PHILIPS

Data handbook

PHILIPS

Electronic components and materials

Electron tubes

Part 8 October 1975

TV picture tubes

ELECTRON TUBES

Part 8 **October 1975**

General section

Colour T V picture tubes

Black and white T.V picture tubes

Index; Maintenance type list

Argentina
Fapesa I.y.C.
Av. Crovara 2550
Tel. 652-7438/7478
BUENOS AIRES

Australia
Philips Industries Ltd.
Elcoma Division
67-71 Mars Road
Tel. 42 1261
LANE COVE, 2066, N.S.W.

Austria
Österreichische Philips
Bauelemente Industrie G.m.b.H.
Zieglergasse 6
Tel. 93 26 11
A-1072 VIENNA

Belgium
M.B.L.E.
80, rue des Deux Gares
Tel. 523 0000
B-1070 BRUSSELS

Brazil
IBRAPE S.A.
Av. Paulista 2073-S/Loja
Tel. 278-1111
SAO PAULO, Sp.

Canada
Philips Electron Devices
116 Vanderhoof Ave.
Tel. 425-5161
TORONTO 17, Ontario

Chile
Philips Chilena S.A.
Av. Santa Maria 0760
Tel. 39-40 01
SANTIAGO

Colombia
SADAPE S.A.
Calle 19, No. 5-51
Tel. 422-175
BOGOTA D.E. 1

Denmark
Miniwatt A/S
Emdrupvej 115A
Tel. (01) 69 16 22
DK-2400 KØBENHAVN NV

Finland
Oy Philips Ab
Elcoma Division
Kaivokatu 8
Tel. 1 72 71
SF-00100 HELSINKI 10

France
R.T.C.
La Radiotechnique-Compelec
130 Avenue Ledru Rollin
Tel. 355-44-99
F-75540 PARIS 11

Germany
Valvo G.m.b.H.
Valvo Haus
Burchardstrasse 19
Tel. (040) 3296-1
D-2 HAMBURG 1

Greece
Philips S.A. Hellénique
Elcoma Division
52, Av. Syngrou
Tel. 915 311
ATHENS

Hong Kong
Philips Hong Kong Ltd.
Components Dept.
11th Fl., Din Wai Ind. Bldg.
49 Hoi Yuen Rd.
Tel. K-42 72 32
KWUNTONG

India
INBELEC Div. of
Philips India Ltd.
Band Box House
254-D, Dr. Annie Besant Rd
Tel. 457 311-5
Prabhadevi, BOMBAY-25-DD

Indonesia
P.T. Philips-Ralin Electronics
Elcoma Division
Djalan Gadjah Mada 18
Tel. 44 163
DJAKARTA

Ireland
Philips Electrical (Ireland) Ltd.
Newstead, Clonskeagh
Tel. 69 33 55
DUBLIN 14

Italy
Philips S.p.A.
Sezione Elcoma
Piazza IV Novembre 3
Tel. 2-6994
I-20124 MILANO

Japan
NIHON PHILIPS
32nd Fl., World Trade Center Bldg.
5, 3-chome, Shiba Hamamatsu-cho
Minato-ku
Tel. 03-435-5268
TOKYO

Korea
Philips Electronics (Korea) Ltd.
Room 2501, Samilro Building
10, Kwanchul-Dong, Chongro-ku
Tel. 73-7222
C.P.O. Box 3680
SEOUL

Mexico
Electrónica S.A. de C.V.
Varsovia No.36
Tel. 5-33-11-80
MEXICO 6, D.F.

Netherlands
Philips Nederland B.V.
Afd. Elonco
Boschdijk 525
Tel. (040) 79 33 33
NL-4510 EINDHOVEN

New Zealand
EDAC Ltd.
70-72 Kingsford Smith Street
Tel. 873 159
WELLINGTON

Norway
Electronica A.S.
Vitaminveien 11
P.O. Box 29, Grefsen
OSLO 4

Peru
CADESA
Jr. Ilo, No. 216
Apartado 10132
Tel. 27 73 17
LIMA

Philippines
ELDAC
Philips Industrial Dev. Inc.
2246 Pasong Tamo
Tel. 86-89-51 to 59
MAKATI-RIZAL

Portugal
Philips Portuguesa S.A.R.L.
Av. Eng. Duharte Pacheco 6
Tel. 68 31 21
LISBOA 1

Singapore
Philips Singapore Private Ltd.
Elcoma Div.
P.O. Box 340, Toa Payoh Central P.O.,
Lorong 1, Toa Payoh
Tel. 53 88 11
SINGAPORE 12

South Africa
EDAC (Pty.) Ltd.
South Park Lane
New Doornfontein
Tel. 24/6701-2
JOHANNESBURG

Spain
COPRESA S.A.
Balmes 22
Tel. 329 63 12
BARCELONA 7

Sweden
ELCOMA A.B.
Lidingövägen 50
Tel. 573231
S-10 250 STOCKHOLM 27

Switzerland
Philips A.G.
Edenstrasse 20
Tel. 01/44 22 11
CH-8027 ZUERICH

Taiwan
Philips Taiwan Ltd.
3rd. Fl., San Min Building
57-1, Chung Shan N.Rd, Section 2
P.O. Box 22978
Tel. 553101-5
TAIPEI

Turkey
Türk Philips Ticaret A.S.
EMET Department
Gümüssuyu Cad. 78-80
Tel. 45.32.50
Beyoglü, ISTANBUL

United Kingdom
Mullard Ltd.
Mullard House
Torrington Place
Tel. 01-580 6633
LONDON WC1E 7HD

United States
North American Philips
Electronic Component Corp.
230, Duffy Avenue
Tel. (516)931-6200
HICKSVILLE, N.Y. 11802

Uruguay
Luzilectron S.A.
Rondeau 1567, piso 5
Tel. 9 43 21
MONTEVIDEO

Venezuela
C.A. Philips Venezolana
Elcoma Dept.
Av. Principal de los Ruices
Edif. Centro Colgate, Apdo 1167
Tel. 36.05.11
CARACAS

DATA HANDBOOK SYSTEM

Our Data Handbook System is a comprehensive source of information on electronic components, subassemblies and materials; it is made up of three series of handbooks each comprising several parts.

ELECTRON TUBES	**BLUE**
SEMICONDUCTORS AND INTEGRATED CIRCUITS	**RED**
COMPONENTS AND MATERIALS	**GREEN**

The several parts contain all pertinent data available at the time of publication, and each is revised and reissued periodically.

Where ratings or specifications differ from those published in the preceding edition they are pointed out by arrows. Where application information is given it is advisory and does not form part of the product specification.

If you need confirmation that the published data about any of our products are the latest available, please contact our representative. He is at your service and will be glad to answer your inquiries.

December 1972

ELECTRON TUBES (BLUE SERIES)

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

Part 1a Transmitting tubes for communications **April 1973**
and Tubes for r.f. heating Types PB2/500 ÷ TBW15/125

Part 1b Transmitting tubes for communication **August 1974**
Tubes for r.f. heating
Amplifier circuit assemblies

Part 2 Microwave products **October 1974**

Communication magnetrons
Magnetrons for microwave heating
Klystrons
Travelling-wave tubes
Diodes
Triodes
T-R Switches
Microwave Semiconductor devices
Isolators Circulators

Part 3 Special Quality tubes; **January 1975**
Miscellaneous devices

Part 4 Receiving tubes **March 1975**

Part 5a Cathode-ray tubes **April 1975**

Part 5b Camera tubes; Image intensifier tubes **May 1975**

Part 6 Products for nuclear technology **July 1975**
Photodiodes

Channel electron multipliers
Geiger-Mueller tubes
Neutron tubes

N.B. Photomultiplier tubes and Photo diodes will be issued in Part 9

Part 7 Gas-filled tubes **August 1975**

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

Part 8 TV Picture tubes **October 1975**

SEMICONDUCTORS AND INTEGRATED CIRCUITS (RED SERIES)

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

Part 1a	**Rectifier diodes and thyristors**		**June 1974**
	Rectifier diodes Voltage regulator diodes (> 1,5 W) Transient suppressor diodes	Thyristors, diacs, triacs Rectifier stacks	
Part 1b	**Diodes**		**October 1975**
	Small signal germanium diodes Small signal silicon diodes Special diodes	Voltage regulator diodes (< 1,5 W) Voltage reference diodes Tuner diodes	
Part 2	**Low frequency transistors**		**July 1974**
Part 3	**High frequency and switching transistors**		**October 1974**
Part 4a	**Special semiconductors**		**November 1974**
	Transmitting transistors Microwave devices Field-effect transistors	Dual transistors Microminiature devices for thick- and thin-film circuits	
Part 4b	**Devices for opto-electronics**		**December 1974**
	Photosensitive diodes and transistors Light emitting diodes Photocouplers	Infra-red sensitive devices Photoconductive devices	
Part 5	**Linear integrated circuits**		**March 1975**
Part 6	**Digital integrated circuits**		**April 1974**
	DTL (FC family) CML (GX family)	MOS (FD family) MOS (FE family)	

COMPONENTS AND MATERIALS (GREEN SERIES)

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

Part 1 Functional units, Input/output devices, Electro-mechanical components, Peripheral devices **June 1974**

High noise immunity logic FZ/30-Series
Circuit blocks 40-Series and CSA70
Counter modules 50-Series
Norbits 60-Series, 61-Series
Circuit blocks 90-Series
Input/output devices
Electro-mechanical components
Peripheral devices

Part 2a Resistors **September 1974**

Fixed resistors
Variable resistors
Voltage dependent resistors (VDR)
Light dependent resistors (LDR)
Negative temperature coefficient thermistors (NTC)
Positive temperature coefficient thermistors (PTC)
Test switches

Part 2b Capacitors **November 1974**

Electrolytic and solid capacitors
Paper capacitors and film capacitors
Ceramic capacitors
Variable capacitors

Part 3 Radio, Audio, Television **February 1975**

FM tuners
Loudspeakers
Television tuners, aerial input assemblies
Components for black and white television
Components for colour television
*)

Part 4a Soft ferrites **April 1975**

Ferrites for radio, audio and television
Beads and chokes
Ferroxcube potcores and square cores
Ferroxcube transformer cores

Part 4b Piezoelectric ceramics, Permanent magnet materials **May 1975**

Part 5 Ferrite core memory products **July 1975**

Ferroxcube memory cores
Matrix planes and stacks
Core memory systems

Part 6 Electric motors and accessories **September 1975**

Small synchronous motors
Stepper motors
Miniature direct current motors

Part 7 Circuit blocks **September 1971**

Circuit blocks 100 kHz-Series
Circuit blocks 1-Series
Circuit blocks 10-Series
Circuit blocks for ferrite core memory drive

Part 8 Variable mains transformers **July 1975**

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*) Deflection assemblies for camera tubes are now included in handbook series "Electron tubes", Part 5b.

General section

LIST OF SYMBOLS

Symbols denoting electrodes/elements and electrode/element connections

Heater or filament	f
Cathode	k
Grid	g
Grids are distinguished by means of an additional numeral; the electrode nearest to the cathode having the lowest number.	
External conductive coating, rim-band	m
Fluorescent screen	l
Tube pin which must not be connected externally	i.c.
Tube pin which may be connected externally	n.c.

Symbols denoting voltages

Symbol for voltage, followed by an index denoting the relevant electrode/element	V
Heater or filament voltage	V_f
Peak value of a voltage	V_p
Peak to peak value of a voltage	V_{pp}
Grid no. 1 voltage for visual extinction of focused raster (grid drive service)	V_{GR}
Cathode voltage for visual extinction of focused raster (cathode drive service)	V_{KR}

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 current unless otherwise stated.

Symbol for current followed by an index denoting the revelant electrode	I
Heater or filament	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 revelant electrode pair. When only one index is given the second electrode is the cathode.	R
Ditto impedance	Z

Symbols denoting various quantities

Brightness	B
Frequency	f
Magnetic field strength	H

GENERAL OPERATIONAL RECOMMENDATIONS T.V. PICTURE TUBES

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GENERAL OPERATIONAL RECOMMENDATIONS
T.V. PICTURE TUBES

1. INTRODUCTION

Equipment design should be based on the characteristics as stated in the data sheets.
Where deviations from these general recommendations are permissible or necessary, statements to that effect will be made.
If applications are considered not referred to in the data sheets of the relevant tube type extra care should be taken with circuit design to avoid that the tube is overloaded due to unfavourable operating conditions.

2. SPREAD IN TUBE CHARACTERISTICS

The spread in tube characteristics is the difference between maximum and minimum values. Values not qualified as maximum or minimum are nominal ones. It is evident that average or nominal values, as well as spread figures, may differ according to the number of tubes of a certain type that are being checked. No guarantee is given for values of characteristics in settings substantially differing from those specified in the data sheets.

3. SPREAD AND VARIATION IN OPERATING CONDITIONS

The operating conditions of a tube are subject to spread and/or variation.

3.1 Spread. Spread in an operating condition is a permanent deviation from an average condition due to, e.g., component value deviations. The average condition is found from such a number individual cases taken at random that an increase of the number will have a negligible influence.

3.2 Variation. Variation in an operating condition is non-permanent (occurs as a function of time), e.g., due to supply voltage fluctuations. The average value is calculated over a period such that a prolongation of that period will have negligible influence.

4. LIMITING VALUES

4.1 Limiting values are in accordance with the applicable rating system as defined by I.E.C. publication 134.
Reference may be made to one of the following 3 rating systems.

4.1.1 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, and should not be exceeded under the worst probable conditions.

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

4.1.2 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.

4.1.3 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 average 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 spread and variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations or spread 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.

Note*. A bogey tube is a tube whose characteristics have the published nominal values for the type. A bogey tube for any particular application can be obtained by considering only those characteristics which are directly related to the application.

4.2 If the tube data specify limiting values according to more than one rating system the circuit has to be designed so that none of these limiting values is exceeded under the relevant conditions.

4.3 In addition to the limiting values given in the individual data sheets the directives in the following paragraphs should be observed.

5. HEATER CIRCUIT

Any deviation from the nominal heater voltage (in case of parallel connection) or from the nominal heater current (in case of series connection) has a detrimental effect on tube performance and life, and should therefore be kept at a minimum. Such deviations may be caused by:

a) Mains voltage fluctuations.
b) Spread in the characteristics of components such as transformers, resistors capacitors etc.

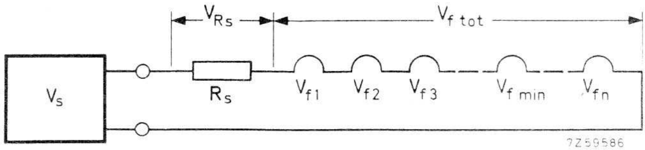
Designers of heater circuits are strongly recommended to bear this in mind when dealing with equipment to be used in areas where the actual mains voltage is likely to differ from the nominal value.

5.1 Parallel connection

The maximum deviation of the heater voltage should not exceed ± 15% (design maximum value).
This condition will be fulfilled when the mains voltage fluctuates by ± 10% and a ordinary transformer (see below) is used.

5.2 Series connection

The maximum deviation of the heater current should not exceed ± 8% (design maximum value).
When a small number of tubes with large differences in the heater voltage is used in series connection combined with a series resistor or a series capacitor, the maximum permitted deviation of the heater current may be exceeded.
To avoid this, certain restrictions must be imposed on the composition of the heater chain; the maximum part of the supply voltage that can be eliminated, and the tolerances of the voltage dropper in series with the heaters.
A number of circuits for If = 300 mA will be described in detail below.



V_S = source voltage (mains voltage or mains voltage stepped down via a transformer)

V_{Rs} = voltage drop over series resistor

$V_{ftot.}$ = $V_{f1} + V_{f2} + V_{f3}$ .... $+ V_{fmin.}$ + ... $V_{fn.}$

$V_{fmin.}$ = lowest individual heater voltage of all tubes in the chain

R_S = series resistor

Voltage source

The following spreads have been taken into account for the source voltage:

- Mains voltage spread ± 10% either or not combined with the voltage spread caused by a transformer with a permanent deviation from the nominal value of ± 1% and with a spread of ± 2% (ordinary, well made transformer).

The following circuits are allowed:

5.2.1 Supply directly from a voltage source ($V_S = V_{ftot.}$)

- No restrictions.

5.2.2 Supply from a voltage source via a 5% series resistor ($V_S = V_{Rs} + V_{ftot.}$)

a. One single tube: permitted if $\frac{V_{Rs}}{V_{ftot.}} \leq 2$

b. Heater chain consisting of 2 or more tubes:

the maximum permitted ratio $\frac{V_{Rs}}{V_{ftot.}}$ can be read from diagram number 1 as follows:

Determine $\frac{V_{fmin.}}{V_{ftot.}}$ of the heater chain. Draw a vertical line through the corresponding point in the diagram. Draw a horizontal line through the point of intersection of this vertical line with the line which indicates the total number of tubes in the chain. The point of intersection of this horizontal line with the vertical axis gives the maximum permitted ratio between the series resistor and the sum of the heater voltages of all tubes in the chain.

5.2.3 Supply from a voltage source via a series diode ($\frac{V_s}{\sqrt{2}} = V_{ftot.}$)

- No restrictions.

5.2.4 Supply from a voltage source via a series diode and a series resistor

($\frac{V_s}{\sqrt{2}} = V_{ftot.} + V_{Rs}$)

In the above formula $V_{ftot.}$ and V_{Rs} are RMS values and the maximum permitted ratio $\frac{V_{Rs}}{V_{ftot.}}$ can be read from diagram number 1 (see 5.2.2).

For calculation of R_s divide the required V_{Rs} (RMS) by the nominal heater current: $R_s = \frac{V_{Rs}}{0.3}$

Remark to 5.2.3 and 5.2.4:

When series diodes are applied, the D.C. component of the resulting heater voltage should preferably be negative with respect to the cathodes of the tubes.

5.2.5 Supply from a voltage source via a series capacitor

a. One single 300 mA tube; permitted if

$\frac{V_{ftot.}}{V_s} \geq 0.50$ when 5% paper capacitors are applied.

b. $\frac{V_{ftot.}}{V_s} \geq 0.70$ when 10% metallized polycarbonate capacitors are applied.

c. Heater chain consisting of 2 tubes or more; permitted if $\frac{V_{ftot.}}{V_s}$

$\frac{V_{ftot.}}{V_s} \geq 0.6$ when 5% paper capacitors are applied.

$\frac{V_{ftot.}}{V_s} \geq 0.8$ when 10% metallized polycarbonate capacitors are applied.

5.3 Stand-by (instant-on circuits)

In order to maintain reliability during life, it is recommended to reduce the heater voltage of the tubes during stand-by operation to $\leq 75\%$ of the nominal value.

Note

If other designs for the heater supply circuit are wanted than the configurations described above it is strongly recommended to contact the tube manufacturer.

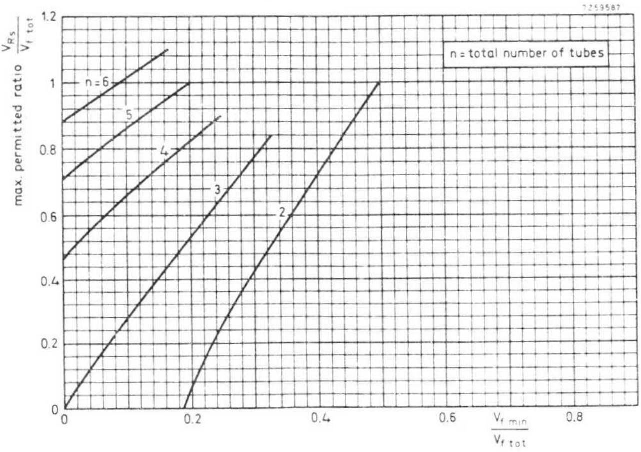


Diagram No. 1

6. CATHODE TO HEATER VOLTAGE

The voltage between cathode and heater should be as low as possible and never exceed the limiting value given on the data sheets of the individual tubes. The values given under "Limiting values" relate to that side of the heater where the voltage between cathode and heater is greatest. The voltage between cathode and heater may be D.C., A.C., or a combination of both voltages. Unless otherwise stated, the maximum values quoted for the voltage between cathode and heater indicate the maximum permissible value (D.C. component). If an A.C. voltage, or an combination of D.C. and A.C. voltages, is applied the peak value may be twice the rated V_{kf}; however, unless otherwise stated, the peak value shall never exceed 315 V. The D.C. component is not allowed to exceed the published value.
Unless otherwise stated, the V_{kf} max. holds for both polarities of the voltage; however, a positive cathode is usually the most favourable in view of insulation during life.
In order to avoid excessive hum the A.C. component of the heater to cathode voltage should be as low as possible and never exceed 20 V_{rms} (mains frequency).

7. INTERMEDIATE ELECTRODES (between cathode and final accelerator)

In no circumstances should the tube be operated without a D.C. connection between each electrode and the cathode. The total effective impedance between each electrode and the cathode should never exceed the published maximum value. However, no electrode should be connected directly to a high energy source such as the hot line. When such a connection is required, it should be made via a series resistor of not less then 1 kΩ.

8. ELECTRODE VOLTAGES

All electrode voltages are given with respect to cathode.
For cathode drive service the reference point is grid No.1

8.1 Grid No.1 cut-off voltage

Generally curves showing the limits of grid No.1 cut-off voltage for specific values of the first accelerator voltage are included in the data. The brightness control should be so dimensioned that it can handle any tube within the limits shown, at the appropriate first accelerator voltage.
The published limits are determined at an ambient illumination level of 10 lux with the aid of a focused raster. Because the brightness of a focused spot is in general greater than that of a raster, the visual cut-off voltage determined with the aid of a spot will be more negative by about 5 V.

8.2 Grid No.2 voltage

For each individual tube the grid No.2 voltage can be adjusted so that the beam current is cut off at a fixed value within the published range of the grid No.1 voltage.
In the data, graphs are included giving the relationship between the grid No.2 voltage and the grid No.1 cut-off voltage.

8.3 Focusing electrode voltage

Individual tubes will have satisfactory focus over the entire screen at some value within the published range of the focusing voltage.
If centre-focusing is desired this range will shift in the negative direction.

9. LUMINESCENT SCREEN

To prevent permanent damage to the screen material care should be taken

a. not to operate the tube with a stationary picture at high beam currents for extended periods
b. not to operate the tube with a stationary or slowly moving spot except at extremely low beam currents
c. to choose the time constants of the grid No.1 the grid No.2 and the time bases supply line circuits such that sufficient beam current is maintained to discharge the e.h.t. capacitance before deflection has ceased after equipment has been switched off.

10. EXTERNAL CONDUCTIVE COATING

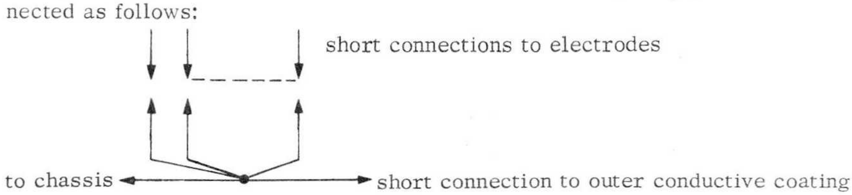
The external conductive coating must be connected to the chassis. The capacitance of this coating to the final accelerating electrode may be used to provide smoothing for the e.h.t. supply.
The coating is not a perfect conductor and in order to reduce radiation caused by the line time base it may be necessary to make multiple connections to the coating. See also 12.

11. METAL RIMBAND

An appreciable capacitance exist between the metal rimband and the internal conductive coating of the tube; its value is quoted in the individual data sheets. To avoid electric shocks, a D.C. connection should be provided between the metal band and the rest of the receiver. In receivers where the chassis can be connected directly to the mains there is a risk of electric shock if acces is made to the metal band. To reduce the shock to the safe limit, it is suggested that a 2 MΩ resistor capable of handling the peak voltages be inserted between the metal band and the point of contact with the external conductive coating. This safety arrangement will provide the necessary insulation from the mains but in the event of flash-over high voltages will be induced on the metal band. It is therefore recommended that the 2 MΩ resistor be bypassed by a 4.7 nF capacitor capable of withstanding the peak voltage determined by the voltage divider formed by this capacitor and the capacitance of the metal rimband to the internal conductive coating.
The 4.7 nF capacitor also serves to reduce the radiation from the band.

12. FLASH-OVER

Picture tubes, in common with other high voltage devices, are prone to internal flash-over. During a breakdown arcing occurs between an electrode connected to the e.h.t. capacitor and an electrode terminated in a pin on the base of the tube. The resulting transient currents and voltages may be of sufficient magnitude to cause damage to the tube itself and to various components on the chassis. Arcing terminates when the e.h.t. capacitor is discharged.
During the subsequent recharging period an additional load is imposed on the e.h.t. generator.
It is of vital importance to provide protective circuits with spark gaps, particularly when semiconductor devices are employed. The spark gaps must be connected as follows:



No other connections between the outer conductive coating and the chassis are permissible.
Additional information available on request.

13. HANDLING

The precautions taken in manufacture reduce the possibility of spontaneous implosion to a minimum but any additional stress due to mishandling considerably increases the risk of implosion: such an implosion may occur immediately or may be delayed. Care should be taken not to scratch or bump any part of the bulb, particularly the screen to cone area, as this will appreciably reduce the strength of the bulb and may lead to implosion.

When a tube is not in its equipment or original packing and is placed screen downwards, it should be placed on a soft pad of suitable material free from abrasive substances. Stresses on the neck should be avoided.

If the transportation method uses the lugs it is necessary to employ at least two lugs in the lifting of the tube. The lift should be made in such a way that the applied forces are equally distributed between the lugs.

The maximum force that may be applied to one lug, at any angle, shall not exceed twice the weight of the tube.

The tube should not be subjected to accelerations higher than 30 g.

Before removing the tube from the equipment the capacitance C_{am} should be discharged via a resistor of approx. 50 kΩ.

The manufacturers notify all concerned that they do not accept any responsibility for any damage on injury sustained in any manner in connection with the picture tube, neither is any condition or warranty given or to be implied.

14. MOUNTING

Unless otherwise specified on the data sheets for individual tubes there are no restrictions on the position of mounting.

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

The weight of the socket and possible additional circuitry should not be more than 80 g. With tubes with a 7-pin miniature base the socket may not be used for mounting components.

Tubes having all-glass bases must not be soldered direct into the wiring.
It is very desirable that tubes should not be exposed to strong electrostatic and magnetic fields.

In front of the face of a mono-panel T.V. picture tube a protecting screen of transparent material should be placed. The screen should be of adequate strength to withstand the effects of an implosion of the tube.
Tubes having integral protection do not require a protective screen.

15. DIMENSIONS

In designing the equipment the tolerances given on the dimensional drawings should be considered. Under no circumstances should the equipment be designed a round dimensions taken from individual tubes.

16. REFERENCE LINE

The reference line indicated on the tube outline drawing is determined by means of a gauge.
Drawings of these gauges are given in this book.

17. **CORNER CUTTING OR NECK SHADOWING**

Corner cutting is caused by a direct interception of the deflected electron beam before it is reaching the screen and results in a non-scanned corner of the raster. It may be avoided by applying an appropriate deflection unit.

18. **RASTER CENTRING**

To centre the raster on the screen it is recommended that either a magnetic field just behind the deflection coils (viewed from the screen) be used or a direct current be passed through the deflection coils.

The centring device should provide a shift to allow for non-centrality of the spot with respect to the geometric centre of the screen, in addition the centring device should provide the shift needed to allow for non-centrality of the visible raster (i.e. to compensate for line blanking and also time base non-linearity, if any) and the earth magnetic field.
The use of a too strong centring magnetic field should be avoided; this may result in raster distortion and even corner cutting.

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

PRO-ELECTRON TYPE DESIGNATION CODE

Single letter, group of figures, hyphen, group of figures, letter or letter group.

The first letter indicates the prime application of the tube:
A – Television display tube for domestic application.
M – Television display tube for professional application-direct view.

First group of figures: Diameter or diagonal of the face in cm.

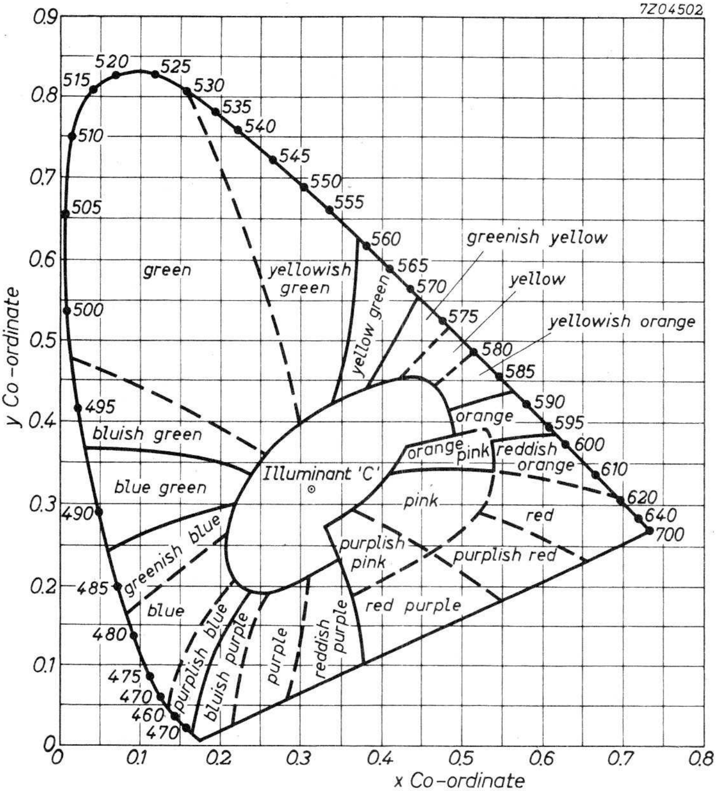
Second group of figures: Development or design number.

Final letter or letter group: Properties of the phosphor screen.
The first letter denotes the colour of the fluorescence, the second letter, if any, other specific differences in screen properties.
W – White screen for T.V. display tubes.
X – Three-colour screen for T.V. display tubes.

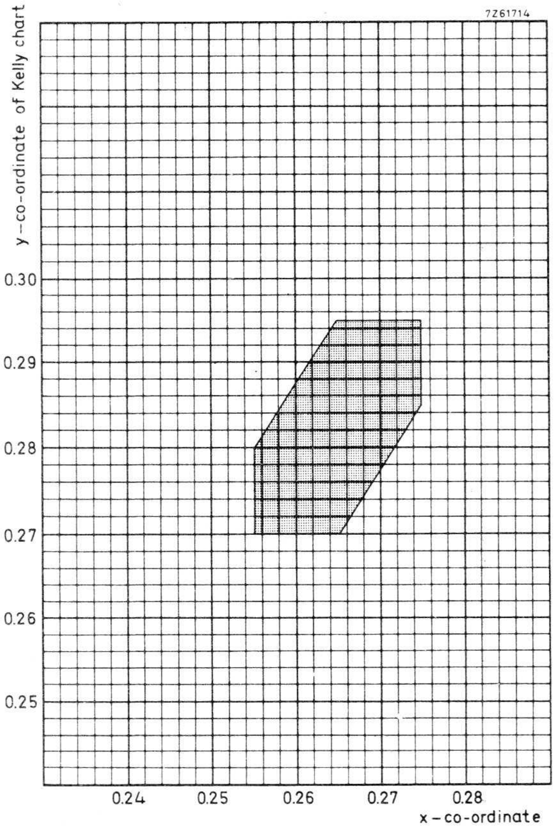
Example A66-410X

A	66	410	X
T V display tube for domestic application	Face diagonal (66 cm)	Development or design number	Three-colour screen

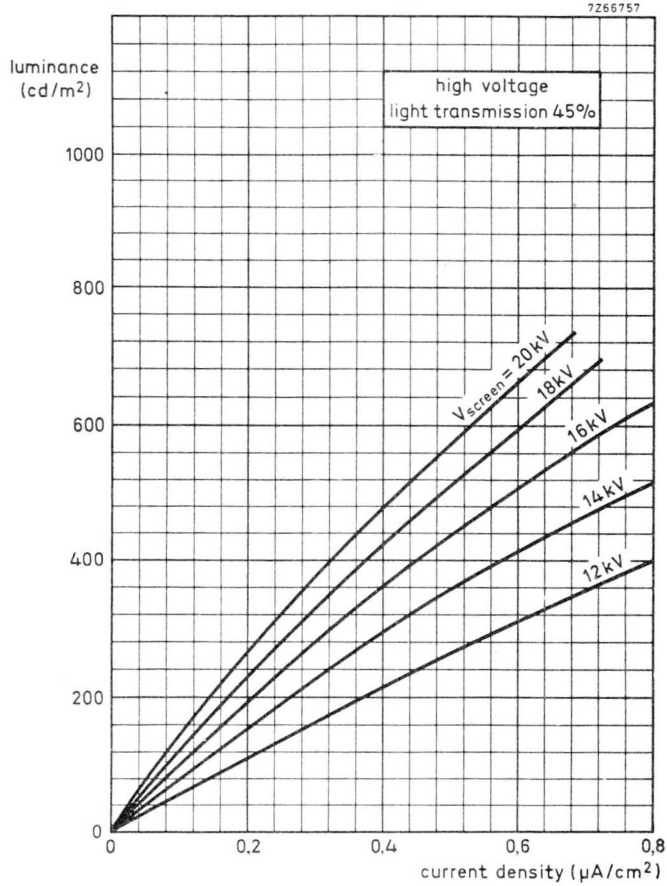
SCREEN PHOSPHORS

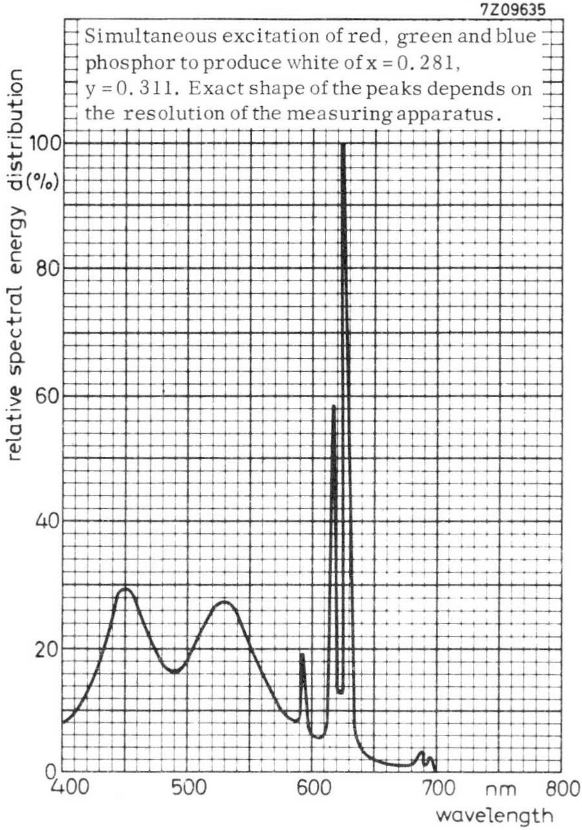


Kelly Chart



Colour point tolerance area for W phosphor


7Z66757
luminance
(cd/m2)
high voltage
light transmission 45%
1000
800
600
400
200
0
0
0,2
0,4
0,6
0,8
current density (μA/cm2)
Vscreen = 20 kV
18 kV
16 kV
14 kV
12 kV

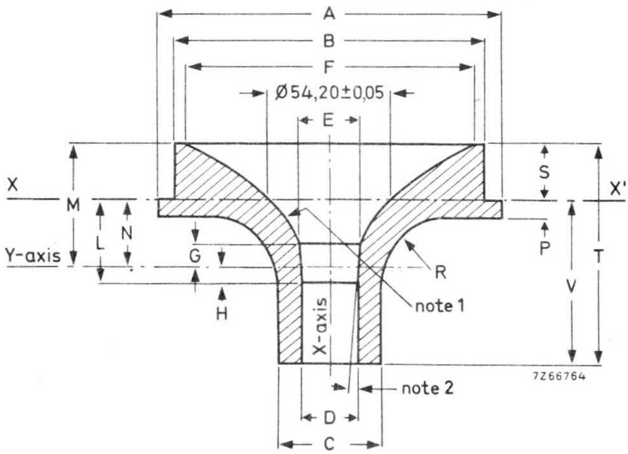


Colour coordinates

	x	y
red	0,630	0,340
green	0,315	0,600
blue	0,150	0,065

REFERENCE LINE GAUGES

REFERENCE LINE GAUGE C (JEDEC 126) (IEC 67-IV-3)



The millimetre dimensions are derived from the original inch dimensions.

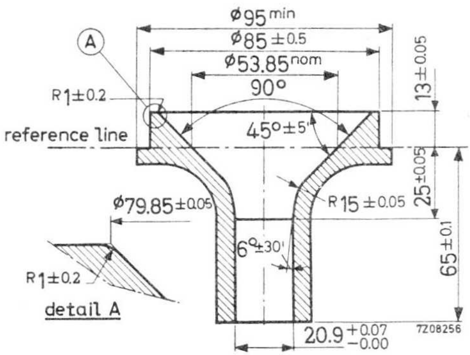
ref	inches			millimetres			notes
	min	nom	max	min	nom	max	
A	-	5,000	-	-	127,00	-	-
B	-	4,500	-	-	114,30	-	-
C	-	2,000	-	-	50,80	-	-
D	1,168	1,168	1,171	29,668	29,668	29,743	-
E	1,241	1,242	1,243	31,522	31,547	31,572	-
F	4,248	4,250	4,252	107,900	107,950	108,000	-
G	-	0,279	-	-	7,09	-	2
H	-	0,250	-	-	6,35	-	-
L	1,165	1,170	1,175	29,60	29,72	29,84	2
M	-	1,634	-	-	41,50	-	-
N	-	0,920	-	-	23,37	-	1
P	-	0,250	-	-	6,35	-	-
R	-	1,000r	-	-	25,40r	-	-
S	0,712	0,714	0,716	18,085	18,136	18,186	-
T	-	3,214	-	-	81,64	-	-
V	2,490	2,500	2,510	63,25	63,50	63,75	-

1. $y = 0,58\,x^2 + 0,576$ inches ($0,0228\,x^2 + 14,630$ mm) 'y' values must be held to $\pm 0,002''$ (0,05 mm). The Y-axis is 0,920" (23,368 mm) below the X-X' reference plane.
2. $4^{\circ} \pm 30'$ taper between planes G and L.

Reference line gauge for 110° deflection angle.

REFERENCE LINE GAUGE D

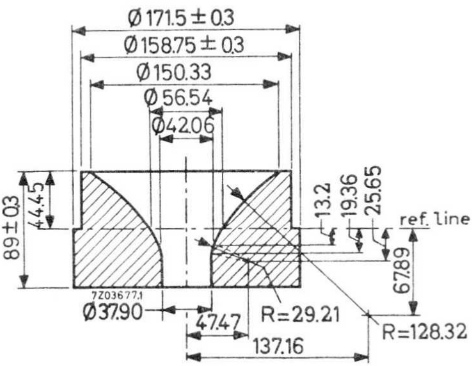
Dimensions in mm



Reference line gauge for 90° deflection angle

REFERENCE LINE GAUGE E

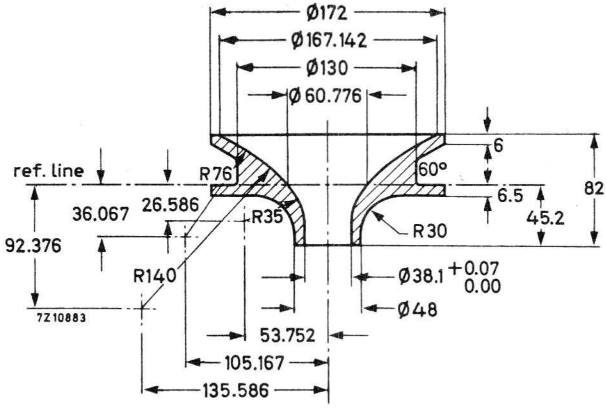
Dimensions in mm



Reference line gauge for 90° deflection angle colour tubes

REFERENCE LINE GAUGE F

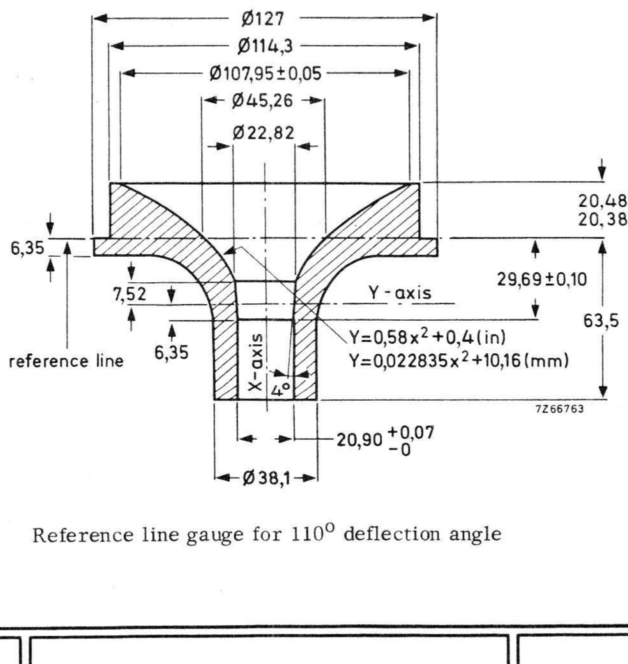
Dimensions in mm



Reference line gauge for 110° deflection angle colour tubes

REFERENCE LINE GAUGE G (JEDEC G148)

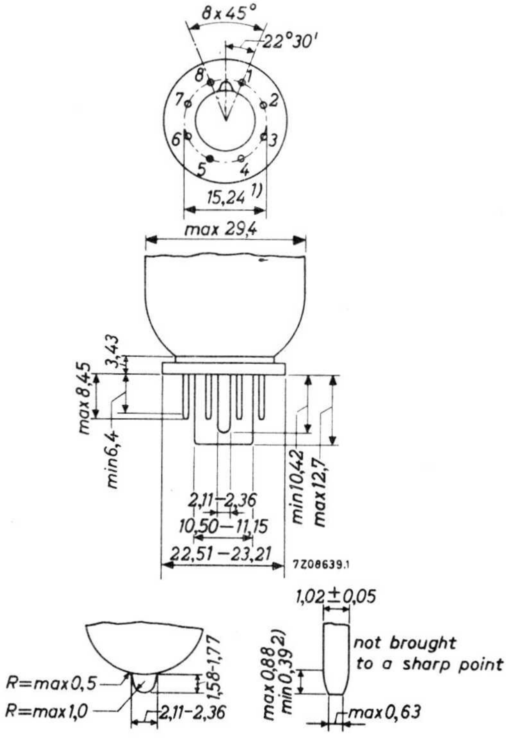
Dimensions in mm



Reference line gauge for 110° deflection angle

BASES

SMALL-BUTTON NEO EIGHTAR BASE IEC67-I-31 JEDEC B7-208 Dimensions in mm

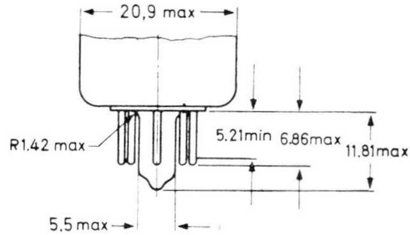


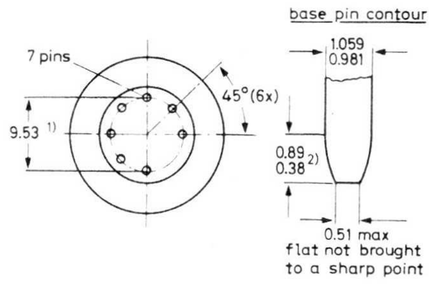
[1]) Base-pin positions are held to tolerances such that the base will fit a flat-plate gauge having a thickness of 9, 53 and eight equally spaced holes of 1, 40 ±0, 01 diameter located on a 15, 24 ±0, 01 diameter circle. The gauge is also provided with a centre hole to provide 0, 25 diametric clearance for the lug and key. Pin fit in the gauge shall be such that the entire length of pins will, without undue force, pass into and disengage from the gauge.

[2]) This dimension may vary within the limits shown around the periphery of any individual pin.

7 PIN MINIATURE BASE WITH PUMPING STEM

Dimensions of this base are within the JEDEC E7-91 dimensions

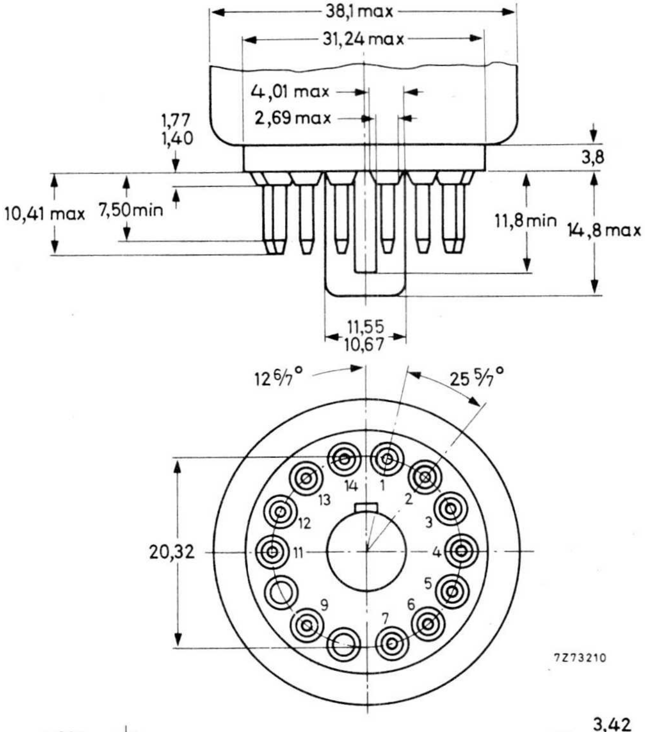


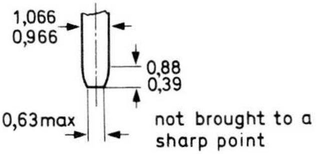


[1]) Base-pin and pumping stem positions are held to tolerances such that entire length of pins and stem will without undue force pass into and disengage from a flat-plate gauge having a thickness of 6, 35 mm and eight holes with diameters of 1, 27 ±0, 013 mm so located on a 9, 525 ±0, 013 mm diameter circle that the distance along the chord between any two adjacent hole centres is 3, 645 ±0, 013 mm and a centre hole of 5, 97 + 0,025 mm being chamfered at the top over 1, 52 mm with an angle of 45 degrees.

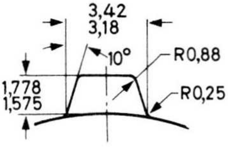
[2]) This dimension around the periphery of any individual pin may vary within the limits shown.

12 PIN BASE JEDEC B12-246, IEC-67-I-47a





pin contour



detail of key

Colour TV picture tubes

90° COLOUR TELEVISION PICTURE TUBE

Three-gun temperature-compensated shadow-mask rectangular colour television tube with electrostatic focus, magnetic deflection and convergence, metal-backed three-colour phosphor dot screen. A high white luminance is obtained at near unity current ratio. Being temperature compensated the shadow-mask makes for optimum field purity and good unifomity during warm-up. Minimum occurence of the moiré effect is ensured by optimizing the mask for the reproduction of 625-line pictures. The tube has a reinforced envelope and therefore no separate safety screen is necessary.

QUICK REFERENCE DATA	
TEMPERATURE-COMPENSATED SHADOW-MASK	
SHADOW-MASK OPTIMIZED FOR 625-LINE SYSTEM	
HIGH WHITE LUMINANCE AT UNITY CURRENT RATIO	
Face diagonal	56 cm
Deflection angle	92 °
Neck length	164.2 mm
Envelope	reinforced suitable for push through
Focusing	electrostatic
Deflection	magnetic
Convergence	magnetic
Heating	6.3 V, 900 mA
Light transmission of face glass	54.5 %

SCREEN

Metal-backed tricolour phosphor dots

Phosphor type	Red: Europium activated rare earth Green and blue: sulphide type
Dot arrangement	Triangular
Spacing between centres of adjacent dot trios	0.68 mm
Light transmission at centre of face glass	54.5 %

HEATING

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

Heater voltage	V_f	6.3	V
Heater current	I_f	900	mA

For maximum cathode life it is recommended that the heater supply be regulated at 6.3 V. If the tube is connected in a series heater chain the r.m.s. surge heater voltage must not exceed 9.5 V when the supply is switched on.

CAPACITANCES

Final accelerator to external conductive coating	$C_{ag_5g_4/m}$	max.	2300	pF
		min.	1700	pF
Final accelerator to metal rimband	$C_{ag_5g_4/m'}$		400	pF
Grid No. 1 of any gun to all other electrodes	C_{g1}		7	pF
Cathodes of all guns (connected in parallel) to all other electrodes	C_k		15	pF
Cathode of any gun to all other electrodes	C_{kR}		5	pF
	C_{kG}		5	pF
	C_{kB}		5	pF
Grid No. 3 (focusing electrode) to all other electrodes	C_{g3}		7	pF

FOCUSING electrostatic

DEFLECTION magnetic

Diagonal deflection angle	92^o
Horizontal deflection angle	79^o
Vertical deflection angle	61^o

CONVERGENCE magnetic

MECHANICAL DATA

Overall length		472.2 ± 9.5	mm
Neck length	max.	168.7	mm
Diagonal of bulb	max.	566.2	mm
Horizontal axis of bulb	max.	486.3	mm
Vertical axis of bulb	max.	381.8	mm
Useful screen			
diagonal	min.	533	mm
horizontal axis	min.	447	mm
vertical axis	min.	337	mm

MECHANICAL DATA (continued)

Mounting position: any

Net weight: approx. 150 N (15 kg)

Base: 12 pin base JEDEC B12-244 but with a 5 mm shorter spigot.

Anode contact: Small cavity contact J1-21, IEC 67-III 2.

Magnetic shielding:

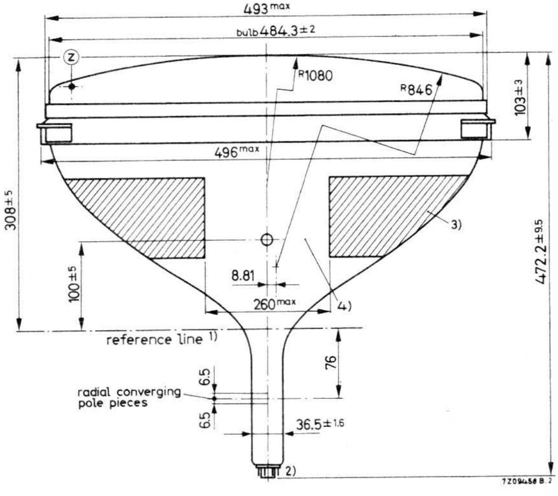
Magnetic shielding should be provided by means of a metal shield extending 24 cm over the cone of the tube measured from the centre of the face plate. The metal shell is preferably constructed of min. 0.5 mm cold rolled steel properly annealed. The air gap between the shield and the metal rimband should be as small as possible and not exceed 10 mm. The magnetic shield should be connected to the outer conductive coating.

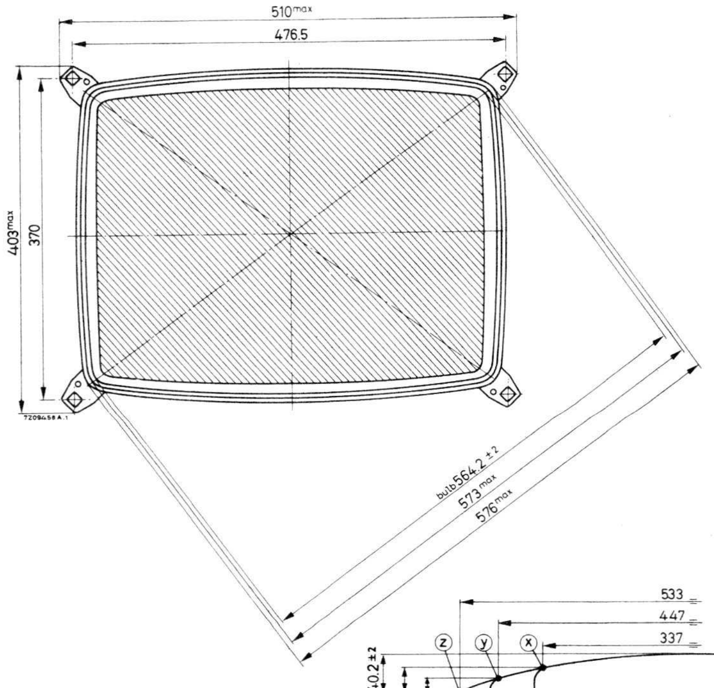
NOTES TO OUTLINE DRAWING (See pages 4 and 5)

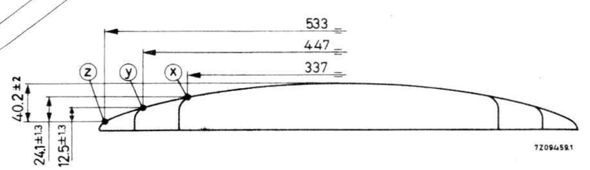
1. Reference line, determined by the plane of the upper edge of the flange of the reference line gauge E, when the gauge is resting on the cone.
2. The socket for this base should not be rigidly mounted; it should have flexible leads and be allowed to move freely. Bottom circumference of base will fall within a circle concentric with bulb axis and having a diameter of 55 mm.
3. Configuration of outer conductive coating may be different, but will contain the contact area as shown in the drawing.
4. To clean this area, whipe only with a solft dry lintless cloth.
5. The displacement of any lug with respect to the plane through the three other lugs is max. 2 mm.
6. Minimum space to be reserved for mounting lug.
7. The position of the mounting screw in the cabinet must be within a circle of 9.5 mm diameter drawn around the true geometrical positions, i.e. the corners of a rectangle of 476.5 mm x 370 mm.
8. Co-ordinates for radius R = 16 mm : x = 203.92 mm, y = 145.50 mm.

MECHANICAL DATA (continued)

Dimensions in mm



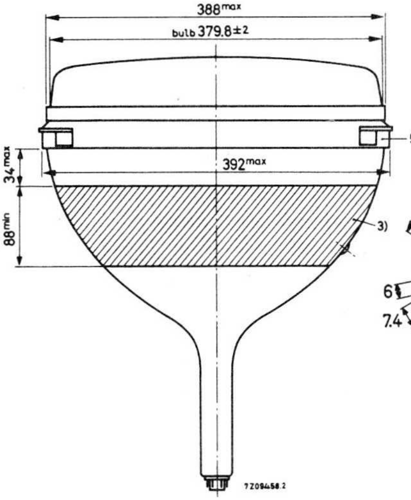


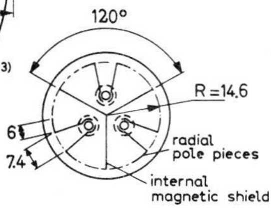


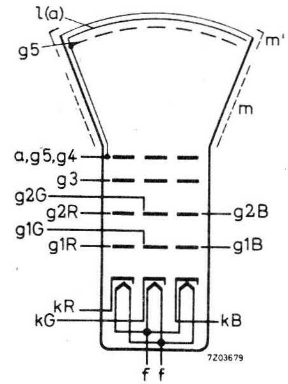
Notes see page 3.

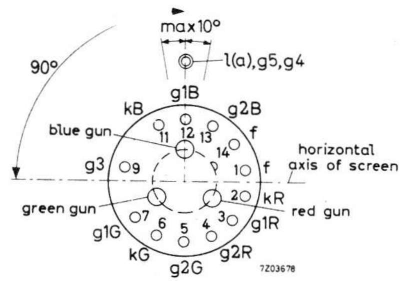
MECHANICAL DATA (continued)

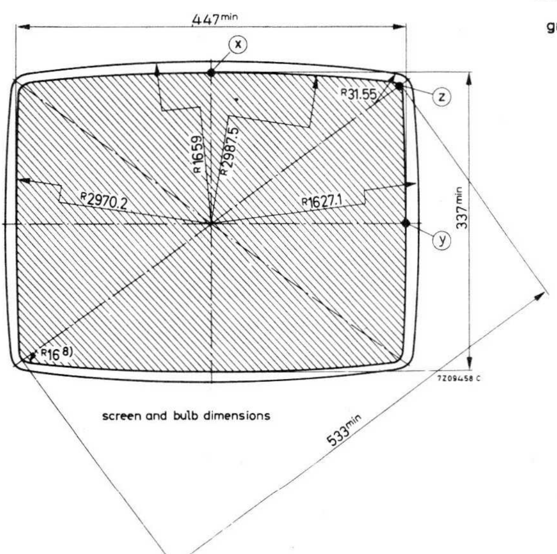
Dimensions in mm

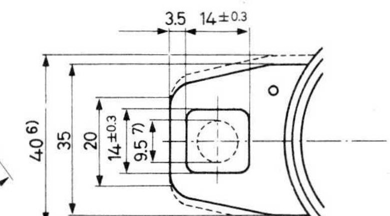


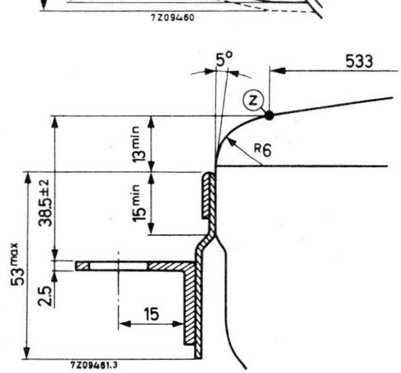








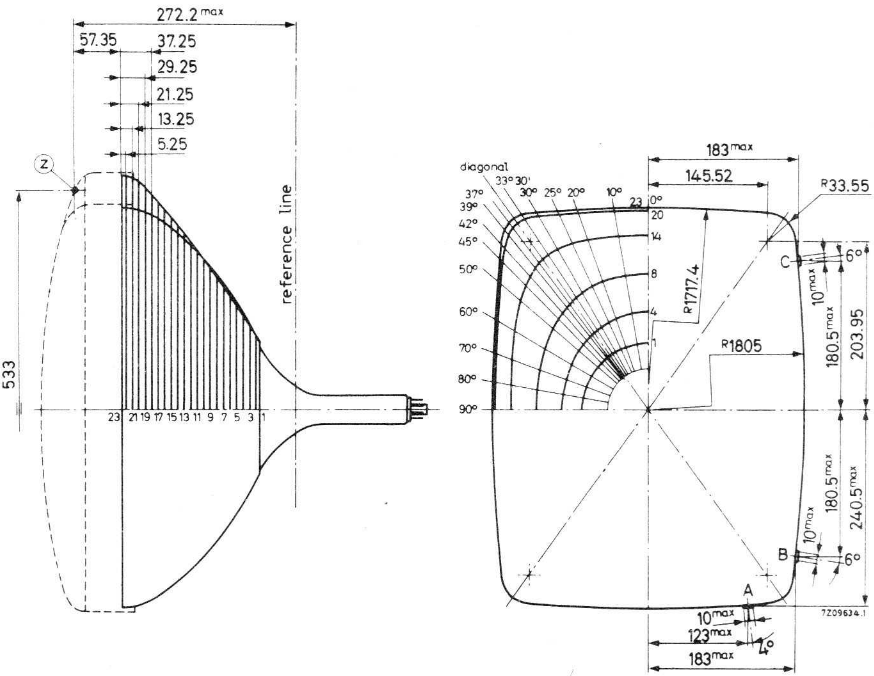




Notes see page 3.

MAXIMUM CONE CONTOUR DRAWING

Dimensions in mm



Sec-tion	Nom. distance from point "Z"	Distance from centre (max. values)														
		0° Long	10°	20°	25°	30°	33° 30'	35° 30' 29.4" Diagonal	37°	39°	42°	45°	50°	60°	70°	80°	90° Short
1	227.20	79.87	79.87	79.87	79.87	79.87	79.87	79.87	79.87	79.87	79.87	79.87	79.87	79.87	79.87	79.87	79.87
2	222.60	87.66	87.64	87.57	87.52	87.47	87.43	87.41	87.39	87.37	87.34	87.31	87.26	87.18	87.13	87.09	87.09
3	214.60	103.28	102.93	102.07	101.53	100.96	100.55	100.32	100.15	99.93	99.6	99.29	98.82	98.06	97.58	97.35	97.3
4	206.60	117.96	117.41	115.98	115.05	114.03	113.3	112.87	112.56	112.13	111.51	100.91	109.95	108.3	107.1	106.4	106.18
5	198.60	130.96	130.45	128.93	127.85	126.6	125.65	125.08	124.66	124.08	123.2	122.33	120.89	118.27	116.19	114.86	114.39
6	190.60	142.65	142.33	141.09	140.04	138.72	137.64	136.97	136.46	135.74	134.64	133.49	131.56	127.85	124.78	122.75	122.02
7	182.60	153.27	153.25	152.55	151.7	150.43	149.3	148.56	147.97	147.14	145.8	144.39	141.92	137.01	132.86	130.1	129.12
8	174.60	163	163.32	163.37	162.85	161.77	160.64	159.85	159.21	158.27	156.71	155	151.94	145.71	140.44	136.96	135.73
9	166.60	172.07	172.74	173.65	173.55	172.76	171.69	170.88	170.18	169.14	167.34	165.31	161.59	153.95	147.53	143.36	141.9
10	158.60	180.58	181.6	183.42	183.83	183.42	182.46	181.64	180.9	179.75	177.69	175.3	170.86	161.7	154.13	149.32	147.66
11	150.60	188.58	189.94	192.7	193.7	193.75	192.97	192.15	191.37	190.1	187.73	184.95	179.7	168.95	160.29	154.88	153.04
12	142.60	196.14	197.8	201.52	203.14	203.76	203.22	202.42	201.59	200.19	197.46	194.21	188.09	175.72	166	160.06	158.06
13	134.60	203.27	205.21	209.87	212.17	213.45	213.24	212.46	211.59	210.03	206.86	203.08	196.01	182.01	171.31	164.88	162.75
14	126.60	210.01	212.21	217.77	220.78	222.82	223.01	222.29	221.36	219.63	215.93	211.53	203.43	187.81	176.21	169.37	167.11
15	118.60	216.38	218.82	225.24	228.98	231.87	232.56	231.9	230.91	228.98	224.64	219.53	210.33	193.14	180.74	173.53	171.17
16	110.60	222.42	225.06	232.28	236.75	240.58	241.89	241.31	240.25	238.08	232.98	227.06	216.69	198.01	184.9	177.38	174.94
17	102.60	228.13	230.96	238.91	244.11	248.96	251	250.52	249.39	246.93	240.93	234.08	222.49	202.42	188.71	180.94	178.42
18	94.60	233.31	236.3	244.94	250.88	256.89	259.85	259.54	258.35	255.57	248.48	240.57	227.71	206.38	192.18	184.21	181.64
19	86.60	237.31	240.42	249.69	256.43	263.92	268.3	268.38	267.22	264.13	255.69	246.51	232.3	209.86	195.3	187.2	184.6
20	78.60	240.24	243.42	253.18	260.67	269.8	276.08	276.83	275.86	272.51	262.37	251.68	236.1	212.8	198.05	189.9	187.29
21	70.60	242.23	245.43	255.39	263.22	273.18	280.54	281.74	280.94	277.51	266.4	254.86	238.59	214.9	200.06	191.89	189.28
22	62.60	243.35	246.56	256.59	264.5	274.68	282.32	283.65	282.92	279.49	268.16	256.4	239.94	216.11	201.22	193.02	190.4
23	57.35	243.81	247.03	257.06	264.98	275.16	282.78	284.11	283.38	279.97	268.68	256.95	240.49	216.63	201.71	193.49	190.86

TYPICAL OPERATING CONDITIONS

Final accelerator voltage	V_{a,g_5,g_4}	25	kV
Grid No.3 (focusing electrode) voltage	V_{g_3}	4.2 to 5	kV
Grid No.2 voltage for a spot cut-off voltage V_{g_1} = −105 V	V_{g_2}	210 to 495	V [1])
Grid No.1 voltage for spot cut-off at V_{g_2} = 300 V	V_{g_1}	−70 to −140	V [2])
Luminance at the centre of the screen		See page 21	

EQUIPMENT DESIGN VALUES (each gun if applicable)

Valid for final accelerator voltages between 20 kV and 27.5 kV.

Grid No.3 (focusing electrode) voltage	V_{g_3}	16.8 to 20 % of final accelerator voltage	
Grid No.2 voltage [1])	V_{g_2}	See cut-off design chart page 22	
Grid No.1 voltage for visual extinction of focused spot (cut-off voltage) [2])	V_{g_1}	See cut-off design chart page 22	
Difference in cut-off voltages between guns in any tube	ΔV_{g_1}	lowest value is min. 65 % of highest value	
Grid No.3 (focusing electrode) current	I_{g_3}	−15 to +15	μA
Grid No.2 current	I_{g_2}	−5 to +5	μA
Grid No.1 current at V_{g_1} = −150 V	I_{g_1}	−5 to +5	μA

		3)	4)	5)	
To produce white of the following CIE coördinates	x	0.310	0.265	0.281	
	y	0.316	0.290	0.311	
Percentage of total anode current supplied by each gun (typical)					
red gun		43.5	27.9	32.2	%
green gun		30.0	34.9	35.6	%
blue gun		26.5	37.2	32.2	%
Ratio of anode currents red gun to green gun	min.	1.05	0.60	0.65	
	av.	1.45	0.80	0.90	
	max.	2.00	1.10	1.25	
Ratio of anode current red gun to blue gun	min.	1.20	0.55	0.75	
	av.	1.65	0.75	1.00	
	max.	2.25	1.05	1.35	

Notes see page 8.

EQUIPMENT DESIGN VALUES (continued)

Required centring, measured at the centre of the screen in any direction	max. 13 mm
Correction which must be supplied by purifying magnet to compensate for mis-register (including caused by earth's magnetic field) when using recommended components. Measured at the centre of the screen in any direction.	max. 115 μm
Lateral distance between the blue spot and the converged red and green spots	max. 6 mm (in both directions)
Radial convergence displacement excluding effects of dynamic convergence (each beam)	max. 9 mm [6] (in both directions)

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1) This range of V_{g_2} has to be used when in circuit design fixed values for cut-off of the three guns are used.

2) This range of V_{g_1} has to be used when in circuit design fixed values for V_{g_2} of the three guns are used.

