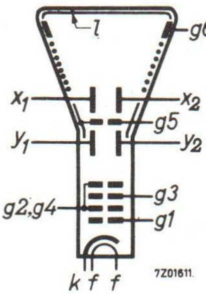
Indirect by A.C. or D.C.; parallel supply

Heater voltage V_f = 6.3 V

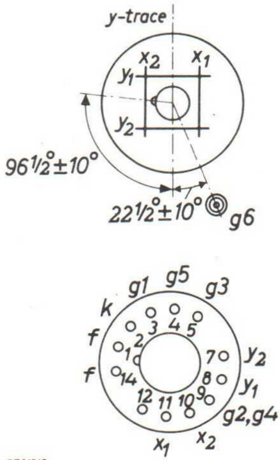
Heater current I_f = 300 mA

7Z2 5644

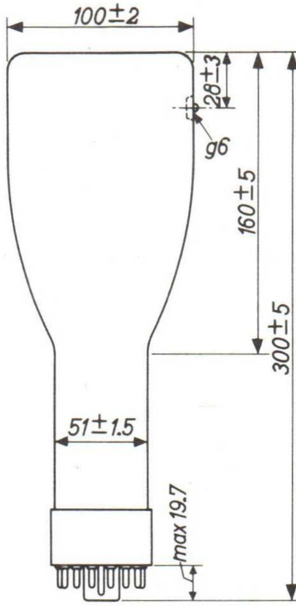
MECHANICAL DATA Dimensions in mm



7Z01611



7Z01612



7Z03155

Mounting position: any

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

Base	Diheptal 12 pins		
Dimensions and connections			
Overall length	max.	305	mm
Face diameter	max.	102	mm
Net weight	approx.	660	g
Accessories			
Socket	type	5914/20	
Final accelerator contact connector	type	55560	
Mu-metal shield	type	55541	

7Z2 5645

CAPACITANCES

x_1 to all other elements except x_2	$C_{x_1(x_2)}$	=	4	pF
x_2 to all other elements except x_1	$C_{x_2(x_1)}$	=	4	pF
y_1 to all other elements except y_2	$C_{y_1(y_2)}$	=	3.5	pF
y_2 to all other elements except y_1	$C_{y_2(y_1)}$	=	3.5	pF
x_1 to x_2	$C_{x_1x_2}$	=	2.1	pF
y_1 to y_2	$C_{y_1y_2}$	=	1.7	pF
Control grid to all other elements	C_{g_1}	=	5.0	pF
Cathode to all other elements	C_k	=	3.4	pF

FOCUSING electrostatic

DEFLECTION double electrostatic

x plates symmetrical

y plates symmetrical

Is use is made of the full deflection capabilities of the tube the deflection plates will intercept part of the electron beam; hence a low impedance deflection plate drive is desirable.

Angle between x and y traces $90 \pm 1^{\circ}$

LINE WIDTH

Measured with the shrinking raster method in the centre of the screen.

Final accelerator voltage	$V_{g_6(\ell)}$	=	4000	V
Astigmatism control electrode voltage	V_{g_4, g_2}	=	1000	V
Beam current	$I(\ell)$	=	10	μA
Line width	l.w.	=	0.35	mm

HELIX

Post deflection accelerator helix resistance min. 50 MΩ

7Z2 5646

TYPICAL OPERATING CONDITIONS

Final accelerator voltage	$V_{g6(\ell)}$	=	4000	V	
Geometry control electrode voltage	V_{g5}	=	1000 ±100	V	[1])
Astigmatism control electrode voltage	$V_{g4,g2}$	=	1000 ± 50	V	[2])
Focusing electrode voltage	V_{g3}	=	150 to 350	V	
Control grid voltage for visual extinction of focused spot	$-V_{g1}$	=	22.5 to 37.5	V	
Deflection factor					
horizontal	M_x	=	29 to 39	V/cm	
vertical	M_y	=	9.4 to 12.6	V/cm	
Deviation of linearity of deflection		=	max. 2	%	[3])
Geometry distortion		=	See note 4		
Useful scan					
horizontal		=	min. 75	mm	
vertical		=	min. 55	mm	

LIMITING VALUES (Absolute max. rating system)

Final accelerator voltage	$V_{g6(\ell)}$	=	max. 8000	V
		=	min. 1500	V
Geometry control electrode voltage	V_{g5}	=	max. 2200	V
Astigmatism control electrode voltage	$V_{g4,g2}$	=	max. 2100	V
		=	min. 1000	V
Focusing electrode voltage	V_{g3}	=	max. 1500	V
Control grid voltage,				
negative	$-V_{g1}$	=	max. 200	V
positive	V_{g1}	=	max. 0	V
positive peak	V_{g1p}	=	max. 2	V
Cathode to heater voltage,				
cathode positive	$V_{+k/f-}$	=	max. 200	V
cathode negative	$V_{-k/f+}$	=	max. 125	V
Voltage between astigmatism control electrode	$V_{g4,g2/x}$	=	max. 500	V
and any deflection plate	$V_{g4,g2/y}$	=	max. 500	V
Screen dissipation	W	=	max. 3	mW/cm^2
Ratio $V_{g6(\ell)}V_{g4,g2}$	$V_{g6(\ell)}/V_{g4,g2}$	=	max. 4	

7Z2 5647

CIRCUIT DESIGN VALUES

Focusing voltage	V_{g3}	=	150 to 350	V per kV of $V_{g4,g2}$
Control grid voltage for visual extinction of focused spot	$-V_{g1}$	=	22.5 to 37.5	V per kV of $V_{g4,g2}$
Deflection factor at $V_{g6(\ell)}/V_{g4,g2} = 4$				
horizontal	M_x	=	29 to 39	V/cm per kV of $V_{g4,g2}$
vertical	M_y	=	9.4 to 12.6	V/cm per kV of $V_{g4,g2}$
Control grid circuit resistance	R_{g1}	=	max. 1.5	MΩ
Deflection plate circuit resistance	R_x, R_y	=	max. 1	MΩ
Focusing electrode current	I_g	=	+15 to -30	μA 5)

1) This tube is designed for optimum performance when operating at the ratio $V_{g6(\ell)}/V_{g4,g2} = 4$. Operation at other ratio may result in changes in deflection uniformity and geometry distortion. The geometry control electrode voltage should be adjusted for optimum performance. For any necessary adjustment its potential will be within the stated range.

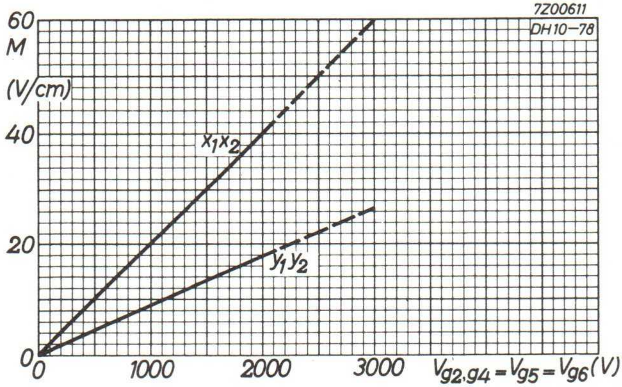
2) The astigmatism control electrode voltage should be adjusted for optimum spot shape. For any necessary adjustment its potential will be within the stated range.

3) 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 the indicated value.

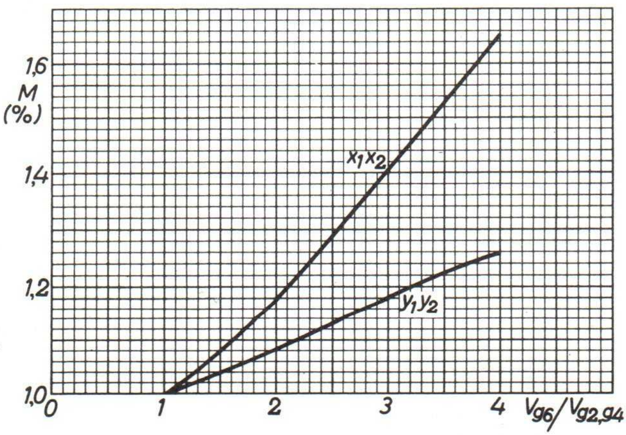
4) A graticule, consisting of concentric rectangles of 51 mm x 51 mm and 49 mm x 49 mm is aligned with the electrical x axis of the tube. The edges of a raster will fall between these rectangles with optimum correction potentials applied.

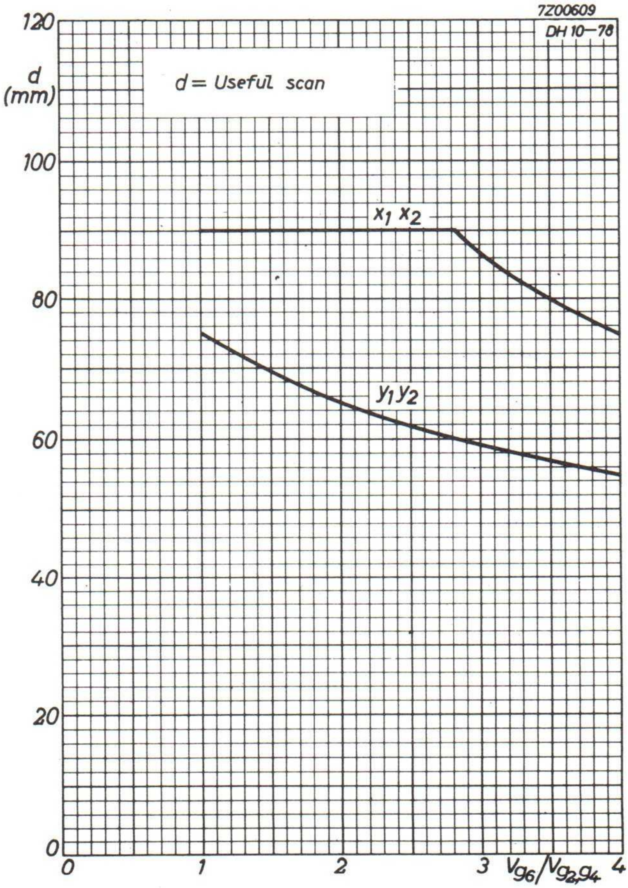
5) Values to be taken into account for the calculation of the focus potentiometer.

7Z2 5648



M = Deflection factor




7Z00609
DH 10—78
d = Useful scan
d
(mm)
120
100
80
60
40
20
0
0
1
2
3
4
$V_{g6}/V_{g2,g4}$
$x_1\ x_2$
$y_1\ y_2$

INSTRUMENT CATHODE-RAY TUBE

Oscilloscope tube with a flat face plate of 10 cm diameter, post deflection acceleration and side contacts to the x and y plates.

QUICK REFERENCE DATA				
Final accelerator voltage	$V_{g5(\ell)}$	=	4	kV
Display area	Both directions full scan			
Deflection factor, horizontal	M_x	=	37	V/cm
vertical	M_y	=	23	V/cm

SCREEN

	Colour	Persistence
DB10-94	blue	medium short
DH10-94	green	medium short
DP10-94	yellowish green	long

Useful screen diameter min. 90 mm

Useful scan at $V_{g5(\ell)}/V_{g4} = 2$

horizontal	full scan	
vertical	full scan	

HEATING

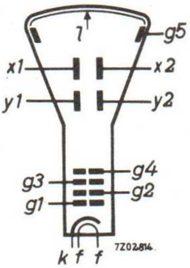
Indirect by A.C. or D.C.; parallel supply

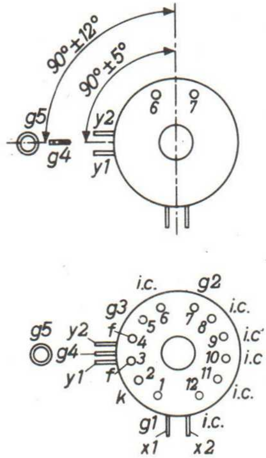
Heater voltage	V_f	=	6.3	V
Heater current	I_f	=	550	mA

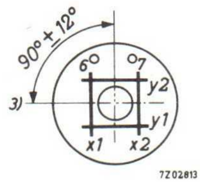
7Z2 5649

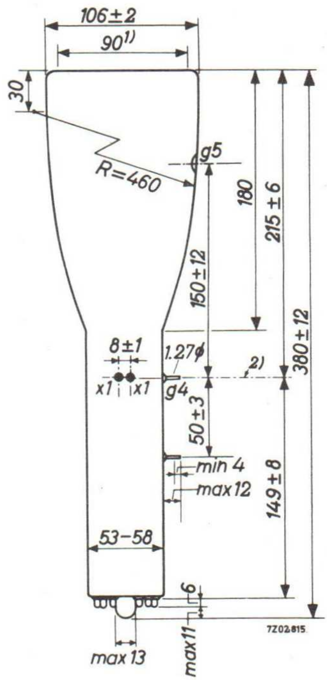
MECHANICAL DATA

Dimensions in mm









[1]) This face flat over a minimum area of 90 mm diameter.

[2]) Line of x pins. The axial distance between the radial planes of the x pins and the g_4 pin is > 2.0 mm. Side connectors 1.27 mm diameter.

[3]) Orientation of axes of deflection as viewed from screen end.

Mounting position: any

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

Base B12F

Dimensions and connections

Overall length	max.	392	mm
Face diameter	max.	108	mm
Net weight	approx.	560	g

Accessories

Socket	type	55562
Final accelerator contact connector	type	55563
Side contact connector	type	55561
Mu-metal shield	type	55543

7Z2 5650

CAPACITANCES

x_1 to all other elements except x_2	$C_{x_1(x_2)}$	=	3.6	pF
x_2 to all other elements except x_1	$C_{x_2(x_1)}$	=	3.6	pF
y_1 to all other elements except y_2	$C_{y_1(y_2)}$	=	3.0	pF
y_2 to all other elements except y_1	$C_{y_2(y_1)}$	=	3.0	pF
x_1 to x_2	$C_{x_1x_2}$	=	1.6	pF
y_1 to y_2	$C_{y_1y_2}$	=	1.5	pF
Control grid to all other elements	C_{g_1}	=	4.7	pF
Cathode to all other elements	C_k	=	4.0	pF

FOCUSING electrostatic

DEFLECTION double electrostatic

x plates symmetrical

y plates symmetrical

If use is made of the full deflection capabilities of the tube the deflection plates will intercept part of the electron beam; hence a low impedance deflection plate drive is desirable.

Angle between x and y traces $90^o \pm 1.5^o$

LINE WIDTH

Measured with the shrinking raster method in the centre of the screen

Final accelerator voltage	$V_{g_5(\ell)}$	=	4000	V
Second accelerator voltage	V_{g_4}	=	2000	V
First accelerator voltage	V_{g_2}	=	2000	V
Beam current	I_ℓ	=	3	μA
Line width	l.w.	=	0.35	mm

Page 4

1) Beam trapping voltage. In order to obviate the necessity for pulsing the grid when displaying pulse or single stroke phenomena, a beam trap is provided on the x_1 plate. When a voltage of suitable magnitude is applied to the x_1 plate the beam is contained on that plate, and a state of minimum brilliance exist.

7Z2 5651

TYPICAL OPERATING CONDITIONS

Final accelerator voltage	$V_{g5(\ell)}$	= 4000	V
Second accelerator voltage	V_{g4}	= 2000	V
Focusing electrode voltage	V_{g3}	= 460 to 530	V
First accelerator voltage	V_{g2}	= 2000	V
Control grid voltage for visual extinction of focused spot	$-V_{g1}$	= 28 to 60	V
Deflection factor			
horizontal	M_x	= 37	V/cm
vertical	M_y	= 23	V/cm
Useful scan			
horizontal		full scan	
vertical		full scan	
Beam trapping voltage	V_{x1-g4}	= 220 to 340	V [1]

LIMITING VALUES (Absolute limits)

Final accelerator voltage	$V_{g5(\ell)}$	= max. 10	kV
		= min. 1000	V
Second accelerator voltage	V_{g4}	= max. 5000	V
Focusing electrode voltage	V_{g3}	= max. 1500	V
First accelerator voltage	V_{g2}	= max. 5000	V
Control grid voltage			
negative	$-V_{g1}$	= max. 200	V
positive	V_{g1}	= max. 0	V
positive peak	V_{g1p}	= max. 2	V
Cathode to heater voltage			
cathode positive	V+k/f−	= max. 200	V
cathode negative	V−k/f+	= max. 125	V
Voltage between and any deflection plate	$V_{g4/x}$	= max. 500	V
	$V_{g4/y}$	= max. 500	V
Ratio $V_{g5(\ell)}/V_{g4}$	$V_{g5(\ell)}/V_{g4}$	= max. 2	

[1]) See page 3

7Z2 5652

INSTRUMENT CATHODE-RAY TUBE

The DG13-2 is a 13 cm spherical faced cathode ray tube primarily intended for inexpensive service oscilloscopes.

QUICK REFERENCE DATA			
Final accelerator voltage	$V_{g_5}(\ell)$	4	kV
Display area	Both directions full scan		
Deflection factor, horizontal	M_x	31	V/cm
vertical	M_y	26.5	V/cm

SCREEN

	colour	persistence
DB 13-2	blue	medium short
DG13-2	yellowish green	medium
DP 13-2	yellowish green	long

Useful screen diameter	min.	114	mm
Useful scan, horizontal	full scan		
vertical	full scan		

HEATING

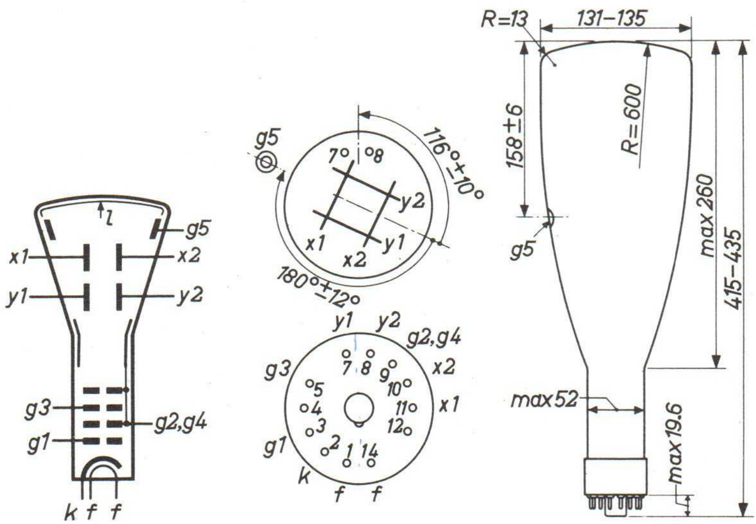
Indirect by A.C. or D.C.; parallel supply

Heater voltage	V_f	6.3	V
Heater current	I_f	300	mA

7Z2 6168

MECHANICAL DATA

Dimensions in mm



Mounting position: any

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

Base	Diheptal		

Dimensions and connections

Overall length	max.	435	mm
Face diameter	max.	135	mm

Accessories

Socket	type	5914/20
Final accelerator contact connector	type	55560
Mu-metal shield	type	55550

7Z2 6169

CAPACITANCES

x_1 to all other elements except x_2	$C_{x_1(x_2)}$	5.5	pF
x_2 to all other elements except x_1	$C_{x_2(x_1)}$	5.5	pF
y_1 to all other elements except y_2	$C_{y_1(y_2)}$	4.7	pF
y_2 to all other elements except y_1	$C_{y_2(y_1)}$	4.7	pF
x_1 to x_2	$C_{x_1x_2}$	2.5	pF
y_1 to y_2	$C_{y_1y_2}$	1.9	pF
Control grid to all other elements	C_{g_1}	4.6	pF
Cathode to all other elements	C_k	6.0	pF

FOCUSING electrostatic

DEFLECTION double electrostatic

x plates symmetrical

y plates symmetrical

Angle between x and y traces 90 ± 1^o

LINE WIDTH

Measured on a circle of 50 mm diameter

Final accelerator voltage	$V_{g_5(\ell)}$	4000	V
First accelerator voltage	V_{g_4,g_2}	2000	V
Beam current	$I(\ell)$	0.5	μA
Line width	l.w.	0.3	mm

7Z2 6170

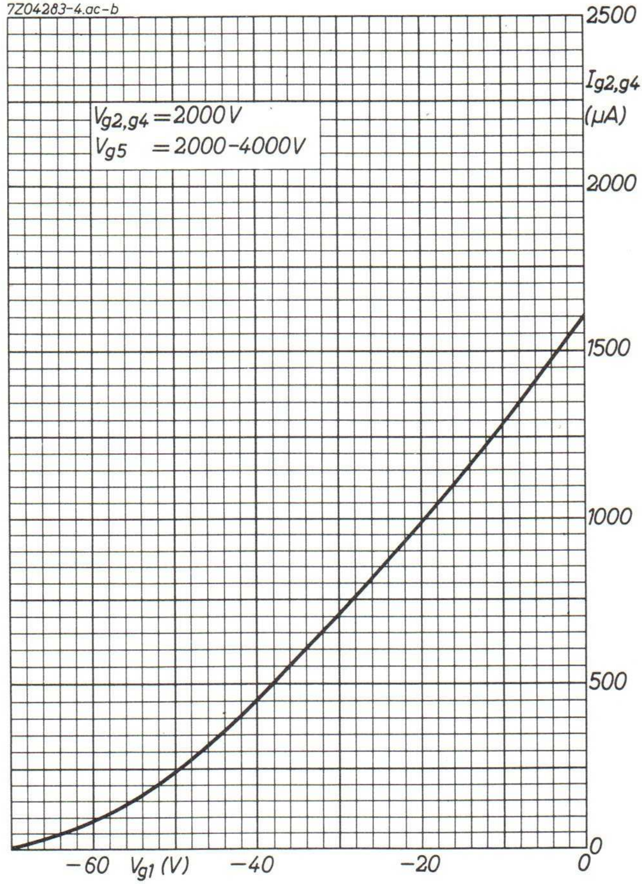
TYPICAL OPERATING CONDITIONS

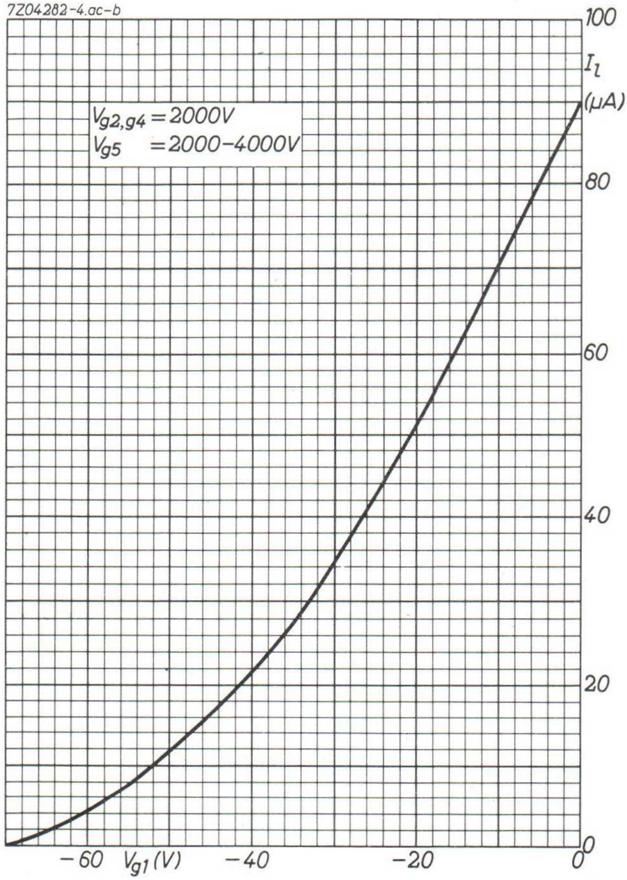
Final accelerator voltage	$V_{g_5}(\ell)$	4000	V
First accelerator voltage	V_{g_4,g_2}	2000	V
Focusing electrode voltage	V_{g_3}	400 to 720	V
Control grid voltage for visual extinction of focused spot	$-V_{g_1}$	45 to 100	V
Deflection factor, horizontal	M_x	27 to 35	V/cm
vertical	M_y	24 to 29	V/cm
Useful scan, horizontal		full scan	
vertical		full scan	

LIMITING VALUES

Final accelerator voltage	$V_{g_5}(\ell)$	max.	5000	V
Final accelerator voltage	V_{g_4,g_2}	max.	2500	V
Focusing electrode voltage	V_{g_3}	max.	1000	V
Control grid voltage,				
negative	$-V_{g_1}$	max.	200	V
positive	V_{g_1}	max.	0	V
positive peak	$V_{g_{1p}}$	max.	2	V
Cathode to heater voltage,				
cathode positive	$V_{+k/f-}$	max.	200	V
cathode negative	$V_{-k/f+}$	max.	125	V
Voltage between accelerator and any deflection plate	$V_{g_4/x}$	max.	500	V
	$V_{g_4/y}$	max.	500	V
Screen dissipation	W_ℓ	max.	3	mW/cm^2

7Z2 6171


7Z04283-4.ac-b
$V_{g2,g4}$ = 2000 V
V_{g5} = 2000-4000 V
2500
$I_{g2,g4}$ (μA)
2000
1500
1000
500
0
−60
V_{g1} (V)
−40
−20
0


7Z04282-4.ac-b
$V_{g2,g4}$ = 2000V
V_{g5} = 2000–4000V
100
I_l
(μA)
80
60
40
20
0
−60
V_{g1} (V)
−40
−20
0

INSTRUMENT CATHODE-RAY TUBE

13 cm diameter oscilloscope tube for inexpensive oscilloscopes.

QUICK REFERENCE DATA			
Final accelerator voltage	$V_{g4, g2(\ell)}$	2	kV
Display area	Both directions full scan		
Deflection factor, horizontal	M_x	26	V/cm
vertical	M_y	21	V/cm

SCREEN

	colour	persistence
DG13-32	yellowish green	medium

Useful screen diameter min. 114 mm

Useful scan

horizontal full scan

vertical full scan

HEATING

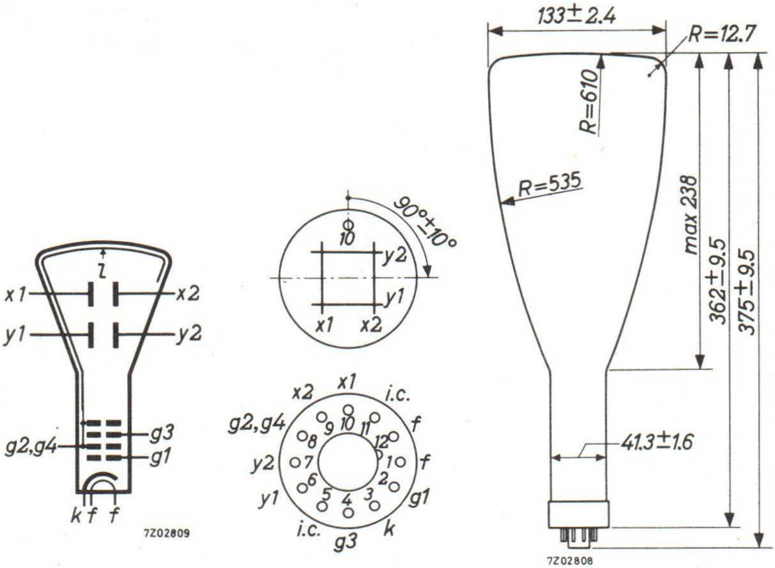
Indirect by A.C. or D.C.; parallel supply

Heater voltage	V_f	6.3	V
Heater current	I_f	600	mA

7Z2 5995

MECHANICAL DATA

Dimensions in mm



Mounting position: any

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

Base	Duodecal 12 p		
Dimensions and connections			
Overall length	max.	384.5	mm
Face diameter	max.	135.4	mm
Net weight	approx.	790	g
Accessories			
Socket	type	5912/20	
Final accelerator contact connector	type	55560	
Mu-metal shield	type	55550	

7Z2 5996

CAPACITANCES

x_1 to all other elements except x_2	$C_{x_1(x_2)}$	9.3	pF
x_2 to all other elements except x_1	$C_{x_2(x_1)}$	5.0	pF
y_1 to all other elements except y_2	$C_{y_1(y_2)}$	4.6	pF
y_2 to all other elements except y_1	$C_{y_2(y_1)}$	4.6	pF
x_1 to x_2	$C_{x_1x_2}$	2.0	pF
y_1 to y_2	$C_{y_1y_2}$	1.5	pF
Control grid to all other elements	C_{g_1}	4.3	pF
Cathode to all other elements	C_k	6.5	pF

FOCUSING electrostatic

DEFLECTION double electrostatic

x plates symmetrical

y plates symmetrical

Angle between x and y traces 90 ± 1^o

LINE WIDTH

Measured on a circle of 50 mm diameter.

Accelerator voltage	$V_{g_4, g_2(\ell)}$	2000	V
Beam current	$I(\ell)$	0.5	µA
Line width	l.w.	0.4	mm

TYPICAL OPERATING CONDITIONS

Accelerator voltage	$V_{g_4, g_2(\ell)}$	2000	V
Focusing electrode voltage	V_{g_3}	340 to 640	V
Control grid voltage for visual extinction of focused spot	$-V_{g_1}$	max. 90	V
Deflection factor, horizontal	M_x	22 to 30	V/cm
vertical	M_y	18.2 to 24.2	V/cm
Useful scan, horizontal		full scan	
vertical		full scan	

7Z2 5997

LIMITING VALUES

Final accelerator voltage	$V_{g_4,g_2(\ell)}$	max.	2500	V
Focusing electrode voltage	V_{g_3}	max.	1000	V
Control grid voltage,				
negative	$-V_{g_1}$	max.	200	V
positive	V_{g_1}	max.	0	V
positive peak	$V_{g_{1p}}$	max.	2	V
Cathode to heater voltage,				
cathode positive	$V_{+k/f-}$	max.	200	V
cathode negative	$V_{-k/f+}$	max.	125	V
Voltage between and any deflection plate	$V_{g_4/x}$	max.	500	V
	$V_{g_4/y}$	max.	500	V
Screen dissipation	W_ℓ	max.	3	mW/cm^2

CIRCUIT DESIGN VALUES

Focusing voltage	V_{g_3}	170 to 320	V per kV of $V_{g.}$
Control grid voltage for visual extinction of focused spot	$-V_{g_1}$	max. 45	V per kV of V_{g_4,g_2}
Deflection factor			
horizontal	M_x	11 to 15	V/cm per kV of V_{g_4,g_2}
vertical	M_y	9.1 to 12.1	V/cm per kV of V_{g_4,g_2}
Control grid circuit resistance	R_{g_1}	max. 1.5	MΩ
Deflection plate circuit resistance	R_x, R_y	max. 5	MΩ
Focusing electrode current	I_{g_3}	−15 to +15	μA [1]

[1]) Values to be taken into account for the calculation of the focus potentiometer.

7Z2 5998

INSTRUMENT CATHODE-RAY TUBE

13 cm diameter flat faced oscilloscope tube for general purpose oscilloscopes.

QUICK REFERENCE DATA			
Final accelerator voltage	$V_{g_5}(\ell)$	4	kV
Display area		10.2 x 10.2	cm
Deflection factor, horizontal	M_x	23.7	V/cm
vertical	M_y	17.7	V/cm

SCREEN

	colour	persistence
DB 13-34	blue	medium short
DG13-34	yellowish green	medium short
DP 13-34	yellowish green	long

Useful screen diameter	min.	114	mm
Useful scan at $V_{g_5}(\ell)/V_{g_4,g_2} = 2$			
horizontal	min.	102	mm
vertical	min.	102	mm

HEATING

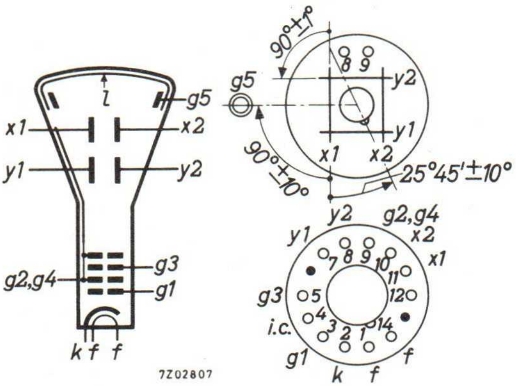
Indirect by A.C. or D.C.; parallel supply

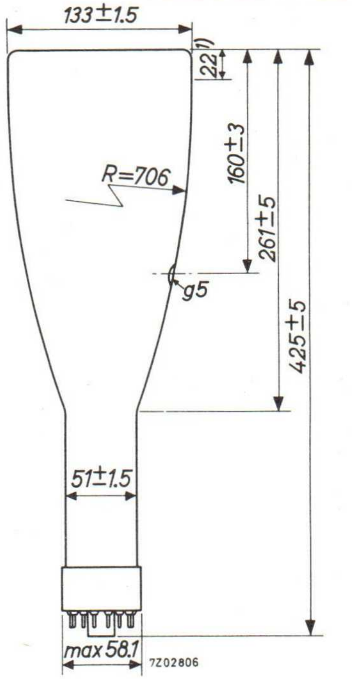
Heater voltage	V_f	6.3	V
Heater current	I_f	600	mA

7Z2 5999

MECHANICAL DATA

Dimensions in mm





Mounting position: any

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

Base	Diheptal 12 p
Dimensions and connections	
Overall length	max. 130 mm
Face diameter	max. 134.5 mm
Net weight	approx. 1100 g
Accessories	
Socket	type 5914/20
Final accelerator contact connector	type 55560
Mu-metal shield	type 55550

1) Lower side of straight part.

7Z2 6000

CAPACITANCES

x_1 to all other elements except x_2	$C_{x_1(x_2)}$	4	pF
x_2 to all other elements except x_1	$C_{x_2(x_1)}$	4	pF
y_1 to all other elements except y_2	$C_{y_1(y_2)}$	4	pF
y_2 to all other elements except y_1	$C_{y_2(y_1)}$	4	pF
x_1 to x_2	$C_{x_1x_2}$	2.5	pF
y_1 to y_2	$C_{y_1y_2}$	1.1	pF
Control grid to all other elements	C_{g_1}	5	pF
Cathode to all other elements	C_k	4	pF

FOCUSING electrostatic

DEFLECTION double electrostatic

x plates symmetrical

y plates symmetrical

If use is made of the full deflection capabilities of the tube the deflection plates will intercept part of the electron beam; hence a low impedance deflection plate drive is desirable.

Angel between x and y traces 90 ± 1^{o}

LINE WIDTH

Measured on a circle of 50 mm diameter.

Final accelerator voltage	$V_{g_5(\ell)}$	4000	V
First accelerator voltage	V_{g_4, g_2}	2000	V
Beam current	$I(\ell)$	0.5	μA
Line width	l.w.	0.3	mm

7Z2 6001

TYPICAL OPERATING CONDITIONS

Final accelerator voltage	$V_{g_5(\ell)}$	4000	V
First accelerator voltage	V_{g_4, g_2}	2000	V
Focusing electrode voltage	V_{g_3}	400 to 690	V
Control grid voltage for visual extinction of focused spot	$-V_{g_1}$	45 to 75	V
Deflection factor, horizontal	M_x	21.2 to 26.2	V/cm
vertical	M_y	15.8 to 19.6	V/cm
Deviation of linearity of deflection	max.	2	% [1]
Geometry distortion		see note 2	
Useful scan, horizontal	min.	102	mm
vertical	min.	102	mm

LIMITING VALUES

Final accelerator voltage	$V_{g_5(\ell)}$	max.	6000	V
		min.	1000	V
First accelerator voltage	V_{g_4, g_2}	max.	2600	V
Focusing electrode voltage	V_{g_3}	max.	1000	V
Control grid voltage,		min.	1000	V
negative	$-V_{g_1}$	max.	200	V
positive	V_{g_1}	max.	0	V
positive peak	$V_{g_{1p}}$	max.	2	V
Cathode to heater voltage,				
cathode positive	$V_{+k/f-}$	max.	200	V
cathode negative	$V_{-k/f+}$	max.	125	V
Voltage between and any deflection plate	$V_{g_4/x}$	max.	500	V
	$V_{g_4/y}$	max.	500	V
Cathode current	$I_{k_{eff}}$	max.		mA
Screen dissipation	W_ℓ	max.	3	W/cm^2
Ratio $V_{g_5}(\ell)/V_{g_4, g_2}$	$V_{g_5}(\ell)/V_{g_4, g_2}$	max.	2.3	

7Z2 6002

CIRCUIT DESIGN VALUES

Focusing voltage	V_{g_3}	200 to 345	V per kV of V_{g_4, g_2}
Control grid voltage for visual extinction of focused spot	$-V_{g_1}$	22.5 to 37.5	V per kV of V_{g_4, g_2}
Deflection factor at $V_{g_5}(\ell)/V_{g_4} = 2$			
horizontal	M_x	10.6 to 13.1	V/cm per kV of V_{g_4, g_2}
vertical	M_y	7.9 to 9.8	V/cm per kV of V_{g_4, g_2}
Control grid circuit resistance	M_{g_1}	max. 1.5	MΩ
Deflection plate circuit resistance	R_x, R_y	max. 1	MΩ
Focusing electrode current	I_{g_3}	-15 to +15	μA [3]

---

[1]) 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 the indicated value.

[2]) A graticule, consisting of concentric rectangles of 81.6 mm x 81.6 mm and 78.4 mm x 78.4 mm 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.

[3]) Values to be taken into account for the calculation of the focus potentiometer

7Z2 6003

INSTRUMENT CATHODE-RAY TUBE

Rectangular cathode-ray tube for radar or oscilloscope applications.

QUICK REFERENCE DATA			
Final accelerator voltage	$V_{g_4}(\ell)$	5000	kV
Display area		37 x 140	mm
Deflection factor, horizontal	M_x	52.6	V/cm
vertical	M_y	47.6	V/cm

SCREEN

	colour	persistence
DB 16-22	blue	medium short
DG16-22	yellowish green	medium
DP 16-22	yellowish green	long

Useful scan, horizontal	min.	140	mm
vertical	min.	37	mm

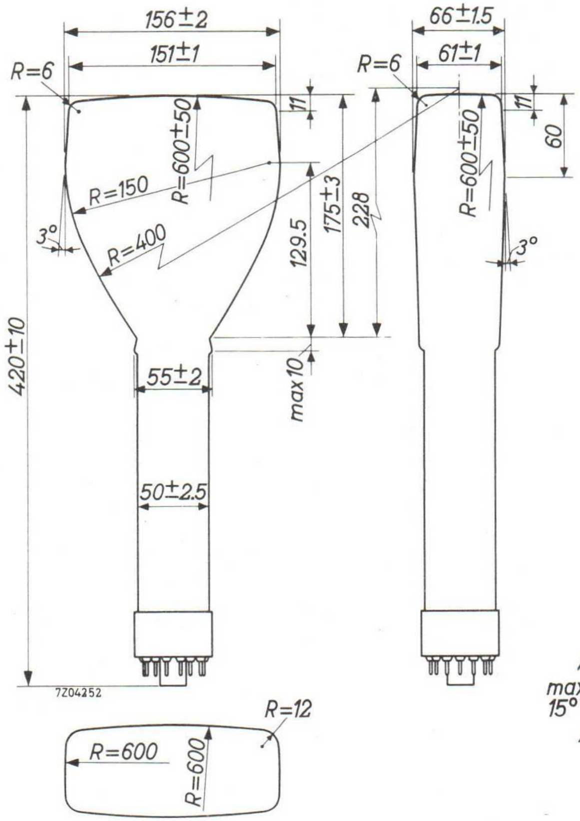
HEATING

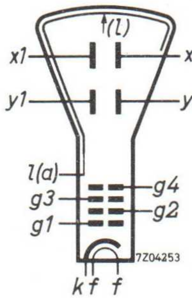
Indirect by A.C. or D.C.; parallel supply

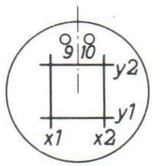
Heater voltage	V_f	6.3	V
Heater current	I_f	300	mA

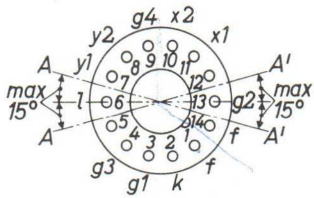
7Z2 6093

MECHANICAL DATA Dimensions in mm









Mounting position: any

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

Base — Diheptal 14 pins

Dimensions and connections

Overall length — max. 430 mm

Accessories

Socket	type	5914/20
Mu-metal shield	type	55559

7Z2 6094

CAPACITANCES

x_1 to all other elements except x_2	$C_{x_1(x_2)}$	max.	16	pF
x_2 to all other elements except x_1	$C_{x_2(x_1)}$	max.	16	pF
y_1 to all other elements except y_2	$C_{y_1(y_2)}$	max.	20	pF
y_2 to all other elements except y_1	$C_{y_2(y_1)}$	max.	20	pF
x_1 to x_2	$C_{x_1x_2}$		3	pF
y_1 to y_2	$C_{y_1y_2}$		3	pF
Control grid to all other elements	C_{g_1}	max.	10	pF

FOCUSING electrostatic

DEFLECTION double electrostatic

x plates	symmetrical/asymmetric
y plates	symmetrical/asymmetric
Angle between x and y traces	$90 \pm 2^{\circ}$

TYPICAL OPERATING CONDITIONS

Final accelerator voltage	$V_{g_4(\ell)}$	5000	V
Focusing electrode voltage	V_{g_3}	600 to 700	V
First accelerator voltage	V_{g_2}	1800	V
Control grid voltage for visual extinction of focused spot	V_{g_1}	25 to 70	V
Deflection factor, horizontal	M_x	52.6	V/cm
vertical	M_y	47.6	V/cm
Useful scan, horizontal	min.	140	mm
vertical	min.	37	mm

7Z2 6095

LIMITING VALUES

Final accelerator voltage	$V_{g_4(\ell)}$	max.	6000	V
Focusing electrode voltage	V_{g_3}	max.	1100	V
First accelerator voltage	V_{g_2}	max.	2500	V
Control grid voltage,				
negative	$-V_{g_1}$	max.	150	V
positive	V_{g_1}	max.	0	V
positive peak	$V_{g_{1p}}$	max.	2	V
Cathode to heater voltage,				
cathode positive	$V_{+k/f-}$	max.	150	V
cathode negative	$V_{-k/f+}$	max.	125	V
Voltage between and any deflection plate	$V_{g_4/x}$	max.	500	V
	$V_{g_4/y}$	max.	500	V
Average cathode current	I_k	max.	300	μA

7Z2 6096

INSTRUMENT CATHODE-RAY TUBE

The DHM10-93 is 10 cm flat faced dual trace oscilloscope tube. The tube features two independent vertical deflection systems and a common x deflection.

QUICK REFERENCE DATA				
Final accelerator voltage		$V_{g_5}(\ell)$	3000	kV
Display area (each scan)		vertical	70	mm
		horizontal	full scan	
Deflection factor, horizontal		M_x	27	V/cm
vertical	each system	M_y	27	V/cm

SCREEN

	colour	persistence
DHM10-93	green	medium short

Useful screen diameter min. 90 mm

Useful scan at $V_{g_5}(\ell)/V_{g_4} = 2$

horizontal	full scan	
vertical	min. 70	mm

For each vertical deflection system the useful scan is min. 70 mm. The two scans overlap each other max. 50 mm.

HEATING

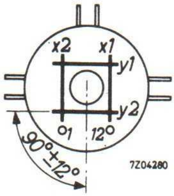
Indirect by A.C. or D.C.; parallel supply

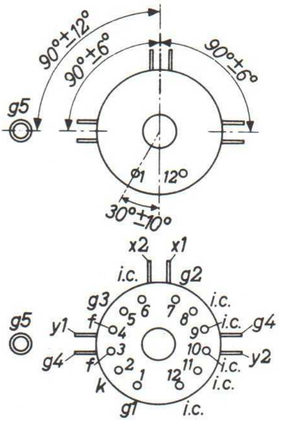
Heater voltage	V_f	6.3	V
Heater current	I_f	550	mA

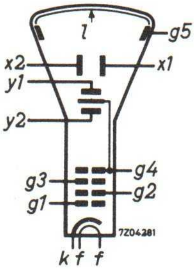
7Z2 6088

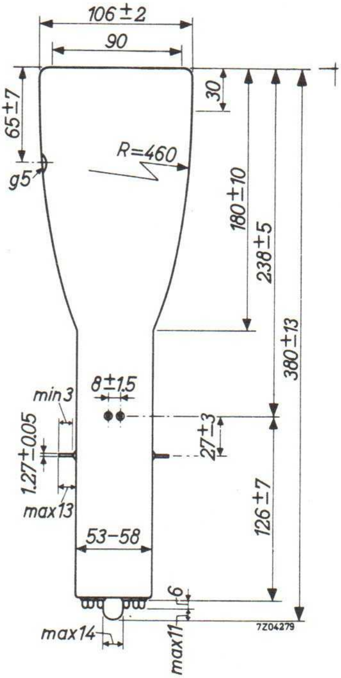
MECHANICAL DATA

Dimensions in mm









Mounting position: any

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

Base	Special all glass 12 pin		
Dimensions and connections			
Overall length	max.	393	mm
Face diameter	max.	108	mm
Net weight	approx.	650	g

Accessories

Socket	type	55562
Final accelerator contact connector	type	55563
Side contact connector	type	55561
Mu-metal shield	type	55542

7Z2 6089

CAPACITANCES

x_1 to all other elements except x_2	$C_{x_1(x_2)}$		3.2	pF
x_2 to all other elements except x_1	$C_{x_2(x_1)}$		3.2	pF
y_1 to all other elements except y_2	$C_{y_1(y_2)}$		3.3	pF
y_2 to all other elements except y_1	$C_{y_2(y_1)}$		3.3	pF
x_1 to x_2	$C_{x_1x_2}$	max.	2	pF
y_1 to y_2	$C_{y_1y_2}$	max.	0.1	pF
Control grid to all other elements	C_{g_1}		5.0	pF
Cathode to all other elements	C_k		4.2	pF

FOCUSING electrostatic

DEFLECTION double electrostatic

x plates symmetrical

y plate pairs asymmetrical

y_1 and y_2 are separated by a beam dividing plate, interconnected to g_4

Angle between x and y traces 90 ± 1.5^o

LINE WIDTH

Measured with the shrinking raster method in the centre of the screen.

Final accelerator voltage	$V_{g_5(\ell)}$	3000	V
Second accelerator electrode voltage	V_{g_4}	1500	V
First accelerator voltage	V_{g_2}	1500	V
Beam current	adjusted for 0.08 cd light output		
Line width	l.w.	0.3	mm

7Z2 6090

TYPICAL OPERATING CONDITIONS

Final accelerator voltage		$V_{g_5}(\ell)$	3000	V
Beam trapping voltage		$V_{g_4-x_2}$	170 to 290	V [1]
Second accelerator electrode voltage		V_{g_4}	1500	V
Focusing electrode voltage		V_{g_3}	320 to 420	V
First accelerator voltage		V_{g_2}	1500	V
Control grid voltage for visual extinction of focused spot		$-V_{g_1}$	40 to 95	V
Deflection factor, horizontal		M_x	27	V/cm
vertical	Both systems	M_y	27	V/cm
Geometry distortion			max. 2.5	% [2]
Useful scan, horizontal			full scan	
vertical			min. 70	mm
vertical overlap			max. 50	mm

[1] Beam trapping voltage. In order to obviate the necessity for pulsing the grid when displaying pulse or single stroke phenomena a positive voltage of suitable magnitude may be applied to the x_2 plate, by which the beam is contained on that plate and a state of minimum brilliance exists.

[2] The length of the edges of a raster pattern whose mean dimensions are less than 65 % of the useful scan will not deviate by more than 2.5 % from these mean dimensions provided V_{g_5}/V_{g_4} max. 2.

7Z2 6091

LIMITING VALUES

Final accelerator voltage	$V_{g_5(\ell)}$	max.	8000	V
		min.	1000	V
Second accelerator voltage	V_{g_4}	max.	4000	V
		min.	600	V
Focusing electrode voltage	V_{g_3}	max.	1200	V
First accelerator voltage	V_{g_2}	max.	1700	V
		min.	600	V
Control grid voltage				
negative	$-V_{g_1}$	max.	200	V
positive	V_{g_1}	max.	0	V
positive peak	$V_{g_{1p}}$	max.	2	V
Cathode to heater voltage				
cathode positive	$V_{+k/f-}$	max.	200	V
cathode negative	$V_{-k/f+}$	max.	125	V
Voltage between accelerator and any deflection plate	$V_{g_4/x}$	max.	500	V
	$V_{g_4/y}$	max.	500	V
Screen dissipation	W_ℓ	max.	3	mW/cm^2
Ratio $V_{g_5(\ell)}/V_{g_4}$	$V_{g_5(\ell)}/V_{g_4}$	max.	2	

7Z2 6092

PART 3

RADAR CATHODE-RAY TUBES

PREFERRED TYPES

RADAR CATHODE - RAY TUBES			
Screen diameter			Focusing
16 cm (6")	F16-10LD	electrostatic	
21 cm (8")	F21-10LD	electrostatic	
31 cm (12")	F31-10LC	electrostatic	
41 cm (16")	F41-10LC F41-11LC	electrostatic magnetic	

2

Valid until 31 December 1966

7Z2 6192

RADAR CATHODE-RAY TUBE

The F16-10LD is a 16 cm diameter radar tube with metal backed long persistence screen. The tube is primarily intended for use in transistorized small boat radar.

QUICK REFERENCE DATA	
Final accelerator voltage	14 kV
Deflection angle	37 °
Focusing	low voltage electrostatic
Cathode drive (from spot cut-off)	25 V

SCREEN

Metal backed

Colour	orange
Persistence	long
Useful screen diameter	135 mm

HEATING

Indirect by A.C. or D.C.; parallel or series supply

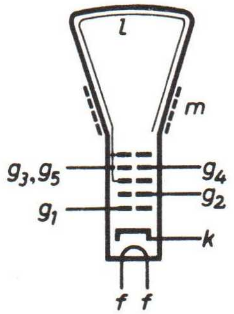
Heater voltage	V_f	=	6.3	V
Heater current	I_f	=	300	mA

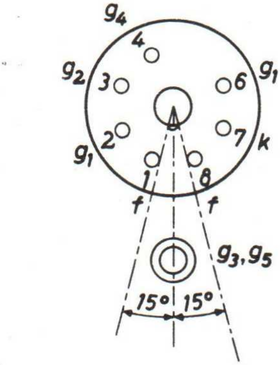
CAPACITANCES

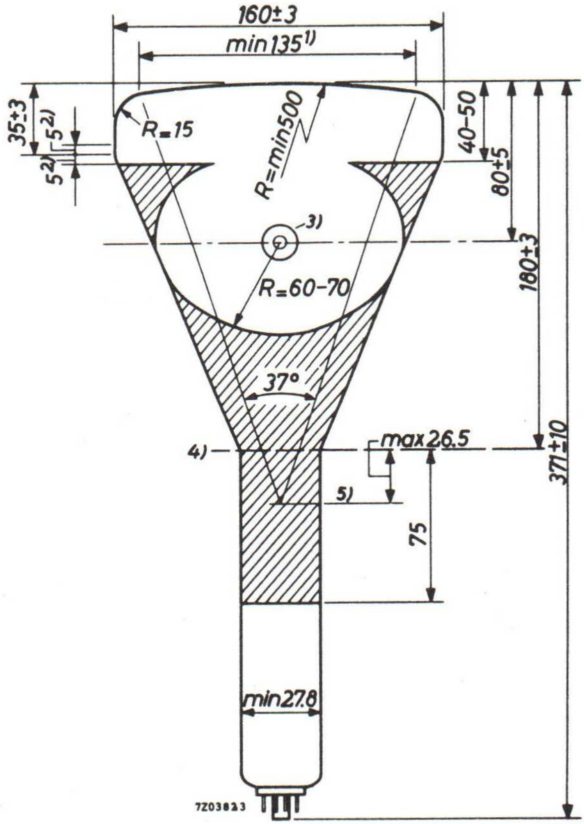
Control grid to all other elements	C_{g_1}	<	10	pF
Cathode to all other elements	C_k	<	6	pF
Final accelerator to external conductive coating	$C_{g_3,g_5/m}$		750	pF

7Z2 5851

MECHANICAL DATA Dimensions in mm







Mounting position: any

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

Base: B8H

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1) Useful screen diameter
2) Any irregularities are kept within these limits
3) CT8 cavity cap
4) 29.5 mm diameter reference line
5) Centre of deflection

7Z2 5852

MECHANICAL DATA (continued)

Dimensions and connections

Overall length	max.	381	mm
Face diameter	max.	163	mm
Net weight:	approx.	1.2	kg

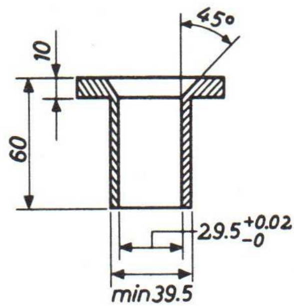
Accessories

Final accelerator contact connector	type	55563

ECCENTRICITY

The projected neck axis passes within 3.5 mm of the geometric centre of the tube face. Neck eccentricity with respect to the geometric centre of the tube face does not exceed 4 mm at the deflection centre and at 100 mm from the reference line.

REFERENCE LINE GAUGE



EXTERNAL CONDUCTIVE COATING

This tube has an external conductive coating-m- and the capacitance of this to the final accelerator may be used to provide smoothing for the e.h.t. supply.

FOCUSING low voltage electrostatic

DEFLECTION double magnetic

deflection angle 37°

7Z2 5853

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 16 kV.

TYPICAL OPERATING CONDITIONS

Final accelerator voltage	$V_{g3,g5(\ell)}$	14	kV
Focusing electrode voltage	V_{g4}	0 to 400	V
Grid No.2 voltage	V_{g2}	500	V
Cathode voltage for visual extinction of a focused spot [1]	V_k	25 to 40	V
Grid No.1 voltage for visual extinction of the focused spot [2]	$-V_{g1}$	27 to 44	V

BRIGHTNESS

Brightness 250 Nits

Measured with 25 V cathode drive on a 12 x 12 cm raster.

LIMITING VALUES (Absolute max. rating system)

Measured with respect to cathode

Final accelerator voltage	$V_{g3,g5(\ell)}$	max.	18	kV
		min.	10	kV
Focusing electrode voltage	V_{g4}	max.	1000	V
		min.	-500	V
Grid No.2 voltage	V_{g2}	max.	600	V
		min.	300	V
Control grid voltage,				
negative	$-V_{g1}$	max.	150	V
positive	V_{g1}	max.	0	V
Focusing electrode current	I_{g4}	max.	+15 to -15	μA
Grid No.2 current	I_{g2}	max.	+15 to -15	μA

[1]) For cathode modulation all voltages measured with respect to grid No.1
[2]) For grid modulation all voltages measured with respect to cathode

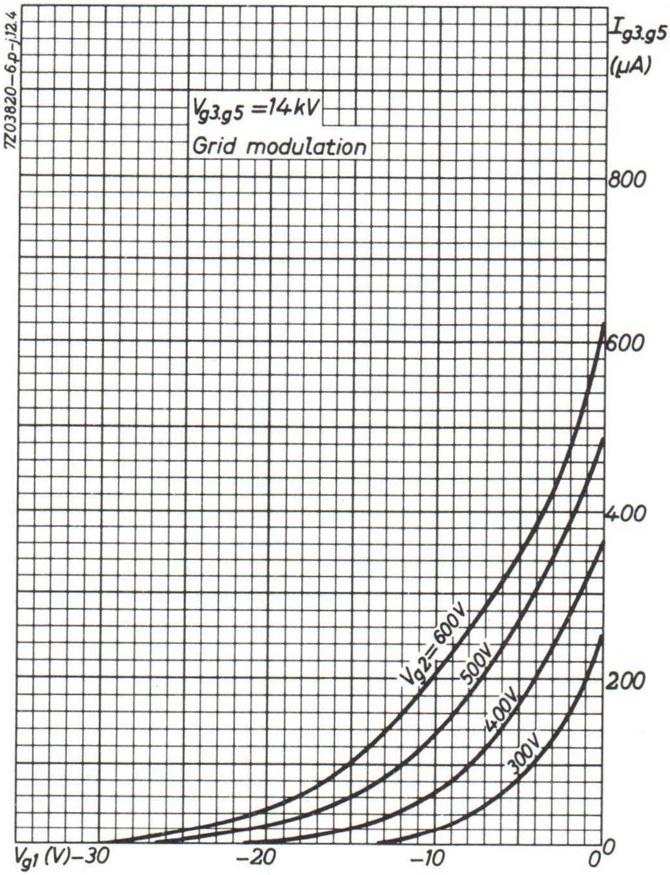
7Z2 5854

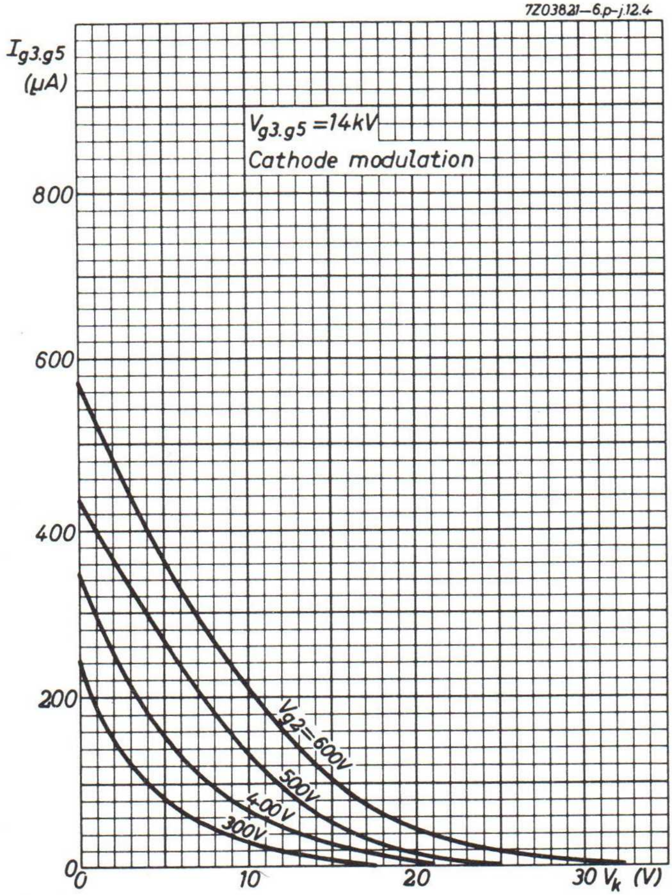
LIMITING VALUES (continued)

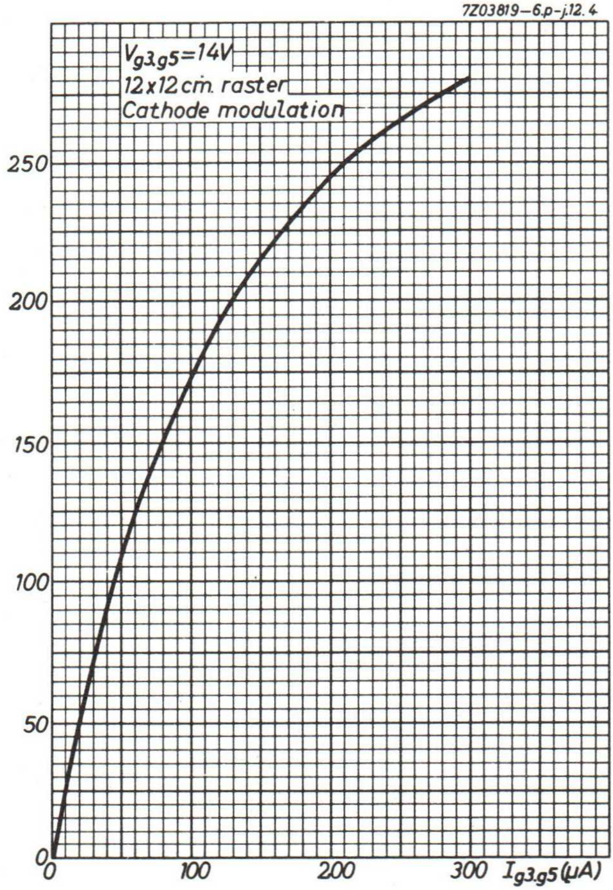
Cathode to heater voltage,

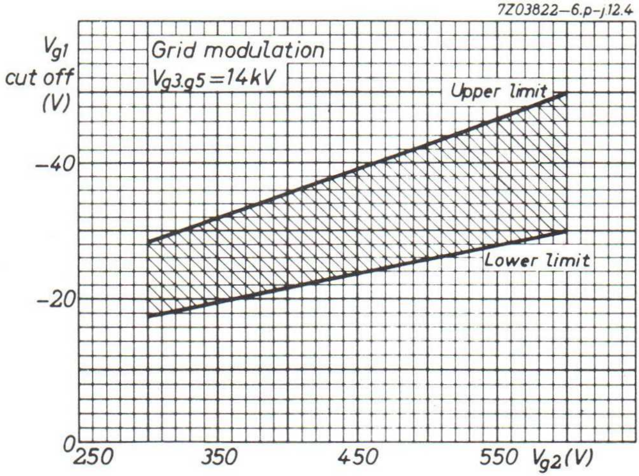
cathode positive	$V_{+k/f-}$	max.	200	V
	$V_{+k/f-p}$	max.	300	V
cathode negative	$V_{-k/f+}$	max.	125	V
	$V_{-k/f+p}$	max.	250	V
Resistance between heater and cathode	R_{kf}	max.	1	MΩ
Resistance between cathode and earth	R_k	max.	1.5	MΩ
Impedance between heater and cathode (f = 50 Hz)	Z_{kf}	max.	100	kΩ
Impedance between cathode and earth (f = 50 Hz)	Z_k	max.	500	kΩ

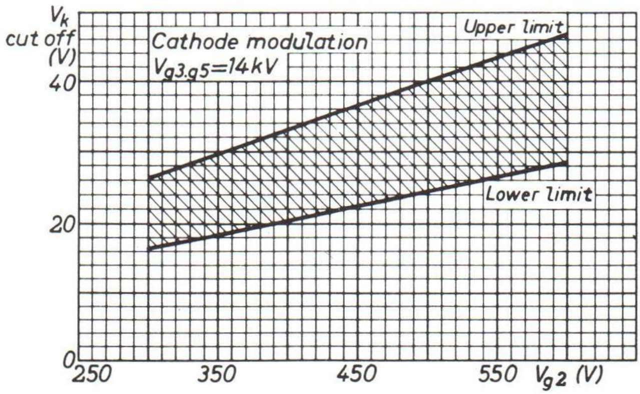
7Z2 6278


7Z03820-6.p-j.12.4
$V_{g3.g5}$ = 14 kV
Grid modulation
$I_{g3.g5}$ (μA)
800
600
400
200
0
V_{g2}=600V
500V
400V
300V
V_{g1} (V) −30
−20
−10
0


7Z03821–6.p–j.12.4
$I_{g3.g5}$ (μA)
$V_{g3.g5}$ =14kV
Cathode modulation
800
600
400
200
0
0
10
20
30 V_k (V)
V_{g2}=600V
500V
400V
300V


7Z03819—6.p—j.12.4
Vg3,g5=14V
12x12 cm raster
Cathode modulation
250
200
150
100
50
0
0
100
200
300
Ig3,g5 (μA)


7Z03822—6.p-j12.4
Vg1
cut off
(V)
Grid modulation
Vg3.g5=14kV
Upper limit
Lower limit
-40
-20
0
250
350
450
550
Vg2(V)


Vk
cut off
(V)
Cathode modulation
Vg3.g5=14kV
Upper limit
Lower limit
40
20
0
250
350
450
550
Vg2 (V)

RADAR CATHODE-RAY TUBE

The F21-10LD is a 21 cm diameter radar tube with metal-backed long persistence screen. The tube is particularly suitable for medium range radar receivers with transistor display units.

