DISPLAY COMPONENTS

DATA HANDBOOK

Colour TV Picture Tubes and Assemblies
Colour Monitor Tube Assemblies

BOOK DC01 1991

PHILIPS

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COLOUR DISPLAY COMPONENTS

INTRODUCTION

INTRODUCTION

GUIDE FOR THE USE OF THE 1991 HANDBOOK

The Selection Guide following this introduction provides a complete list of all the preferred tube types and assemblies that are currently available, together with quick-reference data for each tube type and deflection unit. However, the Device Specifications sections only provide data for basic families of tube types and tube assemblies. At the front of each Device Specification section is a list of types for which full data is provided.

SELECTION GUIDE COLOUR PICTURE TUBES AND ASSEMBLIES

tube type designation	TV lines	tube size	defl angle	neck diameter (mm)	useful screen diag. (mm)	glass transmission	overall length (mm)	base	typical operating conditions Vf/If (V/mA)	Va (kV)	Vg3 (% of Va)	Vg2 (V)	Vcut-off (V)	V_a (abs. max.) (kV)	I_a (long term average) (µA)	remarks
A34EAC00X..	625 525	14"	90°	22.5	335	68%	339	B8-288	6.3/300	23	28%	310-600	120	27.5	750	
A34EAC01X..	625 525	14"	90°	22.5	335	46%	339	B8-288	6.3/300	23	28%	310-600	120	27.5	750	
A36EAM00X..	625	36 cm	90°	22.5	356	65%	345	B8-288	6.3/300	23	31%	310-650	120	27.5	750	
A36EAM01X..	625	36 cm	90°	22.5	356	45%	345	B8-288	6.3/300	23	31%	310-650	120	27.5	750	
A41EAM00X..	625	41 cm	90°	22.5	406	64%	374	B8-288	6.3/300	23	31%	310-650	120	27.5	750	
A41EAM01X..	625	41 cm	90°	22.5	406	42%	374	B8-288	6.3/300	23	31%	310-650	120	27.5	750	
A51EAL10X..	625	51 cm	90°	29.1	508	64%	453.3	B8-274	6.3/310	25	31%	575-825	130	27.5	1000	
A51EAL11X..	625	51 cm	90°	29.1	508	52%	453.3	B8-274	6.3/310	25	31%	575-825	130	27.5	1000	
A51EAL30X..	625	51 cm	90°	29.1	508	52%	448.7	B10-277	6.3/310	25	31%	575-825	130	27.5	1000	
A51EAL40X..	625	51 cm	90°	29.1	508	52%	448.7	B10-277	6.3/310	25	31%	575-825	130	27.5	1000	skirted rimband
A51EAL50X..	625	51 cm	90°	29.1	508	40%	448.7	B10-277	6.3/310	25	31%	575-825	130	27.5	1000	
A51EAL60X..	625	51 cm	90°	29.1	508	57%	448.7	B10-277	6.3/310	25	31%	575-825	130	27.5	1000	

available assemblies	coil type	deflection coil data: line coil inductance (mH)	line coil resistance (Ω)	line coil current (A p-p)	field coil inductance (mH)	field coil resistance (Ω)	field coil current (A p-p)	remarks
A34EAC..X02	AT1625/10	2.43	3.3	2.17	110	54	0.375	incl. loss coil, 0.15 mH
A34EAC..X03	AT1625/20	2.47	3.3	2.17	27.5	14	0.750	incl. loss coil, 0.19 mH
A34EAC..X04	AT1625/30	2.50	3.3	2.07	110	54	0.375	
A34EAC..X05	AT1625/21	2.28	3.2	2.17	27.5	14	0.750	
A34EAC..X06	AT1625/31	2.50	3.3	2.07	27.5	14	0.750	
A34EAC..X10	AT1625/22	2.53	3.3	2.17	27.5	14	0.750	incl. loss coil, 0.25 mH
A34EAC..X12	AT1625/41	2.74	3.9	1.98	27.5	14	0.750	
A34EAC..X17	AT1625/32	2.65	3.4	2.07	27.5	14	0.750	incl. loss coil, 0.15 mH
A34EAC..X45	AT1625/45	2.28	3.2	2.17	42	20	0.620	
A34EAC..X70	AT1625/70	1.64	2.1	2.56	110	54	0.375	WTB-2 connectors
A36EAM..X01	AT6060/00	2.43	3.2	2.10	26.2	12	0.820	
A36EAM..X03	AT6060/03	2.43	3.2	2.10	26.2	12	0.820	WTB-2 connectors
A36EAM..X04	AT6060/30	2.43	3.2	2.10	108	50	0.407	
A3EAM..X16	AT6060/42	1.64	2.2	2.56	108	50	0.407	WTB-2 connectors
A41EAM..X01	AT6050/00	2.43	3.2	2.10	26.2	12	0.820	
A41EAM..X03	AT6050/03	2.43	3.2	2.10	26.2	12	0.820	WTB-2 connectors
A41EAM..X04	AT6050/30	2.43	3.2	2.10	108	50	0.407	
A41EAM..X16	AT6050/42	1.64	2.2	2.56	108	50	0.407	WTB-2 connectors
A51EAL..X01	AT6035/04	2.00	2.3	2.85	19.5	9.7	1.09	
A51EAL..X02	AT6035/02	2.00	2.3	2.85	19.5	9.7	1.09	Stocko connector
A51EAL..X03	AT6035/03	2.00	2.3	2.85	19.5	9.7	1.09	WTB-2 connectors
A51EAL..X05	AT6035/05	1.13	1.4	3.78	78.0	40	0.540	WTB-2 connectors
A51EAL..X11	AT6035/11	1.70	2.0	3.09	19.5	9.7	1.09	Stocko connector
A51EAL..X30	AT6035/30	2.00	2.3	2.85	78.0	39	0.540	

tube type designation	TV lines	tube size	defl angle	neck diameter (mm)	useful screen diag. (mm)	glass transmission	overall length (mm)	base	typical operating conditions Vf/If (V/mA)	Va (kV)	Vg3 (% of Va)	Vg2 (V)	Vcut-off (V)	V_a (abs. max.) (kV)	I_a (long term average) (µA)	remarks
A51EAM31X	625	51 cm	90°	22.5	508	52%	435	B8-288	6.3/310	25	31%	310-650	120	27.5	1000	
A51EAM32X..	625	51 cm	90°	22.5	508	57%	435	B8-288	6.3/310	25	31%	310-650	120	27.5	1000	
A51EAK01X..	625	51 cm	110°	29.1	512	52%	368	B10-277	6.3/310	25	31%	575-825	130	29.9	1000	Invar mask
A59EAK00X..	625	59 cm	110°	29.1	593	67%	398	B10-277	6.3/310	25	31%	575-825	130	29.9	1000	
A59EAK01X..	625	59 cm	110°	29.1	593	53%	398	B10-277	6.3/310	25	31%	575-825	130	29.9	1000	
A59EAK10X..	625	59 cm	110°	29.1	593	67%	398	B10-277	6.3/310	25	31%	575-825	130	29.9	1000	S. Hemisphere
A59EAK11X..	625	59 cm	110°	29.1	593	53%	398	B10-277	6.3/310	25	31%	575-825	130	29.9	1000	S. Hemisphere
A66EAK50X..	625	66 cm	110°	29.1	663	65%	428	B10-277	6.3/310	25	31%	575-825	130	29.9	1000	
A66EAK51X..	625	66 cm	110°	29.1	663	50%	428	B10-277	6.3/310	25	31%	575-825	130	29.9	1000	
A66EAK55X..	525	66 cm	110°	29.1	663	65%	428	B10-277	6.3/310	25	31%	575-825	130	29.9	1000	
A66EAK56X..	525	66 cm	110°	29.1	663	50%	428	B10-277	6.3/310	25	31%	575-825	130	29.9	1000	
A66EAK60X..	625	66 cm	110°	29.1	663	65%	428	B10-277	6.3/310	25	31%	575-825	130	29.9	1000	S. Hemisphere
A66EAK61X..	625	66 cm	110°	29.1	663	50%	428	B10-277	6.3/310	25	31%	575-825	130	29.9	1000	S. Hemisphere
A66EAK65X..	525	66 cm	110°	29.1	663	65%	428	B10-277	6.3/310	25	31%	575-825	130	29.9	1000	S. Hemisphere
A66EAK66X..	525	66 cm	110°	29.1	663	50%	428	B10-277	6.3/310	25	31%	575-825	130	29.9	1000	S. Hemisphere

available assemblies	coil type	deflection coil data: line coil inductance (mH)	line coil resistance (Ω)	line coil current (A p-p)	field coil inductance (mH)	field coil resistance (Ω)	field coil current (A p-p)	remarks
A51EAM..X01	AT6040/00	2.37	3.2	2.26	22.5	11	0.950	
A51EAM..X04	AT6040/30	2.37	3.16	2.26	108	50	0.430	
A51EAM..X16	AT6040/42	1.64	2.3	2.71	108	50	0.430	WTB-2 connectors
A51EAK01X01	AT6020/00	2.03	2.0	3.88	11.7	6.0	1.77	
A51EAK01X02	AT6020/00	2.03	2.0	3.88	11.7	6.0	1.77	6 pin connector in South
A51EAK01X03	AT6020/10	2.03	2.0	3.88	11.7	6.0	1.77	WTB-2 connector
A51EAK01X04	AT6020/15	2.03	2.0	3.9	107	51	0.590	
A51EAK01X05	AT6020/20	1.84	1.9	4.04	11.8	5.9	1.75	
A59EAK..X01	AT6010/00	1.85	1.8	4.10	11.1	6.3	1.65	
A59EAK..X02	AT6010/00	1.85	1.8	4.10	11.1	6.3	1.65	6 pin connector in South
A59EAK..X03	AT6010/10	1.85	1.8	4.10	11.1	6.3	1.65	WTB-2 connectors
A59EAK..X04	AT6010/15	1.85	1.8	4.10	100	56	0.550	
A59EAK..X06	AT6010/20	1.58	1.6	4.38	21.0	12.3	1.20	
A66EAK..X01	AT6005/00	1.84	1.8	4.23	10.7	6.2	1.76	
A66EAK..X02	AT6005/00	1.84	1.8	4.23	10.7	6.2	1.76	6 pin connector in South
A66EAK..X03	AT6005/10	1.84	1.8	4.23	10.7	6.2	1.76	WTB-2 connectors
A66EAK..X04	AT6005/15	1.84	1.8	4.23	96.0	55	0.590	
A66EAK..X32	AT6006/00	0.430	0.59	8.92	6.50	3.9	2.25	32 kHz/100 Hz

tube type designation	TV lines	tube size	defl angle	neck diameter (mm)	useful screen diag. (mm)	glass transmission	overall length (mm)	base	typical operating conditions Vf/If (V/mA)	Va (kV)	Vg3 (% of Va)	Vg2 (V)	Vcut-off (V)	V_a (abs. max.) (kV)	I_a (long term average) (μA)	remarks
A59EAK22X..	625	59 cm	110°	29.1	593	42%	398	B10-277	6.3/310	27.5	31%	700-1020	160	32	1500	
A66EAK22X..	625	66 cm	110°	29.1	663	39%	428	B10-277	6.3/310	27.5	31%	700-1020	160	32	1500	
A80EBK221X..	525 625	80 cm	110°	29.1	796	47.5%	500	B10-277	6.3/310	27.5	31%	700-1020	160	33	1500	

available assemblies	coil type	line coil inductance (mH)	line coil resistance (Ω)	line coil current (A p-p)	field coil inductance (mH)	field coil resistance (Ω)	field coil current (A p-p)	remarks
A59EAK22X01	AT6010/00	1.8	1.85	4.30	11.1	6.3	1.73	
A59EAK22X11	AT6010/30	1.58	1.6	4.69	8.55	5.0	2.03	
A59EAK22X12	AT6010/30	1.58	1.6	4.69	8.55	5.0	2.03	6 pin connector in South
A59EAK22X13	AT6010/31	1.58	1.6	4.69	8.55	5.0	2.03	WTB-2 connectors
A59EAK22X21	AT6016/40	1.58	1.6	4.69	8.55	5.0	2.03	SVM, 4.2 μH, 1.8 Ω
A59EAK22X42	AT6016/30	0.35	0.45	10.9	6.3	3.7	2.41	32 kHz/100Hz
A66EAK22X01	AT6005/00	1.84	1.78	4.44	10.7	6.2	1.85	
A66EAK22X11	AT6005/30	1.58	1.7	4.78	8.63	5.0	2.04	
A66EAK22X12	AT6005/30	1.58	1.7	4.78	8.63	5.0	2.04	6 pin connector in South
A66EAK22X13	AT6005/31	1.58	1.7	4.78	8.63	5.0	2.04	WTB-2 connectors
A66EAK22X21	AT6006/40	1.58	1.7	4.78	8.63	5.0	2.04	SVM, 4.2 μH, 1.8 Ω
A66EAK22X42	AT6006/30	0.35	0.5	10.4	6.0	3.6	2.46	32 kHz/100 Hz
A80EBK221X01	AT6070/00	1.50	1.5	5.10	11.9	6.6	1.80	
A80EBK221X03	AT6070/01	1.50	1.5	5.10	11.9	6.6	1.80	
A80EBK221X11	AT6070/40	1.50	1.5	5.10	11.9	6.6	1.80	SVM, 4.1 μH, 1.8 Ω
A80EBK221X13	AT6070/41	1.50	1.5	5.10	11.9	6.6	1.80	SVM, 4.1 μH, 1.8 Ω
A80EBK221X32	AT6076/00	0.35	0.5	10	6.5	4	2.2	32 kHz/100 Hz
A80EBK221X33	AT6076/01	0.35	0.5	10	6.5	4	2.2	32 kHz/100 Hz
A80EBK221X42	AT6076/40	0.35	0.5	10	6.5	4	2.2	32 kHz, SVM, 2.2 μH, 1.1 Ω
A80EBK221X43	AT6076/41	0.35	0.5	10	6.5	4	2.2	32 kHz, SVM, 2.2 μH, 1.1 Ω

SELECTION GUIDE COLOUR MONITOR TUBES

COLOUR MONITOR TUBE ASSEMBLIES

TUBE DATA							
tube type designation	tube size	defl. angle	neck dia-meter mm	overall length (max.) mm	glass trans-mission	horiz-ontal pitch mm	resolu-tion* h x v
M34ECL	14"	90	29.1	352	46.5%–86%	0.29	860 x 580

* Values given for resolution are measured under the following conditions:

- V_a = 25 kV, V_k = 125 V;
- V_{g3} adjusted for minimum width vertical white lines at half East, or half West zone;
- I_a = 200 μA per gun;
- modulation depth of –9 dB;
- sine-wave drive voltage;
- raster scan of 262 mm x 190 mm.

TUBE DATA						
TYPICAL OPERATING CONDITIONS						Va/Ia (max.) kV/µA
Vf/If V/mA	Va kV	Vg3 (% of Va)	Vg2 V	Vcut-off V		
6.3/315	25	26%	360–750	125	27.5/200	

PREFERRED ASSEMBLIES
M34ECL 66
M34ECL 56
M34ECL 46
M34ECL 36
M34ECL 26

COLOUR MONITOR TUBE ASSEMBLIES AND DEFLECTION UNITS

ASSEMBLY	DEFLECTION COIL DATA							REMARKS
	COIL TYPE	line coil			field coil			
		induct-ance mH	resist-ance Ω	current A(p-p)	induct-ance mH	resist-ance Ω	current A(p-p)	
M34ECL 66	AT1610/66	1.44	1.90	3.16	6.6	5.8	1.5	
M34ECL 56	AT1610/56	0.67	0.89	4.60	6.6	5.8	1.5	
M34ECL 46	AT1610/46	0.45	0.65	5.64	10.6	9.2	1.2	
M34ECL 36	AT1610/36	0.38	0.51	6.14	6.6	5.8	1.5	
M34ECL 26	AT1610/26	0.30	0.43	6.93	6.6	5.8	1.5	

GENERAL

LIST OF SYMBOLS

Symbols denoting electrodes/elements and electrode/element connections

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

Symbols denoting voltages

Unless otherwise stated, the reference point for electrode voltages is the cathode.

V	Symbol for voltage, followed by a subscript denoting the relevant electrode/element
V_f	Heater voltage
V_{p-p}	Peak-to-peak value of a voltage
V_p	Peak value of a voltage
V_{GR}	Grid 1 voltage for visual extinction of focused raster (grid drive service)
V_{KR}	Cathode voltage for visual extinction of focused raster (cathode drive service)

Symbols denoting currents

I	Symbol for current followed by a subscript denoting the relevant electrode
I_f	Heater current (RMS value)

Note: The symbols quoted represent the average value of the current, unless otherwise stated.

Symbols denoting capacitances

See IEC publication 100

Symbols denoting resistances and impedances

R	Symbol for resistance followed by a subscript for the relevant electrode pair. When only one subscript is given the second electrode is the cathode.
Z	Symbol for impedance followed by a subscript for the relevant electrode pair. When only one subscript is given the second electrode is the cathode.

Symbols denoting various quantities

L	Luminance
f	Frequency
H	Magnetic field strength

GENERAL OPERATIONAL RECOMMENDATIONS

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 which are not referred to in the data sheets of the relevant tube type, extra care should be taken with circuit design to prevent the tube being overloaded due to unfavourable operating conditions.

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.

SPREAD AND VARIATION IN OPERATING CONDITIONS

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

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.

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.

LIMITING VALUES

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

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.

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 thoughout 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 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.
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.

The expressions 'long-term' and 'short-term' are used to denote either the maximum time-averaged beam current for one gun to limit the cathode loading, or the maximum time-averaged anode current for three guns to limit the screen loading.

'Short-term' is not related to a specific period of time, but can be interpreted as the condition where the content and intensity of the displayed image vary continuously, as during live television pictures.

'Long-term' means that the image is stationary for an indefinite period of time, as during the display of test pictures, computer images, teletext data or stationary television scenes lasting longer than 30 seconds.

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

* 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.

HEATER SUPPLY

For maximum cathode life and optimum performance it is recommended that the heater supply be designed at the nominal heater voltage at zero beam current. Any deviation from this heater voltage has a detrimental effect on tube performance and life, and should therefore be kept to a minimum. In any case the deviations of the heater voltage must not exceed + 5% and −10% from the nominal value at zero beam current. Such deviations may be caused by:

- mains voltage fluctuations;
- spread in the characteristics of components such as transformers, resistors, capacitors, etc.;
- spread in circuit adjustments;
- operational variations.

CATHODE TO HEATER VOLTAGE

The voltage between cathode and heater should be as low as possible and never exceed the limiting values given in the data sheets of the individual tubes. The 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 DC, AC or a combination of both. Unless otherwise stated, the maximum values quoted indicate the maximum permissible DC voltage. If a combination of DC and AC voltages is applied, the peak value may be twice the rated V_{kf}; however, unless otherwise stated, this peak value shall never exceed 315 V. 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.

A DC connection should always be present between heater and cathode. Unless otherwise specified the maximum resistance should not exceed 1 MΩ; the maximum impedance at mains frequency should less than 100 kΩ.

INTERMEDIATE ELECTRODES (between cathode and anode)

In no circumstances should the tube be operated without a DC 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. When such a connection is required, it should be made via a series resistor of not less than 1 kΩ.

CUT-OFF VOLTAGE

Curves showing the limits of the cut-off voltage as a function of grid 2 voltage are generally included in the data. The brightness control should be so dimensioned that it can handle any tube within the limits shown, at the appropriate grid 2 voltage.

The published limits are determined at an ambient illumination level of 10 lux. Because the brightness of a spot is in general greater than that of a raster of the same current, the cut-off voltage determined with the aid of a focused spot will be more negative by about 5 V as compared with that of a focused raster.

TUBE OPERATING PRECAUTIONS

To prevent permanent screen damage, care should be taken:

– not to operate the tube with a stationary picture at high beam currents for extended periods;
– not to operate the tube with a stationary or slowly moving spot except at extremely low beam currents;
– if no EHT bleeder is used, to choose the time constants of the cathode, grid 1, grid 2, and deflection circuits, such that sufficient beam current is maintained to discharge the EHT capacitance before deflection has ceased after equipment has been switched off.

To prevent stray emissions:

– the anode voltage should be less than 12 kV within 5 seconds of switch-off.

To prevent permanent damage to the screen:

– it is strongly advised to provide the video drive circuitry with a facility which blanks the tube automatically in the event of a deflection failure. This is particularly important in applications where the deflection coil is DC coupled to the vertical output stage, as a short-circuit fault in this stage may otherwise lead to immediate de-evacuation of the tube (pierced neck).

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 EHT supply.

The coating is not a perfect conductor and in order to reduce electromagnetic radiation caused by the line time base and the picture content it may be necessary to make multiple connections to the coating. See also 'Flashover'.

METAL RIMBAND

An appreciable capacitance exists between the metal rimband and the internal conductive coating of the tube; its value is quoted in the individual data sheets. To avoid electric shock, a DC connection should be provided between the metal band and the external conductive coating. In receivers where the chassis can be connected directly to the mains there is a risk of electric shock if access 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 flashover 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, and the anode voltage. The 4.7 nF capacitor also serves to improve EHT smoothing by adding the rimband capacitance to the capacitance of the outer conductive coating.

FLASHOVER

High electric field strengths are present between the gun electrodes of picture tubes. Voltages between gun electrodes may reach values of 20 kV over approx. 1 mm. Although the utmost precautions are taken in the design and manufacture of the tubes, there is always a chance that flashover will occur. 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 EHT capacitor is discharged. Therefore it is of vital importance to provide protective circuits with spark gaps and series resistors, which should be connected according to Fig. 1. No other connections between the outer conductive coating and the chassis are permissible.

As our picture tubes are manufactured in Soft-Flash technology, the peak discharge currents are limited to approx. 60 A, offering higher set reliability, optimum circuit protection and component savings (see also Technical Note 039). However this limited value of 60 A is still too high for the circuitry which is directly connected to the tube socket. Therefore Soft-Flash picture tubes should also be provided with spark gaps.

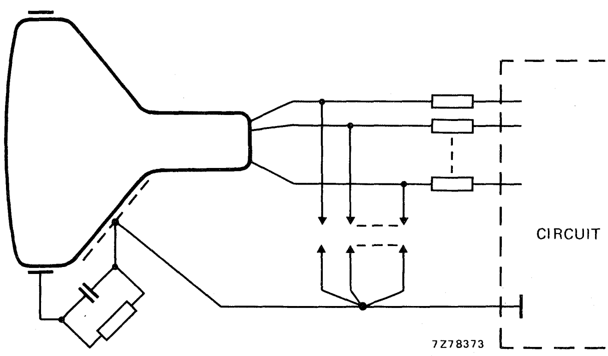

Fig. 1 Flashover protection circuit.

IMPLOSION PROTECTION

All picture tubes employ integral implosion protection and must be replaced with a tube of the same type number or recommended replacement to assure continued safety.

HANDLING

Although all picture tubes are provided with integral implosion protection, which meets the intrinsic protection requirements stipulated in the relevant part of IEC 65, care should be taken not to scratch or knock any part of the tube. The tube assembly should never be handled by the neck, deflection unit or other neck components.

A picture tube assembly can be lifted from the edge-down position by using the two upper mounting lugs. An alternative lifting method is firmly to press the hands against the vertical sides of the rimband.

When placing a tube assembly face downwards ensure that the screen rests on a soft pad of suitable material, kept free from abrasive substances.

In all handling procedures prior to insertion in the receiver cabinet there is a risk of personal injury as a result of severe accidental damage to the tube. It is therefore recommended that protective clothing should be worn, particularly eye shielding.

When suspending the tube assembly from the mounting lugs ensure that a minimum of 2 are used; UNDER NO CIRCUMSTANCES HANG THE TUBE ASSEMBLY FROM ONE LUG.

If provided the slots in the rimband of colour picture tubes are used in the mounting of the degaussing coils. It is not recommended to suspend the tube assembly from one or more of these slots as permanent deformation to the rimband can occur.

Remember when replacing or servicing the tube assembly that a residual electrical charge may be carried by the anode contact and also the external coating if not earthed. Before removing the tube assembly from the equipment, earth the external coating and short the anode contact to the coating. The tube should under no circumstances be subjected to accelerations greater than 350 m/s^2. Observe any instructions given on the packing and handle accordingly.

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.

DEGAUSSING

Colour picture tubes employ internal magnetic shielding. However, for individual tube types, optimal degaussing coils and circuitry are advised.

Strong magnetic fields possibly existing during transportation of the tubes, and the manufacturing process of the television sets, may induce magnetic remanence. This remanence cannot always be removed by the automatic degaussing circuitry of the set. It is therefore strongly recommended to apply an external degaussing field of sufficient magnitude and uniformity on the assembly line. This should be followed by activation of the internal set degaussing, with the set positioned in the same terrestrial orientation as for testing and performance judgement.

LOCAL MAGNETIC FIELDS

Care should be taken to avoid local AC or DC magnetic fields such as loudspeakers and transformers. The influence to beam shift may not exceed 5 microns anywhere on the screen surface.

SOAK TESTING

To ensure that the operating conditions of the tube are optimized for the long term, a short stabilization period is required , after which, the cut-off adjustment should be made and the performance assessed.

It is recommended that the tube should be soak-tested for a minimum period of 2 hours running time, before it is adjusted to its final operating conditions.

After soak testing, if the tube is switched off for a period of 90 seconds or more, a reheat time of 15 minutes is required before making final cut-off adjustments and picture assessment. Where the tube is switched off for less than 90 seconds, the reheat time required is 10 times the switched-off period.

RECOMMANDATIONS GENERALES D'EMPLOI

INTRODUCTION

La conception d'un appareil équipé d'un tube image couleur doit être basée sur les caractéristiques publiées dans les notices techniques. Lorsque certaines de ces recommandations ne sont pas applicables, des indications complémentaires sont données.

Dans le cas d'applications non mentionnées dans les notices techniques du type de tube concerné, des précautions supplémentaires doivent être prises, au moment de la conception des circuits, pour éviter la surcharge du tube due à des conditions de fonctionnement défavorables.

DISPERSION DES CARACTERISTIQUES DES TUBES

La dispersion des caractéristiques des tubes est la différence entre les valeurs maximales et minimales. Les valeurs non qualifiées de maximales ou minimales sont des valeurs nominales. Il est évident que les valeurs moyennes ou minimales, ainsi que les dispersions, peuvent varier suivant la grandeur du lot de tubes mesurés. Aucune garantie n'est donnée pour les valeurs de caractéristiques lorsque les conditions d'emploi diffèrent sensiblement de celles qui sont spécifiées dans les notices techniques.

DISPERSIONS ET VARIATIONS DES CONDITIONS DE FONCTIONNEMENT

Les conditions de fonctionnement d'un tube sont sujettes aux dispersions et/ou aux variations.

La dispersion des conditions de fonctionnement est un écart **permanent** par rapport à une condition moyenne, dû, par exemple, à des écarts de valeurs des composants. La condition moyenne est calculée sur un nombre de cas individuels pris au hasard et tel qu'une augmentation de ce nombre n'a pas d'influence significative.

La variation d'une condition de fonctionnement est **non permanente** (elle est fonction du temps) et peut être due, par exemple, à des variations de la tension d'alimentation. La valeur moyenne est calculée sur une période telle qu'une prolongation de cette période n'a pas d'influence significative.

VALEURS LIMITES

Les systèmes de valeurs limites sont ceux recommandés par la Commission Electrotechnique Internationale (CEI) dans la publication 134. Il peut être fait référence à l'un des 3 systèmes de limites suivantes

Systèmes des limites absolues. Les valeurs données dans ce système sont les limites concernant les conditions extérieures et les conditions de fonctionnement applicables à tout dispositif électronique d'un type déterminé défini par ses caractéristiques publiées, limites qui ne doivent pas être dépassées dans les pires conditions probables.
Le fabricant détermine ces limites pour obtenir un fonctionnement satisfaisant du dispositif, et n'assume aucune responsabilité en ce qui concerne les variations dues à l'appareil ou aux conditions extérieures ainsi que les effets des modifications de conditions de fonctionnement dues aux dispersions des caractéristiques du dispositif considéré et de tous les autres dispositifs électroniques de l'appareil.

L'utilisateur doit déterminer son appareil pour que, à sa mise en service, comme au cours de sa vie, aucune valeur limite concernant l'application envisagée ne soit dépassée pour tout dispositif, dans les pires conditions possibles d'utilisation, qui dépendent des variations de tension du réseau d'alimentation, des dispersions des composants de l'appareil, des modifications, des réglages, des variations de charge ou de signal, des conditions extérieures, ainsi que des dispersions des caractéristiques du dispositif considéré et de tous les autres dispositifs électroniques de l'appareil.

Système des limites hybrides. Les valeurs données dans ce système sont les limites concernant les conditions extérieures et les conditions de fonctionnement applicables à un dispositif électronique moyen* d'un type déterminé, défini par ses caractéristiques publiées, limites qui ne doivent pas être dépassées dans les pires conditions probables.

Le fabricant détermine ces limites pour obtenir un fonctionnement satisfaisant du dispositif, et tenant compte, sous sa responsabilité, des effets provoqués par des modifications de conditions de fonctionnement dues aux dispersions des caractéristiques du dispositif électronique considéré.

L'utilisateur doit déterminer son appareil pour que, à sa mise en service, comme au cours de sa vie, aucune valeur limite concernant l'application envisagée ne soit dépassée pour un dispositif moyen, dans les pires conditions probables d'utilisation, qui dépendent des variations de tension du réseau d'alimentation, des dispersions des composants et des caractéristiques de tous les autres dispositifs électroniques de l'appareil, des modifications des réglages, des variations de charge ou de signal, et des conditions extérieures.

Systèmes des limites moyennes. Les valeurs données dans ce système sont les limites concernant les conditions extérieures et les conditions de fonctionnement applicables à un dispositif électronique moyen* d'un type déterminé défini par les caractéristiques publiées, limites qui ne doivent pas être dépassées dans les conditions normales.

Le fabricant détermine ces limites pour obtenir un fonctionnement satisfaisant du dispositif dans des applications courantes, en tenant compte, sous sa responsabilité, des modifications normales des conditions de fonctionnement dues aux variations admises de la tension du réseau d'alimentation, des dispersions des composants de l'appareil, des modifications des réglages, des variations de charge ou de signal, des conditions extérieures, ainsi que des dispersions des caractéristiques de tous les dispositifs électroniques.

L'utilisateur doit déterminer son appareil pour que, à sa mise en service, aucune valeur limite concernant l'application envisagée ne soit dépassée pour un dispositif électronique moyen* dans l'appareil fonctionnant sous la tension normale définie pour l'alimentation.

Si les valeurs limites spécifiées pour le tube appartiennent à plusieurs systèmes de valeurs limites, le circuit doit être conçu de manière qu'aucune de ces valeurs limites ne soit dépassée dans les conditions applicables.

Les expressions ''long terme'' (long term) et ''court terme'' (short term) sont employées pour indiquer soit le courant de faisceau moyen maximal d'un canon pour limiter la charge de cathode, soit le courant d'anode moyen maximal des trois canons pour limiter la charge d'écran.

''Court terme'' ne concerne pas une période spécifique de temps, mais peut s'interpréter comme la condition dans laquelle le contenu et l'intensité de l'image affichée varient de manière continue, comme avec des images de télévision en direct.

''Long terme'' signifie que l'image est fixe pendant une période indéterminée de temps, comme pour l'affichage de mires, d'images d'ordinateur, de données de télétex ou de scènes fixes de télévision durant plus de 30 secondes.

Outre les valeurs limites spécifiées dans les notices techniques de chaque dispositif, les directives données aux paragraphes suivants doivent être observées.

* Un tube moyen est un tube dont les caractéristiques ont les valeurs nominales publiées pour le type concerné. Un tube moyen, pour une application déterminée, peut être recherché en ne tenant compte que des caractéristiques directement utiles pour cette application.

ALIMENTATION DU FILAMENT

Pour obtenir une durée de vie maximale et des performances optimales, il est recommandé de concevoir l'alimentation du filament de telle sorte que sa valeur soit nominale lorsque le courant de faisceau est nul. Tout écart par rapport à cette tension nominale peut diminuer les performances du tube et réduire sa durée de vie et doit par conséquent être limité au minimum. Dans aucun cas les écarts de la tension appliquée au filament ne doit excéder + 5% et − 10% de la valeur nominale à zéro de courant de faisceau. Ces écarts peuvent être causés par :

- des variations de la tension du secteur
- des dispersions des caractéristiques des composants : transformateurs, résistances, condensateur, etc.
- des dispersions dans les réglages des circuits ;
- des variations de fonctionnement.

TENSION ENTRE CATHODE ET FILAMENT

La tension entre la cathode et le filament doit être aussi réduite que possible et ne jamais dépasser les valeurs limites données dans les notices techniques particulières de chaque tube. Les valeurs limites s'appliquent à l'extrémité du filament où la tension est la plus élevée. La tension entre cathode et filament peut être continue, alternative ou les deux à la fois. Sauf indication contraire, les valeurs maximales indiquent la tension continue maximale admissible. Si une combinaison de tensions continue et alternative est appliquée, la valeur crête peut atteindre le double de la valeur V_{kf} spécifiée ; cependant, sauf indication contraire, cette valeur crête ne doit jamais dépasser 315 V. Sauf indication contraire, la valeur maximale V_{kf} est valable quelle que soit la polarité de la tension, bien qu'une cathode positive soit généralement préférable pour maintenir l'isolement pendant la durée de vie du tube

Une tension électrique continue doit toujours être assurée entre le filament et la cathode. Sauf indication contraire, la résistance maximale ne doit pas dépasser 1 MΩ ; l'impédance maximale à la fréquence du secteur doit être inférieure à 100 kΩ.

ELECTRODES INTERMEDIAIRES (entre cathode et anode)

Le tube ne devra être utilisé en aucune circonstance sans liaison électrique continue entre chacune des électrodes et la cathode. L'impédance effective totale entre chacune des électrodes et la cathode ne doit jamais dépasser la valeur maximale publiée. Aucune électrode ne doit être directement connectée à une source de haute énergie. Si une telle connexion est nécessaire, elle doit être réalisée au moyen d'une résistance série d'au moins 1 kΩ.

TENSION DE BLOCAGE

Les notices techniques contiennent généralement des courbes indiquant les limites de la tension de blocage (cut off) en fonction de la tension de grille 2. La plage de commande de la luminance doit être prévue en fonction des limites de la tension de blocage indiquée pour la tension de grille 2 choisie et des écarts possibles de cette dernière.

Les limites publiées sont déterminées à un niveau d'éclairement ambiant de 10 lux. La tension de blocage déterminée à l'aide d'un spot focalisé sera plus négative d'environ 5 V par rapport à celle obtenue à l'aide d'une trame focalisée ; ceci parce que la brillance d'un spot est en général plus grande que celle d'une trame à même courant.

PRECAUTIONS D'UTILISATION DU TUBE

Les précautions suivantes doivent être prises pour éviter des dommages permanents de l'écran :

— ne pas faire fonctionner le tube avec une image fixe à de forts courants de faisceau pendant de longues périodes ;

— ne pas faire fonctionner le tube avec un spot fixe ou se déplaçant lentement, sauf à des courants de faisceau extrêmement faibles ;

— décharger la THT, soit par une résistance, soit en choisissant les constantes de temps des circuits de cathodes, de grille 1, de grille 2 et de déviation, de manière à maintenir un courant de faisceau suffisamment élevé, avant que la déviation ne cesse, après l'arrêt de l'appareil.

Pour éviter les "rayons diffusés" (stray emissions) :

— la tension d'anode doit être inférieure à 12 kV dans les 5 secondes suivant l'arrêt.

Pour éviter une déterioration permanente de l'écran :

— il est fortement conseillé de munir le circuit de commande vidéo d'un dispositif qui eteint le tube automatiquement en cas de panne de déviation. Ceci est particulièrement important dans les applications où la bobine de déviation est couplée en courant continu (DC coupled) à l'étage de sortie vertical, car un court-circuit sur cet étage peut provoquer une entrée d'air immédiate dans le tube (col percé).

COUCHE CONDUCTRICE EXTERNE

La couche conductrice externe doit être reliée à la masse du châssis. La capacité entre cette couche et l'anode peut servir à filtrer l'alimentation THT.

La couche n'étant pas un conducteur parfait, il peut être nécessaire d'effectuer cette liaison en plusieurs points afin de réduire le rayonnement électromagnétique de la base de temps de lignes et du contenu d'image. Voir également «Arcs internes».

CEINTURE METALLIQUE

Une capacité non négligeable existe entre la ceinture métallique et la couche conductrice interne du tube ; sa valeur est donnée dans les notices techniques. Pour éviter les chocs électriques, une liaison électrique continue doit être prévue entre la ceinture métallique et la couche conductrice externe. Dans le cas des récepteurs dont la masse du châssis est reliée directement au secteur, il y a risque de choc électrique au toucher de la ceinture métallique. Afin de limiter un éventuel choc électrique, à une valeur non dangereuse, on doit insérer entre la ceinture métallique et la couche conductrice externe une résistance de 2 MΩ capable de supporter des tensions élevées. Cette mesure de sécurité garantit un isolement suffisant par rapport au secteur, cependant, en cas d'arc interne, des tensions élevées sont induites sur la ceinture métallique. Il est donc recommandé de placer en parallèle sur la résistance de 2 MΩ, une capacité de 4,7 nF capable de supporter la tension de crête déterminée par le diviseur de tension d'anode formé par cette capacité et celle constituée par la ceinture métallique et la couche conductrice interne. La capacité de 4,7 nF permet également d'améliorer le filtrage de la THT, en ajoutant la capacité de la ceinture métallique à celle de la couche conductrice externe.

ARCS INTERNES

Des champs électriques élevés existent entre les électrodes des canons des tubes image, ils peuvent atteindre des valeurs de 20 kV par 1 mm environ. Bien que les plus grandes précautions soient prises dans la conception et la fabrication des tubes, il y a toujours un risque d'arcs (flash-over). Les courants et tensions transitoires résultants peuvent être suffisamment élevés pour endommager le tube et les composants associés. L'arc s'éteint lorsque le condensateur THT est déchargé. Il est donc particulièrement important de prévoir sur toutes les électrodes, des circuits de protection avec éclateurs et résistances séries, comme disposés suivant la figure 1. Aucune autre connexion entre la couche conductrice externe et le châssis n'est autorisée.

Dans nos tubes image qui sont fabriqués en technologie «mini-arcs» (soft-flash), les courants de décharge de crête sont réduits à 60 A approximativement ce qui augmente la fiabilité des appareils et assure une protection optimale des circuits. (Voir également la Technical Note 039). Toutefois cette limite de 60 A est encore trop élevée pour les circuits qui sont directement connectés au support du tube, la présence des circuits de protection avec éclateurs reste donc indispensable.

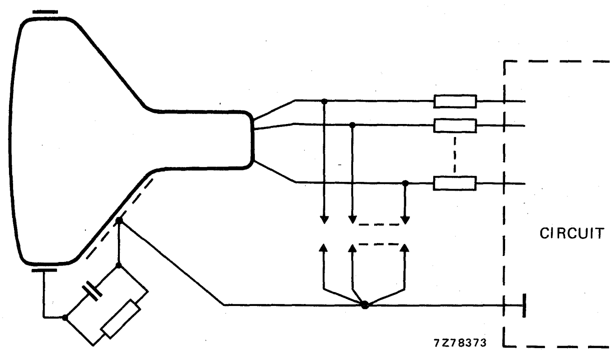

Fig. 1 Circuit de protection contre les arcs internes

PROTECTION CONTRE LES RISQUES D'IMPLOSION

Tous les tubes image sont pourvus d'une protection intégrale contre les implosions et doivent être remplacés par un tube de même type ou d'un type équivalent recommandé pour la maintenance afin d'assurer une sécurité permanente.

MANUTENTION

Quoique tous les tubes image soient pourvus d'une protection intégrale contre l'implosion qui satisfasse aux exigences intrinsèques de protection, conformément au chapitre concernée de la CEI 65, il faut faire attention à ne pas rayer ni cogner une partie quelconque du tube. Lors du montage, le tube ne doit jamais être manipulé par le col, le déviateur ou un autre composant du col.

Un tube image peut être soulevé en utilisant les deux oreilles de fixation supérieures. Une autre méthode consiste à maintenir le tube en appliquant fermement les mains sur les côtés verticaux de la ceinture.

Pour poser un tube sur son écran, placer en dessous un tissus doux, exempt de toute substance abrasive.

Dans toutes les opérations de manutention précédant la mise en coffret, il existe un risque d'être blessé lorsque le tube a été accidentellement et gravement endommagé. Il est par conséquent recommandé de porter des vêtements protecteurs, en particulier des lunettes de protection.

Le tube peut être suspendu par ses oreilles de fixation ; s'assurer qu'au minimum 2 oreilles soient utilisées. MAIS EN AUCUNE CIRCONSTANCE, IL NE DOIT ETRE SUSPENDU PAR UNE SEULE OREILLE.

Des fentes, dans la ceinture métallique d'autoprotection de certains tubes image, servent à la fixation des bobines de désaimantation. Il est interdit de suspendre les tubes par une ou plusieurs de ces fentes car cela peut provoquer une déformation permanente de la ceinture métallique.

Rappelons que lors de l'entretien ou du remplacement du tube, une charge électrique résiduelle peut être présente entre le contact d'anode et la couche externe. Avant de retirer le tube de l'appareil, mettre la couche externe à la masse et court-circuiter le contact d'anode et la couche externe.
Le tube ne doit jamais être soumis à des accélérations supérieures à 350 m/s^2.
Observer les consignes marquées sur l'emballage et manipuler le tube en conséquence.

MONTAGE

Sauf indication contraire dans les notices techniques des différents tubes, la position de montage est indifférente.

Le support du tube ne doit pas être monté de façon rigide, il doit être raccordé par des fils souples et avoir une certaine liberté de débattement.

DESAIMANTATION

Les Tubes Image Couleur sont munis d'un blindage magnétique interne. Cependant pour chaque type de tube, il est conseillé un circuit et des bobines optimales de désaimantation.

De forts champs magnétiques peuvent être appliqués au tube durant le transport et les opérations de fabrication de l'appareil de télévision et induire ainsi une rémanence magnétique. Ce champs rémanent ne peut pas toujours être éliminé par le circuit de désaimantation interne de l'appareil. Il est donc fortement recommandé d'appliquer un champs de désaimantation externe d'intensité et d'uniformité convenables sur la ligne de fabrication. Ceci doit être suivi par la mise en fonctionnement de la désaimantation interne, l'appareil étant orienté dans la même direction que pour les mesures et l'appréciation des performances.

CHAMPS MAGNETIQUE LOCAL

Il convient de porter le plus grand soin à éviter les champs magnétiques locaux alternatifs ou continus tels que ceux produits par transformateurs et haut-parleurs. Le décalage résultant du faisceau ne doit pas excéder 5 microns sur toute la surface de l'écran.

BANC DE CHAUFFE

Afin de s'assurer de l'optimalisation des conditions de fonctionnement du tube à long terme, une courte période de stabilisation est exigée, après laquelle il doit être procédé au réglage du blocage et à l'estimation des performances.

Il est recommandé que le tube ait subi un temps de fonctionnement d'au moins deux heures consécutives avant d'être réglé pour ses conditions de fonctionnement finales.

Après mesure sur banc de chauffe, si le tube a été éteint plus de 90 secondes, une période de 15 minutes de rechauffage est exigée avant de procéder aux réglages du blocage et à l'estimation des performances. Quand le tube a été éteint moins de 90 secondes, une période de 10 fois le temps d'extinction est exigée.

RICHTLINIEN ZUM BETRIEB VON BILDRÖHREN

ALLGEMEINE HINWEISE

Beim Entwurf von Fernsehempfängern sollte von den in den Datenblättern angegebenen Kennwerten ausgegangen werden. Wenn Abweichungen von diesen allgemeinen Empfehlungen zulässig oder notwendig sind, werden entsprechende Hinweise gegeben.
Werden Anwendungen in Betracht gezogen, bei denen die Betriebsbedingungen nicht mit den im Datenblatt gemachten Angaben übereinstimmen, so ist bei der Dimensionierung der Schaltung besondere Vorsicht geboten, um eine Überlastung der Bildröhre durch ungünstige Betriebsbedingungen zu vermeiden.

STREUUNGEN VON BILDRÖHREN-KENNDATEN

Die Streuungen der Bildröhren-Kenndaten erstrecken sich auf die Differenz zwischen Maximal- und Minimalwerten. Wertangaben, die nicht als Maximal- oder Minimalwert gekennzeichnet sind, sind Nennwerte. Abhängig von der betrachteten Anzahl von Röhren eines bestimmten Typs können sowohl die Mittel- oder Nennwerte als auch die Streuwerte voneinander abweichen. Bei Einstellungen, die wesentlich von den im Datenblatt gemachten Angaben abweichen, wird keine Garantie für Kenndaten übernommen.

STREUUNGEN UND ÄNDERUNGEN DER BETRIEBSBEDINGUNGEN

Die Betriebsbedingungen einer Bildröhre sind Streuungen und/oder Änderungen unterworfen.

Die Streuung einer Betriebsbedingung ist eine ständige Abweichung von der mittleren Bedingung, die z.B. durch Wertabweichungen von Bauelementen hervorgerufen wird. Die mittlere Bedingung ist als Durchschnittswert einer hinreichend hohen Anzahl von zufälligen Einzeleinstellungen definiert.
Die Änderung einer Betriebsbedingung ist eine nicht-ständige Abweichung, hervorgerufen z.B. durch Schwankungen der Speisespannung. Der Mittelwert ist über eine solche Zeitspanne ermittelt, daß bei Verlängerung keine nennenswerten Veränderungen mehr eintreten.

GRENZWERTE

Die Grenzwerte entsprechen dem eingeführten Maßsystem, wie es in der IEC-Publikation 134 definiert ist. Es kann auf eine der nachstehend beschriebenen drei Arten von Grenzdaten Bezug genommen werden.

ABSOLUTE-GRENZDATEN

Absolute Grenzdaten sind Grenzwerte für Betriebs- und Umgebungsbedingungen, die auch unter ungünstigen Umständen bei keiner Bildröhre überschritten werden dürfen.
Die absoluten Grenzwerte werden zur Aufrechterhaltung der Bertiebsfähigkeit vom Bildröhrenhersteller festgelegt. Für Abweichungen des Schaltungsentwurfes und der Umgebungsbedingungen sowie für Auswirkungen der Änderung von Betriebsbedingungen, die durch Abweichung die Röhreneigenschaften auch unter Berücksichtigung aller anderen Bauelemente der Schaltung eintreten können, übernimmt der Bildröhrenhersteller keine Verantwortung. Der Gerätehersteller

sollte die Schaltung so auslegen, daß während der Lebensdauer der Bildröhre bei den vorgesehenen Einsatzbedingungen auch unter den ungünstigsten Umständen kein absoluter Grenzwert überschritten wird. Dabei sind zu berücksichtigen: Schwankungen der Speisespannung, Geräteeinstellungen, Streuungen und Änderungen der übrigen Bauelemente, Belastungsänderungen, Signaländerungen, Änderungen der Umgebungsbedingungen sowie Streuungen und Änderungen der Bildröhren-Eigenschaften.

TOLERANZ-GRENZDATEN

Toleranz-Grenzdaten sind Grenzwerte von Betriebs- und Umgebungsbedingungen einer Nominalröhre[1]) eines bestimmten Typs, die auch unter den ungünstigsten Umständen nicht überschritten werden dürfen.
Die Toleranz-Grenzdaten werden zur Aufrechterhaltung der Betriebsfähigkeit vom Bildröhrenhersteller festgelegt. Änderungen der Betriebsbedingungen, die durch Kennwertabweichungen innerhalb der spezifizierten Toleranzgrenzen auftreten, sind zulässig.
Der Geräte-Entwickler sollte die Schaltung so auslegen, daß bei einer Nominalröhre eines bestimmten Typs während ihrer Lebensdauer und bei den vorgesehenen Einsatzbedingungen auch unter den ungünstigsten Bedingungen kein Toleranz-Grenzwert überschritten wird.
Dabei sind zu berücksichtigen: Schwankungen der Speisespannung, Abweichungen und Änderungen aller anderen Bauelemente, Schwankungen der Belastung, des Signals und der Umgebungsbedingungen.

NENNWERT-GRENZDATEN

Nennwert-Grenzdaten sind Grenzwerte von Betriebs- und Umgebungsbedingungen eines bestimmten Typs, die unter mittleren Bedingungen nicht überschritten werden dürfen. Die Nennwert-Grenzdaten werden zur Aufrechterhaltung der Betriebsfähigkeit der Bildröhre in mittleren Anwendungen festgelegt. Normale Abweichungen der Betriebsbedingungen, hervorgerufen durch die spezifizierte Schwankung der Speisespannung, der Einstellung und Steuerung sowie Änderungen der übrigen Bauelemente und auch Schwankungen der Belastung, des Signals und der Umgebungsbedingungen sind berücksichtigt und zulässig.
Wenn die spezifizierten Grenzdaten sich auf mehr als ein Grenzdatensystem beziehen, muß die Schaltung so ausgelegt werden, daß keiner dieser Grenzwerte unter den entsprechenden Bedingungen überschritten wird.
Die Begriffe "long-term" und "short-term" werden benutzt, um jeweils entweder den maximalen zeitlichen Durchschnitt des Strahlstromes für eine Kanone zu kennzeichnen und die Katodenbelastung zu begrenzen oder den maximalen zeitlichen Durchschnitt des Strahlstromes für drei Kanonen, um die Schirmbelastung zu begrenzen.
"Short-term" bezieht sich nicht auf eine bestimmte Zeitdauer, sondern bezeichnet die Betriebsbedingung, bei der sich Inhalt und Intensität eines wiedergegebenen Bildes kontinuierlich ändern wie z.B. während aktueller Fernsehbildübertragungen.
"Long-term" bedeutet, daß das Bild für eine unbestimmte Zeitperiode stillsteht wie z.B. bei der Wiedergabe von Testbildern, Computer-Bildern, Teletext-Daten oder stehenden TV-Szenen, die länger als 30 s dauern.
Zusätzlich zu den in den einzelnen Datenblättern angegebenen Grenzwerten müssen die nachfolgenden Vorschriften beachtet werden.

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[1]) Eine Nominalröhre ist eine Röhre, deren Eigenschaften und Daten den publizierten Nennwerten entspricht.

HEIZUNG

Für maximale Lebensdauer und optimale Performance der Katode wird empfohlen, die Heizungsversorgung für nominale Heizspannung und Strahlstrom Null zu entwerfen. Jede Abweichung von dieser Heizspannung hat eine nachteilige Auswirkung auf die Performance und Lebensdauer der Röhre und sollte daher auf ein Minimum begrenzt bleiben. Auf jeden Fall sollen Abweichungen von dieser Heizspannung + 5 % und - 10 % vom nominalen Wert bei Strahlstrom Null nicht überschreiten. Solche Abweichungen können verursacht sein durch:

a) Netzspannungsänderung
b) Streuung der Charakteristik von Bauelementen wie Transformatoren, Widerständen, Kondensatoren etc.
c) Streuungen im Schaltungsabgleich
d) Funktionsänderungen

SPANNUNG ZWISCHEN HEIZFADEN UND KATODE

Die Spannung zwischen Heizfaden und Katode sollte so klein wie möglich sein und darf die im Datenblatt angegebenen Grenzwerte nicht überschreiten. Diese beziehen sich auf das Heizfadenende, welches die höhere Spannung gegen die Katode führt. Die Spannung zwischen Heizfaden und Katode kann eine Gleichspannung, Wechselspannung oder eine Kombination aus beiden sein. Wenn nicht anders angegeben, gilt der maximale Wert der Spannung zwischen Heizfaden und Katode als maximal zulässiger Wert (Gleichspannungskomponente). Handelt es sich um eine Wechselspannung oder um eine Kombination von Gleich- und Wechselspannung, so ist der zulässige Scheitelwert doppelt so hoch wie der angegebene Grenzwert, jedoch darf der Scheitelwert - wenn nicht anders angegeben - 315 V nicht überschreiten. Die Gleichspannungskomponente darf den publizierten Grenzwert nicht überschreiten.

Wenn nicht anders angegeben, gelten die Grenzwerte bei beliebiger Polarität. Eine positive Katode (gegen Heizfaden) ist jedoch im Hinblick auf Isolation während der Lebensdauer vorzuziehen.

Eine Gleichstromverbindung zwischen Heizfaden und Katode sollte immer vorhanden sein. Wenn nicht anders angegeben, darf der Widerstand dieser Verbindung 1 MΩ nicht übersteigen. Die maximale Impedanz bei Netzfrequenz darf nicht größer als 100 kΩ sein.

ELEKTRODEN ZWISCHEN HEIZFADEN UND BESCHLEUNIGUNGSANODE

Unter keinen Umständen darf die Bildröhre ohne Gleichstromverbindung zwischen jeder Elektrode und Katode betrieben werden. Die zwischen jeder Elektrode und Katode wirksame Impedanz darf die angegebenen Maximalwerte nicht überschreiten. Keine Elektrode darf direkt an eine Hochspannungsquelle angeschlossen werden. Wenn erforderlich, darf eine solche Verbindung nur über einen Serienwiderstand von min.1 kΩ hergestellt werden.

SPERRSPANNUNG

Im allgemeinen werden die Grenzdaten der Sperrspannung in Abhängigkeit von der G2-Spannung als Kurven in den Datenblättern angegeben. Die Helligkeitseinstellung muß so ausgelegt werden, daß beliebige Bildröhren desselben Typs innerhalb der angegebenen Grenzen bei der dafür geltenden G2-Spannung eigesetzt werden können.
Die spezifizierten Grenzen sind für eine Umgebungshelligkeit von 10 lx festgelegt. Weil die Helligkeit eines unabgelenkten Leuchtpunktes größer ist als die eines Gitter-Testbildes bei gleichem Strom, ist die Sperrspannung mit Hilfe eines unabgelenkten Leuchtpunktes etwa 5 V negativer als die eines fokussierten Gitter-Testbildes.

VORSICHTSMAßNAHMEN BEIM BETRIEB DER BILDRÖHRE

Um bleibende Schirmbeschädigungen zu vermeiden, sollten folgende Sorgfaltsmaßnahmen getroffen werden:

- Die Bildröhre nicht mit stehendem Bild und hohem Strahlstrom über längere Zeit betreiben.
- Die Bildröhre nicht mit einem stehenden oder sich langsam bewegenden Punkt betreiben, außer mit extrem niedrigen Strahlströmen.
- Wenn kein bleeder benutzt wird, sollen die Zeitkonstanten von Katode, G1, G2 und Ablenkschaltungen so gewählt sein, daß genügend Strahlstrom aufrechterhalten bleibt, um die auf Hochspannung aufgeladenen Kapazitäten zu entladen, bevor die Ablenkung aufhört.

Um Streuemission zu verhindern:

- Die Anodenspannung soll innerhalb von 5 s nach Abschalten auf unter 12 kV absinken.

Um bleibende Schirmschäden zu vermeiden, wird dringend empfohlen, die Videoansteuerstufe mit einer Schaltung zu versehen, die die Röhre automatisch dunkel steuert, wenn die Ablenkschaltung ausfällt.
Dieses ist besonders wichtig in Applikationen, in denen die Vertikal-Ablenkspule DC-gekoppelt mit der Vertikalendstufe ist. Ein Kurzschlußfehler in dieser Stufe könnte sonst den Röhrenhals beschädigen und die Röhre dadurch belüften.

LEITENDER AUßENBELAG

Der leitende Außenbelag muß mit dem Massepunkt des Chassis verbunden werden. Die Kapazität zwischen dem Außenbelag und der letzten Beschleunigungsanode kann zur Glättung der Hochspannung verwendet werden. Der Außenbelag ist kein guter Leiter. Zur Reduzierung der durch Zeilenablenkung und Bildinhalt erzeugten elektromagnetischen Störstrahlung sollen deshalb mehrfache Kontakte zum Außenbelag, verteilt über diesen, angebracht werden
(siehe auch Abschnitt "Schutz gegen Spannungsüberschläge").

METALLRAHMENVERSTÄRKUNG

Eine merkliche Kapazität besteht zwischen der Metallrahmenverstärkung und dem inneren leitenden Belag der Bildröhre, deren Wert in den Datenblättern angegeben ist. Zur Vermeidung eines elektrischen Schlages sollte zwischen der Metallrahmenverstärkung und dem leitenden Außenbelag eine Gleichstromverbindung vorgesehen werden. In Empfängern, in denen das Chassis direkt mit dem Netz verbunden ist, besteht die Gefahr eines elektrischen Schlages, wenn die Metallrahmenverstärkung von außen zugänglich ist. Es wird daher vorgeschlagen, einen 2 MΩ-Widerstand genügender Spannungsfestigkeit zur Entladung der Spitzenspannungen zwischen der Metallrahmenverstärkung und dem Kontaktpunkt mit dem leitenden Außenbelag einzuschalten. Diese Sicherheitsvorkehrung bietet zwar die notwendige Isolation vom Netz, aber bei hohen Überschlagsspannungen können induzierte Spannungen an der Metallrahmenverstärkung auftreten. Zum Schutz gegen induzierte Spannungen bei Hochspannungsüberschlägen wird empfohlen, dem 2-MΩ Widerstand einen 4,7 nF-Kondensator parallel zu schalten. Dieser muß für eine Spitzenspannung ausgelegt sein, die sich aus der Anodenspannung und dem Spannungsteiler bestehend aus dem 4,7 nF-Kondensator und der Kapazität zwischen dem Metallrahmen und dem leitenden Außenbelag ergibt. Der 4,7 nF-Kondensator dient auch zur Verbesserung der Glättung der Hochspannung durch Einbeziehung der zwischen Metallrahmen und dem leitenden Außenbelag bestehenden Kapazität.

SCHUTZ GEGEN SPANNUNGSÜBERSCHLÄGE (flash over)

Zwischen den Elektroden der Strahlsysteme bestehen hohe elektrische Feldstärken, wobei Werte von 20 kV/mm erreicht werden. Obwohl bei der Entwicklung und bei der Herstellung der Bildröhren mit äußerster Sorgfalt vorgegangen wird, besteht die Möglichkeit, daß Spannungsüberschläge in der Bildröhre vorkommen können. Die dabei kurzzeitig auftretenden Spitzen-

Spannungen und -Ströme können so hohe Werte annehmen, daß die Bildröhre und verschiedene Bauelemente auf dem Chassis beschädigt werden. Der Überschlag endet, wenn die gesamte Hochspannungsladung abgeflossen ist.
Zum Schutz der Bildröhre und der Schaltung sind daher unbedingt Schutz-Funkenstrecken mit Serienwiderständen anzubringen, die wie in Abb. 1 geschaltet werden müssen. Zwischen dem leitenden Außenbelag und dem Chassis dürfen keine weiteren Verbindungen bestehen.
In Bildröhren, die nach der "soft-flash"-Technologie hergestellt sind, werden die Spitzen der Entladeströme auf 60 A begrenzt. Diese bieten damit eine höhere Zuverlässigkeit und Sicherung von Schaltungen und Bauelementen. Der Grenzwert von 60 A ist aber noch zu hoch für die Schaltung, die direkt mit dem Röhrensockel verbunden ist. Deshalb müssen auch die in "soft-flash"-Technologie hergestellten Bildröhren ebenfalls mit Schutz-Funkenstrecken gesichert werden. (Siehe auch technische Notiz 039).

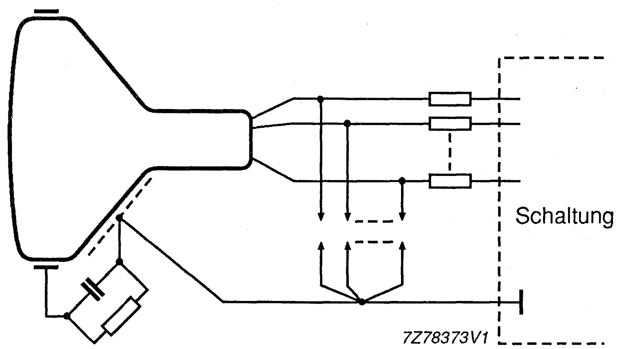


Abb. 1 Implosionsschutz

Alle von uns angebotenen Bildröhren sind implosionsgeschützt und dürfen daher nur durch Bildröhren des gleichen Typs oder eines empfohlenen Ersatztyps ausgetauscht werden. In diesem Zusammenhang wird auf das von der "Berufsgenossenschaft Feinmechanik und Elektrotechnik" herausgegebene "Merkblatt über den Umgang mit Bildröhren" hingewiesen.

HANDHABUNG
Obwohl die Bildröhren mit einem Implosionsschutz ausgerüstet sind, welcher die Sicherheitsanforderungen nach VDE 0860 und DIN 57860 bzw. IEC 65 erfüllt, ist Vorsicht geboten. Die Röhre sollte nicht zerkratzt oder hart angestoßen werden. Eine Belastung des Röhrenhalses muß vermieden werden.
Beim Anheben eines Bildröhrenpaketes (Bildröhre mit fest montierter Ablenkeinheit und Mehrpoleinheit) aus der seitlichen Lage sollten die beiden oberen Befestigungswinkel benutzt werden. Eine weitere Möglichkeit zum Anheben besteht darin, fest mit den Händen an den senkrechten Seiten gegen das Spannband zu drücken.
Beim Ablegen der Bildröhre mit dem Schirm nach unten muß dieser auf eine saubere weiche Unterlage gelegt werden.
Bei allen Handhabungen, vor allem beim Einsetzen in das Empfängergehäuse, besteht Verletzungsgefahr, wenn aus Versehen die Bildröhre zerstört wird. Es wird daher empfohlen, daß Schutzkleidung und vor allem eine Schutzbrille getragen wird. Bei Aufhängung der Bildröhre muß sichergestellt werden, daß sie mindestens an zwei Befestigungswinkeln gehalten wird. Auf keinen Fall darf die Bildröhre an nur einen Befestigungswinkel gehängt werden.

Die Schlitze der Metallrahmenverstärkung sind für die Montage der Entmagnetisierungsspulen bestimmt. Es ist unzulässig, die Bildröhre an einem oder mehreren dieser Schlitze anzuheben, weil eine Verformung der Metallrahmenverstärkung die Folge wäre.
Beim Ausbau der Bildröhre aus dem Empfängergehäuse ist zu beachten, daß am Anodenanschluß und am leitenden Außenbelag noch eine elektrische Ladung vorhanden sein kann. Zur Entladung soll daher der Anodenkontakt mit dem leitenden Außenbelag verbunden und dieser geerdet werden, bevor am Gerät gearbeitet oder die Bildröhre ausgebaut wird.
In diesem Zusammenhang wird noch auf das von der "Berufsgenossenschaft der Feinmechanik und Elektrotechnik" herausgegebene "Merkblatt über den Umgang mit Bildröhren mit Schirmdiagonalen größer als 160 mm" hingewiesen.

MONTAGE
Wenn nichts anderes angegeben, bestehen keine Einschränkungen im Hinblick auf die Einbaulage. Die Röhrenfassung soll nicht starr, sondern mit flexiblen Leitungen angeschlossen werden. Für den Geräteentwurf sind die in den Zeichnungen angegebenen Toleranzen der mechanischen Abmessungen zu berücksichtigen.

Unter keinen Umständen sollte ein Gerät nach den Abmessungen einzelner Musterröhren entworfen werden.

ENTMAGNETISIERUNG
Farbbildröhren benutzen eine interne magnetische Abschirmung.
Für einzelne Röhrentypen werden optimale Entmagnetisierungsspulen und -Schaltungen empfohlen.

Während des Transportes der Bildröhre oder der Fertigung der Fernsehgeräte können möglicherweise starke Magnetfelder eine magnetische Remanenz induzieren. Diese Remanenz kann nicht in jedem Fall durch die automatische Entmagnetisierungsschaltung im Gerät allein beseitigt werden. Daher wird dringend empfohlen, eine externe Entmagnetisierung von hinreichender Stärke und Gleichförmigkeit am Fertigungsband der Geräte vorzusehen.
Dieser externen sollte dann die Geräte-interne automatische Entmagnetisierung folgen. Dabei sollte das Gerät in derselben Himmelsrichtung stehen, wie auch für die weitere Prüfung und Performance-Beurteilung.

EINFLÜSSE EXTERNER MAGNETFELDER
Externe magnetische Gleich- oder Wechselfelder wie die von Lautsprechern oder Transformatoren, müssen von der Röhre ferngehalten werden. Deren Einfluß auf die Ladung darf überall auf dem Schirm 5 µm nicht überschreiten.

OPTIMIERUNG BEI DER ERSTEN INBETRIEBNAHME UND BEURTEILUNG
Um sicherzustellen, daß die Betriebsbedingungen der Röhre langzeit-optimiert sind, ist eine kurze Stabilisierungszeit erforderlich. Danach können Sperr-Punkt-Abgleich und Performance-Beurteilung durchgeführt werden.
Es wird empfohlen, für diesen Stabilisierungsvorgang mindestens 2 Stunden Einlaufzeit vorzusehen, bevor das Gerät auf die endgültigen Betriebsbedingungen abgeglichen wird.
Nach der Stabilisierung, wenn die Röhre für eine Periode von 90 s oder mehr abgeschaltet war, ist eine erneute Anheizzeit von 15 min oder mehr erforderlich, bevor der endgültige Sperrpunktabgleich und die Bildbeurteilung durchgeführt werden können. Wenn die Röhre für weniger als 90 s eingeschaltet war, beträgt die erforderliche Wiederanheizzeit das 10fache der Ausschaltzeit.

GENERAL SAFETY RECOMMENDATIONS

1. GENERAL

When properly used and handled, electronic tubes do not constitute a risk to health or to the environment.

However, certain hazards may arise and it is important that the following recommendations are observed. Care should be taken to ensure that all personnel who may handle, use or dispose of these products are aware of the necessary safety precautions.

Individual product data sheets may indicate if any of the specific hazards given in sections 2 to 5 are likely to be present.

1.1 BREAKAGE

If a tube is broken or otherwise damaged, precautions must be taken against the following hazards which may arise:

- Broken glass or ceramic (see section 4) protective clothing such as gloves should be worn.

- Contamination by toxic materials and vapours. In particular skin contact and inhalation should be avoided.

1.2 DISPOSAL

Most electronic tubes contain toxic materials.

These products should be disposed of in accordance with relevant national legislation: in the United Kingdom the Deposit of Poisonous Waste Act 1972 and the Control of Pollution Act 1974 amended 1980 "special Waste Regulations" apply.

When disposing of large quantities, the advice of the manufacturer's service department should be sought.

1.3 FIRE

Electronic tubes themselves do not present a fire hazard.

However, since most packaging materials are flammable, care should be taken in the disposal of such materials; some of which will emit toxic fumes if burned.

If packaged tubes are involved in a fire, implosion may occur (see section 4), together with the consequent release of toxic vapours and materials.

2. X-RADIATION

All high voltage electronic tubes produce progressively more penetrating x-rays as the operating voltage is increased. The tube will satisfy the European Community permitted limit of 1 microSievert per hour, when driven within the maximum operating conditions denoted in the product published data.

The residual level of x-radiation depends upon the application. The tube envelope provides a measure of protection but under some equipment fault conditions, the x-ray hazard may be considerably increased.

This potential hazard will be present only when the tube is energized.

3. TOXIC COMPOUNDS

Small quantities of cadmium and barium compounds are contained in the products and are toxic. In the event of accidental breakage, there is a risk that personnel might come into contact with these materials. Protective clothing should be worn and any fine debris should be mopped up with a damp cloth.

To protect the environment, materials which may have become contaminated should be sealed (e.g. in a bag) and disposed of in accordance with the relevant national legislation.

This potential hazard is present, if breakage occurs, at all times from receipt to disposal of tubes.

4. IMPLOSION - HANDLING OF TELEVISION PICTURE AND CATHODE RAY TUBES

All vacuum tubes store potential energy by virtue of their vacuum. The energy level represents a hazard.

Most modern tubes are provided with integral implosion protection which conforms to IEC65, clause 18. With these tubes, no additional protection is needed. However, additional stresses due to mishandling may considerably increase the risk of implosion. Implosions may occur immediately or may be delayed.

The strength of the glass envelope will inevitably be impaired by surface damage, such as scratches or bruises (localized surface cracks caused by impact). When a tube is not in its equipment or original packing, it should be placed faceplate downwards on a pad of suitable ribbed material which is kept free from abrasive substances.

Under no circumstances should any attempt be made to remove the bonded faceplate or integral implosion protection band when fitted to a tube.

Stresses on the neck of the tube must be avoided. Handle by the recommended methods as illustrated:

TUBE ON ONE EDGE

To lift a tube from the edge-down position, one hand should be placed around the parabolic section of the cone and the other hand should be placed near (slightly below) the centre of the faceplate as shown in Fig.1 UNDER NO CIRCUMSTANCES SHOULD ANY FORCE BE APPLIED TO THE NECK OF THE TUBE.

TUBE FACE-DOWN

To lift a tube from the face-down position, the hands should be placed under the areas of faceplate close to the fixing lugs (if fitted), at diagonally opposite corners of the face-plate as shown in Fig.2 The tube must not be lifted from this position by the lugs themselves. UNDER NO CIRCUMSTANCES SHOULD ANY FORCE BE APPLIED TO THE NECK OF THE TUBE

TUBE FACE-UP

To lift a tube from the face-up position, the hands should be placed under the areas of the cone close to the fixing lugs (if fitted), at diagonally opposite corners of the cone as shown in Fig 3. The tube must not be lifted from this position by the lugs themselves. UNDER NO CIRCUMSTANCES SHOULD ANY FORCE BE APPLIED TO THE NECK OF THE TUBE.

If the handling procedures for tubes are such that as a consequence of severe accidental damage to the tube, there is a risk of injury to personnel, then it is recommended that protective clothing should be worn, particularly eye shielding.

When fitted, lugs are provided for fixing in equipment. They must not be subjected to excessive forces. Adequate protection must be provided if there is a possibility of injury as a result of failure of a lug or lugs.

5. HIGH VOLTAGE

Attention is called to the fact that a high voltage may remain on the final anode connector and also on the external coating and rimband, if not earthed, even after a tube has been removed from equipment. Before handling a tube it is recommended to discharge the tube capacitance, by connection via a resistor of not less than 10KΩ and capable of withstanding high voltages.

In equipment where the chassis can be connected directly to the mains without electrical separation, there may be a risk of electric shock if access can be gained to the metal rimband through the aperture at the front of the equipment. Consequently, it is recommended that a 2MΩ resistor, capable of withstanding peak voltages of e.h.t. values (as specified in IEC65, clause 14.1) is inserted between the rimband and the braided earth contact to the external coating. A significant capacitance is formed between the rimband and internal conductive layer of the tube. In the event of flashover, high voltages will be induced on the rimband. In order to bypass these voltages a capacitor of a few nanofarads (extra-high-voltage low-inductance in compliance with IEC65, clause 14.2) should be inserted between the rimband and the braided earth contact to the external coating.

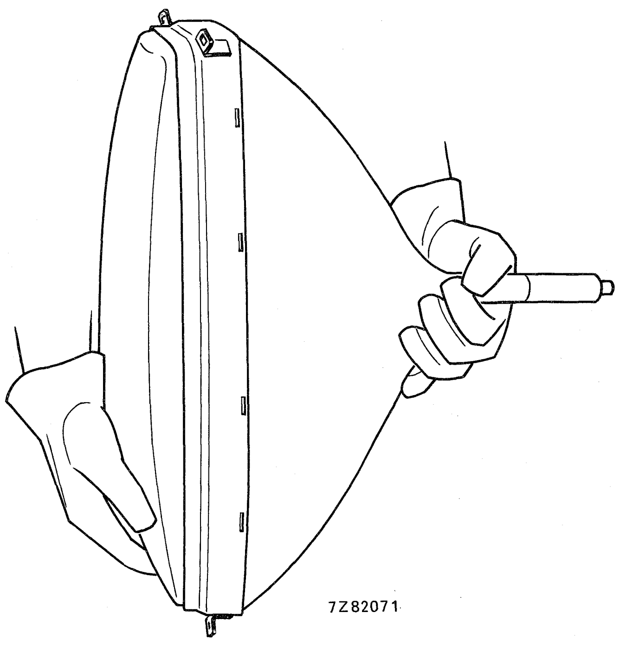


Fig.1 Lifting tube from edge-down position.

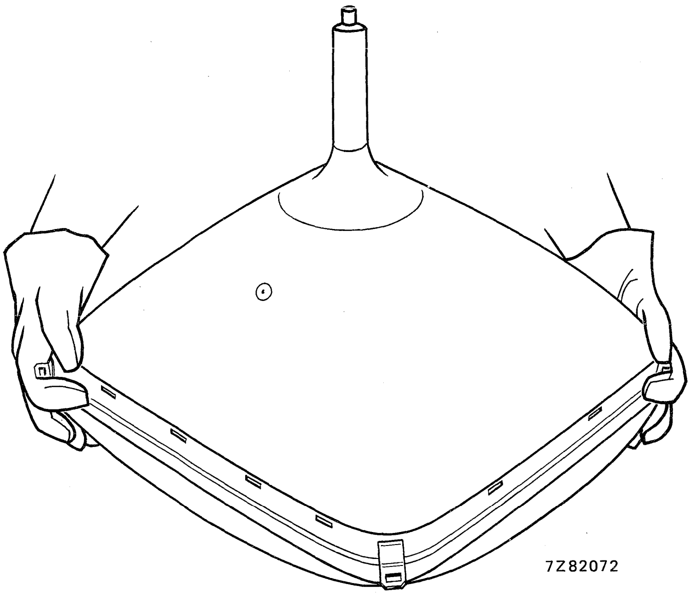


Fig.2 Lifting tube from face-down position.

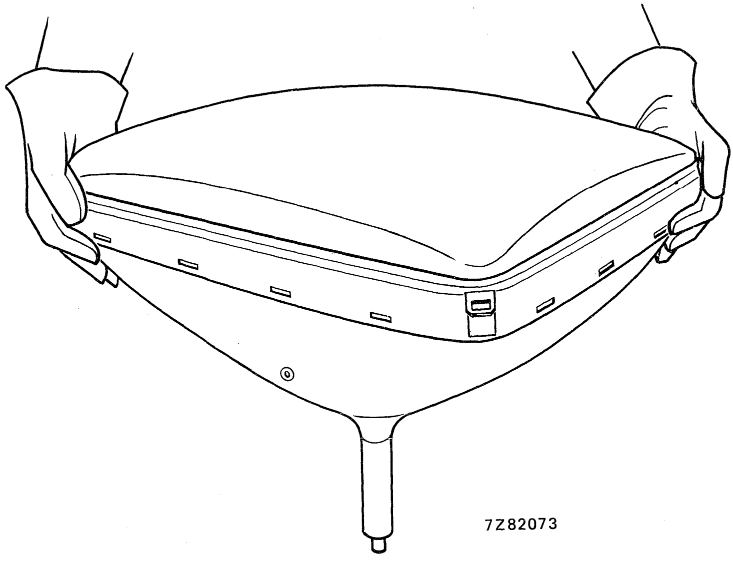


Fig.3 Lifting tube from face-up position.

RECOMMANDATIONS GENERALES DE SECURITE

INTRODUCTION

Les tubes électroniques ne font courir aucun danger ni pour la santé, ni pour l'environnement, s'ils sont employés et manipulés correctement.

Cependant, les tubes présentent certains risques et il est important que les recommandations suivantes soient observées. Il est important de s'assurer que toute personne qui est amenée à manipuler, employer ou se débarasser de ces produits soit au courant des précautions de sécurité nécessaires.

Les notices techniques sur chacun des tubes peuvent préciser si certains des risques spécifiques indiqués dans les chapitres suivants ont une probabilité d'exister.

CASSE

Si un tube est cassé ou même endommagé, des précautions doivent être prises contre les risques suivants qui peuvent se produire :

— verre ou céramique cassé (voir chapitre implosion). Un vêtement de protection tel que des gants doit être porté ;

— contamination par matières et vapeurs toxiques. En particulier, le contact avec la peau et l'inhalation doivent être évités.

MISE AU REBUT

La plupart des tubes électroniques contiennent des produits toxiques.

Il faut se débarrasser de ces produits en conformité avec la législation nationale en vigueur.

Quand il s'agit de mettre au rebut de grandes quantités, consulter le Service Après-Vente du fabricant.

INCENDIE

Les tubes électroniques en eux-mêmes ne présentent aucun risque d'incendie.

Toutefois, sachant que la plupart des matériaux d'emballage sont inflammables, il convient de prendre des précautions pour les jeter ; certains, parmi eux, émettent des fumées toxiques en brûlant.

Si des tubes emballés sont impliqués dans un incendie, des implosions peuvent se produire (voir chapitre implosion), accompagnées d'un dégagement de vapeurs et de matières toxiques.

RAYONS X

Tous les tubes électroniques sous haute tension produisent des rayons X dont la pénétration augmente avec la tension de fonctionnement. Le tube satisfera à la limite autorisée par la Communauté Européenne, soit 1 microSievert par heure, s'il est utilisé dans les conditions de fonctionnement maximales figurant dans les notices techniques publiées.

Le niveau résiduel de rayon X dépend de l'application. L'ampoule du tube constitue un dispositif de protection, mais dans certaines conditions de panne de l'appareil, le danger de rayon X peut se trouver considérablement augmenté.

Ce risque éventuel n'existe que lorsque le tube est sous tension.

PRODUITS TOXIQUES

Ces tubes contiennent de petites quantités de composés de cadmium et de baryum qui sont toxiques. En cas de casse accidentelle, il y a risque pour le personnel d'entrer en contact avec ces substances. Des vêtements de protection doivent être portés et tous les débris doivent être soigneusement ramassés avec un chiffon humide.

Pour protéger l'environnement, les matériaux qui pourraient avoir été contaminés doivent être enveloppés hermétiquement (par exemple dans un sac) et jetés conformément à la législation nationale en vigueur.

Ce risque existe, en cas de casse, à tout moment depuis l'entrée jusqu'à l'élimination des tubes.

IMPLOSION – MANUTENTION DES TUBES IMAGE DE TELEVISION ET DES TUBES A RAYONS CATHODIQUES

Tous les tubes sous vide modernes comportent une protection intégrale contre l'implosion conforme à la CEI 65, paragraphe 18. Ces tubes ne nécessitent aucune protection supplémentaire. Toutefois, le risque d'implosion peut-être considérablement augmenté par des erreurs de manutention. Les implosions peuvent se produire immédiatement ou même ultérieurement.

La résistance de l'ampoule de verre sera inévitablement affaiblie par un dommage superficiel tel que des rayures ou des fêlures (craquelures superficielles et locales provoquées par impact). Quand un tube est hors de son appareil et de son emballage d'origine, il doit être placé face vers le bas sur une surface alvéolée, exempte de subtances abrasives.

En aucune circonstance, on ne doit tenter de retirer du tube la dalle rapportée ou la ceinture d'autoprotection contre l'implosion.

Eviter tout effort sur le col du tube ; manipuler le tube selon les méthodes recommandées, comme illustré :

TUBE REPOSANT SUR UN COTE

Pour soulever un tube reposant sur un côté, une main doit être placée autour de la partie parabolique du cône et l'autre main doit être placée près du centre de la dalle-écran (légèrement en dessous), comme montré sur la figure 1. **EN AUCUNE CIRCONSTANCE, UNE FORCE QUELCONQUE NE DOIT ETRE EXERCEE SUR LE COL DU TUBE.**

TUBE FACE EN BAS

Pour soulever un tube dans sa position face en bas, les mains doivent être placées sous la dalle-écran dans les zones proches des oreilles de fixation (si elles existent) et diagonalement opposées, comme montré sur la figure 2. Le tube ne doit pas être soulevé dans cette position par les oreilles de fixation. **EN AUCUNE CIRCONSTANCE, UNE FORCE QUELCONQUE NE DOIT ETRE EXERCEE SUR LE COL DU TUBE.**

TUBE FACE EN HAUT

Pour soulever un tube dans la position face en haut, les mains doivent être placées sous le cone dans les zones proches des oreilles de fixation (si elles existent) et diagonalement opposées (comme montré à la figure 3). Le tube ne doit pas être soulevé dans cette position par les oreilles de fixation. **EN AUCUNE CIRCONSTANCE, UNE FORCE QUELCONQUE NE DOIT ETRE EXERCEE SUR LE COL DU TUBE.**

Si dans les opérations de manutention des tubes, le personnel risque d'être blessé lorsque un tube a subi des dommages accidentels graves, il est alors recommandé de porter des vêtements protecteurs et des lunettes de protection, en particulier.