3) To produce colour pictures with the best possible quality, this white point should be used as the transmission systems are based on this point. (Point C)

4) To produce black/white pictures a more bluish white point would be preferable. This white point corresponds virtually with the white point of current black/white picture tubes.

5) This point is a compromise between the white point C and the white point x = 0.265 and y = 0.290, given in order to enable good rendition of colour and black-and-white pictures with one white point.

6) Dynamic convergence to be effected by currents of approximately parabolic waveshape synchronized with scanning.

LIMITING VALUES (Each gun if applicable)(Design centre rating system unless otherwise specified)

Final accelerator voltage	V_{a,g_5,g_4}	max.	27.5	kV	[1][2][3]
		min.	20	kV	[1][4]
Average current for 3 guns	I_a	max.	1000	μA	[5]
Grid No.3 (focusing electrode) voltage	V_{g_3}	max.	6000	V	
Grid No.2 voltage, peak, including video signal voltage	V_{g_2p}	max.	1000	V	
Grid No.1 voltage,					
negative	$-V_{g_1}$	max.	400	V	
negative, operating cut-off	$-V_{g_1}$	max.	200	V	
positive	V_{g_1}	max.	0	V	
positive peak	V_{g_1}	max.	2	V	
Cathode to heater voltage,					
positive	V_{kf}	max.	250	V	[6][7]
positive peak	V_{kf_p}	max.	300	V	
negative	$-V_{kf}$	max.	135	V	
negative peak	$-V_{kf_p}$	max.	180	V	

[1]) Absolute max. rating system.

[2]) The X-ray dose rate remains below the acceptable value of 0.5 mr/h, measured with ionization chambre when the tube is used within its limiting values.

[3]) For optimal operating conditions the final accelerator voltage has to be stabilized. Therefore its absolute maximum value can be approached in actual operation and for this reason this value is given instead of the design centre value. During adjustment on the production line this value is likely to be surpassed considerably. It is therefore strongly recommended to first make the necessary adjustments for normal operation without picture tube.

[4]) Operation of the tube at lower voltages impairs the brightness and resolution and may have a detrimental effect on colour purity.

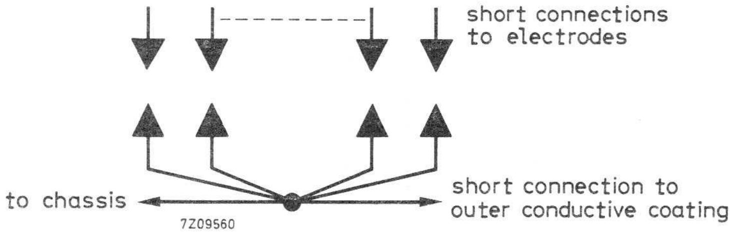
[5]) 1500 μA permitted provided a current limiting circuit is used.

[6]) In order to avoid excessive hum the a.c. component of the heater to chassis voltage should be as low as possible and must not exceed 20 V_{rms}.

[7]) During an equipment warm-up period not exceeding 15 s V_{kf} is allowed to rise to 410 V. Between 15 s and 45 s after switching on a decrease in V_{kf} proportional with time from 410 V to 250 V is permissible.

REMARK

With the high voltage used with this tube (max. 27.5 kV) internal flash overs may occur, which may destroy the cathode(s). Therefore it is necessary to provide protective circuits, using spark gaps.
The sparkgaps must be connected as follows:



No other connections between the outer conductive coating and the chassis are permissible.
Additional information available on request.

REFERENCE LINE GAUGE

Gauge E. See chapter "Reference line gauges" in front of this book.

DESCRIPTION OF THE TUBE

The A56-120X is a rectangular temperature compensated shadow-mask colour picture tube for use in colour television receivers. The tube can display a picture, either in full colour or in black and white, on an almost rectangular, almost flat screen, with rounded-off corners of small curvature. Mounting the tube with the screen protruding through the cabinet front is possible since the rimband is clamped some distance from the screen edge. The minimum useful screen area measures 447 mm x 337 mm and has a projected area of 1471 cm^2

The A56-120X has

- a deflection angle of 92^{o}
- a neck diameter of 36.5 mm
- a three-colour phosphor dot screen, composed of closely spaced dots in a regular pattern of tri-angular groups, each containing a red, a green and a blue light emitting dot.
- Three electron guns with axes tilted towards the screen centre, with electrostatic focusing systems and mounted side by side in the neck of the tube 120^{o} apart.

Colour selection is effected by a metal graded-hole shadow mask positioned in front of the tricolour phosphor-dot screen. This mask is aligned with the dot pattern so that the electron beam from each gun lands only on phosphor dots of the associated colour.

The shadow mask has graded holes that increase gradually in diameter from the edge of the mask towards the centre. Grading enables correct purity to be achieved over the whole screen with minimum adjustment.

Although the three guns are tilted towards the screen centre so that their axes intersect at the shadow mask, lateral and radial convergence are necessary to ensure correct convergence over the entire screen. Each of the three guns is therefore provided with a pair of radial converging pole pieces.

Radial convergence can be achieved by means of magnets and coils mounted externally on the neck of the tube. The magnetic flux provided is coupled through the glass neck of the tube to associated internal pole pieces. The shape of the pole pieces, together with the internal magnetic shielding, is shown in Fig. 1. Internal shielding prevents interaction of the various magnetic fields.

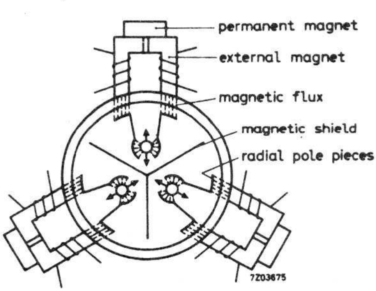


Fig. 1

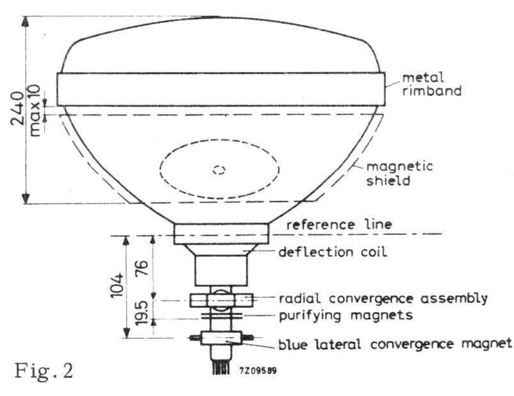


Fig. 2

Fig. 2 shows the position of the components on the neck of the tube.
Lateral convergence is achieved by a separate assembly mounted on the neck of the tube. This assembly causes horizontal movement of the blue beam, and simultaneously, movements of the red and green beams in the opposite direction.
Facilities for dynamic blue lateral convergence are also provided in this convergence assembly.

APPLICATION NOTES

1. Magnetic shielding

The tube should be fitted with a magnetic shield around the cone, to minimize the effects of external magnetic fields, including the horizontal, vertical and axial components of the earth's magnetic field. The latter so influences the colour purity that compensation by means of the purifying magnets is not possible.
The metal shield should preferably be constructed of coldrolled steel, at least 0.5 mm thick and properly annealed at 850 °C. Since the tube re-inforcing band is an essential part of the magnetic circuit used for degaussing, the air gap between the band and the shield should be as small as possible and certainly not more than 10 mm. To be effective, the shield must be degaussed as described under "Adjustment procedures". Building-in of an automatic degaussing system is advised.

2. Centring of raster on the screen.

Raster centring in a shadow-mask colour picture tube is achieved by passing direct current of the required value through each pair of deflection coils. The values for raster displacement given in the data apply when all components are properly adjusted.

3. Component considerations.

The necessary components are the deflection coil, the radial convergence assembly, the purifying magnets and the blue lateral convergence magnet.
Basically the functions of the components are:
- deflection of the three beams over the entire screen: deflection coil.
- good convergence of the three beams over the screen: radial convergence assembly and blue lateral convergence magnet.
- landing adjustment: purifying magnets and deflection coil

The mounting positions of the components are as follows:

The deflection coil: in such a way that its deflection centre coincides with the one used in the screen-laying process during manufacturing. The coil must therefore be designed so that sufficient movement in the axial direction is possible.

The radial convergence assembly: with its pole pieces centred above the convergence pole pieces inside the tube. Initially, the assembly should be mounted upright. Small rotations of the whole assembly influence the convergence and can be used during adjustment of the blue lateral correction to obtain optimum lateral convergence.

APPLICATION NOTES (continued)

The purifying magnets: over the gap between the electrode g3 and g4 of the gun, or still closer to the deflection coil. Placing the purifying magnets closer to the base results in poorer performance as the spot quality is adversely affected.

The blue lateral convergence magnet: as near as possible to the rear side of the purifying magnets but not shifted backwards more than halfway along electrode g3 of the gun.

3.1 Convergence

Static convergence, i.e. convergence of the three beams onto the centre of the screen, is usually accomplished with permanent magnets which are part of the radial convergence assembly, or with D.C. currents through the convergence coils in combinations with the lateral converging magnet.
The strength of the magnetic field that is adjustably coupled to the radial convergence pole pieces of the gun should be such that each beam can be moved 9 mm in both directions towards the centre of the screen excluding effects of dynamic convergence. The static blue lateral convergence magnet should provide a magnetic field adjustable in magnitude and polarity.
This field exerts a directive force on the blue beam and simultaneously a force in the opposite direction on the green and the red beams.
The displacement of the blue beam opposite to the movement of the red and green beams should be 6 mm in both directions.
With these four adjustable magnetic fields static convergence of the three beams can be attained.
For good convergence over the entire screen dynamic radial convergence is required together with a small amount of dynamic lateral convergence in line direction.
The radial convergence assembly consists fundamentally of three cores with associated windings. Through the windings are passed the necessary currents for maintaining convergence when the beams are deflected over the screen.
The required form of the currents can be obtained by adding a current with a sawtooth wave form to one with a parabolic wave form. Two separate windings are required for correction in the horizontal and the vertical direction. The parabolic and sawtooth currents should be adjustable in amplitude and the sawtooth currents and the vertical blue parabola should, in addition be adjustable in polarity.
The blue lateral convergence magnet consists of a core and associated windings to obtain dynamic lateral convergence in line direction.

3.2 Landing

Landing is defined as the relative position of each beam with respect to its associated phosphor dot.
Good landing is achieved when each beam excites only its associated colour phosphor dot.
Optimum landing is achieved by adjusting both the purifying magnets and the deflection coil.

APPLICATION NOTES (continued)

3.2.1 Purifying magnets

Purifying magnets are required to compensate for the effects of outside magnetic fields, (including the earth's magnetic field), and manufacturing variations, which could cause mislanding.
Such purifying magnets, designed to provide a magnetic field adjustable in magnitude and direction, effect good landing over the entire screen when the deflection coil position is properly adjusted.

3.2.2 Deflection coil

The position of the deflection centre must be adjustable to make sure that proper landing can be attained in any set. To achieve this the deflection coil should be free to move along the neck over a minimum distance of 12 mm from its most forward position when the purity adjustment is made with the aid of a microscope, or about 20 mm if purity is adjusted by means of the so-called "red ball" method. (See 6.1.2.1.)

4. Drive requirements

To calculate the drive voltages which should be supplied to the tube the following points should be taken into account.

4.1 In presently known systems the luminance signal is composed as follows:
$Y = 0.30R + 0.59G + 0.11B$.
The colour information is carried by two chrominance signals which in the receiver after subcarrier detection, deliver the so-call colour difference signals R-Y, G-Y and B-Y.
These have to be combined with the Y-signal in a matrix circuit to recover the original red, green and blue signals. With the aid of the luminance signal equation it is possible to calculate the maximum voltage ranges for the colour difference signals. The maximum values are reached when the primary colours and their complementaries are produced at maximum brightness.
These values are tabulated below. All values are referred to the maximum value Y=R=G=B=1 for peak white and are considered positive if they cause an increase in beam current.

Colour	R	G	B	Y	R-Y	G-Y	B-Y
Red	1	0	0	0.3	0.7	-0.3	-0.3
Green	0	1	0	0.59	-0.59	0.41	-0.59
Blue	0	0	1	0.11	-0.11	-0.11	0.89
Cyan	0	1	1	0.7	-0.7	0.3	0.3
Magenta	1	0	1	0.41	0.59	-0.41	0.59
Yellow	1	1	0	0.89	0.11	0.11	-0.89

APPLICATION NOTES (continued)

Signal	Minimum	Maximum	Total range
R-Y	-0.7	0.7	1.4
G-Y	-0.41	0.41	0.82
B-Y	-0.89	0.89	1.78

In practice the saturation of the colours is lower than that of the primary colours as considered above, so that the demands on the colour difference signals can be lower than those indicated.

4.2 The combining of the Y-signal with the R-Y, G-Y and B-Y signals can be performed by two methods:

Method 1. Letting the picture tube perform the matrix function by driving the cathodes with the luminance signal while putting the colour difference signals onto the three first grids of the picture tube. (colour difference drive)

Method 2. By means of a separate matrix circuit that delivers red, green and blue signals to the picture tube. (R.G.B. drive). If fed to the three cathodes these signals attain the same maximum amplitudes as the Y-signal in the first method, and it should be remembered that each channel requires full video bandwidth.

In both methods it should be recognized that with cathode drive a higher slope is obtained than with grid drive and to compensate for this higher drive voltages are required for grid drive in each case. For grid drive the relation between grid drive voltage (V_{drg}) and beam current (I_a) is approximately:

$$I_a = k \frac{V_{drg}^{3}}{V_{cog}^{3/2}}$$

(I_a in μA)
(V_{cog} is cut-off voltage for grid drive)
(k = k factor)

For cathode drive this function reads:

$$I_a = \frac{k\,(1+D)^3}{\left(1 + D\frac{V_{drk}}{V_{cok}}\right)^{3/2}} \cdot \frac{V_{drk}^{3}}{(V_{cok})^{3/2}}$$

(V_{drk} = cathode drive voltage)
(V_{cok} = cut-off voltage for cathode drive)
(D = penetration factor)

This shows that there is a difference in sensivity between the two drive techniques, and that the relationship between them is not strictly linear. In practice the best result is obtained if the gridsignal amplitudes are made 20% larger than the corresponding cathode signal amplitudes.

4.3 Unequal currents are required for the red, green and blue signals to produce white as the efficiencies of the red, green and blue phosphors are different. (See Equipment Design Values)

4.4 Spread occuring in picture tube properties:
(1) k factor, (2) penetration of g2 (D) and (3) phosphor efficiencies.

APPLICATION NOTES (continued)

(1) The k factor, having a nominal value of 3.0, spreads between 2.6 and 3.1 but it can be derived from the $I_a = f(V_{dr})$ graph for cathode drive that compensation for this spread is attainable when the luminance drive stage is capable of producing approx. 6 volts more than the nominal peak drive needed for the red gun.

(2) The penetration D may spread from 0.18 to 0.40 with a nominal value of 0.29 and is experienced as a spread in V_{co}. It can be offset - if required - by adjustment of V_{g_2} (See page 22).

(3) Phosphor efficiencies: the ratios of cathode currents for white having, for example, CIE x and y coordinates:
x = 0.281 and y = 0.311, may spread as follows:

$\frac{I_R}{I_G}$ = 0.90 with a min. value of 0.65 and a max. value of 1.25

$\frac{I_R}{I_B}$ = 1.00 with a min. value of 0.75 and a max. value of 1.35

In calculations, for the worst case the values $I_R/I_G = 1.25$ and $I_R/I_B = 1.35$ should be used if the compromise white point is chosen (x = 0.281 y = 0.311). If the white point C is chosen for reproduction of colours then for the worst case the current ratio values, $I_R/I_G = 2.00$ and $I_R/I_B = 2.25$ should be used.

5. Raster shape correction

It appears that for 90° deflection the combination of picture tube and deflection coil can give good convergence and landing, but it is not practical to design the combination such that a perfectly rectangular raster is obtained. To avoid the pin cushion raster which results it is necessary to provide raster correction electrically by modulating the deflecting current.

6. Adjustment procedures

The following procedures are suggested to ensure good landing, optimum convergence of the three beams over the entire area of the screen and good grey scale tracking.

Exact focusing is the final operation in the sequence of adjustments, see 6.3.
When starting the sequence it is sufficient to adjust the convergence test pattern for optimum sharpness.

Prior to the adjustment procedure the picture tube has to be degaussed. This treatment will correct for localized areas of colour impurity resulting from any magnetization of the shield and internal tube parts and minimize the effect of the earth's magnetic field. Degaussing can be obtained by a coil that consists of 800 turns of 0.7 mm dia. enamelled copper wire (for 220 V_{rms}) and has an outer diameter of approx. 300 mm.
The coil should be moved such that the entire screen is subjected to its field. After about 10 seconds, the coil is moved away from the face plate to a distance of at least 2 m and disconnected from the A.C. power supply.

APPLICATION NOTES (continued)

During manufacture the receiver chassis should be degaussed in a similar manner, with the receiver switched on and care should be taken that the assembly line is properly degaussed. An automatic degaussing system built into the receiver serves for degaussing during normal operation.
It is recommended that the receiver has some adjustments made before the picture tube is built in. These adjustments should include EHT and deflection, and the dynamic convergence in order to facilitate the adjustment of purity and static convergence. Before deflection power and high voltage are applied to the tube, the bias control should be adjusted for maximum bias. After deflection power and high voltage are applied, the beam currents should be increased gradually to minimize the possibility of tube damage in the event of circuit faults. With the application of a test signal, initial adjustment of focus, raster size, linearity and centring should be made.

6.1 Colour purity and convergence procedures

The normal sequence involves, first, static convergence adjustment next the purifying magnet and adjustment of the axial position of the deflection coil, and lastly final adjustment of dynamic convergence.

6.1.1 Static convergence adjustment

A crosshatch pattern is the most suitable signal for convergence adjustments. The pattern should be displayed at moderate brightness to improve the accuracy. It is advisable to converge red and green first, with the blue gun cut off, and then to converge blue into the yellow pattern formed by the coinciding of red and green lines.
The red and green beams are made to converge statically by adjusting the permanent magnets of the radial convergence assembly, or the corresponding D.C. currents. Correct convergence is obtained when the lines in the centre converge to give yellow.
Before the blue lateral convergence magnet is used, the blue lines are brought horizontally adjacent to the yellow lines by means of the radial blue static convergence adjustment (permanent magnet or D.C. current).
Hereafter the blue lines are made to converge with the yellow lines in the centre with the aid of the blue lateral convergence magnet, resulting in white lines in the centre. If necessary this procedure is repeated.

6.1.2 Adjustment for colour purity

Adjustment for colour purity involves two steps:
Adjustment of the purifying magnets. (6.1.2.1)
Adjustment of the position of the deflection coil. (6.1.2.2)
To obtain optimum adjustment, the static and dynamic convergence should be adjusted previously and the picture tube degaussed and well warmed up to normal operating temperature (approx. 30 min, total beam current 600 μA).
Purity assessments are best made on a plain raster.

APPLICATION NOTES (continued)

Adjustment of the purifying magnets influences purity all over the screen. The deflection coil adjustment influences purity mainly at the screen edges. Therefore, the magnets have to be adjusted before the coil.

6.1.2.1 The purifying magnets are adjusted, judging by the landing in the screen centre. There are two ways of doing this.

The first method makes use of a microscope (magnification about 50x). With this method, the deflection coil need not possess more axial adjustment margin than that needed to cope with the spreads of the deflection centres. (12 mm total).

With the microscope, the position of the spot trio's is compared with the position of the phosphor dot trio's at the screen centre. To do this, the three colour rasters are displayed simultaneously, and the phosphor dots are illuminated by means of a light source, shining onto the screen at a small angle. The spot trio's should be made to land on the phosphor dot trio's as shown in Fig.1, with their centre points coinciding.

Due to the beam grouping used in this tube (which improves the overall landing) the spots will then be approx. 25 μm eccentric with respect to their corresponding phosphor dots.

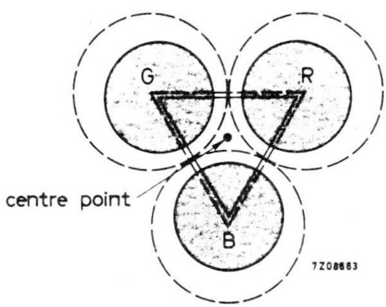


Fig.1. Correct landing in the screen centre.

The second method ("Red ball" method) is applicable if the mounting of the deflection coil is such that it can be drawn away approx. 20 mm backwards from its foremost position when it touches the funnel.

The coil is moved backwards as far as possible, and only the red raster is turned on. (The red gun needs relatively the highest current, thus mislanding on blue and green phosphor dots is seen more clearly so that a sharp indication is obtained).

Now a red area of approx. 10 cm diameter is visible on the screen, surrounded by discoloured and blue and green areas. With the aid of the purifying magnets, the red area is positioned near the screen centre. In order that the above mentioned beam grouping shows to full adventage, the red area should be positioned 20 mm down to the left of the screen centre, see Fig.2.

APPLICATION NOTES (continued)

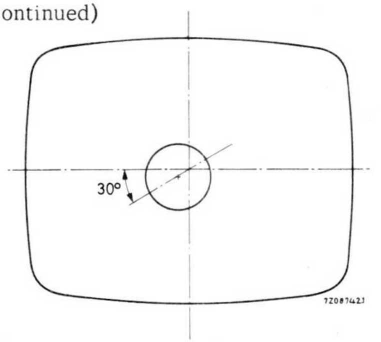


Fig.2

6.1.2.2 After adjustment of the purifying magnets, the deflection coil is adjusted by shifting it axially until optimum landing over the entire screen is reached. This can be done in two stages:

1. Only the red raster turned on, and the coil position giving an overall pure red raster sought.
2. For the final adjustment, a white raster is displayed and, if necessary, very slight adjustment of the deflection coil position made to obtain the best white uniformity.

After having completed 1 and 2, the red, green and blue rasters are checked separately for their purity, and if necessary the procedure repeated.

6.1.3 Adjustment of dynamic convergence

Just as for the static convergence a crosshatch pattern is recommended, displayed at low luminance.
It is advisable to adjust first the convergence in the vertical direction (with frame frequency) and then the horizontal convergence (with currents of line frequency). During the dynamic convergence adjustments, the static convergence (6.1.1) may need readjustment depending on the efficiency of any clamping circuits used.

A favourable sequence is to adjust the red and green convergence controls first so that both rasters coincide to display yellow lines while the blue gun is kept cut-off. Thereafter the blue pattern is added and adjusted to coincide with the yellow to give a white pattern. However, as the blue horizontal convergence system usually has a significant power consumption which influences the line time base to some degree, it is often advisable to start the whole convergence procedure by adjusting the blue horizontal convergence controls coarsely to give a straight blue horizontal centre line.

During the vertical dynamic convergence adjustment, the vertical axis of the screen should be taken as reference, while the horizontal adjustments should be referred to the horizontal axis. During the latter sequence the lateral blue dynamic convergence is also adjusted.

APPLICATION NOTES (continued)

The currents for dynamic convergence (except blue lateral) consist of two components, viz. one of parabolic and one of sawtooth wave form. Usually both have their own controls which have to be adjusted in combination to obtain convergence. The parabolic ("amplitude") controls are used to make the configurations at the extremities of the picture axis equal to that at the centre. With the sawtooth ("phase" or "tilt") control the two extremities of the picture axis are made equal to each other as far as possible.
In addition, the blue horizontal convergence needs an extra waveform correction to correct for the tilting of the outer edges.
The blue lateral waveform needed is basically a sawtooth. Left-to-right asymmetry can be adjusted by slight rotation of the radial convergence assembly.

By repeated adjustments of the controls the line patterns in the various colours ultimately coincide and become parallel to each other. Thereafter these are made to coincide with the aid of the static convergence magnets to white lines.

After convergence onto the axes is obtained, usually some errors in the corners of the picture remain. Slight readjustment may be needed to minimize these errors.

At the end of the procedure purity is checked, and readjusted if needed, with the aid of the purifying magnets.

6.2 Adjustment of grey scale

This adjustment is carried out last of all and the sequence of the manipulations depends on receiver circuitry.

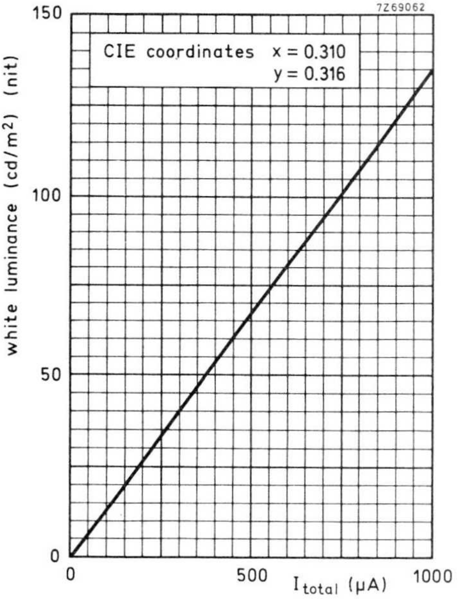
To obtain a constant hue of white over the whole grey scale when displaying a monochrome signal, the three guns must track accurately. This can be achieved by adjusting two points of each gun characteristic, one near cut-off and one near the highlights. To this end the following variables are available, and in a receiver two of them must be made adjustable for each gun:
1. cut-off point (V_{g_1})
2. slope (V_{g_2})
3. drive

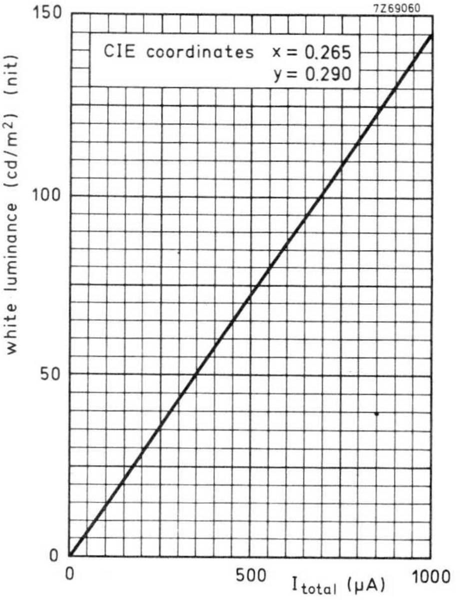
The proper adjustment procedure depends on receiver circuitry. After adjustment, the luminance and contrast controls should not cause any change in hue, and the chosen white point should be displayed.

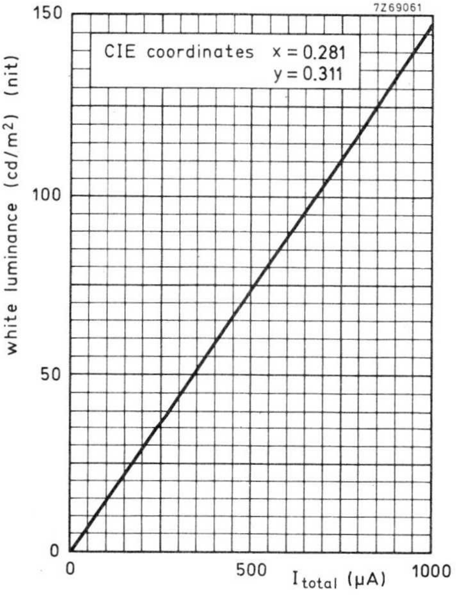
6.3 Focusing

The focusing voltage for all three guns can be adjusted via the common focus base pin No.9. In order to obtain optimum focus it is recommended to use a black-and-white picture with a low peak to mean luminance ratio, such as the RMA test picture, running at a total mean current of about 1 mA (peak currents in the three guns in the order of 2.5 mA), and to focus at the highlights. This procedure will give best overall focus.

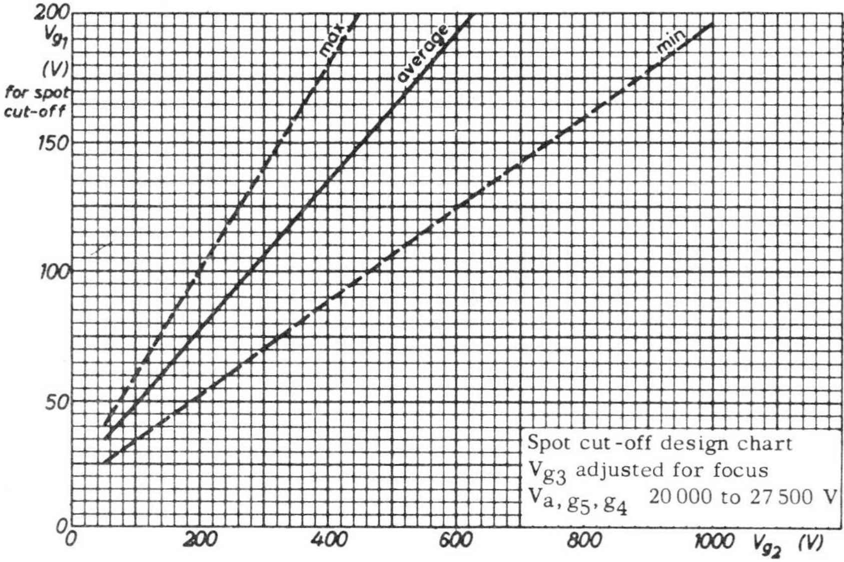
Luminance at the centre of the screen as a function of I_{total}

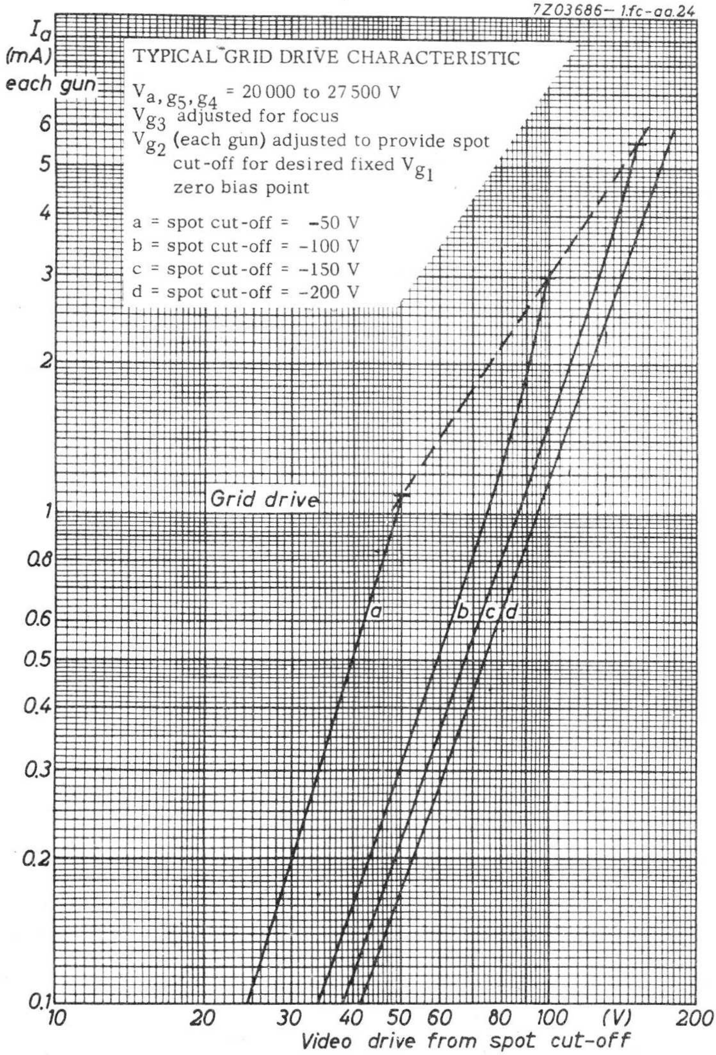


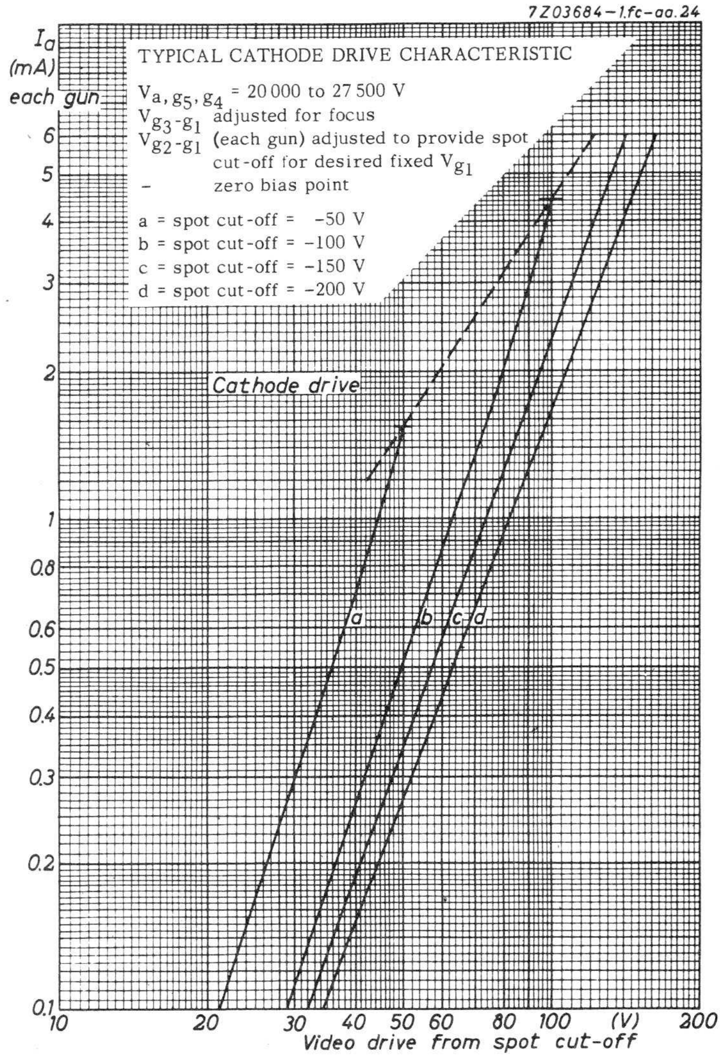




Scanned area 447 mm x 337 mm


200
V_{g_1}
(V)
for spot cut-off
150
100
50
0
0
200
400
600
800
1000
V_{g_2} (V)
max
average
min
7Z03603-1fc-00.24
Spot cut-off design chart
V_{g3} adjusted for focus
V_{a, g_5, g_4} 20 000 to 27 500 V


7Z03686-1.fc-aa.24
TYPICAL GRID DRIVE CHARACTERISTIC
V_{a,g_5,g_4} = 20 000 to 27 500 V
V_{g_3} adjusted for focus
V_{g_2} (each gun) adjusted to provide spot cut-off for desired fixed V_{g_1} zero bias point
a = spot cut-off = −50 V
b = spot cut-off = −100 V
c = spot cut-off = −150 V
d = spot cut-off = −200 V
I_a (mA) each gun
Grid drive
a
b
c
d
0.1
0.2
0.3
0.4
0.5
0.6
0.8
1
2
3
4
5
6
10
20
30
40
50
60
80
100
(V)
200
Video drive from spot cut-off


7Z03684-1.fc-aa.24
TYPICAL CATHODE DRIVE CHARACTERISTIC
V_{a,g_5,g_4} = 20 000 to 27 500 V
$V_{g_3-g_1}$ adjusted for focus
$V_{g_2-g_1}$ (each gun) adjusted to provide spot cut-off for desired fixed V_{g_1}
– zero bias point
a = spot cut-off = −50 V
b = spot cut-off = −100 V
c = spot cut-off = −150 V
d = spot cut-off = −200 V
I_a (mA) each gun
Cathode drive
a
b
c
d
0.1
0.2
0.3
0.4
0.5
0.6
0.8
1
2
3
4
5
6
10
20
30
40
50
60
80
100
(V)
200
Video drive from spot cut-off

110° COLOUR TELEVISION TUBE

Three-gun temperature-compensated shadow-mask rectangular colour television tube with electrostatic focus, magnetic deflection and convergence, metal-backed three-colour phosphor dot screen and internal magnetic shield. A high white luminance is obtained at near unity current ratio. Being temperature compensated, the shadow-mask makes for optimum field purity and good uniformity during warm-up. The design is such that minimum occurence of the moiré effect is ensured. The tube has a reinforced envelope and therefore no separate safety screen is necessary.

QUICK REFERENCE DATA	
TEMPERATURE-COMPENSATED SHADOW-MASK	
DESIGNED FOR MINIMUM MOIRE EFFECT	
HIGH WHITE LUMINANCE AT UNITY CURRENT RATIO	
Face diagonal	56 cm
Deflection angle	110 °
Neck diameter	36.5 mm
Envelope	reinforced suitable for push through
Magnetic shield	internal
Focusing	bipotential
Convergence	magnetic
Heating	6.3 V, 900 mA
Light transmission of face glass	54.5 %

SCREEN

Metal-backed phosphor dots

Phosphor type	Red: Europium activated rare earth Green: Sulphide type Blue: Sulphide type		
Dot arrangement	Triangular		
Spacing between centres of adjacent dot trios		0.81	mm
Light transmission at centre of face glass		54.5	%

HEATING: indirect by A.C. or D.C.; parallel or series supply

Heater voltage	V_f	6.3	V
Heater current	I_f	900	mA

For maximum cathode life it is recommended that the heater supply be regulated at 6.3 V. If the tube is connected in a series heater chain the surge heater voltage must not exceed 9.5 V_{rms} when the supply is switched on.

CAPACITANCES

Final accelerator to external conductive coating	$C_{a,\ g5,\ g4/m}$	max.	1800	pF
		min.	1300	pF
Final accelerator to metal rimband	$C_{a,\ g5,\ g4/m'}$	max.	400	pF
Grid No. 1 of any gun to all other electrodes	C_{g1}		7	pF
Cathodes of all guns (connected in parallel) to all other electrodes	C_k		15	pF
Cathode of any gun to all other electrodes	C_{kR}		5	pF
	C_{kG}		5	pF
	C_{kB}		5	pF
Grid No. 3 (focusing electrode) to all other electrodes	C_{g3}		7	pF

FOCUSING bipotential

DEFLECTION magnetic

Diagonal deflection angle	110	^{o}
Horizontal deflection angle	97	^{o}
Vertical deflection angle	77	^{o}

CONVERGENCE magnetic

MECHANICAL DATA

Overall length		387.3 to	400.3	mm
Neck diameter			36.5	mm
Diagonal	of bulb	max.	566.2	mm
Horizontal axis	of bulb	max.	486.3	mm
Vertical axis	of bulb	max.	381.8	mm
Useful screen				
diagonal		min.	533	mm
horizontal axis		min.	447	mm
vertical axis		min.	337	mm

Mounting position : any

Net weight : approx. 14.5 kg

Base : 12 pin base JEDEC B12-246

Anode contact : Small cavity contact J1-21, IEC 67-III-2

Magnetic shielding, degaussing: The tube is provided with an internal magnetic shield. The internal magnetic shield and the shadow-mask with its suspension system may be provided with an automatic degaussing system, consisting of two coils covering left and right cone parts. For proper degaussing an initial m.m.f. of 450 ampere-turns is required in each of the coils. This m.m.f. has to be gradually decreased by appropriate circuitry. After decreasing to 10 A.t. or less, sudden switch off is permissible. In the steady state, no significant m.m.f. should remain in the coils ($\leq$ 0.5 A.t.).

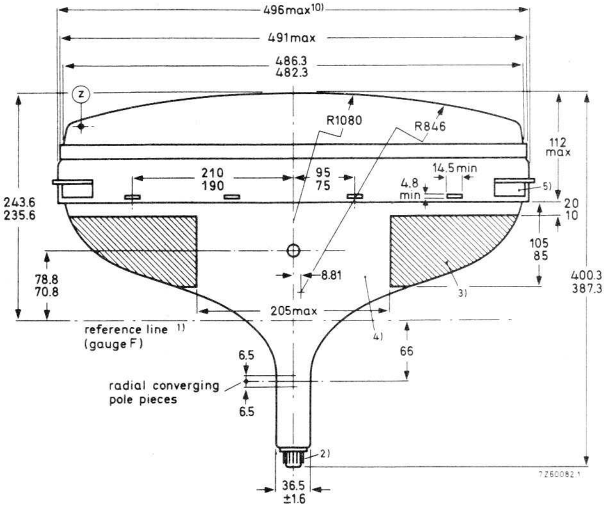
To ease the mounting of the coils, the rimband is provided with rectangular holes.

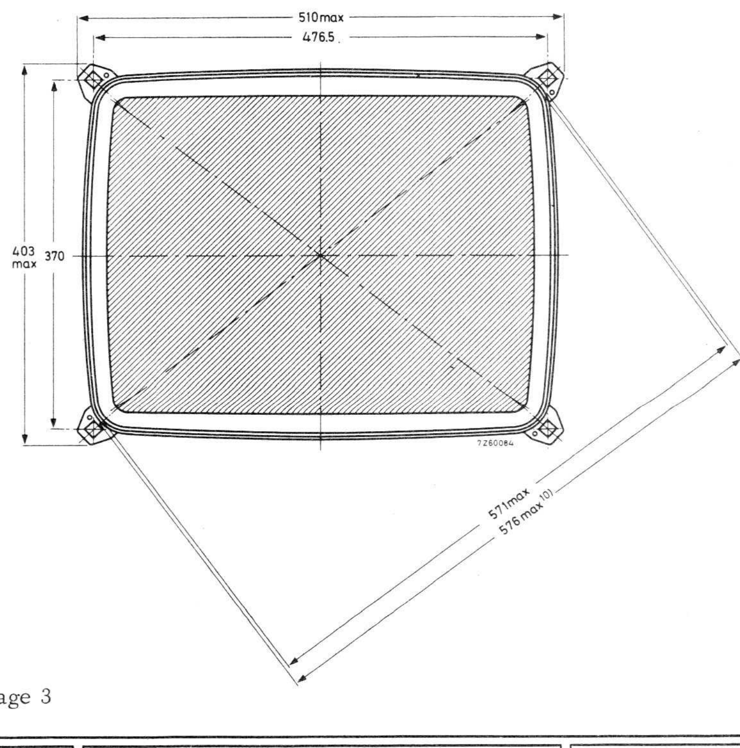
NOTES TO OUTLINE DRAWING (See pages 4, 5, and 6)

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 socket for this base should not be rigidly mounted; it should have flexible leads and be allowed to move freely.. Bottom circumference of base will fall within a concentric circle with the tube axis and having a diameter of 55 mm.
3) Configuration of outer conductive coating may be different, but will contain the contact area as shown in the drawing.
4) To clean this area, whipe only with a soft lintless cloth.
5) The displacement of any lug with respect to the plane through the three other lugs is max. 2 mm.
6) Minimum space to be reserved for mounting lug.
7) The position of the mounting screw in the cabinet must be within a circle of 9.5 mm diameter drawn around the true geometrical positions, i.e. the corners of a rectangle of 476.5 mm x 370 mm.
8) Coördinates for radius R = 15.95 mm: x = 203.95 mm, y = 145.52 mm.
9) Distance from point Z to any hardware.
10) Maximum dimensions in plane of lugs.

MECHANICAL DATA (continued)

Dimensions in mm

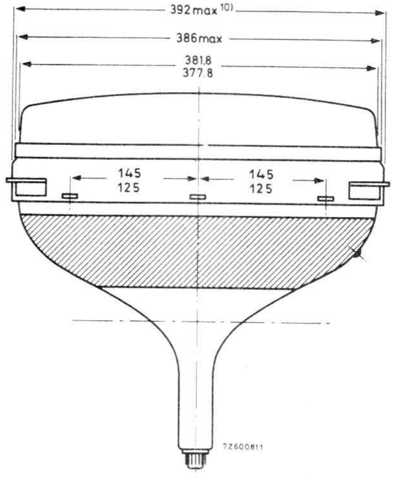


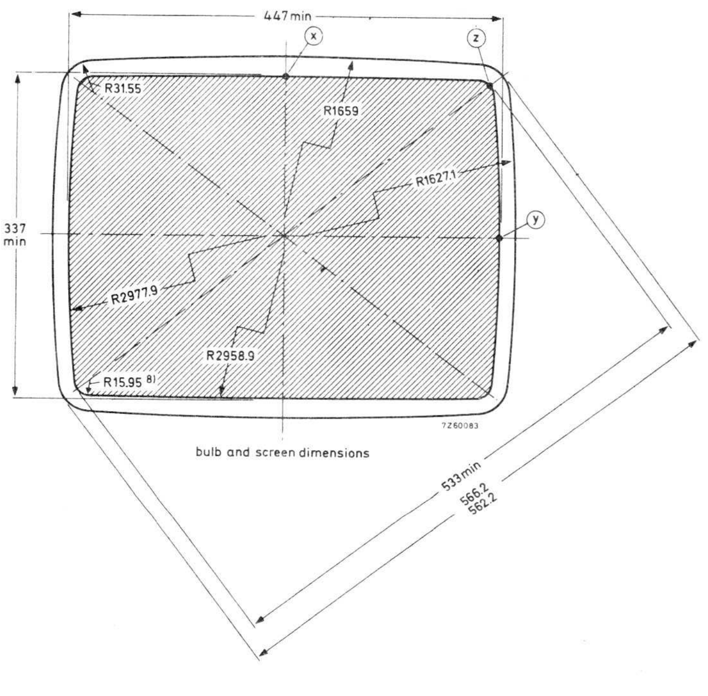


Notes see page 3

MECHANICAL DATA (continued)

Dimensions in mm



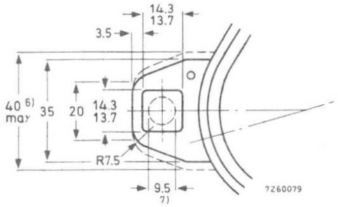


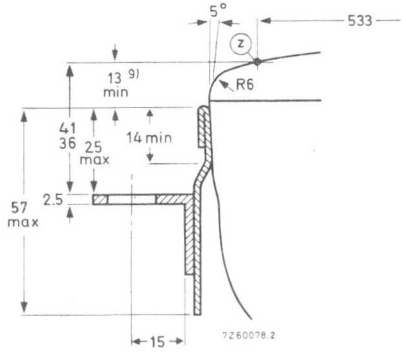
bulb and screen dimensions

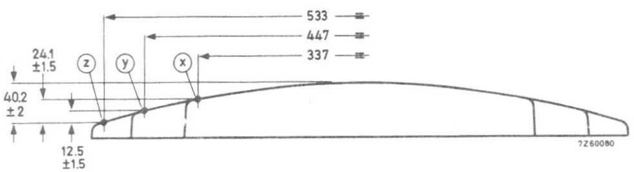
Notes see page 3

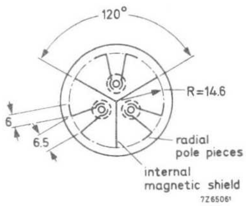
MECHANICAL DATA (continued)

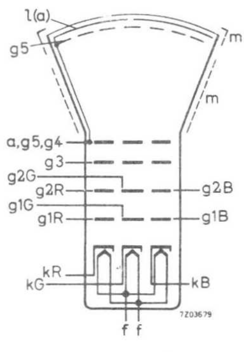
Dimensions in mm

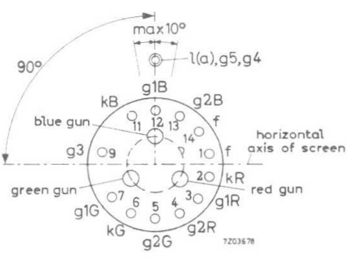












Notes see page 3

TYPICAL OPERATING CONDITIONS

Final accelerator voltage	$V_{a,\,g5,\,g4}$	25	kV	
Grid No. 3 (focusing electrode) voltage	V_{g3}	4.2 to 5	kV	
Grid No. 2 voltage for a spot cut-off voltage $V_{g1} = -105$ V	V_{g2}	212 to 495	V	1)
Grid No. 1 voltage for spot cut-off at $V_{g2} = 300$ V	V_{g1}	−70 to −140	V	2)
Luminance at the centre of the screen		see page 11		

EQUIPMENT DESIGN VALUES (each gun if applicable)

Valid for final accelerator voltages between 20 kV and 27.5 kV.

Grid No. 3 (focusing electrode) voltage	V_{g3}	16.8 to 20% of final accelerator voltage
Grid No. 2 voltage	V_{g2}	See cut-off design chart page 12
Grid No. 1 voltage for visual extinction of focused spot (cut-off voltage) 2)	V_{g1}	See cut-off design chart page 12
Difference in cut-off voltages between guns in any tube	ΔV_{g1}	lowest value is min. 65% of highest value
Grid No. 3 (focusing electrode) current	I_{g3}	−5 to +5 μA
Grid No. 2 current	I_{g2}	−5 to +5 μA
Grid No. 1 current at $V_{g1} = -150$ V	I_{g1}	−5 to +5 μA

		3)	4)	6)
To produce white of the following CIE coordinates	x	0.265	0.281	0.313
	y	0.290	0.311	0.329
Percentage of total anode current supplied by each gun (typical)				
red gun		25.8	30.2	41.0
green gun		33.5	34.5	31.3
blue gun		40.7	35.3	27.7
Ratio of anode currents red gun to green gun	min.	0.55	0.65	0.95
	av.	0.75	0.90	1.30
	max.	1.10	1.25	1.80
Ratio of anode currents red gun to blue gun	min.	0.50	0.65	1.15
	av.	0.65	0.85	1.50
	max.	0.85	1.15	2.00

Notes see page 8

EQUIPMENT DESIGN VALUES (continued)

Required centring, measured at the centre of the screen in any direction	max.	11	mm
Correction that must be supplied by purifying magnet to compensate for mis-register in any direction	max.	100	µm
Lateral distance between blue spot and the converged red and green spots	max.	4.5	mm
	(in both directions)		
Radial convergence displacement excluding effects of dynamic convergence (each gun) 5)	max.	7	mm
	(in both directions)		

---

1) This range of V_{g2} has to be used when in circuit design fixed values for cut-off of the three guns are used.

2) This range of V_{g1} has to be used when in circuit design fixed values for V_{g2} of the three guns are used.

3) To produce black/white pictures a bluish white point would be preferable. This white point corresponds virtually with the white point of current black/white picture tubes.

4) This point is a compromise between white point D and the white point x = 0.265 y = 0.290, given in order to enable good rendition of colour and black and white pictures with one white point.

5) Dynamic convergence to be effected by currents of approximately parabolic wave-shape through the convergence coils synchronized with scanning.

6) To produce colour pictures with the best possible quality, this white point should be used when the transmission system is based on this point (Point D).

LIMITING VALUES (Each gun if applicable)
(Design centre rating system unless otherwise specified)

Final accelerator voltage	$V_{a, g5, g4}$	max.	27.5	kV 1) 2) 3)
		min.	20	kV 1) 4)
Average current for three guns	I_a	max.	1000	μA 5)
Grid No. 3 (focusing electrode) voltage	V_{g3}	max.	6000	V
Grid No. 2 voltage, peak, including video signal voltage	V_{g2p}	max.	1000	V
Grid No. 1 voltage,				
negative	$-V_{g1}$	max.	400	V
negative, operating cut-off	$-V_{g1}$	max.	200	V
positive	V_{g1}	max.	0	V
positive peak	V_{g1p}	max.	2	V
Cathode to heater voltage,				
positive	V_{kf}	max.	250	V 6) 7)
positive peak	V_{kfp}	max.	300	V
negative	$-V_{kf}$	max.	135	V
negative peak	$-V_{kfp}$	max.	180	V

1) Absolute max. rating system.

2) The X-ray dose rate remains below the acceptable value of 0.5 mr/h, measured with ionization chamber when the tube is used within its limiting values.

3) For optimal operating conditions the final accelerator voltage has to be stabilized. Therefore its absolute maximum value can be approached in actual operation and for this reason this value is given instead of the design centre value.
During adjustment on the production line this value is likely to be surpassed considerably. It is therefore strongly recommended to first make the necessary adjustments for normal operation without picture tube.

4) Operation of the tube at lower voltages impairs brightness and resolution and may have a detrimental effect on colour purity.

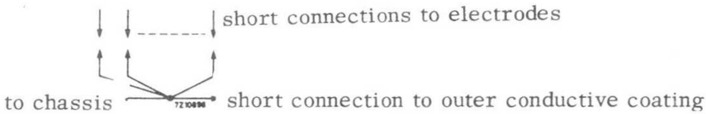
5) 1500 μA permitted provided a current limiting circuit is used.

6) In order to avoid excessive hum the a.c. component of the heater to chassis voltage should be as low as possible and must not exceed 20 V_{rms}.

7) During an equipment warm-up period not exceeding 15 s V_{kf} is allowed to rise to 410 V. Between 15 s and 45 s after switching on a decrease in V_{kf} proportional with time from 410 V to 250 V is permissible.

REMARKS

With the high voltage used with this tube (max. 27.5 kV) internal flash-overs may occur. These may destroy the cathode(s) of the tube. Therefore it is necessary to provide protective circuits, using spark gaps.
The spark gaps must be connected as follows:



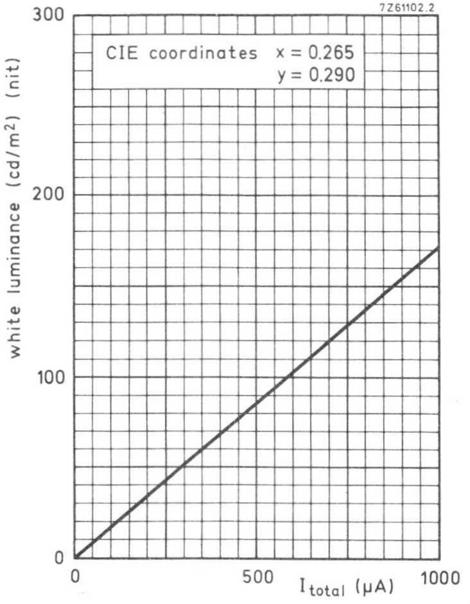
No other connections between the outer conductive coating and the chassis are permissible.
Additional information is given in Application Information 258, available on request.

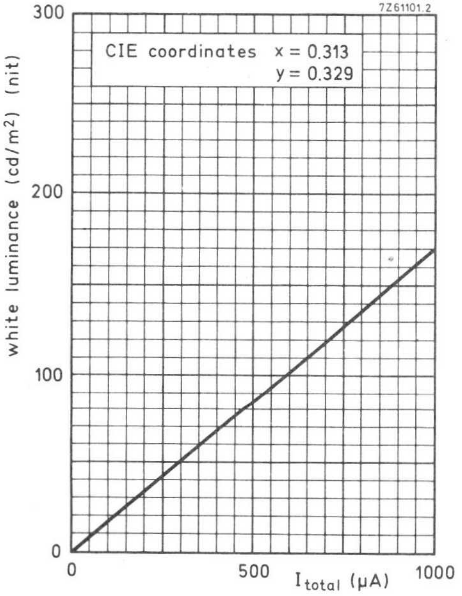
During shipment and handling the tube should not be subjected to accelerations greater than 35 g in any direction.

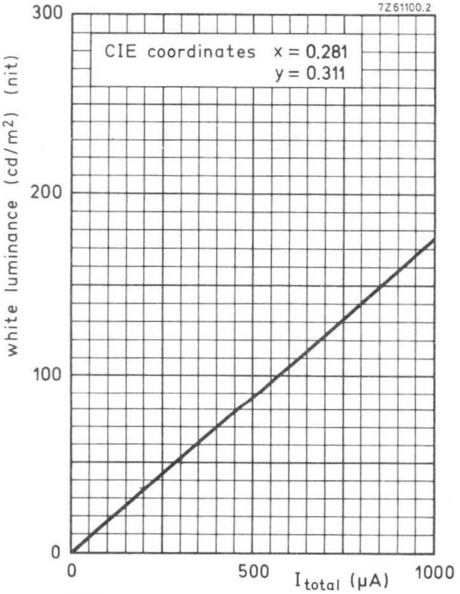
REFERENCE LINE GAUGE (Gauge F)

Gauge F. See chapter "Reference line gauges" in front of this book.

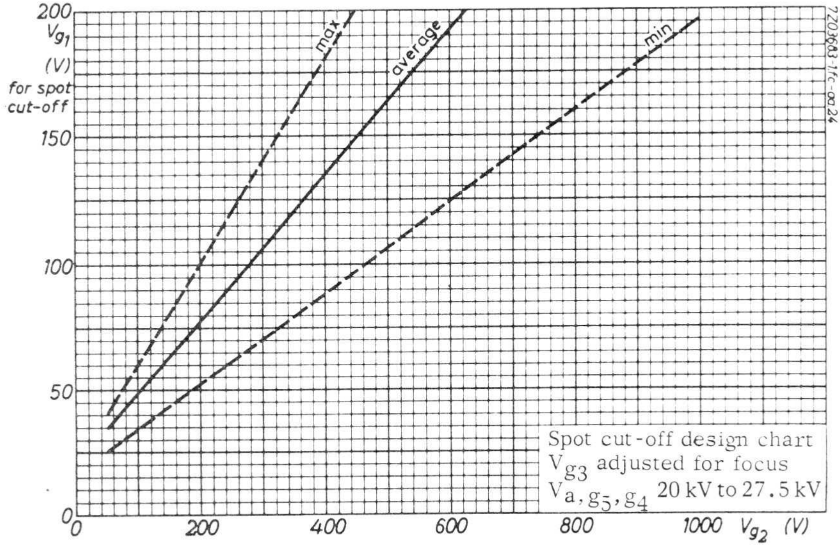
Luminance at the centre of the screen as a function of I_{total}



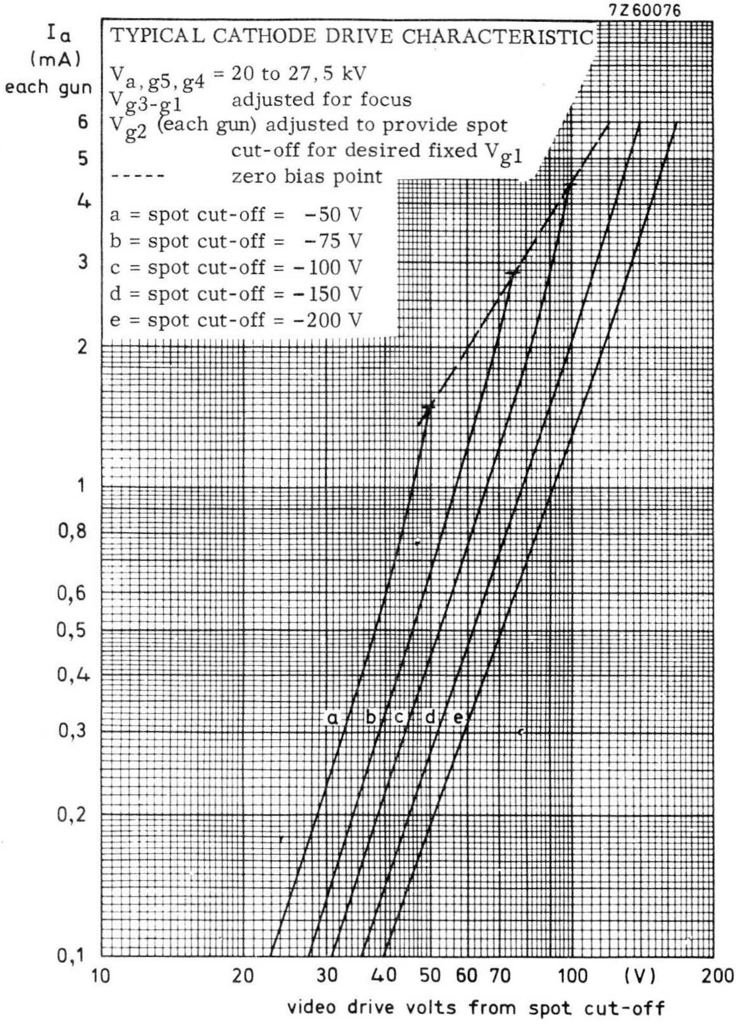


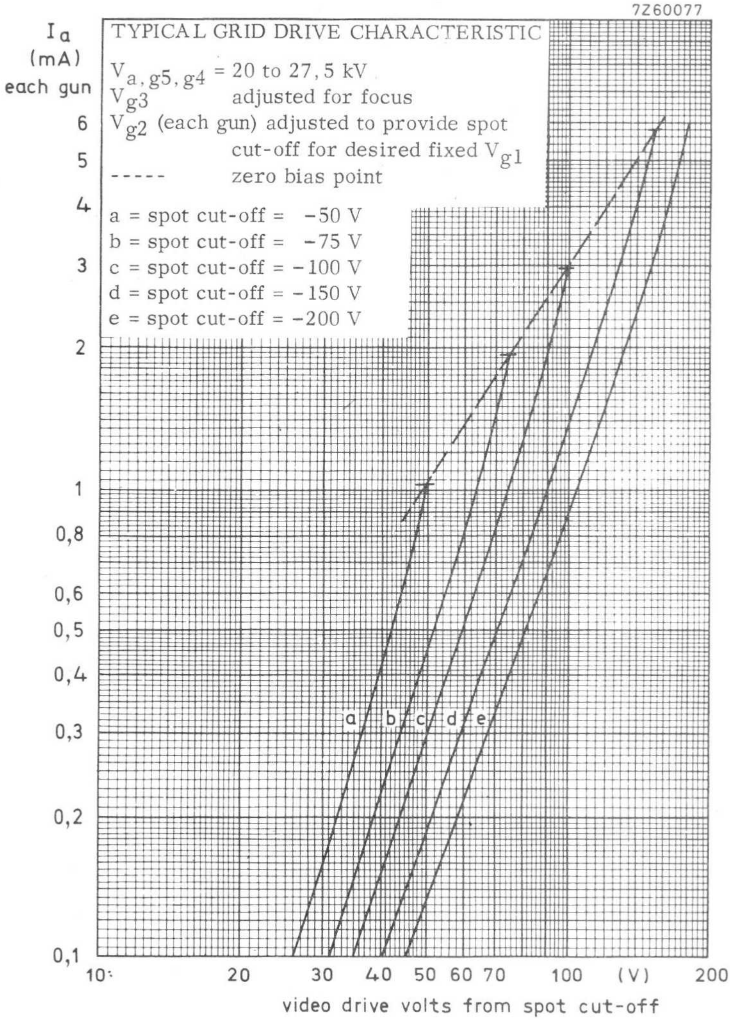


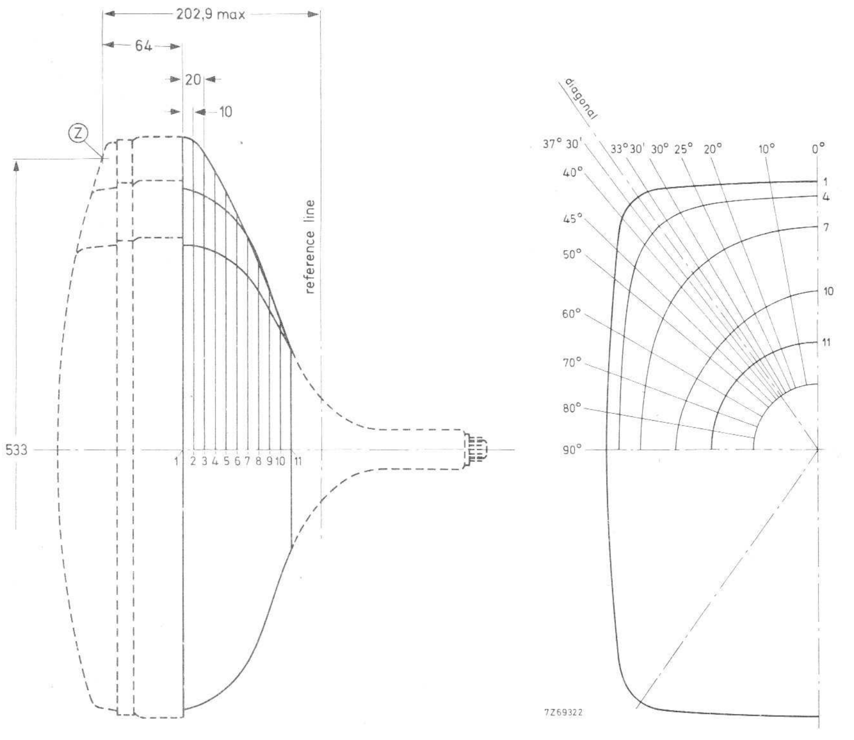
Scanned area 447 mm x 337 mm



200
V_{g1}
(V)
for spot
cut-off
150
100
50
0
0
200
400
600
800
1000
V_{g2} (V)
max
average
min
7Z03683-1fc-aa24
Spot cut-off design chart
V_{g3} adjusted for focus
$V_{a,g5,g4}$ 20 kV to 27.5 kV


7Z60076
TYPICAL CATHODE DRIVE CHARACTERISTIC
$V_{a,g5,g4}$ = 20 to 27,5 kV
V_{g3-g1} adjusted for focus
V_{g2} (each gun) adjusted to provide spot cut-off for desired fixed V_{g1}
----- zero bias point
a = spot cut-off = −50 V
b = spot cut-off = −75 V
c = spot cut-off = −100 V
d = spot cut-off = −150 V
e = spot cut-off = −200 V
I_a (mA) each gun
6
5
4
3
2
1
0,8
0,6
0,5
0,4
0,3
0,2
0,1
a
b
c
d
e
10
20
30
40
50
60
70
100
(V)
200
video drive volts from spot cut-off


7Z60077
TYPICAL GRID DRIVE CHARACTERISTIC
$V_{a,g5,g4}$ = 20 to 27,5 kV
V_{g3} adjusted for focus
V_{g2} (each gun) adjusted to provide spot cut-off for desired fixed V_{g1}
----- zero bias point
a = spot cut-off = −50 V
b = spot cut-off = −75 V
c = spot cut-off = −100 V
d = spot cut-off = −150 V
e = spot cut-off = −200 V
I_a (mA) each gun
6
5
4
3
2
1
0,8
0,6
0,5
0,4
0,3
0,2
0,1
a
b
c
d
e
10
20
30
40
50
60
70
100
(V)
200
video drive volts from spot cut-off



A56-140X

Section	Nom. distance from section 1	Distance from centre (max. values)														
		0°	10°	20°	25°	30°	33°30'	diag.	37°30'	40°	45°	50°	60°	70°	80°	90°
1	0	248.0	251.2	261.3	269.3	279.5	286.8	288.0	286.8	281.7	262,3	245.9	222.0	207.0	198.7	196.0
2	10	244.4	247.6	257.5	265.4	275.3	282.3	283.3	282.0	276.8	257.8	241.6	218.0	203.2	195.0	192.4
3	20	240.5	243.6	252.9	259.6	267.0	271.2	271.3	269.7	265.3	250.6	236.6	214.2	199.6	191.4	188.8
4	30	235.0	237.8	245.5	250.2	254.4	255.7	255.0	253.3	249.9	239.5	228.3	208.6	194.8	186.9	184.3
5	40	227.7	229.9	235.2	237.8	239.1	238.7	237.6	236.0	233.3	225.8	217.3	201.0	188.8	181.6	179.2
6	50	218.2	219.6	222.2	222.9	222.3	220.8	219.6	218.1	215.8	210.1	203.6	191.0	180.9	174.7	172.6
7	60	206.4	206.8	206.8	205.9	204.0	202.2	200.9	199.5	197.5	193.1	188.4	179.2	171.6	166.8	165.2
8	70	191.6	190.9	188.5	186.6	184.1	182.2	181.0	179.8	178.2	175.0	171.7	165.7	160.8	157.7	156.6
9	80	172.5	170.9	166.8	164.4	161.9	160.1	159.1	158.2	157.0	154.8	152.9	149.7	145.6	146.5	146.2
10	90	147.0	144.8	140.5	138.3	136.3	135.0	134.3	133.6	132.9	131.7	130.8	130.0	130.3	131.3	132.0
11	1021	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99,4	99.4	99.4	99,4	99,4	99,4	99.4

110° COLOUR TELEVISION PICTURE TUBE

Three-gun temperature compensated shadow-mask rectangular colour television tube with electrostatic focus, magnetic deflection and convergence, metal-backed three-colour phosphor dot screen and internal magnetic shield. A high white luminance is obtained at near unity current ratio. Being temperature compensated, the shadow-mask makes for optimum field purity and good uniformity during warm-up. The design is such that minimum occurrence of the moiré effect is ensured. The tube has a reinforced envelope and therefore no separate safety screen is necessary. The tube features a quick heating cathode; typically, a legible picture will appear within approx. 5 s.

