INSTRUMENT CATHODE-RAY TUBE

- mono accelerator
- 14 cm diagonal rectangular flat face
- internal graticule
- low power quick heating cathode
- high brightness, long-life GY phosphor
- high precision, factory adjusted for orthogonality, astigmatism and eccentricity
- for oscilloscopes with 20 to 30 MHz bandwidth and read-out devices

QUICK REFERENCE DATA

Accelerator voltage	$V_{g2,g4}$	2000 V
Minimum useful scan area		100 mm x 80 mm
Deflection coefficient		
horizontal	M_x	19 V/cm
vertical	M_y	11,5 V/cm

OPTICAL DATA

Screen		
type		GY
colour		yellowish-green
persistence		medium
Useful screen area		>102 mm x 82 mm ;note 1
Useful scan area		>100 mm x 80 mm
Internal graticule		type 123; see Fig.4

HEATING

Indirect by AC or DC *		
Heater voltage	V_f	6.3 V
Heater current	I_f	0.1 A
Heating time to attain 10% of the cathode current at equilibrium conditions		approx. 7 s

* not to be connected in series with other tubes.

MECHANICAL DATA

Dimensions and connections (see also outline drawings)

Overall length (including socket)	< 333 mm
Faceplate dimensions	118 ± 0.5 mm x 98 ± 0.5 mm
Net mass	approx. 1 kg
Base	12 pin, all glass JEDEC B12-246

Mounting

The tube can be mounted in any position. It must not be supported by the socket and not by the base region alone. The reference points (A, B and C) on adjoining edges of the faceplate (see Fig.4) enable the tube to be positioned accurately in the front panel, for optimum alignment of the internal graticule with respect to the bezel.

Accessories

Socket with solder tags	
Socket with printed wiring pins	type 55595
Mu metal shield	55598/55458

FOCUSING	electrostatic
DEFLECTION	double electrostatic
x plates	symmetrical
y plates	symmetrical

DIMENSIONS AND CONNECTIONS

Dimensions in mm

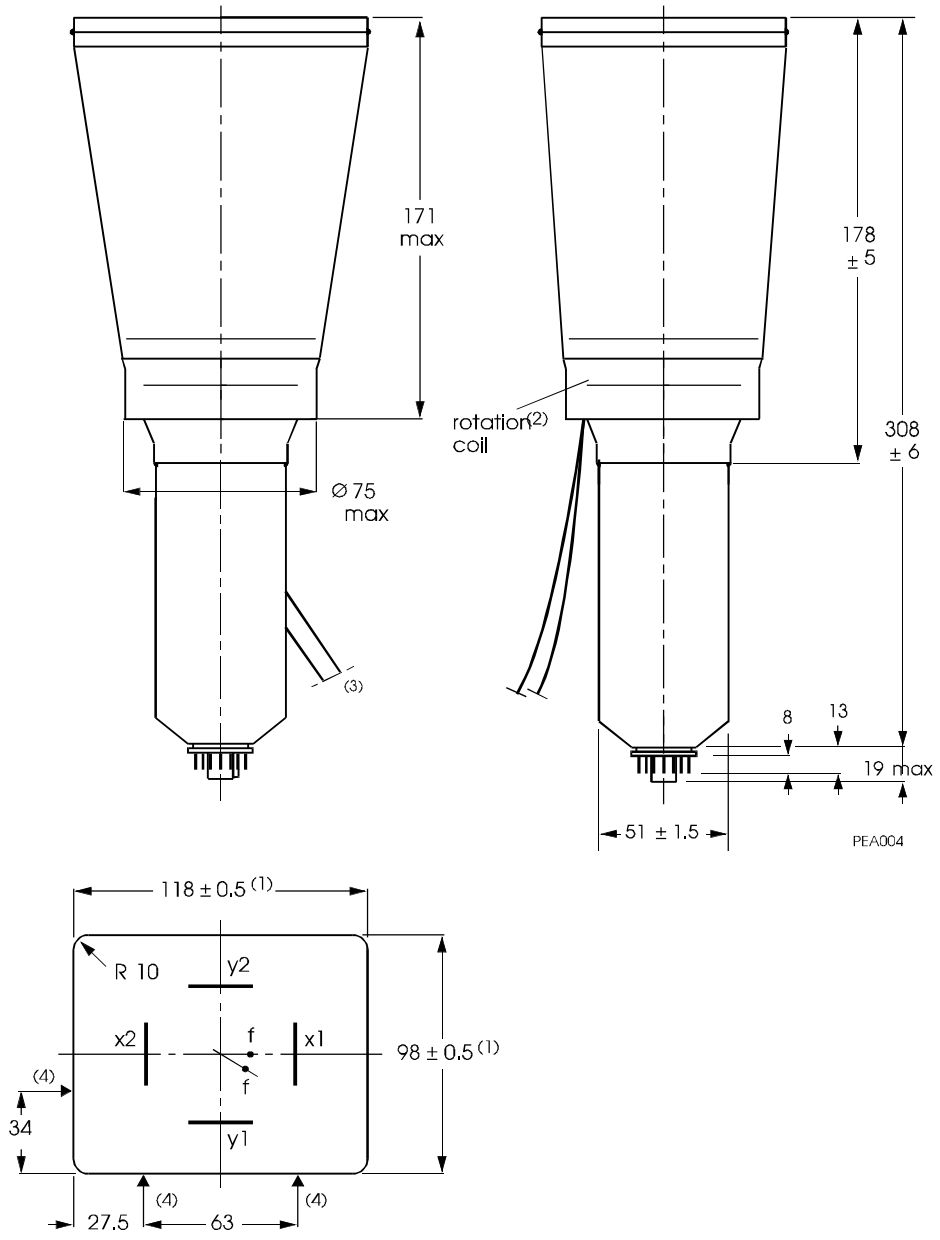


Fig.1 Mechanical outlines.

(1) Dimensions of faceplate only. The complete assembly of faceplate and cone (frit seal included) will pass through an opening of 122 mm x 102 mm.
(2) The coil is fixed to the envelope with resin.
(3) The length of rotation coil connecting leads is min. 350 mm.
(4) Reference points on faceplate for graticule alignment (see Fig. 4).

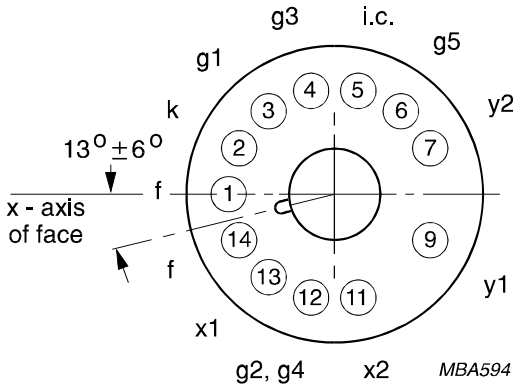


Fig.2 Pin arrangement, bottom view.

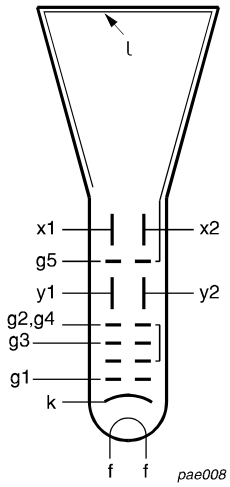


Fig.3 Electrode configuration.

Internal graticule

The internal graticule is aligned with the faceplate by using the faceplate reference points, see Fig.4 and note 1.The reference points A, B and C are for aligning the graticule with the faceplate.
Line thickness = 0.18 mm; dot diameter = 0.38 mm; colour red.

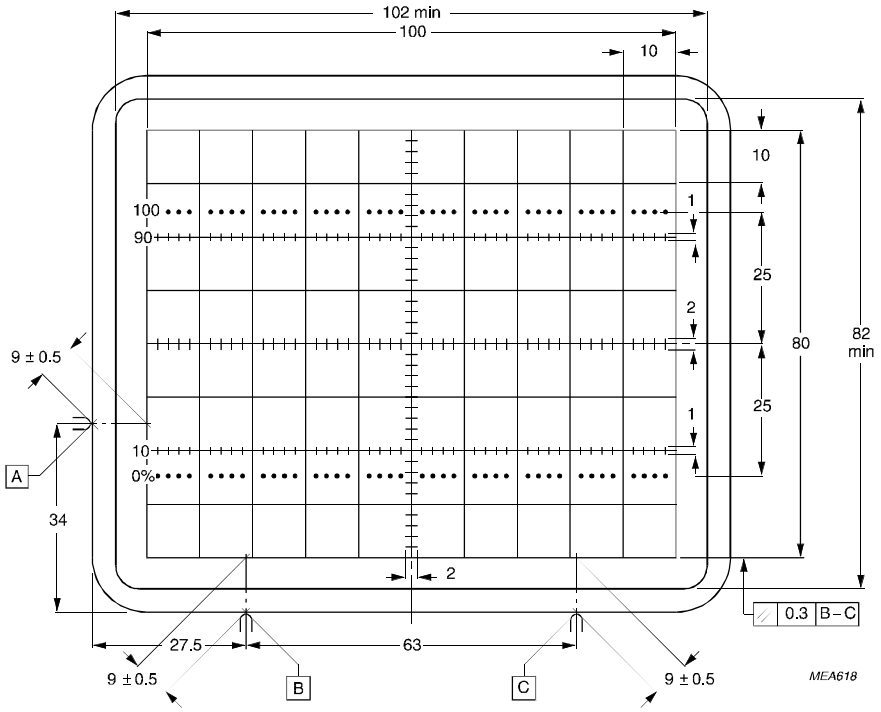


Fig.4 Front view of the tube with internal graticule, type 123.

TYPICAL OPERATION (voltages are with respect to the cathode)

Conditions

Mean deflection plate potential		2 kV	note 2
Shield voltage for optimum geometry	$V_{g5,(I)}$	2 kV	note 3
Accelerator and astigmatism control voltage	$V_{g2,g4}$	2 kV	note 4
Focus voltage	V_{g3}	100 to 200 V	note 5
Cut-off voltage for visual extinction of focused spot	$-V_{g1}$	22 to 65 V	note 6

PERFORMANCE

Horizontal deflection coefficient	M_x	19 V/cm ± 10%	
Vertical deflection coefficient	M_y	11,5 V/cm ± 5%	
Deviation of deflection linearity		< 2%	note 7
Geometry distortion			note 8
Eccentricity of undeflected spot			
in horizontal direction		< 4 mm	note 9
in vertical direction		< 2 mm	
Angle between x and y traces		90 ± 0.5°	note 9
Angle between x-trace and x-axis of internal graticule		< 5°	note 10
Luminance reduction with respect to screen centre			
x-axis, outer graticule line	< 30%		
y-axis, outer graticule line	< 30%		
any corner	< 50%		

Grid drive for 10 μA screen current	V_d	approx. 10 V	Fig.5; note 6
Line width	l.w.	approx. 0.3 mm	note 11

LIMITING VALUES (Absolute maximum rating system)

Accelerator voltage	$V_{g2,g4}$	max. 2.2 kV	
Shield voltage	$V_{g5(I)}$	max. 2.2 kV	
Focus electrode voltage	V_{g3}	max. 2.2 kV	
Control grid voltage	$-V_{g1}$	max. 200 V	
			min. 0 V
Cathode to heater voltage			
	positive	V_{kf}	max. 125 V
	negative	$-V_{kf}$	max. 125 V
Heater voltage	V_f	max. 6.6 V	
			min. 6.0 V
Grid drive, averaged over 1 ms	V_d	max. 20 V	
Screen dissipation	W	max. 3 mW/cm^2	
Control grid circuit resistance	R_{g1}	max. 1 MΩ	

CAPACITANCES *

x_1 to all other elements except x_2	$C_{x1(x2)}$	4.8 pF
x_2 to all other elements except x_1	$C_{x2(x1)}$	4 pF
y_1 to all other elements except y_2	$C_{y1(y2)}$	3.4 pF
y_2 to all other elements except y_1	$C_{y2(y1)}$	3.4 pF
x_1 to x_2	C_{x1x2}	3.3 pF
y_1 to y_2	C_{y1y2}	1 pF
Control grid to all other elements	C_{g1}	6 pF
Cathode to all other elements	C_k	3 pF

* Approximate values

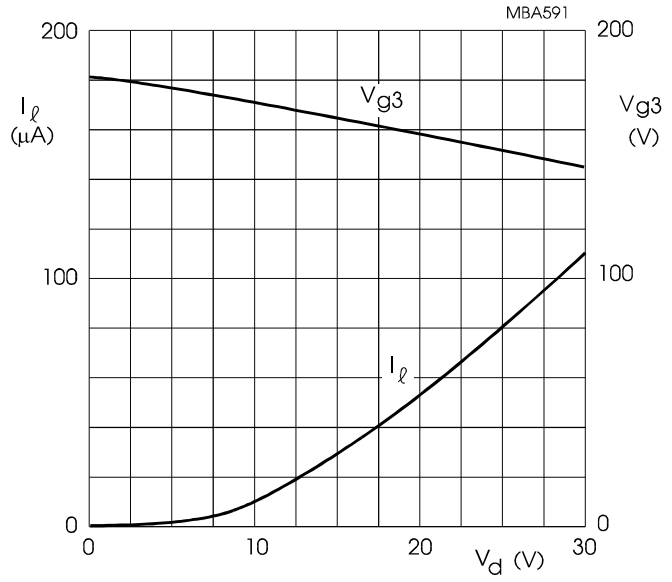


Fig.5 Typical screen current (I_l) and focus voltage (V_{g3}) curves as a function of grid drive voltage (V_d) at $V_{g2,g4,g5}$ = 2 kV.

NOTES

1. Because the frit seal is visible through the faceplate, and is not necessarily aligned with the internal graticule, application of an external passe-partout with an open area of max. 102 mm x 82 mm is recommended. The internal graticule is aligned with the faceplate by using the faceplate reference points (see Fig.4).
2. The deflection plates must be operated symmetrically. Asymmetric drive introduces trace distortion. It is recommended that the tube is operated with equal mean x- and y-potentials in order to minimize tube adjustments. In this event g_5 may be connected to g_2, g_4 and all made equal to mean y-potential for optimum spot (see also notes 3 and 4).
   A difference between mean x- and y-potentials up to 75 V is permissible. However, this may influence the specified deflection coefficients and separate voltages on g_4 and g_5 will be required.
3. The tube will meet the geometry specification (see note 8) if V_{g5} is equal to mean x-potential. A range of ± 30 V around mean x-potential may be applied for further correction.
4. Optimum spot is obtained with $V_{g2,g4}$ equal to mean y-potential (see note 2). Generally, a tolerance of ± 4 V has no visible effect. $V_{g2,g4}$ tends to be lower with V_{g5} more positive. The circuit impedance $R_{g2,g4}$ should be less than 10 kΩ.
5. An actual focus range of 30 V should be provided on the front panel. V_{g3} decreases with increasing grid drive (see also Fig.5).
6. Intensity control on the front panel should be limited to the maximum useful screen current (approx. 50 μA; see also Fig.5). It should be adjusted either by the grid drive voltage (up to 22 V) or for maximum acceptable line width. The corresponding cathode current or $I_{g2,g4}$ (up to 500 μA) depends on the cut-off voltage and therefore cannot be used for control settings.
7. The sensitivity at a deflection of less than 75% of the useful scan will not differ from the sensitivity at a deflection of 25% of the useful scan by more than the indicated value.
8. A graticule consisting of concentric rectangles of 100 mm x 80 mm and 98 mm x 78 mm is aligned with the internal graticule. With optimum trace rotation correction, the raster will fall between these rectangles.
9. The tube features internal magnetic correction for orthogonality between x- and y-traces, spot shaping (astigmatism) and eccentricity calibration.
10. The tube has a trace rotation coil fixed to the lower cone part. The coil has a maximum resistance of 260 Ω at 80 °C. The maximum required voltage is approximately 11 V for tube tolerances (± 5°) and earth magnetic field with reasonable shielding (± 2°).
11. Measured with the shrinking raster method in the centre of the screen under typical operating conditions, adjusted for optimum spot size at beam current I_l = 10 μA.
    The beam current I_l can be measured on g_5 and is approx. equal to $I_{g5(l)}$.

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Specification for oscilloscope CRT

Type: 56862

PDS

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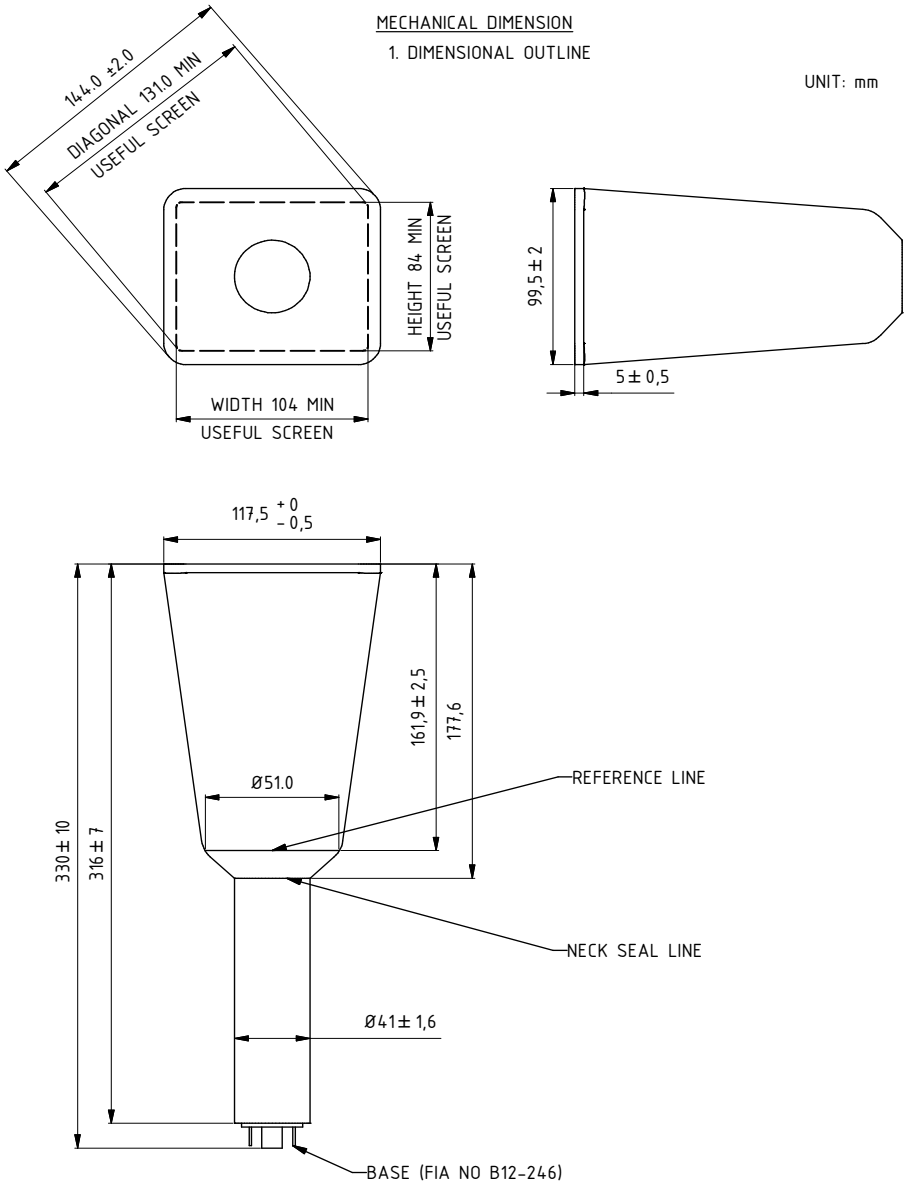
PDS
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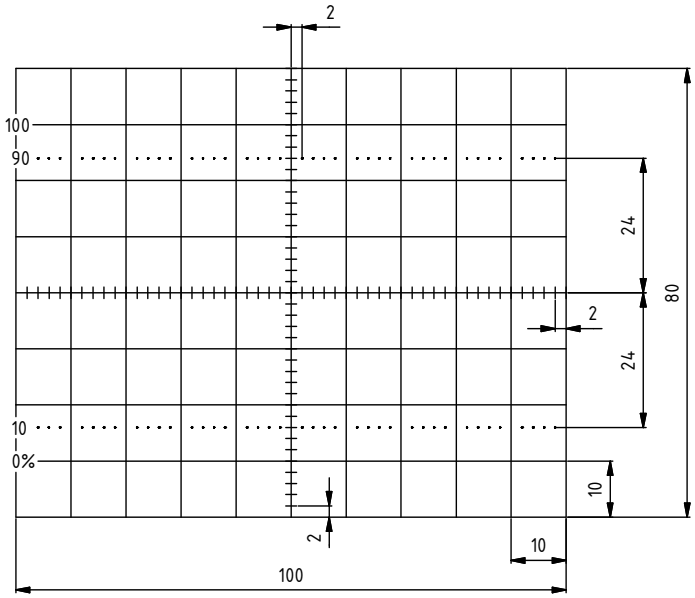
MECHANICAL DIMENSION

1. DIMENSIONAL OUTLINE & BASE CONNECTION (Unit: mm)

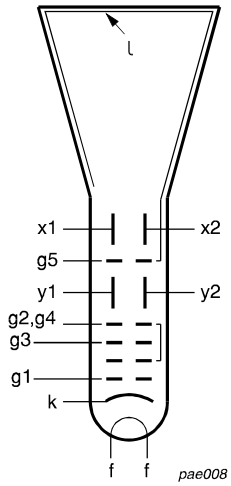


Mechanical outlines.

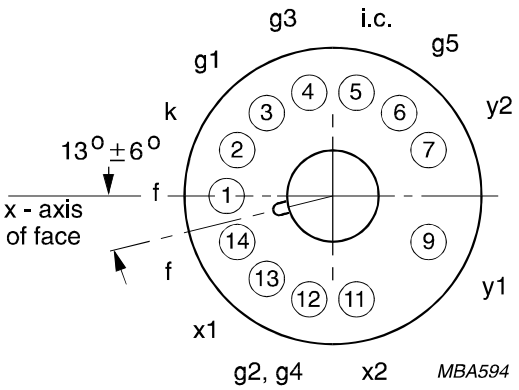
2. Internal Graticule



Graticule color: Red
Graticule line width: 0.20 ± 0.05 mm



Pin arrangement, bottom view



Electrode configuration

GENERAL DATA AND PERFORMANCE

1. GENERAL DATA SHEET

Use	Oscilloscope					
Type	Electrostatic deflection, Electrostatic focusing Mono acceleration					
Construction	Rectangular flat face, Internal graticule					
Out Line	Overall length 330 ±10mm, Neck diameter 41.0 ±1,6mm Greatest diagonal 145 ± 2mm Screen useful area 104 x 84mm²					
Bulb	6" - 41Ø					
light transmittance	Approx. 89%					
Base	EIA No. B12-246					
Phosphor	P31 (EIA No. 31) /GH					
Phosphorescence	Green					
Fluorescence	Green					
Persistence	Medium short					
Symbol & Unit	Vf (V)	Vg1 (Vdc)	Vg2(Vdc)	Vg3(Vdc)	Vg4(Vdc)	Vg5(Vdc)
Absolute max. rating	6,6	0	2750	1000	2750	2750
Absolute min. rating	5,7	-200	1500	-	1500	1500
Test condition	6,3	Adjust	2000	Focus	Adjust	2000
Symbol & Unit	Vkf(Vdc	Vd (V)	Rg1(MΩ)	Zd(MΩ)	-	-
Absolute max. rating	125	30	1.5	1.5	-	-
Absolute min. rating	-125	-	-	-	-	-
Test condition	-	-	-	-	-	-

Notes:

(1) All voltages are referred to cathode except for Vf and Vd.

(2) For optimum performance, the heater voltage of devices should be regulated at 6,3 V for 100% service voltage.

(3) Standard raster size and scanning frequency for test condition are as follows:

H x V = 100 x 80mm² F = 60 Hz (hor.), 4500 Hz (vert.)

2. TEST SPECIFICATION SHEET

TEST ITEMS	SYMBOL	METHOD	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Heater current	If	-		95	105	115	mA
Heater current DC leakage	Ifk	-	Vfk= ± 125V	-	-	30	uAdc
Grid No.1 leakage	LIg1	-		-5	-	-5	uAdc
G2 leakage	Lib1	-		-15	-	15	uAdc
Stray emission	SE	1)	Vg2=Vg4-2750Vdc	-	-	-	
Cutoff voltage	-Vg1	-	Visual extinction of a focused spot	25.0	45.5	66	Vdc
Modulation voltage	ΔVg1	-		-	-	35	Vdc
Cathode current	Ik	-		-	-	150	uAdc
Focusing voltage	Vb1	-		150	175	200	Vdc
Deflection factor (X1-X2)	DFX	8)		18.0	18..5	19.0	Vdc/cm
Deflection factor (Y1-Y2)	DFY	8)		11.0	12.0	13.0	Vdc/cm
Pattern distortion	PD	2)		-	-	1.3	mm
Spot position	SP	3)		-	-	±7	mm
Spot displacement	SD	4)	Zd=10MΩ	-	-	10	mm
Angle between traces	α	5)		89.0	90.0	91.0	deg
Deflection linearity	DFU	6)		-	-	5	%
Astigmatism voltage	Vg4	7)		1900	2000	2100	Vdc
Vert. useful scan	BSPY	-		80	-	-	mm
Hor. useful scan	BSPX	-		100	-	-	mm
Screen quality	SQ	9)		-	-	-	
Internal graticule	IG	10)		-	-	-	
Gun to graticule alignment	DO	-	X1-X2: Hor. axis of graticule	-	-	5	deg

Notes: (1) Specified voltage values are referred to cathode except for ΔVg1

3. TEST SPECIFICATION SHEET (cont'd)

TEST ITEMS	SYMBOL	METHOD	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Capacitance Grid No.1 to all other electrodes	Cg1-all	-		-	6.2	-	pF
Cathode to all other electrodes	Ck-all	-		-	3.2	-	pF
X1 to al other electrodes except X2	Cx+ -all	-		-	4.5	-	pF
X2 to all other electrodes except X1	Cx- -all	-		-	4.5	-	pF
Y1 to all other electrodes except Y2	Cx- -all	-		-	3.5	-	pF
Y2 to all other electrodes except Y1	Cy+ -all	-		-	3.5	-	pF
X1 to X2	Cx-x	-		-	3.2	-	pF
Y1 to Y2	Cy-y	-		-	1.4	-	pF

4. TEST METHOD

**** Standard Test Condition ****

Unless otherwise specified, use the voltages in the general data sheet for all test conditions and evaluate after adjusting astigmatism voltage (Vg4)

The tube shall be shielded against external magnetic and electrical influences.

1) Stray Emission

Ambient light measured at tube face shall be approximately 1 lm/m²

Limits: reject tube, if stray emission is observed.

2) Pattern Distortion

Set up the specified test voltage and display a horizontal single line.

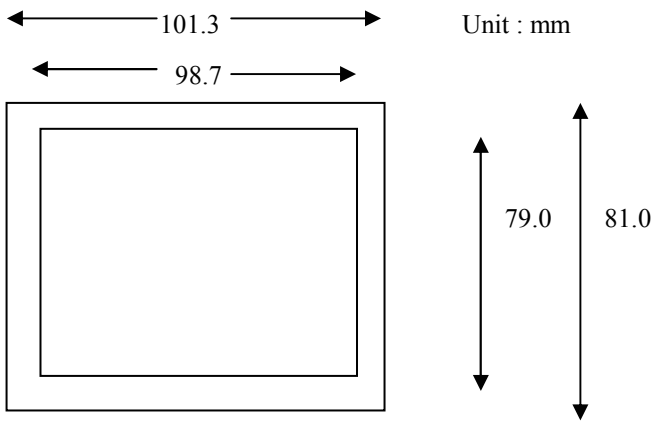
Adjust the horizontal single line to be aligned with the horizontal axis of internal graticule by controlling the rotation coil current.

A graticule (Figure 1) consisting of concentric squares of 101.3 x 81.0 mm² and 98.7 x 79.0 mm², is aligned with the internal graticule.

Evaluate the vertical or horizontal single lines fall between these squares.

Limits: the line center of the edge of the single line must fall between these squares.

Fig. 1. Pattern distorsion gauge



3. Spot Position

Connect X1, X2, Y1 and Y2 with g4 and g5
An undeflected focused spot shall be within +/- 7mm horizontally and +/- 7mm vertically from the center of the screen.

Caution: the grid No.1 voltage shall be set at a value which will avoid damage to the screen.
Limits: Maximum spot position…… 14 mm max.

4. Spot Displacement

The tube shall be operated as specified in Par. 3), insert a 10 Mohm resistor between deflection electrodes and g4 and g5
The spot displacement produced by shorting of each resistor in turn shall not exceed the specified value.

Limit: Maximum spot displacement ……10mm max.

5. Angle Between Traces

The angle between horizontal (X1-X2) and vertical (Y1-Y2) traces shall not exceed the specified value.
The angle shall be measured counter clockwise from the horizontal trace.

Limits: angel between traces ……90 +/- 1.0 deg.

6. Deflection Linearity

Under the specified test condition, display the controlled 20mm single line at the center of horizontal graticule axis. The 20mm line is then positioned in horizontal direction from the center to +/- 4 major divisions without changing the horizontal deflection gain. The line length of each point is measured then.
Same as the above procedure, the displayed 20mm single line at the center of vertical graticule axis is positioned in direction from the center to +/- 3 major divisions and measured.
The line length at each four points shall not exceed the specified value.

Limits: Maximum deflection linearity ……+/- 5% max.

Note: Deflection linearity presented by deviation percentage follows

$$\frac{\text{(Line length in mm after positioning)} - 20\text{mm}}{20\text{mm}} \times 100\%$$

7. Astigmatism voltage (Vg4)

   Under the specified test condition, the Vg4 voltage for astigmatism adjustment shall be within the limits specified.

   Limites: Maximum astigmatism voltage……2100 Vdc Max.
   Minimum astigmatism voltage..... 1900 Vdc Min.

8. Deflection Factor

   Measure the deflection plate (X1-X2) DC voltage for positioning a focused spot horizontally from -5 cm to +5 cm along the graticule axis.
   The above deflection voltage divided 10 cm is the horizontal deflection factor in Vdc/cm

   The deflection plate (Y1-Y2) DC voltage for positioning the spot vertically from –4 cm to +4 cm along the graticule axis, divided 8 cm is the vertical deflection factor in Vdc/cm.

   Limits: Horizontal defl. factor DFX …… 18.0 to 19.0 Vdc/cm
   Vertical defl. factor DFY …… 11.0 to 13.0 Vdc/cm

9. Screen and faceplate Quality
   This specification shall be applied in all screen area of 104 x 84 mm²

   1) Criteria of defects:
      Defects included blisters, bubbles, elongated blisters, stones, opaque spots, pin holes, and dirt.

      Acceptable size and number of defects are in referred criteria chart:

      Elliptical defects should be inspected by the following equivalent diameter formula.

      $$\text{Equivalent Spot Diameter} = \frac{(\text{Length} + \text{Width})}{2}$$

(2) Defects classification and size:

Table 2. Defects classification an size (mm)

Classification	Size	Acceptable No's	Min. Separation
Blisters, bubbles	0.41 to 0.60	4 max.	25
Stones, opaque spots	0.21 to 0.40		
Pinhole, dirt	0.21 to 0.40		
(See note) Elongated blisters	with: 0.20 to 0.35 Max. length: 6.0		

Note: Elongated blisters shall not be subjected to the equivalent diameter formula.

Limits: The tube with defects larger than the above table 2, should be rejected
Defects smaller than the above table 2 should not be counted.

10. Internal Graticule Quality

The graticule lines must be of uniform density. Obvious line breaks are specified in table 3.

Table 3: graticule defects

Line Breaks Size (mm)	Minimum Separation (mm)	Acceptable Numbers (pcs)	
Less then 0.20	----	no count	Total 15
0.21 to 0.45	10	14	
0.46 to 0.75	25	5	
0.76 to 1.00	----	1	
Greater than 10.1	----	0	

Note: (1) Two or more breaks within any 1.0mm segments of the graticule line must be considered as one break whose length would be equal to the length of the segment.

(2) Line breaks must be visible from 38 cm.

PRECAUTION

Heater rating

Heater voltage range should not be exceeded in worst-case conditions of the application. Despite heater voltage range of +/- 10%, equipment should be designed so shat the heater voltage is applied at the typical RMS value. Range of +/- 10% is only for a probable variation with respect to apply voltage.
Exceeding voltage range will result in the short life or low light output, etc. of the tube.

Mounting

The mounting system of this tube should not put mechanical stress on, particularly in the splice area and mold-match line.
Equipment's mounting system should incorporate sufficient cushioning so that an impact force of more than 30 G is never applied to the tube, under normal condition of shipment or handling

Tube handling

Tubes should be kept in the shipping box or similar protective container until just prior to installation. Wear heavy protective clothing, including gloves and safety goggles with side shields, in areas handling unpacked and unprotected tubes to prevent possible injury from flying glass in the event tubes breaks. Handle tubes with extreme care.
Do not strike, scratch, or subject tubes to more than moderate pressure.
Particular care should be taken to prevent damage to the seal and splice area.

Other

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Specification for oscilloscope CRT

Type: Test Tube SG 56862

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MECHANICAL DIMENSIONS **1**

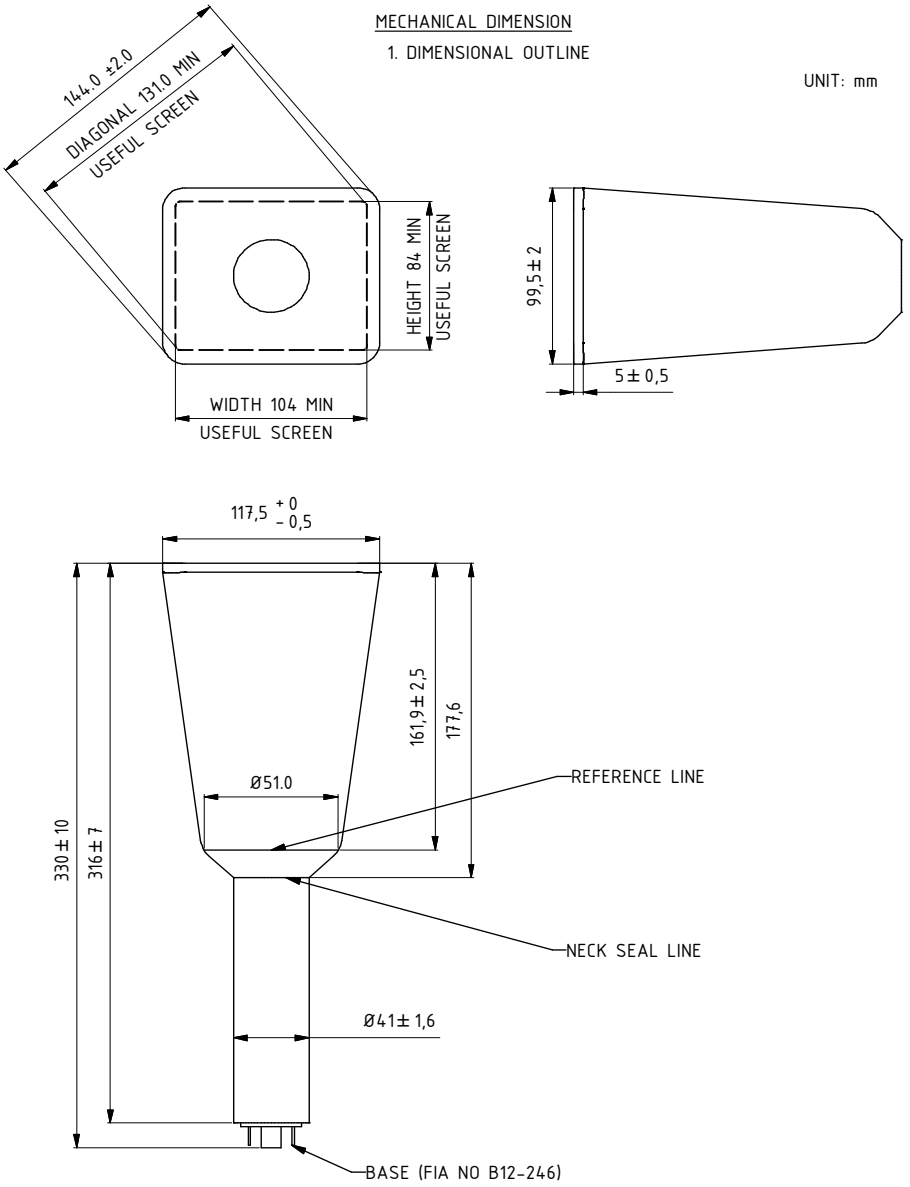
GENERAL DATA and PERFORMANCE **3**

PRECAUTION **10**

INSTRUMENT CATHODE-RAY TUBE 56862

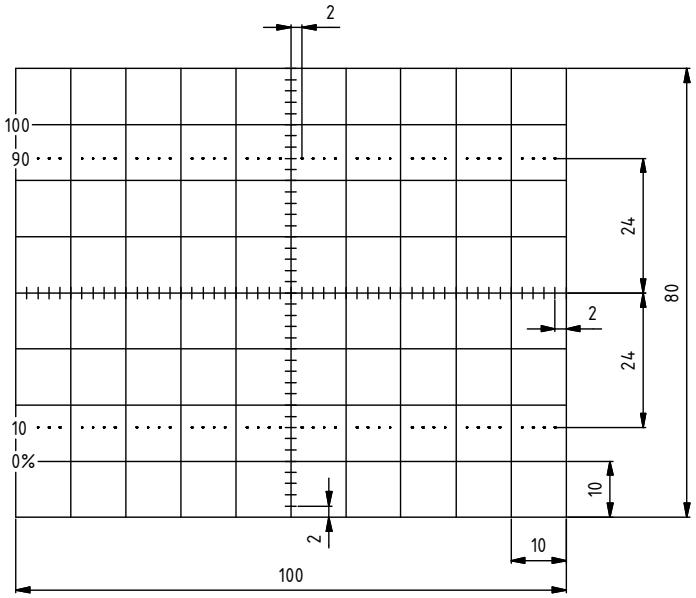
MECHANICAL DIMENSION

1. DIMENSIONAL OUTLINE & BASE CONNECTION (Unit: mm)

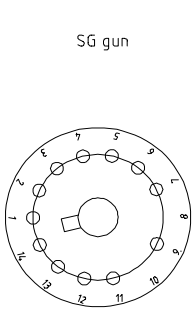


Mechanical outlines.

2. Internal Graticule



Graticule color: Red
Graticule line width: 0.20 ± 0.05 mm



Pin arrangement
Bottom view

1. f
2.G1
3.K
4.G3
5.G4
6.G2+G5
7.Y2
8.–
9.Y1
10.–
11.X2
12.X1
13.i.c
14.f

Pin arrangement, bottom view

GENERAL DATA AND PERFORMANCE

1. GENERAL DATA SHEET

Use	Oscilloscope					
Type	Electrostatic deflection, Electrostatic focusing Mono acceleration					
Construction	Rectangular flat face, Internal graticule					
Out Line	Overall length 330 ±10mm, Neck diameter 41.0 ±1,6mm Greatest diagonal 145 ± 2mm Screen useful area 104 x 84mm²					
Bulb	6" - 41Ø					
light transmittance	Approx. 89%					
Base	EIA No. B12-246					
Phosphor	P31 (EIA No. 31) /GH					
Phosphorescence	Green					
Fluorescence	Green					
Persistence	Medium short					
Symbol & Unit	Vf (V)	Vg1 (Vdc)	Vg2(Vdc)	Vg3(Vdc)	Vg4(Vdc)	Vg5(Vdc)
Absolute max. rating	6,6	0	2750	1000	2750	2750
Absolute min. rating	5,7	-200	1500	-	1500	1500
Test condition	6,3	Adjust	2000	Focus	Adjust	2000
Symbol & Unit	Vkf(Vdc	Vd (V)	Rg1(MΩ)	Zd(MΩ)	-	-
Absolute max. rating	125	30	1.5	1.5	-	-
Absolute min. rating	-125	-	-	-	-	-
Test condition	-	-	-	-	-	-

Notes:

(1) All voltages are referred to cathode except for Vf and Vd.

(2) For optimum performance, the heater voltage of devices should be regulated at 6,3 V for 100% service voltage.

(3) Standard raster size and scanning frequency for test condition are as follows:

H x V = 100 x 80mm² F = 60 Hz (hor.), 4500 Hz (vert.)

2. TEST SPECIFICATION SHEET

TEST ITEMS	SYMBOL	METHOD	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Heater current	If	-		95	105	115	mA
Heater current DC leakage	Ifk	-	Vfk= ± 125V	-	-	30	uAdc
Grid No.1 leakage	LIg1	-		-5	-	-5	uAdc
G2 leakage	Lib1	-		-15	-	15	uAdc
Stray emission	SE	1)	Vg2=Vg4-2750Vdc	-	-	-	
Cutoff voltage	-Vg1	-	Visual extinction of a focused spot	25.0	45.5	66	Vdc
Modulation voltage	ΔVg1	-		-	-	35	Vdc
Cathode current	Ik	-		-	-	150	uAdc
Focusing voltage	Vb1	-		200	350	500	Vdc
Deflection factor (X1-X2)	DFX	8)		18.0	20	22.0	Vdc/cm
Deflection factor (Y1-Y2)	DFY	8)		10.8	12.0	13.2	Vdc/cm
Pattern distortion	PD	2)		-	-	1.3	mm
Spot position	SP	3)		-	-	±7	mm
Spot displacement	SD	4)	Zd=10MΩ	-	-	10	mm
Angle between traces	α	5)		89.0	90.0	91.0	deg
Deflection linearity	DFU	6)		-	-	5	%
Astigmatism voltage	Vg4	7)		1900	2000	2100	Vdc
Vert. useful scan	BSPY	-		80	-	-	mm
Hor. useful scan	BSPX	-		100	-	-	mm
Screen quality	SQ	9)		-	-	-	
Internal graticule	IG	10)		-	-	-	
Gun to graticule alignment	DO	-	X1-X2: Hor. axis of graticule	-	-	5	deg

Notes: (1) Specified voltage values are referred to cathode except for ΔVg1

3. TEST SPECIFICATION SHEET (cont'd)

TEST ITEMS	SYMBOL	METHOD	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Capacitance Grid No.1 to all other electrodes	Cg1-all	-		-	6.2	-	pF
Cathode to all other electrodes	Ck-all	-		-	3.2	-	pF
X1 to al other electrodes except X2	Cx+ -all	-		-	4.5	-	pF
X2 to all other electrodes except X1	Cx- -all	-		-	4.5	-	pF
Y1 to all other electrodes except Y2	Cx- -all	-		-	3.5	-	pF
Y2 to all other electrodes except Y1	Cy+ -all	-		-	3.5	-	pF
X1 to X2	Cx-x	-		-	3.2	-	pF
Y1 to Y2	Cy-y	-		-	1.4	-	pF

4. TEST METHOD

**** Standard Test Condition ****

Unless otherwise specified, use the voltages in the general data sheet for all test conditions and evaluate after adjusting astigmatism voltage (Vg4)

The tube shall be shielded against external magnetic and electrical influences.

1) Stray Emission

Ambient light measured at tube face shall be approximately 1 lm/m²

Limits: reject tube, if stray emission is observed.

2) Pattern Distortion

Set up the specified test voltage and display a horizontal single line.

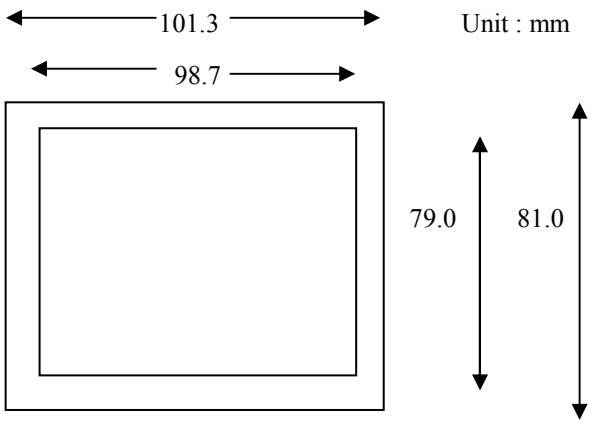
Adjust the horizontal single line to be aligned with the horizontal axis of internal graticule by controlling the rotation coil current.

A graticule (Figure 1) consisting of concentric squares of 101.3 x 81.0 mm² and 98.7 x 79.0 mm², is aligned with the internal graticule.

Evaluate the vertical or horizontal single lines fall between these squares.

Limits: the line center of the edge of the single line must fall between these squares.

Fig. 1. Pattern distorsion gauge



3. Spot Position

Connect X1, X2, Y1 and Y2 with g4 and g5
An undeflected focused spot shall be within +/- 7mm horizontally and +/- 7mm vertically from the center of the screen.

Caution: the grid No.1 voltage shall be set at a value which will avoid damage to the screen.
Limits: Maximum spot position…… 14 mm max.

4. Spot Displacement

The tube shall be operated as specified in Par. 3), insert a 10 Mohm resistor between deflection electrodes and g4 and g5
The spot displacement produced by shorting of each resistor in turn shall not exceed the specified value.

Limit: Maximum spot displacement ……10mm max.

5. Angle Between Traces

The angle between horizontal (X1-X2) and vertical (Y1-Y2) traces shall not exceed the specified value.
The angle shall be measured counter clockwise from the horizontal trace.

Limits: angel between traces ……90 +/- 1.0 deg.

6. Deflection Linearity

Under the specified test condition, display the controlled 20mm single line at the center of horizontal graticule axis. The 20mm line is then positioned in horizontal direction from the center to +/- 4 major divisions without changing the horizontal deflection gain. The line length of each point is measured then.
Same as the above procedure, the displayed 20mm single line at the center of vertical graticule axis is positioned in direction from the center to +/- 3 major divisions and measured.
The line length at each four points shall not exceed the specified value.

Limits: Maximum deflection linearity ……+/- 5% max.

Note: Deflection linearity presented by deviation percentage follows

$$\frac{\text{(Line length in mm after positioning)} - 20\text{mm}}{20\text{mm}} \times 100\%$$

7. Astigmatism voltage (Vg4)

   Under the specified test condition, the Vg4 voltage for astigmatism adjustment shall be within the limits specified.

   Limites: Maximum astigmatism voltage……2100 Vdc Max.
   Minimum astigmatism voltage..... 1900 Vdc Min.

8. Deflection Factor

   Measure the deflection plate (X1-X2) DC voltage for positioning a focused spot horizontally from -5 cm to +5 cm along the graticule axis.
   The above deflection voltage divided 10 cm is the horizontal deflection factor in Vdc/cm

   The deflection plate (Y1-Y2) DC voltage for positioning the spot vertically from –4 cm to +4 cm along the graticule axis, divided 8 cm is the vertical deflection factor in Vdc/cm.

   Limits: Horizontal defl. factor DFX …… 18.0 to 22.0 Vdc/cm
   Vertical defl. factor DFY …… 10.8 to 13.2 Vdc/cm

9. Screen and faceplate Quality
   This specification shall be applied in all screen area of 104 x 84 mm²

   1) Criteria of defects:
      Defects included blisters, bubbles, elongated blisters, stones, opaque spots, pin holes, and dirt.

      Acceptable size and number of defects are in referred criteria chart:

      Elliptical defects should be inspected by the following equivalent diameter formula.

      $$\text{Equivalent Spot Diameter} = \frac{(\text{Length} + \text{Width})}{2}$$

(2) Defects classification and size:

Table 2. Defects classification an size (mm)

Classification	Size	Acceptable No's	Min. Separation
Blisters, bubbles	0.41 to 0.60	4 max.	25
Stones, opaque spots	0.21 to 0.40		
Pinhole, dirt	0.21 to 0.40		
(See note) Elongated blisters	with: 0.20 to 0.35 Max. length: 6.0		

Note: Elongated blisters shall not be subjected to the equivalent diameter formula.

Limits: The tube with defects larger than the above table 2, should be rejected
Defects smaller than the above table 2 should not be counted.

10. Internal Graticule Quality

The graticule lines must be of uniform density. Obvious line breaks are specified in table 3.

Table 3: graticule defects

Line Breaks Size (mm)	Minimum Separation (mm)	Acceptable Numbers (pcs)	
Less then 0.20	----	no count	Total 15
0.21 to 0.45	10	14	
0.46 to 0.75	25	5	
0.76 to 1.00	----	1	
Greater than 10.1	----	0	

Note: (1) Two or more breaks within any 1.0mm segments of the graticule line must be considered as one break whose length would be equal to the length of the segment.

(2) Line breaks must be visible from 38 cm.

PRECAUTION

Heater rating

Heater voltage range should not be exceeded in worst-case conditions of the application.
Despite heater voltage range of +/- 10%, equipment should be designed so shat the heater voltage is applied at the typical RMS value. Range of +/- 10% is only for a probable variation with respect to apply voltage.
Exceeding voltage range will result in the short life or low light output, etc. of the tube.

Mounting

The mounting system of this tube should not put mechanical stress on, particularly in the splice area and mold-match line.
Equipment's mounting system should incorporate sufficient cushioning so that an impact force of more than 30 G is never applied to the tube, under normal condition of shipment or handling

Tube handling

Tubes should be kept in the shipping box or similar protective container until just prior to installation. Wear heavy protective clothing, including gloves and safety goggles with side shields, in areas handling unpacked and unprotected tubes to prevent possible injury from flying glass in the event tubes breaks. Handle tubes with extreme care.
Do not strike, scratch, or subject tubes to more than moderate pressure.
Particular care should be taken to prevent damage to the seal and splice area.

Other

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Specification for oscilloscope CRT

Type: 56863

PDS

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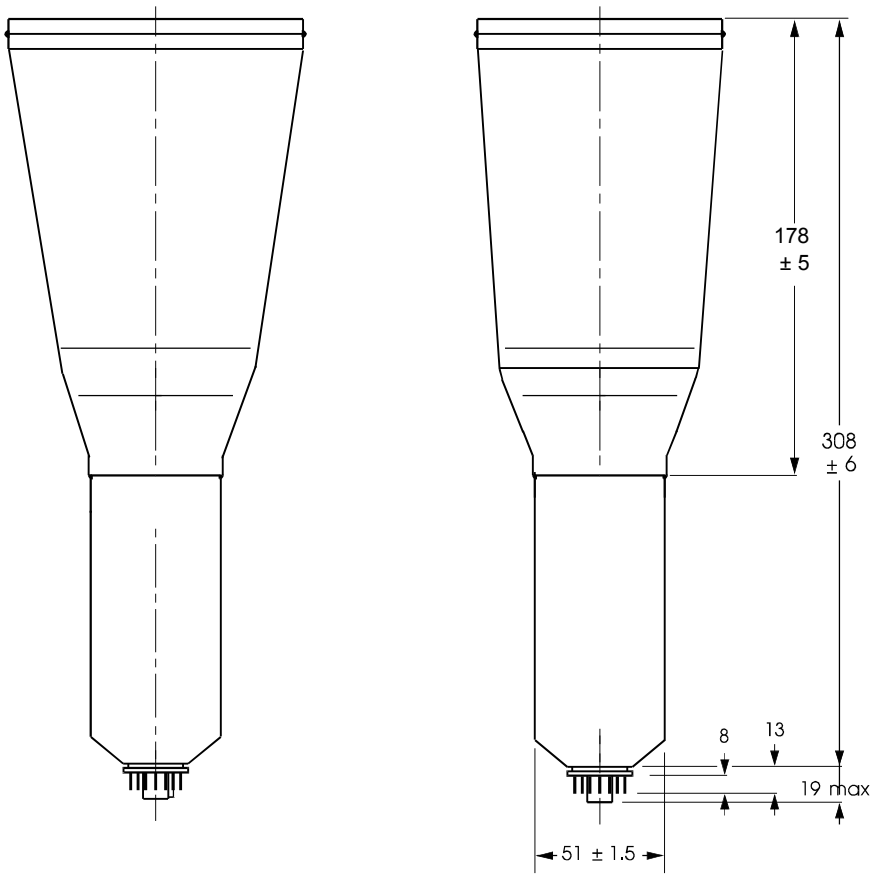
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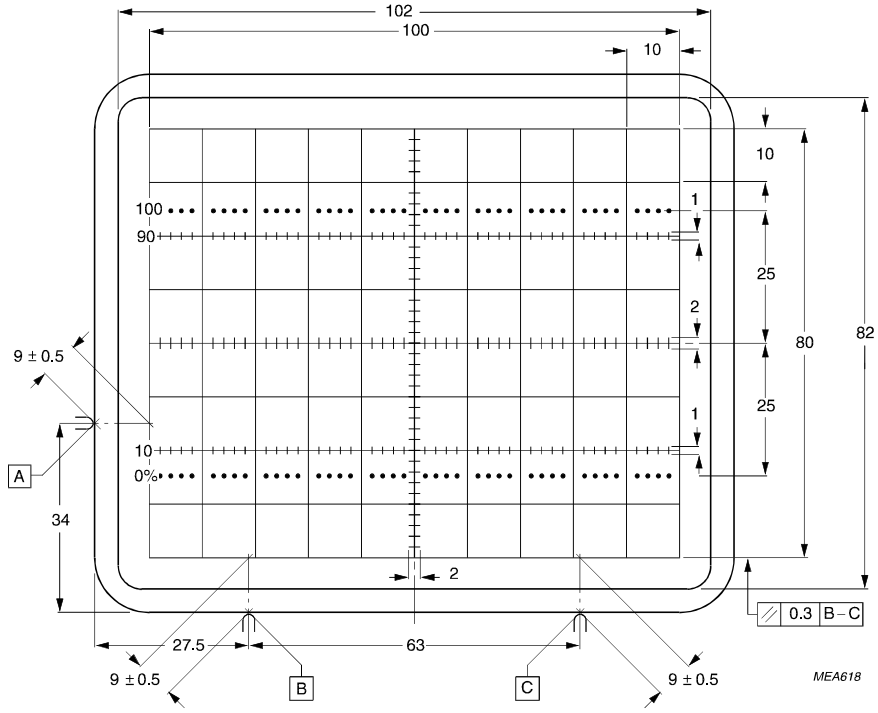
MECHANICAL DIMENSION

1. DIMENSIONAL OUTLINE & BASE CONNECTION (Unit: mm)

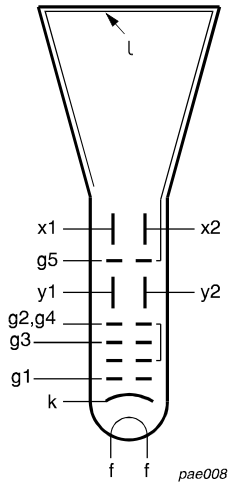


Mechanical outlines.

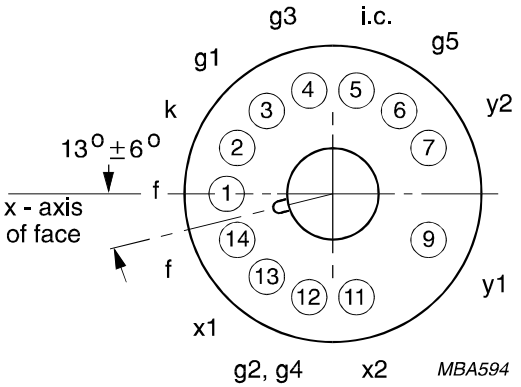
2. Internal Graticule



Graticule color: Red
Graticule line width: 0.18 ± 0.05 mm



Pin arrangement, bottom view



Electrode configuration

GENERAL DATA AND PERFORMANCE

1. GENERAL DATA SHEET

Use	Oscilloscope					
Type	Electrostatic deflection, Electrostatic focusing Mono acceleration					
Construction	Rectangular flat face, Internal graticule					
Out Line	Overall length 330 ±10mm, Neck diameter 51.0 ±1,5mm Greatest diagonal 145 ± 2mm Screen useful area 102 x 82mm²					
Bulb	6" - 51mm Ø					
light transmittance	Approx. 91 %					
Base	EIA No. B12-246					
Phosphor	P31 (EIA No. 31) /GH					
Phosphorescence	Green					
Fluorescence	Green					
Persistence	Medium short					
Symbol & Unit	Vf (V)	Vg1 (Vdc)	Vg2(Vdc)	Vg3(Vdc)	Vg4(Vdc)	Vg5(Vdc)
Absolute max. rating	6,6	0	2750	1000	2750	2750
Absolute min. rating	5,7	-200	1500	-	1500	1500
Test condition	6,3	Adjust	2000	Focus	Adjust	2000
Symbol & Unit	Vkf(Vdc	Vd (V)	Rg1(MΩ)	Zd(MΩ)	-	-
Absolute max. rating	125	30	1.5	1.5	-	-
Absolute min. rating	-125	-	-	-	-	-
Test condition	-	-	-	-	-	-

Notes:

(1) All voltages are referred to cathode except for Vf and Vd.

(2) For optimum performance, the heater voltage of devices should be regulated at 6,3 V for 100% service voltage.

(3) Standard raster size and scanning frequency for test condition are as follows:

H x V = 100 x 80mm² F = 60 Hz (hor.), 4500 Hz (vert.)

2. TEST SPECIFICATION SHEET

TEST ITEMS	SYMBOL	METHOD	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Heater current	If	-		95	105	115	mA
Heater current DC leakage	Ifk	-	Vfk= ± 125V	-	-	30	uAdc
Grid No.1 leakage	LIg1	-		-5	-	-5	uAdc
G2 leakage	Lib1	-		-15	-	15	uAdc
Stray emission	SE	1)	Vg2=Vg4-2750Vdc	-	-	-	
Cutoff voltage	-Vg1	-	Visual extinction of a focused spot	25.0	45.5	66	Vdc
Modulation voltage	ΔVg1	-		-	-	35	Vdc
Cathode current	Ik	-		-	-	150	uAdc
Focusing voltage	Vb1	-		150	175	200	Vdc
Deflection factor (X1-X2)	DFX	8)		18.0	18..5	19.0	Vdc/cm
Deflection factor (Y1-Y2)	DFY	8)		11.0	12.0	13.0	Vdc/cm
Pattern distortion	PD	2)		-	-	1.3	mm
Spot position	SP	3)		-	-	±7	mm
Spot displacement	SD	4)	Zd=10MΩ	-	-	10	mm
Angle between traces	α	5)		89.0	90.0	91.0	deg
Deflection linearity	DFU	6)		-	-	5	%
Astigmatism voltage	Vg4	7)		1900	2000	2100	Vdc
Vert. useful scan	BSPY	-		80	-	-	mm
Hor. useful scan	BSPX	-		100	-	-	mm
Screen quality	SQ	9)		-	-	-	
Internal graticule	IG	10)		-	-	-	
Gun to graticule alignment	DO	-	X1-X2: Hor. axis of graticule	-	-	5	deg

Notes: (1) Specified voltage values are referred to cathode except for ΔVg1

3. TEST SPECIFICATION SHEET (cont'd)

TEST ITEMS	SYMBOL	METHOD	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Capacitance Grid No.1 to all other electrodes	Cg1-all	-		-	6.2	-	pF
Cathode to all other electrodes	Ck-all	-		-	3.2	-	pF
X1 to al other electrodes except X2	Cx+ -all	-		-	4.5	-	pF
X2 to all other electrodes except X1	Cx- -all	-		-	4.5	-	pF
Y1 to all other electrodes except Y2	Cx- -all	-		-	3.5	-	pF
Y2 to all other electrodes except Y1	Cy+ -all	-		-	3.5	-	pF
X1 to X2	Cx-x	-		-	3.2	-	pF
Y1 to Y2	Cy-y	-		-	1.4	-	pF

4. TEST METHOD

**** Standard Test Condition ****

Unless otherwise specified, use the voltages in the general data sheet for all test conditions and evaluate after adjusting astigmatism voltage (Vg4)

The tube shall be shielded against external magnetic and electrical influences.

1) Stray Emission

Ambient light measured at tube face shall be approximately 1 lm/m²

Limits: reject tube, if stray emission is observed.

2) Pattern Distortion

Set up the specified test voltage and display a horizontal single line.

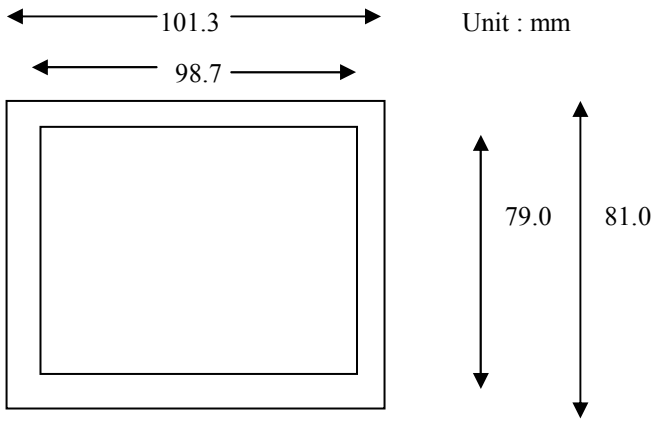
Adjust the horizontal single line to be aligned with the horizontal axis of internal graticule by controlling the rotation coil current.

A graticule (Figure 1) consisting of concentric squares of 101.3 x 81.0 mm² and 98.7 x 79.0 mm², is aligned with the internal graticule.

Evaluate the vertical or horizontal single lines fall between these squares.

Limits: the line center of the edge of the single line must fall between these squares.

Fig. 1. Pattern distorsion gauge



3. Spot Position

Connect X1, X2, Y1 and Y2 with g4 and g5
An undeflected focused spot shall be within +/- 7mm horizontally and +/- 7mm vertically from the center of the screen.

Caution: the grid No.1 voltage shall be set at a value which will avoid damage to the screen.
Limits: Maximum spot position…… 14 mm max.

4. Spot Displacement

The tube shall be operated as specified in Par. 3), insert a 10 Mohm resistor between deflection electrodes and g4 and g5
The spot displacement produced by shorting of each resistor in turn shall not exceed the specified value.

Limit: Maximum spot displacement ……10mm max.

5. Angle Between Traces

The angle between horizontal (X1-X2) and vertical (Y1-Y2) traces shall not exceed the specified value.
The angle shall be measured counter clockwise from the horizontal trace.

Limits: angel between traces ……90 +/- 1.0 deg.

6. Deflection Linearity

Under the specified test condition, display the controlled 20mm single line at the center of horizontal graticule axis. The 20mm line is then positioned in horizontal direction from the center to +/- 4 major divisions without changing the horizontal deflection gain. The line length of each point is measured then.
Same as the above procedure, the displayed 20mm single line at the center of vertical graticule axis is positioned in direction from the center to +/- 3 major divisions and measured.
The line length at each four points shall not exceed the specified value.

Limits: Maximum deflection linearity ……+/- 5% max.

Note: Deflection linearity presented by deviation percentage follows

$$\frac{\text{(Line length in mm after positioning)} - 20\text{mm}}{20\text{mm}} \times 100\%$$

7. Astigmatism voltage (Vg4)

   Under the specified test condition, the Vg4 voltage for astigmatism adjustment shall be within the limits specified.

   Limites: Maximum astigmatism voltage……2100 Vdc Max.
   Minimum astigmatism voltage..... 1900 Vdc Min.

8. Deflection Factor

   Measure the deflection plate (X1-X2) DC voltage for positioning a focused spot horizontally from -5 cm to +5 cm along the graticule axis.
   The above deflection voltage divided 10 cm is the horizontal deflection factor in Vdc/cm

   The deflection plate (Y1-Y2) DC voltage for positioning the spot vertically from –4 cm to +4 cm along the graticule axis, divided 8 cm is the vertical deflection factor in Vdc/cm.

   Limits: Horizontal defl. factor DFX …… 18.0 to 19.0 Vdc/cm
   Vertical defl. factor DFY …… 11.0 to 13.0 Vdc/cm

9. Screen and faceplate Quality
   This specification shall be applied in all screen area of 102 x 82 mm²

   1) Criteria of defects:
      Defects included blisters, bubbles, elongated blisters, stones, opaque spots, pin holes, and dirt.

      Acceptable size and number of defects are in referred criteria chart:

      Elliptical defects should be inspected by the following equivalent diameter formula.

      $$\text{Equivalent Spot Diameter} = \frac{(\text{Length} + \text{Width})}{2}$$

(2) Defects classification and size:

Table 2. Defects classification an size (mm)

Classification	Size	Acceptable No's	Min. Separation
Blisters, bubbles	0.41 to 0.60	4 max.	25
Stones, opaque spots	0.21 to 0.40		
Pinhole, dirt	0.21 to 0.40		
(See note) Elongated blisters	with: 0.20 to 0.35 Max. length: 6.0		

Note: Elongated blisters shall not be subjected to the equivalent diameter formula.

Limits: The tube with defects larger than the above table 2, should be rejected
Defects smaller than the above table 2 should not be counted.

10. Internal Graticule Quality

The graticule lines must be of uniform density. Obvious line breaks are specified in table 3.

Table 3: graticule defects

Line Breaks Size (mm)	Minimum Separation (mm)	Acceptable Numbers (pcs)	
Less then 0.20	----	no count	Total 15
0.21 to 0.45	10	14	
0.46 to 0.75	25	5	
0.76 to 1.00	----	1	
Greater than 10.1	----	0	

Note: (1) Two or more breaks within any 1.0mm segments of the graticule line must be considered as one break whose length would be equal to the length of the segment.

(2) Line breaks must be visible from 38 cm.

PRECAUTION

Heater rating

Heater voltage range should not be exceeded in worst-case conditions of the application.
Despite heater voltage range of +/- 10%, equipment should be designed so shat the heater voltage is applied at the typical RMS value. Range of +/- 10% is only for a probable variation with respect to apply voltage.
Exceeding voltage range will result in the short life or low light output, etc. of the tube.

Mounting

The mounting system of this tube should not put mechanical stress on, particularly in the splice area and mold-match line.
Equipment's mounting system should incorporate sufficient cushioning so that an impact force of more than 30 G is never applied to the tube, under normal condition of shipment or handling

Tube handling

Tubes should be kept in the shipping box or similar protective container until just prior to installation. Wear heavy protective clothing, including gloves and safety goggles with side shields, in areas handling unpacked and unprotected tubes to prevent possible injury from flying glass in the event tubes breaks. Handle tubes with extreme care.
Do not strike, scratch, or subject tubes to more than moderate pressure.
Particular care should be taken to prevent damage to the seal and splice area.

Other

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INSTRUMENT CATHODE-RAY TUBE

- 14 cm diagonal rectangular flat face
- domed mesh post-deflection acceleration
- high sensitivity and high line brightness (writing speed)
- high precision by internal permanent magnetic correction system
- internal graticule
- low heater power consumption
- for compact oscilloscopes with up to 100 MHz bandwidth

QUICK REFERENCE DATA

Final accelerator voltage	$V_{g7(I)}$	10 / 16.5 kV
First accelerator voltage	V_{g4}	2 / 2.2 kV
Minimum useful scan area		100 mm x 80 mm
Deflection coefficient		
horizontal	M_x	8 / 8.3 V/cm
vertical	M_y	4 / 4 V/cm

OPTICAL DATA

Screen	metal-backed phosphor
type	GH
colour	green
persistence	medium short
Useful screen area	≥ 102 mm x 82 mm (note 1)
Useful scan area	≥ 100 mm x 80 mm
Internal graticule	type 123 (see Fig.4)

HEATING

Heater voltage indirect by AC or DC *	V_f	6.3 V
Heater current	I_f	0.1 A
Heating time to attain 10% of the cathode current at equilibrium conditions (approx.)		7 s

* not to be connected in series with other tubes.

MECHANICAL DATA

Dimensions and connections (see also outline drawings)

Overall length (including socket)	≤ 338 mm
Faceplate dimensions	118 ± 0.5 mm x 98 ± 0.5 mm
Net mass	approx. 1 kg
Base	12 pin, all glass, JEDEC B12-246
Final Accelerator Contact	JEDEC J1-21

Mounting

The tube can be mounted in any position. It must not be supported by the socket and not by the base region alone. The reference points on adjoining edges of the faceplate (see Fig.4) enable the tube to be positioned accurately in the front panel, for optimum alignment of the internal graticule.

Accessories

Pin protector (required for shipping)	supplied with tube
Socket with solder tags	type 55594
Socket with printed-wiring pins	type 55595
Final accelerator contact connector	type 55465/66 (JEDEC J1-21)
Mu-metal shield	type 55458/55459 with end rubber 55460

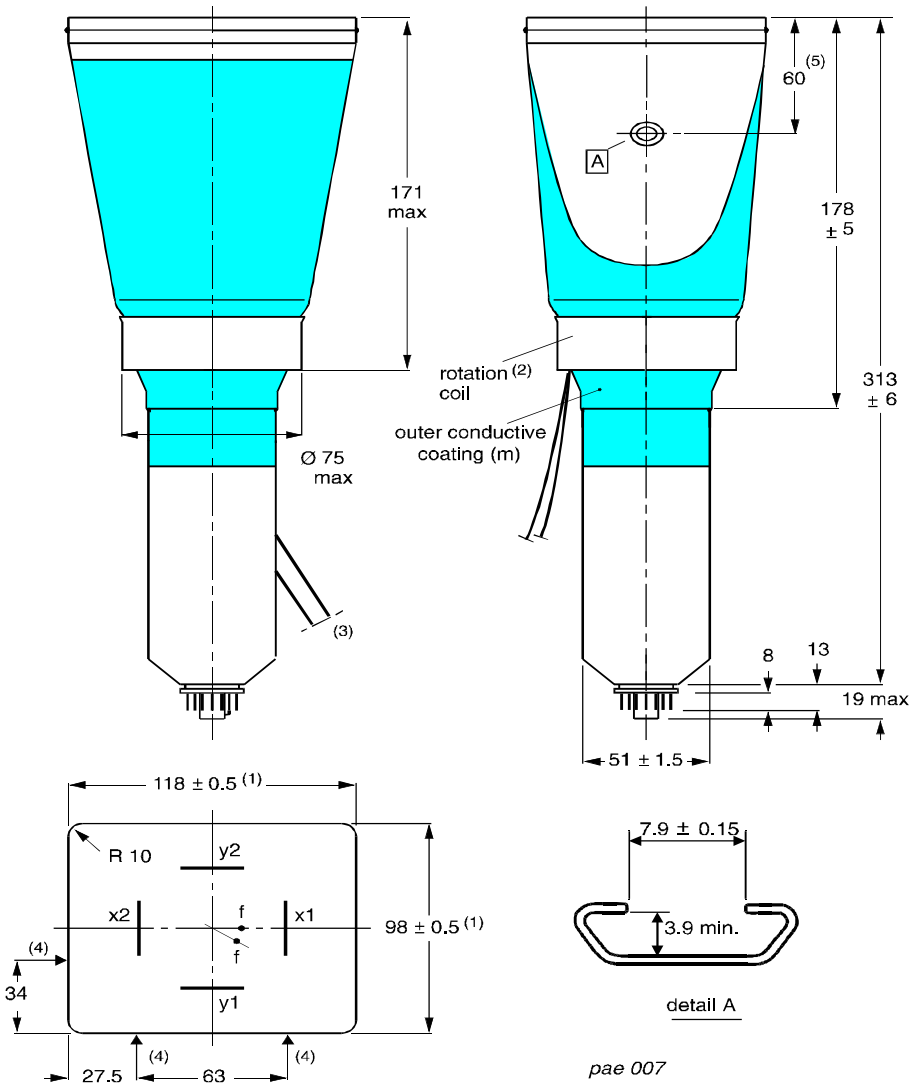
FOCUSING	electrostatic
DEFLECTION	double electrostatic
x-plates	symmetrical
y-plates	symmetrical

CAPACITANCES

x_1 to all other elements except x_2	$C_{x1(x2)}$	4.8 pF
x_2 to all other elements except x_1	$C_{x2(x1)}$	3.6 pF
y_1 to all other elements except y_2	$C_{y1(y2)}$	3.0 pF
y_2 to all other elements except y_1	$C_{y2(y1)}$	3.0 pF
x_1 to x_2	C_{x1x2}	3.3 pF
y_1 to y_2	C_{y1y2}	1.4 pF
Control grid to all other elements	C_{g1}	6.5 pF
Cathode to all other elements	C_k	3.2 pF
Focusing electrode to all other elements	C_{g3}	8 pF
Final accelerator electrode to all other elements	C_{g7}	480 pF

DIMENSIONS AND CONNECTIONS

Dimensions in mm



(1) Dimensions of faceplate only. The complete assembly of faceplate and cone (frit seal included) will pass through an opening of 122 mm x 102 mm (diagonal 153 mm).

(2) The coil is fixed to the envelope with resin.

(3) The length of the rotation coil connecting leads is minimum 350 mm.

(4) Reference points on faceplate for graticule alignment (see Fig.4)

(5) The centre of the final accelerator contact is situated within a square of 10 mm x 10 mm around the indicated position.

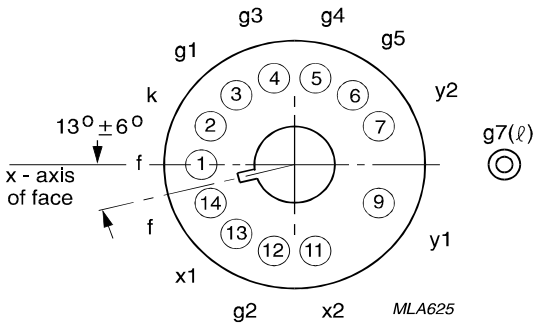


Fig.2 Pin arrangement, bottom view.

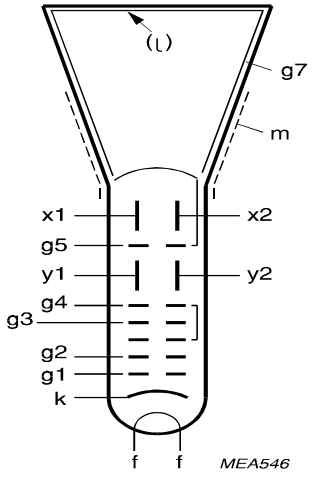


Fig.3 Electrical configuration.

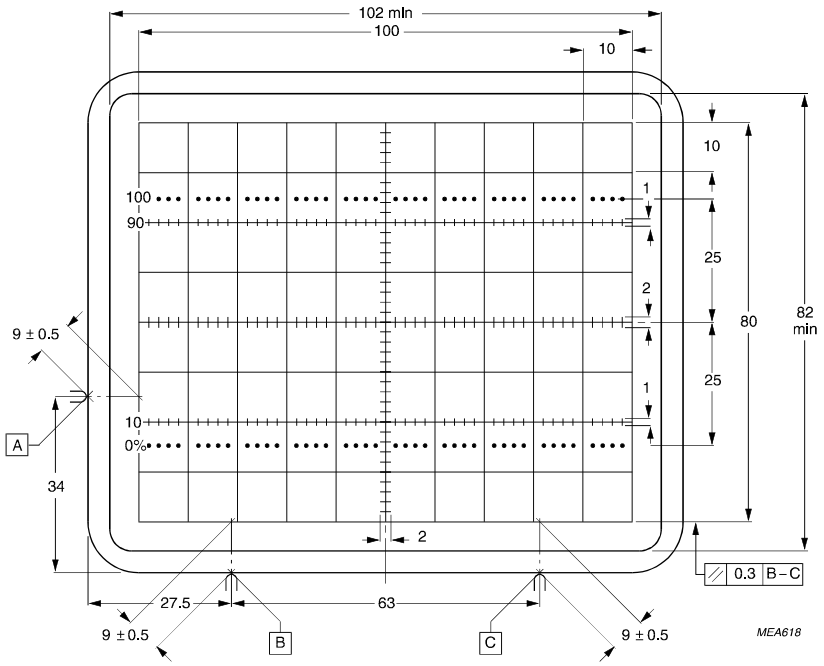


Fig 4. Front view of tube with internal graticule, type 123.

Reference points A,B and C are for aligning the graticule with the faceplate. Line thickness = 0.18 mm; dot diameter = 0.38 mm; colour: red.

TYPICAL OPERATION (voltages with respect to cathode)

Conditions

Final accelerator voltage	$V_{g7(l)}$	10 / 16.5 kV	
Mean deflection plate potential		2 / 2.2 kV	note 2
Shield voltage for optimum geometry	V_{g5}	2 / 2.2 kV	note 3
First accelerator and astigmatism control voltage	V_{g4}	2 / 2.2 kV	note 3
Focusing voltage	V_{g3}	0.19 x V_{g4} to 0.26 x V_{g4}	
Grid 2 voltage	V_{g2}	2 / 2.2 kV	note 9
Cut-off voltage for visual extinction of focused spot	$-V_{g1}$	45 to 90/50 to 100 V	

Outer conductive coating (m) and mu-metal shield to be earthed.

PERFORMANCE

Deflection coefficient			
horizontal	M_x	8.0/8.3 V/cm ± 10%	
vertical	M_y	4.0/4.0 V/cm ± 5%	
Deviation of deflection linearity		≤ 2%	note 4
Geometry distortion			notes 5,6
Eccentricity of undeflected spot			
in horizontal direction		≤ 4 mm	
in vertical direction		≤ 2 mm	
Angle between x- and y- traces		90 ± 0.5°	note 5
Angle between x-trace and x-axis of internal graticule		≤ 5°	note 7
Luminance reduction with respect to screen centre			
x-axis, outer graticule line		≤ 30%	
y-axis, outer graticule line		≤ 30%	
any corner		≤ 50%	
Grid drive for 10 µA screen current	V_d	approx. 20 V	
Line width	l.w.	approx. 0.33 mm	note 8

LIMITING VALUES (Absolute maximum rating system)

Final accelerator voltage	$V_{g7(l)}$	max. 18 kV	Fig. 6
Shield voltage	V_{g5}	max. 3.3 kV	
First accelerator and astigmatism control voltage	V_{g4}	max. 3.3 kV	
Focusing electrode voltage	V_{g3}	max. 2.5 kV	
Grid 2 voltage	V_{g2}	max. 2.5 kV	
Control grid voltage	$-V_{g1}$	max. 200 V min. 0 V	
Cathode to heater voltage			
positive	V_{kf}	max. 125 V	
negative	$-V_{kf}$	max. 125 V	
Heater voltage	V_f	max. 6.6 V min. 5.7 V	
Voltage between g_2 and g_4	$\triangle V_{g2,g4}$	max. 2 kV	
Voltage between $g_{4,}g_5$ and any deflection plate	$\triangle V_{g4,g5,x,y}$	max. 500 V	
Grid drive, averaged over 1 ms	V_d	max. 25 V	
Screen dissipation	Wl	max. 8 mW/cm^2	
Control grid circuit resistance	R_{g1}	max. 1 MΩ	

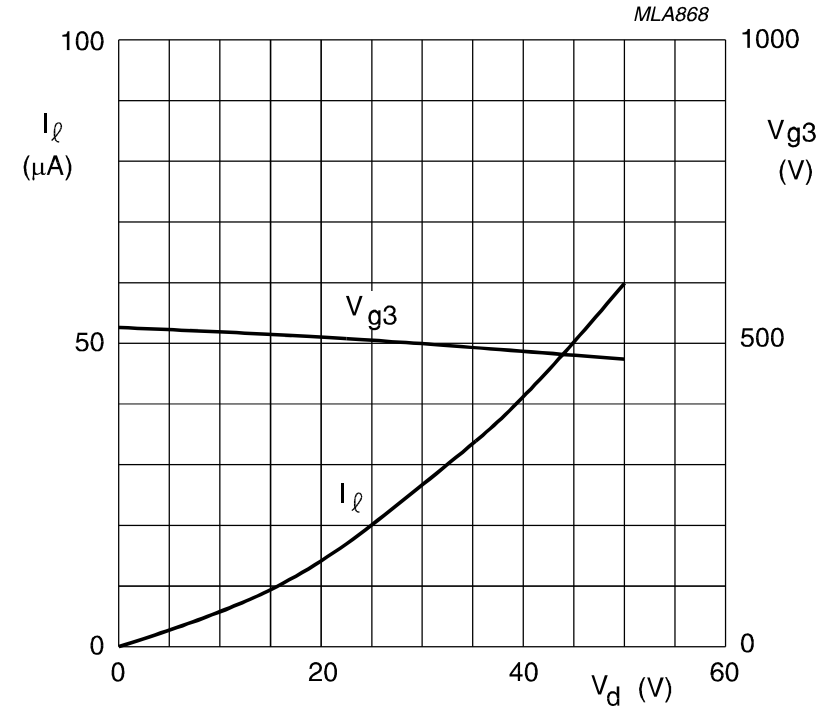


Fig.5 Screen current(I_l) and focusing voltage (V_{g3}) as a function of grid drive voltage (Vd) at V_{g7} = 16.5 kV, V_{g5} = 2.2 kV; typical curves.

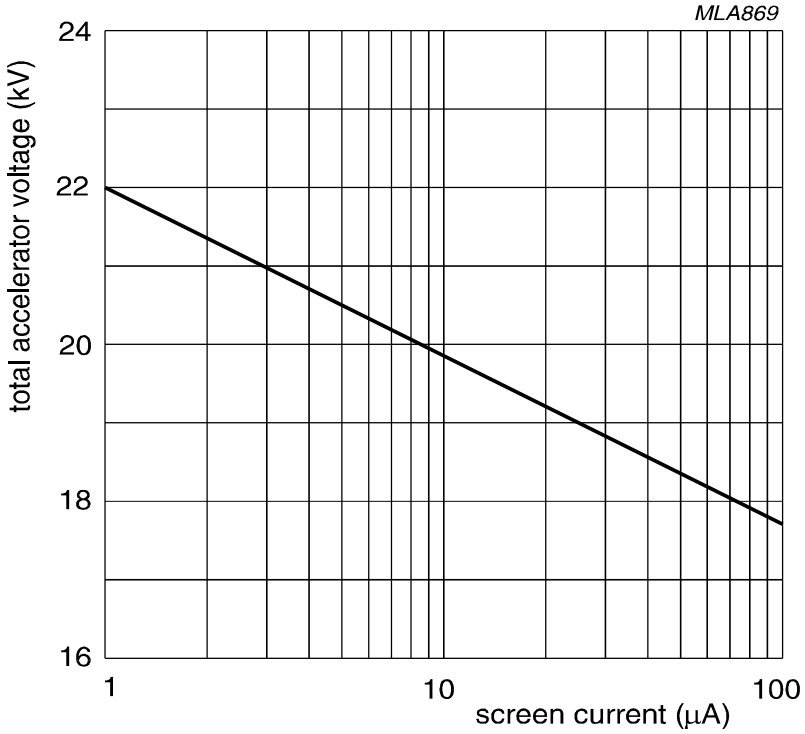


Fig. 6 0.5 mR/h isoexposure-rate limit curve.
Measured according to EIA standard RS-502 , March 1989 (formerly TEPAC 104).

NOTES

1. Because the frit seal is visible through the faceplate, and is not necessarily aligned with the internal graticule, application of an external passe-partout with an open area of max. 102 mm x 82 mm is recommended. The internal graticule is aligned with the faceplate by using the faceplate reference points (see Fig.4).
2. The deflection plates must be operated symmetrically; floating mean x- or y-potentials will result into non-uniform line width and geometry distortion. The mean x- and y-potentials should be equal; under this condition the tube will be within the specification without corrections for astigmatism and geometry (see also note 5).
3. For some applications a mean x-potential up to 50 V positive with respect to mean y-potential is inevitable. In this case V_{g5} must be made equal to mean x-potential, and a range of 0 to -25 V with respect to mean y-potential will be required on g_4 for astigmatism correction. The circuit resistance for V_{g4} should be $\leq$ 10 kΩ and $\leq$ 25 kΩ for V_{g5}.
4. The deflection sensitivity over each division will not differ from the average deflection sensitivity measured over the total useful scan by more than the indicated value, in x and y direction.
5. The tube is adjusted by internal permanent magnets for optimum geometry (orthogonality, trapezium and barrel/pin-cushion), brightness uniformity, eccentricity of undeflected spot and astigmatism.
6. A graticule consisting of concentric rectangles of 100 mm x 80 mm and 98.4 mm x 78.6 mm is aligned with the internal graticule. With optimum trace rotation correction the edges of a raster will fall between these rectangles.
7. The tube has a trace rotation coil, fixed onto the lower cone part. The coil has a maximum resistance of 260 Ω at 80 °C. The maximum required voltage is approx. 10 V for tube tolerances and earth magnetic field with reasonable shielding (± 2°).
8. Measured with the shrinking raster method in the centre of the screen under typical operating conditions, adjusted for optimum spot size at a beam current il = 10μA.
9. Grid 2 voltage (V_{g2}) may be used to adjust the cut-off voltage, otherwise it should be connected to V_{g4}. The V_{g1} range changes approximately proportional to V_{g2}.

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Specification for oscilloscope CRT

Type: 56858-1

PDS

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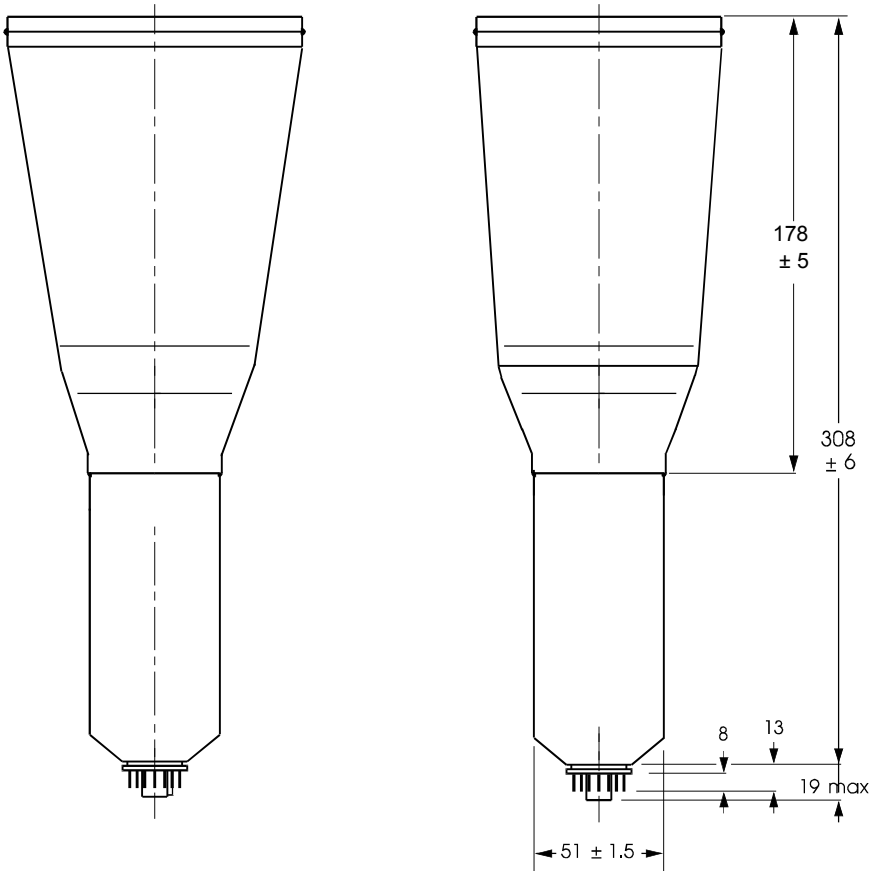
PDS
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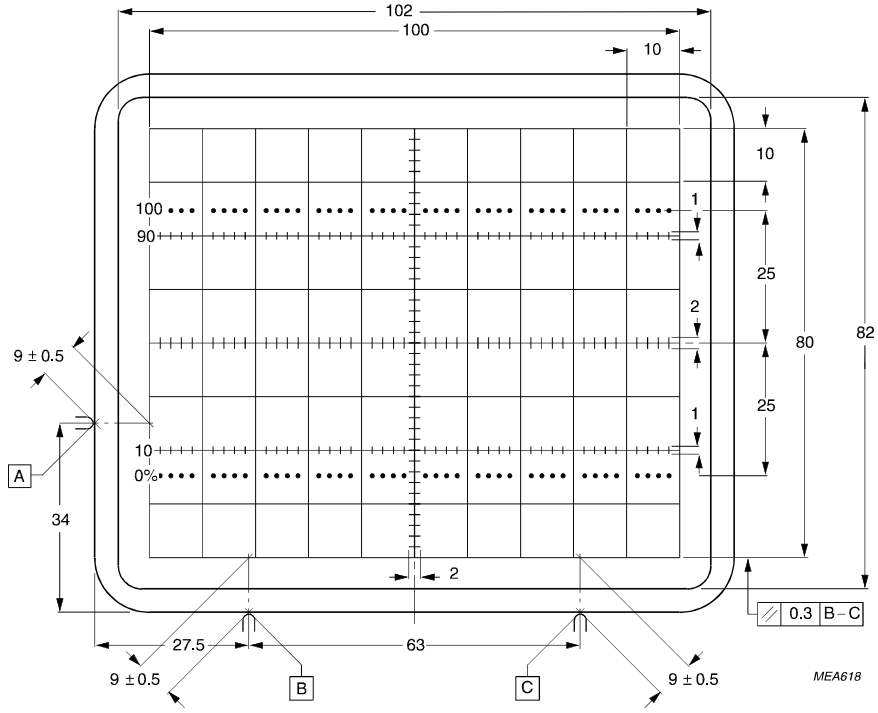
MECHANICAL DIMENSION

1. DIMENSIONAL OUTLINE & BASE CONNECTION (Unit: mm)

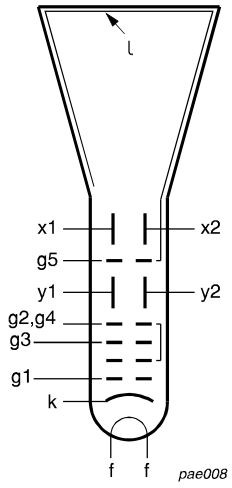


Mechanical outlines.

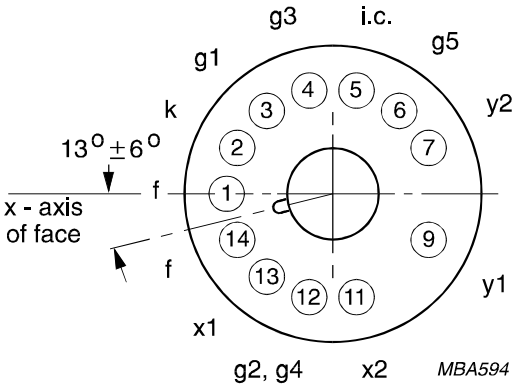
2. Internal Graticule



Graticule color: Red
Graticule line width: 0.18 ± 0.05 mm



Pin arrangement, bottom view



Electrode configuration

GENERAL DATA AND PERFORMANCE

1. GENERAL DATA SHEET

Use	Oscilloscope					
Type	Electrostatic deflection, Electrostatic focusing Mono acceleration					
Construction	Rectangular flat face, Internal graticule					
Out Line	Overall length 330 ±10mm, Neck diameter 51.0 ±1,5mm Greatest diagonal 145 ± 2mm Screen useful area 102 x 82mm²					
Bulb	6" - 51mm Ø					
light transmittance	Approx. 91 %					
Base	EIA No. B12-246					
Phosphor	P31 (EIA No. 31) /GH					
Phosphorescence	Green					
Fluorescence	Green					
Persistence	Medium short					
Symbol & Unit	Vf (V)	Vg1 (Vdc)	Vg2(Vdc)	Vg3(Vdc)	Vg4(Vdc)	Vg5(Vdc)
Absolute max. rating	6,6	0	2750	1000	2750	2750
Absolute min. rating	5,7	-200	1500	-	1500	1500
Test condition	6,3	Adjust	2000	Focus	Adjust	2000
Symbol & Unit	Vkf(Vdc	Vd (V)	Rg1(MΩ)	Zd(MΩ)	-	-
Absolute max. rating	125	30	1.5	1.5	-	-
Absolute min. rating	-125	-	-	-	-	-
Test condition	-	-	-	-	-	-

Notes:

(1) All voltages are referred to cathode except for Vf and Vd.

(2) For optimum performance, the heater voltage of devices should be regulated at 6,3 V for 100% service voltage.

(3) Standard raster size and scanning frequency for test condition are as follows:

H x V = 100 x 80mm² F = 60 Hz (hor.), 4500 Hz (vert.)

2. TEST SPECIFICATION SHEET

TEST ITEMS	SYMBOL	METHOD	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Heater current	If	-		95	105	115	mA
Heater current DC leakage	Ifk	-	Vfk= ± 125V	-	-	30	uAdc
Grid No.1 leakage	LIg1	-		-5	-	-5	uAdc
G2 leakage	Lib1	-		-15	-	15	uAdc
Stray emission	SE	1)	Vg2=Vg4-2750Vdc	-	-	-	
Cutoff voltage	-Vg1	-	Visual extinction of a focused spot	25.0	45.5	66	Vdc
Modulation voltage	ΔVg1	-		-	-	35	Vdc
Cathode current	Ik	-		-	-	150	uAdc
Focusing voltage	Vb1	-		150	175	200	Vdc
Deflection factor (X1-X2)	DFX	8)		18.0	18..5	19.0	Vdc/cm
Deflection factor (Y1-Y2)	DFY	8)		11.0	12.0	13.0	Vdc/cm
Pattern distortion	PD	2)		-	-	1.3	mm
Spot position	SP	3)		-	-	±7	mm
Spot displacement	SD	4)	Zd=10MΩ	-	-	10	mm
Angle between traces	α	5)		89.0	90.0	91.0	deg
Deflection linearity	DFU	6)		-	-	5	%
Astigmatism voltage	Vg4	7)		1900	2000	2100	Vdc
Vert. useful scan	BSPY	-		80	-	-	mm
Hor. useful scan	BSPX	-		100	-	-	mm
Screen quality	SQ	9)		-	-	-	
Internal graticule	IG	10)		-	-	-	
Gun to graticule alignment	DO	-	X1-X2: Hor. axis of graticule	-	-	5	deg

Notes: (1) Specified voltage values are referred to cathode except for ΔVg1

3. TEST SPECIFICATION SHEET (cont'd)

TEST ITEMS	SYMBOL	METHOD	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Capacitance Grid No.1 to all other electrodes	Cg1-all	-		-	6.2	-	pF
Cathode to all other electrodes	Ck-all	-		-	3.2	-	pF
X1 to al other electrodes except X2	Cx+ -all	-		-	4.5	-	pF
X2 to all other electrodes except X1	Cx- -all	-		-	4.5	-	pF
Y1 to all other electrodes except Y2	Cx- -all	-		-	3.5	-	pF
Y2 to all other electrodes except Y1	Cy+ -all	-		-	3.5	-	pF
X1 to X2	Cx-x	-		-	3.2	-	pF
Y1 to Y2	Cy-y	-		-	1.4	-	pF

4. TEST METHOD

**** Standard Test Condition ****

Unless otherwise specified, use the voltages in the general data sheet for all test conditions and evaluate after adjusting astigmatism voltage (Vg4)

The tube shall be shielded against external magnetic and electrical influences.

1) Stray Emission

Ambient light measured at tube face shall be approximately 1 lm/m²

Limits: reject tube, if stray emission is observed.

2) Pattern Distortion

Set up the specified test voltage and display a horizontal single line.

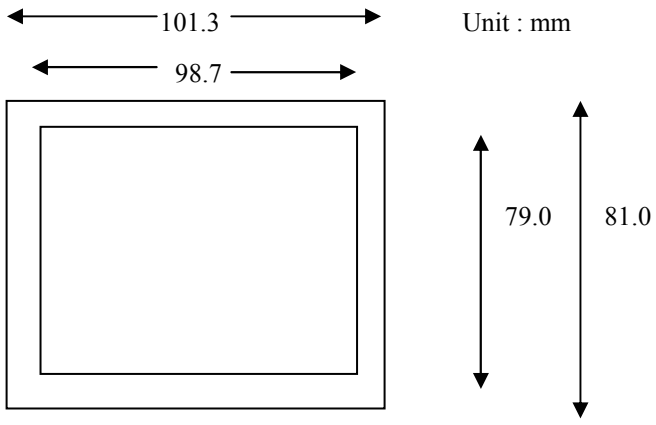
Adjust the horizontal single line to be aligned with the horizontal axis of internal graticule by controlling the rotation coil current.

A graticule (Figure 1) consisting of concentric squares of 101.3 x 81.0 mm² and 98.7 x 79.0 mm², is aligned with the internal graticule.

Evaluate the vertical or horizontal single lines fall between these squares.

Limits: the line center of the edge of the single line must fall between these squares.

Fig. 1. Pattern distorsion gauge



3. Spot Position

Connect X1, X2, Y1 and Y2 with g4 and g5
An undeflected focused spot shall be within +/- 7mm horizontally and +/- 7mm vertically from the center of the screen.

Caution: the grid No.1 voltage shall be set at a value which will avoid damage to the screen.
Limits: Maximum spot position…… 14 mm max.

4. Spot Displacement

The tube shall be operated as specified in Par. 3), insert a 10 Mohm resistor between deflection electrodes and g4 and g5
The spot displacement produced by shorting of each resistor in turn shall not exceed the specified value.

Limit: Maximum spot displacement ……10mm max.

5. Angle Between Traces

The angle between horizontal (X1-X2) and vertical (Y1-Y2) traces shall not exceed the specified value.
The angle shall be measured counter clockwise from the horizontal trace.

Limits: angel between traces ……90 +/- 1.0 deg.

6. Deflection Linearity

Under the specified test condition, display the controlled 20mm single line at the center of horizontal graticule axis. The 20mm line is then positioned in horizontal direction from the center to +/- 4 major divisions without changing the horizontal deflection gain. The line length of each point is measured then.
Same as the above procedure, the displayed 20mm single line at the center of vertical graticule axis is positioned in direction from the center to +/- 3 major divisions and measured.
The line length at each four points shall not exceed the specified value.

Limits: Maximum deflection linearity ……+/- 5% max.

Note: Deflection linearity presented by deviation percentage follows

$$\frac{\text{(Line length in mm after positioning)} - 20\text{mm}}{20\text{mm}} \times 100\%$$

7. Astigmatism voltage (Vg4)

   Under the specified test condition, the Vg4 voltage for astigmatism adjustment shall be within the limits specified.

   Limites: Maximum astigmatism voltage……2100 Vdc Max.
   Minimum astigmatism voltage..... 1900 Vdc Min.

8. Deflection Factor

   Measure the deflection plate (X1-X2) DC voltage for positioning a focused spot horizontally from -5 cm to +5 cm along the graticule axis.
   The above deflection voltage divided 10 cm is the horizontal deflection factor in Vdc/cm

   The deflection plate (Y1-Y2) DC voltage for positioning the spot vertically from –4 cm to +4 cm along the graticule axis, divided 8 cm is the vertical deflection factor in Vdc/cm.

   Limits: Horizontal defl. factor DFX …… 18.0 to 19.0 Vdc/cm
   Vertical defl. factor DFY …… 11.0 to 13.0 Vdc/cm

9. Screen and faceplate Quality
   This specification shall be applied in all screen area of 102 x 82 mm²

   1) Criteria of defects:
      Defects included blisters, bubbles, elongated blisters, stones, opaque spots, pin holes, and dirt.

      Acceptable size and number of defects are in referred criteria chart:

      Elliptical defects should be inspected by the following equivalent diameter formula.

      $$\text{Equivalent Spot Diameter} = \frac{(\text{Length} + \text{Width})}{2}$$

(2) Defects classification and size:

Table 2. Defects classification an size (mm)

Classification	Size	Acceptable No's	Min. Separation
Blisters, bubbles	0.41 to 0.60	4 max.	25
Stones, opaque spots	0.21 to 0.40		
Pinhole, dirt	0.21 to 0.40		
(See note) Elongated blisters	with: 0.20 to 0.35 Max. length: 6.0		

Note: Elongated blisters shall not be subjected to the equivalent diameter formula.

Limits: The tube with defects larger than the above table 2, should be rejected
Defects smaller than the above table 2 should not be counted.

10. Internal Graticule Quality

The graticule lines must be of uniform density. Obvious line breaks are specified in table 3.

Table 3: graticule defects

Line Breaks Size (mm)	Minimum Separation (mm)	Acceptable Numbers (pcs)	
Less then 0.20	----	no count	Total 15
0.21 to 0.45	10	14	
0.46 to 0.75	25	5	
0.76 to 1.00	----	1	
Greater than 10.1	----	0	

Note: (1) Two or more breaks within any 1.0mm segments of the graticule line must be considered as one break whose length would be equal to the length of the segment.

(2) Line breaks must be visible from 38 cm.

PRECAUTION

Heater rating

Heater voltage range should not be exceeded in worst-case conditions of the application.
Despite heater voltage range of +/- 10%, equipment should be designed so shat the heater voltage is applied at the typical RMS value. Range of +/- 10% is only for a probable variation with respect to apply voltage.
Exceeding voltage range will result in the short life or low light output, etc. of the tube.

Mounting

The mounting system of this tube should not put mechanical stress on, particularly in the splice area and mold-match line.
Equipment's mounting system should incorporate sufficient cushioning so that an impact force of more than 30 G is never applied to the tube, under normal condition of shipment or handling

Tube handling

Tubes should be kept in the shipping box or similar protective container until just prior to installation. Wear heavy protective clothing, including gloves and safety goggles with side shields, in areas handling unpacked and unprotected tubes to prevent possible injury from flying glass in the event tubes breaks. Handle tubes with extreme care.
Do not strike, scratch, or subject tubes to more than moderate pressure.
Particular care should be taken to prevent damage to the seal and splice area.

Other

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DATA SHEET

A41EAM40..

17" triple gun
monochrome tube assembly

Product specification

2003 May 10

Professional Display Systems B.V.

B/W picture tube assemblies

A41EAM40WB

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1 HIGHLIGHTS

1.1 Features

- 'Flatter' and 'squarer' screen
- In-line, hi-bi potential ART (Aberration Reducing Triode) gun
- Hi-Bri technology
- Internal multipole
- Cd-free phosphor
- Reinforced envelope for push-through mounting
- Self-converging and raster correction-free assembly.
- Screen finish optional
- Quick-heating low-power cathodes
- Soft-flash

1.2 Quick reference data

PARAMETER	TYP.	UNIT
Deflection angle	90	deg
Nominal useful screen diagonal	41	cm
Overall length	37	cm
Glass transmission	42	%
Neck diameter	22.9	mm
Heater voltage	6.15	V
Heater current	315	mA
Anode voltage	23	kV
Focus voltage	31% of anode voltage	
Tube type A41EAM40WB01		
Horizontal frequency	16	kHz
Vertical frequency	50	Hz
Horizontal inductance	2.43	mH
Vertical resistance	12.20	Ω
Tube type A41EAM40WB14		
Horizontal frequency	16	kHz
Vertical frequency	50	Hz
Horizontal inductance	2.21	mH
Vertical resistance	17.60	Ω
Tube type A41EAM40WB20		
Horizontal frequency	16	kHz
Vertical frequency	50	Hz
Horizontal inductance	1.99	mH
Vertical resistance	17.60	Ω

2 PRODUCT CHARACTERISTICS

2.1 Optical data

PARAMETER	VALUE
Matrix	N.A.
Screen	
Screen finish	Optional AGAS
Nominal useful screen dimensions	
diagonal	410.7 mm
horizontal axis	330.0 mm
vertical axis	250.1 mm
area	≈820 cm^2
Phosphor (Cd-free)	
White P45 (WB)	Yttrium Oxysulfide
White P54 (WA)	Red, Green, Blue
Persistence	medium short
Centre-to-centre distance of identical colour phosphor stripes at centre of screen	N.A.
Light transmission of face glass at centre of screen	42%
Luminance at centre of screen; note 1	350 cd/m^2

Note

1. Tube settings adjusted to produce defocused raster, current density 0.4 $\mu A/cm^2$.

2.1.1 COLOUR COORDINATES

COLOUR	x	y
P45	0.245	0.320
P54	0.324	0.376

2.2 Electro-optical data

PARAMETER	VALUE
Electron gun system	unitized triple-aperture electrodes; Aberration Reducing Triode (ART)
Focus method	electrostatic
Focus lens	hi-bi potential
Deflection method	magnetic
Deflection angles	
diagonal	90°
vertical	78°
horizontal	60°

2.3 Limiting values

In accordance with the Absolute Maximum Rating System (IEC 60134). Voltages are specified with respect to grid 1.

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_a	anode voltage		–	27.5[(1)]	kV
I_a	long-term average anode current for three guns		–	750	μA
	short-term average anode current for three guns		–	1000	μA
V_{foc}	focus voltage	note 2	–	11	kV
V_{g2}	grid 2 voltage	operating	–	1000	V
		during adjustment on the production line	–	1500	V
V_f	heater voltage	note 3	5.7	6.6	V
Cathode voltage					
V_k	positive	operating	–	250	V
		during blanking	–	400	V
V_k	positive operating cut-off		–	200	V
V_k	negative		–	0	V
V_{kp}	negative peak		–	−2	V
Cathode to heater voltage					
V_{kf}	positive		–	250	V
V_{kfp}	positive peak		–	300	V
V_{kf}	negative		–	0	V
V_{kfp}	negative peak		–	−50	V
Circuit limiting values					
R_{gfoc}	focus grid circuit resistance		–	70	MΩ
R_{g2}	grid 2 circuit resistance		–	7	MΩ
R_{g1-k}	grid 1 to cathode circuit resistance (each gun)		–	750	kΩ

Notes

1. 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 the picture tube.
2. During flashover maximum 20 kV is allowed (see “Flashover protection”).
3. For maximum cathode life and optimum performance it is recommended that the heater supply is designed for 6.15 V at average beam current, for most applications this equals 6.3 V at zero beam current.

2.4 Electrical data

SYMBOL	PARAMETER	MIN.	TYP.	UNIT
Capacitances				
$C_{a(m+m')}$	anode to external conductive coating, including rimband	1000	–	pF
C_{kR}, C_{kG}, C_{kB}	cathode of any gun to all other electrodes	–	4	pF
C_{g1}	grid 1 to all other electrodes	–	15	pF
C_{gfoc}	focus grid electrode to all other electrodes	–	4	pF
Heater				
V_f	heater voltage	–	6.15	V
I_f	heater current	–	315	mA
Resistance				
R_{rim}	between rimband and external conductive coating	50	–	MΩ

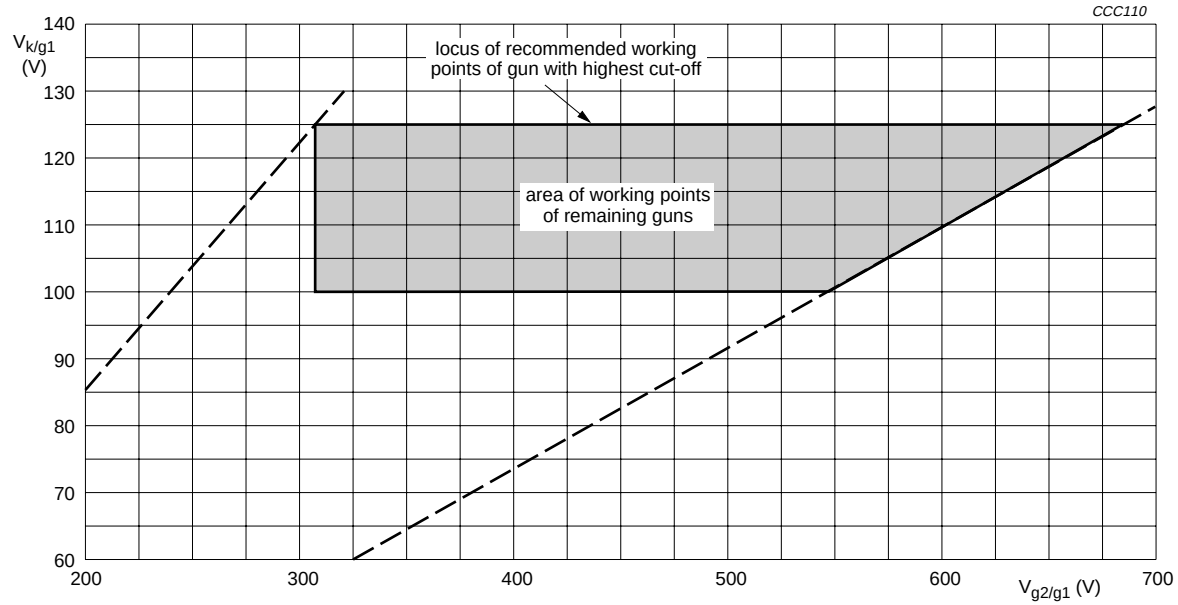
2.5 Chassis design values

The values are valid for anode voltages between 20 and 27.5 kV. Voltages are specified with respect to grid 1.
For optimum picture performance it is recommended that the cathodes are not driven below +1 V.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
V_a	anode voltage	full screen load	20(1)	–	27.5	kV
V_{foc}	focus voltage	as a percentage of anode voltage	29	–	33	%
V_{g2}	grid 2 voltage	for visual extinction of focused spot	see Fig.1			
V_k	cathode voltage					
ΔV_k	difference in cut-off voltage between guns in any tube		lowest value >80% of highest value			
	video drive characteristics		see Fig.2			
V_f	heater voltage	tube operating	–	6.15	–	V
I_{foc}	focus current		−2	–	+2	μA
I_{g2}	grid 2 current		−2	–	+2	μA
I_{g1}	grid 1 current	under cut-off conditions	−2	–	+2	μA
R_{ins}	insulation resistance	each cathode to grid 1 and heater	50	–	–	MΩ
PERCENTAGE OF THE TOTAL ANODE CURRENT SUPPLIED BY EACH GUN						
	red gun		–	100	–	%
	green gun		–	100	–	%
	blue gun		–	100	–	%

Note

1. Operation of the tube at lower voltages impairs the luminance and resolution and could impair convergence.



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.

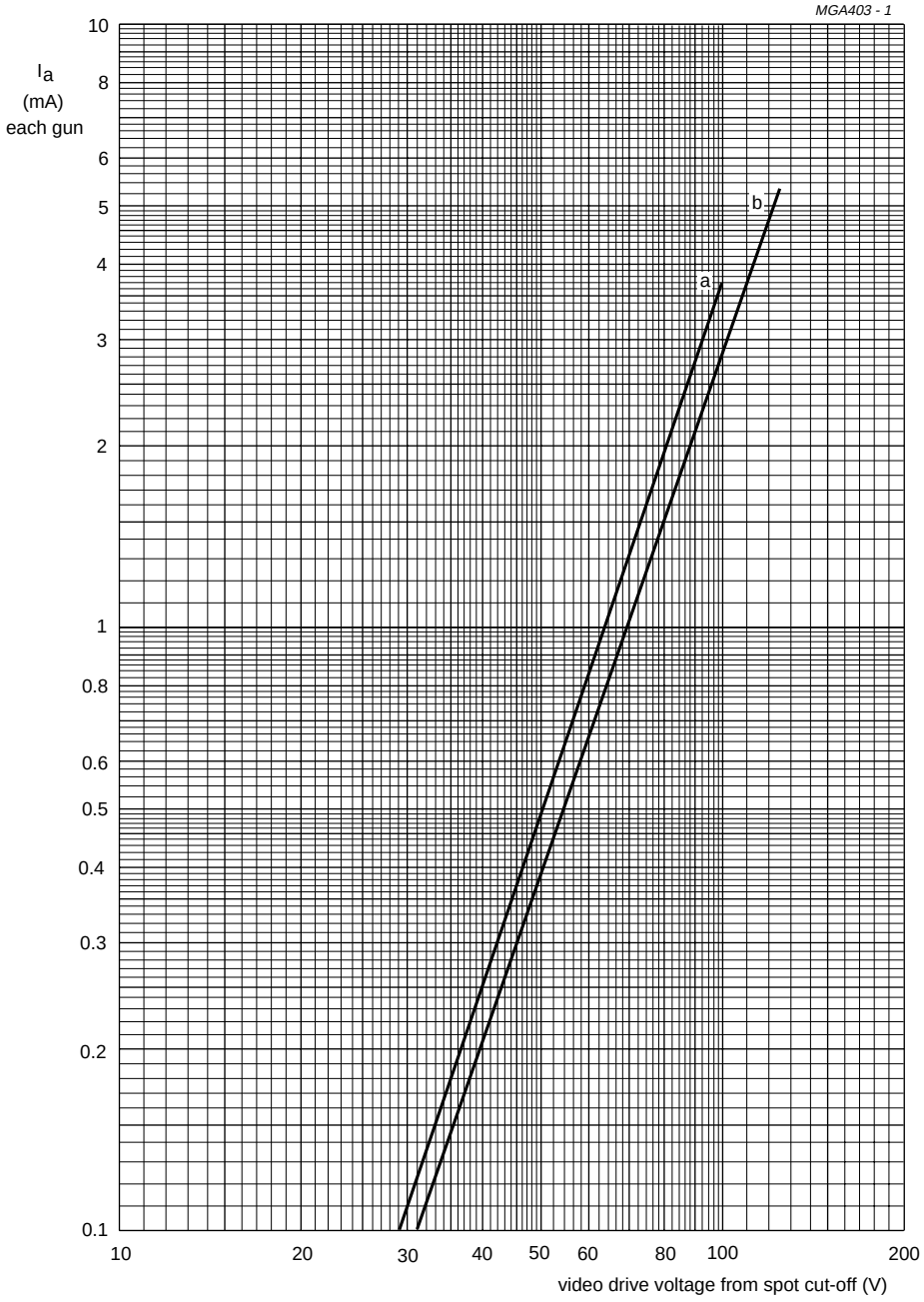
V_{g2} range: 310 to 685 V.

V_k range: 100 to 125 V.

Adjustment procedure:

Set cathode voltage (V_k) for each gun at 125 V; increase the grid 2 voltage (V_{g2}) from approximately 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 become visible.

Fig.1 Spot cut-off design chart.



V_f = 6.15 V.

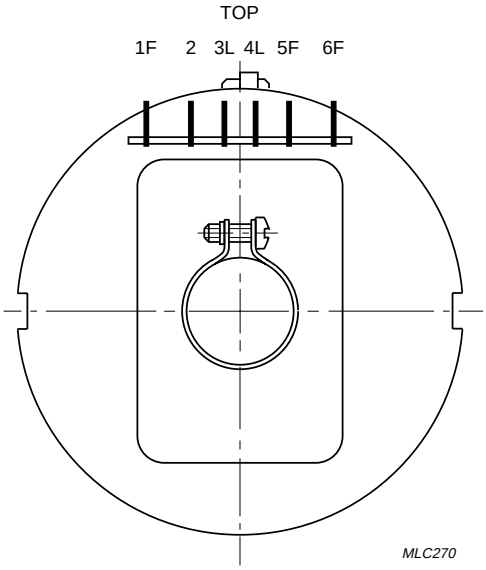
V_a = 23 kV.