Quand elles existent, les oreilles de fixation sont prévues pour la fixation du tube dans l'appareil. Elles ne doivent être soumises à aucun effort excessif. Si le personnel risque d'être blessé suite à la rupture d'une ou plusieurs oreilles de fixation, une protection adéquate doit être prévue.

HAUTE TENSION

L'attention est attirée sur le fait qu'une haute tension peut rester présente sur la prise d'anode ainsi que sur la couche externe et sur la ceinture d'auto-protection, si aucune d'elles n'ont été mises à la masse, même lorsque le tube est hors de l'appareil. Avant de manipuler un tube, il est recommandé de décharger la capacité du tube en connectant une résistance d'au moins 10 kΩ pouvant supporter une haute tension.

Dans un appareil dont le châssis est connecté directement au secteur sans séparation électrique, il y a un risque de recevoir une décharge électrique si on peut atteindre la ceinture métallique d'auto-protection par l'ouverture située sur le devant de l'appareil. En conséquence, il est recommandé de connecter une résistance de 2 MΩ, capable de supporter des tensions crêtes de la valeur de la THT (conformément à la CEI 65, paragraphe 14.1), entre la ceinture et la tresse de masse placée sur la couche externe. La ceinture et la couche interne constituent les armatures d'une capacité de valeur importante. En cas d'arcs internes, des hautes tensions sont induites sur la ceinture. Afin de court-circuiter ces tensions, une capacité de quelques nanofarads (à très haute tension et faible inductance en conformité avec la CEI 65, paragraphe 14.2) doit être connectée entre la ceinture et la tresse de masse appliquée sur la couche externe.

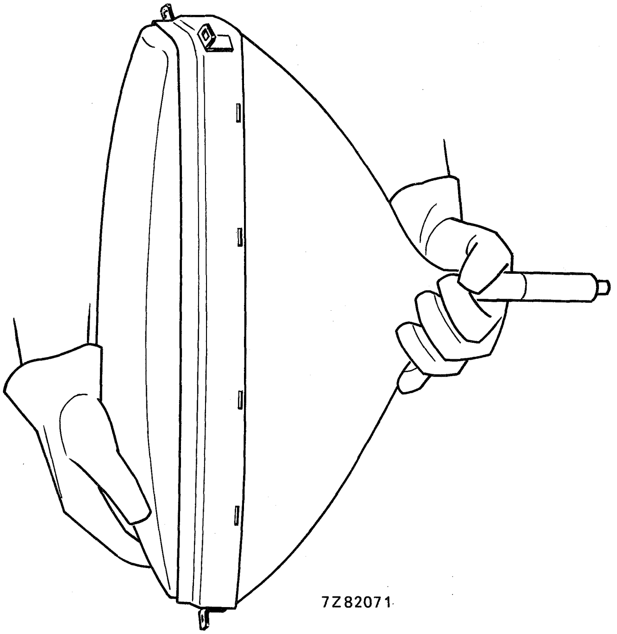


Fig.1 Tube reposant sur un cote.

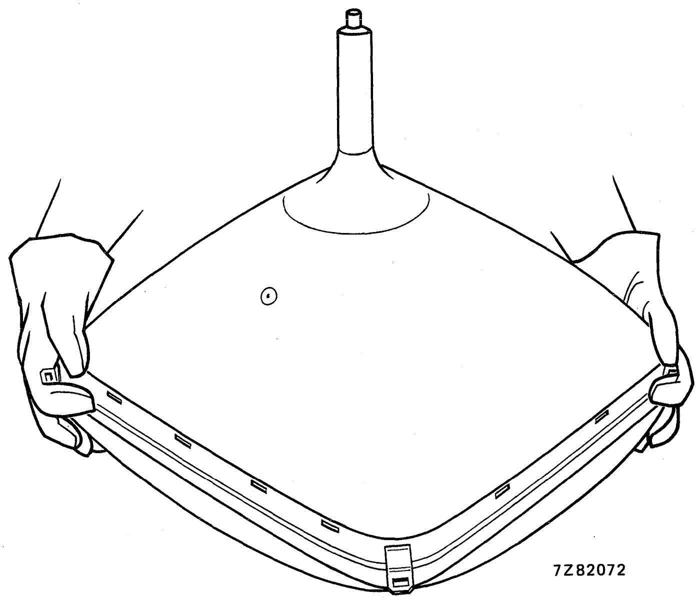


Fig.2 Tube face en bas.

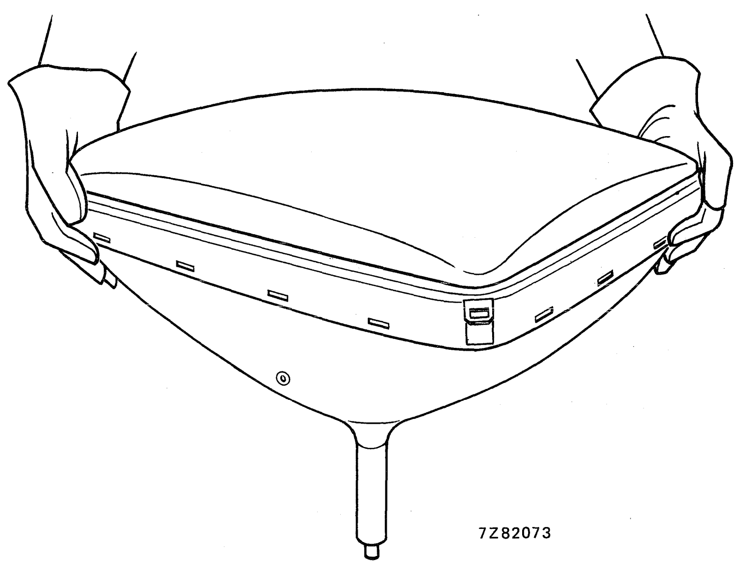


Fig.3 Tube face en haut.

ALLGEMEINE SICHERHEITSHINWEISE

ALLGEMEINES
Bei Betrieb unter normalen Bedingungen und korrekter Handhabung gehen von Elektronenröhren keine gesundheitsgefährdenden oder umweltstörenden Einflüsse aus.

Bei mechanischer Beschädigung oder durch elektrische Überlastung können jedoch Gefahren auftreten. Daher ist es sehr wichtig, daß die folgenden Empfehlungen beachtet werden. Es ist sicherzustellen, daß alle Personen, die diese Bauelemente handhaben, benutzen, besitzen und entsorgen, die allgemeinen Sicherheitsempfehlungen kennen und beachten.

In den einzelnen Datenblättern können spezielle Hinweise enthalten sein ob besondere Risiken, wie in den nachfolgenden Abschnitten beschrieben, vorliegen.

GLASBRUCH
Wenn eine Röhre zerbrochen oder beschädigt ist, müssen Vorsichtsmaßnahmen getroffen werden, falls nachfolgende Gefahren auftreten:

- Glas- oder Keramikbruch (siehe Abschnitt TOXISCHE INHALTSSTOFFE). Schutzkleidung ist zu tragen, z.B. Handschuhe.

- Kontamination durch toxische Materialien und Dämpfe. Besonders Hautkontakt und Einatmen sind zu vermeiden.

ENTSORGUNG
Die meisten Bildröhren enthalten toxische Materialien.

Die Entsorgung dieser Bauelemente muß in Übereinstimmung mit den entsprechenden nationalen Vorschriften und Umweltschutzgesetzen erfolgen.

In der Bundesrepublik Deutschland ist dieses in den einzelnen Bundesländern unterschiedlich geregelt. Für die Entsorgung großer Mengen können Hinweise beim Röhrenhersteller eingeholt werden.

FEUER
Bildröhren an sich sind nicht entflamm- oder brennbar.

Das üblicherweise verwendete Verpackungsmaterial ist jedoch entflamm- und brennbar. Bei der Vernichtung dieser Materialien ist mit entsprechender Vorsicht vorzugehen, da bei einigen Materialien toxische Dämpfe beim Verbrennen freigesetzt werden.

Wenn Röhren direkt oder in Verpackung Feuer ausgesetzt sind, besteht Implosionsgefahr (siehe Abschnitt IMPLOSION) mit der Gefahr der Freisetzung von toxischen Dämpfen und Materialien.

RÖNTGENSTRAHLUNG
In allen mit Hochspannung betriebenen Elektronenröhren entsteht Röntgenstrahlung. Die Intensität der Röntgenstrahlung steigt mit der Anodenspannung an. Alle in diesem Datenbuch beschriebenen Bildröhren erfüllen bei Betrieb mit den im Datenblatt aufgeführten maximal zulässigen Betriebswerten die von der EG vorgegebenen Grenzwerte der Äquivalentdosis < 1 Mikro Sievert pro Stunde.

Der Röntgenstrahlungspegel ist von der Applikation abhängig. Der Glaskörper einer Röhre bietet im Normalfall hinreichend Schutz vor Röntgenstrahlung. Bei bestimmten Fehlfunktionen der Betriebsschaltung kann die Röntgenstrahlungsgefahr jedoch erheblich zunehmen.

In der Bundesrepublik Deutschland sind bei Spitzenspannungen von mehr als 5 kV die Vorschriften über den Schutz vor Schäden durch Röntgenstrahlung gemäß Röntgenverordnung (Röv) vom 8. Januar 1987 zu beachten.

Diese potentielle Gefahr liegt nur bei Betrieb der Röhre vor.

TOXISCHE INHALTSSTOFFE
In den Röhren sind kleine Mengen von Cadmium- und Bariumverbindungen mit toxischer Wirkung enthalten. Bei einem Glasbruch besteht das Risiko, daß Personen mit diesen Stoffen in Berührung kommen. Es ist daher in einem solchen Falle Schutzkleidung zu tragen, und alle feinen Teilchen sind mit einem feuchten Tuch aufzuwischen.

Zum Schutze der Umwelt sind Materialien, die verunreinigt wurden unter Verschluß zu halten (z.B. in einer Plastiktüte) und entsprechend den geltenden Vorschriften zu entsorgen.

Diese potentielle Gefahr im Falle eines Glasbruchs ist über die gesamte Lebensdauer bis hin zur Entsorgung der Röhre gegeben.

IMPLOSION – HANDHABUNG VON FERNSEH-BILD- UND KATODENSTRAHLRÖHREN
Alle Vakuum-Röhren enthalten aufgrund ihres Vakuums ein Potential an Energie. Dieses Energiepotential stellt eine latente Gefährdung dar.

Die meisten modernen Röhren sind mit einem integrierten Implosionsschutz ausgerüstet, der die Anforderungen der IEC65, Absatz 18 erfüllt. Bei diesen Röhren ist kein zusätzlicher Schutz erforderlich. Mechanische Spannungen, hervorgerufen durch falsche Handhabung, erhöhen jedoch erheblich das Implosionsrisiko. Eine Implosion kann unmittelbar oder verzögert erfolgen.

Bei Beschädigung der Oberfläche der Röhre durch Kratzer oder Eindrückung (örtliche Flächeneindrückung hervorgerufen durch Stoß) wird die Festigkeit des Glaskolbens geschwächt. Wenn eine Röhre nicht im Gerätegehäuse eingebaut ist, bzw. sich nicht in ihrer Originalverpackung befindet, ist sie mit dem Schirm nach unten auf einer sauberen, weichen Unterlage ohne schleifende Substanzen abzulegen.

Es darf auf keinen Fall der Versuch gemacht werden die aufgebrachte Frontplatte oder das integrierte Implosions-Schutzband, falls vorhanden, zu entfernen.

Mechanische Spannungen am Hals der Röhre sind zu vermeiden. Das Anheben der Röhre ist den nachfolgenden Grafiken zu entnehmen.

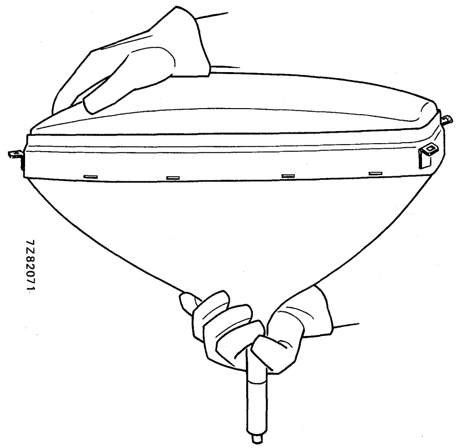


Abb. 1 Anheben der Röhre aus der seitlichen Lage

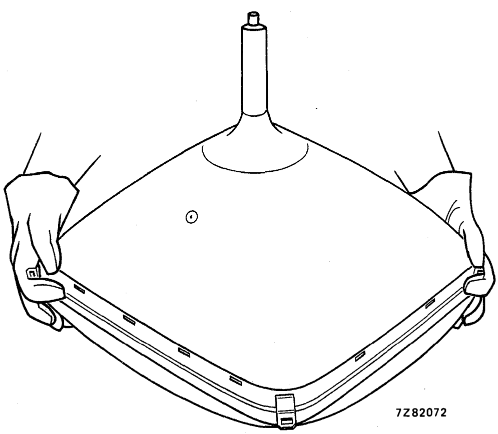


Abb. 2 Anheben der Röhre aus der Position Schirm nach unten

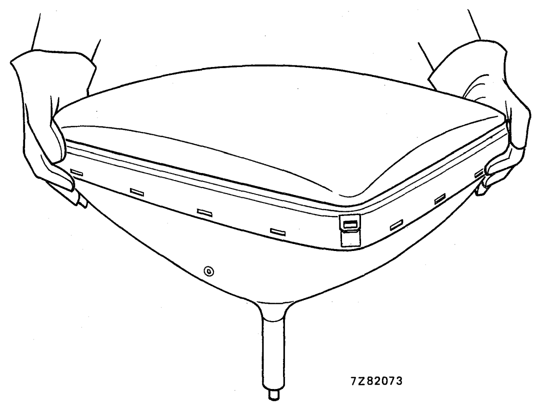


Abb. 3 Anheben der Röhre aus der Position Röhrenhals nach unten

Handhabung

Röhre in seitlicher Lage.
Beim Anheben einer Röhre aus der seitlichen Lage, muß eine Hand den parabolischen Teil des Kolbens umfassen und die andere Hand nahe der Mitte (etwas darunter) des Frontglases, wie in Abb. 1 dargestellt, plaziert werden.
Eine Belastung des Röhrenhalses muß unter allen Umständen vermieden werden.

Röhre mit Schirm nach unten.
Beim Anheben der Röhre aus der Position Schirm nach unten, sind die Hände, unter der Fläche des Schirms, bei den Befestigungswinkeln (wenn vorhanden) zu plazieren, diagonal an gegenüberliegenden Ecken des Kolbens (siehe Abb. 2). Die Röhre darf nicht allein an den Befestigungswinkeln gehoben werden.
Eine Belastung des Röhrenhalses muß unter allen Umständen vermieden werden.

Röhre mit Röhrenhals nach unten.
Beim Anheben der Röhre aus der Position Röhrenhals nach unten, sind die Hände, unter der Fläche des Kolbens bei den Befestigungswinkeln (wenn vorhanden) zu plazieren, diagonal an gegenüberliegenden Ecken des Kolbens (siehe Abb. 3). Die Röhre darf nicht allein an den Befestigungswinkeln gehoben werden, wenn sie aus dieser Position angehoben wird.
Eine Belastung des Röhrenhalses muß unter allen Umständen vermieden werden.

Wenn der Verarbeitungshinweis für Röhren darauf hinweist, daß als Konsequenz einer Beschädigung der Röhre Unfallgefahr besteht, die das Risiko der Verletzung von Personen nicht ausschließt, dann wird empfohlen schützende Kleidung zu tragen, insbesondere eine Schutzbrille.

In diesem Zusammenhang wird auf das von der „Berufsgenossenschaft Feinmechanik und Elektrotechnik" herausgegebene „Merkblatt über den Umgang mit Bildröhren" hingewiesen.

Die Befestigungswinkel, falls vorhanden, dienen der Röhrenmontage im Gehäuse. Sie dürfen nicht übermäßig beansprucht werden. Entsprechende Schutzmaßnahmen sind vorzusehen, wenn die Möglichkeit eines Unfalls, hervorgerufen durch Fehlfunktion eines oder mehrerer Haltewinkel, besteht.

HOCHSPANNUNG
Es wird darauf hingewiesen, daß am Anodenanschluß, am leitenden Außenbelag und am Spannband der Röhre ohne ausreichende Erdung sehr hohe Spannungen anliegen können, auch wenn die Röhre bereits aus dem Gerät ausgebaut wurde. Vor dem Berühren der Röhre ist daher eine Entladung der Röhrenkapazität vorzunehmen. Dies geschieht durch eine Verbindung über einen Widerstand > 10 kΩ mit genügender Spannungsfestigkeit.

In Schaltungen, die es erlauben das Chassis direkt mit dem Netz zu verbinden, d.h. keine Netztrennung haben, ist das Risiko eines elektrischen Schlages gegeben, wenn das metallische Spannband an der Frontseite des Equipments zugänglich ist. Es wird daher empfohlen einen 2 MΩ-Widerstand, genügender Spannungsfestigkeit (spezifiziert in IEC65, Absatz 14.1) zur Entladung der Spitzenspannungen zwischen der Metallrahmenverstärkung und dem Kontaktpunkt mit dem leitenden Außenbelag einzuschalten. Eine merkliche Kapazität besteht zwischen der Metallrahmenverstärkung und dem inneren leitenden Belag der Röhre. Im Falle eines Spannungsüberschlages, wird Hochspannung auf das Spannband induziert. Zum Schutz gegen induzierte Spannungen bei Hochspannungsüberschlägen wird empfohlen, einen Kondensator mit einer Kapazität von einigen nF (Hochspannungsfestigkeit und kleine Induktivität entsprechend IEC65 Absatz 14.2) zwischen dem Spannband und dem Kontaktpunkt des äußeren leitenden Außenbelages einzufügen.

TYPE DESIGNATION

Worldwide type designation system

Example of ITC*

A80EBK221X01

- application category
  - A = TV tube for domestic application
  - M = display tube for monitor application
- useful screen diagonal in cm
- family code
- member of family code
- screen phosphor category
- integral neck components

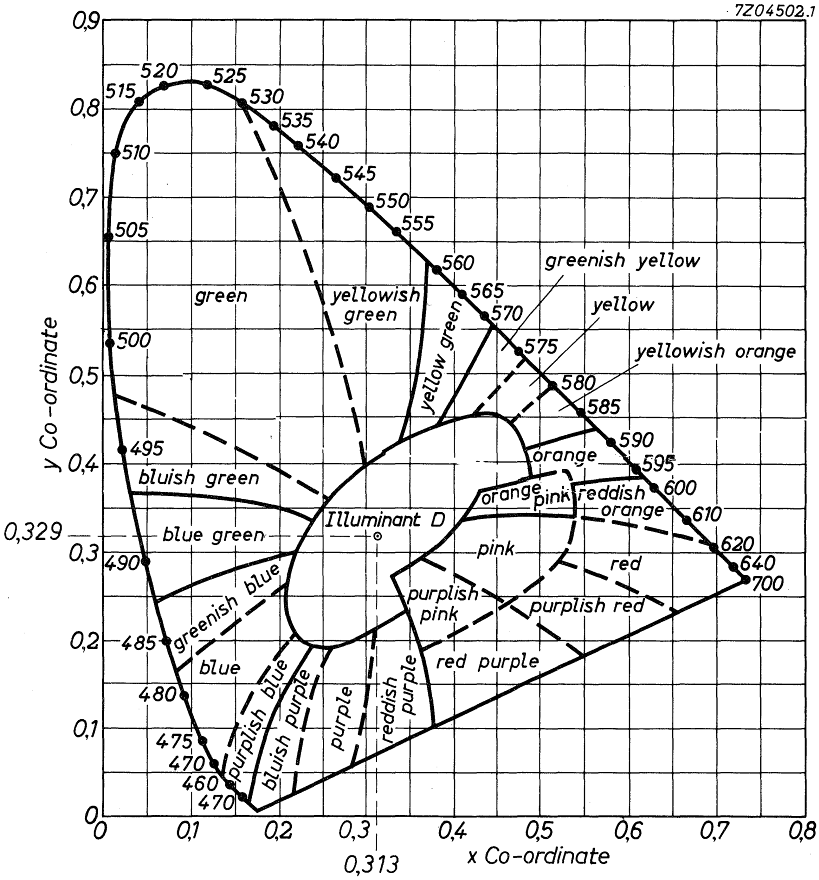
Example of monitor tube assembly

M34ECL42X12

- application category
  - A = TV tube for domestic application
  - M = display tube for monitor application
- useful screen diagonal in cm
- family code
- member of family code
- screen phosphor category
- integral neck components

* Integrated Tube Coil Assembly.

KELLY CHART


7Z04502.1
0,9
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0,329
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y Co-ordinate
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x Co-ordinate
520
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470
460
470
green
yellowish green
yellow green
greenish yellow
yellow
yellowish orange
orange
orange
pink
reddish orange
bluish green
blue green
Illuminant D
pink
red
greenish blue
purplish pink
purplish red
blue
red purple
purplish blue
bluish purple
purple
reddish purple

COLOUR TV PICTURE TUBES AND ASSEMBLIES

SURVEY OF TUBES AND ASSEMBLIES

basic tube	basic assembly
A34EAC01X	A34EAC01X02
A36EAM01X	A36EAM01X01
A41EAM01X	A41EAM01X01
A51EAK01X	A51EAK01X01
A51EAL30X	A51EAL30X01
A51EAM31X	A51EAM31X01
A59EAK01X	A59EAK01X01
A59EAK22X	A59EAK22X11
A66EAK22X	A66EAK22X11
A66EAK51X	A66EAK51X01
A80EBK221X	A80EBK221X01

Hi-Bri COLOUR PICTURE TUBE

- 90° deflection
- In-line, thermally stable hi-bi potential gun
- 22,5 mm neck diameter
- Hi-Bri technology
- Pigmented phosphors
- Slotted shadow mask optimized for minimum moiré
- Fine pitch over entire screen
- Phosphor lines follow glass contour
- Quick heating low-power cathodes
- Soft-flash technology
- Internal magnetic shield
- Reinforced envelope for push-through mounting
- Combined with a deflection unit of the AT1625 series, it forms a self-converging and raster correction free assembly

QUICK REFERENCE DATA

Deflection angle	90°
Minimum useful screen diagonal	34 cm
Overall-length	334 mm
Neck diameter	22,5 mm
Heating	6,3 V, 310 mA
Anode voltage	23 kV
Focusing voltage	28% of anode voltage

ELECTRON-OPTICAL DATA

Electron gun system		unitized triple-aperture electrodes
Focusing method		electrostatic
Focus lens		hi-bi-potential
Deflection method		magnetic
Deflection angles		
diagonal		approx. 90°
horizontal		approx. 78°
vertical		approx. 60°

ELECTRICAL DATA

Capacitances		
anode to external conductive coating including rimband	$C_{a(m + m')}$	min. 800 pF
grid 1 to all other electrodes	C_{g1}	15 pF
cathode of each gun to all other electrodes	C_{kR}, C_{kG}, C_{kB}	4 pF
focusing electrode to all other electrodes	C_{g3}	4 pF
Heating		indirect by AC or DC
heater voltage	V_f	6,3 V
heater current	I_f	310 mA

OPTICAL DATA

Screen		metal-backed vertical phosphor stripes; phosphor lines follow glass contour
Screen finish		high gloss
Useful screen dimensions		
diagonal		min. 335,4 mm
horizontal axis		min. 280,8 mm
vertical axis		min. 210,6 mm
area		min. 580 cm^2
Phosphors		
red		pigmented europium activated rare earth
green		sulphide type
blue		pigmented sulphide type
Centre-to-centre distance of vertical identical colour phosphor stripes, at screen centre		0,65 mm
Light transmission of face glass at centre		46%
Luminance at the centre of the screen	L	85 cd/m^2 *

* Tube settings adjusted to produce white D (x = 0.313, y = 0.329), focused raster, current density 0.4 $\mu A/cm^2$.

MECHANICAL DATA (see also the figures on the following pages)

Overall length	334,4 ± 5 mm
Neck diameter	$22{,}5^{+1{,}4}_{-0{,}7}$ mm*
Bulb dimensions	
diagonal	max. 368 mm
width	max. 317 mm
height	max. 248 mm
Base	JEDEC B8-288
Anode contact	small cavity contact J1-21, IEC 67-III-2
Mounting position	anode contact on top
Net mass	approx. 6 kg

Handling

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

* In the region of 66 mm from the neck end, the maximum diameter is 23,2 mm.

MECHANICAL DATA (continued)

Notes are given after the drawings.

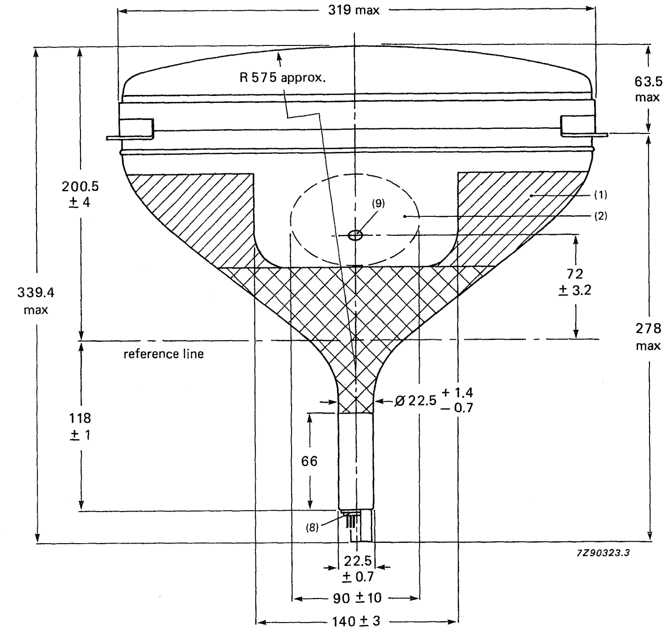


Fig. 1.

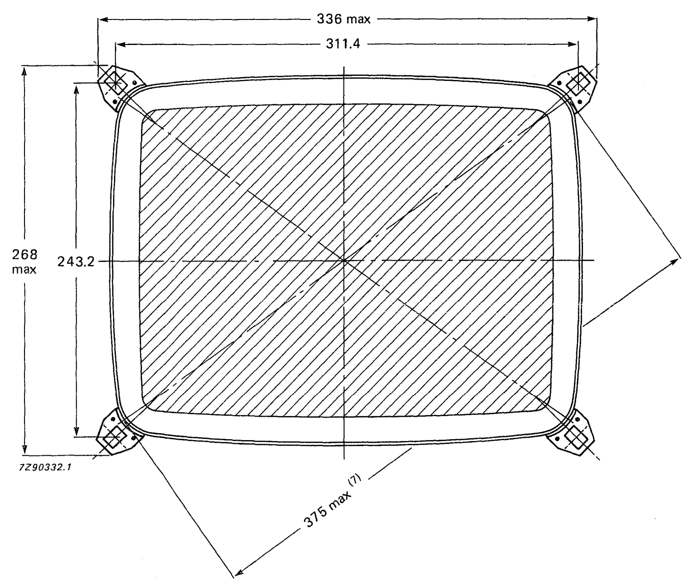


Fig. 2.

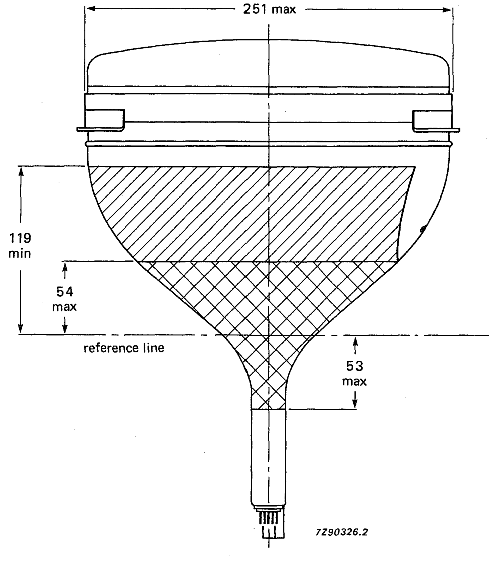

251 max
119
min
54
max
reference line
53
max
7Z90326.2

Fig. 3.

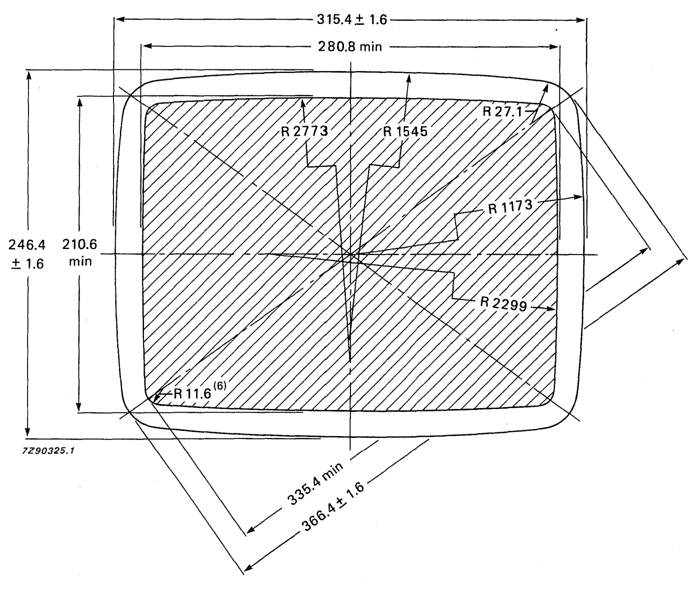

315.4 ± 1.6
280.8 min
R 2773
R 1545
R 27.1
R 1173
R 2299
246.4
± 1.6
210.6
min
R 11.6 (6)
7Z90325.1
335.4 min
366.4 ± 1.6

Fig. 4.

MECHANICAL DATA (continued)

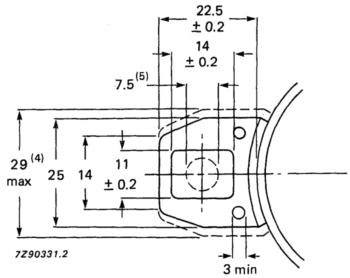


Fig. 5 Lug dimensions.

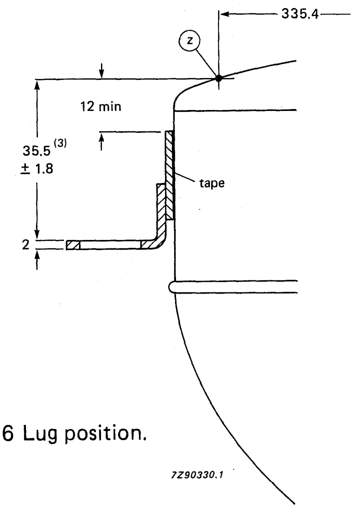


Fig. 6 Lug position.

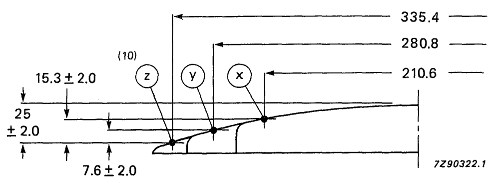


Fig. 7 Screen reference points.

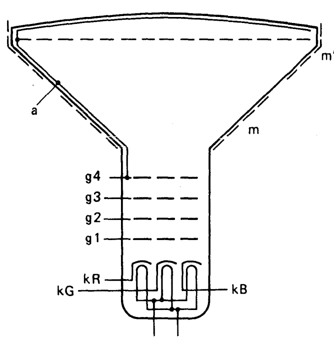


Fig. 8 Electrode configuration.

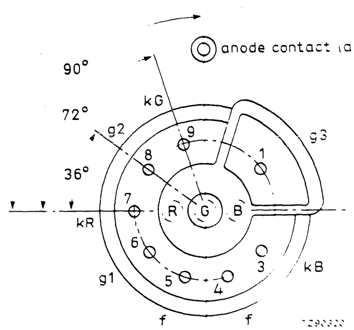


Fig. 9 Pin arrangement.

Notes to outline drawings

1. Configuration of outer conductive coating may be different, but will contain the contact areas as shown in Fig. 1.
2. To clean this area, wipe only with a soft lintless cloth.
3. One of the four mounting lugs may deviate (1,5 mm max.) from the plane of the other three lugs. This deviation is incorporated in the tolerance of ± 1,8 mm.
4. Minimum space to be reserved for mounting lug.
5. The position of the mounting screw in the cabinet must be within a circle of 7,5 mm diameter drawn around the true geometrical positions, i.e. the corners of a rectangle of 311,4 mm x 243,2 mm.
6. Co-ordinates for radius R = 11,6 mm; x = 126,98 mm, y = 90,76 mm.
7. Maximum dimensions in plane of lugs.
8. The socket for this base should not be rigidly mounted; it should have flexible leads and be allowed to move freely. After mounting of the tube in the cabinet note that the position of the base can fall within a circle, having a diameter of max. 50 mm, concentric with an imaginary tube axis.
9. Small cavity contact J1-21, IEC 67-III-2.
10. The X, Y and Z reference points are located on the outside surface of the face plate at the intersection of the minor, major and diagonal screen axis respectively, with the minimum published screen.

Reference line gauge; G-R90CJ10

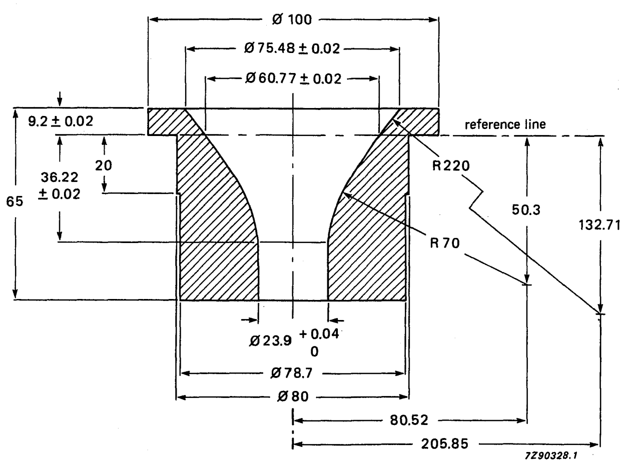


Fig. 10 Reference line guage.

Maximum cone contour

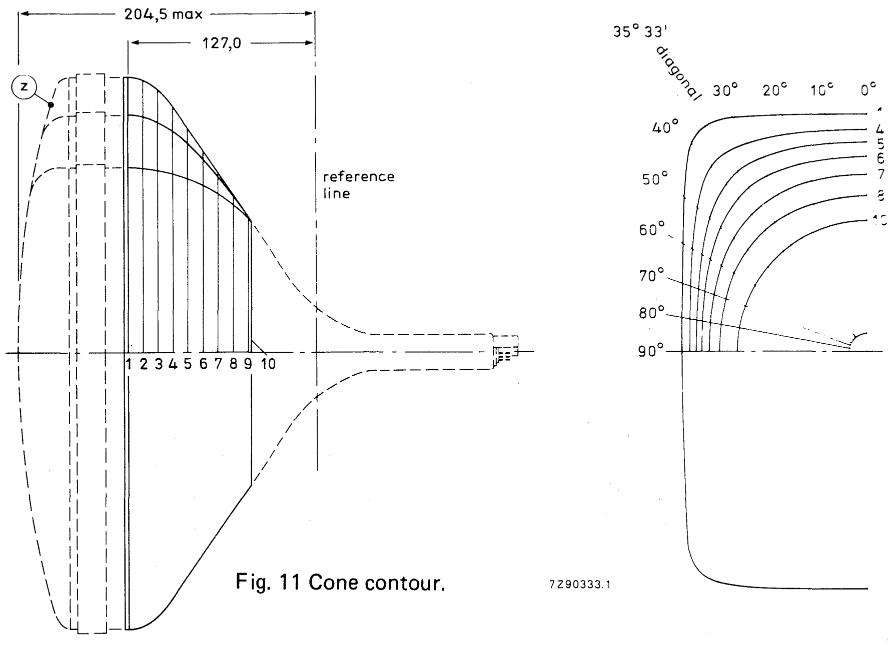


Fig. 11 Cone contour.

Table 1 Cone contour data

Dimensions in mm

section	nom. distance from reference line	distance from centre (max. values)														
		0°	10°	20°	25°	30°	32° 30′	diag. axes	37° 30′	40°	45°	50°	60°	70°	80°	90°
1	127,0	160,3	162,5	169,4	174,8	181,6	185,2	186,7	186,2	183,8	171,7	160,1	143,3	133,0	127.3	125.5
2	117,0	159,5	161,6	168,3	173,5	180,1	183,5	185,3	184,7	181,8	169,8	158,7	142,5	132,3	126.8	125.0
3	107,0	156,4	158,3	164,2	168,5	173,8	176,4	177,7	177,1	174,5	164,7	155,0	140,1	130,5	125.2	123.5
4	97,0	149,9	151,5	156,0	159,2	162,7	164,2	165,1	164,9	163,5	157,0	149,3	136,1	127,3	122.3	120.7
5	87,0	141,3	142,6	146,2	148,5	150,3	150,8	150,8	150,3	149,2	145,3	140,1	130,0	122,6	118,3	116.9
6	77,0	131,1	132,2	134,5	135,7	136,4	136,5	136,4	136,1	135,4	133,4	130,4	123,4	117.4	113,7	112.4
7	67,0	119,0	119,7	120,9	121,5	121,9	121,9	121,9	121,8	121,5	120,6	119,2	115,3	111,2	108,2	107.1
8	57,0	105,7	105,9	106,5	106,8	107,0	107,0	107,0	107,0	107,0	106,7	106,2	104,7	102,7	100,9	100.0
9	47,0	91,6	91,6	91,7	91,8	91,8	91,8	91,9	91,9	91,9	91,8	91,7	91,5	91,1	90,7	90.5
10	45,0	88,6	88,7	88,7	88,8	88,8	88,8	88,8	88,7	88,7	88,7	88,6	88,5	88,3	88,2	88.1

Base JEDEC B8-288

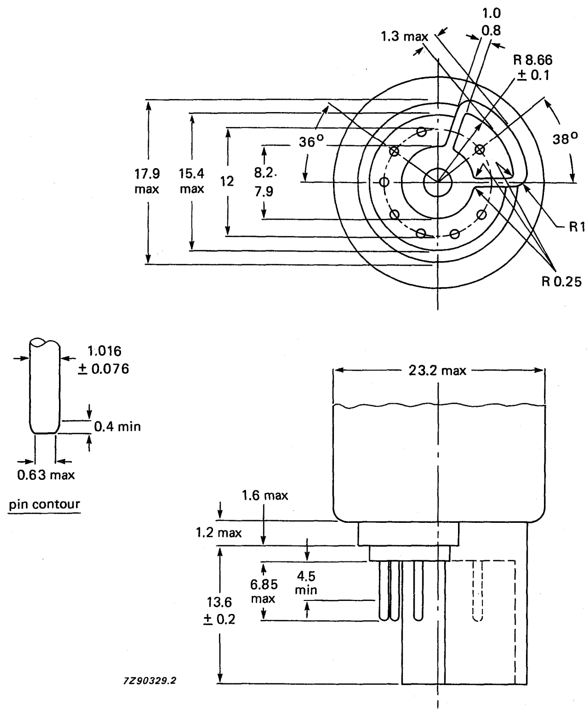


Fig. 12 JEDEC base.

TYPICAL OPERATING CONDITIONS

The voltages are specified with respect to grid 1.

Anode voltage	$V_{a,g4}$	23 kV
Grid 3 (focusing electrode) voltage	V_{g3}	6,1 to 6,9 kV
Grid 2 voltage for a spot cut-off voltage V_k = 120 V	V_{g2}	310 to 600 V
Luminance at the centre of the screen*	L	95 cd/m^2

* Tube settings adjusted to produce white of 6500K + 7 M.P.C.D. (x = 0,313, y = 0,329) focused raster, current density 0,4 μA/cm^2.

EQUIPMENT DESIGN VALUES

The values are valid for anode voltages between 20 and 27,5 kV.
The voltages are specified with respect to grid 1.

Grid 3 (focusing electrode) voltage	V_{g3}	26,6 to 29,8% of anode voltage
Grid 2 voltage and cathode voltage for visual extinction of focused spot	V_{g2} and V_k	see Fig. 14
Difference in cut-off voltages between guns in any tube	ΔV_k	lowest value > 80% of highest value
Video drive characteristics		see graphs*
Grid 3 (focusing electrode) current	I_{g3}	−2 to +2 μA
Grid 2 current	I_{g2}	−2 to +2 μA
Grid 1 current under cut-off conditions	I_{g1}	−2 to +2 μA

To produce white of 6500K + 7 M.P.C.D.
(CIE co-ordinates x = 0,313, y = 0,329)

Percentage of the total anode current supplied by each gun (typical)

red gun	40.5%
green gun	32.4%
blue gun	27.1%

Ratio of anode currents

red gun to green gun	min.	0.90
	average	1.25
	max.	1.60
red gun to blue gun	min.	1.10
	average	1.50
	max.	1.90
blue gun to green gun	min.	0.60
	average	0.85
	max.	1.20

* For optimum picture performance it is recommended that the cathodes are not driven below + 10 V.

LIMITING VALUES (Design maximum rating system unless otherwise stated)

The voltages are specified with respect to grid 1.

Anode voltage	$V_{a,g4}$	max.	27,5 kV	notes 1, 2, 3
		min.	20 kV	notes 1 and 4
Long-term average current for three guns	I_a	max.	750 μA	note 5
Grid 3 (focusing electrode) voltage	V_{g3}	max.	11 kV	
Grid 2 voltage, peak	V_{g2p}	max.	1000 V	
Cathode voltage				
positive	V_k	max.	400 V	
positive operating cut-off	V_k	max.	200 V	
negative	$-V_k$	max.	0 V	
negative peak	$-V_{kp}$	max.	2 V	
Heater voltage	V_f		6,3 V $^{+5\ \%}_{-10\ \%}$	notes 1 and 6
Heater-cathode voltage				
heater negative with respect to cathode after equipment warm-up period	V_{kf}	max.	200 V	
heater positive with respect to cathode	$-V_{kfp}$	peak	200 V	note 1
	$-V_{kf}$	max.	0 V (DC component value)	

Notes

1. Absolute maximum rating system.
2. The picture tube does not emit X-radiation above 1 μSv/h when operated within its absolute maximum ratings.
3. 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 luminance and resolution.
5. The short-term average anode current should be limited by circuitry to 1000 μA.
6. For maximum cathode life and optimum performance, it is recommended that the heater supply be designed for 6,3 V at zero beam current.

FLASHOVER PROTECTION

With the high voltage used with this tube (max. 27,5 kV) internal flashovers may occur. As a result of the Soft-Flash technology these flashover currents are limited to approx. 60 A offering higher set reliability, optimum circuit protection and component savings.

Primary protective circuitry using properly grounded spark gaps and series isolation resistors (preferably carbon composition) is still necessary to prevent tube damage. The spark gaps should be connected to all picture tube electrodes at the socket according to the figure below; they are not required on the heater pins. No other connections between the outer conductive coating and the chassis are permissible. The spark gaps should be designed for a breakdown voltage at the focusing electrode (g3) of 12 kV (1,5 x V_{g3} max. at $V_{a,g4}$ = 25 kV), and at the other electrodes of 1,5 to 2 kV.

The values of the series isolation resistors should be as high as possible (min. 1,5 kΩ) without causing deterioration of the circuit performance. The resistors should be able to withstand an instantaneous surge of 20 kV for the focusing circuit and 12 kV for the remaining circuits without arcing.

Additional information is available on request.

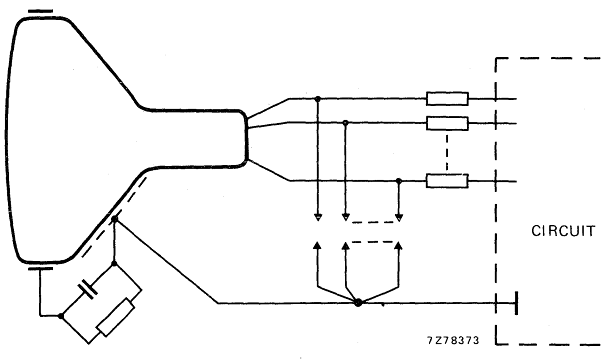


Fig. 13 Flashover protection circuit.

CENTRING ERROR

Maximum centring error in any direction after colour purity, static convergence, and horizontal centre line correction, measured with deflection coils in nominal position	4 mm

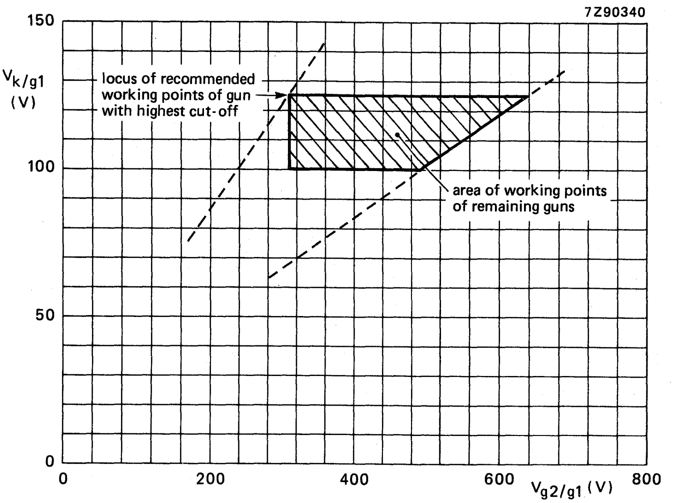


Fig. 14 Spot cut-off design chart.

Grid 2 voltage (V_{g2}) adjusted for highest gun spot cut-off voltage V_k = 125 V.

Remaining guns adjusted for spot cut-off by means of cathode voltage

V_{g2} range 310 to 630 V;

V_k range 100 to 125 V.

Adjustment procedure:

Set the cathode voltage (V_k) for each gun at 125 V; increase the grid 2 voltage (V_{g2}) from approx. 300 V to the value at which one of the colours becomes just visible. Now decrease the cathode voltage of the remaining guns so that the other colours also become visible.

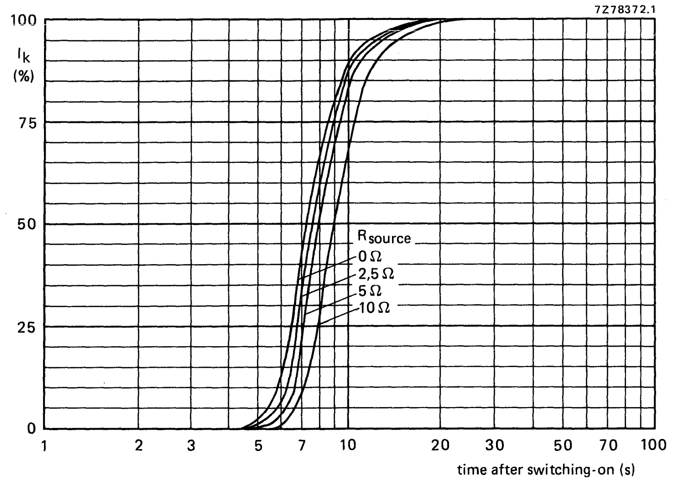


Fig. 15 Cathode heating time after switching on, measured under typical operating conditions.

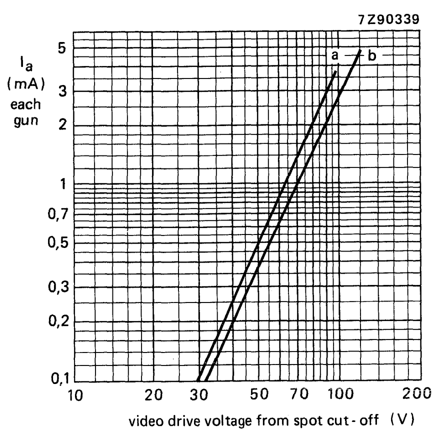


Fig. 16 Typical cathode drive characteristics.

V_f = 6,3 V;

$V_{a,g4}$ = 23 kV;

V_{g3} adjusted for focus

V_{g2} (each gun) adjusted to provide spot cut-off for V_k = 100 V (curve a), V_k = 125 V (curve b).

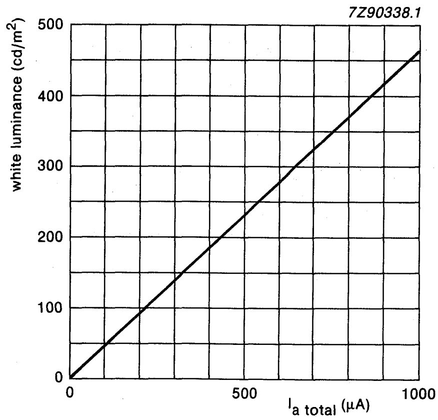


Fig. 17 Luminance at the centre of the screen as a function of I_{total}.

$V_{a,g4}$ = 23 kV, V_f = 6,3 V, V_{g3} adjusted for optimum focus.

Scanned area = 280,8 mm x 210,6 mm; CIE co-ordinates x = 0,313, y = 0,329.

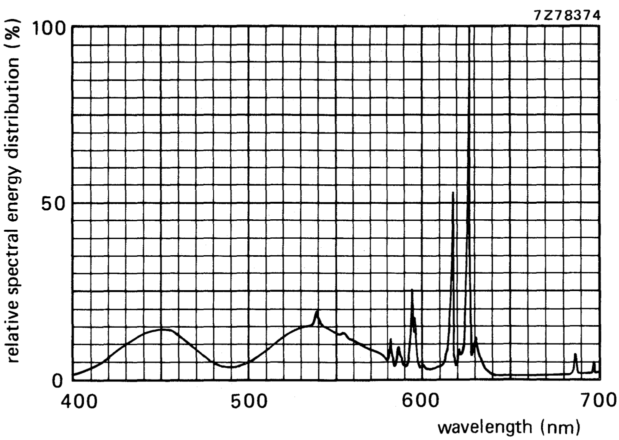


Fig. 18 Simultaneous excitation of red, green and blue phosphor, measured in a tube, to produce white of x = 0,313, y = 0,329. Exact shape of the peaks depends on the resolution of the measuring apparatus.

Colour co-ordinates:

	x	y
red	0.620	0.340
green	0.305	0.600
blue	0.155	0.065

DEGAUSSING

The picture tube has an internal magnetic shield. This shield and the shadow mask with its suspension system may be provided with an automatic degaussing system, consisting of one magnetic coil winding mounted on the cone of the picture tube.

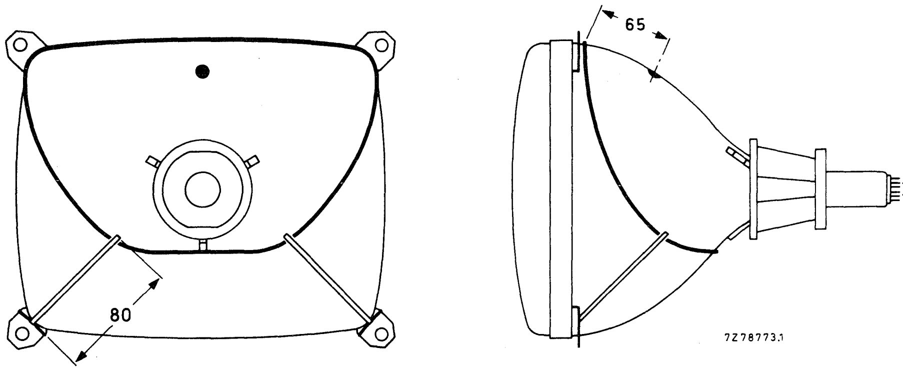


Fig. 19 Position of degaussing coil on the picture tube; dimensions are given in mm.

For proper degaussing an initial magnetomotive force (MMF) of 600 ampere-turns is required in the coil. This MMF has to be gradually decreased by appropriate degaussing circuitry. In the steady state, no significant MMF should remain in the coil (≤ 0,6 ampere-turns). If single-phase power rectification is employed in the TV circuitry, provision should be included to prevent asymmetric distortion of the AC voltage applied to the degaussing circuit due to high DC inrush currents. An example of a degaussing circuit and coil data for various mains voltages are given below.

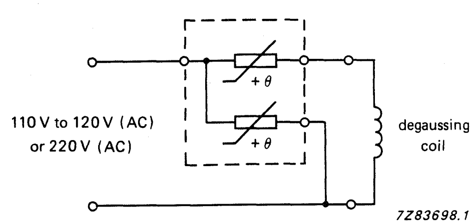


Fig. 20 Degaussing circuit using dual PTC thermistor.

Data of degaussing coil

	110 V (AC) mains	220 V (AC) mains
Circumference	90 cm	90 cm
Number of turns	60	120
Copper wire diameter	0,45 mm	0,3 mm
Resistance	6 Ω	27 Ω
Catalogue number of appropriate dual PTC thermistor	2322 662 98013	2322 662 98009

Hi-Bri COLOUR PICTURE TUBE ASSEMBLY

- Factory preset tube/coil assembly
- Self-converging and raster correction free
- 34 cm, 90° colour picture tube A34EAC01X
- Hybrid saddle toroidal deflection unit AT1625/10

QUICK REFERENCE DATA

Deflection angle	90°
Minimum useful screen diagonal	34 cm
Overall length	339 mm
Neck diameter	22.5 mm

MECHANICAL DATA

Dimensions in mm

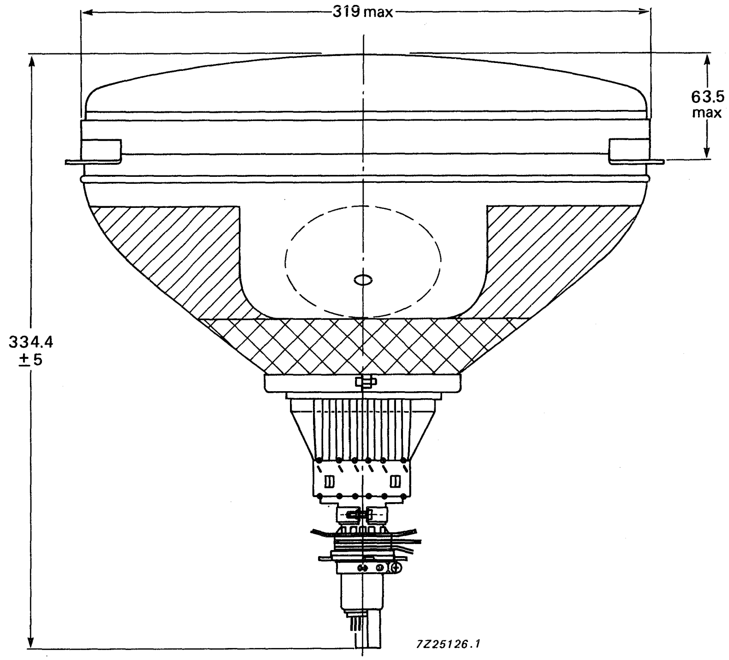


Fig. 1 Colour picture tube assembly A34EAC01X02.

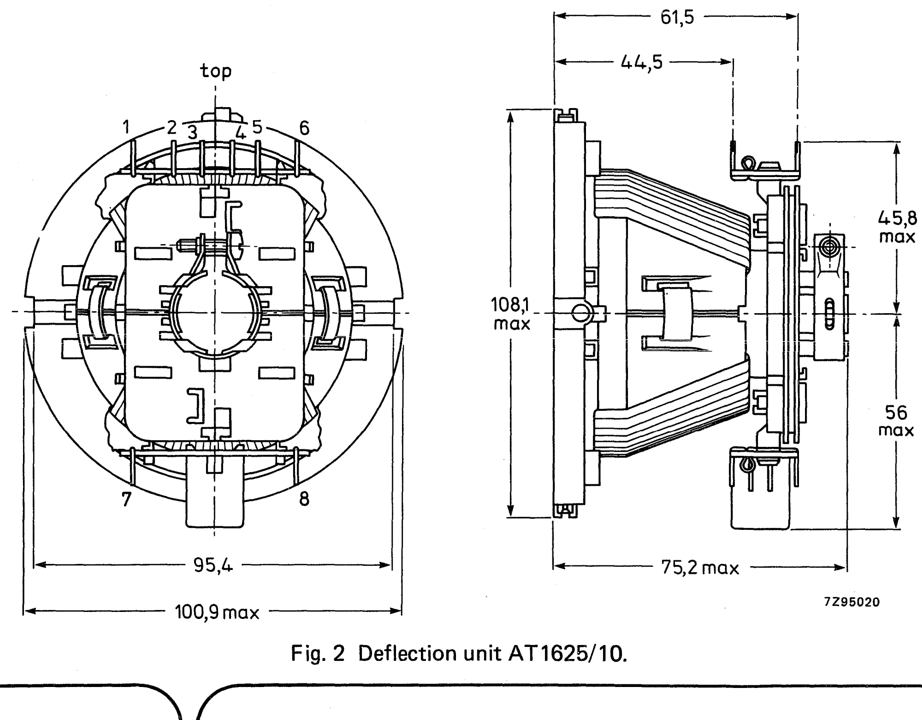


Fig. 2 Deflection unit AT1625/10.

ELECTRICAL DATA OF DEFLECTION UNIT

Line deflection coils (including additional coil)	
Inductance	2.43 mH ± 4%
Resistance at 25 °C	3.3 Ω ± 10%
Magnetic flux at 23 kV	5.27 mWb ± 2.5%
Line deflection current, raster scan, at 23 kV	2.17 A(p-p)
Raster scan	280 mm
Inductance of additional coil	0.15 mH ± 4%
Field deflection coils	
Inductance	110 mH ± 10%
Resistance at 25 °C	54.4 Ω ± 7%
Field deflection current, raster scan, at 23 kV	0.38 A(p-p)
Raster scan	210 mm

Cross-talk	a voltage of 10 V, 15625 Hz applied to the line coils causes no more than 0.40 V across the field coils (damping resistors included)
Insulation resistance at 1 kV DC	
between line and field coils	min. 500 MΩ
between line coil and core clamp	min. 500 MΩ
between field coil and core clamp	min. 10 MΩ
Maximum operating temperature (average copper temperature)	+ 90 °C
Storage temperature range	–25 to + 90 °C
Flame retardent	according to UL 1413, category 94-V1

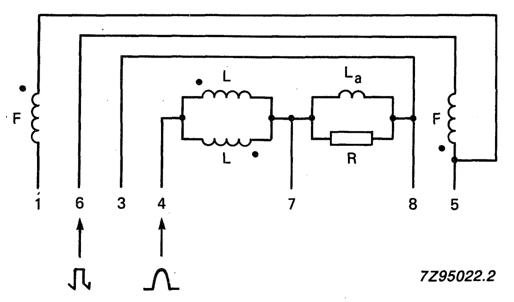


Fig. 3 Connection diagram. L = line coils, F = field coils, L_a = additional coil; R = 4.7 kΩ.

The beginning of the windings is indicated with ●

ENVIRONMENTAL TEST SPECIFICATIONS OF DEFLECTION UNITS

Vibration	IEC 68-2-6 (test Fc)
Shock	IEC 68-2-27 (test Ea)
Bump	IEC 68-2-29 (test Eb; 25g)
Cold	IEC 68-2-1 (test Ab)
Dry heat	IEC 68-2-2 (test Bb)
Damp heat, steady state	IEC 68-2-3 (test Ca)
Cyclic damp heat	IEC 68-2-30 (test Db)
Change of temperature	IEC 68-2-14 (test Nb)

FLAT SQUARE Hi-Bri COLOUR PICTURE TUBE

- Flat and square screen
- 90° deflection
- In-line, hi-bi potential A R T* gun
- 22,5 mm neck diameter
- Shadow mask of NiFe alloy with low thermal expansion
- Hi-Bri technology
- Mask with corner suspension
- Pigmented phosphors
- Fine pitch over entire screen
- Quick-heating low-power cathodes
- Soft flash
- Slotted shadow mask optimized for minimum moiré at 625 lines system
- Internal magnetic shield
- Internal multipole
- Reinforced envelope for push-through mounting
- The tube is supplied with a deflection unit of the AT6060 series; it forms a self-converging and raster correction free assembly

QUICK REFERENCE DATA

Deflection angle	90°
Minimum useful screen diagonal	36 cm
Overall length	340 mm
Neck diameter	22,5 mm
Heating	6,3 V, 310 mA
Anode voltage	23 kV
Focusing voltage	31% of anode voltage

* Aberration Reducing Triode.

ELECTRON-OPTICAL DATA

Electron gun system		unitized triple-aperture electrodes; aberration reducing triode
Focusing method		electrostatic
Focus lens		hi-bi potential
Deflection method		magnetic
Deflection angles		
diagonal		approx. 90°
horizontal		approx. 78°
vertical		approx. 60°

ELECTRICAL DATA

Capacitances		
anode to external conductive coating including rimband	$C_{a(m+m')}$	min. 800 pF
grid 1 to all other electrodes	C_{g1}	15 pF
cathode of each gun to all other electrodes	C_{kR}, C_{kG}, C_{kB}	4 pF
focusing electrode to all other electrodes	C_{g3}	4 pF
Heating		indirect by AC or DC
heater voltage	V_f	6,3 V
heater current	I_f	310 mA

OPTICAL DATA

Screen	metal-backed vertical phosphor stripes; phosphor lines follow glass contour
Screen finish	high polish
Useful screen dimensions	
diagonal	min. 355,6 mm
horizontal axis	min. 284,5 mm
vertical axis	min. 213,4 mm
area	min. 607 cm^2
Positional accuracy of the screen with respect to the glass contour	see Fig.1
Phosphors	
red	pigmented europium activated rare earth
green	sulphide type
blue	pigmented sulphide type
Centre-to-centre distance of vertical identical colour phosphor stripes, at screen centre	0,52 mm

Light transmission of face glass at centre		45%
Luminance at the centre of the screen	L	75 cd/m² *

A = 121,70 mm
B = 161,20 mm
C = 87,50 mm
D = 126,73 mm
E = 26,83 mm

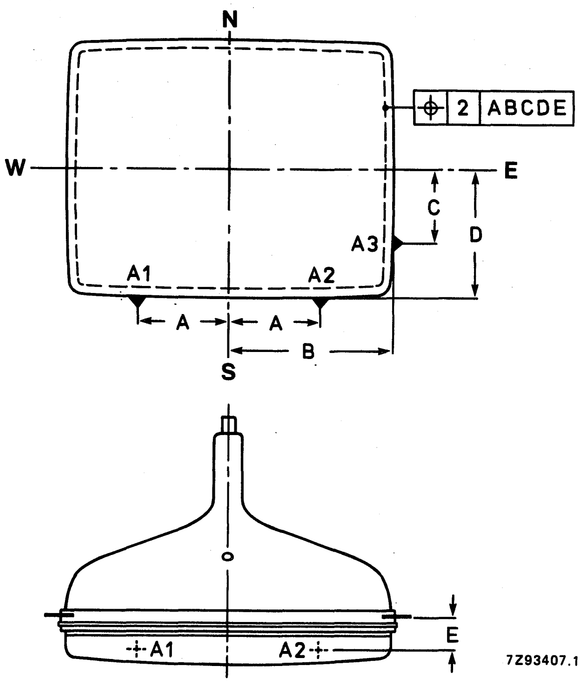


Fig. 1 Tube alignment.

MECHANICAL DATA (see also Figs 2 to 12)

Overall length	340 ± 4,5 mm
Neck diameter	$22{,}5\,^{+1{,}4}_{-0{,}7}$ mm**
Bulb dimensions	
diagonal	max. 392,6 mm
width	max. 328,4 mm
height	max. 263,0 mm
Base	JEDEC B8-288
Anode contact	small cavity contact J1-21, IEC 67-III-2
Mounting position	anode contact on top
Net mass	approx. 7 kg

Handling

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

* Tube settings adjusted to produce white D (x = 0,313, y = 0,329), focused raster, current density 0,4 μA/cm².

** In the region of 66 mm from the neck end, the maximum diameter is 23,2 mm.

MECHANICAL DATA (continued)

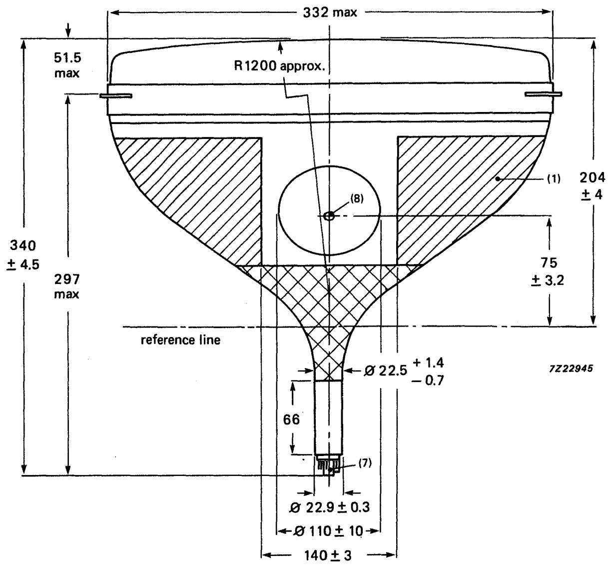


Fig. 2.

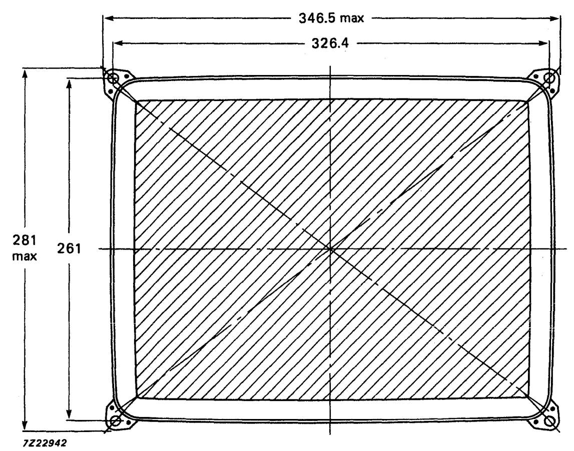


Fig. 3.

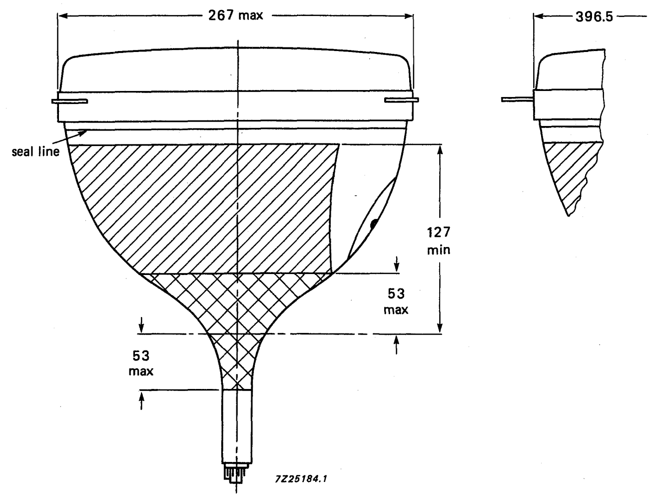

267 max
396.5
seal line
127
min
53
max
53
max
7Z25184.1

Fig. 4.

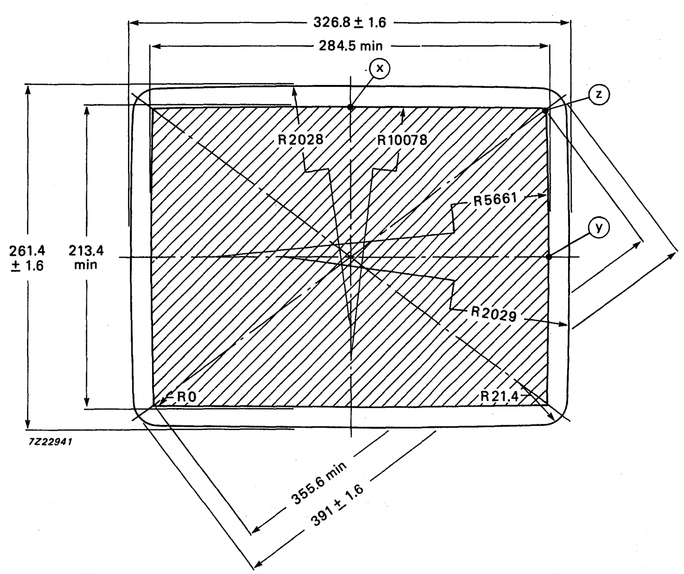

326.8 ± 1.6
284.5 min
x
z
y
R2028
R10078
R5661
R2029
261.4
± 1.6
213.4
min
R0
R21.4
7Z22941
355.6 min
391 ± 1.6

Fig. 5.

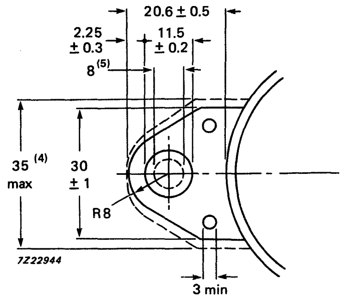


Fig. 6 Lug dimensions.

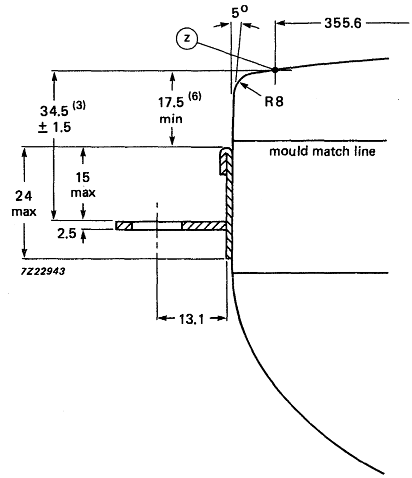


Fig. 7 Lug position.

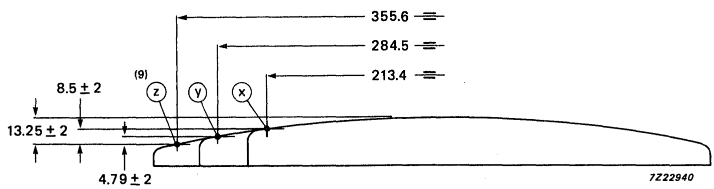


Fig. 8 Screen reference points.

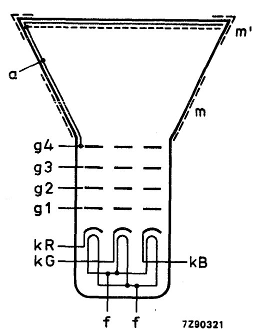


Fig. 9 Electrode configuration.

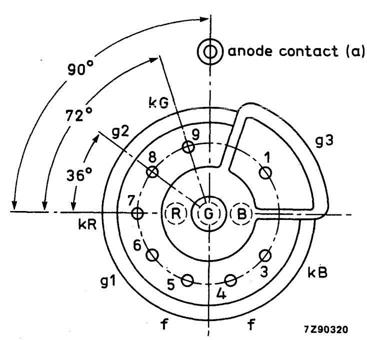


Fig. 10 Pin arrangement.

Notes to outline drawings

1. Configuration of outer conductive coating may be different, but will contain the contact areas as shown in the drawing.
2. To clean this area, wipe only with a soft lintless cloth.
3. One of the four mounting lugs may deviate (1,5 mm max.) from the plane of the other three lugs. This deviation is incorporated in the tolerance of ± 1,5 mm.
4. Minimum space to be reserved for mounting lug.
5. The position of the mounting screw in the cabinet must be within a circle of 8 mm diameter drawn around the true geometrical positions, i.e. corners of a rectangle of 326,4 mm x 261 mm.
6. Distance from point Z to any hardware.
7. The socket for this base should not be rigidly mounted; it should have flexible leads and be allowed to move freely. After mounting of the tube in the cabinet note that the position of the base can fall within a circle, having a diameter of max. 50 mm, concentric with an imaginary tube axis.
8. Small cavity contact J1-21, IEC 67-III-2.
9. The X, Y and Z reference points are located on the outside surface of the face plate at the intersection of the minor, major and diagonal screen axis respectively, with the minimum published screen.

Table 1 Sagittal heights with reference to screen centre at the edge of the minimum useful screen

coordinates x mm	y mm	sagittal height mm
0*	106,70	4,75
10	106,70	4,79
20	106,70	4,92
30	106,70	5,13
40	106,70	5,42
50	106,70	5,80
60	106,70	6,26
70	106,70	6,80
80	106,70	7,43
90	106,70	8,15
100	106,70	8,94
110	106,70	9,83
120	106,70	10,79
130	106,70	11,84
140	106,70	12,98
142,25**	106,70	13,25
142,25	100	12,66
142,25	90	11,86
142,25	80	11,15
142,25	70	10,52
142,25	60	9,97
142,25	50	9,51
142,25	40	9,13
142,25	30	8,84
142,25	20	8,63
142,25	10	8,50
142,25▲	0	8,46

* Point ⓧ
** Diagonal
▲ Point ⓨ

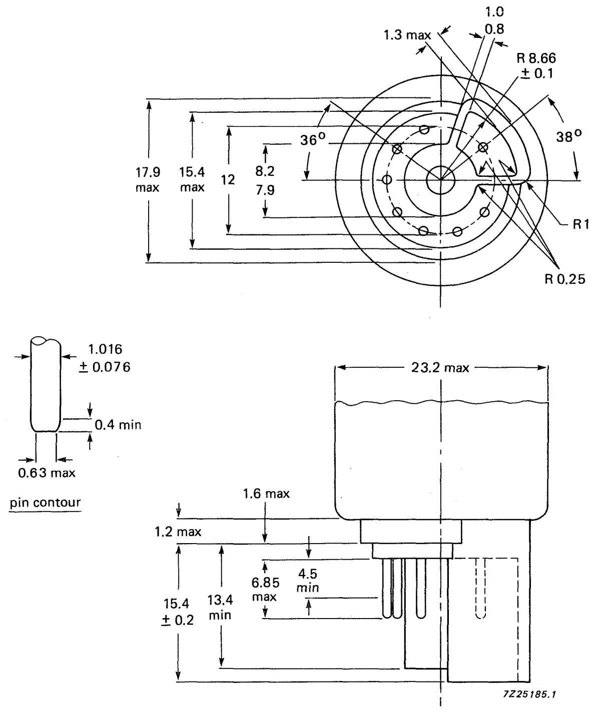


Fig. 11 Base JEDEC B8-288.

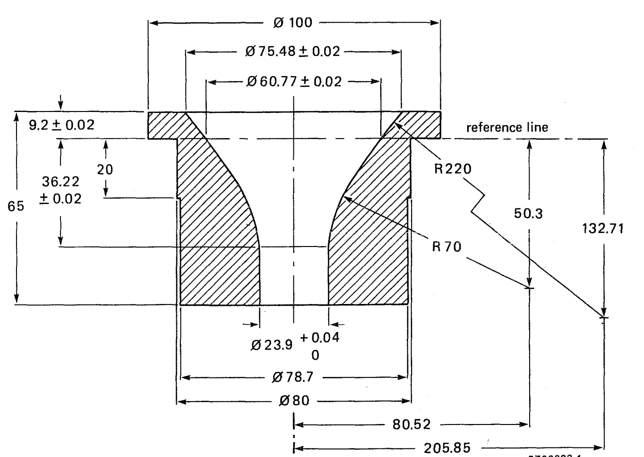


Fig. 12 Reference line gauge; G-R90CJ10.

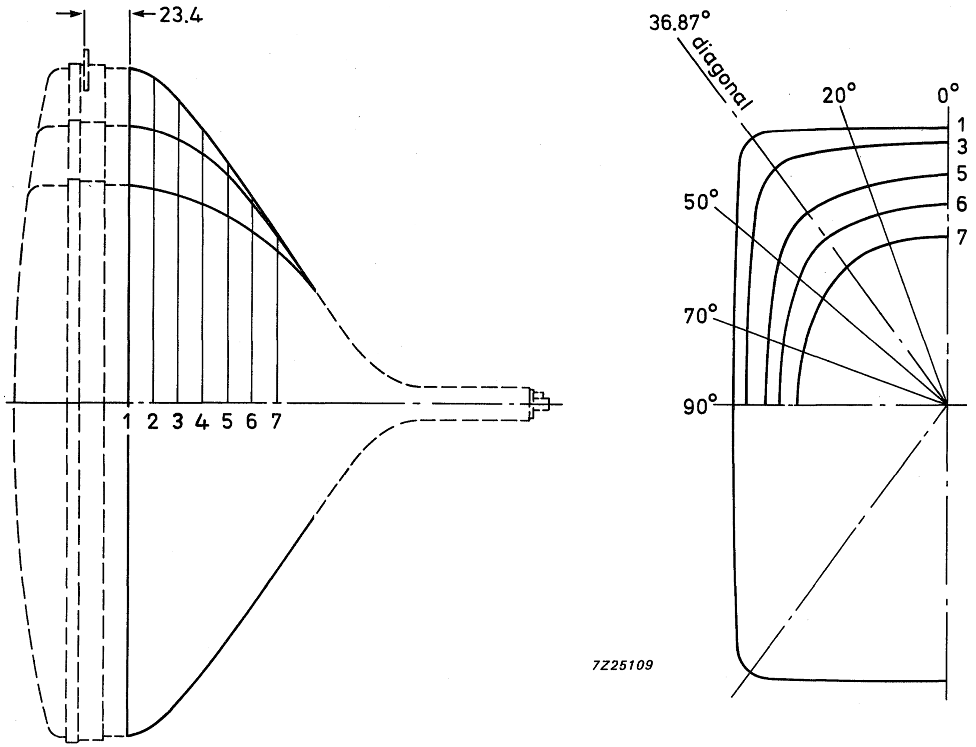


Fig. 13 Maximum cone contour.

Table 2 Cone contour data

section	nom. distance from section 1	distance from centre (max. values)					
		0°	20°	diag.	50°	70°	90°
1	0	163,3	173,0	195,8	166,9	138,2	130,3
2	20	159,1	168,5	188,0	161,1	134,5	127,2
3	40	149,2	154,4	165,5	148,2	127,5	121,5
4	60	133,5	136,4	140,0	131,2	117,4	113,0
5	80	110,7	111,9	112,6	108,7	102,3	100,0
6	100	82,2	82,7	82,7	82,0	80,8	80,2
7	115	58,3	58,3	58,3	58,3	58,5	58,7

TYPICAL OPERATING CONDITIONS

The voltages are specified with respect to grid 1.

Anode voltage	$V_{a,g4}$	23 kV
Grid 3 (focusing electrode) voltage	V_{g3}	6,7 to 7,6 kV
Grid 2 voltage for a spot cut-off voltage V_k = 120 V	V_{g2}	310 to 650 V

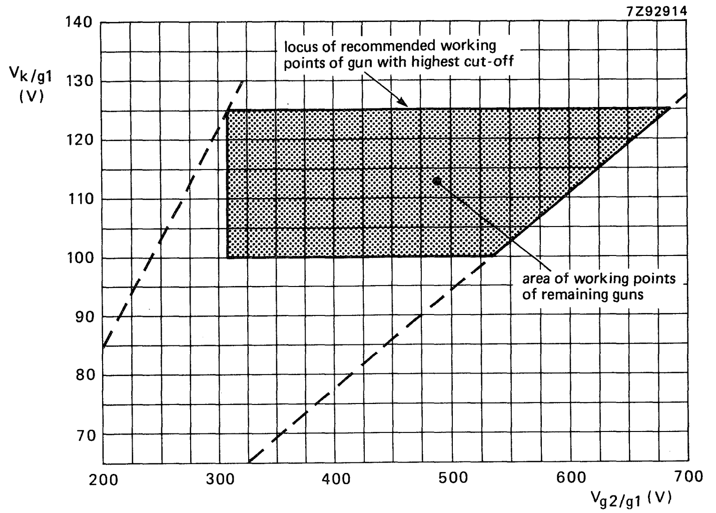


Fig. 14 Spot cut-off design chart.

Grid 2 voltage (V_{g2}) adjusted for highest gun spot cut-off voltage V_k = 125 V.

Remaining guns adjusted for spot cut-off by means of cathode voltage

V_{g2} range 310 to 685 V;

V_k range 100 to 125 V.

Adjustment procedure:

Set the cathode voltage (V_k) for each gun at 125 V; increase the grid 2 voltage (V_{g2}) from approx. 300 V to the value at which one of the colours become just visible. Now decrease the cathode voltage of the remaining guns so that the other colours also become visible.

EQUIPMENT DESIGN VALUES

The values are valid for anode voltages between 20 and 27,5 kV.
The voltages are specified with respect to grid 1.