QUICK REFERENCE DATA	
Final accelerator voltage	14 kV
Deflection angle	41 °
Focusing	low voltage electrostatic
Cathode drive (from spot cut-off)	30 V

SCREEN

Metal backed

Colour	orange
Persistence	long
Useful screen diameter	197 mm

HEATING

Indirect by A.C. or D.C.; parallel or series supply

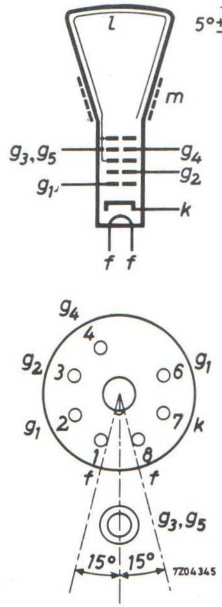
Heater voltage	V_f	=	6.3	V
Heater current	I_f	=	300	mA

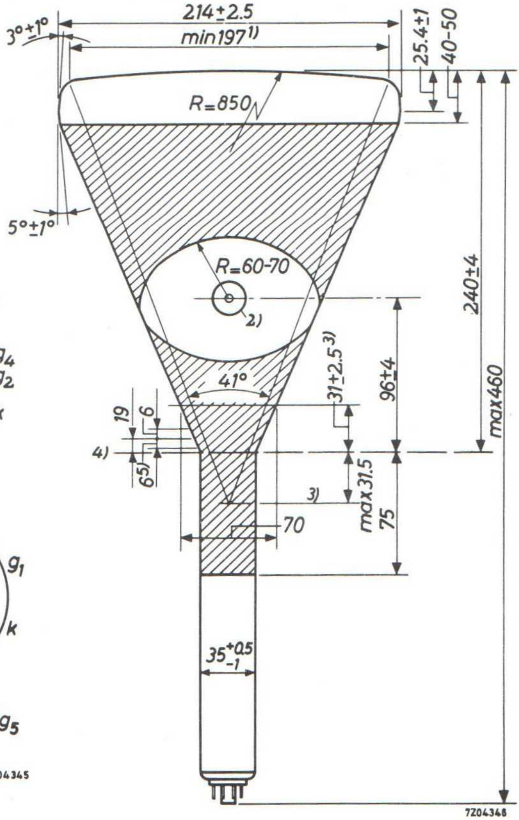
CAPACITANCES

Control grid to all other elements	C_{g_1}	<	10	pF
Cathode to all other elements	C_k	<	6	pF
Final accelerator to external conductive coating	$C_{g_3, g_5/m}$		1250	pF

7Z2 5855

MECHANICAL DATA Dimensions in mm





Neck axis makes an angle of less than 2.5° with the perpendicular to the tangent at centre of face and passes within 3.5 mm of centre of face.

Mounting position: any

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

---

1) Useful screen diameter

2) CT8 cavity cap

3) 70 mm diameter ring gauge position

4) 36 mm diameter reference line. Reference line gauge 36.0 mm inner diameter, 100 mm long

5) Centre of deflection

7Z2 5856

MECHANICAL DATA (continued)

Dimensions in mm

Base: B8H

Dimensions and connections

Overall length	max.	460	mm
Face diameter	max.	216.5	mm
Net weight:	approx.	2.6	kg
Accessories			
Final accelerator contact connector	type	55563	

EXTERNAL CONDUCTIVE COATING

This tube has an external conductive coating-m- and the capacitance of this to the final accelerator may be used to provide smoothing for the e.h.t. supply.

FOCUSING low voltage electrostatic

DEFLECTION double magnetic

deflection angle 41°

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 16 kV.

TYPICAL OPERATING CONDITIONS

Final accelerator voltage	$V_{g_3,g_5(\ell)}$	14	kV
Focusing electrode voltage	V_{g_4}	0 to 400	V
Grid No.2 voltage	V_{g_2}	600	V
Cathode voltage for visual extinction of a focused spot [1]	V_k	30 to 45	V

[1] For cathode modulation all voltages measured with respect to grid No.1

7Z2 5857

LIMITING VALUES (Absolute max. rating system)

Measured with respect to cathode

Final accelerator voltage	$V_{g_3,g_5(\ell)}$	max. min.	18 10	kV kV
Focusing electrode voltage	V_{g_4}	max. min.	1000 -500	V V
Grid No. 2 voltage	V_{g_2}	max. min.	800 400	V V
Control grid voltage,				
negative	$-V_{g_1}$	max.	150	V
positive	V_{g_1}	max.	0	V
Focusing electrode current	I_{g_4}	max.	+15 to -15	μA
Grid No. 2 current	I_{g_2}	max.	+15 to -15	μA
Cathode to heater voltage				
cathode positive	$V_{+k/f-}$ $V_{+k/f-p}$	max. max.	200 300	V V
cathode negative	$V_{-k/f+}$ $V_{-k/f+p}$	max. max.	125 250	V V.
Resistance between heater and cathode	R_{kf}	max.	1	MΩ
Resistance between cathode and earth	R_k	max.	1.5	MΩ
Impedance between heater and cathode (f = 50 Hz)	Z_{kf}	max.	100	kΩ
Impedance between cathode and earth (f = 50 Hz)	Z_k	max.	500	kΩ

7Z2 5858

RADAR CATHODE-RAY TUBE

The F31-10LC is a 31 cm diameter radar tube with metal-backed very long persistence screen. The tube is particularly suitable for radar receivers with transistor display units.

QUICK REFERENCE DATA		
Final accelerator voltage	16	kV
Deflection angle	40	°
Focusing	low voltage electrostatic	
Cathode drive (from spot cut-off)	30	V

SCREEN

Metal backed

Colour	orange	
Persistence	very long	
Useful screen diameter	265	mm

HEATING

Indirect by A.C. or D.C.; parallel or series supply

Heater voltage	V_f	=	6.3	V
Heater current	I_f	=	300	mA

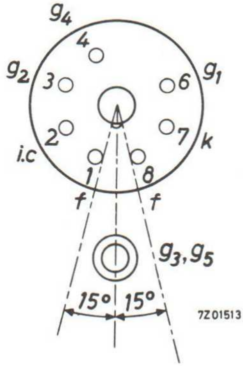
CAPACITANCES

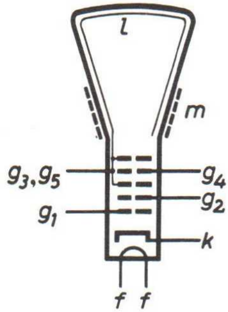
Control grid to all other elements	C_{g_1}	<	10	pF
Cathode to all other elements	C_k	<	6	pF
Final accelerator to external conductive coating	$C_{g_3,g_5/m}$		2200	pF

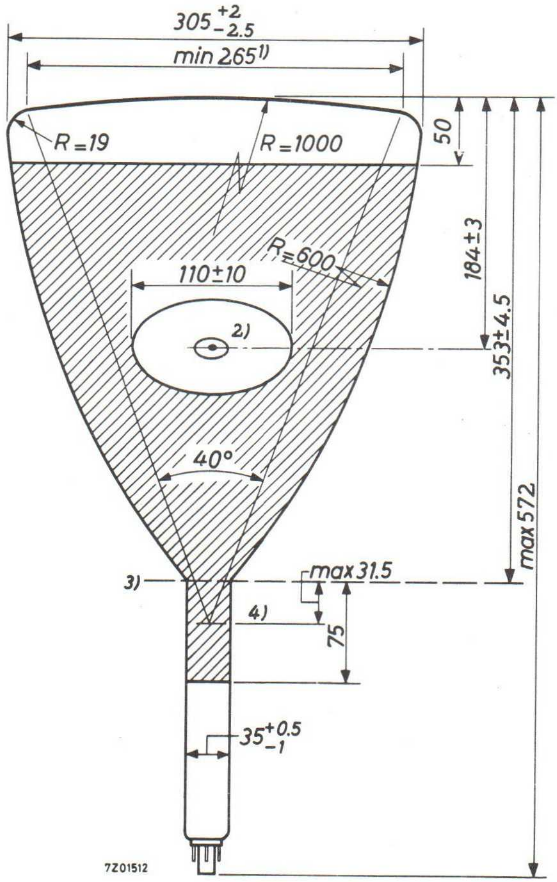
7Z2 5859

MECHANICAL DATA

Dimensions in mm







Mounting position: any

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

Base: B8H

1) Useful screen diameter
2) CT8 cavity connector
3) Point at which 36 mm diameter ring gauge is stopped
4) Effective centre of deflection

7Z2 5860

MECHANICAL DATA (continued)

Dimensions and connections

Overall length	max.	572	mm
Face diameter	max.	307	mm
Net weight:	approx.	6.2	kg

Accessories

Final accelerator contact connector	type	55563

EXTERNAL CONDUCTIVE COATING

This tube has an external conductive coating -m- and the capacitance of this to the final accelerator may be used to provide smoothing for the e.h.t. supply.

FOCUSING low voltage electrostatic

DEFLECTION double magnetic

deflection angle 40 °

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 16 kV.

TYPICAL OPERATING CONDITIONS

Final accelerator voltage	$V_{g_3,g_5(\ell)}$		16	kV
Focusing electrode voltage	V_{g_4}	approx.	200	V
Grid No.2 voltage	V_{g_2}		500	V
Cathode voltage for visual extinction of a focused spot [1])	V_k		50 to 80	V

[1]) For cathode modulation all voltages measured with respect to grid No.1.

7Z2 5861

LIMITING VALUES (Absolute max. rating system)

Measured with respect to cathode

Final accelerator voltage	$V_{g_3,g_5}(\ell)$	max.	18	kV
		min.	12	kV
Focusing electrode voltage	V_{g_4}	max.	700	V
		min.	−700	V
Grid No.2 voltage	V_{g_2}	max.	700	V
		min.	300	V
Control grid voltage,				
negative	$-V_{g_1}$	max.	150	V
positive	V_{g_1}	max.	0	V
Focusing electrode current	I_{g_4}	max.	+25 to −25	μA
Grid No.2 current	I_{g_2}	max.	+15 to −15	μA
Cathode to heater voltage, cathode positive	$V_{+k/f-}$	max.	200	V
	$V_{+k/f-p}$	max.	300	V
cathode negative	$V_{-k/f+}$	max.	125	V
	$V_{-k/f+p}$	max.	250	V
Resistance between heater and cathode	R_{kf}	max.	1	MΩ
Resistance between cathode and earth	R_k	max.	1.5	MΩ
Impedance between heater and cathode (f = 50 Hz)	Z_{kf}	max.	100	kΩ
Impedance between cathode and earth (f = 50 Hz)	Z_k	max.	500	kΩ

7Z2 5862

RADAR CATHODE-RAY TUBE

The F41-10LC is a 41 cm diameter radar tube with metal backed, very long persistence screen.

QUICK REFERENCE DATA	
Final accelerator voltage	16 kV
Deflection angle	50 ^{o}
Focusing	low voltage electrostatic

SCREEN

Metal backed

Colour	orange
Persistence	very long
Useful screen diameter	368 mm

HEATING:

Indirect by A.C. or D.C.; parallel or series supply

Heater voltage	V_f	=	6.3	V
Heater current	I_f	=	300	mA

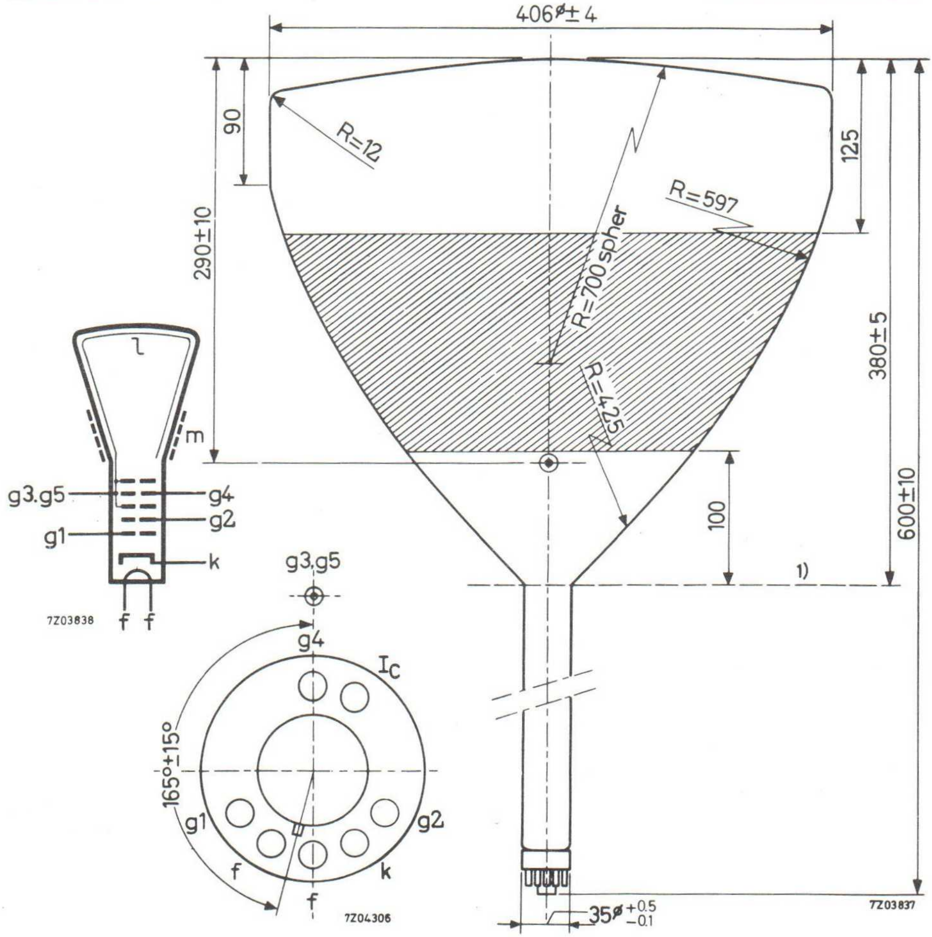
CAPACITANCES

Control grid to all other elements	C_{g_1}	<	10	pF
Cathode to all other elements	C_k	<	6	pF
Final accelerator to external conductive coating	$C_{g_3, g_5/m}$		1500	pF

7Z2 5863

MECHANICAL DATA

Dimensions in mm



Mounting position: any

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

Base: B12A

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1) Reference line. Point at which 36 mm diameter ring gauge is stopped.

2) Effective centre of deflection.

7Z2 5864

MECHANICAL DATA (continued)

Dimensions and connections

Overall length	max.	610	mm
Face diameter	max.	410	mm
Net weight:	approx.	11.3	kg

Accessories

Final accelerator contact connector	type	55563

EXTERNAL CONDUCTIVE COATING

This tube has an external conductive coating-m- and the capacitance of this to the final accelerator may be used to provide smoothing for the e.h.t. supply.

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 16 kV.

FOCUSING low voltage electrostatic

DEFLECTION double magnetic

deflection angle 50^{o}

TYPICAL OPERATING CONDITIONS

Final accelerator voltage	$V_{g_3,g_5(\ell)}$	16	kV
Focusing electrode voltage	V_{g_4}	approx. 300	V
Grid No.2 voltage	V_{g_2}	500	V
Grid No.1 voltage for visual extinction of a focused spot	V_{g_1}	-50 to -80	V

7Z2 5865

LIMITING VALUES (Absolute max. rating system)

Measured with respect to cathode

Final accelerator voltage	$V_{g3,g5(\ell)}$	max. min.	18 12	kV kV
Focusing electrode voltage	V_{g4}	max. min.	700 -700	V V
Grid No.2 voltage	V_{g2}	max. min.	700 300	V V
Control grid voltage,				
negative	$-V_{g1}$	max.	150	V
positive	V_{g1}	max.	0	V
Focusing electrode current	I_{g4}	max.	+25 to -25	μA
Grid No.2 current	I_{g2}	max.	+15 to -15	μA
Cathode to heater voltage,				
cathode positive	$V_{+k/f-}$ $V_{+k/f-p}$	max. max.	200 300	V V
cathode negative	$V_{-k/f+}$ $V_{-k/f+p}$	max. max.	125 250	V V
Resistance between heater and cathode	R_{kf}	max.	1	MΩ
Resistance between cathode and earth	R_k	max.	1.5	MΩ
Impedance between heater and cathode (f = 50 Hz)	Z_{kf}	max.	100	kΩ
Impedance between cathode and earth (f = 50 Hz)	Z_k	max.	500	kΩ

7Z2 5866

RADAR CATHODE-RAY TUBE

The F41-11LC is a 41 cm diameter radar tube with metal backed very long persistence screen.

QUICK REFERENCE DATA	
Final accelerator voltage	25 kV
Deflection angle	50 o
Focusing	magnetic
Cathode drive (from spot cut-off)	40 V

SCREEN

Metal backed

Colour	orange
Persistence	very long
Useful screen diameter	368 mm

HEATING

Indirect by A.C. or D.C.; parallel or series supply

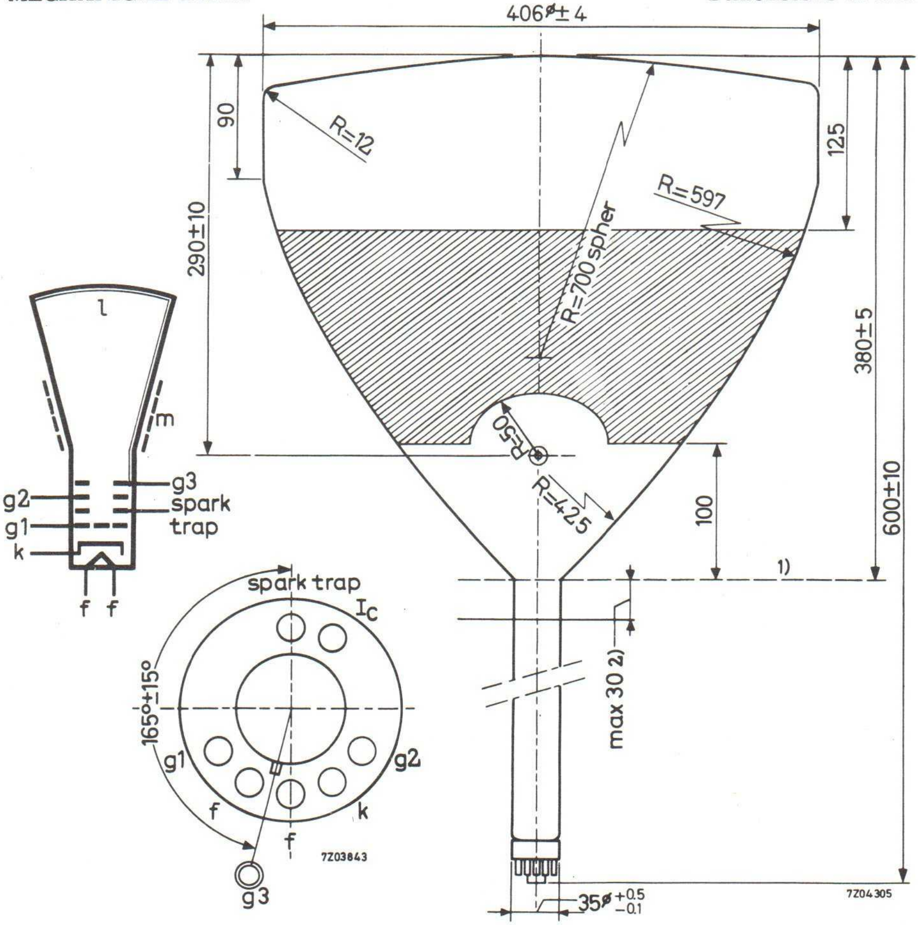
Heater voltage	V_f	=	6.3	V
Heater current	I_f	=	300	mA

CAPACITANCES

Control grid to all other elements	C_{g_1}	<	6	pF
Cathode to all other elements	C_k	<	4.5	pF
Final accelerator to external conductive coating	$C_{g_3/m}$		2000	pF

7Z2 5867

MECHANICAL DATA Dimensions in mm



Mounting position: any

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

Base: B12A

Dimensions and connections

Overall length	max. 610 mm
Face diameter	max. 410 mm

1) Reference line. Point at which 36 mm diameter ring gauge is stopped.

2) Effective distance from the deflection centre to the reference line.

7Z2 5868

MECHANICAL DATA (continued) Dimensions in mm

Net weight: approx. 11.3 kg

Accessories

Final accelerator contact connector	type	55563
Focusing magnet	type	55567

EXTERNAL CONDUCTIVE COATING

This tube has an external conductive coating -m- and the capacitance of this to the final accelerator may be used to provide smoothing for the e.h.t. supply.

FOCUSING magnetic

DEFLECTION double magnetic

deflection angle 50°

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 16 kV.

TYPICAL OPERATING CONDITIONS

Final accelerator voltage	$V_{g_3(\ell)}$	25	kV
Grid No. 2 voltage	V_{g_2}	120 to 300	V
Cathode voltage for visual extinction of a focused raster [1]	V_k	40	V

[1]) For cathode modulation all voltages measured with respect to grid No. 1

7Z2 5869

LIMITING VALUES (Absolute max. rating system)

Measured with respect to cathode

Final accelerator voltage	$V_{g3(\ell)}$	max.	27	kV
Grid No.2 voltage	V_{g2}	max.	400	V
Control grid voltage				
negative	$-V_{g1}$	max.	150	V
positive	V_{g1}	max.	0	V
Grid No.2 current	I_{g2}	max.	+15 to −15	μA
Cathode to heater voltage,				
cathode positive	$V_{+k/f-}$	max.	200	V
	$V_{+k/f-p}$	max.	300	V
cathode negative	$V_{-k/f+}$	max.	125	V
	$V_{-k/f+p}$	max.	250	V
Resistance between heater and cathode	R_{kf}	max.	1	MΩ
Resistance between cathode and earth	R_k	max.	1.5	MΩ
Impedance between heater and cathode (f = 50 Hz)	Z_{kf}	max.	100	kΩ
Impedance between cathode and earth (f = 50 Hz)	Z_k	max.	500	kΩ

7Z2 5870

RADAR CATHODE-RAY TUBE

The AL13-36 is a 16 cm diameter radar tube with metal backed long persistence screen. The tube is suitable for small boat radar.

QUICK REFERENCE DATA	
Final accelerator voltage	12 kV
Deflection angle	53 °
Focusing	Low voltage electrostatic

SCREEN

Metal backed

Colour	orange
Persistence	long
Useful screen diameter	108 mm

HEATING

Indirect by A.C. or D.C.; parallel or series supply

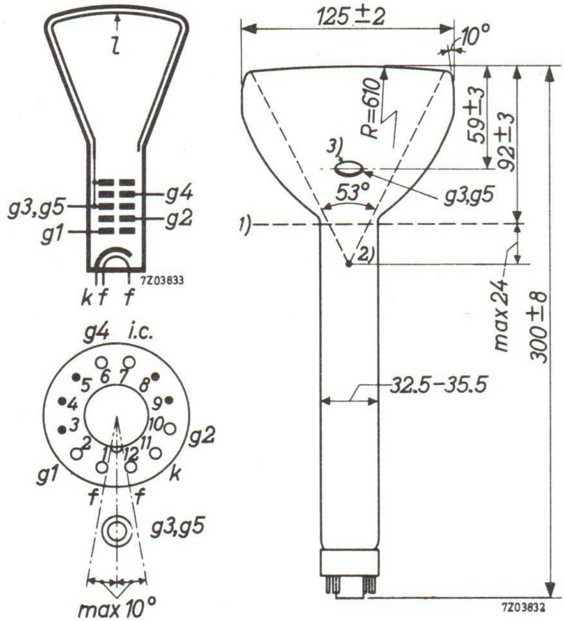
Heater voltage	V_f	=	6.3	V
Heater current	I_f	=	300	mA

CAPACITANCES

Control grid to all other elements	C_{g_1}	<	8	pF
Cathode to all other elements	C_k	<	8	pF

7Z2 5871

MECHANICAL DATA Dimensions in mm



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.

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

Base: B12A

Dimensions and connections

Overall length	max.	308	mm
Face diameter	max.	127	mm
Net weight:	approx.	0.5	kg

Accessories

Final accelerator contact connector	type	55560

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1) Reference line, determined by the point at which a ring gauge of 36 mm diameter is stopped.
2) Effective centre of deflection.
3) CT7 Recessed ball contact.

7Z2 5872

EXTERNAL CONDUCTIVE COATING

This tube has an external conductive coating -m- and the capacitance of this to the final accelerator may be used to provide smoothing for the e.h.t. supply.

FOCUSING Low voltage electrostatic

DEFLECTION double magnetic

deflection angle 53°

TYPICAL OPERATING CONDITIONS

Final accelerator voltage	$V_{g3,g5(\ell)}$	12	kV
Focusing electrode voltage	V_{g4}	-200 to +200	V [1]
Grid No.2 voltage	V_{g2}	300	V
Grid No.1 voltage for visual extinction of a focused spot	V_{g1}	-30 to -70	V

LIMITING VALUES (Absolute max. rating system)

Measured with respect to cathode

Final accelerator voltage	$V_{g3,g5(\ell)}$	max.	14	kV
		min.	8	kV
Focusing electrode voltage	V_{g4}	max.	500	V
		min.	-500	V
Grid No.2 voltage	V_{g2}	max.	500	V
		min.	200	V
Control grid voltage,				
negative	$-V_{g1}$	max.	150	V
positive	V_{g1}	max.	0	V
Focusing electrode current	I_{g4}	max.	+15 to -15	μA
Grid No.2 current	I_{g2}	max.	+15 to -15	μA

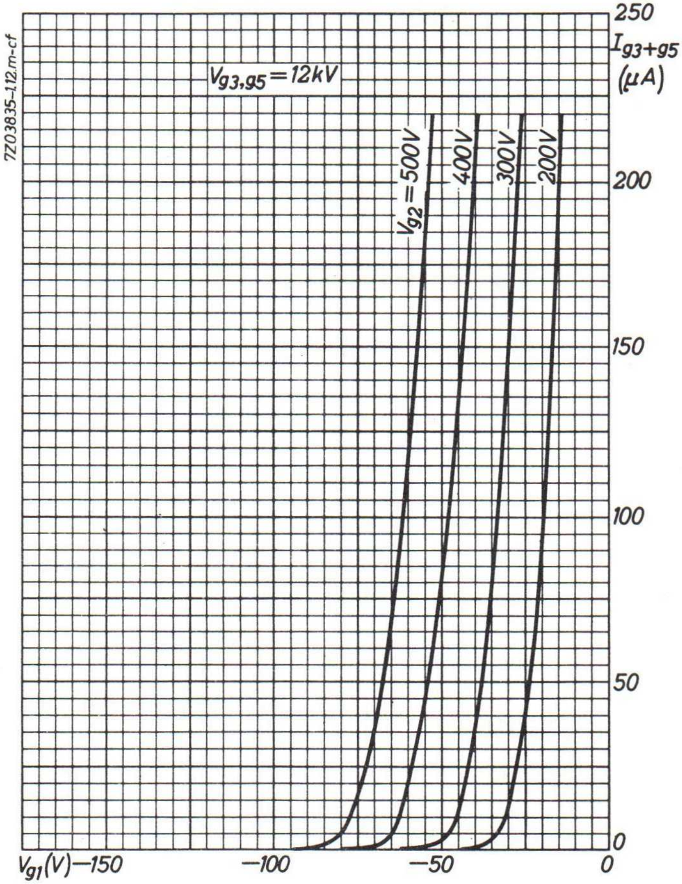
[1] With the small change in focus spotsize with variations of focus voltage the limit of -200 to +200 is such that an acceptable focus quality is obtained within this range. If it is required to pass through the point of focus a voltage of at least -300 V to +300 V will be required.

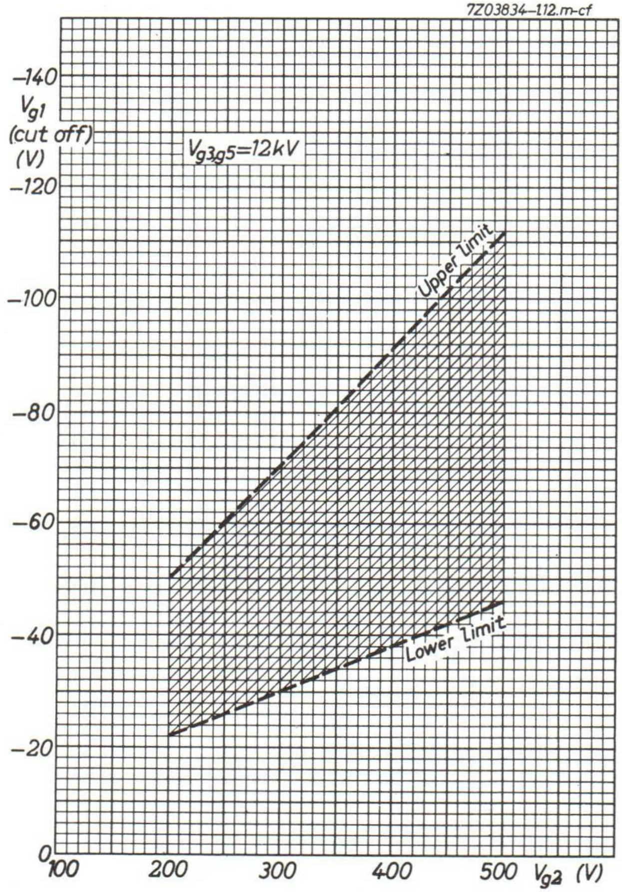
7Z2 5873

LIMITING VALUES (Absolute max. rating system) (continued)

Cathode to heater voltage,				
cathode positive	$V_{+k/f-}$	max.	200	V
	$V_{+k/f-p}$	max.	300	V
cathode negative	$V_{-k/f+}$	max.	125	V
	$V_{-k/f+p}$	max.	250	V
Resistance between heater and cathode	R_{kf}	max.	1	MΩ
Resistance between cathode and earth	R_k	max.	1.5	MΩ
Impedance between heater and cathode (f = 50 Hz)	Z_{kf}	max.	100	kΩ
Impedance between cathode and earth (f = 50 Hz)	Z_k	max.	500	kΩ

7Z2 5874


7Z03835-1.12.m-cf
$V_{g3,g5}$ = 12kV
V_{g2} = 500V
400V
300V
200V
250
I_{g3+g5} (µA)
200
150
100
50
0
V_{g1}(V) −150
−100
−50
0


7Z03834-1.12.m-cf
V_{g1}
(cut off)
(V)
V_{g3g5}=12kV
Upper Limit
Lower Limit
-140
-120
-100
-80
-60
-40
-20
0
100
200
300
400
500
V_{g2} (V)

RADAR CATHODE-RAY TUBE

The AL22-10 is a 22 cm diameter radar tube with metal-backed long persistence screen. The tube is designed for medium range radar receivers.

QUICK REFERENCE DATA	
Final accelerator voltage	12 kV
Deflection angle	58 °
Focusing	low voltage electrostatic

SCREEN

Metal backed

Colour	orange
Persistence	long
Useful screen diameter	200 mm

HEATING

Indirect by A.C. or D.C.; parallel or series supply

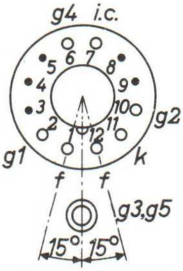
Heater voltage	V_f	=	6.3	V
Heater current	I_f	=	300	mA

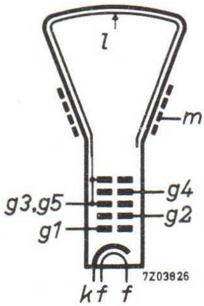
CAPACITANCES

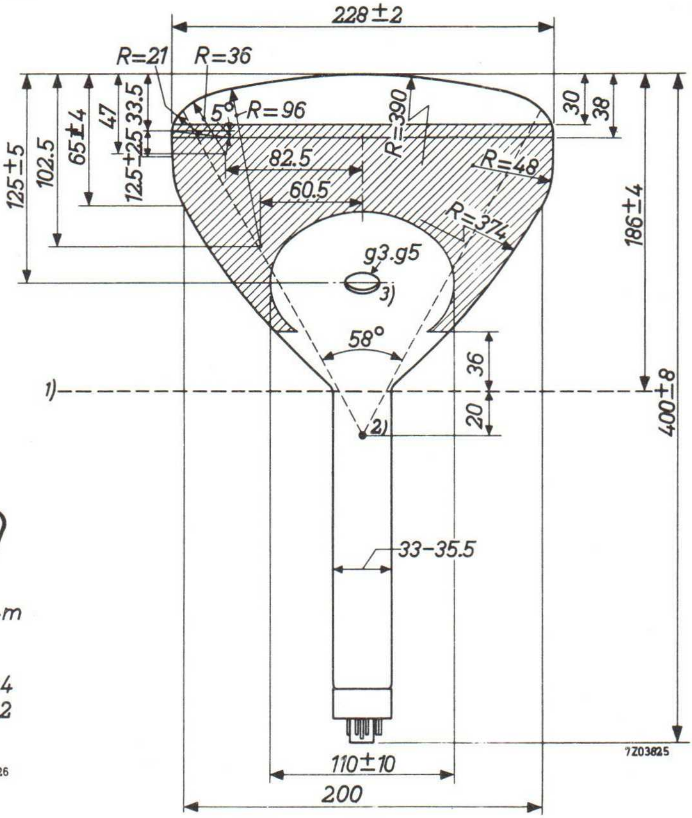
Control grid to all other elements	C_{g_1}	<	8	pF
Cathode to all other elements	C_k	<	8	pF
Final accelerator to external conductive coating	$C_{g_3,g_5/m}$		700	pF

7Z2 5875

MECHANICAL DATA Dimensions in mm







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

Base B12A

[1]) Reference line. Point at which 36 mm diameter ring gauge is stopped
[2]) Effective centre of deflection
[3]) CT8 cavity connector

7Z2 5876

MECHANICAL DATA (continued)

Dimensions and connections

Overall length	max.	408	mm
Face diameter	max.	230	mm
Net weight:	approx.	2.8	kg

Accessories

Final accelerator contact connector	type	55563

EXTERNAL CONDUCTIVE COATING

This tube has an external conductive coating -m- and the capacitance of this to the final accelerator may be used to provide smoothing for the e.h.t. supply.

FOCUSING low voltage electrostatic

DEFLECTION double magnetic

deflection angle 58 °

TYPICAL OPERATING CONDITIONS

Final accelerator voltage	$V_{g_3,g_5(\ell)}$	12	kV
Focusing electrode voltage	V_g	-200 to +200	V [1]
Grid No.2 voltage	V_{g_2}	300	V
Grid No.1 voltage for visual extinction of a focused spot	V_{g_1}	-30 to -70	V

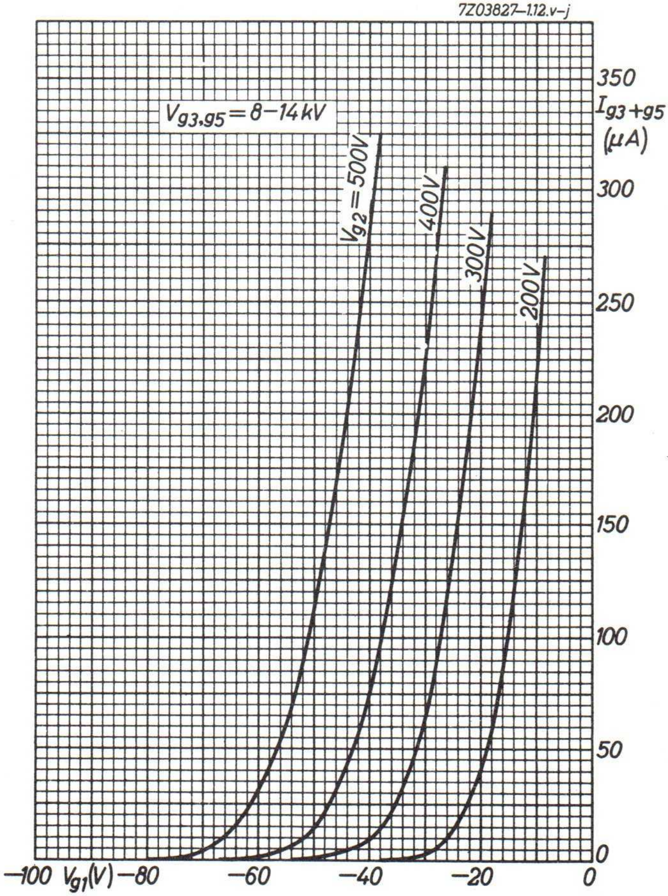
[1]) With the small change in focus spotsize with variations of focus voltage the limit of -200 to +200 is such that an acceptable focus quality is obtained within this range. If it is required to pass through the point of focus a voltage of at least -300 V to +300 V will be required. 7Z2 5877

LIMITING VALUES (Absolute max. rating system)

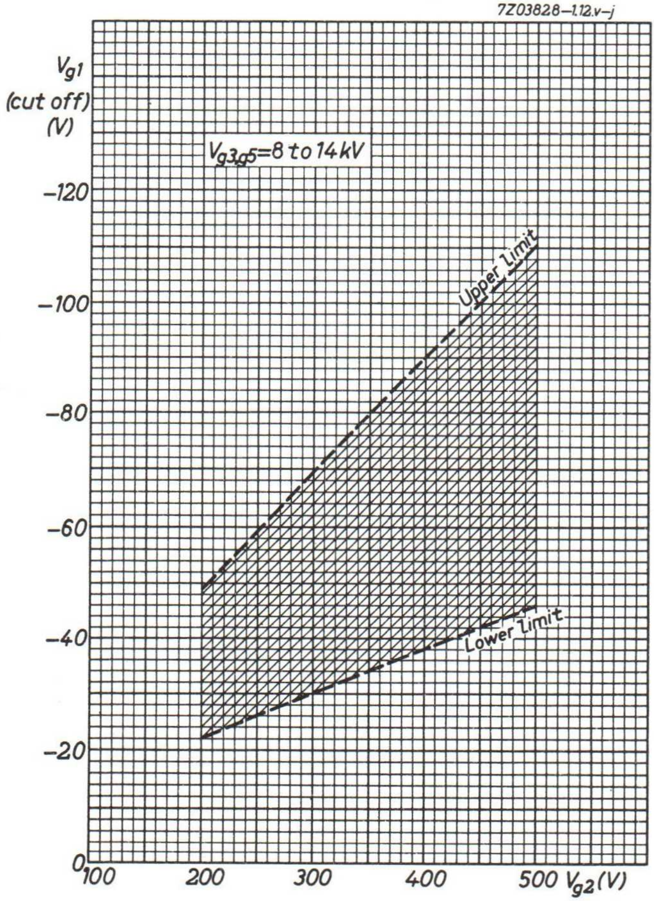
Measured with respect to cathode

Final accelerator voltage	$V_{g_3,g_5(\ell)}$	max.	14	kV
		min.	8	kV
Focusing electrode voltage	V_{g_4}	max.	500	V
		min.	-500	V
Grid No. 2 voltage	V_{g_2}	max.	500	V
		min.	200	V
Control grid voltage,				
negative	$-V_{g_1}$	max.	150	V
positive	V_{g_1}	max.	0	V
Focusing electrode current	I_g	max.	+15 to -15	μA
Grid No. 2 current	I_{g_2}	max.	+15 to -15	μA
Cathode to heater voltage, cathode positive	$V_{+k/f-}$	max.	200	V
	$V_{+k/f-p}$	max.	300	V
cathode negative	$V_{-k/f+}$	max.	125	V
	$V_{-k/f+}$	max.	250	V
Resistance between heater and cathode	R_{kf}	max.	1	MΩ
Resistance between cathode and earth	R_k	max.	1.5	MΩ
Impedance between heater and cathode (f = 50 Hz)	Z_{kf}	max.	100	kΩ
Impedance between cathode and earth (f = 50 Hz)	Z_k	max.	500	kΩ

7Z2 5878



7Z03827–1.12.v–j
$V_{g3,g5}$ = 8–14 kV
V_{g2} = 500V
400V
300V
200V
350
I_{g3+g5}
(µA)
300
250
200
150
100
50
0
–100
V_{g1}(V)
–80
–60
–40
–20
0


7Z03828—1.12.v—j
V_{g1}
(cut off)
(V)
$V_{g3,g5}$=8 to 14 kV
−120
−100
−80
−60
−40
−20
0
Upper Limit
Lower Limit
100
200
300
400
500 V_{g2} (V)

RADAR CATHODE-RAY TUBE

The AL31-10 is a 31 cm diameter radar tube with long persistence screen, and low voltage electrostatic focusing lens.

QUICK REFERENCE DATA	
Final accelerator voltage	12 kV
Deflection angle	50°
Focusing	low voltage electrostatic

SCREEN

Metal backed

Colour	orange
Persistence	long
Useful screen diameter	265 mm

HEATING

Indirect by A.C. or D.C.; parallel or series supply

Heater voltage	V_f	6.3	V
Heater current	I_f	300	mA

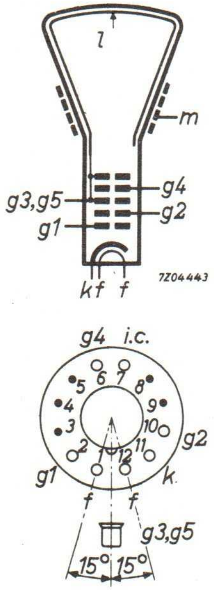
CAPACITANCES

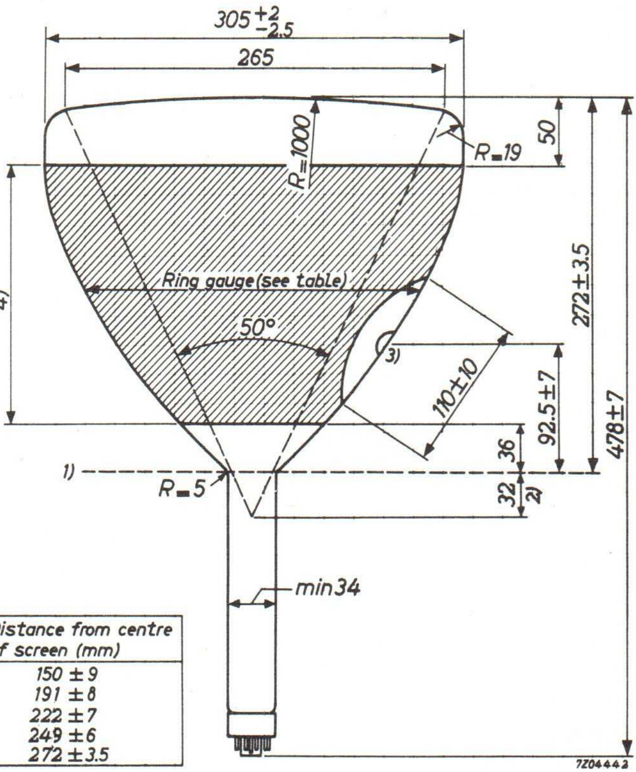
Control grid to all other elements	C_{g_1}	max.	8	pF
Cathode to all other elements	C_k	max.	8	pF
Final accelerator to external conductive coating	$C_{g_3,g_5/m}$		1200	pF

7Z2 6379

MECHANICAL DATA

Dimensions in mm





Ring gauge (mm)	Distance from centre of screen (mm)
230	150 ± 9
180	191 ± 8
130	222 ± 7
80	249 ± 6
36.1	272 ± 3.5

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

Base	Duodecal 7 p
Dimensions and connections	
Overall length	max. 485 mm
Face diameter	max. 307 mm

1) Reference line, determined by the point at which a ring gauge of 36 mm diameter is stopped
2) Distance from reference line to effective centre of deflection
3) Cavity contact CT8
4) Approx. limits of aquadag coating

7Z2 6380

MECHANICAL DATA (continued)

Accessories

Socket	type	5912/20
Final accelerator contact connector	type	55563

FOCUSING low voltage electrostatic

DEFLECTION double magnetic
deflection angle 50^{o}

TYPICAL OPERATING CONDITIONS

Final accelerator voltage	$V_{g_3,g_5(\ell)}$	12	kV
Focusing electrode voltage	V_{g_4}	−200 to +200	V [1])
Grid No. 2 voltage	V_{g_2}	300	V
Negative grid No. 1 voltage for visual extinction of a focused spot	$-V_{g_1}$	30 to 70	V

[1]) With the small change in focus spot size with variation of focus voltage the limit of −200 to +200 V is such that an acceptable focus quality is obtained within the range. If it is required to pass through the point of focus a voltage of at least −300 to +300 V will be required.

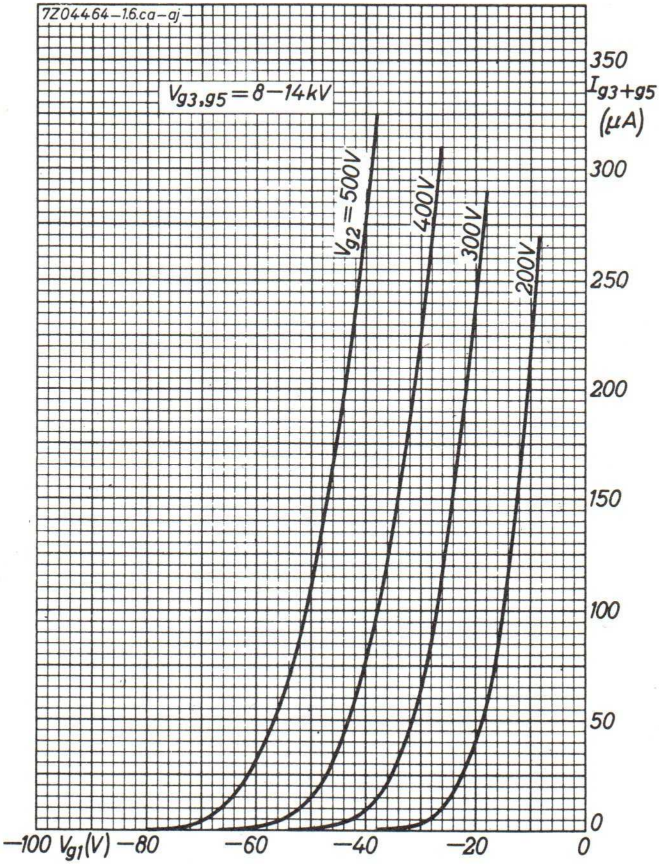
7Z2 6381

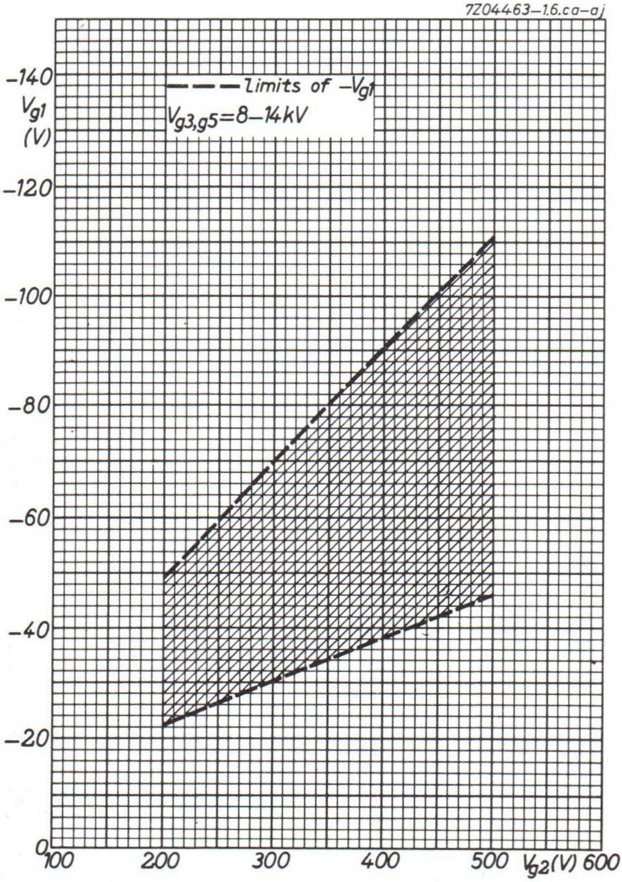
LIMITING VALUES (Absolute max. rating system)

Measured with respect to cathode

Final accelerator voltage	$V_{g_3,g_5(\ell)}$	max.	14	kV
		min.	8	kV
Focusing electrode voltage	V_{g_4}	max.	500	V
		min.	-500	V
Grid No. 2 voltage	V_{g_2}	max.	500	
		min.	200	
Control grid voltage,				
negative	$-V_{g_1}$	max.	200	V
		min	1	V
Focusing electrode current	I_{g_4}	max.	-15 to +15	μA
Cathode to heater voltage,				
cathode positive	$V_{+k/f-}$	max.	150	V
cathode negative	$V_{-k/f+}$	max.	150	V
Resistance between heater and cathode	R_{kf}	max.	1	MΩ
Resistance between grid and earth	R_{g_1}	max.	1.5	MΩ
Impedance between cathode and earth (f = 50 Hz)	Z_k	max.	100	kΩ

7Z2 6382


7Z04464–1.6.ca–aj
$V_{g3,g5}$ = 8–14 kV
V_{g2} = 500V
400V
300V
200V
350
I_{g3+g5}
(μA)
300
250
200
150
100
50
0
–100 V_{g1}(V) –80
–60
–40
–20
0


7Z04463–1.6.ca–aj
limits of $-V_{g1}$
$V_{g3,g5}$=8–14kV
V_{g1} (V)
–140
–120
–100
–80
–60
–40
–20
0
100
200
300
400
500
V_{g2}(V)
600

RADAR CATHODE-RAY TUBE

The MF13-1 is a 13 cm diameter radar tube with very long persistence screen. The tube is primarily intended for use in p.p.i. applications.

QUICK REFERENCE DATA	
Final accelerator voltage	7 kV
Deflection angle	53^{o}
Focusing	magnetic

SCREEN

Metal backed

Colour	orange
Persistence	very long
Useful screen diameter	108 mm

HEATING

Indirect by A.C. or D.C.; parallel or series supply

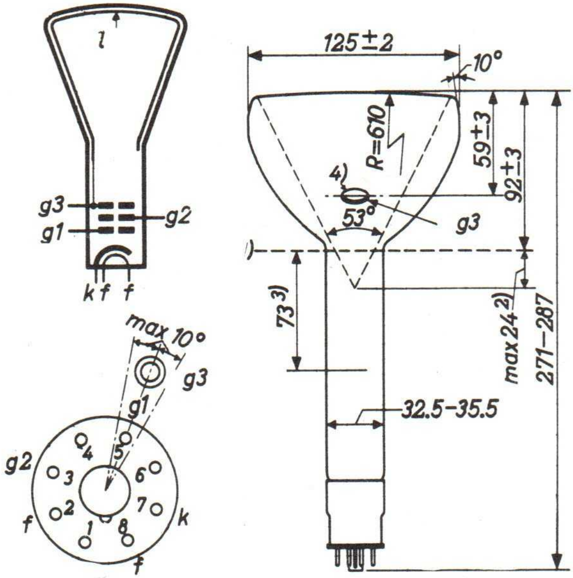
Heater voltage	V_f	6.3	V
Heater current	I_f	300	mA

CAPACITANCES

Control grid to all other elements	C_{g_1}	max.	10	pF
Cathode to all other elements	C_k	max.	10	pF

7Z2 6383

MECHANICAL DATA Dimensions in mm



Mounting position: any

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

Base	Octal		
Dimensions and connections			
Overall length	max.	287	mm
Face diameter	max.	127	mm
Net weight			kg
Accessories			
Final accelerator contact connector	type	55560	

---

1) Reference line determined by the point at which a ring gauge of 36 mm diameter is stopped.
2) Distance from reference line to effective centre of deflection.
3) Recommended distance from reference line to centre of magnetic lengths of focus unit.
4) Recessed ball contact CT7.

7Z2 6384

FOCUSING	magnetic
DEFLECTION	double magnetic deflection angle 53^o

TYPICAL OPERATING CONDITIONS

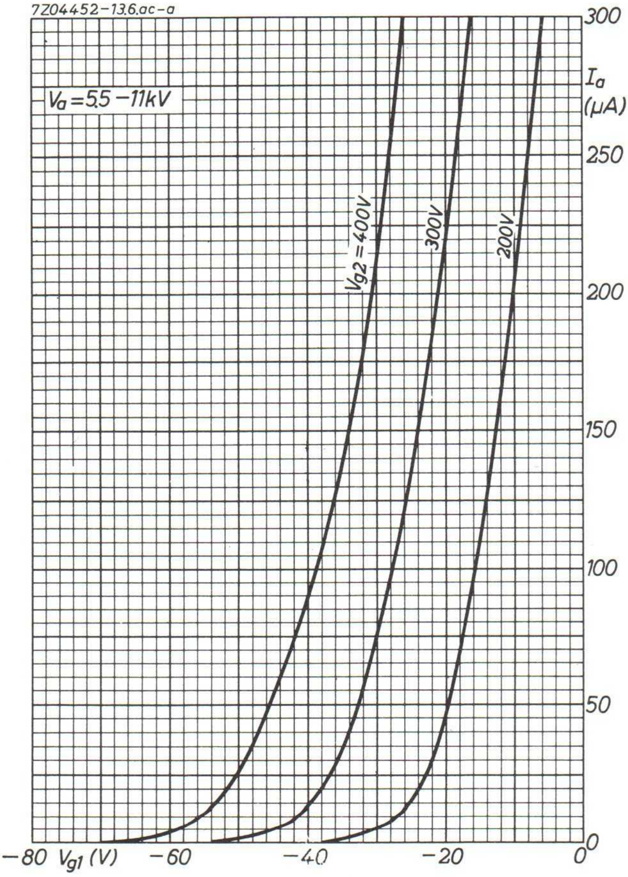
Final accelerator voltage	$V_{g_3(\ell)}$	7	kV
Grid No. 2 voltage	V_{g_2}	250	V
Negative control grid voltage for visual extinction of a focused spot	$-V_{g_1}$	28 to 63	V
Recommended distance from reference line to centre of magnetic length of focus unit		73	mm

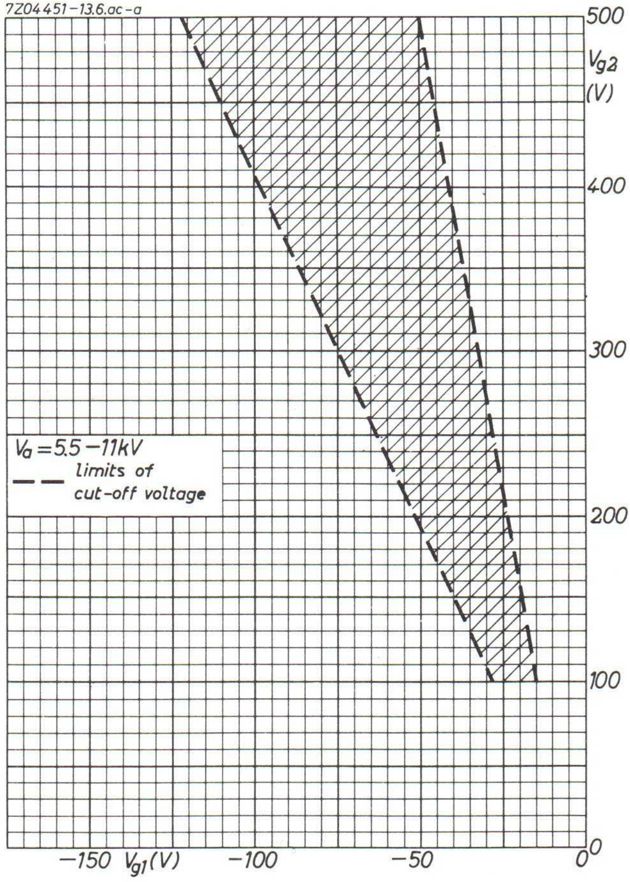
LIMITING VALUES (Absolute max. rating system)

Measured with respect to cathode

Final accelerator voltage	$V_{g_3(\ell)}$	max.	11	kV
		min.	5.5	kV
Grid No. 2 voltage	V_{g_2}	max.	500	V
		min.	200	V
Control grid voltage,				
negative	$-V_{g_1}$	max.	200	V
		min.	1	V
Cathode current	I_k	max.	150	μA
Cathode to heater voltage,				
cathode positive	$V_{+k/f-}$	max.	150	V
cathode negative	$V_{-k/f+}$	max.	150	V
Resistance between heater and cathode	R_{kf}	max.	1	MΩ
Resistance between grid and earth	R_{g_1}	max.	1.5	MΩ

7Z2 6385


7Z04452-13.6.ac-a
V_a = 5.5 − 11kV
V_{g2} = 400V
300V
200V
300
I_a
(μA)
250
200
150
100
50
0
−80 V_{g1} (V)
−60
−40
−20
0



7Z04451-13.6.ac-a
500
V_{g2}
(V)
400
300
200
100
0
$V_a = 5.5 - 11 kV$
limits of cut-off voltage
−150
V_{g1}(V)
−100
−50
0

RADAR CATHODE-RAY TUBE

The MF31-55 is a 31 cm diameter radar tube with very long persistence screen. The tube is primarily intended for P.P.I. applications.

QUICK REFERENCE DATA	
Final accelerator voltage	15 kV
Deflection angle	47°
Focusing	magnetic

SCREEN

Metal backed

Colour	orange
Persistence	very long
Useful screen diameter	min. 265 mm

HEATING

Indirect by A.C. or D.C.; parallel or series supply

Heater voltage	V_f	6.3	V
Heater current	I_f	300	mA

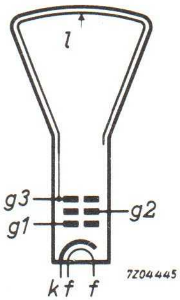
CAPACITANCES

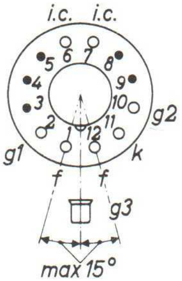
Control grid to all other elements	C_{g_1}	max.	8	pF
Cathode to all other elements	C_k	max.	8	pF

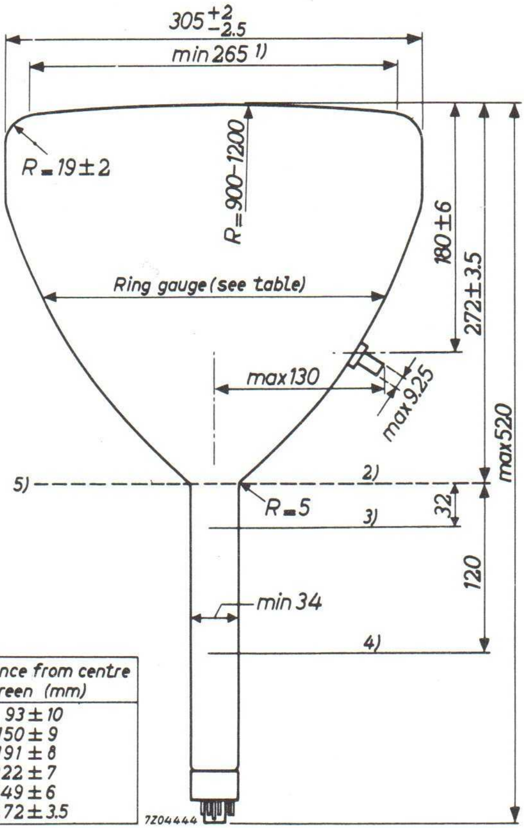
7Z2 6386

MECHANICAL DATA

Dimensions in mm







Ring gauge (mm)	Distance from centre of screen (mm)
280	93 ± 10
230	150 ± 9
180	191 ± 8
130	222 ± 7
80	249 ± 6
36.1	272 ± 3.5

Mounting position: any

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

Base	Duodecal 7 pins
Dimensions and connections	
Overall length	520 mm
Face diameter	307 mm

1) Useful screen diameter
2) Point at which 36.1 diameter ring gauge is stopped
3) Effective centre of deflection
4) Centre of magnetic length of focus unit
5) Reference line

7Z2 6387

FOCUSING magnetic

DEFLECTION double magnetic
deflection angle 47°

TYPICAL OPERATING CONDITIONS

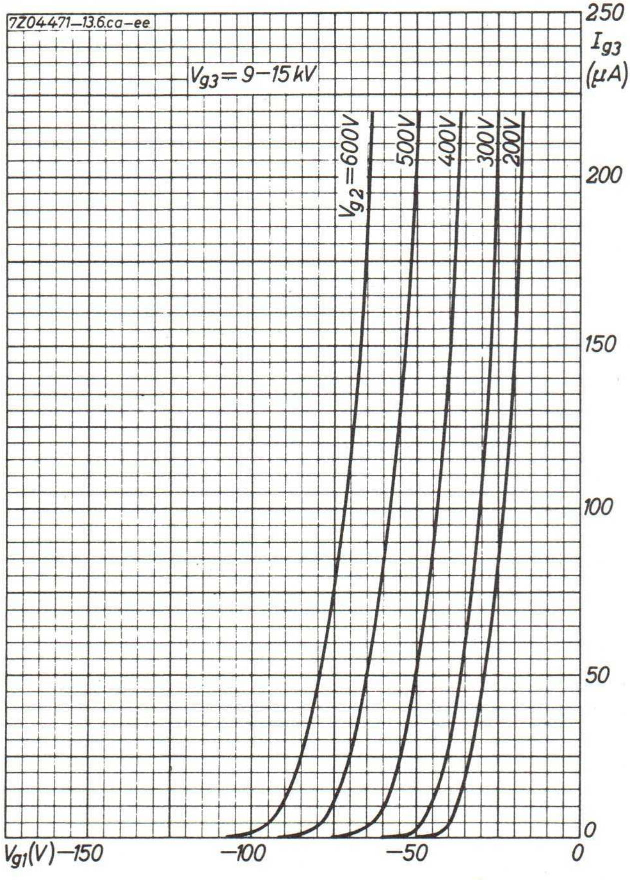
Final accelerator voltage	$V_{g_3}(\ell)$	15	kV
Grid No. 2 voltage	V_{g_2}	300	V
Negative control grid voltage for visual extinction of a focused spot	$-V_{g_1}$	30 to 90	V
Recommended distance of centre of magnetic length of focus unit from reference line		120	mm

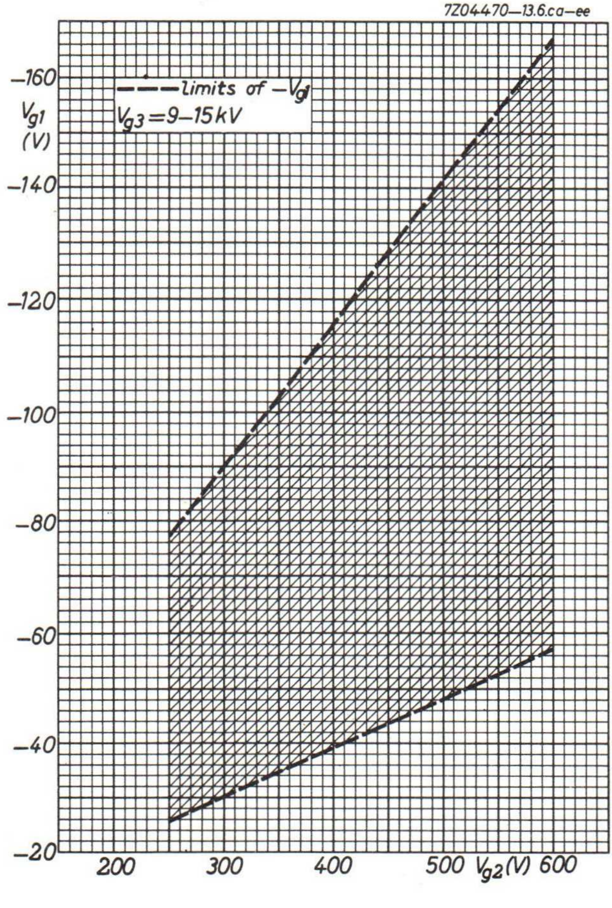
LIMITING VALUES (Absolute max. rating system)

Measured with respect to cathode

Final accelerator voltage	$V_{g_3}(\ell)$	max.	15.5	kV
		min.	9	kV
Grid No. 2 voltage	V_{g_2}	max.	600	V
		min.	250	V
Control grid voltage,				
negative	$-V_{g_1}$	max.	250	V
		min.	1	V
Cathode current	I_k	max.	150	μA
Cathode to heater voltage,				
cathode positive	$V_{+k/f-}$	max.	150	V
cathode negative	$V_{-k/f+}$	max.	150	V
Resistance between heater and cathode	R_{kf}	max.	1.5	MΩ
Resistance between cathode and earth	R_k	max.	1.0	MΩ

7Z2 6388


7Z04471—13.6.ca—ee
V_{g3} = 9—15 kV
V_{g2} = 600V
500V
400V
300V
200V
250
I_{g3}
(μA)
200
150
100
50
0
V_{g1}(V) —150
—100
—50
0


7Z04470—13.6.ca—ee
limits of $-V_{g1}$
V_{g3}=9–15 kV
V_{g1} (V)
–160
–140
–120
–100
–80
–60
–40
–20
200
300
400
500
V_{g2}(V)
600

RADAR CATHODE-RAY TUBE

The MF41-10 is a 41 cm diameter radar tube with very long persistence screen. The tube is primarily intended for p.p.i. applications.