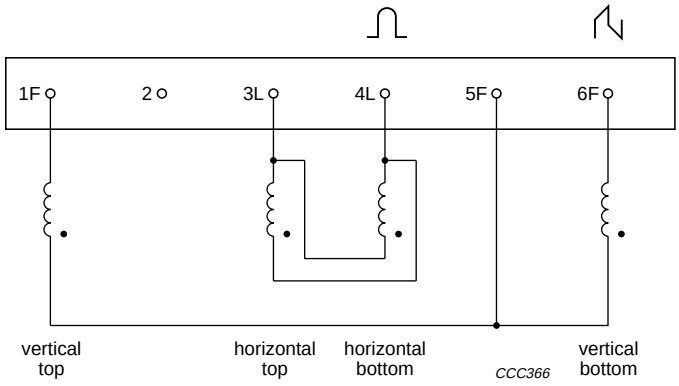
V_{foc} adjusted for focus.

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

Fig.2 Typical cathode drive characteristics.

2.6 Deflection unit data





The beginning of the windings is indicated with •

Fig.3 Electrical diagram: deflection coil assemblies A41EAM40WB01, A41EAM40WB14 and A41EAM40WB20.

2.6.1 TUBE TYPE A41EAM40WB01

PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Horizontal deflection coil					
Frequency		–	16	–	kHz
Inductance	1 V (RMS); 1 kHz	2.33	2.43	2.53	mH
Resistance	T_{amb} = 25 °C	2.89	3.21	3.53	Ω
Magnetic flux	V_a = 23 kV	4.96	5.09	5.22	mWb
Deflection current (peak-to-peak value)	edge-to-edge; V_a = 23 kV	–	2.10	–	A
Average copper temperature	measured by the resistance method	–	–	90	°C
Temperature rise (ΔT)	V_a = 23 kV; I_a = short-term average value	–	25	–	°C
Vertical deflection coil					
Frequency		–	50	–	Hz
Inductance	1 V (RMS); 1 kHz	23.58	26.20	28.82	mH
Resistance	T_{amb} = 25 °C	11.35	12.20	13.05	Ω
Deflection current (peak-to-peak value)	edge-to-edge; V_a = 23 kV	–	0.82	–	A
Average copper temperature	measured by the resistance method	–	–	90	°C
Temperature rise (ΔT)	V_a = 23 kV; I_a = short-term average value	–	25	–	°C
Deflection unit					
Insulation resistance	1 kV (DC)				
between horizontal and vertical coils		500	–	–	MΩ
between horizontal coil and yoke ring		500	–	–	MΩ
between vertical coil and yoke ring		10	–	–	MΩ
Crosstalk from horizontal to vertical coils	10 V; 500 Hz across the horizontal coils	–	–	0.2	V

2.6.2 TUBE TYPE A41EAM40WB14

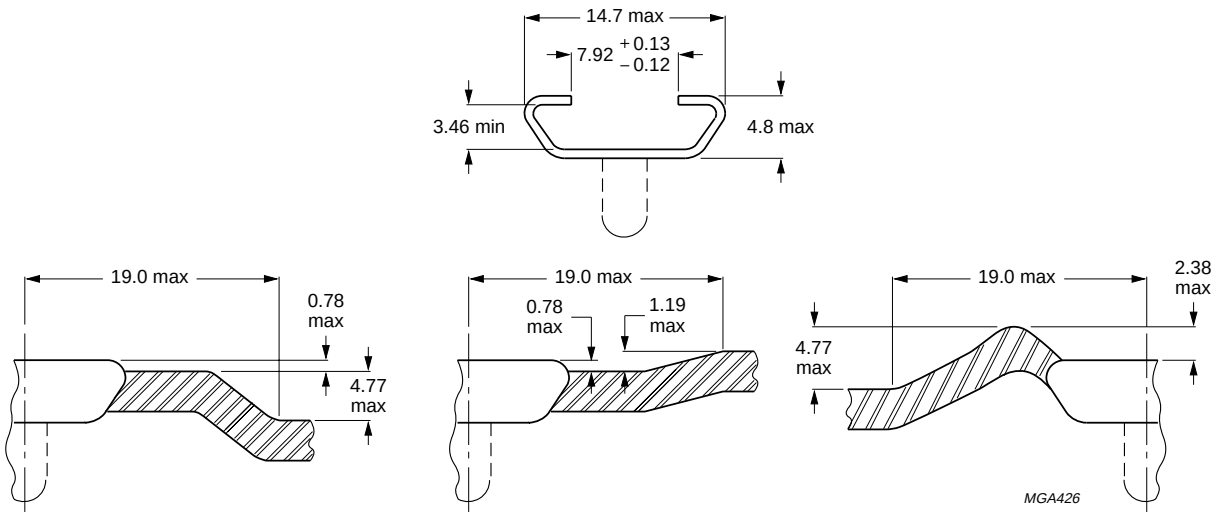
PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Horizontal deflection coil					
Frequency		–	16	–	kHz
Inductance	1 V (RMS); 1 kHz	2.12	2.21	2.30	mH
Resistance	T_{amb} = 25 °C	2.69	2.99	3.29	Ω
Magnetic flux	V_a = 23 kV	4.76	4.88	5.00	mWb
Deflection current (peak-to-peak value)	edge-to-edge; V_a = 23 kV	–	2.21	–	A
Average copper temperature	measured by the resistance method	–	–	90	°C
Temperature rise (ΔT)	V_a = 23 kV; I_a = short-term average value	–	25	–	°C
Vertical deflection coil					
Frequency		–	50	–	Hz
Inductance	1 V (RMS); 1 kHz	30.33	33.70	37.10	mH
Resistance	T_{amb} = 25 °C	16.37	17.60	18.83	Ω
Deflection current (peak-to-peak value)	edge-to-edge; V_a = 23 kV	–	0.73	–	A
Average copper temperature	measured by the resistance method	–	–	90	°C
Temperature rise (ΔT)	V_a = 23 kV; I_a = short-term average value	–	25	–	°C
Deflection unit					
Insulation resistance	1 kV (DC)				
between horizontal and vertical coils		500	–	–	MΩ
between horizontal coil and yoke ring		500	–	–	MΩ
between vertical coil and yoke ring		10	–	–	MΩ
Crosstalk from horizontal to vertical coils	10 V; 500 Hz across the horizontal coils	–	–	0.2	V

2.6.3 TUBE TYPE A41EAM40WB20

PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Horizontal deflection coil					
Frequency		–	16	–	kHz
Inductance	1 V (RMS); 1 kHz	1.91	1.99	2.07	mH
Resistance	T_{amb} = 25 °C	2.44	2.71	2.98	Ω
Magnetic flux	V_a = 23 kV	4.65	4.77	4.89	mWb
Deflection current (peak-to-peak value)	edge-to-edge; V_a = 23 kV	–	2.40	–	A
Average copper temperature	measured by the resistance method	–	–	90	°C
Temperature rise (ΔT)	V_a = 23 kV; I_a = short-term average value	–	25	–	°C
Vertical deflection coil					
Frequency		–	50	–	Hz
Inductance	1 V (RMS); 1 kHz	30.33	33.70	37.10	mH
Resistance	T_{amb} = 25 °C	16.37	17.60	18.83	Ω
Deflection current (peak-to-peak value)	edge-to-edge; V_a = 23 kV	–	0.73	–	A
Average copper temperature	measured by the resistance method	–	–	90	°C
Temperature rise (ΔT)	V_a = 23 kV; I_a = short-term average value	–	25	–	°C
Deflection unit					
Insulation resistance	1 kV (DC)				
between horizontal and vertical coils		500	–	–	MΩ
between horizontal coil and yoke ring		500	–	–	MΩ
between vertical coil and yoke ring		10	–	–	MΩ
Crosstalk from horizontal to vertical coils	10 V; 500 Hz across the horizontal coils	–	–	0.2	V

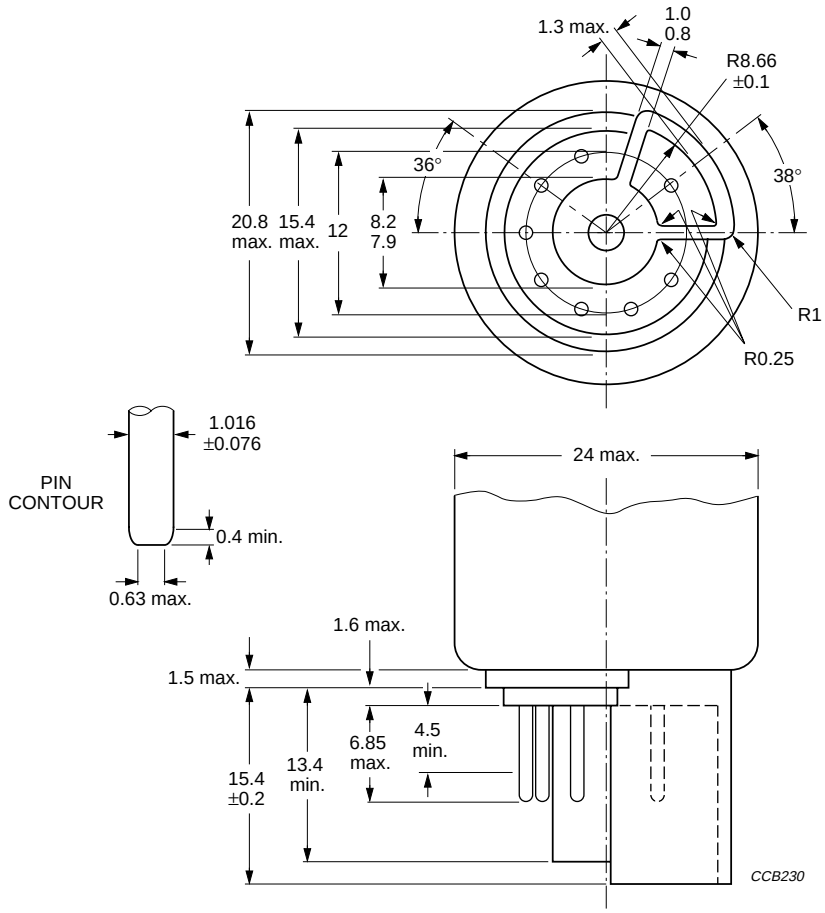
2.7 Mechanical data

PARAMETER	VALUE
Base	JEDEC B8-294
Anode contact	small cavity contact; JEDEC J1-21; IEC 60067-III-2
Mounting position	anode contact on top
Implosion protection	push-through rimband
Mass including deflection unit	≈10 kg



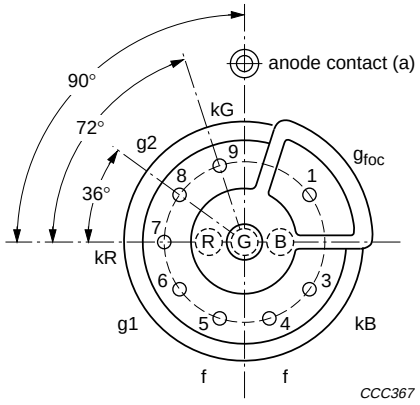
Dimensions in mm according to the JEDEC registration.

Fig.4 Cavity cap JEDEC J1-21, IEC 60067-III-2.



Dimensions in mm according to the JEDEC registration.

Fig.5 Base JEDEC B8-294.



i.c. = internally connected and not to be used.

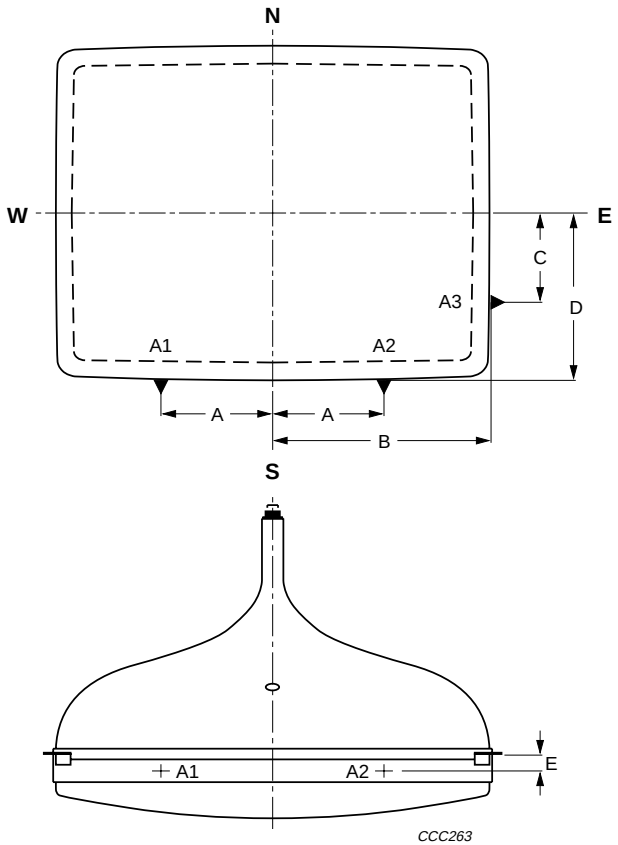
Fig.6 Pin arrangement.

Remarks: to Figs 5 and 6.

The socket for this base should not be rigidly mounted, it should have flexible leads and be allowed to move freely. After mounting the tube in the cabinet, note that the position of the base can fall within a circle having a diameter of max. 40 mm concentric with an imaginary tube axis.

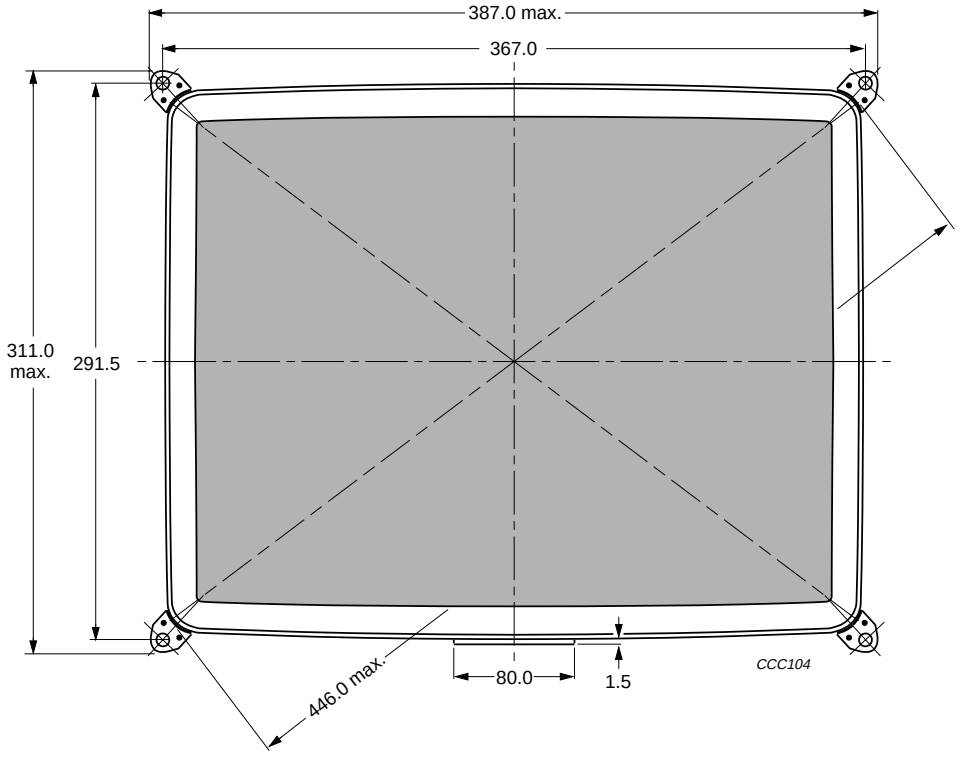
The mass of the mounting socket circuitry should not exceed 150 g.

Maximum permissible torque on the tube neck is 0.04 Nm.



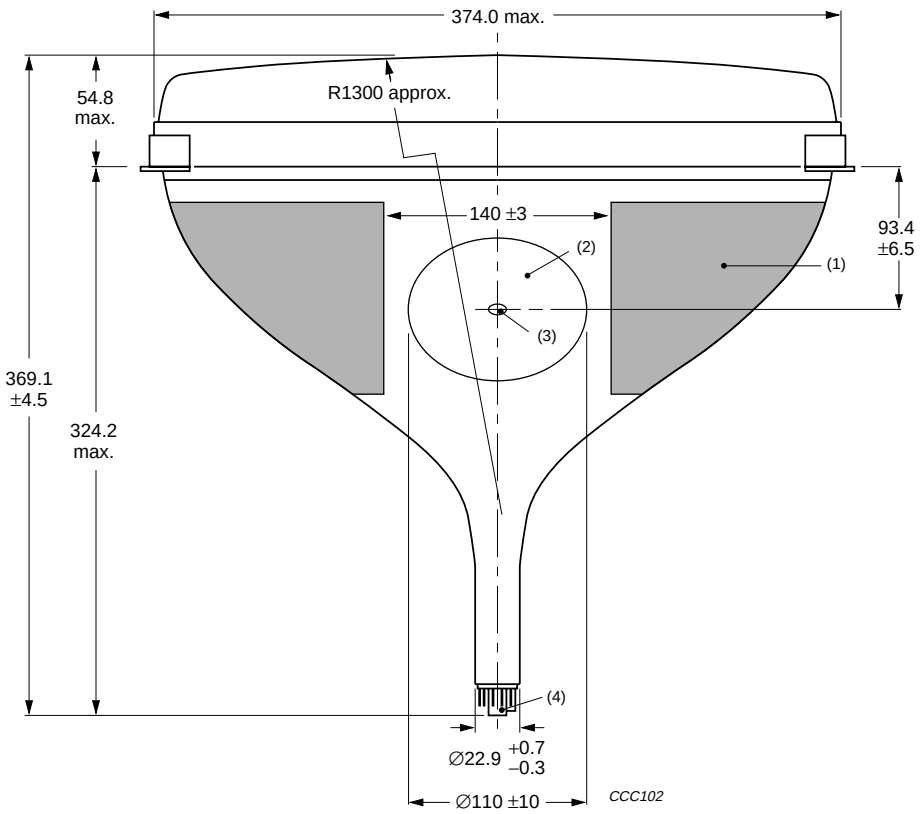
A = 139.40 mm.
B = 181.94 mm.
C = 100.0 mm.
D = 142.24 mm.
E = 29.20 mm.

Fig.7 Mechanical reference points.



Dimensions in mm.

Fig.8 Tube dimensions; front view.



Dimensions in mm.

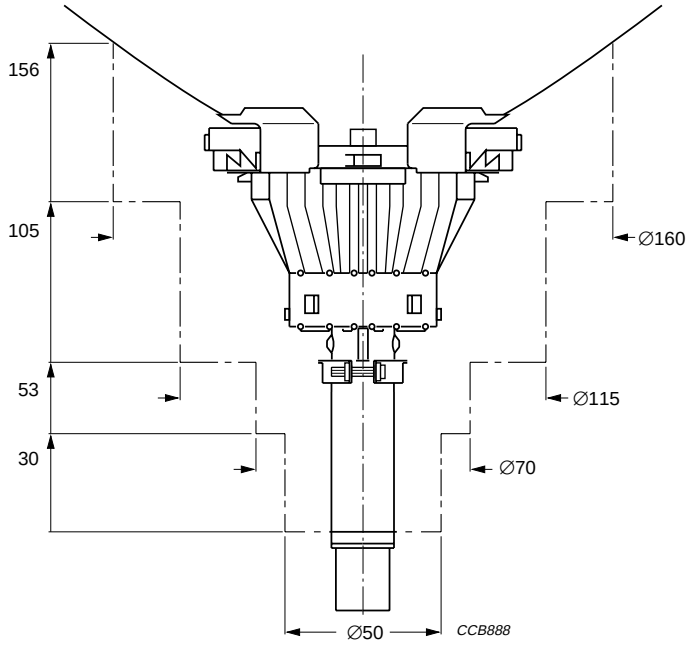
(1) The configuration of the outer conductive coating may differ, but will contain the contact area as shown.

(2) To clean this area, wipe only with a soft lint-free cloth.

(3) Small cavity contact JEDEC J1-21; IEC 60067-III-2.

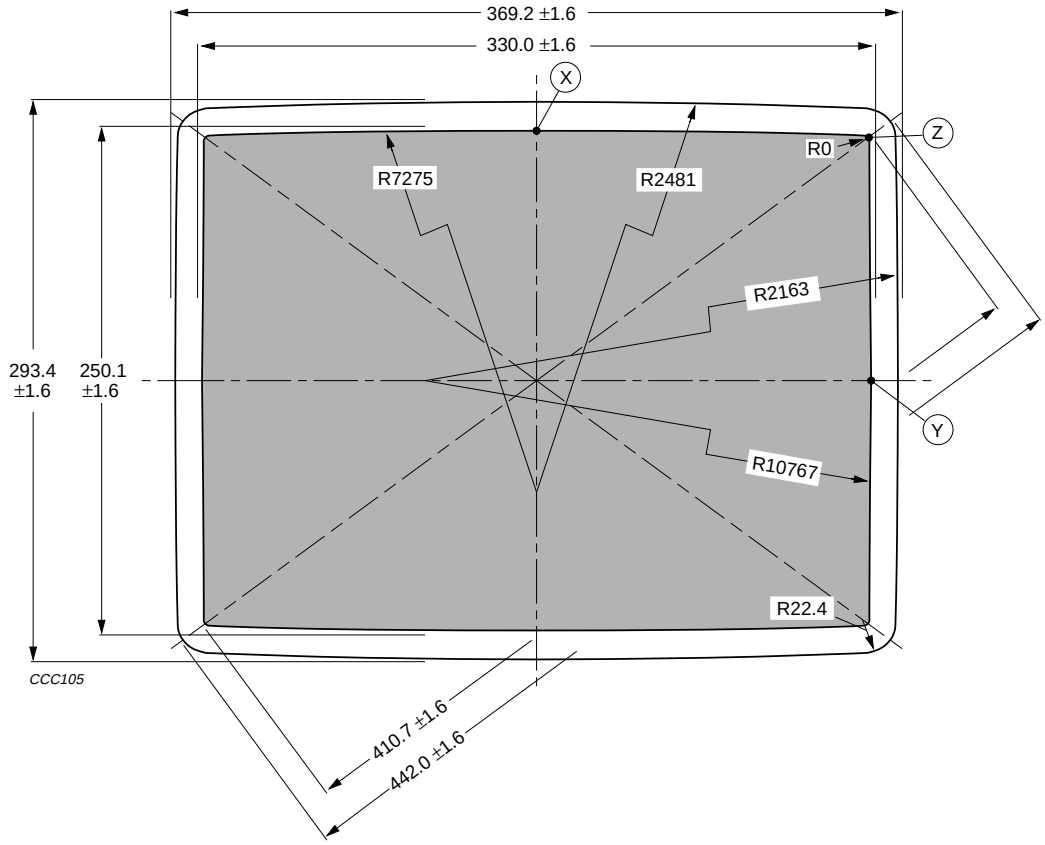
(4) The socket for this base should not be rigidly mounted, it should have flexible leads and be allowed to move freely. After mounting the tube in the cabinet, note that the position of the base can fall within a circle having a diameter of max. 30 mm concentric with an imaginary tube axis.

Fig.9 Tube dimensions; top view.



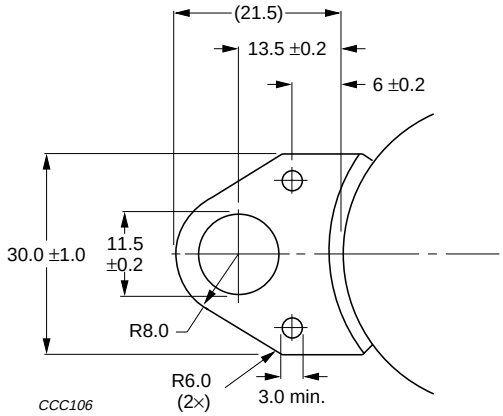
Dimensions in mm.

Fig.10 Yoke clearance.



Dimensions in mm.

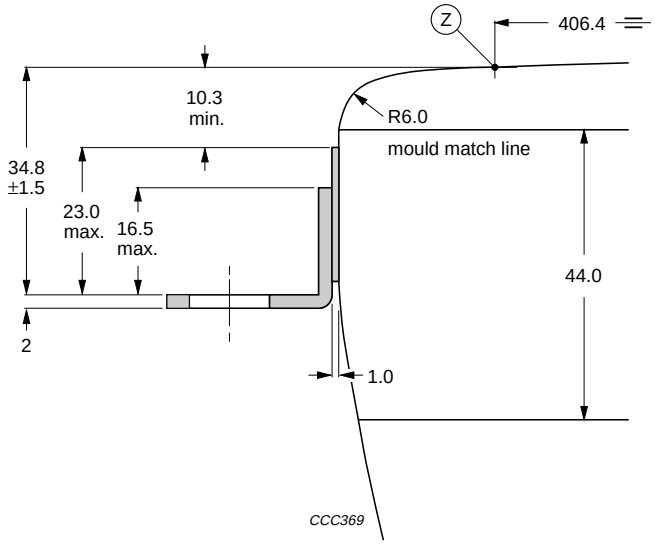
Fig.11 Phosphor dimensions.



Dimensions in mm.

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 367.0 mm × 291.5 mm.

Fig.12 Lug dimensions.

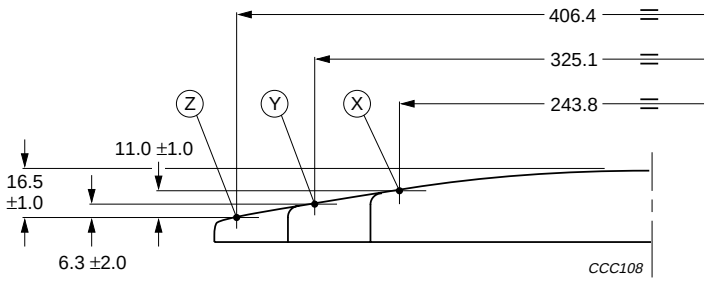


Dimensions in mm.

The maximum displacement of any lug with respect to the plane through the other 3 lugs is maximum 1.5 mm. The 1.5 mm tolerance is incorporated in this deviation.

Fig.13 Lug position.

2.7.1 BEZEL CONTOUR



Dimensions in mm.

The X, Y and Z reference points are located on the outside surface of the faceplate at the intersection of the minor, major and diagonal screen axis respectively.

The distance Z from any point on the screen to the centre can be calculated using the following formula:

$R_1 = 1370$

$R_2 = 1100$

$X_A = 90.01$

$X_B = 17.74$

$$X_X = \sqrt{X^2 + Y^2}$$

$$X_B = X_A - \frac{R_2}{R_1} \times X_A$$

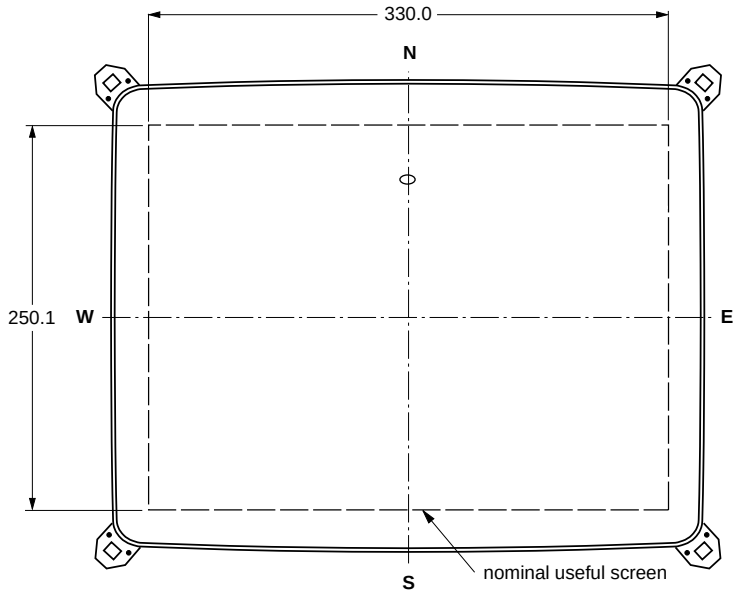
$$Z_A = R_1 - \sqrt{{R_1}^2 - {X_A}^2}$$

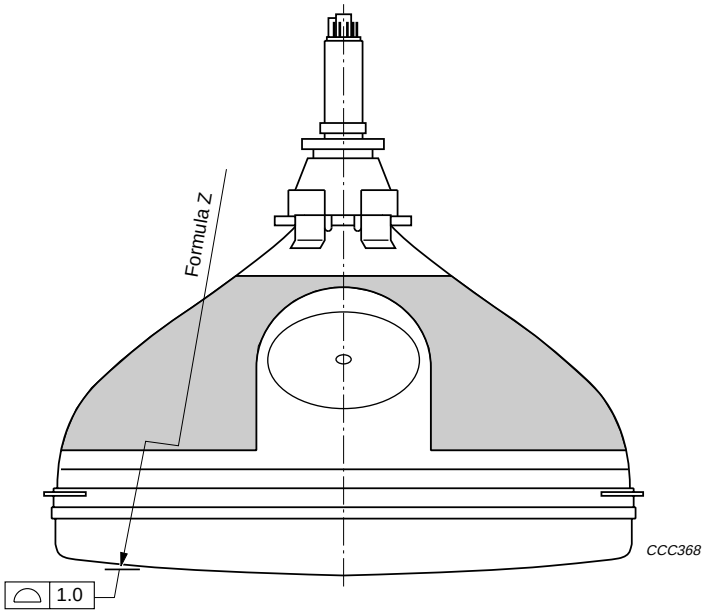
$$Z_B = R_1 - R_2 - Z_C$$

$$Z_C = (R_1 - Z_A) \times \frac{X_B}{X_A}$$

if $X_X < X_A$ then $Z = R_1 - \sqrt{{R_1}^2 - {X_X}^2}$ else $Z = Z_B + R_2 - \sqrt{{R_2}^2 - (X_X - X_B)^2}$

Fig.14 Screen reference points.





Dimensions in mm.

Fig.15 Bezel contour details.

2.7.2 BEZEL CONTOUR DATA

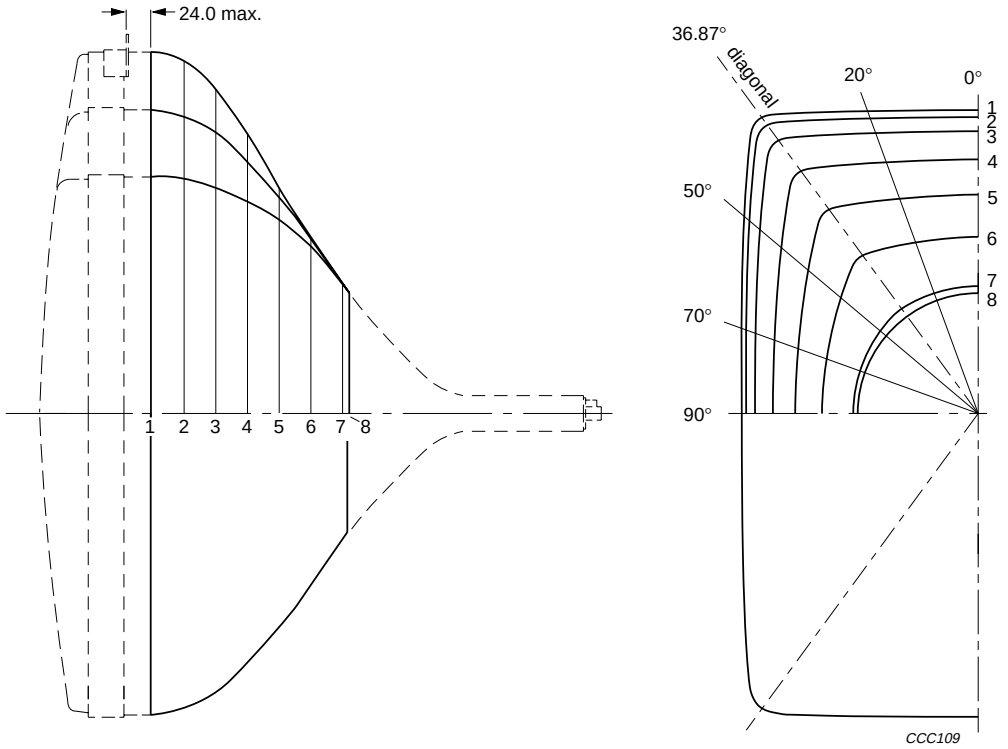
Sagittal heights of the useful screen measured with respect to the end of the diagonal axis.

NOMINAL USEFUL SCREEN (NUS)			3 mm INSIDE NUS			5 mm OUTSIDE NUS		
COORDINATES		SAGITTAL HEIGHT	COORDINATES		SAGITTAL HEIGHT	COORDINATES		SAGITTAL HEIGHT
X (mm)	Y (mm)	(mm)	X (mm)	Y (mm)	(mm)	X (mm)	Y (mm)	(mm)
0.0[1]	125.1	10.9	0.0	122.1	10.5	0.0	130.1	11.6
10.0	125.1	10.8	10.0	122.1	10.4	10.0	130.1	11.5
20.0	125.0	10.7	20.0	122.0	10.3	20.0	130.0	11.4
30.0	125.0	10.5	30.0	122.0	10.1	30.0	130.0	11.2
40.0	125.0	10.3	40.0	122.0	9.8	40.0	130.0	11.0
50.0	124.9	9.9	50.0	121.9	9.5	50.0	129.9	10.6
60.0	124.8	9.5	60.0	121.9	9.1	60.0	128.8	10.2
70.0	124.7	9.0	70.0	121.7	8.5	70.0	129.7	9.7
80.0	124.6	8.4	80.0	121.6	8.0	80.0	129.6	9.1
90.0	124.5	7.7	90.0	121.5	7.3	90.0	129.5	8.4
100.0	124.4	6.9	100.0	121.4	6.5	100.0	129.4	7.6
110.0	124.2	6.1	110.0	121.2	5.7	110.0	129.2	6.8
120.0	124.1	5.2	120.0	121.1	4.8	120.0	129.1	5.9
130.0	123.9	4.1	130.0	120.9	3.7	130.0	128.9	4.8
140.0	123.7	3.0	140.0	120.7	2.6	140.0	128.7	3.7
150.0	123.5	1.9	150.0	120.5	1.5	150.0	128.5	2.5
160.0	123.3	0.6	160.0	120.3	0.2	160.0	128.3	1.3
164.3[2]	123.2	0.0	161.3	120.3	0.0	169.2	128.1	0.0
164.3	120.0	0.3	–	–	–	169.3	120.0	0.8
164.4	110.0	1.2	161.4	110.0	1.0	169.4	110.0	1.8
164.5	100.0	2.1	161.5	100.0	1.8	169.5	100.0	2.7
164.6	90.0	2.9	161.6	90.0	2.6	169.6	90.0	3.4
164.7	80.0	3.6	161.7	80.0	3.3	169.7	80.0	4.1
164.8	70.0	4.2	161.8	70.0	3.9	169.8	70.0	4.8
164.8	60.0	4.8	161.8	60.0	4.5	169.8	60.0	5.3
164.9	50.0	5.2	161.9	50.0	4.9	169.9	50.0	5.7
164.9	40.0	5.6	161.9	40.0	5.3	169.9	40.0	6.1
164.9	30.0	5.9	161.9	30.0	5.5	169.9	30.0	6.4
165.0	20.0	6.1	162.0	20.0	5.8	170.0	20.0	6.6
165.0	10.0	6.2	162.0	10.0	5.9	170.0	10.0	6.7
165.0[3]	0.0	6.2	162.0	0.0	5.9	170.0	0.0	6.7

Notes

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

2.7.3 CONE CONTOUR



Dimensions in mm.

Fig.16 Maximum cone contour.

2.7.4 CONE CONTOUR DATA

SECTION	NOMINAL DISTANCE FROM SECTION 1 (mm)	MAXIMUM DISTANCE FROM TUBE AXIS (mm)										
		0°	10°	20°	30°	36.87°	40°	50°	60°	70°	80°	90°
1	0.0	184.3	186.9	195.1	210.0	221.0	217.9	187.3	167.2	154.9	148.2	146.1
2	20.0	179.8	182.1	189.2	201.1	209.6	207.2	181.5	162.5	150.6	144.1	142.1
3	40.0	169.9	171.6	176.4	183.5	186.6	185.2	169.0	153.5	143.2	137.4	135.5
4	60.0	154.8	155.8	158.5	161.7	162.0	160.9	152.4	142.1	134.3	129.6	128.1
5	80.0	134.1	134.7	136.1	137.1	136.6	135.9	132.2	127.2	122.6	119.5	118.4
6	100.0	109.9	110.2	110.6	110.6	110.3	110.0	108.6	106.9	105.1	103.7	103.2
7	120.0	82.4	82.5	82.7	82.7	82.6	82.6	82.3	81.9	81.5	81.1	80.9
8	124.8	75.4	75.4	75.4	75.5	75.5	75.4	75.4	75.3	75.3	75.2	75.2

3 APPLICATION CONDITIONS

3.1 Flashover protection

With the high voltage used with this tube (max. 27.5 kV) internal flashovers may occur. As a result of Soft-flash technology these flashover currents are limited to approximately 60 A offering higher 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 in accordance with Fig.17; 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 focus electrode (g_{foc}) of 12 kV ($1.5 \times V_{gfoc}$ max. at V_a = 25 kV), and 2 kV at the other electrodes, at an atmospheric pressure of 100 kPa.

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.

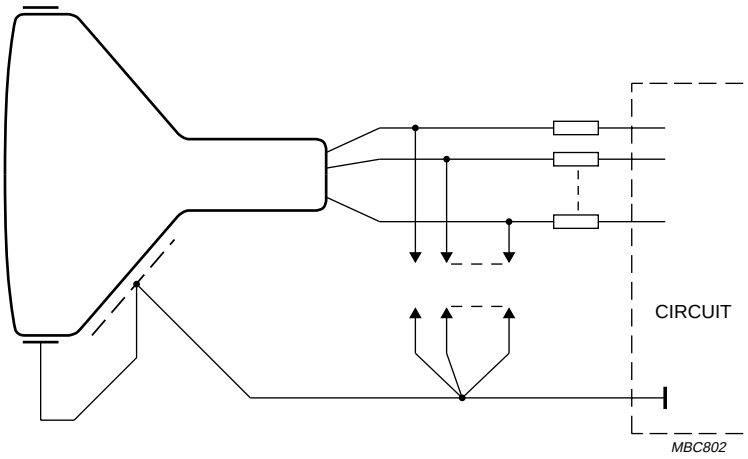


Fig.17 Flashover protection circuit.

4 PERFORMANCE SPECIFICATION

4.1 Test conditions

All voltages are measured with respect to grid 1 (V_{g1} = 0 V) and apply to all tests unless otherwise stated.
The tube must be preheated (V_f = 6.15 V) for a minimum of 30 minutes before measurement unless otherwise stated.

SYMBOL	PARAMETER	VALUE
COL	colour	white (x = 0.245, y = 0.320)
V_f	heater voltage	6.15 V
V_k	cathode voltage	100 to 125 V
V_{g2}	grid 2 voltage	310 to 685 V; nom. = 500 V
V_{gfoc}	focus grid voltage	to be adjusted for focus in east and west, using a crosshatch pattern, when beam current (black background) is adjusted to 5 mA (p-p) for white
V_a	anode voltage	23 kV
T_{amb}	ambient temperature	25 ±5 °C
	magnetic field	local field, facing east
	test pattern	crosshatch; 350 μA (p-p) for each gun

4.2 Electrical tests

TEST	CONDITIONS	REQUIREMENTS
Heater current		270 to 350 mA
Inter-electrode insulation: $-g_1g_2/+kfg_{foc}$ $-g_1g_{foc}/+kfg_2$	insulation test voltage = 450 V; R_{series} = 10 MΩ; leakage current measured on each gun separately	 ≤10 μA ≤10 μA
Cathode to heater insulation	insulation test voltage = −150 to +250 V; R_{series} = 3.3 MΩ; each gun measured separately	≥50 MΩ
Grid 2 leakage current	V_k = 200 V	−4 to +4 μA
Focus grid leakage current	V_k = 200 V	−4 to +4 μA
Stray emission	measured on line; V_k = 200 V; ambient light level at tube face ≈1 lux	no annoying stray emission
Flashover	V_k adjusted for $I_a = 3 \times 10$ μA; flashovers occurring during setting-up should be ignored	not more than 1 flashover within 1 minute or not more than 2 flashovers within 15 minutes after setting-up; if more than 2 flashovers occur, test is extended for 15 minutes during which 2 flashovers are permitted
Voltage breakdown	V_k = 400 V; V_{g2} = 1200 V; V_{gfoc} = 7.8 kV; V_a = 25 kV	no continuous external arcing
Focus voltage (V_{gfoc})		6.7 to 7.6 kV
Difference in focus voltage between red, green and blue guns		≤300 V
Sharpness (halo)		≤1.0 mm on horizontal line at screen centre

TEST	CONDITIONS	REQUIREMENTS
Cut-off voltage (V_{g2})	V_k = 120 V; V_{g2} adjusted for spot just cut-off; each gun measured separately	310 to 650 V
Cathode voltage ratio ($V_{k\ max}/V_{k\ min}$)	V_k adjusted for spot just cut-off on screen; V_{g2} = 500 V	≤1.25
Cathode emission (I_k)	I_k is measured after reducing V_k = 51 V; each gun measured separately	≥700 μA
Cathode warm-up time	V_k = 70 V; tube has been in operation for at least 1 hour during previous 10 hours; no preheating	≤10 s (50% of I_k after 2 minutes)
Static convergence drift after switching on	V_k adjusted for I_a = 350 μA (peak) (crosshatch pattern); tube has been in operation for at least 1 hour during previous 10 hours	≤0.4 mm
Raster shift	V_k adjusted for spot just visible; position of undeflected green spot measured with respect to screen centre	≤±3 mm
Centring error	V_k adjusted for spot just visible; position of undeflected green spot measured with respect to screen centre	≤±4 mm
White colour uniformity	V_k adjusted for $I_{a\ (total)}$ ≈60% of long term average value, measured 15 minutes after switching on; V_{gfoc} adjusted for focus; viewing distance = 5 × screen height in ambient light of ≈1 lux; ensure adequate degaussing; colour uniformity of individual rasters should also be considered	no distinct colour differences
Gas value (I_a)	V_k adjusted for I_{gfoc} = 400 μA; V_{g2} = 250 V; V_{gfoc} = 250 V; V_a = −80 V; tube is operated as an ionization gauge according to stated conditions	I_a ≤−40 nA

4.3 Blemish specification

4.3.1 QUALITY OF FACEPLATE AND OF UNACTIVATED SCREEN

Measurable blemishes are faults in the screen glass or phosphor layer, having clearly defined edges and are clearly visible immediately (within 5 seconds) at the viewing distance, or show up as high contrast in the *"Philips Graticule*" (catalogue number 7322 991 00882).

The size of a measurable blemish is given by:

$\frac{L+W}{2}$ (for $L < 4W$) or,

$\frac{L}{20} + 2W$ (for $L \geq 4W$),

where:

L = length of the blemish

W = width of the blemish.

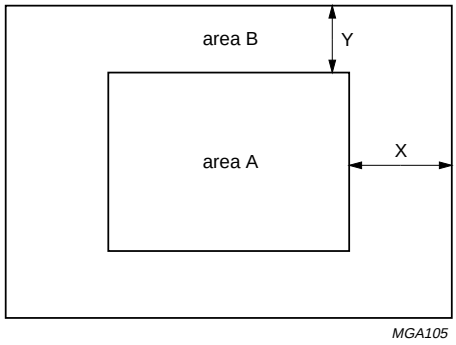
In those size categories where a minimum enclosing circle is indicated, the blemishes lying within this circle shall be regarded as one fault equal in size to the sum of the individual blemish sizes.

The quality assessment is performed at a viewing distance ≥1 m, in a diffused ambient light of 1000 lux maximum.

The useful screen area is bounded by the edge of the phosphor screen. This area is divided into areas A and B, located as shown in Fig.19.

4.3.2 MAXIMUM PERMISSIBLE NUMBER OF BLEMISHES FOR GLASS AND OF UNACTIVATED SCREEN (see Fig.19 for area definitions)

BLEMISH SIZE (mm)	MAXIMUM PERMISSIBLE NUMBER OF BLEMISHES		DIAMETER OF MINIMUM ENCLOSING CIRCLE (mm)
	AREA A	AREA B	
>1.0	0	0	–
>0.6 to 1.0	0	2	30
>0.4 to 0.6	2	5	30
≤0.4	limited only by cloud		–



X = 80 mm.
Y = 60 mm.

Fig.19 Dimensions of areas A and B.

4.3.3 MAXIMUM PERMISSIBLE LENGTH OF SCRATCHES ON THE FACEPLATE

WIDTH OF SCRATCHES (mm)	MAXIMUM PERMISSIBLE LENGTH OF SCRATCHES (mm)
>0.15	none
>0.1 to ≤0.15	10
>0.05 to ≤0.1	40
≤0.05	no limit

4.3.4 QUALITY OF ACTIVATED SCREEN

Measurable blemishes are faults affecting the illuminance of the phosphor layer, which are clearly visible immediately (within 5 seconds) at viewing distance.

The size of a measurable blemish is given by:

$\frac{L+W}{2}$ (for $L < 4W$) or,

$\frac{L}{20} + 2W$ (for $L \geq 4W$),

where:

L = length of the blemish.

W = width of the blemish.

Blemishes are classified according to contrast degree:

- High contrast:
  - Blemishes which are clearly visible immediately (within 5 seconds). Missing or unlit green phosphor stripes fall into this category.
- Medium contrast:
  - Blemishes which are just visible. Missing or unlit blue and/or red phosphor stripes fall into this category.

To determine the contrast category it is advisable to use the *"Philips Graticule"*. This graticule is held at arms length over the blemish and then moved from the 0.7 to the 1.3 filter. The following criteria are used to determine the contrast categories:

- High contrast:
  - Blemishes which are visible through the 0.7 filter and are immediately visible upon entering the 1.3 filter.
- Medium contrast:
  - Blemishes which are visible through the 0.7 filter but disappear momentarily upon entering the 1.3 filter.

In those size categories where a minimum enclosing circle is indicated, the blemishes lying within this circle shall be regarded as one fault equal in size to the sum of the individual blemish sizes.

If blemishes falling under different contrast categories are visible simultaneously, apply the larger minimum enclosing circle rule and treat all such enclosed blemishes as being in the lower contrast category, provided that the individual blemishes are within the limits for their own contrast category.

If blemishes falling under different size categories are visible simultaneously, then the total quantity of blemishes should not exceed the maximum number of blemishes allowable for the least critical of these categories.

The quality assessment should take place at nominal conditions. The beam current is adjusted to 60% of the long term average value. The assessment is performed at a viewing distance of approximately 5 × screen height, in an ambient light of approximately 1 lux, using a white raster.

The useful screen area is bounded by the edge of the phosphor screen. The area is divided into areas A and B, located as shown in Fig.19.

4.3.5 ACCEPTANCE LIMITS AND CLASSIFICATION OF BLEMISHES

Maximum permissible number of blemishes for activated screen (see Fig.19 for area definitions).

BLEMISH SIZE (mm)	MAXIMUM PERMISSIBLE NUMBER OF BLEMISHES				DIAMETER OF MINIMUM ENCLOSING CIRCLE (mm)
	HIGH CONTRAST		MEDIUM CONTRAST		
	AREA A	AREA A + B	AREA A	AREA A + B	
>2.5	0	0	0	0	–
>1.8 to 2.5	0	0	1	2	30
>1.2 to 1.8	0	0	2	3	30
>1.0 to 1.2	0	0	4	6	30 (high contrast) 10 (medium contrast)
>0.6 to 1.0	0	2			
>0.4 to 0.6	2	5			
≤0.4	limited only by cloud				–

4.4 White uniformity

White uniformity is the uniformity of colour and brightness of the luminescent screen when viewed with a white raster

The assessment of screen uniformity should take place at nominal conditions (see “Test conditions”) and a total beam current of approximately 60% of the published long term average value. The assessment should be made after the tube has been operated for 15 minutes under the stated conditions. The tube should be thoroughly degaussed and properly adjusted with respect to the convergence and colour purity.

The screen should be viewed at a distance of approximately 5 × screen height and in an ambient light of approximately 1 lux.

A tube should be accepted if no distinct colour differences are immediately visible within 5 s.

The colour uniformity of individual rasters should also be considered.

4.5 Convergence specification

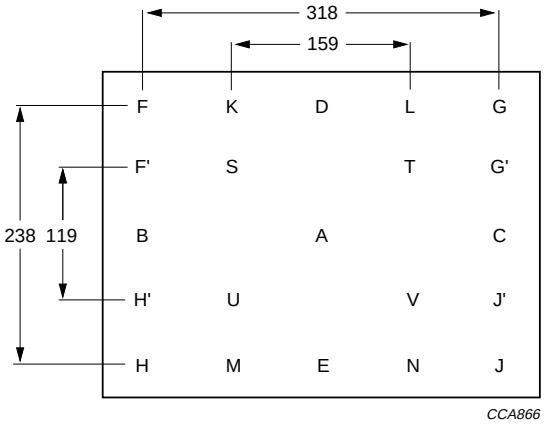
Misconvergence is the distance between centres of the red, green and blue lines at the screen using rectangular coordinates.

Anode and/or focus voltage may affect the static convergence performance.

All measurements are carried out with the tube facing east and after 15 minutes operation.

4.5.1 MAXIMUM MISCONVERGENCE AFTER 15 MINUTES OPERATION

LOCATION (see Fig.20)	MAXIMUM ERROR BETWEEN ANY COLOUR (mm)
A	0.3
B, C, D, E	0.8
F, G, H, J	1.3
K, L, M, N	1.0
F’, G’, H’, J’	1.0
S, T, U, V	0.9

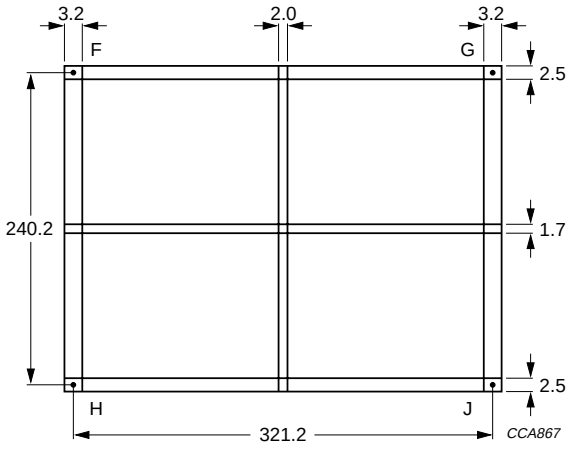


Dimensions in mm.
Maximum centring error is 4 mm.
Diameter of test circles at measuring points is 10 mm.

Fig.20 Convergence test points.

4.6 Raster distortion

Raster lines of a matched tube/coil combination should fall within the area defined in Fig.21.



Dimensions in mm.
Total pattern distortion measured with east-west correction.

Fig.21 Total pattern distortion.

5 ERGONOMIC, ENVIRONMENTAL DATA

5.1 X-radiation

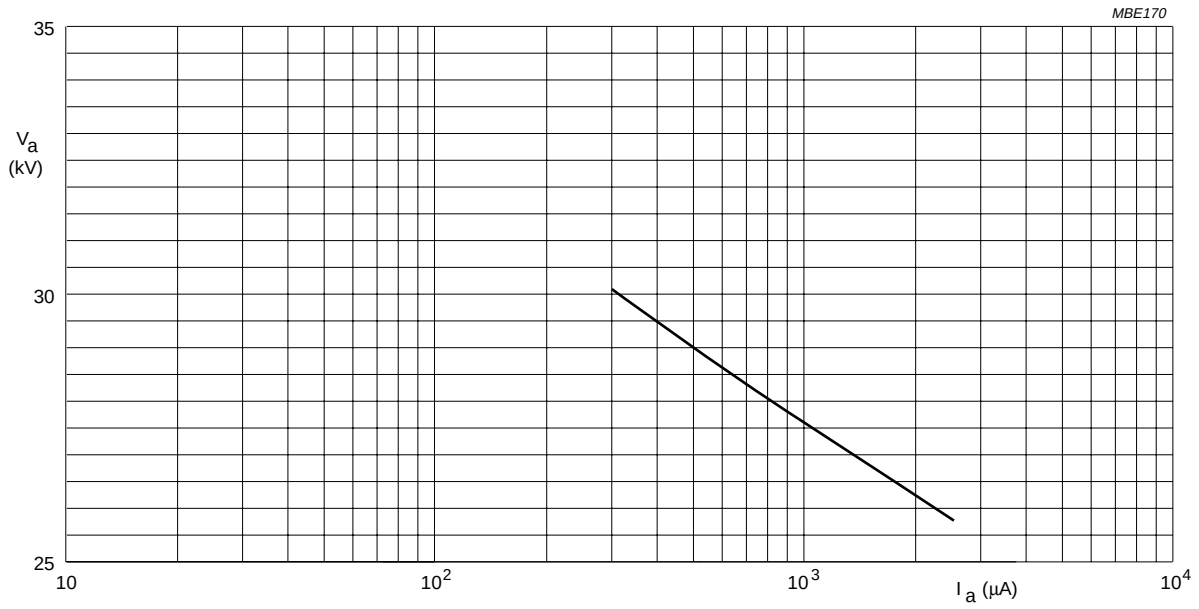
Maximum anode voltage at which the X-radiation emitted will not exceed 1 μSv/h when operated at 27.5 kV and 1 mA.

PARAMETER	TYP.	UNIT
Entire tube; note 1	30	kV

Note

1. 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 iso-exposure-rate limit curve and the iso-exposure-rate limit curve for the entire tube.

WARNING
The cathode ray tube is intrinsically safe in accordance with *"Appendix III Röntgenverordnung"*.
Eigensichere Kathodenstrahlröhre nach *"Anlage III Röntgenverordnung"*.



The X-radiation emitted will also not exceed 1 μSv/h for anode voltage and current combinations shown in the iso-exposure-rate limit curve.

Fig.22 1 μSv/h iso-exposure-rate limit curve.

5.2 Electrical safety

The high voltage at which the tube is operated may be very dangerous. The TV-set should include safeguards to prevent the user from coming into contact with the high voltage.

Remember when replacing or servicing the tube assembly that a residual electrical charge may be carried by the anode contact and also by 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. Extreme care should be taken in servicing or adjustment of any high voltage circuit.

Discharging the high voltage to isolated metal parts such as cabinets and control brackets may produce a shock hazard.

5.3 Handling

Although all picture tubes are provided with integral implosion protection, which meets the intrinsic safety requirements stipulated in the relevant part of *"IEC 65000"*, 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. In addition it should not be handled in the anode and A2 insulation area which should be kept clean and free from dust and dirt.

In all handling procedures prior to insertion in the receiver cabinet, there is a risk of personal injury if severe accidental damage to the tube occurs.

It is therefore recommended that in areas containing unpacked and unprotected tubes, protective clothing is worn, **particularly gloves and safety glasses with side-shields** to prevent possible injury from flying glass in the event of such an accident. **Handle the tube with extreme care.** Do not strike, scratch or subject the tube to more than moderate pressure.

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

A picture tube assembly can be lifted from the edge-down position by using the two upper mounting lugs.

If suspending the tube assembly from the mounting lugs, ensure that a **minimum of two** are used. **Under no circumstances suspend the tube assembly from one lug.**

5.4 Packaging

The standard packaging provides protection against tube damage under normal conditions of shipment or handling. This is also valid for tubes with screen coatings, so no foil is being used on the screen. Observe any instructions given on the packaging and handle accordingly.

Under no circumstances should the tube assembly be subjected to accelerations greater than the values given in "Accelerations".

5.4.1 ACCELERATIONS

PARAMETER	PULSE DURATION	MAX.	UNIT
Acceleration in cone direction	≤10 ms	350	m/s^2
	30 ms	350	m/s^2
Acceleration in all other directions	30 ms	350	m/s^2

5.4.2 STORAGE CONDITIONS

SYMBOL	PARAMETER	MIN.	MAX.	UNIT
T_{stg}	storage temperature	−20	+60	°C
RH	relative humidity	5	95	%
p_{stg}	atmospheric pressure	90	1060	hPa

6 DEFINITIONS

Data sheet status	
Objective specification	This data sheet contains target or goal specifications for product development.
Preliminary specification	This data sheet contains preliminary data; supplementary data may be published later.
Product specification	This data sheet contains final product specifications.
Application information	
Where application information is given, it is advisory and does not form part of the specification.	

7 LIFE SUPPORT APPLICATIONS

These products are not designed for use in life support appliances, devices, or systems where malfunction of these products can reasonably be expected to result in personal injury. PDS customers using or selling these products for use in such applications do so at their own risk and agree to fully indemnify PDSfor any damages resulting from such improper use or sale.

NOTES

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PDS B.V.

Jan Campertstraat 5

6416 SG Heerlen

The Netherlands

Tel. +31 (0)45 543 9312

Fax. +31 (0)45 542 6458

Printed in The Netherlands

INSTRUMENT CATHODE-RAY TUBE

- 10cm diagonal rectangular flat face
- domed mesh post-deflection acceleration
- short tube max. 220 mm
- high precision by permanent magnetic correction system
- low heater power consumption
- very high brightness
- for small oscilloscopes with up to 50 MHz bandwidth and read-out devices

QUICK REFERENCE DATA

Final accelerator voltage	$V_{g7(l)}$	10 kV
First accelerator voltage	$V_{g\,2,4}$	1 kV
Minimum useful scan area		70 mm x 56 mm
Deflection coefficient		
horizontal	M_x	16,5 V/cm
vertical	M_y	11 V/cm

OPTICAL DATA

Screen		metal backed phosphor
type		GH (P31)
colour		green
persistence		medium short
Useful screen area		≥70 mm x 56 mm (note 1)
Useful scan area		≥70 mm x 56 mm
Internal graticule		type 125 (see Fig.4)

HEATING

Indirect by AC or DC *		
Heater voltage	V_f	6.3 V
Heater current	I_f	0.1 A
Heating time to attain 10% of the cathode current at equilibrium conditions		approx. 7 s

* not to be connected in series with other tubes.

MECHANICAL DATA

Dimensions and connections (see also outline drawings)

Overall length (socket included)	max. 220 mm
Faceplate dimensions	82 ± 0.5 mm x 69 ± 0.5 mm
Net mass (including trace rotation coil)	approx. 450 g
Base	12 pin, all glass JEDEC B12-246

Mounting

The tube can be mounted in any position. It must not be supported by the socket and not by the base region alone. The reference points on adjoining edges of the faceplate (see Fig.4) enable the tube to be positioned accurately in the front panel, with optimum alignment of the internal graticule with respect to the bezel.

Accessories

Socket with solder tags	type 55594
Socket with printed wiring pins	type 55595
Final accelerator contact connector	type 55569
Mu metal shield	type 55461

FOCUSING	electrostatic
DEFLECTION	double electrostatic
x plates	symmetrical
y plates	symmetrical

CAPACITANCES *

x_1 to all other elements except x_2	$C_{x1(x2)}$	4 pF
x_2 to all other elements except x_1	$C_{x2(x1)}$	4 pF
y_1 to all other elements except y_2	$C_{y1(y2)}$	3 pF
y_2 to all other elements except y_1	$C_{y2(x1)}$	3 pF
x_1 to x_2	C_{x1x2}	2 pF
y_1 to y_2	C_{y1y2}	1 pF
Control grid to all other elements	C_{g1}	6 pF
Cathode to all other elements	C_k	3 pF
Focus electrode to all other elements	C_{g3}	5 pF
Final accelerator electrode to all other elements	C_{g7}	240 pF

* Approximate values

DIMENSIONS AND CONNECTIONS Dimensions in mm

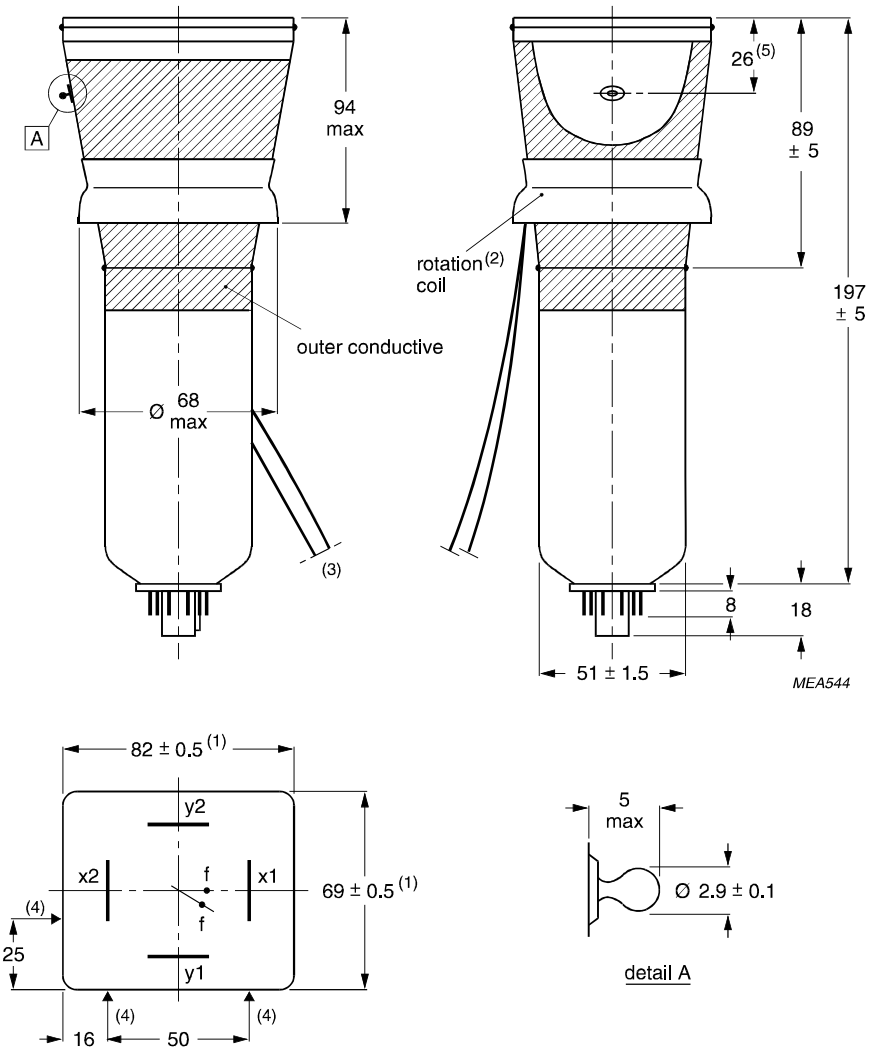


Fig.1 Mechanical outlines.

(1) Dimensions of faceplate only. The complete assembly of faceplate and cone (frit seal included) will pass through an opening of 85 mm x 72 mm (diagonal 107 mm).
(2) The coil is fixed to the envelope with silicone rubber and adhesive tape.
(3) The length of rotation coil connecting leads is min. 350 mm.
(4) Reference points on faceplate for graticule alignment.(see Fig.4)
(5) The centre of the final accelerator contact is situated within a square of 7 mm x 7 mm around the indicated position.

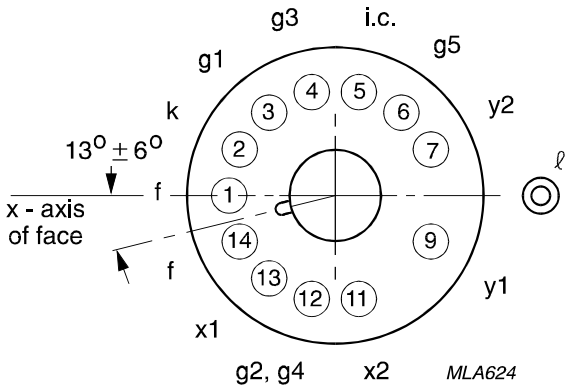
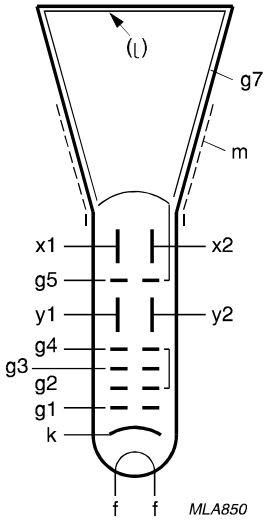
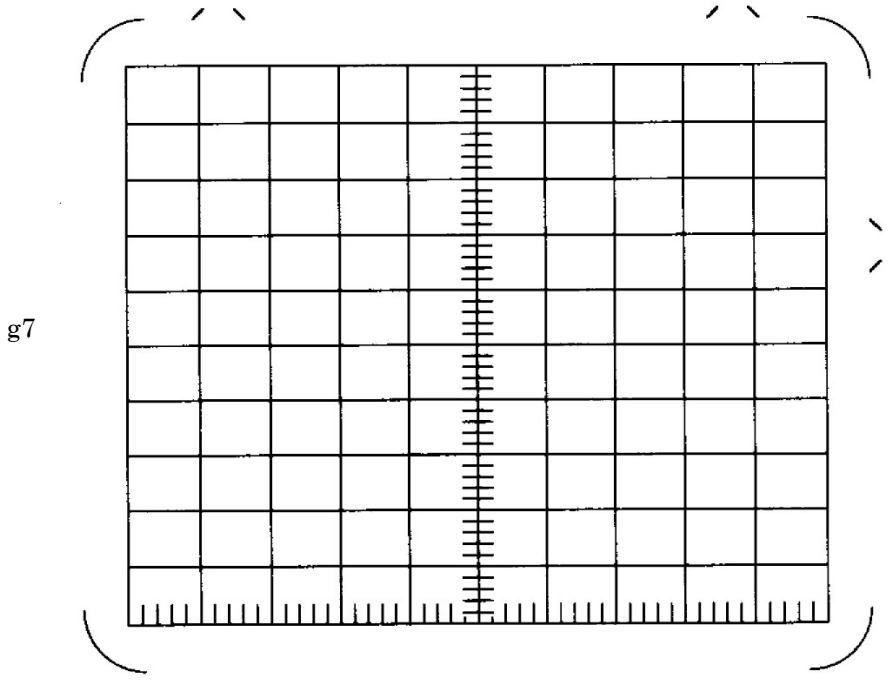


Fig.2 Pin arrangement, bottom view.



Internal graticule

Line thickness = 0.15 mm , colour N 1.5.



TYPICAL OPERATION (voltages are with respect to the cathode)

Conditions

Final accelerator voltage	$V_{g7(l)}$	10 kV	
Mean deflection plate potential		1 kV	note 2
Shield voltage for optimum geometry	V_{g5}	1 kV	note 3
First accelerator and astigmatism control voltage	$V_{g2,4}$	1 kV	note 3
Focusing voltage	V_{g3}	150 to 250 V	
Cut-off voltage for visual extinction of focused spot	$-V_{g1}$	45 to 90 V	

Outer conductive coating (m) and mu-metal shield to be earthed

PERFORMANCE

Horizontal deflection coefficient	M_x	16.5 V/cm ± 10 %	
Vertical deflection coefficient	M_y	11 V/cm ± 5 %	
Deviation of deflection linearity		< 2%	note 4
Geometry distortion			note 5
Eccentricity of undeflected spot			
in horizontal direction		< 4 mm	
in vertical direction		< 2 mm	
Angle between x and y traces		90°	note 5
Angle between x-trace and x-axis of internal graticule		< 5°	note 7
Luminance reduction with respect to screen centre			
x axis, outer graticule line		< 30%	
y axis, outer graticule line		< 30%	
any corner		< 50%	
Grid drive for 10 μA screen current	V_d	approx. 15 V	Fig. 5
Line width			
at 10 μA	l.w.	approx. 0.23 mm	note 8
at 25 μA	l.w.	approx. 0.30 mm	note 8

LIMITING VALUES (Absolute maximum rating system)

Final accelerator voltage	$V_{g7(l)}$	max. 15 kV	Fig. 6
Shield voltage	V_{g5}	max. 2 kV	
First accelerator and astigmatism control voltage	$V_{g2,4}$	max. 2 kV	
Focusing electrode voltage	V_{g3}	max. 2 kV	
Control grid voltage	$-V_{g1}$	max. 200 V	
		min. 0 V	
Cathode to heater voltage			
positive	V_{kf}	max. 125 V	
negative	$-V_{kf}$	max. 125 V	
Heater voltage	V_f	max. 6.6 V	
		min. 6.0 V	
Voltage between $g_{4,5}$ and any deflection plate	$V_{g4,g5,x,y,}$	max. 500 V	
Grid drive, averaged over 1 ms	V_d	max. 25 V	
Screen dissipation	W_l	max. 8 mW/cm^2	
Control grid circuit resistance	R_{g1}	max. 1 MΩ	

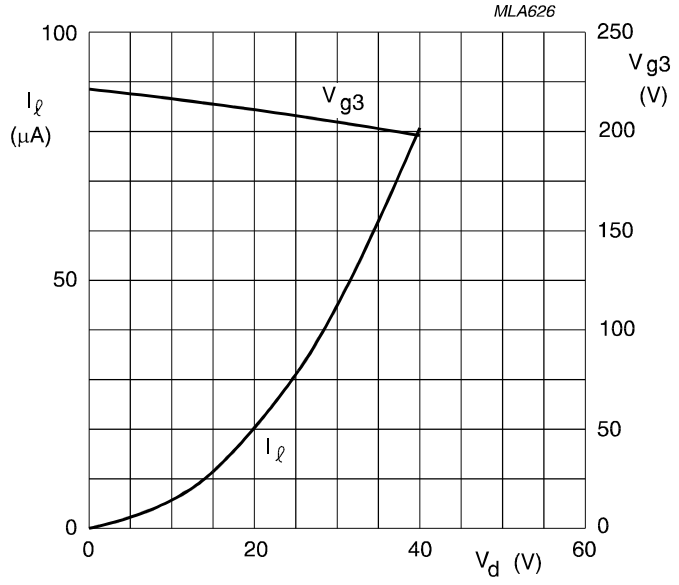


Fig.5 Screen current (I_l) and focusing voltage (V_{g3}) as a function of grid drive voltage (V_d) at $V_{g2,g4,}$ = 1000 V; typical curves.

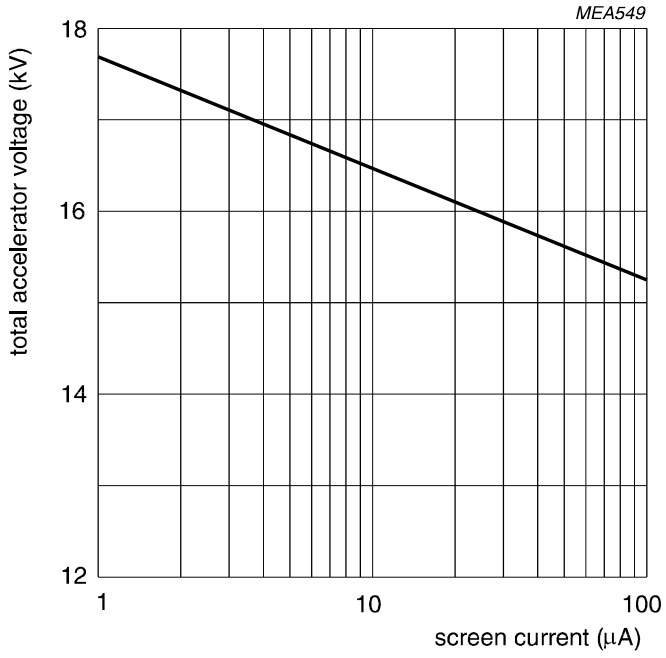


Fig.6 Isoexposure-rate limit curve for 0.5 mR/h, measured in accordance with EIA RS-502.

NOTES

1. Because the frit seal is visible through the faceplate, and not necessarily aligned with the internal graticule, application of an external mask, or bezel, with open area of max. 70 mm x 56 mm is recommended. The internal graticule is aligned with the faceplate by using the faceplate reference points (see Fig.4).
2. The deflection plates must be operated symmetrically: floating mean x- or y-potentials will result into non-uniform line width and geometry distortion. The mean x- and y-potentials should be equal; under this condition the tube will be within the specification without corrections for astigmatism and geometry (see also note 5).
3. For some applications a mean x-potential up to 50 V positive with respect to mean y-potential is inevitable. In this case V_{g5} must be made equal to mean x-potential, and a range of 0 to - 25 V with respect to mean y-potential will be required on $g_{2,4}$ for astigmatism correction. The circuit resistance for $V_{g2,4}$ should be < 10 kΩ and < 25 kΩ for V_{g5}.
4. The sensitivity at a deflection of less than 75 % of the useful scan will not differ from the sensitivity at a deflection of 25 % of the useful scan by more than the indicated value.
5. The tube is adjusted by internal permanent magnetic elements for optimum geometry (orthogonality,trapezium and barrel/pin-cushion), brightness uniformity, eccentricity of undeflected spot, and astigmatism.
6. A graticule consisting of concentric rectangles of 68 x 54.4 mm and 66.8 x 53.2 mm is aligned with the internal graticule. With optimum trace rotation correction the edges of a raster will fall between these rectangles.
7. The tube has a trace rotation coil, fixed onto the lower cone part. The coil has a maximum resistance of 235 Ω at 80° C. The maximum required voltage is approx. 8 V for tube tolerances (± 5°) and earth magnetic field with reasonable shielding (± 2°).
8. Measured with the shrinking raster method in the centre of the screen under typical operating conditions, adjusted for optimum spot size.

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INSTRUMENT CATHODE-RAY TUBE

- mono accelerator
- 14 cm diagonal rectangular flat face
- internal graticule
- low power quick heating cathode
- high brightness, long-life GY phosphor
- high precision, factory adjusted for orthogonality, astigmatism and eccentricity
- for oscilloscopes with 20 to 30 MHz bandwidth and read-out devices

QUICK REFERENCE DATA

Accelerator voltage	$V_{g2,g4}$	2000 V
Minimum useful scan area		100 mm x 80 mm
Deflection coefficient		
horizontal	M_x	19 V/cm
vertical	M_y	11,5 V/cm

OPTICAL DATA

Screen		
type		GY
colour		yellowish-green
persistence		medium
Useful screen area		>102 mm x 82 mm ;note 1
Useful scan area		>100 mm x 80 mm
Internal graticule		type 123; see Fig.4

HEATING

Indirect by AC or DC *		
Heater voltage	V_f	6.3 V
Heater current	I_f	0.1 A
Heating time to attain 10% of the cathode current at equilibrium conditions		approx. 7 s

* not to be connected in series with other tubes.

MECHANICAL DATA

Dimensions and connections (see also outline drawings)

Overall length (including socket)	< 333 mm
Faceplate dimensions	118 ± 0.5 mm x 98 ± 0.5 mm
Net mass	approx. 1 kg
Base	12 pin, all glass JEDEC B12-246

Mounting

The tube can be mounted in any position. It must not be supported by the socket and not by the base region alone. The reference points (A, B and C) on adjoining edges of the faceplate (see Fig.4) enable the tube to be positioned accurately in the front panel, for optimum alignment of the internal graticule with respect to the bezel.

Accessories

Socket with solder tags	
Socket with printed wiring pins	type 55595
Mu metal shield	55598/55458

FOCUSING	electrostatic
DEFLECTION	double electrostatic
x plates	symmetrical
y plates	symmetrical

DIMENSIONS AND CONNECTIONS

Dimensions in mm

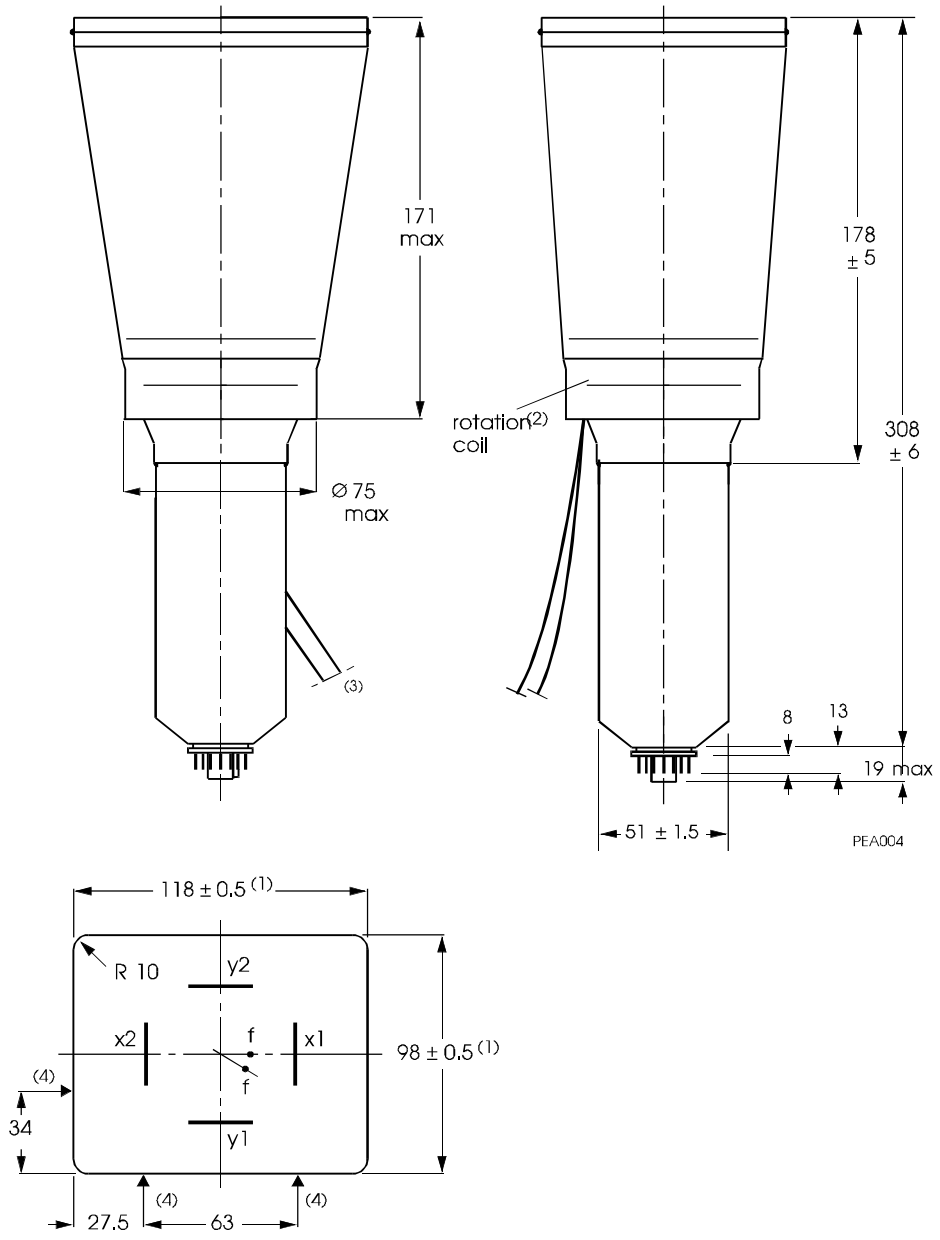


Fig.1 Mechanical outlines.

(1) Dimensions of faceplate only. The complete assembly of faceplate and cone (frit seal included) will pass through an opening of 122 mm x 102 mm.
(2) The coil is fixed to the envelope with resin.
(3) The length of rotation coil connecting leads is min. 350 mm.
(4) Reference points on faceplate for graticule alignment (see Fig. 4).

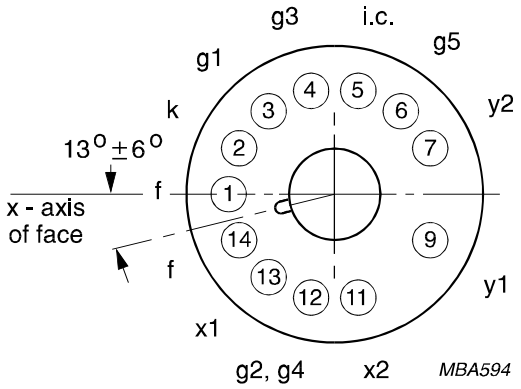


Fig.2 Pin arrangement, bottom view.

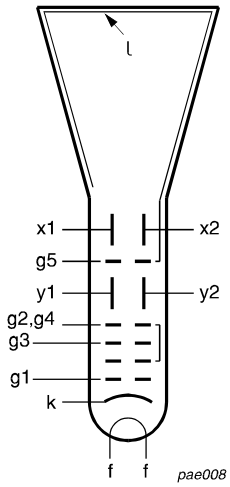


Fig.3 Electrode configuration.

Internal graticule

The internal graticule is aligned with the faceplate by using the faceplate reference points, see Fig.4 and note 1.The reference points A, B and C are for aligning the graticule with the faceplate.
Line thickness = 0.18 mm; dot diameter = 0.38 mm; colour red.

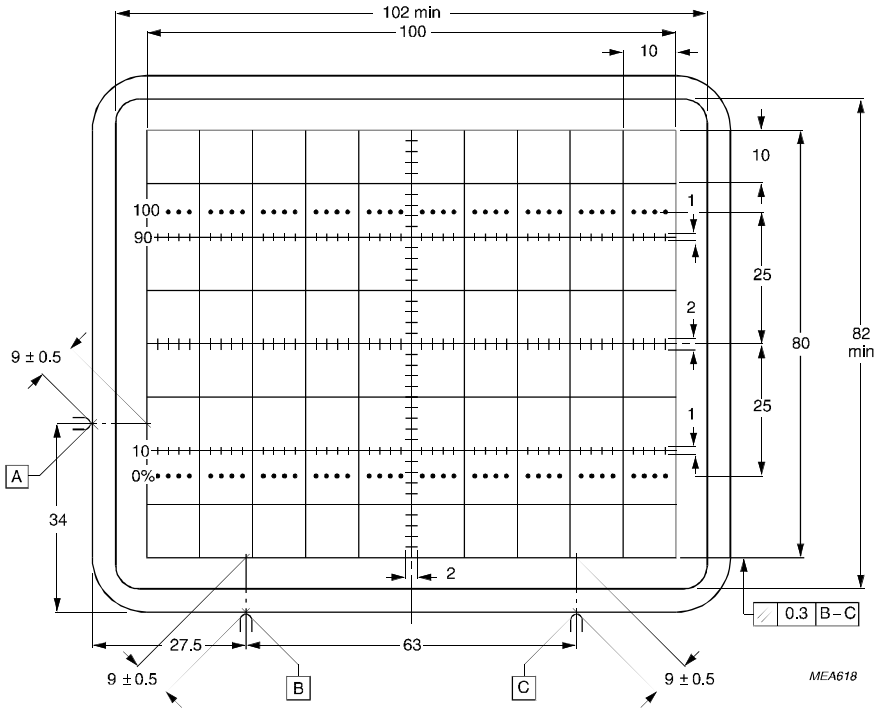


Fig.4 Front view of the tube with internal graticule, type 123.

TYPICAL OPERATION (voltages are with respect to the cathode)

Conditions

Mean deflection plate potential		2 kV	note 2
Shield voltage for optimum geometry	$V_{g5,(I)}$	2 kV	note 3
Accelerator and astigmatism control voltage	$V_{g2,g4}$	2 kV	note 4
Focus voltage	V_{g3}	100 to 200 V	note 5
Cut-off voltage for visual extinction of focused spot	$-V_{g1}$	22 to 65 V	note 6

PERFORMANCE

Horizontal deflection coefficient	M_x	19 V/cm ± 10%	
Vertical deflection coefficient	M_y	11,5 V/cm ± 5%	
Deviation of deflection linearity		< 2%	note 7
Geometry distortion			note 8
Eccentricity of undeflected spot			
in horizontal direction		< 4 mm	note 9
in vertical direction		< 2 mm	
Angle between x and y traces		90 ± 0.5°	note 9
Angle between x-trace and x-axis of internal graticule		< 5°	note 10
Luminance reduction with respect to screen centre			
x-axis, outer graticule line	< 30%		
y-axis, outer graticule line	< 30%		
any corner	< 50%		

Grid drive for 10 μA screen current	V_d	approx. 10 V	Fig.5; note 6
Line width	l.w.	approx. 0.3 mm	note 11

LIMITING VALUES (Absolute maximum rating system)

Accelerator voltage	$V_{g2,g4}$	max. 2.2 kV	
Shield voltage	$V_{g5(I)}$	max. 2.2 kV	
Focus electrode voltage	V_{g3}	max. 2.2 kV	
Control grid voltage	$-V_{g1}$	max. 200 V	
			min. 0 V
Cathode to heater voltage			
	positive	V_{kf}	max. 125 V
	negative	$-V_{kf}$	max. 125 V
Heater voltage	V_f	max. 6.6 V	
			min. 6.0 V
Grid drive, averaged over 1 ms	V_d	max. 20 V	
Screen dissipation	W	max. 3 mW/cm^2	
Control grid circuit resistance	R_{g1}	max. 1 MΩ	

CAPACITANCES *

x_1 to all other elements except x_2	$C_{x1(x2)}$	4.8 pF
x_2 to all other elements except x_1	$C_{x2(x1)}$	4 pF
y_1 to all other elements except y_2	$C_{y1(y2)}$	3.4 pF
y_2 to all other elements except y_1	$C_{y2(y1)}$	3.4 pF
x_1 to x_2	C_{x1x2}	3.3 pF
y_1 to y_2	C_{y1y2}	1 pF
Control grid to all other elements	C_{g1}	6 pF
Cathode to all other elements	C_k	3 pF

* Approximate values

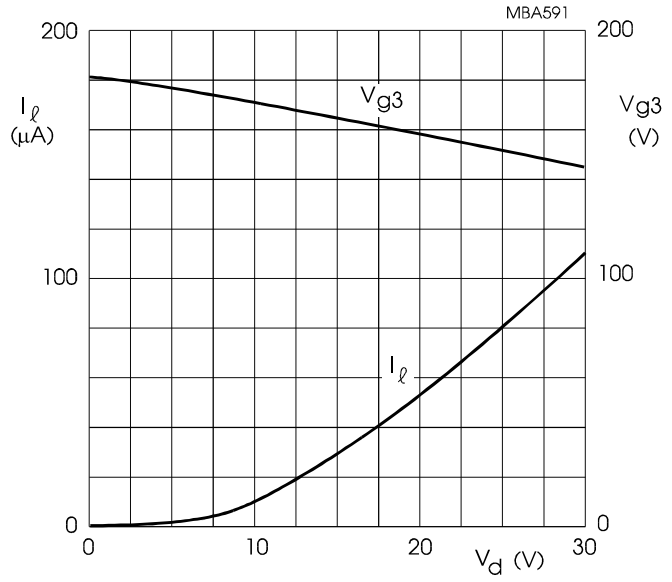


Fig.5 Typical screen current (I_l) and focus voltage (V_{g3}) curves as a function of grid drive voltage (V_d) at $V_{g2,g4,g5}$ = 2 kV.

NOTES

1. Because the frit seal is visible through the faceplate, and is not necessarily aligned with the internal graticule, application of an external passe-partout with an open area of max. 102 mm x 82 mm is recommended. The internal graticule is aligned with the faceplate by using the faceplate reference points (see Fig.4).
2. The deflection plates must be operated symmetrically. Asymmetric drive introduces trace distortion. It is recommended that the tube is operated with equal mean x- and y-potentials in order to minimize tube adjustments. In this event g_5 may be connected to g_2, g_4 and all made equal to mean y-potential for optimum spot (see also notes 3 and 4).
   A difference between mean x- and y-potentials up to 75 V is permissible. However, this may influence the specified deflection coefficients and separate voltages on g_4 and g_5 will be required.
3. The tube will meet the geometry specification (see note 8) if V_{g5} is equal to mean x-potential. A range of ± 30 V around mean x-potential may be applied for further correction.
4. Optimum spot is obtained with $V_{g2,g4}$ equal to mean y-potential (see note 2). Generally, a tolerance of ± 4 V has no visible effect. $V_{g2,g4}$ tends to be lower with V_{g5} more positive. The circuit impedance $R_{g2,g4}$ should be less than 10 kΩ.
5. An actual focus range of 30 V should be provided on the front panel. V_{g3} decreases with increasing grid drive (see also Fig.5).
6. Intensity control on the front panel should be limited to the maximum useful screen current (approx. 50 μA; see also Fig.5). It should be adjusted either by the grid drive voltage (up to 22 V) or for maximum acceptable line width. The corresponding cathode current or $I_{g2,g4}$ (up to 500 μA) depends on the cut-off voltage and therefore cannot be used for control settings.
7. The sensitivity at a deflection of less than 75% of the useful scan will not differ from the sensitivity at a deflection of 25% of the useful scan by more than the indicated value.
8. A graticule consisting of concentric rectangles of 100 mm x 80 mm and 98 mm x 78 mm is aligned with the internal graticule. With optimum trace rotation correction, the raster will fall between these rectangles.
9. The tube features internal magnetic correction for orthogonality between x- and y-traces, spot shaping (astigmatism) and eccentricity calibration.
10. The tube has a trace rotation coil fixed to the lower cone part. The coil has a maximum resistance of 260 Ω at 80 °C. The maximum required voltage is approximately 11 V for tube tolerances (± 5°) and earth magnetic field with reasonable shielding (± 2°).
11. Measured with the shrinking raster method in the centre of the screen under typical operating conditions, adjusted for optimum spot size at beam current I_l = 10 μA.
    The beam current I_l can be measured on g_5 and is approx. equal to $I_{g5(l)}$.

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INSTRUMENT CATHODE-RAY TUBE

- 14 cm diagonal rectangular flat face
- domed mesh post-deflection acceleration
- improved spot quality for character readout
- high precision by internal permanent magnetic correction system
- internal graticule
- low heater power consumption
- for compact oscilloscopes with up to 100 MHz bandwidth

QUICK REFERENCE DATA

Final accelerator voltage	$V_{g7(l)}$	16 kV
First accelerator voltage	V_{g4}	2 kV
Minimum useful scan area		100 mm x 80 mm
Deflection coefficient		
horizontal	M_x	7.7 V/cm
vertical	M_y	3.6 V/cm

OPTICAL DATA

Screen	metal-backed phosphor
type	GH
colour	green
persistence	medium short
Useful screen area	≥ 102 mm x 82 mm (note 1)
Useful scan area	≥ 100 mm x 80 mm
Internal graticule	type 123 (see Fig.4)

HEATING

Heater voltage indirect by AC or DC *	V_f	6.3 V
Heater current	I_f	0.1 A
Heating time to attain 10% of the cathode current at equilibrium conditions (approx.)		7 s

* not to be connected in series with other tubes.

MECHANICAL DATA

Dimensions and connections (see also outline drawings)

Overall length (including socket)	≤ 344 mm
Faceplate dimensions	118 ± 0.5 mm x 98 ± 0.5 mm
Net mass	approx. 1 kg
Base	12 pin, all glass, JEDEC B12-246
Final Accelerator Contact	JEDEC J1-21

Mounting

The tube can be mounted in any position. It must not be supported by the socket and not by the base region alone. The reference points on adjoining edges of the faceplate (see Fig.4) enable the tube to be positioned accurately in the front panel, for optimum alignment of the internal graticule.

Accessories

Pin protector (required for shipping)	supplied with tube
Socket with solder tags	type 55594
Socket with printed-wiring pins	type 55595
Final accelerator contact connector	type 55466 (JEDEC J1-21)
Mu-metal shield	type 55458/55459
	with end rubber 55460

FOCUSING	electrostatic
DEFLECTION	double electrostatic
x-plates	symmetrical
y-plates	symmetrical

CAPACITANCES

x_1 to all other elements except x_2	$C_{x1(x2)}$	4.8 pF
x_2 to all other elements except x_1	$C_{x2(x1)}$	3.6 pF
y_1 to all other elements except y_2	$C_{y1(y2)}$	3.0 pF
y_2 to all other elements except y_1	$C_{y2(y1)}$	3.0 pF
x_1 to x_2	C_{x1x2}	3.3 pF
y_1 to y_2	C_{y1y2}	1.4 pF
Control grid to all other elements	C_{g1}	7.2 pF
Cathode to all other elements	C_k	3.6 pF
Focusing electrode to all other elements	C_{g3}	9 pF
Final accelerator electrode to all other elements	C_{g7}	480 pF

DIMENSIONS AND CONNECTIONS

Dimensions in mm

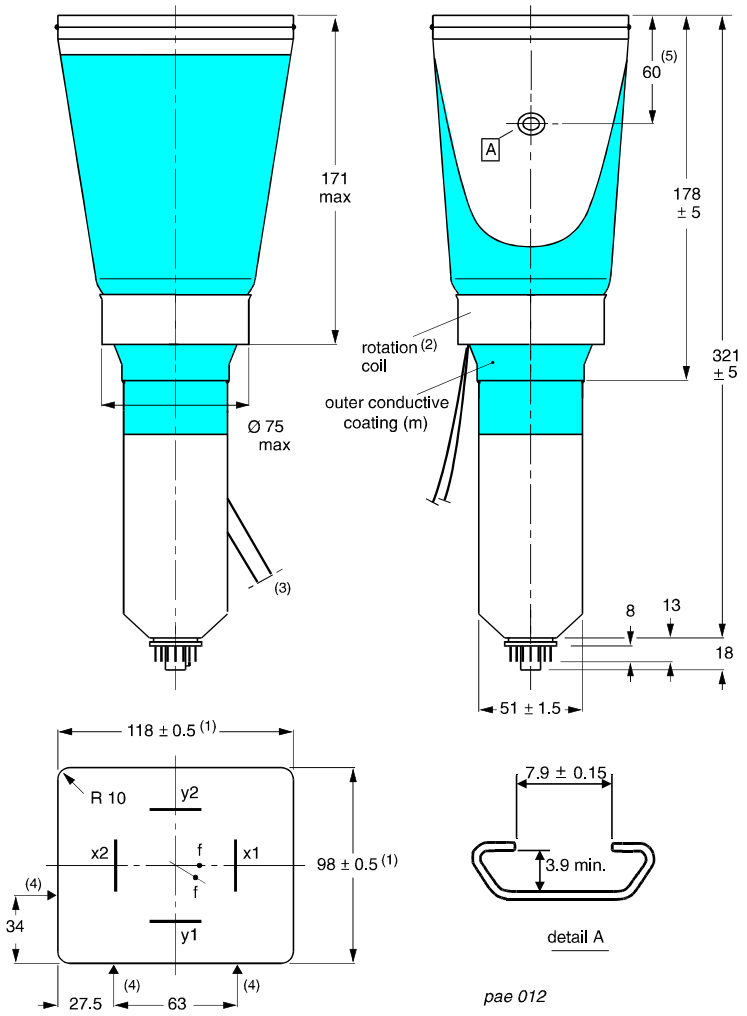


Fig.1 Mechanical outlines.

(1) Dimensions of faceplate only. The complete assembly of faceplate and cone (frit seal included) will pass through an opening of 122 mm x 102 mm (diagonal 153 mm).
(2) The coil is fixed to the envelope with resin and adhesive tape.
(3) The length of the rotation coil connecting leads is minimum 350 mm.
(4) Reference points on faceplate for graticule alignment (see Fig.4)
(5) The centre of the final accelerator contact is situated within a square of 10 mm x 10 mm around the indicated position.

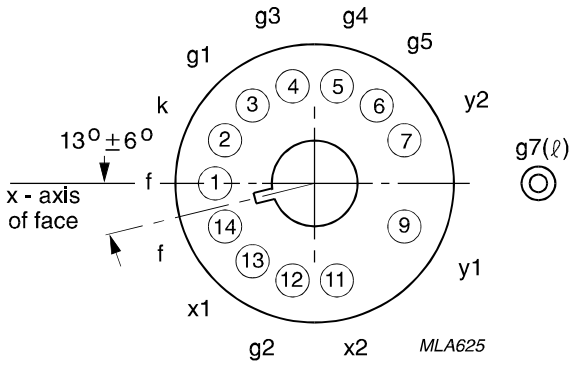


Fig.2 Pin arrangement, bottom view.

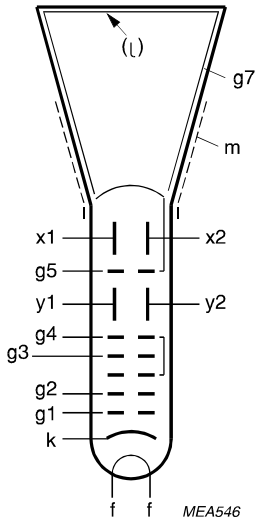


Fig.3 Electrical configuration.

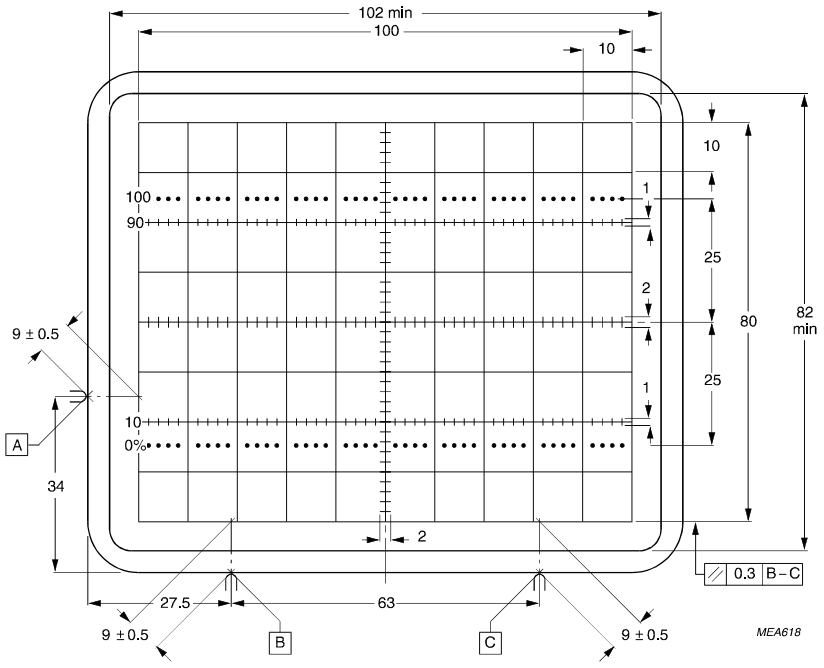


Fig 4. Front view of tube with internal graticule, type 123.

Reference points A,B and C are for aligning the graticule with the faceplate. Line thickness = 0.18 mm; dot diameter = 0.38 mm; colour: red.

TYPICAL OPERATION (voltages with respect to cathode)

Conditions

Final accelerator voltage	$V_{g7(l)}$	16 kV	
Mean deflection plate potential		2 Kv	note 2
Shield voltage for optimum geometry	V_{g5}	2 kV	note 3
First accelerator and astigmatism control voltage	V_{g4}	2 kV	note 3
Focusing voltage	V_{g3}	440 to 560 V	
Grid 2 voltage	V_{g2}	2 kV	note 9
Cut-off voltage for visual extinction of focused	V_{g1}	55 to 100 V	note 9

Outer conductive coating (m) and mu-metal shield to be earthed.

PERFORMANCE

Deflection coefficient			
horizontal	M_x	7.7 V/cm ± 10%	
vertical	M_y	3.6 V/cm ± 5%	
Deviation of deflection linearity		≤ 2%	note 4
Geometry distortion			notes 5,6
Eccentricity of undeflected spot			
in horizontal direction		≤ 4 mm	
in vertical direction		≤ 2 mm	
Angle between x- and y- traces		90 ± 0.5°	note 5
Angle between x-trace and x-axis of internal graticule		≤ 5°	note 7
Luminance reduction with respect to screen centre			
x-axis, outer graticule line		≤ 30%	
y-axis, outer graticule line		≤ 30%	
any corner		≤ 50%	
Grid drive for 10 μA screen current	V_d	approx. 30 V	Fig.5
Line width	l.w.	approx. 0.3 mm	note 8

LIMITING VALUES (Absolute maximum rating system)

Final accelerator voltage	$V_{g7(l)}$	max. 18 kV	Fig. 6
Shield voltage	V_{g5}	max. 3.3 kV	
First accelerator and astigmatism control voltage	V_{g4}	max. 3.3 kV	
Focusing electrode voltage	V_{g3}	max. 2.5 kV	
Grid 2 voltage	V_{g2}	max. 2.5 kV	
Control grid voltage	$-V_{g1}$	max. 200 V	
		min. 0 V	
Cathode to heater voltage			
positive	V_{kf}	max. 125 V	
negative	$-V_{kf}$	max. 125 V	
Heater voltage	V_f	max. 6.6 V	
		min. 5.7 V	
Voltage between g_2 and g_4	$\Delta V_{g2,g4}$	max. 2 kV	
Voltage between g_4,g_5 and any deflection plate	$\Delta V_{g4,g5,x,y}$	max. 500 V	
Grid drive, averaged over 1 ms	V_d	max. 25 V	
Screen dissipation	Wl	max. 8 mW/cm^2	
Control grid circuit resistance	R_{g1}	max. 1 MΩ	

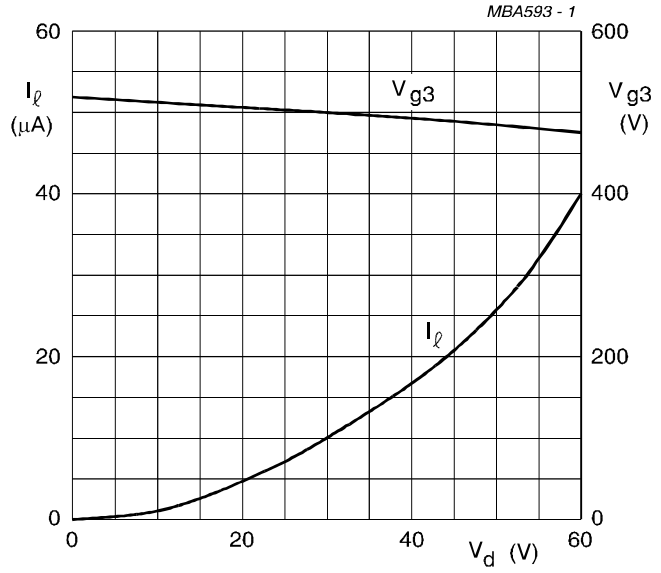


Fig.5 Screen current(I_l) and focusing voltage (V_{g3}) as a function of grid drive voltage (Vd) at V_{g7} = 16 kV, V_{g5} = 2 kV; typical curves.

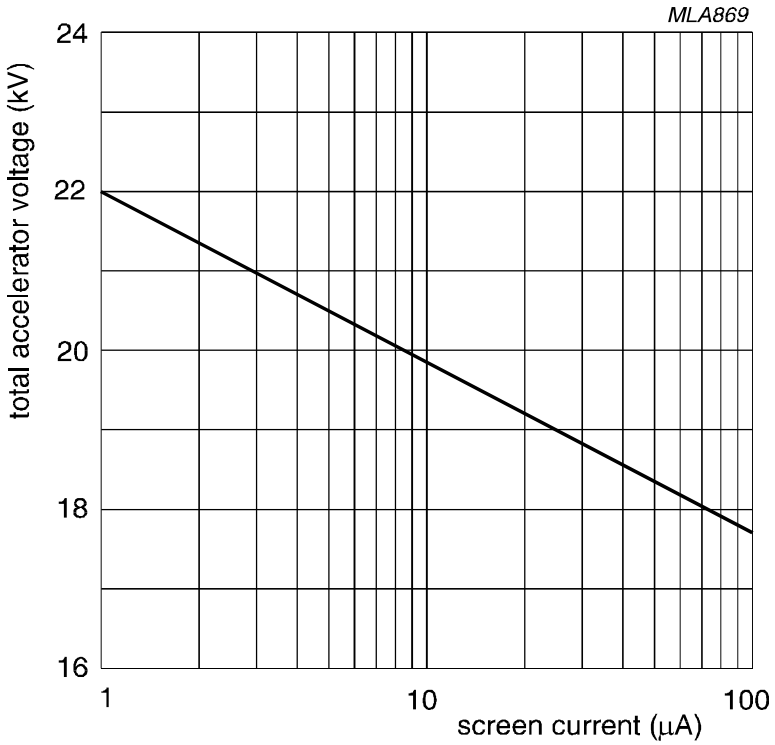


Fig. 6 0.5 mR/h isoexposure-rate limit curve.
Measured according to EIA standard RS-502 , March 1989 (formerly TEPAC 104).

NOTES

1. Because the frit seal is visible through the faceplate, and is not necessarily aligned with the internal graticule, application of an external mask, or bezel, with an open area of max. 102 mm x 82 mm is recommended. The internal graticule is aligned with the faceplate by using the faceplate reference points (see Fig.4).
2. The deflection plates must be operated symmetrically; floating mean x- or y-potentials will result into non-uniform line width and geometry distortion. The mean x- and y-potentials should be equal; under this condition the tube will be within the specification without corrections for astigmatism and geometry (see also note 5).
3. For some applications a mean x-potential up to 50 V positive with respect to mean y-potential is inevitable. In this case V_{g5} must be made equal to mean x-potential, and a range of 0 to -25 V with respect to mean y-potential will be required on g_4 for astigmatism correction. The circuit resistance for V_{g4} should be $\leq$ 10 kΩ and $\leq$ 25 kΩ for V_{g5}.
4. The sensitivity at a deflection of less than 75% of the useful scan will not differ from the sensitivity at a deflection of 25% of the useful scan by more than the indicated value.
5. The tube is adjusted by internal permanent magnets for optimum geometry (orthogonality, trapezium and barrel/pin-cushion), brightness uniformity, eccentricity of undeflected spot and astigmatism.
6. A graticule consisting of concentric rectangles of 100 mm x 80 mm and 98.4 mm x 78.6 mm is aligned with the internal graticule. With optimum trace rotation correction the edges of a raster will fall between these rectangles.
7. The tube has a trace rotation coil, fixed onto the lower cone part. The coil has a maximum resistance of 260 Ω at 80 °C. The maximum required voltage is approx. 13 V for tube tolerances and earth magnetic field with reasonable shielding (± 2°).
8. Measured with the shrinking raster method in the centre of the screen under typical operating conditions, adjusted for optimum spot size at a beam current Il = 10μA.
9. Grid 2 voltage (V_{g2}) may be used to adjust the cut-off voltage, otherwise it should be connected to V_{g4}. The V_{g1} range changes approximately proportional to V_{g2}.

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INSTRUMENT CATHODE-RAY TUBE

- 14 cm diagonal rectangular flat face
- domed mesh post-deflection acceleration
- high sensitivity and high line brightness (writing speed)
- high precision by internal permanent magnetic correction system
- internal graticule
- low heater power consumption
- for compact oscilloscopes with up to 100 MHz bandwidth

QUICK REFERENCE DATA

Final accelerator voltage	$V_{g7(l)}$	10 / 16.5 kV
First accelerator voltage	V_{g4}	2 / 2.2 kV
Minimum useful scan area		100 mm x 80 mm
Deflection coefficient		
horizontal	M_x	8 / 8.3 V/cm
vertical	M_y	4 / 4 V/cm

OPTICAL DATA

Screen	metal-backed phosphor
type	GH
colour	green
persistence	medium short
Useful screen area	≥ 102 mm x 82 mm (note 1)
Useful scan area	≥ 100 mm x 80 mm
Internal graticule	type 123 (see Fig.4)

HEATING

Heater voltage indirect by AC or DC *	V_f	6.3 V
Heater current	I_f	0.1 A
Heating time to attain 10% of the cathode current at equilibrium conditions (approx.)		7 s

* not to be connected in series with other tubes.

MECHANICAL DATA

Dimensions and connections (see also outline drawings)

Overall length (including socket)	≤ 338 mm
Faceplate dimensions	118 ± 0.5 mm x 98 ± 0.5 mm
Net mass	approx. 1 kg
Base	12 pin, all glass, JEDEC B12-246
Final Accelerator Contact	JEDEC J1-21

Mounting

The tube can be mounted in any position. It must not be supported by the socket and not by the base region alone. The reference points on adjoining edges of the faceplate (see Fig.4) enable the tube to be positioned accurately in the front panel, for optimum alignment of the internal graticule.

Accessories

Pin protector (required for shipping)	supplied with tube
Socket with solder tags	type 55594
Socket with printed-wiring pins	type 55595
Final accelerator contact connector	type 55465/66 (JEDEC J1-21)
Mu-metal shield	type 55458/55459 with end rubber 55460

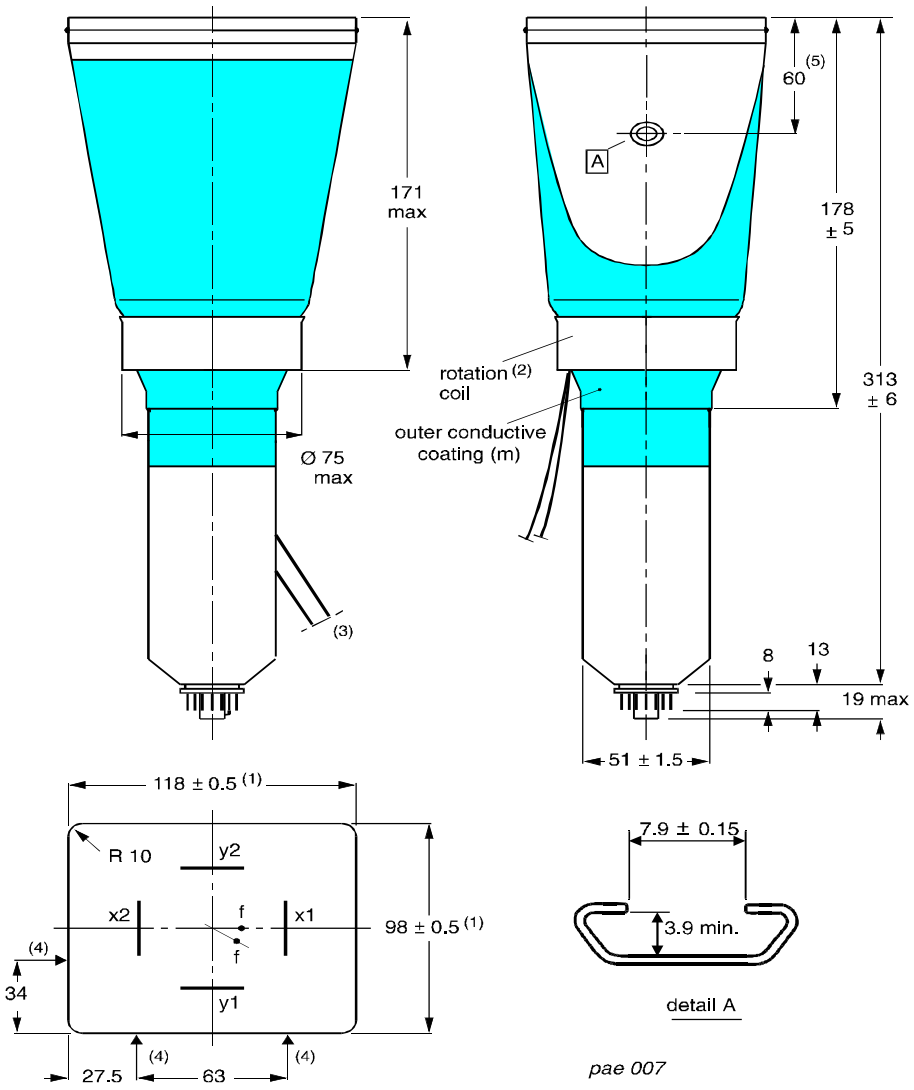
FOCUSING	electrostatic
DEFLECTION	double electrostatic
x-plates	symmetrical
y-plates	symmetrical

CAPACITANCES

x_1 to all other elements except x_2	$C_{x1(x2)}$	4.8 pF
x_2 to all other elements except x_1	$C_{x2(x1)}$	3.6 pF
y_1 to all other elements except y_2	$C_{y1(y2)}$	3.0 pF
y_2 to all other elements except y_1	$C_{y2(y1)}$	3.0 pF
x_1 to x_2	C_{x1x2}	3.3 pF
y_1 to y_2	C_{y1y2}	1.4 pF
Control grid to all other elements	C_{g1}	6.5 pF
Cathode to all other elements	C_k	3.2 pF
Focusing electrode to all other elements	C_{g3}	8 pF
Final accelerator electrode to all other elements	C_{g7}	480 pF

DIMENSIONS AND CONNECTIONS

Dimensions in mm



(1) Dimensions of faceplate only. The complete assembly of faceplate and cone (frit seal included) will pass through an opening of 122 mm x 102 mm (diagonal 153 mm).

(2) The coil is fixed to the envelope with resin.

(3) The length of the rotation coil connecting leads is minimum 350 mm.

(4) Reference points on faceplate for graticule alignment (see Fig.4)

(5) The centre of the final accelerator contact is situated within a square of 10 mm x 10 mm around the indicated position.

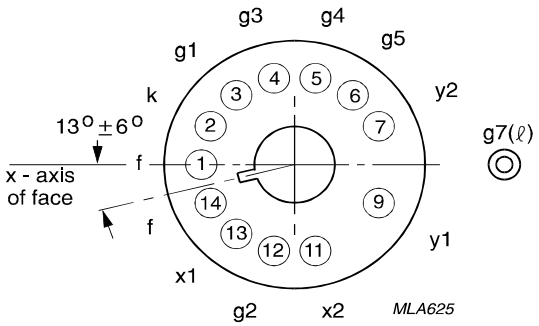


Fig.2 Pin arrangement, bottom view.

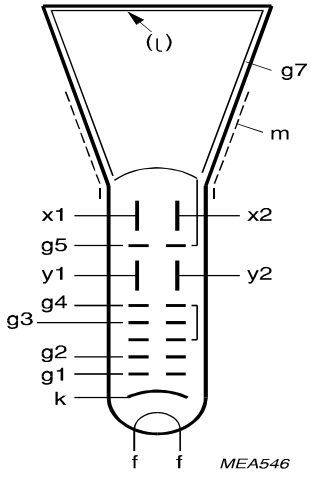


Fig.3 Electrical configuration.