Grid 3 (focusing electrode) voltage	V_{g3}	29 to 33% of anode voltage
Grid 2 voltage and cathode voltage for visual extinction of focused spot	V_{g2} and V_k	see Fig. 14
Difference in cut-off voltages between guns in any tube	ΔV_k	lowest value > 80% of highest value
Heater voltage	V_f	6,3 V at zero beam current
Video drive characteristics		see Figs 16 and 17
Grid 3 (focusing electrode) current	I_{g3}	−2 to + 2 μA
Grid 2 current	I_{g2}	−2 to + 2 μA
Grid 1 current under cut-off conditions	I_{g1}	−2 to + 2 μA

To produce white of 6500K + 7 M.P.C.D.
(CIE co-ordinates x = 0,313, y = 0,329)

Percentage of the total anode current supplied by each gun (typical)

red gun	40.5%
green gun	32.4%
blue gun	27.1%

Ratio of anode currents

red gun to green gun	min.	0.90
	average	1.25
	max.	1.60
red gun to blue gun	min.	1.10
	average	1.50
	max.	1.90
blue gun to green gun	min.	0.6
	average	0.85
	max.	1.20

LIMITING VALUES (Design maximum rating system unless otherwise stated)

The voltages are specified with respect to grid 1.

Anode voltage	$V_{a,g4}$	max.	27,5 kV	notes 1, 2, 3
		min.	20 kV	notes 1 and 4
Long-term average current for three guns	I_a	max.	750 μA	note 5
Grid 3 (focusing electrode) voltage	V_{g3}	max.	11 kV	
Grid 2 voltage, peak	V_{g2p}	max.	1000 V	
Cathode voltage				
positive	V_k	max.	400 V	
positive operating cut-off	V_k	max.	200 V	
negative	$-V_k$	max.	0 V	
negative peak	$-V_{kp}$	max.	2 V	
Heater voltage	V_f		$6,3\ V^{+5\ \%}_{-10\ \%}$	notes 1 and 6
Heater-cathode voltage				
heater negative with respect to cathode after equipment warm-up period	V_{kf}	max.	200 V	
heater positive with respect to cathode	$-V_{kfp}$	peak	200 V	note 1
	$-V_{kf}$	max.	0 V (DC component value)	

Notes

1. Absolute maximum rating system.
2. The picture tube does not emit X-radiation above 1 μSv/h when operated within its absolute maximum ratings.
3. 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 luminance and resolution.
5. The short-term average anode current should be limited by circuitry to 1000 μA.
6. For maximum cathode life and optimum performance, it is recommended that the heater supply be designed for 6,3 V at zero beam current.

FLASHOVER PROTECTION

With the high voltage used with this tube (max. 27,5 kV) internal flashovers may occur. As a result of the Soft-Flash technology these flashover currents are limited to approx. 60 A offering higher set reliability, optimum circuit protection and component savings.
Primary protective circuitry using properly grounded spark gaps and series isolation resistors (preferably carbon composition) is still necessary to prevent tube damage. The spark gaps should be connected to all picture tube electrodes at the socket according to the figure below; they are not required on the heater pins. No other connections between the outer conductive coating and the chassis are permissible. The spark gaps should be designed for a breakdown voltage at the focusing electrode (g3) of 12 kV (1,5 x V_{g3} max. at $V_{a,g4}$ = 25 kV), and at the other electrodes of 1,5 to 2 kV.
The values of the series isolation resistors should be as high as possible (min. 1,5 kΩ) without causing deterioration of the circuit performance. The resistors should be able to withstand an instantaneous surge of 20 kV for the focusing circuit and 12 kV for the remaining circuits without arcing.
Additional information is available on request.

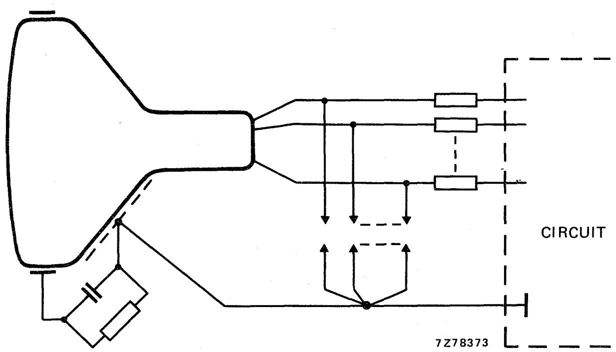


Fig. 15 Flashover protection circuit.

CENTRING ERROR

Maximum centring error in any direction after colour purity, static convergence, and horizontal centre line correction, measured with deflection coils in nominal position	3 mm

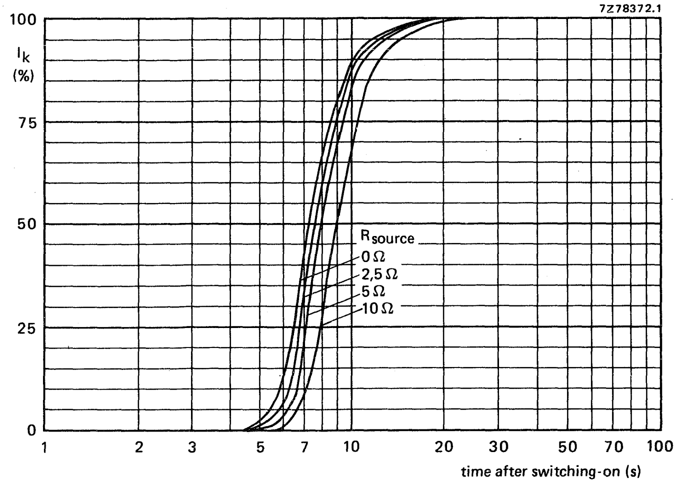
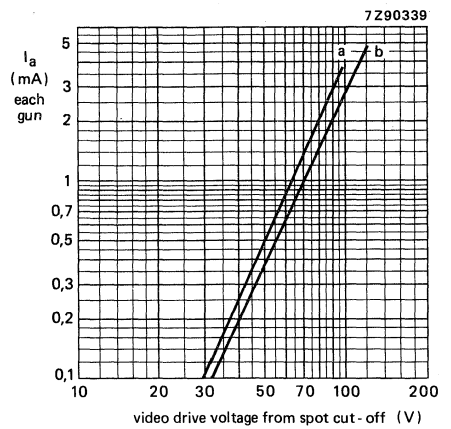


Fig. 16 Cathode heating time after switching on, measured under typical operating conditions.



V_f = 6,3 V;

$V_{a,g4}$ = 23 kV;

V_{g3} adjusted for focus;

V_{g2} (each gun) adjusted to provide spot cut-off for V_k = 100 V (curve a), and V_k = 125 V (curve b).

For optimum picture performance it is recommended that the cathodes are not driven below + 1 V.

Fig.17 Typical cathode drive characteristics.

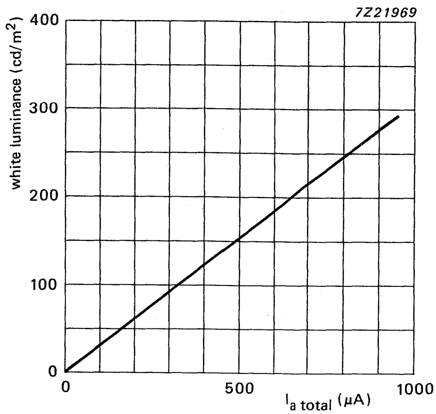


Fig. 18 Luminance at the centre of the screen as a function of I_{total}.

$V_{a,g4}$ = 23 kV.
Scanned area = 284,5 mm x 213,4 mm;
CIE co-ordinates x = 0,313, y = 0,329.

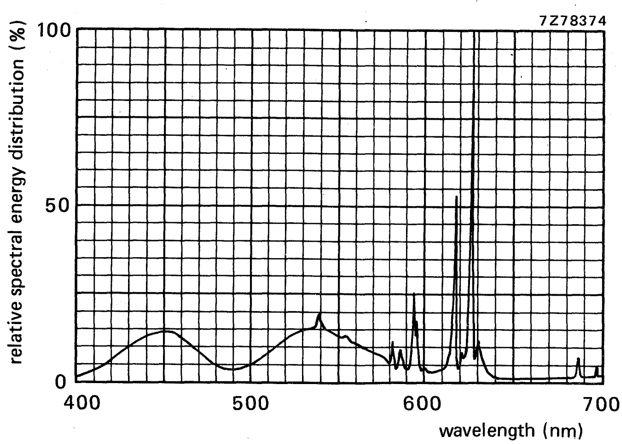


Fig. 19 Simultaneous excitation of red, green and blue phosphor, measured in a tube, to produce white of x = 0,313, y = 0,329. Exact shape of the peaks depends on the resolution of the measuring apparatus.

Colour co-ordinates:	x	y
red	0.620	0.340
green	0.305	0.600
blue	0.155	0.065

DEGAUSSING

The picture tube has an internal magnetic shield. This shield and the shadow mask with its suspension system may be provided with an automatic degaussing system, consisting of one magnetic coil winding mounted on the cone of the picture tube.

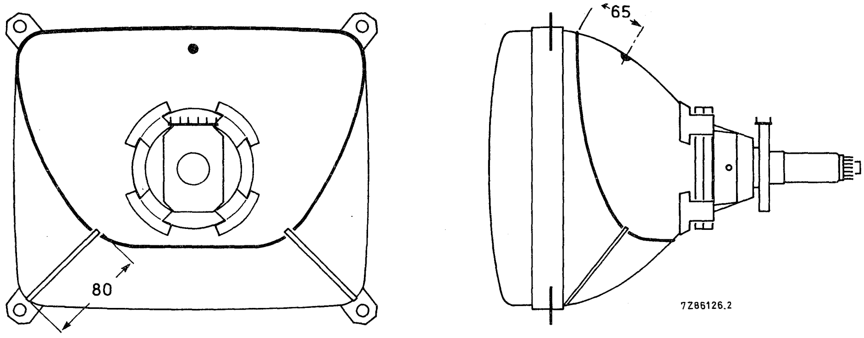


Fig. 20 Position of degaussing coil on the picture tube; dimensions are given in mm.

For proper degaussing an initial magnetomotive force (MMF) of 600 ampere-turns is required in the coil. This MMF has to be gradually decreased by appropriate degaussing circuitry. In the steady state, no significant MMF should remain in the coil (≤ 0,6 ampere-turns). If single-phase power rectification is employed in the TV circuitry, provision should be included to prevent asymmetric distortion of the AC voltage applied to the degaussing circuit due to high DC inrush currents. An example of a degaussing circuit and coil data for various mains voltages are given below.

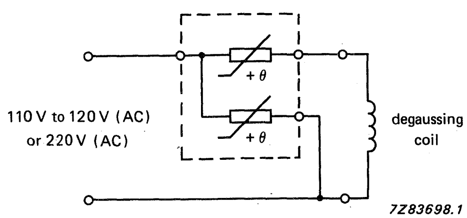


Fig. 21 Degaussing circuit using dual PTC thermistor.

Table 3 Data of degaussing coil

	110 V (AC) mains	220 V (AC) mains
Circumference	90 cm	90 cm
Number of turns	60	120
Copper wire diameter	0,45 mm	0,3 mm
Resistance	6 Ω	27 Ω
Catalogue number of appropriate dual PTC thermistor	2322 662 98013	2322 662 98009

FLAT SQUARE COLOUR PICTURE TUBE ASSEMBLY

- Factory preset tube/coil assembly
- Self-converging and raster correction free
- 36 cm, 90° colour picture tube A36EAM01X
- Hybrid saddle toroidal deflection unit AT6060/00

QUICK REFERENCE DATA

Deflection angle	90°
Minimum useful screen diagonal	36 cm
Overall length	340 mm
Neck diameter	22,5 mm

MECHANICAL DATA

Dimensions in mm

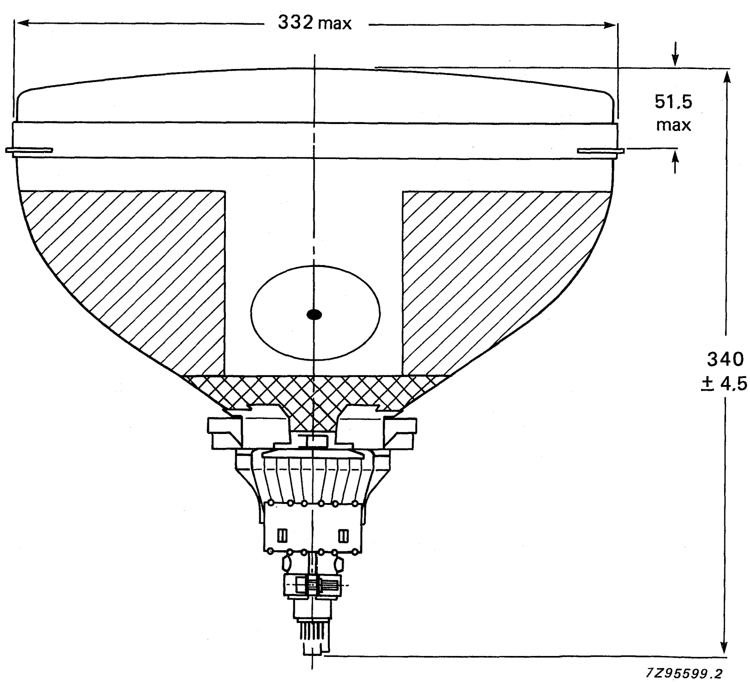


Fig. 1 Colour picture tube assembly.

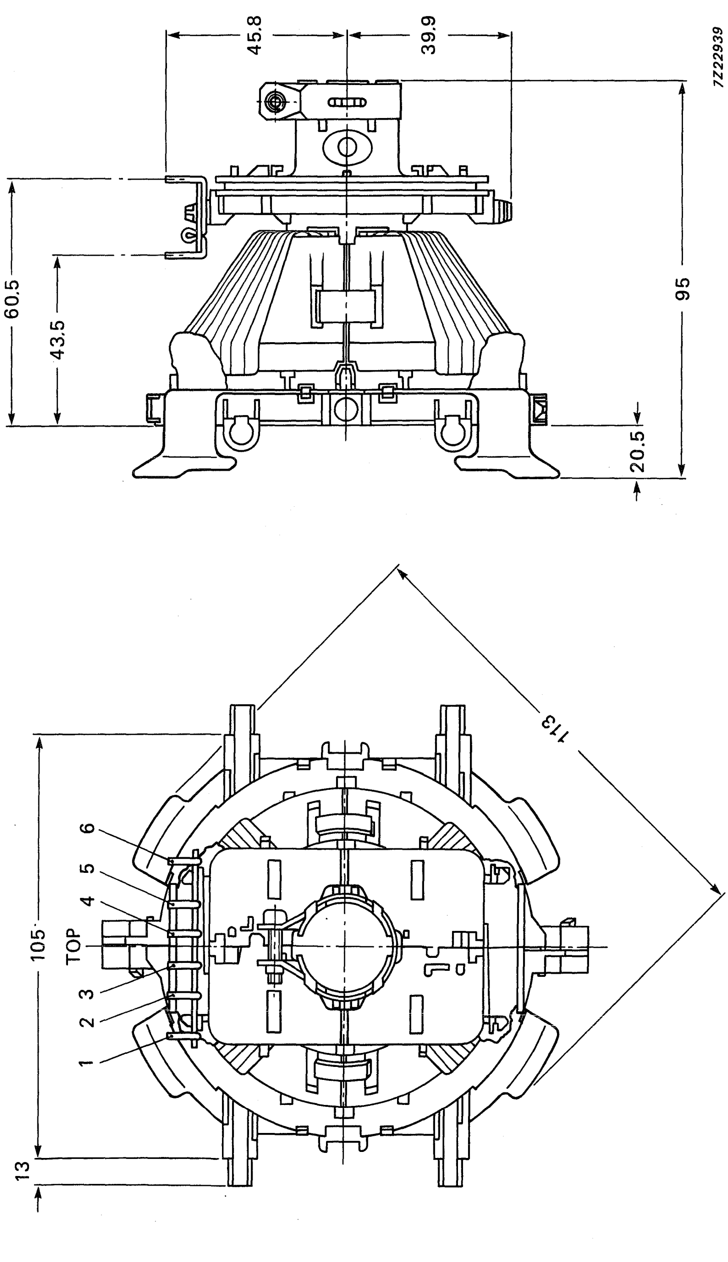


Fig. 2 Deflection unit AT6060/00.

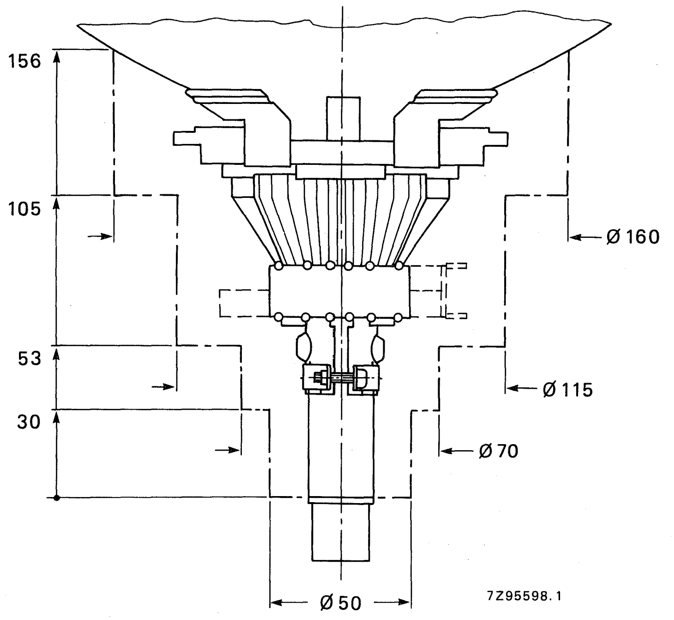


Fig. 3 Yoke clearance.

Maximum operating temperature (average copper temperature measured with resistance method)	+ 90 °C
Storage temperature range	−25 to +90 °C
Flame retardent	according to UL 1413, category 94-V1
Torque on neck clamp screw	1,0 Nm

ENVIRONMENTAL TEST SPECIFICATIONS OF DEFLECTION UNITS

Vibration	IEC 68-2-6 (test Fc)
Shock	IEC 68-2-27 (test Ea)
Bump	IEC 68-2-29 (test Eb; 25g)
Cold	IEC 68-2-1 (test Ab)
Dry heat	IEC 68-2-2 (test Bb)
Damp heat, steady state	IEC 68-2-3 (test Ca)
Cyclic damp heat	IEC 68-2-30 (test Db)
Change of temperature	IEC 68-2-14 (test Nb)

ELECTRICAL DATA OF DEFLECTION UNIT

parameter	AT6060/00
Line deflection coils	
inductance at 1 V (rms), 1 kHz	2,43 mH ± 4%
resistance at 25 °C	3,2 Ω ± 10%
magnetic flux	5,14 mWb ± 2,5%
Line deflection current, edge to edge, at 23 kV	2,095 A(p-p)
Field deflection coils	
inductance at 1 V (rms), 1 kHz	26,2 mH ± 10%
resistance at 25 °C	12,2 Ω ± 7%
Field deflection current, edge to edge, at 23 kV	0,82 A(p-p)
Cross-talk: voltage across the field coils when a voltage of 10 V, 15625 Hz is applied to the line coils	< 0,2 V

Insulation resistance at 1 kV (DC)

between line and field coils	min. 500 MΩ
between line coil and core clamp	min. 500 MΩ
between field coil and core clamp	min. 10 MΩ

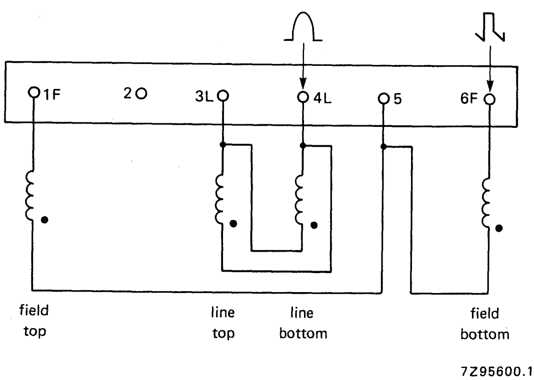


Fig. 4 Connection diagram.

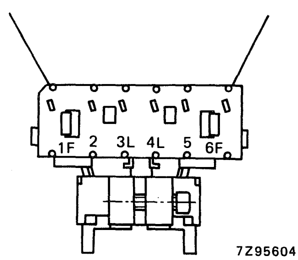


Fig. 5 Terminal Location.

The beginning of the windings is indicated with •.

FLAT SQUARE Hi-Bri COLOUR PICTURE TUBE

- Flat and square screen
- 90° deflection
- In-line, hi-bi potential A R T* gun
- 22,5 mm neck diameter
- Shadow mask of NiFe alloy with low thermal expansion
- Hi-Bri technology
- Mask with corner suspension
- Pigmented phosphors
- Fine pitch over entire screen
- Quick-heating low-power cathodes
- Soft flash
- Slotted shadow mask optimized for minimum moiré at 625 lines system
- Internal magnetic shield
- Internal multipole
- Reinforced envelope for push-through mounting
- The tube is supplied with a deflection unit of the AT6050 series; it forms a self-converging and raster correction free assembly

QUICK REFERENCE DATA

Deflection angle	90°
Minimum useful screen diagonal	41 cm
Overall length	369 mm
Neck diameter	22,5 mm
Heating	6,3 V, 310 mA
Anode voltage	23 kV
Focusing voltage	31% of anode voltage

* Aberration Reducing Triode.

ELECTRON-OPTICAL DATA

Electron gun system	unitized triple-aperture electrodes; aberration reducing triode
Focusing method	electrostatic
Focus lens	hi-bi-potential
Deflection method	magnetic
Deflection angles	
diagonal	approx. 90°
horizontal	approx. 78°
vertical	approx. 60°

ELECTRICAL DATA

Capacitances		
anode to external conductive coating including rimband	$C_{a(m + m')}$	min. 1000 pF
grid 1 to all other electrodes	C_{g1}	15 pF
cathode of each gun to all other electrodes	C_{kR}, C_{kG}, C_{kB}	4 pF
focusing electrode to all other electrodes	C_{g3}	4 pF
Heating		indirect by AC or DC
heater voltage	V_f	6,3 V
heater current	I_f	310 mA

OPTICAL DATA

Screen	metal-backed vertical phosphor stripes; phosphor lines follow glass contour
Screen finish	high polish
Useful screen dimensions	
diagonal	min. 406,4 mm
horizontal axis	min. 325,1 mm
vertical axis	min. 243,8 mm
area	min. 793 cm^2
Positional accuracy of the screen with respect to the glass contour	see Fig. 1
Phosphors	
red	pigmented europium activated rare earth
green	sulphide type
blue	pigmented sulphide type
Centre-to-centre distance of vertical identical colour phosphor stripes, at screen centre	0,55 mm

Light transmission of face glass at centre		42%
Luminance at the centre of the screen	L	70 cd/cm² *

A = 139,40 mm
B = 181,94 mm
C = 100,00 mm
D = 142,24 mm
E = 29,20 mm

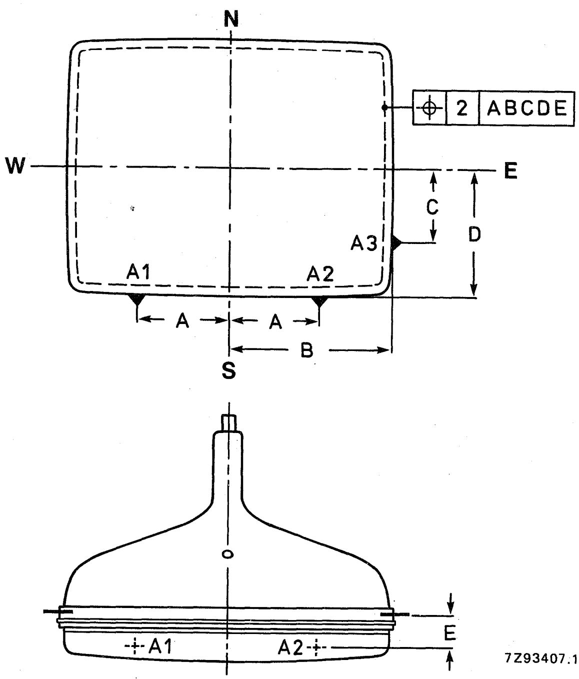


Fig. 1 Tube alignment.

MECHANICAL DATA

Overall length	369,1 ± 4,5 mm
Neck diameter	$22,5 \,^{+1,4}_{-0,7}$ mm**
Bulb dimensions	
diagonal	max. 443,6 mm
width	max. 370,8 mm
height	max. 295,0 mm
Base	JEDEC B8-288
Anode contact	small cavity contact J1-21, IEC 67-III-2
Mounting position	anode contact on top
Net mass	approx. 9 kg

Handling

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

* Tube settings adjusted to produce white D (x = 0,313, y = 0,329), focused raster, current density 0,4 μA/cm².

** In the region of 66 mm from the neck end, the maximum diameter is 23,2 mm.

MECHANICAL DATA (continued)

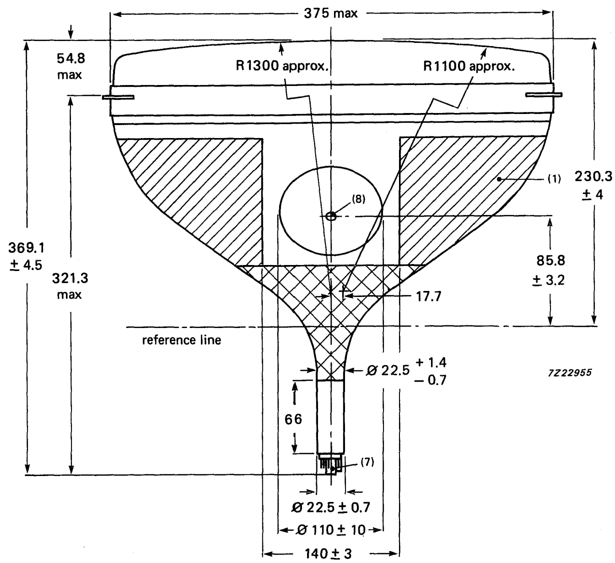


Fig. 2.

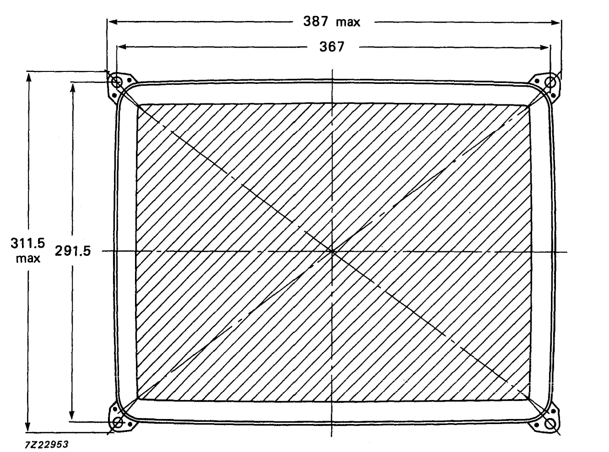


Fig. 3.

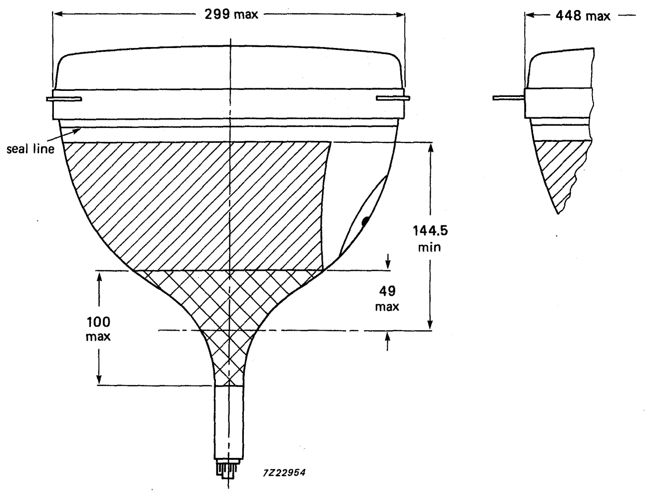

299 max
448 max
seal line
144.5
min
49
max
100
max
7Z22954

Fig. 4.

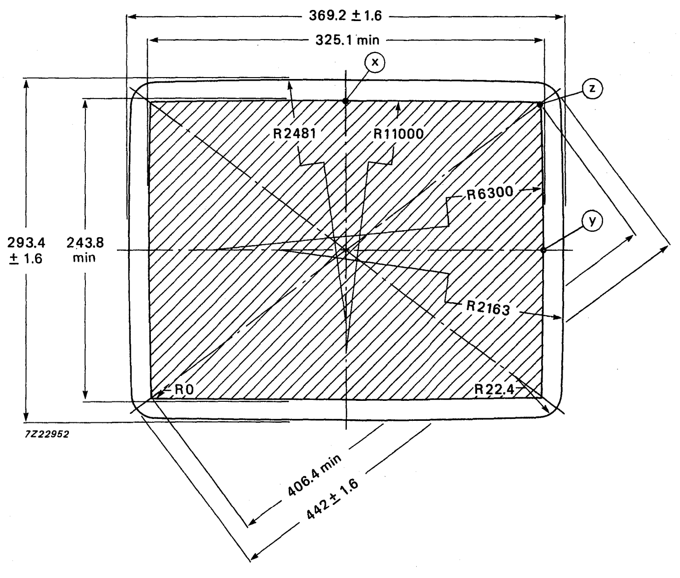

369.2 ± 1.6
325.1 min
x
z
y
R2481
R11000
R6300
R2163
R0
R22.4
293.4
± 1.6
243.8
min
7Z22952
406.4 min
442 ± 1.6

Fig. 5.

MECHANICAL DATA (continued)

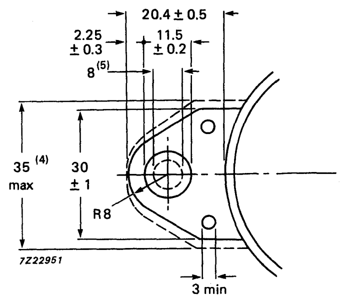


Fig. 6 Lug dimensions.

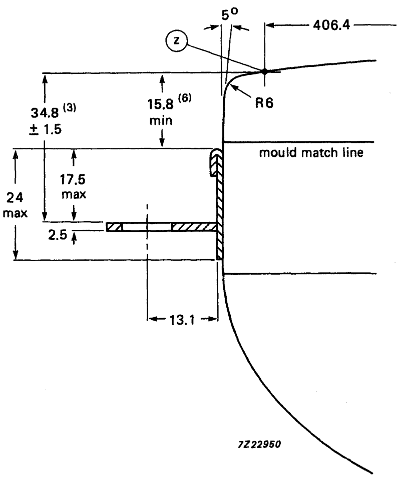


Fig. 7 Lug position.

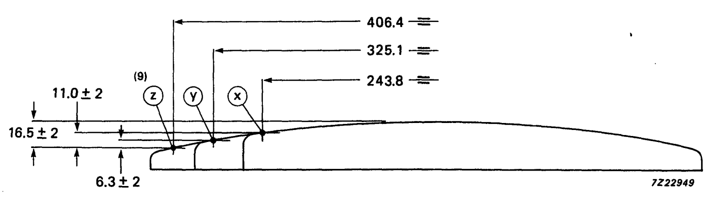


Fig. 8 Screen reference points.

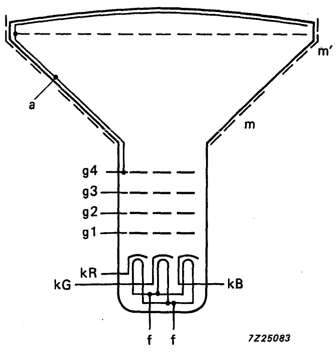


Fig. 9 Electrode configuration.

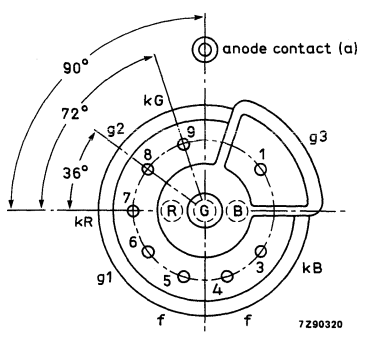


Fig. 10 Pin arrangement.

Notes to outline drawings

1. Configuration of outer conductive coating may be different, but will contain the contact areas as shown in the drawing.
2. To clean this area, wipe only with a soft lintless cloth.
3. One of the four mounting lugs may deviate (1,5 mm max.) from the plane of the other three lugs. This deviation is incorporated in the tolerance of ± 1,5 mm.
4. Minimum space to be reserved for mounting lug.
5. The position of the mounting screw in the cabinet must be within a circle of 8 mm diameter drawn around the true geometrical positions, i.e. corners of a rectangle of 367 mm x 291,5 mm.
6. Distance from point Z to any hardware.
7. The socket for this base should not be rigidly mounted; it should have flexible leads and be allowed to move freely. After mounting of the tube in the cabinet note that the position of the base can fall within a circle, having a diameter of max. 50 mm, concentric with an imaginary tube axis.
8. Small cavity contact J1-21, IEC 67-III-2.
9. The X, Y and Z reference points are located on the outside surface of the face plate at the intersection of the minor, major and diagonal screen axis respectively, with the minimum published screen.

Table 1 Sagittal heights with reference to screen centre at the edge of the minimum useful screen

coordinates x mm	coordinates y mm	sagittal height mm
0*	121,90	5,5
10	121,90	5,6
20	121,90	5,7
30	121,90	5,9
40	121,90	6,2
50	121,90	6,5
60	121,90	6,9
70	121,90	7,5
80	121,90	8,1
90	121,90	8,8
100	121,90	9,5
110	121,90	10,4
120	121,90	11,3
130	121,90	12,4
140	121,90	13,5
150	121,90	14,7
160	121,90	16,0
162,55**	121,90	16,3
162,55	120	16,1
162,55	110	15,2
162,55	100	14,3
162,55	90	13,5
162,55	80	12,8
162,55	70	12,2
162,55	60	11,6

coordinates x mm	coordinates y mm	sagittal height mm
162,55	50	11,2
162,55	40	10,8
162,55	30	10,5
162,55	20	10,3
162,55	10	10,2
162,55▲	0	10,2

* Point ⓧ
** Diagonal
▲ Point ⓨ

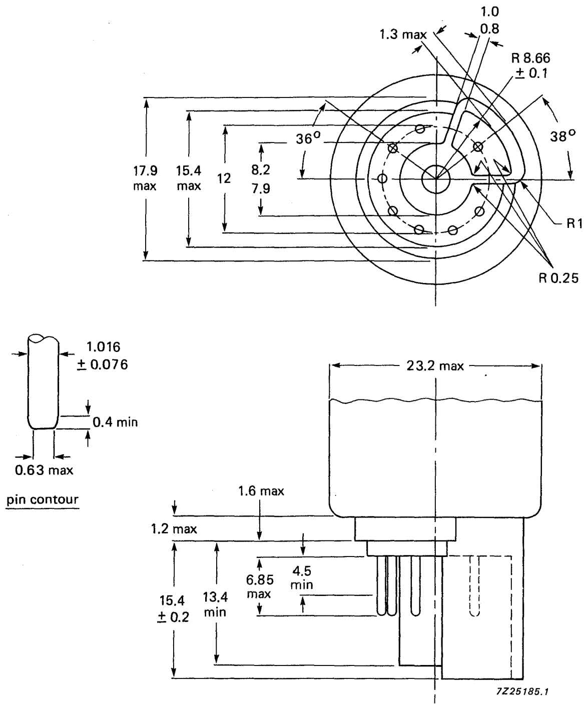


Fig. 11 Base JEDEC B8-288.

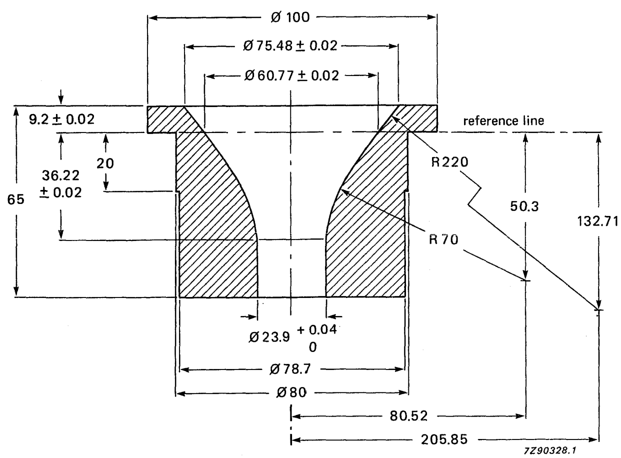


Fig. 12 Reference line gauge; GR90CJ10.

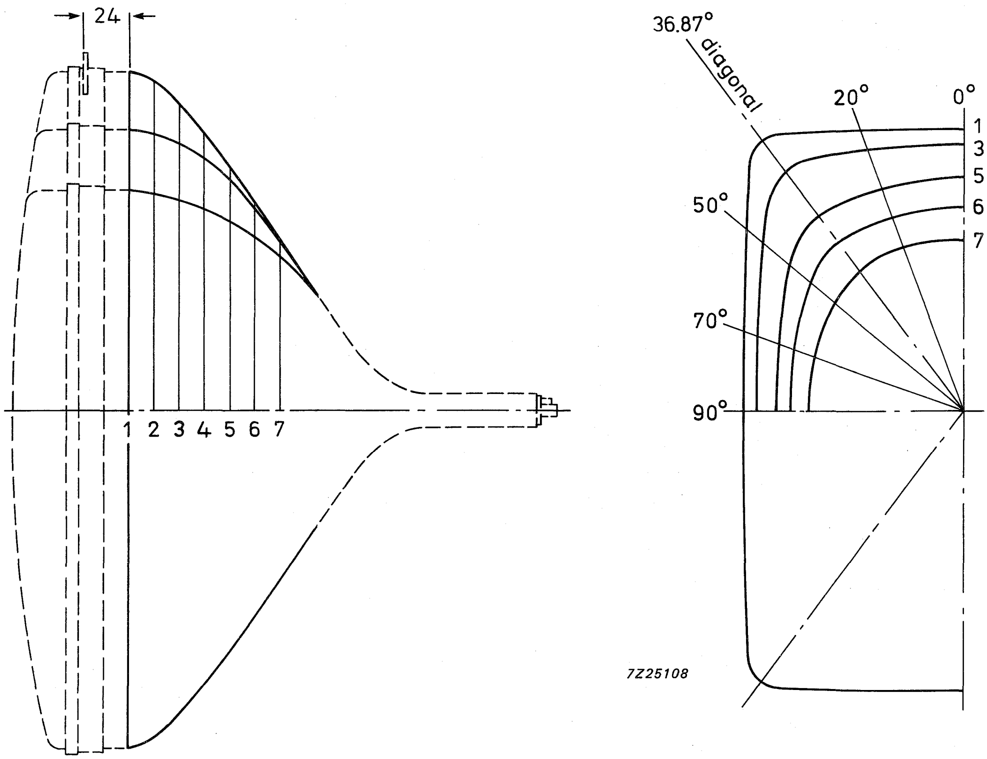


Fig. 13 Maximum cone contour.

Table 2 Cone contour data

section	nom. distance from section 1	distance from centre (max. values)					
		0°	20°	diag.	50°	70°	90°
1	0	184,3	195,1	221,0	187,3	154,9	146,1
2	20	179,7	188,7	209,5	180,0	150,4	142,2
3	40	169,8	175,2	186,7	167,5	143,2	136,2
4	60	154,8	157,5	162,9	151,8	134,2	128,7
5	80	134,0	135,7	137,7	131,8	121,7	118,3
6	100	110,2	111,4	111,1	108,5	104,9	103,6
7	120	82,9	82,3	82,8	83,0	82,7	82,2
8	140	52,6	52,7	52,7	52,7	52,7	52,7

TYPICAL OPERATING CONDITIONS

The voltages are specified with respect to grid 1.

Anode voltage	$V_{a,g4}$	23 kV
Grid 3 (focusing electrode) voltage	V_{g3}	6,7 to 7,6 kV
Grid 2 voltage for a spot cut-off voltage V_k = 120 V	V_{g2}	310 to 650 V

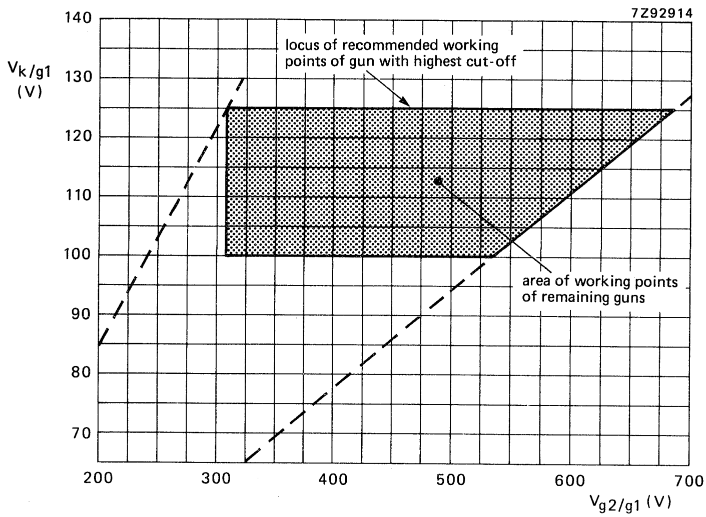


Fig. 14 Spot cut-off design chart.

Grid 2 voltage (V_{g2}) adjusted for highest gun spot cut-off voltage V_k = 125 V.

Remaining guns adjusted for spot cut-off by means of cathode voltage

V_{g2} range 310 to 685 V;

V_k range 100 to 125 V.

Adjustment procedure:

Set the cathode voltage (V_k) for each gun at 125 V; increase the grid 2 voltage (V_{g2}) from approx. 300 V to the value at which one of the colours become just visible. Now decrease the cathode voltage of the remaining guns so that the other colours also become visible.

EQUIPMENT DESIGN VALUES

The values are valid for anode voltages between 20 and 27,5 kV.
The voltages are specified with respect to grid 1.

Grid 3 (focusing electrode) voltage	V_{g3}	29 to 33% of anode voltage
Grid 2 voltage and cathode voltage for visual extinction of focused spot	V_{g2} and V_k	see Fig. 14
Difference in cut-off voltages between guns in any tube	ΔV_k	lowest value > 80% of highest value
Heater voltage	V_f	6,3 V at zero beam current
Video drive characteristics		see Fig. 17
Grid 3 (focusing electrode) current	I_{g3}	−2 to + 2 μA
Grid 2 current	I_{g2}	−2 to + 2 μA
Grid 1 current under cut-off conditions	I_{g1}	−2 to + 2 μA

To produce white of 6500K + 7 M.P.C.D.
(CIE co-ordinates x = 0,313, y = 0,329)

Percentage of the total anode current supplied by each gun (typical)

red gun	40.5%
green gun	32.4%
blue gun	27.1%

Ratio of anode currents

red gun to green gun	min.	0.90
	average	1.25
	max.	1.60
red gun to blue gun	min.	1.10
	average	1.50
	max.	1.90
blue gun to green gun	min.	0.60
	average	0.85
	max.	1.20

LIMITING VALUES (Design maximum rating system unless otherwise stated)

The voltages are specified with respect to grid 1.

Anode voltage	$V_{a,g4}$	max.	27,5	kV	notes 1, 2, 3
		min.	20	kV	notes 1 and 4
Long-term average current for three guns	I_a	max.	750	μA	note 5
Grid 3 (focusing electrode) voltage	V_{g3}	max.	11	kV	
Grid 2 voltage, peak	V_{g2p}	max.	1000	V	
Cathode voltage					
positive	V_k	max.	400	V	
positive operating cut-off, during adjustment	V_k	max.	200	V	
negative	$-V_k$	max.	0	V	
negative peak	$-V_{kp}$	max.	2	V	
Heater voltage	V_f		$6{,}3\ V^{+5\ \%}_{-10\ \%}$		notes 1 and 6
Heater-cathode voltage					
heater negative with respect to cathode after equipment warm-up period	V_{kf}	max.	200	V	
heater positive with respect to cathode	$-V_{kfp}$	peak	200	V	note 1
	$-V_{kf}$	max.	0	V (DC component value)	

Notes to the limiting values

1. Absolute maximum rating system.
2. The picture tube does not emit X-radiation above 1 μSv/h when operated within its absolute maximum ratings.
3. 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 luminance and resolution.
5. The short-term average anode current should be limited by circuitry to 1000 μA.
6. For maximum cathode life and optimum performance, it is recommended that the heater supply be designed for 6,3 V at zero beam current.

FLASHOVER PROTECTION

With the high voltage used with this tube (max. 27,5 kV) internal flashovers may occur. As a result of the Soft-Flash technology these flashover currents are limited to approx. 60 A offering higher set reliability, optimum circuit protection and component savings.
Primary protective circuitry using properly grounded spark gaps and series isolation resistors (preferably carbon composition) is still necessary to prevent tube damage. The spark gaps should be connected to all picture tube electrodes at the socket according to the figure below; they are not required on the heater pins. No other connections between the outer conductive coating and the chassis are permissible.
The spark gaps should be designed for a breakdown voltage at the focusing electrode (g3) of 12 kV (1,5 x V_{g3} max. at $V_{a,g4}$ = 25 kV), and at the other electrodes of 1,5 to 2 kV.
The values of the series isolation resistors should be as high as possible (min. 1,5 kΩ) without causing deterioration of the circuit performance. The resistors should be able to withstand an instantaneous surge of 20 kV for the focusing circuit and 12 kV for the remaining circuits without arcing.
Additional information is available on request.

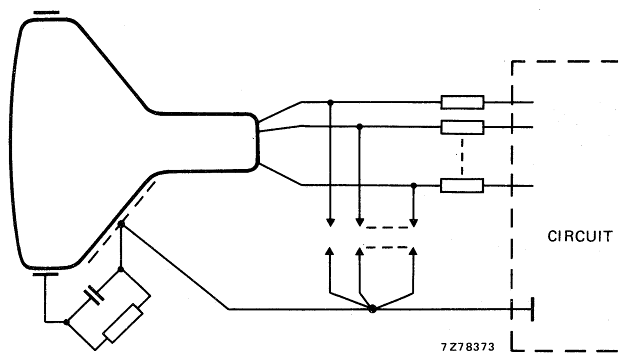


Fig. 15 Flashover protection circuit.

CENTRING ERROR

Maximum centring error in any direction after colour purity, static convergence, and horizontal centre line correction, measured with deflection coils in nominal position	3 mm

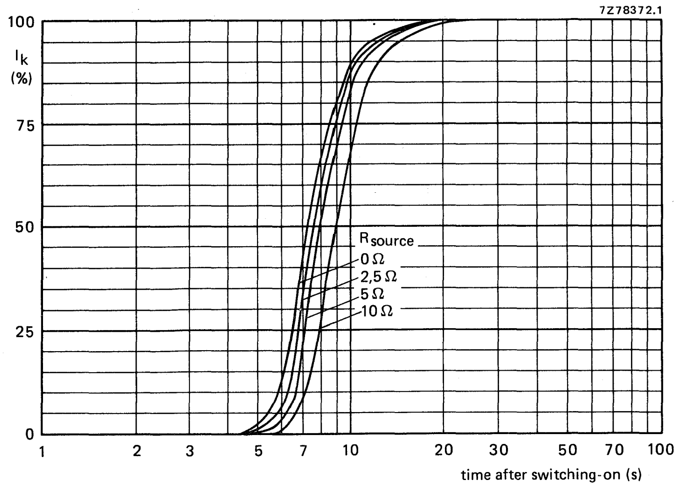
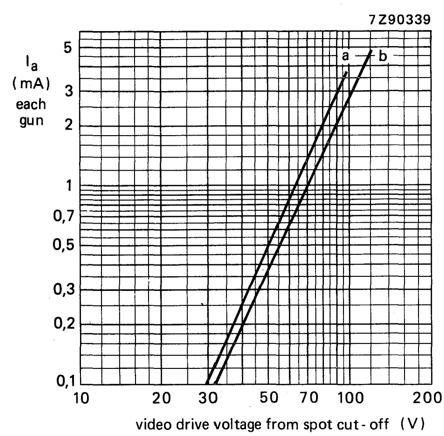


Fig. 16 Cathode heating time after switching on, measured under typical operating conditions.



V_f = 6,3 V;

$V_{a,g4}$ = 23 kV;

V_{g3} adjusted for focus;

V_{g2} (each gun) adjusted to provide spot cut-off for V_k = 100 V (curve a), and V_k = 125 V (curve b).

For optimum picture performance it is recommended that the cathodes are not driven below + 1 V.

Fig. 17 Typical cathode drive characteristics.

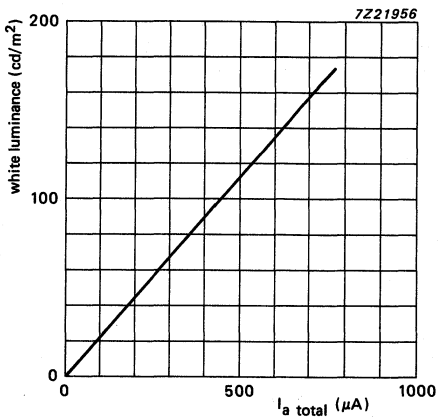


Fig. 18 Luminance at the centre of the screen as a function of I_{total}.

$V_{a,g4}$ = 23 kV.
Scanned area = 325,1 mm x 243,8 mm;
CIE co-ordinates x = 0,313, y = 0,329.

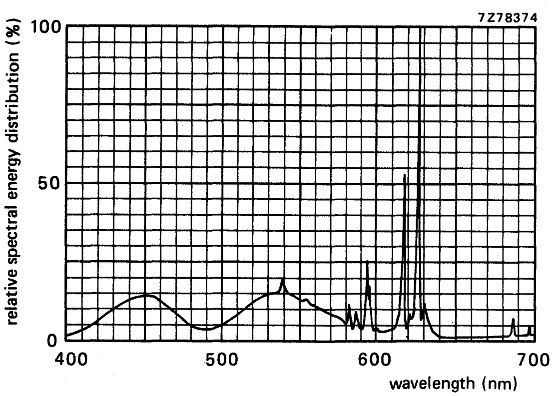


Fig. 19. Simultaneous excitation of red, green and blue phosphor, measured in a tube, to produce white of x = 0,313, y = 0,329. Exact shape of the peaks depends on the resolution of the measuring apparatus.

Colour co-ordinates:	x	y
red	0.620	0.340
green	0.305	0.600
blue	0.155	0.065

DEGAUSSING

The picture tube has an internal magnetic shield. This shield and the shadow mask with its suspension system may be provided with an automatic degaussing system, consisting of one magnetic coil winding mounted on the cone of the picture tube.

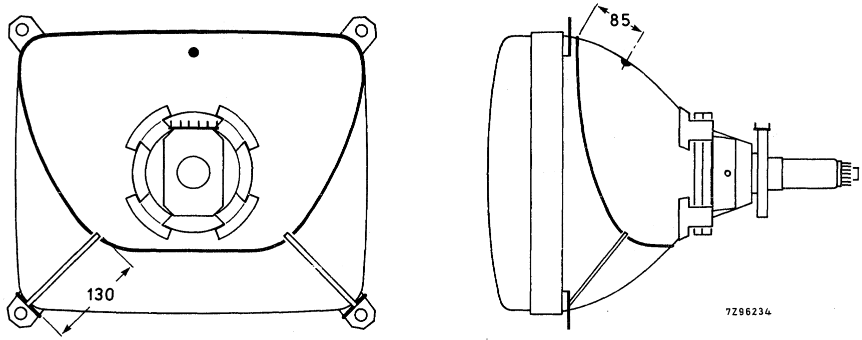


Fig. 20 Position of degaussing coil on the picture tube; dimensions are given in mm.

For proper degaussing an initial magnetomotive force (MMF) of 600 ampere-turns is required in the coil. This MMF has to be gradually decreased by appropriate degaussing circuitry. In the steady state, no significant MMF should remain in the coil (≤ 0,6 ampere-turns). If single-phase power rectification is employed in the TV circuitry, provision should be included to prevent asymmetric distortion of the AC voltage applied to the degaussing circuit due to high DC inrush currents. An example of a degaussing circuit and coil data for various mains voltages are given below.

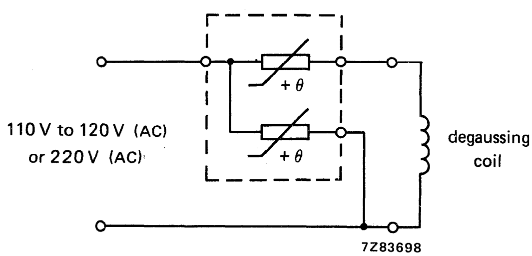


Fig. 21 Degaussing circuit using dual PTC thermistor.

Data of degaussing coil	110 V to 120 V (AC) mains	220 V (AC) mains
Circumference	113 cm	113 cm
Number of turns	70	120
Copper wire diameter	0,50 mm	0,36 mm
Resistance	6,8 Ω	23,5 Ω
Catalogue number of appropriate dual PTC thermistor	2322 662 98009	

90° FLAT SQUARE COLOUR PICTURE TUBE ASSEMBLY

- Factory preset tube/coil assembly
- Self-converging and raster correction free
- 41 cm, 90° colour picture tube A41EAM01X
- Hybrid saddle toroidal deflection unit of the AT6050/00

QUICK REFERENCE DATA

Deflection angle	90°	
Minimum useful screen diagonal	41	cm
Overall length	369	mm
Neck diameter	22,5	mm

MECHANICAL DATA

Dimensions in mm

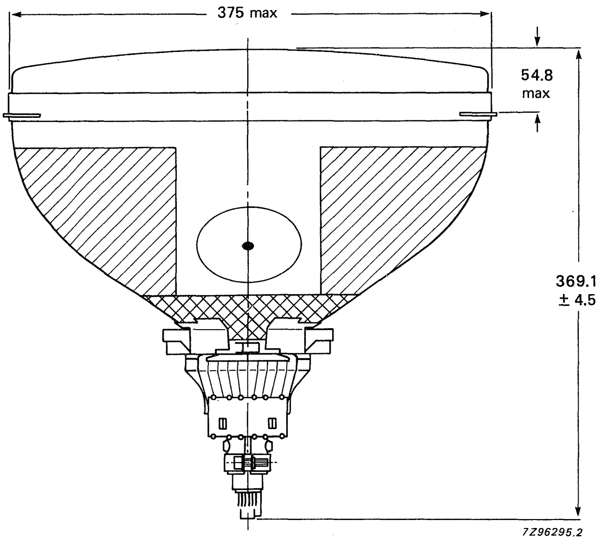


Fig.1 Colour picture tube assembly.

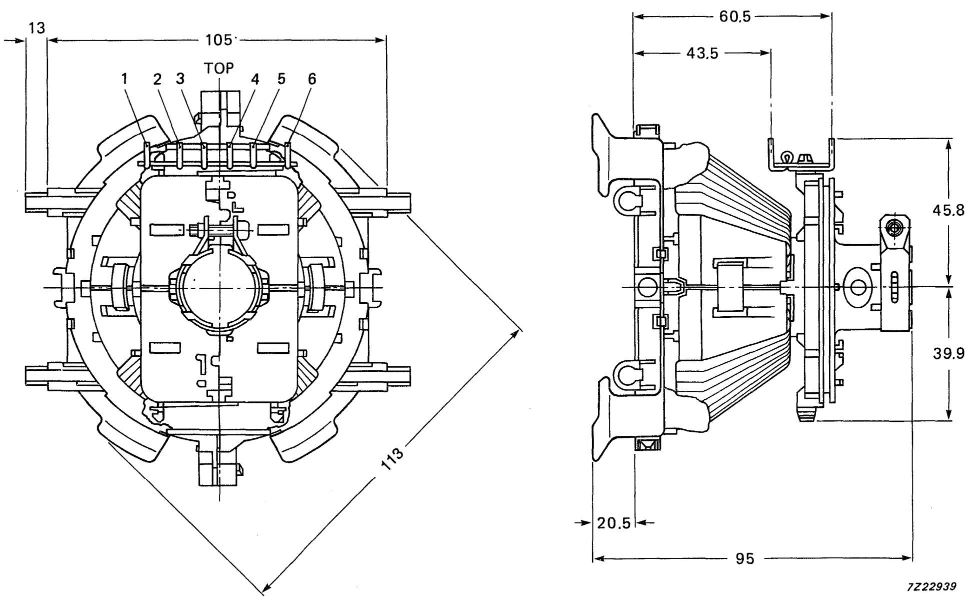


Fig.2 Deflection unit AT6050/00.

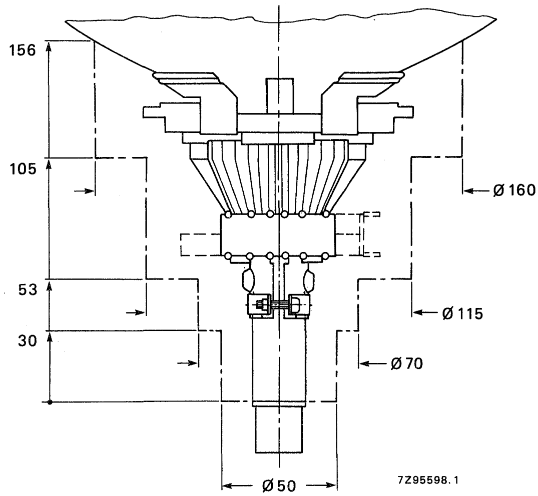


Fig.3 Yoke clearance.

Maximum operating temperature (average copper temperature measured with resistance method)	+ 90 °C
Storage temperature range	−25 to +90 °C
Flame retardent	according to UL 1413, category 94-V1
Torque on neck clamp screw	1,0 Nm

ENVIRONMENTAL TEST SPECIFICATIONS OF DEFLECTION UNITS

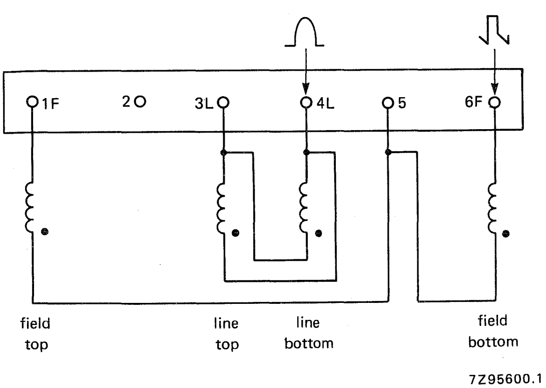
Vibration	IEC 68-2-6 (test Fc)
Shock	IEC 68-2-27 (test Ea)
Bump	IEC 68-2-29 (test Eb; 25g)
Cold	IEC 68-2-1 (test Ab)
Dry heat	IEC 68-2-2 (test Bb)
Damp heat, steady state	IEC 68-2-3 (test Ca)
Cyclic damp heat	IEC 68-2-30 (test Db)
Change of temperature	IEC 68-2-14 (test Nb)

ELECTRICAL DATA OF DEFLECTION UNIT

parameter	AT6050/00
Line deflection coils	
inductance at 1 V (RMS), 1 kHz	2,43 mH ± 4%
resistance at 25 °C	3,2 Ω ± 10%
magnetic flux	5,14 mWb ± 2,5%
Line deflection current	
edge to edge, at 25 kV	2,095 A(p-p)
Field deflection coils	
inductance at 1 V (RMS), 1 kHz	26,2 mH ± 10%
resistance at 25 °C	12,2 Ω ± 7%
Field deflection current,	
edge to edge, at 25 kV	0,82 A(p-p)
Cross-talk: voltage across the field coils when a voltage of 10 V, 15625 Hz is applied to the line coils	max. 0,2 V

Insulation resistance at 1 kV (DC)

between line and field coils	min. 500 MΩ
between line coil and core clamp	min. 500 MΩ
between field coil and core clamp	min. 10 MΩ



The beginning of the windings is indicated with ●.

Fig.4 Connection diagram.

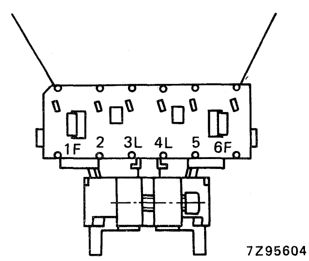


Fig.5 Terminal location.

FLAT AND SQUARE Hi-Bri COLOUR PICTURE TUBE

- Flat and square screen
- 110° deflection
- Shadow mask of NiFe alloy with low thermal expansion
- In-line, hi-bi potential A R T* gun with quadrupole cathode lens
- 29,1 mm neck diameter
- Mask with corner suspension
- Hi-Bri technology
- Pigmented phosphors
- Quick-heating low-power cathodes
- Soft-flash
- Slotted shadow mask optimized for minimum moiré at 625 lines systems
- Internal magnetic shield
- Internal multipole
- Reinforced envelope for push-through mounting
- Anti-crackle coating

QUICK REFERENCE DATA

Deflection angle	110°
Useful screen diagonal	51 cm
Overall length	36 cm
Neck diameter	29,1 mm
Heating	6,3 V, 310 mA
Anode voltage	25 kV
Focusing voltage	31% of anode voltage

* Aberration Reducing Triode.

ELECTRON-OPTICAL DATA

Electron gun system	unitized triple-aperture electrodes; aberration reducing triode
Focusing method	electrostatic
Focus lens	hi-bi-potential
Deflection method	magnetic
Deflection angles	
diagonal	110^{o}
horizontal	97^{o}
vertical	77^{o}

ELECTRICAL DATA

Capacitances				
anode to external conductive coating including rimband	$C_{a,g5,\,g4/m+m'}$	min.	1600	pF
anode to metal rimband	$C_{a,\,g5,\,g4/m'}$		250	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 3 (focusing electrode) to all other electrodes	C_{g3}		6	pF
grid 1 to all other electrodes	C_{g1}		17	pF
grid 2 to all other electrodes	C_{g2}		4,5	pF
Resistance between rimband and external conductive coating		min.	50	MΩ
Heating: indirect by AC (preferably mains or line frequency) or DC				
heater voltage	V_f		6,3	V
heater current	I_f		310	mA

OPTICAL DATA

Screen	metal-backed vertical phosphor stripes, phosphor lines follow glass contour
Screen finish	high gloss
Useful screen dimensions	
diagonal	511.8 mm
horizontal axis	415.6 mm
vertical axis	312.8 mm
area	1300 cm^2
Positional accuracy of the screen with respect to the glass contour	see Fig.1
Phosphors	
red	pigmented europium activated rare earth
green	sulphide type
blue	pigmented sulphide type
Persistence	medium short

A = 171.7 mm
B = 223.7 mm
C = 115.6 mm
D = 173.9 mm
E = 23.5 mm

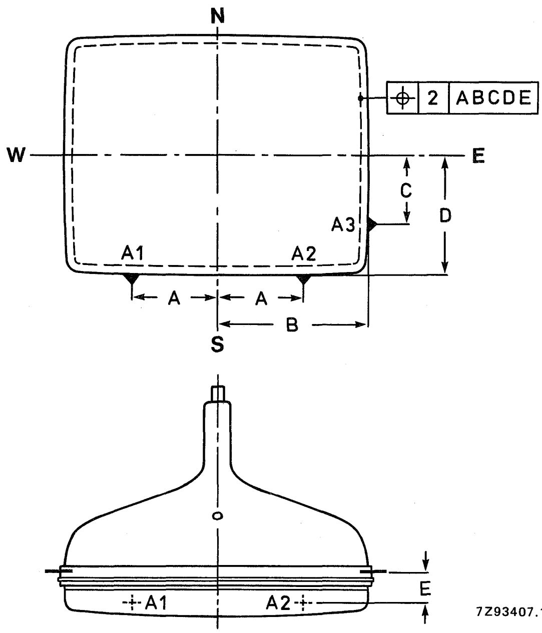


Fig. 1 Tube alignment.

DEVELOPMENT DATA

Colour co-ordinates	x	y
red	0.620	0.340
green	0.305	0.600
blue	0.155	0.065

Centre-to-centre distance of identical colour phosphor stripes	approx. 0.6 mm
Light transmission of face glass at screen centre	52%
Luminance at the centre of the screen	100 cd/m² *

MECHANICAL DATA (see Figs 2 to 9)

Overall length	362 ± 6 mm
Neck diameter	$29.1^{+1.4}_{-0.7}$ mm
Base	JEDEC B10-277
Anode contact	small cavity contact J1-21, IEC 67-III-2
Mounting position	anode contact on top
Net mass	approx. 15 kg

Handling

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

* Tube setting adjusted to produce white D (x = 0.313, y = 0.329), focused raster, current density 0,4 μA/cm².

MECHANICAL DATA (continued)

Dimensions in mm

Notes are given after the drawings.

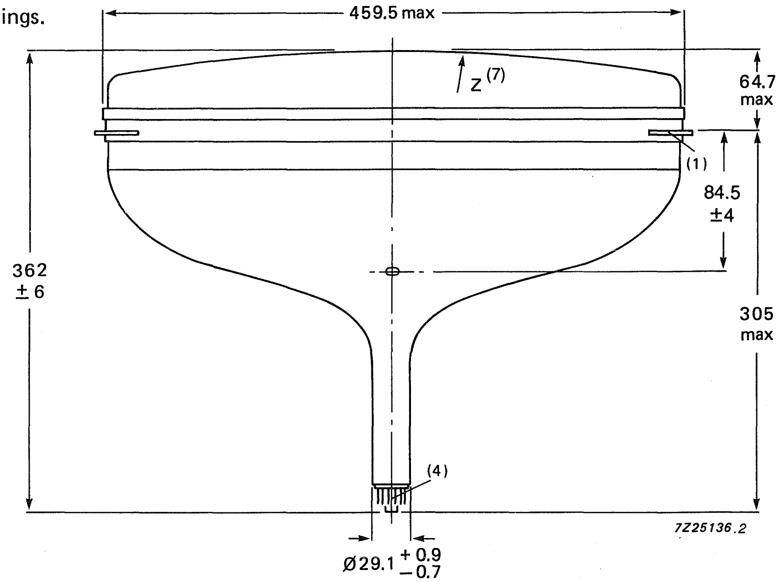


Fig. 2.

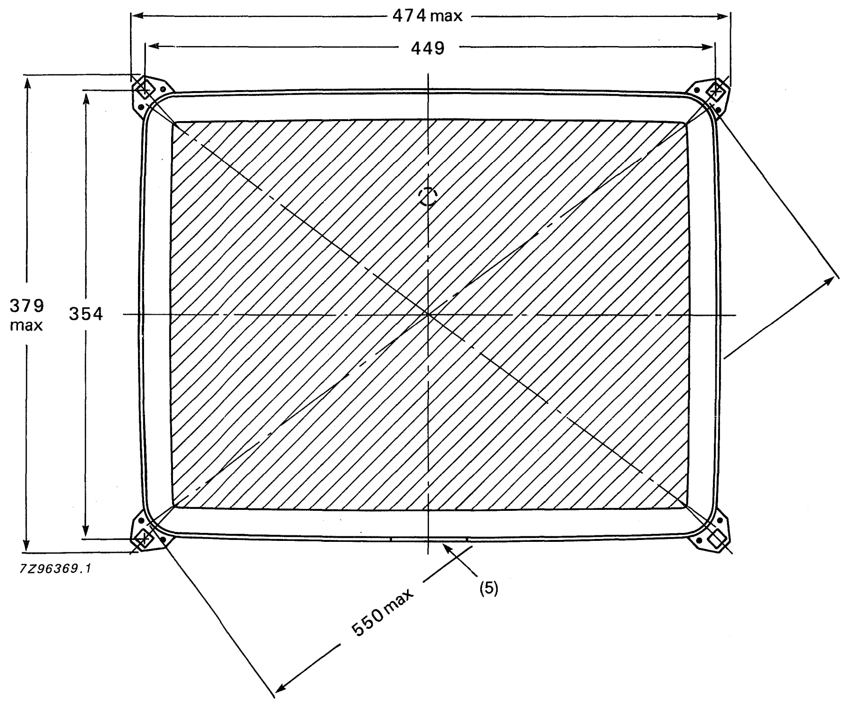


Fig. 3.

DEVELOPMENT DATA

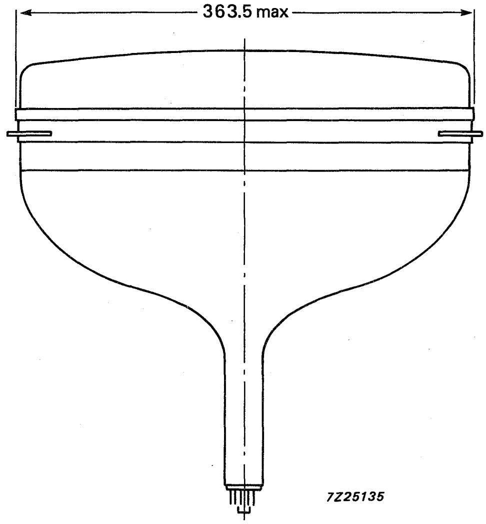


Fig. 4.

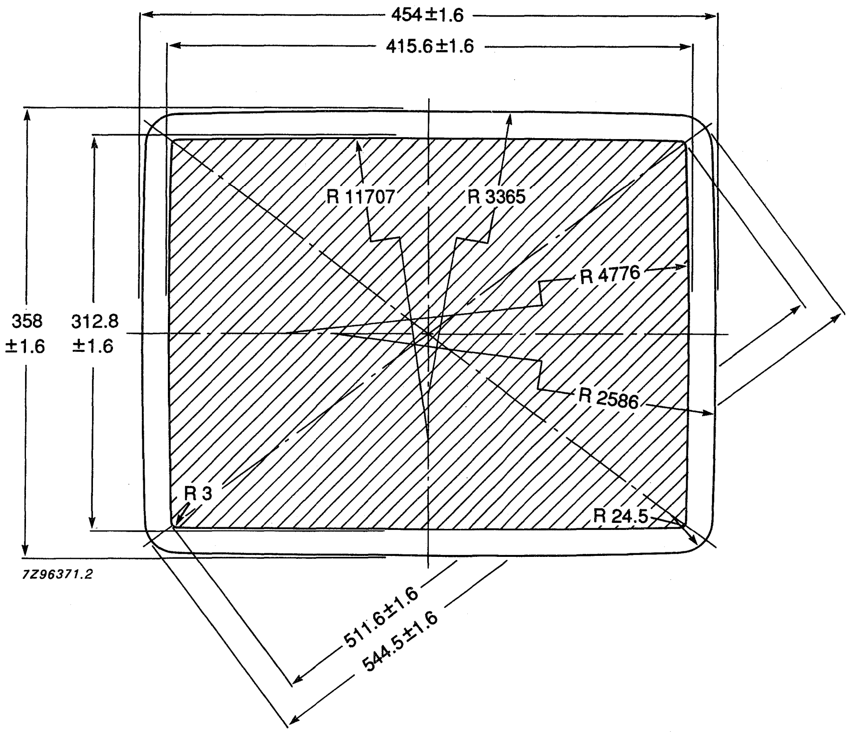


Fig. 5.

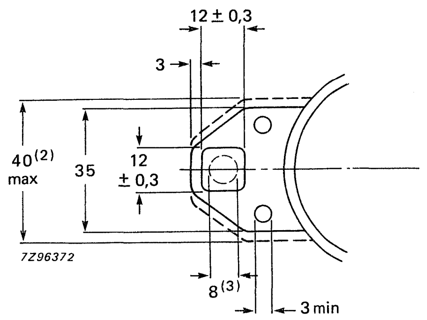


Fig. 6 Lug dimensions.

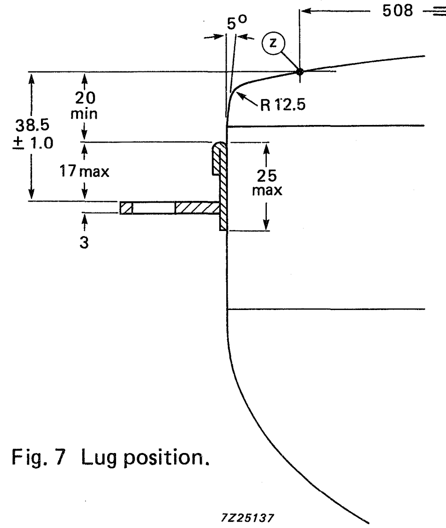


Fig. 7 Lug position.

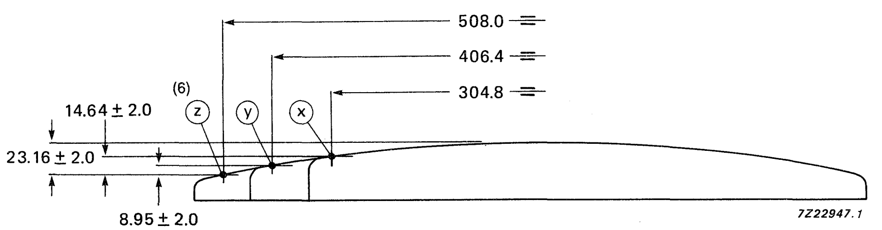


Fig. 8 Screen reference points.

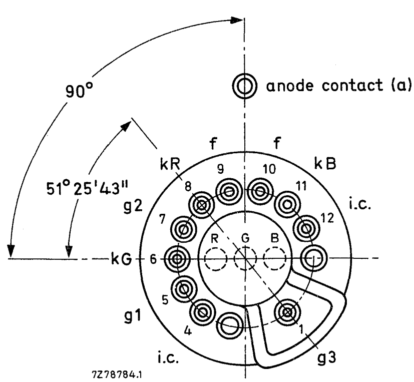


Fig. 9 Pin arrangement.

Notes to outline drawings on the preceding pages

1. The displacement of any lug with respect to the plane through the three other lugs is maximum 1.5 mm.
2. Minimum space to be reserved for mounting lug.
3. The position of the mounting screw in the cabinet must be within a circle of 8 mm diameter drawn around the true geometrical positions, i.e. the corners of a rectangle of 449 mm x 354 mm.
4. The socket for this base should not be rigidly mounted; it should have flexible leads and be allowed to move freely. After mounting of the tube in the cabinet note that the position of the base can fall within a circle, having a diameter of maximum 50 mm, concentric with an imaginary tube axis.
5. Location of fishplate.
6. Co-ordinates for point Z: x = 203.2, y = 152.4.
7. The distance Z from any point on the screen to the centre can be calculated using the following formula; (a number of points are given in Table 1):

A1 = 0.394323E-3 B1 = 1.98
A2 = 0.287534E-3 B2 = 2.05
A3 = −0.172431E-7 B3 = 1.37
A4 = 0.211206E-13 B4 = 2.11068
B5 = 3.9777
B6 = 2.05845

$$Z = A1 \times X^{B1} + A2 \times Y^{B2} + A3 \times X^{B3} \times Y^{B4} + A4 \times X^{B5} \times Y^{B6}$$

Table 1 Sagittal heights with reference to screen centre

	Nominal useful screen (NUS)			3 mm inside NUS			5 mm outside NUS		
	co-ordinates x mm	y mm	sagittal height mm	co-ordinates x mm	y mm	sagittal height mm	co-ordinates x mm	y mm	sagittal height mm
(1)	0	156.4	9.0	0	153.4	8.7	0	161.4	9.6
	20	156.3	9.2	20	153.3	8.8	20	161.3	9.8
	40	156.3	9.5	40	153.3	9.2	40	161.3	10.1
	60	156.2	10.1	60	153.2	9.8	60	161.2	10.7
	80	156.1	11.0	80	153.1	10.7	80	161.1	11.6
	100	155.9	12.2	100	152.9	11.9	100	160.9	12.8
	120	155.8	13.8	120	152.8	13.4	120	160.8	14.3
	140	155.5	15.6	140	152.5	15.2	140	160.5	16.1
	160	155.3	17.7	160	152.2	17.3	160	160.3	18.2
	180	155.0	20.2	180	152.0	19.8	180	156.0	20.7
	200	154.7	23.0	190	151.8	21.2	200	159.7	23.6
	202.4	154.6	23.4	200	151.7	22.6	210	159.5	25.1
(2)	204.8	153.4	23.6	202.4	151.6	23.0	210.1	159.5	25.2
	205.4	151.7	23.5	202.4	150	22.8	210.3	155	24.6
	205.7	140	22.2	202.7	140	21.8	210.7	140	23.0
	206.3	120	20.4	203.3	120	19.9	211.3	120	21.1
	206.8	100	18.8	203.8	100	18.3	211.8	100	19.6
	207.1	80	17.5	204.1	80	17.1	212.1	80	18.3
	207.4	60	16.5	204.4	60	16.1	212.4	60	17.3
	207.6	40	15.8	204.6	40	15.4	212.6	40	16.6
	207.8	20	15.4	204.8	20	15.0	212.8	20	16.2
(3)	207.8	0	15.3	204.8	0	14.9	212.8	0	16.0

(1) End of short axis. (2) End of diagonal axis. (3) End of long axis.

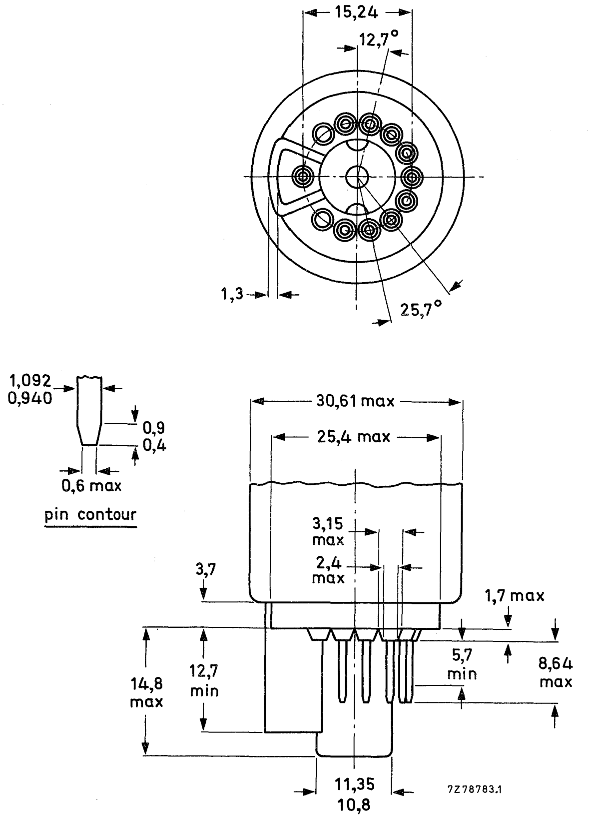


Fig. 10 10-pin base; JEDEC B10-277.

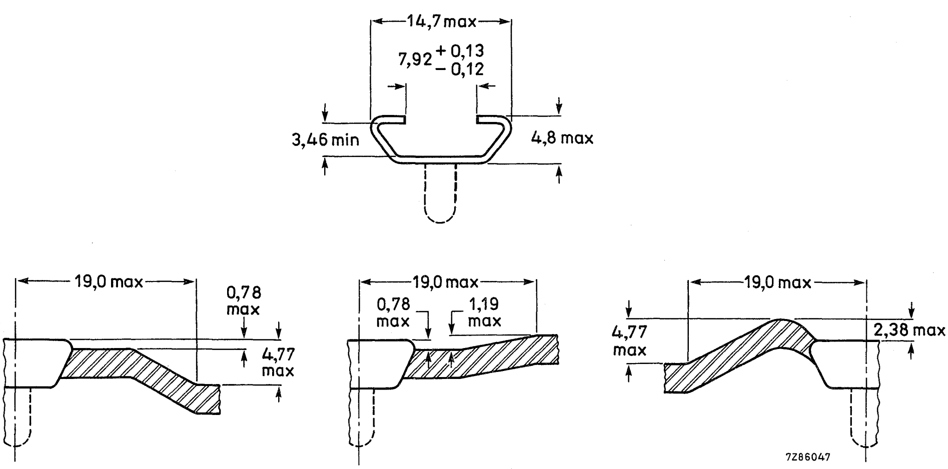


Fig. 11 Cavity cap JEDEC J1-21, IEC 67-III-2.

