PHILIPS

DATA HANDBOOK

PHILIPS ELECTRONIC COMPONENTS AND MATERIALS

ELECTRON TUBES

PART 5

MAY 1971

Cathode-ray tubes
Associated accessories

Camera tubes
Photo tubes

ELECTRON TUBES

Part 5 **May 1971**

Cathode-ray tubes

Associated accessories

Camera tubes

Photo tubes

Photoconductive devices

The Photoconductive Devices included in the previous edition of this Part will in future be incorporated in Part 4 of the Semiconductor Handbook (edition December 1970)

DATA HANDBOOK SYSTEM

To provide you with a comprehensive source of information on electronic components, subassemblies and materials, our Data Handbook System is made up of three series of handbooks, each comprising several parts.
The three series, identified by the colours noted, are:

ELECTRON TUBES (9 parts)	BLUE
SEMICONDUCTORS AND INTEGRATED CIRCUITS (5 parts)	RED
COMPONENTS AND MATERIALS (5 parts)	GREEN

The several parts contain all pertinent data available at the time of publication, and each is revised and reissued annually; the contents of each series are summarized on the following pages.
We have made every effort to ensure that each series is as accurate, comprehensive and up-to-date as possible, and we hope you will find it to be a valuable source of reference. Where ratings or specifications quoted differ from those published in the preceding edition they will be pointed out by arrows. You will understand that we can not guarantee that all products listed in any one edition of the handbook will remain available, or that their specifications will not be changed, before the next edition is published. If you need confirmation that the pusblished data about any of our products are the latest available, may we ask that you contact our representative. He is at your service and will be glad to answer your inquiries.

January 1970

ELECTRON TUBES (BLUE SERIES)

This series consists of the following parts, issued on the dates indicated.

Part 1 — **January 1971**

Transmitting tubes (Tetrodes, Pentodes)
Associated accessories

Part 2 — **March 1971**

Tubes for microwave equipment

Part 3 — **March 1970**

Special Quality tubes
Miscellaneous devices

Part 4 — **April 1971**

Receiving tubes

Part 5 — **May 1971**

Cathode-ray tubes
Photo tubes
Camera tubes
Photoconductive devices
Associated accessories

Part 6 — **June 1970**

Photomultiplier tubes
Scintillators
Photoscintillators
Radiation counter tubes
Semiconductor radiation detectors
Neutron generator tubes
Associated accessories

Part 7 — **July 1970**

Voltage stabilizing and reference tubes
Counter, selector, and indicator tubes
Trigger tubes
Switching diodes
Thyratrons
Ignitrons
Industrial rectifying tubes
High-voltage rectifying tubes

Part 8 — **August 1970**

T.V. Picture tubes

Part 9 — **January 1971**

Transmitting tubes (Triodes)
Tubes for R.F. heating (Triodes)
Associated accessories

SEMICONDUCTORS AND INTEGRATED CIRCUITS (RED SERIES)

This series consists of the following parts, issued on the dates indicated.

Part 1 Diodes and Thyristors **September 1970**

General
Signal diodes
Tunnel diodes
Variable capacitance diodes
Voltage regulator diodes
Rectifier diodes
Thyristors, diacs, triacs
Rectifier stacks
Accessories
Heatsinks

Part 2 Low frequency; Deflection **October 1970**

General
Low frequency transistors (low power)
Low frequency power transistors
Deflection transistors
Accessories

Part 3 High frequency; Switching **November 1970**

General
High frequency transistors
Switching transistors
Accessories

Part 4 Special types **December 1970**

General
Transmitting transistors
Microwave devices
Field effect transistors
Dual transistors
Microminiature devices for thick- and thin-film circuits
Beam lead devices for thick- and thin-film circuits
Photo devices
Accessories

Part 5 Integrated Circuits **March 1971**

General
Digital integrated circuits
- DTL (FC family)
- TTL (FJ family)
- MOS (FD family)

Linear integrated circuits

COMPONENTS AND MATERIALS (GREEN SERIES)

This series consists of the following parts, issued on the dates indicated.

Part 1 Circuit Blocks, Input/Output Devices **September 1970**

Circuit blocks 100 kHz Series
Circuit blocks 1-Series
Circuit blocks 10-Series
Circuit blocks 20-Series
Circuit blocks 40-Series
Counter modules 50-Series
Norbits 60-Series, 61-Series
Circuit blocks 90-Series
Circuit blocks for ferrite core memory drive
Input/output devices

Part 2 Resistors, Capacitors **December 1970**

Fixed resistors
Variable resistors
Non-linear resistors
Ceramic capacitors
Polyester, polycarbonate, polystyrene, paper capacitors
Electrolytic capacitors
Variable capacitors

Part 3 Radio, Audio, Television **February 1971**

FM tuners
Coils
Piezoelectric ceramic resonators and filters
Loudspeakers
Audio and mains transformers
Television tuners
Components for black and white television
Components for colour television
Deflection assemblies for camera tubes

Part 4 Magnetic Materials, White Ceramics **April 1971**

Ferrites for radio, audio and television
Ferroxcube potcores and square cores
Small coils, assemblies and assembling parts
Ferroxcube transformer cores
Piezoxide
Permanent magnet materials

Part 5 Memory Products, Magnetic Heads, Quartz Crystals, Microwave Devices, Variable Transformers, Electro-mechanical Components **June 1970**

Ferrite memory cores
Matrix planes, matrix stacks
Complete memories
Magnetic heads
Quartz crystal units, crystal filters
Isolators, circulators
Variable mains transformers
Electro-mechanical components

Technology relating to the products described in this publication is shared by the following companies.

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CARACAS

Cathode-ray tubes

LIST OF SYMBOLS

<u>Symbols denoting electrodes and electrode connections</u>

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.

<u>Symbols denoting voltages</u>

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}

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 coefficient	M

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_{g3}) 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.

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.

TYPE DESIGNATION

Two type designation systems are currently in use 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 (PRO-ELECTRON TYPE DESIGNATION CODE)

The type number consists of a single letter followed by two sets of figures,and ends 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 or three-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.

For the standard television tube phosphors, the letters 'W' and 'X' are used without a second letter.

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

D - 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.

SCREEN TYPES

new system	old system	fluorescent colour	phosphorescent colour	persistance	equivalent Jedec designation
BA	C	purplish-blue	–	very short	–
BC	V	purplish-blue	–	killed	–
BE	B	blue	blue	medium short	P11
BF	U	purplish-blue	–	medium short	–
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
GP	–	bluish-green	green	medium short	P2
GR	–	green	green	long	P39
GU	–	white	white	very short	–
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	–

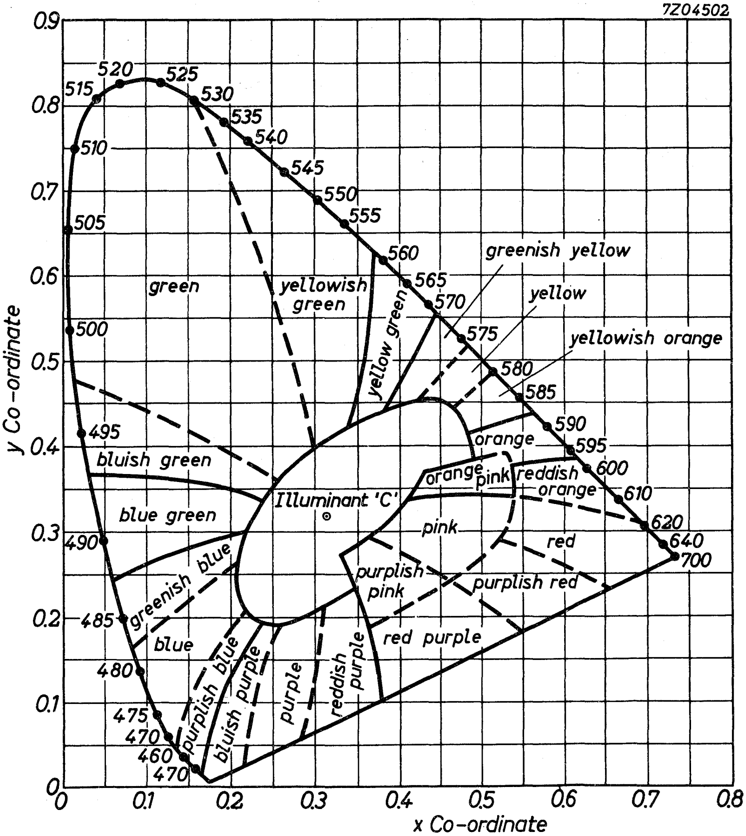
[1]) used in projection tubes

SURVEY OF PERSISTENCE OF CATHODE-RAY TUBE SCREENS

Screen type		Application	Persistence		
New system	Old system		Relative level of brightness		
			10 %	1 %	0.1 %
BA GE GU	C K –	Flying spot scanners	0.13 μs 1.2 μs 0.16 μs	0.4 μs 110 μs 1 μs	– 10 ms –
BE GH GJ GM GP	B H G P –	Oscilloscopes	20 ms 600 μs 28 ms 60 ms 1.2 ms	70 ms 8 ms 75 ms 1.5 s 140 ms	120 ms 90 ms 120 ms 13 s 2 s
GR W	– yellow blue	Monitors	100 ms 0.6 ms 0.4 ms	1.4 s 7 ms 4 ms	9 s 17 ms 14.5 ms
LA LC LD	D F L	Radar	32 ms 0.3 s 0.5 s	110 ms 22 s 45 s	200 ms 50 s 100 s

OPERATING CONDITIONS

Final accelerator voltage	
Oscilloscope types	4 kV
Remaining types	10 to 15 kV
Screen current	5 $\mu A/cm^2$
Focusing	defocused
Exitation	sufficient for complete build-up


7Z04502
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600
610
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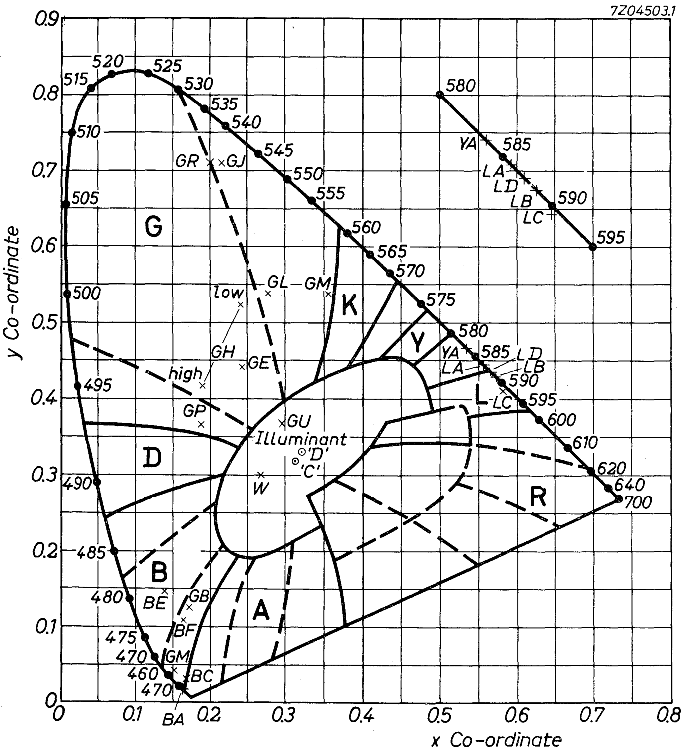
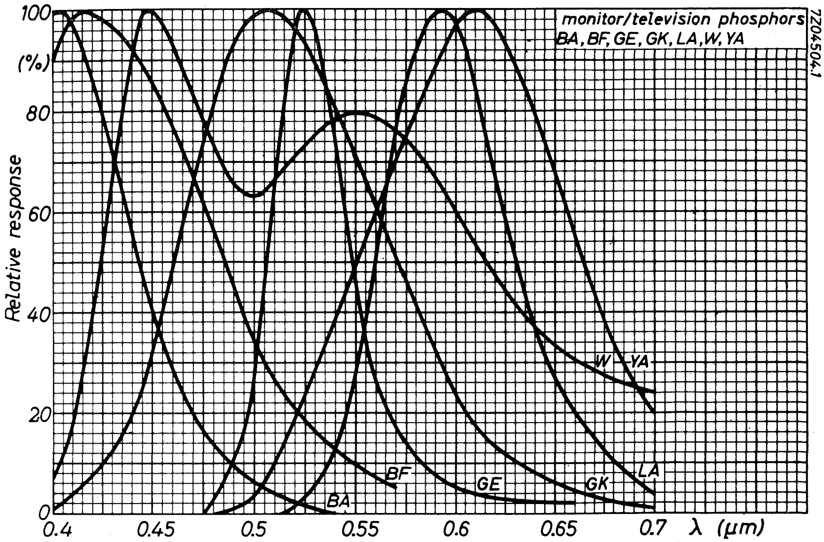
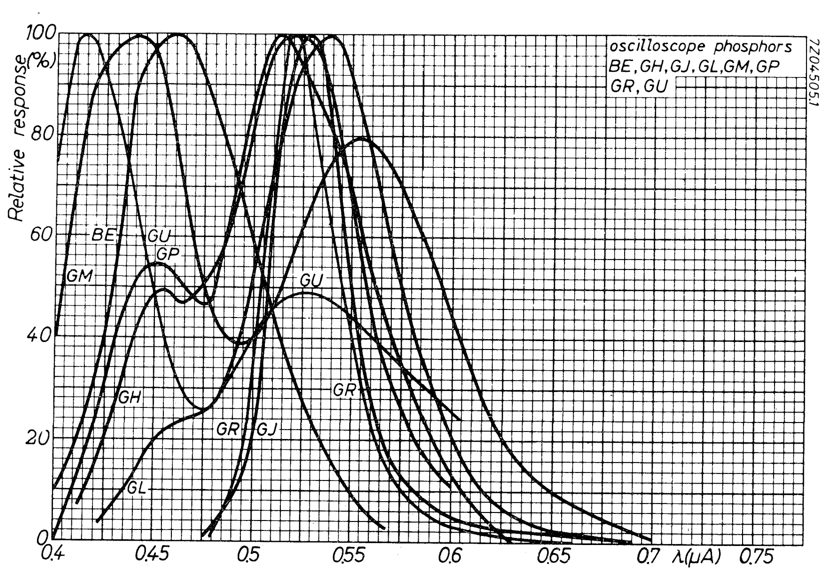
640
700
490
485
480
475
470
460
470
green
yellowish green
yellow green
greenish yellow
yellow
yellowish orange
orange
bluish green
orange pink
reddish orange
Illuminant 'C'
blue green
pink
red
greenish blue
purplish pink
purplish red
blue
red purple
purplish blue
bluish purple
purple
reddish purple

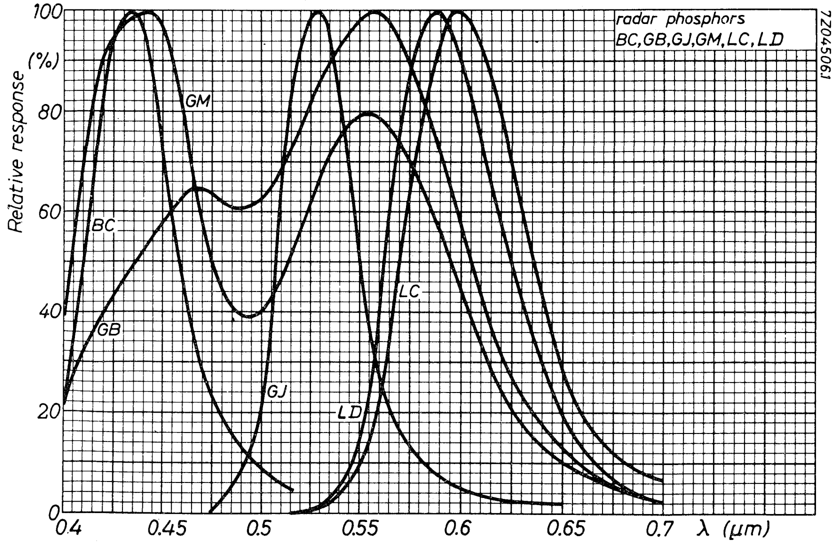
Kelly Chart

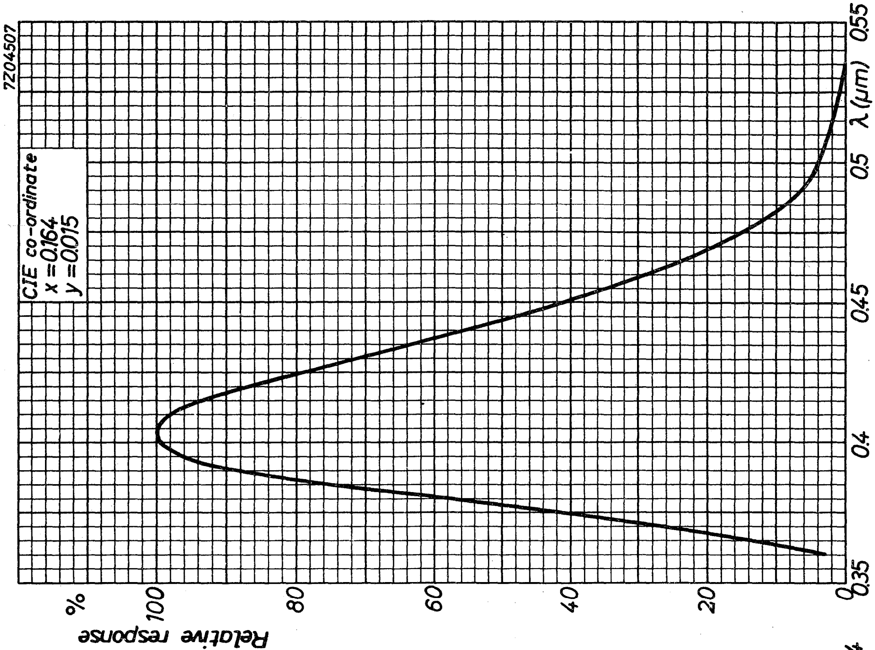


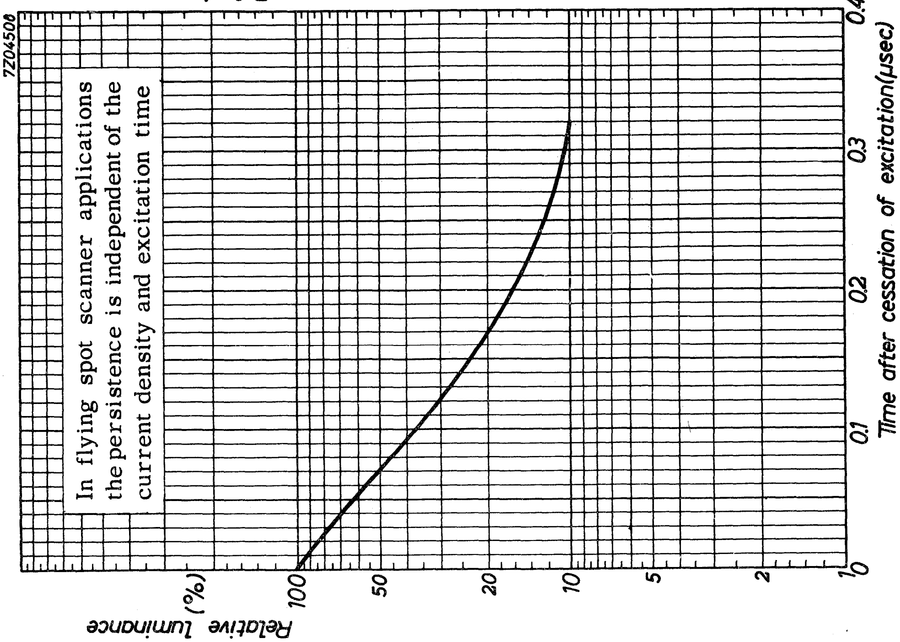
Co-ordinates of individual phosphors

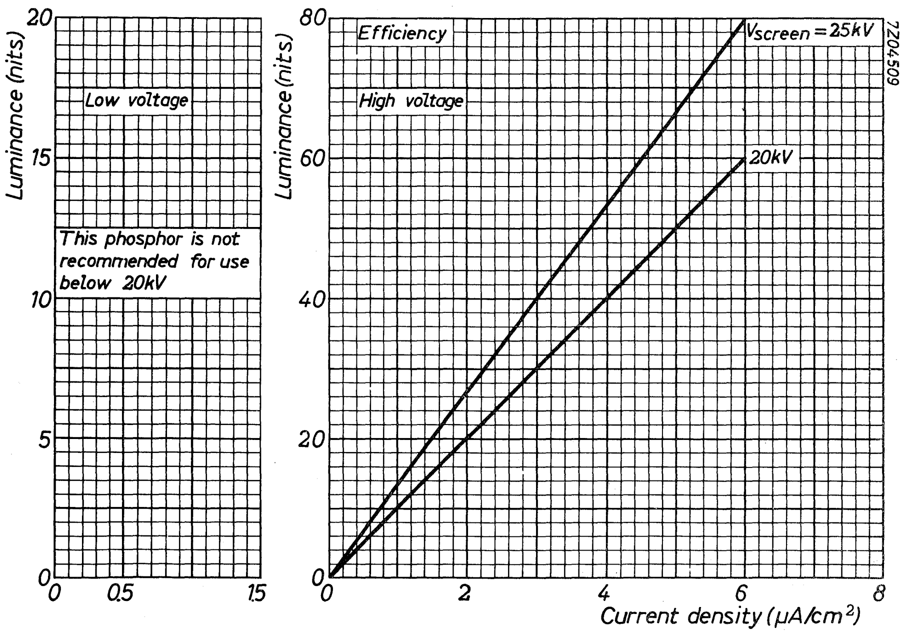

monitor/television phosphors
BA, BF, GE, GK, LA, W, YA
7Z04504.1
100
(%)
80
60
40
20
0
Relative response
0.4
0.45
0.5
0.55
0.6
0.65
0.7
λ (μm)
BA
BF
GE
GK
LA
W
YA

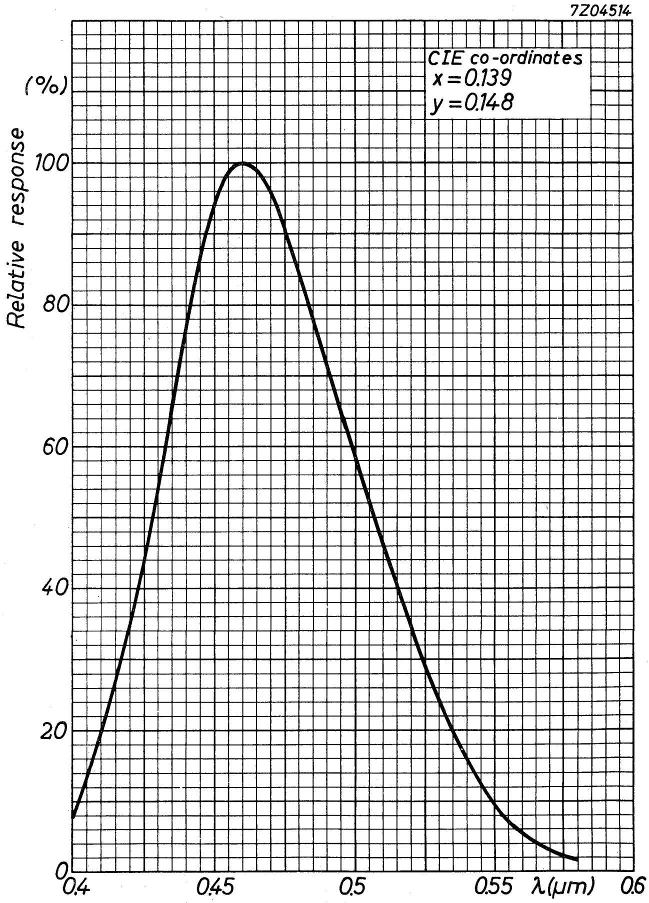

oscilloscope phosphors
BE, GH, GJ, GL, GM, GP
GR, GU
7Z04505.1
Relative response (%)
100
80
60
40
20
0
BE
GU
GP
GM
GH
GL
GR
GJ
GU
GR
0.4
0.45
0.5
0.55
0.6
0.65
0.7
λ(μA)
0.75

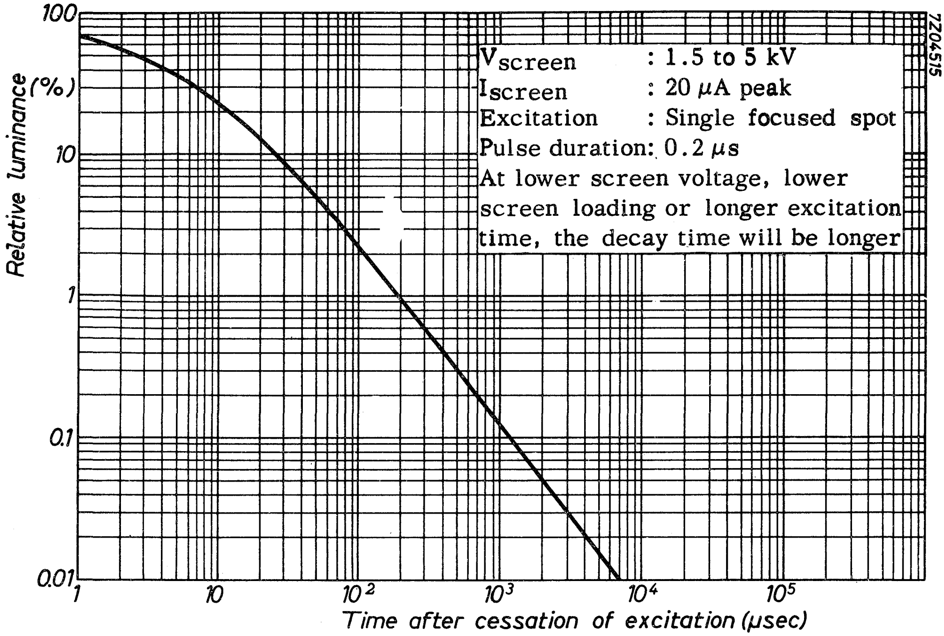

radar phosphors
BC, GB, GJ, GM, LC, LD
7Z04506.1
Relative response (%)
100
80
60
40
20
0
GM
BC
GB
GJ
LD
LC
0.4
0.45
0.5
0.55
0.6
0.65
0.7
λ (μm)

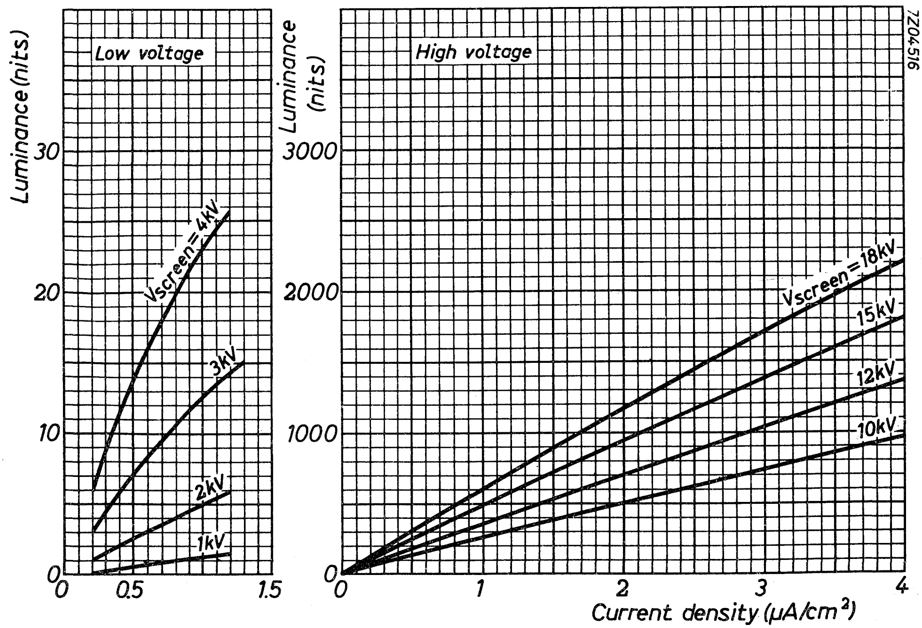

7Z04507
CIE co-ordinate
x = 0.164
y = 0.015
λ (μm)
0.35
0.4
0.45
0.5
0.55
Relative response
%
0
20
40
60
80
100

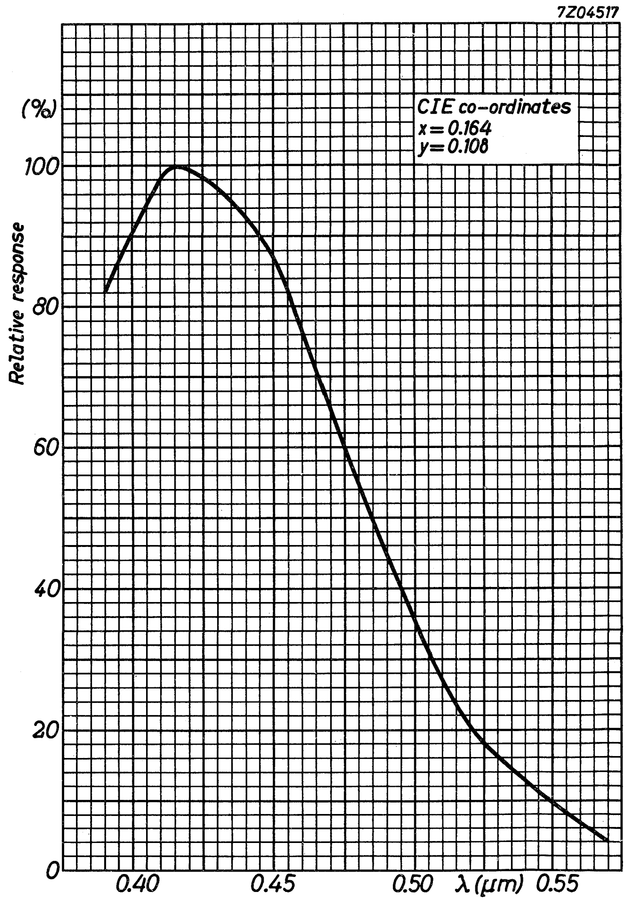

7Z04508
In flying spot scanner applications the persistence is independent of the current density and excitation time
Time after cessation of excitation (μsec)
0
0.1
0.2
0.3
0.4
Relative luminance (%)
1
2
5
10
20
50
100

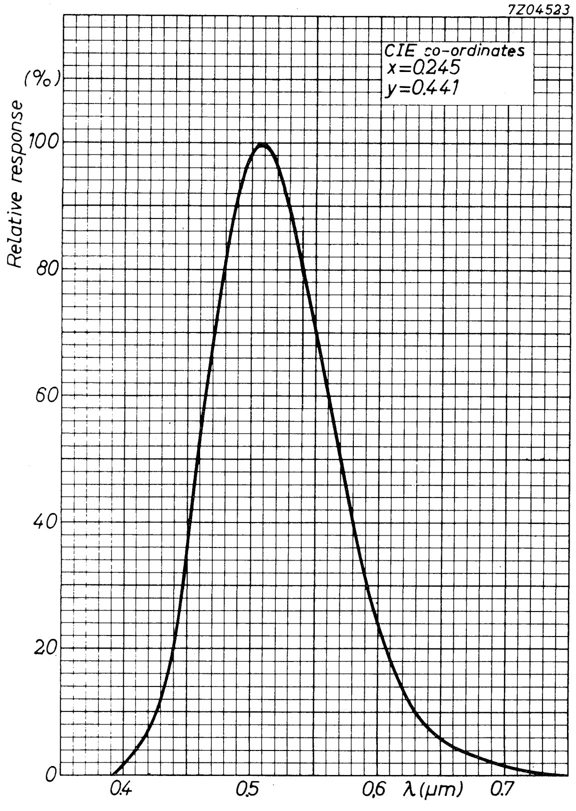

Luminance (nits)
Low voltage
This phosphor is not recommended for use below 20kV
0
5
10
15
20
0
0.5
1.5
Luminance (nits)
Efficiency
High voltage
V_{screen} = 25kV
20kV
7Z04509
0
20
40
60
80
0
2
4
6
8
Current density (µA/cm²)

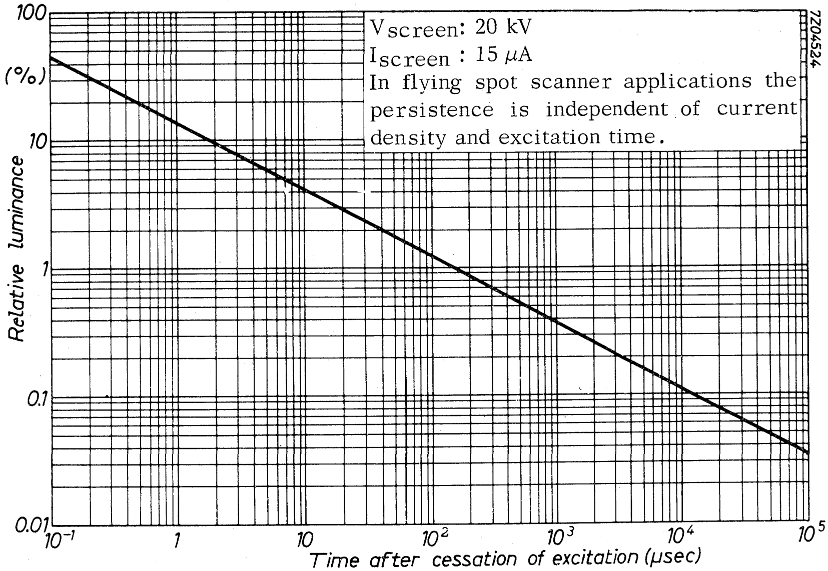

7Z04514
CIE co-ordinates
x = 0.139
y = 0.148
(%)
Relative response
100
80
60
40
20
0
0.4
0.45
0.5
0.55
λ(μm)
0.6

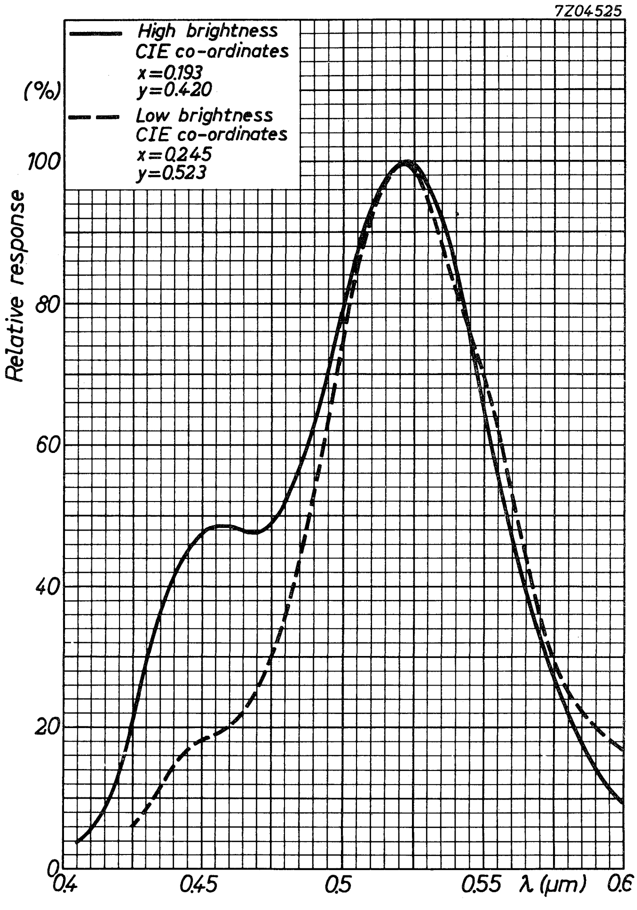

100
10
1
0.1
0.01
Relative luminance (%)
1
10
10^2
10^3
10^4
10^5
Time after cessation of excitation (μsec)
7Z04515
Vscreen : 1.5 to 5 kV
Iscreen : 20 μA peak
Excitation : Single focused spot
Pulse duration: 0.2 μs
At lower screen voltage, lower screen loading or longer excitation time, the decay time will be longer

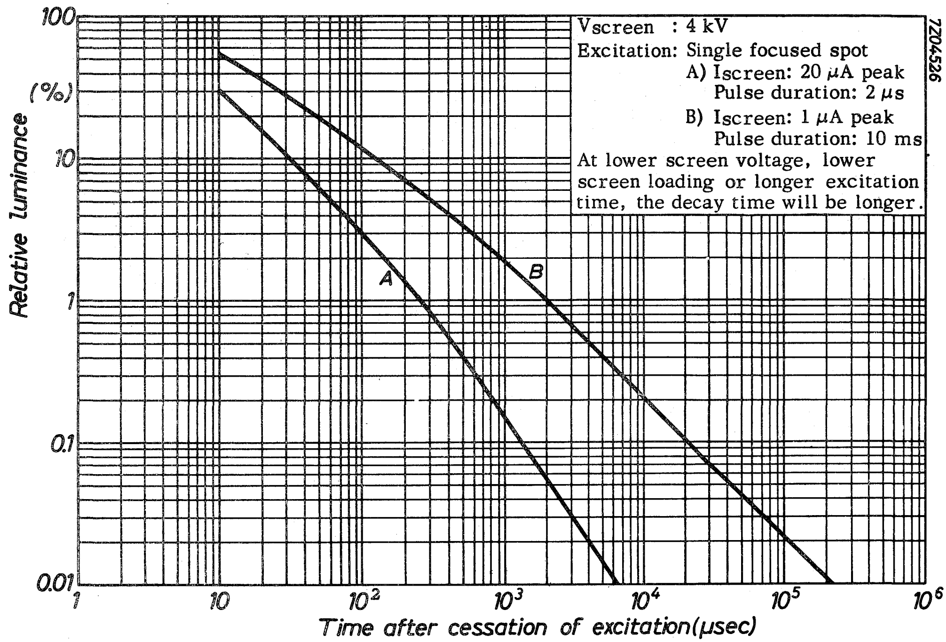

Low voltage
Luminance (nits)
30
20
10
0
0
0.5
1.5
Vscreen=4kV
3kV
2kV
1kV
High voltage
Luminance (nits)
3000
2000
1000
0
0
1
2
3
4
Vscreen=18kV
15kV
12kV
10kV
Current density (μA/cm²)
7Z04516

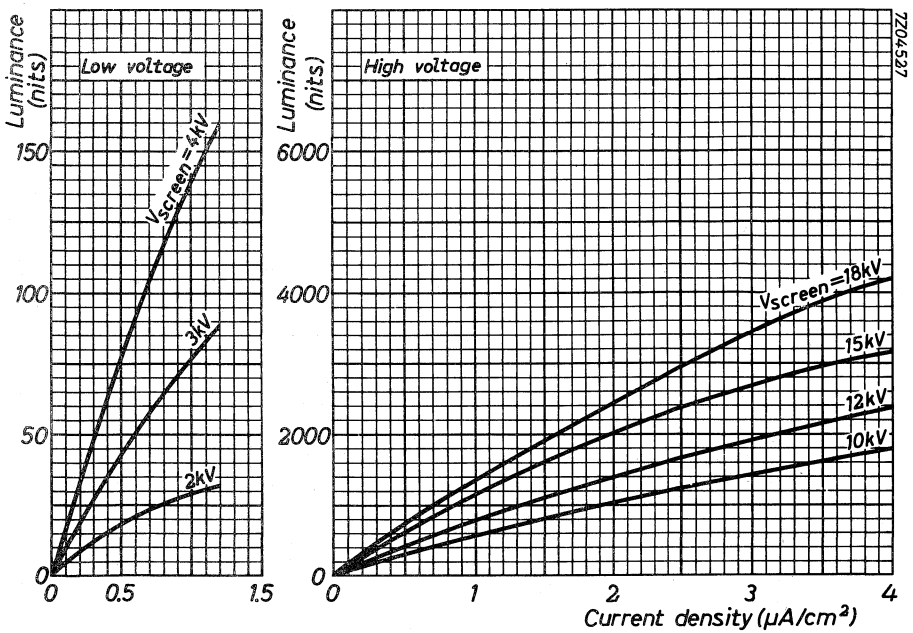

7Z04517
(%)
100
80
60
40
20
0
Relative response
CIE co-ordinates
x = 0.164
y = 0.108
0.40
0.45
0.50
λ (μm)
0.55

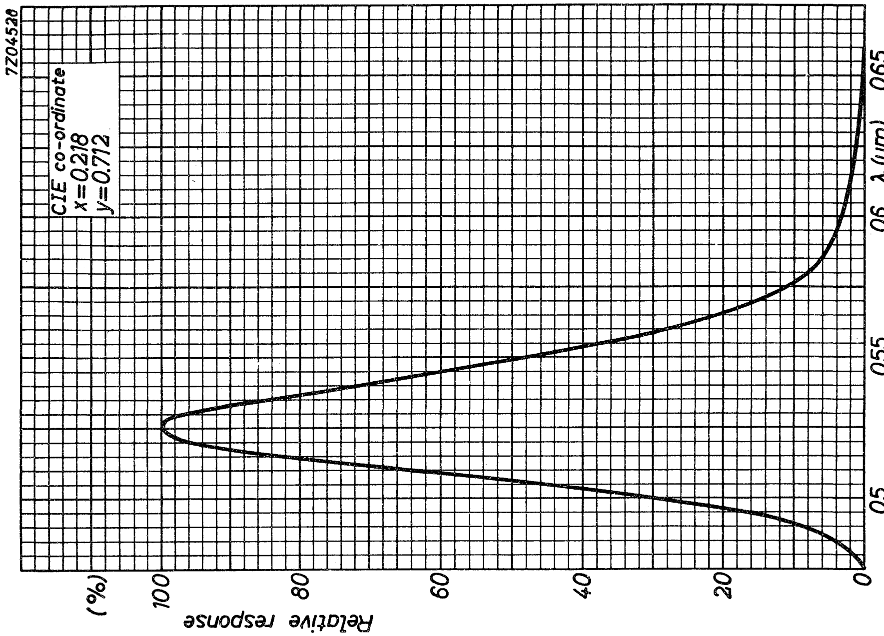

7Z04523
CIE co-ordinates
x=0.245
y=0.441
Relative response
(%)
100
80
60
40
20
0
0.4
0.5
0.6
λ (μm)
0.7

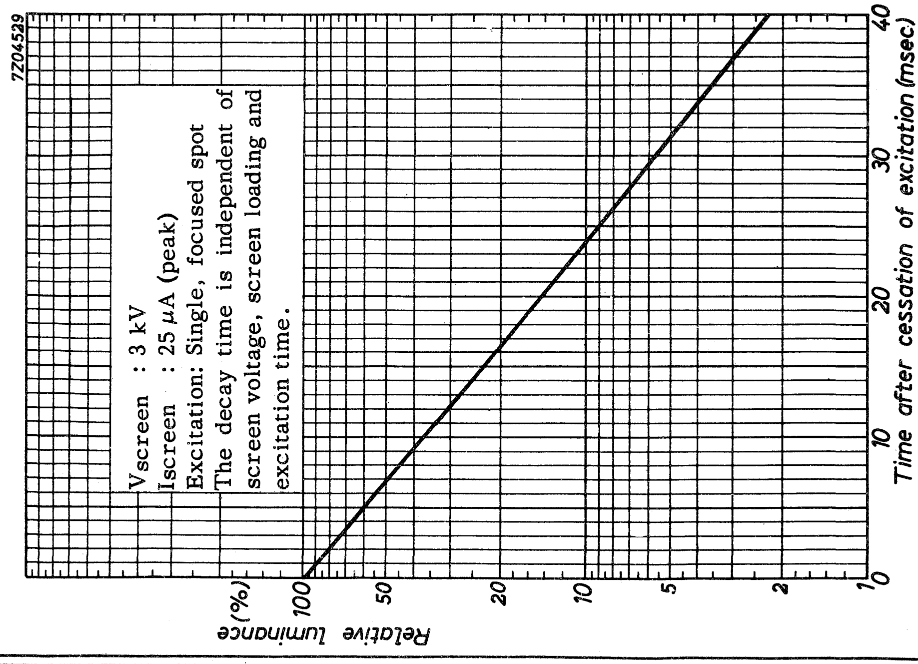

100
(%)
10
1
0.1
0.01
Relative luminance
10^{-1}
1
10
10^2
10^3
10^4
10^5
Time after cessation of excitation (μsec)
V_{screen}: 20 kV
I_{screen} : 15 μA
In flying spot scanner applications the persistence is independent of current density and excitation time.
7Z04524

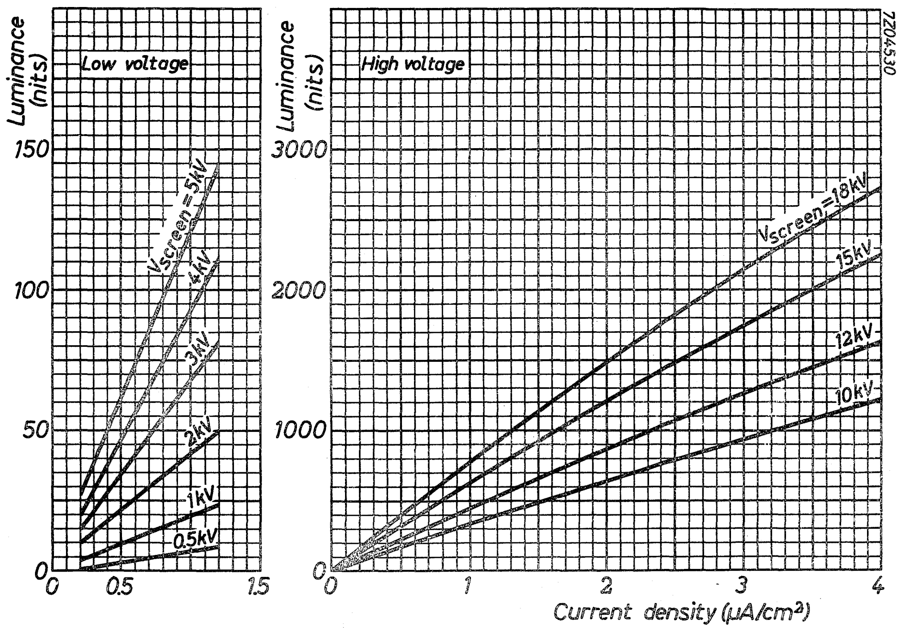

7Z04525
High brightness
CIE co-ordinates
x=0.193
y=0.420
Low brightness
CIE co-ordinates
x=0.245
y=0.523
(%)
Relative response
100
80
60
40
20
0
0.4
0.45
0.5
0.55
λ (μm)
0.6

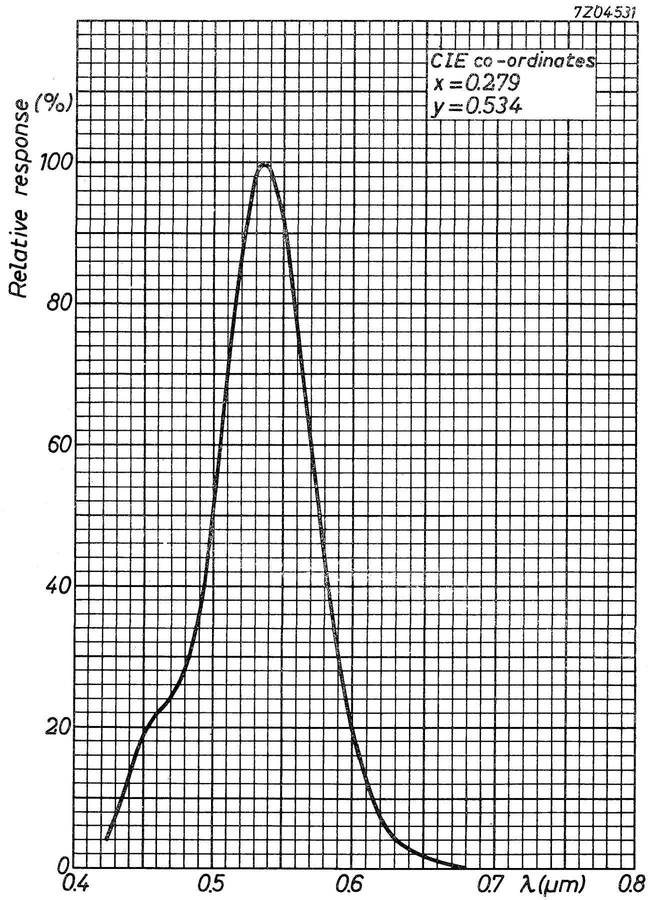

7Z04526
Vscreen : 4 kV
Excitation: Single focused spot
A) Iscreen: 20 μA peak
Pulse duration: 2 μs
B) Iscreen: 1 μA peak
Pulse duration: 10 ms
At lower screen voltage, lower screen loading or longer excitation time, the decay time will be longer.
Relative luminance (%)
100
10
1
0.1
0.01
A
B
1
10
10^2
10^3
10^4
10^5
10^6
Time after cessation of excitation (μsec)

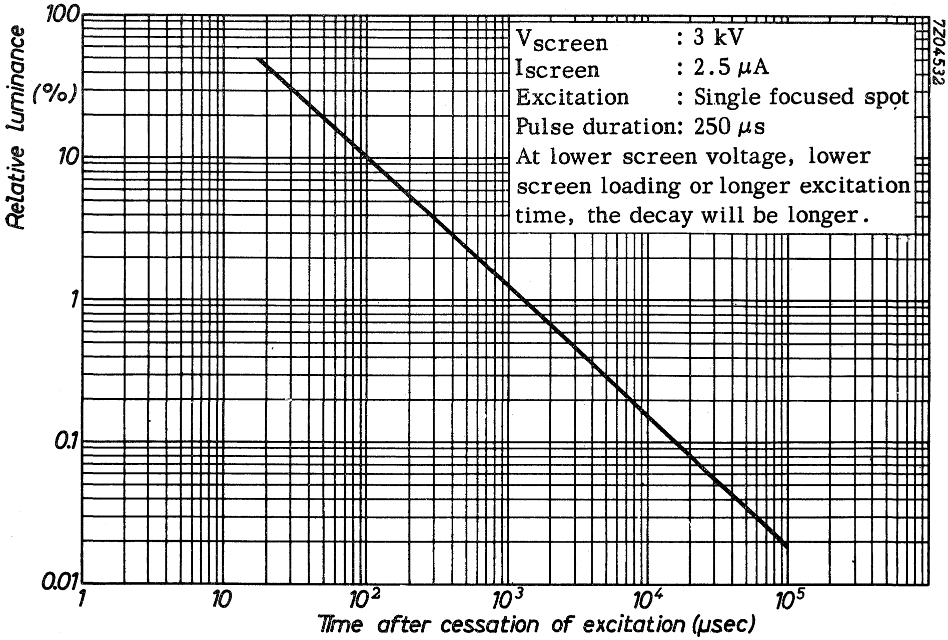

7Z04527
Luminance (nits)
Low voltage
Vscreen = 4kV
3kV
2kV
150
100
50
0
0
0.5
1.5
Luminance (nits)
High voltage
Vscreen = 18kV
15kV
12kV
10kV
6000
4000
2000
0
0
1
2
3
4
Current density (μA/cm²)

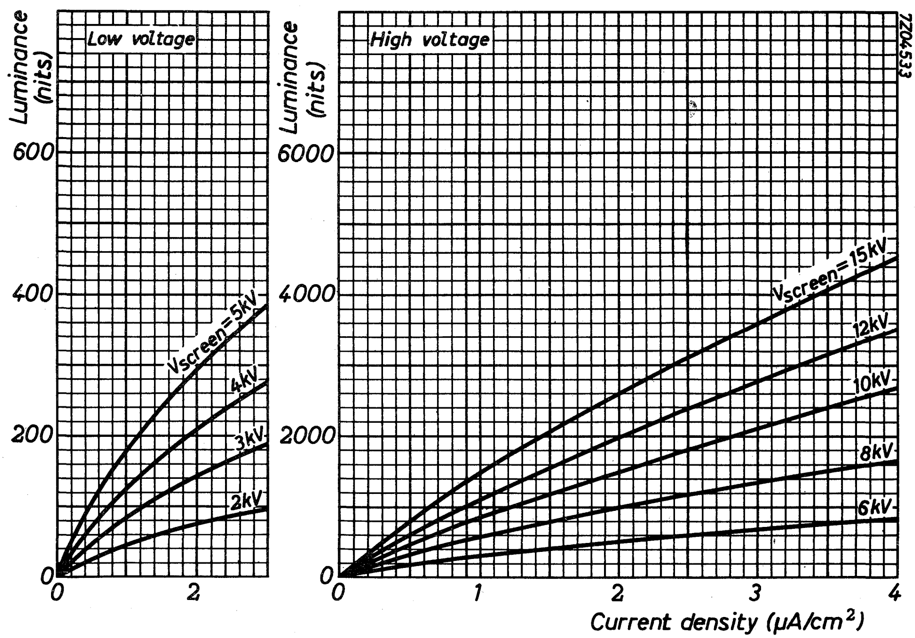

7Z04528
CIE co-ordinate
x=0.218
y=0.712
λ (μm)
0.5
0.55
0.6
0.65
Relative response
(%)
100
80
60
40
20
0

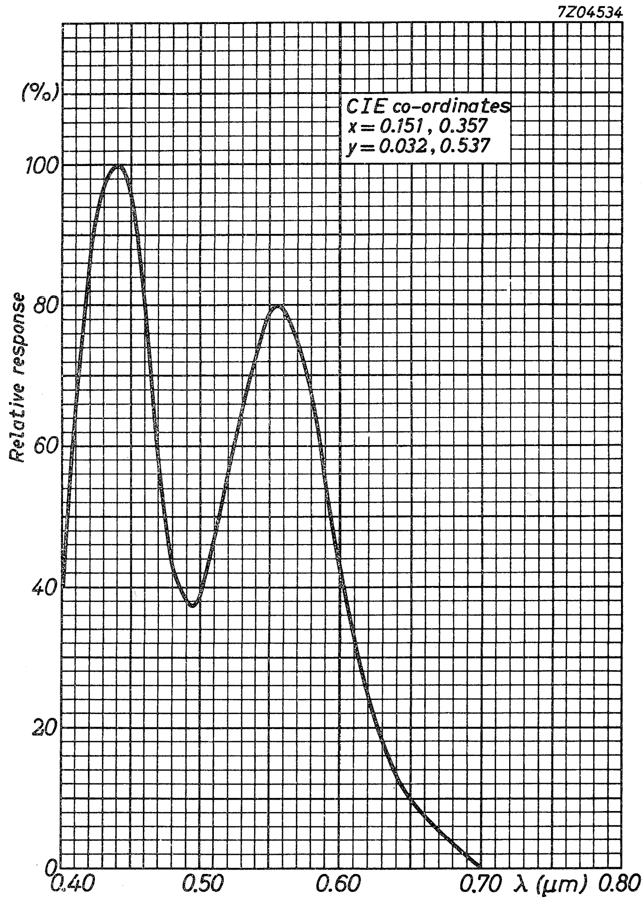

7Z04529
Vscreen : 3 kV
Iscreen : 25 μA (peak)
Excitation: Single, focused spot
The decay time is independent of
screen voltage, screen loading and
excitation time.
Time after cessation of excitation (msec)
0
10
20
30
40
Relative luminance
(%)
100
50
20
10
5
2
1

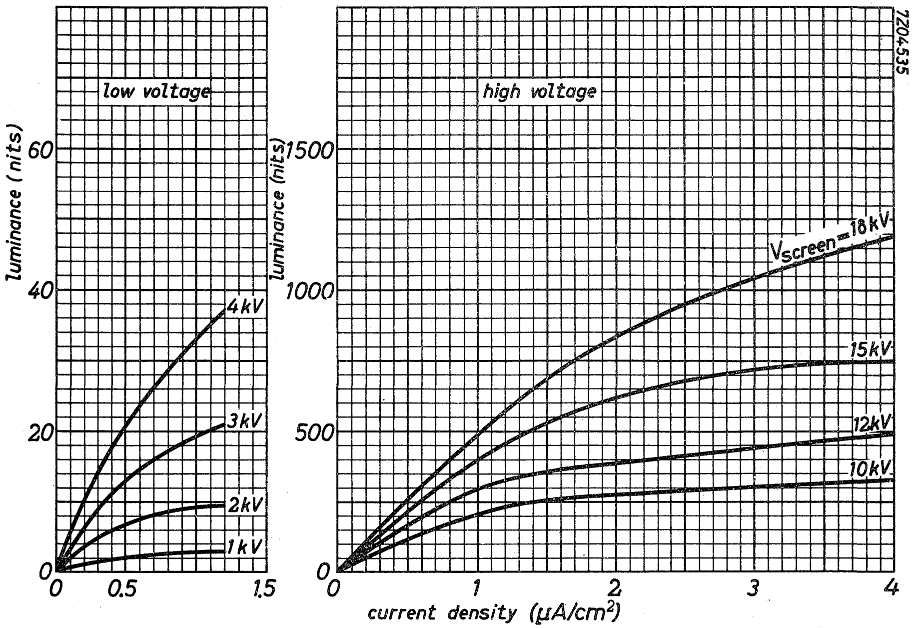

Luminance (nits)
Low voltage
150
100
50
0
0
0.5
1.5
Vscreen = 5kV
4kV
3kV
2kV
1kV
0.5kV
Luminance (nits)
High voltage
3000
2000
1000
0
0
1
2
3
4
Vscreen=18kV
15kV
12kV
10kV
Current density (μA/cm²)
7Z04530

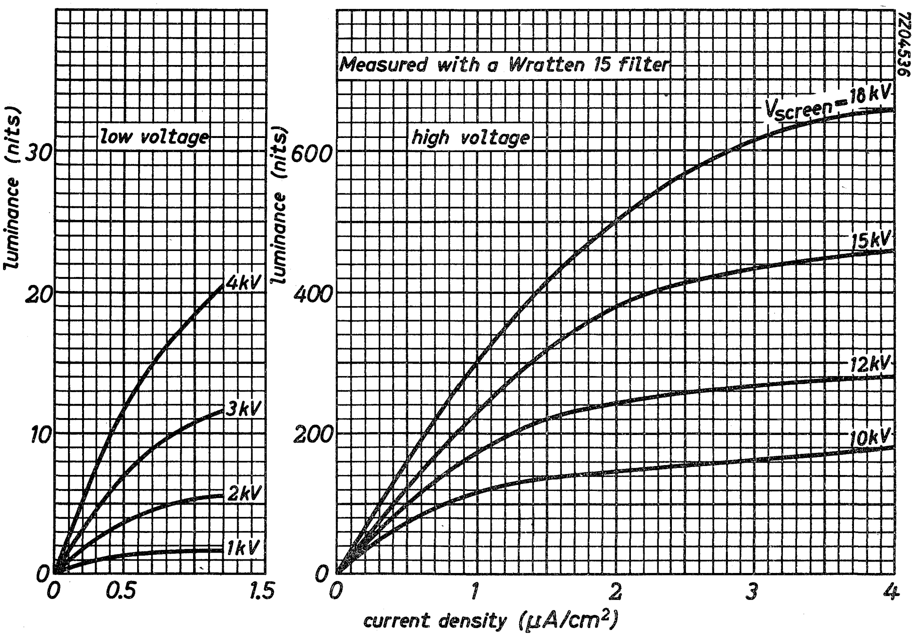

7Z04531
CIE co-ordinates
x = 0.279
y = 0.534
Relative response (%)
100
80
60
40
20
0
0.4
0.5
0.6
0.7
λ (μm)
0.8

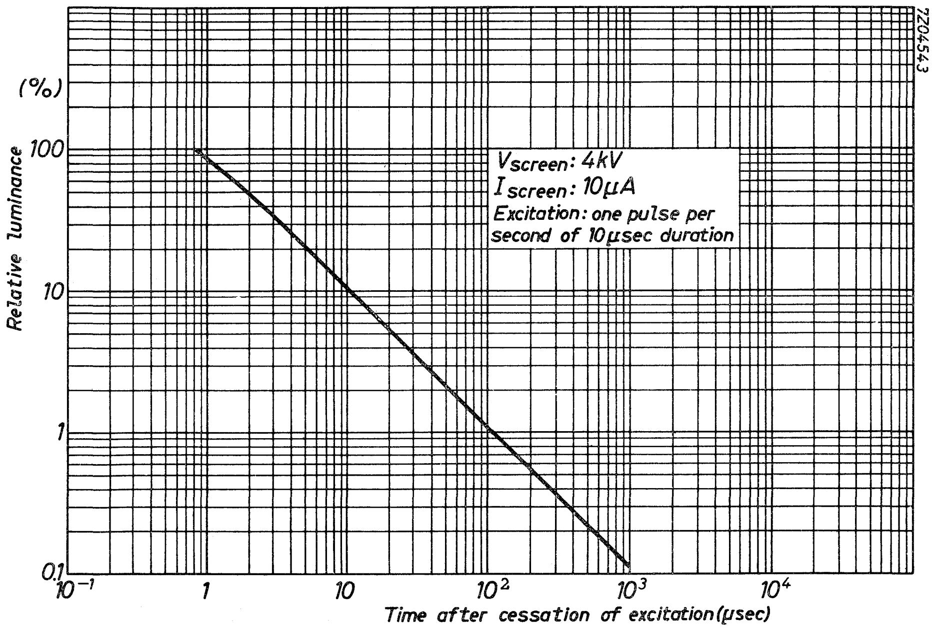

7Z04532
Relative luminance (%)
100
10
1
0.1
0.01
1
10
10^2
10^3
10^4
10^5
Time after cessation of excitation (μsec)
V_{screen} : 3 kV
I_{screen} : 2.5 μA
Excitation : Single focused spot
Pulse duration: 250 μs
At lower screen voltage, lower screen loading or longer excitation time, the decay will be longer.

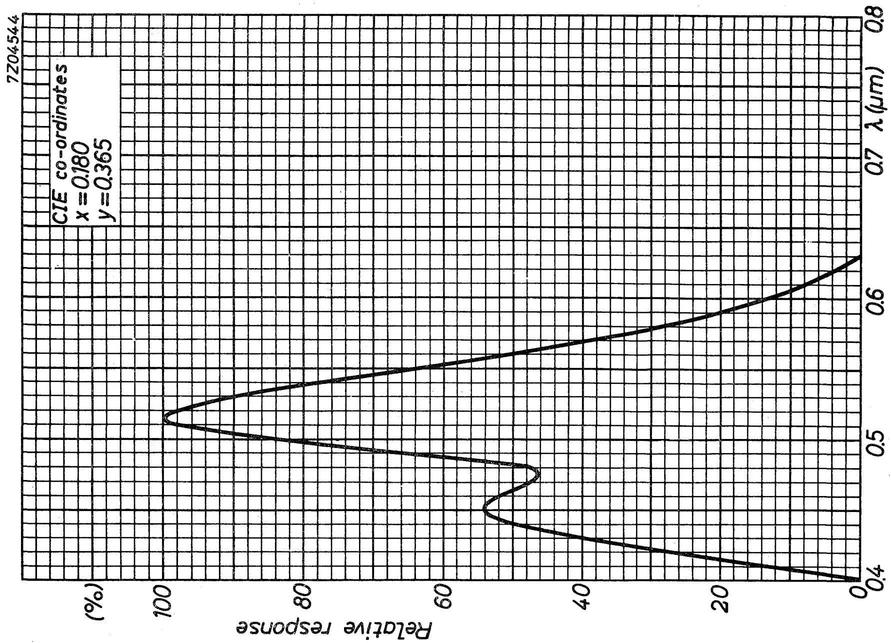

7Z04533
Luminance (nits)
Low voltage
600
400
200
0
0
2
V_{screen}=5kV
4kV
3kV
2kV
High voltage
6000
4000
2000
0
0
1
2
3
4
V_{screen}=15kV
12kV
10kV
8kV
6kV
Current density (μA/cm²)

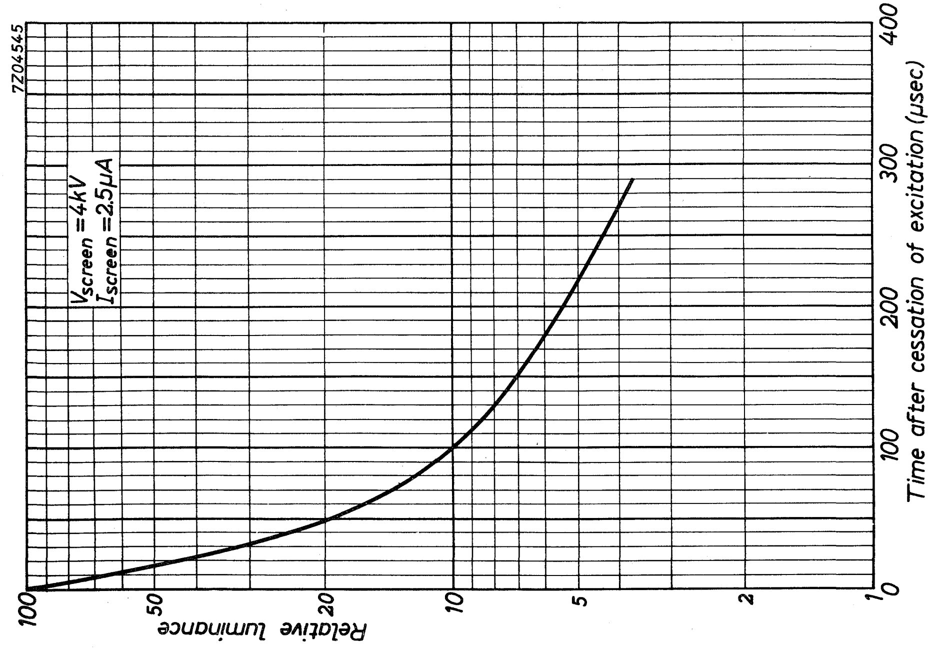

7Z04534
(%)
CIE co-ordinates
x = 0.151 , 0.357
y = 0.032 , 0.537
100
80
60
40
20
0
Relative response
0.40
0.50
0.60
0.70
λ (μm)
0.80

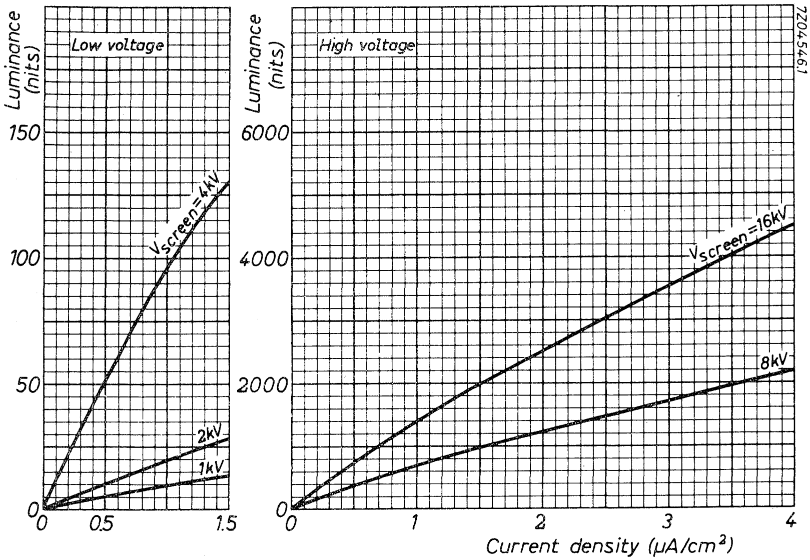

7Z04535
low voltage
high voltage
luminance (nits)
0
20
40
60
500
1000
1500
4kV
3kV
2kV
1kV
V_{screen}=18kV
15kV
12kV
10kV
0.5
1.5
1
2
3
4
current density (μA/cm²)

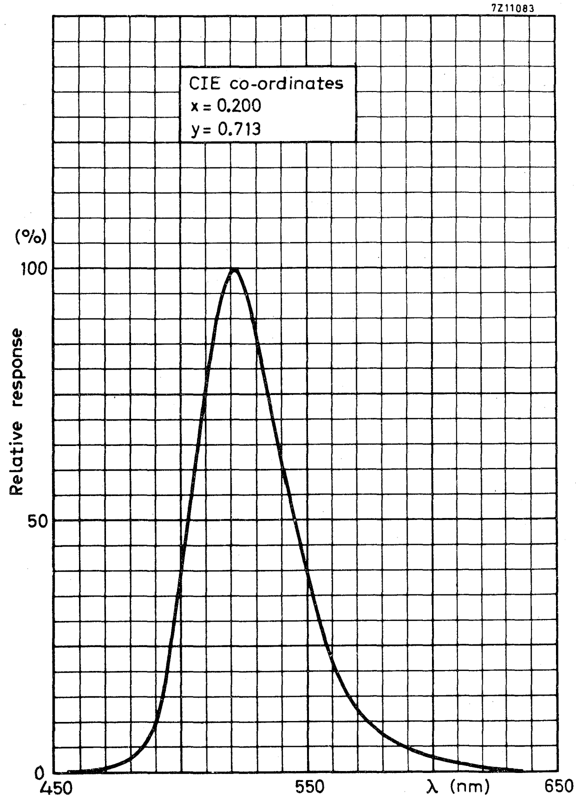

7Z04536
Measured with a Wratten 15 filter
low voltage
high voltage
luminance (nits)
0
10
20
30
200
400
600
4kV
3kV
2kV
1kV
V_{screen}=18kV
15kV
12kV
10kV
0.5
1.5
1
2
3
4
current density (μA/cm²)

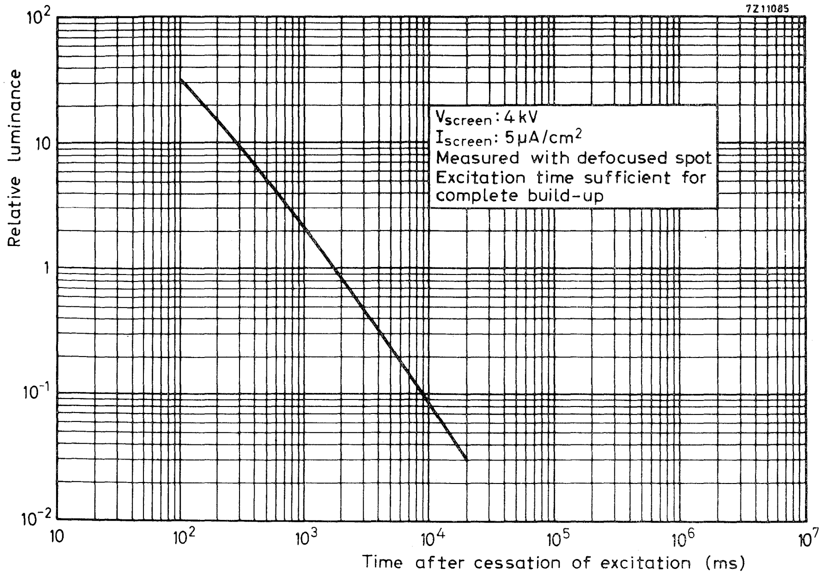

7Z04543
(%)
Relative luminance
100
10
1
0.1
V_{screen}: 4kV
I_{screen}: 10μA
Excitation: one pulse per second of 10μsec duration
10^{-1}
1
10
10^2
10^3
10^4
Time after cessation of excitation (μsec)

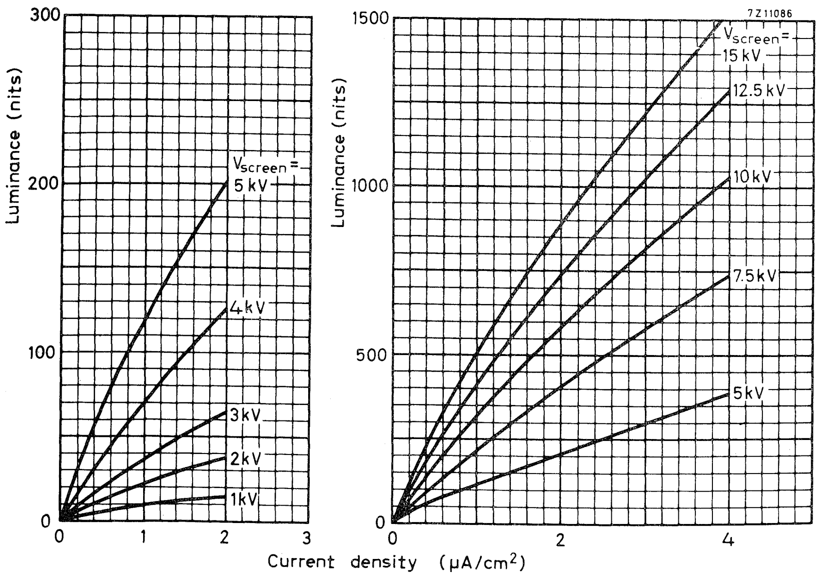

7Z04544
CIE co-ordinates
x = 0.180
y = 0.365
λ (μm)
0.4
0.5
0.6
0.7
0.8
Relative response
(%)
0
20
40
60
80
100

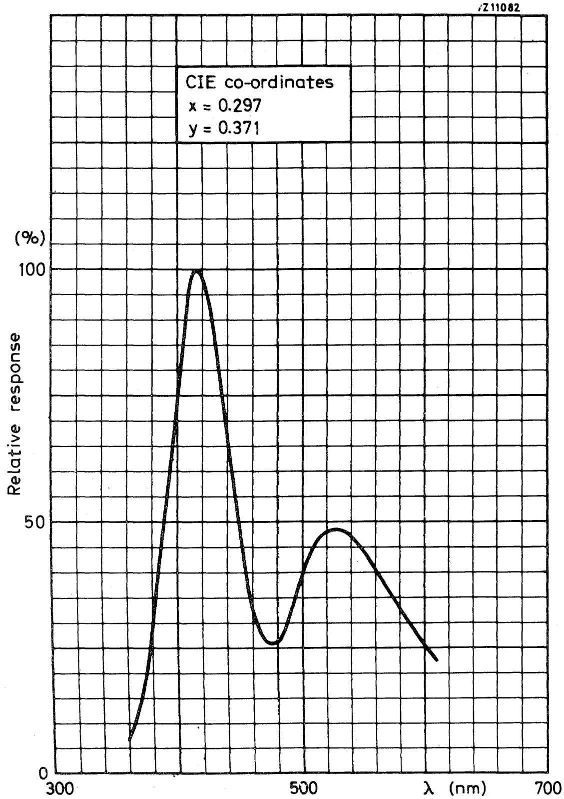

7Z04545
V_{screen} = 4kV
I_{screen} = 2.5μA
Time after cessation of excitation (μsec)
0
100
200
300
400
Relative luminance
100
50
20
10
5
2
1

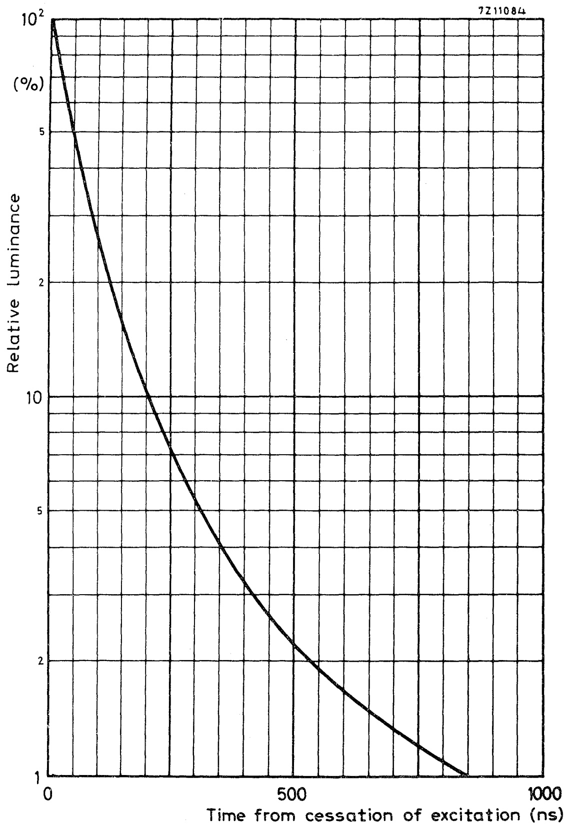

Luminance (nits)
Low voltage
150
100
50
0
Vscreen=4kV
2kV
1kV
0
0.5
1.5
Luminance (nits)
High voltage
6000
4000
2000
0
Vscreen=16kV
8kV
0
1
2
3
4
Current density (μA/cm²)
7Z04546.1

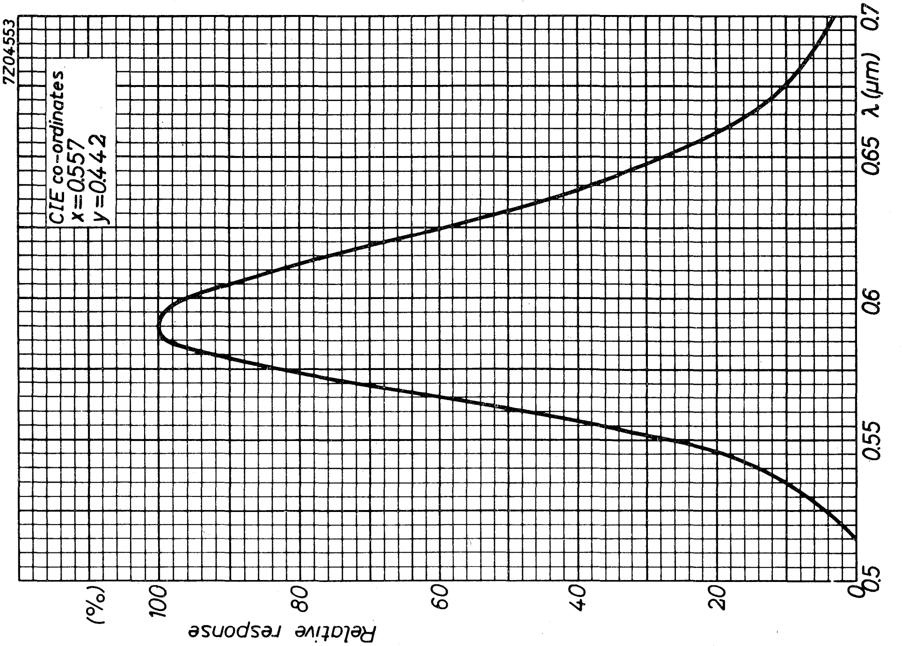

7Z11083
CIE co-ordinates
x = 0.200
y = 0.713
(%)
100
Relative response
50
0
450
550
λ (nm)
650