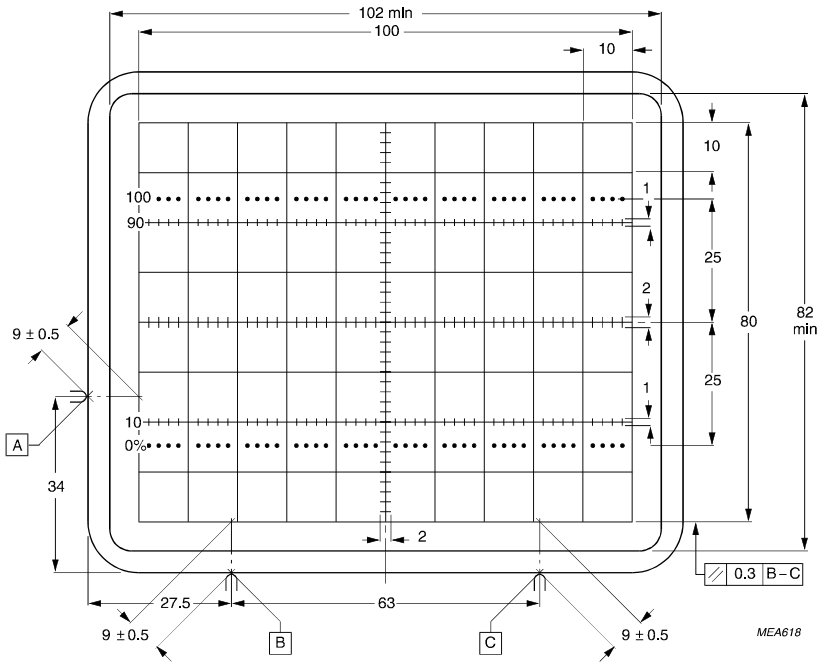


Fig 4. Front view of tube with internal graticule, type 123.

Reference points A,B and C are for aligning the graticule with the faceplate. Line thickness = 0.18 mm; dot diameter = 0.38 mm; colour: red.

TYPICAL OPERATION (voltages with respect to cathode)

Conditions

Final accelerator voltage	$V_{g7(l)}$	10 / 16.5 kV	
Mean deflection plate potential		2 / 2.2 kV	note 2
Shield voltage for optimum geometry	V_{g5}	2 / 2.2 kV	note 3
First accelerator and astigmatism control voltage	V_{g4}	2 / 2.2 kV	note 3
Focusing voltage	V_{g3}	0.19 x V_{g4} to 0.26 x V_{g4}	
Grid 2 voltage	V_{g2}	2 / 2.2 kV	note 9
Cut-off voltage for visual extinction of focused spot	$-V_{g1}$	45 to 90/50 to 100 V	

Outer conductive coating (m) and mu-metal shield to be earthed.

PERFORMANCE

Deflection coefficient			
horizontal	M_x	8.0/8.3 V/cm ± 10%	
vertical	M_y	4.0/4.0 V/cm ± 5%	
Deviation of deflection linearity		≤ 2%	note 4
Geometry distortion			notes 5,6
Eccentricity of undeflected spot			
in horizontal direction		≤ 4 mm	
in vertical direction		≤ 2 mm	
Angle between x- and y- traces		90 ± 0.5°	note 5
Angle between x-trace and x-axis of internal graticule		≤ 5°	note 7
Luminance reduction with respect to screen centre			
x-axis, outer graticule line		≤ 30%	
y-axis, outer graticule line		≤ 30%	
any corner		≤ 50%	
Grid drive for 10 ìA screen current	V_d	approx. 20 V	
Line width	l.w.	approx. 0.33 mm	note 8

LIMITING VALUES (Absolute maximum rating system)

Final accelerator voltage	$V_{g7(l)}$	max. 18 kV	Fig. 6
Shield voltage	V_{g5}	max. 3.3 kV	
First accelerator and astigmatism control voltage	V_{g4}	max. 3.3 kV	
Focusing electrode voltage	V_{g3}	max. 2.5 kV	
Grid 2 voltage	V_{g2}	max. 2.5 kV	
Control grid voltage	$-V_{g1}$	max. 200 V min. 0 V	
Cathode to heater voltage			
positive	V_{kf}	max. 125 V	
negative	$-V_{kf}$	max. 125 V	
Heater voltage	V_f	max. 6.6 V min. 5.7 V	
Voltage between g_2 and g_4	$\triangle V_{g2,g4}$	max. 2 kV	
Voltage between $g_{4,}g_5$ and any deflection plate	$\triangle V_{g4,g5,x,y}$	max. 500 V	
Grid drive, averaged over 1 ms	V_d	max. 25 V	
Screen dissipation	Wl	max. 8 mW/cm^2	
Control grid circuit resistance	R_{g1}	max. 1 MΩ	

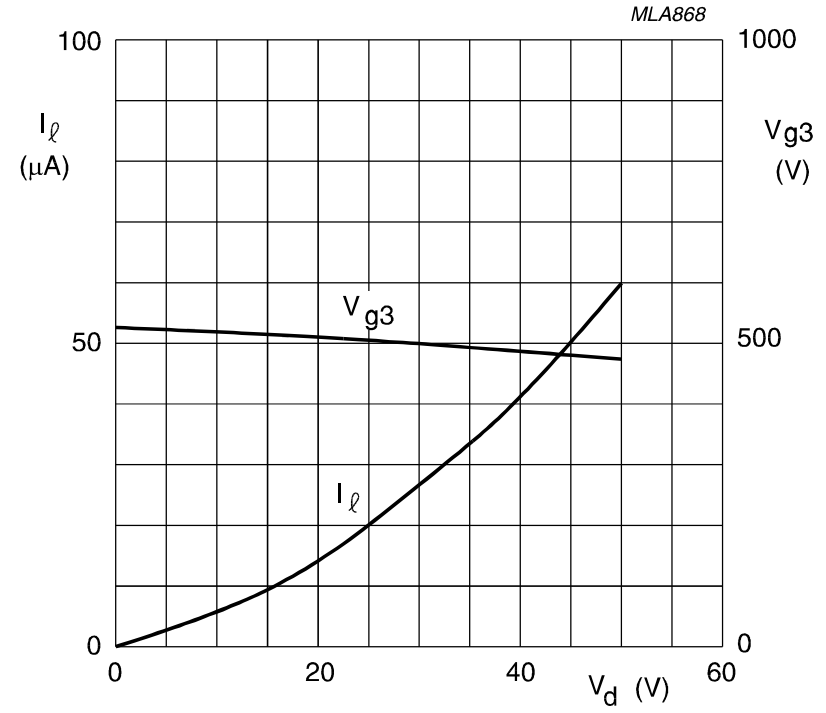


Fig.5 Screen current(I_l) and focusing voltage (V_{g3}) as a function of grid drive voltage (Vd) at V_{g7} = 16.5 kV, V_{g5} = 2.2 kV; typical curves.

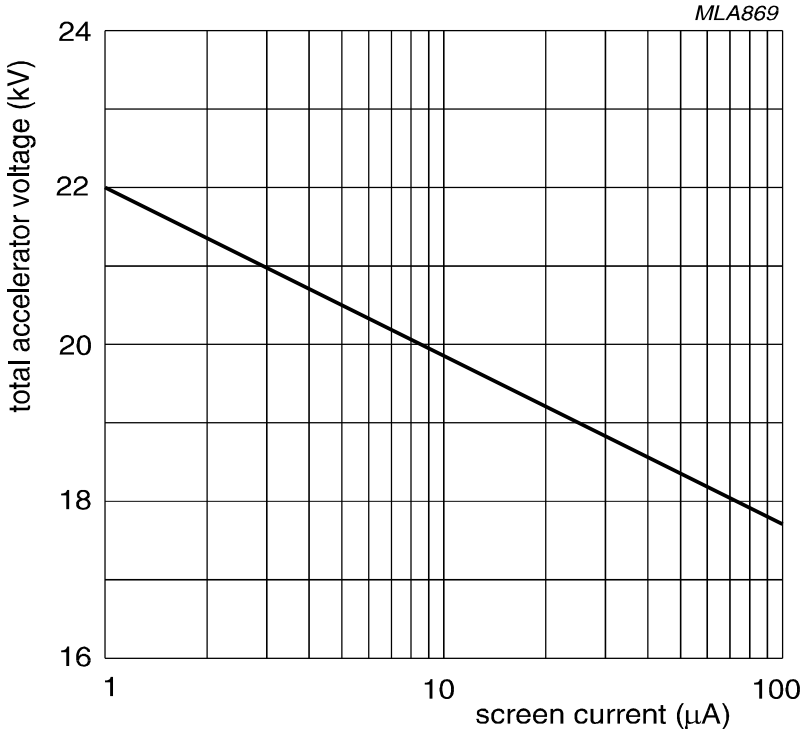


Fig. 6 0.5 mR/h isoexposure-rate limit curve.
Measured according to EIA standard RS-502 , March 1989 (formerly TEPAC 104).

NOTES

1. Because the frit seal is visible through the faceplate, and is not necessarily aligned with the internal graticule, application of an external passe-partout with an open area of max. 102 mm x 82 mm is recommended. The internal graticule is aligned with the faceplate by using the faceplate reference points (see Fig.4).
2. The deflection plates must be operated symmetrically; floating mean x- or y-potentials will result into non-uniform line width and geometry distortion. The mean x- and y-potentials should be equal; under this condition the tube will be within the specification without corrections for astigmatism and geometry (see also note 5).
3. For some applications a mean x-potential up to 50 V positive with respect to mean y-potential is inevitable. In this case V_{g5} must be made equal to mean x-potential, and a range of 0 to -25 V with respect to mean y-potential will be required on g_4 for astigmatism correction. The circuit resistance for V_{g4} should be ≤ 10 kΩ and ≤ 25 kΩ for V_{g5}.
4. The deflection sensitivity over each division will not differ from the average deflection sensitivity measured over the total useful scan by more than the indicated value, in x and y direction.
5. The tube is adjusted by internal permanent magnets for optimum geometry (orthogonality, trapezium and barrel/pin-cushion), brightness uniformity, eccentricity of undeflected spot and astigmatism.
6. A graticule consisting of concentric rectangles of 100 mm x 80 mm and 98.4 mm x 78.6 mm is aligned with the internal graticule. With optimum trace rotation correction the edges of a raster will fall between these rectangles.
7. The tube has a trace rotation coil, fixed onto the lower cone part. The coil has a maximum resistance of 260 Ω at 80 °C. The maximum required voltage is approx. 10 V for tube tolerances and earth magnetic field with reasonable shielding (± 2°).
8. Measured with the shrinking raster method in the centre of the screen under typical operating conditions, adjusted for optimum spot size at a beam current il = 10µA.
9. Grid 2 voltage (V_{g2}) may be used to adjust the cut-off voltage, otherwise it should be connected to V_{g4}. The V_{g1} range changes approximately proportional to V_{g2}.

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INSTRUMENT CATHODE-RAY TUBE

- 14 cm diagonal rectangular flat face
- domed mesh post-deflection acceleration
- high precision by internal permanent magnetic correction system
- internal graticule
- low heater power consumption
- for compact oscilloscopes with typically 40 to 60 MHz bandwidth

QUICK REFERENCE DATA

Final accelerator voltage	$V_{g7(l)}$	12 kV
First accelerator voltage	V_{g4}	2 kV
Deflection coefficient		
horizontal	M_x	10.8 V/cm
vertical	M_y	6.3 V/cm
Minimum useful scan area		100 mm x 80 mm

OPTICAL DATA

Screen	metal-backed phosphor
type	GH
colour	green
persistence	medium short
Useful screen area	≥ 102 mm x 82 mm (note 1)
Useful scan area	≥ 100 mm x 80 mm
Internal graticule	type 123 (see Fig.4)

HEATING

Heater voltage indirect by AC or DC *	V_f	6.3 V
Heater current	I_f	0.1 A
Heating time to attain 10% of the cathode current at equilibrium conditions (approx.)		7 s

* not to be connected in series with other tubes.

MECHANICAL DATA

Dimensions and connections (see also outline drawings)

Overall length (including socket)	max. 330 mm
Faceplate dimensions	118 ± 0.5 mm x 98 ± 0.5 mm
Net mass	approx. 1 kg
Base	12 pin, all glass, JEDEC B12-246
Final Accelerator Contact	JEDEC J1-21

Mounting

The tube can be mounted in any position. It must not be supported by the socket and not by the base region alone. The reference points on adjoining edges of the faceplate (see Fig.4) enable the tube to be positioned accurately in the front panel, for optimum alignment of the internal graticule.

Accessories

Trace rotation coil	3322 138 2260
Socket with printed-wiring pins	type 55595
Final accelerator contact connector	type 55466 (JEDEC J1-21)
Mu-metal shield	type 55458
End rubber	type 55460

FOCUSING	electrostatic
DEFLECTION	double electrostatic
x-plates	symmetrical
y-plates	symmetrical

CAPACITANCES

x_1 to all other elements except x_2	$C_{x1(x2)}$	4.8 pF
x_2 to all other elements except x_1	$C_{x2(x1)}$	3.9 pF
y_1 to all other elements except y_2	$C_{y1(y2)}$	3.0 pF
y_2 to all other elements except y_1	$C_{y2(y1)}$	3.2 pF
x_1 to x_2	C_{x1x2}	2.9 pF
y_1 to y_2	C_{y1y2}	1.2 pF
Control grid to all other elements	C_{g1}	6.5 pF
Cathode to all other elements	C_k	3.2 pF
Focusing electrode to all other elements	C_{g3}	9 pF
Final accelerator electrode to all other elements	C_{g7}	480 pF

DIMENSIONS AND CONNECTIONS

Dimensions in mm

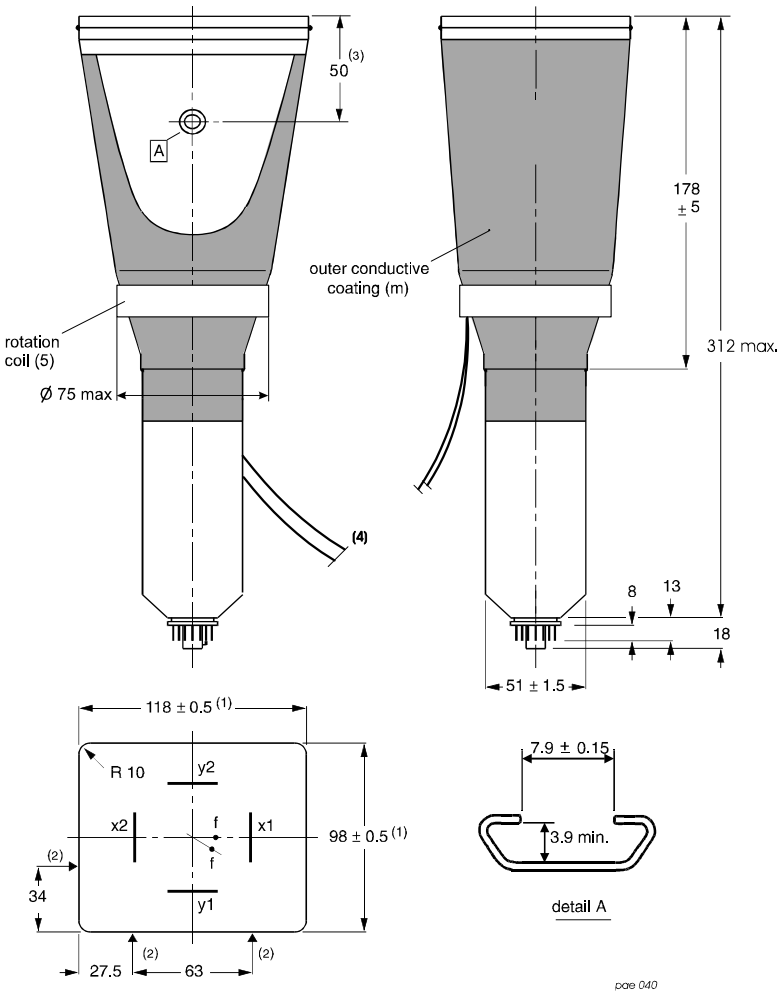


Fig. 1 Mechanical Dimensions

(1) Dimensions of faceplate only. The complete assembly of faceplate and cone (frit seal included) will pass through an opening of 122 mm x 102 mm (diagonal 153 mm).
(2) Reference points on faceplate for graticule alignment (see Fig.4)
(3) The centre of the final accelerator contact is situated within a square of 10 mm x 10 mm around the indicated position.
(4) The length of the rotation coil connecting leads is minimum 350 mm.
(5) The coil is fixed to the envelope with resin.

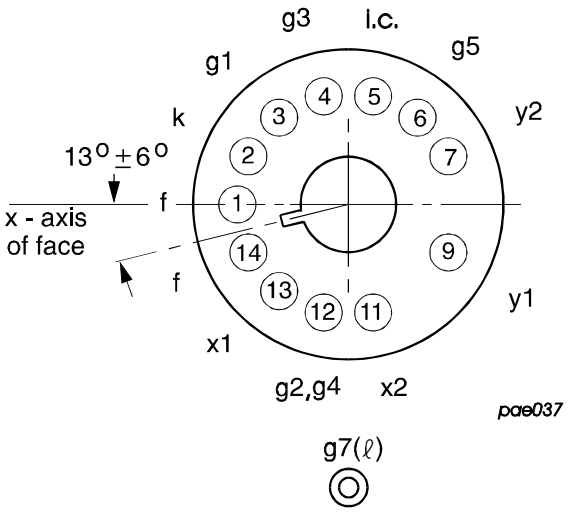


Fig.2 Pin arrangement, bottom view.

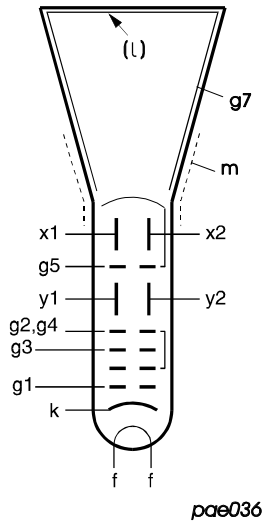


Fig.3 Electrical configuration.

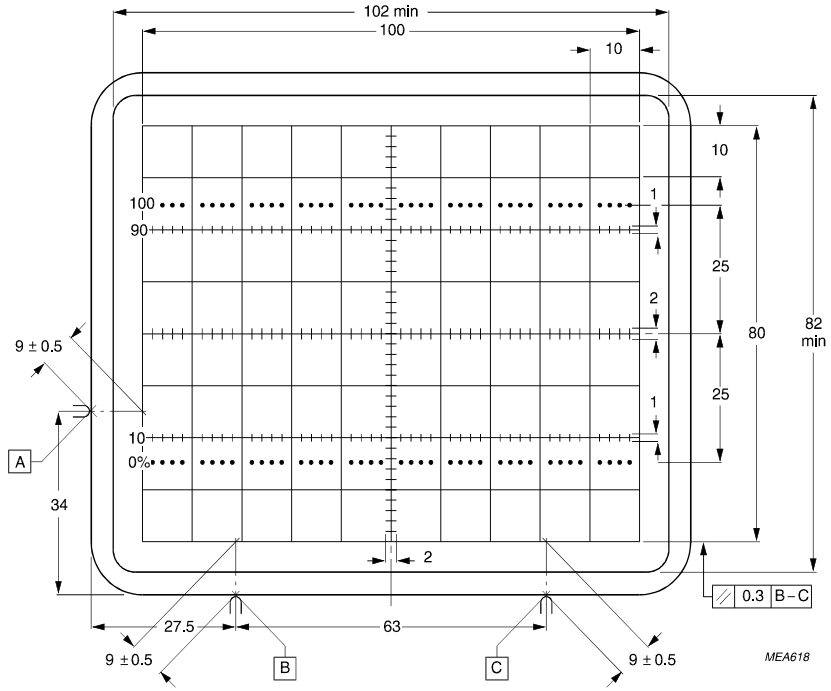


Fig 4. Front view of tube with internal graticule, type 123.

Reference points A,B and C are for aligning the graticule with the faceplate. Line thickness = 0.18 mm; dot diameter = 0.38 mm; colour: red; anode on bottom side.

TYPICAL OPERATION (voltages with respect to cathode)

Conditions

Final accelerator voltage	$V_{g7(l)}$	12 kV	
Mean deflection plate potential		2 kV	note 2
Shield voltage for optimum geometry	V_{g5}	2 kV	note 3
First accelerator and astigmatism			
Control voltage	V_{g4}	2 kV	note 3
Cut-off voltage for visual extinction of focused spot	$-V_{g1}$	45 to 90 V	
Focusing voltage	V_{g3}	0,18 to 0.23 x V_{g4}	

Outer conductive coating (m) and mu-metal shield to be earthed.

PERFORMANCE

Deflection coefficient			
horizontal	M_x	10.8 V/cm ± 10%	
vertical	M_y	6.3 V/cm ± 5%	
Deviation of deflection linearity		≤ 2%	note 4
Geometry distortion			notes 5,6
Eccentricity of undeflected spot			
in horizontal direction		≤ 4 mm	
in vertical direction		≤ 2 mm	
Angle between x- and y- traces		90 ± 0.5°	note 5
Angle between x-trace and x-axis of internal graticule		≤ 5°	
Luminance reduction with respect to screen centre			
x-axis, outer graticule line		≤ 30%	
y-axis, outer graticule line		≤ 30%	
any corner		≤ 50%	
Grid drive for 10 μA screen current	V_d	approx. 30 V	
Line width	l.w.	approx. 0.33 mm	note 7

LIMITING VALUES (Absolute maximum rating system)

Final accelerator voltage	$V_{g7(l)}$	max. 14 kV	Fig. 6
Shield voltage	V_{g5}	max. 2.2 kV	
First accelerator and astigmatism control voltage	V_{g4}	max. 2.2 kV	
Focusing electrode voltage	V_{g3}	max. 2.2 kV	
Grid 2 voltage	V_{g2}	max. 2.2 kV	
Control grid voltage	$-V_{g1}$	max. 200 V	
		min. 0 V	
Cathode to heater voltage			
positive	V_{kf}	max. 125 V	
negative	$-V_{kf}$	max. 125 V	
Heater voltage	V_f	max. 6.6 V	
		min. 5.7 V	
Voltage between g_2 and g_4	$\Delta V_{g2,g4}$	max. 2 kV	
Voltage between g_4,g_5 and any deflection plate	$\Delta V_{g4,g5,x,y}$	max. 500 V	
Grid drive, averaged over 1 ms	V_d	max. 25 V	
Screen dissipation	Wl	max. 8 mW/cm^2	
Control grid circuit resistance	R_{g1}	max. 1 MΩ	

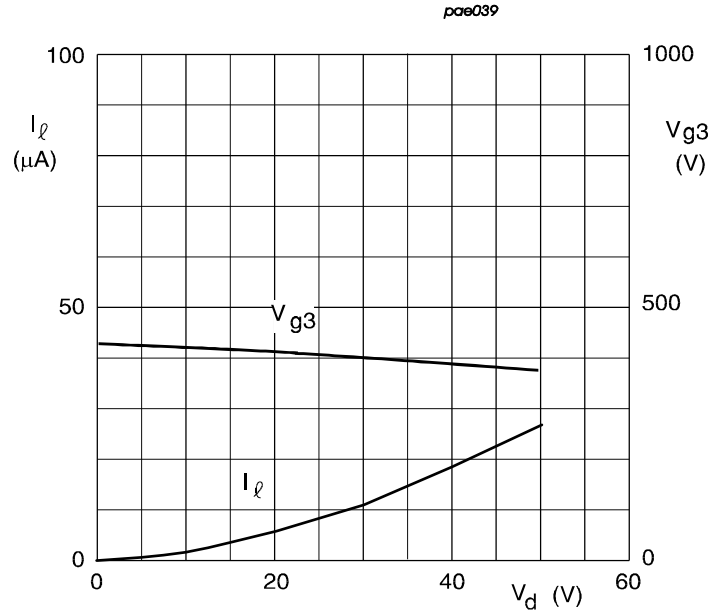


Fig.5 Screencurrent($I_l$and focusing voltage (V_{g3}) as a function of grid drive voltage (Vd) at V_{g7} = 12 kV, V_{g5} = 2 kV; typical curves.

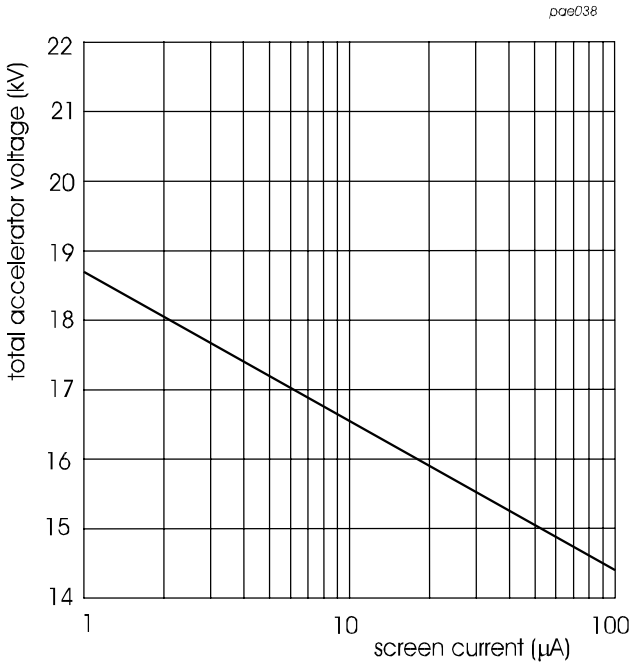


Fig. 6 0.5 mR/h isoexposure-rate limit curve.
Measured according to EIA standard RS-502 , March 1989 (formerly TEPAC 104).

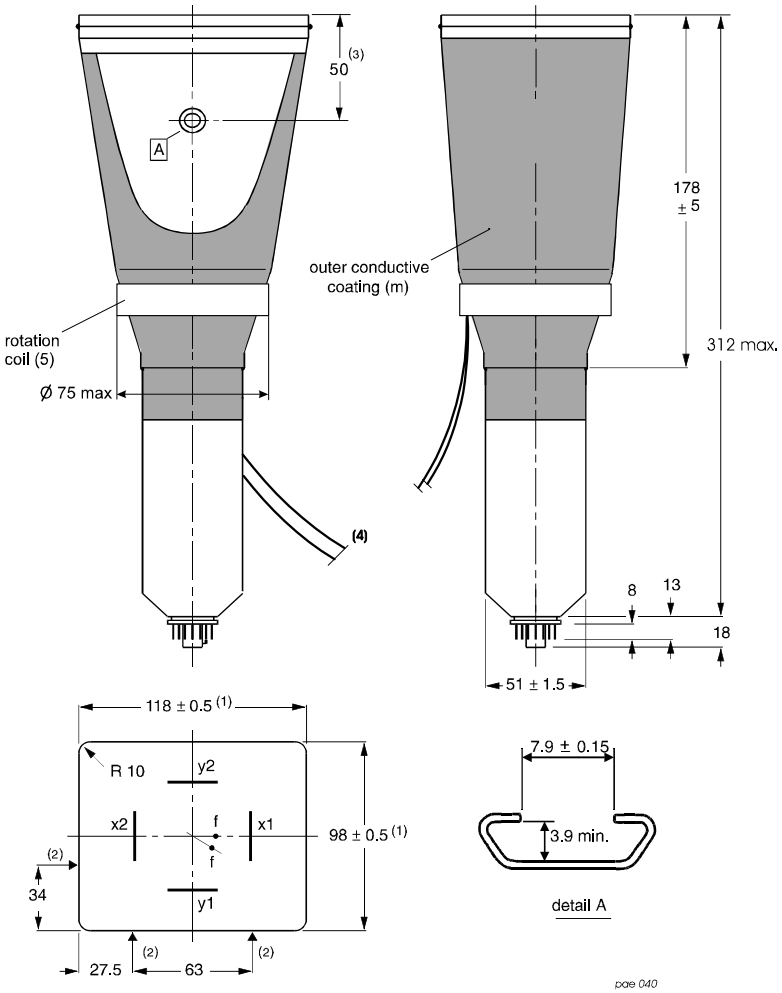
NOTES

1. Because the frit seal is visible through the faceplate, and is not necessarily aligned with the internal graticule, application of an external passe-partout with an open area of max. 102 mm x 82 mm is recommended. The internal graticule is aligned with the faceplate by using the faceplate reference points (see Fig.4).
2. The deflection plates must be operated symmetrically; floating mean x- or y-potentials will result into non-uniform line width and geometry distortion. The mean x- and y-potentials should be equal; under this condition the tube will be within the specification without corrections for astigmatism and geometry (see also note 5).
3. For some applications a mean x-potential up to 50 V positive with respect to mean y-potential is inevitable. In this case V_{g5} must be made equal to mean x-potential, and a range of 0 to -25 V with respect to mean y-potential will be required on g_4 for astigmatism correction. The circuit resistance for V_{g4} should be $\leq$ 10 kΩ and $\leq$ 25 kΩ for V_{g5}.
4. The deflection sensitivity over each division will not differ from the average deflection sensitivity measured over the total useful scan by more than the indicated value, in x and y direction.
5. The tube is adjusted by internal permanent magnets for optimum geometry (orthogonality, trapezium and barrel/pin-cushion), brightness uniformity, eccentricity of undeflected spot and astigmatism.
6. A graticule consisting of concentric rectangles of 100 mm x 80 mm and 98.4 mm x 78.6 mm is aligned with the internal graticule. With optimum trace rotation correction the edges of a raster will fall between these rectangles.
7. Measured with the shrinking raster method in the centre of the screen under typical operating conditions, adjusted for optimum spot size at a beam current Il = 10μA.

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D14-376GH/123
56859 (w/o coil)



INSTRUMENT CATHODE-RAY TUBE

- 14 cm diagonal rectangular flat face
- domed mesh post-deflection acceleration
- improved spot quality for character readout
- high precision by internal permanent magnetic correction system
- internal graticule
- low heater power consumption
- side contacts to deflection plates
- for compact oscilloscopes with up to 200 MHz bandwidth

QUICK REFERENCE DATA

Final accelerator voltage	$V_{g7(l)}$	16 kV
First accelerator voltage	V_{g4}	2 kV
Minimum useful scan area		100 mm x 80 mm
Deflection coefficient		
horizontal	M_x	7.7 V/cm
vertical	M_y	3.6 V/cm

OPTICAL DATA

Screen		metal-backed phosphor
type		GH
colour		green
persistence		medium short
Useful screen area		≥ 102 mm x 82 mm (note 1)
Useful scan area		≥ 100 mm x 80 mm
Internal graticule		type 123 (see Fig.5)

HEATING

Heater voltage indirect by AC or DC *	V_f	6.3 V
Heater current	I_f	0.1 A
Heating time to attain 10% of the cathode current at equilibrium conditions (approx.)		7 s

* not to be connected in series with other tubes.

MECHANICAL DATA

Dimensions and connections (see also outline drawings)

Overall length (including socket)	≤ 344 mm
Faceplate dimensions	118 ± 0.5 mm x 98 ± 0.5 mm
Net mass	approx. 1 kg
Base	12 pin, all glass, JEDEC B12-246
Final Accelerator Contact	JEDEC J1-21

Mounting

The tube can be mounted in any position. It must not be supported by the socket and not by the base region alone. The reference points on adjoining edges of the faceplate (see Fig.5) enable the tube to be positioned accurately in the front panel, for optimum alignment of the internal graticule.

Accessories

Pin protector (required for shipping)	supplied with tube
Socket with solder tags	type 55594
Socket with printed-wiring pins	type 55595
Final accelerator contact connector	type 55466 (JEDEC J1-21)
Side contact connector for Ø 0.65 mm pin (4 required)	type 55596 (AMP 87313)
Mu-metal shield	type 55458/55459 with end rubber 55460

FOCUSING	electrostatic
DEFLECTION	double electrostatic
x-plates	symmetrical
y-plates	symmetrical

CAPACITANCES

x_1 to all other elements except x_2	$C_{x1(x2)}$	2.4 pF
x_2 to all other elements except x_1	$C_{x2(x1)}$	2.5 pF
y_1 to all other elements except y_2	$C_{y1(y2)}$	1.9 pF
y_2 to all other elements except y_1	$C_{y2(y1)}$	2.0 pF
x_1 to x_2	C_{x1x2}	3.2 pF
y_1 to y_2	C_{y1y2}	1.5 pF
Control grid to all other elements	C_{g1}	7.2 pF
Cathode to all other elements	C_k	3.6 pF
Focusing electrode to all other elements	C_{g3}	9 pF
Final accelerator electrode to all other elements	C_{g7}	480 pF

DIMENSIONS AND CONNECTIONS

Dimensions in mm

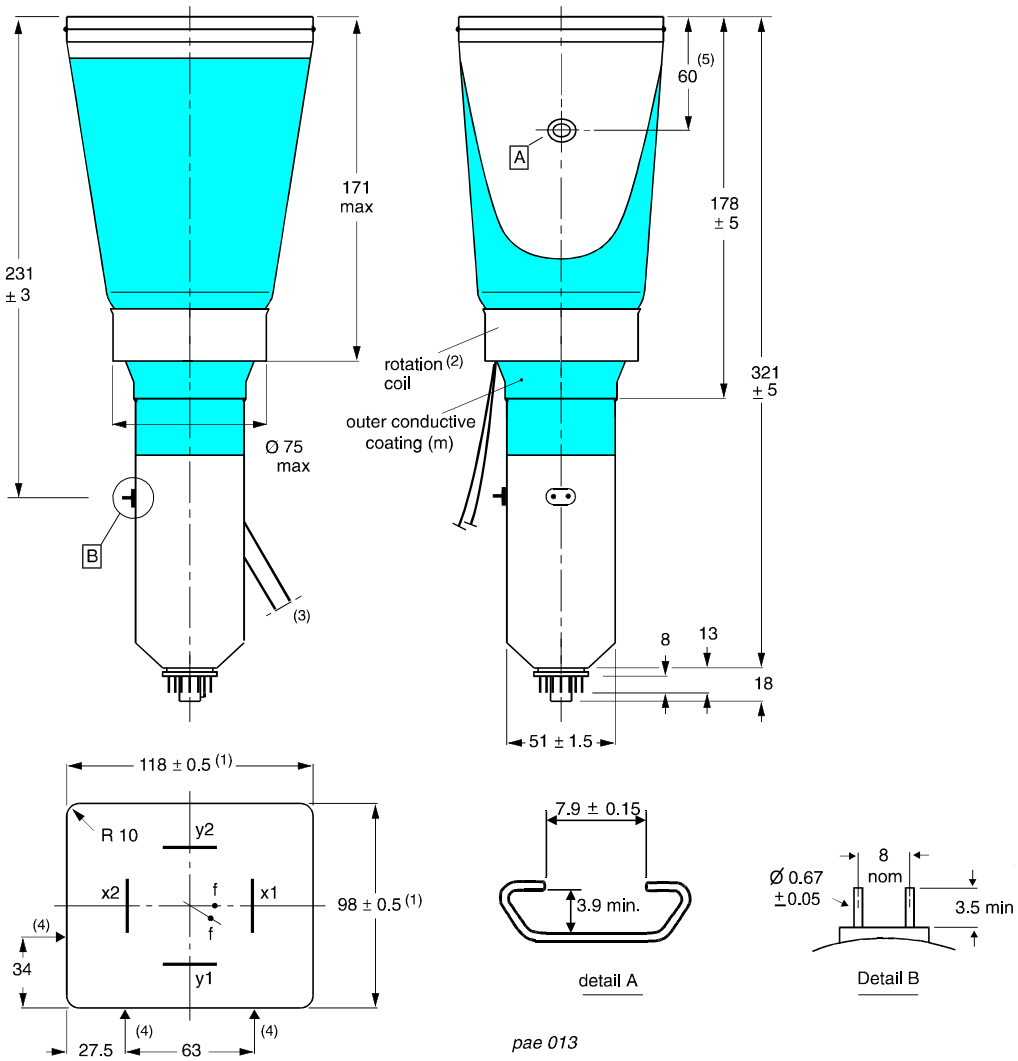


Fig.1 Mechanical outlines.

(1) Dimensions of faceplate only. The complete assembly of faceplate and cone (frit seal included) will pass through an opening of 122 mm x 102 mm (diagonal 153 mm).
(2) The coil is fixed to the envelope with resin and adhesive tape.
(3) The length of the rotation coil connecting leads is minimum 350 mm.
(4) Reference points on faceplate for graticule alignment (see Fig.5)
(5) The centre of the final accelerator contact is situated within a square of 10 mm x 10 mm around the indicated position.

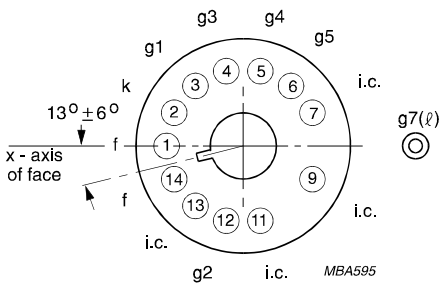
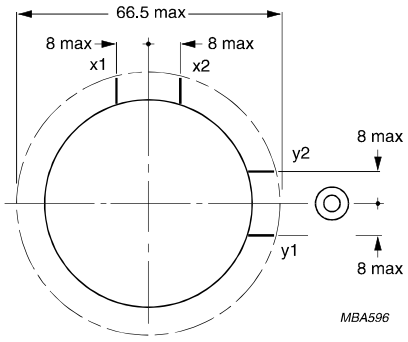


Fig.2 Pin arrangement, bottom view.



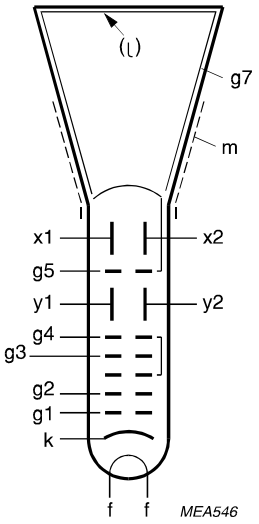


Fig.3 Side contact arrangement; bottom view

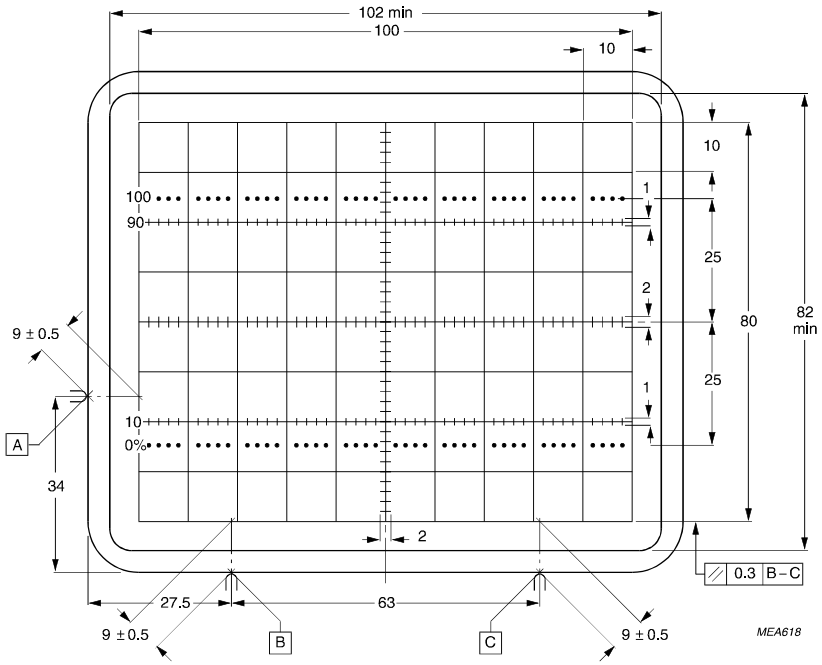


Fig 5. Front view of tube with internal graticule, type 123.

Reference points A,B and C are for aligning the graticule with the faceplate. Line thickness = 0.18 mm; dot diameter = 0.38 mm; colour: red.

TYPICAL OPERATION (voltages with respect to cathode)

Conditions

Final accelerator voltage	$V_{g7(l)}$	16 kV	
Mean deflection plate potential		2 kV	note 2
Shield voltage for optimum geometry	V_{g5}	2 kV	note 3
First accelerator and astigmatism control voltage	V_{g4}	2 kV	note 3
Focusing voltage	V_{g3}	440 to 560 V	
Grid 2 voltage	V_{g2}	2 kV	note 9
Cut-off voltage for visual extinction of focused	V_{g1}	55 to 100 V	note 9

Outer conductive coating (m) and mu-metal shield to be earthed.

PERFORMANCE

Deflection coefficient			
horizontal	M_x	7.7 V/cm ± 10%	
vertical	M_y	3.6 V/cm ± 5%	
Deviation of deflection linearity		≤ 2%	note 4
Geometry distortion			notes 5,6
Eccentricity of undeflected spot			
in horizontal direction		≤ 4 mm	
in vertical direction		≤ 2 mm	
Angle between x- and y- traces		90 ± 0.5°	note 5
Angle between x-trace and x-axis of internal graticule		≤ 5°	note 7
Luminance reduction with respect to screen centre			
x-axis, outer graticule line		≤ 30%	
y-axis, outer graticule line		≤ 30%	
any corner		≤ 50%	
Grid drive for 10 μA screen current	V_d	approx. 30 V	Fig.6
Line width	l.w.	approx. 0.3 mm	note 8

LIMITING VALUES (Absolute maximum rating system)

Final accelerator voltage		$V_{g7(l)}$	max. 18 kV	Fig. 7
Shield voltage		V_{g5}	max. 3.3 kV	
First accelerator and astigmatism control voltage	V_{g4}		max. 3.3 kV	
Focusing electrode voltage		V_{g3}	max. 2.5 kV	
Grid 2 voltage		V_{g2}	max. 2.5 kV	
Control grid voltage		$-V_{g1}$	max. 200 V min. 0 V	
Cathode to heater voltage				
positive		V_{kf}	max. 125 V	
negative		$-V_{kf}$	max. 125 V	
Heater voltage	V_f		max. 6.6 V min. 5.7 V	
Voltage between g_2 and g_4		$\Delta V_{g2,g4}$	max. 2 kV	
Voltage between g_4,g_5 and any deflection plate		$\Delta V_{g4,g5,x,y}$	max. 500 V	
Grid drive, averaged over 1 ms	V_d		max. 25 V	
Screen dissipation		WI	max. 8 mW/cm^2	
Control grid circuit resistance		R_{g1}	max. 1 MΩ	

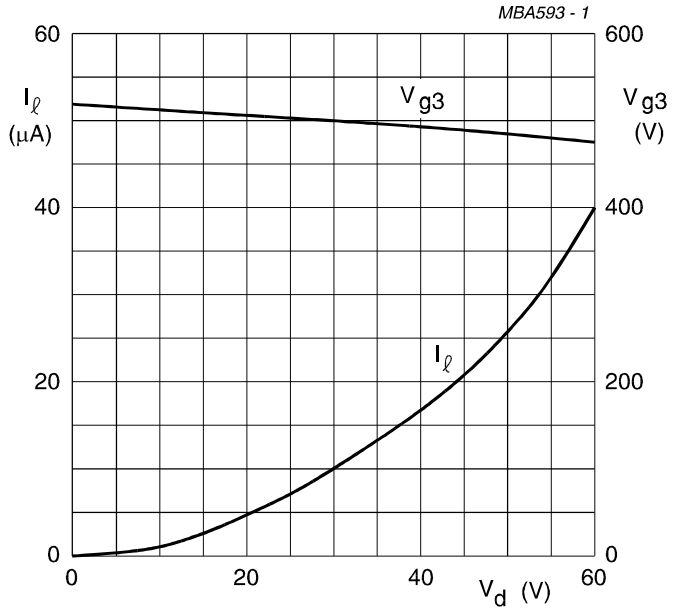


Fig.6 Screen current(I_l) and focusing voltage (V_{g3}) as a function of grid drive voltage (Vd) at V_{g7} = 16 kV, V_{g5} = 2 kV; typical curves.

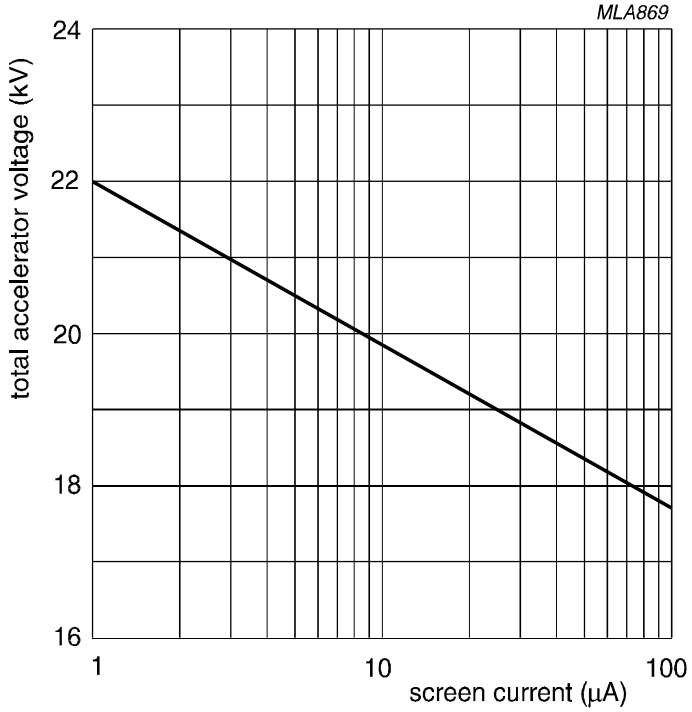


Fig. 7 0.5 mR/h isoexposure-rate limit curve.
Measured according to EIA standard RS-502 , March 1989 (formerly TEPAC 104).

NOTES

1. Because the frit seal is visible through the faceplate, and is not necessarily aligned with the internal graticule, application of an external mask, or bezel, with an open area of max. 102 mm x 82 mm is recommended. The internal graticule is aligned with the faceplate by using the faceplate reference points (see Fig.5).

2. The deflection plates must be operated symmetrically; floating mean x- or y-potentials will resultinto non-uniform line width and geometry distortion. The mean x- and y-potentials should be equal; under this condition the tube will be within the specification without corrections for astigmatism and geometry (see also note 5).

3. For some applications a mean x-potential up to 50 V positive with respect to mean y-potential isinevitable. In this case V_{g5} must be made equal to mean x-potential, and a range of 0 to -25 V with respect to mean y-potential will be required on g_4 for astigmatism correction. The circuit resistance for V_{g4} should be ≤ 10 kΩ and ≤ 25 kΩ for V_{g5}.

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

5. The tube is adjusted by internal permanent magnets for optimum geometry (orthogonality, trapezium and barrel/pin-cushion), brightness uniformity, eccentricity of undeflected spot and astigmatism.

6. A graticule consisting of concentric rectangles of 100 mm x 80 mm and 98.4 mm x 78.6 mm isaligned with the internal graticule. With optimum trace rotation correction the edges of a raster will fall between these rectangles.

7. The tube has a trace rotation coil, fixed onto the lower cone part. The coil has a maximum resistance of 260 Ω at 80 °C. The maximum required voltage is approx. 13 V for tube tolerances and earth magnetic field with reasonable shielding (± 2°).

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

9. Grid 2 voltage (V_{g2}) may be used to adjust the cut-off voltage, otherwise it should be connected to V_{g4}. The V_{g1} range changes approximately proportional to V_{g2}.

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INSTRUMENT CATHODE-RAY TUBE

- 14 cm diagonal rectangular flat face
- domed mesh post-deflection acceleration
- improved spot quality for character readout
- high precision by internal permanent magnetic correction system
- internal graticule
- low heater power consumption
- side contacts to deflection plates
- for compact oscilloscopes with up to 200 MHz bandwidth

QUICK REFERENCE DATA

Final accelerator voltage	$V_{g7(l)}$	16 kV
First accelerator voltage	V_{g4}	2 kV
Minimum useful scan area		100 mm x 80 mm
Deflection coefficient		
horizontal	M_x	7.7 V/cm
vertical	M_y	3.6 V/cm

OPTICAL DATA

Screen	metal-backed phosphor
type	GH
colour	green
persistence	medium short
Useful screen area	≥ 102 mm x 82 mm (note 1)
Useful scan area	≥ 100 mm x 80 mm
Internal graticule	type 123 (see Fig.5)

HEATING

Heater voltage indirect by AC or DC *	V_f	6.3 V
Heater current	I_f	0.1 A
Heating time to attain 10% of the cathode current at equilibrium conditions (approx.)		7 s

* not to be connected in series with other tubes.

MECHANICAL DATA

Dimensions and connections (see also outline drawings)

Overall length (including socket)	≤ 344 mm
Faceplate dimensions	118 ± 0.5 mm x 98 ± 0.5 mm
Net mass	approx. 1 kg
Base	12 pin, all glass, JEDEC B12-246
Final Accelerator Contact	JEDEC J1-21

Mounting

The tube can be mounted in any position. It must not be supported by the socket and not by the base region alone. The reference points on adjoining edges of the faceplate (see Fig.5) enable the tube to be positioned accurately in the front panel, for optimum alignment of the internal graticule.

Accessories

Pin protector (required for shipping)	supplied with tube
Socket with solder tags	type 55594
Socket with printed-wiring pins	type 55595
Final accelerator contact connector	type 55466 (JEDEC J1-21)
Side contact connector for Ø 0.65 mm pin (4 required)	type 55596 (AMP 87313)
Mu-metal shield	type 55458/55459 with end rubber 55460
FOCUSING	electrostatic
DEFLECTION	double electrostatic
x-plates	symmetrical
y-plates	symmetrical

CAPACITANCES

x_1 to all other elements except x_2	$C_{x1(x2)}$	2.2 pF
x_2 to all other elements except x_1	$C_{x2(x1)}$	2.3 pF
y_1 to all other elements except y_2	$C_{y1(y2)}$	1.7 pF
y_2 to all other elements except y_1	$C_{y2(y1)}$	1.8 pF
x_1 to x_2	C_{x1x2}	3.0 pF
y_1 to y_2	C_{y1y2}	1.3 pF
Control grid to all other elements	C_{g1}	7.2 pF
Cathode to all other elements	C_k	3.6 pF
Focusing electrode to all other elements	C_{g3}	9 pF
Final accelerator electrode to all other elements	C_{g7}	480 pF

DIMENSIONS AND CONNECTIONS

Dimensions in mm

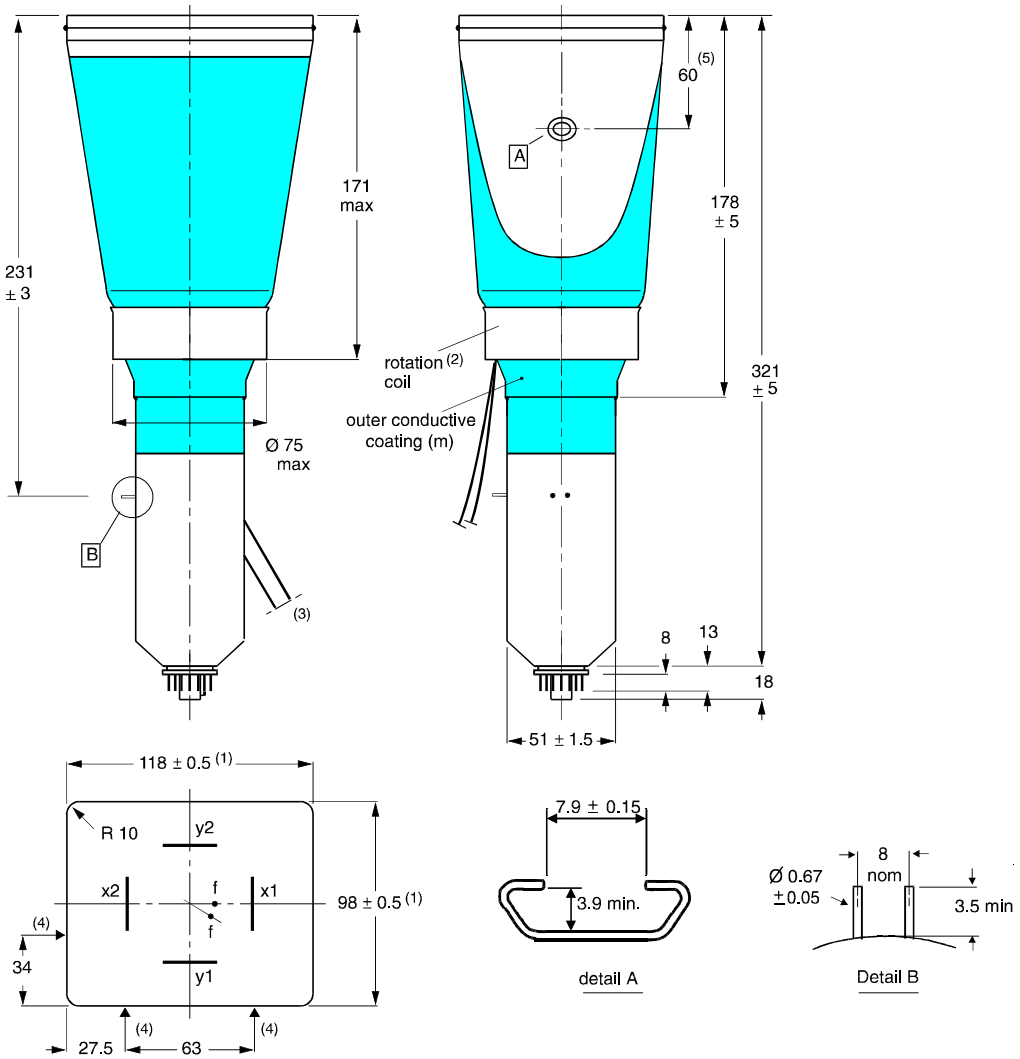


Fig. 1 Mechanical Outlines

(1) Dimensions of faceplate only. The complete assembly of faceplate and cone (frit seal included) will pass through an opening of 122 mm x 102 mm (diagonal 153 mm).
(2) The coil is fixed to the envelope with resin and adhesive tape.
(3) The length of the rotation coil connecting leads is minimum 350 mm.
(4) Reference points on faceplate for graticule alignment (see Fig.5)
(5) The centre of the final accelerator contact is situated within a square of 10 mm x 10 mm around the indicated position.

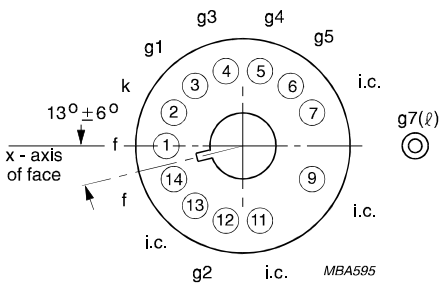
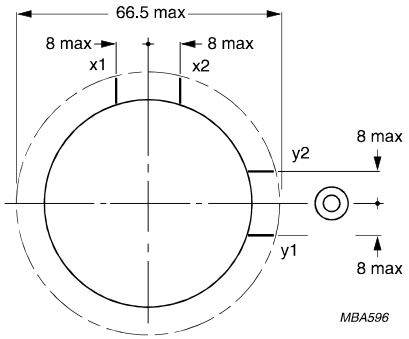


Fig.2 Pin arrangement, bottom view.



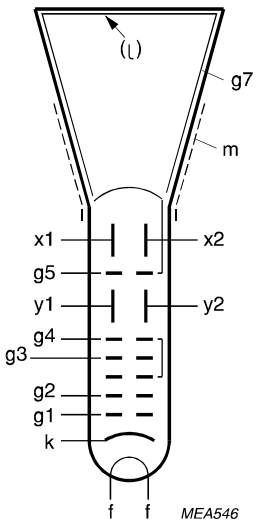


Fig.3 Side contact arrangement; bottom view

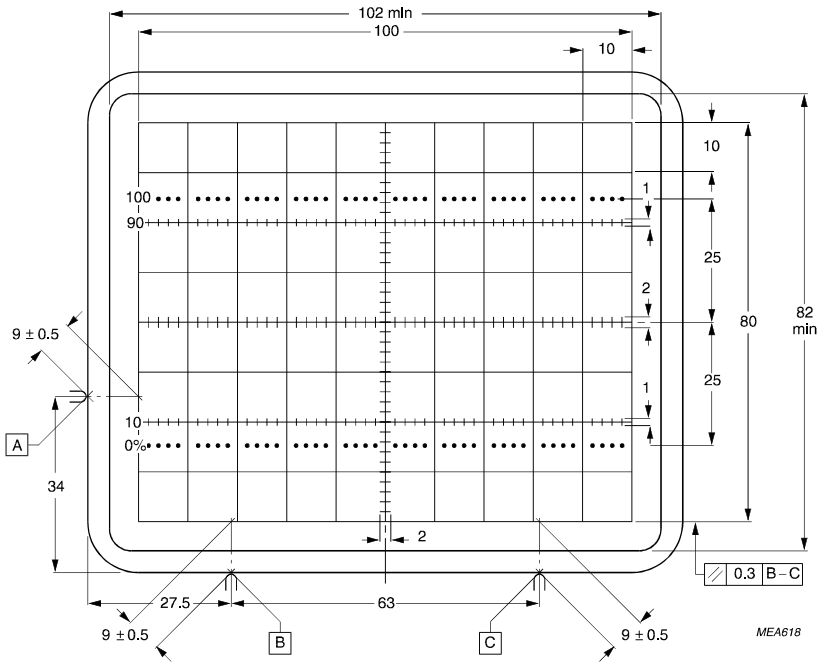


Fig 5. Front view of tube with internal graticule, type 123.

Reference points A,B and C are for aligning the graticule with the faceplate. Line thickness = 0.18 mm; dot diameter = 0.38 mm; colour: red.

TYPICAL OPERATION (voltages with respect to cathode)

Conditions

Final accelerator voltage	$V_{g7(l)}$	16 kV	
Mean deflection plate potential		2 kV	note 2
Shield voltage for optimum geometry	V_{g5}	2 kV	note 3
First accelerator and astigmatism control voltage	V_{g4}	2 kV	note 3
Focusing voltage	V_{g3}	440 to 560 V	
Grid 2 voltage	V_{g2}	2 kV	note 9
Cut-off voltage for visual extinction of focused	V_{g1}	55 to 100 V	note 9

Outer conductive coating (m) and mu-metal shield to be earthed.

PERFORMANCE

Deflection coefficient			
horizontal	M_x	7.7 V/cm ± 10%	
vertical	M_y	3.6 V/cm ± 5%	
Deviation of deflection linearity		≤ 2%	note 4
Geometry distortion			notes 5,6
Eccentricity of undeflected spot			
in horizontal direction		≤ 4 mm	
in vertical direction		≤ 2 mm	
Angle between x- and y- traces		90 ± 0.5°	note 5
Angle between x-trace and x-axis of internal graticule		≤ 5°	note 7
Luminance reduction with respect to screen centre			
x-axis, outer graticule line		≤ 30%	
y-axis, outer graticule line		≤ 30%	
any corner		≤ 50%	
Grid drive for 10 μA screen current	V_d	approx. 30 V	Fig.6
Line width	l.w.	approx. 0.3 mm	note 8

LIMITING VALUES (Absolute maximum rating system)

Final accelerator voltage	$V_{g7(l)}$	max. 18 kV	Fig. 7
Shield voltage	V_{g5}	max. 3.3 kV	
First accelerator and astigmatism control voltage	V_{g4}	max. 3.3 kV	
Focusing electrode voltage	V_{g3}	max. 2.5 kV	
Grid 2 voltage	V_{g2}	max. 2.5 kV	
Control grid voltage	$-V_{g1}$	max. 200 V min. 0 V	
Cathode to heater voltage			
positive	V_{kf}	max. 125 V	
negative	$-V_{kf}$	max. 125 V	
Heater voltage	V_f	max. 6.6 V min. 5.7 V	
Voltage between g_2 and g_4	$\Delta V_{g2,g4}$	max. 2 kV	
Voltage between $g_{4,}g_5$ and any deflection plate	$\Delta V_{g4,g5,x,y}$	max. 500 V	
Grid drive, averaged over 1 ms	V_d	max. 25 V	
Screen dissipation	WI	max. 8 mW/cm^2	
Control grid circuit resistance	R_{g1}	max. 1 MΩ	

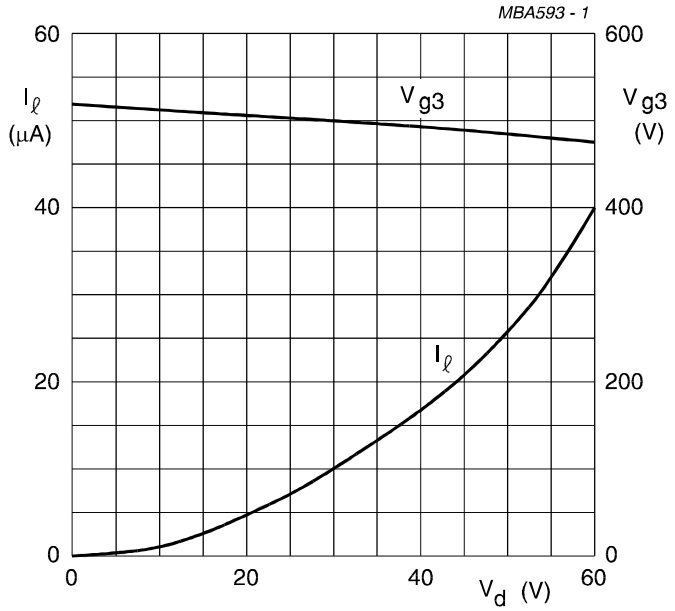


Fig.6 Screen current(I_l) and focusing voltage (V_{g3}) as a function of grid drive voltage (Vd) at V_{g7} = 16 kV, V_{g5} = 2 kV; typical curves.

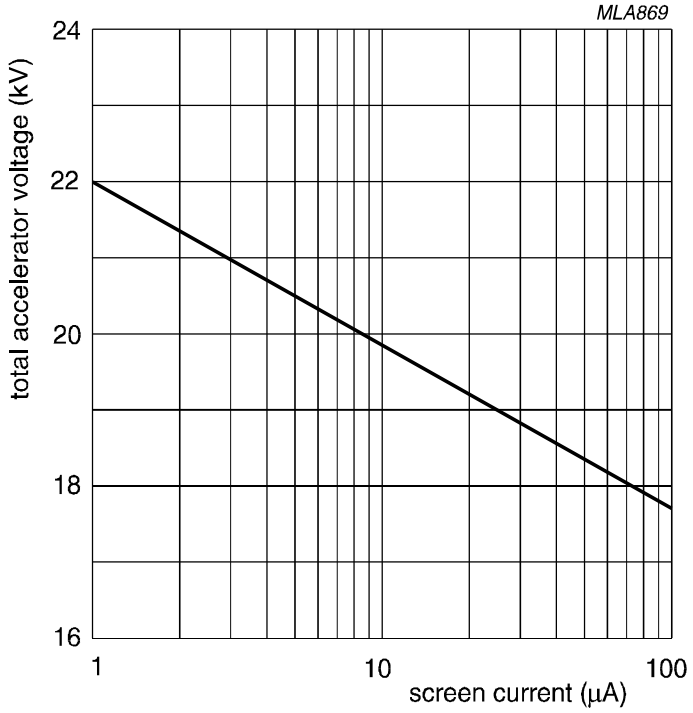


Fig. 7 0.5 mR/h isoexposure-rate limit curve.
Measured according to EIA standard RS-502 , March 1989 (formerly TEPAC 104).

NOTES

1. Because the frit seal is visible through the faceplate, and is not necessarily aligned with the internal graticule, application of an external mask, or bezel, with an open area of max. 102 mm x 82 mm is recommended. The internal graticule is aligned with the faceplate by using the faceplate reference points (see Fig.5).

2. The deflection plates must be operated symmetrically; floating mean x- or y-potentials will resultinto non-uniform line width and geometry distortion. The mean x- and y-potentials should be equal; under this condition the tube will be within the specification without corrections for astigmatism and geometry (see also note 5).

3. For some applications a mean x-potential up to 50 V positive with respect to mean y-potential isinevitable. In this case V_{g5} must be made equal to mean x-potential, and a range of 0 to -25 V with respect to mean y-potential will be required on g_4 for astigmatism correction. The circuit resistance for V_{g4} should be $\leq$ 10 kΩ and $\leq$ 25 kΩ for V_{g5}.

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

5. The tube is adjusted by internal permanent magnets for optimum geometry (orthogonality, trapezium and barrel/pin-cushion), brightness uniformity, eccentricity of undeflected spot and astigmatism.

6. A graticule consisting of concentric rectangles of 100 mm x 80 mm and 98.4 mm x 78.6 mm isaligned with the internal graticule. With optimum trace rotation correction the edges of a raster will fall between these rectangles.

7. The tube has a trace rotation coil, fixed onto the lower cone part. The coil has a maximum resistance of 260 Ω at 80 °C. The maximum required voltage is approx. 13 V for tube tolerances and earth magnetic field with reasonable shielding (± 2°).

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

9. Grid 2 voltage (V_{g2}) may be used to adjust the cut-off voltage, otherwise it should be connected to V_{g4}. The V_{g1} range changes approximately proportional to V_{g2}.

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PDS
Professional Display Systems B.V.

Preliminary SPECIFICATION

M41EAA250WB00

41 cm / 17 inch
rectangular monochrome CRT
landscape format

Modifications may be agreed upon after evaluation of about 200 products

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Application

For displays in medical and alphanumerical applications.

Technical responsibility

The committed details in this specification are obligatory upon both parties.

Changes and supplements to this specification during the development require the agreement of all persons responsible.

Responsible for the contents of this document are:

Company/Department	*Name*	*Tel.*	*Date*	*Signature*

Distribution list

	Name	Date	Release #	Copy #
			1.0	
			1.0	

Characteristics

- High resolution
- 110° 29 mm neck
- High contrast
- High luminance
- Flat & square colour bulb (low browning glass)
- Multicoated panel
- Conductive coated against charging
- Intrinsically safe
- Long life time
- Low phosphor noise
- Low drift
- Protected against internal flash

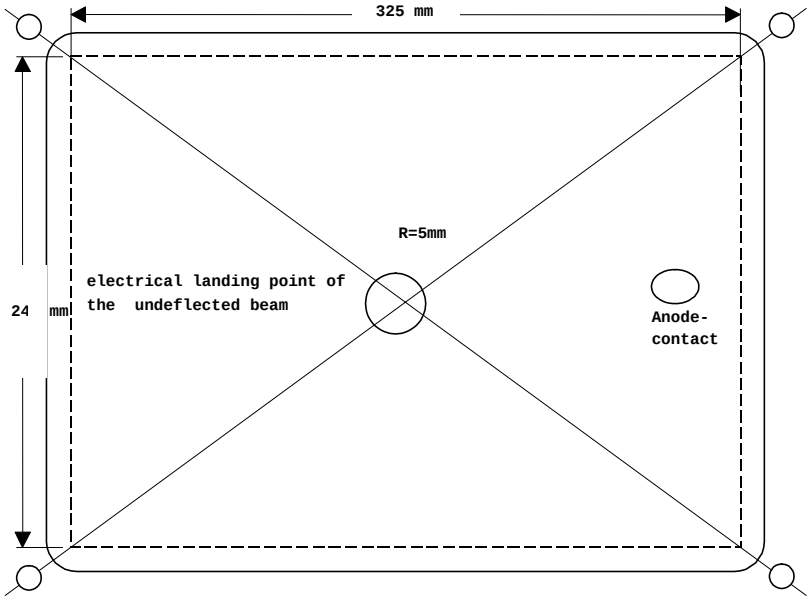
Important notes

Implosion hazard	CRT's are evacuated. In case of mechanical damage (e.g. by shock or scratches) implosion may occur.
CRT is labelled according	UL 1418 MPR II
High voltage	For reasons of the CRT's capacities, the anode connection can conduct high voltage for a long time after high voltage has been switched off.
X-ray emission	When operating the CRT within the limits, the x-ray dose rate will be under the allowed value of 1 µSv/h (equivalent to: 0.1 mR/h). The tube is an intrinsic CRT type according the RöV (German Röntgenverordnung) dated Jan, 8th 1987, Part I; Attachment III, paragraph 6.

Mechanical data

Useful screen	- Screen diagonal - Screen width - Screen height	min. 409.8 mm min. 329.0 mm min. 248.1 mm
Inner radius of glass-bulb panel	Diagonal Axis Long Axis Short Axis	R = 1130 mm R = 1130 mm R = 1130 mm
Position of operation	Anode connector on the right side (front view)	
Socket	JEDEC B7-218	
Neck diameter	28.6 ± 0.7 mm	
Anode connector	Bulb contact 7.92	J1–21
Deflection yoke	-	
Weight	Approx. 7,2 kg	
Mechanical outlines Overall length Base Configuration	See attachment 1) max. 315 mm See attachment 2)	

Maximum of non-deflected spot landing

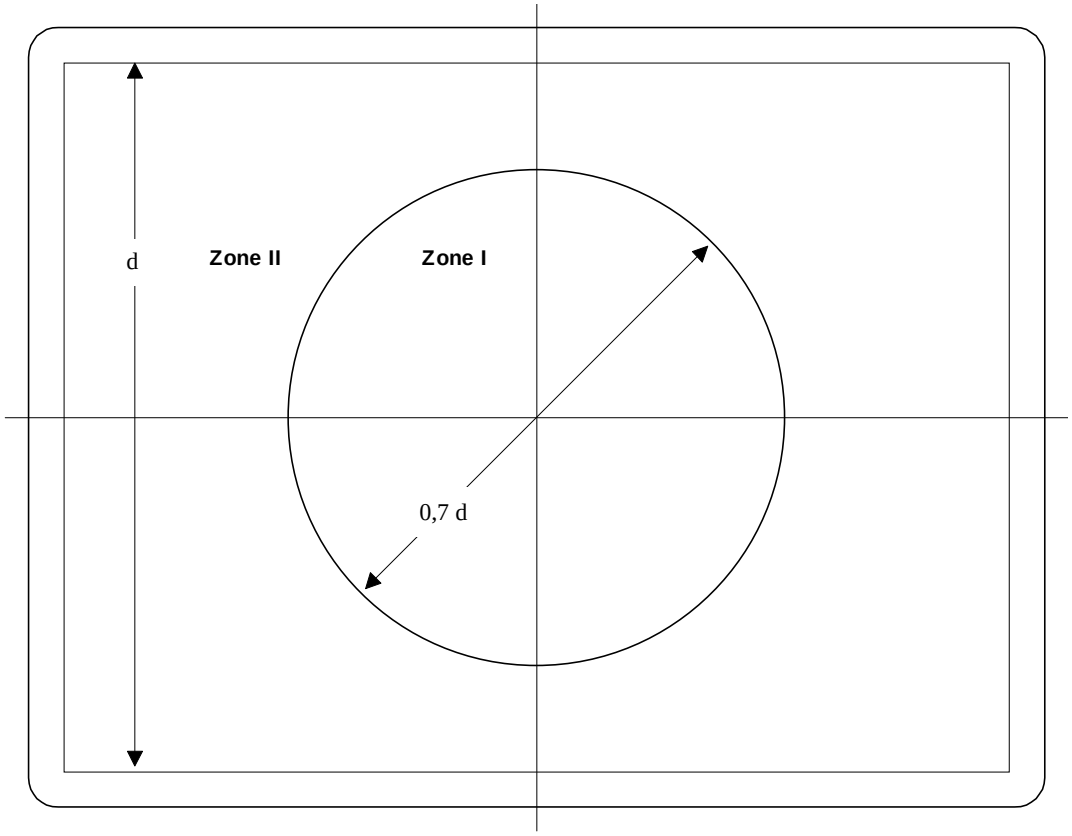


- Phosphor material must be everywhere within a window of 244 × 325 mm. The centre of that phosphor window matches the mechanical centre of the CRT.
- The non-deflected spot landing must be within a circle with a radius of 3 mm around a point 3 mm left and 2 mm down from the mechanical centre of the CRT, provided that:
  - the CRT axis is in east-west direction and the front panel is facing east,
  - the anode connector is located on the right,
  - the deflection unit has been mounted to the tube,
  - there is a metal shield behind the deflection unit around the tube neck.
- The maximum rotation angle of the deflection unit may not exceed 0.2°.

Optical data

Total transmission of bulb including coating / panel.	Approx. 27 % at 546 nm	
Phosphor	P45	
Colour co-ordinates: (during operation at a luminance of 250 cd/m^2)	x = 0.250 ± 0.01 y = 0.320 ± 0.01	measured with LMT Colormeter or Minolta CA100 adjusted to P45
Front panel	Transmission 60 % (at 546 nm) Pilkington / Flabeg OEL-65 or equivalent Anti-static < 2 kΩ/□ The connection of the coating with the mounting device will be guaranteed 100 000 switch-on / switch-off cycles.	
Uniformity of luminance	At a luminance level of 60 cd/m^2 the luminance deviation between the centre and any point of the screen may not exceed 15 cd/m^2.	
Glass bulb	NEG 17” 110° H28.6 or equivalent	
Copper Strip Connection	See attachment 2	
Getter mounting	On top of gun	
Silicon diameter	> 80 mm	
Label Location	See attachment 1)	

Permissible Glass and Screen Defects

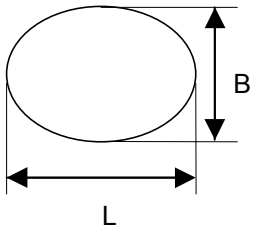


d = 244 mm

Defect size G for the screen and glass specification

L: max. lenght of defect

B: max. width of defect



for a side ratio of $L/B \leq 3$ $G = (L + B)/2$

for a side ratio of $L/B > 3$ $G = L/20 + 2B$

Permissible defects inclusive Panel

Defect size G in mm	Number of defects		
	Zone I	Zone II	Sum [1]
≤ 0.2	Any, but no accumulation		
0.2 < G ≤ 0.4	2	3	4
0.4 < G ≤ 0.6	-	3	3
Distance between defects	≥ 50 mm	≥ 50 mm	

[1] Maximum number of all defects in zone I + II : 4

The maximum number of phosphor defects with defect size 0,1 < G ≤ 0,2 within in area of 30 × 30 mm : 3.

Permissible panel scratches:

Sum ≤ 2, distance ≥ 50 mm, max. length/scratch ≤ 10 mm, max. width ≤ 50 µm.

All defects are measured with Peak Stand Micro 25×

Resolution (at 50 % of peak value)

Limiting values

625 lines / 25 Hz

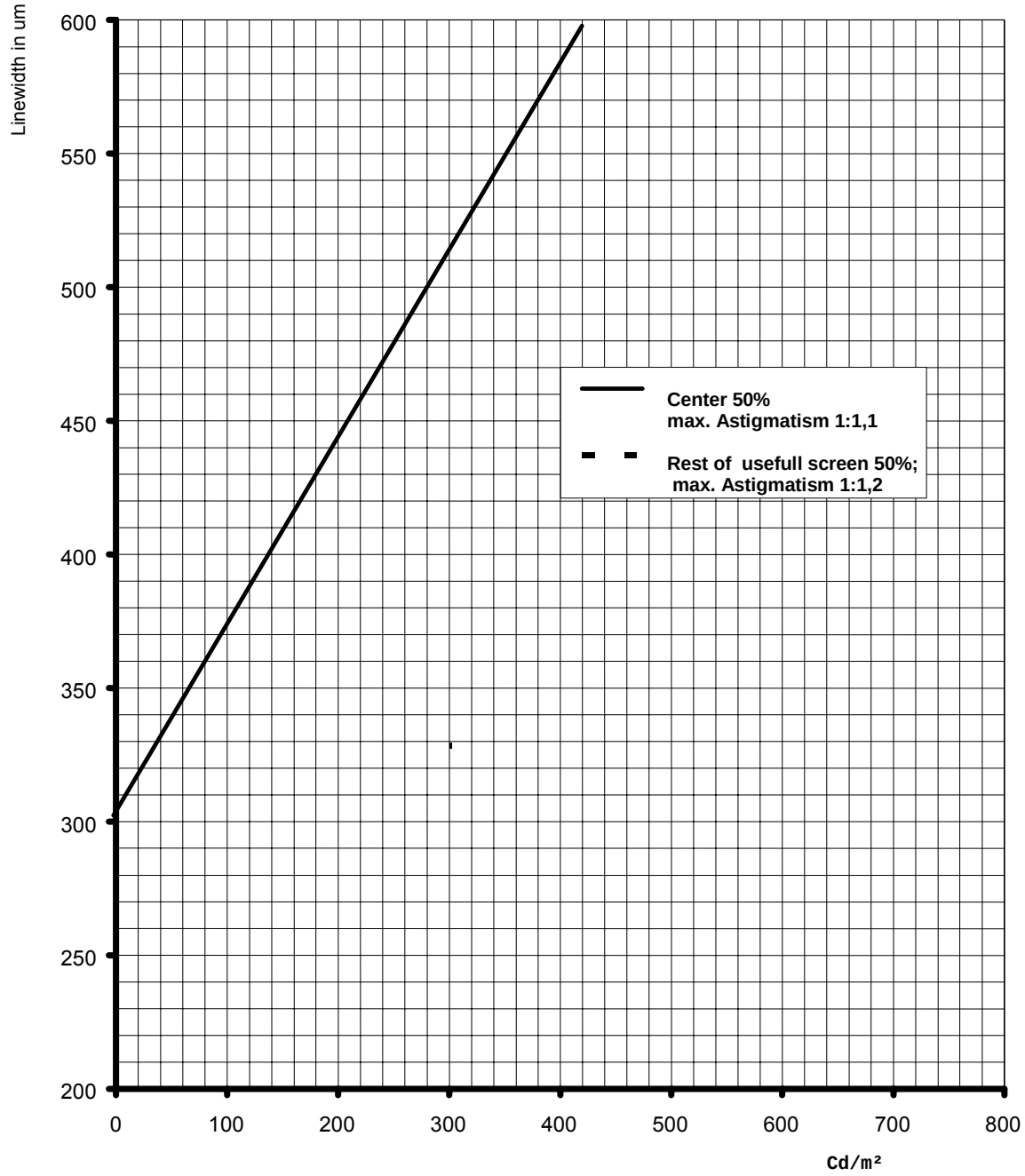
U_a = 19 kV

U_{g2A} = 700 V

Cathode drive

Duty cycle = 100 %

Maximum linewidth at 50% of peak value



The focus is adjusted at 100 cd/m² and it is not allowed to readjust the focus voltage during the measurement.
Measured with PDS spotvision system or Microvision SS100

Electrical data

Deflection	Magnetically
deflection angle:	- horizontal approx. 99° - vertical approx. 84° - diagonal approx.110°
Focussing	Electrostatic
Maximum leakage * currents	Ig2 ± 5 µA Ig4 ± 25 µA
Capacity (Grid 1 to all other electrodes)	C_{g1} < 8 ± 1pF
Capacity (Cathode to all other electrodes)	C_{Cat} 3 ± 1 pF
Capacity (Focus to all other electrodes)	C_{g3} 4 ± 1 pF
Capacity (Anode to outer coating)	C 600 – 1500 pF

Absolute limiting values

Cathode is reference point for all voltage values

First accelerating voltage	U_{g2A}	max. 1000 V min. 400 V
Second accelerating voltage	U_a	max. 21 kV min. 13 kV
Focus voltage	U_{g3}	max. 1000V -200 V
Grid1 voltage	$-U_{g1}$	max. 400 V min. 3 V
Heating against cathode	U_{hc}	100 V
	I_{hc}	max. 15 µA

Anode current

Long time average value	max. 300 µA
Peak value	max. 800 µA

Operating values

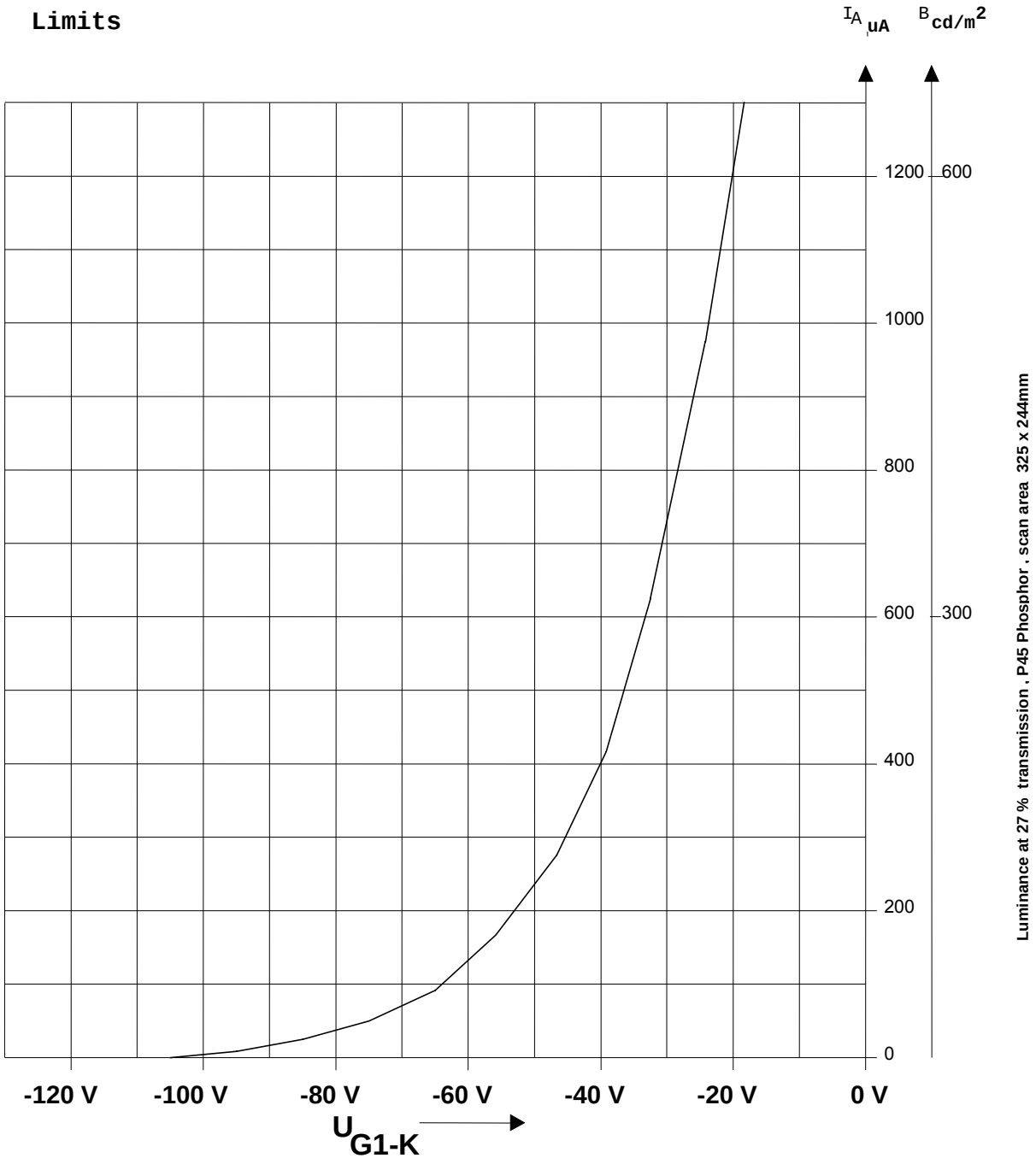
Cathode heating	- Indirect		
	- Heating voltage	U_h	6.15 V +2 % / -5 %
	- Heating current	I_h	approx. 240 mA

Cathode is reference point for all following voltage values

First accelerating voltage	U_{g2}	700 V
Grid 1 voltage (for spot suppression)	$-U_{g1}$	max. 120 V min. 60 V
Second accelerating voltage	U_a	19 kV
Drive voltage (grid drive) (from I_C = 0 µA to I_C = 800 µA) at U_a = 19 kV U_{g2} = 700 V (Spot cut-off) Duty cycle = 100 %	ΔU_{g1}	max. 70 V
Focus voltage (at centre of screen at I_C = 100 µA)	U_{g3}	min. 0 V max. 400 V
Dynamic focus voltage with reference yoke	$U_{g3\ dyn.}$	max. 450 V

Grid drive characteristics

Ua = 27.5 kV
U_{g2A} = 600 – 930 V
U_{g2B} = 50 – 250 V
$U_{spot\ cut\text{-}off}$ = 105 V
Duty Cycle = 100 %



Environmental conditions

Temperature range:

Operation	0 to + 70 °C Max. relative humidity 75 % Non-condensing
Storage	- 25 to + 70 °C

Max. temperature gradient	20 °C/h

Air pressure	400 hPa – 1060 hPa

Estimated life time

Decrease of measured brightness of 350 Cd/m² at constant drive.

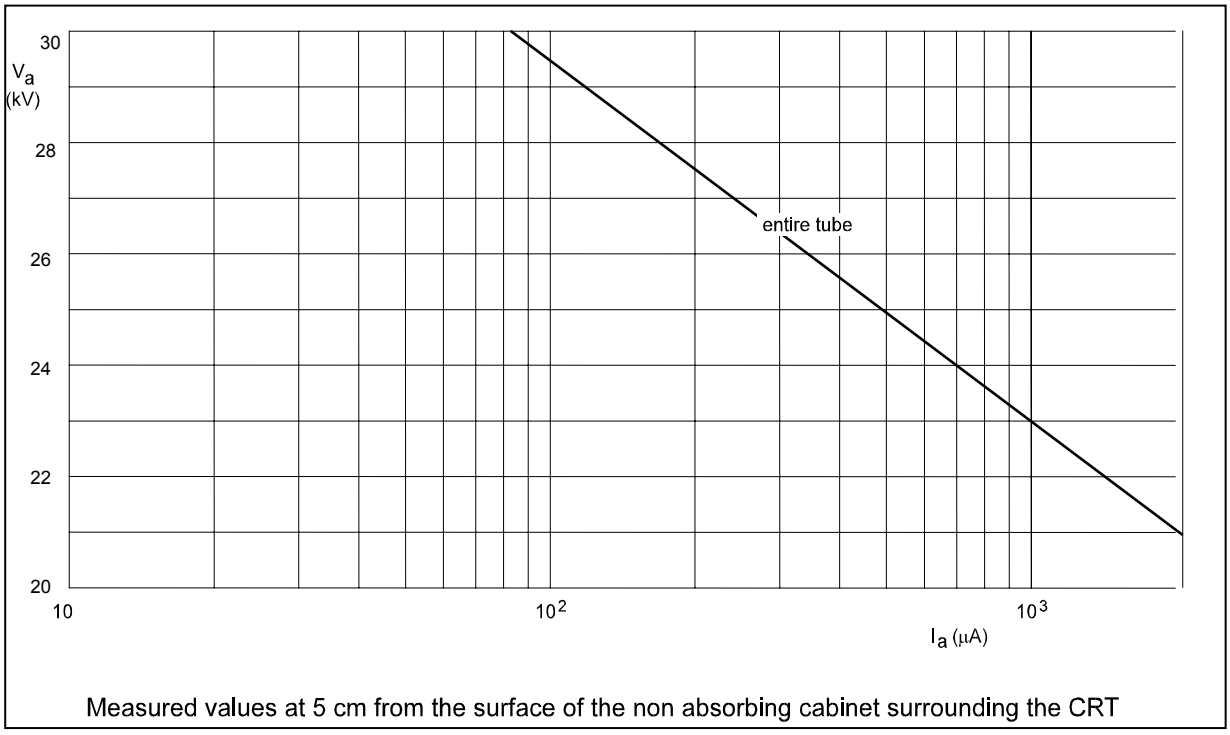
After 2000 hours	< 25 %
After 10 000 hours	< 30 %
After 20 000 hours	< 35 %

Burning Conditions	Duty cycle = 100% Scan frequency = 15 kHz Scan area 325 x 244 mm

Iso-exposure Calculated for 5 µSv/h

Rate Limit Curve

Calculated for 5 µSv/h



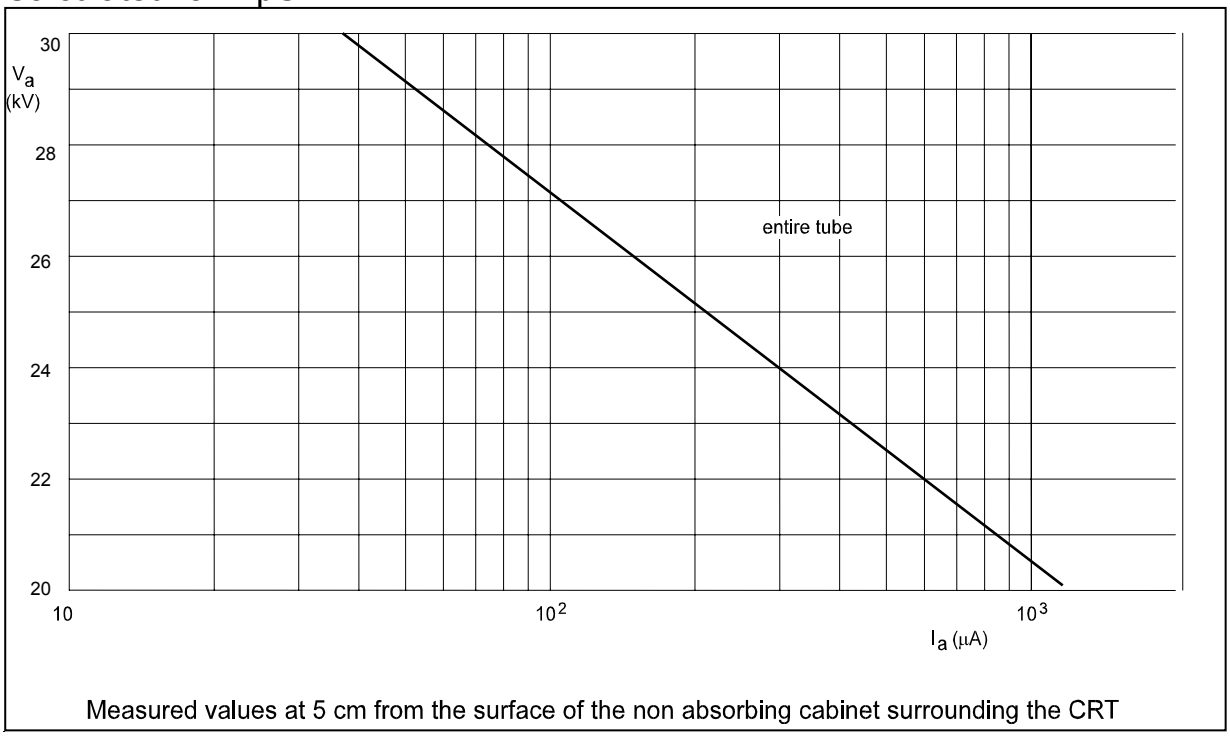
Measured values at 5 cm from the surface of the non absorbing cabinet surrounding the CRT

The X–radiation emitted will not exceed 1 µSv/h for anode voltage and current combinations shown in the iso-exposure-rate limit curve, according to Eigensichere Kathodenstrahlröhre nach "*Anlage III Röntgenverordnung".*

Iso-exposure Calculated for 1 µSv/h

Rate Limit Curve

Calculated for 1 µSv/h



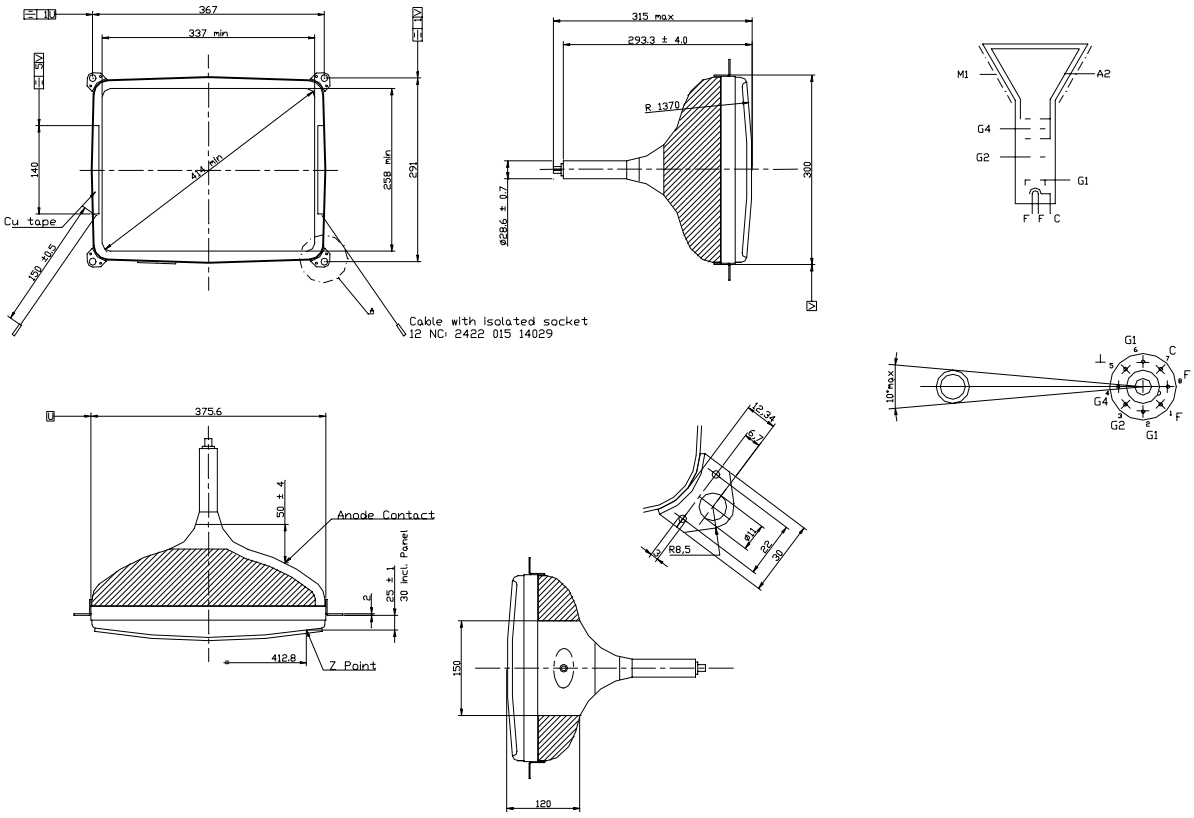
Measured values at 5 cm from the surface of the non absorbing cabinet surrounding the CRT

The X–radiation emitted will not exceed 1 µSv/h for anode voltage and current combinations shown in the iso-exposure-rate limit curve, according to Eigensichere Kathodenstrahlröhre nach "*Anlage III Röntgenverordnung".*

Packaging

Packaging t.b.f.

Attachment 1)



DATA SHEET

M41EHN30WB20/02

17" high resolution triple gun monochrome monitor tube assembly

Product specification

2003 Feb 20

Professional Display Systems B.V.

17" high resolution triple gun monochrome monitor tube assembly

M41EHN30WB20/02

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17" high resolution triple gun monochrome monitor tube assembly

M41EHN30WB20/02

1 HIGHLIGHTS

1.1 Features

1.1.1 HIGH PERFORMANCE DESIGN

- High resolution; higher pixel density possible up to 1280 × 1024 pixels (non-interlaced) displayable conform ISO 9241 by:
  - high resolution DAF gun
- High brightness and contrast
- Excellent white uniformity
- Accurate convergence and raster geometry:
  - double mussel coil technology
  - internal magnetostatic beam alignment
- Application friendly design:
  - worldwide useable design
  - East-West correction max. 10.0%
  - deflection units designed for minimal ringing
  - static convergence adjustment on monitor level: multipole for 4 and 6 pole correction
  - dynamic convergence adjustment on monitor level: horizontal balance coil; vertical balance potentiometer
  - rotation coil for adjustment of axial magnetic fields

1.1.2 ERGONOMIC DESIGN

- Less ambient reflection:
  - 'flat' and 'square' design
  - AGAS (Anti Glare Anti Static) coating
- Less eye strain:
  - P45 medium/short persistence phosphor
  - high frequency yokes
- Green design:
  - CFC-free production process
  - Cd-free phosphor
  - 0.65 W power saving cathode
- Fulfilling electric/magnetic radiation standards
- Safety approved:
  - VDE; CSA; UL.

1.1.3 OPTIMUM DISPLAY SOLUTION

- High-end PC applications
- Workstation applications
- Resolution standards up to 1280 × 1024 pixels non-interlaced application.

1.2 Quick reference data

PARAMETER	TYP.	UNIT
Deflection angle	90	deg
Face diagonal	444	mm
Overall length	<388	mm
Neck diameter	29.4	mm
Glass transmission	43	%
Colour coordinates		
x	244	
y	309	
Heater voltage	6.1	V
Anode voltage	26	kV
Focus voltage	27.5% of anode voltage	

1.3 Deflection coil data

Deflection coil is mounted with dynamic convergence correction coils (PECOMA).

PARAMETER	VALUE	UNIT
Horizontal coil inductance	0.101	mH
Vertical coil inductance	6.27	mH
Maximum advised frequency	95	kHz

1.4 Ordering information

TYPE NUMBER	SCREEN FINISH
M41EHN30WB20/02	AGAS

2 PERFORMANCE SPECIFICATION

2.1 Colour coordinates

PHOSPHOR DATA	COLOUR COORDINATES	
	x	y
Phosphor type: P45 (N 1045) $I_{a(av)}$ = 300 μA (per gun) V_a = 26 kV Scanned duty cycle = 75% Scanned area = 312 × 234 mm Screen finish AGAS Spot size 5%	244±10	309±15

2.2 Brightness uniformity

Brightness uniformity between centre and corners: > 85%; < 110%.

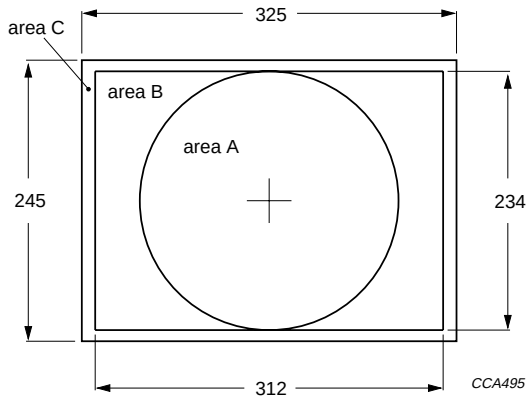
2.3 Convergence specification

2.3.1 TEST CONDITIONS

1. Set-up in accordance with Section 4.1.
2. Measure maximum misconvergence after 30 minutes operation.
3. To be adjusted for focus at $^2/_3$ centre-corner using crosshatch pattern at anode current is 300 μA (peak value) per gun.
4. Misconvergence is the distance between the centres of the red, green and blue guns at the screen using a crosshatch pattern.
5. Anode and/or focusing voltage and terrestrial magnetism may slightly affect the static convergence. Therefore, small re-adjustments to static convergence may be necessary.
6. Avoid stray magnetic fields etc. due to chassis influences which may affect convergence.

2.3.2 CONVERGENCE LIMITS

LOCATION (see Fig.1)	TYPE OF ERROR	MAXIMUM ERROR BETWEEN GUN SPOTS	
		STANDARD	WITH PECOMA
Centre	red-green-blue gun line separation in either the horizontal or vertical direction	0.30 mm	0.2 mm
Area A/corner		0.50 mm	0.2 mm



Dimensions in mm.

Fig.1 Maximum misconvergence.

2.4 Resolution specification

With the settings given in Section 4.1, the displayed characters will be recognisable as individual $ characters on a data raster measuring 325 mm × 234 mm.

ANODE CURRENT	SPOT SIZE CENTRE (NOMINAL)		SPOT SIZE CORNER (NOMINAL)		UNIT
	X	Y	X	Y	
100 μA	0.5	0.5	0.8	0.4	mm
200 μA	0.5	0.5	0.8	0.4	mm
400 μA	0.6	0.6	1.0	0.5	mm

2.5 Raster geometry

2.5.1 RASTER CENTRING

CENTRING	MAX.	UNIT
Horizontal	±5.0	mm
Vertical	±5.0	mm

2.5.2 RASTER ORTHOGONALITY

Orthogonality of the horizontal/vertical scan axis is ±0.5°.

2.5.3 RASTER ROTATION

Measure the angle of the horizontal green scanning line with reference to a horizontal centre line that is drawn parallel to the tube reference points A1 and A2, see Fig.2. Chassis influences may affect raster rotation.

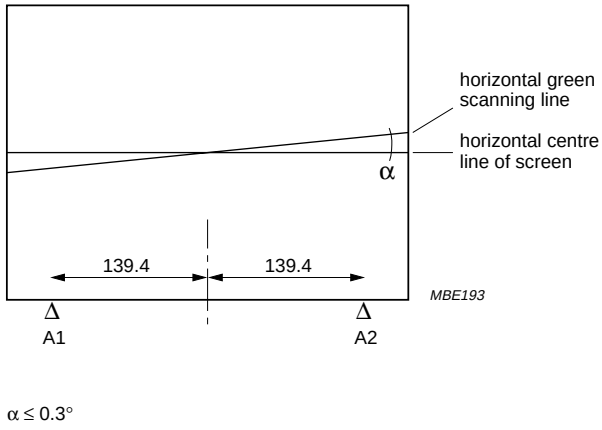
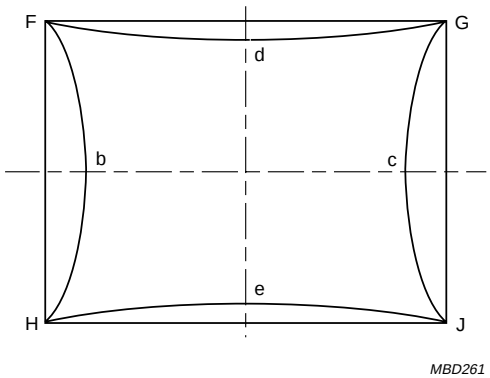


Fig.2 Rotation measurement.

2.5.4 PIN¬CUSHION DISTORTION



FG = HJ = 312 mm.
FH = GJ = 234 mm.
Measured with no pin-cushion correction applied, with ‘b’, ‘c’, ‘d’ and ‘e’ measured along the main axis.

Fig.3 Pin-cushion distortion.

2.5.5 DISTORTION NORTH - SOUTH

The following formulae define the pin¬cushion distortion in the north and south directions.

$$\text{North} = \frac{4d}{FH + GJ} \times 100\% = 0\% \text{ to } +0.8\%$$

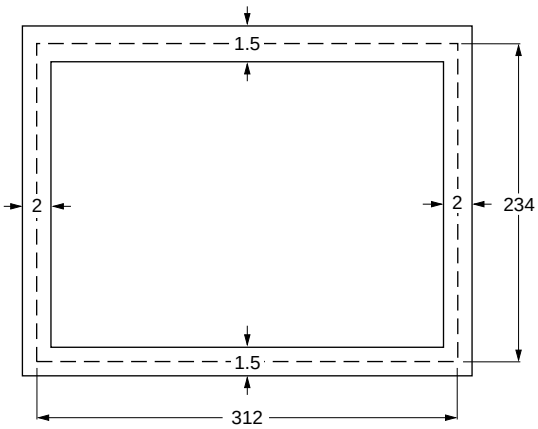
$$\text{South} = \frac{4e}{FH + GJ} \times 100\% = 0\% \text{ to } +0.8\%$$

2.5.6 DISTORTION EAST - WEST

The following formulae define the pin-cushion distortion in the east and west directions.

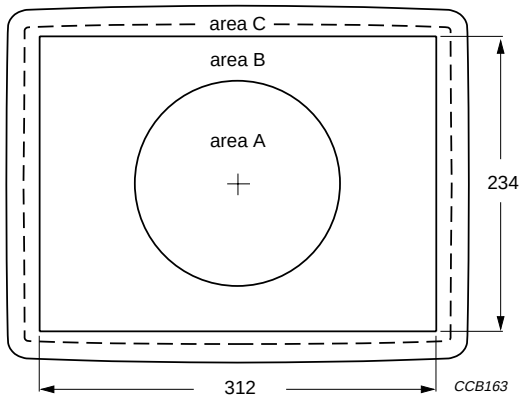
$$\text{East} = \frac{4b}{FG + HJ} \times 100\% \leq 8\%$$

$$\text{West} = \frac{4c}{FG + HJ} \times 100\% \leq 8\%$$



Dimensions in mm.

Fig.4 General distortion.



Dimensions in mm.

Fig.5 Screen areas.

2.6 Screen quality

2.6.1 GENERAL TEST PROCEDURE

Tests are to be done under the following general conditions:

- Viewing distance should be 50 cm minimum.
- For an activated screen the diffuse ambient light level at the centre of the screen should be between 2 and 5 lux.
- For an unactivated screen the diffuse ambient light level at the centre of the screen should be between 700 and 1000 lux.
- The viewing angle relative to the tube axis should not exceed 45°.
- Faults not visible under these general conditions are permitted.
- The following quality areas are specified (see Fig.5):
  - Area A: a circular area with a diameter of 165 mm, of which the centre coincides with the mechanical centre of the screen.
  - Area B: the area between the edge of area A and the rectangular area measuring 312 mm × 234 mm, of which the centre coincides with the mechanical centre of the screen.
  - Area C: the area between the edge of area B and the rimband.

2.6.2 ASSESSMENT OF THE GLASS AND THE UNACTIVATED SCREEN QUALITY

2.6.2.1 Definition of blemishes

Unless otherwise specified, the shape of a blemish is defined as round and elliptical.

The size of a blemish is given by:

- $\frac{L + W}{2}$; if L > 3W the size is given by $\frac{L}{20} + 2W$,

  where L = length and W = width.

2.6.2.2 Limits

Table 1 Limits of measurable glass blemishes

SIZE (mm)	MAX. NUMBER OF BLEMISHES IN AREAS		MIN. PERMISSIBLE DIST ANCE BETWEEN ANY 2 BLEMISHES (mm)	AREA C
	A	A + B		
>0.6	0	0	not applicable	only limits as regards tube safety
>0.4 to ≤0.6	1	2	50	
>0.2 to ≤0.4	2	5	50	
Total number	2	5	50	–
≤0.2	limited only by cloud			–

Table 2 Limits of measurable coating blemishes for AGAS coating

SIZE (mm)	MAX. NUMBER OF BLEMISHES IN AREA A+B	MIN. PERMISSIBLE DISTANCE BETWEEN ANY 2 BLEMISHES (mm)	AREA C
High contrast			
>1.5	0	not applicable	acceptable
>1.0 to ≤1.5	3	50	
>0.5 to ≤1.0	5	30	
≤0.50	no limits	no limits	
Low contrast			
>3.0	0	not applicable	acceptable
>1.0 to ≤3.0	5	30	
≤1.0	no limits	no limits	

Table 3 Limits of scratches

AREA	WIDTH (mm)	MAX. ALLOWABLE TOTAL LENGTH (mm)	MIN. SEPARATION (mm)
A+B	>0.15	0	not permitted
	>0.10 to ≤0.15	13	50
	>0.05 to ≤0.10	25	20
	≤0.05	no limits	not applicable
C	only as regards tube safety		

2.6.3 ASSESSMENT OF THE QUALITY OF THE ACTIVATED PHOSPHOR SCREEN

The assessment of the quality of the phosphor and matrix layer at area A should take place at typical operating conditions and a blanked raster. The current for each gun must be adjusted to a brightness of 200 cd/m^2.

2.6.3.1 Definition of blemishes

- A blemish is a fault which is clearly visible within 5 seconds.
- A defect, which looks visually as one blemish should be regarded as a single blemish.
- Unless otherwise specified, the shape of a blemish is defined as round and elliptical.

The size of a blemish is given by:

- $\frac{L+W}{2}$; if L > 3W the size is given by $\frac{L}{20} + 2W$,

  where L = length and W = width.

2.6.3.2 Limits

1. The distance between any two blemishes >0.2 mm should be >50 mm.
2. Maximum number of blemishes >0.2mm per screen is 9.
3. Blemishes ≤0.2 mm can be ignored, except for a concentration of such blemishes that have a diameter of more than 8 mm.

Table 4 Limits of blemishes

BLEMISH SIZE (mm)	MAXIMUM NUMBER OF BLEMISHES IN		
	AREA A	AREA B	AREA A + B
>0.6	0	0	0
>0.4 to ≤0.6	1	5	5
>0.2 to ≤0.4	4	6	9
≤0.2	limited only by cloud		

2.7 Coating performance

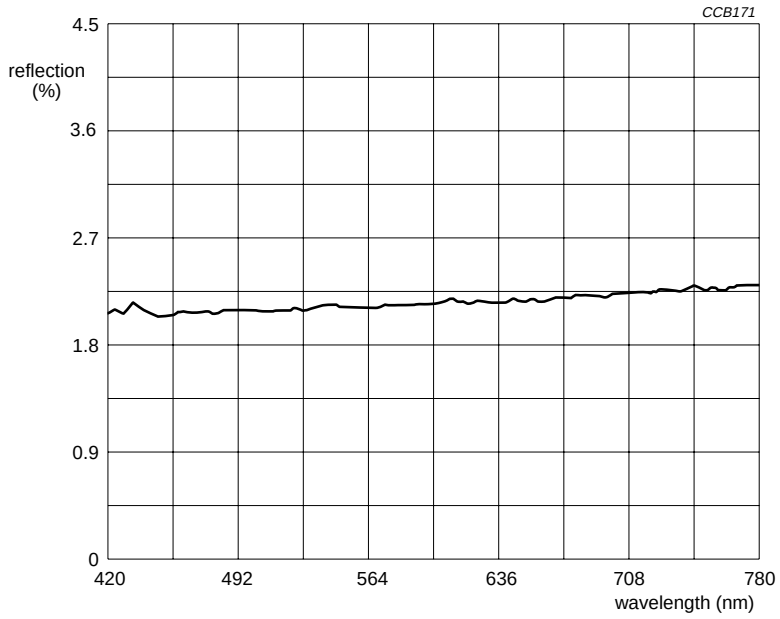


Fig.6 Relative reflection for AGAS.

3 PRODUCT CHARACTERISTICS

3.1 Electrical data

SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNIT
Capacitances					
$C_{a(m + m')}$	anode to external conductive cone coating, including rimband (with and without screen coating)	1000	1300	1600	pF
C_k	cathodes of all guns, connected in parallel, to all other electrodes	–	10	15	pF
C_{kR}, C_{kG}, C_{kB}	cathode of any gun to all other electrodes	–	4	–	pF
C_{g1}	grid 1 of any gun to all other electrodes	–	22	–	pF
C_{g2}	grid 2 to all other electrodes	–	17	–	pF
C_{g3a}	grid 3a (focus electrode) to all other electrodes	–	12	–	pF
C_{g3b}	grid 3b (dynamic focus electrode) to all other electrodes	–	10	–	pF
$C_{(g3a-g3b)}$	grid 3a to grid 3b	–	9	–	pF
Heater					
V_f	heater voltage	–	6.1	–	V
I_f	heater current	289	309	329	mA
t_{kwu}	cathode warm up time at 0-hour from 10% to 80% of end emission	–	–	8	s
Deflection unit					
V_{max}	maximum permissible DC voltage				
	between horizontal and vertical coils	–	–	2000	V
	between vertical coils and core	–	–	300	V
R_{ins}	insulation resistance at 1 kV (DC)				
	between horizontal and vertical coils	500	–	–	MΩ
	between horizontal coil and core clamping ring	500	–	–	MΩ
	between vertical coil and core clamping ring	10	–	–	MΩ
	crosstalk (1 V applied to the horizontal coils)	–	–	30	mV

3.2 Deflection unit data

All values are valid at T_{amb} = 25 °C and V_a = 26.0 kV; deflection units fulfil the MPRII and TCO magnetic requirements (see Section 5.1); the deflection coil is designed for a positive pulse on the horizontal coil.

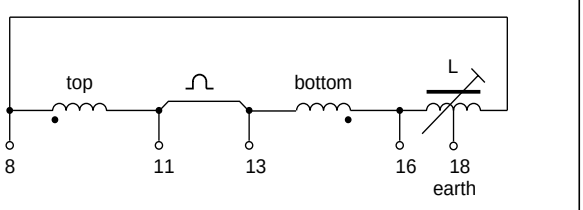
PARAMETER	VALUE	TOLERANCE	UNIT
Advised frequency; notes 1 and 2	95	–	kHz
Horizontal deflection coil			
Inductance	0.101	±4%	mH
Resistance	0.19	±10%	Ω
Current (peak-to-peak value)	13.5	±4%	A
Used wire	litz	–	
Vertical deflection coil			
Inductance	6.27	±4%	mH
Resistance	6.06	±7%	Ω
Current (peak-to-peak value)	1.81	±5%	A
Used wire	litz	–	

Notes

1. Advised maximum frequency depends on the internal maximum set temperature and used deflection-overscan.
2. No annoying ringing with 0% overscan.

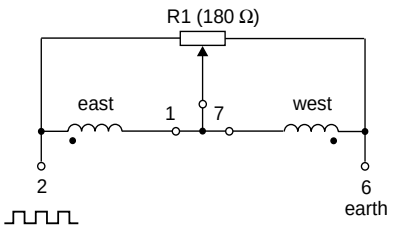
Rotation coil data

PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Resistance	T_{amb} = 20 °C	50.9	56.6	62.3	Ω
Sensitivity	I = 75 mA; V_a = 26.0 kV	–	0.95	–	deg



The beginning of the windings is indicated with •

Fig.7 Horizontal coils.



The beginning of the windings is indicated with •

Fig.8 Vertical coils.