DEVELOPMENT DATA

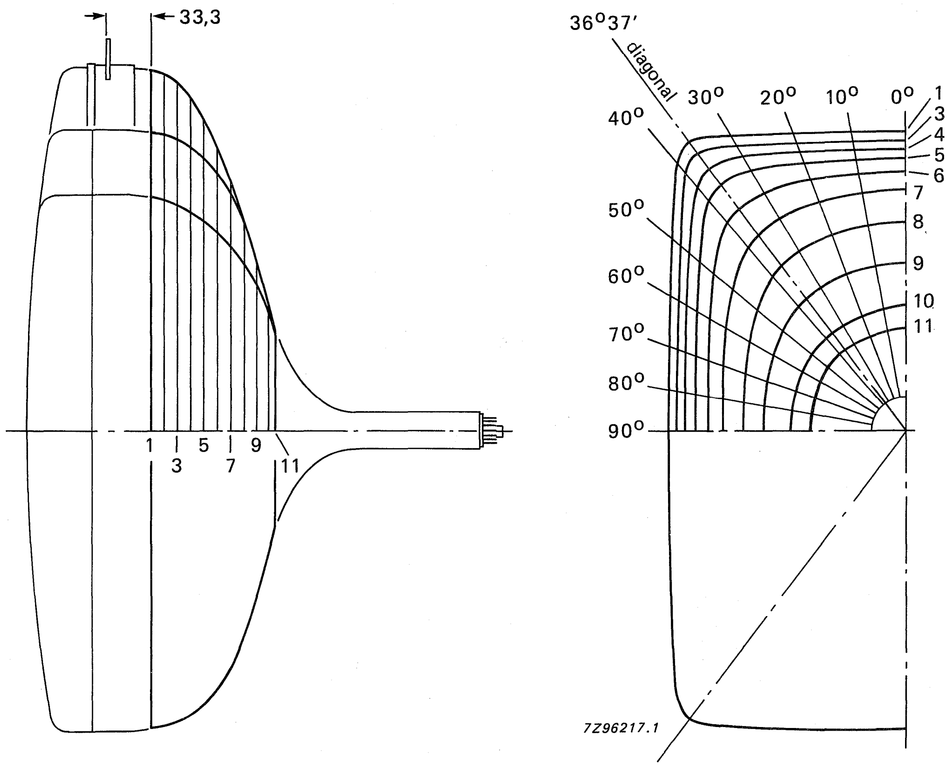


Fig. 12 Maximum cone contour.

Table 2 Cone contour data

section	nom. distance from section 1	distance from centre										
		0°	10°	20°	30°	36,87°	40°	50°	60°	70°	80°	90°
1	0.00	225.8	229.0	239.2	257.7	272.0	267.4	228.1	203.2	188.0	179.7	177.1
2	10.00	224.2	227.4	237.5	255.9	270.0	264.8	226.3	201.7	186.6	178.4	175.8
3	20.00	220.0	223.2	233.1	250.9	263.1	257.1	220.7	196.8	182.1	174.1	171.5
4	30.00	214.0	217.0	226.4	242.8	252.1	246.3	212.9	190.2	176.2	168.5	166.1
5	40.00	206.4	209.2	217.5	231.1	235.3	230.1	202.1	181.4	168.4	161.3	159.0
6	50.00	196.7	198.9	205.4	212.9	211.5	207.4	187.2	169.7	158.2	151.8	149.8
7	60.00	182.2	183.8	187.5	189.1	185.3	182.1	167.9	154.3	144.7	139.2	137.4
8	70.00	158.0	159.1	161.0	160.7	157.7	155.4	146.0	136.2	128.7	124.2	122.7
9	80.00	127.9	128.6	129.8	129.6	128.0	126.8	121.6	115.6	110.4	107.0	105.8
10	90.00	95.2	95.4	95.6	95.1	94.3	93.9	92.0	89.7	87.6	86.0	85.4
11	94.6	75.9	75.8	75.7	75.4	75.1	75.0	74.6	74.2	73.8	73.6	73.5

TYPICAL OPERATING CONDITIONS

The voltages are specified with respect to grid 1.

Anode voltage	$V_{a,g4}$	25 kV
Grid 3 (focusing electrode) voltage	V_{g3}	7.25 to 8.25 kV
Grid 2 voltage for a spot cut-off voltage V_k = 130 V	V_{g2}	see Fig. 13
Heater voltage under operating conditions	V_f	6.3 V

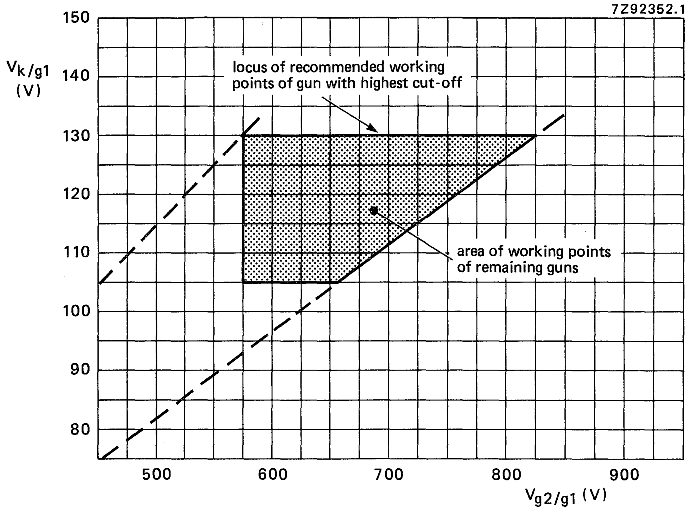


Fig. 13 Spot cut-off design chart.

Grid 2 voltage (V_{g2}) adjusted for highest gun spot cut-off voltage V_k = 130 V.

Remaining guns adjusted for spot cut-off by means of cathode voltage

V_{g2} range 575 to 825 V;

V_k range 105 to 130 V.

Adjustment procedure:

Set the cathode voltage (V_k) for each gun at 130 V; increase the grid 2 voltage (V_{g2}) from approximately 550 V to the value at which one of the colours become just visible. Now decrease the cathode voltage of the remaining guns so that the other colours also become visible.

EQUIPMENT DESIGN VALUES

The values are valid for anode voltages between 20 and 27,5 kV.
The voltages are specified with respect to grid 1.

Grid 3 (focusing electrode) voltage	V_{g3}	29 to 33% of anode voltage
Grid 2 voltage and cathode voltage for visual extinction of focused spot	V_{g2} and V_k	see Fig. 13
Difference in cut-off voltages between guns in any tube	ΔV_k	lowest value > 80% of highest value
Heater voltage	V_f	6.3 V at zero beam current
Video drive characteristics		see Fig. 14*
Grid 3 (focusing electrode) current	I_{g3}	−2 to + 2 μA
Grid 2 current	I_{g2}	−2 to + 2 μA
Grid 1 current under cut-off conditions	I_{g1}	−2 to + 2 μA

To produce white of 6500K + 7 M.P.C.D.
(CIE co-ordinates x = 0,313, y = 0,329)

Percentage of the total anode current supplied by each gun (typical)

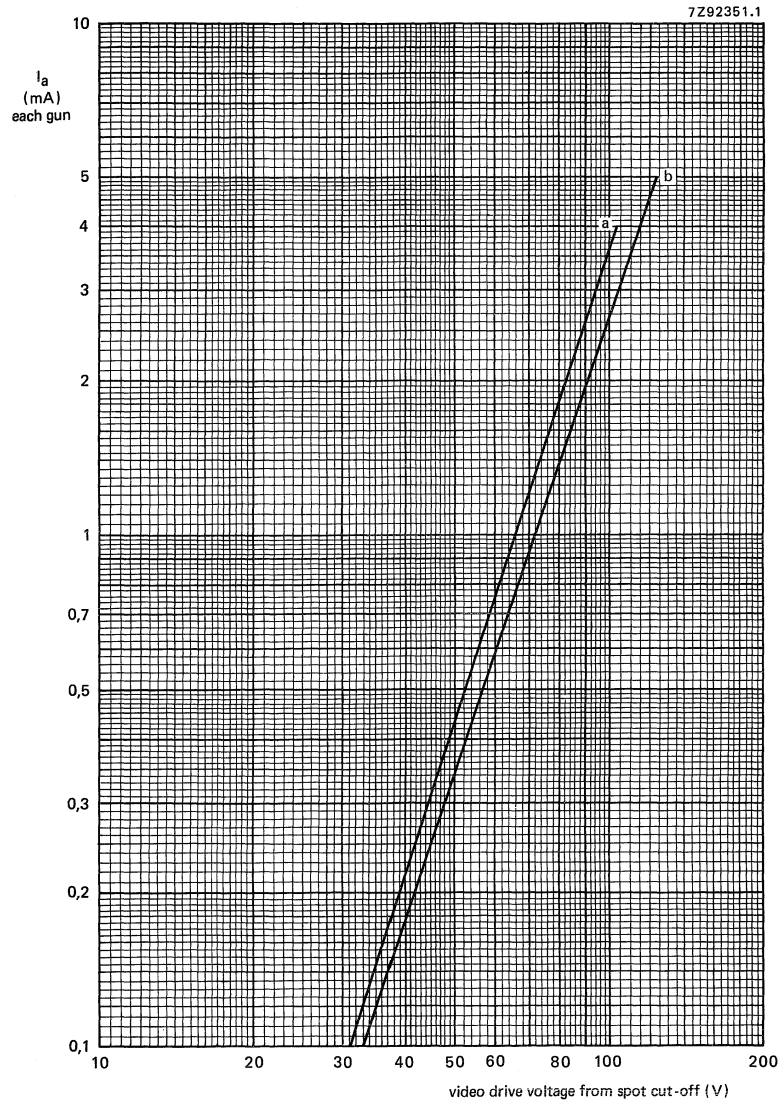
red gun	40.5%
green gun	32.4%
blue gun	27.1%

Ratio of anode currents

red gun to green gun	min.	0.90
	average	1.25
	max.	1.60
red gun to blue gun	min.	1.10
	average	1.50
	max.	1.90
blue gun to green gun	min.	0.60
	average	0.85
	max.	1.20

Insulation resistance between each cathode and grid 1 and heater	min.	50 MΩ

* For optimum picture performance it is recommended that the cathodes are not driven below + 1 V.



V_f = 6.3 V;

$V_{a,g4}$ = 25 kV;

V_{g3} adjusted for focus;

V_{g2} (each gun) adjusted to provide spot cut-off for V_k = 105 V (curve a) and V_k = 130 V (curve b).

Fig. 14 Typical cathode drive characteristics.

DEVELOPMENT DATA

LIMITING VALUES (Design maximum rating system unless otherwise stated)

The voltages are specified with respect to grid 1.

				notes
Anode voltage	$V_{a,g4}$	max.	29.5 kV	1, 2, Fig.15
		min.	20 kV	1, 3
Long-term average current for three guns	I_a	max.	1000 μA	4
Grid 3 (focusing electrode) voltage	V_{g3}	max.	12 kV	
Grid 2 voltage	V_{g2}	max.	1200 V	5
Cathode voltage				
positive	V_k	max.	400 V	
positive operating cut-off	V_k	max.	200 V	
negative	$-V_k$	max.	0 V	
negative peak	$-V_{kp}$	max.	2 V	
Cathode to heater voltage				
positive	V_{kf}	max.	250 V	
positive peak	V_{kfp}	max.	300 V	1
negative	$-V_{kf}$	max.	135 V	
negative peak	$-V_{kfp}$	max.	180 V	1
Heater voltage	V_f		6.3 V $^{+5}_{-10}$ %	1, 6

LIMITING CIRCUIT VALUES

Grid 3 circuit resistance	R_{g3}	max.	70 MΩ
Grid 1 to cathode circuit resistance (each gun)	R_{g1k}	max.	0.75 MΩ

BEAM CENTRING

Maximum centring error in any direction 3 mm

Notes

1. Absolute maximum rating system.
2. 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.
3. Operating of the tube at lower voltages impairs the luminance and resolution, and could impair convergence.
4. The short-term average anode current should be limited by circuitry to 1500 μA.
5. During adjustment on the production line max. 1500 V is permitted.
6. For maximum cathode life it is recommended that the heater supply be designed for 6,3 V at zero beam current.

The colour picture tube does not emit X-radiation above 1 μSv/h when operated at 29.5 kV and 1 mA. The X-radiation emitted will also not exceed 1 μSv/h for anode voltage and current combinations given by the isoexposure-rate limit curve shown in Fig. 15.

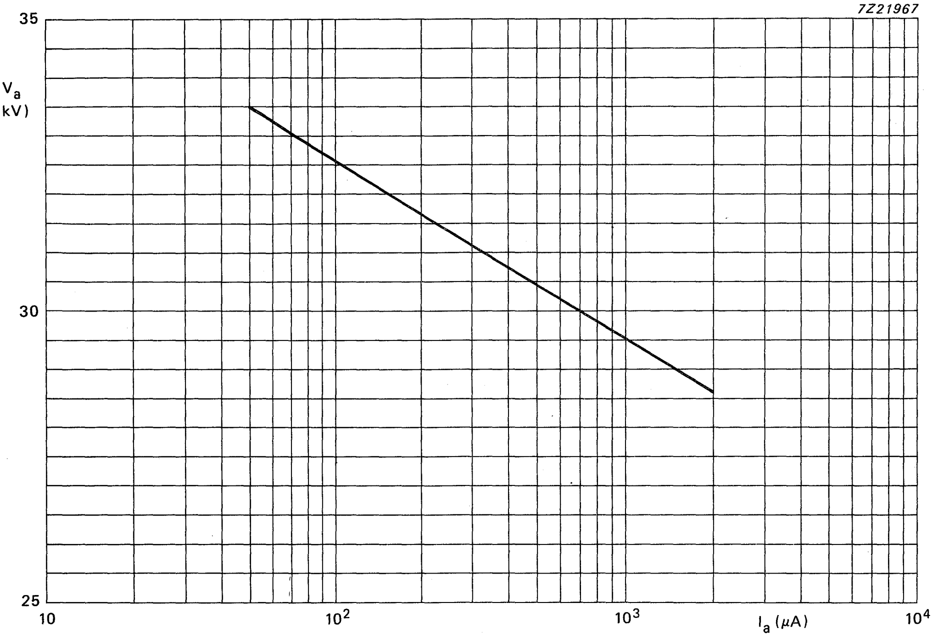


Fig. 15 1 μSv/h isoexposure-rate limit curve.

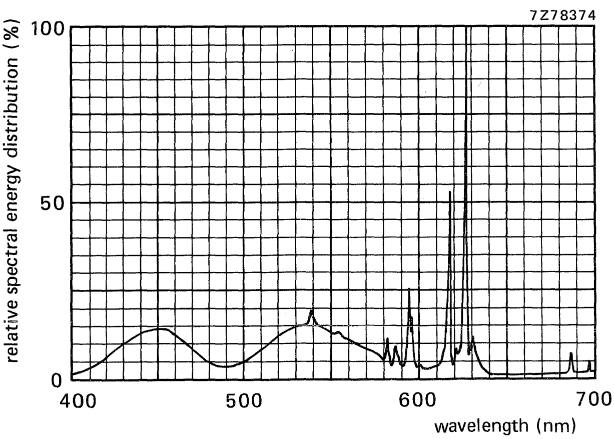


Fig. 16 Simultaneously excitation of red, green and blue phosphor, measured in a tube, to produce white of x = 0.313, y = 0.329. Exact shape of the peaks depends on the resolution of the measuring apparatus.

Colour co-ordinates:	x	y
red	0.620	0.340
green	0.305	0.600
blue	0.155	0.065

DEGAUSSING

The picture tube is provided with an internal magnetic shield. This shield and the shadow mask with its suspension system may be provided with an automatic degaussing system, consisting of one magnetic coil winding mounted on the cone of the picture tube.

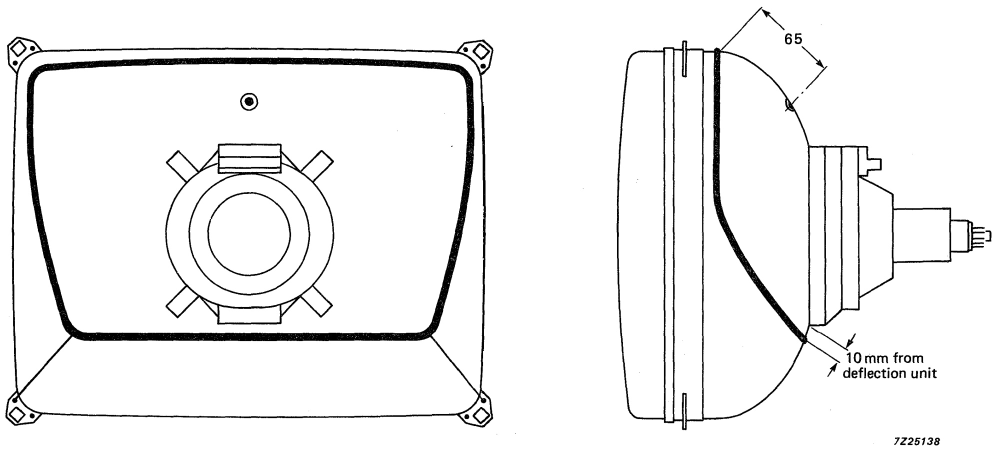


Fig. 17 Position of degaussing coil on the picture tube.

For proper degaussing, an initial magnetomotive force (MMF) of 700 ampere turns is required in the coil. This MMF has to be gradually decreased by appropriate degaussing circuitry. In the steady state, no sifnificant MMF should remain in the coil (⩽ 0.35 ampere-turns). If single-phase power rectification is employed in the TV circuitry, provision should be included to prevent asymmetric distortion of the AC voltage applied to the degaussing circuit due to high DC inrush currents.

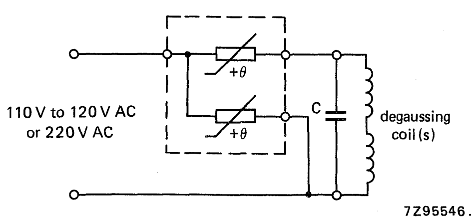


Fig. 18 Degaussing circuit using dual PTC thermistor.

Data of degaussing coil

	single-coil system
Circumference	139 cm
Number of turns	140
Copper wire diameter	0.4 mm
Aluminium wire diameter	0.5 mm
Resistance	27 Ω
Catalogue number of appropriate dual PTC thermistor	2322 662 98009

110° FLAT SQUARE COLOUR PICTURE TUBE ASSEMBLY

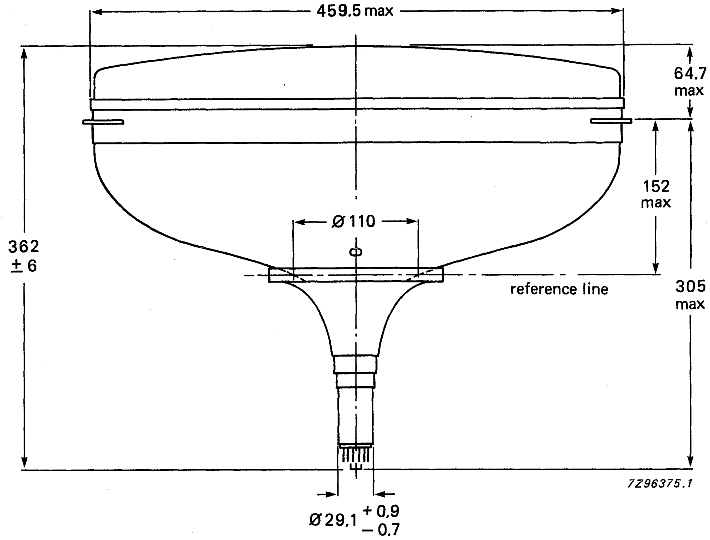
- Factory preset tube/coil assembly
- Self-converging and north-south raster correction free
- 51 cm, 110° colour picture tube A51EAK01X
- Double saddle deflection unit AT6020

QUICK REFERENCE DATA

Deflection angle	110°
Minimum useful screen diagonal	51 cm
Overall length	36 cm
Neck diameter	29,1 mm

MECHANICAL DATA

Dimensions in mm



Net mass of tube assembly: 16 kg

Fig. 1 Tube assembly.

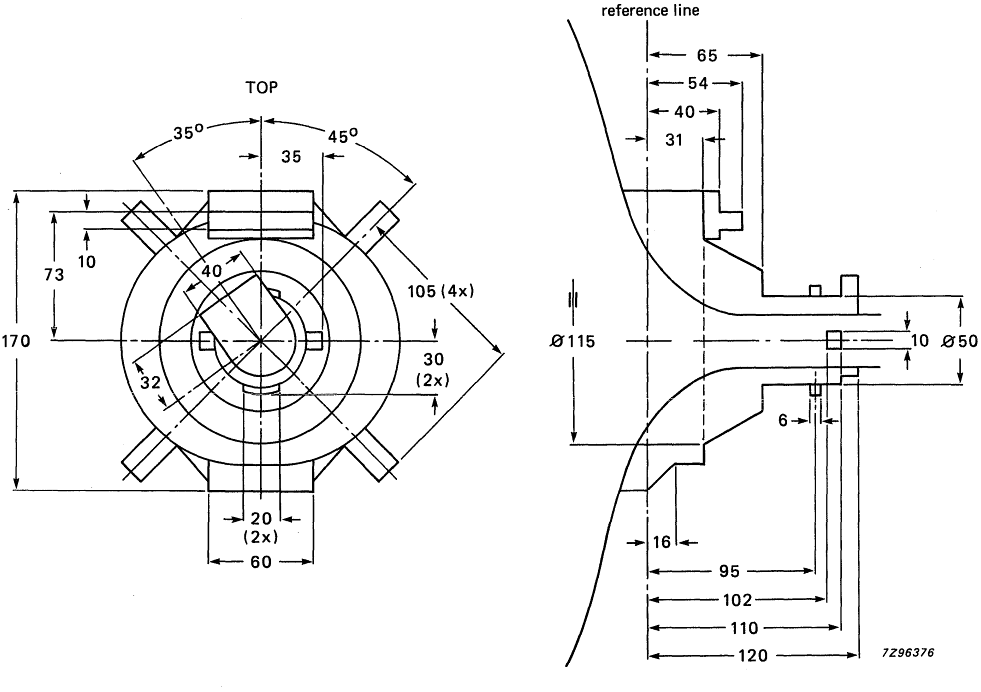


Fig. 2 Yoke clearance.

DEVELOPMENT DATA

ELECTRICAL DATA OF DEFLECTION UNIT

Line coils	parallel connected
Inductance at 1 V (rms), 1 kHz	2.03 mH
Resistance at 25 °C	2.0 Ω
Magnetic flux	7.9 mWb ± 5%
Line deflection current, edge to edge, at 25 kV	3.88 A (p-p)
Field coils	series connected
Inductance at 1 V (rms), 1 kHz	11.7 mH
Resistance at 25 °C	6.0 Ω
Field deflection current, edge to edge, at 25 kV	1.77 A (p-p)

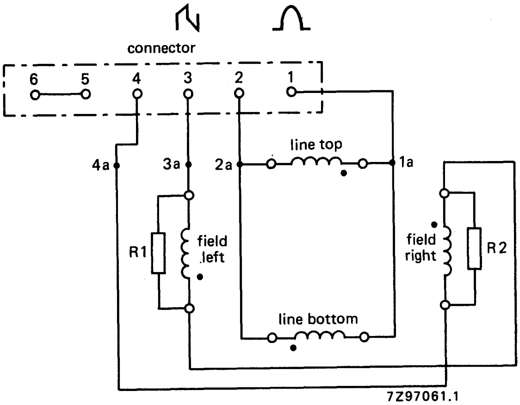


Fig. 3 Electrical diagram

The beginning of the windings is indicated with ●.
R1 = R2 = 100 Ω, 0.25 W.
Matching Stocko connector MKF 2806-1-0-606.

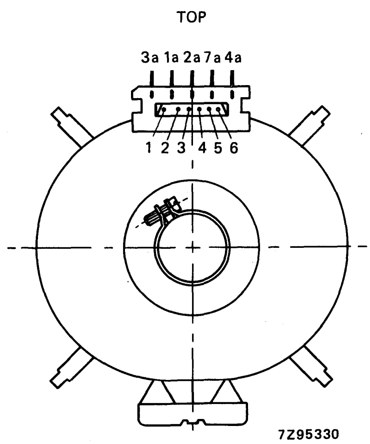


Fig. 4 Terminal location.

FLAT AND SQUARE Hi-Bri COLOUR PICTURE TUBE

- Flat and square screen
- 90° deflection
- In-line, hi-bi potential A R T* gun
- 29.1 mm neck diameter
- Mask with corner suspension
- Hi-Bri technology
- Pigmented phosphors
- Quick-heating low-power cathodes
- Soft flash
- Slotted shadow mask optimized for minimum moiré at 625 lines system
- Internal magnetic shield
- Internal multipole
- Reinforced envelope for push-through mounting
- The tube is supplied with a matched hybrid saddle toroidal deflection unit of the AT6035 series; it forms a self-converging and raster correction free assembly

QUICK REFERENCE DATA

Deflection angle	90°
Minimum useful screen diagonal	51 cm
Overall length	444 mm
Neck diameter	29.1 mm
Heating	6.3 V, 310 mA
Anode voltage	25 kV
Focusing voltage	31% of anode voltage

* Aberration Reducing Triode.

ELECTRON-OPTICAL DATA

Electron gun system		unitized triple-aperture electrodes; aberration reducing triode
Focusing method		electrostatic
Focus lens		hi-bi potential
Deflection method		magnetic
Deflection angles		
diagonal		approx. 90°
horizontal		approx. 78°
vertical		approx. 60°

ELECTRICAL DATA

capacitances		
anode to external conductive coating including rimband	$C_a(m + m')$	> 1600 pF
grid 1 to all other electrodes	C_{g1}	17 pF
cathode of each gun to all other electrodes	C_{kR}, C_{kG}, C_{kB}	5 pF
focusing electrode to all other electrodes	C_{g3}	6 pF
Heating		indirect by AC or DC
heater voltage	V_f	6,3 V
heater current	I_f	310 mA

OPTICAL DATA

Screen		metal-backed vertical phosphor stripes; phosphor lines follow glass contour
Screen finish		high gloss
Useful screen dimensions		
diagonal		min. 508,0 mm
horizontal axis		min. 411,4 mm
vertical axis		min. 310,8 mm
area		min. 1265 cm²
Positional accuracy of the screen with respect to the glass contour		see Fig.1
Phosphors		
red		pigmented europium activated rare earth
green		sulphide type
blue		pigmented sulphide type
Centre-to-centre distance of vertical identical colour phosphor stripes, at screen centre		approx. 0,75 mm
Light transmission of face glass at centre		52%
Luminance at the centre of the screen	L	100 cd/m² *

* Tube settings adjusted to produce white D (x = 0,313, y = 0,329), focused raster, current density 0,4 μA/cm².

A = 171,7 mm
B = 223,7 mm
C = 115,6 mm
D = 173,9 mm
E = 23,5 mm

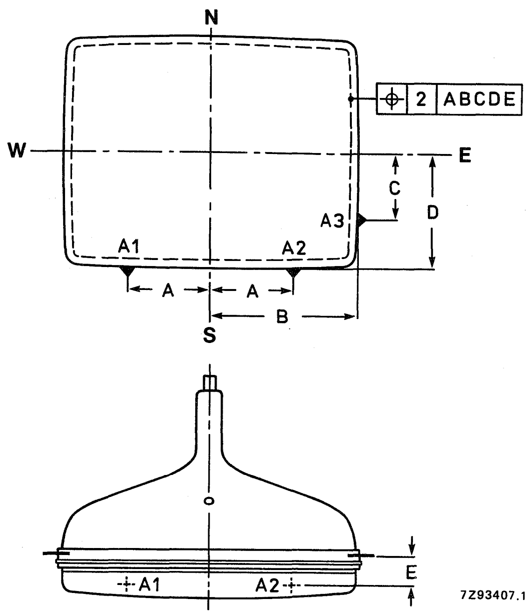


Fig. 1 Tube alignment.

MECHANICAL DATA (see also Figs 2 to 10)

Overall length	443,7 ± 6 mm
Neck diameter	$29,1\ ^{+1,4}_{-0,7}$ mm*
Bulb dimensions	
diagonal	max. 546,1 mm
width	max. 455,6 mm
height	max. 359,6 mm
Base	JEDEC B10-277
Anode contact	small cavity contact J1-21, IEC 67-III-2
Mounting position	anode contact on top

Handling

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

* In the region of 78,5 mm from the neck end, the maximum diameter is 30 mm.

MECHANICAL DATA (continued)

Dimensions in mm

Notes are given after the drawings

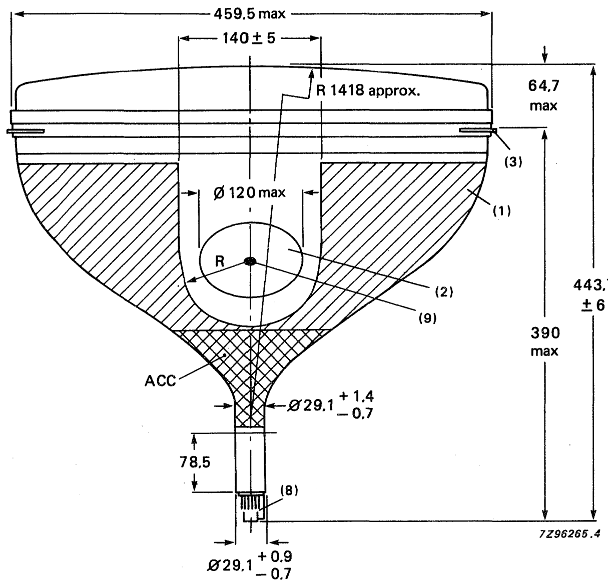


Fig. 2.

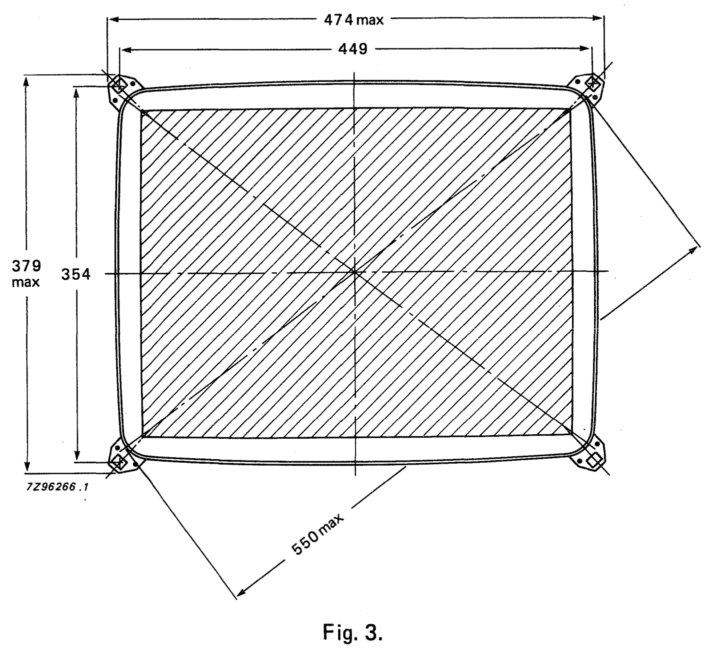


Fig. 3.

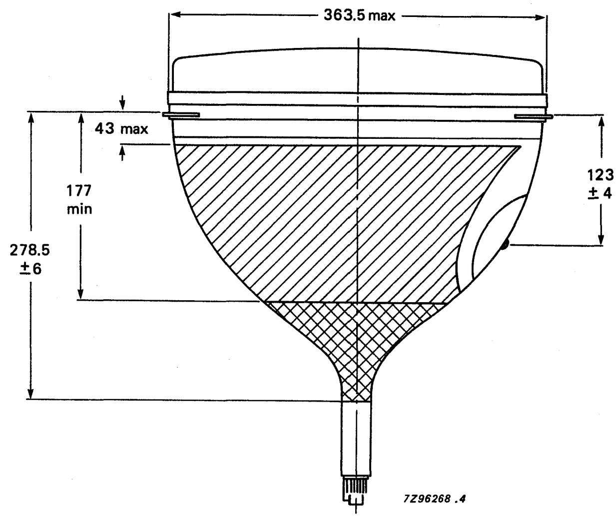

363.5 max
43 max
177
min
278.5
±6
123
± 4
7Z96268 .4

Fig. 4.

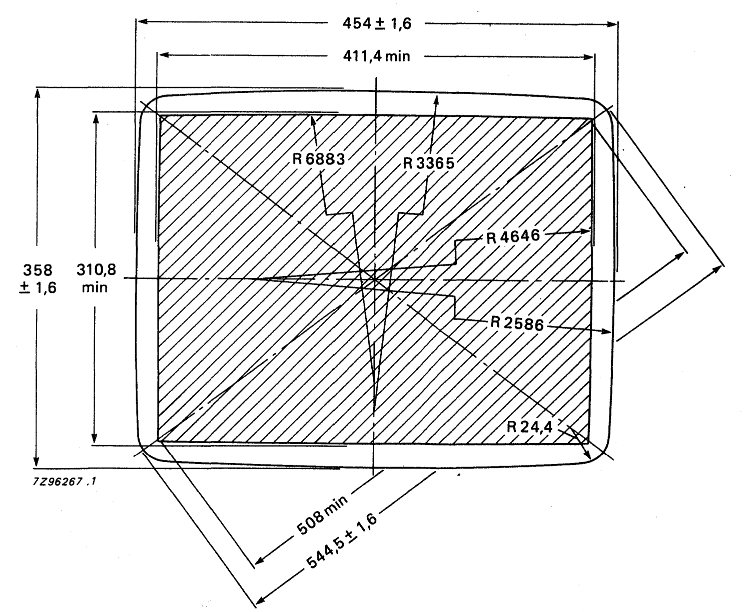

454 ± 1,6
411,4 min
R 6883
R 3365
R 4646
R 2586
R 24,4
358
± 1,6
310,8
min
508 min
544,5 ± 1,6
7Z96267 .1

Fig. 5.

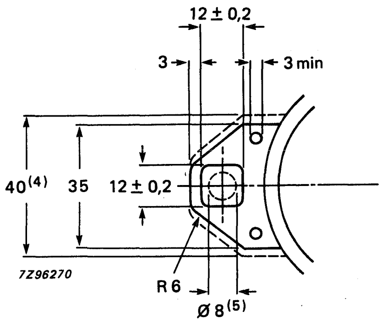


Fig. 6 Lug dimensions.

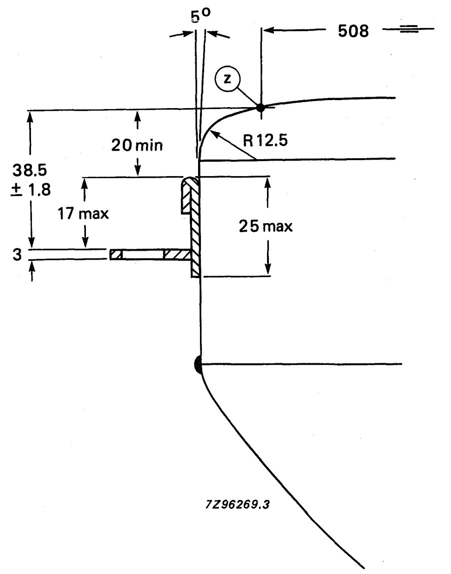


Fig. 7 Lug position.

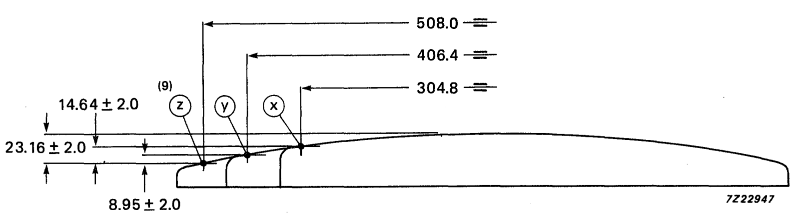


Fig. 8 Screen reference points.

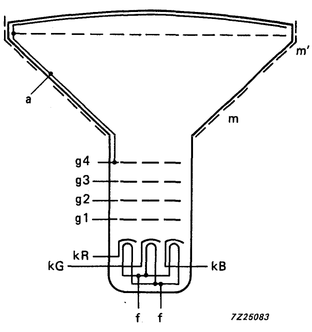


Fig. 9 Electrode configuration.

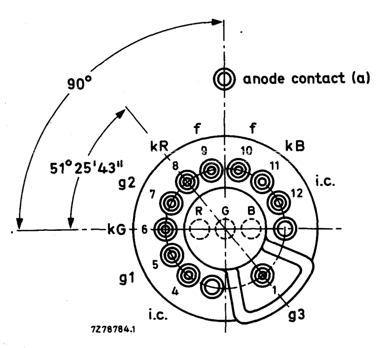


Fig. 10 Pin arrangement.

i.c. = internally connected (not to be used)

Notes to outline drawings

1. Configuration of outer conductive coating may be different but will contain the contact area as shown in the drawing.
2. To clean this area, wipe only with a soft lintless cloth.
3. The displacement of any lug with respect to the plane through the three other lugs is max. 1,3 mm. This deviation is incorporated in the tolerance of ± 1,8 mm.
4. Minimum space to be reserved for mounting lug.
5. The position of the mounting screw in the cabinet must be within a circle of 8 mm diameter drawn around the true geometrical positions, i.e. the corners of a rectangle of 354 x 449 mm.
6. Not applicable.
7. Not applicable.
8. The socket for this base should not be rigidly mounted; it should have flexible leads and be allowed to move freely. After mounting of the tube in the cabinet note that the position of the base can fall within a circle, having a diameter of max. 50 mm (1,968 in), concentric with an imaginary tube axis.
9. Small cavity contact J1-21, IEC 67-III-2.

Table 1 Sagittal heights with reference to screen centre at the edge of the minimum useful screen

coordinates x mm	coordinates y mm	sagittal height mm
0*	155,4	9,0
20	155,4	9,1
40	155,3	9,4
60	155,1	10,1
80	154,9	11,0
100	154,7	12,2
120	154,4	13,7
140	153,9	15,4
160	153,5	17,5
180	153,0	19,9
200	152,5	22,7
203,2**	152,4	23,2
203,3	150	22,9
203,6	140	21,8
204,2	120	19,9
204,6	100	18,4
205,0	80	17,2
205,3	60	16,3
205,5	40	15,6
205,7	20	15,8
205,7▲	0	15,0

* Point (x).
** Diagonal.
▲ Point (y).

10-pin base; JEDEC B10-277

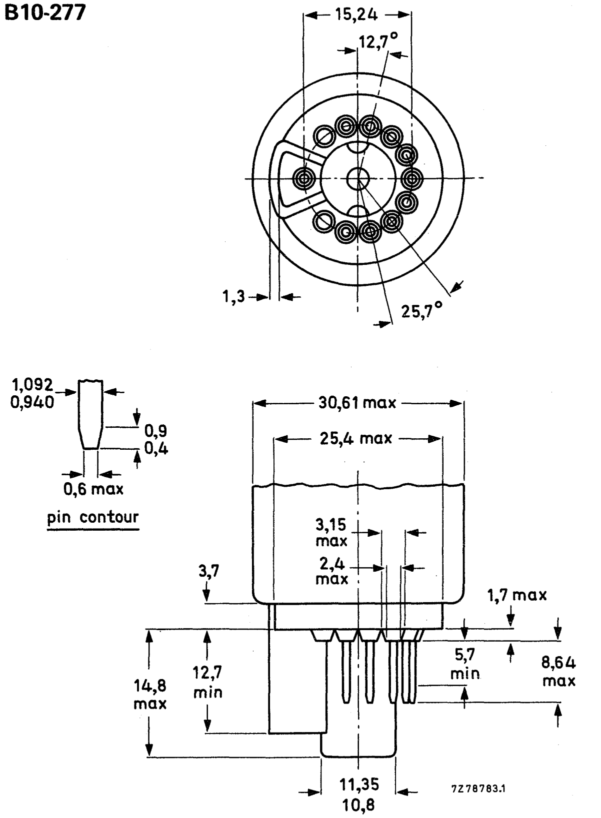


Fig.11 JEDEC base.

Cavity cap JEDEC J1-21, IEC 67-III-2

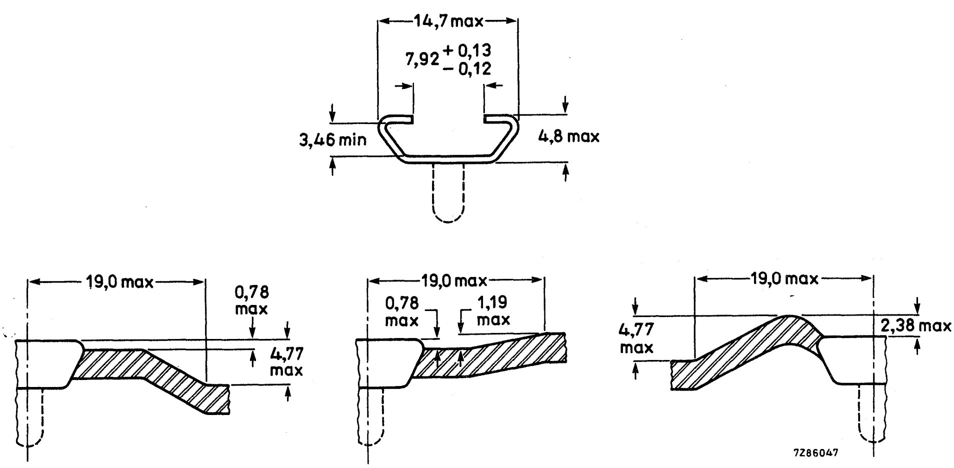


Fig.12 Cavity cap.

Maximum cone contour

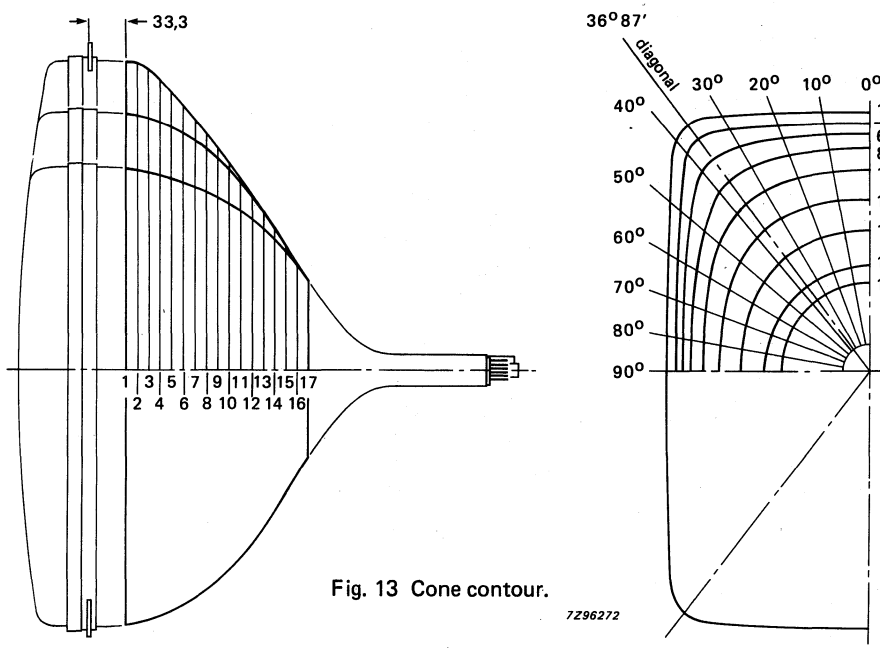


Fig. 13 Cone contour.

Table 2 Cone contour data

Dimensions in mm

section	nom. distance from section 1	max. distance from centre										
		0°	10°	20°	30°	diag.	40°	50°	60°	70°	80°	90°
1	0	225,7	228,9	239,1	257,6	271,8	267,2	227,9	203,1	187,9	179,6	177,0
2	10	224,6	227,7	237,7	255,9	270,0	265,3	226,7	201,9	186,8	178,6	175,9
3	20	221,8	224,8	234,3	251,1	264,3	259,6	222,9	198,9	184,2	176,1	173,5
4	30	218,1	220,9	229,6	244,5	254,7	250,6	217,9	195,1	180,9	173,1	170,6
5	40	213,8	216,4	224,1	236,5	243,1	239,6	212,0	190,9	177,3	169,9	167,5
6	50	208,7	211,0	217,7	227,5	231,3	228,4	205,6	186,3	173,6	166,5	164,2
7	60	202,6	204,5	210,0	217,5	219,5	217,0	198,5	181,0	169,3	162,6	160,5
8	70	195,1	196,8	201,3	206,9	207,6	205,4	190,3	175,1	164,4	158,3	156,3
9	80	186,2	187,6	191,4	195,6	195,4	193,5	181,3	168,4	158,9	153,3	151,5
10	90	175,6	176,9	180,1	183,3	182,8	181,1	171,4	160,7	152,5	147,6	146,0
11	100	163,6	164,6	167,4	169,9	169,2	167,9	160,4	151,9	145,2	141,0	139,6
12	110	150,3	151,3	153,8	155,7	154,7	153,6	147,9	141,7	136,6	133,4	132,3
13	120	136,4	137.3	139,3	140,4	139,5	138,6	134,5	130,3	126,8	124,6	123,9
14	130	122,1	122,8	124,4	124,9	124,0	123,3	120,7	118,2	116,1	114,7	114,3
15	140	107,5	107,7	108,2	108,6	108,4	108,2	107,0	105,7	104,5	103,8	103,5
16	150	92,6	92,3	92,3	92,6	92,8	92,9	92,9	92,6	92,1	91,6	91,4
17	159,5	78,1	78,1	78,1	78,1	78,1	78,1	78,1	78,1	78,1	78,1	78,1

TYPICAL OPERATING CONDITIONS

The voltages are specified with respect to grid 1.

Anode voltage	$V_{a,g4}$	25 kV
Grid 3 (focusing electrode) voltage	V_{g3}	7,25 to 8,25 kV
Grid 2 voltage for a spot cut-off voltage V_k = 130 V	V_{g2}	see below
Heater voltage under operating conditions	V_f	6,3 V

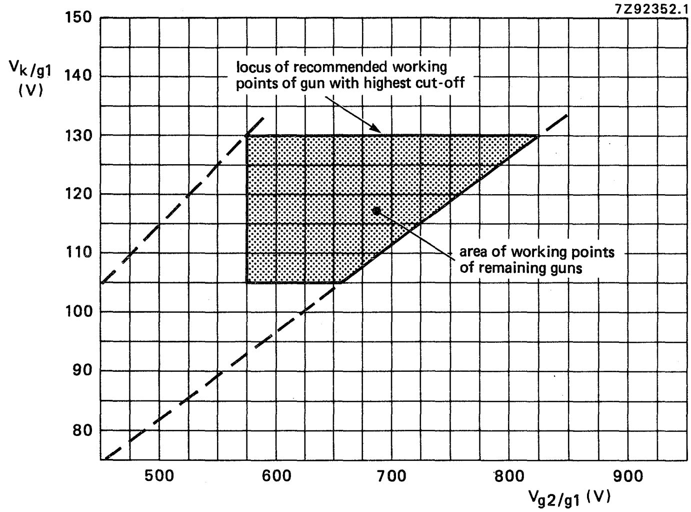


Fig. 14 Spot cut-off design chart.

Grid 2 voltage (V_{g2}) adjusted for highest gun spot cut-off voltage V_k = 130 V.

Remaining guns adjusted for spot cut-off by means of cathode voltage

V_{g2} range 575 to 825 V;

V_k range 105 to 130 V.

Adjustment procedure:

Set the cathode voltage (V_k) for each gun at 130 V; increase the grid 2 voltage (V_{g2}) from approx. 650 V to the value at which one of the colours become just visible. Now decrease the cathode voltage of the remaining guns so that the other colours also become visible.

EQUIPMENT DESIGN VALUES

The values are valid for anode voltages between 20 and 27,5 kV.
The voltages are specified with respect to grid 1.

Grid 3 (focusing electrode) voltage	V_{g3}	29 to 33% of anode voltage
Grid 2 voltage and cathode voltage for visual extinction of focused spot	V_{g2} and V_k	see Fig. 14
Difference in cut-off voltages between guns in any tube	ΔV_k	lowest value > 80% of highest value
Heater voltage	V_f	6,3 V at zero beam current
Video drive characteristics		see graphs*
Grid 3 (focusing electrode) current	I_{g3}	−2 to + 2 μA
Grid 2 current	I_{g2}	−2 to + 2 μA
Grid 1 current under cut-off conditions	I_{g1}	−2 to + 2 μA

To produce white of 6500K + 7 M.P.C.D.
(CIE co-ordinates x = 0,313, y = 0,329)

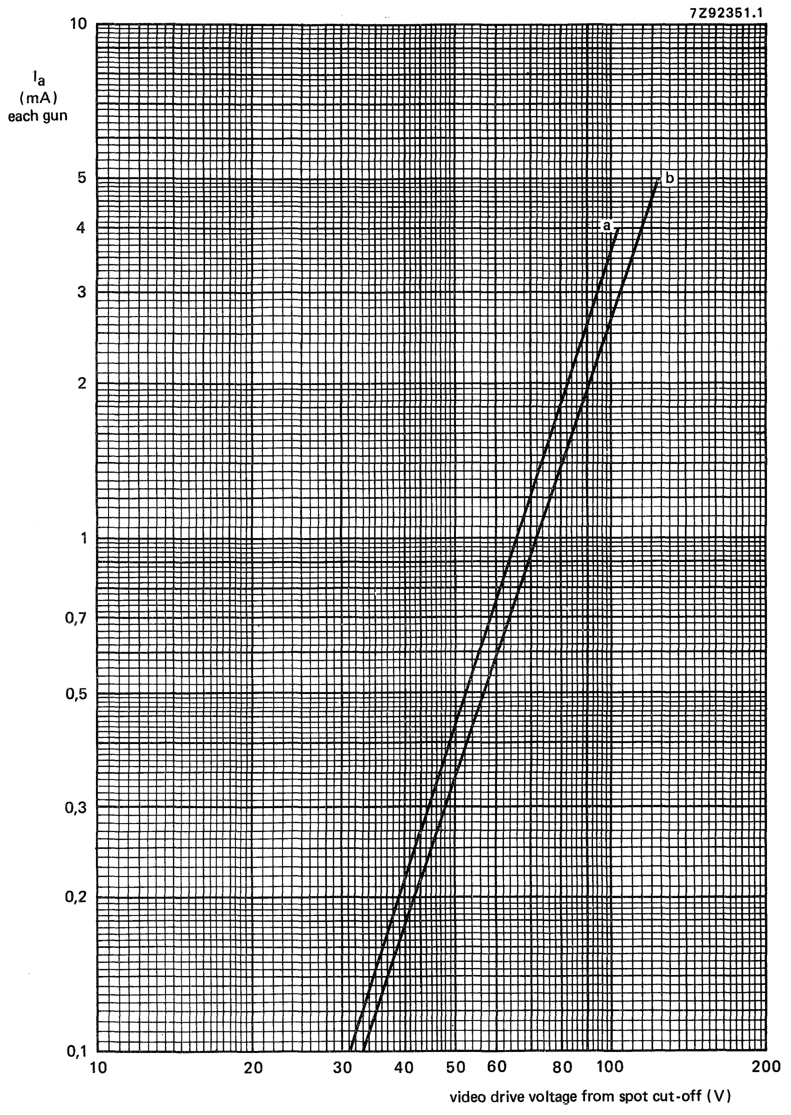
Percentage of the total anode current supplied by each gun (typical)

red gun	40.5%
green gun	32.4%
blue gun	27.1%

Ratio of anode currents

red gun to green gun	min.	0.90
	average	1.25
	max.	1.60
red gun to blue gun	min.	1.10
	average	1.50
	max.	1.90
biue gun to green gun	min.	0.60
	average	0.85
	max.	1.20

* For optimum picture performance it is recommended that the cathodes are not driven below + 1 V.



V_f = 6,3 V;

$V_{a,g4}$ = 25 kV;

V_{g3} adjusted for focus;

V_{g2} (each gun) adjusted to provide spot cut-off for V_k = 105 V (curve a) and V_k = 130 V (curve b).

Fig. 15 Typical cathode drive characteristic.

LIMITING VALUES (Design maximum rating system unless otherwise specified)

The voltages are specified with respect to grid 1.

				notes
Anode voltage	$V_{a,g4}$	max.	27,5 kV	1, 2, 3
		min.	20 kV	1, 4
Long-term average current for three guns	I_a	max.	1000 μA	5
Grid 3 (focusing electrode) voltage	V_{g3}	max.	11 kV	
Grid 2 voltage, peak	V_{g2p}	max.	1200 V	6
Cathode voltage				
positive	V_k	max.	400 V	
positive operating cut-off	V_k	max.	200 V	
negative	$-V_k$	max.	0 V	
negative peak	$-V_{kp}$	max.	2 V	
Cathode to heater voltage				
positive	V_{kf}	max.	250 V	
positive peak	V_{kfp}	max.	300 V	1
negative	$-V_{kf}$	max.	135 V	
negative peak	$-V_{kfp}$	max.	180 V	1
Heater voltage	V_f		$6,3\ V\ ^{+5\ \%}_{-10\ \%}$	1, 7

LIMITING CIRCUIT VALUES

Grid 3 circuit resistance	R_{g3}	max.	70 MΩ
Grid 1 to cathode circuit resistance (each gun)	R_{g1k}	max.	0,75 MΩ

Notes to the limiting values

1. Absolute maximum rating system.
2. The picture tube does not emit X-radiation above 1 μSv/h when operated within its absolute maximum ratings.
3. 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 luminance and resolution, and could impair convergence.
5. The short-term average anode current should be limited by circuitry to 1500 μA.
6. During adjustment on the production line max. 1500 V is permitted.
7. For maximum cathode life it is recommended that the heater supply be designed for 6,3 V at zero beam current.

FLASHOVER PROTECTION

With the high voltage used with this tube (max. 27,5 kV) internal flashovers may occur. As a result of the Soft-Flash technology these flashover currents are limited to approx. 60 A offering higher set reliability, optimum circuit protection and component savings.
Primary protective circuitry using properly grounded spark gaps and series isolation resistors (preferably carbon composition) is still necessary to prevent tube damage. The spark gaps should be connected to all picture tube electrodes at the socket according to the figure below; they are not required on the heater pins. No other connections between the outer conductive coating and the chassis are permissible.
The spark gaps should be designed for a breakdown voltage at the focusing electrode (g3) of 11,5 kV (1,5 x V_{g3} max. at $V_{a,g4}$ = 25 kV), and at the other electrodes of 1,5 to 2 kV.
The values of the series isolation resistors should be as high as possible (min. 1,5 kΩ) without causing deterioration of the circuit performance. The resistors should be able to withstand an instantaneous surge of 20 kV for the focusing circuit and 12 kV for the remaining circuits without arcing.
Additional information is available on request.

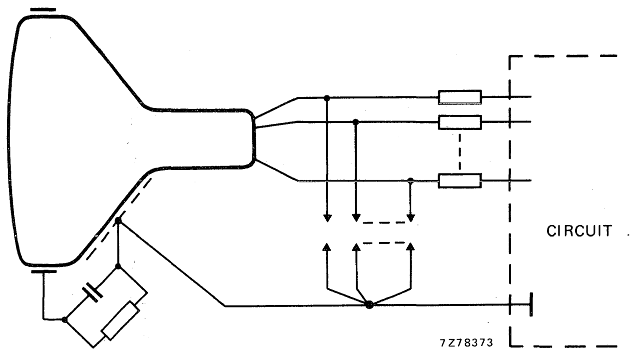


Fig. 16 Flashover protection circuit.

BEAM CORRECTIONS

Maximum centring error in any direction after colour purity, static convergence, and horizontal centre line correction, measured with deflection coils in nominal position — 4 mm

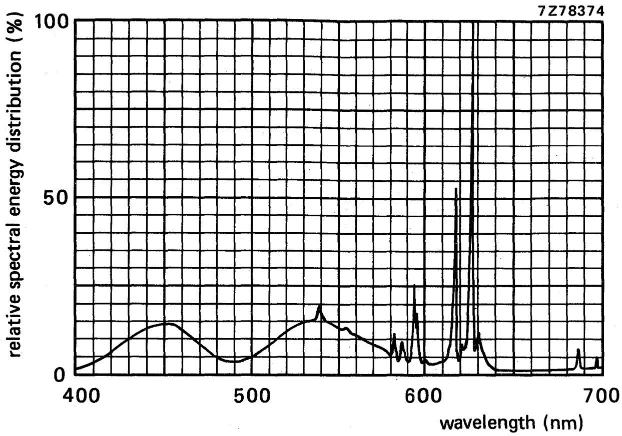


Fig. 17 Simultaneous excitation of red, green and blue phosphor, measured in a tube, to produce white of x = 0,313, y = 0,329. Exact shape of the peaks depends on the resolution of the measuring apparatus.

Colour co-ordinates:	x	y
red	0.620	0.340
green	0.305	0.600
blue	0.155	0.065

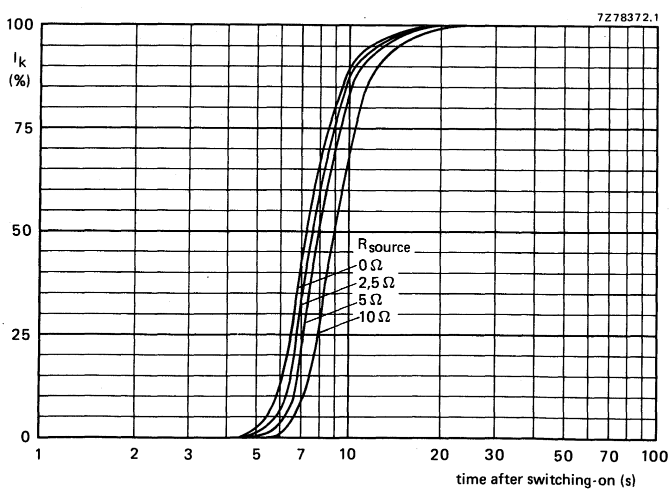


Fig. 18 Cathode heating time after switching on, measured under typical operating conditions.

DEGAUSSING

The picture tube has an internal magnetic shield. This shield and the shadow mask with its suspension system may be provided with an automatic degaussing system. Three degaussing systems are available, double-coil, continuous-coil and single-coil, these are shown in Figs 19, 20 and 21.

For proper degaussing an initial magnetomotive force (MMF) of 300 ampere-turns* is required in each of the coils. This MMF has to be gradually decreased by appropriate degaussing circuitry. In the steady state, no significant MMF should remain in the coils (≤ 0,3 ampere-turns**).

If single-phase power rectification is employed in the TV circuitry, provision should be included to prevent asymmetric distortion of the AC voltage applied to the degaussing circuit due to high DC inrush currents.

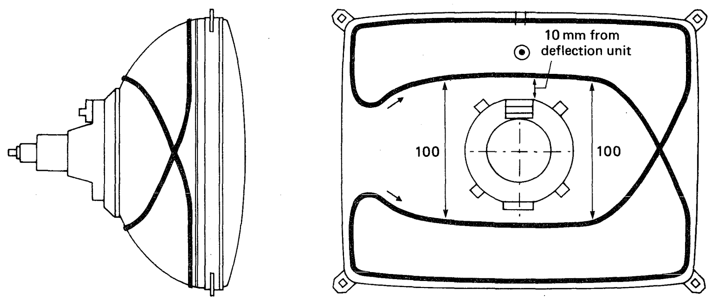


Fig. 19 Continuous-coil system.

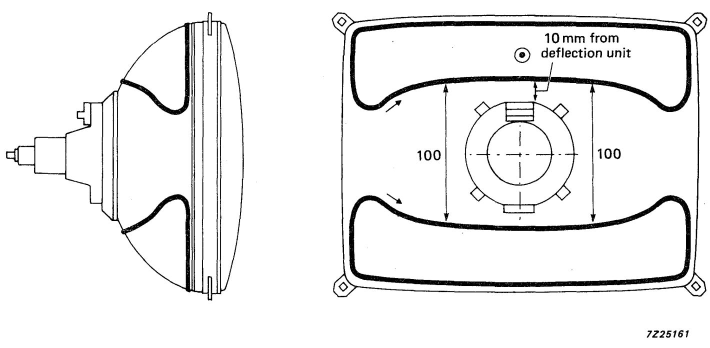


Fig. 20 Double-coil system.

* 300 ampere-turns for double-coil system; 700 ampere-turns for single-coil system.
** ≤ 0,3 ampere-turns for double-coil system; ≤ 0,6 ampere-turns for single-coil system.

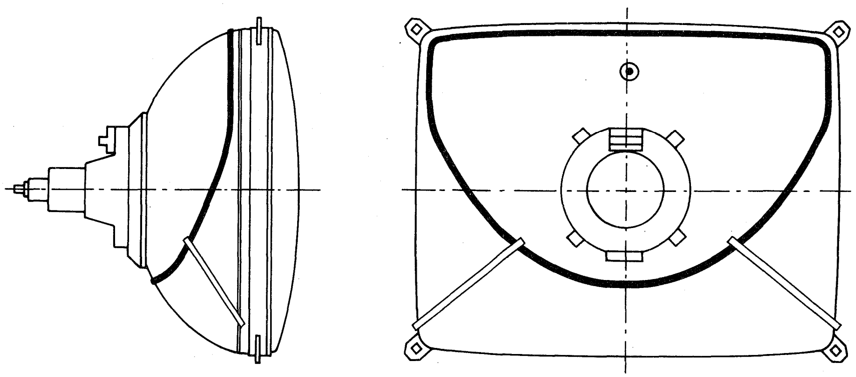


Fig. 21 Single-coil system.

Degaussing circuit using dual PTC thermistor 2322 662 98009; C = 100 nF, for double-coil system, optional for single- and continuous-coil system.

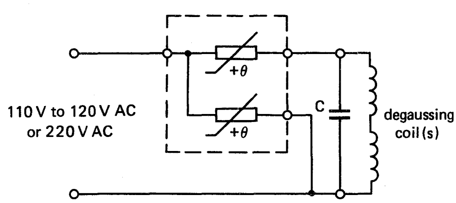


Fig. 22 Degaussing circuit.

Data of degaussing coil

	double-coil system	single-coil system	continuous-coil system
Circumference	125 cm	139 cm	248 cm
Number of turns	60	140	140
Copper-wire diameter	0,4 mm	0,4 mm	0,4 mm
Aluminium-wire diameter	0,5 mm	0,5 mm	0,5 mm
Resistance	22 Ω (two coils in series)	27 Ω	47 Ω

FLAT SQUARE COLOUR PICTURE TUBE ASSEMBLY

- Factory preset tube/coil assembly
- Self-converging and raster correction free
- 51 cm, 90° colour picture tube A51EAL30X
- Hybrid saddle toroidal deflection unit AT6035/04

QUICK REFERENCE DATA

Deflection angle	90°
Minimum useful screen diagonal	51 cm
Overall length	444 mm
Neck diameter	29.1 mm

MECHANICAL DATA

Dimensions in mm

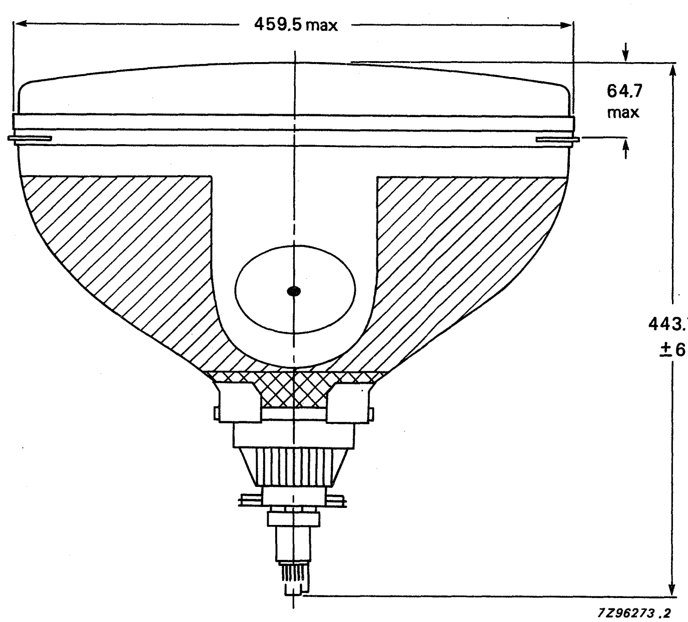


Fig. 1 Colour picture tube assembly A51EAL30X01.

MECHANICAL DATA

Dimensions in mm

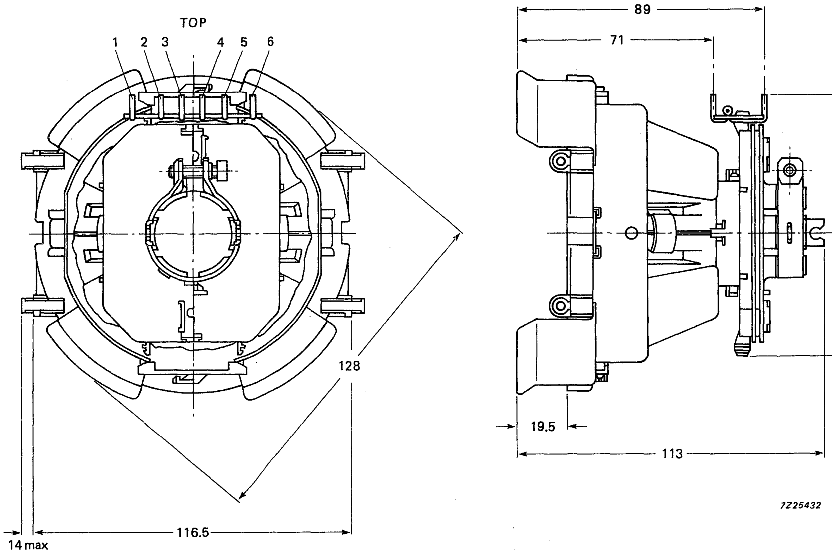


Fig. 2 Deflection unit.

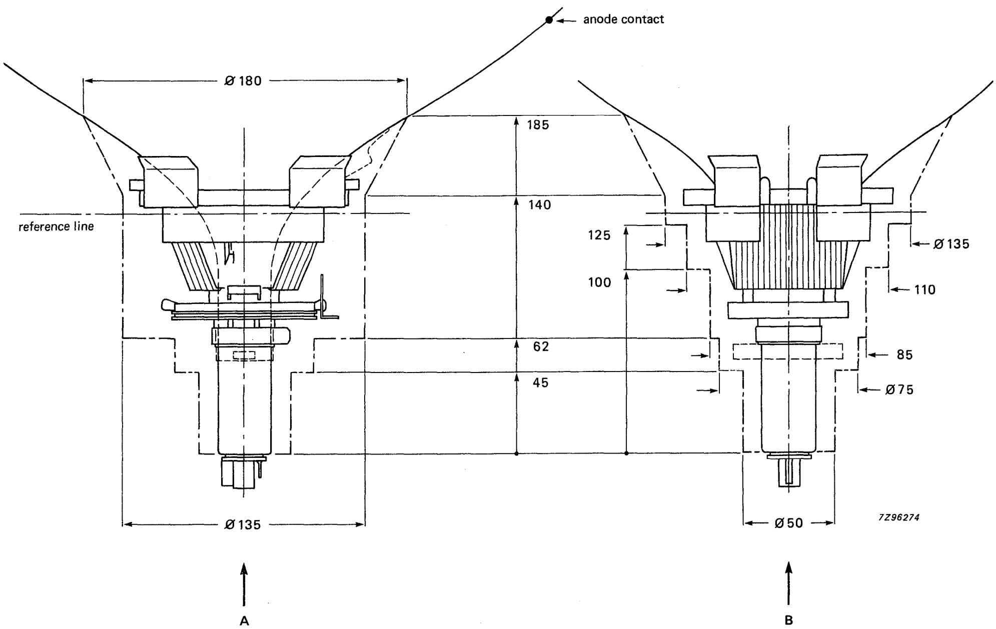


Fig. 3 Yoke clearance.

ELECTRICAL DATA OF DEFLECTION UNIT AT6035/04

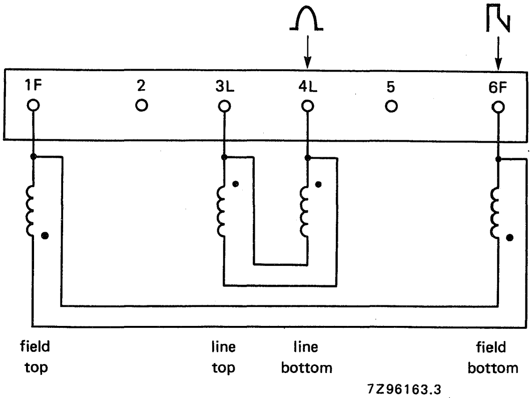
Line deflection coils

Inductance	2.00 mH ± 4%
Resistance at 25 °C	2.35 Ω ± 10%
Magnetic flux at 25 kV	5.70 mWb ± 2.5%
Line deflection current, raster scan, at 25 kV	2.85 A(p-p)
Raster scan	411 mm

Field deflection coils

Inductance	19.5 mH ± 10%
Resistance at 25 °C	9.7 Ω ± 7%
Field deflection current, raster scan, at 25 kV	1.09 A(p-p)
Raster scan	311 mm

Cross-talk	a voltage of 10 V, 15625 Hz applied to the line coils causes no more than 0.20 V across the field coils (damping resistors included)
Insulation resistance at 1 kV DC	
between line and field coils	> 500 MΩ
between line coil and core clamp	> 500 MΩ
between field coil and core clamp	> 10 MΩ
Maximum operating temperature (average copper temperature)	+ 90 °C
Storage temperature range	−25 to + 90 °C
Flame retardent	according to UL 413, category 94V−1



The beginning of the windings is indicated with •.

Fig. 4 Connection diagram.

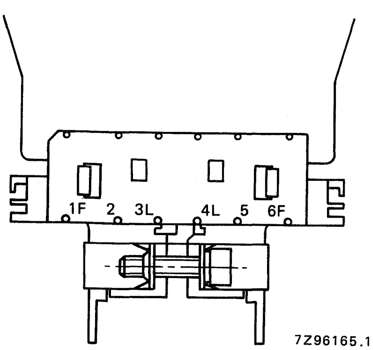


Fig. 5 Terminal location.

ENVIRONMENTAL TEST SPECIFICATIONS OF DEFLECTION UNITS

Vibration	IEC 68-2-6 (test Fc)
Shock	IEC 68-2-27 (test Ea)
Bump	IEC 68-2-29 (test Eb; 25g)
Cold	IEC 68-2-1 (test Ab)
Dry heat	IEC 68-2-2 (test Bb)
Damp heat, steady state	IEC 68-2-3 (test Ca)
Cyclic damp heat	IEC 68-2-30 (test Db)
Change of temperature	IEC 68-2-14 (test Nb)

FLAT SQUARE Hi-Bri COLOUR PICTURE TUBE

- Flat and square screen
- 90^{o} deflection
- In-line, hi-bi potential A R T* gun
- 22,5 mm neck diameter
- Hi-Bri technology
- Mask with corner suspension
- Pigmented phosphors
- Quick-heating low-power cathodes
- Soft flash
- Slotted shadow mask optimized for minimum moiré at 625 lines system
- Internal magnetic shield
- Internal multipole
- Reinforced envelope for push-through mounting
- The tube is supplied with a deflection unit of the AT6040 series; it forms a self-converging and raster correction free assembly

QUICK REFERENCE DATA

Deflection angle	90^{o}
Minimum useful screen diagonal	51 cm
Overall length	430 mm
Neck diameter	22,5 mm
Heating	6,3 V, 310 mA
Focusing voltage	31% of anode voltage
Anode voltage	25 kV

* Aberration Reducing Triode.

ELECTRON-OPTICAL DATA

Electron gun system		unitized triple-aperture electrodes; aberration reducing triode
Focusing method		electrostatic
Focus lens		hi-bi-potential
Deflection method		magnetic
Deflection angles		
diagonal		approx. 90°
horizontal		approx. 78°
vertical		approx. 60°

ELECTRICAL DATA

Capacitances		
anode to external conductive coating including rimband	$C_{a(m + m')}$	min. 1500 pF
grid 1 to all other electrodes	C_{g1}	15 pF
cathode of each gun to all other electrodes	C_{kR}, C_{kG}, C_{kB}	4 pF
focusing electrode to all other electrodes	C_{g3}	4 pF
Heating		indirect by AC or DC
heater voltage	V_f	6,3 V
heater current	I_f	310 mA

OPTICAL DATA

Screen	metal-backed vertical phosphor stripes; phosphor lines follow glass contour
Screen finish	high gloss
Useful screen dimensions	
diagonal	min. 508,0 mm
horizontal axis	min. 406,4 mm
vertical axis	min. 304,8 mm
area	min. 1240 cm²
Positional accuracy of the screen with respect to the glass contour	see Figures on the next page
Phosphors	
red	pigmented europium activated rare earth
green	sulphide type
blue	pigmented sulphide type
Centre-to-centre distance of vertical identical colour phosphor stripes, at screen centre	0,69 mm
Light transmission of face glass at centre	52%
Luminance at the centre of the screen	100 cd/m² *

* Tube settings adjusted to produce white D (x = 0.313, y = 0,329), focused raster, current density 0,4 μA/cm².

A = 171,67 mm
B = 223,70 mm
C = 115,63 mm
D = 173,89 mm
E = 23,50 mm

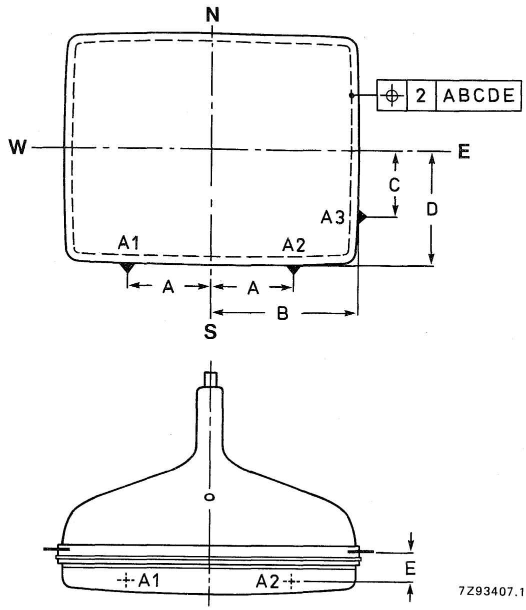


Fig. 1 Tube alignment.

MECHANICAL DATA (see also the figures on the following pages)

Overall length	430,4 ± 4,5 mm
Neck diameter	$22,5^{+1,4}_{-0,7}$ mm*
Bulb dimensions	
diagonal	max. 546,1 mm
width	max. 455,6 mm
height	max. 359,6 mm
Base	JEDEC B8-288
Anode contact	small cavity contact J1-21, IEC 67-III-2
Mounting position	anode contact on top
Net mass	approx. 14 kg

Handling

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

* In the region of 66 mm from the neck end, the maximum diameter is 23,2 mm.

MECHANICAL DATA (continued)

Notes are given after the drawings.

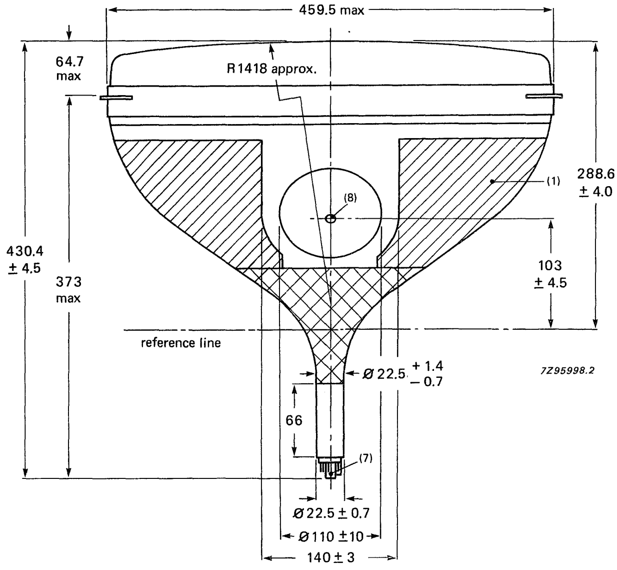


Fig. 2.

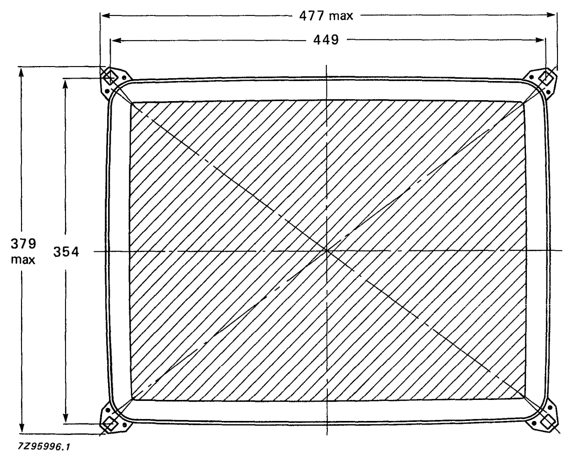


Fig. 3.

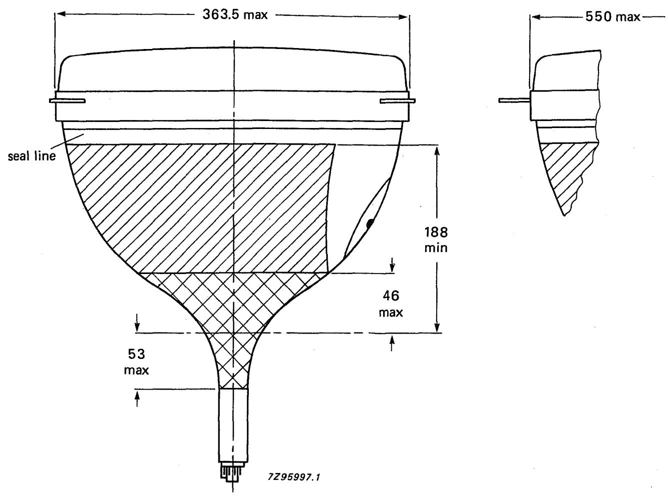

363.5 max
550 max
seal line
188
min
46
max
53
max
7Z95997.1

Fig. 4.

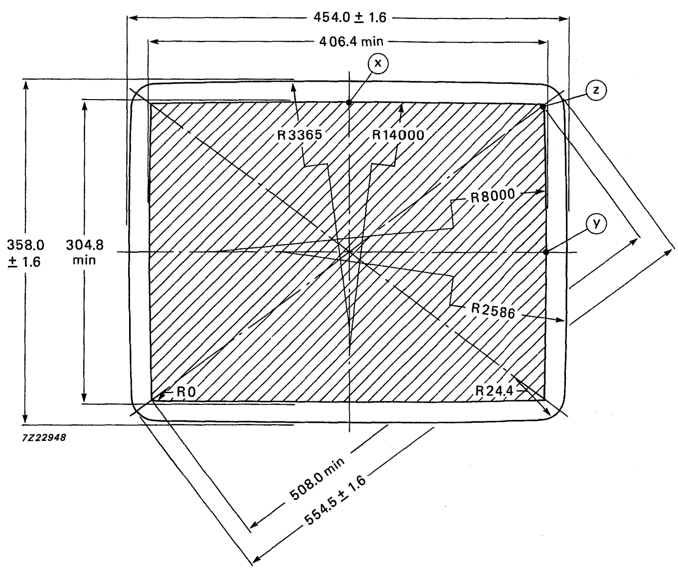

454.0 ± 1.6
406.4 min
x
z
y
R3365
R14000
R8000
R2586
R0
R24.4
358.0
± 1.6
304.8
min
7Z22948
508.0 min
554.5 ± 1.6

Fig. 5.

MECHANICAL DATA (continued)

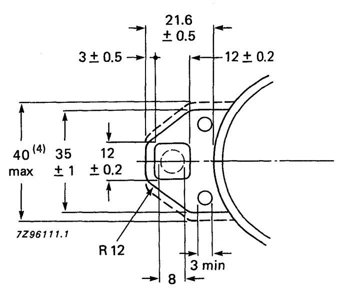


Fig. 6 Lug dimensions.

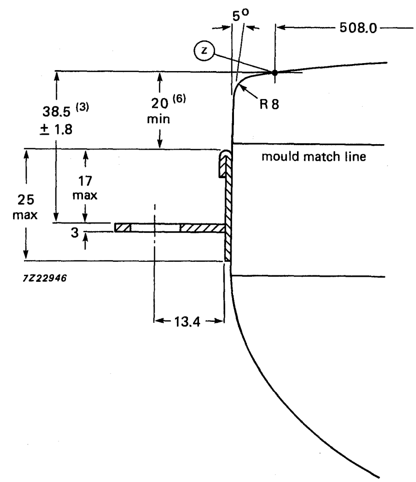


Fig. 7 Lug position.