QUICK REFERENCE DATA		
TEMPERATURE COMPENSATED SHADOW MASK		
DESIGNED FOR MINIMUM MOIRÉ EFFECT		
HIGH WHITE LUMINANCE AT UNITY CURRENT RATIO		
Face diagonal	56	cm
Deflection angle	110	deg
Neck diameter	36,5	mm
Envelope	reinforced suitable for push through	
Magnetic shield	internal	
Focusing	bi-potential	
Deflection	magnetic	
Convergence	magnetic	
Heating	6,3 V, 730 mA	
Light transmission of face glass	54,5	%
Quick heating cathode	with a typical tube a legible picture will appear within approx. 5 s	

SCREEN

Metal-backed phosphor dots

Phosphor type	Red : Europium activated rare earth Green: Sulphide type Blue : Sulphide type	
Dot arrangement	Triangular	
Spacing between centres of adjacent dot trios	0,81	mm
Light transmission of face glass	54,5	%

HEATING : indirect by a.c. or d.c. ; parallel supply

Heater voltage	V_f	6,3	V
Heater current	I_f	730	mA [1]

For maximum cathode life it is recommended that the heater supply be regulated at 6,3 V.

For heating time as a function of source impedance see graph page 12 below.

CAPACITANCES

Final accelerator to external conductive coating	$C_{a,g3,g4/m}$	max.	1800	pF
		min.	1300	pF
Final accelerator to rimband	$C_{a,g3,g4/m'}$		400	pF
Grid no.1 of any gun to all other electrodes	C_{g1}		7	pF
Cathodes of all guns (connected in parallel) to all other electrodes	C_k		15	pF
Cathode of any gun to all other electrodes	C_{kR}, C_{kG}, C_{kB}		5	pF
Grid no.3 (focusing electrode) to all other electrodes	C_{g3}		7	pF

FOCUSING electrostatic (bi-potential)

DEFLECTION magnetic

Diagonal deflection angle	110	deg
Horizontal deflection angle	97	deg
Vertical deflection angle	77	deg

CONVERGENCE magnetic

---

[1]) If the heater is supplied from a mains transformer designed for tube type A56-140X, the source impedance should not exceed 0,6 Ω to ensure that the heater voltage of the A56-410X is not exceeded.

If the **heater** is supplied from a line time base designed for tube type A56-140X, the series impedance, if any, should match the lower heater current of the quick-heating tube.

MECHANICAL DATA

Overall length		387,3 to	400,3	mm
Neck diameter			36,5	mm
Diagonal	of bulb	max.	566,2	mm
Horizontal axis	of bulb	max.	486,3	mm
Vertical axis	of bulb	max.	381,8	mm
Useful screen				
diagonal		min.	533	mm
horizontal axis		min.	447	mm
vertical axis		min.	337	mm

Mounting position : any

Net weight : approx. 14,5 kg

Base : 12 pin base IEC 67-I-47a, type 2

Anode contact : Small cavity contact J1-21, IEC 67-III-2

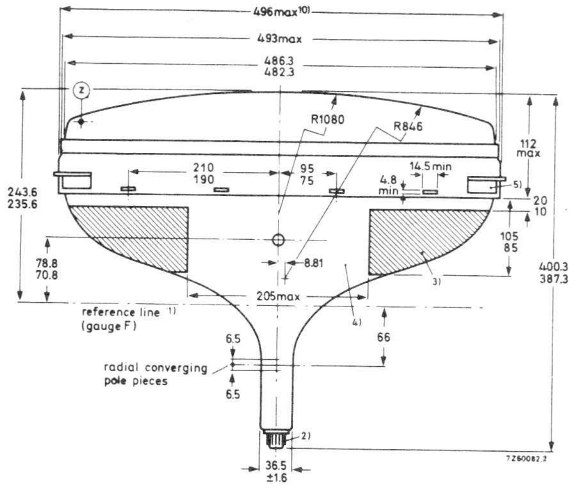
Magnetic shielding, degaussing: The tube is provided with an internal magnetic shield. The internal magnetic shield and the shadow-mask with its suspension system may be provided with an automatic degaussing system, consisting of two coils covering left and right cone parts. For proper degaussing an initial m.m.f. of 450 ampere-turns is required in each of the coils. This m.m.f. has to be gradually decreased by appropriate circuitry. After decreasing to 10 A.t. or less, sudden switch off is permissible. In the steady state, no significant m.m.f. should remain in the coils (< 0,5 A.t.).
To ease the mounting of the coils, the rimband is provided with rectangular holes.

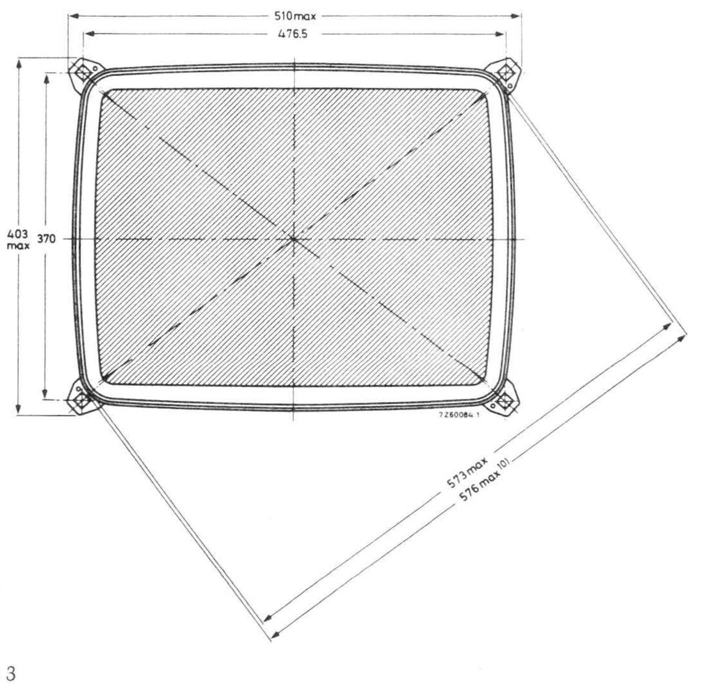
NOTES TO OUTLINE DRAWING (see pages 4, 5, and 6)

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 socket for this base should not be rigidly mounted; it should have flexible leads and be allowed to move freely. Bottom circumference of base will fall within a circle concentric with the tube axis and having a diameter of 55 mm.
3) Configuration of outer conductive coating may be different, but will contain the contact area as shown in the drawing.
4) To clean this area, wipe only with a soft lintless cloth.
5) The displacement of any lug with respect to the plane through the three other lugs is max. 2 mm.
6) Minimum space to be reserved for mounting lug.
7) The position of the mounting screw in the cabinet must be within a circle of 9,5 mm diameter drawn around the true geometrical positions, i.e. the corners of a rectangle of 476,5 mm x 370 mm.
8) Coördinates for radius R = 15,95 mm: x = 203,95 mm, y = 145,52 mm.
9) Distance from point z to any hardware.
10) Maximum dimensions in plane of lugs.

MECHANICAL DATA (continued)

Dimensions in mm

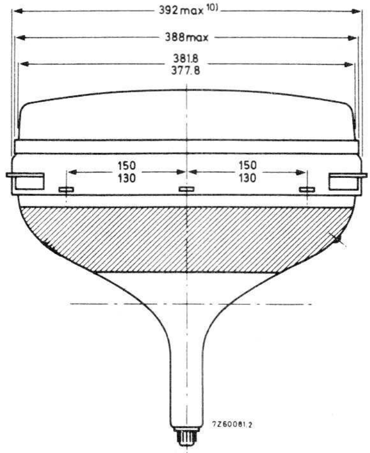


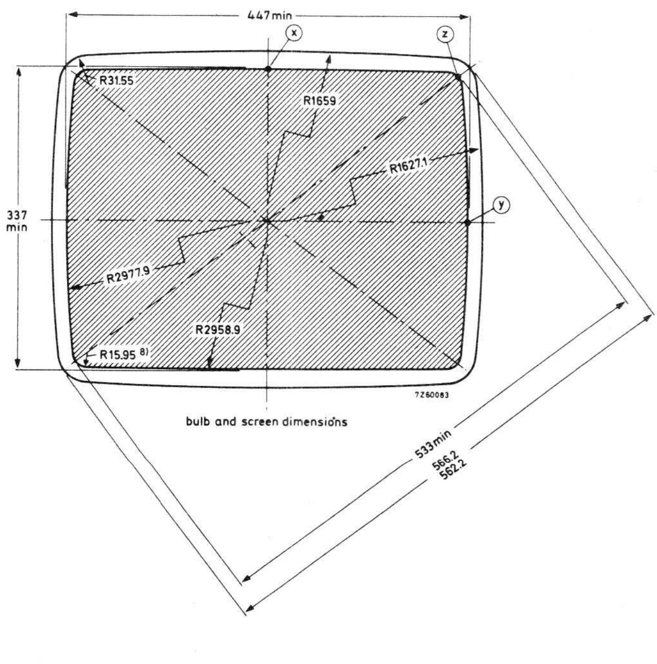


Notes see page 3

MECHANICAL DATA

Dimensions in mm



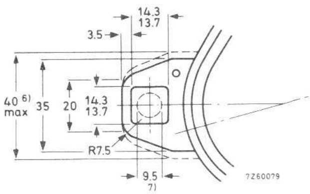


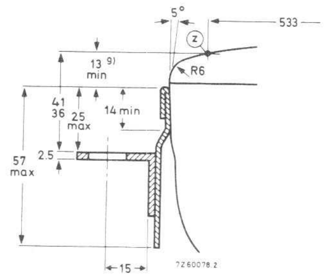
bulb and screen dimensions

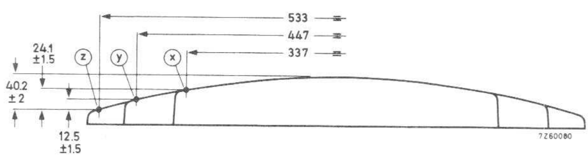
Notes see page 3

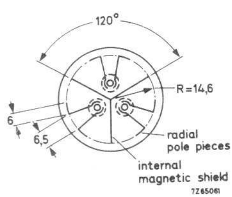
MECHANICAL DATA

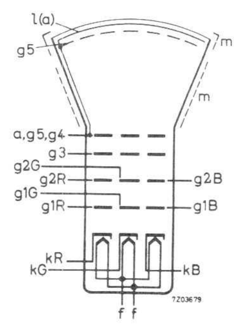
Dimensions in mm

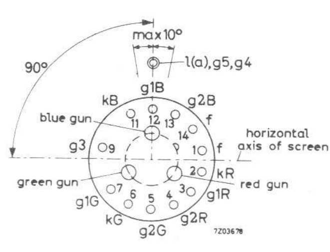












Notes see page 3

TYPICAL OPERATING CONDITIONS

Final accelerator voltage	$V_{a,g5,g4}$			25	kV
Grid no.3(focusing electrode voltage)	V_{g3}	4,2	to	5	kV
Grid no.2 voltage for a spot cut-off voltage V_{g1} = -105 V	V_{g2}	212	to	495	V [1]
Grid no.1 voltage for spot cut-off at V_{g2} = 300 V	V_{g1}	-70	to	-140	V [2]
Luminance at the centre of the screen	L	See page 11			

EQUIPMENT DESIGN VALUES (each gun if applicable)
Valid for final accelerator voltages between 20 kV and 27,5 kV.

Grid no.3 (focusing electrode) voltage	V_{g3}	16,8 to 20 % of final accelerator voltage			
Grid no.2 voltage	V_{g2}	See cut-off design chart page 12			
Grid no.1 voltage for visual extinction of focused spot (cut-off voltage)	V_{g1}	See cut-off design chart page 12			
Difference in cut-off voltages between guns in any tube	ΔV_{g1}	lowest value is min. 65 % of highest value			
Grid no.3 (focusing electrode) current	I_{g3}	-5	to	+5	μA
Grid no.2 current	I_{g2}	-5	to	+5	μA
Grid no.1 current at V_{g1} = -150 V	I_{g1}	-5	to	+5	μA

			[3]	[4]	[6]	
To produce white of the following CIE co-ordinates		x	0,265	0,281	0,313	
		y	0,290	0,311	0,329	
Percentage of total anode current supplied by each gun (typical)	red gun		25,8	30,2	41,0	%
	green gun		33,5	34,5	31,3	%
	blue gun		40,7	35,3	27,7	%
Ratio of anode current red gun to green gun		min.	0,55	0,65	0,95	
		av.	0,75	0,90	1,30	
		max.	1,10	1,25	1,80	
Ratio of anode currents red gun to blue gun		min.	0,50	0,65	1,15	
		av.	0,65	0,85	1,50	
		max.	0,85	1,15	2,00	

Notes see page 8

EQUIPMENT DESIGN VALUES (continued)

Required centring, measured at the centre of the screen in any direction	max.	11	mm
Correction that must be supplied by purifying magnet to compensate for mis-register in any direction	max.	100	μm
Lateral distance between blue spot and the converged red and green spots	max.	4,5	mm
	(in both directions)		
Radial convergence displacement excluding effects of dynamic convergence (each gun) [5]	max.	7	mm
	(in both directions)		

---

1) This range of V_{g2} has to be used when in circuit design fixed values for cut-off of the three guns are used.

2) This range of V_{g1} has to be used when in circuit design fixed values for V_{g2} of the three guns are used.

3) To produce black/white pictures a bluish white point would be preferable. This white point corresponds virtually with the white point of current black/white picture tubes.

4) This point is a compromise between white point D and the white point x = 0,265 , y = 0,290 given in order to enable good rendition of colour and black and white pictures with one white point.

5) Dynamic convergence to be effected by currents of approximately parabolic waveshape through the convergence coils synchronized with scanning.

6) To produce colour pictures with the best possible quality, this white point should be used when the transmission system is based on this point. (Point D).

LIMITING VALUES (Each gun if applicable)
(Design centre rating system unless otherwise specified)

Final accelerator voltage	$V_{a,g5,g4}$	max.	27,5	kV [1][2][3]
		min.	20	kV [1][4]
Average current for three guns	I_a	max.	1000	μA [5]
Grid no.3 (focusing electrode) voltage	V_{g3}	max.	6000	V
Grid no.2 voltage, peak, including video signal voltage	V_{g2_p}	max.	1000	V
Grid no.1 voltage,				
negative	$-V_{g1}$	max.	400	V
negative, operating cut-off	$-V_{g1}$	max.	200	V
positive	V_{g1}	max.	0	V
positive peak	V_{g1_p}	max.	2	V
Cathode to heater voltage,				
positive	V_{kf}	max.	250	V [6]
positive peak	V_{kf_p}	max.	300	V
negative	$-V_{kf}$	max.	135	V
negative peak	$-V_{kf_p}$	max.	180	V

1) Absolute max. rating system.

2) The X-ray dose rate remains below the acceptable value of 0,5 mr/h, measured with ionization chamber when the tube is used within its limiting values.

3) For optimal operating conditions the final accelerator voltage has to be stabilized. Therefore its absolute maximum value can be approached in actual operation and for this reason this value is given instead of the design centre value, During adjustment on the production line this value is likely to be surpassed considerably. It is therefore strongly recommended to first make the necessary adjustments for normal operation without picture tube.

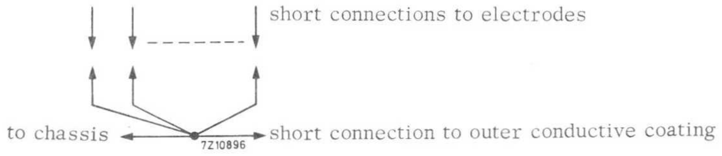
4) Operation of the tube at lower voltages impairs luminance and resolution and may have a detrimental effect on colour purity.

5) 1500 μA permitted provided a current limiting circuit is used.

6) During an equipment warm-up period not exceeding 15 s V_{kf} is allowed to rise to 385V. Between 15 s and 45 s after switching on a decrease in V_{kf} propotional with time from 385 V to 250 V is permissible.

REMARKS

With the high voltage used with this tube (max. 27,5 kV) internal flash-overs may occur. These may destroy the cathode(s) of the tube. Therefore it is necessary to provide protective circuits, using spark gaps.
The spark gaps must be connected as follows:



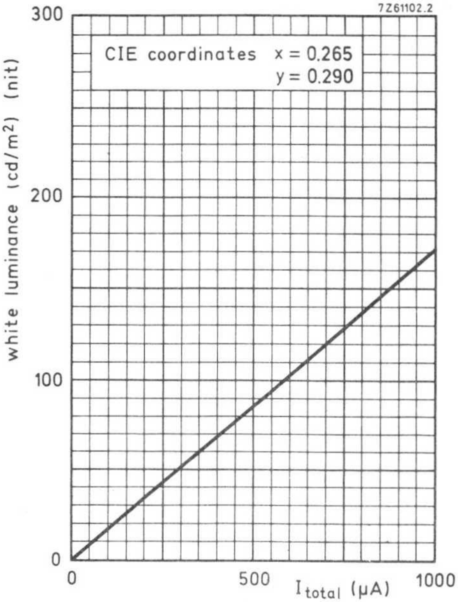
No other connections between the outer conductive coating and the chassis are permissible. Additional information is given in Application Information 258, available on request.

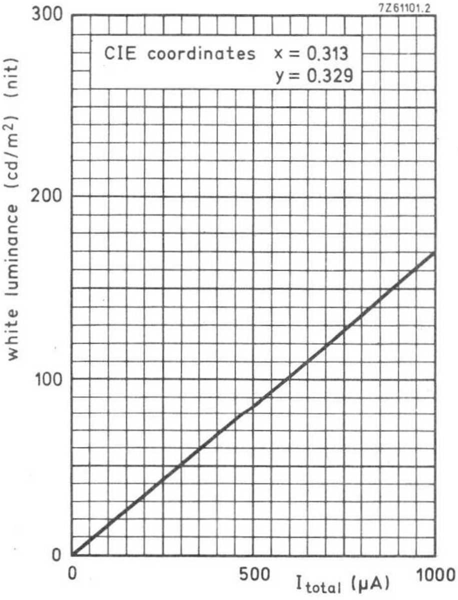
During shipment and handling the tube should not be subjected to accelerations greater than 35 g in any direction.

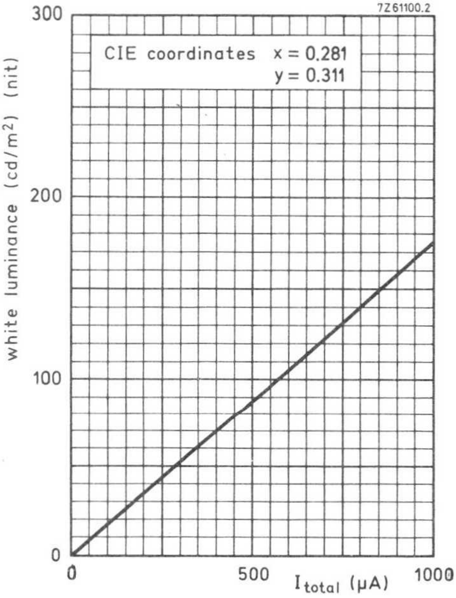
REFERENCE LINE GAUGE

Gauge F. See chapter "Reference line gauges" in front of this book.

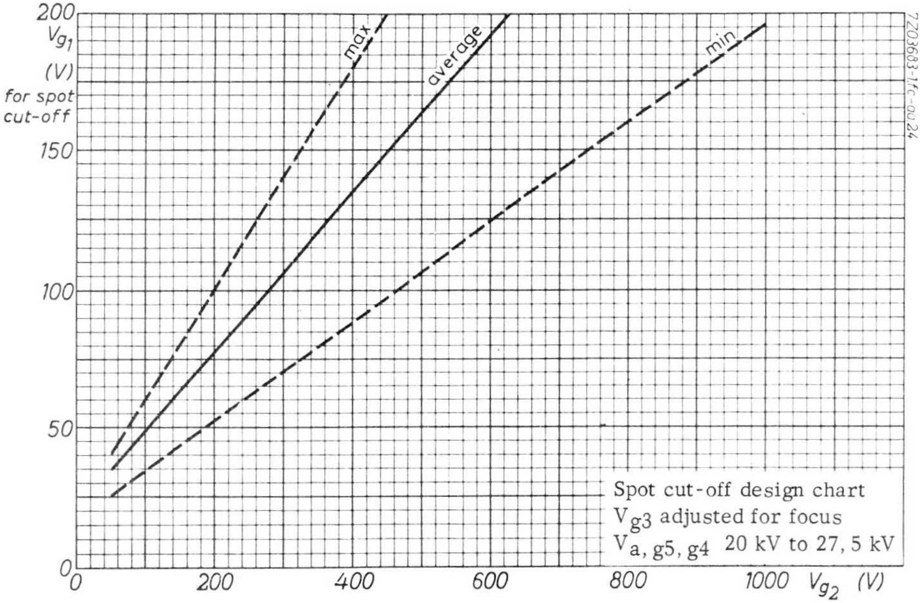
Luminance at the centre of the screen as a function of I_{total}.

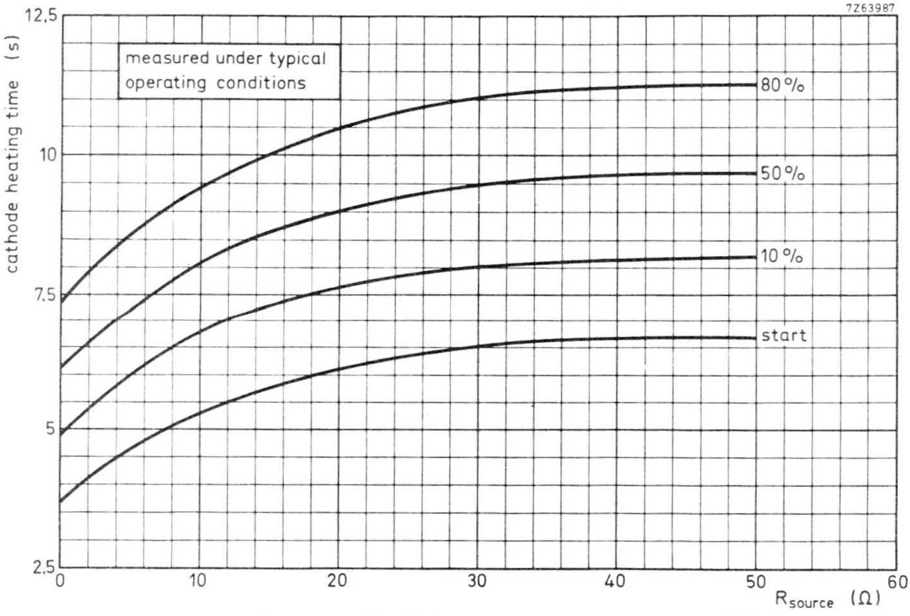




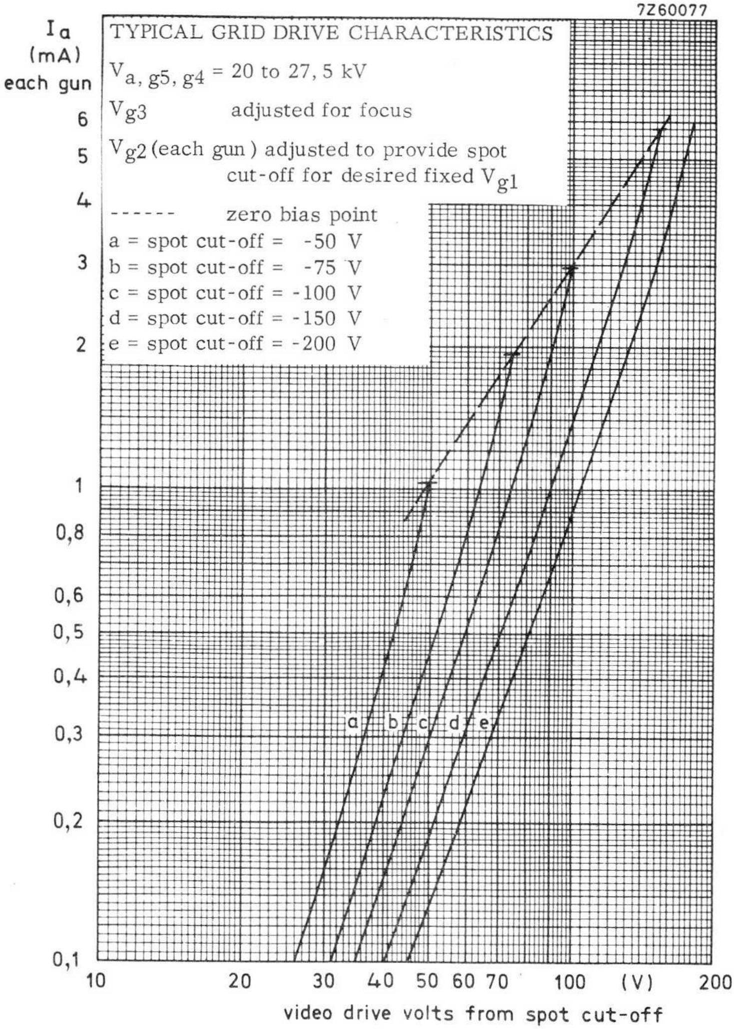


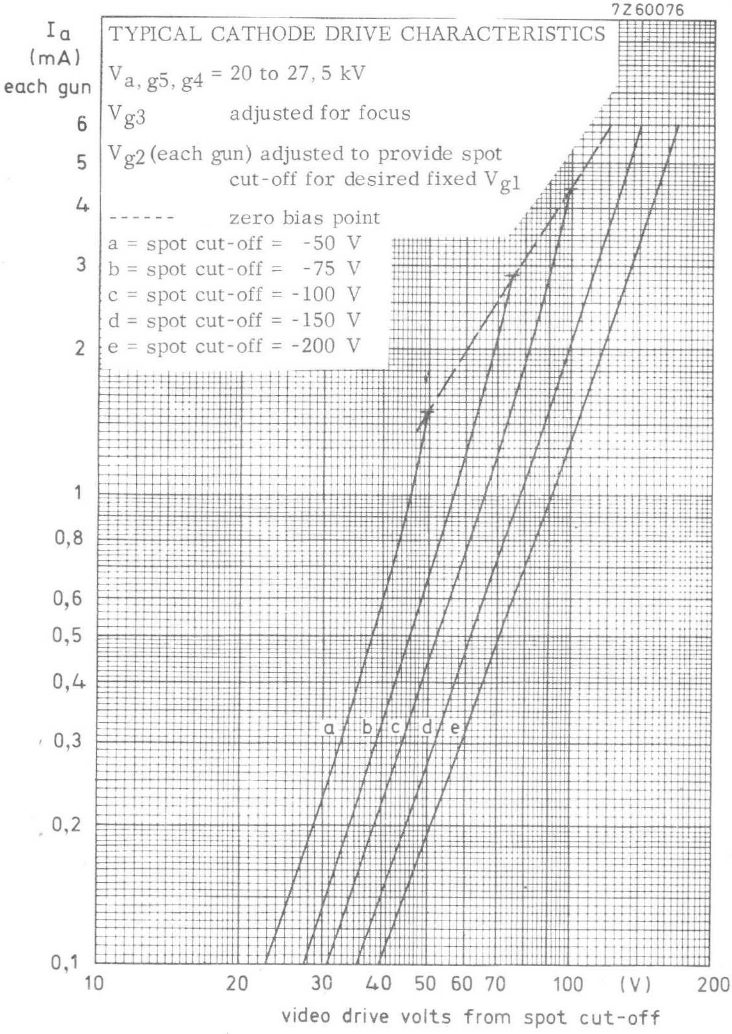
Scanned area 447 mm x 337 mm

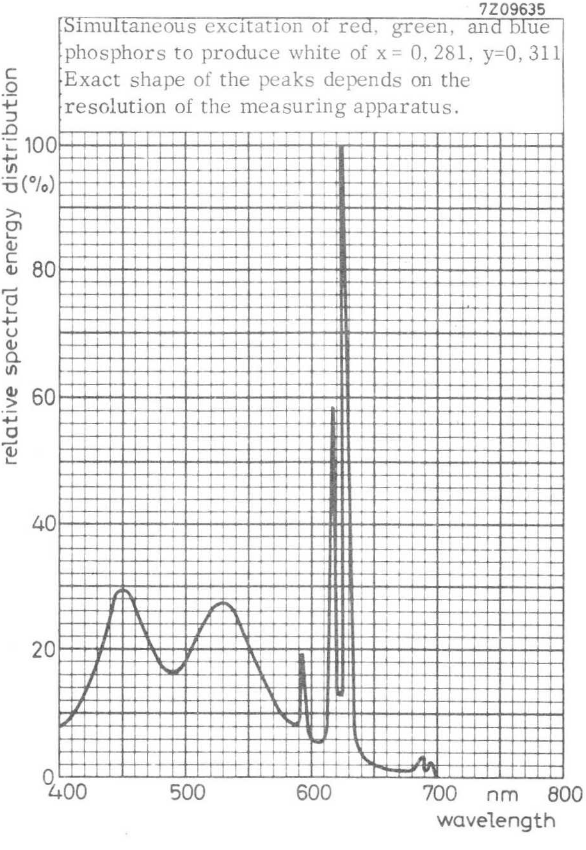




Cathode heating time to attain x% of the cathode current at equilibrium condition


7Z60077
TYPICAL GRID DRIVE CHARACTERISTICS
$V_{a, g5, g4}$ = 20 to 27,5 kV
V_{g3} adjusted for focus
V_{g2} (each gun) adjusted to provide spot cut-off for desired fixed V_{g1}
------ zero bias point
a = spot cut-off = -50 V
b = spot cut-off = -75 V
c = spot cut-off = -100 V
d = spot cut-off = -150 V
e = spot cut-off = -200 V
I_a (mA) each gun
6
5
4
3
2
1
0,8
0,6
0,5
0,4
0,3
0,2
0,1
10
20
30
40
50
60
70
100
(V)
200
video drive volts from spot cut-off
a
b
c
d
e


7Z60076
TYPICAL CATHODE DRIVE CHARACTERISTICS
$V_{a,\,g5,\,g4}$ = 20 to 27,5 kV
V_{g3} adjusted for focus
V_{g2} (each gun) adjusted to provide spot cut-off for desired fixed V_{g1}
------ zero bias point
a = spot cut-off = -50 V
b = spot cut-off = -75 V
c = spot cut-off = -100 V
d = spot cut-off = -150 V
e = spot cut-off = -200 V
I_a (mA) each gun
6
5
4
3
2
1
0,8
0,6
0,5
0,4
0,3
0,2
0,1
a
b
c
d
e
10
20
30
40
50
60
70
100
(V)
200
video drive volts from spot cut-off



Colour co-ordinates

	x	y
red	0, 630	0, 340
green	0, 315	0, 600
blue	0, 150	0, 065

90° COLOUR TELEVISION PICTURE TUBE

Three-gun temperature-compensated shadow-mask rectangular colour television tube with electrostatic focus, magnetic deflection and convergence, metal-backed three-colour phosphor dot screen. A high white luminance is obtained at near unity current ratio. Temperature compensating the shadow-mask has led to optimum field purity and good uniformity during warm-up. Minimum occurrence of the moiré effect is ensured by optimizing the mask for the reproduction of 625-line pictures. The tube has a reinforced envelope and therefore no separate safety screen is necessary.

QUICK REFERENCE DATA

TEMPERATURE-COMPENSATED SHADOW-MASK

SHADOW-MASK OPTIMIZED FOR 625-LINE SYSTEM

HIGH WHITE LUMINANCE AT UNITY CURRENT RATIO

Face diagonal	63 cm
Deflection angle	90 °
Neck length	164.2 mm
Envelope	reinforced suitable for push through
Focusing	electrostatic
Deflection	magnetic
Convergence	magnetic
Heating	6.3 V, 900 mA
Light transmission of face glass	52.5 %

SCREEN

Metal-backed tricolour phosphor dots

Phosphor type	Red: Europium activated rare earth Green and blue: sulphide type
Dot arrangement	Triangular
Spacing between centres of adjacent dot trios	0.81 mm
Light transmission at centre of face glass	52.5 %

HEATING

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

Heater voltage	V_f	6.3	V
Heater current	I_f	900	mA

For maximum cathode life it is recommended that the heater supply be regulated at 6.3 V. If the tube is connected in a series heater chain the surge heater voltage must not exceed 9.5 V_{rms} when the supply is switched on.

CAPACITANCES

Final accelerator to external conductive coating	$C_{ag_5g_4/m}$	max. min.	2500 2000	pF pF
Final accelerator to metal rimband	$C_{ag_5g_4/m'}$		500	pF
Grid No.1 of any gun to all other electrodes	C_{g_1}		7	pF
Cathodes of all guns (connected in parallel) to all other electrodes	C_k		15	pF
Cathode of any gun to all other electrodes	C_{kR} C_{kG} C_{kB}		5 5 5	pF pF pF
Grid No.3 (focusing electrode) to all other electrodes	C_{g_3}		7	pF

FOCUSING electrostatic

DEFLECTION magnetic

Diagonal deflection angle	90°
Horizontal deflection angle	79°
Vertical deflection angle	62°

CONVERGENCE magnetic

MECHANICAL DATA

Overall length			521 ± 9.5	mm
Neck length			164.2 ± 4.5	mm
Diagonal	of bulb	max.	626	mm
Horizontal axis	of bulb	max.	548.1	mm
Vertical axis	of bulb	max.	440.5	mm
Useful screen diagonal		min.	584	mm
horizontal axis		min.	504	mm
vertical axis		min.	396	mm

Mounting position: any

Net weight: approx. 188N (18.8 kg)

Base: 12 pin base JEDEC B12-246

Anode contact : Small cavity contact J1-21, IEC67-III-2.

Magnetic shielding

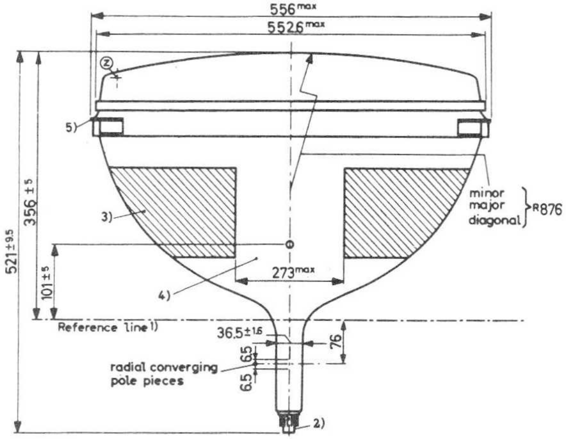
Magnetic shielding should be provided by means of a metal shield extending 28 cm over the cone of the tube measured from the centre of the face plate. The metal shell is preferably constructed of min. 0.5 mm cold rolled steel properly annealed. The air gap between the shield and the metal rimband should be as small as possible and not exceed 10 mm. The magnetic shield should be connected to the outer conductive coating.

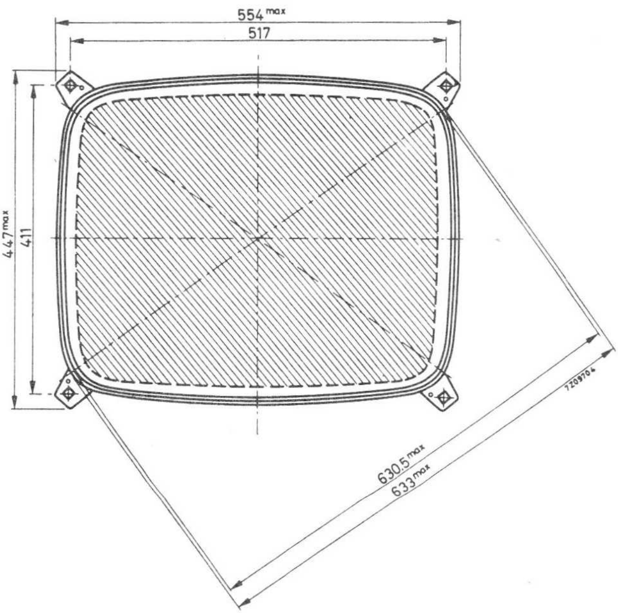
NOTES TO OUTLINE DRAWING (See pages 4 and 5)

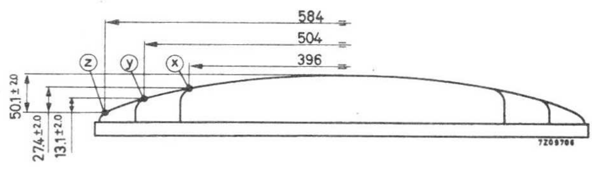
1. Reference line, determined by the plane of the upper edge of the flange of the reference line gauge E, when the gauge is resting on the cone.
2. The socket for this base should not be rigidly mounted; it should have flexible leads and be allowed to move freely. Bottom circumference of base will fall within a circle concentric with bulb axis and having a diameter of 55 mm.
3. Configuration of outer conductive coating may be different, but will contain the contact area as shown in the drawing.
4. To clean this area, whipe only with a soft dry lintless cloth.
5. The displacement of any lug with respect to the plane through the three other lugs is max. 2 mm.
6. Minimum space to be reserved for mounting lug.
7. The position of the mounting screw in the cabinet must be within a circle of 9.5 mm diameter drawn around the true geometrical positions, i.e. the corners of a rectangle of 517 mm x 411 mm.
8. Co-ordinates for radius R = 30 mm : x = 213.66 mm, y = 151.63 mm.

MECHANICAL DATA

Dimensions in mm



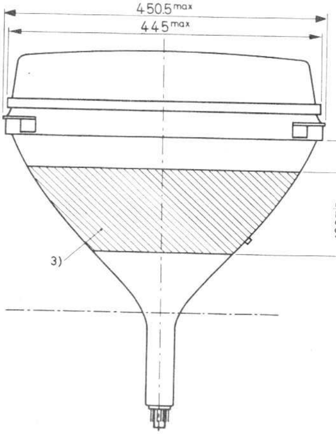


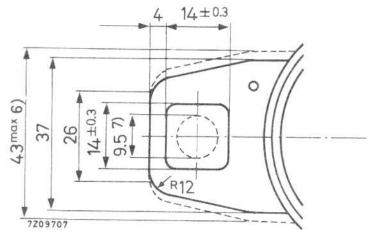


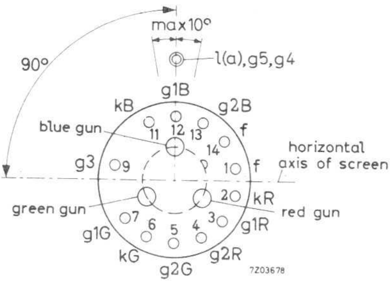
Notes see page 3

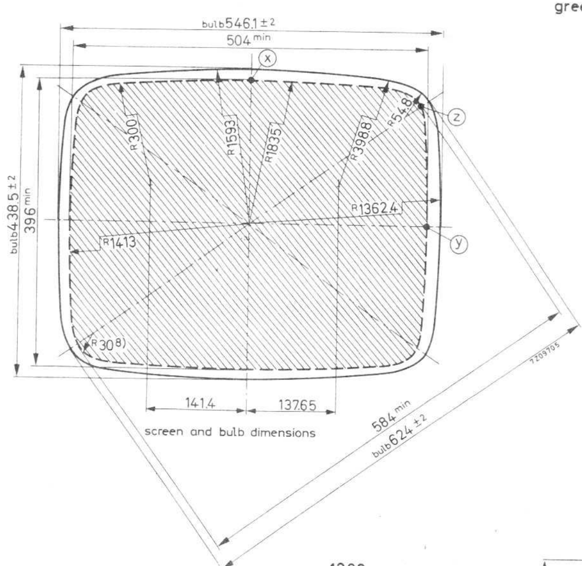
MECHANICAL DATA (continued)

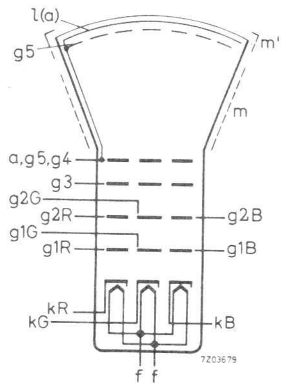
Dimensions in mm

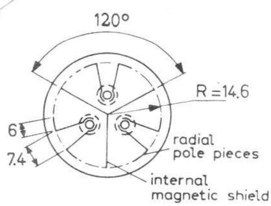


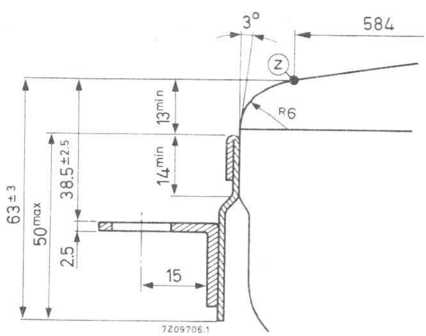








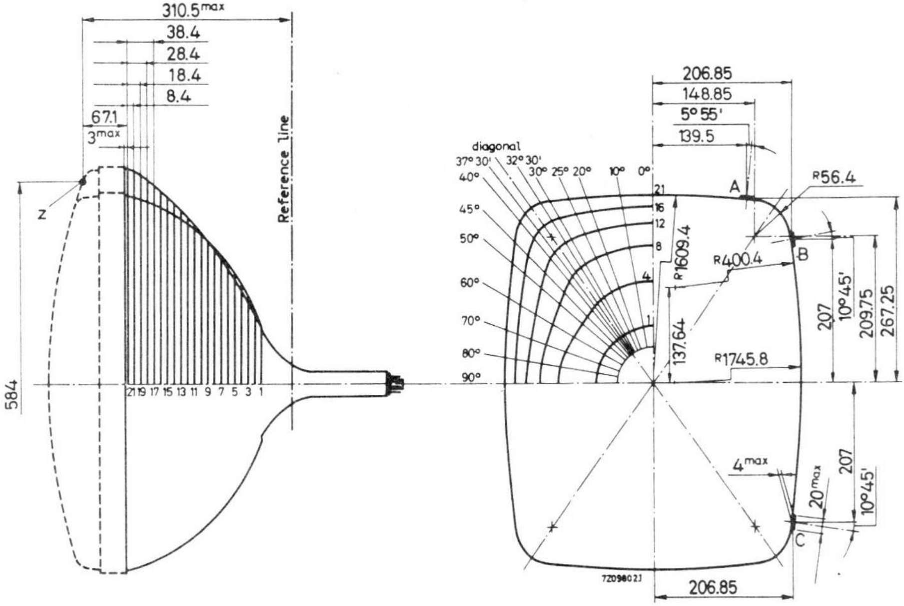




Notes see page 3

MAXIMUM CONE CONTOUR DRAWING

Dimensions in mm



Section	Nom. distance from point Z	Distance from centre (max. values)													
		Long axis 0°	10°	20°	25°	30°	32°30'	35°21'38" Diag.	37°30'	40°	45°	50°	60°	70°	80°	Short axis 90°
1	265.5	82.5	82.6	83.0	83.0	83.0	83.0	83.0	83.0	83.0	83.3	83.5	83.5	83.0	82.8	82.8
2	255.5	107.6	107.4	106.7	106.1	105.7	105.5	105.2	105.1	105.0	104.7	104.5	106.3	111.0	115.0	115.5
3	245.5	129.3	129.5	128.0	127.3	126.6	125.8	124.8	124.0	123.2	122.2	121.4	122.5	126.9	129.9	130.2
4	235.5	147.4	147.2	146.0	145.0	144.8	144.2	142.6	141.2	139.6	137.2	135.4	134.7	138.0	140.0	140.0
5	225.5	162.8	162.8	161.6	160.7	160.3	159.4	157.7	156.2	154.3	150.4	147.7	145.0	146.4	148.2	148.0
6	215.5	176.3	176.3	175.4	175.0	174.3	173.5	171.6	169.9	167.9	163.1	159.0	154.4	154.0	155.4	155.3
7	205.5	188.2	188.2	187.8	187.6	187.2	186.6	185.2	183.4	181.1	175.4	169.9	163.5	161.2	161.6	161.5
8	195.5	198.8	199.0	199.2	199.4	199.6	199.1	197.8	196.1	193.4	186.9	180.3	171.9	170.0	167.4	167.2
9	185.5	208.2	208.8	209.6	210.3	211.1	210.9	209.7	207.8	205.3	197.9	190.3	179.7	174.4	172.9	172.7
10	175.5	216.9	217.9	219.2	220.5	222.2	222.2	221.3	218.9	216.1	208.0	199.4	187.2	180.8	178.2	178.1
11	165.5	224.7	225.6	227.7	229.7	231.9	232.2	231.6	229.6	226.4	217.5	208.0	194.4	186.9	183.5	182.9
12	155.5	231.9	232.9	235.9	238.5	241.4	242.1	241.9	240.1	237.0	226.9	216.4	201.5	191.5	188.6	187.7
13	145.5	238.2	239.7	243.6	246.8	250.5	251.7	251.9	250.4	247.0	236.0	224.5	208.3	198.0	193.4	192.3
14	135.5	244.4	246.3	251.0	254.9	259.5	261.3	261.8	260.5	257.1	245.3	232.6	214.8	203.4	198.2	196.8
15	125.5	250.3	252.2	258.0	262.3	268.1	270.5	271.3	270.1	266.3	254.0	240.4	220.9	208.5	202.4	200.3
16	115.5	256.1	258.2	264.9	270.0	276.6	279.6	280.7	279.3	275.4	262.4	247.8	226.8	213.7	206.6	204.1
17	105.5	260.0	263.4	270.8	276.8	284.7	287.9	289.3	287.9	283.9	270.0	254.7	232.3	218.5	210.5	207.7
18	95.5	265.6	268.3	276.4	283.3	292.4	295.7	297.6	296.3	292.1	277.0	261.0	237.6	223.1	214.3	211.2
19	85.5	269.4	272.4	281.5	289.4	299.4	302.9	305.2	304.2	299.6	283.8	267.1	242.6	227.2	217.9	214.7
20	75.5	272.3	275.5	286.0	294.0	304.6	309.4	311.1	310.5	305.9	289.8	272.5	247.0	230.6	221.2	218.0
21	67.1	273.3	276.79	287.64	296.17	307.1	311.8	313.6	312.6	308.79	292.55	275.38	248.85	232.15	222.91	219.95

TYPICAL OPERATING CONDITIONS

Final accelerator voltage	$V_{a, g5, g4}$	25	kV
Grid No. 3 (focusing electrode) voltage	V_{g3}	4.2 to 5	kV
Grid No. 2 voltage for a spot cut-off voltage $V_{g1} = -105$ V	V_{g2}	210 to 495	V [1]
Grid No. 1 voltage for spot cut-off at $V_{g2} = 300$ V	V_{g1}	-70 to -140	V [2]
Luminance at the centre of the screen		See page 21	

EQUIPMENT DESIGN VALUES (each gun if applicable)

Valid for final accelerator voltages between 20 kV and 27.5 kV.

Grid No. 3 (focusing electrode) voltage	V_{g3}	16.8 to 20 % of final accelerator voltage
Grid No. 2 voltage [1]	V_{g2}	See cut-off design chart page 22
Grid No. 1 voltage for visual extinction of focused spot (cut-off voltage) [2]	V_{g1}	See cut-off design chart page 22
Difference in cut-off voltages between guns in any tube	ΔV_{g1}	lowest value is min. 65 % of highest value
Grid No. 3 (focusing electrode) current	I_{g3}	-15 to +15 μA
Grid No. 2 current	I_{g2}	-5 to +5 μA
Grid No. 1 current at $V_{g1} = -150$ V	I_{g1}	-5 to +5 μA

		[3]	[4]	[5]	
To produce white of the following CIE co-ordinates	x	0.310	0.265	0.281	
	y	0.316	0.290	0.311	
Percentage of total anode current supplied by each gun (typical)					
red gun		43.5	27.9	32.2	%
green gun		30.0	34.9	35.6	%
blue gun		26.5	37.2	32.2	%
Ratio anode currents red gun to green gun	min.	1.05	0.60	0.65	
	av.	1.45	0.80	0.90	
	max.	2.00	1.10	1.25	
Ratio of anode currents red gun to blue gun	min.	1.20	0.55	0.75	
	av.	1.65	0.75	1.00	
	max.	2.25	1.05	1.35	

Notes see page 8.

EQUIPMENT DESIGN VALUES (continued)

Required centring, measured at the centre of the screen in any direction	max.	15	mm
Correction which must be supplied by purifying magnet to compensate for mis-register (including that caused by earth's magnetic field) when using recommended components. Measured at the centre of the screen in any direction	max.	130	μm
Lateral distance between the blue spot and the converged red and green spots	max. (in both directions)	6.5	mm
Radial convergence displacement excluding effects of dynamic convergence (each beam)	max. (in both directions)	9.5	mm 6)

1) This range of V_{g_2} has to be used when in circuit design fixed values for cut-off of the three guns are used.

2) This range of V_{g_1} has to be used when in circuit design fixed values for V_{g_2} of the three guns are used.

3) To produce colour pictures with the best possible quality, this white point should be used as the transmission systems are based on this point. (Point C).

4) To produce black/white pictures a more bluish white point would be preferable. This white point corresponds virtually with the white point of current black/white picture tubes.

5) This point is a compromise between the white point C and the white point x = 0.265 and y = 0.290, given in order to enable good rendition of colour and black-and-white pictures with one white point.

6) Dynamic convergence to be effected by currents of approximately parabolic wave-shape synchronized with scanning.

LIMITING VALUES (Each gun if applicable) (Design centre rating system unless otherwise specified)

Final accelerator voltage	V_{a,g_5,g_4}	max.	27.5	kV [1][2][3]
		min.	20	kV [1][4]
Average current for 3 guns	I_a	max.	1000	μA [5]
Grid No.3 (focusing electrode) voltage	V_{g_3}	max.	6000	V
Grid No.2 voltage, peak, including video signal voltage	$V_{g_{2p}}$	max.	1000	V
Grid No.1 voltage,				
negative	$-V_{g_1}$	max.	400	V
negative, operating cut-off	$-V_{g_1}$	max.	200	V
positive	V_{g_1}	max.	0	V
positive peak	$V_{g_{1p}}$	max.	2	V
Cathode to heater voltage,				
positive	V_{kf}	max.	250	V [6][7]
positive peak	V_{kf_p}	max.	300	V
negative	$-V_{kf}$	max.	135	V
negative peak	$-V_{kf_p}$	max.	180	V

1) Absolute maximum rating system.

2) The X-ray dose rate remains below the acceptable value of 0.5 mr/h, measured with ionisation chambre when the tube is used within its limiting values.

3) For optimal operating conditions the final accelerator voltage has to be stabilized. Therefore its absolute maximum value can be approached in actual operation and for this reason this value is given instead of the design centre value. During adjustment on the production line this value is likely to be surpassed considerably. It is therefore strongly recommended to first make the necessary adjustments for normal operation without picture tube.

4) Operation of the tube at lower voltages impairs brightness and resolution and may have a detrimental effect on colour purity.

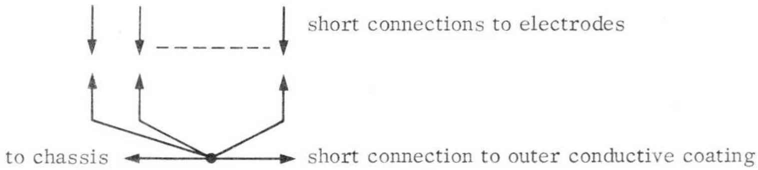
5) 1500μA permitted provided a current limiting circuit is used.

6) In order to avoid excessive hum the a.c. component of the heater to chassis voltage should be as low as possible and must not exceed 20 V_{RMS}.

7) During an equipment warm-up period not exceeding 15 s $V_{k/f}$ is allowed to rise to 410 V. Between 15 s and 45 s after switching on a decrease in $V_{k/f}$ proportional with time from 410 V to 250 V is permissible.

REMARK

With the high voltage used with this tube (max. 27.5 kV) internal flash-overs may occur. These may destroy the cathode(s) of the tube. Therefore it is necessary to provide protective circuits, using spark gaps.
The spark gaps must be connected as follows:



No outer connections between the outer conductive coating and the chassis are permissible.
Additional information available on request.

REFERENCE LINE GAUGE

Dimensions in mm

Reference line E. See chapter "Reference line gauges" in front of this book.

DESCRIPTION OF THE TUBE

The A63-120X is a rectangular temperature compensated shadow-mask colour picture tube for use in colour television receivers. The tube can display a picture, either in full colour or in black and white measuring 504 mm x 396 mm minimum (projected area of 1905 cm^2).

The A63-120X has

- a deflection angle of 90^o
- a neck diameter of 36.5 mm
- a three-colour phosphor dot screen, composed of closely spaced dots in a regular pattern of tri-angular groups, each containing a red, a green and a blue light emitting dot.
- Three electron guns with axes tilted towards the screen centre, with electrostatic focusing systems and mounted side by side in the neck of the tube 120^o apart.

Colour selection is effected by a metal graded-hole shadow mask positioned in front of the tricolour phosphor-dot screen. This mask is aligned with the dot pattern so that the electron beam from each gun lands only on phosphor dots of the associated colour.

The shadow mask has graded holes that increase gradually in diameter from the edge of the mask towards the centre. Grading enables correct purity to be achieved over the whole screen with minimum adjustment.

Although the three guns are tilted towards the screen centre so that their axes intersect at the shadow mask, lateral and radial convergence are necessary to ensure correct convergence over the entire screen. Each of the three guns is therefore provided with a pair of radial converging pole pieces.

Radial convergence can be achieved by means of magnets and coils mounted externally on the neck of the tube. The magnetic flux provided is coupled through the glass neck of the tube to associated internal pole pieces. The shape of the pole pieces, together with the internal magnetic shielding, is shown in Fig.1. Internal shielding prevents interaction of the various magnetic fields.

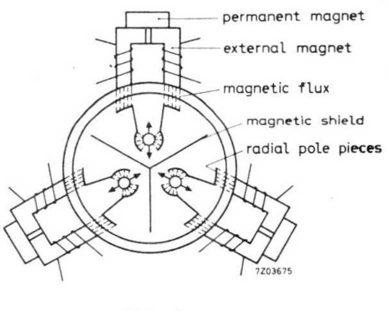


Fig.1

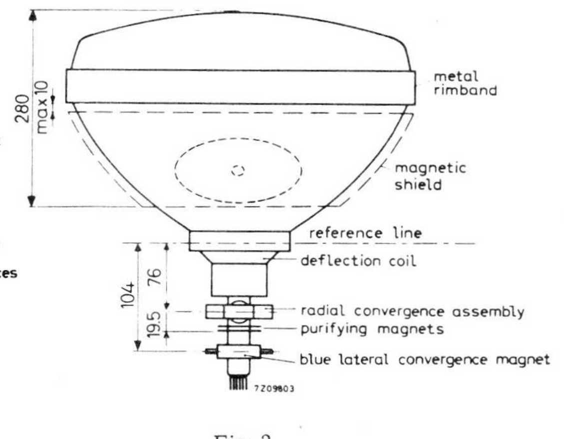


Fig.2

Fig. 2 shows the position of the components on the neck of the tube.
Lateral convergence is achieved by a separate assembly mounted on the neck of the tube. This assembly causes horizontal movement of the blue beam, and simultaneously, movements of the red and green beams in the opposite direction.
Facilities for dynamic blue lateral convergence are also provided in this convergence assembly.

APPLICATION NOTES

1. Magnetic shielding

The tube should be fitted with a magnetic shield around the cone, to minimize the effects of external magnetic fields, including the horizontal, vertical and axial components of the earth's magnetic field. The latter so influences the colour purity that compensation by means of the purifying magnets is not possible.
The metal shield should preferably be constructed of coldrolled steel, at least 0.5 mm thick and properly annealed at 850 °C. Since the tube re-inforcing band is an essential part of the magnetic circuit used for degaussing, the air gap between the band and the shield should be as small as possible and certainly not more than 10 mm. To be effective, the shield must be degaussed as described under "Adjustment procedures". Building-in of an automatic degaussing system is advised.

2. Centring of raster on the screen.

Raster centring in a shadow-mask colour picture tube is achieved by passing direct current of the required value through each pair of deflection coils. The values for raster displacement given in the data apply when all components are properly adjusted.

3. Component considerations.

The necessary components are the deflection coil, the radial convergence assembly, the purifying magnets and the blue lateral convergence magnet.
Basically the functions of the components are:
- deflection of the three beams over the entire screen: deflection coil.
- good convergence of the three beams over the screen: radial convergence assembly and blue lateral convergence magnet.
- landing adjustment: purifying magnets and deflection coil

The mounting positions of the components are as follows:

The deflection coil: in such a way that its deflection centre coincides with the one used in the screen-laying process during manufacturing. The coil must therefore be designed so that sufficient movement in the axial direction is possible.

The radial convergence assembly: with its pole pieces centred above the convergence pole pieces inside the tube. Initially, the assembly should be mounted upright. Small rotations of the whole assembly influence the convergence and can be used during adjustment of the blue lateral correction to obtain optimum lateral convergence.

APPLICATION NOTES (continued)

The purifying magnets: over the gap between the electrode g3 and g4 of the gun, or still closer to the deflection coil. Placing the purifying magnets closer to the base results in poorer performance as the spot quality is adversely affected.

The blue lateral convergence magnet: as near as possible to the rear side of the purifying magnets but not shifted backwards more than halfway along electrode g3 of the gun.

3.1 Convergence

Static convergence, i.e. convergence of the three beams onto the centre of the screen, is usually accomplished with permanent magnets which are part of the radial convergence assembly, or with D.C. currents through the convergence coils in combinations with the lateral converging magnet.
The strength of the magnetic field that is adjustably coupled to the radial convergence pole pieces of the gun should be such that each beam can be moved 9.5 mm in both directions towards the centre of the screen excluding effects of dynamic convergence. The static blue lateral convergence magnet should provide a magnetic field adjustable in magnitude and polarity.
This field exerts a directive force on the blue beam and simultaneously a force in the opposite direction on the green and the red beams.
The displacement of the blue beam opposite to the movement of the red and green beams should be 6.5 mm in both directions.
With these four adjustable magnetic fields static convergence of the three beams can be attained.
For good convergence over the entire screen dynamic radial convergence is required together with a small amount of dynamic lateral convergence in line direction.
The radial convergence assembly consists fundamentally of three cores with associated windings. Through the windings are passed the necessary currents for maintaining convergence when the beams are deflected over the screen.
The required form of the currents can be obtained by adding a current with a sawtooth wave form to one with a parabolic wave form. Two separate windings are required for correction in the horizontal and the vertical direction. The parabolic and sawtooth currents should be adjustable in amplitude and the sawtooth currents and the vertical blue parabola should, in addition be adjustable in polarity.
The blue lateral convergence magnet consists of a core and associated windings to obtain dynamic lateral convergence in line direction.

3.2 Landing

Landing is defined as the relative position of each beam with respect to its associated phosphor dot.
Good landing is achieved when each beam excites only its associated colour phosphor dot.
Optimum landing is achieved by adjusting both the purifying magnets and the deflection coil.

APPLICATION NOTES (continued)

3.2.1 Purifying magnets

Purifying magnets are required to compensate for the effects of outside magnetic fields, (including the earth's magnetic field), and manufacturing variations, which could cause mislanding.
Such purifying magnets, designed to provide a magnetic field adjustable in magnitude and direction, effect good landing over the entire screen when the deflection coil position is properly adjusted.

3.2.2 Deflection coil

The position of the deflection centre must be adjustable to make sure that proper landing can be attained in any set. To achieve this the deflection coil should be free to move along the neck over a minimum distance of 12 mm from its most forward position when the purity adjustment is made with the aid of a microscope, or about 20 mm if purity is adjusted by means of the so-called "red ball" method. (See 6.1.2.1.)

4. Drive requirements

To calculate the drive voltages which should be supplied to the tube the following points should be taken into account.

4.1 In presently known systems the luminance signal is composed as follows:
$Y = 0.30R + 0.59G + 0.11B$.
The colour information is carried by two chrominance signals which in the receiver after subcarrier detection, deliver the so-call colour difference signals R-Y, G-Y and B-Y.
These have to be combined with the Y-signal in a matrix circuit to recover the original red, green and blue signals. With the aid of the luminance signal equation it is possible to calculate the maximum voltage ranges for the colour difference signals. The maximum values are reached when the primary colours and their complementaries are produced at maximum brightness.
These values are tabulated below. All values are referred to the maximum value Y=R=G=B=1 for peak white and are considered positive if they cause an increase in beam current.

Colour	R	G	B	Y	R-Y	G-Y	B-Y
Red	1	0	0	0.3	0.7	-0.3	-0.3
Green	0	1	0	0.59	-0.59	0.41	-0.59
Blue	0	0	1	0.11	-0.11	-0.11	0.89
Cyan	0	1	1	0.7	-0.7	0.3	0.3
Magenta	1	0	1	0.41	0.59	-0.41	0.59
Yellow	1	1	0	0.89	0.11	0.11	-0.89

APPLICATION NOTES (continued)

Signal	Minimum	Maximum	Total range
R-Y	-0.7	0.7	1.4
G-Y	-0.41	0.41	0.82
B-Y	-0.89	0.89	1.78

In practice the saturation of the colours is lower than that of the primary colours as considered above, so that the demands on the colour difference signals can be lower than those indicated.

4.2 The combining of the Y-signal with the R-Y, G-Y and B-Y signals can be performed by two methods:

Method 1. Letting the picture tube perform the matrix function by driving the cathodes with the luminance signal while putting the colour difference signals onto the three first grids of the picture tube. (colour difference drive)

Method 2. By means of a separate matrix circuit that delivers red, green and blue signals to the picture tube. (R.G.B. drive). If fed to the three cathodes these signals attain the same maximum amplitudes as the Y-signal in the first method, and it should be remembered that each channel requires full video bandwidth.

In both methods it should be recognized that with cathode drive a higher slope is obtained than with grid drive and to compensate for this higher drive voltages are required for grid drive in each case. For grid drive the relation between grid drive voltage (V_{drg}) and beam current (I_a) is approximately:

$$I_a = k \frac{V_{drg}^{\;3}}{V_{cog}^{\;3/2}}$$

(I_a in μA)
(V_{cog} is cut-off voltage for grid drive)
(k = k factor)

For cathode drive this function reads:

$$I_a = \frac{k\,(1+D)^3 \quad . \quad V_{drk}^{\;3}}{\left(1 + D\frac{V_{drk}}{V_{cok}}\right)^{3/2} \; . \; (V_{cok})^{3/2}}$$

(V_{drk} = cathode drive voltage)
(V_{cok} = cut-off voltage for cathode drive)
(D = penetration factor)

This shows that there is a difference in sensivity between the two drive techniques, and that the relationship between them is not strictly linear. In practice the best result is obtained if the gridsignal amplitudes are made 20% larger than the corresponding cathode signal amplitudes.

4.3 Unequal currents are required for the red, green and blue signals to produce white as the efficiencies of the red, green and blue phosphors are different. (See Equipment Design Values)

4.4 Spread occuring in picture tube properties:
(1) k factor, (2) penetration of g2 (D) and (3) phosphor efficiencies.

APPLICATION NOTES (continued)

(1) The k factor, having a nominal value of 3.0, spreads between 2.6 and 3.1 but it can be derived from the $I_a = f(V_{dr})$ graph for cathode drive that compensation for this spread is attainable when the luminance drive stage is capable of producing approx. 6 volts more than the nominal peak drive needed for the red gun.

(2) The penetration D may spread from 0.18 to 0.40 with a nominal value of 0.29 and is experienced as a spread in V_{co}. It can be offset - if required - by adjustment of V_{g_2} (See page 22).

(3) Phosphor efficiencies: the ratios of cathode currents for white having, for example, CIE x and y coordinates:
x = 0.281 and y = 0.311, may spread as follows:

$\frac{I_R}{I_G}$ = 0.90 with a min. value of 0.65 and a max. value of 1.25

$\frac{I_R}{I_B}$ = 1.00 with a min. value of 0.75 and a max. value of 1.35

In calculations, for the worst case the values $I_R/I_G = 1.25$ and $I_R/I_B = 1.35$ should be used if the compromise white point is chosen (x = 0.281 y = 0.311). If the white point C is chosen for reproduction of colours then for the worst case the current ratio values, $I_R/I_G = 2.00$ and $I_R/I_B = 2.25$ should be used.