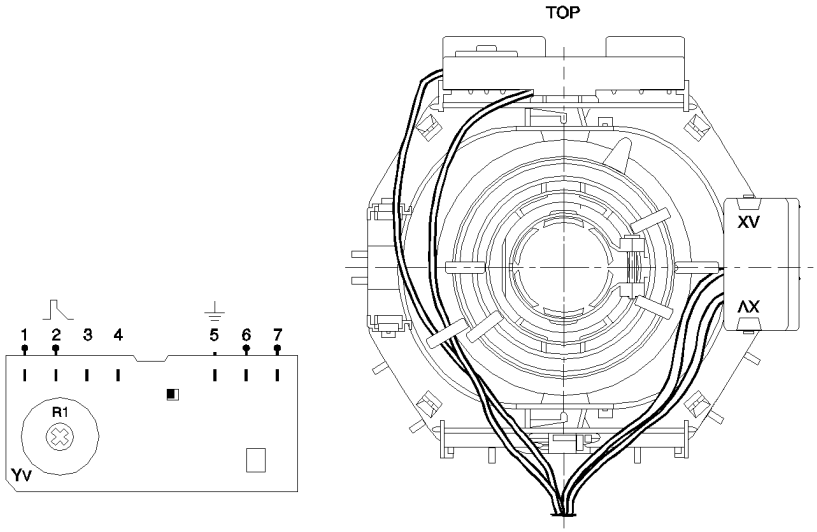
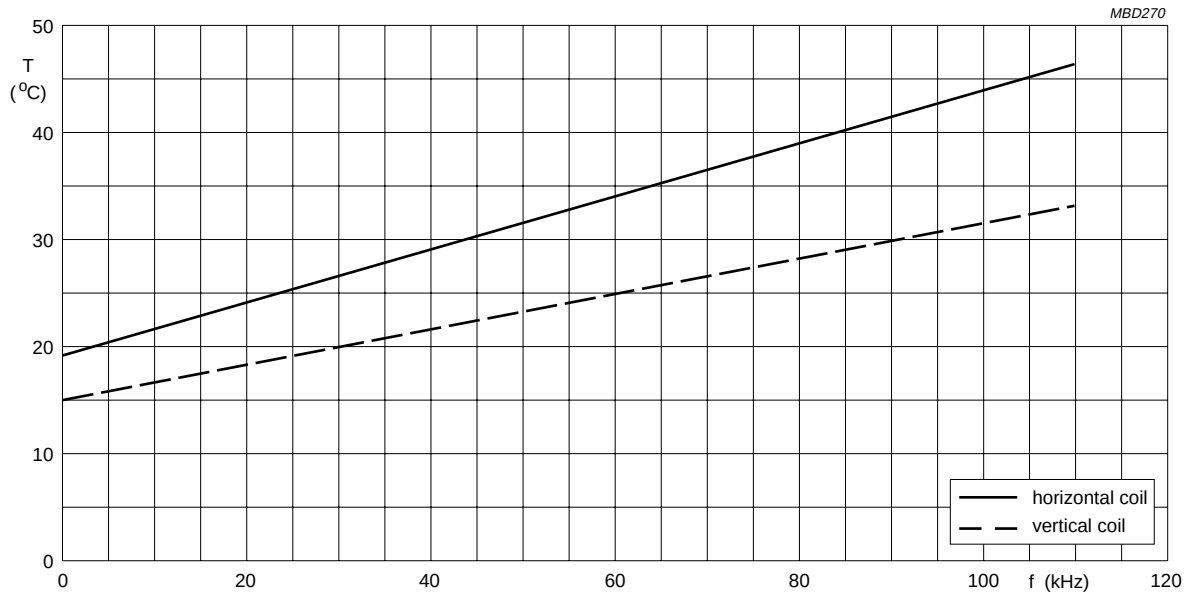


Fig.9 Deflection coil connections.

3.2.1 DEFLECTION UNIT TEMPERATURE

SYMBOL	PARAMETER	MAX.	UNIT
T_{copper}	average copper temperature of horizontal coil	110	°C
ΔT	maximum temperature rise of used wire	50	°C



Maximum operating copper temperature (resistance measurement) is 110 °C.

Fig.10 Temperature rise as a function of frequency.

3.3 Electro optical data

PARAMETER	VALUE
Electron gun system	three in-line integrated guns
Focus method	electrostatic
Focus lens	polygon and DAF
Convergence method	magnetic
Deflection method	self converging
Deflection angle	
diagonal	≈90°
horizontal	≈78°
vertical	≈60°

3.4 Screen properties

PARAMETER	VALUE
Screen finish	AGAS
Light transmission at screen centre	43%
Recommended active screen area	
horizontal axis	312 mm
vertical axis	234 mm

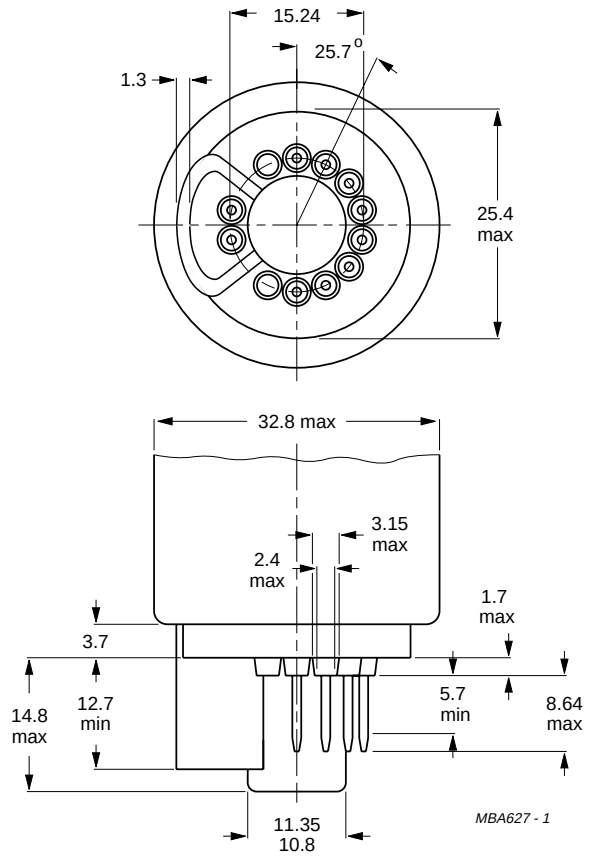
3.5 Coating properties

TYPE NUMBER	SCREEN FINISH	GLOSS
M41EHN30WB20/02	Anti Glare Anti Static (AGAS), tested in the centre	60 ±12%

3.6 Mechanical tube data

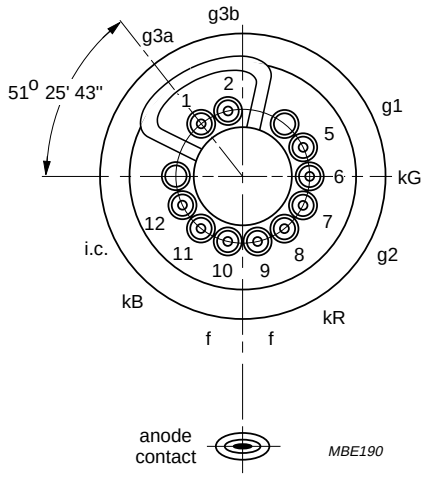
PARAMETER	VALUE
Overall length	383.5 ±4.5 mm
Neck diameter	29.4 +0.6/–0.4 mm
Maximum dimensions, excluding mounting lugs but including rimband	
diagonal	446.2 mm
width	387.9 mm
height	297.6 mm
Implosion protection	pre-stressed banded Mini-P shrunk-on rimband; CSA, UL and VDE approved
Anode contact	JEDEC J1-21; IEC 60067-III-2
Base designation	JEDEC B10-301
Base pin configuration	see Fig.12
Mass	≈10 kg
Mounting position	anode contact on top

3.7 Mechanical tube drawings



Dimensions in mm.

Fig.11 Base JEDEC B10-301.



i.c. = internally connected and not to be used.

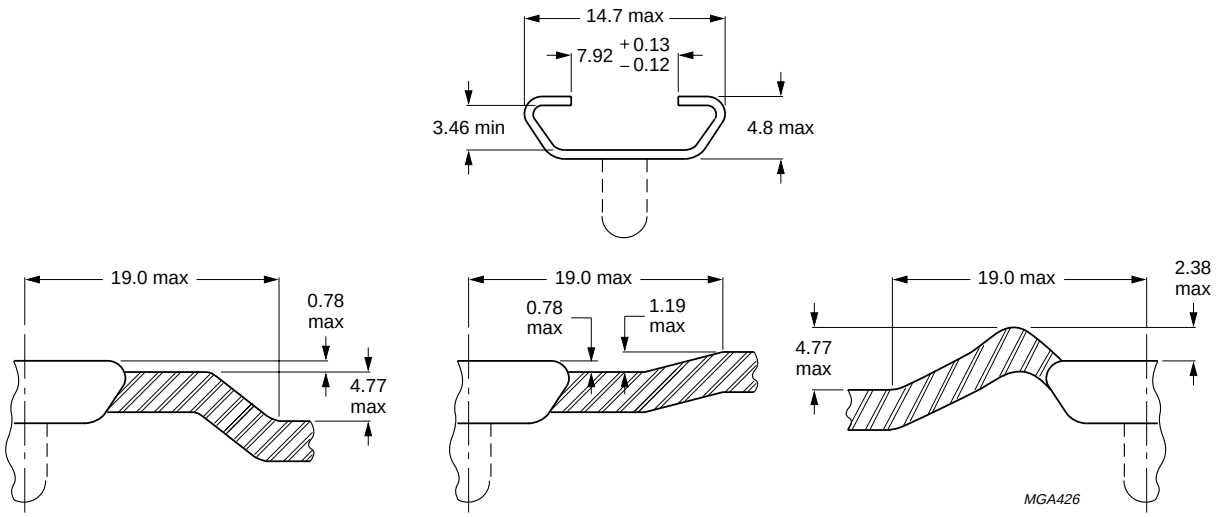
Fig.12 Pin arrangement.

Remarks: to Figs 11 and 12.

The socket for this base should not be rigidly mounted, it should have flexible leads and be allowed to move freely. After mounting the tube in the cabinet, note that the position of the base can fall within a circle, having a diameter of max. 40 mm concentric with an imaginary tube axis.

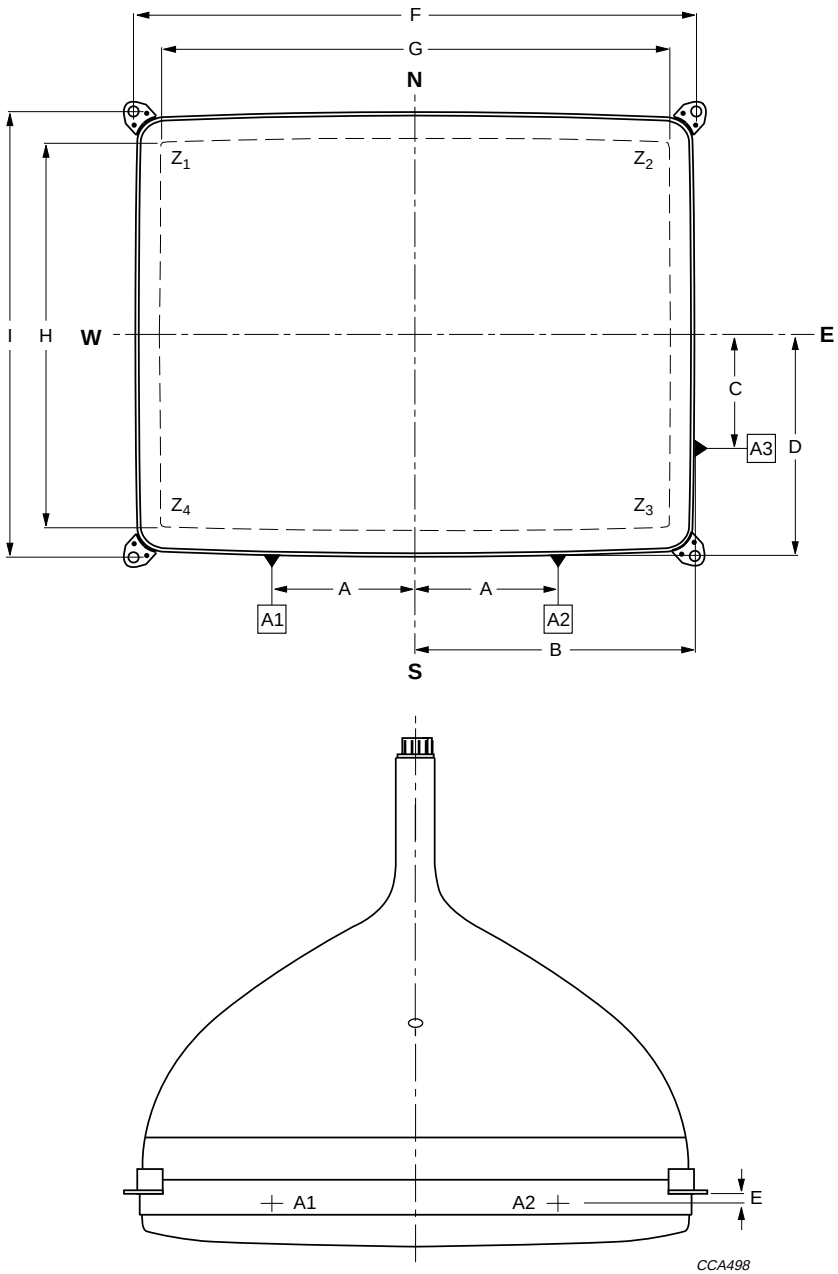
The mass of the mounting socket assembly should not exceed 450 g.

Maximum permissible torque on the tube neck is 0.14 Nm.



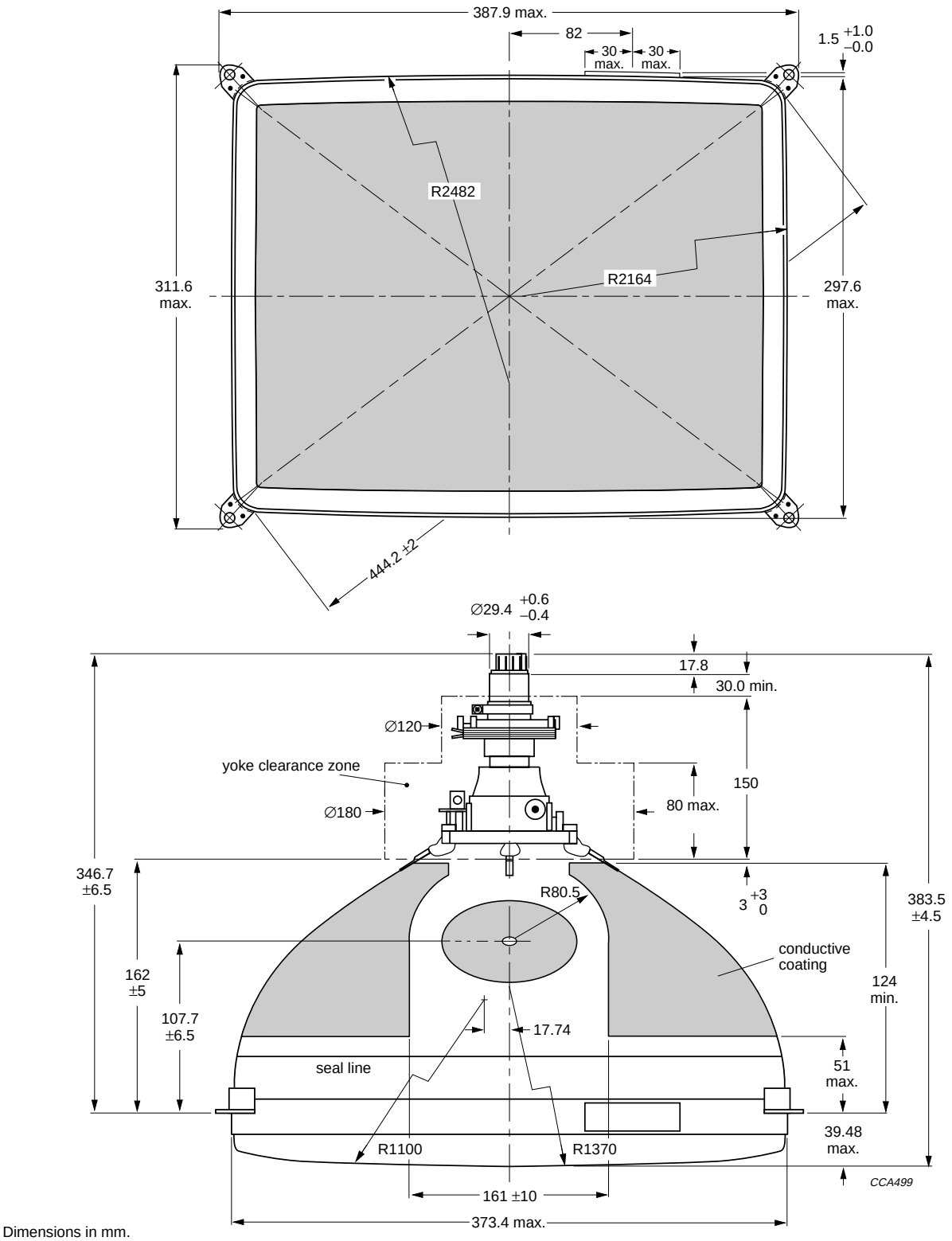
Dimensions in mm.

Fig.13 Cavity cap JEDEC J1-21, IEC60067-III-2.



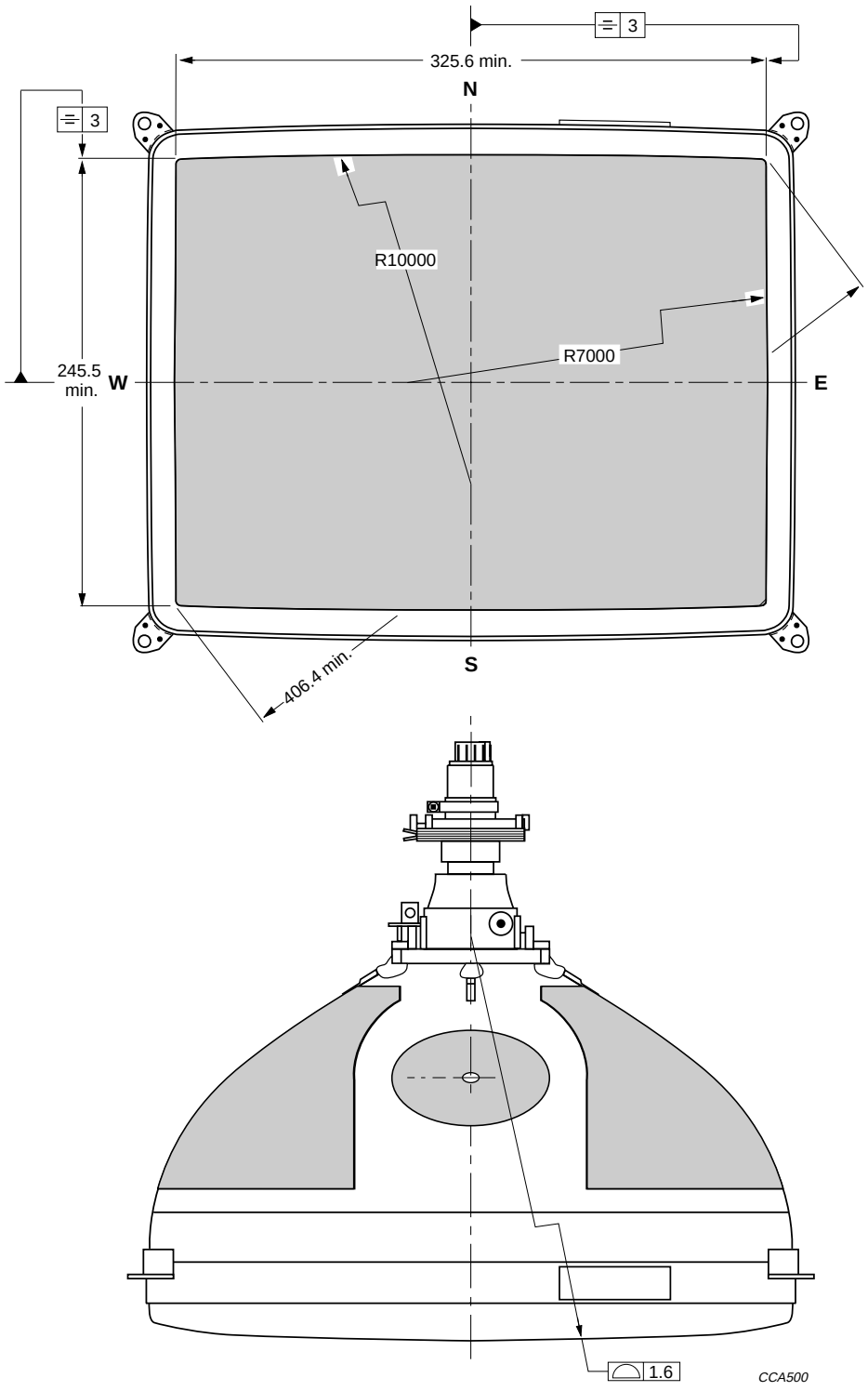
A = 139.4 mm.
B = 183.60 mm.
C = 100.00 mm.
D = 143.80 mm.
E = 0.58 mm.
F = 366.90 mm.
G = 330.24 mm.
H = 247.68 mm.
I = 290.60 mm.

Fig.14 Mechanical reference points.



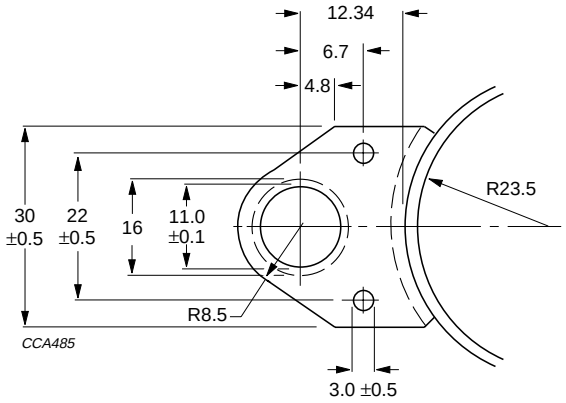
Dimensions in mm.

Fig.15 Top view.



Dimensions in mm.

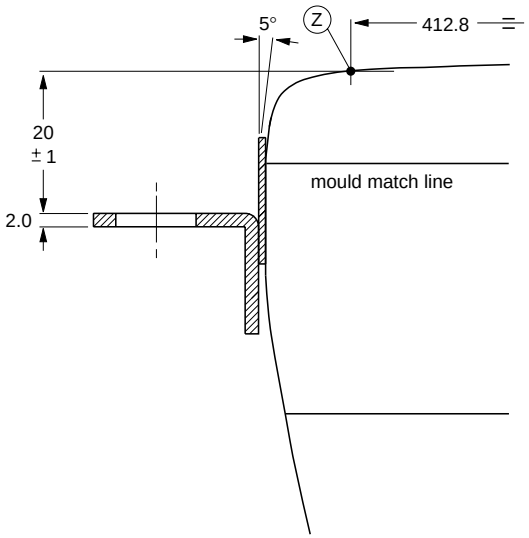
Fig.16 Dimensions of phosphor area on screen.



Dimensions in mm.

The mounting screw in the cabinet must be within a circle of 6.5 mm diameter drawn around the true geometrical positions, i.e. the corners of a rectangle of 366.9 mm × 290.6 mm.

Fig.17 Lug dimensions.



Dimensions in mm.

Fig.18 Lug position.

3.8 Sagittal heights of screen

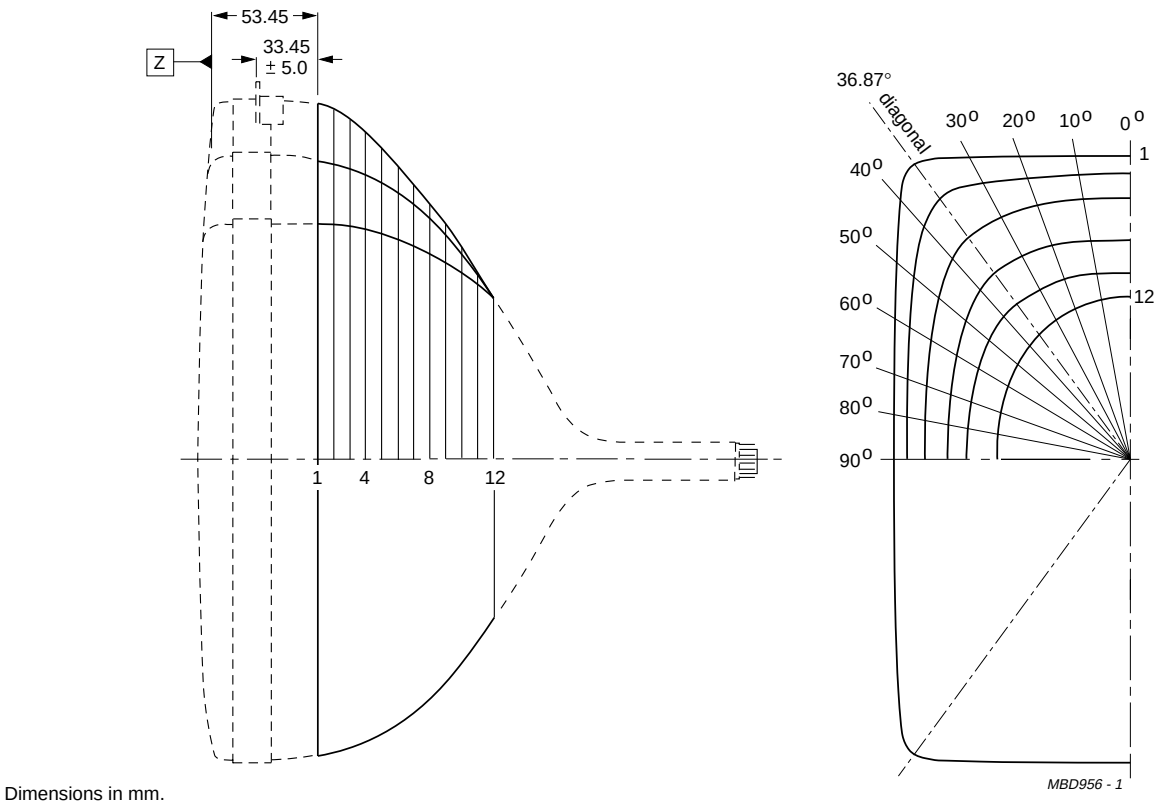
Sagittal heights of the nominal useful screen measured with respect to the end of the diagonal axis.

COORDINATES		SAGITTAL HEIGHT
X (mm)	Y (mm)	(mm)
0.0	0.0	16.3
0.0[1]	123.0	10.6
10.0	123.0	10.6
20.0	123.0	10.5
30.0	123.0	10.3
40.0	122.9	10.0
50.0	122.9	9.7
60.0	122.8	9.2
70.0	122.8	8.7
80.0	122.7	8.1
90.0	122.6	7.4
100.0	122.5	6.7
110.0	122.4	5.8
120.0	122.3	4.9
130.0	122.2	3.9
140.0	122.0	2.8
150.0	121.9	1.6
160.0	121.7	0.3
162.2[2]	121.7	0.0
162.3	120.0	0.2
162.4	110.0	1.1
162.5	100.0	2.0
162.7	90.0	2.8
162.8	80.0	3.4
162.9	70.0	4.1
162.9	60.0	4.6
163.0	50.0	5.0
163.1	40.0	5.4
163.1	30.0	5.7
163.1	20.0	5.9
163.1	10.0	6.0
163.2[3]	0.0	6.0

Notes

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

3.9 Cone contour



Dimensions in mm.

Fig.19 Maximum cone contour.

Cone contour data

SECTION	NOMINAL DISTANCE FROM SECTION 1 (mm)	MAXIMUM DISTANCE FROM TUBE AXIS (mm)										
		0°	10°	20°	30°	36.87°	40°	50°	60°	70°	80°	90°
1	0.0	184.3	186.9	195.1	210.1	221.0	217.9	187.3	167.2	154.9	148.2	146.1
2	10.0	182.9	185.4	193.5	208.2	218.6	215.8	185.8	165.8	153.5	146.9	144.7
3	20.0	179.5	181.7	188.6	201.0	209.2	207.1	181.0	162.2	150.6	144.3	142.2
4	30.0	175.0	176.8	182.2	191.6	197.6	196.1	174.9	157.8	147.1	141.2	139.4
5	40.0	169.3	170.6	174.5	181.2	185.5	184.4	167.8	152.8	143.2	137.9	136.2
6	50.0	162.0	162.9	165.6	170.0	172.9	172.2	159.8	147.1	138.9	134.2	132.7
7	60.0	152.6	153.2	155.0	158.0	160.0	159.4	150.6	140.6	133.9	130.1	128.8
8	70.0	141.7	142.1	143.3	145.2	146.4	146.1	140.1	132.8	127.8	124.8	123.9
9	80.0	129.8	130.0	130.6	131.7	132.4	132.1	128.6	123.7	120.3	118.3	117.6
10	90.0	116.7	116.8	117.0	117.4	117.7	117.6	115.7	113.1	111.2	110.1	109.7
11	100.0	102.3	102.3	102.4	102.4	102.5	102.4	101.5	100.7	100.2	99.8	99.7
12	103.4	86.4	86.4	86.4	86.4	86.4	86.4	86.4	86.4	86.4	86.4	86.4

4 APPLICATION CONDITIONS

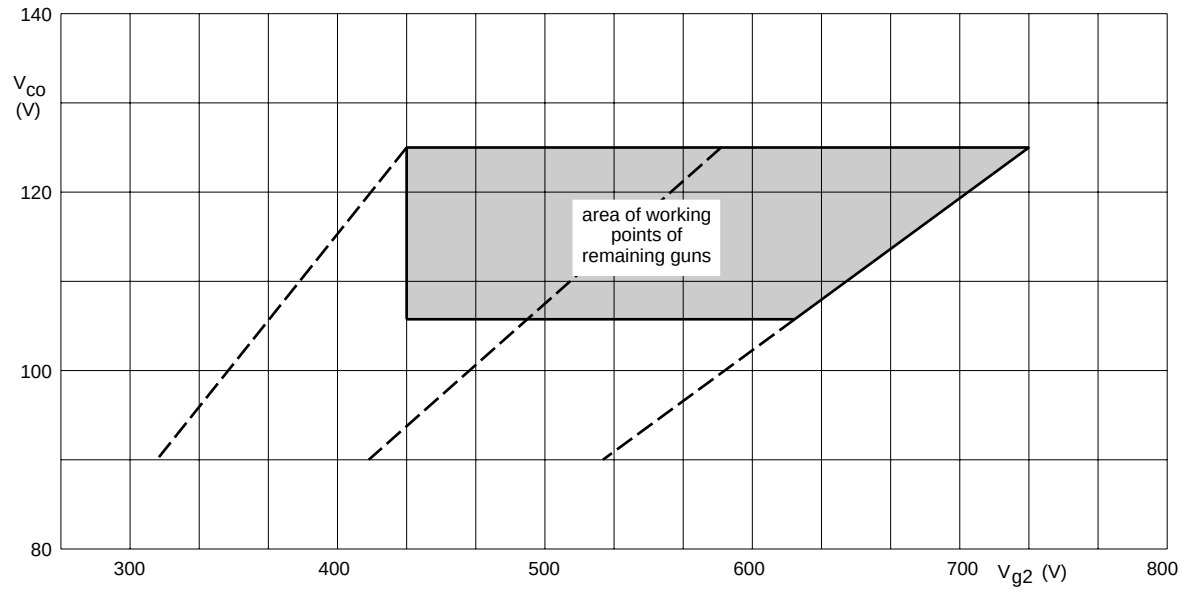
4.1 Recommended adjustment and operating conditions

The voltages are applied to each gun and are measured with respect to grid 1; RH = 40% to 60%; tube facing east; local magnetic field: 0.03 mT vertical, 0.00 mT lateral, 0.00 mT axial. Pre-heat the tube for 15 minutes minimum before tests. Avoid misconvergence, distortion etc. due to stray magnetic fields and chassis influences.

SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNIT
$V_{a,g4}$	anode voltage	–	26	–	kV
V_{g3a}	grid 3a (static focus electrode) voltage as a percentage of the anode voltage; note 1	25.5	–	29.5	%
V_{g3b}	grid 3b (dynamic focus electrode) voltage				
	DC voltage as a percentage of the anode voltage	25.5	–	29.5	%
	horizontal parabola	–	300	–	V
	vertical parabola	–	150	–	V
V_{g2}	grid 2 voltage at a spot cut-off voltage V_{co} = 125 V; note 2	see Fig.20			V
V_f	heater voltage	–	6.1(3)	–	V
f_H	horizontal sweep frequency	–	30 to 110	–	kHz
f_V	vertical sweep frequency	–	60 to 80	–	Hz
T_{amb}	ambient temperature	–	25	–	°C

Notes

1. Focus adjustment procedure:
   a) Adjust anode current for 750 cd/m^2.
   b) Adjust for optimum focus at $^2/_3$ centre-corner.
2. Grid 2 adjustment procedure:
   a) Grid 2 voltage (V_{g2}) adjusted for highest gun spot cut-off voltage: V_{co} = 125 V.
   b) Remaining guns adjusted for spot cut-off by means of cathode voltage.
   c) V_{g2} range: 425 V to 700 V at V_{co} = 125 V.
   d) Set the cathode voltage (V_k) for each gun at 125 V; increase the grid 2 voltage (V_{g2}) from ≈400 V to the value at which the spot of the gun with the lowest (V_{g2}) cut-off voltage becomes just visible, then decrease the cathode voltage of the remaining guns until the other gun beams become just visible.
3. For maximum cathode life it is recommended that the heater voltage is regulated at 6.1 V.



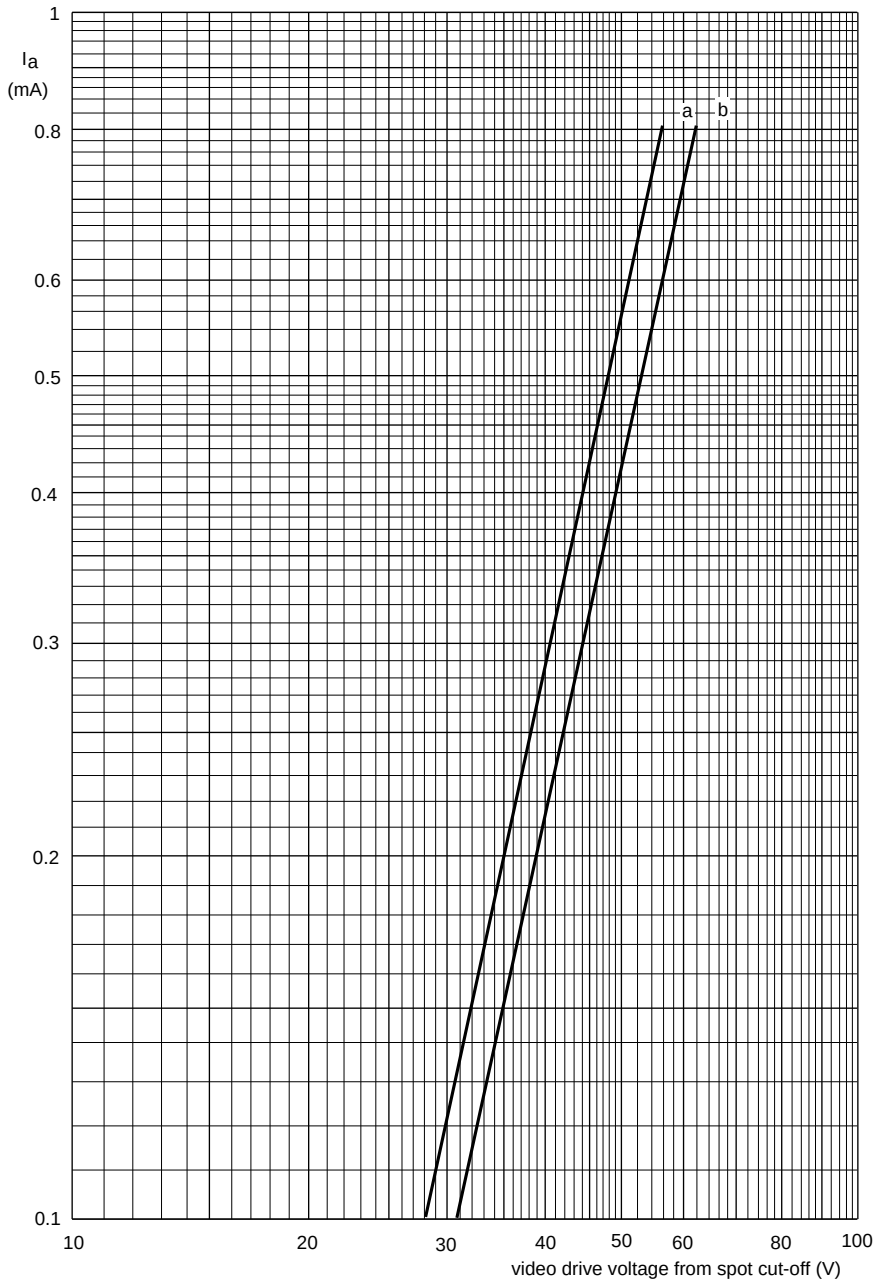
The voltages are specified with respect to grid 1.

Fig.20 Spot cut-off design chart.

4.2 Chassis design values

The values are valid for anode voltages between 20 and 29.9 kV. The voltages are specified with respect to grid 1.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
V_{g3a}	grid 3a (static focus voltage) as a percentage of anode voltage		25.5	–	29.5	%
V_{g3b}	grid 3b (dynamic focus voltage) as a percentage of anode voltage	raster size = 312 × 234 mm				
	DC voltage as a percentage of anode voltage		25.5	–	29.5	%
	horizontal parabola		–	300	–	V
	vertical parabola		–	150	–	V
ΔV_{g3a}	difference in focus voltage between red, green and blue guns when separately focused		–	–	300	V
ΔV_{g3a-b}	difference between the static focus voltage and dynamic focus voltage		–	–	200	V
V_{g2}	grid 2 voltage	for visual extinction of focused spot	see Fig.20			
V_k	cathode voltage		see Figs 20 and 21			
ΔV_k	difference in cut-off voltage between guns in any tube (cathodes cut-off ratio)		highest value <1.18 × lowest value			
V_f	heater voltage	at zero beam current	–	6.1	–	V
I_{g3a}	focus current	under cut-off conditions	–3	–	+3	µA
I_{g3b}	focus current	under cut-off conditions	–3	–	+3	µA
I_{g2}	grid 2 current	under cut-off conditions	–2	–	+2	µA
I_{g1}	grid 1 current	under cut-off conditions	–5	–	+5	µA
I_{kf}	cathode/heater current	V_{co} = 125 V	–3	–	+3	µA
Resistance						
R_{kgf}	insulation resistance between each cathode and all other electrodes and heater		50	–	–	MΩ
R_{g2}	grid 2 circuit impedance		–	–	5	MΩ
R_{g3}	grid 3 circuit impedance		–	–	50	MΩ



V_{co} = 100 V (curve a).
V_{co} = 125 V (curve b).

Fig.21 Typical cathode drive characteristics.

4.3 Limiting values

In accordance with the Absolute Maximum Rating System (IEC 60134). Voltages are specified with respect to grid 1.

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
$V_{a,g4}$	anode voltage	note 1	20(2)	28.5(3)	kV
I_{ap}	anode current for each gun (peak value)		–	550	μA
I_a	long-term average anode current for each gun		–	400	μA
I_a	long-term average anode current for three guns		–	1100	μA
V_{g3a}	grid 3a (focus) voltage		–	10	kV
V_{g3b}	grid 3b (focus) voltage		–	10	kV
$\Delta V_{g3a-g3b}$	grid 3 (focus) differential voltage		–	1	kV
V_{g2p}	grid 2 voltage, including video signal voltage (peak value)		–	1000	V
V_f	heater voltage	note 4	5.7	6.6(3)	V
Cathode voltage					
V_k	positive	operating	–	200	V
		operating cut-off	–	135	V
V_k	negative		–	0	V
V_{kp}	negative peak		–	–2	V
Cathode to heater voltage					
V_{kf}	positive		–	250	V
V_{kfp}	positive peak		–	300(3)	V
V_{kf}	negative		–	0	V
V_{kfp}	negative peak		–	-50	V

Notes

1. 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 the picture tube.
2. Operation of the tube at lower voltages impairs the luminance and resolution and could impair the convergence.
3. This value is an absolute maximum.
4. For maximum cathode life it is required that the heater supply is designed for 6.1 V at zero beam current. Heater source impedance should have a minimum value of 2 Ω (maximum current during switching on is 600 mA).

4.4 Flashover protection

With the high voltage used with this tube (max. 26 kV) internal flashovers may occur. As a result of Soft-Flash technology these flashover currents are limited to approximately 200 A offering higher 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 in accordance with Fig.22; 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 focus electrode (g3a and g3b) of 11 kV and at the other electrodes of 1.5 to 2 kV, both at an atmospheric pressure of 100 kPa.

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.

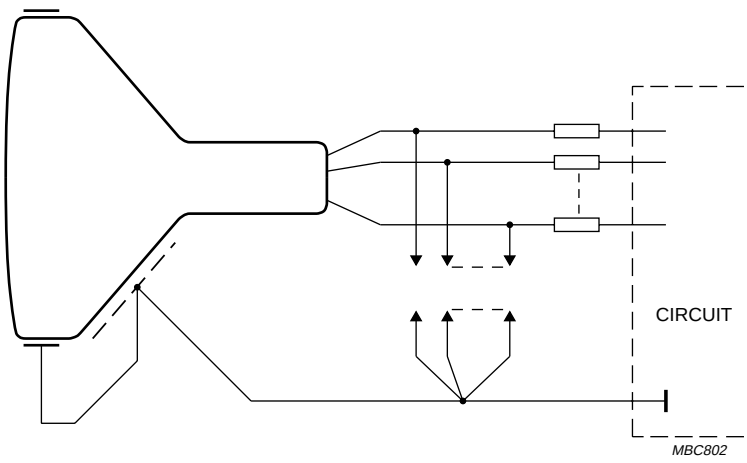


Fig.22 Flashover protection circuit.

5 ERGONOMIC, ENVIRONMENTAL DATA

5.1 X-radiation

Maximum anode voltage at which the X-radiation emitted will not exceed 0.5 mR/h at an anode current of 300 μA.

PARAMETER	TYP.	UNIT
Entire tube; note 1	34	kV

Note

1. 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 iso-exposure-rate limit curve and the iso-exposure-rate limit curve for the entire tube.

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 ensure 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 is 30 kV.
If this voltage can be exceeded in the monitor, additional attenuation of the X-radiation through the neck may be required.
The X-radiation emitted from this picture tube, as measured in accordance with the procedure of *"JEDEC Publications No.64D"* will not exceed 0.5 mR/h throughout the useful life of the tube 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 iso-exposure-rate limit characteristics as shown in Fig.24.
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 *"Federal Register Volume 38, No. 198,b Monday, October 15, 1973"*.
Maximum X-radiation as a function of anode voltage at 300 μA current is shown by Fig.23. X-radiation at a constant anode voltage varies linearly with anode current.

WARNING
The cathode ray tube is intrinsically safe in accordance with *"Appendix III Röntgenverordnung"*.
Eigensichere Kathodenstrahlröhre nach *"Anlage III Röntgenverordnung"*.

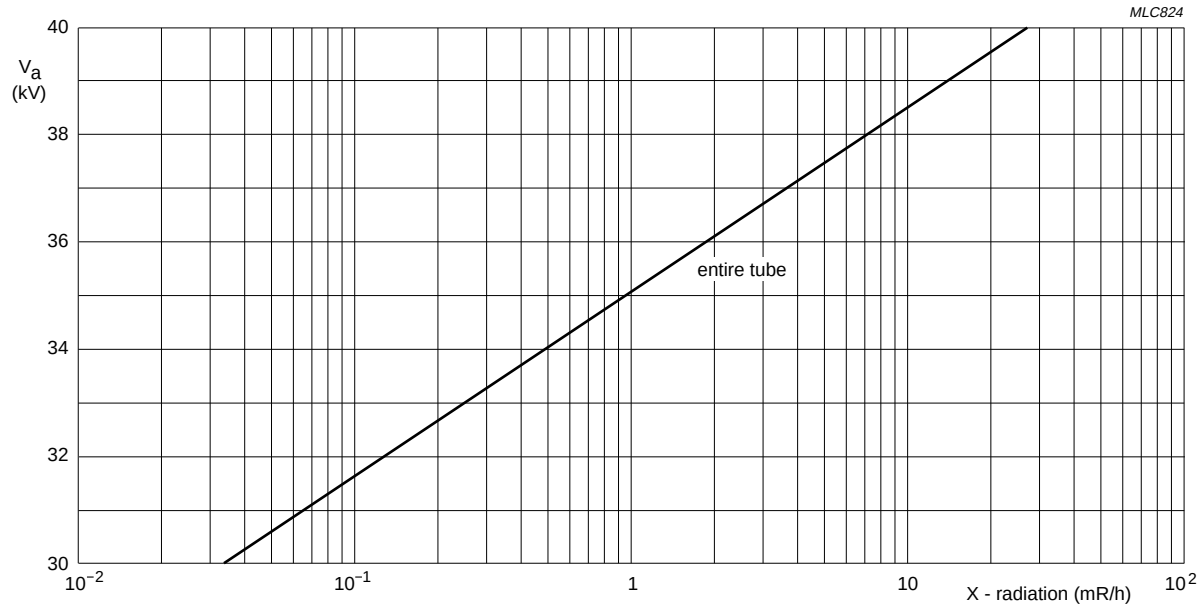


Fig.23 X-radiation limit curve at a constant anode current of 300 μA.

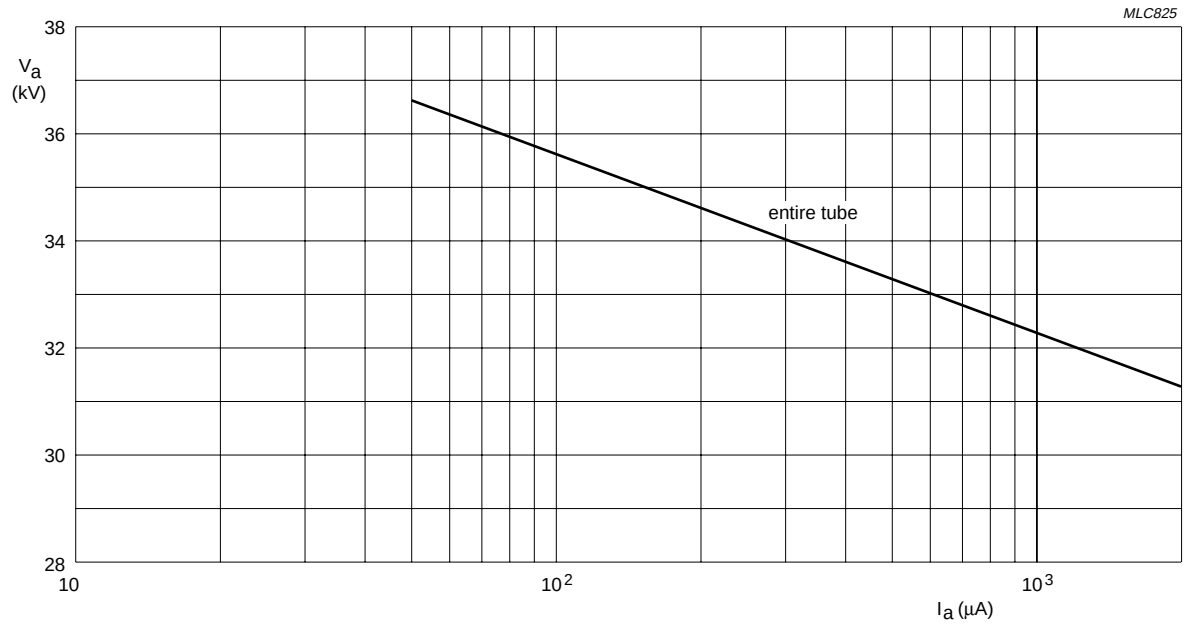
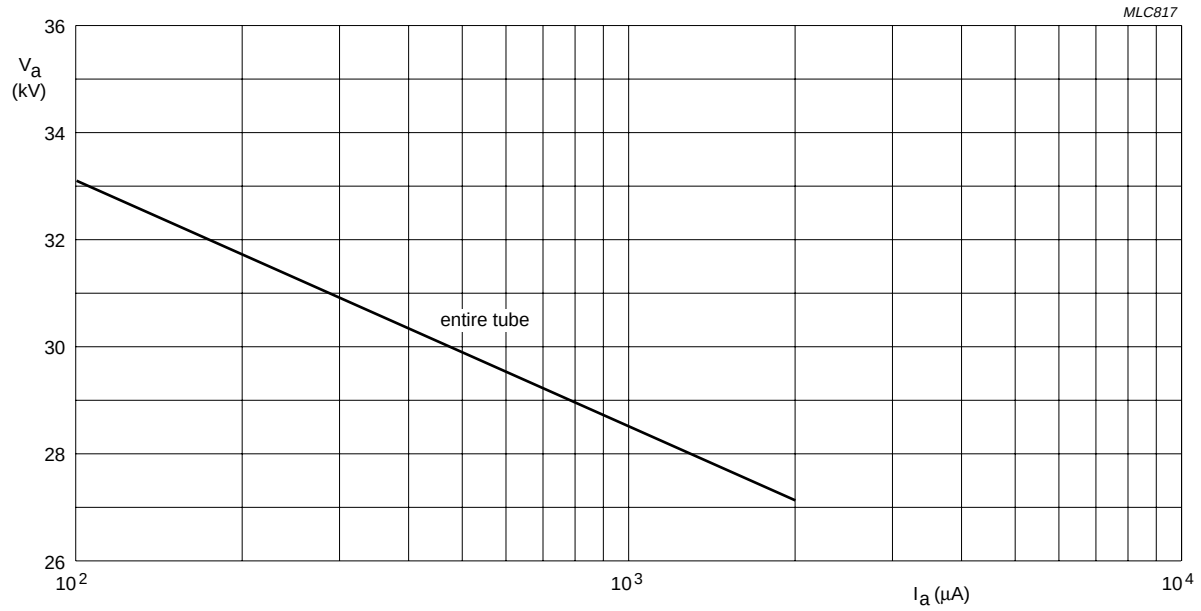


Fig.24 0.5 mR/h iso-exposure-rate limit curve.



The X-radiation emitted will also not exceed 1 μSv/h for anode voltage and current combinations shown in the iso-exposure-rate limit curve according to Eigensichere Kathodenstrahlröhre nach *"Anlage III Röntgenverordnung"*.

Fig.25 1 μSv/h iso-exposure-rate limit curve.

5.2 Warnings

X-radiation
Operation of the colour monitor tube under abnormal conditions that exceed the 0.5 mR/h iso-exposure-rate curve shown in Fig.24 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 values stated in Section 4.3 are not exceeded.
Tube replacement
This monitor tube incorporates integral X-radiation and implosion protection and must be replaced with a tube of the same type number or 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 taken during replacement or servicing of the monitor tube since a residual electrical charge may be held by the high-voltage capacitor formed by the external and internal conductive coatings of the monitor 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.

5.3 Handling

The packaging provides protection against tube damage under normal conditions of shipment or handling. Observe any instructions given on the packaging and handle accordingly. Under no circumstances should the tube assembly be subjected to accelerations greater than the values given in Table “Accelerations”.

Accelerations

PARAMETER	PULSE DURATION	MAX.	UNIT
Acceleration in cone direction	≤10 ms	350	m/s^2
	25 ms	300	m/s^2
Acceleration in all other directions	25 ms	350	m/s^2

Monitor tubes should be kept in the shipping box or similar protective container prior to installation.

Although monitor tubes are provided with integral implosion protection which meets the intrinsic safety requirements stipulated in the relevant part of IEC 60065, care should be taken not to scratch or knock any part of the tube. Particularly care should be taken to prevent damage to the seal area.

In all handling procedures prior to insertion in the cabinet, there is a risk of personal injury if severe accidental damage to the tube occurs. It is therefore recommended that in areas containing unpacked and unprotected tubes, protective clothing is worn, particularly, gloves and safety glasses with side-shields to prevent possible injury from flying glass in the event of such an accident.
Handle the tube with extreme care. Do not strike, scratch or subject the tube to more than moderate pressure.

The tube assembly should never be handled by the tube neck, deflection unit or other neck components.

If suspending the tube assembly from the mounting lugs, ensure that a **minimum of two** are used.
Under no circumstances suspend the tube assembly from one lug.

An alternative lifting method is to firmly grasp the assembly by the vertical sides of the rimband. Manually lifting the assembly from the face-down or face-up position is shown in Figs 26 and 27.

To protect the screen when placing the tube face-down, ensure that the tube face rests on a cushion kept free from abrasive substances.

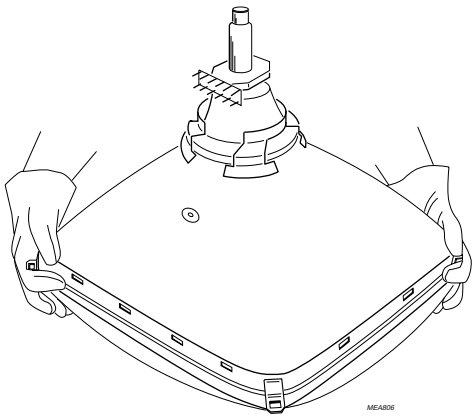


Fig.26 Lifting tube from face-down position.

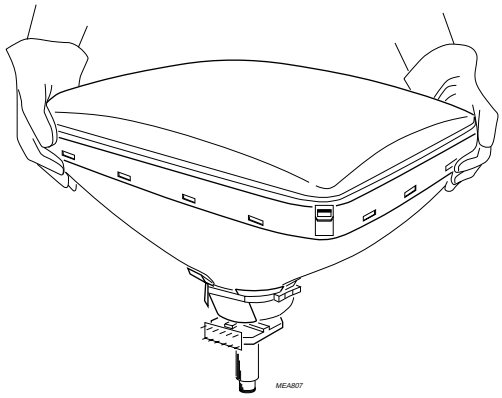


Fig.27 Lifting tube from face-up position.

6 DEFINITIONS

Data sheet status	
Objective specification	This data sheet contains target or goal specifications for product development.
Preliminary specification	This data sheet contains preliminary data; supplementary data may be published later.
Product specification	This data sheet contains final product specifications.
Limiting values	
Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 60134). Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only and operation of the device at these or at any other conditions above those given in the Characteristics sections of the specification is not implied. Exposure to limiting values for extended periods may affect device reliability.	

7 LIFE SUPPORT APPLICATIONS

These products are not designed for use in life support appliances, devices, or systems where malfunction of these products can reasonably be expected to result in personal injury. PDS customers using or selling these products for use in such applications do so at their own risk and agree to fully indemnify PDS for any damages resulting from such improper use or sale.

5.4 Environmental conditions

The tube assembly must be capable of meeting the requirements of this specification under/after the following environmental conditions.

5.4.1 AMBIENT TEMPERATURE

- Tube operating +10 °C to +53 °C
- Storage and shipment –20 °C to +60 °C with a thermal shock up to 24 °C
- 50% relative humidity at either limit with the tube assembly inside the shipping container.

5.4.2 RELATIVE HUMIDITY

- Operating 8% to 80%
- Storage and shipment 5% to 100% (including condensation, but excluding rain).

5.4.3 BAROMETRIC PRESSURE

- Operating and storage 769 hPa to 1060 hPa
- Shipment 91 hPa to 1060 hPa.

5.4.4 WET BULB TEMPERATURE

- Operating maximum 26.7 °C
- Storage and shipment 29.4 °C.

NOTES

PDS

Professional Display Systems B.V.

PDS

Jan Campertstraat 5

6416 SG Heerlen

The Netherlands

Tel. +31 (0)45 543 9312

Fax. +31 (0)45 542 6458

Printed in The Netherlands

DATA SHEET

M41EHN..WB11

17" high resolution triple gun monochrome monitor tube assembly

Product specification

2001 Mar 20

Professional Display Systems B.V.

17" high resolution triple gun monochrome monitor tube assembly

M41EHN..WB11

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17" high resolution triple gun monochrome monitor tube assembly

M41EHN..WB11

1 HIGHLIGHTS

1.1 Features

1.1.1 HIGH PERFORMANCE DESIGN

- High resolution; higher pixel density possible up to 1280 × 1024 pixels (non-interlaced) displayable conform ISO 9241 by:
  - high resolution DAF gun
- High brightness and contrast
- Excellent white uniformity
- Accurate convergence and raster geometry:
  - double mussel coil technology
  - internal magnetostatic beam alignment
- Application friendly design:
  - worldwide useable design
  - East-West correction max. 10.0%
  - deflection units designed for minimal ringing
  - static convergence adjustment on monitor level: multipole for 4 and 6 pole correction
  - dynamic convergence adjustment on monitor level: horizontal balance coil; vertical balance potentiometer
  - rotation coil for adjustment of axial magnetic fields (optional).

1.1.2 ERGONOMIC DESIGN

- Less ambient reflection:
  - 'flat' and 'square' design
  - AGAS (Anti Glare Anti Static) coating
- Less eye strain:
  - P45 medium/short persistence phosphor
  - high frequency yokes
- Green design:
  - CFC-free production process
  - Cd-free phosphors
  - 0.65 W power saving cathode
- Fulfilling electric/magnetic radiation standards
- Safety approved:
  - VDE; CSA; UL.

1.1.3 OPTIMUM DISPLAY SOLUTION

- High-end PC applications
- Workstation applications
- Resolution standards up to 1280 × 1024 pixels non-interlaced application.

1.2 Quick reference data

PARAMETER	TYP.	UNIT
Deflection angle	90	deg
Face diagonal	444	mm
Overall length	<388	mm
Neck diameter	29.4	mm
Glass transmission	43	%
Colour coordinates		
x	244	
y	309	
Heater voltage	6.1	V
Anode voltage	26	kV
Focus voltage	30% of anode voltage	

1.3 Deflection coil data

Deflection coil is mounted with dynamic convergence correction coils (PECOMA).

PARAMETER	VALUE	UNIT
Horizontal coil inductance	0.101	mH
Vertical coil inductance	6.27	mH
Maximum advised frequency	95	kHz

1.4 Ordering information

TYPE NUMBER	SCREEN FINISH
M41EHN30WB11	AGAS

2 PERFORMANCE SPECIFICATION

2.1 Colour coordinates

PHOSPHOR DATA	COLOUR COORDINATES	
	x	y
Phosphor type: P45 (N 1045) $I_{a(av)}$ = 300 μA (per gun) V_a = 26 kV Scanned duty cycle = 75% Scanned area = 312 × 234 mm Screen finish AGAS Spot size 5%	244±10	309±15

2.2 Brightness uniformity

Brightness uniformity between centre and corners: > 85%; < 110%.

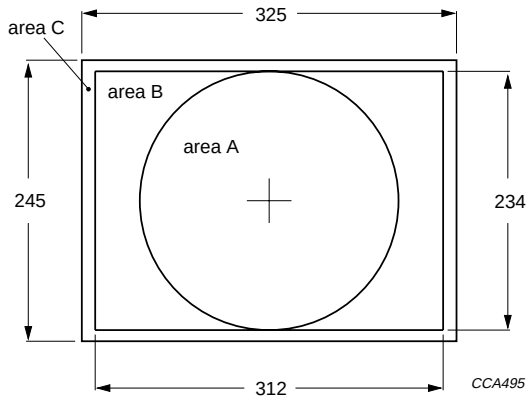
2.3 Convergence specification

2.3.1 TEST CONDITIONS

1. Set-up in accordance with Section 4.1.
2. Measure maximum misconvergence after 30 minutes operation.
3. To be adjusted for focus at $^2/_3$ centre-corner using crosshatch pattern at anode current is 300 μA (peak value) per gun.
4. Misconvergence is the distance between the centres of the red, green and blue guns at the screen using a crosshatch pattern.
5. Anode and/or focusing voltage and terrestrial magnetism may slightly affect the static convergence. Therefore, small re-adjustments to static convergence may be necessary.
6. Avoid stray magnetic fields etc. due to chassis influences which may affect convergence.

2.3.2 CONVERGENCE LIMITS

LOCATION (see Fig.1)	TYPE OF ERROR	MAXIMUM ERROR BETWEEN GUN SPOTS	
		STANDARD	WITH PECOMA
Centre	red-green-blue gun line separation in either the horizontal or vertical direction	0.30 mm	0.2 mm
Area A/corner		0.50 mm	0.2 mm



Dimensions in mm.

Fig.1 Maximum misconvergence.

2.4 Resolution specification

With the settings given in Section 4.1, the displayed characters will be recognisable as individual $ characters on a data raster measuring 325 mm × 234 mm.

ANODE CURRENT	SPOT SIZE CENTRE (NOMINAL)		SPOT SIZE CORNER (NOMINAL)		UNIT
	X	Y	X	Y	
100 μA	0.5	0.5	0.8	0.4	mm
200 μA	0.5	0.5	0.8	0.4	mm
400 μA	0.6	0.6	1.0	0.5	mm

2.5 Raster geometry

2.5.1 RASTER CENTRING

CENTRING	MAX.	UNIT
Horizontal	±5.0	mm
Vertical	±5.0	mm

2.5.2 RASTER ORTHOGONALITY

Orthogonality of the horizontal/vertical scan axis is ±0.5°.

2.5.3 RASTER ROTATION

Measure the angle of the horizontal green scanning line with reference to a horizontal centre line that is drawn parallel to the tube reference points A1 and A2, see Fig.2. Chassis influences may affect raster rotation.

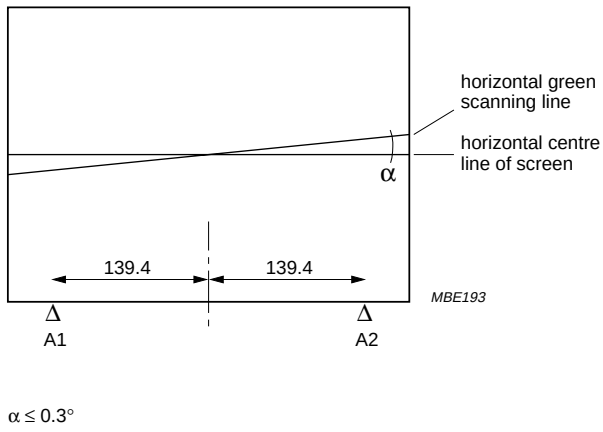
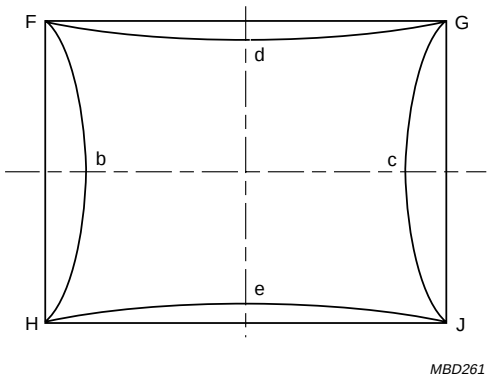


Fig.2 Rotation measurement.

2.5.4 PIN¬CUSHION DISTORTION



FG = HJ = 312 mm.
FH = GJ = 234 mm.
Measured with no pin-cushion correction applied, with ‘b’, ‘c’, ‘d’ and ‘e’ measured along the main axis.

Fig.3 Pin-cushion distortion.

2.5.5 DISTORTION NORTH - SOUTH

The following formulae define the pin¬cushion distortion in the north and south directions.

$$\text{North} = \frac{4d}{FH + GJ} \times 100\% = 0\% \text{ to } +0.8\%$$

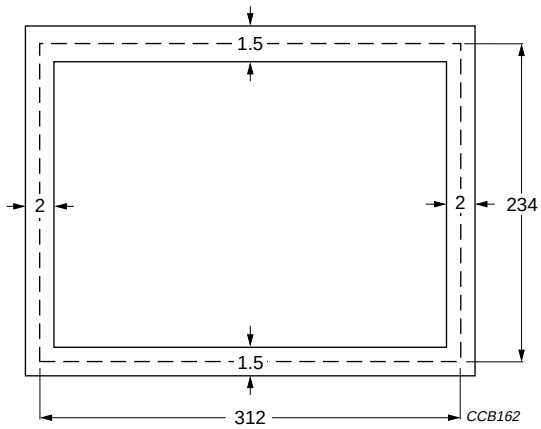
$$\text{South} = \frac{4e}{FH + GJ} \times 100\% = 0\% \text{ to } +0.8\%$$

2.5.6 DISTORTION EAST - WEST

The following formulae define the pin-cushion distortion in the east and west directions.

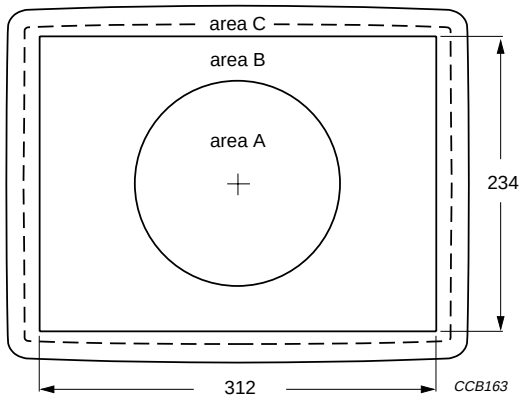
$$\text{East} = \frac{4b}{FG + HJ} \times 100\% \leq 8\%$$

$$\text{West} = \frac{4c}{FG + HJ} \times 100\% \leq 8\%$$



Dimensions in mm.

Fig.4 General distortion.



Dimensions in mm.

Fig.5 Screen areas.

2.6 Screen quality

2.6.1 GENERAL TEST PROCEDURE

Tests are to be done under the following general conditions:

- Viewing distance should be 50 cm minimum.
- For an activated screen the diffuse ambient light level at the centre of the screen should be between 2 and 5 lux.
- For an unactivated screen the diffuse ambient light level at the centre of the screen should be between 700 and 1000 lux.
- The viewing angle relative to the tube axis should not exceed 45°.
- Faults not visible under these general conditions are permitted.
- The following quality areas are specified (see Fig.5):
  - Area A: a circular area with a diameter of 165 mm, of which the centre coincides with the mechanical centre of the screen.
  - Area B: the area between the edge of area A and the rectangular area measuring 312 mm × 234 mm, of which the centre coincides with the mechanical centre of the screen.
  - Area C: the area between the edge of area B and the rimband.

2.6.2 ASSESSMENT OF THE GLASS AND THE UNACTIVATED SCREEN QUALITY

2.6.2.1 Definition of blemishes

Unless otherwise specified, the shape of a blemish is defined as round and elliptical.

The size of a blemish is given by:

- $\frac{L + W}{2}$; if L > 3W the size is given by $\frac{L}{20} + 2W$,

  where L = length and W = width.

2.6.2.2 Limits

Table 1 Limits of measurable glass blemishes

SIZE (mm)	MAX. NUMBER OF BLEMISHES IN AREAS		MIN. PERMISSIBLE DISTANCE BETWEEN ANY 2 BLEMISHES (mm)	AREA C
	A	A + B		
>0.6	0	0	not applicable	only limits as regards tube safety
>0.4 to ≤0.6	1	2	50	
>0.2 to ≤0.4	2	5	50	
Total number	2	5	50	–
≤0.2	limited only by cloud			–

Table 2 Limits of measurable coating blemishes for AGAS coating

SIZE (mm)	MAX. NUMBER OF BLEMISHES IN AREA A+B	MIN. PERMISSIBLE DISTANCE BETWEEN ANY 2 BLEMISHES (mm)	AREA C
High contrast			
>1.5	0	not applicable	acceptable
>1.0 to ≤1.5	3	50	
>0.5 to ≤1.0	5	30	
≤0.50	no limits	no limits	
Low contrast			
>3.0	0	not applicable	acceptable
>1.0 to ≤3.0	5	30	
≤1.0	no limits	no limits	

Table 3 Limits of scratches

AREA	WIDTH (mm)	MAX. ALLOWABLE TOTAL LENGTH (mm)	MIN. SEPARATION (mm)
A+B	>0.15	0	not permitted
	>0.10 to ≤0.15	13	50
	>0.05 to ≤0.10	25	20
	≤0.05	no limits	not applicable
C	only as regards tube safety		

2.6.3 ASSESSMENT OF THE QUALITY OF THE ACTIVATED PHOSPHOR SCREEN

The assessment of the quality of the phosphor and matrix layer at area A should take place at typical operating conditions and a blanked raster. The current for each gun must be adjusted to a brightness of 200 cd/m^2.

2.6.3.1 Definition of blemishes

- A blemish is a fault which is clearly visible within 5 seconds.
- A defect, which looks visually as one blemish should be regarded as a single blemish.
- Unless otherwise specified, the shape of a blemish is defined as round and elliptical.

The size of a blemish is given by:

- $\frac{L+W}{2}$; if L > 3W the size is given by $\frac{L}{20} + 2W$, where L = length and W = width.

2.6.3.2 Limits

1. The distance between any two blemishes >0.2 mm should be >50 mm.
2. Maximum number of blemishes >0.2mm per screen is 9.
3. Blemishes ≤0.2 mm can be ignored, except for a concentration of such blemishes that have a diameter of more than 8 mm.

Table 4 Limits of blemishes

BLEMISH SIZE (mm)	MAXIMUM NUMBER OF BLEMISHES IN		
	AREA A	AREA B	AREA A + B
>0.6	0	0	0
>0.4 to ≤0.6	1	5	5
>0.2 to ≤0.4	4	6	9
≤0.2	limited only by cloud		

2.7 Coating performance

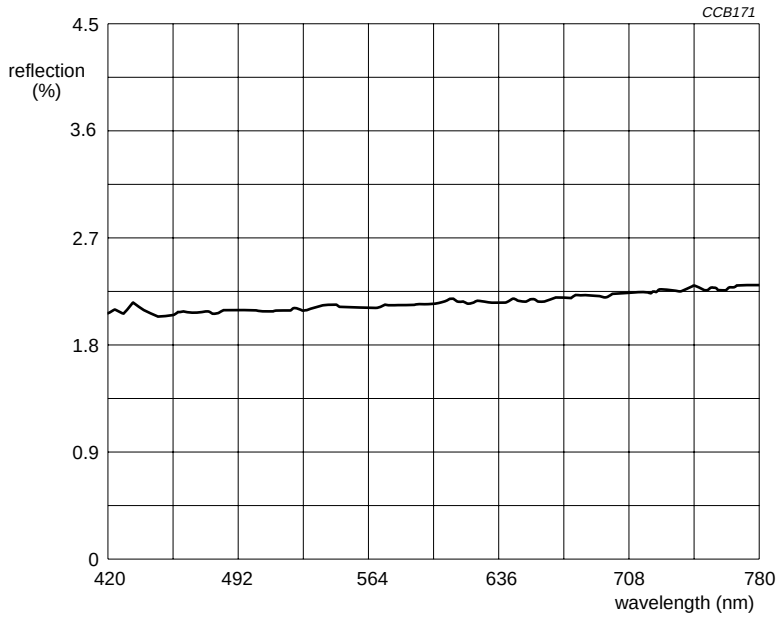


Fig.6 Relative reflection for AGAS.

3 PRODUCT CHARACTERISTICS

3.1 Electrical data

SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNIT
Capacitances					
$C_{a(m + m')}$	anode to external conductive cone coating, including rimband (with and without screen coating)	1000	1300	1600	pF
C_k	cathodes of all guns, connected in parallel, to all other electrodes	–	11	–	pF
C_{kR}, C_{kG}, C_{kB}	cathode of any gun to all other electrodes	–	4	–	pF
C_{g1}	grid 1 of any gun to all other electrodes	–	20	–	pF
C_{g2}	grid 2 to all other electrodes	–	15	–	pF
C_{g3a}	grid 3a (focus electrode) to all other electrodes	–	8	–	pF
C_{g3b}	grid 3b (dynamic focus electrode) to all other electrodes	–	12	–	pF
$C_{(g3a-g3b)}$	grid 3a to grid 3b	–	7	–	pF
Heater					
V_f	heater voltage	–	6.1	–	V
I_f	heater current	294	312	330	mA
t_{kwu}	cathode warm up time at 0-hour from 10% to 80% of end emission	–	–	8	s
Deflection unit					
V_{max}	maximum permissible DC voltage				
	between horizontal and vertical coils	–	–	2000	V
	between vertical coils and core	–	–	300	V
R_{ins}	insulation resistance at 1 kV (DC)				
	between horizontal and vertical coils	500	–	–	MΩ
	between horizontal coil and core clamping ring	500	–	–	MΩ
	between vertical coil and core clamping ring	10	–	–	MΩ
	crosstalk (1 V applied to the horizontal coils)	–	–	30	mV

3.2 Deflection unit data

All values are valid at T_{amb} = 25 °C and V_a = 26.0 kV; deflection units fulfil the MPRII and TCO magnetic requirements (see Section 5.1); the deflection coil is designed for a positive pulse on the horizontal coil.

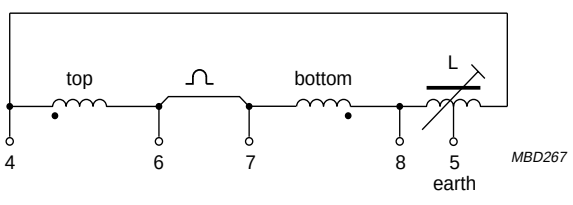
PARAMETER	VALUE	TOLERANCE	UNIT
Advised frequency; notes 1 and 2	95	–	kHz
Horizontal deflection coil			
Inductance	0.101	±4%	mH
Resistance	0.19	±10%	Ω
Current (peak-to-peak value)	13.5	±4%	A
Used wire	litz	–	
Vertical deflection coil			
Inductance	6.27	±4%	mH
Resistance	6.06	±7%	Ω
Current (peak-to-peak value)	1.81	±5%	A
Used wire	litz	–	

Notes

1. Advised maximum frequency depends on the internal maximum set temperature and used deflection-overscan.
2. No annoying ringing with 0% overscan.

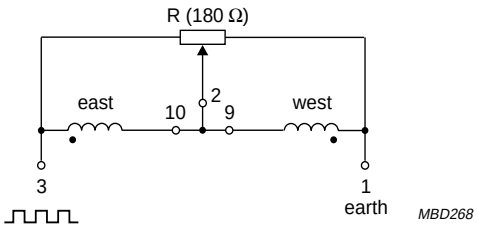
Rotation coil data

PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Resistance	T_{amb} = 20 °C	50.9	56.6	62.3	Ω
Sensitivity	I = 75 mA; V_a = 26.0 kV	–	0.95	–	deg



The beginning of the windings is indicated with •

Fig.7 Horizontal coils.



The beginning of the windings is indicated with •

Fig.8 Vertical coils.

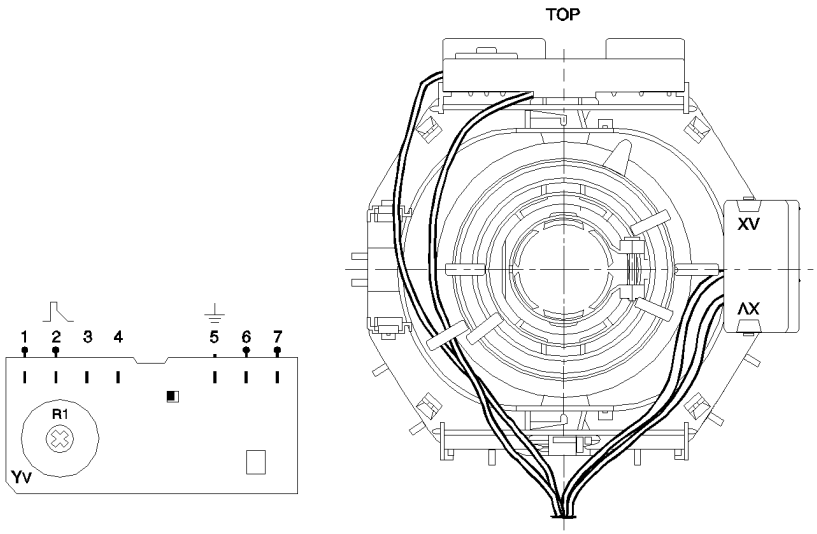
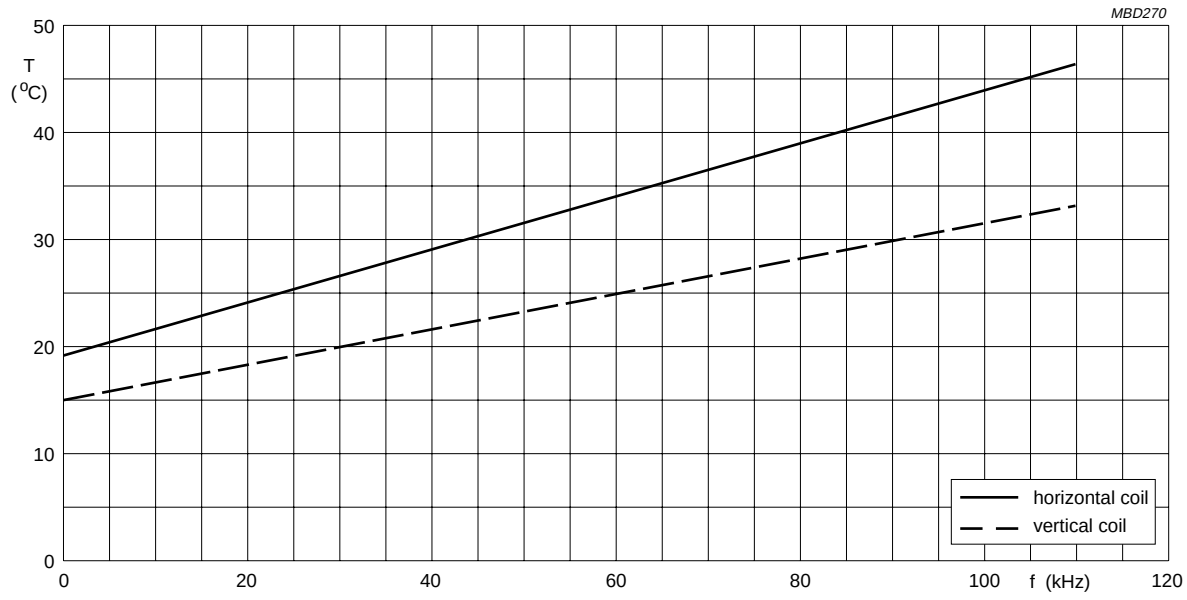


Fig.9 Deflection coil connections.

3.2.1 DEFLECTION UNIT TEMPERATURE

SYMBOL	PARAMETER	MAX.	UNIT
T_{copper}	average copper temperature of horizontal coil	110	°C
ΔT	maximum temperature rise of used wire	50	°C



Maximum operating copper temperature (resistance measurement) is 110 °C.

Fig.10 Temperature rise as a function of frequency.

3.3 Electro optical data

PARAMETER	VALUE
Electron gun system	three in-line integrated guns
Focus method	electrostatic
Focus lens	polygon and DAF
Convergence method	magnetic
Deflection method	self converging
Deflection angle	
diagonal	≈90°
horizontal	≈78°
vertical	≈60°

3.4 Screen properties

PARAMETER	VALUE
Screen finish	AGAS
Light transmission at screen centre	43%
Recommended active screen area	
horizontal axis	312 mm
vertical axis	234 mm

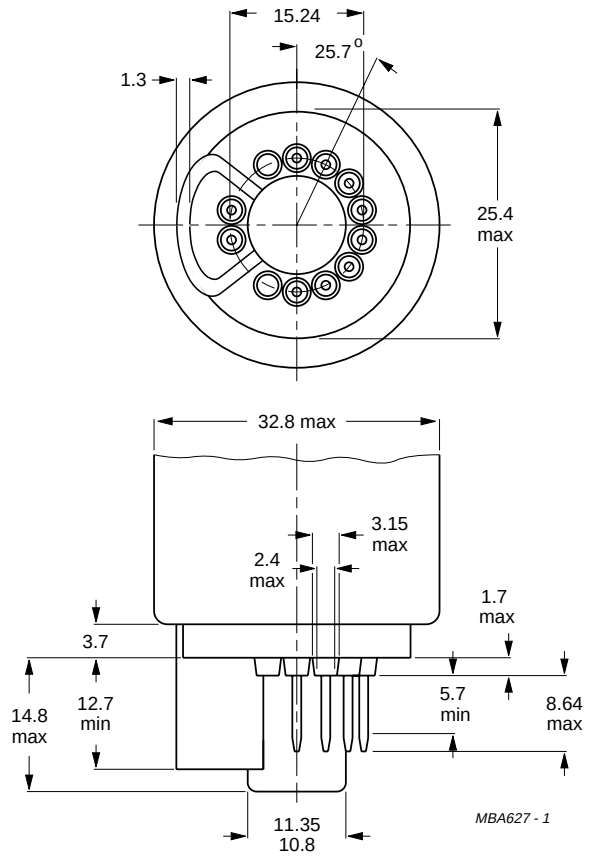
3.5 Coating properties

TYPE NUMBER	SCREEN FINISH	GLOSS
M41EHN30WB11	Anti Glare Anti Static (AGAS), tested in the centre	60 ±12%

3.6 Mechanical tube data

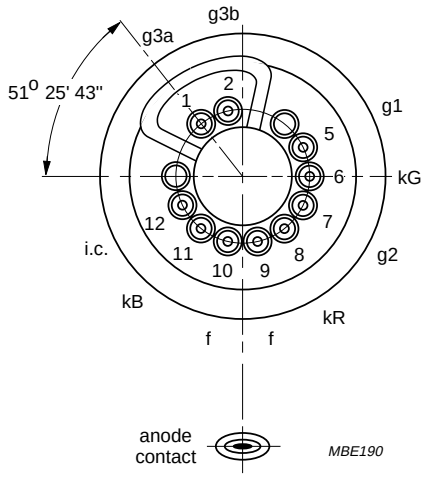
PARAMETER	VALUE
Overall length	383.5 ±4.5 mm
Neck diameter	29.4 +0.6/–0.4 mm
Maximum dimensions, excluding mounting lugs but including rimband	
diagonal	446.2 mm
width	387.9 mm
height	297.6 mm
Implosion protection	pre-stressed banded Mini-P shrunk-on rimband; CSA, UL and VDE approved
Anode contact	JEDEC J1-21; IEC 60067-III-2
Base designation	JEDEC B10-301
Base pin configuration	see Fig.12
Mass	≈10 kg
Mounting position	anode contact on top

3.7 Mechanical tube drawings



Dimensions in mm.

Fig.11 Base JEDEC B10-301.



i.c. = internally connected and not to be used.

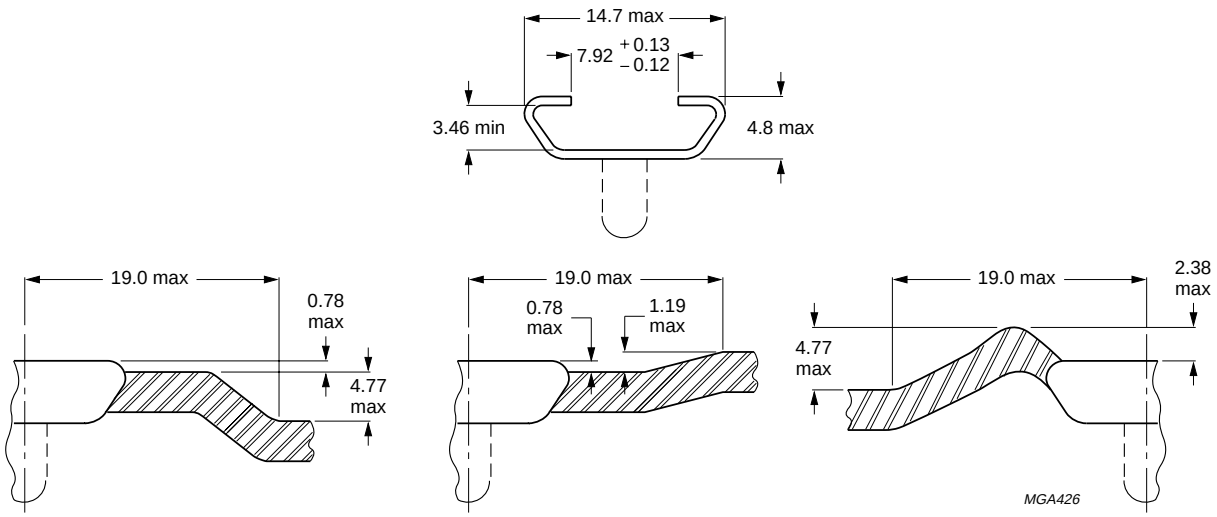
Fig.12 Pin arrangement.

Remarks: to Figs 11 and 12.

The socket for this base should not be rigidly mounted, it should have flexible leads and be allowed to move freely. After mounting the tube in the cabinet, note that the position of the base can fall within a circle, having a diameter of max. 40 mm concentric with an imaginary tube axis.

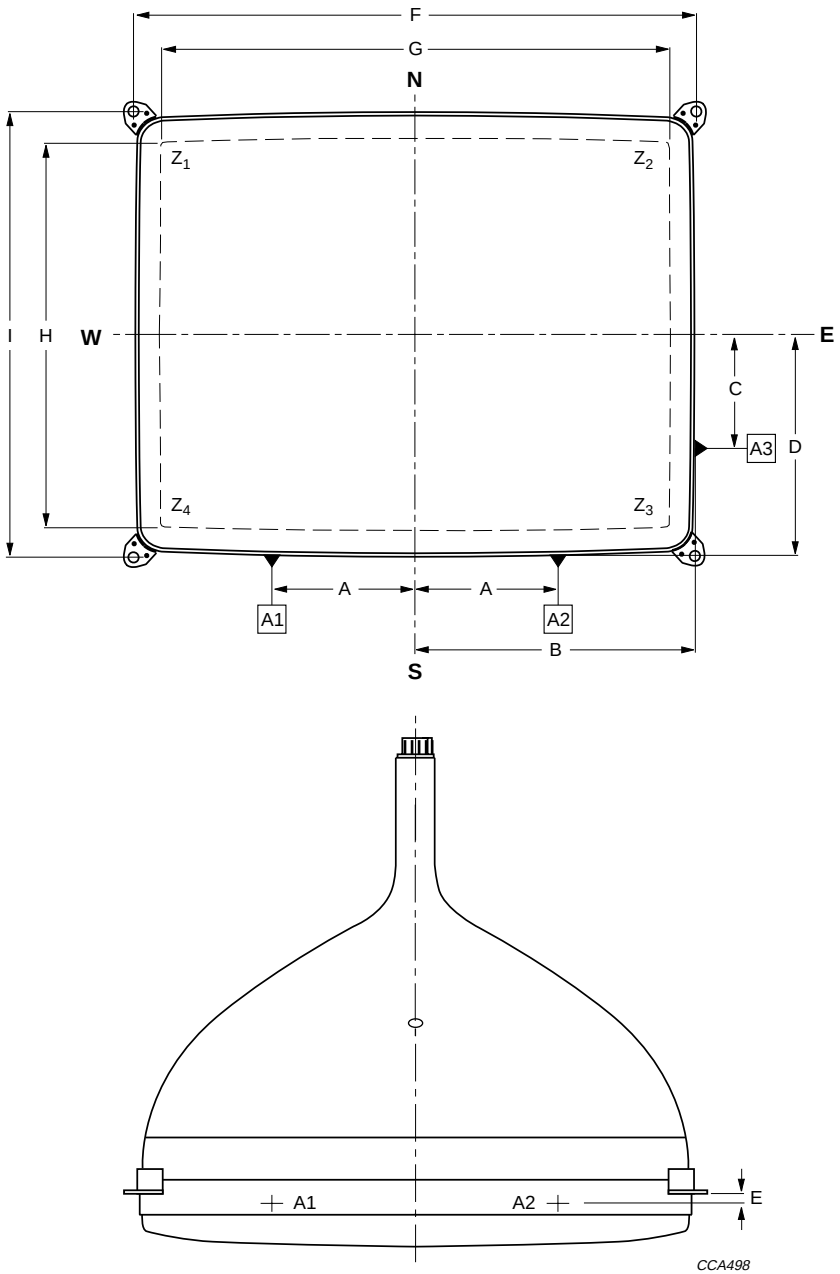
The mass of the mounting socket assembly should not exceed 450 g.

Maximum permissible torque on the tube neck is 0.14 Nm.



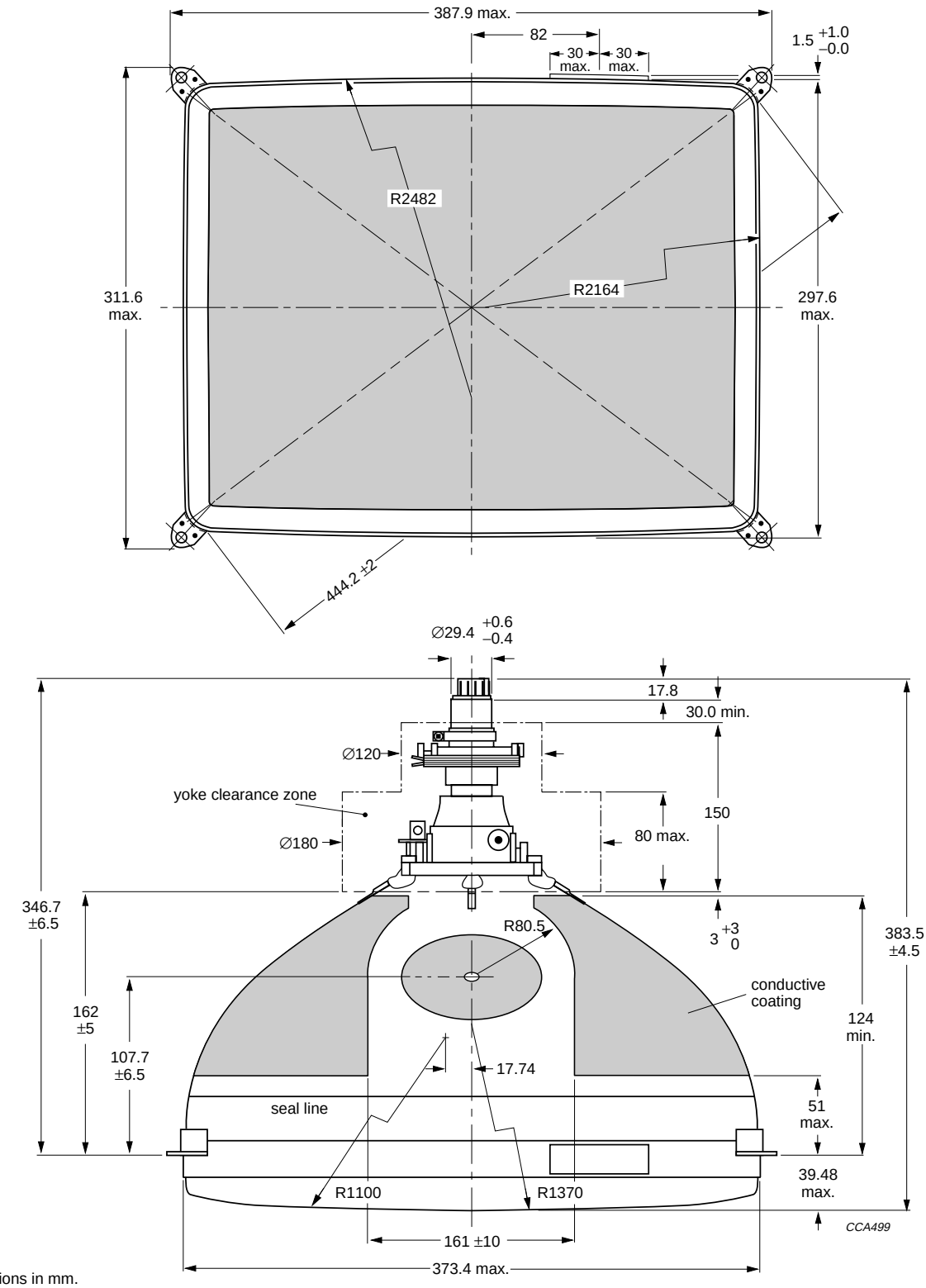
Dimensions in mm.

Fig.13 Cavity cap JEDEC J1-21, IEC60067-III-2.



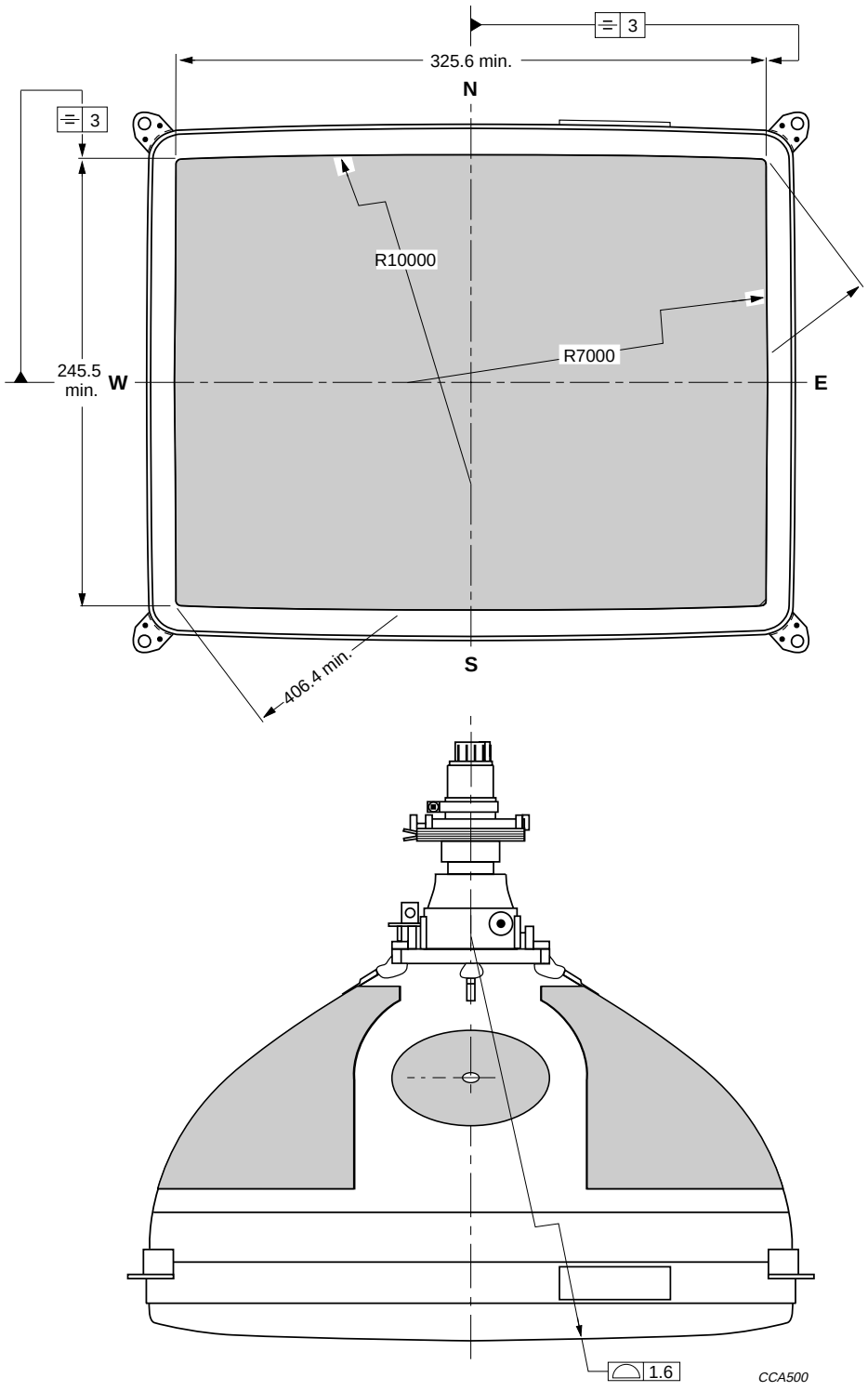
A = 139.4 mm.
B = 183.60 mm.
C = 100.00 mm.
D = 143.80 mm.
E = 0.58 mm.
F = 366.90 mm.
G = 330.24 mm.
H = 247.68 mm.
I = 290.60 mm.

Fig.14 Mechanical reference points.



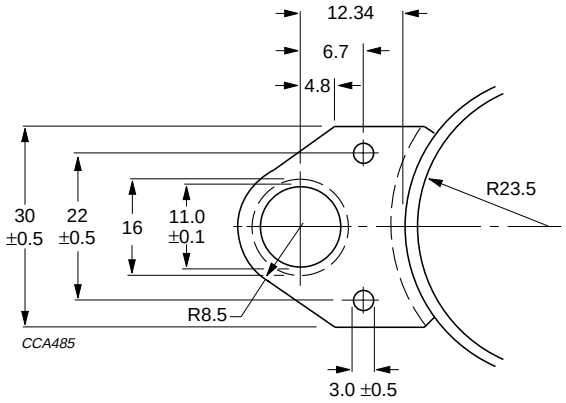
Dimensions in mm.

Fig.15 Top view.



Dimensions in mm.

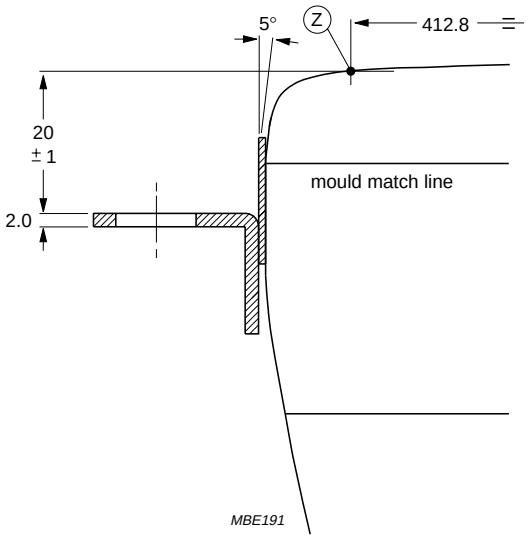
Fig.16 Dimensions of phosphor area on screen.



Dimensions in mm.

The mounting screw in the cabinet must be within a circle of 6.5 mm diameter drawn around the true geometrical positions, i.e. the corners of a rectangle of 366.9 mm × 290.6 mm.

Fig.17 Lug dimensions.



Dimensions in mm.

Fig.18 Lug position.

3.8 Sagittal heights of screen

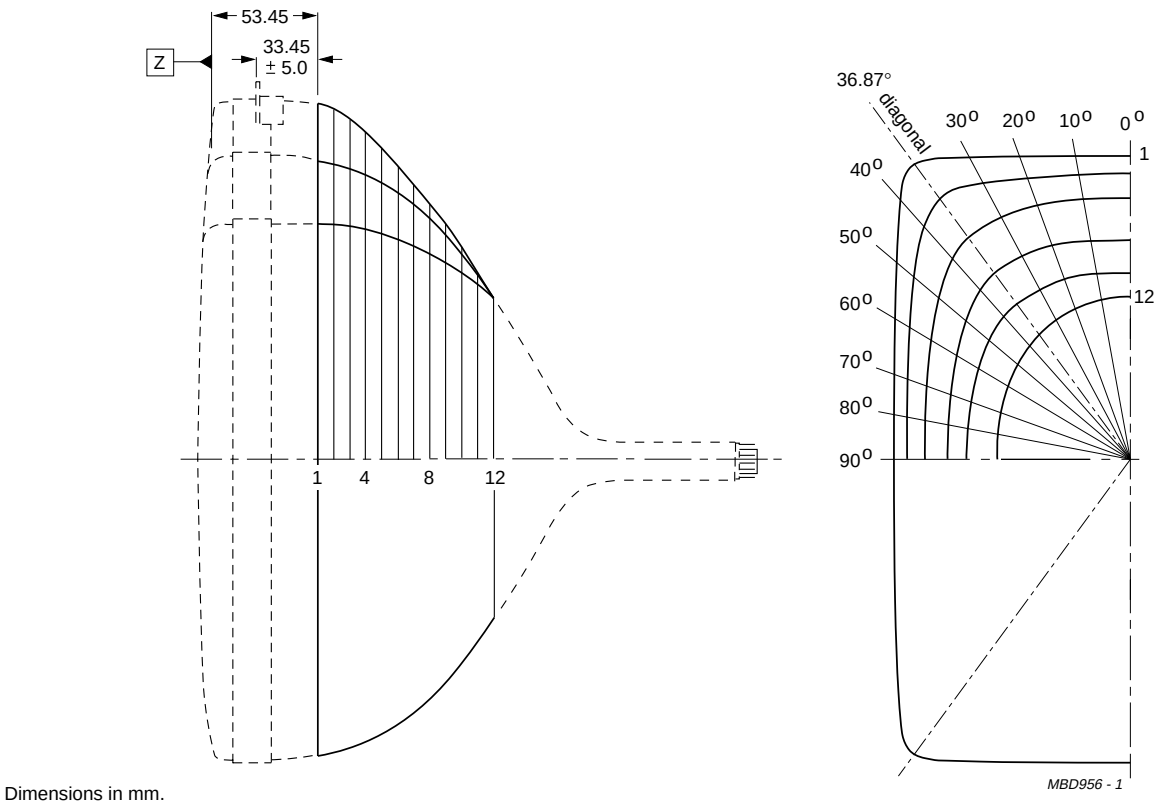
Sagittal heights of the nominal useful screen measured with respect to the end of the diagonal axis.

COORDINATES		SAGITTAL HEIGHT
X (mm)	Y (mm)	(mm)
0.0	0.0	16.3
0.0[1]	123.0	10.6
10.0	123.0	10.6
20.0	123.0	10.5
30.0	123.0	10.3
40.0	122.9	10.0
50.0	122.9	9.7
60.0	122.8	9.2
70.0	122.8	8.7
80.0	122.7	8.1
90.0	122.6	7.4
100.0	122.5	6.7
110.0	122.4	5.8
120.0	122.3	4.9
130.0	122.2	3.9
140.0	122.0	2.8
150.0	121.9	1.6
160.0	121.7	0.3
162.2[2]	121.7	0.0
162.3	120.0	0.2
162.4	110.0	1.1
162.5	100.0	2.0
162.7	90.0	2.8
162.8	80.0	3.4
162.9	70.0	4.1
162.9	60.0	4.6
163.0	50.0	5.0
163.1	40.0	5.4
163.1	30.0	5.7
163.1	20.0	5.9
163.1	10.0	6.0
163.2[3]	0.0	6.0

Notes

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

3.9 Cone contour



Dimensions in mm.

Fig.19 Maximum cone contour.

Cone contour data

SECTION	NOMINAL DISTANCE FROM SECTION 1 (mm)	MAXIMUM DISTANCE FROM TUBE AXIS (mm)										
		0°	10°	20°	30°	36.87°	40°	50°	60°	70°	80°	90°
1	0.0	184.3	186.9	195.1	210.1	221.0	217.9	187.3	167.2	154.9	148.2	146.1
2	10.0	182.9	185.4	193.5	208.2	218.6	215.8	185.8	165.8	153.5	146.9	144.7
3	20.0	179.5	181.7	188.6	201.0	209.2	207.1	181.0	162.2	150.6	144.3	142.2
4	30.0	175.0	176.8	182.2	191.6	197.6	196.1	174.9	157.8	147.1	141.2	139.4
5	40.0	169.3	170.6	174.5	181.2	185.5	184.4	167.8	152.8	143.2	137.9	136.2
6	50.0	162.0	162.9	165.6	170.0	172.9	172.2	159.8	147.1	138.9	134.2	132.7
7	60.0	152.6	153.2	155.0	158.0	160.0	159.4	150.6	140.6	133.9	130.1	128.8
8	70.0	141.7	142.1	143.3	145.2	146.4	146.1	140.1	132.8	127.8	124.8	123.9
9	80.0	129.8	130.0	130.6	131.7	132.4	132.1	128.6	123.7	120.3	118.3	117.6
10	90.0	116.7	116.8	117.0	117.4	117.7	117.6	115.7	113.1	111.2	110.1	109.7
11	100.0	102.3	102.3	102.4	102.4	102.5	102.4	101.5	100.7	100.2	99.8	99.7
12	103.4	86.4	86.4	86.4	86.4	86.4	86.4	86.4	86.4	86.4	86.4	86.4

4 APPLICATION CONDITIONS

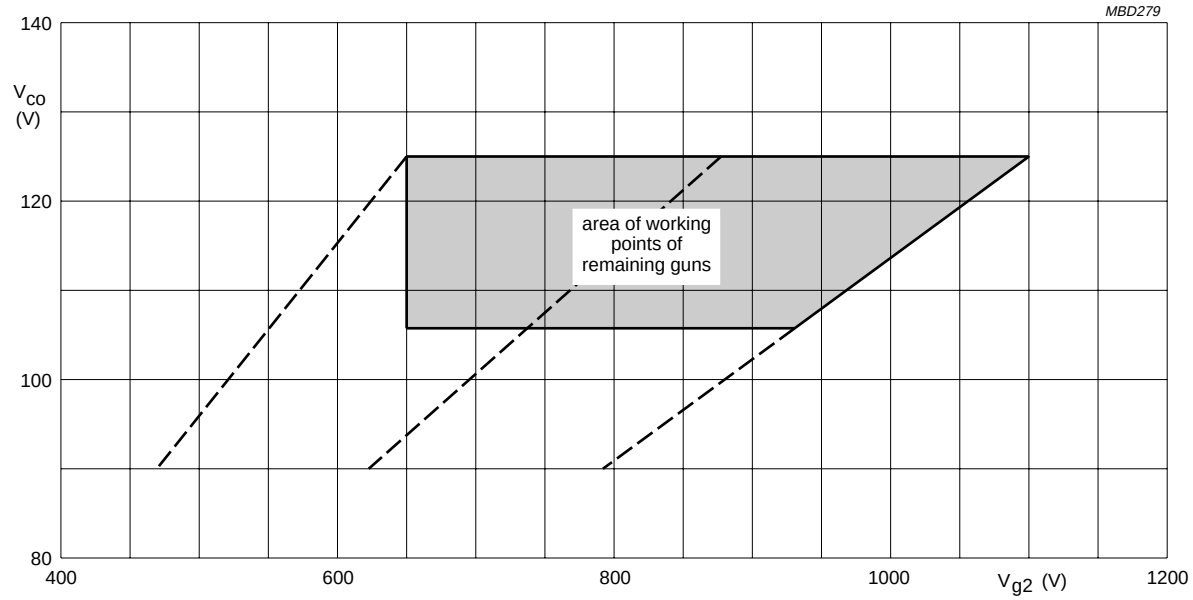
4.1 Recommended adjustment and operating conditions

The voltages are applied to each gun and are measured with respect to grid 1; RH = 40% to 60%; tube facing east; local magnetic field: 0.03 mT vertical, 0.00 mT lateral, 0.00 mT axial. Pre-heat the tube for 15 minutes minimum before tests. Avoid misconvergence, distortion etc. due to stray magnetic fields and chassis influences.

SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNIT
$V_{a,g4}$	anode voltage	–	26	–	kV
V_{g3a}	grid 3a (static focus electrode) voltage as a percentage of the anode voltage; note 1	28	–	32	%
V_{g3b}	grid 3b (dynamic focus electrode) voltage				
	DC voltage as a percentage of the anode voltage	28	–	32	%
	horizontal parabola	250	–	500	V
	vertical parabola	100	–	200	V
V_{g2}	grid 2 voltage at a spot cut-off voltage V_{co} = 125 V; note 2	see Fig.20			V
V_f	heater voltage	–	6.1(3)	–	V
f_H	horizontal sweep frequency	–	30 to 110	–	kHz
f_V	vertical sweep frequency	–	60 to 80	–	Hz
T_{amb}	ambient temperature	–	25	–	°C

Notes

1. Focus adjustment procedure:
   a) Adjust anode current for 750 cd/m^2.
   b) Adjust for optimum focus at $^2/_3$ centre-corner.
2. Grid 2 adjustment procedure:
   a) Grid 2 voltage (V_{g2}) adjusted for highest gun spot cut-off voltage: V_{co} = 125 V.
   b) Remaining guns adjusted for spot cut-off by means of cathode voltage.
   c) V_{g2} range: 650 V to 1100 V at V_{co} = 125 V.
   d) Set the cathode voltage (V_k) for each gun at 125 V; increase the grid 2 voltage (V_{g2}) from ≈650 V to the value at which the spot of the gun with the lowest (V_{g2}) cut-off voltage becomes just visible, then decrease the cathode voltage of the remaining guns until the other gun beams become just visible.
3. For maximum cathode life it is recommended that the heater voltage is regulated at 6.1 V.



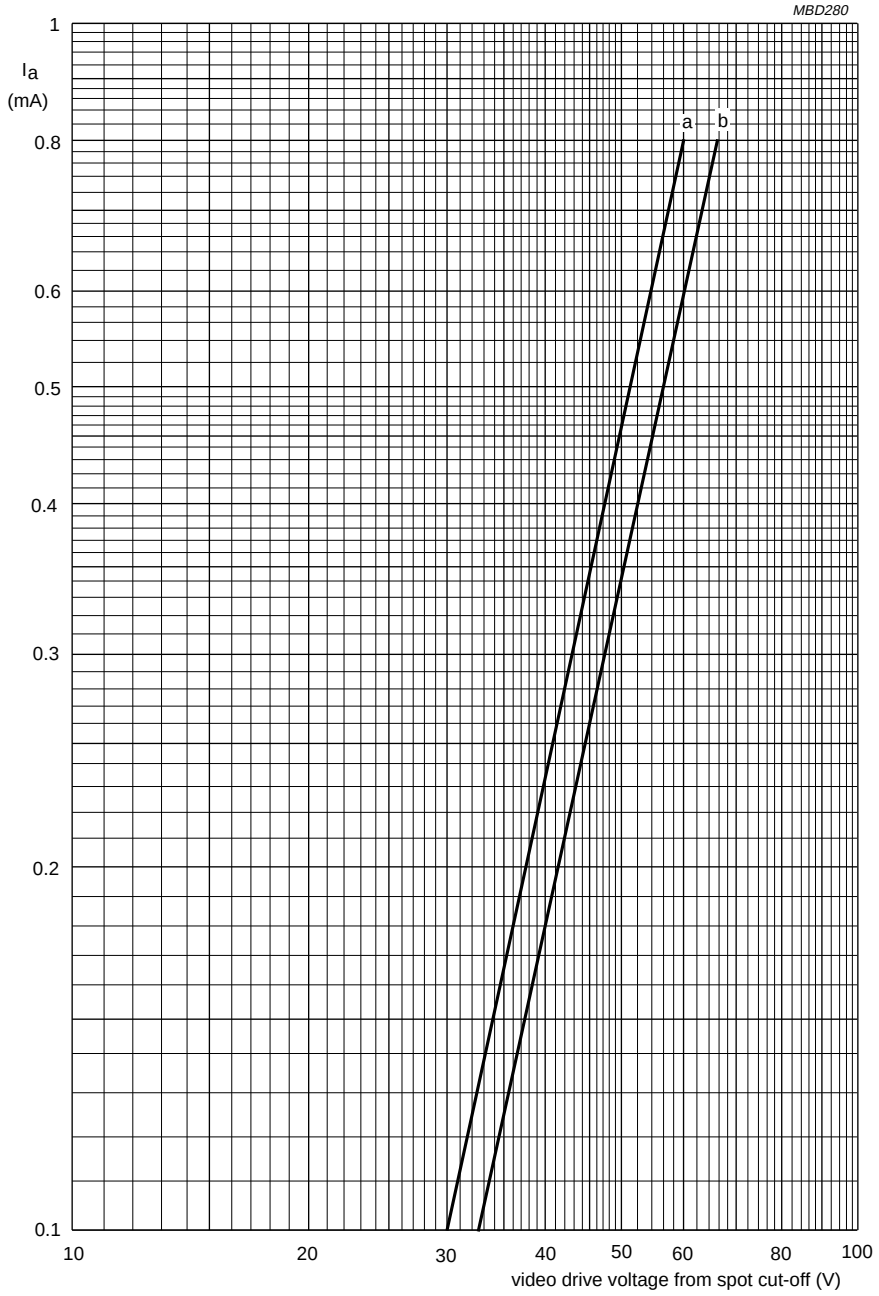
The voltages are specified with respect to grid 1.

Fig.20 Spot cut-off design chart.

4.2 Chassis design values

The values are valid for anode voltages between 20 and 29.9 kV. The voltages are specified with respect to grid 1.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
V_{g3a}	grid 3a (static focus voltage) as a percentage of anode voltage		28	–	32	%
V_{g3b}	grid 3b (dynamic focus voltage) as a percentage of anode voltage	raster size = 312 × 234 mm				
	DC voltage as a percentage of anode voltage		28	–	32	%
	horizontal parabola		–	350	–	V
	vertical parabola		–	150	–	V
ΔV_{g3a}	difference in focus voltage between red, green and blue guns when separately focused		–	–	200	V
ΔV_{g3a-b}	difference between the static focus voltage and dynamic focus voltage		–	–	500	V
V_{g2}	grid 2 voltage	for visual extinction of focused spot	see Fig.20			
V_k	cathode voltage		see Figs 20 and 21			
ΔV_k	difference in cut-off voltage between guns in any tube (cathodes cut-off ratio)		highest value <1.18 × lowest value			
V_f	heater voltage	at zero beam current	–	6.1	–	V
I_{g3a}	focus current	under cut-off conditions	–2	–	+2	µA
I_{g3b}	focus current	under cut-off conditions	–2	–	+2	µA
I_{g2}	grid 2 current	under cut-off conditions	–2	–	+2	µA
I_{g1}	grid 1 current	under cut-off conditions	–2	–	+2	µA
I_{kf}	cathode/heater current	V_{co} = 125 V	–3	–	+3	µA
Resistance						
R_{kgf}	insulation resistance between each cathode and all other electrodes and heater		50	–	–	MΩ
R_{g2}	grid 2 circuit impedance		–	–	5	MΩ
R_{g3}	grid 3 circuit impedance		–	–	50	MΩ



V_{co} = 100 V (curve a).
V_{co} = 125 V (curve b).

Fig.21 Typical cathode drive characteristics.

4.3 Limiting values

In accordance with the Absolute Maximum Rating System (IEC 60134). Voltages are specified with respect to grid 1.

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
$V_{a,g4}$	anode voltage	note 1	20(2)	28.5(3)	kV
I_{ap}	anode current for each gun (peak value)		–	550	μA
I_a	long-term average anode current for each gun		–	400	μA
I_a	long-term average anode current for three guns		–	1100	μA
V_{g3a}	grid 3a (focus) voltage		–	11	kV
V_{g3b}	grid 3b (focus) voltage		–	11	kV
$\Delta V_{g3a-g3b}$	grid 3 (focus) differential voltage		–	3	kV
V_{g2p}	grid 2 voltage, including video signal voltage (peak value)		–	1200	V
V_f	heater voltage	note 4	5.7	6.6(3)	V
Cathode voltage					
V_k	positive	operating	–	200	V
		operating cut-off	–	135	V
V_k	negative		–	0	V
V_{kp}	negative peak		–	–2	V
Cathode to heater voltage					
V_{kf}	positive		–	250	V
V_{kfp}	positive peak		–	300(3)	V
V_{kf}	negative		–	0	V
V_{kfp}	negative peak		–	-50	V

Notes

1. 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 the picture tube.
2. Operation of the tube at lower voltages impairs the luminance and resolution and could impair the convergence.
3. This value is an absolute maximum.
4. For maximum cathode life it is required that the heater supply is designed for 6.1 V at zero beam current. Heater source impedance should have a minimum value of 2 Ω (maximum current during switching on is 600 mA).

4.4 Flashover protection

With the high voltage used with this tube (max. 26 kV) internal flashovers may occur. As a result of Soft-Flash technology these flashover currents are limited to approximately 200 A offering higher 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 in accordance with Fig.22; 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 focus electrode (g3a and g3b) of 11 kV and at the other electrodes of 1.5 to 2 kV, both at an atmospheric pressure of 100 kPa.