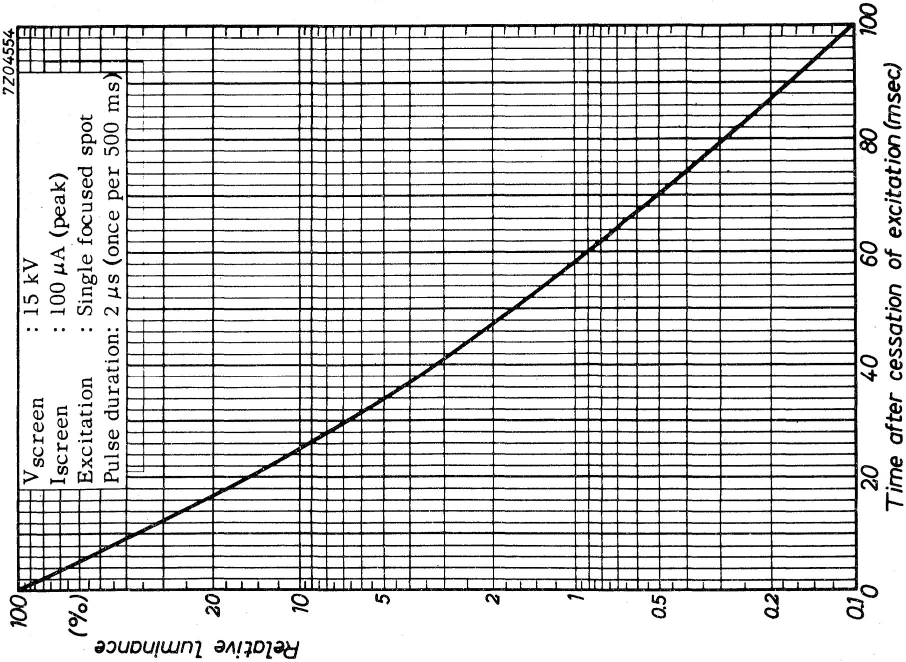

7Z11085
Relative luminance
10^2
10
1
10^{-1}
10^{-2}
10
10^2
10^3
10^4
10^5
10^6
10^7
Time after cessation of excitation (ms)
V_{screen}: 4 kV
I_{screen}: 5 μA/cm²
Measured with defocused spot
Excitation time sufficient for complete build-up

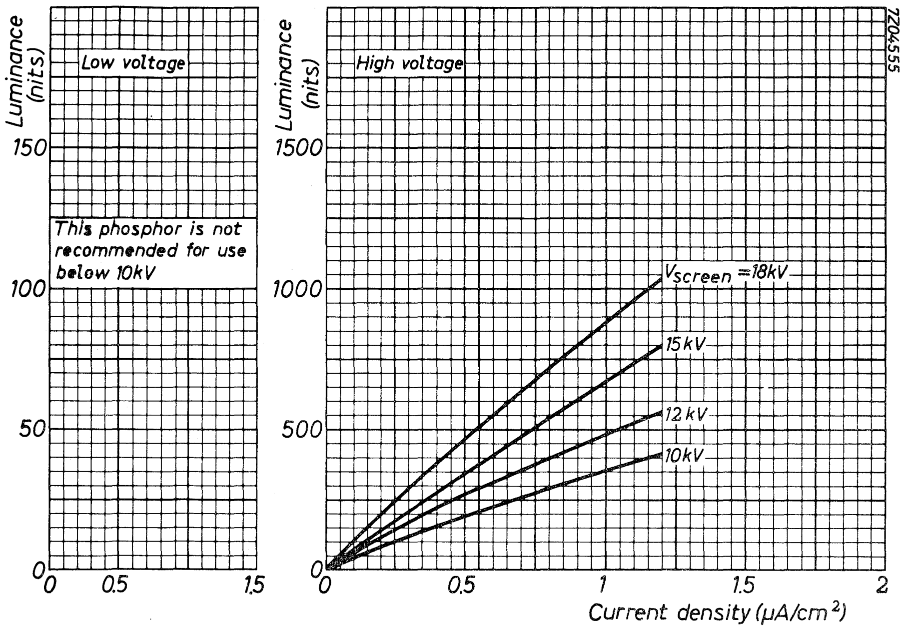

7Z11086
Luminance (nits)
300
200
100
0
1
2
3
V_{screen} =
5 kV
4 kV
3 kV
2 kV
1 kV
1500
1000
500
0
2
4
V_{screen} =
15 kV
12.5 kV
10 kV
7.5 kV
5 kV
Current density (μA/cm²)

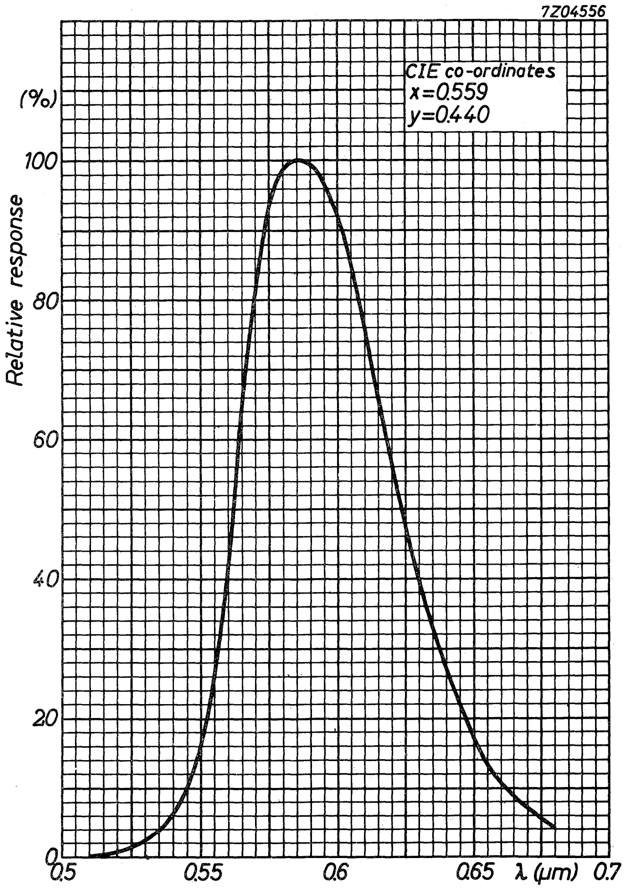

7Z11082
CIE co-ordinates
x = 0.297
y = 0.371
(%)
100
Relative response
50
0
300
500
λ (nm)
700

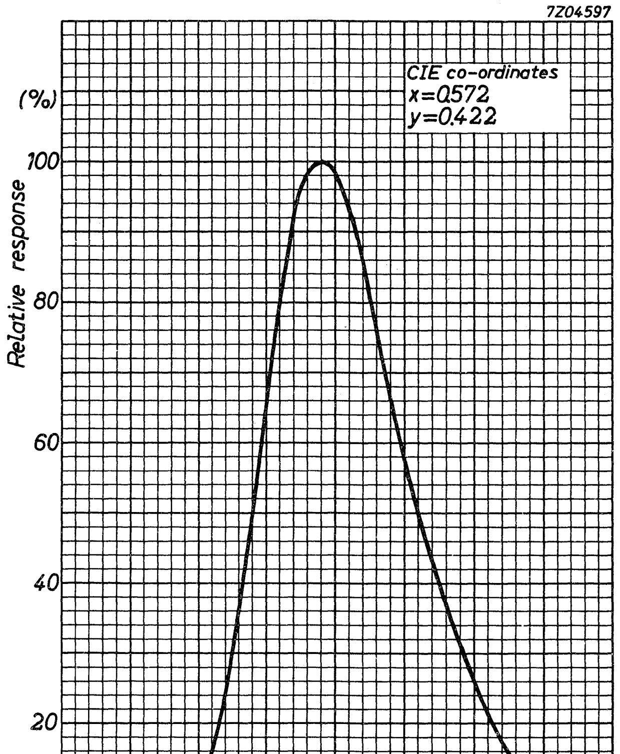

7Z11084
10^2
(%)
5
2
10
5
2
1
Relative luminance
0
500
1000
Time from cessation of excitation (ns)

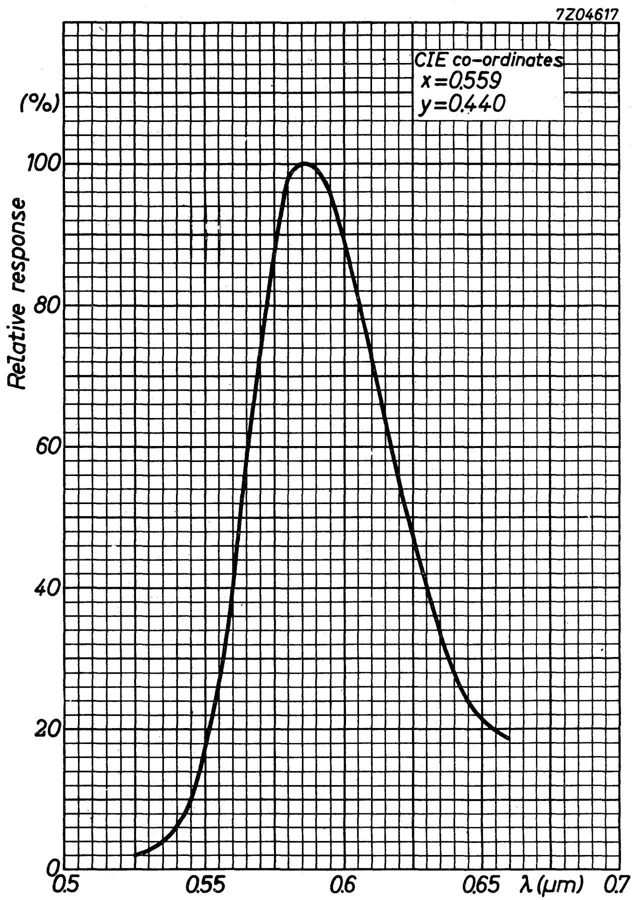

7Z04553
CIE co-ordinates
x = 0.557
y = 0.442
Relative response
(%)
100
80
60
40
20
0
0.5
0.55
0.6
0.65
0.7
λ (μm)

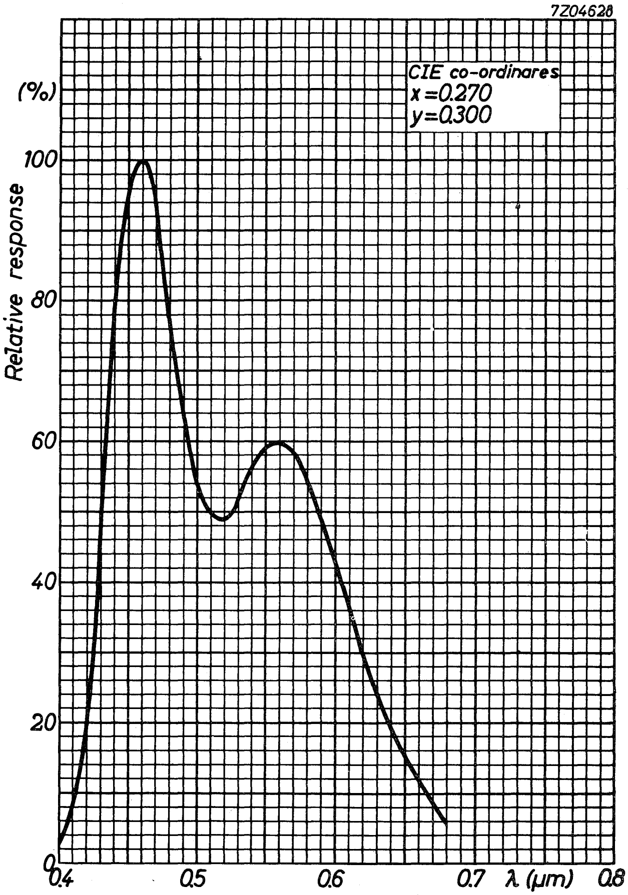

7Z04554
Vscreen : 15 kV
Iscreen : 100 μA (peak)
Excitation : Single focused spot
Pulse duration: 2 μs (once per 500 ms)
Relative luminance
(%)
100
20
10
5
2
1
0.5
0.2
0.1
0
20
40
60
80
100
Time after cessation of excitation (msec)

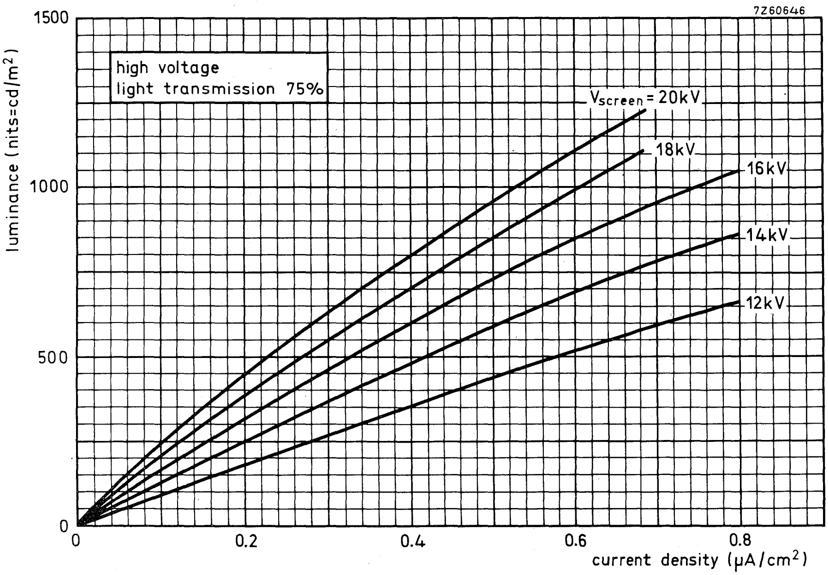

Luminance (nits)
Low voltage
This phosphor is not recommended for use below 10kV
150
100
50
0
0
0.5
1.5
Luminance (nits)
High voltage
7Z04555
1500
1000
500
0
0
0.5
1
1.5
2
Current density (μA/cm²)
Vscreen =18kV
15kV
12kV
10kV

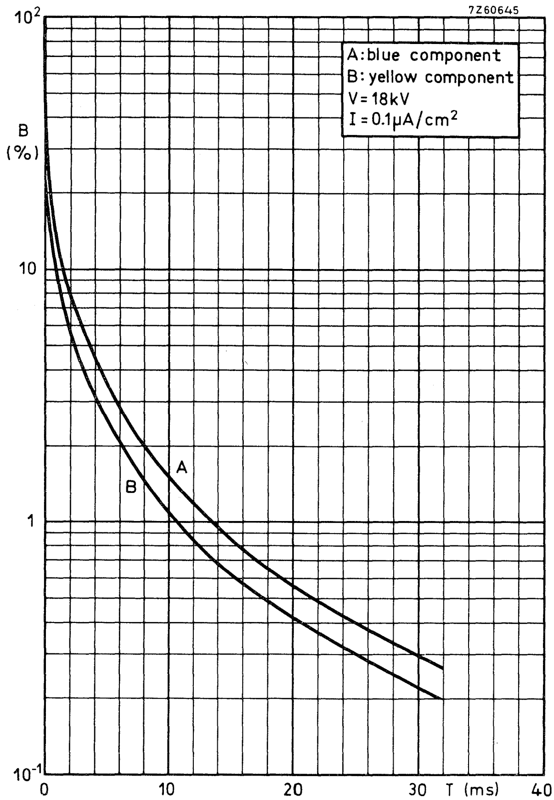

7Z04556
CIE co-ordinates
x=0.559
y=0.440
(%)
Relative response
100
80
60
40
20
0
0.5
0.55
0.6
0.65
λ (μm)
0.7

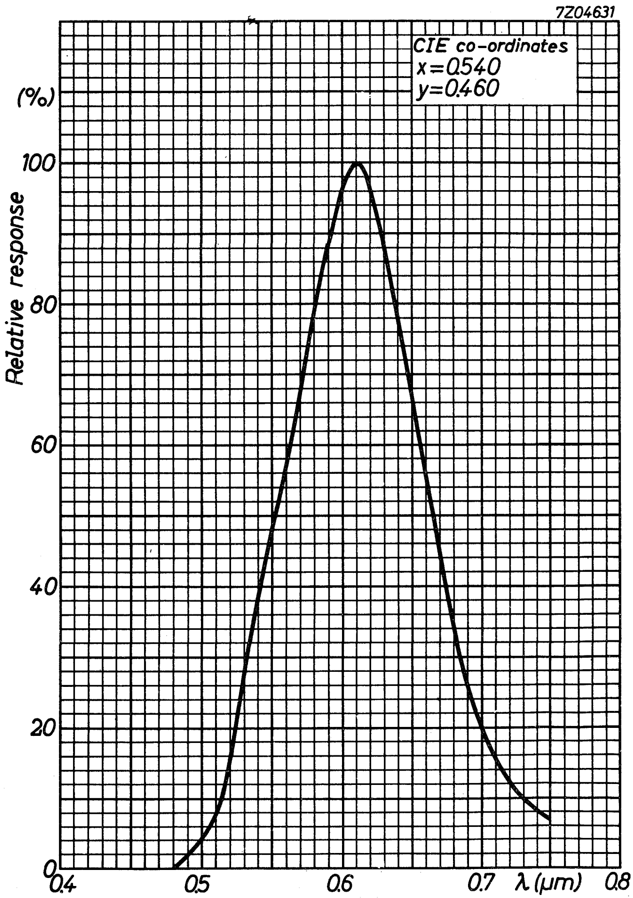

7Z04597
CIE co-ordinates
x=0.572
y=0.422
(%)
Relative response
100
80
60
40
20
0
0.5
0.55
0.6
0.65
λ (μm)
0.7

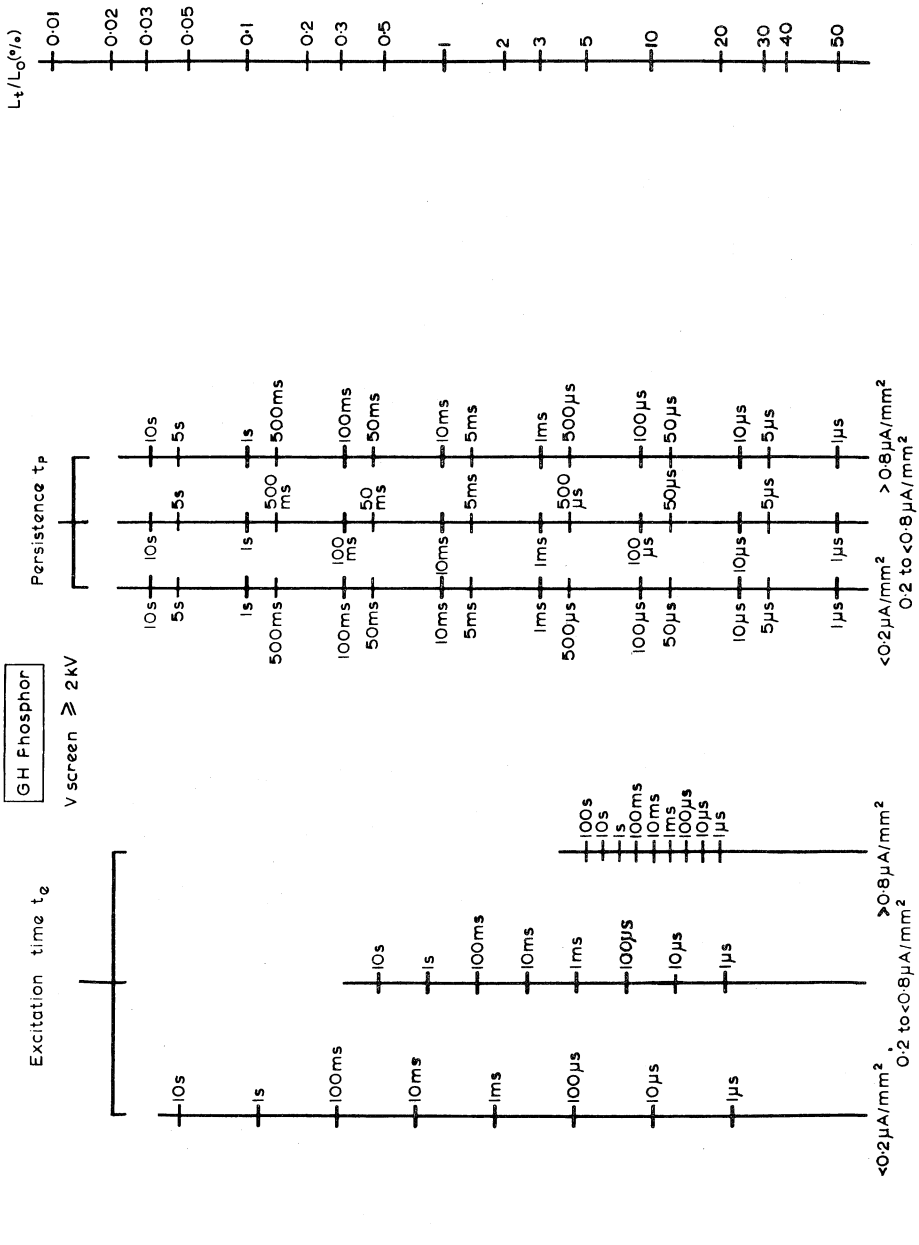

7Z04617
CIE co-ordinates
x=0.559
y=0.440
(%)
Relative response
100
80
60
40
20
0
0.5
0.55
0.6
0.65
λ (μm)
0.7


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


7Z60646
high voltage
light transmission 75%
V_{screen} = 20kV
18kV
16kV
14kV
12kV
luminance (nits=cd/m²)
1500
1000
500
0
0
0.2
0.4
0.6
0.8
current density (μA/cm²)


7Z60645
A: blue component
B: yellow component
V = 18kV
I = 0.1μA/cm²
B (%)
10^2
10
1
10^{-1}
0
10
20
30
40
T (ms)
A
B


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


GH Phosphor
V screen ⩾ 2 kV
L_t/L_o(%)
Persistence t_p
Excitation time t_e
<0·2µA/mm²
0·2 to <0·8µA/mm²
>0·8µA/mm²

INSTRUMENT CATHODE-RAY TUBES

PREFERED TYPES

(Recommended types for new designs)

Mono-accelerator tubes	D7-190.. D10-160.. D13-480.. DG7-32
Post-deflection accelerator tubes	D10-170.. D13-27.. D14-120.. D14-121.. D14-160../09 D.7-11 E10-12.. E10-130..
Large bandwidth instrument tubes	D10-200../07 D13-450../01 D13-500../01

INSTRUMENT CATHODE-RAY TUBE

7 cm diameter flat faced monoaccelerator oscilloscope tube primarily intended for use in inexpensive oscilloscopes and monitoring devices.

QUICK REFERENCE DATA				
Accelerator voltage		$V_{g2,g4,g5,\ell}$	1000	V
Display area			60 x 50	mm^2
Deflection coefficient,	horizontal	M_x	29	V/cm
	vertical	M_y	11.5	V/cm

SCREEN

	colour	persistence
D7-190GH	green	medium short
D7-190GM	yellowish green	long
D7-190GP	bluish green	medium short

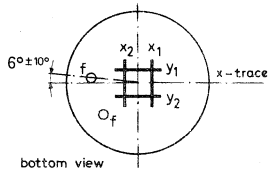
Useful screen diameter	min.	64	mm
Useful scan			
horizontal	min.	60	mm
vertical	min.	50	mm

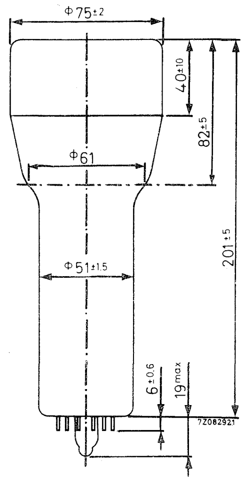
The useful scan may be shifted vertically to a maximum of 4mm with respect to the geometric centre of the faceplate.

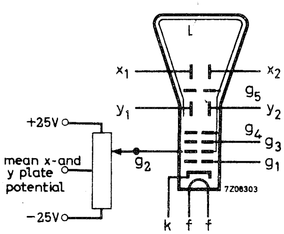
HEATING: Indirect by A.C. or D.C.; parallel supply

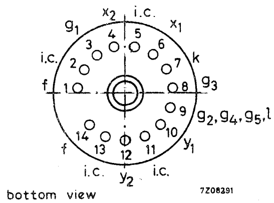
Heater voltage	V_f	6.3	V
Heater current	I_f	300	mA

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.

Dimensions and connections

See also outline drawing

Overall length	max.	225	mm
Face diameter	max.	77	mm

Base 14 pin all glass

Net weight	approx.	260	g

Accessories

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

CAPACITANCES

x_1 to all other elements except x_2	$C_{x1(x2)}$	4	pF
x_2 to all other elements except x_1	$C_{x2(x1)}$	4	pF
y_1 to all other elements except y_2	$C_{y1(y2)}$	3.5	pF
y_2 to all other elements except y_1	$C_{y2(y1)}$	3	pF
x_1 to x_2	C_{x1x2}	1.6	pF
y_1 to y_2	C_{y1y2}	1.1	pF
Control grid to all other elements	C_{g1}	5.5	pF
Cathode to all other elements	C_k	4.0	pF

FOCUSING electrostatic

DEFLECTION 3) 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 3)

Measured with the shrinking raster method in the centre of the screen under typical operating conditions, adjusted for optimum spot size at a beam current $I_\ell = 10\ \mu A$. 1)

Line width l.w. 0.28 mm

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

a) under typical operating conditions, apply a small raster display (no overscan), adjust V_{g1} for a beam current of approx. 10 μA and adjust V_{g3} and $V_{g2,g4,g5,\ell}$ for optimum spot quality at the centre of the screen.

b) under these conditions, but no raster, the deflection plate voltages should be changed to

$V_{y1} = V_{y2} = 1000$ V; $V_{x1} = 300$ V; $V_{x2} = 700$ V, thus directing the total beam current to x2.

Measure the current on x_2 and adjust V_{g1} for $I_{x2} = 10\ \mu A$ (being the beam current I_ℓ)

c) set again for the conditions under a), without touching the V_{g1} control. Now a raster display with a true 10 μA screen current is achieved.

d) focus optimally in the centre of the screen (do not adjust the astigmatism control) and measure the line width.

3) See page 4

TYPICAL OPERATING CONDITIONS 3)

Accelerator voltage	$V_{g2,g4,g5,\ell}$	1000	V
Astigmatism control voltage	$\Delta V_{g2,g4,g5,\ell}$	± 25	V 1)
Focusing electrode voltage	V_{g3}	100 to 180	V
Control grid voltage for visual extinction of focused spot	V_{g1}	max. -35	V
Grid drive for 10 μA screen current		approx. 10	V
Deflection coefficient, horizontal	M_x	29	V/cm
		max. 31	V/cm
vertical	M_y	11.5	V/cm
		max. 12.5	V/cm
Deviation of linearity of deflection		max. 1	% 2)
Geometry distortion		see note 4	
Useful scan, horizontal		min. 60	mm
vertical		min. 50	mm

LIMITING VALUES (Absolute max. rating system)

Accelerator voltage	$V_{g2,g4,g5,\ell}$	max. 2200	V
		min. 900	V
Focusing electrode voltage	V_{g3}	max. 2200	V
Control grid voltage, negative	$-V_{g1}$	max. 200	V
		min. 0	V
Cathode to heater voltage	V_{kf}	max. 125	V
	$-V_{kf}$	max. 125	V
Grid drive, average		max. 20	V
Screen dissipation	W_ℓ	max. 3	mW/cm^2

---

1) All that will be necessary when putting the tube into operation is to adjust the astigmatism control voltage once for optimum spot shape in the screen centre. The control voltage will always be in the range stated, provided the mean x plate and certainly the mean y plate potential was made equal to $V_{g2,g4,g5,\ell}$ with zero astigmatism correction.

2) 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.

3) The mean x and certainly the mean y plate potential should be equal to $V_{g2,g4,g5,\ell}$ with astigmatism adjustment set to zero.

4) A graticule, consisting of concentric rectangles of 40 mm x 50 mm and 39.2 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.

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 coefficient,	horizontal	M_x	=	27.5	V/cm
	vertical	M_y	=	9.8	V/cm

SCREEN

	Colour	Persistence
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.

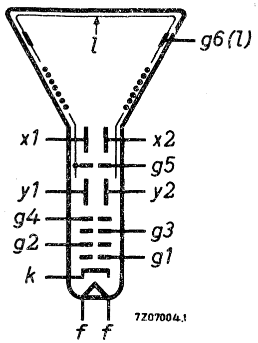
HEATING

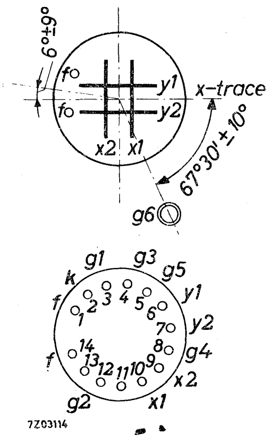
Indirect by A.C. or D.C.; parallel supply

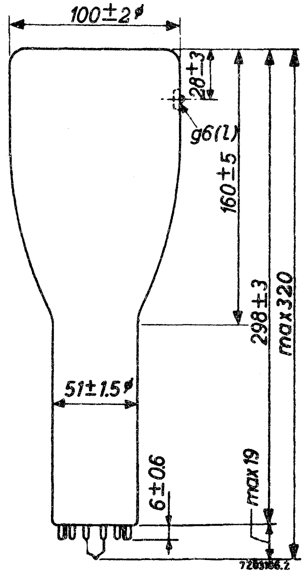
Heater voltage	V_f	=	6.3	V
Heater current	I_f	=	95	mA

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 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

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 [2]
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

[2] See page 5

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 coefficient				
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 coefficient 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

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.

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 coefficient,	horizontal	M_x	=	27.5	V/cm
	vertical	M_y	=	9.8	V/cm

SCREEN

	Colour	Persistence
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

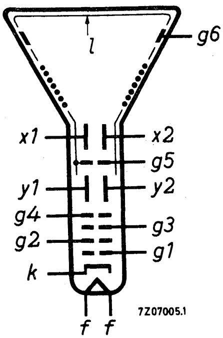
The useful scan may be shifted vertically to a max. of 4 mm with respect to the geometric centre of the faceplate.

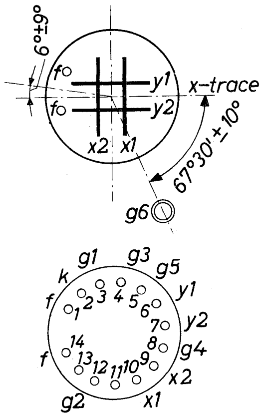
HEATING

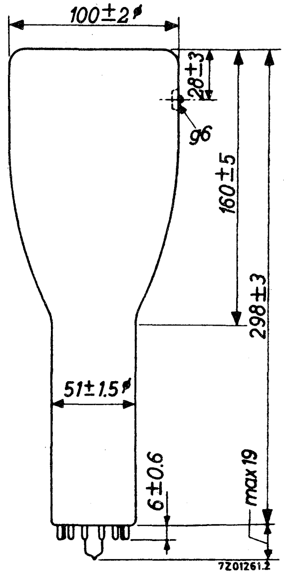
Indirect by A.C. or D.C.; parallel supply

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

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

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 2)
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

2) See page 6

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 coefficient				
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 coefficient 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

LIMITING VALUES (Absolute max. rating system)

Final accelerator voltage	$V_{g_6(\ell)}$	= max.	5000	V
		= min.	1500	V
Geometry control electrode voltage	V_{g_5}	= max.	2200	V
Astigmatism control electrode voltage	V_{g_4}	= max.	2200	V
		= min.	900	V
Focusing electrode voltage	V_{g_3}	= max.	1500	V
First accelerator voltage	V_{g_2}	= max.	2200	V
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.	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
Screen dissipation	W_ℓ	= max.	3	mW/cm^2
Ratio $V_{g_6(\ell)}/V_{g_4}$	$V_{g_6(\ell)}/V_{g_4}$	= max.	4	
Ratio V_{g_2}/V_{g_4}	V_{g_2}/V_{g_4}	= 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.

INSTRUMENT CATHODE-RAY TUBE

10 cm diameter flat faced monoaccelerator oscilloscope tube primarily intended for use in inexpensive oscilloscopes and read-out devices.

QUICK REFERENCE DATA			
Accelerator voltage	$V_{g_2,g_4,g_5(\ell)}$	1500	V
Display area		80 x 60	mm^2
Deflection coefficient, horizontal	M_x	32	V/cm
vertical	M_y	13.7	V/cm

SCREEN

	colour	persistence
D10-160GH	green	medium short
D10-160GM	yellowish green	long
D10-160GP	bluish green	medium short

Useful screen diameter min. 85 mm

Useful scan

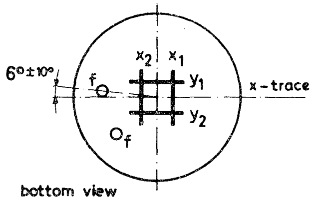
horizontal	min.	80	mm
vertical	min.	60	mm

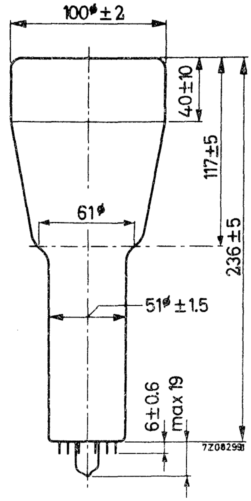
The useful scan may be shifted vertically to a max. of 5 mm with respect to the geometric centre of the faceplate.

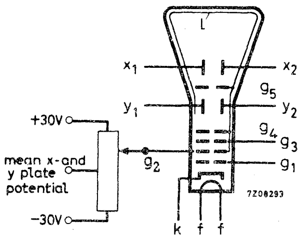
HEATING: Indirect by A.C. or D.C.; parallel supply

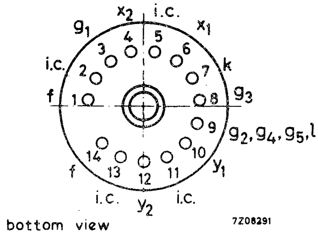
Heater voltage	V_f	6.3	V
Heater current	I_f	300	mA

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.

Dimensions and connections

See also outline drawing

Overall length	max.	260	mm
Face diameter	max.	102	mm

Base 14 pin all glass

Net weight	approx.	400	g

Accessories

Socket (supplied with tube)	type	55566
Mu metal shield	type	55547

CAPACITANCES

x_1 to all other elements except x_2	$C_{x1(x2)}$	4	pF
x_2 to all other elements except x_1	$C_{x2(x1)}$	4	pF
y_1 to all other elements except y_2	$C_{y1(y2)}$	3.5	pF
y_2 to all other elements except y_1	$C_{y2(y1)}$	3	pF
x_1 to x_2	C_{x1x2}	1.6	pF
y_1 to y_2	C_{y1y2}	1.1	pF
Control grid to all other elements	C_{g1}	5.5	pF
Cathode to all other elements	C_k	4	pF

FOCUSING electrostatic

DEFLECTION 3) 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 under typical operating conditions, adjusted for optimum spot size at a beam current $I_\ell = 10\ \mu A$. 1)

Line width l.w. 0.27 mm

1) As the construction of this tube does not permit a direct measurement of the beam current, this current should be determined as follows:
a) under typical operating conditions, apply a small raster display (no overscan), adjust V_{g1} for a beam current of approx. 10 μA and adjust V_{g3} and $V_{g2,g4,g5,\ell}$ for optimum spot quality at the centre of the screen.
b) under these conditions, but no raster, the deflection plate voltages should be changed to
$V_{y1} = V_{y2} = 1500$ V; $V_{x1} = 800$ V; $V_{x2} = 1200$ V, thus directing the total beam current to x2.
Measure the current on x_2 and adjust V_{g1} for $I_{x2} = 10\ \mu A$ (being the beam current I_ℓ)
c) set again for the conditions under a), without touching the V_{g1} control. Now a raster display with a true 10 μA screen current is achieved.
d) focus optimally in the centre of the screen (do not adjust the astigmatism control) and measure the line width.

3) See page 4

TYPICAL OPERATING CONDITIONS [3]

Accelerator voltage	$V_{g2,g4,g5,\ell}$	max.	1500	V
Astigmatism control voltage	$\Delta V_{g2,g4,g5,\ell}$		± 30	V [1]
Focusing electrode voltage	V_{g3}		140 to 275	V
Control grid voltage for visual extinction of focused spot	V_{g1}	max.	−50	V
Grid drive for 10 μA screen current		approx.	10	V
Deflection coefficient, horizontal	M_x		32	V/cm
		max.	34	V/cm
vertical	M_y		13.7	V/cm
		max.	14.5	V/cm
Deviation of linearity of deflection		max.	1	% [2]
Geometry distortion		see note 4		
Useful scan, horizontal		min.	80	mm
vertical		min.	60	mm

LIMITING VALUES (Absolute max. rating system)

Accelerator voltage	$V_{g2,g4,g5,\ell}$	max.	2200	V
		min.	1350	V
Focusing electrode voltage	V_{g3}	max.	2200	V
Control grid voltage, negative	$-V_{g1}$	max.	200	V
		min.	0	V
Cathode to heater voltage	V_{kf}	max.	125	V
	$-V_{kf}$	max.	125	V
Grid drive, average		max.	20	V
Screen dissipation	W_ℓ	max.	3	mW/cm²

1) All that will be necessary when putting the tube into operation is to adjust the astigmatismcontrol voltage once for optimum spot shape in the screen centre. The control voltage will always be in the range stated, provided the mean x plate and centainly the mean y plate potential was made equal to $V_{g2,g4,g5,\ell}$ with zero astigmatism correction.

2) 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.

3) The mean x and certainly the mean y plate potentials should be equal to $V_{g2,g4,g5,\ell}$ with astigmatism adjustment set to zero.

4) A graticule, consisting of concentric rectangles of 50 mm x 60 mm and 49 mm x 58.6 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.

INSTRUMENT CATHODE-RAY TUBE

10 cm diameter flat faced monoaccelerator oscilloscope tube with low heater consumption.

QUICK REFERENCE DATA			
Accelerator voltage	$V_{g2,g4,g5(\ell)}$	1500	V
Display area		80 x 60	mm^2
Deflection coefficient, horizontal	M_x	32	V/cm
vertical	M_y	13.7	V/cm

The D10-161.. is equivalent to the type D10-160.. except for the following:

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

Heater voltage	V_f	6.3	V
Heater current	I_f	95	mA

LIMITING VALUES (Absolute max. rating system)

Cathode to heater voltage

Cathode positive	$V_{+k/f-}$	max.	100	V
Cathode negative	$V_{-k/f+}$	max.	15	V

INSTRUMENT CATHODE-RAY TUBE

10 cm diameter flat faced oscilloscope tube with mesh, designed for compact, transistorized oscilloscopes of 10 MHz to 30 MHz bandwidth.

QUICK REFERENCE DATA				
Final accelerator voltage		$V_{g7(\ell)}$	6	kV
Display area			80 x 60	mm^2
Deflection coefficient,	horizontal	M_x	13	V/cm
	vertical	M_y	3.5	V/cm

SCREEN

	colour	persistence
D10-170GH	green	medium short

Useful screen diameter	min.	85	mm
Useful scan at $V_{g7(\ell)}/V_{g2,g4} = 6$			
horizontal	min.	80	mm
vertical	min.	60	mm

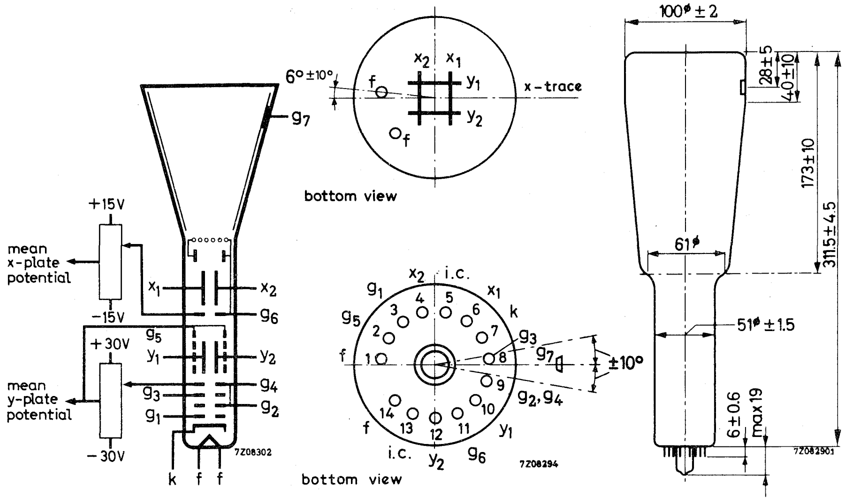
The useful scan may be found shifted vertically to a max. of 5 mm with respect to the geometric centre of the faceplate.

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

Heater voltage	V_f	6.3	V
Heater current	I_f	300	mA

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.

Dimensions and connections

See also outline drawing

Overall length (socket included)	max.	335	mm
Face diameter	max.	102	mm

Net weight	approx.	500	g

Base 14 pin all glass

Accessories

Socket (supplied with tube)	type	55566
Final accelerator contact connector	type	55563
Mu-metal shield	type	55548

CAPACITANCES

x_1 to all other elements except x_2	$C_{x_1(x_2)}$	7	pF
x_2 to all other elements except x_1	$C_{x_2(x_1)}$	7	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
Control grid 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

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 $90 \pm 45'$

LINE WIDTH

Measured with the shrinking raster method over the whole screen area under typical operating conditions, adjusted for optimum spot size at a beam current I_ℓ = 10 μA.

Line width	l.w.	0.42	mm

TYPICAL OPERATING CONDITIONS

Final accelerator voltage	$V_{g_7(\ell)}$	6000	V
Interplate shield voltage	V_{g_6}	1000	V
Geometry control voltage	ΔV_{g_6}	± 15	V 1)
Deflection plate shield voltage	V_{g_5}	1000	V 2)
Focusing electrode voltage	V_{g_3}	170 to 230	V
First accelerator voltage	V_{g_2,g_4}	1000	V
Astigmatism control voltage	$\Delta V_{g_2,g_4}$	± 30	V 3)
Control grid voltage for visual extinction of focused spot	V_{g_1}	-16 to -40	V
Deflection coefficient, horizontal	M_x	av. 13 max. 14	V/cm
vertical	M_y	av. 3.5 max. 3.8	V/cm
Deviation of linearity of deflection		max. 2	% 4)
Geometry distortion		see note 5	
Useful scan, horizontal		min. 80	mm
vertical		min. 60	mm

LIMITING VALUES (Absolute maximum rating system)

Final accelerator voltage	$V_{g_7(\ell)}$	max. 6600 min. 4000	V V
Interplate shield voltage and geometry control electrode voltage	V_{g_6}	max. 2200	V
Deflection plate shield voltage	V_{g_5}	max. 2200	V
Focusing electrode voltage	V_{g_3}	max. 2200	V
First accelerator and astigmatism control electrode voltage	V_{g_2,g_4}	max. 2200 min. 900	V V
Control grid voltage, negative	$-V_{g_1}$	max. 200 min. 0	V V
Cathode to heater voltage	V_{kf} $-V_{kf}$	max. 125 max. 125	V V
Voltage between astigmatism control electrode and any deflection plate	$V_{g_4/x}$ $V_{g_4/y}$	max. 500 max. 500	V V
Grid drive, average		max. 20	V
Screen dissipation	W_ℓ	max. 3	mW/cm^2
Ratio $V_{g_7(\ell)}/V_{g_2,g_4}$	$V_{g_7(\ell)}/V_{g_2,g_4}$	max. 6	

For notes see page 5

Notes

1) This tube is designed for optimum focus when operating at a ratio $V_{g7}/V_{g2,g4}$ not higher than 6.
The geometry electrode voltage should be adjusted within the indicated range (values with respect to the mean x-plate potential). A negative control voltage will cause some pincushion distortion and less background light, a positive control voltage will give some barrel distortion and a slight increase of background light.

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

3) The astigmatism control 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 58.6 mm x 58.6 mm, is aligned with the electrical x-axis of the tube.
With optimum correction potentials applied the edges of a raster lie between these rectangles.

INSTRUMENT CATHODE-RAY TUBE

Oscilloscope tube with rectangular 10 cm diagonal flat face and metal-backed screen, provided with internal graticule. The high sensitivities of this mesh tube, together with the sectioned y-deflection plates, render the tube suitable for transistorized oscilloscopes for frequencies up to 100 MHz to 250 MHz.

QUICK REFERENCE DATA			
Final accelerator voltage	$V_{g8(\ell)}$	15	kV
Display area		50 x 80	mm^2
Deflection coefficient, horizontal	M_x	12	V/cm
vertical	M_y	3.5	V/cm

SCREEN

	Colour	Persistence
D10-200GH/07	green	medium short

Useful screen dimensions	min.	50 x 80	mm^2
Useful scan at $V_{g8(\ell)}/V_{g4}$ = 10			
horizontal	min.	80	mm
vertical	min.	50	mm

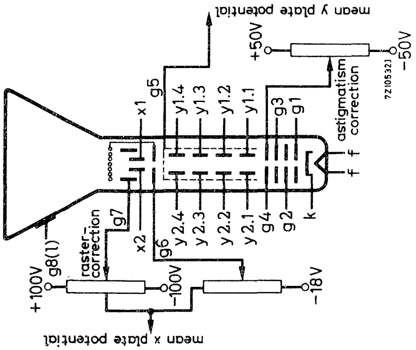
The tube is supplied with a correction coil unit which ensures that the scanned area can be centred on and aligned with the internal graticule. See page 6

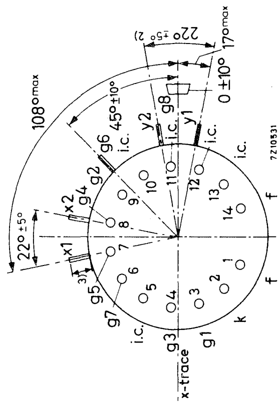
HEATING: Indirect by A.C. or D.C.; parallel supply

Heater voltage	V_f	6.3	V
Heater current	I_f	300	mA

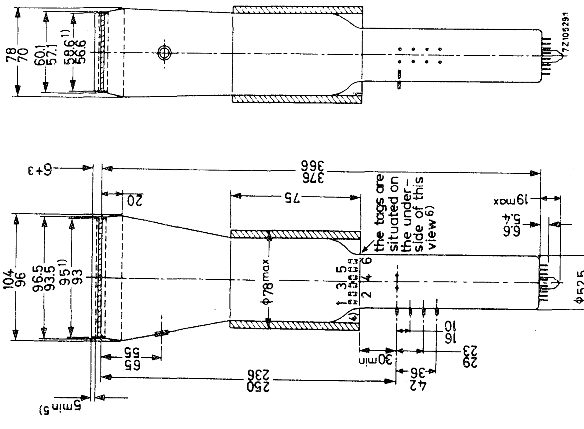
MECHANICAL DATA

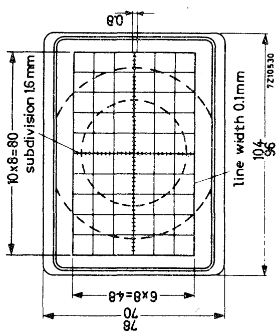
Dimensions in mm





bottom view





1) The edges of the faceplate will always be within a rectangle 95 ± 1.5 mm x 58.6 ± 1.5 mm.
2) In each plane.
3) Recommended inside diameter of the mu-metal shield is min. 70 mm.
4) It is recommended to solder the supply wires on the tags before the tube is placed in the mu-metal shield. This shield is provided with a hole for these wires.
5) Clear area for light conductor.
6) Coil connections see page 6.

For notes see page 7.

MECHANICAL DATA (continued) 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.

Dimensions and connections

See also outline drawing			
Overall length (socket included)	max.	405	mm
Faceplate dimensions	max.	104 x 78	mm^2
Net weight	approx.	900	g
Base	14 pin all glass		

Accessories

Socket (supplied with tube)	type 55566
Final accelerator contact connector	type 55563
Side contact connector	type 55561
Mu-metal shield	

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
$y_{1.1}$ to all other elements except $y_{2.1}$	$C_{y_{1.1}(y_{2.1})}$	1.5	pF
x_1 to x_2	$C_{x_1x_2}$	2.5	pF
$y_{1.1}$ to $y_{2.1}$	$C_{y_{1.1}\,y_{2.1}}$	0.80	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 (see page 6 "Correction coils")

LINE WIDTH

Measured with the shrinking raster method in the centre of the screen under typical operating conditions, adjusted for optimum spot size at a beam current I = 10 μA:

Line width l.w. approx. 0.35 mm

TYPICAL OPERATING CONDITIONS

Final accelerator voltage	$V_{g8(\ell)}$	15000	V
Geometry control electrode voltage	V_{g7}	1500 ± 70	V [1])
Post deflection (mesh) and interplate shield voltage	V_{g6}	1500	V
Background illumination control voltage	ΔV_{g6}	-12 to -18	V
Deflection plate shield voltage	V_{g5}	1500	V [2])
Astigmatism control electrode voltage	V_{g4}	1500 ± 50	V [3])
Focusing electrode voltage	V_{g3}	380 to 520	V
First accelerator voltage	V_{g2}	1500	V
Control grid voltage for visual extinction of focused spot	V_{g1}	-40 to -100	V
Deflection coefficient, horizontal	M_x	av. 12	V/cm
		max. 13.2	V/cm
vertical	M_y	av. 3.5	V/cm
		max. 3.85	V/cm
Deviation of linearity of deflection		max. 2	% [4])
Geometry distortion		see note 5	
Useful scan, horizontal		80	mm
vertical		50	mm

LIMITING VALUES (Absolute max. rating system)

Final accelerator voltage	$V_{g8(\ell)}$	max. 16500	V
		min. 9000	V
Geometry control electrode voltage	V_{g7}	max. 2400	V
Post deflection and interplate shield voltage	V_{g6}	max. 2400	V
		min. 1300	V
Deflection plate shield voltage	V_{g5}	max. 2400	V
Astigmatism control electrode voltage	V_{g4}	max. 2400	V
		min. 1350	V
Focusing electrode voltage	V_{g3}	max. 2400	V
First accelerator voltage	V_{g2}	max. 1800	V
		min. 1350	V
Control grid voltage, positive	V_{g1}	max. 0	V
negative	$-V_{g1}$	max. 200	V

Notes see page 5.

LIMITING VALUES (continued)

Cathode to heater voltage	V_{kf}	max.	200	V
	$-V_{kf}$	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
Screen dissipation	W_{ℓ}	max.	3	mW/cm^2
Ratio $V_{g_8(\ell)}/V_{g_4}$	$V_{g_8(\ell)}/V_{g_4}$	max.	10	
Cathode current, average	I_k	max.	300	μA

NOTES

1) This tube is designed for optimum performance when operating at the ratio $V_{g_8(\ell)}/V_{g_4} = 10$. Operation at other ratios 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 y plate 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 be more than the indicated value.

5) The geometry distortion is such that, with optimum correction potentials applied, it will always be possible to have a scanned raster with the edges remaining between two rectangles, one measuring 80 mm x 50 mm, the other 78.4 mm x 48.5 mm and with:
- coinciding centres
- the longer sides aligned with the electrical x-axis of the tube.

CORRECTION COILS

The D10-200../07 is provided with a coil unit consisting of:

1. a pair of coils L_1 and L_2 for
   a. correction of the orthogonality of the x and y traces enabling the angle between the x and y traces at the centre of the screen to be made exactly 90^o.
   b. vertical shift of the scanned area.
2. a single coil L_3 for image rotation enabling the alignment of the x trace with the x lines of the graticule.

Ortogonality and shift (coils L_1 and and L_2)

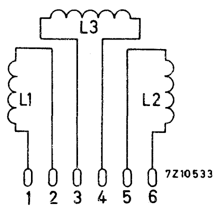
The current required under typical operating conditions is max. 45 mA for complete correction of orthogonality and shift. This value applies to a tube operating without a mu-metal shield, and will be 30 to 50% lower with a shield, depending on the shield diameter.
The resistance of each coil is approx. 175 Ω.

Image rotation (coil L_3)

The image rotation coil is wound concentrically around the tube neck. Under typical operating conditions a current of max. 30 mA will be required for complete correction. The resistance of this coil is approx. 500 Ω.

Connections of the coils

The coils are connected to the 6 soldering tags as follows:



With L_1 and L_2 connected in series according to Fig.1, a current in the direction indicated will produce a clockwise rotation of the vertical trace and a anti-clockwise rotation of the horizontal trace.
With the connection according to Fig.2 the current as indicated will produce an upward shift.

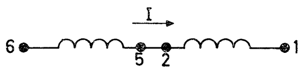


Fig.1

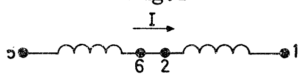


Fig.2

By controlling the current of each coil separately, see Fig.3, a change in the angle of the traces and a vertical shift can be made simultaneously. The change in angle will be proportional to the algebraic sum of the two currents and the shift to the algebraic difference.

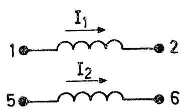


Fig.3

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.

SCREEN

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

HEATING

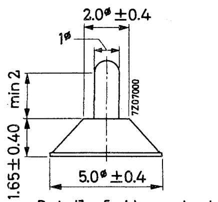
Indirect by A.C. or D.C.; parallel supply

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

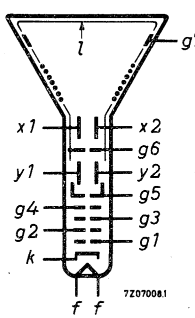
MECHANICAL DATA

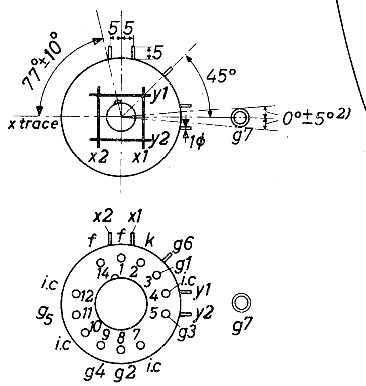
Dimensions in mm

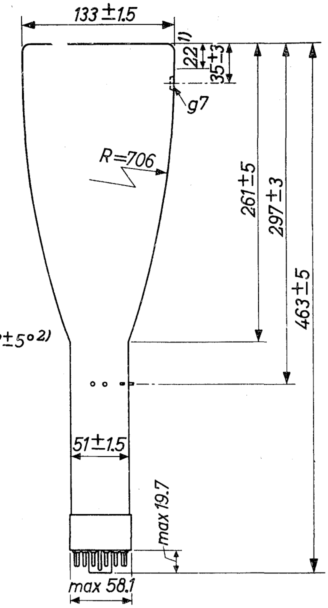
1) Straight part of the bulb.
2) Location of the recessed cavity button contact with respect to the x-trace.



Detail of side contact







MECHANICAL DATA (continued)

Base	Diheptal medium shell
Accessories	
Socket	type 2422 517 00001

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 $90^{o} \pm 1^{o}$

TYPICAL OPERATING CONDITIONS

Final accelerator voltage	$V_{g_7(\ell)}$	=	4000	V
Geometry control electrode voltage	V_{g_6}	=	2000 ± 200	V
Deflection plate shield voltage	V_{g_5}	=	2000	V
Astigmatism control electrode voltage	V_{g_4}	=	2000 ± 100	V
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 coefficient				
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	%
Useful scan				
horizontal		=	min. 100	mm
vertical		=	min. 60	mm

LIMITING VALUES (Absolute max. rating system)

Final accelerator voltage	$V_{g_7(\ell)}$	= max.	8800	V
		= min.	2500	V
Geometry control electrode voltage	V_{g_6}	= max.	2200	V
Deflection plate shield voltage	V_{g_5}	= max.	2200	V
Astigmatism control electrode voltage	V_{g_4}	= max.	2200	V
		= min.	1000	V
Focusing electrode voltage	V_{g_3}	= max.	1500	V
First accelerator voltage	V_{g_2}	= max.	2200	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	$V_{g\ /x}$	= max.	500	V
	$V_{g\ /y}$	= max.	500	V
Screen dissipation	W_{ℓ}	= max.	3	mW/cm^2
Ratio $V_{g_7(\ell)}/V_{g_4}$	$V_{g_7(\ell)}/V_{g_4}$	= max.	4	
Ratio V_{g_2}/V_{g_4}	V_{g_2}/V_{g_4}	= max.	1	

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 coefficient,	horizontal	M_x	max.	18	V/cm
	vertical	M_y	=	6	V/cm

SCREEN

	Colour	Persistence
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

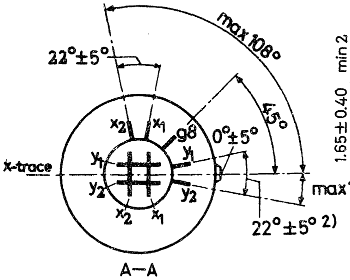
HEATING

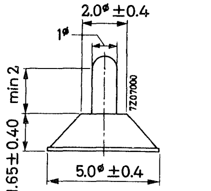
Indirect by A.C. or D.C.; parallel supply

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

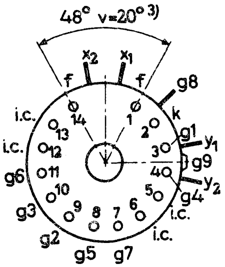
MECHANICAL DATA

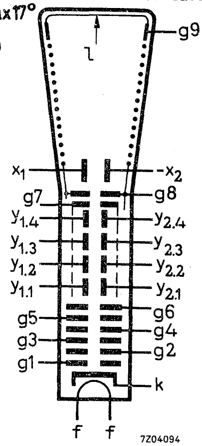
Dimensions in mm

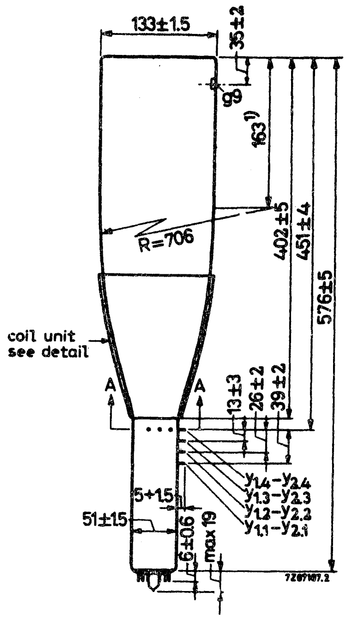




Detail of side contact







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 4)	

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°.

4) See page 6.

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° See "Correction Coils"

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[5]
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

[5]) See page 6

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 [5]
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 [6]
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 coefficient				
horizontal	M_x	=	max. 18	V/cm
vertical	M_y	=	5.6 to 6.6	V/cm
Deviation of linearity of deflection		=	max. 2	% [7]
Geometry distortion	See note 8			
Useful scan				
horizontal		=	100	mm
vertical		=	60	mm

[1] [2] [3] [5] [6] [7] [8] See page 6

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

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) To avoid damaging the side contacts the narrower end of the mu-metal shield should have an internal diameter of not less than 70 mm.

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

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

7) 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.

8) 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.

CORRECTION COILS

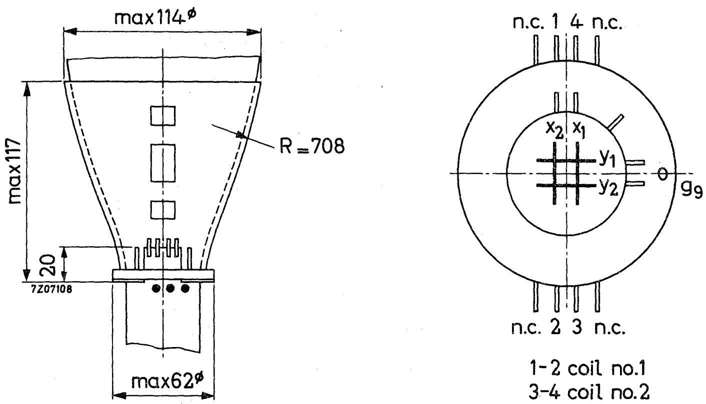
The D13-16.. is provided with a coil unit consisting of a pair of coils for:

a. Correction of the orthogonality of the x and y traces (which means that at the centre of the screen the angle between the x and y traces can be made exactly 90°).

b. Vertical shift of the scanned area.

DETAIL DRAWING OF COIL UNIT

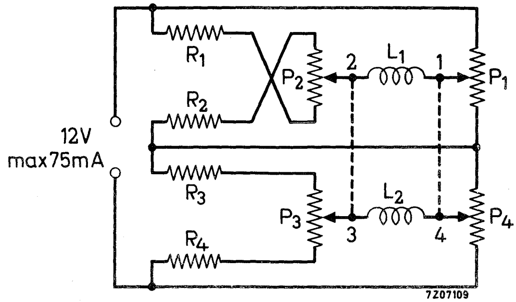
Dimensions in mm



The currents required under typical operating conditions, the tube being screened by a mu-metal shield closely surrounding the coils (e.g. 55554), are max. 2.5 mA per degree of angle correction and max. 2 mA per mm of shift. If not such shield is used these values have to be multiplied by a factor k ($1 < k < 2$), the value of which depends on the diameter of the shield and approaches 2 for the case no shield is present.
The D.C. resistance is approx. 180 Ω per coil.
When designing the supply circuit for these coils it should be considered that the maximum current required in either coil can be 15 mA.

Circuit diagrams

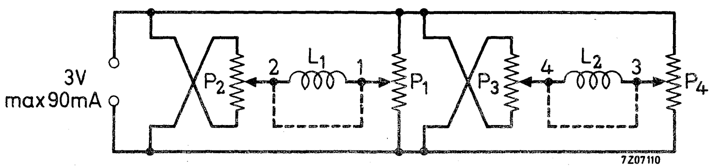
A suitable circuit permitting independent controls of orthogonality correction and vertical shift is given in fig. 1.



P_1, P_4	: Potentiometers 220 Ω,	1 Watt, ganged
P_2, P_3	: Potentiometers 100 Ω,	0,5 Watt, ganged
R_1, R_2, R_3, R_4	: Resistors 56 Ω,	0,5 Watt

Fig. 1

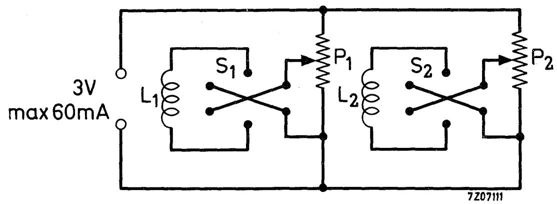
The dissipation in the potentiometers can be reduced considerably if the requirement of independent controls is dropped (see fig. 2).



P_1, P_2 : Potentiometers, 220 Ω, 0,5 Watt, ganged
P_3, P_4 : Potentiometers, 220 Ω, 0,5 Watt, ganged

Fig. 2

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



P_1, P_2 : Potentiometers, 500 Ω, 0,5 Watt.
S_1, S_2 : Commutators

Fig.3

For the adjustment of the currents the following procedure is recommended:

a. With the tube fully scanned in the vertical direction the scanned area must be shifted so that the useful vertical scan on either side of the geometric centre of the screen meets the published value of 30 mm min.
With the circuit according to fig.1 this is done by means of the ganged potentiometers P_1 and P_4.

b. Adjustment of orthogonality by means of the ganged potentiometers P_2 and P_3 in fig.1. A slight readjustment of P_1 and P_4 may be necessary afterwards.

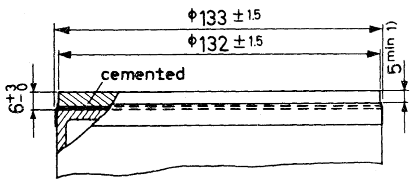
With a circuit according to fig.2 or 3 these corrections have to be performed by means of successive adjustments of the currents in the coils.
The most convenient deflection signal is a square waveform permitting an easy and fairly accurate check of orthogonality.

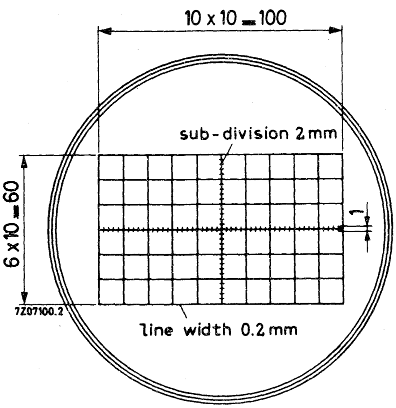
INSTRUMENT CATHODE-RAY TUBE

The D13-16../01 is equivalent to the D13-16.. but features an internal graticule. This graticule can be illuminated.

MECHANICAL DATA

Dimensions in mm





Maximum angle between x-trace and x-axis of the graticule: $\pm 5^{\circ}$

1) Clear area for light conductor.

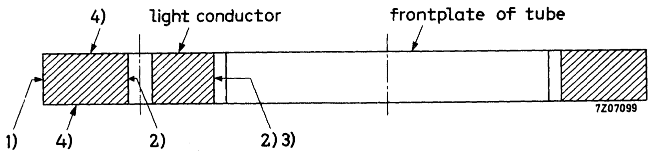
ALIGNMENT

In order to align the x-trace and the x-axis of the graticule an image rotating coil may be used. This coil should be positioned at one third of the cone length, seen from the face end, and can be attached to the inner surface of the mu-metal shield.
Under typical operating conditions maximum 50 ampere-turns are required for alignment.

ILLUMINATION

To illuminate the internal graticule the use of a light conductor (e.g. of Perspex) is obligatory. The following design considerations should be observed:

In order to achieve the most efficient light conductance the holes for the light bulb as well as the contact area with the front plate should be polished. The contact with the edges of the front plate should be as close as possible and the edges of the front plate and the corresponding hole in the light conductor should be parallel to achieve light beams perpendicular to the edges. It is advised to apply reflective material to the outer circumference of the conductor and if possible also to both planes (see drawing).



1) Reflective material.

2) Polished.

3) Close and constant distance to front plate of tube.
It is essential that the light conductor and the front plate of the tube are in plane.

4) If possible reflective material.

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.

SCREEN

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

HEATING

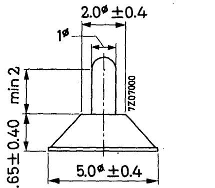
Indirect by A.C. or D.C.; parallel supply

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

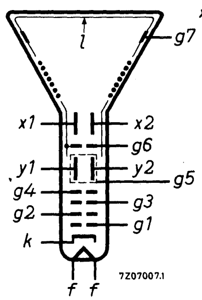
MECHANICAL DATA

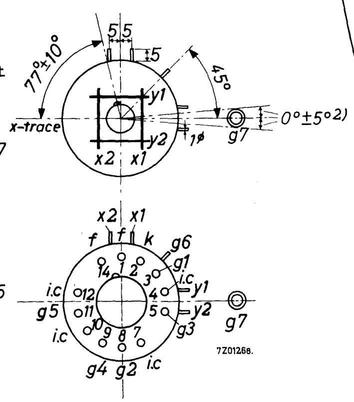
Dimensions in mm

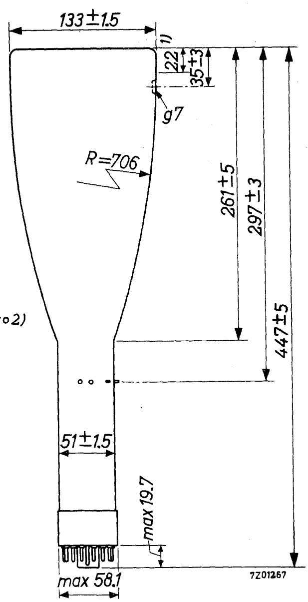
1) Straight part of the bulb
2) Location of the recessed cavity button contact with respect to the x-trace.



Detail of side contact







MECHANICAL DATA (continued)

Base: Diheptal

Accessories

Socket	type	2422 517 00001
Final accelerator contact connector	type	55563
Side contact connector	type	55561
Mu-metal shield	type	55551

FOCUSING electrostatic

DEFLECTION double electrostatic

x plates symmetrical

y plates symmetrical

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

TYPICAL OPERATING CONDITIONS

Final accelerator voltage	$V_{g7(\ell)}$	=	10	kV
Geometry control electrode voltage	V_{g6}	=	1670 ± 170	V
Deflection plate shield voltage	V_{g5}	=	1670 ± 85	V
Astigmatism control electrode voltage	V_{g4}	=	1670 ± 85	V
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 coefficient, 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	%
Useful scan, horizontal		=	min. 100	mm
vertical		=	min. 60	mm

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	

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 coefficient, horizontal	M_x	=	30	V/cm
vertical	M_y	=	6.4	V/cm

SCREEN

	colour	persistence
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

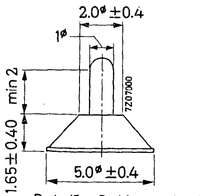
Indirect by A.C. or D.C.; parallel supply

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

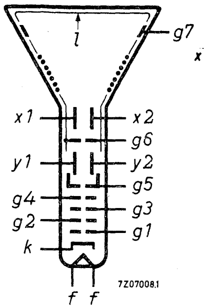
MECHANICAL DATA

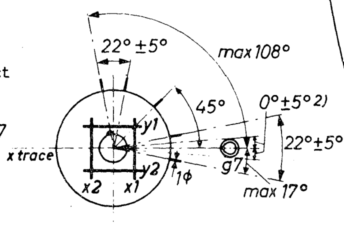
Dimensions in mm

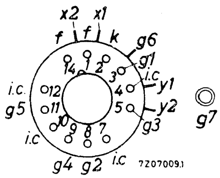
1) Straight part of the bulb.
2) Location of the recessed cavity button contact with respect to the x-trace.

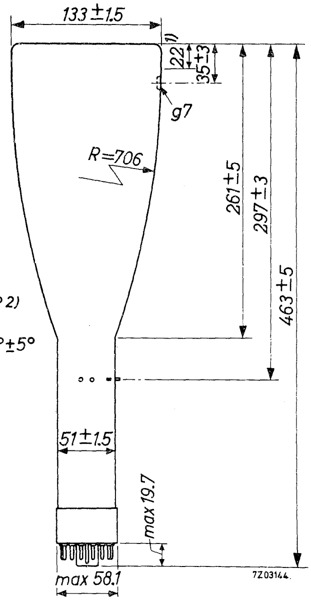


Detail of side contact









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	2422 517 00001
Final accelerator contact connector	type	55563
Side contact connector	type	55561
Mu-metal shield	type	55551

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 $90^\circ \pm 1^\circ$

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[3]
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

---

3) See page 6

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 coefficient, 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 coefficient 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

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	

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 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_{g_3}-potentiometer.

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 MHz to 900 MHz 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	$V_{g_9(\ell)}$	=	6	kV
Display area		=	5x10	cm
Deflection coefficient, horizontal	M_x	=	max. 14	V/cm
vertical	M_y		See note 7 page 4	

SCREEN

	colour	persistence
D13-23GH	green	medium short

Useful screen diameter	min.	114	mm
Useful scan at $V_{g_9(\ell)}/V_{g_5} = 5$			
horizontal	min.	100	mm
vertical	min.	50	mm

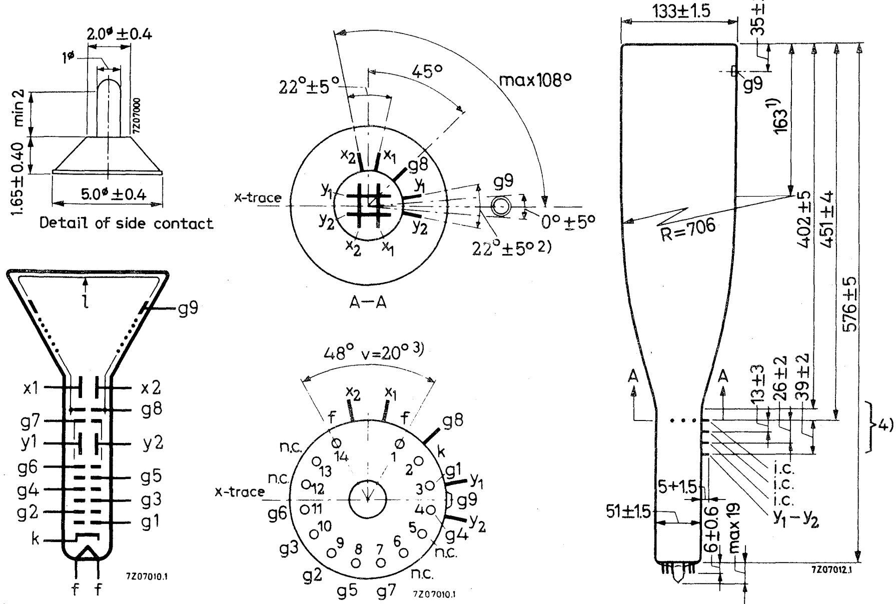
The useful scan may be shifted vertically to a max. of 5 mm with respect to the geometric centre of the faceplate.

HEATING

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

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

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.	134.5	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	
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°.

4) To avoid damaging the side contacts the narrower end of the mu-metal shield should have an internal diameter of not less than 70 mm.

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 $90^o \pm 1^o$

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 coefficient 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.

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 coefficient						
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.

LIMITING VALUES (Absolute max. rating system)

Final accelerator voltage	$V_{g9(\ell)}$	=	max.	10000	V
		=	min.	5000	V
Geometry control electrode voltage	V_{g8}	=	max.	2000	V
Deflection plate shield voltage	V_{g7}	=	max.	2000	V
Beam centring electrode voltage	V_{g6}	=	max.	2000	V
Astigmatism control electrode voltage	V_{g5}	=	max.	2000	V
Focusing electrode voltage	V_{g4}	=	max.	2000	V
Deflection blanking electrode voltage	V_{g3}	=	max.	2000	V
First accelerator voltage	V_{g2}	=	max.	2000	V
		=	min.	1200	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 electrode	$V_{g5/x}$	=	max.	500	V
and any deflection plate	$V_{g5/y}$	=	max.	500	V
Cathode current (average)	I_k	=	max.	300	mA
Screen dissipation	W_ℓ	=	max.	3	mW/cm^2
Ratio $V_{g9(\ell)}/V_{g5}$	$V_{g9(\ell)}/V_{g5}$	=	max.	10	
Ratio V_{g9}/V_{g5}	V_{g2}/V_{g5}	=	max.	1	

INSTRUMENT CATHODE-RAY TUBE

Oscilloscope tube with flat face, side connections to the deflector plates. The high sensitivities of this mesh tube render it suitable for transistorized equipment. The phosphor screen is metal backed.

QUICK REFERENCE DATA				
Final accelerator voltage	$V_{g_9(\ell)}$		15	kV
Display area			6x10	cm
Deflection coefficient, horizontal	M_x		9.5	V/cm
vertical	M_y	=	2.9	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 $V_{g_9(\ell)}/V_{g_4} = 10$			
horizontal	min.	100	mm
vertical	min.	60	mm

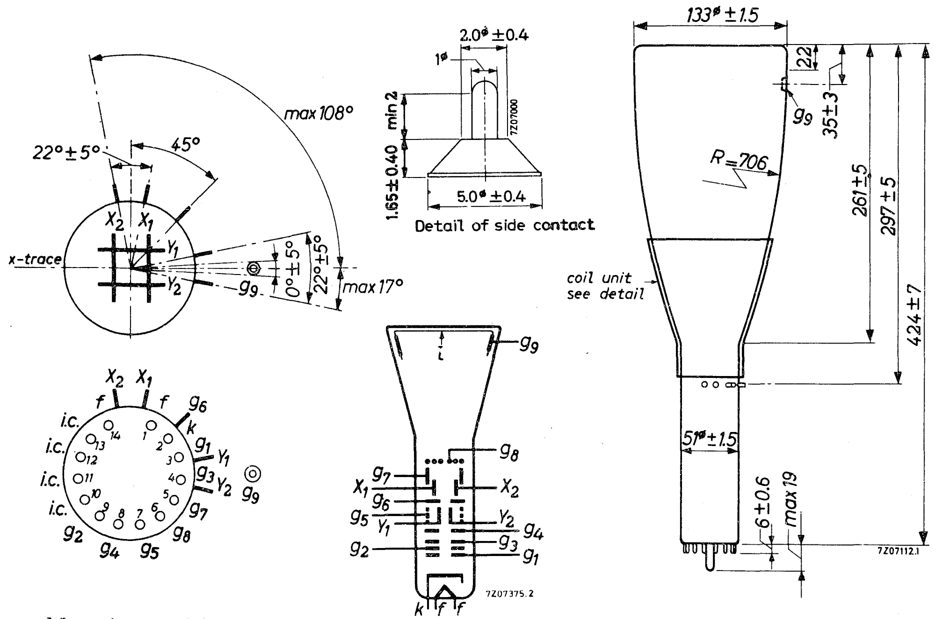
HEATING

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



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.	450	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[1]	

[1]) See page 6.