QUICK REFERENCE DATA	
Final accelerator voltage	15 kV
Deflection angle	70^{o}
Focusing	magnetic

SCREEN

Metal backed

Colour	orange
Persistence	very long
Useful screen diameter	373 mm

HEATING

Indirect by A.C. or D.C.; parallel or series supply

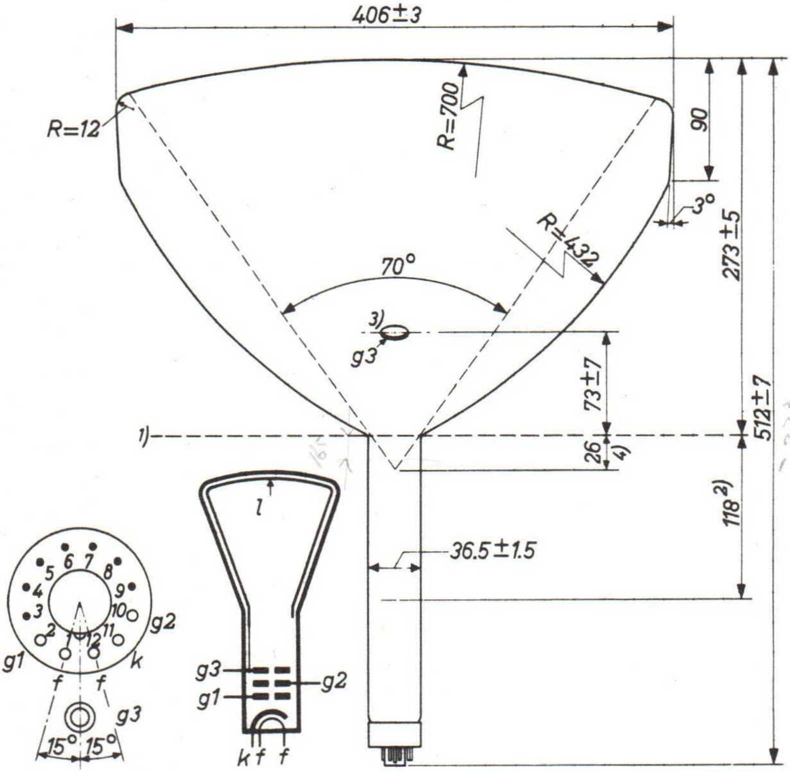
Heater voltage	V_f	6.3	V
Heater current	I_f	300	mA

CAPACITANCES

Control grid to all other elements	C_{g_1}	max.	8	pF
Cathode to all other elements	C_k	max.	8	pF
Final accelerator to external conductive coating	$C_{ag_3/m}$		1400	pF

7Z2 6389

MECHANICAL DATA Dimensions in mm



Mounting position: any

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

Base	Duodecal 5 p
Dimensions and connections	
Overall length	max. 518 mm
Face diameter	max. 409 mm

1) Reference line.

2) Recommended distance from reference line to centre of magnetic length of focusing unit.

3) Recessed cavity contact.

4) Distance from reference line to effective centre of deflection. 7Z2 6390

MECHANICAL DATA (continued)

Accessories

Socket	type
Final accelerator contact connector	type 55563

FOCUSING magnetic

DEFLECTION double magnetic

deflection angle 70°

TYPICAL OPERATING CONDITIONS

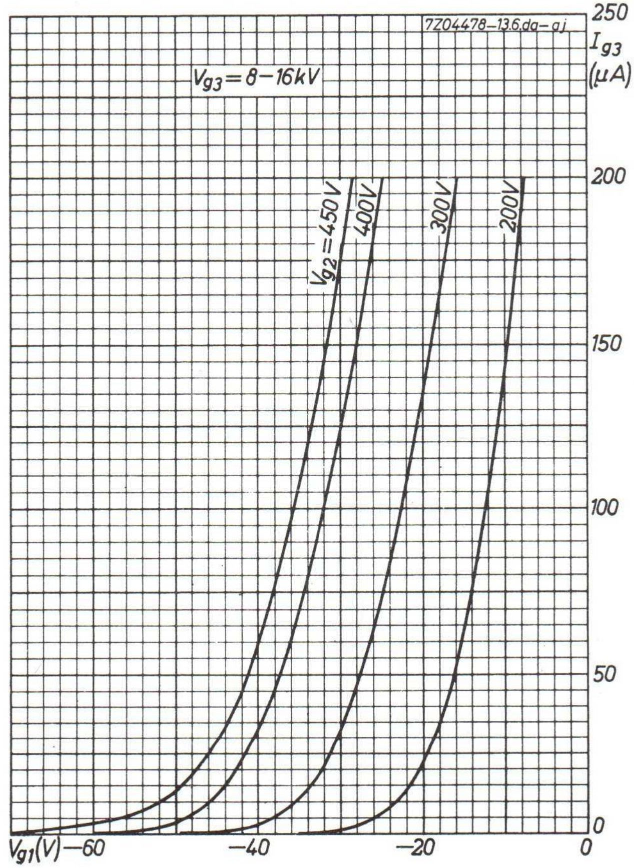
Final accelerator voltage	$V_{g_3(\ell)}$	15	kV
Grid No.2 voltage	V_{g_2}	300	V
Negative controll grid voltage for visual extinction of a focused spot	$-V_{g_1}$	30 to 70	V
Recommended distance of focus unit from reference line		118	mm

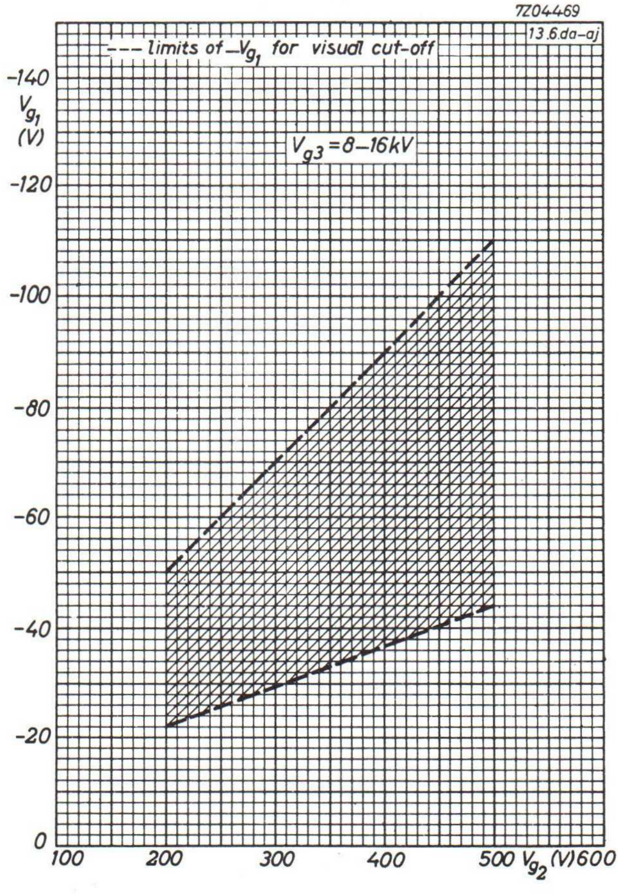
LIMITING VALUES (Absolute max. rating system)

Measured with respect to cathode

Final accelerator voltage	$V_{g_3(\ell)}$	max.	16	kV
		min.	8	kV
Grid No.2 voltage	V_{g_2}	max.	500	V
		min.	200	V
Control grid voltage, negative	$-V_{g_1}$	max.	200	V
		min.	1.0	V
Cathode heater voltage,				
cathode positive	$V_{+k/f-}$	max.	150	V
cathode negative	$V_{-k/f+}$	max.	150	V
Resistance between heater and cathode	R_{kf}	max.	1.5	MΩ
Resistance between cathode and earth	R_k	max.	1.0	MΩ
Impedance between cathode and earth (f = 50 Hz)	Z_k	max.	100	kΩ

7Z2 6391


7Z04478-13.6.da-aj
V_{g3}=8-16kV
250
I_{g3}
(μA)
200
150
100
50
0
V_{g2}=450V
400V
300V
200V
V_{g1}(V) -60
-40
-20
0


7Z04469
13.6.da-aj
--- limits of $-V_{g_1}$ for visual cut-off
V_{g3} = 8–16 kV
V_{g_1} (V)
-140
-120
-100
-80
-60
-40
-20
0
100
200
300
400
500
V_{g_2} (V)
600

PART 4

MONITOR TUBES

PREFERRED TYPES

TELEVISION STUDIO TUBES		
Monitor tubes		AW17-20 AW43-48 M21-11W M21-12W M36-11W M36-13W

MONITOR TUBE

21 cm rectangular television tube with metal-backed screen primarily intended for use as a precision monitor.

QUICK REFERENCE DATA	
Deflection angle	90 °
Focusing	electrostatic
Resolution	min. 650 lines
Overall length	max. 222 mm

SCREEN

Metal backed phosphor

Lumenescence	white
Useful diagonal	min. 195 mm
Useful width	min. 180 mm
Useful height	min. 135 mm

HEATING

Indirect by A.C. or D.C.; parallel supply

heater voltage	V_f =	11.5 V ± 10 %
heater current	I_f =	60 mA

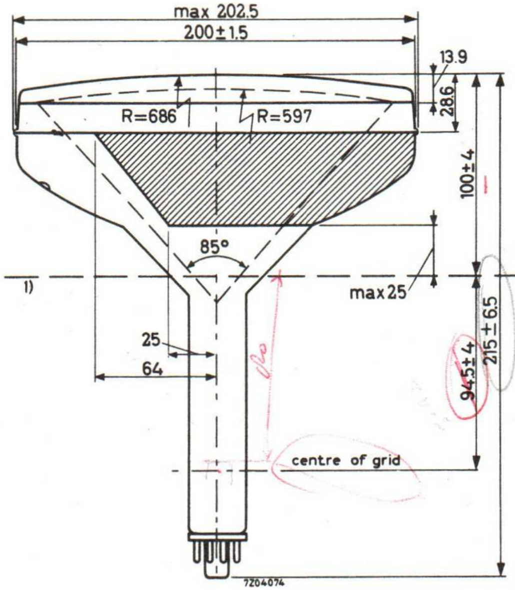
CAPACITANCES

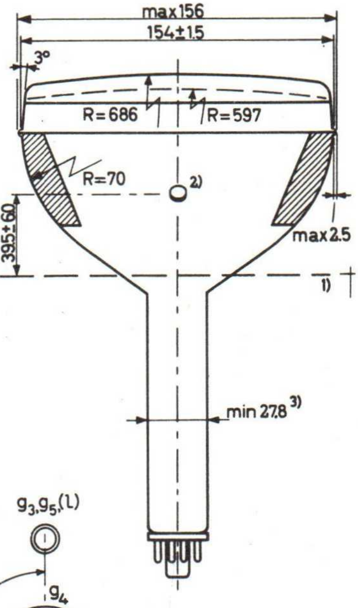
Final accelerator to external conductive coating	$C_{a,g_3,g_5/m}$	=	max. 9.0 pF
Cathode to all other elements	C_k	=	5.0 pF
Grid No. 1 to all other elements	C_{g_1}	=	375 pF

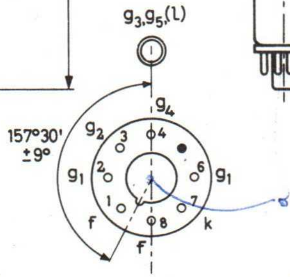
7Z2 6117

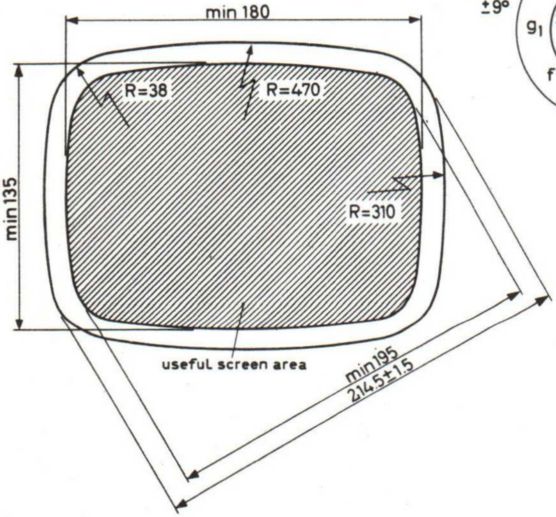
MECHANICAL DATA

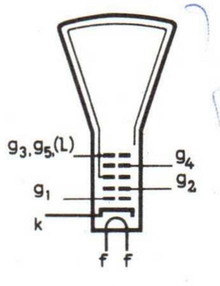
Dimensions in mm











Mounting position: any

Except vertical with the screen downward and the axis of the tube making an angle of less than 20 ° with the vertical.

7Z2 6118

MECHANICAL DATA (continued)

Base: Neo Eightar (B8H)

Accessories

Socket

Final accelerator connector type 55563

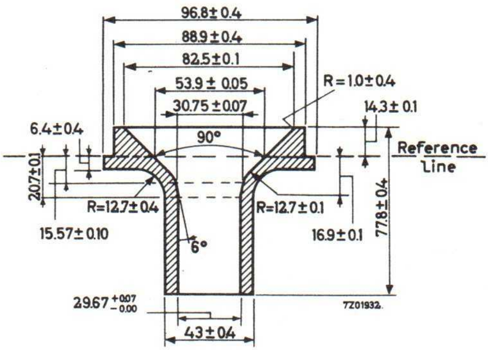
FOCUSING electrostatic

The range of focus voltage shown under "Typical operating conditions" results in optimum focus at a beam current of 100 μA.

DEFLECTION magnetic

Diagonal deflection angle 90^{o}

REFERENCE LINE GAUGE Dimensions in mm



TYPICAL OPERATING CONDITIONS

Final accelerator voltage	$V_{g_3, g_5(\ell)}$	=	12	kV
Focusing electrode voltage	V_{g_4}	=	0 to 400	V
First accelerator voltage	V_{g_2}	=	400	V
Grid No.1 voltage for visual extinction of focused raster (grid drive service)	$-V_{g_1}$	=	32 to 69	V
Cathode voltage for visual extinction of focused raster (cathode drive service)	V_k	=	29 to 62	V

1) Reference line
2) Cavity contact CT8
3) The maximum dimension is determined by the reference line gauge

7Z2 6119

RESOLUTION

Resolution at screen centre			min.	650	lines
Measured at:	$V_{g_3, g_5(\ell)}$	=		12	kV
	V_{g_2}	=		400	V

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

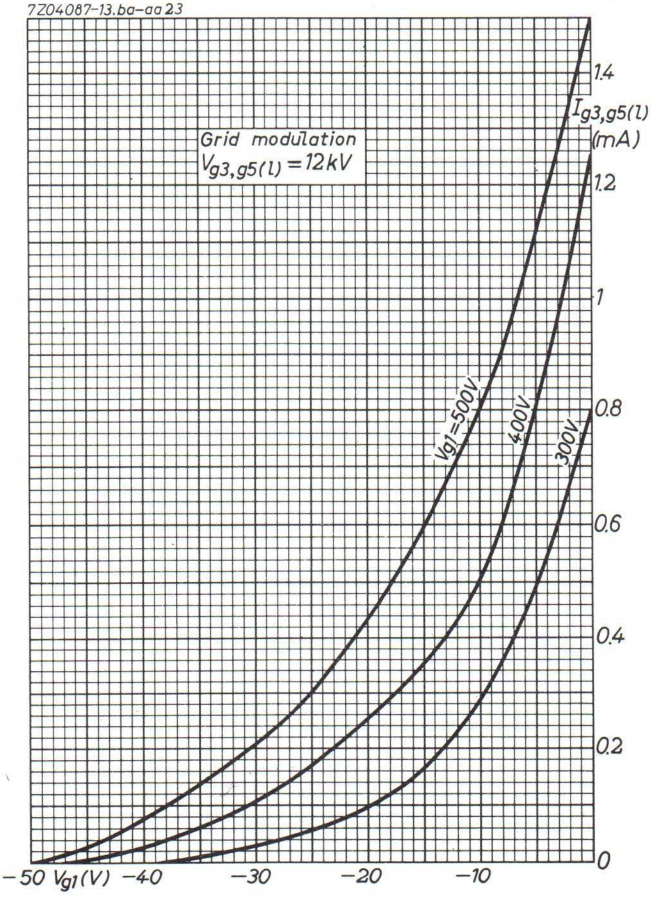
LIMITING VALUES (Absolute max. rating system)

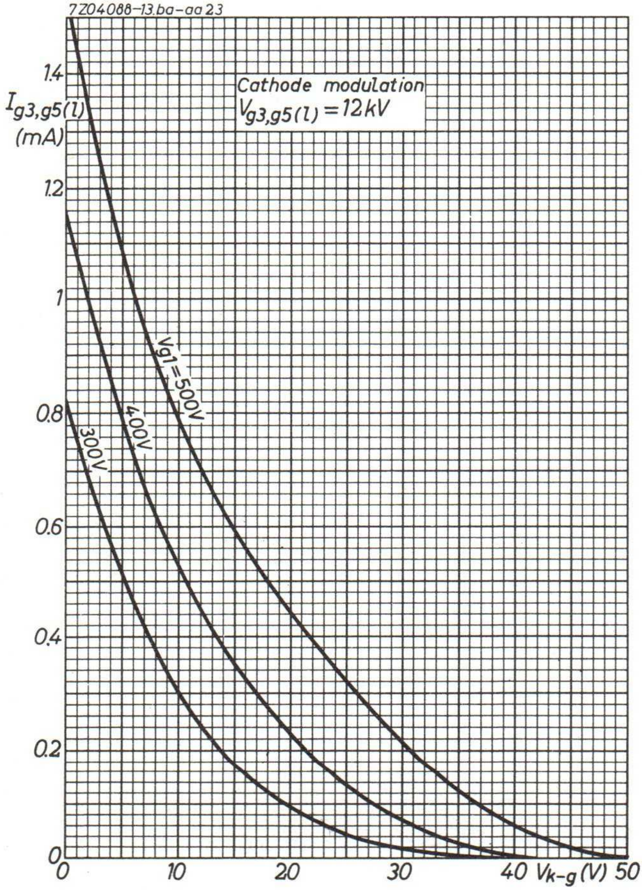
Final accelerator voltage	$V_{g_3, g_5(\ell)}$	=	max.	16	kV
		=	min.	9	kV
Focus voltage					
positive	V_{g_4}	=	max.	1000	V
negative	$-V_{g_4}$	=	max.	500	V
First accelerator voltage	V_{g_2}	=	~~min.~~ max.	800	V
Grid No.1 voltage					
positive	V_{g_1}	=	max.	0	V
positive peak	$V_{g_{1p}}$	=	max.	2	V
negative	$-V_{g_1}$	=	max.	180	V
Cathode to heater voltage					
positive	V_{k-f}	=	max.	80	V
positive peak	V_{k-f_p}	=	max.	130	V
Focusing electrode current	I_{g_4}	=	max.	±25	μA
Accelerator current	I_{g_2}	=	max.	± 5	μA

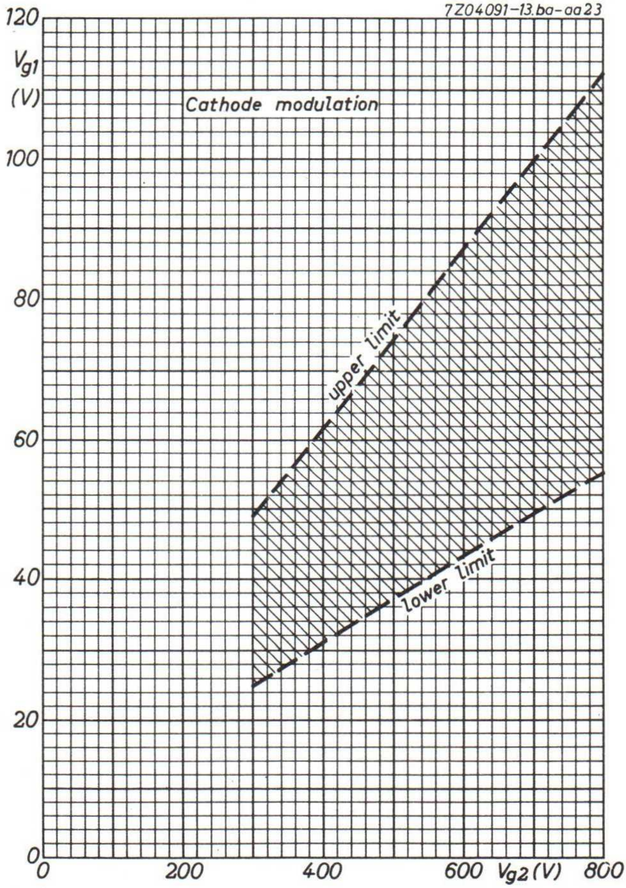
MAXIMUM CIRCUIT VALUES

Resistance between cathode and heater	$R_{k/f}$	=	max.	1	MΩ
Impedance between cathode and heater	$Z_{k/f}$ (50 Hz)	=	max.	500	kΩ
Impedance between cathode and earth	Z_k (50 Hz)	=	max.	100	kΩ
Grid No.1 circuit resistance	R_{g_1}	=	max.	1.5	MΩ
Grid No.1 circuit impedance	Z_{g_1} (50 Hz)	=	max.	500	kΩ
Accelerator circuit resistance	R_{g_2}	=	max.	1	MΩ
Focusing electrode circuit resistance	R_{g_4}	=	max.	3	MΩ

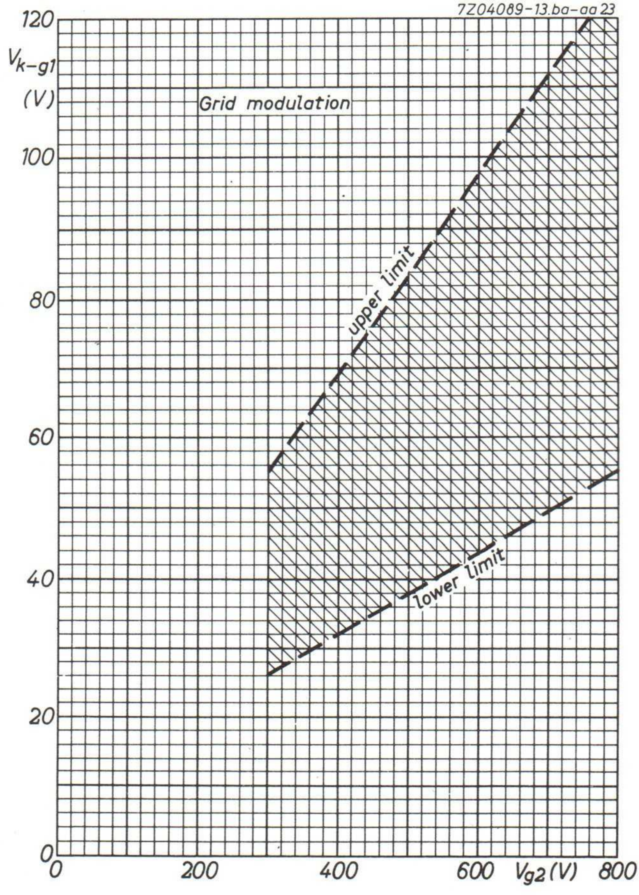
7Z2 6120

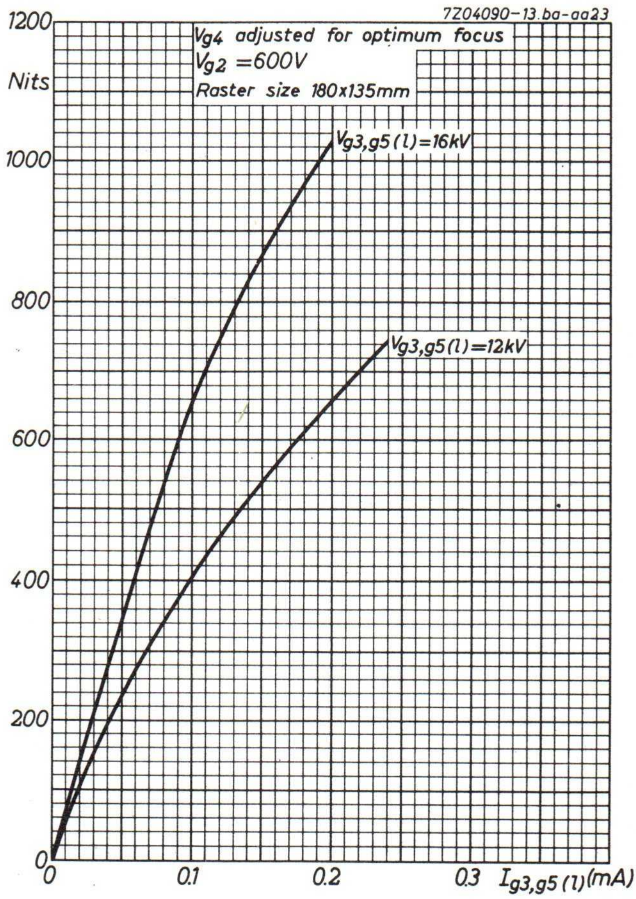

7Z04087-13.ba-aa 23
Grid modulation
$V_{g3,g5(l)} = 12 kV$
$I_{g3,g5(l)}$
(mA)
1.4
1.2
1
0.8
0.6
0.4
0.2
0
V_{g1}=500V
400V
300V
−50 V_{g1}(V) −40
−30
−20
−10


7Z04088-13.ba-aa 23
Cathode modulation
$V_{g3,g5(l)} = 12\,kV$
$I_{g3,g5(l)}$ (mA)
1.4
1.2
1
0.8
0.6
0.4
0.2
0
$V_{g1} = 500V$
400V
300V
0
10
20
30
40
V_{k-g} (V)
50



7Z04091-13.ba-aa23
120
V_{g1}
(V)
Cathode modulation
100
80
60
40
20
0
0
200
400
600
V_{g2} (V)
800
upper limit
lower limit


7Z04089-13.ba-aa 23
120
V_{k-g1}
(V)
Grid modulation
100
80
upper limit
60
40
lower limit
20
0
0
200
400
600
V_{g2} (V)
800



7Z04090-13.ba-aa23
V_{g4} adjusted for optimum focus
V_{g2} =600V
Raster size 180x135mm
$V_{g3,g5(l)}$=16kV
$V_{g3,g5(l)}$=12kV
1200
Nits
1000
800
600
400
200
0
0
0.1
0.2
0.3
$I_{g3,g5(l)}$(mA)

MONITOR TUBE

21 cm rectangular television tube with metal backed screen primarily intended for use as a picture monitor tube.

QUICK REFERENCE DATA	
Deflection angle	110 °
Focusing	electrostatic
Resolution	625 lines
Overall length	max. 205 mm

SCREEN

Metal backed phosphor

Lumenescence		white	
Light transmission of face glass		80	%
Useful diagonal	min.	200	mm
Useful width	min.	190.5	mm
Useful height	min.	149.2	mm

HEATING

Indirect by A.C. or D.C.; parallel supply

Heater voltage	V_f	=	6.3	V
Heater current	I_f	=	300	mA

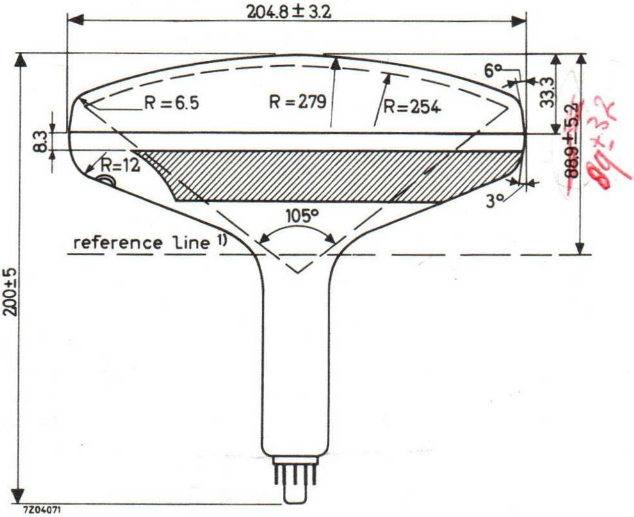
CAPACITANCES

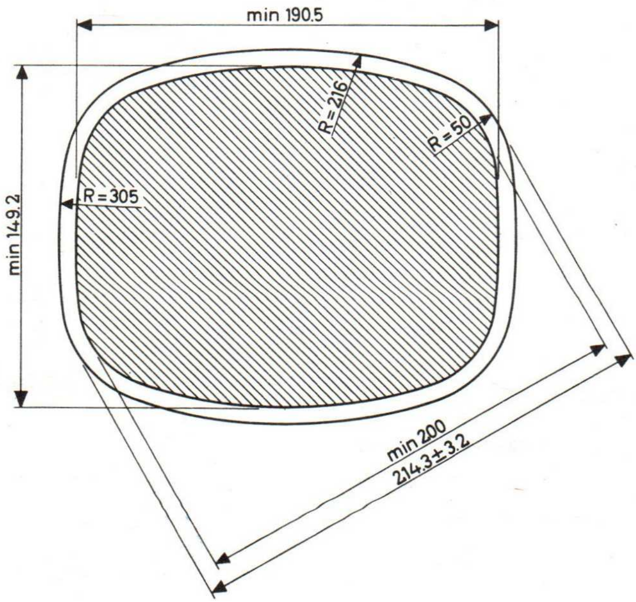
Final accelerator to external conductive coating	$C_{g_3, g_5(\ell)/m}$	=	250	pF
Cathode to all other elements	C_k	=	4.0	pF
Grid No.1 to all other elements	C_{g_1}	=	7.0	pF

7Z2 5653

MECHANICAL DATA

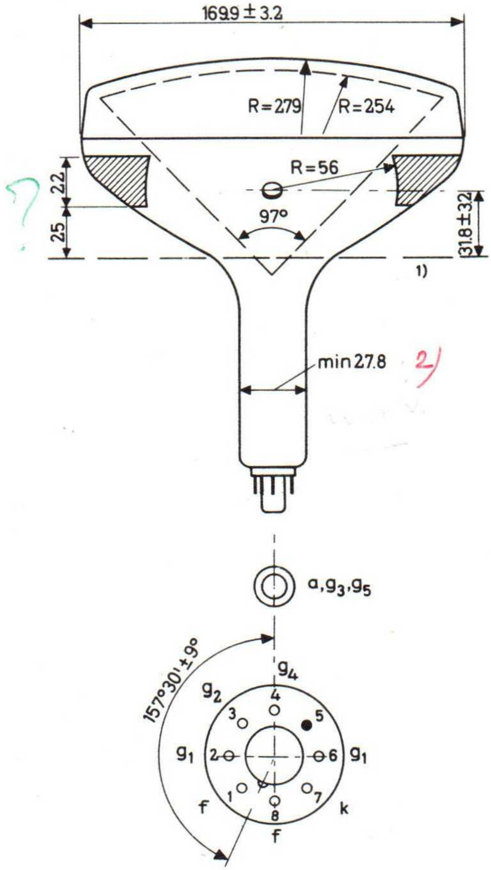
Dimensions in mm





7Z2 5654

MECHANICAL DATA (continued)



Principe schema

Mounting position: any

Except vertical with the screen downward and the axis of the tube making an angle of less than 20° with the vertical.

Base:	Neo Eightar (B8H)
Accessories	
Socket	type
Final accelerator connector	type 55563

---

1) Reference line, determined by the plane of the upper edge of the flange of the reference line gauge when the gauge is resting on the cone. line.

2) Max. will be determined by reference gauge JEDEC 126

7Z2 5655

FOCUSING electrostatic

The range of focus voltage shown under "Typical operating conditions" results in optimum focus at a beam current of 100 μA.

DEFLECTION magnetic

Diagonal deflection angle 110°

PICTURE CENTRING MAGNET

Field intensity perpendicular to the tube axis adjustable from 0 to 79.6 A/m (0 to 10 Oerstedt).
Adjustment of the centring magnet should not be such that a general reduction in brightness or shading of the raster occurs.

TYPICAL OPERATION

Final accelerator voltage	$V_{g_3,g_5(\ell)}$	=	16	kV
Focusing electrode voltage	V_{g_4}	=	0 to 400	V [1]
First accelerator voltage	V_{g_2}	=	300	V
Grid No.1 voltage for extinction of focused raster	V_{g_1}	=	-35 to -72	V

RESOLUTION

Resolution at screen centre measured at $V_{g_3,g_5(\ell)}$ = 16 kV, V_{g_2} = 300 V	625	lines

BRIGHTNESS

Brightness at $V_{g_3,g_5(\ell)}$ = 16 kV, $I_{g_3,g_5(\ell)}$ = 100 μA measured with a raster of 18 x 13.5 cm^2 } see test sheets. 6,6 mW/cm².	450	Nit

[1]) 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 -100 to +500 V will be required.

7Z2 5656

LIMITING VALUES (Absolute max. rating system)

Final accelerator voltage	$V_{g_3, g_5(\ell)}$	=	max.	20	kV
		=	min.	13	kV
Focusing electrode voltage	V_{g_4}	=	max.	1	kV
	$-V_{g_4}$	=	max.	500	V
First accelerator voltage	V_{g_2}	=	max.	450	V
		=	min.	200	V
Cathode to heater voltage	$V_{+k/f-}$	=	max.	200	V
	$V_{+k/f-_p}$	=	max.	300	V [1]
	$V_{-k/f+}$	=	max.	125	V
	$V_{-k/f+_p}$	=	max.	250	V
Grid No.1 voltage					
positive	V_{g_1}	=	max.	0	V [2]
positive peak	$V_{g_{1p}}$	=	max.	2	V
negative	$-V_{g_1}$	=	max.	150	V
Focusing electrode current	I_{g_4}	=	max.	±25	μA
First accelerator current	I_{g_2}	=	max.	± 5	μA

CIRCUIT DESIGN VALUES

Resistance between cathode and heater	R_{kf}	=	max.	1	MΩ
Impedance between cathode and heater	Z_{kf} (50 c/s)	=	max.	0.5	MΩ
Impedance between cathode and earth	Z_k (50 c/s)	=	max.	0.1	MΩ
Grid No.1 circuit resistance	R_{g_1}	=	max.	1.5	MΩ
Grid No.1 circuit impedance	Z_{g_1} (50 c/s)	=	max.	0.5	MΩ
First accelerator circuit resistance	R_{g_2}	=	max.	1	MΩ
Focusing electrode circuit resistance	R_{g_4}	=	max.	3	MΩ

[1]) During a warm-up period not exceeding 45 s the heater may be 410 V negative with respect to the cathode.

[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 +1 V. The maximum positive excursion of the video signal must not exceed +2 V, and at this voltage the grid current may be expected to be approximately 2 mA.

7Z2 5657

MONITOR TUBE

36 cm rectangular television tube with metal backed screen primarily intended for use as a precision monitor.

QUICK REFERENCE DATA	
Deflection angle	90 °
Focusing	electrostatic
Resolution	min. 650 lines
Overall length	max. 317 mm

SCREEN

Metal backed phosphor

Lumenescence	white	
Useful diagonal	min.	330 mm
Useful width	min.	306.5 mm
Useful height	min.	241 mm

HEATING

Indirect by A.C. or D.C.; parallel supply

Heater voltage	V_f	=	~~11.5~~ 11 V ±10 %
Heater current	I_f	=	~~60~~ mA = 70 mA

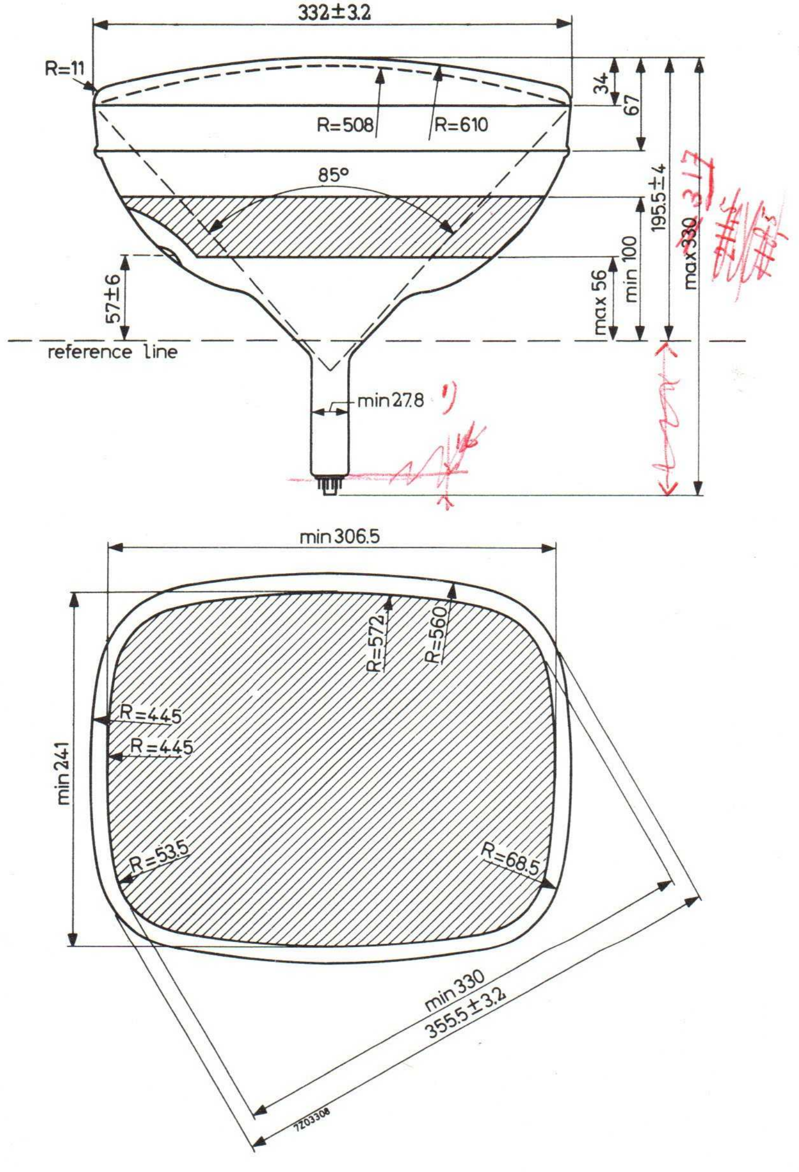
CAPACITANCES

Final accelerator to external conductive coating	$C_{g_3, g_5(\ell)/m}$	=	800 pF
Cathode to all other elements	C_k	=	5.0 pF
Grid No.1 to all other elements	C_{g_1}	=	9.0 pF

7Z2 6441

MECHANICAL DATA

Dimensions in mm



1) Max. will be determined by the reference gauge (page 4).

7Z2 6442

INTERNE MEDEDELIN

datum 18-1-'74 nr,

van v. Liempt afd. F.V. RAH tel.nr. 88216

aan Hr. Wassenaar afd. kwal. lab. pref. bzn.

betreft

Hr Wassenaar

Wilt U zo vriendelijk zijn om op bonnr. 26902 RV-3-6-52/419 en RV-3-6-52/450 toe te voegen?

B.v.d

Paraaf

afgehandeld

nog af te handelen

2822 100 05033

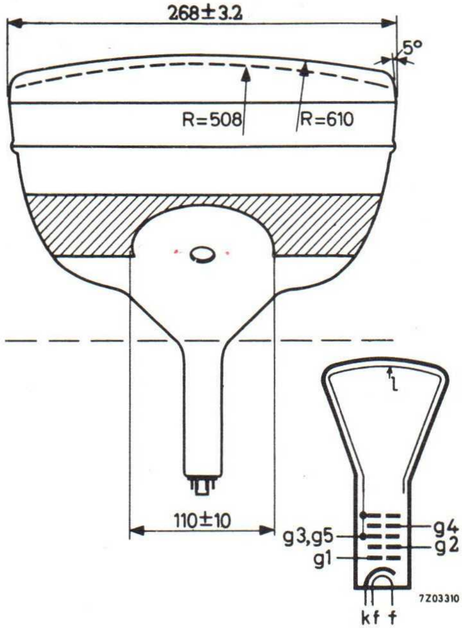
1 daf

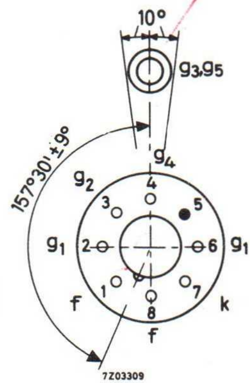
9 dafs à 8
72 ...
70 x 50. 3500

1 – 8
5 – 13
7 – 21
2 – 17
5 – 12
2 – 15
5 · 15½

25 – 99.

MECHANICAL DATA (continued) Dimensions in mm





Mounting position: any

Except vertical with the screen downward and the axis of the tube making an angle of less than 20° with the vertical.

Base: Neo Eightar (B8H)

Accessories:

Socket

Final accelerator connector type 55563

FOCUSING electrostatic

The range of focus voltage shown under typical operating conditions results in optimum focus at a beam current of 100 μA.

DEFLECTION magnetic

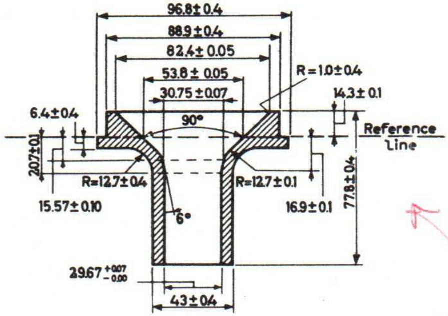
Diagonal deflection angle 90°

7Z2 6443

PICTURE CENTRING MAGNET

Field intensity perpendicular to the tube axis adjustable from 0 to 79.6 A/m (0 to 10 Oerstedt).
Adjustment of the centring magnet should not be such that a general reduction in brightness or shading of the raster occurs.

REFERENCE LINE GAUGE



TYPICAL OPERATION

Final accelerator voltage	$V_{g3, g5(\ell)}$	=	16	kV
Focusing electrode voltage	V_{g4}	=	0 to 500	V [1]
First accelerator voltage	V_{g2}	=	600	V
Grid No.1 voltage for extinction of focused raster (grid drive service)	$-V_{g1}$	=	43 to 98	V
Cathode voltage for extinction of focused raster (cathode drive service)	V_k	=	40 to 90	V

RESOLUTION

Resolution at screen centre			min. 650	lines
Measured at:	$V_{g3, g5(\ell)}$	=	16	kV
	V_{g2}	=	600	V

This tube will resolve 650 lines measured at a brightness of 340 Nits based on a picture height of 237 mm.
The focus voltage is adjusted to obtain the smallest roundest spot. For optimum overall resolution an external centring magnet may be required.

[1]) With the small change in focus spot size with variation of focus voltage, the limit of 0 to 500 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 −100 V to +600 V will be required.

7Z2 6444

LIMITING VALUES (Absolute max. rating system)

Final accelerator voltage	$V_{g_3,g_5(\ell)}$	= max.	18	kV
		= min.	12	kV
Focusing electrode voltage	V_{g_4}	= max.	1	kV
	$-V_{g_4}$	= max.	500	V
First accelerator voltage	V_{g_2}	= max.	800	V
Grid No.1 voltage				
positive	V_{g_1}	= max.	0	V [1]
positive peak	$V_{g_{1p}}$	= max.	2	V
negative	$-V_{g_1}$	= max.	180	V
Cathode to heater voltage	$V_{k/f}$	= max.	80	V
Cathode to heater peak voltage	V_{k/f_p}	= max.	130	V
Focusing electrode current	I_{g_4}	= max.	±25	μA
First accelerator current	I_{g_2}	= max.	± 5	μA

MAXIMUM CIRCUIT VALUES

Resistance between cathode and heater	$R_{k/f}$	= max.	1	MΩ
Impedance between cathode and heater	$Z_{k/f}$ (50c/s)	= max.	500	kΩ
Impedance between cathode and earth	$Z_{k/f}$ (50c/s)	= max.	100	kΩ
Grid No.1 circuit resistance	R_{g_1}	= max.	1.5	MΩ
Grid No.1 circuit impedance	Z_{g_1} (50c/s)	= max.	500	kΩ
First accelerator circuit resistance	R_{g_2}	= max.	1	MΩ
Focusing electrode circuit resistance	R_{g_4}	= max.	3	MΩ

[1] 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 V. The maximum positive excursion of the video signal must not exceed +2 V, and at this voltage the grid current may be expected to be approximately 2 mA.

7Z2 6445

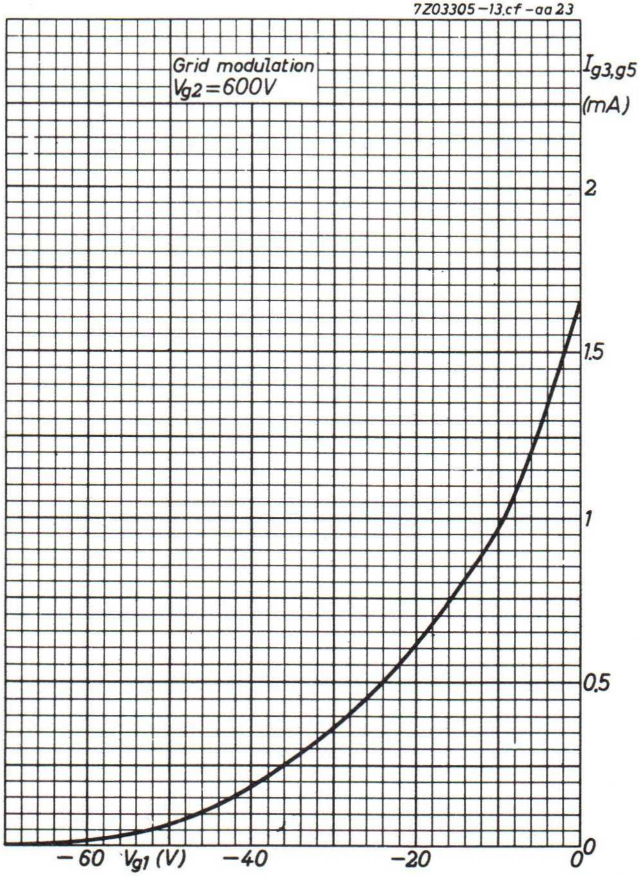
EXTERNAL CONDUCTIVE COATING

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

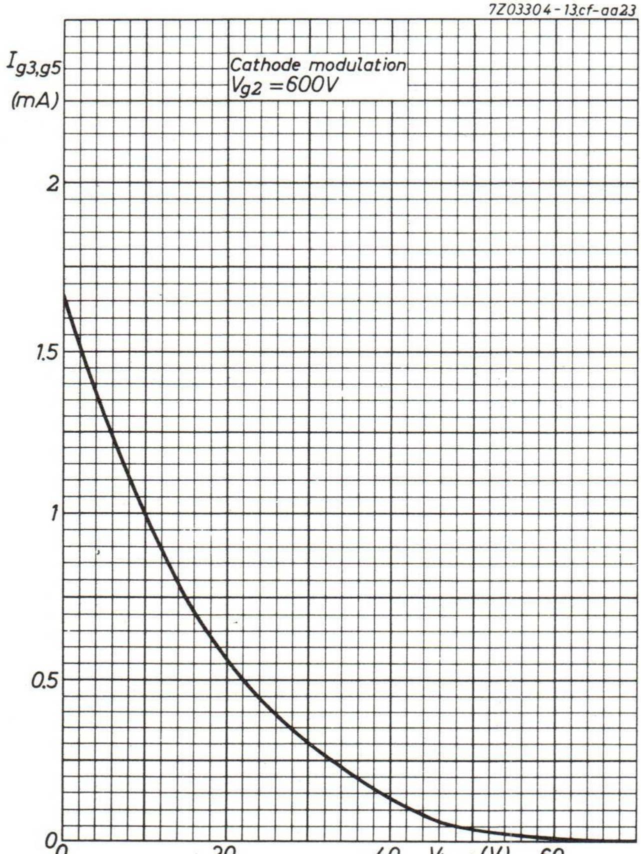
WARNING

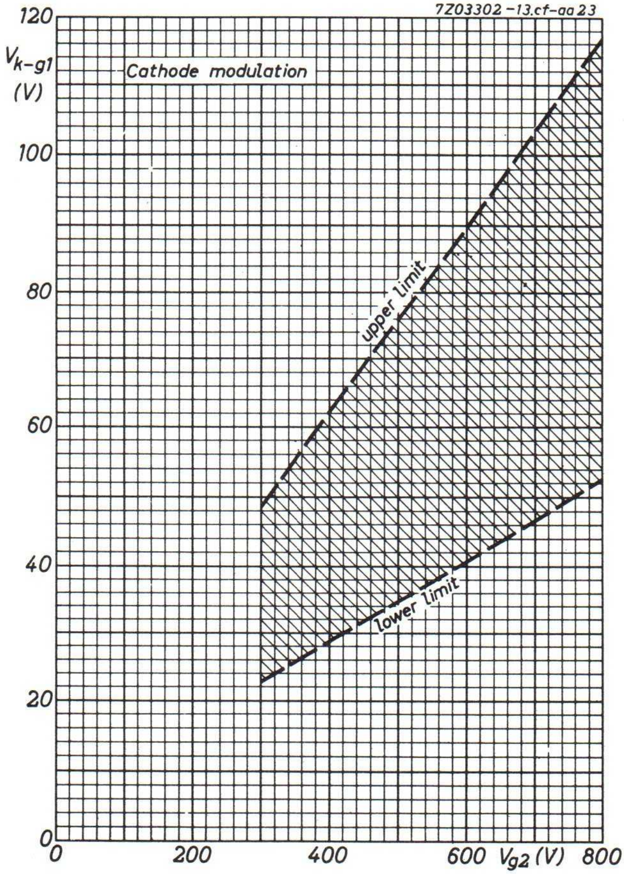
X-ray shielding is advisable to give protection against danger of personal injury arising from prolonged exposure at close range to this tube,

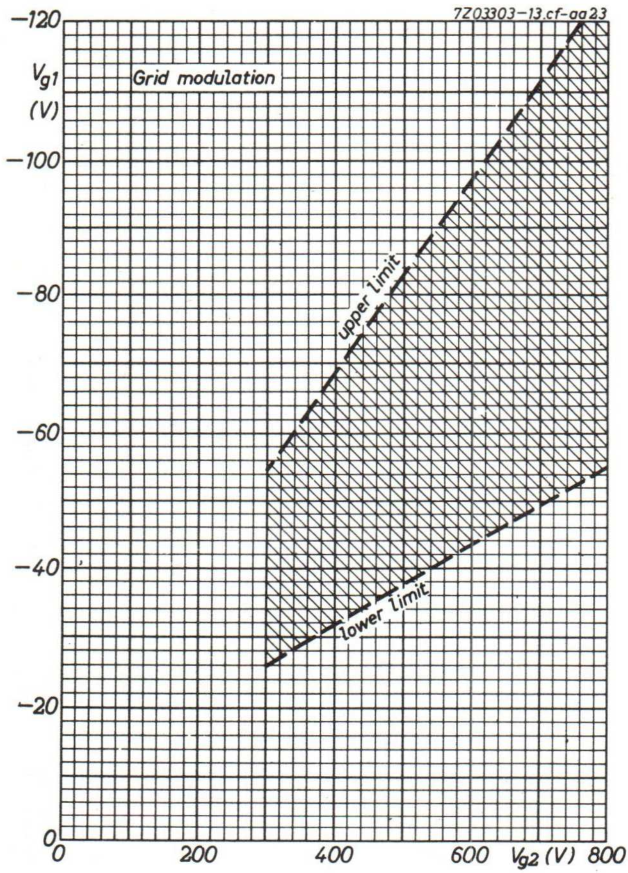
7Z2 6446

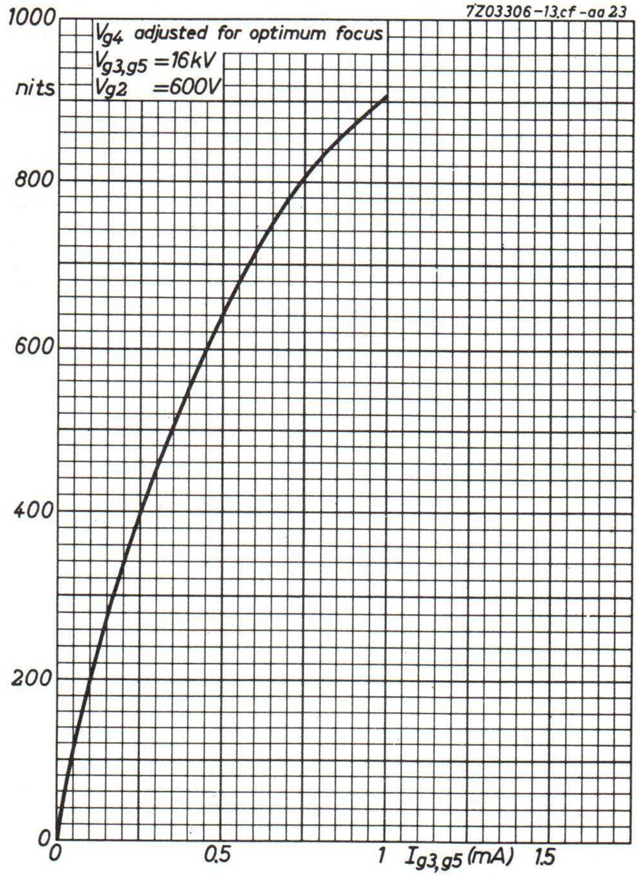


7Z03305-13.cf-aa 23
Grid modulation
V_{g2}=600V
$I_{g3,g5}$
(mA)
2
1.5
1
0.5
0
-60
V_{g1} (V)
-40
-20
0


7Z03304-13.cf-aa23
$I_{g3,g5}$
(mA)
Cathode modulation
V_{g2} = 600V
2
1.5
1
0.5
0
0
20
40
V_{k-g1} (V)
60


7Z03302-13.cf-aa23
120
V_{k-g1}
(V)
Cathode modulation
100
80
60
40
20
0
upper limit
lower limit
0
200
400
600
V_{g2} (V)
800


7Z03303-13.cf-aa23
V_{g1} (V)
Grid modulation
upper limit
lower limit
V_{g2} (V)
-120
-100
-80
-60
-40
-20
0
0
200
400
600
800


7Z03306-13.cf-aa 23
V_{g4} adjusted for optimum focus
$V_{g3,g5}$ = 16 kV
V_{g2} = 600 V
1000
nits
800
600
400
200
0
0
0.5
1
$I_{g3,g5}$ (mA)
1.5

MONITOR TUBE

The M36-13W is a 36 cm diameter rectangular television tube with metal backed screen primarily intedned for use as a monitor tube.

QUICK REFERENCE DATA			
Deflection angle		110^{o}	
Focusing		electrostatic	
Resolution	min.	625	lines
Overall length	max.	268.5	mm

SCREEN

Metal backed

Colour	white		
Useful screen diagonal	min.	333.4	mm
Useful screen width	min.	314.3	mm
Useful screen height	min.	250.8	mm

HEATING

Indirect by A.C. or D.C.; parallel or series supply

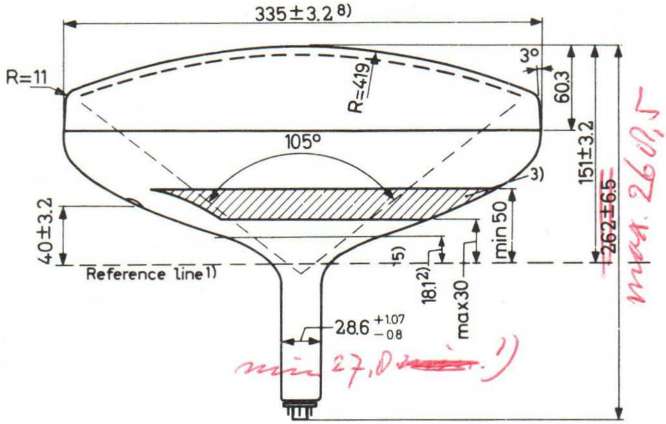
Heater voltage	V_f	6.3	V
Heater current	I_f	300	mA

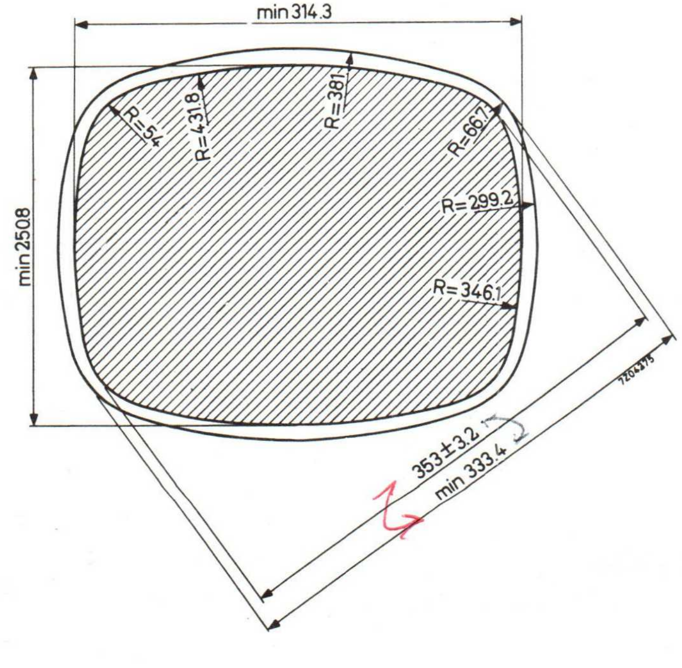
CAPACITANCES

Control grid to all other elements	C_{g_1}	4.0	pF	3.
Cathode to all other elements	C_k	7.0	pF	2.
Final accelerator to external conductive coating	$C_{g_3,g_5(\ell)/m}$	800	pF	1.

7Z2 6447

MECHANICAL DATA Dimensions in mm



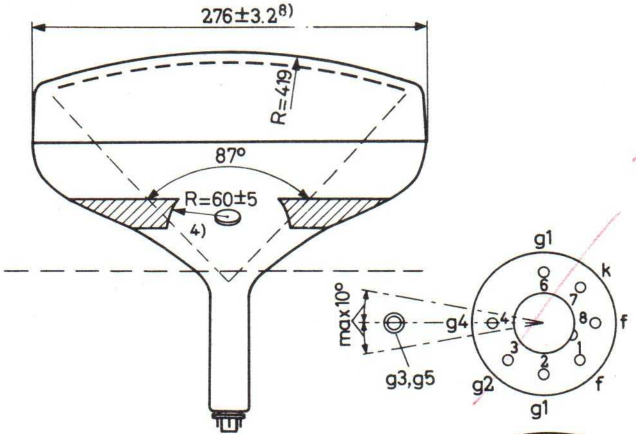


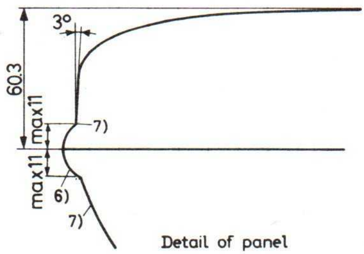
1) max. will be determined by the reference line gauge

7Z2 6448

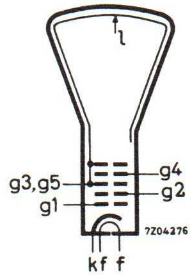
MECHANICAL DATA (continued)

Dimensions in mm





Detail of panel



Mounting position: any, except vertical with the screen downward and the axis of the tube making an angle of less than 20° with the vertical.