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.

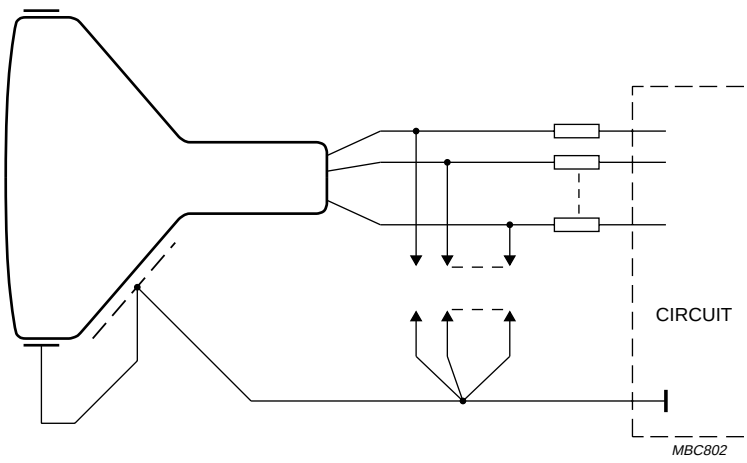


Fig.22 Flashover protection circuit.

5 ERGONOMIC, ENVIRONMENTAL DATA

5.1 X-radiation

Maximum anode voltage at which the X-radiation emitted will not exceed 0.5 mR/h at an anode current of 300 μA.

PARAMETER	TYP.	UNIT
Entire tube; note 1	34	kV

Note

1. 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 iso-exposure-rate limit curve and the iso-exposure-rate limit curve for the entire tube.

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 ensure 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 is 30 kV.
If this voltage can be exceeded in the monitor, additional attenuation of the X-radiation through the neck may be required.
The X-radiation emitted from this picture tube, as measured in accordance with the procedure of *"JEDEC Publications No.64D"* will not exceed 0.5 mR/h throughout the useful life of the tube 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 iso-exposure-rate limit characteristics as shown in Fig.24.
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 *"Federal Register Volume 38, No. 198,b Monday, October 15, 1973"*.
Maximum X-radiation as a function of anode voltage at 300 μA current is shown by Fig.23. X-radiation at a constant anode voltage varies linearly with anode current.

WARNING
The cathode ray tube is intrinsically safe in accordance with *"Appendix III Röntgenverordnung"*.
Eigensichere Kathodenstrahlröhre nach *"Anlage III Röntgenverordnung"*.

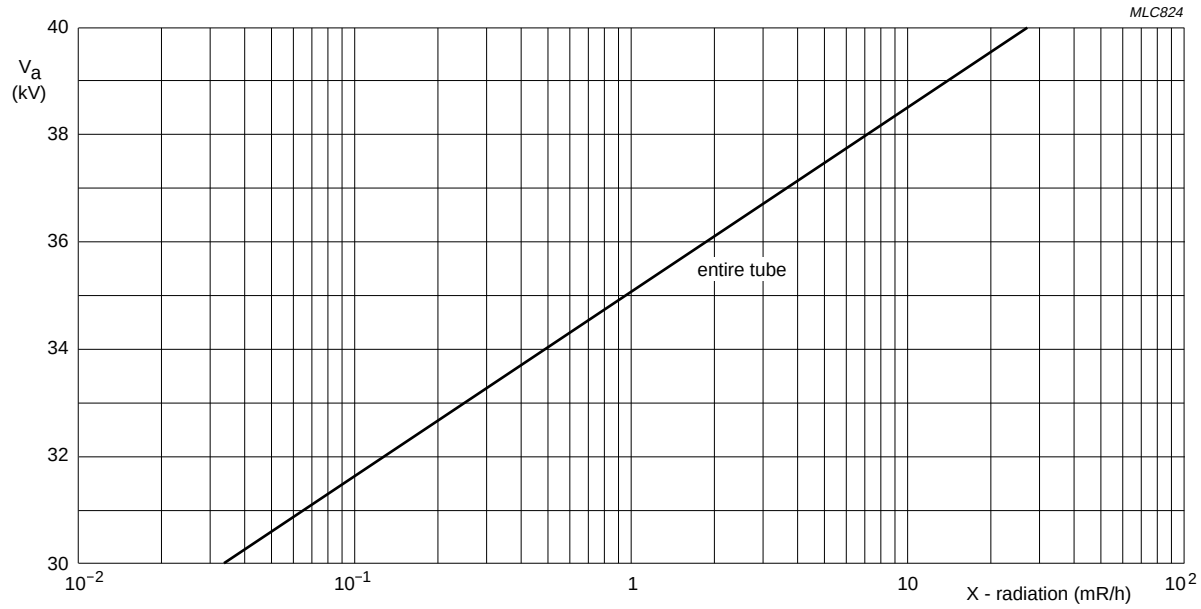


Fig.23 X-radiation limit curve at a constant anode current of 300 μA.

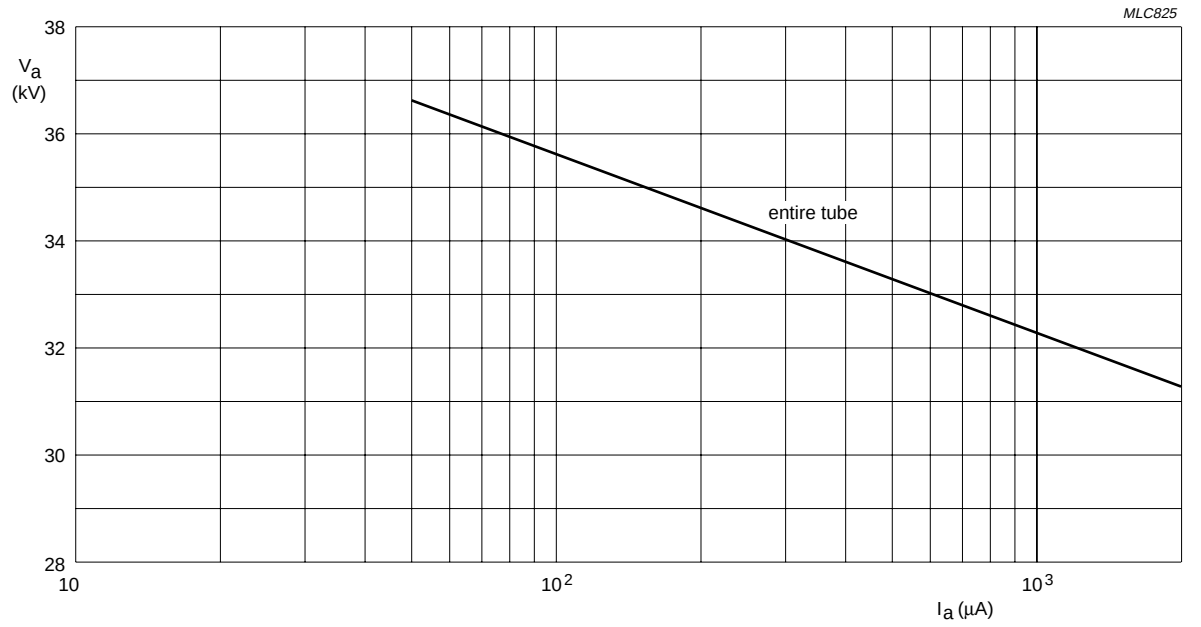
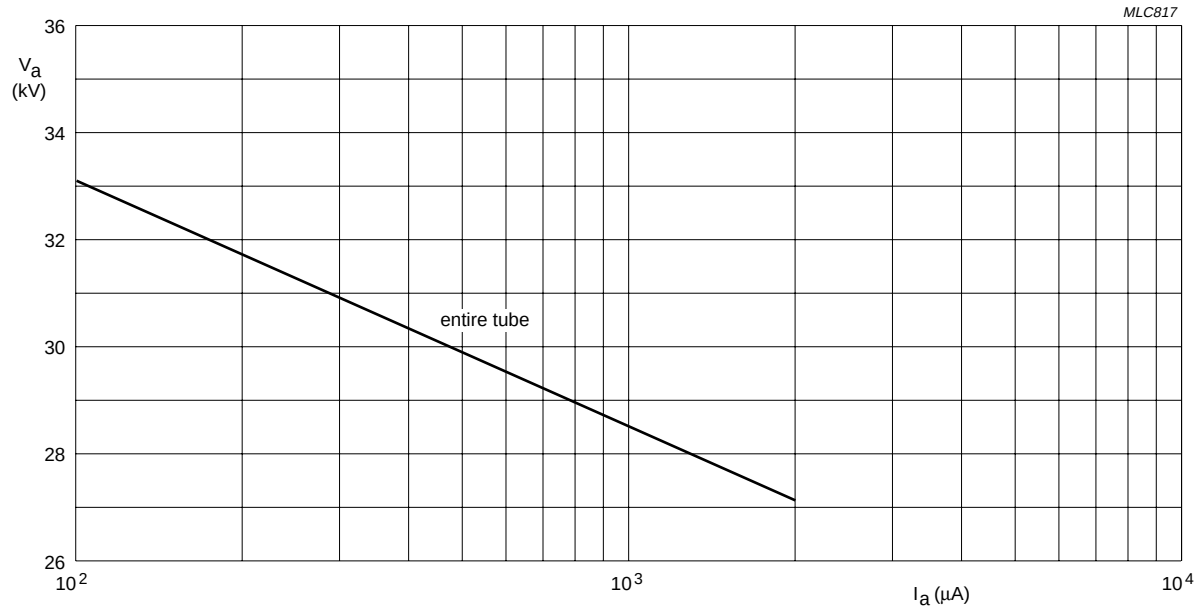


Fig.24 0.5 mR/h iso-exposure-rate limit curve.



The X-radiation emitted will also not exceed 1 µSv/h for anode voltage and current combinations shown in the iso-exposure-rate limit curve according to Eigensichere Kathodenstrahlröhre nach *"Anlage III Röntgenverordnung"*.

Fig.25 1 µSv/h iso-exposure-rate limit curve.

5.2 Warnings

X-radiation
Operation of the colour monitor tube under abnormal conditions that exceed the 0.5 mR/h iso-exposure-rate curve shown in Fig.24 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 values stated in Section 4.3 are not exceeded.
Tube replacement
This monitor tube incorporates integral X-radiation and implosion protection and must be replaced with a tube of the same type number or 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 taken during replacement or servicing of the monitor tube since a residual electrical charge may be held by the high-voltage capacitor formed by the external and internal conductive coatings of the monitor 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.

5.3 Handling

The packaging provides protection against tube damage under normal conditions of shipment or handling. Observe any instructions given on the packaging and handle accordingly. Under no circumstances should the tube assembly be subjected to accelerations greater than the values given in Table “Accelerations”.

Accelerations

PARAMETER	PULSE DURATION	MAX.	UNIT
Acceleration in cone direction	≤10 ms	350	m/s^2
	25 ms	300	m/s^2
Acceleration in all other directions	25 ms	350	m/s^2

Monitor tubes should be kept in the shipping box or similar protective container prior to installation.

Although monitor tubes are provided with integral implosion protection which meets the intrinsic safety requirements stipulated in the relevant part of IEC 60065, care should be taken not to scratch or knock any part of the tube. Particularly care should be taken to prevent damage to the seal area.

In all handling procedures prior to insertion in the cabinet, there is a risk of personal injury if severe accidental damage to the tube occurs. It is therefore recommended that in areas containing unpacked and unprotected tubes, protective clothing is worn, particularly, gloves and safety glasses with side-shields to prevent possible injury from flying glass in the event of such an accident.
Handle the tube with extreme care. Do not strike, scratch or subject the tube to more than moderate pressure.

The tube assembly should never be handled by the tube neck, deflection unit or other neck components.

If suspending the tube assembly from the mounting lugs, ensure that a **minimum of two** are used.
Under no circumstances suspend the tube assembly from one lug.

An alternative lifting method is to firmly grasp the assembly by the vertical sides of the rimband. Manually lifting the assembly from the face-down or face-up position is shown in Figs 26 and 27.

To protect the screen when placing the tube face-down, ensure that the tube face rests on a cushion kept free from abrasive substances.

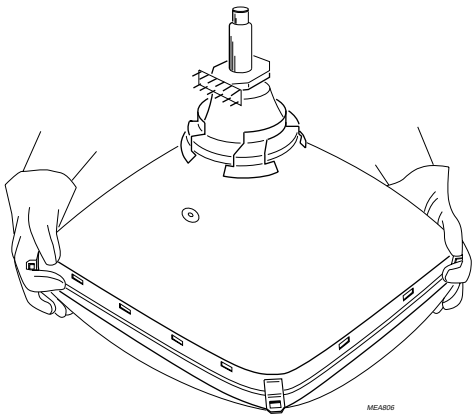


Fig.26 Lifting tube from face-down position.

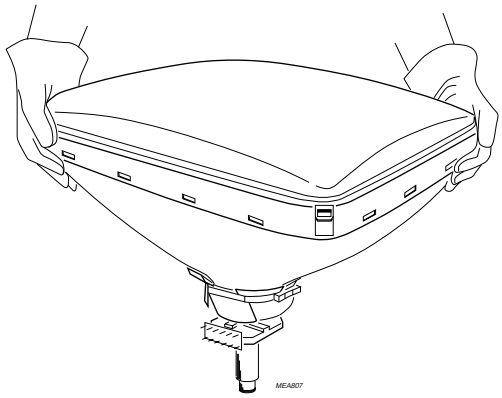


Fig.27 Lifting tube from face-up position.

6 DEFINITIONS

Data sheet status	
Objective specification	This data sheet contains target or goal specifications for product development.
Preliminary specification	This data sheet contains preliminary data; supplementary data may be published later.
Product specification	This data sheet contains final product specifications.
Limiting values	
Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 60134). Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only and operation of the device at these or at any other conditions above those given in the Characteristics sections of the specification is not implied. Exposure to limiting values for extended periods may affect device reliability.	

7 LIFE SUPPORT APPLICATIONS

These products are not designed for use in life support appliances, devices, or systems where malfunction of these products can reasonably be expected to result in personal injury. PDS customers using or selling these products for use in such applications do so at their own risk and agree to fully indemnify PDS for any damages resulting from such improper use or sale.

5.4 Environmental conditions

The tube assembly must be capable of meeting the requirements of this specification under/after the following environmental conditions.

5.4.1 AMBIENT TEMPERATURE

- Tube operating +10 °C to +53 °C
- Storage and shipment –20 °C to +60 °C with a thermal shock up to 24 °C
- 50% relative humidity at either limit with the tube assembly inside the shipping container.

5.4.2 RELATIVE HUMIDITY

- Operating 8% to 80%
- Storage and shipment 5% to 100% (including condensation, but excluding rain).

5.4.3 BAROMETRIC PRESSURE

- Operating and storage 769 hPa to 1060 hPa
- Shipment 91 hPa to 1060 hPa.

5.4.4 WET BULB TEMPERATURE

- Operating maximum 26.7 °C
- Storage and shipment 29.4 °C.

NOTES



PDS B.V.

Jan Campertstraat 5

6416 SG Heerlen

The Netherlands

Tel. +31 (0)45 543 9312

Fax. +31 (0)45 542 6458

Printed in The Netherlands

S p e z i f i k a t i o n

SIEMENS AUT 31E2	***Rechteckige Monitorröhre für SIMOMED 90 H W79045-A2089-X***	***M51-EDE1 WB-CL60***

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Änderungen gegenüber Ausgabe 11:

Blatt5 Maximale strahlabweichung

S p e z i f i k a t i o n

SIEMENS ***AUT E 31B3***	***Rechteckige Monitorröhre*** ***für SIMOMED 90 H*** ***W79045-A2089-X***	***M51-EDE1*** ***WB-CL60***

Merkmale

höchste Auflösung
90°-Ablenkung, magnetisch
Einbrand sicherer FS-Farbkolben
Lambda/4-Beschichtung
Leitschicht gegen statische Aufladung
Eigensicher
hoher Kontrast
große Helligkeit
hohe Lebensdauer

S p e z i f i k a t i o n

SIEMENS AUT E 31B3	***Rechteckige Monitorröhre für SIMOMED 90 H W79045-A2089-X***	***M51-EDE1 WB-CL60***

Wichtige Hinweise

Implosionsgefahr	Die Röhre ist luftleer. Bei mechanischer Beschädigung (durch Schlag, Kratzer o.ä.) besteht Implosionsgefahr.
Die Röhre trägt folgende Prüfzeichen:	UL 544 VDE 860 (IEC 65)
Hochspannung	Der Hochspannungsanschluß der Röhre kann infolge der Röhrenkapazitäten auch noch lange Zeit nach dem Abschalten Hochspannung führen.
Röntgenstrahlung	Bei Betrieb der Röhre innerhalb der Grenzdaten bleibt die Dosisleistung einer möglichen Röntgenstrahlung unter dem zulässigen Wert von 1 uSv/h (in bisherigen Einheiten: 0,1 mR/h). 5 µSv/h wird bei einer Hochspannung von ≥33 kV erreicht. Die Röhre gilt als eigensichere Kathoden-Strahlröhre im Sinne der Röntgenverordnung RöV vom 08. Januar 1987, Teil I, Anlage III, Absatz 6.

S p e z i f i k a t i o n

SIEMENS AUT E 31B3	***Rechteckige Monitorröhre für SIMOMED 90 H W79045-A2089-X***	***M51-EDE1 WB-CL60***

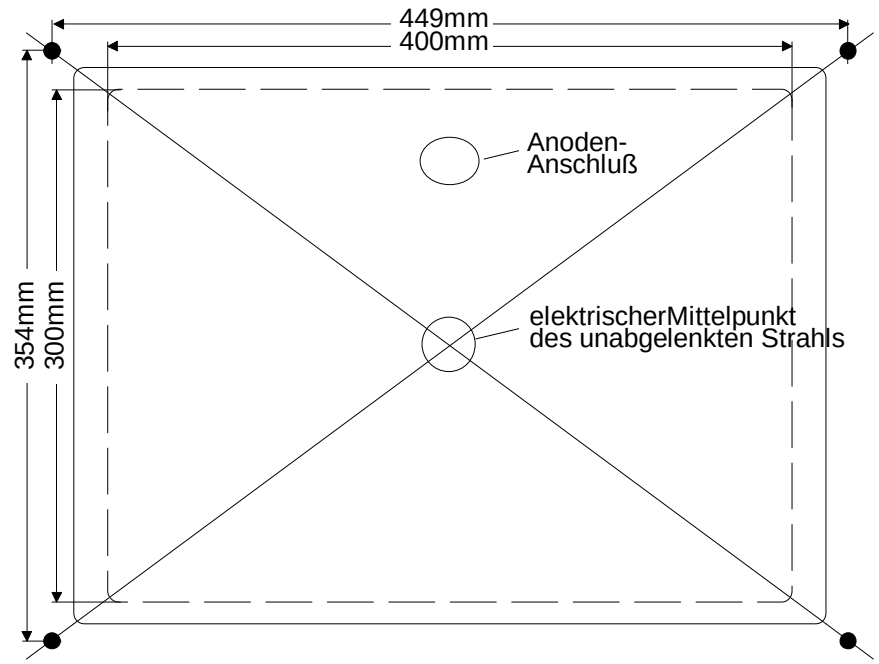
Mechanische Daten

Frontscheibe	rechteckig, R = 1400 mm siehe Anlage 5)
	nutzbare - Schirmdiagonale min. 508 mm - Schirmbreite min. 406,4 mm - Schirmhöhe min. 304,8 mm
Betriebslage	beliebig
Sockel	JEDEC B12-285
Halsdurchmesser	29,1 mm $\pm$0,7
Anodenkontakt	Hohlkontakt 7,92 DIN 41543
Gewicht	ca. 15 kg
Bildröhrenabmessungen	W79045-A 2089 -X-*-6 siehe Anlage 1)

S p e z i f i k a t i o n

SIEMENS AUT 31E2	***Rechteckige Monitorröhre für SIMOMED 90 H W79045-A2089-X***	***M51-EDE1 WB-CL60***

Maximale Strahlabweichung



o Die Röhre ist auf eine Vorrichtung (449 x 354mm) mit 4 Bolzen von 8,5 mm Durchmesser an ihren Ohren montiert.

o Der mechanische Mittelpunkt der Röhre entspricht dem Schnittpunkt der diagonalen Verbindungslinie durch die Mittelpunkte der Bolzen.

o Die Röhre wird nun in ihren Befestigungsohren so verschoben, daß der Mittelpunkt des Glaskörpers auf den mechanischen Mittelpunkt mit einer Toleranz von + 0,5 mm fällt.

o Innerhalb eines Fensters von 400 x 300mm, dessen Mittelpunkt dem mechanischen Mittelpunkt entspricht, muß überall Leuchtstoff sein.

o Die Röhrenachse liegt in Ost- West Richtung (Frontscheibe nach Osten zeigend), der Anodenanschluß befindet sich oben, die Ablenkeinheit ist auf der Röhre montiert und über dem Röhrenhals befindet sich eine Mumetallabschirmung

o Die Strahllage oder die Ablenkeinheit wird nun so justiert, daß sich ein symetrische bzw.gleichmäßige Schärfeverteilung ergibt.

o Der Landepunkt des unabgelenkten Elektronenstrahls muß innerhalb eines Kreises, mit dem Radiusvon 5mm um den mechanischen Mittelpunkt liegen.

o Die Ablenkeinheit darf max. + 0,2° gegenüber der Vorrichtung verdreht sein.

S p e z i f i k a t i o n

SIEMENS AUT E 31B3	***Rechteckige Monitorröhre für SIMOMED 90 H W79045-A2089-X***	***M51-EDE1 WB-CL60***

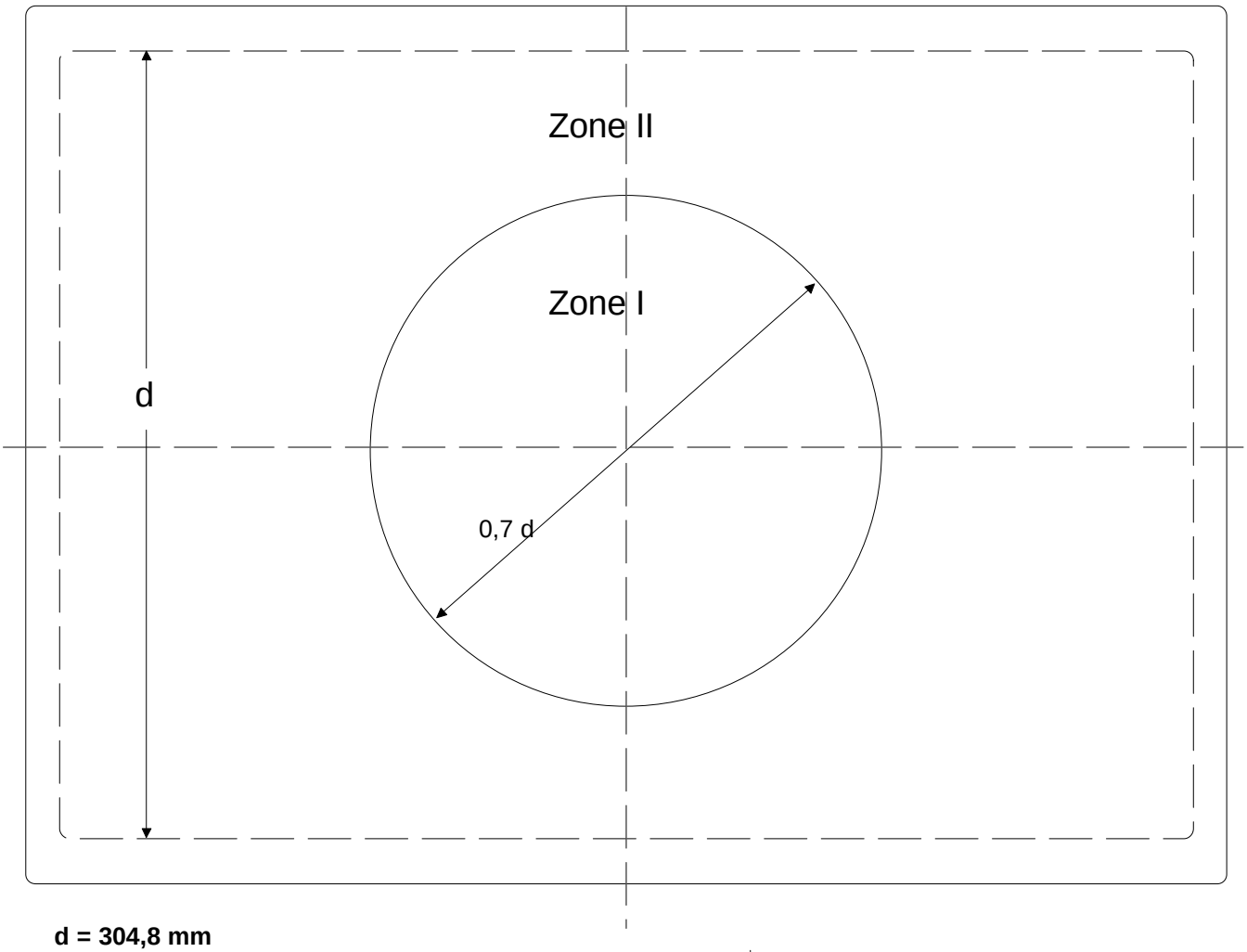
Optische Daten

Gesamtdurchlässigkeit der Röhre mit Frontscheibe:	ca. 30 % bei 546 nm
Phosphor	WB (P45)
Farbort außer Betrieb:	X = 0,370 ± 0,025 Y = 0,465 ± 0,025 } (siehe Anlage 3)
Farbort im Betrieb:	X = 0,257 +0,06 Y = 0,320 ±0,02 } bei einer Leuchtdichte von 100 cd/m^2

gemessen mit Minolta TV Analyser 2

Frontscheibe	Lichtdurchlässigkeit der Scheibe bei 546 nm: ca. 60 % Beschichtung mit IRALIN 185L, oder eine äquivalente nach Absprache mit Siemens Kleber: Silgel 612 A+B oder Araldit CY221 & Härter HY2962
Abweichung der Helligkeit von der Mitte zum Rand der Bildröhre:	Bei einer Leuchtdichte von 50 cd/m^2 darf die Differenz zwischen den über dem ganzen Bild meßbaren min. und max. Werten nicht mehr als 10 cd/m^2 betragen.
Glaskolben	Schott: U1371249080 GZEN oder einen äquivalenten Kolben nach Absprache mit Siemens

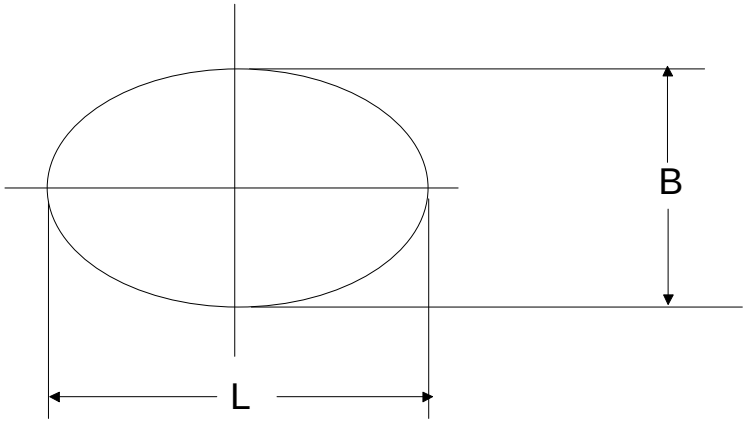
Schirm-Fehlerspezifikation



d = 304,8 mm

L: größte Länge vom Punktfehler

B: größte Breite



S p e z i f i k a t i o n

SIEMENS AUT E 31B3	***Rechteckige Monitorröhre für SIMOMED 90 H W79045-A2089-X***	***M51-EDE1 WB-CL60***

Fehlergröße G

für ein Seitenverhältnis von $\frac{L}{B} \leq 3$ $\quad G = \frac{L + B}{2}$

für ein Seitenverhältnis von $\frac{L}{B} > 3$ $\quad G = \frac{L}{20} + 2B$

Zulässige Fehler

Fehlergröße G	Zone I	Zone II	Summe 1)
$\leq 0{,}2$	beliebig, aber keine Anhäufung		
$0{,}2 < G \leq 0{,}4$	2	3	4
$0{,}4 < G \leq 0{,}6$	-	3	4
Fehlerabstand	> 50 mm	> 50 mm	

1) Maximal zulässige Fehlerzahl in Zone I und II: 4 Stück

Nicht zulässige Fehler

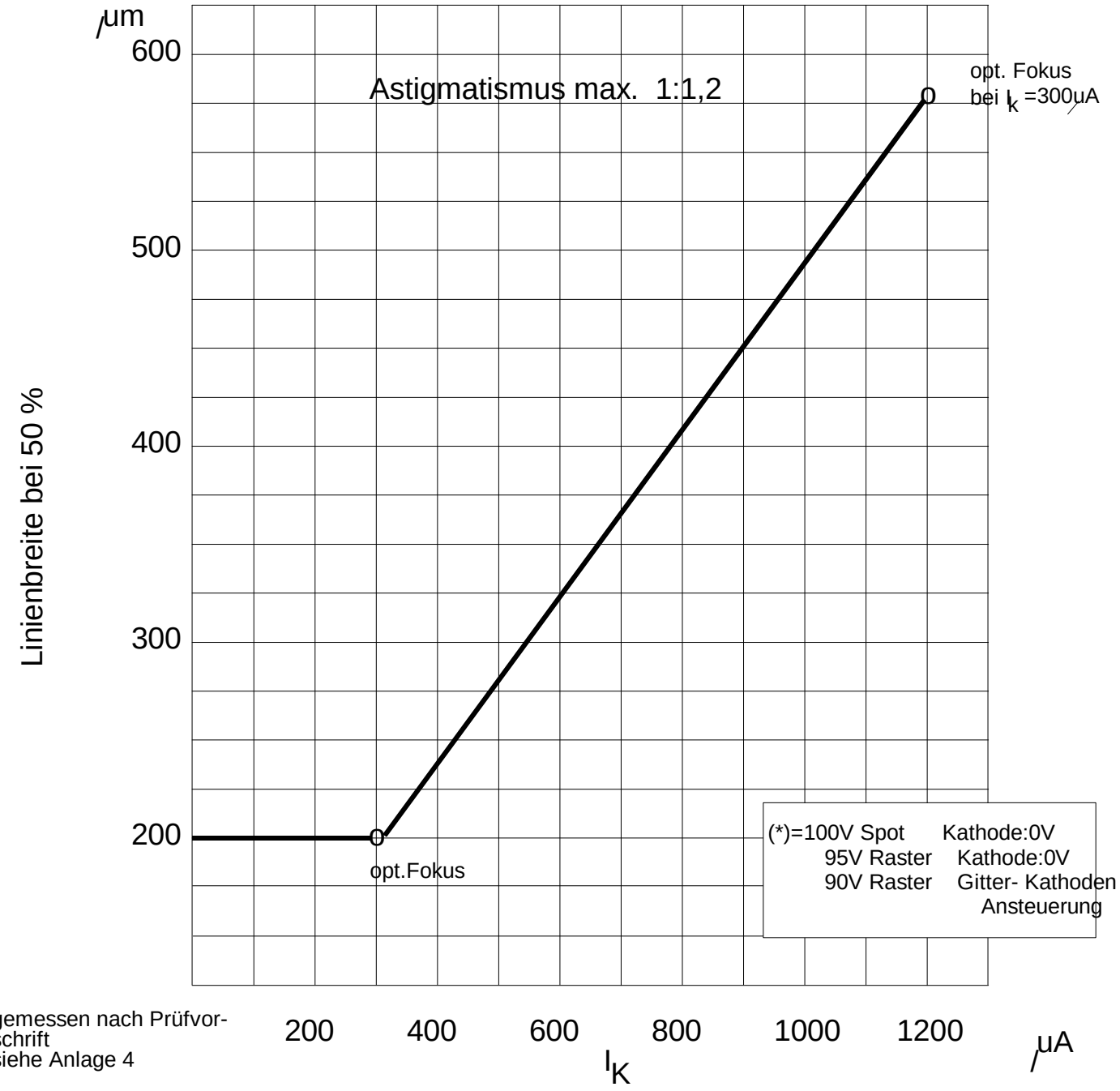
Offene Blasen, Steine, Falten, Risse, Schlagstellen, Sprünge Fehleranhäufung "Wolke".

S p e z i f i k a t i o n

SIEMENS *AUT E 31B3*	*Rechteckige Monitorröhre* *für SIMOMED 90 H* *W79045-A2089-X*	*M51-EDE1* *WB-CL60*

U_A = 25 kV Tastverhältnis 100 %
U_{G2} = 550 -850 V
U_{WE} (für Strahlunterdrückung) = 100 V (*)

Auflösung (Mitte) **Grenzwerte**



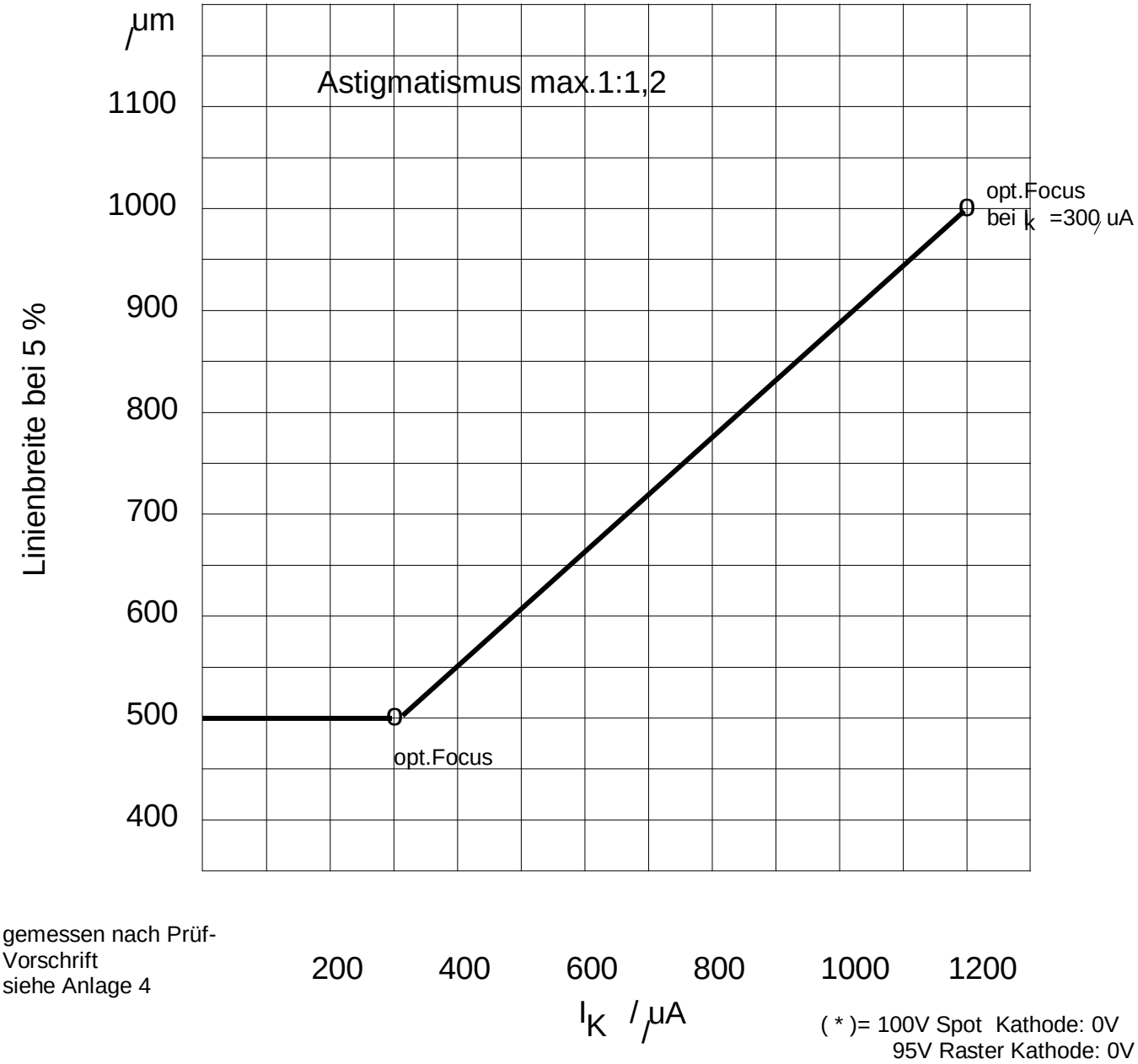
gemessen nach Prüfvorschrift
siehe Anlage 4

S p e z i f i k a t i o n

SIEMENS ***AUT E 31B3***	***Rechteckige Monitorröhre*** ***für SIMOMED 90 H*** ***W79045-A2089-X***	***M51-EDE1*** ***WB-CL60***

U_A = 25 kV Tastverhältnis 100 %
U_{G2} = 550 V - 850 V
U_{WE} (für Strahlunterdrückung) = 100V (*)

Auflösung **Grenzwerte**



gemessen nach Prüf-Vorschrift
siehe Anlage 4

(*)= 100V Spot Kathode: 0V
95V Raster Kathode: 0V
90V Raster Gitter-Kathoden-Ansteuerung

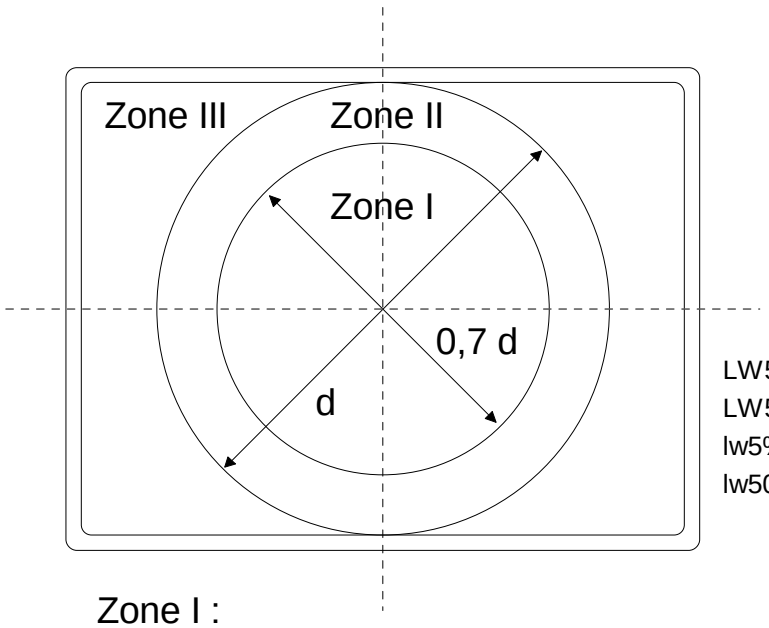
S p e z i f i k a t i o n

SIEMENS AUT E 31B3	***Rechteckige Monitorröhre für SIMOMED 90 H W79045-A2089-X***	***M51-EDE1 WB-CL60***

Schärfeverteilung

Grenzwerte

U_A = 25 kV Tastverhältnis 100 %
U_{G2} = 550 -850 V
U_{WE} (für Strahlunterdrückung) = 100 V (*)



LW5% = Linewidth at 5% of peak intesity
LW50% = Linewidth at 50 % of peak intensity
lw5% = Linewidth at 5% of peak intensity in center
lw50% = Linewidth at 50% of peak intensity in center

Zone I :

(lw5% / LW5%) * 100% > 90%
(lw50% / LW50%) * 100% > 90%
max Astigmatismus 1:1,2

Zone II :

(lw5% / LW5%) * 100% > 70%
(lw50% / LW50%) * 100% > 80%
max Astigmatismus 1:1,4

Zone III :

(lw5% / LW5%) * 100% > 50%
(lw50% / LW50%) * 100% > 60%
max Astigmatismus 1:1,7

(*)=100V Spot Kathode:0V
95V Raster Kathode:0V
90V Raster Gitter- Kathoden Ansteuerung

Bildröhre mit Scheibe (30 % Gesamttransmission). Gemessen mit Syntronic Ablenkeinheit C16015-8 bei 100 cd/m ^{2}

S p e z i f i k a t i o n

SIEMENS AUT E 31B3	***Rechteckige Monitorröhre für SIMOMED 90 H W79045-A2089-X***	***M51-EDE1 WB-CL60***

Elektrische Daten

Ablenkung	magnetisch Ablenkwinkel - horizontal - vertikal - diagonal	 ca. 78° ca. 60° ca. 90°	
Fokussierung	elektrostatisch		
maximale Ströme *	I_{G2} I_{G4}	$\pm$ 3 µA $\pm$ 3 µA	*Kein Wechselanteil erlaubt
Kapazität Wehnelt gegen alle anderen Elektroden	C_{G1}	6 pF $\pm$ 1pF	
Kapazität Kathode gegen alle anderen Elektroden	C_K	5 pF $\pm$ 1pF	
Kapazität Anode gegen Außen-belag	C_{A-M1}	1500....2100 pF	
Kapazität Wehnelt gegen Kathode	C_{G1-K}	5 pF $\pm$ 1pF	

Absolute Grenzwerte

Bezugspunkt für alle Spannungswerte ist dieKathode

erste Beschleunigungsspannung	U_{G2}	max. 1100 V min. 0 V
zweite Beschleunigungsspanung	U_A	max. 30 kV min. 16 kV
Fokussierspannung	$+U_{G4}$	7 kV
Wehneltspannung	$-U_{G1}$	max. 270 V min. 3 V
Heizung-Kathode	U_{FK} I_{FK}	max. $\pm$ 125 V max. 15 uA
Wehneltableitwiderstand	R_{WE}	1,5 MOhm
Wehnelt-Impedanz (50 Hz)	Z_{WE}	0,5 MOhm
Dämpfung des Ablenkfeldes: Bestimmt durch die Güte der Horizontal-Ablenkspule auf der Röhre	Q	$\geq$ 115
gemessen mit: Syntronic Ablenkeinheit C16015-8 ohne Röhre Meßbrücke Wayne Kerr 3245 bei 75 kHz	Q	= 140

S p e z i f i k a t i o n

SIEMENS AUT E 31B3	***Rechteckige Monitorröhre für SIMOMED 90 H W79045-A2089-X***	***M51-EDE1 WB-CL60***

Betriebswerte

Heizung für imprägnierte Kathode	- indirekt - Heizspannung - Heizstrom, ca.	U_F I_F	6,3 V ±2 % 190 -330mA

Bezugspunkt für alle folgenden Spannungswerte ist die Kathode

erste Beschleunigungsspannung	U_{G2}	550 V-850V
Wehneltspannung (für Punktunterdrückung)	$-U_{WE}$	100 V
zweite Beschleunigungsspannung	U_A	25 kV
Helltastspannung von I_K = 0 µA auf I_K = 1200 µA 1)	$\triangle U_{WE}$	max. 85 V
Fokussierspannung in Bildmitte bei B) I_K = 300 µA 1)	U_{G4}	min. 5,0 kV nom.5,2 kV max.5,5 kV
dyn. Fokussierspannung mit Syntronic-Ablenkeinheit Nr. C 16015-8	$U_{G4\ dyn.}$	max. =650 V

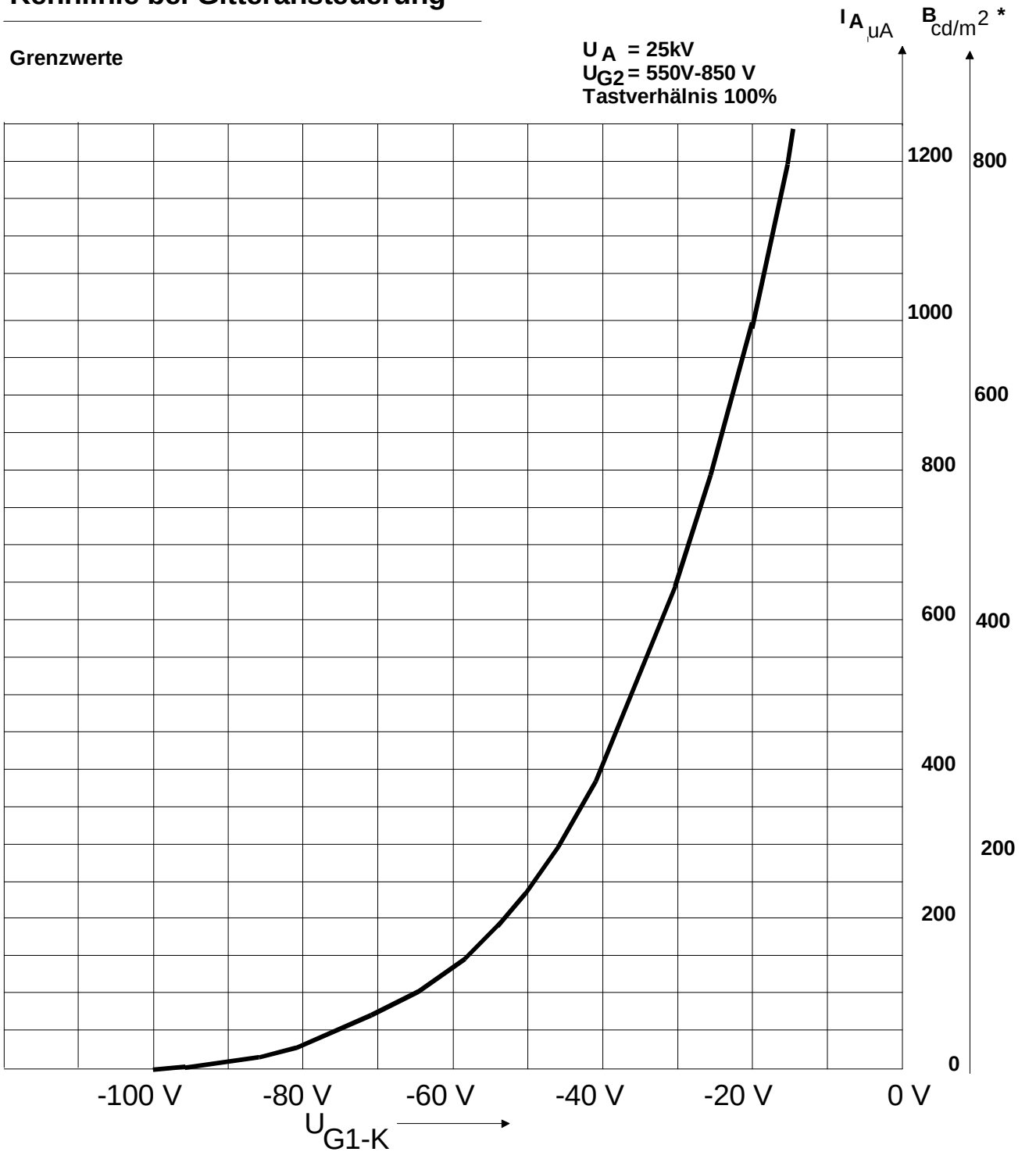
1) bei U_A = 25 kV
U_{G2} = 550 - 850 V
$-U_{WE}$ = 100V (für Punktunterdrückung)
Tastverhältnis 100 %

S p e z i f i k a t i o n

SIEMENS ***AUT E 31B3***	***Rechteckige Monitorröhre*** ***für SIMOMED 90 H*** ***W79045-A2089-X***	***M51-EDE1*** ***WB-CL60***

Kennlinie bei Gitteransteuerung

Grenzwerte



Umweltbedingungen

Temperaturbereich für:

Betrieb	0 bis +70 °C relative Feuchte 75 % keine Betauung
Lagerung	-40 bis 70 °C
Temperaturgradient	20° C/h
Luftdruck	400 hPa bis 1060 hPa (bis 7200 mH)

Lebensdauererwartung

Die zu erwartende Lebensdauer der Bildröhre mit imprägnierten Kathoden

Rückgang des Kathodenstromes von1200 µA bei 100 % Tastverhältnis

5.000 Stunden < 5 %
10.000 Stunden < 10 %
20.000 Stunden < 20 %
50.000 Stunden < noch zu spezifizieren

Gemessen bei einem Kathodenstrom von 550 µA bei 100 % Tastverhältnis über den gesamten Bildschirm während der Testdauer.

Die zu erwartende Lebensdauer des Phosphors bei einer mittleren Leuchtdichte von 350 cd/m^2 beträgt 20.000 Stunden für einen Leuchtdichte-abfall von 30%.

DATA SHEET

M51EDF30WB11/02

21" high resolution triple gun monochrome monitor tube assembly

Product specification

2002 Apr 02

Professional Display Systems B.V.

21" high resolution triple gun monochrome monitor tube assembly

M51EDF30WB11/02

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4.2 Chassis design values
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4.4 Flashover protection

5 ERGONOMIC AND ENVIRONMENTAL DATA

5.1 X-radiation
5.2 Warnings
5.3 Handling
5.4 Environmental conditions

6 DEFINITIONS

7 LIFE SUPPORT APPLICATIONS

21" high resolution triple gun monochrome monitor tube assembly

M51EDF30WB11/02

1 HIGHLIGHTS

1.1 Features

1.1.1 HIGH PERFORMANCE DESIGN

- High resolution; higher pixel density up to 1600 × 1280 pixels (non-interlaced) displayable conform ISO 9241 by:
  - 'larger' effective screen area: 377 mm × 285 mm
  - high resolution in-line electron polygon DAF triple gun(1)
- High brightness and contrast:
  - anti reflection screen coating
- Excellent uniformity
- Accurate convergence and raster geometry:
  - double mussel coil technology
  - internal magnetostatic beam alignment
  - charge drift compensation by internal neck coating
  - optional additional north-south raster correction circuitry available
- Application-friendly design:
  - worldwide useable design
  - East-West correction max. 10%
  - horizontal balance coil; vertical balance potentiometer
  - deflection units designed for minimal ringing
  - optional rotation coil for adjustment of axial magnetic fields
  - up to and including 110 kHz horizontal frequency
  - static convergence adjustments (multipole for 4 and 6 pole correction) on monitor level.

1.1.2 ERGONOMIC DESIGN

- Less ambient reflection:
  - 'flat' and 'square' design
  - AGAS (Anti Glare Anti Static) coating
- Less eye strain:
  - P45 medium-persistence white phosphor
  - high frequency yokes
- Green design:
  - CFC-free production process
  - Cd-free phosphor
  - 0.65 W power saving cathode
- Fulfils electric/magnetic radiation standards
- Safety approved:
  - VDE; CSA; UL.

1.1.3 OPTIMUM DISPLAY SOLUTION

- High-end PC applications
- Workstation applications
- Resolution standards up to 1600 × 1280 pixels non-interlaced applications.

1.2 Quick reference data

PARAMETER	TYP.	UNIT
Deflection angle	90	deg
Face diagonal	51	cm
Overall length	<454.4	mm
Neck diameter	29.4	mm
Glass transmission	43	%
Colour co-ordinates		
x	244	
y	309	
Brightness	750	cd/m^2
Heater voltage	6.1	V
Focus voltage	27% of anode voltage	
Anode voltage	27.5	kV

1.3 Deflection coil data

Deflection coil is mounted with dynamic convergence correction coils (PECOMA).

PARAMETER	VALUE	UNIT
Horizontal coil inductance	0.092	mH
Vertical coil inductance	4.4	mH
Maximum advised frequency	110	kHz

1.4 Ordering information

TYPE NUMBER	SCREEN FINISH	LUG DISTANCE
M51EDF30WB11/02	AGAS	38.5 mm

(1) Whenever in this data sheet the words 'red', 'green' and 'blue' are used, with respect to the guns, the guns are meant as in an equivalent colour monitor tube.

2 PERFORMANCE SPECIFICATION

2.1 Colour coordinates

PHOSPHOR DATA	COLOUR COORDINATES	
	x	y
Phosphor type: P45 (N 1045) $I_{a(av)}$ = 300 μA (per gun) V_a = 27.5 kV Scanned duty cycle = 75% Scanned area = 312 × 234 mm Screen finish AGAS	244±10	309±10

2.2 Brightness uniformity

Brightness uniformity between centre and corners: .80%; <110%.

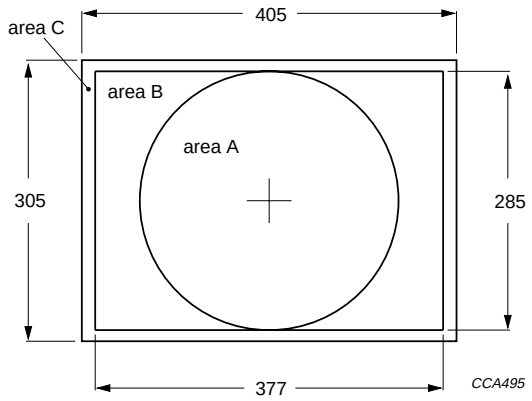
2.3 Convergence specification

2.3.1 TEST CONDITIONS

1. Set-up in accordance with Section 4.1.
2. Measure maximum misconvergence after 30 minutes operation.
3. To be adjusted for focus at $^2/_3$ centre-corner using crosshatch pattern at anode current is 300 μA (peak value) per gun.
4. Misconvergence is the distance between the centres of the red, green and blue guns at the screen using a crosshatch pattern.
5. Anode and/or focusing voltage and terrestrial magnetism may slightly affect the static convergence. Therefore, small re-adjustments to static convergence may be necessary.
6. Avoid stray magnetic fields etc. due to chassis influences which may affect convergence.

2.3.2 CONVERGENCE LIMITS

LOCATION (see Fig.1)	TYPE OF ERROR	MAXIMUM ERROR BETWEEN GUN SPOTS	
		STANDARD	WITH PECOMA
Centre	red-green-blue gun line separation in either the horizontal or vertical direction	0.30 mm	0.2 mm
Area A/corner		0.50 mm	0.2 mm



Dimensions in mm.

Fig.1 Maximum misconvergence.

2.4 Resolution specification

With the settings given in Section 4.1, the displayed characters will be recognisable as individual $ characters on a data raster measuring 377 mm × 285 mm.

ANODE CURRENT	SPOT SIZE CENTRE (NOMINAL)		SPOT SIZE CORNER (NOMINAL)		UNIT
	X	Y	X	Y	
100 μA	0.5	0.5	0.8	0.4	mm
200 μA	0.5	0.5	0.8	0.4	mm
400 μA	0.6	0.6	1.0	0.5	mm

2.5 Raster geometry

2.5.1 RASTER CENTRING

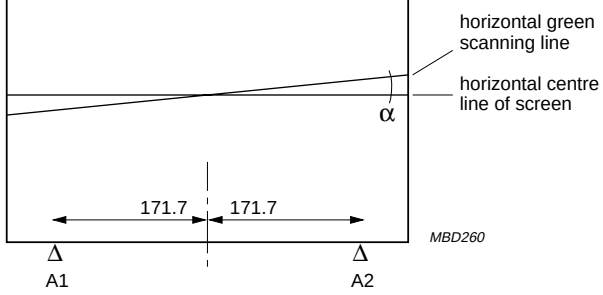
CENTRING	MAX.	UNIT
Horizontal	±5.5	mm
Vertical	±5.5	mm

2.5.2 RASTER ORTHOGONALITY

Orthogonality of the horizontal/vertical scan axis is ±0.5°.

2.5.3 RASTER ROTATION

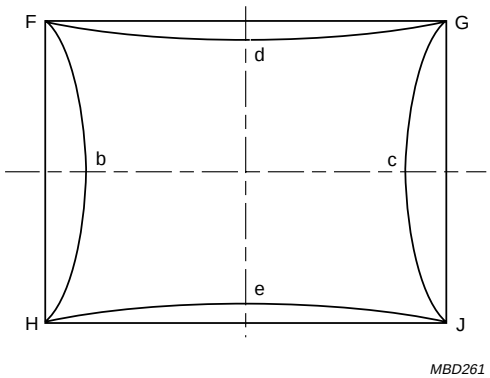
Measure the angle of the horizontal green scanning line with reference to a horizontal centre line that is drawn parallel to the tube reference points A1 and A2, see Fig.2. Chassis influences may affect raster rotation.



$\alpha \leq 0.3°$

Fig.2 Rotation measurement.

2.5.4 PIN-CUSHION DISTORTION



FG = HJ = 377 mm.

FH = GJ = 285 mm.

Measured with no pin-cushion correction applied, with 'b', 'c', 'd' and 'e' measured along the main axis.

Fig.3 Pin-cushion distortion.

2.5.5 DISTORTION NORTH - SOUTH

The following formulae define the pin-cushion distortion in the north and south directions.

$$\text{North} = \frac{4d}{FH + GJ} \times 100\% = 0\% \text{ to } +1.3\%$$

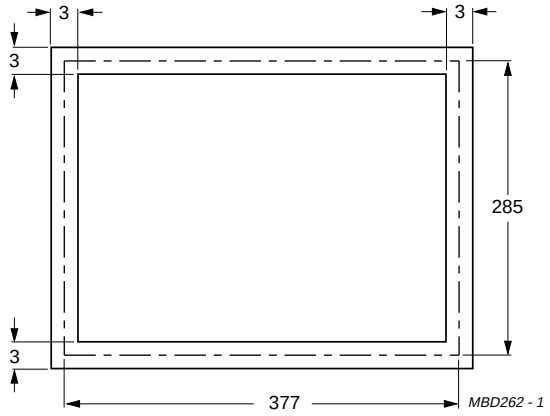
$$\text{South} = \frac{4e}{FH + GJ} \times 100\% = 0\% \text{ to } +1.3\%$$

2.5.6 DISTORTION EAST - WEST

The following formulae define the pin-cushion distortion in the east and west directions.

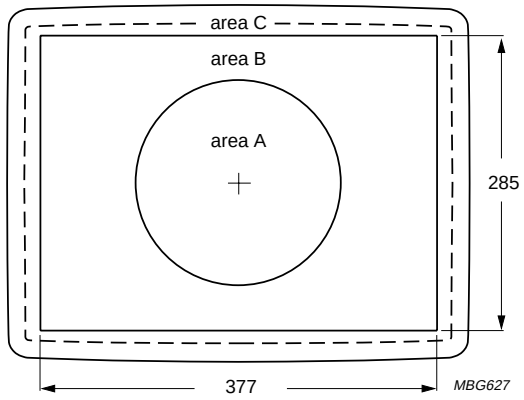
$$\text{East} = \frac{4b}{FG + HJ} \times 100\% \leq 10\%$$

$$\text{West} = \frac{4c}{FG + HJ} \times 100\% \leq 10\%$$



Dimensions in mm.

Fig.4 General distortion.



Dimensions in mm.

Fig.5 Screen areas.

2.6 Screen quality

2.6.1 GENERAL TEST PROCEDURE

Tests are to be done under the following general conditions:

- Viewing distance should be 50 cm minimum.
- For an activated screen the diffuse ambient light level at the centre of the screen should be between 2 and 5 lux.
- For an unactivated screen the diffuse ambient light level at the centre of the screen should be between 700 and 1000 lux.
- The viewing angle relative to the tube axis should not exceed 45°.
- Faults not visible under these general conditions are permitted.
- The following quality areas are specified (see Fig.5):
  - Area A: a circular area with a diameter of 200 mm, of which the centre coincides with the mechanical centre of the screen.
  - Area B: the area between the edge of area A and the rectangular area measuring 377 mm × 285 mm, of which the centre coincides with the mechanical centre of the screen.
  - Area C: the area between the edge of area B and the rimband.

2.6.2 ASSESSMENT OF THE GLASS AND THE UNACTIVATED SCREEN QUALITY

2.6.2.1 Definition of blemishes

Unless otherwise specified, the shape of a blemish is defined as round and elliptical.

The size of a blemish is given by:

- $\frac{L + W}{2}$; if L > 3W the size is given by $\frac{L}{20} + 2W$,

  where L = length and W = width.

2.6.2.2 Limits

Table 1 Limits of measurable glass blemishes

SIZE (mm)	MAX. NUMBER OF BLEMISHES IN AREAS		MIN. PERMISSIBLE DISTANCE BETWEEN ANY TWO BLEMISHES (mm)	AREA C
	A	A + B		
>0.6	0	0	not applicable	only limits as regards tube safety
>0.4 to ≤0.6	1	2	50	
>0.2 to ≤0.4	2	5	50	
Total number	2	5	50	–
≤0.2	limited only by cloud			–

Table 2 Limits of measurable coating blemishes for AGAS coating

SIZE (mm)	MAX. NUMBER OF BLEMISHES IN AREA A+B	MIN. PERMISSIBLE DISTANCE BETWEEN ANY TWO BLEMISHES (mm)	AREA C
High contrast			
>1.5	0	not applicable	acceptable
>1.0 to ≤1.5	3	50	
>0.5 to ≤1.0	5	30	
≤0.50	no limits	no limits	
Low contrast			
>3.0	0	not applicable	acceptable
>1.0 to ≤3.0	5	30	
≤1.0	no limits	no limits	

Table 3 Limits of scratches

AREA	WIDTH (mm)	MAX. ALLOWABLE TOTAL LENGTH (mm)	MIN. SEPARATION (mm)
A+B	>0.15	0	not permitted
	>0.10 to ≤0.15	13	50
	>0.05 to ≤0.10	25	20
	≤0.05	no limits	not applicable
C	only as regards tube safety		

2.6.3 ASSESSMENT OF THE QUALITY OF THE ACTIVATED PHOSPHOR SCREEN

The assessment of the quality of the phosphor and matrix layer at area A should take place at typical operating conditions and a blanked raster. The current for each gun must be adjusted to a brightness of 200 cd/m^2.

2.6.3.1 Definition of blemishes

- A blemish is a fault which is clearly visible within 5 seconds.
- A defect, which looks visually as one blemish should be regarded as a single blemish.
- Unless otherwise specified, the shape of a blemish is defined as round and elliptical.

The size of a blemish is given by:

- $\frac{L+W}{2}$; if L > 3W the size is given by $\frac{L}{20} + 2W$, where L = length and W = width.

2.6.3.2 Limits

1. The distance between any two blemishes >0.2 mm should be >50 mm.
2. Maximum number of blemishes >0.2 mm per screen is 9.
3. Blemishes ≤0.2 mm can be ignored, except for a concentration of such blemishes that has a diameter of more than 8 mm.

Table 4 Limits of blemishes

BLEMISH SIZE (mm)	MAXIMUM NUMBER OF BLEMISHES IN		
	AREA A	AREA B	AREA A + B
>0.6	0	0	0
>0.4 to ≤0.6	1	5	5
>0.2 to ≤0.4	4	6	9
≤0.2	limited only by cloud		

2.7 Coating performance

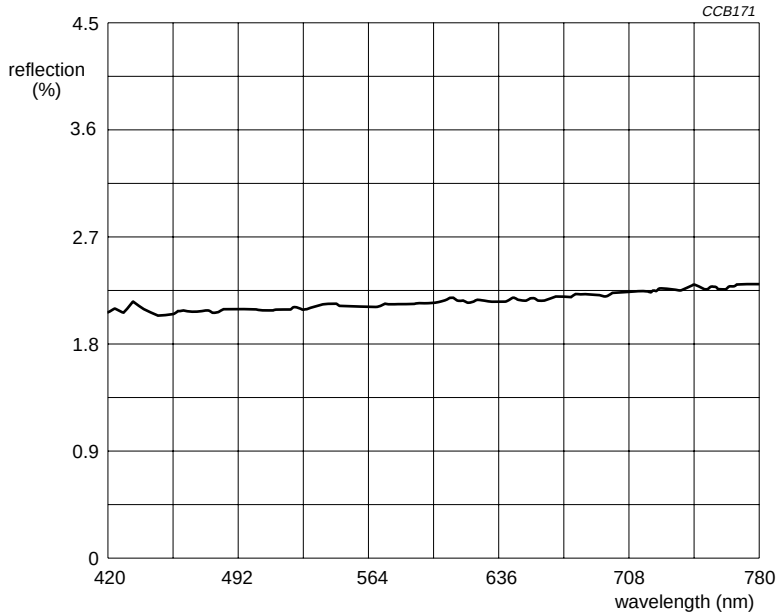


Fig.6 Relative reflection for AGAS.

3 PRODUCT CHARACTERISTICS

3.1 Electrical data

SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNIT
Capacitances					
$C_{a(m+m')}$	anode to external conductive cone coating, including rimband (with and without screen coating)	1000	1300	1600	pF
C_k	cathodes of all guns, connected in parallel, to all other electrodes	–	10	15	pF
C_{kR}, C_{kG}, C_{kB}	cathode of any gun to all other electrodes	–	4	–	pF
C_{g1}	grid 1 of any gun to all other electrodes	–	22	–	pF
C_{g2}	grid 2 to all other electrodes	–	17	–	pF
C_{g3a}	grid 3a (focus electrode) to all other electrodes	–	12	–	pF
C_{g3b}	grid 3b (dynamic focus electrode) to all other electrodes	–	10	–	pF
$C_{(g3a-g3b)}$	grid 3a to grid 3b	–	9	–	pF
Heater					
V_f	heater voltage	–	6.1	–	V
I_f	heater current	289	309	329	mA
t_{kwu}	cathode warm up time at 0-hour from 10% to 80% of end emission	–	–	8	s
Deflection unit					
V_{max}	maximum permissible DC voltage				
	between horizontal and vertical coils	–	–	2000	V
	between vertical coils and core	–	–	300	V
R_{ins}	insulation resistance at 1 kV (DC)				
	between horizontal and vertical coils	500	–	–	MΩ
	between horizontal coil and core clamping ring	500	–	–	MΩ
	between vertical coil and core clamping ring	10	–	–	MΩ
	crosstalk (1 V applied to the horizontal coils)	–	–	30	mV

3.2 Deflection unit data

All values are valid at T_{amb} = 25 °C and V_a = 27.5 kV; deflection units fulfil the MPRII and TCO magnetic requirements (see Section 5.1); the deflection coil is designed for a positive pulse on the horizontal coil.

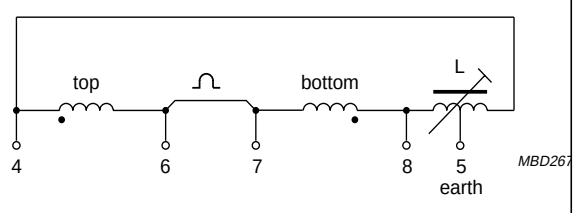
PARAMETER	VALUE	TOLERANCE	UNIT
Advised frequency; notes 1 and 2	110	–	kHz
Horizontal deflection coil			
Inductance	0.092	±4%	mH
Resistance	0.15	±10%	Ω
Current (peak-to-peak value)	13.5	±4%	A
Used wire	litz	–	
Vertical deflection coil			
Inductance	4.4	±4%	mH
Resistance	4.50	±7%	Ω
Current (peak-to-peak value)	1.81	±5%	A
Used wire	litz	–	

Notes

1. Advised maximum frequency depends on the internal maximum set temperature and used deflection-overscan.
2. No annoying ringing with 0% overscan.

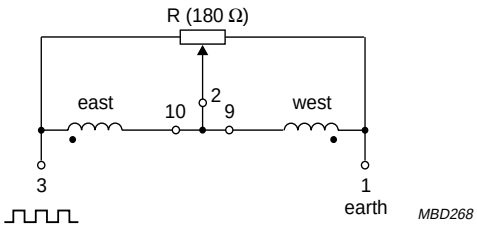
Rotation coil data

PARAMETER	CONDITION	MIN.	TYP.	MAX.	UNIT
Resistance	T_{amb} = 20 °C	50.9	56.6	62.3	Ω
Sensitivity	I = 75 mA; V_a = 27.5 kV	–	0.95	–	deg



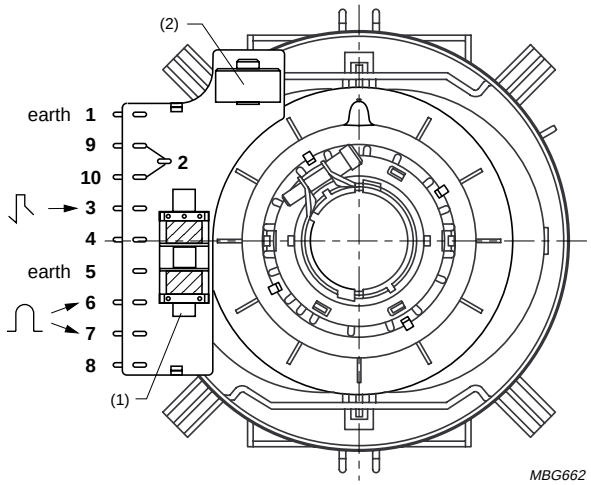
The beginning of the windings is indicated with •

Fig.7 Horizontal coils.



The beginning of the windings is indicated with •

Fig.8 Vertical coils.

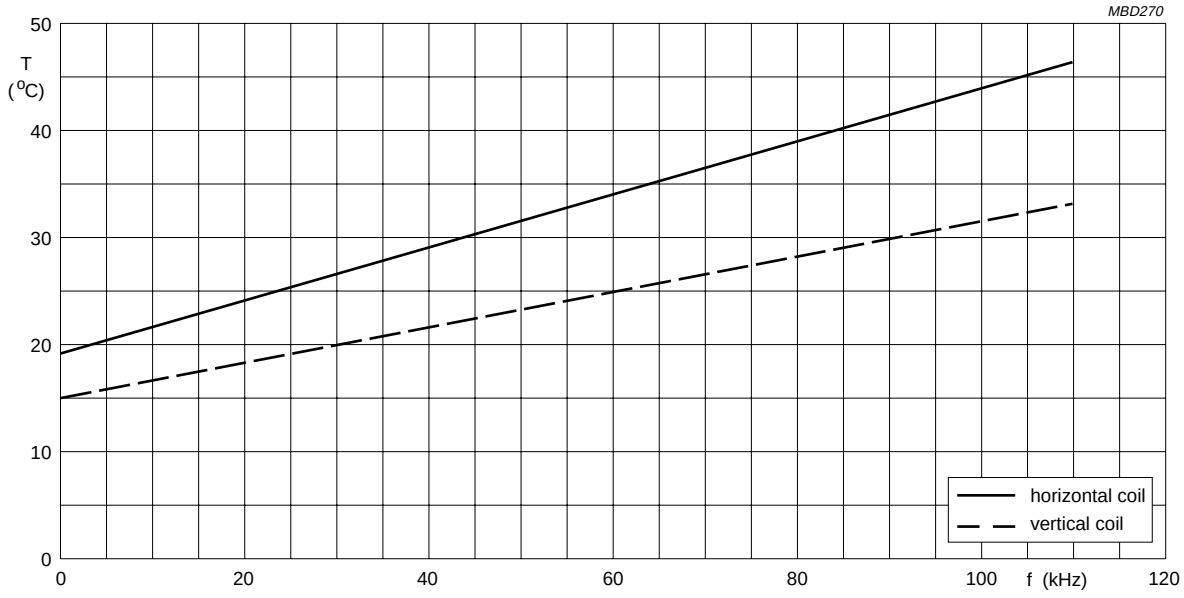


(1) Horizontal balance coil.
(2) Vertical balance potentiometer.

Fig.9 Deflection coil connections.

3.2.1 DEFLECTION UNIT TEMPERATURE

SYMBOL	PARAMETER	MAX.	UNIT
T_{copper}	average copper temperature of horizontal coil	110	°C
ΔT	maximum temperature rise of used wire	50	°C



Maximum operating copper temperature (resistance measurement) is 110 °C.

Fig.10 Temperature rise as a function of frequency.

3.3 Electro optical data

PARAMETER	VALUE
Electron gun system	three in-line integrated guns
Focus method	electrostatic
Focus lens	polygon and DAF
Convergence method	magnetic
Deflection method	self converging
Deflection angle	
diagonal	≈90°
horizontal	≈78°
vertical	≈60°

3.4 Screen properties

PARAMETER	VALUE
Screen finish	AGAS
Light transmission at screen centre	43%
Recommended active screen area	
horizontal axis at a 1600 × 1280 pixels screen	377 mm
vertical axis at a 1600 × 1280 pixels screen	285 mm

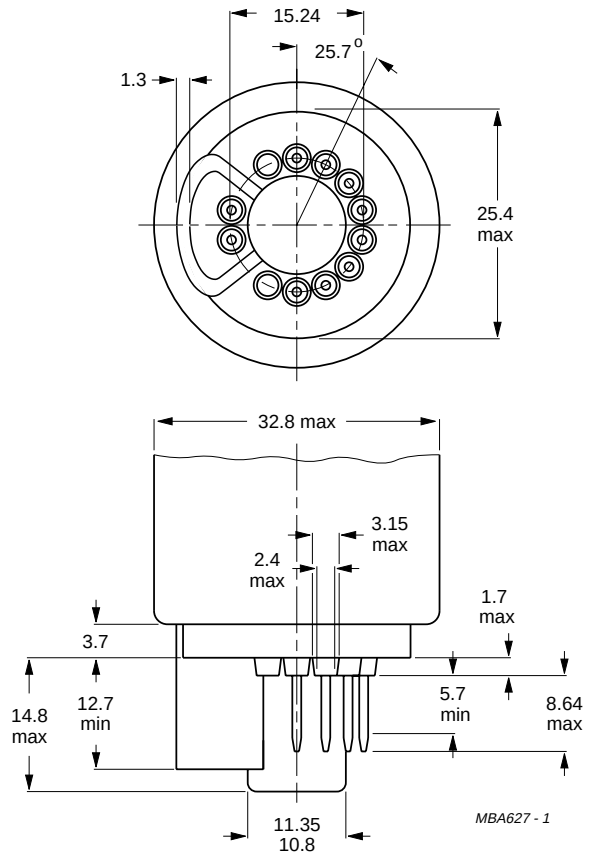
3.5 Coating properties

TYPE NUMBER	SCREEN FINISH	GLOSS
M51EDF.30WB11	Anti Glare Anti Static (AGAS), tested in the centre	60 ±12%

3.6 Mechanical tube data

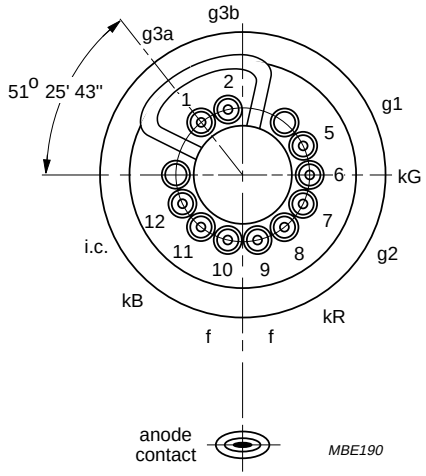
PARAMETER	VALUE
Overall length	447.9 ±6.5 mm
Neck diameter	29.4 +0.6/–0.4 mm
Maximum dimensions, excluding mounting lugs but including rimband	
diagonal	553.5 mm
width	470.0 mm
height	374.0 mm
Implosion protection	pre-stressed banded Mini-P shrunk-on rimband; CSA, UL and VDE approved
Anode contact	JEDEC J1-21; IEC 60067-III-2
Base designation	JEDEC B10-301
Base pin configuration	see Fig.12
Mass	≈15 kg
Mounting position	anode contact on top

3.7 Mechanical tube drawings



Dimensions in mm.

Fig.11 Base JEDEC B10-301.



i.c. = internally connected and not to be used.

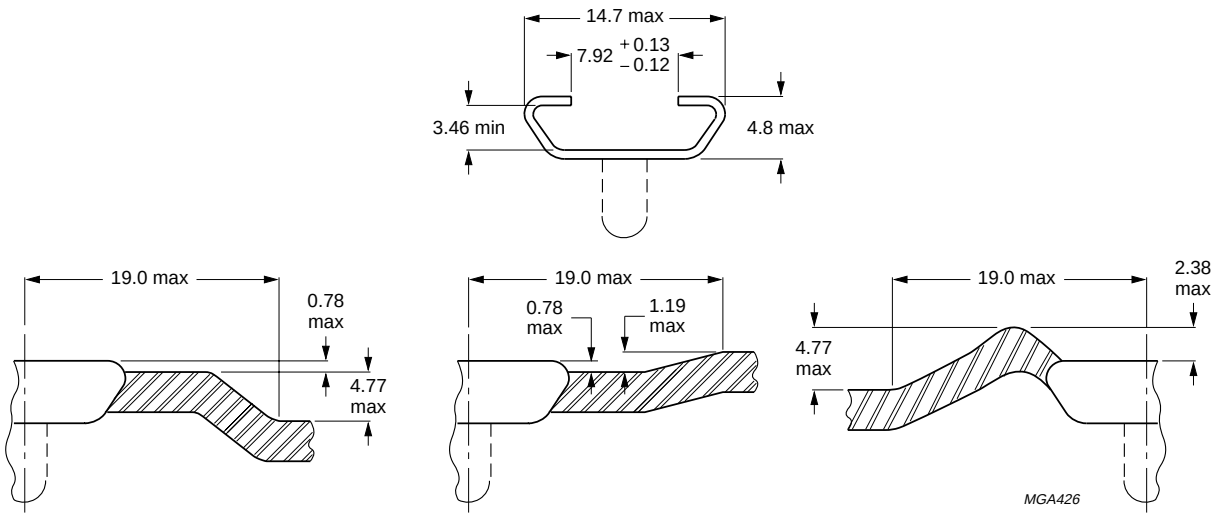
Fig.12 Pin arrangement.

Remarks: to Figs 11 and 12.

The socket for this base should not be rigidly mounted, it should have flexible leads and be allowed to move freely. After mounting the tube in the cabinet, note that the position of the base can fall within a circle, having a diameter of max. 40 mm concentric with an imaginary tube axis.

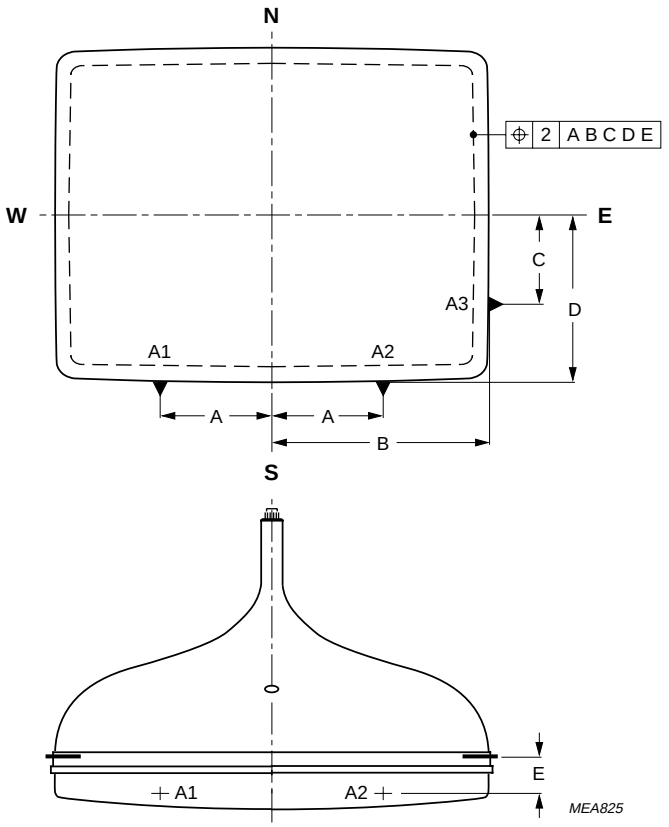
The mass of the mounting socket assembly should not exceed 450 g.

Maximum permissible torque on the tube neck is 0.14 Nm.



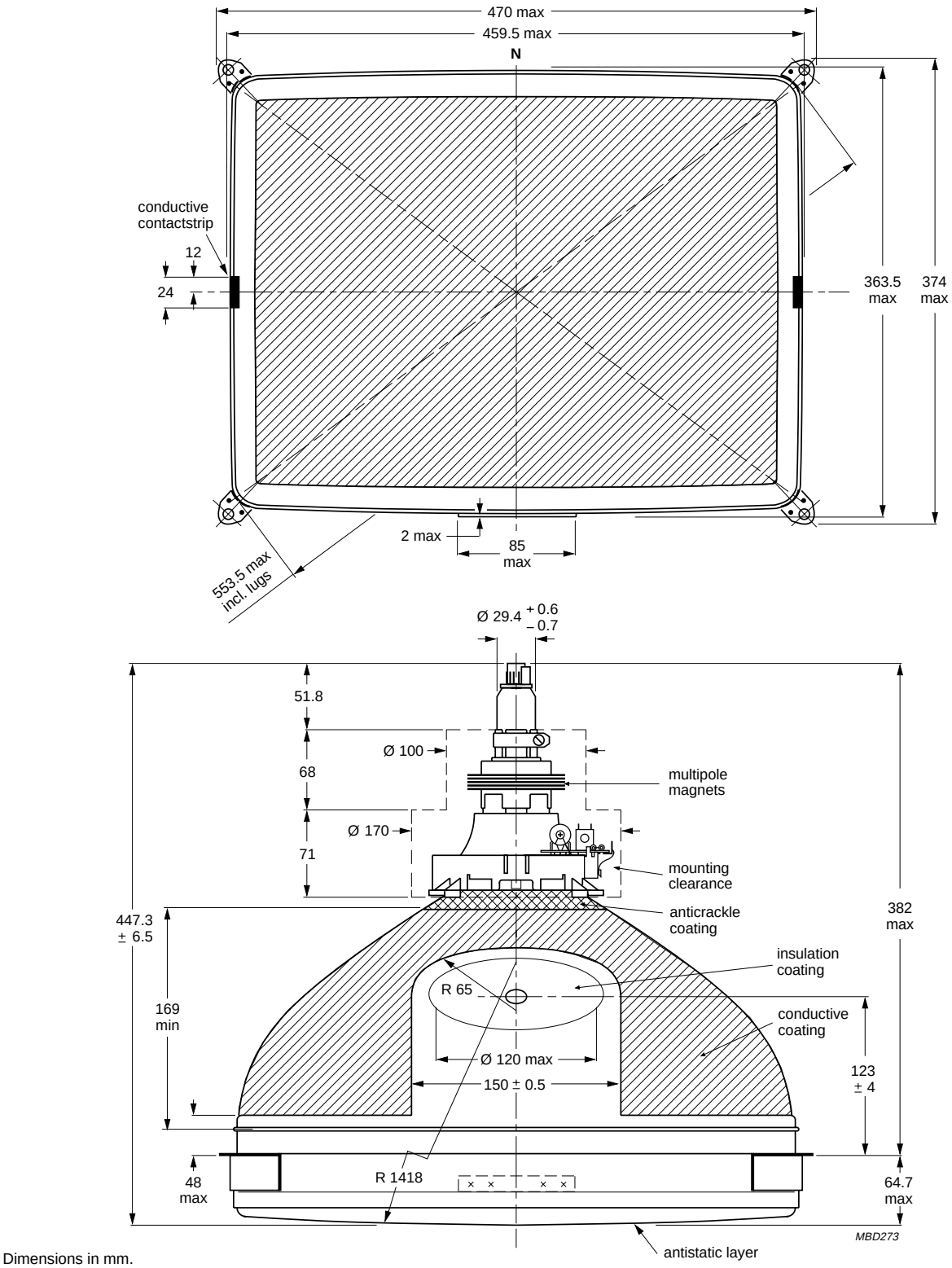
Dimensions in mm.

Fig.13 Cavity cap JEDEC J1-21, IEC 60067-III-2.



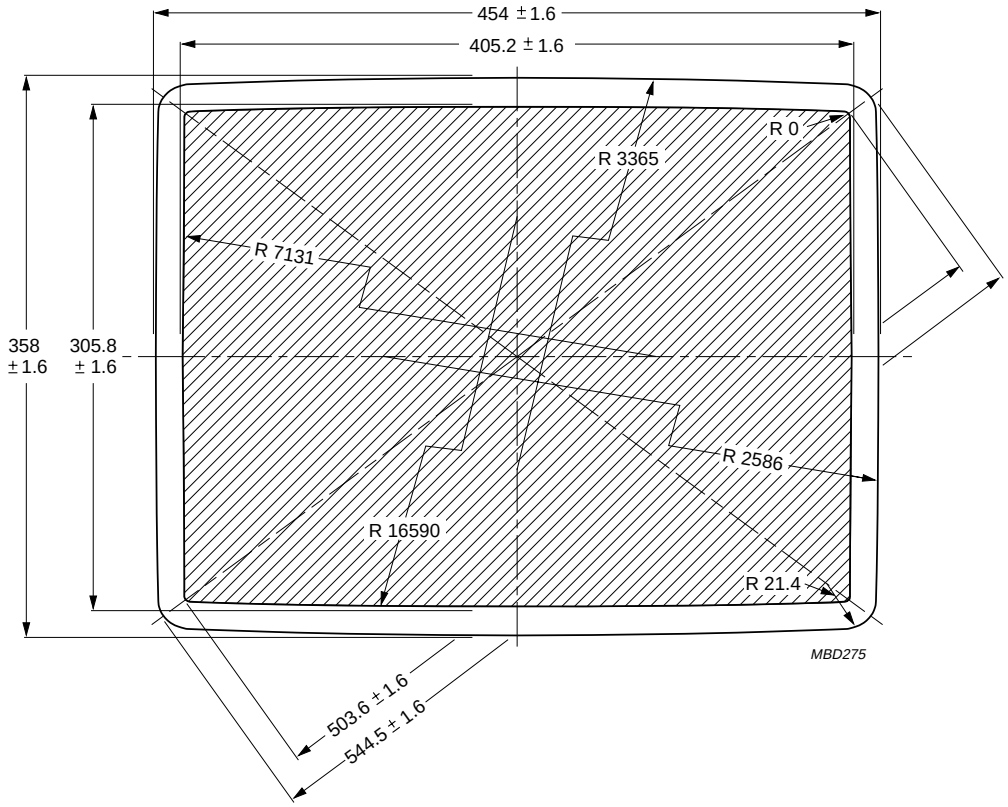
Dimensions in mm.
A = 171.7 mm.
B = 225.1 mm.
C = 115.6 mm.
D = 175.2 mm.
E = 5.1 mm.

Fig.14 Mechanical reference points.



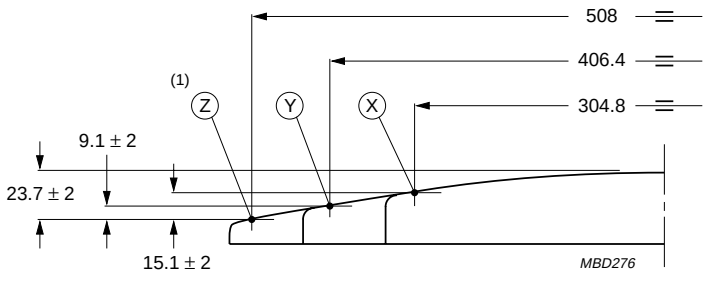
Dimensions in mm.

Fig.15 Top view.



Dimensions in mm.

Fig.16 Screen dimensions.

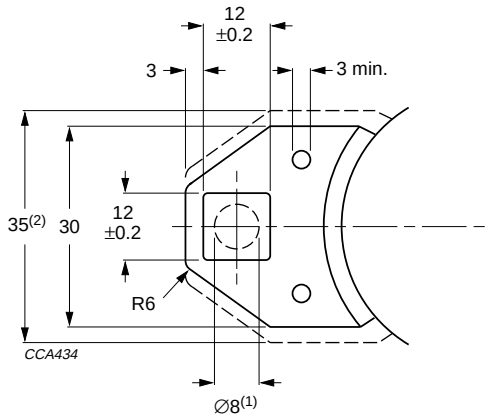


Dimensions in mm.

(1) The X, Y and Z reference points are located on the outside surface of the face plate.

Fig.17 Screen reference points.

3.7.1 LUG DATA

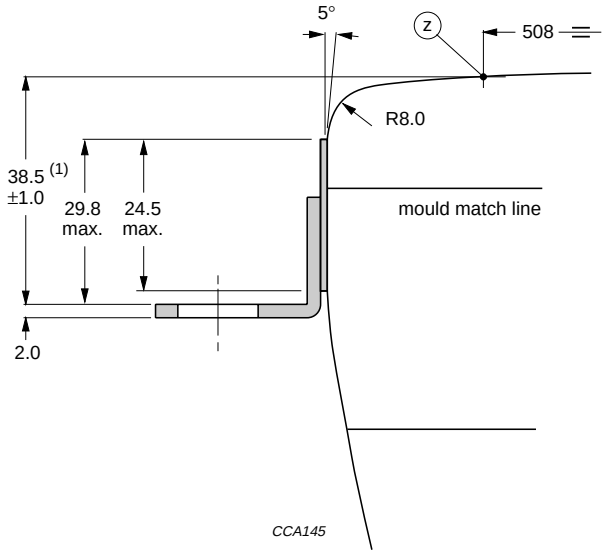


Dimensions in mm.

(1) 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 354.0 mm × 449.0 mm.

(2) Minimum space to be reserved for mounting lug in cabinet.

Fig.18 Lug dimensions.



Dimensions in mm.

(1) The displacement of any lug with respect to the plane through the other 3 lugs is maximum 0.8 mm.

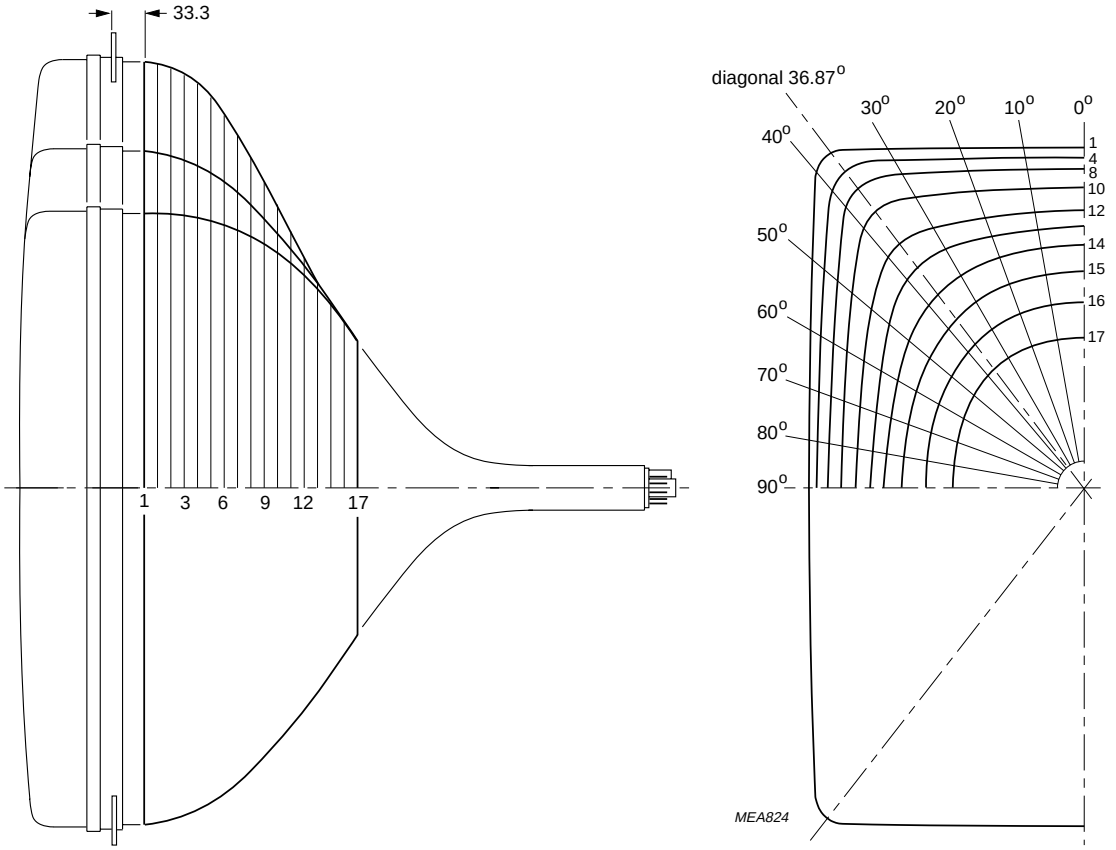
Fig.19 Lug position

3.8 Sagittal heights of screen

Sagittal heights of the nominal useful screen measured with respect to the end of the diagonal axis.

NOMINAL USEFUL SCREEN (NUS)			3 mm INSIDE NUS			5 mm OUTSIDE NUS		
COORDINATES		SAGITTAL HEIGHT	COORDINATES		SAGITTAL HEIGHT	COORDINATES		SAGITTAL HEIGHT
X (mm)	Y (mm)	(mm)	X (mm)	Y (mm)	(mm)	X (mm)	Y (mm)	(mm)
202.6	0.0	14.6	199.6	0.0	14.1	207.6	0.0	15.3
202.6	10.0	14.6	199.6	10.0	14.2	207.6	10.0	15.3
202.6	20.0	14.7	199.6	20.0	14.3	207.6	20.0	15.4
202.6	30.0	14.9	199.6	30.0	14.4	207.6	30.0	15.6
202.5	40.0	15.1	199.5	40.0	14.7	207.5	40.0	15.8
202.5	50.0	15.4	199.5	50.0	15.0	207.4	50.0	16.1
202.5	60.0	15.8	199.4	60.0	15.4	207.4	60.0	16.5
202.4	70.0	16.3	199.4	70.0	15.8	207.4	70.0	17.0
202.3	80.0	16.8	199.3	80.0	16.4	207.3	80.0	17.5
202.2	90.0	17.4	199.2	90.0	17.0	207.2	90.0	18.1
202.1	100.0	18.1	199.1	100.0	17.6	207.1	100.0	18.8
202.0	110.0	18.8	199.0	110.0	18.4	207.0	110.0	19.6
201.9	120.0	19.7	198.4	120.0	19.2	206.9	120.0	20.4
201.7	130.0	20.6	198.7	130.0	20.1	206.7	130.0	21.3
201.6	140.0	21.6	198.6	140.0	21.1	206.6	140.0	22.3
201.5	150.0	22.6	198.5	145.0	21.6	206.5	150.0	23.4
201.4	151.1	22.7	198.5	148.1	22.0	206.4	156.0	24.1
200.0	151.1	22.5	195.0	148.2	21.5	200.0	156.1	23.1
190.0	151.3	21.1	190.0	148.3	20.7	190.0	156.3	21.6
180.0	151.4	19.7	180.0	148.4	19.4	180.0	156.4	20.3
170.0	151.6	18.4	170.0	148.6	18.1	170.0	156.6	19.0
160.0	151.8	17.3	160.0	148.8	16.9	160.0	156.8	17.8
150.0	151.9	16.2	150.0	148.9	15.8	150.0	156.9	16.7
140.0	152.0	15.1	140.0	149.0	14.8	140.0	157.0	15.7
130.0	152.1	14.2	130.0	149.1	13.9	130.0	157.1	14.8
120.0	152.3	13.3	120.0	149.3	13.0	120.0	157.3	13.9
110.0	152.4	12.6	110.0	149.4	12.2	110.0	157.4	13.1
100.0	152.5	11.8	100.0	149.5	11.5	100.0	157.5	12.4
90.0	152.5	11.2	90.0	149.5	10.9	90.0	157.5	11.8
80.0	152.6	10.7	80.0	149.6	10.3	80.0	157.6	11.2
70.0	152.7	10.2	70.0	149.7	9.8	70.0	157.7	10.7
60.0	152.7	9.7	60.0	149.7	9.4	60.0	157.7	10.3
50.0	152.8	9.4	50.0	149.8	9.1	50.0	157.8	10.0
40.0	152.8	9.1	40.0	149.8	8.8	40.0	157.8	9.7
30.0	152.9	8.9	30.0	149.9	8.6	30.0	157.9	9.5
20.0	152.9	8.7	20.0	149.9	8.4	20.0	157.9	9.3
10.0	152.9	8.7	10.0	149.9	8.3	10.0	157.9	9.3
0.0	152.9	8.6	0.0	149.9	8.3	0.0	157.9	9.2

3.9 Cone contour



Dimensions in mm.

Fig.20 Maximum cone contour.

Cone contour data

SECTION	NOMINAL DISTANCE FROM SECTION 1 (mm)	MAXIMUM DISTANCE FROM TUBE AXIS (mm)										
		0°	10°	20°	30°	36.87°	40°	50°	60°	70°	80°	90°
1	0.0	225.7	228.9	239.1	257.6	271.8	267.2	227.9	203.1	187.9	179.6	177.0
2	10.0	224.6	227.7	237.7	255.9	270.0	265.3	226.7	201.9	186.8	178.6	175.9
3	20.0	221.8	224.8	234.3	251.1	264.3	259.6	222.9	198.9	184.2	176.1	173.5
4	30.0	218.1	220.9	229.6	244.5	254.7	250.6	217.9	195.1	180.9	173.1	170.6
5	40.0	213.8	216.4	224.1	236.5	243.1	239.6	212.0	190.9	177.3	169.9	167.5
6	50.0	208.7	211.0	217.7	227.5	231.3	228.4	205.6	186.3	173.6	166.5	164.2
7	60.0	202.6	204.5	210.0	217.5	219.5	217.0	198.5	181.0	169.3	162.6	160.5
8	70.0	195.1	196.8	201.3	206.9	207.6	205.4	190.3	175.1	164.4	158.3	156.3
9	80.0	186.2	187.6	191.4	195.6	195.4	193.5	181.3	168.4	158.9	153.3	151.5
10	90.0	175.6	176.9	180.1	183.3	182.8	181.1	171.4	160.7	152.5	147.6	146.0
11	100.0	163.6	164.6	167.4	169.9	169.2	167.9	160.4	151.9	145.2	141.0	139.6
12	110.0	150.3	151.3	153.8	155.7	154.7	153.6	147.9	141.7	136.6	133.4	132.3
13	120.0	136.4	137.3	139.3	140.4	139.5	138.6	134.5	130.3	126.8	124.6	123.9
14	130.0	122.1	122.8	124.4	124.9	124.0	123.3	120.7	118.2	116.1	114.7	114.3
15	140.0	107.5	107.7	108.2	108.6	108.4	108.2	107.0	105.7	104.5	103.8	103.5
16	150.0	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

4 APPLICATION CONDITIONS

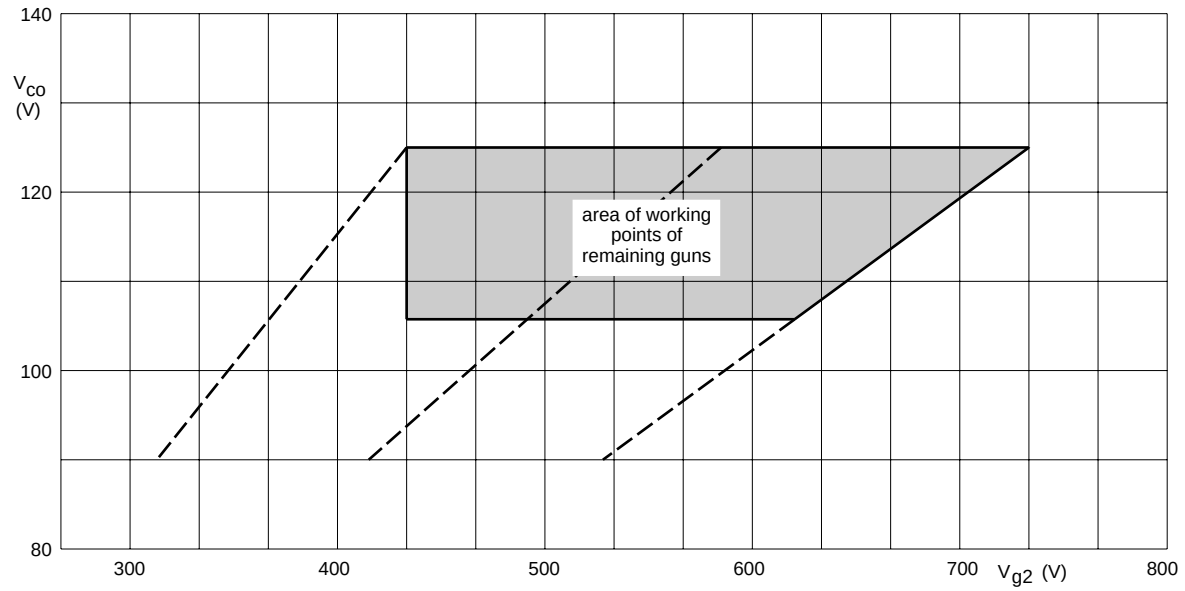
4.1 Recommended adjustment and operating conditions

The voltages are applied to each gun and are measured with respect to grid 1; RH = 40% to 60%; tube facing east; local magnetic field: 0.03 mT vertical, 0.00 mT lateral, 0.00 mT axial. Pre-heat the tube for 15 minutes minimum before tests. Avoid misconvergence, distortion etc. due to stray magnetic fields and chassis influences.

SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNIT
$V_{a,g4}$	anode voltage	–	27.5	–	kV
V_{g3a}	grid 3a (static focus electrode) voltage as a percentage of the anode voltage; note 1	25.5	–	29.5	%
V_{g3b}	grid 3b (dynamic focus electrode) voltage				
	DC voltage as a percentage of the anode voltage	25.5	–	29.5	%
	horizontal parabola	–	300	–	V
	vertical parabola	–	150	–	V
V_{g2}	grid 2 voltage at a spot cut-off voltage V_{co} = 125 V; note 2	see Fig.21			V
V_f	heater voltage	–	6.1(3)	–	V
f_H	horizontal sweep frequency	–	30 to 110	–	kHz
f_V	vertical sweep frequency	–	60 to 80	–	Hz
T_{amb}	ambient temperature	–	25	–	°C

Notes

1. Focus adjustment procedure:
   a) Adjust anode current for 750 cd/m^2.
   b) Adjust for optimum focus at $^2/_3$ centre-corner.
2. Grid 2 adjustment procedure:
   a) Grid 2 voltage (V_{g2}) adjusted for highest gun spot cut-off voltage: V_{co} = 125 V.
   b) Remaining guns adjusted for spot cut-off by means of cathode voltage.
   c) V_{g2} range: 425 V to 700 V at V_{co} = 125 V.
   d) Set the cathode voltage (V_k) for each gun at 125 V; increase the grid 2 voltage (V_{g2}) from ≈400 V to the value at which the spot of the gun with the lowest (V_{g2}) cut-off voltage becomes just visible, then decrease the cathode voltage of the remaining guns until the other gun beams become just visible.
3. For maximum cathode life it is recommended that the heater voltage is regulated at 6.1 V.



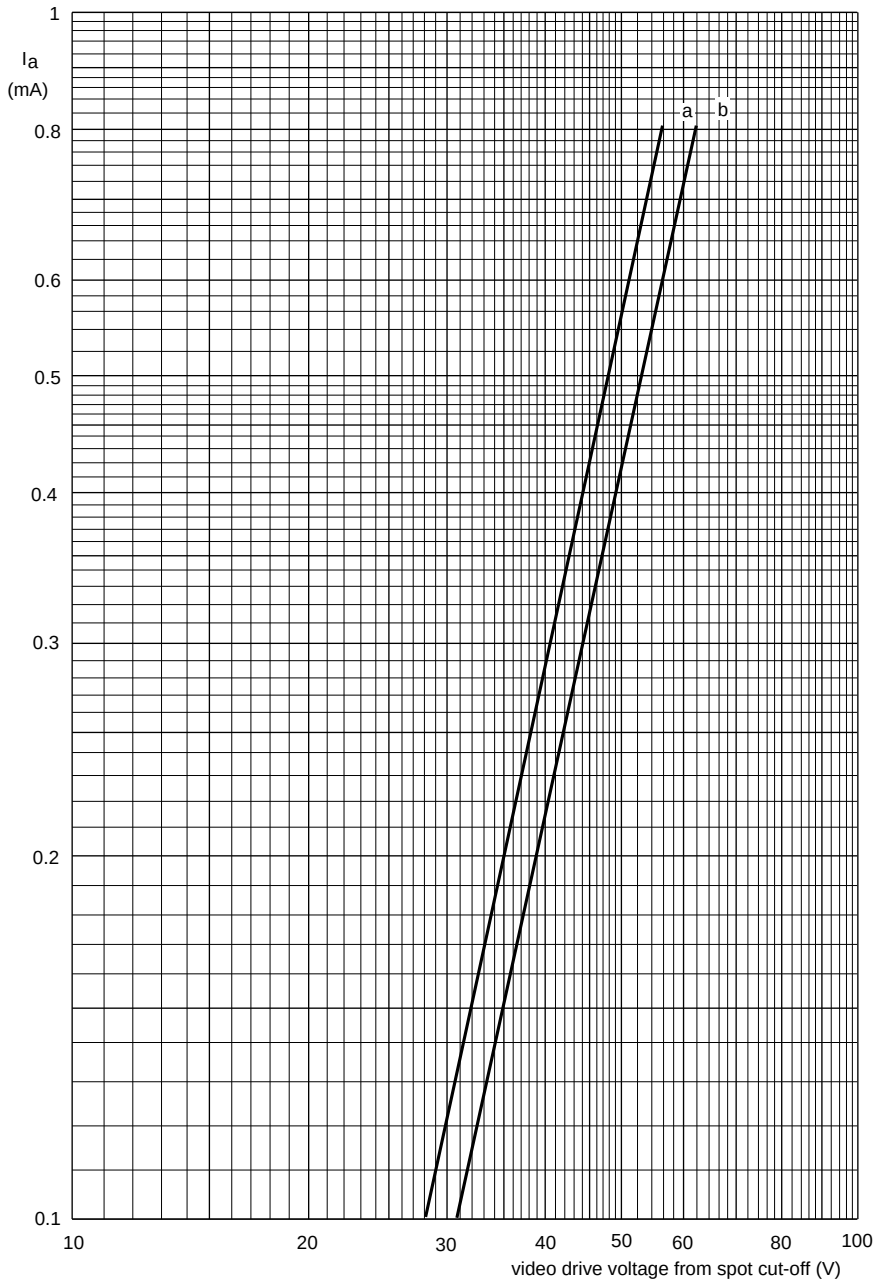
The voltages are specified with respect to grid 1.

Fig.21 Spot cut-off design chart.

4.2 Chassis design values

The values are valid for anode voltages between 20 and 29.9 kV. The voltages are specified with respect to grid 1.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
V_{g3a}	grid 3a (static focus voltage) as a percentage of anode voltage		25.5	–	29.5	%
V_{g3b}	grid 3b (dynamic focus voltage) as a percentage of anode voltage	raster size = 312 × 234 mm				
	DC voltage as a percentage of anode voltage		25.5	–	29.5	%
	horizontal parabola		–	300	–	V
	vertical parabola		–	150	–	V
ΔV_{g3a}	difference in focus voltage between red, green and blue guns when separately focused		–	–	300	V
ΔV_{g3a-b}	difference between the static focus voltage and dynamic focus voltage		–	–	200	V
V_{g2}	grid 2 voltage	for visual extinction of focused spot	see Fig.21			
V_k	cathode voltage		see Figs 21 and 22			
ΔV_k	difference in cut-off voltage between guns in any tube (cathodes cut-off ratio)		highest value <1.18 × lowest value			
V_f	heater voltage	at zero beam current	–	6.1	–	V
I_{g3a}	focus current	under cut-off conditions	–3	–	+3	μA
I_{g3b}	focus current	under cut-off conditions	–3	–	+3	μA
I_{g2}	grid 2 current	under cut-off conditions	–2	–	+2	μA
I_{g1}	grid 1 current	under cut-off conditions	–5	–	+5	μA
I_{kf}	cathode/heater current	V_{co} = 125 V	–3	–	+3	μA
Resistance						
R_{kgf}	insulation resistance between each cathode and all other electrodes and heater		50	–	–	MΩ
R_{g2}	grid 2 circuit impedance		–	–	5	MΩ
R_{g3}	grid 3 circuit impedance		–	–	50	MΩ



V_{co} = 100 V (curve a).
V_{co} = 125 V (curve b).

Fig.22 Typical cathode drive characteristics.

4.3 Limiting values

In accordance with the Absolute Maximum Rating System (IEC 60134). Voltages are specified with respect to grid 1.

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
$V_{a,g4}$	anode voltage	note 1	20(2)	29.9(3)	kV
I_{ap}	anode current for each gun (peak value)		–	550	μA
I_a	long-term average anode current for each gun		–	400	μA
I_a	long-term average anode current for three guns		–	1100	μA
V_{g3a}	grid 3a (focus) voltage		–	10	kV
V_{g3b}	grid 3b (focus) voltage		–	10	kV
$\Delta V_{g3a-g3b}$	grid 3 (focus) differential voltage		–	1	kV
V_{g2p}	grid 2 voltage, including video signal voltage (peak value)		–	1000	V
V_f	heater voltage	note 4	5.7	6.6(3)	V
Cathode voltage					
V_k	positive	operating	–	200	V
		operating cut-off	–	135	V
V_k	negative		–	0	V
V_{kp}	negative peak		–	–2	V
Cathode to heater voltage					
V_{kf}	positive		–	250	V
V_{kfp}	positive peak		–	300(3)	V
V_{kf}	negative		–	0	V
V_{kfp}	negative peak		–	-50	V

Notes

1. 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 the picture tube.
2. Operation of the tube at lower voltages impairs the luminance and resolution and could impair the convergence.
3. This value is an absolute maximum.
4. For maximum cathode life it is required that the heater supply is designed for 6.1 V at zero beam current. Heater source impedance should have a minimum value of 2 Ω (maximum current during switching on is 600 mA).

4.4 Flashover protection

With the high voltage used with this tube (max. 29.9 kV) internal flashovers may occur. As a result of Soft-Flash technology these flashover currents are limited to approximately 60 A offering higher 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 in accordance with Fig.23; 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 focus electrode (g3a and g3b) of 11 kV and at the other electrodes of 1.5 to 2 kV, both at an atmospheric pressure of 100 kPa.

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.

To guarantee the soft flash behaviour, the internal dynamic resistance of the tube during flashover is minimal 200 Ω.

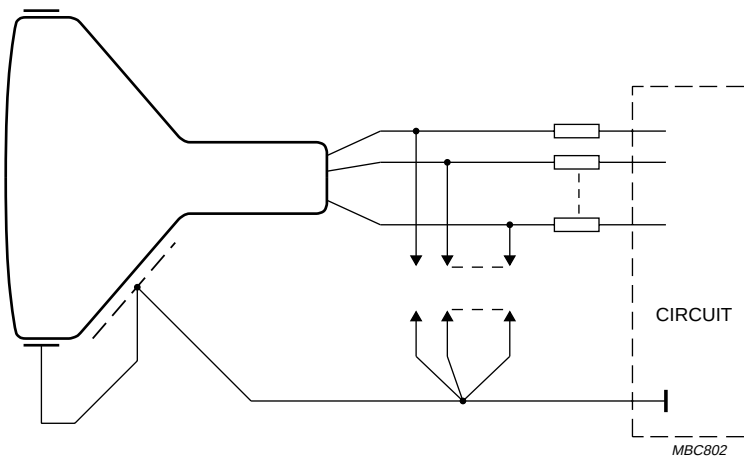


Fig.23 Flashover protection circuit.

5 ERGONOMIC AND ENVIRONMENTAL DATA

5.1 X-radiation

Maximum anode voltage at which the X-radiation emitted will not exceed 0.5 mR/h at an anode current of 300 μA.

PARAMETER	TYP.	UNIT
Entire tube; note 1	37	kV

Note

1. 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 iso-exposure-rate limit curve and the iso-exposure-rate limit curve for the entire tube.

WARNING
The tube will satisfy the European Community permitted limit of 1 μSv/h, when driven within the maximum published operating conditions.
Maximum voltage difference between anode and focus electrode at which the X-radiation will not exceed 0.5 mR/h is given in Fig.25.
If this voltage can be exceeded in the monitor, additional attenuation of the X-radiation may be required.
The X-radiation emitted from this picture tube, as measured in accordance with the procedure of *"TEPAC PublicationsNo.EIA501"* will not exceed 0.5 mR/h throughout the useful life of the tube 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 iso-exposure-rate limit characteristics as shown in Fig.25.
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 *"Federal Register Volume 38, No. 198,b Monday, October 15, 1973"*.
Maximum X-radiation as a function of anode voltage at 300 μA current is shown by Fig.24. X-radiation at a constant anode voltage varies linearly with anode current.

WARNING
The cathode ray tube is intrinsically safe in accordance with *"Appendix III Röntgenverordnung"*.
Eigensichere Kathodenstrahlröhre nach *"Anlage III Röntgenverordnung"*.

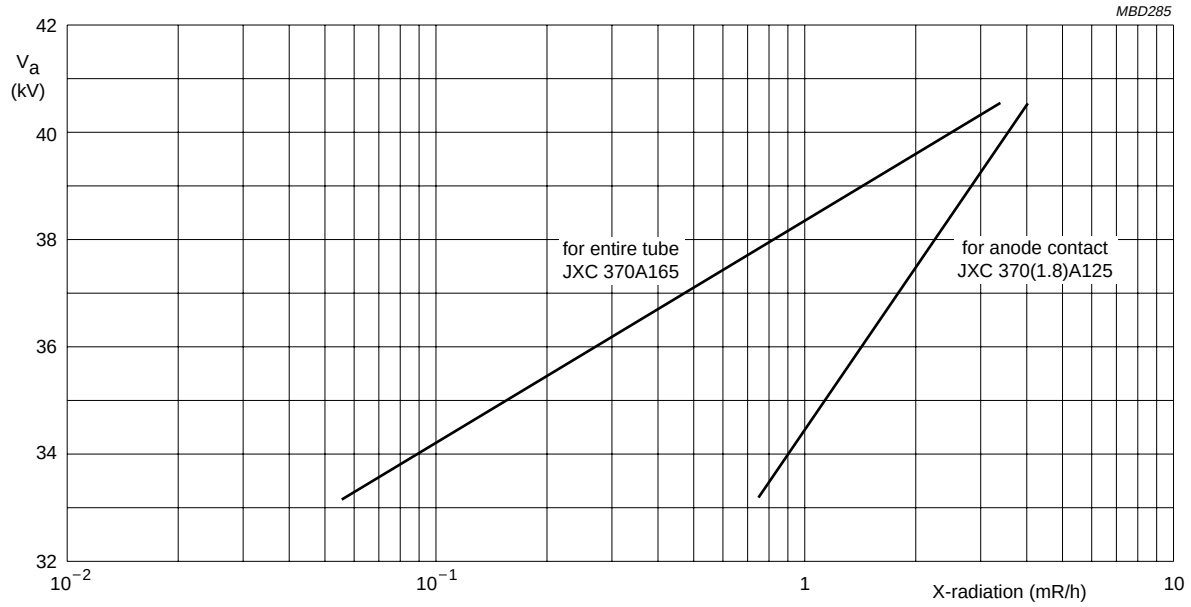


Fig.24 X-radiation limit curves at a constant anode current of 300 μA.