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° See "Correction coils"

LINE WIDTH

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

Final accelerator voltage	$V_{g_9(\ell)}$	=	15 000	15 000	V
Astigmatism control electrode voltage	V_{g_4}	=	2400	1500	V[4]
First accelerator voltage	V_{g_2}	=	2400	1500	V
Beam current	$I(\ell)$	=	10	10	μA
Line width	l.w.	=	0.3	0.4	mm

[4]) See page 6

TYPICAL OPERATING CONDITIONS

Final accelerator voltage	$V_{g9(\ell)}$	=	15 000	V	
Post deflection shield voltage (with respect to V_{g7})	V_{g8}	=	-12 to -18	V	
Geometry control electrode voltage	V_{g7}	=	1500 ±70	V	2)
Interplate shield voltage	V_{g6}	=	1500	V	
Deflection plate shield voltage	V_{g5}	=	1500	V	3)
Astigmatism control electrode voltage	V_{g4}	=	1500 ±70	V	4)
Focusing electrode voltage	V_{g3}	=	375 to 625	V	
First accelerator voltage	V_{g2}	=	1500	V	
Control grid voltage for visual extinction of focused spot	$-V_{g1}$	=	40 to 90	V	
Deflection coefficient					
horizontal	M_x	=	8 to 11	V/cm	
vertical	M_y	=	2.3 to 3.5	V/cm	
Deviation of linearity of deflection		=	max. 2	%	5)
Geometry distortion			See note 6		
Useful scan					
horizontal		=	min. 100	mm	
vertical		=	min. 60	mm	

CIRCUIT DESIGN VALUES

Focusing voltage	V_{g3}	=	250 to 417	V per kV of V_{g4}	
Control grid voltage for visual extinction of focused spot	$-V_{g1}$	=	30 to 56.7	V per kV of V_{g2}	
Deflection coefficient at $V_{g9(\ell)}/V_{g4} = 10$					
horizontal	M_x	=	6.3 to 8.4	V/cm per kV of V_{g4}	
vertical	M_y	=	1.53 to 2.33	V/cm per kV of V_{g4}	
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_{g3}	=	-25 to +25	μA	7)

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

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
Interplate shield voltage	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.	2500	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	
Cathode current, average	I_k	=	max.	300	μA

1) To avoid damaging the side contacts the narrower end of the mu-metal shield should have an internal diameter of not less than 70 mm.

2) 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.

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

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) 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.

6) 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.

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

CORRECTION COILS

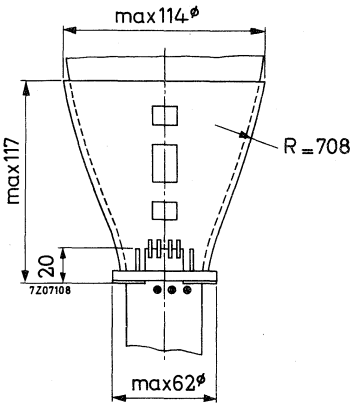
The D13-26.. is provided with a coil unit consisting of a pair of coils for:

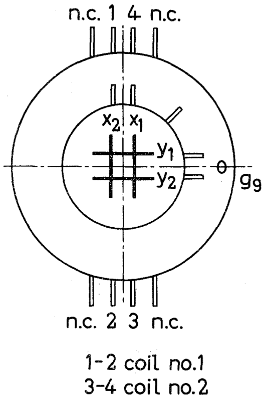
a. Correction of the orthogonality of the x and y traces (which means that at the centre of the screen the angle between the x and y traces can be made exactly 90°).

b. Vertical shift of the scanned area.

DETAIL DRAWING OF COIL UNIT

Dimensions in mm

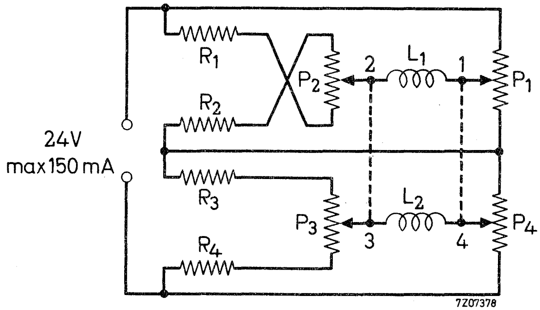




The currents required under typical operating conditions, the tube being screened by a mu-metal shield closely surrounding the coils (e.g. 55555), are max. 7 mA per degree of angle correction and max. 4 mA per mm of shift. If no such shield is used these values have to be multiplied by a factor k ($1 < k < 2$), the value of which depends on the diameter of the shield and approaches 2 for the case no shield is present.
The D.C. resistance is approx. 180 Ω per coil.
When designing the supply circuit for these coils it should be considered that the maximum current required in either coil can be 34 mA.

Circuit diagrams

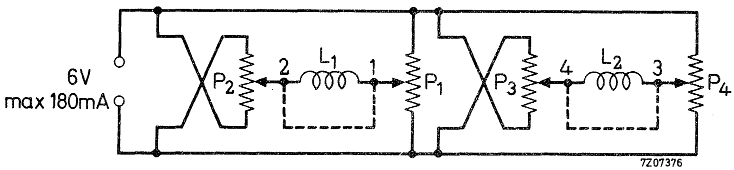
A suitable circuit permitting independent controls of orthogonality correction and vertical shift is given in fig. 1.



P_1, P_4	: Potentiometers 220 Ω, 3 Watt, ganged
P_2, P_3	: Potentiometers 150 Ω, 2 Watt, ganged
R_1, R_2, R_3, R_4	: Resistors 33 Ω, 0,5 Watt

Fig. 1

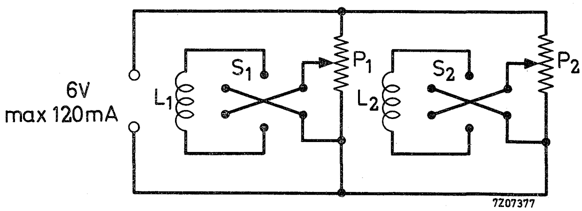
The dissipation in the potentiometers can be reduced considerably if the requirement of independent controls is dropped (see fig. 2).



P_1, P_2 : Potentiometers, 220 Ω, 1 Watt, ganged
P_3, P_4 : Potentiometers, 220 Ω, 1 Watt, ganged

Fig. 2

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



P_1, P_2 : Potentiometers, 500 Ω, 0,5 Watt
S_1, S_2 : Commutators

Fig.3

For the adjustment of the currents the following procedure is recommended:

a. With the tube fully scanned in the vertical direction the scanned area must be shifted so that the useful vertical scan on either side of the geometric centre of the screen meets the published value of 30 mm min.
With the circuit according to fig.1 this is done by means of the ganged potentiometers P_1 and P_4.

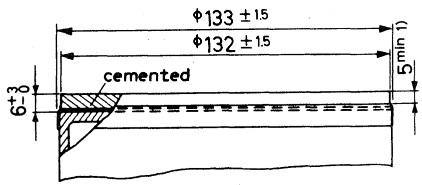
b. Adjustment of orthogonality by means of the ganged potentiometers P_2 and P_3 in fig.1. A slight readjustment of P_1 and P_4 may be necessary afterwards.

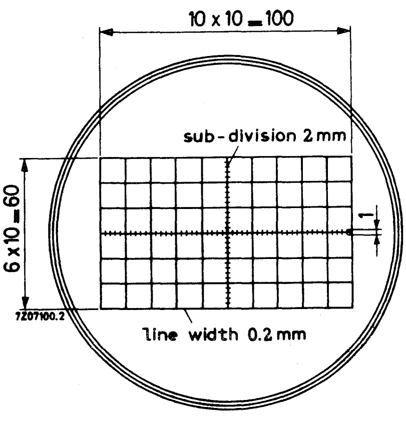
With a circuit according to fig.2 or 3 these corrections have to be performed by means of successive adjustments of the currents in the coils.
The most convenient deflection signal is a square waveform permitting an easy and fairly accurate check of orthogonality.

INSTRUMENT CATHODE-RAY TUBE

The D13-26../01 is equivalent to the D13-26.. but features an internal graticule. This graticule can be illuminated.

MECHANICAL DATA Dimensions in mm





Maximum angle between x-trace and x-axis of the graticule $\pm 5^{\circ}$

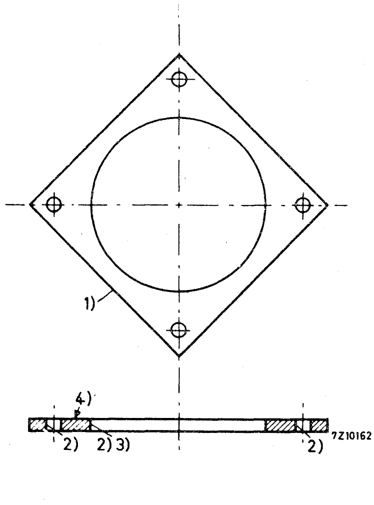
1) Clear area for light conductor.

ALIGNMENT

In order to align the x-trace and the x-axis of the graticule an image rotating coil may be used. This coil should be positioned at one third of the cone length, seen from the face end, and can be attached to the inner surface of the mu-metal shield. Under typical operating conditions maximum 90 ampere-turns are required for alignment.

ILLUMINATION OF THE GRATICULE

To illuminate the internal graticule a light conductor (e.g. of perspex) should be used. In order to achieve the most efficient light conductance, the holes for the lamps and the edge adjacent to the tube should be polished, and the distance between the perspex plate and the tube should be as small as possible. It is advisable to apply reflective material to the outer circumference and, if possible, also to the upper and lower faces of the light conductor. The thickness of the conductor should not exceed 3 mm, and its position relative to the frontplate of the tube should be adjusted for optimum illumination of the graticule lines.



1) Reflective material.
2) Polished.
3) Close and constant distance to front plate of tube.
It is essential that the light conductor and the front plate of the tube are in plane.
4) If possible reflective material.

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	$V_{g_7(\ell)}$	=	3000	V
Display area			8 cm x full scan	
Deflection coefficient, horizontal	M_x	=	24	V/cm
vertical	M_y	=	11.5	V/cm

SCREEN

	Colour	Persistence
D13-27GH	green	medium short

Useful screen diameter min. 114 mm

Useful scan at $V_{g_7(\ell)}/V_{g_5} = 2$

horizontal full scan

vertical min. 80 mm

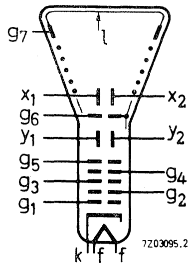
The useful scan may be shifted vertically to a max. of 4 mm with respect to the geometric centre of the faceplate.

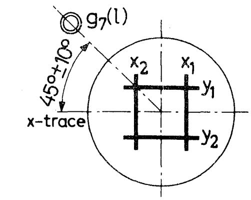
HEATING

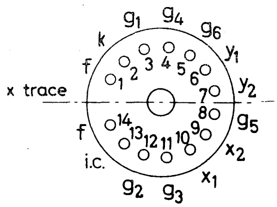
Indirect by A.C. or D.C.; parallel supply

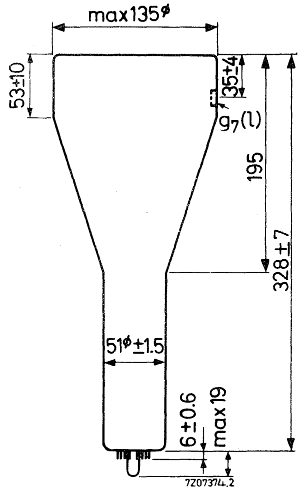
Heater voltage	V_f	=	6.3	V
Heater current	I_f	=	300	mA

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.	135	mm

Net weight	approx.	680	g

Accessories

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

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	$C_{y_2(y_1)}$	=	5.5	pF
x_1 to x_2	$C_{x_1x_2}$	=	2.5	pF
y_1 to y_2	$C_{y_1y_2}$	=	1.2	pF
Grid No.1 to all other elements	C_{g_1}	=	5.5	pF
Cathode to all other elements	C_k	=	5	pF
Grid No.3 to all other elements	C_{g_3}	=	10	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	$V_{g_7(\ell)}$	=	3000	V
Astigmatism control electrode voltage	V_{g_5}	=	1500	V 2)
First accelerator voltage	V_{g_2}	=	1500	V
Beam current	$I_{g_7(\ell)}$	=	10	µA
Line width	l.w.	=	0.25	mm

HELIX

Post deflection accelerator helix resistance min. 50 MΩ

The helix is connected between $g_7(\ell)$ and g_6

---

2) See page 5

TYPICAL OPERATING CONDITIONS

Final accelerator voltage	$V_{g_7(\ell)}$	=	3000	V
Geometry control electrode voltage	V_{g_6}	=	1500 ± 75	V [1])
Astigmatism control electrode voltage	V_{g_5}	=	1500 ± 75	V [2])
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 [3])
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 coefficient				
horizontal	M_x	=	21 to 27	V/cm
vertical	M_y	=	9.8 to 12.2	V/cm
Deviation of linearity of deflection		=	max. 2	% [4])
Geometry distortion			See note 5	
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 coefficient at $V_{g_7(\ell)}/V_{g_5} = 2$				
horizontal	M_x	=	14 to 18	V/cm per kV of V_{g_5}
vertical	M_y	=	6.5 to 8.2	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. 50	kΩ
Focusing electrode current	I_{g_4}	=	-15 to +10	μA [6])

Notes see page 5

LIMITING VALUES (Absolute max. rating system)

Final accelerator voltage	$V_{g_7(\ell)}$	= max.	3300	V
		= min.	1800	V
Geometry control electrode voltage	V_{g_6}	= max.	1700	V
Astigmatism control electrode voltage	V_{g_5}	= max.	1700	V
		= min.	1200	V
Focusing electrode voltage	V_{g_4}	= max.	1200	V
Deflection blanking electrode voltage	V_{g_3}	= max.	1700	V
First accelerator voltage	V_{g_2}	= max.	1700	V
Control grid voltage				
negative	$-V_{g_1}$	= max.	200	V
positive	$-V_{g_1}$	= min.	0	V
Voltage between astigmatism control electrode and any deflection plate	$V_{g_5/x}$	= max.	500	V
	$V_{g_5/y}$	= max.	500	V
Screen dissipation	W_ℓ	= max.	3	mW/cm^2
Ratio $V_{g_7(\ell)}/V_{g_5}$	$V_{g_7(\ell)}/V_{g_5}$	= max.	2	
Cathode current, average	I_k	= max.	300	μA

---

1) This tube is designed for optimum performance when operating at the ratio $V_{g_7(\ell)}/V_{g_5} = 2$. 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) 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) For beam blanking of a beam current of 10 μA.

4) 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.

5) 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.

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

INSTRUMENT CATHODE-RAY TUBE

Oscilloscope tube with flat face, post deflection acceleration by means of a helical electrode and metal-backed screen. The tube has a delay line system for vertical deflection and is designed for observation and measurement of high frequency (2500 MHz) phenomena. The optical rise time is 150 ps.

QUICK REFERENCE DATA			
Final accelerator voltage	$V_{g8(\ell)}$	24	kV
Display area		20 x 63	mm^2
Deflection coefficient, horizontal	M_x	32	V/cm
vertical	M_y	10	V/cm

SCREEN

	colour	persistence
D13-49BE	blue	medium short

Useful screen diameter	min.	114	mm
Useful scan at V_{g8}/V_{g4} = 6,			
horizontal	min.	60	mm
vertical	typical	20	mm
	min.	17	mm

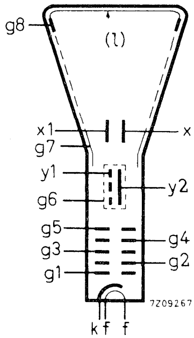
The useful scan may be found shifted vertically to a max. of 10 mm with respect to the geometric centre of the faceplate. The vertical useful scan will be at least 8 mm in either direction from the position of the undeflected spot, with a total of at least 17 mm. A positive voltage on the vertical deflection system will deflect the spot towards pin No. 7.

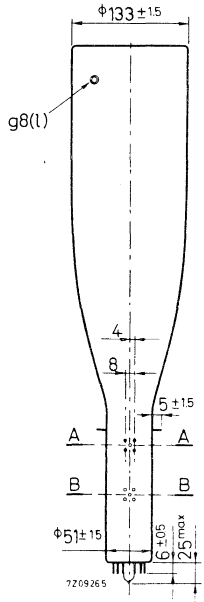
HEATING: Indirected by A.C. or D.C.; parallel supply

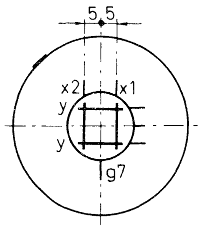
Heater voltage	V_f	6.3	V
Heater current	I_f	300	mA

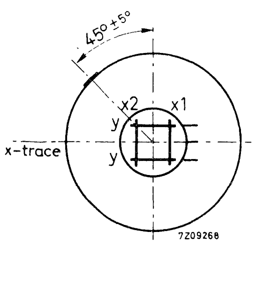
MECHANICAL DATA

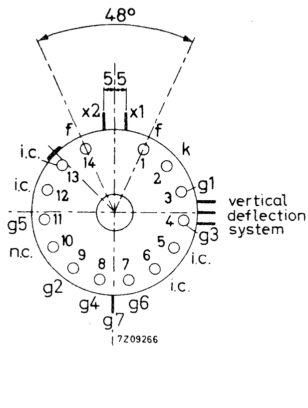
Dimensions in mm





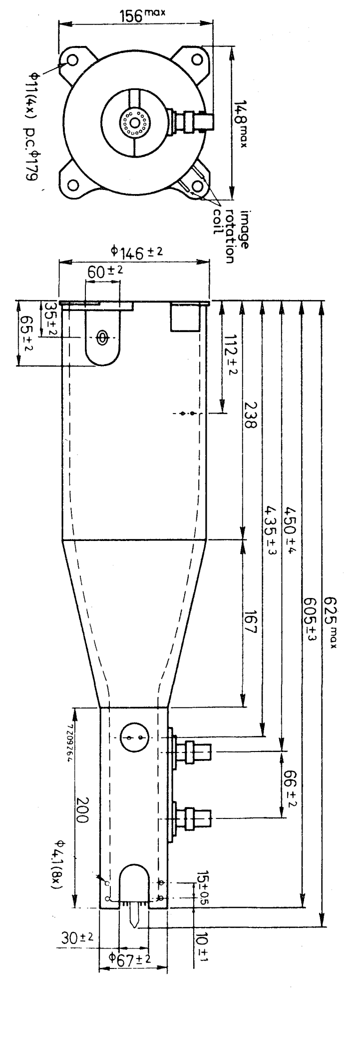






MECHANICAL DATA (continued)

Dimensions in mm



MECHANICAL DATA (continued)

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 (mu-metal shield included)	max.	625	mm
Face diameter	max.	134.5	mm
Net weight	approx.		g

Accessories

Socket (supplied with tube)	55566
Final accelerator contact connector	55563
Side contact connector	55561
Mu-metal shield	supplied with tube
Input and output connectors of the delay line for vertical deflection	UG832. type "C", 100

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

FOCUSING Electrostatic

DEFLECTION

Horizontal	Electrostatic, symmetrical				
Vertical	Delay-line system, asymmetrical				
Characteristic impedance of the delay-line system			100	Ω	
V.S.W.R. up to 1000 MHz		max.	1.25		1)
Bandwidth			2500	MHz	2)
Rise time (optical)			150	ps	3)
Angle between x and y traces			90 ± 1	°	

HELIX

Post deflection accelerator helix resistance	min.	300	MΩ

TYPICAL OPERATING CONDITIONS

Final accelerator voltage	$V_{g_8(\ell)}$	24	kV
Geometry control electrode voltage	V_{g_7}	4000 ± 200	V
Vertical deflection system shield voltage	V_{g_6}	4000	V [4][7]
Beam centring electrode voltage	V_{g_5}	4000 ± 80	V [5]
Astigmatism control electrode voltage	V_{g_4}	4000 ± 200	V [6]
Focusing electrode voltage	V_{g_3}	500 to 1200	V
First accelerator voltage	V_{g_2}	4000	V [7]
Control grid voltage for extinction of focused spot	V_{g_1}	−90 to −300	V
Deflection coefficient, horizontal	M_x	32	V/cm
vertical	M_y	10	V/cm
Useful scan, horizontal		min. 60	mm [8]
vertical		typ. 20	mm
		min. 17	mm

LIMITING VALUES (Absolute max. rating system)

Final accelerator voltage	$V_{g_8(\ell)}$	max.	25	kV
		min.	10	kV
Geometry control electrode voltage	V_{g_7}	max.	4400	V
Vertical deflection system shield voltage	V_{g_6}	max.	4400	V
Beam centrign electrode voltage	V_{g_5}	max.	4400	V
Asigmatism control electrode voltage	V_{g_4}	max.	4400	V
		min.	2400	V
Focusing electrode voltage	V_{g_3}	max.	1500	V
First accelerator voltage	V_{g_2}	max.	4400	V
		min.	2400	V
Control grid voltage, peak	$-V_{g_{1p}}$	max.	350	V
Modulation voltage	V_{g_1}	max.	30	V [9]
Cathode to heater voltage, cathode positive	$+V_{kf}$	max.	200	V
cathode negative	$-V_{kf}$	max.	125	V
Ratio $V_{g_8}(\ell)/V_{g_4}$	$V_{g_8}(\ell)/V_{g_4}$	max.	10	
Ratio V_{g_2}/V_{g_4}	V_{g_2}/V_{g_4}	max.	1	

WARNING

When in operation this tube produces X-rays which may constitute a health hazard unless the tube is adequately shielded.

Notes see page 6

NOTES

1) The V.S.W.R. is approximately 1.5 at 1500 MHz and 2 at 2500 MHz, with a max. of 2.5.

2) 2500 MHz is the frequency at which the vertical sensitivity is 3 dB down with respect to that at D.C.

3) The rise time is defined to be the time interval between 10% and 90% of the final deflection amplitude, when a step function signal is applied to the vertical deflection system. 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 rise time. The rise time of the tube will be taken to be the arithmetic mean of the two values.

4) A "by-pass" is mounted within the mu-metal shield. With this device a vertical beam shift can be obtained.

5) The beam centring electrode voltage should be adjusted for equal deflection defocusing and deflection linearity is the x-direction at either side of the electrical centre of the tube.

6) The astigmatism control electrode voltage should be adjusted for optimum spot shape.

7) The delay-line deflection system has been designed for an accelerator voltage of 4000 V. Deviation from this value will cause deterioration of the bandwidth and rise time. The potential of g_2 should not vary during the deflection of the beam, otherwise variations in the brightness of the display may occur.

8) The image can be rotated by means of a coil. With a current of $\pm$ 50 mA through this coil ($R = 460\ \Omega$) an image rotation of approx. $\pm 4^{\circ}$ can be obtained.

9) For continuous service the grid no. 1 modulation voltage (difference between applied voltage and extinction voltage) should not exceed the stated value.

INSTRUMENT CATHODE-RAY TUBE

Oscilloscope tube with rectangular 13 cm diagonal flat face and metal-backed screen, provided with internal graticule. The high sensitivities of this mesh tube, together with the sectioned y-deflection plates, render the tube suitable for transistorized oscilloscopes for frequencies up to 100-250 MHz.

QUICK REFERENCE DATA			
Final accelerator voltage	$V_{g_9(\ell)}$	15	kV
Display area		100 x 60	mm^2
Deflection coefficient, horizontal	M_x	9.9	V/cm
vertical	M_y	3	V/cm

SCREEN

	colour	persistence
D13-450GH/01	green	medium short

Useful screen dimensions min. 100 x 60 mm^2

Useful scan at $V_{g_9(\ell)}/V_{g_4} = 10$

horizontal	min.	100	mm
vertical	min.	60	mm

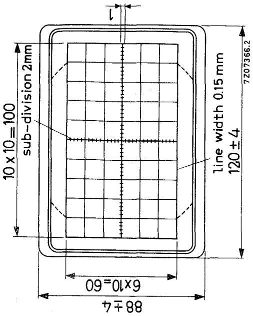
The scanned raster can be centered and aligned with the internal graticule by means of correction coils mounted on the tube (see page 6). For illumination of the internal graticule see page 8.

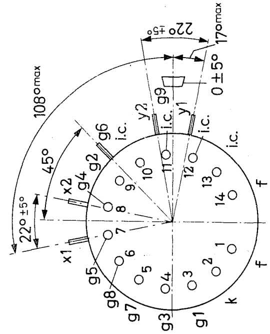
HEATING: Indirect by A.C. or D.C.; parallel supply

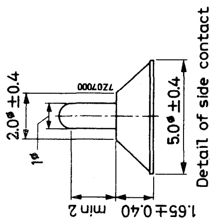
Heater voltage	V_f	6.3	V
Heater current	I_f	300	mA

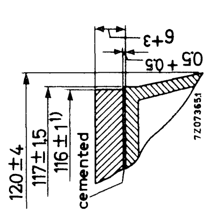
→ MECHANICAL DATA

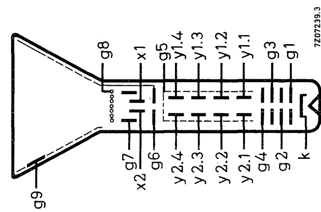
Dimensions in mm

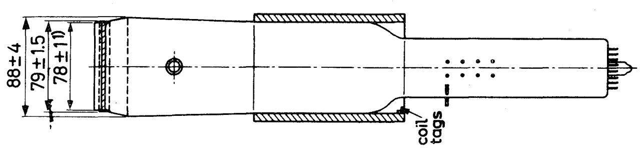


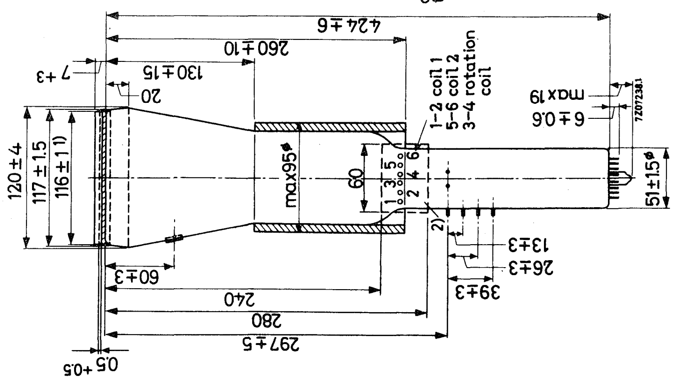












1) These dimensions apply to the illumination plate which will always be within the limits 117 ± 1.5 x 79 ± 1.5 mm of the screen.
2) Tags are situated within this area (on the rearside of this view).

MECHANICAL DATA (continued)

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.

Dimensions and connections

See also outline drawing

Overall length (socket and front glass plate inclusive)	max.	459	mm
Face dimensions	max.	124x92	mm^2
Net weight	approx.	1200	g
Base	14-pin all glass		

Accessories

Socket	type	55566
Final accelerator contact connector	type	55563
Side contact connector	type	55561
Mu-metal screen	type	55568

CAPACITANCES

x_1 to all other elements except x_2	$C_{x_1(x_2)}$	4.8	pF
x_2 to all other elements except x_1	$C_{x_2(x_1)}$	4.8	pF
$y_{1.1}$ to all other elements except $y_{2.1}$	$C_{y_{1.1}(y_{2.1})}$	1.2	pF
x_1 to x_2	$C_{x_1x_2}$	2.5	pF
$y_{1.1}$ to $y_{2.1}$	$C_{y_{1.1}y_{2.1}}$	0.8	pF
Control grid 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

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 (see page 6: "Correction Coils")

LINE WIDTH

Measured with the shrinking raster method in the centre of the screen under typical operating conditions, adjusted for optimum spot size at a beam current I_ℓ = 10 μA.

Line width	l.w.	0.40	mm

TYPICAL OPERATING CONDITIONS

Final accelerator voltage	V_{g_9} (ℓ)		15000	V
Post deflection shield voltage (mesh) w.r.t. V_{g_7}	V_{g_8/g_7}	-12 to	-18	V
Geometry control electrode voltage	V_{g_7}	1500 ±	70	V 1)
Interplate shield voltage	V_{g_6}		1500	V 2)
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}	400 to	550	V
First accelerator voltage	V_{g_2}		1500	V
Control grid voltage for visual extinction of focused spot	V_{g_1}	-40 to	-100	V
Deflection coefficient, horizontal	M_x		9.9	V/cm
		max.	11	V/cm
vertical	M_y		3	V/cm
		max.	3.3	V/cm
Deviation of linearity of deflection		max.	2	% 4)
Geometry distortion		see note 5		
Useful scan, horizontal			100	mm
vertical			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 58.2 mm is aligned with the electrical x axis of the tube.
With optimum correction potentials applied the edges of a raster will fall between these rectangles.

LIMITING VALUES (Absolute max. rating system)

Final accelerator voltage	V_{g_9} (ℓ)	max.	16500	V
		min.	9000	V
Post deflection shield voltage	V_{g_8}	max.	2400	V
Geometry control electrode voltage	V_{g_7}	max.	2400	V
Interplate shield voltage	V_{g_6}	max.	2400	V
		min.	1350	V
Deflection plate shield voltage	V_{g_5}	max.	2400	V
Astigmatism control electrode voltage	V_{g_4}	max.	2400	V
		min.	1350	V
Focusing electrode voltage	V_{g_3}	max.	2400	V
First accelerator voltage	V_{g_2}	max.	1800	V
		min.	1350	V
Control grid voltage,				
negative	$-V_{g_1}$	max.	200	V
positive	V_{g_1}	max.	0	V
Cathode to heater voltage,				
cathode positive	V_{kf}	max.	200	V
cathode negative	$-V_{kf}$	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
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	
Average cathode current	I_k	max.	300	μA

CORRECTION COILS

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

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

Orthogonality and shift

The currents required under typical operating conditions are max. 4 mA per degree of angle correction and max. 2 mA per millimeter of shift; the maximum current required for both purposes taken together does not exceed 30 mA.
These values apply to a tube operating with a mu metal shield closely surrounding the coils.
If no such shield is used they have to be multiplied by a factor K ($1<K<2$) the value of which depends on the dimensions of the shield and approaches 2 for the case no shield is present.
The D.C. resistance of each coil is approx. 220 Ω.

Image rotation

The image rotation coil is concentrically wound. Under typical operating conditions a current of max. 45 mA will be required for complete correction.
The D.C. resistance of this coil is approx. 550 Ω.

Circuit diagrams

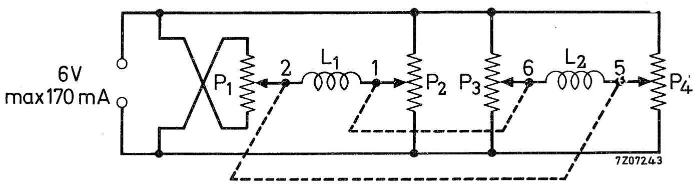


Fig. 1

P_1, P_4 potentiometers 220 Ω, 1 Watt; ganged
P_2, P_3 potentiometers 220 Ω, 1 Watt; ganged

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

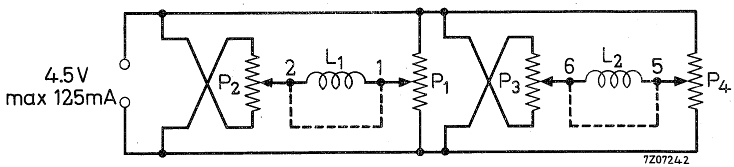


Fig.2

P_1, P_2 potentiometers 220 Ω, 1 watt; ganged

P_3, P_4 potentiometers 220 Ω, 1 watt; ganged

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

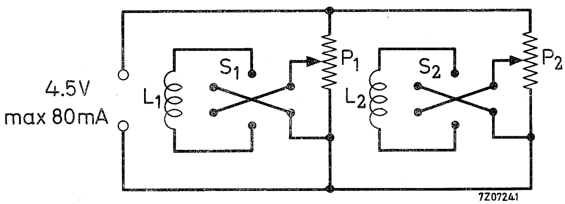


Fig.3

P_1, P_2 potentiometers, 220 Ω, 1 Watt

S_1, S_2 commutators

A suitable circuit for the image rotating coil is given in fig.4.

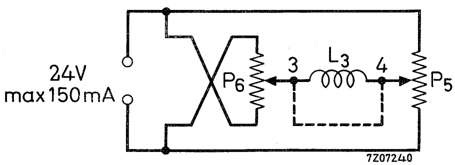


Fig.4

P_5, P_6 potentiometers 500 Ω, 3 Watt; ganged

The following procedure of adjustment is recommended

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

b. With the tube fully scanned in the vertical direction, the image has to be shifted so that the graticule is fully covered. With the circuit according to fig.1 this is done by means of the ganged potentiometers P_1 and P_4.

c. Adjustment of orthogonality by means of the ganged potentiometers P_2 and P_3. A slight readjustment of P_1 and P_4 may be necessary afterwards.

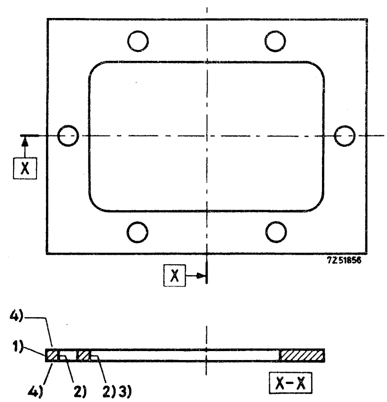
d. Readjustment of the image rotation if necessary.

With a circuit according to fig.2 or 3 these corrections have to be performed by means of successive adjustments of the currents in the coils.

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

ILLUMINATION OF THE GRATICULE

To illuminate the internal graticule a light conductor (e.g. of perspex) should be used. In order to achieve the most efficient light conductance, the holes for the lamps and the edge adjacent to the tube should be polished, and the distance between the perspex plate and the tube should be as small as possible. It is advisable to apply reflective material to the outer circumference and, if possible, also to the upper and lower faces of the light conductor. The thickness of the conductor should not exceed 3 mm, and its position relative to the frontplate of the tube should be adjusted for optimum illumination of the graticule lines.



1) Reflective material.

2) Polished.

3) Close and constant distance to front plate of tube.
It is essential that the light conductor and the front plate of the tube are in plane.

4) If possible reflective material

INSTRUMENT CATHODE-RAY TUBE

13 cm diameter flat faced monoaccelerator oscilloscope tube primarily intended for use in inexpensive oscilloscopes and read-out devices.

QUICK REFERENCE DATA			
Accelerator voltage	$V_{g_2,g_4,g_5(\ell)}$	2000	V
Display area		100 x 80	mm^2
Deflection coefficient, horizontal	M_x	31.3	V/cm
vertical	M_y	14.4	V/cm

SCREEN

	colour	persistence
D13-480GH	green	medium short
D13-480GM	yellowish green	long
D13-480GP	bluish green	medium short

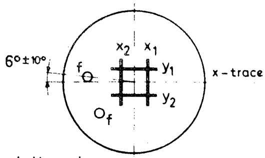
Useful screen diameter	min.	114	mm
Useful scan			
horizontal	min.	100	mm
vertical	min.	80	mm

The useful scan may be shifted vertically to a max. of 6 mm with respect to the geometric centre of the faceplate.

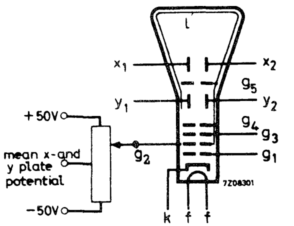
HEATING: Indirect by A.C. or D.C.; parallel supply

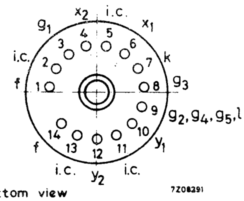
Heater voltage	V_f	6.3	V
Heater current	I_f	300	mA

MECHANICAL DATA (Dimensions in mm)

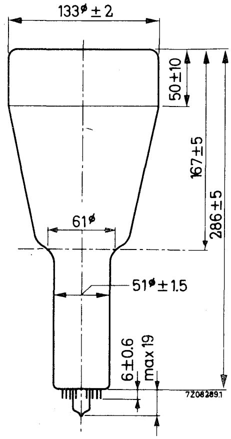


bottom view





bottom view



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.

Dimensions and connections

See also outline drawing

Overall length	max.	310	mm
Face diameter	max.	135	mm

Base 14 pin all glass

Net weight	approx.	650	g

Accessories

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

CAPACITANCES

x_1 to all other elements except x_2	$C_{x1(x2)}$	4	pF
x_2 to all other elements except x_1	$C_{x2(x1)}$	4	pF
y_1 to all other elements except y_2	$C_{y1(y2)}$	3.5	pF
y_2 to all other elements except y_1	$C_{y2(y1)}$	3	pF
x_1 to x_2	C_{x1x2}	1.6	pF
y_1 to y_2	C_{y1y2}	1.1	pF
Control grid to all other elements	C_{g1}	5.5	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.

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

LINE WIDTH 3)

Measured with the shrinking raster method in the centre of the screen under typical operating conditions, adjusted for optimum spot size at a beam current I_ℓ = 10 µA.1)

Line width	l.w.	0.30	mm

1) As the construction of this tube does not permit a direct measurement of the beam current, this current should be determined as follows:
a) under typical operating conditions, apply a small raster display (no overscan), adjust V_{g1} for a beam current of approx. 10 µA and adjust V_{g3} and $V_{g2,g4,g5,\ell}$ for optimum spot quality at the centre of the screen.
b) under these conditions, but no raster, the deflection plate voltages should be changed to
$V_{y1} = V_{y2}$ = 2000 V; V_{x1} = 1300 V; V_{x2} = 1700 V, thus directing the total beam current to x2.
Measure the current on x_2 and adjust V_{g1} for I_{x2} = 10 µA (being the beam current I_ℓ)
c) set again for the conditions under a), without touching the V_{g1} control. Now a raster display with a true 10 µA screen current is achieved.
d) focus optimally in the centre of the screen (do not adjust the astigmatism control) and measure the line width.

3) See page 4

TYPICAL OPERATING CONDITIONS 3)

Accelerator voltage	$V_{g2,g4,g5,\ell}$	2000	V
Astigmatism control voltage	$\Delta V_{g2,g4,g5,\ell}$	± 50	V 1)
Focusing electrode voltage	V_{g3}	220 to 370	V
Control grid voltage for visual extinction of focused spot	V_{g1}	max. -65	V
Grid drive for 10 μA screen current		approx. 10	V
Deflection coefficient, horizontal	M_x	31.3	V/cm
		max. 33	V/cm
vertical	M_y	14.4	V/cm
		max. 15.5	V/cm
Deviation of linearity of deflection		max. 1	% 2)
Geometry distortion		see note 4	
Useful scan, horizontal		max. 100	mm
vertical		min. 80	mm

LIMITING VALUES (Absolute max. rating system)

Accelerator voltage	$V_{g2,g4,g5,\ell}$	max. 2200	V
		min. 1500	V
Focusing electrode voltage	V_{g3}	max. 2200	V
Control grid voltage, negative	$-V_{g1}$	max. 200	V
		min. 0	V
Cathode to heater voltage	V_{kf}	max. 125	V
	$-V_{kf}$	max. 125	V
Grid drive, average		max. 20	V
Screen dissipation	W_ℓ	max. 3	mW/cm^2

1) All that will be necessary when putting the tube into operation is to adjust the astigmatism control voltage once for optimum spot shape in the screen centre. The control voltage will always be in the range stated, provided the mean x and certainly the mean y plate potential was made equal to $V_{g2,g4,g5,\ell}$ with zero astigmatism correction.

2) 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.

3) The mean x and certainly the mean y plate potential should be equal to $V_{g2,g4,g5,\ell}$ with astigmatism adjustment set to zero.

4) A graticule, consisting of concentric rectangles of 70 mm x 85 mm and 68.8 mm x 83 mm as aligned with the electrical x-axis of the tube. The edges of a raster will fall between these ractangles, with optimum correction potentials applied.

INSTRUMENT CATHODE-RAY TUBE

13 cm diameter flat faced monoaccelerator oscilloscope tube with low heater consumption.

QUICK REFERENCE DATA			
Accelerator voltage	$V_{g2,g4,g5(\ell)}$	2000	V
Display area		100 x 80	mm^2
Deflection coefficient, horizontal	M_x	31.3	V/cm
vertical	M_y	14.4	V/cm

The D13-481.. is equivalent to the type D13-480.. except for the following:

HEATING: Indirect by A.C. or D.C.; parallel

Heater voltage	V_f	6.3	V
Heater current	I_f	95	mA

LIMITING VALUES (Absolute max. rating system)

Cathode to heater voltage

Cathode positive	$V_{+k/f-}$	max.	100	V
Cathode negative	$V_{-k/f+}$	max.	15	V

INSTRUMENT CATHODE-RAY TUBE

The D13-500../01 is a wide-band oscilloscope tube designed for observation and measurement of high frequency phenomena.
This tube has a rectangular 13 cm diagonal flat face with aluminized screen and internal graticule, post-deflection accelerator with mesh, vertical deflection by means of a symmetrical helix system, scan magnification in the vertical direction by means of an electrostatic quadrupole lens and correction coils for trace alignment, vertical shift of the display area and correction of the orthogonality of traces.

QUICK REFERENCE DATA			
Final accelerator voltage	$V_{g13(\ell)}$	15	kV
Display area		100x60	mm^2
Deflection coefficient, horizontal	M_x	15	V/cm
vertical	M_y	2	V/cm
Bandwidth of the vertical deflection system	B	800	MHz

SCREEN

	colour	persistence
D13-500GH/01	green	medium short

Useful screen dimensions	min.	100 x 60	mm^2
Useful scan at $V_{g13(\ell)}/V_{g2} = 6$			
horizontal	min.	100	mm
vertical	min.	60	mm

By means of adjusting the current in the correction coils, full coverage of the internal graticule by the scanned area can be obtained for any tube.

Data based on pre-production tubes.

DESCRIPTION

General

The D13-500../01 has been primarily designed for wide-band high-frequency applications. It combines high brightness, high deflection sensitivity and a large bandwidth of the vertical deflection system.

In order to obtain the high sensitivity, the post-deflection acceleration system embodies a mesh. The sensitivity in the vertical direction has been further increased by means of an electrostatic quadrupole lens that has been inserted between the vertical deflection system and the horizontal deflection plates. The large bandwidth has been obtained by using, for the vertical deflection, a delay-line system instead of deflection plates. With the typical operating conditions, 2500 V first accelerator voltage and 15000 V final accelerator voltage, the vertical and the horizontal deflection factors are about 2 V/cm and 15 V/cm respectively, with a $10 \times 6\ cm^2$ display area.

The bulb has a rectangular face and the screen is aluminized. To eliminate parallax errors, an internal graticule is incorporated. Correction coils have been provided to permit image rotation, correction of the orthogonality of traces and the adjustment of the vertical useful scan with respect to the graticule.

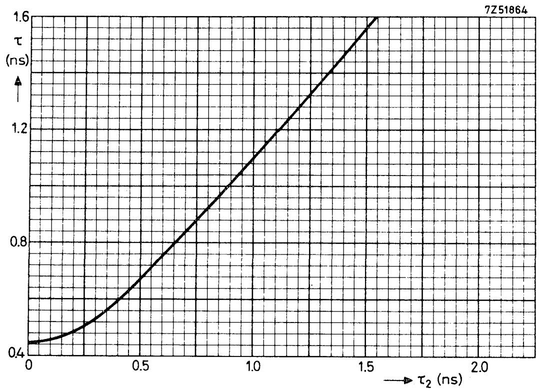


Fig.1
Rise time of the display τ as a function of the rise time of the input signal τ_2

The vertical deflection system

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

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

The rise time τ_1, i.e. the time interval during which the display of an ideal step-function signal applied to the input goes from 10% to 90% of its final value, is about 0.45 ns. If the input signal has the rise-time τ_2, the rise-time τ of the display is approximately given by

$$\tau = \sqrt{\tau_1^{\,2} + \tau_2^{\,2}}$$

In Fig.1, τ has been plotted as a function of τ_2, with $\tau_1 = 0.45$ ns. If, for example, the tube is used in combination with an amplifier and the rise-time of the display is to be 1.4 ns (corresponding with 250 MHz band-width), the rise-time of the amplifier should be 1.33 ns. It can be seen that in this region the rise-time of the display is almost equal to the amplifier rise-time, without a significant contribution of the cathode-ray tube.

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

Fig.2 shows how the tube can be connected to a 50 Ω coaxial input. A matched power divider is used which delivers two identical output signals. One of these is inverted by means of a pulse inverter. An additional length of 50 Ω cable should be inserted into the path of the non-inverted signal having the same delay time as the pulse inverter so that the two signals arrive at the input of the deflection system at the same time. The 75 Ω shunt resistors serve to obtain a correct termination of the 50 Ω lines. Since each branch of the power divider has 6 dB attenuation, the sensitivity, measured at the 50 Ω input, is also 2 V/cm.

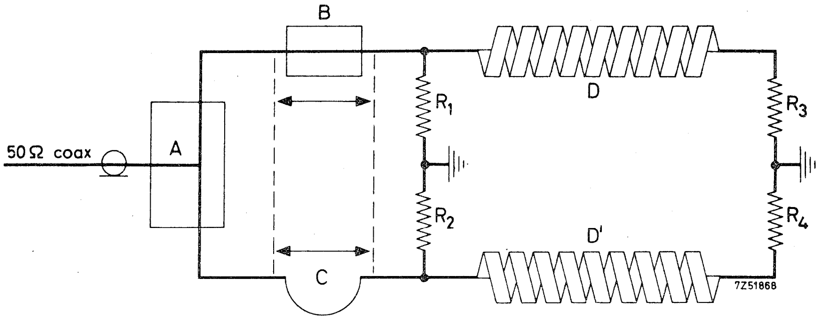


Fig.2
Connection to an asymmetrical 50 Ω input

A: Power divider — R_1, R_2: Resistors 75 Ω
B: Inverter — R_3, R_4: Resistors 150 Ω
C: Cable — D, D': Deflection system

Note: Delay of inverter B and cable C are equal.

Scan magnifier and focusing system

As already mentioned, an electrostatic quadrupole lens, i.e. an electron lens which has two mutually perpendicular planes of symmetry, divergent in one plane and convergent in the other, is used for the magnification of the vertical deflection. This lens is inserted between the vertical deflection system and the horizontal deflection plates, with its plane of divergence in the direction of the vertical deflection. Therefore, it magnifies the vertical deflection without affecting the horizontal deflection.

Because of the astigmatic properties of this quadrupole lens, a conventional, rotationally symmetrical focusing lens cannot be used. Instead of this, two more electrostatic quadrupole lenses are incorporated so that focusing is accomplished by means of three quadrupole lenses, with alternating orientation of their planes of convergence and divergence. The focusing action is schematically shown in Fig.3. The strength of the scan-magnifier lens is controlled by applying to the electrode g_9 a negative voltage with respect to g_2. Within a certain range of this voltage, corresponding to a scan-magnification factor Msc, i.e. the ratio of the deviations on the screen with and without scan magnification respectively, between 1.8 and 2 the combined effect of the three lenses will yield an approximately circular spot at moderate beam currents. (At high beam currents, when space-charge repulsion causes an increase of spot size, the width of the vertical lines will be smaller than that of the horizontal lines).

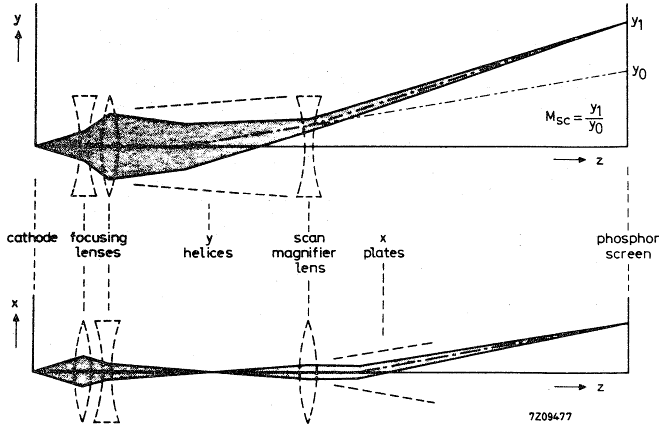


Fig.3

In this range, line-width at a fixed value of screen current, and screen current at a fixed value of grid No.1 voltage, are increasing functions of the scan-magnification factor. Figs.4 and 5 show the average relative change with respect to the values at Msc = 1.9 which, generally, is the most suitable compromise.

For minimum defocusing of vertical lines near the upper and lower edge of the display area, the electrode g_8 should be kept at a positive voltage with respect to g_2 (about 200 V with 2500 V first accelerator voltage). As this voltage also has some effect on the scan-magnification factor, both g_8 and g_9 should be connected to g_2 when the deviation without scan magnification is being measured.

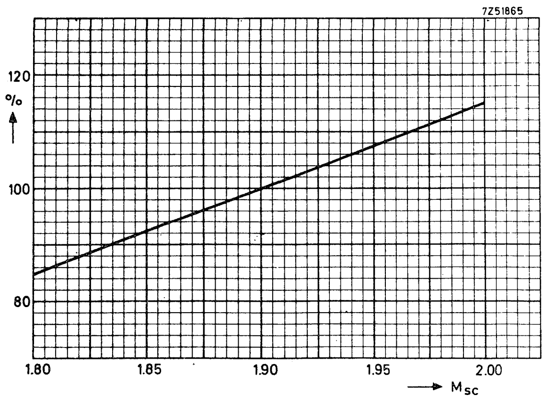


Fig.4

Line-width as a function of the scan-magnification factor (approximately)
Line-width at M_{sc} = 1.9 is 100%, I_{screen} = const.

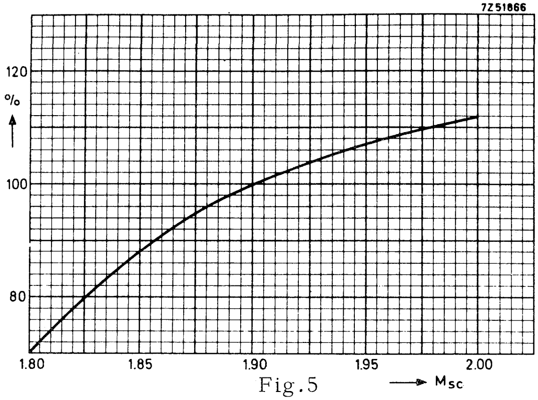


Fig.5

Screen current as a function of the scan-magnification factor (approximately)
Screen current at M_{sc} = 1.9 is 100%, V_{g_1} = const.

For the adjustment of the scan-magnification factor the following procedure is recommended:

a. Set V_{g_8} and V_{g_9} to 0 with respect to g_2.
b. Display a time-base line and adjust V_{g_6} so that the line appears sharply focused.
c. Apply a square wave signal to the vertical deflection system (the vertical parts of the trace will be out of focus but this is immaterial) and adjust the amplitude so that the height of the display has a convenient value, e.g. 30 mm.
d. Set V_{g_8} and V_{g_9} to the appropriate values and readjust V_{g_6} so that the horizontal parts of the trace are again in focus.
e. Check the height of the display (e.g. for M_{sc} = 1.9 this height should now be 57 mm).
f. If necessary, readjust V_{g_9} until the desired value of M_{sc} has been obtained.

Focusing is controlled by means of the electrode voltage V_{g_4} and V_{g_6}. The electrodes g_5 and g_7 can be used to centre the beam with respect to the vertical and horizontal deflection systems.

The voltages of the focusing and correction electrodes can be adjusted as follows:

a. Display a square-wave signal on the screen so that both horizontal and vertical traces are visible.
b. Adjust V_{g_6} so that the horizontal parts of the display are in focus.
   The vertical parts will, in general, be out of focus.
c. Adjust V_{g_4} so that the vertical traces are brought into focus.
   Now the horizontal parts of the display will be out of focus again.
d. Repeat b) and c) successively until both vertical and horizontal traces are simultaneously in focus.
e. Adjust V_{g_3} for minimum width of a horizontal line.
   If necessary, readjust focusing voltages V_{g_4} and V_{g_6}.

f. Adjust V_{g7} for equal brightness at the left-hand and right-hand edges of the display area. If necessary, readjust the focus by means of V_{g6}.

g. Adjust V_{g5} so that the position of a horizontal trace not deflected in the vertical direction is at the centre of the vertical useful scan. If necessary, readjust the focus by means of V_{g4}.

If the graticule is not fully covered by the scanned area the image should be shifted by adjusting the correction coil current (see page 16) before the adjustment of V_{g5} is made.

The procedure for the adjustment of the scan-magnification factor and for focusing, as described above, seams to be rather complicated.
However, in practice it will be sufficient to adjust V_{g9} to its nominal value without determining the scan-magnification factor for each individual tube. As to focusing, the user can, with some experience, achieve the best setting with very few adjustments.

Post-deflection acceleration

The use of a p.d.a. shield (mesh) ensures a high deflection sensitivity. A geometry control electrode, g_{11}, serves for the correction of pin cushion or barrel distortion of the pattern. In order to suppress background illumination due to secondary electrons originating from the p.d.a. shield g_{12}, this shield should be kept 12 V negative with respect to g_{11} whereas the voltage of the interplate shield, g_{10} should be equal to the mean x-plate potential.

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	$C_{x1(x2)}$	4.5	pF
x_2 to all other elements except x_1	$C_{x2(x1)}$	4.5	pF
x_1 to x_2	C_{x1x2}	2.7	pF
Control grid to all other elements	C_{g1}	6	pF
Cathode to all other elements	C_k	5	pF

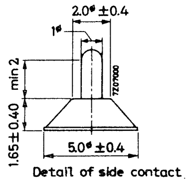
1) Clear area for light conductor.

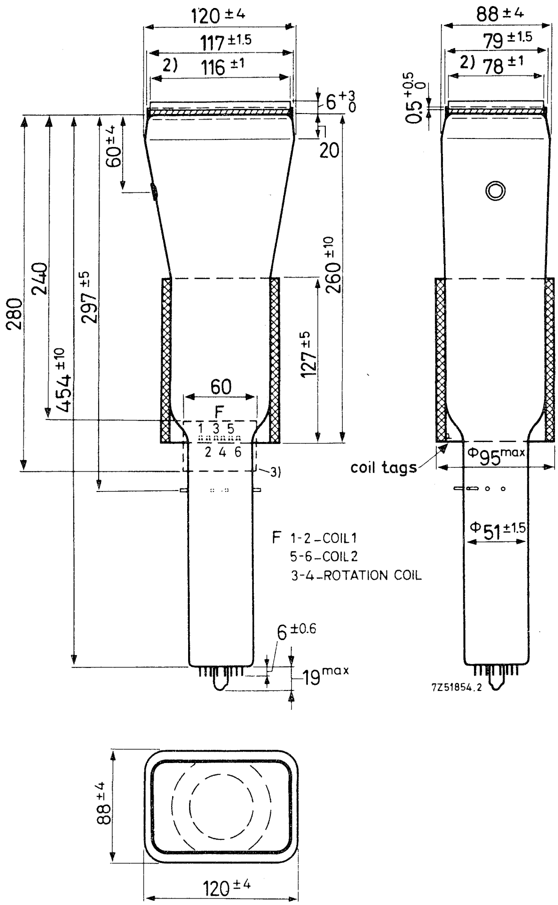
2) These dimensions apply to the illumination plate which will always be within the limits 117 ± 1.5 x 79 ± 1.5 mm of the tube face.

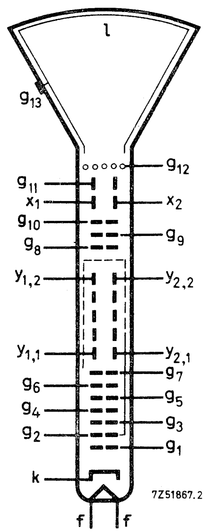
3) The soldering tags will be situated within a rectangle of 60 mm x 40 mm on the rearside of the tube.

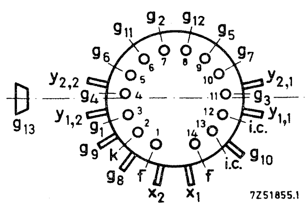
MECHANICAL DATA

Dimensions in mm



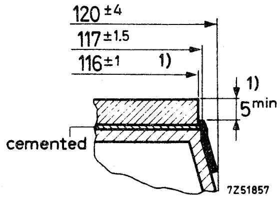


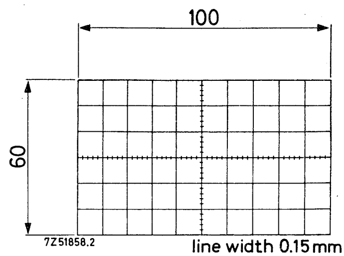




Notes: see page 7

MECHANICAL DATA (continued)





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.

Dimensions and connections

See also outline drawing

Overall length (socket and front glass plate inclusive)	max.	493	mm
Face dimensions	max.	124 x 92	mm^2

Net weight	approx.	1300	g

Base — 14-pin all glass

Accessories

Socket	type 55566
Final accelerator contact connector	type 55563
Side contact connector	type 55561
Mu-metal screen	type 55582

In order to avoid damage to the side contacts the narrower end of the mu-metal screen should have an internal diameter of not less than 65 mm.

[1]) see page 7

FOCUSING electrostatic [1]

DEFLECTION double electrostatic

x plates symmetrical

The y deflection system consists of a symmetrical delay line system.

Characteristic impedance	2 x 150	Ω
Bandwidth (−3 dB)	800	MHz [2]
Rise time	0.45	ns

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° [4] (see page 14 "Correction coils")

1) Because of the applications of a quadrupole lens for the magnification of the vertical deflection, two more quadrupole lenses are used for focusing. Therefore, controls for two voltages have to be provided.

2) The band-width is defined as the frequency at which the vertical deflection sensitivity is 3 dB lower than at D.C.

3) The rise-time is defined as the time interval between 10% and 90% of the final value of deflection when an ideal step-function signal is applied to the vertical deflection system. If the actual signal has an appreciable rise-time, τ_2 the rise-time of the tube can be determined from

$$\tau_1 = \sqrt{\tau^2 - \tau_2^2}$$

where τ is the rise-time observed on the display.
This should be measured after the angle between the x-traces and y-traces has been corrected by means of the correction coils, otherwise two measurements have to be taken (using either a different polarity of the vertical deflection signal or different direction of the time-base sweep) and the true value of τ has to be calculated as the arithmetic mean of the two results.

4) Deviations from the orthogonality of traces can be eliminated by means of correction coils

LINE WIDTH

Measured with the shrinking raster method in the centre of the screen under typical operating conditions, adjusted for optimum spot size at a beam current I_ℓ = 10 μA and a screen magnification factor M_{sc} = 1.9. See also 3) page 13.

Line width	l.w.	approx. 0.35	mm

TYPICAL OPERATING CONDITIONS

Final accelerator voltage	$V_{g13(\ell)}$	15 000	V
Post deflection shield voltage (with respect to g_{11})	$V_{g12-g11}$	−9 to −15	V
Geometry control electrode voltage	V_{g11}	2500 ± 100	V 1)
Interplate shield voltage	V_{g10}	2500	V 2)
Scan magnifier electrode voltage (with respect to g_2)	V_{g9-g2}	−250 to −375	V 3)
Correction electrode voltage (with respect to g_2)	V_{g8-g2}	+200	V 4)
Horizontal beam centering electrode voltage	V_{g7}	2500 ± 50	V 5)
Vertical beam centering electrode voltage	V_{g5}	2500 ± 50	V 6)
Focusing electrode voltages (with respect to g_2)	V_{g6-g2}	−400 to −600	V 7)
	V_{g4-g2}	−600 to −800	V 7)
Spot correction electrode voltage	V_{g3}	2500 ± 50	V 8)
First accelerator voltage	V_{g2}	2500	V
Control grid voltage for visual extinction of a focused spot	V_{g1}	−50 to −150	V
Deflection coefficient, horizontal	M_x	approx. 15	V/cm
vertical	M_y	approx. 2	V/cm 9)
Deviation of linearity of deflection		2	% 10)
Geometry distortion		see note 11	
Useful scan, horizontal		100	mm
vertical		60	mm

Notes see page 13

LIMITING VALUES (absolute max. rating system)

Final accelerator voltage	$V_{g13(\ell)}$	max.	20 000	V
		min.	9 000	V
Post-deflection shield voltage	V_{g12}	max.	3 100	V
Geometry control electrode voltage	V_{g11}	max.	3 100	V
Interplate shield voltage	V_{g10}	max.	3 100	V
Scan-magnifier electrode voltage	V_{g9}	max.	3 000	V
Correction electrode voltage	V_{g8}	max.	3 200	V
Focusing electrode voltages	V_{g6}	max.	3 000	V
	$-V_{g6-g2}$	max.	1 000	V
	V_{g4}	max.	3 000	V
	$-V_{g4-g2}$	max.	1 000	V
Beam centering electrode voltages	V_{g7}	max.	3 100	V
	V_{g5}	max.	3 100	V
Spot correction electrode voltage	V_{g3}	max.	3 100	V
First accelerator voltage	V_{g2}	max.	3 000	V
		min.	2 000	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.	125	V
cathode negative	$V_{-k\,f}$	max.	125	V
Voltage between first accelerator and any deflection electrode	$V_{g2\,x}$	max.	500	V
	$V_{g2\,y}$	max.	500	V
Screen dissipation	W_{ℓ}	max.	3	mW/cm^2
Ratio $V_{g13(\ell)}/V_{g2}$	$V_{g13(\ell)}/V_{g2}$	max.	10	
Average accelerator voltage	I_k	max.	300	μA

Notes to page 11

1) This voltage should be adjusted for optimum pattern geometry.

2) This voltage should be equal to the mean x-plate potential.

3) The range indicated corresponds to a scan magnification factor M_{sc}, i.e. the ratio by which the vertical deviation on the screen is increased, in the approximate range $1.8 < M_{sc} < 2.0$, and the tube should not be operated outside this range. Within this range, line-width and screen current at a fixed value of the control-grid voltage are increasing functions of M_{sc}. The best compromise between brightness and line width is usually found at $M_{sc} \approx 1.9$ which corresponds to $V_{g9-g2} \approx 310$ V.

4) For minimum defocusing of vertical lines near the upper and lower edges of the scanned area this voltage should be approximately adjusted to the value indicated. Since the value of V_{g8-g2} has some effect on the scan-magnification factor both V_{g8} and V_{g9} should be connected to g_2 when the deviation without scan magnification is to be measured.

5) This voltage should be adjusted for equal brightness in the x-direction with respect to the electrical centre of the tube.

6) By adjusting this voltage a spot not deflected in the vertical direction may be centered with respect to the vertical useful scan.

7) These voltages should be stabilized to within 1 V.

8) This voltage should be adjusted for minimum width of a horizontal line.

9) For a scan-magnification factor $M_{sc} = 1.9$. In the above mentioned range of V_{g9-g2} the vertical deflection factor will vary approximately $\pm$ 5%.

10) 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.

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

CORRECTIONS COILS

The tube is provided with a coil unit consisting of:

1. A pair of coils (No.1 and 2), with approx. 220 Ω D.C. resistance per coil, for
   a) correction of the orthogonality of the x- and y-traces so that the angle between these traces at the centre of the screen can be made exactly 90°.
   b) vertical shift of the scanned area.
2. A single coil (No.3) with approx. 550 Ω D.C. resistance, for image rotation (alignment of the x-trace with the x-lines of the graticule).

Orthogonality and shift

The change in the angle between the traces and the shift of the scanned area will be proportional to the algebraic sum and the algebraic difference of the currents in the coils No.1 and 2.
Under typical operating conditions and with the coil unit closely surrounded by a mu-metal shield, the currents required are max. 5 mA per degree of angle correction and max. 2 mA per millimeter shift. The supply circuit for these coils should be so designed that in each coil a maximum current of 20 mA, with either polarity, can be produced.

If a wider mu-metal shield is used the above-mentioned values have to be multiplied by a factor K ($1 < K < 2$) the value of which depends on the dimensions of the shield and approaches 2 for the case no shield is present.

Image rotation

Under typical operating conditions, a current of max. 45 mA will be required for the alignment.

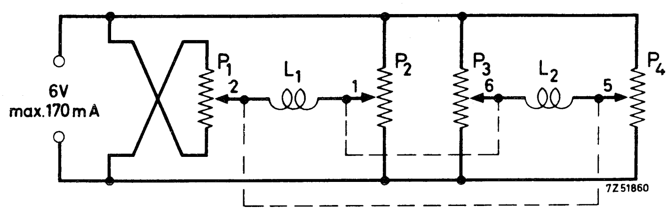


Fig.1

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

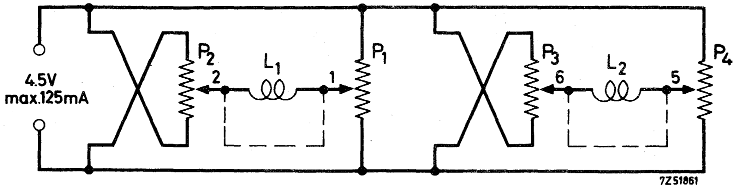


Fig.2

P_1, P_2 potentiometers 220 Ω, 1 watt: ganged
P_3, P_4 potentiometers 220 Ω, 1 watt: ganged

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

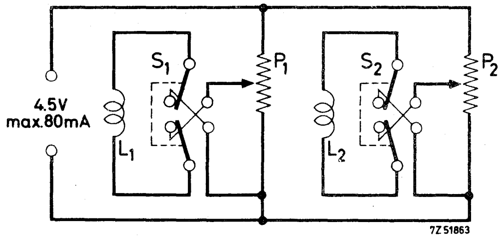


Fig.3

P_1, P_2 potentiometers 220 Ω, 1 watt
S_1, S_2 commutators

A suitable circuit for the image rotating coil is given in fig.4.

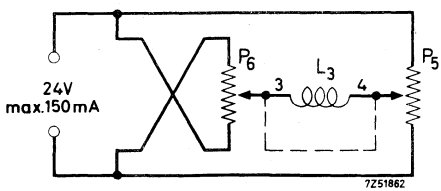


Fig.4

P_5, P_6 potentiometers 500 Ω, 3 watt: ganged

The following procedure of adjustment is recommended

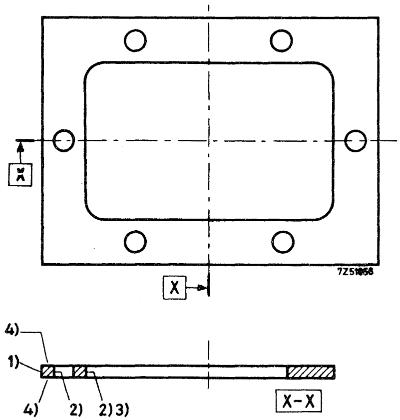
a. Align the x-trace with the graticule by means of the image rotating coil.
b. With the tube fully scanned in the vertical direction, the image has to be shifted so that the graticule is fully covered. With the circuit according to fig.1 this is done by means of the ganged potentiometers P_1 and P_4.
c. Adjustment of orthogonality by means of the ganged potentiometers P_2 and P_3. A slight readjustment of P_1 and P_4 may be necessary afterwards.
d. Readjustment of the image rotation if necessary.

With a circuit according to fig.2 or 3 these corrections have to be performed by means of successive adjustments of the currents in the coils.

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

ILLUMINATION OF THE GRATICULE

To illuminate the internal graticule a light conductor (e.g. of perspex) should be used. In order to achieve the most efficient light conductance, the holes for the lamps and the edge adjacent to the tube should be polished, and the distance between the perspex plate and the tube should be as small as possible. It is advisable to apply reflective material to the outer circumference and, if possible, also to the upper and lower faces of the light conductor. The thickness of the conductor should not exceed 3 mm, and its position relative to the frontplate of the tube should be adjusted for optimum illumination of the graticule lines.



1) Reflective material.
2) Polished.
3) Close and constant distance to front plate of tube.
It is essential that the light conductor and the front plate of the tube are in plane.
4) If possible reflective material.

INSTRUMENT CATHODE-RAY TUBE

14 cm diagonal, rectangular flat faced oscilloscope tube with mesh and metal backed screen.

QUICK REFERENCE DATA			
Final accelerator voltage	$V_{g7(\ell)}$	10	kV
Display area		100 x 80	mm^2
Deflection coefficient, horizontal	M_x	15.5	V/cm
vertical	M_y	4.2	V/cm

SCREEN: Metal backed phosphor

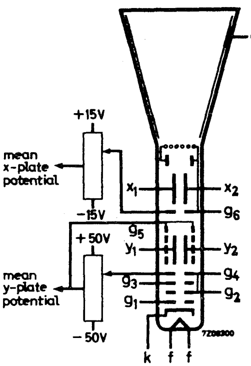
	colour	persistence
D14-120GH	green	medium short
D14-120GM	purplish blue	long
D14-120GP	bluish green	medium short

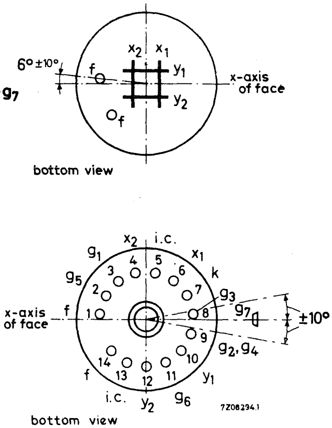
Useful screen dimensions	min.	100 x 80	mm^2
Useful scan at $V_{g7(\ell)}/V_{g2,g4}$ = 6.7			
horizontal	min.	100	mm
vertical	min.	80	mm
Spot eccentricity in horizontal and vertical directions		.6	mm

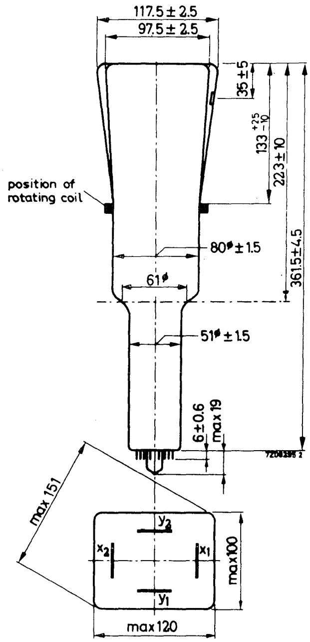
HEATING: Indirect by A.C. or D.C.;parallel supply

Heater voltage	V_f	6.3	V
Heater current	I_f	300	mA

MECHANICAL DATA Dimensions in mm







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.

Dimensions and connections

See also outline drawing

Overall length (socket included)	max.	385	mm
Face dimensions	max.	100 x 120	mm^2
Net weight	approx.	900	g

Base 14 pin all glass

Accessories

Socket (supplied with tube)	type 55566
Final accelerator contact connector	type 55563
Mu-metal shield	type 55581

CAPACITANCES

x_1 to all other elements except x_2	$C_{x_1(x_2)}$	6.5	pF
x_2 to all other elements except x_1	$C_{x_2(x_1)}$	6.5	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	$C_{x_1x_2}$	2.2	pF
y_1 to y_2	$C_{y_1y_2}$	1.7	pF
Control grid to all other elements	C_{g_1}	5.5	pF
Cathode to all other elements	C_k	4.5	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 $90 \pm 1^{\circ}$

Angle between x trace and the horizontal axis of the face max. 5° [1]

LINE WIDTH

Measured with the shrinking raster method under typical operating conditions, adjusted for optimum spot size at a beam current I_ℓ = 10 μA.

Line width at screen centre	l.w.		0.40	mm
over the whole screen area	l.w.	av. <	0.45	mm

[1]) See page 5

TYPICAL OPERATING CONDITIONS

Final accelerator voltage	$V_{g7(\ell)}$	10000	V
Interplate shield voltage	V_{g6}	1500	V
Geometry control voltage	ΔV_{g6}	± 15	V 2)
Deflection plate shield voltage	V_{g5}	1500	V 3)
Focusing electrode voltage	V_{g3}	250 to 350	V
First accelerator voltage	$V_{g2,g4}$	1500	V
Astigmatism control voltage	$\Delta V_{g2,g4}$	± 50	V 4)
Control grid voltage for visual extinction of focused spot	V_{g1}	-20 to -60	V
Grid drive for 10 μA screen current		approx. 12	V
Deflection coefficient, horizontal	M_x	av. 15.5	V/cm
		max. 16	V/cm
vertical	M_y	av. 4.2	V/cm
		max. 4.6	V/cm
Deviation of linearity of deflection		max. 2	% 5)
Geometry distortion		See note 6	
Useful scan, horizontal		min. 100	mm
vertical		min. 80	mm

LIMITING VALUES (Absolute max. rating system)

Final accelerator voltage	$V_{g7(\ell)}$	max. 11000	V
		min. 9000	V
Interplate shield voltage and geometry control electrode voltage	V_{g6}	max. 2200	V
Deflection plate shield voltage	V_{g5}	max. 2200	V
Focusing electrode voltage	V_{g3}	max. 2200	V
First accelerator and astigmatism control electrode voltage	$V_{g2,g4}$	max. 2200	V
		min. 1350	V
Control grid voltage	$-V_{g1}$	max. 200	V
		min. 0	V
Cathode to heater voltage	V_{kf}	max. 125	V
	$-V_{kf}$	max. 125	V
Voltage between astigmatism control electrode and any deflection plate	$V_{g4/x}$	max. 500	V
	$V_{g4/y}$	max. 500	V
Grid drive, average		max. 20	V
Screen dissipation	W_ℓ	max. 3	mW/cm^2
Ratio $V_{g7(\ell)}/V_{g2,g4}$	$V_{g7(\ell)}/V_{g2,g4}$	max. 6.7	

For notes see page 5

Notes

[1]) In order to align the x-trace with the horizontal axis of the screen, the whole picture can be rotated by means of a rotation coil. This coil will have 50 amp. turns for the indicated max. rotation of 5^{o} and should be positioned as indicated in the drawing.

[2]) This tube is designed for optimum performance when operating at a ratio $V_{g7}/V_{g2,g4}$ not higher than 6.7
The geometry electrode voltage should be adjusted within the indicated range (values with respect to the mean x-plate potential).
A negative control voltage will cause some pincushion distortion and less background light, a positive control voltage will give some barrel distortion and a slight increase of background light.

[3]) The deflection plate shield voltage should be equal to the mean y-plate potential. The mean x- and y-plate potentials should be equal for optimum spot quality.

[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]) 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.

[6]) A graticule, consisting of concentric rectangles of 95 mm x 75 mm and 93 mm x 73.6 mm is aligned with the electrical x-axis of the tube. With optimum correction potentials applied a raster will fall between these rectangles.

INSTRUMENT CATHODE-RAY TUBE

14 cm diagonal, rectangular flat-faced oscilloscope tube with mesh and metal backed screen. The tube has side connections to the x- and y-plates, and is intended for use in transistorized oscilloscopes up to a frequency of 50 MHz.

QUICK REFERENCE DATA			
Final accelerator voltage	$V_{g8(\ell)}$	10	kV
Display area		100 x 80	mm^2
Deflection coefficient, horizontal	M_x	15.5	V/cm
vertical	M_y	4.2	V/cm

SCREEN : Metal backed phosphor

	Colour	Persistence
D14-121GH	green	medium short
D14-120GM	pusplish blue	long
D14-120GP	bluish green	medium short

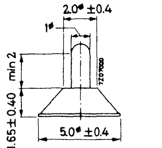
Useful screen dimensions	min.	100 x 80	mm^2
Useful scan at $V_{g8(\ell)}/V_{g2,g4} = 6.7$,			
horizontal	min.	100	mm
vertical	min.	80	mm
Spot eccentricity in horizontal and vertical directions		6	mm

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

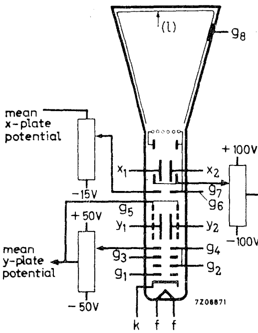
Heater voltage	V_f	6.3	V
Heater current	I_f	300	mA

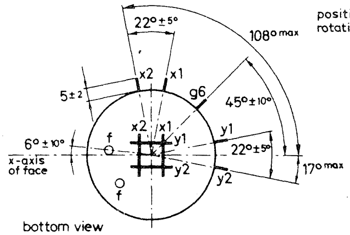
MECHANICAL DATA

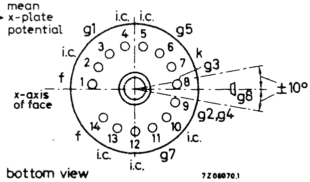
Dimensions in mm

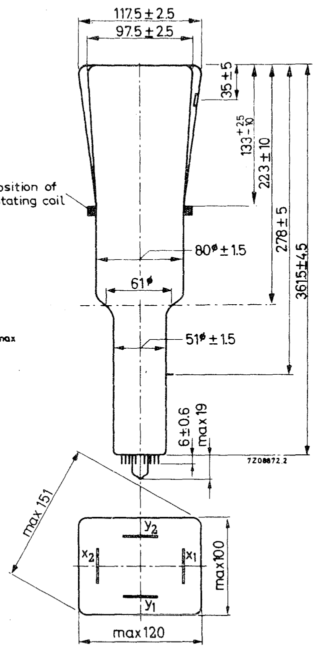


Detail of side contact









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.