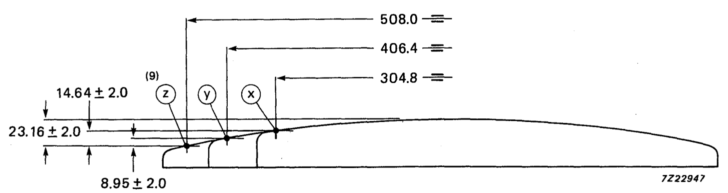


Fig. 8 Screen reference points.

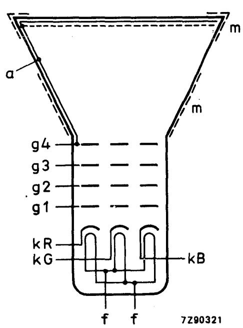


Fig. 9 Electrode configuration.

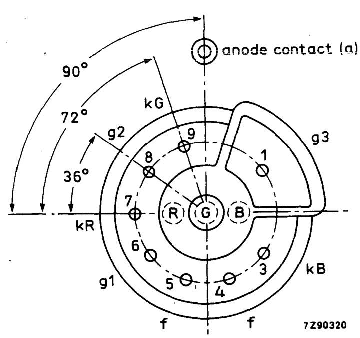


Fig. 10 Pin arrangement.

Notes to outline drawings

1. Configuration of outer conductive coating may be different, but will contain the contact areas as shown in the drawing.
2. To clean this area, wipe only with a soft lintless cloth.
3. One of the four mounting lugs may deviate (1,3 mm max.) from the plane of the other three lugs. This deviation is incorporated in the tolerance of ± 1,8 mm.
4. Minimum space to be reserved for mounting lug.
5. The position of the mounting screw in the cabinet must be within a circle of 8 mm diameter drawn around the true geometrical positions, i.e. corners of a rectangle of 354 mm x 449 mm.
6. Distance from point Z to any hardware.
7. The socket for the base should not be rigidly mounted but should be free to move and the leads connected to the socket should be flexible. After mounting the tube in the cabinet, the position of the base will fall within a circle of diameter 50 mm maximum, concentric with an imaginary tube axis. The mass of the socket plus circuitry should not exceed 0,1 kg. Maximum permissible torque on the neck is 0,04 Nm.
8. Small cavity contact J1-21, IEC 67-III-2.
9. The X, Y and Z reference points are located on the outside surface of the face plate at the intersection of the minor, major and diagonal screen axis respectively, with the minimum published screen.

Table 1 Sagittal heights with reference to screen centre at the edge of the minimum useful screen.

coordinates x mm	coordinates y mm	sagittal height mm
0*	152,4	8,6
10	152,4	8,6
20	152,4	8,7
30	152,4	8,8
40	152,4	9,1
50	152,4	9,4
60	152,4	9,7
70	152,4	10,1
80	152,4	10,6
90	152,4	11,2
100	152,4	11,8
110	152,4	12,6
120	152,4	13,4
130	152,4	14,2
140	152,4	15,2
150	152,4	16,2
160	152,4	17,3
170	152,4	18,5
180	152,4	19,8
190	152,4	21,2
200	152,4	22,7
203,2**	152,4	23,2
203,2	150	22,9
203,2	140	21,8
203,2	130	20,8

coordinates x mm	coordinates y mm	sagittal height mm
203,2	120	19,9
203,2	110	19,0
203,2	100	18,2
203,2	90	17,5
203,2	80	16,9
203,2	70	16,4
203,2	60	15,9
203,2	50	15,5
203,2	40	15,2
203,2	30	15,0
203,2	20	14,8
203,2	10	14,7
203,2▲	0	14,6

* Point ⓧ
** Diagonal
▲ Point ⓨ

Base JEDEC B8-288

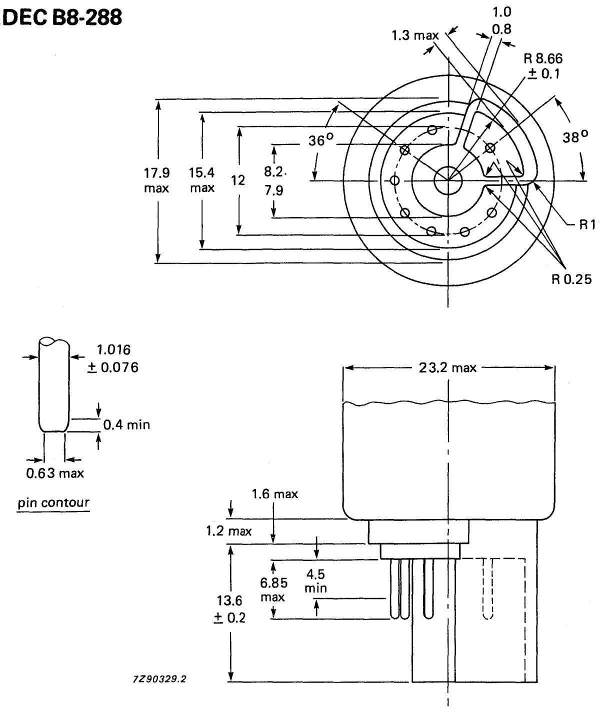


Fig. 11 JEDEC base.

Reference line gauge; G-R90CJ10

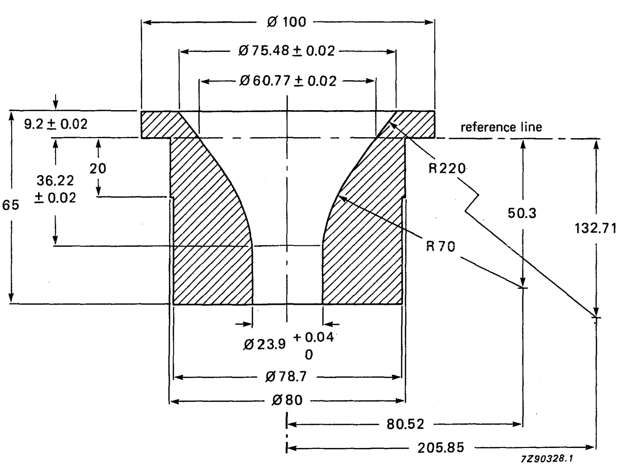


Fig. 12 Reference line guage.

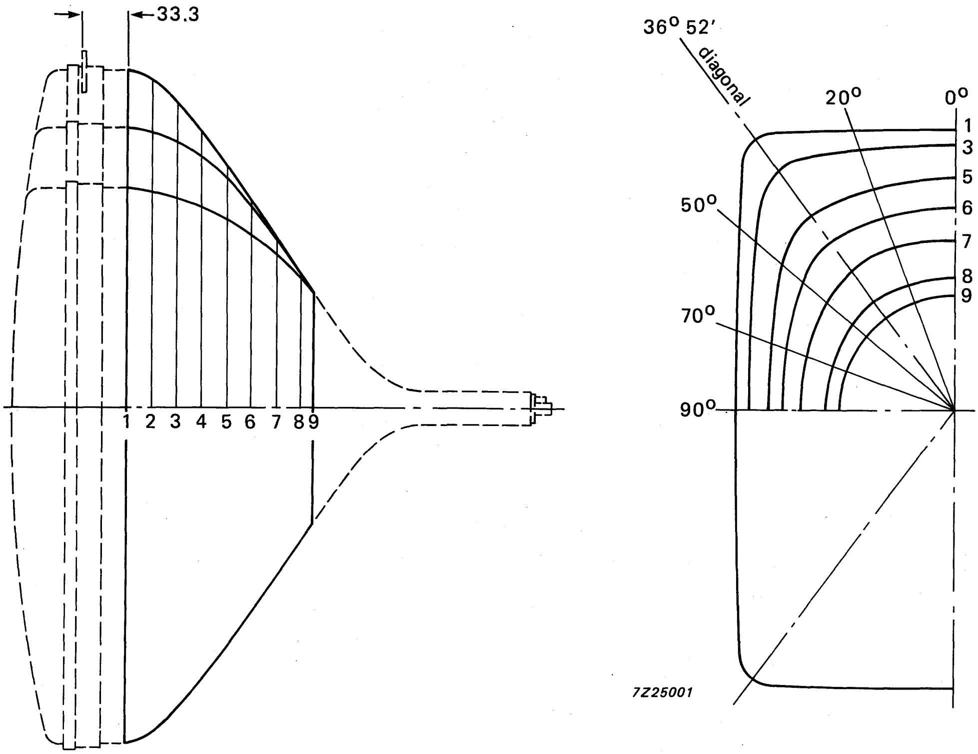


Fig. 13 Maximum cone contour.

Table 2 Cone contour data.

section	nom. dist. from section 1	distance from centre (maximum values)					
		0°	20°	diag.	50°	70°	90°
1	0	225.70	239.06	171.80	227.93	187.87	177.00
2	20	220.16	232.06	258.20	220.62	182.80	172.33
3	40	211.58	221.08	236.60	208.89	175.66	166.06
4	60	199.26	205.77	212.88	194.29	167.09	158.70
5	80	181.50	185.73	187.97	175.74	155.84	149.11
6	100	157.69	160.75	161.44	153.87	141.18	136.50
7	120	130.23	132.65	132.37	128.22	122.18	119.85
8	140	101.15	101.36	101.87	101.01	99.76	98.80
9	149	87.94	87.98	88.00	87.99	87.94	87.88

TYPICAL OPERATING CONDITIONS

The voltages are specified with respect to grid 1.

Anode voltage	$V_{a,g4}$	25 kV
Grid 3 (focusing electrode) voltage	V_{g3}	7,25 to 8,25 kV
Grid 2 voltage for a spot cut-off voltage V_k = 120 V	V_{g2}	310 to 650 V

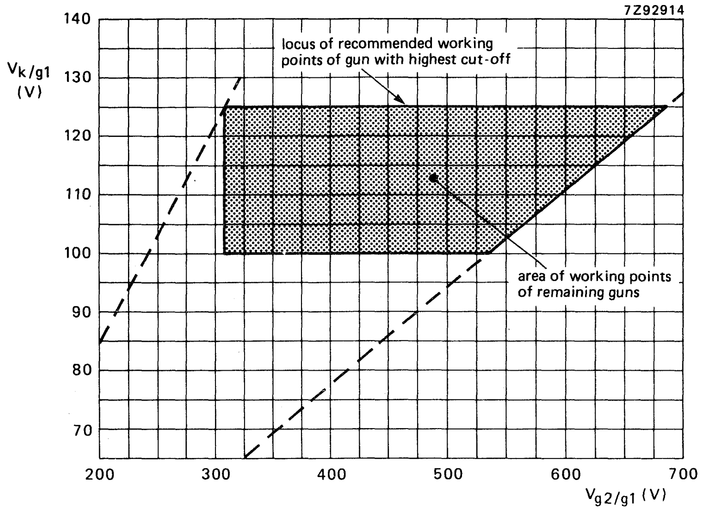


Fig. 14 Spot cut-off design chart.

Grid 2 voltage (V_{g2}) adjusted for highest gun spot cut-off voltage V_k = 125 V.

Remaining guns adjusted for spot cut-off by means of cathode voltage

V_{g2} range 310 to 685 V;

V_k range 100 to 125 V.

Adjustment procedure:

Set the cathode voltage (V_k) for each gun at 125 V; increase the grid 2 voltage (V_{g2}) from approx. 300 V to the value at which one of the colours become just visible. Now decrease the cathode voltage of the remaining guns so that the other colours also become visible.

EQUIPMENT DESIGN VALUES

The values are valid for anode voltages between 20 and 27,5 kV.
The voltages are specified with respect to grid 1.

Grid 3 (focusing electrode) voltage	V_{g3}	29 to 33% of anode voltage
Grid 2 voltage and cathode voltage for visual extinction of focused spot	V_{g2} and V_k	see cut-off design chart
Difference in cut-off voltages between guns in any tube	ΔV_k	lowest value > 80% of highest value
Heater voltage	V_f	6,3 V at zero beam current
Video drive characteristics		see graphs
Grid 3 (focusing electrode) current	I_{g3}	−2 to + 2 μA
Grid 2 current	I_{g2}	−2 to + 2 μA
Grid 1 current under cut-off conditions	I_{g1}	−2 to + 2 μA

To produce white of 6500K + 7 M.P.C.D.
(CIE co-ordinates x = 0,313, y = 0,329)

Percentage of the total anode current supplied by each gun (typical)

red gun	40.5%
green gun	32.4%
blue gun	27.1%

Ratio of anode currents

red gun to green gun	min.	0.90
	average	1.25
	max.	1.60
red gun to blue gun	min.	1.10
	average	1.50
	max.	1.90
blue gun to green gun	min.	0.60
	average	0.85
	max.	1.20

LIMITING VALUES (Design maximum rating system unless otherwise stated)

The voltages are specified with respect to grid 1.

Anode voltage	$V_{a,g4}$	max.	27,5 kV	notes 1, 2, 3
		min.	20 kV	notes 1 and 4
Long-term average current for three guns	I_a	max.	1000 μA	note 5
Grid 3 (focusing electrode) voltage	V_{g3}	max.	11 kV	
Grid 2 voltage, peak	V_{g2p}	max.	1000 V	
Cathode voltage				
positive	V_k	max.	400 V	
positive operating cut-off, during adjustment	V_k	max.	200 V	
negative	$-V_k$	max.	0 V	
negative peak	$-V_{kp}$	max.	2 V	
Heater voltage	V_f		$6{,}3\ V^{+5\ \%}_{-10\ \%}$	notes 1 and 6
Heater-cathode voltage				
heater negative with respect to cathode				
after equipment warm-up period	V_{kf}	max.	200 V	
heater positive with respect to cathode	$-V_{kfp}$	peak	200 V	note 1
	$-V_{kf}$	max.	0 V (DC component value)	

Notes

1. Absolute maximum rating system.
2. The picture tube does not emit X-radiation above 1 μSv/h when operated within its absolute maximum ratings.
3. 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 luminance and resolution.
5. The short-term average anode current should be limited by circuitry to 1500 μA.
6. For maximum cathode life and optimum performance, it is recommended that the heater supply be designed for 6,3 V at zero beam current.

FLASHOVER PROTECTION

With the high voltage used with this tube (max. 27,5 kV) internal flashovers may occur. As a result of the Soft-Flash technology these flashover currents are limited to approx. 60 A offering higher set reliability, optimum circuit protection and component savings.
Primary protective circuitry using properly grounded spark gaps and series isolation resistors (preferably carbon composition) is still necessary to prevent tube damage. The spark gaps should be connected to all picture tube electrodes at the socket according to the figure below; they are not required on the heater pins. No other connections between the outer conductive coating and the chassis are permissible.
The spark gaps should be designed for a breakdown voltage at the focusing electrode (g3) of 12,5 kV (1,5 x V_{g3} max. at $V_{a,g4}$ = 25 kV), and at the other electrodes of 1,5 to 2 kV.
The values of the series isolation resistors should be as high as possible (min. 1,5 kΩ) without causing deterioration of the circuit performance. The resistors should be able to withstand an instantaneous surge of 20 kV for the focusing circuit and 12 kV for the remaining circuits without arcing.
Additional information is available on request.

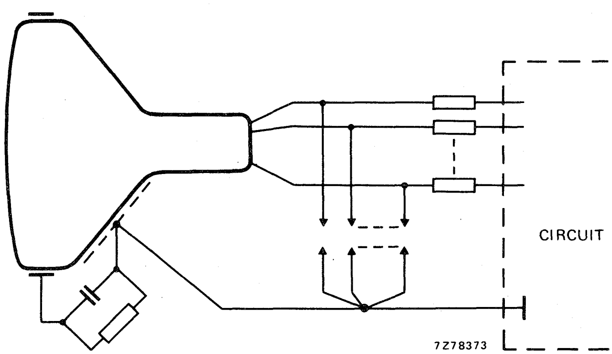


Fig. 15 Flashover protection circuit.

BEAM CORRECTIONS

Maximum centring error in any direction after colour purity, static convergence, and horizontal centre line correction, measured with deflection coils in nominal position	4 mm

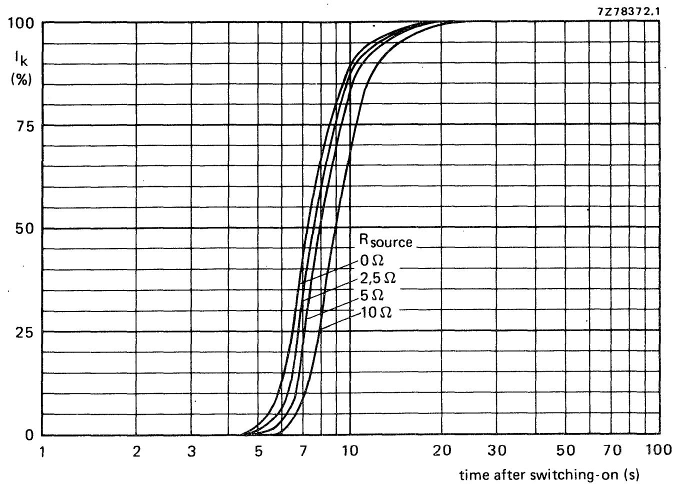
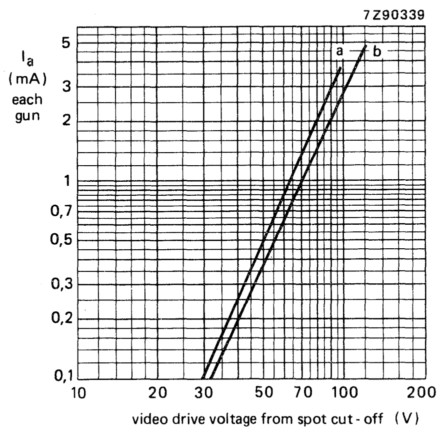


Fig. 16 Cathode heating time after switching on, measured under typical operating conditions.



V_f = 6,3 V;

$V_{a,g4}$ = 25 kV;

V_{g3} adjusted for focus;

V_{g2} (each gun) adjusted to provide spot cut-off for V_k = 100 V (curve a), and V_k = 125 V (curve b).

For optimum picture performance it is recommended that the cathodes are not driven below + 1 V.

Fig. 17 Typical cathode drive characteristics.

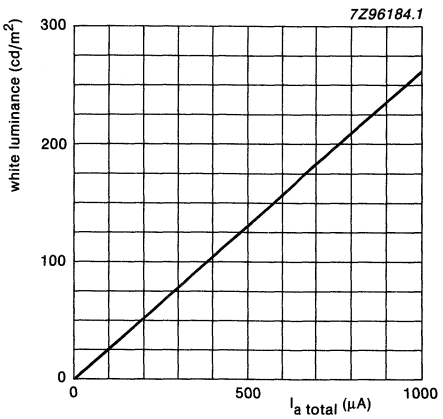


Fig. 18 Luminance at the centre of the screen as a function of I_{total}.
$V_{a,g5}$ = 25 kV.
Scanned area = 406,4 mm x 304,8 mm;
CIE co-ordinates x = 0,313, y = 0,329.

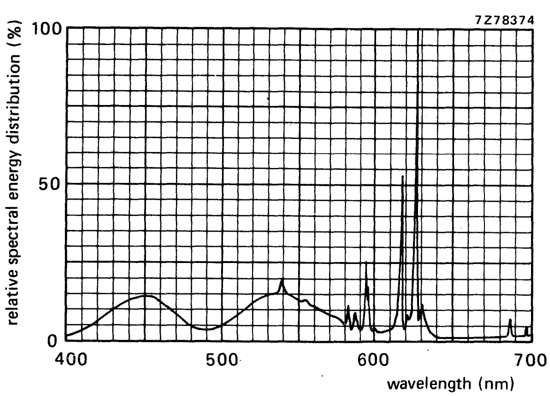


Fig. 19 Simultaneous excitation of red, green and blue phosphor, measured in a tube, to produce white of x = 0,313, y = 0,329. Exact shape of the peak depends on the resolution of the measuring apparatus.

Colour co-ordinates:	x	y
red	0.620	0.340
green	0.305	0.600
blue	0.155	0.065

DEGAUSSING

The picture tube has an internal magnetic shield. This shield and the shadow mask with its suspension system may be provided with an automatic degaussing system, consisting of one magnetic coil winding mounted on the cone of the picture tube.

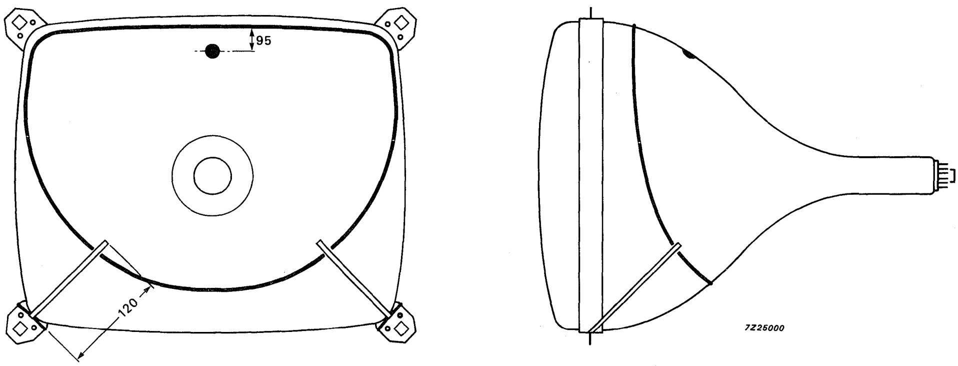


Fig. 20 Position of degaussing coil on the picture tube; dimensions are given in mm.

For proper degaussing an initial magnetomotive force (MMF) of 700 ampere-turns is required in the coil. This MMF has to be gradually decreased by appropriate degaussing circuitry. In the steady state, no significant MMF should remain in the coil (≤0,6 ampere-turns). If single-phase power rectification is employed in the TV circuitry, provision should be included to prevent asymmetric distortion of the AC voltage applied to the degaussing circuit due to high DC inrush currents. An example of a degaussing circuit and coil data are given below.

Degaussing circuit using dual PTC thermistor 2322 662 98009.

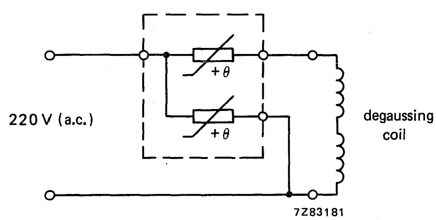


Fig. 21 Degaussing circuit using dual PTC thermistor.

Data of degaussing coil

Circumference	139 cm
Number of turns	140
Copper-wire diameter	0,4 mm
Aluminium-wire diameter	0,5 mm
Resistance	27 Ω

FLAT SQUARE COLOUR PICTURE TUBE ASSEMBLY

- Factory preset tube/coil assembly
- Self-converging and raster correction free
- 51 cm, 90° colour picture tube A51EAM30X
- Hybrid saddle toroidal deflection unit AT6040/00

QUICK REFERENCE DATA

Deflection angle	90°	
Minimum useful screen diagonal	51	cm
Overall length	430	mm
Neck diameter	22,5	mm

MECHANICAL DATA

Dimensions in mm

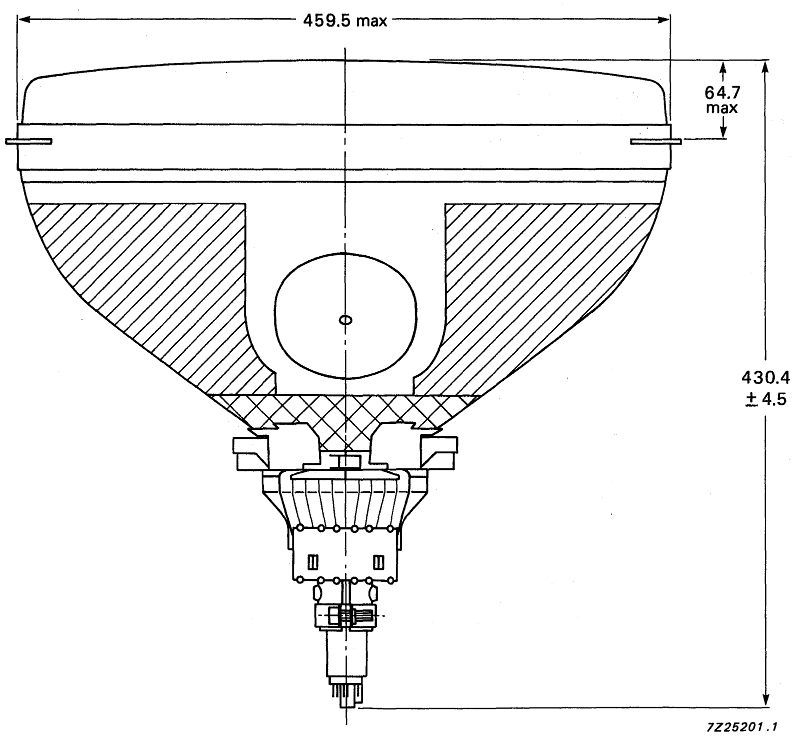


Fig. 1 Colour picture tube assembly.

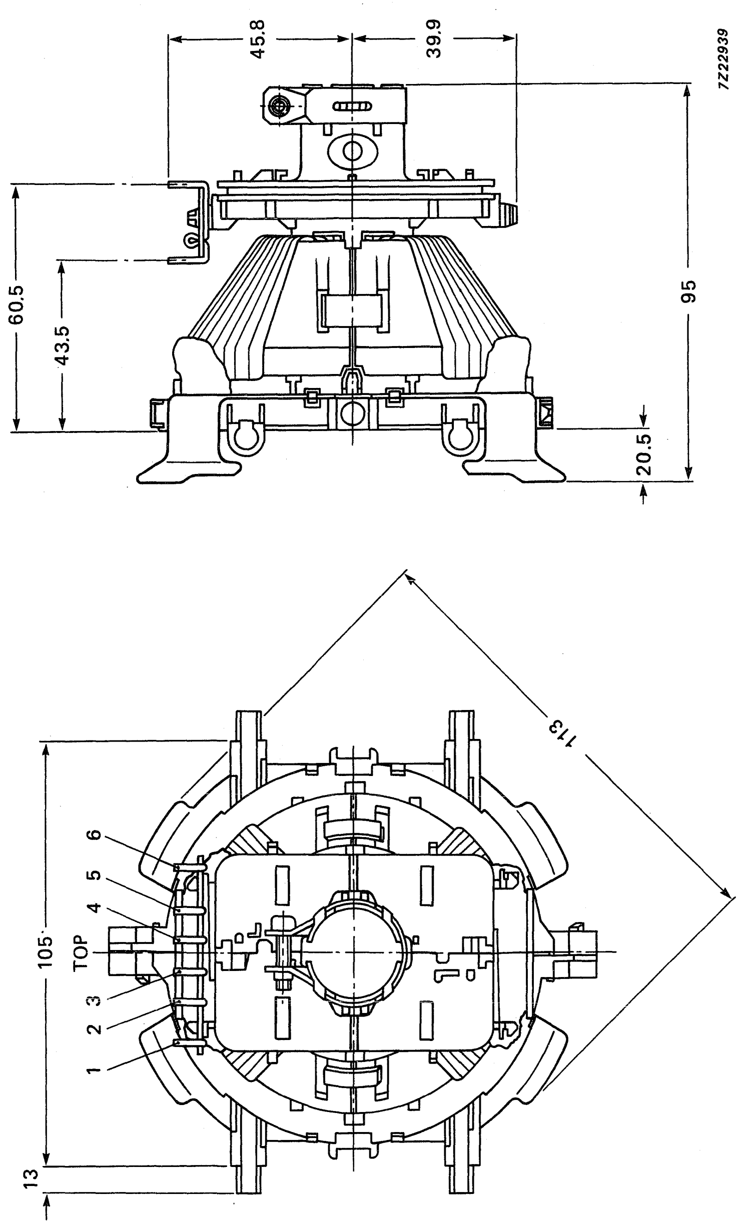


Fig. 2 Deflection unit AT6040/00.

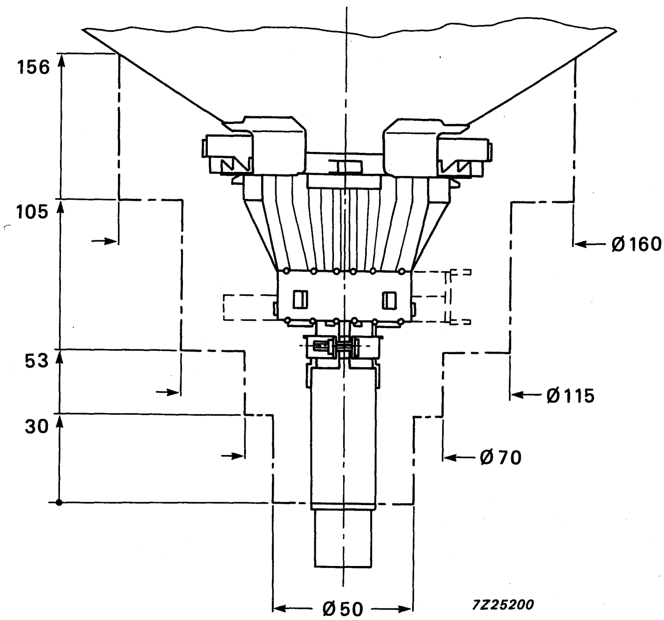


Fig. 3 Yoke clearance.

Maximum operating temperature (average copper temperature measured with resistance method)	+ 90 °C
Storage temperature range	−25 to + 90 °C
Flame retardent	according to UL 1413, category 94-V1
Torque on neck clamp screw	1,0 Nm

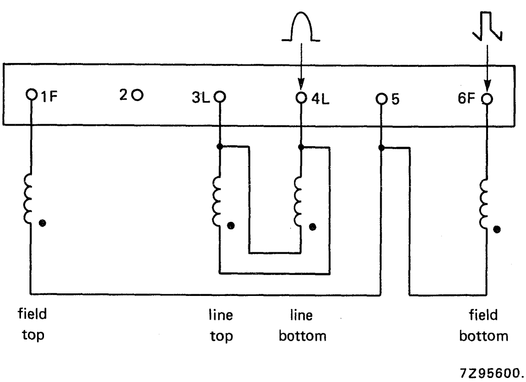
ENVIRONMENTAL TEST SPECIFICATIONS OF DEFLECTION UNITS

Vibration	IEC 68-2-6 (test Fc)
Shock	IEC 68-2-27 (test Ea)
Bump	IEC 68-2-29 (test Eb; 25g)
Cold	IEC 68-2-1 (test Ab)
Dry heat	IEC 68-2-2 (test Bb)
Damp heat, steady state	IEC 68-2-3 (test Ca)
Cyclic damp heat	IEC 68-2-30 (test Db)
Change of temperature	IEC 68-2-14 (test Nb)

ELECTRICAL DATA OF DEFLECTION UNITS

parameter	AT6040/00
Line deflection coils	
inductance at 1 V (rms), 1 kHz	2.37 mH ± 4%
resistance at 25 °C	3.16 Ω ± 10%
magnetic flux	5.35 mWb ± 2,5%
Line deflection current	
edge to edge, at 25 kV	2.26 A (p-p)
Field deflection coils	
inductance at 1 V (rms), 1 kHz	22.5 mH ± 10%
resistance at 25 °C	11.3 Ω ± 7%
Field deflection current,	
edge to edge, at 25 kV	0.95 A (p-p)
Cross-talk: voltage across the field coils when a voltage of 10 V, 15625 Hz is applied to the line coils	max. 0.2 V

Insulation resistance at 1 kV (DC)
- between line and field coils: min. 500 MΩ
- between line coil and core clamp: min. 500 MΩ
- between field coil and core clamp: min. 10 MΩ



The beginning of the windings is indicated with •.

Fig.4 Electrical diagram.

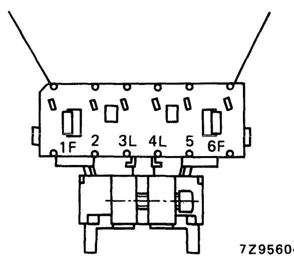


Fig. 5 Terminal location.

FLAT AND SQUARE Hi-Bri COLOUR PICTURE TUBE

- Flat and square screen
- 110° deflection
- In-line, hi-bi potential A R T* gun with quadrupole cathode lens
- 29.1 mm neck diameter
- Mask with corner suspension
- Hi-Bri technology
- Pigmented phosphors
- Quick-heating low-power cathodes
- Soft-flash
- Slotted shadow mask optimized for minimum moiré at 625 lines systems
- Internal magnetic shield
- Internal multipole
- Reinforced envelope for push-through mounting
- Anti-crackle coating

QUICK REFERENCE DATA

Deflection angle	110°
Useful screen diagonal	59 cm
Overall length	39 cm
Neck diameter	29.1 mm
Heating	6.3 V, 310 mA
Anode voltage	25 kV
Focusing voltage	31% of anode voltage

* Aberration Reducing Triode.

ELECTRON-OPTICAL DATA

Electron gun system	unitized triple-aperture electrodes; aberration reducing triode	
Focusing method	electrostatic	
Focus lens	hi-bi-potential	
Deflection method	magnetic	
Deflection angles		
diagonal	110°	
horizontal	97°	
vertical	77°	

ELECTRICAL DATA

Capacitances			
anode to external conductive coating including rimband	$C_{a(m + m')}$		> 1800 pF
anode to metal rimband	$C_{am'}$		300 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 3 (focusing electrode) to all other electrodes	C_{g3}		6 pF
grid 1 to all other electrodes	C_{g1}		17 pF
grid 2 to all other electrodes	C_{g2}		4.5 pF
Resistance between rimband and external conductive coating		min.	50 MΩ
Heating: indirect by AC (preferably mains or line frequency) or DC			
heater voltage	V_f		6.3 V
heater current	I_f		310 mA

OPTICAL DATA

Screen	metal-backed vertical phosphor stripes; phosphor lines follow glass contour
Screen finish	satinized
Useful screen dimensions	
diagonal	593.6 mm
horizontal axis	479.6 mm
vertical axis	364.6 mm
area	1730 cm^2
Positional accuracy of the screen with respect to the glass contour	see Fig. 1
Phosphors	
red	pigmented europium activated rare earth
green	sulphide type
blue	pigmented sulphide type
Persistence	medium short

A = 180.3 mm
B = 257.7 mm
C = 123.0 mm
D = 200.2 mm
E = 25.2 mm

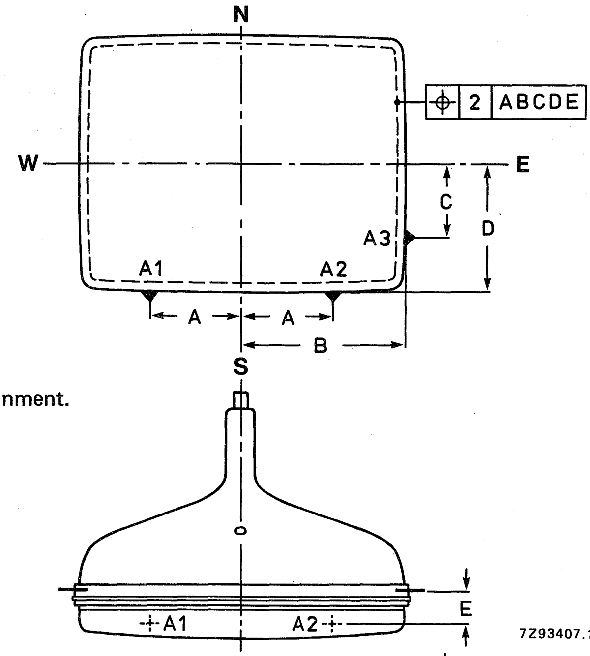


Fig. 1 Tube alignment.

Colour co-ordinates	x	y
red	0.620	0.340
green	0.305	0.600
blue	0.155	0.065

Centre-to-centre distance of identical colour phosphor stripes: approx. 0.8 mm

Light transmission of face glass at screen centre: 53%

Luminance at the centre of the screen L: 103 cd/m² *

MECHANICAL DATA (see also Figs 2 to 9)

Overall length	392 ± 6 mm
Neck diameter	$29.1^{+1.4}_{-0.7}$ mm
Base	JEDEC B10-277
Anode contact	small cavity contact J1-21, IEC 67-III-2
Mounting position	anode contact on top
Implosion protection	rimband provided with skirt and slots to accommodate clips for mounting of degaussing coils
Net mass	approximately 18 kg

Handling

During shipment and handling the tube should not be subjected to accelerations greater than 350 m/s^2 in any direction.

* Tube setting adjusted to produce white D (x = 0.313, y = 0.329), focused raster, current density 0.4 μA/cm^2.

MECHANICAL DATA (continued)

Dimensions in mm

Notes are given after the drawings.

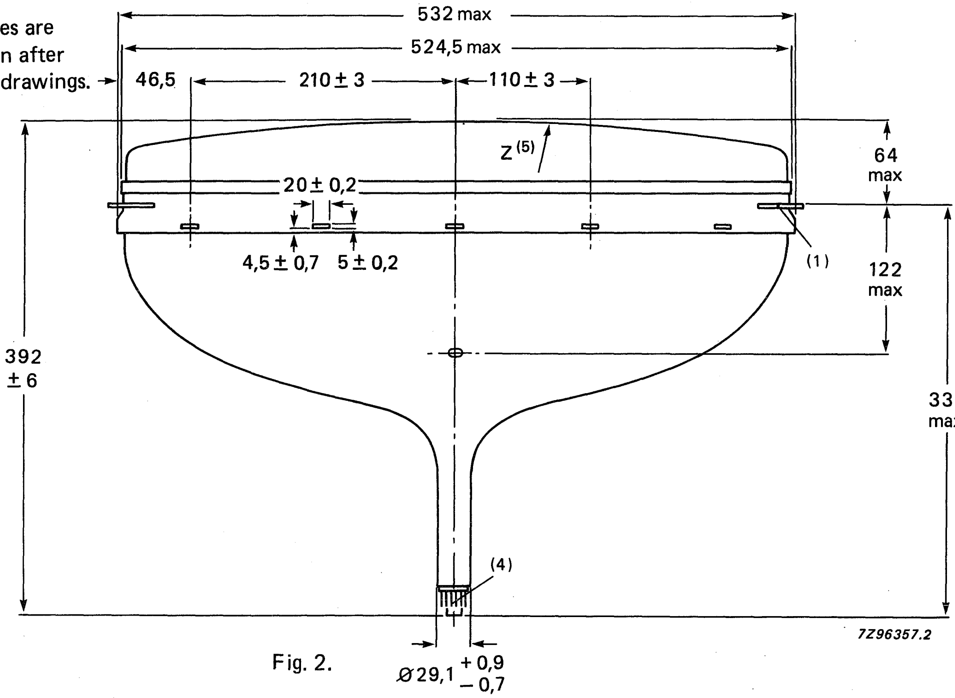


Fig. 2.

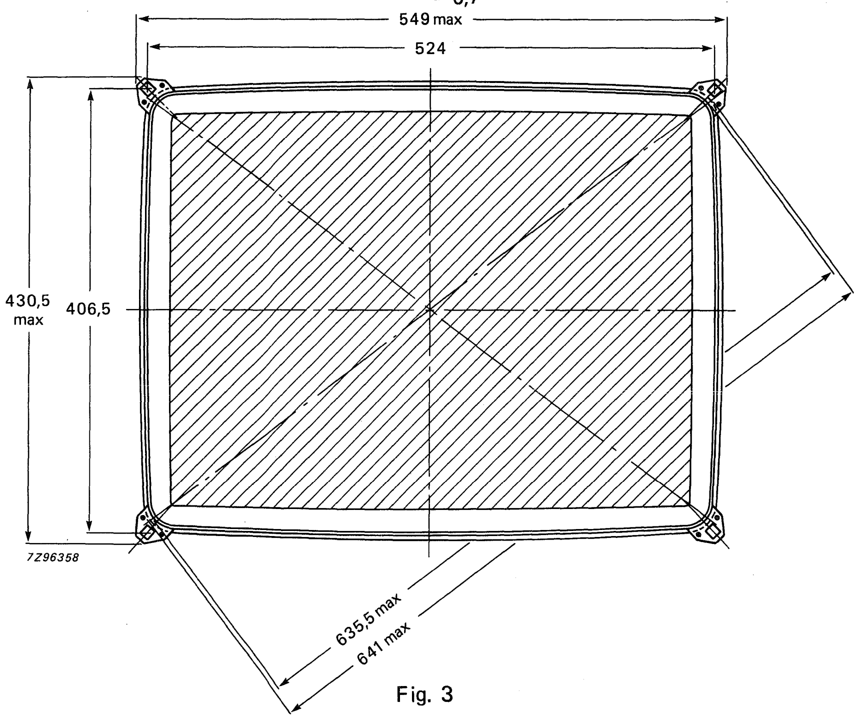


Fig. 3

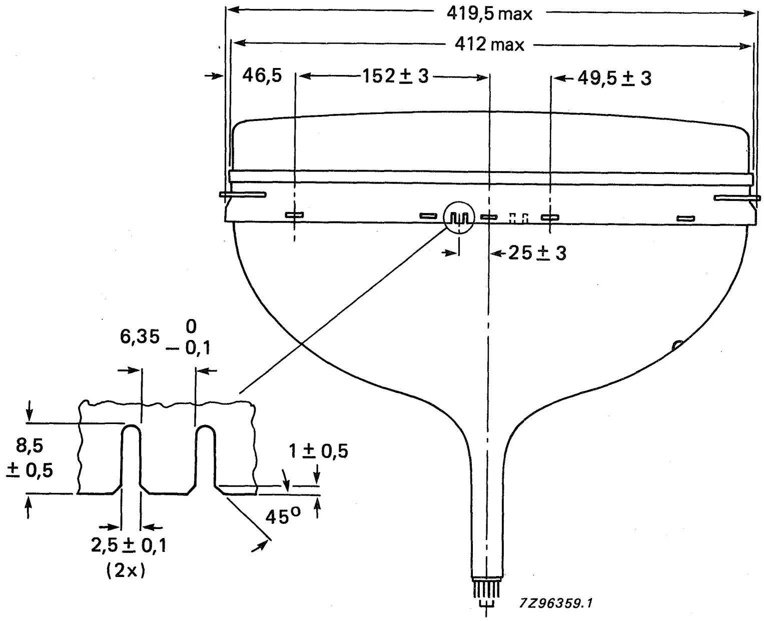

419,5 max
412 max
46,5
152 ± 3
49,5 ± 3
25 ± 3
6,35 0 − 0,1
8,5 ± 0,5
1 ± 0,5
45°
2,5 ± 0,1 (2x)
7Z96359.1

Fig. 4

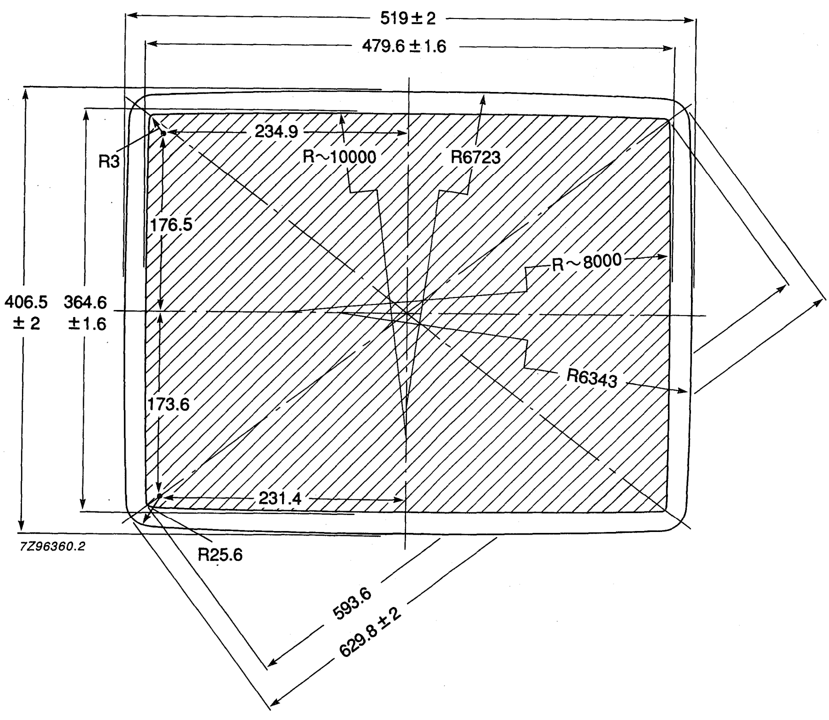

519 ± 2
479.6 ± 1.6
234.9
R~10000
R6723
R3
176.5
R~8000
406.5 ± 2
364.6 ±1.6
R6343
173.6
231.4
7Z96360.2
R25.6
593.6
629.8 ± 2

Fig. 5

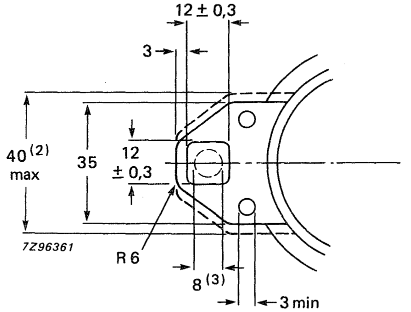


Fig. 6 Lug dimensions.

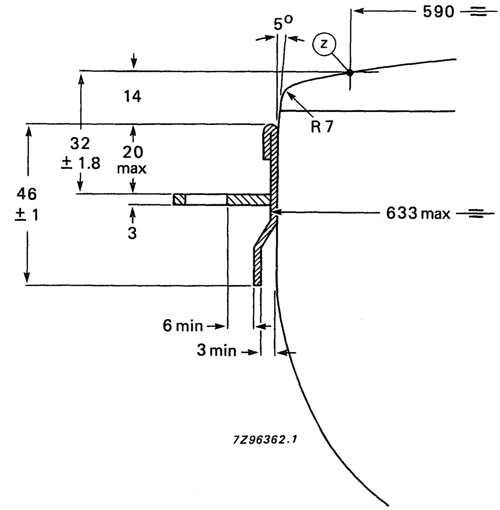


Fig. 7 Lug position.

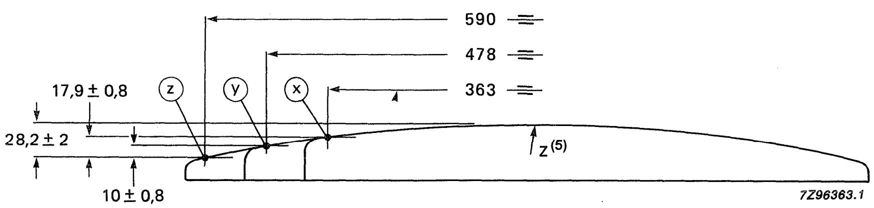


Fig. 8 Screen reference points.

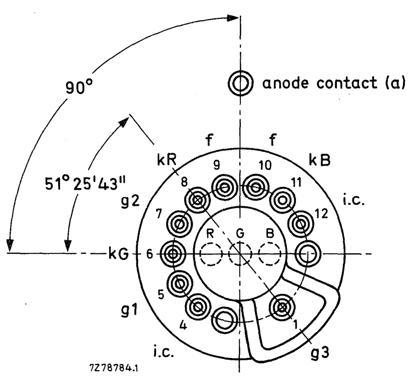


Fig. 9 Pin arrangement.

Notes to outline drawings

1. The displacement of any lug with respect to the plane through the three other lugs is max. 1.5 mm.
2. Minimum space to be reserved for mounting lug.
3. The position of the mounting screw in the cabinet must be within a circle of 8 mm diameter drawn around the true geometrical positions, i.e. the corners of a rectangle of 524 mm x 406.5 mm.
4. The socket for this base should not be rigidly mounted; it should have flexible leads and be allowed to move freely. After mounting of the tube in the cabinet note that the position of the base can fall within a circle, having a diameter of maximum 50 mm, concentric with an imaginary tube axis.
5. The distance Z from any point on the screen to the centre can be calculated using the following formula; (a number of points are given in Table 1):

$Z = F(X, Y)$
$R = \sqrt{(X \times X + Y \times Y)}$
$Z1 = 1607.25 - \sqrt{(1607.25 \times 1607.25 - 150.4 \times 150.4)}$
$Z2 = (1607.25 - Z1) \times 17.86/150.4$
$Z3 = 1607.25 - 1416.39 - Z2$
IF ($R < 150.4$) THEN $Z = 1607.25 - \sqrt{(1607.25 \times 1607.25 - R \times R)}$ ELSE
$Z = Z3 + 1416.39 - \sqrt{(1416.39 \times 1416.39 - (R - 17.86)^2)}$

Table 1 Sagittal heights with reference to screen centre at the edge of the nominal useful screen

	Nominal useful screen (NUS)			3 mm inside NUS			10 mm outside NUS		
	co-ordinates x mm	y mm	sagittal height mm	co-ordinates x mm	y mm	sagittal height mm	co-ordinates x mm	y mm	sagittal height mm
(1)	0	182.3	10.4	0	179.3	10.1	0	192.3	11.6
	20	182.3	10.5	20	179.3	10.2	20	192.3	11.7
	40	182.2	10.9	40	179.2	10.6	40	192.2	12.1
	60	182.1	11.6	60	179.1	11.2	60	192.1	12.8
	80	182.0	12.4	80	179.0	12.1	80	192.0	13.6
	100	181.8	13.6	100	178.8	13.2	100	192.8	14.8
	120	181.6	15.0	120	178.6	14.6	120	191.6	16.2
	140	181.3	16.7	140	178.3	16.3	140	191.3	17.9
	160	181.0	18.6	160	178.0	18.3	160	191.0	19.8
	180	180.6	20.8	180	177.6	20.5	180	190.6	22.1
	200	180.2	23.3	200	177.2	23.0	200	190.2	24.6
	220	179.8	26.1	220	176.8	25.7	220	189.8	27.3
(2)	237.3	178.3	28.6	234.9	175.0	27.8	247.6	189.2	31.6
	238.2	160	26.6	235.2	160	26.1	248.2	160	28.3
	238.6	140	24.7	235.6	140	24.2	248.6	140	26.3
	239.0	120	23.0	235.9	120	22.5	248.9	120	24.6
	239.2	100	21.6	236.2	100	21.1	249.2	100	23.2
	239.4	80	20.4	236.4	80	19.9	249.4	80	22.0
	239.6	60	19.5	236.6	60	19.0	249.6	60	21.1
	239.7	40	18.8	236.7	40	18.4	249.7	40	20.5
	239.8	20	18.5	236.8	20	18.0	249.8	20	20.1
(3)	239.8	0	18.3	236.8	0	17.9	249.8	0	19.9

(1) End of long axis.
(2) End of diagonal axis.
(3) End of short axis.

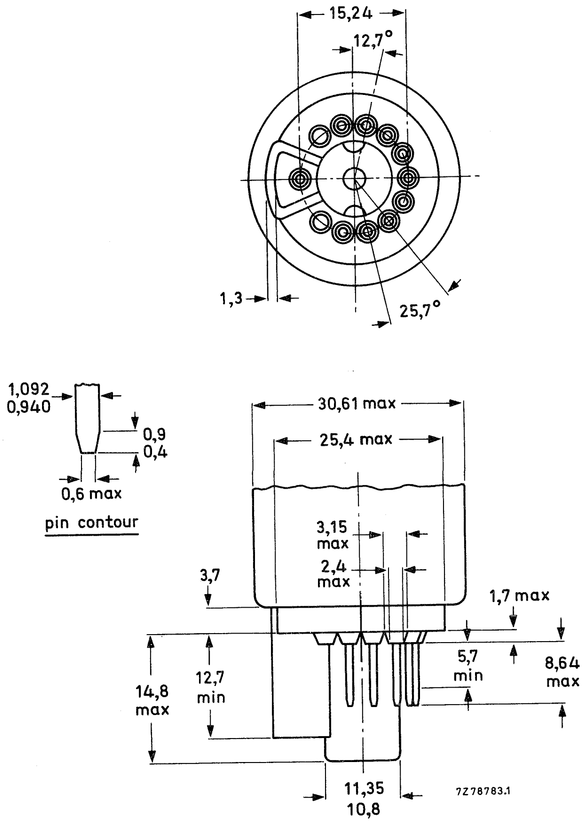


Fig. 10 10-pin base; JEDEC B10-277.

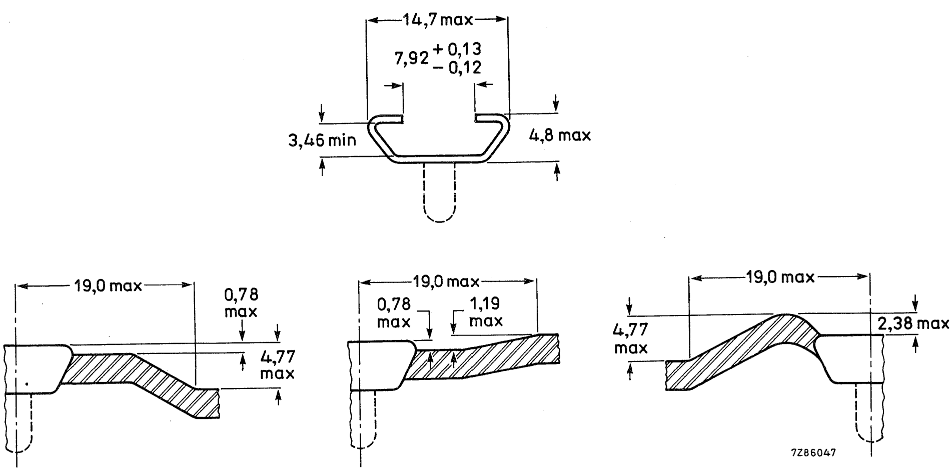


Fig. 11 Cavity cap JEDEC J-21, IEC 67-III-2.

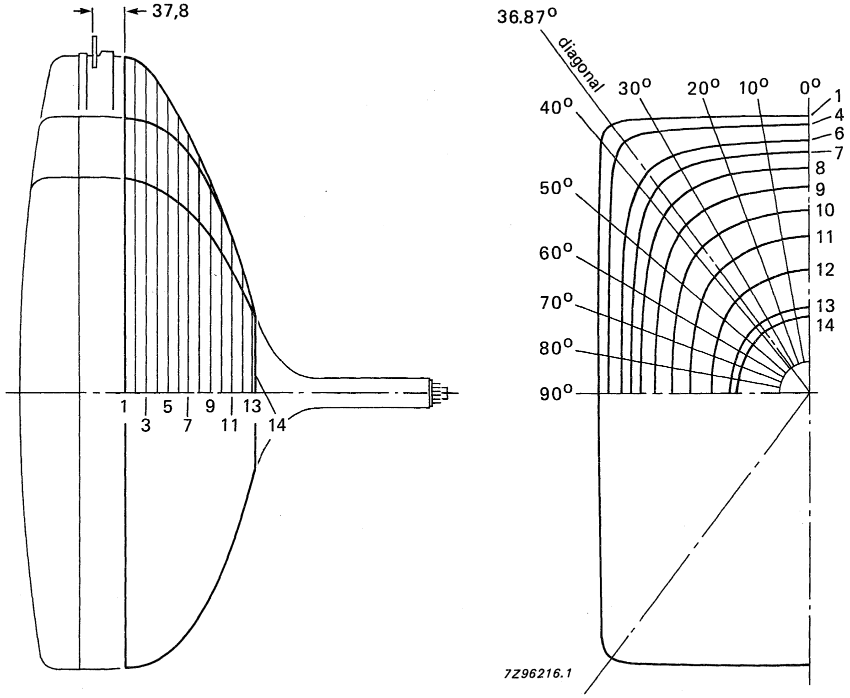


Fig. 12 Maximum cone contour.

Table 2 Cone contour data. Dimensions in mm

section	nom. distance from section 1	distance from centre										
		0°	10°	20°	30°	36,87°	40°	50°	60°	70°	80°	90°
1	0.00	257.6	261.5	273.7	296.3	314.1	307.9	260.3	231.0	213.3	203.7	200.6
2	10.00	256.9	260.7	272.8	294.9	311.7	305.1	258.6	229.7	212.1	202.6	199.6
3	20.00	254.8	258.5	270.2	291.3	304.7	297.9	254.5	226.3	209.2	199.8	196.9
4	30.00	250.9	254.5	265.5	284.7	293.0	286.6	248.0	221.0	204.5	195.5	192.6
5	40.00	245.1	248.4	258.5	274.1	277.4	271.6	239.0	213.9	198.3	189.7	187.0
6	50.00	237.0	239.9	248.7	260.3	260.0	254.9	228.1	205.4	190.7	182.7	180.1
7	60.00	225.8	228.3	235.6	243.3	241.1	236.7	214.8	194.8	181.5	174.0	171.7
8	70.00	210.7	212.9	218.6	223.2	220.3	216.6	199.0	181.9	170.0	163.2	161.1
9	80.00	191.7	193.4	197.8	200.5	197.6	194.6	180.4	166.1	155.8	149.8	147.9
10	90.00	170.1	171.5	174.6	175.9	173.0	170.4	159.1	147.5	138.8	133.6	131.9
11	100.00	145.8	146.7	148.5	148.4	145.6	143.5	135.0	126.2	119.3	115.1	113.7
12	110.00	115.2	115.8	116.7	116.2	114.4	113.3	108.4	103.0	98.4	95.5	94.4
13	120.00	79.9	80.1	80.3	80.1	79.8	79.6	78.7	77.5	76.4	75.5	75.1
14	121.4	74.4	74.5	74.5	74.5	74.4	74.3	73.9	73.4	72.9	72.5	72.3

TYPICAL OPERATING CONDITIONS

The voltages are specified with respect to grid 1.

Anode voltage	$V_{a,g4}$	25 kV
Grid 3 (focusing electrode) voltage	V_{g3}	7.25 to 8.25 kV
Grid 2 voltage for a spot cut-off voltage V_k = 130 V	V_{g2}	see below
Heater voltage under operating conditions	V_f	6.3 V

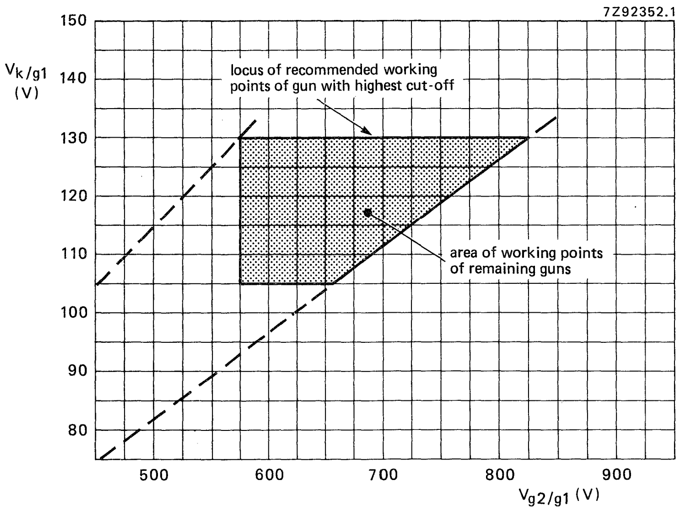


Fig. 13 Spot cut-off design chart.

Grid 2 voltage (V_{g2}) adjusted for highest gun spot cut-off voltage V_k = 130 V.

Remaining guns adjusted for spot cut-off by means of cathode voltage

V_{g2} range 575 to 825 V;

V_k range 105 to 130 V.

Adjustment procedure:

Set the cathode voltage (V_k) for each gun at 130 V; increase the grid 2 voltage (V_{g2}) from approximately 550 V to the value at which one of the colours become just visible. Now decrease the cathode voltage of the remaining guns so that the other colours also become visible.

EQUIPMENT DESIGN VALUES

The values are valid for anode voltages between 20 and 27.5 kV.
The voltages are specified with respect to grid 1.

Grid 3 (focusing electrode) voltage	V_{g3}	29 to 33% of anode voltage
Grid 2 voltage and cathode voltage for visual extinction of focused spot	V_{g2} and V_k	see Fig. 13
Difference in cut-off voltages between guns in any tube	ΔV_k	lowest value > 80% of highest value
Heater voltage	V_f	6.3 V at zero beam current
Video drive characteristics		see Fig. 14*
Grid 3 (focusing electrode) current	I_{g3}	−2 to + 2 μA
Grid 2 current	I_{g2}	−2 to + 2 μA
Grid 1 current under cut-off conditions	I_{g1}	−2 to + 2 μA

To produce white of 6500K + 7 M.P.C.D.
(CIE-co-ordinates x = 0.313, y = 0.329)

Percentage of the total anode current supplied by each gun (typical)

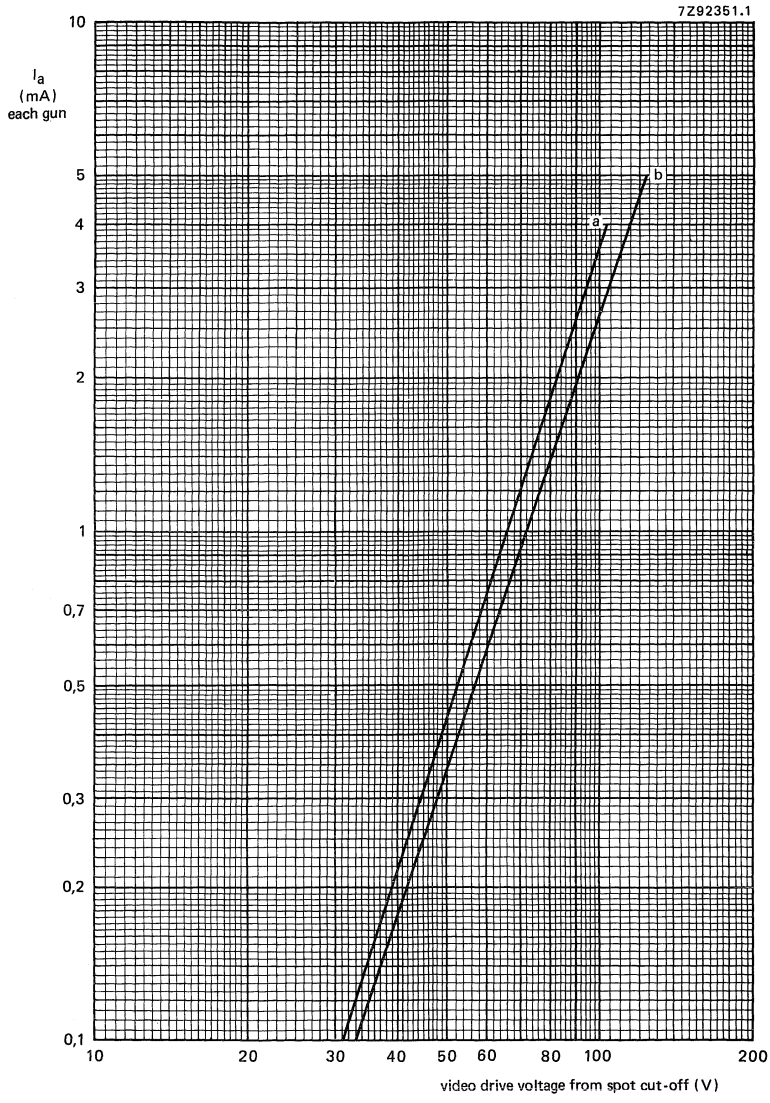
red gun	40.5%
green gun	32.4%
blue gun	27.1%

Ratio of anode currents

red gun to green gun	min.	0.90
	average	1.25
	max.	1.60
red gun to blue gun	min.	1.10
	average	1.50
	max.	1.90
blue gun to green gun	min.	0.60
	average	0.85
	max.	1.20

Insulation resistance between each cathode and grid 1 and heater — min. 50 MΩ

* For optimum picture performance it is recommended that the cathodes are not driven below + 1 V.



V_f = 6.3 V;

$V_{a,g4}$ = 25 kV;

V_{g3} adjusted for focus;

V_{g2} (each gun) adjusted to provide spot cut-off for V_k = 105 V (curve a) and V_k 130 V (curve b).

Fig. 14 Typical cathode drive characteristics.

LIMITING VALUES (Design maximum rating system unless otherwise stated)

The voltages are specified with respect to grid 1.

					notes
Anode voltage	$V_{a,g4}$	max.	29.5	kV	1, 2, Fig.15
		min.	20	kV	1, 3
Long-term average current for three guns	I_a	max.	1000	μA	4
Grid 3 (focusing electrode) voltage	V_{g3}	max.	12	kV	
Grid 2 voltage	V_{g2}	max.	1200	V	5
Cathode voltage					
positive	V_k	max.	400	V	
positive operating cut-off	V_k	max.	200	V	
negative	$-V_k$	max.	0	V	
negative peak	$-V_{kp}$	max.	2	V	
Cathode to heater voltage					
positive	V_{kf}	max.	250	V	
positive peak	V_{kfp}	max.	300	V	1
negative	$-V_{kf}$	max.	135	V	
negative peak	$-V_{kfp}$	max.	180	V	1
Heater voltage	V_f		6.3 V $^{+5}_{-10}$	%	1, 6

LIMITING CIRCUIT VALUES

Grid 3 circuit resistance	R_{g3}	max.	70	MΩ
Grid 1 to cathode circuit resistance (each gun)	R_{g1k}	max.	0.75	MΩ

BEAM CENTRING

Maximum centring error in any direction 4 mm

Notes

1. Absolute maximum rating system
2. 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 with-output picture tube.
3. Operation of the tube at lower voltages impairs the luminance and resolution, and could impair convergence.
4. The short-term average anode current should be limited by circuitry to 1500 μA.
5. During adjustment on the production line maximum 1500 V is permitted.
6. For maximum cathode life it is recommended that the heater supply be designed for 6.3 V at zero beam current.

The colour picture tube does not emit X-radiation above 1 µSv/h when operated at 29.5 kV and 1 mA. The X-radiation emitted will also not exceed 1 µSv/h for anode voltage and current combinations given by the isoexposure-rate limit curve shown in Fig.15.

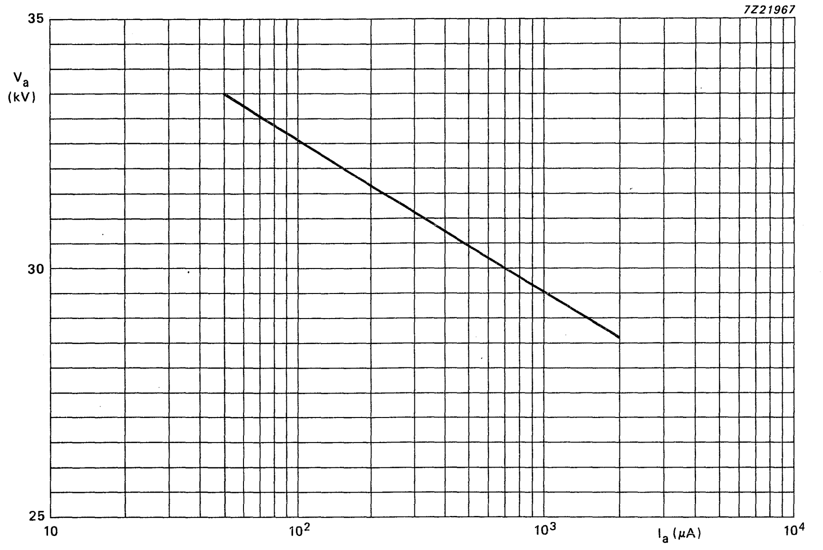


Fig. 15 µSv/h isoexposure-rate limit curve.

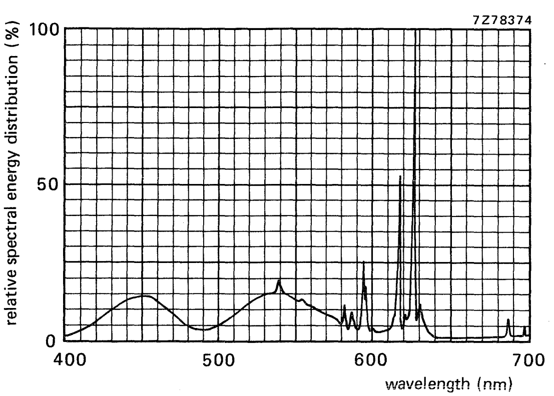


Fig. 16 Simultaneous excitation of red, green and blue phosphor, measured in a tube, to produce white of x = 0.313, y = 0.329. Exact shape of the peaks depends on the resolution of the measuring apparatus.
Colour co-ordinates:

	x	y
red	0.620	0.340
green	0.305	0.600
blue	0.155	0.065

DEGAUSSING

The picture tube is provided with an internal magnetic shield. This shield and the shadow mask with its suspension system may be provided with an automatic degaussing system, consisting of two coils covering top and bottom cone parts, or one large coil.

For proper degaussing an initial magnetomotive force (MMF) of 300 ampere-turns is required in each of the coils. This MMF has to be gradually decreased by appropriate circuitry. To prevent beam landing disturbances by line-frequency currents induced in the degaussing coils, these coils should be shunted by a capacitor of sufficiently high value. In the steady state, no significant MMF should remain in the coils ($\leqslant$ 0.15 ampere-turns).

If single-phase power rectification is employed in the TV circuitry, provision should be included to prevent asymmetric distortion of the AC voltage applied to the degaussing circuit due to high DC inrush currents.

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

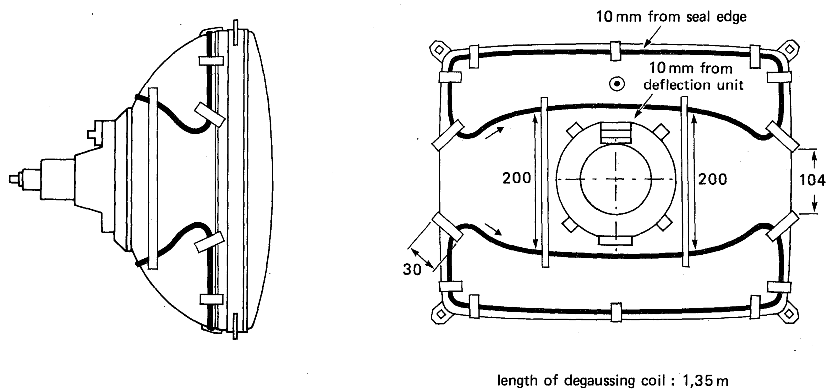


Fig. 17 Double-coil system.

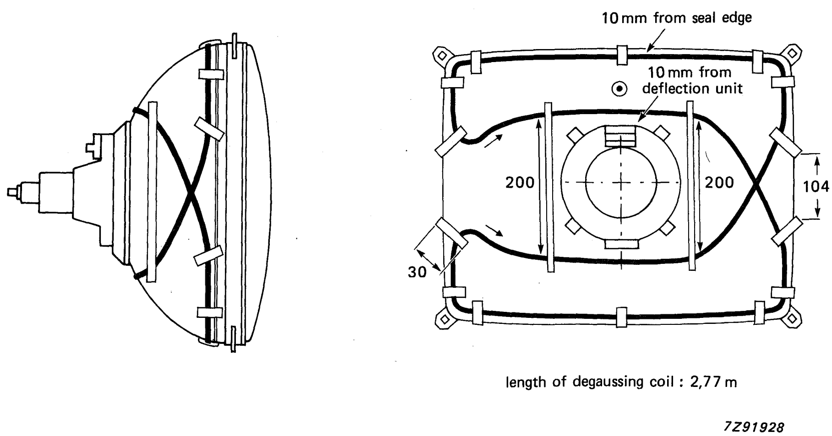


Fig. 18 Single-coil system.

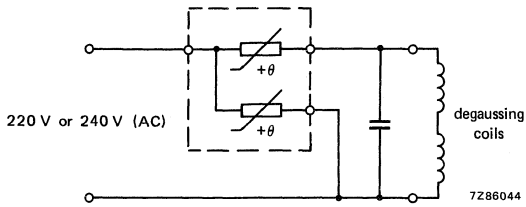


Fig. 19 Deguassing circuit using dual PTC thermistor 2322 662 98009; C = 100 nF.

Table 3 Data of each degaussing coil

	double-coil system	single-coil system
Circumference	135 cm	277 cm
Number of turns	60	60
Copper-wire diameter	0.4 mm	0.4 mm
Aluminium-wire diameter	0.5 mm	0.5 mm
Resistance	11 Ω	22 Ω

110° FLAT SQUARE COLOUR PICTURE TUBE ASSEMBLY

- Factory preset tube/coil assembly
- Self-converging and north-south raster correction free
- 59 cm, 110° colour picture tube A59EAK01X
- Double saddle deflection unit AT6010/00

QUICK REFERENCE DATA

Deflection angle	110°
Minimum useful screen diagonal	59 cm
Overall length	39 cm
Neck diameter	29.1 mm

MECHANICAL DATA

Dimensions in mm

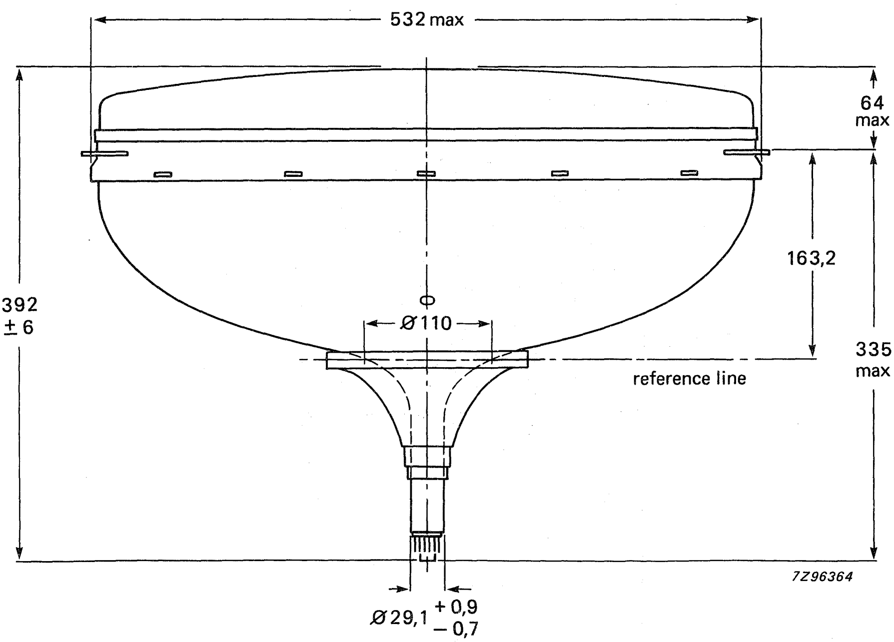


Fig. 1 Tube assembly.

Net mass of tube assembly: 20 kg

MECHANICAL DATA

Dimensions in mm

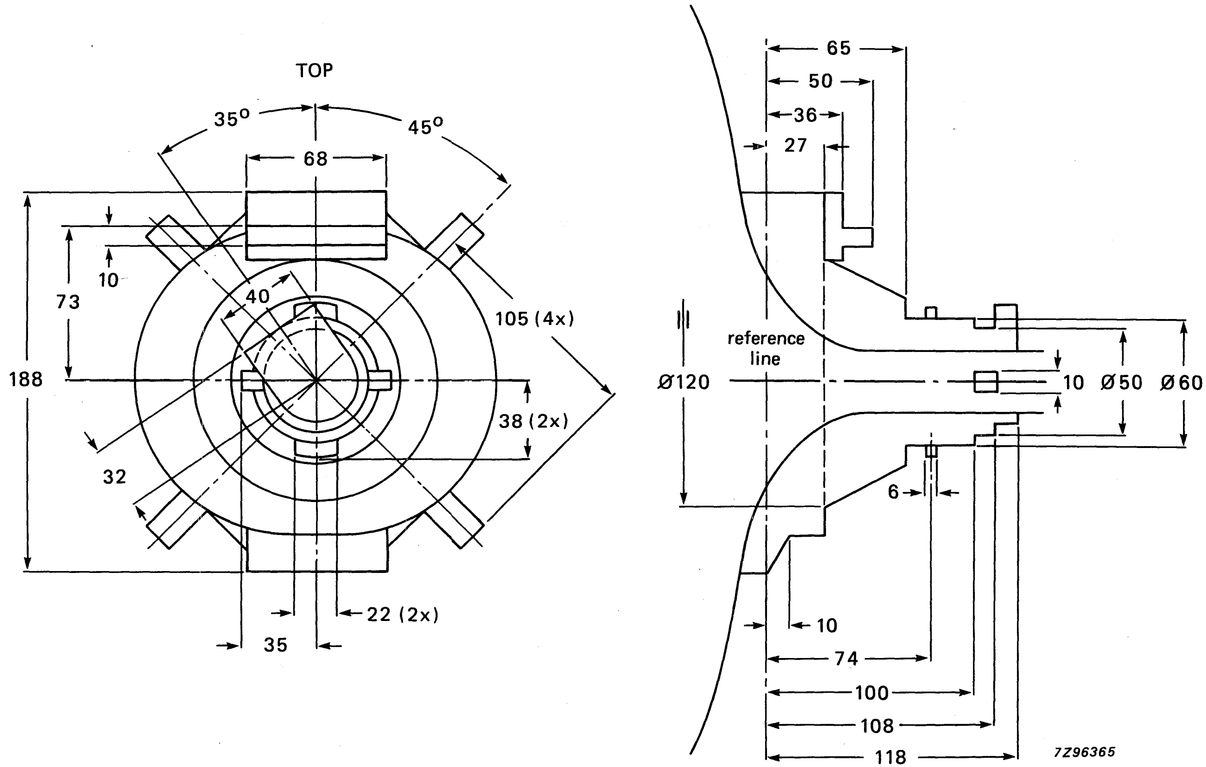
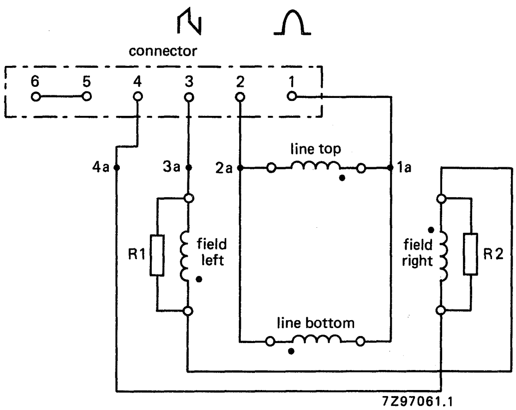


Fig. 2 Yoke clearance.

ELECTRICAL DATA OF DEFLECTION UNIT

Line coils	parallel connected
Inductance at 1 V (RMS), 1 kHz	1.85 mH
Resistance at 25 °C	1.8 Ω
Magnetic flux	7.6 mWb ± 5%
Line deflection current, edge to edge, at 25 kV	4.10 A (p-p)
Field coils	series connected
Inductance at 1 V (RMS), 1 kHz	11.1 mH
Resistance at 25 °C	6.3 Ω
Field deflection current, edge to edge, at 25 kV	1.65 A (p-p)



The beginning of the windings is indicated with ●.
R1 = R2 = 100 Ω, 0.25 W.
Matching Stocko connector MKF 2806-1-0-606.

Fig.3 Electrical diagram.

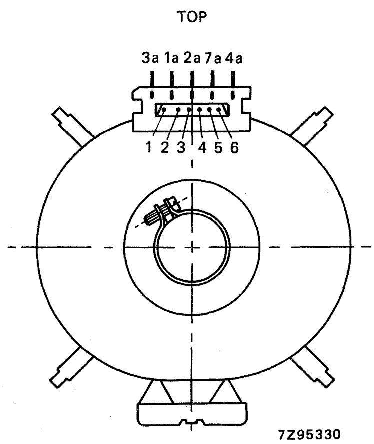


Fig.4 Terminal location.

FLAT AND SQUARE 'BLACK LINE' COLOUR PICTURE TUBE

- Flat and square screen
- 110° deflection
- In-line, hi-bi potential A R T* gun with quadrupole cathode lens
- 29.1 mm neck diameter
- INVAR mask with corner suspension
- Hi-Bri technology
- Pigmented phosphors
- Quick-heating low-power cathodes
- Soft-flash
- Slotted shadow mask optimized for minimum moiré at 625 lines systems
- Internal magnetic shield
- Internal multipole
- Reinforced envelope for push-through mounting
- Anti-crackle coating

QUICK REFERENCE DATA

Deflection angle	110°
Useful screen diagonal	59 cm
Overall length	39 cm
Glass transmission	42%
Neck diameter	29.1 mm
Heating	6.3 V, 310 mA
Anode voltage	27.5 kV
Focusing voltage	31% of anode voltage

* Aberration Reducing Triode.