5. Raster shape correction

It appears that for 90° deflection the combination of picture tube and deflection coil can give good convergence and landing, but it is not practical to design the combination such that a perfectly rectangular raster is obtained. To avoid the pin cushion raster which results it is necessary to provide raster correction electrically by modulating the deflecting current.

6. Adjustment procedures

The following procedures are suggested to ensure good landing, optimum convergence of the three beams over the entire area of the screen and good grey scale tracking.

Exact focusing is the final operation in the sequence of adjustments, see 6.3. When starting the sequence it is sufficient to adjust the convergence test pattern for optimum sharpness.

Prior to the adjustment procedure the picture tube has to be degaussed. This treatment will correct for localized areas of colour impurity resulting from any magnetization of the shield and internal tube parts and minimize the effect of the earth's magnetic field. Degaussing can be obtained by a coil that consists of 800 turns of 0.7 mm dia. enamelled copper wire (for 220 V_{rms}) and has an outer diameter of approx. 300 mm.
The coil should be moved such that the entire screen is subjected to its field. After about 10 seconds, the coil is moved away from the face plate to a distance of at least 2 m and disconnected from the A.C. power supply.

APPLICATION NOTES (continued)

During manufacture the receiver chassis should be degaussed in a similar manner, with the receiver switched on and care should be taken that the assembly line is properly degaussed. An automatic degaussing system built into the receiver serves for degaussing during normal operation.
It is recommended that the receiver has some adjustments made before the picture tube is built in. These adjustments should include EHT and deflection, and the dynamic convergence in order to facilitate the adjustment of purity and static convergence. Before deflection power and high voltage are applied to the tube, the bias control should be adjusted for maximum bias. After deflection power and high voltage are applied, the beam currents should be increased gradually to minimize the possibility of tube damage in the event of circuit faults. With the application of a test signal, initial adjustment of focus, raster size, linearity and centring should be made.

6.1 Colour purity and convergence procedures

The normal sequence involves, first, static convergence adjustment next the purifying magnet and adjustment of the axial position of the deflection coil, and lastly final adjustment of dynamic convergence.

6.1.1 Static convergence adjustment

A crosshatch pattern is the most suitable signal for convergence adjustments. The pattern should be displayed at moderate brightness to improve the accuracy. It is advisable to converge red and green first, with the blue gun cut off, and then to converge blue into the yellow pattern formed by the coinciding of red and green lines.
The red and green beams are made to converge statically by adjusting the permanent magnets of the radial convergence assembly, or the corresponding D.C. currents. Correct convergence is obtained when the lines in the centre converge to give yellow.
Before the blue lateral convergence magnet is used, the blue lines are brought horizontally adjacent to the yellow lines by means of the radial blue static convergence adjustment (permanent magnet or D.C. current).
Hereafter the blue lines are made to converge with the yellow lines in the centre with the aid of the blue lateral convergence magnet, resulting in white lines in the centre. If necessary this procedure is repeated.

6.1.2 Adjustment for colour purity

Adjustment for colour purity involves two steps:
Adjustment of the purifying magnets. (6.1.2.1)
Adjustment of the position of the deflection coil. (6.1.2.2)
To obtain optimum adjustment, the static and dynamic convergence should be adjusted previously and the picture tube degaussed and well warmed up to normal operating temperature (approx. 30 min, total beam current 600 μA).
Purity assessments are best made on a plain raster.

APPLICATION NOTES (continued)

Adjustment of the purifying magnets influences purity all over the screen. The deflection coil adjustment influences purity mainly at the screen edges. Therefore, the magnets have to be adjusted before the coil.

6.1.2.1 The purifying magnets are adjusted, judging by the landing in the screen centre. There are two ways of doing this.

The first method makes use of a microscope (magnification about 50x). With this method, the deflection coil need not possess more axial adjustment margin than that needed to cope with the spreads of the deflection centres. (12 mm total).

With the microscope, the position of the spot trio's is compared with the position of the phosphor dot trio's at the screen centre. To do this, the three colour rasters are displayed simultaneously, and the phosphor dots are illuminated by means of a light source, shining onto the screen at a small angle. The spot trio's should be made to land on the phosphor dot trio's as shown in Fig.1, with their centre points coinciding.

Due to the beam grouping used in this tube (which improves the overall landing) the spots will then be approx. 25 μm eccentric with respect to their corresponding phosphor dots.

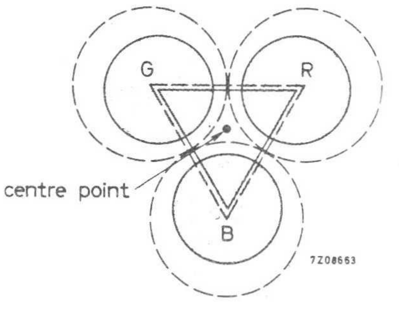


Fig.1. Correct landing in the screen centre.

The second method ("Red ball" method) is applicable if the mounting of the deflection coil is such that it can be drawn away approx. 20 mm backwards from its foremost position when it touches the funnel.

The coil is moved backwards as far as possible, and only the red raster is turned on. (The red gun needs relatively the highest current, thus mis-landing on blue and green phosphor dots is seen more clearly so that a sharp indication is obtained).

Now a red area of approx. 10 cm diameter is visible on the screen, surrounded by discoloured and blue and green areas. With the aid of the purifying magnets, the red area is positioned near the screen centre. In order that the above mentioned beam grouping shows to full adventage, the red area should be positioned 20 mm down to the left of the screen centre, see Fig.2.

APPLICATION NOTES (continued)

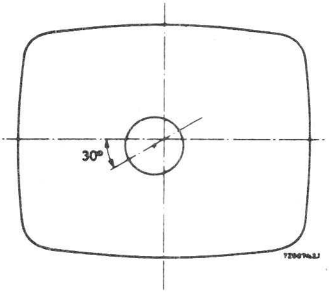


Fig.2

6.1.2.2 After adjustment of the purifying magnets, the deflection coil is adjusted by shifting it axially until optimum landing over the entire screen is reached. This can be done in two stages:

1. Only the red raster turned on, and the coil position giving an overall pure red raster sought.
2. For the final adjustment, a white raster is displayed and, if necessary, very slight adjustment of the deflection coil position made to obtain the best white uniformity.

After having completed 1 and 2, the red, green and blue rasters are checked separately for their purity, and if necessary the procedure repeated.

6.1.3 Adjustment of dynamic convergence

Just as for the static convergence a crosshatch pattern is recommended, displayed at low brightness.
It is advisable to adjust first the convergence in the vertical direction (with frame frequency) and then the horizontal convergence (with currents of line frequency). During the dynamic convergence adjustments, the static convergence (6.1.1) may need readjustment depending on the efficiency of any clamping circuits used.

A favourable sequence is to adjust the red and green convergence controls first so that both rasters coincide to display yellow lines while the blue gun is kept cut-off. Thereafter the blue pattern is added and adjusted to coincide with the yellow to give a white pattern. However, as the blue horizontal convergence system usually has a significant power consumption which influences the line time base to some degree, it is often advisable to start the whole convergence procedure by adjusting the blue horizontal convergence controls coarsely to give a straight blue horizontal centre line.

During the vertical dynamic convergence adjustment, the vertical axis of the screen should be taken as reference, while the horizontal adjustments should be referred to the horizontal axis. During the latter sequence the lateral blue dynamic convergence is also adjusted.

APPLICATION NOTES (continued)

The currents for dynamic convergence (except blue lateral) consist of two components, viz. one of parabolic and one of sawtooth wave form Usually both have their own controls which have to be adjusted in combination to obtain convergence. The parabolic ("amplitude") controls are used to make the configurations at the extremities of the picture axis equal to that at the centre. With the sawtooth ("phase" or "tilt") control the two extremities of the picture axis are made equal to each other as far as possible.
In addition, the blue horizontal convergence needs an extra waveform correction to correct for the tilting of the outer edges.
The blue lateral waveform needed is basically a sawtooth. Left-to-right asymmetry can be adjusted by slight rotation of the radial convergence assembly.

By repeated adjustments of the controls the line patterns in the various colours ultimately coincide and become parallel to each other. Thereafter these are made to coincide with the aid of the static convergence magnets to white lines.

After convergence onto the axes is obtained, usually some errors in the corners of the picture remain.,Slight readjustment may be needed to minimize these errors.

At the end of the procedure purity is checked, and readjusted if needed, with the aid of the purifying magnets.

6.2 Adjustment of grey scale

This adjustment is carried out last of all and the sequence of the manipulations depends on receiver circuitry.

To obtain a constant hue of white over the whole grey scale when displaying a monochrome signal, the three guns must track accurately. This can be achieved by adjusting two points of each gun characteristic, one near cut-off and one near the highlights. To this end the following variables are available, and in a receiver two of them must be made adjustable for each gun:

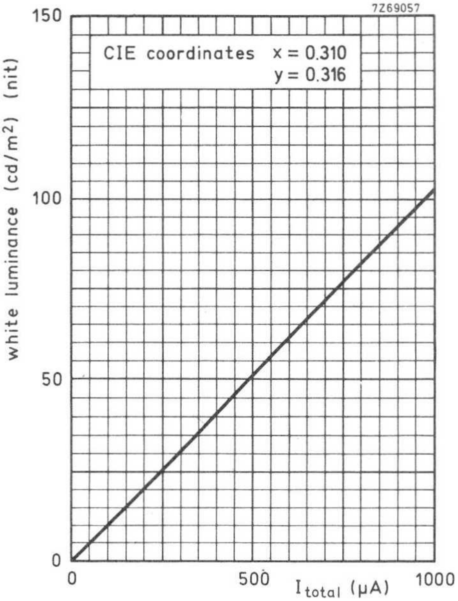
1. cut-off point (V_{g_1})
2. slope (V_{g_2})
3. drive

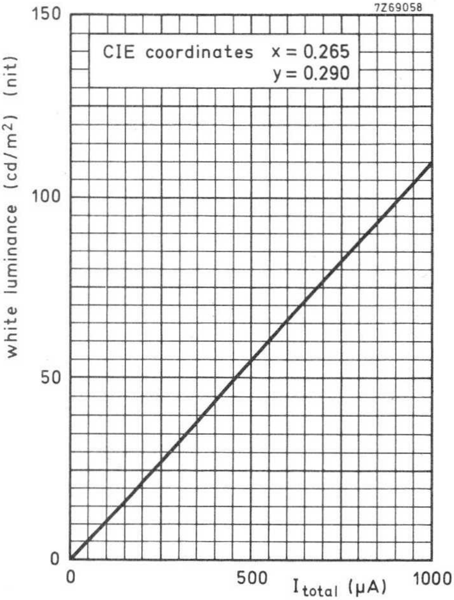
The proper adjustment procedure depends on receiver circuitry. After adjustment, the brightness and contrast controls should not cause any change in hue, and the chosen white point should be displayed.

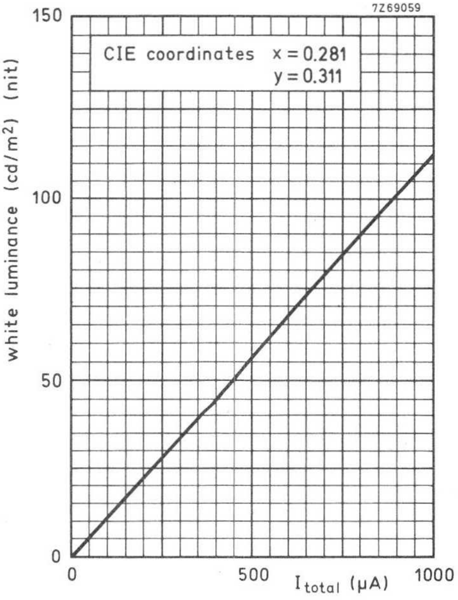
6.3 Focusing

The focusing voltage for all three guns can be adjusted via the common focus base pin No.9. In order to obtain optimum focus it is recommended to use a black-and-white picture with a low peak to mean brightness ratio, such as the RMA test picture, running at a total mean current of about 1 mA (peak currents in the three guns in-the order of 2.5 mA), and to focus at the highlights. This procedure will give best overall focus.

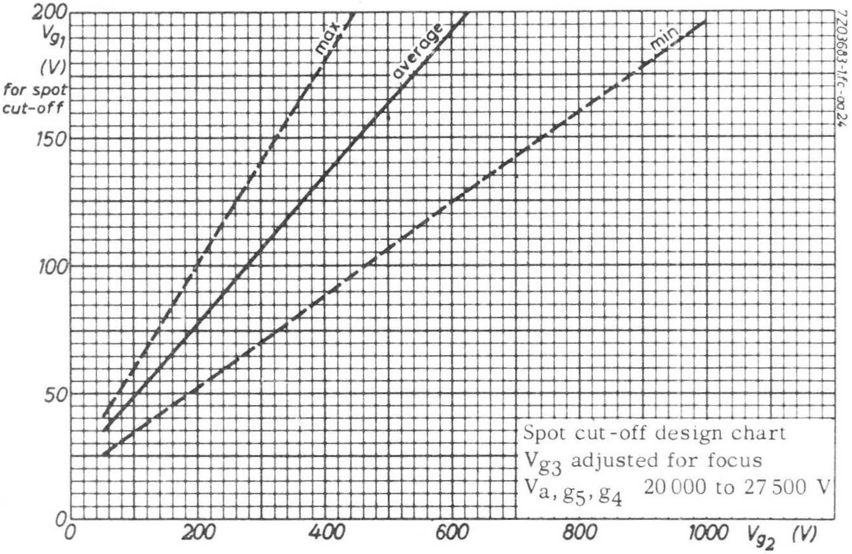
Luminance at the centre of the screen as a function of I_{total}

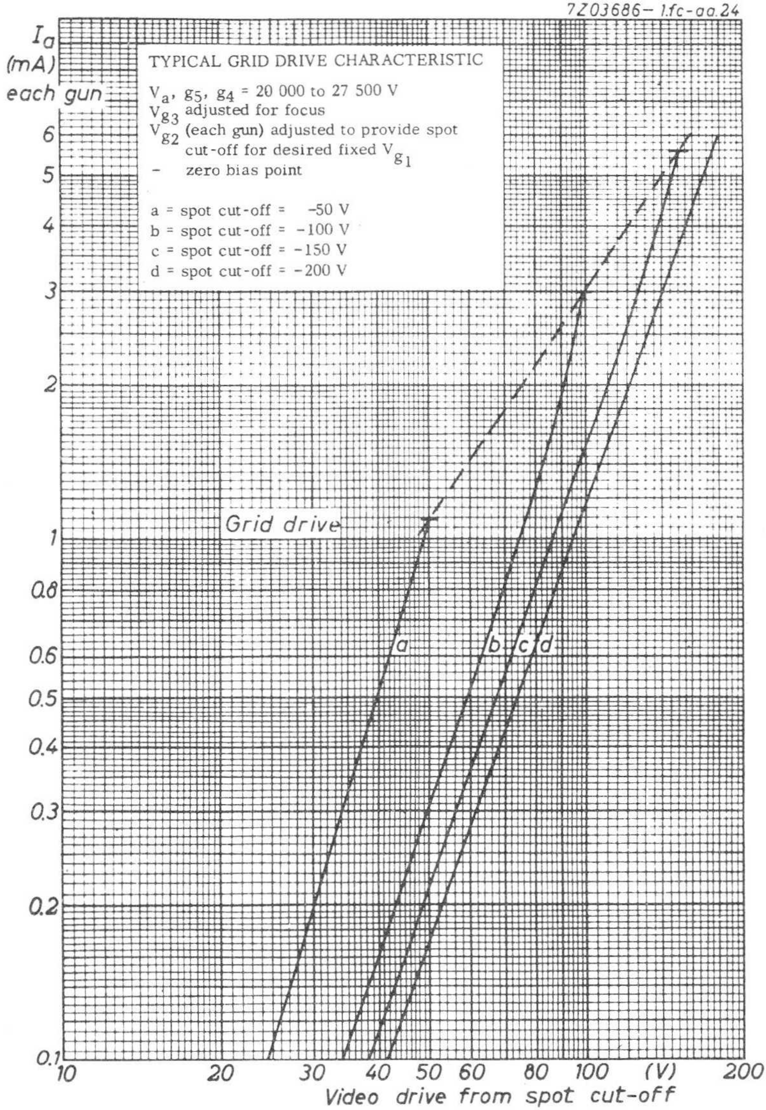


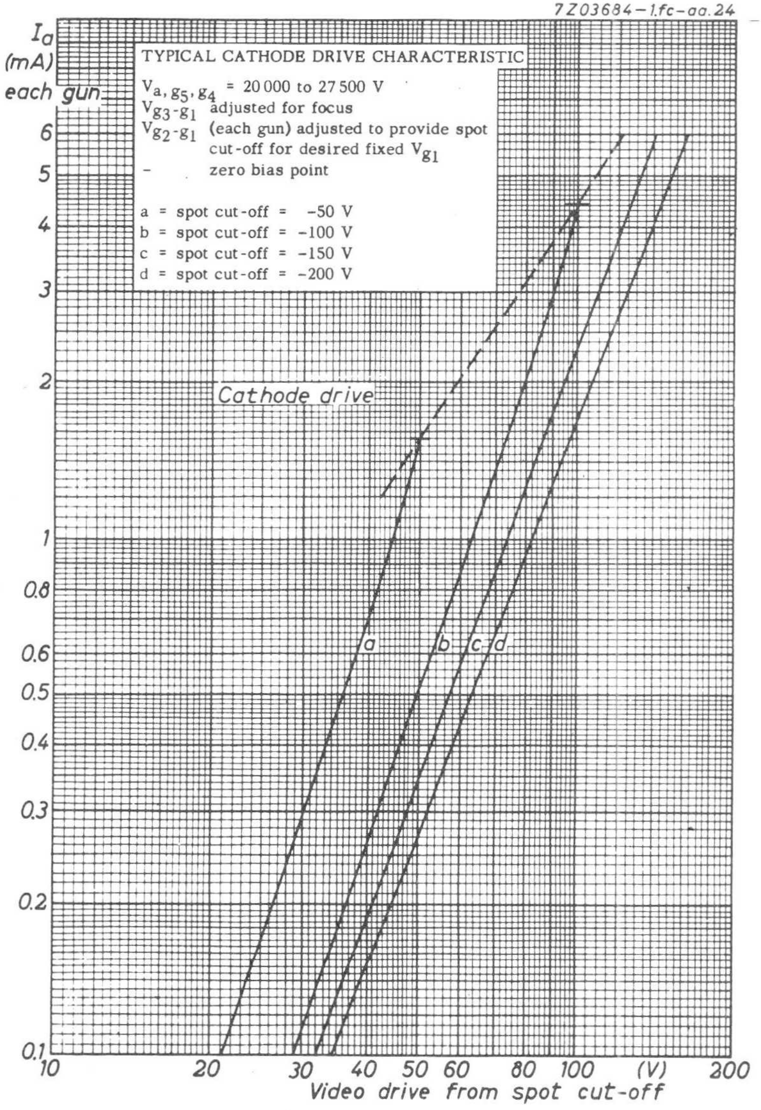




Scanned area 504 mm x 396 mm


200
V_{g_1}
(V)
for spot
cut-off
150
100
50
0
0
200
400
600
800
1000
V_{g_2} (V)
max
average
min
7Z03683-1.fc-oo.24
Spot cut-off design chart
V_{g3} adjusted for focus
V_{a,g_5,g_4} 20 000 to 27 500 V


7Z03686-1.fc-aa.24
I_a (mA) each gun
TYPICAL GRID DRIVE CHARACTERISTIC
V_a, g_5, g_4 = 20 000 to 27 500 V
V_{g3} adjusted for focus
V_{g2} (each gun) adjusted to provide spot cut-off for desired fixed V_{g1}
– zero bias point
a = spot cut-off = −50 V
b = spot cut-off = −100 V
c = spot cut-off = −150 V
d = spot cut-off = −200 V
Grid drive
a
b
c
d
6
5
4
3
2
1
0.8
0.6
0.5
0.4
0.3
0.2
0.1
10
20
30
40
50
60
80
100
(V)
200
Video drive from spot cut-off


7Z03684-1.fc-aa.24
I_a (mA) each gun
TYPICAL CATHODE DRIVE CHARACTERISTIC
V_{a,g_5,g_4} = 20 000 to 27 500 V
$V_{g_3-g_1}$ adjusted for focus
$V_{g_2-g_1}$ (each gun) adjusted to provide spot cut-off for desired fixed V_{g_1}
– zero bias point
a = spot cut-off = −50 V
b = spot cut-off = −100 V
c = spot cut-off = −150 V
d = spot cut-off = −200 V
Cathode drive
a
b
c
d
0.1
0.2
0.3
0.4
0.5
0.6
0.8
1
2
3
4
5
6
10
20
30
40
50
60
80
100
(V)
200
Video drive from spot cut-off

90 ° COLOUR TELEVISION TUBE

Three-gun temperature-compensated shadow-mask rectangular colour television tube with electrostatic focus magnetic deflection and convergence, metal-backed three-colour phosphor dot screen. A high white luminance is obtained at near unity current ratio. Being temperature compensated, the shadow-mask makes for optimum field purity and good uniformity during warm-up. Minimum occurrence of the moiré effect is ensured by optimizing the shadow-mask for reproduction of 625-line pictures. The tube has a reinforced envelope and therefore no separate safety screen is necessary. The rimband leaves the edge of the faceplate free.

QUICK REFERENCE DATA

TEMPERATURE COMPENSATED SHADOW-MASK

SHADOW-MASK OPTIMIZED FOR 625-LINE SYSTEM

HIGH WHITE LUMINANCE AT UNITY CURRENT RATIO

Face diagonal	66 cm
Deflection angle	90 °
Neck diameter	36.5 mm
Envelope	reinforced suitable for push through
Focusing	electrostatic
Deflection	magnetic
Convergence	magnetic
Heating	6.3 V, 900 mA
Light transmission	52.5 %

SCREEN

Metal-backed tricolour phosphor dots

Phosphor type	Red: Europium activated rare earth Green and blue: sulphide type	
Dot arrangement	Triangular	
Spacing between centres of adjacent dot trios		0.81 mm
Light transmission at centre of face glass		52.5 %

HEATING

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

Heater voltage	V_f	6.3 V
Heater current	I_f	900 mA

For maximum cathode life it is recommended that the heater supply be regulated at 6.3 V. If the tube is connected in a series heater chain the surge heater voltage must not exceed 9.5 V_{rms} when the supply is switched on.

CAPACITANCES

Final accelerator to external conductive coating	$C_{ag5g4/m}$	max. 2500 min. 2000	pF pF
Final accelerator to metal rimband	$C_{ag5g4/m'}$	500	pF
Grid No. 1 of any gun to all other electrodes	C_{g1}	7	pF
Cathodes of all guns (connected in parallel) to all other electrodes	C_k	15	pF
Cathode of any gun to all other electrodes	C_{kR} C_{kG} C_{kB}	5 5 5	pF pF pF
Grid No. 3 (focusing electrode) to all other electrodes	C_{g3}	7	pF

FOCUSING electrostatic

DEFLECTION magnetic

Diagonal deflection angle	92 °
Horizontal deflection angle	79 °
Vertical deflection angle	61 °

CONVERGENCE magnetic

MECHANICAL DATA

Overall length			521.8±6.5	mm
Neck length			164.2±4.5	mm
Diagonal		max.	657.6	mm
Horizontal axis	of bulb	max.	556.4	mm
Vertical axis		max.	435.3	mm
Useful screen diagonal		min.	617.8	mm
horizontal axis		min.	518	mm
vertical axis		min.	390	mm

Mounting position: any

Net weight: approx.21.5 kg

Base: 12 pin base JEDEC B12-246

Anode contact: Small cavity contact J1-21, IEC67-III-2

Magnetic shielding

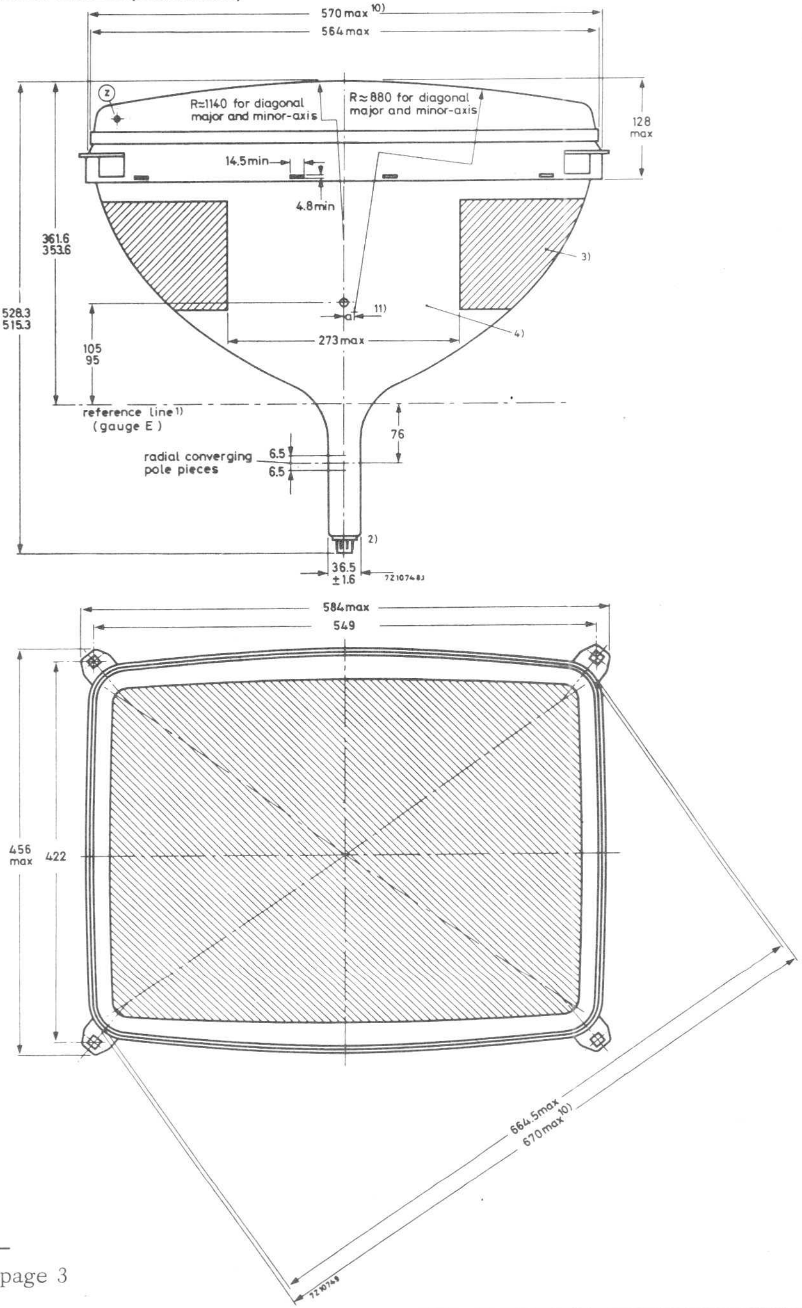
Magnetic shielding should be provided by means of a metal shield extending 285 mm over the cone of the tube measured from the centre of the face plate. The metal shield is preferably constructed of min. 0.5 mm cold rolled steel properly annealed. The air gap between the shield and the metal rimband should be as small as possible and not exceed 10 mm. The magnetic shield should be connected to the outer conductive coating.

NOTES TO OUTLINE DRAWING (See pages 4, 5 and 6)

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. Gauge see page 10.
2. The socket for this base should not be rigidly mounted; it should have flexible leads and be allowed to move freely. Bottom circumference of base will fall within a circle concentric with bulb axis and having a diameter of 55 mm.
3. Configuration of outer conductive coating may be different, but will contain the contact area as shown in the drawing.
4. To clean this area, whipe only with a soft lintless cloth.
5. The displacement of any lug with respect to the plane through the three other lugs is max. 2 mm
6. Minimum space to be reserved for mounting lug.
7. The position of the mounting screw in the cabinet must be within a circle of 9.5 mm diameter drawn around the true geometrical positions, i.e. the corners of a rectangle of 549 mm x 422 mm.
8. Coördinates for radius R = 18.2 mm: x = 236.6 mm, y = 168.9 mm
9. Distance from point Z to any hardware.
10. Maximum dimension in plane of lugs.
11. a = 30.0 mm on diagonal, 28.4 mm on major axis, 18.8 mm on minor axis.

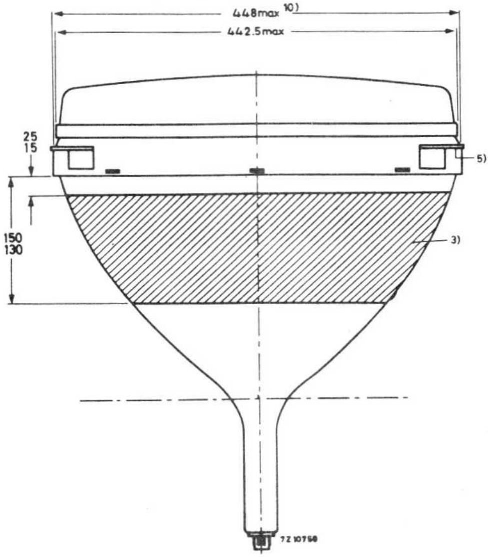
MECHANICAL DATA (continued)

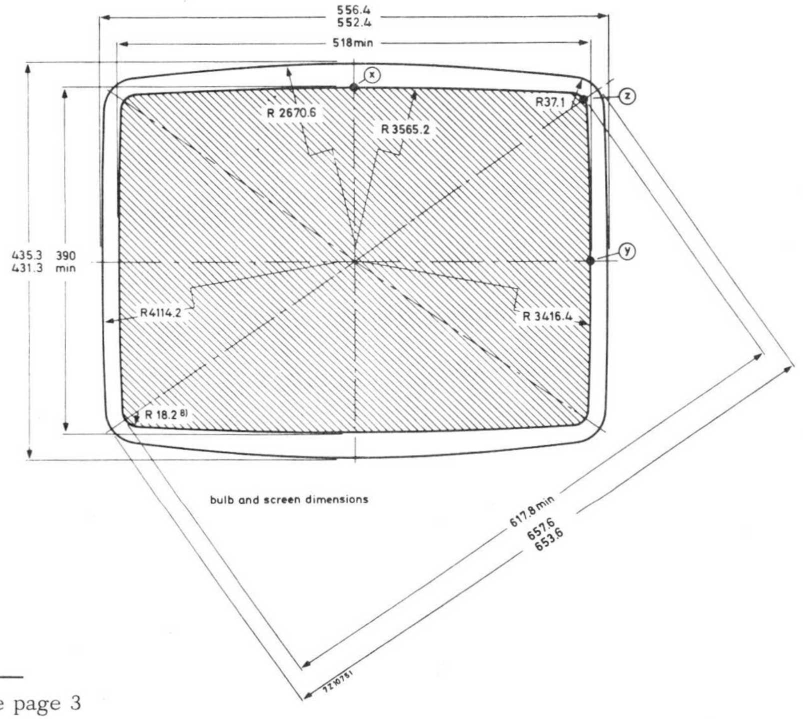
Dimensions in mm



Notes see page 3

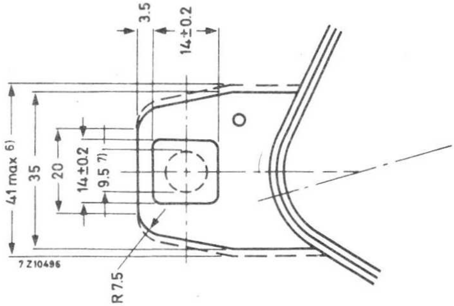
MECHANICAL DATA (continued) Dimensions in mm

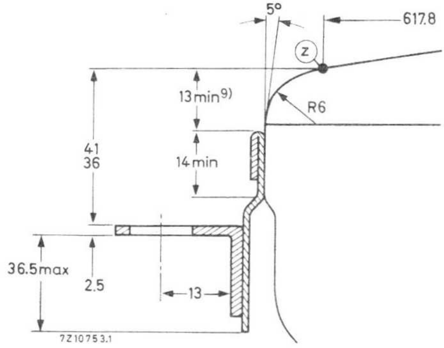


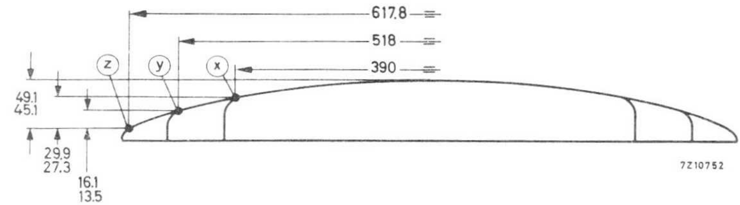


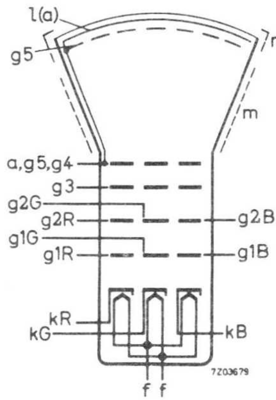
Notes see page 3

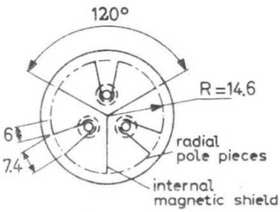
MECHANICAL DATA (continued) Dimensions in mm

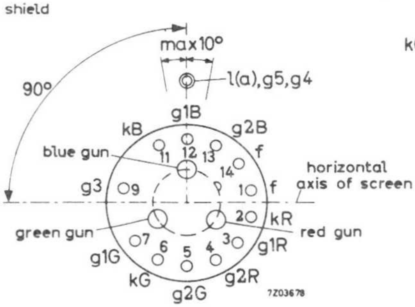












Notes see page 3

TYPICAL OPERATING CONDITIONS

Final accelerator voltage	$V_{a.g5.g4}$	25 kV
Grid No.3 (focusing electrode) voltage	V_{g3}	4.2 to 5 kV
Grid No.2 voltage for a spot cut-off voltage V_{g1} = −105 V	V_{g2}	210 to 495 V [1])
Grid No.1 voltage for spot cut-off at V_{g2} = 300 V	V_{g1}	−70 to −140 V [2])
Luminance at centre of screen		see page 11

EQUIPMENT DESIGN VALUES (each gun if applicable)

Valid for final accelerator voltages between 20 kV and 27.5 kV

Grid No.3 (focusing electrode) voltage	V_{g3}	16.8 to 20% of final accelerator voltage
Grid No.2 voltage [1])	V_{g2}	See cut-off design chart page 12
Grid No.1 voltage for visual extinction of focused spot (cut-off voltage) [2])	V_{g1}	See cut-off design chart page 12
Difference in cut-off voltages between guns in any tube	ΔV_{g1}	lowest value is min. 65% of highest value
Grid No.3 (focusing electrode) current	I_{g3}	−15 to +15 μA
Grid No.2 current	I_{g2}	−5 to +5 μA
Grid No.1 current at V_{g1} = −150 V	I_{g1}	−5 to +5 μA

		3)	4)	5)	6)	
To produce white of the following CIE coordinates	x	0.310	0.265	0.281	0.313	
	y	0.316	0.290	0.311	0.329	
Percentage of total anode current supplied by each gun (typical)						
red gun		43.5	27.9	32.3	43.1	%
green gun		30.0	34.9	35.6	32.0	%
blue gun		26.5	37.2	32.2	24.9	%
Ratio of anode currents red gun to green gun	min.	1.05	0.55	0.65	0.95	
	av.	1.45	0.80	0.90	1.35	
	max.	2.00	1.10	1.25	1.85	
Ratio of anode currents red gun to blue gun	min.	1.25	0.55	0.75	1.30	
	av.	1.65	0.75	1.00	1.75	
	max.	2.25	1.00	1.35	2.35	

Notes see page 8

EQUIPMENT DESIGN VALUES (continued)

Required centring, measured at the centre of the screen in any direction	max. 15 mm
Correction that must be supplied by purifying magnet to compensate for mis-register in any direction	max. 100 μm
Lateral distance between blue spot and the converged red and green spots	max. 6.4 mm (in both directions)
Radial convergence displacement excluding effects of dymanic convergence (each beam)	max. 9.4 mm [7] (in both directions)

1) This range of V_{g2} has to be used when in circuit design fixed values for cut-off of the three guns are used.

2) This range of V_{g1} has to be used when in circuit design fixed values for V_{g2} of the three guns are used.

3) To produce colour pictures with the best possible quality, this white point should be used when the transmission system is based on this point. (Point C).

4) To produce black/white pictures a more bluish white point would be preferable. This white point corresponds virtually with the white point of current black/white picture tubes.

5) This point is a compromise between the white point C and the white point x = 0.265 and y = 0.290, given in order to enable good rendition of colour and black and white pictures with one white point.

6) To produce colour pictures with the best possible quality, this white point should be used when the transmission system is based on this point. (Point D).

7) Dynamic convergence to be effected by currents of approximately parabolic wave-shape synchronized with scanning.

LIMITING VALUES (Each gun if applicable)
(Design centre rating system unless otherwise specified)

Final accelerator voltage	$V_{a,\ g5,\ g4}$	max.	27.5	kV [1][2][3]
		min.	20	kV [1][4]
Average current for three guns	I_a	max.	1000	μA [5]
Grid No.3 (focusing electrode) voltage	V_{g3}	max.	6000	V
Grid No.2 voltage, peak, including video signal voltage	V_{g2p}	max.	1000	V
Grid No.1 voltage,				
negative	$-V_{g1}$	max.	400	V
negative, operating cut-off	$-V_{g1}$	max.	200	V
positive	V_{g1}	max.	0	V
positive peak	V_{g1p}	max.	2	V
Cathode to heater voltage,				
positive	V_{kf}	max.	250	V [6][7]
positive peak	V_{kf_p}	max.	300	V
negative	$-V_{kf}$	max.	135	V
negative peak	$-V_{kf_p}$	max.	180	V

[1]) Absolute max. rating system.

[2]) The X-ray dose rate remains below the acceptable value of 0.5 mr/h, measured with ionization chambre when the tube is used within its limiting values.

[3]) For optimal operating conditions the final accelerator voltage has to be stabilized. Therefore its absolute maximum value can be approached in actual operation and for this reason this value is given instead of the design centre value. During adjustment on the production line this value is likely to be surpassed considerably. It is therefore strongly recommended to first make the necessary adjustment for normal operation without picture tube.

[4]) Operation of the tube at lower voltages impairs brightness and resolution and may have a detrimental effect on colour purity.

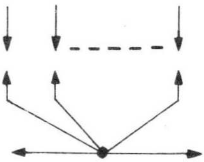
[5]) 1500 μA permitted provided a current limiting circuit is used.

[6]) In order to avoid excessive hum the a.c. component of the heater to chassis voltage should be as low as possible and must not exceed 20 V_{rms}.

[7]) During an equipment warm-up period not exceeding 15 s V_{kf} is allowed to rise to 410 V. Between 15 s and 45 s after switching on a decrease in V_{kf} proportional with time from 410 V to 250 V is permissible.

REMARKS

With the high voltage used with this tube (max. 27.5 kV) internal flash-overs may occur, these may destroy the cathode(s) of the tube. Therefore it is necessary to provide protective circuits, using spark gaps.
The spark gaps must be connected as follows:



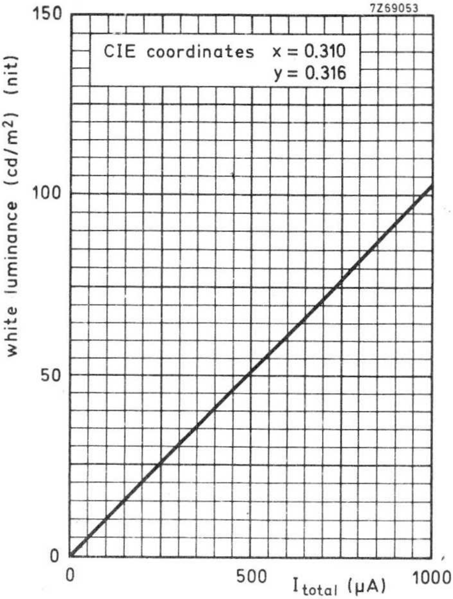
No other connections between the outer conductive coating and the chassis are permissible.
Additional information available on request.

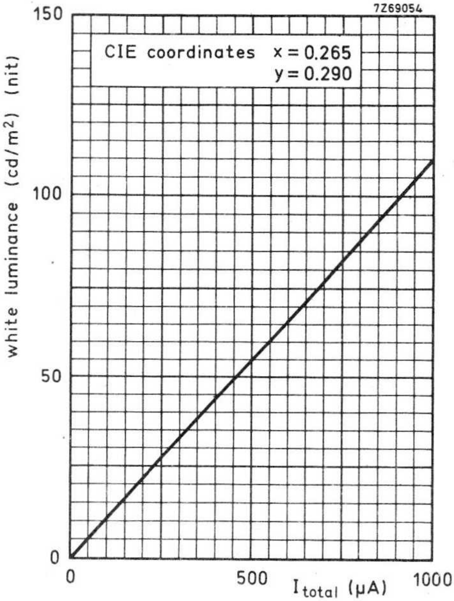
During shipment and handling the tube should not be subjected to accelerations greater than 35 g in any directions.

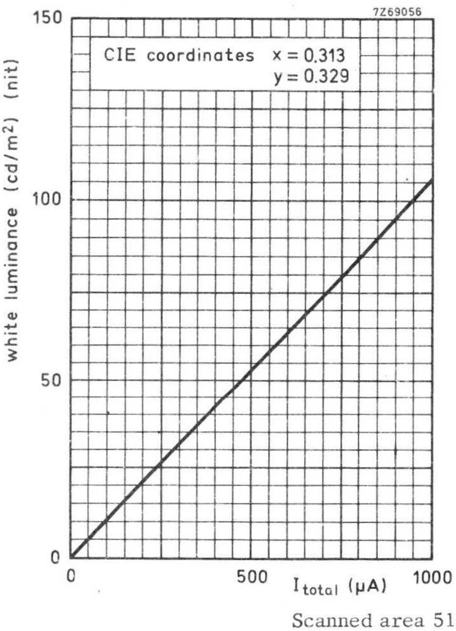
REFERENCE LINE GAUGE (gauge E)

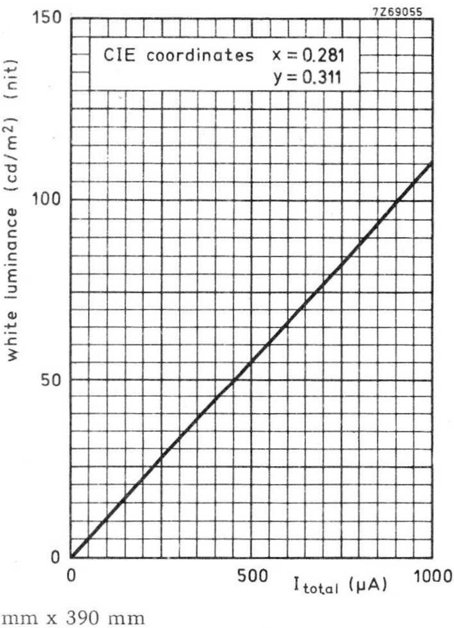
Gauge E. See chapter "Reference line gauges" in front of this book

Luminance at the centre of the screen as a function of I_{total}

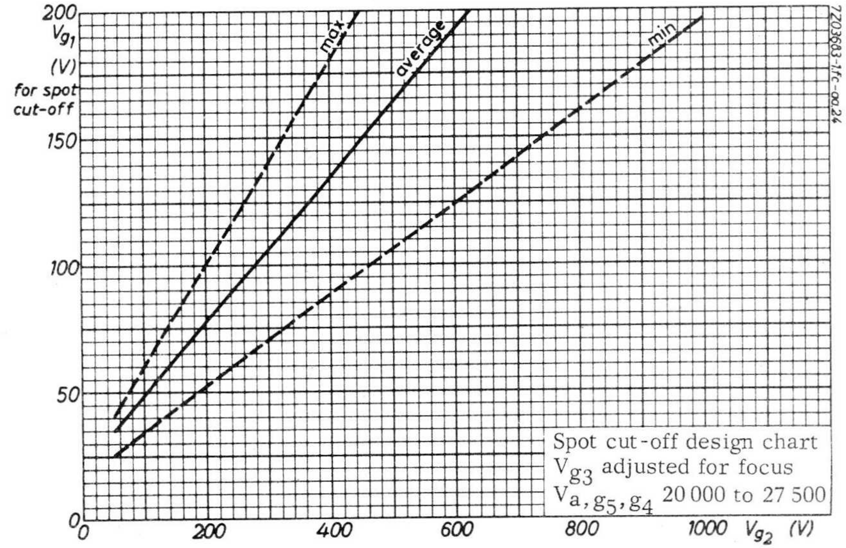


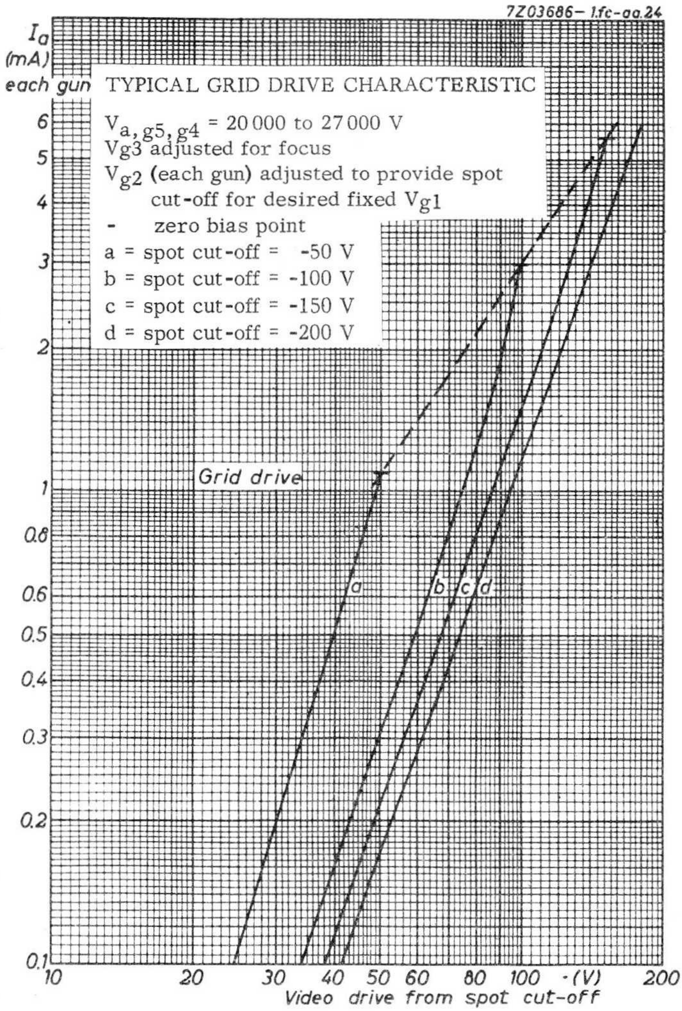






Scanned area 518 mm x 390 mm


200
V_{g_1}
(V)
for spot cut-off
150
100
50
0
0
200
400
600
800
1000 V_{g_2} (V)
max
average
min
7Z03683-1.fc-aa.24
Spot cut-off design chart
V_{g_3} adjusted for focus
V_{a,g_5,g_4} 20 000 to 27 500


7Z03686-1.fc-aa.24
I_a (mA) each gun
TYPICAL GRID DRIVE CHARACTERISTIC
$V_{a,g5,g4}$ = 20 000 to 27 000 V
V_{g3} adjusted for focus
V_{g2} (each gun) adjusted to provide spot cut-off for desired fixed V_{g1}
- zero bias point
a = spot cut-off = -50 V
b = spot cut-off = -100 V
c = spot cut-off = -150 V
d = spot cut-off = -200 V
Grid drive
a
b
c
d
6
5
4
3
2
1
0.8
0.6
0.5
0.4
0.3
0.2
0.1
10
20
30
40
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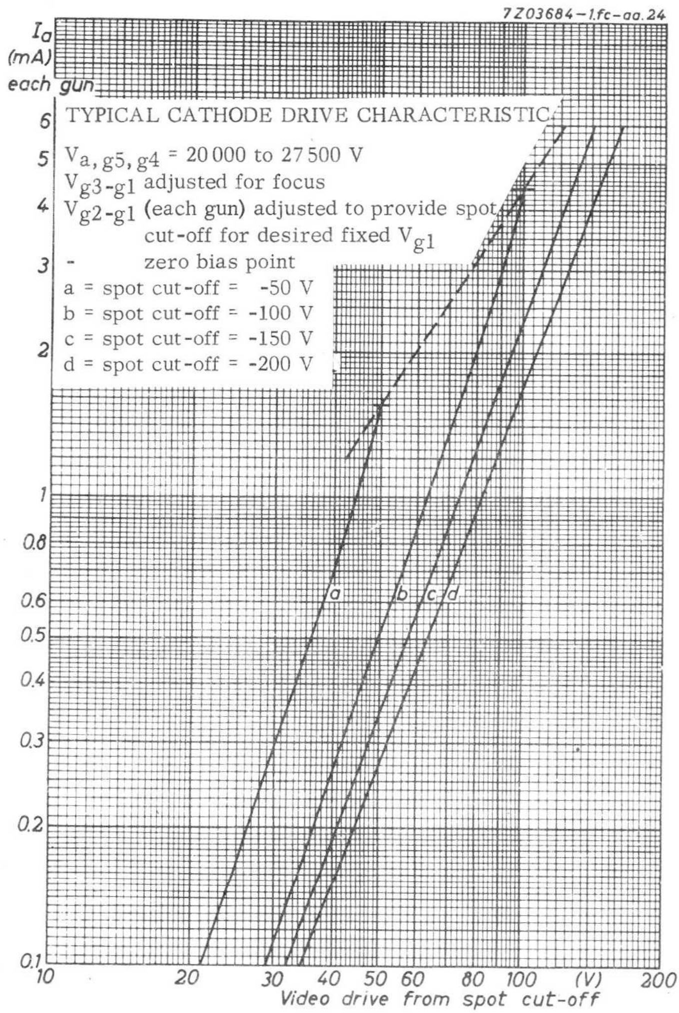
60
80
100
-(V)
200
Video drive from spot cut-off


7Z03684-1.fc-aa.24
I_a (mA) each gun
TYPICAL CATHODE DRIVE CHARACTERISTIC
$V_{a,g5,g4}$ = 20 000 to 27 500 V
V_{g3-g1} adjusted for focus
V_{g2-g1} (each gun) adjusted to provide spot cut-off for desired fixed V_{g1}
- zero bias point
a = spot cut-off = -50 V
b = spot cut-off = -100 V
c = spot cut-off = -150 V
d = spot cut-off = -200 V
6
5
4
3
2
1
0.8
0.6
0.5
0.4
0.3
0.2
0.1
a
b
c
d
10
20
30
40
50
60
80
100
(V)
200
Video drive from spot cut-off

110° COLOUR TELEVISION TUBE

Three-gun temperature-compensated shadow-mask rectangular colour television tube with electrostatic focus, magnetic deflection and convergence, metal-backed three-colour phosphor dot screen and internal magnetic shield. A high white luminance is obtained at near unity current ratio. Being temperature compensated, the shadow-mask makes for optimum field purity and good uniformity during warm-up. The design is such that minimum occurence of the moiré effect is ensured. The tube has a reinforced envelope and therefore no separate safety screen is necessary.

QUICK REFERENCE DATA	
TEMPERATURE-COMPENSATED SHADOW-MASK	
DESIGNED FOR MINIMUM MOIRE EFFECT	
HIGH WHITE LUMINANCE AT UNITY CURRENT RATIO	
Face diagonal	66 cm
Deflection angle	110 °
Neck diameter	36.5 mm
Envelope	reinforced suitable for push through
Magnetic shield	internal
Focusing	bi-potential
Deflection	magnetic
Convergence	magnetic
Heating	6.3 V, 900 mA
Light transmission of face glass	52.5 %

SCREEN

Metal-backed phosphor dots

Phosphor type	Red: Europium activated rare earth Green: Sulphide type Blue: Sulphide type		
Dot arrangement	Triangular		
Spacing between centres of adjacent dot trios		0.81	mm
Light transmission at centre of face glass		52.5	%

HEATING: indirect by A.C. or D.C.; parallel or series supply

Heater voltage	V_f	6.3	V
Heater current	I_f	900	mA

For maximum cathode life it is recommended that the heater supply be regulated at 6.3 V. If the tube is connected in a series heater chain the surge heater voltage must not exceed 9.5 V_{rms} when the supply is switched on.

CAPACITANCES

Final accelerator to external conductive coating	$C_{a, g5, g4/m}$	max.	2100	pF
		min.	1600	pF
Final accelerator to metal rimband	$C_{a, g5, g4/m'}$		500	pF
Grid No.1 of any gun to all other electrodes	C_{g1}		7	pF
Cathodes of all guns (connected in parallel) to all other electrodes	C_k		15	pF
Cathode of any gun to all other electrodes	C_{kR}		5	pF
	C_{kG}		5	pF
	C_{kB}		5	pF
Grid No.3 (focusing electrode) to all other electrodes	C_{g3}		7	pF

FOCUSING electrostatic (bi-potential)

DEFLECTION magnetic

Diagonal deflection angle	110	°
Horizontal deflection angle	97	°
Vertical deflection angle	77	°

CONVERGENCE magnetic

MECHANICAL DATA

Overall length		425.1 to 438.1		mm
Neck diameter			36.5	mm
Diagonal	of bulb	max.	657.6	mm
Horizontal axis	of bulb	max.	556.4	mm
Vertical axis	of bulb	max.	435.3	mm
Useful screen				
diagonal		min.	617.8	mm
horizontal axis		min.	518	mm
vertical axis		min.	390	mm

Mounting position : any

Net weight : approx. 20 kg

Base : 12 pin base JEDEC B12-246

Anode contact : Small cavity contact J1-21, IEC 67-III-2

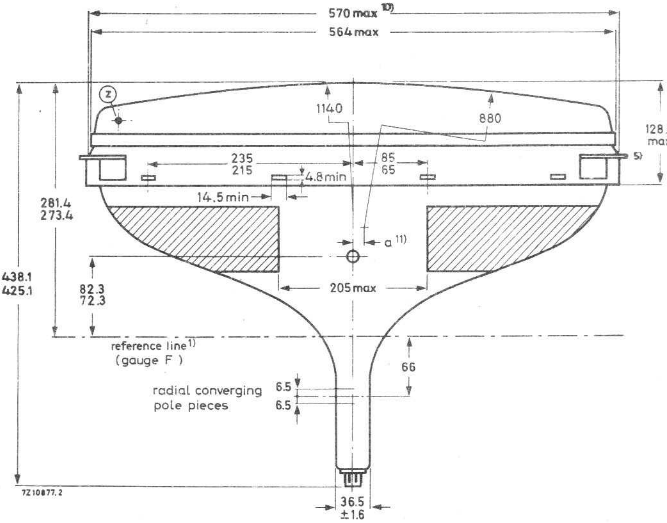
Magnetic shielding, degaussing: The tube is provided with an internal magnetic shield. The internal magnetic shield and the shadow-mask with its suspension system may be provided with an automatic degaussing system, consisting of two coils covering left and right cone parts. For proper degaussing an initial m.m.f. of 500 ampere-turns is required in each of the coils. This m.m.f. has to be gradually decreased by appropriate circuitry. After decreasing to 10 A.t. or less, sudden switch off is permissible. In the steady state, no significant m.m.f. should remain in the coils ($\leq$ 0.5 A.t).
To ease the mounting of the coils, the rimband is provided with rectangular holes.

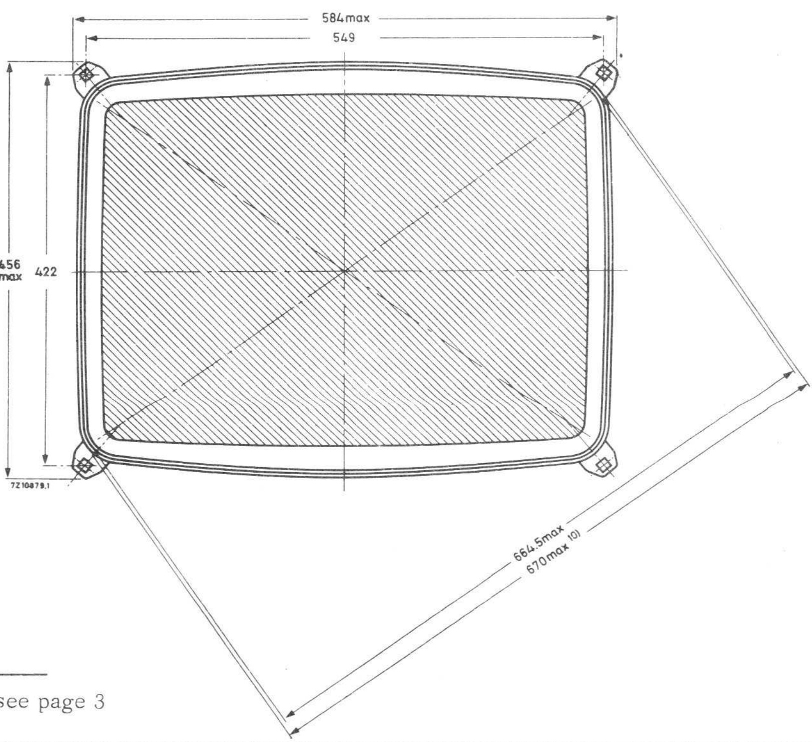
NOTES TO OUTLINE DRAWINGS (See pages 4, 5, and 6)

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 socket for this base should not be rigidly mounted; it should have flexible leads and be allowed to move freely. Bottom circumference of base will fall within a circle concentric with the tube axis and having a diameter of 55 mm.
3) Configuration of outer conductive coating may be different, but will contain the contact area as shown in the drawing.
4) To clean this area, wipe only with a soft lintless cloth.
5) The displacement of any lug with respect to the plane through the three other lugs is max. 2 mm.
6) Minimum space to be reserved for mounting lug.
7) The position of the mounting screw in the cabinet must be within a circle of 9.5 mm diameter drawn around the true geometrical positions, i.e. the corners of a rectangle of 549 mm x 422 mm.
8) Coördinates for radius R = 18.2 mm: x = 236.6 mm, y = 168.9 mm.
9) Distance from point z to any hardware.
10) Maximum dimensions in plane of lugs.
11) Dimension a = 30.0 mm on diagonal, 28.4 mm on major axis, 18.8 mm on minor axis.

MECHANICAL DATA (continued)

Dimensions in mm

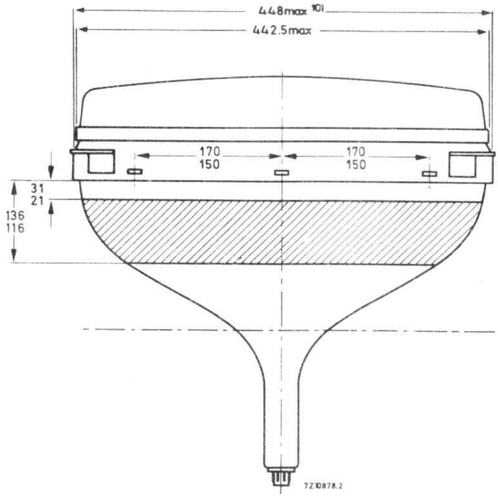


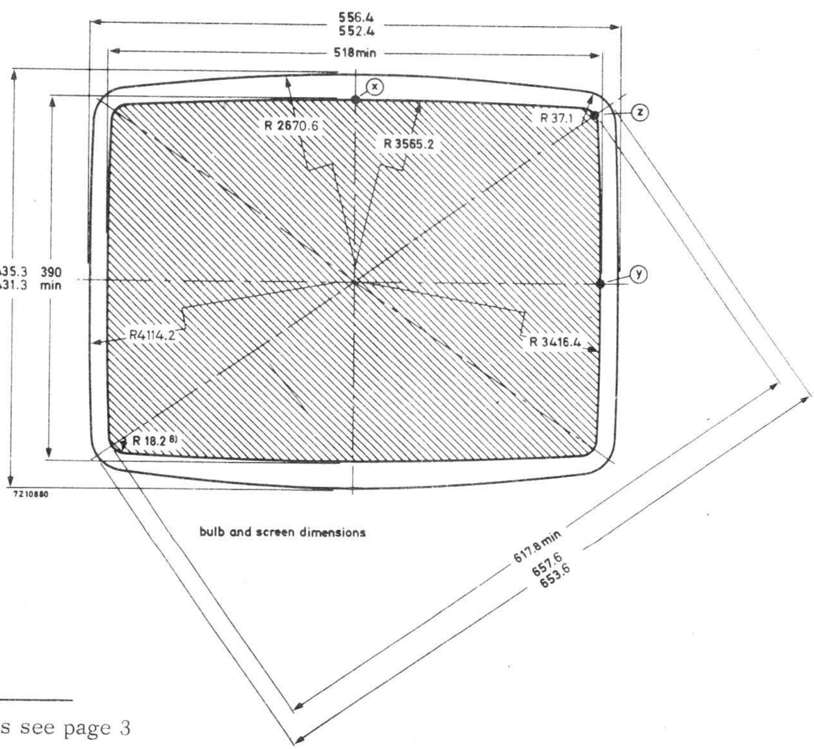


Notes see page 3

MECHANICAL DATA

Dimensions in mm

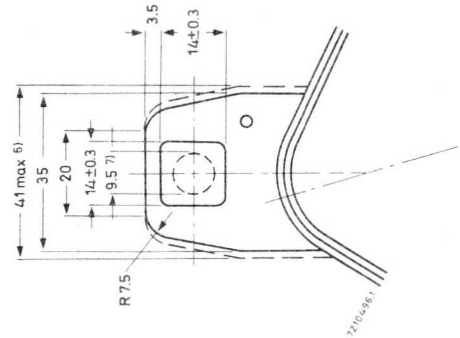


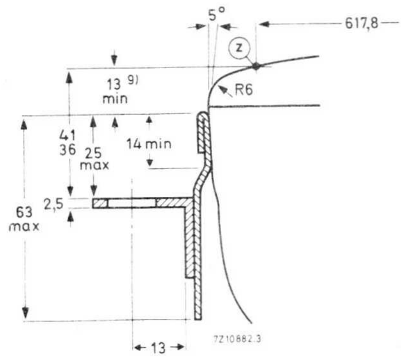


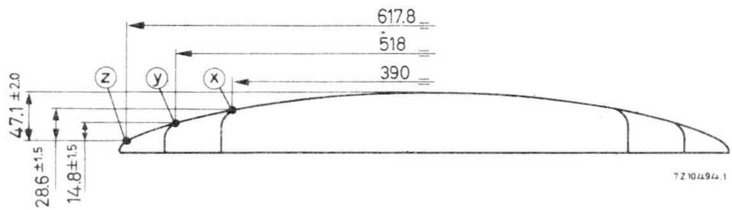
bulb and screen dimensions

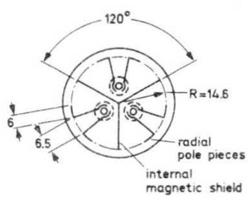
Notes see page 3

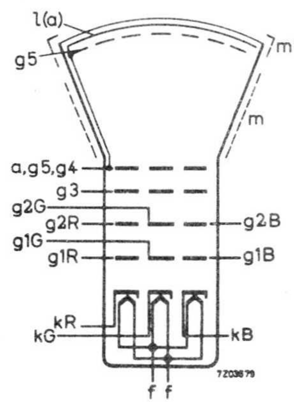
MECHANICAL DATA (continued) Dimensions in mm

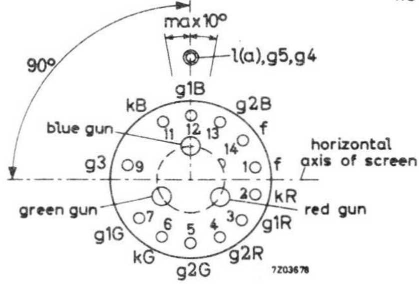








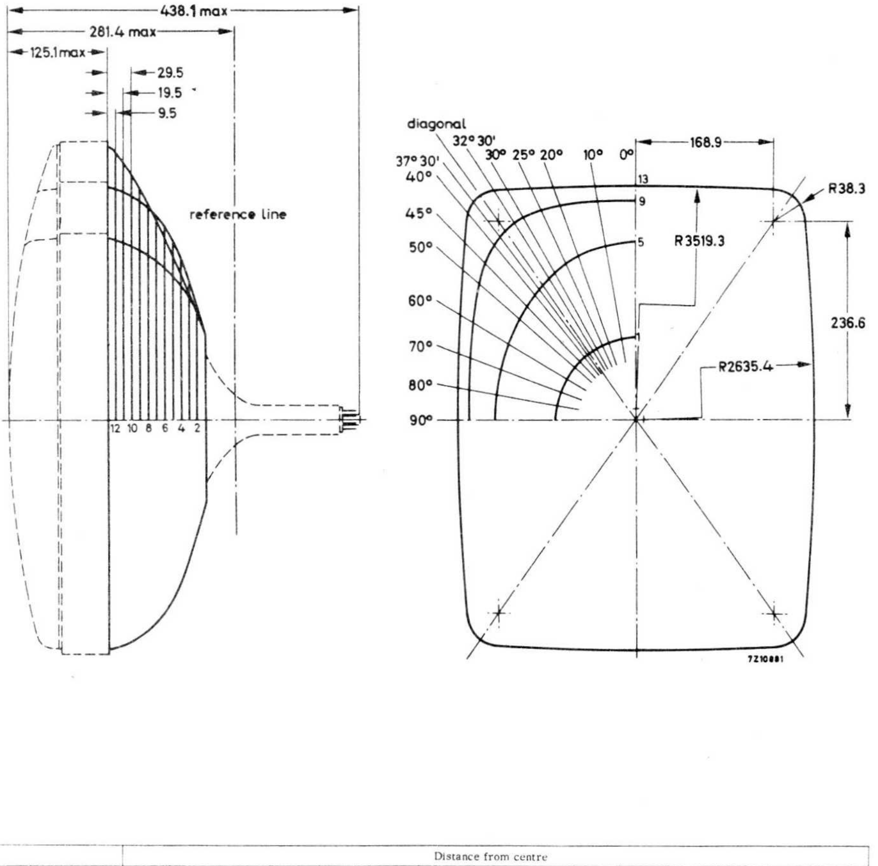




Notes see page 3

MAXIMUM CONE CONTOUR DRAWING

Dimensions in mm



		Distance from centre													
Section	Distance from section 13	0° Long	10°	20°	25°	30°	32° 30'	35° 31' Diagon.	37° 30'	40°	45°	50°	60°	70°	80°	90° Short
1	119.5 nom.	99.41	99.18	98.70	98.46	98.26	98.18	98.11	98.07	98.05	98.05	98.13	98.51	99.08	99.65	99.93
2	109.5 "	142.11	139.07	133.90	131.47	129.35	128.43	127.45	126.89	126.28	125.38	124.90	125.49	126.92	129.46	131.09
3	99.5 "	171.81	168.10	161.35	157.99	154.92	153.52	151.98	151.06	149.99	148.22	146.91	145.65	145.96	147.25	148.22
4	89.5 "	193.96	191.36	185.57	182.25	178.92	177.30	175.41	174.22	172.78	170.12	167.81	164.25	162.10	161.14	160.96
5	79.5 "	213.30	211.91	207.82	204.94	201.66	199.92	197.75	196.31	194.48	190.86	187.37	181.15	176.39	173.40	172.38
6	69.5 "	230.11	229.83	227.80	225.69	222.75	220.99	218.64	216.97	214.76	210.09	205.28	196.20	188.93	184.26	182.64
7	59.5 "	243.54	244.45	245.30	244.63	242.68	241.15	238.79	236.97	234.39	228.50	222.08	209.60	199.67	193.44	191.31
8	49.5 "	253.95	255.93	260.00	261.38	261.16	260.19	258.10	256.19	253.23	245.82	237.40	221.05	208.54	200.97	198.44
9	39.5 "	262.25	265.05	272.04	275.72	277.94	277.99	276.37	274.36	270.89	261.35	250.54	230.35	215.70	207.15	204.34
10	29.5 "	268.76	272.13	281.47	287.43	292.66	294.27	293.44	291.30	287.13	274.58	261.11	237.50	221.30	212.11	209.13
11	19.5 "	273.39	277.11	288.19	296.17	304.82	308.65	309.17	307.00	301.85	285.09	268.75	242.46	225.33	215.81	212.75
12	9.5 "	276.43	280.34	292.47	301.96	313.84	320.37	323.09	321.27	314.80	292.49	273.50	245.58	228.11	218.52	215.46
13	0	279.00	282.96	295.36	305.23	318.01	325.40	329.00	327.49	320.66	296.49	276.73	248.34	230.73	221.08	218.00

TYPICAL OPERATING CONDITIONS

Final accelerator voltage	$V_{a,g5,g4}$	25 kV
Grid No.3 (focusing electrode) voltage	V_{g3}	4.2 to 5 kV
Grid No.2 voltage for a spot cut-off voltage V_{g1} = −105 V	V_{g2}	212 to 495 V [1]
Grid No.1 voltage for spot cut-off at V_{g2} = 300 V	V_{g1}	−70 to −140 V [2]
Luminance at the centre of the screen		See page 12

EQUIPMENT DESIGN VALUES (each gun if applicable)

Valid for final accelerator voltages between 20 kV and 27.5 kV.