Dimensions and connections

See also outline drawing			
Overall length (socket included)	max.	385	mm
Face dimensions	max.	100 x 120	mm^2

Net weight	approx.	900	g
Base	14 pin, all glass		

Accessories

Socket (supplied with tube)	type 55566
Final-accelerator contact connector	type 55563
Mu-metal shield	type 55581A

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	pF
y_2 to all other elements except y_1	$C_{y_2(y_1)}$	4	pF
x_1 to x_2	$C_{x_1x_2}$	2.2	pF
y_1 to y_2	$C_{y_1y_2}$	1.7	pF
Control grid to all other elements	C_{g_1}	5.5	pF
Cathode to all other elements	C_k	4.5	pF

FOCUSING Electrostatic

DEFLECTION Double electrostatic

x-plates symmetrical

y-plates symmetrical

If use is made ot 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}

Angle between x trace and the horizontal axis of the face max. 5^{o} [1])

LINE WIDTH

Mearured with the shrinking raster method under typical operating conditions, adjusted for optimum spot size at a beam current $I_{\ell} = 10\ \mu A$.

Line width screen centre	l.w.	0.40	mm
over the whole screen area	l.w.	av. < 0.45	mm

[1]) See page 5

TYPICAL OPERATING CONDITIONS

Final accelerator voltage	$V_{g8(\ell)}$		10	kV
Geometry-control electrode voltage	V_{g7}		1500 ± 100	V 2)
Post deflection and interplate shield voltage	V_{g6}		1500	V
Background illumination control voltage	ΔV_{g6}		0 to -15	V 2)
Deflection plate shield voltage	V_{g5}		1500	V 3)
Focusing electrode voltage	V_{g3}		250 to 350	V
First accelerator voltage	$V_{g2,g4}$		1500	V
Astigmatism control voltage	$\Delta V_{g2,g4}$		±50	V 4)
Control grid voltage for extinction of focused spot	V_{g1}		-20 to -60	V
Grid drive for 10 μA screen current		approx.	12	V
Deflection coefficient, horizontal	M_x	av.	15.5	V/cm
		max.	16	V/cm
vertical	M_y	av.	4.2	V/cm
		max.	4.6	V/cm
Deviation of linearity of deflection		max.	2	% 5)
Geometry distortion		See note 6		
Useful scan, horizontal		min.	100	mm
vertical		min.	80	mm

LIMITING VALUES (Absolute max. rating system)

Final accelerator voltage	$V_{g8(\ell)}$	max.	11	kV
		min.	9	kV
Post deflection and interplate shield voltage and geometry control electrode voltage	V_{g7}, V_{g6}	max.	2200	V
Deflection plate shield voltage	V_{g5}	max.	2200	V
Focusing electrode voltage	V_{g3}	max.	2200	V
First accelerator and astigmatism control electrode voltage	$V_{g2,g4}$	max.	2200	V
		min.	1350	V
Control grid voltage	$-V_{g1}$	max.	200	V
		min.	0	V
Cathode to heater voltage	V_{kf}	max.	125	V
	$-V_{kf}$	max.	125	V
Voltage between astigmatism control electrode and any deflection plate	$V_{g4/x}$	max.	500	V
	$V_{g4/y}$	max.	500	V
Grid drive, average		max.	20	V
Screen dissipation	W_ℓ	max.	3	mW/cm^2
Ratio $V_{g8(\ell)}/V_{g2,g4}$	$V_{g8(\ell)}/V_{g2,g4}$	max.	6.7	

For notes see page 5

Notes

1) In order to align the x-trace with the horizontal axis of the screen, the whole picture can be rotated by means of a rotation coil. This coil will have 50 amp. turns for the indicated max. rotation of 5^{o} and should be positioned as indicated on the drawing.

2) This tube is designed for optimum performance when operating at a ratio $V_{g8(\ell)}/V_{g2,g4} \leq 6.7$.
The geometry control voltage V_{g7} should be adjusted within the indicated range (values with respect to the mean x-plate potential).
A negative control voltage on g_6 (with respect to the mean x-plate potential) will cause some pincushion distortion and less background light.
By the use of the two voltages, V_{g6} and V_{g7}, it is possible to find the best compromise between background light and raster distortion.

3) The deflection plate shield voltage should be equal to the mean y-plate potential. The mean x- and y-plate potentials should be equal for optimum spot quality.

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.

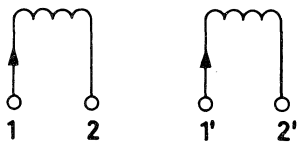
5) The sensitivity at a deflection of less than 75% of the useful scan will not differ from the sensitivity at a deflection of 25% of the useful scan by more than the indicated value.

6) A graticule, consisting of concentric rectangles of 95 mm x 75 mm and 93 mm x 73.6 mm is aligned with the electrical x axis of the tube. With optimum correction potentials applied a raster will fall between these rectangles.

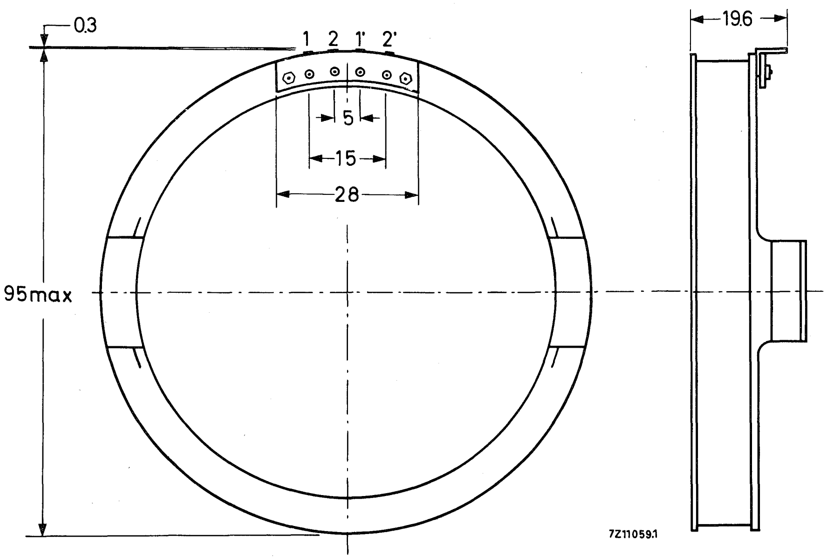
INSTRUMENT CATHODE-RAY TUBE

This type is equivalent with type D14-120 but provided with a rotation coil as indicated in note 1 of D14-120..

COIL



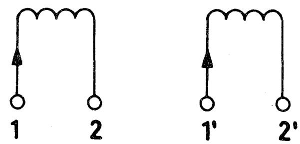
Number of turns	1 -2	850 turns
	1'-2'	850 turns
Resistance of coils	1 -2	360 Ω (±10 %)
	1'-2'	375 Ω (±10 %)



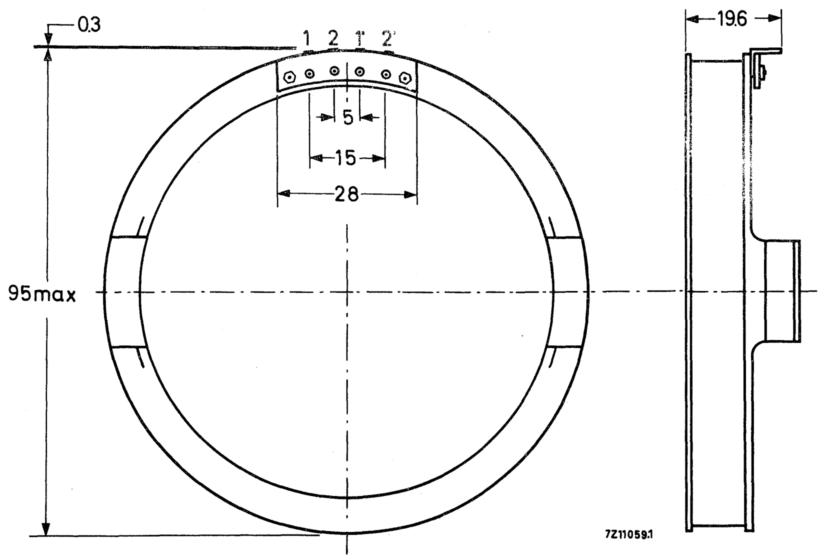
INSTRUMENT CATHODE-RAY TUBE

This type is equivalent with type D14-121 but provided with a rotation coil as indicated in note 1 of D14-121

COIL



Number of turns	1 -2	850 turns
	1'-2'	850 turns
Resistance of coils	1 -2	360 Ω (±10 %)
	1'-2'	375 Ω (±10 %)



INSTRUMENT CATHODE-RAY TUBE

14 cm diagonal, rectangular flat-faced oscilloscope tube with mesh and metal backed screen. The tube has side connections to the x- and y-plates, internal graticule and a light-conducting glassplate set in front of the face.

QUICK REFERENCE DATA			
Final accelerator voltage	$V_{g8(\ell)}$	10	kV
Display area		100 x 80	mm^2
Deflection factor, horizontal	M_x	15.2	V/cm
vertical	M_y	4.1	V/cm

SCREEN : Metal backed phosphor

	Colour	Persistence
D14-160GH/09	green	medium short
D14-160GM/09	yellowish-green	long

Useful screen dimensions	min.	100 x 80	mm^2
Useful scan at $V_{g8(\ell)}/V_{g2,g4} = 6.7$,			
horizontal	min.	100	mm
vertical	min.	80	mm

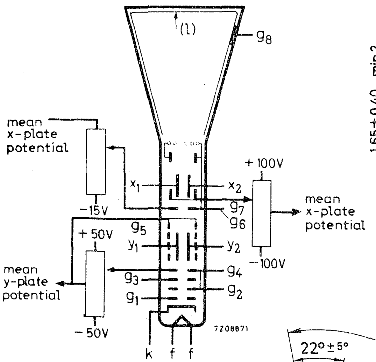
The scanned raster can be centred and aligned with the internal graticule by means of correction coils fitted around the tube by the manufacturer (see page 5).

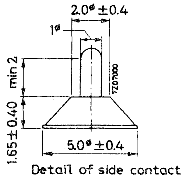
HEATING : Indirect by A.C. or D.C.; parallel supply

Heater voltage	V_f	6.3	V
Heater current	I_f	300	mA

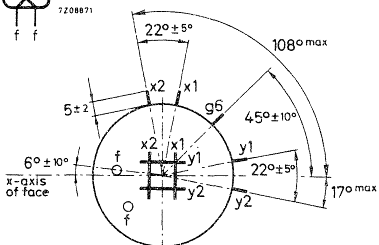
MECHANICAL DATA

Dimensions in mm

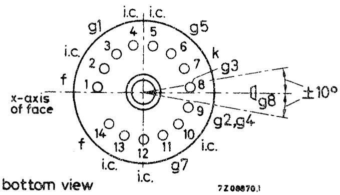




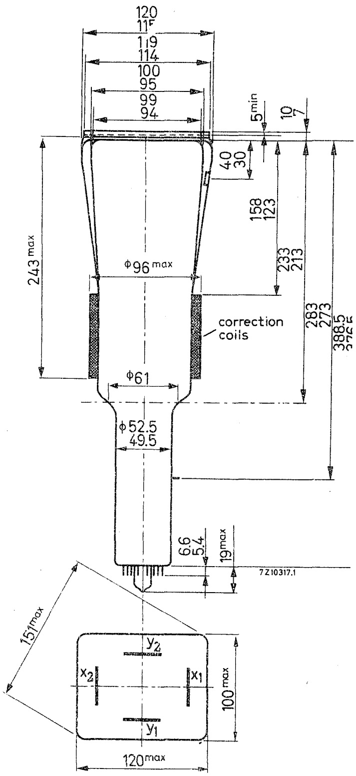
Detail of side contact



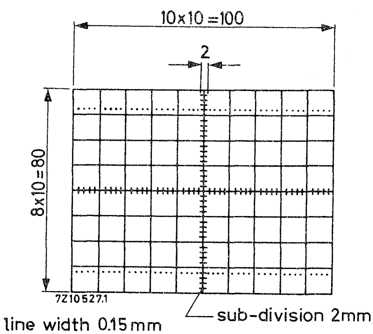
bottom view



bottom view



top view



line width 0.15 mm
dot diameter 0.3 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.

MECHANICAL DATA (continued) Dimensions in mm

Dimensions and connections

See also outline drawing	
Overall length (socket included)	max. 417.5 mm
Face dimensions	max. 100 x 120 mm^2
Net weight	approx. 1300 g
Base	14 pin, all glass

Accessories

Socket (supplied with tube)	type 55566
Final-accelerator contact connector	type 55563
Mu-metal shield	type 55585 1)

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

Angle between x trace and the horizontal axis of the face 0^o.
See page 5 "Correction coils".

LINE WIDTH

Measured with the shrinking raster method in the centre of the screen under typical operating conditions, adjusted for optimum spot size at a beam current I_ℓ = 10 μA.

Line width at the centre of the screen l.w. 0.3 mm

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	$C_{y_1(y_2)}$	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	$C_{y_1y_2}$	1.6	pF
Control grid to all other elements	C_{g_1}	5.5	pF
Cathode to all other elements	C_k	4	pF

1) See page 5

TYPICAL OPERATING CONDITIONS

Final accelerator voltage	$V_{g8(\ell)}$	10	kV
Geometry-control electrode voltage	V_{g7}	1500 ± 100	V 2)
Post deflection and interplate shield voltage	V_{g6}	1500	V
Background illumination control voltage	ΔV_{g6}	0 to −15	V 2)
Deflection plate shield voltage	V_{g5}	1500	V 3)
Focusing electrode voltage	V_{g3}	450 to 550	V
First accelerator voltage	$V_{g2, g4}$	1500	V
Astigmatism control voltage	$\Delta V_{g2, g4}$	±50	V 4)
Control grid voltage extinction of focused spot	V_{g1}	−25 to −60	V
Grid drive for 10 μA screen current		approx. 20	V
Deflection factor, horizontal	M_x	15.2	V/cm
		max. 16	V/cm
vertical	M_y	4.1	V/cm
		max. 4.4	V/cm
Deviation of linearity deflection		max. 2	% 5)
Geometry distortion		See note 6	
Useful scan, horizontal		min. 100	mm
vertical		min. 80	mm

LIMITING VALUES

Final accelerator voltage	$V_{g8(\ell)}$	max.	13	kV
		min.	9	kV
Post deflection and interplate shield voltage and geometry control electrode voltage	V_{g7}, V_{g6}	max.	2200	V
Deflection shield voltage	V_{g5}		2200	V
Focusing electrode voltage	V_{g3}		2200	V
First accelerator and astigmatism control electrode voltage	$V_{g2, g4}$	max.	2200	V
		min.	1350	V
Control grid voltage	$-V_{g1}$	max.	200	V
		min.	0	V
Cathode to heater voltage	V_{kf}	max.	125	V
	$-V_{kf}$	max.	125	V
Voltage between astigmatism control electrode and any deflection plate	$V_{g4/x}$	max.	500	V
	$V_{g4/y}$	max.	500	V
Grid drive, average		max.	30	V
Screen dissipation	W_ℓ	max.	3	mW/cm^2
Ratio $V_{g8(\ell)}/V_{g2, g4}$	$V_{g8(\ell)}/V_{g2, g4}$	max.	6.7	

For notes see page 5

Notes

1) To avoid damage to the side contacts the narrower end of the Mu-metal shield should have an internal diameter of not less than 65 mm.

2) This tube is designed for optimum performance when operating at a ratio $V_{g8(\ell)}/V_{g2,g4} \leq 6.7$.
The geometry control voltage V_{g7} should be adjusted within the indicated range (values with respect to the mean x-plate potential).
A negative control voltage on g_6 (with respect to the mean x-plate potential) will cause some pincushion distortion and less background light.
By the use of the two voltages, V_{g6} and V_{g7}, it is possible to find the best compromise between background light and raster distortion.
If a fixed voltage on g_6 is required this voltage should be 10 V lower than the mean x-plate potential.

3) The deflection plate shield voltage should be equal to the mean y-plate potential. The mean x- and y-plate potentials should be equal for optimum spot quality.

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) 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.

6) A graticule, consisting of concentric rectangles of 95 mm x 75 mm and 93 mm x 73.6 mm is aligned with the electrical x axis of the tube. With optimum correction potentials applied a raster will fall between these rectangles.

CORRECTION COILS

General

The D14-160../09 is provided with a coil unit consisting of: (see Fig. 1)

1. a pair of coils L_3 and L_4 which enable
   a. the angle between the x and y traces at the centre of the screen to be made exactly 90° (orthogonality correction);
   b. the scanned area to be shifted up and down (vertical shift)
2. a pair of coils L_1 and L_2 for image rotation which enable the alignment of the x trace with the x lines of the graticule.

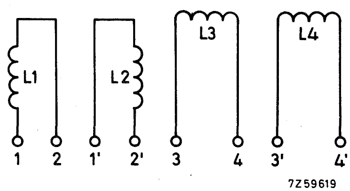


Fig. 1

Orthogonality and shift (coils L_3 and L_4)
The current required under typical operating conditions without the mu-metal shield being used is max. 45 mA for complete correction of orthogonality and shift. It will be 30% to 50% lower with shield, depending on the shield diameter. The resistance of each coil is approx. 225 Ω.

Image rotation (coils L_1 and L_2)
The image rotation coils are wound concentrically around the tube neck. Under typical operating conditions 50 A turns are required for the maximum rotation of 5°. Both coils have 850 turns. This means that a current of max. 30 mA per coil is required which can be obtained by using a 24 V supply when the coils are connected in series or a 12 V supply when they are in parallel.

Connecting the coils
The coils have been connected to the 8 soldering tags according to Fig. 2.

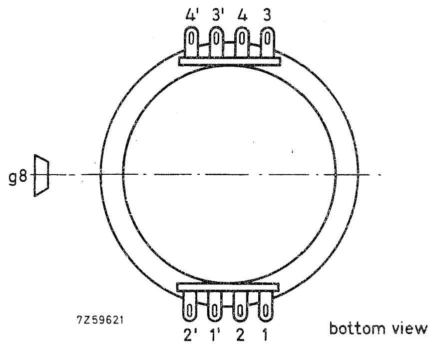


Fig. 2

With L_3 and L_4 connected in series according to Fig. 3 a current in the direction indicated will produce a clockwise rotation of the vertical trace and an anti-clockwise rotation of the horizontal trace. With the connection according to Fig. 4 the current as indicated will produce an upward shift.

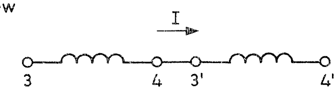


Fig. 3

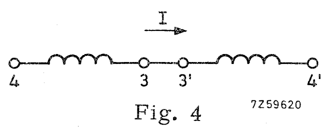


Fig. 4

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 coefficient, horizontal	M_x	=	56.5	V/cm
vertical	M_y	=	49	V/cm

SCREEN

	Colour	Persistence
DH3-91	green	medium short

Useful screen diameter min. 28 mm

Useful scan

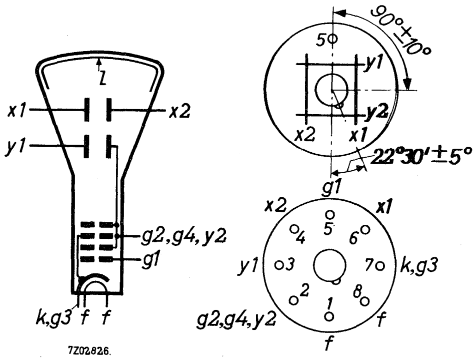
- horizontal: full scan
- vertical: full scan

HEATING:

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

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

MECHANICAL DATA Dimensions in mm



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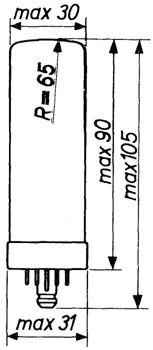


7Z02825

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	2422 501 05001	
Mu-metal shield	type	55525	

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	$C_{x_1x_2}$	=	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 coefficient				
horizontal	M_x	=	41 to 72	V/cm
vertical	M_y	=	35 to 63	V/cm
Useful scan				
horizontal			full scan	
vertical			full scan	

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 coefficient				
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).

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 coefficient, horizontal	M_x	= 62.5 V/cm
vertical	M_y	= 40 V/cm

SCREEN

	colour	persistence
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

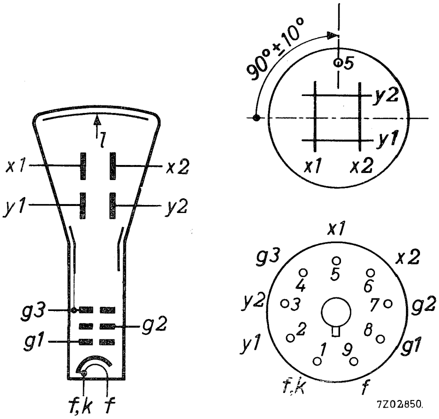
HEATING

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

Heater voltage V_f = 6.3 V

Heater current I_f = 300 mA

MECHANICAL DATA Dimensions in mm



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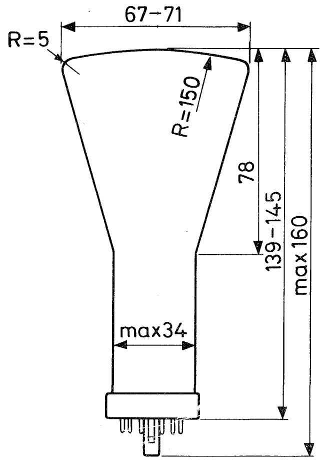


7Z02849.

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	2422 502 04001
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	$-V_{g_1}$	=	max. 50	V
Deflection coefficient, 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	

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 coefficient			
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.

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 coefficient, horizontal	M_x	=	62.5	V/cm
vertical	M_y	=	40	V/cm

SCREEN

	colour	persistence
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

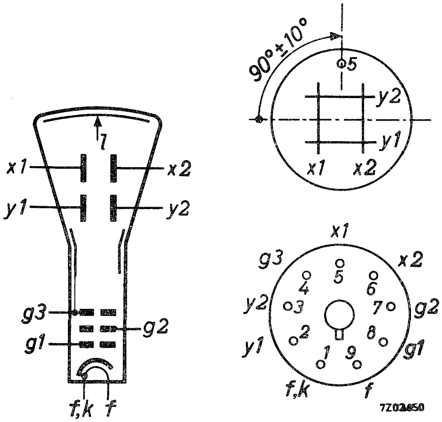
HEATING

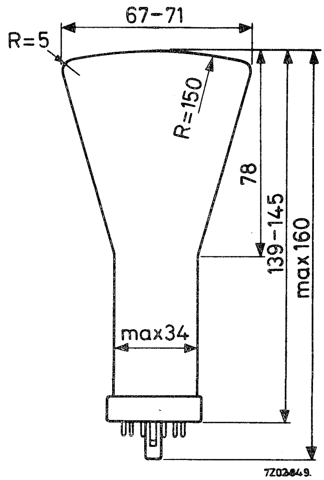
Indirect by A.C. or D.C.; parallel supply

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

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	2422 502 04001
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 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	$-V_{g_1}$	=	max. 50	V
Deflection coefficient, 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	

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 coefficient			
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.

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 coefficient, horizontal	M_x	=	10.7	V/cm
vertical	M_y	=	3.65	V/cm

SCREEN

	Colour	Persistence
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 $V_{g6(\ell)}/V_{g4} = 4$

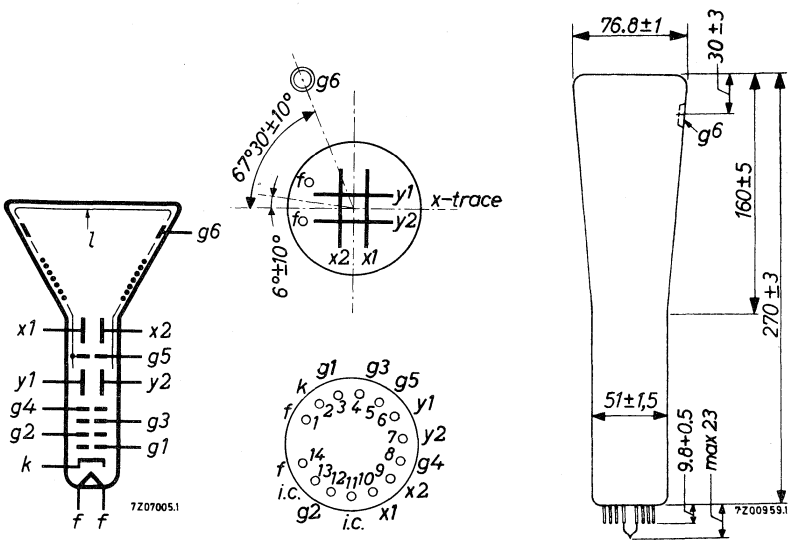
horizontal	min.	60	mm
vertical	min.	45	mm

HEATING

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

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

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 tube)	type	40467
Final accelerator contact connector	type	55563
Mu-metal shield	type	55532

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 [2])
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

2) See page 6

TYPICAL OPERATING CONDITIONS

Final accelerator voltage	$V_{g6(\ell)}$	=	1200	V
Geometry control electrode voltage	V_{g5}	=	300 ± 30	V [1]
Astigmatism control electrode voltage	V_{g4}	=	$300 \pm {}^{40}_{15}$	V [2]
Focusing electrode voltage	V_{g3}	=	20 to 150	V
First accelerator voltage	V_{g2}	=	1200	V
Control grid voltage for visual extinction of focused spot	$-V_{g1}$	=	30 to 80	V
Deflection coefficient				
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

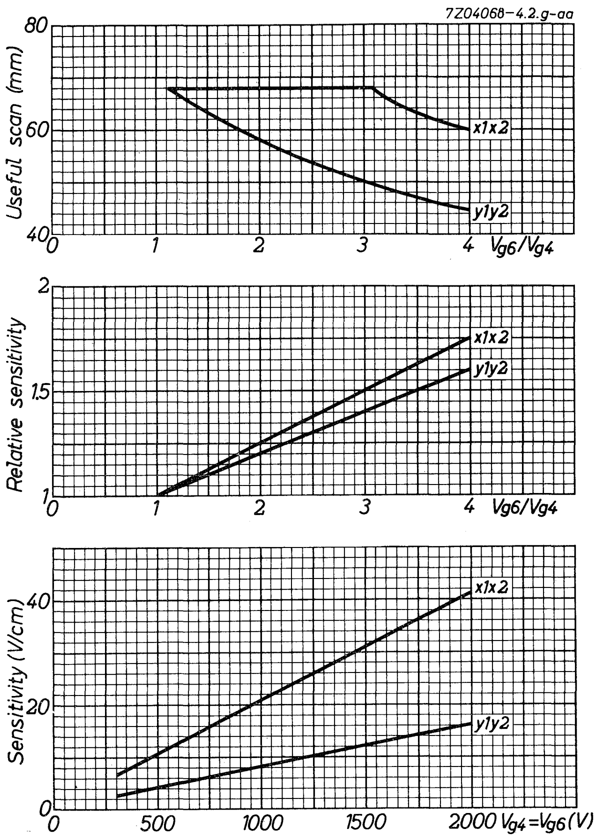
CIRCUIT DESIGN VALUES

Focusing voltage	V_{g3}	=	35 to 165	V per kV of V_{g4}
Control grid voltage for visual extinction of focused spot	$-V_{g1}$	=	30 to 60	V per kV of V_{g2}
Deflection coefficient at $V_{g6(\ell)}/V_{g4} = 4$				
horizontal	M_x	=	31.3 to 40.0	V/cm per kV of V_{g4}
vertical	M_y	=	10.7 to 13.7	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. 50	kΩ
Focusing electrode current	I_{g3}	=	−15 to +10	μA [5]

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

LIMITING VALUES (Absolute max. rating system)

Final accelerator voltage	$V_{g6(\ell)}$	=	max.	5000	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	



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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 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.

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 coefficient, 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

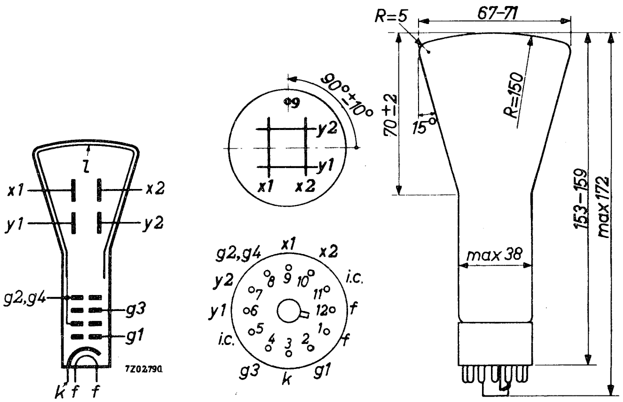
Indirect by A.C. or D.C.; parallel supply

Heater voltage V_f = 6.3 V

Heater current I_f = 300 mA

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	2422 516 00001
Mu-metal shield	type	55530

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

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 coefficient, 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	

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 coefficient 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)

INSTRUMENT CATHODE-RAY TUBE

Low accelerator voltage cathode-ray tube for monitoring purposes.

QUICK REFERENCE DATA		
Final accelerator voltage	$V_{g_4g_2(\ell)}$ =	500 V
Display area	Both directions full scan	
Deflection coefficient, horizontal	M_x =	37 V/cm
vertical	M_y =	21 V/cm

SCREEN

	Colour	Persistence
DG7-32	yellowish green	medium short

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

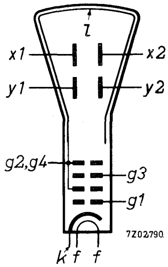
HEATING

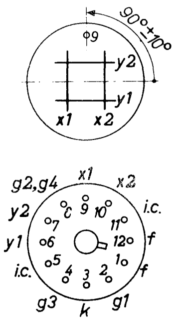
Indirect by A.C. or D.C.; parallel supply

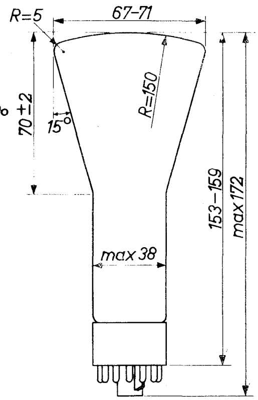
Heater voltage	V_f	=	6.3 V
Heater current	I_f	=	300 mA

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	2422 516 00001
Mu-metal shield	type	55530

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 coefficient, 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	

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
		= 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 coefficient at $V_{g4g2(\ell)}/V_g$				
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)

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	$V_{g_4g_2(\ell)}$	=	1500	V
Display area		=	5.7 x 6.8	cm
Deflection coefficient, horizontal	M_x	=	27.3	V/cm
vertical	M_y	=	18.8	V/cm

SCREEN

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

Useful scan

horizontal	min.	68	mm
vertical	min.	57	mm

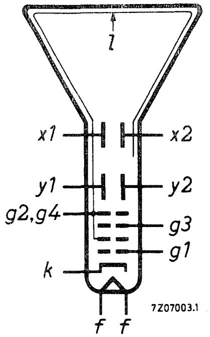
HEATING

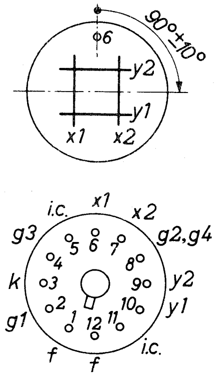
Indirect by A.C. or D.C.; parallel supply

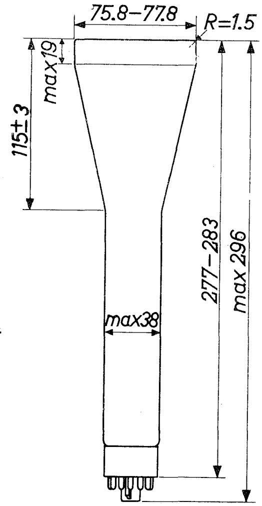
Heater voltage	V_f	=	6.3	V
Heater current	I_f	=	300	mA

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	2422 516 00001
Mu-metal shield	type	55531

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 $90^{o} \pm 1^{o}$

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

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 coefficient			
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	V
		= min. 1000	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]) 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.

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 coefficient				
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.

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 coefficient, horizontal	M_x	=	10.7	V/cm
vertical	M_y	=	3.65	V/cm

SCREEN

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

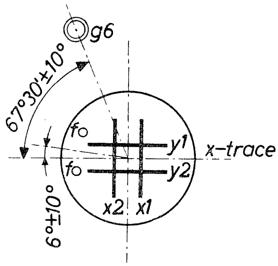
Useful screen diameter	min.	68	mm
Useful scan at $V_{g6(\ell)}/V_{g4} = 4$			
horizontal	min.	60	mm
vertical	min.	45	mm

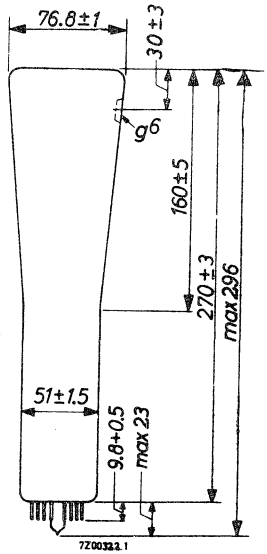
HEATING

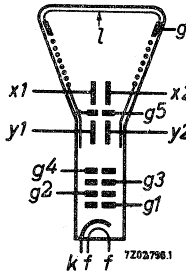
Indirect by A.C. or D.C.; parallel supply

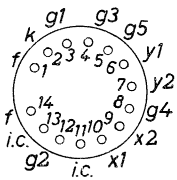
Heater voltage	V_f	=	6.3	V
Heater current	I_f	=	300	mA

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	

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_{g4}	=	300	V [2)]
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

2) See page 5

TYPICAL OPERATING CONDITIONS

Final accelerator voltage	$V_{g6(\ell)}$	=	1200	4000	V
Geometry control electrode voltage	V_{g5}	=	300 ± 30	1000 ± 100	V [1]
Astigmatism control electrode voltage	V_{g4}	=	300 ± 40	1000 ± 50	V [2]
Focusing electrode voltage	V_{g3}	=	20 to 150	35 to 165	V
First accelerator voltage	V_{g2}	=	1200	1000	V
Control grid voltage for visual extinction of focused spot	$-V_{g1}$	=	36 to 72	30 to 60	V
Modulation voltage for $I(\ell) = 10\ \mu A$	V_{g1}	=	max. 25	max. 25	V
Deflection coefficient					
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_{g4}
Control grid voltage for visual extinction of focused spot	$-V_{g1}$	=	30 to 60	V per kV of V_{g2}
Deflection coefficient at $V_{g6(\ell)}/V_{g4} = 4$				
horizontal	M_x	=	31.3 to 40.0	V/cm per kV of V_{g4}
vertical	M_y	=	10.7 to 13.7	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. 50	kΩ
Focusing electrode current	I_{g3}	=	−15 to +10	μA [5]

LIMITING VALUES (Absolute max. rating system)

Final accelerator voltage	$V_{g6(\ell)}$	= max. 5000	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. 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	

---

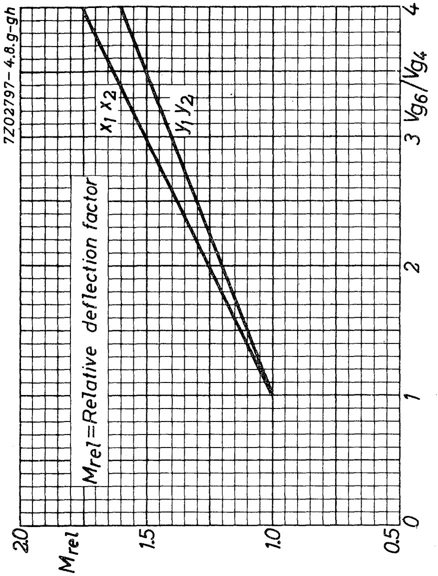
1) This tube is designed for optimum performance when operating at the ratio $V_{g6(\ell)}/V_{g4} = 4$. Operating at other ratio may result in changes in deflection uniformity and geometry distortion. The geometry control electrode voltage should be adjusted for optimum performance. For any necessary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

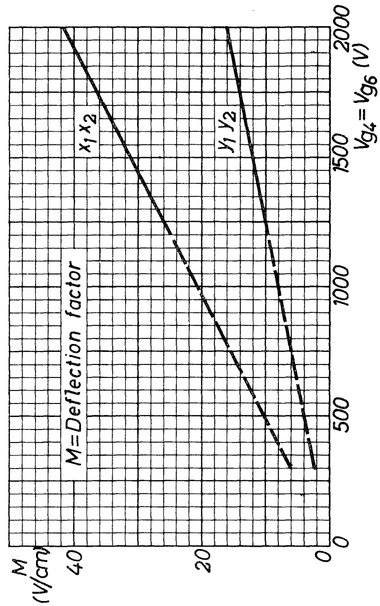
2) The astigmatism control electrode voltage should be adjusted for optimum spot shape. For any necessary adjustment its potential will be within the stated range.

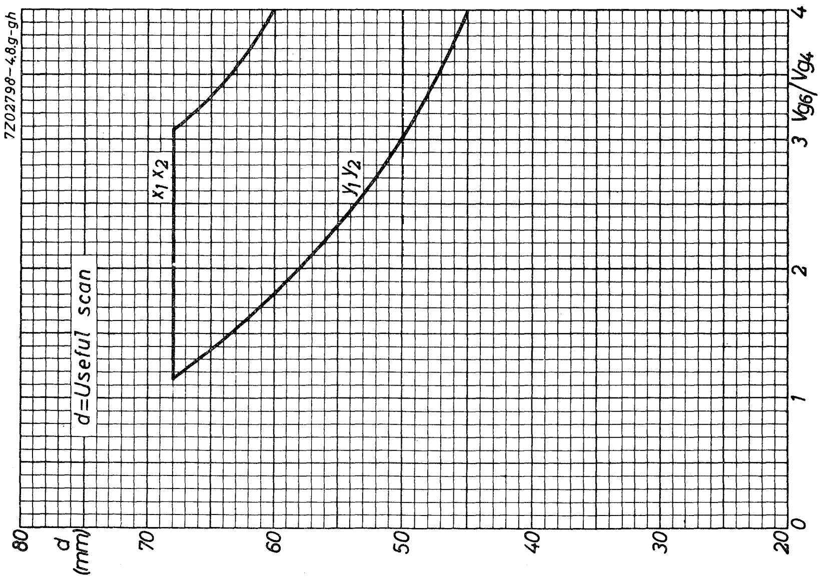
3) The sensitivity at a deflection of less than 75% of the useful scan will not differ from the sensitivity at a deflection of 25% of the useful scan by more than the indicated value.

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.


7Z02797–4.8.g–gh
M_{rel} = Relative deflection factor
$x_1 x_2$
$y_1 y_2$
M_{rel}
2.0
1.5
1.0
0.5
0
1
2
3 V_{g6}/V_{g4}
4


M = Deflection factor
$x_1 x_2$
$y_1 y_2$
M (V/cm)
40
20
0
0
500
1000
1500
2000
$V_{g4} = V_{g6}$ (V)


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

INSTRUMENT CATHODE-RAY TUBE

SCREEN

	colour	persistence
DG10-6	yellowish green	medium
DP10-6	yellowish green	long

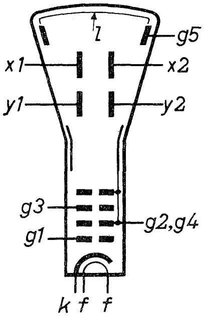
HEATING: Indirect by A.C. or D.C.; parallel supply

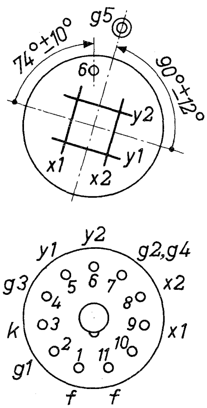
Heater voltage	V_f	6.3	V
Heater current	I_f	300	mA

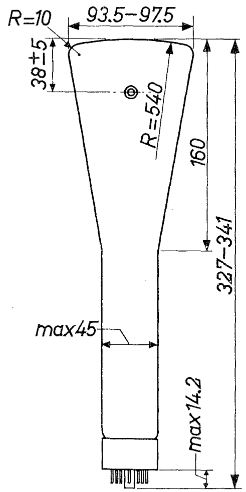
MECHANICAL DATA

Dimensions in mm

Base: Magnal







Accessories

Socket type 2422 515 00001

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 coefficient, horizontal	M_x	40 to 52.5	V/cm
vertical	M_y	32 to 40	V/cm

LIMITING VALUES

Final accelerator voltage	$V_{g_5(\ell)}$	max. 5000	V
First accelerator voltage	V_{g_4,g_2}	max. 2500	V

INSTRUMENT CATHODE-RAY TUBE

SCREEN

	colour	persistence
DG10-74	yellowish green	medium
DP10-74	yellowish green	long

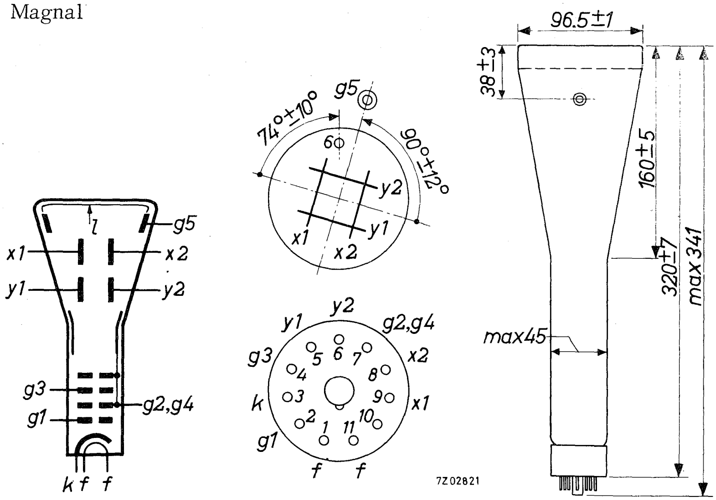
HEATING: Indirect by A.C. or D.C.; parallel supply

Heater voltage	V_f	6.3	V
Heater current	I_f	300	mA

MECHANICAL DATA

Dimensions in mm

Base: Magnal



Accessories

Socket type 2422 515 00001

FOCUSING	electrostatic
DEFLECTION	double electrostatic
x plates	symmetrical
y plates	symmetrical
Angle between x and y traces	$90 + 1.5^{\circ}$

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 coefficient, horizontal	M_x	40 to 52.5	V/cm
vertical	M_y	32 to 40	V/cm

LIMITING VALUES

Final accelerator voltage	$V_{g_5(\ell)}$	max. 5000	V
First accelerator voltage	V_{g_2,g_4}	max. 2500	V

INSTRUMENT CATHODE-RAY TUBE

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

SCREEN

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

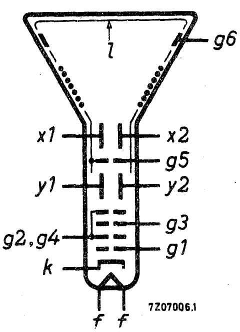
HEATING

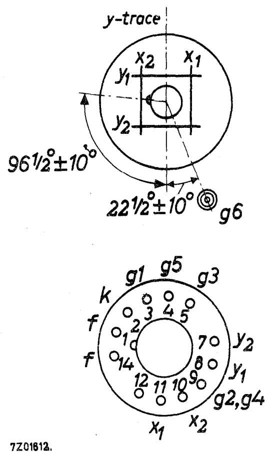
Indirect by A.C. or D.C.; parallel supply

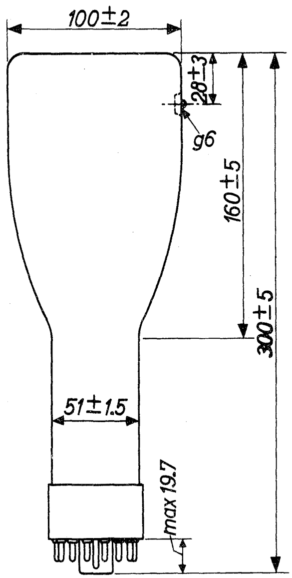
Heater voltage	V_f	=	6.3	V
Heater current	I_f	=	300	mA

MECHANICAL DATA

Dimensions in mm







Base | Diheptal 12 pins

Accessories

Socket	type	2422 517 00001
Final accelerator contact connector	type	55560
Mu-metal shield	type	55541

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 $90 \pm 1^{\circ}$

TYPICAL OPERATING CONDITIONS

Final accelerator voltage	$V_{g6(\ell)}$	=		4000	V
Geometry control electrode voltage	V_{g5}	=	1000	$\pm$100	V
Astigmatism control electrode voltage	$V_{g4,g2}$	=	1000	$\pm$ 50	V
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 coefficient					
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	%
Useful scan					
horizontal		=	min.	75	mm
vertical		=	min.	55	mm

LIMITING VALUES (Absolute max. rating system)

Final accelerator voltage	$V_{g_6(\ell)}$	=	max.	8000	V
		=	min.	1500	V
Geometry control electrode voltage	V_{g_5}	=	max.	2200	V
Astigmatism control electrode voltage	V_{g_4,g_2}	=	max.	2100	V
		=	min.	1000	V
Focusing electrode voltage	V_{g_3}	=	max.	1500	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	$V_{g_4,g_2/x}$	=	max.	500	V
and any deflection plate	$V_{g_4,g_2/y}$	=	max.	500	V
Screen dissipation	W	=	max.	3	mW/cm^2
Ratio $V_{g_6(\ell)}V_{g_4,g_2}$	$V_{g_6(\ell)}/V_{g_4,g_2}$	=	max.	4	

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 coefficient, horizontal	M_x	31	V/cm
vertical	M_y	26.5	V/cm

SCREEN

	colour	persistence
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		

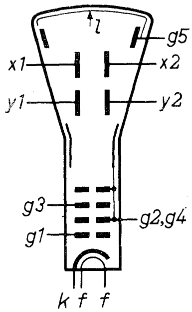
HEATING

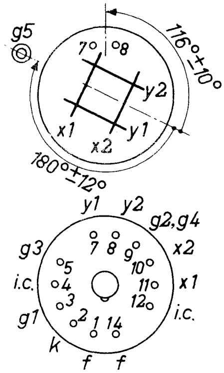
Indirect by A.C. or D.C.; parallel supply

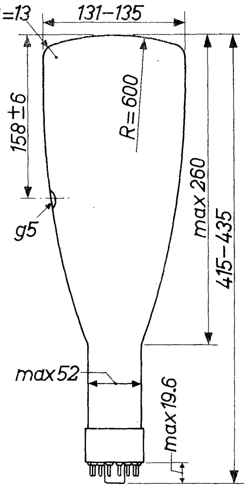
Heater voltage	V_f	6.3	V
Heater current	I_f	300	mA

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	2422 517 00001	
Final accelerator contact connector	type	55560	
Mu-metal shield	type	55550	

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

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 coefficient, 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

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 coefficient, horizontal	M_x	26	V/cm
vertical	M_y	21	V/cm

SCREEN

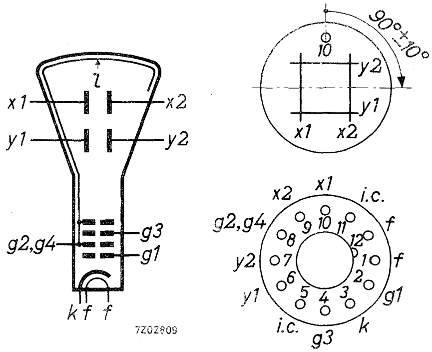
	colour	persistence
DG13-32	yellowish green	medium

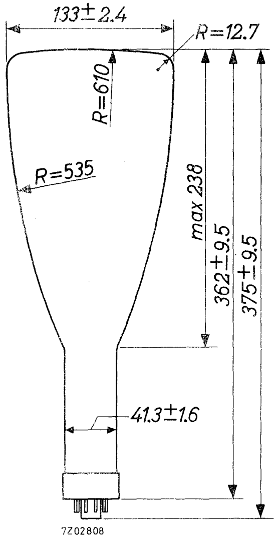
HEATING

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

Heater voltage	V_f	6.3	V
Heater current	I_f	600	mA

MECHANICAL DATA Dimensions in mm





Mounting position: any

Base Duodecal 12 p

Accessories

Socket	type	2422 516 00001
Final accelerator contact connector	type	55560
Mu-metal shield	type	55550

FOCUSING electrostatic

DEFLECTION double electrostatic

x plates symmetrical

y plates symmetrical

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

TYPICAL OPERATING CONDITIONS

Accelerator voltage	$V_{g4,g2(\ell)}$	2000	V
Focusing electrode voltage	V_{g3}	340 to 640	V
Control grid voltage for visual extinction of focused spot	$-V_{g1}$	max. 90	V
Deflection coefficient, 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	

LIMITING VALUES

Final accelerator voltage	$V_{g4,g2(\ell)}$	max.	2500	V
Focusing electrode voltage	V_{g3}	max.	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 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

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 coefficient, horizontal	M_x	23.7	V/cm
vertical	M_y	17.7	V/cm

SCREEN

	colour	persistence
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

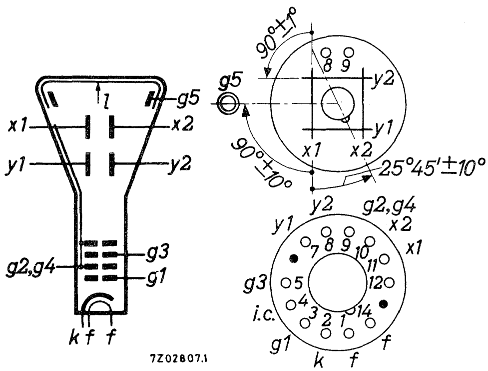
HEATING

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

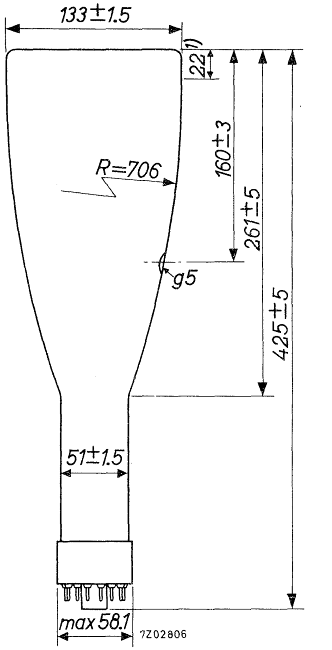
Heater voltage	V_f	6.3	V
Heater current	I_f	600	mA

MECHANICAL DATA

Dimensions in mm



7Z02807.1



7Z02806

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. 430 mm
Face diameter	max. 134.5 mm
Net weight	approx. 1100 g
Accessories	
Socket	type 2422 517 00001
Final accelerator contact connector	type 55560
Mu-metal shield	type 55550

1) Lower side of straight part.

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

Notes to page 4

[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.

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 coefficient, 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	

[1], [2] See page 3

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 coefficient 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.

INSTRUMENT CATHODE-RAY TUBE

10 cm diameter flat faced double gun oscilloscope tube, post-deflection acceleration by means of a helical electrode and low interaction between traces. The tube features beam-blanking.

QUICK REFERENCE DATA			
Final accelerator voltage	$V_{g_8}(\ell)$	3000	V
Display area	horizontal full scan		
	vertical	7	cm
Deflection coefficient, horizontal	M_x	15	V/cm
vertical	M_y	7	V/cm

SCREEN

	colour	persistence
E10-12GH	green	medium short
E10-12GM	yellowish green	long
E10-12GP	bluish green	medium short

Useful screen diameter min. 85 mm

Useful scan (each gun) at $V_{g_8}(\ell)/V_{g_5} = 3$

horizontal	full scan		
vertical	min.	70	mm

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

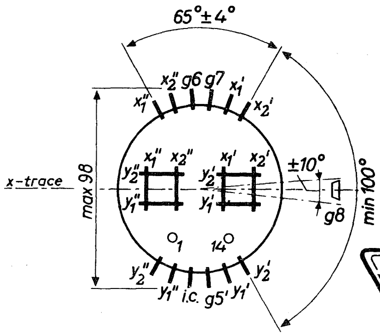
HEATING

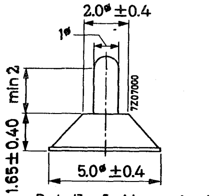
Indirect by A.C. or D.C.; parallel supply

Heater voltage	each gun	V_f	6.3	V
Heater current	each gun	I_f	300	mA

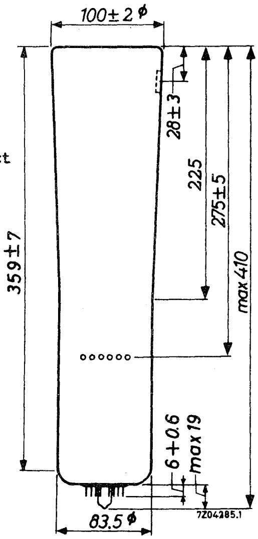
MECHANICAL DATA

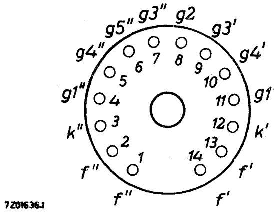
Dimensions in mm

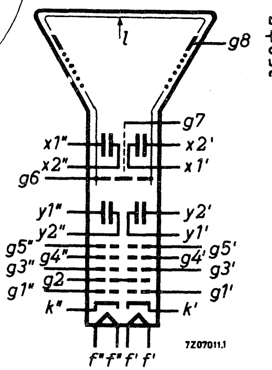




Detail of side contact







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
Net weight	approx.	800	g
Accessories			
Socket, supplied with tube	type	55566	
Final accelerator contact connector	type	55563	
Side contact connector	type	55561	
Mu-metal shield	type	55545	

CAPACITANCES (each gun)

x_1' to all elements except x_2'	$C_{x_1'(x_2')}$	4.5	pF
x_2' to all elements except x_1'	$C_{x_2'(x_1')}$	3	pF
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	$C_{y_1(y_2)}$	2	pF
y_2 to all other elements except y_1	$C_{y_2(y_1)}$	2	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}	5.2	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 $90 \pm 1^\circ$

Angle between x-traces $\pm 0.8^\circ$ max. in the centre of the screen.

Angle between y-traces $\pm 1^\circ$ max. in the centre of the screen.

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	$V_{g_8(\ell)}$	3000	V
Astigmatism control electrode voltage	V_{g_5}	1000	V [3])
First accelerator voltage	V_{g_2}	1000	V
Beam current	$I_{g_8(\ell)}$	10	μA
Line width	l.w.	0.50	mm

HELIX

Post deflection accelerator helix resistance: min. 100 MΩ

[3]) See page 6.

TYPICAL OPERATING CONDITIONS (each gun)

Final accelerator voltage	$V_{g_8}(\ell)$	3000	V
Intergun shield voltage	V_{g_7}	1000±100	V [1]
Geometry control electrode voltage	V_{g_6}	1000±100	V [1] [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
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 coefficient, horizontal	M_x	12 to 18	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

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

Final accelerator voltage	$V_{g_8}(\ell)$	max. min.	3300 2700	V V
Intergun shield voltage	V_{g_7}	max.	1200	V
Geometry control electrode voltage	V_{g_6}	max.	1200	V
Astigmatism control electrode voltage	V_{g_5}	max. min.	1200 800	V 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. min.	1200 200	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_{kf}	max.	200	V
cathode negative	$-V_{kf}$	max.	125	V
Average cathode current	I_k	max.	300	μA
Screen dissipation	W_ℓ	max.	3	mW/cm^2
Ratio $V_{g_8}(\ell)/V_{g_5}$	$V_{g_8}(\ell)/V_{g_5}$	max.	3	

CIRCUIT DESIGN VALUES (each gun, if applicable)

Focusing voltage	V_{g_4}	180 to 380	V/kV of V_{g_2}
Control grid voltage for visual cut-off focused spot	V_{g_1}	25 to −90	V/kV of V_{g_2}
Deflection coefficient $V_{g_8}(\ell)/V_{g_5} = 3$			
horizontal	M_x	10 to 20	V/cm per kV of V_{g_5}
vertical	M_y	6 to 8	V/cm per kV of V_{g_5}
Focusing electrode current	I_{g_4}	−15 to +10	μA
Control grid circuit resistance	R_{g_1}	max. 1.5	MΩ

---

1) This tube is designed for optimum performance when operating at the ratio $V_{g_8}(\ell)/V_{g_5} = 3$. 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.

INSTRUMENT CATHODE-RAY TUBE

10 cm diameter metal-backed flat-faced double gun oscilloscope tube with post-deflection acceleration by means of a helical electrode and low interaction between beams.

QUICK REFERENCE DATA			
Final accelerator voltage	$V_{g8}(\ell)$	4000	V
Display area	horizontal	full scan	
	vertical	7	cm
Deflection coefficient, horizontal	M_x	17	V/cm
vertical	M_y	7.4	V/cm

SCREEN

	Colour	Persistence
E10-130GH	green	medium short
E10-130GM	yellowish green	long
E10-130GP	bluish green	medium short

Useful screen diameter		min. 85	mm
Useful scan (each gun) at $V_{g8}(\ell)/V_{g5} = 4$	horizontal	full scan	
	vertical	min. 70	mm

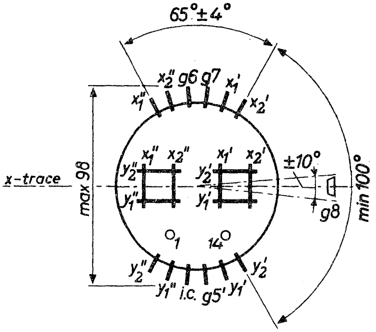
The useful scan may be shifted vertically to a maximum of 5 mm with respect to the geometric centre of the face plate.

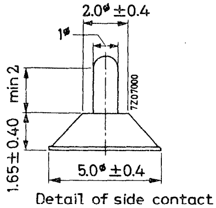
HEATING

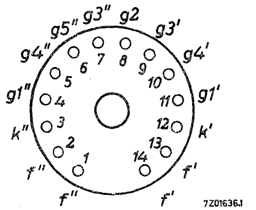
Indirect by A.C. or D.C.; parallel supply

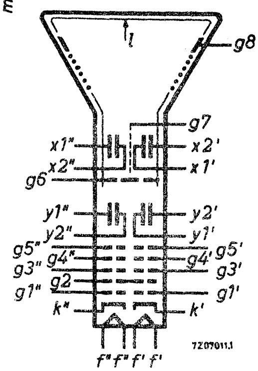
Heater voltage	V_f	6.3	V
Heater current	I_f	300	mA

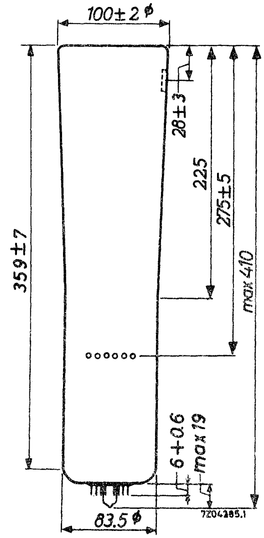
MECHANICAL DATA











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
Net weight	approx.	800	g
Accessories			
Socket, supplied with tube	type	55566	
Final-accelerator contact connector	type	55563	
Side contact connector	type	55561	
Mu-metal shield	type	55545	

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'	$C_{x_2'(x_1')}$	3	pF
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	$C_{y_1(y_2)}$	2	pF
y_2 to all other elements except y_1	$C_{y_2(y_1)}$	2	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}	5.2	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 (each gun)		90 ± 1	°
Angle between corresponding x traces at the centre of the screen	max.	0.6	°
Angle between corresponding y traces at the centre of the screen	max.	1	°

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	$V_{g_8(\ell)}$	4000	V
Astigmatism-control electrode voltage	V_{g_5}	1000	V 2)
First accelerator voltage	V_{g_2}	1000	V
Beam current	$I_{g_8(\ell)}$	10	μA
Line width	l.w.	0.4	mm

HELIX

Post-deflection accelerator helix resistance min. 100 MΩ

2) See page 5

TYPICAL OPERATING CONDITIONS (each gun, if applicable)

Final accelerator voltage	$V_{g_8(\ell)}$		4000	V	
Intergun shield voltage	V_{g_7}		1000±100	V	1)
Geometry-control electrode voltage	V_{g_6}		1000±100	V	1)
Astigmatism-control electrode voltage	V_{g_5}		1000±100	V	2)
Focusing electrode voltage	V_{g_4}		200 to 320	V	
Deflection-blanking electrode voltage	V_{g_3}		1000	V	
Deflection-blanking control voltage for blanking a beam current $I_{g_8(\ell)}$ = 10 µA	ΔV_{g_3}	max.	40	V	
First accelerator voltage	V_{g_2}		1000	V	
Control grid voltage for extinction of focused spot	V_{g_1}		−25 to −90	V	
Deflection coefficient, horizontal	M_x		14 to 20	V/cm	
vertical	M_y		6.4 to 8.4	V/cm	
Deviation of linearity of deflection		max.	2	%	3)
Geometry distortion			see note 4		
Interaction factor		max.	2.10^{-3}	mm/V_{DC}	5)
Tracking error			1.2	mm	6)

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

Final accelerator voltage	$V_{g_8(\ell)}$	max.	5000	V
		min.	2700	V
Intergun shield voltage	V_{g_7}	max.	1200	V
Geometry control electrode 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
Cathode to heater voltage, cathode positive	V_{kf}	max.	125	V
cathode negative	$-V_{kf}$	max.	125	V
Average cathode current	I_k	max.	300	µA
Screen dissipation	W_ℓ	max.	3	mW/cm^2
Ratio $V_{g_8(\ell)}/V_{g_5}$	$V_{g_8(\ell)}/V_{g_5}$	max.	4	

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

CIRCUIT DESIGN VALUES (each gun, if applicable)

Focusing voltage	V_{g_4}	200 to 320 V	per kV of V_{g_2}
Control grid voltage for extinction of focused spot	V_{g_1}	-25 to -90 V	per kV of V_{g_2}
Deflection coefficient at $V_{g_8}(\ell)/V_{g_5} = 4$			
horizontal	M_x	14 to 20 V/cm	per kV of V_{g_5}
vertical	M_y	6.4 to 8.4 V/cm	per kV of V_{g_5}
Focusing electrode current	I_{g_4}	-15 to +10 μA	
Control grid circuit resistance	R_{g_1}	max. 1.5 MΩ	

1) This tube is designed for optimum performance when operating at the ratio $V_{g_8}(\ell)/V_{g_5} = 4$. Operation at higher ratio may result in changes in deflection uniformity and geometry distortion. The geometry control electrode voltage and the intergun shield 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 $\leq 75\%$ 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 60 mm x 60 mm and 57.5 mm x 57.5 mm is aligned with the electrical x axis of the tube. The edges of a raster will fall between these rectangles with optimum potentials applied.

5) The deflection of one beam when balanced DC voltages are applied to the deflection plates of the other beam, will not be greater than the indicated value.

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

MONITOR TUBES

PREFERED TYPES

(Recommended types for new designs)

M17-140W
M17-141W
M24-100W
M38-120W

MONITOR TUBE

17 cm flat-faced rectangular picture tube primarily intended for use as a viewfinder in television cameras.

QUICK REFERENCE DATA		
Deflection angle, diagonal		70 °
Focusing		electrostatic
Resolution	min.	1100 lines
Overall length	max.	234 mm

SCREEN

Metal-backed phosphor

Luminescence	white
Useful rectangle	min. 124 x 93 mm^2

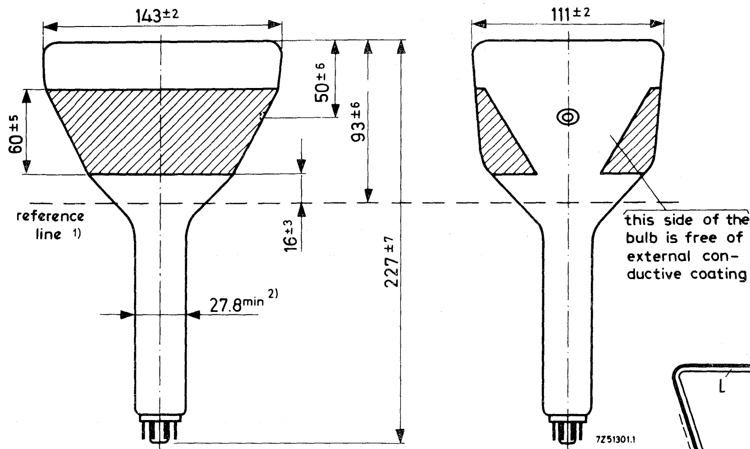
HEATING

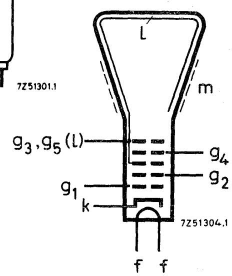
Indirect by A.C. or D.C.; parallel supply

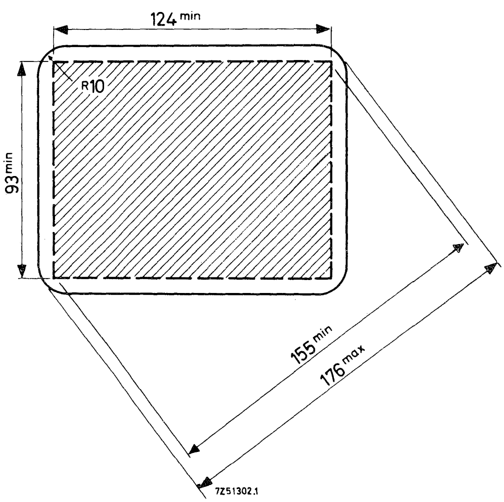
Heater voltage	V_f	6.3	V
Heater current	I_f	300	mA

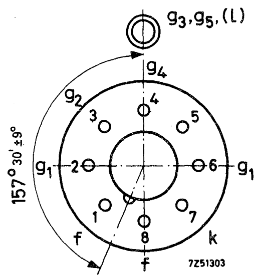
MECHANICAL DATA

Dimensions in mm









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.

2) The maximum dimension is determined by the reference line gauge.

MECHANICAL DATA (continued)

Mounting position: any

Base:	Neo Eightar (B8H)
Cavity contact	CT8
Accessories	
Socket	2422 501 06001
Final-accelerator contact connector	55563

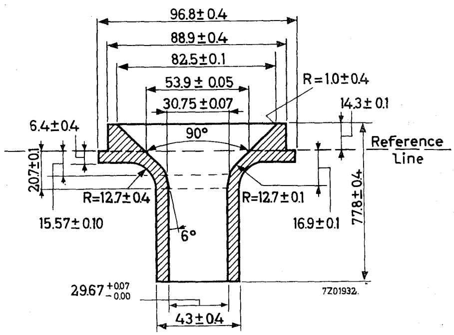
FOCUSING Electrostatic

The range of focus voltage shown under "Typical operating conditions" results in optimum focus at a beam current of 50 μA.

DEFLECTION Magnetic

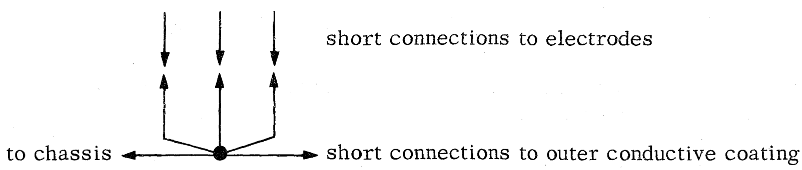
Diagonal deflection angle 70°

REFERENCE LINE GAUGE Dimensions in mm



REMARK

With the high voltage used with this tube internal flash-overs may occur, which may destroy the cathode. Therefore it is necessary to provide protective circuits using sparkgaps. The sparkgaps must be connected as follows:



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

CAPACITANCES

Final accelerator to external conductive coating	$C_{g3,g5(\ell)/m}$	300	pF
Cathode to all other elements	C_k	5	pF
Grid No.1 to all other elements	C_{g1}	7	pF

TYPICAL OPERATING CONDITIONS

Final accelerator voltage	$V_{g3,g5(\ell)}$	14	kV
Focusing electrode voltage	V_{g4}	0 to 400	V
First accelerator voltage	V_{g2}	400	V
Grid No.1 voltage for extinction of focused raster	V_{g1}	-30 to -62	V

RESOLUTION

Resolution at screen centre measured with the shrinking raster method

at $V_{g3,g5(\ell)} = 14$ kV, $V_{g2} = 400$ V, $I_\ell = 50\ \mu A$, $B = 50\ mcd/cm^2$ (500 Nit)	min.	1000	lines [1]
at $V_{g3,g5(\ell)} = 16$ kV, $V_{g2} = 600$ V, $I_\ell = 50\ \mu A$, $B = 60\ mcd/cm^2$ (600 Nit)	min.	1100	lines [1]

LIMITING VALUES (Absolute max. rating system)

Final accelerator voltage	$V_{g3,g5(\ell)}$	max.	16	kV
		min.	12	kV
Focusing electrode voltage	V_{g4}	max.	1	kV
	$-V_{g4}$	max.	500	V
First accelerator voltage	V_{g2}	max.	800	V
		min.	300	V
Cathode to heater voltage, positive	V_{kf}	max.	250	V
positive peak	V_{kf_p}	max.	300	V [2]
negative	$-V_{kf}$	max.	135	V
negative peak	$-V_{kf_p}$	max.	180	V

WARNING

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

1) If necessary the resolution can be improved by the use of a beam centring magnet. This magnet, type number 3322 142 11401, together with directions for use, is supplied on request.

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

MONITOR TUBE

17 cm flat-faced rectangular picture tube primarily intended for use as a viewfinder in television cameras. The tube is provided with a bonded face plate and a metal mounting band.

QUICK REFERENCE DATA		
Deflection angle, diagonal		70 ^{o}
Focusing		electrostatic
Resolution	min.	1100 lines
Overall length	max.	240 mm

SCREEN

Metal-backed phosphor

Luminescence white

Useful rectangle min. 124 x 93 mm^2

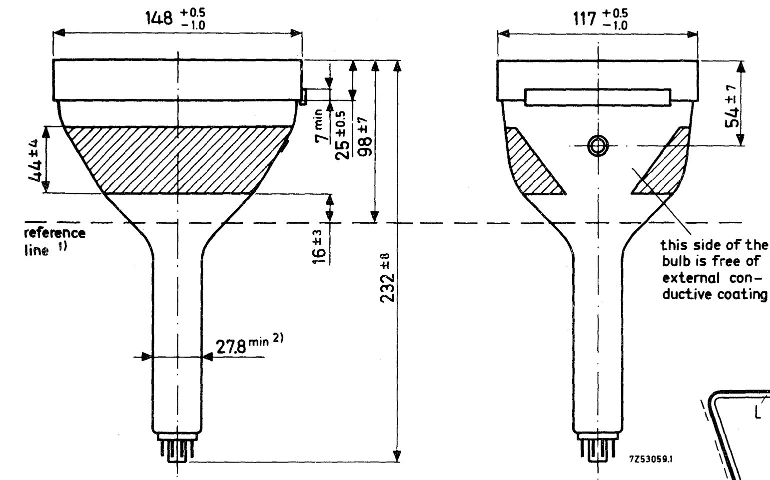
HEATING

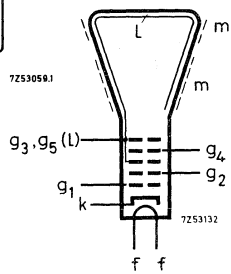
Indirect by A.C. or D.C.; parallel supply

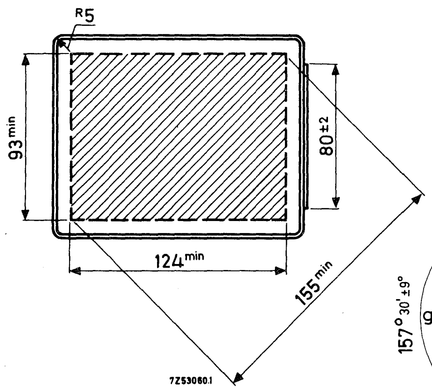
Heater voltage	V_f	6.3	V
Heater current	I_f	300	mA

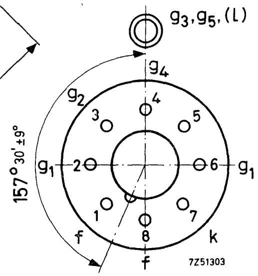
MECHANICAL DATA

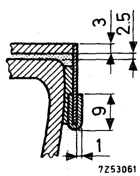
Dimensions in mm











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.

2) The maximum dimension is determined by the reference line gauge.

MECHANICAL DATA (continued)

Mounting position: any

Base:	Neo Eightar (B8H)
Cavity contact	CT8
Accessories	
Socket	2422 501 06001
Final-accelerator contact connector	55563

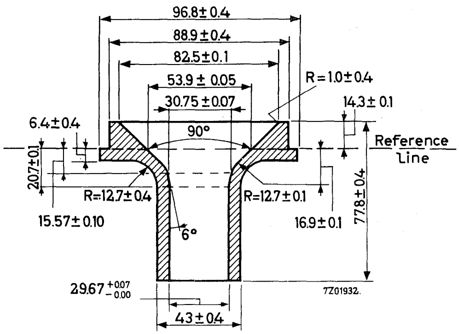
FOCUSING Electrostatic

The range of focus voltage shown under "Typical operating conditions" results in optimum focus at a beam current of 50 μA.

DEFLECTION Magnetic

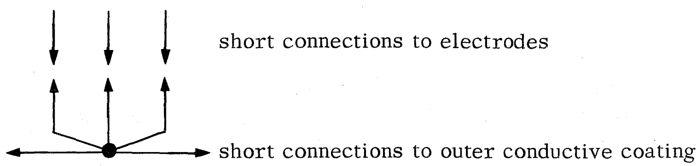
Diagonal deflection angle 70°

REFERENCE LINE GAUGE Dimensions in mm



REMARK

With the high voltage used with this tube internal flash-overs may occur, which may destroy the cathode. Therefore it is necessary to provide protective circuits using sparkgaps. The sparkgaps must be connected as follows:



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

CAPACITANCES

Final accelerator to metal band	$C_{g_3,g_5(\ell)/m'}$	135 pF
Final accelerator to external conductive coating	$C_{g_3,g_5(\ell)/m}$	240 pF
Cathode to all other elements	C_k	5 pF
Grid No.1 to all other elements	C_{g_1}	7 pF

TYPICAL OPERATING CONDITIONS

Final accelerator voltage	$V_{g_3,g_5(\ell)}$	14	16	kV
Focusing electrode voltage	V_{g_4}	0 to 400	0 to 400	V
First accelerator voltage	V_{g_2}	400	600	V
Grid No.1 voltage for extinction of focused raster	V_{g_1}	-30 to -62	-40 to -90	V

RESOLUTION

Resolution at screen centre measured with the shrinking raster method

at $V_{g_3,g_5(\ell)} = 14$ kV, $V_{g_2} = 400$ V, $I_\ell = 50\ \mu A$, $B = 50\ mcd/cm^2$ (500 Nit) — min. 1000 lines [1])

at $V_{g_3,g_5(\ell)} = 16$ kV, $V_{g_2} = 600$ V, $I_\ell = 50\ \mu A$, $B = 60\ mcd/cm^2$ (600 Nit) — min. 1100 lines [1])

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
		min.	300 V
Cathode to heater voltage, positive	V_{kf}	max.	250 V
positive peak	V_{kf_p}	max.	300 V [2])
negative	$-V_{kf}$	max.	135 V
negative peak	$-V_{kf_p}$	max.	180 V

WARNING

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

1) If necessary the resolution can be improved by the use of a beam centring magnet. This magnet, type number 3322 142 11401, together with directions for use, is supplied on request.
2) During a warm-up period not exceeding 15 s the heater may be 410 V negative with respect to the cathode.

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 $^{\circ}$
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

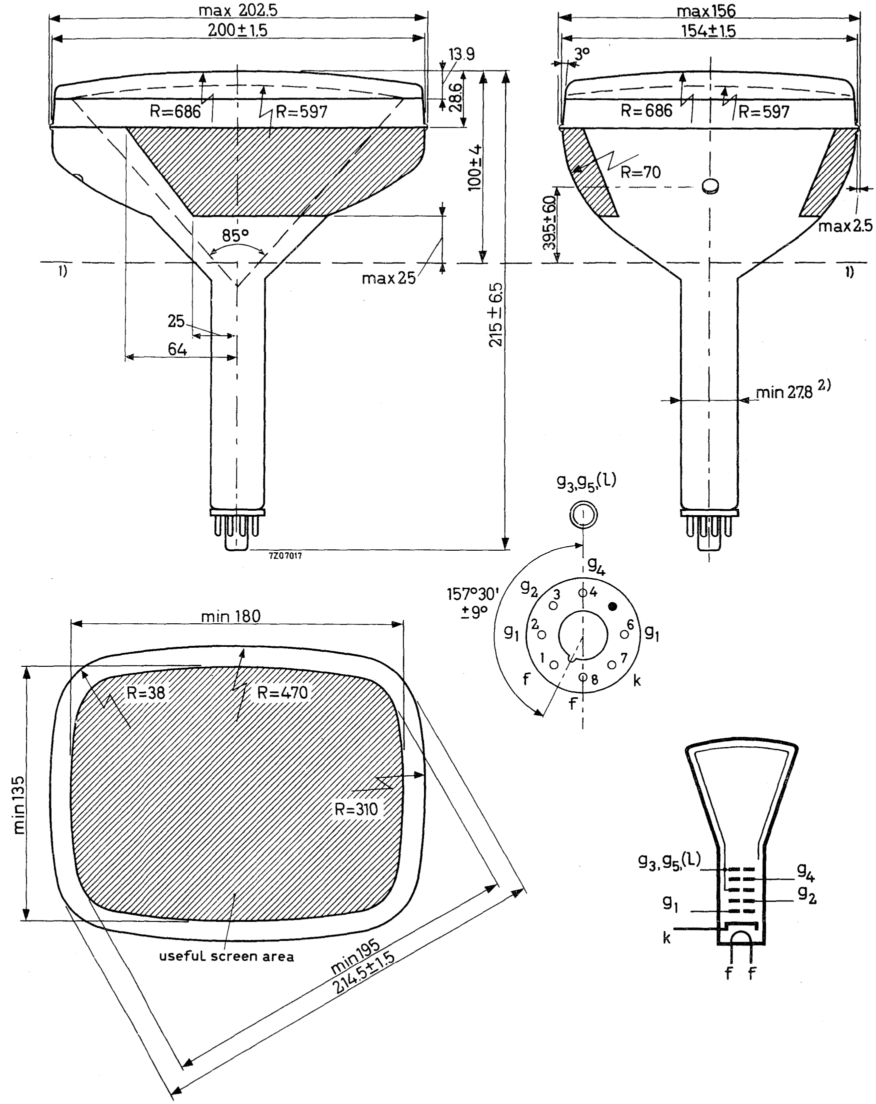
heater voltage	V_f	=	11	V $\pm$ 10 %
heater current	I_f	=	70	mA

CAPACITANCES

Final accelerator to external conductive coating	$C_{g3,g5(\ell)/m}$	=	max. 375	pF
Cathode to all other elements	C_k	=	5.0	pF
Grid No.1 to all other elements	C_{g_1}	=	9.0	pF

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 $^{\circ}$ with the vertical.