Base	Neo eightar (B8H)
Accessories	
Socket	type
Final accelerator contact connector	type 55563

FOCUSING electrostatic

The range of focus voltage shown under "Typical operating conditions" results in optimum focus at a beam current of 100 μA.

DEFLECTION double magnetic

diagonal deflection angle 110°

1) 2) 3) 4) 5) 6) 7) 8) See page 6.

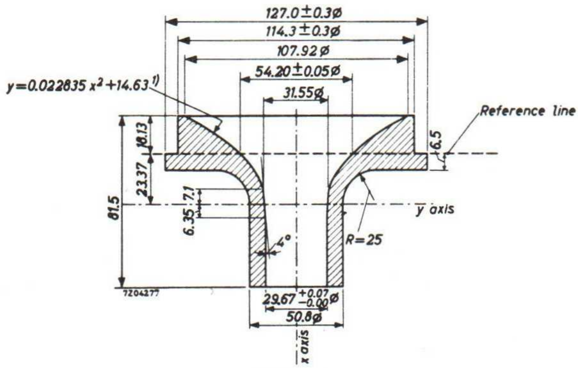
7Z2 6449

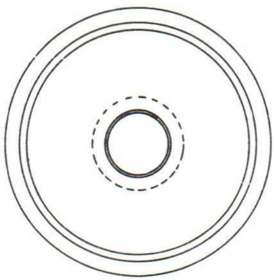
PICTURE CENTRING MAGNET

Field intensity perpendicular to the tube axis adjustable from 0 to 79.6 A/m (0 to 10 Oerstedt). Adjustment of the centring magnet should not be such that a general reduction in brightness or shading of the raster occurs.

REFERENCE LINE GAUGE

Dimensions in mm





TYPICAL OPERATING CONDITIONS

Final accelerator voltage	$V_{g_3, g_5}(\ell)$	16	kV
Focusing electrode voltage	V_{g_4}	0-400	V [1])
First accelerator voltage	V_{g_2}	400	V
Grid No.1 voltage for visual extinction of a focused raster	$-V_{g_1}$	40 to 85	V
Resolution at screen centre		min. 625	lines
Measured at	$V_{g_3, g_5}(\ell)$	16	kV
	V_{g_2}	400	V

This tube will resolve 625 lines measured at a brightness of 340 Nits based on a picture height of 237 mm.
The focus voltage is adjusted to obtain the smallest roundest spot. For optimum overall resolution an external centring magnet may be required.

7Z2 6450

LIMITING VALUES (Absolute max. rating system)

Measured with respect to cathode

Final accelerator voltage	$V_{g_3,g_5(\ell)}$	max.	18	kV
		min.	13	kV
Focusing electrode voltage	V_{g_4}	max.	1	kV
	$-V_{g_4}$	max.	500	V
First accelerator voltage	V_{g_2}	max.	550	V
		min.	350	V
Control grid voltage,				
negative	$-V_{g_1}$	max.	150	V
positive	V_{g_1}	max.	0	V
Focusing electrode current	I_{g_4}	max.	±25	μA
Grid No. 2 current	I_{g_2}	max.	±5	μA
Cathode to heater voltage,				
cathode positive	$V_{+k/f-}$	max.	250	V
	$V_{+k/f-p}$	max.	300	V
cathode negative	$V_{-k/f+}$	max.	135	V
	$V_{-k/f+p}$	max.	180	V
Resistance between heater and cathode	R_{kf}	max.	1	MΩ
Resistance between grid No. 1 and earth	R_{g_1}	max.	1.5	MΩ
Impedance between heater and cathode (f = 50 c/s)	Z_{kf}	max.	500	kΩ
Impedance between cathode and earth (f = 50 c/s)	Z_k	max.	100	kΩ

---

1) With the small change in focus spot size with variation of focus voltage the limit of 0-400 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 −100 V to +500 V will be required. 7Z2 6451

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 16 kV.

EXTERNAL CONDUCTIVE COATING

This tube has an external conductive coating (m), which must be earthed and capacitance of this to the final electrode is used to provide smoothing for the EHT supply. The tube marking and warning labels are on the side of the cone opposite the final electrode connector and this side should not be used for making contact to the external conductive coating.

NOTES TO OUTLINE DRAWING

1) The reference line is determined by the plane of the upper edge of the flange of the reference line gauge, (JEDEC 126) when the gauge is resting on the cone.

2) End of guaranteed zone.

3) Configuration of outer coating optional, but contains the contactarea as shown on drawing.
External conductive coating must be earthed.

4) This area must be kept clean.

5) Maximum neck and cone contour given by reference line gauge. (JEDEC 126).

6) Bulge at splice-line seal may increase the indicated maximum value for envelope width, diagonal and height by not more than 6.4 mm, but at any point around the seal, the bulge will not protrude more than 3.2 mm beyond the envelope surface at the location specified for dimensioning the envelope width, diagonal and height.

7) The tube should be supported on both sides of the bulge. The mechanism used should provide clearance for the maximum dimensions of the bulge.

8) Measured 12 $\pm$ 1 mm from the centre-line of the screen-cone seal.

7Z2 6452

MONITOR TUBE

Television monitor tube with 17 cm diagonal rectangular metal backed screen. This tube has electrostatic focusing and magnetic deflection.

QUICK REFERENCE DATA			
Deflection angle		44	^{o}
Focusing		electrostatic	
Resolution	min.	650	lines
Overall length	max.	345.5	mm

SCREEN

Metal backed phosphor

Lumenescence	white		
Useful diagonal	min.	155	mm
Useful width	min.	124	mm
Useful height	min.	93	mm

HEATING

Indirect by A.C. or D.C.; parallel supply

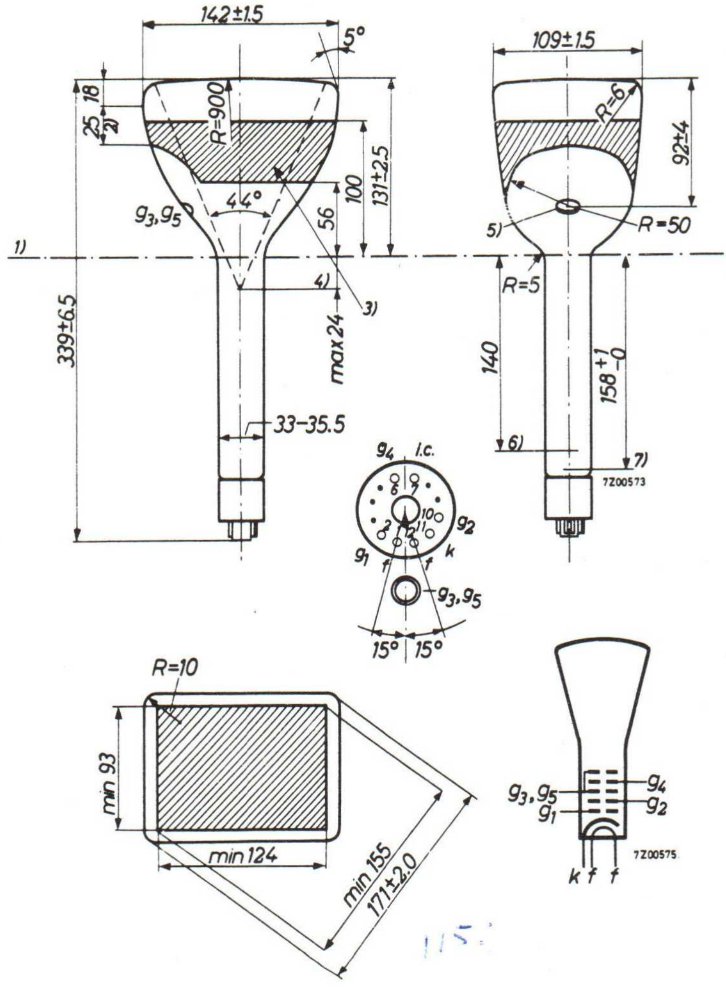
Heater voltage	V_f	=	6.3	V
Heater current	I_f	=	300	mA

CAPACITANCES

Final accelerator to external conductive coating	$C_{g_3,g_5(\ell)}$	=	min.	350	pF
Cathode to all other elements	C_k	=	max.	8	pF
Grid No. 1 to all other elements	C_{g_1}	=	max.	8	pF

7Z2 6407

MECHANICAL DATA Dimensions in mm



Mounting position: any

Except vertical with the screen downward and the axis of the tube making an angle of less than 20° with the vertical

Base Duodecal 7p.

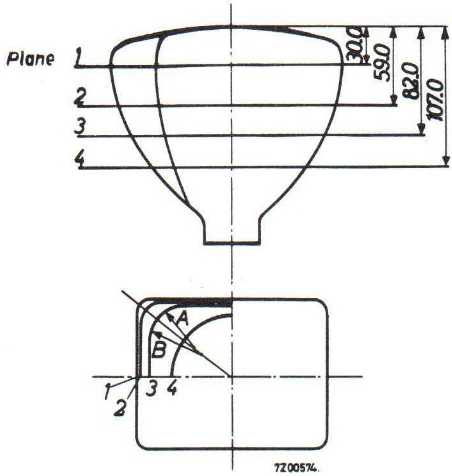
Accessories

Socket	type	5912/20
Final accelerator connector	type	55563

7Z2 6408

MAX. CONE CONTOUR DRAWING

Dimensions in mm



The bulb sizes in planes 1, 2, 3 and 4 will not be greater than the following values:

Plane	Major axis	Minor axis	Diagonal	Corner radii	
				A	B
1	144	111	173.5	10	10
2	138.5	107.6	162.7	14.4	18
3	123.8	102.7	138.1	26.1	31.4
4	90.4	87.7	90.8	41.6	44.4

NOTES TO OUTLINE DRAWING

1. Reference line determined by the position where a gauge of 36.0 mm internal diameter rests on the cone.
2. Over this region the glass contour is indeterminate
3. Allowable contact area.
4. Effective centre of deflection.
5. Cavity contact.
6. Maximum extent of shield.
7. Position of centring magnet.

7Z2 6409

FOCUSING electrostatic

DEFLECTION magnetic

Diagonal deflection angle 44°

PICTURE CENTRING MAGNET

Field intensity perpendicular to the tube axis adjustable from 0 to 79.6 A/m (0 to 10 Oerstedt).
Adjustment of the centring magnet should not be such that a general reduction in brightness or shading of the raster occurs.

TYPICAL OPERATING CONDITIONS

Final accelerator voltage	$V_{g_3,g_5(\ell)}$	=	12	kV
Focusing electrode voltage	V_{g_4}	=	200 to +200	V [1]
Accelerator voltage	V_{g_2}	=	300	V
Grid No.1 voltage for visual extinction of focused raster (Grid drive service)	$-V_{g_1}$	=	30 to 80	V
Focusing electrode current	I_{g_4}	=	−15 to +15	μA

RESOLUTION

Resolution at centre of screen > 650 lines

Measured at:

V_{g_3,g_5}	=	12	kV
V_{g_2}	=	300	V

This tube will resolve a minimum of 650 lines based on a picture height of 93 mm and is measured at a brightness of 50 ft. lamberts. The focus voltage is adjusted to obtain the smallest roundest spot.

The line width is controlled to 0.38 mm measured at a point corresponding to 50% of the peak brightness measured on a photomicrometer equipment.

[1]) With the small change in focus spot size with variation of focus voltage the limit of −200 to +200 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 −300 to +300 V will be required. 7Z2 6410

LIMITING VALUES (Absolute max. rating system)

Final accelerator voltage	$V_{g_3,g_5(\ell)}$	= max.	14	kV
		= min.	10	kV
Focusing electrode voltage				
positive	V_{g_4}	= max.	500	V
negative	$-V_{g_4}$	= max.	400	V
First accelerator voltage	V_{g_2}	= max.	350	V
		= min.	250	V
Grid No.1 voltage				
negative	$-V_{g_1}$	= max.	200	V
		= min.	1	V [1]
Cathode to heater voltage				
positive	$V_{+k/f-}$	= max.	200	V [2]
positive peak	$V_{+k/f-p}$	= max.	410	V [3]
negative	$V_{-k/f+}$	= max.	125	V [2]

MAXIMUM CIRCUIT VALUES

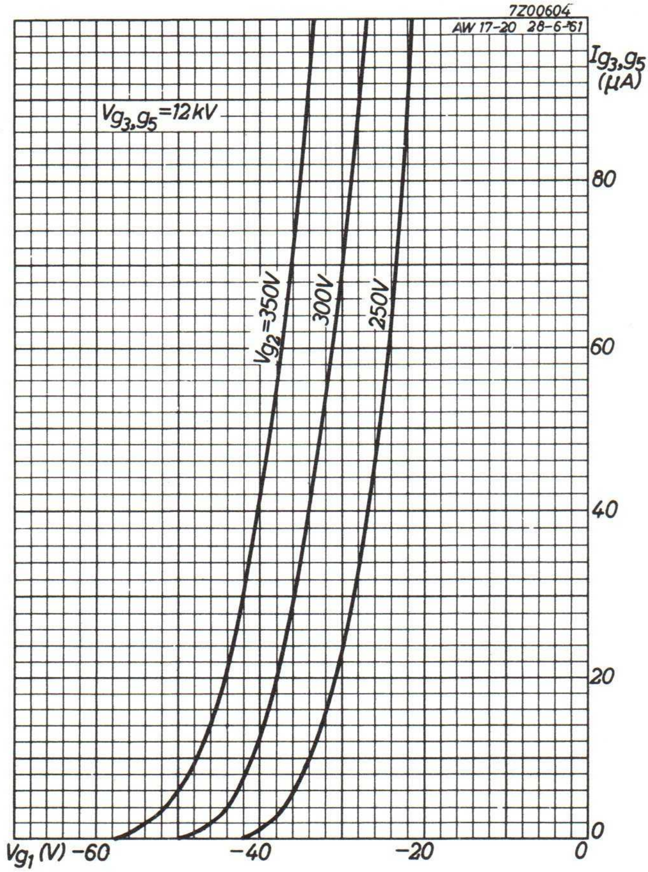
Resistance between cathode and heater	R_{k-f}	= max.	1	MΩ
Grid No.1 circuit resistance	R_{g_1}	= max.	1.5	MΩ
Grid No.1 circuit impedance	Z_{g_1} (50 Hz)	= max.	0.5	MΩ

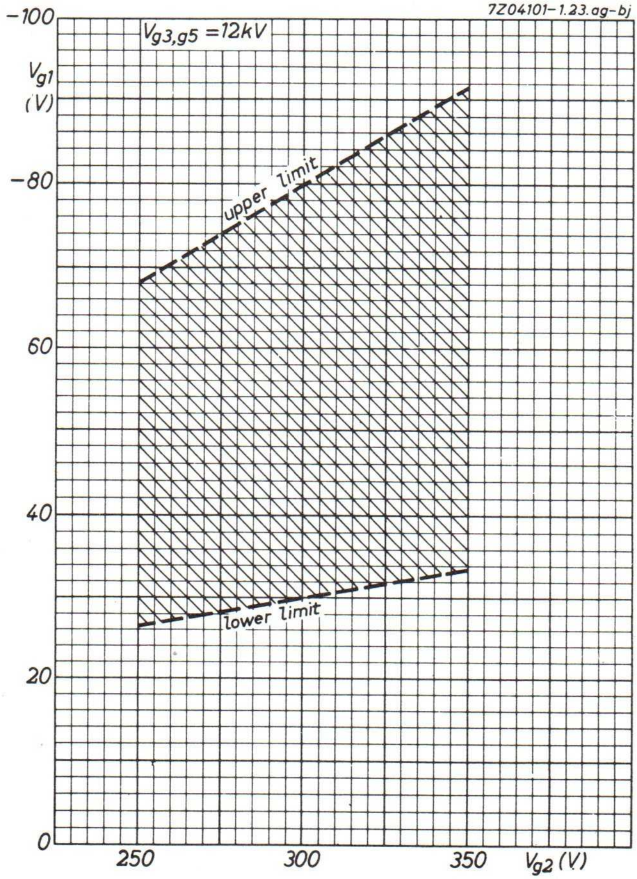
[1] The d.c. value of grid bias must not be allowed to become positive with respect to the cathode, except during the period immediately after switching the equipment on or off when it may be allowed to rise to + 1.0 V.

[2] In order to avoid excessive hum the a.c. component of $V_{k/f}$ should be as low as possible (< 20 V_{eff}).

[3] During a warming-up period not exceeding 45 sec.

7Z2 6411


7Z00604
AW 17-20 28-6-'61
I_{g_3,g_5} (μA)
V_{g_3,g_5}=12kV
V_{g_2}=350V
300V
250V
80
60
40
20
0
V_{g_1} (V) -60
-40
-20
0


7Z04101-1.23.ag-bj
$V_{g3,g5}$ = 12 kV
-100
V_{g1}
(V)
-80
60
40
20
0
upper limit
lower limit
250
300
350
V_{g2} (V)

MONITOR TUBE

21 cm rectangular television tube with metalbacked screen intended for use as monitor tube.

QUICK REFERENCE DATA			
Deflection angle		90^{o}	
Focusing	electrostatic/magnetic		
Resolution	min.	625	lines
Overall length	max.	274	mm

SCREEN

Metal backed phosphor

Lumenescene	White		
Useful diagonal	min.	195	mm
Useful width	min.	180	mm
Useful height	min.	135	mm

HEATING

Indirect by A.C. or D.C.; parallel supply

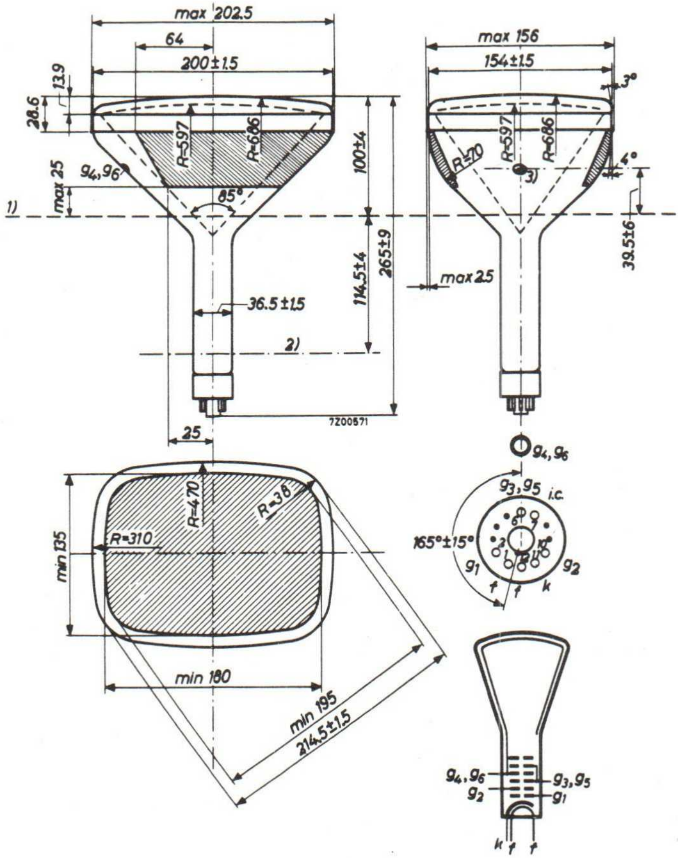
Heater voltage	V_f	6.3	V
Heater current	I_f	300	mA

CAPACITANCES

Final accelerator to external conductive coating	$C_{g_4,g_6(\ell)/m}$	max.	350	pF
		min.	250	pF
Cathode to all other elements	C_k	max.	6	pF
Grid No.1 to all other elements	C_{g_1}	max.	8	pF

7Z2 6412

MECHANICAL DATA Dimensions in mm



Mounting position: any

Except vertical with the screen downward and the axis of the tube making an angle of less than 20° with the vertical.

Base	Duodecal 7 pins
Accessories	
Socket	type 5912/20
Final accelerator connector	type 55563

1) Reference line
2) Centre of grid
3) Cavity contact

7Z2 6413

FOCUSING electrostatic

DEFLECTION magnetic

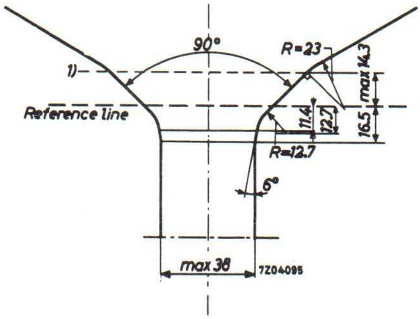
Diagonal deflection angle 90°

ION TRAP MAGNET

Field intensity 45 - 65 gausses

The space between a point 114.5 mm from the reference line along the neck of the tube and the edge of the base should be kept clear of the ion trap magnet. The direction of the field of the ion trap magnet should be such that the south pole is adjacent to the spigot. The ion-trap magnet assembly should be earthed.

REFERENCE LINE GAUGE Dimensions in mm



The reference line of the tube is determined by the plane of the upper edge of the flange of the gauge when it is resting on the cone.
The inner surface of the deflection coils must not extend into the interior of the gauge.

TYPICAL OPERATING CONDITIONS

Final accelerator voltage	$V_{g_4,g_6(\ell)}$	9	kV
Focusing electrode voltage	V_{g_3,g_5}	−30 to +200	V [2])
First accelerator voltage	V_{g_2}	400	V
Grid No.1 voltage for visual extinction of focused raster (grid drive service)	$-V_{g_1}$	40 to 80	V

[1]) The tube contour is not controlled in the region above this line

[2]) Measured at $I_{g_4+g_6}$ = 100 μA. The range of focus voltage quoted results in optimum focus at the screen centre. An increase in focus voltage of 100 to 200 V in the positive direction will give a greater uniformity of focus over the whole screen.

7Z2 6414

LIMITING VALUES (Absolute max. rating system)

Final accelerator voltage	$V_{g_4,g_6}(\ell)$	max.	11	kV
		min.	7	kV
Focusing electrode voltage				
positive	V_{g_3,g_5}	max.	500	V
negative	$-V_{g_3,g_5}$	max.	500	V
First accelerator voltage	V_{g_2}	min.	200	V
		max.	500	V
Grid No. 1 voltage,				
positive	V_{g_1}	max.	0	V [1]
positive peak	$V_{g_{1p}}$	max.	2	V
negative	$-V_{g_1}$	max.	150	V
Cathode to heater voltage,				
positive	V_{k-f}	max.	195	V [2]
positive peak	V_{k-fp}	max.	410	V [3]
negative	$-(V_{k-f})$	max.	125	V [2]

MAXIMUM CIRCUIT VALUES

Resistance between cathode and heater	R_{k-f}	see note 4		
Grid No. 1 circuit resistance	R_{g_1}	max.	1.5	MΩ
Grid No. 1 circuit impedance	Z_{g_1} (50 Hz)	max.	0.5	MΩ

---

[1]) The d.c. 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 +1 V. The maximum positive grid excursion of the video signal may reach 2 V and at this voltage the grid current may be expected to be approximately 2 mA.

[2]) In order to avoid excessive hum the a.c. component of $V_{k/f}$ should be as low as possible (< 20 V_{eff}).

[3]) During a warming-up period not exceeding 45 sec.

[4]) When the heater is in a series chain, or earthed, Zk max. is 100 kΩ, where Zk is the 50 c/s impedance between earth and the cathode. When the heater is supplied from a separate transformer $R_{k/f}$ is 1 MΩ. 7Z2 6415

MONITOR TUBE

36 cm rectangular television tube with grey filter glass, metal-backed screen, primarily intended for use as picture monitor tube.

QUICK REFERENCE DATA	
Deflection angle	70 °
Focusing	electrostatic
Resolution	min. 650 lines
Overall length	max. 455 mm

SCREEN

Metal backed phosphor

Lumenescence	white		
Useful diagonal	min.	318	mm
Useful width	min.	288	mm
Useful height	min.	217	mm

HEATING

Indirect by A.C. or D.C.; parallel supply

Heater voltage	V_f	=	6.3	V
Heater current	I_f	=	300	mA

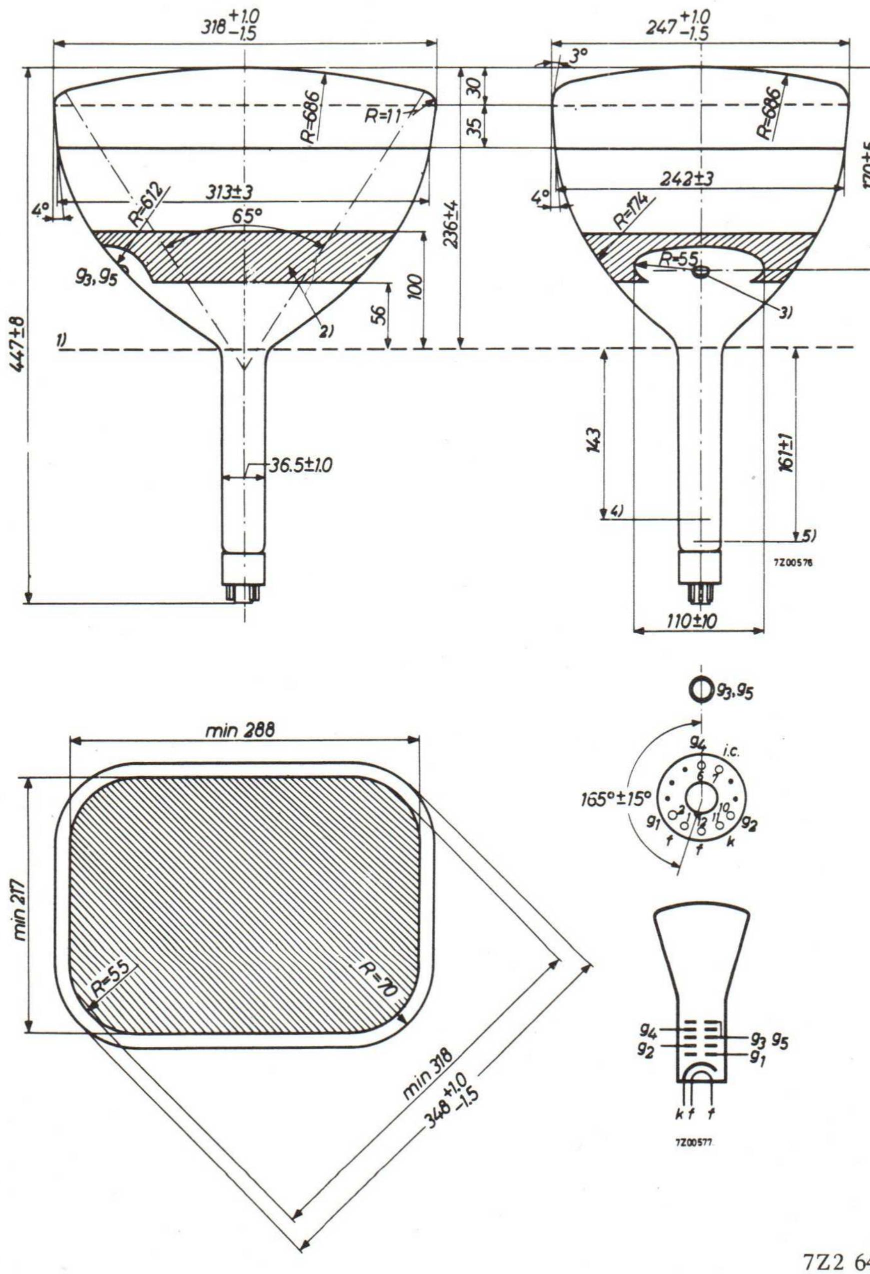
CAPACITANCES

Final accelerator to external conductive coating	$C_{g_3,g_5(\ell)/m}$	=		1100	pF
Cathode to all other elements	C_k	=	max.	8	pF
Grid No.1 to all other elements	C_{g_1}	=	max.	8	pF

7Z2 6416

MECHANICAL DATA

Dimensions in mm



7Z2 6417

MECHANICAL DATA

Mounting position: any

Except vertical with the screen downward and the axis of the tube making an angle of less than 20° with the vertical.

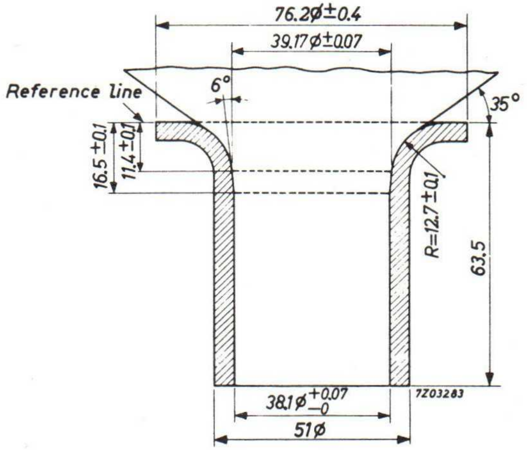
Base	Duodecal 7p
Accessories	
Socket	type 5912/20
Final accelerator connector	type 55563

FOCUSING electrostatic

DEFLECTION magnetic

Diagonal deflection angle 70°

REFERENCE LINE GAUGE



NOTES TO OUTLINE DRAWING

1. Reference line
2. Allowable contact area
3. Cavity contact
4. Maximum extent of shield
5. Position of centring magnet

7Z2 6418

TYPICAL OPERATING CONDITION

Final accelerator voltage	$V_{g_3,g_5(\ell)}$	=	14	kV
Focusing electrode voltage	V_{g_4}	=	-200 to +200	V [1]
First accelerator voltage	V_{g_2}	=	300	V
Grid No. 1 voltage for visual extinction of focused raster (grid drive service)	$-V_{g_1}$	=	30 to 70	V
Focusing electrode current	I_{g_4}	=	-15 to +15	μA

RESOLUTION

Resolution at centre of screen		>	650	lines
Measured at:	V_{g_3,g_5}	=	14	kV
	V_{g_2}	=	300	V

This tube will resolve a minimum of 650 lines based on a picture height of 217 mm and is measured at a brightness of 170 Nit. The focus voltage is adjusted to obtain the smallest roundest spot.
The line width is controlled to 0.38 mm measured at a point corresponding to 50% of the peak brightness measured on a photomicrometer equipment.

LIMITING VALUES (Absolute max. rating system)

Final accelerator voltage	$V_{g_3,g_5(\ell)}$	= max.	15	kV
		= min.	9	kV
Focus electrode voltage				
positive	V_{g_4}	= max.	500	V
negative	$-V_{g_4}$	= max.	500	V
First accelerator voltage	V_{g_2}	= min.	250	V
		= max.	500	V
Grid No. 1 voltage				
positive	V_{g_1}	= max.	0	V [2]
negative	$-V_{g_1}$	= max.	200	V
Cathode to heater voltage				
positive	V_{k-f}	= max.	200	V [3]
positive peak	V_{k-f_p}	= max.	410	V [4]
negative	$-(V_{k-f})$	= max.	125	V [3]

[1] [2] [3] [4] [5] See page 5.

7Z2 6419

MAXIMUM CIRCUIT VALUES

Resistance between cathode and heater	R_{k-f}	= see note 5
Grid No. 1 circuit resistance	R_{g_1}	= max. 1.5 MΩ
Grid No. 1 circuit impedance	Z_{g_1} (50 c/s)	= max. 0.5 MΩ

[1]) With the small change in focus spot size with variation of focus voltage the limit of −200 to +200 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 −300 to +300 V will be required.

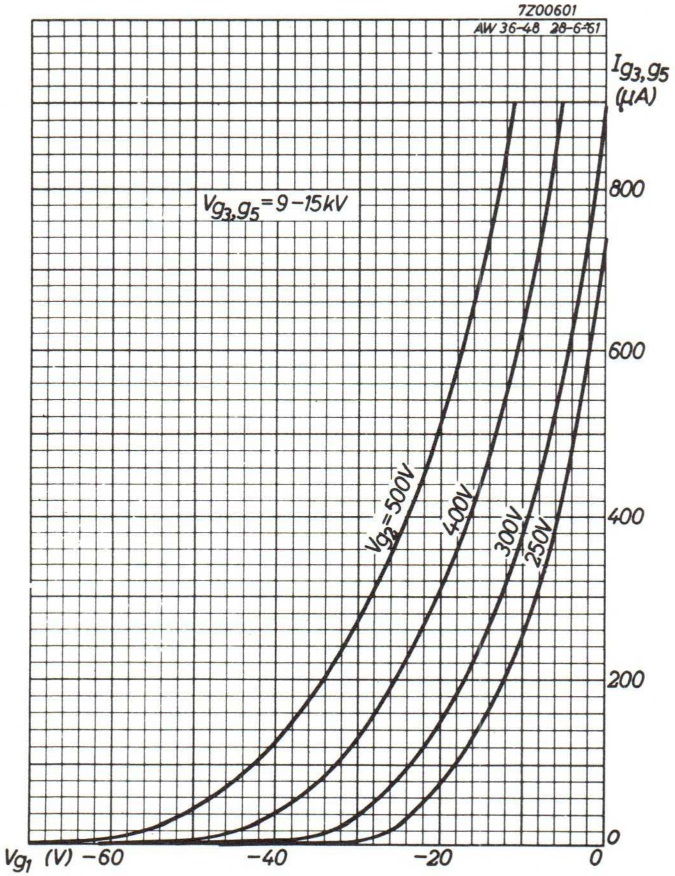
[2]) The d.c. value of grid bias must not be allowed to become positive with respect to the cathode, except during the periods immediately after switching the equipment on or off, when it may be allowed to rise to +1 V. The maximum positive grid excursion may reach 2 V and at this voltage the grid current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

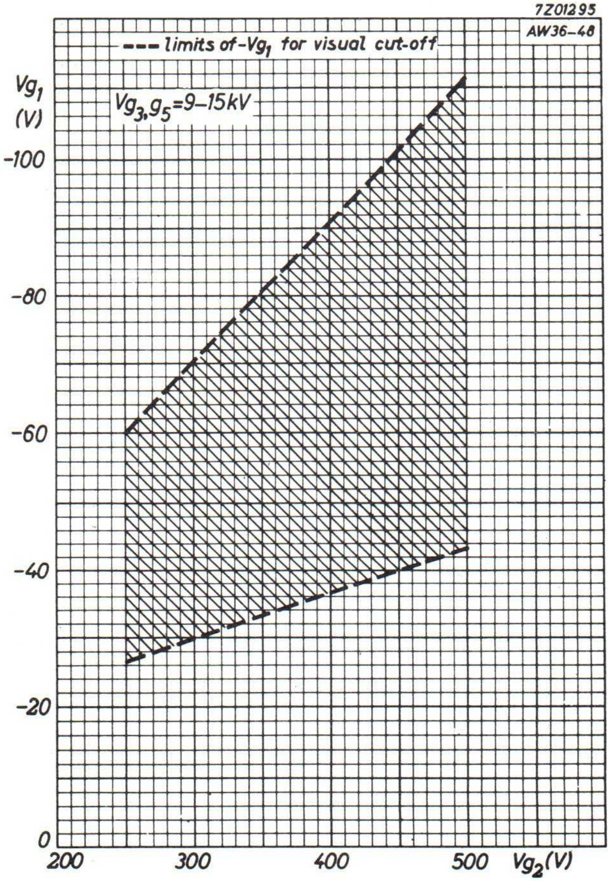
[3]) In order to avoid excessive hum the a.c. component of $V_{k/f}$ should be as low as possible (< 20 V_{RMS}).

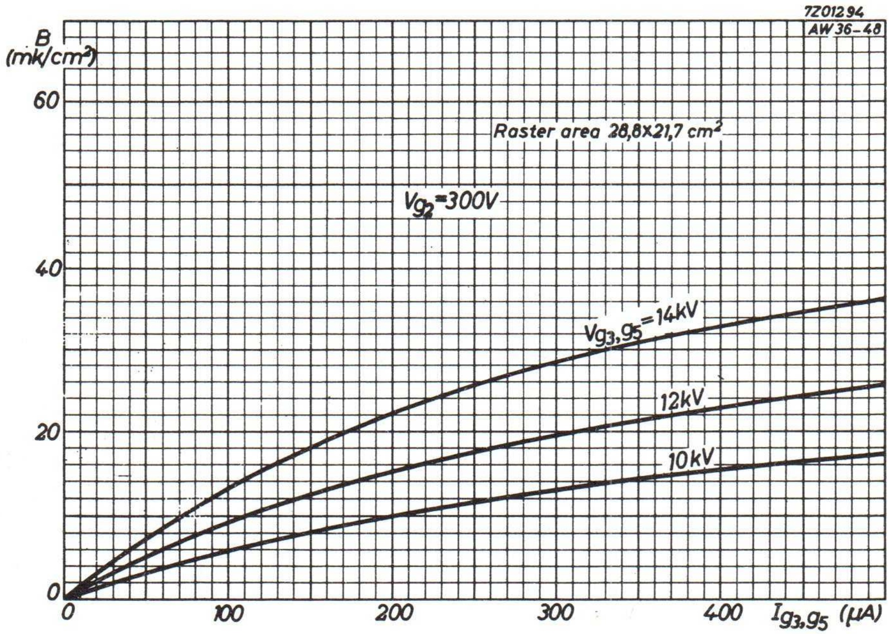
[4]) During a warming-up period not exceeding 45 sec.

[5]) When the heater is in a series chain, or earthed, Z_k max. is 100 kΩ where Z_k is the 50 c/s impendance between earth and the cathode.
When the heater is supplied from a separate transformer $R_{k/f}$ max. is 1 MΩ.

7Z2 6420


7Z00601
AW 36-48 28-6-61
I_{g_3,g_5} (μA)
V_{g_3,g_5} = 9 − 15 kV
V_{g_2} = 500V
400V
300V
250V
800
600
400
200
0
V_{g_1} (V) −60
−40
−20
0


7Z01295
AW36-48
--- limits of -Vg1 for visual cut-off
Vg3,g5=9–15kV
Vg1
(V)
-100
-80
-60
-40
-20
0
200
300
400
500
Vg2(V)


7Z01294
AW36-48
B
(mk/cm²)
60
40
20
0
Raster area 28,8×21,7 cm²
V_{g_2}=300V
V_{g_3,g_5}=14kV
12kV
10kV
0
100
200
300
400
I_{g_3,g_5} (μA)

MONITOR TUBE

43 cm rectangular television tube with metal-backed, grey glass screen. The tube is primarily intended for use as a television studio monitor tube.

QUICK REFERENCE DATA	
Deflection angle	70 °
Focusing	electrostatic
Resolution	min. 650 lines
Overall length	max. 519 mm

SCREEN

Metal backed phosphor

Lumenescence	white	
Useful diagonal	min. 390	mm
Useful width	min. 362	mm
Useful height	min. 273	mm

HEATING

Indirect by A.C. or D.C.; parallel supply

Heater voltage	V_f	=	6.3	V
Heater current	I_f	=	300	mA

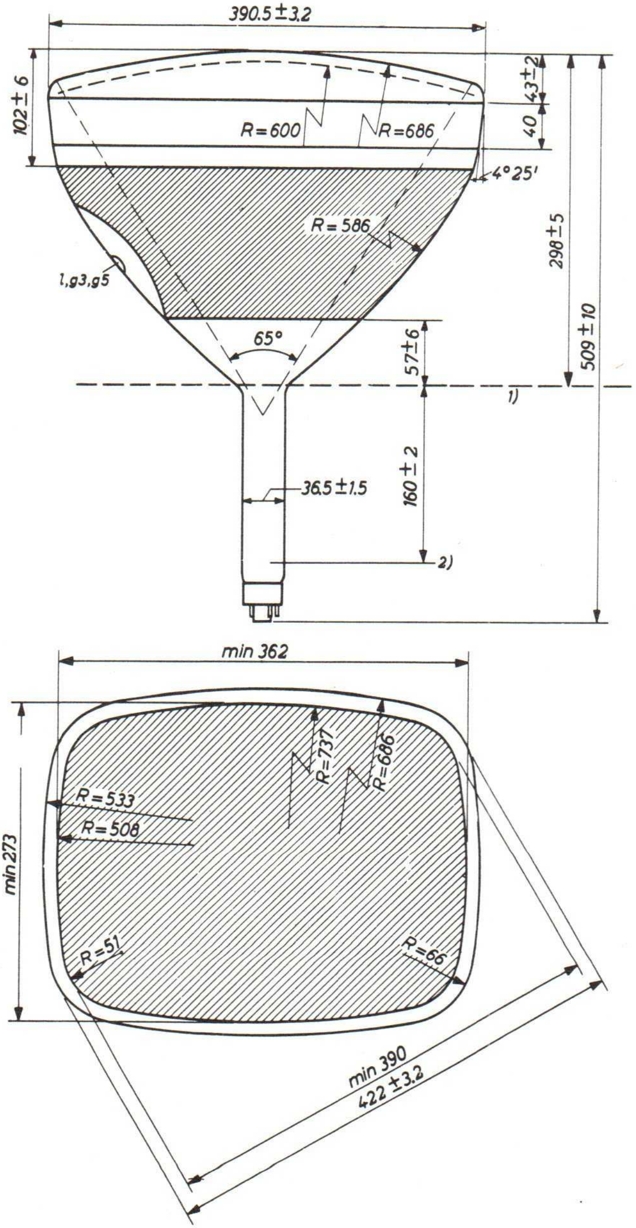
CAPACITANCES

Final accelerator to external conductive coating	$C_{g3,g5(\ell)/m}$	=		1100	pF
Cathode to all other elements	C_k	=	max.	8	pF
Grid No.1 to all other elements	C_{g1}	=	max.	8	pF

7Z2 6421

MECHANICAL DATA

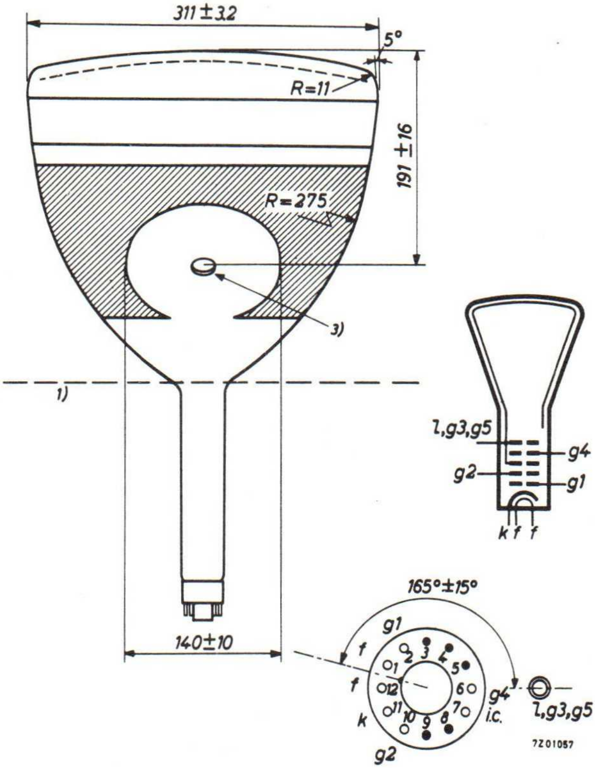
Dimensions in mm



7Z2 6422

MECHANICAL DATA

Dimensions in mm



Mounting position: any

Except vertical with the screen downward and the axis of the tube making an angle of less than 20° with the vertical.

Base — Duodecal 7 p.

Accessories

Socket	type	5912/20
Final accelerator connector	type	55563

1) Reference line
2) Centre of grid
3) Cavity contact

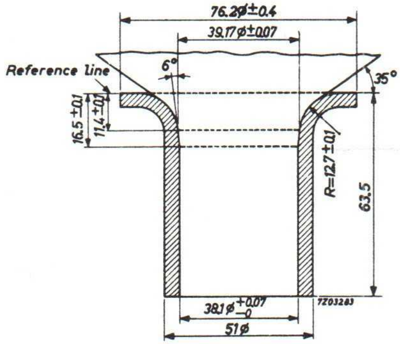
7Z2 6423

FOCUSING electrostatic

DEFLECTION magnetic

Diagonal deflection angle 70°

REFERENCE LINE GAUGE Dimensions in mm



TYPICAL OPERATION

Final accelerator voltage	$V_{g_3,g_5(\ell)}$	=	16	kV
Focusing electrode voltage	V_{g_4}	=	−200 to +200	V [1])
First accelerator voltage	V_{g_2}	=	300	V
Grid No. 1 voltage for visual extinction of focused raster	$-V_{g_1}$	=	30 to 70	V
Focusing electrode current	I_{g_4}	=	−15 to +15	μA

RESOLUTION

Resolution at centre of screen		>	650	lines
Measured at:	$V_{g_3,g_5(\ell)}$	=	14	kV
	V_{g_2}	=	300	V

This tube will resolve a minimum of 650 lines based on a picture height of 273 mm and is measured at a brightness of 170 Nit.
The focus voltage is adjusted to obtain the smallest roundest spot.
The line width is controlled to 0.48 mm measured at a point corresponding to 50% of the peak brightness measured on a photomicrometer equipment.

---

1) With a small change in focus spot size with variation of focus voltage the limit of −200 V to +200 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 −300 to +300 V will be required. 7Z2 6424

LIMITING VALUES (Absolute max. rating system)

Final accelerator voltage	$V_{g_3, g_5(\ell)}$	= max.	18	kV
		= min.	10	kV
Positive focusing electrode voltage	$+V_{g_4}$	= max.	500	V
Negative focusing electrode voltage	$-V_{g_4}$	= max.	500	V
First accelerator voltage	V_{g_2}	= max.	500	V
		= min.	250	V
Negative grid No. 1 voltage	$-V_{g_1}$	= max.	200	V
Positive grid No. 1 voltage	$+V_{g_1}$	= max.	0	V [1]
Positive grid No. 1 peak voltage	$+V_{g_{1p}}$	= max.	2	V
Focusing electrode current	I_{g_4}	= max.	±25	μA
First accelerator electrode current	I_{g_2}	= max.	±15	μA
Cathode-heater voltage				
positive	$V_{+k/f-}$ d.c.	= max.	200	V [2]
positive peak	$V_{+k/f-}$ p	= max.	300	V [2]
negative (k neg.)	$V_{-k/f+}$ d.c.	= max.	125	V [2]
negative peak (k neg.)	$V_{-k/f+}$ p	= max.	250	V [2]

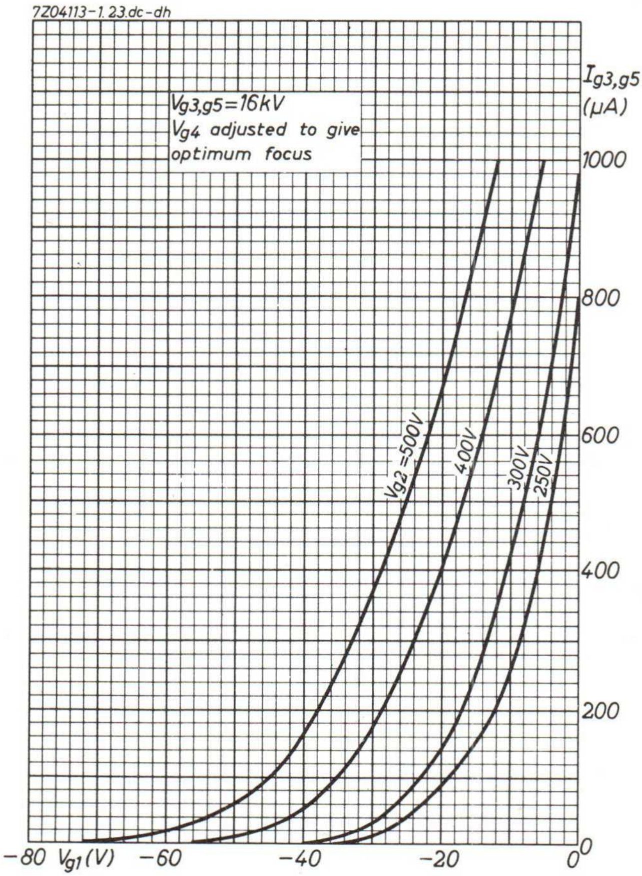
MAXIMUM CIRCUIT VALUES

Resistance between cathode and heater	$R_{k/f}$	= max.	1.0	MΩ
Impedance between cathode and heater	$Z_{k/f}$ (50 c/s)	= max.	100	kΩ
Grid No. 1 circuit resistance	R_{g_1}	= max.	1.5	MΩ
Grid No. 1 circuit impedance	Z_{g_1} (50 c/s)	= max.	0.5	MΩ

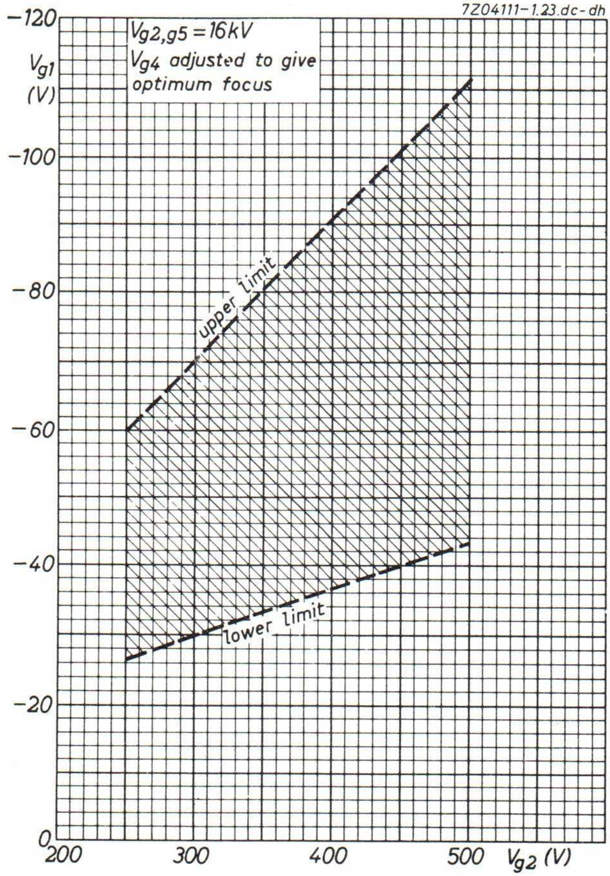
[1]) The d.c. value of grid bias must not be allowed to become positive with respect to the cathode, except during the periods immediately after switching the equipment on or off, when it may be allowed to rise to +1 V.
The maximum positive grid excursion may reach 2 V and at this voltage the grid current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

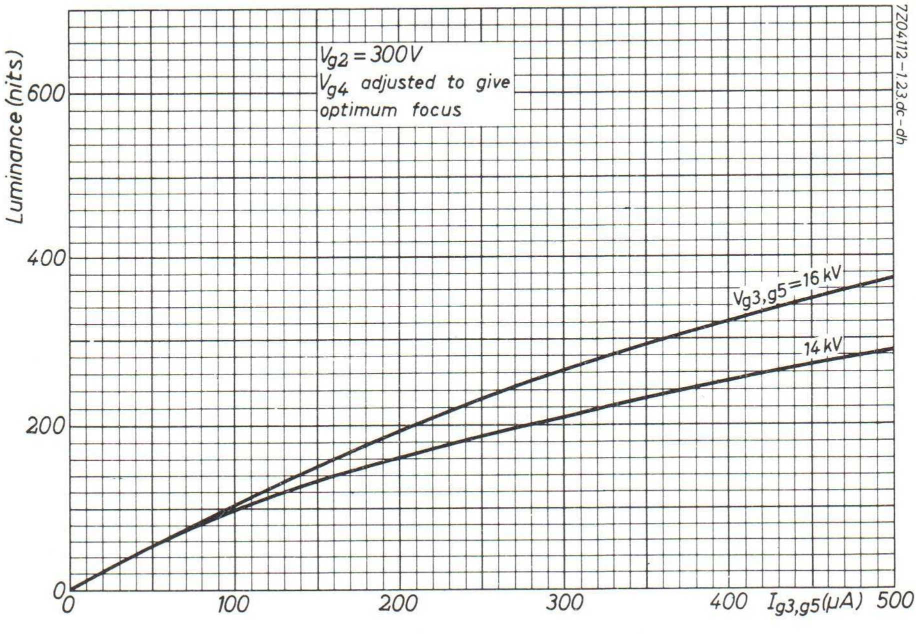
[2]) In order to avoid excessive hum the a.c. component of $V_{k/f}$ should be as low as possible (<20 V_{RMS}).
During a warming-up period not exceeding 45 s, V_{k/f_p} max. (cathode positive) is allowed to rise to 410 V.

7Z2 6425



7Z04113-1.23.dc-dh
$V_{g3,g5}$=16kV
V_{g4} adjusted to give optimum focus
$I_{g3,g5}$ (μA)
1000
800
600
400
200
0
V_{g2}=500V
400V
300V
250V
−80 V_{g1}(V) −60
−40
−20
0


7Z04111-1.23.dc-dh
$V_{g2,g5}$ = 16 kV
V_{g4} adjusted to give optimum focus
V_{g1} (V)
-120
-100
-80
-60
-40
-20
0
200
300
400
500
V_{g2} (V)
upper limit
lower limit



Luminance (nits)
600
400
200
0
$V_{g2} = 300V$
V_{g4} adjusted to give optimum focus
$V_{g3,g5} = 16$ kV
14 kV
0
100
200
300
400
$I_{g3,g5}$ (μA)
500
7Z04112-1.23.dc-dh

MONITOR TUBE

The M.13-35 is 13 cm diameter monitor tube with metal-backed screen. The tube is primarily intended for use as a television viewfinder tube.

QUICK REFERENCE DATA		
Deflection angle		53^{o}
Focusing		magnetic
Overall length	max.	287 mm

SCREEN

Metal backed

Colour		white
Useful diameter	min.	108

HEATING

Indirect by A.C. or D.C.; series or parallel supply

Heater voltage	V_f	=	6.3	V [1])
Heater current	I_f	=	0.3	A

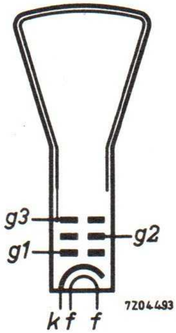
CAPACITANCES

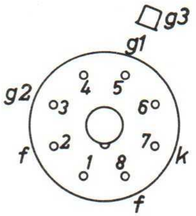
Control grid to all other elements	C_{g_1}	max.	10	pF
Cathode to all other elements	C_k	max.	10	pF

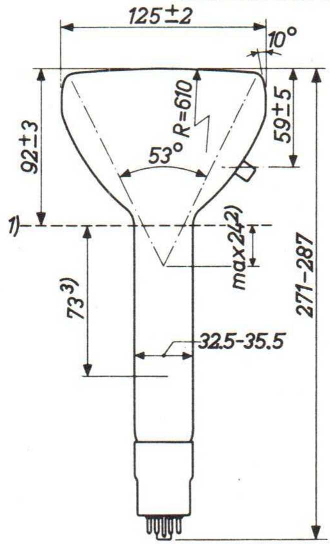
[1]) When the tube is used in a series heater chain, the heater voltage must not exceed 9.5 V when the supply is switched on. If necessary a current limiting device must be used for this purpose.

7Z2 6429

MECHANICAL DATA Dimensions in mm







Mounting position: any, except with screen downwards with the axis at an angle of less than 20° to the vertical.
The tube should not be supported by the base alone and under no circumstances should the socket be allowed to support the tube.

Base Octal 8 p.

FOCUSING magnetic

DEFLECTION double magnetic

deflection angle 53°

1) Reference line, determined by the diameter of 36 mm.

2) The distance from deflection centre to reference line should not exceed 24 mm.

3) Distance from focusing centre to reference line.

7Z2 6430

TYPICAL OPERATING CONDITIONS

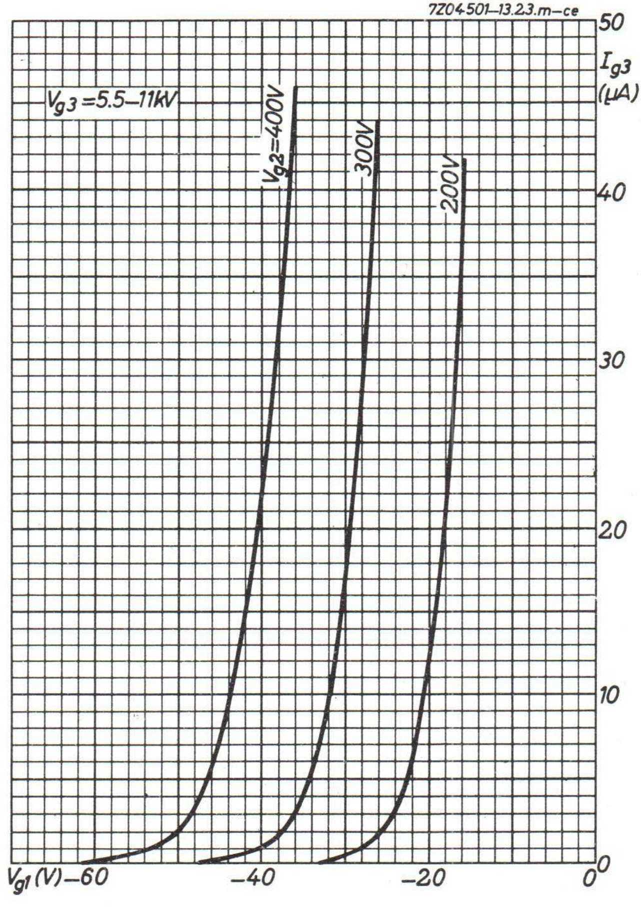
Final accelerator voltage	$V_{g3(\ell)}$	7	kV
Grid No. 2 voltage	V_{g2}	300	V
Negative grid No. 2 voltage for visual extinction of a focused spot	$-V_{g1}$	30 to 70	V

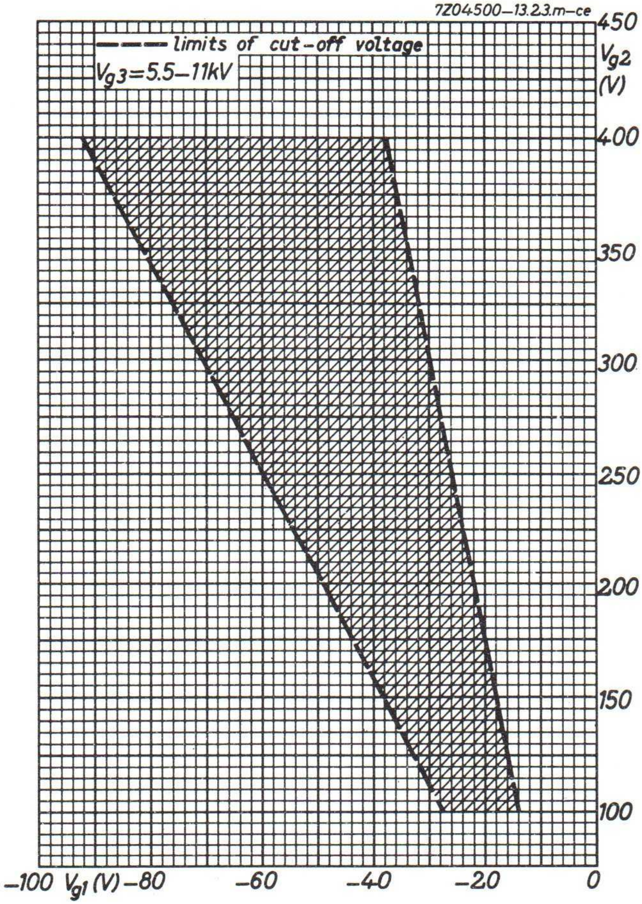
LIMITING VALUES (Absolute max. rating system)

Measured with respect to cathode

Final accelerator voltage	$V_{g3(\ell)}$	max.	11	kV
		min.	5.5	kV
Grid No. 2 voltage	V_{g2}	max.	500	V
		min.	200	V
Control grid voltage,				
negative	$-V_{g1}$	max.	200	V
positive	V_{g1}	max.	0	V
Cathode to heater voltage,				
cathode positive	$V_{+k/f-}$	max.	200	V
cathode negative	$V_{-k/f+}$	max.	125	V
Resistance between heater and cathode	R_{kf}	max.	1	MΩ
Resistance between grid and earth	R_{g1}	max.	1.5	MΩ

7Z2 6431


7Z04501–13.2.3.m–ce
V_{g3} = 5.5–11kV
V_{g2} = 400V
300V
200V
50
I_{g3} (µA)
40
30
20
10
0
V_{g1} (V) –60
–40
–20
0


7Z04500–13.2.3.m–ce
limits of cut-off voltage
V_{g3}=5.5–11kV
450
V_{g2}
(V)
400
350
300
250
200
150
100
–100
V_{g1} (V)
–80
–60
–40
–20
0

MONITOR TUBE

36 cm rectangular television tube with metal backed grey glass screen. The tube is primarily intended for use as a television studio monitor tube.

QUICK REFERENCE DATA	
Deflection angle	70^{o}
Focusing	magnetic
Overall length	max. 457 mm

SCREEN

Metal backed	
Colour	white
Useful diagonal	min. 318 mm
Useful width	min. 288 mm
Useful height	min. 217 mm

HEATING

Indirect by A.C. or D.C.; series or parallel supply

Heater voltage	V_f	6.3	V [1])
Heater current	I_f	300	mA

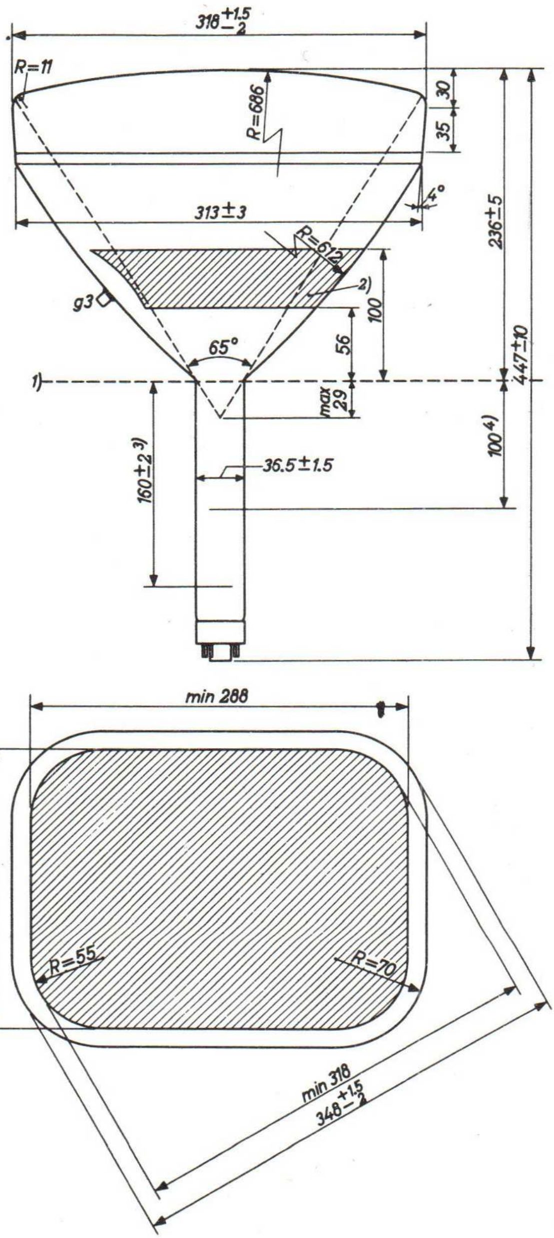
CAPACITANCES

Control grid to all other elements	C_{g_1}	max.	8	pF
Cathode to all other elements	C_k	max.	8	pF
Final accelerator to external conductive coating	$C_{g_3(\ell)/m}$		1100	pF

1) When the tube is used in a series heater chain, the heater voltage must not exceed 9.5 V when the supply is switched on. If necessary a current limiting device must be used for this purpose.