Grid No.3 (focusing electrode) voltage	V_{g3}	16.8 to 20% of final accelerator voltage
Grid No.2 voltage	V_{g2}	See cut-off design chart page 13
Grid No.1 voltage for visual extinction of focused spot (cut-off voltage) [2]	V_{g1}	See cut-off design chart page 13
Difference in cut-off voltages between guns in any tube	ΔV_{g1}	lowest value is min. 65% of highest value
Grid No.3 (focusing electrode) current	I_{g3}	−5 to +5 μA
Grid No.2 current	I_{g2}	−5 to +5 μA
Grid No.1 current at V_{g1} = −150 V	I_{g1}	−5 to +5 μA

		[3]	[4]	[6]
To produce white of the following CIE coordinates	x	0.265	0.281	0.313
	y	0.290	0.311	0.329
Percentage of total anode current supplied by each gun (typical)				
red gun		25.8	30.2	41.0
green gun		33.5	34.5	31.3
blue gun		40.7	35.3	27.7
Ratio of anode currents red gun to green gun	min.	0.55	0.65	0.95
	av.	0.75	0.90	1.30
	max.	1.10	1.25	1.80
Ratio of anode currents red gun to blue gun	min.	0.50	0.65	1.15
	av.	0.65	0.85	1.50
	max.	0.85	1.15	2.00

Notes see page 9.

EQUIPMENT DESIGN VALUES (continued)

Required centring, measured at the centre of the screen in any direction	max.	12	mm
Correction that must be supplied by purifying magnet to compensate for mis-register in any direction	max.	100	μm
Lateral distance between blue spot and the converged red and green spots	max.	5	mm
	(in both directions)		
Radial convergence displacement excluding effects of dynamic convergence (each gun) [5]	max.	8	mm
	(in both directions)		

---

1) This range of V_{g2} has to be used when in circuit design fixed values for cut-off of the three guns are used.

2) This range of V_{g1} has to be used when in circuit design fixed values for V_{g2} of the three guns are used.

3) To produce black/white pictures a bluish white point would be preferable. This white point corresponds virtually with the white point of current black/white picture tubes.

4) This point is a compromise between white point D and the white point x = 0.265 y = 0.290, given in order to enable good rendition of colour and black and white pictures with one white point.

5) Dynamic convergence to be effected by currents of approximately parabolic wave-shape through the convergence coils synchronized with scanning.

6) To produce colour pictures with the best possible quality, this white point should be used when the transmission system is based on this point. (Point D).

LIMITING VALUES (Each gun if applicable)
(Design centre rating system unless otherwise specified)

Final accelerator values	$V_{a, g5, g4}$	max.	27.5	kV [1] [2] [3]
		min.	20	kV [1] [4]
Average current for three guns	I_a	max.	1000	μA [5]
Grid No.3 (focusing electrode) voltage	V_{g3}	max.	6000	V
Grid No.2 voltage, peak, including video signal voltage	V_{g2p}	max.	1000	V
Grid No.1 voltage,				
negative	$-V_{g1}$	max.	400	V
negative, operating cut-off	$-V_{g1}$	max.	200	V
positive	V_{g1}	max.	0	V
positive peak	V_{g1p}	max.	2	V
Cathode to heater voltage,				
positive	V_{kf}	max.	250	V [6] [7]
positive peak	V_{kfp}	max.	300	V
negative	$-V_{kf}$	max.	135	V
negative peak	$-V_{kfp}$	max.	180	V

[1] Absolute max. rating system.

[2] The X-ray dose rate remains below the acceptable value of 0.5 mr/h, measured with ionization chamber when the tube is used within its limiting values.

[3] For optimal operating conditions the final accelerator voltage has to be stabilized. Therefore its absolute maximum value can be approached in actual operation and for this reason this value is given instead of the design centre value. During adjustment on the production line this value is likely to be surpassed considerably. It is therefore strongly recommended to first make the necessary adjustments for normal operation without picture tube.

[4] Operation of the tube at lower voltages impairs brightness and resolution and may have a detrimental effect on colour purity.

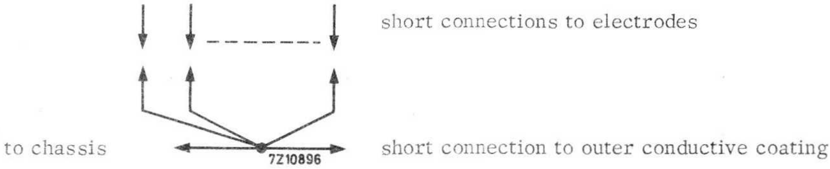
[5] 1500 μA permitted provided a current limiting circuit is used.

[6] In order to avoid excessive hum the a.c. component of the heater to chassis voltage should be as low as possible and must not exceed 20 V_{rms}.

[7] During an equipment warm-up period not exceeding 15 s V_{kf} is allowed to rise to 410 V. Between 15 s and 45 s after switching on a decrease in V_{kf} proportional with time 410 V to 250 V is permissible.

REMARK

With the high voltage used with this tube (max. 27.5 kV) internal flash-overs may occur. These may destroy the cathode(s) of the tube. Therefore it is necessary to provide protective circuits, using spark gaps.
The spark gaps must be connected as follows:



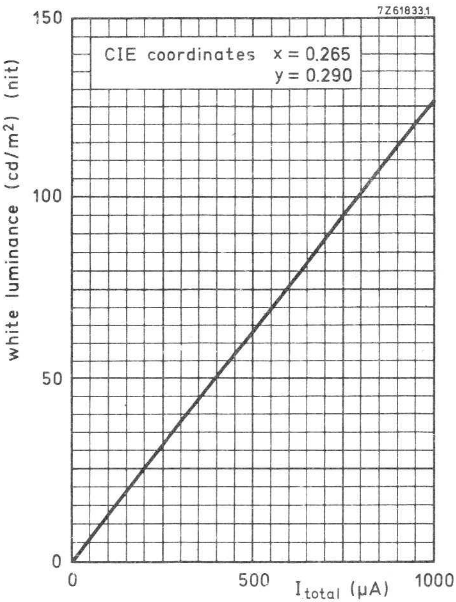
No other connections between the outer conductive coating and the chassis are permissible.
Additional information is given in Application Information 258, available on request.

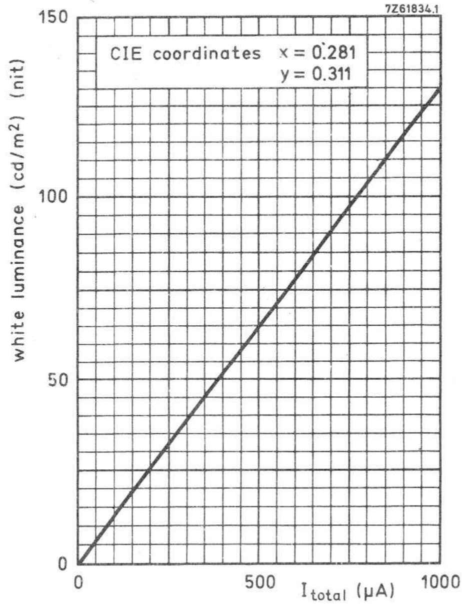
During shipment and handling the tube should not be subjected to accelerations greater than 35 g in any direction.

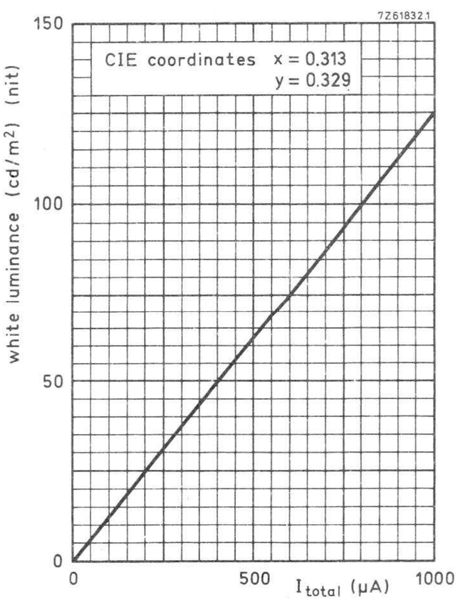
REFERENCE LINE GAUGE (Gauge F)

Gauge F. See chapter "Reference line gauges" in front of this book.

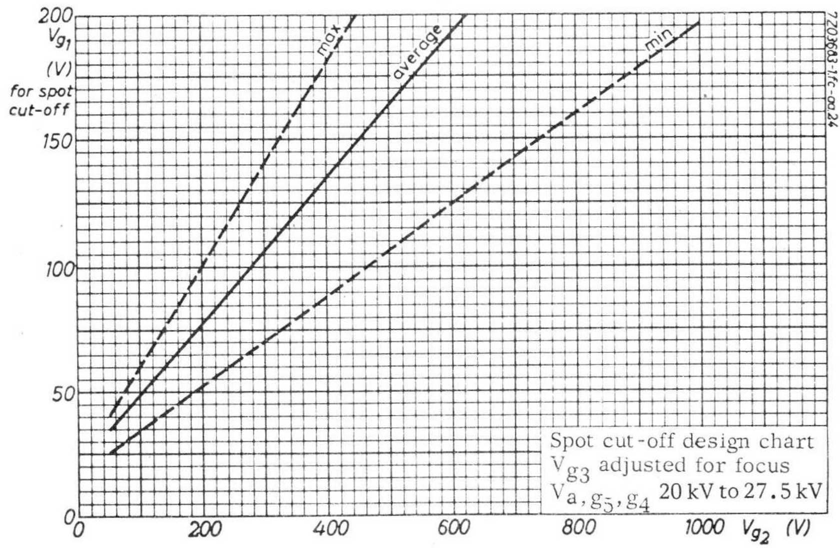
Luminance at the centre of the screen as function of I_{total}

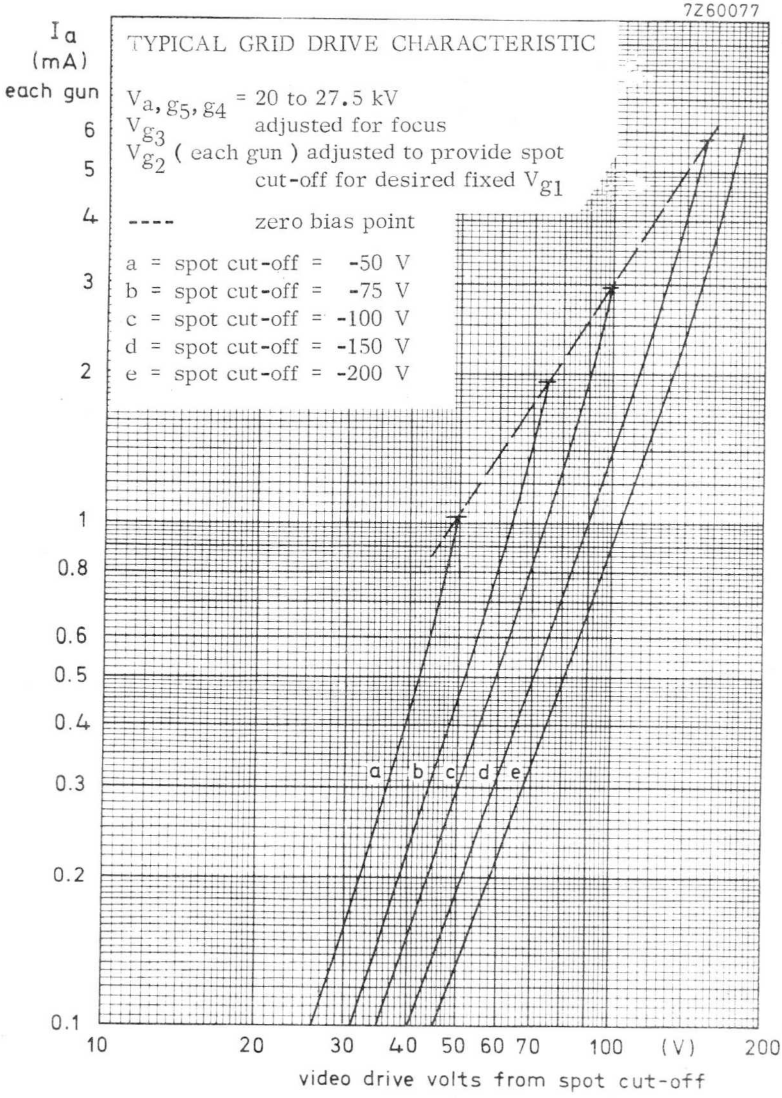


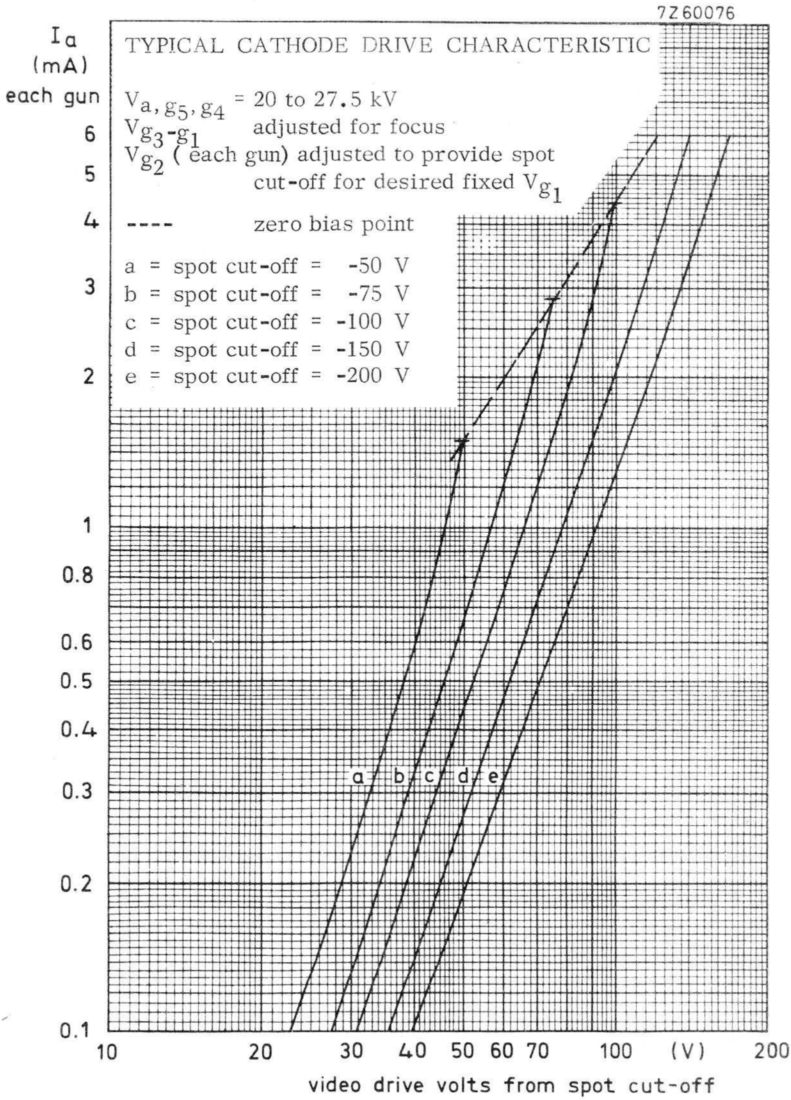




Scanned area 518 mm x 390 mm


200
V_{g_1}
(V)
for spot
cut-off
150
100
50
0
0
200
400
600
800
1000
V_{g_2} (V)
max
average
min
7Z03683-1.fc-aa.24
Spot cut-off design chart
V_{g3} adjusted for focus
V_{a,g_5,g_4} 20 kV to 27.5 kV


7Z60077
TYPICAL GRID DRIVE CHARACTERISTIC
V_{a,g_5,g_4} = 20 to 27.5 kV
V_{g_3} adjusted for focus
V_{g_2} (each gun) adjusted to provide spot cut-off for desired fixed V_{g_1}
---- zero bias point
a = spot cut-off = -50 V
b = spot cut-off = -75 V
c = spot cut-off = -100 V
d = spot cut-off = -150 V
e = spot cut-off = -200 V
Ia (mA) each gun
6
5
4
3
2
1
0.8
0.6
0.5
0.4
0.3
0.2
0.1
a
b
c
d
e
10
20
30
40
50
60
70
100
(V)
200
video drive volts from spot cut-off


7Z60076
TYPICAL CATHODE DRIVE CHARACTERISTIC
V_{a, g_5, g_4} = 20 to 27.5 kV
$V_{g_3-g_1}$ adjusted for focus
V_{g_2} (each gun) adjusted to provide spot cut-off for desired fixed V_{g_1}
---- zero bias point
a = spot cut-off = -50 V
b = spot cut-off = -75 V
c = spot cut-off = -100 V
d = spot cut-off = -150 V
e = spot cut-off = -200 V
Ia (mA) each gun
6
5
4
3
2
1
0.8
0.6
0.5
0.4
0.3
0.2
0.1
a
b
c
d
e
10
20
30
40
50
60
70
100
(V)
200
video drive volts from spot cut-off

110° COLOUR TELEVISION PICTURE TUBE

Three-gun temperature-compensated shadow-mask rectangular colour television tube with electrostatic focus, magnetic deflection and convergence, metal-backed three-colour phosphor dot screen and internal magnetic shield. A high white luminance is obtained at near unity current ratio. Being temperature compensated, the shadow-mask makes for optimum field purity and good uniformity during warm-up. The design is such that minimum occurence of the moiré effect is ensured. The tube has a reinforced envelope and therefore no separate safety screen is necessary. Typically, a legible picture will appear within 5 s.

QUICK REFERENCE DATA		
TEMPERATURE-COMPENSATED SHADOW-MASK		
DESIGNED FOR MINIMUM MOIRÉ EFFECT		
HIGH WHITE LUMINANCE AT UNITY CURRENT RATIO		
Face diagonal	66	cm
Deflection angle	110	deg
Neck diameter	36,5	mm
Envelope	reinforced	
Magnetic shield	internal	
Focusing	bi-potential	
Deflection	magnetic	
Convergence	magnetic	
Heating	6,3 V, 730 mA	
Light transmission of face glass	52,5	%
Quick heating cathode	with a typical tube a legible picture will appear after within 5 s	

SCREEN

Metal-backed phosphor dots

Phosphor type	Red: Europium activated rare earth Green: Sulphide type Blue: Sulphide type	
Dot arrangement	Triangular	
Spacing between centres of adjacent dot trios	0,81	mm
Light transmission at centre of face glass	52,5	%

HEATING : indirect by a.c. or d.c. ; parallel supply

Heater voltage	V_f	6,3	V
Heater current	I_f	730	mA [1]

For maximum cathode life it is recommended that the heater supply be regulated at 6,3 V.

For heating time as a function of source impedance see graph page 13 below.

CAPACITANCES

Final accelerator to external conductive coating	$C_{a,g3,g4/m}$	max. 2100 min. 1600	pF pF
Final accelerator to metal rimband	$C_{a,g3,g4/m'}$	500	pF
Grid no.1 of any gun to all other electrodes	C_{g1}	7	pF
Cathodes of all guns (connected in parallel) to all other electrodes	C_k	15	pF
Cathode of any gun to all other electrodes	C_{kR}, C_{kG}, C_{kB}	5	pF
Grid no.3 (focusing electrode) to all other electrodes	C_{g3}	7	pF

FOCUSING electrostatic (bi-potential)

DEFLECTION magnetic

Diagonal deflection angle	110 °
Horizontal deflection angle	97 °
Vertical deflection angle	77 °

CONVERGENCE magnetic

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[1]) If the heater is fed from a mains transformer designed for tube type A66-140X, the source impedance should not exceed 0,6 Ω to ensure that the heater voltage of the A66-410X is not exceeded.

If the heater is fed from a line time base designed for tube type A66-140X, the series impedance, if any, should match the lower heater current of the quick-heating tube.

MECHANICAL DATA

Overall length			425,1 to 438,1 mm
Neck diameter			36,5 mm
Diagonal	of bulb	max.	657,6 mm
Horizontal axis	of bulb	max.	556,4 mm
Vertical axis	of bulb	max.	435,3 mm
Useful screen			
diagonal		min.	617,8 mm
horizontal axis		min.	518 mm
vertical axis		min.	390 mm

Mounting position: any

Net weight : approx. 20 kg

Base : 12 pin base JEDEC B12-246

Anode contact : Small cavity contact J1-21, IEC 67-III-2

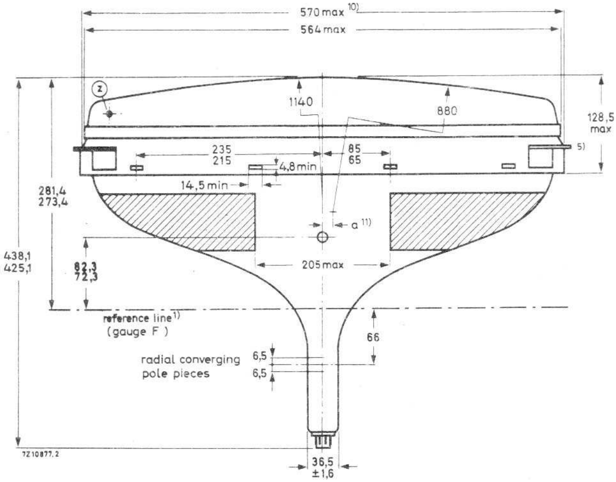
Magnetic shielding, degaussing: The tube is provided with an internal magnetic shield. The internal magnetic shield and the shadow-mask with its suspension system may be provided with an automatic degaussing system, consisting of two coils covering left and right cone parts. For proper degaussing an initial m.m.f. of 500 ampere-turns is required in each of the coils. This m.m.f. has to be gradually decreased by appropriate circuitry. After decreasing to 10 A.t. or less, sudden switch off is permissible. In the steady state, no significant m.m.f. should remain in the coils (< 0,5 A.t.).
To ease the mounting of the coils, the rimband is provided with rectangular holes.

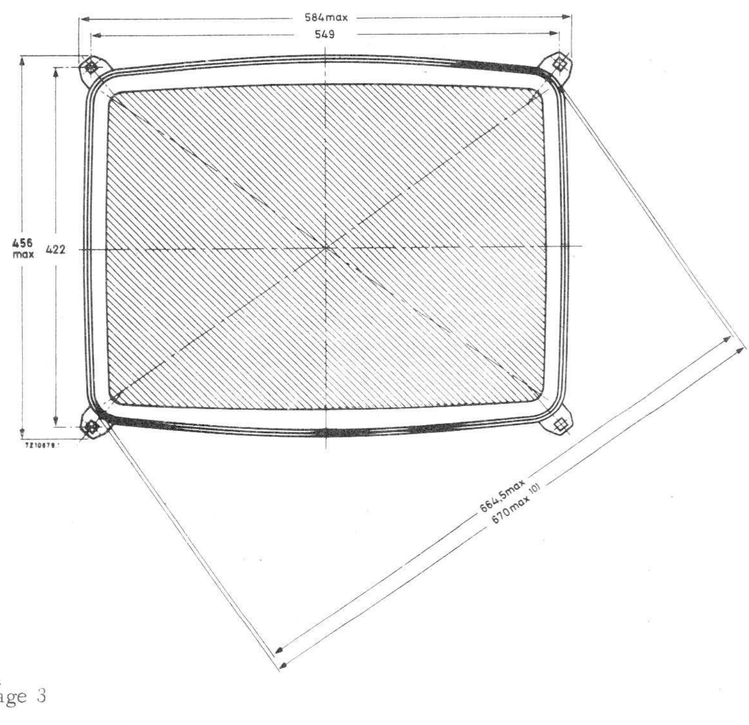
NOTES TO OUTLINE DRAWING (see pages 4, 5, and 6)

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 socket for this base should not be rigidly mounted; it should have flexible leads and be allowed to move freely. Bottom circumference of base will fall within a circle concentric with the tube axis and having a diameter of 55 mm.
3) Configuration of outer conductive coating may be different, but will contain the contact area as shown in the drawing.
4) To clean this area, wipe only with a soft lintless clotch.
5) The displacement of any lug with respect to the plane through the three other lugs is max. 2 mm.
6) Minimum space to be reserved for mounting lug.
7) The position of the mounting screw in the cabinet must be within a circle of 9,5 mm diameter drawn around the true geometrical positions, i.e. the corners of a rectangle of 549 mm x 422 mm.
8) Coördinates for radius R = 18,2 mm: x = 236,6 mm, y = 168,9 mm.
9) Distance from point z to any hardware.
10) Maximum dimensions in plane of lugs.
11) Dimension a = 30,0 mm on diagonal, 28,4 mm on major axis, 18,8 mm on minor axis.

MECHANICAL DATA (continued)

Dimensions in mm

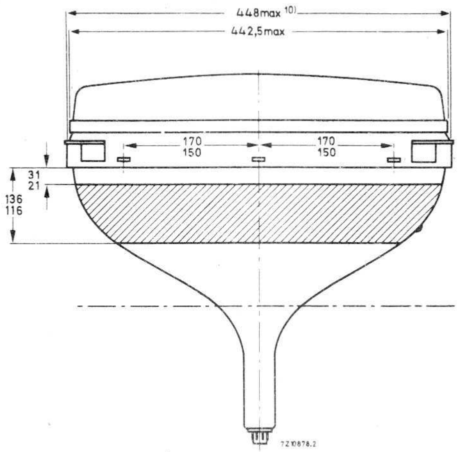


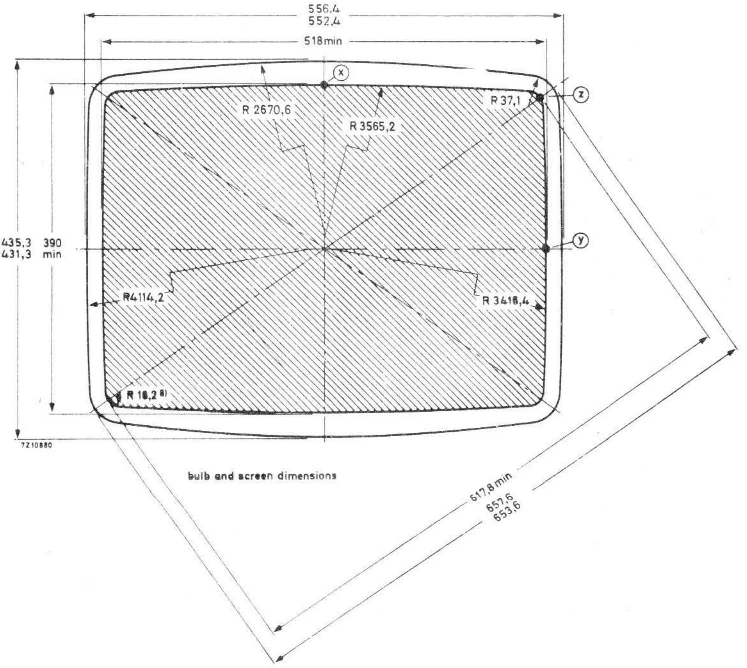


Notes see page 3

MECHANICAL DATA

Dimensions in mm

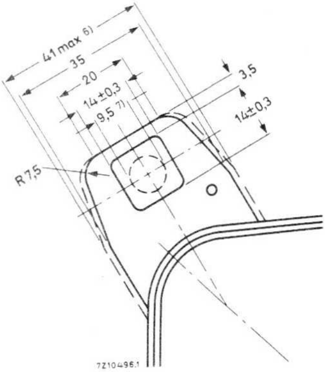


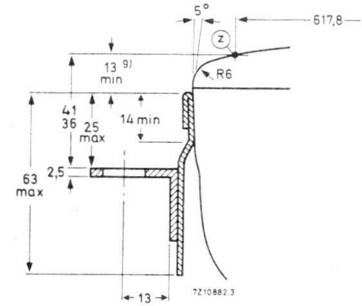


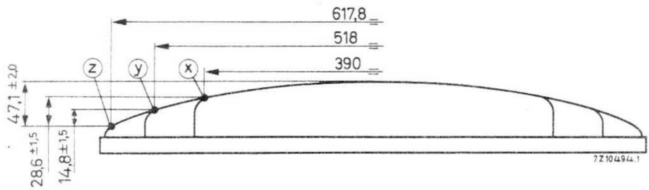
bulb and screen dimensions

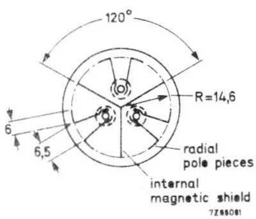
Notes see page 3

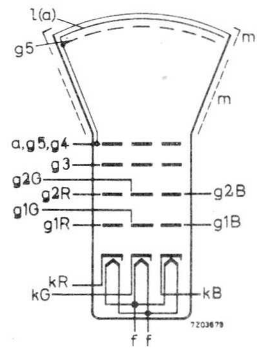
MECHANICAL DATA (continued) Dimensions in mm

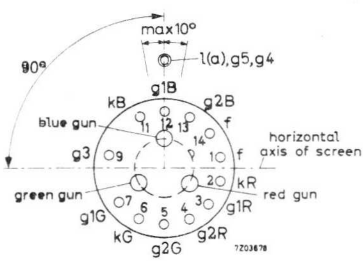








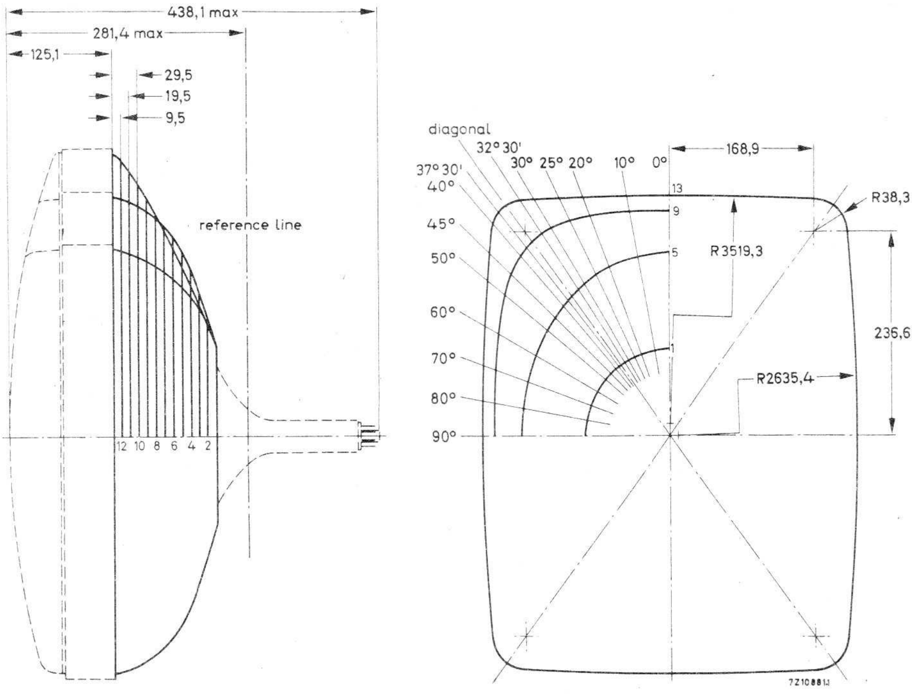




Notes see page 3

MAXIMUM CONE CONTOUR DRAWING

dimensions in mm



Sec-tion	Distance from section 13	Distance from centre														
		0° Long	10°	20°	25°	30°	32° 30'	35° 31' Diagon.	37° 30'	40°	45°	50°	60°	70°	80°	90° Short
1	119,5 nom.	99,41	99,18	98,70	98,46	98,26	98,18	98,11	98,07	98,05	98,05	98,13	98,51	99,08	99,65	99,93
2	109,5 "	142,11	139,07	133,90	131,47	129,35	128,43	127,45	126,89	126,28	125,38	124,90	125,19	126,92	129,46	131,09
3	99,5 "	171,81	168,10	161,35	157,99	154,92	153,52	151,98	151,06	149,99	148,22	146,91	145,65	145,96	147,25	148,22
4	89,5 "	193,96	191,36	185,57	182,25	178,92	177,30	175,41	174,22	172,78	170,12	167,81	164,25	162,10	161,14	160,96
5	79,5 "	213,30	211,91	207,82	204,94	201,66	199,92	197,75	196,31	194,48	190,86	187,37	181,15	176,39	173,40	172,38
6	69,5 "	230,11	229,83	227,80	225,69	222,75	220,99	218,64	216,97	214,76	210,09	205,28	196,20	188,93	184,26	182,64
7	59,5 "	243,54	244,45	245,30	244,63	242,68	241,15	238,79	236,97	234,39	228,50	222,08	209,60	199,67	193,44	191,31
8	49,5 "	253,95	255,93	260,00	261,38	261,16	260,19	258,10	256,19	253,23	245,82	237,40	221,05	208,54	200,97	198,44
9	39,5 "	262,25	265,05	272,04	275,72	277,94	277,99	276,37	274,36	270,89	261,35	250,54	230,35	215,70	207,15	204,34
10	29,5 "	268,76	272,13	281,47	287,43	292,66	294,27	293,44	291,30	287,13	274,58	261,11	237,50	221,30	212,11	209,13
11	19,5 "	273,39	277,11	288,19	296,17	304,82	308,65	309,17	307,00	301,85	285,09	268,75	242,46	225,33	215,81	212,75
12	9,5 "	276,43	280,34	292,47	301,96	313,84	320,37	323,09	321,27	314,80	292,49	273,50	245,58	228,11	218,52	215,46
13	0	279,00	282,96	295,36	305,23	318,01	325,40	329,00	327,49	320,66	296,49	276,73	248,34	230,73	221,08	218,00

TYPICAL OPERATING CONDITIONS

Final accelerator voltage	Va, g5, g4	25 kV
Grid No. 3 (Focusing electrode) voltage	V_{g3}	4,2 to 5 kV
Grid No. 2 voltage for a spot cut-off voltage V_{g1} = - 105 V	V_{g2}	212 to 495 V [1]
Grid No. 1 voltage for spot cut-off at V_{g2} = 300 V	V_{g1}	-70 to -140 V [2]
Luminance at the centre of the screen		See page 12

EQUIPMENT DESIGN VALUES (each gun if applicable)

Valid for final accelerator voltages between 20 kV and 27,5 kV.

Grid No. 3 (focusing electrode) voltage	V_{g3}	16,8 to 20% of final accelerator voltage
Grid No. 2 voltage	V_{g2}	See cut-off design chart page 13
Grid No. 1 voltage for visual extinction of focused spot (cut-off voltage) [2]	V_{g1}	See cut-off design chart page 13
Difference in cut-off voltages between guns in any tube	ΔV_{g1}	lowest value is min. 65% of highest value
Grid No. 3 (focusing electrode) current	I_{g3}	-5 to +5 μA
Grid No. 2 current	I_{g2}	-5 to +5 μA
Grid No. 1 current at V_{g1} = -150 V	I_{g1}	-5 to +5 μA

		[3]	[4]	[6]
To produce white of the following CIE coordinates	x	0,265	0,281	0,313
	y	0,290	0,311	0,329
Percentage of total anode current supplied by each gun (typical)				
red gun		25,8	30,2	41,0
green gun		33,5	34,5	31,3
blue gun		40,7	35,3	27,7
Ratio of anode currents red gun to green gun	min.	0,55	0,65	0,95
	av.	0,75	0,90	1,30
	max.	1,10	1,25	1,80
Ratio of anode currents red gun to blue gun	min.	0,50	0,65	1,15
	av.	0,65	0,85	1,50
	max.	0,85	1,15	2,00

Notes see page 9.

EQUIPMENT DESIGN VALUES (continued)

Required centring, measured at the centre of the screen in any direction	max.	12	mm
Correction that must be supplied by purifying magnet to compensate for mis-register in any direction	max.	100	μm
Lateral distance between blue spot and the converged red and green spots	max.	5	mm
	(in both directions)		
Radial convergence diaplacement excluding effects of dynamic convergence (each gun) [5]	max.	8	mm
	(in both directions)		

---

1) This range of V_{g2} has to be used when in circuit design fixed values for cut-off of the three guns are used.

2) This range of V_{g1} has to be used when in circuit design fixed values for V_{g2} of the three guns are used.

3) To produce black/white pictures a bluish white point would be preferable. This white point corresponds virtually with the white point of current black/white picture tubes.

4) This point is a compromise between white point D and the white point x = 0.265 y = 0.290, given in order to enable good rendition of colour and black and white pictures with one white point.

5) Dynamic convergence to be effected by currents of approximately parabolic waveshape through the convergence coils synchronized with scanning.

6) To produce colour pictures with the best possible quality, this white point should be used when the transmission system is based on this point. (Point D).

LIMITING VALUES (Each gun if applicable)
(Design centre rating system unless otherwise specified)

Final accelerator values	$V_{a, g5, g4}$	max.	27,5	kV 1) 2) 3)
		min.	20	kV 1) 4)
Average current for three guns	I_a	max.	1000	µA 5)
Grid No. 3 (focusing electrode) voltage	V_{g3}	max.	6000	V
Grid No. 2 voltage, peak, including video signal voltage	V_{g2p}	max.	1000	V
Grid No. 1 voltage,				
negative,	$-V_{g1}$	max.	400	V
negative, operating cut-off	$-V_{g1}$	max.	200	V
positive	V_{g1}	max.	0	V
positive peak	V_{g1p}	max.	2	V
Cathode to heater voltage,				
positive	V_{kf}	max.	250	V 6)
positive peak	V_{kfp}	max.	300	V
negative	$-V_{kf}$	max.	135	V
negative peak	$-V_{kfp}$	max.	180	V

1) Absolute max. rating system.

2) The X-ray dose rate remains below the acceptable value of 0,5mr/h, measured with ionization chamber when the tube is used within its limiting values.

3) For optimal operating conditions the final accelerator voltage has to be stabilized. Therefore its absolute maximum value can be approached in actual operation and for this reason this value is given instead of the design centre value. During adjustment on the production line this value is likely to be surpassed considerably. It is therefore strongly recommended to first make the necessary adjustments for normal operation without picture tube.

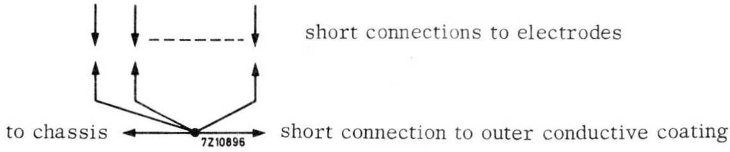
4) Operation of the tube at lower voltages impairs brightness and resolution and may have a detrimental effect on colour purity.

5) 1500 µA permitted provided a current limiting circuit is used.

6) During an equipment warm-up period not exceeding 15 s V_{kf} is allowed to rise to 385 V. Between 15 s and 45 s after switching on a decrease in V_{kf} proportional with time from 385 V to 250 V is permissible.

REMARKS

With the high voltage used with this tube (max. 27,5 kV) internal flash-overs may occur. These may destroy the cathode(s) of the tube. Therefore it is necessary to provide protective circuits, using spark gaps.
The spark gaps must be connected as follows:



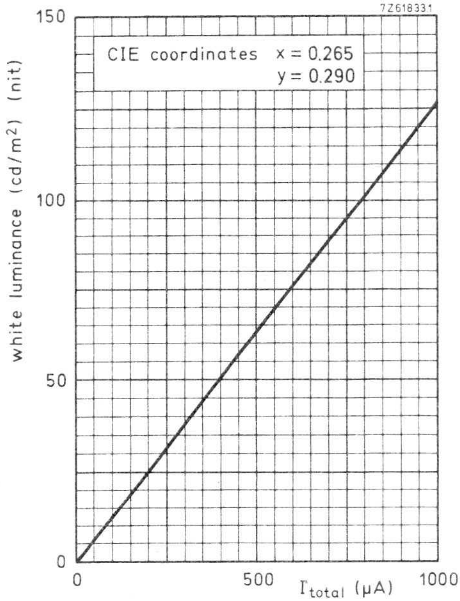
No other connections between the outer conductive coating and the chassis are permissible.
Additional information is given in Application Information 258, available on request.

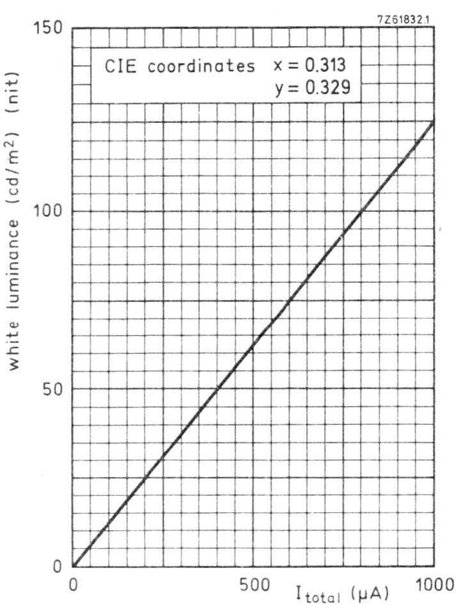
During shipment and handling the tube should not be subjected to accelerations greater than 35 g in any direction.

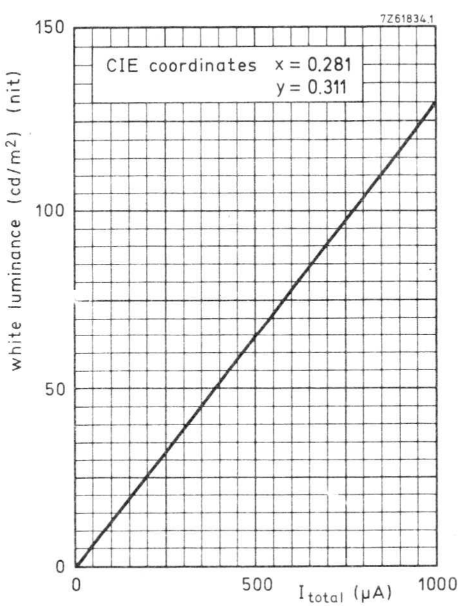
REFERENCE LINE GAUGE (gauge F)

Gauge F. See chapter "Reference line gauges" in front of this book.

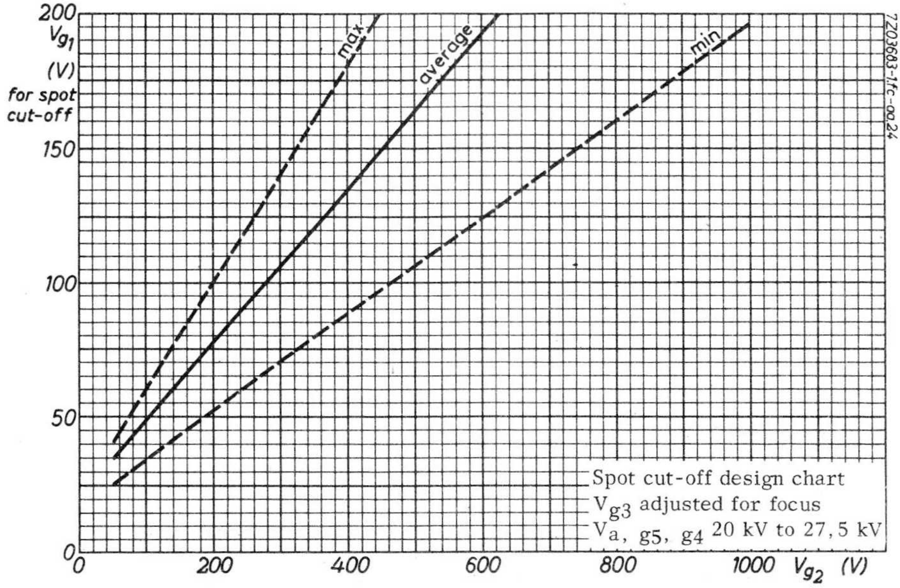
Luminance at the centre of the screen as a function of I_{total}.

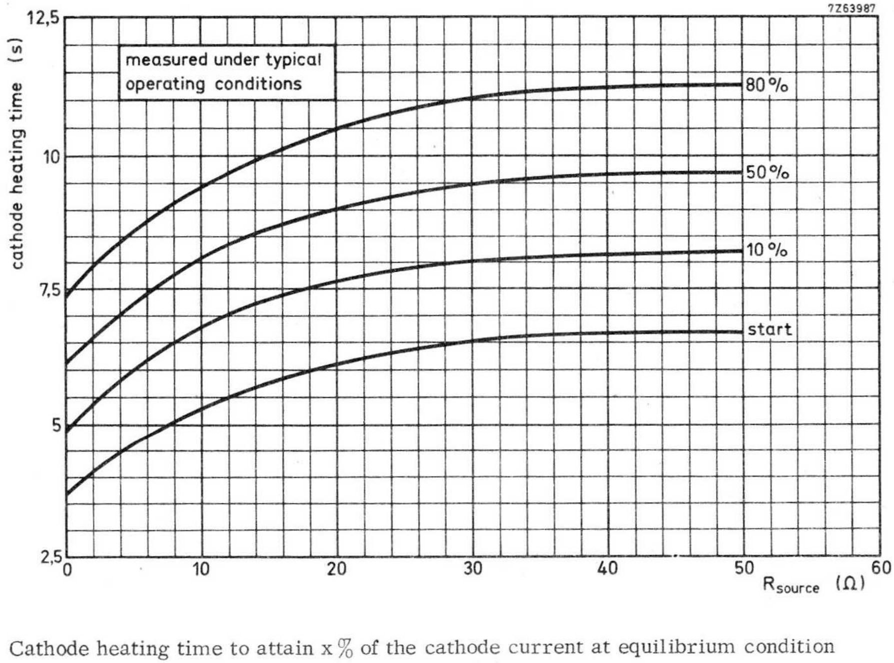




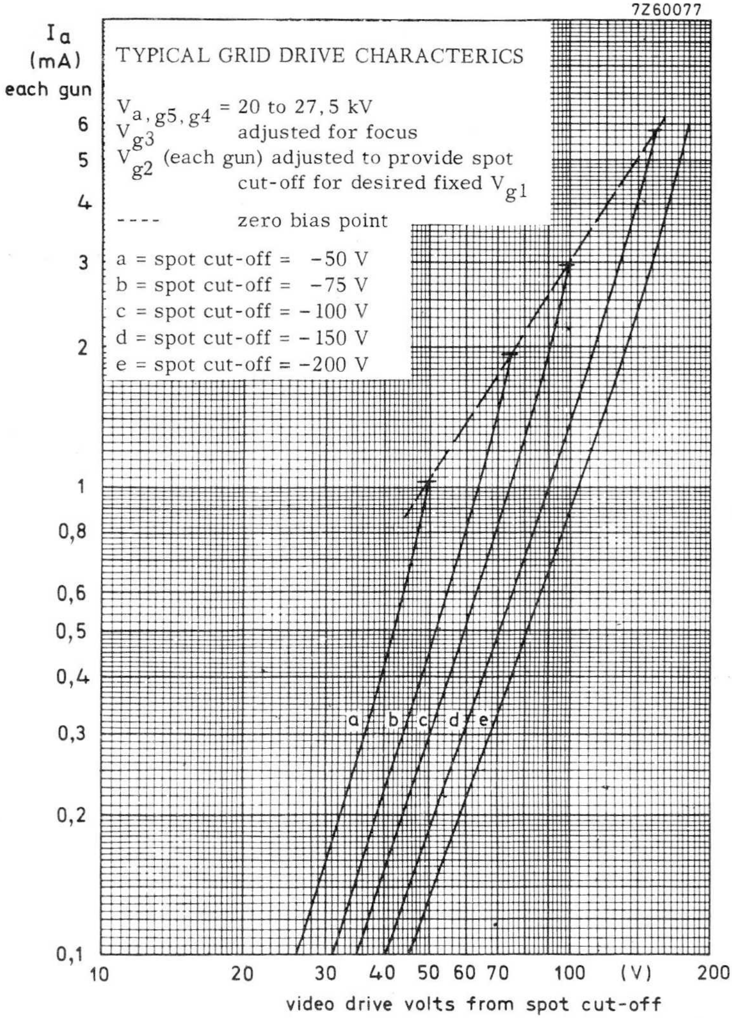


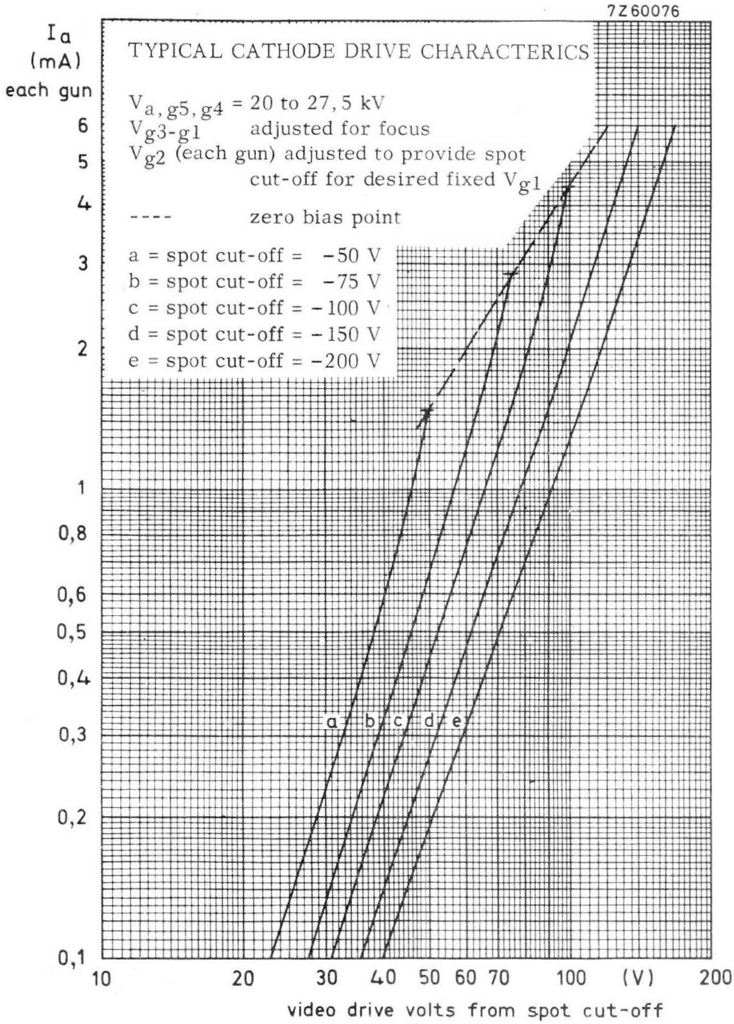
Scanned area 518 mm x 390 mm





Cathode heating time to attain x % of the cathode current at equilibrium condition


7Z60077
TYPICAL GRID DRIVE CHARACTERICS
$V_{a,g5,g4}$ = 20 to 27,5 kV
V_{g3} adjusted for focus
V_{g2} (each gun) adjusted to provide spot cut-off for desired fixed V_{g1}
---- zero bias point
a = spot cut-off = −50 V
b = spot cut-off = −75 V
c = spot cut-off = −100 V
d = spot cut-off = −150 V
e = spot cut-off = −200 V
I_a (mA) each gun
6
5
4
3
2
1
0,8
0,6
0,5
0,4
0,3
0,2
0,1
a
b
c
d
e
10
20
30
40
50
60
70
100
(V)
200
video drive volts from spot cut-off


7Z60076
I_a
(mA)
each gun
TYPICAL CATHODE DRIVE CHARACTERICS
$V_{a,g5,g4}$ = 20 to 27,5 kV
V_{g3-g1} adjusted for focus
V_{g2} (each gun) adjusted to provide spot cut-off for desired fixed V_{g1}
---- zero bias point
a = spot cut-off = −50 V
b = spot cut-off = −75 V
c = spot cut-off = −100 V
d = spot cut-off = −150 V
e = spot cut-off = −200 V
6
5
4
3
2
1
0,8
0,6
0,5
0,4
0,3
0,2
0,1
a
b
c
d
e
10
20
30
40
50
60
70
100
(V)
200
video drive volts from spot cut-off

Black and white
TV picture tubes

TV PICTURE TUBE

31 cm (12), 110°, rectangular direct vision picture tube with integral protection for black and white TV. The 20 mm neck diameter ensures a low deflection energy.
A special feature of this tube is its short cathode heating time.

QUICK REFERENCE DATA.			
Face diagonal		31	cm (12 in)
Deflection angle		110°	
Overall length	max.	233	mm
Neck diameter		20	mm
Heating	11 V ,	140	mA
Grid no. 2 voltage		250	V
Final accelerator voltage		12 to 15	kV
Quick heating cathode	with a typical tube a legible picture will appear within 5 s.		

SCREEN

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

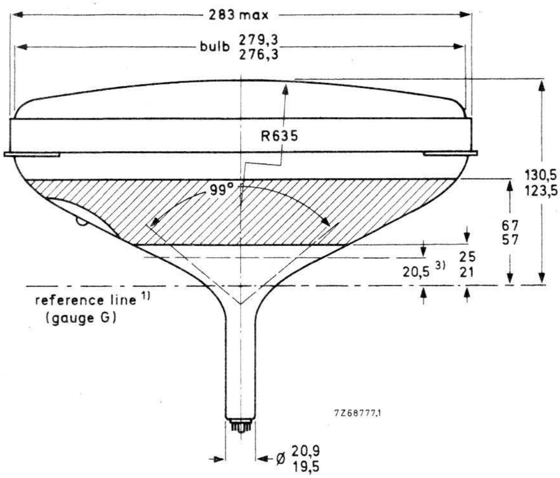
Heater voltage	V_f		11	V	
Heater current	I_f		140	mA	
Limits (Absolute max. rating system) of r.m.s. heater voltage, measured in any 20 ms.	V_f	max.	12,7	V	1)
		min.	9,13	V	

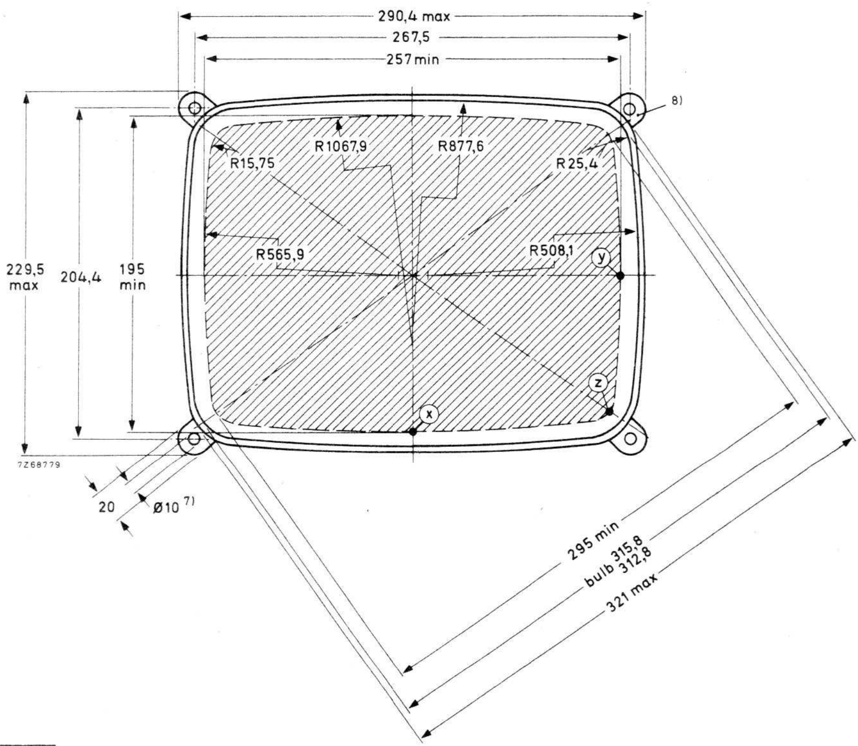
For heating time as a function of source impedance see page 11.

1) This limit also applies during equipment warming up. Use of the tube in a series heater chain is not allowed.

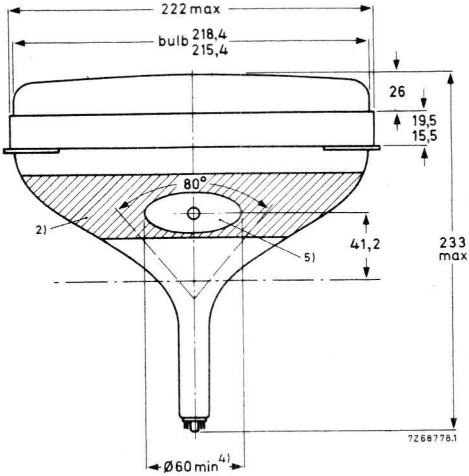
→ MECHANICAL DATA

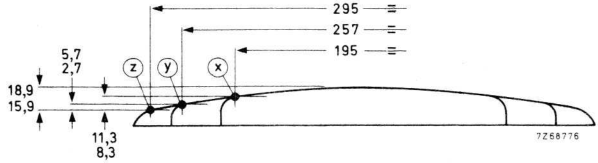
Dimensions in mm

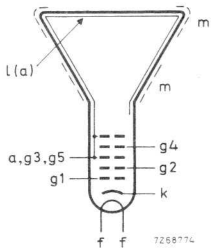


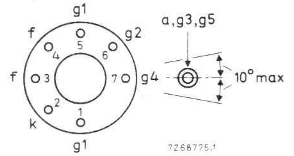


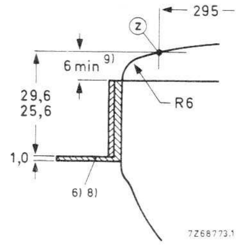
Notes see page 4


222 max
bulb 218,4 215,4
26
19,5
15,5
80°
2)
5)
41,2
233 max
7Z68778.1
Ø60 min 4)


295
257
195
5,7
2,7
z
y
x
18,9
15,9
11,3
8,3
7Z68776







Mounting position : any

Net mass : approx. 2, 8 kg.

Base : JEDEC E7-91

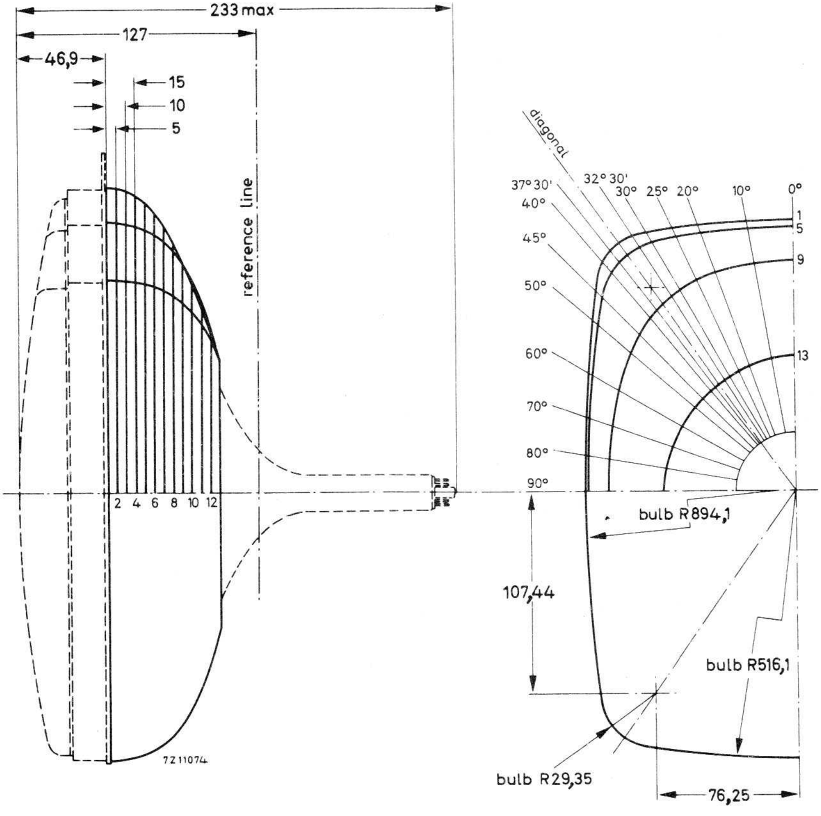
The socket for the base should not be rigidly mounted, it should have flexible leads and be allowed to move freely.

NOTES TO OUTLINE DRAWINGS

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. (Gauge G).
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 G.
4. This area must be kept clean.
5. Recessed cavity contact IEC 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.
Electrical contact between the metal band and the mounting lugs is guaranteed.
9. Distance from reference point Z to any hardware.

MAXIMUM CONE CONTOUR DRAWING

Dimensions in mm



Section	Nom. distance from section 1	Distance from centre (max. values)														
		0^{o}	10^{o}	20^{o}	25^{o}	38'	$32^{o}30'$	diag	$37^{o}30'$	40^{o}	45^{o}	50^{o}	60^{o}	70^{o}	80^{o}	90^{o}
13	59.6	72,2	72,0	71,7	71,4	71,2	71,1	71,0	71,0	70,9	70,8	70,7	70,6	70,7	70,8	70,8
12	55	85,9	85,6	84,9	84,4	84,0	83,8	83.5	83,3	83,1	82,7	82,4	81,9	81,6	81.5	81,5
11	50	99.5	99,4	98,9	98.5	97,9	97,5	97.1	96,8	96,3	95,4	94,4	92,4	90,7	89.5	89,1
10	45	112,3	112,4	112,2	111,7	110,9	110,4	109,7	109,1	108.3	106,6	104,7	100,9	97,7	95,5	94,7
9	40	121.3	121,3	122,8	122,9	122.4	121,9	121.2	120.5	119,5	117,1	114,3	108.6	103.8	100,8	99,7
8	35	127,9	128,9	131,2	132,1	140,8	132,3	131,7	130,9	129,7	126,5	122,7	114,9	108.8	105,0	103,7
7	30	132,6	134,0	137,4	139,3	147,2	141,2	140,9	140,2	138,8	134,6	129,5	119,7	112,5	108,2	106,8
6	25	136.0	137,5	141,7	144,4	151,6	148,3	148,5	147,9	146,5	140,9	134,3	122,9	115,0	110,5	109,0
5	20	138,4	140,0	144,5	147,8	154,6	153,2	153,7	153,2	151,7	144,8	137,1	124,7	116,5	111,8	110,3
4	15	140,3	141,9	146,6	150,2	156,5	156,6	157,4	156,9	155,1	147,1	138,5	125,4	117,0	112,3	110,8
3	10	141,6	143,2	148,0	151,8	154,6	158,7	159,5	159,0	157,1	148,5	139.4	126,0	117,6	112,9	111.4
2	5	142,4	143,9	148,8	152,6	157,4	159,5	160,7	160,2	158,2	149,4	140,1	126,6	118,1	113,4	111,9
1	0	142,8	144,4	149,3	153.1	157,9	160.2	161,1	160,6	158,7	149,9	140,6	127,1	118,5	113,8	112,3

CAPACITANCES

Final accelerator to external conductive coating	$C_{a, g3, g5/m}$	< 900 pF > 450 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	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 Oe). Maximum distance between centre of field of this magnet and reference line : 47 mm.