MECHANICAL DATA (continued)

Base:	Neo Eightar (B8H)
Cavity contact	CT8
Accessories	
Final accelerator connector	type 55563
Socket	2422 501 06001

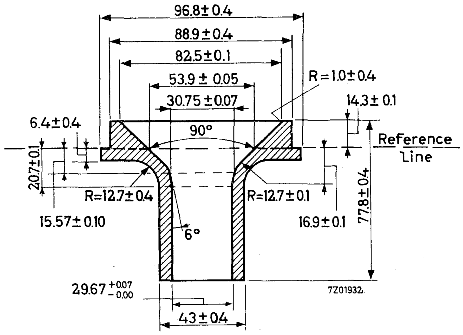
FOCUSING electrostatic

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°

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) The maximum dimension is determined by the reference line gauge

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}	=	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	$V_{k\text{-}f}$	=	max.	80	V
positive peak	$V_{k\text{-}f_p}$	=	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

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

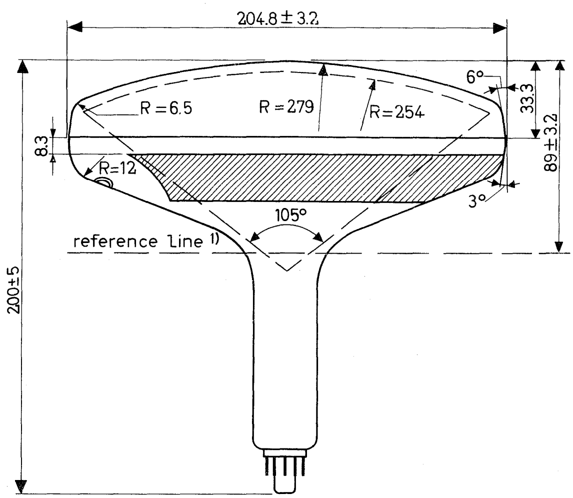
Heater voltage	V_f	=	6.3	V
Heater current	I_f	=	300	mA

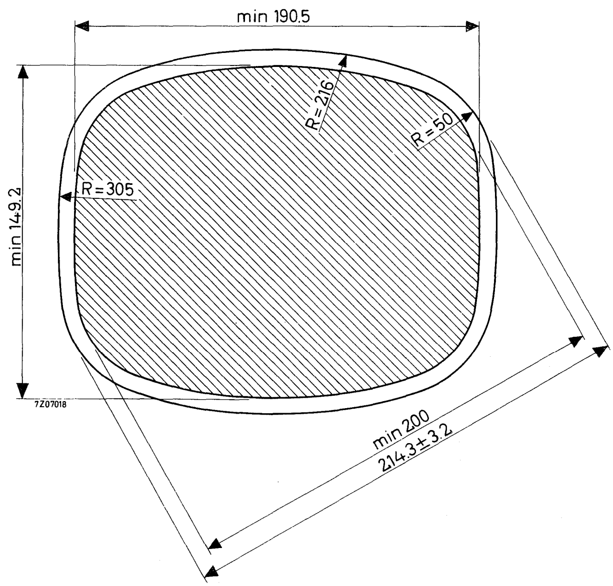
CAPACITANCES

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

MECHANICAL DATA

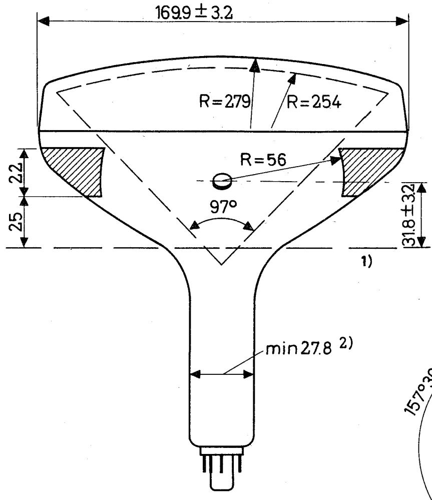
Dimensions in mm

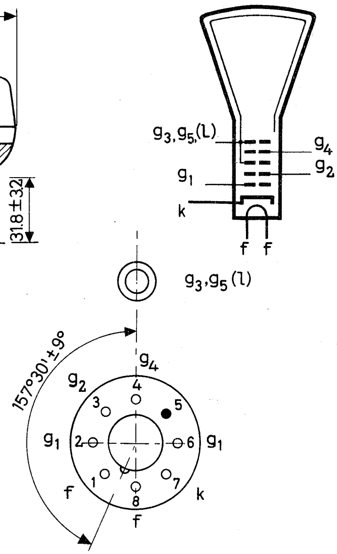




MECHANICAL DATA (continued)

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)
Cavity contact	CT8
Accessories	
Final accelerator connector	type 55563
Socket	2422 501 06001

1) Reference line, 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) The maximum dimension is determined by the reference line gauge.

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^o

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, $I_{g_3,g_5(\ell)}$ = 80 μA measured with a raster of 14 x 14 cm^2	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.

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 Hz)	=	max.	0.5	MΩ
Impedance between cathode and earth	Z_k (50 Hz)	=	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 Hz)	=	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.

MONITOR TUBE

The M24-100W is a 24 cm diagonal rectangular television tube with metal backed screen primarily intended for use as a monitor or display tube.

QUICK REFERENCE DATA		
Deflection angle	90°	
Focusing	electrostatic	
Resolution	900	lines
Overall length	max. 260	mm

SCREEN

Metal backed phosphor

Luminescence	white	
Light transmission of face glass	52	%
Useful diagonal	min. 225	mm
Useful width	min. 190	mm
Useful height	min. 140	mm

HEATING

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

Heater voltage	V_f	6.3	V
Heater current	I_f	300	mA

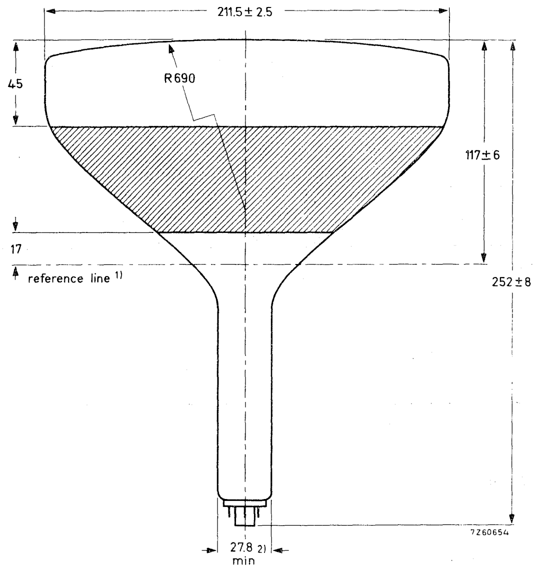
CAPACITANCES

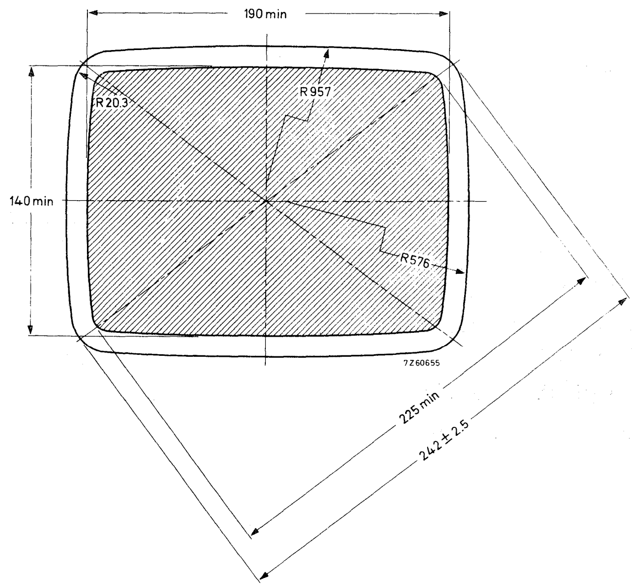
Final accelerator to external conductive coating	$C_{g3,\,g5(\ell)/m}$	420	pF
Cathode to all other elements	C_k	4	pF
Control grid to all other elements	C_{g1}	7	pF

Data based on pre-production tubes

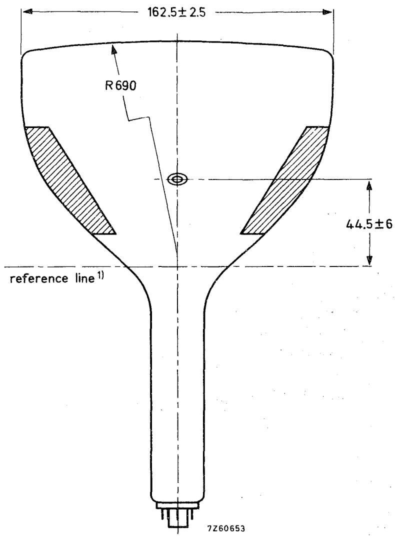
MECHANICAL DATA

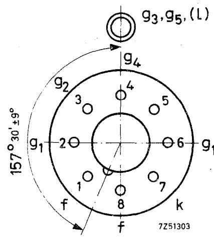
Dimensions in mm

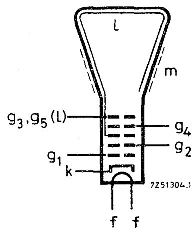




MECHANICAL DATA (continued)







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)
Cavity contact	CT8
Accessories	
Socket	2422 501 06001
Final accelerator contact connector	type 55563

FOCUSSING electrostatic

The range of focus voltage shown under "Typical operating conditions" results in optimum focus at a beam current of 100 μA.

DEFLECTION [3] magnetic

diagonal deflection angle 90°

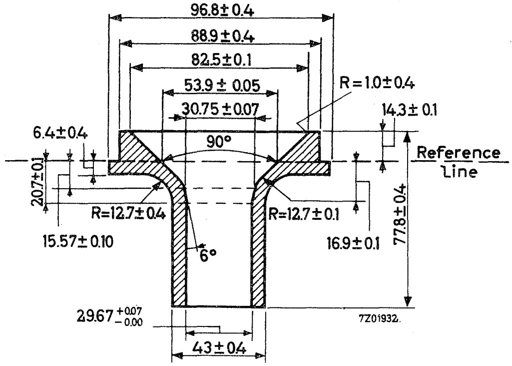
1) 2) 3) See page 5

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	$V_{g3,\,g5(\ell)}$	14	kV
Focusing electrode voltage	V_{g4}	0 to 400	V
First accelerator voltage	V_{g2}	600	V
Grid No. 1 voltage for extinction of focused raster	V_{g1}	−32 to −85	V

RESOLUTION

Resolution at screen centre measured with the shrinking raster method (non-interlaced raster), under typical operating conditions, and a brightness of 60 mcd/cm^2 (600 Nit): 900 lines

LIMITING VALUES (Absolute max. rating system)

Final accelerator voltage	$V_{g3,\,g5(\ell)}$	max.	16	kV
		min.	10	kV
Focusing electrode voltage	V_{g4}	max.	1	kV
	$-V_{g4}$	max.	500	V
First accelerator voltage	V_{g2}	max.	800	V
		min.	300	V
Cathode to heater voltage,				
positive	V_{kf}	max.	250	V
positive peak	V_{kf_p}	max.	300	V [4])
negative	$-V_{kf}$	max.	135	V
negative peak	$-V_{kf_p}$	max.	180	V

NOTES

1) Reference line is determined by the plane of the upper edge of the flange of the reference line gauge when the gauge is resting on the cone.
2) The maximum dimension is determined by the reference line gauge.
3) For a deflection coil the AT1040 is recommended. If another coil is considered, it is advisable to contact the local tube supplier.
4) During a warm-up period not exceeding 15 s the heater may be 410 V negative with respect to the cathode.

MONITOR TUBE

TheM28-12W is a rectangular 28 cm 90^o deflection angle direct viewing picture tube primarily intended as a monitor tube.

QUICK REFERENCE DATA			
Face diagonal		28	cm (11 inch)
Deflection angle		90^o	
Overall length		245	mm
Neck length		105.5	mm
Neck diameter		20	mm
Light transmission of face glass		50	%
Focusing			electrostatic
Bulb			reinforced
Heating	11 V,	75	mA
Resolution	min.	850	lines

SCREEN [1])

Metal backed phosphor			
Luminescence	white		
Light transmission of face glass		50	%
Useful diagonal	min.	262.5	mm
Useful width	min.	228	mm
Useful height	min.	171	mm

HEATING

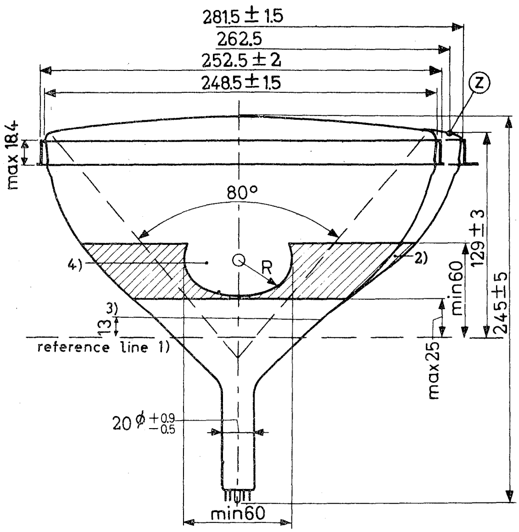
Indirect by A.C. or D.C.

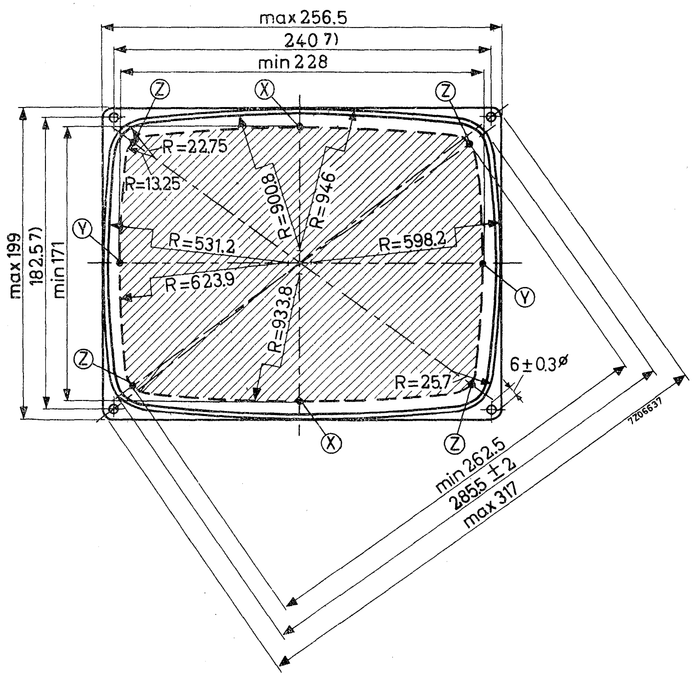
Heater voltage	V_f	11	V
heater current	I_f	75	mA

[1]) Certain applications require a phosphor with a longer persistence. Tubes with such phosphors (LA, GM, GR for instance) are supplied to special order.

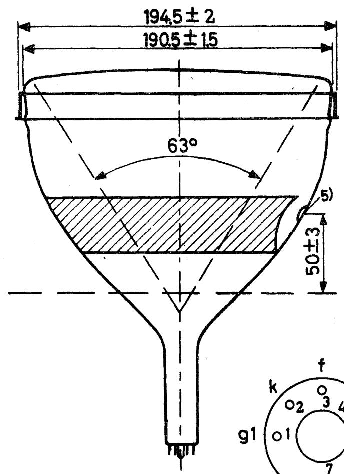
MECHANICAL DATA

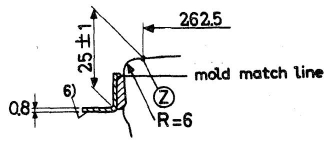
Dimensions in mm

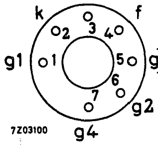


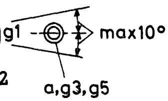


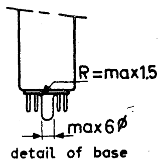
MECHANICAL DATA (continued) Dimensions in mm

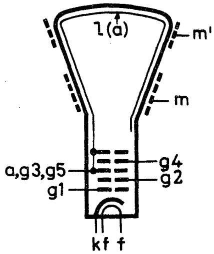


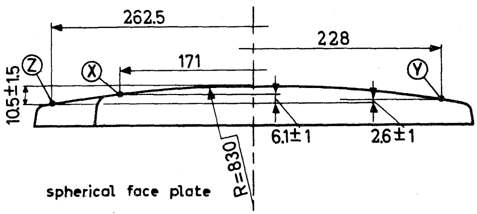












Mounting position: any

Base : 7 pins miniature, with pumping stem

Net weight : approx. 2.2 kg

The socket for the base should not be rigidly mounted; it should have flexible leads and be allowed to move freely.

For notes see page 4

CAPACITANCES

Final accelerator to external conductive coating	$C_{a,g3,g5/m}$	< 850 > 550	pF pF
Final accelerator to metal band	$C_{a,g3,g5/m}$	150	pF
Cathode to all	C_k	3	pF
Grid No.1 to all	C_{g1}	7	pF

FOCUSING electrostatic

DEFLECTION magnetic

Diagonal deflection angle	90^o
Horizontal deflection angle	80^o
Vertical deflection angle	63^o

PICTURE CENTRING MAGNET

Field intensity perpendicular to the tube axis adjustable from 0 to 800 A/m (0 to 10 Oerstedt).
Maximum distance between centre of field of this magnet and reference line: 55mm. The centring magnet should be mounted as close to the deflection coils as possible.

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 when the gauge is resting on the cone.
2. The configuration of the external conductive coating is optional but contains the contact area shown in the drawing.
   The external conductive coating must be earthed.
3. End of guaranteed contour. The maximum neck and cone contour is given by the reference line gauge.
4. This area must be kept clean.
5. Recessed cavity contact.
6. Maximum unflatness of the rim is 1 mm.
7. The mounting screws in the cabinet must be situated inside a circle with a diameter of 5 mm drawn around the corner points of a geometrical rectangle of 240 mm x 182.5 mm.

TYPICAL OPERATING CONDITIONS

Grid drive service

Final accelerator voltage	$V_{a,g_3,g_5(\ell)}$	11	13	kV
Focusing electrode voltage	V_{g_4}	0 to 350	50 to 400	V 1)
Grid No.2 voltage	V_{g_2}	250	350	V
Grid No.1 voltage for visual extinction of focused raster	V_{g_1}	−35 to −69	−46 to −91	V

Cathode drive service

Voltages are specified with respect to grid No.1

Final accelerator voltage	$V_{a,g_3,g_5(\ell)}$	11	13	kV
Focusing electrode voltage	V_{g_4}	0 to 350	50 to 400	V 1)
Grid No.2 voltage	V_{g_2}	200 to 350	350	V
Cathode voltage for visual extinction of focused raster	V_k	approx. 45	44 to 80	V

LIMITING VALUES (Absolute max. rating system)

Final accelerator voltage	$V_{a,g_3,g_5(\ell)}$	max. min.	14 7.5	kV kV
Grid No.4 voltage	V_g			
positive	V_{g_4}	max.	500	V
negative	$-V_{g_4}$	max.	50	V
Grid No.2 voltage	V_{g_2}	max. min.	350 200	V V
Grid No.2 to grid No.1 voltage	V_{g_2}/V_{g_1}	max.	450	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.	100	V
negative peak	$-V_{g_{1p}}$	max.	350	V 2)

1) Voltage range to obtain optimum overall focus at 100 μA beam current.

2) Maximum pulse duration 22% of a cycle but max. 1.5 ms.

LIMITING VALUES (continued)

Cathode to grid No.1 voltage				
positive	V_{k/g_1}	max.	100	V
positive peak	$V_{k/g_{1p}}$	max.	350	V [1]
negative	$-V_{k/g_1}$	max.	0	V
negative peak	$-V_{k/g_{1p}}$	max.	2	V
Cathode to heater voltage				
positive	$V_{k/f}$	max.	110	V
positive peak	V_{k/f_p}	max.	130	V

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.	0.1	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
Resistance between external conductive coating and rimband	$R_{m/m'}$	max.	2	MΩ

[1]) Maximum pulse duration 22% of a cycle but max. 1.5 ms.

MONITOR TUBE

31 cm (12 in), 110°, rectangular direct vision monitor tube with integral protection for black-and-white T.V. The rimband leaves the edge of the faceplate free. The 20 mm neck diameter results in a low deflection energy.

QUICK REFERENCE DATA			
Face diagonal		31	cm (12 in)
Deflection angle		110°	
Overall length	max.	233	mm
Neck diameter		20	mm
Light transmission of face glass		50	%
Focusing	electrostatic		
Bulb	reinforced		
Heating		11 V, 75	mA
Resolution	min.	850	lines

SCREEN [1])

Metal backed phosphor			
Luminescence	white		
Light transmission of face glass		50	%
Useful diagonal	min.	295	mm
Useful width	min.	257	mm
Useful height	min.	195	mm

HEATING

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

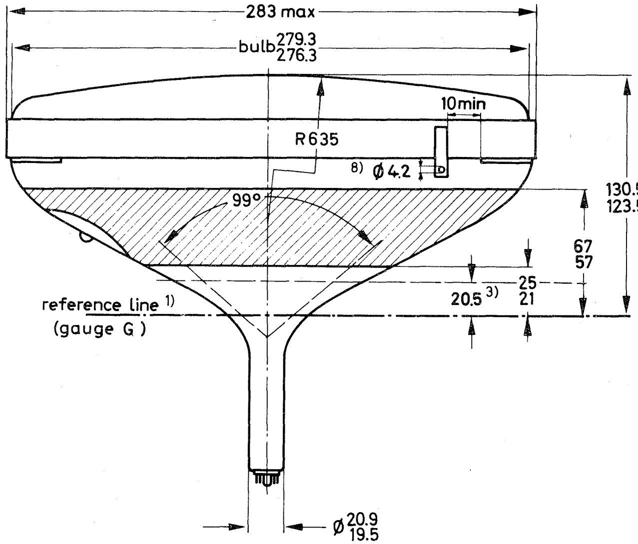
Heater voltage	V_f	11	V
Heater current	I_f	75	mA

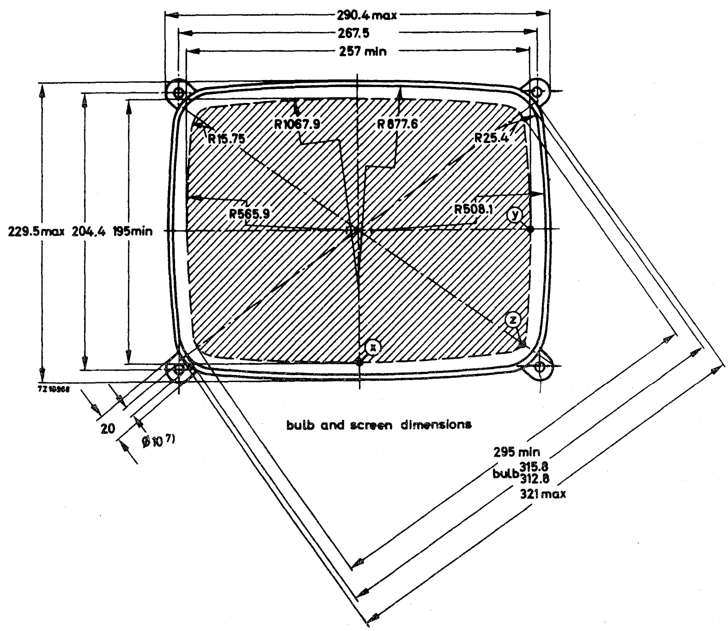
The maximum total deviation from the nominal heater voltage is 15%.
The deviation may consists of:
max. 7% continuous deviation, e.g. due to component spread,
max. 10% temporary variation.
In case of supply direct from a battery, the heater voltage must be within the limits given on page 8.

[1]) Certain applications require a phosphor with a longer persistence. Tubes with such phosphors (LA, GM, GR for instance) are supplied to special order.

→ MECHANICAL DATA

Dimensions in mm

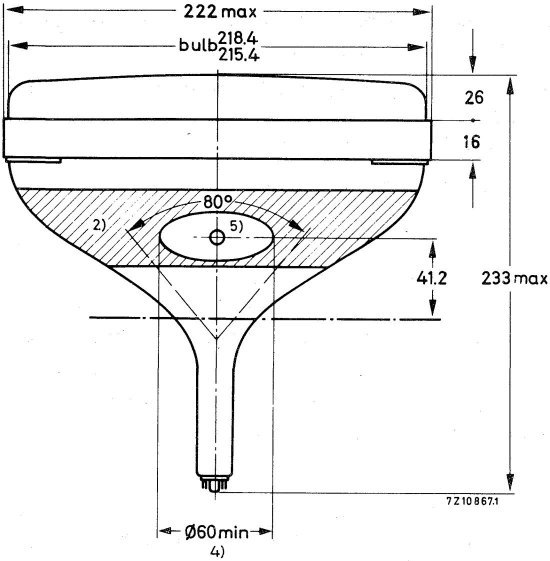


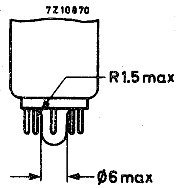


Notes see page 4

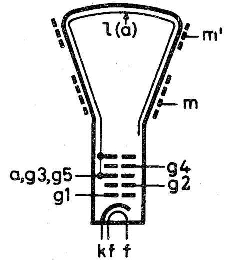
MECHANICAL DATA (continued)

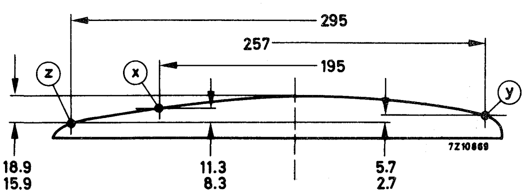
Dimensions in mm

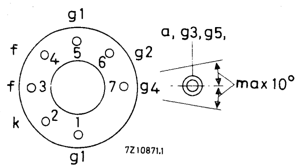


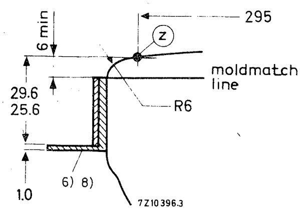


detail of base









Mounting position: any

Net weight : approx. 2.8 kg

Base : 7 pins miniature, with pumping stem

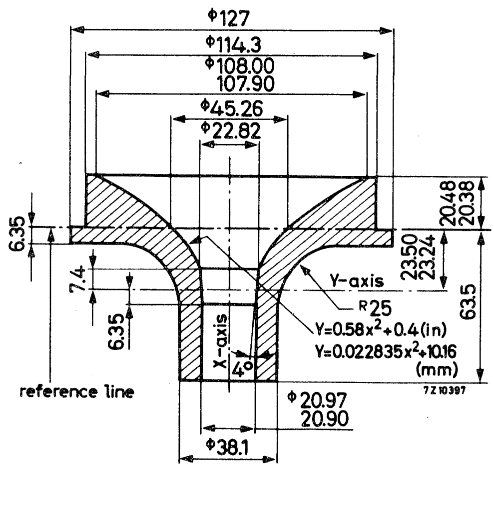
The socket for the base should not be rigidly mounted, it should have flexible leads and be allowed to move freely.

Notes see page 4

NOTES TO OUTLINE DRAWING

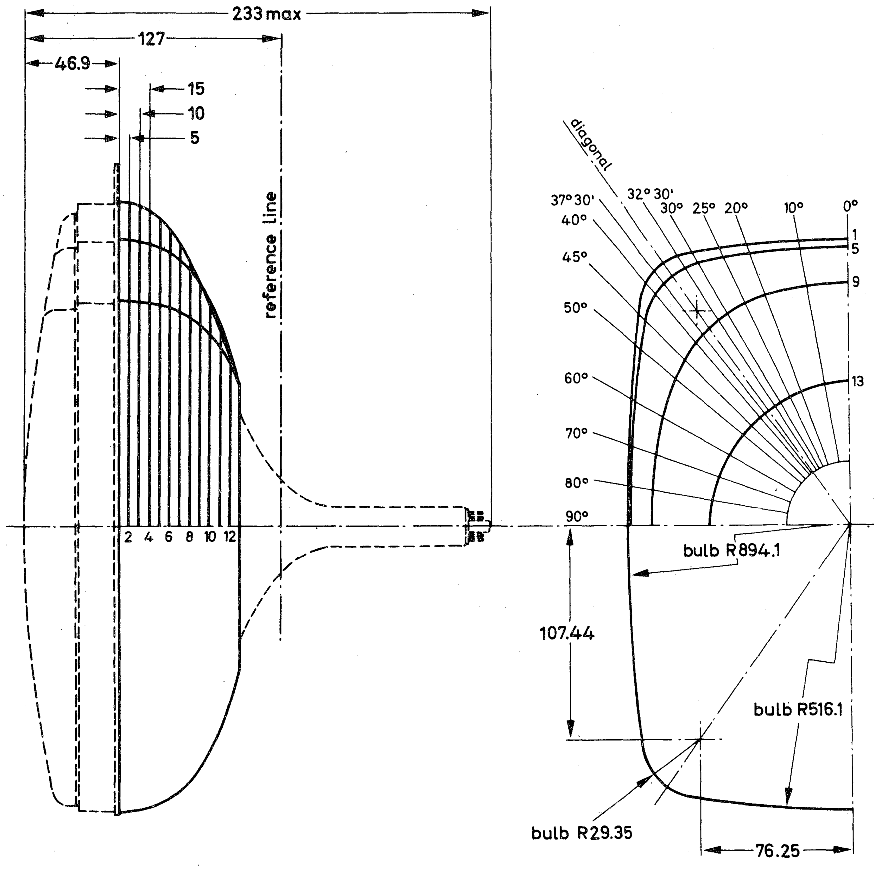
1. The reference line is determined by the plane of the upper edge of the flange of the reference line gauge when the gauge is resting on the cone.
2. The configuration of the external conductive coating may be different but contains the contact area shown in the drawing.
   The external conductive coating must be earthed.
3. End of guaranteed contour. The maximum neck and cone contour is given by the reference line gauge.
4. This area must be kept clean.
5. Recessed cavity contact I.E.C. 67-III-2.
6. The displacement of any lug with respect to the plane through the three other lugs is max. 2 mm.
7. The mounting screws in the cabinet must be situated inside a circle of 7 mm diameter drawn around the true geometrical positions, i.e. at the corners of a rectangle of 267.5 mm x 204.4 mm.
8. The metal band must be earthed by means of the tag provided.
   No electrical contact between the metal band and the mounting lug can be guaranteed.

REFERENCE LINE GAUGE



MAXIMUM CONE CONTOUR DRAWING

Dimensions in mm



		Distance from centre (Max. values)														
Section	Distance from section 1	0° long	10°	20°	25°	30°	32° 30'	Diagon.	37° 30'	40°	45°	50°	60°	70°	80°	90° short
13	59.6 nom.	72.19	72.03	71.66	71.44	71.24	71.14	71.03	70.96	70.88	70.76	70.66	70.6	70.67	70.8	70.87
12	55 "	85.86	85.57	84.86	84.43	83.98	83.75	83.5	83.32	83.11	82.72	82.38	81.88	81.6	81.5	81.5
11	50 "	99.45	99.36	98.89	98.46	97.88	97.53	97.1	96.75	96.32	95.38	94.4	92.42	90.7	89.52	89.08
10	45 "	112.3	112.41	112.2	111.73	110.94	110.41	109.7	109.1	108.33	106.6	104.72	100.9	97.65	95.48	94.7
9	40 "	121.29	121.87	122.76	122.85	122.41	121.94	121.18	120.47	119.48	117.07	114.3	108.57	103.8	100.73	99.66
8	35 "	127.9	128.92	131.17	132.12	132.46	132.27	131.65	130.9	129.74	126.54	122.7	114.93	108.76	104.96	103.67
7	30 "	132.64	133.98	137.39	139.31	140.81	141.16	140.85	140.16	138.87	134.6	129.45	119.71	112.47	108.18	106.76
6	25 "	135.97	137.47	141.65	144.41	147.22	148.29	148.45	147.88	146.49	140.89	134.31	122.94	115.02	110.48	109
5	20 "	138.44	139.99	144.54	147.82	151.55	153.17	153.7	153.2	151.66	144.83	137.09	124.69	116.45	111.81	110.31
4	15 "	140.31	141.88	146.63	150.22	154.59	156.61	157.35	156.85	155.08	147.13	138.48	125.41	117.01	112.34	110.84
3	10 "	141.62	143.2	148.04	151.78	156.46	158.67	159.52	159	157.1	148.53	139.42	126.02	117.55	112.87	111.36
2	5 "	142.36	143.94	148.82	152.63	157.44	159.75	160.66	160.15	158.21	149.41	140.12	126.58	118.07	113.37	111.86
1	0 "	142.8	144.38	149.27	153.07	157.88	160.19	161.1	160.59	158.67	149.9	140.62	127.06	118.53	113.81	112.3

CAPACITANCES

Final accelerator to external conductive coating	$C_{a,g_3,g_5/m}$	<	900	pF
		>	450	pF
Final accelerator to metal band	$C_{a,g_3,g_5/m'}$		300	pF
Cathode to all	C_k		3	pF
Grid No. 1 to all	C_{g1}		7	pF

FOCUSING electrostatic

DEFLECTION magnetic

Diagonal deflection angle	110°
Horizontal deflection angle	99°
Vertical deflection angle	80°

PICTURE CENTRING MAGNET

Field intensity perpendicular to the tube axis adjustable from 0 to 800 A/m (0 to 10 Oerstedt).
Maximum distance between centre of field of this magnet and reference line: 55 mm.

TYPICAL OPERATING CONDITIONS

<u>Grid drive service</u>

Final accelerator voltage	V_{a,g_3,g_5}	11	kV
Focusing electrode voltage	V_{g4}	0 to 350	V [1])
Grid No. 2 voltage	V_{g2}	250	V
Grid No. 1 voltage for visual extinction of focused raster	V_{g1}	-35 to -69	V

<u>Cathode drive service</u>

Voltages are specified with respect to grid No. 1

Final accelerator voltage	V_{a,g_3,g_5}	11	kV
Focusing electrode voltage	V_{g4}	0 to 350	V [1])
Grid No. 2 voltage	V_{g2}	250	V
Cathode voltage for visual extinction of focused raster	V_k	32 to 58	V

1) Individual tubes will have optimum focus within this range. In general an acceptable picture will be obtained with a fixed focus voltage.

LIMITING VALUES (Design centre rating system, unless otherwise stated)

Final accelerator voltage	V_{a,g_3,g_5}	max.	12	kV
		min.	8.5	kV [1]
Grid No.4 voltage				
positive	V_{g_4}	max.	500	V
negative	$-V_{g_4}$	max.	50	V
Grid No.2 voltage	V_{g_2}	max.	350	V
		min.	200	V
Grid No.2 to grid No.1 voltage	V_{g_2/g_1}	max.	450	V
Cathode to grid No.1 voltage				
positive	V_{k/g_1}	max.	100	V
positive peak	$V_{k/g_{1p}}$	max.	350	V [2]
negative	$-V_{k/g_1}$	max.	0	V
negative peak	$-V_{k/g_{1p}}$	max.	2	V
Cathode to heater voltage				
positive	$V_{k/f}$	max.	110	V
positive peak	V_{k/f_p}	max.	130	V

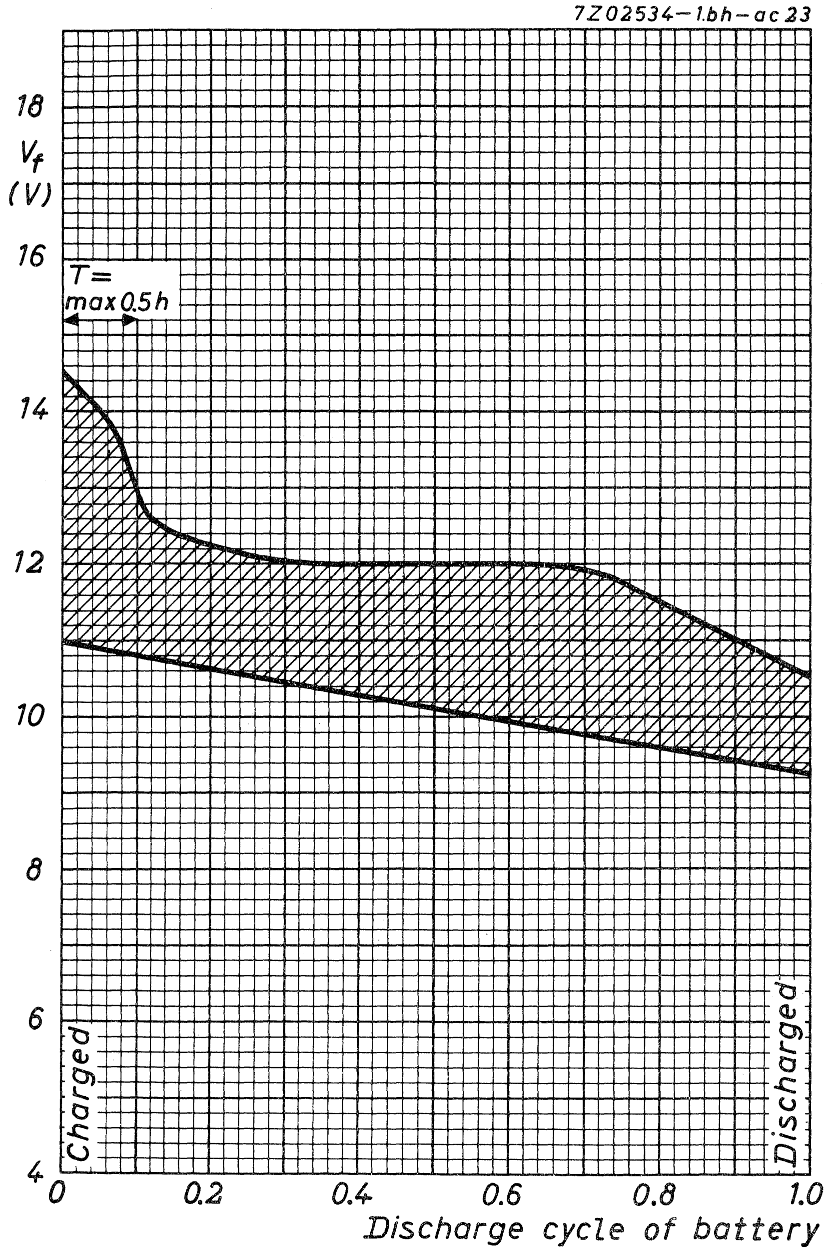
CIRCUIT DESIGN VALUES

Grid No.4 current				
positive	I_{g_4}	max.	25	μA
negative	$-I_{g_4}$	max.	25	μA
Grid No.2 current				
positive	I_{g_2}	max.	5	μA
negative	$-I_{g_2}$	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.	0.1	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
Resistance between external conductive coating and rimband	$R_{m/m'}$	min.	2	MΩ

[1]) Absolute maximum rating system.
[2]) Maximum pulse duration 22% of a cycle but max. 1.5 ms.


7Z02534–1.bh–ac 23
18
V_f
(V)
16
T= max 0.5 h
14
12
10
8
6
4
Charged
Discharged
0
0.2
0.4
0.6
0.8
1.0
Discharge cycle of battery

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 ^{o}
Focusing	electrostatic
Resolution	min. 650 lines
Overall length	max. 317 mm

SCREEN

Metal backed phosphor

Lumenescence	white	
Useful diagonal	min.	329 mm
Useful width	min.	304.5 mm
Useful height	min.	241 mm

HEATING

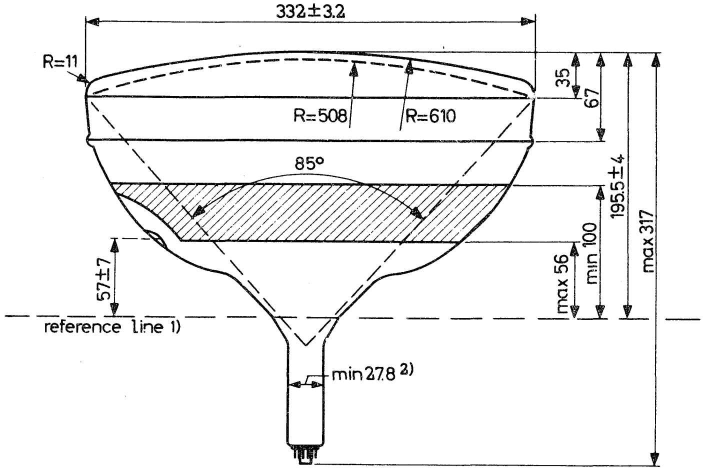
Indirect by A.C. or D.C.; parallel supply

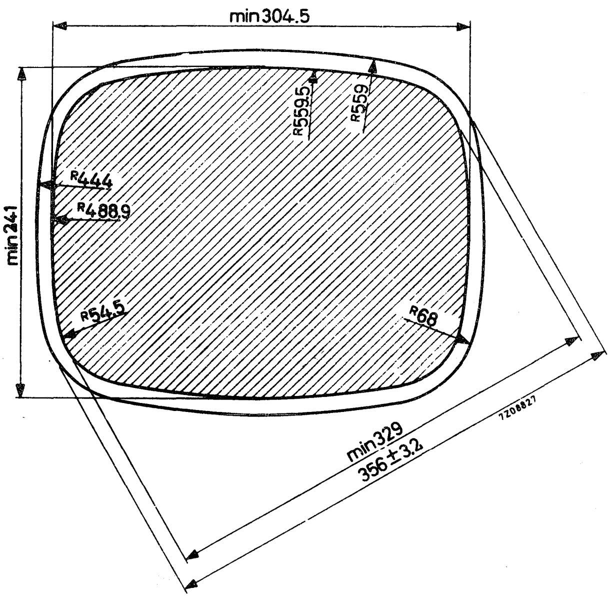
Heater voltage	V_f	=	11 V	$\pm$10 %
Heater current	I_f	=	75 mA	

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

MECHANICAL DATA Dimensions in mm

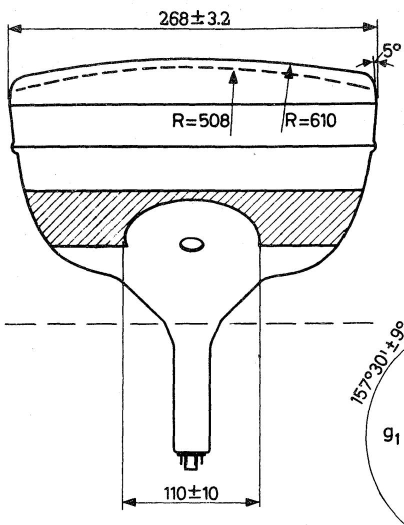


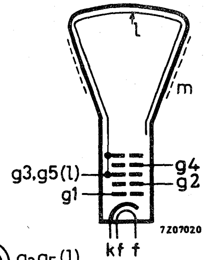


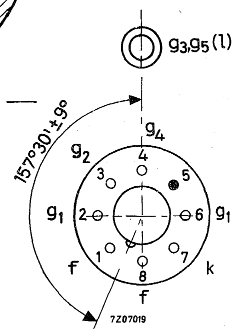
1) Reference line is determined by the plane of the upper edge of the flange of the reference line gauge when the gauge is resting on the cone.
2) The maximum dimension is determined by the reference line gauge.

MECHANICAL DATA (continued)

Dimensions in mm







Base:	Neo Eightar (B8H)
Cavity contact	CT8
Accessories:	
Socket	2422 501 06001
Final accelerator contact connector	type 55563

FOCUSING electrostatic

DEFLECTION magnetic

Diagonal deflection angle 90°

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	$V_{g3,g5(\ell)}$	=	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.

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

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.

[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.

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°
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

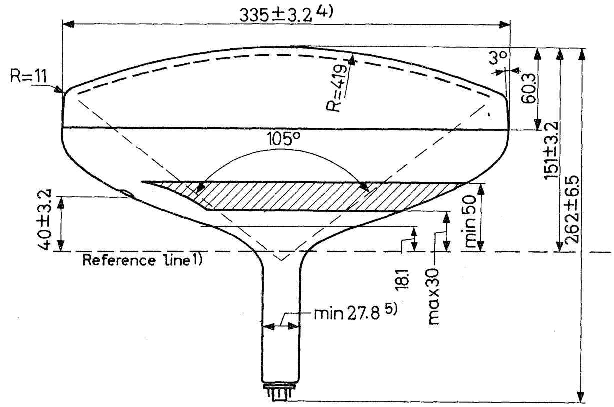
HEATING

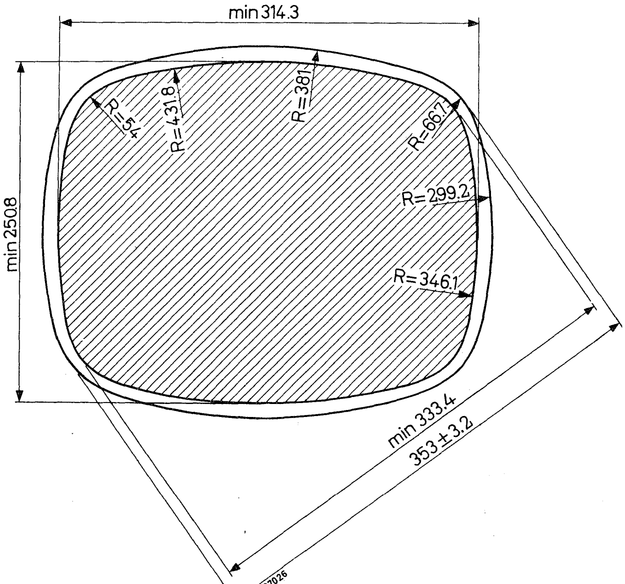
Indirect by A.C. or D.C.; parallel or series supply

Heater voltage	V_f	6.3	V
Heater current	I_f	300	mA

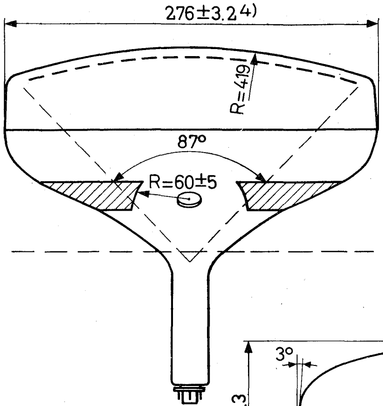
MECHANICAL DATA

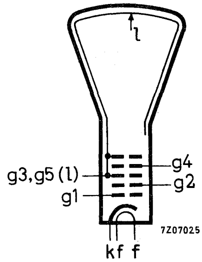
Dimensions in mm

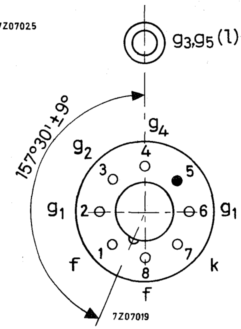


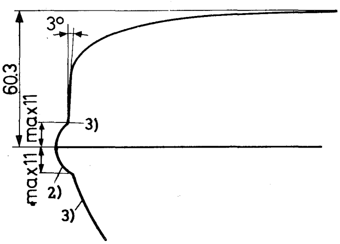


MECHANICAL DATA (continued) Dimensions in mm









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)
Cavity contact	CT8
Accessories	
Final accelerator contact connector	type 55563
Socket	2422 501 06001

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°

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

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	$V_{g_3,g_5(\ell)}$	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.

LIMITING VALUES (Absolute max. rating system)

Measured with respect to cathode

Final accelerator voltage	V_{g_3,g_5}(1)	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 Hz)	Z_{kf}	max.	500	kΩ
Impedance between cathode and earth (f = 50 Hz)	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.

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) 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.

3) The tube should be supported on both sides of the bulge. The mechanism used should provide clearance for the maximum dimensions of the bulge.

4) Measured 12 + 1 mm from the centre-line of the screen-cone seal.

5) The maximum dimension is determined by the reference line gauge.

MONITOR TUBE

36 cm rectangular television tube with metal backed screen and integral protection 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			
Lumenescene	white		
Useful diagonal	min.	329	mm
Useful width	min.	304.5	mm
Useful height	min.	241	mm

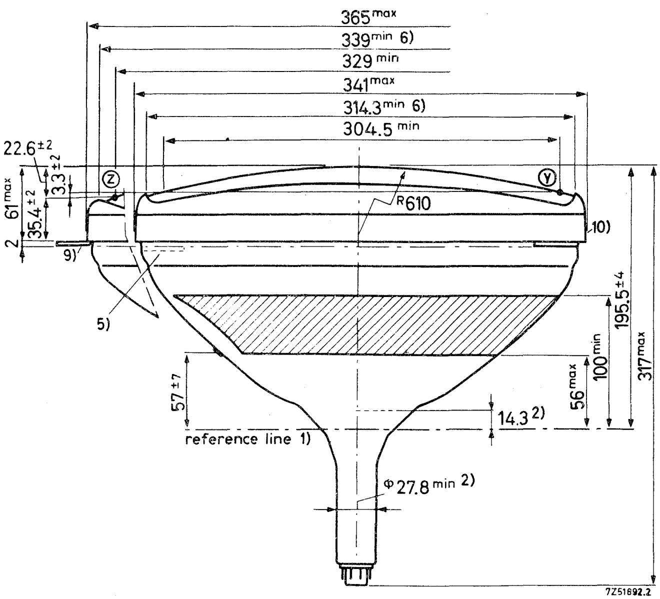
HEATING

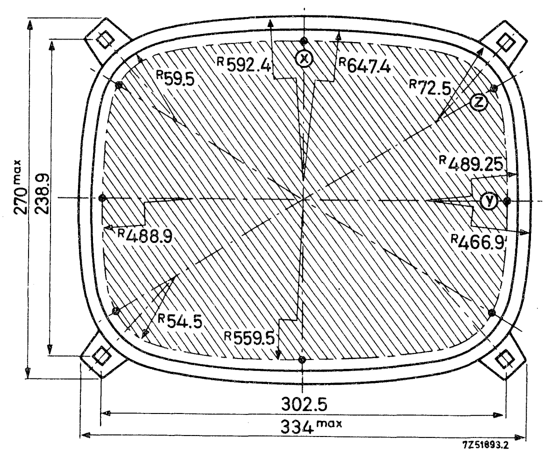
Indirect by A.C. or D.C.; parallel supply

Heater voltage	V_f	11	V±10%
Heater current	I_f	75	mA

MECHANICAL DATA

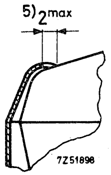
Dimensions in mm

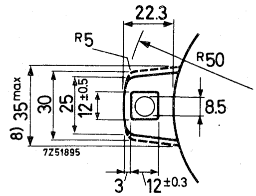


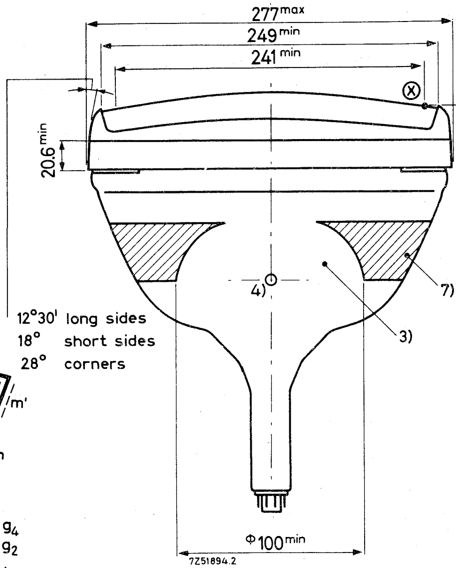


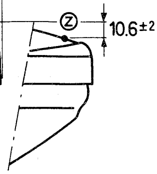
Notes see page 4

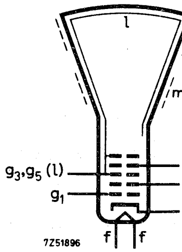
MECHANICAL DATA (continued) Dimensions in mm

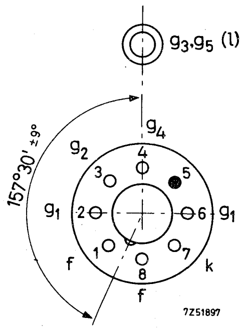












Mounting position: any

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)

Cavity contact	CT8

Accessories:

Socket	2422 501 06001
Final-accelerator contact connector	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°

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.

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 when the gauge is resting on the cone.
2. End of guaranteed contour. The maximum neck and cone contour is given by the reference line gauge.
3. This area must be kept clean.
4. Recessed cavity contact.
5. Meniscus of resin filler on screen.
6. Opening of the metal ring band. Eccentricity with respect to centre of screen max. 1.5 mm.
7. The configuration of the external conductive coating is optional but contains the contact area shown in the drawing.
8. Minimum space to be reserved for mounting lugs.
   The mounting screws in the cabinet must be situated inside a circle of 8.5 mm diameter drawn around the true geometrical position i.e. corners of a rectangle of 302.5 mm x 238.9 mm.
9. The deviation of any lug with respect to the plane through the other three lugs is max. 2 mm.
10. The metal rimband must be earthed. No electrical contact between the band and the mounting lugs can be guaranteed.

TYPICAL OPERATION

Final accelerator voltage	$V_{g_3,g_5(\ell)}$	16 kV
Focusing electrode voltage	V_{g_4}	0 to 500 V [1])
First accelerator voltage	V_{g_2}	600 V
Grid No.1 voltage for extinction of focused raster (grid drive service)	$-V_{g_1}$	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:	$V_{g_3,g_5(\ell)}$	16 kV
	V_{g_2}	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.

LIMITING VALUES (Absolute max. rating system)

Final accelerator	$V_{g_3,g_5(\ell)}$	max. 18 kV min. 12 kV
Focusing electrode voltage	V_{g_4} $-V_{g_4}$	max. 1 kV max. 500 V
First accelerator voltage	V_{g_2}	max. 800 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. 180 V
Cathode to heater voltage	V_{kf}	max. 80 V
peak	V_{kf_p}	max. 130 V
Focusing electrode current	I_{g_4}	max. ±25 μA
First accelerator current	I_{g_2}	max. ± 5 μA

For notes see page 6

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	$Z_{k/f}$ (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
First accelerator circuit resistance	R_{g_2}	max. 1	MΩ
Focusing electrode circuit resistance	R_{g_4}	max. 3	MΩ

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.

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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.

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.

MONITOR TUBE

The M38-120W is a 38 cm diameter rectangular television tube with metal backed screen primarily intended for use as a monitor tube.

QUICK REFERENCE DATA			
Deflection angle		110^{o}	
Focusing		electrostatic	
Resolution	min.	650	lines
Overall length	max.	279.5	mm

SCREEN

Metal backed phosphor

Luminescence		white	
Light transmission of face glass		50	%
Useful diagonal	min.	350	mm
Useful width	min.	290.9	mm
Useful height	min.	226	mm

HEATING

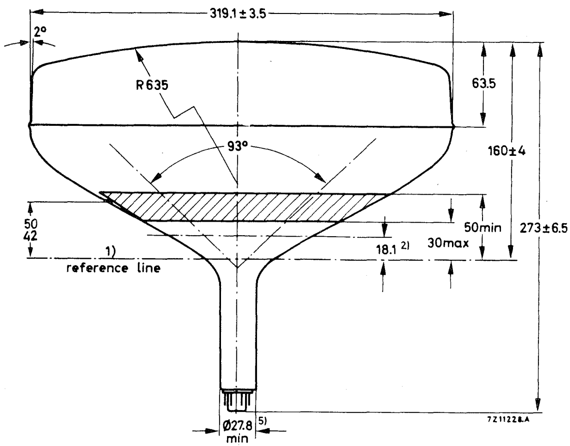
Indirect by A.C. or D.C.; parallel or series supply

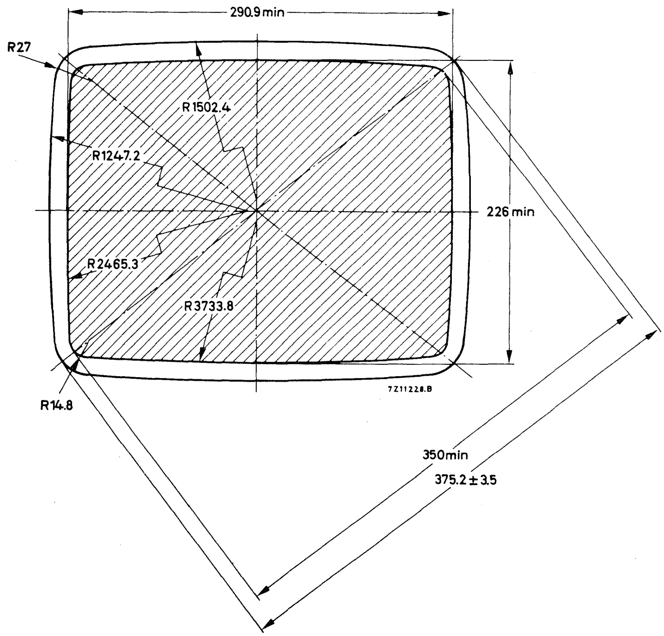
Heater voltage	V_f	6.3	V
Heater current	I_f	300	mA

CAPACITANCES

Control grid to all other elements	C_{g_1}	6.0	pF
Cathode to all other elements	C_k	4.5	pF
Final accelerator to external conductive coating	$C_{g_3,g_5(\ell)/m}$	600	pF

MECHANICAL DATA





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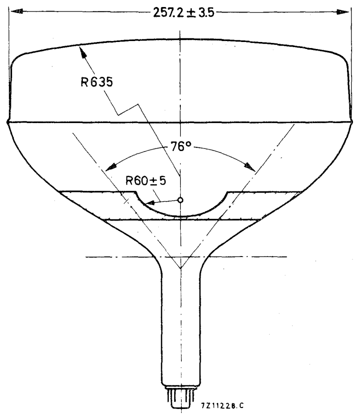
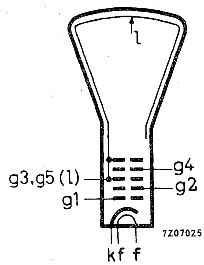
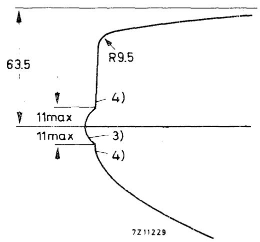
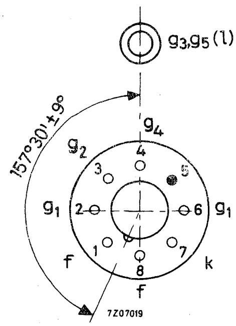








Mounting position: any, except vertical with the screen downward and the axis of the tube making an angle of less than 20° with the vertical.

Base	Neo eightar (B8H)
Cavity contact	CT8
Accessories	
Final accelerator contact connector	type 55563
Socket	2422 501 06001

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) See page 6.

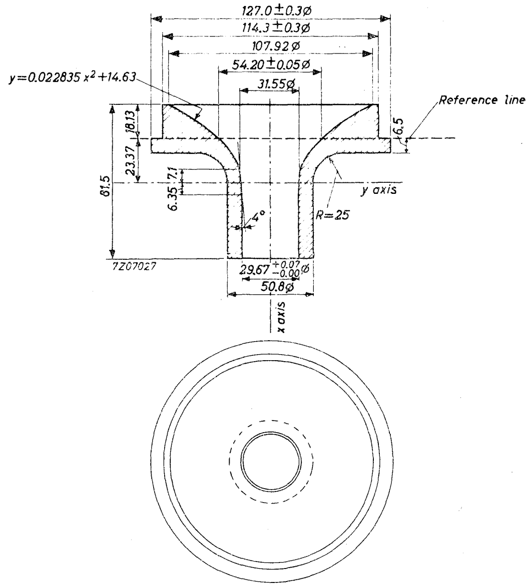
PICTURE CENTRING MAGNET

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

JEDEC 126



TYPICAL OPERATING CONDITIONS

Final accelerator voltage	$V_{g3,g5(\ell)}$	16	kV
Focusing electrode voltage	V_{g4}	0-400	V 1)
First accelerator voltage	V_{g2}	400	V
Grid No.1 voltage for visual extinction of a focused raster	$-V_{g1}$	40 to 85	V
Resolution at screen centre		min. 625	lines
Measured at	$V_{g3,g5(\ell)}$	16	kV
	V_{g2}	400	V

This tube will resolve 650 lines measured at a screen current of 100 μA.
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)

Measured with respect to cathode

Final accelerator voltage	$V_{g_3 \cdot g_5 (\ell)}$	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 Hz)	Z_{kf}	max.	500	kΩ
Impedance between cathode and earth (f = 50 Hz)	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.

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 reference line gauge, (JEDEC 126) when the gauge is resting on the cone.

2) End of guaranteed contour. The maximum neck and cone contour is given by the Reference line gauge (see page 4).

3) 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.

4) The tube should be supported on both sides of the bulge. The mechanism used should provide clearance for the maximum dimensions of the bulge.

5) The maximum dimension is determined by the reference line gauge.

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	red
Colour point	x=0.19 y=0.72	x=0.17 y=0.13	x=0.661 y=0.331

Useful area min. 92x69 mm^2

Brightness

MG13-38	2000	mcd/cm^2
MU13-38	290	mcd/cm^2
MY13-38	600	mcd/cm^2

measured at V_{g_2} = 50 kV
I_ℓ = 500 μA
raster size 92x69 mm^2

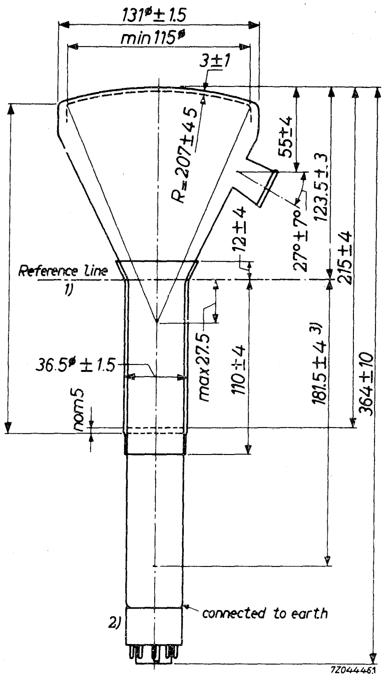
HEATING

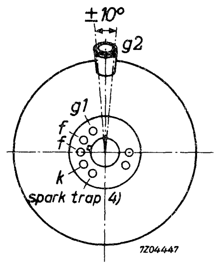
Indirect by A.C. or D.C.; parallel or series supply

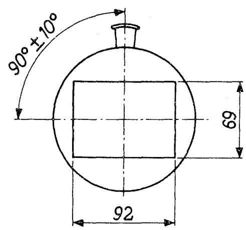
Heater voltage	V_f	6.3	V
Heater current	I_f	300	mA

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.

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

LIMITING VALUES (Absolute max. rating system)

Measured with respect to cathode

Accelerator voltage	$V_{g_2(\ell)}$	max. min.	55 40	kV 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
cathode negative	$V_{-k/f+}$	max.	50	V [2]
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}.

GENERAL OBSERVATIONS

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

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 area	92 x 69 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

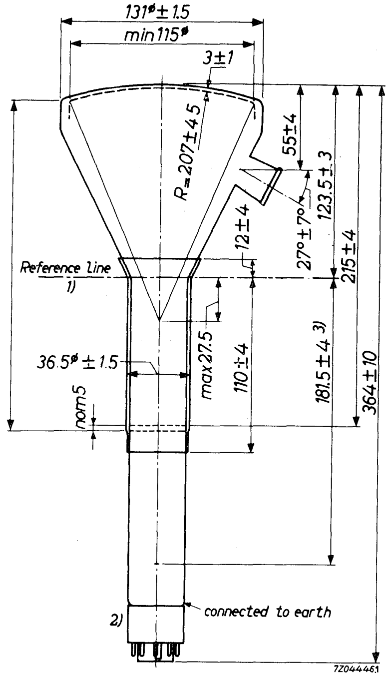
Indirect by A.C. or D.C.; parallel or series supply

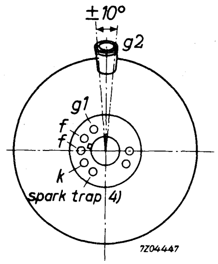
Heater voltage	V_f	6.3	V
Heater current	I_f	300	mA

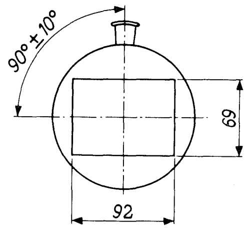
CAPACITANCES

Control grid to all other elements	C_{g_1}	max.	10	pF
Cathode to all other elements	C_k	max.	9	pF

MECHANICAL DATA Dimensions in mm







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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.

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

LIMITING VALUES (Absolute max. rating system)

Measured with respect to cathode

Accelerator voltage	$V_{g_2(\ell)}$	max. min.	55 40	kV 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}.

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.

Replacement type, see Q13-110..

Apart from the phosphor, the Q13-110.. is equivalent to the M.13-16.
The Q13-110GU has an improved phosphor with respect to the MK13-16.
The Q13-110BA has the same phosphor as the MC13-16.

FLYING SPOT SCANNER TUBE

The Q13-110.. 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
Q13-110BA	Purplish blue	Very short
Q13-110GU	White	Very short

Useful screen diameter	min.	108	mm

HEATING

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

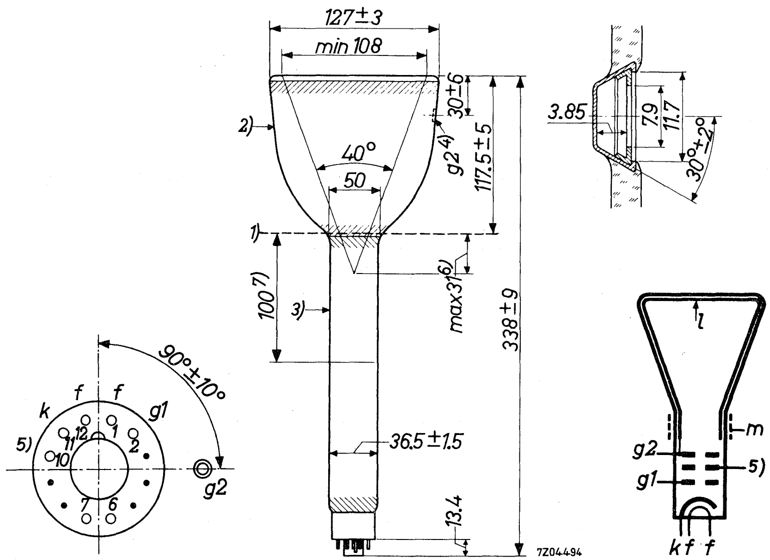
Heater voltage	V_f	6.3	V
Heater current	I_f	300	mA

CAPACITANCES

Grid No.1 to all other electrodes	C_{g1}	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

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.

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.

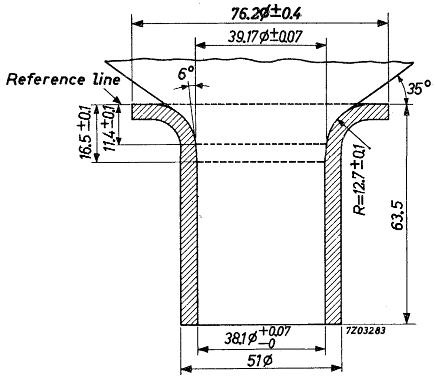
7) Distance between the centre of the magnetic length of the focusing unit and the reference line.

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

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 Hz	Z_{g_1} (f = 50 Hz)	max.	0.5	MΩ

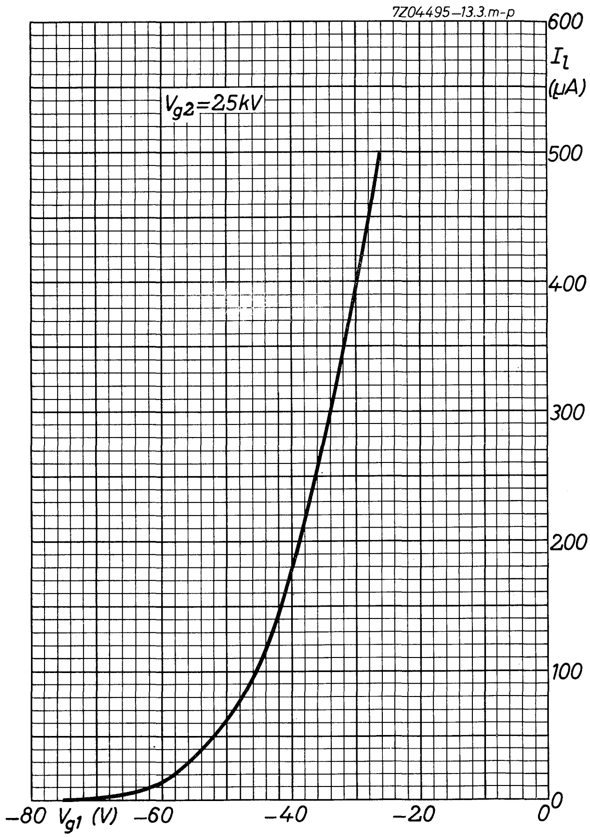
REMARKS

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.

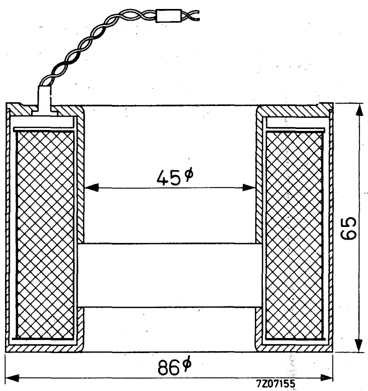
[1] In order to avoid excessive hum, the A.C. component of the heater to cathode voltage should be as low as possible and should not exceed 20 V_{RMS}.

[2] During a heating-up period not exceeding 45 sec.


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

Associated accessories

FOCUSING COIL

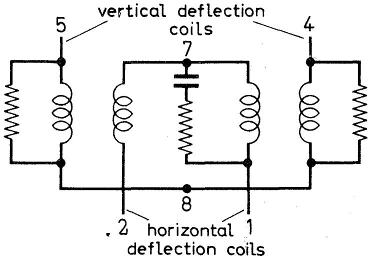


Number of turns	26500
D.C. Resistance	6000 Ω

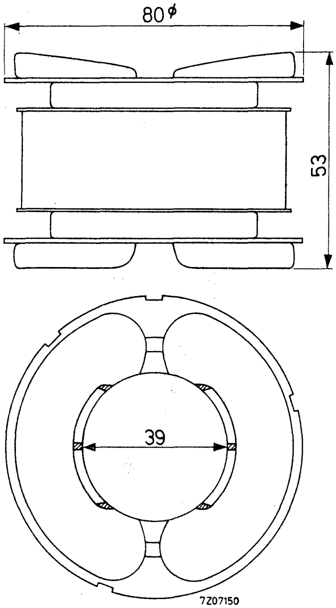
When the MC13-16 is operated at $V_{g_2}(\ell)$ = 25 kV, the current through the focusing coil should be adjusted at approx. 33 mA.

The distance between air-gap centre and the screen surface of the MC13-16 should be 217 mm.

DEFLECTION COIL UNIT



When the MC13-16 is operated at $V_{g_2(\ell)}$ = 25 kV and raster dimensions 60 x 80 mm^2, the horizontal and vertical deflection coils should be connected in series.