7Z2 6435

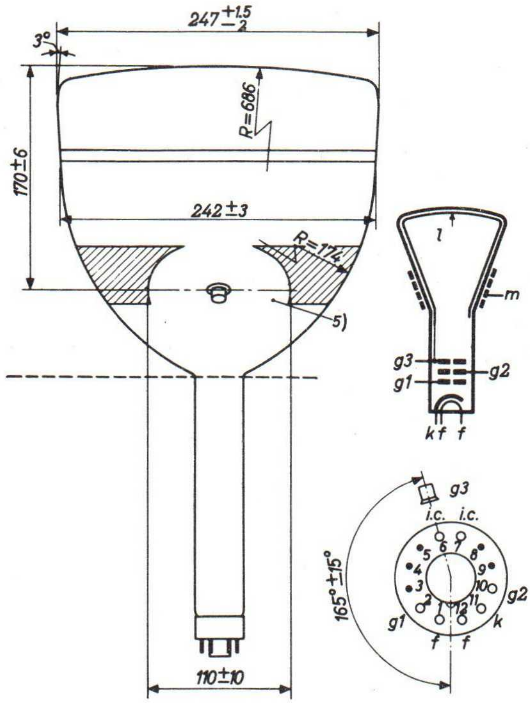
MECHANICAL DATA Dimensions in mm



7Z2 6436

MECHANICAL DATA (continued)

Dimensions in mm



Mounting position: any, except with screen downwards with the axis at an angle of less than 20° to the vertical.
The tube should not be supported by the base alone and under no circumstances should the socket be allowed to support the tube.

Base — Duodecal 7p

---

1) Reference line, determined by the plane of the upper edge of the reference line gauge when the gauge is resting on the cone.

2) Allowable contact area.

3) Distance from reference line to top centre of grid.

4) Distance from reference line to centre of magnetic length of focus unit.

5) This area must be kept clean.

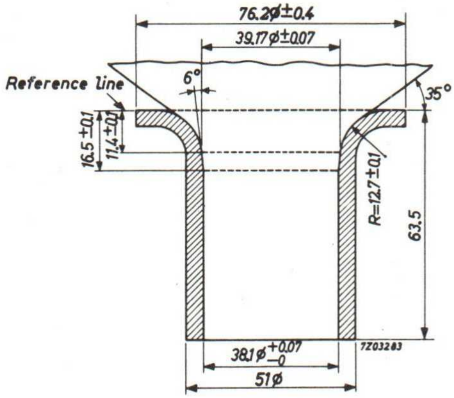
7Z2 6437

FOCUSING magnetic

DEFLECTION double magnetic

deflection angle 70^{o}

REFERENCE LINE GAUGE



TYPICAL OPERATING CONDITIONS

Final accelerator voltage	$V_{g3(\ell)}$	14	kV
Grid No.2 voltage	V_{g2}	300	V
Negative grid No.1 voltage for visual extinction of a focused spot	$-V_{g1}$	30 to 70	V
Recommended distance from reference line to centre of magnetic length of focus unit		100	mm

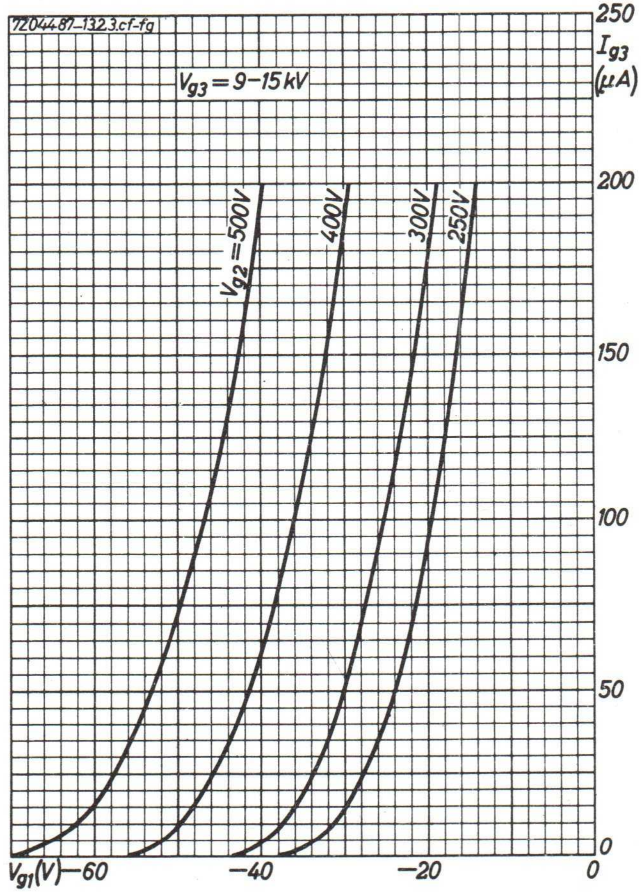
7Z2 6438

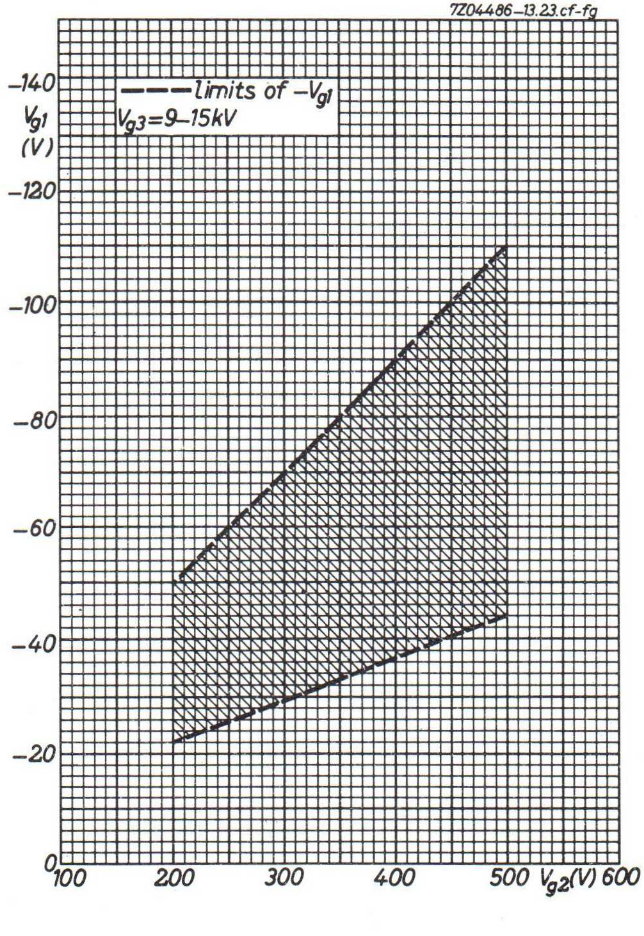
LIMITING VALUES (Absolute max. rating system)

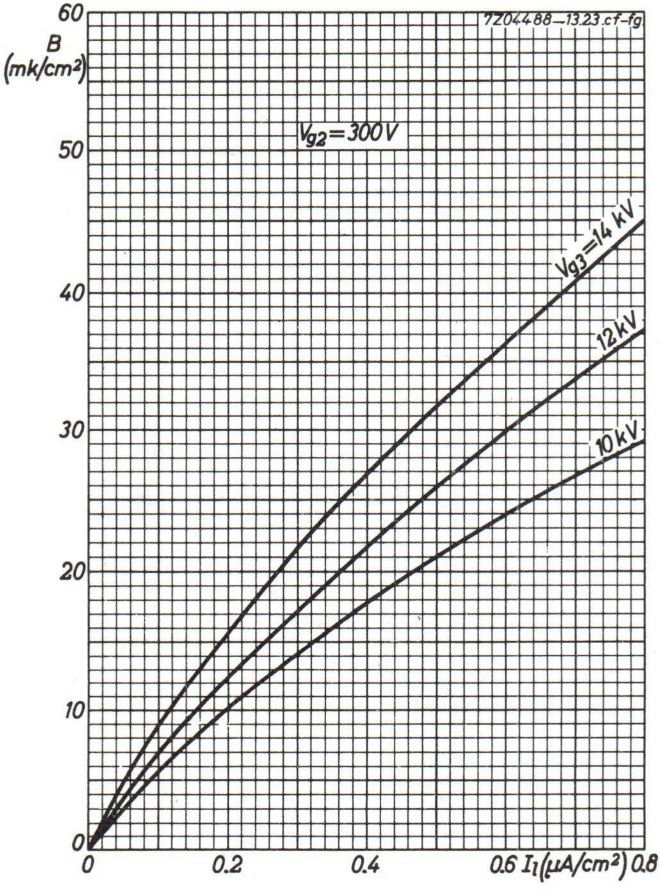
Measured with respect to cathode

Final accelerator voltage	$V_{g3(\ell)}$	max.	15	kV
		min.	9	kV
Grid No.2 voltage	V_{g2}	max.	500	V
		min.	250	V
Control grid voltage,				
negative	$-V_{g1}$	max.	150	V
positive	V_{g1}	max.	0	V
Cathode to heater voltage,				
cathode positive	$V_{+k/f-}$	max.	200	V
cathode negative	$V_{-k/f+}$	max.	125	V
Resistance between heater and cathode	R_{kf}	max.	1	MΩ
Resistance between grid and earth	R_{g1}	max.	1.5	MΩ
Impedance between heater and cathode (f = 50 c/s)	Z_{kf}	max.	100	kΩ

7Z2 6439


7204487-132.3.cf-fg
V_{g3} = 9–15 kV
250
I_{g3}
(μA)
200
150
100
50
0
V_{g2} = 500V
400V
300V
250V
V_{g1}(V) −60
−40
−20
0


7Z04486-13.23.cf-fg
limits of $-V_{g1}$
V_{g3}=9–15kV
V_{g1}
(V)
-140
-120
-100
-80
-60
-40
-20
0
100
200
300
400
500
V_{g2}(V)
600


7Z04488-13.23.cf-fg
B (mk/cm²)
60
50
40
30
20
10
0
Vg2=300V
Vg3=14 kV
12 kV
10 kV
0
0.2
0.4
0.6
I1 (μA/cm²)
0.8

PART 5

FLYING SPOT SCANNERS

PREFERRED TYPES

TELEVISION STUDIO TUBES		
Flying spot scanners		MC13-16 MK13-16

Valid until 31 December 1966

FLYING SPOT SCANNER TUBE

The M.13-36 is a 13 cm diameter cathode-ray tube intended for flying spot applications.

QUICK REFERENCE DATA		
Accelerator voltage	25	kV
Deflection angle	40^o	
Resolution	1000	lines

SCREEN

Metal backed

	Colour	Persistence
MC13-16	Purplish blue	Very short
MK13-16	Green	Short

Useful screen diameter	min.	108	mm

HEATING

Indirect by A.C. or D.C.; series or parallel supply

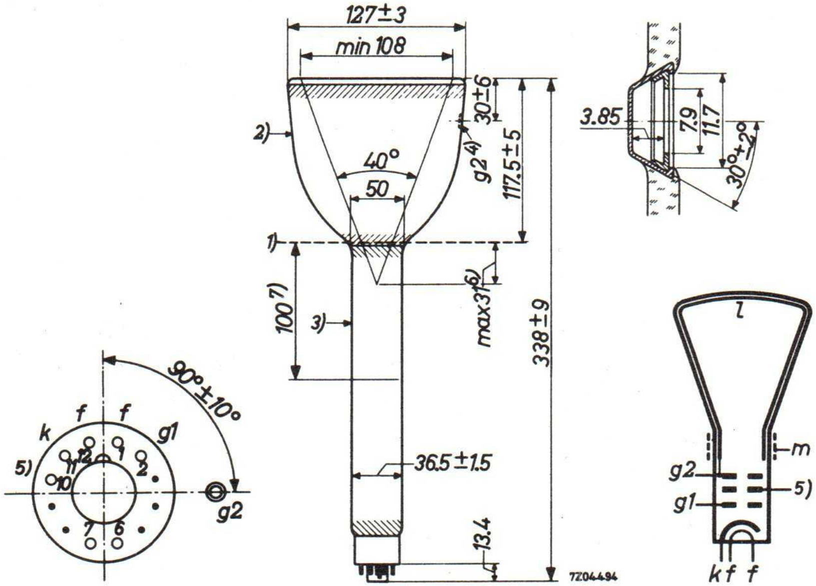
Heater voltage	V_f	6.3	V
Heater current	I_f	300	mA

CAPACITANCES

Grid No.1 to all other electrodes	C_{g_1}	6.5	pF
Cathode to all other electrodes	C_k	6.5	pF
Accelerator to outer conductive coating	$C_{g_2(\ell)/m}$	250 to 450	pF

7Z2 6432

MECHANICAL DATA Dimensions in mm



Mounting position: any, except with screen downwards and the axis of the tube making an angle of less than 50° with the vertical.

Base Duodecal 7p.

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1) Reference line, determined by the plane of the upper edge of the reference line gauge when the gauge is resting on the cone.

2) Insulating outer coating; should not be in close proximity to any metal part.

3) Conductive outer coating; to be grounded.

4) Recessed cavity contact.

5) Spark trap; to be grounded.

6) The distance between the deflection centre and the reference line should not exceed 31 mm.

7) Distance between the centre of the magnetic length of the focusing unit and the reference line.

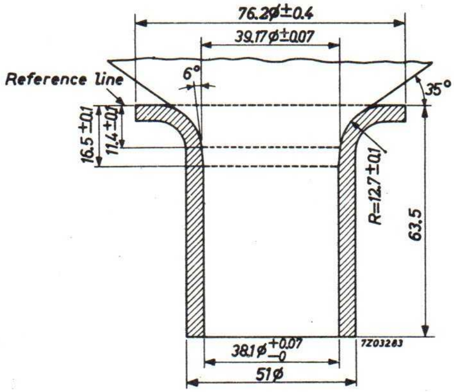
7Z2 6433

FOCUSING magnetic

Focusing coil type AT1997

DEFLECTION magnetic

REFERENCE LINE GAUGE Dimensions in mm



OPERATING CHARACTERISTICS

Accelerator voltage	$V_{g2(\ell)}$	25	kV
Beam current	I_{ℓ}	50 to 150	μA
Negative grid No.1 cut-off voltage	$-V_{g1}(I_{\ell}=0)$	50 to 100	V

Resolution at centre of screen better than 1000 lines [1])

[1]) With focusing coil AT1997

7Z2 6434

LIMITING VALUES (Absolute max. rating system)

Accelerator voltage	$V_{g_2(\ell)}$	max. min.	27 20	kV kV
Grid No. 1 voltage,				
negative value	$-V_{g_1}$	max.	200	V
positive value	$+V_{g_1}$	max.	0	V
peak positive value	$+V_{g_{1p}}$	max.	2	V
Cathode current	I_k	max.	150	μA
Voltage between heater and cathode [1]				
cathode negative	V_{kf} (k neg.)	max.	125	V
cathode positive	V_{kf} (k pos.)	max.	200	V
peak value, cathode positive	V_{kf_p} (k pos.)	max.	410	V [2]
External resistance between heater and cathode	R_{kf}	max.	1	MΩ
External grid No. 1 resistance	R_{g_1}	max.	1.5	MΩ
External grid No. 1 impedance at a frequency of 50 c/s	Z_{g_1} (f = 50 c/s)	max.	0.5	MΩ

REMARKS

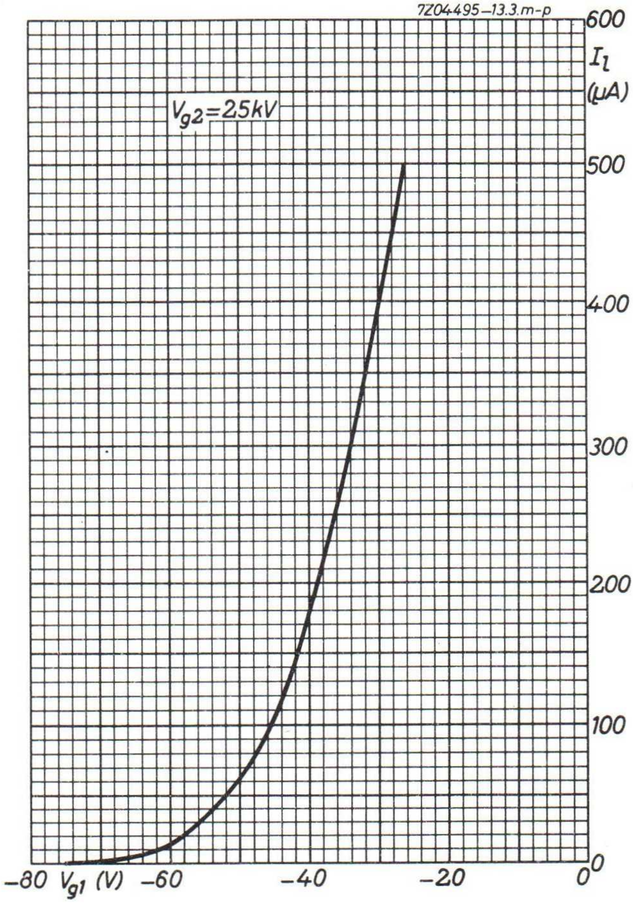
Measures should be taken for the beam current to be switched off immediately when one of the time-base circuits becomes defective.

An X-ray radiation shielding with an equivalent lead thickness of 0.5 mm is required to protect the observer.

1) In order to avoid excessive hum, the A.C. component of the heater to cathode voltage should be as low as possible and should not exceed 20 V_{RMS}.

2) During a heating-up period not exceeding 45 sec.

7Z2 6440


7Z04495–13.3.m-p
V_{g2}=25kV
600
I_l
(μA)
500
400
300
200
100
0
–80 V_{g1} (V) –60
–40
–20
0

PART 6

PROJECTION CATHODE-RAY TUBES

PREFERRED TYPES

PROJECTION TUBES			
Colour			
White	Blue	Red	Green
MW13-38	MU6-2 MU13-38	MY6-2 MY13-38	MG6-2 MG13-38

PROJECTION TUBE

The M.6-2 are 6 cm diameter colour TV projection tubes.

QUICK REFERENCE DATA	
Accelerator voltage	25 kV
Deflection angle	67.5°
Focusing	magnetic

SCREEN

Metal backed

Type	MG6-2	MU6-2	MY6-2
Colour	green	blue	yellow
Colour point	x=0.19 y=0.72	x=0.17 y=0.13	x=0.54 y=0.46

The MY6-2 should be used in conjunction with a suitable filter (e.g. Wratten filter No.25).

Colour points of MY in combination with Wratten No.25 filter x=0.67 y=0.33

Useful screen diameter min. 55 mm

HEATING

Indirect by A.C. or D.C.; parallel or series supply

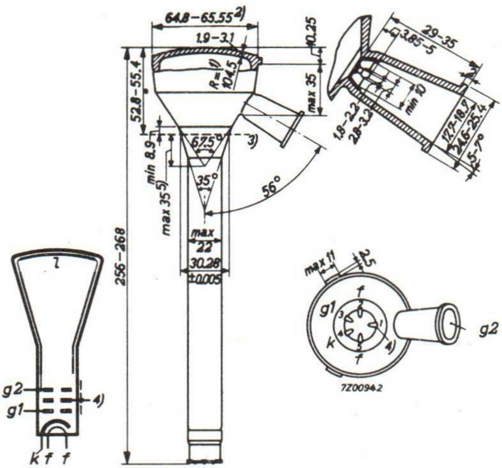
Heater voltage	V_f	6.3	V
Heater current	I_f	300	mA

CAPACITANCES

Control grid to all other elements	C_{g_1}	6.3	pF
Cathode to all other elements	C_k	6.3	pF
Accelerator to external conductive coating	$C_{g_2/m}$	450	pF

7Z2 6406

MECHANICAL DATA Dimensions in mm



Mounting position: any, except with screen downwards with the axis at an angle of less than 50° with the vertical.
The tube should not be supported by the base alone and under no circumstances should the socket be allowed to support the tube.

Base

Dimensions and connections

Overall length	max.	268	mm
Face diameter	max.	65.55	mm
Net weight		145	g

1) Inner radius of curvature of the face plate.
The deviation of the centre of the outer radius of curvature with respect to the centre line of the neck is max. 2 mm.

2) Eccentricity of the face plate with respect to the centre line of the neck max. 0.9 mm.

3) Reference line, determined by the diameter of 30.28 ± 0.005 mm.

4) Spark trap and outer coating. This connection must be earthed.

5) The distance from deflection centre to reference line should not exceed 35 mm.

7Z2 6403

FOCUSING magnetic

Focusing coil	with iron casing	
Number of ampere-turns (V_a = 25 kV)	920	[1]
Air gap	11-13	mm
Distance from the centre of the air gap to the reference line	83-87	mm
Inner diameter of the inner bush	27.5	mm

For centering it is necessary that the focusing coil can be tilted over 2.5 - 3° to either side.

DEFLECTION double magnetic

deflection angle 67.5°

TYPICAL OPERATING CONDITIONS

Accelerator voltage	$V_{g_2}(\ell)$	25	kV
Negative grid No. 1 voltage for visual extinction of a focused spot	$-V_{g_1}$	40 to 90	V

LIMITING VALUES (Absolute max. rating system)

Measured with respect to cathode

Accelerator voltage	$V_{g_2}(\ell)$	max.	25	kV [2]
Control grid voltage				
negative	$-V_{g_1}$	max.	200	V
positive	V_{g_1}	max.	0	V
Cathode to heater voltage,				
cathode positive	$V_{+k/f-}$	max.	125	V
Resistance between heater and cathode	R_{kf}	max.	20	kΩ
Resistance between grid and earth	R_{g_1}	max.	1.5	MΩ

General observations

Measures should be taken for the anode current to be switched off immediately when one of the time-base circuits becomes defective. An X-ray radiation shielding with an equivalent lead thickness of 0.5 mm is required to protect the observer. When the tube is used in an optical box, the screening by the box will in general be sufficient.

[1][2] See page 4.

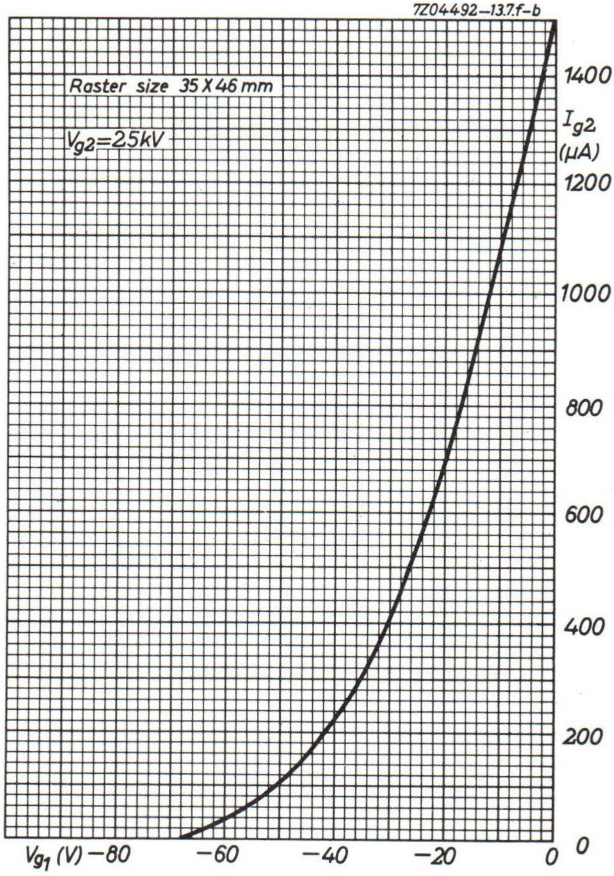
7Z2 6404

[1]) Without saturation of the iron casing.
In order to reduce the influence of voltage fluctuations it is, however, advisable to saturate the iron to such an extend that the required number of ampere-turns becomes about 10% higher.

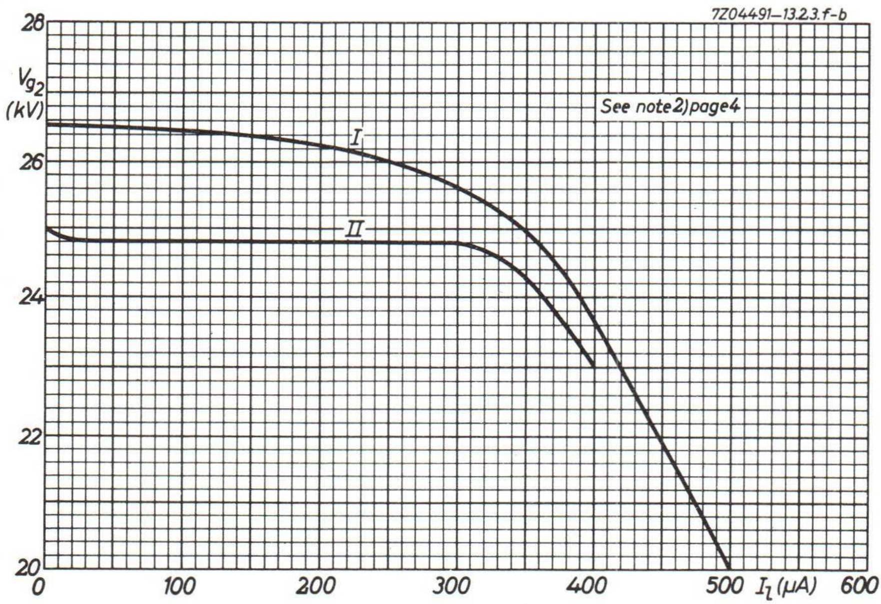
[2]) At nominal mains voltage and with a raster area of at least 14 cm^2 and a spot velocity of at least 450 m/s the load curve of the E.H.T. unit should not at any point go beyond the curve I on page B. It is desirable that under these conditions the design load curve is in accordance with curve II.

The total charge of the filter capacitors in the supply unit should not exceed 130 μC.
The curves on page B refer to application of the M.6-2 in normal television receivers. In case of other applications the average current, consumed by the M.6-2 should be limited to 200 μA.

7Z2 6405


7Z04492–13.7.f–b
Raster size 35 X 46 mm
V_{g2}=2.5kV
1400
I_{g2}
(μA)
1200
1000
800
600
400
200
0
V_{g1} (V) −80
−60
−40
−20
0

MW 6-2 Cathode →



PROJECTION TUBE

The MW6-2 is a 6 cm diameter TV projection tube.

QUICK REFERENCE DATA	
Accelerator voltage	25 kV
Deflection angle	67.5^{o}
Focusing	magnetic

SCREEN

Metal backed

Colour	white
Useful screen diameter	min. 55 mm

HEATING

Indirect by A.C. or D.C.; parallel or series supply

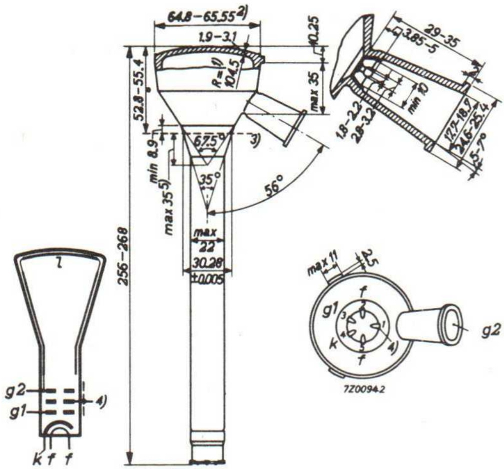
Heater voltage	V_f	6.3	V
Heater current	I_f	300	mA

CAPACITANCES

Control grid to all other elements	C_{g_1}	6.3	pF
Cathode to all other elements	C_k	6.3	pF
Accelerator to external conductive coating	$C_{g_2/m}$	450	pF

7Z2 6402

MECHANICAL DATA Dimensions in mm



Mounting position: any, except with screen downwards with the axis at an angle of less than 50° with the vertical.
The tube should not be supported by the base alone and under no circumstances should the socket be allowed to support the tube.

Base

Dimensions and connections

Overall length	max.	268	mm
Face diameter	max.	65.55	mm
Net weight		145	g

1) Inner radius of curvature of the face plate.
The deviation of the centre of the outer radius of curvature with respect to the centre line of the neck is max. 2 mm.

2) Eccentricity of the face plate with respect to the centre line of the neck max. 0.9 mm.

3) Reference line, determined by the diameter of 30.28 ± 0.005 mm.

4) Spark trap and outer coating. This connection must be earthed.

5) The distance from deflection centre to reference line should not exceed 35 mm.

7Z2 6403

FOCUSING	magnetic		
Focusing coil		with iron casing	
Number of ampere-turns (V_a = 25 kV)		920	[1]
Air gap		11-13	mm
Distance from the centre of the air gap to the reference line		83-87	mm
Inner diameter of the inner bush		27.5	mm

For centering it is necessary that the focusing coil can be tilted over 2.5 - 3^{o} to either side.

DEFLECTION double magnetic

deflection angle 67.5^{o}

TYPICAL OPERATING CONDITIONS

Accelerator voltage	$V_{g_2}(\ell)$	25	kV
Negative grid No.1 voltage for visual extinction of a focused spot	$-V_{g_1}$	40 to 90	V

LIMITING VALUES (Absolute max. rating system)

Measured with respect to cathode

Accelerator voltage	$V_{g_2}(\ell)$	max.	25	kV [2]
Control grid voltage				
negative	$-V_{g_1}$	max.	200	V
positive	V_{g_1}	max.	0	V
Cathode to heater voltage,				
cathode positive	$V_{+k/f-}$	max.	125	V
Resistance between heater and cathode	R_{kf}	max.	20	kΩ
Resistance between grid and earth	R_{g_1}	max.	1.5	MΩ

General observations

Measures should be taken for the anode current to be switched off immediately when one of the time-base circuits becomes defective. An X-ray radiation shielding with an equivalent lead thickness of 0.5 mm is required to protect the observer. When the tube is used in an optical box, the screening by the box will in general be sufficient.

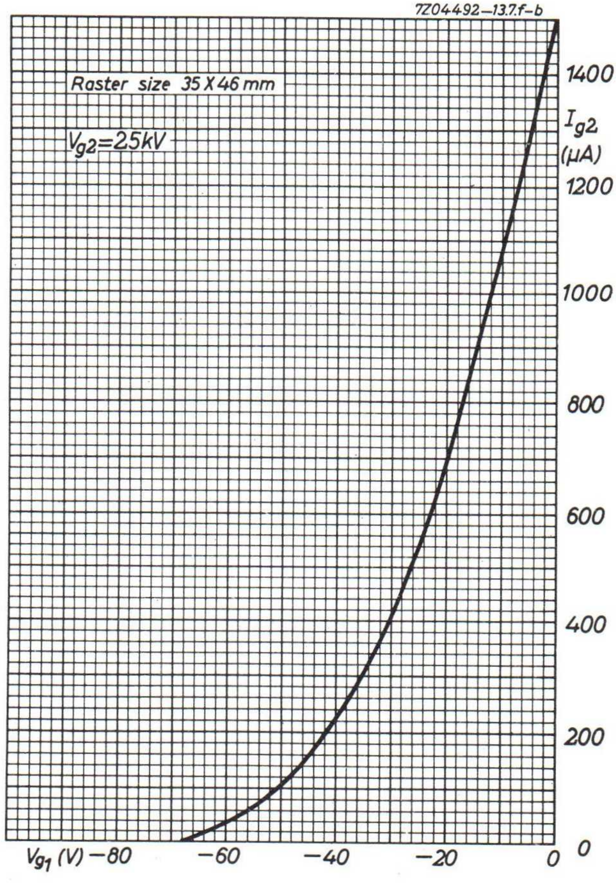
[1][2] See page 4.

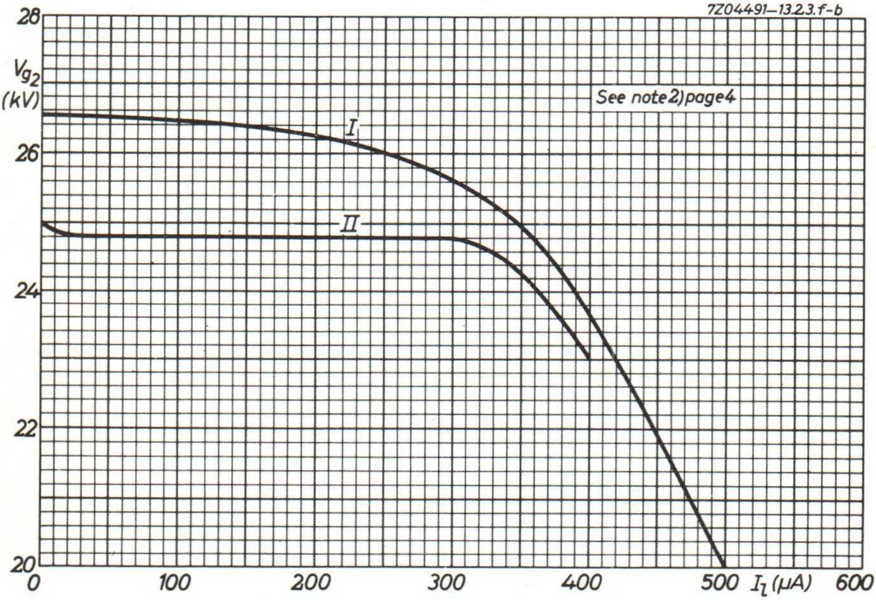
---

[1]) Without saturation of the iron casing.
In order to reduce the influence of voltage fluctuations it is, however, advisable to saturate the iron to such an extend that the required number of ampere-turns becomes about 10% higher.

[2]) At nominal mains voltage and with a raster area of at least 14 cm^2 and a spot velocity of at least 450 m/s the load curve of the E.H.T. unit should not at any point go beyond the curve I on page B. It is desirable that under these conditions the design load curve is in accordance with curve II.

The total charge of the filter capacitors in the supply unit should not exceed 130 μC.
The curves on page B refer to application of the M.6-2 in normal television receivers. In case of other applications the average current, consumed by the M.6-2 should be limited to 200 μA.


7Z04492–13.7.f–b
Raster size 35 X 46 mm
V_{g2}=25kV
1400
I_{g2}
(μA)
1200
1000
800
600
400
200
0
V_{g1} (V) −80
−60
−40
−20
0


7Z04491–13.2.3.f-b
28
V_{g_2} (kV)
26
24
22
20
0
100
200
300
400
500
600
I_l (µA)
I
II
See note 2) page 4

PROJECTION TUBE

The M.13-38 are 13 cm diameter projection tubes.
The tubes are designed for large screen projection of colour TV displays.

QUICK REFERENCE DATA	
Final accelerator voltage	50 kV
Deflection angle	47^o
Focusing	magnetic

SCREEN

Type	MG13-38	MU13-38	MY13-38
Colour	green	blue	yellow [1]
Colour point	x=0.19 y=0.72	x=0.17 y=0.13	x=0.54 y=0.46 x=0.67 y=0.33 [2]

Useful diameter min. 69x92 mm^2

Brightness

MG13-38	2000	mcd/cm^2
MU13-38	290	mcd/cm^2
MY13-38 without Wratten No. 25 filter	~~1600~~	mcd/cm^2
MY13-38 with Wratten No. 25 filter	~700 ~~375~~	mcd/cm^2

measured at V_{g_2} = 50 kV
I_ℓ = 500 μA
raster size 92x69 mm^2

HEATING

Indirect by A.C. or D.C.; parallel or series supply

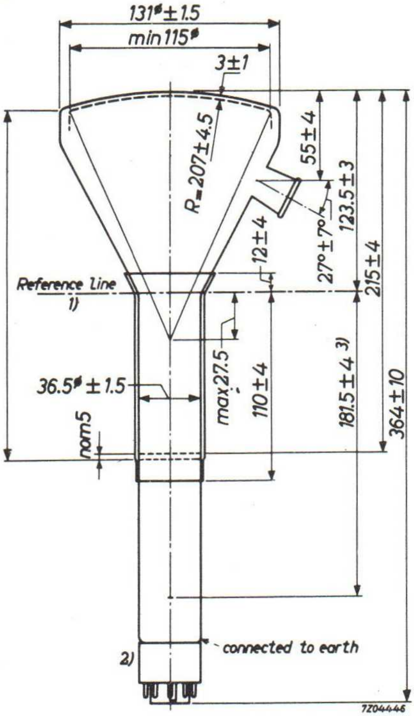
Heater voltage	V_f	6.3	V
Heater current	I_f	300	mA

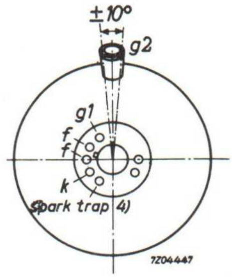
[1][2]) See page 4

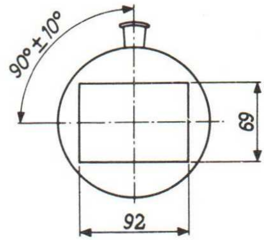
7Z2 6397

MECHANICAL DATA

Dimensions in mm







1) Reference line is determined by position where a gauge 38.1 $^{+0.05}_{-0.00}$ mm diameter and 50 mm long will rest on bulb cone.

2) Socket for this base should not be rigidly mounted; it should have flexible leads and be allowed to move freely. Bottom circumference of base shell will fall within circle concentric with cone axis and having a diameter of 50 mm.

3) Distance reference line - top centre of grid.

4) This pin must be connected to earth.

7Z2 6398

MECHANICAL DATA (continued)

Mounting position: any, except with screen downwards with the axis at an angle of less than 50° to the vertical.
The tube should not be supported by the base alone and under no circumstances should the socket be allowed to support the tube.

Base	Duodecal 7 p
Dimensions and connections	
Overall length	max. 374 mm
Face diameter	max. 132.5 mm
Net weight	approx. 950 g
Accessories	
Socket	type 5912/20
Final accelerator contact connector	supplied with tube

CAPACITANCES

Control grid to all other elements	C_{g_1}	max.	10	pF
Cathode to all other elements	C_k	max.	9	pF

FOCUSING magnetic

Distance from the centre of the air gap of the focusing coil to the front of the screen 240 mm

DEFLECTION double magnetic

deflection angle 47°

TYPICAL OPERATING CONDITIONS

Accelerator voltage	$V_{g_2(\ell)}$	50	kV
Negative grid No.1 voltage for visual extinction of focused raster	$-V_{g_1}$	100 to 170	V
Peak accelerator current	$I_{g_{2p}}$	min. 2500	μA

7Z2 6399

LIMITING VALUES (Absolute max. rating system)

Measured with respect to cathode

Accelerator voltage	$V_{g_2(\ell)}$	max.	55	kV	
		min.	40	kV	
Control grid voltage,					
negative	$-V_{g_1}$	max.	200	V	
positive	V_{g_1}	max.	0	V	
positive peak	$V_{g_{1p}}$	max.	0	V	
Grid No.2 current	I_{g_2}	max.	500	μA	[3]
Cathode to heater voltage,					
cathode positive	$V_{+k/f-}$	max.	100	V	
cathode negative	$V_{-k/f+}$	max.	50	V	[4]
Resistance between heater and cathode	R_{kf}	max.	20	kΩ	
Resistance between grid and earth	R_{g_1}	max.	1.5	MΩ	
Impedance between grid and earth (f = 50 Hz)	Z_{g_1}	max.	0.5	MΩ	

[1] The tube must be combined with a suitable filter (e.g. Wratten No.25).

[2] Measured in combination with Wratten filter No.25.

[3] In order to prevent the possible occurrence of cracked faces, for images with concentrated bright areas (high screen loads) the g_2 current should be kept lower than the indicated value. This is especially the case as for as stationary pictures are concerned.

[4] In order to avoid excessive hum, the A.C. component of the heater to cathode voltage should be as low as possible and must not exceed 20 V_{RMS}.

7Z2 6400

GENERAL OBSERVATIONS

It is essential that means be provided for the instantaneous removel 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.

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

The raster dimensions should not come below the minimum of 69x72 mm^2. The screen shall be given adequate cooling by applying a continuous airblast onto the screen of approx. 0.06 m^3/sec.

In order to prevent damage of the tube caused by a momentary internal arc a resistor of 50 kΩ has to be connected between anode contact and the power supply.

Before removing the tube, the screen and the cone should be discharged.

The spark trap and the outer coating of the tube must be connected to earth.

It is necessary to centre the focusing coil to get optimum sharpness.

It is recommended to use the E.H.T. connector, which is delivered with each tube.

PROJECTION TUBE

The MW13-38 is a 13 cm diameter projection tube.
The brightness of the tube is such that it can be used for large screen projection of TV displays.

QUICK REFERENCE DATA	
Final accelerator voltage	50 kV
Deflection angle	47^{o}
Focusing	magnetic

SCREEN

Metal backed

Colour	white
Useful screen diameter	69 x 92 mm^2
Brightness	min. 870 mcd/cm^2

measured at V_{g_2} = 50 kV
I_l = 500 μA
raster size 92 x 69 mm^2

HEATING

Indirect by A.C. or D.C.; parallel or series supply

Heater voltage	V_f	6.3	V
Heater current	I_f	300	mA

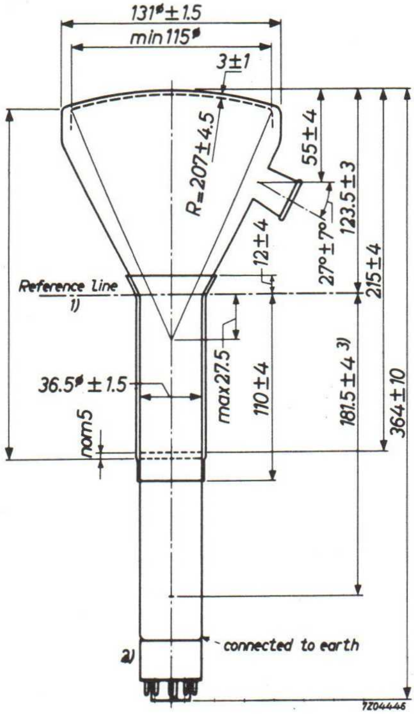
CAPACITANCES

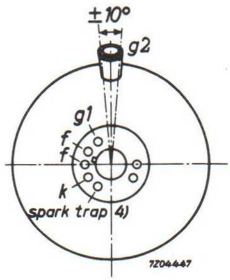
Control grid to all other elements	C_{g_1}	max.	10	pF
Cathode to all other elements	C_k	max.	9	pF

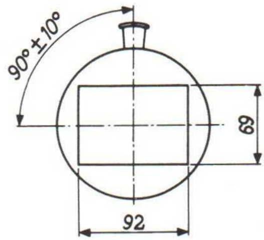
7Z2 6392

MECHANICAL DATA

Dimensions in mm







1) Reference line is determined by position where a gauge 38.1 $^{+0.05}_{-0.00}$ mm diameter and 50 mm long will rest on bulb cone.

2) Socket for this base should not be rigidly mounted; it should have flexible leads and be allowed to move freely. Bottom circumference of base shell will fall within circle concentric with cone axis and having a diameter of 50 mm.

3) Distance reference line - top centre of grid.

4) This pin must be connected to earth.

7Z2 6393

MECHANICAL DATA (continued)

Mounting position: any, except screen downwards with the axis at an angle of less than 50° to the vertical.
The tube should not be supported by the base alone and under no circumstances should the socket be allowed to support the tube.

Base	Duodecal 7 p
Dimensions and connections	
Overall length	max. 374 mm
Face diameter	max. 132.5 mm
Net weight	approx. 950 g
Accessories	
Socket	type 5912/20
Final accelerator contact connector	supplied with tube

FOCUSING magnetic

Distance from the centre of the air gap of the focusing coil to the front of the screen 240 mm

DEFLECTION double magnetic

deflection angle 47°

TYPICAL OPERATING CONDITIONS

Accelerator voltage	$V_{g_2(\ell)}$	50	kV
Negative grid No.1 voltage for visual extinction of a focused raster	$-V_{g_1}$	100 to 170	V
Peak accelerator current	$I_{g_{2p}}$	min. 2500	μA

duty cycle:

7Z2 6394

LIMITING VALUES (Absolute max. rating system)

Measured with respect to cathode

Accelerator voltage	$V_{g_2(\ell)}$	max.	55	kV	
		min.	40	kV	
Control grid voltage,					
negative	$-V_{g_1}$	max.	200	V	
positive	V_{g_1}	max.	0	V	
positive peak	$V_{g_{1p}}$	max.	0	V	
Grid No. 2 current	I_{g_2}	max.	500	μA	[1]
Cathode to heater voltage,					
cathode positive	$V_{+k/f-}$	max.	100	V	[2]
cathode negative	$V_{-k/f+}$	max.	50	V	
Magnification maximum			40	x	
Resistance between heater and cathode	R_{kf}	max.	20	kΩ	
Resistance between grid and earth	R_{g_1}	max.	1.5	MΩ	
Impedance between grid and earth (f = 50 Hz)	Z_{g_1}	max.	0.5	MΩ	

[1]) In order to prevent the possible occurrence of cracked faces, for images with concentrated bright areas (high screen loads) the g_2 current should be kept lower than the indicated value. This is especially the case as for as stationary pictures are concerned.

[2]) In order to avoid excessive hum, the A.C. component of the heater to cathode voltage should be as low as possible and must not exceed 20 V_{RMS}.

7Z2 6395

GENERAL OBSERVATIONS

It is essential that means be provided for the instantaneous removel 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.

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

The raster dimensions should not come below the minimum of 69x72 mm^2. The screen shall be given adequate cooling by applying a continuous airblast onto the screen of approx. 0.06 m^3/sec.

In order to prevent damage of the tube caused by a momentary internal arc a resistor of 50 kΩ has to be connected between anode contact and the power supply.

Before removing the tube, the screen and the cone should be discharged.

The spark trap and the outer coating of the tube must be connected to earth.

It is recommended to use the E.H.T. connector, which is delivered with each tube.

It is necessary to centre the focusing coil to get optimum sharpness.

7Z2 6396

PART 7

SCREEN PHOSPHORS

SCREEN PHOSPHORS AND

INDUSTRIAL CATHODE-RAY TUBES

CHOICE OF SCREEN

When a cathode ray tube is chosen for a particular application, the designer of the apparatus bases his choice on a number of factors; for example, screen shape and size, the operating potentials that will be available, and the screen characteristics. He may find that the required physical and electrical configuration is provided by a number of tube types which employ different screen phosphors, so that he will have to choose between one phosphor and another. In any event, the performance obtainable from the screen is of major importance, since the purpose of any cathode ray tube application is the provision of a suitable display.

Here the relationship between screen characteristics and the requirements of the main groups of applications will be discussed. The suitability of particular screen types is considered in terms of operating conditions that will be met and the performance that must be achieved.

The ultimate choice is determined by the detailed requirements of each specific application; therefore, in addition to general guidance, the methods of calculating the performance that will be obtained under given conditions are included. The calculations take into account the characteristics of the screen, the operational requirements, the nature of the viewing device, and the effect (where the screen is viewed by the eye) of the external viewing conditions.

GENERAL REQUIREMENTS

The three major screen properties - energy conversion efficiency, persistence, and spectral distribution - should be those most suitable for the application. Where there is any degree of conflict between one requirement and another, the best compromise must be achieved. The performance of the screen should be reasonably constant throughout the range of beam currents that is likely to be met.

These general requirements will be discussed in relation to the main groups of cathode ray tube applications. These are:

1. Raster type applications, in which the writing speed is generally constant but the beam current is modulated to produce variation of light and shade.
2. Oscilloscope applications, in which the beam current is usually constant during a trace but the writing speed may vary.

7Z2 5898

3. Radar applications

4. Flying-spot scanners

5. Storage applications

SCREENS FOR RASTER TYPE APPLICATIONS

A number of different screens are available for raster type displays. Those which are most suitable for the main sub-groups of this group of applications are indicated in the following notes.

Monitors and Viewfinders

Monitoring and viewfinding systems in television studios operate at the same field repetition frequency and timebase speed as the broadcast channel, and their screen requirements are substantially the same as those of domestic television tubes. The repetition frequencies are such that persistence of vision and the persistence of the screen obviate flicker. The persistence must not be sufficiently great to smear the images of moving objects.

In monochrome television systems, white fluorescence is used, for aesthetic reasons. The W type screen is widely established for domestic viewing tubes and studio monitors and viewfinders.

Closed Circuit Systems

Where closed circuit monochrome television systems make use of normal television field and line speeds, screens with W phosphor are suitable.

In some systems, however, other speeds are used. If the scanning speed is low, the screen must have a persistence which is long enough to minimise flicker, and a long-persistence screen such as type LA, LD or LC must be used in order to maintain a complete picture.

Data Transmission

Since the images to be transmitted are, in general, stationary, the information does not need to be modified at the same rate as television picture information. The field repetition frequency and the bandwidth can be reduced, and transmission over lines is relatively simple. At repetition frequencies down to five fields per second a tolerable freedom from flicker is achieved with the cadmium chloro-phosphate phosphors that are used, for example, in the LA screen. For even lower frequencies, the LD screen is recommended. This screen, it should be noted, has a relatively low power-loading limit, and care must be taken to avoid burning.

7Z2 5899

Telerecording

A major limitation to the quality of telerecording is the difficulty of both pulling the film through the camera gate and operating the shutter in the field flyback time. In early systems, the first field of the interlaced picture was used for these operations; therefore only half the information was recorded.

To overcome this limitation, the information from the first field is stored in the screen of the cathode ray tube during the time that the shutter is closed. The film is pulled through the gate and the shutter is opened. The second field is then imposed on the stored field on the screen. The stored information of the first field will, of course, have lost some of its initial luminance; therefore the second field is written on the screen at a correspondingly reduced luminance level. The full interlaced information is then photographed.

The application is obviously a critical one, and the screen must meet a number of special requirements. The persistence must be defined within narrow limits, and it must be substantially constant throughout the life of the tube, otherwise the timing of the system will be inaccurate. There must not be a sharp peak of light output ("flash") at the moment of excitation, otherwise the second field will appear brighter than the first. And the light output from the first field must not have decayed to an unusably low level by the time that the second field has to be written.

These special requirements are met by screen type LA.

SCREENS FOR RASTER TYPE APPLICATIONS

The range of frequencies for which oscilloscopes are designed is extremely wide, and even in a single instrument a wide range may have to be covered. The requirements of light output and persistence at high speeds conflict with the requirements at low speeds, therefore a compromise is usually necessary. If the screen that is used has a good luminous efficiency, a satisfactory compromise can be attained.

General Purpose Applications

The screens in the G group are widely used in general purpose oscilloscopy. They have a high efficiency and a reasonably fast build-up, so that they are suitable for use at fairly high writing speeds. The GH screen has two spectral distribution peaks, one in the green and one in the blue region. The blue peak provides a high actinic efficiency for use with panchromatic film or, in some instances, with orthochromatic film. However, the effective visual persistence is rather short, so that at slow scan speeds very little information is obtained from the trace.

The lack of visual persistence in the GH screen has led to the introduction of the GL and GP types. The high efficiency of the GH screen is largely retained, but the persistence is of the order of one to five seconds, depending on the operating conditions. Slow scan speeds can therefore be used.

The GM screen has a purplish-blue flash and a yellowish-green persistence. For normal oscilloscopic work, and especially at voltages between 1 kV and 10 kV, this is the recommended screen if a long persistence is the main requirement. The luminous efficiency is about one-fourth of that of the GH type, so that for this reason, as well as the long persistence, the GM screen is not suitable for high-speed applications.

Non-recurrent High-speed Applications

When a rapid non-recurrent phenomenon is to be observed, a long-persistence screen with a slow build-up is not suitable. The usual technique is to use a fast screen and photographic recording. A timebase, triggered by the incoming signal, is applied to the X deflectors, and the signal itself to the Y deflectors.

The choice of screen for the single-shot type of application is dictated by the recording material that is to be used. For panchromatic and some orthochromatic film, the GH screen provides the fastest writing speed. If the trace is visible on this screen, then, in general, it can also be photographed if good photographic materials and techniques are used. For blue-sensitive film or recording paper the BE screen is preferable. Its luminous efficiency is low, but its spectral characteristic matches that of the emulsion.

Moving Film Applications

When a moving film technique is employed for the recording of recurrent phenomena, the persistence of the screen must be short if smearing of the image is to be avoided. With orthochromatic film, the BE screen is recommended. Smearing is negligible in the majority of applications, and appears only under certain unusual and extreme conditions. Equally good results may be obtained with panchromatic film and the GH screen.

Slow-scan Applications

Visual observations of slowly-varying functions is often unsatisfactory with general purpose screens. The eye does not easily appreciate the path of a moving spot, since the spot tends to attract most of the observer's attention. This difficulty is overcome, to some extent, by the use of a long-persistence screen. The spot leaves a trace which persists long enough for the waveform to be examined.

The useful persistence of any screen is dependent on the ambient illumination. If the screen is provided with a hood, a dark-adapted eye can see the trace down to quite low levels of light output. Writing speed also affects the persistence, to a certain limit which depends on the screen type which is used. In single-shot applications an increase in spot velocity will reduce the persistence, and vice versa. The observation of information which recurs only a few times per second can be improved by the use of a long-persistence screen; but, in general, the length of the persistence obtained will not be great.

For most long-persistence applications the GM screen is recommended. The GL and GP screens are also useful.

For very long persistence the LC or LD screens are used. They have orange luminescence. Care should be taken to avoid overloading these screens, since they are prone to burning.

SCREENS FOR RADAR APPLICATIONS

A long persistence is usually of primary importance in radar applications, because the aerial sweep is slow and the picture must be retained for relatively long periods. The choice of a screen is complicated if the display is to be viewed where there is much ambient light. A long-persistence screen with a relatively low light output may be less suitable than a screen with shorter persistence but greater light output.

The build-up characteristic is of particular interest in radar applications. It can be exploited, under conditions of repeated excitation, to differentiate between the desired "permanent" echoes and noise such as sea clutter. The echo from a target is repeatedly displayed on successive scans, and full brightness is built up; whereas transitory echoes are not additive, and produce less than peak brightness. The published build-up curves for radar-type screens are presented in a way that simulates p.p.i. conditions. Points on the curve, as shown in "Screen data", represent the light output from the screen immediately before each excitation pulse.

Radar requirements, when examined in detail, are found to be exacting. For instance, in general purpose marine navigational systems the performance must be satisfactory throughout a wide variety of aerial sweep speeds, pulse repetition frequencies, and target ranges (say from 0.5 to 50 miles). In a single installation, a diversity of operating conditions must be catered for, therefore the choice of screen for the display tube is necessarily a compromise. A number of screen types are available.

The LD screen has found extensive use in medium-range marine navigational systems. It has a very long persistence which provides a good display over a large variety of aerial rotation speeds and pulse repetition frequencies.

In river radar systems with short ranges and fast-moving targets, a rather shorter persistence is required, since it is only necessary to maintain good brightness between sweeps. Also, if the range has to be changed when navigating at close quarters, the trace from the earlier scan must clear quickly if it is not to clutter the first traces of the later scan. The LB screen meets these requirements.

7Z2 5902

In long-range navigational radar, and particularly in marine true-motion installations, the LC very long-persistence screen is widely used. It is also suitable where successive traces of a moving target are required for comparison, so that paths and speeds can be seen directly. The LC screen is also used in meteorological work, in airfield control, and in military radar systems. In many instances it is used in conjunction with interscan and data-handling techniques.

The GM long-persistence screen is sometimes used in marine radar. Its persistence is considerably shorter than that of the LC and LD screens. It has a disadvantage in that it does not provide the resolution capabilities possessed by tubes which use LC or LD screens. The reason for the lower resolution is that the screen is of the double-layer type; and, in order to obtain the desired decay characteristic, it is thicker than the LC and LD screens. The first layer is excited by electrons. This layer re-emits energy in the ultraviolet region, which then excites the second layer from which the luminous output is obtained. Resolution is lost during this process because of the scattering of the ultraviolet through the thickness of the second layer.

The GB screen is, like the GM screen, of the double-layer variety. It is used successfully in weather warning systems in aircraft cockpits. The main requirement is the ability to withstand the high accelerating voltages used in tubes for this type of application. Its long persistence is similar to that of the GM screen. With the aerial scanning speeds that occur in this type of equipment it displays complete cloud formations during the aerial sweep.

One of the main uses of the GJ medium-persistence screen is in airborne radar systems, where the scan rate is high enough to overcome the limited persistence of the screen. Its spectral emission makes it suitable for visual observation at the high ambient light levels normally encountered in this type of application.

For large radar displays a projection system may be used. For this purpose the BC screen, which has a killed persistence, provides a purplish-blue and ultraviolet output which is projected, by optical means, on to a large secondary screen which has suitable long-persistence characteristics.

SCREENS FOR FLYING-SPOT SCANNERS

In flying-spot scanners the energy conversion efficiency of the screen, throughout the spectral range that corresponds to the colour response of the detecting device, must be as high as possible.

Very short persistence is essential where high-definition scans are used, but the requirement is less stringent for slow-speed facsimile reproduction. For example, if a 625-line raster of 5 Mc/s definition is required, then there must be no effective light output after 0.3 μs; but for a slow-speed system of comparable definition and a line speed of one second, the persistence can be as long as 2 ms.

7Z2 5903

The BA very short-persistence screen is widely used for monochrome raster-type applications. Its peak output is at 400 to 420 mμm, in the ultraviolet region. It is therefore particularly suitable for use with photomultipliers having conventional caesium-antimony photocathodes. The persistence enables a good overall signal-to-noise ratio to be achieved.

The GE short-persistence screen has been developed for flying-spot applications in colour television systems. Its persistence is sufficiently short. It has an adequate light output in the red region of the visible spectrum, with a peak at 510 mμm in the green region.

SCREENS FOR STORAGE APPLICATIONS

In some applications it is an advantage if a trace can be stored for future examination or for direct comparison with later traces. The GN screen provides storage for periods up to several hours.

A back layer emits energy in the blue and ultraviolet region when it is bombarded with electrons. The front layer, excited by the ultraviolet radiation, has blue fluorescence and green phosphorescence, with a persistence of the same order as that of the GM screen.

If the screen is subsequently exposed to infrared radiation, a second light output is obtained, with an intensity and a persistence which are functions of the original writing conditions and of the intensity of the infrared irradiation. The stored trace, or a succession of superimposed traces, can thus be made available. The stored traces, when they are made visible by irradiation, have a brightness related to that at which they were written, and they all decay at the same rate as one another. Erasure is effected by prolonged infrared irradiation.

Ambient ultraviolet radiation should be excluded, since it will activate the front layer and produce background light which reduces contrast. Stray infrared should also, of course, be excluded, since it will dissipate the stored trace. The GN screen has a rather low maximum writing speed.

INTERPRETATION OF PUBLISHED SCREEN CHARACTERISTICS

INTERPRETATION OF PUBLISHED SCREEN CHARACTERISTICS

The field of c.r.t. applications is very extensive. For this reason it is impossible to provide published data covering all conceivable requirements. The measurements for published data are taken under conditions as close as possible to those at which the given screen is expected to operate. In some applications, the nature of the display does not readily lend itself to measurement purposes, and a resort has to be made to a more suitable type of display.

Where a given application departs from the conditions specified in published data, some valuable information can be extracted by means of simple calculations. Inevitably, some errors will be introduced; but in view of the approximately logarithmic response of the eye, the answers obtained are reasonably valid.

Much of the information presented in published data is based on a raster type of display, using - for measurement purposes - a non-interlaced raster of 200 lines and 50 fields per second. Whenever possible, the raster is defocused so that the lines just begin to merge together. This produces reasonably uniform screen loading. The quoted values of screen loading apply to the loading while the screen is under electron bombardment, and the effect of flyback is taken into account. The values of screen luminance given in published data are in terms of photometric units. This implies that the results are intended to represent the appearance of the display as seen by the eye.

In the following discussions, small letters are used for general considerations and for quantities in published data, while capital letters represent quantities involved in a particular case under consideration.

SCREEN LUMINANCE

The user can control four factors which affect screen luminance as seen by the eye. They are the area of excitation, the beam current, the applied potential, and the duration of excitation. A brief review of the effect of these factors on luminance will be made. In the first instance it will be assumed that only one of the factors is varied at a time.

7Z2 5905

The relationship between the luminance b and the current i reaching the screen can be written as

$$b = k_1 i^\gamma \tag{1}$$

where k_1 is a constant and the index γ at small values of current is, for most screens, slightly less than unity. It decreases in value with increase in beam current.

The relationship between the potential v applied to the screen and the luminance is more complex, and is often written in the form

$$b = k_2 (v - v_0)^n \tag{2}$$

where

k_2 = a constant
v_0 = a threshold potential
n = an index, greater than unity.

Both v_0 and n are functions of the phosphor and of the manner in which it is deposited on the tube face. For this reason the relationship may vary from one tube type to another, although the same screen type may be used.

When a screen is operated at a current density well below the saturation level, it may be assumed that the luminance increases with increase of the duration of excitation. Thus,

$$b = k_3 t \tag{3}$$

This holds only within the maximum limit for t, which is set by the time resolution of the eye and is about 0.1 s.

Over reasonably small variations in size of the excited area, the luminance can be considered as inversely proportional to the area, or

$$b = k_4/a \tag{4}$$

Experimental results seem to indicate that the luminance of the screen produced by all the factors can be represented as:

$$b = \frac{k}{a} i^\gamma (v - v_0)^n t \tag{5}$$

Thus, to a first approximation, the luminance is a function of the energy applied to the screen. The range over which the beam current and the duration of excitation may vary is considerable. However, the amount of energy the screen can handle is limited; therefore the screen can deal with an increase in one of these quantities at the expense of the other. A large increase in both the beam current and the excitation time will lead to saturation and eventually to permanent screen damage in the form of burn.

7Z2 5906

The published data are normally given in the form of average luminance b as a function of average screen loading u, or

$$b = f(u) \tag{6}$$

for several values of potential applied to the screen.