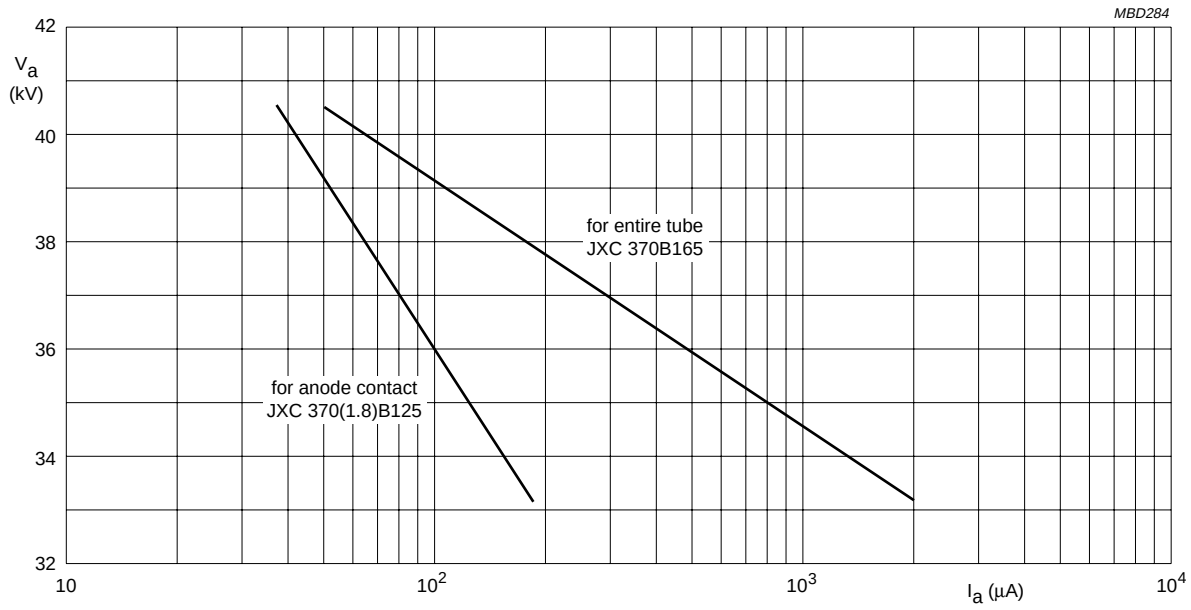
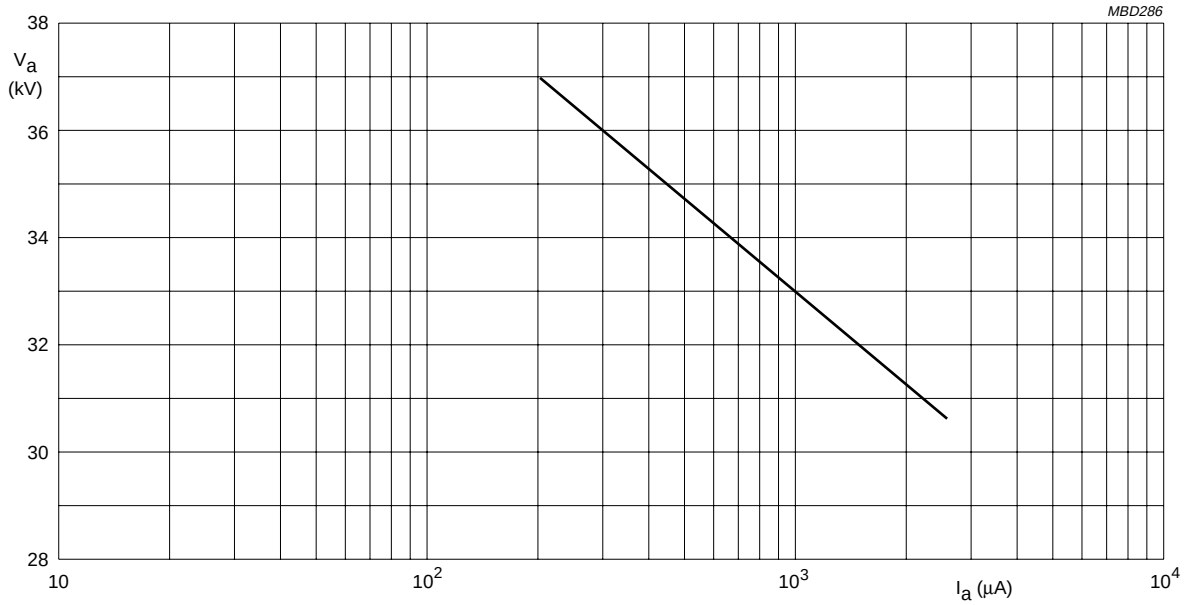


Fig.25 0.5 mR/h iso-exposure-rate limit curves.



The X-radiation emitted will also not exceed 1 μSv/h for anode voltage and current combinations shown in the iso-exposure-rate limit curve according to Eigensichere Kathodenstrahlröhre nach *"Anlage III Röntgenverordnung"*.

Fig.26 1 μSv/h iso-exposure-rate limit curve.

5.2 Warnings

X-radiation
Operation of the monochrome monitor tube under abnormal conditions that exceed the 0.5 mR/h iso-exposure-rate curve shown in Fig.25 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 values stated in Section 4.3 are not exceeded.
Tube replacement
This monitor tube incorporates integral X-radiation and implosion protection and must be replaced with a tube of the same type number or 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 taken during replacement or servicing of the monitor tube since a residual electrical charge may be held by the high-voltage capacitor formed by the external and internal conductive coatings of the monitor 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.

5.3 Handling

The packaging provides protection against tube damage under normal conditions of shipment or handling. Observe any instructions given on the packaging and handle accordingly. Under no circumstances should the tube assembly be subjected to accelerations greater than the values given in Table “Accelerations”.

Accelerations

PARAMETER	CONDITIONS	MAX.	UNIT
Pulse in cone direction	≤10 ms	350	m/s^2
	30 ms	200	m/s^2
Pulse in all other directions	30 ms	350	m/s^2

Monitor tubes should be kept in the shipping box or similar protective container prior to installation.

Although monitor tubes are provided with integral implosion protection which meets the intrinsic safety requirements stipulated in the relevant part of IEC 60065, care should be taken not to scratch or knock any part of the tube. Particularly care should be taken to prevent damage to the seal area.

In all handling procedures prior to insertion in the cabinet, there is a risk of personal injury if severe accidental damage to the tube occurs. It is therefore recommended that in areas containing unpacked and unprotected tubes, protective clothing is worn, particularly, gloves and safety glasses with side-shields to prevent possible injury from flying glass in the event of such an accident.
Handle the tube with extreme care. Do not strike, scratch or subject the tube to more than moderate pressure.

The tube assembly should never be handled by the tube neck, deflection unit or other neck components.

If suspending the tube assembly from the mounting lugs, ensure that a **minimum of two** are used.
Under no circumstances suspend the tube assembly from one lug.

An alternative lifting method is to firmly grasp the assembly by the vertical sides of the rimband. Manually lifting the assembly from the face-down or face-up position is shown in Figs 27 and 28.

To protect the screen when placing the tube face-down, ensure that the tube face rests on a cushion kept free from abrasive substances.

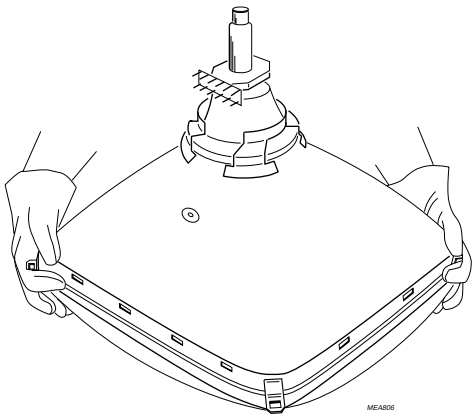


Fig.27 Lifting tube from face-down position.

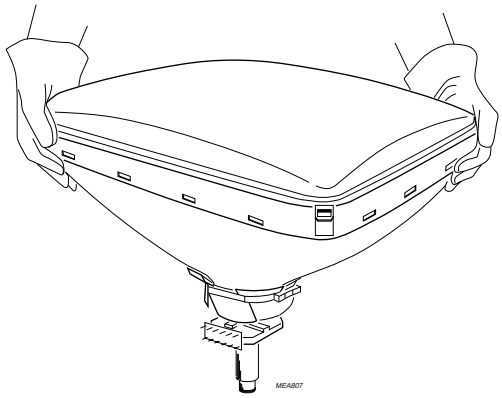


Fig.28 Lifting tube from face-up position.

5.4 Environmental conditions

The tube assembly must be capable of meeting the requirements of this specification under/after the following environmental conditions.

5.4.1 AMBIENT TEMPERATURE

- Tube operating +10 °C to +53 °C
- Storage and shipment –20 °C to +60 °C with a thermal shock up to 24 °C
- 50% relative humidity at either limit with the tube assembly inside the shipping container.

5.4.2 RELATIVE HUMIDITY

- Operating 8% to 80%
- Storage and shipment 5% to 100% (including condensation, but excluding rain).

5.4.3 BAROMETRIC PRESSURE

- Operating and storage 769 hPa to 1060 hPa
- Shipment 91 hPa to 1060 hPa.

5.4.4 WET BULB TEMPERATURE

- Operating maximum 26.7 °C
- Storage and shipment 29.4 °C.

6 DEFINITIONS

Data sheet status	
Objective specification	This data sheet contains target or goal specifications for product development.
Preliminary specification	This data sheet contains preliminary data; supplementary data may be published later.
Product specification	This data sheet contains final product specifications.
Limiting values	
Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 60134). Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only and operation of the device at these or at any other conditions above those given in the Characteristics sections of the specification is not implied. Exposure to limiting values for extended periods may affect device reliability.	

7 LIFE SUPPORT APPLICATIONS

These products are not designed for use in life support appliances, devices, or systems where malfunction of these products can reasonably be expected to result in personal injury. PDS customers using or selling these products for use in such applications do so at their own risk and agree to fully indemnify PDS for any damages resulting from such improper use or sale.



PDS B.V.

Jan Campertstraat 5

6416 SG Heerlen

The Netherlands

Tel. +31 (0)45 543 9312

Fax. +31 (0)45 542 6458

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DATA SHEET

M51EDF30WB11/04

21" high resolution triple gun monochrome monitor tube assembly

Product specification

2004 May 22

Professional Display Systems B.V.

21" high resolution triple gun monochrome monitor tube assembly

M51EDF30WB11/04

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21" high resolution triple gun monochrome monitor tube assembly

M51EDF30WB11/04

1 HIGHLIGHTS

1.1 Features

1.1.1 HIGH PERFORMANCE DESIGN

- High resolution; higher pixel density up to 1600 × 1280 pixels (non-interlaced) displayable conform ISO 9241 by:
  - 'larger' effective screen area: 377 mm × 285 mm
  - high resolution in-line electron polygon DAF triple gun(1)
- High brightness and contrast:
  - anti glare screen coating
- Excellent uniformity
- Accurate convergence and raster geometry:
  - double mussel coil technology
  - internal magnetostatic beam alignment
  - charge drift compensation
  - optional additional north-south raster correction circuitry available
- Application-friendly design:
  - worldwide useable design
  - East-West correction max. 10%
  - horizontal balance coil; vertical balance potentiometer
  - deflection units designed for minimal ringing
  - optional rotation coil for adjustment of axial magnetic fields
  - up to and including 110 kHz horizontal frequency
  - static convergence adjustments (multipole for 4 and 6 pole correction) on monitor level.

1.1.2 ERGONOMIC DESIGN

- Less ambient reflection:
  - 'flat' and 'square' design
  - AGAS (Anti Glare Anti Static) coating
- Less eye strain:
  - P45 medium-persistence white phosphor
  - high frequency yokes
- Green design:
  - CFC-free production process
  - Cd-free phosphor
  - 0.65 W Cermet © power saving cathodes
- Fulfils electric/magnetic radiation standards
- Safety approved:
  - VDE; CSA; UL.

1.1.3 OPTIMUM DISPLAY SOLUTION

- High-end PC applications
- Workstation applications
- Resolution standards up to 1600 × 1280 pixels non-interlaced applications.

1.2 Quick reference data

PARAMETER	TYP.	UNIT
Deflection angle	90	deg
Face diagonal	51	cm
Overall length	<454.4	mm
Neck diameter	29.4	mm
Glass transmission	43	%
Colour co-ordinates		
x	244	
y	309	
Brightness	750	cd/m^2
Heater voltage	6.15	V
Focus voltage	25% of anode voltage	
Anode voltage	27.5	kV

1.3 Deflection coil data

Deflection coil is mounted with dynamic convergence correction coils (PECOMA).

PARAMETER	VALUE	UNIT
Horizontal coil inductance	0.092	mH
Vertical coil inductance	4.4	mH
Maximum advised frequency	110	kHz

1.4 Ordering information

TYPE NUMBER	SCREEN FINISH	LUG DISTANCE
M51EDF30WB11/04	AGAS	38.5 mm

(1) Whenever in this data sheet the words 'red', 'green' and 'blue' are used, with respect to the guns, the guns are meant as in an equivalent colour monitor tube.

2 PERFORMANCE SPECIFICATION

2.1 Colour coordinates

PHOSPHOR DATA	COLOUR COORDINATES	
	x	y
Phosphor type: P45 (N 1045) $I_{a(av)}$ = 300 μA (per gun) V_a = 27.5 kV Scanned duty cycle = 75% Scanned area = 312 × 234 mm Screen finish AGAS	244±10	309±10

2.2 Brightness uniformity

Brightness uniformity between centre and corners: >80%; <110%.

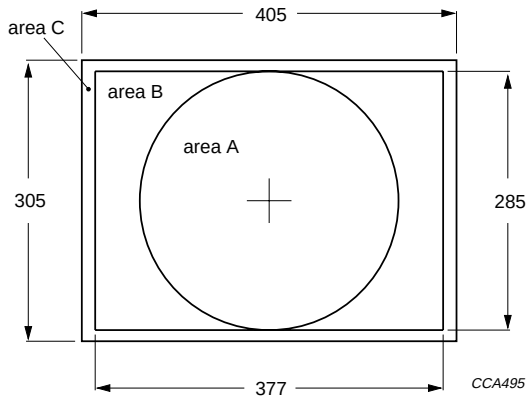
2.3 Convergence specification

2.3.1 TEST CONDITIONS

1. Set-up in accordance with Section 4.1.
2. Measure maximum misconvergence after 30 minutes operation.
3. To be adjusted for focus at $^2/_3$ centre-corner using crosshatch pattern at anode current is 300 μA (peak value) per gun.
4. Misconvergence is the distance between the centres of the red, green and blue guns at the screen using a crosshatch pattern.
5. Anode and/or focusing voltage and terrestrial magnetism may slightly affect the static convergence. Therefore, small re-adjustments to static convergence may be necessary.
6. Avoid stray magnetic fields etc. due to chassis influences which may affect convergence.

2.3.2 CONVERGENCE LIMITS

LOCATION (see Fig.1)	TYPE OF ERROR	MAXIMUM ERROR BETWEEN GUN SPOTS	
		STANDARD	WITH PECOMA
Centre	red-green-blue gun line separation in either the horizontal or vertical direction	0.30 mm	0.2 mm
Area A/corner		0.50 mm	0.2 mm



Dimensions in mm.

Fig.1 Maximum misconvergence.

2.4 Resolution specification

With the settings given in Section 4.1, the 50% spot value is as listed below.
Measured within raster of 377 mm × 285 mm.

ANODE CURRENT	SPOT SIZE CENTRE (NOMINAL)		SPOT SIZE CORNER (NOMINAL)		UNIT
	X	Y	X	Y	
100 μA.	0.4	0.4	0.6	0.4	mm
200 μA	0.5	0.5	0.6	0.5	mm
400 μA	0.6	0.6	0.7	0.5	mm

2.5 Raster geometry

2.5.1 RASTER CENTRING

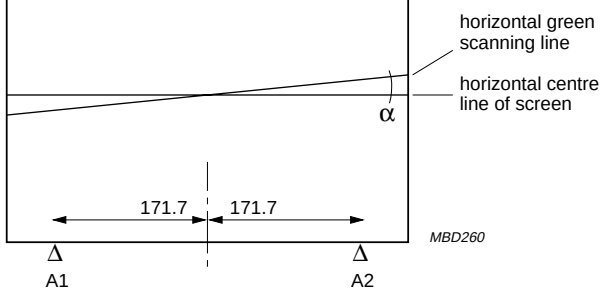
CENTRING	MAX.	UNIT
Horizontal	±5.5	mm
Vertical	±5.5	mm

2.5.2 RASTER ORTHOGONALITY

Orthogonality of the horizontal/vertical scan axis is ±0.5°.

2.5.3 RASTER ROTATION

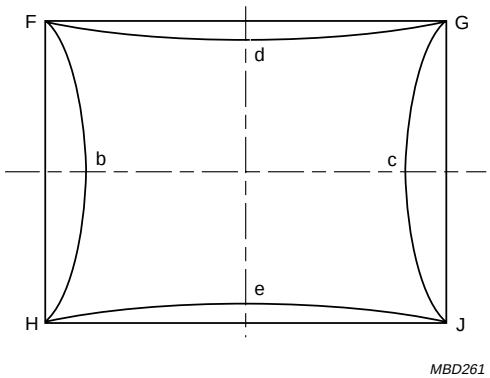
Measure the angle of the horizontal green scanning line with reference to a horizontal centre line that is drawn parallel to the tube reference points A1 and A2, see Fig.2. Chassis influences may affect raster rotation.



$\alpha \leq 0.3°$

Fig.2 Rotation measurement.

2.5.4 PIN-CUSHION DISTORTION



FG = HJ = 377 mm.
FH = GJ = 285 mm.
Measured with no pin-cushion correction applied, with 'b', 'c', 'd' and 'e' measured along the main axis.

Fig.3 Pin-cushion distortion.

2.5.5 DISTORTION NORTH - SOUTH

The following formulae define the pin-cushion distortion in the north and south directions.

$$\text{North} = \frac{4d}{FH + GJ} \times 100\% = 0\% \text{ to } +1.3\%$$

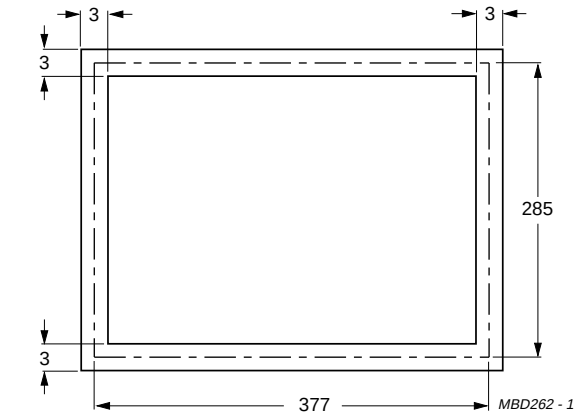
$$\text{South} = \frac{4e}{FH + GJ} \times 100\% = 0\% \text{ to } +1.3\%$$

2.5.6 DISTORTION EAST - WEST

The following formulae define the pin-cushion distortion in the east and west directions.

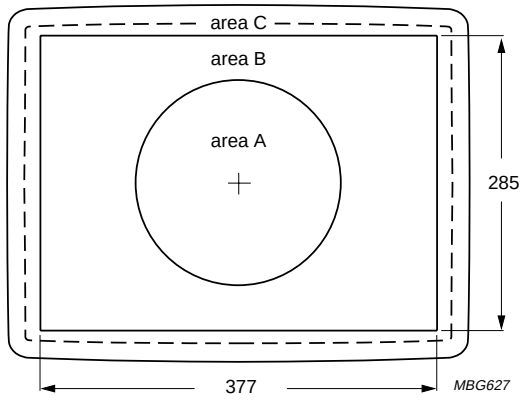
$$\text{East} = \frac{4b}{FG + HJ} \times 100\% \leq 10\%$$

$$\text{West} = \frac{4c}{FG + HJ} \times 100\% \leq 10\%$$



Dimensions in mm.

Fig.4 General distortion.



Dimensions in mm.

Fig.5 Screen areas.

2.6 Screen quality

2.6.1 GENERAL TEST PROCEDURE

Tests are to be done under the following general conditions:

- Viewing distance should be 50 cm minimum.
- For an activated screen the diffuse ambient light level at the centre of the screen should be between 2 and 5 lux.
- For an unactivated screen the diffuse ambient light level at the centre of the screen should be between 700 and 1000 lux.
- The viewing angle relative to the tube axis should not exceed 45°.
- Faults not visible under these general conditions are permitted.
- The following quality areas are specified (see Fig.5):
  - Area A: a circular area with a diameter of 200 mm, of which the centre coincides with the mechanical centre of the screen.
  - Area B: the area between the edge of area A and the rectangular area measuring 377 mm × 285 mm, of which the centre coincides with the mechanical centre of the screen.
  - Area C: the area between the edge of area B and the rimband.

2.6.2 ASSESSMENT OF THE GLASS AND THE UNACTIVATED SCREEN QUALITY

2.6.2.1 Definition of blemishes

Unless otherwise specified, the shape of a blemish is defined as round and elliptical.

The size of a blemish is given by:

- $\frac{L + W}{2}$; if L > 3W the size is given by $\frac{L}{20} + 2W$,

  where L = length and W = width.

2.6.2.2 Limits

Table 1 Limits of measurable glass blemishes

SIZE (mm)	MAX. NUMBER OF BLEMISHES IN AREAS		MIN. PERMISSIBLE DISTANCE BETWEEN ANY TWO BLEMISHES (mm)	AREA C
	A	A + B		
>0.6	0	0	not applicable	only limits as regards tube safety
>0.4 to ≤0.6	1	2	50	
>0.2 to ≤0.4	2	5	50	
Total number	2	5	50	–
≤0.2	limited only by cloud			–

Table 2 Limits of measurable coating blemishes for AGAS coating

SIZE (mm)	MAX. NUMBER OF BLEMISHES IN AREA A+B	MIN. PERMISSIBLE DISTANCE BETWEEN ANY TWO BLEMISHES (mm)	AREA C
High contrast			
>1.5	0	not applicable	acceptable
>1.0 to ≤1.5	3	50	
>0.5 to ≤1.0	5	30	
≤0.50	no limits	no limits	
Low contrast			
>3.0	0	not applicable	acceptable
>1.0 to ≤3.0	5	30	
≤1.0	no limits	no limits	

Table 3 Limits of scratches

AREA	WIDTH (mm)	MAX. ALLOWABLE TOTAL LENGTH (mm)	MIN. SEPARATION (mm)
A+B	>0.15	0	not permitted
	>0.10 to ≤0.15	13	50
	>0.05 to ≤0.10	25	20
	≤0.05	no limits	not applicable
C	only as regards tube safety		

2.6.3 ASSESSMENT OF THE QUALITY OF THE ACTIVATED PHOSPHOR SCREEN

The assessment of the quality of the phosphor and matrix layer at area A should take place at typical operating conditions and a blanked raster. The current for each gun must be adjusted to a brightness of 200 cd/m^2.

2.6.3.1 Definition of blemishes

- A blemish is a fault which is clearly visible within 5 seconds.
- A defect, which looks visually as one blemish should be regarded as a single blemish.
- Unless otherwise specified, the shape of a blemish is defined as round and elliptical.

The size of a blemish is given by:

- $\frac{L+W}{2}$; if L > 3W the size is given by $\frac{L}{20} + 2W$, where L = length and W = width.

2.6.3.2 Limits

1. The distance between any two blemishes >0.2 mm should be >50 mm.
2. Maximum number of blemishes >0.2 mm per screen is 9.
3. Blemishes ≤0.2 mm can be ignored, except for a concentration of such blemishes that has a diameter of more than 8 mm.

Table 4 Limits of blemishes

BLEMISH SIZE (mm)	MAXIMUM NUMBER OF BLEMISHES IN		
	AREA A	AREA B	AREA A + B
>0.6	0	0	0
>0.4 to ≤0.6	1	5	5
>0.2 to ≤0.4	4	6	9
≤0.2	limited only by cloud		

2.7 Coating performance

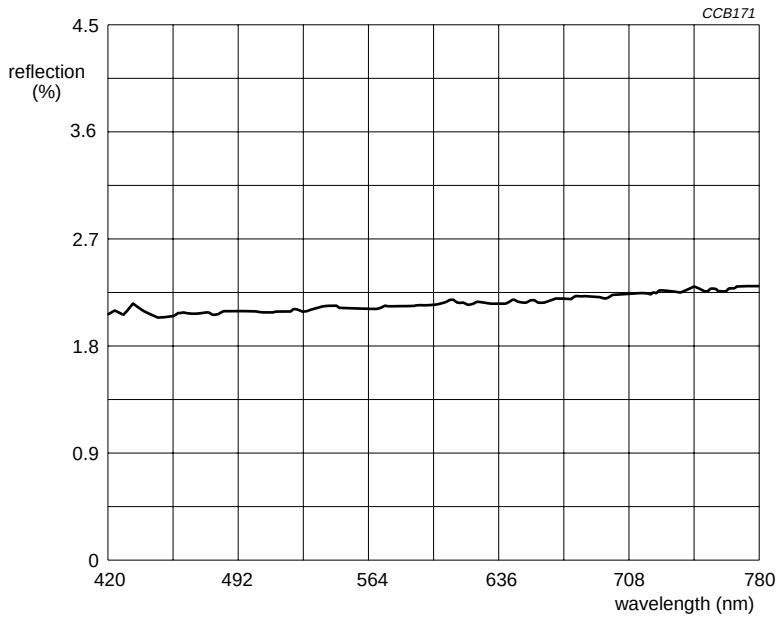


Fig.6 Relative reflection for AGAS.

3 PRODUCT CHARACTERISTICS

3.1 Electrical data

SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNIT
Capacitances					
$C_{a(m+m')}$	anode to external conductive cone coating, including rimband (with and without screen coating)	1000	1300	1600	pF
C_k	cathodes of all guns, connected in parallel, to all other electrodes	–	10	15	pF
C_{kR}, C_{kG}, C_{kB}	cathode of any gun to all other electrodes	–	4	–	pF
C_{g1}	grid 1 of any gun to all other electrodes	–	15	–	pF
C_{g2}	grid 2 to all other electrodes	–	10	–	pF
C_{g3a}	grid 3a (focus electrode) to all other electrodes	–	12	–	pF
C_{g3b}	grid 3b (dynamic focus electrode) to all other electrodes	–	17	–	pF
$C_{(g3a-g3b)}$	grid 3a to grid 3b	–	9	–	pF
Heater					
V_f	heater voltage	–	6.15		V
I_f	heater current	295	315	335	mA
t_{kwu}	cathode warm up time at 0-hour from 10% to 80% of end emission	–	–	8	s
Deflection unit					
V_{max}	maximum permissible DC voltage				
	between horizontal and vertical coils	–	–	2000	V
	between vertical coils and core	–	–	300	V
R_{ins}	insulation resistance at 1 kV (DC)				
	between horizontal and vertical coils	500	–	–	MΩ
	between horizontal coil and core clamping ring	500	–	–	MΩ
	between vertical coil and core clamping ring	10	–	–	MΩ
	crosstalk (1 V applied to the horizontal coils)	–	–	30	mV

3.2 Deflection unit data

All values are valid at T_{amb} = 25 °C and V_a = 27.5 kV; deflection units fulfil the MPRII and TCO magnetic requirements (see Section 5.1); the deflection coil is designed for a positive pulse on the horizontal coil.

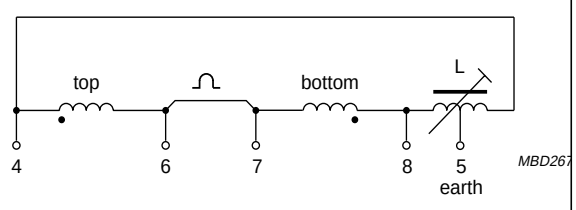
PARAMETER	VALUE	TOLERANCE	UNIT
Advised frequency; notes 1 and 2	110	–	kHz
Horizontal deflection coil			
Inductance	0.092	±4%	mH
Resistance	0.15	±10%	Ω
Current (peak-to-peak value)	13.5	±4%	A
Used wire	litz	–	
Vertical deflection coil			
Inductance	4.4	±4%	mH
Resistance	4.50	±7%	Ω
Current (peak-to-peak value)	1.81	±5%	A
Used wire	litz	–	

Notes

1. Advised maximum frequency depends on the internal maximum set temperature and used deflection-overscan.
2. No annoying ringing with 0% overscan.

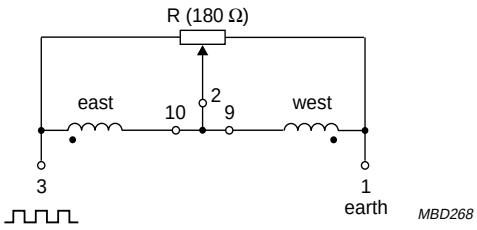
Rotation coil data

PARAMETER	CONDITION	MIN.	TYP.	MAX.	UNIT
Resistance	T_{amb} = 20 °C	50.9	56.6	62.3	Ω
Sensitivity	I = 75 mA; V_a = 27.5 kV	–	0.95	–	deg



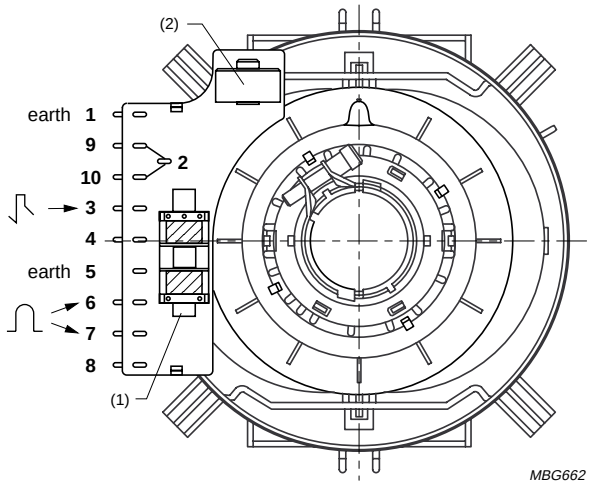
The beginning of the windings is indicated with •

Fig.7 Horizontal coils.



The beginning of the windings is indicated with •

Fig.8 Vertical coils.

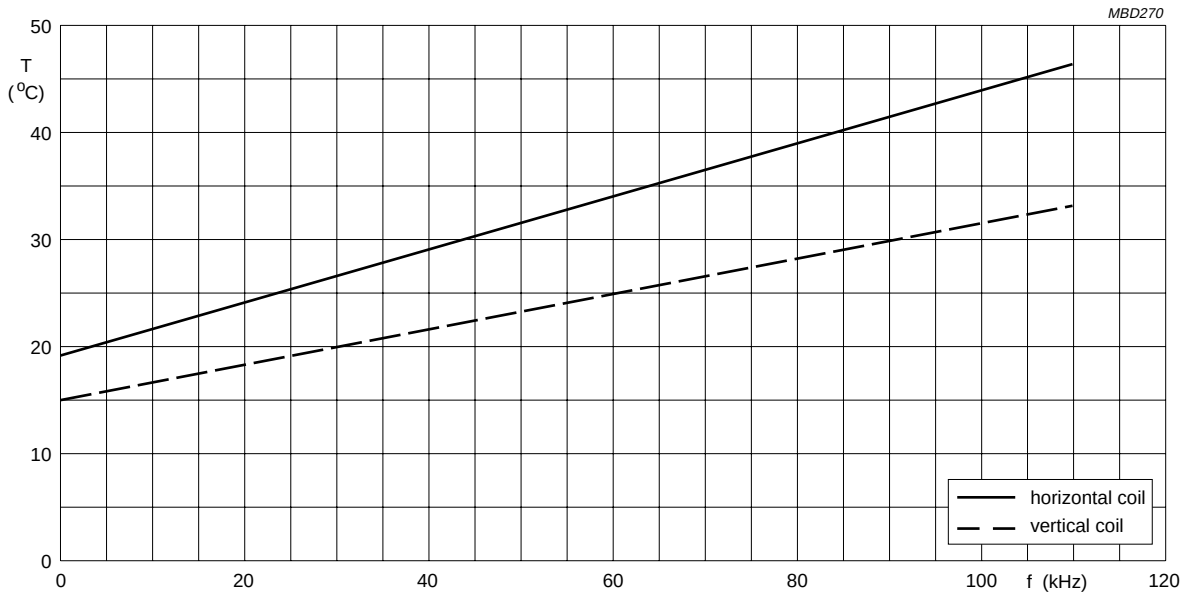


(1) Horizontal balance coil.
(2) Vertical balance potentiometer.

Fig.9 Deflection coil connections.

3.2.1 DEFLECTION UNIT TEMPERATURE

SYMBOL	PARAMETER	MAX.	UNIT
T_{copper}	average copper temperature of horizontal coil	110	°C
ΔT	maximum temperature rise of used wire	50	°C



Maximum operating copper temperature (resistance measurement) is 110 °C.

Fig.10 Temperature rise as a function of frequency.

3.3 Electro optical data

PARAMETER	VALUE
Electron gun system	three in-line integrated guns
Focus method	electrostatic
Focus lens	polygon and DAF
Convergence method	magnetic
Deflection method	self converging
Deflection angle	
diagonal	≈90°
horizontal	≈78°
vertical	≈60°

3.4 Screen properties

PARAMETER	VALUE
Screen finish	AGAS
Light transmission at screen centre	43%
Recommended active screen area	
horizontal axis at a 1600 × 1280 pixels screen	377 mm
vertical axis at a 1600 × 1280 pixels screen	285 mm

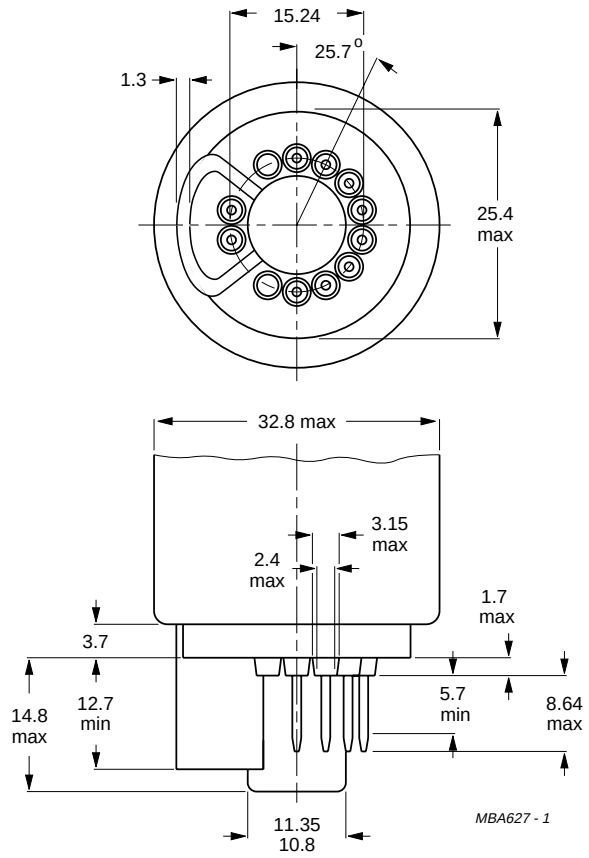
3.5 Coating properties

TYPE NUMBER	SCREEN FINISH	GLOSS
M51EDF30WB11/04	Anti Glare Anti Static (AGAS), tested in the centre	60 ±12%

3.6 Mechanical tube data

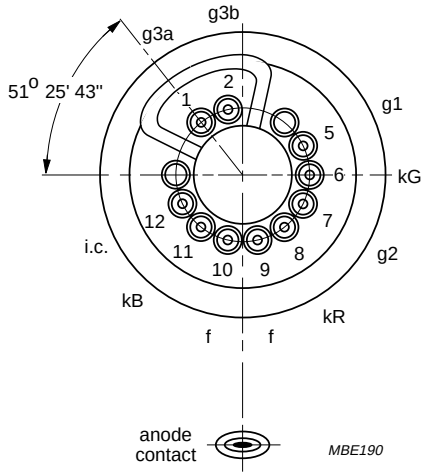
PARAMETER	VALUE
Overall length	447.9 ±6.5 mm
Neck diameter	29.4 +0.6/–0.4 mm
Maximum dimensions, excluding mounting lugs but including rimband	
diagonal	553.5 mm
width	470.0 mm
height	374.0 mm
Implosion protection	pre-stressed banded Mini-P shrunk-on rimband; CSA, UL and VDE approved
Anode contact	JEDEC J1-21; IEC 60067-III-2
Base designation	JEDEC B10-301
Base pin configuration	see Fig.12
Mass	≈15 kg
Mounting position	anode contact on top

3.7 Mechanical tube drawings



Dimensions in mm.

Fig.11 Base JEDEC B10-301.



i.c. = internally connected and not to be used.

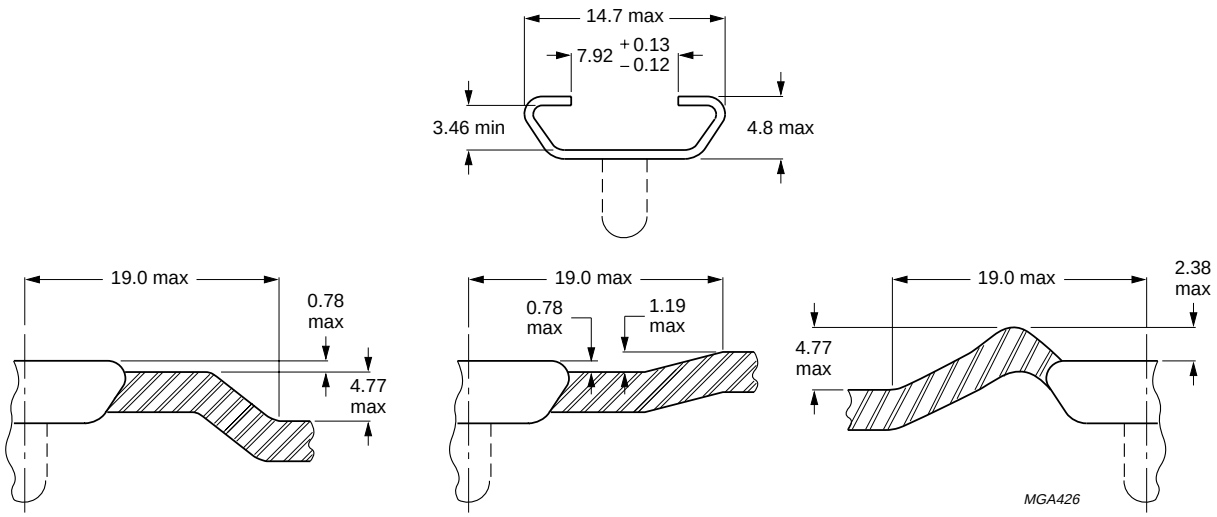
Fig.12 Pin arrangement.

Remarks: to Figs 11 and 12.

The socket for this base should not be rigidly mounted, it should have flexible leads and be allowed to move freely. After mounting the tube in the cabinet, note that the position of the base can fall within a circle, having a diameter of max. 40 mm concentric with an imaginary tube axis.

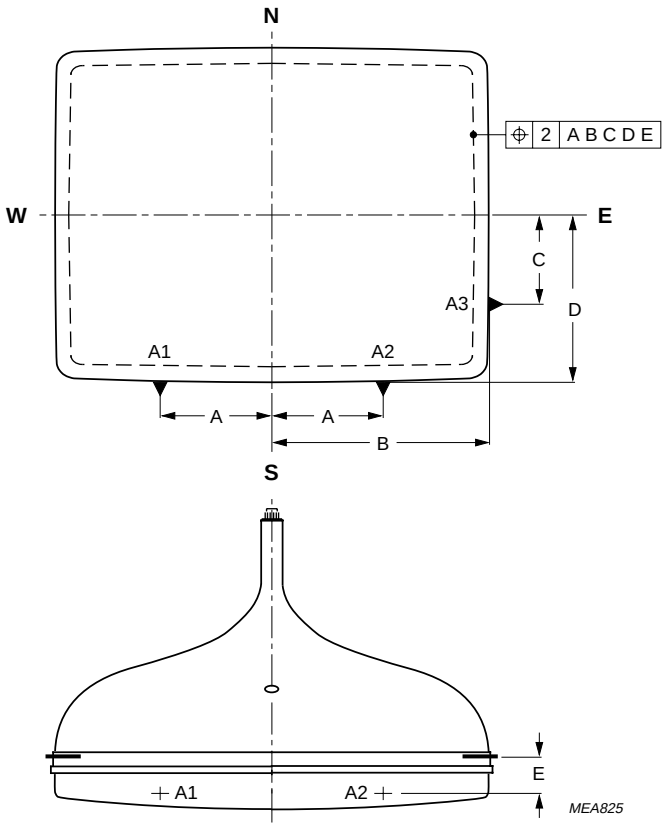
The mass of the mounting socket assembly should not exceed 450 g.

Maximum permissible torque on the tube neck is 0.14 Nm.



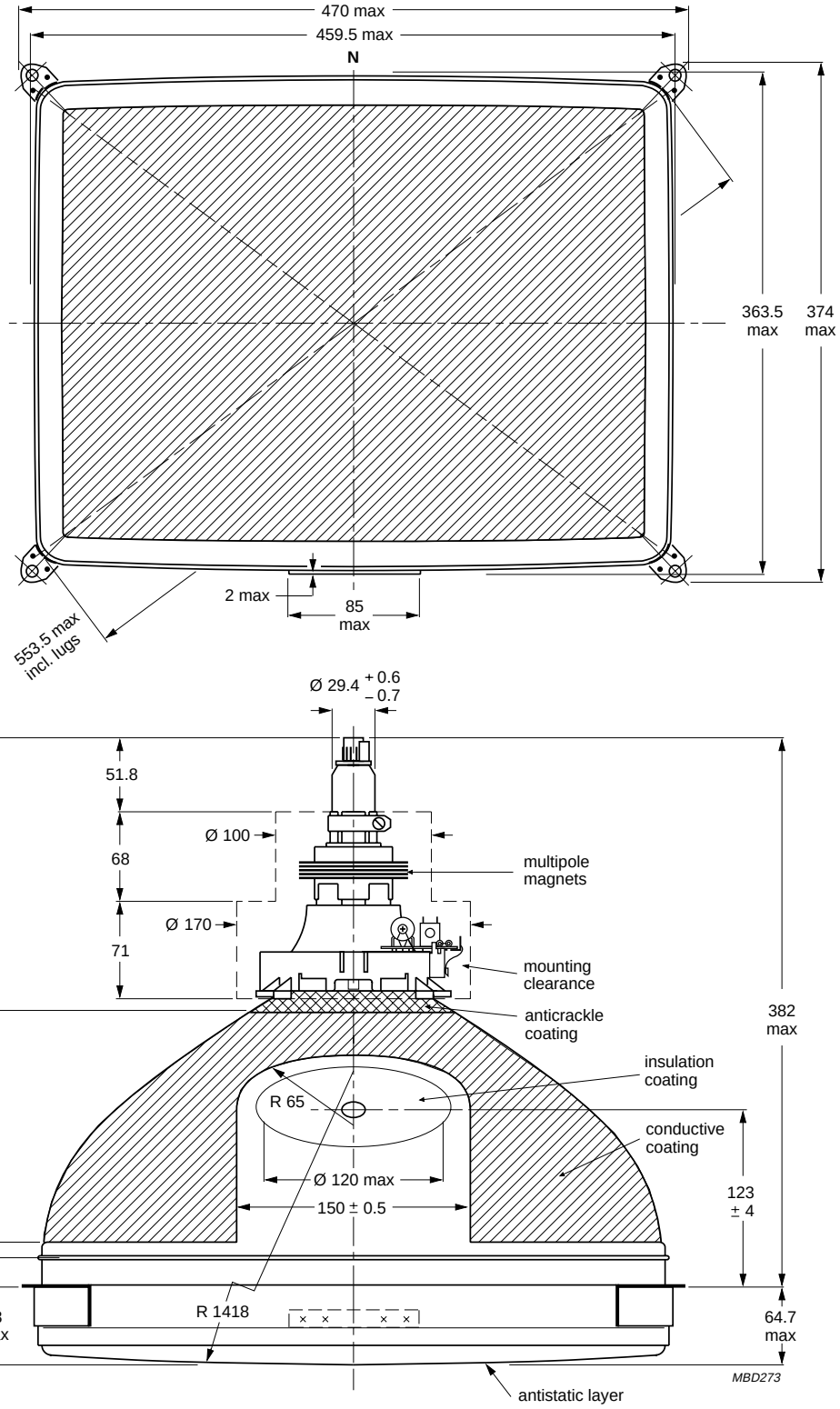
Dimensions in mm.

Fig.13 Cavity cap JEDEC J1-21, IEC 60067-III-2.



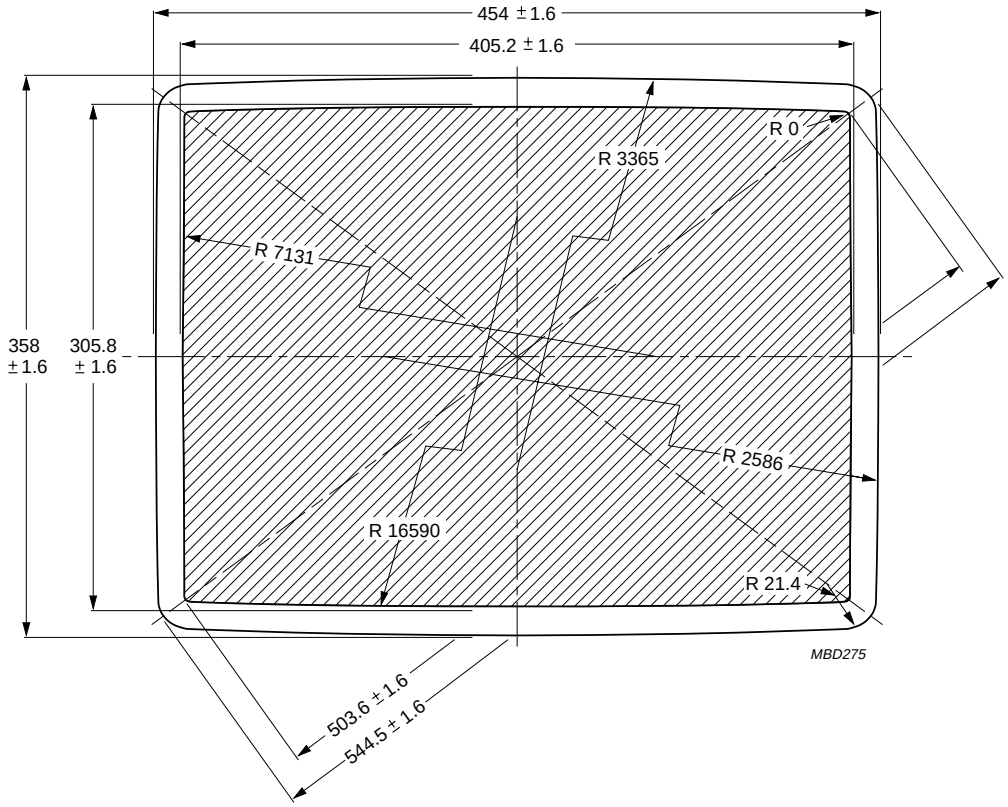
Dimensions in mm.
A = 171.7 mm.
B = 225.1 mm.
C = 115.6 mm.
D = 175.2 mm.
E = 5.1 mm.

Fig.14 Mechanical reference points.



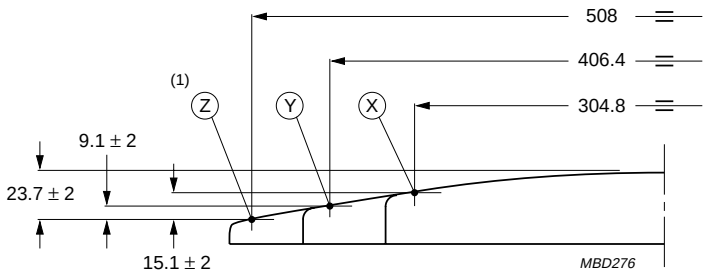
Dimensions in mm.

Fig.15 Top view.



Dimensions in mm.

Fig.16 Screen dimensions.

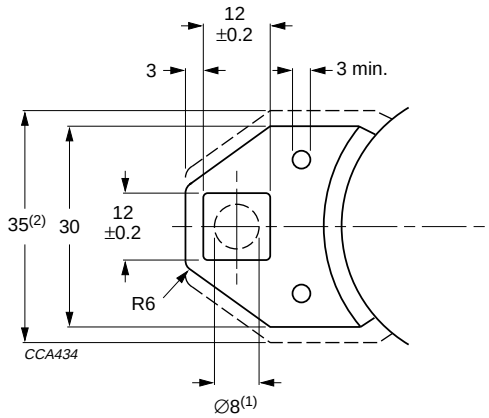


Dimensions in mm.

(1) The X, Y and Z reference points are located on the outside surface of the face plate.

Fig.17 Screen reference points.

3.7.1 LUG DATA

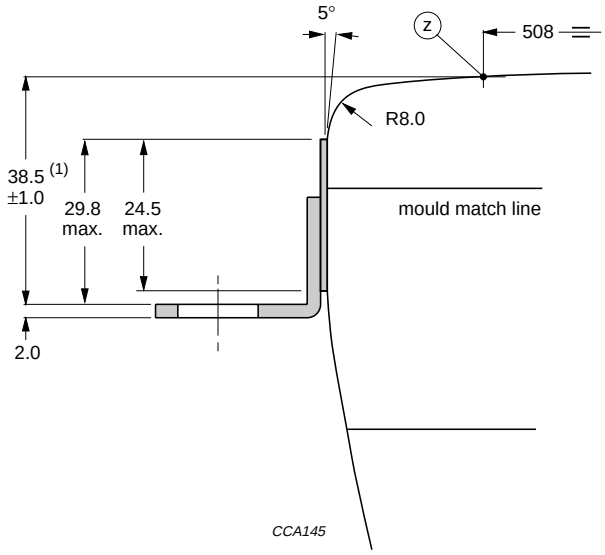


Dimensions in mm.

(1) 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 354.0 mm × 449.0 mm.

(2) Minimum space to be reserved for mounting lug in cabinet.

Fig.18 Lug dimensions.



Dimensions in mm.

(1) The displacement of any lug with respect to the plane through the other 3 lugs is maximum 0.8 mm.

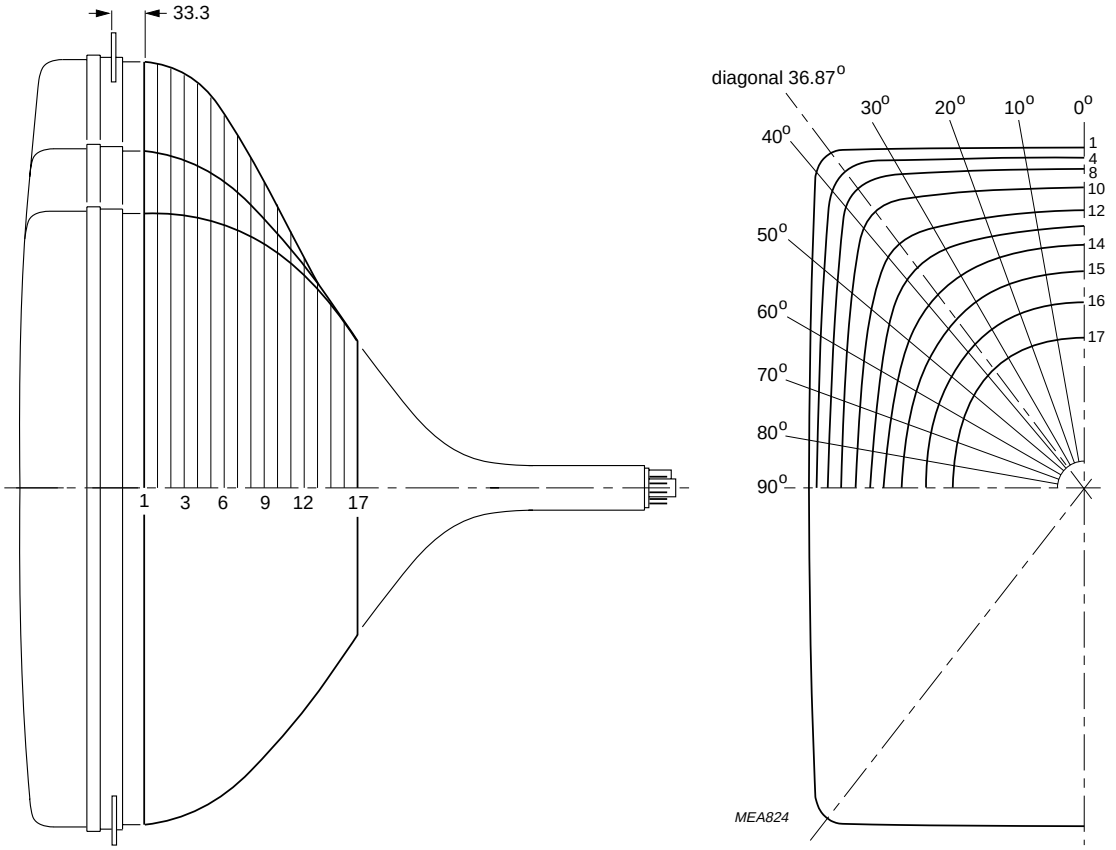
Fig.19 Lug position

3.8 Sagittal heights of screen

Sagittal heights of the nominal useful screen measured with respect to the end of the diagonal axis.

NOMINAL USEFUL SCREEN (NUS)			3 mm INSIDE NUS			5 mm OUTSIDE NUS		
COORDINATES		SAGITTAL HEIGHT	COORDINATES		SAGITTAL HEIGHT	COORDINATES		SAGITTAL HEIGHT
X (mm)	Y (mm)	(mm)	X (mm)	Y (mm)	(mm)	X (mm)	Y (mm)	(mm)
202.6	0.0	14.6	199.6	0.0	14.1	207.6	0.0	15.3
202.6	10.0	14.6	199.6	10.0	14.2	207.6	10.0	15.3
202.6	20.0	14.7	199.6	20.0	14.3	207.6	20.0	15.4
202.6	30.0	14.9	199.6	30.0	14.4	207.6	30.0	15.6
202.5	40.0	15.1	199.5	40.0	14.7	207.5	40.0	15.8
202.5	50.0	15.4	199.5	50.0	15.0	207.4	50.0	16.1
202.5	60.0	15.8	199.4	60.0	15.4	207.4	60.0	16.5
202.4	70.0	16.3	199.4	70.0	15.8	207.4	70.0	17.0
202.3	80.0	16.8	199.3	80.0	16.4	207.3	80.0	17.5
202.2	90.0	17.4	199.2	90.0	17.0	207.2	90.0	18.1
202.1	100.0	18.1	199.1	100.0	17.6	207.1	100.0	18.8
202.0	110.0	18.8	199.0	110.0	18.4	207.0	110.0	19.6
201.9	120.0	19.7	198.4	120.0	19.2	206.9	120.0	20.4
201.7	130.0	20.6	198.7	130.0	20.1	206.7	130.0	21.3
201.6	140.0	21.6	198.6	140.0	21.1	206.6	140.0	22.3
201.5	150.0	22.6	198.5	145.0	21.6	206.5	150.0	23.4
201.4	151.1	22.7	198.5	148.1	22.0	206.4	156.0	24.1
200.0	151.1	22.5	195.0	148.2	21.5	200.0	156.1	23.1
190.0	151.3	21.1	190.0	148.3	20.7	190.0	156.3	21.6
180.0	151.4	19.7	180.0	148.4	19.4	180.0	156.4	20.3
170.0	151.6	18.4	170.0	148.6	18.1	170.0	156.6	19.0
160.0	151.8	17.3	160.0	148.8	16.9	160.0	156.8	17.8
150.0	151.9	16.2	150.0	148.9	15.8	150.0	156.9	16.7
140.0	152.0	15.1	140.0	149.0	14.8	140.0	157.0	15.7
130.0	152.1	14.2	130.0	149.1	13.9	130.0	157.1	14.8
120.0	152.3	13.3	120.0	149.3	13.0	120.0	157.3	13.9
110.0	152.4	12.6	110.0	149.4	12.2	110.0	157.4	13.1
100.0	152.5	11.8	100.0	149.5	11.5	100.0	157.5	12.4
90.0	152.5	11.2	90.0	149.5	10.9	90.0	157.5	11.8
80.0	152.6	10.7	80.0	149.6	10.3	80.0	157.6	11.2
70.0	152.7	10.2	70.0	149.7	9.8	70.0	157.7	10.7
60.0	152.7	9.7	60.0	149.7	9.4	60.0	157.7	10.3
50.0	152.8	9.4	50.0	149.8	9.1	50.0	157.8	10.0
40.0	152.8	9.1	40.0	149.8	8.8	40.0	157.8	9.7
30.0	152.9	8.9	30.0	149.9	8.6	30.0	157.9	9.5
20.0	152.9	8.7	20.0	149.9	8.4	20.0	157.9	9.3
10.0	152.9	8.7	10.0	149.9	8.3	10.0	157.9	9.3
0.0	152.9	8.6	0.0	149.9	8.3	0.0	157.9	9.2

3.9 Cone contour



Dimensions in mm.

Fig.20 Maximum cone contour.

Cone contour data

SECTION	NOMINAL DISTANCE FROM SECTION 1 (mm)	MAXIMUM DISTANCE FROM TUBE AXIS (mm)										
		0°	10°	20°	30°	36.87°	40°	50°	60°	70°	80°	90°
1	0.0	225.7	228.9	239.1	257.6	271.8	267.2	227.9	203.1	187.9	179.6	177.0
2	10.0	224.6	227.7	237.7	255.9	270.0	265.3	226.7	201.9	186.8	178.6	175.9
3	20.0	221.8	224.8	234.3	251.1	264.3	259.6	222.9	198.9	184.2	176.1	173.5
4	30.0	218.1	220.9	229.6	244.5	254.7	250.6	217.9	195.1	180.9	173.1	170.6
5	40.0	213.8	216.4	224.1	236.5	243.1	239.6	212.0	190.9	177.3	169.9	167.5
6	50.0	208.7	211.0	217.7	227.5	231.3	228.4	205.6	186.3	173.6	166.5	164.2
7	60.0	202.6	204.5	210.0	217.5	219.5	217.0	198.5	181.0	169.3	162.6	160.5
8	70.0	195.1	196.8	201.3	206.9	207.6	205.4	190.3	175.1	164.4	158.3	156.3
9	80.0	186.2	187.6	191.4	195.6	195.4	193.5	181.3	168.4	158.9	153.3	151.5
10	90.0	175.6	176.9	180.1	183.3	182.8	181.1	171.4	160.7	152.5	147.6	146.0
11	100.0	163.6	164.6	167.4	169.9	169.2	167.9	160.4	151.9	145.2	141.0	139.6
12	110.0	150.3	151.3	153.8	155.7	154.7	153.6	147.9	141.7	136.6	133.4	132.3
13	120.0	136.4	137.3	139.3	140.4	139.5	138.6	134.5	130.3	126.8	124.6	123.9
14	130.0	122.1	122.8	124.4	124.9	124.0	123.3	120.7	118.2	116.1	114.7	114.3
15	140.0	107.5	107.7	108.2	108.6	108.4	108.2	107.0	105.7	104.5	103.8	103.5
16	150.0	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

4 APPLICATION CONDITIONS

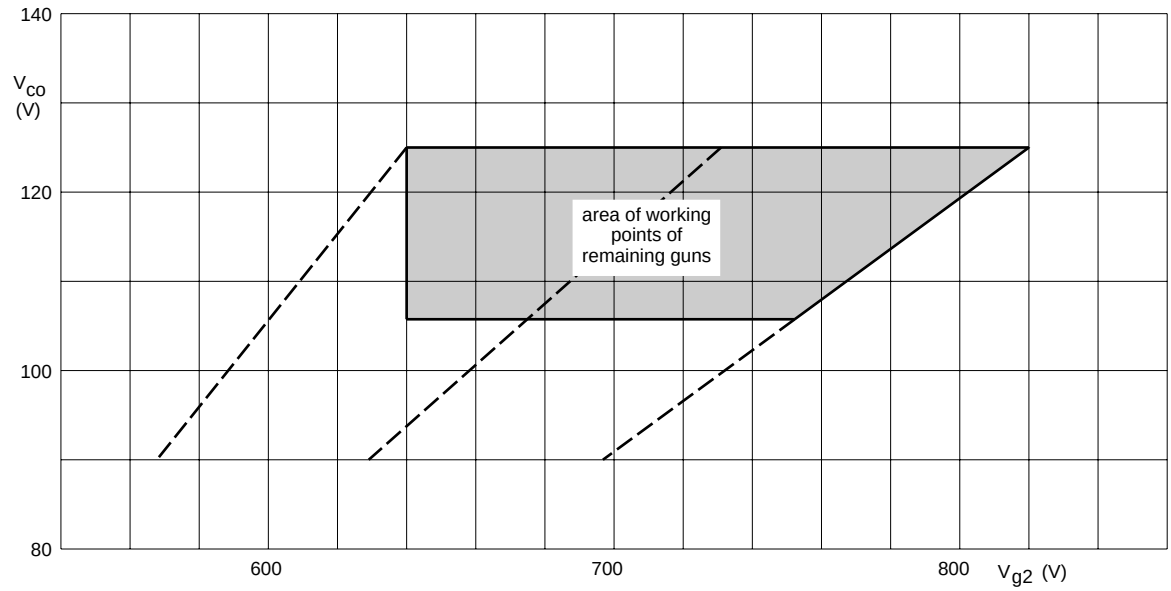
4.1 Recommended adjustment and operating conditions

The voltages are applied to each gun and are measured with respect to grid 1; RH = 40% to 60%; tube facing east; local magnetic field: 0.03 mT vertical, 0.00 mT lateral, 0.00 mT axial. Pre-heat the tube for 15 minutes minimum before tests. Avoid misconvergence, distortion etc. due to stray magnetic fields and chassis influences.

SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNIT
$V_{a,g4}$	anode voltage	–	27.5	–	kV
V_{g3a}	grid 3a (static focus electrode) voltage as a percentage of the anode voltage; note 1	23	–	27	%
V_{g3b}	grid 3b (dynamic focus electrode) voltage				
	DC voltage as a percentage of the anode voltage	23	–	27	%
	horizontal parabola	–	300	–	V
	vertical parabola	–	150	–	V
V_{g2}	grid 2 voltage at a spot cut-off voltage V_{co} = 125 V; note 2	see Fig.21			V
V_f	heater voltage	–	6.15 (3)	-	V
f_H	horizontal sweep frequency	–	30 to 110	–	kHz
f_V	vertical sweep frequency	–	60 to 80	–	Hz
T_{amb}	ambient temperature	–	25	–	°C

Notes

1. Focus adjustment procedure:
   a) Adjust anode current for 750 cd/m^2.
   b) Adjust for optimum focus at $^2/_3$ centre-corner.
2. Grid 2 adjustment procedure:
   a) Grid 2 voltage (V_{g2}) adjusted for highest gun spot cut-off voltage: V_{co} = 125 V.
   b) Remaining guns adjusted for spot cut-off by means of cathode voltage.
   c) V_{g2} range: 640 V to 820 V at V_{co} = 125 V.
   d) Set the cathode voltage (V_k) for each gun at 125 V; increase the grid 2 voltage (V_{g2}) from ≈400 V to the value at which the spot of the gun with the lowest (V_{g2}) cut-off voltage becomes just visible, then decrease the cathode voltage of the remaining guns until the other gun beams become just visible.
3. For maximum cathode life it is recommended that the heater voltage is regulated at 6.15 V.



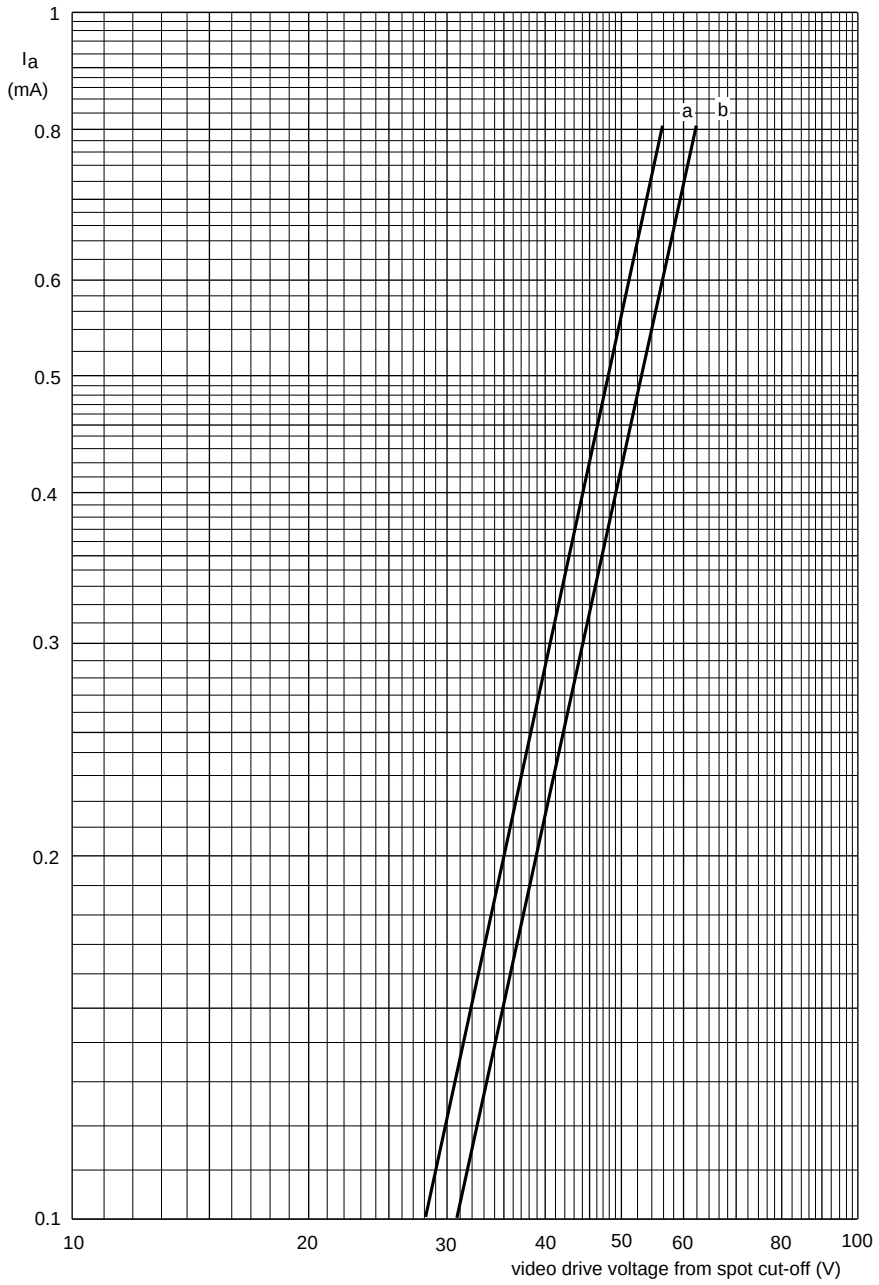
The voltages are specified with respect to grid 1.

Fig.21 Spot cut-off design chart.

4.2 Chassis design values

The values are valid for anode voltages between 20 and 29.9 kV. The voltages are specified with respect to grid 1.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
V_{g3a}	grid 3a (static focus voltage) as a percentage of anode voltage		23	–	27	%
V_{g3b}	grid 3b (dynamic focus voltage) as a percentage of anode voltage	raster size = 312 × 234 mm				
	DC voltage as a percentage of anode voltage		23	–	27	%
	horizontal parabola		–	300	–	V
	vertical parabola		–	150	–	V
ΔV_{g3a}	difference in focus voltage between red, green and blue guns when separately focused		–	–	300	V
ΔV_{g3a-b}	difference between the static focus voltage and dynamic focus voltage		–	–	500	V
V_{g2}	grid 2 voltage	for visual extinction of focused spot	see Fig.21			
V_k	cathode voltage		see Figs 21 and 22			
ΔV_k	difference in cut-off voltage between guns in any tube (cathodes cut-off ratio)		highest value <1.18 × lowest value			
V_f	heater voltage	at zero beam current	–	6.15	–	V
I_{g3a}	focus current	under cut-off conditions	–3	–	+3	µA
I_{g3b}	focus current	under cut-off conditions	–3	–	+3	µA
I_{g2}	grid 2 current	under cut-off conditions	–2	–	+2	µA
I_{g1}	grid 1 current	under cut-off conditions	–5	–	+5	µA
I_{kf}	cathode/heater current	V_{co} = 125 V	–5	–	+5	µA
Resistance						
R_{kgf}	insulation resistance between each cathode and all other electrodes and heater		50	–	–	MΩ
R_{g2}	grid 2 circuit impedance		1	–	70	MΩ
R_{g3}	grid 3 circuit impedance		–	–	70	MΩ



V_{co} = 100 V (curve a).
V_{co} = 125 V (curve b).

Fig.22 Typical cathode drive characteristics.

4.3 Limiting values

In accordance with the Absolute Maximum Rating System (IEC 60134). Voltages are specified with respect to grid 1.

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
$V_{a,g4}$	anode voltage	note 1	20(2)	29.9(3)	kV
I_{ap}	anode current for each gun (peak value)		–	550	μA
I_a	long-term average anode current for each gun		–	400	μA
I_a	long-term average anode current for three guns		–	1100	μA
V_{g3a}	grid 3a (focus) voltage		–	10	kV
V_{g3b}	grid 3b (focus) voltage		–	10	kV
$\Delta V_{g3a-g3b}$	grid 3 (focus) differential voltage		–	1	kV
V_{g2p}	grid 2 voltage, including video signal voltage (peak value)		–	1000	V
V_f	heater voltage	note 4	5.7	6.6(3)	V
Cathode voltage					
V_k	positive	operating	–	200	V
		operating cut-off	–	135	V
V_k	negative		–	0	V
V_{kp}	negative peak		–	–2	V
Cathode to heater voltage					
V_{kf}	positive		–	250	V
V_{kfp}	positive peak		–	300(3)	V
V_{kf}	negative		–	0	V
V_{kfp}	negative peak		–	-50	V

Notes

1. 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 the picture tube.
2. Operation of the tube at lower voltages impairs the luminance and resolution and could impair the convergence.
3. This value is an absolute maximum.
4. For maximum cathode life it is required that the heater supply is designed for 6.15 V at zero beam current. Heater source impedance should have a minimum value of 2 Ω (maximum current during switching on is 700 mA).

4.4 Flashover protection

With the high voltage used with this tube (max. 29.9 kV) internal flashovers may occur. As a result of Soft-Flash technology these flashover currents are limited to approximately 60 A offering higher 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 in accordance with Fig.23; 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 focus electrode (g3a and g3b) of 11 kV and at the other electrodes of 1.5 to 2 kV, both at an atmospheric pressure of 100 kPa.

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.

To guarantee the soft flash behaviour, the internal dynamic resistance of the tube during flashover is minimal 200 Ω.

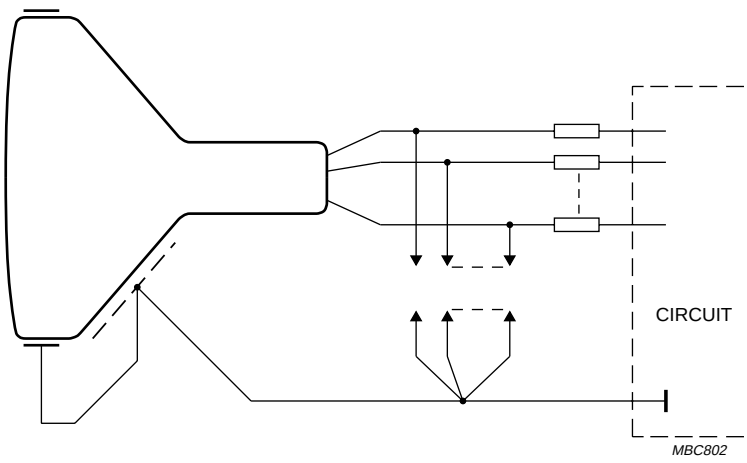


Fig.23 Flashover protection circuit.

5 ERGONOMIC AND ENVIRONMENTAL DATA

5.1 X-radiation

Maximum anode voltage at which the X-radiation emitted will not exceed 0.5 mR/h at an anode current of 300 μA.

PARAMETER	TYP.	UNIT
Entire tube; note 1	37	kV

Note

1. 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 iso-exposure-rate limit curve and the iso-exposure-rate limit curve for the entire tube.

WARNING
The tube will satisfy the European Community permitted limit of 1 μSv/h, when driven within the maximum published operating conditions.
Maximum voltage difference between anode and focus electrode at which the X-radiation will not exceed 0.5 mR/h is given in Fig.25.
If this voltage can be exceeded in the monitor, additional attenuation of the X-radiation may be required.
The X-radiation emitted from this picture tube, as measured in accordance with the procedure of *"TEPAC PublicationsNo.EIA501"* will not exceed 0.5 mR/h throughout the useful life of the tube 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 iso-exposure-rate limit characteristics as shown in Fig.25.
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 *"Federal Register Volume 38, No. 198,b Monday, October 15, 1973"*.
Maximum X-radiation as a function of anode voltage at 300 μA current is shown by Fig.24. X-radiation at a constant anode voltage varies linearly with anode current.

WARNING
The cathode ray tube is intrinsically safe in accordance with *"Appendix III Röntgenverordnung"*.
Eigensichere Kathodenstrahlröhre nach *"Anlage III Röntgenverordnung"*.

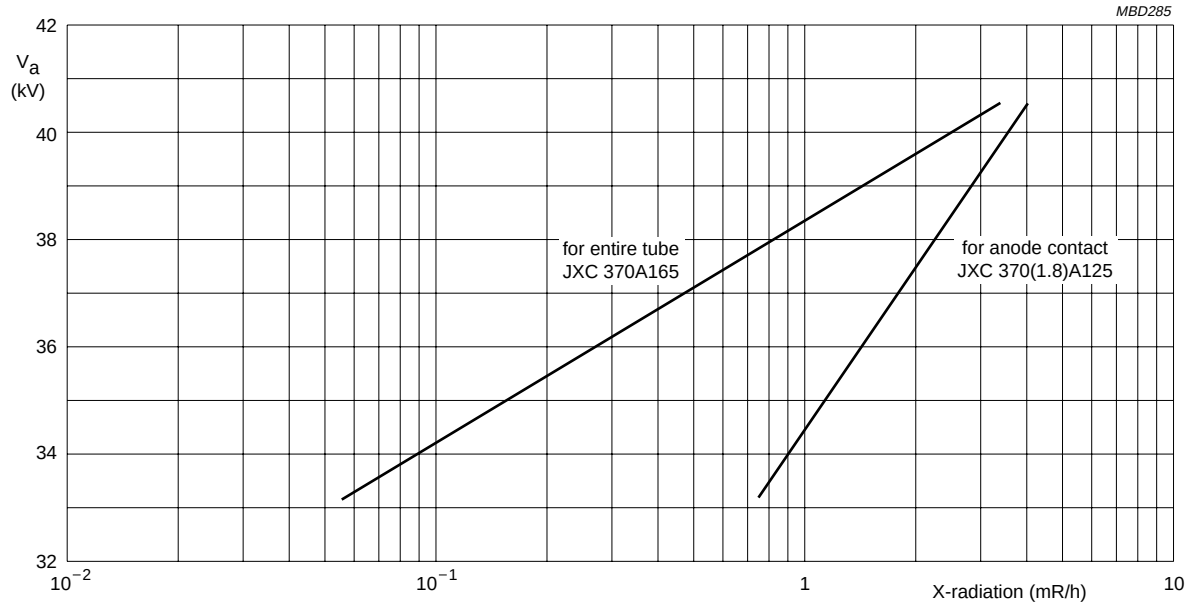


Fig.24 X-radiation limit curves at a constant anode current of 300 μA.

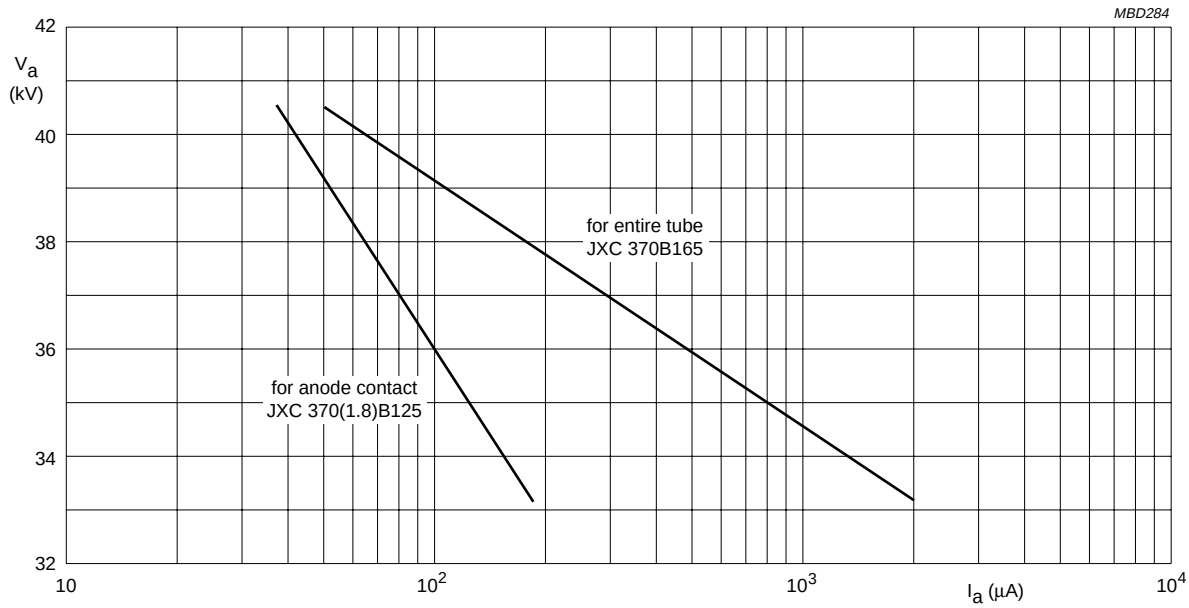
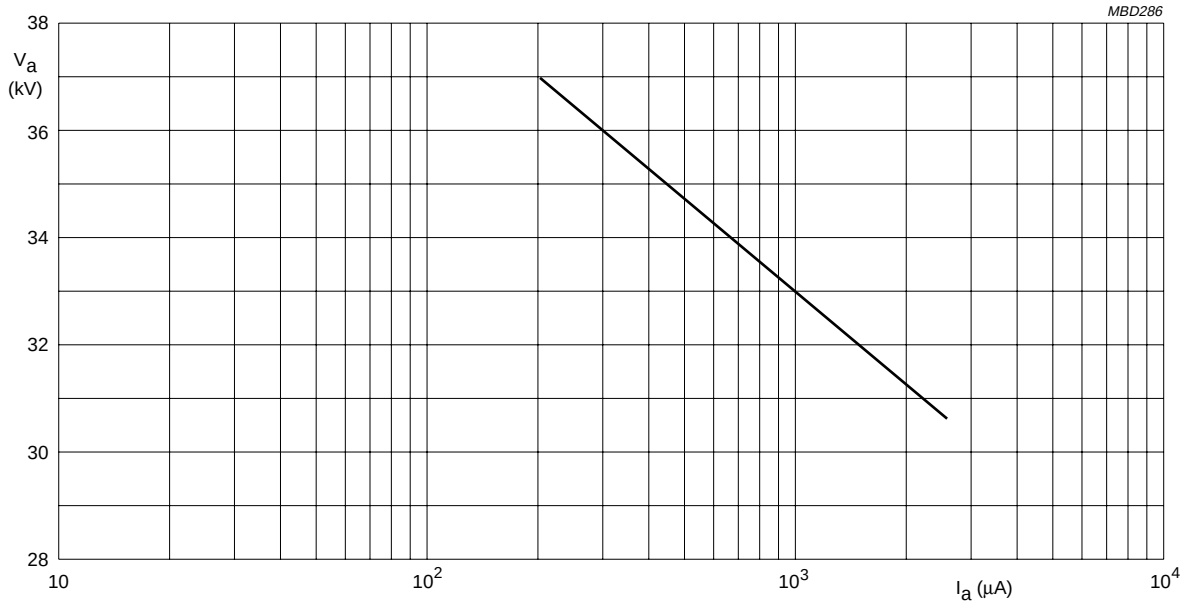


Fig.25 0.5 mR/h iso-exposure-rate limit curves.



The X-radiation emitted will also not exceed 1 μSv/h for anode voltage and current combinations shown in the iso-exposure-rate limit curve according to Eigensichere Kathodenstrahlröhre nach *"Anlage III Röntgenverordnung"*.

Fig.26 1 μSv/h iso-exposure-rate limit curve.

5.2 Warnings

X-radiation
Operation of the monochrome monitor tube under abnormal conditions that exceed the 0.5 mR/h iso-exposure-rate curve shown in Fig.25 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 values stated in Section 4.3 are not exceeded.
Tube replacement
This monitor tube incorporates integral X-radiation and implosion protection and must be replaced with a tube of the same type number or 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 taken during replacement or servicing of the monitor tube since a residual electrical charge may be held by the high-voltage capacitor formed by the external and internal conductive coatings of the monitor 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.

5.3 Handling

The packaging provides protection against tube damage under normal conditions of shipment or handling. Observe any instructions given on the packaging and handle accordingly. Under no circumstances should the tube assembly be subjected to accelerations greater than the values given in Table “Accelerations”.

Accelerations

PARAMETER	CONDITIONS	MAX.	UNIT
Pulse in cone direction	≤10 ms	350	m/s^2
	30 ms	200	m/s^2
Pulse in all other directions	30 ms	350	m/s^2

Monitor tubes should be kept in the shipping box or similar protective container prior to installation.

Although monitor tubes are provided with integral implosion protection which meets the intrinsic safety requirements stipulated in the relevant part of IEC 60065, care should be taken not to scratch or knock any part of the tube. Particularly care should be taken to prevent damage to the seal area.

In all handling procedures prior to insertion in the cabinet, there is a risk of personal injury if severe accidental damage to the tube occurs. It is therefore recommended that in areas containing unpacked and unprotected tubes, protective clothing is worn, particularly, gloves and safety glasses with side-shields to prevent possible injury from flying glass in the event of such an accident.
Handle the tube with extreme care. Do not strike, scratch or subject the tube to more than moderate pressure.

The tube assembly should never be handled by the tube neck, deflection unit or other neck components.

If suspending the tube assembly from the mounting lugs, ensure that a **minimum of two** are used.
Under no circumstances suspend the tube assembly from one lug.

An alternative lifting method is to firmly grasp the assembly by the vertical sides of the rimband. Manually lifting the assembly from the face-down or face-up position is shown in Figs 27 and 28.

To protect the screen when placing the tube face-down, ensure that the tube face rests on a cushion kept free from abrasive substances.

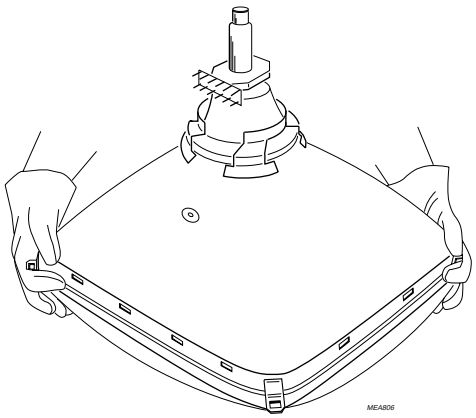


Fig.27 Lifting tube from face-down position.

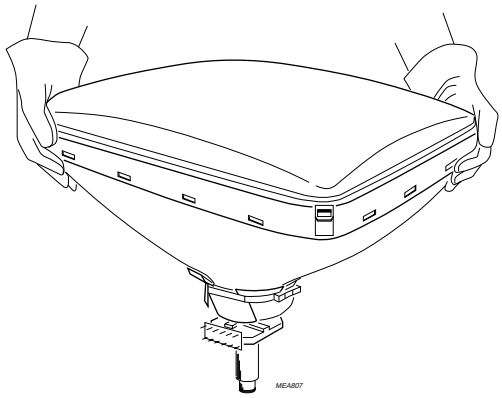


Fig.28 Lifting tube from face-up position.

5.4 Environmental conditions

The tube assembly must be capable of meeting the requirements of this specification under/after the following environmental conditions.

5.4.1 AMBIENT TEMPERATURE

- Tube operating +10 °C to +53 °C
- Storage and shipment –20 °C to +60 °C with a thermal shock up to 24 °C
- 50% relative humidity at either limit with the tube assembly inside the shipping container.

5.4.2 RELATIVE HUMIDITY

- Operating 8% to 80%
- Storage and shipment 5% to 100% (including condensation, but excluding rain).

5.4.3 BAROMETRIC PRESSURE

- Operating and storage 769 hPa to 1060 hPa
- Shipment 91 hPa to 1060 hPa.

5.4.4 WET BULB TEMPERATURE

- Operating maximum 26.7 °C
- Storage and shipment 29.4 °C.

6 DEFINITIONS

Data sheet status	
Objective specification	This data sheet contains target or goal specifications for product development.
Preliminary specification	This data sheet contains preliminary data; supplementary data may be published later.
Product specification	This data sheet contains final product specifications.
Limiting values	
Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 60134). Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only and operation of the device at these or at any other conditions above those given in the Characteristics sections of the specification is not implied. Exposure to limiting values for extended periods may affect device reliability.	

7 LIFE SUPPORT APPLICATIONS

These products are not designed for use in life support appliances, devices, or systems where malfunction of these products can reasonably be expected to result in personal injury. PDS customers using or selling these products for use in such applications do so at their own risk and agree to fully indemnify PDS for any damages resulting from such improper use or sale.

PDS

Professional Display Systems B.V.

Professional Display Systems B.V.

Jan Campertstraat 5

6416 SG Heerlen

The Netherlands

Tel: +31 (0)45 5439312

Fax: +31 (0)45 5426458

E-mail : info@crt.nl

Internet : www.professionaldisplaysystems.nl

DATA SHEET

M51EDF40WB11/04

21" high resolution triple gun monochrome monitor tube assembly

Product specification

2004 May 22

Professional Display Systems B.V.

21" high resolution triple gun monochrome monitor tube assembly

M51EDF40WB11/04

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21" high resolution triple gun monochrome monitor tube assembly

M51EDF40WB11/04

1 HIGHLIGHTS

1.1 Features

1.1.1 HIGH PERFORMANCE DESIGN

- High resolution; higher pixel density up to 1600 × 1280 pixels (non-interlaced) displayable conform ISO 9241 by:
  - 'larger' effective screen area: 377 mm × 285 mm
  - high resolution in-line electron polygon DAF triple gun(1)
- High brightness and contrast:
  - anti reflection antistatic panel
- Excellent uniformity
- Accurate convergence and raster geometry:
  - double mussel coil technology
  - internal magnetostatic beam alignment
  - charge drift compensation
  - optional additional north-south raster correction circuitry available
- Application-friendly design:
  - worldwide useable design
  - East-West correction max. 10%
  - horizontal balance coil; vertical balance potentiometer
  - deflection units designed for minimal ringing
  - optional rotation coil for adjustment of axial magnetic fields
  - up to and including 110 kHz horizontal frequency
  - static convergence adjustments (multipole for 4 and 6 pole correction) on monitor level.

1.1.2 ERGONOMIC DESIGN

- Less ambient reflection:
  - 'flat' and 'square' design
  - ARAS (Anti Reflection Anti Static) panel
- Less eye strain:
  - P45 medium-persistence white phosphor
  - high frequency yokes
- Green design:
  - CFC-free production process
  - Cd-free phosphor
  - 0.65 W Cermet © power saving cathodes
- Fulfils electric/magnetic radiation standards
- Safety approved:
  - VDE; CSA; UL.

1.1.3 OPTIMUM DISPLAY SOLUTION

- High-end PC applications
- Workstation applications
- Resolution standards up to 1600 × 1280 pixels non-interlaced applications.

1.2 Quick reference data

PARAMETER	TYP.	UNIT
Deflection angle	90	deg
Face diagonal	51	cm
Overall length	<454.4	mm
Neck diameter	29.4	mm
Glass transmission	43	%
Colour co-ordinates		
x	244	
y	309	
Brightness	750	cd/m^2
Heater voltage	6.15	V
Focus voltage	25% of anode voltage	
Anode voltage	27.5	kV

1.3 Deflection coil data

Deflection coil is mounted with dynamic convergence correction coils (PECOMA).

PARAMETER	VALUE	UNIT
Horizontal coil inductance	0.092	mH
Vertical coil inductance	4.4	mH
Maximum advised frequency	110	kHz

1.4 Ordering information

TYPE NUMBER	SCREEN FINISH	LUG DISTANCE
M51EDF40WB11/04	ARAS panel	42.5 mm

(1) Whenever in this data sheet the words 'red', 'green' and 'blue' are used, with respect to the guns, the guns are meant as in an equivalent colour monitor tube.

2 PERFORMANCE SPECIFICATION

2.1 Colour coordinates

PHOSPHOR DATA	COLOUR COORDINATES	
	x	y
Phosphor type: P45 (N 1045) $I_{a(av)}$ = 300 μA (per gun) V_a = 27.5 kV Scanned duty cycle = 75% Scanned area = 312 × 234 mm Screen finish ARAS	244±10	309±10

2.2 Brightness uniformity

Brightness uniformity between centre and corners: >80%; <110%.

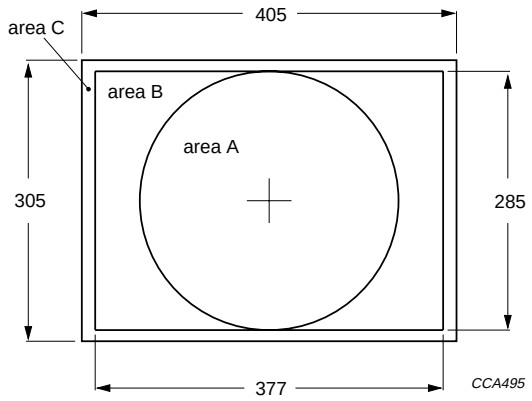
2.3 Convergence specification

2.3.1 TEST CONDITIONS

1. Set-up in accordance with Section 4.1.
2. Measure maximum misconvergence after 30 minutes operation.
3. To be adjusted for focus at $^2/_3$ centre-corner using crosshatch pattern at anode current is 300 μA (peak value) per gun.
4. Misconvergence is the distance between the centres of the red, green and blue guns at the screen using a crosshatch pattern.
5. Anode and/or focusing voltage and terrestrial magnetism may slightly affect the static convergence. Therefore, small re-adjustments to static convergence may be necessary.
6. Avoid stray magnetic fields etc. due to chassis influences which may affect convergence.

2.3.2 CONVERGENCE LIMITS

LOCATION (see Fig.1)	TYPE OF ERROR	MAXIMUM ERROR BETWEEN GUN SPOTS	
		STANDARD	WITH PECOMA
Centre	red-green-blue gun line separation in either the horizontal or vertical direction	0.30 mm	0.2 mm
Area A/corner		0.50 mm	0.2 mm



Dimensions in mm.

Fig.1 Maximum misconvergence.

2.4 Resolution specification

With the settings given in Section 4.1, the 50% spot value is as listed below.
Measured within raster of 377 mm × 285 mm.

ANODE CURRENT	SPOT SIZE CENTRE (NOMINAL)		SPOT SIZE CORNER (NOMINAL)		UNIT
	X	Y	X	Y	
100 μA.	0.4	0.4	0.6	0.4	mm
200 μA	0.5	0.5	0.6	0.5	mm
400 μA	0.6	0.6	0.7	0.5	mm

2.5 Raster geometry

2.5.1 RASTER CENTRING

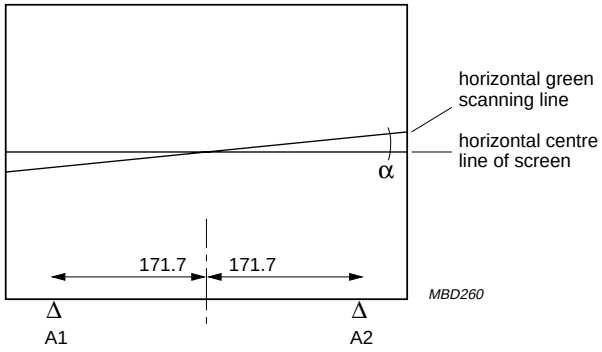
CENTRING	MAX.	UNIT
Horizontal	±5.5	mm
Vertical	±5.5	mm

2.5.2 RASTER ORTHOGONALITY

Orthogonality of the horizontal/vertical scan axis is ±0.5°.

2.5.3 RASTER ROTATION

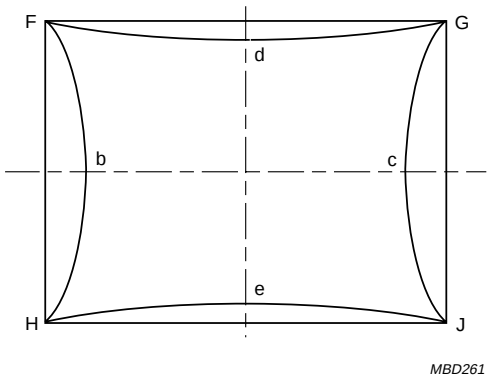
Measure the angle of the horizontal green scanning line with reference to a horizontal centre line that is drawn parallel to the tube reference points A1 and A2, see Fig.2. Chassis influences may affect raster rotation.



$\alpha \leq 0.3°$

Fig.2 Rotation measurement.

2.5.4 PIN-CUSHION DISTORTION



FG = HJ = 377 mm.
FH = GJ = 285 mm.
Measured with no pin-cushion correction applied, with 'b', 'c', 'd' and 'e' measured along the main axis.

Fig.3 Pin-cushion distortion.

2.5.5 DISTORTION NORTH - SOUTH

The following formulae define the pin-cushion distortion in the north and south directions.

$$\text{North} = \frac{4d}{FH + GJ} \times 100\% = 0\% \text{ to } +1.3\%$$

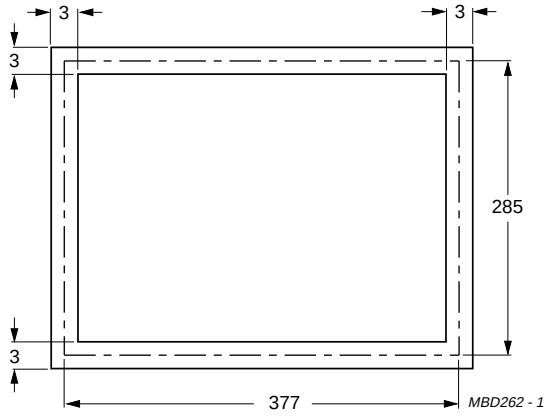
$$\text{South} = \frac{4e}{FH + GJ} \times 100\% = 0\% \text{ to } +1.3\%$$

2.5.6 DISTORTION EAST - WEST

The following formulae define the pin-cushion distortion in the east and west directions.

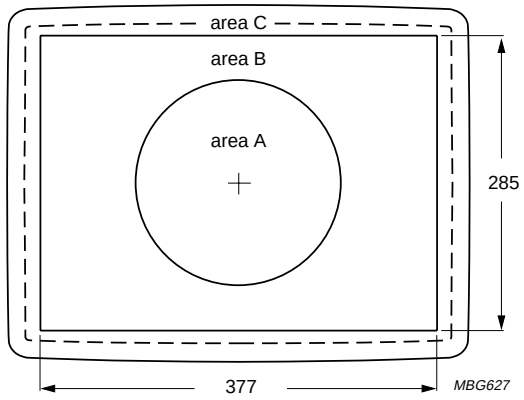
$$\text{East} = \frac{4b}{FG + HJ} \times 100\% \leq 10\%$$

$$\text{West} = \frac{4c}{FG + HJ} \times 100\% \leq 10\%$$



Dimensions in mm.

Fig.4 General distortion.



Dimensions in mm.

Fig.5 Screen areas.

2.6 Screen quality

2.6.1 GENERAL TEST PROCEDURE

Tests are to be done under the following general conditions:

- Viewing distance should be 50 cm minimum.
- For an activated screen the diffuse ambient light level at the centre of the screen should be between 2 and 5 lux.
- For an unactivated screen the diffuse ambient light level at the centre of the screen should be between 700 and 1000 lux.
- The viewing angle relative to the tube axis should not exceed 45°.
- Faults not visible under these general conditions are permitted.
- The following quality areas are specified (see Fig.5):
  - Area A: a circular area with a diameter of 200 mm, of which the centre coincides with the mechanical centre of the screen.
  - Area B: the area between the edge of area A and the rectangular area measuring 377 mm × 285 mm, of which the centre coincides with the mechanical centre of the screen.
  - Area C: the area between the edge of area B and the rimband.

2.6.2 ASSESSMENT OF THE GLASS AND THE UNACTIVATED SCREEN QUALITY

2.6.2.1 Definition of blemishes

Unless otherwise specified, the shape of a blemish is defined as round and elliptical.

The size of a blemish is given by:

- $\frac{L + W}{2}$; if L > 3W the size is given by $\frac{L}{20} + 2W$,

  where L = length and W = width.

2.6.2.2 Limits

Table 1 Limits of measurable glass blemishes

SIZE (mm)	MAX. NUMBER OF BLEMISHES IN AREAS		MIN. PERMISSIBLE DISTANCE BETWEEN ANY TWO BLEMISHES (mm)	AREA C
	A	A + B		
>0.6	0	0	not applicable	only limits as regards tube safety
>0.4 to ≤0.6	1	2	50	
>0.2 to ≤0.4	2	5	50	
Total number	2	5	50	–
≤0.2	limited only by cloud			–

Table 2 Limits of measurable coating blemishes for ARAS coating

SIZE (mm)	MAX. NUMBER OF BLEMISHES IN AREA A+B	MIN. PERMISSIBLE DISTANCE BETWEEN ANY TWO BLEMISHES (mm)	AREA C
High contrast			
>1.5	0	not applicable	acceptable
>1.0 to ≤1.5	3	50	
>0.5 to ≤1.0	5	30	
≤0.50	no limits	no limits	
Low contrast			
>3.0	0	not applicable	acceptable
>1.0 to ≤3.0	5	30	
≤1.0	no limits	no limits	

Table 3 Limits of scratches

AREA	WIDTH (mm)	MAX. ALLOWABLE TOTAL LENGTH (mm)	MIN. SEPARATION (mm)
A+B	>0.15	0	not permitted
	>0.10 to ≤0.15	13	50
	>0.05 to ≤0.10	25	20
	≤0.05	no limits	not applicable
C	only as regards tube safety		

2.6.3 ASSESSMENT OF THE QUALITY OF THE ACTIVATED PHOSPHOR SCREEN

The assessment of the quality of the phosphor and matrix layer at area A should take place at typical operating conditions and a blanked raster. The current for each gun must be adjusted to a brightness of 200 cd/m^2.

2.6.3.1 Definition of blemishes

- A blemish is a fault which is clearly visible within 5 seconds.
- A defect, which looks visually as one blemish should be regarded as a single blemish.
- Unless otherwise specified, the shape of a blemish is defined as round and elliptical.

The size of a blemish is given by:

- $\frac{L+W}{2}$; if L > 3W the size is given by $\frac{L}{20} + 2W$,

  where L = length and W = width.

2.6.3.2 Limits

1. The distance between any two blemishes >0.2 mm should be >50 mm.
2. Maximum number of blemishes >0.2 mm per screen is 9.
3. Blemishes ≤0.2 mm can be ignored, except for a concentration of such blemishes that has a diameter of more than 8 mm.

Table 4 Limits of blemishes

BLEMISH SIZE (mm)	MAXIMUM NUMBER OF BLEMISHES IN		
	AREA A	AREA B	AREA A + B
>0.6	0	0	0
>0.4 to ≤0.6	1	5	5
>0.2 to ≤0.4	4	6	9
≤0.2	limited only by cloud		

2.7 Coating performance

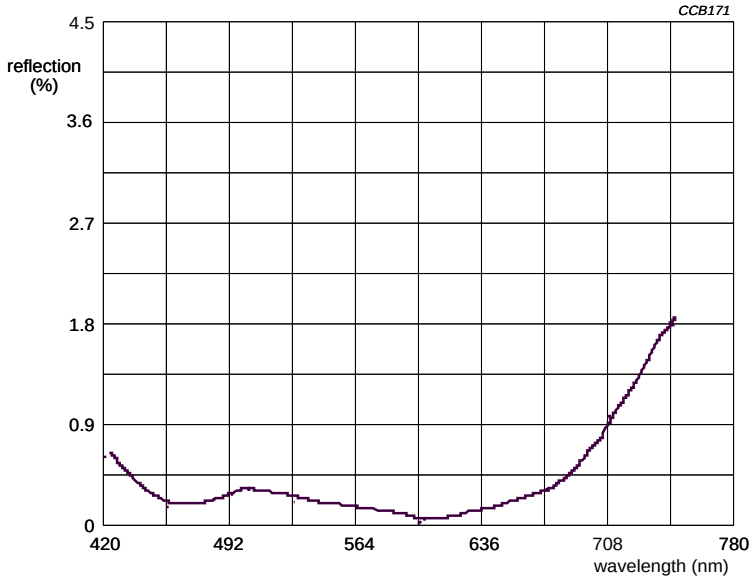


Fig.6 Relative reflection for ARAS.

3 PRODUCT CHARACTERISTICS

3.1 Electrical data

SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNIT
Capacitances					
$C_{a(m+m')}$	anode to external conductive cone coating, including rimband (with and without screen coating)	1000	1300	1600	pF
C_k	cathodes of all guns, connected in parallel, to all other electrodes	–	10	15	pF
C_{kR}, C_{kG}, C_{kB}	cathode of any gun to all other electrodes	–	4	–	pF
C_{g1}	grid 1 of any gun to all other electrodes	–	15	–	pF
C_{g2}	grid 2 to all other electrodes	–	10	–	pF
C_{g3a}	grid 3a (focus electrode) to all other electrodes	–	12	–	pF
C_{g3b}	grid 3b (dynamic focus electrode) to all other electrodes	–	17	–	pF
$C_{(g3a-g3b)}$	grid 3a to grid 3b	–	9	–	pF
Heater					
V_f	heater voltage	–	6.15		V
I_f	heater current	295	315	335	mA
t_{kwu}	cathode warm up time at 0-hour from 10% to 80% of end emission	–	–	8	s
Deflection unit					
V_{max}	maximum permissible DC voltage				
	between horizontal and vertical coils	–	–	2000	V
	between vertical coils and core	–	–	300	V
R_{ins}	insulation resistance at 1 kV (DC)				
	between horizontal and vertical coils	500	–	–	MΩ
	between horizontal coil and core clamping ring	500	–	–	MΩ
	between vertical coil and core clamping ring	10	–	–	MΩ
	crosstalk (1 V applied to the horizontal coils)	–	–	30	mV

3.2 Deflection unit data

All values are valid at T_{amb} = 25 °C and V_a = 27.5 kV; deflection units fulfil the MPRII and TCO magnetic requirements (see Section 5.1); the deflection coil is designed for a positive pulse on the horizontal coil.

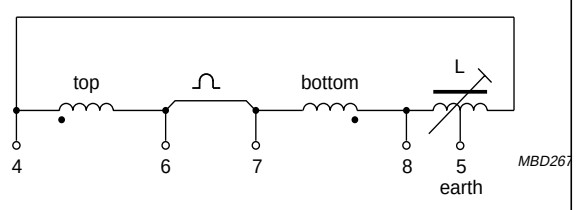
PARAMETER	VALUE	TOLERANCE	UNIT
Advised frequency; notes 1 and 2	110	–	kHz
Horizontal deflection coil			
Inductance	0.092	±4%	mH
Resistance	0.15	±10%	Ω
Current (peak-to-peak value)	13.5	±4%	A
Used wire	litz	–	
Vertical deflection coil			
Inductance	4.4	±4%	mH
Resistance	4.50	±7%	Ω
Current (peak-to-peak value)	1.81	±5%	A
Used wire	litz	–	

Notes

1. Advised maximum frequency depends on the internal maximum set temperature and used deflection-overscan.
2. No annoying ringing with 0% overscan.

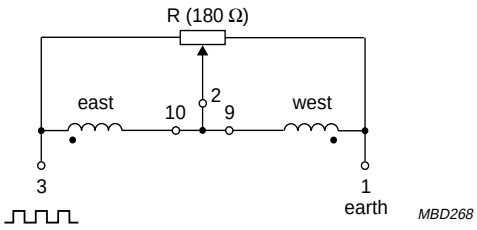
Rotation coil data

PARAMETER	CONDITION	MIN.	TYP.	MAX.	UNIT
Resistance	T_{amb} = 20 °C	50.9	56.6	62.3	Ω
Sensitivity	I = 75 mA; V_a = 27.5 kV	–	0.95	–	deg



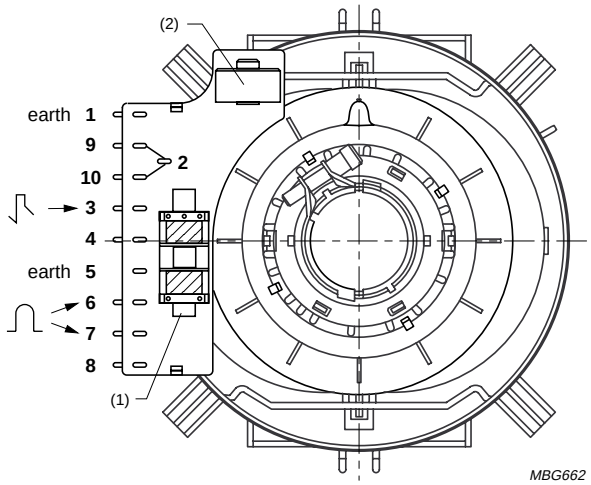
The beginning of the windings is indicated with •

Fig.7 Horizontal coils.



The beginning of the windings is indicated with •

Fig.8 Vertical coils.

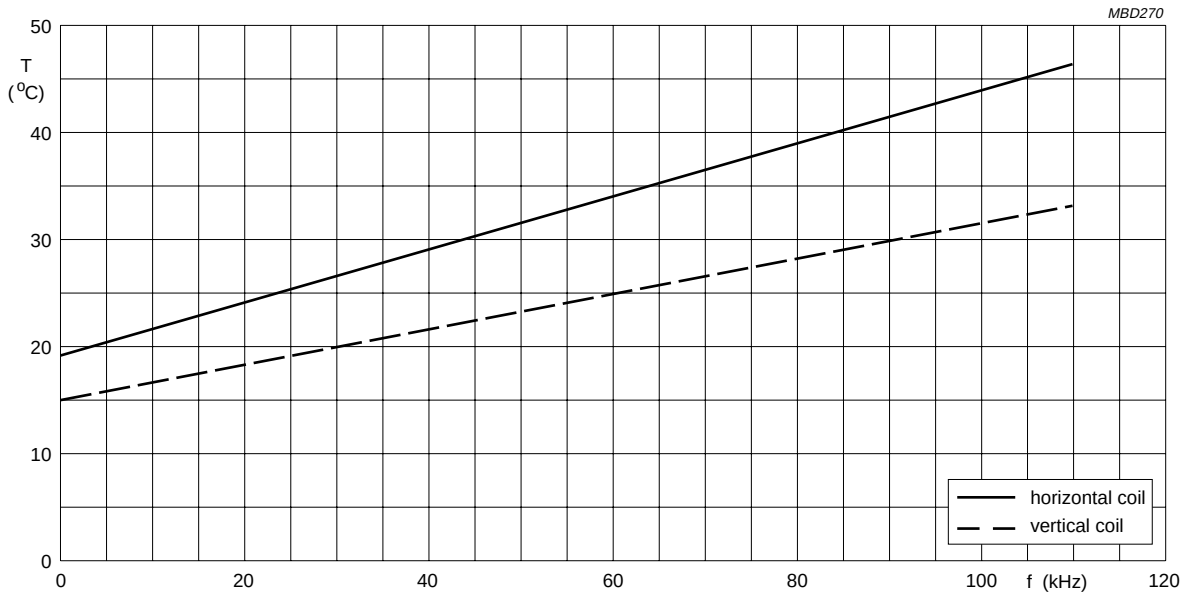


(1) Horizontal balance coil.
(2) Vertical balance potentiometer.

Fig.9 Deflection coil connections.

3.2.1 DEFLECTION UNIT TEMPERATURE

SYMBOL	PARAMETER	MAX.	UNIT
T_{copper}	average copper temperature of horizontal coil	110	°C
ΔT	maximum temperature rise of used wire	50	°C



Maximum operating copper temperature (resistance measurement) is 110 °C.

Fig.10 Temperature rise as a function of frequency.

3.3 Electro optical data

PARAMETER	VALUE
Electron gun system	three in-line integrated guns
Focus method	electrostatic
Focus lens	polygon and DAF
Convergence method	magnetic
Deflection method	self converging
Deflection angle	
diagonal	≈90°
horizontal	≈78°
vertical	≈60°

3.4 Screen properties

PARAMETER	VALUE
Screen finish	ARAS
Light transmission at screen centre	28 %
Recommended active screen area	
horizontal axis at a 1600 × 1280 pixels screen	377 mm
vertical axis at a 1600 × 1280 pixels screen	285 mm

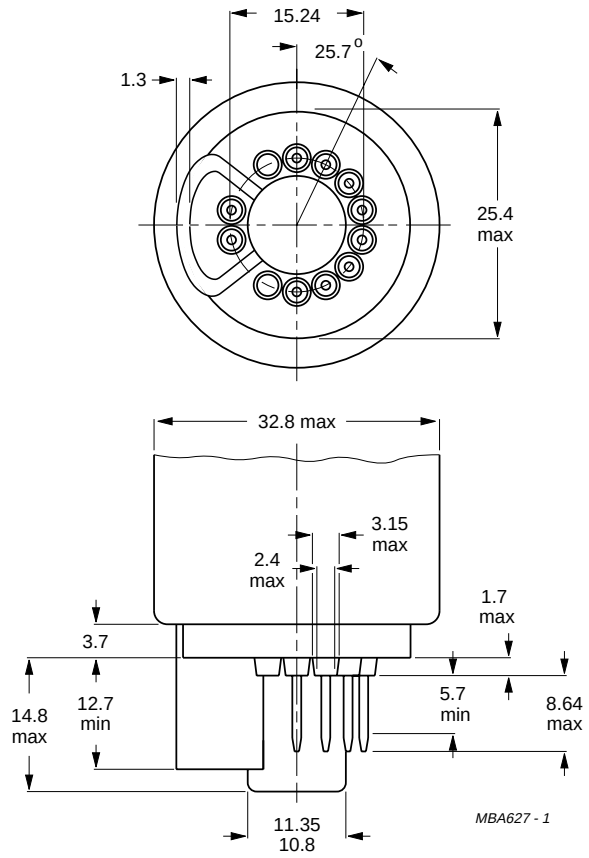
3.5 Coating properties

TYPE NUMBER	SCREEN FINISH	Reflection
M51EDF40WB11/04	Anti Reflection Anti Static (ARAS) < 500 Ohm/#	< 2.2%

3.6 Mechanical tube data

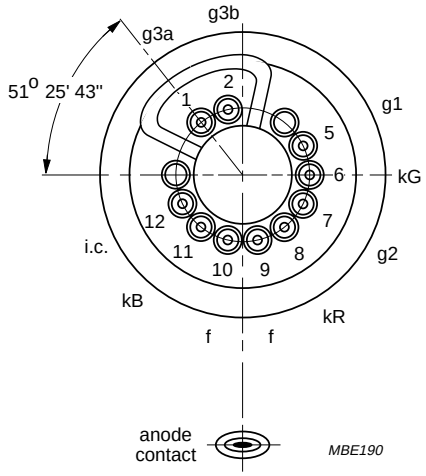
PARAMETER	VALUE
Overall length	452.9 ±6.5 mm
Neck diameter	29.4 +0.6/–0.4 mm
Maximum dimensions, excluding mounting lugs but including rimband	
diagonal	553.5 mm
width	470.0 mm
height	374.0 mm
Implosion protection	pre-stressed banded Mini-P shrunk-on rimband; CSA, UL and VDE approved
Anode contact	JEDEC J1-21; IEC 60067-III-2
Base designation	JEDEC B10-301
Base pin configuration	see Fig.12
Mass	≈15 kg
Mounting position	anode contact on top

3.7 Mechanical tube drawings



Dimensions in mm.

Fig.11 Base JEDEC B10-301.



i.c. = internally connected and not to be used.

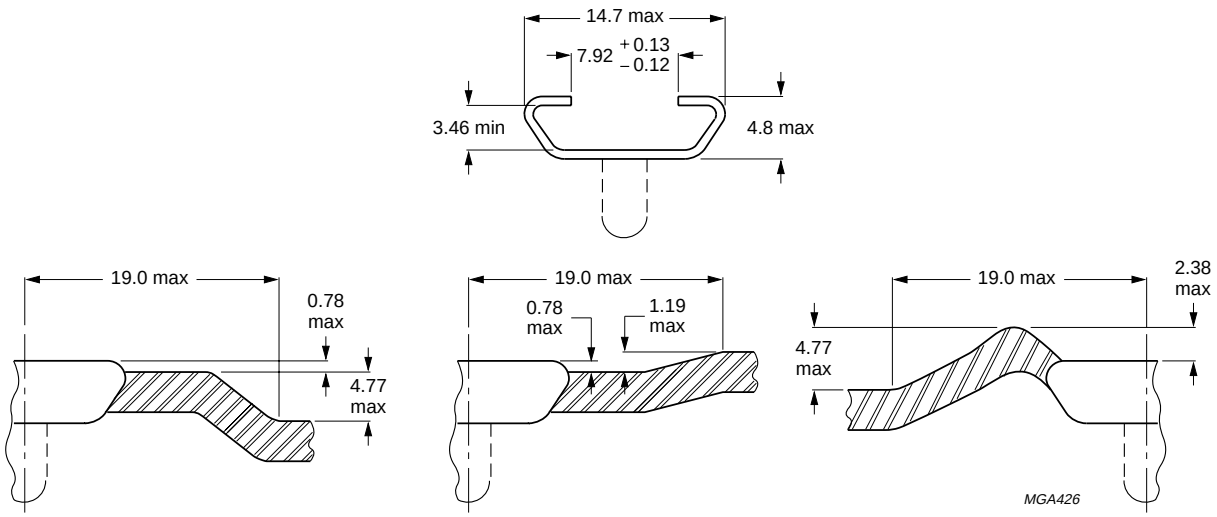
Fig.12 Pin arrangement.