Horizontal deflection coils

Inductance	6	mH
Resistance	5.6	Ω
Current, peak to peak	700	mA
Connections (red, grey)	1 and 2	

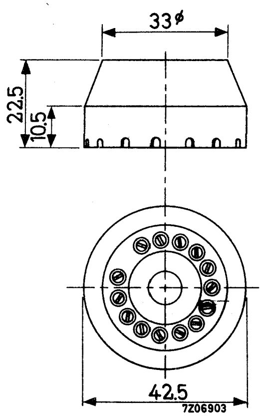
Vertical deflection coils

Inductance	8	mH
Resistance	9.6	Ω
Current, peak to peak	540	mA
Connections (yellow, black)	4 and 5	

Operating temperature max. 85 °C

TUBE SOCKET

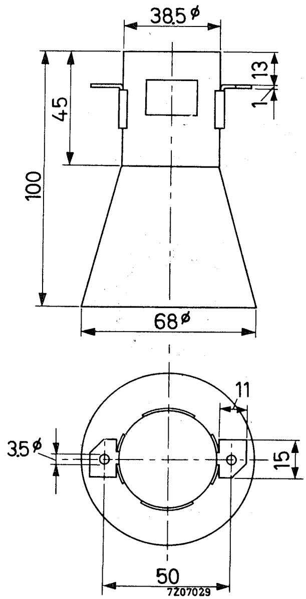
FOR 14-PIN ALL GLASS BASES



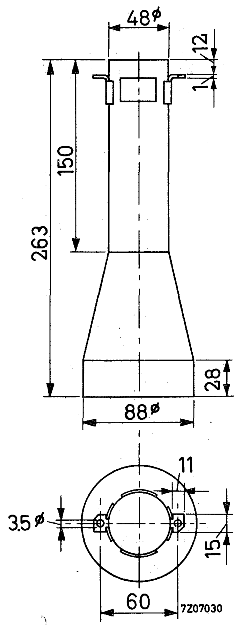
Material: Synthetic resin insulating material

14 silver plated fork-shaped contacts

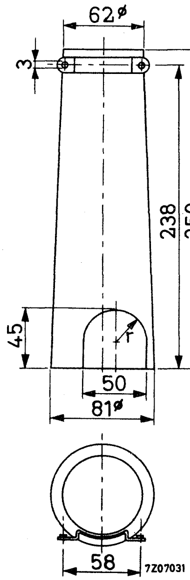
MU-METAL SCREEN



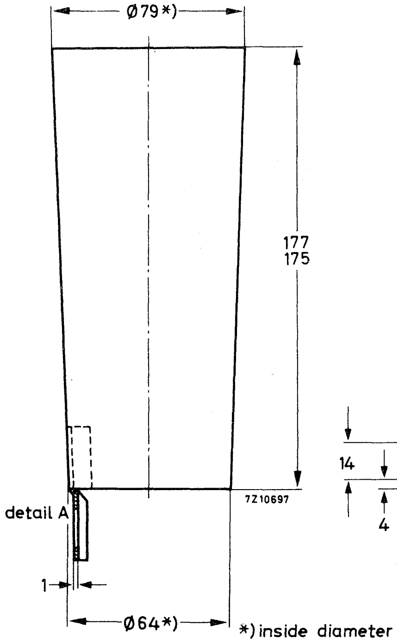
MU-METAL SCREEN



MU-METAL SCREEN

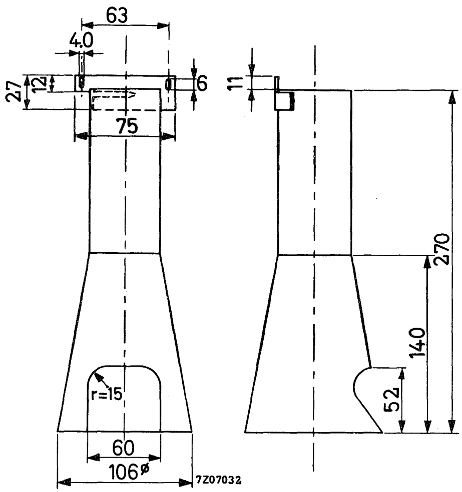


MU-METAL SCREEN

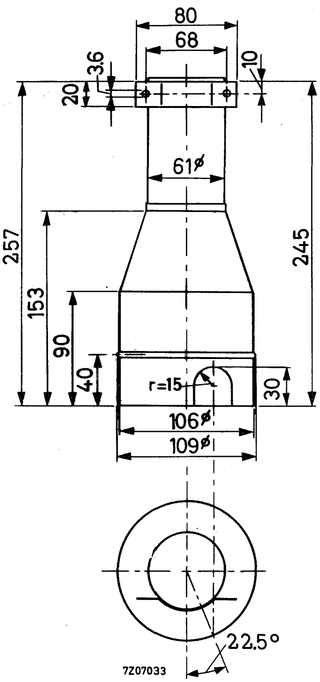


Material: Mu-metal, 0.35 mm thick

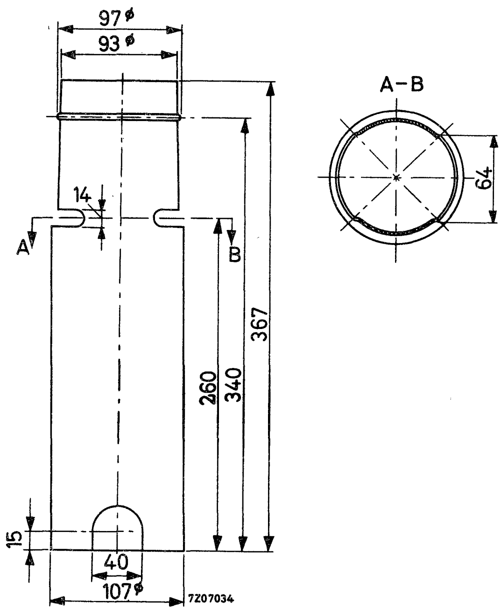
MU-METAL SCREEN



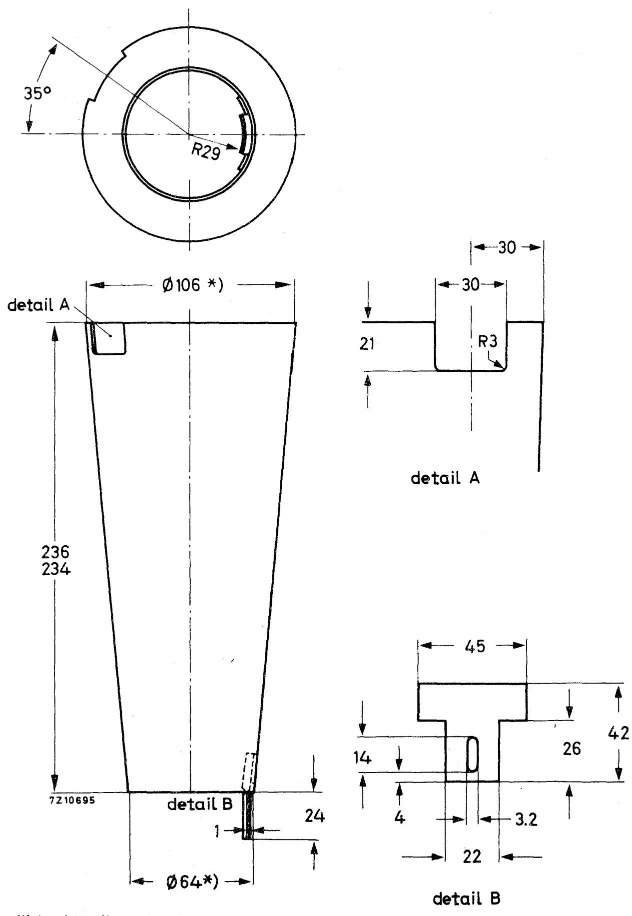
MU-METAL SCREEN



MU-METAL SCREEN



MU–METAL SCREEN

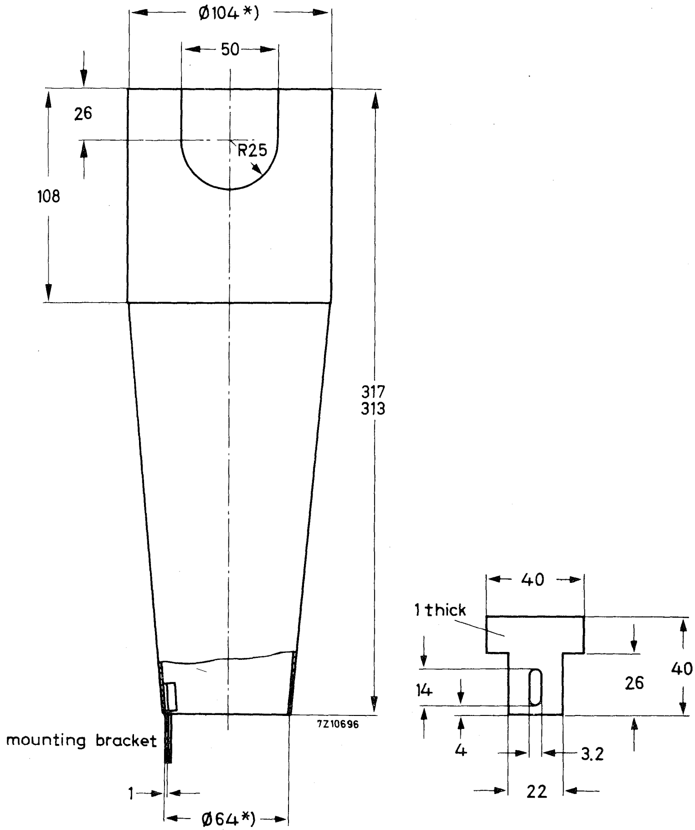


*) inside diameter

Material: Mu-metal, 0.35 mm thick

MU-METAL SCREEN

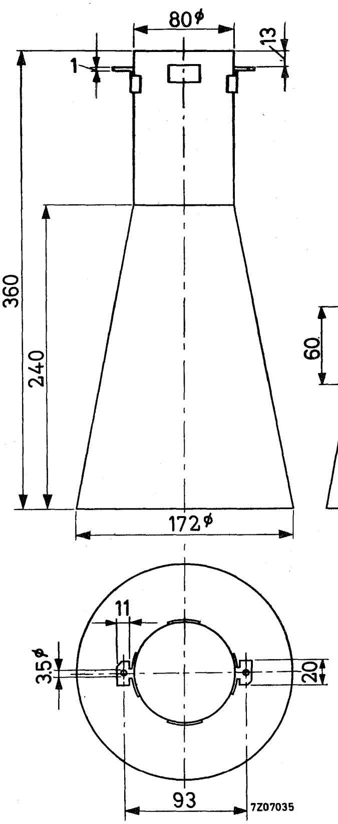
Type 55548A without mounting bracket
Type 55548 with mounting bracket



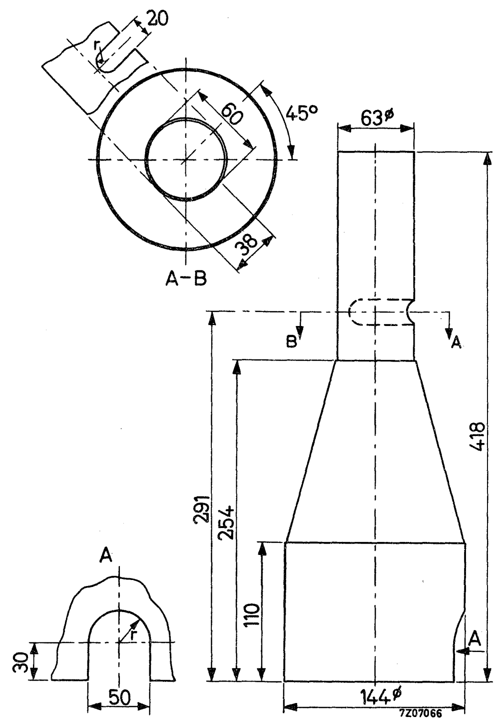
*) inside diameter

Material: Mu-metal, 0.5 mm thick

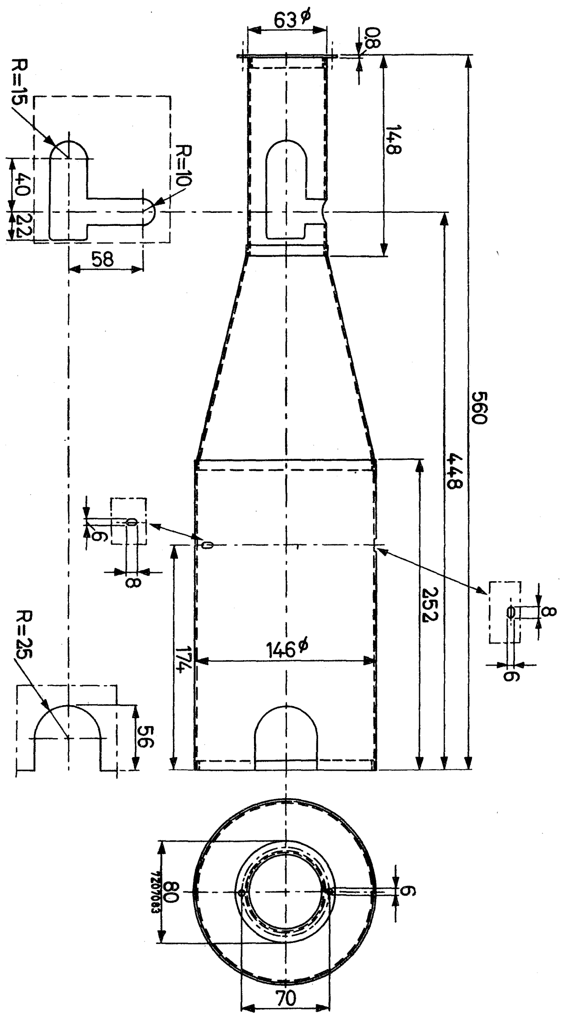
MU-METAL SCREEN



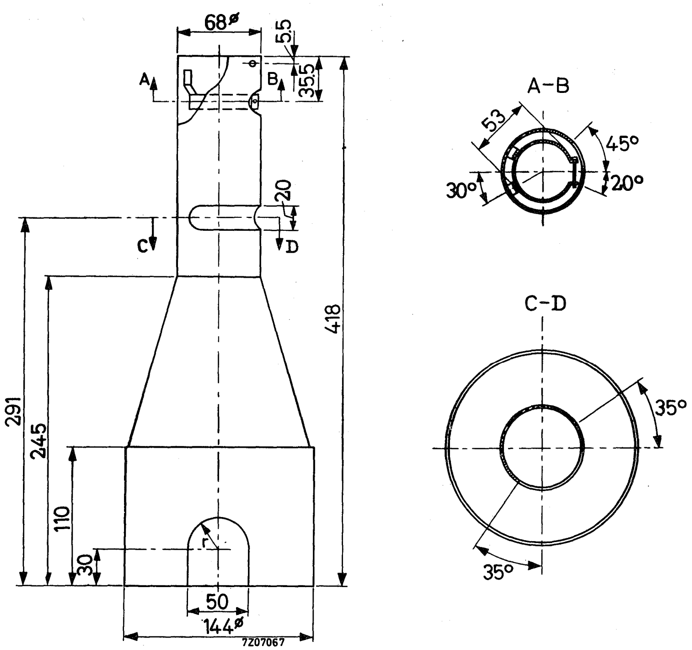
MU-METAL SCREEN



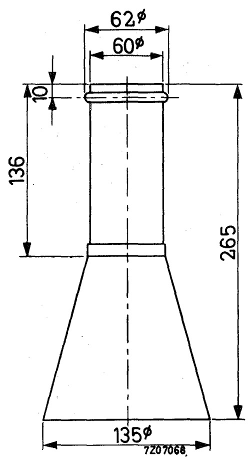
MU-METAL SCREEN



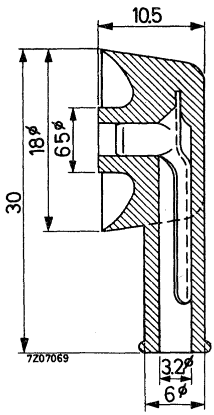
MU-METAL SCREEN



MU-METAL SCREEN

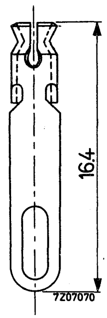


FINAL ACCELERATOR CONTACT CONNECTOR

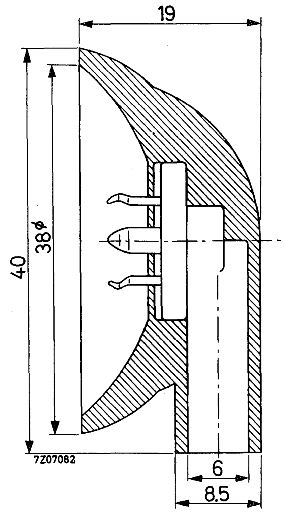


Material: cadmium plated spring contact
rubber insulating material

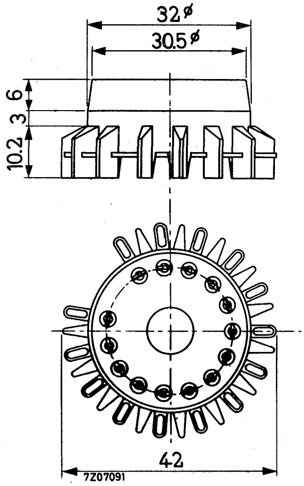
SIDE CONTACT CONNECTOR



FINAL ACCELERATOR CONTACT CONNECTOR



TUBE SOCKET FOR 14-PIN BASES

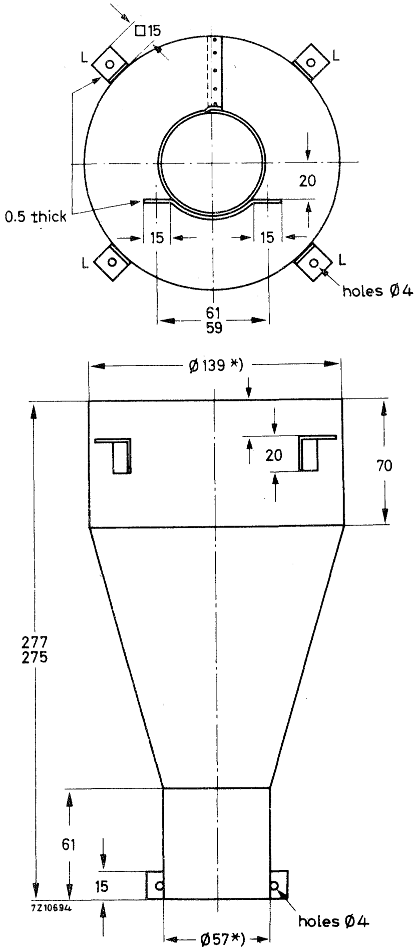


Material: synthetic resin insulating material

14 gold plated fork shaped contacts

MU-METAL SCREEN

Type 55580A with 4 mounting lugs L
Type 55580 without mounting lugs L

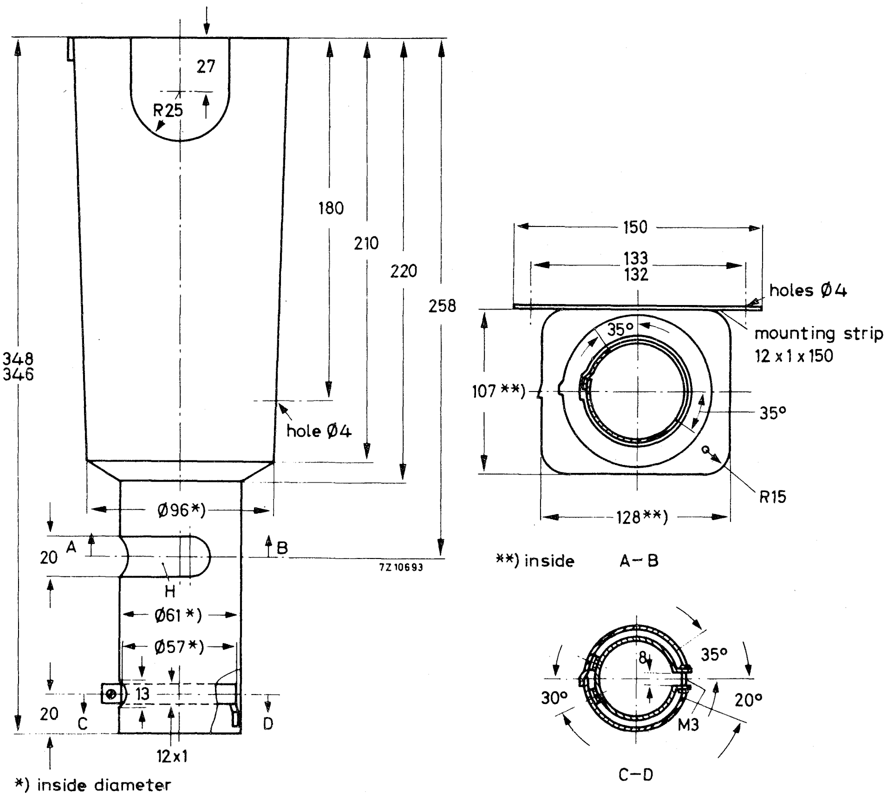


*) inside diameter

Material: Mu-metal, 0.35 mm thick

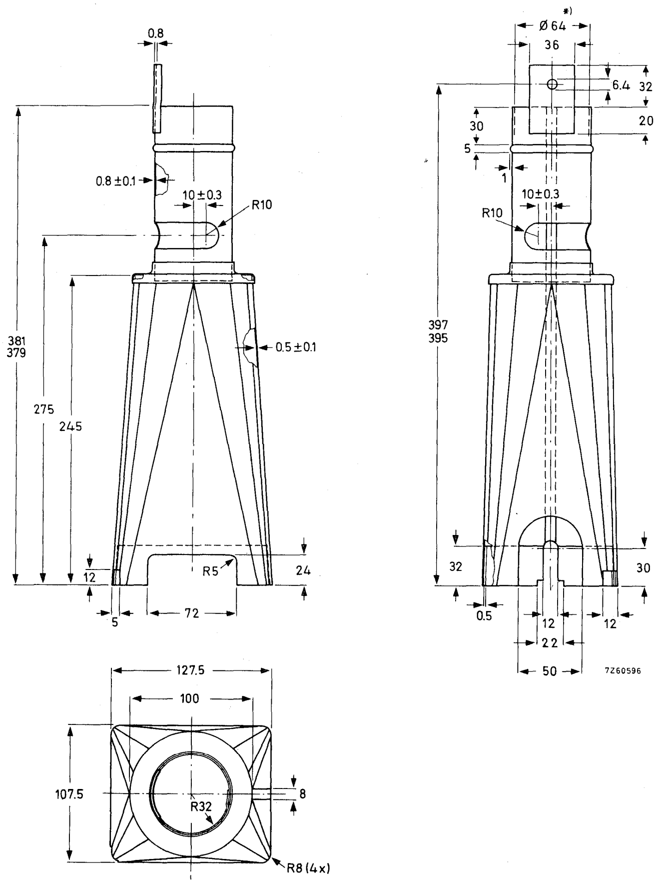
MU-METAL SCREEN

Type 55581A with hole H
Type 55581 without hole H



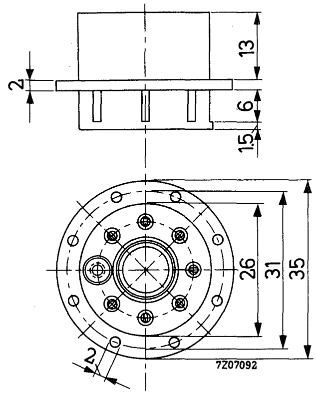
Material: Mu-metal, 0.5 mm thick

MU-METAL SCREEN



*) inside diameter

TUBE SOCKET FOR 7-PIN BASES



Material: synthetic resin insulating material

7 contacts, guiding hole and central hole

Camera tubes

GENERAL OPERATIONAL NOTES CAMERA TUBES VIDICONS

A. PRINCIPLES OF OPERATION OF VIDICONS WITH MAGNETIC FOCUSING; MAGNETIC DEFLECTION

1. With integral mesh

Mechanical design

The schematic arrangement of the vidicon with its accessories is shown in Fig.1.

The vidicon may be assumed to consist of three sections, namely the electron gun, the scanning section, and the target section.

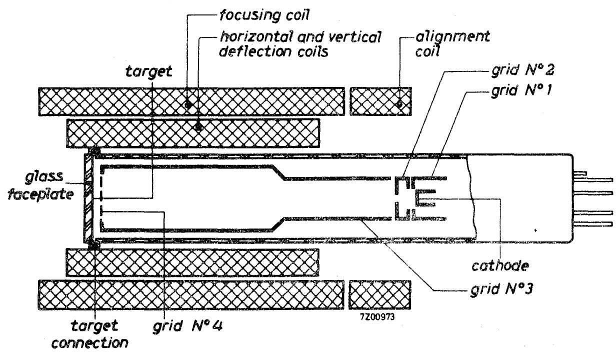


Fig.1. Schematic electrode and coil arrangement

The electron gun contains a thermionic cathode, a grid g_1 controlling the beam current, and a limiter electrode g_2 which accelerates the electrons and releases them in a fine beam through its diaphragm.

The scanning section. The electron beam released by g_2 enters the space enclosed by the cylindrical electrode g_3. By means of the combined action of the adjustable electrical field of g_3 (beam focus control) and a fixed axial magnetic field produced by the focusing coil, the electrons are focused in one loop on to the target.

The far end of the g_3 cylinder is closed with a fine metal mesh, g_4, electrically connected to g_3, which produces a uniform, decelerating field in front of the target. The focused beam is magnetically deflected by two pairs of deflection coils so that it scans the target. Proper alignment of the beam with the axial magnetic field is achieved by either an adjustable magnet, or, as shown in Fig.1, by two sets of alignment coils producing an adjustable transverse magnetic field.

The target section is illustrated in Fig.2. It consists of:

- an optically flat glass faceplate,
- a transparent conductive film on the inner surface of the faceplate, connected electrically to the external signal-electrode ring,
- a thin layer of photoconductive material deposited on the conductive film; in the dark this material has a high specific resistance, which decreases with increasing illumination.

The optical image to be televised is focused on the conductive film by means of a lens system.

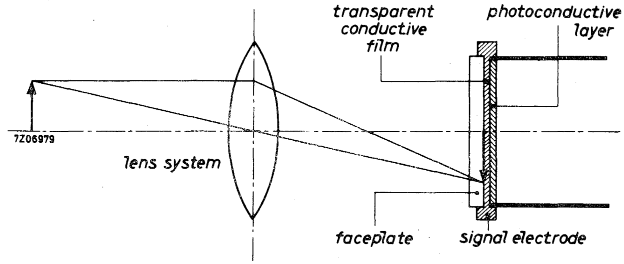


Fig.2. Target section

Operation

The external signal-electrode ring is connected via a load resistor to a positive voltage in the order of 30 V (see Fig.3).

The target may be assumed to consist of a large number of target elements corresponding to the number of picture elements. Each target element consists of a small capacitor (C_e), connected on one side to the signal electrode via the transparent conductive film and shunted by a light-dependent resistor(R_{ld}), see Fig.3).

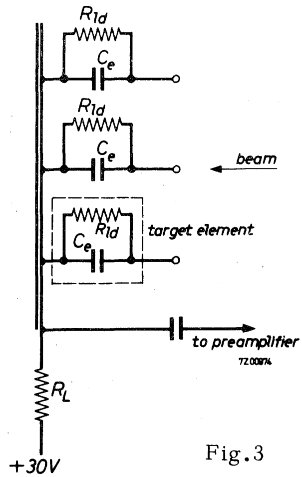


Fig.3

When the target is scanned by the beam its surface will be "stabilized" at approximately the cathode potential (low-velocity stabilization) and a potential difference will be established across the photoconductive layer, in other words, each elementary capacitor will be charged to nearly the same potential as applied to the electrode ring.

In the dark, the photoconductive material is a fairly good insulator, so that only a minute fraction of the charge of the elementary capacitors will leak away between successive scans. This charge will be restored by the beam; the resulting current to the signal electrode is termed "dark current".

When an optical image is focused on to the target, those target elements which are illuminated will become more conductive and will be partly discharged. As a consequence a pattern of positive charges corresponding to the optical image will be produced on the side of target facing the gun section.

While scanning this charge pattern the electron beam will deposit electrons on the positive elements until the latter are restored to their original cathode potential, causing a capacitive current to the signal electrode and hence a voltage across the load resistor R_L. This voltage, negative going for the highlights, is the video signal and is fed to the pre-amplifier.

A vidicon is called "stabilized" when the magnitude of the beam current applied is just sufficient to restore the scanned surface to cathode potential, so that all elementary capacitors, inclusing those at the highlights in the image, are recharged successively.

During the retrace periods the beam electrons should be prevented from landing on the target since otherwise the scan retraces will appear as dark lines in the picture obtained on the monitor. This may be achieved either by cutting off the beam with suitable negative blanking pulses on the control grid or by cutting off the target with adequate positive blanking pulses applied to the cathode.

2. With a separate mesh construction

The focus coils commonly used in vidicon cameras do not produce an ideal focus field distribution in the vicinity of the vidicon's photoconductive target.

The resulting "landing errors" of the scanning beam reduce the sensitivity and resolution at the periphery of the picture. The beam landing errors can be corrected by electron-optical means. A lens for this purpose may be formed by the cylindrical electrode (g_3) and the mesh electrode (g_4). In the vidicons with a separate mesh electrode g_4 is electrically insulated from g_3 and connected to a separate base pin.

The mesh electrode (g_4) should be made positive with respect to the cylindrical electrode (g_3); the optimum potential difference depends on:
a. the operating mode of the vidicon (choice of the focusing field and V_{g_3});
b. the particular type of deflection coil unit used.
As a rule, to obtain the best resolution and most uniform whites the V_{g_4} should be from 1.1 to 1.5 times higher than V_{g_3}. Fig.4 shows a typical curve revealing the effect of the ratio V_{g_4}/V_{g_3} on the resolution measured on a vidicon type XQ1040 in a coil unit type AT1101. The fall-off in resolution at $V_{g_4}/V_{g_3} = 1$, corresponding to the situation with conventional vidicons, is caused by the defocusing effect of a space charge at the cathode side of the mesh electrode, produced by secondary electrons released from the mesh. This space charge can be prevented from building up by making g_4 at least 15 Volts positive relative to g_3.

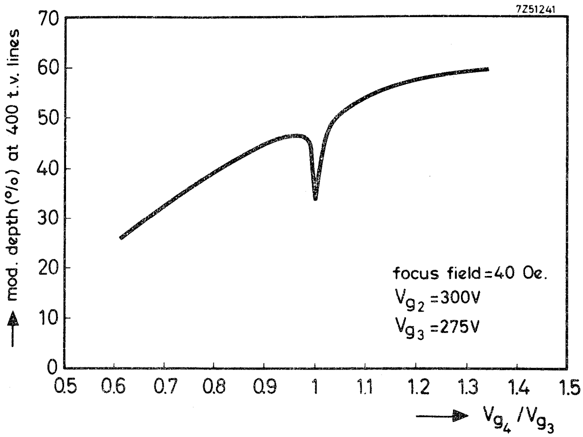


Fig.4. Effect of the V_{g4}/V_{g3} ratio on the resolution of a vidicon type XQ1040.

Operation of g_4 at a negative potential with respect to g_3 must be avoided in any case, since this would inflict permanent damage on the target, due to ion bombardment. A higher potential applied to g_4 will slightly raise the required deflection currents but these will usually remain well within the ratings of the camera deflection circuits.

Caution. If the camera wiring has been adapted) for the use of vidicons with separate mesh, insertion of an integral-mesh vidicon will result in normal performance of the tube and do no harm to the tube or the wiring of the camera. However, it should be borne in mind that the insertion of a separate-mesh vidicon in an unmodified camera may be detrimental to the vidicon, its target being damaged by ion bombardment; moreover, performance will be unsatisfactory.

) A leaflet is available on request giving suggestions for making cameras suitable for incorporating integral-mesh tubes.

B. EQUIPMENT DESIGN AND OPERATING CONSIDERATIONS

The signal electrode connection should be made by a spring contact which bears against the metal ring at the face end of the tube. The spring contact may be provided as part of the focusing coil design.
The signal-electrode voltage should be limited to such a value that the peak dark current does not exceed 0.25 μA.

This is of particular importance for the design and adjustment of vidicon cameras with automatically controlled sensitivity (automatic control of the signal-electrode voltage).

Operation of vidicons at excess dark current will result in damage to the photoconductive target and hence shorten the tube life.

The deflection yoke and the focus coil used must be so designed that the beam lands perpendicularly to the target at all points of the scanned area, to ensure high uniformity of sensitivity and focus.

The deflection circuits must provide constant scanning speeds in order to obtain good black-level reproduction. The dark-current signal being proportional to the velocity of scanning, any change in this velocity will produce a black-level error.

The polarity of the focusing coil should be such that a north-seeking pole is attracted to the image end of the focusing coil, with the indicator located outside of and at the image end of the focusing coil.

The alignment coil assembly should be located on the tube so that its centre is at a distance of approx. 94 mm (3 11/16 in) from the face of the tube, and be positioned so that its axis coincides with the axis of the tube, the deflecting yoke and the focusing coil.

The temperature of the faceplate should never exceed 80 °C, either during operation or storage. Operation at a faceplate temperature of 25 to 35 °C is recommended.

The temperature of the faceplate is determined by the heating effects of the incident illumination, the associated components and the environment and, to a minor extent, by the tube itself.

To reduce these heating effects and to permit operation in the preferred temperature range under conditions of high light levels, respectively high ambient temperatures, the use of an infra-red filter between object and camera lens, or a flow of cooling air directed across the faceplate, is recommended.

Scanning amplitude

Full-size scanning of the 9.6 mm x 12.8 mm area of the photoconductive layer should always be applied.
Underscanning of the photoconductive layer, i.e. scanning of an area of less than 9.6 mm x 12.8 mm or failure of scanning for even a short duration should always be avoided, since this may cause permanent damage to the specified full-size area.

The resolution of a vidicon generally decreases with decreasing V_{g3} and V_{g4}. The voltage range will depend on the design of the focusing coil, which should be such as to provide a field strength within 2.9 A/mm and 3.5 A/mm (36 Oe to 44 Oe).
Definition, focus uniformity and picture quality also decrease with decreasing V_{g3} and V_{g4}. In general g_3 and g_4 should be operated above 250 V.
A substantial increase in both limiting resolution and amplitude response may be obtained by increasing the operating voltage of g_3 and g_4 to 750 V. With this mode of operation, the focusing field strength must be increased to approx. 5.6 A/mm (70 Oe).

Since beam-landing errors increase with increasing V_{g3} and V_{g4}, such operation will show a reduced signal output in the corners of the scanned area. When a vidicon with integral mesh is operated in this manner, the deflecting and focusing coils employed must be designed in such a way that beam-landing errors are minimized.

Compensation of residual beam-landing errors can be obtained by supplying modulating voltages of parabolic shape and of both horizontal and vertical scanning frequencies to the cathode and additionally, in order to prevent beam-modulation, to g_1, g_2, g_3 and g_4.

A suitable amplitude for this mixed parabolic waveform is approximately 4 V peak-to-peak. The polarity should be chosen such that the potential of the cathode is lowered as the beam approaches the edges of the scanned area. The use of this modulating waveform also improves the centre-to-edge focus of the vidicon.

Operation with V_{g3} and V_{g4} at 750 V and a field strength of 5.6 A/mm (70 Oe) requires increased power for the deflecting and focusing coils, which will result in a higher tube temperature unless adequate provisions for cooling are made. Compensation of beam-landing errors by means of mixed modulating voltages of parabolic shape is in general not needed for vidicons with separate mesh since the beam-landing errors may be sufficiently reduced by a proper choice of V_{g4}.

C. INSTRUCTIONS FOR USE FOR VIDICONS WITH MAGNETIC FOCUSING AND MAGNETIC DEFLECTION

1. In the case of a separate-mesh vidicon make certain that the camera is adapted for separate-mesh vidicons.
2. Clean the faceplate of the tube.
3. Insert the tube in the deflection unit so that the straight sides of the masked portions of the faceplate are essentially parallel to the line scan.
4. Press the socket firmly onto the base pins.
5. Cap lens and close iris.
6. Set: (a) grid No.1 bias control at maximum negative bias (beam cut-off)
   (b) signal-electrode voltage to approximately 25 V
   (c) scanning amplitude to maximum scan.
7. Switch on camera equipment and monitor; allow a few minutes for heating up.
8. Adjust monitor to produce a faint, non overscanned, raster.
9. Direct camera to the scane to be televised and uncap lens.
10. Turn grid No.1 bias-control slowly till a picture is produced on the monitor. If this picture appears washed out, increase beam current. If the picture is too faint, increase lens aperture.
11. Adjust beam focus (V_{g3} and V_{g4} for integral-mesh tubes, V_{g3} for separate-mesh tubes) and optical focus alternately for best possible focus.
12. Adjust scanning amplitudes:
    (a) by means of a mask of 9.6 mm x 12.8 mm, which is in contact with and centred at the faceplate. Decrease horizontal and vertical deflecting currents till the periphery of this mask is just outside the raster on the

monitor. This procedure may be facilitated by small adjustments of the centring controls;

(b) if no mask is available, direct the camera to a test chart having correct aspect ratio (3 : 4) and adjust the centring controls in such a way that the target ring is just visible in the corners of the picture. Adjust distance from camera to test chart and optical focus alternately till the picture of the test chart completely fills the scanned raster on the monitor.

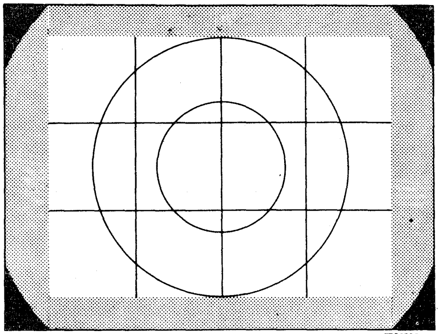


Fig.5 7Z03793

13. Adjust alignment controls so that the centre of the picture does not move when beam focus (V_{g_3} and V_{g_4} for integral-mesh tubes, V_{g_3} for separate-mesh tubes) is varied.
14. Cap lens and adjust signal-electrode voltage to such a value that further increase would cause the background signal to become objectionally high or non-uniform.
15. Uncap lens. Adjust beam focus control for optimal picture uniformity in respect of picture whites and resolution.
16. Adjust iris for a picture of sufficient contrast and adjust beam current to the minimum value which will give details in the picture highlights.
17. Check alignment, beam focus and optical focus.

Always:

- make sure the camera wiring is adapted for a separate-mesh tube before installation;
- make sure that the deflection circuits are operative before adjusting beam current;
- maintain the same scanned target area, hence avoid rotating the tube;
- use full size (9.6 mm x 12.8 mm) scanning of the target, hence avoid underscanning;
- use sufficient beam current to stabilize the picture highlights;
- adjust V_{g_4} of separate-mesh tubes to a value positive with respect to V_{g_3};
- avoid peak-dark currents in excess of 0.25 μA;
- avoid directing the camera at the sun;
- keep lens capped when transporting the camera.

D. VIDICON TUBES WITH OTHER ELECTRODE-GUN SYSTEMS

To facilitate the construction of compact, low power or light weight cameras vidicons with the following electron gun systems have been developed.

Type of electron gun	Focus	Deflection	Main features	Available type
hybrid gun	E	M	uniform high resolution no focus power required	-
reverse hybrid gun	M	E	uniform very high resolution no deflection power short tube	-
fully electrostatic gun	E	E	no deflection power no focus power	XQ1010

E = electrostatic, M = magnetic

E. PROPERTIES OF THE PHOTOCONDUCTIVE TARGETS AS USED IN THE VIDICONS OF THE XQ1010, XQ1030, XQ1040, XQ1050 SERIES

Spectral response

The spectral response of the targets used in the above tubes is shown in Fig.6.

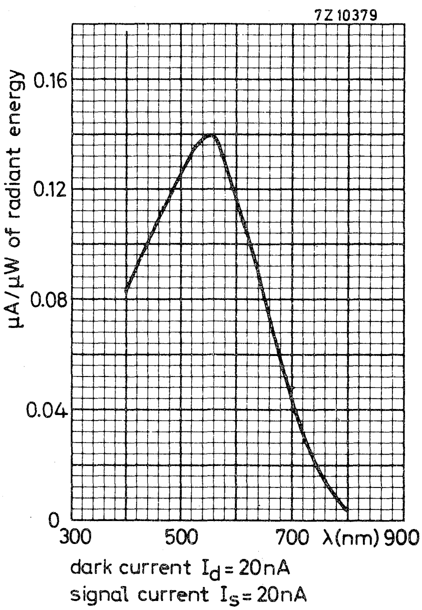


Fig.6

Dark current

The range of dark currents determined at a faceplate temperature of 30 ± 2 °C is shown in Fig. 7.

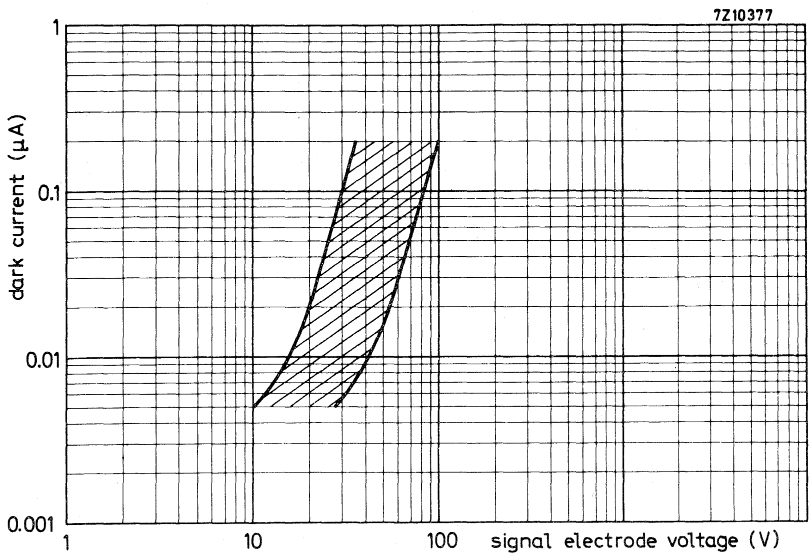


Fig. 7

Transfer characteristics

The light transfer characteristics of a typical vidicon with three dark current settings as parameters are given in Fig. 8.

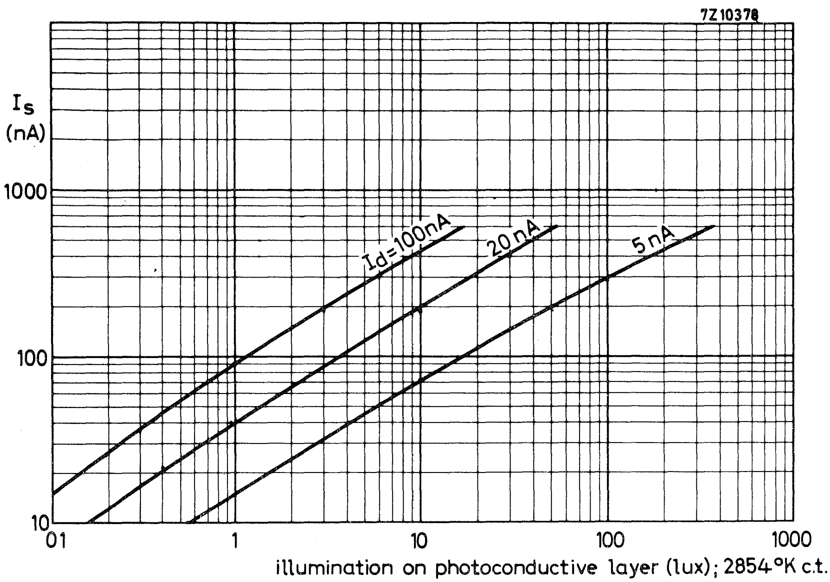


Fig. 8

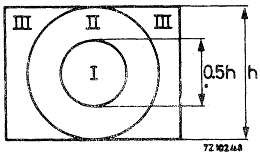
Spurious signal specification for Vidicon tubes

Section A Vidicons for telecine, other broadcast applications and critical industrial applications.

Test conditions

1. A back illuminated test transparency, with a aspect ratio of 3:4, with three quality zones (see Fig. 1) is projected onto the specified target area (9.6 x 12.8 mm^2), producing even illumination.

Fig. 1



2. Light level adjusted to produce a total target current of 0.3 μA, target voltage adjusted for a dark current of approx. 20 nA, temperature $30^{o} \pm 2\ ^{o}C$, colour temperature of light source 2854 ^{o}K.
3. Tube aligned and focused in accordance with the published instructions for use.
4. Video-amplifier system having a bandwidth of 5.5 MHz.
5. Monitor adjusted for a non-blooming white.
6. In the evaluation of blemishes the following definitions apply:
   a) a spot (black or white) is a blemish with a maximum linear dimension measured in any direction of 0.75% of the picture height (0.8% for industrial grade tubes, 1% for low cost tubes)
   b) a smudge (black or white) is a blemish with a maximum linear dimension measured in any direction exceeding 0.75% of picture height (0.8% for industrial grade tubes, 1% for low cost tubes)

Permitted number, size and location of blemishes [1])

Dimensions of blemishes in % of picture height	Permitted number of blemishes		
	Zone I	Zone II	Zone III
> 0.75%	0	0	0
≤ 0.75% but > 0.45%	0	0	1
≤ 0.45% but > 0.2%	0	2 [2])	2
≤ 0.2%	[3])	[3])	[3])

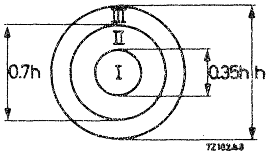
[1]) Spots (black and white) and smudges (black and white) are not counted when their contrast expressed in % of picture white as measured on a waveform oscilloscope is less than 25% respectively 10%.
[2]) Sum of diameters of these spots shall not exceed 0.75%.
[3]) Spots of this size are allowed unless concentration causes a smudge appearance. As contrast of the smudge the average contrast of the concentration is taken.

Section B Vidicons for medical X-ray applications.

Test conditions

1. A back illuminated test transparency with three quality zones (see Fig.2) is projected onto the specified target area (15 mm dia circular) producing an even illumination.

Fig.2



2. Light level adjusted to produce a total target current of 0.2 μA, target voltage adjusted for a dark current of approx. 20 nA, temperature 30° ± 2 °C.
3. Tube aligned and focused in accordance with the published instructions for use.
4. Video-amplifier system having a bandwidth of 5.5 MHz.
5. Monitor adjusted for a non-blooming white.
6. As Section A.6

Permitted number, size and location of blemishes [2])

Dimensions of blemishes in % of picture height	Permitted number of blemishes		
	Zone I	Zone II	Zone III
> 0.75%	0	0	0
≤ 0.75% but > 0.45%	0	1	3
≤ 0.45% but > 0.2%	2	3	6
≤ 0.2%	[3])	[3])	[3])

---

[1]) Sum of numbers of spots in zones II and III shall not exceed 6.

[2]) Spots (black or white) and smudges (black or white) are not counted when their contrast expressed in % of picture white as measured on a waveform oscilloscope is less than 25% respectively 5%.

[3]) Spots of this size are allowed unless concentration causes a smudge appearance. As contrast of the smudge the average contrast of the concentration is taken.

Section C Vidicons for industrial applications

Test conditions

As Section A

Permitted number, size and location of blemishes

Dimensions of blemishes in % of picture height	Permitted number of blemishes	
	Zone I + Zone II	Zone III
> 0.8%	0	0
≤ 0.8% but > 0.6%	0	1
≤ 0.6% but > 0.2%	2	3
< 0.2%	2)	2)

1) Spots (black and white) and smudges (black and white) are not counted when their contrast expressed in % of picture white as measured on a waveform oscilloscope is less than 50%.

2) Spots of this size are allowed unless concentration causes a smudge appearance. As contrast of the smudge the average contrast of the concentration is taken.

Section C Vidicons for low cost CCTV cameras

Test conditions

As Section A

Permitted number, size and location of blemishes [1)]

Dimensions of blemishes in % of picture height	Permitted number of blemishes	
	Zone I + Zone II	Zone III
> 1%	0	0
≤ 1% but > 0.6%	1	3
≤ 0.6% but > 0.2%	4	6
≤ 0.2%	2)	2)

1) Spots (black and white) and smudges (black and white) are not counted when their contrast expressed in % of picture white as measured on a waveform oscilloscope is less than 50%.

2) Spots of this size are allowed unless concentration causes a smudge appearance. As contrast of the smudge the average contrast of the concentration is taken.

Spurious signal specification for Plumbicon * tubes

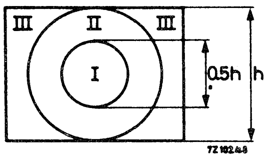
Section A

Test conditions

The spurious signal tests on the Plumbicon tubes are carried out in the manufacturer's test channel under the following conditions:

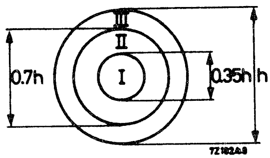
1. Light source: 2854 °K colour temperature (broadcast and industrial tubes)
   P20 light distribution (tubes for medical X-ray equipment)
2. Filter inserted in the light path for chrominance tubes
   (see published data for required filter characteristics)
3. Test transparency, back-illuminated, projected on to the target by means of a high quality lens, producing an even illumination on the specified scanned area.
   The test transparency has an aspect ratio of 3 : 4 for the evaluation of broadcast and industrial quality tubes. The area of the chart is divided into three quality zones by two concentric circles as shown in Fig.1.

   Fig.1

   The test transparency is of a circular shape for the evaluation of tubes for medical X-ray equipment. The area of the chart is divided into three quality zones by two concentric circles as shown in Fig.2.

   Fig.2

4. The video amplifier frequency response is essentially flat to 5 MHz, with a sharp fall-off to 6 MHz.
5. No gamma correction or aperture correction is applied in the video amplifier.
6. Light level. The light level on the Plumbicon target is adjusted to produce a peak signal current I_s in accordance with Table I.
7. Beam current. The beam current of the Plumbicon tube is adjusted to just stabilize a peak signal current of magnitude I_b in accordance with table I.
8. Monitor. The obtained picture is observed on a monitor producing a non-blooming white.

*Registered Trade Mark for T.V. camera tube.

Table I I_s and I_b settings

			Tube diameter 30 mm		Tube diameter 25 mm	
			Scanned area 12.8 x 17.1 mm^2		Scanned area 9.6 x 12.8 mm^2	
			I_s μA	I_b μA	I_s μA	I_b μA
Broadcast quality tubes	Black and white		0.3	0.6	0.2	0.4
	Luminance	L	0.3	0.6	0.2	0.4
	Chrominance tubes	Red R	0.15	0.3	0.1	0.2
		Green G	0.3	0.6	0.2	0.4
		Blue B	0.15	0.3	0.1	0.2
Industrial quality tubes	Black and white		0.3	0.6	0.2	0.4
	Chrominance tubes	Red R	0.15	0.3	0.1	0.2
		Green G	0.3	0.6	0.2	0.4
		Blue B	0.15	0.3	0.1	0.2
X-ray medical tubes (for use in combination with an X-ray intensifier)	P20 light source		Scanned area 18 mm circular		Scanned area 15 mm circular	
			0.15	0.3	0.1	0.2

Section B

Definitions

Blemishes, can be regarded as either spots or smudges.

Spots and smudges are small areas of uneven modulation of any signal current between black level (dark current) and white level (peak signal current). For broadcast quality tubes and tubes for medical X-ray equipment a spot is defined as a blemish with a maximum linear dimension in any direction of 0.7% of the picture height, a smudge as a blemish with a maximum linear dimension in any direction exceeding 0.7% of the picture height.

For industrial quality tubes a spot is defined as a blemish with a maximum linear dimension in any direction of 1% of the picture height and a contrast in excess of 10% of 100% white level (I_s as described in Section A, Table I), as measured on a waveform oscilloscope (bandwidth 5.5 MHz), black level being defined as 0%.

Section C

Number, size, location and contrast of blemishes

1. Broadcast quality tubes

Dimensions of blemishes in % of picture height	Permitted number of blemishes [1]					
	Black and white Luminance (L) tubes Red, Green (R, G)			Blue tubes (B)		
	Zone I	Zone II	Zone III	Zone I	Zone II	Zone III
> 0.7%	0	0	0	0	0	0
≤ 0.7% but > 0.45%	0	0	1	0	1 [2]	3 [2]
≤ 0.45% but > 0.2%	0	2 [3]	2	1	2 [2]	4 [2]
≤ 0.2%	[4]	[4]	[4]	[4]	[4]	[4]

[1] The distance between any two spots shall be greater than 5% of the picture height.
[2] The sum of the number of spots in zones II and III shall not exceed 5.
[3] The sum of the diameters of these spots shall not exceed 0.7% of the picture height.
[4] Spots of this size are not counted unless the concentration causes a smudge appearance. Such concentrations are evaluated as smudges and as contrast, the average contrast of the concentration is taken.
The maximum contrasts allowed for blemishes are shown in Figs. 3 and 4.

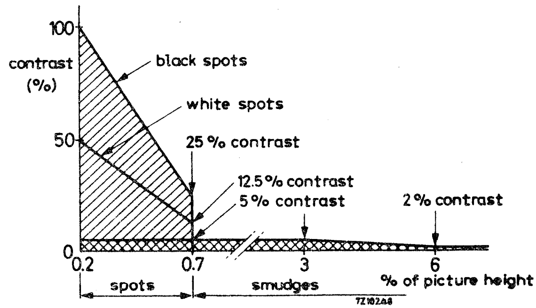


Fig.3. [1][2]
Maximum contrasts allowed for spots and smudges for tubes for monochrome, luminance and green channels

[1] Spots and smudges with a maximum size of 3% of the picture height with contrasts less than 5% for the black and white and luminance tubes or less than 8% for red and blue tubes are not counted.
[2] Smudges with sizes over 3% of the picture height are allowed provided their contrasts remain within the cross-hatched areas.

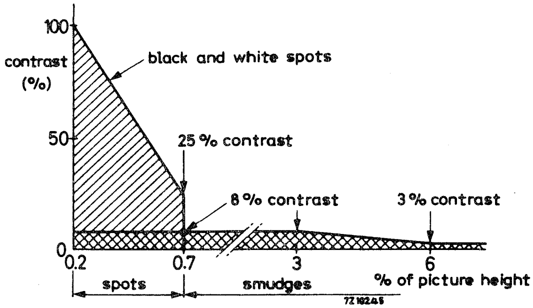


Fig.4. 1)2)
Maximum contrasts allowed for spots and smudges
for tubes for red and blue channels

1) Spots and smudges with a maximum size of 3% of the picture height with contrasts less than 5% for the black and white and luminance tubes or less than 8% for red and blue tubes are not counted.

2) Smudges with sizes over 3% of the picture height are allowed provided their contrasts remain within the cross-hatched areas.

II. Industrial quality tubes

Dimensions of blemishes in % of picture height	Permitted number of blemishes 1)			
	Zone I	Zone II	Zone III	Total
> 1%	0	0	0	0
≤ 1% but > 0.7%	0	1	2	2
≤ 0.7% but > 0.45%	1	2	4	4
≤ 0.45% but > 0.2%	2	4	6	6
≤ 0.2%	2)	2)	2)	2)
Total permitted number of blemishes	2	4	6	6 4)

1) The distance between any two spots shall be greater than 5% of the picture height in any direction.

2) Spots of this size are not counted unless concentration causes a smudge appearance. Such concentrations are evaluated as smudges, and as contrast, the average contrast of the concentration is taken.

3) Blemishes with contrasts ≤ 10% are not counted.

4) For 30 mm diameter tubes only.

III. Tubes for medical X-ray equipment

Dimensions of blemishes in % of picture height	Permitted number of blemishes		
	Zone I	Zone II [2]	Zone III [2]
≤ 1% but > 0.7%	0	0	0
≤ 0.7% but > 0.45%	0	1	3
≤ 0.45% but > 0.2%	2	3	6
≤ 0.2%	[1]	[1]	[1]

[1]) Spots of this size are not counted unless concentration causes a smudge appearance. Such concentrations are evaluated as smudges, and, as contrast, the average contrast of the concentration is taken.

[2]) The sum of the number of spots in zones II and III shall not exceed 6.

The maximum contrasts allowed for blemishes are shown in the Fig.5.

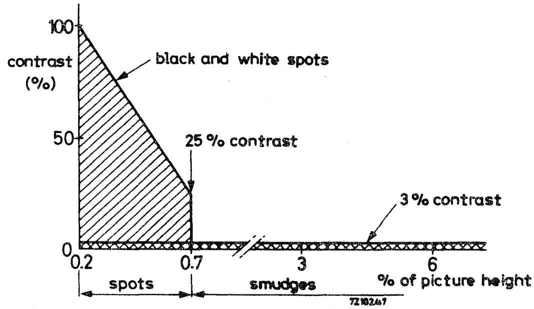


Fig.5.
Blemishes with contrasts ≤ 3% are not counted.

RATING SYSTEM

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.

CAMERA TUBE

Plumbicon*, sensitive high-definition pick-up tube with photoconductive target and low velocity stabilization.
The XQ1020 is intended for use in black and white, the L, R, G, and B versions for use in four and three tube colour studio cameras.

QUICK REFERENCE DATA			
Focusing	magnetic		
Deflection	magnetic		
Diameter	approx.	30	mm
Heater	6.3 V,	300	mA

OPTICAL

Dimensions of quality rectangle on photoconductive layer (aspect ratio 3:4)	12.8 mm x 17.1	mm 1)	
Orientation of image on photoconductive layer	By means of index pin 2)		
Sensitivity at colour temperature of illumination = 2850 °K			
type: XQ1020, XQ1020L	min.	275	μA/lumen
XQ1020R	min.	60	μA/lumen 3)
XQ1020G	min.	125	μA/lumen 3)
XQ1020B	min.	32	μA/lumen 3)
Gamma of transfer characteristic		0.95±0.05	4)
Spectral response; max. response at	approx.	500	nm

HEATING

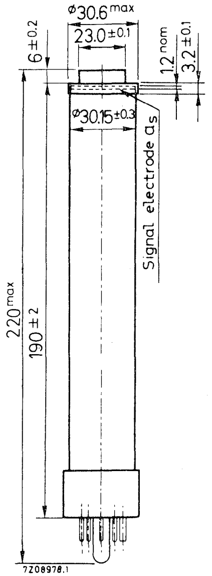
Indirect by A.C. or D.C.; parallel supply

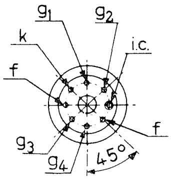
Heater voltage	V_f	6.3	V ± 5%
Heater current	I_f	300	mA

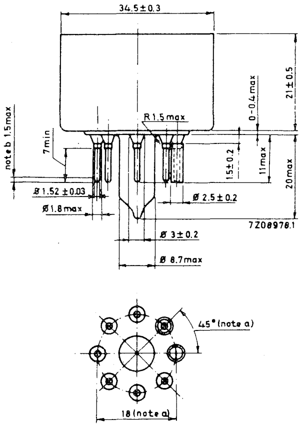
* Registered Trade Mark for T.V. camera tube
1) 2) 3) 4) See page 5.

MECHANICAL DATA Dimensions in mm

Distance between axis of anti-reflection glass disc and geometrical centre of signal electrode ring, measured in plane of faceplate: max. 0.2 mm.
total glass thickness: 7.2 ± 0.2 n = 1.5







a) The base passes a flat gauge with a centre hole 9.00 ± 0.01 ø and holes for passing the pins with the following diameters: 7 holes of 1.75 ± 0.005 ø and one hole of 3.00 ± 0.005 ø. The holes may deviate max. 0.01 from their true geometrical position. Thickness of gauge 7 mm.
b) The ends of the pins are tapered and/or rounded but not brought to a sharp point.

Mounting position: any Net weight: approx. 100 g

ACCESSORIES

Socket	type 56021
Focusing and deflection coil assembly	
for XQ1020	type AT1132 or 3122 108 68300
for XQ1020L, R, G, B	type AT1112 or
	type AT1113 or type AT1113/01

For optimal screening of the target from the live end of the line deflection coils the use of 3122 108 68300 or AT1113/01 is recommended.

CAPACITANCE

Signal electrode to all	C_{as}		3 to 6	pF 5)

FOCUSING magnetic 6)

DEFLECTION magnetic 6)

CHARACTERISTICS

Grid No. 1 voltage for cut-off at V_{g_2} = 300 V	V_{g_1}		−30 to −100	V 7) 8)
Blanking voltage, peak to peak				
on grid No. 1	$V_{g_{1p-p}}$	max.	70	V
on cathode	$V_{k_{p-p}}$	min.	25	V
Grid No. 2 current at normally required beam currents	I_{g_2}	max.	2	mA
Dark current at V_{as} = 45 V	I_{a_s}	max.	0.003	μA

LIMITING VALUES (Absolute max. rating system)

Signal electrode voltage	V_{a_s}	max.	50	V 8)
Grid No. 4 voltage	V_{g_4}	max.	1100	V 8)
Grid No. 3 voltage	V_{g_3}	max.	800	V 8)
Voltage between grid No. 4 and grid No. 3	V_{g_4/g_3}	max.	350	V 8)
Grid No. 2 voltage	V_{g_2}	max.	350	V 8)
Grid No. 2 dissipation	W_{g_2}	max.	1	W
Grid No. 1 voltage, positive	V_{g_1}	max.	0	V
negative	$-V_{g_1}$	max.	125	V
Cathode current	I_k	max.	6	mA
Cathode heating time before drawing cathode current	T_h	min.	1	min
Cathode to heater voltage,				
positive peak	V_{kf_p}	max.	50	V
negative peak	$-V_{kf_p}$	max.	50	V
Ambient temperature, storage and operation	t_{amb}	max.	50	°C
		min.	−30	°C
Faceplate temperature, storage and operation	t	max.	50	°C
		min.	−30	°C
Faceplate illumination		max.	500	lx 9)

5) 6) 7) 8) 9) See page 5.

OPERATING CONDITIONS AND PERFORMANCE

Cathode voltage	V_k	0	V
Grid No.2 voltage	V_{g_2}	300	V
Signal electrode voltage	V_{a_s}	45	V [10])
Beam current	I_{beam}	See note 11	
Focusing coil current at given values of grid No.4 and grid No.3 voltage		See note 12	
Line coil current and frame coil current		See note 12	
Faceplate illumination	See notes 13 and 14		
Faceplate temperature	t	20 to 45	°C

Resolution

Modulation depth i.e. uncompensated horizontal amplitude response at 400 TV lines, at centre of picture.

The figures shown represent the typical horizontal amplitude response of the tube after correction for faults introduced by the optical system. [15])

	XQ1020 XQ1020L	XQ1020R	XQ1020G	XQ1020B	
Highlight signal current I_s	0.3	0.15	0.3	0.15	μA
V_{g_4} = 550 to 650 V					
V_{g_4/g_3} = 50 to 100 V (adjusted for optimum focus)	40	35	40	50	%

See also note 12

Limiting resolution	≥ 600	TV lines
Signal to noise ratio at I_s = 0.15 μA	approx. 200 : 1	[16])

Decay (or lag)

Measured with 100% signal current = 0.1 μA and a light source with a colour temperature of 2850 °K.
Appropriate filter inserted in light-path for tubes XQ1020R, G, B.

	XQ1020L, R, G, B	XQ1020B	
Residual signal after dark pulse of 60 ms	max. 5	max. 6	%
Residual signal after dark pulse of 200 ms	max. 2	max. 3	%

[10]) [11]) [12]) [13]) [14]) [15]) [16]) See page 5 and 6

NOTES

1) Underscanning of the specified useful target area of 12.8 mm x 17.1 mm, or failure of scanning, should be avoided since this may cause damage to the photoconductive layer.

2) For correct orientation of the image on the photoconductive layer the horizontal scan should be essentially parallel to the plane passing through the tube axis and the index pin.

3) Measuring conditions:

Illumination 4.54 lx at black body colour temperature of 2850 ^{o}K; the appropriate filter inserted in the light path. The signal current obtained in nA is a measure of the colour sensitivity expressed in μA per lumen of white light before the filter.
Filters used:

55875R	Schott	OG2	thickness	3 mm
55875G	Schott	VG9	thickness	1 mm
55875B	Schott	BG12	thickness	3 mm

See page 8 for transmission curves.

4) a) Gamma is, to a certain extent, dependent on the wavelength of the illumination applied.
b) The use of gamma-stretching circuitry is recommended.

5) The capacitance C_{a_s} to all, which effectively is the output impedance, increases when the tube is inserted into the deflecting/focusing coil assembly.

6) For focusing/deflection coil assembly, see under "Accessories".

7) Without blanking voltage on grid No.1.

8) At V_k = 0 V.

9) For short intervals. During storage the tube face shall be covered with the plastic hood provided; when the camera is idle the lens shall be capped.

10) The signal electrode voltage shall be adjusted to 45 V. To enable the tube to handle excessive highlights in the scene to be televised the signal electrode voltage may be reduced to a minimum of 25 V, this will, however, result in some reduction in performance, especially in respect of sensitivity.

11) The beam current shall be adjusted for correct stabilization of the highlight signal currents stated in the table.

12)

	Focus current mA	Line current mA_{pp}	Frame current mA_{pp}
Black/white coil assembly AT 1132 and 3122 108 68300 V_{g3} = 550 to 600 V, V_{g4} = 675 V	25	235	35
Colour coil assemblies AT 1112, AT 1113, AT 1113/01 V_{g3} = 550 to 600 V, V_{g4} = 675 V	100	235	35

(approx. values)

The optimum voltage ratio V_{g_4}/V_{g_3} depends on the type of focusing/deflection coil used: for types AT1112, AT1113, AT1113/01, AT1132, 3122 108 68300 a ratio of 1.1 : 1 to 1.15 : 1 is recommended.

13) Typical faceplate illumination level for the XQ1020 and XQ1020L to produce 0.3 μA signal current will be approx. 4 lx. The signal currents stated for the colour tubes XQ1020R, G, B respectively will be obtained with an incident white light level (2850 ^{o}K) on the filter of approx. 10 lx. These figures are based on the filters described in note 3, for filter BG12 however a thickness of 1 mm is chosen.

14) In the case of a black/white camera the illumination on the photoconductive layer, B_{ph}, is related to scene illumination, B_{sc}, by the formula:

$$B_{ph} = B_{sc} \frac{R.T}{4F^2 (m+1)^2}$$

in which R represents the average scene reflectivity or the object reflectivity, whichever is relevant, T the lens transmission factor, F the lens aperture, and m the linear magnification from scene to target.
A similar formula may be derived for the illumination level on the photoconductive layers of the R, G, and B tubes in which the effects of the various components of the complete optical system have been taken into account.

15) The horizontal amplitude response can be raised by the application of suitable correction circuits, which affects neither the vertical resolution, nor the limiting resolution.

16) The stated ratio represents the "visual equivalent signal-to-noise ratio", which is taken as the ratio of highlight video-signal current to RMS noise current, multiplied by a factor of 3, assuming an RMS noise current of the video pre-amplifier of 2 nA, bandwidth 5 MHz.

GENERAL RECOMMENDATIONS

1. During transport, handling and storage the axis of the Plumbicon must be either vertical, with faceplate up, or horizontal; the faceplate should be covered with the hood provided.

2. To avoid damage to the tungsten basepins, the Plumbicon should be inserted into its socket with care. Shocks, undue force, and bending loads on the pins are to be avoided.

3. During long term storage the ambient temperature should not exceed 30 ^{o}C.

4. The properties of the photoconductive material used in the Plumbicon may deteriorate during long idle periods. To restore them, the tube should be operated for a few hours, in overscanned condition, with an evenly illuminated target and a signal current of 0.15 μA, at the voltage settings indicated in its test data.

5. The signal electrode connection is made by a springcontact, which is part of the focusing coil assembly, and is kept pressed against the signal electrode ring.

6. Electrostatic shielding of the signal electrode is required to avoid interference effects in the picture. Effective shielding is provided by a grounded shield inside the focusing coil at the faceplate end, and one inside the deflecting yoke.

7. The light transfer characteristic of the Plumbicon tube being characterized by a gamma near unity, it may be desirable for broadcast applications to incorporate a gamma correcting circuitry in the video-amplifier system with an adjustable gamma of 0.5 to 1.

   It is suggested to design this gamma correcting circuitry such that an extra compression can be introduced by manual control in the video signal range of 75% to 100% of normal peak white level.

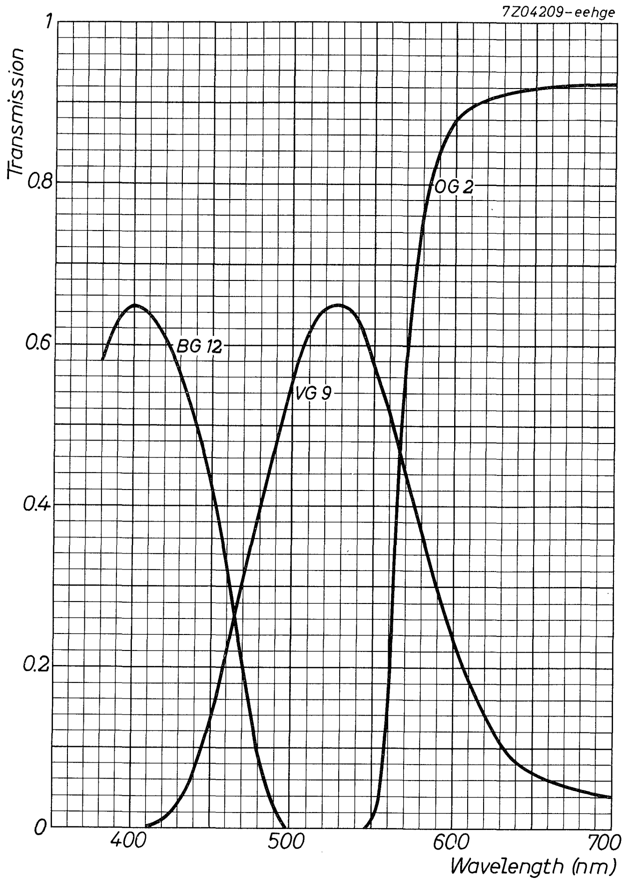
   This provision will prevent the video-amplifier system from becoming overloaded when the Plumbicon tube is exposed to scenes containing small peaked highlights as caused by reflections of shiny objects.

8. The Plumbicon tube not generating own noise to any noticeable extent. the signal-to-noise ratio will be determined mainly by the entrance noise of the video-amplifier system.

   The high sensitivity of the Plumbicon tube warrants pictures with excellent signal-to-noise ratio under normal studio lighting conditions provided its output is fed into a well-designed input stage of the video-amplifier system. In such a system an aperture correction may be incorporated to ensure an attractive gain in resolving power without visually impairing the signal-to-noise ratio.

INSTRUCTIONS FOR USE

Instructions for use are packed with each tube


7Z04209-eehge
Transmission
1
0.8
0.6
0.4
0.2
0
BG 12
VG 9
OG 2
400
500
600
700
Wavelength (nm)

CAMERA TUBE

Plumbicon*, sensitive pick-up tube with lead oxide photoconductive target and low velocity stabilization. Provided with sepatate mesh construction.

The tubes of this series are mechanically and electrically identical to the tubes of the XQ1020 series, the only difference being the degree of freedom from blemishes of the photoconductive target.

The tubes are intended for industrial and educational black and white and colour cameras. The series comprises the following versions:

XQ1021	for black and white cameras
XQ1021R XQ1021G XQ1021B	for use in the chrominance channels of colour cameras

For all further information see data of the QX1020 series.

* Registered Trade Mark for T.V. camera tube.

CAMERA TUBE

Plumbicon*, sensitive high definition pick-up tube with lead-oxide photoconductive target and low velocity stabilisation.
Provided with separate mesh construction.
The XQ1022 is exclusively intended for use with X-ray image intensifiers in medical equipment.

QUICK REFERENCE DATA			
Focusing	magnetic		
Deflection	magnetic		
Diameter	approx.	30	mm
Heater	6.3 V,	300	mA
Without anti halation glass disc			

OPTICAL

Dimensions of quality area on photoconductive layer	circle of 18 mm diameter [1] [2]		
Orientation of image on photoconductive layer	By means of index pin [2]		
Sensitivity, measured with a fluorescent light source having P_{20} distribution	min.	200	μA/lumen
	typ.	275	μA/lumen
Gamma of transfer characteristic		0.95 ± 0.05	[3]
Spectral response; max. response at	approx.	500	nm

HEATING

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

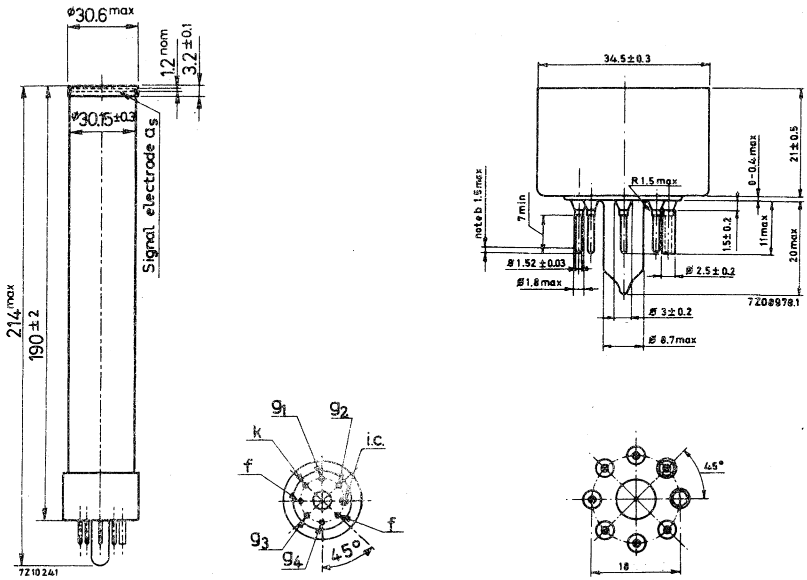
Heater voltage	V_f	6.3	V $\pm$ 5%
Heater current	I_f	300	mA

*Registered Trade Mark for T.V. camera tube

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

MECHANICAL DATA

Dimensions in mm



a) The base passes a flat gauge with a centre hole 9.00 ± 0.01 ø and holes for passing the pins with the following diameters: 7 holes of 1.75 ± 0.005 ø and one hole of 3.00 ± 0.005 ø. The holes may deviate max. 0.01 from their true geometrical position. Thickness of gauge 7 mm.

b) The ends of the pins are tapered and/or rounded but not brought to a sharp point.

Mounting position: any — Net weight: approx. 100 g

ACCESSORIES

Socket	type 56021
Focusing and deflection coil assembly	AT1122, AT1132, AT1132/01 [4])

CAPACITANCE

Signal electrode to all	C_{as}	3 to 6	pF [5])

FOCUSING magnetic [6])

DEFLECTION magnetic [6])

[4])[5])[6]) See page 5

CHARACTERISTICS

Grid No.1 voltage for cut-off at V_{g_2} = 300 V	V_{g_1}		−30 to −100	V [7][8]
Blanking voltage, peak to peak				
on grid No.1, min. required	$V_{g_{1p-p}}$		70	V
on cathode, min. required	$V_{k_{p-p}}$		25	V
Grid No.2 current at normally required beam currents	I_{g_2}	max.	1	mA
Dark current	I_{a_s}	max.	3	nA)

LIMITING VALUES (Absolute max. rating system)

Signal electrode voltage	V_{a_s}	max.	50	V [8]
Grid No.4 voltage	V_{g_4}	max.	1100	V [8]
Grid No.3 voltage	V_{g_3}	max.	800	V [8]
Voltage between grid No.4 and grid No.3	V_{g_4/g_3}	max.	350	V [8]
Grid No.2 voltage	V_{g_2}	max.	350	V [8]
Grid No.2 dissipation	W_{g_2}	max.	1	W
Grid No.1 voltage, positive	V_{g_1}	max.	0	V
negative	$-V_{g_1}$	max.	125	V
Cathode current	I_k	max.	6	mA
Cathode heating time before drawing cathode current	T_h	min.	1	min
Cathode to heater voltage,				
positive peak	V_{kf_p}	max.	50	V
negative peak	$-V_{kf_p}$	max.	50	V
Ambient temperature, storage and operation	t_{amb}	max.	50	°C
		min.	−30	°C
Faceplate temperature, storage and operation	t	max.	50	°C
		min.	−30	°C
Faceplate illumination		max.	100	lx [9]

[5][6][7][8][9] See page 5

) Target voltage adjusted to the value indicated by the tube manufacturer in the test sheet as delivered with each individual tube.

OPERATING CONDITIONS AND PERFORMANCE

Cathode voltage	V_k	0	V
Grid No. 2 voltage	V_{g_2}	300	V
Grid No. 3 voltage	V_{g_3}	550-600	V [10]
Grid No. 4 voltage	V_{g_4}	See note 11	
Signal electrode voltage	V_{a_s}	15-45	V [12]
Beam current	I_b	See note 13	
Focusing coil current Line coil current and frame coil current		See note 14	
Highlight signal electrode current	I_{a_s}	0.1 to 0.5	μA
Average signal output		approx. 0.06	μA [15]
Faceplate temperature	t	25 to 40	^{o}C
Faceplate illumination		approx. 2	lux [16]

Resolution

Modulation depth, i.e. uncompensated horizontal amplitude response at MHz (625 lines, 50 field system) in picture centre	< 30	% [17][18]
Signal to noise ratio at $I_S = 0.15\ \mu$A	approx. 200 : 1	[19]

Decay (or lag)

Measured with 100% video signal current of 0.1 μA which has been flowing through the layer for a minimum of 5 s
Beam adjusted for correct stabilisation.
Fluorescent light source having P_{20} distribution.

Residual signal after dark pulse of 60 msec	max. 10 %	typ. 5 % [17]
Residual signal after dark pulse of 200 msec	max. 4 %	typ. 2 % [17]

[10][11][12][13][14][15][16][17][18][19] See pages 5 and 6

NOTES

1. All underscanning of the specified useful target area of 18 mm diameter or failure of scanning should be avoided. Since this may cause permanent damage to the photoconductive layer.
2. The area beyond the 18 mm circular optical image preferably to be covered by a mask.
3. The near unity gamma of the XQ1022 ensures good contrast when televising low contrast X-ray image-intensifier pictures as encountered in radiology. Further contrast improvement may be obtained when an adjustable gamma expansion circuitry is incorporated in the video amplifier system.
4. For optimal screening of the target from the live end of the line deflection coils the use of AT1132/01 is recommended.
5. Cas which effectively is the output impedance, increases when the tube is inserted into the deflection/focusing coil assembly.
6. See "Accessories".
7. With no blanking voltage on g_1.
8. At V_k = 0 V.
9. For short intervals. During storage the tube face shall be covered with the plastic hood provided.
10. Grid No.3 voltage adjusted for optimum picture focus.
11. Grid No.4 voltage 50-100 V positive to grid No.3 voltage.
12. The target voltage should be adjusted to the value indicated by the tube manufacturer on the test sheet as delivered with each individual tube.
13. Operation of the tube with beam currents I_b not sufficient to stabilize the brightest picture elements must be carefully avoided by order to prevent loss of highlight detail and/or "sticking" effects. The incorporation of a separate mesh construction allows excess beam currents I_b up to 0.6 μA to be applied without appreciable loss in resolution.
14. For AT1122, AT1132, AT1132/01, at V_{g_3} = 550 to 600 V, V_{g_4} = 675 V

Focus current	25 mA	for 18 mm x 18 mm scanning
Line deflection current	250 mApp	
Frame deflection current	50 mApp	

    The optimum voltage ratio V_{g4}/V_{g3} depends on the type of focusing/deflection coil used: for types AT1112, AT1132, AT1132/01 ratio of 1.1 : 1 to 1.15 : 1 is recommended.

15. Substraction of the dark current is unnecessary because of the extremely small value.

16. In the case of a black/white camera the illumination on the photoconductive layer, B_{ph}, is related to scene illumination, B_{sc}, by the formula:

$$B_{ph} = B_{sc} \frac{R.T.}{4F^2 (m + 1)^2}$$

in which R represents the average scene reflectivity or the object reflectivity, whichever is relevant, T the lens transmission factor, F the lens aperture, and m the linear magnification from scene to target.

17. With a signal current of 0.1 μA and a beam current of 0.5 μA.

18. Horizontal amplitude response can be raised by the application of aperture correction. Such compensation, however, does not affect the vertical resolution, nor does it influence the limiting resolution.

19. The stated ratio represents the "visual equivalent signal-to-noise ratio", which is taken as the ratio of highlight video-signal current to R.M.S. noise current, multiplied by a factor of 3. (Assuming an R.M.S. noise current of the video pre-amplifier of 2.10^{-9} A, bandwidth 5 MHz).

GENERAL RECOMMENDATIONS

1. During transport, handling and storage the axis of the Plumbicon must be either vertical, with faceplate up, or horizontal; the faceplate should be covered with the hood provided.
2. To avoid damage to the tungsten basepins, the Plumbicon should be inserted into its socket with care. Shocks, undue force, and bending loads on the pins are to be avoided.
3. During long term storage the ambient temperature should not exceed 30 ^{o}C.
4. The properties of the photoconductive material used in the Plumbicon may deteriorate during long idle periods. To restore them, the tube should be operated for a few hours, in overscanned condition, with an evenly illuminated target and a signal current of 0.15 μA, at the voltage settings indicated in its test data.
5. The signal electrode connection is made by a springcontact, which is part of the focusing coil assembly, and is kept pressed against the signal electrode ring.
6. Electrostatic shielding of the signal electrode is required to avoid interference effects in the picture. Effective shielding is provided by a grounded shield inside the focusing coil at the faceplate end, and one inside the deflecting yoke.

INSTRUCTIONS FOR USE

Instructions for use are packed with each tube

CAMERA TUBE

Plumbicon *, sensitive pick up tube, with lead-oxide photoconductive target with extended red response and high resolution.
Low velocity target stabilization. Provided with separate mesh construction for good uniformity of signal and resolution and good highlight handling.
The XQ1023 is intended for use in black and white cameras, the XQ1023L for use in the luminance channel of four tube colour cameras, the XQ1023R for use in the red channel of both three and four tube colour cameras.

QUICK REFERENCE DATA			
Focusing	: magnetic	Heater	: 6.3 V, 300 mA
Deflection	: magnetic	Cut-off of spectral response	: over 850 nm
Diameter	: approx. 30 mm	Provided with anti-halation glass disc	

OPTICAL

Dimensions of quality rectangle on target (aspect ratio 3:4)	12.8 x 17.1 mm^2 1)
Orientation of image on target	See note 2)
Sensitivity (colour temperature of light source 2854 °K), typical	

	notes	XQ1023	XQ1023L	XQ1023R
white	3), 4)	450 μA/LmF	450 μA/LmF	
red	5)			160 μA/LmF

* Registered trade mark for T.V. camera tube.