The raster itself is formed by scanning a spot progressively over a specified area. Thus an elementary screen area can be considered as that covered by the area of the electron beam. For the purpose of calculation let us assume this elementary area to be w cm wide and w cm long. If the current in the beam is i μA, then as the beam is passing the elementary area, the real screen loading is given by

$$u_{(pk)} = \frac{i}{w^2} \tag{7}$$

The duration of the loading is t_w, that is the transit time of the spot over the elementary area.

The amplitude of the waveform of peak luminance is a function of the build-up and decay characteristics of the particular screen under consideration. For screens with extremely short characteristics, the luminance is in the form of a pulse of light of amplitude $b_{(pk)}$ and duration t_w. On the other hand, a screen having long characteristics will produce luminance which follows the build-up characteristic during the excitation time t_w, and afterwards the decay characteristic. Two screens operating under identical conditions and having the same conversion efficiency, but differing in build-up and decay characteristics, should have the same $b_{(pk)}\, t_w$ product. However, their instantaneous luminance will follow their build-up characteristics, and therefore may differ considerably.

Thus the $b_{(pk)}$ used in these calculations is largely a fictitious quantity. It is equal to the area embraced by the build-up and persistence characteristic of a given screen, divided by the time of excitation. As an absolute quantity it is of little value. However, since it is derived from the screen characteristics, it is useful in comparing screen operating conditions.

Let the raster repetition frequency be $f_r = \frac{1}{t_r}$. Then: the average screen loading is

$$u = \frac{i}{w^2}\frac{t_w}{t_r} \tag{8}$$

and the average screen luminance

$$b = b_{(pk)}\frac{t_w}{t_r} \tag{9}$$

7Z2 5907

Both equations contain the term t_w/t_r. Since the raster is scanned linearly,

$$t_w = t_l \frac{w}{l} \tag{10}$$

where l is the length of scanned line and t_l is the time required to scan the line, therefore

$$\frac{t_w}{t_r} = \frac{t_l}{t_r} \frac{w}{l} \tag{11}$$

Let us assume that the raster produced for preparation of published data is so defocused that the lines are touching each other. If the raster height is h, its width is l, and the number of lines is n, then

$$w = \frac{h}{n}$$

therefore

$$\frac{t_w}{t_r} = \frac{t_l}{t_r} \frac{h}{nl} \tag{12}$$

Furthermore,

$$t_l = \frac{t_r}{n}$$

therefore

$$\frac{t_w}{t_r} = \frac{h}{n^2 l} = \frac{w^2}{hl} \tag{13}$$

Substituting in Eqs (8) and (9) we obtain

$$u = \frac{i}{hl} \tag{14}$$

and

$$b = b(pk) \frac{w^2}{hl} \tag{15a}$$

or

$$b = b(pk) \frac{h}{n^2 l} \tag{15b}$$

when the lines just touch.

The published data provide the values of average screen luminance b as a function of average screen loading u. Thus, if one of the quantities is known, it is possible to determine the other. In many cases allowances have been made for flyback times, so i is the actual current and b the actual luminance during excitation.

7Z2 5908

In all cases the published data provide information at several values of potential applied to the screen. In this way all the factors in Eq (5) are taken into account.

The derived formulas enable investigation of the effect of various screen operating conditions on the screen luminance to be made. For instance, it has been shown in Eq (15) that the peak luminance is inversely proportional to the square of spot size. Thus, with the raster size and the number of lines maintained constant, halving of the spot diameter increases the screen loading by a factor of 4. If the efficiency characteristics were linear, no change in light output would be obtained. Any possible reduction in average light output can be found approximately from published data as a ratio of

$$\frac{\text{screen luminance at 4 x operating current}}{\text{4 x screen luminance at the operating current}}$$

But there would be an increase in peak luminance in accordance with Eq (15a). It should be noted that Eq (15b) will not apply in this case, as the lines would not be touching (that is, $nw \neq h$); this equation is relevant only for luminance changes of a raster in which the lines are just touching

In oscilloscope work, especially at high writing speeds, it is of importance to obtain as high a spot luminance as possible. Consequently, the value of beam current is pushed to the limit. Unfortunately, as the beam current is increased there is some increase in beam diameter. Since the spot luminance is proportional to i/w^2, the optimum conditions are occurring when the quotient is at a maximum.

In slow-scan applications, let us assume that the tube operating conditions and the number of lines used are the same as for the published data. For the same length of scanned line, let the scanning time be T_l (where $T_l > t_l$). The increase in screen loading is in the ratio T_l/t_l.

In consequence, one would expect only a slight drop in light output for a small value of the quotient; but for large values there would be not only a drop in average screen luminance but also some distortion of spot shape caused by screen saturation.

Let us now assume that the raster repetition frequency is constant and the number of lines is varied. On the whole, not much change will be expected when the lines are overlapping. When the lines are well separated, a reduction in the number of lines will produce higher screen loading and a reduction in light output. The converse will happen when the number of lines is increased.

In the following sections an attempt will be made to evaluate various applications in terms of published data information.

7Z2 5909

DATA INTERPRETATION FOR RASTER TYPE APPLICATIONS

From the preceding argument, the average screen loading in a practical case is

$$U = \frac{I}{W^2} \cdot \frac{T_w}{T_r} \tag{16}$$

where T_w is the time taken to traverse one spot width, and T_r is the time taken to scan one raster.

The average screen luminance is

$$B = B_{(pk)} \frac{T_w}{T_r} \tag{17}$$

Let us assume that the height of the scanned raster is H, the width is L, the active line scanning time.is T_l, the raster repetition period is T_r, the number of lines is N, and the number of active lines is N_a. Then

$$T_w = T_l \frac{W}{L}$$

and

$$\frac{T_w}{T_r} = \frac{T_l}{T_r} \cdot \frac{W}{L}. \tag{18}$$

For any scan, if

τ_s = duration of scan
τ_f = duration of flyback
τ = duration of whole cycle

then

$$\tau = \tau_s + \tau_f.$$

If we write

$$\frac{\tau_f}{\tau_s + \tau_f} = p \text{ (the flyback fraction)}$$

then

$$\tau_s = \tau(1 - p) \tag{19}$$

In the case under consideration, T_l is the active scanning time, and T_m is the interval between lines, therefore

$$T_l = T_m(1 - P_l)$$

where P_l is the flyback fraction in the line direction. Similarly

$$N_a = N(1 - P_v)$$

where P_v is the vertical flyback factor.

7Z2 5910

Substitution for T_l in Eq (18) gives

$$\frac{T_w}{T_r} = \frac{1 - P_l}{T_r} \cdot T_m \cdot \frac{W}{L} \qquad (20)$$

But $T_r = NT_m$ and $N = N_a/(1 - P_v)$ therefore

$$T_m = \frac{T_r}{N_a}(1 - P_v) \qquad (21)$$

If we assume that the lines are touching, then $N_a = H/W$, therefore

$$\frac{T_w}{T_r} = (1 - P_l)(1 - P_v)\frac{W^2}{HL} \qquad (22)$$

Finally, substituting in Eqs (16) and (17) we have

$$U = \frac{I}{HL}(1 - P_l)(1 - P_v) \qquad (23)$$

and

$$B = B(pk)\frac{W^2}{HL}(1 - P_l)(1 - P_v) \qquad (24)$$

Since $W = H/N_a$ and $N_a = N(1 - P_v)$, then

$$B = B(pk)\frac{H}{N^2L}\frac{(1 - P_l)}{(1 - P_v)}\,. \qquad (25)$$

Now

$$I(1 - P_l)(1 - P_v) = I_{av} \qquad (26)$$

where I_{av} represents an average current flowing through the cathode ray tube in presence of line and field blanking. For the 405-line and 625-line television systems, $P_l = 0.185$ and $P_v = 0.07$. Thus in these systems the current I present in the raster exceeds the average current by a factor of 1.31.

In the above calculations it has been assumed that the lines of the raster are touching each other. This is rather an exception than a rule. When considering this problem it is necessary to define more accurately the screen luminance. In most cases it is a mean value for the whole raster. For these considerations the calculations are acceptable in their present form.

Frequently, the published data for television tubes are given in terms of beam current for a quoted raster size. From these values the average screen loading $u = i/hl$ may be readily obtained. Alternatively, we have from Eqs (23) and (26)

$$\frac{i}{hl} = \frac{I}{HL}$$

or

$$i = I\frac{hl}{HL}\,. \qquad (27)$$

7Z2 5911

Example

It is intended to operate a tube with a W screen as a television monitor at a screen potential of 14 kV and with a raster 20 cm by 15 cm. What luminance can be expected if the average beam current is 50 μA.

As the tube is intended for operation in a television system,

$$I_{av} = I\,(1 - P_l)\,(1 - P_v) = I \times 0.76$$

$$I = \frac{50}{0.76} = 66\ \mu A.$$

The current density is therefore

$$\frac{i}{hl} = \frac{66}{300} = 0.22\ \mu A/cm^2.$$

At this current density and at a screen potential of 14 kV, the luminance, as can be seen from the relevant curve, is 280 nt.

DATA INTERPRETATION FOR OSCILLOSCOPE APPLICATIONS

The requirements of repetitive and single-pulse applications must be considered.

Repetitive Excitation

An oscilloscope display is essentially a single trace display. In any particular situation, let us assume that the length of trace is L, the duration T_l, and the repetition frequency $F_r = 1/T_r$. For a line width W, let the transit time be T_W, then from Eq (8) the screen loading is

$$U = \frac{I}{W^2}\frac{T_W}{T_r}.$$

Since

$$T_W = T_l \frac{W}{L}$$

then

$$U = \frac{I}{WL}\frac{T_l}{T_r}. \qquad (28)$$

The average screen loading obtained from the above formula may be used to find the corresponding average trace luminance from the published data.

Single-Pulse Excitation

It is possible to estimate, from the published data, the trace luminance under single-pulse excitation. Since the trace is not repetitive, let us take a repetition frequency at which the eye resolves light modulation, say about 10 c/s.

7Z2 5912

Let this repetitive time be T_r, then the average screen loading is

$$U = \frac{I}{W^2}\frac{T_w}{T_r} \tag{29}$$

and the corresponding average screen luminance B can be found from the published data.

From Eq (9) the peak luminance is

$$B_{(pk)} = B\frac{T_r}{T_w} \tag{30}$$

and its duration is T_w.

The $B_{(pk)}T_w$ product is equal to the area under the build-up and decay characteristic of a given screen. For fast- and medium-persistence screens, most of this area will be within time T_r (< 0.1 s). Hence the luminance perceived by the eye will be

$$\frac{B_{(pk)}T_w}{T_r} = B \tag{31}$$

Example

In a particular application a scan of 4 cm and a duration of 10 μs are produced at a repetition frequency of 400 c/s. The tube has a GH type screen. It is operated at 10 kV, and the current reaching the screen during the trace is 10 μA. What trace luminance can be expected at a line width of 0.2 mm.

$I = 10\ \mu A$

$W = \frac{2}{100}$ cm

$L = 4$ cm

$T_l = \frac{10}{10^6}$ s

$T_r = \frac{1}{400}$ s

Substitution in Eq (28) gives

$$U = 10\ \frac{100}{2 \times 4}\ \frac{10}{10^6}\ \frac{400}{1} = 0.5\ \mu A/cm^{-2}$$

From the published data for the GH screen the trace luminance at 10 kV and this screen current density is seen to be 300 nt.

DATA INTERPRETATION FOR RADAR APPLICATIONS

For radar type applications, persistence is of primary importance. For this reason the published information on persistence characteristics of radar screens is more extensive than that provided for other types. The data are prepared from measurements made with a non-interlaced raster. Care is taken to defocus the raster uniformly, so that the individual lines of the raster touch each other. The whole raster is considered as a single pulse, since any given area is excited only once during any one field. 7Z2 5913

To cover a variety of situations, several sets of data are published. Single raster excitations simulate the case of moving targets, when the screen area is excited only once. For permanent echoes and marker pips, there are curves showing persistence with repeated raster excitation. The persistence is measured from the end of excitation. From this information can be derived the variation in trace luminance during normal operation and the screen persistence when changing from one range to another.

The build-up characteristic is important during range-changing. The required information is given by a separate build-up characteristic which shows the luminance of the trace just before the next pulse arrives.

Screen Loading

Consider a small portion of screen under published data conditions. As in previous considerations, the raster area is hl, but only one field of n lines is applied. The current reaching the screen is i, with suitable corrections for flyback times. The spot is defocused so that the lines are touching each other. The charge per unit area reaching the screen is

$$q = \frac{i}{w2} t_w \qquad (32)$$

and this is proportional to screen luminance Eq (5).

Since

$$t_w = t_l \frac{w}{l}$$

$$q = \frac{i}{wl} t_l \qquad (33)$$

also

$$w = \frac{h}{n} \text{ and } nt_l = t_r$$

therefore

$$q = \frac{i}{hl} t_r \qquad (34)$$

Under p.p.i. conditions Eq (33) is also applicable. In order to express it in terms of p.p.i. constants, let

D = diameter of p.p.i. display
R = range corresponding to the radius of display.

Consider a portion of the display at a distance $\frac{1}{2}D'$ from the centre, so that

$$\frac{D'}{D} = x \text{ and } x < 1.$$

7Z2 5914

Then the length of considered scan is

$$L = \tfrac{1}{2}D'.$$

With a signal velocity of 12.3 μs per loop nautical mile,

$$T_x = 12.3 \times RK10^{-6} \text{ s}.$$

It was necessary to include a constant K in the equation for T_x in order to take into account overlap of scanning lines of the p.p.i. display. The overlap can be calculated as the ratio of the number of scans per aerial rotation to the number of lines that can be placed on the circumference of the considered portion of display. In terms of p.p.i. data, at a point distant $\frac{1}{2}D'$ from the centre.

$$K_x = \frac{F_pT_a}{\pi x D}W$$

where

F_p = pulse repetition frequency
T_a = time of one aerial revolution.

Substitution of the above data in Eq (33) gives

$$Q_x = \frac{2I}{\pi x D^2} 12.3\ R\ F_pT_a10^{-6}.$$

The screen luminance of the p.p.i. display is the same as that in published data if the above equation is equal to Eq (34). Equating and rearranging gives a screen loading of

$$u_x = \frac{i}{hl} = \frac{2I}{\pi x D^2} = 12.3\ R\ F_p \frac{T_a}{t_r} 10^{-6}.$$

For published data, $t_r = \frac{1}{50}$ s, therefore

$$u_x = \frac{i}{hl} = \frac{3.91}{x D^2} IRF_pT_a\ 10^{-4}\ \mu A/cm^2 \qquad (35)$$

Now i/hl is the screen loading used in the presentation of published data, therefore the value of screen persistence can be determined.

It should be noted that u_x varies over the screen. If a constant value of u is required, then a bright-up circuit must be incorporated, so that I/x will be constant.

Single-pulse Excitation: Moving Target Conditions

For fast-moving objects a situation can exist where within one aerial rotation the echo moves on the display a distance greater than the spot diameter of the tube. The persistence curve resulting from such an excitation is given in published data by graphs for single-pulse excitation. The screen loading can be calculated from Eq (35).

7Z2 5915

Repeated-pulse Excitation:
Permanent Echoes

The luminance produced by a permanent echo is a result of excitation received from a succession of aerial sweeps. The persistence is given in the published data by graphs for repeated-pulse excitation. The repetition interval t_a of pulses in the published data is 1 s. In practical applications, the aerial rotation frequency may be different, and for that reason the equation for screen loading needs adjustment. Experimental evidence indicates that under the conditions shown in the published data, the screen luminance is a function u of the product of the current and the number of pulses. Thus the necessary adjustment can be effected by multiplying Eq (35) by t_a/T_a. With t_a = 1 s, the modified equation becomes

$$U_x = \frac{3.91}{x\,D^2} IRF_p\, 10^{-4}\ \mu A/cm^2 \tag{36}$$

Build-up

The rate at which persistence luminance builds up for a permanent echo is shown in published data by means of build-up characteristics. Since these characteristics are given as a function of the number of pulses, the screen loading can be calculated from Eq (36).

Example

A tube with an LD screen is employed in a p.p.i. display. It is operated at 10 kV, and the peak current at the end of the trace is 150 μA. If the pulse repetition frequency is 3 kc/s and the aerial rotational frequency is 20 r.p.m., determine the luminance of the persistence trace at the edge of the display when the display is set to operate at a range of one nautical mile for the full useful screen radius of 10 cm.

(a) Moving targets

Screen loading is calculated from Eq (35):

$$U_x = \frac{3.91}{x\,D^2} IRF_pT_a\, 10^{-4}\ \mu A/cm^2$$

D = 20 cm	F_p = 3 kc/s
I = 150 μA	T_a = 3 s
R = 1 nautical mile	x = 1

so that

$$U_x = 1.32\ \mu A/cm^2.$$

7Z2 5916

The persistence characteristics of the LD screen (pages 68 and 69) gives persistence luminance for single-pulse excitation at an e.h.t. of 10 kV. The required persistence can be read off the graph for a screen loading of 1.32 $\mu A/cm^2$. This screen loading is higher than any shown on the graph, but the results can be deduced by extrapolation.

(b) Permanent echoes

Screen loading is calculated from Eq (36):

$$U_x = \frac{3.91}{x \cdot D^2} IRF_p \, 10^{-4} \, \mu A/cm^2.$$

Substitution gives

$$U_x = 0.44 \, \mu A/cm^2.$$

This lower value has no actual meaning in terms of current; but it indicates which curve in the graphs on pages 68 or 69 is to be used. The result will apply for a fully built-up condition - say after 60 or more pulses.

(c) Build-up

For any intermediate number of pulses down to about ten, the small variation in the starting point of the decay curves can be obtained from the build-up curve on page 70. The value of U_x = 0.44 $\mu A/cm^2$, and the persistence curves for multiple pulse excitation on pages 68 and 69 can then be used.

AMBIENT ILLUMINATION

In the discussion of the requirements of different applications it has been assumed that the only light to be considered is that produced by the display. Background illumination has been altogether neglected. Under practical conditions the background illumination is of the greatest importance. In fact, it determines the luminance that the tube must produce if the display is to be usable.

There are three sources of stray illumination:

Light from the back of the screen is reflected by the tube walls. It returns to the screen in a diffuse form and reduces the contrast between the trace and the unexcited parts of the screen.

Light from the front of the screen is reflected back to the screen from surrounding surfaces. Again the effect is to illuminate the unexcited areas.

Ambient illumination, especially in lighted rooms and in daylight situations, is obviously a major factor in the reduction of contrast.

7Z2 5917

The minimum contrast perceptible by the eye is about 2 per cent. If the luminance of the trace in the absence of background illumination is B, and the luminance of the rest of the tube face is b, then the luminance of the trace in the presence of the background illumination is B + b. The change in luminance from trace to background is B. For limit perception,

$$\frac{B}{B+b} 100 = 2$$

so that

$$B = \frac{b}{49} .$$

This is practically the absolute minimum that can be tolerated. For comfortable viewing the contrast should be about 80 per cent; that is, B = 4b. For an oscilloscope display a lower contrast is acceptable than for a raster display.

A laboratory during hours of daylight may have an illumination of about 250 lx. In this illumination a perfectly diffusing surface will have a luminance of $250/\pi \simeq 80$ nt. With transmission and reflection losses of 30 per cent, the tube surface will have a luminance of 56 nt.

For the examples calculated in this chapter we have

Television monitor tube	280 nt
Oscilloscope display	300 nt
P.P.I. display (permanent echo at 1 s)	1.3 nt

The contrast for the last case in the presence of a 250 lx background illumination is

$$\frac{1.3}{56} 100 = 2.3\ \%,$$

which is just about perceptible.

At night an average laboratory will have a lower illumination. If this is, say, 50 lx, the luminance of the radar display quoted will improve, for the contrast will be

$$\frac{1.3}{11.2} 100 = 11.6\ \%.$$

When the decay characteristic is taken into consideration, the effect of ambient illumination is even more serious. If the persistence of the p.p.i. display which has been discussed is plotted in the presence of laboratory illumination as above, the resulting curve will be entirely different from that given on pages 68 and 69 for a current density of 0.2 $\mu A/cm^2$. After about seven seconds the display will be lost in the background.

7Z2 5918

USE OF FILTERS

Contrast can be improved by placing a filter in front of the tube. Light from outside has to pass through the filter twice before reaching the eye, whereas the light from the trace passes through only once.

For maximum contrast the filter should be as dense as possible; but if the luminance of the trace is already low, it will be attenuated to an unusable level if the filter is too dense. However, a filter whose transmission characteristic is matched to the spectral distribution of the screen will provide differential filtering. The light output from the screen will be transmitted with minimum loss, while external light from other parts of the spectrum will be suppressed.

The GM double-layer screen has a purplish-blue fluorescence and a yellowish-green phosphorescence. As the blue component is subjectively brighter than the yellow, it is advantageous in some applications to filter it out with a suitable filter if maximum use is to be made of the yellow persistence period. The Chance C2 glass filter is suitable; or, for combination with a graticule, a sheet of amber Perspex may be used.

Exclusion of ambient ultraviolet radiation from the GN storage screen is provided by filters such as the Ilford 108. The infrared radiation for reading can be obtained from low-power tungsten lamps. They should be provided with filters to suppress the visible light which would reduce contrast. A combination of the Ilford filters 207 and 813 is suitable. A composite viewing hood can be used, containing the lamps, filters, and ultraviolet stop filter.

7Z2 5919

GENERAL DATA

The information given in this reference section is obtained from measurements of phosphors settled in typical cathode ray tubes. The tube used is, of course, of a type appropriate for the screen in question.

For each screen type there is a spectral response curve. The relative response is plotted against the wavelength of the light output, the peak light output being shown as 100 per cent. No absolute values of light output can be read off; and no comparisons of the luminance of different screen types can be made from these curves.

On each response curve is quoted the subjective colour sensation in terms of the x-y co-ordinates of the C.I.E. system. These points are also indicated on the diagram.

For two or three screen types, the diagram shows two points: one refers to the initial "flash" or fluorescence, while the other point refers to the persistence (phosphorescence) colour. Thus, the GM screen has a purplish-blue flash and a yellowish-green persistence, and it is classified as a screen of the G group. The two linked points shown for the GH screen are those pertaining to high-brilliance and low-brilliance operation.

For comparison of the spectral response of the screens available for each of the main groups of application, collective response curves, are given. Here again, the response curves are normalised, and they provide no information about the comparative light outputs of different screens.

The Kelly charts are marked - in accordance with general colorimetric practice - with the wavelengths in milli-micrometres (mμm) that correspond to the saturated spectral colours lying on the perimeter.

The persistence and efficiency curves, and the special curves relating to radar screens, should be read in conjunction with the relevant parts of the text.

PERSISTENCE NOMOGRAPHS FOR OSCILLOSCOPE SCREENS

Although the persistence curves give a good indication of the differences between screens under typical conditions, it is found in practice that the operation of the screen is often far removed from the published conditions. This is especially so for oscilloscope applications. With this as a prime consideration, the screens most used for oscilloscope work have been investigated in rather more detail than, say, the screens used in television monitors.

7Z2 5920

Radar screens, although subjected to some changes in operation conditions, are limited in their applicational range, and in most cases the published curves give adequate information. The flying spot screen BA has only a small dynamic characteristic change, and once again requires no elaboration.

Most oscilloscope screens have a persistence dependent on current density, electron energy, excitation time, and repetition frequency. The exception to this is the GJ screen which has a decay law of the form exp (-80 t) which is independent of the above characteristics and is therefore specified by the published decay curve. The dynamic range of the other oscilloscope screens has been evaluated empirically.

The BE and GH screens have a common decay law:

$$L_t \propto t_p^{-1}$$

where L_t is the light output at a time t_p during the decay.

Experiment has shown that modification to the form

$$\frac{L_t}{L_o} = \frac{k}{t_p + k}$$

where

L_o = initial light output at $t_p = 0$
k = a constant

produces a good approximation to the practical persistence curve.

Incorporation of some of the relevant screen characteristics gives

$$t_p = \left[\gamma (I_b/a)^{\beta} \, t_e^{\,\alpha (k - \tan^{-1} s \log \frac{I_b/a}{q})}\right] \left(\frac{L_o}{L_t} - 1\right)$$

where

t_e = excitation time
I_b/a = beam current density

and the constants α, β, γ, k, s, and q have been evaluated for each screen type.

Voltage and repetition frequency are not included in this formula. The voltage has little effect on persistence if it exceeds 3 kV. Below 3 kV the persistence increases. The repetition frequency has a pronounced effect; but, because of the complexity of interrelating occupance and build-up time limits, the formula in its present form applies only for single or low-occupance occurrences.

To simplify the use of the equation, nomographs have been constructed in which the variables are light output (as a percentage of flash), excitation time, and persistence. Current density is introduced as a parameter. Nomographs for the BE and GH screens are given.

7Z2 5921

Each nomograph consists of three main scales: t_e (excitation time), t_p (decay time), and L_t/L_o per cent (decay percentage). The t_e and t_p scales are split into three, for various current densities. As the current density has a second-order effect, the range over which the scales may be used is denoted at the foot of the scale.

To use the nomograph, a straight edge is placed across the sheet against the two known variables, and the third variable is read off. For example:

What is the persistence of the GH screen at 0.5 per cent of flash under the following conditions.

Excitation time = 10 μs
Current density = 0.8 $\mu A/mm^2$

A straight-edge placed against L_t/L_o = 0.5 per cent and t_e = 10 μs on the $>$ 0.8 $\mu A/mm^2$ scale will intersect the $>$ 0.8 $\mu A/mm^2$ t_p scale at 0.9 ms. Thus the persistence is 0.9 ms to 0.5 per cent under this condition.
Excitation time is determined, in practice, by dividing the spot diameter by the spot velocity. That is,

$$t_e = \frac{d}{v}$$

where

d = spot diameter (mm)
v = spot velocity (mm/s)

A maximum limit for t_e occurs when build-up is accomplished by steady excitation, or when the time occupance approaches unity. This maximum limit is indicated by the discontinuation of the t_e scale at its top end. Thus for excitation times greater than the limit value, the limit value should be used.

The reading accuracy of the nomographs has been reduced by including only the scale intervals of 5 and 10 on the logarithmic t_p and t_e scales. The reasons for this are that the nomograph includes several approximations, and, secondly, unavoidable spreads in screen production may cause significant deviations. This spread has less significance when the wide dynamic range covered by the logarithmic characteristics is being considered.
No nomograph is given for the GM screen, since the interdependent characteristics of the two phosphor layers are too complex for this kind of presentation.

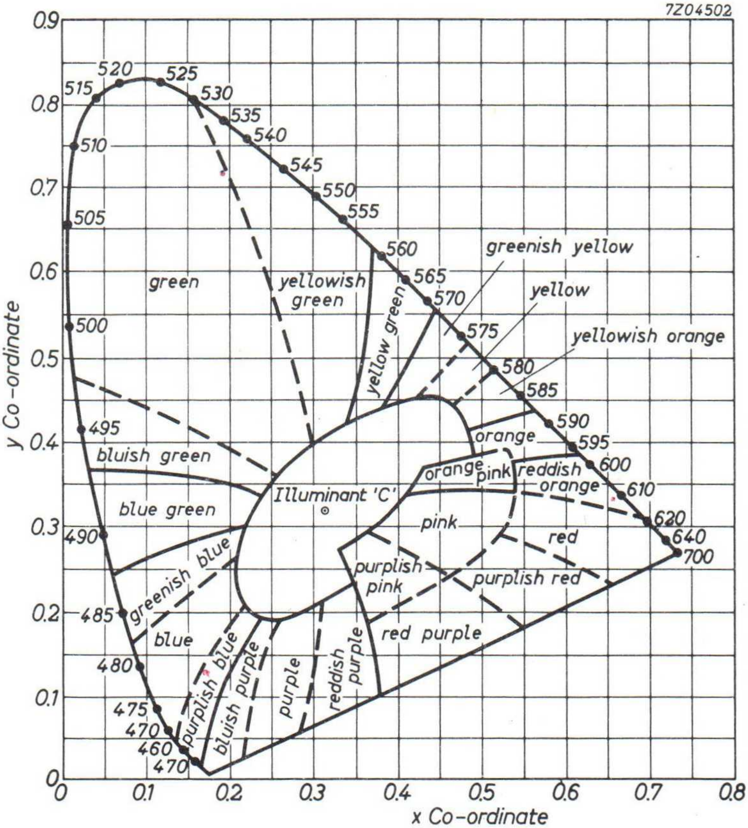
7Z2 5922

SCREEN TYPES

new system	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	purplish-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[1]	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 (infrared excited)	medium short (fluorescence)	-
GP	-	bluish-green	green	medium short	P2
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	-

[1]) used in projection tubes

7Z2 5923


7Z04502
y Co-ordinate
x Co-ordinate
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
520
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585
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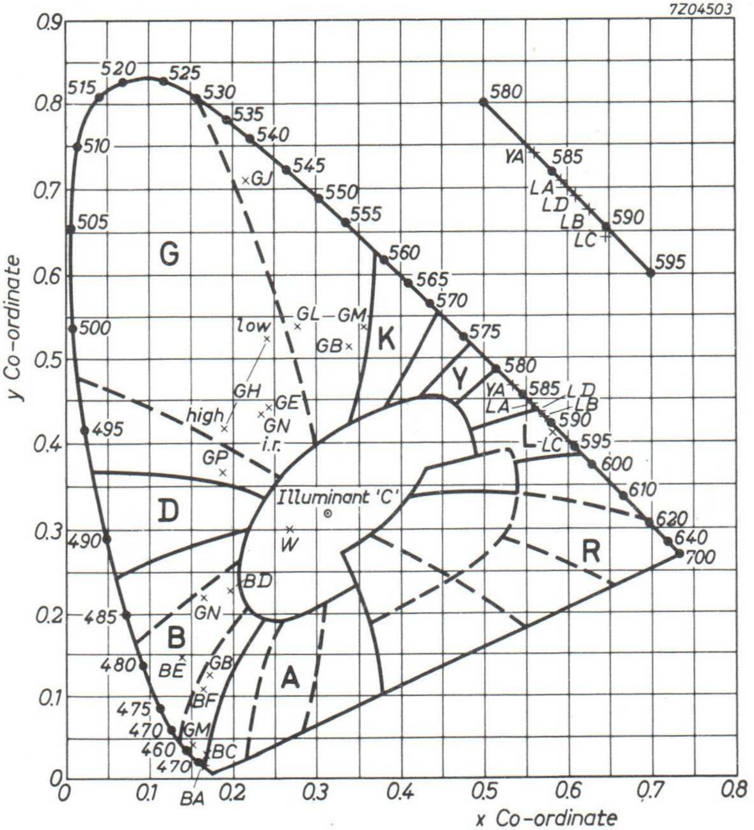
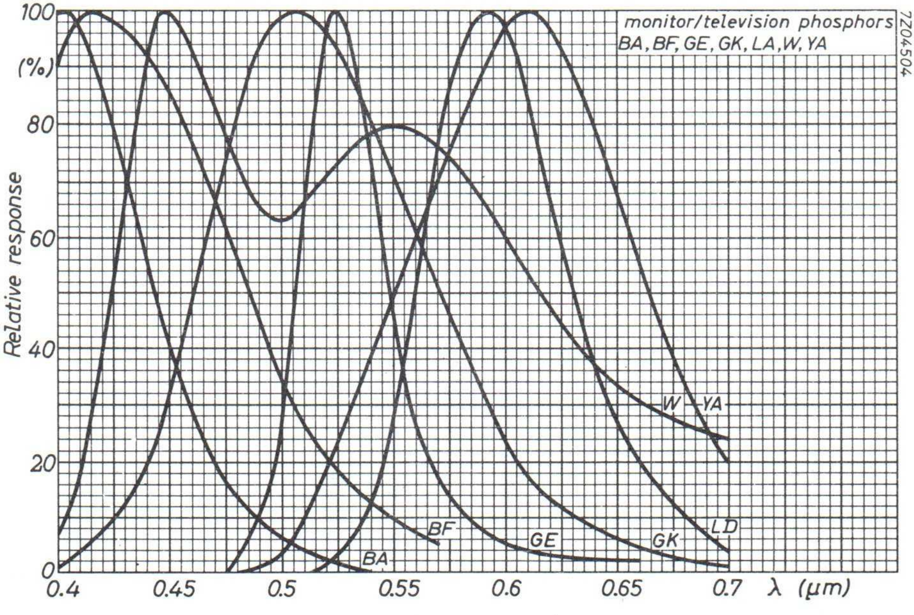
610
620
490
640
700
485
480
475
470
460
470
green
yellowish green
yellow green
greenish yellow
yellow
yellowish orange
bluish green
orange
orange
pink
reddish orange
Illuminant 'C'
blue green
pink
red
greenish blue
purplish pink
purplish red
blue
red purple
purplish blue
bluish purple
purple
reddish purple

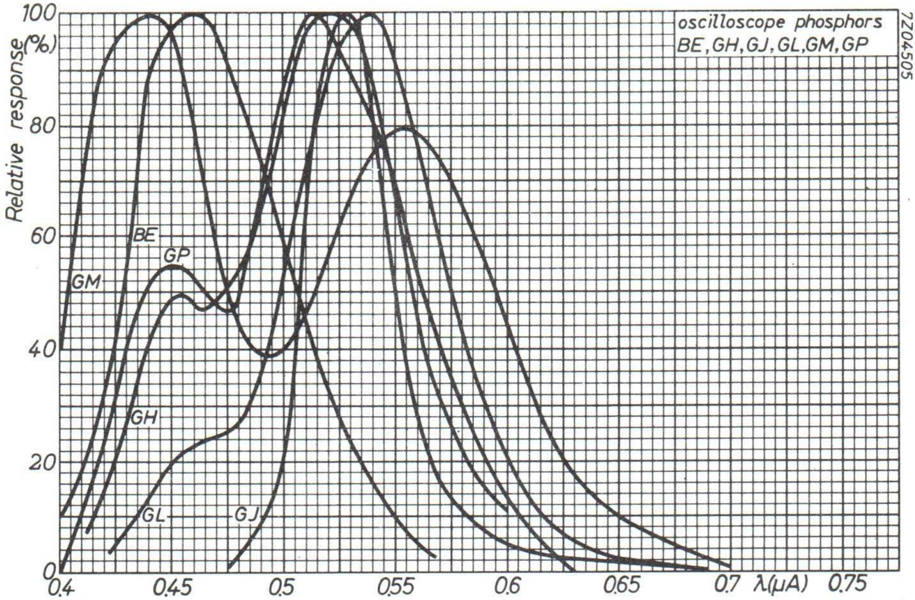
Kelly Chart

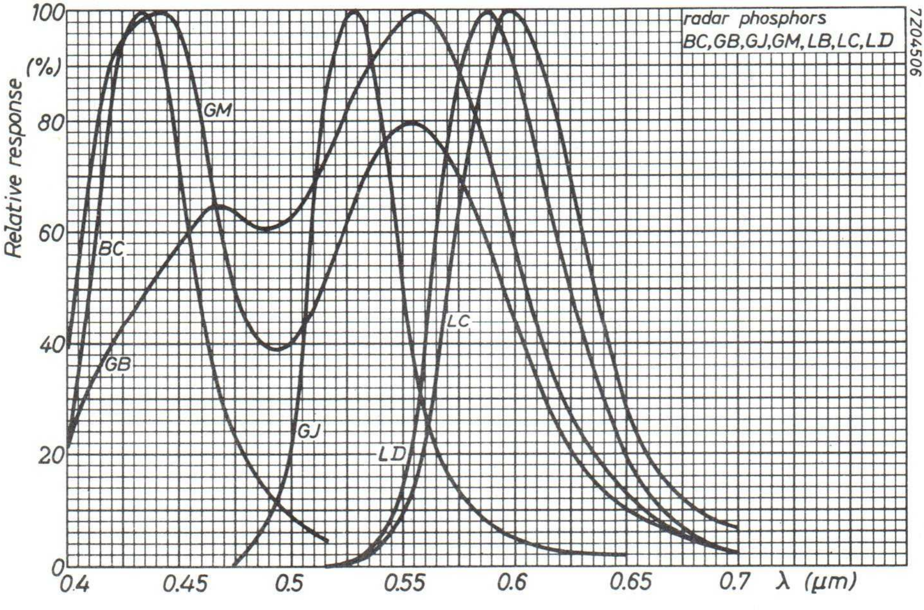


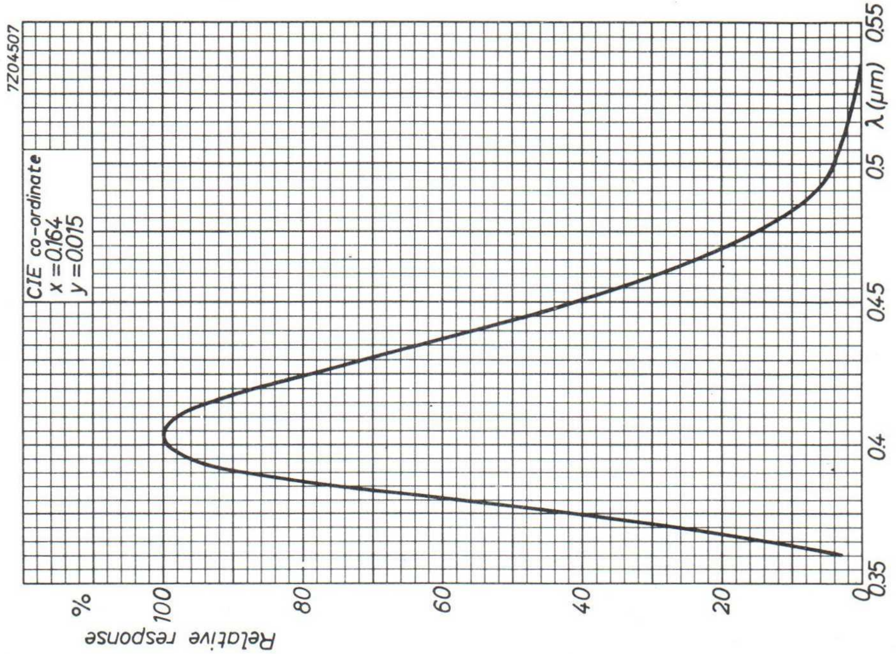
Co-ordinates of individual phosphors

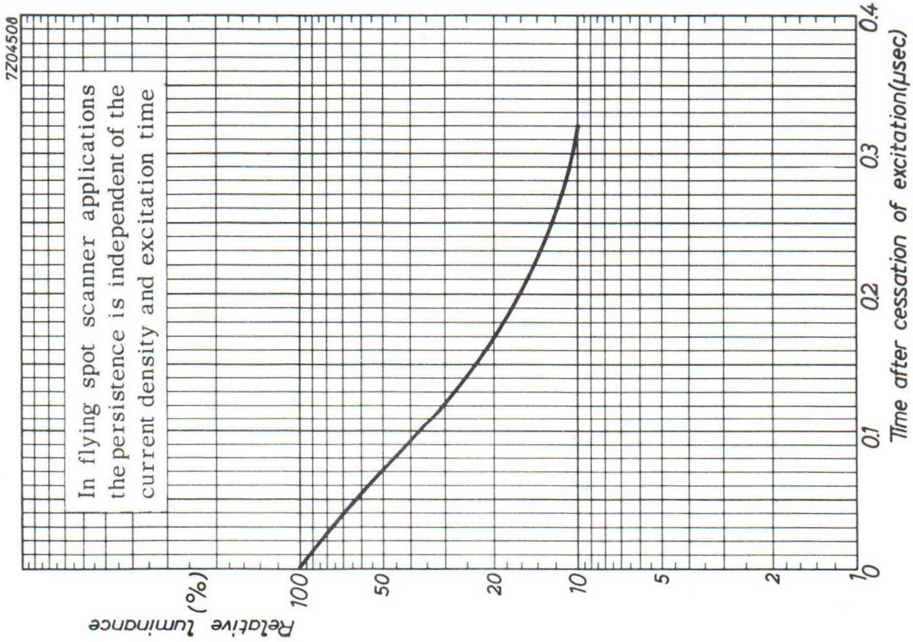


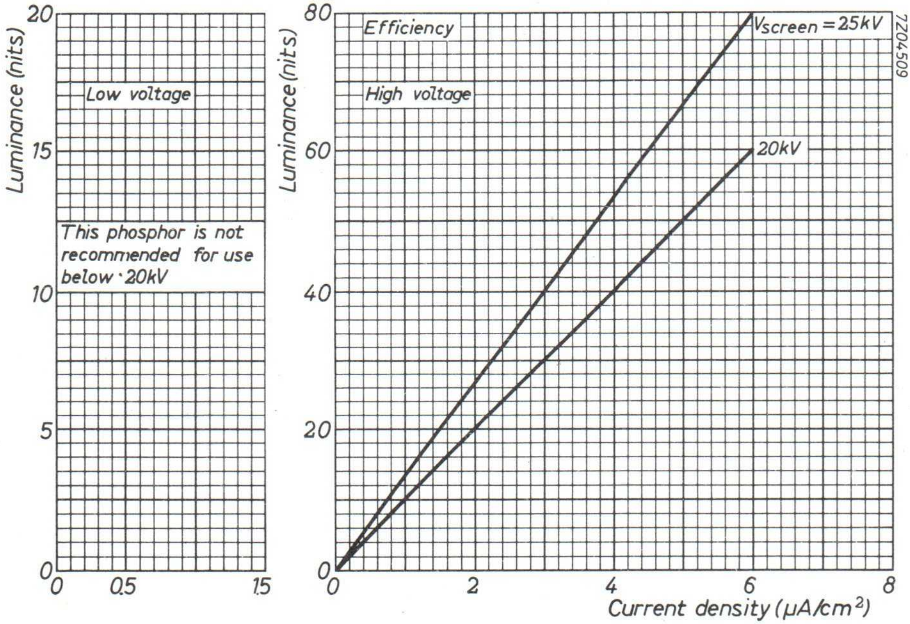
100
(%)
80
60
40
20
0
Relative response
monitor/television phosphors
BA, BF, GE, GK, LA, W, YA
7Z04504
W
YA
BF
GE
GK
LD
BA
0.4
0.45
0.5
0.55
0.6
0.65
0.7
λ (μm)

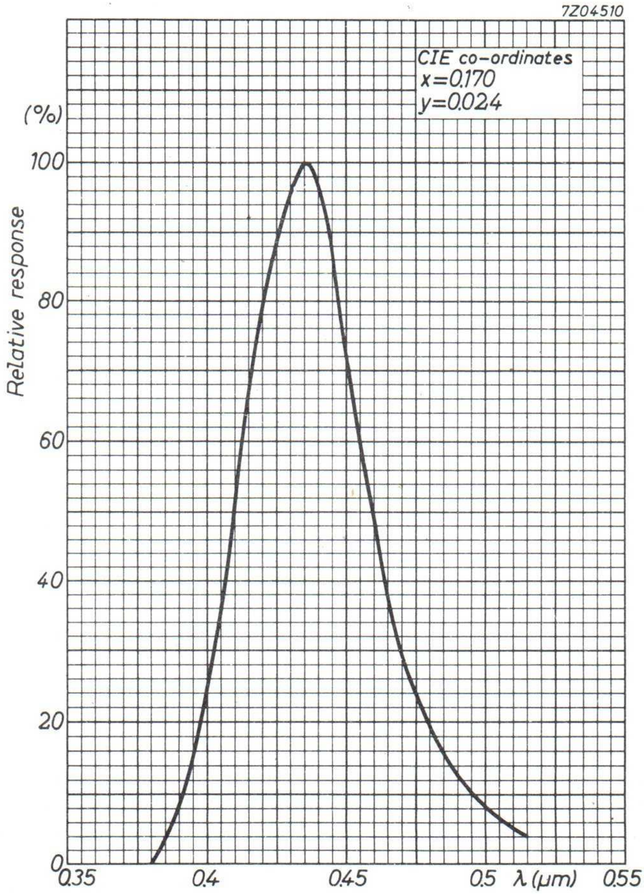

oscilloscope phosphors
BE, GH, GJ, GL, GM, GP
7Z04505
Relative response (%)
100
80
60
40
20
0
BE
GP
GM
GH
GL
GJ
0.4
0.45
0.5
0.55
0.6
0.65
0.7
λ(μA)
0.75

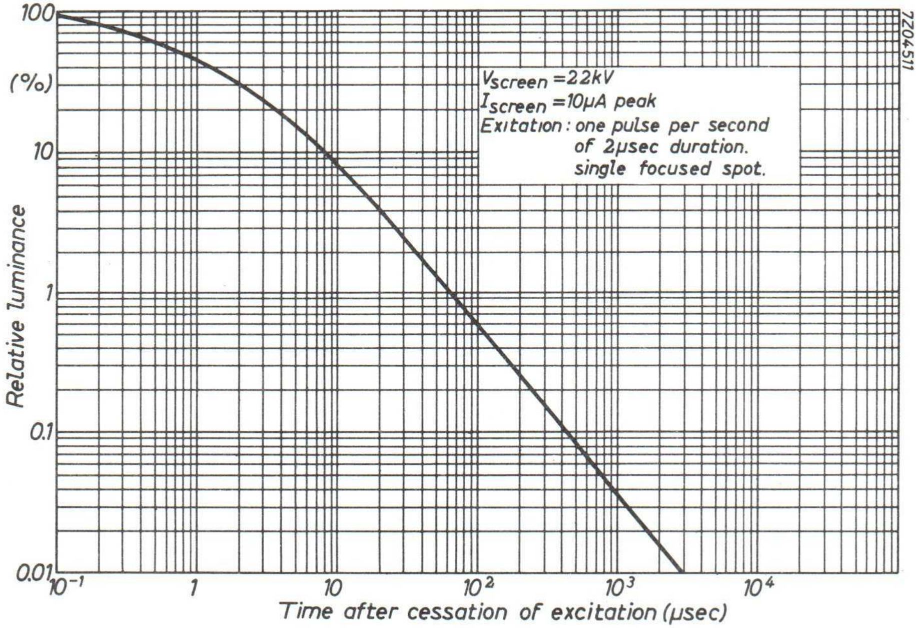

radar phosphors
BC, GB, GJ, GM, LB, LC, LD
7Z04506
Relative response (%)
100
80
60
40
20
0
GM
BC
GB
GJ
LD
LC
0.4
0.45
0.5
0.55
0.6
0.65
0.7
λ (μm)

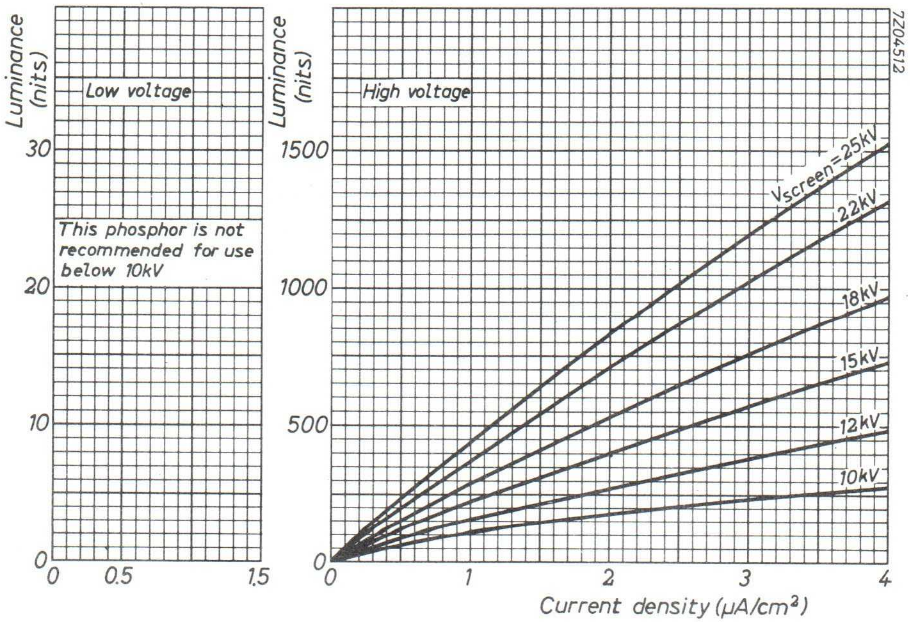

7Z04507
CIE co-ordinate
x = 0.164
y = 0.015
%
Relative response
100
80
60
40
20
0
0.35
0.4
0.45
0.5
0.55
λ (μm)

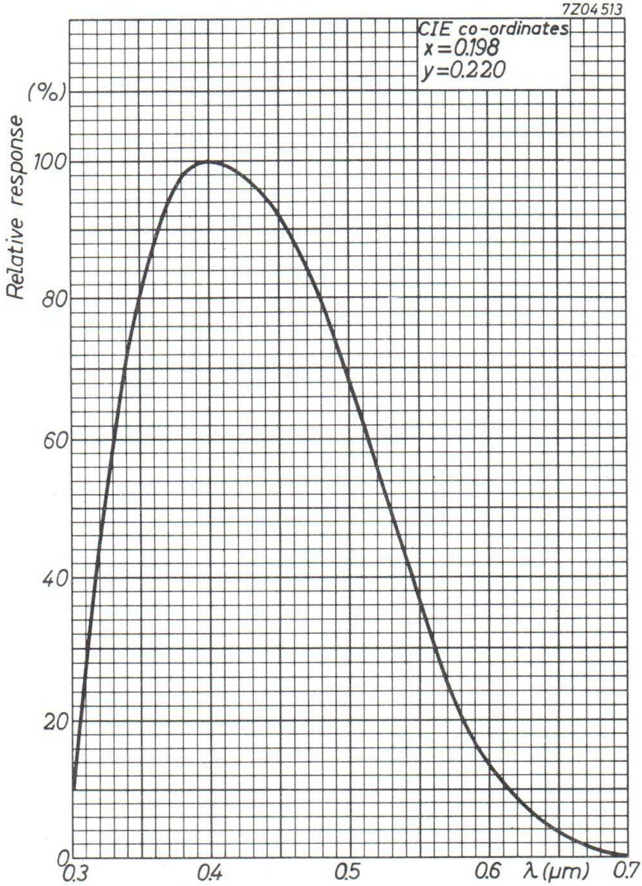

7Z04508
In flying spot scanner applications the persistence is independent of the current density and excitation time
Relative luminance (%)
100
50
20
10
5
2
1
0
0.1
0.2
0.3
0.4
Time after cessation of excitation(μsec)

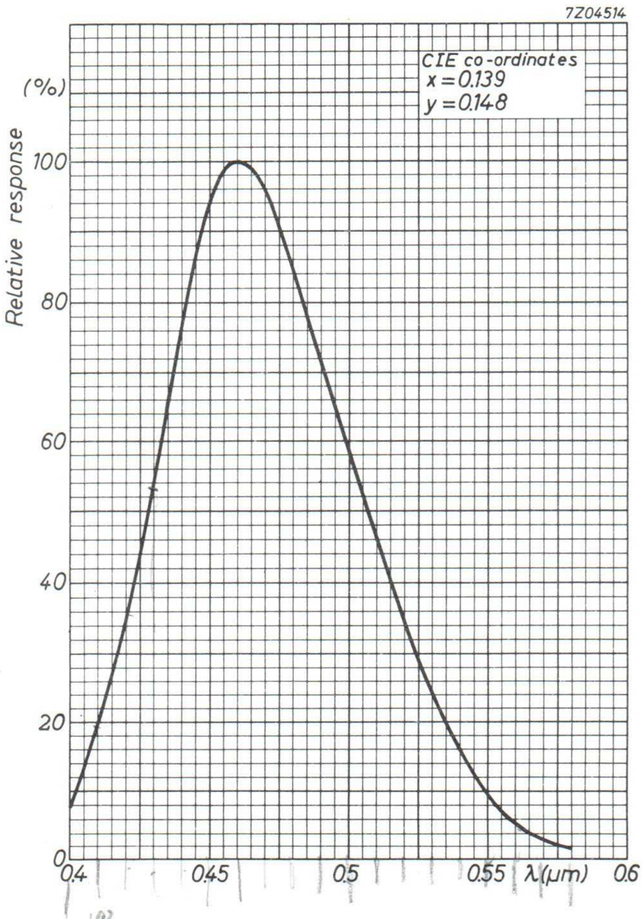

Luminance (nits)
20
15
10
5
0
0
0.5
1.5
Low voltage
This phosphor is not recommended for use below 20kV
Luminance (nits)
80
60
40
20
0
0
2
4
6
8
Efficiency
High voltage
Vscreen = 25kV
20kV
Current density (μA/cm²)
7Z04509

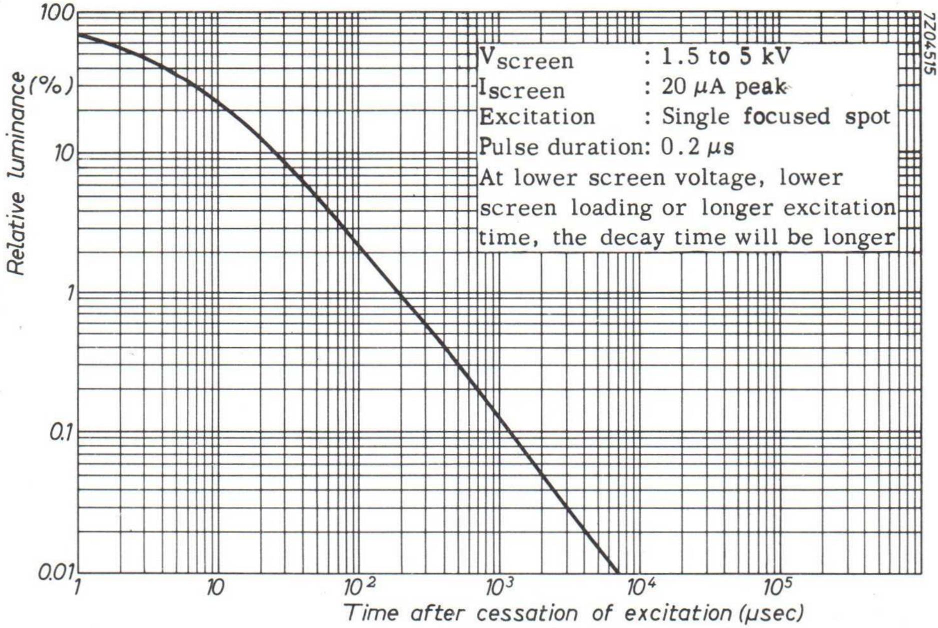

7Z04510
CIE co-ordinates
x=0.170
y=0.024
(%)
100
80
60
40
20
0
Relative response
0.35
0.4
0.45
0.5
λ (μm)
0.55

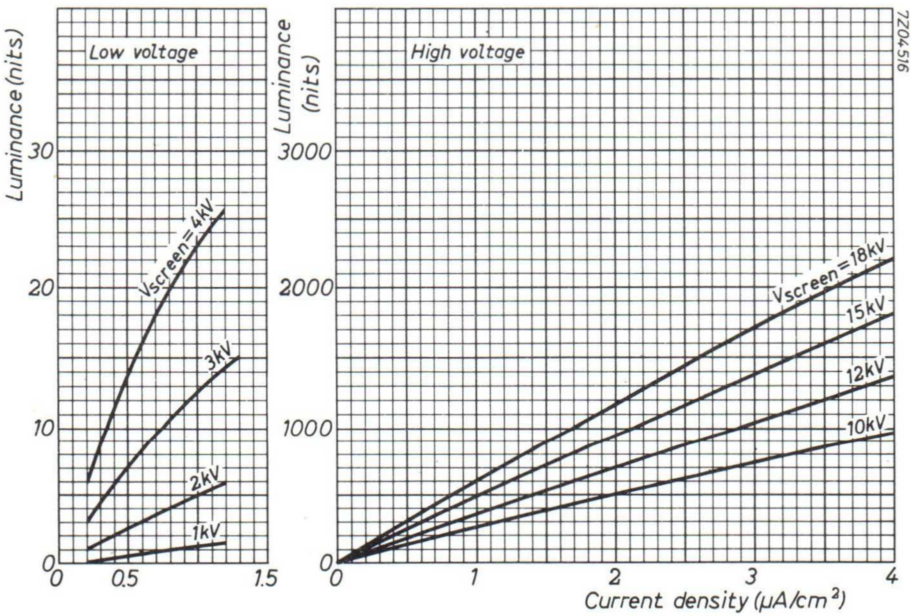

100
(%)
10
1
0.1
0.01
Relative luminance
V_{screen} = 22kV
I_{screen} = 10μA peak
Exitation: one pulse per second
of 2μsec duration.
single focused spot.
7Z04511
10^{-1}
1
10
10^2
10^3
10^4
Time after cessation of excitation (μsec)

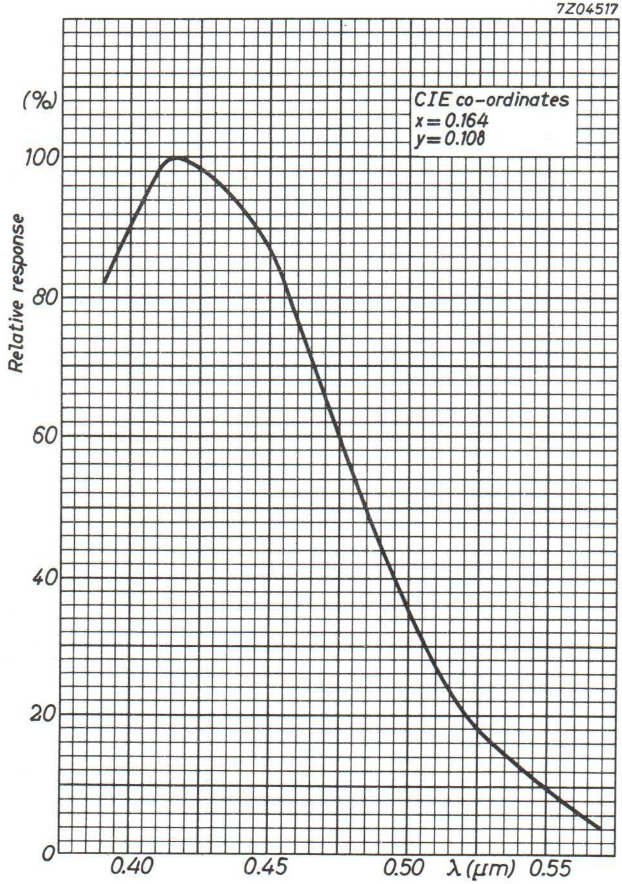

Luminance (nits)
Low voltage
This phosphor is not recommended for use below 10kV
30
20
10
0
0
0.5
1.5
Luminance (nits)
High voltage
7Z04512
1500
1000
500
0
V_{screen}=25kV
22kV
18kV
15kV
12kV
10kV
0
1
2
3
4
Current density (μA/cm²)


7Z04513
CIE co-ordinates
x=0.198
y=0.220
(%)
Relative response
100
80
60
40
20
0
0.3
0.4
0.5
0.6
λ (μm)
0.7

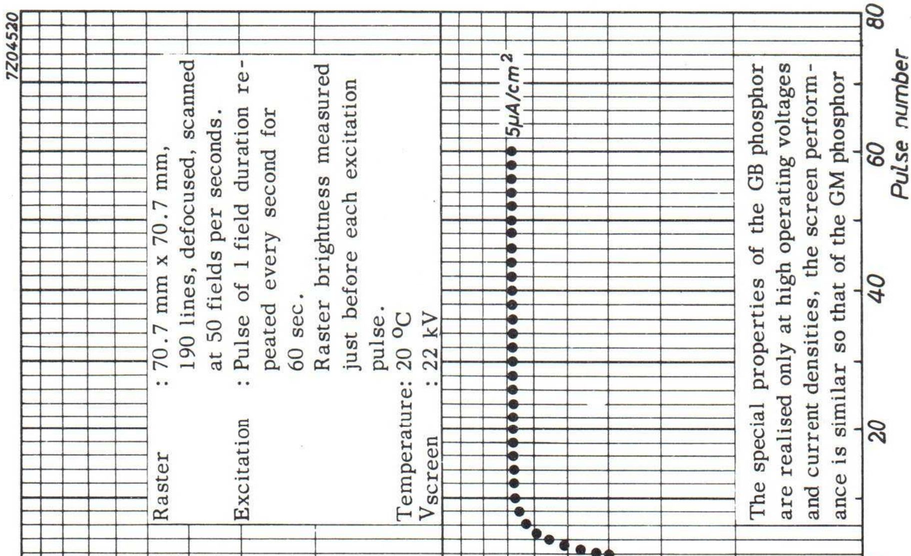

7Z04514
CIE co-ordinates
x = 0.139
y = 0.148
(%)
Relative response
100
80
60
40
20
0
0.4
0.45
0.5
0.55
λ(μm)
0.6

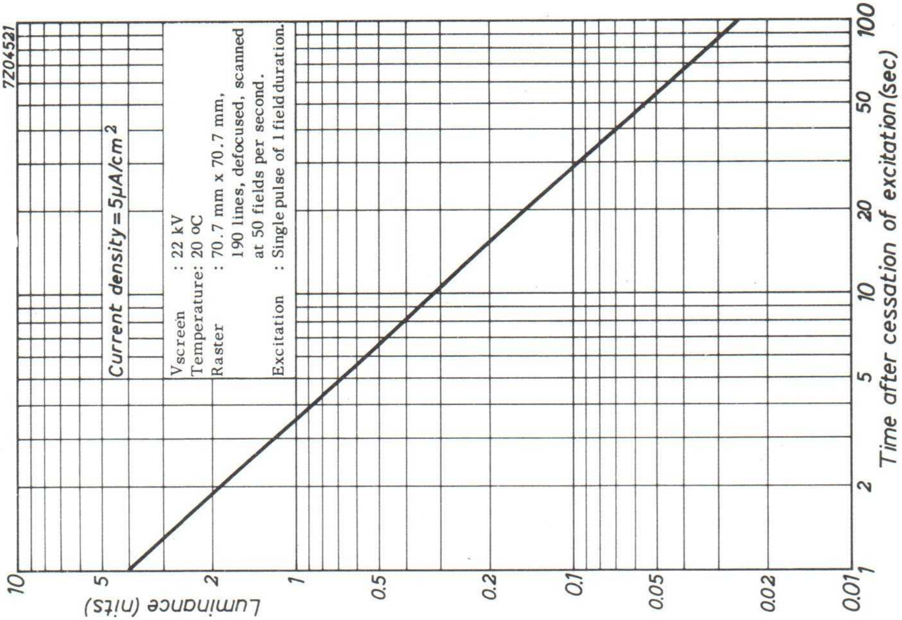

7Z04515
Relative luminance (%)
100
10
1
0.1
0.01
1
10
10^2
10^3
10^4
10^5
Time after cessation of excitation (μsec)
Vscreen : 1.5 to 5 kV
Iscreen : 20 μA peak
Excitation : Single focused spot
Pulse duration: 0.2 μs
At lower screen voltage, lower screen loading or longer excitation time, the decay time will be longer