→ TYPICAL OPERATING CONDITIONS

Grid drive service

Final accelerator voltage	$V_{a, g3, g5}$	12 to 15	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_{GR}	-35 to -69	V

Cathode drive service

Voltages are specified with respect to grid no. 1

Final accelerator voltage	$V_{a, g3, g5}$	12 to 15	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_{KR}	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 max. rating system)

Final accelerator voltage	$V_{a,g3,g5}$	max.	17	kV
		min.	9	kV
Grid No. 4 voltage				
positive	V_{g4}	max.	500	V
negative	$-V_{g4}$	max.	50	V
Grid No. 2 voltage	V_{g2}	max.	350	V
		min.	200	V
Grid No. 2 to grid No. 1 voltage	$V_{g2/g1}$	max.	450	V
Cathode to grid No. 1 voltage				
positive	$V_{k/g1}$	max.	200	V
positive peak	$V_{k/g1p}$	max.	400	V [1]
negative	$-V_{k/g1}$	max.	0	V
negative peak	$-V_{k/g1p}$	max.	2	V
Cathode-to-heater voltage				
positive	$V_{k/f}$	max.	200	V

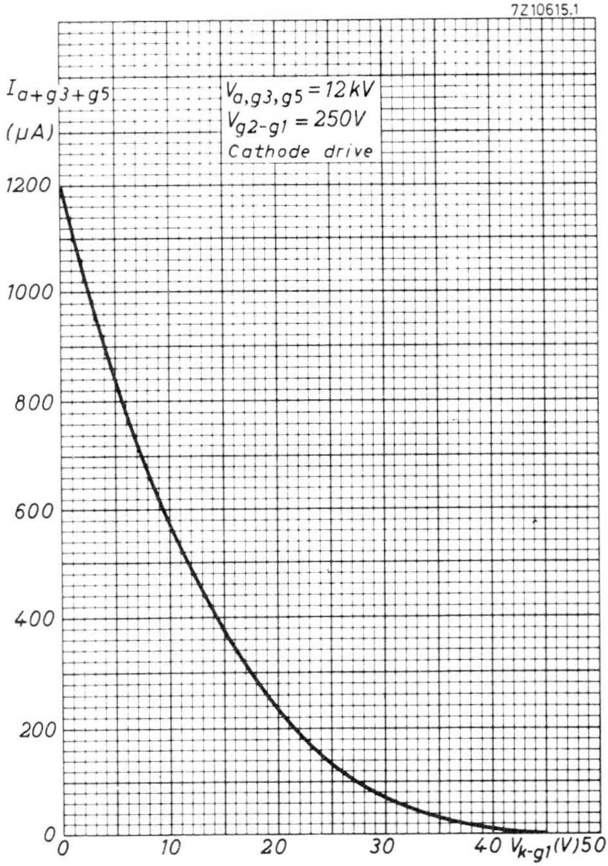
CIRCUIT DESIGN VALUES

Grid No. 4 current				
positive	I_{g4}	max.	25	μA
negative	$-I_{g4}$	max.	25	μA
Grid No. 2 current				
positive	I_{g2}	max.	5	μA
negative	$-I_{g2}$	max.	5	μA

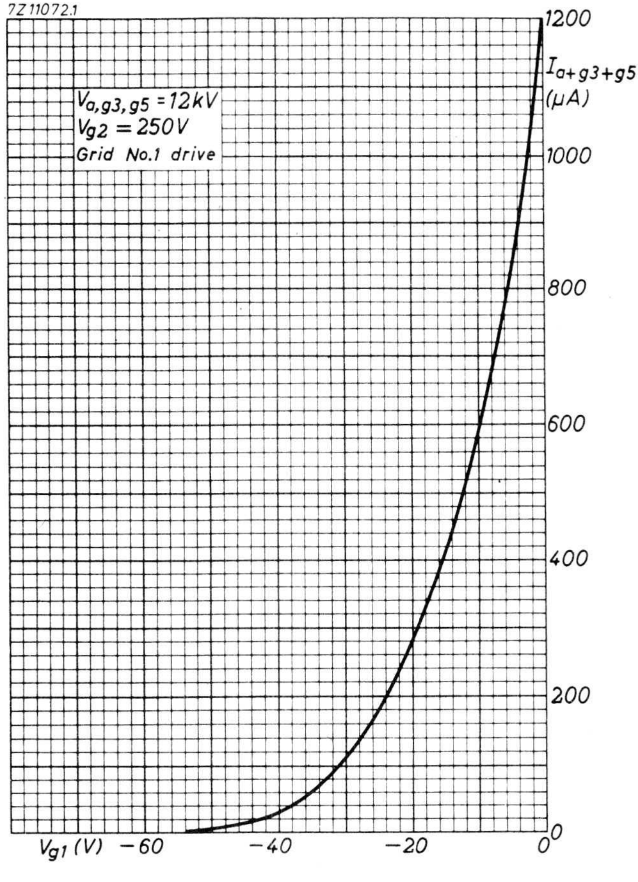
MAXIMUM CIRCUIT VALUES

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_{g1}	max.	1,5	MΩ
Grid No. 1 circuit impedance	Z_{g1} (50 Hz)	max.	0,5	MΩ

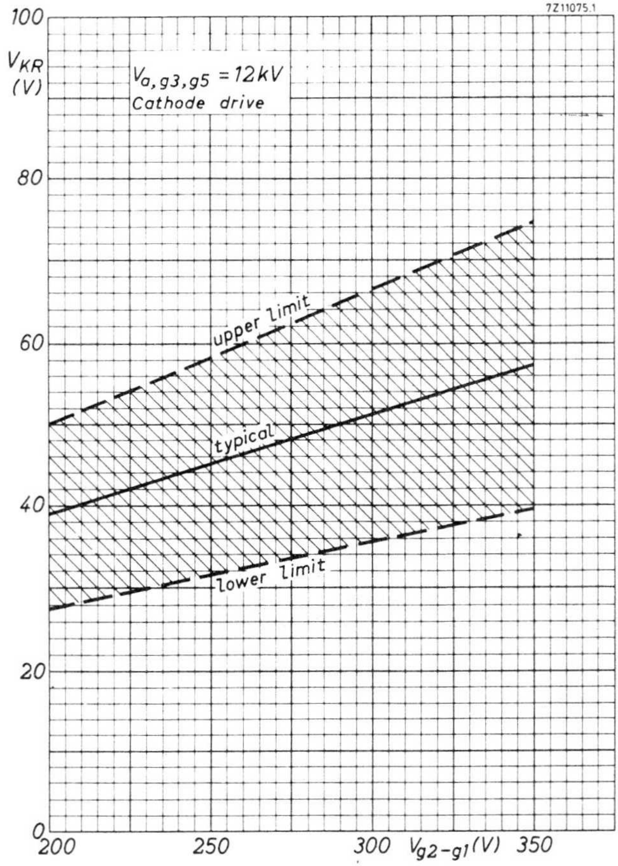
[1]) Maximum pulse duration 22% of a cycle but max. 1,5 ms.



Final accelerator voltage as a function of cathode voltage

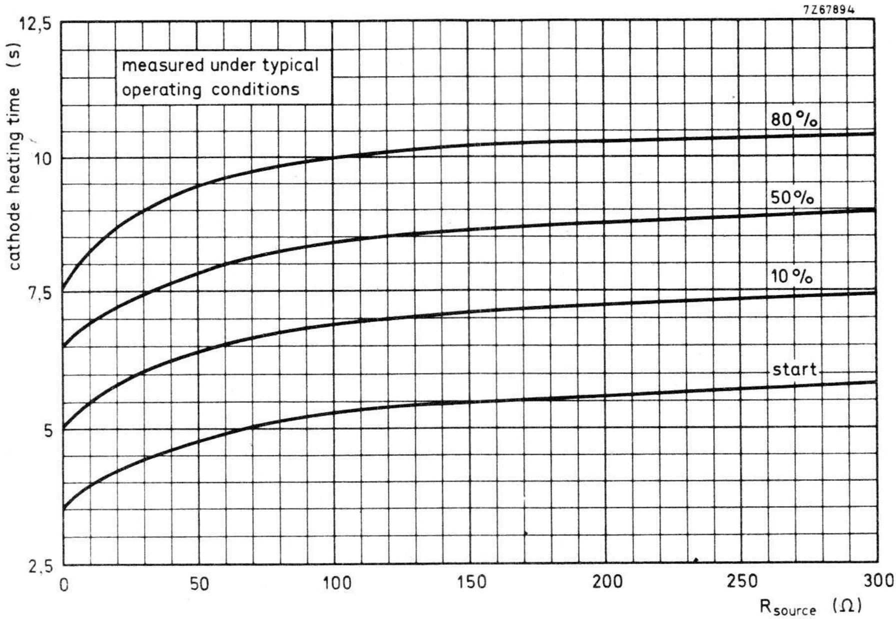


Final accelerator voltage as a function of grid no. 1 voltage



$$\frac{\Delta V_{KR}}{\Delta V_{a,\,g3,\,g5}} = 0,3 \times 10^{-3}$$

Limits of cathode cut-off voltage as a function of grid no. 2 voltage



Cathode heating time to attain x% of the cathode current at equilibrium condition

TV PICTURE TUBE

31 cm (12 in), 110°, rectangular direct vision picture tube with integral protection for black and white TV. The 20 mm neck diameter ensures a low deflection energy.
A special feature of this tube is its short cathode heating time.

QUICK REFERENCE DATA			
Face diagonal		31	cm (12 in)
Deflection angle		110 °	
Overall length	max.	233	mm
Neck diameter		20	mm
Heating	11 V ,	140	mA
Grid no. 2 voltage		130	V
Final accelerator voltage		12 to 15	kV
Quick heating cathode	with a typical tube a legible picture will appear within 5 s.		

SCREEN

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

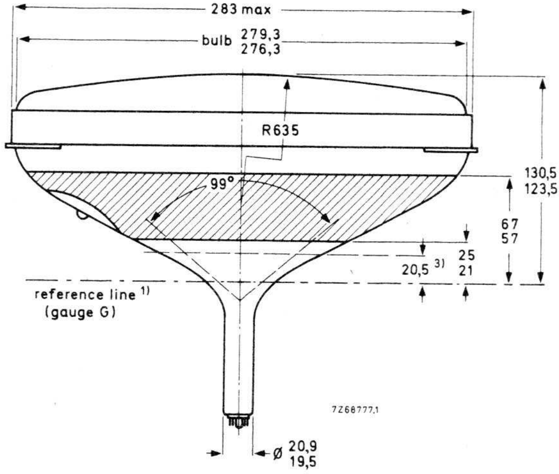
Heater voltage		V_f	11	V
Heater current		I_f	140	mA
Limits (Absolute max. rating system) of r.m.s. heater voltage	V_f	max.	12,7	V [1]
		min.	9,3	V

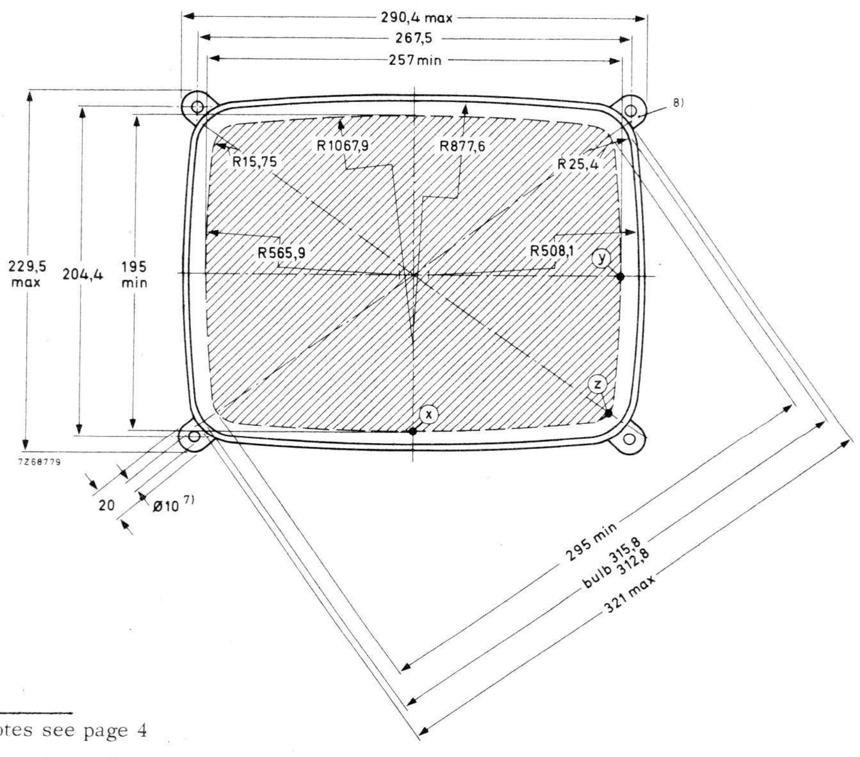
For heating time as a function of source impedance see page 10.

[1]) This limit also applies during equipment warming-up. Use of the tube in a series heaterchain is not allowed.

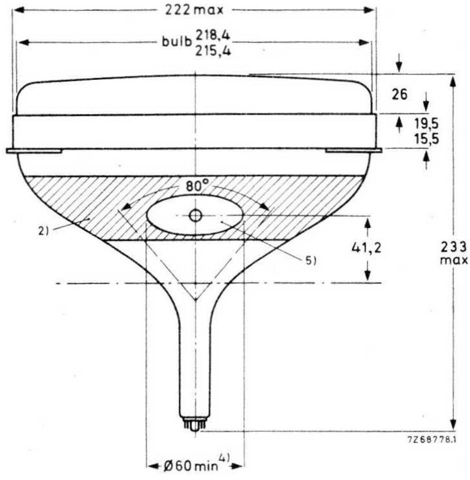
MECHANICAL DATA

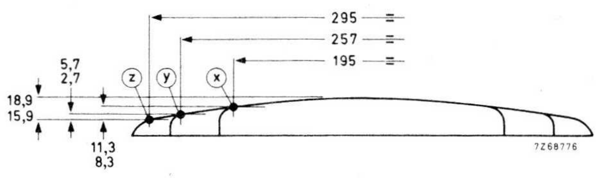
Dimensions in mm

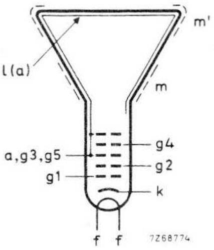


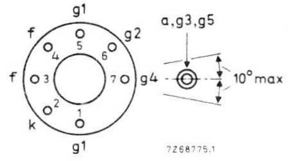


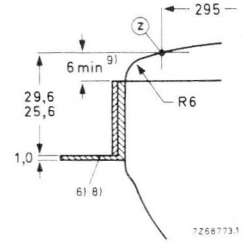
Notes see page 4


222 max
bulb 218,4
215,4
26
19,5
15,5
80°
2)
5)
41,2
233
max
7Z68778.1
Ø60 min 4)


295
257
195
5,7
2,7
z
y
x
18,9
15,9
11,3
8,3
7Z68776







Mounting position : any

Net mass : approx. 2, 8 kg

Base : JEDEC E7-91

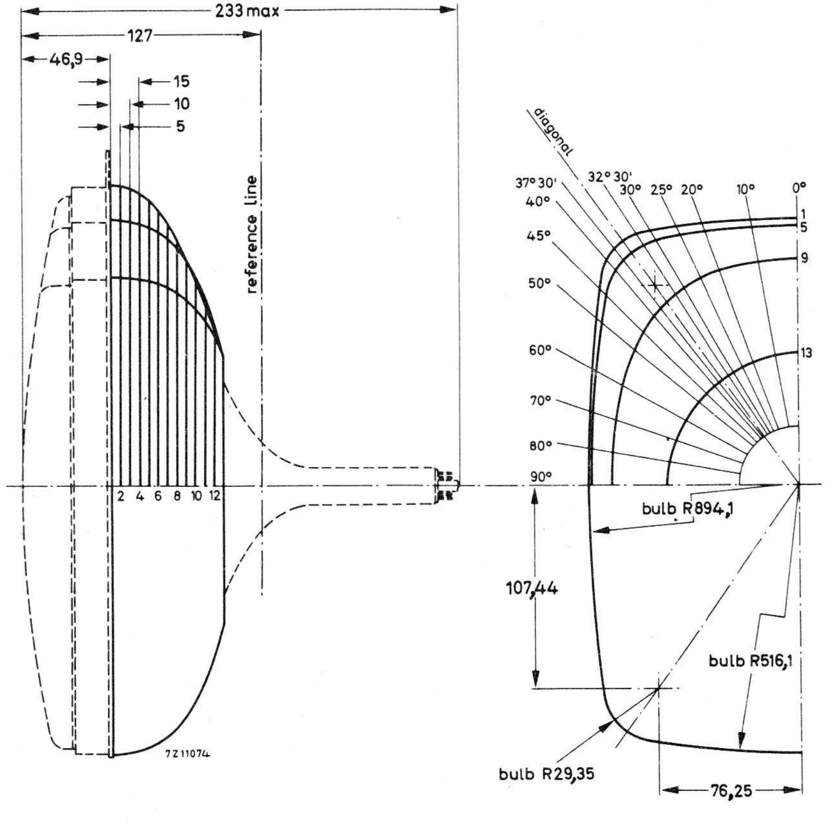
The socket for this base should not be mounted rigidly, it should have flexible leads and be allowed to move freely.

NOTES TO OUTLINE DRAWINGS

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 (Gauge G).
2. The configuration of the external conductive coating may be different, but covers 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 G.
4. This area must be kept clean.
5. Recessed cavity contact IEC 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. Electrical contact between the metal band and the mounting lugs is guaranteed.
9. Distance from reference point Z to any hardware.

MAXIMUM CONE CONTOUR DRAWING

Dimensions in mm



Section	Nom. distance from section 1	Distance from centre (max. values)														
		0°	10°	20°	25°	38'	32°30'	diag	37°30'	40°	45°	50°	60°	70°	80°	90°
13	59.6	72,2	72,0	71,7	71,4	71,2	71,1	71,0	71,0	70,9	70,8	70,7	70,6	70,7	70,8	70,8
12	55	85,9	85,6	84,9	84,4	84,0	83,8	83,5	83,3	83,1	82,7	82,4	81,9	81,6	81,5	81,5
11	50	99,5	99,4	98,9	98,5	97,9	97,5	97,1	96,8	96,3	95,4	94,4	92,4	90,7	89,5	89,1
10	45	112,3	112,4	112,2	111,7	110,9	110,4	109,7	109,1	108,3	106,6	104,7	100,9	97,7	95,5	94,7
9	40	121,3	121,3	122,8	122,9	122,4	121,9	121,2	120,5	119,5	117,1	114,3	108,6	103,8	100,8	99,7
8	35	127,9	128,9	131,2	132,1	140,8	132,3	131,7	130,9	129,7	126,5	122,7	114,9	108,8	105,0	103,7
7	30	132,6	134,0	137,4	139,3	147,2	141,2	140,9	140,2	138,8	134,6	129,5	119,7	112,5	108,2	106,8
6	25	136,0	137,5	141,7	144,4	151,6	148,3	148,5	147,9	146,5	140,9	134,3	122,9	115,0	110,5	109,0
5	20	138,4	140,0	144,5	147,8	154,6	153,2	153,7	153,2	151,7	144,8	137,1	124,7	116,5	111,8	110,3
4	15	140,3	141,9	146,6	150,2	156,5	156,6	157,4	156,9	155,1	147,1	138,5	125,4	117,0	112,3	110,8
3	10	141,6	143,2	148,0	151,8	154,6	158,7	159,5	159,0	157,1	148,5	139,4	126,0	117,6	112,9	111,4
2	5	142,4	143,9	148,8	152,6	157,4	159,5	160,7	160,2	158,2	149,4	140,1	126,6	118,1	113,4	111,9
1	0	142,8	144,4	149,3	153,1	157,9	160,2	161,1	160,6	158,7	149,9	140,6	127,1	118,5	113,8	112,3

CAPACITANCES

Final accelerator to external conductive coating	$C_{a,g3,g5/m}$	< 900 < 450	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	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 Oe). Maximum distance between centre of field of this magnet and reference line: 47 mm.

→ TYPICAL OPERATING CONDITIONS

Cathode drive service

Voltages are specified with respect to grid no. 1

Final accelerator voltage	$V_{a,g3,g5}$	**12 to 15**	kV
Focusing electrode voltage	V_{g4}	0 to 130	V [1])
Grid no. 2 voltage	V_{g2}	130	V
Cathode voltage for visual extinction of focused raster	V_{KR}	30 to 50	V

---

1) Because of the flat focus characteristic it is sufficient to choose a focusing voltage between 0 and +130 V (e.g. two taps; 0 V and 130 V).
The optimum focusing voltage of individual tubes may be between -100 V and +200 V.

LIMITING VALUES (Design max. rating system)

Final accelerator voltage	$V_{a,g3,g5}$	max.	17	kV
		min.	9	kV
Grid no. 4 voltage				
positive	V_{g4}	max.	500	V
negative	$-V_{g4}$	max.	200	V
Grid no. 2 voltage	V_{g2}	max.	200	V
Cathode to grid no. 1 voltage				
positive	$V_{k/g1}$	max.	200	V
positive peak	$V_{k/g1_p}$	max.	400	V [1]
negative	$-V_{k/g1}$	max.	0	V
negative peak	$-V_{k/g1_p}$	max.	2	V
Cathode-to-heater voltage				
positive	$V_{k/f}$	max.	200	V

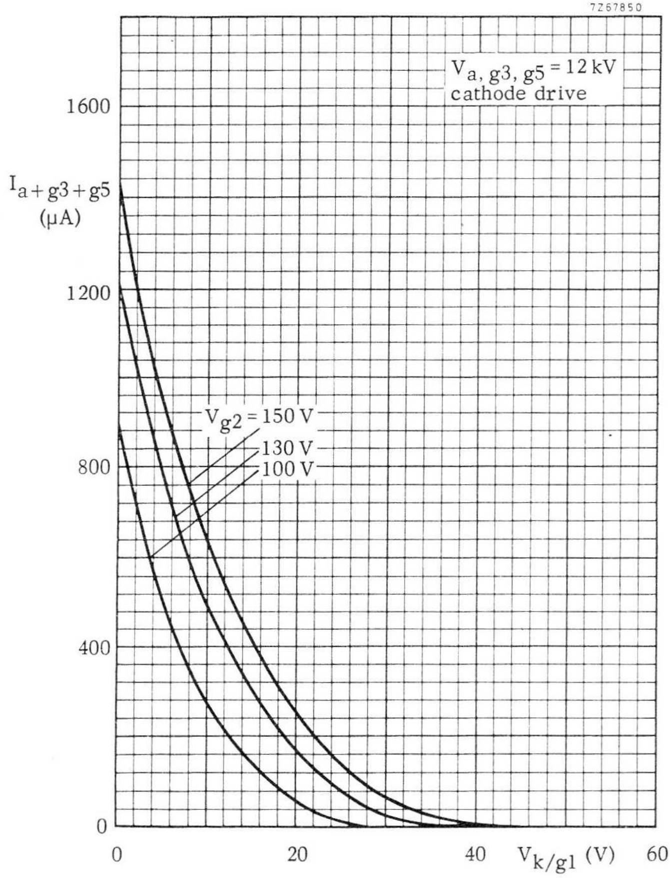
CIRCUIT DESIGN VALUES

Grid no. 4 current				
positive	I_{g4}	max.	25	µA
negative	$-I_{g4}$	max.	25	µA
Grid no. 2 current				
positive	I_{g2}	max.	5	µA
negative	$-I_{g2}$	max.	5	µA

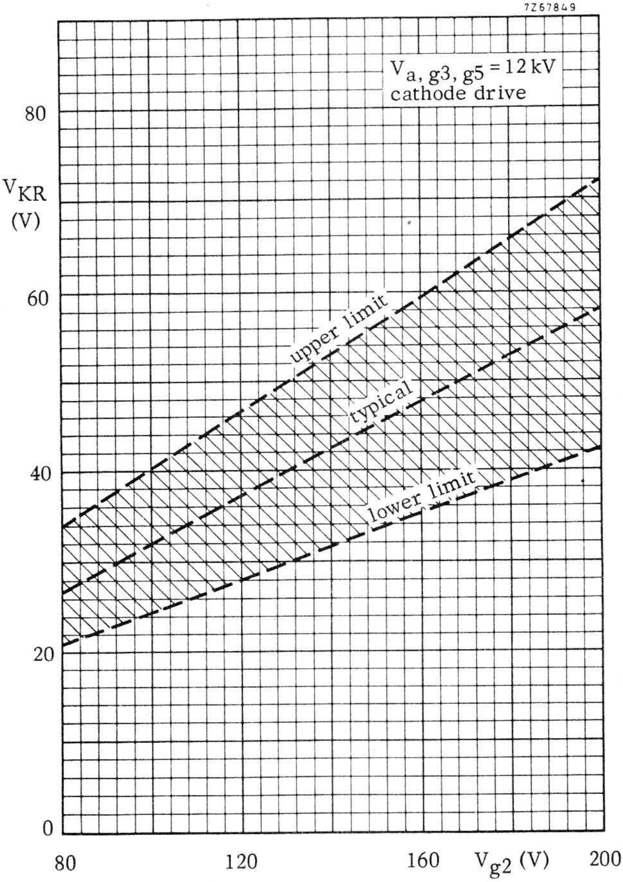
MAXIMUM CIRCUIT VALUES

Resistance between cathode and heater	$R_{k/f}$	max.	1	MΩ
Impedance between cathode and heater	$Z_{k/f}$(50Hz)	max.	0,1	MΩ
Grid no. 1 circuit resistance	R_{g1}	max.	1,5	MΩ
Grid no. 1 circuit impedance	Z_{g1}(50Hz)	max.	0,5	MΩ

[1] Maximum pulse duration 22 % of a cycle but max. 1,5 ms.

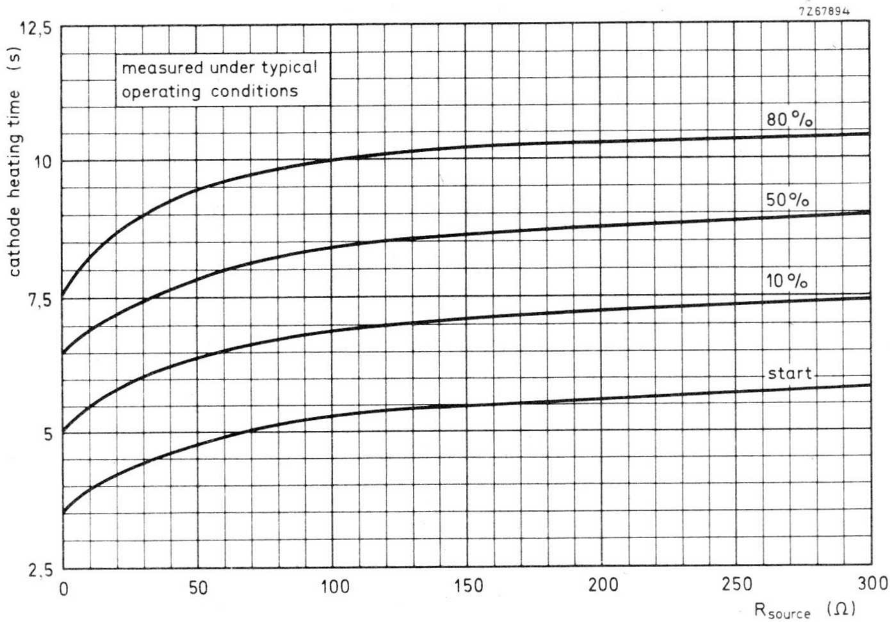


Final accelerator current as a function of cathode voltage



$$\frac{\Delta V_{KR}}{\Delta V_{a, g3, g5}} = 0,3 \times 10^{-3}$$

Limits of cathode cut-off voltage as a function of grid no. 2 voltage



Cathode heating time to attain x % of the cathode current at equilibrium condition

TV PICTURE TUBE

34 cm (14 in), 110°, rectangular direct vision picture tube with integral protection for black and white TV. The 20 mm neck diameter ensures a low deflection energy.
A special feature of this tube is its short cathode heating time.
The tube is designed for "push through" application and is provided with four metal lugs for mounting into a cabinet.

QUICK REFERENCE DATA			
Face diagonal		34	cm (14 in)
Deflection angle		110°	
Overall length	max.	247	mm
Neck diameter		20	mm
Heating		11 V, 140	mA
Grid no. 2 voltage		130	V
Final accelerator voltage		12 to 15	kV
Quick heating cathode	with a typical tube a legible picture will appear within 5 s.		

SCREEN

Metal-backed phosphor			
Luminance	white		
Light transmission of face glass	approx.	48	%
Useful diagonal	min.	322,3	mm
Useful width	min.	270,2	mm
Useful height	min.	210,7	mm

HEATING

Indirect by a.c. or d.c.

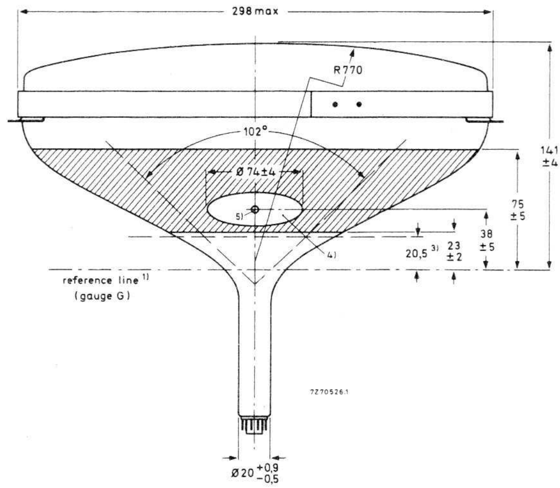
Heater voltage	V_f		11	V	
Heater current	I_f		140	mA	
Limits (Absolute max. rating system) of r.m.s. heater voltage measured in any 20 ms	V_f	max.	12,7	V	[1]
		min.	9,3	V	

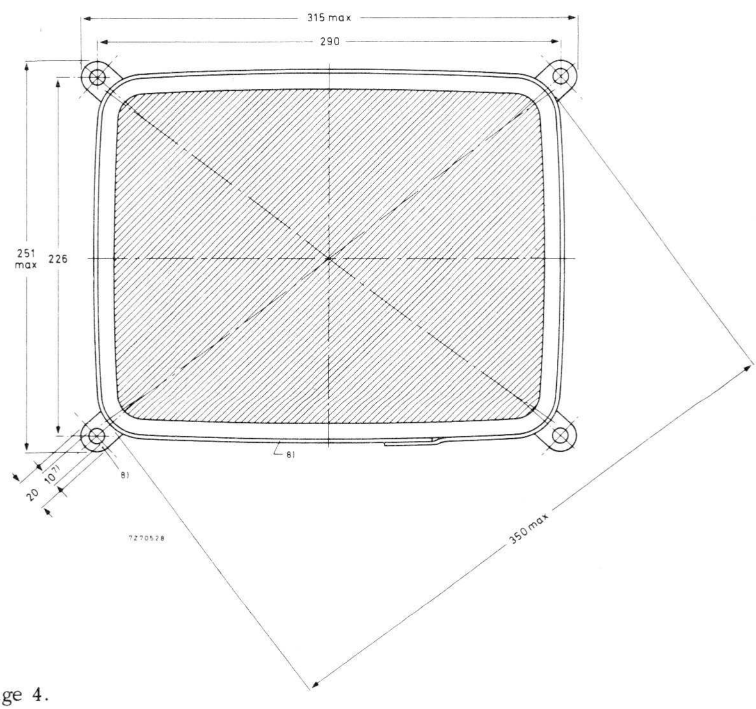
For heating time as a function of source impedance see page 10.

[1]) This limit also applies during equipment warming up. Use of the tube in a series heater chain is not allowed.

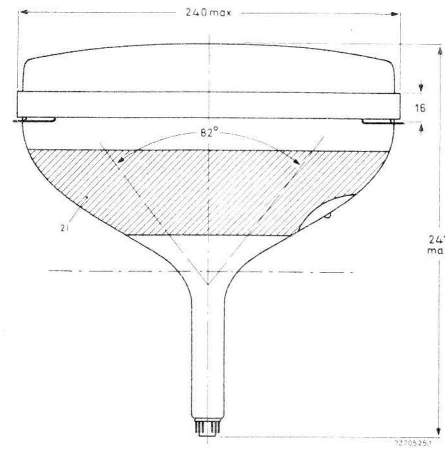
MECHANICAL DATA

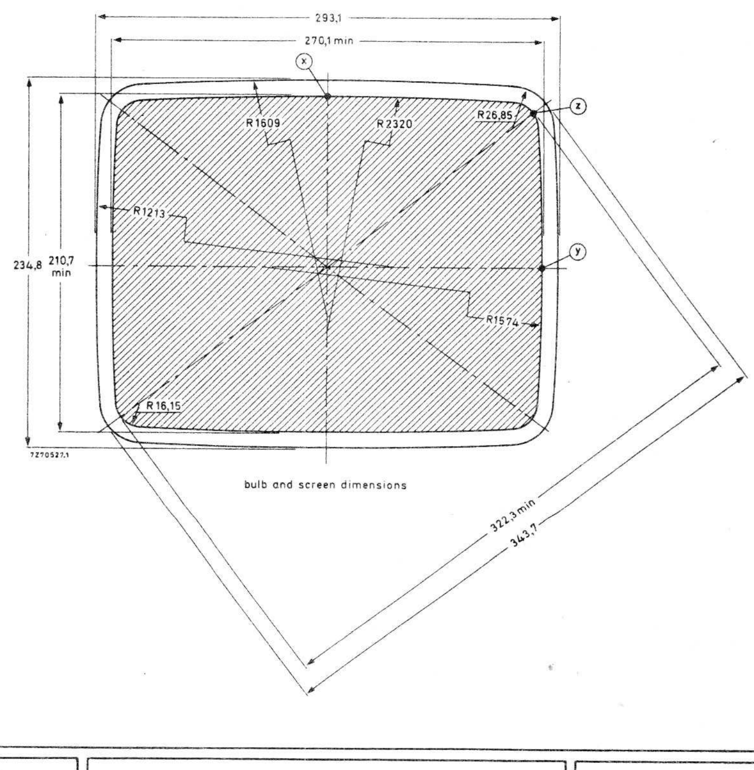
Dimensions in mm



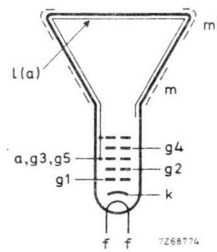


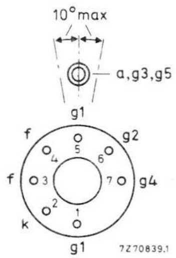
Notes see page 4.

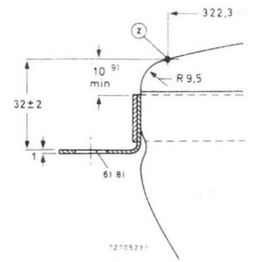


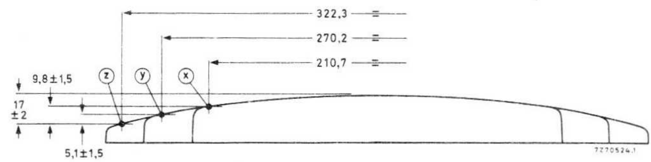


bulb and screen dimensions









Mounting position : any

Netmass : approx. 3,2 kg

Base : JEDEC E7-91

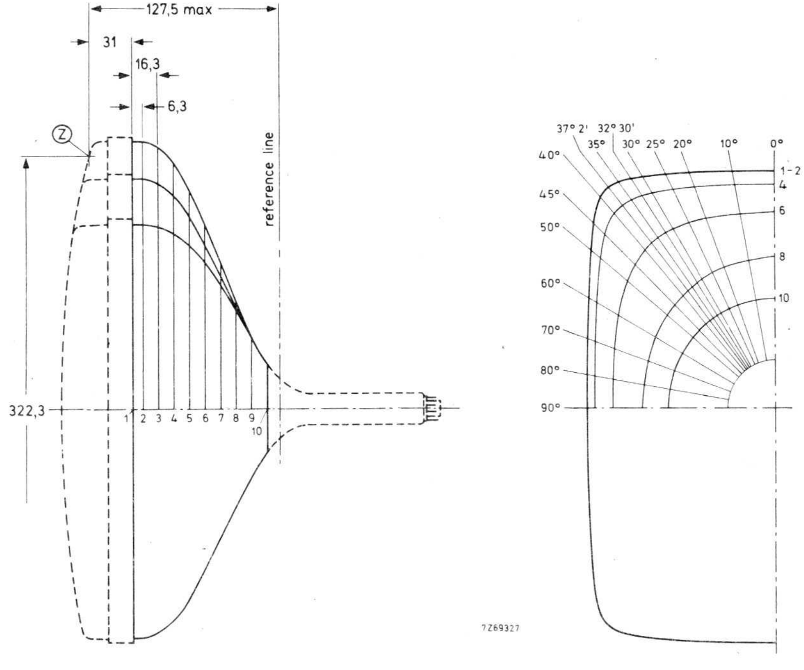
The socket for this base should not be mounted rigidly it should have flexible leads and be allowed to move freely.

NOTES TO OUTLINE DRAWINGS

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 (gauge G).
2. The configuration of the external conductive coating may be different, but covers 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 G.
4. This area must be kept clean.
5. Recessed cavity contact IEC67-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 drawn around the true geometrical positions i.e. at the corners of a rectangle of 290 mm x 226 mm.
8. Electrical contact between the metal band and mounting lugs is guaranteed.
9. Distance from reference point Z to any hardware.

MAXIMUM CONE CONTOUR DRAWING

Dimensions in mm



Sec-tion	Nom. distance from section 1	Distance from centre (max. values)														
		0^o	10^o	20^o	25^o	30^o	$32^o30'$	35^o	$37^o2'$	40^o	45^o	50^o	60^o	70^o	80^o	90^o
1	0	150,6	152,7	159,3	164,4	170,4	173,4	175,7	176,5	174,8	165,3	154,6	138,6	128,6	123,2	121,4
2	6,3	150,6	152,7	159,3	164,4	170,4	173,4	175,7	176,5	174,8	165,3	154,6	138,6	128,6	123,2	121,4
3	16,3	148,1	150,2	156,6	161,6	167,6	170,6	173,0	173,9	172,6	163,7	153,2	137,3	127,4	121,9	120,2
4	26,3	141,6	143,5	149,3	153,6	158,3	160,3	161,8	162,2	161,3	155,5	147,2	132,8	123,5	118,3	116,7
5	36,3	133,5	135,2	139,9	142,9	145,7	146,7	147,3	147,3	146,4	142,8	137,4	126,1	117,7	113,0	111,5
6	46,3	124,0	125,3	128,5	130,1	131,2	131,4	131,4	131,1	130,3	127,9	124,6	116,9	110,3	106,2	104,9
7	56,3	112,2	113,0	114,1	114,3	114,2	114,0	113,6	113,2	112,5	110,0	109,1	104,7	100,7	97,8	96,7
8	66,3	95,8	95,6	95,6	94,6	93,9	93,6	93,2	92,9	92,4	91,5	90,6	88,9	87,4	86,3	85,9
9	71,3	84,5	84,1	83,3	82,8	82,2	81,9	81,7	81,4	81,1	80,6	80,1	79,3	78,8	78,5	78,5
10	76,0	69,0	69,0	69,0	69,0	69,0	69,0	69,0	69,0	69,0	69,0	69,0	69,0	69,0	69,0	69,0

CAPACITANCES

Final accelerator to external conductive coating	$C_{a, g3, g5/m}$	<900 >400	pF pF
Final accelerator to metal band	$C_{a, g3, g5/m}$	200	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^o
Horizontal deflection angle	102^o
Vertical deflection angle	82^o

PICTURE CENTRING MAGNET

Field intensity perpendicular to the tube axis adjustable from 0 to 800 A/m (0 to 10 Oe). Maximum distance between centre of field of this magnet and reference line: 47 mm.

TYPICAL OPERATING CONDITIONS

Cathode drive service

Voltages are specified with respect to grid no. 1.

Final accelerator voltage	$V_{a, g3, g5}$	12 to 15	kV
Focusing electrode voltage	V_{g4}	0 to 130	V [1]
Grid no. 2 voltage	V_{g2}	130	V
Cathode voltage for visual extinction of focused raster	V_{KR}	30 to 50	V

[1] Because of the flat focus characteristic it is sufficient to choose a focusing voltage between 0 V and +130 V (e.g. two taps, 0 V and 130 V).
The optimum focus voltage of individual tubes may be between -100 V and +200 V.

LIMITING VALUES (Design max. rating system)

Final accelerator voltage at $I_{a, g3, g5} = 0$	$V_{a, g3, g5}$	max.	17	kV
		min.	9	kV
Grid no. 4 voltage,				
positive	V_{g4}	max.	500	V
negative	$-V_{g4}$	max.	200	V
Grid no. 2 voltage	V_{g2}	max.	200	V
Cathode to grid no. 1 voltage,				
positive	$V_{k/g1}$	max.	200	V
positive peak	$V_{k/g1p}$	max.	400	V [1]
negative	$-V_{k/g1}$	max.	0	V
negative peak	$-V_{k/g1p}$	max.	2	V
Cathode-to-heater voltage				
positive	$V_{k/f}$	max.	200	V

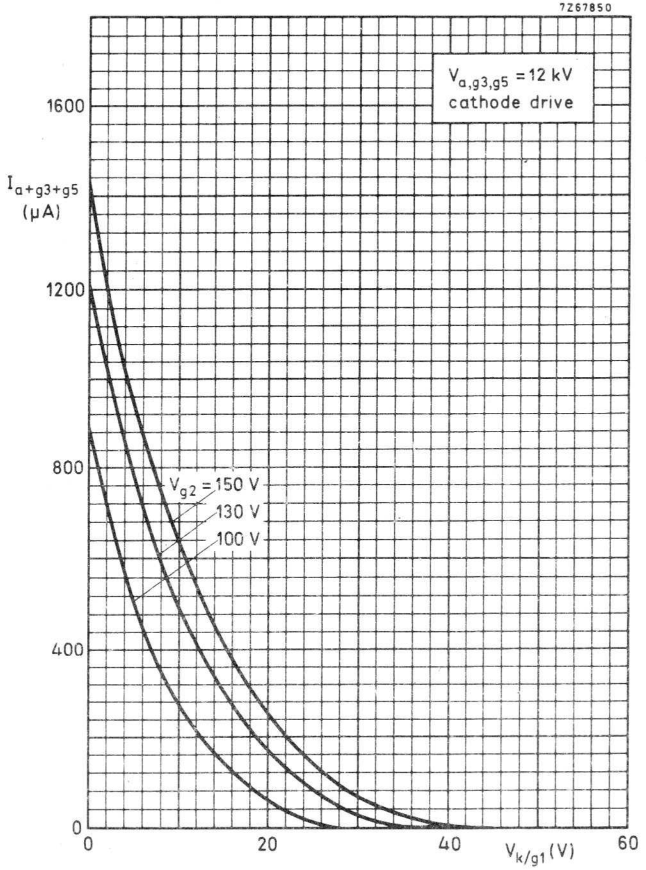
CIRCUIT DESIGN VALUES

Grid no. 4 current				
positive	I_{g4}	max.	25	µA
negative	$-I_{g4}$	max.	25	µA
Grid no. 2 current				
positive	I_{g2}	max.	5	µA
negative	$-I_{g2}$	max.	5	µA

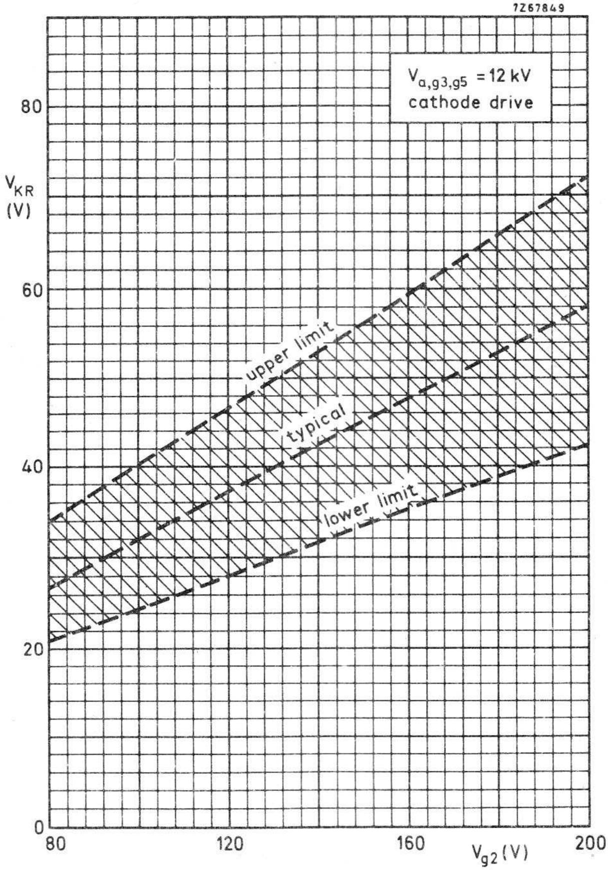
MAXIMUM CIRCUIT VALUES

Resistance between cathode and heater	$R_{k/f}$	max.	1	MΩ
Impedance between cathode and heater	$Z_{f/k}$(50 Hz)	max.	0,1	MΩ
Grid no. 1 circuit resistance	R_{g1}	max.	1,5	MΩ
Grid no. 1 circuit impedance	Z_{g1}(50 Hz)	max.	0,5	MΩ

[1]) Maximum pulse duration 22% of a cycle but max. 1,5 ms.

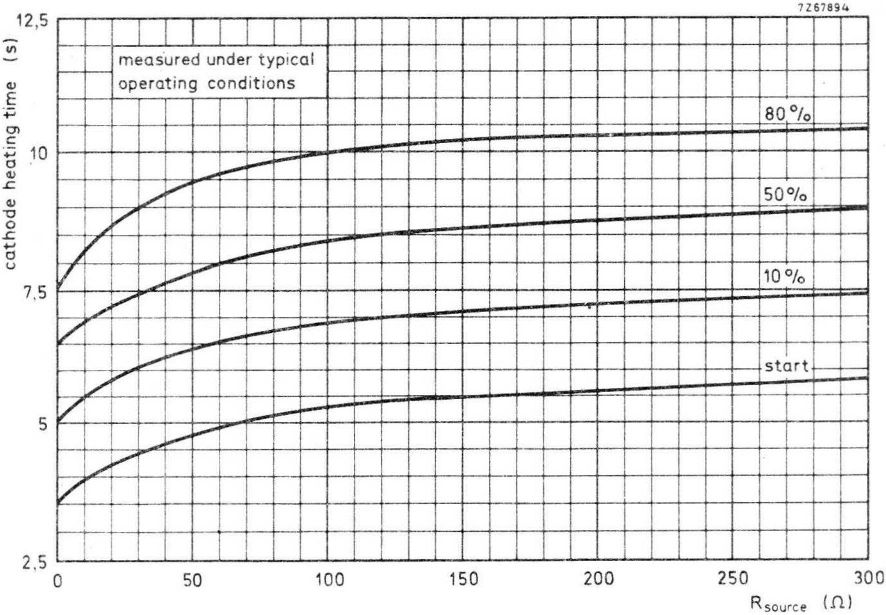


Final accelerator current as a function of cathode voltage.



$$\frac{\Delta V_{KR}}{\Delta V_{a,g3,g5}} \doteq 0,3 \times 10^{-3}$$

Limits of cathode cut-off voltage as a function of grid no. 2 voltage.



Cathode heating time to attain x % of the cathode current at equilibrium condition.

TV PICTURE TUBE

44 cm (17 in), 110°, rectangular direct vision picture tube with integral protection for black-and-white TV.

QUICK REFERENCE DATA	
Face diagonal	44 cm
Deflection angle	110°
Overall length	284,5 mm
Neck diameter	28,6 mm
Heating	6,3 V, 300 mA
Grid no. 2 voltage	400 V
Final accelerator voltage	20 kV

SCREEN

Metal-backed phosphor	
Luminescence	white
Light transmission of face glass	48 %
Useful diagonal	min. 413 mm
Useful width	min. 346 mm
Useful height	min. 270 mm

HEATING

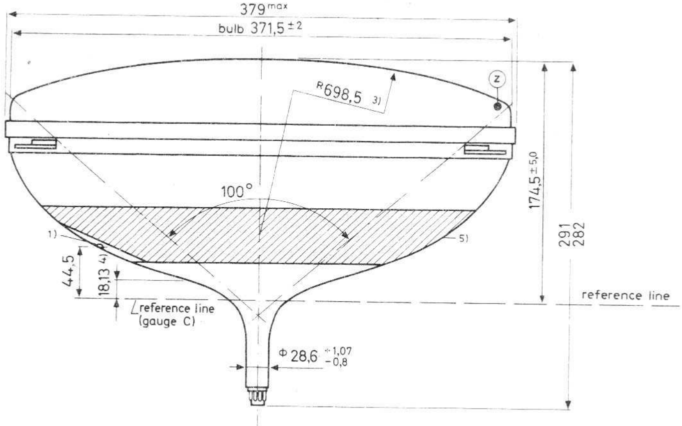
Indirect by a.c. or d.c.; series or parallel supply

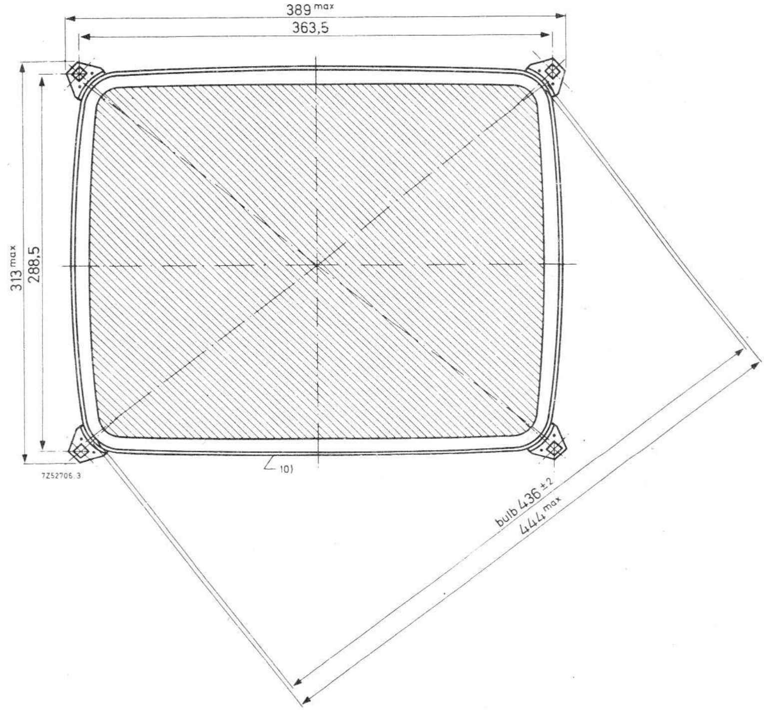
Heater current	I_f	300 mA
Heater voltage	V_f	6,3 V

If the tube is connected in a series heater chain the surge heater voltage must not exceed an r.m.s. value of 9,5 V when the supply is switched on.

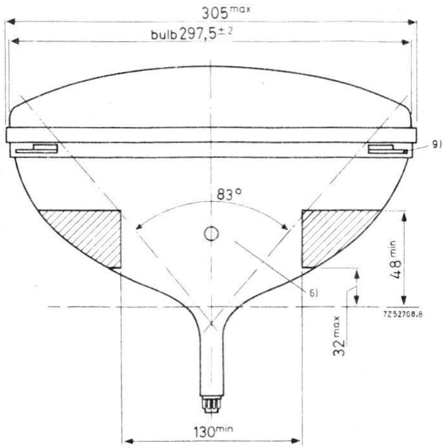
MECHANICAL DATA

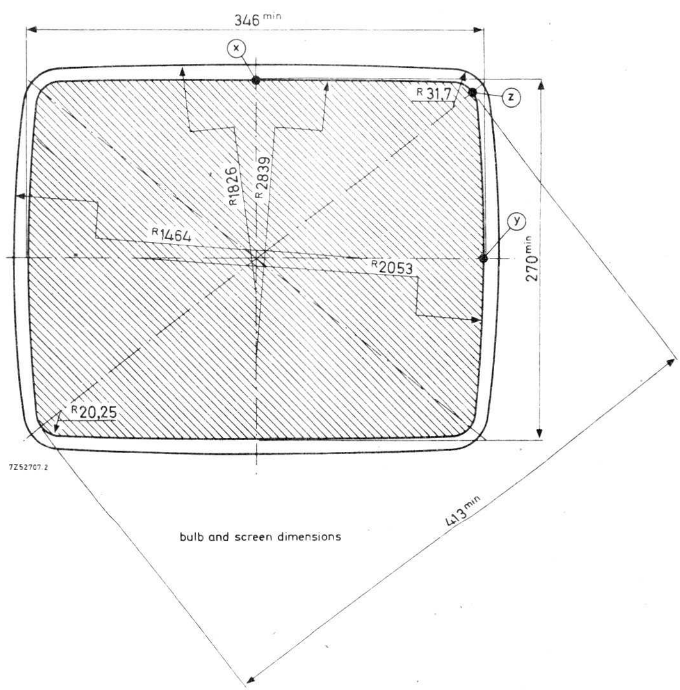
Dimensions in mm





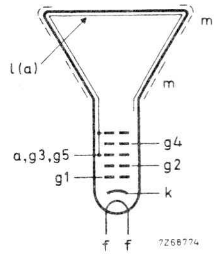
Notes see page 5.

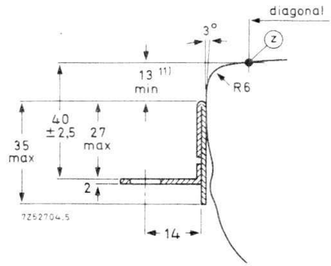


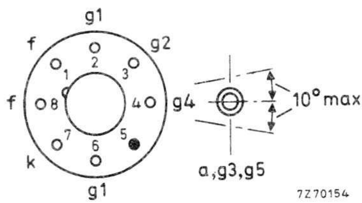


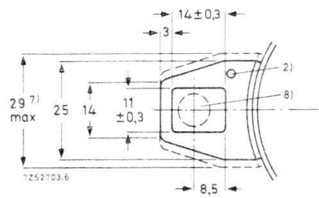
bulb and screen dimensions

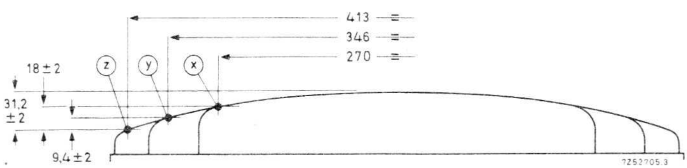
Dimensions in mm











Mounting position : any

Base : neo eightar 7 pin JEDEC B7-208, B8H, IEC-67-I-31a

Net mass : approx. 6 kg

The bottom circumference of the base wafer will fall within a circle concentric with the tube axis and having a diameter of 40 mm.
The socket for the base should not be rigidly mounted: it should have flexible leads and be allowed to move freely.

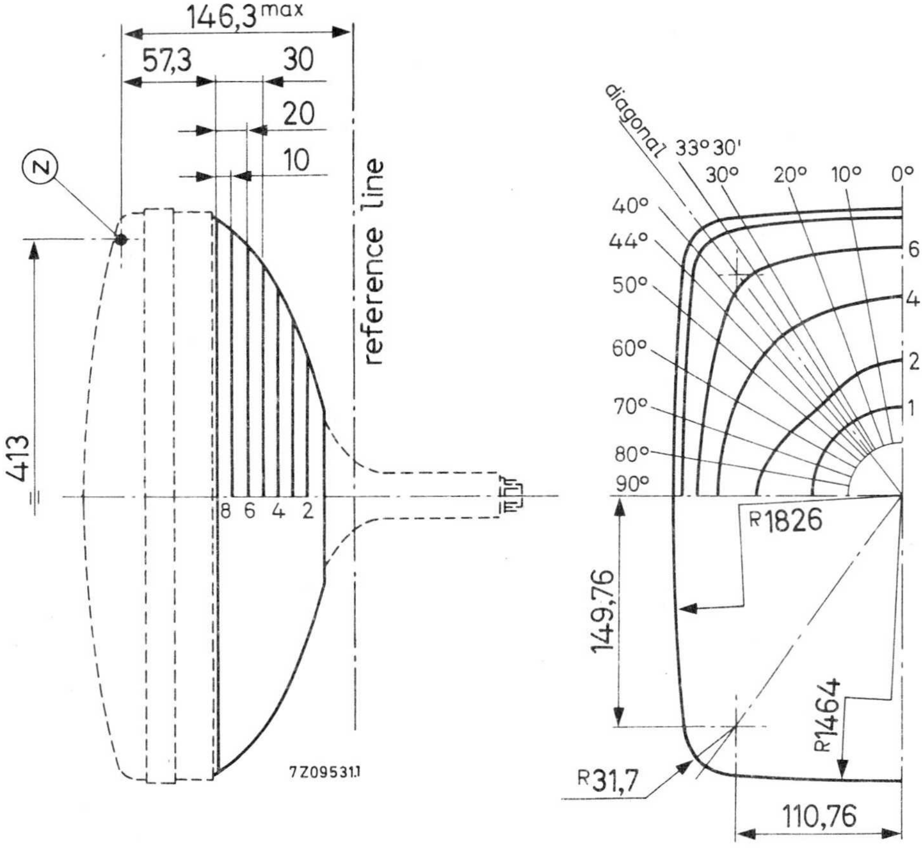
Notes see page 5

NOTES TO OUTLINE DRAWINGS

1. Small cavity contact IEC-67-III-2.
2. The metal rim-band must be earthed. The hole of 3 mm dia in each lug is provided for this purpose.
3. Spherical face-plate.
4. End of guaranteed contour. The maximum contour from reference line towards screen is given by the reference line gauge C (18, 13 mm).
5. The configuration of the external conductive coating may be different but contains the contact area as shown in the drawing.
   The external conductive coating must be earthed.
6. This area must be kept clean.
7. Minimum space to be reserved for mounting lug.
8. The mounting screws in the cabinet must be situated inside a circle of 7,5 mm diameter drawn around the true geometrical positions i.e. at the corners of a rectangle of 363,5 mm x 288,5 mm.
9. The displacement of any lug with respect to the plane through the other three lugs is max. 2 mm.
10. Max. curvatures of the outside rim-band are nominal bulb radius + 4 mm.
11. Distance from reference point Z to any hardware.

MAXIMUM CONE CONTOUR DRAWING

Dimensions in mm



		Distance from centre (max. values)												
Section	Nom. distance from point "Z"	0^0 Long	10^0	20^0	30^o	$33^030'$	$36^030'$ Diagonal	40^0	44^0	50^0	60^0	70^0	80^0	90^0 Short
1	128, 0	60, 0	60, 0	60, 0	60, 0	60, 0	60, 0	60, 0	60, 0	60, 0	60, 0	60, 0	60, 0	60, 0
2	117, 3	95, 9	95, 2	93, 0	92, 3	92, 1	92, 1	92, 3	92, 6	93, 1	93, 8	94, 6	94, 9	95, 1
3	107, 3	118, 1	117, 8	118, 3	118, 3	118, 6	119, 2	117, 8	117, 7	117, 2	115, 5	113, 3	111, 2	109, 8
4	97, 3	135, 0	136, 1	138, 3	139, 9	141, 0	141, 6	141, 1	138, 5	135, 4	130, 5	125, 6	121, 8	120, 8
5	87, 3	149, 5	151, 1	155, 1	159, 1	161, 3	162, 0	161, 5	157, 5	151, 0	142, 0	135, 8	130, 8	129, 5
6	77, 3	162, 5	164, 0	168, 8	176, 0	179, 0	179, 5	178, 0	173, 5	163, 4	150, 8	143, 3	138, 3	136, 4
7	67, 3	172, 5	174, 4	180, 1	190, 0	194, 1	196, 3	194, 9	186, 8	174, 5	159, 1	149, 3	143, 9	141, 7
8	57, 3	179, 7	183, 1	189, 3	201, 1	207, 4	210, 9	206, 1	196, 0	182, 8	165, 5	154, 0	147, 9	145, 6

CAPACITANCES

Final accelerator to external conductive coating	$C_{a,g3,g5/m}$	< 1300 > 700	pF pF
Final accelerator to metal band	$C_{a,g3,g5/m'}$	200	pF
Cathode to all	C_k	5	pF
Grid no. 1 to all	C_{g1}	7	pF

FOCUSING electrostatic

DEFLECTION magnetic

Diagonal deflection angle	110^o
Horizontal deflection angle	100^o
Vertical deflection angle	83^o

PICTURE CENTRING MAGNET

Field intensity perpendicular to the tube axis adjustable from 0 to 800 A/m (0 to 10 Oe).

Maximum distance between centre of field of this magnet and reference line: 57 mm.

TYPICAL OPERATING CONDITIONS

Grid drive service

Final accelerator voltage	$V_{a,g3,g5}$	20	kV
Focusing electrode voltage	V_{g4}	0 to 400	V [1]
Grid no. 2 voltage	V_{g2}	400	V
Grid no. 1 voltage for visual extinction of focused raster	V_{GR}	-40 to -77	V

Cathode drive service

Voltages are specified with respect to grid no. 1

Final accelerator voltage	$V_{a,g3,g5}$	20	kV
Focusing electrode voltage	V_{g4}	0 to 400	V [1]
Grid no. 2 voltage	V_{g2}	400	V
Cathode voltage for visual extinction of focused raster	V_{KR}	36 to 66	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 max. rating system)

Final accelerator voltage at $I_{a,g3,g5} = 0$	$V_{a,g3,g5}$	max. min.	23 12	kV kV
Grid no. 4 voltage,				
positive	V_{g4}	max.	1000	V
negative	$-V_{g4}$	max.	500	V
Grid no. 2 voltage	V_{g2}	max. min.	700 350	V [2] V
Grid no. 2 to grid no. 1 voltage	$V_{g2/g1}$	max.	850	V
Grid no. 1 voltage				
positive	V_{g1}	max.	0	V
positive peak	V_{g1p}	max.	2	V
negative	$-V_{g1}$	max.	200	V
negative peak	$-V_{g1p}$	max.	400	V [1]
Cathode to heater voltage,				
positive	$V_{k/f}$	max.	250	V
positive peak	$V_{k/fp}$	max.	300	V
negative	$-V_{k/f}$	max.	200	V
positive during equipment warm-up period not exceeding 15 s	$V_{k/f}$	max.	450	V [3]

[1] Maximum pulse duration 22% of a cycle but maximum 1,5 ms.

[2] At $V_{g1/k} = 0$ V.

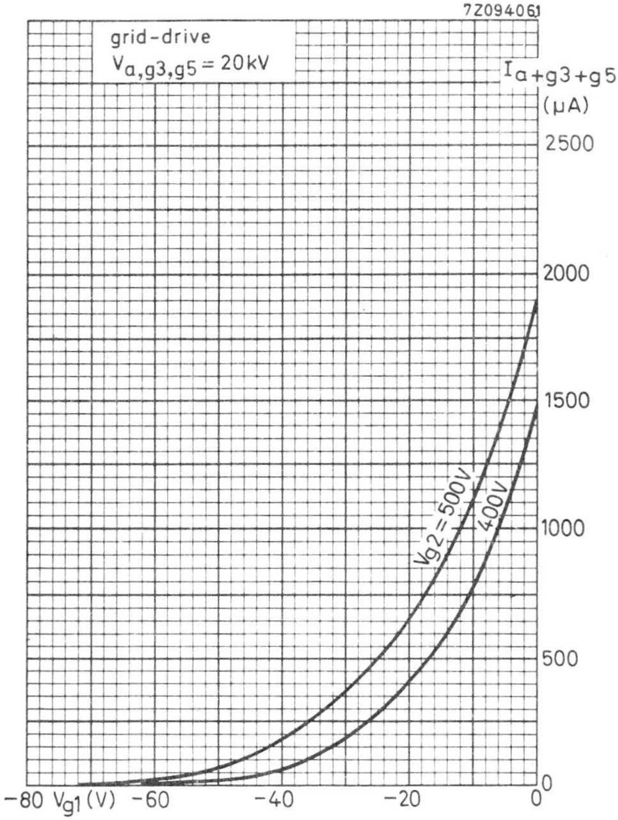
[3] Between 15 s and 45 s after switching on a decrease in k/f voltage from 450 V to 250 V, linearly proportional with time, is permissible.