ELECTRON-OPTICAL DATA

Electron gun system	unitized triple-aperture electrodes; aberration reducing triode
Focusing method	electrostatic
Focus lens	hi-bi potential
Deflection method	magnetic
Deflection angles	
diagonal	110°
horizontal	97°
vertical	77°

ELECTRICAL DATA

Capacitances			
anode to external conductive coating including rimband	$C_{a(m+m')}$		> 1800 pF
anode to metal rimband	$C_{am'}$		300 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 3 (focusing electrode) to all other electrodes	C_{g3}		6 pF
grid 1 to all other electrodes	C_{g1}		17 pF
grid 2 to all other electrodes	C_{g2}		4.5 pF
Resistance between rimband and external conductive coating		min.	50 MΩ
Heating: indirect by AC (preferably mains or line frequency) or DC			
heater voltage	V_f		6.3 V
heater current	I_f		310 mA

OPTICAL DATA

Screen	metal-backed vertical phosphor stripes; phosphor lines follow glass contour
Screen finish	satinized
Useful screen dimensions	
diagonal	593.6 mm
horizontal axis	479.6 mm
vertical axis	364.6 mm
area	1730 cm^2
Positional accuracy of the screen with respect to the glass contour	see Fig. 1
Phosphors	
red	pigmented europium activated rare earth
green	sulphide type
blue	pigmented sulphide type
Persistence	medium short

A = 180.3 mm
B = 257.7 mm
C = 123.0 mm
D = 200.2 mm
E = 25.2 mm

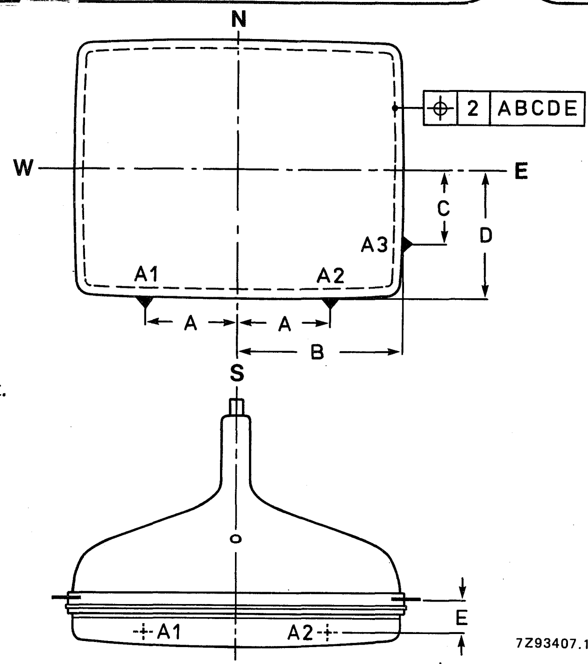


Fig. 1 Tube alignment.

Colour co-ordinates	x	y
red	0.620	0.340
green	0.305	0.600
blue	0.155	0.065

Centre-to-centre distance of identical colour phosphor stripes		approx. 0.8 mm
Light transmission of face glass at screen centre		42%
Luminance at the centre of the screen	L	90 cd/m² *

MECHANICAL DATA (see also Figs 2 to 9)

Overall length	392 ± 6 mm
Neck diameter	$29.1^{+1.4}_{-0.7}$ mm
Base	JEDEC B10-277
Anode contact	small cavity contact J1-21, IEC 67-III-2
Mounting position	anode contact on top
Implosion protection	rimband provided with skirt and slots to accommodate clips for mounting of degaussing coils
Net mass	approx. 18 kg

Handling

During shipment and handling the tube should not be subjected to accelerations greater than 350 m/s^2 in any direction.

* Tube setting adjusted to produce white D (x = 0.313, y = 0.329), focused raster, current density 0.4 $\mu A/cm^2$.

MECHANICAL DATA (continued)

Notes are given after the drawings.

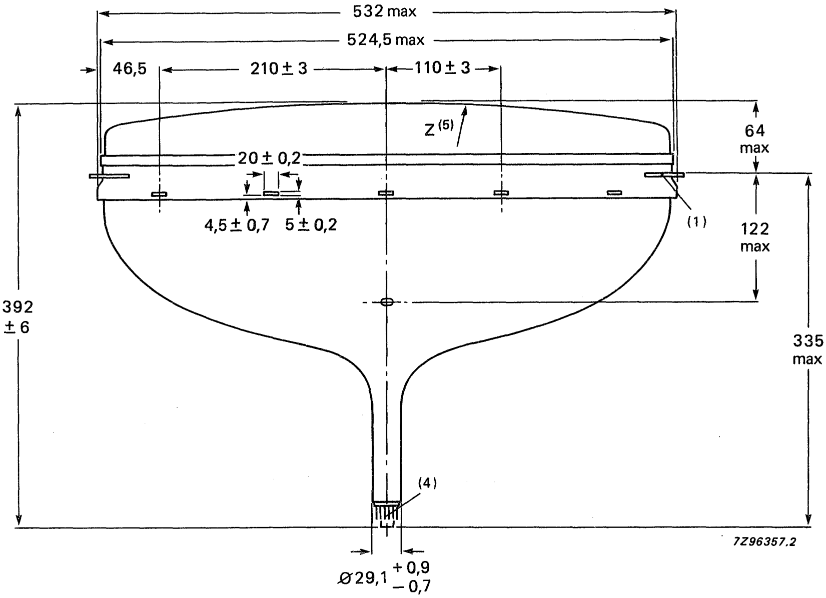


Fig. 2.

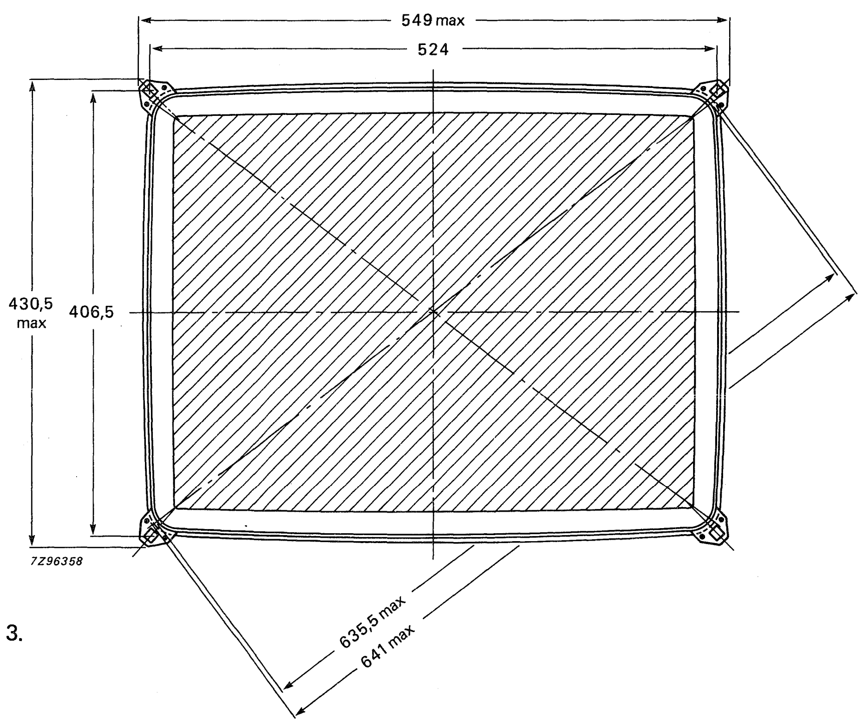


Fig. 3.

DEVELOPMENT DATA

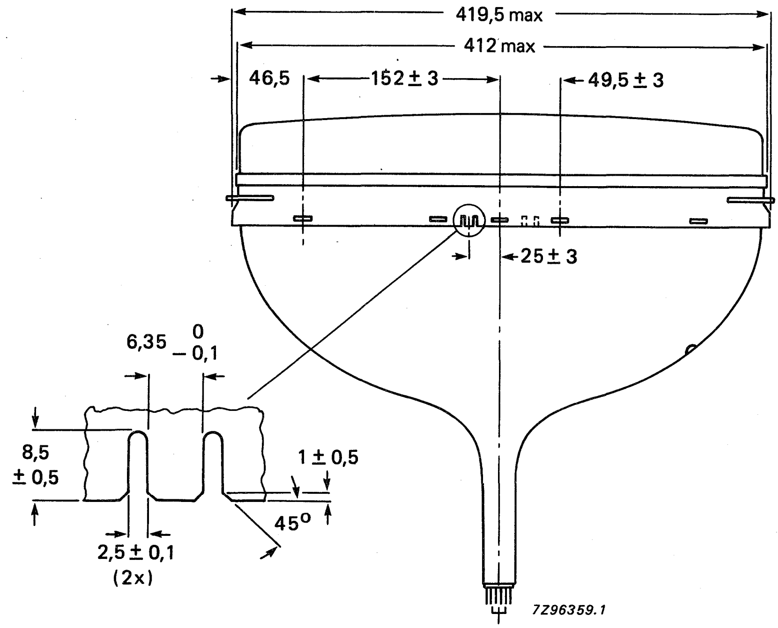


Fig. 4.

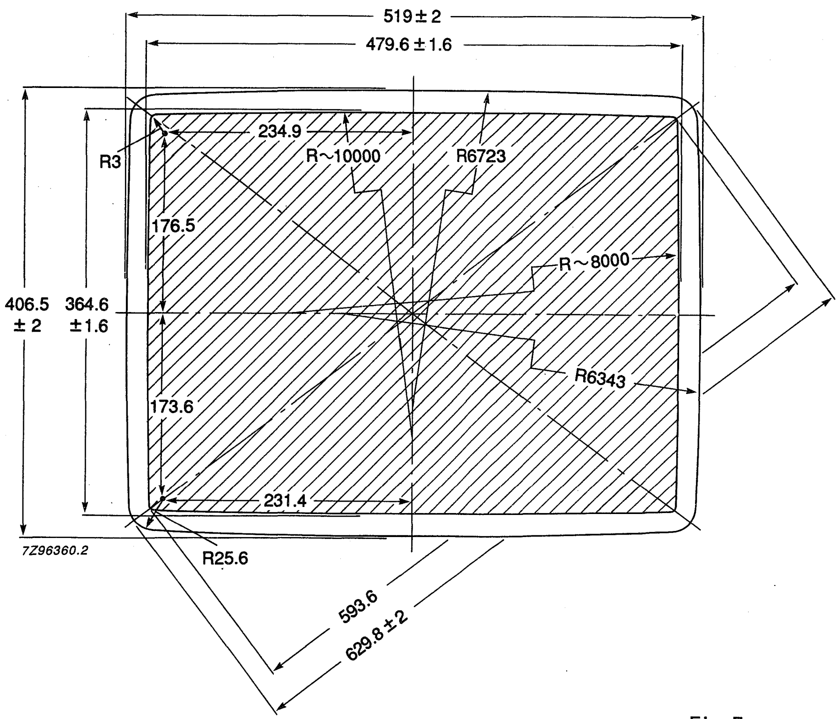


Fig. 5.

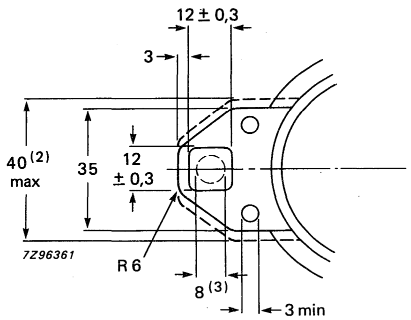


Fig. 6 Lug dimensions.

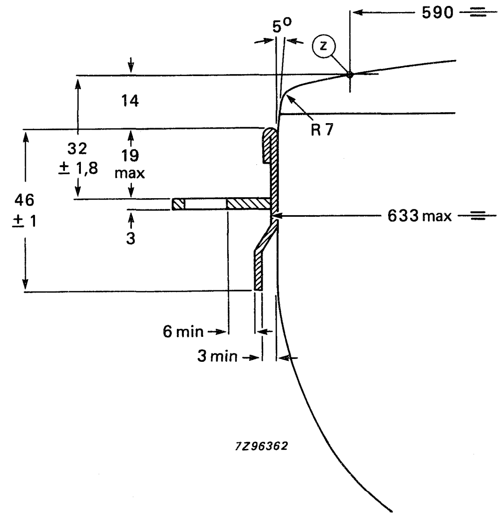


Fig. 7 Lug position.

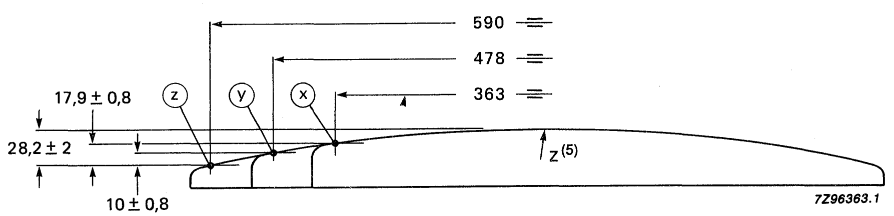


Fig. 8 Screen reference points.

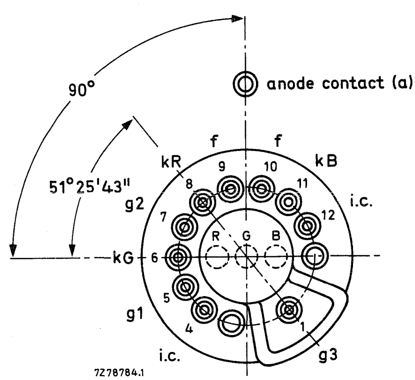


Fig. 9 Pin arrangement.

Notes to outline drawings

1. The displacement of any lug with respect to the plane through the three other lugs is max. 1.5 mm.
2. Minimum space to be reserved for mounting lug.
3. The position of the mounting screw in the cabinet must be within a circle of 8 mm diameter drawn around the true geometrical positions, i.e. the corners of a rectangle of 524 mm x 406.5 mm.
4. The socket for this base should not be rigidly mounted; it should have flexible leads and be allowed to move freely. After mounting of the tube in the cabinet note that the position of the base can fall within a circle, having a diameter of maximum 50 mm, concentric with an imaginary tube axis.
5. The distance Z from any point on the screen to the centre can be calculated using the following formula:

$Z = F(X, Y)$

$R = \sqrt{(X \times X + Y \times Y)}$

$Z1 = 1607.25 - \sqrt{(1607.25 \times 1607.25 - 150.4 \times 150.4)}$

$Z2 = (1607.25 - Z1) \times 17.86/150.4$

$Z3 = 1607.25 - 1416.39 - Z2$

IF $(R < 150.4)$ THEN $Z = 1607.25 - \sqrt{(1607.25 \times 1607.25 - R \times R)}$ ELSE

$Z = Z3 + 1416.39 - \sqrt{(1416.39 \times 1416.39 - (R - 17.86)^2)}$

Table 1 Sagittal heights with reference to screen centre at the edge of the nominal useful screen

	Nominal useful screen (NUS)			3 mm inside NUS			10 mm outside NUS		
	co-ordinates x mm	co-ordinates y mm	sagittal height mm	co-ordinates x mm	co-ordinates y mm	sagittal height mm	co-ordinates x mm	co-ordinates y mm	sagittal height mm
(1)	0	182.3	10.4	0	179.3	10.1	0	192.3	11.6
	20	182.3	10.5	20	179.3	10.2	20	192.3	11.7
	40	182.2	10.9	40	179.2	10.6	40	192.2	12.1
	60	182.1	11.6	60	179.1	11.2	60	192.1	12.8
	80	182.0	12.4	80	179.0	12.1	80	192.0	13.6
	100	181.8	13.6	100	178.8	13.2	100	192.8	14.8
	120	181.6	15.0	120	178.6	14.6	120	191.6	16.2
	140	181.3	16.7	140	178.3	16.3	140	191.3	17.9
	160	181.0	18.6	160	178.0	18.3	160	191.0	19.8
	180	180.6	20.8	180	177.6	20.5	180	190.6	22.1
	200	180.2	23.3	200	177.2	23.0	200	190.2	24.6
	220	179.8	26.1	220	176.8	25.7	220	189.8	27.3
(2)	237.3	178.3	28.6	234.9	175.0	27.8	247.6	189.2	31.6
	238.2	160	26.6	235.2	160	26.1	248.2	160	28.3
	238.6	140	24.7	235.6	140	24.2	248.6	140	26.3
	239.0	120	23.0	235.9	120	22.5	248.9	120	24.6
	239.2	100	21.6	236.2	100	21.1	249.2	100	23.2
	239.4	80	20.4	236.4	80	19.9	249.4	80	22.0
	239.6	60	19.5	236.6	60	19.0	249.6	60	21.1
	239.7	40	18.8	236.7	40	18.4	249.7	40	20.5
	239.8	20	18.5	236.8	20	18.0	249.8	20	20.1
(3)	239.8	0	18.3	236.8	0	17.9	249.8	0	19.9

(1) End of long axis.
(2) End of diagonal axis.
(3) End of short axis.

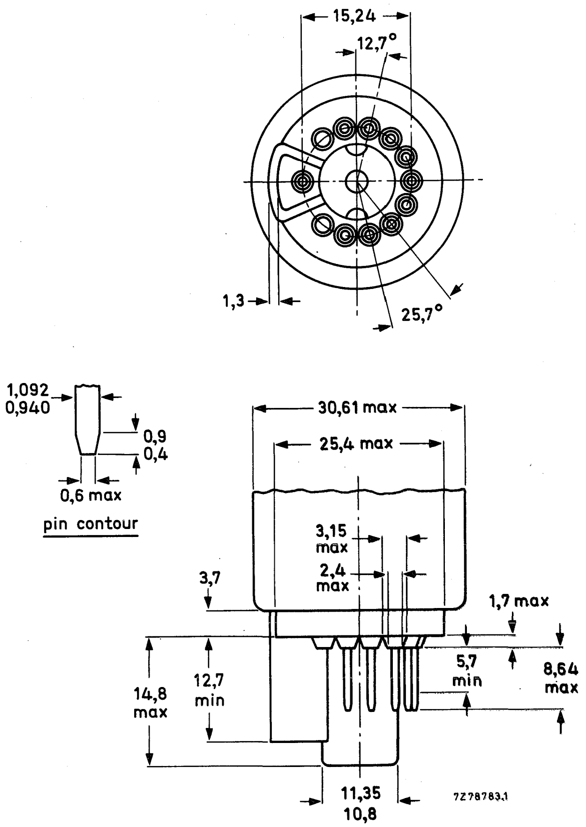


Fig. 10 10-pin base; JEDEC B10-277.

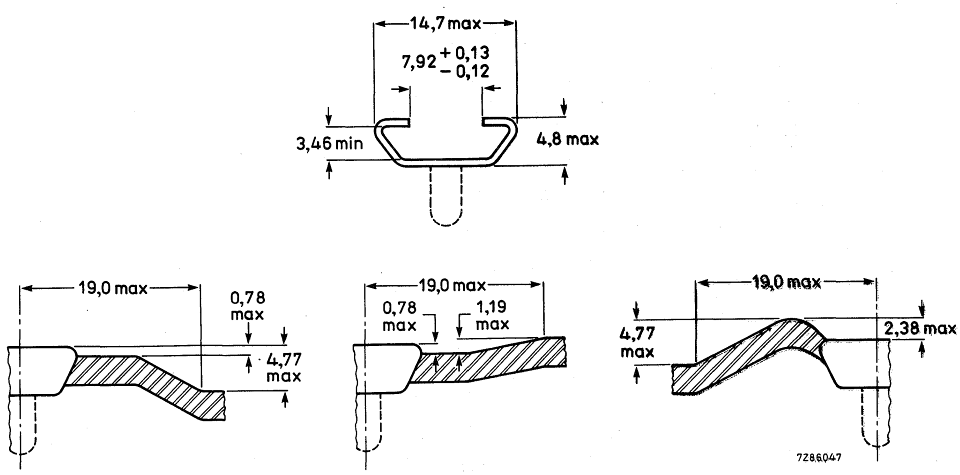


Fig. 11 Cavity cap JEDEC J-21, IEC 67-111-2.

DEVELOPMENT DATA

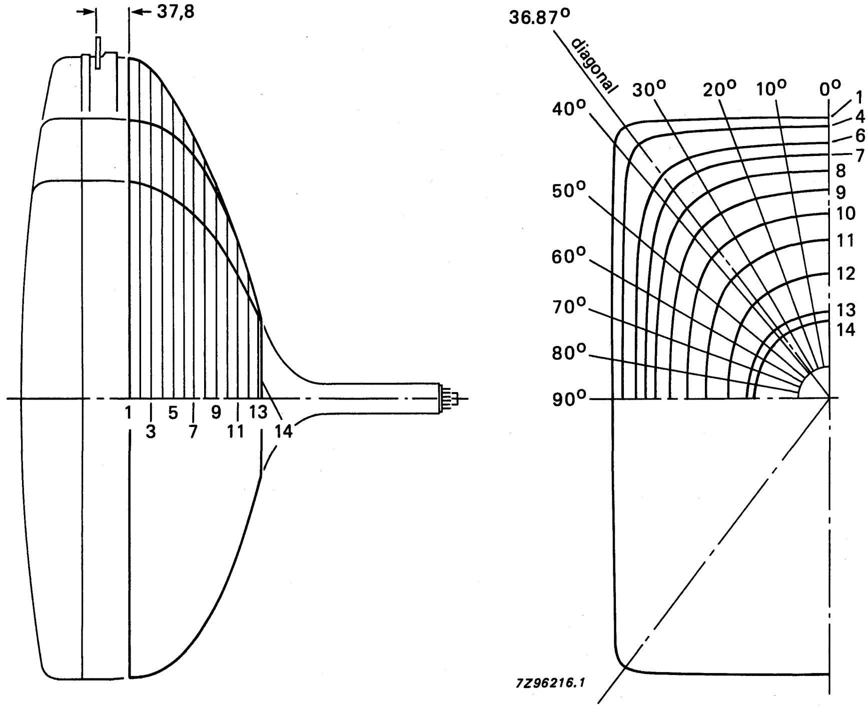


Fig. 12 Maximum cone contour.

Table 2 Cone contour data

Dimensions in mm

section	nom. distance from section 1	distance from centre										
		0°	10°	20°	30°	36.87°	40°	50°	60°	70°	80°	90°
1	0.00	257.6	261.5	273.7	296.3	314.1	307.9	260.3	231.0	213.3	203.7	200.6
2	10.00	256.9	260.7	272.8	294.9	311.7	305.1	258.6	229.7	212.1	202.6	199.6
3	20.00	254.8	258.5	270.2	291.3	304.7	297.9	254.5	226.3	209.2	199.8	196.9
4	30.00	250.9	254.5	265.5	284.7	293.0	286.6	248.0	221.0	204.5	195.5	192.6
5	40.00	245.1	248.4	258.5	274.1	277.4	271.6	239.0	213.9	198.3	189.7	187.0
6	50.00	237.0	239.9	248.7	260.3	260.0	254.9	228.1	205.4	190.7	182.7	180.1
7	60.00	225.8	228.3	235.6	243.3	241.1	236.7	214.8	194.8	181.5	174.0	171.7
8	70.00	210.7	212.9	218.6	223.2	220.3	216.6	199.0	181.9	170.0	163.2	161.1
9	80.00	191.7	193.4	197.8	200.5	197.6	194.6	180.4	166.1	155.8	149.8	147.9
10	90.00	170.1	171.5	174.6	175.9	173.0	170.4	159.1	147.5	138.8	133.6	131.9
11	100.00	145.8	146.7	148.5	148.4	145.6	143.5	135.0	126.2	119.3	115.1	113.7
12	110.00	115.2	115.8	116.7	116.2	114.4	113.3	108.4	103.0	98.4	95.5	94.4
13	120.00	79.9	80.1	80.3	80.1	79.8	79.6	78.7	77.5	76.4	75.5	75.1
14	121.4	74.4	74.5	74.5	74.5	74.4	74.3	73.9	73.4	72.9	72.5	72.3

TYPICAL OPERATING CONDITIONS

The voltages are specified with respect to grid 1.

Anode voltage	$V_{a,g4}$	27.5 kV
Grid 3 (focusing electrode) voltage	V_{g3}	8 to 9.1 kV
Grid 2 voltage for a spot cut-off voltage V_k = 160 V	V_{g2}	see notes below
Heater voltage under operating conditions	V_f	6.3 V

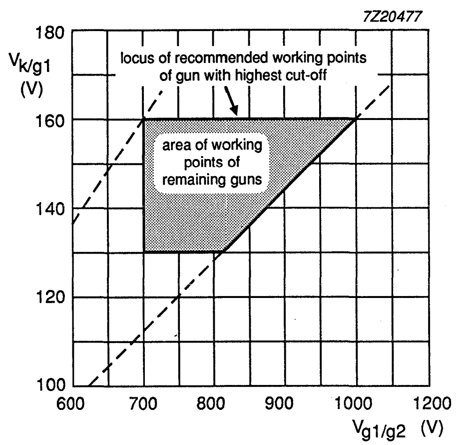


Fig. 13 Spot cut-off design chart.

Grid 2 voltage (V_{g2}) adjusted for highest gun spot cut-off voltage V_k = 160 V.

Remaining guns adjusted for spot cut-off by means of cathode voltage

V_{g2} range 700 to 1000 V;

V_k range 130 to 160 V.

Adjustment procedure:

Set the cathode voltage (V_k) for each gun at 160 V; increase the grid 2 voltage (V_{g2}) from approximately 650 V to the value at which one of the colours become just visible. Now decrease the cathode voltage of the remaining guns so that the other colours also become visible.

DEVELOPMENT DATA

EQUIPMENT DESIGN VALUES

The values are valid for anode voltages between 25 and 29.9 kV.
The voltages are specified with respect to grid 1.

Grid 3 (focusing electrode) voltage	V_{g3}	29 to 33% of anode voltage
Grid 2 voltage and cathode voltage for visual extinction of focused spot	V_{g2} and V_k	see Fig.13
Difference in cut-off voltages between guns in any tube	ΔV_k	lowest value > 80% of highest value
Heater voltage	V_f	6.3 V at zero beam current
Grid 3 (focusing electrode) current	I_{g3}	−2 to + 2 μA
Grid 2 current	I_{g2}	−2 to + 2 μA
Grid 1 current under cut-off conditions	I_{g1}	−2 to + 2 μA

To produce white of 6500K + 7 M.P.C.D.
(CIE-co-ordinates x = 0.313, y = 0.329)

Percentage of the total anode current supplied by each gun (typical)

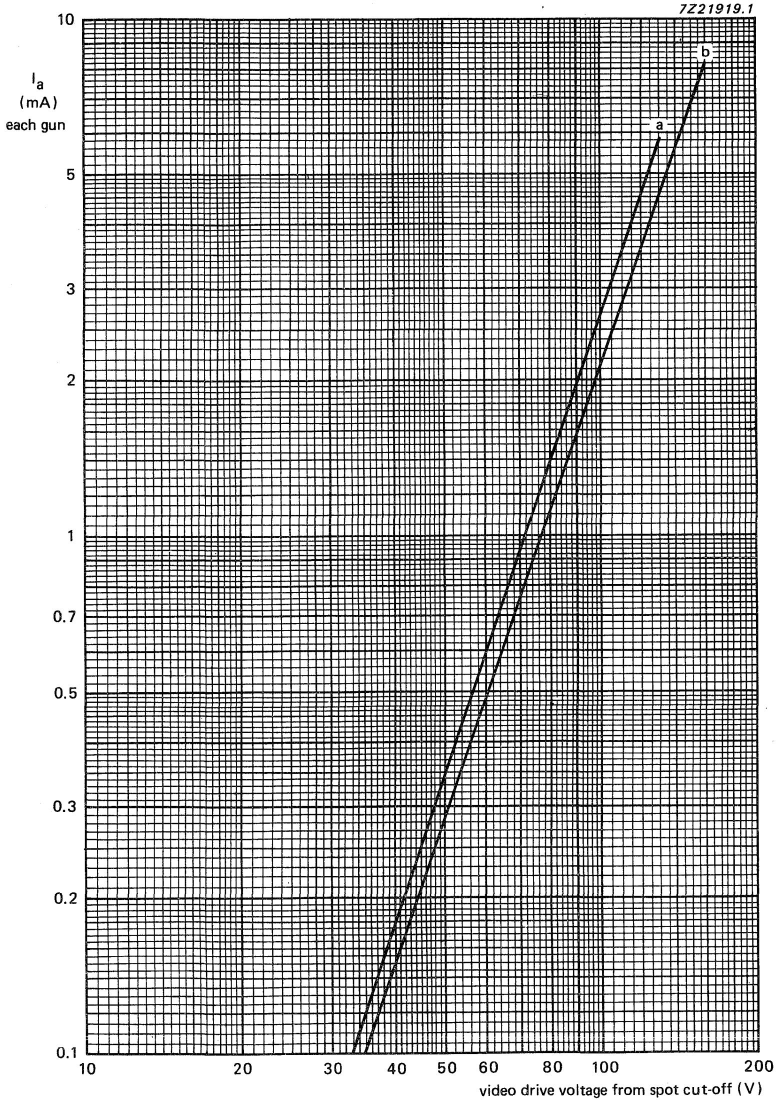
red gun	40.5%
green gun	32.4%
blue gun	27.1%

Ratio of anode currents

red gun to green gun	min.	0.90
	average	1.25
	max.	1.60
red gun to blue gun	min.	1.10
	average	1.50
	max.	1.90
blue gun to green gun	min.	0.60
	average	0.85
	max.	1.20

Insulation resistance between each cathode and grid 1 and heater — min. 50 MΩ

Note: For optimum picture performance it is recommended that the cathodes are not driven below + 1 V.



$V_f = 6.3$ V;

$V_{a,g4} = 27.5$ kV;

V_{g3} adjusted for focus;

V_{g2} (each gun) adjusted to provide spot cut-off for $V_k = 130$ V (curve a) and V_k 160 V (curve b).

Fig. 14 Typical cathode drive characteristic.

DEVELOPMENT DATA

LIMITING VALUES (Design maximum rating system unless otherwise specitied)

The voltages are specified with respect to grid 1.

					notes
Anode voltage	$V_{a,g4}$	max.	32	kV	1, 2, Fig.15
		min.	25	kV	1, 3
Long-term average current for three guns	I_a	max.	1500	μA	4
Grid 3 (focusing electrode) voltage	V_{g3}	max.	20	kV	
Grid 2 voltage	V_{g2}	max.	1200	V	5
Cathode voltage					
positive	V_k	max.	400	V	
positive operating cut-off	V_k	max.	200	V	
negative	$-V_k$	max.	0	V	
negative peak	$-V_{kp}$	max.	2	V	
Cathode to heater voltage					
positive	V_{kf}	max.	250	V	
positive peak	V_{kfp}	max.	300	V	1
negative	$-V_{kf}$	max.	135	V	
negative peak	$-V_{kfp}$	max.	180	V	1
Heater voltage	V_f		$6.3\ V\ ^{+5}_{-10}$	%	1, 6

LIMITING CIRCUIT VALUES

Grid 3 circuit resistance	R_{g3}	max.	70	MΩ
Grid 1 to cathode circuit resistance (each gun)	R_{g1k}	max.	0.75	MΩ

BEAM CENTRING

Maximum centring error in any direction 4 mm

Notes

1. Absolute maximum rating system.
2. 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 with-output picture tube.
3. Operation of the tube at lower voltages impairs the luminance and resolution, and could impair convergence.
4. The short-term average anode current should be limited by circuitry to 2100 μA.
5. During adjustment on the production line maximum 1500 V is permitted.
6. For maximum cathode life it is recommended that the heater supply be designed for 6.3 V at zero beam current.

The colour picture tube does not emit X-radiation above 1 μSv/h when operated at 29.9 kV and 1.5 mA. The X-radiation emitted will also not exceed 1 μSv/h for anode voltage and current combinations given by the isoexposure-rate limit curve shown in Fig.15.

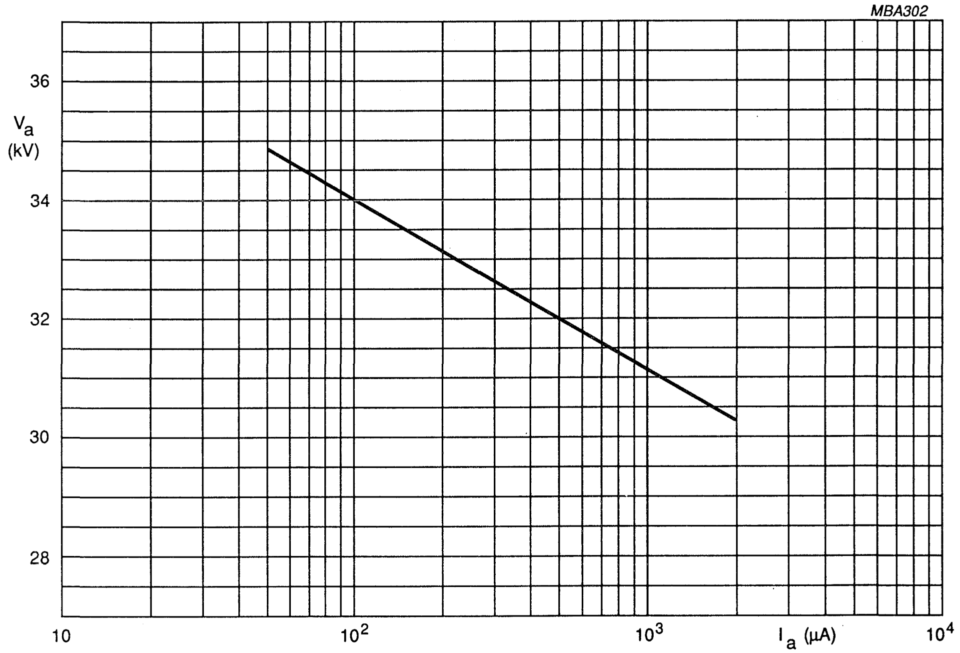


Fig.15 1 μSv/h isoexposure-rate limit curve.

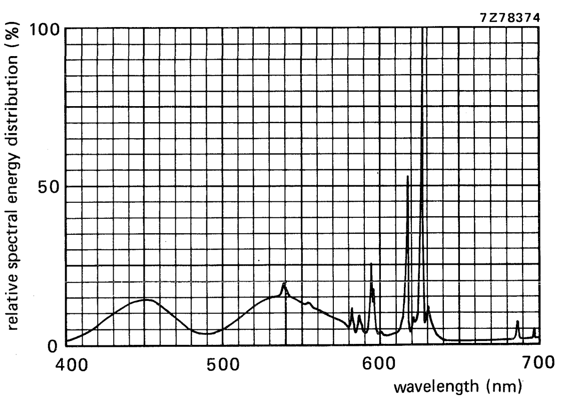


Fig. 16 Simultaneous excitation of red, green and blue phosphor, measured in a tube, to produce white of x = 0.313, y = 0.329. Exact shape of the peaks depends on the resolution of the measuring apparatus.

Colour co-ordinates:	x	y
red	0.620	0.340
green	0.305	0.600
blue	0.155	0.065

DEVELOPMENT DATA

DEGAUSSING

The picture tube is provided with an internal magnetic shield. This shield and the shadow mask with its suspension system may be provided with an automatic degaussing system, consisting of two coils covering top and bottom cone parts, or one large coil.

For proper degaussing an initial magnetomotive force (MMF) of 300 ampere-turns is required in each of the coils. This MMF has to be gradually decreased by appropriate circuitry. To prevent beam landing disturbances by line-frequency currents induced in the degaussing coils, these coils should be shunted by a capacitor of sufficiently high value. In the steady state, no significant MMF should remain in the coils ($\leqslant$ 0.15 ampere-turns).

If single-phase power rectification is employed in the TV circuitry, provision should be included to prevent asymmetric distortion of the AC voltage applied to the degaussing circuit due to high DC inrush currents.

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

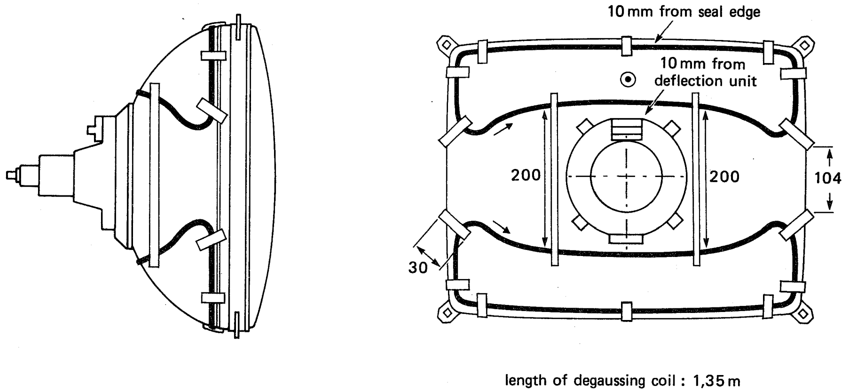


Fig. 17 Double-coil system.

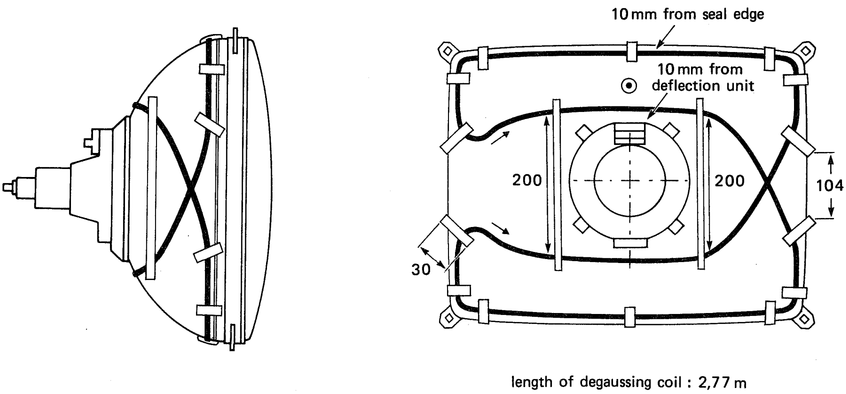


Fig. 18 Single-coil system.

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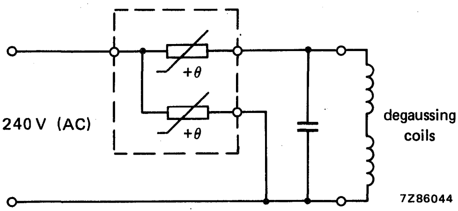


Fig.19 Degaussing circuit using dual PTC thermistor 2322 662 98009; C = 100 nF.

Table 3 Data of each degaussing coil

	double-coil system	single-coil system
Circumference	135 cm	277 cm
Number of turns	60	60
Copper-wire diameter	0.4 mm	0.4 mm
Aluminium-wire diameter	0.5 mm	0.5 mm
Resistance	11 Ω	22 Ω

110° FLAT AND SQUARE 'BLACK LINE' COLOUR PICTURE TUBE ASSEMBLY

- Factory preset tube/coil assembly
- Invar mask
- Self-converging and north-south raster correction free
- 59 cm, 110° colour picture tube A59EAK022X
- Double saddle deflection unit AT6010/30

QUICK REFERENCE DATA

Deflection angle	110°
Minimum useful screen diagonal	59 cm
Overall length	39 cm
Neck diameter	29.1 mm

MECHANICAL DATA

Dimensions in mm

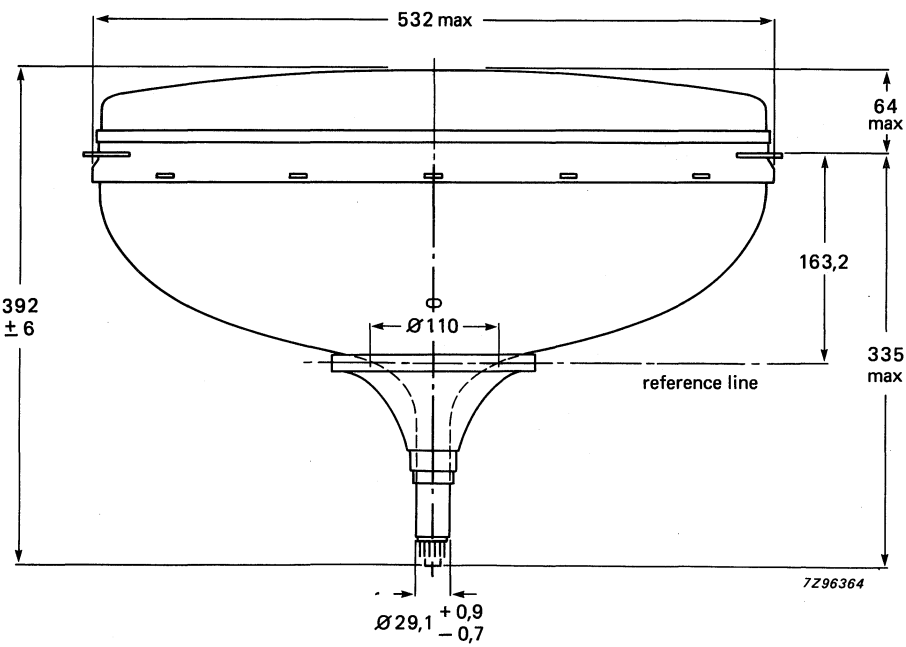


Fig. 1 Tube assembly.

Net mass of tube assembly: 20 kg

MECHANICAL DATA

Dimensions in mm

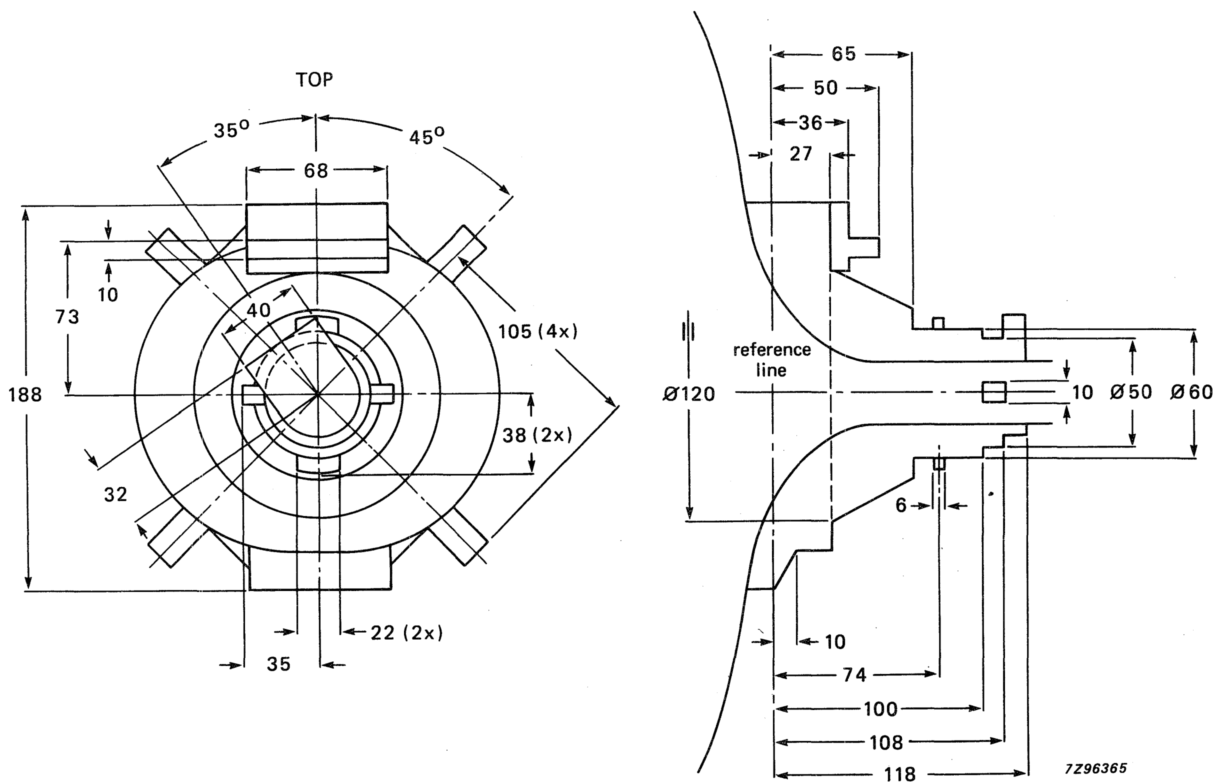


Fig. 2 Yoke clearance.

ELECTRICAL DATA OF DEFLECTION UNIT

Line coils	parallel connected
Inductance at 1 V (RMS), 1 kHz	1.58 mH
Resistance at 25 °C	1.6 Ω
Magnetic flux	7.6 mWb ± 5%
Line deflection current, edge to edge, at 27.5 kV	4.69 A (p-p)
Field coils	series connected
Inductance at 1 V (RMS), 1 kHz	8.55 mH
Resistance at 25 °C	5.0 Ω
Field deflection current, edge to edge, at 27.5 kV	2.03 A (p-p)

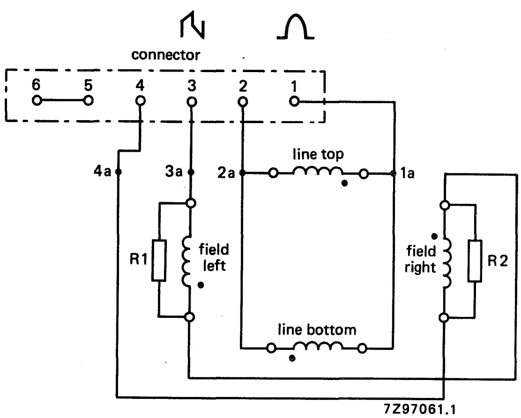


Fig. 3 Electrical diagram.

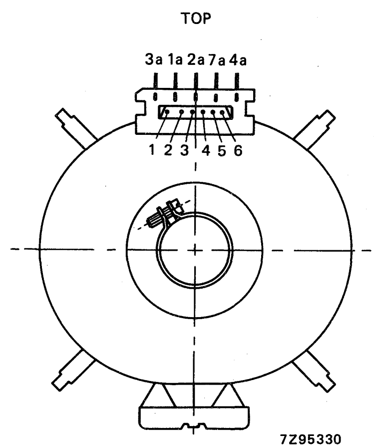


Fig. 4 Terminal location.

The beginning of the windings is indicated with ●.
R1 = R2 = 100 Ω, 0.25 W.
Matching Stocko connector MKF 2806-1-0-606.

DEVELOPMENT DATA

FLAT AND SQUARE 'BLACK LINE' COLOUR PICTURE TUBE

- Flat and square screen
- 110° deflection
- In-line, hi-bi potential A R T* gun with quadrupole cathode lens
- 29.1 mm neck diameter
- INVAR mask with corner suspension
- Hi-Bri technology
- Pigmented phosphors
- Quick-heating low-power cathodes
- Soft flash
- Slotted shadow mask optimized for minimum moiré at 625 lines systems
- Internal magnetic shield
- Internal multipole
- Reinforced envelope for push-through mounting
- Anti-crackle coating

QUICK REFERENCE DATA

Deflection angle	110°
Useful screen diagonal	66 cm
Overall length	42 cm
Glass transmission	36.5%
Neck diameter	29.1 mm
Heating	6.3 V, 310 mA
Anode voltage	27.5 kV
Focusing voltage	31% of anode voltage

* Aberration Reducing Triode.

ELECTRON-OPTICAL DATA

Electron gun system	unitized triple-aperture electrodes; aberration reducing triode
Focusing method	electrostatic
Focus lens	hi-bi potential
Deflection method	magnetic
Deflection angles	
diagonal	110°
horizontal	97°
vertical	77°

ELECTRICAL DATA

Capacitances				
anode to external conductive coating including rimband	C_a (m + m′)	min.	2000	pF
anode to metal rimband	C_a m′		300	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 3 (focusing electrode) to all other electrodes	C_{g3}		6	pF
grid 1 to all other electrodes	C_{g1}		17	pF
grid 2 to all other electrodes	C_{g2}		4.5	pF
Resistance between rimband and external conductive coating		min.	50	MΩ
Heating: indirect by AC (preferably mains or line frequency) or DC				
heater voltage	V_f		6.3	V
heater current	I_f		310	mA

OPTICAL DATA

Screen	metal-backed vertical phosphor stripes; phosphor lines follow glass contour
Screen finish	satinized
Useful screen dimensions	
diagonal	663.6 mm
horizontal axis	536.1 mm
vertical axis	407.6 mm
area	2160 cm²
Positional accuracy of the screen with respect to the glass contour	see Fig. 1
Phosphors	
red	pigmented europium activated rare earth
green	sulphide type
blue	pigmented sulphide type
Persistence	medium short

A = 203.2 mm
B = 287.0 mm
C = 140.2 mm
D = 222.6 mm
E = 25.6 mm

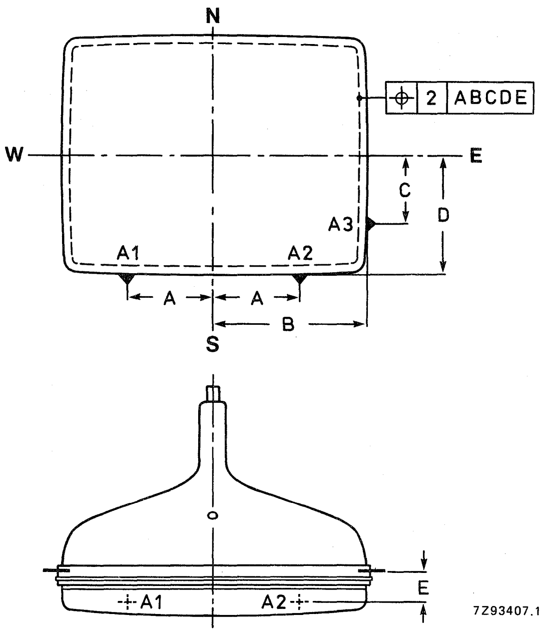


Fig. 1 Tube alignment.

DEVELOPMENT DATA

Colour co-ordinates		x	y
red		0.620	0.340
green		0.305	0.600
blue		0.155	0.065
Centre-to-centre distance of identical colour phosphor stripes		approx. 0.8 mm	
Light transmission of face glass at screen centre		36.5%	
Luminance at the centre of the screen	L	80 cd/m² *	

MECHANICAL DATA (see also Figs 2 to 9)

Overall length	422 ± 6 mm
Neck diameter	$29.1^{+1.4}_{-0.7}$ mm
Base	JEDEC B10-277
Anode contact	small cavity contact J1-21, IEC 67-III-2
Mounting position	anode contact on top
Implosion protection	rimband provided with skirt and slots to accommodate clips for mounting of degaussing coils
Net mass	approx. 22.5 kg

Handling

During shipment and handling the tube should not be subjected to accelerations greater than 350 m/s^2 in any direction.

* Tube settings adjusted to produce white D (x = 0.313, y = 0.329), focused raster, current density 0.4 $\mu A/cm^2$.

MECHANICAL DATA (continued)

Dimensions in mm

Notes are given after the drawings.

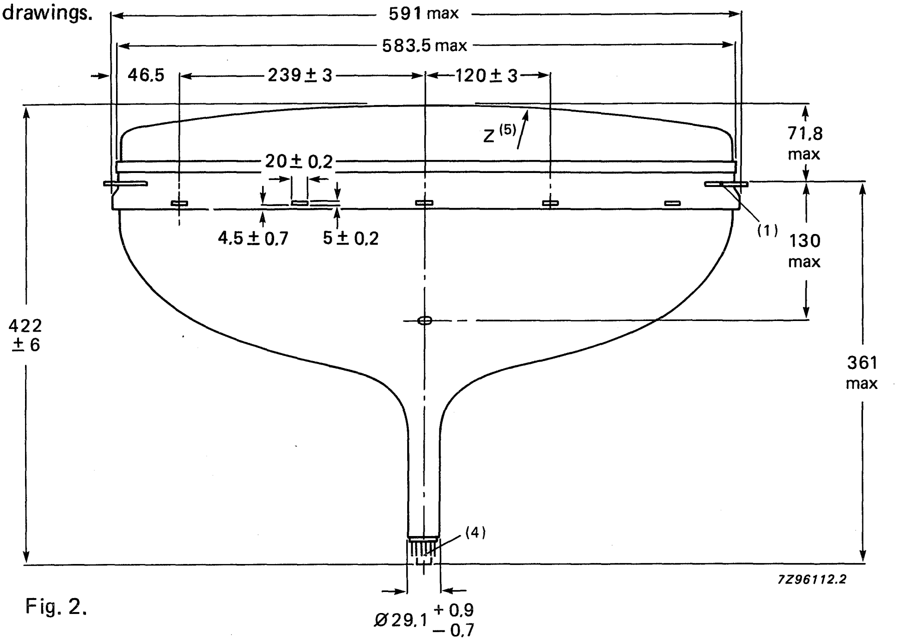


Fig. 2.

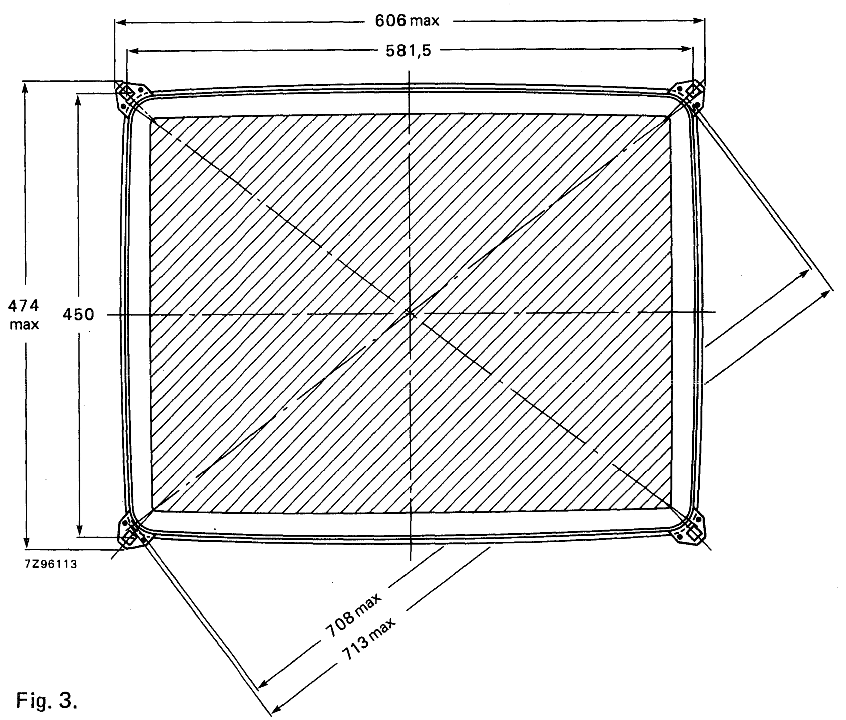


Fig. 3.

DEVELOPMENT DATA

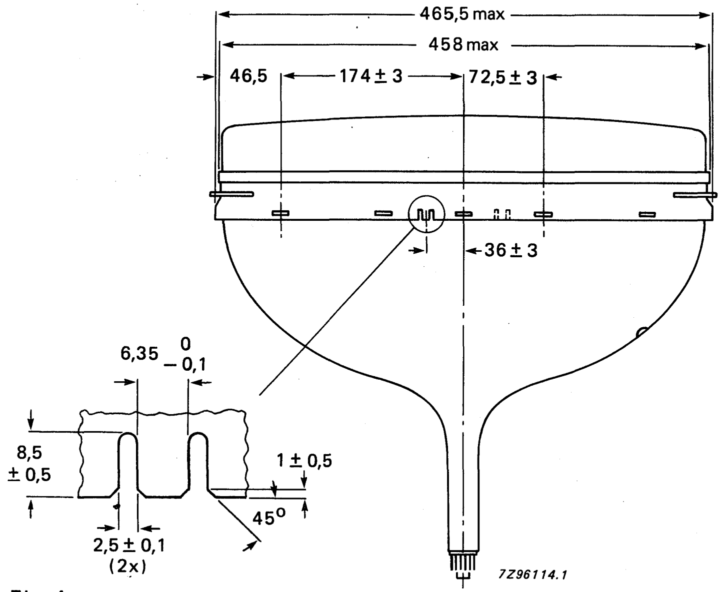


Fig. 4.

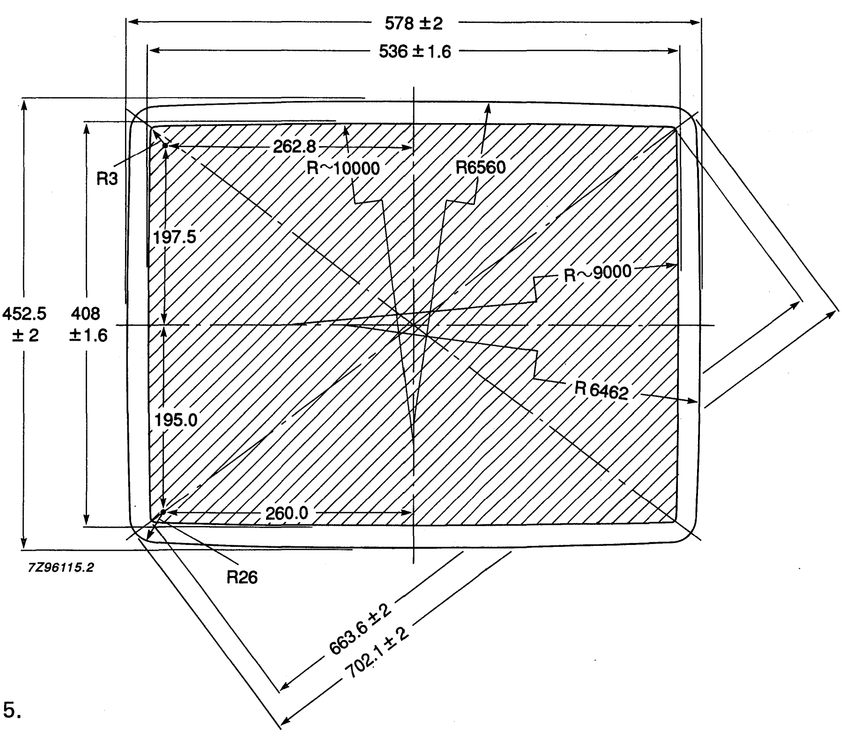


Fig. 5.

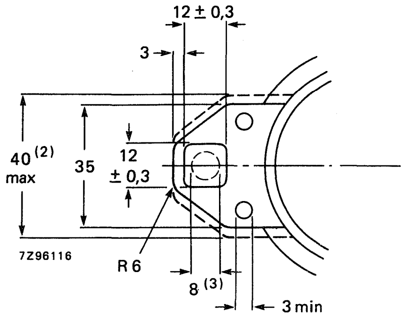


Fig. 6 Lug dimensions.

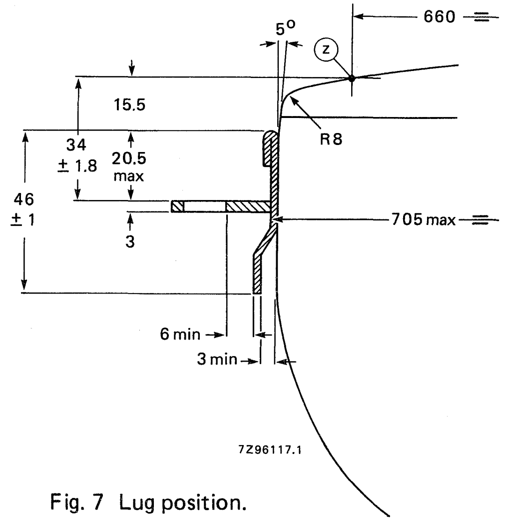


Fig. 7 Lug position.

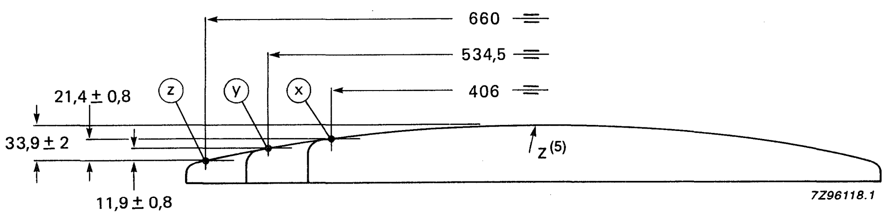


Fig. 8 Screen reference points.

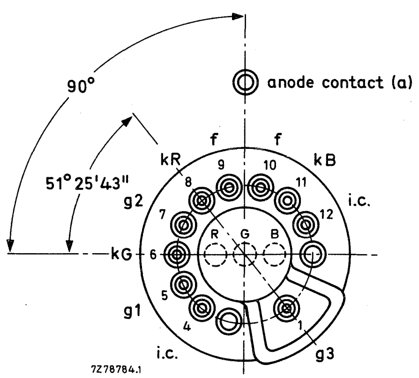


Fig. 9 Pin arrangement.

Notes to outline drawings

1. The displacement of any lug with respect to the plane through the three other lugs is maximum 1.5 mm.
2. Minimum space to be reserved for mounting lug.
3. The position of the mounting screw in the cabinet must be within a circle of 8 mm diameter drawn around the true geometrical positions, i.e. the corners of a rectangle of 581.5 mm x 450 mm.
4. The socket for this base should not be rigidly mounted; it should have flexible leads and be allowed to move freely. After mounting of the tube in the cabinet note that the position of the base can fall within a circle, having a diameter of maximum 50 mm, concentric with an imaginary tube axis.
5. The distance Z from any point on the screen to the centre can be calculated using the following formula; a number of points are given in Table 1:

$XX = \sqrt{(X \times X + Y \times Y)}$
$ZA = 1688.4 - \sqrt{(1688.4 \times 1688.4 - 93.62 \times 93.62)}$
$ZC = (1688.4 - ZA) \times 6.6/93.62$
$ZB = 1688.4 - 1568.29 - ZC$
$\text{IF } (XX < 93.62) \text{ THEN } Z = 1688.4 - \sqrt{(1688.4 \times 1688.4 - XX \times XX)} \text{ ELSE}$
$Z = ZB + 1568.29 - \sqrt{(1568.29 \times 1568.29 - (XX - 6.6)^2)}$

Table 1 Sagittal heights with reference to screen centre at the edge of the nominal useful screen

	Nominal useful screen (NUS)			3 mm inside NUS			10 mm outside NUS		
	co-ordinates x mm	co-ordinates y mm	sagittal height mm	co-ordinates x mm	co-ordinates y mm	sagittal height mm	co-ordinates x mm	co-ordinates y mm	sagittal height mm
(1)	0	203.8	12.6	0	200.8	12.2	0	213.8	13.9
	20	203.8	12.7	20	200.8	12.4	20	213.8	14.0
	40	203.7	13.1	40	200.7	12.7	40	213.7	14.4
	60	203.6	13.7	60	200.6	13.3	60	213.6	15.0
	80	203.5	14.6	80	200.5	14.2	80	213.5	15.8
	100	203.3	15.7	100	200.3	15.3	100	213.3	17.0
	120	203.1	17.0	120	200.1	16.6	120	213.1	18.3
	140	202.8	18.6	140	199.9	18.2	140	212.9	19.9
	160	202.6	20.5	160	199.6	20.1	160	212.6	21.8
	180	202.3	22.6	180	199.3	22.2	180	212.3	23.9
	200	201.9	24.9	200	198.9	24.6	200	211.9	26.2
	220	201.5	27.6	220	198.5	27.2	220	211.5	28.9
	240	201.1	30.4	240	198.1	30.0	240	211.1	31.7
	260	200.6	33.5	260	197.6	33.2	260	210.6	34.8
(2)	265.2	199.3	34.3	262.8	197.5	33.6	275.6	210.3	37.5
	266.2	180	32.1	263.2	180	31.6	276.2	180	33.8
	266.6	160	30.0	263.6	160	29.5	276.6	160	31.7
	266.9	140	28.1	263.9	140	27.6	276.9	140	29.9
	267.2	120	26.5	264.2	120	26.0	277.2	120	28.3
	267.5	100	25.2	264.5	100	24.7	277.5	100	26.9
	267.7	80	24.1	264.7	80	23.6	277.7	80	25.8
	267.8	60	23.2	264.8	60	22.7	277.8	60	24.9
	268.0	40	22.6	265.0	40	22.1	278.0	40	24.3
	268.0	20	22.2	265.0	20	21.7	278.0	20	24.0
(3)	268.0	0	22.1	265.0	0	21.6	278.0	0	23.8

(1) End of short axis. (2) End of diagonal axis. (3) End of long axis.

10-pin base; JEDEC B10-277

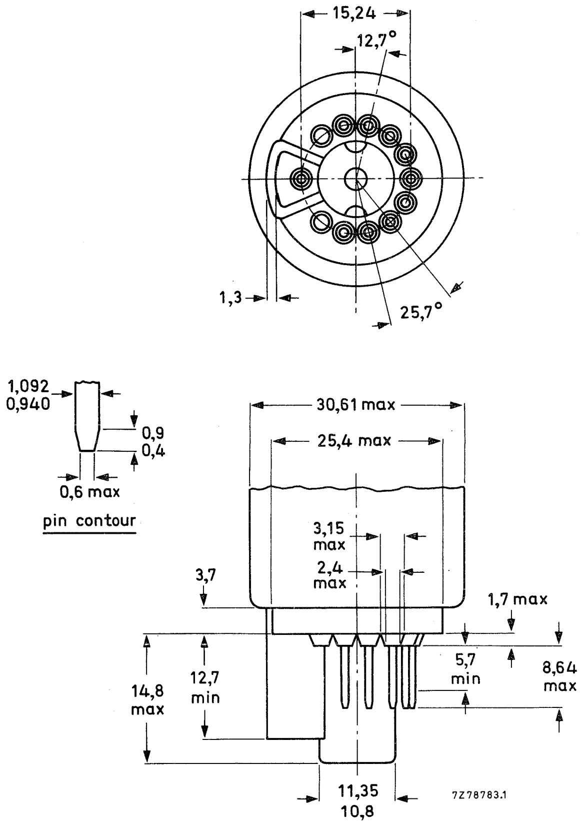


Fig. 10 JEDEC base.

Cavity cap JEDEC J1-21, IEC 67-III-2

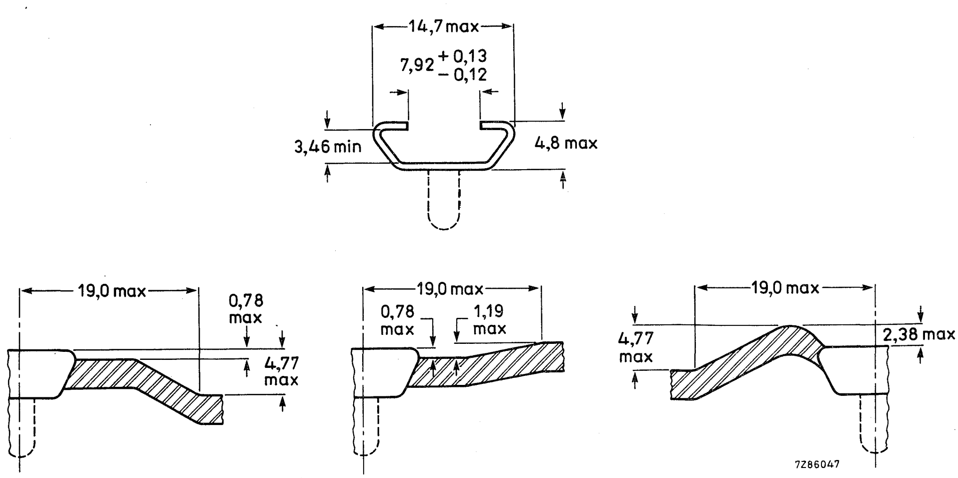


Fig. 11 Cavity cap.

Maximum cone contour

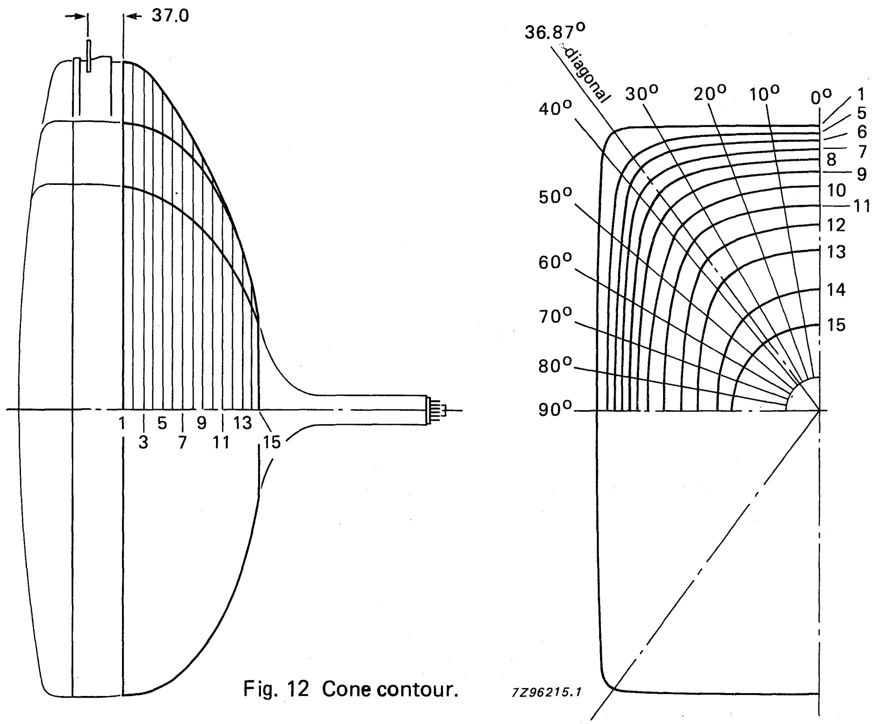


Fig. 12 Cone contour.

Table 2 Cone contour data

Dimensions in mm

section	nom. distance from section 1	distance from centre										
		0°	10°	20°	30°	36,87°	40°	50°	60°	70°	80°	90°
1	0.00	287.2	291.4	304.9	329.6	349.8	341.6	289.2	257.0	237.4	226.8	223.5
2	10.00	286.6	290.8	304.2	328.8	348.1	339.9	288.4	256.2	236.7	226.1	222.8
3	20.00	285.0	289.2	302.4	326.4	342.6	334.6	285.6	253.8	234.5	224.1	220.8
4	30.00	282.1	286.1	298.9	321.2	332.5	324.7	279.7	249.2	230.5	220.3	217.1
5	40.00	277.7	281.5	293.5	313.3	319.6	312.1	271.7	242.7	224.8	215.1	212.0
6	50.00	271.6	275.2	286.3	302.8	305.1	298.2	262.4	235.2	218.2	208.9	205.9
7	60.00	263.8	267.1	276.9	287.8	289.2	283.0	252.1	227.0	211.0	202.1	199.3
8	70.00	253.9	256.8	265.2	274.3	271.9	266.6	240.6	217.8	202.9	194.6	192.0
9	80.00	241.4	243.9	250.9	257.0	253.7	249.1	227.2	207.0	193.2	185.6	183.1
10	90.00	225.6	227.8	233.6	237.8	234.3	230.2	211.4	193.4	180.9	173.9	171.6
11	100.00	207.1	209.1	214.0	217.4	213.8	210.0	192.9	176.7	165.4	159.0	157.0
12	110.00	186.8	188.4	192.6	195.1	191.4	187.7	172.1	157.5	147.5	141.8	139.9
13	120.00	163.7	165.0	168.0	169.0	165.3	162.1	149.2	137.1	128.6	123.7	122.1
14	130.00	126.3	126.7	126.8	125.3	123.2	121.9	117.1	112.0	107.7	104.7	103.7
15	137.12	88.4	88.4	88.4	88.4	88.4	88.4	88.4	88.4	88.4	88.4	88.4

TYPICAL OPERATING CONDITIONS

The voltages are specified with respect to grid 1.

Anode voltage	$V_{a,g4}$	27.5 kV
Grid 3 (focusing electrode) voltage	V_{g3}	8 to 9.1 kV
Grid 2 voltage for a spot cut-off voltage V_k = 160 V	V_{g2}	see Fig. 13
Heater voltage under operating conditions	V_f	6.3 V

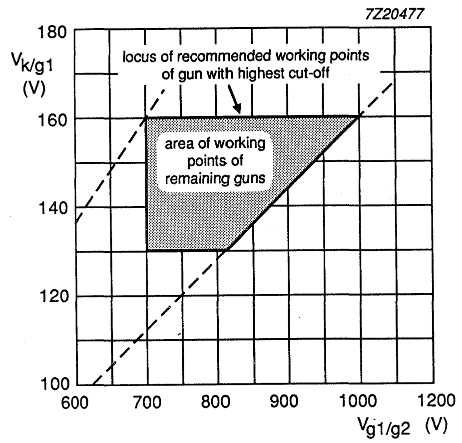


Fig. 13 Spot cut-off design chart.

Grid 2 voltage (V_{g2}) adjusted for highest gun spot cut-off voltage V_k = 160 V.

Remaining guns adjusted for spot cut-off by means of cathode voltage

V_{g2} range 700 to 1020 V;

V_k range 130 to 160 V.

Adjustment procedure:

Set the cathode voltage (V_k) for each gun at 160 V; increase the grid 2 voltage (V_{g2}) from approximately 650 V to the value at which one of the colours become just visible. Now decrease the cathode voltage of the remaning guns so that the other colours also become visible.

DEVELOPMENT DATA

EQUIPMENT DESIGN VALUES

The values are valid for anode voltages between 25 and 29.9 kV.
The voltages are specified with respect to grid 1.

Grid 3 (focusing electrode) voltage	V_{g3}	29 to 33% of anode voltage
Grid 2 voltage and cathode voltage for visual extinction of focused spot	V_{g2} and V_k	see Fig. 13
Difference in cut-off voltages between guns in any tube	ΔV_k	lowest value > 80% of highest value
Heater voltage	V_f	6.3 V at zero beam current
Grid 3 (focusing electrode) current	I_{g3}	−2 to + 2 μA
Grid 2 current	I_{g2}	−2 to + 2 μA
Grid 1 current under cut-off conditions	I_{g1}	−2 to + 2 μA

To produce white of 6500K + 7 M.P.C.D.
(CIE co-ordinates x = 0.313, y = 0.329)

Percentage of the total anode current supplied by each gun (typical)

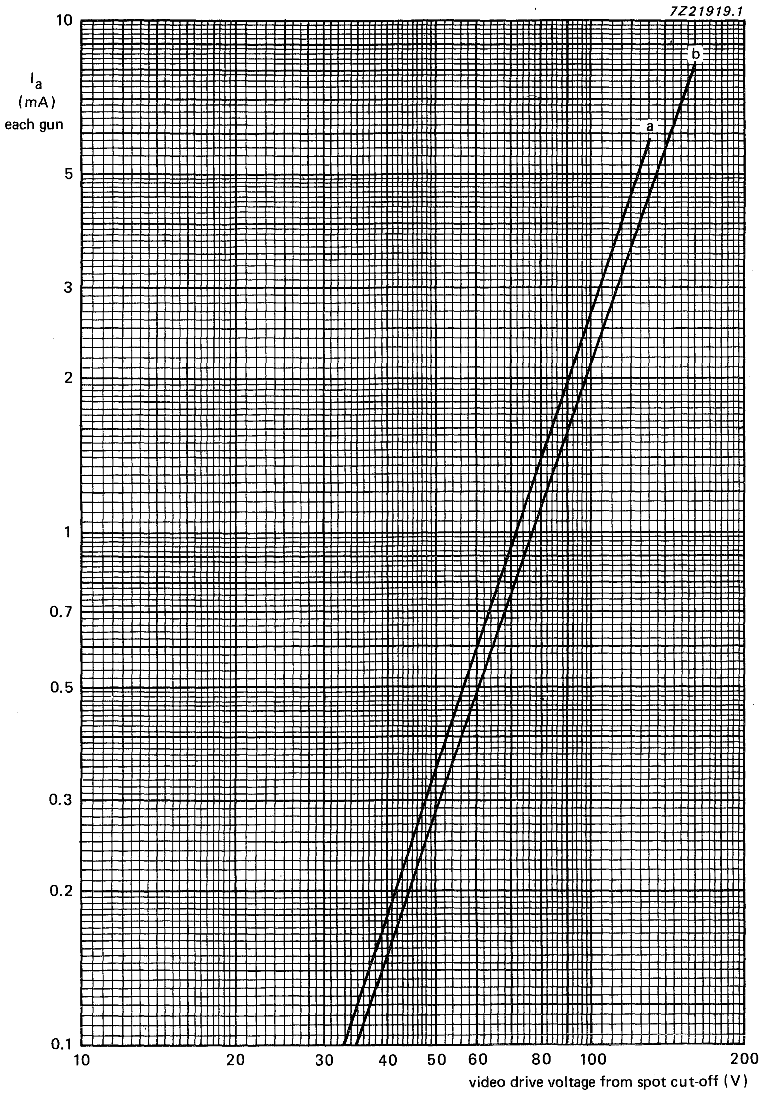
red gun	40.5%
green gun	32.4%
blue gun	27.1%

Ratio of anode currents

red gun to green gun	min.	0.90
	average	1.25
	max.	1.60
red gun to blue gun	min.	1.10
	average	1.50
	max.	1.90
blue gun to green gun	min.	0.60
	average	0.85
	max.	1.20

Insulation resistance between each cathode and grid 1 and heater — min. 50 MΩ

Note: For optimum picture performance it is recommended that the cathodes are not driven below + 1 V.



V_f = 6.3 V;

$V_{a,g4}$ = 27.5 kV;

V_{g3} adjusted for focus;

V_{g2} (each gun) adjusted to provide spot cut-off for V_k = 130 V (curve a) and V_k = 160 V (curve b).

Fig. 14 Typical cathode drive characteristic.

LIMITING VALUES (Design maximum rating system unless otherwise stated)

The voltages are specified with respect to grid 1.

				notes
Anode voltage	$V_{a,g4}$	max.	32 kV	1, 2, Fig.15
		min.	25 kV	1, 3
Long-term average current for three guns	I_a	max.	1300 μA	4
Grid 3 (focusing electrode) voltage	V_{g3}	max.	20 kV	
Grid 2 voltage	V_{g2}	max.	1200 V	5
Cathode voltage				
positive	V_k	max.	400 V	
positive operating cut-off	V_k	max.	200 V	
negative	$-V_k$	max.	0 V	
negative peak	$-V_{kp}$	max.	2 V	
Cathode to heater voltage				
positive	V_{kf}	max.	250 V	
positive peak	V_{kfp}	max.	300 V	1
negative	$-V_{kf}$	max.	135 V	
negative peak	$-V_{kfp}$	max.	180 V	1
Heater voltage	V_f		6.3 V $^{+5}_{-10}$ %	1, 6

LIMITING CIRCUIT VALUES

Grid 3 circuit resistance	R_{g3}	max.	70 MΩ
Grid 1 to cathode circuit resistance (each gun)	R_{g1k}	max.	0.75 MΩ

BEAM CENTRING

Maximum centring error in any direction 4 mm

Notes

1. Absolute maximum rating system.
2. 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.
3. Operation of the tube at lower voltages impairs the luminance and resolution, and could impair convergence.
4. The short-term average anode current should be limited by circuitry to 1800 μA.
5. During adjustment on the production line maximum 1500 V is permitted.
6. For maximum cathode life it is recommended that the heater supply be designed for 6.3 V at zero beam current.

The colour picture tube assembly does not emit X-radiation above 1 μSv/h when operated at 29.9 kV and 1.5 mA. The X-radiation emitted will also not exceed 1 μSv/h for anode voltage and current combinations given by the isoexposure-rate limit curve shown in Fig. 15.