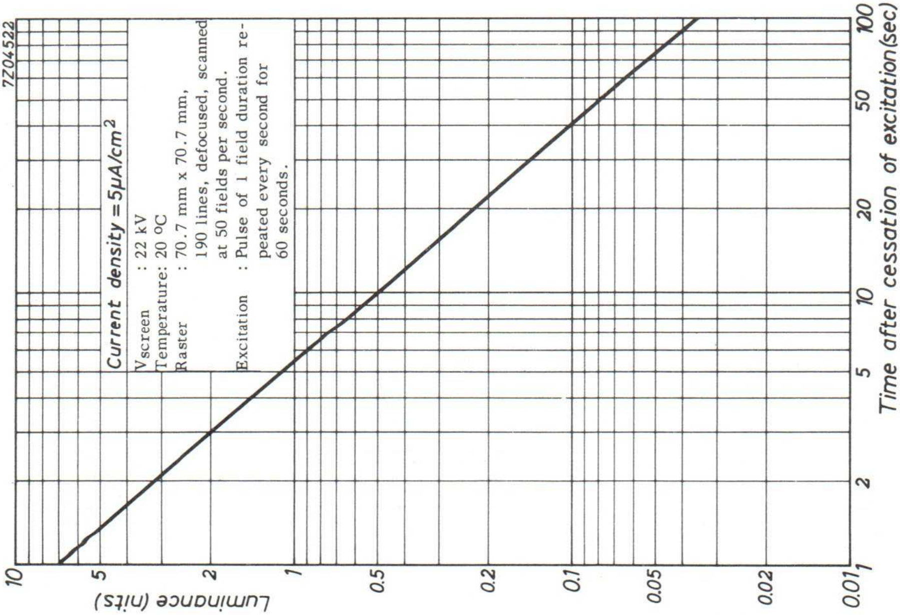

7Z04516
Low voltage
Luminance (nits)
30
20
10
0
0
0.5
1.5
Vscreen = 4kV
3kV
2kV
1kV
High voltage
Luminance (nits)
3000
2000
1000
0
0
1
2
3
4
Vscreen = 18kV
15kV
12kV
10kV
Current density (μA/cm²)

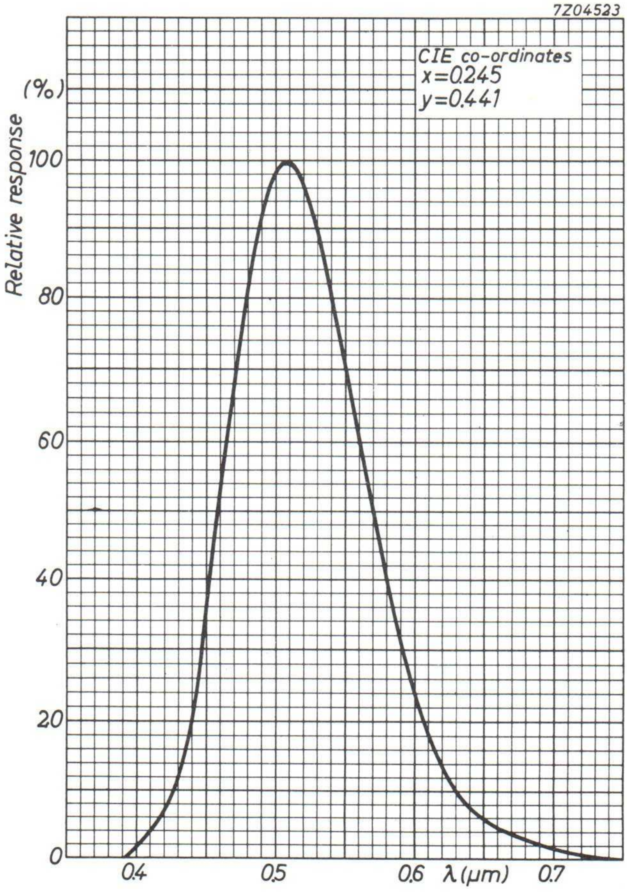

7Z04517
(%)
100
80
60
40
20
0
Relative response
CIE co-ordinates
x = 0.164
y = 0.108
0.40
0.45
0.50
λ (μm)
0.55

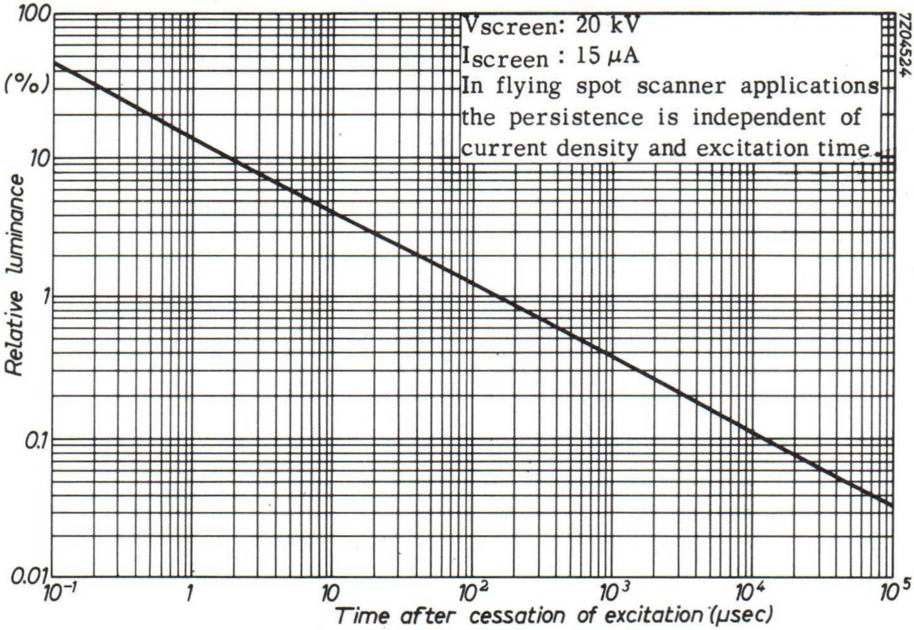

7Z04519
CIE co-ordinates
x = 0.340, 0.170
y = 0.515, 0.124
Relative response
(%)
100
80
60
40
20
0
0.40
0.50
0.60
0.70
0.80
λ (μm)

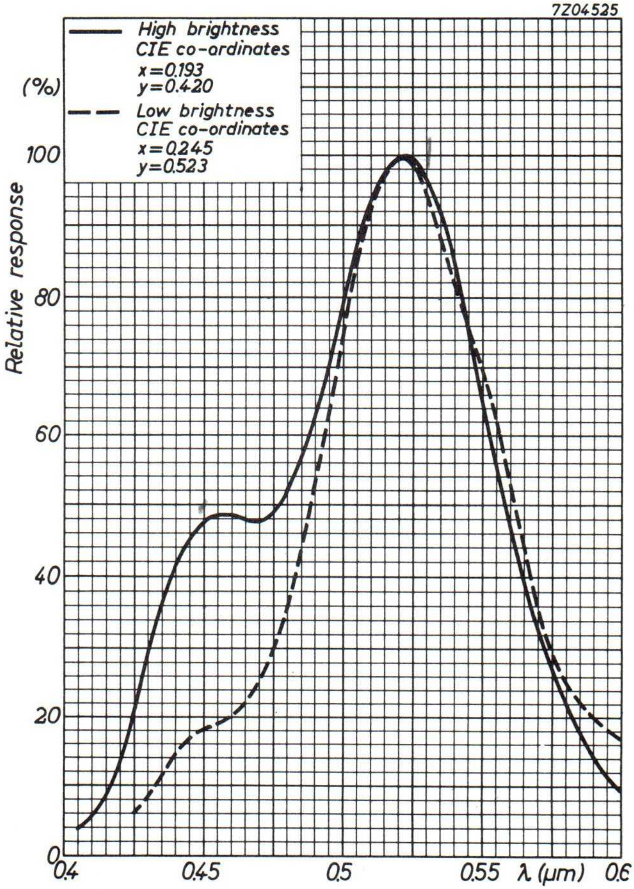

7Z04520
Raster : 70.7 mm x 70.7 mm, 190 lines, defocused, scanned at 50 fields per seconds.
Excitation : Pulse of 1 field duration repeated every second for 60 sec. Raster brightness measured just before each excitation pulse.
Temperature: 20 °C
Vscreen : 22 kV
5μA/cm²
The special properties of the GB phosphor are realised only at high operating voltages and current densities, the screen performance is similar so that of the GM phosphor
Luminance (nits)
100
50
20
10
5
2
1
0
20
40
60
80
Pulse number

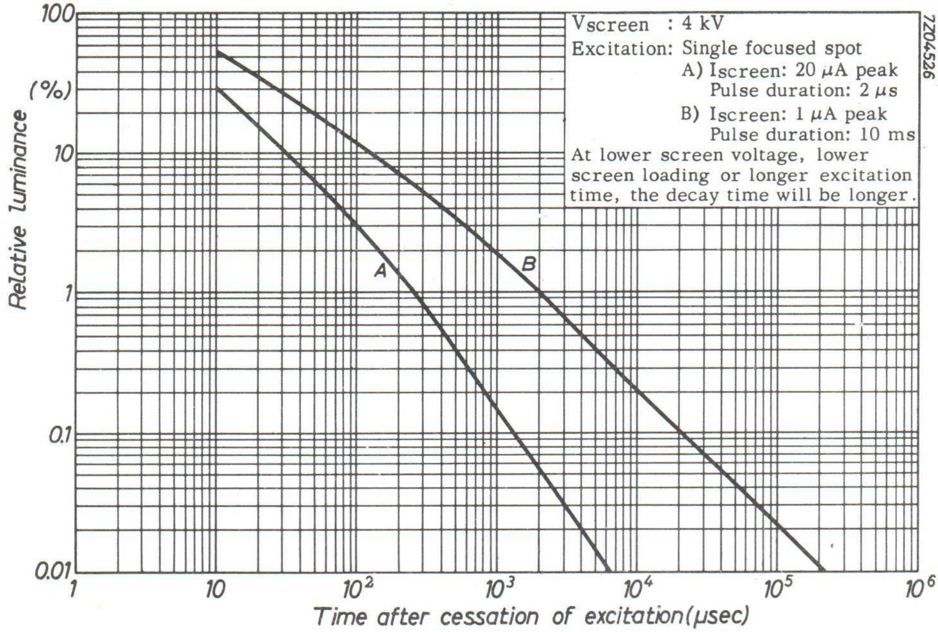

7Z04521
Current density = 5μA/cm²
Vscreen : 22 kV
Temperature: 20 °C
Raster : 70.7 mm x 70.7 mm, 190 lines, defocused, scanned at 50 fields per second.
Excitation : Single pulse of 1 field duration.
Luminance (nits)
10
5
2
1
0.5
0.2
0.1
0.05
0.02
0.01
Time after cessation of excitation (sec)
1
2
5
10
20
50
100

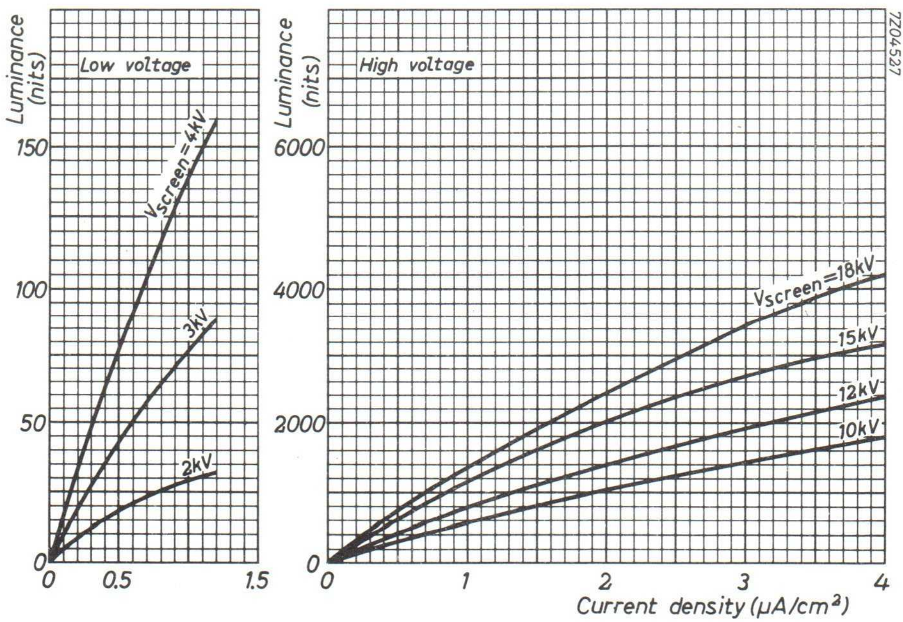

7Z04522
Current density = 5μA/cm²
Vscreen : 22 kV
Temperature: 20 °C
Raster : 70.7 mm x 70.7 mm, 190 lines, defocused, scanned at 50 fields per second.
Excitation : Pulse of 1 field duration repeated every second for 60 seconds.
Luminance (nits)
10
5
2
1
0.5
0.2
0.1
0.05
0.02
0.01
Time after cessation of excitation (sec)
1
2
5
10
20
50
100

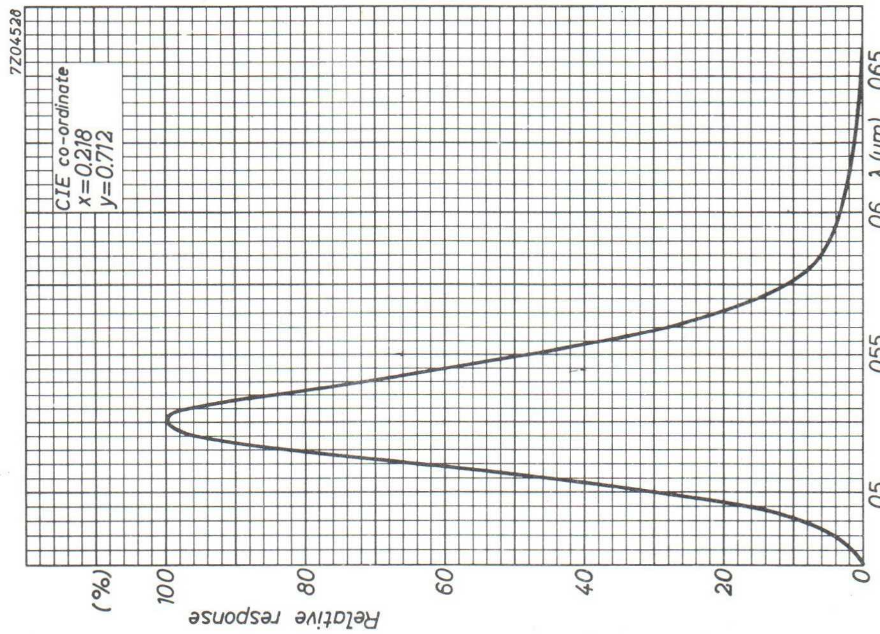

7Z04523
CIE co-ordinates
x=0.245
y=0.441
(%)
Relative response
100
80
60
40
20
0
0.4
0.5
0.6
λ (μm)
0.7

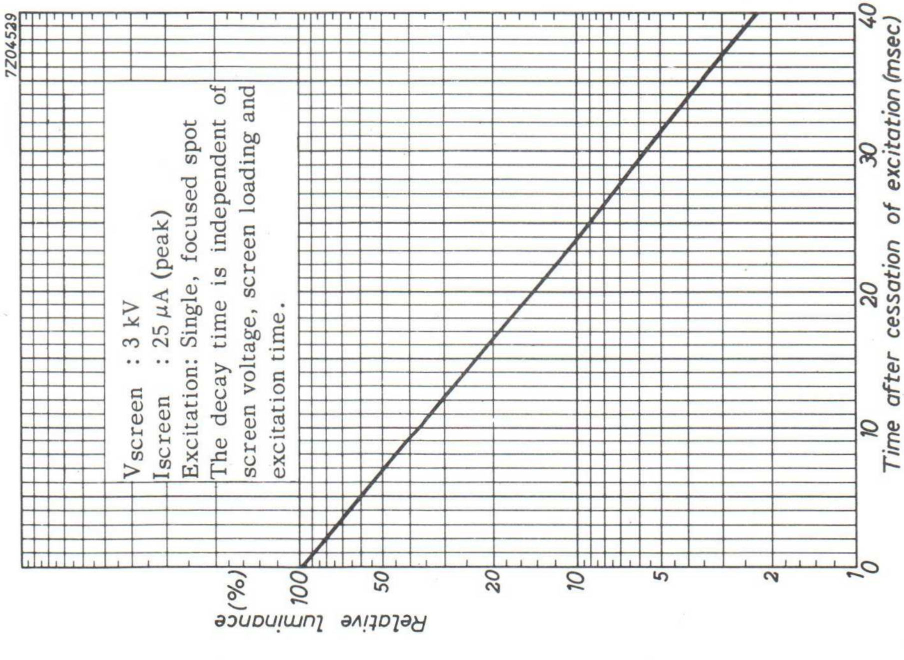

Vscreen: 20 kV
Iscreen : 15 μA
In flying spot scanner applications the persistence is independent of current density and excitation time.
7Z04524
100
(%)
10
1
0.1
0.01
Relative luminance
10^{-1}
1
10
10^2
10^3
10^4
10^5
Time after cessation of excitation (μsec)

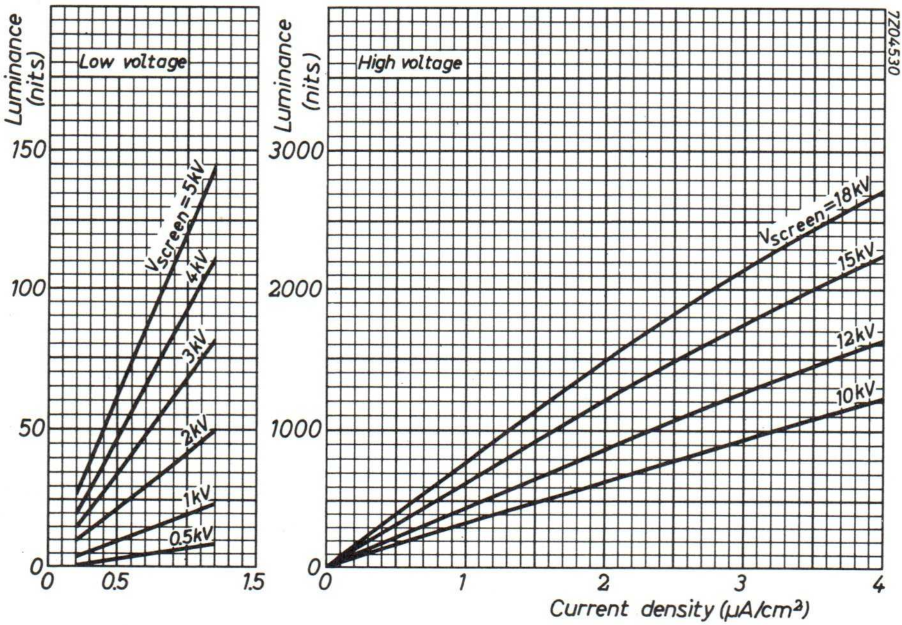

7Z04525
High brightness
CIE co-ordinates
x=0.193
y=0.420
Low brightness
CIE co-ordinates
x=0.245
y=0.523
(%)
Relative response
100
80
60
40
20
0
0.4
0.45
0.5
0.55
λ (μm)
0.6

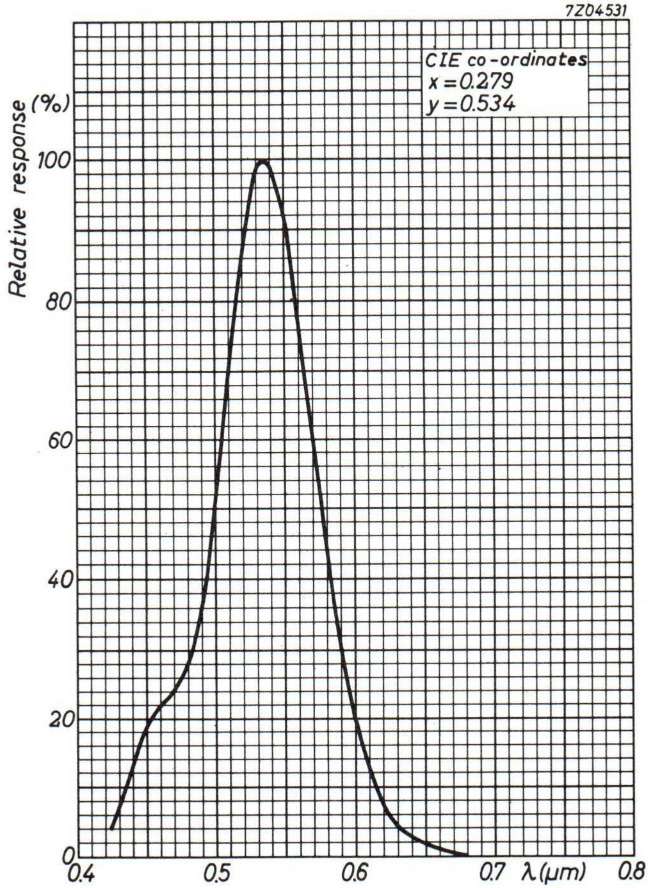

Vscreen : 4 kV
Excitation: Single focused spot
A) Iscreen: 20 μA peak
Pulse duration: 2 μs
B) Iscreen: 1 μA peak
Pulse duration: 10 ms
At lower screen voltage, lower screen loading or longer excitation time, the decay time will be longer.
7Z04526
Relative luminance (%)
100
10
1
0.1
0.01
A
B
1
10
10²
10³
10⁴
10⁵
10⁶
Time after cessation of excitation (μsec)

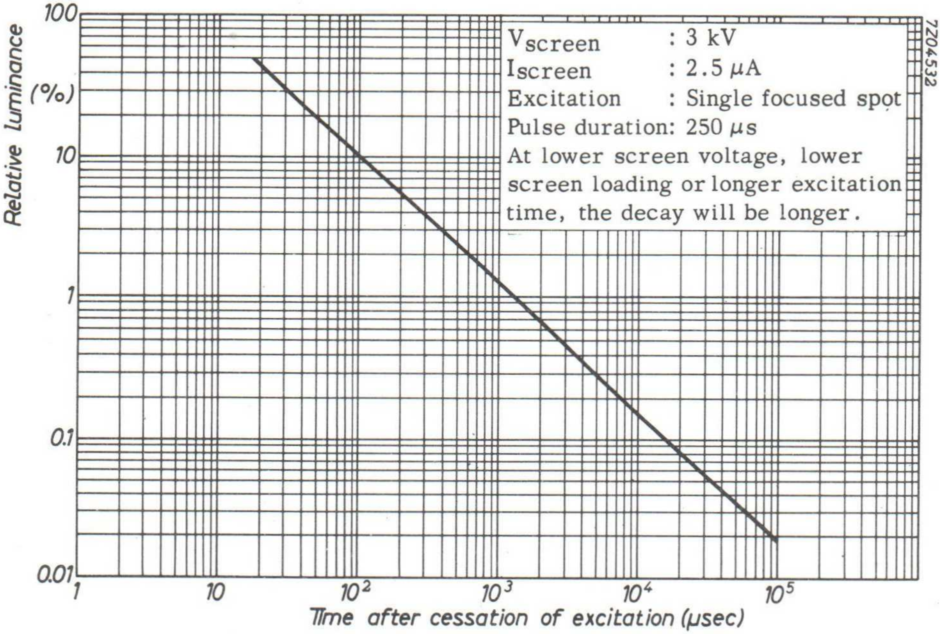

Low voltage
Luminance (nits)
150
100
50
0
Vscreen=4kV
3kV
2kV
0
0.5
1.5
High voltage
6000
4000
2000
0
Vscreen=18kV
15kV
12kV
10kV
0
1
2
3
4
Current density (μA/cm²)
7Z04527

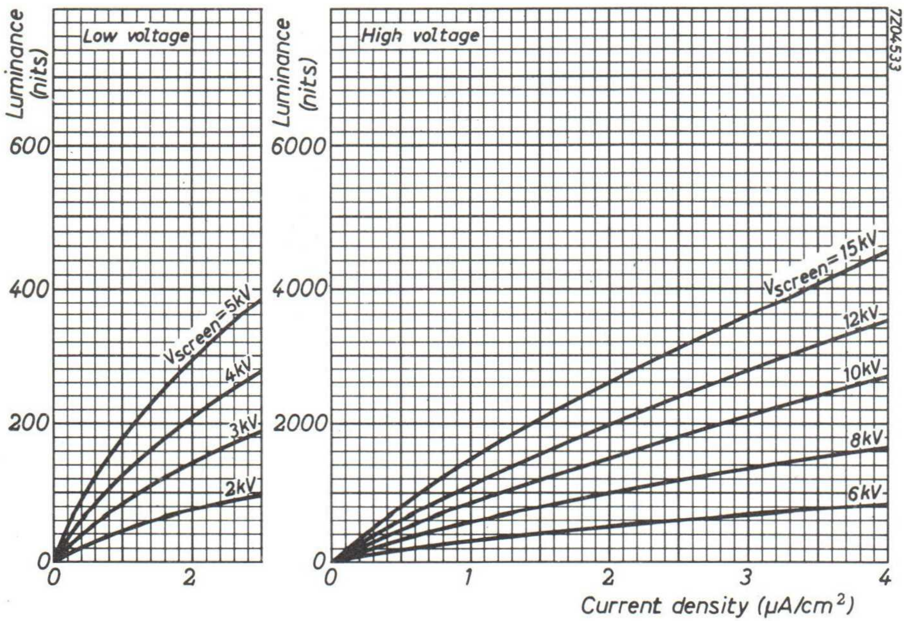

7Z04528
CIE co-ordinate
x=0.218
y=0.712
Relative response
(%)
100
80
60
40
20
0
0.5
0.55
0.6
0.65
λ (μm)

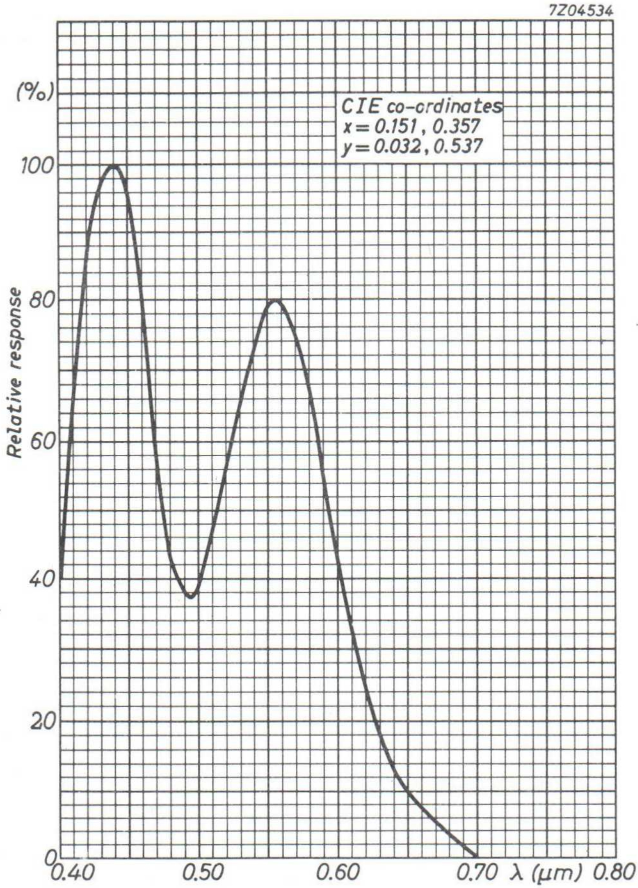

7Z04529
Vscreen : 3 kV
Iscreen : 25 μA (peak)
Excitation: Single, focused spot
The decay time is independent of screen voltage, screen loading and excitation time.
Relative luminance
(%)
100
50
20
10
5
2
1
0
10
20
30
40
Time after cessation of excitation (msec)

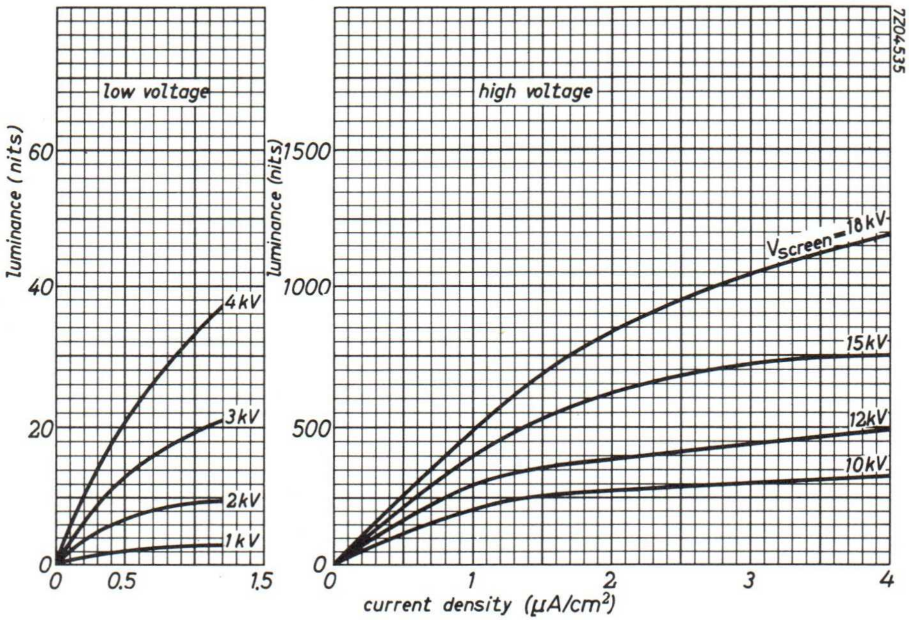

Luminance (nits)
Low voltage
150
100
50
0
0
0.5
1.5
Vscreen=5kV
4kV
3kV
2kV
1kV
0.5kV
Luminance (nits)
High voltage
3000
2000
1000
0
0
1
2
3
4
Vscreen=18kV
15kV
12kV
10kV
Current density (μA/cm²)
7Z04530

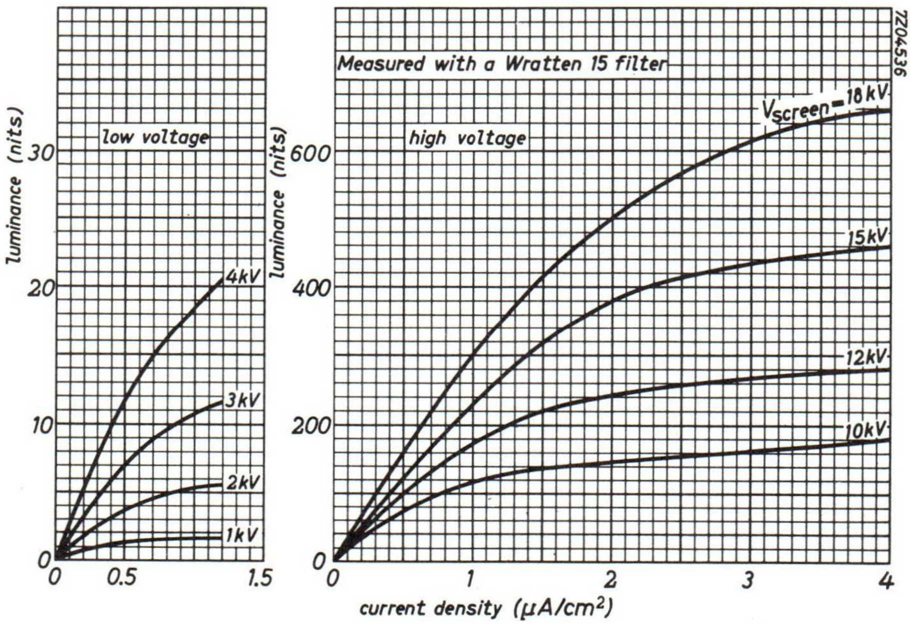

7Z04531
CIE co-ordinates
x = 0.279
y = 0.534
Relative response (%)
100
80
60
40
20
0
0.4
0.5
0.6
0.7
λ (μm)
0.8

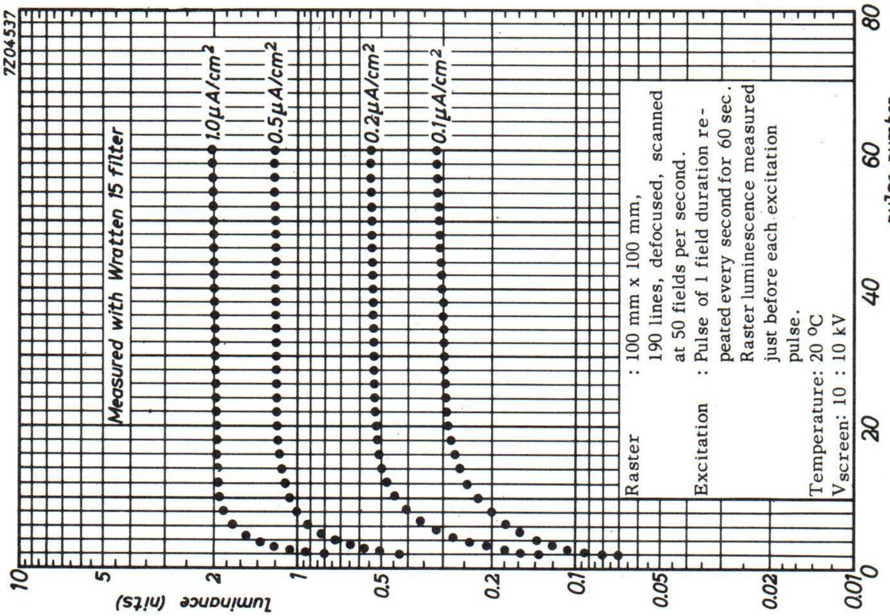

Vscreen : 3 kV
Iscreen : 2.5 μA
Excitation : Single focused spot
Pulse duration: 250 μs
At lower screen voltage, lower screen loading or longer excitation time, the decay will be longer.
7Z04532
Relative luminance (%)
100
10
1
0.1
0.01
1
10
10²
10³
10⁴
10⁵
Time after cessation of excitation (μsec)

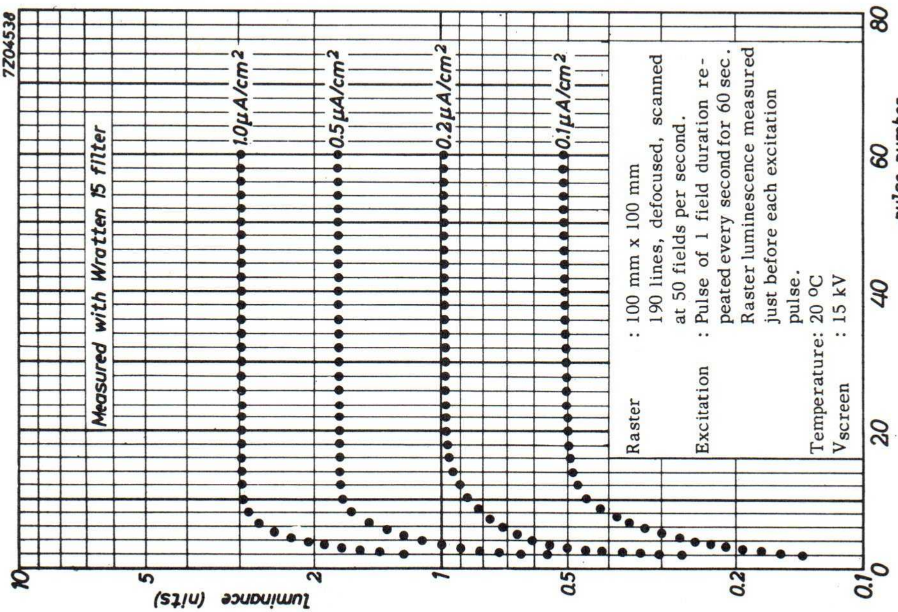

Low voltage
Luminance (nits)
600
400
200
0
0
2
Vscreen=5kV
4kV
3kV
2kV
High voltage
Luminance (nits)
6000
4000
2000
0
0
1
2
3
4
Vscreen=15kV
12kV
10kV
8kV
6kV
7Z04533
Current density (μA/cm²)

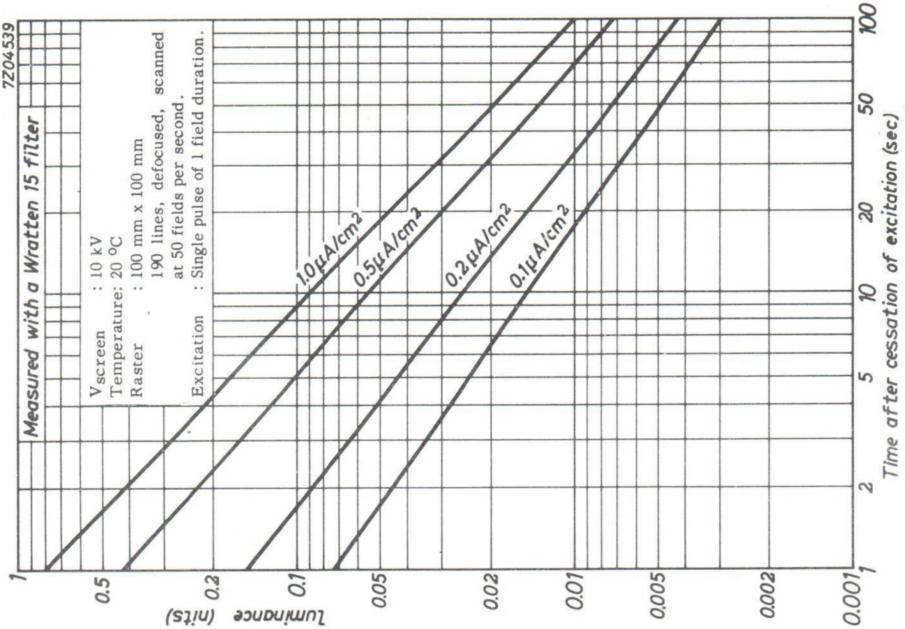

7Z04534
(%)
100
80
60
40
20
0
Relative response
CIE co-ordinates
x = 0.151, 0.357
y = 0.032, 0.537
0.40
0.50
0.60
0.70
λ (μm)
0.80

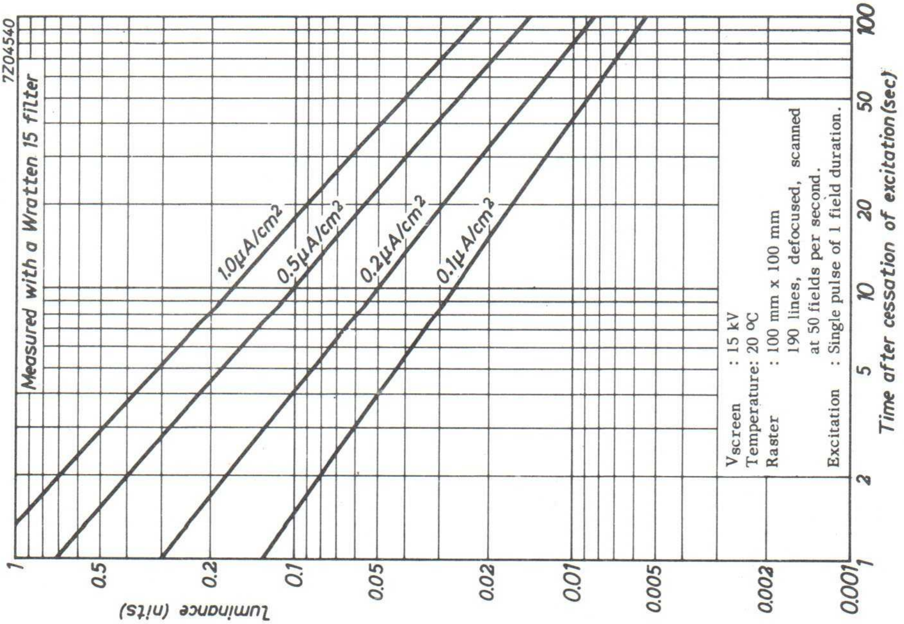

low voltage
high voltage
luminance (nits)
60
40
20
0
1500
1000
500
4kV
3kV
2kV
1kV
V_{screen}=18kV
15kV
12kV
10kV
0.5
1.5
1
2
3
4
current density (μA/cm²)
7Z04535

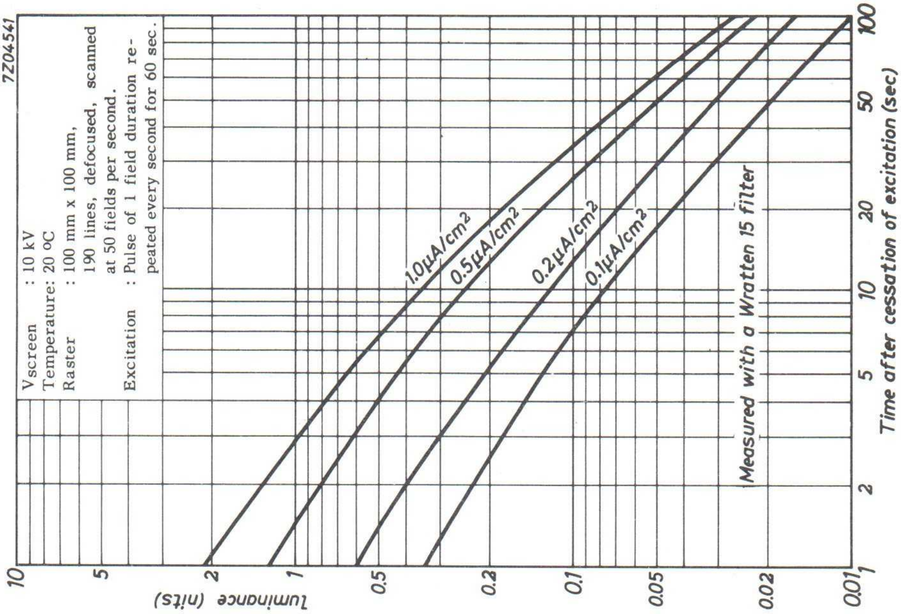

low voltage
Measured with a Wratten 15 filter
high voltage
luminance (nits)
30
20
10
0
600
400
200
4kV
3kV
2kV
1kV
V_{screen}=18kV
15kV
12kV
10kV
0.5
1.5
1
2
3
4
current density (μA/cm²)
7Z04536

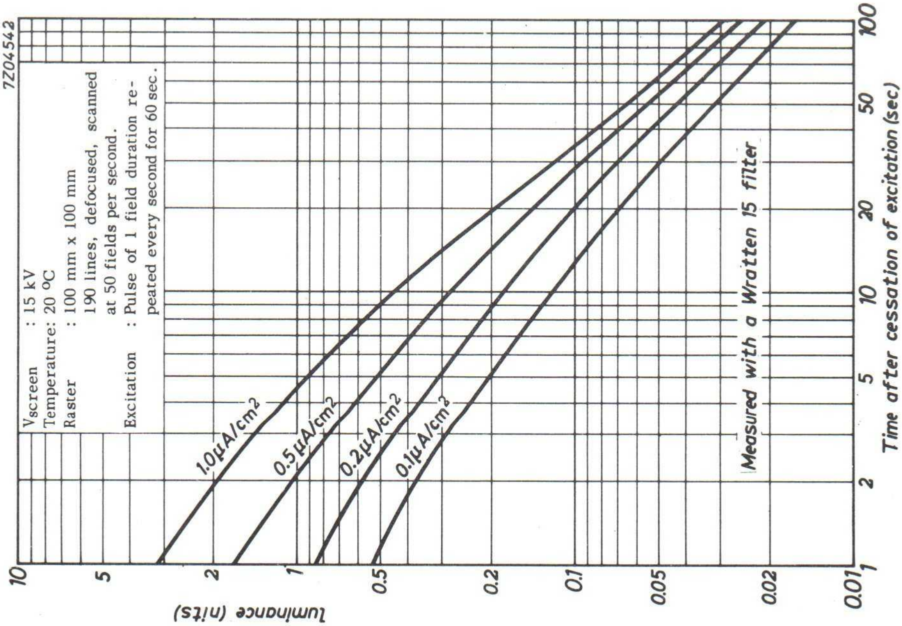

7Z04537
Measured with Wratten 15 filter
1.0μA/cm²
0.5μA/cm²
0.2μA/cm²
0.1μA/cm²
Raster : 100 mm x 100 mm, 190 lines, defocused, scanned at 50 fields per second.
Excitation : Pulse of 1 field duration repeated every second for 60 sec. Raster luminescence measured just before each excitation pulse.
Temperature: 20 °C
Vscreen: 10 : 10 kV
luminance (nits)
10
5
2
1
0.5
0.2
0.1
0.05
0.02
0.01
0
20
40
60
80
pulse number

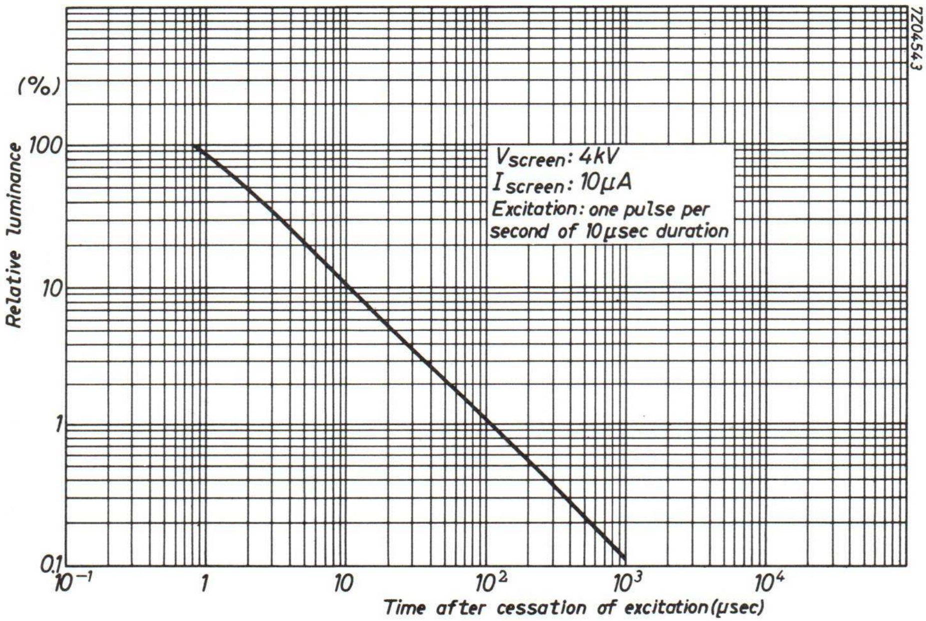

7Z04538
Measured with Wratten 15 filter
1.0μA/cm²
0.5μA/cm²
0.2μA/cm²
0.1μA/cm²
Raster : 100 mm x 100 mm 190 lines, defocused, scanned at 50 fields per second.
Excitation : Pulse of 1 field duration repeated every second for 60 sec. Raster luminescence measured just before each excitation pulse.
Temperature: 20 °C
Vscreen : 15 kV
luminance (nits)
10
5
2
1
0.5
0.2
0.1
0
20
40
60
80
pulse number

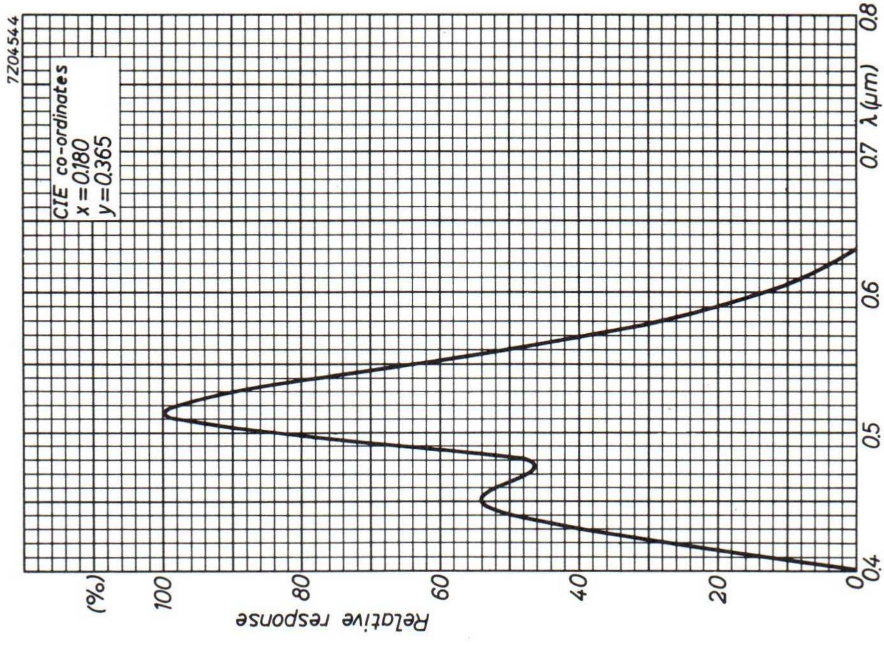

7Z04539
Measured with a Wratten 15 filter
Vscreen : 10 kV
Temperature: 20 °C
Raster : 100 mm x 100 mm
190 lines, defocused, scanned
at 50 fields per second.
Excitation : Single pulse of 1 field duration.
1.0μA/cm²
0.5μA/cm²
0.2μA/cm²
0.1μA/cm²
Luminance (nits)
1
0.5
0.2
0.1
0.05
0.02
0.01
0.005
0.002
0.001
Time after cessation of excitation (sec)
1
2
5
10
20
50
100

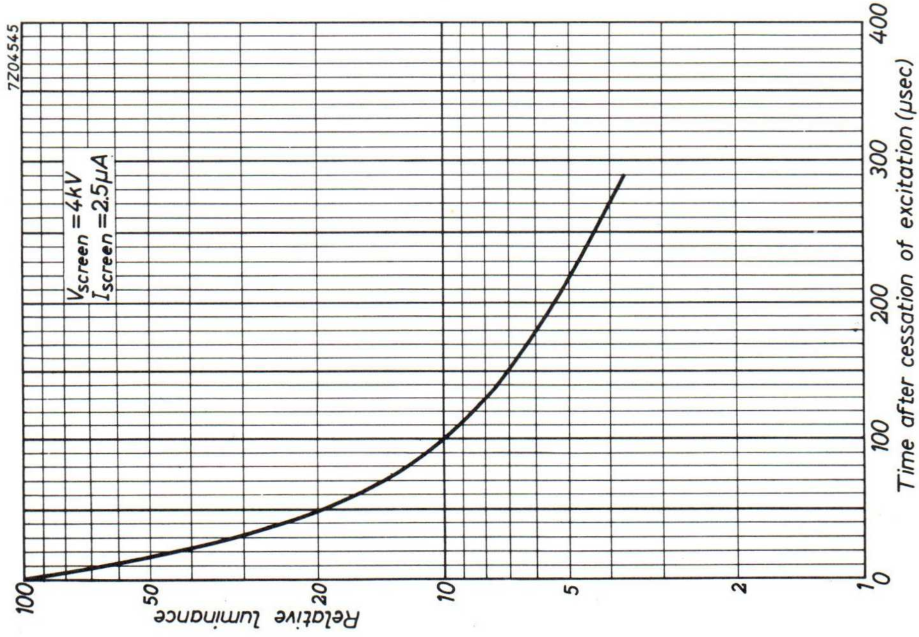

7Z04540
Measured with a Wratten 15 filter
Vscreen : 15 kV
Temperature: 20 °C
Raster : 100 mm x 100 mm
190 lines, defocused, scanned
at 50 fields per second.
Excitation : Single pulse of 1 field duration.
1.0μA/cm²
0.5μA/cm²
0.2μA/cm²
0.1μA/cm²
Luminance (nits)
1
0.5
0.2
0.1
0.05
0.02
0.01
0.005
0.002
0.001
Time after cessation of excitation (sec)
1
2
5
10
20
50
100

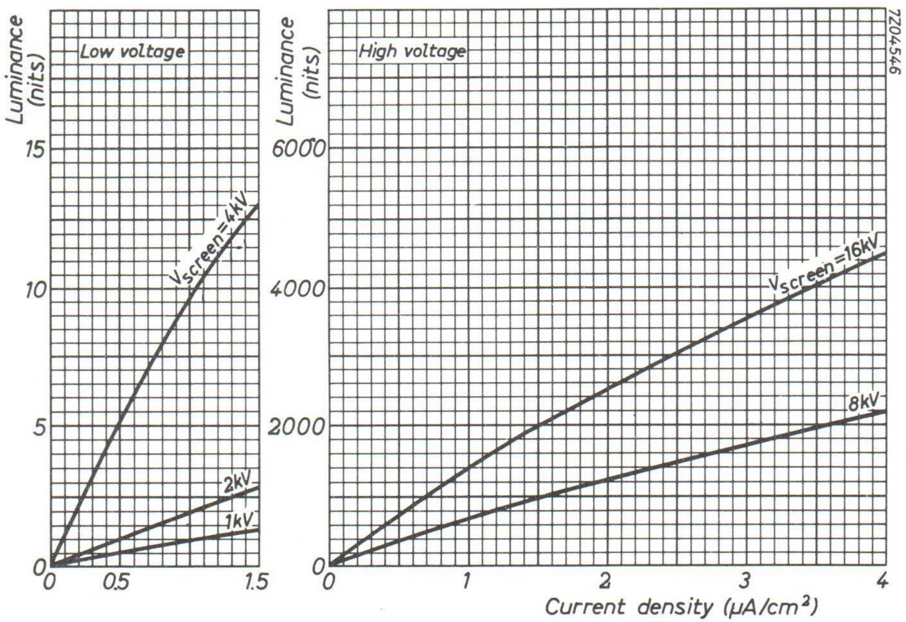

7Z04541
Vscreen : 10 kV
Temperature: 20 °C
Raster : 100 mm x 100 mm, 190 lines, defocused, scanned at 50 fields per second.
Excitation : Pulse of 1 field duration re-peated every second for 60 sec.
1.0μA/cm²
0.5μA/cm²
0.2μA/cm²
0.1μA/cm²
Measured with a Wratten 15 filter
Luminance (nits)
10
5
2
1
0.5
0.2
0.1
0.05
0.02
0.01
Time after cessation of excitation (sec)
1
2
5
10
20
50
100

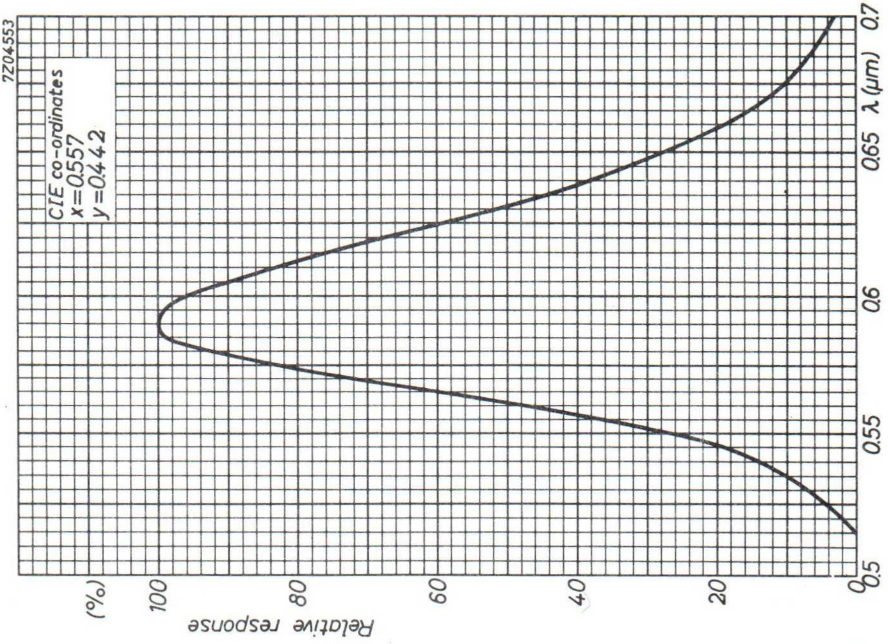

7Z04542
Vscreen : 15 kV
Temperature: 20 °C
Raster : 100 mm x 100 mm 190 lines, defocused, scanned at 50 fields per second.
Excitation : Pulse of 1 field duration re-peated every second for 60 sec.
1.0μA/cm²
0.5μA/cm²
0.2μA/cm²
0.1μA/cm²
Measured with a Wratten 15 filter
Luminance (nits)
10
5
2
1
0.5
0.2
0.1
0.05
0.02
0.01
Time after cessation of excitation (sec)
1
2
5
10
20
50
100

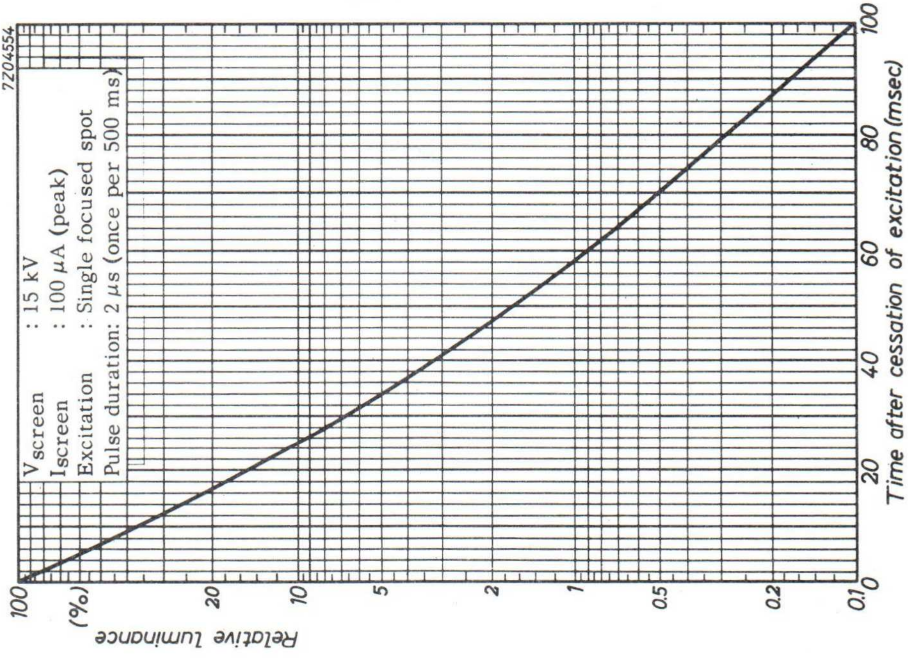

7Z04543
(%)
Relative luminance
100
10
1
0.1
10^{-1}
1
10
10^2
10^3
10^4
Time after cessation of excitation (µsec)
V_{screen}: 4kV
I_{screen}: 10µA
Excitation: one pulse per second of 10µsec duration

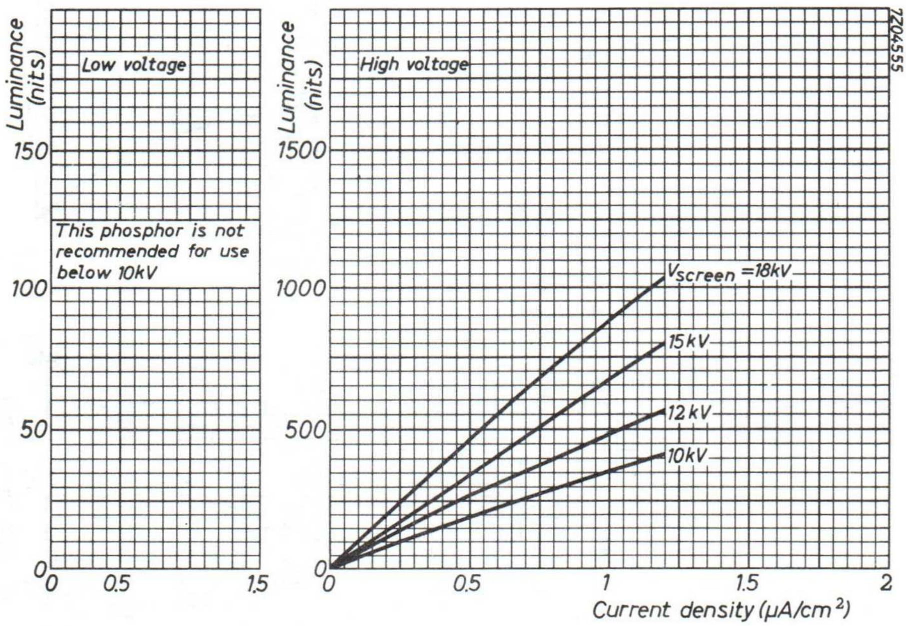

7Z04544
CIE co-ordinates
x = 0.180
y = 0.365
Relative response
(%)
100
80
60
40
20
0
0.4
0.5
0.6
0.7
0.8
λ (μm)

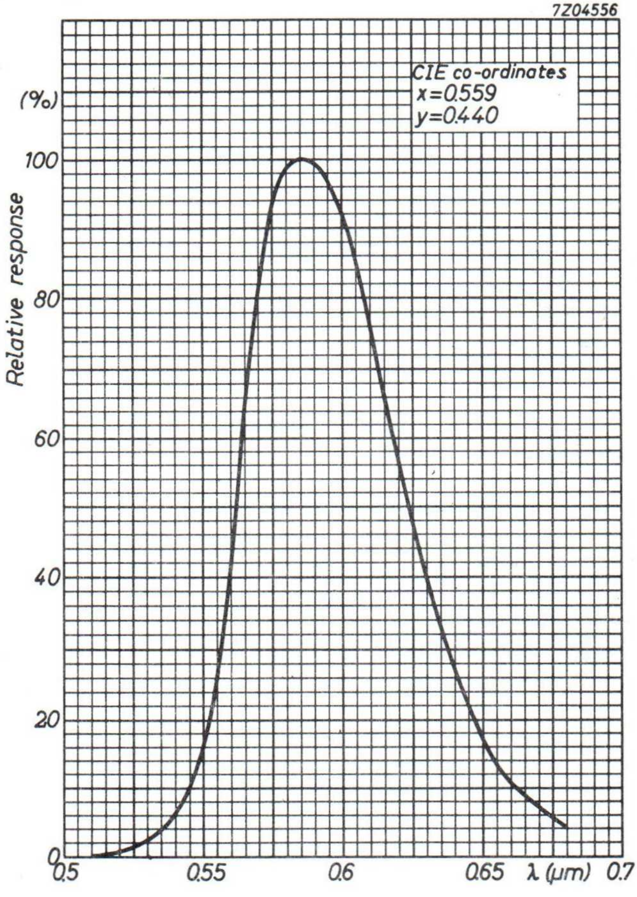

7Z04545
V_screen = 4kV
I_screen = 2.5μA
Relative luminance
100
50
20
10
5
2
1
0
100
200
300
400
Time after cessation of excitation (μsec)