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

Data based on pre-production tubes.

Gamma of transfer characteristic	0.95 ± 0.05	6)
Spectral response	See page 11	
max. response at	approx. 500 nm	

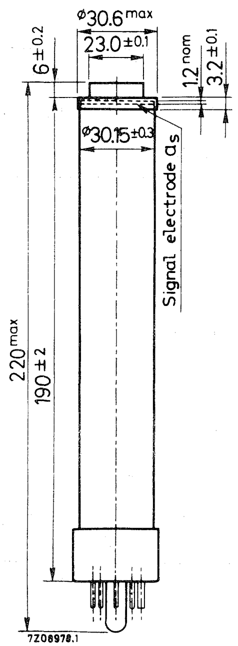
HEATING: Indirect by A.C. or D.C.; parallel supply

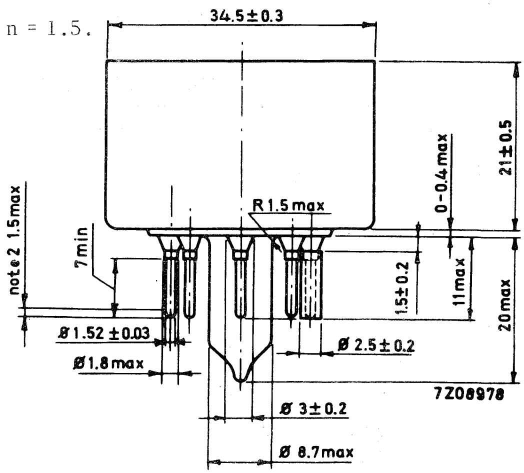
Heater voltage	V_f	6.3	V ±5%
Heater current	I_f	approx. 300	mA

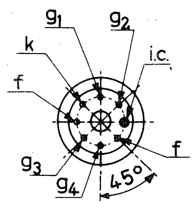
MECHANICAL DATA Dimensions in mm

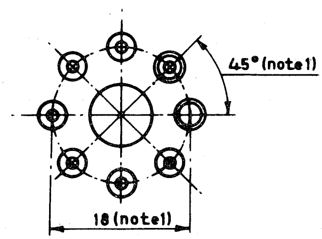
Distance between axis of anti-reflection glass disc and geometrical centre of signal electrode ring, measured in plane of faceplate: max. 0.2 mm.

total glass thickness: 7.2 ± 0.2 n = 1.5.









1) The base passes a flat gauge with a centre hole 9.00 ± 0.01 Ø and holes for passing the pins with the following diameters: 7 holes of 1.75 ± 0.005 Ø and one hole of 3.00 ± 0.005 Ø.
The holes may deviate max. 0.01 from their true geometrical position. Thickness of gauge 7 mm.

2) The ends of the pins are tapered and/or rounded but not brought to a sharp point.

6) See page 5

MOUNTING POSITION any

WEIGHT

Net weight	approx.	100	g

ACCESSORIES

Socket	type 56021
Focusing and deflection coil assembly for XQ1023	AT1132, AT1132/01 7)
for XQ1023L, XQ1023R	AT1112 AT1113 AT1113/01 7)

CAPACITANCES

Signal electrode to all	C_a	3 to 6	pF	8)

FOCUSING magnetic 9)

DEFLECTION magnetic 9)

CHARACTERISTICS

Grid No.1 voltage for cut-off at V_{g_2} = 300 V	V_{g_1}		-30 to -100	V	10)
Blanking voltage peak to peak on grid No.1, minimum required	$V_{g_{1pp}}$		70	V	
on cathode , minimum required	$V_{k_{pp}}$		25	V	
Grid No.2 current at normally required beam currents	I_{g_2}	max.	1	mA	
Dark current at V_{a_s} = 45 V	I_{a_s}	max.	0.003	μA	

LIMITING VALUES (Absolute max. rating system)

Signal electrode voltage	V_{a_s}	max.	50	V	11)
Grid No.4 voltage	V_{g_4}	max.	1100	V	11)
Grid No.3 voltage	V_{g_3}	max.	800	V	11)
Potential difference between grid No.4 and No.3	V_{g_4/g_3}	max.	350	V	
Grid No.2 voltage	V_{g_2}	max.	350	V	11)

7) 8) 9) 10) 11) See pages 5 and 6

LIMITING VALUES (Absolute max. rating system) (continued)

Grid No.2 dissipation	W_{g_2}	max.	1	W
Grid No.1 voltage, positive	V_{g_1}	max.	0	V
negative	$-V_{g_1}$	max.	125	V
Cathode to heater voltage, positive peak	V_{kf_p}	max.	50	V
negative peak	$-V_{kf_p}$	max.	50	V
Heating-up time of heater		min.	1	min. 12)
Ambient temperature, storage and operation	t_{amb}	max.	50	°C
		min.	−30	°C
Faceplate temperature, storage and operation	t	max.	50	°C
		min.	−30	°C
Faceplate illumination		max.	500	lux 13)

OPERATING CONDITIONS AND PERFORMANCE

Cathode voltage	V_k	0	V
Grid No.2 voltage	V_{g_2}	300	V
Signal electrode voltage	V_{a_s}	45	V 14)
Grid No.3 and No.4 voltage	V_{g_3} and V_{g_4}	see note 15) and 17)	
Beam current	I_{beam}	see note 16)	
Focusing coil current		see note 15)	
Line and frame deflection coil current		see note 15)	
Faceplate illumination		see note 18) and 19)	
Faceplate temperature		20 to 45	°C

Resolution
Modulation depth, i.e. uncompensated horizontal amplitude response at 400 T.V.-lines (note 20)

		XQ1023, XQ1023L	XQ1023R
Highlight signal current	I_s	0.3 μA	0.3 μA
Beam current	I_{beam}	0.6 μA	0.6 μA
Picture centre		55%	20)
Corners		40%	21) 22)

12) 13) 14) 15) 16) 17) 18) 19) 20) 21) 22) See pages 6 and 7

OPERATING CONDITIONS AND PERFORMANCE (continued)

Limiting resolution ≥ 700 T.V. lines

Signal to noise ratio at a signal current of 0.15 μA approx. 200 : 1 [23]

Decay (or lag)

	XQ1023 XQ1023L		XQ1023R	
	I_s = 0.3 I_b = 0.6	I_s = 0.04 I_b = 0.6	I_s = 0.15 I_b = 0.3	I_s = 0.04 μA I_b = 0.3 μA
Residual signal after dark pulse of 60 ms typ.	3	14	5	13 %
Residual signal after dark pulse of 200 ms typ.	1.5	5	2	5 %

see note 24

NOTES

1. a) Underscanning of the specified target area of 12.8 x 17.1 mm^2 or failure of scanning, should be avoided since this may cause damage to the photoconductive target.
   b) In a colour camera the effective useful image dimensions will be slightly smaller, due to small displacements of the guns in the tube from the central position (in that case the centers of the optical images on the faceplates do not coincide exactly with the centers of the useful photoconductive surfaces). An effective useful image area of 12.6 x 16.8 mm^2 is guaranteed.

2. For proper orientation of the image on the photoconductive layer the horizontal scan direction should be parallel to the plane passing through the tube axis and the index pin.

3. All measurements are made with an infrared absorbing filter, Balzers, Calflex B1/K1 interposed between light source and target. For typical transmission curve of this filter see page 10.

4. Measured with 4.54 lux on the specified target area, when the infrared absorbing filter is removed. The signal current obtained in nA equals the sensitivity in μA per filtered lumen (μA/LmF).

5. Measured as indicated in notes 3 and 4 but with additional filter inperposed between light source and target. Filter used is: Schott, OG2 (3 mm). For transmission curve see page 10.

6. The use of gamma-stretching circuitry is recommended.

7. For optimal screening of target from live end of line deflection coils type AT1113/01 and type AT1132/01 are recommended.

8. Capacitance C_{as} to all, which effectively is the output impedance, increases when the tube is inserted into the deflecting/focusing assembly.

9. For focusing/deflecting coil assembly, see under "Accessories".

[23][24]) See page 7.

NOTES (continued)

10. With no blanking voltage on g_1.

11. At V_K = 0 V.

12. A minimum of 1 minute heating-up time for the heater is to be observed before drawing cathode current.

13. For short intervals. During storage and idle periods of the camera the tube-face shall be covered with the plastic hood provided, respectively the lens be capped.

14. The signal electrode voltage shall be adjusted to 45 V. To compete with excessive highlights in the scene to be televised the signal electrode voltage may be reduced to a minimum of 25 V, this will however result in some reduction in performance.

15.

		focus current mA	line deflection current mA_{pp}	frame deflection current mA_{pp}
Black and white coil assemblies AT1132, AT1132/01 V_{g_3} = 600 V V_{g_4} = 650 V to 700 V	approx.	25	235	35
Colour assemblies AT1112, AT1113, AT1113/01 V_{g_3} = 600 V V_{g_4} = 650 V to 700 V	approx.	100	235	35

The direction of the current through the focusing coil should be chosen such that a north seeking pole will be repelled at the faceplate end of the coil.

The optimum voltage difference between grid No.4 and grid No.3 is depending on the type of focusing/deflection assembly used. For above types a voltage difference of 50 V to 100 V is recommended.

16. To accomodate for peaked highlights (reflections etc.) in the scene to be televised some over-stabilization is recommended.
The figures quoted underneath for resolution relate to a "white" signal I_s of 0.3 μA and a beam current I_{beam} sufficient to just stabilize a peaked "white" signal of 0.6 μA for XQ1023 and XQ1023L, respectively 0.15 μA and 0.3 μA for XQ1023R.

17. Grid No.3 voltage adjusted for correct electrical focus.

18. Faceplate illumination level for the XQ1023 and XQ1023L typically needed to produce 0.3 μA signal current will be approx. 3 lux. The signal current stated for the XQ1023R will be obtained with an incident light-level (2854 ^{o}K) on the filter of approx. 10 lux.
The figures stated for modulation depth are based on the use of the filter described in note 5.

NOTES (continued)

19. Illumination on the photo-conductive layer, B_{ph}, in the case of a black/white camera is related to scene-illumination, B_{sc}, by the formula:

$$B_{ph} = B_{sc} \frac{R.T.}{4F^2 (m+1)^2}$$

in which R represents the scene-reflexivity (average or the object under consideration, whichever is relevant), T the lens transmission factor, F the lens aperture and m the linear magnification from scene to target.
A similar formula may be derived for the illumination level on the photoconductive layer of the XQ1023L, XQ1023R tubes in which the effects of the various components of the complete optical system have been taken into account.

20. The figures shown represent the typical horizontal amplitude responses of the tubes proper after correction for losses in resolution introduced by the optical system.

Horizontal amplitude response can be raised by the application of suitable correction circuits. Such compensation, however, does not affect vertical resolution, nor does it influence the limiting resolution.

21. Corner resolution is measured on the diagonal, at a distance from the picture center equal to 0.35 times the picture diagonal.

22. After readjustment of the electrical focus. For optimal overall resolution the application of dynamic focusing voltages to grid No.3 is recommended.

23. The stated radio represents the "visual equivalent signal-to-noise ratio", which is taken as the ratio of highlight video-signal current to R.M.S. noise-current, multiplied by a factor of 3. (Assuming an R.M.S. noise-current of the video-pre-amplifier of 2.10^{-9} A, bandwidth 5 MHz).

24. Measured with a signal current I_s which has been flowing through the target at least 30 s and beam current sufficient to just stabilize a signal current of magnitude I_b. The figures in the columns 2 and 4 are indicative for the performance of the tubes under low-key conditions when overbeamed.

GENERAL RECOMMENDATIONS AND INSTRUCTIONS FOR USE

TRANSPORT, HANDLING, STORAGE

During transport, handling or storage the longitudinal axis must either be in a horizontal position or be kept vertically with the faceplate of the tube up.

During long-term storage the ambient temperature should preferably not exceed 30 °C.

GENERAL

1. Signal-electrode connection is made by a suitable spring-contact, executed as part of the focusing coil assembly, against the signal electrode ring at the face-end of the tube.

2. Electrostatic shielding of the signal-electrode is required in order to avoid interference effects in the picture. Effective shielding is provided by grounding shields on the inside of the face-end of the focusing coil and on the inside of the deflecting yoke.

3. The properties of the photoconductive layer of the Plumbicon may be found to have slightly deteriorated during long idle periods such as encountered between the last test in our works and actual delivery to the user.

   It is therefore recommended to operate the tube directly after receipt under normal voltage settings, in overscanned position with evenly illuminated target and a signal current of 0.15 μA for some hours after which the initial properties will have been fully restored.

4. The Plumbicon as described in these data has been provided with tungsten base pins. It is recommended to avoid mechanical force and shocks to these pins and to insert the tube into its socket, type 56021, with care.

5. The light-transfer characteristic of the Plumbicon being characterised by a gamma near unity, it may be desirable for broadcast applications to incorporate a gamma correcting circuitry in the video-amplifier system with an adjustable gamma of 0.5 to 1.
   It is suggested to design this gamma correcting circuitry such that an extra compression can be introduced by manual control in the video signal range of 75 to 100% of normal peak white level.

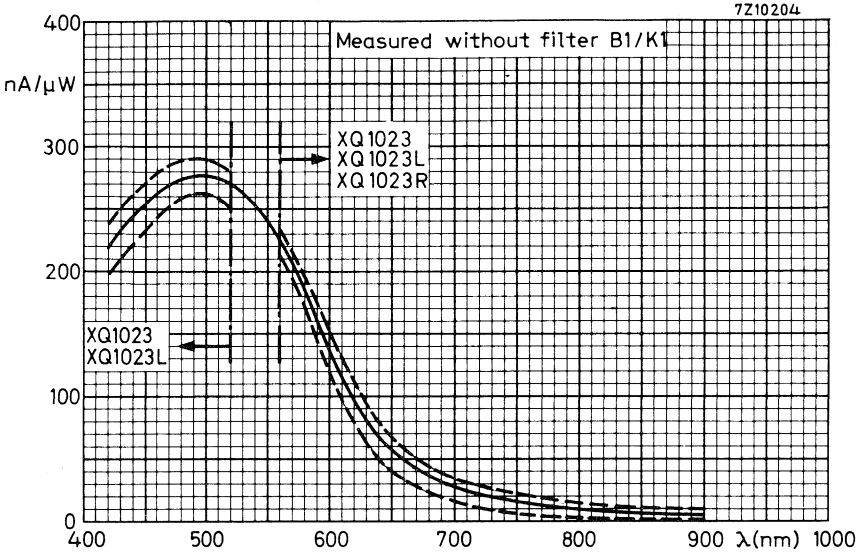
   This provision will prevent the video amplifier system from becoming overloaded when the Plumbicon with its near unity gamma is exposed to scenes containing small peaked highlights as caused by reflections of shiny objects.

6. The Plumbicon not generating own noise to any noticeable extent, the signal to noise ratio will mainly be determined by the entrance noise of the video amplifier system.

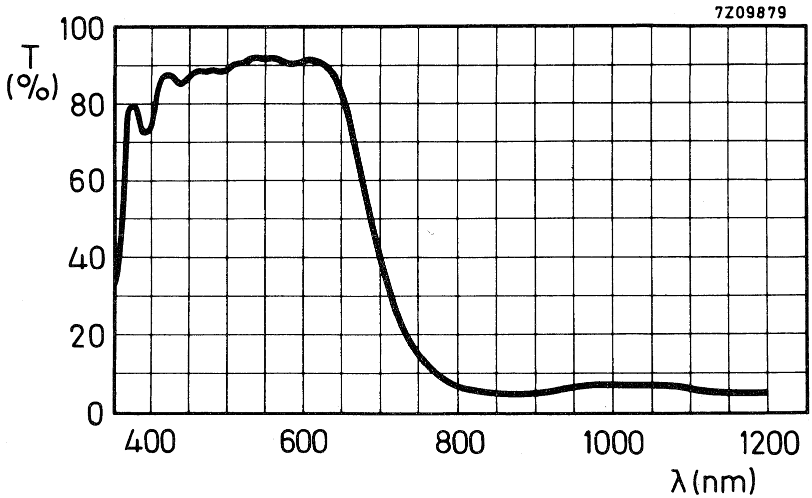
The high sensitivity of the Plumbicon warrants pictures with excellent signal-to-noise ratio under normal studio lighting conditions provided its output is fed into a well-designed input stage of the video-amplifier system. In such a system an aperture correction may be incorporated to ensure an attractive gain in resolving power without impairing the signal to noise ratio.

INSTRUCTION FOR USE

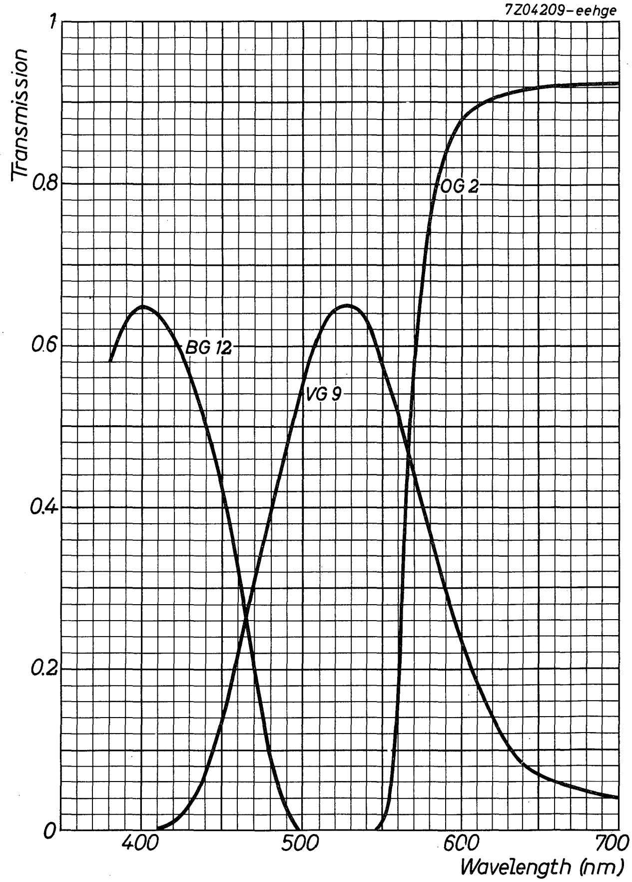
Instructions for use are packed with each tube



Spectral sensitivity characteristic measured at a constant signal output of 50 nA from 12.8 x 17 mm^2 (except at low sensitivity values).



Typical transmission curve of heat-reflecting interference filter, Type CALFLEX-B1/K1


7Z04209-eehge
Transmission
1
0.8
0.6
0.4
0.2
0
400
500
600
700
Wavelength (nm)
BG 12
VG 9
OG 2

CAMERA TUBE

Plumbicon*, sensitive pick-up tube with lead-oxide photoconductive target with extended red response and high resolution. Low velocity target stabilization. Provided with separate mesh construction.

The tubes of this series are mechanically and electrically identical to the tubes of the XQ1023 series, the only difference being the degree of freedom from blemishes of the photoconductive target.

The tubes are intended for industrial and educational black and white and colour cameras. The series comprises the following versions:

XQ1024	for black and white cameras
XQ1024R	for use in the red channel of colour cameras

For all further information see data of XQ1023.

* Registered Trade Mark for T.V. camera tube.

CAMERA TUBE

Plumbicon*, sensitive pick-up tube with lead-oxide photoconductive target with extended red response and high resolution.

Low velocity target stabilization. Provided with separate mesh for good uniformity of signal and resolution and good highlight handling.

The tubes of the XQ1025 series are identical to the tubes of the XQ1023 series but incorporate an infra-red reflecting filter on the anti-halation glass disc.

QUICK REFERENCE DATA			
Focusing :	magnetic	Heater:	6,3V, 300 mA
Deflection:	magnetic	Cut-off of	
Diameter :	approx. 30 mm	spectral response:	~ 750 nm [1])
Provided with anti-halation glass disc with infra-red reflecting filter.			

The infra-red reflecting filter eliminates [2]) the need for additional filters in the colour splitting systems when the XQ1025L and XQ1025R are applied in colour cameras originally designed for tubes of the XQ1020 series.

The manufacturer selects the filters per individual tube such, that the spreads in spectral responses in the long wavelength region as published for the XQ1023 tubes (See data XQ1023, Febr. 1969, page 10) are greatly reduced, warranting minimum differences in colour rendition between colour cameras of identical manufacture.

The XQ1025 will provide black and white pictures with true tonal rendition of colours, the spectral response approaching very nearly the relative spectral sensitivity of the human eye.

The XQ1025L is intended for use in the luminance channel of four tube colour cameras, the XQ1025R for use in the red channel of both three and four tube colour cameras.

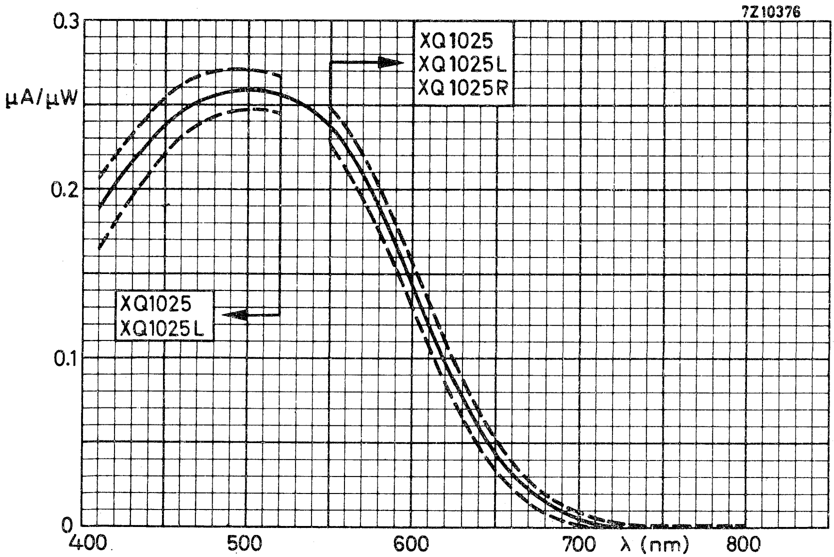
*Registered Trade Mark for T.V. camera tube

OPTICAL

Spectral response	see below
Max. response at	approx. 500 nm
Cut-off	~ 750 nm [1])

Filter: Hard coating on anti-halation glass disc. Care in handling to avoid scratches is strongly recommended.

For all further data revert to the Published Data of the tubes of the XQ1023 series, Febr. 1969 issue. Note 3, page 5 of these data, referring to the Balzers B1/K1 filter, does not apply.



Typical spectral response

1) Defined as the wavelength at which the spectral response has dropped to ≤ 1% of the peak response (~ 500nm).

2) An infra-red absorbing filter for wavelengths in excess of 900 nm is assumed to be incorporated in the optical system of the camera.

CAMERA TUBE

Plumbicon*, sensitive pick-up tube with lead-oxide photoconductive target with extended red response and high resolution. Low velocity target stabilization.

Provided with separate mesh construction and anti-halation glass disc with I.R. filter.

The tubes of this series are mechanically and electrically identical to the tubes of the XQ1025 series, the only difference being found in the degree of freedom from blemishes of the photoconductive target.

The tubes are intended for industrial and educational black and white and colour cameras. The series comprises the following versions:

XQ1026	for black and white cameras
XQ1026R	for use in the red channel of colour cameras

For all further information see data of the XQ1025 series.

* Registered Trade Mark for T.V. camera tube.

CAMERA TUBE

Vidicon television camera tube with low heater consumption, magnetic focusing, magnetic deflection and 25.4 mm (1 in) diameter intended for use in low-cost industrial cameras, home cameras, and for amateur use.

QUICK REFERENCE DATA	
Integral mesh	
Focusing	magnetic
Deflection	magnetic
Diameter	25.4 mm (1 in)
Length	147 mm (5 7/8 in)
Heater	6.3 V, 95 mA
Resolution	$\geq$ 600 TV lines

OPTICAL

Diagonal of quality rectangle on photoconductive layer (aspect ratio 3 : 4)	max.	16	nm

Orientation of image on photoconductive layer:
The direction of the horizontal scan should be essentially parallel to the plane defined by the short index pin and the longitudinal tube axis, unless rotation of the tube is found necessary to minimize the number of blemishes in the picture.

Spectral response, max. response at	approx.	550	nm

HEATING

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

Heater voltage	V_f	6.3	V$\pm$ 10%
Heater current	I_f	95	mA

When the tube is used in a series heater chain, the heater voltage must not exceed 9.5 V_{rms} when the supply is switched on.

CAPACITANCE

Signal electrode to all	C_{as}	4.5	pF

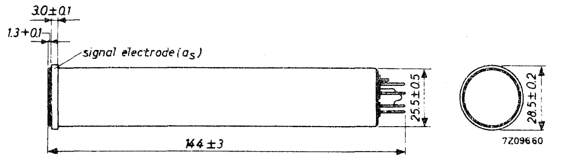
This capacitance, which effectively is the output impedance of the tube, increases when the tube is inserted into the deflection and focusing-coil unit.

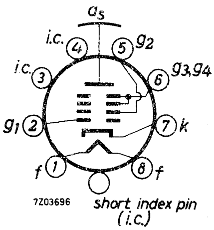
Data based on pre-production tubes.

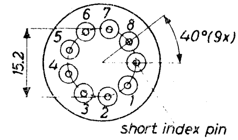
MECHANICAL DATA

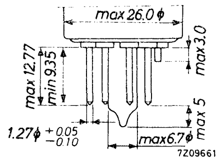
Dimensions in mm

Base: JEDEC no. E8-11 except for pumping stem









Mounting position: any

Net weight approx. 50 g

FOCUSING magnetic

DEFLECTION magnetic

ACCESSORIES

Socket	Cinch no. 54A18088 or equivalent
Deflection and focusing coil unit	AT1101, AT1102 or equivalent

LIMITING VALUES (Absolute max. rating system)
for scanned area of 9.6 mm x 12.8 mm (3/8 in x 1/2 in)

"Full-size scanning", i.e. scanning of a 9.6 mm x 12.8 mm area of the photoconductive layer should always be applied. The use of a mask having these dimensions is recommended. Underscanning, i.e. scanning of an area less than 9.6 mm x 12.8 mm, may cause permanent damage to the specified full-size area.

Signal-electrode voltage	V_{as}	max.	100	V
Grid no.4 and grid no.3 voltage	V_{g4}, V_{g3}	max.	800	V
Grid no.2 voltage	V_{g2}	max.	450	V
Grid no.1 voltage, negative	$-V_{g1}$	max.	125	V
positive	V_{g1}	max.	0	V
Cathode-to-heater voltage, peak positive	V_{kf_p}	max.	125	V
negative	$-V_{kf_p}$	max.	10	V
Output current, peak	I_{as_p}	max.	0.6	μA [1]
Dark current, peak	I_{dark_p}	max.	0.25	μA
Faceplate illumination	E	max.	5000	lx
Faceplate temperature, storage and operation	t	max.	80	°C [2]
Cathode current	I_k	max.	2	mA

[1]) Video amplifiers should be capable of handling signal-electrode currents of this magnitude without overloading the amplifier or distorting the picture.

[2]) Under difficult environmental conditions a flow of cooling air directed at the faceplate is recommended. When televising flames and furnaces appropriate infra-red filters should be used.

OPERATING CONDITIONS AND PERFORMANCE

For a scanned area of 9.6 mm x 12.8 mm and a faceplate temperature of 25 °C to 35 °C.

CONDITIONS

Grid no.4 and grid no.3 (beam focus electrode) voltage	V_{g_4}, V_{g_3}	250 to 300	V [1]
Grid no.2 (accelerator) voltage	V_{g_2}	300	V
Grid no.1 voltage	V_{g_1}	adjusted for sufficient beam current to stabilize highlights	
Blanking voltage, peak-to-peak			
when applied to grid no.1		≥ 75	V
when applied to the cathode		≥ 20	V
Field strength at centre of focusing coil	H	40	Oe [2]
Field strength of adjustable alignment coils	H	0 to 4	Oe [3]

PERFORMANCE

		min.	typ.	max.	
Signal-electrode voltage for output current of 0.3 μA	V_{as}	-	40	70	V [4]
Dark current at output current of 0.3 μA	I_{dark}	-	40	70	nA [4][5]
Decay: residual signal current after dark pulse of 200 ms		-	10	15	% [4][5][6]
Amplitude response at 400 TV lines in picture centre		25	35	-	% [7]
Limiting resolution in picture centre		600			TV lines
Grid no.1 voltage for picture cut-off with no blanking applied	V_{g_1}	-30	-55	-110	V
Average γ of transfer characteristic for signal currents between 0.01 μA and 0.3 μA	γ		0.7		

Spurious signals

Shading

Camera directed towards a uniformly illuminated white background. See also notes [4] and [5]

The composite video signal when viewed at horizontal rate on a waveform oscilloscope will fall within an envelope having a width of 40% of the peak signal

Spots and blemishes

See notes [4], [5], and [8]

For notes see page 5.

Notes to page 4

1) Beam focus is obtained by the combined effect of grid no.3, the voltage of which should be adjustable over the indicated range, and a focus coil having an average field strength of 40 oerstedt.

2) The polarity of the focusing coil should be such that a north-seeking pole is attracted to the image end of the focusing coil, with this pole located outside of and at the image end of the focusing coil.

3) The alignment coil unit should be positioned on the tube so that its centre is at a distance of approx. 94 mm (3 11/16 in) from the face of the tube and that its axis coincides with the axis of the tube, the deflecting yoke and the focusing coil.

4) With 8 lux (c.t. = 2854 ^{o}K) on faceplate.

5) The deflection circuit must provide sufficiently linear scanning for good black-level reproduction. The output current being proportional to the velocity of scanning, any change in this velocity will produce non-uniformity.

6) Signal current is defined as the component of the output current after the dark current has been subtracted.

7) Square wave response. Measured with a video amplifier system having an appropriate bandwidth.

8) Conditions:
The camera focused on a uniformly illuminated two-zone test pattern, the diameter of the centre zone (1) being equal to the raster height. Zone (2) being defined as the remainder of the scanned area.
Scanning amplitudes of rectangular monitor adjusted to obtain a raster with an aspect ratio of 3 : 4.

Monitor set-up and contrast control adjusted for faint raster when lens of camera is capped, and for non-blooming bright raster when lens of camera is uncapped.

Under the above conditions the number and size of the spots visible in the monitor picture will not exceed the limits stated below. Both black and white spots must be counted, unless the amplitude is less than 50% of the peak white signal.

Spot size in % of raster height	Maximum number of spots zone 1	zone 2
> 1	none	none
1 to 0.6	1	3
0.6 to 0.2	4	6
< 0.2	*	*

* Do not count spots of this size unless their concentration is so high as to cause a smudgy appearance.

CAMERA TUBE

Vidicon television camera tube with low heater consumption, separate mesh construction, magnetic focusing, magnetic deflection and 25.4 mm (1 in) diameter intended for use in black-and-white and colour television cameras in industrial, medical and broadcast applications.

QUICK REFERENCE DATA	
Separate mesh	
Focusing	magnetic
Deflection	magnetic
Diameter	25.4 mm (1 in)
Length	158 mm ($6\frac{1}{4}$ in)
Provided with particle trap	
Heater	6.3 V, 95 mA
Resolution	$\geq$ 1000 TV lines

The electrical and mechanical properties of the four types are essentially identical, the main differences being found in the degree of freedom from blesmishes of the photoconductive layers.

XQ1040 - for use in colour and black-and-white telecine equipment
XQ1042 - for use in industrial and broadcast applications in which a high picture quality is required
XQ1043 - for use in normal industrial applications
XQ1044 - low-cost tube for non-critical applications, experiments, amateur use etc.

OPTICAL

Diagonal of quality rectangle on photoconductive layer (aspect ratio 3 : 4)	max.	16	mm

Orientation of image on photoconductive layer:
The direction of the horizontal scan should be essentially parallel to the plane defined by the short index pin and the longitudinal axis of the tube.

Spectral response, max. response at	approx.	550	nm

HEATING

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

Heater voltage	V_f	6.3	V$\pm$10%
Heater current	I_f	95	mA

When the tube is used in a series heater chain, the heater voltage must not exceed 9.5 V_{rms} when the supply is switched on.

Data based on pre-production tubes

CAPACITANCE

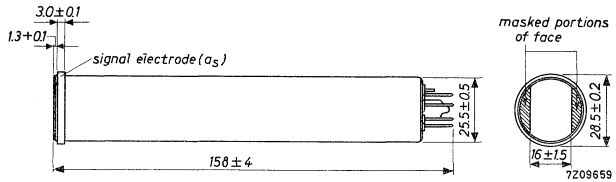
Signal electrode to all $\quad C_{as} \quad 4.5 \text{ pF}$

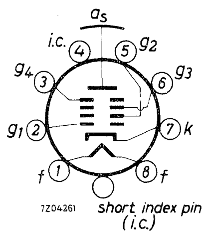
This capacitance, which effectively is the output impedance of the tube, increases when the tube is inserted into the deflection and focusing coil unit.

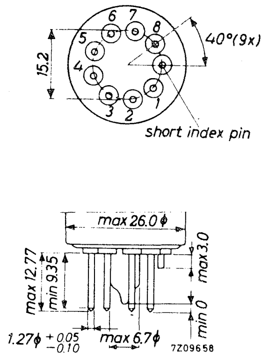
MECHANICAL DATA

Dimensions in mm

Base: JEDEC no. E8-11







Mounting position: any

Net weight approx. 55 g

ACCESSORIES

Socket — Cinch no. 54A18088 or equivalent

Deflection and focusing coil unit — AT1101, AT1102 or equivalent

DEFLECTION magnetic

FOCUSING magnetic

LIMITING VALUES (Absolute max. rating system)
for scanned area of 9.6 mm x 12.8 mm (3/8 in x 1/2 in)

"Full-size scanning", i.e. scanning of a 9.6 mm x 12.8 mm area of the photoconductive layer should always be applied. The use of a mask having these dimensions is recommended. Underscanning, i.e. scanning of an area less than 9.6 mm x 12.8 mm, may cause permanent damage to the specified full-size area.

Signal-electrode voltage	V_{as}	max.	100	V
Grid no.4 voltage	V_{g4}	max.	1000	V
Grid no.3 voltage	V_{g3}	max.	850	V
Grid no.2 voltage	V_{g2}	max.	450	V
Grid no.1 voltage, negative	$-V_{g1}$	max.	125	V
positive	V_{g1}	max.	0	V
Cathode-to-heater voltage, peak positive	V_{kf_p}	max.	125	V
negative	$-V_{kf_p}$	max.	10	V
Dark current, peak	I_{dark_p}	max.	0.25	μA
Output current, peak	I_{as_p}	max.	0.6	μA 1)
Cathode current	I_k	max.	2	mA
Faceplate illumination		max.	5000	lx
Faceplate temperature, storage and operation	t	max.	80	°C 2)3)

1) Video amplifiers should be capable of handling signal-electrode currents of this magnitude without overloading the amplifier or distorting the picture.

2) Under difficult environmental conditions a flow of cooling air directed at the faceplate is recommended.

3) Under conditions of high heat irradiation the use of a infra-red absorbing filter is recommended.

OPERATING CONDITIONS AND PERFORMANCE

for a scanned area of 9.6 mm x 12.8 mm and a faceplate temperature of 30 ± 2 °C

CONDITIONS		Normal operation	Operation for high resolution		
Mesh voltage	V_{g4}	300 to 450	650 to 1000 1)		V
Focusing electrode voltage	V_{g3}	250 to 300	550 to 650		V
Accelerator voltage	V_{g2}	300	300		V
Grid no. 1 voltage	V_{g1}	Adjusted for sufficient beam current to stabilize highlights			
Blanking voltage, peak-to-peak					
when applied to g_1		≥ 75	≥ 75		V
when applied to cathode		≥ 20	≥ 20		V
Field strength at centre of focusing coil	H	40	60 2)		Oe 3)
Field strength of adjustable alignment coils	H	0 to 4	0 to 4		Oe 4)
PERFORMANCE		XQ1042, XQ1043,	XQ1044	XQ1040	
Signal-electrode voltage for dark current of 20 nA	V_{as}	20 to 55	20 to 55		V
typical		30	30		V
for XQ1044 only	V_{as}	15 to 55	15 to 55		V
Signal current faceplate illumination 8 lx, c.t. 2854 °K	I_s	0.17	0.17		µA 5) 6)
Decay: residual signal current after dark pulse of 200 ms. 8 lx, c.t. 2854 °K on faceplate		8	8		% 5) 6)
Signal electrode voltage for dark current of 5 nA	V_{as}			15 to 30	V
Faceplate illumination to produce 0.3 µA output current	E			100	lx 5)
Decay: residual signal current after dark pulse of 200 ms. Output current 0.3 µA, dark current 5 nA				4	% 6)

For notes see page 5.

		XQ1040	XQ1042, XQ1043, XQ1044	
Grid no.1 voltage for picture cut-off, with no blanking applied	V_{g_1}	-30 to -100	-30 to -100	V
Limiting resolution at picture centre		750	1000	[7] TV lines
Modulation depth at 400 TV lines at picture centre		50	65	% [8]
Average γ of transfer characteristic for signal currents between 0.01 μA and 0.3 μA		0.7	0.7	

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1) The optimal grid no.4 voltage for maximum resolution and optimal uniformity of black and white level depends on the type of coil unit used and will be within the range 1.2 to 1.5 times V_{g_3}.
Under no circumstances should grid no.4 (mesh) be allowed to operate at a voltage level below the V_{g_3} level as needed for beam focus, since this may damage the target.

2) Because of the higher deflecting and focusing power required to produce adequate field strength the tube temperature will increase and adequate provisions for cooling should be made.

3) The polarity of the focusing coil should be such that a north-seeking pole is attracted to the image end of the focusing coil, with this pole located outside of and at the image end of the focusing coil.

4) The alignment coil unit should be positioned on the tube so that its centre is at a distance of approx. 94 mm (3 11/16 in) from the face of the tube and that its axis coincides with the axis of the tube, the deflecting yoke and the focusing coil.

5) Signal-electrode voltage adjusted for a dark current of 20 nA (XQ1040 : 5 nA)

6) Signal current is defined as the component of the output current after the dark current has been subtracted.

7) Square wave response. Measured with a video amplifier system having an appropriate bandwidth.

8) Square wave response. Typical values for the tube proper, after correction for faults introduced by the optical system, measured under conditions of a peak signal current I_{sp} = 0.15 μA and a beam current sufficient to stabilize a signal current of 0.5 μA.

CAMERA TUBE

Vidicon television camera tube with low heater consumption, separate mesh construction, magnetic focusing, magnetic deflection and 25.4 mm (1 in) diameter intended for use in medical and industrial X-ray equipment in combination with an X-ray image intensifier tube.

QUICK REFERENCE DATA	
Separate mesh	
Focusing	magnetic
Deflection	magnetic
Diameter	25.4 mm (1 in)
Length	158 mm ($6\frac{1}{4}$ in)
Provided with particle trap	
Heater	6.3 V, 95 mA
Resolution	$\geq$ 1000 TV lines

The electrical and mechanical properties of the XQ1041 are essentially identical to those of the other tubes of the XQ1040 series, the main differences being found in the degree of freedom from blemishes of the photoconductive layer and from mesh deficiencies.

OPTICAL

Quality area on photoconductive layer — circular area diam. max. 15 mm

Direction of scan.
The direction of the horizontal scan should be essentially parallel to the plane defined by the short index pin and the tube axis.

Spectral response, max. response at — approx. 550 mm

HEATING

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

Heater voltage	V_f	6.3	V ± 10%
Heater current	I_f	95	mA

When the tube is used in a series heater chain, the heater voltage must not exceed 9.5 V_{rms} when the supply is switched on.

Data based on pre-production tubes

CAPACITANCE

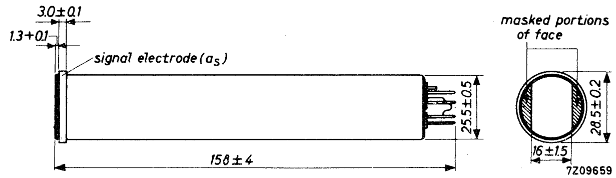
Signal electrode to all C_{as} 4.5 pF

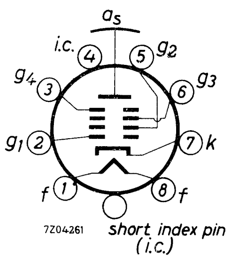
This capacitance, which effectively is the output impedance of the tube, increases when the tube is inserted into the deflection and focusing coil unit.

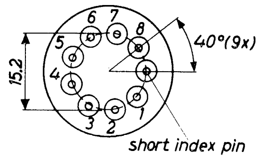
MECHANICAL DATA

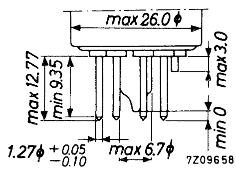
Dimensions in mm

Base: JEDEC no. E8-11









Mounting position: any

Net weight approx. 55 g

ACCESSORIES

Socket Cinch no. 54A18088 or equivalent

Deflection and focusing coil unit AT1101, AT1102 or equivalent

DEFLECTION magnetic

FOCUSING magnetic

LIMITING VALUES (Absolute max. rating system)
for scanned area of 15 x 15 mm^2

Signal-electrode voltage	V_{as}	max.	100	V
Grid no. 4 voltage	V_{g4}	max.	1000	V
Grid no. 3 voltage	V_{g3}	max.	850	V
Grid no. 2 voltage	V_{g2}	max.	450	V
Grid no. 1 voltage, negative	V_{g1}	max.	125	V
positive	V_{g1}	max.	0	V
Cathode-to-heater voltage, peak positive	V_{kf_p}	max.	125	V
negative	V_{kf_p}	max.	10	V
Dark current, peak	I_{dark_p}	max.	0.25	μA
Output current, peak	I_{as_p}	max.	0.6	μA [1])
Cathode current	I_k	max.	2	mA
Faceplate illumination	E	max.	5000	lx
Faceplate temperature, storage and operation	t	max.	80	°C [2])

[1]) Video amplifiers should be capable of handling signal-electrode currents of this magnitude without overloading the amplifier or distorting the picture.

[2]) Under difficult environmental conditions a flow of cooling air directed at the faceplate is recommended.

OPERATING CONDITIONS AND PERFORMANCE

For a scanned area of 15 x 15 mm^2, the area beyond the quality area of 15 mm ∅ covered with a mask, and a faceplate temperature of 30 °C ± 2 °C.

CONDITIONS		Normal operation	Operation for high resolution	
Mesh voltage	V_{g_4}	300 to 450	650 to 1000 1)	V
Focusing electrode voltage	V_{g_3}	250 to 300	550 to 650	V
Accelerator voltage	V_{g_2}	300	300	V
Grid no. 1 voltage	V_{g_1}	Adjusted for sufficient beam current to stabilize highlights		
Blanking voltage, peak-to-peak				
when applied to g_1		≥ 75	≥ 75	V
when applied to cathode		≥ 20	≥ 20	V
Field strength at centre of focusing coil	H	40	60 2)	Oe 3)
Field strength of adjustable alignment coils	H	0 to 4	0 to 4	Oe 4)
PERFORMANCE				
Signal-electrode voltage for dark current of 35 nA	V_{as}	20 to 55	20 to 55	V 5)
typical		30	30	V
Signal current faceplate illumination 2 lx, light source with P20 distribution	I_s	0.075	0.075	μA 6) 7)
Decay: residual signal current after dark pulse of 200 ms. 8 lx, P20 light source on faceplate		8	8	% 6) 7)
Grid no. 1 voltage for picture cut-off, with no blanking applied	V_{g_1}	-30 to -100	-30 to -100	V
Limiting resolution at picture centre		750	1000	TV lines 8)
Modulation depth at 5 Mc/s (625 lines, 50 fields system) lines at picture centre		50	65	% 9)
Average γ of transfer characteristic for signal currents between 0.01 μA and 0.3 μA		0.7	0.7	

NOTES to page 4.

1) The optimal grid no.4 voltage for maximum resolution and optimal uniformity of black and white level depends on the type of coil unit used and will be within the range 1.2 to 1.5 times V_{g_3}.
Under no circumstances should grid no.4 (mesh) be allowed to operate at a voltage level below the V_{g_3} level as needed for beam focus, since this may damage the target.

2) Because of the higher deflecting and focusing power required to produce adequate field strength the tube temperature will increase and adequate provisions for cooling should be made.

3) The polarity of the focusing coil should be such that a north-seeking pole is attracted to the image end of the focusing coil, with this pole located outside of and at the image end of the focusing coil.

4) The alignment coil unit should be positioned on the tube so that its centre is at a distance of approx. 94 mm (3 11/16 in) from the face of the tube and that its axis coincides with the axis of the tube, the deflecting yoke and the focusing coil.

5) Corresponds to 20 nA for 9.6 mm x 12.8 mm beam.

6) Signal electrode voltage adjusted for a dark current of 35 nA.

7) Signal current is defined as the component of the output current after the dark current has been subtracted.

8) Measured with a video amplifier system having an appropriate bandwidth.

9) Square wave response. Typical values for the tube proper, after correction for faults introduced by the optical system, measured under conditions of a peak signal current I_{s_p} = 0.15 μA and a beam current sufficient to stabilize a signal current of 0.5 μA.

CAMERA TUBE

The vidicon television camera tubes of the XQ1050 series are identical to the tubes of the XQ1040 series except for the heater current.

HEATING

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

Heater voltage	V_f	6.3	V ±10%
Heater current	I_f	300	mA

When the tube is used in a series heater chain, the heater voltage must not exceed 9.5 V_{rms} when the supply is switched on.

For all other data refer to the data of the tubes of the XQ1040 series.

CAMERA TUBES

Plumbicon*, sensitive high-definition pick-up tube with lead-oxide photoconductive target. Provided with: separate mesh construction for good overall resolution; Anti--Comet Tail electron gun for improved highlight handling; lightpipe for reduced lag under low-key conditions; fibre optic faceplate. The tubes of the XQ1220 and XQ1230 series can be used in medical, scientific and low light level T. V. systems in which they can be coupled direct to, e.g., X-ray image intensifiers and light intensifiers with fibre optic output windows.

QUICK REFERENCE DATA

Focusing		magnetic
Deflection		magnetic
Diameter	approx.	30 mm
Length	approx.	210 mm

Available types:

Quality area	$12.8 \times 17.1\ mm^2$		18 mm ϕ		21 mm ϕ	
Grade	A	B	A	B	A	B
Non-cladded fibre optic	XQ1220	XQ1223	XQ1221	XQ1224	XQ1222	XQ1225
Black-cladded fibre optic	XQ1230	XQ1233	XQ1231	XQ1234	XQ1232	XQ1235

Resolution	$\geq$	25 lp/mm
Heater	6.3 V,	300 mA
Cut-off of spectral response	approx.	650 nm

Data based on pre-production tubes.

* Registered Trade Mark for television camera tube.

OPTICAL

Quality rectangle on photoconductive target (aspect ratio 3 : 4)	12.8 x 17.1 mm² [1]

Orientation of image on photoconductive target
For correct orientation of the image on the target the horizontal scan should be essentially parallel to the plane passing through the tube axis and the index pin (grid no. 3)

Faceplate		
Diameter of fibres	approx.	7 µm
Flat within		1 µm

ELECTRICAL

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

Heater voltage	V_f		6.3 V ± 5%
Heater current	I_f	approx.	300 mA

Electron gun characteristics

Cut-off

Grid no. 1 voltage for cut-off at $V_{g2,4}$ = 300 V, without blanking nor A.C.T. pulses	-45 to -110 V

Blanking

Applied to grid no. 1, at $V_{g2,4}$ = 300 V		50 ± 10 V_{pp} [6][9]
Grid no. 2 and no. 4 current	max.	0.2 mA [7]

Focussing (see under Accessories)	magnetic
Deflection (see under Accessories)	magnetic

Capacitance

Signal-electrode to all	C_{a_s}	3 to 6 pF

This capacitance, which is effectively the output impedance, increases when the tube is inserted in the coil unit.

LIMITING VALUES (Absolute max. rating system)

All voltages are referred to the cathode, unless otherwise stated.

Signal electrode voltage	V_{as}	max.	50	V
Grid no. 6 (mesh) voltage	V_{g6}	max.	1100	V
Grid no. 5 (collector) voltage	V_{g5}	max.	800	V
Voltage between grid no. 6 and grid no. 5	$V_{g6/g5}$	max.	350	V
Grid no. 4 (limiter) and grid no. 2 (accelerator, or first anode) voltage	$V_{g2,4}$	max.	350	V
Grids no. 4 and no. 2 dissipation	$W_{g2,4}$	max.	1	W
Grid no. 3 (auxiliary grid) voltage	V_{g3}	max.	350	V
Grid no. 1 (control grid) voltage, positive	V_{g1}	max.	0	V
negative	$-V_{g1}$	max.	125	V
Grid no. 1 A.C.T. pulse		max.	40	V_p [6]
Cathode to heater voltage, positive peak	V_{kfp}	max.	50	V
negative peak	$-V_{kfp}$	max.	50	V
Faceplate temperature, storage and operation	t	max.	50	$^{\circ}C$
		min.	−30	$^{\circ}C$
Faceplate illumination	E	max.	500	lx [2]

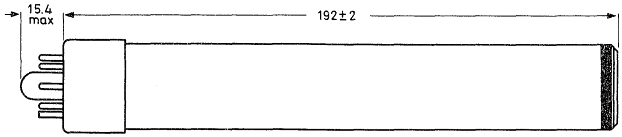
ACCESSORIES

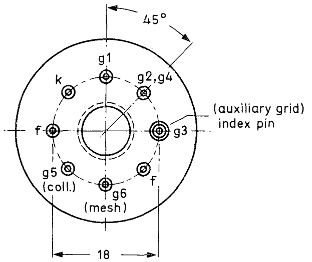
Coil unit	AT1132, AT1132/01 [3]
Socket	modified version of 56021 (under development)

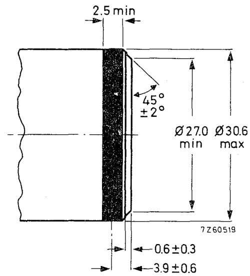
MECHANICAL Dimensions in mm

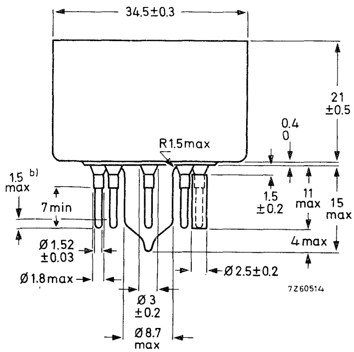
Mounting position: any

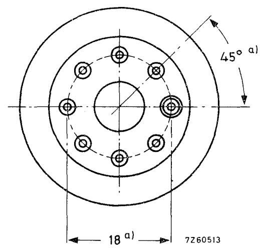
Weight: approx. 110 g











a) The base passes a flat gauge with a centre hole 9.00 ± 0.01 ϕ and holes for passing the pins with the following diameters: 7 holes of 1.750 ± 0.005 ϕ and one hole of 3.000 ± 0.005 ϕ. The holes may deviate max. 0.01 from their true geometrical position. Thickness of gauge 7 mm.

b) The ends of the pins are tapered and/or rounded but not brought to a sharp point.

OPERATING CONDITIONS AND PERFORMANCE

TYPICAL OPERATING CONDITIONS (with Anti-Comet Tail action) [4]
All voltages are specified with respect to cathode.

Cathode voltage,			
during read-out mode	V_k	0	V [5] [6] [7]
during A.C.T. mode	V_k	0 to 10	V
Signal electrode voltage	V_{as}	45	V
Grid no. 6 (mesh) voltage	V_{g6}	675	V [7]
Grid no. 5 (collector) voltage	V_{g5}	600	V [7]
Grid no. 4 (limiter) and grid no. 2 (accelerator, or first anode) voltage	$V_{g2,4}$	300	V [7]
Grid no. 3 (auxiliary grid) voltage,			
during read-out mode	V_{g3}	240 to 260	V [7]
during A.C.T. mode	V_{g3}	0 to 10	V
Grid no. 1 (control grid) voltage	V_{g1}	see note [8]	
blanking voltage to grid no. 1		50	V_p [6] [9]
Scanned area on target		12.8 x 17.1	mm^2
Temperature of faceplate		20 to 45	°C
Coil unit		AT1132/01	

Deflection, focusing and alignment currents

Focus current (adjusted for correct electrical focus) (mA)	Line deflection current (mA_{pp})	Frame deflection current (mA_{pp})
25	235	35

Line and frame alignment coil currents max. 5 mA,
corresponding to a flux density of approx. 4×10^{-4} T (4 Gs)

PERFORMANCE

Dark current (without bias lighting via lightpipe)	$\leq$	3	nA
Sensitivity			
to white light of c.t. 2854 K			
XQ1220 series	typ.	375	µA/lm
XQ1230 series	typ.	300	µA/lm
to light with P11 distribution			
XQ1220 series	typ.	20×10^{-3}	µA/µW [10]
XQ1230 series	typ.	13×10^{-3}	µA/µW [10]
to light with P20 distribution			
XQ1220 series	typ.	15×10^{-3}	µA/µW [10]
XQ1230 series	typ.	10×10^{-3}	µA/µW [10]

Transfer characteristics see page 12

Gamma of transfer characteristic below knee 0.95 ± 0.05

Spectral response

Max. response at	approx.	550	nm
Cut-off at	approx.	650	nm
Response curve	see page 13		

Resolution (I_s/I_b = 150/300 nA) [8] [11]

	P11	P20	
XQ1220 series 15 lp/mm (385 T.V. lines) typ.	40	30	%
XQ1230 series 15 lp/mm (385 T.V. lines) typ.	45	40	%

Modulation transfer characteristic see page 14

Lag (typical values), white light (2854 K), P11, and P20

	build-up lag [12]				decay lag [13]			
	I_s/I_b=20/300 nA		150/300 nA		20/300 nA		150/300 nA [8]	
	60 (ms)	200 (ms)	60 (ms)	200 (ms)	60 (ms)	200 (ms)	60 (ms)	200 (ms)
without bias lighting	70	100	98	100	16	5	3.5	1.2
with 2.5nA bias lighting [14]	98	100	99	100	11	2.5	2.8	0.9
with 5 nA bias lighting [14]	99	100	100	100	8	2	2.4	0.7

NOTES

1) All figures quoted in these data sheets refer to a scanned area of $12.8 \times 17.1\ mm^2$. Underscanning of the once chosen area or failure of scanning should be avoided since this may cause damage to the photoconductive target.

2) For short intervals. During storage and idle periods the tube face must be covered with the plastic hood provided for the purpose, or the lens be capped.

3) For optimal screening of the signal-electrode from the live end of the line deflection coils the AT1132/01 is recommended.

4) When the tube is to be used without Anti-Comet Tail action, grid no. 3 (auxiliary grid) should be connected to grids no. 2 and no. 4 and no A.C.T. pulses should be applied to the cathode and grid no. 1 (control grid). The performance of the tube will then be as described herein with the exception of the highlight handling.

5) a. Read-out mode: defined as the operating conditions during the active line scan (full line period - line blanking interval).
For the CCIR system this will amount to 64 μs - 12 μs = 52 μs.

b. A.C.T. mode: defined as the operating conditions during that part of the line blanking interval during which the A.C.T. electrode gun is fully operative.
The A.C.T. interval is equal to or slightly overlaps the line flyback time.

6. Pulse timing and amplitudes for A.C.T. action (CCIR system)
(blanking on grid no. 1)

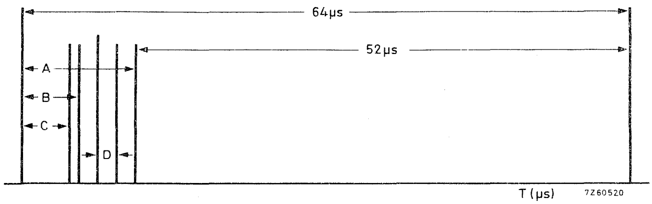
For proper operation of the A.C.T. electrode gun three pulses are required, being:

a. - a positive-going pulse on the cathode with an adjustable amplitude of 0 to 10 V.

b. - a positive-going pulse on grid no. 1 (control grid) of fixed amplitude of 30 to 35 V. The duration of this pulse should be chosen such that it just includes the flyback period (≈5 μs) of the line deflection (e.g. 6 μs).

c. - a negative-going pulse on grid no. 3 (auxiliary grid) with an amplitude of approx. 240 V, adjusted for a V_{g3} voltage during the A.C.T. interval of 0 to 10 V.
Duration and timing of this pulse should be equal to those of the grid no. 1 pulse.

The timing diagram is as follows:



A = Line blanking period: ≈ 12 μs, V_k pulse
B = A.C.T. period: ≈6 μs, grids no. 1 and no. 3 pulses
C = Line flyback period: ≈5 μs
D = Clamping time: 2 to 3 μs

7) The D.C. voltage supply and/or pulse supply to these electrodes should have a sufficiently low impedance to prevent distortion caused by the peak currents drawn during the A.C.T. mode.
These peak currents may amount to:

grid no. 1	0 mA
grids no. 2 and no. 4	1 mA
grid no. 3	150 μA
grid no. 5	300 μA
grid no. 6	300 μA

8) Adjusted, with the A.C.T. switched off, to produce a beam current I_b = 300 nA. I_b is not the actual current available in the scanning beam, but is defined as the maximum amount of signal current, I_s, that can be obtained with this beam.

In the performance figures e.g. for resolution and lag the signal current and beam current conditions are given as I_s/I_b = 20/300 nA.
This hence means: with a signal current of 20 nA and a beam setting which just allows a signal current of 300 nA.

N.B. The signal currents are measured with an integrating instrument connected in the signal-electrode lead, and an uniform illumination on the scanned area. The peak signal currents as measured on a waveform oscilloscope will be a factor α larger ($\alpha = \frac{100}{100 - \beta}$), β being the total blanking time in %; for CCIR system α amounts to 1.33).

9) Blanking can also be applied to the cathode:
a. - without A.C.T. action (see note 4): required cathode pulse approx. 25 V.
b. - with A.C.T. action: timing, polarity and amplitudes of the A.C.T. pulses will have to be adapted.

10) The figures shown represent the signal output current in μA obtained per μW of electrical input power into a P11 or P20 phosphor on a fibre optic output window of e.g. an image intensifier or a converter tube.
Such an output window will usually be provided with non-cladded fibre optics when it feeds into an XQ1220 and with black-cladded fibre optics when it is coupled to an XQ1230.
The figures were obtained as the products $S \times T_1^2 \times \eta$ or $S \times T_2^2 \times \eta$ (see table below) whichever applied.

		symbol	P11	P20	unit
Plumbicon target	Sensitivity of photoconductive target		1800	290	μA/lm
	Conversion factor Watt to lumen		140	480	lm/W
	Sensitivity of photoconductive target	S	0.25	0.14	μA/μW
Fibre optics	Transmission of a non-cladded fibre plate	T_1 *	90	90	%
	Transmission of a black-cladded fibre plate	T_2 *	70	70	%
Phosphor	Luminous efficiency of phosphor	η **	10	14	%

* For the sake of simplicity it is assumed that the fibre optics in the output window and in the Plumbicon faceplate have identical transmissions.

** The phosphors being usually metal-backed, the figures for the luminous efficiencies have been corrected for the effects of the backing.

11) Measured with a test transparency with the emulsion side in direct contact with the faceplate and which is illuminated with diffused light (lambertian illumination). The test transparency has square wave patterns in a white background.
The figures given relate to a low frequency reference obtained from a square wave pattern of 1.0 lp/mm (330 kHz).

12) After 10 seconds of complete darkness. The figures given represent typical percentages of the ultimate signal current obtained 60 ms respectively 200 ms after the illumination has been applied.

13) After a minimum of 5 s of illumination on the target. The figures given represent typical residual signals in % of the original signal current 60 ms respectively 200 ms after the illumination has been removed.

14) The special socket incorporates a small incandescent light bulb (6 V, 1 W), which projects its light on the pumping stem via a blue-green transmitting filter. The light is conducted via a fine glass rod (lightpipe) to cause a bias illumination on the target. The desired amount of bias light can be obtained by adjusting the current through the filament of the small bulb.

GENERAL AND RECOMMENDATIONS

1. During transport, handling and storage the axis of the Plumbicon must be either vertical, with faceplate up, or horizontal; the faceplate must be kept covered with the hood provided for the purpose.

2. To avoid damage to the tungsten basepins, the Plumbicon should be inserted into its socket with care, avoiding undue forces and bending loads on the pins.

3. During long-term storage the ambient temperature should preferably not exceed 30 ^{o}C.

4. In isolated cases the properties of a Plumbicon may deteriorate slightly when it is kept idle for long periods such as may occur:
   . between the factory's pre-shipment test and the actual delivery to the customer.
   . between receipt of the tube and its installation.
   . if the camera is not used for a long time.
   Although the chances of such deterioration are remote it is advisable to operate the tube for some hours at intervals not more than 4 weeks apart.

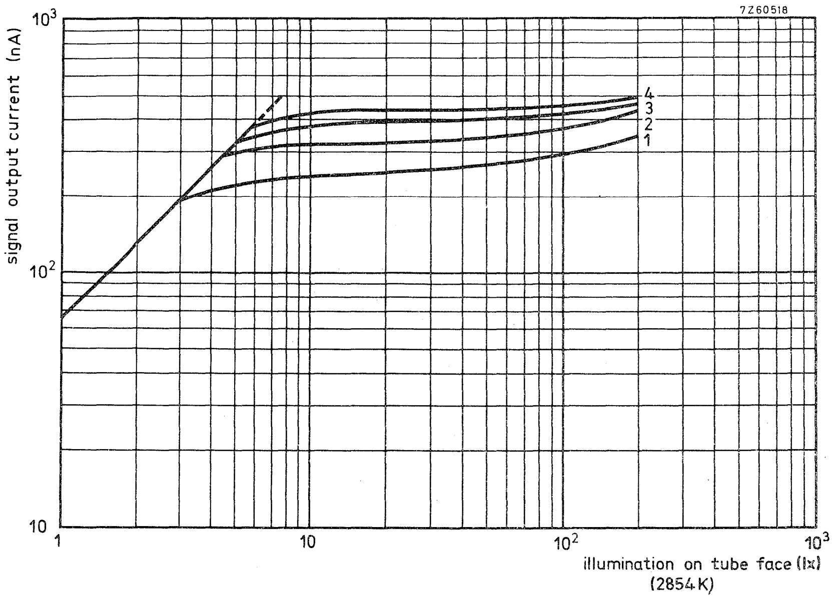
   The following procedure and conditions are recommended:
   . Set grid no. 1 bias-control to maximum negative bias (beam cut-off).
   . Allow a heating-up time of the cathode of at least one minute before turning up the grid no. 1 bias-control to produce a beam.
   . Set scanning amplitudes to overscan condition.
   . Apply an even illumination to the target to obtain a signal current of approx. 0.15 μA and adjust the beam current for correct stabilization.

5. The signal electrode connection is made by a spring contact, which is part of the focusing coil unit and is kept pressed against the signal electrode ring.

6 Electrostatic shielding of the signal electrode is required to avoid interference effects in the picture. Effective shielding is provided by one grounded shield inside the focusing coil at the faceplate end, and one inside the deflecting yoke.

7. The Plumbicon tube not generating own noise to any noticeable extent, the signal-to-noise ratio will be determined mainly by the input noise of the video-amplifier system.

   The high sensitivity of the Plumbicon tube warrants pictures with excellent signal-to-noise ratio under normal lighting conditions provided its output is fed into a well-designed input stage of the video-amplifier system. In such a system an aperture correction may be incorporated to ensure an attractive gain in resolving power without visually impairing the signal-to-noise ratio.

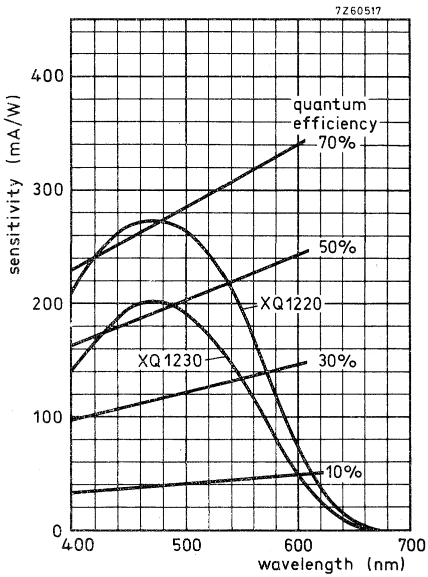


Typical signal output characteristics in A.C.T. operation

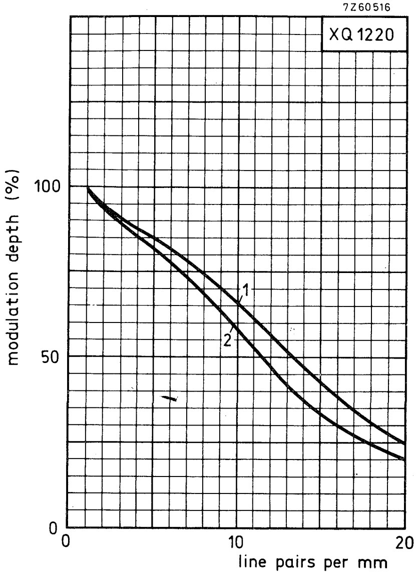
Scanning area : 12.8 x 17.1 mm^2

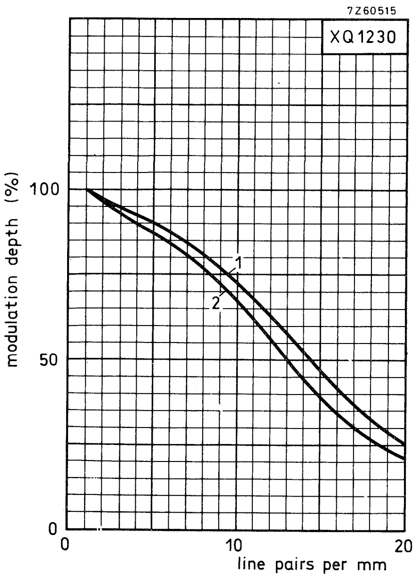
Beam current : just sufficient to stabilize
500 nA signal current

Cathode voltage during flyback :
curve 1 : 4.5 V
curve 2 : 6 V
curve 3 : 7.5 V
curve 4 : 9 V



Typical spectral response characteristics





Typical square wave modulation transfer characteristics in tube centre.

(1) for blue light (P11)
(2) for green light (P20)
Measuring conditions: see note 11

IMAGE INTENSIFIER TUBE

Self-focusing electrostatic diode image intensifier tube with fibre-optic windows for general purpose applications.

QUICK REFERENCE DATA		
Luminance gain	> 50	
Photocathode	S20 with enhanced red response	
Screen phosphor	P20	
Useful cathode and screen diameters	25	mm
Anode voltage	15	kV
Overall dimensions (approx.)	60 x 50 dia.	mm

PHOTOCATHODE

Surface	S20 with enhanced red response	
Wavelength at maximum response	500	nm
Useful diameter	> 25	mm
External surface of cathode window	Flat to within 2 μm over entire diameter	

SCREEN

Surface — Metal-backed P20

Fluorescent colour — Yellow green

Persistence — Medium short

The screen luminance falls to 36% (e^{-1}) of the initial peak value 200 μs after the excitation is removed.

Useful diameter — > 25 mm

External surface of screen window — Flat to within 2 μm over entire diameter

FOCUSING

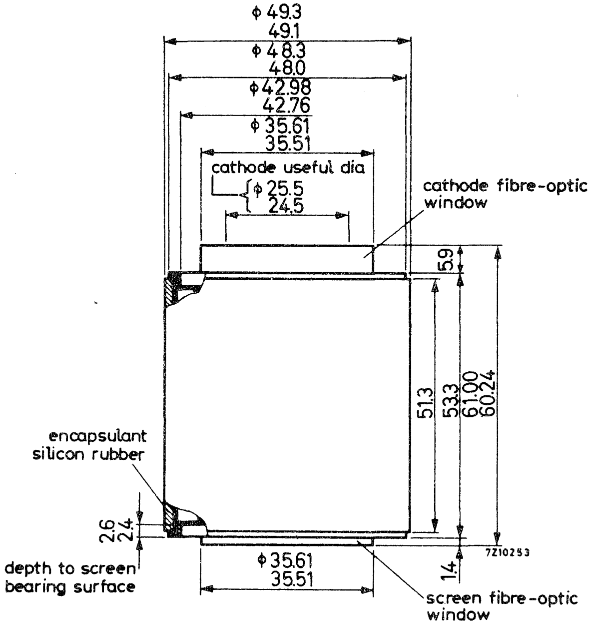
Self-focusing electrostatic with image inversion.

MECHANICAL DATA

Dimensions in mm

Mounting position: any

Net weight : approx. 145 g



Contacts to cathode and screen should be made to the respective bearing surfaces. Contact rings should be kept well clear of the fibre-optic windows. Maximum contact force must not exceed 1 kg.

CHARACTERISTICS (Measured at V_a = 15 kV, t_{amb} = −50 to +30 °C)

Luminance gain (see note 1)	>	50	
Photocathode sensitivity (measured using a tungsten lamp of colour temperature 2854 °K)	>	100	μA/lm
Radiant sensitivity at λ = 800 nm	>	2.0	mA/W
at λ = 850 nm	>	0.5	mA/W
Centre magnification, M_c (see note 2)		0.935 ± 0.010	
Distortion (see note 3)		7.00 ± 1.65	%
Centre resolution (see note 4)	>	60	line pairs/mm
Edge resolution (see note 5)	>	50	line pairs/mm
Background equivalent illumination (see note 6)		1.0	μlux

Axial eccentricity
A point at the centre of the photocathode will form an image within a concentric circle of 1.5 mm diameter on the screen.

OPERATING CONDITIONS

V_a (see note 7)	15	kV

LIMITING VALUES (Absolute max. rating system)

Anode voltage		max.	16	kV
Anode voltage (useful continuous operation)		min.	10	kV
Photocathode illumination, continuous (see note 8)		max.	2.0	lux
Ambient temperature	t_{amb}	max.	+50	°C

NOTES

1. Luminance gain is defined as $\frac{\pi . L_o}{E_i}$

   where L_o = luminance (cd/m^2) in a direction normal to the screen, measured with an eye-corrected photometer having an acceptance angle of less than 2 degrees.

   and E_i = illumination (lux) incident on a 19 mm diameter concentric area of the cathode, produced by a tungsten lamp at a colour temperature of 2850 ^oK.

2. This is the magnification of a 2 mm diameter concentric circle on the photocathode, as measured on the screen.

3. Percentage distortion = $(\frac{M_d}{M_c} \times 100)$, where M_d is the magnification at a distance of 10 mm from the centre of the photocathode and M_c is the magnification at a distance of 1 mm from the centre of the photocathode.

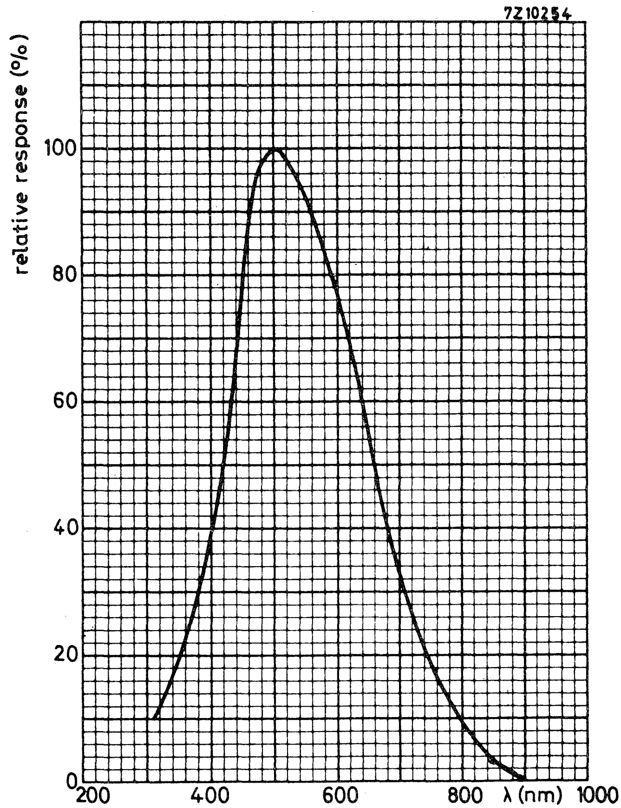
4. Measured at the centre of the photocathode.

5. Measured at the photocathode at a distance of 7 mm from the centre.

6. This is the value of input illumination required to give an increase in screen luminance equivalent to the background luminance.

7. Permanent damage may result from a temporary reversal of polarity.

8. This figure assumes uniform illumination of the photocathode. Permanent damage may result if the tube is exposed to radiant power so great as to cause excessive heating of the photocathode.



PHOTOCATHODE SPECTRAL RESPONSE CURVE

CAMERA TUBE

Plumbicon*, sensitive high-definition pick-up tube with photoconductive target and low velocity stabilization.
The 55875 is intended for use in black and white, the L, R, G, and B versions for use in four and three tube colour studio cameras.

QUICK REFERENCE DATA			
Focusing	magnetic		
Deflection	magnetic		
Diameter	approx.	30	mm
Heater	6.3 V,	90	mA

OPTICAL

Dimensions of quality rectangle on photoconductive layer (aspect ratio 3 : 4)	12.8 mm x 17.1		mm	1)
Orientation of image on photoconductive layer	By means of mark on tube base			2)
Sensitivity at colour temperature of illumination = 2850 °K				
type: 55875, 55875L	min.	275	μA/lumen	
55875R	min.	60	μA/lumen	3)
55875G	min.	125	μA/lumen	3)
55875B	min.	32	μA/lumen	3)
Gamma of transfer characteristic		0.95 ± 0.05		4)
Spectral response; max. response at	approx.	500	nm	

HEATING

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

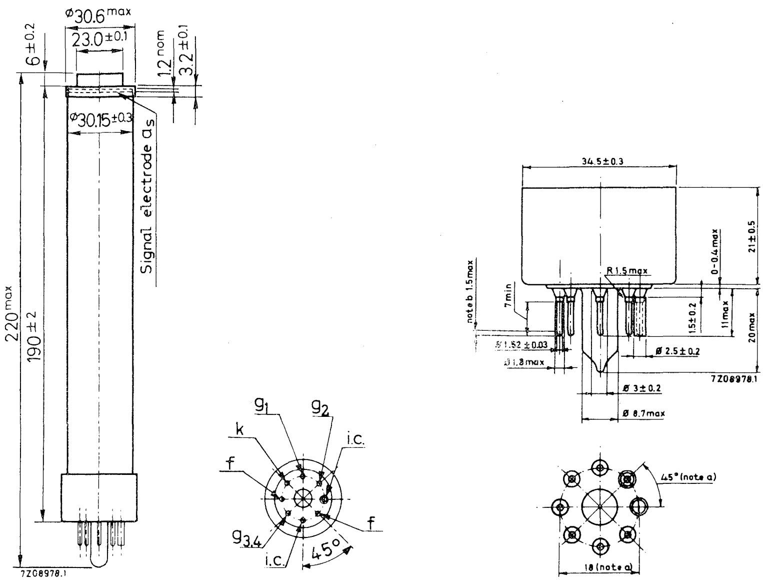
Heater voltage	V_f	6.3	$V \pm 5\%$
Heater current	I_f	90	mA

* Registered Trade Mark for T.V. camera tube

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

MECHANICAL DATA Dimensions in mm

Distance between axis of anti-reflection glass disc and geometrical centre of signal electrode ring, measured in plane of faceplate: max. 0.2 mm.
total glass thickness 7.2 ± 0.2 n = 1.5.



a) The base passes a flat gauge with a centre hole 9.00 ± 0.01 Ø and holes for passing the pins with the following diameters: 7 holes of 1.75 ± 0.005 Ø and one hole of 3.00 ± 0.005 Ø.
The holes may deviate max. 0.01 from their true geometrical position. Thickness of gauge 7 mm.

b) The ends of the pins are tapered and/or rounded but not brought to a sharp point.

Mounting position: any

Net weight approx. 100 g

ACCESSORIES

Socket	type 56021
Focusing and deflection coil assembly	
for 55875	type AT1132
for 55875L, R, G, B	type AT1112 or type AT1113

CAPACITANCE

Signal electrode to all	C_{a_s}	3 to 6	pF [5]

FOCUSING magnetic [6]

DEFLECTION magnetic [6]

CHARACTERISTICS

Grid No.1 voltage for cut-off at V_{g_2} = 300 V	V_{g_1}		-30 to -100	V [7] [8]
Blanking voltage, peak to peak				
on grid No.1	$V_{g_{1p-p}}$	max.	70	V
on cathode	$V_{k_{p-p}}$	min.	25	V
Grid No.2 current at normally required beam currents	I_{g_2}	max.	0.5	mA
Dark current at V_{as} = 45 V	I_{a_s}	max.	0.003	μA

LIMITING VALUES (Absolute max. rating system)

Signal electrode voltage	V_{a_s}	max.	50	V [8]
Grid No.4 and No.3 voltage	V_{g_4}, V_{g_3}	max.	750	V [8]
Grid No.2 voltage	V_{g_2}	max.	450	V [8]
Grid No.1 voltage, positive	V_{g_1}	max.	0	V
negative	$-V_{g_1}$	max.	125	V
Cathode current	I_k	max.	3	mA
Cathode heating time before drawing cathode current	T_h	min.	1	min
Cathode to heater voltage,				
positive peak	V_{kfp}	max.	125	V
negative peak	$-V_{kfp}$	max.	10	V
Ambient temperature, storage and operation	t_{amb}	max.	50	°C
		min.	-30	°C
Faceplate temperature, storage and operation	t	max.	50	°C
		min.	-30	°C
Faceplate illumination		max.	500	lx [9]

[5] [6] [7] [8] [9] See page 5.