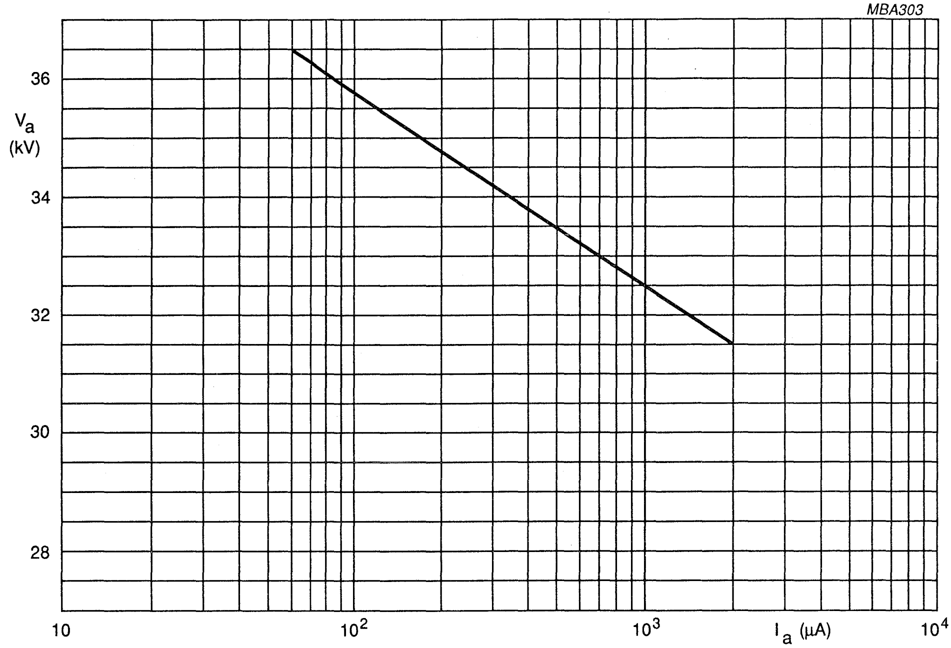


Fig. 15 1 μSv/h isoexposure-rate limit curve.

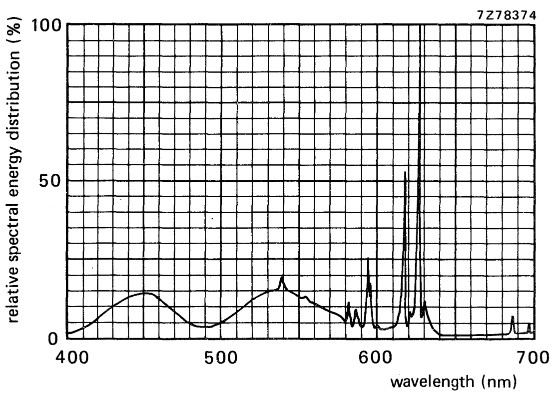


Fig. 16 Simultaneous excitation of red, green and blue phosphor, measured in a tube, to produce white of x = 0.313, y = 0.329. Exact shape of the peaks depends on the resolution of the measuring apparatus.

Colour co-ordinates:	x	y
red	0.620	0.340
green	0.305	0.600
blue	0.155	0.065

DEVELOPMENT DATA

DEGAUSSING

The picture tube is provided with an internal magnetic shield. This shield and the shadow mask with its suspension system may be provided with an automatic degaussing system, consisting of two coils covering top and bottom cone parts, or on large coil.
For proper degaussing an initial magnetomotive force (MMF) of 300 ampere-turns is required in each of the coils. This MMF has to be gradually decreased by appropriate circuitry. To prevent beam landing disturbances by line-frequency currents induced in the degaussing coils, these coils should be shunted by a capacitor of sufficiently high value. In the steady state, no significant MMF should remain in the coils (⩽ 0.15 ampere-turns).
If single-phase power rectification is employed in the TV circuitry, provision should be included to prevent asymmetric distortion of the AC voltage applied to the degaussing circuit due to high DC inrush currents.
To ease the mounting of the coils, the rimband is provided with rectangular holes.

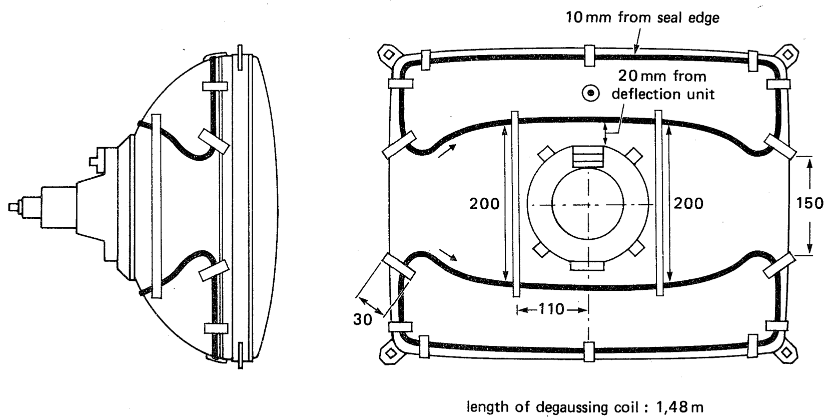


Fig. 17 Double-coil system.

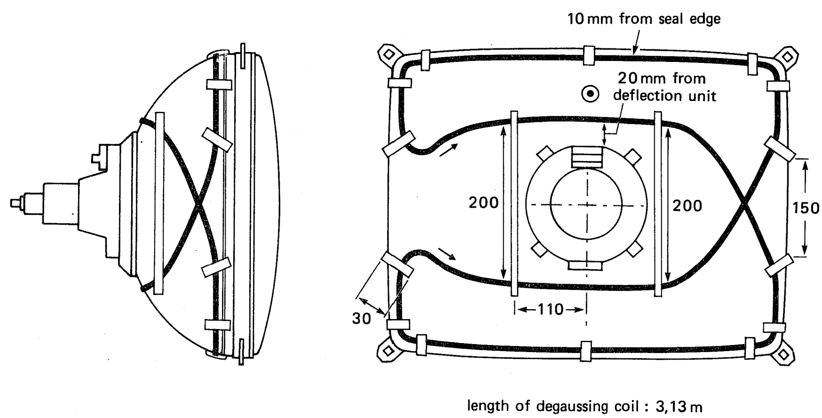


Fig. 18 Single-coil system.

7Z91928

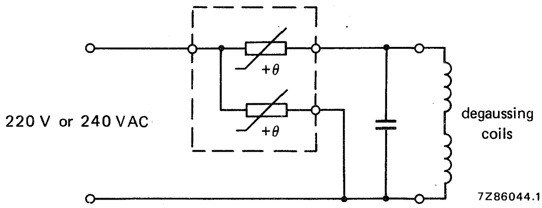


Fig. 19 Degaussing circuit using dual PTC thermistor 2322 662 98009; C = 100 nF.

Data of each degaussing coil

	double-coil system	single-coil system
Circumference	148 cm	313 cm
Number of turns	60	60
Copper-wire diameter	0.4 mm	0.4 mm
Aluminium-wire diameter	0.5 mm	0.5 mm
Resistance	12 Ω	25 Ω

110° FLAT AND SQUARE 'BLACK LINE' COLOUR PICTURE TUBE ASSEMBLY

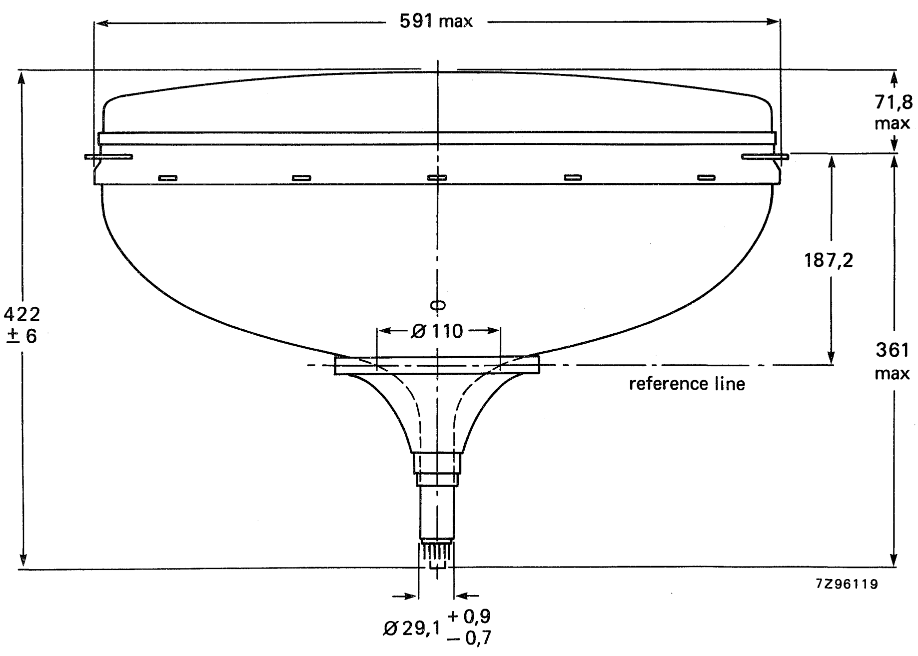
- Factory preset tube/coil assembly
- Invar mask
- Self-converging and north-south raster correction free
- 66 cm, 110° colour picture tube A66EAK22X
- Double saddle deflection unit AT6005/30

QUICK REFERENCE DATA

Deflection angle	110°
Minimum useful screen diagonal	66 cm
Overall length	42 cm
Neck diameter	29.1 mm

MECHANICAL DATA

Dimensions in mm



Net mass of tube assembly: 25.5 kg.

Fig. 1 Tube assembly.

MECHANICAL DATA

Dimensions in mm

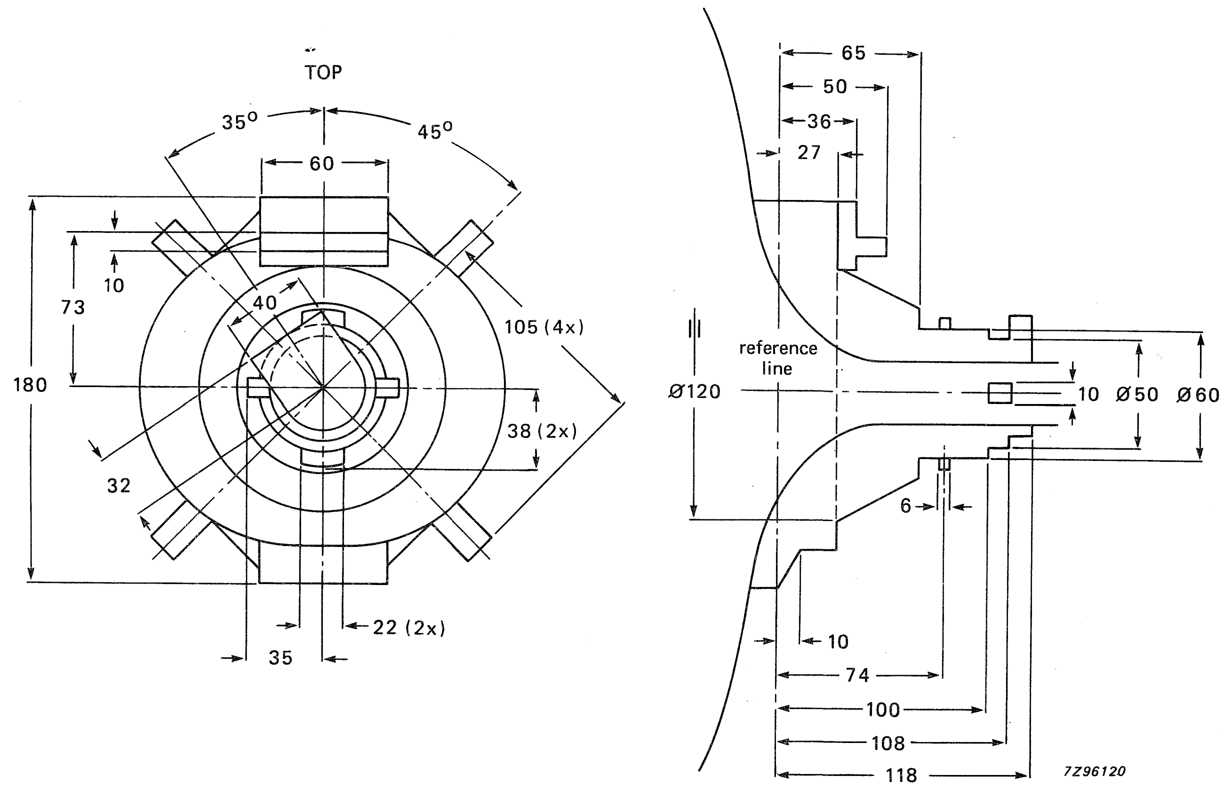
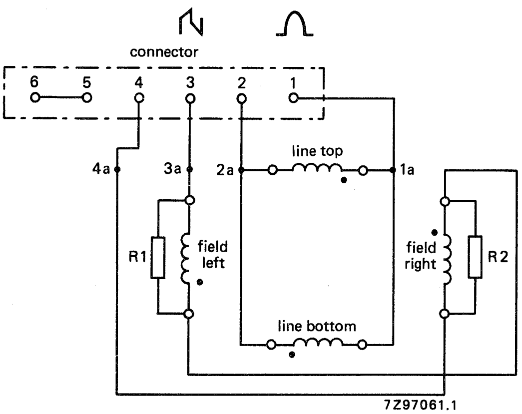


Fig. 2 Yoke clearance.

ELECTRICAL DATA OF DEFLECTION UNIT

Line coils	parallel connected
Inductance at 1 V (RMS), 1 kHz	1.58 mH
Resistance at 25 °C	1.7 Ω
Magnetic flux	7.6 mWb ± 5%
Line deflection current, edge to edge, at 27.5 kV	4.78 A (p-p)
Field coils	series connected
Inductance at 1 V (RMS), 1 kHz	8.63 mH
Resistance at 25 °C	5.0 Ω
Field deflection current, edge to edge, at 27.5 kV	2.04 A (p-p)



The beginning of the windings is indicated with ●.
R1 = R2 = 100 Ω, 0.25 W.
Matching Stocko connector MKF2806-1-0-606

Fig. 3 Electrical diagram.

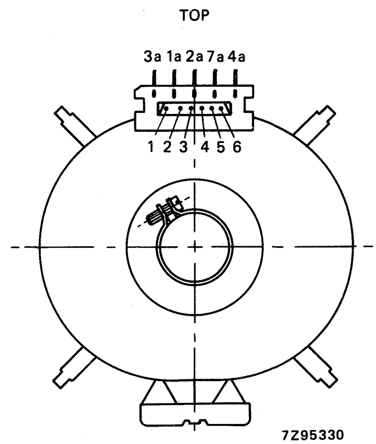


Fig. 4 Terminal location.

DEVELOPMENT DATA

FLAT AND SQUARE Hi-Bri COLOUR PICTURE TUBE

- Flat and square screen
- 110° deflection
- In-line, hi-bi potential A R T* gun with quadrupole cathode lens
- 29.1 mm neck diameter
- Mask with corner suspension
- Hi-Bri technology
- Pigmented phosphors
- Quick-heating low-power cathodes
- Soft flash
- Slotted shadow mask optimized for minimum moiré at 625 lines systems
- Internal magnetic shield
- Internal multipole
- Reinforced envelope for push-through mounting
- Anti-crackle coating

QUICK REFERENCE DATA

Deflection angle	110°
Useful screen diagonal	66 cm
Overall length	42 cm
Neck diameter	29.1 mm
Heating	6.3 V, 310 mA
Anode voltage	25 kV
Focusing voltage	31% of anode voltage

* Aberration Reducing Triode.

ELECTRON-OPTICAL DATA

Electron gun system	unitized triple-aperture electrodes; aberration reducing triode
Focusing method	electrostatic
Focus lens	hi-bi potential
Deflection method	magnetic
Deflection angles	
diagonal	110°
horizontal	97°
vertical	77°

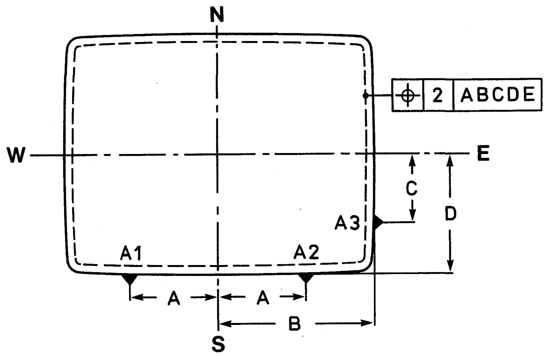
ELECTRICAL DATA

Capacitances				
anode to external conductive coating including rimband	C_a (m + m′)	min.	2000	pF
anode to metal rimband	C_a m′		300	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 3 (focusing electrode) to all other electrodes	C_{g3}		6	pF
grid 1 to all other electrodes	C_{g1}		17	pF
grid 2 to all other electrodes	C_{g2}		4.5	pF
Resistance between rimband and external conductive coating		min.	50	MΩ
Heating: indirect by AC (preferably mains or line frequency) or DC				
heater voltage	V_f		6.3	V
heater current	I_f		310	mA

OPTICAL DATA

Screen	metal-backed vertical phosphor stripes; phosphor lines follow glass contour
Screen finish	satinized
Useful screen dimensions	
diagonal	661.6
horizontal axis	536.1
vertical axis	407.6
area	2162
Positional accuracy of the screen with respect to the glass contour	see Fig. 1
Phosphors	
red	pigmented europium activated rare earth
green	sulphide type
blue	pigmented sulphide type
Persistence	medium short

A = 203.2 mm
B = 287.0 mm
C = 140.2 mm
D = 222.6 mm
E = 25.6 mm



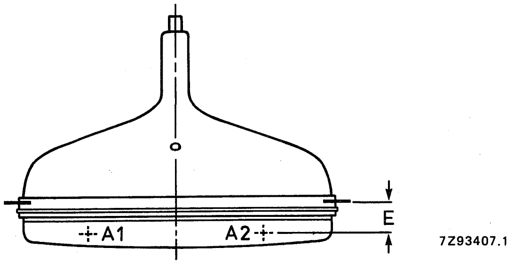


Fig.1 Tube alignment.

DEVELOPMENT DATA

Colour co-ordinates	x	y
red	0.620	0.340
green	0.305	0.600
blue	0.155	0.065

Centre-to-centre distance of identical colour phosphor stripes		approx. 0.8 mm
Light transmission of face glass at screen centre		50%
Luminance at the centre of the screen	L	100 cd/m^2 *

MECHANICAL DATA (see also Figs 2 to 9)

Overall length	422 ± 6 mm
Neck diameter	$29.1^{+1.4}_{-0.7}$ mm
Base	JEDEC B10-277
Anode contact	small cavity contact J1-21, IEC 67-III-2
Mounting position	anode contact on top
Implosion protection	rimband provided with skirt and slots to accommodate clips for mounting of degaussing coils
Net mass	approx. 23 kg

Handling

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

* Tube settings adjusted to produce white D (x = 0.313, y = 0.329), focused raster, current density 0.4 μA/cm^2.

MECHANICAL DATA (continued)

Dimensions in mm

Notes are given after the drawings.

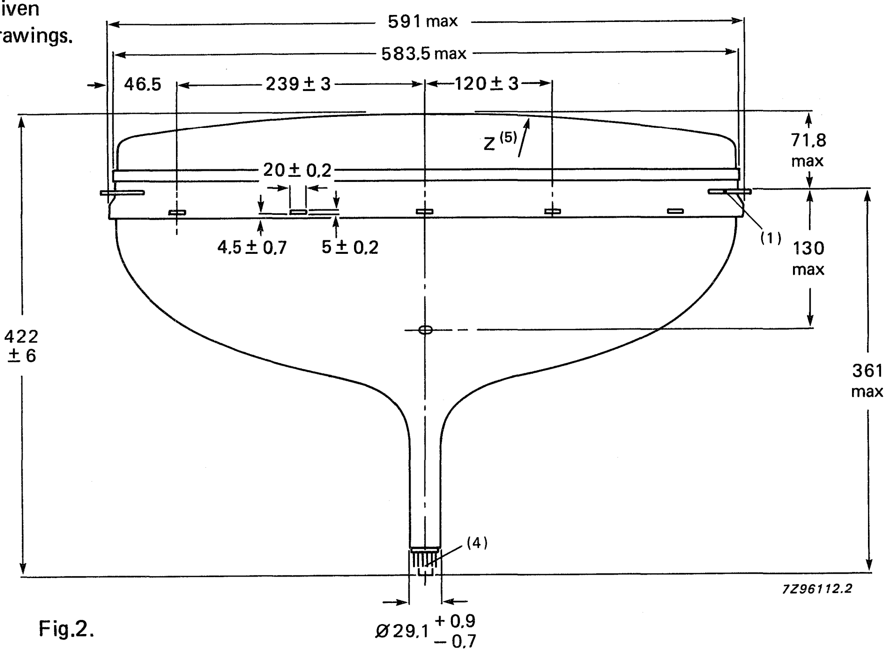


Fig.2.

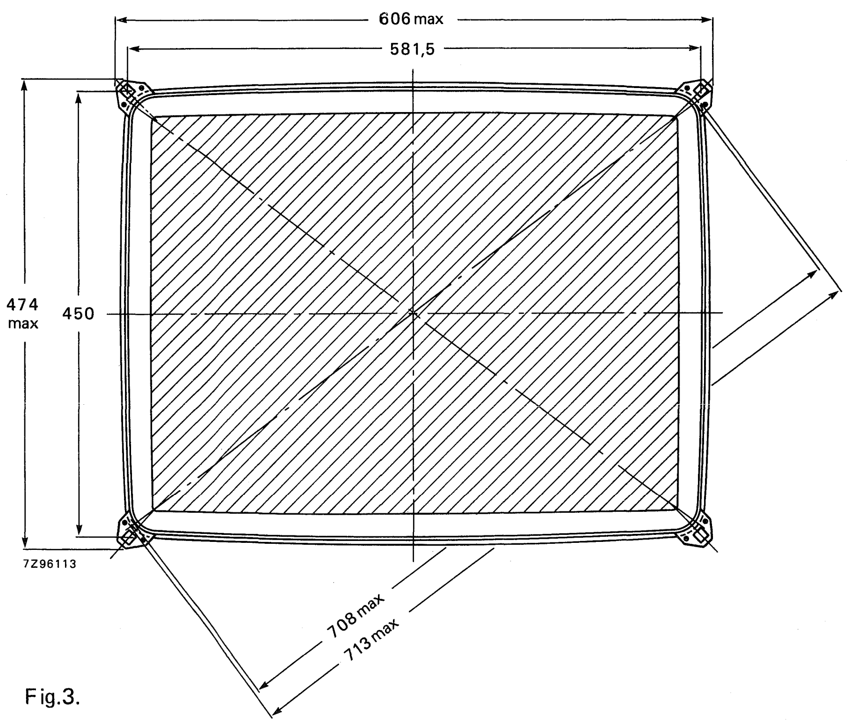


Fig.3.

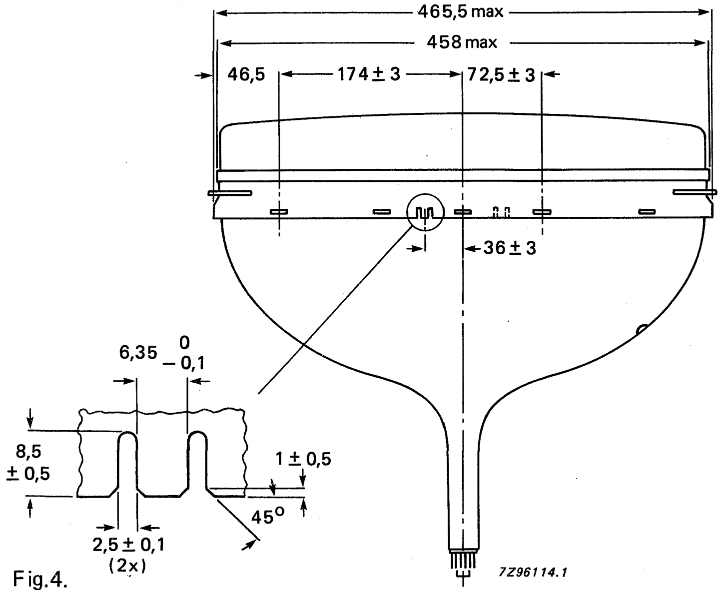


Fig.4.

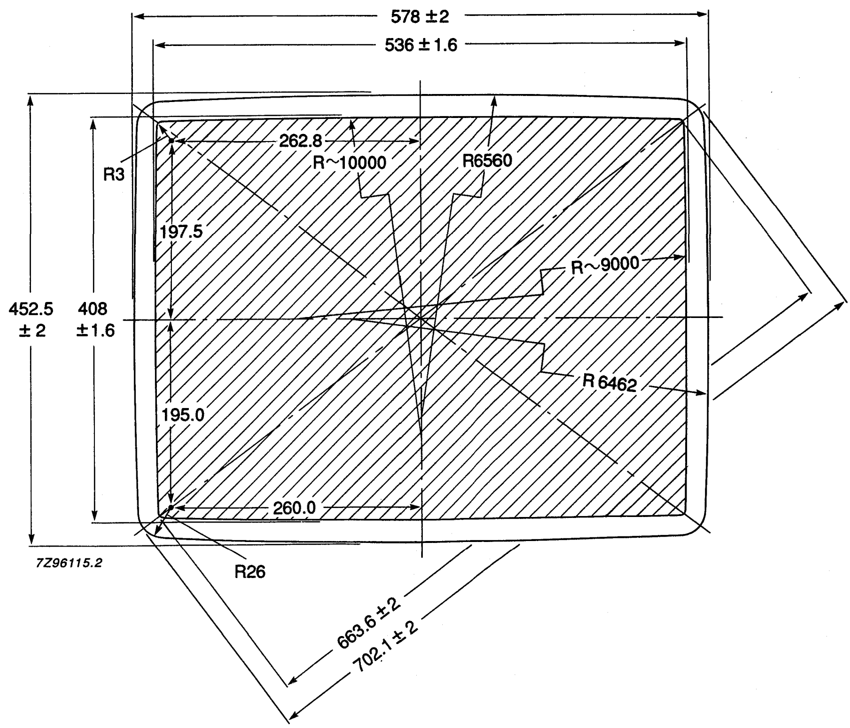


Fig.5.

DEVELOPMENT DATA

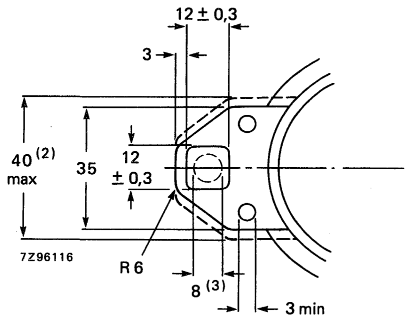


Fig.6 Lug dimensions.

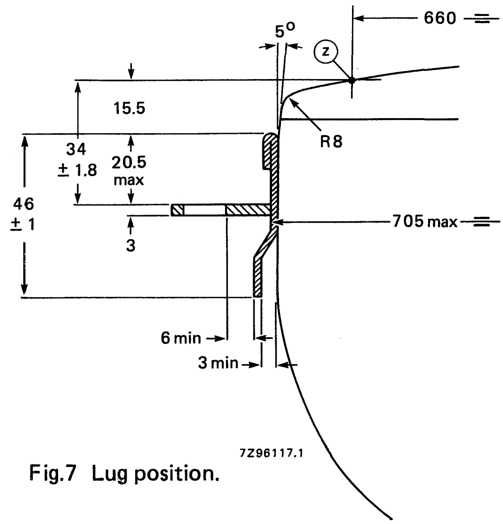


Fig.7 Lug position.

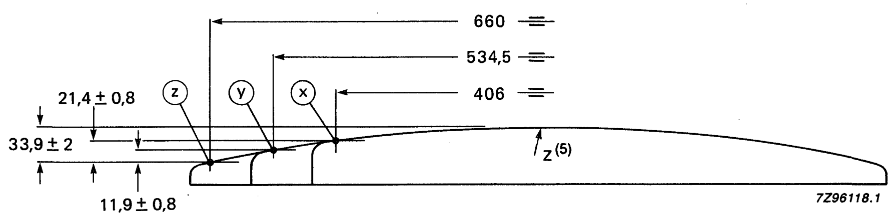


Fig.8 Screen reference points.

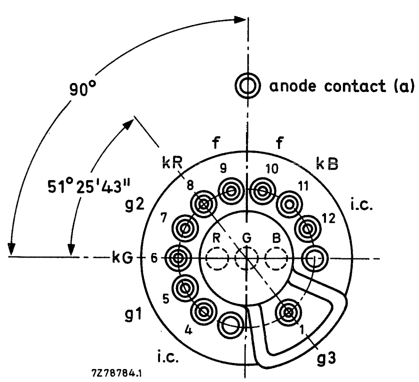


Fig.9 Pin arrangement.

Notes to outline drawings

1. The displacement of any lug with respect to the plane through the three other lugs is maximum 1.5 mm.
2. Minimum space to be reserved for mounting lug.
3. The position of the mounting screw in the cabinet must be within a circle of 8 mm diameter drawn around the true geometrical positions, i.e. the corners of a rectangle of 581.5 mm x 450 mm.
4. The socket for this base should not be rigidly mounted; it should have flexible leads and be allowed to move freely. After mounting of the tube in the cabinet note that the position of the base can fall within a circle, having a diameter of maximum 50 mm, concentric with an imaginary tube axis.
5. The distance Z from any point on the screen to the centre can be calculated using the following formula; (a number of points are given in Table 1):

$$XX = \sqrt{(X \times X + Y \times Y)}$$
$$ZA = 1688.4 - \sqrt{(1688.4 \times 1688.4 - 93.62 \times 93.62)}$$
$$ZC = (1688.4 - ZA) \times 6.6/93.62$$
$$ZB = 1688.4 - 1568.29 - ZC$$
$$\text{IF } (XX < 93.62) \text{ THEN } Z = 1688.4 - \sqrt{(1688.4 \times 1688.4 - XX \times XX)} \text{ ELSE}$$
$$Z = ZB + 1568.29 - \sqrt{(1568.29 \times 1568.29 - (XX - 6.6)^2)}$$

Table 1 Sagittal heights with reference to screen centre at the edge of the nominal useful screen

	Nominal useful screen (NUS)			3 mm inside NUS			10 mm outside NUS		
	co-ordinates x mm	y mm	sagittal height mm	co-ordinates x mm	y mm	sagittal height mm	co-ordinates x mm	y mm	sagittal height mm
(1)	0	203.8	12.6	0	200.8	12.2	0	213.8	13.9
	20	203.8	12.7	20	200.8	12.4	20	213.8	14.0
	40	203.7	13.1	40	200.7	12.7	40	213.7	14.4
	60	203.6	13.7	60	200.6	13.3	60	213.6	15.0
	80	203.5	14.6	80	200.5	14.2	80	213.5	15.8
	100	203.3	15.7	100	200.3	15.3	100	213.3	17.0
	120	203.1	17.0	120	200.1	16.6	120	213.1	18.3
	140	202.8	18.6	140	199.9	18.2	140	212.9	19.9
	160	202.6	20.5	160	199.6	20.1	160	212.6	21.8
	180	202.3	22.6	180	199.3	22.2	180	212.3	23.9
	200	201.9	24.9	200	198.9	24.6	200	211.9	26.2
	220	201.5	27.6	220	198.5	27.2	220	211.5	28.9
	240	201.1	30.4	240	198.1	30.0	240	211.1	31.7
	260	200.6	33.5	260	197.6	33.2	260	210.6	34.8
(2)	265.2	199.3	34.3	262.8	197.5	33.6	275.6	210.3	37.5
	266.2	180	32.1	263.2	180	31.6	276.2	180	33.8
	266.6	160	30.0	263.6	160	29.5	276.6	160	31.7
	266.9	140	28.1	263.9	140	27.6	276.9	140	29.9
	267.2	120	26.5	264.2	120	26.0	277.2	120	28.3
	267.5	100	25.2	264.5	100	24.7	277.5	100	26.9
	267.7	80	24.1	264.7	80	23.6	277.7	80	25.8
	267.8	60	23.2	264.8	60	22.7	277.8	60	24.9
	268.0	40	22.6	265.0	40	22.1	278.0	40	24.3
	268.0	20	22.2	265.0	20	21.7	278.0	20	24.0
(3)	268.0	0	22.1	265.0	0	21.6	278.0	0	23.8

(1) End of long axis.
(2) End of diagonal axis.
(3) End of short axis.

10-pin base; JEDEC B10-277

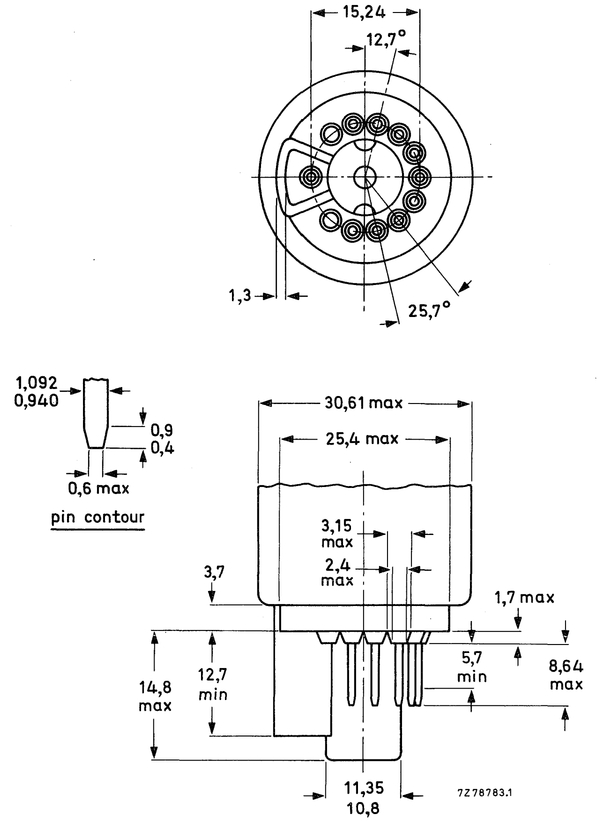


Fig.10 JEDEC base.

Cavity cap JEDEC J1-21, IEC 67-III-2

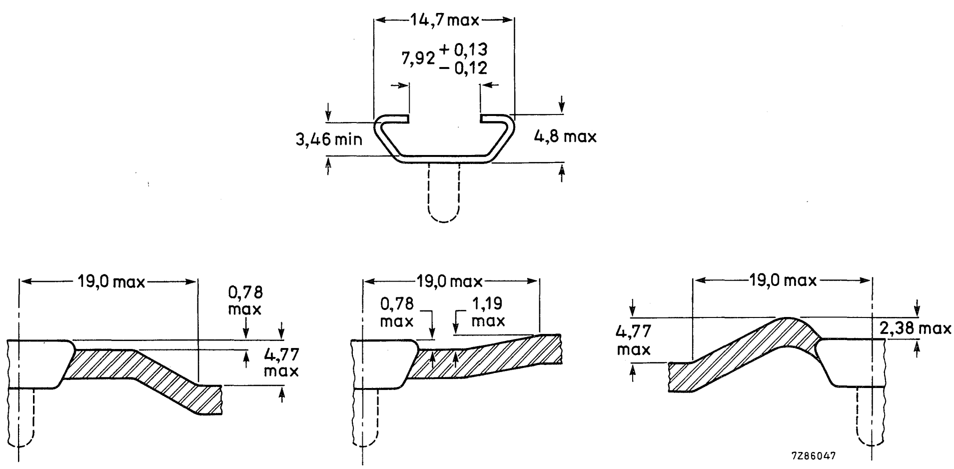


Fig.11 Cavity cap.

Maximum cone contour

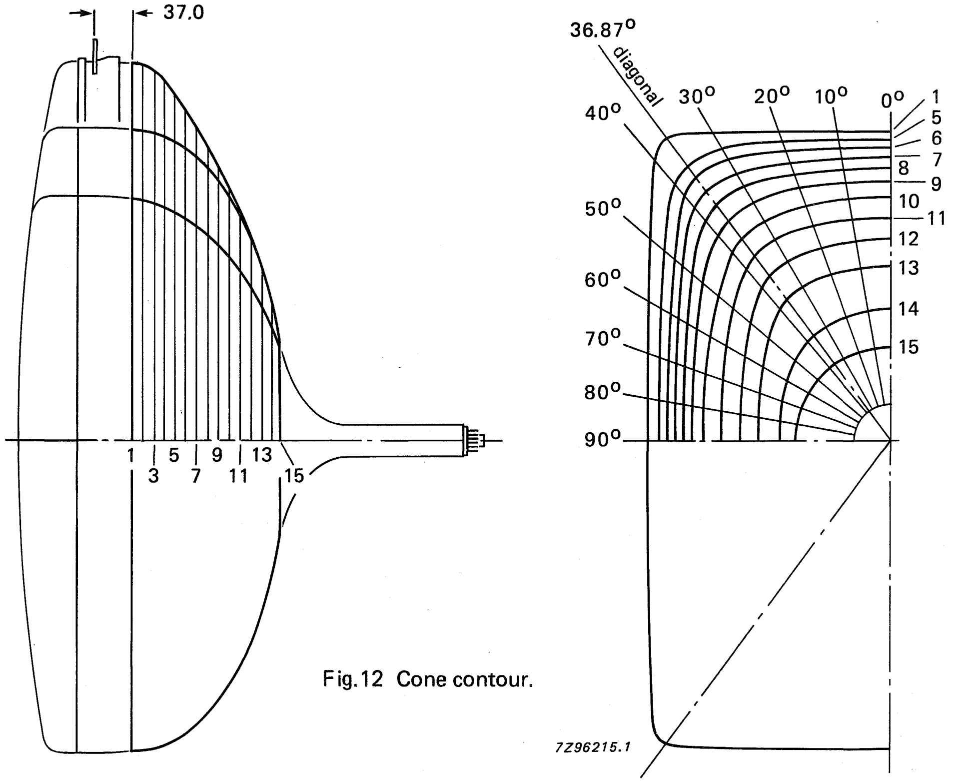


Fig.12 Cone contour.

Table 2 Cone contour data

Dimensions in mm

section	nom. distance from section 1	distance from centre										
		0°	10°	20°	30°	36.87°	40°	50°	60°	70°	80°	90°
1	0.00	287.2	291.4	304.9	329.6	349.8	341.6	289.2	257.0	237.4	226.8	223.5
2	10.00	286.6	290.8	304.2	328.8	348.1	339.9	288.4	256.2	236.7	226.1	222.8
3	20.00	285.0	289.2	302.4	326.4	342.6	334.6	285.6	253.8	234.5	224.1	220.8
4	30.00	282.1	286.1	298.9	321.2	332.5	324.7	279.7	249.2	230.5	220.3	217.1
5	40.00	277.7	281.5	293.5	313.3	319.6	312.1	271.7	242.7	224.8	215.1	212.0
6	50.00	271.6	275.2	286.3	302.8	305.1	298.2	262.4	235.2	218.2	208.9	205.9
7	60.00	263.8	267.1	276.9	287.8	289.2	283.0	252.1	227.0	211.0	202.1	199.3
8	70.00	253.9	256.8	265.2	274.3	271.9	266.6	240.6	217.8	202.9	194.6	192.0
9	80.00	241.4	243.9	250.9	257.0	253.7	249.1	227.2	207.0	193.2	185.6	183.1
10	90.00	225.6	227.8	233.6	237.8	234.3	230.2	211.4	193.4	180.9	173.9	171.6
11	100.00	207.1	209.1	214.0	217.4	213.8	210.0	192.9	176.7	165.4	159.0	157.0
12	110.00	186.8	188.4	192.6	195.1	191.4	187.7	172.1	157.5	147.5	141.8	139.9
13	120.00	163.7	165.0	168.0	169.0	165.3	162.1	149.2	137.1	128.6	123.7	122.1
14	130.00	126.3	126.7	126.8	125.3	123.2	121.9	117.1	112.0	107.7	104.7	103.7
15	137.12	88.4	88.4	88.4	88.4	88.4	88.4	88.4	88.4	88.4	88.4	88.4

TYPICAL OPERATING CONDITIONS

The voltages are specified with respect to grid 1.

Anode voltage	$V_{a,g4}$	25 kV
Grid 3 (focusing electrode) voltage	V_{g3}	7.25 to 8.25 kV
Grid 2 voltage for a spot cut-off voltage V_k = 130 V	V_{g2}	see Fig.13
Heater voltage under operating conditions	V_f	6.3 V

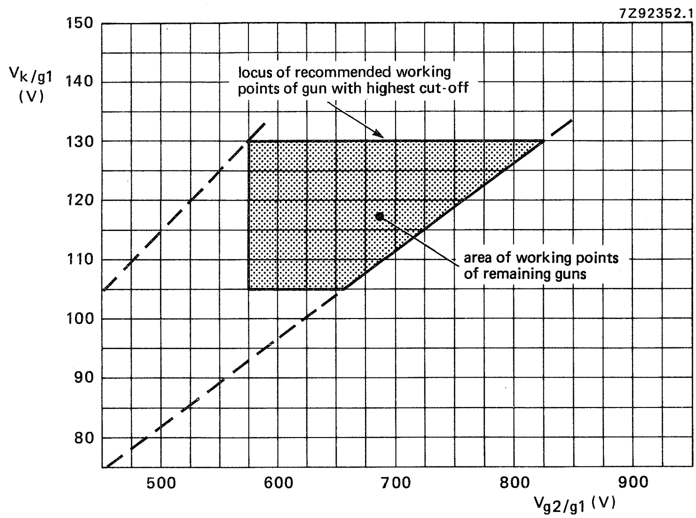


Fig.13 Spot cut-off design chart.

Grid 2 voltage (V_{g2}) adjusted for highest gun spot cut-off voltage V_k = 130 V.

Remaining guns adjusted for spot cut-off by means of cathode voltage

V_{g2} range 575 to 825 V;

V_k range 105 to 130 V.

Adjustment procedure:

Set the cathode voltage (V_k) for each gun at 130 V; increase the grid 2 voltage (V_{g2}) from approximately 550 V to the value at which one of the colours become just visible. Now decrease the cathode voltage of the remaining guns so that the other colours also become visible.

DEVELOPMENT DATA

EQUIPMENT DESIGN VALUES

The values are valid for anode voltages between 20 and 27.5 kV.
The voltages are specified with respect to grid 1.

Grid 3 (focusing electrode) voltage	V_{g3}	29 to 33% of anode voltage
Grid 2 voltage and cathode voltage for visual extinction of focused spot	V_{g2} and V_k	see Fig.13
Difference in cut-off voltages between guns in any tube	ΔV_k	lowest value > 80% of highest value
Heater voltage	V_f	6,3 V at zero beam current
Video drive characteristics		see Fig.14*
Grid 3 (focusing electrode) current	I_{g3}	−2 to + 2 μA
Grid 2 current	I_{g2}	−2 to + 2 μA
Grid 1 current under cut-off conditions	I_{g1}	−2 to + 2 μA

To produce white of 6500K + 7 M.P.C.D.
(CIE co-ordinates x = 0.313, y = 0.329)

Percentage of the total anode current supplied by each gun (typical)

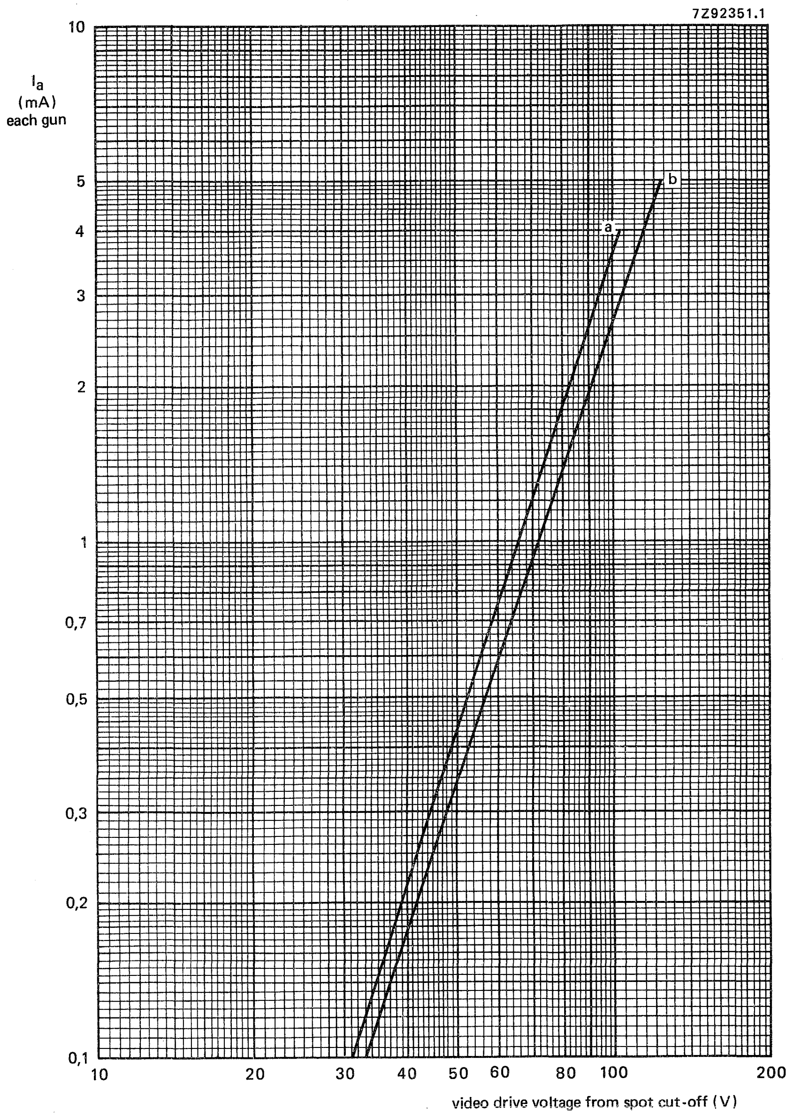
red gun	40.5%
green gun	32.4%
blue gun	27.1%

Ratio of anode currents

red gun to green gun	min.	0.90
	average	1.25
	max.	1.60
red gun to blue gun	min.	1.10
	average	1.50
	max.	1.90
blue gun to green gun	min.	0.60
	average	0.85
	max.	1.20

Insulation resistance between each cathode and grid 1 and heater — min. 50 MΩ

* For optimum picture performance it is recommended that the cathodes are not driven below + 1 V.



V_f = 6.3 V;
$V_{a,g4}$ = 25 kV;
V_{g3} adjusted for focus;
V_{g2} (each gun) adjusted to provide spot cut-off for V_k = 105 V (curve a) and V_k = 130 V (curve b).

Fig.14 Typical cathode drive characteristic.

DEVELOPMENT DATA

LIMITING VALUES (Design maximum rating system unless otherwise stated)

The voltages are specified with respect to grid 1.

				notes
Anode voltage	$V_{a,g4}$	max.	29.9 kV	1, 2, Fig.15
		min.	20 kV	1, 3
Long-term average current for three guns	I_a	max.	1000 μA	4
Grid 3 (focusing electrode) voltage	V_{g3}	max.	12 kV	
Grid 2 voltage	V_{g2}	max.	1200 V	5
Cathode voltage				
positive	V_k	max.	400 V	
positive operating cut-off	V_k	max.	200 V	
negative	$-V_k$	max.	0 V	
negative peak	$-V_{kp}$	max.	2 V	
Cathode to heater voltage				
positive	V_{kf}	max.	250 V	
positive peak	V_{kfp}	max.	300 V	1
negative	$-V_{kf}$	max.	135 V	
negative peak	$-V_{kfp}$	max.	180 V	1
Heater voltage	V_f		6,3 V $^{+5\ \%}_{-10\ \%}$	1, 6

LIMITING CIRCUIT VALUES

Grid 3 circuit resistance	R_{g3}	max.	70 MΩ
Grid 1 to cathode circuit resistance (each gun)	R_{g1k}	max.	0.75 MΩ

BEAM CENTRING

Maximum centring error in any direction 4 mm

Notes

1. Absolute maximum rating system.
2. 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.
3. Operation of the tube at lower voltages impairs the luminance and resolution, and could impair convergence.
4. The short-term average anode current should be limited by circuitry to 1500 μA.
5. During adjustment on the production line maximum 1500 V is permitted.
6. For maximum cathode life it is recommended that the heater supply be designed for 6.3 V at zero beam current.

The colour picture tube does not emit X-radiation above 1 μSv/h when operated at 29.9 kV and 1 mA. The X-radiation emitted will also not exceed 1 μSv/h for anode voltage and current combinations given by the isoexposure-rate limit curve shown below.

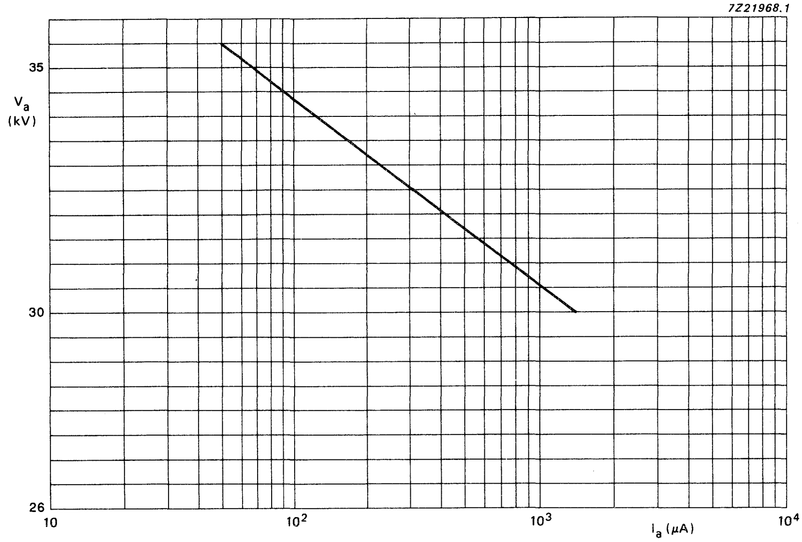


Fig.15 1 μSv/h isoexposure-rate limit curve.

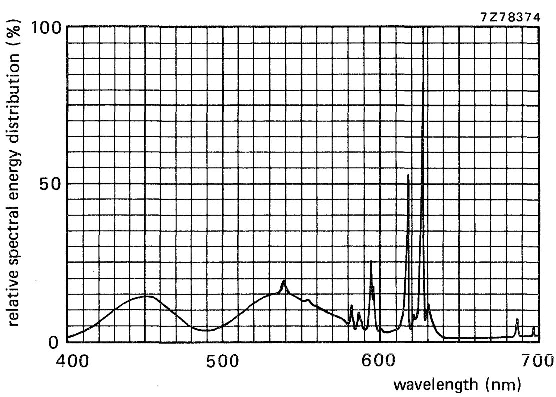


Fig.16 Simultaneous excitation of red, green and blue phosphor, measured in a tube, to produce white of x = 0.313, y = 0.329. Exact shape of the peaks depends on the resolution of the measuring apparatus.

Colour co-ordinates:	x	y
red	0.620	0.340
green	0.305	0.600
blue	0.155	0.065

DEVELOPMENT DATA

DEGAUSSING

The picture tube is provided with an internal magnetic shield. This shield and the shadow mask with its suspension system may be provided with an automatic degaussing system, consisting of two coils covering top and bottom cone parts, or on large coil.
For proper degaussing an initial magnetomotive force (MMF) of 300 ampere-turns is required in each of the coils. This MMF has to be gradually decreased by appropriate circuitry. To prevent beam landing disturbances by line-frequency currents induced in the degaussing coils, these coils should be shunted by a capacitor of sufficiently high value. In the steady state, no significant MMF should remain in the coils (⩽ 0.15 ampere-turns).
If single-phase power rectification is employed in the TV circuitry, provision should be included to prevent asymmetric distortion of the AC voltage applied to the degaussing circuit due to high DC inrush currents.
To ease the mounting of the coils, the rimband is provided with rectangular holes.

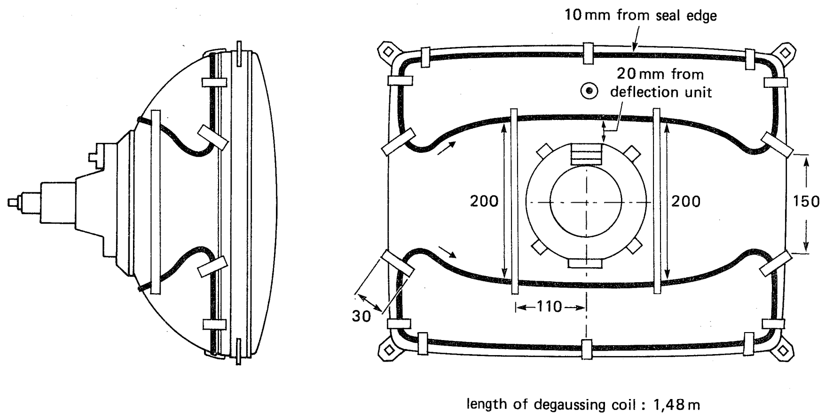


Fig. 17 Double-coil system.

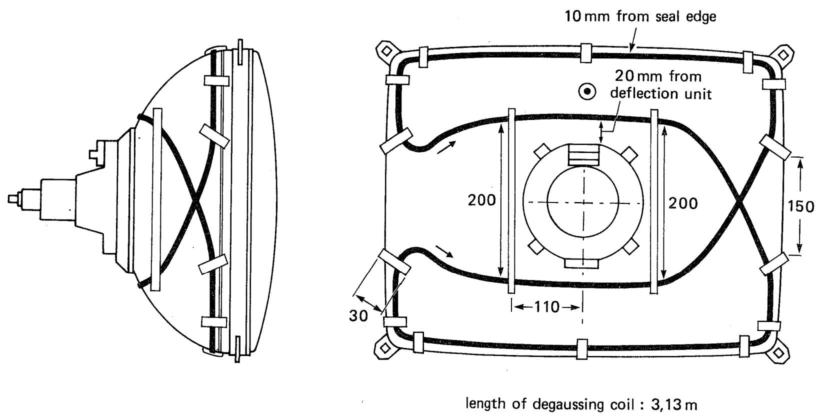


Fig. 18 Single-coil system.

7Z91928

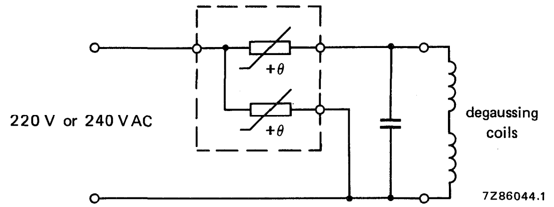


Fig.19 Degaussing circuit using dual PTC thermistor 2322 662 98009; C = 100 nF.

Data of each degaussing coil

	double-coil system	single-coil system
Circumference	148 cm	313 cm
Number of turns	60	60
Copper-wire diameter	0.4 mm	0.4 mm
Aluminium-wire diameter	0.5 mm	0.5 mm
Resistance	12 Ω	25 Ω

110° FLAT SQUARE COLOUR PICTURE TUBE ASSEMBLY

- Factory preset tube/coil assembly
- Self-converging and north-south raster correction free
- 66 cm, 110° colour picture tube A66EAK51X
- Double saddle deflection unit AT6005/00

QUICK REFERENCE DATA

Deflection angle	110°
Minimum useful screen diagonal	66 cm
Overall length	42 cm
Neck diameter	29.1 mm

MECHANICAL DATA

Dimensions in mm

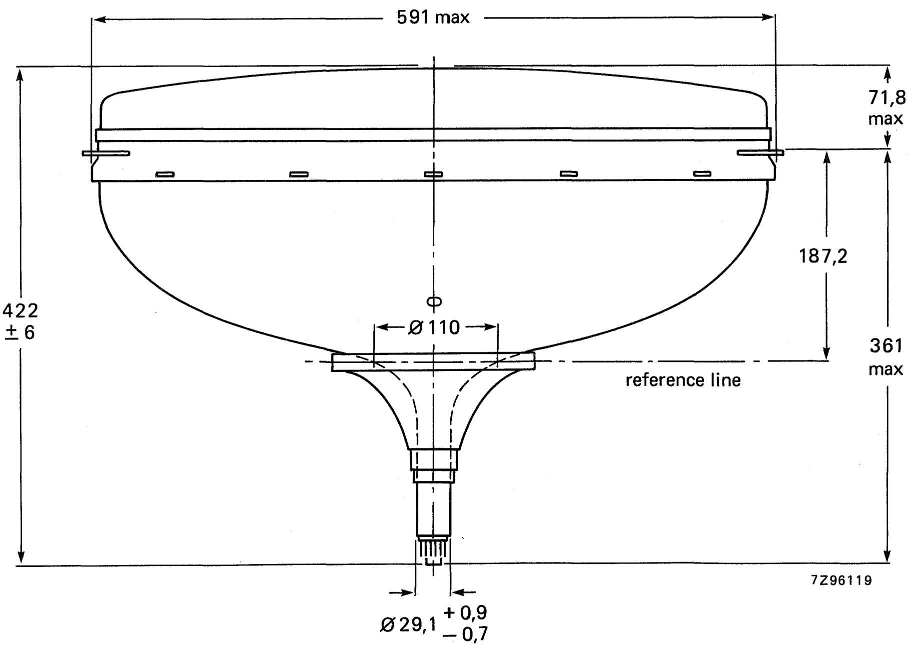


Fig.1 Tube assembly.

Net mass of tube assembly: 25.5 kg.

MECHANICAL DATA

Dimensions in mm

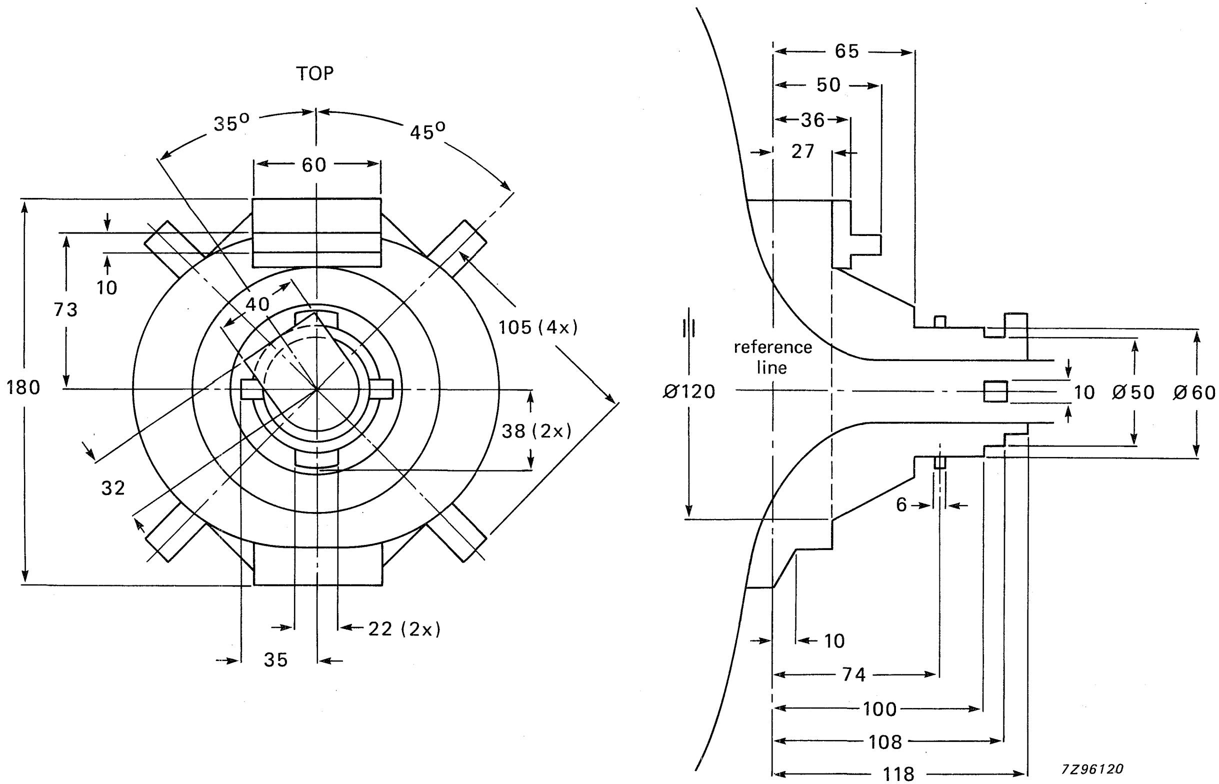
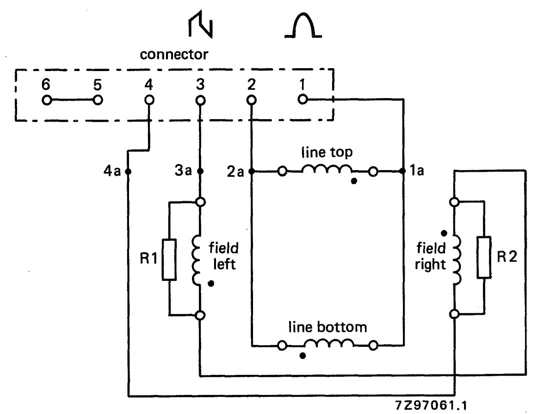


Fig.2 Yoke clearance.

DEVELOPMENT DATA

ELECTRICAL DATA OF DEFLECTION UNIT

Line coils	parallel connected
Inductance at 1 V (RMS), 1 kHz	1.84 mH
Resistance at 25 °C	1.8 Ω
Magnetic flux	7.6 mWb ± 5%
Line deflection current, edge to edge, at 25 kV	4.23 A (p-p)
Field coils	series connected
Inductance at 1 V (RMS), 1 kHz	10.7 mH
Resistance at 25 °C	6.2 Ω
Field deflection current, edge to edge, at 25 kV	1.76 A (p-p)



The beginning of the windings is indicated with •.
R1 = R2 = 100 Ω, 0.25 W.
Matching Stocko connector MKF2806-1-0-606.

Fig.3 Electrical diagram.

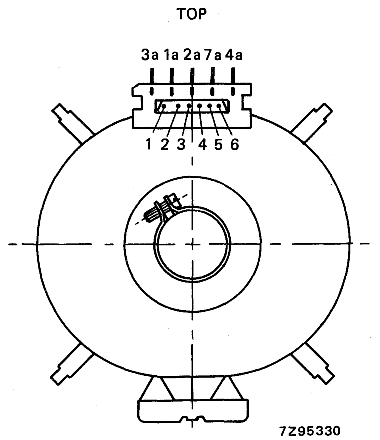


Fig.4 Terminal location.

FLAT AND SQUARE 'BLACK LINE' COLOUR PICTURE TUBE

- Flat and square screen
- 110° deflection
- In-line, polygon A R T* gun with quadrupole cathode lens
- 29.1 mm neck diameter
- INVAR mask with corner suspension
- Black matrix technology
- Pigmented phosphors
- Quick-heating low-power cathodes
- Soft flash
- Slotted shadow mask optimized for minimum moiré at 625 lines systems
- Internal magnetic shield
- Internal multipole
- Reinforced envelope for re-entrant mounting
- Anti-crackle coating

QUICK REFERENCE DATA

Deflection angle	110°
Useful screen diagonal	80 cm
Overall length	50 cm
Neck diameter	29.1 mm
Heating	6.3 V, 310 mA
Anode voltage	27.5 kV
Focusing voltage	28% of anode voltage

45AX Black Line

* Aberration Reducing Triode.

ELECTRON-OPTICAL DATA

Electron gun system	unitized triple-aperture electrodes; aberration reducing triode
Focusing method	electrostatic
Main lens	polygon
Deflection method	magnetic
Deflection angles	
diagonal	110°
horizontal	97°
vertical	77°

ELECTRICAL DATA

Capacitances				
anode to external conductive coating including rimband	C_a (m + m')	min.	3000	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 3 (focusing electrode) to all other electrodes	C_{g3}		6	pF
grid 1 to all other electrodes	C_{g1}		17	pF
grid 2 to all other electrodes	C_{g2}		4.5	pF
Resistance between rimband and external conductive coating		min.	50	MΩ
Heating: indirect by AC (preferably mains or line frequency) or DC				
heater voltage	V_f		6.3	V
heater current	I_f		310	mA

OPTICAL DATA

Screen	metal-backed vertical phosphor stripes; phosphor lines follow glass contour
Matrix	black opaque material, PVP technology
Screen finish	satinized
Useful screen dimensions	
diagonal	796.5 mm
horizontal axis	648.5 mm
vertical axes	478.5 mm
area	3100 cm²
Positional accuracy of the screen with respect to the glass contour	see Fig.1
Phosphors	
red	pigmented europium activated rare earth
green	sulphide type
blue	pigmented sulphide type
Persistence	medium short

DEVELOPMENT DATA

A = 256.0 mm
B = 346.4 mm
C = 174.0 mm
D = 269.9 mm
E = 24.1 mm

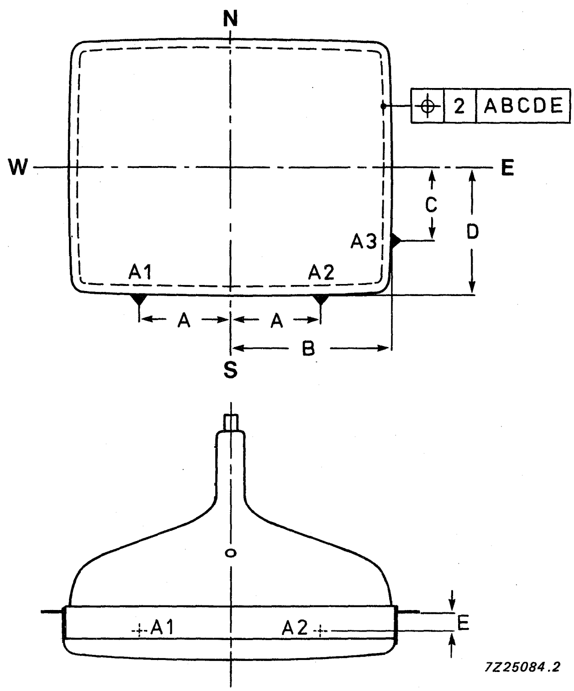


Fig.1 Tube alignment.

Colour co-ordinates	x	y
red	0.620	0.340
green	0.305	0.600
blue	0.155	0.065

Centre-to-centre distance of identical colour phosphor stripes		approx. 0.9 mm
Light transmission of face glass at screen centre		47.5%
Luminance at the centre of the screen	L	100 cd/m² *

MECHANICAL DATA (see also Figs 2 to 9 inclusive)

Overall length	498 ± 6 mm
Neck diameter	$29.1^{+1.4}_{-0.7}$ mm
Base	JEDEC B10-277
Anode contact	small cavity contact J1-21, IEC 67-III-2
Mounting position	anode contact on top
Implosion protection	shrunk-on rimband
Net mass	approx. 39 kg

Handling

During shipment and handling the tube should not be subjected to accelerations greater than 350 m/s^2 in any direction.

* Tube setting adjusted to produce white D (x = 0.313, y = 0.329), focused raster, current density 0.4 $\mu A/cm^2$.

MECHANICAL DATA (continued)

Dimensions in mm

Notes are given after the drawings.

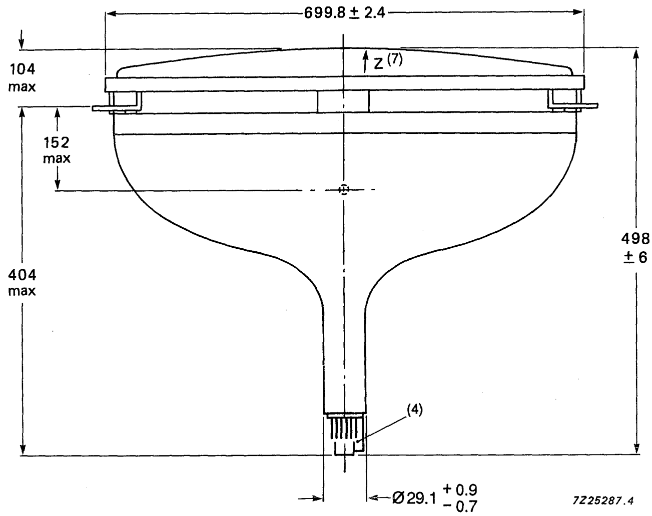


Fig.2.

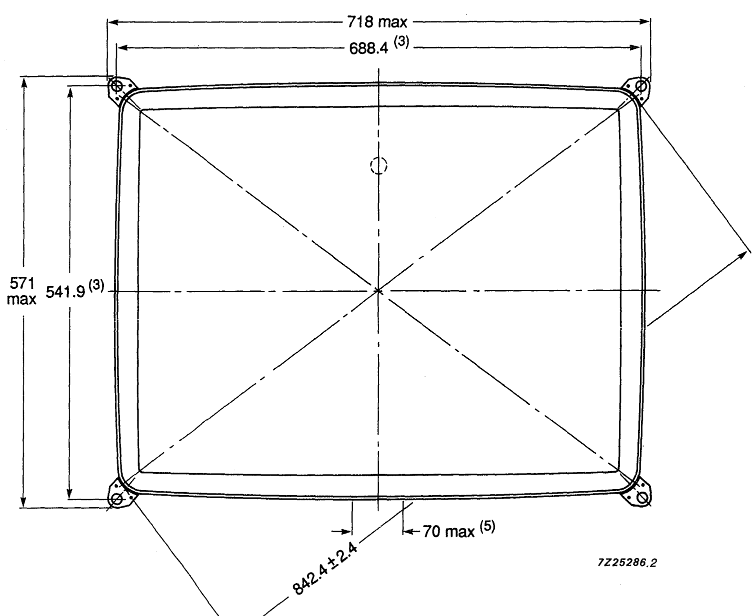


Fig.3.

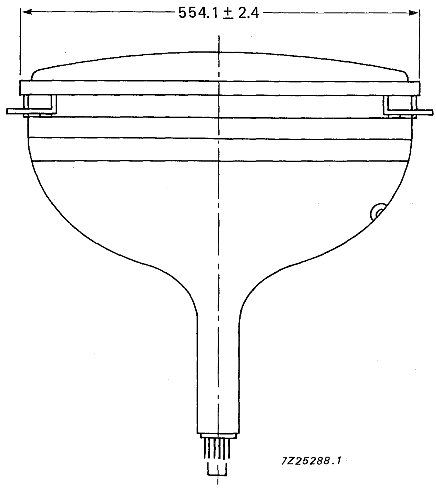


Fig.4.

DEVELOPMENT DATA

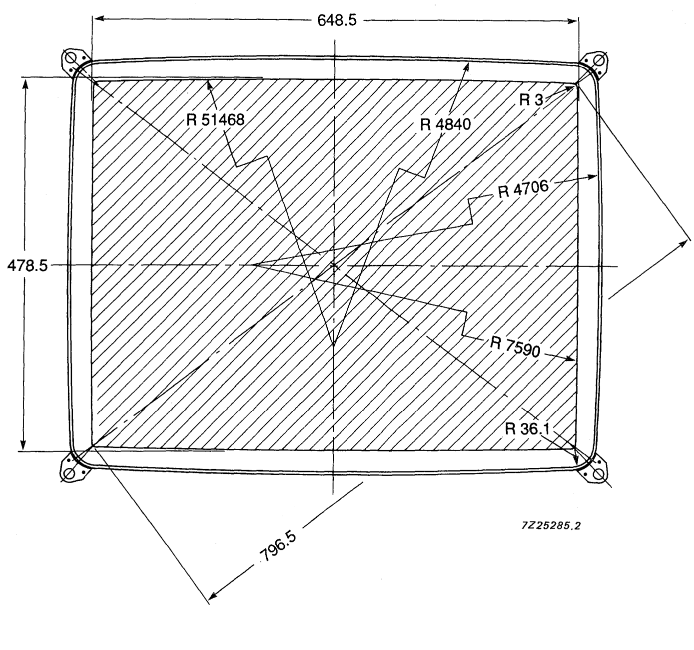


Fig.5.

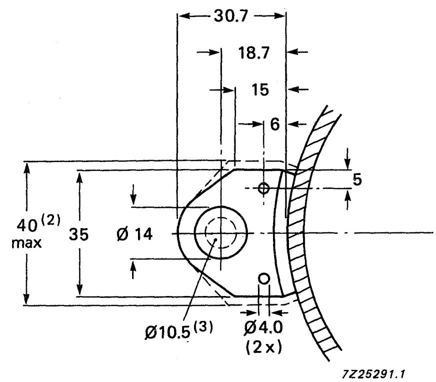


Fig.6 Lug dimensions.

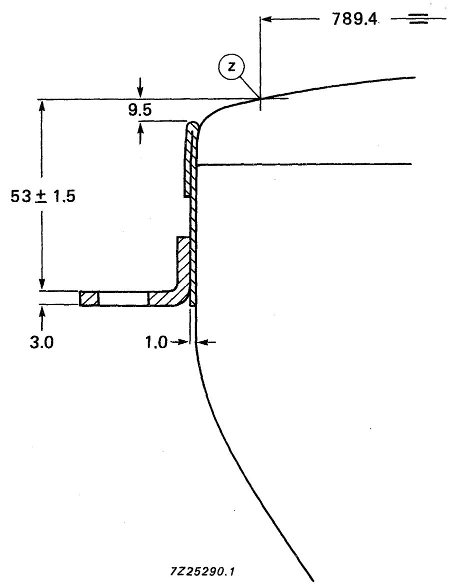


Fig.7 Lug position.

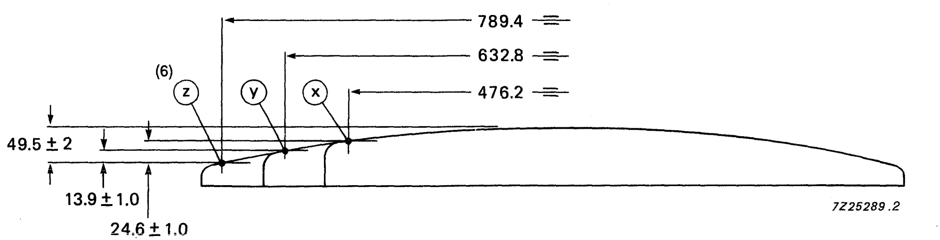
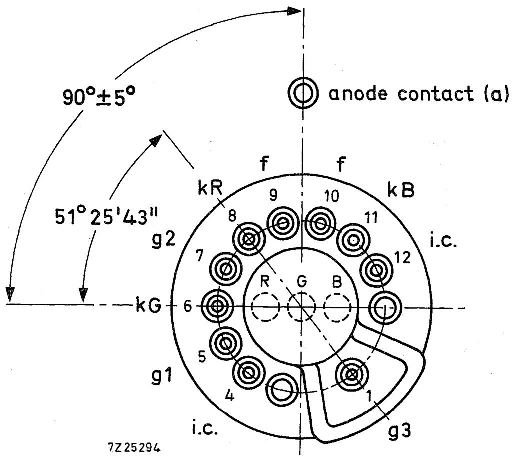


Fig.8 Screen reference points.



i.c. = internally connected (not to be used).

Fig.9 Pin arrangement.

DEVELOPMENT DATA

$R = \sqrt{(X^2 + Y^2)}$

$A = \tan^{-1}(Y/X)$

$P = \sum_{i=0}^{5} \{B_i \times \cos(2 \times i \times A)\}$

$Q = \left[\sum_{i=0}^{5} \{K_i \times \cos(2 \times i \times A)\}\right]^{-1}$

$Z1 = \{\sqrt{(Q^2 + R^2)} - Q\}/P$

table:

B_0 = 1.5212766E 0	K_0 = 1.0898877E-3
B_1 = 0.4812777E 0	K_1 = 3.0225573E-4
B_2 = −1.3812790E 0	K_2 = −1.0012023E-3
B_3 = −0.3712766E 0	K_3 = −2.3277834E-4
B_4 = 2.3713430E-6	K_4 = 7.6873502E-6
B_5 = −1.0992640E-6	K_5 = 2.6051020E-6

$Z2 = 3.834025E\text{-}5 \times X^2 - 1.837469E\text{-}10 \times X^4 + 6.944444E\text{-}5 \times Y^2$
$-1.331259E\text{-}9 \times X^2 \times Y^2 + 6.380099E\text{-}15 \times X^4 \times Y^2 +$
$-6.028164E\text{-}10 \times Y^4 + 1.155607E\text{-}14 \times X^2 \times Y^4 +$
$-5.538280E\text{-}20 \times X^4 \times Y^4$

$Z = Z1 + Z2$

Notes to outline drawings

1. The displacement of any lug with respect to the plane through the three other lugs is max. 1.0 mm.
2. Minimum space to be reserved for mounting lug.
3. The position of the mounting screw in the cabinet must be within a circle of 10.5 mm diameter drawn around the true geometrical positions, i.e. the corners of a rectangle of 688.4 mm x 541.9 mm.
4. The socket for this base must not be rigidly mounted; it should have flexible leads and be allowed to move freely. After mounting of the tube in the cabinet note that the position of the base can fall within a circle, having a diameter of max. 55 mm, concentric with an imaginary tube axis.
5. Location of fishplate.
6. Coordinates of Z-point: X = 315.76, Y = 236.82.
7. The distance Z from any point on the screen to the centre can be calculated using the formula given on the previous page; a number of points are given in Table 1.

Table 1 Sagittal heights with reference to screen centre

	Nominal useful screen (NUS)			3 mm inside NUS			10 mm outside NUS		
	coordinates X mm	coordinates Y mm	sagittal height mm	coordinates X mm	coordinates Y mm	sagittal height mm	coordinates X mm	coordinates Y mm	sagittal height mm
(1)	0	239.3	25.2	0	235.3	24.6	0	249.2	27.1
	20	239.2	25.3	20	236.2	24.7	20	249.2	27.2
	40	239.2	25.5	40	236.2	24.9	40	249.2	27.5
	60	239.2	26.0	60	236.2	25.4	60	249.2	28.0
	80	239.2	26.7	80	236.2	26.1	80	249.2	28.6
	100	239.1	27.6	100	236.1	27.0	100	249.2	29.5
	120	239.1	28.7	120	236.1	28.1	120	249.1	30.6
	140	239.0	30.0	140	236.0	29.4	140	249.0	31.9
	160	239.0	31.5	160	236.0	30.9	160	249.0	33.4
	180	238.9	33.1	180	235.9	32.6	180	248.9	34.9
	200	238.9	34.9	200	235.8	34.4	200	248.9	36.7
	220	238.8	36.9	220	235.8	36.4	220	248.8	38.7
	240	238.7	39.2	240	235.7	38.7	240	248.7	40.9
	260	238.6	41.6	260	235.6	41.2	260	248.6	43.2
	280	238.5	44.3	280	235.5	43.9	280	248.5	45.8
	300	238.4	47.2	300	235.4	46.8	300	248.4	48.7
	315	238.3	49.6	315	235.3	49.2	320	248.2	51.8
(2)	317.6	238.3	50.0	317.6	235.3	49.7	330.3	245.0	53.1
	320.0	237.0	50.3	317.6	350	49.6	330.4	240	52.5
	320.8	230	49.5	317.7	230	49.0	330.6	235	51.8
	321.1	220	48.4	318.1	220	47.8	331.1	220	50.2
	321.6	200	46.3	318.6	200	45.8	331.6	200	48.2
	322.1	180	44.6	319.1	180	44.0	332.1	180	46.6
	322.6	160	43.1	319.6	160	42.6	332.6	160	45.2
	323.0	140	41.9	319.9	140	41.3	333.0	140	44.0
	323.3	120	40.8	320.3	120	40.2	333.3	120	43.0
	323.6	100	39.9	320.6	100	39.3	333.6	100	42.0
	323.8	80	39.0	320.8	80	38.4	333.8	80	41.2
	324.0	60	38.3	321.0	60	37.7	334.0	60	40.5
	324.1	40	37.7	321.1	40	37.1	334.1	40	39.9
	324.2	20	37.5	321.2	20	36.8	334.2	20	39.7
(3)	324.3	0	37.4	321.3	0	36.7	334.3	0	39.6

(1) End of short axis (2) End of diagonal axis (3) End of long axis

Maximum cone contour

Dimensions in mm

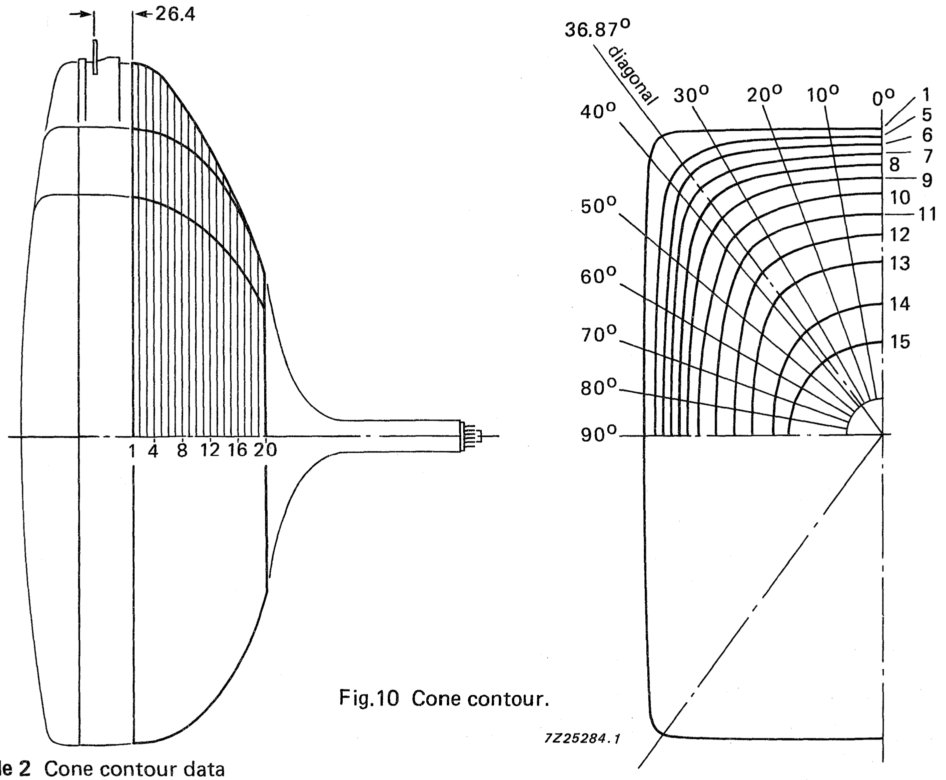


Fig.10 Cone contour.