Remarks: to Figs 11 and 12.

The socket for this base should not be rigidly mounted, it should have flexible leads and be allowed to move freely. After mounting the tube in the cabinet, note that the position of the base can fall within a circle, having a diameter of max. 40 mm concentric with an imaginary tube axis.

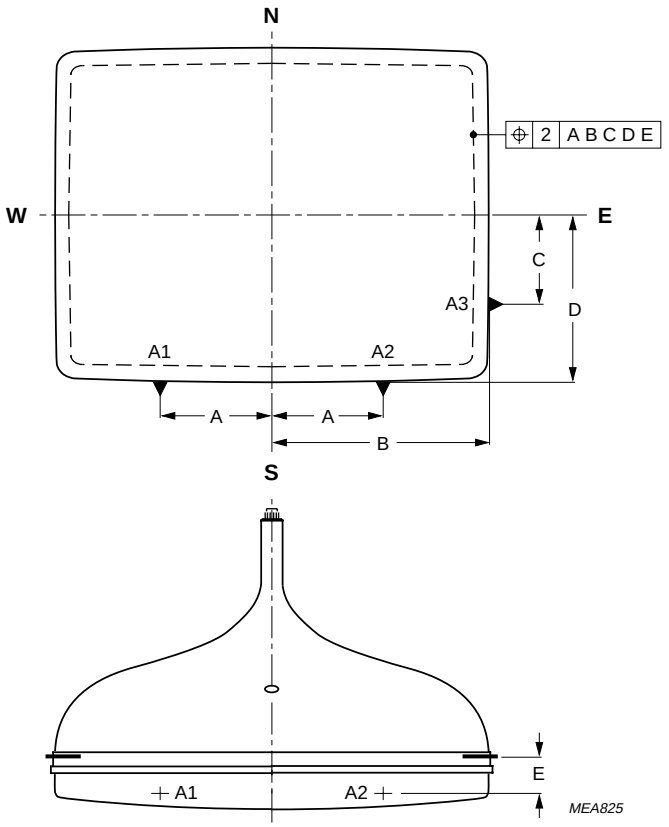
The mass of the mounting socket assembly should not exceed 450 g.

Maximum permissible torque on the tube neck is 0.14 Nm.



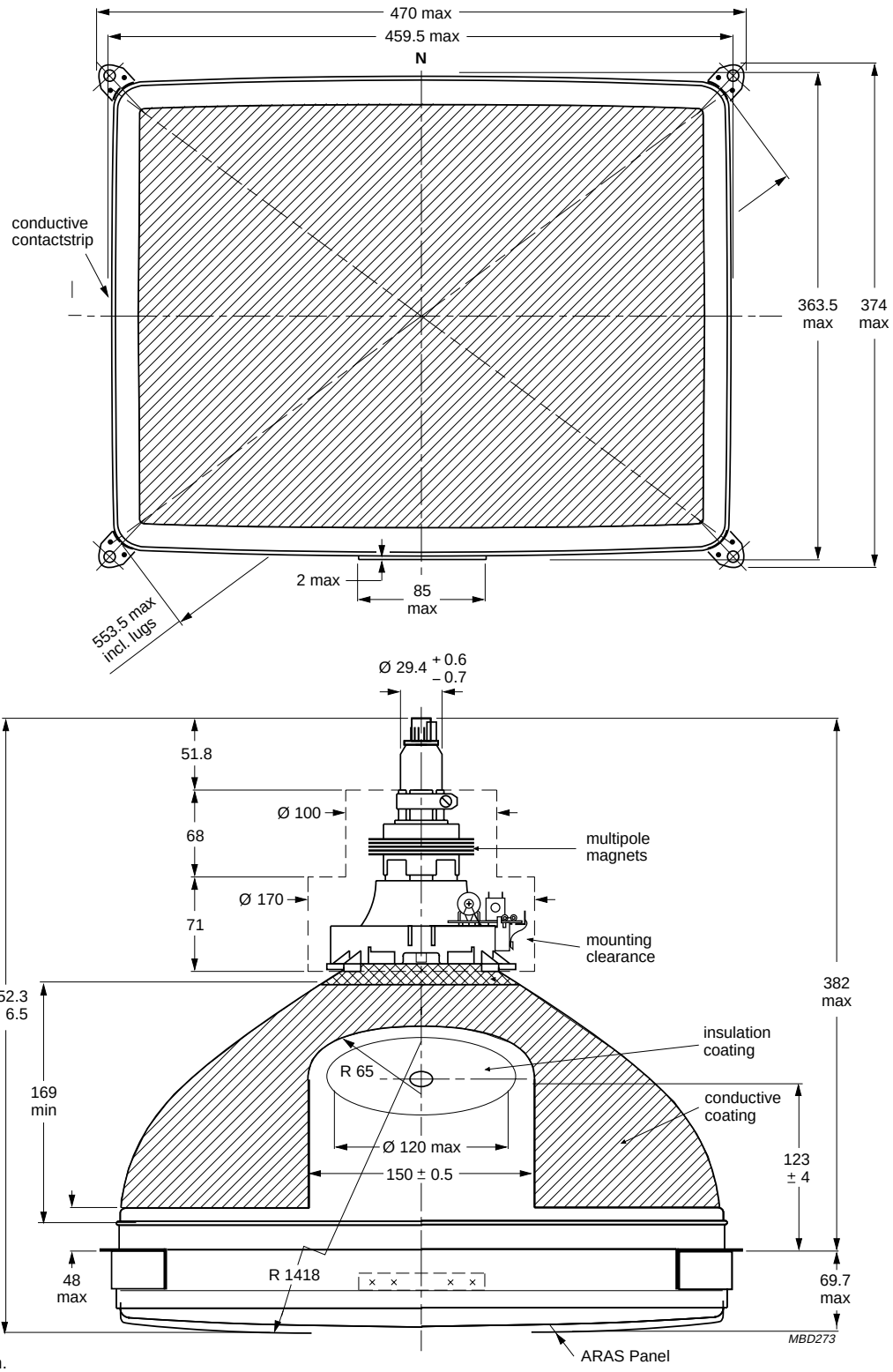
Dimensions in mm.

Fig.13 Cavity cap JEDEC J1-21, IEC 60067-III-2.



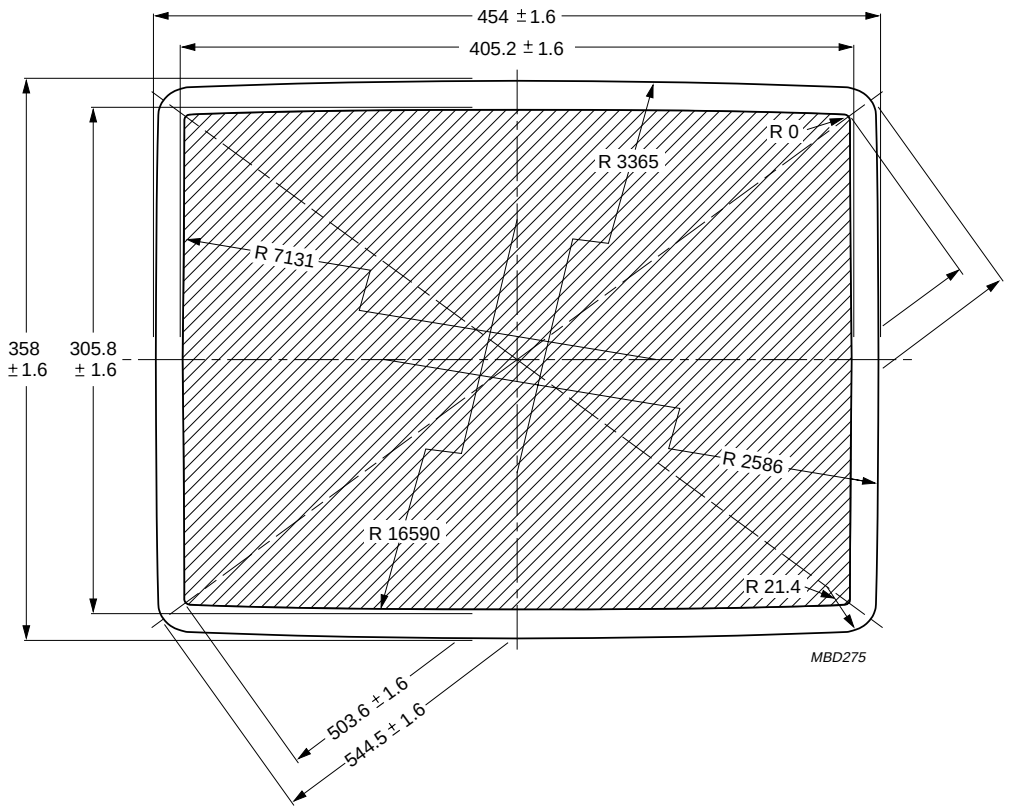
Dimensions in mm.
A = 171.7 mm.
B = 225.1 mm.
C = 115.6 mm.
D = 175.2 mm.
E = 5.1 mm.

Fig.14 Mechanical reference points.



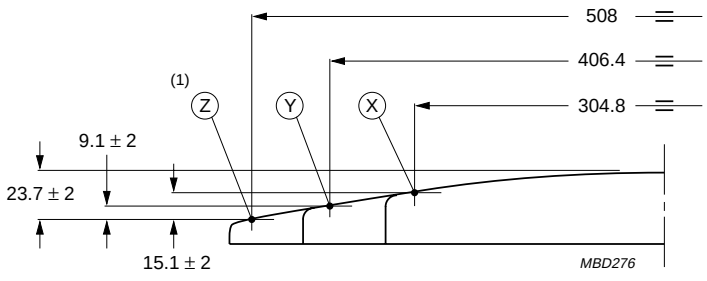
Dimensions in mm.

Fig.15 Top view.



Dimensions in mm.

Fig.16 Screen dimensions.

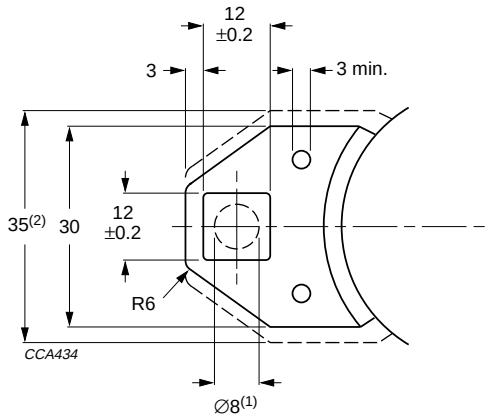


Dimensions in mm.

(1) The X, Y and Z reference points are located on the outside surface of the face plate.

Fig.17 Screen reference points.

3.7.1 LUG DATA

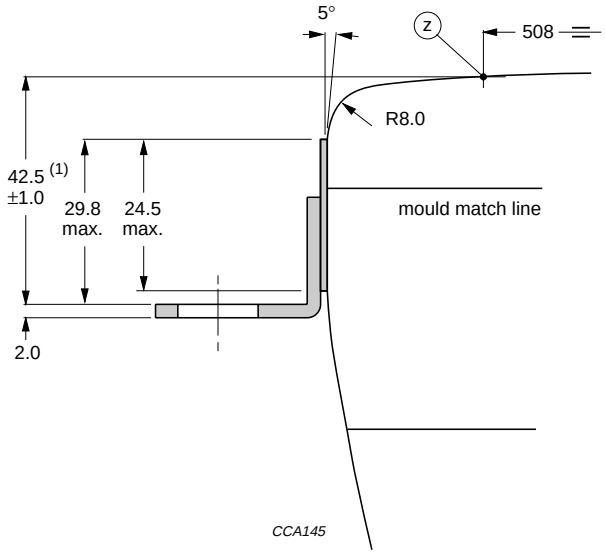


Dimensions in mm.

(1) 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 354.0 mm × 449.0 mm.

(2) Minimum space to be reserved for mounting lug in cabinet.

Fig.18 Lug dimensions.



Dimensions in mm.

(1) The displacement of any lug with respect to the plane through the other 3 lugs is maximum 0.8 mm.

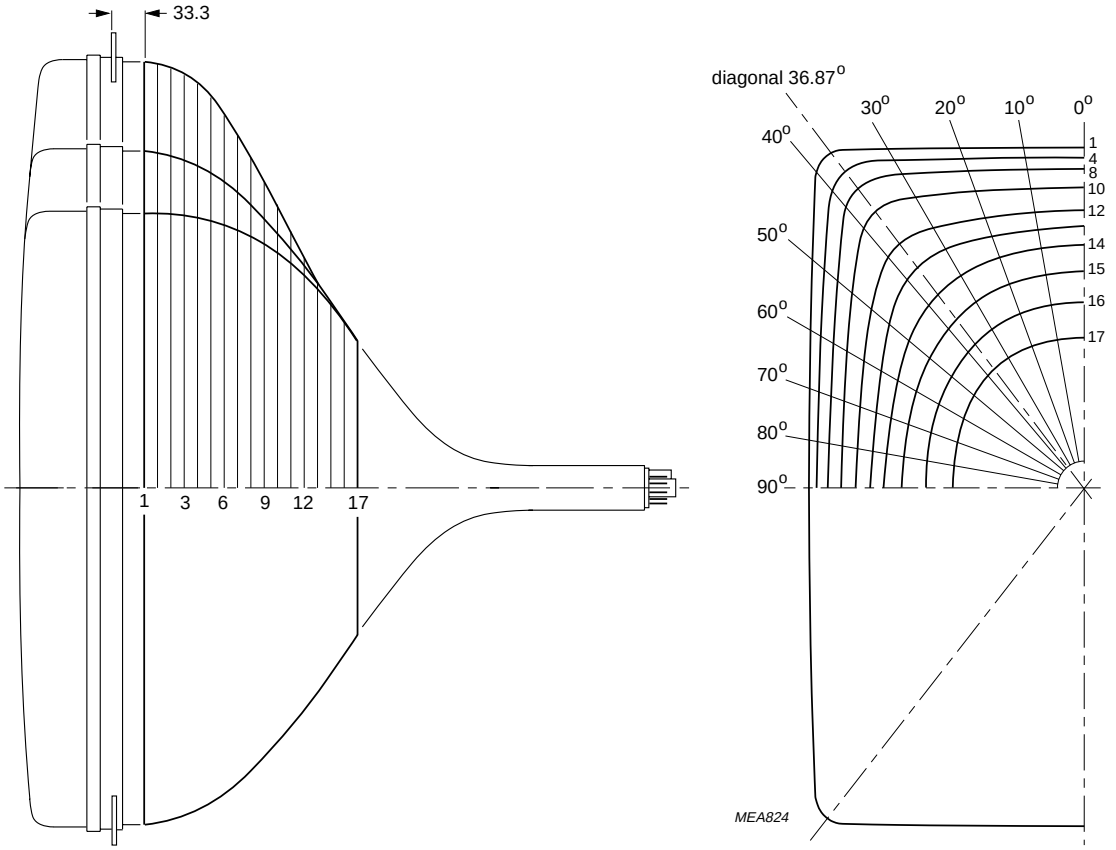
Fig.19 Lug position

3.8 Sagittal heights of screen

Sagittal heights of the nominal useful screen measured with respect to the end of the diagonal axis.

NOMINAL USEFUL SCREEN (NUS)			3 mm INSIDE NUS			5 mm OUTSIDE NUS		
COORDINATES		SAGITTAL HEIGHT	COORDINATES		SAGITTAL HEIGHT	COORDINATES		SAGITTAL HEIGHT
X (mm)	Y (mm)	(mm)	X (mm)	Y (mm)	(mm)	X (mm)	Y (mm)	(mm)
202.6	0.0	14.6	199.6	0.0	14.1	207.6	0.0	15.3
202.6	10.0	14.6	199.6	10.0	14.2	207.6	10.0	15.3
202.6	20.0	14.7	199.6	20.0	14.3	207.6	20.0	15.4
202.6	30.0	14.9	199.6	30.0	14.4	207.6	30.0	15.6
202.5	40.0	15.1	199.5	40.0	14.7	207.5	40.0	15.8
202.5	50.0	15.4	199.5	50.0	15.0	207.4	50.0	16.1
202.5	60.0	15.8	199.4	60.0	15.4	207.4	60.0	16.5
202.4	70.0	16.3	199.4	70.0	15.8	207.4	70.0	17.0
202.3	80.0	16.8	199.3	80.0	16.4	207.3	80.0	17.5
202.2	90.0	17.4	199.2	90.0	17.0	207.2	90.0	18.1
202.1	100.0	18.1	199.1	100.0	17.6	207.1	100.0	18.8
202.0	110.0	18.8	199.0	110.0	18.4	207.0	110.0	19.6
201.9	120.0	19.7	198.4	120.0	19.2	206.9	120.0	20.4
201.7	130.0	20.6	198.7	130.0	20.1	206.7	130.0	21.3
201.6	140.0	21.6	198.6	140.0	21.1	206.6	140.0	22.3
201.5	150.0	22.6	198.5	145.0	21.6	206.5	150.0	23.4
201.4	151.1	22.7	198.5	148.1	22.0	206.4	156.0	24.1
200.0	151.1	22.5	195.0	148.2	21.5	200.0	156.1	23.1
190.0	151.3	21.1	190.0	148.3	20.7	190.0	156.3	21.6
180.0	151.4	19.7	180.0	148.4	19.4	180.0	156.4	20.3
170.0	151.6	18.4	170.0	148.6	18.1	170.0	156.6	19.0
160.0	151.8	17.3	160.0	148.8	16.9	160.0	156.8	17.8
150.0	151.9	16.2	150.0	148.9	15.8	150.0	156.9	16.7
140.0	152.0	15.1	140.0	149.0	14.8	140.0	157.0	15.7
130.0	152.1	14.2	130.0	149.1	13.9	130.0	157.1	14.8
120.0	152.3	13.3	120.0	149.3	13.0	120.0	157.3	13.9
110.0	152.4	12.6	110.0	149.4	12.2	110.0	157.4	13.1
100.0	152.5	11.8	100.0	149.5	11.5	100.0	157.5	12.4
90.0	152.5	11.2	90.0	149.5	10.9	90.0	157.5	11.8
80.0	152.6	10.7	80.0	149.6	10.3	80.0	157.6	11.2
70.0	152.7	10.2	70.0	149.7	9.8	70.0	157.7	10.7
60.0	152.7	9.7	60.0	149.7	9.4	60.0	157.7	10.3
50.0	152.8	9.4	50.0	149.8	9.1	50.0	157.8	10.0
40.0	152.8	9.1	40.0	149.8	8.8	40.0	157.8	9.7
30.0	152.9	8.9	30.0	149.9	8.6	30.0	157.9	9.5
20.0	152.9	8.7	20.0	149.9	8.4	20.0	157.9	9.3
10.0	152.9	8.7	10.0	149.9	8.3	10.0	157.9	9.3
0.0	152.9	8.6	0.0	149.9	8.3	0.0	157.9	9.2

3.9 Cone contour



Dimensions in mm.

Fig.20 Maximum cone contour.

Cone contour data

SECTION	NOMINAL DISTANCE FROM SECTION 1 (mm)	MAXIMUM DISTANCE FROM TUBE AXIS (mm)										
		0°	10°	20°	30°	36.87°	40°	50°	60°	70°	80°	90°
1	0.0	225.7	228.9	239.1	257.6	271.8	267.2	227.9	203.1	187.9	179.6	177.0
2	10.0	224.6	227.7	237.7	255.9	270.0	265.3	226.7	201.9	186.8	178.6	175.9
3	20.0	221.8	224.8	234.3	251.1	264.3	259.6	222.9	198.9	184.2	176.1	173.5
4	30.0	218.1	220.9	229.6	244.5	254.7	250.6	217.9	195.1	180.9	173.1	170.6
5	40.0	213.8	216.4	224.1	236.5	243.1	239.6	212.0	190.9	177.3	169.9	167.5
6	50.0	208.7	211.0	217.7	227.5	231.3	228.4	205.6	186.3	173.6	166.5	164.2
7	60.0	202.6	204.5	210.0	217.5	219.5	217.0	198.5	181.0	169.3	162.6	160.5
8	70.0	195.1	196.8	201.3	206.9	207.6	205.4	190.3	175.1	164.4	158.3	156.3
9	80.0	186.2	187.6	191.4	195.6	195.4	193.5	181.3	168.4	158.9	153.3	151.5
10	90.0	175.6	176.9	180.1	183.3	182.8	181.1	171.4	160.7	152.5	147.6	146.0
11	100.0	163.6	164.6	167.4	169.9	169.2	167.9	160.4	151.9	145.2	141.0	139.6
12	110.0	150.3	151.3	153.8	155.7	154.7	153.6	147.9	141.7	136.6	133.4	132.3
13	120.0	136.4	137.3	139.3	140.4	139.5	138.6	134.5	130.3	126.8	124.6	123.9
14	130.0	122.1	122.8	124.4	124.9	124.0	123.3	120.7	118.2	116.1	114.7	114.3
15	140.0	107.5	107.7	108.2	108.6	108.4	108.2	107.0	105.7	104.5	103.8	103.5
16	150.0	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

4 APPLICATION CONDITIONS

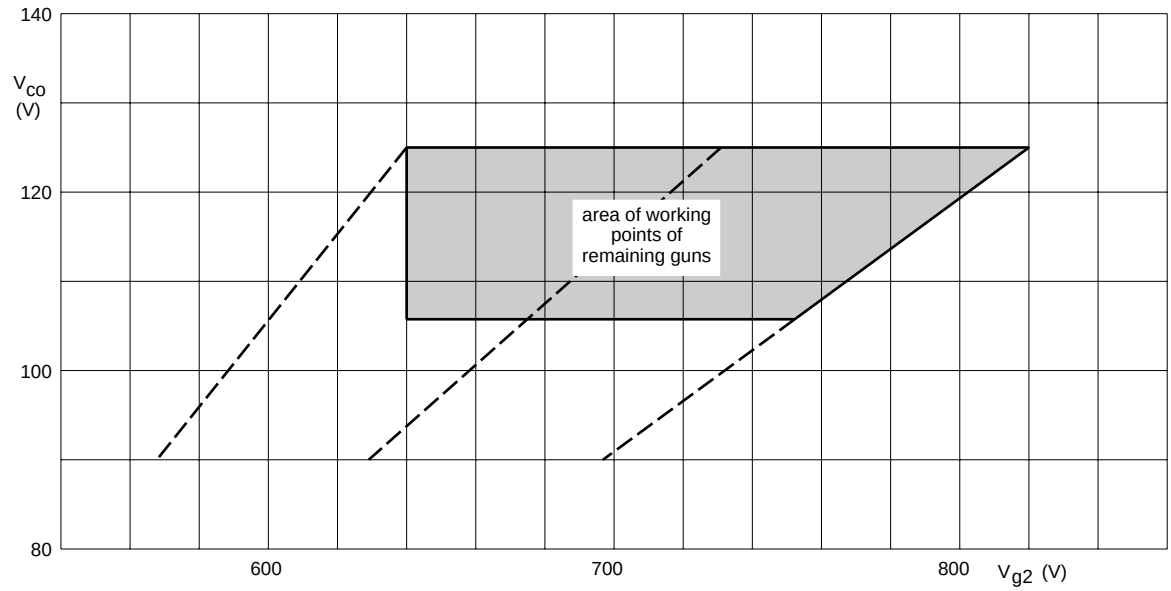
4.1 Recommended adjustment and operating conditions

The voltages are applied to each gun and are measured with respect to grid 1; RH = 40% to 60%; tube facing east; local magnetic field: 0.03 mT vertical, 0.00 mT lateral, 0.00 mT axial. Pre-heat the tube for 15 minutes minimum before tests. Avoid misconvergence, distortion etc. due to stray magnetic fields and chassis influences.

SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNIT
$V_{a,g4}$	anode voltage	–	27.5	–	kV
V_{g3a}	grid 3a (static focus electrode) voltage as a percentage of the anode voltage; note 1	23	–	27	%
V_{g3b}	grid 3b (dynamic focus electrode) voltage				
	DC voltage as a percentage of the anode voltage	23	–	27	%
	horizontal parabola	–	300	–	V
	vertical parabola	–	150	–	V
V_{g2}	grid 2 voltage at a spot cut-off voltage V_{co} = 125 V; note 2	see Fig.21			V
V_f	heater voltage	–	6.15 (3)	-	V
f_H	horizontal sweep frequency	–	30 to 110	–	kHz
f_V	vertical sweep frequency	–	60 to 80	–	Hz
T_{amb}	ambient temperature	–	25	–	°C

Notes

1. Focus adjustment procedure:
   a) Adjust anode current for 750 cd/m^2.
   b) Adjust for optimum focus at $^2/_3$ centre-corner.
2. Grid 2 adjustment procedure:
   a) Grid 2 voltage (V_{g2}) adjusted for highest gun spot cut-off voltage: V_{co} = 125 V.
   b) Remaining guns adjusted for spot cut-off by means of cathode voltage.
   c) V_{g2} range: 640 V to 820 V at V_{co} = 125 V.
   d) Set the cathode voltage (V_k) for each gun at 125 V; increase the grid 2 voltage (V_{g2}) from ≈400 V to the value at which the spot of the gun with the lowest (V_{g2}) cut-off voltage becomes just visible, then decrease the cathode voltage of the remaining guns until the other gun beams become just visible.
3. For maximum cathode life it is recommended that the heater voltage is regulated at 6.15 V.



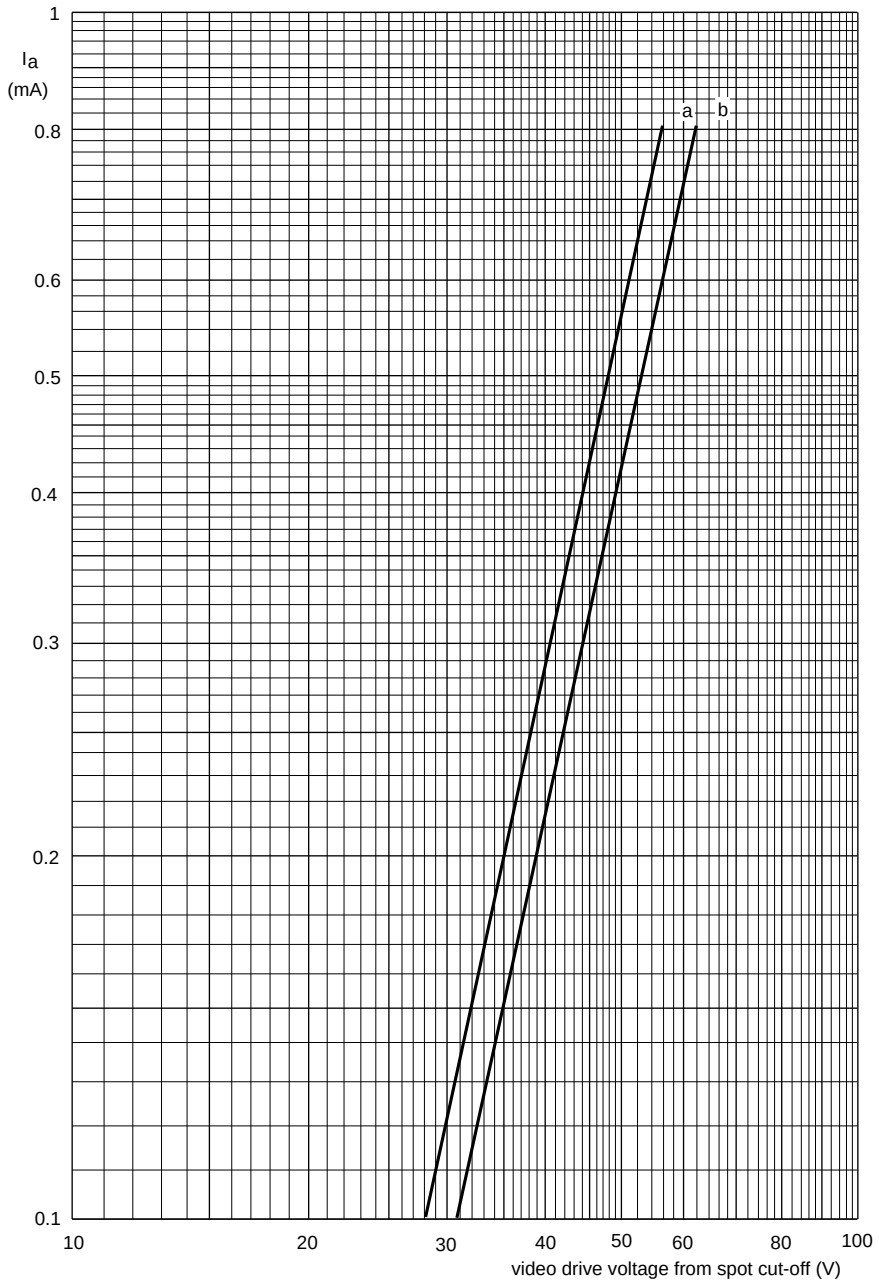
The voltages are specified with respect to grid 1.

Fig.21 Spot cut-off design chart.

4.2 Chassis design values

The values are valid for anode voltages between 20 and 29.9 kV. The voltages are specified with respect to grid 1.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
V_{g3a}	grid 3a (static focus voltage) as a percentage of anode voltage		23	–	27	%
V_{g3b}	grid 3b (dynamic focus voltage) as a percentage of anode voltage	raster size = 312 × 234 mm				
	DC voltage as a percentage of anode voltage		23	–	27	%
	horizontal parabola		–	300	–	V
	vertical parabola		–	150	–	V
ΔV_{g3a}	difference in focus voltage between red, green and blue guns when separately focused		–	–	300	V
ΔV_{g3a-b}	difference between the static focus voltage and dynamic focus voltage		–	–	500	V
V_{g2}	grid 2 voltage	for visual extinction of focused spot	see Fig.21			
V_k	cathode voltage		see Figs 21 and 22			
ΔV_k	difference in cut-off voltage between guns in any tube (cathodes cut-off ratio)		highest value <1.18 × lowest value			
V_f	heater voltage	at zero beam current	–	6.15	–	V
I_{g3a}	focus current	under cut-off conditions	–3	–	+3	µA
I_{g3b}	focus current	under cut-off conditions	–3	–	+3	µA
I_{g2}	grid 2 current	under cut-off conditions	–2	–	+2	µA
I_{g1}	grid 1 current	under cut-off conditions	–5	–	+5	µA
I_{kf}	cathode/heater current	V_{co} = 125 V	–5	–	+5	µA
Resistance						
R_{kgf}	insulation resistance between each cathode and all other electrodes and heater		50	–	–	MΩ
R_{g2}	grid 2 circuit impedance		1	–	70	MΩ
R_{g3}	grid 3 circuit impedance		–	–	70	MΩ



V_{co} = 100 V (curve a).
V_{co} = 125 V (curve b).

Fig.22 Typical cathode drive characteristics.

4.3 Limiting values

In accordance with the Absolute Maximum Rating System (IEC 60134). Voltages are specified with respect to grid 1.

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
$V_{a,g4}$	anode voltage	note 1	20(2)	29.9(3)	kV
I_{ap}	anode current for each gun (peak value)		–	550	μA
I_a	long-term average anode current for each gun		–	400	μA
I_a	long-term average anode current for three guns		–	1100	μA
V_{g3a}	grid 3a (focus) voltage		–	10	kV
V_{g3b}	grid 3b (focus) voltage		–	10	kV
$\Delta V_{g3a-g3b}$	grid 3 (focus) differential voltage		–	1	kV
V_{g2p}	grid 2 voltage, including video signal voltage (peak value)		–	1000	V
V_f	heater voltage	note 4	5.7	6.6(3)	V
Cathode voltage					
V_k	positive	operating	–	200	V
		operating cut-off	–	135	V
V_k	negative		–	0	V
V_{kp}	negative peak		–	–2	V
Cathode to heater voltage					
V_{kf}	positive		–	250	V
V_{kfp}	positive peak		–	300(3)	V
V_{kf}	negative		–	0	V
V_{kfp}	negative peak		–	-50	V

Notes

1. 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 the picture tube.
2. Operation of the tube at lower voltages impairs the luminance and resolution and could impair the convergence.
3. This value is an absolute maximum.
4. For maximum cathode life it is required that the heater supply is designed for 6.15 V at zero beam current. Heater source impedance should have a minimum value of 2 Ω (maximum current during switching on is 700 mA).

4.4 Flashover protection

With the high voltage used with this tube (max. 29.9 kV) internal flashovers may occur. As a result of Soft-Flash technology these flashover currents are limited to approximately 60 A offering higher 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 in accordance with Fig.23; 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 focus electrode (g3a and g3b) of 11 kV and at the other electrodes of 1.5 to 2 kV, both at an atmospheric pressure of 100 kPa.

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.

To guarantee the soft flash behaviour, the internal dynamic resistance of the tube during flashover is minimal 200 Ω.

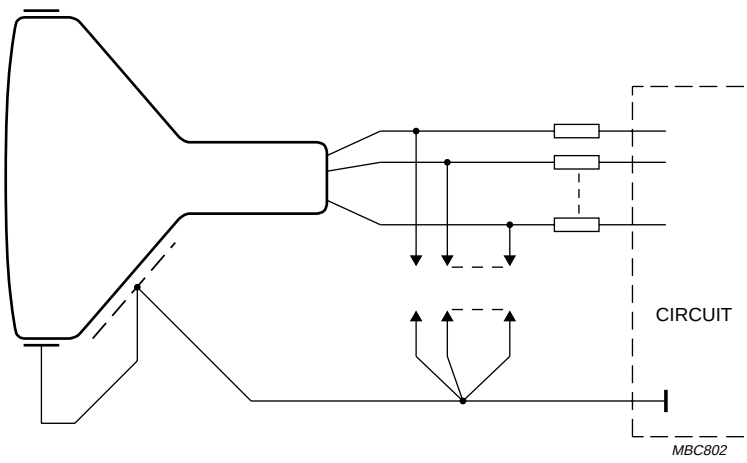


Fig.23 Flashover protection circuit.

5 ERGONOMIC AND ENVIRONMENTAL DATA

5.1 X-radiation

Maximum anode voltage at which the X-radiation emitted will not exceed 0.5 mR/h at an anode current of 300 μA.

PARAMETER	TYP.	UNIT
Entire tube; note 1	37	kV

Note

1. 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 iso-exposure-rate limit curve and the iso-exposure-rate limit curve for the entire tube.

WARNING
The tube will satisfy the European Community permitted limit of 1 μSv/h, when driven within the maximum published operating conditions.
Maximum voltage difference between anode and focus electrode at which the X-radiation will not exceed 0.5 mR/h is given in Fig.25.
If this voltage can be exceeded in the monitor, additional attenuation of the X-radiation may be required.
The X-radiation emitted from this picture tube, as measured in accordance with the procedure of *"TEPAC PublicationsNo.EIA501"* will not exceed 0.5 mR/h throughout the useful life of the tube 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 iso-exposure-rate limit characteristics as shown in Fig.25.
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 *"Federal Register Volume 38, No. 198,b Monday, October 15, 1973"*.
Maximum X-radiation as a function of anode voltage at 300 μA current is shown by Fig.24. X-radiation at a constant anode voltage varies linearly with anode current.

WARNING
The cathode ray tube is intrinsically safe in accordance with *"Appendix III Röntgenverordnung"*.
Eigensichere Kathodenstrahlröhre nach *"Anlage III Röntgenverordnung"*.

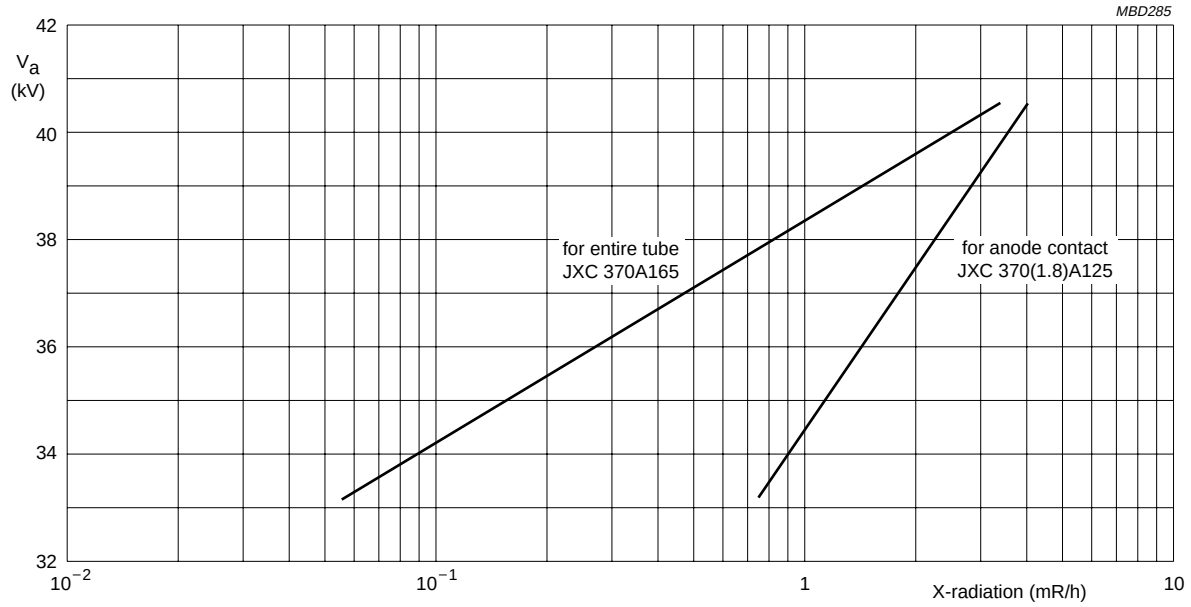


Fig.24 X-radiation limit curves at a constant anode current of 300 μA.

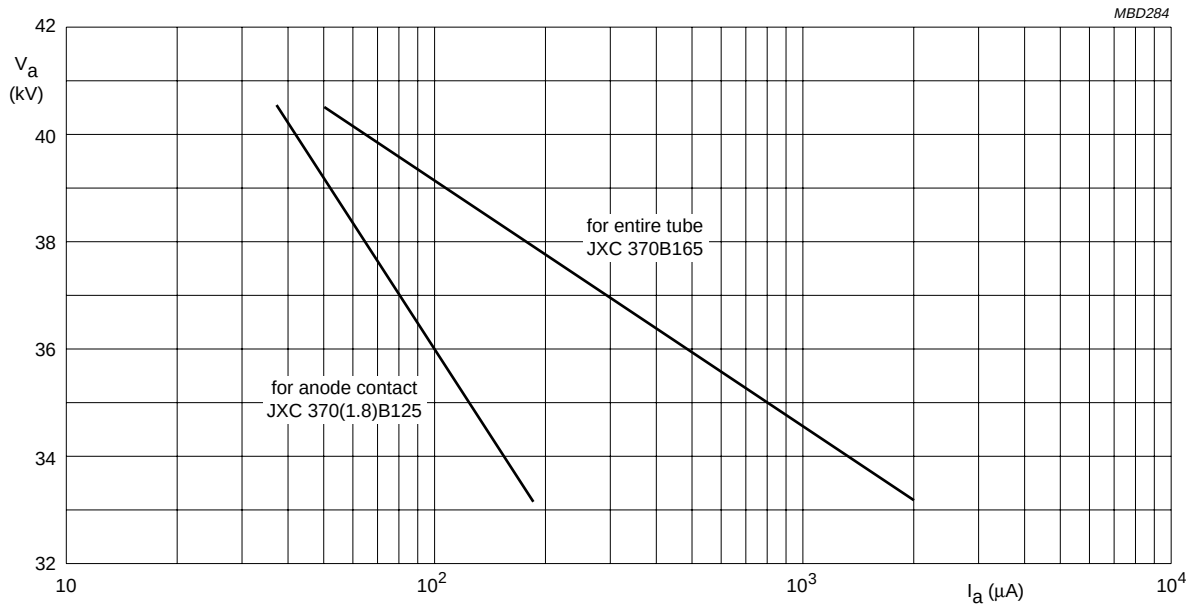
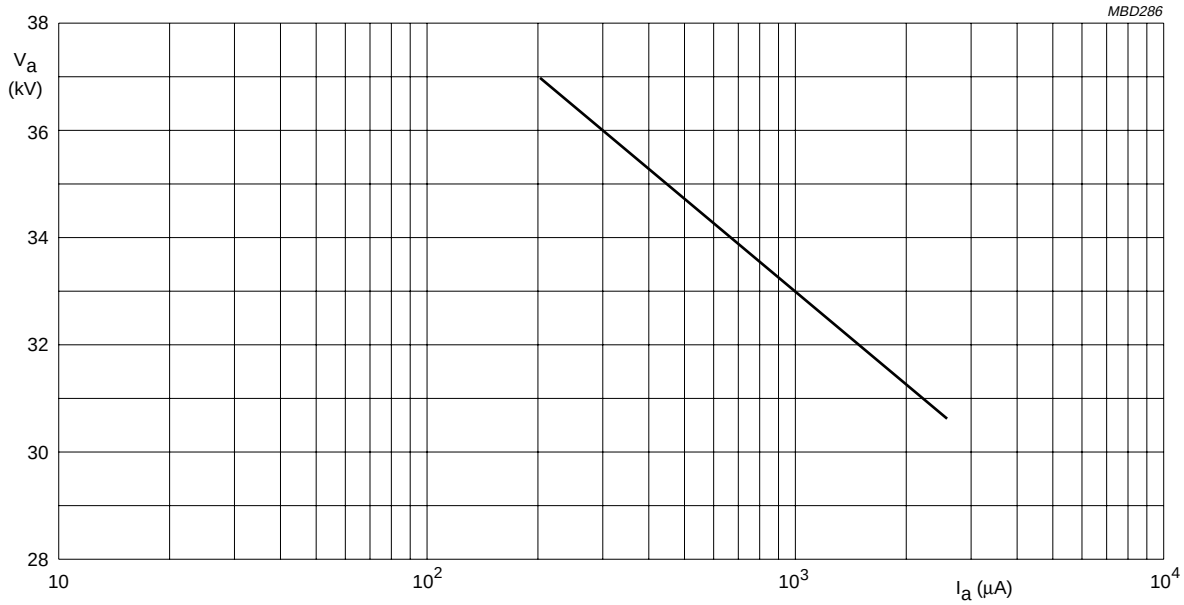


Fig.25 0.5 mR/h iso-exposure-rate limit curves.



The X-radiation emitted will also not exceed 1 μSv/h for anode voltage and current combinations shown in the iso-exposure-rate limit curve according to Eigensichere Kathodenstrahlröhre nach *"Anlage III Röntgenverordnung"*.

Fig.26 1 μSv/h iso-exposure-rate limit curve.

5.2 Warnings

X-radiation
Operation of the monochrome monitor tube under abnormal conditions that exceed the 0.5 mR/h iso-exposure-rate curve shown in Fig.25 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 values stated in Section 4.3 are not exceeded.
Tube replacement
This monitor tube incorporates integral X-radiation and implosion protection and must be replaced with a tube of the same type number or 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 taken during replacement or servicing of the monitor tube since a residual electrical charge may be held by the high-voltage capacitor formed by the external and internal conductive coatings of the monitor 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.

5.3 Handling

The packaging provides protection against tube damage under normal conditions of shipment or handling. Observe any instructions given on the packaging and handle accordingly. Under no circumstances should the tube assembly be subjected to accelerations greater than the values given in Table “Accelerations”.

Accelerations

PARAMETER	CONDITIONS	MAX.	UNIT
Pulse in cone direction	≤10 ms	350	m/s^2
	30 ms	200	m/s^2
Pulse in all other directions	30 ms	350	m/s^2

Monitor tubes should be kept in the shipping box or similar protective container prior to installation.

Although monitor tubes are provided with integral implosion protection which meets the intrinsic safety requirements stipulated in the relevant part of IEC 60065, care should be taken not to scratch or knock any part of the tube. Particularly care should be taken to prevent damage to the seal area.

In all handling procedures prior to insertion in the cabinet, there is a risk of personal injury if severe accidental damage to the tube occurs. It is therefore recommended that in areas containing unpacked and unprotected tubes, protective clothing is worn, particularly, gloves and safety glasses with side-shields to prevent possible injury from flying glass in the event of such an accident.
Handle the tube with extreme care. Do not strike, scratch or subject the tube to more than moderate pressure.

The tube assembly should never be handled by the tube neck, deflection unit or other neck components.

If suspending the tube assembly from the mounting lugs, ensure that a **minimum of two** are used.
Under no circumstances suspend the tube assembly from one lug.

An alternative lifting method is to firmly grasp the assembly by the vertical sides of the rimband. Manually lifting the assembly from the face-down or face-up position is shown in Figs 27 and 28.

To protect the screen when placing the tube face-down, ensure that the tube face rests on a cushion kept free from abrasive substances.

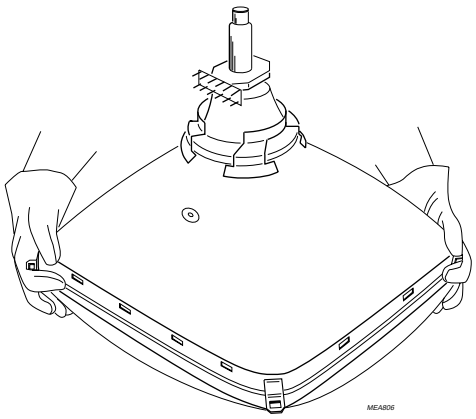


Fig.27 Lifting tube from face-down position.

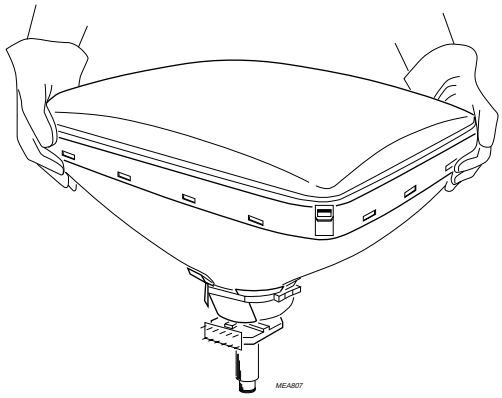


Fig.28 Lifting tube from face-up position.

5.4 Environmental conditions

The tube assembly must be capable of meeting the requirements of this specification under/after the following environmental conditions.

5.4.1 AMBIENT TEMPERATURE

- Tube operating +10 °C to +53 °C
- Storage and shipment –20 °C to +60 °C with a thermal shock up to 24 °C
- 50% relative humidity at either limit with the tube assembly inside the shipping container.

5.4.2 RELATIVE HUMIDITY

- Operating 8% to 80%
- Storage and shipment 5% to 100% (including condensation, but excluding rain).

5.4.3 BAROMETRIC PRESSURE

- Operating and storage 769 hPa to 1060 hPa
- Shipment 91 hPa to 1060 hPa.

5.4.4 WET BULB TEMPERATURE

- Operating maximum 26.7 °C
- Storage and shipment 29.4 °C.

6 DEFINITIONS

Data sheet status	
Objective specification	This data sheet contains target or goal specifications for product development.
Preliminary specification	This data sheet contains preliminary data; supplementary data may be published later.
Product specification	This data sheet contains final product specifications.
Limiting values	
Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 60134). Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only and operation of the device at these or at any other conditions above those given in the Characteristics sections of the specification is not implied. Exposure to limiting values for extended periods may affect device reliability.	

7 LIFE SUPPORT APPLICATIONS

These products are not designed for use in life support appliances, devices, or systems where malfunction of these products can reasonably be expected to result in personal injury. PDS customers using or selling these products for use in such applications do so at their own risk and agree to fully indemnify PDS for any damages resulting from such improper use or sale.

PDS

Professional Display Systems B.V.

Professional Display Systems B.V.

Jan Campertstraat 5

6416 SG Heerlen

The Netherlands

Tel: +31 (0)45 5439312

Fax: +31 (0)45 5426458

E-mail : info@crt.nl

Internet : www.professionaldisplaysystems.nl

DATA SHEET

M51EDF40WB11/06

21" high resolution triple gun monochrome monitor tube assembly

Product specification

2009 Jan 22

Professional Display Systems B.V.

21" high resolution triple gun monochrome monitor tube assembly

M51EDF40WB11/06

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21" high resolution triple gun monochrome monitor tube assembly

M51EDF40WB11/06

1 HIGHLIGHTS

1.1 Features

1.1.1 HIGH PERFORMANCE DESIGN

- High resolution; higher pixel density up to 1600 × 1280 pixels (non-interlaced) displayable conform ISO 9241 by:
  - 'larger' effective screen area: 377 mm × 285 mm
  - high resolution in-line electron polygon DAF triple gun(1)
- High brightness and contrast:
  - anti reflection antistatic panel
- Excellent uniformity
- Accurate convergence and raster geometry:
  - double mussel coil technology
  - internal magnetostatic beam alignment
  - charge drift compensation
  - optional additional north-south raster correction circuitry available
- Application-friendly design:
  - worldwide useable design
  - East-West correction max. 10%
  - horizontal balance coil; vertical balance potentiometer
  - deflection units designed for minimal ringing
  - optional rotation coil for adjustment of axial magnetic fields
  - up to and including 110 kHz horizontal frequency
  - static convergence adjustments (multipole for 4 and 6 pole correction) on monitor level.

1.1.2 ERGONOMIC DESIGN

- Less ambient reflection:
  - 'flat' and 'square' design
  - AGAS (Anti Glare Anti Static) panel
- Less eye strain:
  - P45 medium-persistence white phosphor
  - high frequency yokes
- Green design:
  - CFC-free production process
  - Cd-free phosphor
  - 0.65 W Cermet © power saving cathodes
- Fulfils electric/magnetic radiation standards
- Safety approved:
  - VDE; CSA; UL.

1.1.3 OPTIMUM DISPLAY SOLUTION

- High-end PC applications
- Workstation applications
- Resolution standards up to 1600 × 1280 pixels non-interlaced applications.

1.2 Quick reference data

PARAMETER	TYP.	UNIT
Deflection angle	90	deg
Face diagonal	51	cm
Overall length	<454.4	mm
Neck diameter	29.4	mm
Glass transmission	43	%
Colour co-ordinates		
x	244	
y	309	
Brightness	750	cd/m^2
Heater voltage	6.15	V
Focus voltage	25% of anode voltage	
Anode voltage	27.5	kV

1.3 Deflection coil data

Deflection coil is mounted with dynamic convergence correction coils (PECOMA).

PARAMETER	VALUE	UNIT
Horizontal coil inductance	0.092	mH
Vertical coil inductance	4.4	mH
Maximum advised frequency	110	kHz

1.4 Ordering information

TYPE NUMBER	SCREEN FINISH	LUG DISTANCE
M51EDF40WB11/06	AGAS panel	42.5 mm

(1) Whenever in this data sheet the words 'red', 'green' and 'blue' are used, with respect to the guns, the guns are meant as in an equivalent colour monitor tube.

2 PERFORMANCE SPECIFICATION

2.1 Colour coordinates

PHOSPHOR DATA	COLOUR COORDINATES	
	x	y
Phosphor type: P45 (N 1045) $I_{a(av)}$ = 300 μA (per gun) V_a = 27.5 kV Scanned duty cycle = 75% Scanned area = 312 × 234 mm Screen finish AGAS	244±10	309±10

2.2 Brightness uniformity

Brightness uniformity between centre and corners: >80%; <110%.

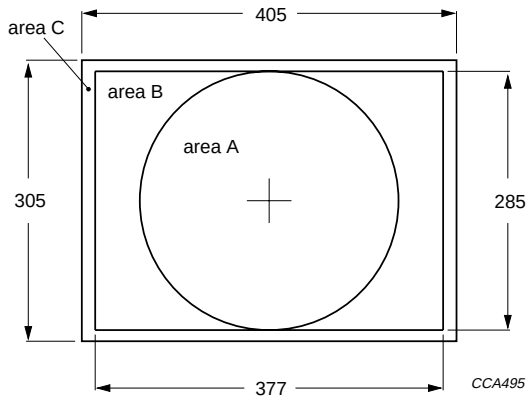
2.3 Convergence specification

2.3.1 TEST CONDITIONS

1. Set-up in accordance with Section 4.1.
2. Measure maximum misconvergence after 30 minutes operation.
3. To be adjusted for focus at $^2/_3$ centre-corner using crosshatch pattern at anode current is 300 μA (peak value) per gun.
4. Misconvergence is the distance between the centres of the red, green and blue guns at the screen using a crosshatch pattern.
5. Anode and/or focusing voltage and terrestrial magnetism may slightly affect the static convergence. Therefore, small re-adjustments to static convergence may be necessary.
6. Avoid stray magnetic fields etc. due to chassis influences which may affect convergence.

2.3.2 CONVERGENCE LIMITS

LOCATION (see Fig.1)	**TYPE OF ERROR**	**MAXIMUM ERROR BETWEEN GUN SPOTS**	
		STANDARD	**WITH PECOMA**
Centre	red-green-blue gun line separation in either the horizontal or vertical direction	0.30 mm	0.2 mm
Area A/corner		0.50 mm	0.2 mm



Dimensions in mm.

Fig.1 Maximum misconvergence.

2.4 Resolution specification

With the settings given in Section 4.1, the 50% spot value is as listed below.
Measured within raster of 377 mm × 285 mm.

ANODE CURRENT	SPOT SIZE CENTRE (NOMINAL)		SPOT SIZE CORNER (NOMINAL)		UNIT
	X	Y	X	Y	
100 μA.	0.4	0.4	0.6	0.4	mm
200 μA	0.5	0.5	0.6	0.5	mm
400 μA	0.6	0.6	0.7	0.5	mm

2.5 Raster geometry

2.5.1 RASTER CENTRING

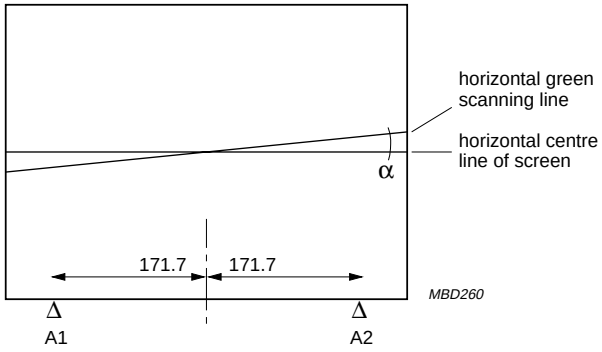
CENTRING	MAX.	UNIT
Horizontal	±5.5	mm
Vertical	±5.5	mm

2.5.2 RASTER ORTHOGONALITY

Orthogonality of the horizontal/vertical scan axis is ±0.5°.

2.5.3 RASTER ROTATION

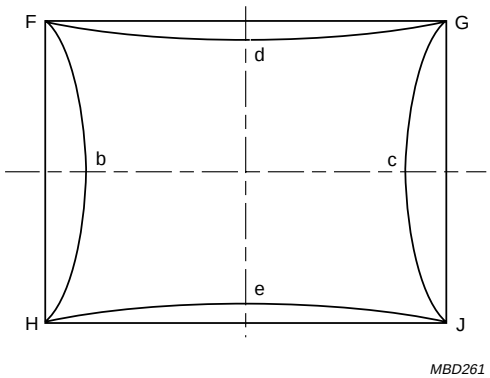
Measure the angle of the horizontal green scanning line with reference to a horizontal centre line that is drawn parallel to the tube reference points A1 and A2, see Fig.2. Chassis influences may affect raster rotation.



$\alpha \leq 0.3°$

Fig.2 Rotation measurement.

2.5.4 PIN-CUSHION DISTORTION



FG = HJ = 377 mm.
FH = GJ = 285 mm.
Measured with no pin-cushion correction applied, with 'b', 'c', 'd' and 'e' measured along the main axis.

Fig.3 Pin-cushion distortion.

2.5.5 DISTORTION NORTH - SOUTH

The following formulae define the pin-cushion distortion in the north and south directions.

$$\text{North} = \frac{4d}{FH + GJ} \times 100\% = 0\% \text{ to } +1.3\%$$

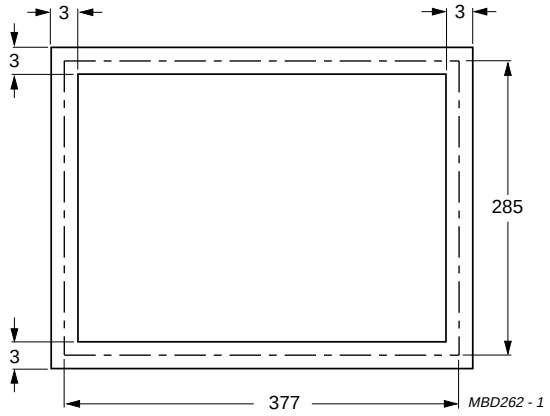
$$\text{South} = \frac{4e}{FH + GJ} \times 100\% = 0\% \text{ to } +1.3\%$$

2.5.6 DISTORTION EAST - WEST

The following formulae define the pin-cushion distortion in the east and west directions.

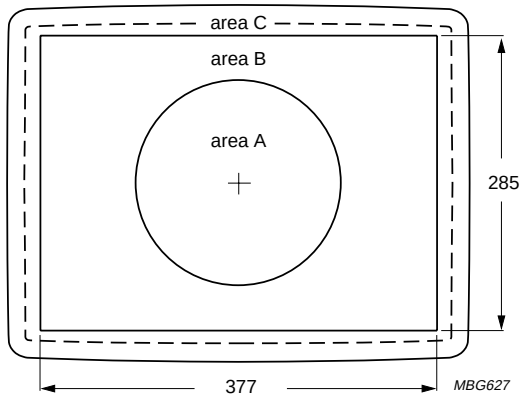
$$\text{East} = \frac{4b}{FG + HJ} \times 100\% \leq 10\%$$

$$\text{West} = \frac{4c}{FG + HJ} \times 100\% \leq 10\%$$



Dimensions in mm.

Fig.4 General distortion.



Dimensions in mm.

Fig.5 Screen areas.

2.6 Screen quality

2.6.1 GENERAL TEST PROCEDURE

Tests are to be done under the following general conditions:

- Viewing distance should be 50 cm minimum.
- For an activated screen the diffuse ambient light level at the centre of the screen should be between 2 and 5 lux.
- For an unactivated screen the diffuse ambient light level at the centre of the screen should be between 700 and 1000 lux.
- The viewing angle relative to the tube axis should not exceed 45°.
- Faults not visible under these general conditions are permitted.
- The following quality areas are specified (see Fig.5):
  - Area A: a circular area with a diameter of 200 mm, of which the centre coincides with the mechanical centre of the screen.
  - Area B: the area between the edge of area A and the rectangular area measuring 377 mm × 285 mm, of which the centre coincides with the mechanical centre of the screen.
  - Area C: the area between the edge of area B and the rimband.

2.6.2 ASSESSMENT OF THE GLASS AND THE UNACTIVATED SCREEN QUALITY

2.6.2.1 Definition of blemishes

Unless otherwise specified, the shape of a blemish is defined as round and elliptical.

The size of a blemish is given by:

- $\frac{L + W}{2}$; if L > 3W the size is given by $\frac{L}{20} + 2W$,

  where L = length and W = width.

2.6.2.2 Limits

Table 1 Limits of measurable glass blemishes

SIZE (mm)	MAX. NUMBER OF BLEMISHES IN AREAS		MIN. PERMISSIBLE DISTANCE BETWEEN ANY TWO BLEMISHES (mm)	AREA C
	A	A + B		
>0.6	0	0	not applicable	only limits as regards tube safety
>0.4 to ≤0.6	1	2	50	
>0.2 to ≤0.4	2	5	50	
Total number	2	5	50	–
≤0.2	limited only by cloud			–

Table 2 Limits of measurable coating blemishes for AGAS coating

SIZE (mm)	MAX. NUMBER OF BLEMISHES IN AREA A+B	MIN. PERMISSIBLE DISTANCE BETWEEN ANY TWO BLEMISHES (mm)	AREA C
High contrast			
>1.5	0	not applicable	acceptable
>1.0 to ≤1.5	3	50	
>0.5 to ≤1.0	5	30	
≤0.50	no limits	no limits	
Low contrast			
>3.0	0	not applicable	acceptable
>1.0 to ≤3.0	5	30	
≤1.0	no limits	no limits	

Table 3 Limits of scratches

AREA	WIDTH (mm)	MAX. ALLOWABLE TOTAL LENGTH (mm)	MIN. SEPARATION (mm)
A+B	>0.15	0	not permitted
	>0.10 to ≤0.15	13	50
	>0.05 to ≤0.10	25	20
	≤0.05	no limits	not applicable
C	only as regards tube safety		

2.6.3 ASSESSMENT OF THE QUALITY OF THE ACTIVATED PHOSPHOR SCREEN

The assessment of the quality of the phosphor and matrix layer at area A should take place at typical operating conditions and a blanked raster. The current for each gun must be adjusted to a brightness of 200 cd/m^2.

2.6.3.1 Definition of blemishes

- A blemish is a fault which is clearly visible within 5 seconds.
- A defect, which looks visually as one blemish should be regarded as a single blemish.
- Unless otherwise specified, the shape of a blemish is defined as round and elliptical.

The size of a blemish is given by:

- $\frac{L+W}{2}$; if L > 3W the size is given by $\frac{L}{20} + 2W$, where L = length and W = width.

2.6.3.2 Limits

1. The distance between any two blemishes >0.2 mm should be >50 mm.
2. Maximum number of blemishes >0.2 mm per screen is 9.
3. Blemishes ≤0.2 mm can be ignored, except for a concentration of such blemishes that has a diameter of more than 8 mm.

Table 4 Limits of blemishes

BLEMISH SIZE (mm)	MAXIMUM NUMBER OF BLEMISHES IN		
	AREA A	AREA B	AREA A + B
>0.6	0	0	0
>0.4 to ≤0.6	1	5	5
>0.2 to ≤0.4	4	6	9
≤0.2	limited only by cloud		

2.7 Coating performance

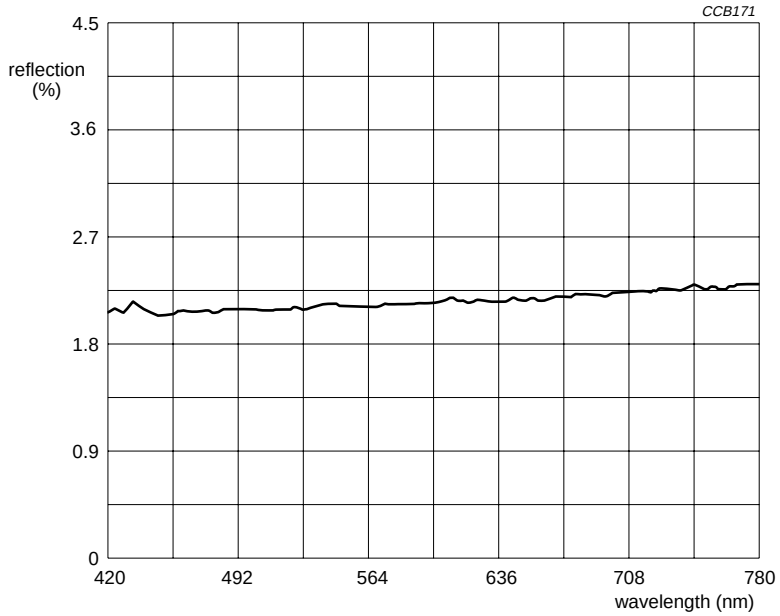


Fig.6 Relative reflection for AGAS.

3 PRODUCT CHARACTERISTICS

3.1 Electrical data

SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNIT
Capacitances					
$C_{a(m+m')}$	anode to external conductive cone coating, including rimband (with and without screen coating)	1000	1300	1600	pF
C_k	cathodes of all guns, connected in parallel, to all other electrodes	–	10	15	pF
C_{kR}, C_{kG}, C_{kB}	cathode of any gun to all other electrodes	–	4	–	pF
C_{g1}	grid 1 of any gun to all other electrodes	–	15	–	pF
C_{g2}	grid 2 to all other electrodes	–	10	–	pF
C_{g3a}	grid 3a (focus electrode) to all other electrodes	–	12	–	pF
C_{g3b}	grid 3b (dynamic focus electrode) to all other electrodes	–	17	–	pF
$C_{(g3a-g3b)}$	grid 3a to grid 3b	–	9	–	pF
Heater					
V_f	heater voltage	–	6.15		V
I_f	heater current	295	315	335	mA
t_{kwu}	cathode warm up time at 0-hour from 10% to 80% of end emission	–	–	8	s
Deflection unit					
V_{max}	maximum permissible DC voltage				
	between horizontal and vertical coils	–	–	2000	V
	between vertical coils and core	–	–	300	V
R_{ins}	insulation resistance at 1 kV (DC)				
	between horizontal and vertical coils	500	–	–	MΩ
	between horizontal coil and core clamping ring	500	–	–	MΩ
	between vertical coil and core clamping ring	10	–	–	MΩ
	crosstalk (1 V applied to the horizontal coils)	–	–	30	mV

3.2 Deflection unit data

All values are valid at T_{amb} = 25 °C and V_a = 27.5 kV; deflection units fulfil the MPRII and TCO magnetic requirements (see Section 5.1); the deflection coil is designed for a positive pulse on the horizontal coil.

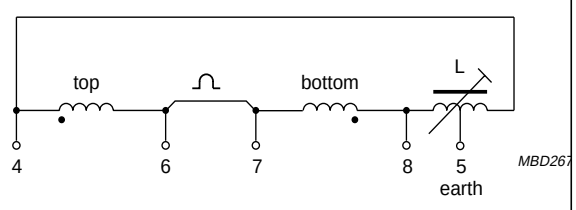
PARAMETER	VALUE	TOLERANCE	UNIT
Advised frequency; notes 1 and 2	110	–	kHz
Horizontal deflection coil			
Inductance	0.092	±4%	mH
Resistance	0.15	±10%	Ω
Current (peak-to-peak value)	13.5	±4%	A
Used wire	litz	–	
Vertical deflection coil			
Inductance	4.4	±4%	mH
Resistance	4.50	±7%	Ω
Current (peak-to-peak value)	1.81	±5%	A
Used wire	litz	–	

Notes

1. Advised maximum frequency depends on the internal maximum set temperature and used deflection-overscan.
2. No annoying ringing with 0% overscan.

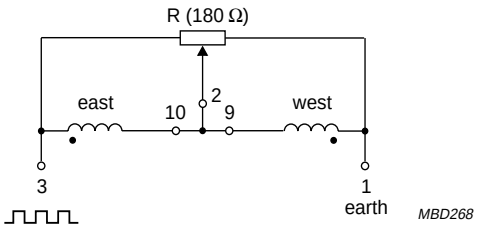
Rotation coil data

PARAMETER	CONDITION	MIN.	TYP.	MAX.	UNIT
Resistance	T_{amb} = 20 °C	50.9	56.6	62.3	Ω
Sensitivity	I = 75 mA; V_a = 27.5 kV	–	0.95	–	deg



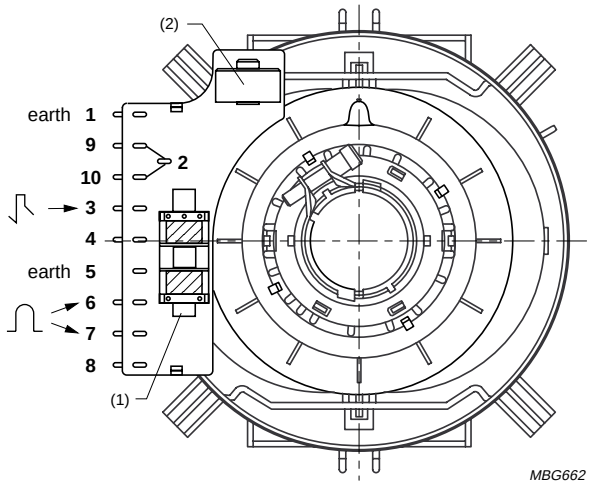
The beginning of the windings is indicated with •

Fig.7 Horizontal coils.



The beginning of the windings is indicated with •

Fig.8 Vertical coils.

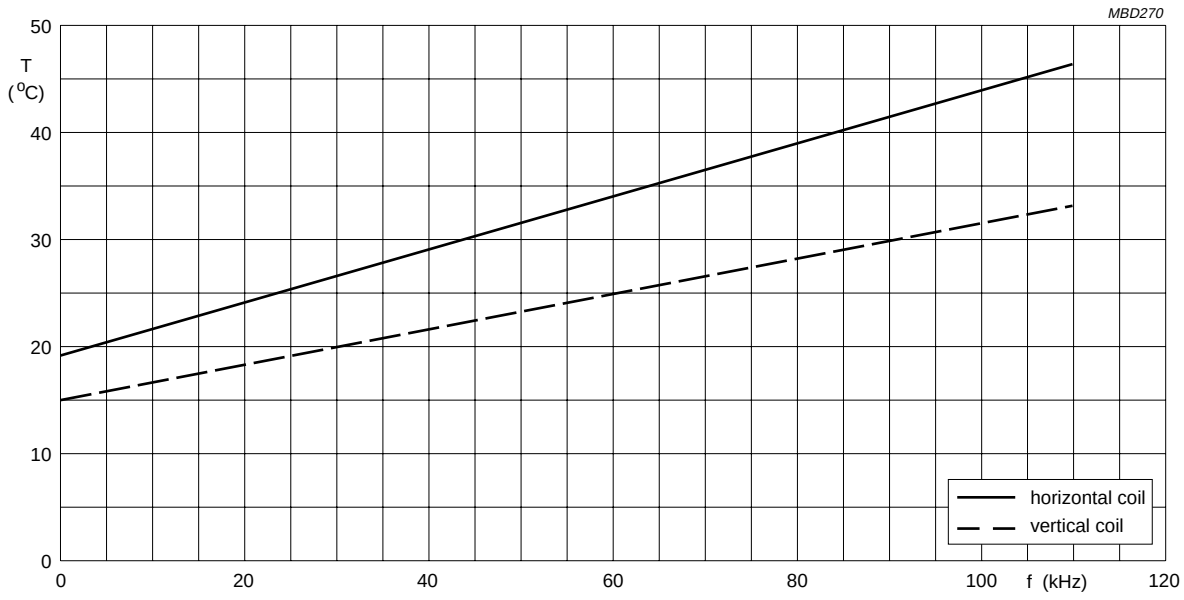


(1) Horizontal balance coil.
(2) Vertical balance potentiometer.

Fig.9 Deflection coil connections.

3.2.1 DEFLECTION UNIT TEMPERATURE

SYMBOL	PARAMETER	MAX.	UNIT
T_{copper}	average copper temperature of horizontal coil	110	°C
ΔT	maximum temperature rise of used wire	50	°C



Maximum operating copper temperature (resistance measurement) is 110 °C.

Fig.10 Temperature rise as a function of frequency.

3.3 Electro optical data

PARAMETER	VALUE
Electron gun system	three in-line integrated guns
Focus method	electrostatic
Focus lens	polygon and DAF
Convergence method	magnetic
Deflection method	self converging
Deflection angle	
diagonal	≈90°
horizontal	≈78°
vertical	≈60°

3.4 Screen properties

PARAMETER	VALUE
Screen finish	AGAS
Light transmission at screen centre	43 %
Recommended active screen area	
horizontal axis at a 1600 × 1280 pixels screen	377 mm
vertical axis at a 1600 × 1280 pixels screen	285 mm

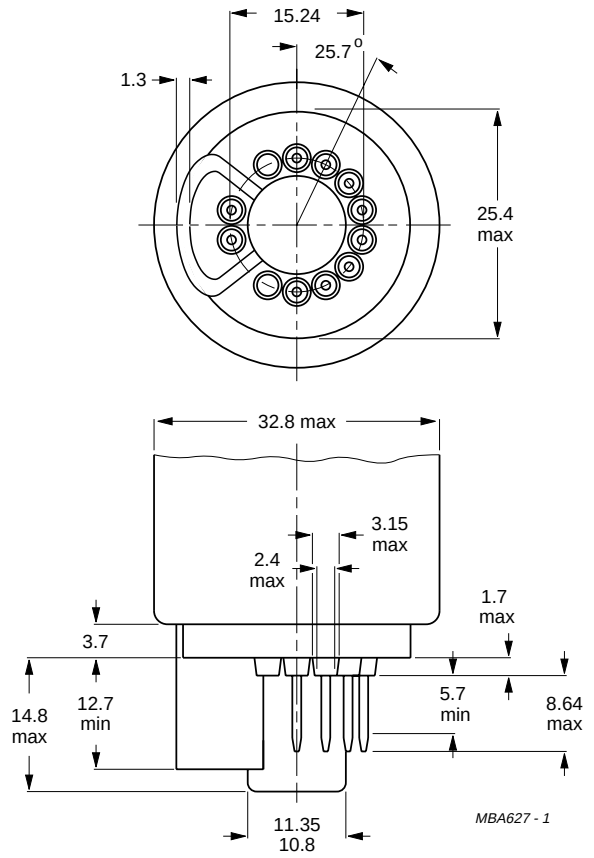
3.5 Coating properties

TYPE NUMBER	SCREEN FINISH	Reflection
M51EDF40WB11/06	Anti Static Anti Static (AGAS) < 500 Ohm/#	< 2.2%

3.6 Mechanical tube data

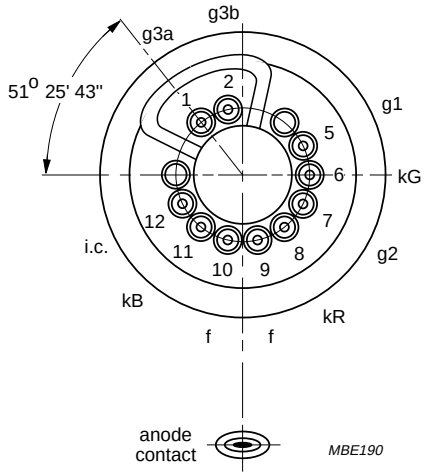
PARAMETER	VALUE
Overall length	452.9 ±6.5 mm
Neck diameter	29.4 +0.6/–0.4 mm
Maximum dimensions, excluding mounting lugs but including rimband	
diagonal	553.5 mm
width	470.0 mm
height	374.0 mm
Implosion protection	pre-stressed banded Mini-P shrunk-on rimband; CSA, UL and VDE approved
Anode contact	JEDEC J1-21; IEC 60067-III-2
Base designation	JEDEC B10-301
Base pin configuration	see Fig.12
Mass	≈15 kg
Mounting position	anode contact on top

3.7 Mechanical tube drawings



Dimensions in mm.

Fig.11 Base JEDEC B10-301.



i.c. = internally connected and not to be used.

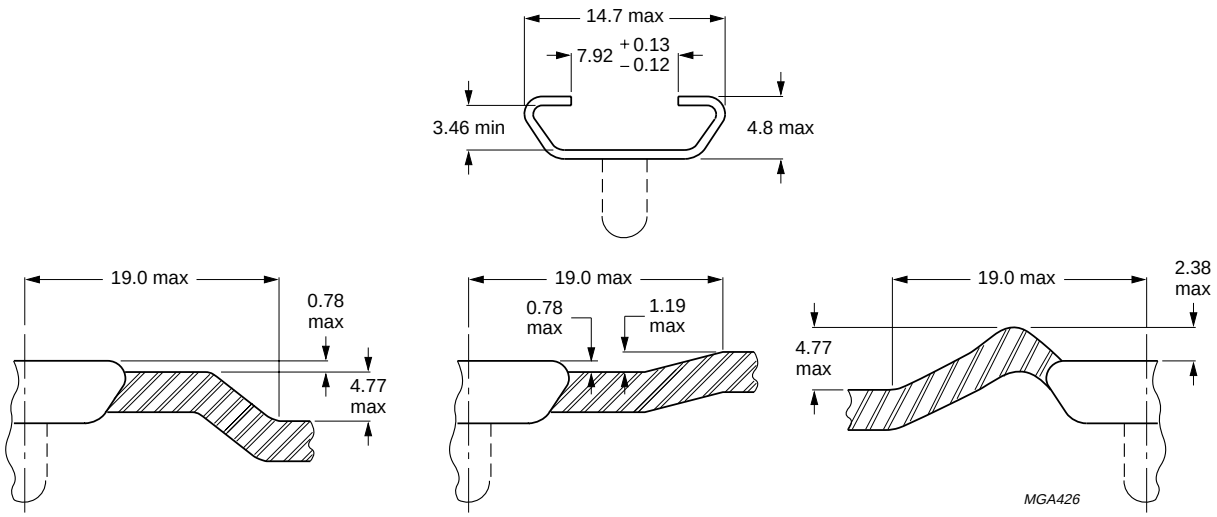
Fig.12 Pin arrangement.

Remarks: to Figs 11 and 12.

The socket for this base should not be rigidly mounted, it should have flexible leads and be allowed to move freely. After mounting the tube in the cabinet, note that the position of the base can fall within a circle, having a diameter of max. 40 mm concentric with an imaginary tube axis.

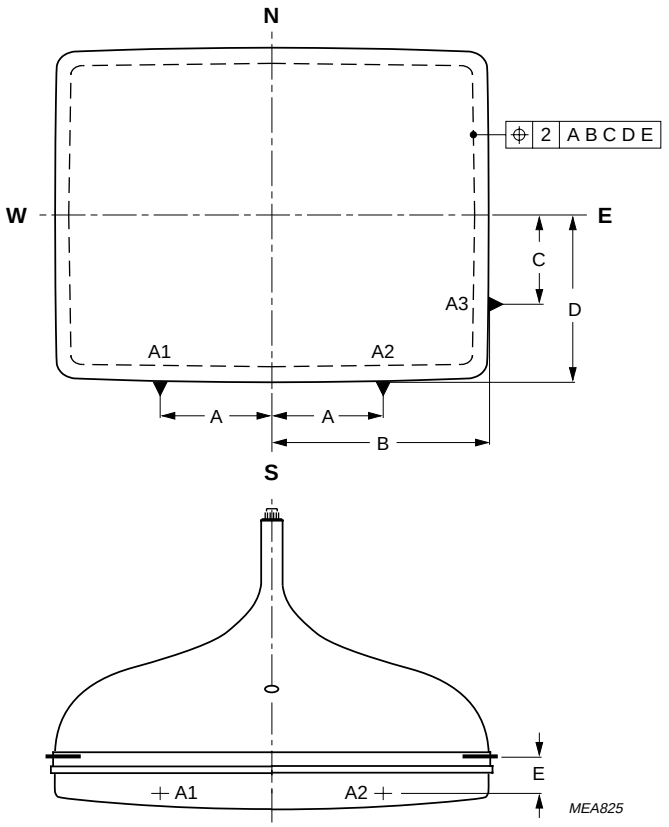
The mass of the mounting socket assembly should not exceed 450 g.

Maximum permissible torque on the tube neck is 0.14 Nm.



Dimensions in mm.

Fig.13 Cavity cap JEDEC J1-21, IEC 60067-III-2.

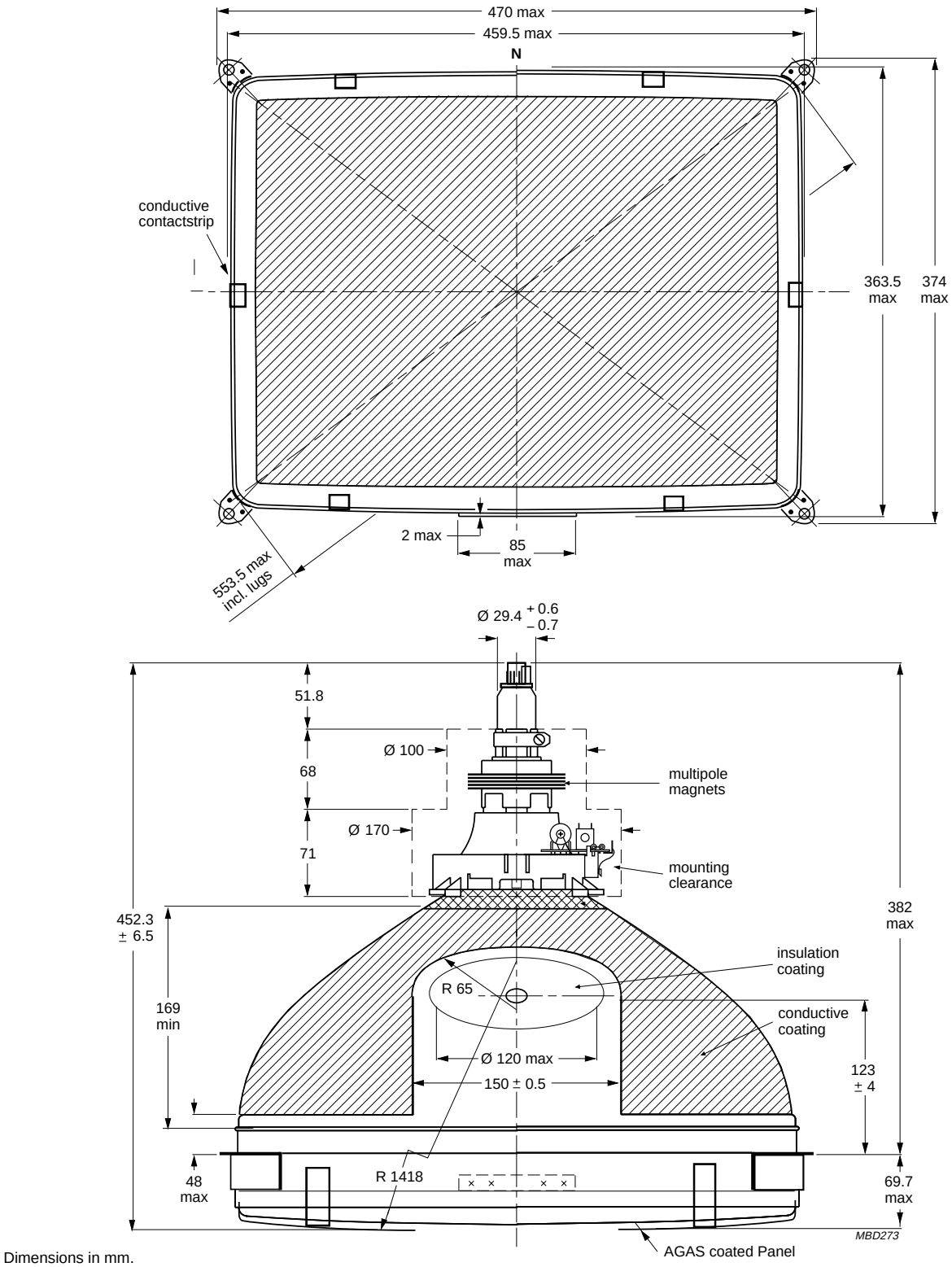


Dimensions in mm.
A = 171.7 mm.
B = 225.1 mm.
C = 115.6 mm.
D = 175.2 mm.
E = 5.1 mm.

Fig.14 Mechanical reference points.

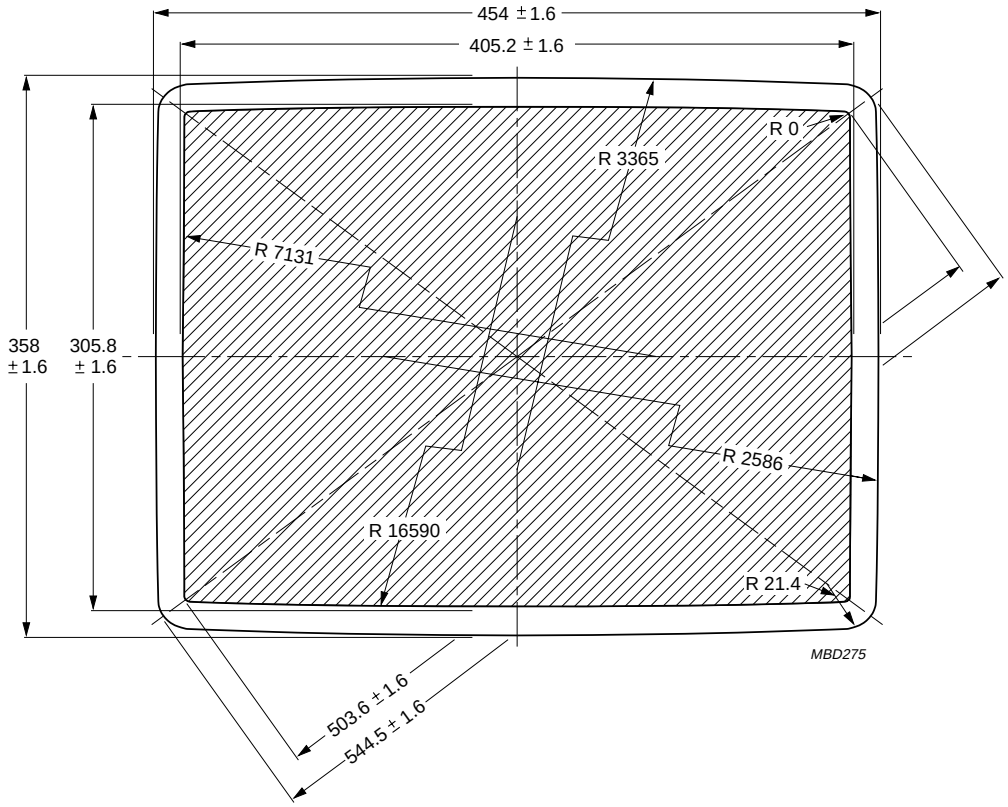
21" high resolution triple gun monochrome monitor tube assembly

M51EDF40WB11/06



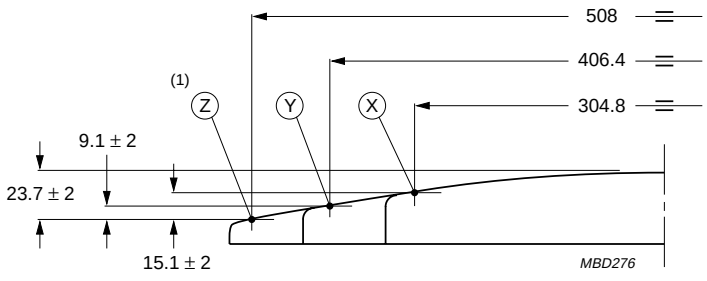
Dimensions in mm.

Fig.15 Top view.



Dimensions in mm.

Fig.16 Screen dimensions.

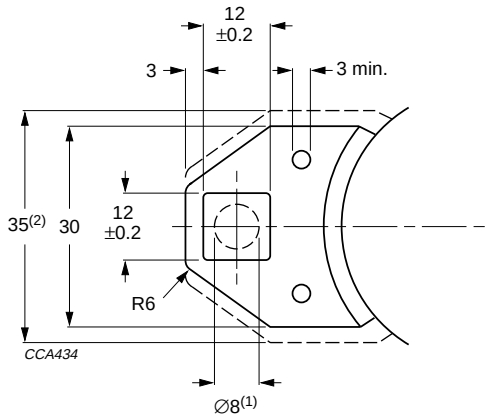


Dimensions in mm.

(1) The X, Y and Z reference points are located on the outside surface of the face plate.

Fig.17 Screen reference points.

3.7.1 LUG DATA

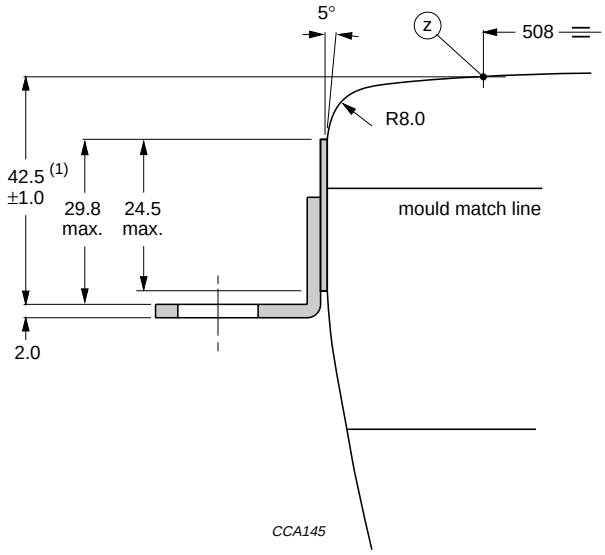


Dimensions in mm.

(1) 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 354.0 mm × 449.0 mm.

(2) Minimum space to be reserved for mounting lug in cabinet.

Fig.18 Lug dimensions.



Dimensions in mm.

(1) The displacement of any lug with respect to the plane through the other 3 lugs is maximum 0.8 mm.

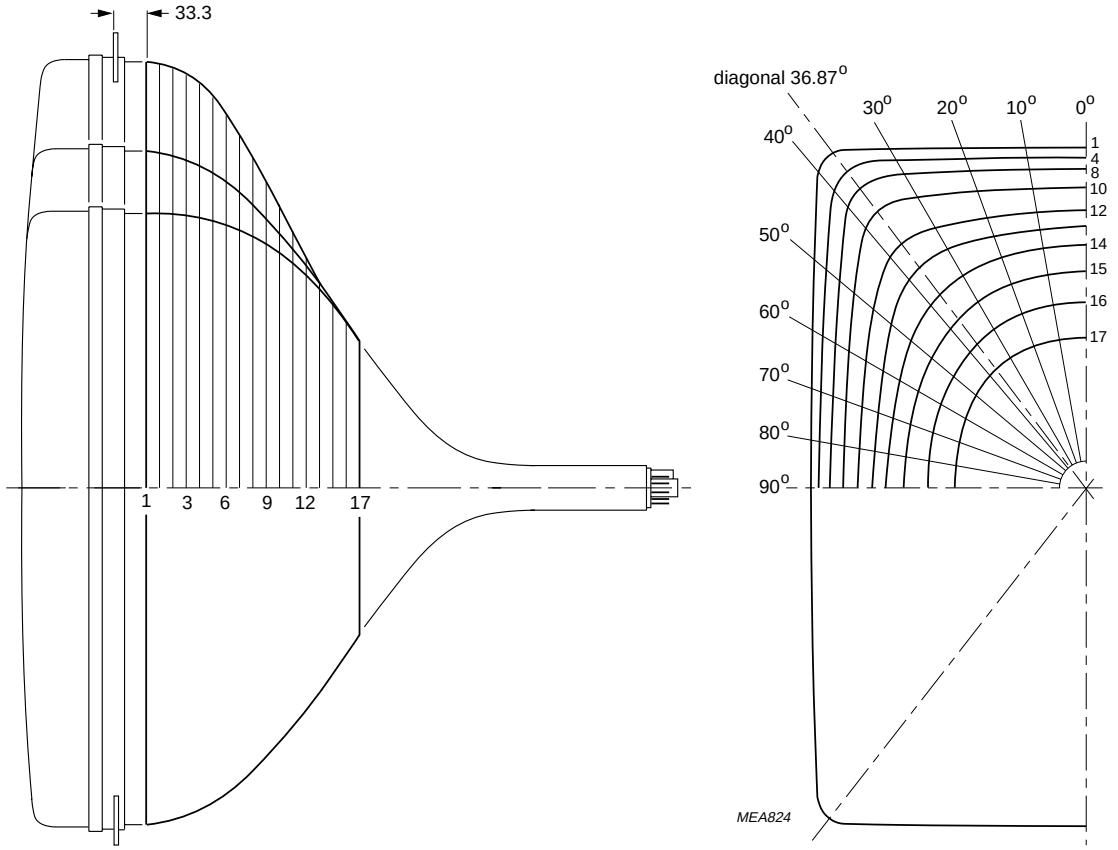
Fig.19 Lug position

3.8 Sagittal heights of screen

Sagittal heights of the nominal useful screen measured with respect to the end of the diagonal axis.

NOMINAL USEFUL SCREEN (NUS)			3 mm INSIDE NUS			5 mm OUTSIDE NUS		
COORDINATES		SAGITTAL HEIGHT	COORDINATES		SAGITTAL HEIGHT	COORDINATES		SAGITTAL HEIGHT
X (mm)	Y (mm)	(mm)	X (mm)	Y (mm)	(mm)	X (mm)	Y (mm)	(mm)
202.6	0.0	14.6	199.6	0.0	14.1	207.6	0.0	15.3
202.6	10.0	14.6	199.6	10.0	14.2	207.6	10.0	15.3
202.6	20.0	14.7	199.6	20.0	14.3	207.6	20.0	15.4
202.6	30.0	14.9	199.6	30.0	14.4	207.6	30.0	15.6
202.5	40.0	15.1	199.5	40.0	14.7	207.5	40.0	15.8
202.5	50.0	15.4	199.5	50.0	15.0	207.4	50.0	16.1
202.5	60.0	15.8	199.4	60.0	15.4	207.4	60.0	16.5
202.4	70.0	16.3	199.4	70.0	15.8	207.4	70.0	17.0
202.3	80.0	16.8	199.3	80.0	16.4	207.3	80.0	17.5
202.2	90.0	17.4	199.2	90.0	17.0	207.2	90.0	18.1
202.1	100.0	18.1	199.1	100.0	17.6	207.1	100.0	18.8
202.0	110.0	18.8	199.0	110.0	18.4	207.0	110.0	19.6
201.9	120.0	19.7	198.4	120.0	19.2	206.9	120.0	20.4
201.7	130.0	20.6	198.7	130.0	20.1	206.7	130.0	21.3
201.6	140.0	21.6	198.6	140.0	21.1	206.6	140.0	22.3
201.5	150.0	22.6	198.5	145.0	21.6	206.5	150.0	23.4
201.4	151.1	22.7	198.5	148.1	22.0	206.4	156.0	24.1
200.0	151.1	22.5	195.0	148.2	21.5	200.0	156.1	23.1
190.0	151.3	21.1	190.0	148.3	20.7	190.0	156.3	21.6
180.0	151.4	19.7	180.0	148.4	19.4	180.0	156.4	20.3
170.0	151.6	18.4	170.0	148.6	18.1	170.0	156.6	19.0
160.0	151.8	17.3	160.0	148.8	16.9	160.0	156.8	17.8
150.0	151.9	16.2	150.0	148.9	15.8	150.0	156.9	16.7
140.0	152.0	15.1	140.0	149.0	14.8	140.0	157.0	15.7
130.0	152.1	14.2	130.0	149.1	13.9	130.0	157.1	14.8
120.0	152.3	13.3	120.0	149.3	13.0	120.0	157.3	13.9
110.0	152.4	12.6	110.0	149.4	12.2	110.0	157.4	13.1
100.0	152.5	11.8	100.0	149.5	11.5	100.0	157.5	12.4
90.0	152.5	11.2	90.0	149.5	10.9	90.0	157.5	11.8
80.0	152.6	10.7	80.0	149.6	10.3	80.0	157.6	11.2
70.0	152.7	10.2	70.0	149.7	9.8	70.0	157.7	10.7
60.0	152.7	9.7	60.0	149.7	9.4	60.0	157.7	10.3
50.0	152.8	9.4	50.0	149.8	9.1	50.0	157.8	10.0
40.0	152.8	9.1	40.0	149.8	8.8	40.0	157.8	9.7
30.0	152.9	8.9	30.0	149.9	8.6	30.0	157.9	9.5
20.0	152.9	8.7	20.0	149.9	8.4	20.0	157.9	9.3
10.0	152.9	8.7	10.0	149.9	8.3	10.0	157.9	9.3
0.0	152.9	8.6	0.0	149.9	8.3	0.0	157.9	9.2

3.9 Cone contour



Dimensions in mm.

Fig.20 Maximum cone contour.

Cone contour data

SECTION	NOMINAL DISTANCE FROM SECTION 1 (mm)	MAXIMUM DISTANCE FROM TUBE AXIS (mm)										
		0°	10°	20°	30°	36.87°	40°	50°	60°	70°	80°	90°
1	0.0	225.7	228.9	239.1	257.6	271.8	267.2	227.9	203.1	187.9	179.6	177.0
2	10.0	224.6	227.7	237.7	255.9	270.0	265.3	226.7	201.9	186.8	178.6	175.9
3	20.0	221.8	224.8	234.3	251.1	264.3	259.6	222.9	198.9	184.2	176.1	173.5
4	30.0	218.1	220.9	229.6	244.5	254.7	250.6	217.9	195.1	180.9	173.1	170.6
5	40.0	213.8	216.4	224.1	236.5	243.1	239.6	212.0	190.9	177.3	169.9	167.5
6	50.0	208.7	211.0	217.7	227.5	231.3	228.4	205.6	186.3	173.6	166.5	164.2
7	60.0	202.6	204.5	210.0	217.5	219.5	217.0	198.5	181.0	169.3	162.6	160.5
8	70.0	195.1	196.8	201.3	206.9	207.6	205.4	190.3	175.1	164.4	158.3	156.3
9	80.0	186.2	187.6	191.4	195.6	195.4	193.5	181.3	168.4	158.9	153.3	151.5
10	90.0	175.6	176.9	180.1	183.3	182.8	181.1	171.4	160.7	152.5	147.6	146.0
11	100.0	163.6	164.6	167.4	169.9	169.2	167.9	160.4	151.9	145.2	141.0	139.6
12	110.0	150.3	151.3	153.8	155.7	154.7	153.6	147.9	141.7	136.6	133.4	132.3
13	120.0	136.4	137.3	139.3	140.4	139.5	138.6	134.5	130.3	126.8	124.6	123.9
14	130.0	122.1	122.8	124.4	124.9	124.0	123.3	120.7	118.2	116.1	114.7	114.3
15	140.0	107.5	107.7	108.2	108.6	108.4	108.2	107.0	105.7	104.5	103.8	103.5
16	150.0	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

4 APPLICATION CONDITIONS

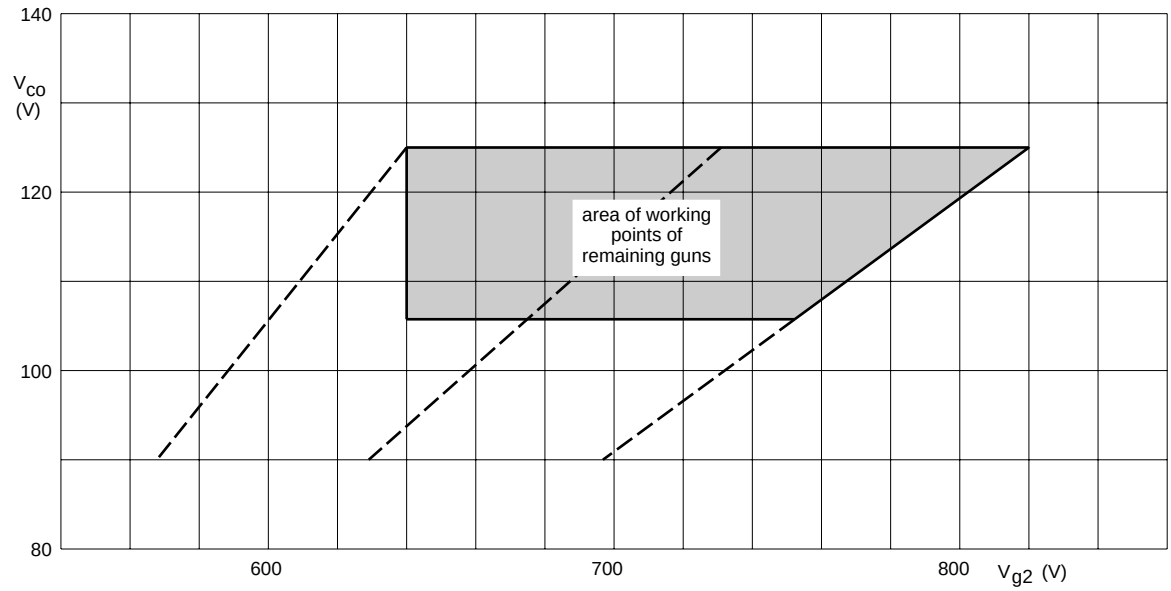
4.1 Recommended adjustment and operating conditions

The voltages are applied to each gun and are measured with respect to grid 1; RH = 40% to 60%; tube facing east; local magnetic field: 0.03 mT vertical, 0.00 mT lateral, 0.00 mT axial. Pre-heat the tube for 15 minutes minimum before tests. Avoid misconvergence, distortion etc. due to stray magnetic fields and chassis influences.

SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNIT
$V_{a,g4}$	anode voltage	–	27.5	–	kV
V_{g3a}	grid 3a (static focus electrode) voltage as a percentage of the anode voltage; note 1	23	–	27	%
V_{g3b}	grid 3b (dynamic focus electrode) voltage				
	DC voltage as a percentage of the anode voltage	23	–	27	%
	horizontal parabola	–	300	–	V
	vertical parabola	–	150	–	V
V_{g2}	grid 2 voltage at a spot cut-off voltage V_{co} = 125 V; note 2	see Fig.21			V
V_f	heater voltage	–	6.15 (3)	-	V
f_H	horizontal sweep frequency	–	30 to 110	–	kHz
f_V	vertical sweep frequency	–	60 to 80	–	Hz
T_{amb}	ambient temperature	–	25	–	°C

Notes

1. Focus adjustment procedure:
   a) Adjust anode current for 750 cd/m^2.
   b) Adjust for optimum focus at $^2/_3$ centre-corner.
2. Grid 2 adjustment procedure:
   a) Grid 2 voltage (V_{g2}) adjusted for highest gun spot cut-off voltage: V_{co} = 125 V.
   b) Remaining guns adjusted for spot cut-off by means of cathode voltage.
   c) V_{g2} range: 640 V to 820 V at V_{co} = 125 V.
   d) Set the cathode voltage (V_k) for each gun at 125 V; increase the grid 2 voltage (V_{g2}) from ≈400 V to the value at which the spot of the gun with the lowest (V_{g2}) cut-off voltage becomes just visible, then decrease the cathode voltage of the remaining guns until the other gun beams become just visible.
3. For maximum cathode life it is recommended that the heater voltage is regulated at 6.15 V.



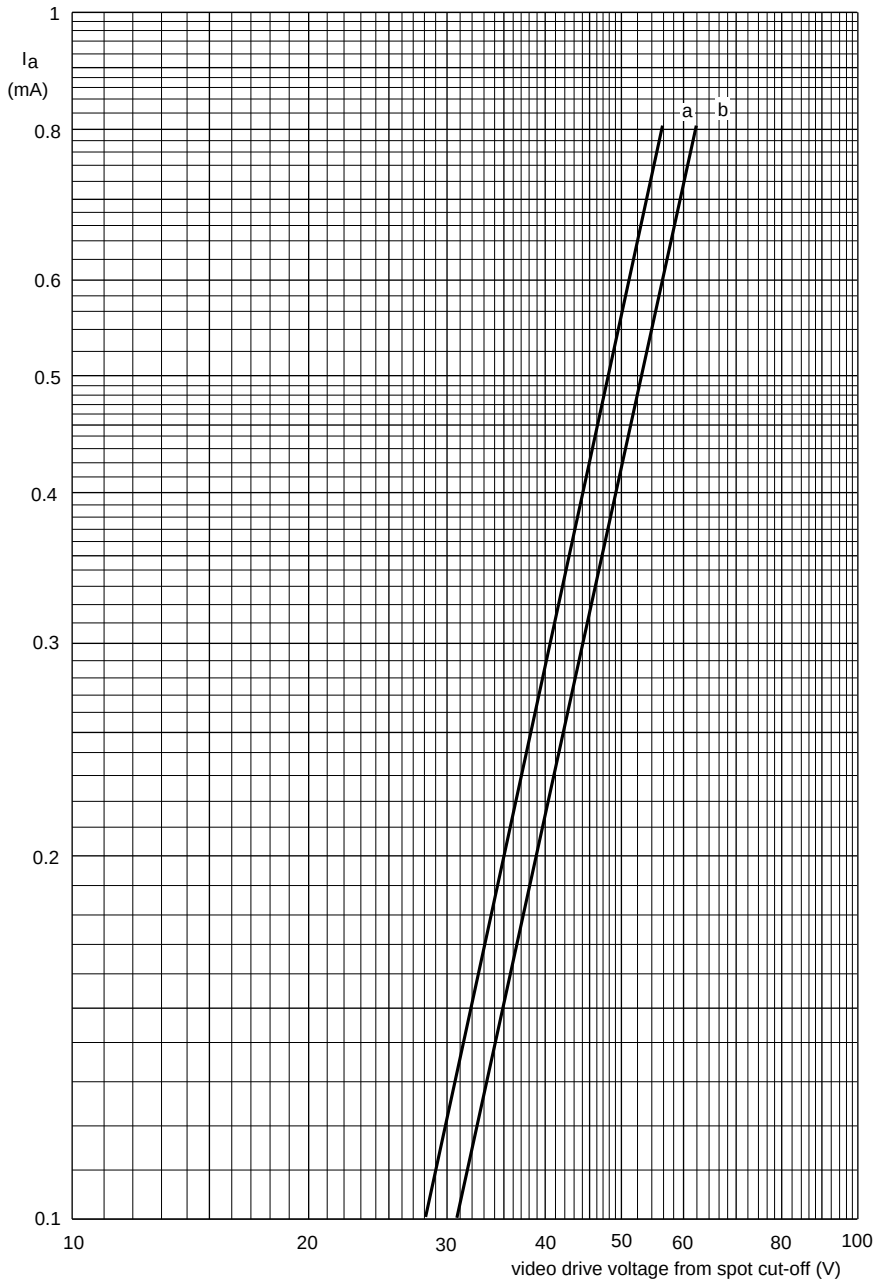
The voltages are specified with respect to grid 1.

Fig.21 Spot cut-off design chart.

4.2 Chassis design values

The values are valid for anode voltages between 20 and 29.9 kV. The voltages are specified with respect to grid 1.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
V_{g3a}	grid 3a (static focus voltage) as a percentage of anode voltage		23	–	27	%
V_{g3b}	grid 3b (dynamic focus voltage) as a percentage of anode voltage	raster size = 312 × 234 mm				
	DC voltage as a percentage of anode voltage		23	–	27	%
	horizontal parabola		–	300	–	V
	vertical parabola		–	150	–	V
ΔV_{g3a}	difference in focus voltage between red, green and blue guns when separately focused		–	–	300	V
ΔV_{g3a-b}	difference between the static focus voltage and dynamic focus voltage		–	–	500	V
V_{g2}	grid 2 voltage	for visual extinction of focused spot	see Fig.21			
V_k	cathode voltage		see Figs 21 and 22			
ΔV_k	difference in cut-off voltage between guns in any tube (cathodes cut-off ratio)		highest value <1.18 × lowest value			
V_f	heater voltage	at zero beam current	–	6.15	–	V
I_{g3a}	focus current	under cut-off conditions	–3	–	+3	µA
I_{g3b}	focus current	under cut-off conditions	–3	–	+3	µA
I_{g2}	grid 2 current	under cut-off conditions	–2	–	+2	µA
I_{g1}	grid 1 current	under cut-off conditions	–5	–	+5	µA
I_{kf}	cathode/heater current	V_{co} = 125 V	–5	–	+5	µA
Resistance						
R_{kgf}	insulation resistance between each cathode and all other electrodes and heater		50	–	–	MΩ
R_{g2}	grid 2 circuit impedance		1	–	70	MΩ
R_{g3}	grid 3 circuit impedance		–	–	70	MΩ



V_{co} = 100 V (curve a).
V_{co} = 125 V (curve b).

Fig.22 Typical cathode drive characteristics.

4.3 Limiting values

In accordance with the Absolute Maximum Rating System (IEC 60134). Voltages are specified with respect to grid 1.

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
$V_{a,g4}$	anode voltage	note 1	20(2)	29.9(3)	kV
I_{ap}	anode current for each gun (peak value)		–	550	μA
I_a	long-term average anode current for each gun		–	400	μA
I_a	long-term average anode current for three guns		–	1100	μA
V_{g3a}	grid 3a (focus) voltage		–	10	kV
V_{g3b}	grid 3b (focus) voltage		–	10	kV
$\Delta V_{g3a-g3b}$	grid 3 (focus) differential voltage		–	1	kV
V_{g2p}	grid 2 voltage, including video signal voltage (peak value)		–	1000	V
V_f	heater voltage	note 4	5.7	6.6(3)	V
Cathode voltage					
V_k	positive	operating	–	200	V
		operating cut-off	–	135	V
V_k	negative		–	0	V
V_{kp}	negative peak		–	–2	V
Cathode to heater voltage					
V_{kf}	positive		–	250	V
V_{kfp}	positive peak		–	300(3)	V
V_{kf}	negative		–	0	V
V_{kfp}	negative peak		–	-50	V

Notes

1. 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 the picture tube.
2. Operation of the tube at lower voltages impairs the luminance and resolution and could impair the convergence.
3. This value is an absolute maximum.
4. For maximum cathode life it is required that the heater supply is designed for 6.15 V at zero beam current. Heater source impedance should have a minimum value of 2 Ω (maximum current during switching on is 700 mA).

4.4 Flashover protection

With the high voltage used with this tube (max. 29.9 kV) internal flashovers may occur. As a result of Soft-Flash technology these flashover currents are limited to approximately 60 A offering higher 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 in accordance with Fig.23; 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 focus electrode (g3a and g3b) of 11 kV and at the other electrodes of 1.5 to 2 kV, both at an atmospheric pressure of 100 kPa.

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.

To guarantee the soft flash behaviour, the internal dynamic resistance of the tube during flashover is minimal 200 Ω.

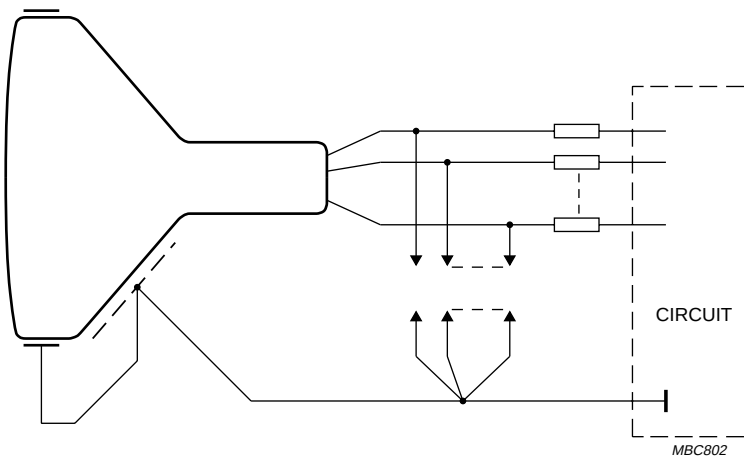


Fig.23 Flashover protection circuit.

5 ERGONOMIC AND ENVIRONMENTAL DATA

5.1 X-radiation

Maximum anode voltage at which the X-radiation emitted will not exceed 0.5 mR/h at an anode current of 300 μA.

PARAMETER	TYP.	UNIT
Entire tube; note 1	37	kV

Note

1. 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 iso-exposure-rate limit curve and the iso-exposure-rate limit curve for the entire tube.

WARNING
The tube will satisfy the European Community permitted limit of 1 μSv/h, when driven within the maximum published operating conditions.
Maximum voltage difference between anode and focus electrode at which the X-radiation will not exceed 0.5 mR/h is given in Fig.25.
If this voltage can be exceeded in the monitor, additional attenuation of the X-radiation may be required.
The X-radiation emitted from this picture tube, as measured in accordance with the procedure of *"TEPAC PublicationsNo.EIA501"* will not exceed 0.5 mR/h throughout the useful life of the tube 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 iso-exposure-rate limit characteristics as shown in Fig.25.
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 *"Federal Register Volume 38, No. 198,b Monday, October 15, 1973"*.
Maximum X-radiation as a function of anode voltage at 300 μA current is shown by Fig.24. X-radiation at a constant anode voltage varies linearly with anode current.

WARNING
The cathode ray tube is intrinsically safe in accordance with *"Appendix III Röntgenverordnung"*.
Eigensichere Kathodenstrahlröhre nach *"Anlage III Röntgenverordnung"*.

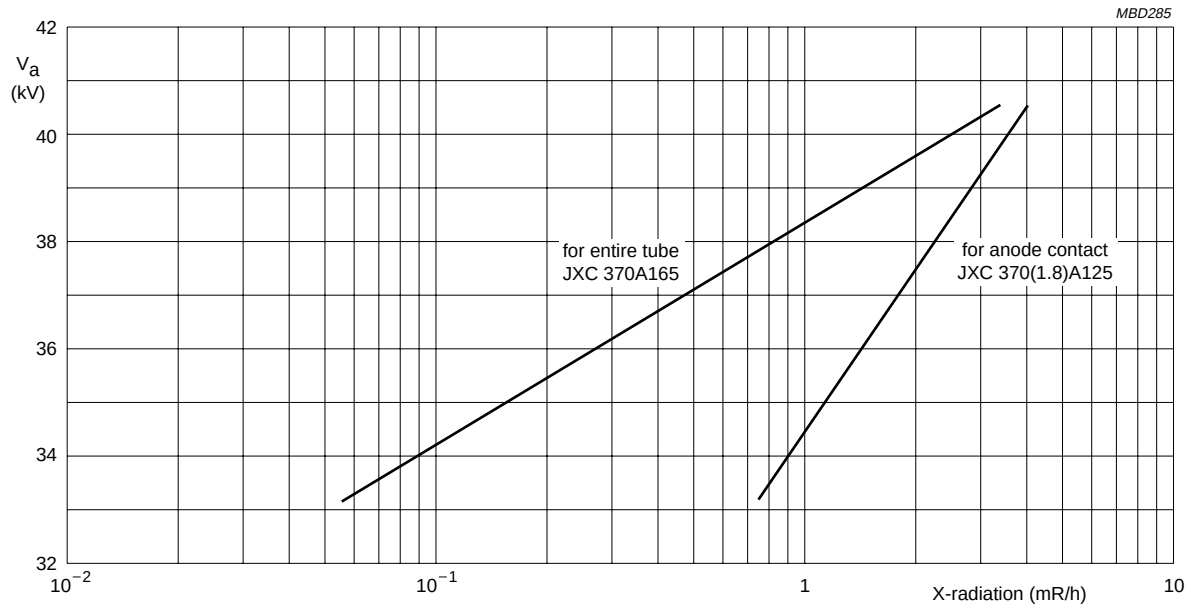


Fig.24 X-radiation limit curves at a constant anode current of 300 μA.