OPERATING CONDITIONS AND PERFORMANCE

Cathode voltage	V_k	0	V
Grid No. 2 voltage	V_{g_2}	300	V
Signal electrode voltage	V_{a_s}	45	V [10]
Beam current	I_{beam}	See note 11	
Focusing coil current at given values of grid No. 4 and grid No. 3 voltage		See note 12	
Line coil current and frame coil current		See note 12	
Faceplate illumination		See notes 13 and 14	
Faceplate temperature	t	20 to 45	°C

Resolution

Modulation depth i.e. uncompensated horizontal amplitude response at 400 TV lines, at centre of picture.

The figures shown represent the typical horizontal amplitude response of the tube after correction for faults introduced by the optical system. [15]

	55875 55875L	55875R	55875G	55875B	
Highlight signal current I_s	0.3	0.15	0.3	0.15	μA
V_{g_4}, V_{g_3} = 550 to 600 V (adjusted for optimum focus) See also note 12	40	35	40	50	%

Limiting resolution	≥ 600	TV lines
Signal to noise ratio [16]	approx. 200 : 1	

Decay (or lag)

The decay is basically independent of the illumination level.
Measured with 100% signal current = 0.1 μA and a light source with a colour temperature of 2850 °K.
Appropriate filter inserted in light-path for tubes 55875R, G, B.

	55875L, R, G	55875B	
Residual signal after dark pulse of 60 ms	max. 5	max. 6	%
Residual signal after dark pulse of 200 ms	max. 2	max. 3	%

[10] [11] [12] [13] [14] [15] [16] See pages 5 and 6.

NOTES

1) Underscanning of the specified useful target area of 12.8 mm x 17.1 mm, or failure of scanning, should be avoided since this may cause damage to the photoconductive layer.

2) For correct orientation of the image on the photoconductive layer the vertical scan should be essentially parallel to the plane passing through the tube axis and the mark on the tube base.

3) Measuring conditions:

Illumination 4.54 lx at black body colour temperature of 2850 ^{o}K; the appropriate filter inserted in the light path. The signal current obtained in nA is a measure of the colour sensitivity expressed in μA per lumen of white light before the filter.
Filters used:

55875R	Schott	OG2	thickness	3 mm
55875G	Schott	VG9	thickness	1 mm
55875B	Schott	BG12	thickness	3 mm

See page 8 for transmission curves.

4) a) Gamma is, to a certain extent, dependent on the wavelength of the illumination applied.
b) The use of gamma-stretching circuitry is recommended.

5) The capacitance C_{a_s} to all, which effectively is the output impedance, increases when the tube is inserted into the deflecting/focusing coil assembly.

6) For focusing/deflection coil assembly, see under "Accessories".

7) Without blanking voltage on grid No.1.

8) At $V_k = 0$ V.

9) For short intervals. During storage the tube face shall be covered with the plastic hood provided; when the camera is idle the lens shall be capped.

10) The signal electrode voltage shall be adjusted to 45 V. To enable the tube to handle excessive highlights in the scene to be televised the signal electrode voltage may be reduced to a minimum of 25 V, this will, however, result in some reduction in performance, especially in respect of sensitivity.

11) The beam current shall be adjusted for correct stabilization of the highlight signal currents stated in the table.

12)

	Focus current mA	Line current mA_{pp}	Frame current mA_{pp}
Black/white coil assembly AT1132 V_{g_4}, V_{g_3} = 600 V	25	235	35
Colour coil assemblies AT1112, AT1113 V_{g_4}, V_{g_3} = 600 V	100	235	35

(approx. values)

13) Typical faceplate illumination level for the 55875 and 55875L to produce 0.3 μA signal current will be approx. 4 lx. The signal currents stated for the colour tubes 55875R, G, B respectively will be obtained with an incident white light level (2850 ^{o}K) on the filter of approx. 10 lx. These figures are based on the filters described in note 3, for filter BG12 however a thickness of 1 mm is chosen.

14) In the case of a black/white camera the illumination on the photoconductive layer, B_{ph}, is related to scene illumination, B_{sc}, by the formula:

$$B_{ph} = B_{sc} \frac{R.T}{4F^2 (m+1)^2}$$

in which R represents the average scene reflectivity or the object reflectivity, whichever is relevant, T the lens transmission factor, F the lens aperture, and m the linear magnification from scene to target.
A similar formula may be derived for the illumination level on the photoconductive layers of the R, G, and B tubes in which the effects of the various components of the complete optical system have been taken into account.

15) The horizontal amplitude response can be raised by the application of suitable correction circuits, which affects neither the vertical resolution, nor the limiting resolution.

16) The stated ratio represents the "visual equivalent signal-to-noise ratio", which is taken as the ratio of highlight video-signal current to RMS noise current, multiplied by a factor of 3, assuming an RMS noise current of the video pre-amplifier of 2 nA, bandwidth 5 MHz.

GENERAL RECOMMENDATIONS

1. During transport, handling and storage the axis of the Plumbicon must be either vertical, with faceplate up, or horizontal; the faceplate should be covered with the hood provided.
2. To avoid damage to the tungsten basepins, the Plumbicon should be inserted into its socket with care. Shocks, undue force, and bending loads on the pins are to be avoided.
3. During long term storage the ambient temperature should not exceed 30 ^{o}C.
4. The properties of the photoconductive material used in the Plumbicon may deteriorate during long idle periods. To restore them, the tube should be operated for a few hours, in overscanned condition, with an evenly illuminated target and a signal current of 0.15 μA, at the voltage setttings indicated in its test data.
5. The signal electrode connection is made by a springcontact, which is part of the focusing coil assembly, and is kept pressed against the signal electrode ring.
6. Electrostatic shielding of the signal electrode is required to avoid interference effects in the picture. Effective shielding is provided by a grounded shield inside the focusing coil at the faceplate end, and one inside the deflecting yoke.

7. The light transfer characteristic of the Plumbicon tube being characterized by a gamma near unity, it may be desirable for broadcast applications to incorporate a gamma correcting circuitry in the video-amplifier system with an adjustable gamma of 0.5 to 1.

   It is suggested to design this gamma correcting circuitry such that an extra compression can be introduced by manual control in the video signal range of 75% to 100% of normal peak white level.

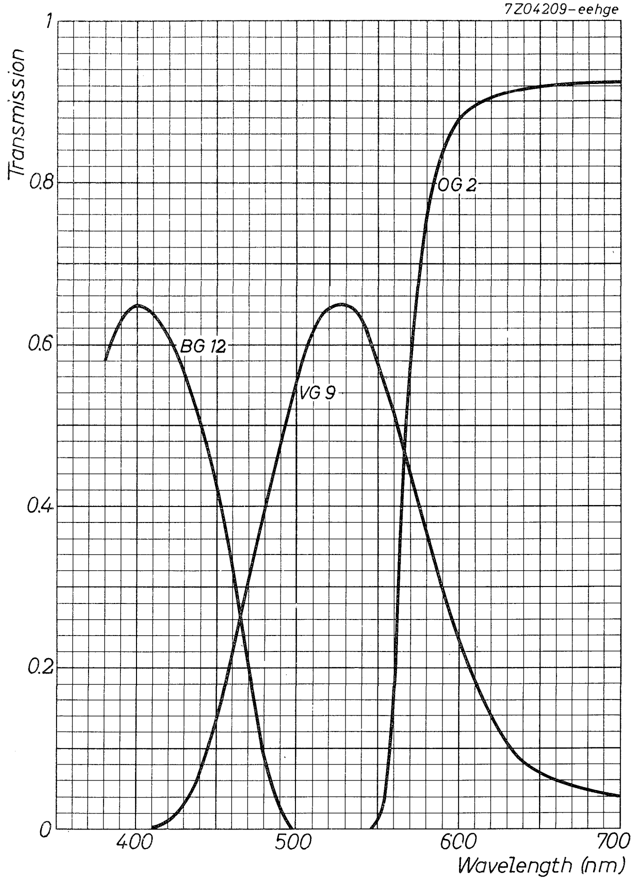
   This provision will prevent the video-amplifier system from becoming overloaded when the Plumbicon tube is exposed to scenes containing small peaked highlights as caused by reflections of shiny objects.

8. The Plumbicon tube not generating own noise to any noticeable extent, the signal-to-noise ratio will be determined mainly by the entrance noise of the video-amplifier system.

   The high sensitivity of the Plumbicon tube warrants pictures with excellent signal-to-noise ratio under normal studio lighting conditions provided its output is fed into a well-designed input stage of the video-amplifier system. In such a system an aperture correction may be incorporated to ensure an attractive gain in resolving power without visually impairing the signal-to-noise ratio.

INSTRUCTIONS FOR USE

Instructions for use are packed with each tube.


7Z04209-eehge
Transmission
1
0.8
0.6
0.4
0.2
0
OG 2
BG 12
VG 9
400
500
600
700
Wavelength (nm)

CAMERA TUBE

Plumbicon*, sensitive pick-up tube with lead-oxide photoconductive target and low velocity stabilization.

The tubes of this series are mechanically and electrically identical to the tubes of the 55875 series, the only difference being the degree of freedom from blemishes of the photoconductive target.

The tubes are intended for industrial and educational black and white and colour cameras. The series comprises the following versions:

55875-IG	for black and white cameras
55875R-IG 55875G-IG 55875B-IG	for use in the chrominance channels of colour cameras

For all further information see data of the 55875 series.

* Registered Trade Mark for T.V. camera tube.

CAMERA TUBE

Plumbicon*, pick-up tube with photoconductive target and low velocity stabilisation exclusively intended for use with X-ray image intensifier in medical equipment.

QUICK REFERENCE DATA	
Focusing	magnetic
Deflection	magnetic
Diameter	30 mm
Heater	6.3 V, 90 mA
Without anti-halation glass disc	

OPTICAL

Image dimensions on photoconductive layer	circle of 18.0 mm diameter [1][2][3]		
Sensitivity, measured with a fluorescent light source having P20 distribution	min.	200	μA/lumen
	typ.	275	μA/lumen
Gamma of transfer characteristic	0.95 ± 0.05		[4]
Spectral response, max. response	= at approx.	500	nm

HEATING

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

Heater voltage	V_f	6.3	V ± 10%
Heater current	I_f	90	mA

1) All underscanning of the specified useful target-area of 18.0 mm diameter or failure of scanning, should be carefully avoided, since this may cause permanent damage to the photoconductive layer.
2) The area beyond the 18.0 mm circular optical image preferably to be covered by a mask.
3) Direction of vertical scan should be essentially parallel to the plane passing through the tube axis and the mark on the tube base.
4) The near unity gamma of the 55876/01 ensures good contrast when televising low contrast X-ray image-intensifier pictures as encountered in radiology. Further contrast improvement may be obtained when an adjustable gamma expansion circuitry is incorporated in the video amplifier system.

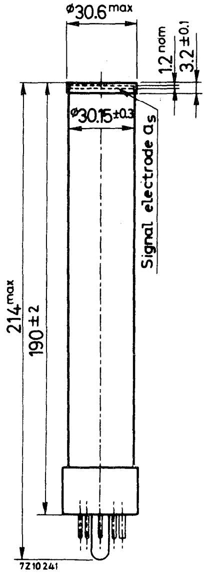
*) Registered T.M. for TV camera tube.

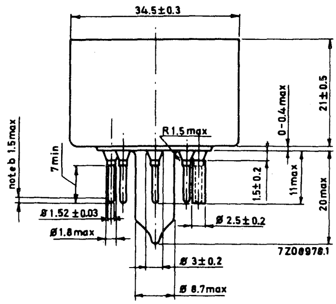
CAPACITANCES

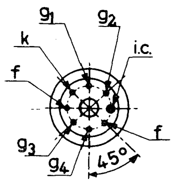
Signal electrode to all	C_{a_s}	3 to 6 pF [1])

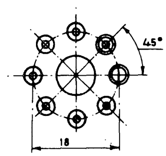
MECHANICAL DATA

Dimensions in mm









FOCUSING	magnetic
DEFLECTION	magnetic
MOUNTING POSITION	any

ACCESSORIES

Socket	type 56021
Focusing and deflection coil assembly	type AT1122, AT1132, AT1132/01

NET WEIGHT approx. 100 g

[1]) Cap. a_s-rest, which effectively is the output impedance, increases when the tube is inserted into the deflection/focusing coil assembly.

CHARACTERISTICS

Grid No. 1 voltage for cut-off at V_{g_2} = 300 V	V_{g_1}		−30 to −100	V [1]
Blanking voltage, peak to peak				
on grid No. 1 min. required	$V_{g_{1p-p}}$	min.	70	V
on cathode min. required	$V_{k_{p-p}}$	min.	25	V
Grid No. 2 current at normally required beam current	I_{g_2}	max.	1	mA
Dark current	I_{a_s}	max.	0.003	μA [2]

LIMITING VALUES (Absolute max. rating system)

Signal electrode voltage	V_{a_s}	max.	50	V [3]
Grid No. 4 and grid No. 3 voltage	V_{g_4}, V_{g_3}	max.	750	V [3]
Grid No. 2 voltage	V_{g_2}	max.	450	V [3]
Grid No. 1 voltage positive	V_{g_1}	max.	0	V [3]
negative	$-V_{g_1}$	max.	125	V [3]
Cathode current	I_k	max.	3	mA
Cathode to heater voltage positive peak	V_{kf_p}	max.	125	V
negative peak	V_{kf_p}	max.	10	V
Ambient temperature (storage and operation)	t_{amb}	max.	50	°C
		min.	−30	°C
Face-plate illumination		max.	100	lux [4]
Face-plate temperature (storage and operation)	t	max.	50	°C
		min.	−30	°C

---

1) With no blanking voltage on g_1

2) Target voltage adjusted to the value indicated by the tube manufacturer on the test sheet as delivered with each individual tube.

3) At V_k = 0 V.

4) For short intervals. During storage the tube face shall be covered with the plastic hood provided.

OPERATING CONDITIONS AND PERFORMANCE

Cathode voltage	V_k	0	V
Grid No. 2 voltage	V_{g_2}	300	V
Grid No. 4 and grid No. 3 voltage	V_{g_4}, V_{g_3}	550 to 600	V [1]
Signal electrode voltage	V_{a_s}	15 to 45	V [2]
Beam current	I_{beam}	See note 3	
Focusing coil current			
Line coil and frame coil current		See note 4	
Highlight signal electrode current	I_{a_s}	0.1 to 0.5	μA [5]
Average signal output		approx. 0.06	μA [5]
Face-plate temperature	t	25 to 40	°C
Face-plate illumination		approx. 2	lux [6]

[1]) Grid No.4 and No.3 voltage adjusted for optimum picture focus.

[2]) The target voltage should be adjusted to the value indicated by the tube manufacturer on the test sheet as delivered with each individual tube.

[3]) Operation of the tube with beam currents I_b not sufficient to stabilize the brightest highlight picture elements must be carefully avoided in order to prevent loss of highlight-detail and/or "sticking" effects.
Operation at excessively high beam currents will result in loss of resolution.

[4]) For AT1122, AT1132, AT1132/01:

Focus coil current : 25 mA
Line deflection current : 250 mApp
Frame deflection current: 50 mApp

approx. values at $V_{g_3g_4}$ = 550-600 V for 18 mm x 18 mm scanning

[5]) Substraction of dark current is unnecessary because of the extremely small value.

[6]) Illumination on the photoconductive layer, B_{ph}, is related to scene-illumination, B_{sc}, by the formula:

$$B_{ph} = B_{sc} \frac{R.T.}{4.F^2.(m+1)^2}$$

in which R represents the scene-reflexivity (average or of the object under consideration, whichever is relevant), T the lens transmissionfactor, F the lens aperture and m the linear magnification from scene to target.

OPERATING CONDITIONS AND PERFORMANCE(continued)

Resolution	
Modulation depth, i.e. uncompensated horizontal amplitude response (see note 1) at 5 MHz in picture centre (625 lines, 50 fields system)	> 30 % 2)
Signal to noise ratio	
at a signal current of 0.15 μA	approx. 200 : 1 3)
Persistence (or lag)	
Low persistence renders tube very suitable for medical X-ray applications in combination with X-ray image intensifier	
Persistence is basically independent of illumination level	
Decay	
Measured with 100% video signal current of 0.1 μA to zero signal after 5 s peak video signal. Beam current adjusted for correct stabilisation. Fluorescent light source having P20 distribution.	
Residual signal after dark pulse of 60 ms	max. 10 % typ. 5 %
Residual signal after dark pulse of 200 ms	max. 4 % 2 %

1) With a signal current of 0.10 μA and a beam current of 0.20 μA.

2) Horizontal amplitude response can be raised by the application of suitable phase-and-aperture correction circuits. Such compensation, however, does not affect vertical resolution, nor does it influence the limiting resolution.

3) The specified ratio represents the "visual equivalent signal-to-noise ratio", which is taken as the ratio of highlight video-signal current to R.M.S. noise-current, multiplied by a factor of 3. (Assuming an R.M.S. noise-current of the video pre-amplifier of 2.10^{-9} A, bandwidth 5 MHz.)

GENERAL RECOMMENDATIONS AND INSTRUCTIONS FOR USE

MOUNTING, WORKING POSITION

1. Any
2. During transport, handling or storage the longitudinal axis must either be in a horizontal position or be kept vertically with the face-plate of the tube up.
3. During long term storage the ambient temperature should not exceed 30 °C.

GENERAL

1. Signal-electrode connection is made by a suitable spring-contact which is executed as part of the focusing coil.
2. Electrostatic shielding of the signal-electrode is required in order to avoid interference effects in the picture. Effective shielding is provided by grounding shields on the inside of the face-plate end of the focusing coil and on the inside of the deflecting yoke.
3. The Plumbicon as described in these data has been provided with tungsten base pins. It is recommended to avoid mechanical force and shocks to these pins and to insert the tube into its socket with care.
4. In some cases the properties of the photoconductive layer as used in the Plumbicon may be found to have slightly deteriorated during long idle periods, such as encountered between the last test in our works and actual delivery to the user.
   It is therefore recommended to operate the tube directly after receipt under normal voltage settings, in overscanned position with evenly illuminated target and a signal current of 0.15 μA for some hours after which the initial properties will have been fully restored.
5. The Plumbicon not generating own noise to any noticeable extent, the signal-to-noise ratio will mainly be determined by the entrance noise of the video amplifier system.
   The high sensitivity of the Plumbicon warrants pictures with excellent signal-to-noise ratio, provided its output is fed into a well-designed input stage of the video-amplifier system. In such a system an aperture correction may be incorporated to ensure an attractive gain in resolving power without impairing the visual signal-to-noise ratio.

INSTRUCTIONS FOR USE

Instructions for use are packed with each tube

Photo tubes

LIST OF SYMBOLS

Supply voltage	V_b
Cathode current	I_k
Anode series resistance	R_a
Sensitivity	N
Capacitance, anode to cathode	C_{ak}
Ambient temperature	t_{amb}
Envelope temperature	t_{env}

GENERAL OPERATIONAL RECOMMENDATIONS PHOTOTUBES

1. GENERAL

1.1 Photo tubes are photo-electric devices of the emissive type, as distinct from the barrier-layer and photo-conductive cells. They may be divided into two groups:

1. High-vacuum photo tubes,
2. Gas-filled photo tubes

Each of these groups can be subdivided into red sensitive and blue sensitive photo tubes; the spectral response depending upon the photocathode material. For the blue sensitive photo tubes the "A" type of cathode is used (caesium-antimony).
For the red sensitive photo tubes the "C" type of cathode is used (caesium-oxidised silver).
Spectral response curves for each type of cathode are given at the end of these recommendations.

2. OPERATING CHARACTERISTICS

For a vacuum photo tube, the anode current for a fixed quantity of light, is reasonably constant at anode voltages above a certain low value known as the "saturation voltage".
The gas-filled photo tube contains a quantity of inert gas, the ionising potential of which is generally somewhat higher than the saturation voltage of an equivalent vacuum photo tube so that the anode current is substantially constant between the saturation voltage and the voltage at which ionisation commences. Above this voltage range, ionisation increases, resulting in a progressive increase in anode current.
Since a gas-filled photo tube operates at a higher voltage than the ionising potential it will have a greater sensitivity than a similar vacuum photo tube.
Within the operating ranges of both groups of photo tubes the anode current is directly proportional to the quantity of light incident on the cathode surface.

2.1 Luminous sensitivity. The response of a photo tube to light falling on its cathode is termed its luminous sensitivity; this is expressed in micro-amperes per lumen.
The sensitivity of all types is dependent upon the colour temperature of the light source and in some cases upon the portion of the cathode that is illuminated.

The sensitivity of gas-filled photo tubes moreover is dependent upon the anode voltage; the sensitivity of vacuum photo tubes in the "saturation region" in which region the tube mainly operates, is practically independent of the anode voltage.

Unless otherwise stated, the values given in the data sheets have been obtained by illuminating the total useful cathode area with an incandescent lamp having a colour temperature of 2700 ^{O}K.

The values given for sensitivity on the data sheets are the initial values for average photo tubes. The ratio between the maximum and minimum initial sensitivity of photo tubes of a given type will not exceed 3 to 1.

2.2 Dark current. This is the current which flows between photocathode and anode when the photo tube is in total darkness. The tube is in total darkness when no radiation within the spectral sensitivity curve of the photocathode is present. This current is caused mainly by electrical leakage and thermionic emission from the photocathode and will therefore increase with temperature and voltage.

2.3 Frequency response. The sensitivity of a vacuum photo tube is constant for frequencies of light modulation up to those generally met in practice. Only at very high frequencies, at which transit time limitations occur, the sensitivity becomes dependent upon the frequency.

The sensitivity of gas-filled photo tubes, however, decreases with the frequency. At a frequency of 15 000 Hz this decrease is about 3 dB, as is shown in the accompanying curve.

3. THERMAL DATA

Ambient temperature. The temperature of the photocathode may not be too high otherwise evaporation of the emissive cathode layer may result, with consequent reduction in sensitivity and life. As it is difficult to measure this temperature a limiting value for the ambient temperature is given on the published data sheets.

It must be considered, however, that even in case the ambient temperature in the immediate vicinity of the photo tube is not beyond the limit, an excessive temperature rise of the photocathode can be caused e.g. by infrared heat radiation. If the possibility of this radiation exists, a suitable filter should be inserted in the optical path to minimize this effect.

4. OPERATIONAL NOTES

Stability during life. Where a gas-filled photo tube is continuously operated at its maximum rated voltage its sensitivity may fall by as much as 50%, during 500 hours.

Vacuum photo tubes on the other hand are inherently more stable.

The stability of both types of photo tubes will be improved if the current density of the photocathode is reduced (e.g. by reducing the incident light or enlarging the illuminated area of the photocathode).
Particularly in the case of gas-filled photo tubes reduction of the anode voltage will improve the stability.

Also in the inoperative periods photo tubes must not be exposed to strong radiation such as direct sunlight.

A loss of sensitivity of both vacuum and gas-filled photo tubes during operation will be wholly or partially restored during the inoperative periods.

Prevention of glow discharge. Gas-filled photo tubes must not be operated above the published maximum voltage since a glow discharge, indicated by a faint blue glow in the bulb, may occur which adversely affects the good operation of the photo tube and even can result in rapid destruction of the photocathode. If accidental over-running can be expected the anode resistance should have a value of at least 0.1 MΩ.
Where it is necessary to use the maximum operating voltage a stabilized supply is recommended.

5. MOUNTING

If no restrictions are made on the individual published data sheets photo tubes may be mounted in any position.

6. STORAGE

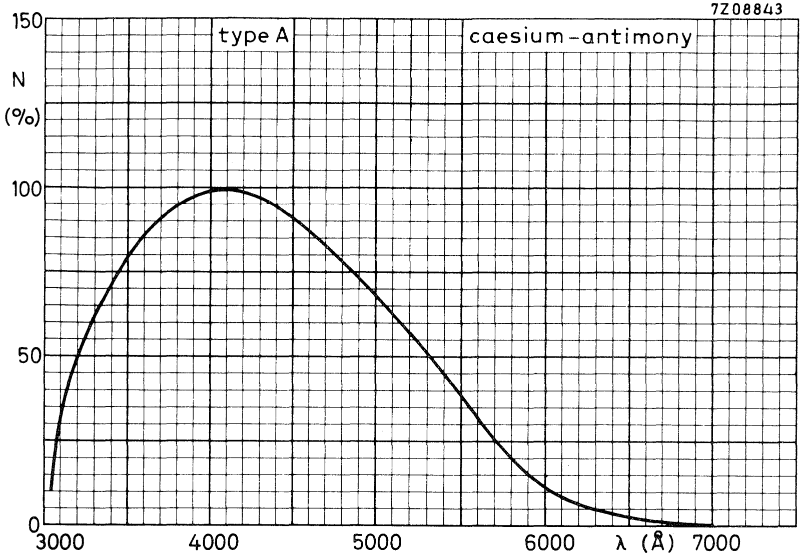
It is necessary that photo tubes be always stored in the dark.

7. LIMITING VALUES

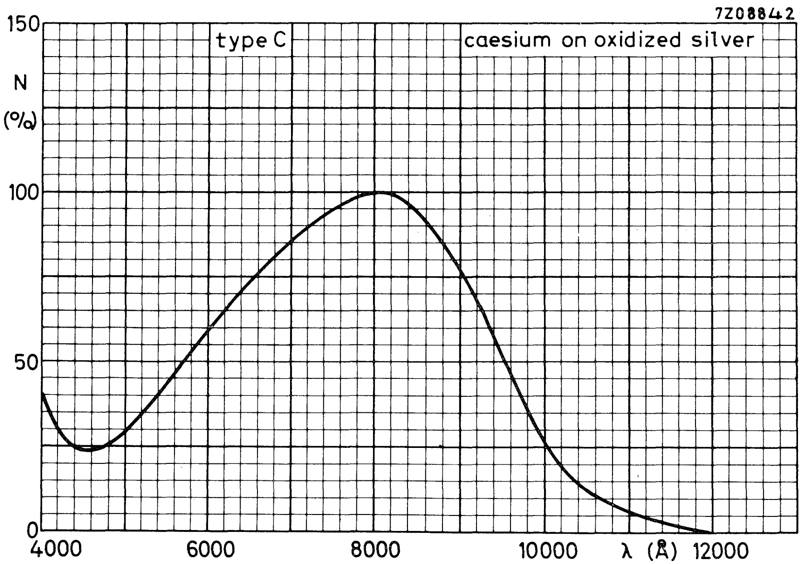
The limiting values of photo tubes are given in the absolute max. rating system.

8. OUTLINE DIMENSIONS

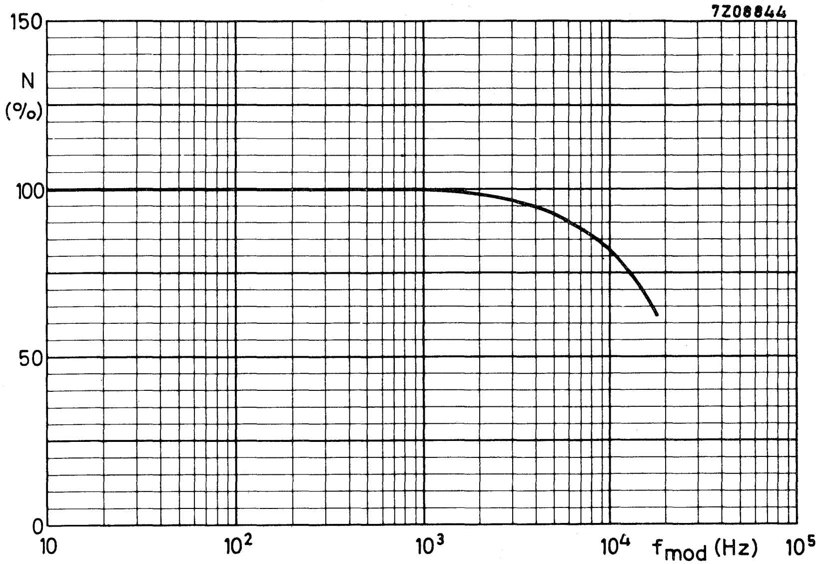
The outline dimensions are given in mm.



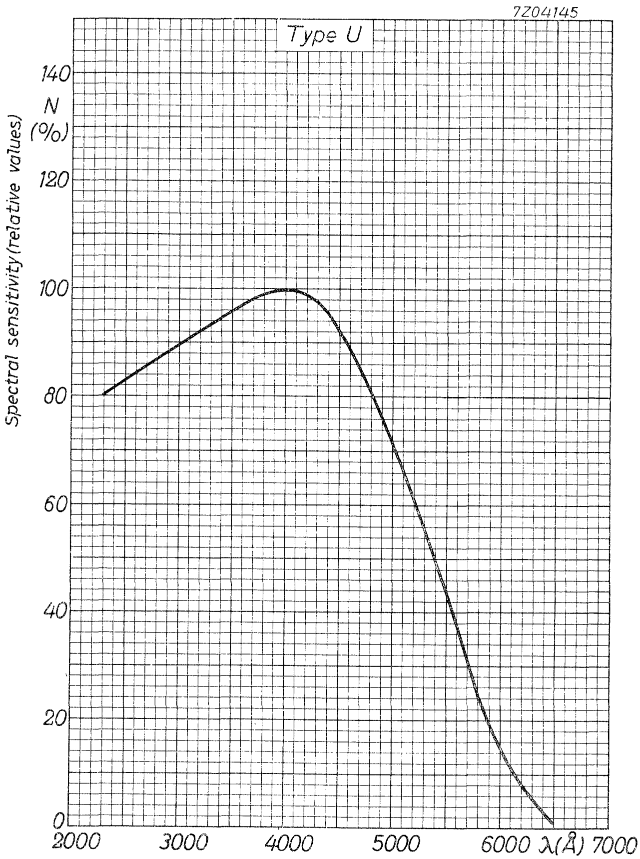
Reletive spectral response curve type A



Relative spectral response curve type C



Frequency response curve (see also 2.3)


7Z04145
Type U
Spectral sensitivity (relative values)
N (%)
140
120
100
80
60
40
20
0
2000
3000
4000
5000
6000
λ(Å)
7000

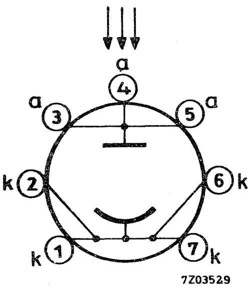
VACUUM PHOTOTUBE

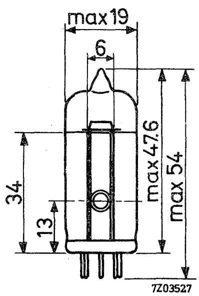
Vacuum phototube, particularly sensitive to daylight and to light radiation with a blue predominance.

QUICK REFERENCE DATA				
Anode supply voltage	V_b	max.	100	V
Luminous sensitivity	N		45	μA/lumen
Spectral response curve		type A		
Outline dimensions		max. 19 dia. x 54		mm

MECHANICAL DATA Dimensions in mm

Base: Miniature





The arrows show the direction of the incident radiation

The cathode connection should be made to pins 1, 2, 6 and 7 connected together and the anode connection to pins 3, 4 and 5 together

Photo cathode

Surface	caesium antimony
Projected sensitive area	4 cm^2

ELECTRICAL DATA

Operating characteristics

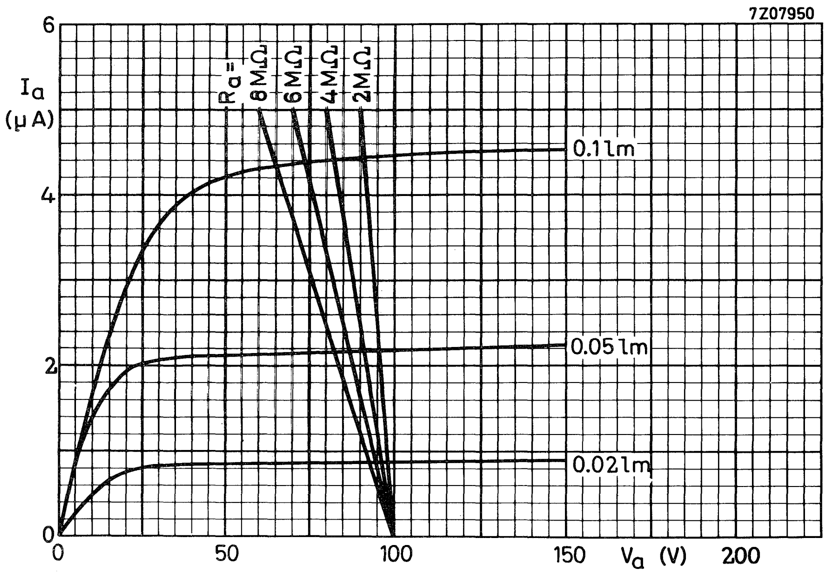
Anode supply voltage	V_b	100	V
Anode series resistor	R_a	1	MΩ
Luminous sensitivity measured with the whole cathode area illuminated by a lamp of colour temperature 2700 °K	N	45	μA/lumen
Dark current	I_{dark}	max. 0.05	μA

Capacitance

Anode to cathode	C_{ak}	0.7	pF

LIMITING VALUES (Absolute max. rating system)

Anode supply voltage	V_b	max.	100	V
Cathode current	I_k	max.	5	μA
Ambient temperature	t_{amb}	max.	70	°C



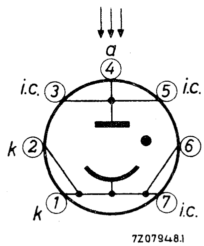
GAS FILLED PHOTOTUBE

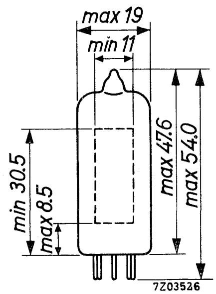
Gas filled phototube particularly sensitive to incandescent light sources, and to near infra-red radiation.

QUICK REFERENCE DATA				
Anode supply voltage	V_b	max.	90	V
Luminous sensitivity	N		125	μA/lumen
Spectral response curve		type C		
Outline dimensions		max. 19 dia. x 54		mm

MECHANICAL DATA Dimensions in mm

Base: Miniature





The arrows show the direction of the incident radiation

The cathode connection may be made to pins 1, 2, 6 and 7 connected together and the anode connection to pins 3, 4 and 5 connected together.

Photocathode

Surface	Caesium on oxidized silver
Projected sensitive area	3.0 cm^2

ELECTRICAL DATA

Operating characteristics

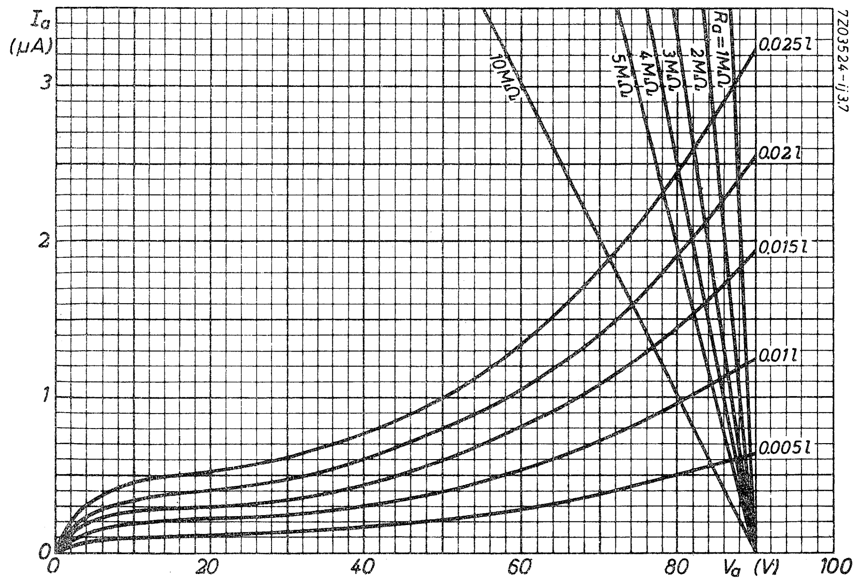
Anode supply voltage	V_b		90	V
Anode series resistor	R_a		1	MΩ
Luminous sensitivity measured with the whole cathode area illuminated by a lamp of colour temperature 2700 ^{o}K	N		125	μA/lumen
Dark current	I_{dark}	max.	0.1	μA

Capacitance

Anode to cathode	C_{ak}		1.1	pF

LIMITING VALUES (Absolute max. rating system)

Anode supply voltage	V_b	max.	90	V
Cathode current	I_k	max.	2.0	μA
Ambient temperature	t_{amb}	max.	100	^{o}C



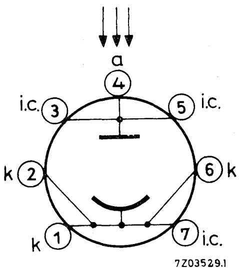
VACUUM PHOTOTUBE

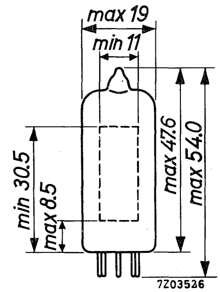
Vacuum phototube, particularly sensitive to incandescent light sources, and to near infra-red radiation.

QUICK REFERENCE DATA				
Anode supply voltage	V_b	max.	250	V
Luminous sensitivity	N		20	μA/lumen
Spectral response curve		type C		
Outline dimensions		max. 19 dia. x 54		mm

MECHANICAL DATA Dimensions in mm

Base: Miniature





The arrows show the direction of the incident radiation.

The cathode connection may be made to pins 1, 2, 6 and 7 connected together and the anode connection to pins 3, 4 and 5 connected together.

Photo cathode

Surface	Ceasium on oxidised silver
Projected sensitive area	3.0 cm^2

ELECTRICAL DATA

Operating characteristics

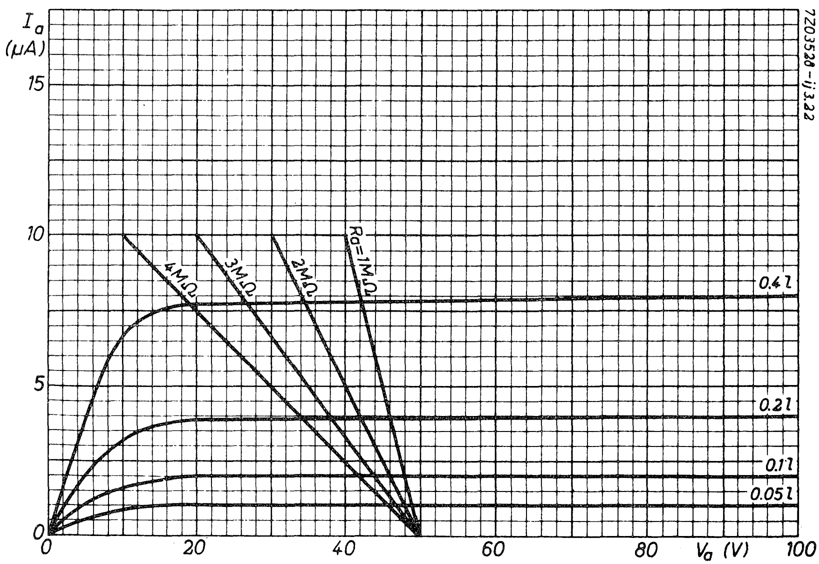
Anode supply voltage	V_b		50	V
Anode series resistor	R_a		1	MΩ
Luminous sensitivity measured with the whole cathode area illuminated by a lamp of colour temperature 2700 °K	N		20	μA/lumen
Dark current (at V_a = 100 V)	I_{dark}	max.	0.05	μA

Capacitance

Anode to cathode	C_{ak}		0.8	pF

LIMITING VALUES (Absolute max. rating system)

Anode supply voltage	V_b	max.	250	V
Cathode current	I_k	max.	10	μA
Ambient temperature	t_{amb}	max.	100	°C



GAS FILLED PHOTOTUBE

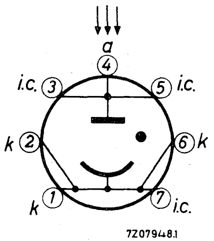
Gas-filled phototube particularly sensitive to daylight and to radiation having a blue predominance.

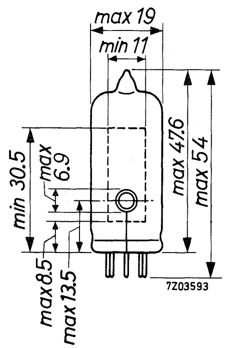
QUICK REFERENCE DATA				
Anode supply voltage	V_b	max.	90	V
Luminous sensitivity	N		130	μA/lumen
Spectral response curve		type A		
Outline dimensions		max. 19 dia. x 54		mm

MECHANICAL DATA

Dimensions in mm

Base: Miniature





The arrows show the direction of the incident radiation

The cathode connection may be made to pins 1, 2, 6 and 7 connected together and the anode connection to pins 3, 4 and 5 connected together.

Photocathode

Surface	Caesium antimony
Projected sensitive area	2.1 cm^2

ELECTRICAL DATA

Operating characteristics

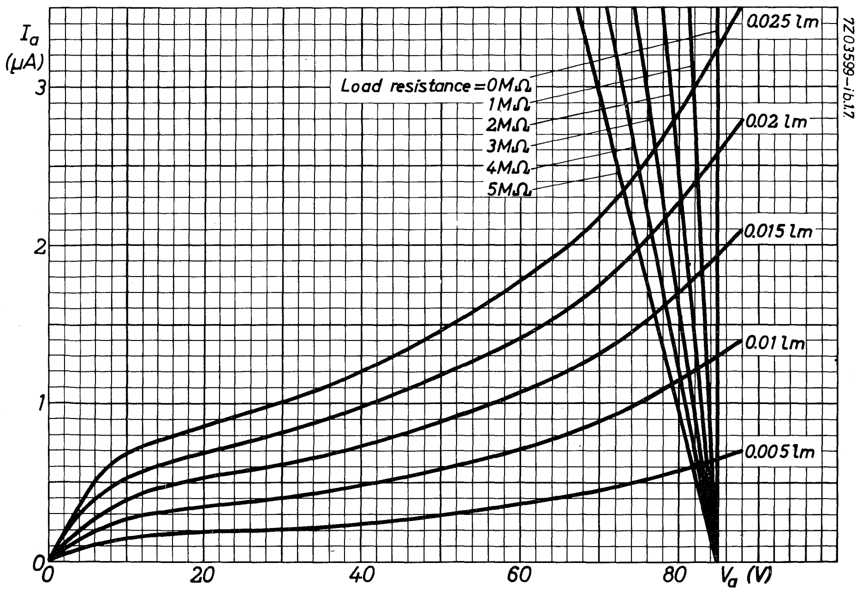
Anode supply voltage	V_b		85	V
Anode series resistor	R_a		1	MΩ
Luminous sensitivity measured with the whole cathode area illuminated by a lamp of colour temperature 2700 $^{\circ}$K	N		130	µA/lumen
Dark current	I_{dark}	max.	0.1	µA

Capacitance

Anode to cathode	C_{ak}	0.9	pF

LIMITING VALUES (Absolute max. rating system)

Anode supply voltage	V_b	max.	90	V
Cathode current	I_k	max.	0.0125	µA/mm2
Ambient temperature	t_{amb}	max.	70	$^{\circ}$C



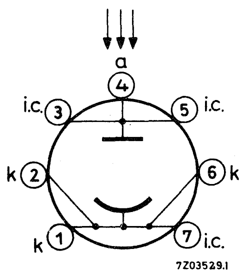
VACUUM PHOTOTUBE

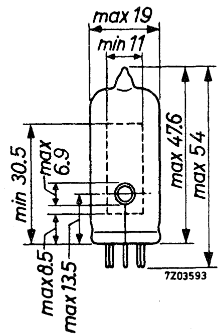
Vacuum phototube particularly sensitive to daylight and to light radiation with a blue predominance.

QUICK REFERENCE DATA				
Anode supply voltage	V_b	max.	100	V
Luminous sensitivity	N		45	μA/lumen
Spectral response curve		type A		
Outline dimensions		max. 19 dia. x 54		mm

MECHANICAL DATA Dimensions in mm

Base: Miniature





The arrows show the direction of the incident radiation.

The cathode connection may be made to pins 1, 2, 6 and 7 connected together and the anode connection to pins 3, 4 and 5 connected together.

Photocathode

Surface	caesium antimony
Projected sensitive area	2.1 cm^2

ELECTRICAL DATA

Operating characteristics

Anode supply voltage	V_b		85	V
Anode series resistor	R_a		1	MΩ
Luminous sensitivity measured with the whole cathode area illuminated by a lamp of colour temperature 2700 ^{o}K	N		45	μA/lumen
Dark current	I_{dark}	max.	0.05	μA

Capacitance

Anode to cathode	C_{ak}		0.9	pF

LIMITING VALUES (Absolute max. rating system)

Anode supply voltage	V_b	max.	100	V
Cathode current	I_k	max.	0.025	$\mu A/mm^2$
Ambient temperature	t_{amb}	max.	70	^{o}C

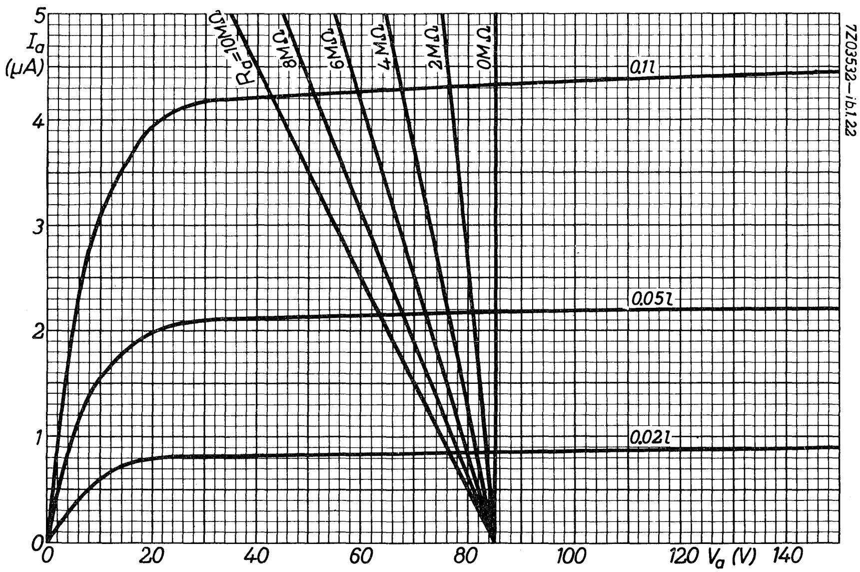
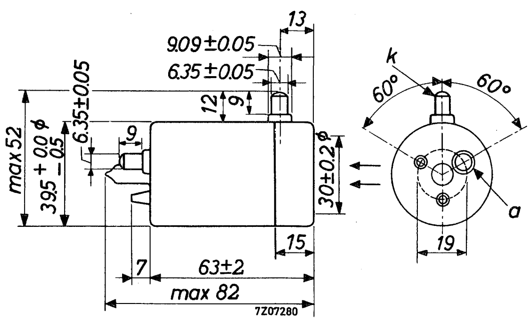


PHOTO TUBE

Vacuum phototube with high stability and linearity intended for use in high precision photometry (maximum intensity 1 lux) and for measurements of quickly changing light phenomena (maximum light intensity approx. 1000 lux).

QUICK REFERENCE DATA				
Anode voltage	V_a		6 to 90	$V_{D.C.}$
Average current	I	max.	50×10^{-9}	A
Peak current	I_p	max.	35×10^{-6}	A
Sensitivity	N		60×10^{-6}	A/lumen
Rise time			14	ns
Spectral response			type A	
Outline dimensions		max.	52 x 82	mm

MECHANICAL DATA Dimensions in mm



Mounting position: any

Photocathode

Cathode material — Caesium-antimony

The cathode material has been deposed on the inner surface of the window. This window is optically plane and polished.
It therefore allows the luminous source to be at close and narrowly reproducable distance from the cathode.

Useful cathode area	dia.	30	mm
Spectral response	type A		

The spectral response curve shown is a nominal curve and considerable variation between individual tubes may be expected.

Sensitivity measured with a tungsten ribbon lamp having a c.t. of 2850 ^{o}C	typical	60×10^{-6}	A/lumen
	min.	35×10^{-6}	A/lumen

Each tube is marked with its sensitivity

An angle of 15^{o} between the axis of the tube and the direction of the incident light decreases the sensitivity not more than 5 %.

CAPACITANCE

Anode to cathode	C_{ak}	13	pF

TYPICAL CHARACTERISTICS

Saturation voltage, luminous flux 0.05 lumen			< 6	$V_{D.C.}$
luminous flux 1 lumen			< 70	$V_{D.C.}$
Anode voltage	V_a		6 to 90	$V_{D.C.}$
Dark current	I_{ao}	max.	10^{-12}	A
Linearity [1]			0.1	‰
Insulation resistance	r_{ins}	min.	10^{15}	Ω
Rise time	T_r		14	ns

1) The relation between the incident luminous flux and the tube current is linear within measuring errors, provided the anode voltage is higher than the saturation voltage.

LIMITING VALUES (Absolute max. rating system)

Anode voltage	V_a	max.	100	$V_{D.C.}$
Cathode current per mm^2 of cathode area, peak	I_{kp}	max.	50×10^{-9}	A/mm^2
average (T_{av} = 1 s)	I_k	max.	70×10^{-12}	A/mm^2
Cathode current, peak [1]	I_{kp}	max.	35×10^{-6}	A
average (T_{av} = 1 s)	I_k	max.	50×10^{-9}	A
Envelope temperature	t_{bulb}	min.	-90	^oC
	t_{bulb}	max.	+60	^oC

LIFE EXPECTANCY

With an average cathode current of 50×10^{-9} A, the sensitivity will not decrease more than 10% of its initial value between zero and 500 operating hours.

At lower cathode currents a higher stability may be expected.

REMARKS

- The cathode should not be exposed to direct sunlight.
- In cases where low frequency noise influences the measuring results, this source of noise may be reduced by cooling the tube to -90 ^oC.

APPLICATION

The currents allowed through 150AV are so low that amplification will always be necessary. To maintain the precision of the signal coming from the phototube is often the main problem.

This problem may be divided into four parts:

1. Distortion due to capacitive shunting:

The signal on the input of the amplifier is

$$v = \frac{i}{\sqrt{\frac{1}{R^2} + \omega^2 C^2}}$$

in which v = signal in V
i = current through phototube in A
R = part of series-resistance (in Ω) from which the signal is taken
ω = 2πX frequency of the signal in Hz
C = total capacitance of cathode of phototube + input-capacitance of amplifier + stray capacitance of wiring in F. The value of C will not easily be kept below 20 pF.

1) With the cathode uniformly illuminated.

If a certain distortion only is accepted the maximum frequency of the signal to be transferred will limit the value of the resistance from which the signal will be taken and by this limit the value of the signal on the input of the amplifier.

2. Noise:

The level of the signal on the input of the amplifier shall be above the noise level.
The 3 main sources of noise are:

a. Shot noise in the phototube which follows the formula:

$$I_{noise} = \sqrt{2ei \times B} \text{ in } A_{R.M.S.}$$

$$V_{noise} = R x I_{noise}$$

in which e = 1.6×10^{-19} in As
i = the current through the phototube in A
B = the bandwidth in Hz
R = value of resistor from which signal is taken in Ω

b. Resistance noise of that part of the series-resistor from which the input signal for the amplifier is taken.
This part of the noise follows the formula:

$$V_{noise} = \sqrt{4 k T R B}$$

in which k = 1.35×10^{-23}
T = temperature in ^{o}K
R = value of resistor in Ω
B = bandwidth in Hz

c. Input-noise of the amplifier

In such cases where an electron tube is used in the input of the amplifier, the noise-voltage follows the formula

$$V_{noise} = \sqrt{\sum V^2_{eq} \Delta B}$$

The value of V_{eq} as a function of frequency is different for each type of tube, but for frequencies above 1000 Hz V_{eq} does not change much with the frequency allowing the formula to be reduced to

$$V_{noise} = V_{eq}\sqrt{B}$$

In that case V_{eq} can be approximated within a factor 2 to 3 by

$$V_{eq} = \frac{3 \times 10^{-9} \sqrt{I_a}}{S}$$

in which I_a is the anode current of the tube in A and S is the transconductance in A/V.

3. Input current of the amplifier

The input-current of the amplifier should be low compared with the signal current through the phototube.

4. Linearity of the amplifier

The amplifier should have a feedback so that the stability and the distortion of the signal is not impaired.

If the circumstances are such that the signal to noise ratio cannot be kept within acceptable limits - usually there where low incident illumination levels combine with high frequencies - use of this type of phototube should be abandoned in preference to photomultipliers where the distortion due to capacitive shunting and noise sources other than shot noise are of smaller relative importance.

Examples:

An example for a simple circuit which is useful for many purposes of static light measurements is shown in fig.1.

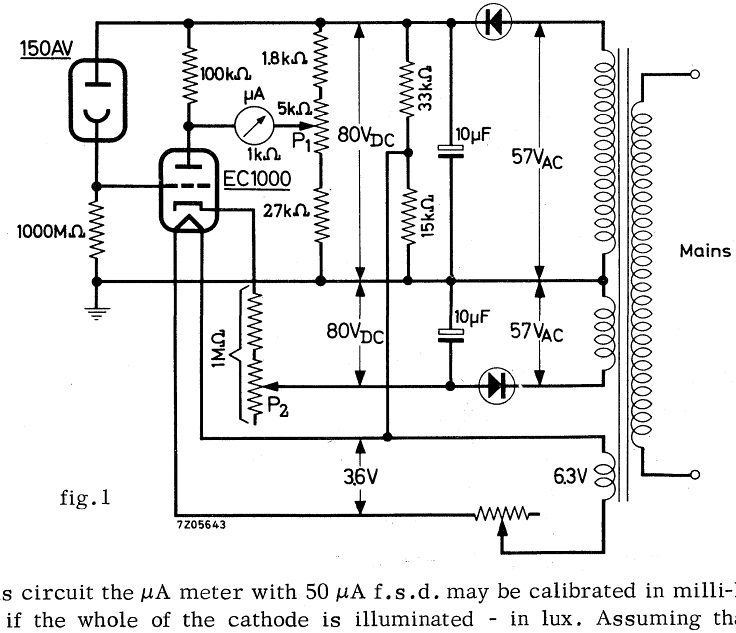


fig.1

In this circuit the μA meter with 50 μA f.s.d. may be calibrated in milli-lumen or - if the whole of the cathode is illuminated - in lux. Assuming that the pointer of the μA meter will not move with frequencies above 20 Hz, for calculation of the noise level frequencies below 20 Hz are of interest only.
For currents of 5×10^{-9} A through the phototube the signal on the input of the amplifier is of a level of 5 V, the shot noise on a level of 10^{-4} V, the resistance noise on a level of 10^{-5} V, the equivalent noise voltage on the input of EC1000 on a level of 10^{-6} V.

The feedback of this system is about 1000 times, so the accuracy is solely determined by the accuracy of the μA meter, all other sources being small.

Mains voltage variations of +10% and −15% are of no influence on the measuring result.

The circuit of Fig.1 is calibrated as follows:
Adjust P_2 so that the total cathode resistance of the EC1000 is $\frac{A \times R_1}{50 \times 1000}\ \Omega$

in which R_1 is the value of the series resistance of the 150AV and
A is the actual sensitivity in μA/lumen of the 150AV as marked on the tube.

Disconnect the connection between the phototube and the grid of the EC1000 and connect the grid of EC1000 to earth. Connect the circuit to the mains and adjust P_1 so that the μA meter indicates zero.

The circuit is now restored and has been calibrated for 0.02 mlumen per μA deflection of the μA meter.

For measurements of rapidly changing phenomena the series-resistor in Fig.1 of 150AV should be adapted for an acceptable signal to noise ratio and acceptable distortion while the μA meter should be replaced by a resistor shunted by the input of an oscilloscope.

Depending on the frequency further adaptations of the circuit may be necessary, e.g. further smoothing of the D.C. voltages and a D.C. heater supply for the EC1000.

For extremely rapid changes when all time constants of the circuit have to be reduced as far as possible a circuit as shown in fig.2 may be used on which laser light flashes can be recorded with a rise time of the signal on the oscilloscope of 20 ns.

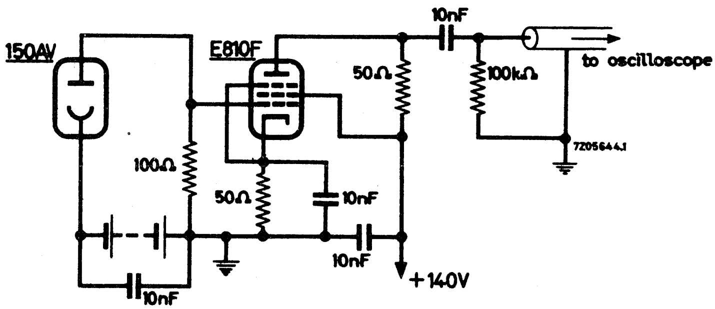


fig.2

Remark P_1 and P_2 should be wirewound resistors.

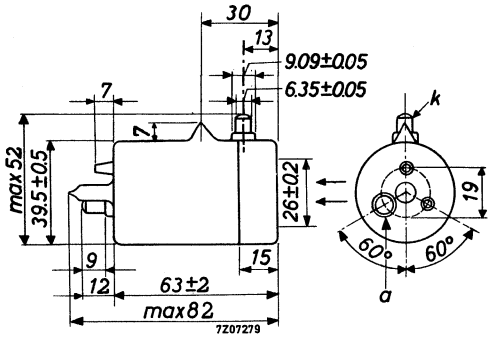
PHOTO TUBE

Vacuum phototube with high stability and linearity intended for use in high precision/photometry (maximum intensity 1 lux) and for measurements of quickly changing light phenomena (maximum light intensity approx. 1000 lux).

QUICK REFERENCE DATA				
Anode voltage	V_a		6 to 90	$V_{D.C.}$
Average current	I	max.	35×10^{-9}	A
Peak current	I_p	max.	25×10^{-6}	A
Sensitivity	N		20×10^{-6}	A/lumen
Rise time			14	ns
Spectral response			type C	
Outline dimensions		max.	52 x 82	mm

MECHANICAL DATA

Dimensions in mm



Mounting position: any

Photocathode

Cathode material	Caesium on oxidized silver		

The cathode material has been deposed on the inner surface of the window. This window is optically plane and polished.
It therefore allows the luminous source to be at close and narrowly reproducable distance from the cathode.

Useful cathode area	dia.	26	mm
Spectral response	type C		

The spectral response curve shown is a nominal curve and considerable variation between individual tubes may be expected.

Sensitivity measured with a tungsten ribbon lamp having a c.t. of 2850 ^{o}K	typical	20×10^{-6}	A/lumen
	min.	14×10^{-6}	A/lumen

Each tube is marked with its sensitivity.

An angle of 15^{o} between the axis of the tube and the direction of the incident light decreases the sensitivity not more than 5%.

CAPACITANCE

Anode to cathode	C_{ak}		13	pF

TYPICAL CHARACTERISTICS

Saturation voltage, luminous flux 0.05 lumen			$<$ 6	$V_{D.C.}$
luminous flux 1 lumen			$<$ 70	$V_{D.C.}$
Anode voltage	V_a		6 to 90	$V_{D.C.}$
Dark current	I_{a_o}	max.	10^{-9}	A
Linearity [1]			0.1	‰
Insulation resistance	r_{ins}	min.	10^{15}	Ω
Rise time	T_r		14	ns

[1]) The relation between the incident luminous flux and the tube current is linear within measuring errors, provided the anode voltage is higher than the saturation voltage.

LIMITING VALUES (Absolute max. rating system)

Anode voltage	V_a	max.	100	$V_{D.C.}$
Cathode current per mm^2 of cathode area, peak	I_{kp}	max.	50×10^{-9}	A/mm^2
average (T_{av} = 1 s)	I_k	max.	70×10^{-12}	A/mm^2
Cathode current, peak [1]	I_{kp}	max.	25×10^{-6}	A
average (T_{av} = 1 s)	I_k	max.	35×10^{-9}	A
Envelope temperature	t_{bulb}	min.	-90	^{o}C
	t_{bulb}	max.	+60	^{o}C

LIFE EXPECTANCY

With an average cathode current of 35×10^{-9} A, the sensitivity will not decrease more than 10% of its initial value between zero and 500 operating hours.

At lower cathode currents a higher stability may be expected.

REMARKS

- The cathode should not be exposed to direct sunlight.
- In cases where low frequency noise influences the measuring results, this source of noise may be reduced by cooling the tube to -90 ^{o}C.

APPLICATION

Please refer to data of 150AV.

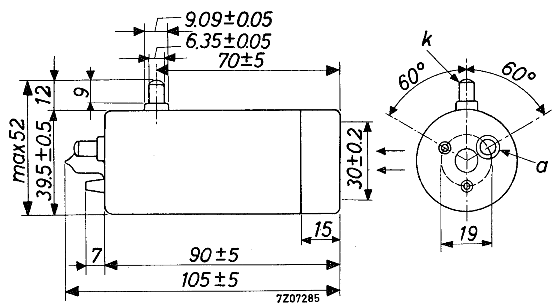
PHOTO TUBE

Vacuum phototube with high stability and linearity intended for use in high precision photometry (maximum intensity 1 lux) and for measurements of quickly changing light phenomena (maximum light intensity approx. 1000 lux).

QUICK REFERENCE DATA				
Anode voltage	V_a		6 to 90	$V_{D.C.}$
Average current	I	max.	50×10^{-9}	A
Peak current	I_p	max.	35×10^{-6}	A
Sensitivity	N		60×10^{-6}	A/lumen
Rise time			14	ns
Spectral response			type U	
Outline dimensions		max.	52 x 110	mm

MECHANICAL DATA

Dimensions in mm



Mounting position: any

Photocathode

Cathode material	Caesium-antimony		

The cathode material has been deposed on the inner surface of the quartz window. This window is optically plane and polished.
It therefore allows the luminous source to be at close and narrowly reproducable distance from the cathode.

Useful cathode area	dia.	30	mm
Spectral response	type U		

The spectral response curve shown is a nominal curve and considerable variation between individual tubes may be expected.

Sensitivity measured with a tungsten ribbon lamp having a c.t. of 2850 ^{o}K	typical	60×10^{-6}	A/lumen
	min.	35×10^{-6}	A/lumen

Each tube is marked with its sensitivity.

An angle of 15^{o} between the axis of the tube and the direction of the incident light decreases the sensitivity not more than 5 %.

CAPACITANCE

Anode to cathode	C_{ak}	13	pF

TYPICAL CHARACTERISTICS

Saturation voltage, luminous flux 0.05 lumen		< 6	$V_{D.C.}$
luminous flux 1 lumen		< 70	$V_{D.C.}$
Anode voltage	V_a	6 to 90	$V_{D.C.}$
Dark current	I_{a_o}	max. 10^{-12}	A
Linearity [1])		0.1	‰
Insulation resistance	r_{ins}	min. 10^{15}	Ω
Rise time	T_r	14	ns

[1]) The relation between the incident luminous flux and the tube current is linear within measuring errors, provided the anode voltage is higher than the saturation voltage.

LIMITING VALUES (Absolute max. rating system)

Anode voltage	V_a	max.	100	$V_{D.C.}$
Cathode current per mm^2 of cathode area, peak	I_{kp}	max.	50×10^{-9}	A/mm^2
average (T_{av} = 1 s)	I_k	max.	70×10^{-12}	A/mm^2
Cathode current, peak [1])	I_{kp}	max.	35×10^{-6}	A
average (T_{av} = 1 s)	I_k	max.	50×10^{-9}	A
Envelope temperature	t_{bulb}	min.	−90	°C
	t_{bulb}	max.	+60	°C

LIFE EXPECTANCY

With an average cathode current of 50×10^{-9} A, the sensitivity will not decrease more than 10 % of its initial value between zero and 500 operating hours.

At lower cathode currents a higher stability may be expected.

REMARKS

- The cathode should not be exposed to direct sunlight.
- In cases where low frequency noise influences the measuring results, this source of noise may be reduced by cooling the tube to −90 °C.

APPLICATION

Please refer to data of 150AV.

PHOTO TUBE

Top sensitive gas-filled phototube, sensitive to ultra-violet radiation, intended for use as an on-off device in flame failure circuits.

QUICK REFERENCE DATA			
Supply voltage	V_b	220	V_{RMS}

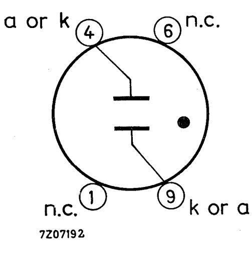
OPERATING PRINCIPLE

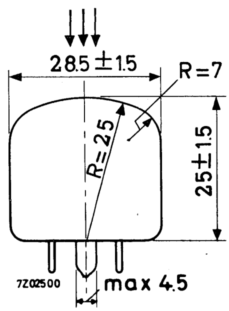
When photons of sufficient energy strike the cathode of the device electrons may be released. Provided the tube voltage is sufficiently high, these electrons may initiate a discharge. The probability that this will occur is dependent amongst other things on the value of the supply voltage and the ultra-violet radiation intensity.
The discharge will extinguish as soon as the instantaneous value of the tube voltage falls below the maintaining voltage.
It should be noted that most sources of visible light (e.g. the sun, fluorescent lamps) are at the same time sources of U.V. radiation.
Where the level of such radiation affects the reliable operation of the circuit, adequate shielding or filtering should be provided.

DIMENSIONS AND CONNECTIONS

Dimensions in mm

Base: Noval 4 pins





The arrows show the required direction of incident radiation for highest sensitivity.
Mounting position: any

MOUNTING

A noval socket with a centre hole diameter of at least 5.4 mm should be used. Pins 1 and 6 should be connected to pins 9 and 4 respectively on the socket.

CHARACTERISTICS

Spectral response		0.2 to 0.29 μm (2000 to 2900 Å) See also page 7
Maintaining voltage	V_m	180 to 220 V

RECOMMENDED CIRCUITS

I. DIRECT RELAY CIRCUIT (t_{amb} = max. 70 °C)

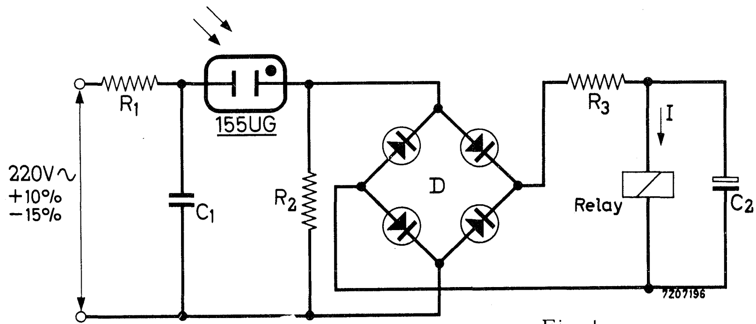


Fig.1

R_1	100 Ω ± 10 %
R_2	220 kΩ ± 10 %
R_3	270 Ω ± 10 %
D	4 diodes
C_1	12 nF ± 15 %
C_2	25 μF ± 15 %

Relay:

R		12 kΩ ± 10 %
I_{on}	<	3 mA
I_{off}		0.5 to 1.5 mA
W_{max}	>	1.2 W.

Notes

1. The filter R_1 C_1 reduces the effects of high voltage transients on the mains.
2. Incidental discharges of the tube will not activate the relay for any value of the mains voltage within the range 220 V + 10 % to −15 %.

Sensitivity

Under the worst probable conditions of supply voltage (190 V) component variation and characteristic variation of the tube during 10.000 hours, the tube will activate the relay when a "standard radiation source" (candle, see fig.4) is at a distance < 50 mm from the tube.

RECOMMENDED CIRCUITS (continued)

II. INDIRECT RELAY CIRCUITS (t_{amb} = max. 100 °C)

IIa

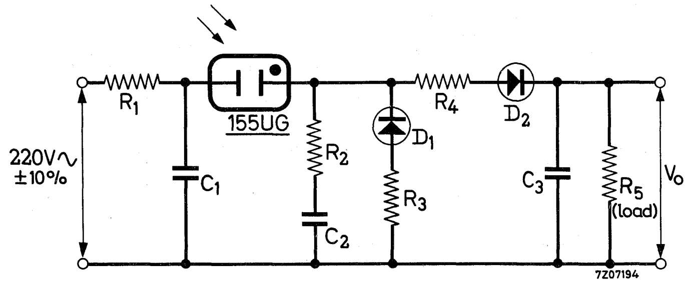


Fig.2

R_1	100 Ω ±10%	C_1	12 nF ±15%
R_2	100 Ω ±10%	C_2	12 nF ±15%
R_3	120 kΩ ±10%	C_3	2.2 μF ±15%
R_4	120 kΩ ±10%	D_1, D_2	diodes
R_5	470 kΩ ±10%		

Note

The filter R_1 C_1 reduces the effects of high voltage transients on the mains.

Sensitivity

The curve on page 8 shows the relationship between the output voltage V_o and the distance between the tube and the "standard radiation source" (see fig.4) under the worst probable conditions of supply voltage (198 V) and component variation for the least sensitive new tube.
After the first 10 000 hours of operation the sensitivity will have decreased, but will in all cases be better than indicated by the curve on page 8 provided the radiation source is doubled (two candles according to fig.4).

RECOMMENDED CIRCUITS (continued)

IIb

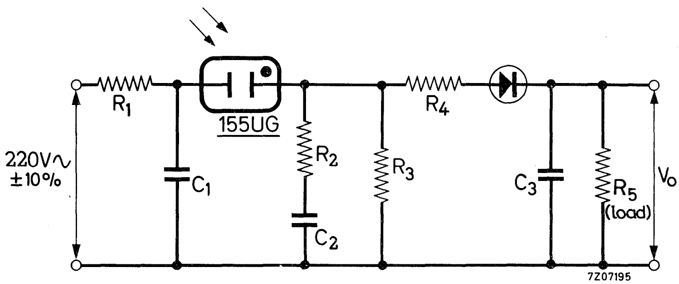


Fig.3

R_1	100 Ω ±10%	C_1	12 nF ±15%
R_2	100 Ω ±10%	C_2	12 nF ±15%
R_3	330 kΩ ±10%	C_3	2.2 μF ±15%
R_4	150 kΩ ±10%	D_1	diode
R_5	470 kΩ ±10%		

Note

The filter R_1 C_1 reduces the effects of high voltage transients on the mains.

Sensitivity

The curve on page 8 shows the relationship between the output voltage V_o and the distance between the tube and the "standard radiation source" (see fig.4) under the worst probable conditions of supply voltage (198 V) and component variation for the least sensitive new tube.
After the first 10 000 hours of operation the sensitivity will have decreased, but will in all cases be better than indicated by the curve on page 8 provided the radiation source is doubled (two candles according to fig.4).

LIMITING VALUES

Ambient temperature, operating		t_{amb}	min. −25	°C	
			max. 70	°C	when used in circuit fig.1
			max. 100	°C	when used in circuits fig.2 and 3
	storage	t_{stg}	min. −50	°C	
			max. +50	°C	

Warning

Designers of flame failure detectors are strongly advised not to depart from the recommended circuits. Any such departure may result in an unsafe operating mode which is likely to cause an internal short in the tube before its rated useful life has expired.

Application notes

To ensure that the intensity of radiation incident on the built-in tube will be sufficient throughout its service life (10 000 hours in the case of a new tube) the following procedure should be observed:

For circuit fig.1

Place a "standard radiation source" at a distance of 50 mm from the tube and measure the average voltage across the relay.
In actual operation the same tube should be mounted at a distance from the flame such that the average voltage across the relay is at least equal to that obtained under irradiation from the "standard radiation source" at 50 mm.
Care should be taken that the value of the mains voltage is the same during both measurements.
The flame used during this measurement should be the minimum flame which has to be detected. No further readjustment of the distance between tube and flame will be necessary when the tube has to be replaced.

For circuits fig.2 and fig.3

The output power from the circuits in fig.2 and 3 is too low for direct tripping of a relay. For effective discrimination, the voltage on the input of the added amplifier must attain a certain threshold value when the U.V. energy emitted by the flame attains a certain critical intensity.
The implication is that steps must be taken to ensure that the output voltage V_o from the recommended circuit will remain above this threshold value throughout the life of the tube. This is done in the following way.
Read from the dotted curve on page 8 the distance d corresponding to the required minimum output voltage V_o.
Place two "standard radiation sources" at the distance d from the tube and connect the circuit output to a d.c. voltmeter with a high input resistance; observe the average output voltage V_o. (The mean value around which the needle swings.)
In actual operation the same tube should be mounted at a distance from the flame such that the average output voltage V_o is at least equal to that obtained under irradiation from the two "standard irradiation sources" at the distance d.

Care should be taken that the value of the mains voltage is the same during both measurements.
The flame used during this measurement should be the minimum flame which has to be detected.
No further readjustment of the distance between tube and flame is necessary when the tube has to be replaced.

Above procedures do of course not include allowance for dirt deposited on the tube during life.

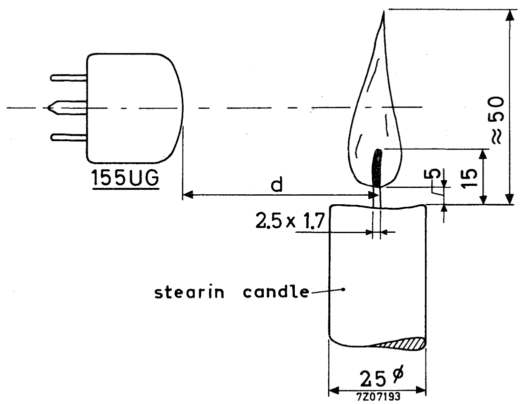
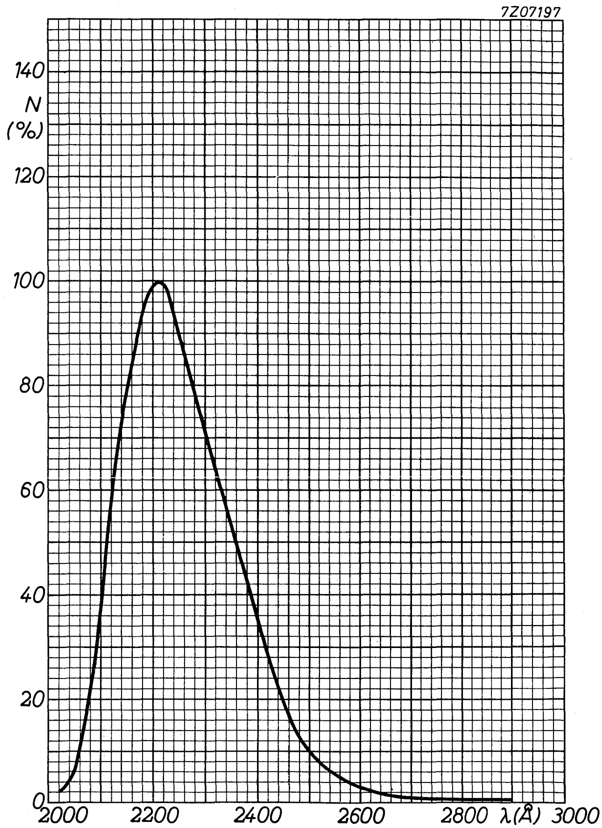
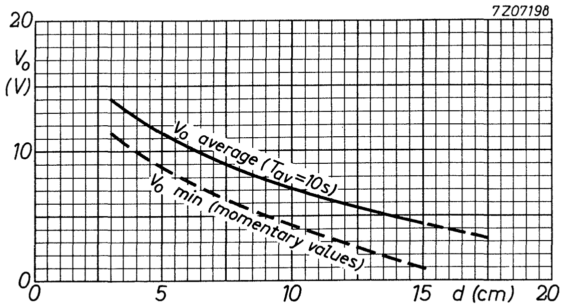


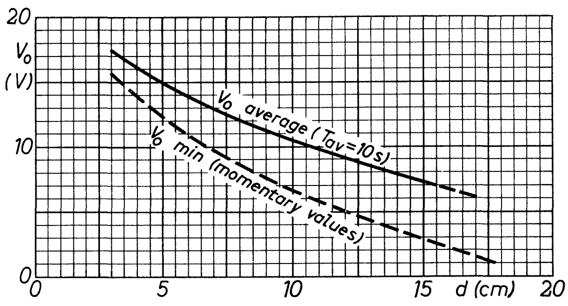
Fig.4

"Standard radiation source"


7Z07197
140
N
(%)
120
100
80
60
40
20
0
2000
2200
2400
2600
2800
λ(Å)
3000



The output voltage as a function of the distance between radiation source and the least sensitive tube in the circuit of fig.3.
The curve is valid at 0 hours when the tube is irradiated by one "standard radiation source" and at 10 000 hours when irradiated by two "standard radiation sources".



The output voltage as a function of the distance between radiation source and the least sensitive tube in the circuit of fig.2.
The curve is valid at 0 hours when the tube is irradiated by one "standard radiation source" and at 10 000 hours when irradiated by two "standard radiation sources".

Photoconductive devices

The Photoconductive Devices included in the previous edition of this Part will be in future be incorporated in Part 4 of the Semiconductor Handbooks (edition December 1970)

ORP30N	RPY13
ORP50	RPY18
ORP52	RPY19
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	RPY58

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Acc = Accessories
CRT = Cathode-ray tubes
CT = Camera tubes
PT = Photo tubes

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Photoconductive devices

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