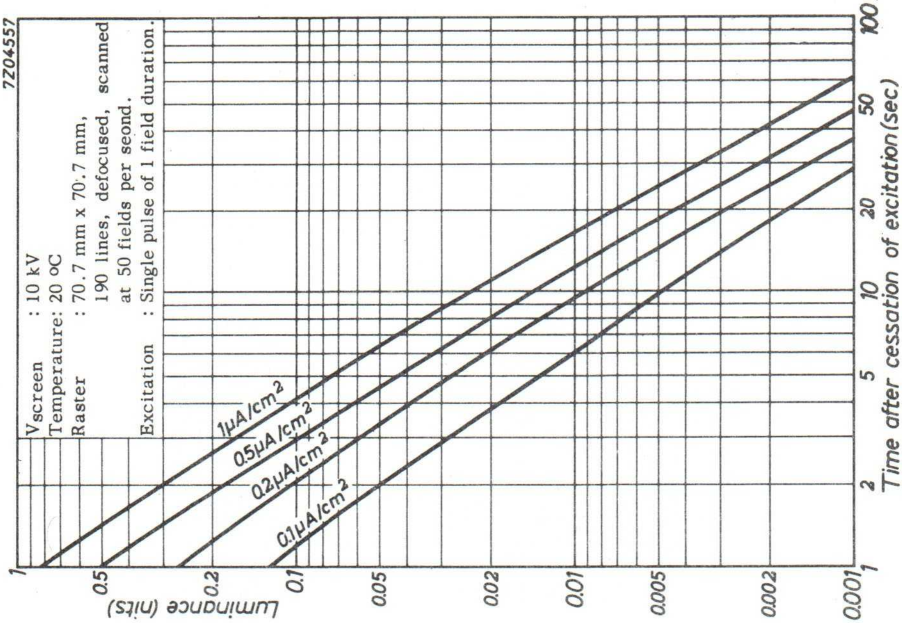

Luminance (nits)
Low voltage
15
10
5
0
0
0.5
1.5
Vscreen=4kV
2kV
1kV
Luminance (nits)
High voltage
6000
4000
2000
0
0
1
2
3
4
Vscreen=16kV
8kV
Current density (μA/cm²)
7Z04546


7204553
CIE co-ordinates
x=0.557
y=0.442
Relative response
(%)
100
80
60
40
20
0
0.5
0.55
0.6
0.65
0.7
λ (μm)

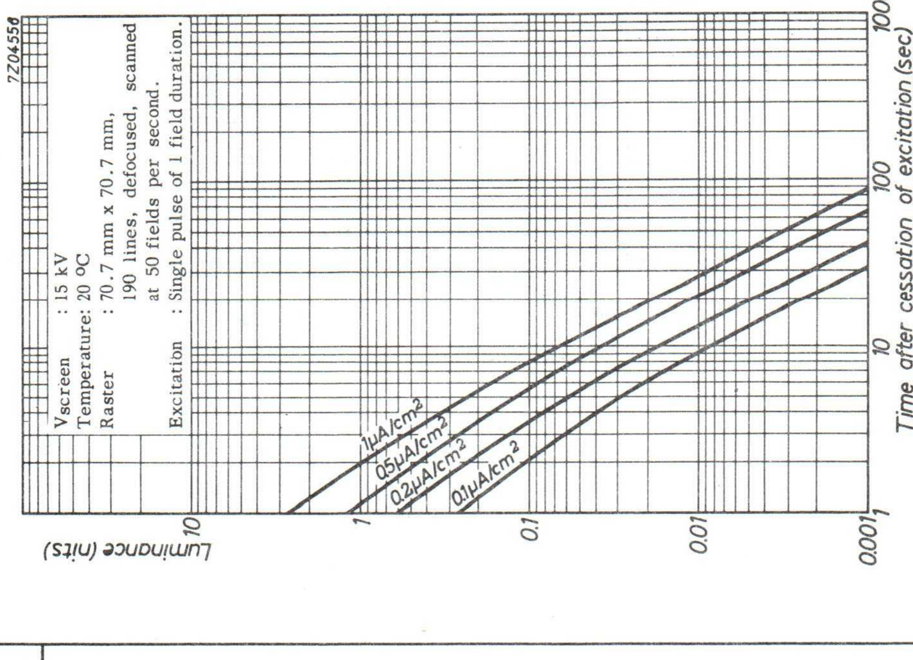

7204554
V screen : 15 kV
I screen : 100 μA (peak)
Excitation : Single focused spot
Pulse duration: 2 μs (once per 500 ms)
Relative luminance
(%)
100
20
10
5
2
1
0.5
0.2
0.1
0
20
40
60
80
100
Time after cessation of excitation (msec)


Luminance (nits)
Low voltage
This phosphor is not recommended for use below 10kV
150
100
50
0
0
0.5
1.5
Luminance (nits)
High voltage
1500
1000
500
0
0
0.5
1
1.5
2
Current density (µA/cm²)
Vscreen =18kV
15kV
12kV
10kV
7Z04555

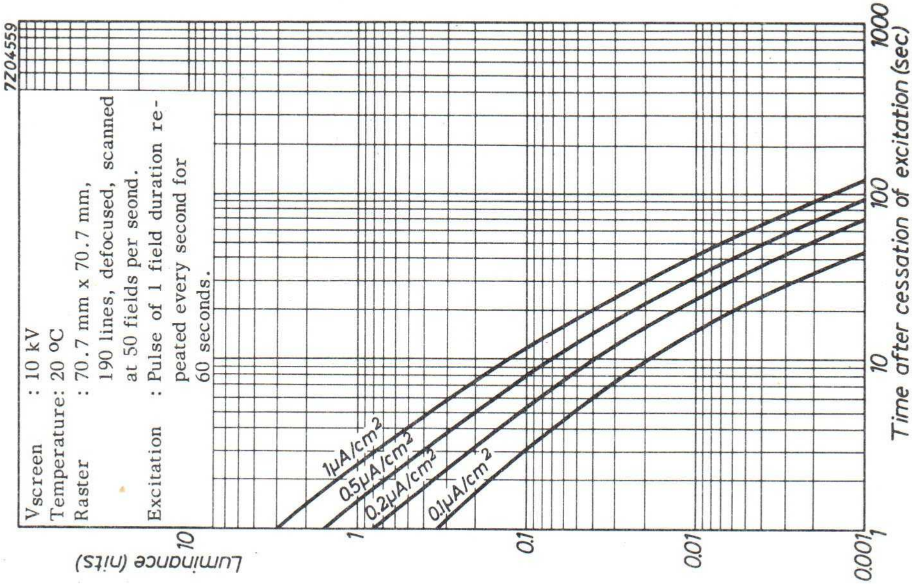

7Z04556
CIE co-ordinates
x=0.559
y=0.440
(%)
100
80
60
40
20
0
Relative response
0.5
0.55
0.6
0.65
λ (μm)
0.7

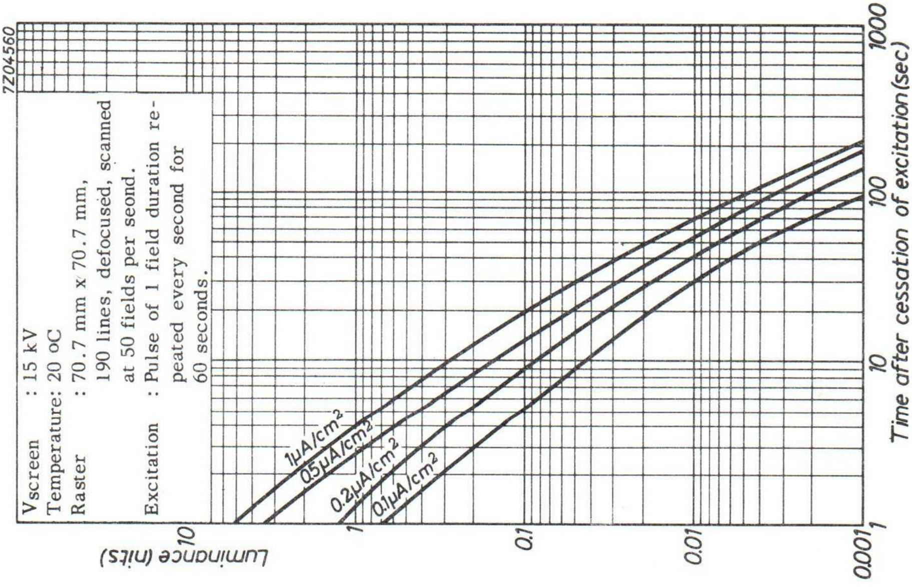


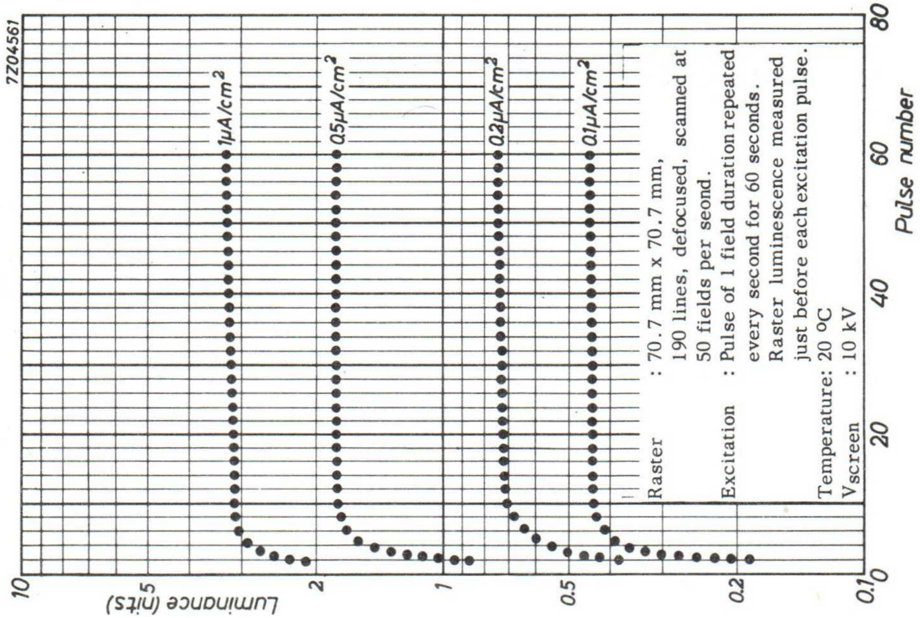
7Z04557
Vscreen : 10 kV
Temperature: 20 °C
Raster : 70.7 mm x 70.7 mm, 190 lines, defocused, scanned at 50 fields per seond.
Excitation : Single pulse of 1 field duration.
1μA/cm²
0.5μA/cm²
0.2μA/cm²
0.1μA/cm²
Luminance (nits)
1
0.5
0.2
0.1
0.05
0.02
0.01
0.005
0.002
0.001
Time after cessation of excitation (sec)
1
2
5
10
20
50
100

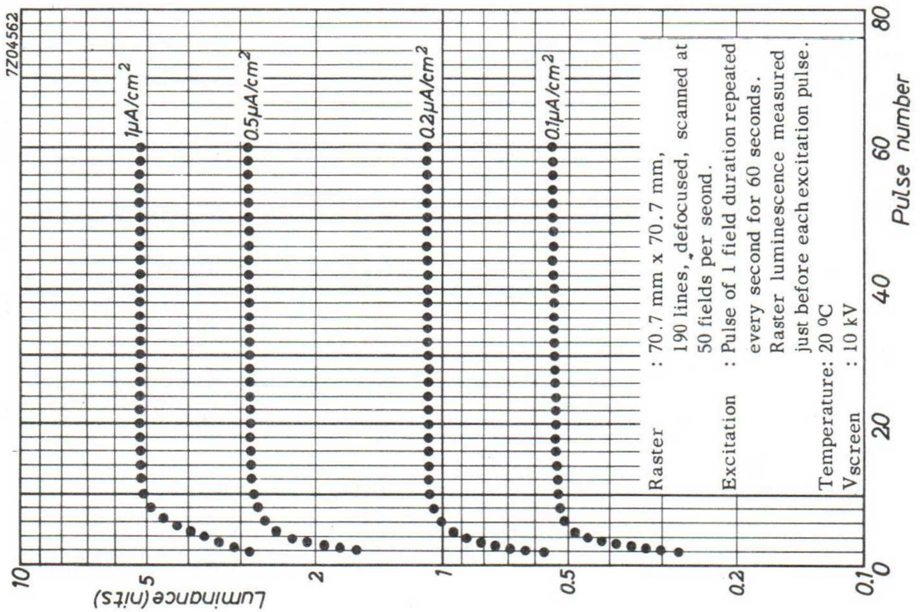


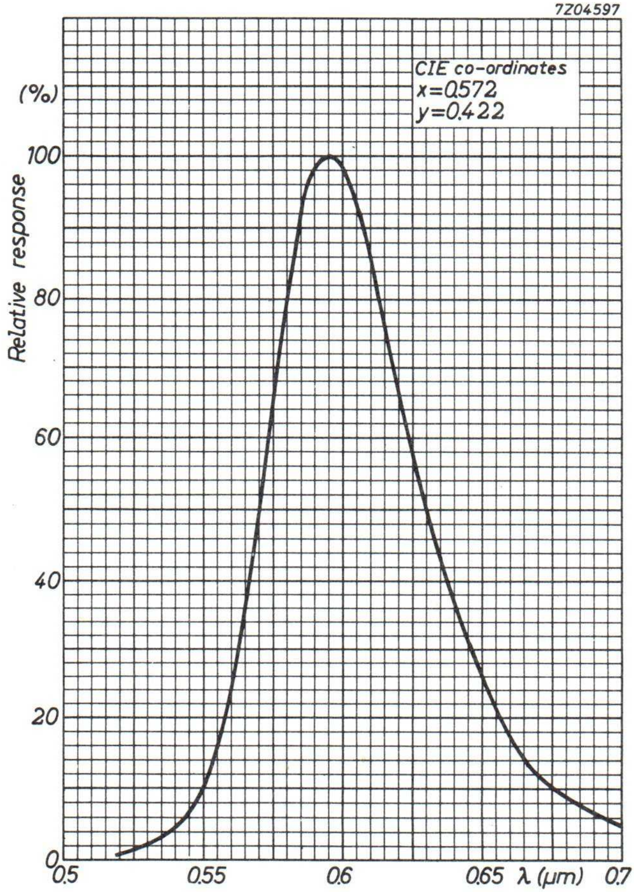
7Z04556
Vscreen : 15 kV
Temperature: 20 °C
Raster : 70.7 mm x 70.7 mm, 190 lines, defocused, scanned at 50 fields per second.
Excitation : Single pulse of 1 field duration.
1μA/cm²
0.5μA/cm²
0.2μA/cm²
0.1μA/cm²
Luminance (nits)
10
1
0.1
0.01
0.001
Time after cessation of excitation (sec)
1
10
100
1000

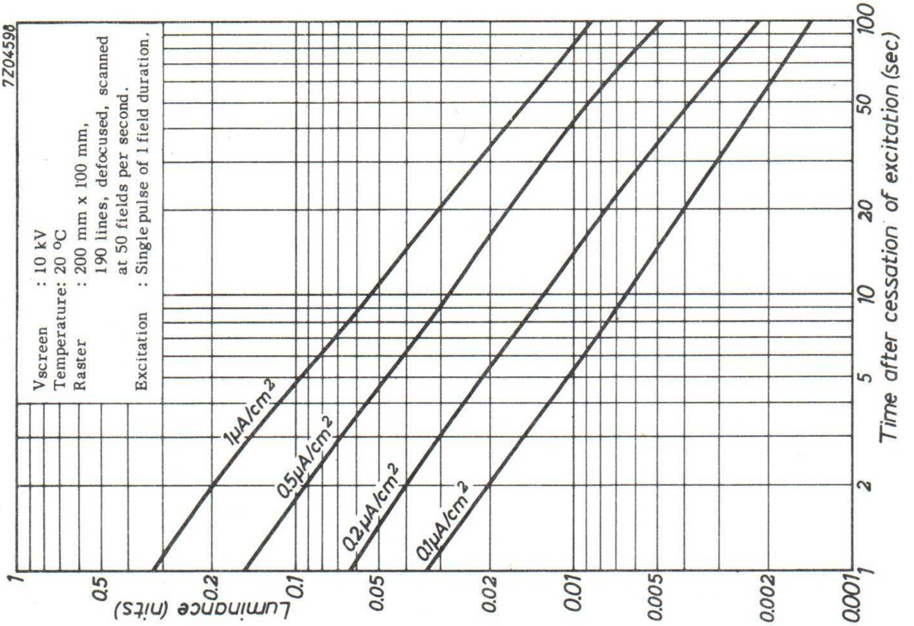

7Z04559
Vscreen : 10 kV
Temperature: 20 °C
Raster : 70.7 mm x 70.7 mm,
190 lines, defocused, scanned
at 50 fields per seond.
Excitation : Pulse of 1 field duration re-
peated every second for
60 seconds.
1μA/cm²
0.5μA/cm²
0.2μA/cm²
0.1μA/cm²
Luminance (nits)
10
1
0.1
0.01
0.001
1
10
100
1000
Time after cessation of excitation (sec)

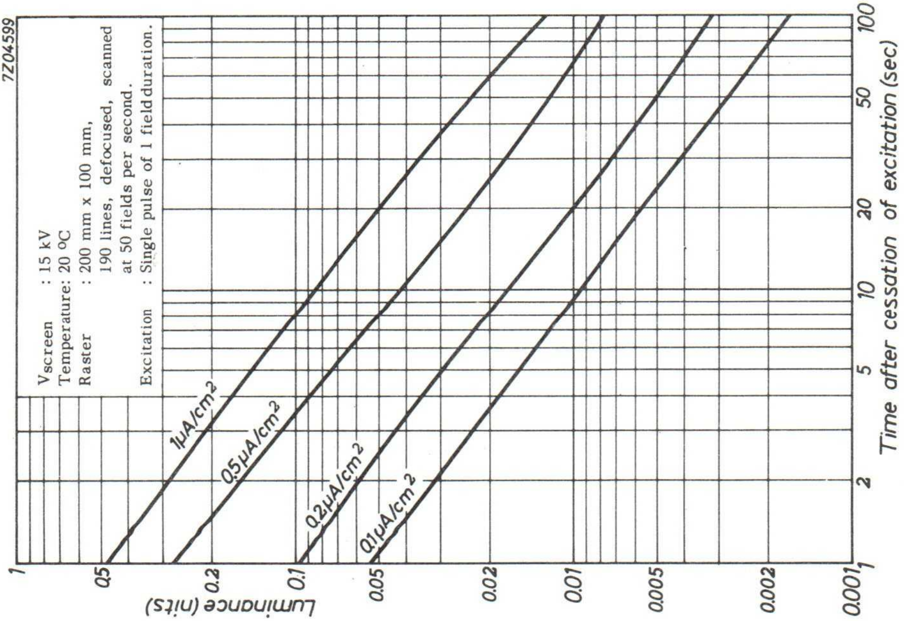

7Z04560
Vscreen : 15 kV
Temperature: 20 oC
Raster : 70.7 mm x 70.7 mm,
190 lines, defocused, scanned
at 50 fields per seond.
Excitation : Pulse of 1 field duration re-
peated every second for
60 seconds.
1μA/cm²
0.5μA/cm²
0.2μA/cm²
0.1μA/cm²
Luminance (nits)
10
1
0.1
0.01
0.001
1
10
100
1000
Time after cessation of excitation (sec)

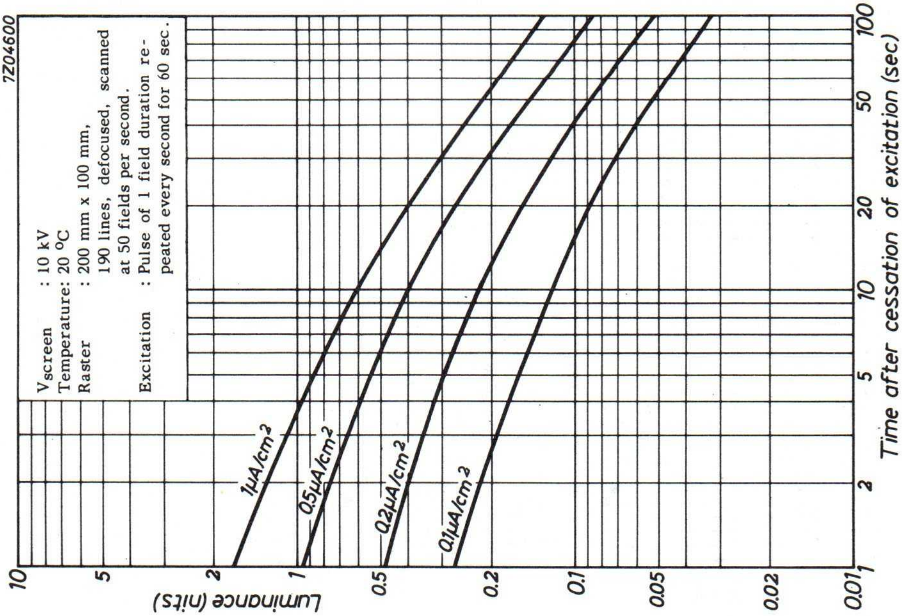

7Z04561
Luminance (nits)
10
5
2
1
0.5
0.2
0.1
0
20
40
60
80
Pulse number
1μA/cm2
0.5μA/cm2
0.2μA/cm2
0.1μA/cm2
Raster : 70.7 mm x 70.7 mm,
190 lines, defocused, scanned at
50 fields per seond.
Excitation : Pulse of 1 field duration repeated
every second for 60 seconds.
Raster luminescence measured
just before each excitation pulse.
Temperature: 20 ºC
Vscreen : 10 kV

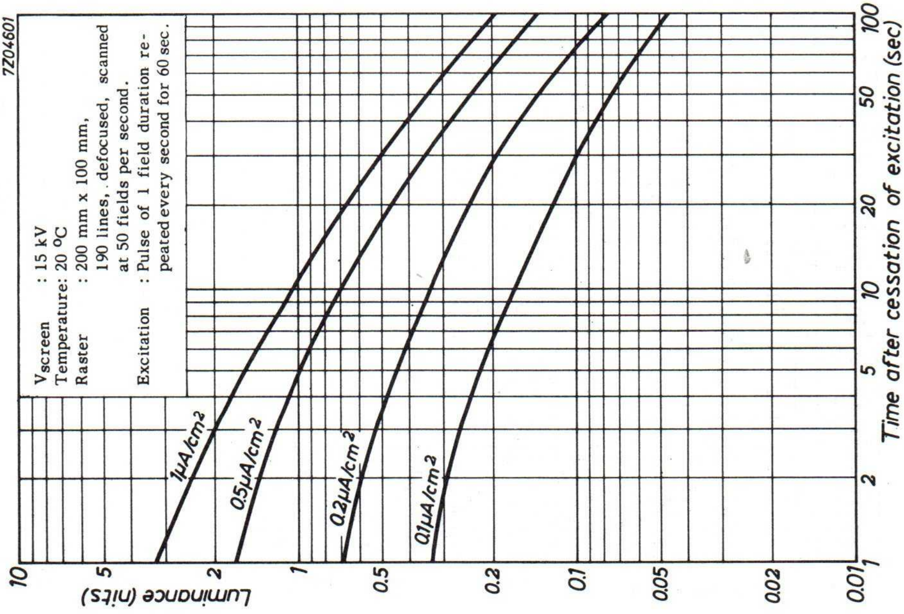

7Z04562
Luminance (nits)
10
5
2
1
0.5
0.2
0.1
0
20
40
60
80
Pulse number
1μA/cm2
0.5μA/cm2
0.2μA/cm2
0.1μA/cm2
Raster : 70.7 mm x 70.7 mm,
190 lines, defocused, scanned at
50 fields per seond.
Excitation : Pulse of 1 field duration repeated
every second for 60 seconds.
Raster luminescence measured
just before each excitation pulse.
Temperature: 20 ºC
Vscreen : 10 kV

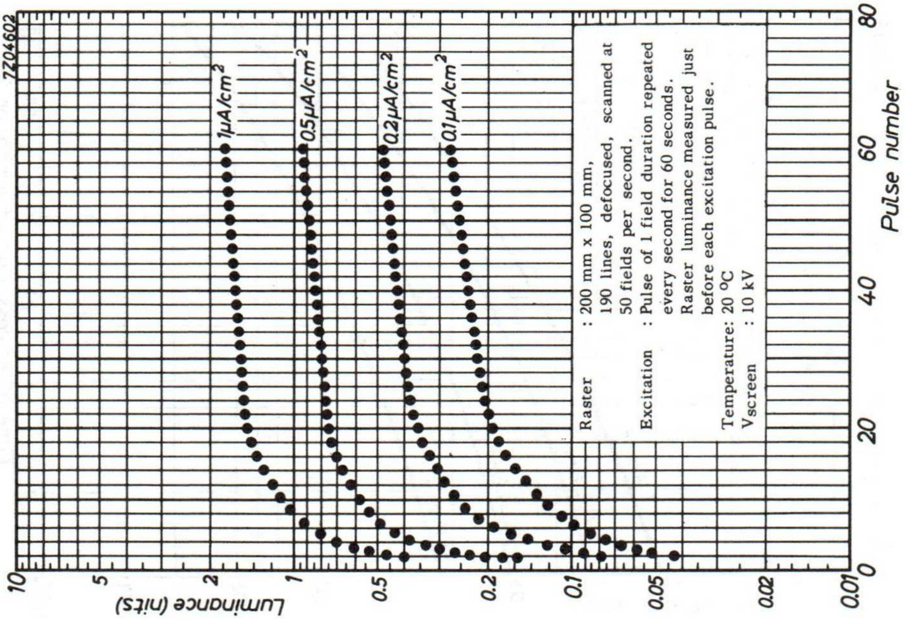

7Z04597
CIE co-ordinates
x=0.572
y=0.422
(%)
Relative response
100
80
60
40
20
0
0.5
0.55
0.6
0.65
λ (μm)
0.7

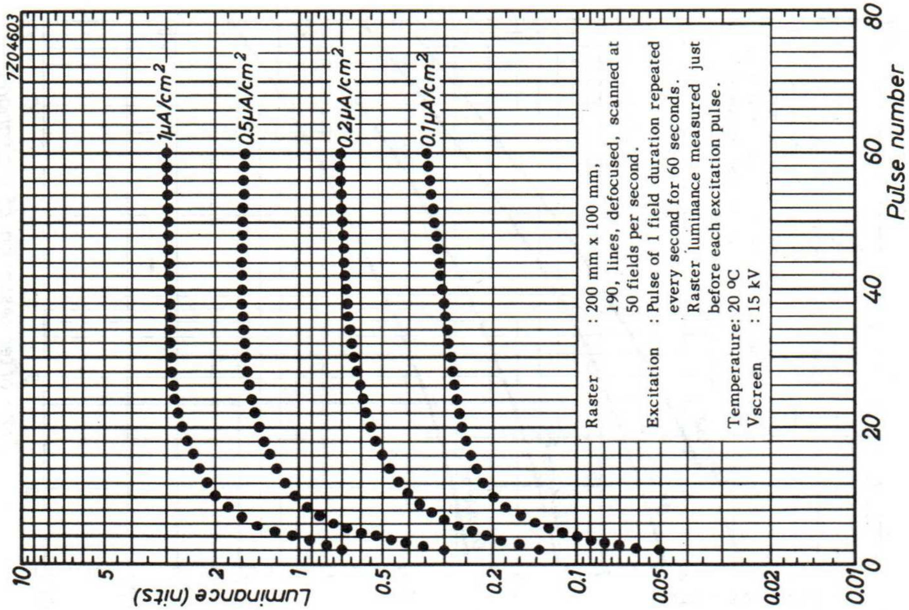

7Z04598
Vscreen : 10 kV
Temperature: 20 °C
Raster : 200 mm x 100 mm, 190 lines, defocused, scanned at 50 fields per second.
Excitation : Single pulse of 1 field duration.
1μA/cm²
0.5μA/cm²
0.2μA/cm²
0.1μA/cm²
Luminance (nits)
1
0.5
0.2
0.1
0.05
0.02
0.01
0.005
0.002
0.001
Time after cessation of excitation (sec)
1
2
5
10
20
50
100

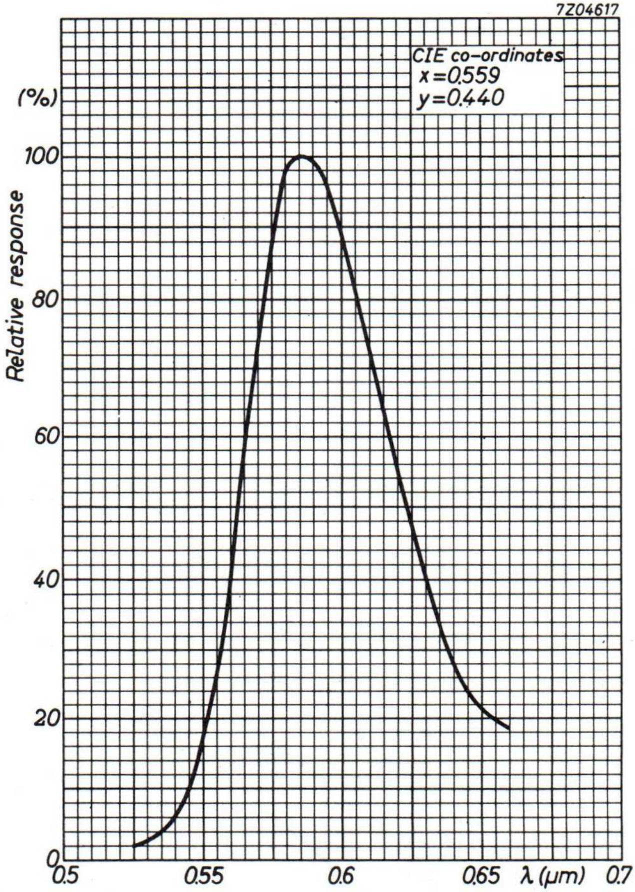

7Z04599
Vscreen : 15 kV
Temperature: 20 °C
Raster : 200 mm x 100 mm, 190 lines, defocused, scanned at 50 fields per second.
Excitation : Single pulse of 1 field duration.
1μA/cm²
0.5μA/cm²
0.2μA/cm²
0.1μA/cm²
Luminance (nits)
1
0.5
0.2
0.1
0.05
0.02
0.01
0.005
0.002
0.001
Time after cessation of excitation (sec)
1
2
5
10
20
50
100

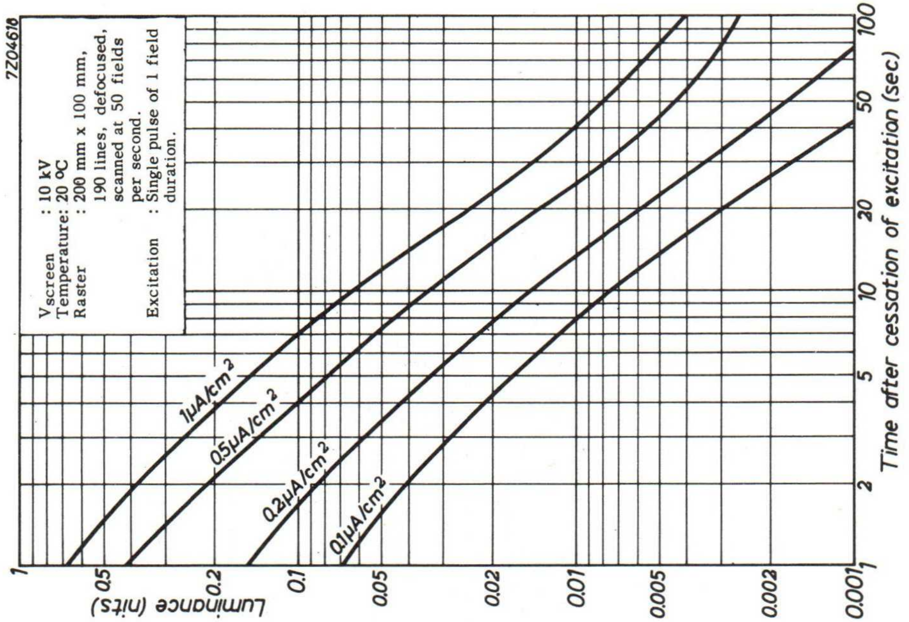

7Z04600
Vscreen : 10 kV
Temperature: 20 °C
Raster : 200 mm x 100 mm, 190 lines, defocused, scanned at 50 fields per second.
Excitation : Pulse of 1 field duration repeated every second for 60 sec.
1μA/cm2
0.5μA/cm2
0.2μA/cm2
0.1μA/cm2
Luminance (nits)
10
5
2
1
0.5
0.2
0.1
0.05
0.02
0.01
1
2
5
10
20
50
100
Time after cessation of excitation (sec)

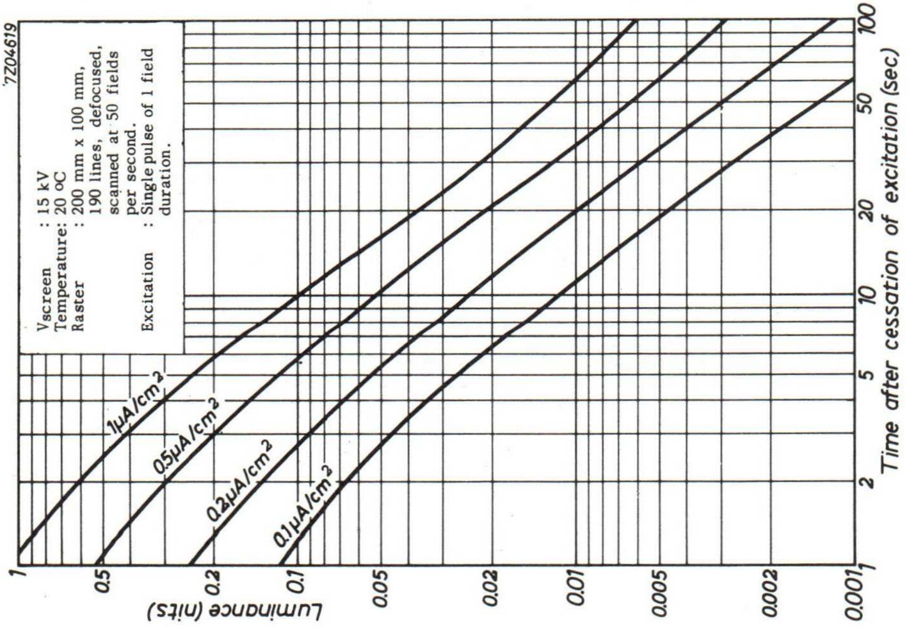

7Z04601
Vscreen : 15 kV
Temperature: 20 °C
Raster : 200 mm x 100 mm, 190 lines, defocused, scanned at 50 fields per second.
Excitation : Pulse of 1 field duration repeated every second for 60 sec.
1μA/cm2
0.5μA/cm2
0.2μA/cm2
0.1μA/cm2
Luminance (nits)
10
5
2
1
0.5
0.2
0.1
0.05
0.02
0.01
1
2
5
10
20
50
100
Time after cessation of excitation (sec)

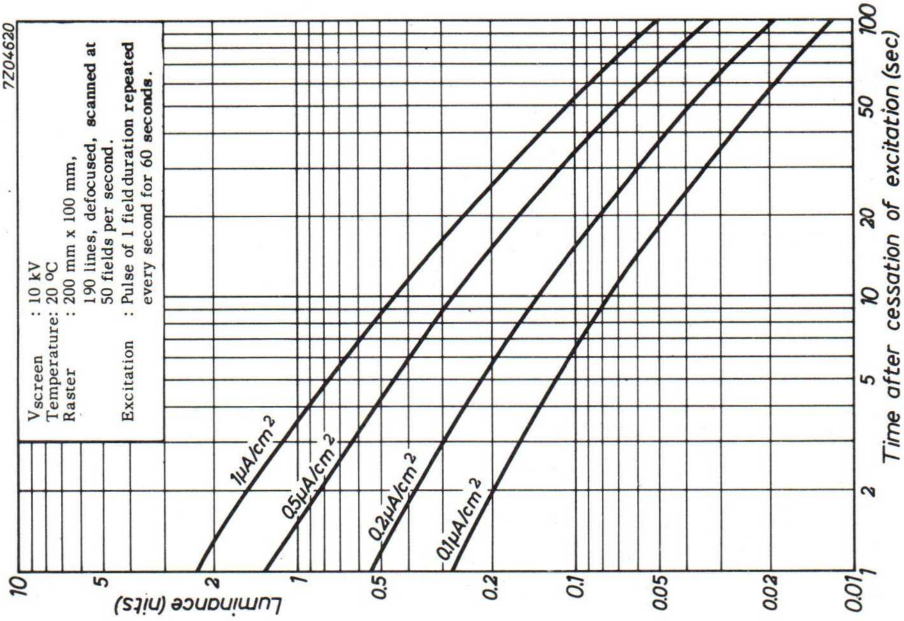

7Z04602
1μA/cm²
0.5μA/cm²
0.2μA/cm²
0.1μA/cm²
Raster : 200 mm x 100 mm, 190 lines, defocused, scanned at 50 fields per second.
Excitation : Pulse of 1 field duration repeated every second for 60 seconds. Raster luminance measured just before each excitation pulse.
Temperature: 20 °C
Vscreen : 10 kV
Luminance (nits)
10
5
2
1
0.5
0.2
0.1
0.05
0.02
0.01
0
20
40
60
80
Pulse number

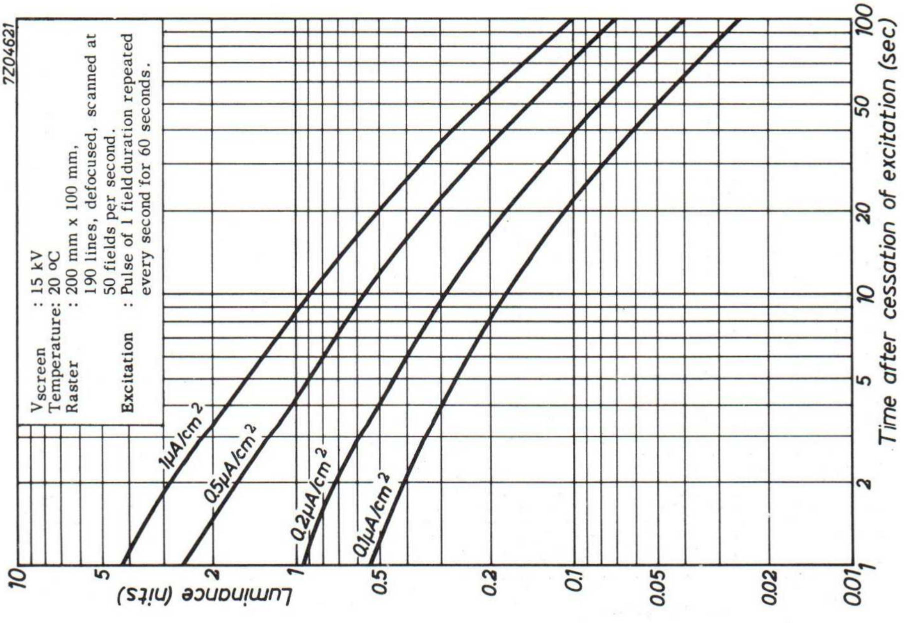

7Z04603
1μA/cm²
0.5μA/cm²
0.2μA/cm²
0.1μA/cm²
Raster : 200 mm x 100 mm, 190, lines, defocused, scanned at 50 fields per second.
Excitation : Pulse of 1 field duration repeated every second for 60 seconds. Raster luminance measured just before each excitation pulse.
Temperature: 20 °C
Vscreen : 15 kV
Luminance (nits)
10
5
2
1
0.5
0.2
0.1
0.05
0.02
0.01
0
20
40
60
80
Pulse number

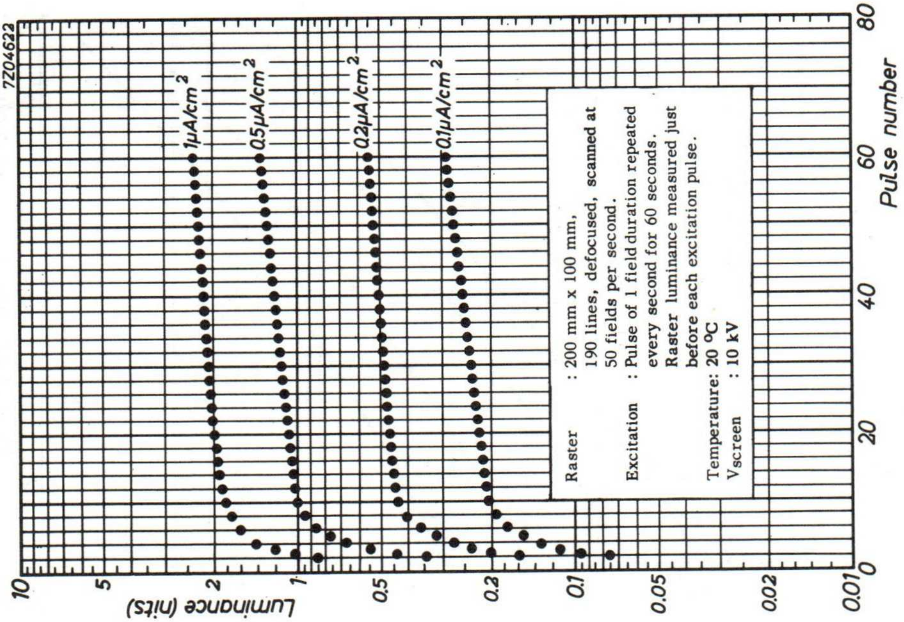

7Z04617
CIE co-ordinates
x = 0.559
y = 0.440
(%)
100
80
60
40
20
0
Relative response
0.5
0.55
0.6
0.65
λ (μm)
0.7

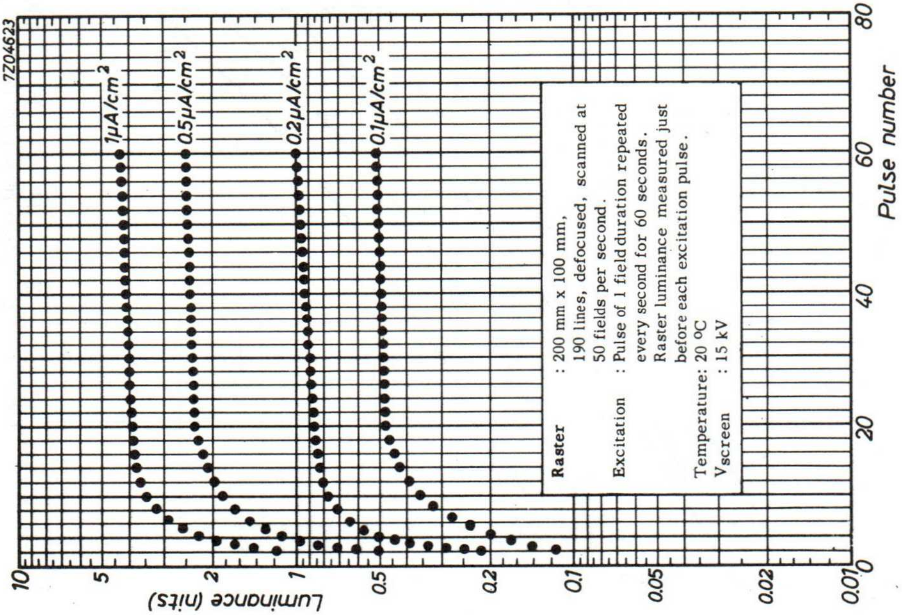

7Z04618
Vscreen : 10 kV
Temperature: 20 °C
Raster : 200 mm x 100 mm, 190 lines, defocused, scanned at 50 fields per second.
Excitation : Single pulse of 1 field duration.
1μA/cm2
0.5μA/cm2
0.2μA/cm2
0.1μA/cm2
Luminance (nits)
1
0.5
0.2
0.1
0.05
0.02
0.01
0.005
0.002
0.001
Time after cessation of excitation (sec)
1
2
5
10
20
50
100

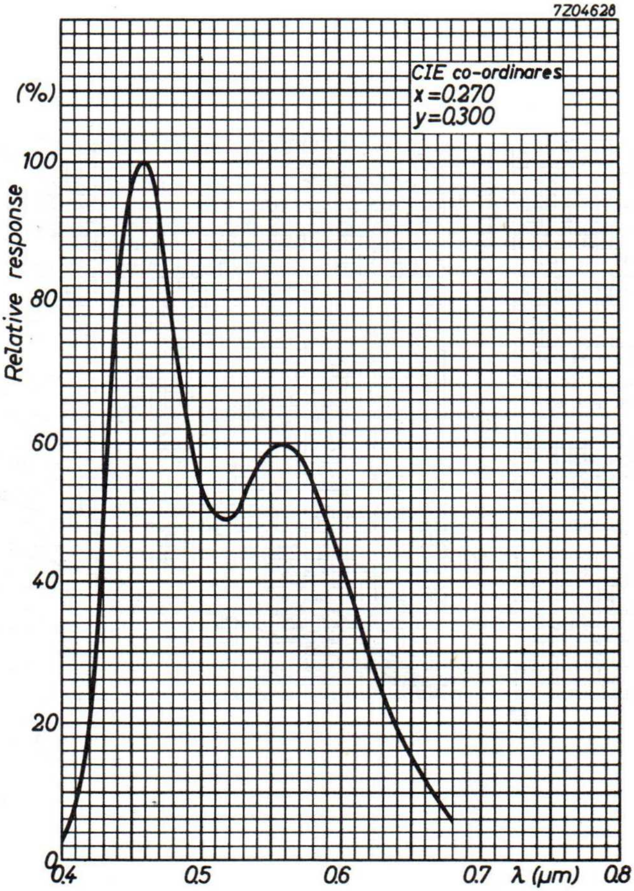

7Z04619
Vscreen : 15 kV
Temperature: 20 °C
Raster : 200 mm x 100 mm, 190 lines, defocused, scanned at 50 fields per second.
Excitation : Single pulse of 1 field duration.
1μA/cm2
0.5μA/cm2
0.2μA/cm2
0.1μA/cm2
Luminance (nits)
1
0.5
0.2
0.1
0.05
0.02
0.01
0.005
0.002
0.001
Time after cessation of excitation (sec)
1
2
5
10
20
50
100

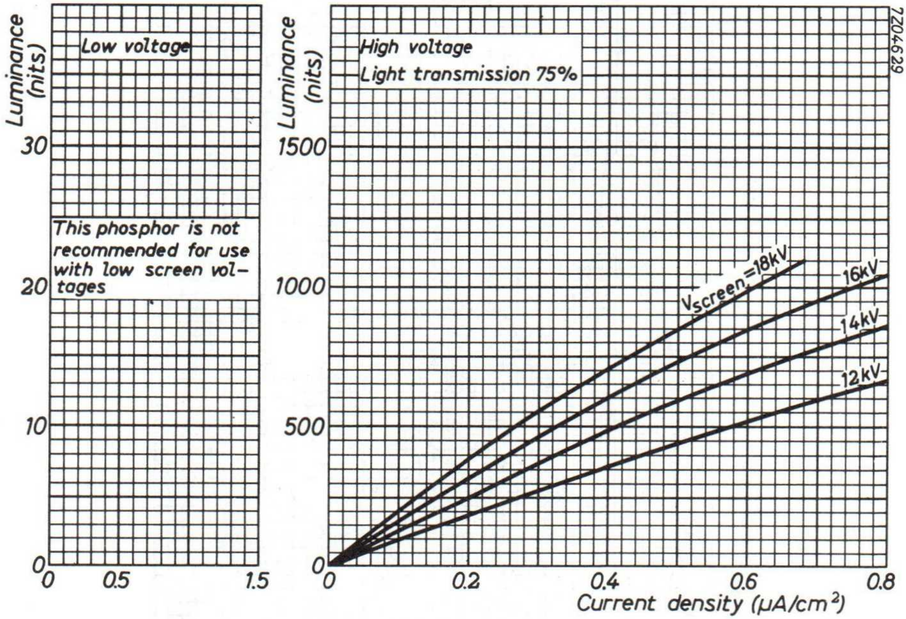

7Z04620
Vscreen : 10 kV
Temperature: 20 ºC
Raster : 200 mm x 100 mm, 190 lines, defocused, scanned at 50 fields per second.
Excitation : Pulse of 1 field duration repeated every second for 60 seconds.
1μA/cm²
0.5μA/cm²
0.2μA/cm²
0.1μA/cm²
Luminance (nits)
10
5
2
1
0.5
0.2
0.1
0.05
0.02
0.01
Time after cessation of excitation (sec)
1
2
5
10
20
50
100

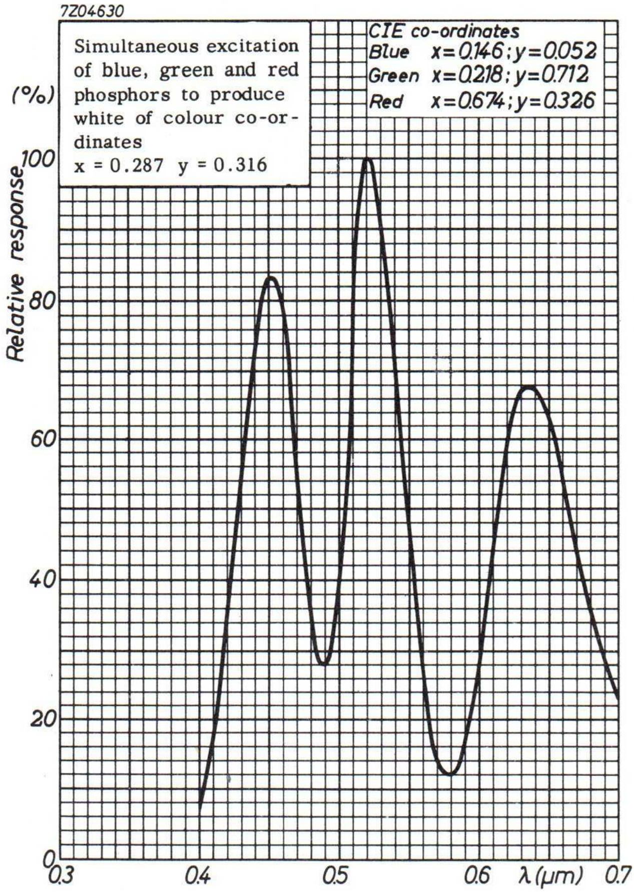

7Z04621
Vscreen : 15 kV
Temperature: 20 ºC
Raster : 200 mm x 100 mm, 190 lines, defocused, scanned at 50 fields per second.
Excitation : Pulse of 1 field duration repeated every second for 60 seconds.
1μA/cm²
0.5μA/cm²
0.2μA/cm²
0.1μA/cm²
Luminance (nits)
10
5
2
1
0.5
0.2
0.1
0.05
0.02
0.01
Time after cessation of excitation (sec)
1
2
5
10
20
50
100

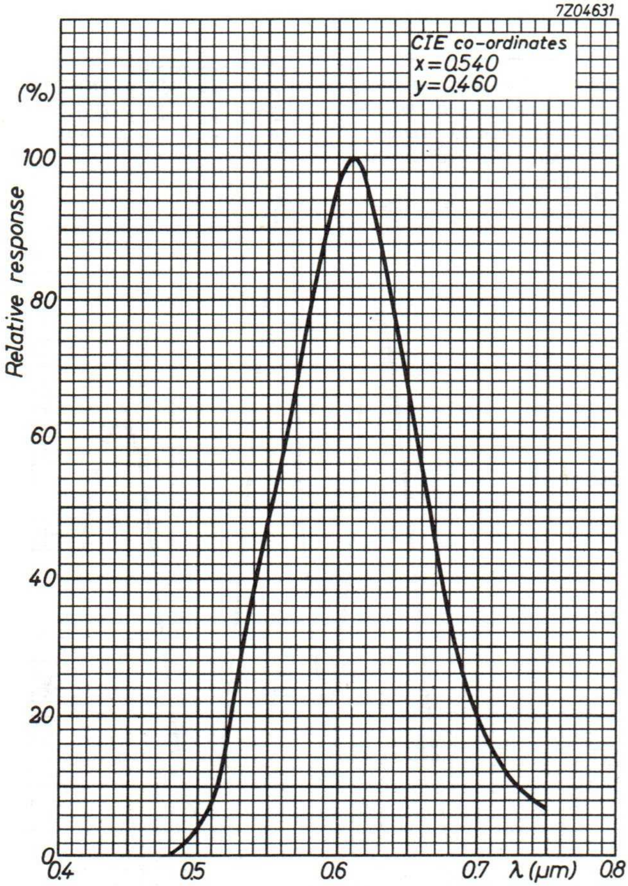

7Z04622
Luminance (nits)
10
5
2
1
0.5
0.2
0.1
0.05
0.02
0.01
0
20
40
60
80
Pulse number
1μA/cm²
0.5μA/cm²
0.2μA/cm²
0.1μA/cm²
Raster : 200 mm x 100 mm, 190 lines, defocused, scanned at 50 fields per second.
Excitation : Pulse of 1 field duration repeated every second for 60 seconds. Raster luminance measured just before each excitation pulse.
Temperature: 20 °C
Vscreen : 10 kV

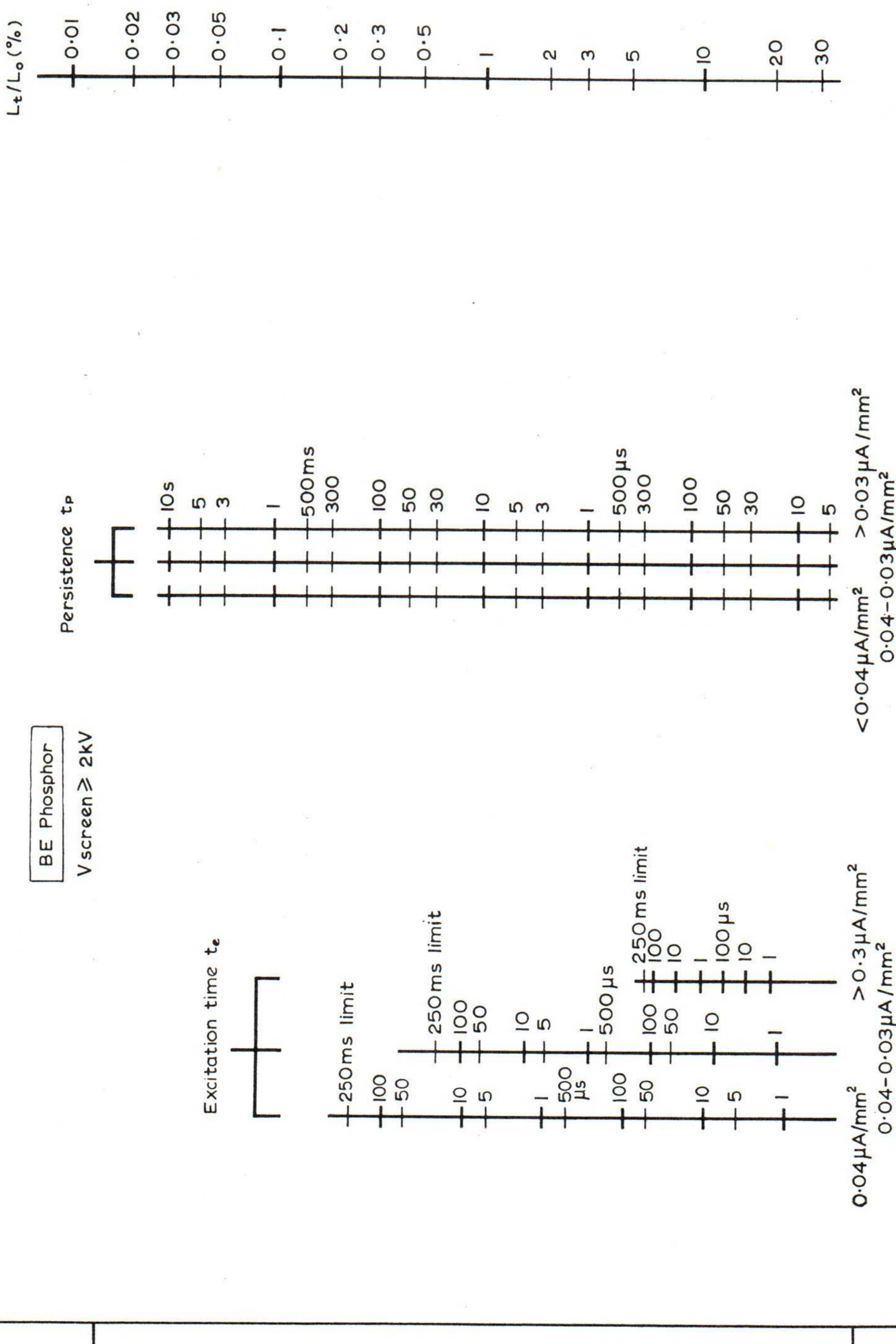

7Z04623
Luminance (nits)
10
5
2
1
0.5
0.2
0.1
0.05
0.02
0.01
0
20
40
60
80
Pulse number
1μA/cm²
0.5μA/cm²
0.2μA/cm²
0.1μA/cm²
Raster : 200 mm x 100 mm, 190 lines, defocused, scanned at 50 fields per second.
Excitation : Pulse of 1 field duration repeated every second for 60 seconds. Raster luminance measured just before each excitation pulse.
Temperature: 20 °C
Vscreen : 15 kV

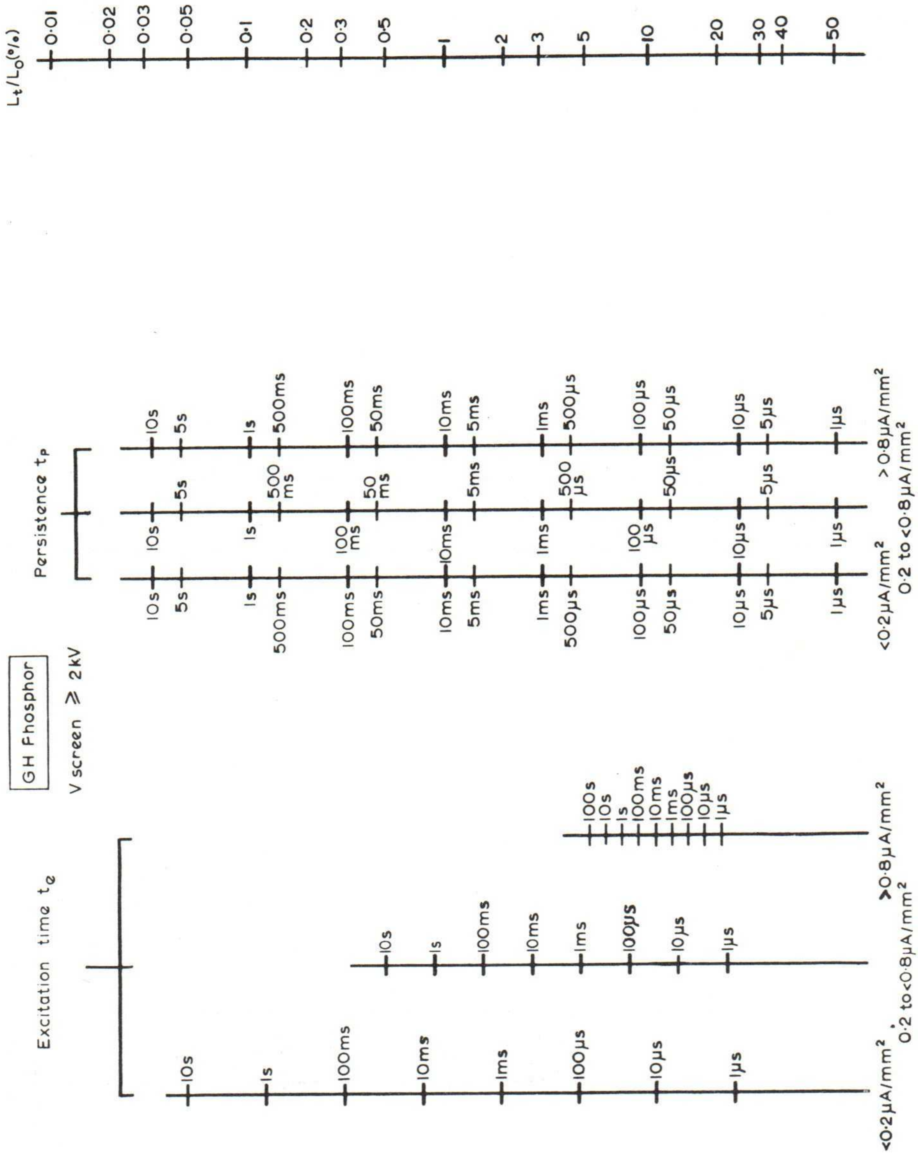

7Z04628
CIE co-ordinares
x=0.270
y=0.300
(%)
Relative response
100
80
60
40
20
0
0.4
0.5
0.6
0.7
λ (μm)
0.8


Luminance (nits)
Low voltage
This phosphor is not recommended for use with low screen voltages
30
20
10
0
0
0.5
1.5
Luminance (nits)
High voltage
Light transmission 75%
7Z04629
1500
1000
500
0
Vscreen=18kV
16kV
14kV
12kV
0
0.2
0.4
0.6
0.8
Current density (μA/cm²)


7Z04630
Simultaneous excitation of blue, green and red phosphors to produce white of colour co-ordinates
x = 0.287 y = 0.316
CIE co-ordinates
Blue x=0.146; y=0.052
Green x=0.218; y=0.712
Red x=0.674; y=0.326
(%)
Relative response
100
80
60
40
20
0
0.3
0.4
0.5
0.6
λ (μm)
0.7


7Z04631
CIE co-ordinates
x=0.540
y=0.460
(%)
Relative response
100
80
60
40
20
0
0.4
0.5
0.6
0.7
λ (μm)
0.8


L_t/L_o (%)
0·01 0·02 0·03 0·05 0·1 0·2 0·3 0·5 1 2 3 5 10 20 30
BE Phosphor
V screen ≥ 2kV
Persistence t_p
10s 5 3 1 500ms 300 100 50 30 10 5 3 1 500µs 300 100 50 30 10 5
<0·04µA/mm²
0·04–0·03µA/mm²
>0·03µA/mm²
Excitation time t_e
250ms limit 100 50 10 5 1 500 µs 100 50 10 5 1
250ms limit 100 50 10 5 1 500µs 100 50 10 1
250ms limit 100 10 1 100µs 10 1
0·04µA/mm²
0·04–0·03µA/mm²
>0·3µA/mm²


GH Phosphor
V screen ≥ 2kV
Lt/Lo(%)
Persistence tp
Excitation time te
<0·2μA/mm²
0·2 to <0·8μA/mm²
>0·8μA/mm²

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