Table 2 Cone contour data

section	nominal distance from section 1	distance from centre										
		0°	10°	20°	30°	36.87°	40°	50°	60°	70°	80°	90°
1	0.00	345.90	350.89	366.43	349.91	417.60	409.16	349.59	312.13	289.15	276.63	272.65
2	10.00	344.58	349.58	365.28	393.86	416.33	407.72	348.83	311.27	288.20	275.64	271.64
3	20.00	341.34	346.36	362.08	390.60	412.75	404.19	346.36	308.86	285.83	273.29	269.30
4	30.00	336.90	341.83	357.26	385.19	406.64	398.64	342.06	305.20	282.51	270.15	266.21
5	40.00	331.99	336.78	351.78	378.65	397.70	390.36	336.86	301.03	278.88	266.78	262.93
6	50.00	326.60	311.29	345.66	370.77	385.75	379.34	330.60	296.24	274.84	263.11	259.37
7	60.00	320.80	325.18	338.73	361.18	371.47	365.88	323.11	290.59	270.12	258.85	255.24
8	70.00	314.15	318.28	330.38	350.16	356.57	351.56	314.53	283.98	264.49	253.70	250.24
9	80.00	306.52	310.37	321.89	337.90	341.40	336.83	304.86	276.30	257.89	247.60	244.30
10	90.00	297.71	301.26	311.57	324.26	325.71	321.53	294.04	267.79	250.34	240.57	237.43
11	100.00	287.45	290.69	299.64	309.41	309.22	305.44	282.02	258.22	241.88	232.66	229.69
12	110.00	275.32	278.21	285.76	292.95	291.85	288.52	260.85	247.68	232.55	223.91	221.12
13	120.00	261.08	263.62	269.87	275.08	273.61	270.70	254.53	236.07	222.27	214.24	211.63
14	130.00	244.87	247.08	252.20	256.03	254.54	252.21	238.98	223.20	210.82	203.44	201.02
15	140.00	227.19	229.08	233.24	236.05	234.66	232.75	222.05	208.78	197.89	191.21	189.00
16	150.00	208.05	209.64	212.98	215.02	213.74	212.18	203.57	192.59	183.19	177.26	175.27
17	160.00	187.13	188.45	191.09	192.53	191.40	190.13	183.27	174.36	166.46	161.31	159.55
18	170.00	163.97	165.03	167.03	167.99	167.02	166.02	160.73	153.76	147.39	143.10	141.59
19	180.00	137.90	138.67	140.01	140.50	139.71	138.99	135.30	130.40	125.74	122.45	121.24
20	190.00	108.60	109.04	109.68	109.76	109.25	108.84	106.85	104.20	101.54	99.52	98.71
21	200.00	76.33	76.41	76.47	76.45	76.35	76.29	76.00	75.62	75.22	74.87	74.70
22	200.82	73.59	73.62	73.66	73.64	73.59	73.55	73.40	73.20	72.98	72.80	72.71

TYPICAL OPERATING CONDITIONS

The voltages are specified with respect to grid 1.

Anode voltage	$V_{a, g4}$	27.5 kV
Grid 3 (focusing electrode) voltage	V_{g3}	7.15 to 8.2 kV
Grid 2 voltage for a spot cut-off voltage V_k = 160 V	V_{g2}	700 to 1000 V
Heater voltage under operating conditions	V_f	6.3 V

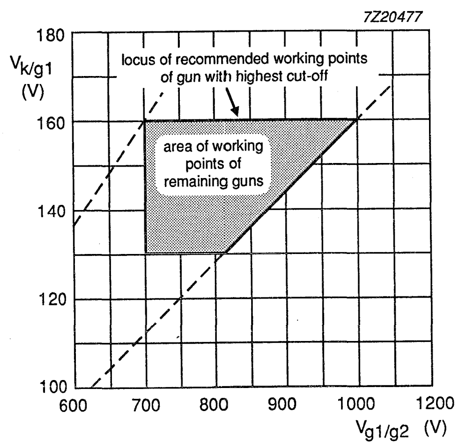


Fig.11 Spot cut-off design chart.

Grid 2 voltage (V_{g2}) adjusted for highest gun spot cut-off voltage V_k = 160 V.

Remaining guns adjusted for spot cut-off by means of cathode voltage

V_{g2} range 700 to 1000 V;

V_k range 130 to 160 V.

Adjustment procedure:

Set the cathode voltage (V_k) for each gun at 160 V; increase the grid 2 voltage (V_{g2}) from approx. 650 V to the value at which one of the colours become just visible. Now decrease the cathode voltage of the remaining guns so that the other colours also become visible.

DEVELOPMENT DATA

EQUIPMENT DESIGN VALUES

The values are valid for anode voltages between 25 and 29.9 kV
The voltages are specified with respect to grid 1

Grid 3 (focusing electrode) voltage	V_{g3}	26 to 29.8% of anode voltage
Grid 2 voltage and cathode voltage for visual extinction of focused spot	V_{g2} and V_k	see Fig.11
Difference in cut-off voltages between guns in any tube	ΔV_k	lowest value > 80% of highest value
Heater voltage	V_f	6.3 V at zero beam current
Grid 3 (focusing electrode) current	I_{g3}	−2 to + 2 μA
Grid 2 current	I_{g2}	−2 to + 2 μA
Grid 1 current under cut-off conditions	I_{g1}	−2 to + 2 μA

To produce white of 6500K + 7 M.P.C.D.
(CIE co-ordinates x = 0.313, y = 0.329)

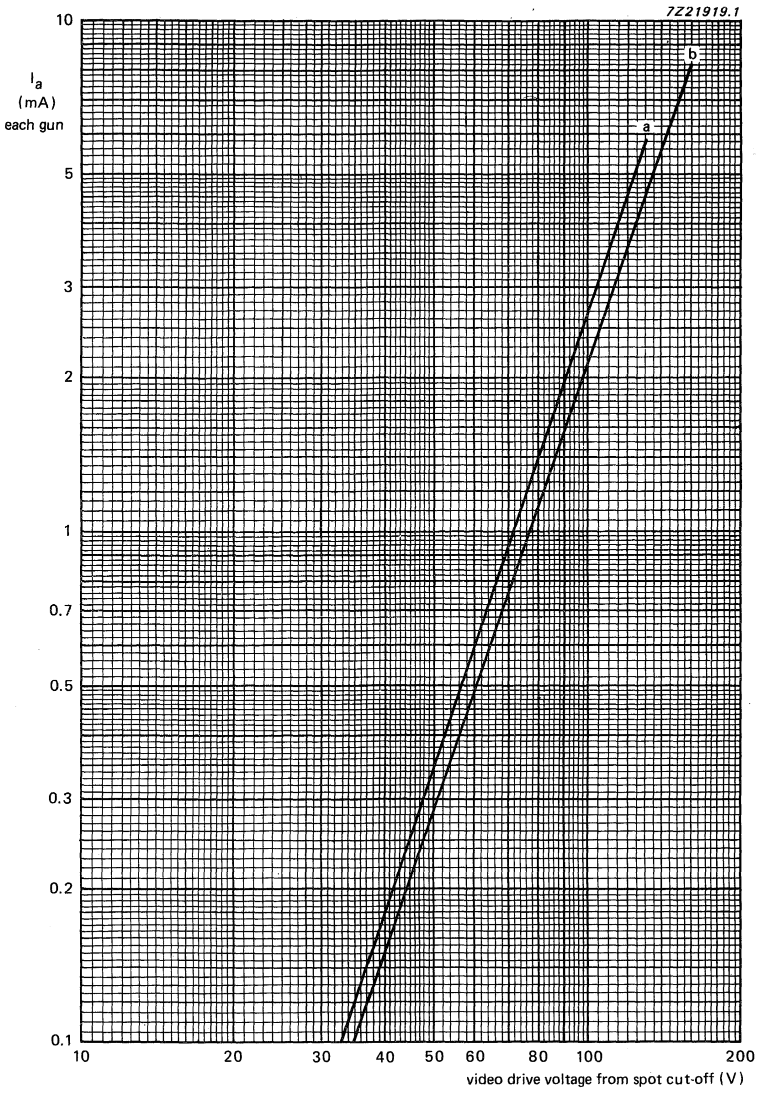
Percentage of the total anode current supplied by each gun (typical)

red gun	40.5%
green gun	32.4%
blue gun	27.1%

Ratio of anode currents

red gun to green gun	min.	0.90
	average	1.25
	max.	1.60
red gun to blue gun	min.	1.10
	average	1.50
	max.	1.90
blue gun to green gun	min.	0.60
	average	0.85
	max.	1.20

Insulation resistance between each cathode and grid 1 and heater — min. 50 MΩ



V_f = 6.3 V
$V_{a,\,g4}$ = 27.5 kV
V_{g3} adjusted for focus
V_{g2} (each gun) adjusted to provide spot cut-off for V_k = 130 V (curve a) and V_k = 160 V (curve b).

Fig.12 Typical cathode drive characteristic.

DEVELOPMENT DATA

LIMITING VALUES (Design maximum rating system unless otherwise stated)

The voltages are specified with respect to grid 1.

					notes
Anode voltage	$V_{a,g4}$	max.	33	kV	1, 2, 3
		min.	25	kV	1, 4
Long-term average current for three guns	I_a	max.	1300	μA	5
Grid 3 (focusing electrode) voltage	V_{g3}	max.	12	kV	
Grid 2 voltage	V_{g2}	max.	1200	V	6
Cathode voltage					
positive	V_k	max.	400	V	
positive operating cut-off	V_k	max.	200	V	
negative	$-V_k$	max.	0	V	
negative peak	$-V_{kp}$	max.	2	V	
Cathode to heater voltage					
positive	V_{kf}	max.	250	V	
positive peak	V_{kfp}	max.	300	V	1
negative	$-V_{kf}$	max.	135	V	
negative peak	$-V_{kfp}$	max.	180	V	1
Heater voltage	V_f		$6.3\ V\ ^{+5\ \%}_{-10\ \%}$		1, 7

LIMITING CIRCUIT VALUES

Grid 3 circuit resistance	R_{g3}	max.	70	MΩ
Grid 1 to cathode circuit resistance (each gun)	R_{g1k}	max.	0.75	MΩ

BEAM CENTRING

Maximum centring error in any direction 5 mm

Notes

1. Absolute maximum rating system.
2. The picture tube does not emit X-radiation above 1 μSv/h when operated at 29.9 kV and 1500 μA.
3. 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 luminance and resolution, and could impair convergence.
5. The short-term average anode current should be limited by circuitry to 1800 μA.
6. During adjustment on the production line max. 1500 V is permitted.
7. For maximum cathode life it is recommended that the heater supply be designed for 6.3 V at zero beam current.

The colour picture tube assembly does not emit X-radiation above 1 μSv/h when operated at 29.9 kV and 1.5 mA. The X-radiation emitted will also not exceed 1 μSv/h for anode voltage and current combinations given by the isoexposure-rate limit curve shown below.

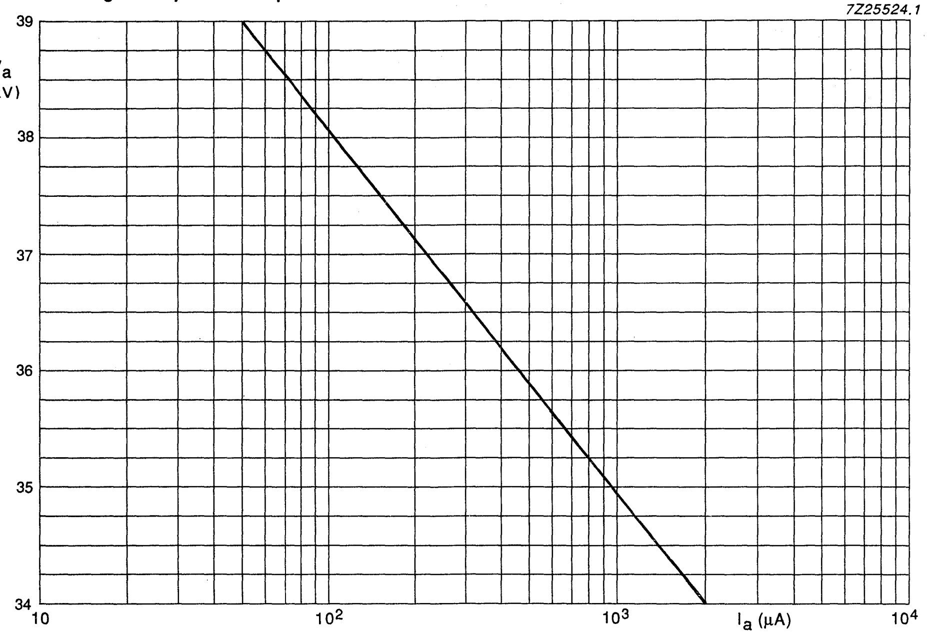


Fig.13 1 μSv/h isoexposure-rate limit curve.

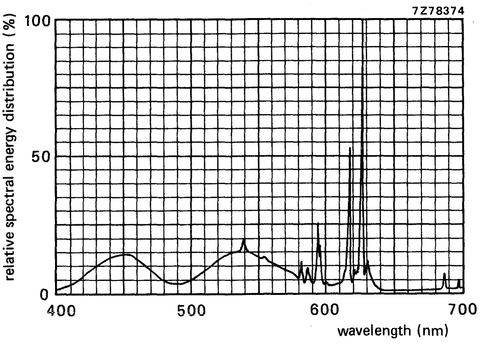


Fig.14 Simultaneous excitation of red, green and blue phosphor, measured in a tube, to produce white of x = 0.313, y = 0.329. Exact shape of the peaks depends on the resolution of the measuring apparatus.

Colour co-ordinates:	x	y
red	0.620	0.340
green	0.305	0.600
blue	0.155	0.065

DEGAUSSING

The picture tube is provided with an internal magnetic shield. This shield and the shadow mask with its suspension system, may be provided with an automatic degaussing system consisting of two coils covering top and bottom cone parts.
For correct degaussing an initial magnetomotive force (MMF) of 600 peak ampere-turns is required in each of the coils. This MMF has to be gradually decreased by appropriate circuitry. To prevent beam landing disturbances by line frequency currents induced in the degaussing coils, these coils should be shunted by a capacitor of sufficiently high value. In steady state, no significant MMF should remain in the coils (< 0.25 ampere-turns).

In principle, degaussing should be made during "off" scanning period (especially, vertical scanning should be "off"). If degaussing is attempted during "on" scanning condition, beam register of the tube may be affected.

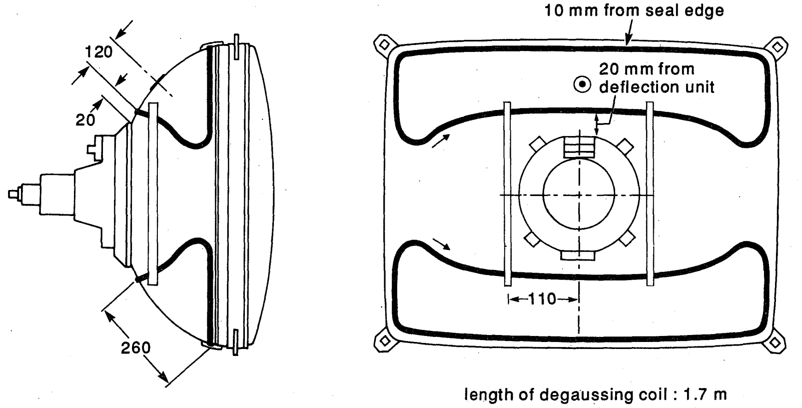
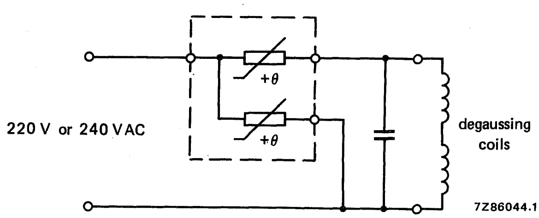


Fig.15 Double coil system.

Fig.16 Degaussing circuit using dual PTC thermistor 2322 662 98009; C = 100 nF.



Data of each degaussing coil

	double-coil system
Circumference	170 cm
Number of turns	120
Copper-wire diameter	0.63 mm
Resistance	11 Ω

DEVELOPMENT DATA

110° FLAT AND SQUARE 'BLACK LINE' COLOUR PICTURE TUBE ASSEMBLY

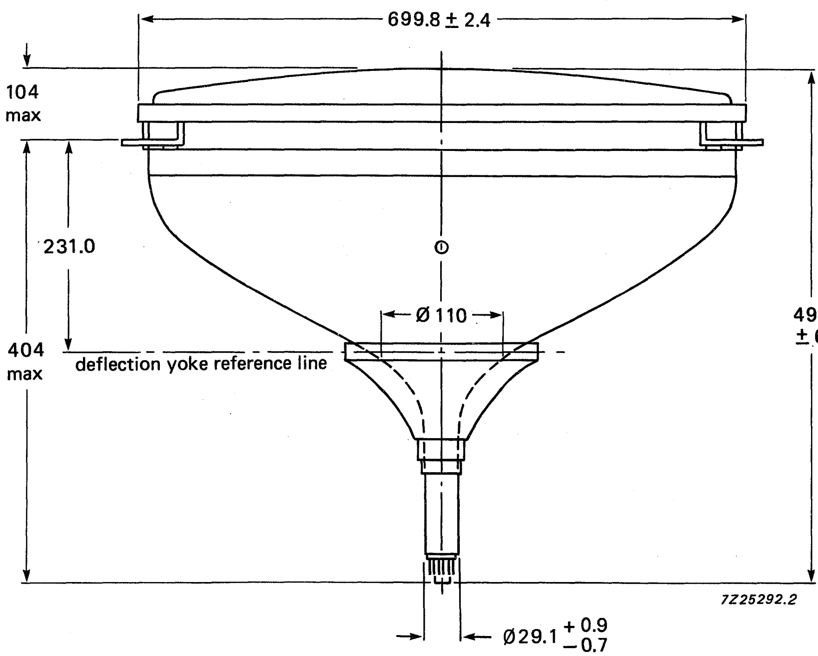
- Factory preset tube/coil assembly
- Self-converging and north-south raster correction free
- 80 cm, 110° colour picture tube A80EBK221X
- Double saddle deflection unit AT6070/00

QUICK REFERENCE DATA

Deflection angle	110°
Useful screen diagonal	80 cm
Overall length	50 cm
Neck diameter	29.1 mm

MECHANICAL DATA

Dimensions in mm



Net mass of tube assembly: 39.5 kg.

Fig. 1 Tube assembly.

45AX Black Line

MECHANICAL DATA

Dimensions in mm

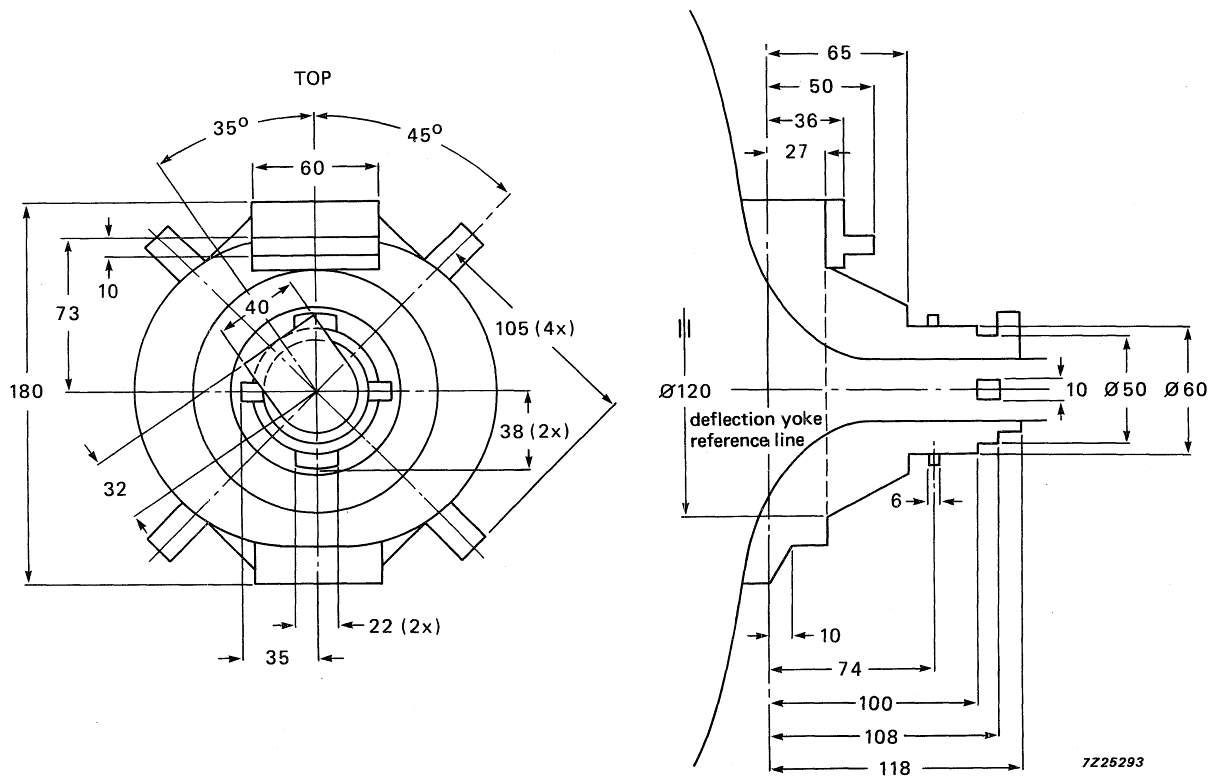
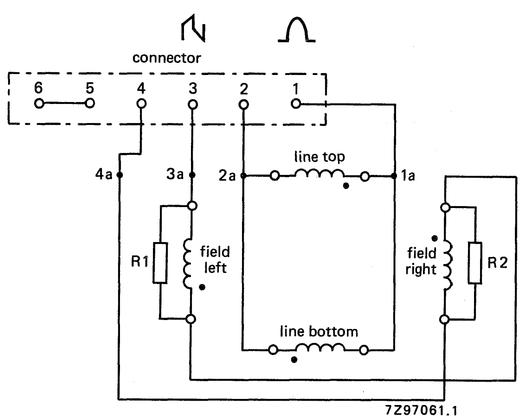


Fig.2 Yoke clearance.

ELECTRICAL DATA OF DEFLECTION UNIT

Line coils	parallel connected
Inductance at 1 V (RMS), 1 kHz	1.50 mH
Resistance at 25 °C	1.5 Ω
Line deflection current, edge to edge, at 27.5 kV	4.80 A (p-p)
Field coils	series connected
Inductance at 1 V (RMS), 1 kHz	11.9 mH
Resistance at 25 °C	6.6 Ω
Field deflection current, edge to edge, at 27.5 kV	1.62 A (p-p)



The beginning of the windings is indicated with ●.
R1 = R2 = 100 Ω, 0,25 W.
Matching Stocko connector MKF2806-1-0-606

Fig.3 Electrical diagram.

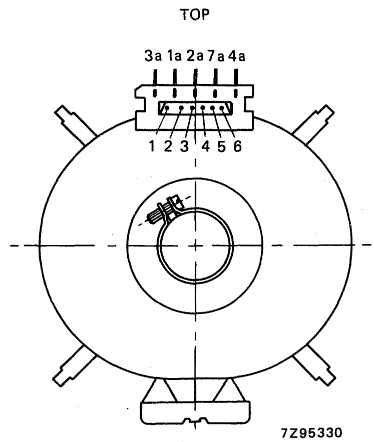


Fig.4 Terminal location.

DEVELOPMENT DATA

COLOUR MONITOR TUBE ASSEMBLIES

SURVEY OF MONITOR TUBES

M34ECL series

HIGH RESOLUTION COLOUR DISPLAY TUBE ASSEMBLIES

- 90° deflection angle
- 37 cm (14 in) face diagonal
- 29,1 mm neck diameter
- High resolution obtained by 0,29 mm dot triplet pitch and high-resolution in-line electron polygon gun
- Hexagonal dot arrangement
- Black matrix screen for high brightness and contrast
- Internal magneto-static beam alignment
- Soft-Flash technology offering improved monitor reliability
- Internal magnetic shield
- Rimband type implosion protection
- Supplied as a pre-aligned, self-converging tube-coil assembly; dynamic convergence is not required
- VDE, CSA, UL and BSI approved
- High gloss or non-glare faceplate
- Applicable up to and including 48 kHz line frequency
- East-West correction max. 4.5%

QUICK REFERENCE DATA

Deflection angle	90°
Face diagonal	37 cm (14 in)
Overall length	352 mm max
Neck diameter	29,1 mm
Dot triplet pitch	0,29 mm (0,011 in)
Resolution: minimum number of resolvable pixels* at 200 μA peak; mod. depth −9 dB	860 x 580
Heating	6,3 V/315 mA
Focusing voltage	26% of anode voltage

Available versions

M34ECL.. .. ..

Light transmission at screen centre (first ..):
00 = 86% etched
01 = 86% polished
02 = 86% direct grind
10 = 57% etched
11 = 57% polished
12 = 57% direct grind
20 = 46.5% etched
21 = 46.5% polished
22 = 46.5% direct grind

phosphor type (second ..):
X = P22 (short persistence)
DA = SW (medium persistence)

Deflection unit, see Table 1 (third ..)

* Pixel = picture element.

ELECTRON–OPTICAL DATA

Electron gun system	unitized in-line
Focusing method	electrostatic
Focus lens	hi-bi potential
Convergence method	magnetic
Deflection method	magnetic
Deflection angles	
diagonal	approx. 90°
horizontal	approx. 78°
vertical	approx. 60°

ELECTRICAL DATA

Tube

Capacitances		
anode to external conductive coating including rimband	$C_{a(m + m')}$	max. 1300 pF min. 800 pF
grid 1 of any gun to all other electrodes	C_{g1}	17 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
focusing electrode to all other electrodes	C_{g3}	6 pF
Heating		indirect by AC or DC
heater voltage	V_f	6,3 V
heater current	I_f	315 ± 20 mA

Deflection unit

Maximum permissible voltage	
between line and field coils	3000 V (DC)
between field coils and core	300 V (DC)
Insulation resistance	
between line and field coils, at 1 kV (DC)	⩾ 500 MΩ
between line coil and core clamping ring, at 1000 V (DC)	⩾ 500 MΩ
between field coil and core clamping ring, at 1000 V (DC)	⩾ 10 MΩ
Cross-talk	a voltage of 1 V, 15625 Hz applied to the line coils causes no more than 20 mV across the field coils

Table 1 Deflection unit data

parameter	unit	M34ECL . . . . followed by:*				
		66	56	46	36	26**
Line deflection coils, Fig.1						
inductance	mH ± 4%	1.44	0.67	0.45	0.38	0.30
resistance (at 25 °C)	Ω ± 10%	1.90	0.89	0.65	0.51	0.43
Line deflection current, edge to edge at 25 kV	A (p-p) ± 4%	3.16	4.60	5.64	6.14	6.93
Field deflection coils, Fig.2						
inductance	mH ± 10%	6.6	6.6	10.6	6.6	6.6
resistance (at 25 °C)	Ω ± 7%	5.8	5.8	9.2	5.8	5.8
Field deflection current edge to edge at 25 kV	A (p-p) ± 5%	1.5	1.5	1.20	1.5	1.5

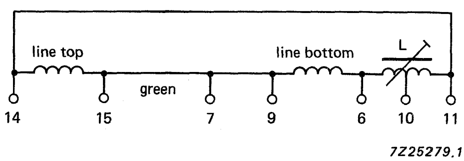


Fig.1 Line coils.
L is factory adjusted.

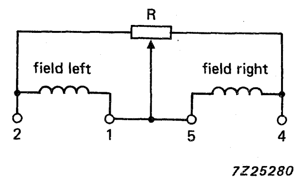


Fig.2 Field coils.
R is factory adjusted.

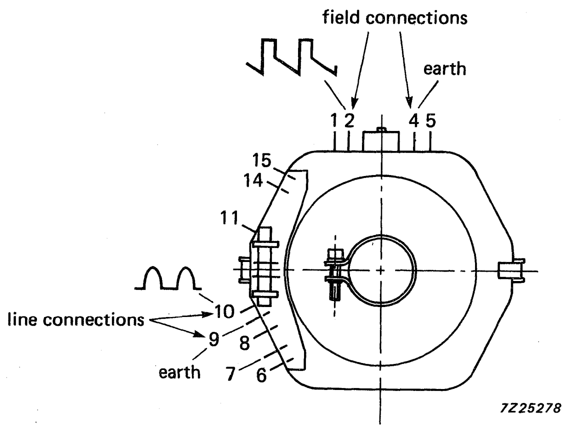


Fig.3 Terminal location of deflection coils.

* All deflection units are prefixed by AT1610/. Therefore, a code of 36 = AT1610/36, etc.

** Under development.

OPTICAL DATA

Screen	metal-backed phosphor dot triplets; black matrix
Screen finish	non-glare or high gloss
Useful screen dimensions	
diagonal	min. 335,4 mm
horizontal axis	min. 280,8 mm
vertical axis	min. 210,6 mm
area	min. 580 cm^2
Recommended useful screen dimensions for alphanumeric display	
diagonal	324 mm
horizontal axis	262 mm
vertical axis	190 mm
Dot arrangement	hexagonal
Spacing between centres of adjacent dot triplets	approx. 0,29 mm (0,011 in)

Table 2 Type P22 phosphor data; persistence = short

phosphor colour	colour co-ordinates x	colour co-ordinates y	luminance at screen centre (cd/m^2)* M34ECL00/01/02	M34ECL10/11/12	M34ECL20/21/22
red**	0.620	0.340	40.6	26.6	21.8
green	0.305	0.600	159.8	105	85.6
blue**	0.155	0.065	21.7	14.4	11.8

Table 3 Type SW phosphor data; persistence = medium

phosphor colour	colour co-ordinates x	colour co-ordinates y	luminance at screen centre (cd/m^2)* M34ECL00/01/02	M34ECL10/11/12	M34ECL20/21/22
red	0.605	0.355	43.2	28.5	23.2
green	0.275	0.610	147.3	96.6	78.9
blue	0.235	0.255	59.0	39.2	31.9

Table 4 Light transmission and reflectivity

tube parameters (M34ECL followed by:)	/00	/01	/02	/10	/11	/12	/20	/21	/22
light transmission at screen centre	86%	86%	86%	57%	57%	57%	46.5%	46.5%	46.5%
min. reflectivity: (P22)	22.5	24.5		9.0	10.0		5.5	6.5	
(SW)	27.5	29.0		11.0	12.5		6.5	8.0	

* Measuring conditions:
(i) I_{ap} per gun = 200 μA, scan duty cycle = 75%; scanned area = 262 mm x 190 mm.
(ii) Brightness decrease within the active screen area (262 x 190 mm) ⩽ 40%.

** Pigmented phosphors.

Resolution	see Table 5; values shown are measured under following conditions: V_a = 25 kV, V_k = 100 V, V_{g3} adjusted for minimum width of vertical white lines at half east or half west zone; sine-wave drive voltage; horizontal raster scan of H x V = 262 x 190 mm

Table 5 Resolution

modulation depth	number of resolvable picture elements (n.H x n.V)		
	I_{ap} = 100 μA per gun	I_{ap} = 200 μA per gun	I_{ap} = 400 μA per gun
–6 dB	900 x 570	760 x 530	580 x 440
–9 dB	1020 x 640	860 x 580	665 x 490
–12 dB	1050 x 675	960 x 610	740 x 540
–20 dB	1050 x 785	1050 x 705	870 x 620

Notes

- The resolution figures in the Table are worst-case values in the display area, and include losses of modulation depth due to deflection defocusing and screen texture; the resolution at the screen centre is in general higher.
- Limitations due to moiré effects are not taken into account; the maximum resolution imposed by the Shannon limit of the phosphor screen = n.H x n.V = 1050 x 1290 (signal dot rate equals phosphor dot rate).

MECHANICAL DATA (see Figs 4 to 13)

Overall length	347.0 ± 5 mm
Neck diameter	29.1 mm
Greatest dimensions of tube face (excluding mounting lugs but including rimband)	
diagonal	368.9 ± 1.6 mm
width	318.9 ± 1.6 mm
height	248.9 ± 1.6 mm
Implosion protection	rimband (VDE, CSA, UL and BSI approved)
Anode contact designation	JEDEC J1-21; IEC67-III-2
Base designation	10-pin base JEDEC B10-277
Basing designation	see Fig.13
Mass	approx. 6.4 kg
Mounting position	anode contact on top

MECHANICAL DATA Dimensions in mm

Notes are given after the drawings.

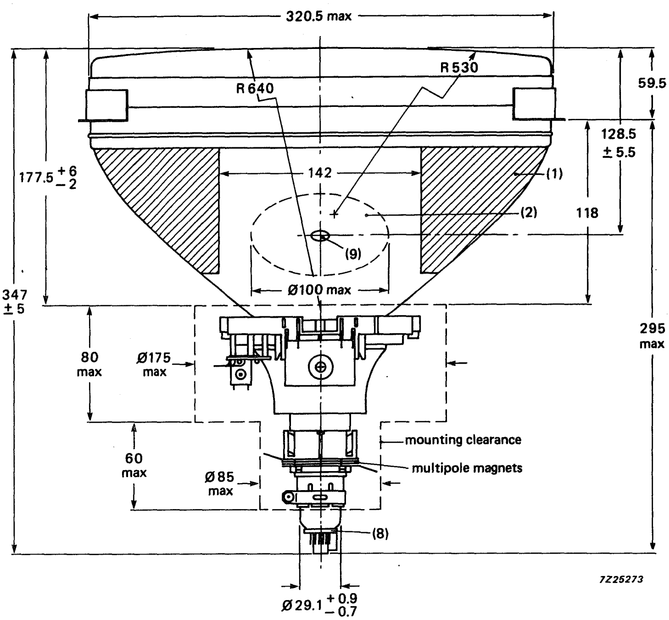


Fig.4.

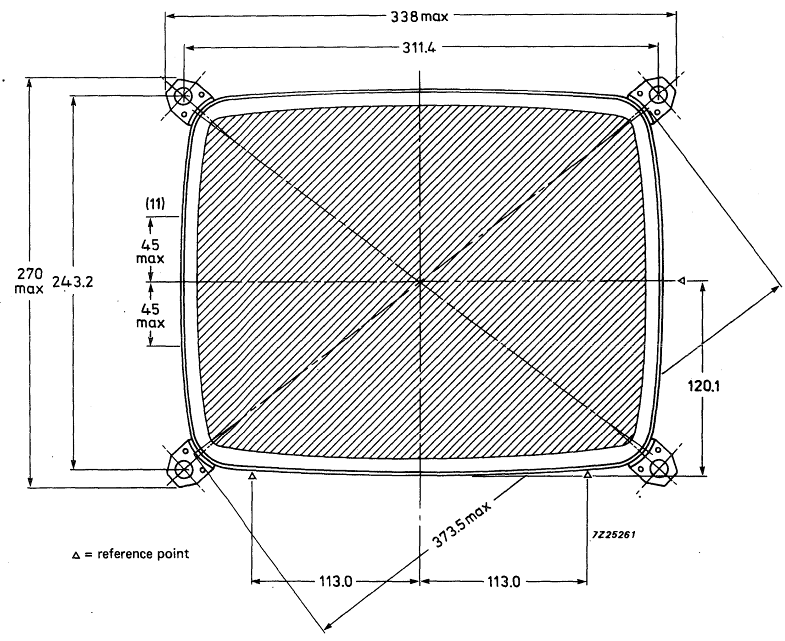


Fig.5.

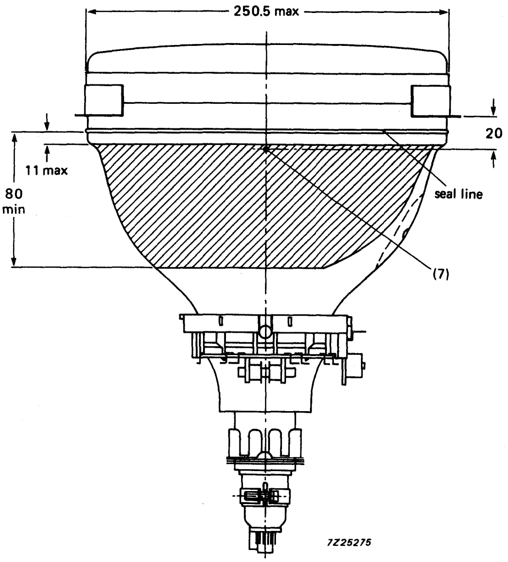

250.5 max
20
11 max
80
min
seal line
(7)
7Z25275

Fig.6.

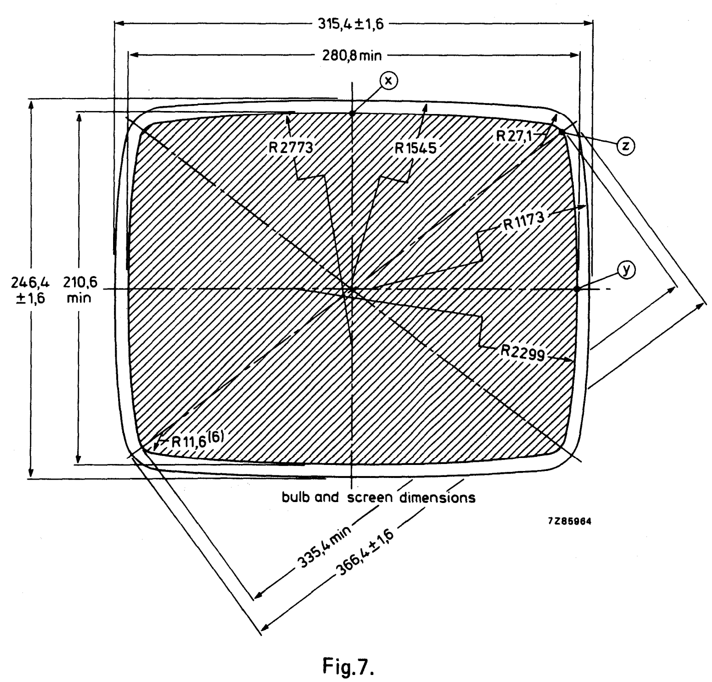

315,4 ± 1,6
280,8 min
x
R2773
R1545
R27,1
z
R1173
y
246,4
± 1,6
210,6
min
R2299
R11,6 (6)
bulb and screen dimensions
7Z85964
335,4 min
366,4 ± 1,6

Fig.7.

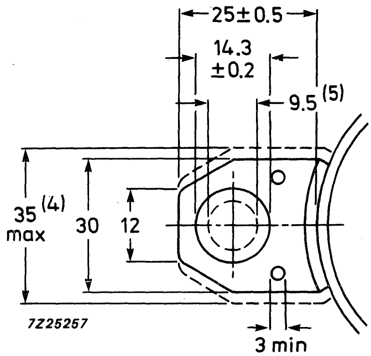


Fig.8 Lug dimensions.

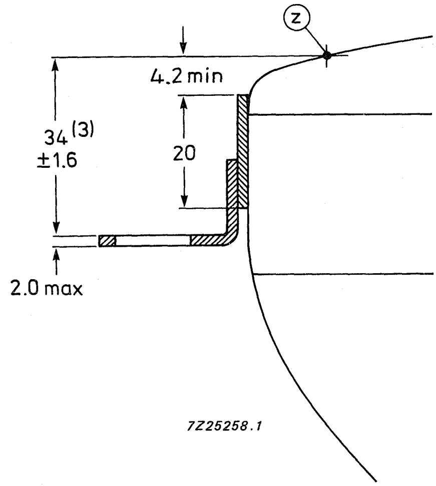


Fig.9 Lug position.

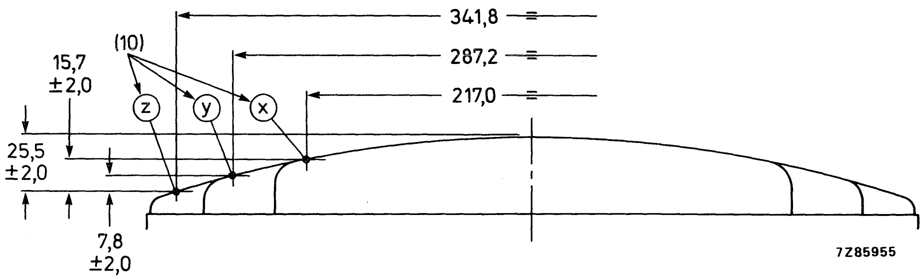


Fig.10 Screen reference points.

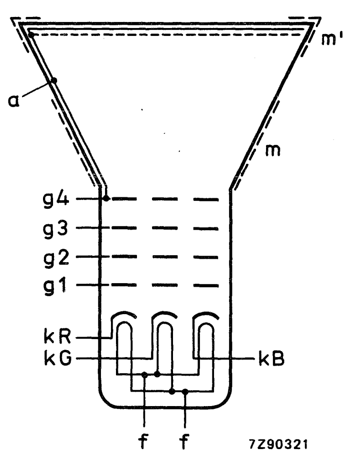
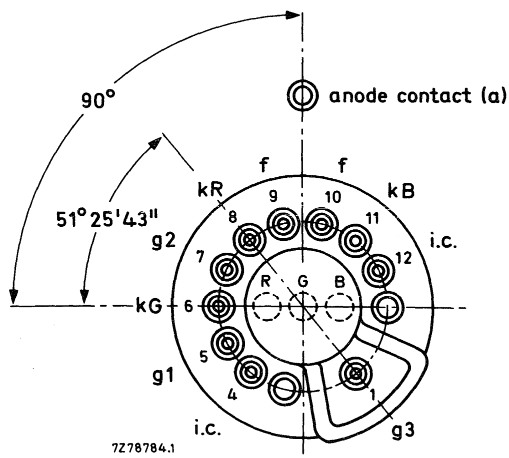


Fig.11 Electrode configuration.



i.c. = internally connected (not to be used)

Fig.12 Pin arrangement.

Notes to outline drawings

1. Configuration of outer conductive coating may be different, but will contain the contact area as shown in the drawing.
2. To clean this area, wipe only with a soft lintless cloth.
3. The displacement of any lug with respect to the plane through the other three lugs is max. 0.8 mm.
4. Minimum space to be reserved for mounting lug.
5. 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 311,4 mm x 243,2 mm.
6. Co-ordinates for radius R = 11,6 mm: x = 126,98 mm, y = 90,76 mm.
7. Centre of gravity.
8. The socket for this base should not be rigidly mounted; it should have flexible leads and be allowed to move freely. After mounting of the tube in the cabinet note that the position of the base can fall within a circle, having a diameter of max. 50 mm, concentric with an imaginary tube axis. The mass of the mating socket with circuitry should not be more than 150 g; maximum permissible torque is 40 mNm.
9. Small cavity contact J1-21, IEC 67-III-2.
10. The X, Y and Z reference points are located on the outside surface of the face plate 3,2 mm beyond the intersection of the minor, major and diagonal screen axis respectively, with the minimum published screen.
11. Indicated area is available for band fixing.

10-pin base; JEDEC B10-277

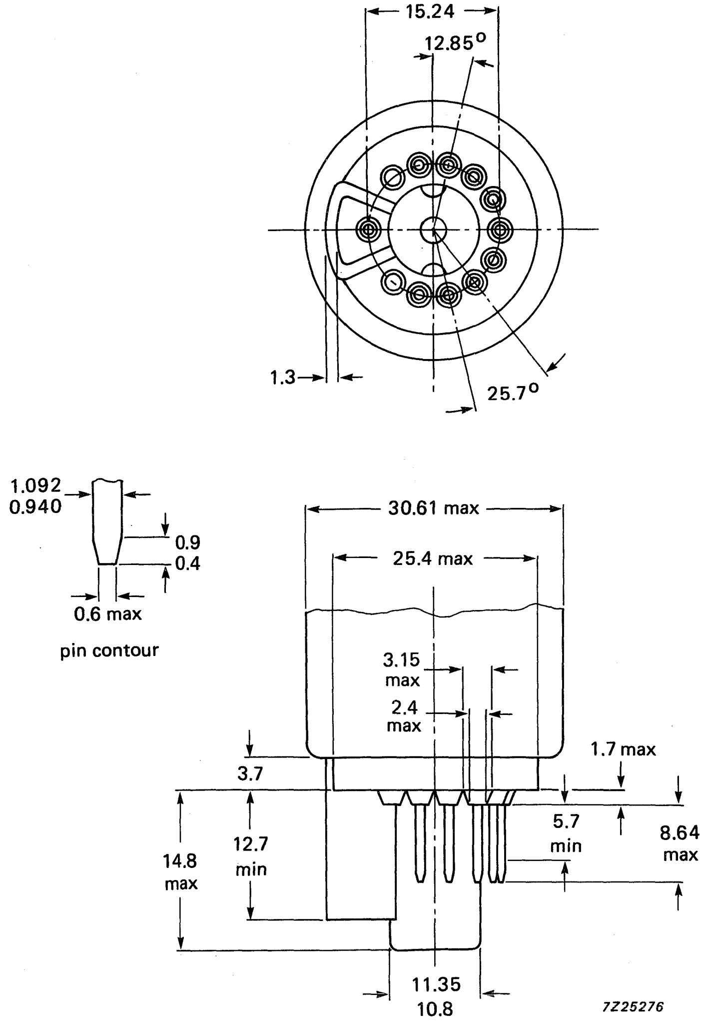


Fig.13 JEDEC base.

Maximum cone contour

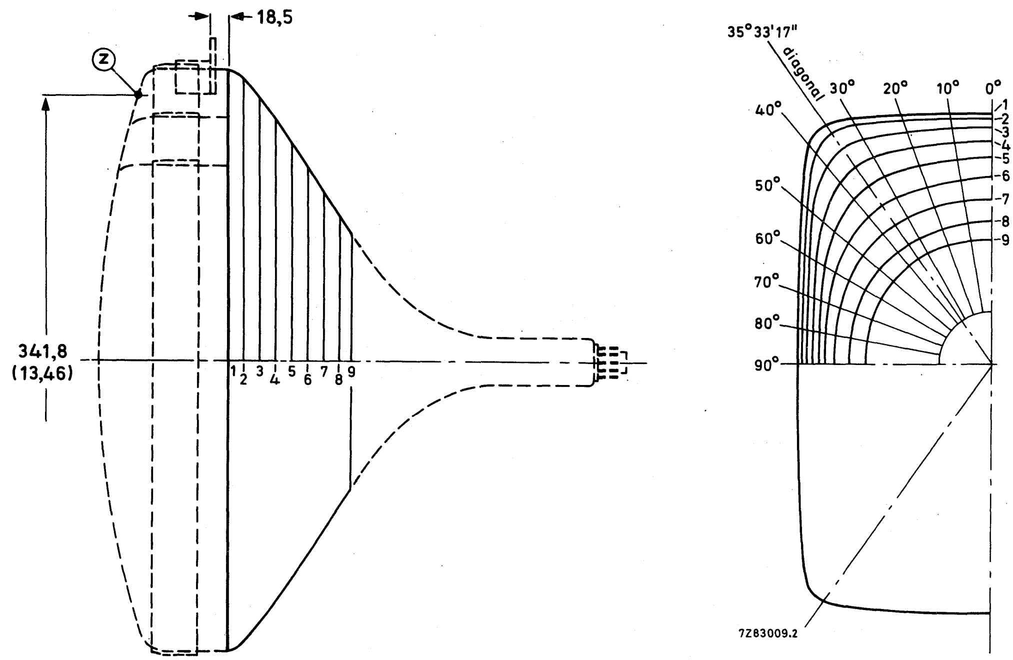


Fig.14 Cone contour.

Table 6 Cone contour data

Dimensions in mm

section	nom. distance from section 1	distance from centre (max. values)														
		0°	10°	20°	25°	30°	32° 30'	diag. axes	37° 30'	40°	45°	50°	60°	70°	80°	90°
1	0	157,2	159,4	166,3	171,7	178,2	181,2	183,6	183,3	180,0	167,9	156,5	140,0	129,8	124,2	122,4
2	10	154,7	156,9	163,5	168,5	174,1	176,6	178,1	177,7	174,8	164,4	153,7	137,8	127,9	122,4	120,7
3	20	148,8	150,7	156,3	160,0	163,5	164,6	165,0	164,4	162,6	156,0	147,7	133,6	124,4	119,3	117,7
4	30	140,4	142,1	146,2	148,6	150,5	151,0	151,1	150,7	149,6	145,6	140,0	128,6	120,3	115,7	114,2
5	40	130,3	131,3	134,0	135,4	136,5	136,8	136,8	136,6	136,1	134,1	130,8	122,7	115,9	111,7	110,3
6	50	118,2	118,8	120,1	120,9	121,6	121,8	122,0	122,0	121,9	121,2	119,8	115,4	110,5	107,0	105,8
7	60	104,9	104,7	105,1	105,5	106,0	106,2	106,5	106,7	106,9	107,1	107,0	105,6	103,1	100,8	99,8
8	70	90,6	89,9	89,8	90,0	90,4	90,6	90,9	91,1	91,4	91,9	92,3	92,5	91,7	90,4	89,7
9	77	79,9	79,1	79,0	79,1	79,4	79,6	79,9	80,1	80,4	80,9	81,4	81,8	81,4	80,5	79,9

RECOMMENDED OPERATING CONDITIONS (cathode drive)

The voltages are specified with respect to grid 1.

Anode voltage	$V_{a,g4}$	25 kV ± 5%
Grid 3 (focusing electrode) voltage	V_{g3}	6.0 to 7.0 kV
Grid 2 voltage	V_{g2}	see Fig.15

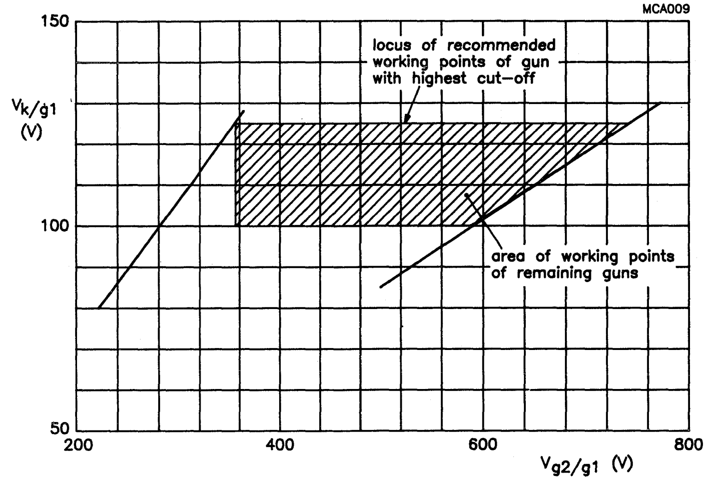


Fig.15 Spot cut-off design chart.

Grid 2 voltage (V_{g2}) adjusted for highest gun spot cut-off voltage V_k = 125 V.

Remaining guns adjusted for spot cut-off by means of cathode voltage.

V_{g2} range 360 to 750 V

V_k range 100 to 125 V

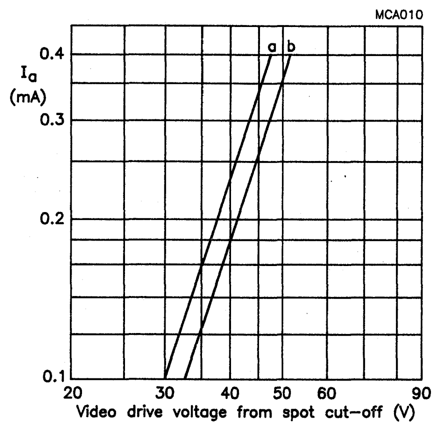
Adjustment procedure:

Set the cathode voltage (V_k) for each gun at 125 V; increase the grid voltage (V_{g2}) from approximately 360 V to the value at which the colour of the gun with the lowest cut-off voltage (V_{g2}) becomes just visible. Now decrease the cathode voltage of the remaining guns so that the other colours also become just visible.

EQUIPMENT DESIGN VALUES (each gun if applicable)

The values are valid for anode voltages between 20 and 27,5 kV.
The voltages are specified with respect to grid 1.

Grid 3 (focusing electrode) voltage	V_{g3}	24.0 to 28% of anode voltage
Grid 2 voltage for visual extinction of focused spot (V_k = max. 125 V)	V_{g2} and V_k	see Fig.15
Difference in cut-off voltages between guns in any tube	ΔV_k	lowest value ≥ 80% of highest value
Cathode drive characteristic		see Fig.16
Grid 3 (focusing electrode) current	I_{g3}	−5 to + 5 μA
Grid 2 current	I_{g2}	−5 to + 5 μA
Grid 1 current at V_k = 125 V	I_{g1}	−5 to + 5 μA



V_f = 6.3 V; $V_{a,g4}$ = 25 kV; V_{g3} adjusted for focus; V_{g2} adjusted to provide spot cut-off for desired V_k.

Fig.16 Typical cathode drive characteristics at spot cut-off voltages of 100 V (curve a) and 125 V (curve b).

LIMITING VALUES (each gun if applicable)

Tube

Design maximum rating system unless otherwise stated.
The voltages are specified with respect to grid 1.

Anode voltage	$V_{a,g4}$	max.	27,5 kV	notes 1 and 2
		min.	20 kV	note 3
Anode current for each gun, peak value	I_{ap}	max.	400 μA	
Long term average anode current for each gun	I_a	max.	200 μA	
Long term average anode current for three guns	I_a	max.	450 μA	note 6
Grid 3 (focusing electrode) voltage	V_{g3}	max.	10 kV	
Grid 2 voltage, peak	V_{g2p}	max.	1000 V	
Cathode voltage				
positive	V_k	max.	200 V	
positive operating cut-off	V_k	max.	135 V	
negative	$-V_k$	max.	0 V	
negative peak	$-V_{kp}$	max.	2 V	
Cathode to heater voltage				
positive DC component value	V_{kf}	max.	250 V	
positive peak	V_{kfp}	max.	300 V	note 1
negative DC component value	$-V_{kf}$	max.	0 V	
Heater voltage	V_f	6,3 V	$^{+5\%}_{-10\%}$	note 4

Deflection unit

Maximum operating copper temperature		95 °C
Temperature rise of the coils (ΔT)	see Table 7	

Table 7 Temperature data (see note 5)

line frequency/ flyback time	temperature rise (ΔT) line coils	frame coils
24 kHz/8 μs	20 °C	15 °C
32 kHz/6 μs	25 °C	20 °C
48 kHz/4 μs	35 °C	30 °C

LIMITING CIRCUIT VALUES

Grid 3 circuit resistance	R_{g3}	max.	30 MΩ
Grid 1 to cathode circuit resistance (each gun)	R_{g1k}	max.	0,75 MΩ

Notes

1. Absolute Maximum rating system.
2. During adjustment on the production line this value is likely to be surpassed considerably. It is therefore strongly recommended first to make the necessary adjustments for normal operation.
3. Operation of the tube at lower voltages impairs the luminance and resolution.
4. For maximum cathode life, it is recommended that the heater supply be regulated at 6,0 V.
5. Measured using resistance method.
6. Defined at full scanned raster.

FLASHOVER PROTECTION

With the high voltage used with this tube (max. 27,5 kV) internal flashovers may occur. As a result of the Soft-Flash technology these flashover currents are limited to approx. 60 A offering higher set reliability, optimum circuit protection and component savings.
Primary protective circuitry using properly grounded spark gaps and series isolation resistors (preferably carbon composition) is still necessary to prevent tube damage. The spark gaps should be connected to all picture tube electrodes at the socket according to the figure below; they are not required on the heater pins. No other connections between the outer conductive coating and the chassis are permissible.
The spark gaps should be designed for a breakdown voltage at the focusing electrode (g3) of 11 kV ($1,5 \times V_{g3}$ max. at $V_{a,g4} = 25$ kV), and at the other electrodes of 1,5 to 2 kV.
The values of the series isolation resistors should be as high as possible (min. 0,5 kΩ) without causing deterioration of the circuit performance. The resistors should be able to withstand an instantaneous surge of 20 kV for the focusing circuit and 12 kV for the remaining circuits without arcing.
Additional information is available on request.

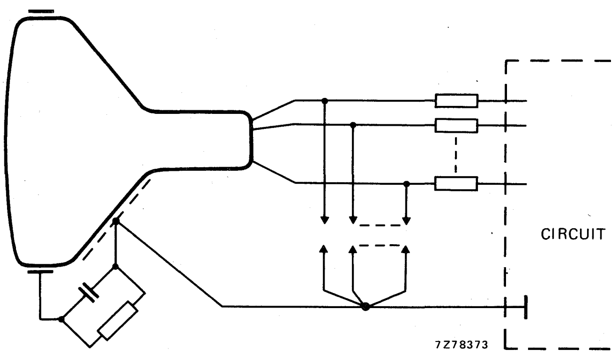


Fig.17 Flashover protection circuit.

X-RADIATION LIMIT

Maximum anode voltage at which the X-radiation emitted will not exceed 0,5 mR/h at an anode current of 300 μA

entire tube	31 kV*
face-plate only	33 kV

Warning:

If the value for the tube face only is used as design criterion, adequate shielding must be provided in the monitor for the anode contact and/or certain portions of the tube funnel and panel sidewalls to insure that the X-radiation from the monitor is attenuated to a value equal to or lower than that specified for the face of the tube.

Maximum voltage difference between anode and focus electrode at which the X-radiation will not exceed 0,5 mR/h	30 kV

Warning:

If the voltage value above can be exceeded in the monitor additional attenuation of the X-radiation through the tube neck may be required.

The X-radiation emitted from this display tube, as measured in accordance with the procedure of TEPAC Publication No. 194, will not exceed 0,5 mR/h throughout the useful tube life when operated within the 'Design maximum ratings'.

The tube should not be operated beyond its 'Design maximum ratings' stated above, but its X-radiation will not exceed 0,5 mR/h for anode voltage and current combinations given by the isoexposure-rate limits characteristics shown on the next page.

Operation above the values shown by the curve may result in failure of the monitor to comply with the Federal Performance Standard of the U.S. for Television Receivers, Section 1020. 10 of Part 1020 of Title 21, Code of Federal Regulation (PL90-602) as published in the Federal Register Volume 38, No. 198, Monday, October 15, 1973.

Maximum X-radiation as a function of anode voltage at 300 μA anode current is shown by the curve on the next page. X-radiation at a constant anode voltage varies linearly with anode current.

* This rating applies only if the anode connector used by the set maker provides the necessary attenuation to reduce the X-radiation from the anode contact by a factor equal to the difference between the anode button isoexposure-rate limit curve and the isoexposure-rate limit curve for the entire tube.

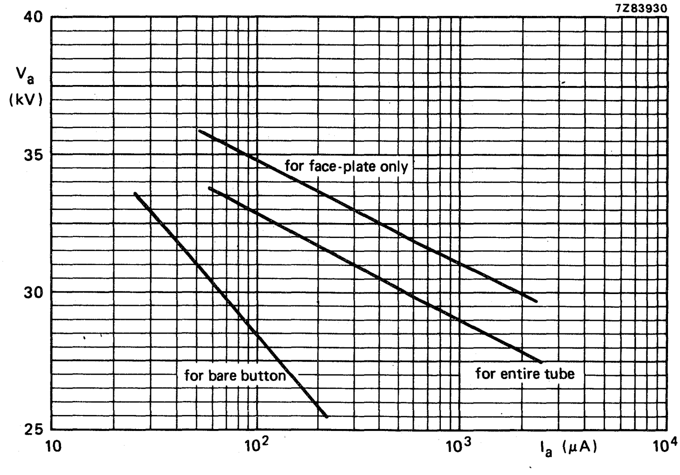


Fig.18 0,5 mR/h isoexposure-rate limit curve.

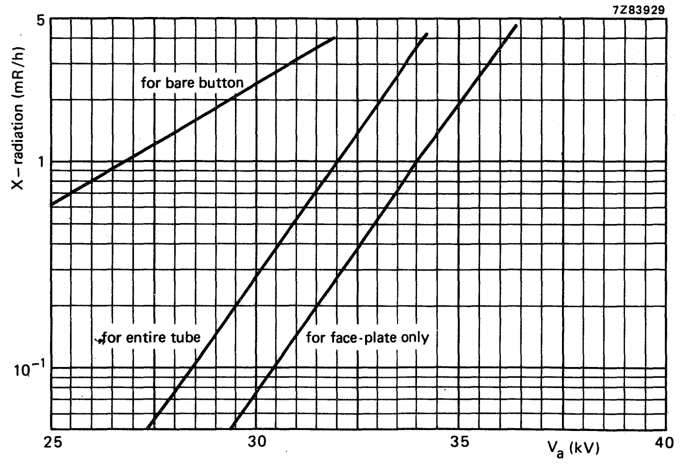


Fig.19 X-radiation limit curve at a constant anode current of 300 μA.

WARNINGS

X-radiation

Operation of this colour display tube under abnormal conditions which exceed the 0,5 mR/h iso-dose rate curve shown on the preceding page may produce soft X-rays which may constitute a health hazard on prolonged exposure at close range unless adequate external screening is provided. Precautions must therefore be exercised during servicing of monitors using this tube to ensure that the anode voltage and other tube voltages are adjusted to the recommended values so that the 'Design maximum ratings' are not exceeded.

Tube replacement

This display tube incorporates integral X-radiation and implosion protection and must be replaced with a tube of the same type number or a recommended replacement to assure continued safety.

Shock hazard

The high voltage at which the tube is operated may be very dangerous. The monitor should include safeguards to prevent the user from coming in contact with the high voltage. Extreme care should be taken in servicing or adjustment of any high-voltage circuit.

Caution must be exercised during the replacement or servicing of the display tube since a residual electrical charge may be held by the high-voltage capacitor formed by the external and internal conductive coatings of the display tube funnel. To remove any residual charge, short the anode contact button, located in the funnel of the tube, to the external conductive coating before handling the tube. Discharging the high voltage to isolated metal parts such as cabinets and control brackets may produce a shock hazard.

Tube handling

Display tubes should be kept in the shipping box or similar protective container just prior to installation. Wear heavy protective clothing, including gloves and safety goggles with side shields, in areas containing unpacked and unprotected tubes to prevent possible injury from flying glass in the event of a tube breaking. Handle the tube with extreme care. Do not strike, scratch or subject the tube to more than moderate pressure. Particular care should be taken to prevent damage to the seal area.

The packing should incorporate sufficient cushioning so that under normal conditions of shipment or handling an impact acceleration of more than 35g is never applied to the tube.

LUMINANCE: P22 phosphor

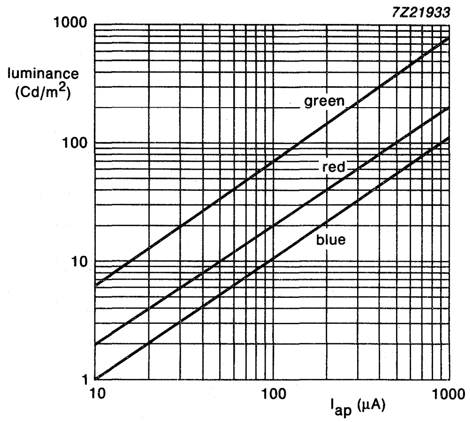


Fig.20.

M34ECL00/01/02X

Luminance at the centre of the screen as a function of I_{total}.
$V_{a,g4}$ = 25 kV; V_f = 6,3 V; V_{g3} adjusted for optimum focus.
Raster size = 262 mm x 190 mm.

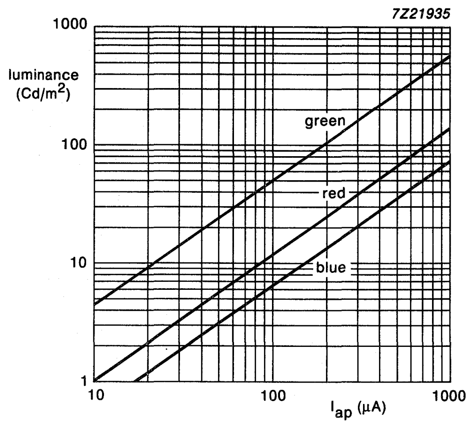


Fig.21.

M34ECL10/11/12X

Luminance at the centre of the screen as a function of I_{total}.
$V_{a,g4}$ = 25 kV; V_f = 6,3 V; V_{g3} adjusted for optimum focus.
Raster size = 262 mm x 190 mm.

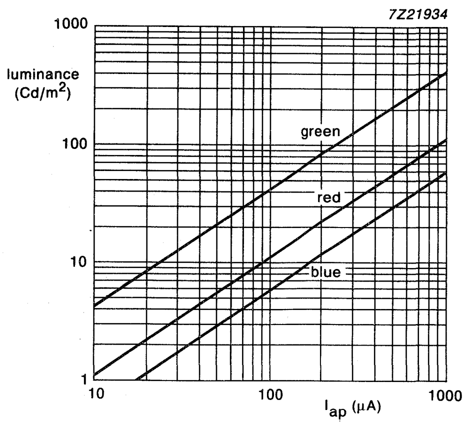


Fig.22.

M34ECL20/21/22X

Luminance at the centre of the screen as a function of I_{total}.
$V_{a,g4}$ = 25 kV; V_f = 6,3 V; V_{g3} adjusted for optimum focus.
Raster size = 262 mm x 190 mm.

LUMINANCE: SW phosphor

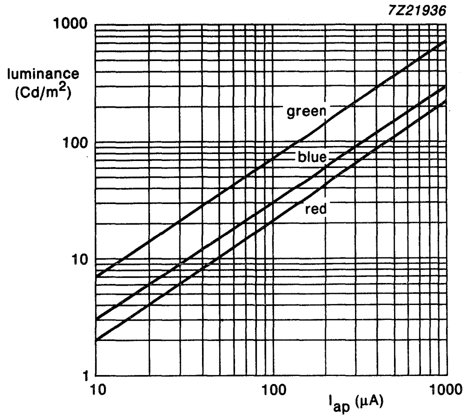


Fig.23.

M34ECL00/01/02DA

Luminance at the centre of the screen as a function of I_{total}.
$V_{a,g4}$ = 25 kV; V_f = 6,3 V; V_{g3} adjusted for optimum focus.
Raster size = 262 mm x 190 mm.

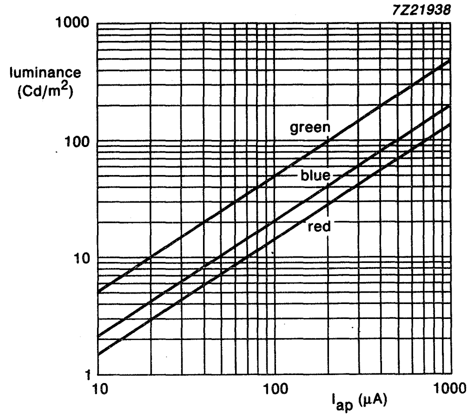


Fig.24.

M34ECL10/11/12DA

Luminance at the centre of the screen as a function of I_{total}.
$V_{a,g4}$ = 25 kV; V_f = 6,3 V; V_{g3} adjusted for optimum focus.
Raster size = 262 mm x 190 mm.

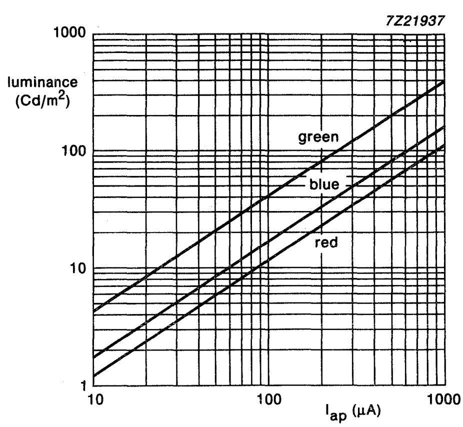


Fig.25.

M34ECL20/21/22DA

Luminance at the centre of the screen as a function of I_{total}.
$V_{a,g4}$ = 25 kV; V_f = 6,3 V; V_{g3} adjusted for optimum focus.
Raster size = 262 mm x 190 mm.

DEGAUSSING

The display tube has an internal magnetic shield. This shield and the shadow mask with its suspension system may be automatically degaussed by a coil mounted on the cone of the display tube as shown in Fig.26.

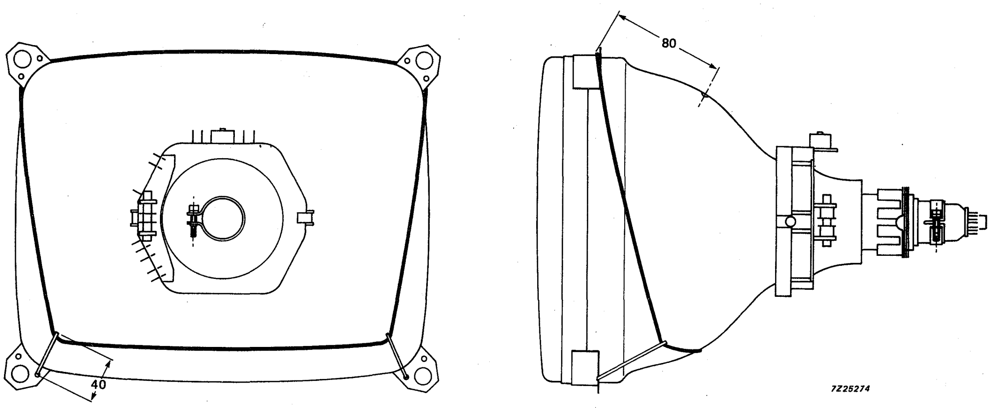


Fig.26 Position of degaussing coil on the display tube; dimensions are given in mm.

For proper degaussing an initial magnetomotive force (MMF) of 600 ampere-turns is required in the coil. This MMF has to be gradually decreased. In the steady state, no significant MMF should remain in the coil (≤ 0,6 ampere-turns).

If single-phase power rectification is used, provision should be included to prevent asymmetric distortion of the AC voltage applied to the degaussing circuit due to high DC inrush currents.

An example of a degaussing circuit and coil data for various mains voltage are given below.

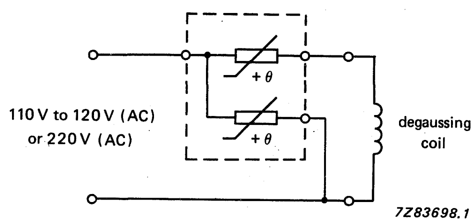


Fig.27 Degaussing circuit using dual PTC thermistor.

Data of degaussing coil

	110 to 120 V (AC)	220 V (AC)
Circumference	90 cm	90 cm
Number of turns	70	120
Copper-wire diameter	0,45 mm	0,3 mm
Resistance	6,7 Ω	25,9 Ω
Catalogue number of dual PTC thermistor	2322 662 98009	

CONVERGENCE AND RASTER SPECIFICATION

The maximum misconvergence after 30 min operation is given in Table 8 and Fig.28.

Test conditions (all voltages are measured with respect to grid 1)

Heater voltage	V_f	6,3 V
Grid 2 voltage	V_{g2}	600 V
Grid 3 voltage	V_{g3}	to be adjusted for focus at half east or half west, using cross-hatch pattern, at anode current of 350 μA (peak) per gun
Anode voltage	V_a	25 kV ± 5%
Test pattern		cross-hatch pattern
Ambient temperature	T_{amb}	25 ± 5 °C
Tube facing		East

Notes

1. Misconvergence is the distance between centres of the red, green, blue lines at the screen using performance.
2. Anode and/or focusing voltage and terrestrial magnetism may slightly affect the static convergence.

Table 8 Maximum misconvergence after 30 min operation

location (see Fig.28)	type of error	max. error between any colour
centre area A area B	red-green-blue line separation in either the horizontal or vertical direction	0,15 mm 0,30 mm 0,40 mm

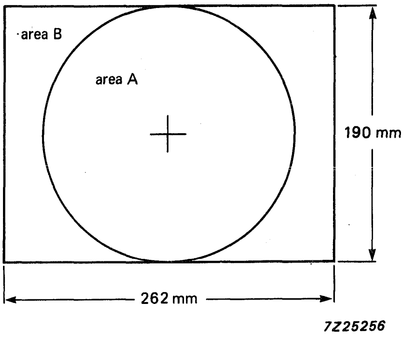


Fig.28 Maximum misconvergence.

Raster centring

horizontal	max. 4 mm
vertical	max. 4 mm

Raster rotation max. 0.35° (Fig.29)

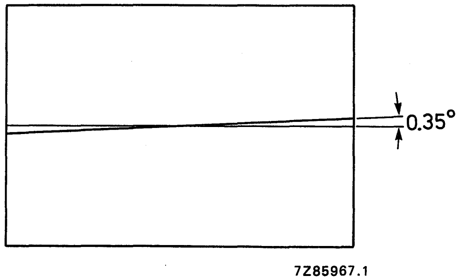


Fig.29 Raster rotation.

Average pattern distortion, measured without east-west and north-south correction

Pin cushion distortion		
east-west	$\frac{2(H1 + H2)}{B1 + B2} \times 100\%$ (Fig.30)	max. 4.5%
north-south	$\frac{2(V1 + V2)}{A1 + A2} \times 100\%$ (Fig.30)	max. 1,0%
Pin-cushion distortion at each side		
east-west	H1 or H2 (Fig.30)	max. 6 mm
north-south	V1 or V2 (Fig.30)	max. 1,0 mm
Parallelogram	P1 or P2 (Fig.31)	max. 2,5 mm

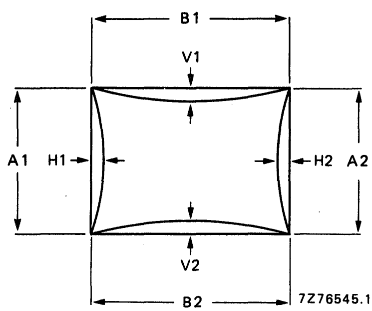


Fig.30 A1, A2 = 190 mm; B1, B2 = 262 mm.

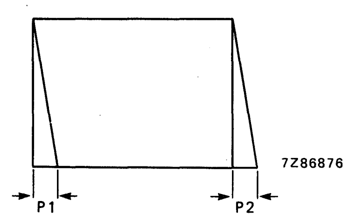


Fig.31.

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DATA HANDBOOK SYSTEM

DATA HANDBOOK SYSTEM

Our Data Handbook System comprises more than 60 books with specifications on electronic components, subassemblies and materials. It is made up of seven series of handbooks:

INTEGRATED CIRCUITS

DISCRETE SEMICONDUCTORS

DISPLAY COMPONENTS

PASSIVE COMPONENTS*

PROFESSIONAL COMPONENTS**

MAGNETIC PRODUCTS*

LIQUID CRYSTAL DISPLAYS

The contents of each series are listed on pages iii to ix.

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

Where application is given it is advisory and does not form part of the product specification.

Condensed data on the preferred products of Philips Components is given in our Preferred Type Range catalogue (issued annually).

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Product specialists are at your service and enquiries will be answered promptly.

* Will replace the Components and materials (green) series of handbooks.
** Will replace the Electron tubes (blue) series of handbooks.

INTEGRATED CIRCUITS

This series of handbooks comprises:

code	handbook title
IC01	**Radio, audio and associated systems** Bipolar, MOS
IC02a/b	**Video and associated systems** Bipolar, MOS
IC03	**ICs for Telecom** Bipolar, MOS Subscriber sets, Cordless Telephones
IC04	**HE4000B logic family** CMOS
IC05	**Advanced Low-power Schottky (ALS) Logic Series**
IC06	**High-speed CMOS; PC74HC/HCT/HCU** Logic family
IC07	**Advanced CMOS logic (ACL)**
IC08	**10/100K ECL Logic/Memory/PLD**
IC09	**TTL logic series**
IC10	**Memories** MOS, TTL, ECL
IC11	**Linear Products**
IC12	**I^2C-bus compatible ICs**
IC13	**Semi-custom** Programmable Logic Devices (PLD)
IC14	**Microcontrollers** NMOS, CMOS
IC15	**FAST TTL logic series**
IC16	**CMOS integrated circuits for clocks and watches**
IC17	**ICs for Telecom** Bipolar, MOS Radio pagers Mobile telephones ISDN
IC18	**Microprocessors and peripherals**
IC19	**Data communication products**
IC23*	**Solid state image sensors and peripheral integrated circuits**

* Not yet issued in this series of handbooks: previously issued as PC11.

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This series of data handbooks comprises:

current code	new code	handbook title
S1	SC01	**Diodes** High-voltage tripler units
S2a	SC02	**Power diodes**
S2b	SC03	**Thyristors and triacs**
S3	SC04	**Small-signal transistors**
S4a	SC05	**Low-frequency power transistors and hybrid IC power modules**
S4b	SC06	**High-voltage and switching power transistors**
S5	SC07	**Small-signal field-effect transistors**
S6	SC08a*	**RF bipolar transistors**
	SC08b*	**RF power transistors**
	SC09	**RF power modules**
S7	SC10	**Surface mounted semiconductors**
S8b	SC12	**Optocouplers**
S9	SC13*	**PowerMOS transistors**
S10	SC14	**Wideband transistors and wideband hybrid IC modules**
S11	SC15	**Microwave transistors**
S15**	SC16	**Laser diodes**
S13	SC17	**Semiconductor sensors**

* Not yet issued with the new code in this series of handbooks.
** New handbook in this series; will be issued shortly.

DISPLAY COMPONENTS

This series of data handbooks comprises:

code	handbook title
DC01	**Colour display components** Colour TV Picture Tubes and Assemblies Colour Monitor Tube Assemblies
DC02	**Monochrome monitor tubes and deflection units**
DC03	**Television tuners, coaxial aerial input assemblies**
DC04	**Loudspeakers**
DC05	**Flyback transformers, mains transformers and general-purpose FXC assemblies**

PASSIVE COMPONENTS

This series of data handbooks comprises:

current code	new code	handbook title
C14	**PA01**	**Electrolytic capacitors; solid and non-solid**
C11	**PA02**	**Varistors, thermistors and sensors**
C12	**PA03**	**Potentiometers and switches**
C7	**PA04**	**Variable capacitors**
C22	**PA05***	**Film capacitors**
C15	**PA06***	**Ceramic capacitors**
C9	**PA07***	**Piezoelectric quartz devices**
C13	**PA08**	**Fixed resistors**

* Not yet issued with the new code in this series of handbooks.

PROFESSIONAL COMPONENTS

This series of data handbooks comprises:

current code	new code	handbook title
T3	**PC01**	**High-power klystrons and accessories**
T5	**PC02***	**Cathode-ray tubes**
T6	**PC03***	**Geiger-Müller tubes**
T9	**PC04**	**Photo multipliers**
T10	**PC05**	**Plumbicon camera tubes and accessories**
T11	**PC06**	**Circulators and Isolators**
T12	**PC07**	**Vidicon and Newvicon camera tubes and deflection units**
T13	**PC08**	**Image intensifiers**
T15	**PC09**	**Dry-reed switches**
	PC11**	**Solid state image sensors and peripheral integrated circuits**
T9	**PC12***	**Electron multipliers**

* Not yet issued with the new code in this series of handbooks.
** Will be issued as IC23 in the future.

MAGNETIC PRODUCTS

This series of data handbooks comprises:

current code	new code	handbook title
C4 **C5**	**MA01**	**Soft Ferrites**
C16	**MA02***	**Permanent magnet materials**
C19	**MA03***	**Piezoelectric ceramics**

* Not yet issued with the new code in this series of handbooks.

LIQUID CRYSTAL DISPLAYS

current code	new code	handbook title
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