CIRCUIT DESIGN VALUES

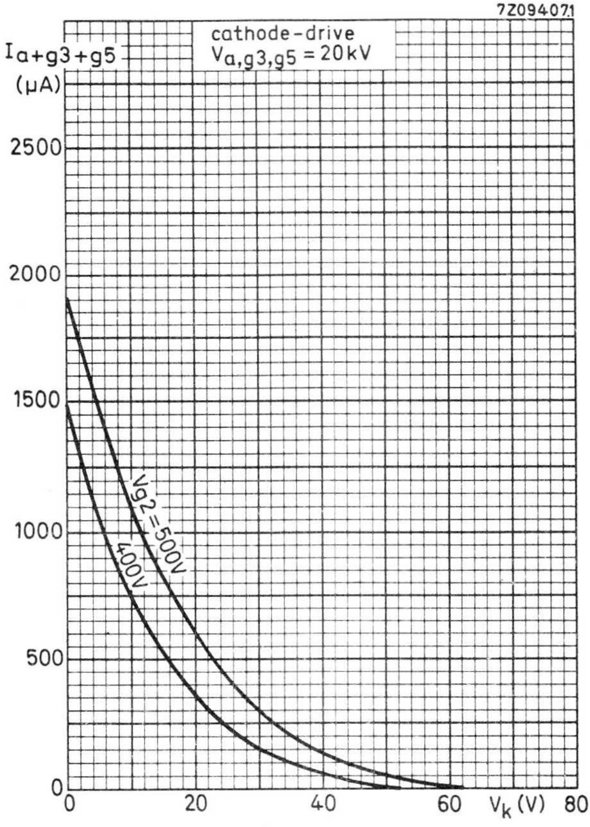
Grid no. 4 current,				
positive	I_{g4}	<	25	μA
negative	$-I_{g4}$	<	25	μA
Grid no. 2 current,				
positive	I_{g2}	<	5	μA
negative	$-I_{g2}$	<	5	μA

MAXIMUM CIRCUIT VALUES

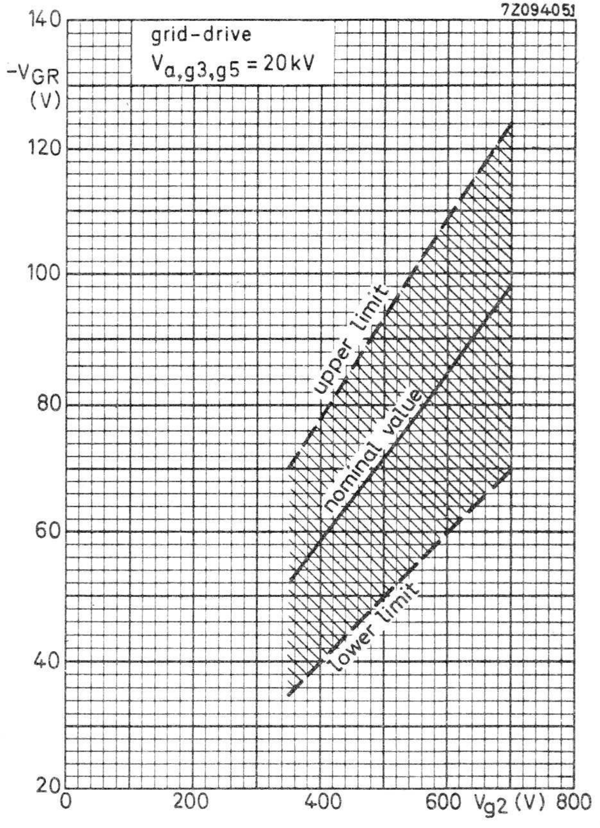
Resistance between cathode and heater	$R_{k/f}$	max.	1,0	MΩ
Impedance between cathode and heater	$Z_{k/f}$(50 Hz)	max.	0,1	MΩ
Grid no. 1 circuit resistance	R_{g1}	max.	1,5	MΩ
Grid no. 1 circuit impedance	Z_{g1}(50 Hz)	max.	0,5	MΩ



Final accelerator current as a function of grid no. 1 voltage

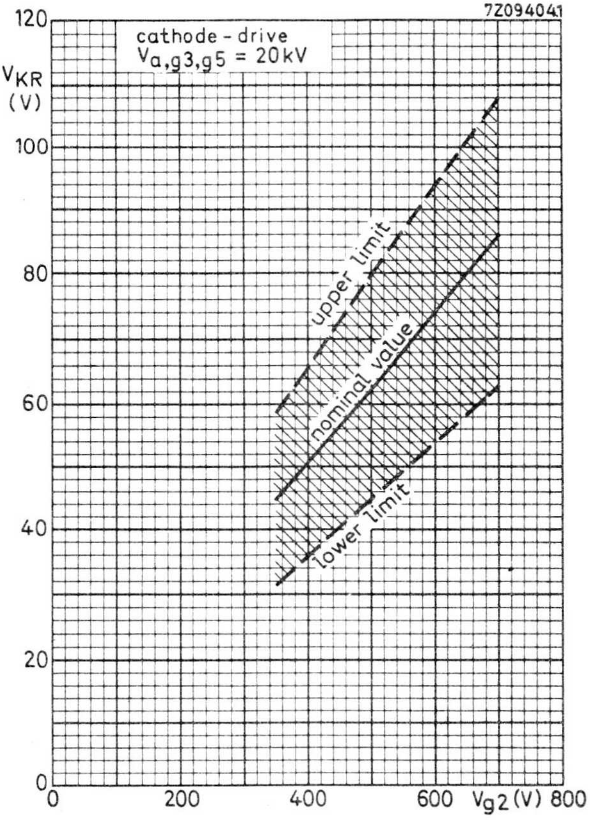


Final accelerator current as a function of cathode voltage



$$\frac{\Delta V_{GR}}{\Delta V_{a,g3,g5}} = 0,15 \times 10^{-3}$$

Limits of grid No. 1 cut-off voltage as a function of grid no. 2 voltage



$$\frac{\Delta V_{KR}}{\Delta V_{a,g3,g5}} = 0,15 \times 10^{-3}$$

Limits of cathode cut-off voltage as a function of grid no. 2 voltage

TV PICTURE TUBE

44 cm (17 in), 110°, rectangular direct vision picture tube with integral protection for black and white TV. The 20 mm neck diameter ensures a low deflection energy.
A special feature of this tube is its short cathode heating time.
The tube is designed for "push through" application and is provided with four metal lugs for mounting into a cabinet.

QUICK REFERENCE DATA			
Face diagonal		44	cm (17 in)
Deflection angle		110°	
Overall length	max.	288	mm
Neck diameter		20	mm
Heating		11 V, 140	mA
Grid no. 2 voltage		130	V
Final accelerator voltage		12 to 15	kV
Quick heating cathode	with a typical tube a legible picture will appear within 5 s.		

SCREEN

Metal-backed phosphor			
Luminescence	white		
Light transmission of face glass	approx.	48	%
Useful diagonal	min.	413	mm
Useful width	min.	346	mm
Useful height	min.	270	mm

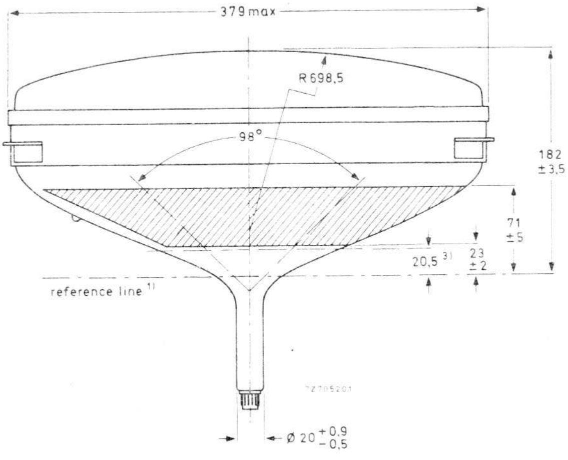
HEATING

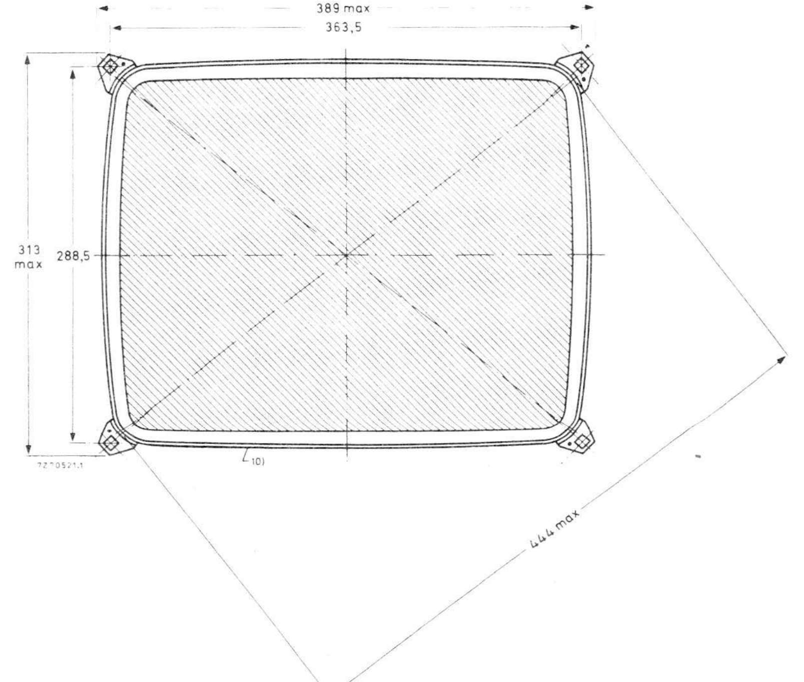
Indirect by a.c. or d.c.

Heater voltage	V_f		11	V
Heater current	I_f		140	mA
Limits (Absolute max. rating system) of r.m.s. heater voltage measured in any 20 ms	V_f	max.	12,7	V [1]
		min.	9,3	V

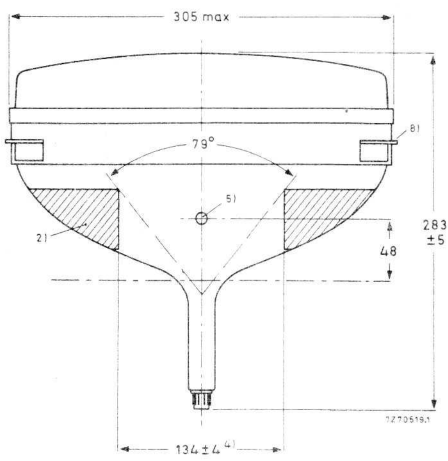
For heating time as a function of source impedance see page 10.

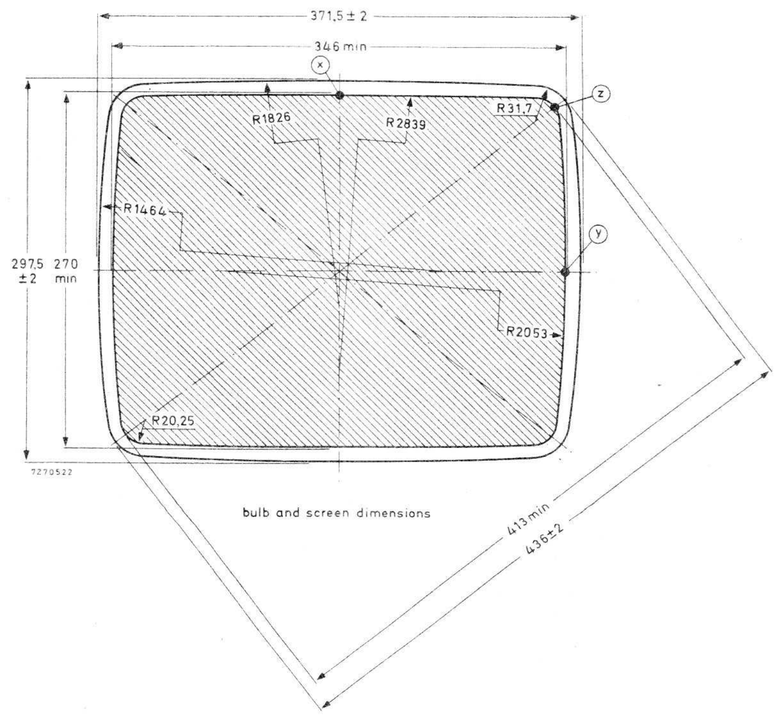
[1]) This limit also applies during equipment warming-up. Use of the tube in a series heater chain is not allowed.



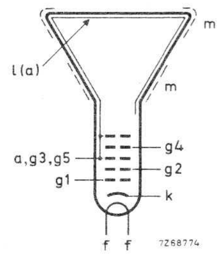


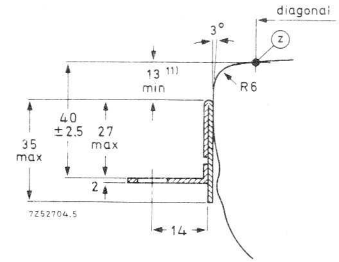
Notes see page 5

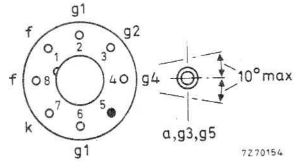


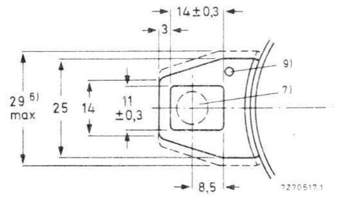


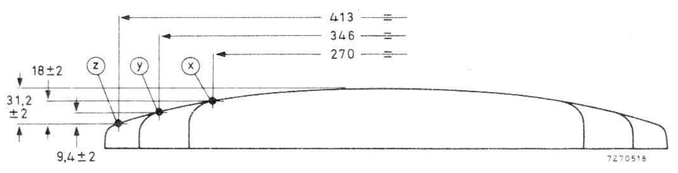
bulb and screen dimensions











Mounting position: any

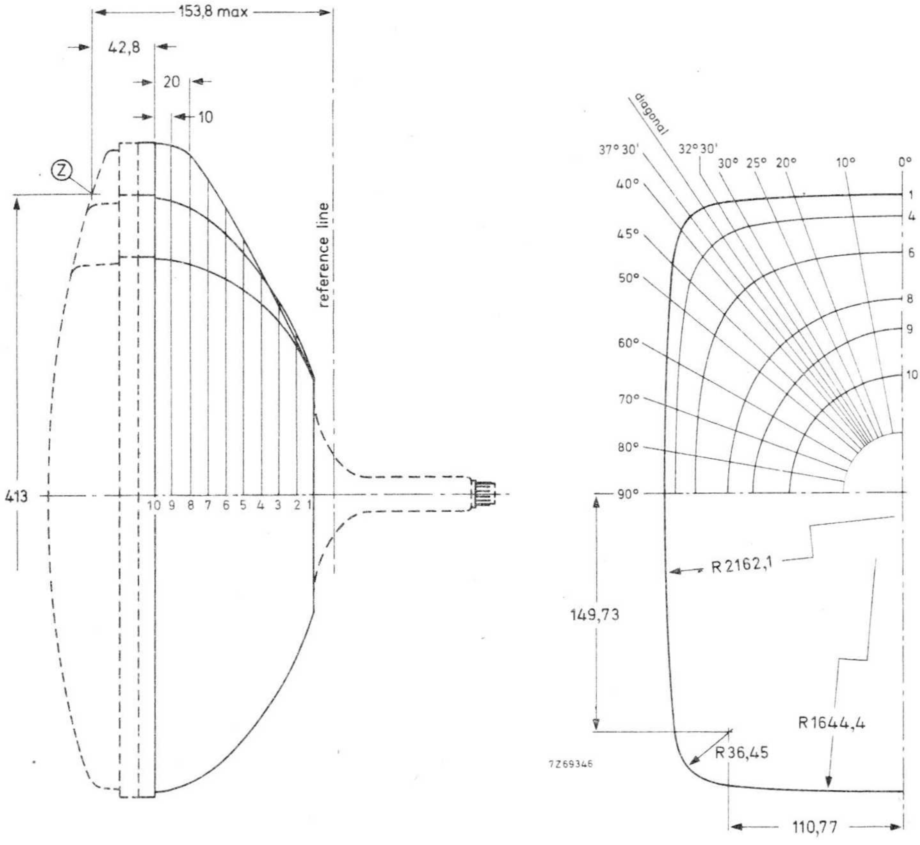
Net mass : approx. 6 kg

Base : JEDEC E7-91

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

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 (gauge G).
2. The configuration of the external conductive coating may be different, but covers 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 G.
4. This area must be kept clean.
5. Recessed cavity contact IEC67-III 2.
6. Minimum space to be reserved for mounting lug.
7. The mounting screws in the cabinet must be situated inside a circle of 7,5 mm drawn around the true geometrical positions i.e. at the corners of a rectangle of 363,5 mm x 288,5 mm.
8. The displacement of any lug with respect to the plane through the three other lugs is max. 2 mm.
9. The metal rim-band must be earthed. The hole of 3 mm dia in each lug is provided for this purpose. Electrical contact between the metal band and mounting lugs is guaranteed.
10. Max. curvatures of the outside rim-band are: nominal bulb radius + 4 mm.
11. Distance from reference point Z to any hardware.



A44-510W

Section	Nom. distance from section 1	Distance from centre (max values)														
		0°	10°	20°	25°	30°	$32^{\circ}30'$	diag.	$37^{\circ}30'$	40°	45°	50°	60°	70°	80°	90°
10	90	73,8	73,6	73,1	72,9	72,6	72,5	72,3	72,2	72,1	71,9	71,8	71,7	71,7	71,8	71,9
9	80	104,7	103,9	102,1	101,0	99,9	99,4	98,6	98,4	98,0	97,2	96,5	95,6	95,2	95,2	95,3
8	70	123,9	124,0	123,8	123,5	123,0	122,6	122,0	121,8	121,2	120,1	118,7	116,0	113,5	111,7	111,1
7	60	140,4	141,3	143,3	144,1	144,5	144,5	144,0	143,8	143,2	141,2	138,6	132,7	127,3	123,8	122,5
6	50	154,8	156,3	160,3	162,5	164,3	164,9	164,7	164,5	163,7	160,5	156,0	146,1	138,1	133,2	131,5
5	40	166,9	168,9	174,5	178,1	181,6	183,1	183,4	183,2	182,1	177,2	170,2	156,6	146,6	140,8	138,9
4	30	176,8	179,1	185,9	190,9	196,3	198,9	200,0	199,8	198,4	191,2	181,2	164,4	153,0	146,7	144,6
3	20	184,1	186,6	194,4	200,4	208,0	212,0	214,6	214,3	212,6	202,0	189,0	169,6	157,4	150,8	148,6
2	10	188,6	191,2	199,3	205,6	213,9	218,4	221,3	221,2	219,2	207,2	193,1	172,9	160,4	153,6	151,4
1	0	190,0	192,6	200,7	207,1	215,3	219,9	222,7	222,5	220,5	208,6	194,4	174,1	161,5	154,7	152,5

CAPACITANCES

Final accelerator to external conductive coating	$C_{a,g3,g5/m}$	< 1300 >700	pF pF
Final accelerator to metal rimband	$C_{a,g3,g5/m'}$	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	98°
Vertical deflection angle	79°

PICTURE CENTRING MAGNET

Field intensity perpendicular to the tube axis adjustable from 0 to 800 A/m (0 to 10 Oe). Maximum distance between centre of filed of this magnet and reference line: 47 mm.

TYPICAL OPERATING CONDITIONS

Cathode drive service

Voltages are specified with respect to grid no. 1

Final accelerator voltage	$V_{a,g3,g5}$	12 to 15	kV
Focusing electrode voltage	V_{g4}	0 to 130	V [1]
Grid no. 2 voltage	V_{g2}	130	V
Cathode voltage for visual extinction of focused raster	V_{KR}	30 to 50	V

[1] Because of the flat focus characteristic it is sufficient to choose a focusing voltage between 0 V and + 130 V (e.g. two taps, 0 V and 130 V).
The optimum focus voltage of individual tubes may be between − 100 V and + 200 V.

LIMITING VALUES (Design max. rating system)

Final accelerator voltage at $I_{a,g3,g5} = 0$	$V_{a,g3,g5}$	max. min.	17 9	kV kV
Grid no. 4 voltage				
Positive	V_{g4}	max.	500	V
Negative	$-V_{g4}$	max.	200	V
Grid no. 2 voltage	$V_{g2/k}$	max.	200	V
Cathode to grid no. 1 voltage,				
positive	$V_{k/g1}$	max.	200	V
positive peak	$V_{k/g1p}$	max.	400	V [1]
negative	$-V_{k/g1}$	max.	0	V
negative peak	$-V_{k/g1p}$	max.	2	V
Cathode to heater voltage				
positive	$V_{k/f}$	max.	200	V

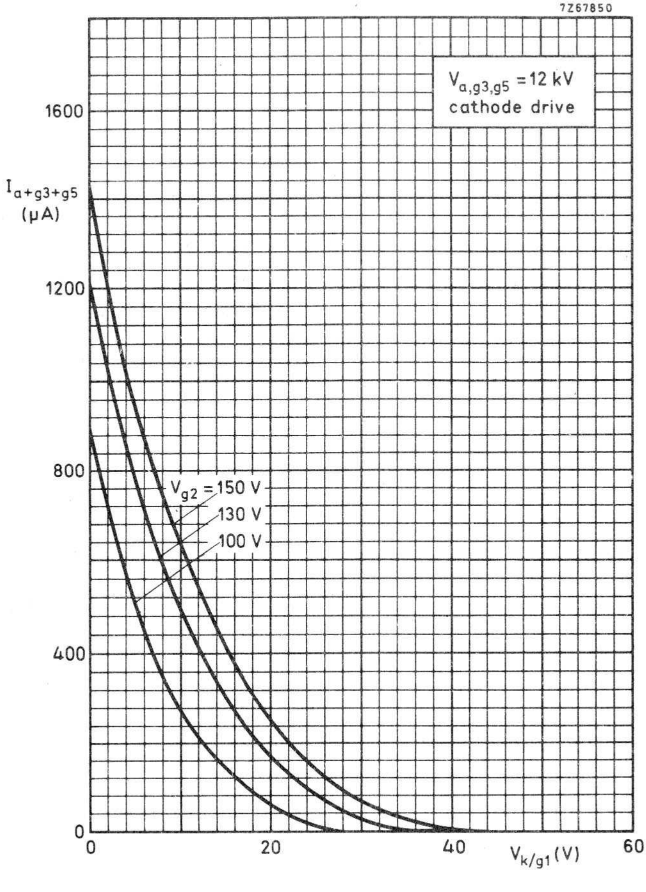
CIRCUIT DESIGN VALUES

Grid no. 4 current				
positive	I_{g4}	max.	25	μA
negative	$-I_{g4}$	max.	25	μA
Grid no. 2 current				
positive	I_{g2}	max.	5	μA
negative	$-I_{g2}$	max.	5	μA

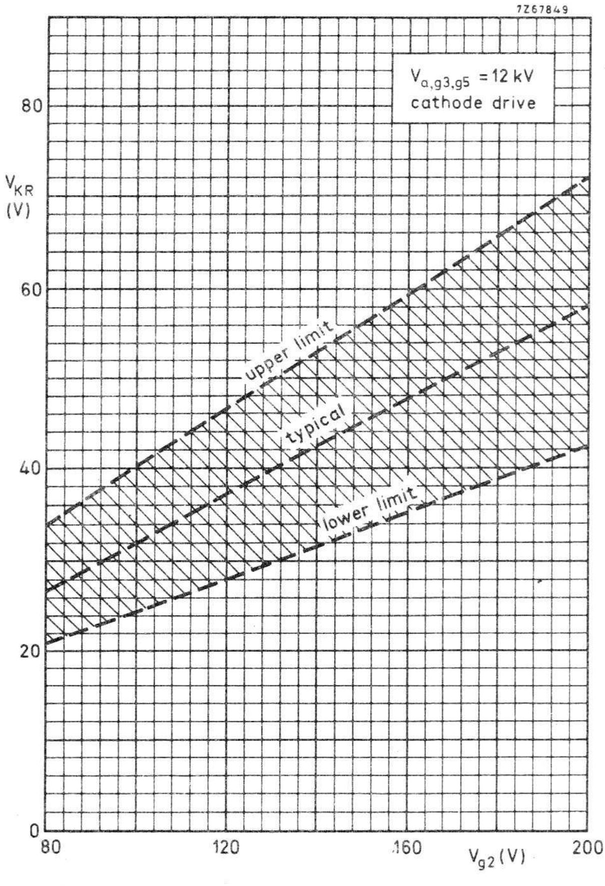
MAXIMUM CIRCUIT VALUES

Resistance between cathode and heater	$R_{k/f}$	max.	1	MΩ
Impedance between cathode and heater	$Z_{f/k}$(50 Hz)	max.	0,1	MΩ
Grid no. 1 circuit resistance	R_{g1}	max.	1,5	MΩ
Grid no. 1 impedance	Z_{g1}(50 Hz)	max.	0,5	MΩ

[1]) Maximum pulse duration 22% of a cycle but max. 1,5 ms.

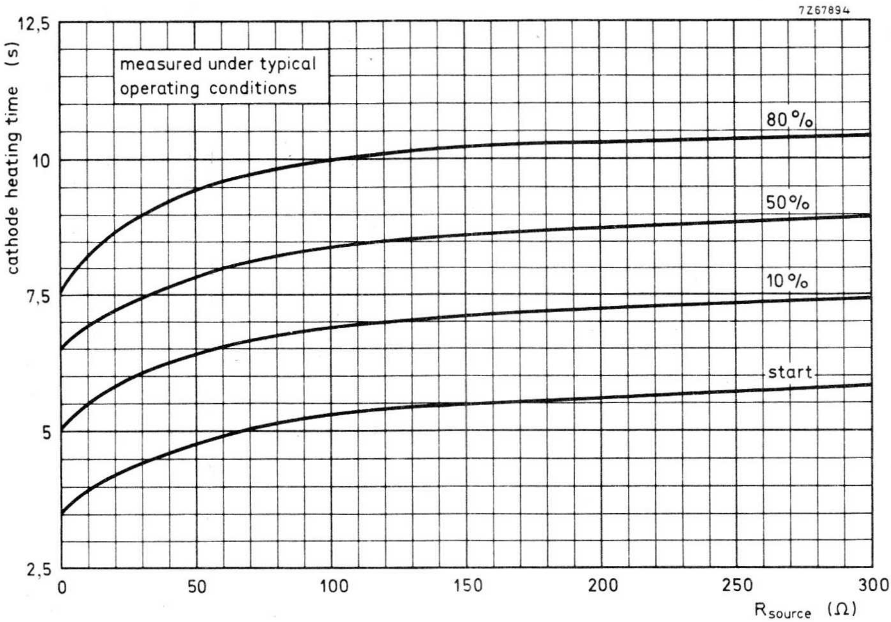


Final accelerator current as a function of cathode voltage.



$$\frac{\Delta V_{KR}}{\Delta V_{a,g3,g5}} = 0,3 \times 10^{-3}$$

Limits of cathode cut-off voltage as a function of grid no. 2 voltage.



Cathode heating time to attain x% of the cathode current at equilibrium condition.

TV PICTURE TUBE

44 cm (17 in), 110°, rectangular direct vision picture tube with integral protection for black and white TV. A special feature of this tube is its short cathode heating time.

QUICK REFERENCE DATA		
Face diagonal		44 cm
Deflection angle		110°
Overall length	max.	291 mm
Neck diameter		28, 6 mm
Heating		6, 3 V, 240 mA
Grid no. 2 voltage		130 V
Final accelerator voltage		20 kV
Quick heating cathode	with a typical tube a legible picture will appear within 5 s.	

SCREEN

Metal backed phosphor		
Luminescence	white	
Light transmission of face glass		48 %
Useful diagonal	min.	413 mm
Useful width	min.	346 mm
Useful height	min.	270 mm

HEATING

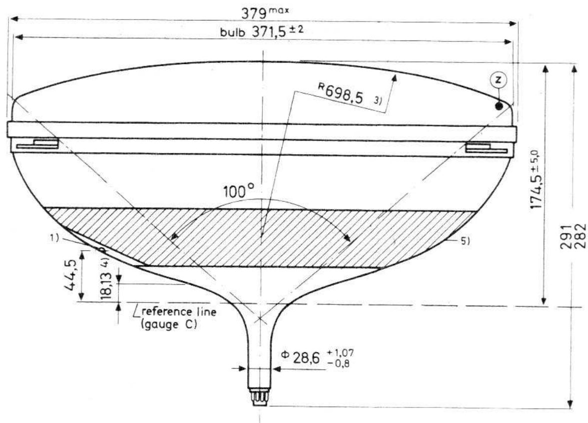
Indirect by a.c. or d.c.			
Heater voltage	V_f		6, 3 V
Heater current	I_f		240 mA
Limits (Absolute max. rating system) of r.m.s. heater voltage measured in any 20 ms	V_f	max. min.	7, 3 V [1]) 5, 3 V

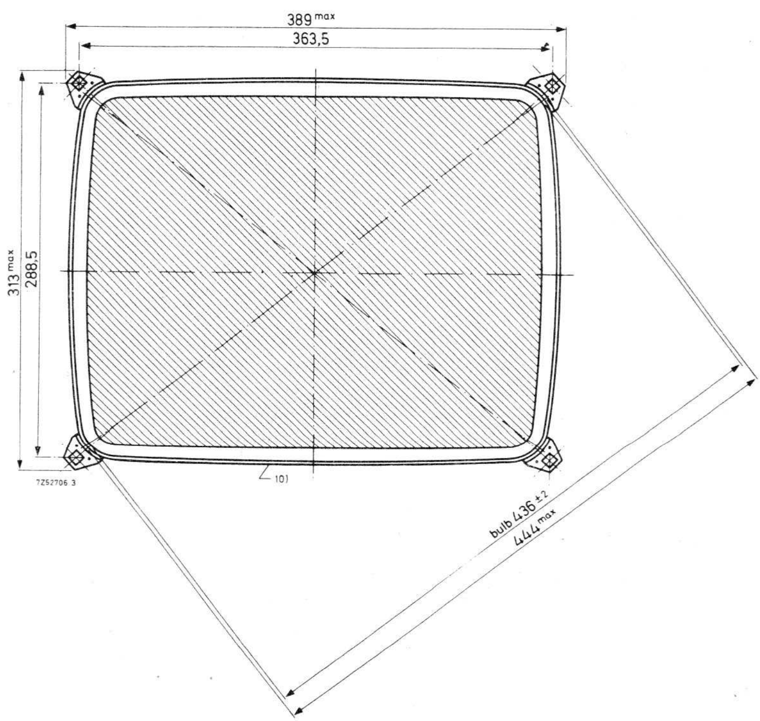
For heating time as a function of source impedance see page 11.

[1]) This limit also applies during equipment warming up. Use of the tube in a series heater chain is not allowed.

MECHANICAL DATA

Dimensions in mm

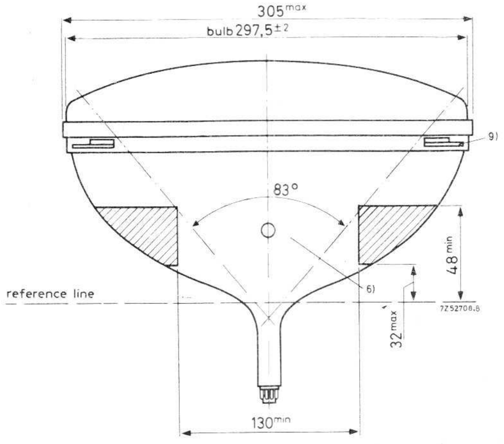


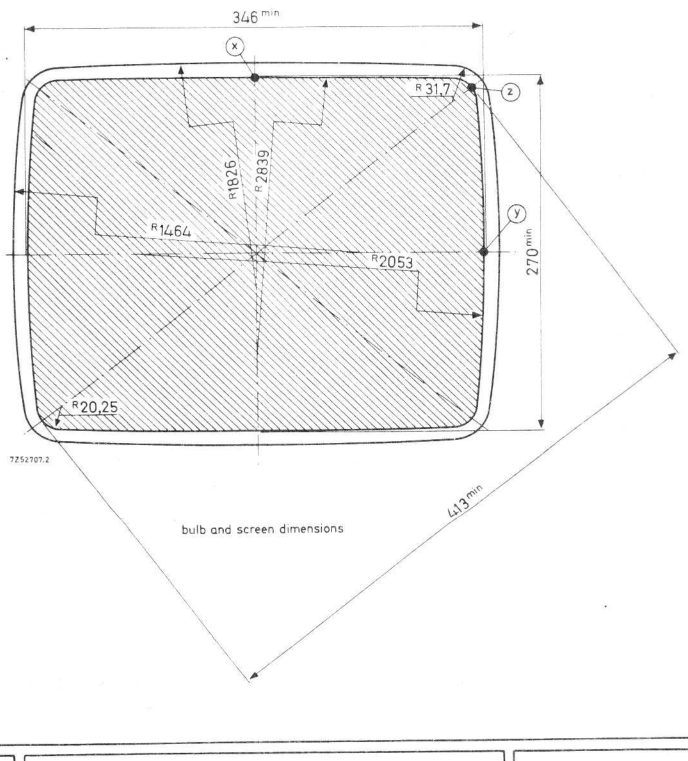


Notes see page 5

MECHANICAL DATA (continued)

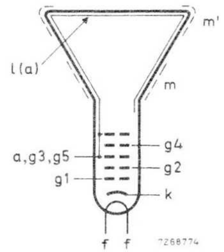
Dimensions in mm

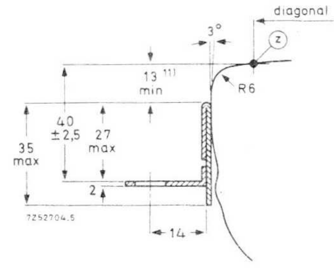


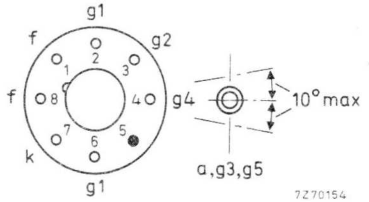


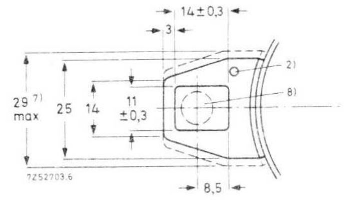
bulb and screen dimensions

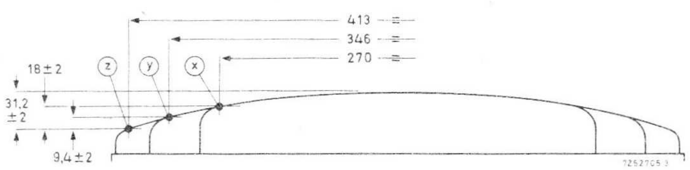
Notes see page 5











Mounting position : any

Base : neo eightar 7 pin JEDEC B7-208, B8H, IEC 67-I-31a

Net mass : approx. 6 kg

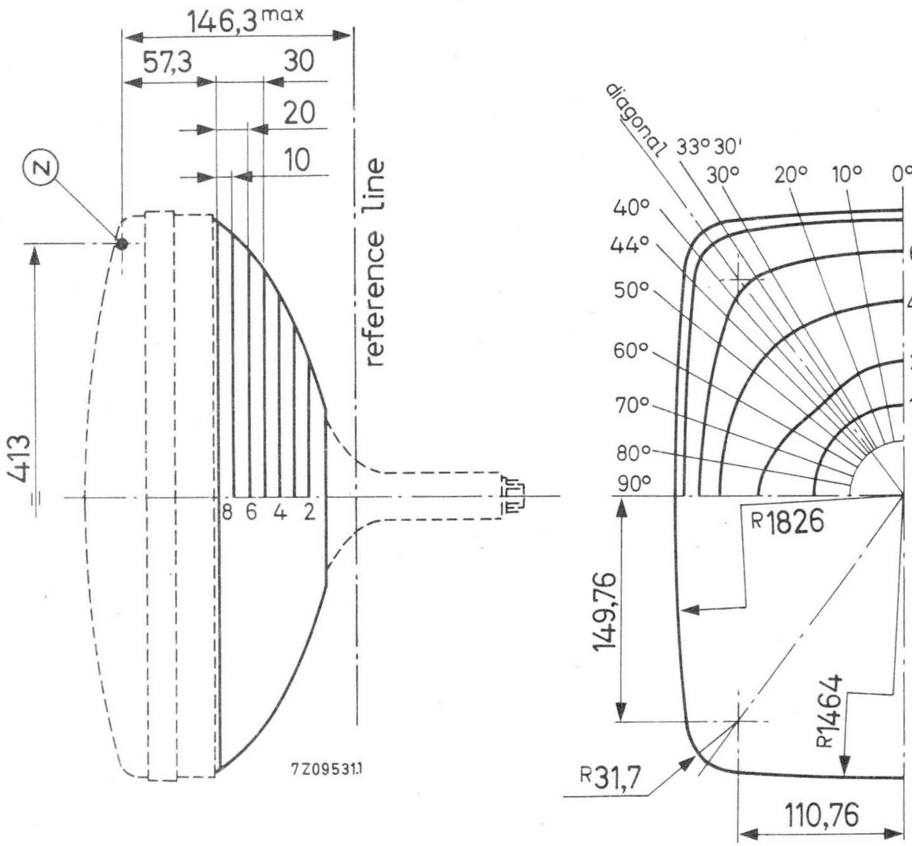
The bottom circumference of the base wafer will fall within a circle concentric with the tube axis and having a diameter of 40 mm.
The socket for the base should not be rigidly mounted: it should have flexible leads and be allowed to move freely.

NOTES TO OUTLINE DRAWING

1. Small cavity contact IEC 67-III-2.
2. The metal rim-band must be earthed. The hole of 3 mm dia in each lug is provided for this purpose.
3. Spherical face-plate.
4. End of guaranteed contour. The maximum contour from reference line towards screen is given by the reference line gauge C (18,13 mm).
5. The configuration of the external conductive coating may be different but contains the contact area as shown in the drawing.
   The external conductive coating must be earthed.
6. This area must be kept clean.
7. Minimum space to be reserved for mounting lug.
8. The mounting screws in the cabinet must be situated inside a circle of 7,5 mm diameter drawn around the true geometrical positions i.e. at the corners of a rectangle of 363,5 mm x 288,5 mm.
9. The displacement of any lug with respect to the plane through the other three lugs is max. 2 mm.
10. Max. curvatures of the outside rim-band are nominal bulb radius +4 mm.
11. Distance from reference point Z to any hardware.

MAXIMUM CONE CONTOUR DRAWING

Dimensions in mm



		Distance from centre (max. values)												
Section	Nom. distance from point "Z"	0° Long	10°	20°	30°	33°30'	36°30' Diagonal	40°	44°	50°	60°	70°	80°	90° Short
1	128,0	60,0	60,0	60,0	60,0	60,0	60,0	60,0	60,0	60,0	60,0	60,0	60,0	60,0
2	117,3	95,9	95,2	93,0	92,3	92,1	92,1	92,3	92,6	93,1	93,8	94,6	94,9	95,1
3	107,3	118,1	117,8	118,3	118,3	118,6	119,2	117,8	117,7	117,2	115,5	113,3	111,2	109,8
4	97,3	135,0	136,1	138,3	139,9	141,0	141,6	141,1	138,5	135,4	130,5	125,6	121,8	120,8
5	87,3	149,5	151,1	155,1	159,1	161,3	162,0	161,5	157,5	151,0	142,0	135,8	130,8	129,5
6	77,3	162,5	164,0	168,8	176,0	179,0	179,5	178,0	173,5	163,4	150,8	143,3	138,3	136,4
7	67,3	172,5	174,4	180,1	190,0	194,1	196,3	194,9	186,8	174,5	159,1	149,3	143,9	141,7
8	57,3	179,7	183,1	189,3	201,1	207,4	210,9	206,1	196,0	182,8	165,5	154,0	147,9	145,6

CAPACITANCES

Final accelerator to external conductive coating	$C_{a,g3,g5/m}$	< 1300 > 700	pF pF
Final accelerator to metal band	$C_{a,g3,g5/m'}$	200	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	100°
Vertical deflection angle	83°

PICTURE CENTRING MAGNET

Field intensity perpendicular to the tube axis adjustable from 0 to 800 A/m (0 to 10 Oe). Maximum distance between centre of field of this magnet and reference line: 57 mm.

TYPICAL OPERATING CONDITIONS

Cathode drive service

Voltages are specified with respect to grid no. 1

Final accelerator voltage	$V_{a,g3,g5}$	20	kV
Focusing electrode voltage	V_{g4}	0 to 130	V [1]
Grid no. 2 voltage	V_{g2}	130	V
Cathode voltage for visual extinction of focused raster	V_{KR}	42 to 62	V

[1] Because of the flat focus characteristic it is sufficient to choose a focusing voltage between 0 and + 130 V (e.g. two taps, 0 V and 130 V).
The optimum focus voltage of individual tubes may be between − 100 V and + 200 V.

LIMITING VALUES (Design max. rating system)

Final accelerator voltage at $I_{a,g3,g5} = 0$	$V_{a,g3,g5}$	max. min.	23 12	kV kV
Grid no. 4 voltage,				
positive	V_{g4}	max.	1000	V
negative	$-V_{g4}$	max.	500	V
Grid no. 2 voltage	V_{g2}	max. min.	200 80	V [1] V
Cathode to grid no. 1 voltage,				
positive	$V_{k/g1}$	max.	200	V
positive peak	$V_{k/g1_p}$	max.	400	V [2]
negative	$-V_{k/g1}$	max.	0	V
negative peak	$-V_{k/g1_p}$	max.	2	V
Cathode-to-heater voltage	V_{kf}	max.	200	V

CIRCUIT DESIGN VALUES

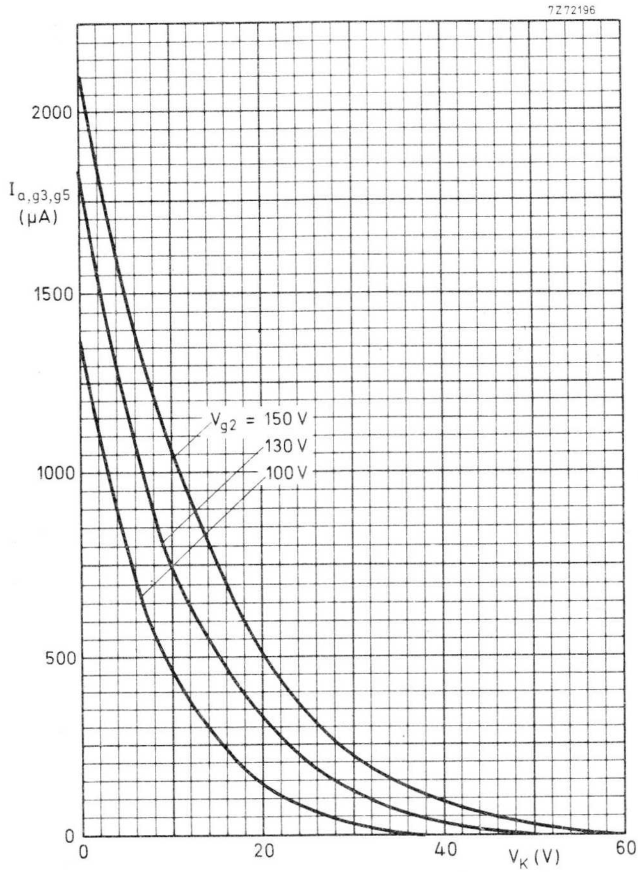
Grid no. 4 current,				
positive	I_{g4}	max.	25	μA
negative	$-I_{g4}$	max.	25	μA
Grid no. 2 current,				
positive	I_{g2}	max.	5	μA
negative	$-I_{g2}$	max.	5	μA

MAXIMUM CIRCUIT VALUES

Resistance between cathode and heater	$R_{k/f}$	max.	1,0	MΩ
Impedance between cathode and heater	$Z_{k/f}$ (50 Hz)	max.	0,1	MΩ
Grid no. 1 circuit resistance	R_{g1}	max.	1,5	MΩ
Grid no. 1 circuit impedance	Z_{g1} (50 Hz)	max.	0,5	MΩ

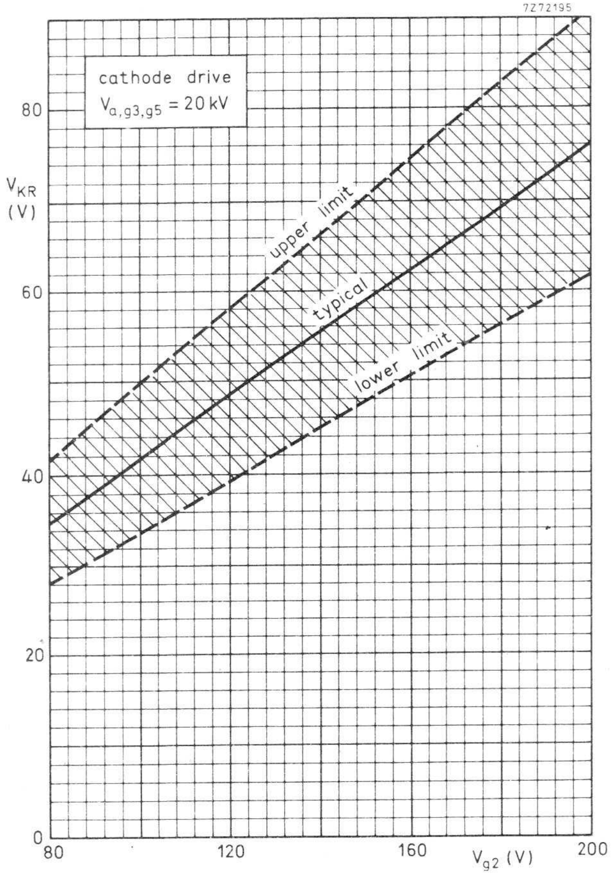
[1] At $V_{k/g1} = 0$ V.

[2] Maximum pulse duration 22% of a cycle but maximum 1,5 ms.



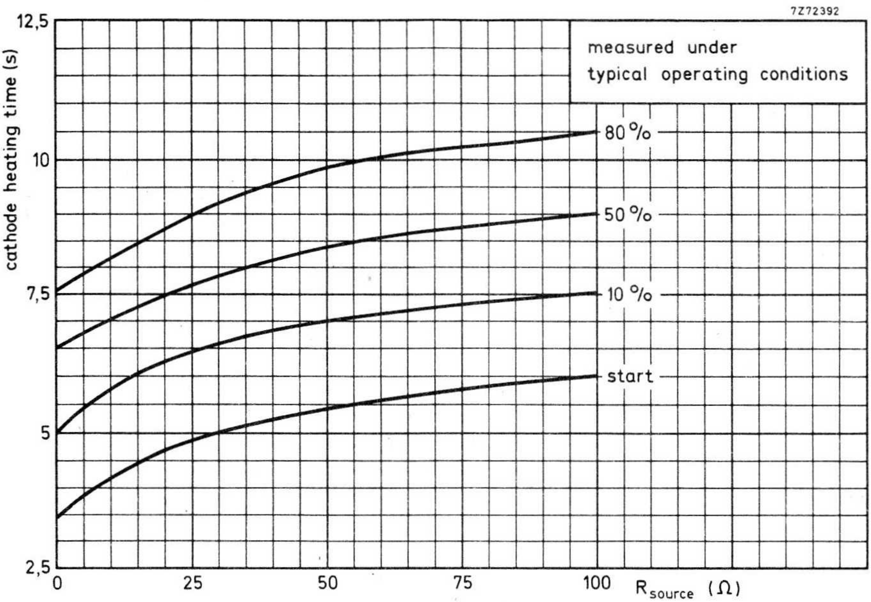
Final accelerator current as a function of cathode voltage

Cathode drive $\qquad V_{a,g_3,g_5}$ = 20 kV



$$\frac{\Delta V_{KR}}{\Delta V_{a,\,g3,\,g5}} = 0,75 \times 10^{-3}$$

Limits of cathode cut-off voltage as a function of grid no. 2 voltage



Cathode heating time to attain x % of the cathode current at equilibrium conditions

TV PICTURE TUBE

50 cm (20 in), 110^{o}, rectangular direct vision picture tube with integral protection for black-and-white TV.

QUICK REFERENCE DATA	
Face diagonal	50 cm (20 in)
Deflection angle	110^{o}
Overall length	312,5 mm
Neck diameter	28,6 mm
Heating	6,3 V, 300 mA
Grid no. 2 voltage	400 V
Final accelerator voltage	20 kV

SCREEN

Metal-backed phosphor

Luminescence	white		
Light transmission of face glass	approx.	45	%
Useful diagonal	min.	473	mm
Useful width	min.	394	mm
Useful height	min.	308	mm

HEATING

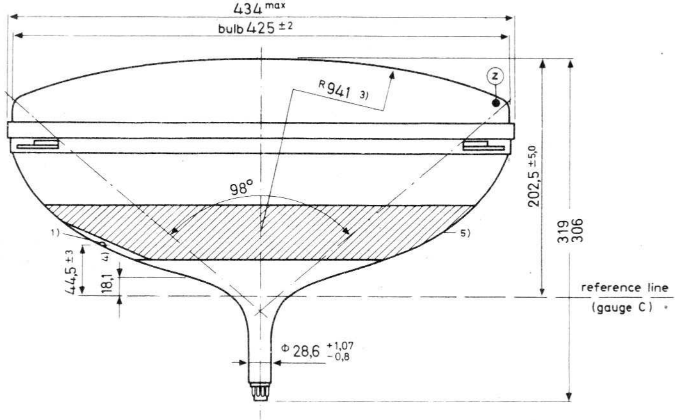
Indirect by a.c. or d.c.; series or parallel supply

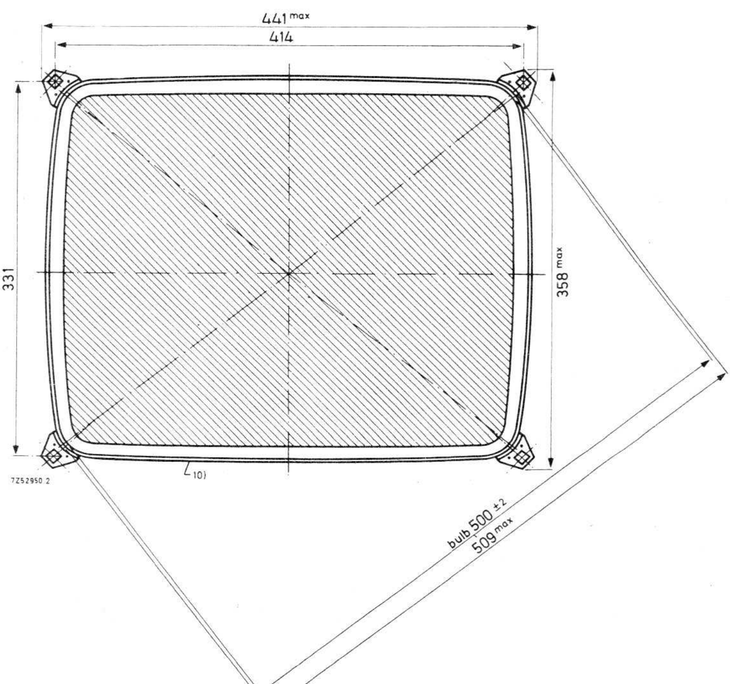
Heater current	I_f	300	mA
Heater voltage	V_f	6,3	V

If the tube is connected in a series heater chain the surge heater voltage must not exceed an r.m.s. value of 9,5 V when the supply is switched on.

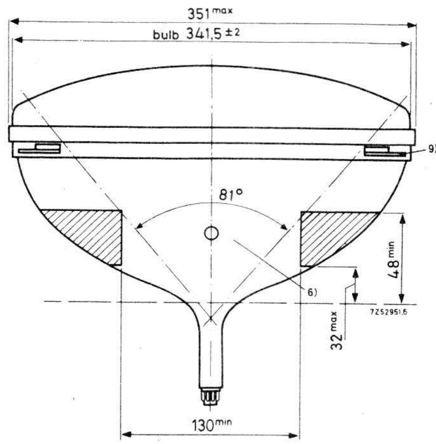
MECHANICAL DATA

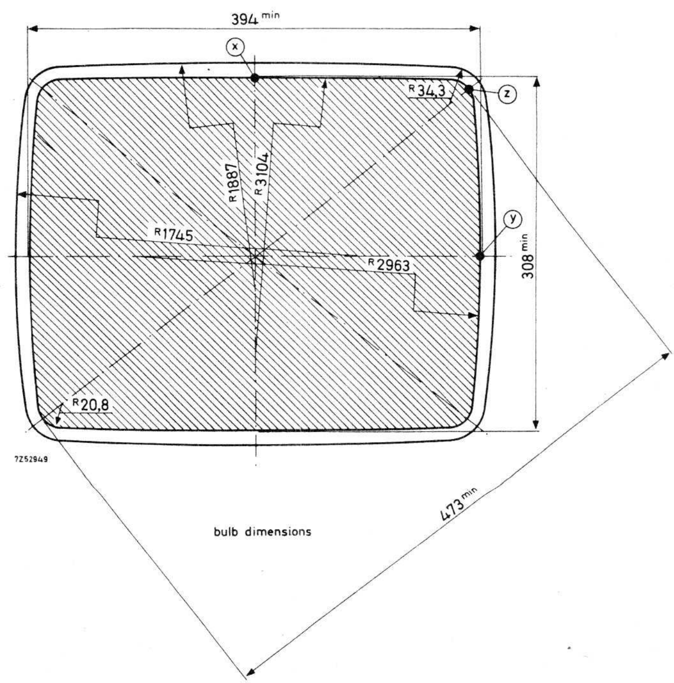
Dimensions in mm



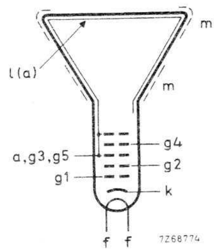


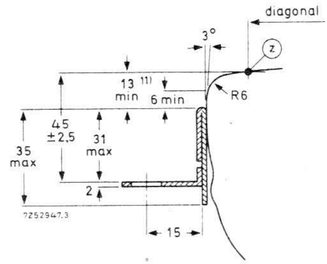
Notes see page 5

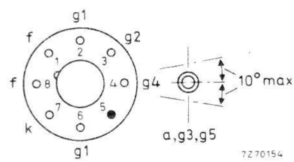


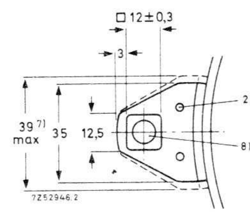


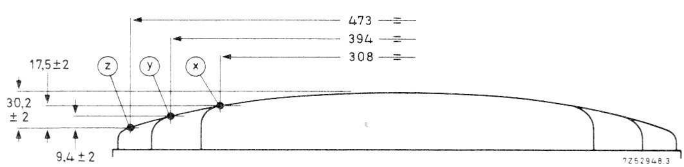
bulb dimensions











Mounting position: any

Base : neo eightar 7 pin JEDEC B7-208, B8H, IEC67-1-31a

Net mass : approx. 8,5 kg

The bottom circumference of the base wafer will fall within a circle concentric with the tube axis and having a diameter of 40 mm.

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

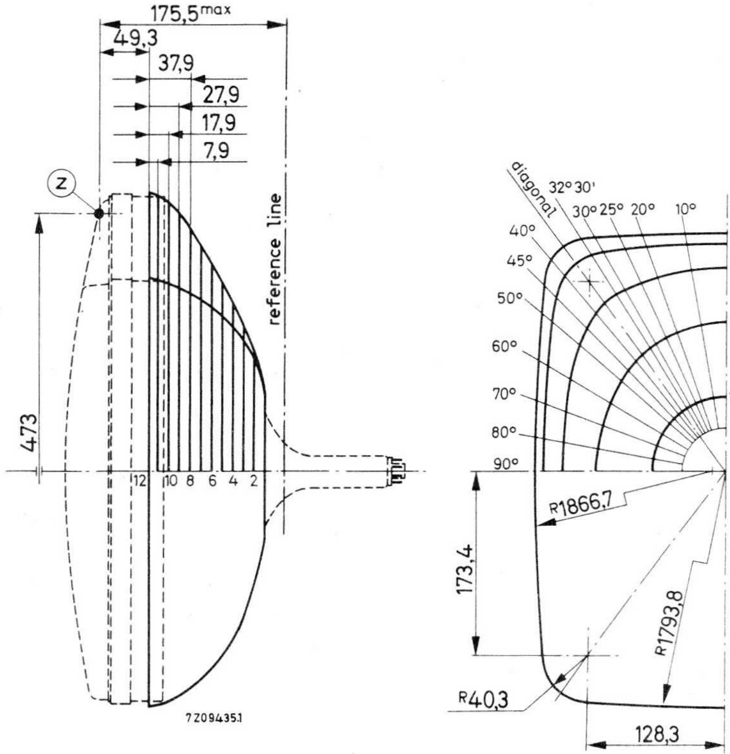
Notes see page 5

NOTES TO OUTLINE DRAWINGS

1. Small cavity contact IEC67-III-2.
2. The metal rim-band must be earthed. The holes of 3 mm dia in each lug are provided for this purpose.
3. Spherical face-plate.
4. End of guaranteed contour. The maximum neck-and-cone contour is given by the reference line gauge C (18,13 mm).
5. The configuration of the external conductive coating may be different but contains the contact area as shown in the drawing.
   The external conductive coating must be earthed.
6. This area must be kept clean.
7. Minimum space to be reserved for mounting lug.
8. The mounting screws in the cabinet must be situated inside a circle of 8 mm diameter drawn around the true geometrical position i.e. at the corners of a rectangle of 414 mm x 331 mm.
9. The displacement of any lug with respect to the plane through the other three lugs is max. 2 mm.
10. Max. curvatures of the outside rim-band are: nominal bulb radius +4 mm.
11. Distance from reference point Z to any hardware.

MAXIMUM CONE CONTOUR DRAWING

Dimensions in mm



A50-120W A50-520W

Sec-tion	Nom distance from point "Z"	0° Long	10°	20°	25°	30°	32° 30'	36° 30' Diagonal	40°	45°	50°	60°	70°	80°	90° Short
		Distance from centre (max. values)													
1	157,2	69,0	69,0	69,0	69,0	69,0	69,0	69,0	69,0	69,0	69,0	69,0	69,0	69,0	69,0
2	147,2	109,2	107,8	107,1	106,4	106,0	105,9	105,5	105,0	104,5	103,9	102,8	102,6	102,8	103,4
3	137,2	136,7	134,5	133,7	133,0	132,3	131,8	130,7	129,3	127,5	125,3	121,9	120,7	120,2	120,2
4	127,2	157,2	156,5	155,7	154,8	153,8	153,0	151,5	150,0	147,5	144,7	138,7	134,9	133,4	132,5
5	117,2	174,2	174,0	174,4	174,3	173,4	172,8	171,0	169,3	165,7	160,8	152,0	146,5	143,7	142,3
6	107,2	185,8	186,3	188,4	190,0	191,2	191,2	189,5	186,7	181,7	174,7	163,2	156,0	151,7	150,4
7	97,2	194,5	195,7	202,2	203,8	206,9	207,3	206,4	203,5	196,4	187,4	173,0	163,5	158,6	156,9
8	87,2	201,7	203,8	210,2	215,4	220,6	222,1	222,2	218,8	210,5	198,8	181,2	170,3	164,7	162,7
9	77,2	208,2	210,6	218,5	224,8	231,4	234,8	236,5	233,5	222,2	208,5	188,5	176,6	169,9	167,9
10	67,2	213,1	215,9	225,2	231,9	239,8	244,3	248,5	244,8	230,3	216,0	194,7	181,6	174,5	172,0
11	57,2	215,6	219,0	228,2	235,4	244,5	249,6	253,7	250,2	235,7	220,5	198,6	184,8	177,2	174,7
12	49,3	217,0	219,8	229,3	236,6	246,0	251,2	254,5	251,7	237,2	222,0	199,6	185,6	177,8	175,7

CAPACITANCES

Final accelerator to external conductive coating	$C_{a,g3,g5/m}$	1300 pF 850 pF
Final accelerator to metal band	$C_{a,g3,g5/m'}$	300 pF
Cathode to all	C_k	5 pF
Grid no. 1 to all	C_{g1}	7 pF

FOCUSING electroststic

DEFLECTION magnetic

Diagonal	110^{o}
Horizontal deflection angle	98^{o}
Vertical deflection angle	81^{o}

PICTURE CENTRING MAGNET

Field intensity perpendicular to the tube axis adjustable from 0 to 800 A/m (0 to 10 Oe).

Maximum distance between centre of field of this magnet and reference line: 57 mm.

TYPICAL OPERATING CONDITIONS

Grid drive service

Final accelerator voltage	$V_{a,g3,g5}$	20	kV
Focusing electrode voltage	V_{g4}	0 to 400	V [1]
Grid no. 2 voltage	V_{g2}	400	V
Grid no. 1 voltage for visual extinction of focused raster	V_{GR}	-40 to -77	V

Cathode drive service

Voltages are specifiec with respect to grid no. 1

Final accelerator voltage	$V_{a,g3,g5}$	20	kV
Focusing electrode voltage	V_{g4}	0 to 400	V [1]
Grid no. 2 voltage	V_{g2}	400	V
Cathode voltage for visual extinction of focused raster	V_{KR}	36 to 66	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 max. rating system)

Final accelerator voltage at $I_{a,g3,g5} = 0$	$V_{a,g3,g5}$	max. min.	23 12	kV kV
Grid no. 4 voltage				
positive	V_{g4}	max.	1000	V
negative	$-V_{g4}$	max.	500	V
Grid no. 2 voltage	V_{g2}	max. min.	700 350	V V
Grid no. 2 to grid no. 1 voltage	$V_{g2/g1}$	max.	850	V
Grid no. 1 voltage,				
positive	V_{g1}	max.	0	V
positive peak	V_{g1p}	max.	2	V
negative	$-V_{g1}$	max.	200	V
negative peak	$-V_{g1p}$	max.	400	V [1]
Cathode-to-heater voltage				
positive	$V_{k/f}$	max.	250	V
positive peak	$V_{k/fp}$	max.	300	V
negative	$-V_{k/f}$	max.	200	V
positive during equipment warm-up period not exceeding 15 s	$V_{k/f}$	max.	450	V [3]

[1]) Maximum pulse duration 22% of a cycle but maximum 1,5 ms.

[2]) At $V_{g1/k} = 0$ V.

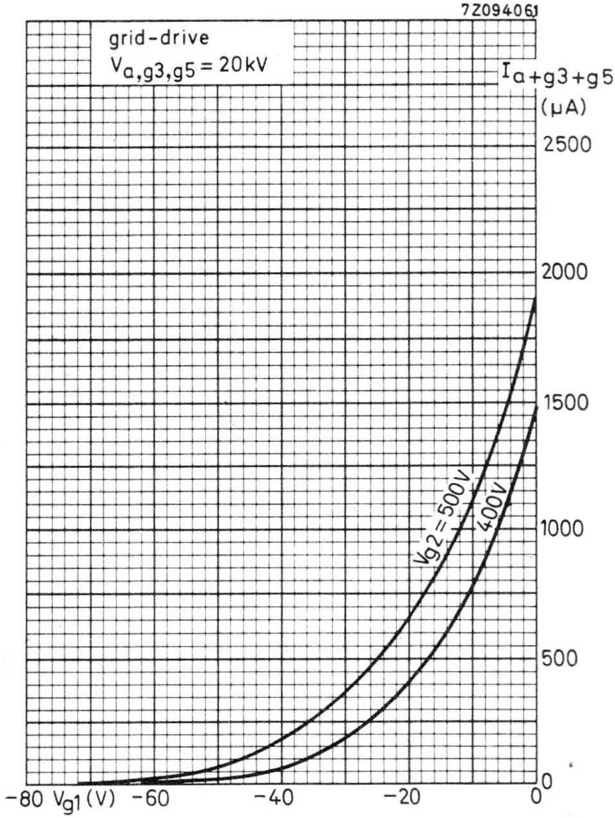
[3]) Between 15 s and 45 s after switching on a decrease in k/f voltage from 450 V to 250 V, linearly proportional with time, is permissible.

CIRCUIT DESIGN VALUES

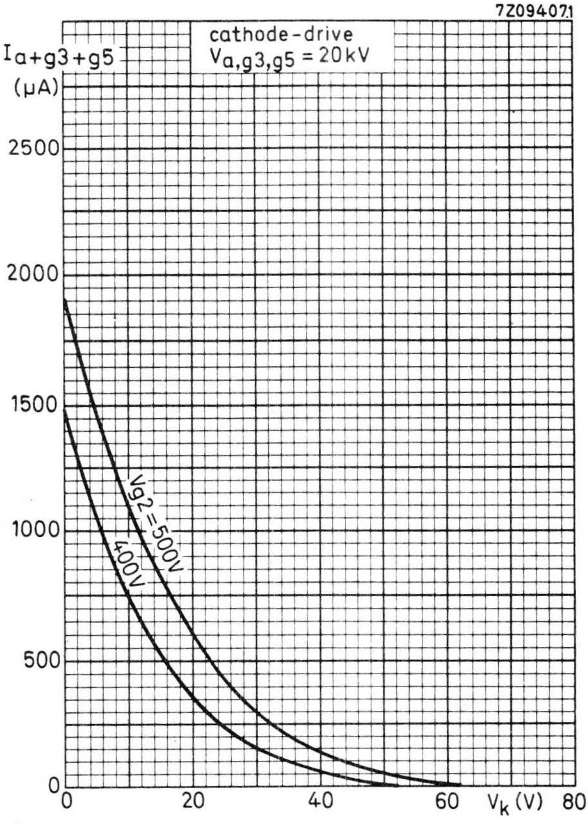
Grid no. 4 current				
positive	I_{g4}	max.	25	µA
negative	$-I_{g4}$	max.	25	µA
Grid no. 2 current				
positive	I_{g2}	max.	5	µA
negative	$-I_{g2}$	max.	5	µA

MAXIMUM CIRCUIT VALUES

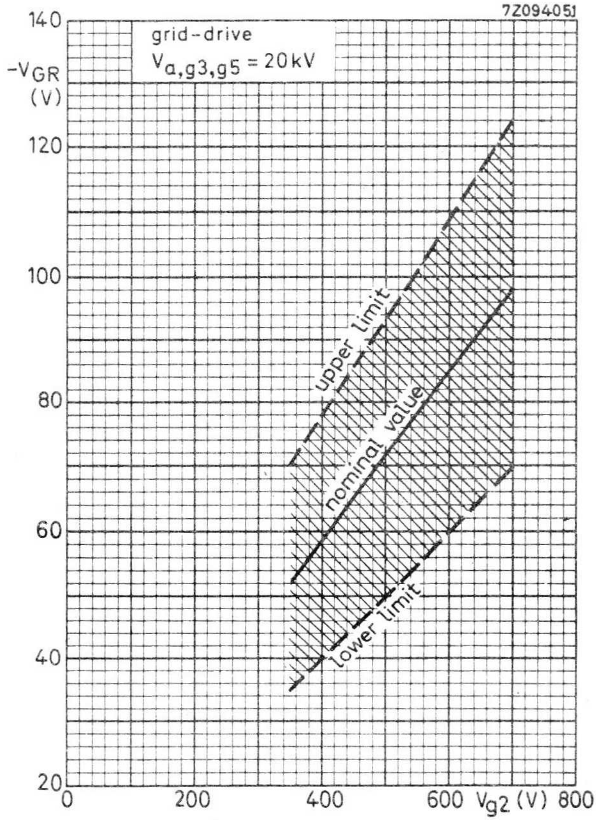
Resistance between cathode and heater	$R_{k/f}$	max.	1,0	MΩ
Impedance between cathode and heater	$Z_{k/f}$ (50 Hz)	max.	0,1	MΩ
Grid no. 1 circuit resistance	R_{g1}	max.	1,5	MΩ
Grid no. 1 circuit impedance	Z_{g1} (50 Hz)	max.	0,5	MΩ



Final accelerator current as a function of grid no. 1 voltage

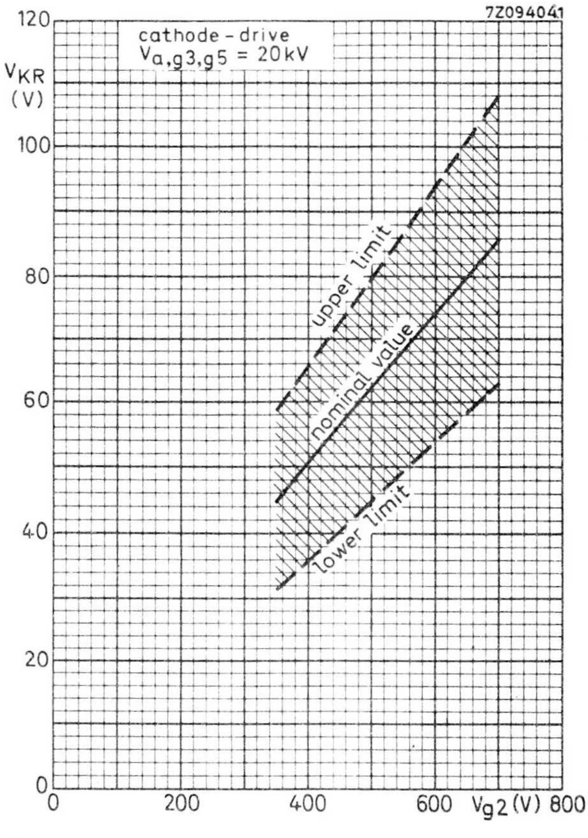


Final accelerator current as a function of cathode voltage



$$\frac{\Delta V_{GR}}{\Delta V_{a,\,g3,\,g5}} = 0,15 \times 10^{-3}$$

Limits of grid no. 1 cut-off voltage as a function of grid no. 2 voltage



$$\frac{\Delta V_{KR}}{\Delta V_{a,\,g3,\,g5}} = 0,15 \times 10^{-3}$$

Limits of cathode cut-off voltage as a function of grid no. 2 voltage

TV PICTURE TUBE

50 cm (20 in), 110°, rectangular direct vision picture tube with integral protection for black and white TV. A special feature of this tube is its short cathode heating time.

QUICK REFERENCE DATA		
Face diagonal		50 cm
Deflection angle		110°
Overall length	max.	319 mm
Neck diameter		28,6 mm
Heating		6,3 V, 240 mA
Grid no. 2 voltage		130 V
Final accelerator voltage		20 kV
Quick heating cathode	with a typical tube a legible picture will appear within 5 s.	

SCREEN

Metal backed phosphor		
Luminescence	white	
Light transmission of face glass	approx.	45 %
Useful diagonal	min.	473 mm
Useful width	min.	394 mm
Useful height	min.	308 mm

HEATING

Indirect by a.c. or d.c.

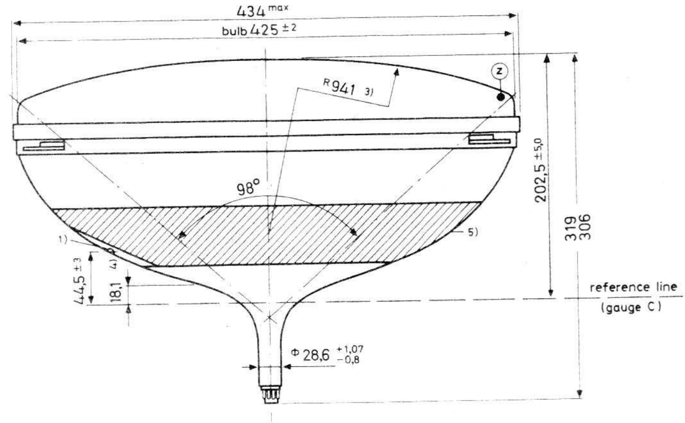
Heater voltage	V_f		6,3 V
Heater current	I_f		240 mA
Limits (Absolute max. rating system) of r.m.s. heater voltage measured in any 20 ms	V_f	max. min.	7,3 V [1] 5,3 V

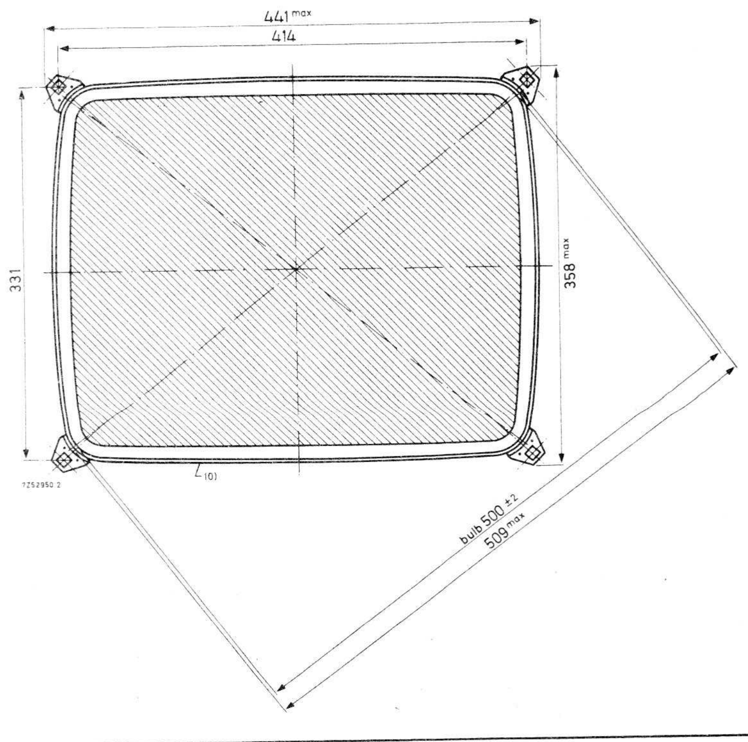
For heating time as a function of source impedance see page 11.

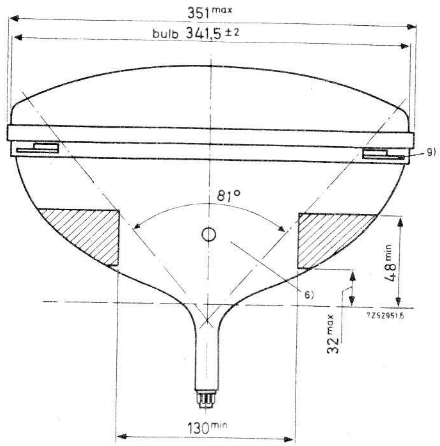
1) This limit also applies during equipment warming up. Use of the tube in a series heater chain it not allowed.

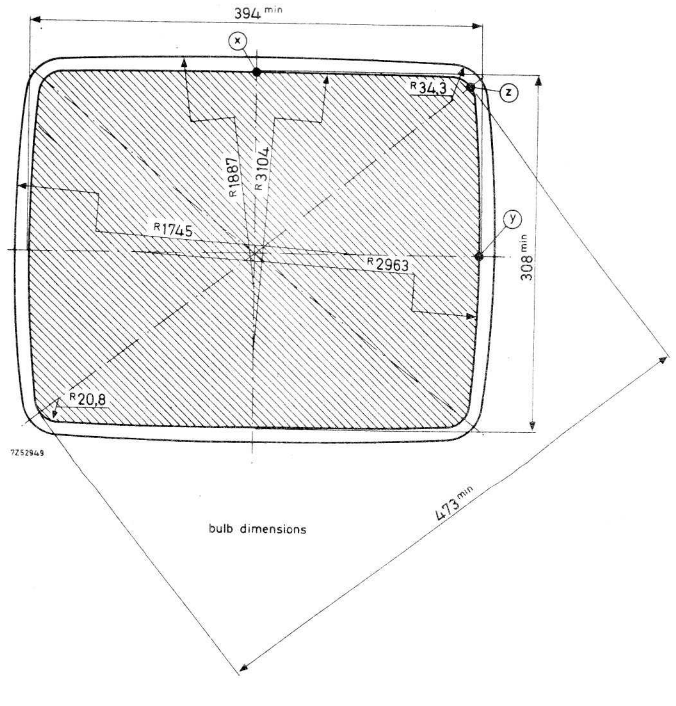
MECHANICAL DATA

Dimensions in mm

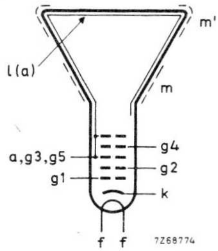


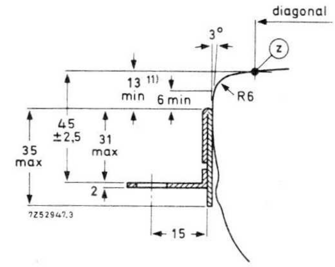


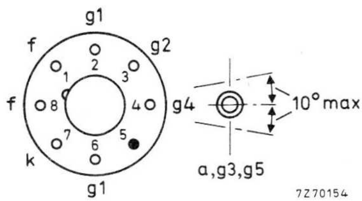


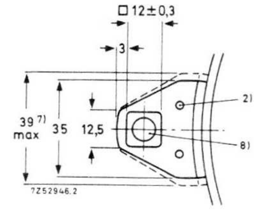


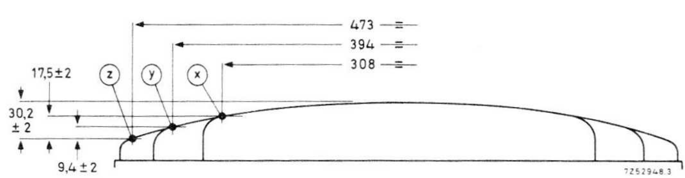
bulb dimensions











Mounting position : any

Base : neo eightar 7 pin JEDEC B7-208, B8H, IEC 67-1-31a

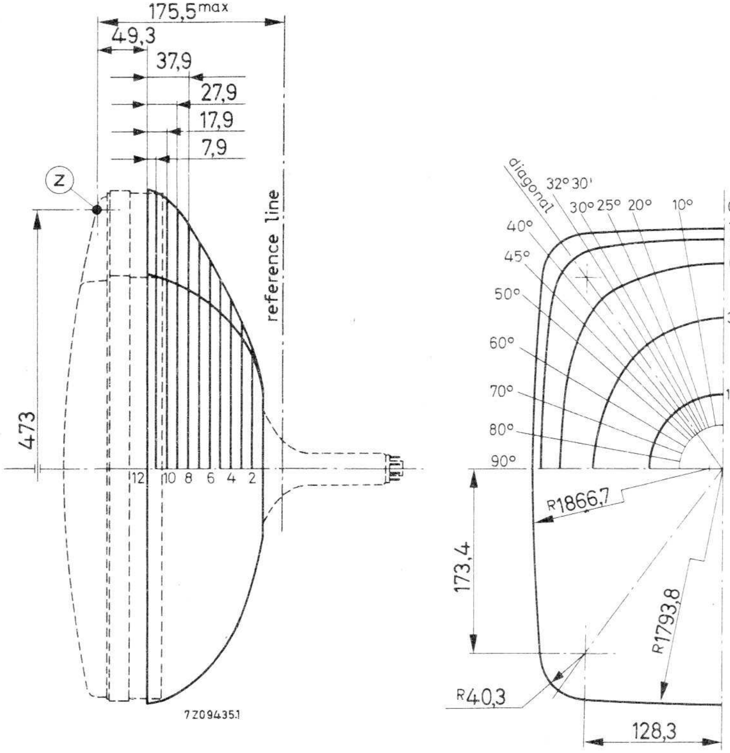
Net mass : approx. 8,5 kg

The bottom circumference of the base wafer will fall within a circle concentric with the tube axis and having a diameter of 40 mm.

NOTES TO OUTLINE DRAWINGS

1. Small cavity contact IEC 67-III-2.
2. The metal rim-band must be earthed. The holes of 3 mm dia in each lug are provided for this purpose.
3. Spherical face plate.
4. End of guaranteed contour. The maximum neck-and-cone contour is given by the reference line gauge C (18, 13 mm).
5. The configuration of the external conductive coating may be different but contains the the contact area as shown in the drawing.
   The external conductive coating must be earthed.
6. This area must be kept clean.
7. Minimum space to be reserved for mounting lug.
8. The mounting screws in the cabinet must be situated inside a circle of 8 mm diameter drawn around the true geometrical position i. e. at the corners of a rectangle of 414 mm x 331 mm.
9. The displacement of any lug with respect to the plane through the other three lugs is max. 2 mm.
10. Max. curvatures of the outside rim-band are: nominal bulb radius + 4 mm.
11. Distance from reference point Z to any hardware.

MAXIMUM CONE CONTOUR DRAWING



A50-120W A50-520W

Distance from centre (max. values)															
Section	Nom distance from point "Z"	0° Long	10°	20°	25°	30°	32° 30'	36° 30' Diagonal	40°	45°	50°	60°	70°	80°	90° Short
1	157,2	69,0	69,0	69,0	69,0	69,0	69,0	69,0	69,0	69,0	69,0	69,0	69,0	69,0	69,0
2	147,2	109,2	107,8	107,1	106,4	106,0	105,9	105,5	105,0	104,5	103,9	102,8	102,6	102,8	103,4
3	137,2	136,7	134,5	133,7	133,0	132,3	131,8	130,7	129,3	127,5	125,3	121,9	120,7	120,2	120,2
4	127,2	157,2	156,5	155,7	154,8	153,8	153,0	151,5	150,0	147,5	144,7	138,7	134,9	133,4	132,5
5	117,2	174,2	174,0	174,4	174,3	173,4	172,8	171,0	169,3	165,7	160,8	152,0	146,5	143,7	142,3
6	107,2	185,8	186,3	188,4	190,0	191,2	191,2	189,5	186,7	181,7	174,7	163,2	156,0	151,7	150,4
7	97,2	194,5	195,7	202,2	203,8	206,9	207,3	206,4	203,5	196,4	187,4	173,0	163,5	158,6	156,9
8	87,2	201,7	203,8	210,2	215,4	220,6	222,1	222,2	218,8	210,5	198,8	181,2	170,3	164,7	162,7
9	77,2	208,2	210,6	218,5	224,8	231,4	234,8	236,5	233,5	222,2	208,5	188,5	176,6	169,9	167,9
10	67,2	213,1	215,9	225,2	231,9	239,8	244,3	248,5	244,8	230,3	216,0	194,7	181,6	174,5	172,0
11	57,2	215,6	219,0	228,2	235,4	244,5	249,6	253,7	250,2	235,7	220,5	198,6	184,8	177,2	174,7
12	49,3	217,0	219,8	229,3	236,6	246,0	251,2	254,5	251,7	237,2	222,0	199,6	185,6	177,8	175,7

CAPACITANCES

Final accelerator to external conductive coating	$C_{a,g3,g5/m}$	< 1300 > 850	pF pF
Final accelerator to metal band	$C_{a,g3,g5/m'}$	250	pF
Cathode to all	C_k	3	pF
Grid no. 1 to all	C_{g1}	7	pF

FOCUSING electrostatic

DEFLECTION magnetic

Diagonal	110°
Horizontal deflection angle	98°
Vertical deflection angle	81°

PICTURE CENTRING MAGNET

Field intensity perpendicular to the tube axis adjustable from 0 to 800 A/m (0 to 10 Oe). Maximum distance between centre of field of this magnet and reference line: 57 mm.

TYPICAL OPERATING CONDITIONS

Cathode drive service

Voltages are specified with respect to grid no. 1

Final accelerator voltage	$V_{a,g3,g5}$	20	kV
Focusing electrode voltage	V_{g4}	0 to 130	V [1])
Grid no. 2 voltage	V_{g2}	130	V
Cathode voltage for visual extinction of focused raster	V_{KR}	42 to 62	V

1) Because of the flat focus characteristic it is sufficient to choose a focusing voltage between 0 and + 130 V (e.g. two taps, 0 V and 130 V).
The optimum focus voltage of individual tubes may be between − 100 V and + 200 V.

LIMITING VALUES (Design max. rating system)

Final accelerator voltage at $I_{a,g3,g5} = 0$	$V_{a,g3,g5}$	max.	23	kV
		min.	12	kV
Grid no. 4 voltage				
positive	V_{g4}	max.	1000	V
negative	$-V_{g4}$	max.	500	V
Grid no. 2 voltage	V_{g2}	max.	200	V [1]
		min.	80	V
Cathode to grid no. 1 voltage				
positive	$V_{k/g1}$	max.	200	V
positive peak	$V_{k/g1p}$	max.	400	V [2]
negative	$-V_{k/g1}$	max.	0	V
negative peak	$-V_{k/g1p}$	max.	2	V
Cathode-to-heater voltage	V_{kf}	max.	200	V

CIRCUIT DESIGN VALUES

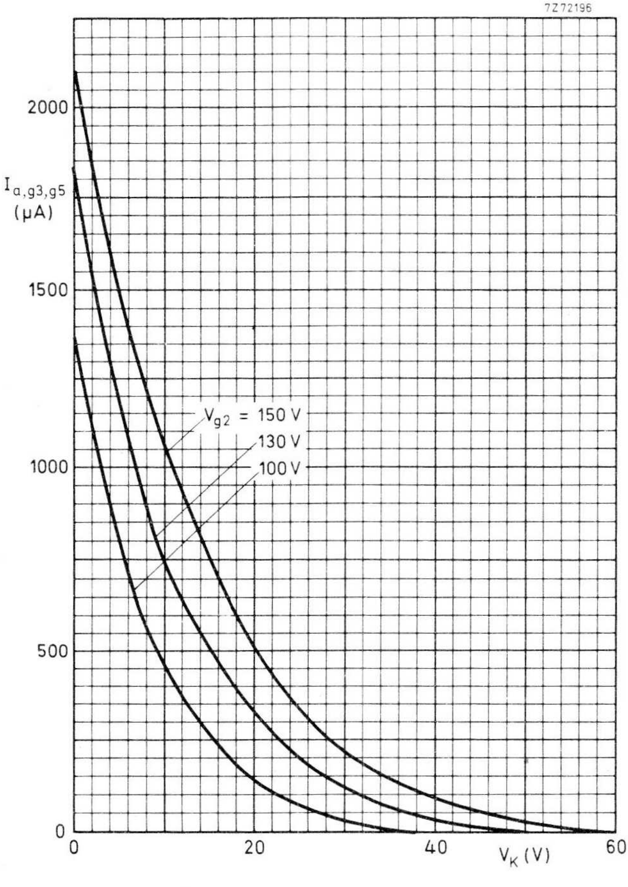
Grid no. 4 current,				
positive	I_{g4}	max.	25	μA
negative	$-I_{g4}$	max.	25	μA
Grid no. 2 current,				
positive	I_{g2}	max.	5	μA
negative	$-I_{g2}$	max.	5	μA

MAXIMUM CIRCUIT VALUES

Resistance between cathode and heater	$R_{k/f}$	max.	1,0	MΩ
Impedance between cathode and heater	$Z_{k/f}$ (50 Hz)	max.	0,1	MΩ
Grid no. 1 circuit resistance	R_{g1}	max.	1,5	MΩ
Grid no. 1 impedance	Z_{g1} (50 Hz)	max.	0,5	MΩ

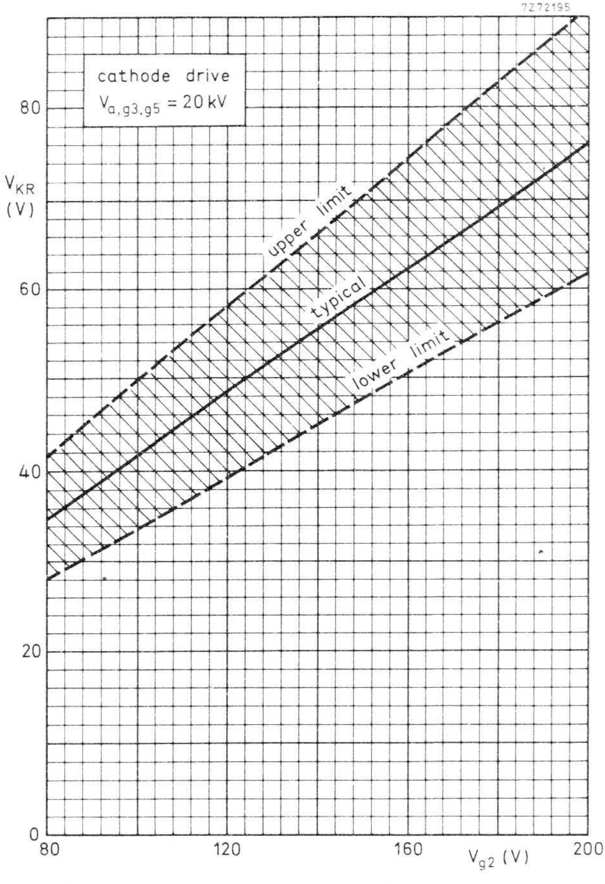
1) At $V_{g1/k} = 0$ V.

2) Maximum pulse duration 22 % of a cycle but maximum 1,5 ms.



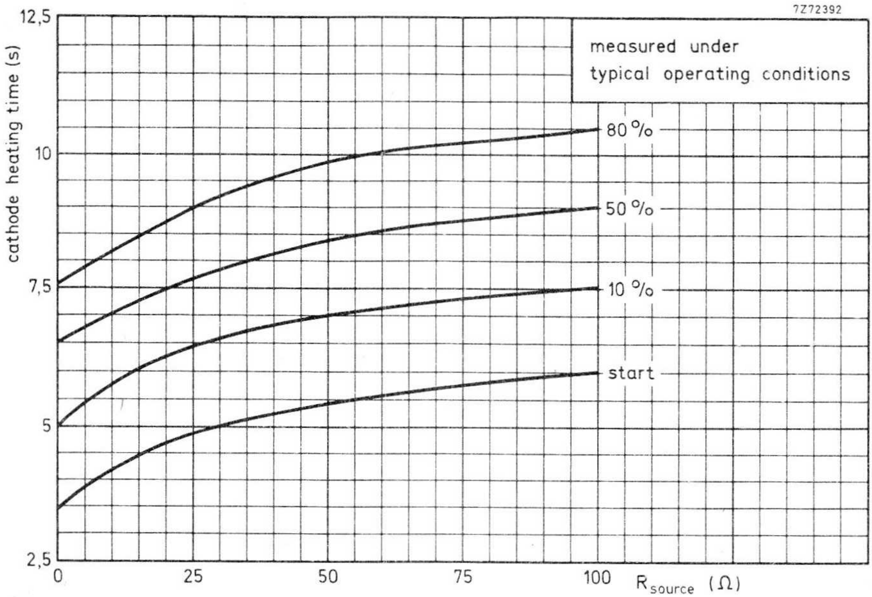
Final accelerator current as a function of cathode voltage

Cathode drive $V_{a,g3,g5} = 20$ kV



$$\frac{\Delta V_{KR}}{\Delta V_{a,g3,g5}} = 0,75 \times 10^{-3}$$

Limits of cathode cut-off voltage as a function of grid no. 2 voltage



Cathode heating time to attain x% of the cathode current at equilibrium conditions

TV PICTURE TUBE

61 cm (24 in), 110°, rectangular direct vision picture tube with integral protection for black and white TV.

QUICK REFERENCE DATA			
Face diagonal		61	cm (24 in)
Deflection angle		110°	
Overall length	max.	370	mm
Neck diameter		28, 6	mm
Heating	6, 3 V,	300	mA
Grid no. 2 voltage		400	V
Final accelerator voltage		20	kV

SCREEN

Metal backed phosphor			
Luminescence	white		
Light transmission of face glass	approx.		42%
Useful diagonal	min.	577, 5	mm
Useful width	min.	481	mm
Useful height	min.	375	mm

HEATING

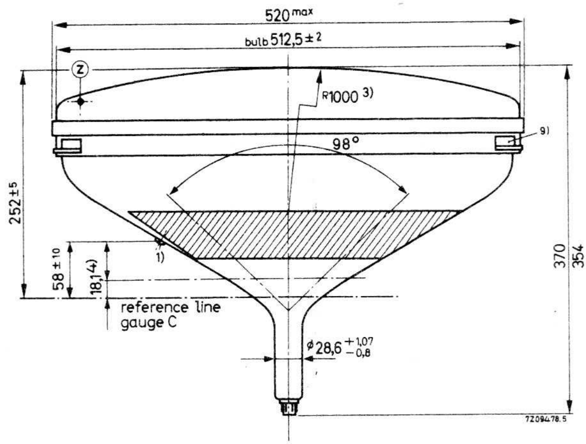
Indirect by a.c. or d.c.; series or parallel supply

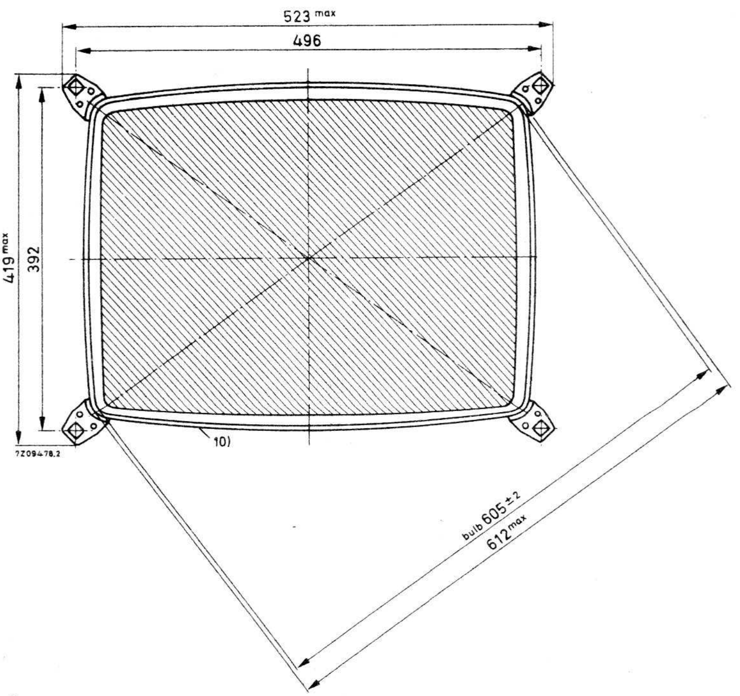
Heater current	I_f	300	mA
Heater voltage	V_f	6, 3	V

If the tube is connected in a series heater chain the surge heater voltage must not exceed an r.m.s. value of 9, 5 V when the supply is switched on.

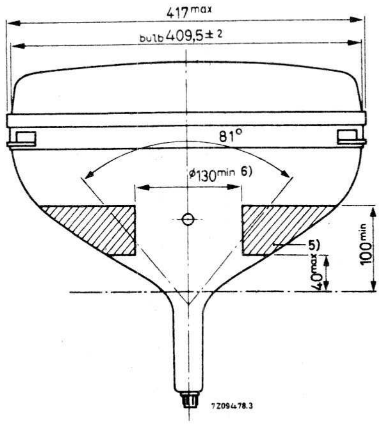
MECHANICAL DATA

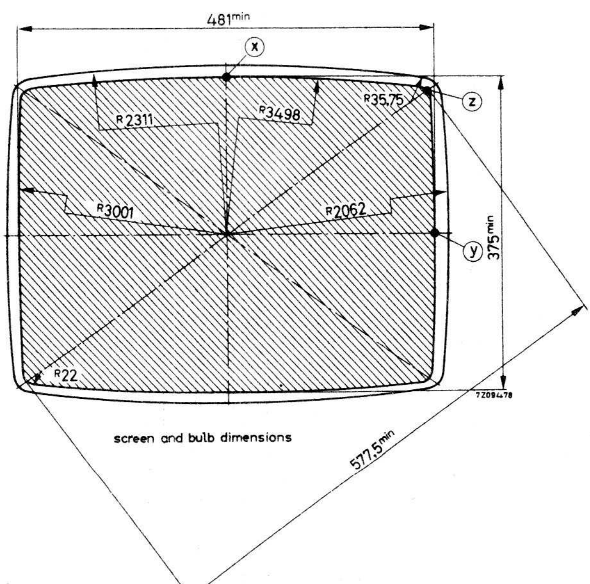
Dimensions in mm



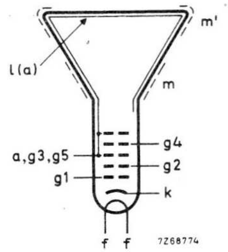


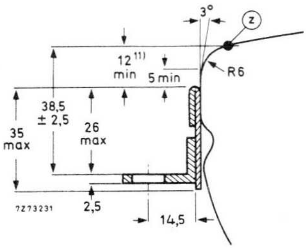
Notes see page 5.

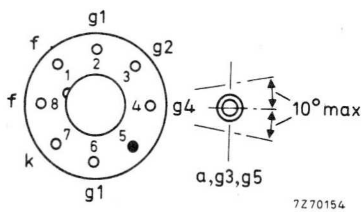


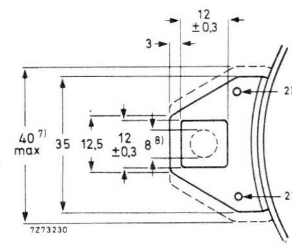


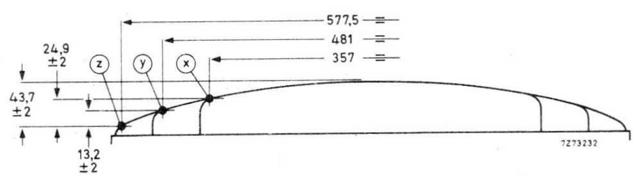
screen and bulb dimensions











Mounting position: any

Base : neo eightar 7 pin JEDEC B7-208, B8H, IEC-67-I-31a

Net mass : approx. 13, 5 kg.

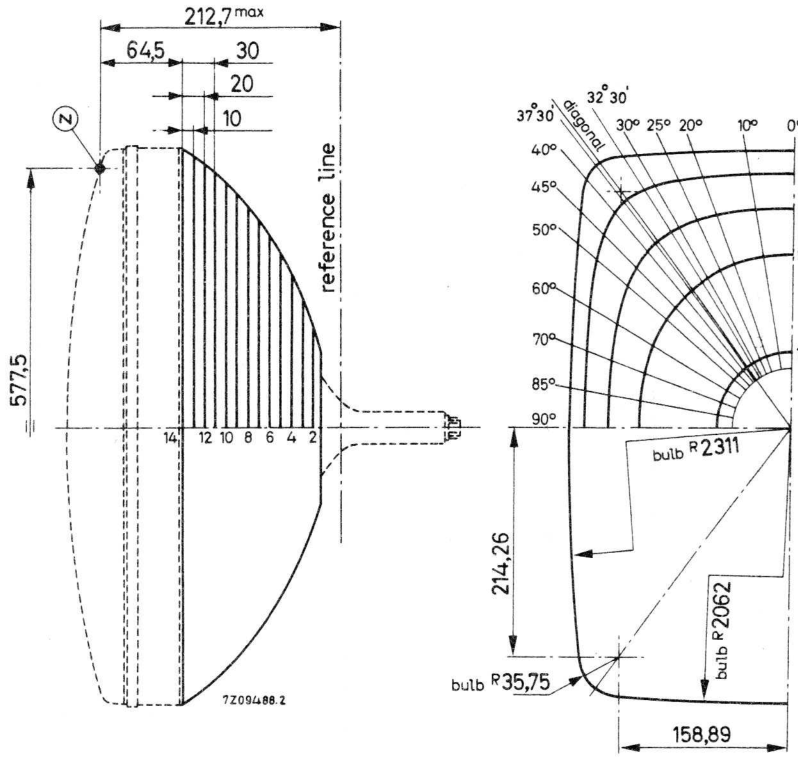
The bottom circumference of the base wafer will fall within a circle concentric with the tube axis and having a diameter of 40 mm.
The socket for the base should not be rigidly mounted: it should have flexible leads and be allowed to move freely.

NOTES TO OUTLINE DRAWINGS

1. Small cavity contact I E C -67-III-2.
2. The metal rim-band must be earthed. The holes of 3 mm dia in each lug are provided for this purpose.
3. Spherical face plate.
4. End of guaranteed contour. The maximum contour from reference line towards screen is given by the reference line gauge C (18, 13 mm).
5. The configuration of the external conductive coating may be different but contains the contact area as shown in the drawing.
   The external conductive coating must be earthed.
6. This area must be kept clean.
7. Minimum space to be reserved for mounting lug.
8. The mounting screws in the cabinet must be situated inside a circle of 8 mm diameter drawn around the true geometrical position; i.e. at the corners of a rectangle of 496 x 392 mm.
9. The displacement of any lug with respect to the plane through the other three lugs is max. 2 mm.
10. The max. outer contour of the tube with the rim-band is determined by adding 5 mm to the nominal bulb dimensions.
11. Distance from reference point Z to any hardware.

MAXIMUM CONE CONTOUR DRAWING

Dimensions in mm



Section	Nom. distance from section 1	Distance from centre (max. values)														
		0°	10°	20°	25°	30°	32°30'	diag.	37°30'	40°	45°	50°	60°	70°	80°	90°
1	130	72,9	72,4	71,6	71,1	70,7	70,5	70,3	70,3	70,2	70,1	70,0	70,2	70,8	71,5	71,8
2	120	104,4	102,6	99,4	97,8	96,5	96,0	95,2	95,1	94,7	94,2	94,0	94,5	96,0	98,0	99,3
3	110	134,3	131,5	126,5	124,2	122,1	121,2	119,9	119,6	119,0	118,0	117,4	117,4	118,7	120,7	122,0
4	100	160,4	157,1	151,1	148,1	145,3	144,1	142,2	141,8	140,8	139,1	137,9	136,7	136,9	137,9	138,7
5	90	178,7	176,9	172,9	170,1	167,5	166,1	164,0	163,5	162,3	159,9	157,8	154,3	151,9	150,7	150,3
6	80	193,3	193,0	191,4	189,9	187,8	186,6	184,4	183,4	182,4	179,2	175,9	169,6	164,4	161,0	159,8
7	70	205,7	206,5	207,6	207,5	206,4	205,5	203,4	202,8	201,1	196,9	192,2	182,7	174,8	169,7	168,0
8	60	216,8	212,5	222,1	223,5	223,8	223,4	221,5	220,9	218,9	213,6	207,2	194,3	183,9	177,6	175,4
9	50	226,9	229,3	235,0	238,1	240,0	240,3	238,9	238,2	235,9	229,0	220,7	204,4	192,1	184,7	182,3
10	40	236,0	238,7	246,3	250,9	254,9	256,1	255,4	254,7	252,4	243,2	232,7	213,3	199,3	191,2	188,6
11	30	243,7	246,8	255,9	262,0	268,1	270,6	271,0	270,3	267,4	256,0	243,1	220,8	205,7	197,1	194,3
12	20	250,0	253,4	263,5	270,9	279,3	283,5	285,5	284,8	281,6	267,2	251,8	227,2	211,1	202,2	199,4
13	10	255,0	258,5	269,3	277,7	288,1	293,9	298,0	297,6	294,1	276,2	258,5	232,1	215,6	206,5	203,6
14	0	258,5	262,0	273,1	281,9	293,2	300,0	305,4	305,1	301,5	281,6	262,7	235,6	218,8	209,6	206,6

CAPACITANCES

Final accelerator to external conductive coating	$C_{a, g3, g5/m}$	< 2500 pF > 1500 pF
Final accelerator to metal band	$C_{a, g3, g5/m'}$	400 pF
Cathode to all	C_k	5 pF
Grid no. 1 to all	C_{g1}	7 pF

FOCUSING electrostatic

DEFLECTION magnetic

Diagonal deflection angle	110°
Horizontal deflection angle	98°
Vertical deflection angle	81°

PICTURE CENTRING MAGNET

Field intensity perpendicular to the tube axis adjustable from 0 to 800 A/m (0 to 10 Oe). Maximum distance between centre of field of this magnet and reference line: 57 mm.

TYPICAL OPERATING CONDITIONS

Grid drive service

Final accelerator voltage	$V_{a, g3, g5}$	20 kV
Focusing electrode voltage	V_{g4}	0 to 400 V 1)
Grid no. 2 voltage	V_{g2}	400 V
Grid no. 1 voltage for visual exinction of focused raster	V_{GR}	-40 to -77 V

Cathode drive service

Voltages are specified with respect to grid no. 1

Final accelerator voltage	$V_{a, g3, g5}$	20 kV
Focusing electrode voltage	V_{g4}	0 to 400 V 1)
Grid no. 2 voltage	V_{g2}	400 V
Cathode voltage for visual extinction of focused raster	V_{KR}	36 to 66 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 max. rating system)

Final accelerator voltage at Ia, g3, g5 = 0	Va, g3, g5	max. min.	23 12	kV kV
Grid no. 4 voltage,				
positive	Vg4	max.	1000	V
negative	-Vg4	max.	500	V
Grid no. 2 voltage	Vg2	max. min.	700 350	V 2) V
Grid no. 2 to grid no. 1 voltage	Vg2/g1	max.	850	V
Grid no. 1 voltage				
positive	Vg1	max.	0	V
positive peak	Vg1p	max.	2	V
negative	-Vg1	max.	200	V
negative peak	-Vg1p	max.	400	V 1)
Cathode to heater voltage,				
positive	Vk/f	max.	250	V
positive peak	Vk/fp	max.	300	V
negative	-Vk/f	max.	200	V
positive during equipment warm-up period not exceeding 15 s	Vk/f	max.	450	V 3)

1) Maximum pulse duration 22% of a cycle but maximum 1, 5 ms.

2) At Vg1/k = 0V.

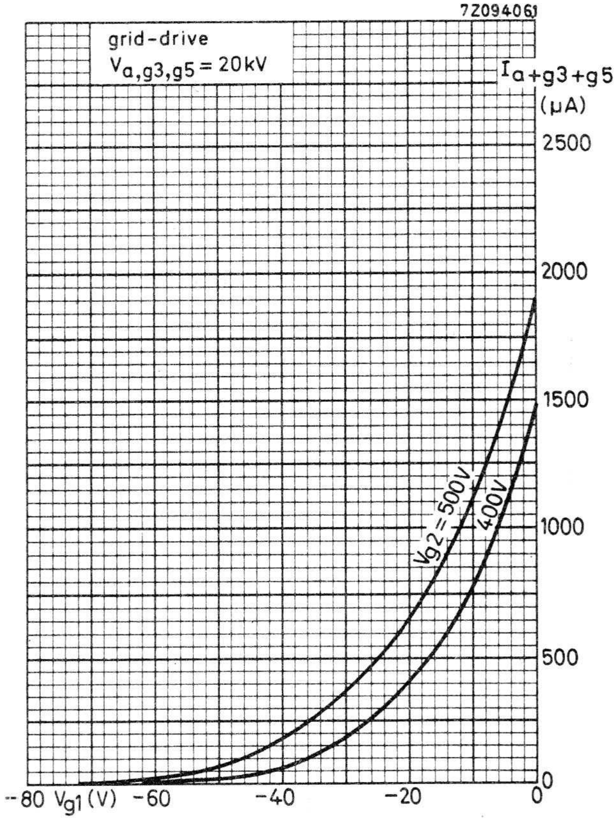
3) Between 15 s and 45 s after switching on a decrease in k/f voltage from 450 V to 250 V, linearly proportional with time, is permissible.

CIRCUIT DESIGN VALUES

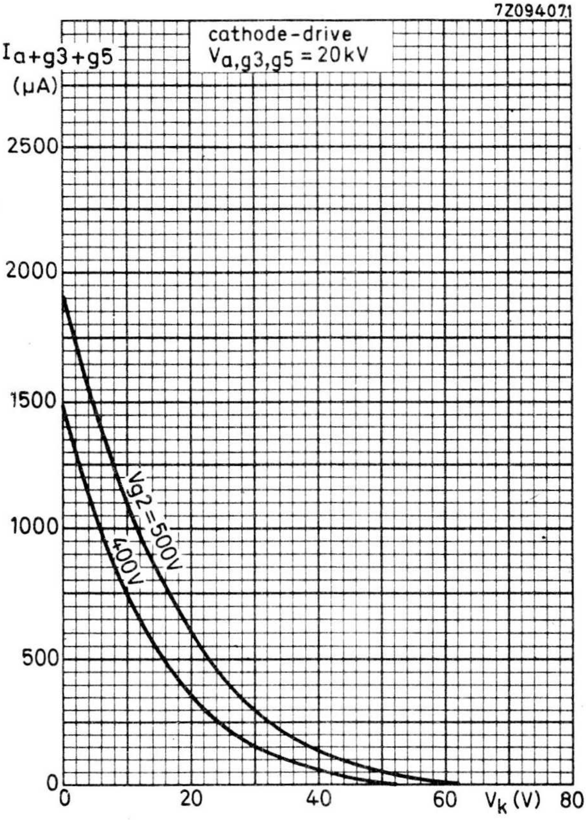
Grid no. 4 current,				
positive	Ig4	max.	25	μA
negative	-Ig4	max.	25	μA
Grid no. 2 current				
positive	Ig2	max.	5	μA
negative	-Ig2	max.	5	μA

MAXIMUM CIRCUIT VALUES

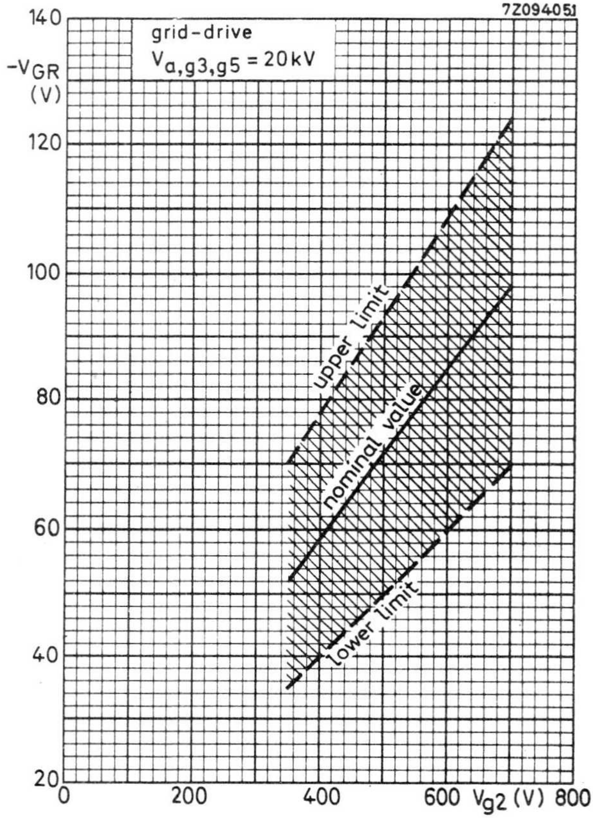
Resistance between cathode and heater	Rk/f	max.	1	MΩ
Impedance between cathode and heater	Zk/f(50 Hz)	max.	0,1	MΩ
Grid no. 1 circuit resistance	Rg1	max.	1,5	MΩ
Grid no. 1 circuit impedance	Zg1(50 Hz)	max.	0,5	MΩ



Final accelerator current as a function of grid no. 1 voltage.

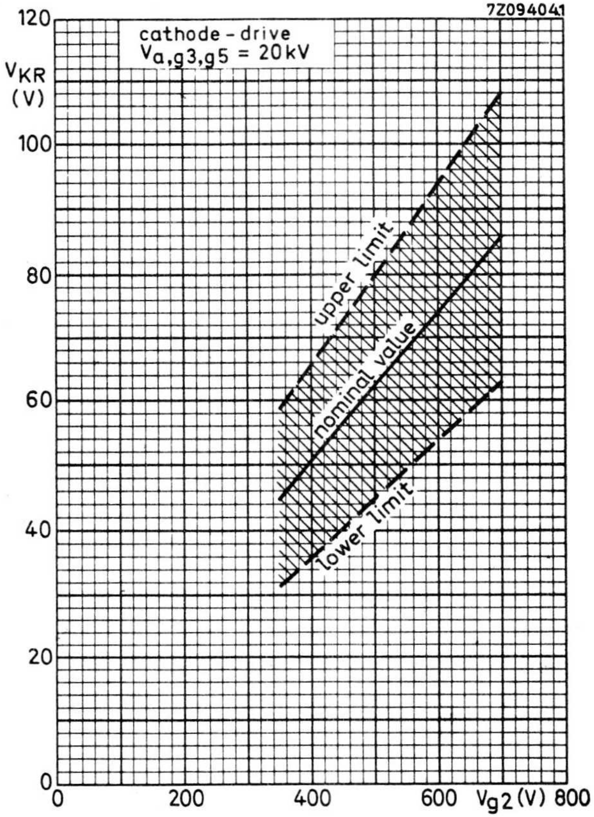


Final accelerator current as a function of cathode voltage.



$$\frac{\Delta V_{GR}}{\Delta V_{a,\,g3,\,g5}} = 0,15 \times 10^{-3}$$

Limits of grid no. 1 cut-off voltage as a function of grid no. 2 voltage.



$$\frac{\Delta V_{KR}}{\Delta V_{a,\, g3,\, g5}} = 0,15 \times 10^{-3}$$

Limits of cathode cut-off voltage as a function of grid no. 2 voltage.

TV PICTURE TUBE

61 cm (24 in), 110°, rectangular direct vision picture tube with integral protection for black and white TV. A special feature of this tube is its short cathode heating time.

QUICK REFERENCE DATA		
Face diagonal		61 cm
Deflection angle		110°
Overall length	max.	370 mm
Neck diameter		28,6 mm
Heating		6,3 V, 240 mA
Grid no. 2 voltage		130 V
Final accelerator voltage		20 kV
Quick heating cathode		with a typical tube a legible picture will appear within 5 s.

SCREEN

Metal backed phosphor		
Luminescence	white	
Light transmission of face glass		42 %
Useful diagonal	min.	577,5 mm
Useful width	min.	481 mm
Useful height	min.	375 mm

HEATING

Indirect by a.c. or d.c.

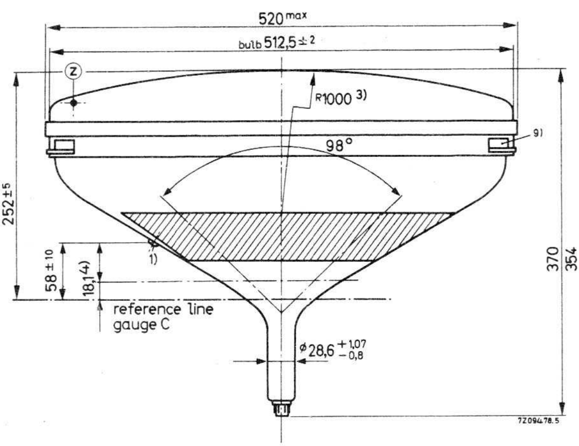
Heater voltage	V_f		6,3 V
Heater current	I_f		240 mA
Limits (Absolute max. rating system) of r.m.s. heater voltage measured in any 20 ms	V_f	max. min.	7,3 V [1] 5,3 V

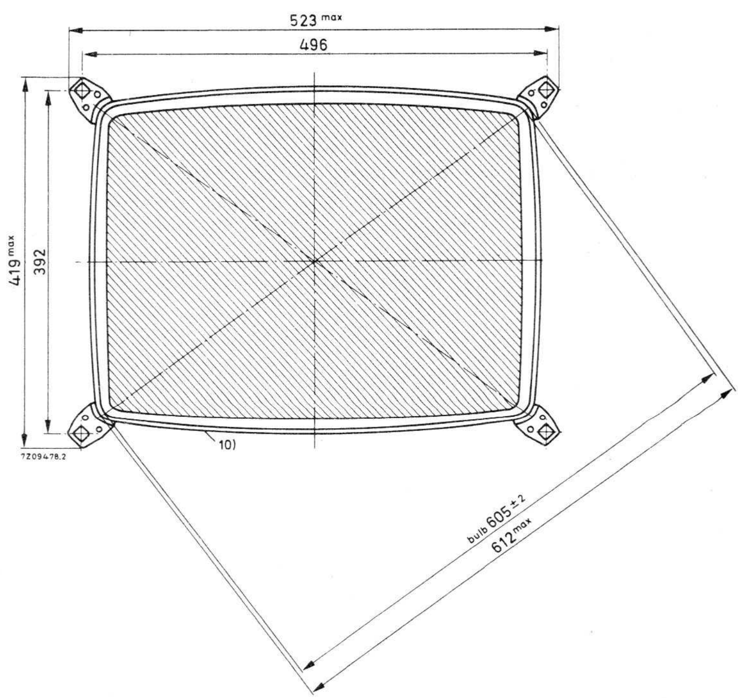
For heating time as a function of source impedance see page 11.

[1]) This limit also applies during equipment warming up. Use of the tube in a series heater chain is not allowed.

MECHANICAL DATA

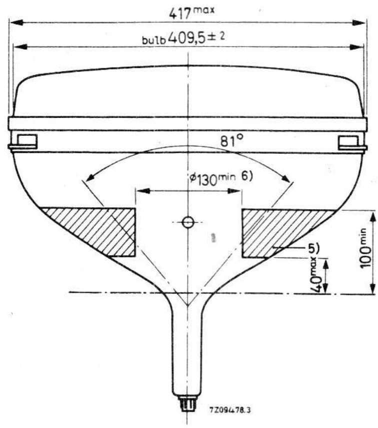
Dimensions in mm

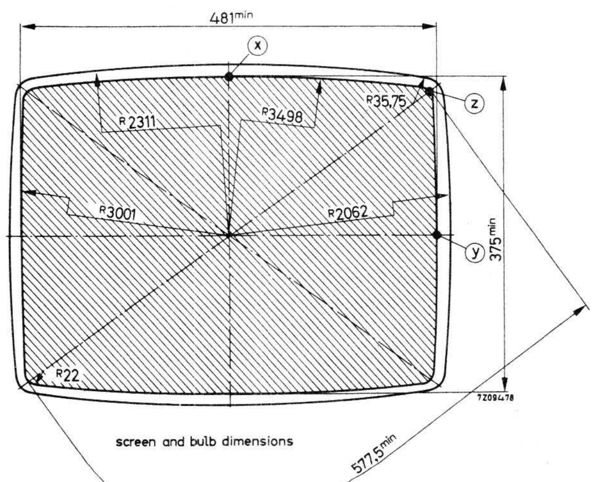




MECHANICAL DATA (continued)

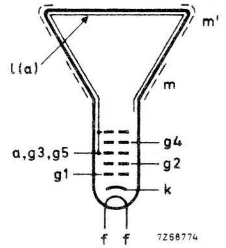
Dimensions in mm

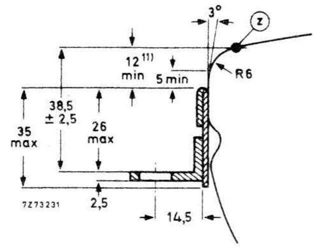


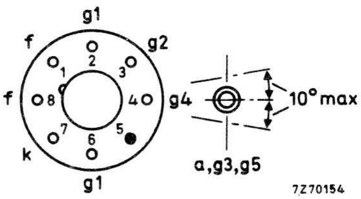


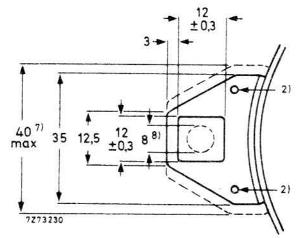
screen and bulb dimensions

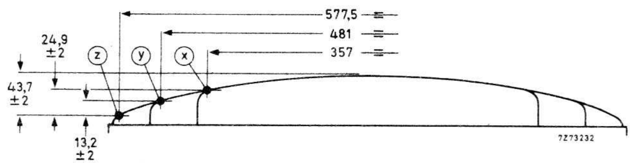
For notes see page 5











Mounting position : any

Base : neo eightar 7 pin JEDEC B7-208, B8H, IEC-67-I-31a

Net mass : approx. 13,5 kg

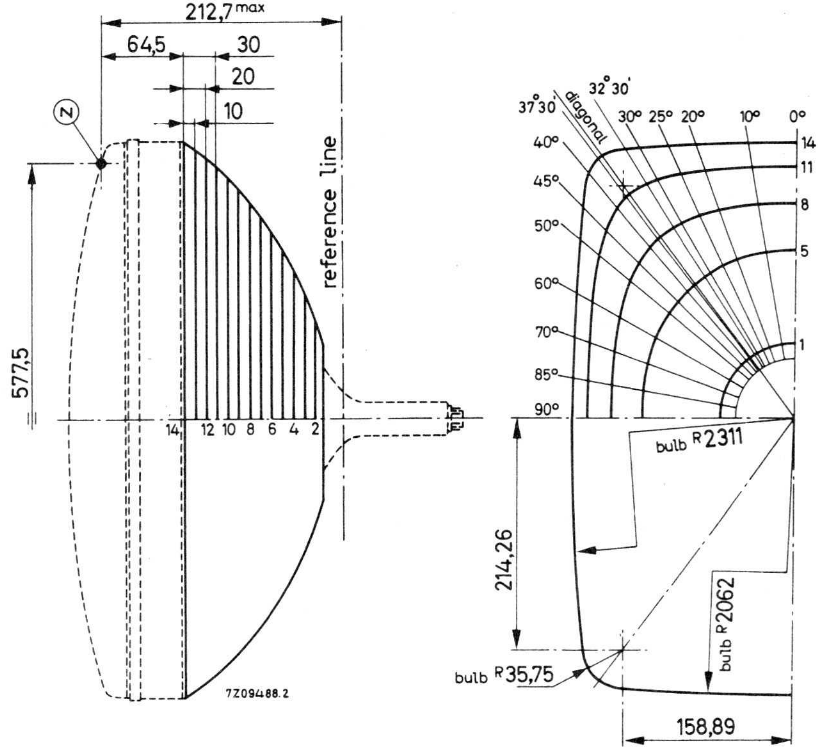
The bottom circumference of the base wafer will fall within a circle concentric with the tube axis and having a diameter of 40 mm.
The socket for the base should not be rigidly mounted: it should have flexible leads and be allowed to move freely.

NOTES TO OUTLINE DRAWINGS

1. Small cavity contact IEC 67-III-2.
2. The metal rim-band must be earthed. The holes of 3 mm dia in each lug are provided for this purpose.
3. Spherical face plate.
4. End of guaranteed contour. The maximum contour from reference line towards screen is given by the reference line gauge C (18, 13 mm).
5. The configuration of the external conductive coating may be different but contains the contact area as shown in the drawing.
   The external conductive coating must be earthed.
6. This area must be kept clean.
7. Minimum space to be reserved for mounting lug.
8. The mounting screws in the cabinet must be situated inside a circle of 8 mm diameter drawn around the true geometrical position; i.e. at the corners of a rectangle of 496 x 392 mm.
9. The displacement of any lug with respect to the plane through the other three lugs is max. 2 mm.
10. The max. outer contour of the tube with the rim-band is determined by adding 5 mm to the nominal bulb dimensions.
11. Distance from reference point Z to any hardware.

MAXIMUM CONE CONTOUR DRAWING

Dimensions in mm



Section	Nom. distance from section 1	Distance from centre (max. values)														
		0°	10°	20°	25°	30°	32°30'	diag.	37°30'	40°	45°	50°	60°	70°	80°	90°
1	130	72,9	72,4	71,6	71,1	70,7	70,5	70,3	70,3	70,2	70,1	70,0	70,2	70,8	71,5	71,8
2	120	104,4	102,6	99,4	97,8	96,5	96,0	95,2	95,1	94,7	94,2	94,0	94,5	96,0	98,0	99,3
3	110	134,3	131,5	126,5	124,2	122,1	121,2	119,9	119,6	119,0	118,0	117,4	117,4	118,7	120,7	122,0
4	100	160,4	157,1	151,1	148,1	145,3	144,1	142,2	141,8	140,8	139,1	137,9	136,7	136,9	137,9	138,7
5	90	178,7	176,9	172,9	170,1	167,5	166,1	164,0	163,5	162,3	159,9	157,8	154,3	151,9	150,7	150,3
6	80	193,3	193,0	191,4	189,9	187,8	186,6	184,4	183,4	182,4	179,2	175,9	169,6	164,4	161,0	159,8
7	70	205,7	206,5	207,6	207,5	206,4	205,5	203,4	202,8	201,1	196,9	192,2	182,7	174,8	169,7	168,0
8	60	216,8	212,5	222,1	223,5	223,8	223,4	221,5	220,9	218,9	213,6	207,2	194,3	183,9	177,6	175,4
9	50	226,9	229,3	235,0	238,1	240,0	240,3	238,9	238,2	235,9	229,0	220,7	204,4	192,1	184,7	182,3
10	40	236,0	238,7	246,3	250,9	254,9	256,1	255,4	254,7	252,4	243,2	232,7	213,3	199,3	191,2	188,6
11	30	243,7	246,8	255,9	262,0	268,1	270,6	271,0	270,3	267,4	256,0	243,1	220,8	205,7	197,1	194,3
12	20	250,0	253,4	263,5	270,9	279,3	283,5	285,5	284,8	281,6	267,2	251,8	227,2	211,1	202,2	199,4
13	10	255,0	258,5	269,3	277,7	288,1	293,9	298,0	297,6	294,1	276,2	258,5	232,1	215,6	206,5	203,6
14	0	258,5	262,0	273,1	281,9	293,2	300,0	305,4	305,1	301,5	281,6	262,7	235,6	218,8	209,6	206,6

CAPACITANCES

Final accelerator to external conductive coating	$C_{a, g3, g5/m}$	< 2500 pF > 1500 pF
Final accelerator to metal band	$C_{a, g3, g5/m'}$	350 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^o
Horizontal deflection angle	98^o
Vertical deflection angle	81^o

PICTURE CENTRING MAGNET

Field intensity perpendicular to the tube axis adjustable from 0 to 800 A/m (0 to 10 Oe).

Maximum distance between centre of field of this magnet and reference line: 57 mm.

TYPICAL OPERATING CONDITIONS

Cathode drive service

Voltages are specified with respect to grid no. 1

Final accelerator voltage	$V_{a, g3, g5}$	20 kV
Focusing electrode voltage	V_{g4}	0 to 130 V [1]
Grid no. 2 voltage	V_{g2}	130 V
Cathode voltage for visual extinction of focused raster	V_{KR}	42 to 62 V

[1]) Because of the flat focus characteristic it is suffient to choose a focusing voltage between 0 and 130 V (e.g. two taps, 0 V and 130 V).
The optimum focus voltage of individual tubes may between −100 V and +200 V.

LIMITING VALUES (Design max. rating system)

Final accelerator voltage at $I_{a,g3,g5} = 0$	$V_{a,g3,g5}$	max. min.	23 12	kV kV
Grid no. 4 voltage,				
positive	V_{g4}	max.	1000	V
negative	$-V_{g4}$	max.	500	V
Grid no. 2 voltage	V_{g2}	max. min.	200 80	V 1) V
Cathode to grid no. 1 voltage				
positive	$V_{k/g1}$	max.	200	V
positive peak	$V_{k/g1_p}$	max.	400	V 2)
negative	$-V_{k/g1}$	max.	0	V
negative peak	$-V_{k/g1_p}$	max.	2	V
Cathode to heater voltage	V_{kf}	max.	200	V

CIRCUIT DESIGN VALUES

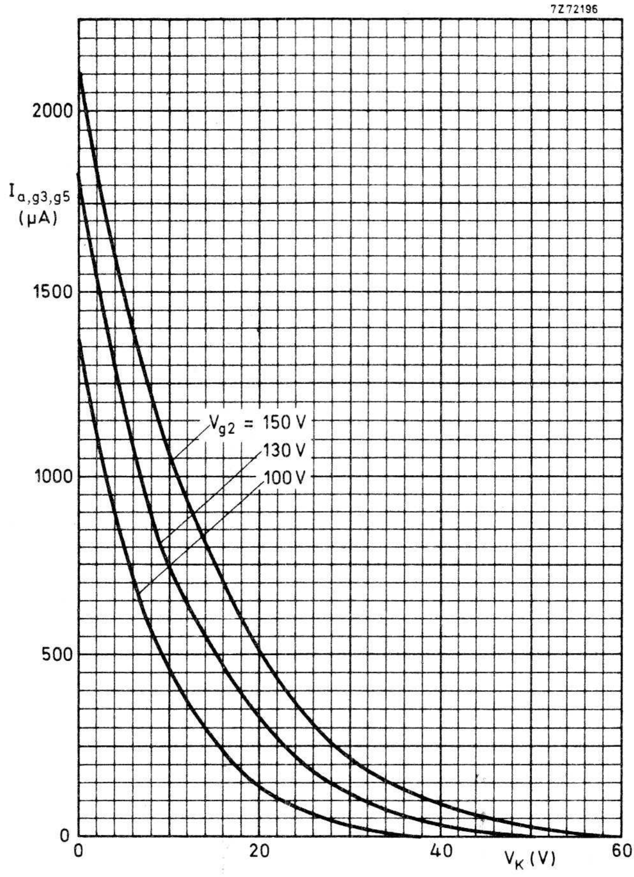
Grid no. 4 current				
positive	I_{g4}	max.	25	µA
negative	$-I_{g4}$	max.	25	µA
Grid no. 2 current				
positive	I_{g2}	max.	5	µA
negative	$-I_{g2}$	max.	5	µA

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_{g1}	max.	1, 5	MΩ
Grid no. 1 circuit impedance	Z_{g1} (50 Hz)	max.	0, 5	MΩ

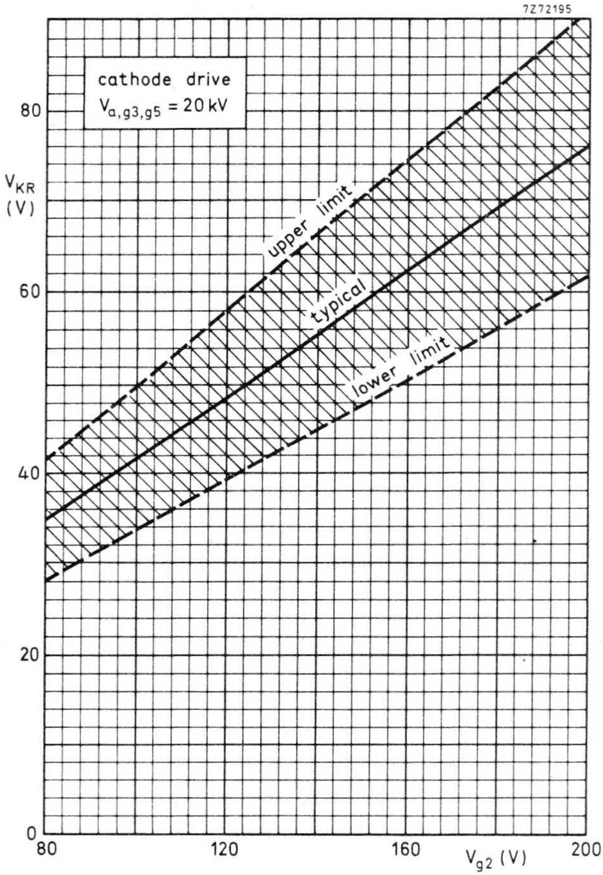
1) At $V_{k/g1} = 0$ V.

2) Maximum pulse duration 22% of a cycle but maximum 1, 5 ms.



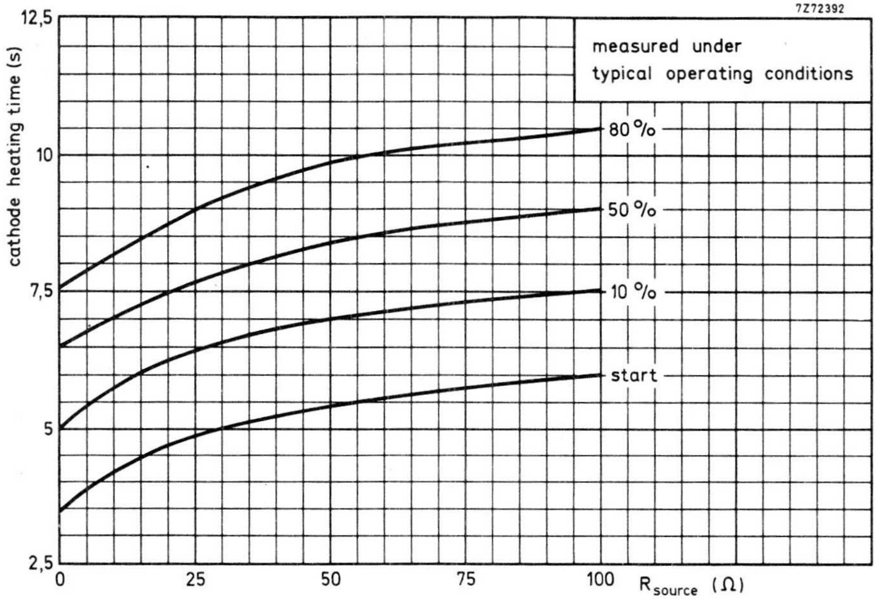
Final accelerator current as a function of cathode voltage.

Cathode drive $\quad V_{a,g3,g5} = 20$ kV



$$\frac{\Delta V_{KR}}{\Delta V_{a,g3,g5}} = 0,75 \times 10^{-3}$$

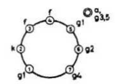
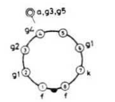
Limits of cathode cut-off voltage as a function of grid no. 2 voltage.



Cathode heating time to attain x % of the cathode current at equilibrium conditions.

Index; Maintenance type list

MAINTENANCE TYPES (Abridged data)

Type Deflection angle Transmission	V_f (V) I_f (A)	Typical operating conditions	Min. useful screen diag.	width	height	Max. overall length	Base connections
A28-14 W 90° 50%	11 0,075	$V_{a,g3,g5}$ = 11 kV V_{g4} = 0-350 V V_{g2} = 250 V $-V_{GR}$ = 35 to 69 V V_{KR} = 32 to 58 V	263	228	171	250	
A31-20 W 90° 54%			295	257	195	277	
A31-120 W 110° 50%			295	257	195	233	
A47-14 W 110° 48%			446	384	305	309	
A47-26 W 110° 45%	6,3 0,3	$V_{a,g3,g5}$ = 20 kV V_{g4} = 0-400 V V_{g2} = 400 V $-V_{GR}$ = 40 to 77 V V_{KR} = 36 to 66 V	446	384	305	309	
A59-15 W 110° 45%			566	489	385	367	
A59-23 W 110° 45%			566	489	385	367	
A63-11 X 90° 52,5%		Replacement type A63-120X					

INDEX OF TYPE NUMBERS

Type number	Section	Type number	Section
A31-410W	BW	A56-410X	C
A31-510W	BW	A61-120W	BW
A34-510W	BW	A61-520W	BW
A44-120W	BW	A63-120X	C
A44-510W	BW	A66-120X	C
A44-520W	BW	A66-140X	C
A50-120W	BW	A66-410X	C
A50-520W	BW		
A56-120X	C		
A56-140X	C		

BW = Black and white TV picture tubes
C = Colour TV picture tubes

General section

Colour TV picture tubes

Black and white TV picture tubes

Index; Maintenance type list

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