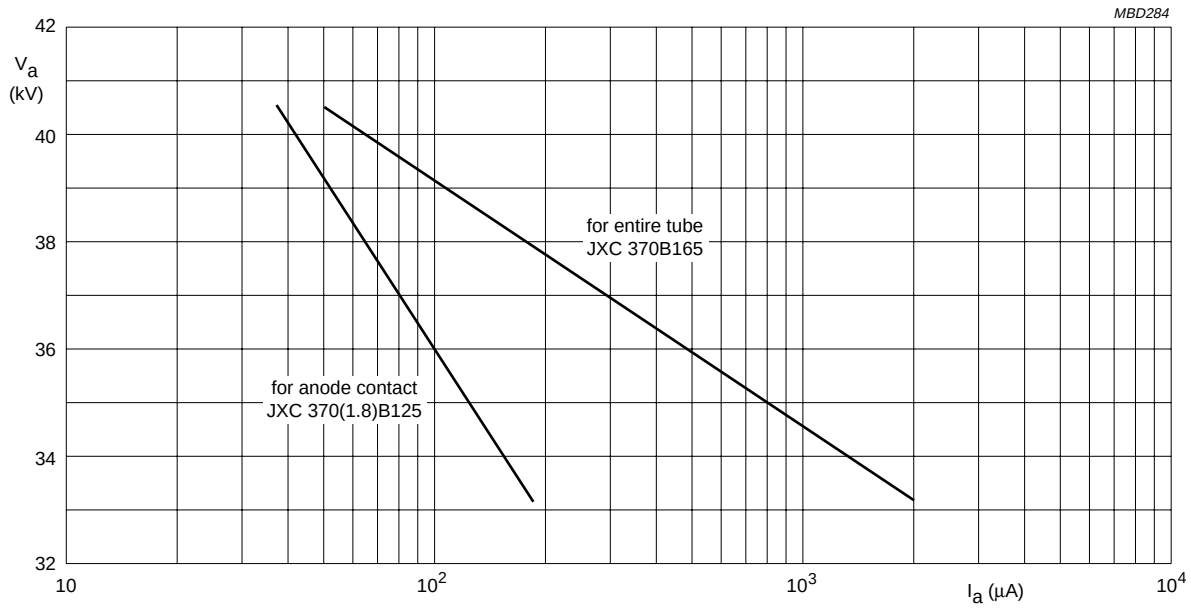
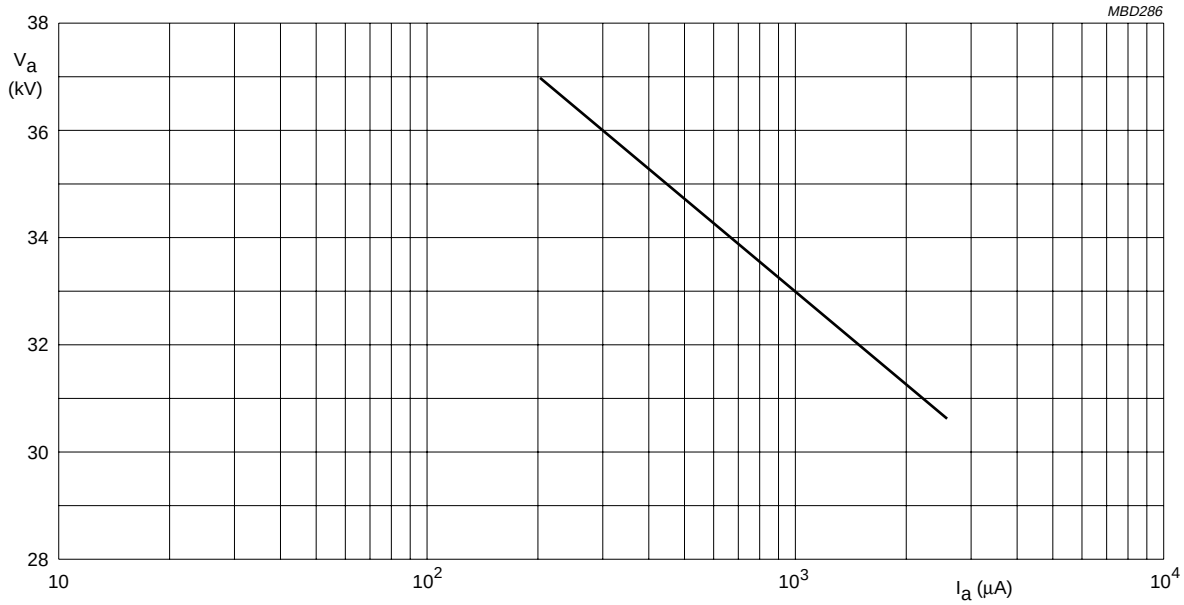


Fig.25 0.5 mR/h iso-exposure-rate limit curves.



The X-radiation emitted will also not exceed 1 μSv/h for anode voltage and current combinations shown in the iso-exposure-rate limit curve according to Eigensichere Kathodenstrahlröhre nach *"Anlage III Röntgenverordnung"*.

Fig.26 1 μSv/h iso-exposure-rate limit curve.

5.2 Warnings

X-radiation
Operation of the monochrome monitor tube under abnormal conditions that exceed the 0.5 mR/h iso-exposure-rate curve shown in Fig.25 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 values stated in Section 4.3 are not exceeded.
Tube replacement
This monitor tube incorporates integral X-radiation and implosion protection and must be replaced with a tube of the same type number or 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 taken during replacement or servicing of the monitor tube since a residual electrical charge may be held by the high-voltage capacitor formed by the external and internal conductive coatings of the monitor 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.

5.3 Handling

The packaging provides protection against tube damage under normal conditions of shipment or handling. Observe any instructions given on the packaging and handle accordingly. Under no circumstances should the tube assembly be subjected to accelerations greater than the values given in Table “Accelerations”.

Accelerations

PARAMETER	CONDITIONS	MAX.	UNIT
Pulse in cone direction	≤10 ms	350	m/s^2
	30 ms	200	m/s^2
Pulse in all other directions	30 ms	350	m/s^2

Monitor tubes should be kept in the shipping box or similar protective container prior to installation.

Although monitor tubes are provided with integral implosion protection which meets the intrinsic safety requirements stipulated in the relevant part of IEC 60065, care should be taken not to scratch or knock any part of the tube. Particularly care should be taken to prevent damage to the seal area.

In all handling procedures prior to insertion in the cabinet, there is a risk of personal injury if severe accidental damage to the tube occurs. It is therefore recommended that in areas containing unpacked and unprotected tubes, protective clothing is worn, particularly, gloves and safety glasses with side-shields to prevent possible injury from flying glass in the event of such an accident.
Handle the tube with extreme care. Do not strike, scratch or subject the tube to more than moderate pressure.

The tube assembly should never be handled by the tube neck, deflection unit or other neck components.

If suspending the tube assembly from the mounting lugs, ensure that a **minimum of two** are used.
Under no circumstances suspend the tube assembly from one lug.

An alternative lifting method is to firmly grasp the assembly by the vertical sides of the rimband. Manually lifting the assembly from the face-down or face-up position is shown in Figs 27 and 28.

To protect the screen when placing the tube face-down, ensure that the tube face rests on a cushion kept free from abrasive substances.

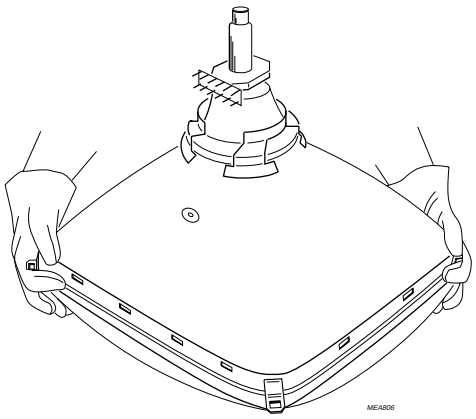


Fig.27 Lifting tube from face-down position.

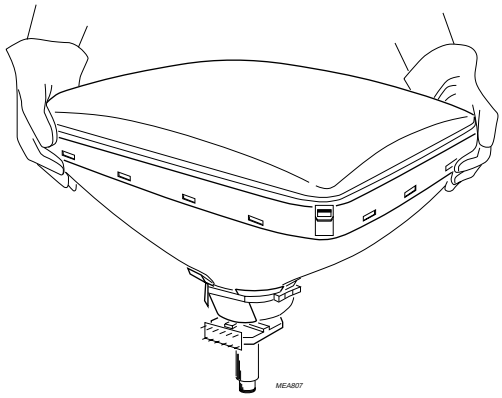


Fig.28 Lifting tube from face-up position.

5.4 Environmental conditions

The tube assembly must be capable of meeting the requirements of this specification under/after the following environmental conditions.

5.4.1 AMBIENT TEMPERATURE

- Tube operating +10 °C to +53 °C
- Storage and shipment –20 °C to +60 °C with a thermal shock up to 24 °C
- 50% relative humidity at either limit with the tube assembly inside the shipping container.

5.4.2 RELATIVE HUMIDITY

- Operating 8% to 80%
- Storage and shipment 5% to 100% (including condensation, but excluding rain).

5.4.3 BAROMETRIC PRESSURE

- Operating and storage 769 hPa to 1060 hPa
- Shipment 91 hPa to 1060 hPa.

5.4.4 WET BULB TEMPERATURE

- Operating maximum 26.7 °C
- Storage and shipment 29.4 °C.

6 DEFINITIONS

Data sheet status	
Objective specification	This data sheet contains target or goal specifications for product development.
Preliminary specification	This data sheet contains preliminary data; supplementary data may be published later.
Product specification	This data sheet contains final product specifications.
Limiting values	
Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 60134). Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only and operation of the device at these or at any other conditions above those given in the Characteristics sections of the specification is not implied. Exposure to limiting values for extended periods may affect device reliability.	

7 LIFE SUPPORT APPLICATIONS

These products are not designed for use in life support appliances, devices, or systems where malfunction of these products can reasonably be expected to result in personal injury. PDS customers using or selling these products for use in such applications do so at their own risk and agree to fully indemnify PDS for any damages resulting from such improper use or sale.

PDS

Professional Display Systems B.V.

Professional Display Systems B.V.

Jan Campertstraat 5

6416 SG Heerlen

The Netherlands

Tel: +31 (0)45 5439312

Fax: +31 (0)45 5426458

E-mail : info@crt.nl

Internet : www.professionaldisplaysystems.nl

Specification

M 51EDF240WB50P

51 cm / 21 inch rectangular monochrome CRT

Portrait format

Status: Preliminary
Modifications may be agreed upon after evaluation of about 200 products.

CONTENTS

1 VIEW OF CHANGES
2 APPLICATION
3 CHARACTERISTICS
4 IMPORTANT NOTES
5 MECHANICAL DATA
6 MAXIMUM OF NOT DEFLECTED SPOT LANDING
7 OPTICAL DATA
8 PERMISSIBLE GLASS AND SCREEN DEFECTS
9 RESOLUTION
10 ELECTRICAL DATA
11 ABSOLUTE LIMITING VALUES
12 OPERATING VALUES
13 GRID DRIVE CHARACTERISTICS
14 LARGE AREA CONTRAST
15 ENVIRONMENTAL CONDITIONS
16 ESTIMATED LIFE TIME
17 X-RADIATION

1 View of changes

- The first release will be "01" .
- Changes and supplements to this specification during the development require the agreement of all persons responsible.

Responsible for the contents of this document are:

Company/Department	*Name*	*Tel.*	*Date*	*Signature*
PDS	P.Aerssens	+31 45 5439331		
Siemens A&D SE BT E				

ChangeNr.	1			
Date	March 10 2006	June 21 2006	July 23 2007	
Release	01	02	03	04

ChangeNr.				
Date				
Release	05	06	07	08

Changed pages:

Release: 01 Pages: 11, changed blemish specification < 0,2mm.
Release: 02 Pages:15, heater voltage specification, brightness variation. 20 : stray emission. 24 : drawing.
Release :03 Page 15: heater voltage specification. 16: Grid drive characteristics.

2 Aplication

CRT for displays in medical and alphanumerical applications

3 Characteristics

high resolution
90° -deflection
flat & square colour bulb (low browning glass)
multicoated
conductive coated against charging
intrinsically safe
high contrast
high luminance
long life time

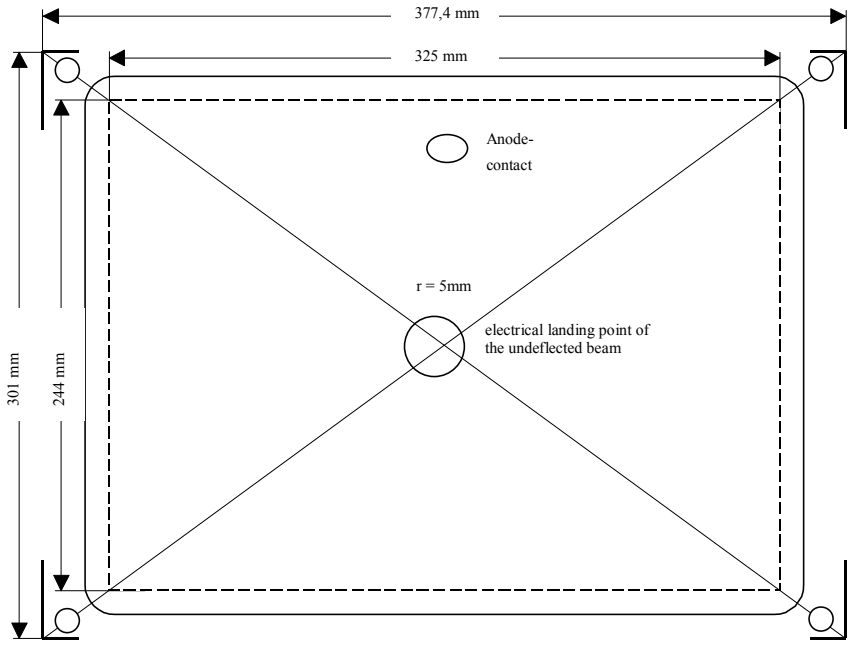
4 Important notes

Implosion hazard	**CRT is evacuated. In case of mechanical damage (e.g. by shock or scratches) implosion can occur.**
CRT is labeled according:	**UL 1418** **MPR II**
High voltage	**For reasons of the CRT's capacities the anode connection can conduct high voltage for a long time after high voltage is switches off.**
X-ray emission	**Operating the tube within the limits the x-ray dose rate will be under the allowed value of 1 µSv/h (adequate to: 0,1 mR/h)** **The tube is an intrinsic CRT type according the RöV (German Röntgenverordnung) dated Jan, 8th 1987, Part I; Attachment III, paragraph 6.**

5 Mechanical Data

Screen	**rectangular, R = 1370 mm**	
Useable screen	• **Screen diagonal** • **Screen width** • **Screen height**	**min. 508,0 mm** **min. 304,8 mm** **min. 406,4 mm**
Position of operation	**anode connector on the right (front view)**	
Socket	**JEDEC B10-277 or equal**	
Neck diameter	**29,1 mm**	**± 0,7 mm**
Anode connector	**Bulb contact 7,92**	**DIN 41543**
Deflection yoke	**Drawing nr. 250 898.ZZ** **THOMSON-Yoke No.: 9290.xx**	
Weight	**Approx. 17,0 kg incl. Deflection yoke**	
Mechanical outlines	**see attachment 1**	

6 Maximum of not deflected spot landing

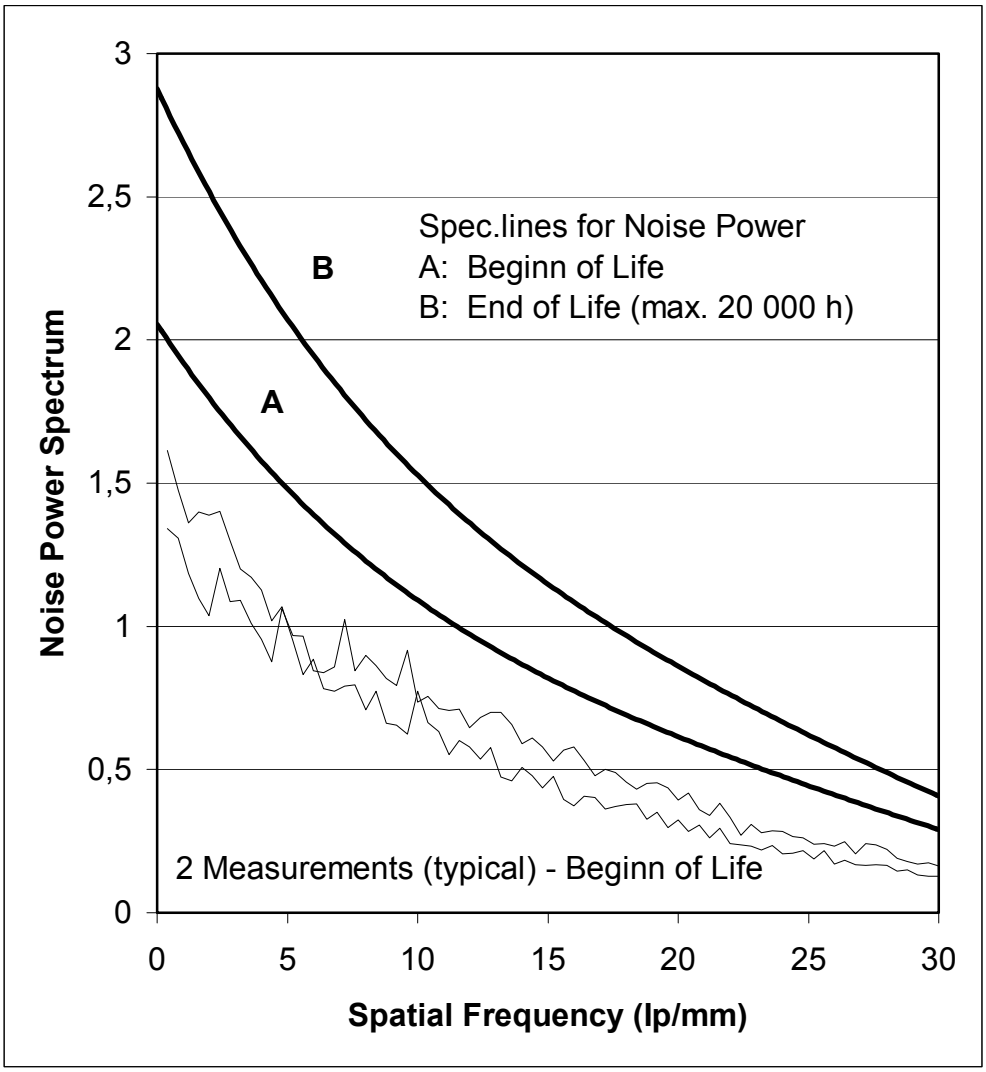


- **The CRT is mounted by angle brackets to a jig (see schematic) whose pick-up holes meet those of the monitor chassis.**
- **The CRT has to be moved in its fitting ears in such a way, that finally the centre of the glass bulb matches the mechanical centre of the jig ± 1 mm.**
- **Phosphor material must be everywhere within a window of 300 × 400 mm. The centre of that phosphor window matches the mechanical centre of the CRT.**
- **The spot or the deflection yoke will be adjusted, so that equal and symmetrical focus exists.**
- **The non-deflected spot landing must be within a circle with a radius of 2 mm around a point 3 mm left and 2 mm down from the mechanical centre of the CRT, provided that:**
  - **the CRT axis is in east-west direction and the front panel is facing east,**
  - **the anode connector is located on the right,**
  - **the deflection unit has been mounted to the tube,**
  - **there is a metal shield behind the deflection unit around the tube's neck**
- **The maximum rotation angle of the deflection unit may not exceed 0.2°.**

7 Optical data

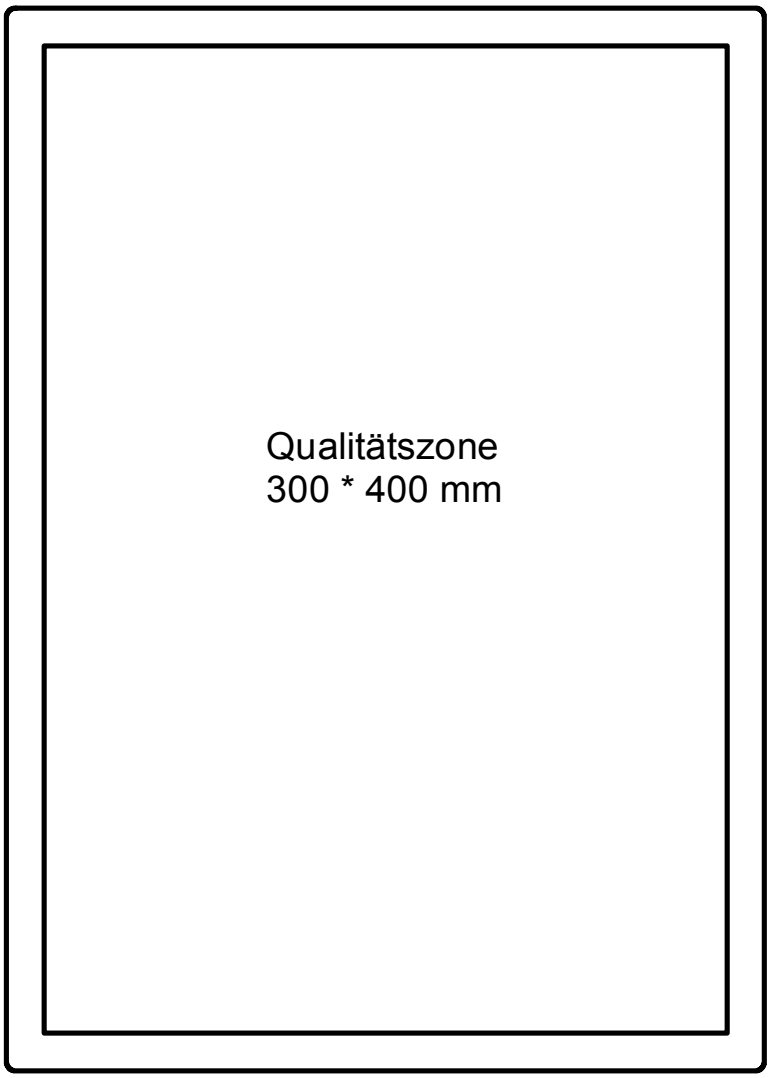
Total transmission of bulb including coating/panel:	**32 % ± 3 % at 546 nm**	
Phosphor	**P45**	
7.1	**Noise Power (see fig.)**	
Colour coordinates: (during operation)	**P45-Phosphor**	
at a luminance of 250 Cd/m^2 (Nit) with CL60-Filter, (measured with LMT Colour meter or Minolta CA100)	**X = (0,250 ± 0,01)**	**Y = (0,305 ± 0,01)**
Front panel	**Transmission at 546 nm ca.60% Coating Flabeg OEL-65. Direct coating alternative after agreement with customer. The connection with the mounting device aluminium strips are mounted on front panel.**	
Uniformity of luminance from centre to any corner	**At a luminance of 50 Nit the overall deviation of luminance from centre to any corner may not exceed 12 Cd/m^2 (Nit) at any point of the screen.**	
Glass bulb	**Drawing nr. 252 907.GZ or equivalent bulb after agreement with customer.**	

7.1 Noise power



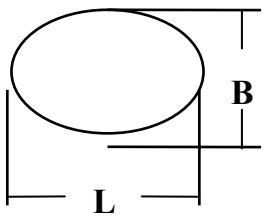
Noise Power measured with SIEMENS Measurement system.

8 Permissible Glass and screen defects



L: max. length of defects

B: max. width of defects



d = 300 mm

Defect size G for the screen and glass specification

for a side ratio of L/B ≤ 3 G = ½ (L + B)
for a side ratio of L/B > 3 G = L/20 + 2 B

Permissible defect (inclusive Panel)

Defect size G in mm	Quality zone 400 x 300 mm
≤ 0,2*	Within an area of 30x30mm there are allowed 3 defects with size 0,1- 0,2mm.
0,2* < G ≤ 0,4*	4
Distance between defects	> 50 mm

Scratches

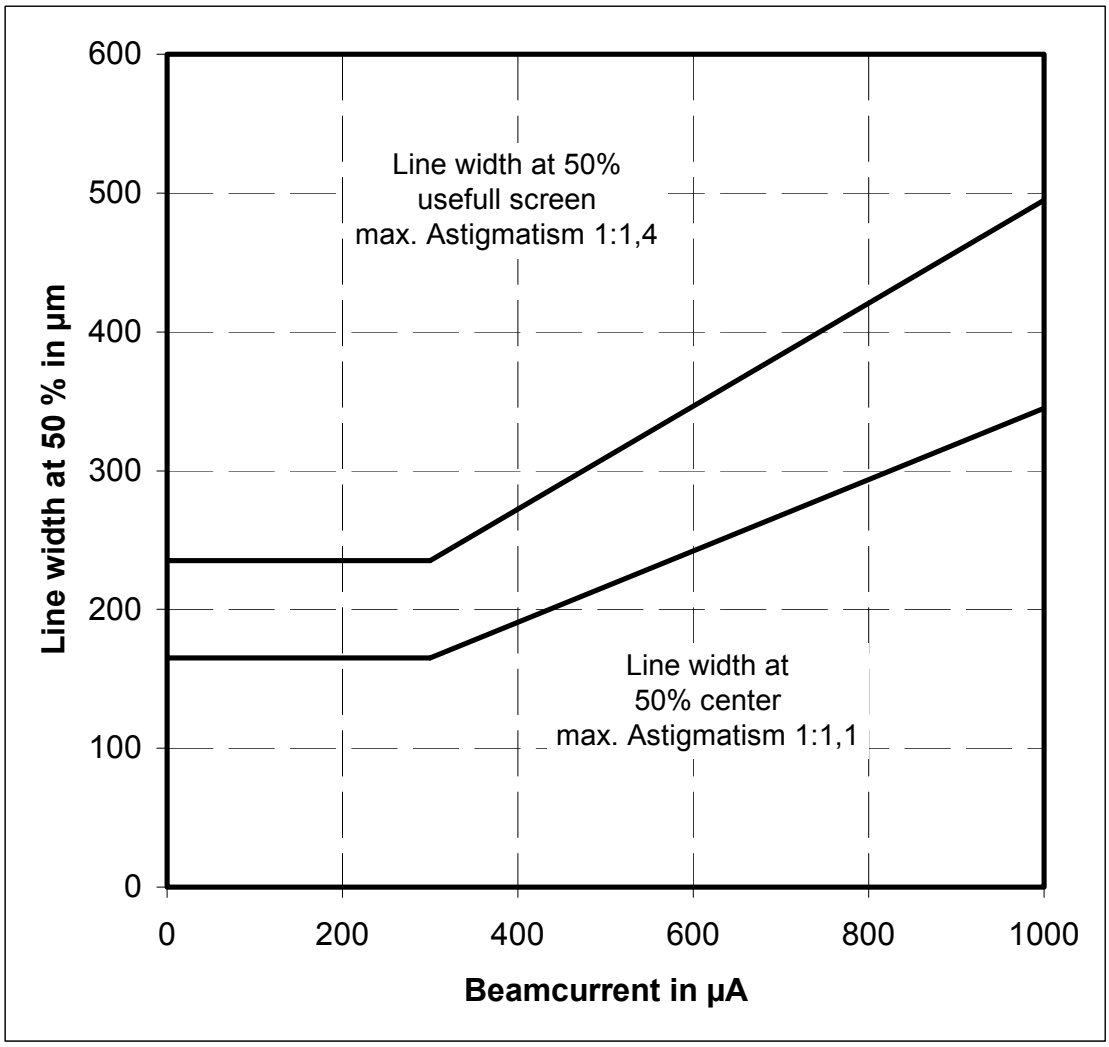
Sum ≤ 2
distance > 50 mm
max. length < 10 mm
max. width < 50 µm

Scratches <15 µm are permitted

Not allowed defects:
Open holes, stones, folds, cracks, accumulated defects, 'cloud'.

9 Resolution

50 % of peak value
Optimal focus: 300µA
Duty cycle 100 %

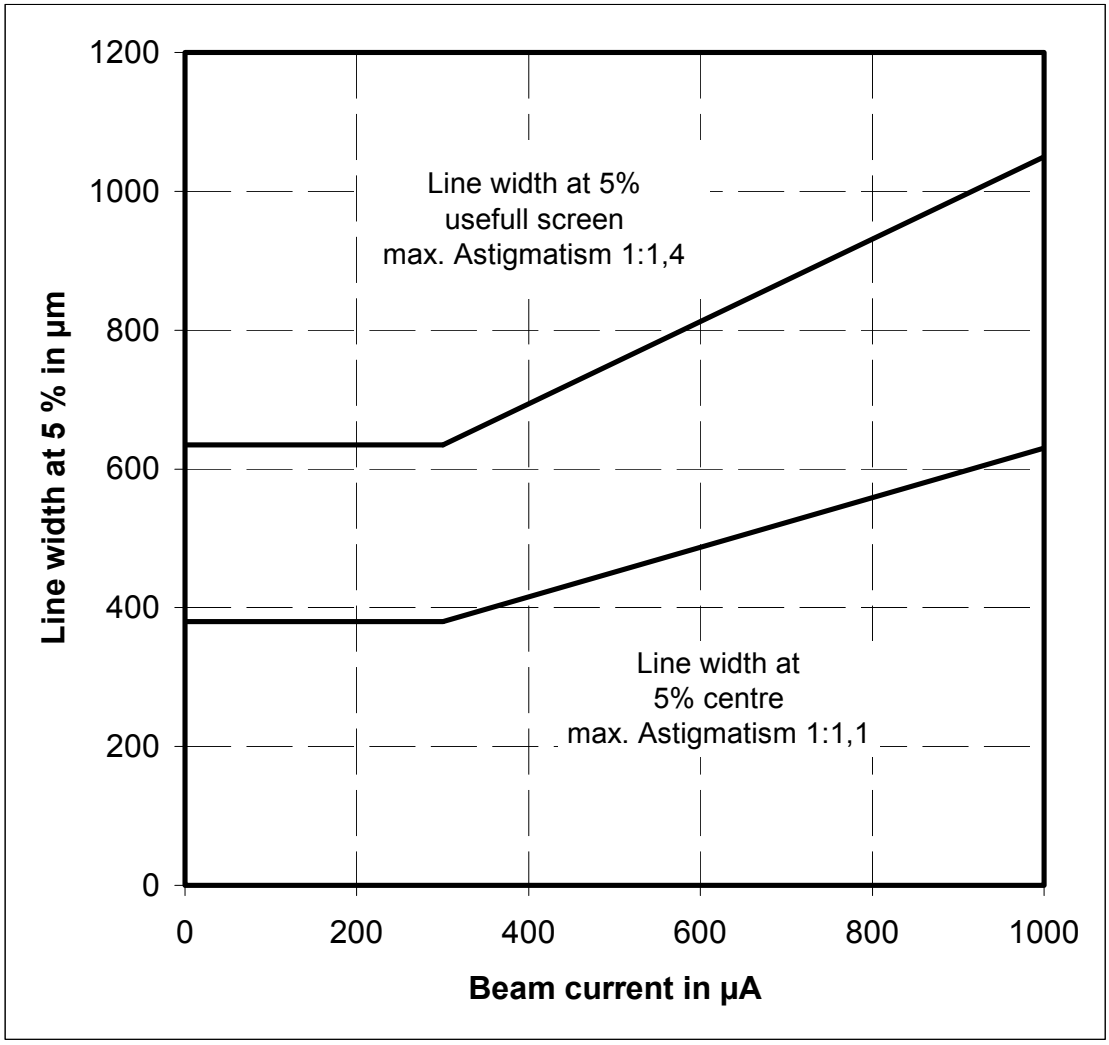


Measured with Microvision Superspot SS200 or PDS spot profile measuring system

- Astigmatism at 5% and 50%-line width has the same shape.
- Astigmatism is not allowed to turn at increased beam current
- The spot profile approximates the Gaussian distribution.

Resolution

5 % of peak value
Duty cycle 100 %



Measured with Microvision Superspot SS200 or PDS spot profile measuring system

10 Electrical Data

Deflection		magnetically, deflection angle - horizontal ca. 60° - vertical ca. 78° - diagonal ca. 90°	
Focussing		electrostatic	
Maximum currents (leakage)	I_{G1}	± 1µA	
	I_{G2a}	± 1µA	max. 5 changes allowed
	I_{G2b}	± 1µA	
	I_{G3}	± 2µA	
Capacity *) (Grid 1 to all other electrodes)	$C_{G1\text{-}all}$		5,3 pF ± 1 pF
Capacity *) (Cathode to all other electrodes)	C_K		3.5 pF ± 1 pF
Capacity *) (Grid1 to cathode)	$C_{G1\text{-}K}$		2,3 pF ± 0,7 pF
Capacity (Anode to outher coating)	$C_{A\text{-}M1}$		1600 ... 3000 pF

Electrical Data from THOMSON-Coil		**Drawing nmbr. 250 898.ZZ THOMSON-YOKE Nr. 9290.xx**
Horizontal deflection	**Lx**	**27 µH ± 5 %**
	Rx	**125 mΩ ± 10 %**
Vertical deflection	**Ly**	**1.80 mH ± 5 %**
	Ry	**3.00 Ω ± 10 %**
Rotation coil	**Rr**	**140 Ω ± 10 %**
	Ir	**100 mA / 5.2 °**
Astigmatism Axial	**La**	**22.5 µH ± 5 %**
	Ra	**5.05 Ω ± 10 %**
Astigmatism Diagonal	**Ld**	**23.2 µH ± 5 %**
	Rd	**5.05 Ω ± 10 %**

***) measured with PHILIPS RLC Meßbrücke PM6303**

11 Absolute limiting values

Cathode is reference point for all voltage values

First accelerating voltage	$U_{G2\ I\&II}$	max. 1300 V min. - 400 V	
Second accelerating voltage	U_A	max. 29,9 kV	
Focus voltage	U_{G4}	max. 9 kV	
Grid 1 voltage	$-U_{G1}$	max. 150 V (200 V for 5 sec. after switch off) min. 2 V	
Heating against cathode	U_{HC}	negative negative peak positive positive peak	255 V 300 V 3 V 50 V
	I_{HC}	max. 15 µA	
Grid 1 leakage resistance	R_{G1}	1,5 MΩ	
Damping of deflection field:	The power consumption of the horizontal deflection is allowed to increase by max. 2,3W when yoke is mounted to the CRT. (at 200 kHz horizontal frequency, a retrace time of $\leq$ 1,2 µs and a horizontal width of 300 mm at U_A = 29,0 kV).		

12 Operating values

Cathode heating	- indirect		
	- Heating voltage	U_h	6,0 – 6,2 V
	- Heating current,	I_h	approx. 100 mA;
		$I_{h\ max}$	0,5 A (cold state)

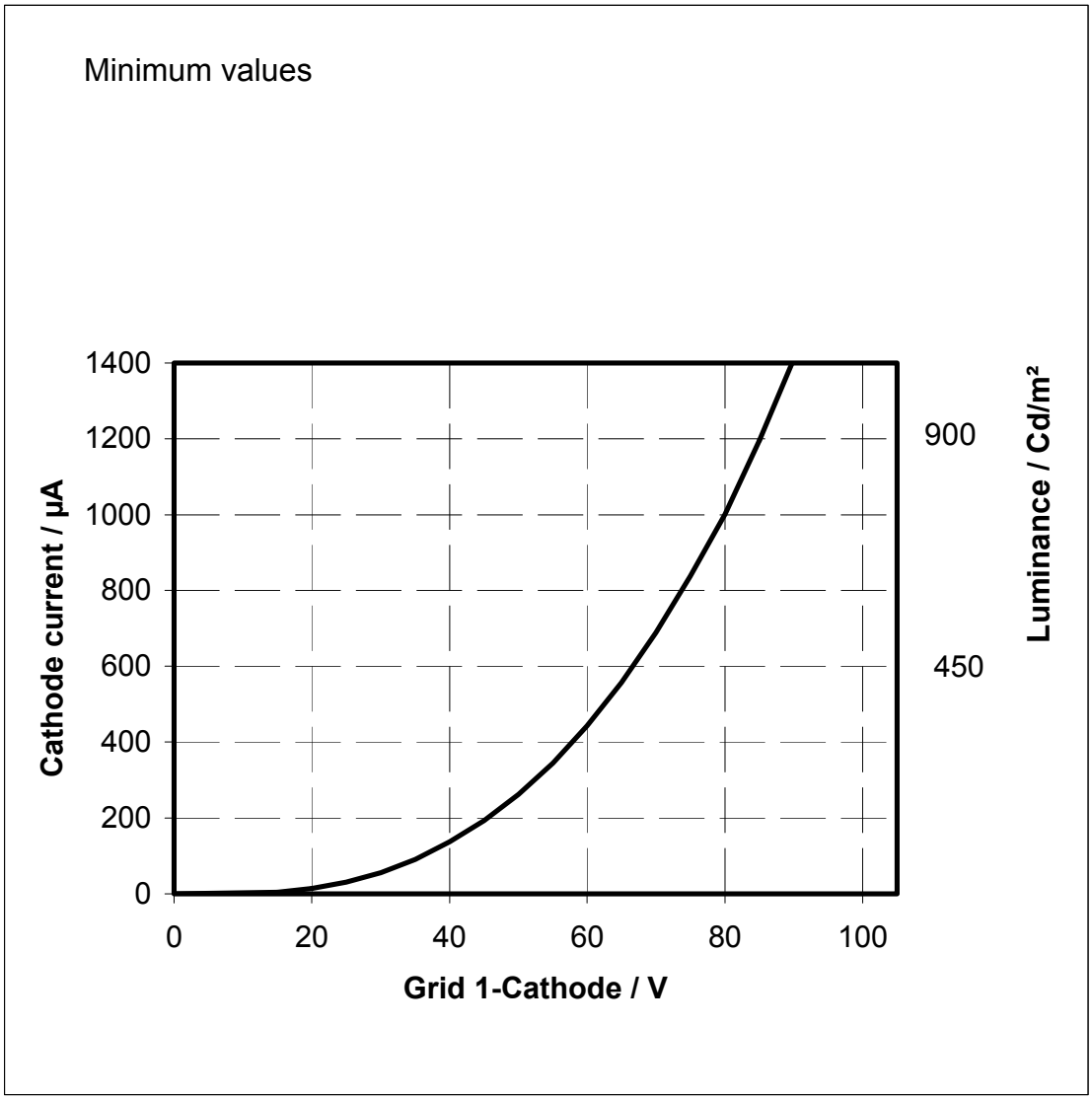
An integrated series resistor of 0.39 Ω reduces the effective heater voltage to 5.6-5.8V.

Cathode is reference point vor all valtage values following

First accelerating voltage	$U_{G2\ I}$	600 - 930 V
Halo suppression voltage	$U_{G2\ II}$	0 - 200 V

Grid 1 voltage (for spot suppression)	$-U_{G1}$	105 V
second accelerating voltage	U_A	29,0 kV
Drive voltage (grid drive) (from I_C = 0 µA to I_C = 1200 µA[1)]	ΔU_{WE}	max. 85 V
Luminance drift over time		max. 18 minutes after switch on (an overshoot of max 10% of cut-off voltage is allowed during this time)
Focus voltage (at centre of screen at I_C = 300 µA	U_{G3}	min. 6,80 kV nom. 7,15 kV max. 7,50 kV
Dynamic focus voltage (with reference to Thomson-yoke Nr. 9290.xx)	$U_{G3\ dyn.}$	max. = 850 V
Brightness variation when changing from 100% white pattern to 10% square white pattern (same drive voltage)		No brightness variation allowed

Grid drive characteristics

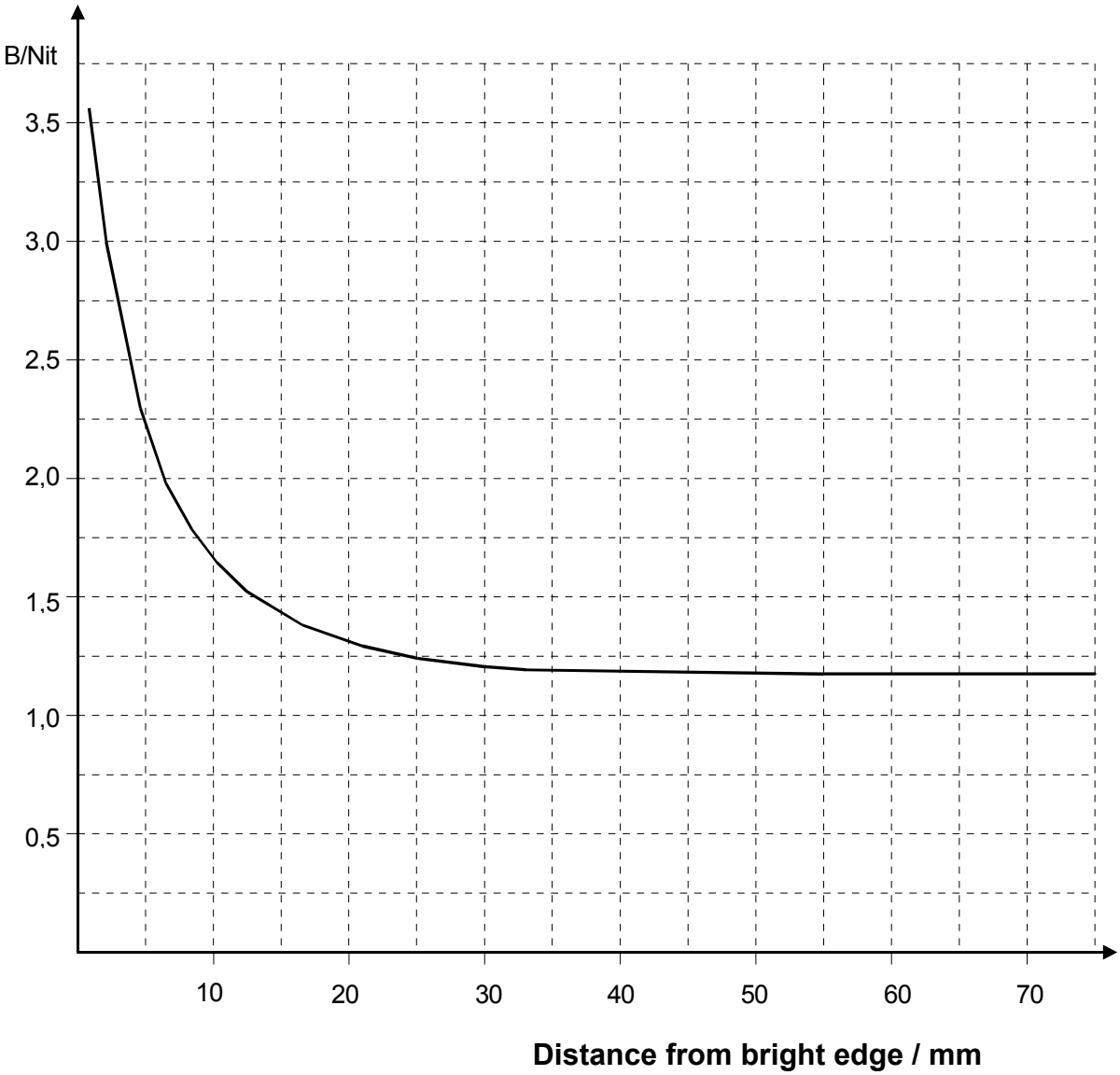


Luminance at 100% duty cycle . Horizontal freq: 64 kHz; Vertical freq: 50 Hz.

Scan area 300*400 mm

14 Large area contrast

Max. value



To measure the large area contrast a bright rectangle is displayed on one half of the screen. This area must be 50% of the total screen area with an aspect ratio of x : y = 2:3, and a luminance of 400 Nit.
The luminance of the black area is adjusted in such way that no lines can be seen in dark room conditions (optical cut-off value).
With the Microvisionsystem Superspot (or similar) the brightness is measured in relation to the distance from the black/white edge.
The bright rectangle must be totally covered with a non reflecting cover during measuring.

15 Environmental conditions

Temperature range:

Operation	**0 to + 70 °C** **relative humidity 75 %** **non condensing**
Storage	**- 40 to 70 °C**
Temperature gradient	**20 °C/h**
Air pressure	**400 hPa to 1060 hPa**

16 Estimated life time

Decrease of the cathode current of 800 µA at 100 % duty cycle and constant Cut-Off-voltage (Grid 2-voltage adjusted)

after	**20.000 hrs. < 10 %**

Burning conditions:
The cathode current during testing is max. 500 µA at 100 % duty cycle over total scan area.

During life time of the CRT (20 000 hours) G2a voltage may be increased to max. 1250 V, to maintain G1-Cut-Off voltage of –105V.

At a maximum luminance level of 350 Nit, after 20.000 hours of operation ,the maximum decrease in phosphor luminance is 15 %.

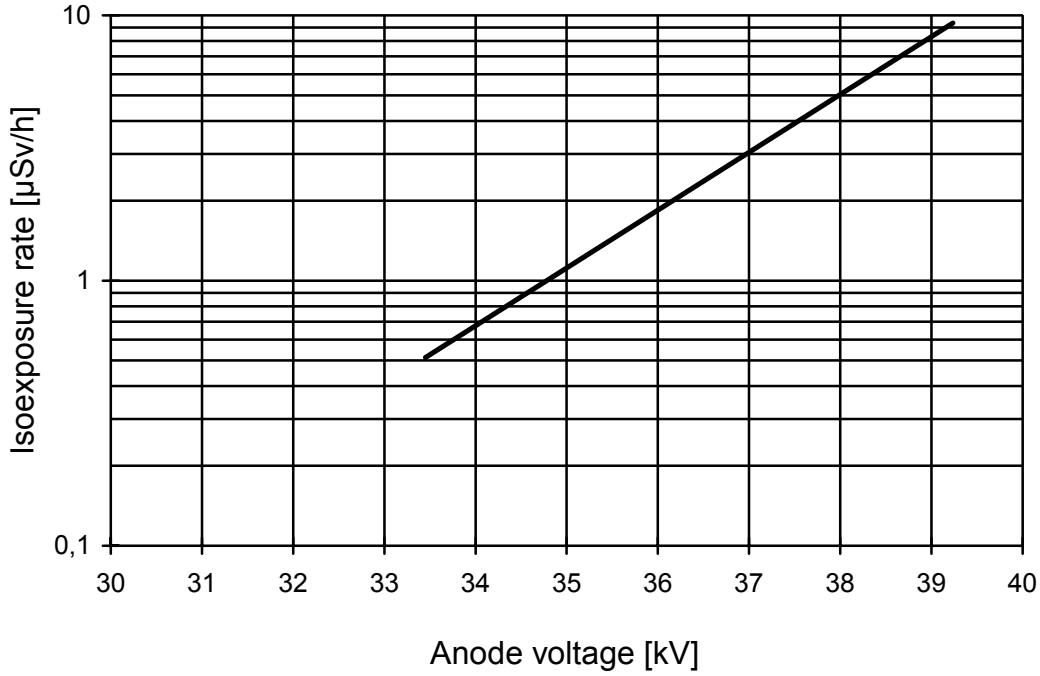
Stray emission : Maximum anode current in cut-off condition Uc- Ug1 > Uco after 10.000 hrs. : < 1 µA

17 X-radiation

X-Radiation Limit Curve

Conditions:

Cathode current I_C = 250 µA

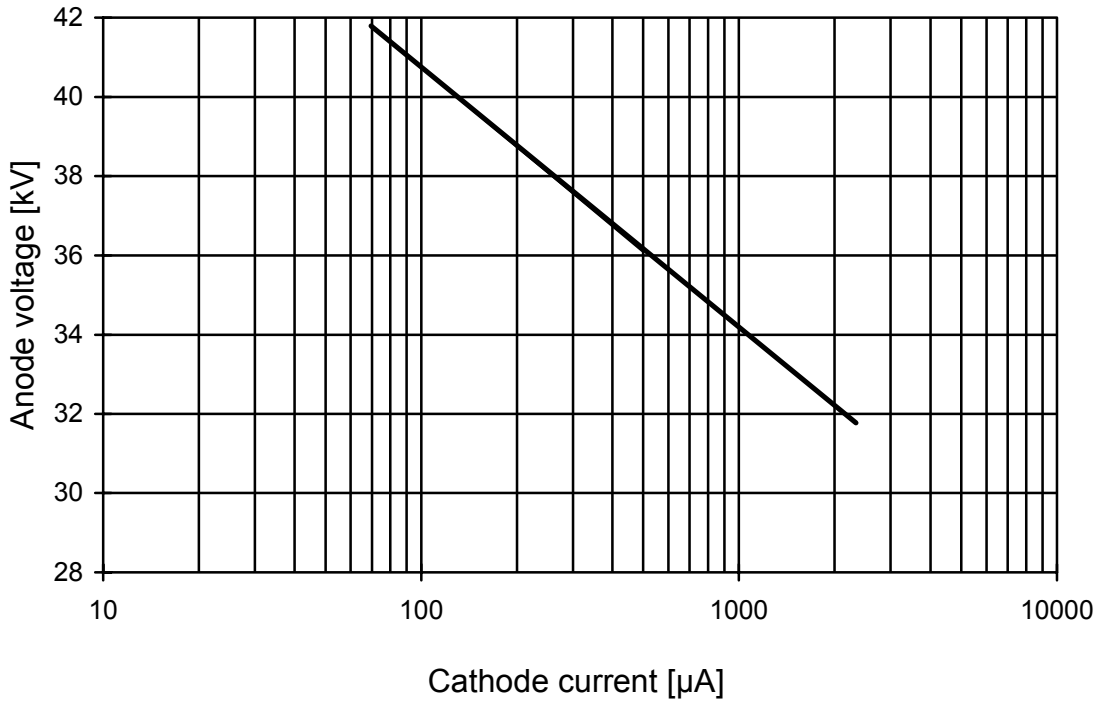


X-Radiation exposure rate vs. anode voltage at a constant value of cathode current measured at 5 cm from the CRT.

The measurement is according:
"Röntgenverordnung der Bundesrepublik Deutschland vom 8. Januar 1987"

Isoexposure - Rate Limit Curve

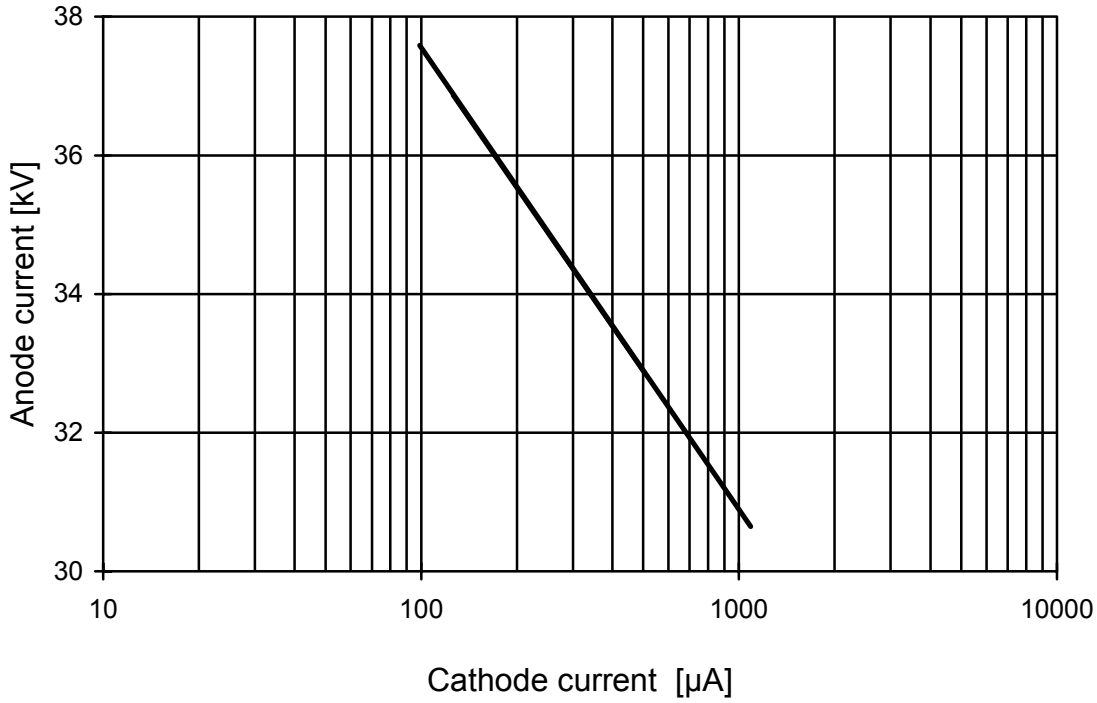
Calculated for 5 µSv/h



This limit curve is plotted at an isoexposure rate of 5 µSv/h (0,5 mR/h) measured at 5 cm from the CRT.

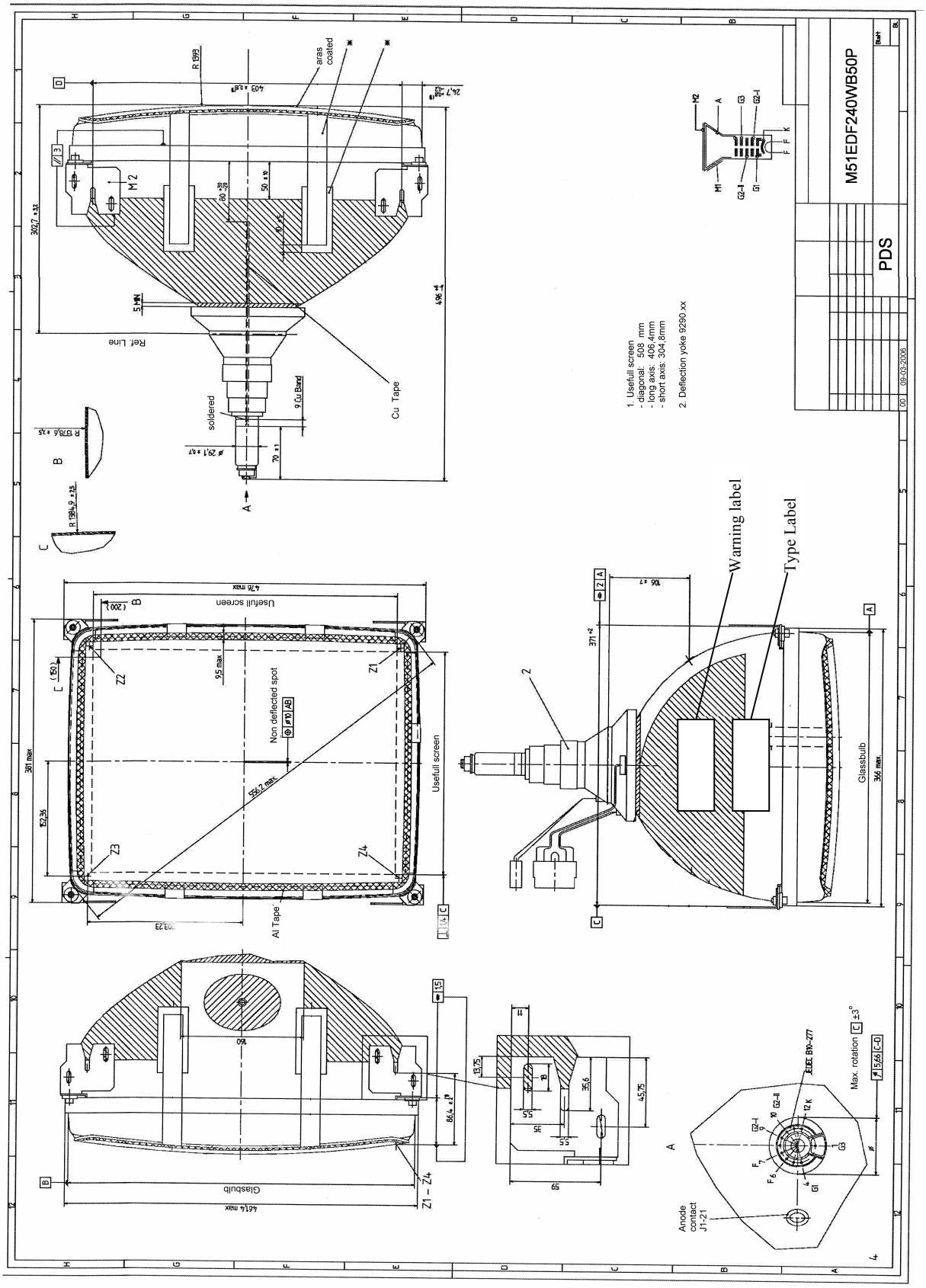
Isoexposure - Rate Limit Curve

Calculated for 1 µSv/h



This limit curve is plotted at an isoexposure rate of 1 µSv/h (0,1 mR/h) measured at 5 cm from the CRT.

Attachment 1



Specification

M 51EDF290WB60P

51 cm / 21 inch rectangular monochrome CRT

Portrait format

Status: Preliminary
Modifications may be agreed upon after evaluation of about 200 products.

CONTENTS

1 VIEW OF CHANGES
2 APPLICATION
3 CHARACTERISTICS
4 IMPORTANT NOTES
5 MECHANICAL DATA
6 MAXIMUM OF NOT DEFLECTED SPOT LANDING
7 OPTICAL DATA
8 PERMISSIBLE GLASS AND SCREEN DEFECTS
9 RESOLUTION
10 ELECTRICAL DATA
11 ABSOLUTE LIMITING VALUES
12 OPERATING VALUES
13 GRID DRIVE CHARACTERISTICS
14 LARGE AREA CONTRAST
15 ENVIRONMENTAL CONDITIONS
16 ESTIMATED LIFE TIME
17 X-RADIATION
21 ATTACHMENT 1
22 BASE CONFIGURATION

1 View of changes

- The first release will be "01" .
- Changes and supplements to this specification during the development require the agreement of all persons responsible.

Responsible for the contents of this document are:

Company/Department	*Name*	*Tel.*	*Date*	*Signature*

ChangeNr.	01			
Date	16-7-2004			
Release	01	02	03	04

ChangeNr.				
Date				
Release	05	06	07	08

Changed pages:

Release: 01 Pages: 09 : Added Potting faults.

2 Application

CRT for displays in medical and alphanumerical applications

3 Characteristics

- High resolution
- 90° -deflection
- Flat & square color bulb (low browning glass)
- Multicoated
- Conductive coating against charging
- Intrinsically safe
- High contrast
- High luminance
- Long life time
- Low phosphor noise
- Low drift
- Protected against internal flash over

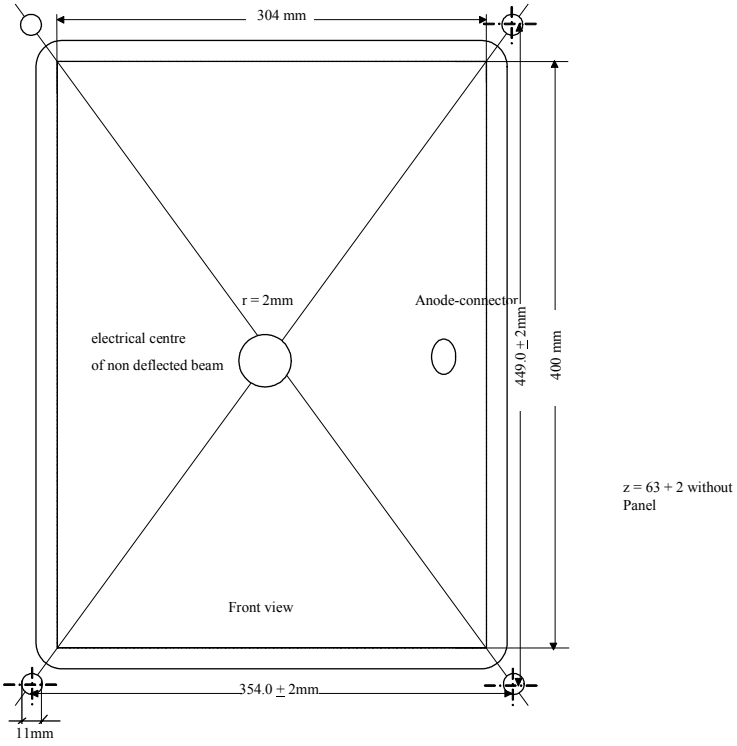
4 Important notes

Implosion hazard	CRT is evacuated. In case of mechanical damage (e.g. by shock or scratches) implosion may occur.
CRT is labeled according:	UL 1418 MPR II
High voltage	Because of the CRT's capacities the anode connection can maintain it's high voltage for an extended period after high voltage is switched off.
X-ray emission	When operating the tube within the limits, the X-ray dose rate will be under the allowed value of 1 µSv/h (equivalent to: 0,1 mR/h) The tube is an intrinsic CRT type according the RöV (German Röntgenverordnung) dated Jan, 8th 1987, Part I; Attechment III, paragraph 6.

5 Mechanical Data

Screen	rectangular, R = 1370 mm	
Useable screen	• Screen diagonal • Screen width • Screen height	min. 508,0 mm min. 304,8 mm min. 406,4 mm
Position of operation	anode connector on the right (front view)	
Socket	JEDEC B10-277 or equal	
Neck diameter	29,1 mm	± 0,7 mm
Anode connector	Bulb contact 7,92	DIN 41543
Deflection yoke	Drawing nmbr. THOMSON-Yoke 9288.xx	
Weight	Approx. 17,0 kg incl. Deflection yoke	
Mechanical outlines	see attachment 1	

6 Maximum of not deflected spot landing



- The CRT is mounted by angle brackets with pick-up holes that meet those of the monitor chassis. (see schematic in attachment 1)

- The CRT has to be moved in its fitting ears in such a way, that the centre of the glass bulb matches the mechanical centre of the jig ± 1 mm.

- Phosphor material must be everywhere within a window of 304 × 380 mm. The centre of that phosphor window matches the mechanical centre of the CRT.

- The beam alignment and the deflection yoke will be adjusted in a way that a symmetrical and equally distributed sharpness is obtained over the entire screen.

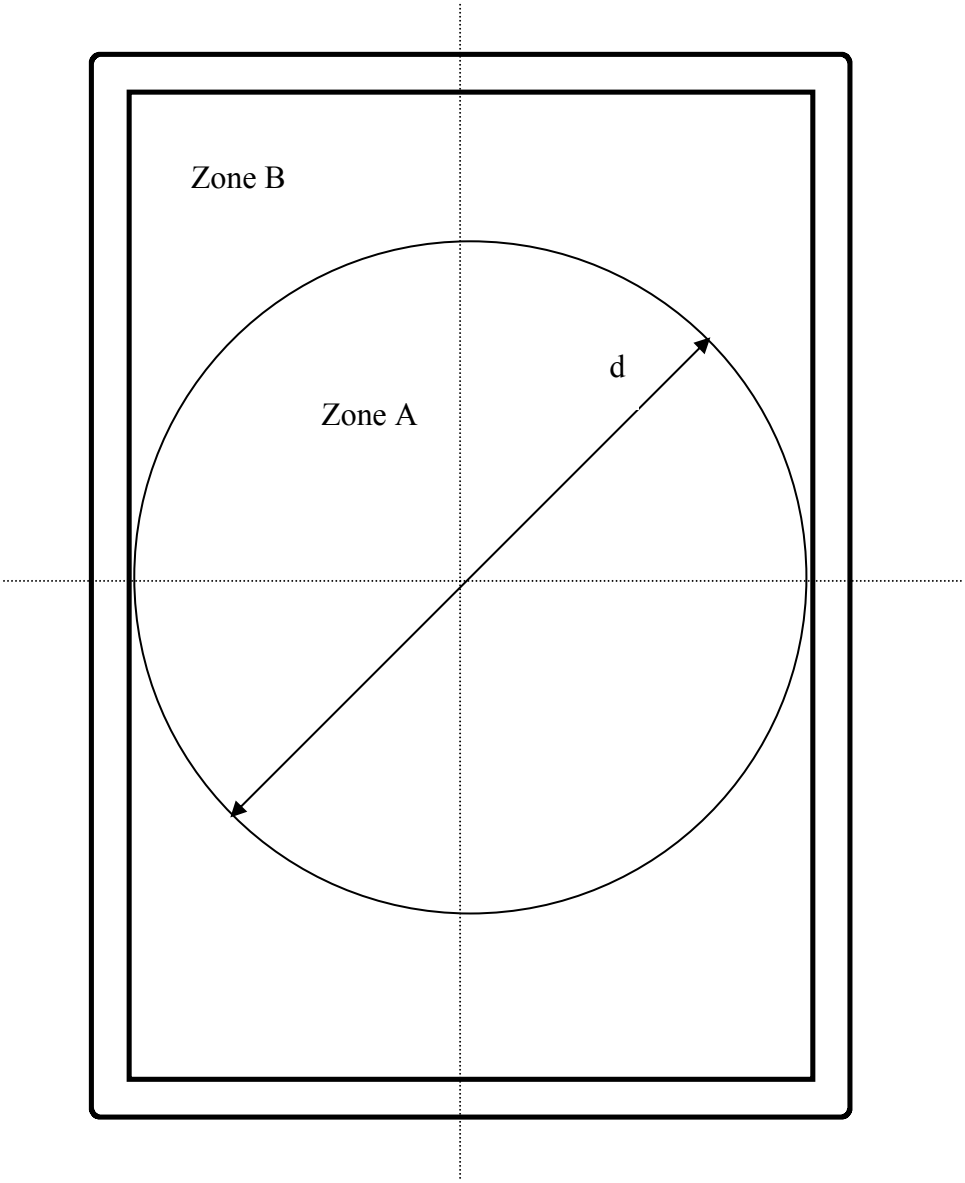
- The non-deflected spot landing must be within a circle with a radius of 2 mm around the mechanical centre of the CRT, provided that:
  - the CRT axis is in east-west direction and the front panel is facing east,
  - the anode connector is located on the right,
  - the deflection unit has been mounted to the tube,
  - there is a metal shield behind the deflection unit around the tube's neck

- The maximum rotation angle of the deflection unit may not exceed 0.2°.

7 Optical data

Total transmission of bulb including coating/panel:	32 % ± 3 % at 546 nm	
Phosphor	P45	
Color coordinates: (during operation)	P45-Phosphor	
at a luminance of 250 Cd/m^2 (Cd/m2) with CL60-Filter, (measured with LMT Color meter or Minolta CA100)	X = (0,250 ± 0,01)	Y = (0,305 ± 0,01)
Front panel	Transmission 65% at 546 nm. Unaxis Iralin 185. Anti-static , 2kΩ/□ Direct coating alternative after agreement with customer. The connection with the mounting device copper strips are mounted on front panel.	
Uniformity of luminance from centre to any corner	At a luminance of 50 Cd/m^2 the overall deviation of luminance from centre to any corner may not exceed 12 Cd/m^2 (Nit) at any point of the screen.	
Glass bulb	Panel : NEG 51 FS 4:3 or equivalent Funnel : Schott 51FS/90/H29/11 or equivalent	

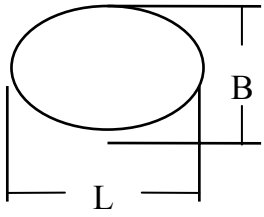
8 Permissible Glass and screen defects



d = 300 mm

L: max. length of defects

B: max. width of defects



Defect size G for the screen and glass specification

for a side ratio of $L/B < 3$ $G = ½ (L + B)$

for a side ratio of $L/B \geq 3$ $G = L/20 + 2\,B$

Permissible defect

Blemish Size G (mm)	Zone A	Zone B	Sum
< 0,2	disregard, but no accumulation *		-
0.2 < G < 0.4	2	3	4
0.4 < G < 0.6	-	3	3
Blemish Distance	> 50 mm	> 50 mm	

* max. 5 defects in a circle of Ø 15 mm.

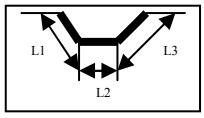
Viewing distance 0.5 m.

Scratches

Sum ≤ 2 , max. width < 30 µm independent from its length.

Not allowed defects:
Open holes, stones, faults, cracks, accumulated defects, 'cloud'.

Hairs, fuzz or similar particles in potting



Length = L1+L2+L3

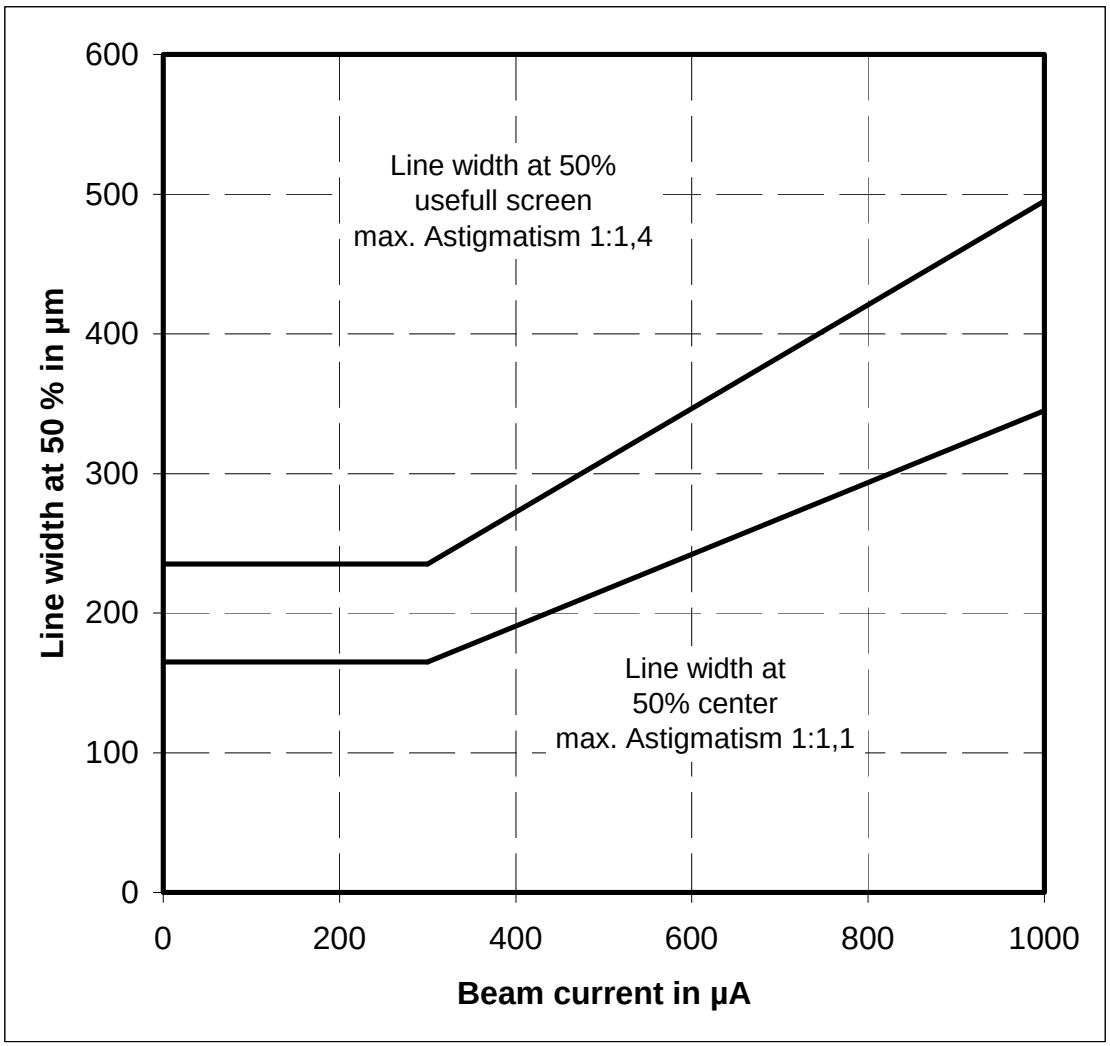
Lenght(L) of hairs,fuzz or similar particles in potting (mm)	Zone A	Zone B	Sum
L< 0,2	disregard, but no accumulation *		-
0.3 ≤ L ≤ 0.6	3	3	4
0.6 < L ≤ 0.8	0	1	1
L > 0.8	0	0	0
Distance	> 50 mm	> 50 mm	

Zone C requirements: L < 0.8mm disregard , but no accumulation*

* max. 5 defects in a circle of Ø 15 mm.

9 Resolution

50 % of peak value
Optimal focus: 300µA
Duty cycle 100 %

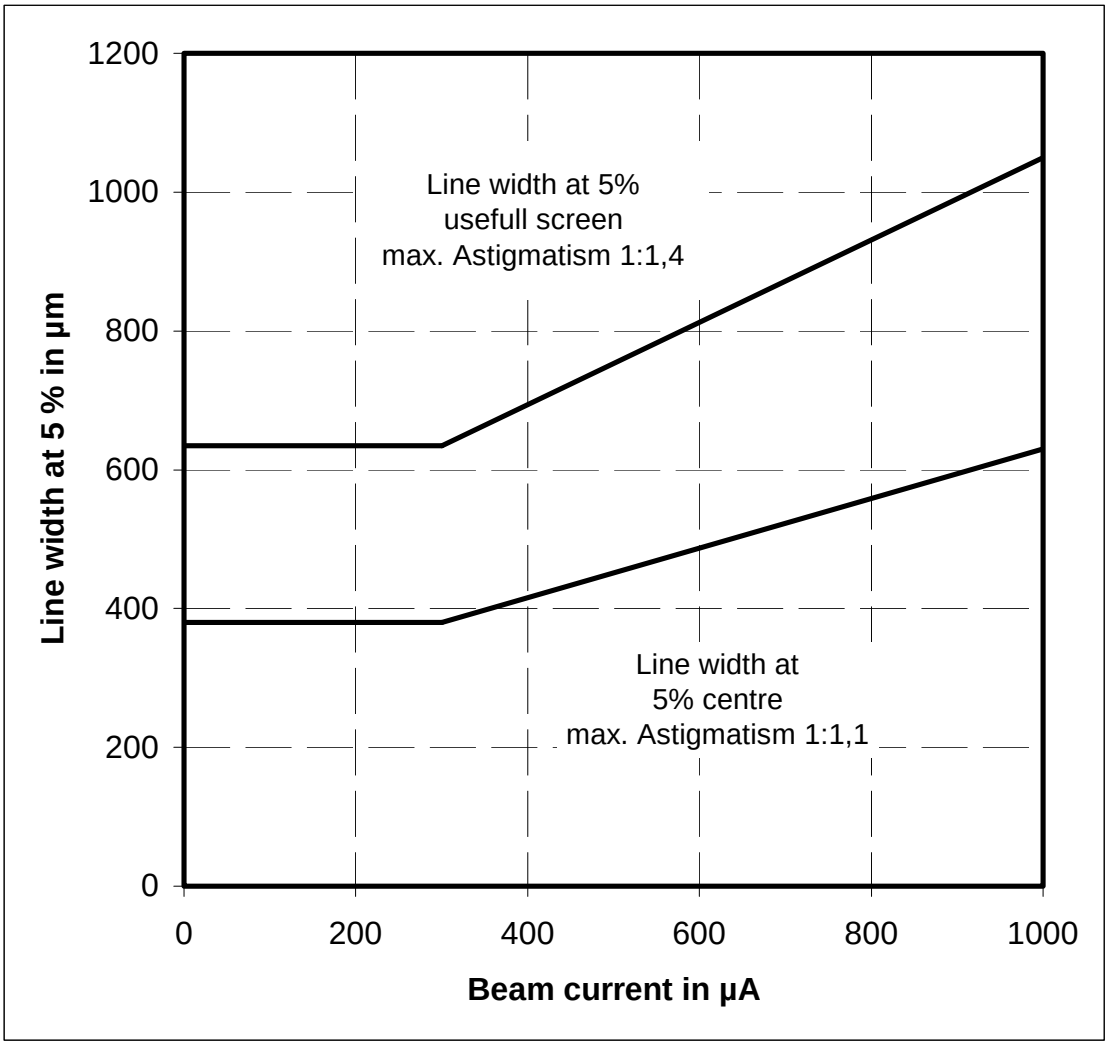


Measured with Microvision Superspot SS200 or PDS spotvision system.

- Astigmatism at 5% and 50%-line width must have the same shape.
- Astigmatism is not allowed to rotate with increased beam current
- Spotprofile approximates gaussian profile

Resolution

5 % of peak value
Duty cycle 100 %



Measured with Microvision Superspot SS200 or PDS spotvision system.

10 Electrical Data

Deflection	magnetically, deflection angle	
	- horizontal	ca. 60°
	- vertical	ca. 78°
	- diagonal	ca. 90°

Focussing	electrostatic	

Maximum currents (leakage)	I_{G1}	$\pm$ 1µA
	I_{G2a}	$\pm$ 1µA
	I_{G2b}	$\pm$ 1µA
	I_{G3}	$\pm$ 2µA

Capacity (Grid 1 to all other electrodes)	$C_{G1\text{-}all}$	5,3 pF ± 1 pF

Capacity (Cathode to all other electrodes)	C_K	3.5 pF ± 1 pF

Capacity (Grid1 to cathode)	$C_{G1\text{-}K}$	2,3 pF ± 0,7 pF

Capacity (Anode to outher coating)	$C_{A\text{-}M1}$	1600 ... 3000 pF

Electrical Data from THOMSON-Coil	Drawing #. THOMSON-YOKE Nr. 9288.00	
Horizontal deflection	Lx : 30 µH ± 5%	Rx : 0.56 Ω ± 10%
Vertical deflection	Ly : 2.6 mH ± 5%	Ry : 5.1 Ω ± 10%
Rotationcoil	Rr : 78 Ω ± 10%	Ir : < 55 mA/°
Astigmatism Axial	La : 9.9 µH ± 10%	Ra : 2.1 Ω ± 10%
Astigmatism Diagonal	Ld : 9.9 µH ± 10%	Rd : 2.1 Ω ± 10%

*) measured with PHILIPS RLC Bridge PM6303

11 Absolute limiting values

Cathode is reference point for all voltage values

First accelerating voltage	$U_{G2\ I\&II}$	max. 1300 V min. - 400 V	
Second accelerating voltage	U_A	max. 29,9 kV	
Focus voltage	U_{G3}	max. 9 kV	
Grid 1 voltage	$-U_{G1}$	max. 150 V (200 V for 5 sec. after switch off) min. 3 V	
Heating against cathode	U_{HC}	negative negative peak positive positive peak	255 V 300 V 3 V 50 V
	I_{HC}	max. 15 µA	
Grid 1 leakage resistance	R_{G1}	1,5 MΩ	
Damping of deflection field:	The power consumption of the horizontal deflection is allowed to increase by max. 2,3W when yoke is mounted to the CRT. (at 200 kHz horizontal frequency, a retrace time of $\leq$ 1,2 µs and a horizontal width of 300 mm at U_A 29,0 kV).		

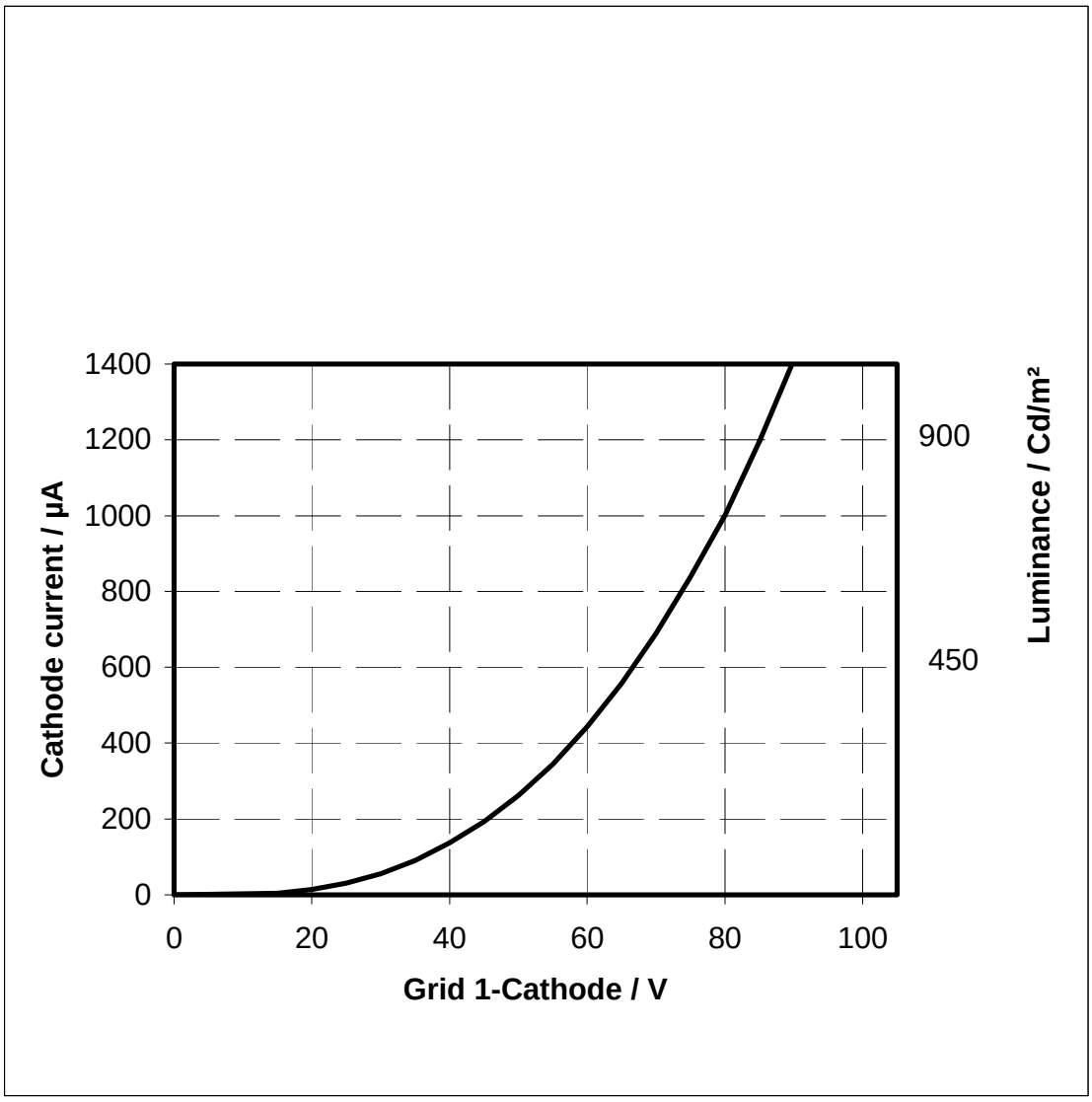
12 Operating values

Cathode heating	- indirect		
	- Heating voltage	U_H	6,1 V + 5 % / -5 %
	- Heating current,	I_H	approx. 100 mA
		I_{Hmax}	0,5 A (cold state)

Cathode is reference point vor all voltage values following

First accelerating voltage	$U_{G2\ I}$	600 - 930 V
Halo suppression voltage	$U_{G2\ II}$	-200 - 0 V
Grid 1 voltage (for spot suppression)	U_{G1}	- 105 V
second accelerating voltage	U_A	29,0 kV
Drive voltage (grid drive) (from I_c = 0 µA to I_c = 1200 µA	ΔU_{G1}	max. 85 V
Luminance drift over time	max. 18 minutes after switch on (an overshoot of max 10% of the cutoff voltage is allowed during this time)	
Focus voltage (at centre of screen at I_c = 300 µA)	U_{G3}	min. 6,80 kV nom. 7,15 kV max. 7,50 kV
Dynamic focus voltage (with reference to Thomson-yoke Nr. 9288.00)	$U_{G3\ dyn.}$	max. = 850 V

13 Grid drive characteristics

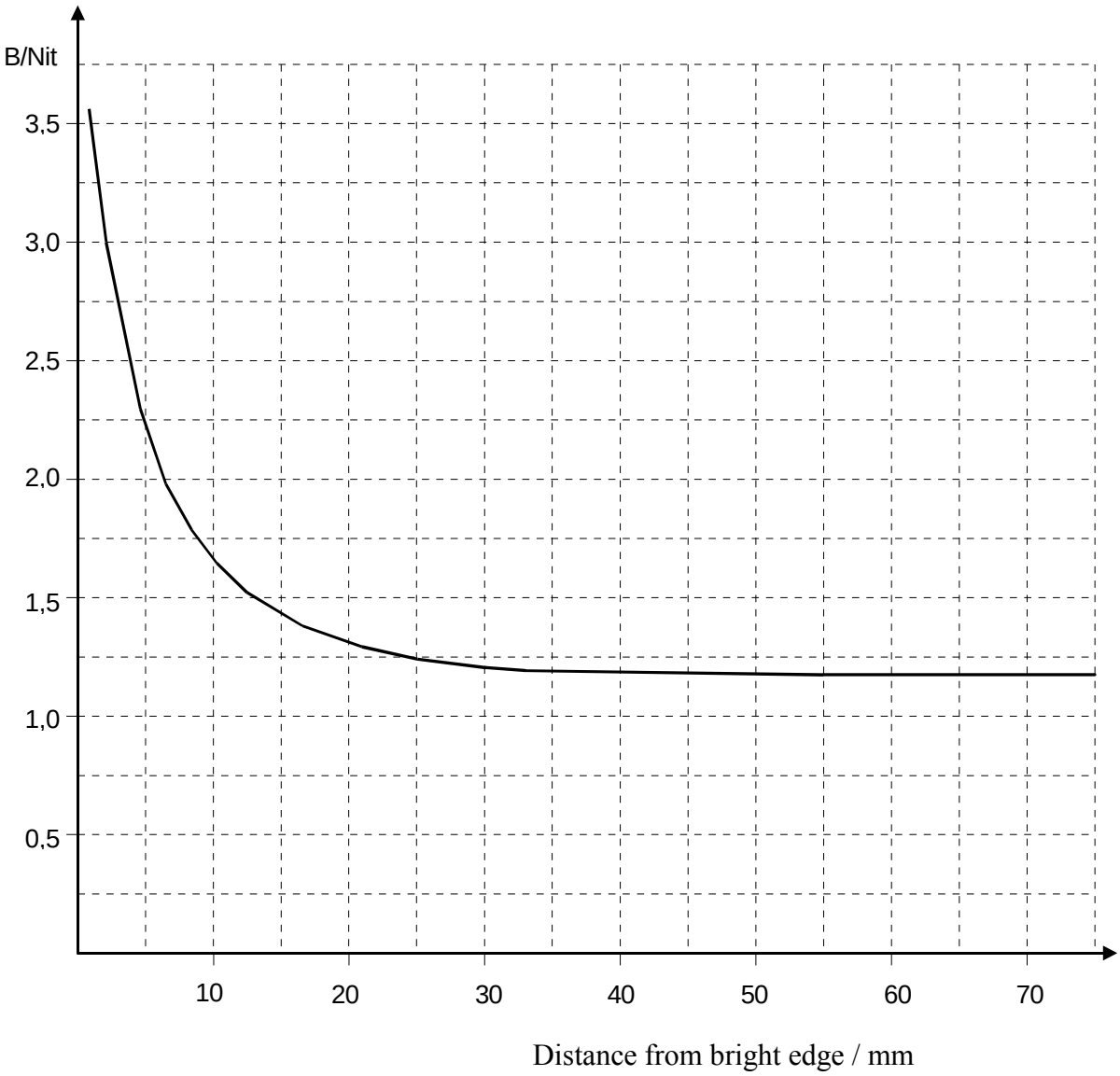


Luminance at 100% Duty Cycle

Scan area 300*400 mm

14 Large area contrast

Max. values



To measure the large area contrast, a bright rectangle is displayed on one half of the sreen. This area must be 50% of the total screen area with an aspect ratio of x : y = 2 : 3, and a luminance of 400 Cd/m^2.
The luminance of the black area is adjusted in such way that no lines can be seen in dark room conditions (optical cut-off value).
With the Microvisionsystem Superspot (or similar equipment) the brightness is measured in relation to the distance from the black/with edge.
The bright rectangle must be totally covered with a non reflecting cover during measuring.

15 Environmental conditions

Temperature range:

Operation	0 to + 70 °C relative humidity 75 % non condensing
Storage	- 40 to 70 °C
Temperature gradient	20 °C/h
Air pressure	400 hPa to 1060 hPa

16 Estimated life time

Decrease of the cathode current of 800 µA at 100 % duty cycle and constant Cut-Off Voltage (Grid 2-voltage readjusted)

after	20.000 hrs. < 20 %

Burning conditions:
Maximum cathode current during testing is 500 µA at 100 % duty cycle over total scan area.

During life time of the CRT (20 000 hours) G2A voltage may be increased to max. 1250 V, to maintain G1-Cut-Off voltage of –105V.

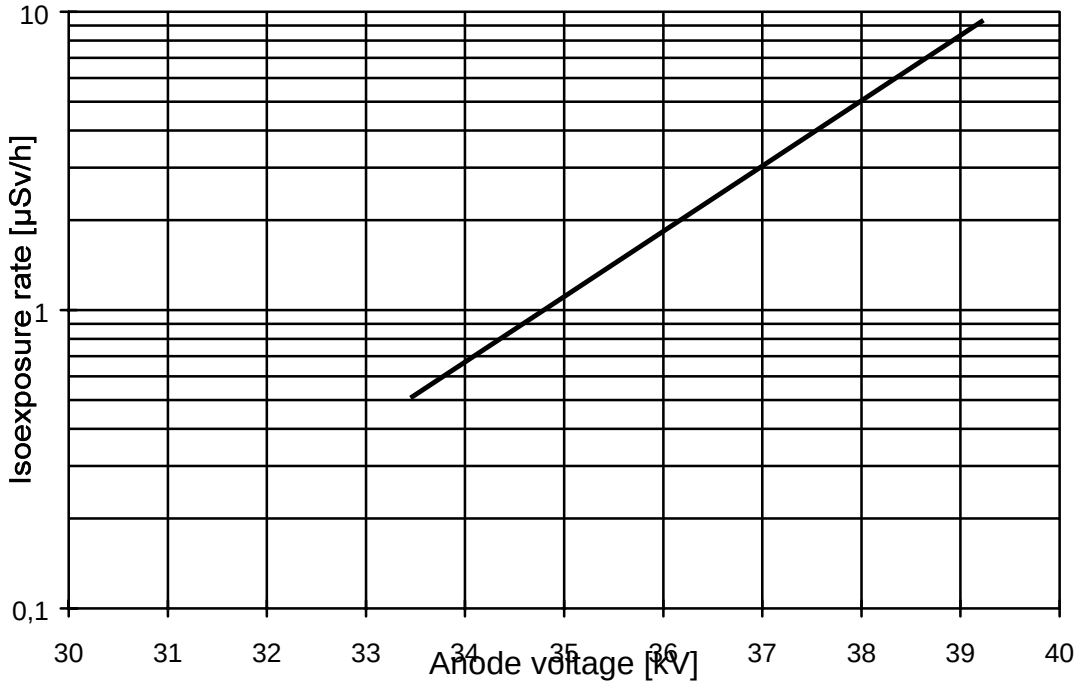
At a maximum luminance level of 350 Cd/m^2 ,after 20.000 hours of operation , the maximum decrease in phosphor luminance is 15 %.

17 X-radiation

X-Radiation Limit Curve

Conditions:

Cathode current I_c = 250 µA

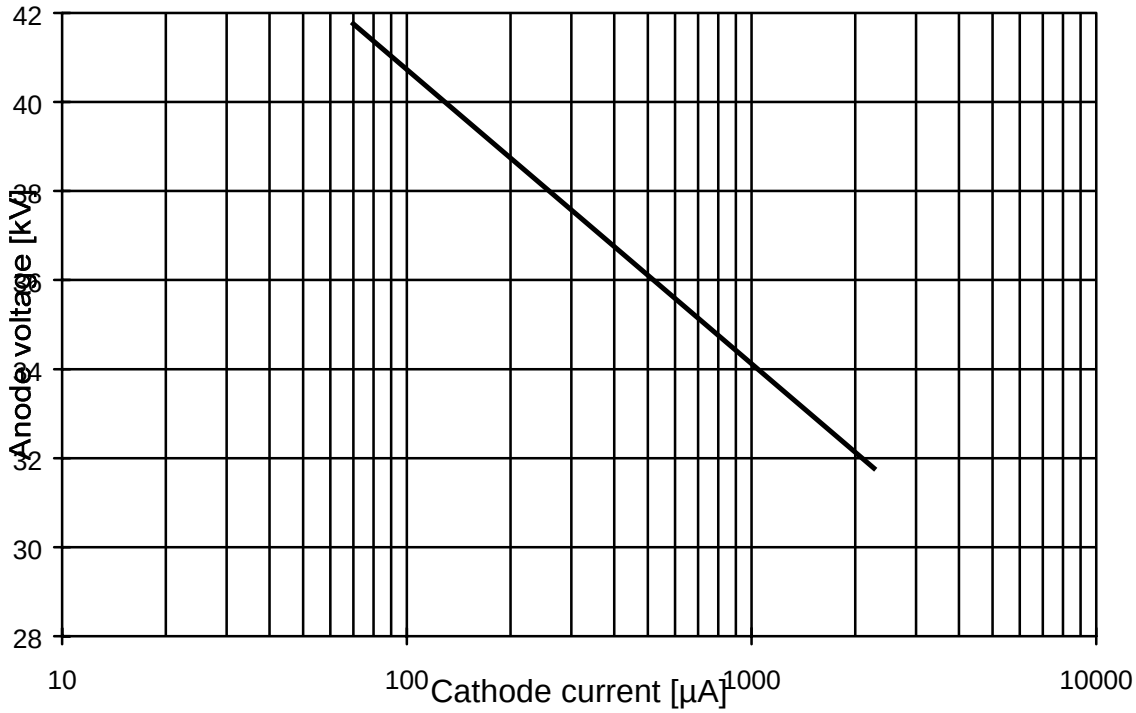


X-Radiation exposure rate vs. anode voltage at constant value of cathode current measured at 5 cm from the CRT.

The measurement is according:
"Röntgenverordnung der Bundesrepublik Deutschland vom 8. Januar 1987"

Isoexposure - Rate Limit Curve

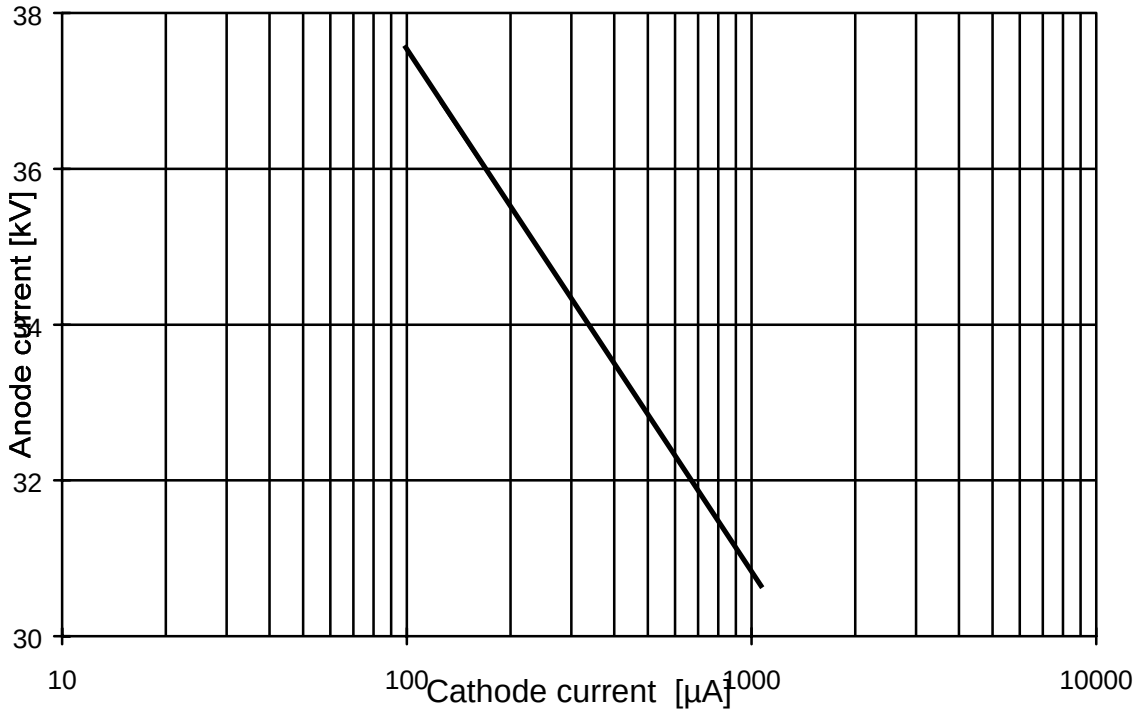
Calculated for 5 µSv/h



This limit curve is plotted at an isoexposure rate of 5 µSv/h (0,5 mR/h) measured at 5 cm from the CRT.

Isoexposure - Rate Limit Curve

Calculated for 1 µSv/h



This limit curve is plotted at an isoexposure rate of 1 µSv/h (0,1 mR/h) measured at 5 cm from the CRT.

Attachment 1

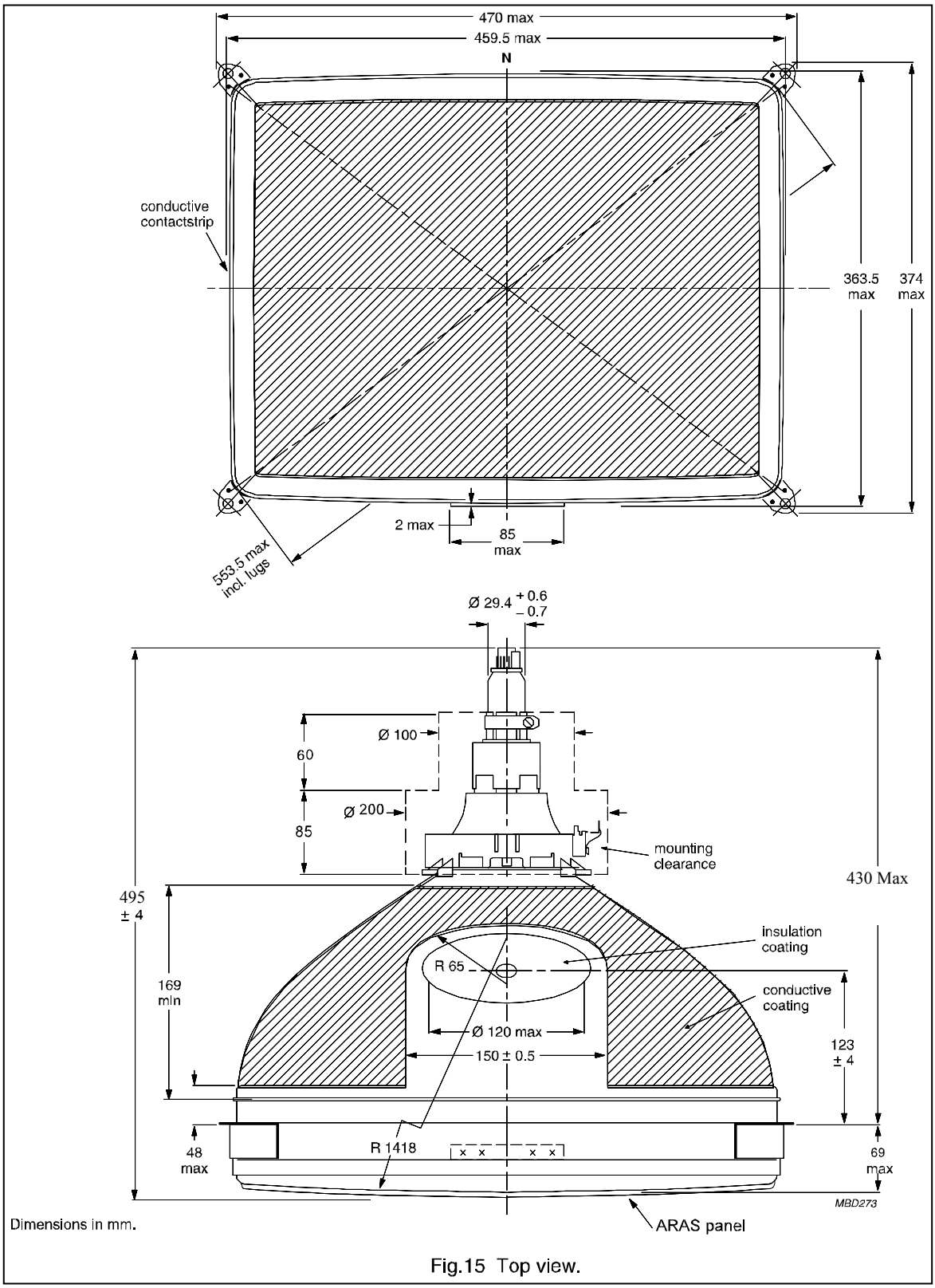
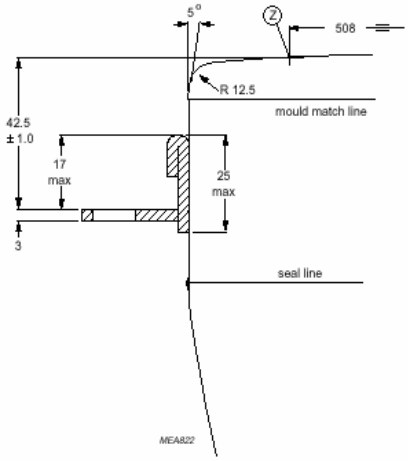


Fig.15 Top view.

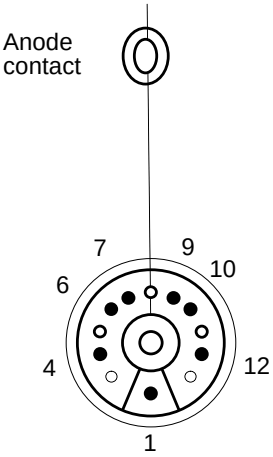
Lug Position



Dimensions in mm.
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.

Lug position .

Base Configuration



1	: Focus
4	: Grid 1
6,7	: Heater
9	: Grid 21
10	: Grid 22
12	: Cathode
5,8,11	: not connected

Specification

M 51EDF300WB70L

51 cm / 21 inch rectangular monochrome CRT

Landscape format

Status: Preliminary
Modifications may be agreed upon after evaluation of about 200 products.

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10 ELECTRICAL DATA
11 ABSOLUTE LIMITING VALUES
12 OPERATING VALUES
13 GRID DRIVE CHARACTERISTICS
14 LARGE AREA CONTRAST
15 ENVIRONMENTAL CONDITIONS
16 ESTIMATED LIFE TIME
17 X-RADIATION

1 View of changes

- The first release will be "01" .
- Changes and supplements to this specification during the development require the agreement of all persons responsible.

Responsible for the contents of this document are:

Company/Department	*Name*	*Tel.*	*Date*	*Signature*
PDS	P.Aerssens	+31 45 5439331		

Siemens
A&D SE BT E

ChangeNr.				
Date	11-1-2006	2-2-2006	21-6-2006	
Release	01	02	03	04

ChangeNr.				
Date				
Release	05	06	07	08

Changed pages:

Release:	Pages:
02	01 :Type designation changed
	11 : Blemish specification changed
	16 : Heater Cathode voltage
	25 : Drawing : brackets added
03	16 : Heater voltage specification , Brightness variation
	19 : Stray emission
	23 : Drawing

2 Aplication

CRT for displays in medical and alphanumerical applications

3 Characteristics

high resolution
90° -deflection
flat & square color bulb (low browning glass)
multicoated
conductive coated against charching
intrinsically safe
high contrast
high luminance
long life time

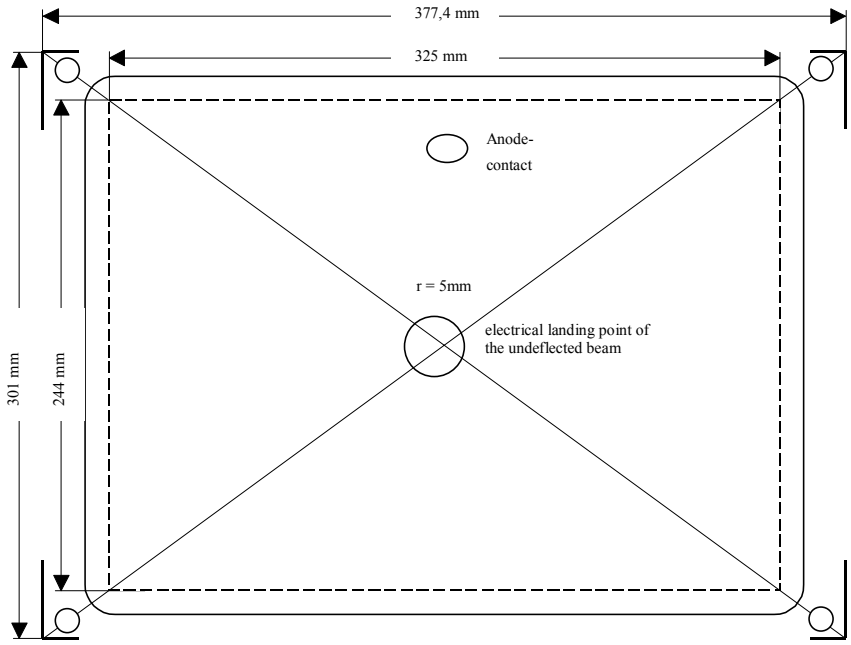
4 Important notes

Implosion hazard	**CRT is evacuated. In case of mechanical damage (e.g. by shock or scratches) implosion can occur.**
CRT is labeled according:	**UL 1418** **MPR II**
High voltage	**For reasons of the CRT's capacities the anode connection can conduct high voltage for a long time after high voltage is switches off.**
X-ray emission	**Operating the tube within the limits the x-ray dose rate will be under the allowed value of 1 µSv/h (adequate to: 0,1 mR/h)** **The tube is an intrinsic CRT type according the RöV (German Röntgenverordnung) dated Jan, 8th 1987, Part I; Attechment III, paragraph 6.**

5 Mechanical Data

Screen	**rectangular, R = 1370 mm**
Useable screen	**• Screen diagonal min. 508,0 mm • Screen width min. 304,8 mm • Screen height min. 406,4 mm**
Position of operation	**anode connector on top of tube**
Socket	**JEDEC B10-277 or equal**
Neck diameter	**29,1 mm ± 0,7 mm**
Anode connector	**Bulb contact 7,92 DIN 41543**
Deflection yoke	**Drawing nmbr. 250 898.ZZ THOMSON-Yoke No.: 9294.xx**
Weight	**Approx. 17,0 kg incl. Deflection yoke**
Mechanical outlines	**see attachment 1**

6 Maximum of not deflected spot landing



- **The CRT is mounted by angle brackets to an apparatus (see schematic in enclosure 1) whose pick-up holes meet those of the monitor chassis.**

- **The CRT has to be moved in its fitting ears in such a way, that finally the centre of the glass bulb matches the mechanical centre of the jig ± 1 mm.**

- **Phosphor material must be everywhere within a window of 300 × 400 mm. The centre of that phosphor window matches the mechanical centre of the CRT.**

- **The spot or the deflection yoke will be adjusted, so that symmetrical and equal focus exists.**

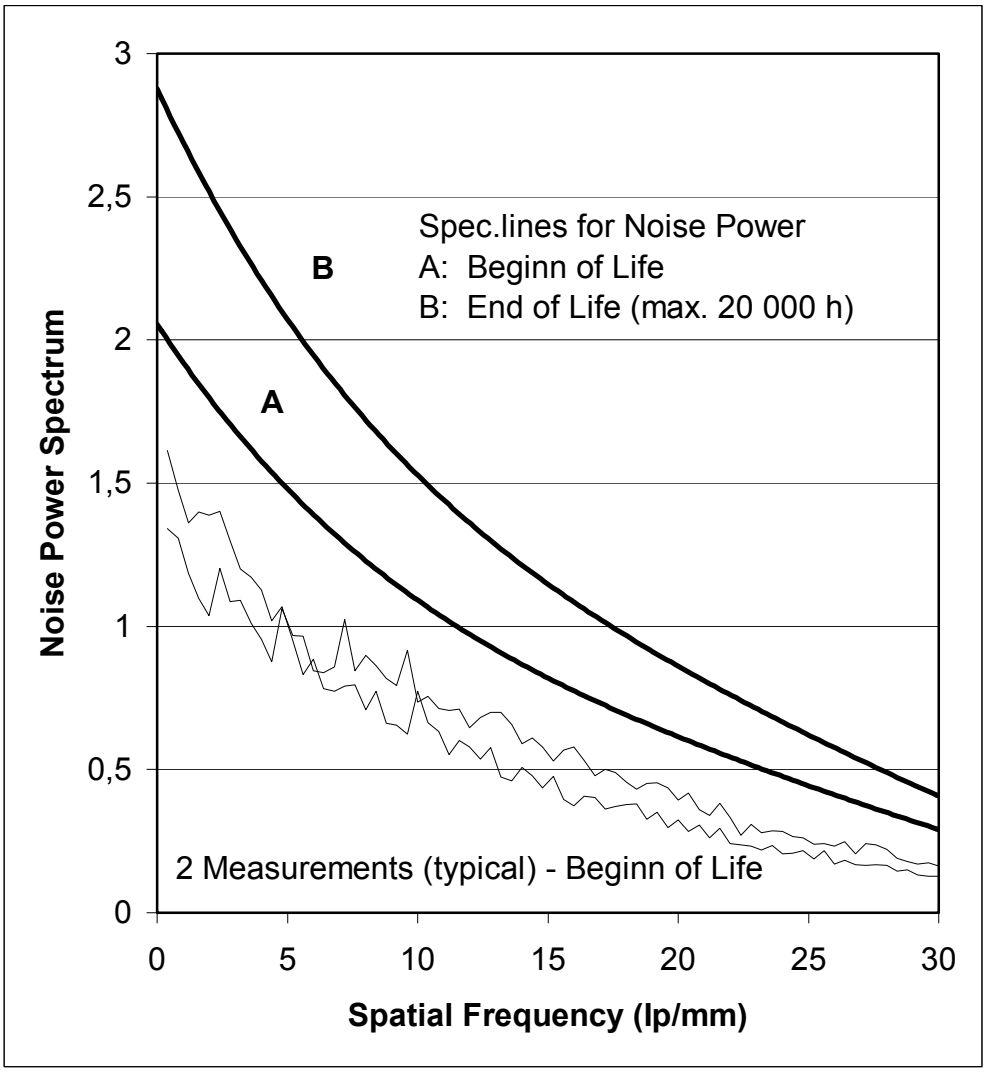
- **The non-deflected spot landing must be within a circle with a radius of 2 mm around a point 3 mm left and 2 mm down from the mechanical centre of the CRT, provided that:**
  - **the CRT axis is in east-west direction and the front panel is facing east,**
  - **the anode connector is located on top of the tube,**
  - **the deflection unit has been mounted to the tube,**
  - **there is a metal shield behind the deflection unit around the tube's neck**

- **The maximum rotation angle of the deflection unit may not exceed 0.2°.**

7 Optical data

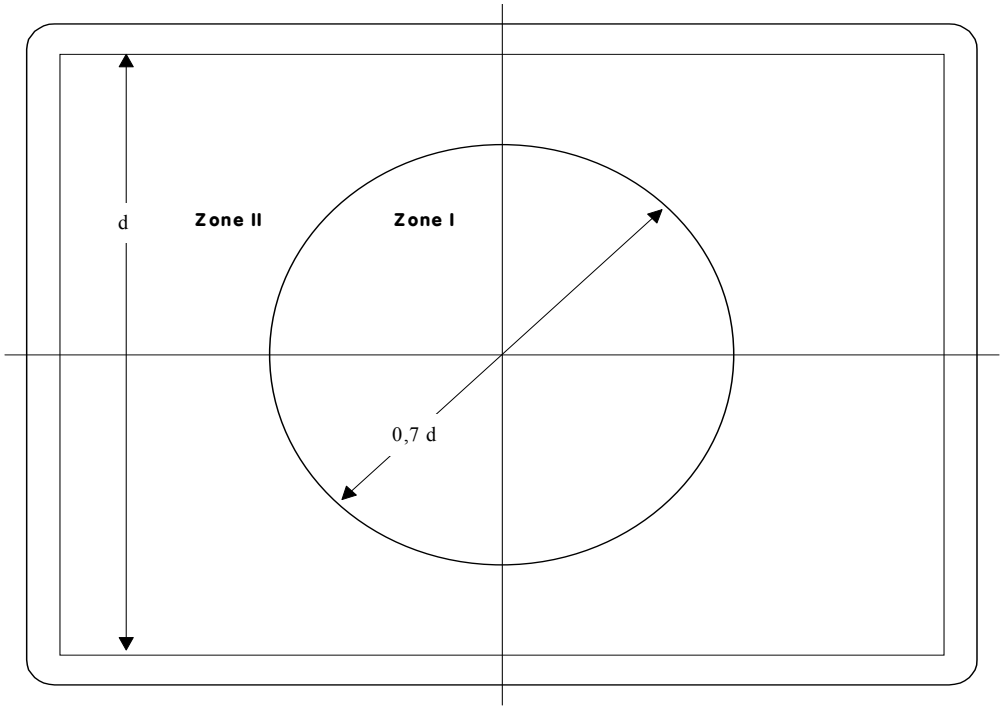
Total transmission of bulb including coating/panel:	**49 % ± 3 % at 546 nm**	
Phosphor	**P45**	
7.1	**Noise Power (see fig.)**	
Color coordinates: (during operation)	**P45-Phosphor**	
at a luminance of 250 Cd/m^2 (Nit) with CL60-Filter, (measured with LMT Color meter or Minolta CA100)	**X = (0,250 ± 0,01)**	**Y = (0,305 ± 0,01)**
Front panel	**Transmission at 546 nm ca. 95% Coating Flabeg OEL-95** **Direct coating alternative after agreement with customer. The connection with the mounting device aluminium strips are mounted on front panel.**	
Uniformity of luminance from centre to any corner	**At a luminance of 50 Nit the overall deviation of luminance from centre to any corner may not exceed 12 Cd/m^2 (Nit) at any point of the screen.**	
Glass bulb	**Drawingnmbr. 252 907.GZ or equivalent bulb after agreement with customer.**	

7.1 Noise power



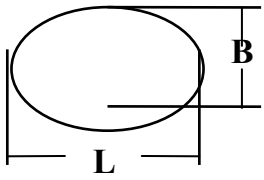
Noise Power measured with SIEMENS Measurement system.

8 Permissible Glass and screen defects



L: max. length of defects

B: max. width of defects



d = 300 mm

Defect size G for the screen and glass specification

for a side ratio of L/B ≤ 3 G = ½ (L + B)
for a side ratio of L/B > 3 G = L/20 + 2 B

Permissible defect (Panel included)

Defect size G in mm	Number of defects Zone I	Number of defects Zone II	Number of defects Sum [1)]
< 0,2	Within any area of 30 *30 mm only 3 phosphor defects with size 0.1 – 0.2 mm are allowed.		
0,2 < G < 0,4	2	3	4
0,4 < G < 0,6	-	3	3
Distance between defects	> 50 mm	> 50 mm	

[1)] Maximum number of defects in zone I and II : 4

Scratches

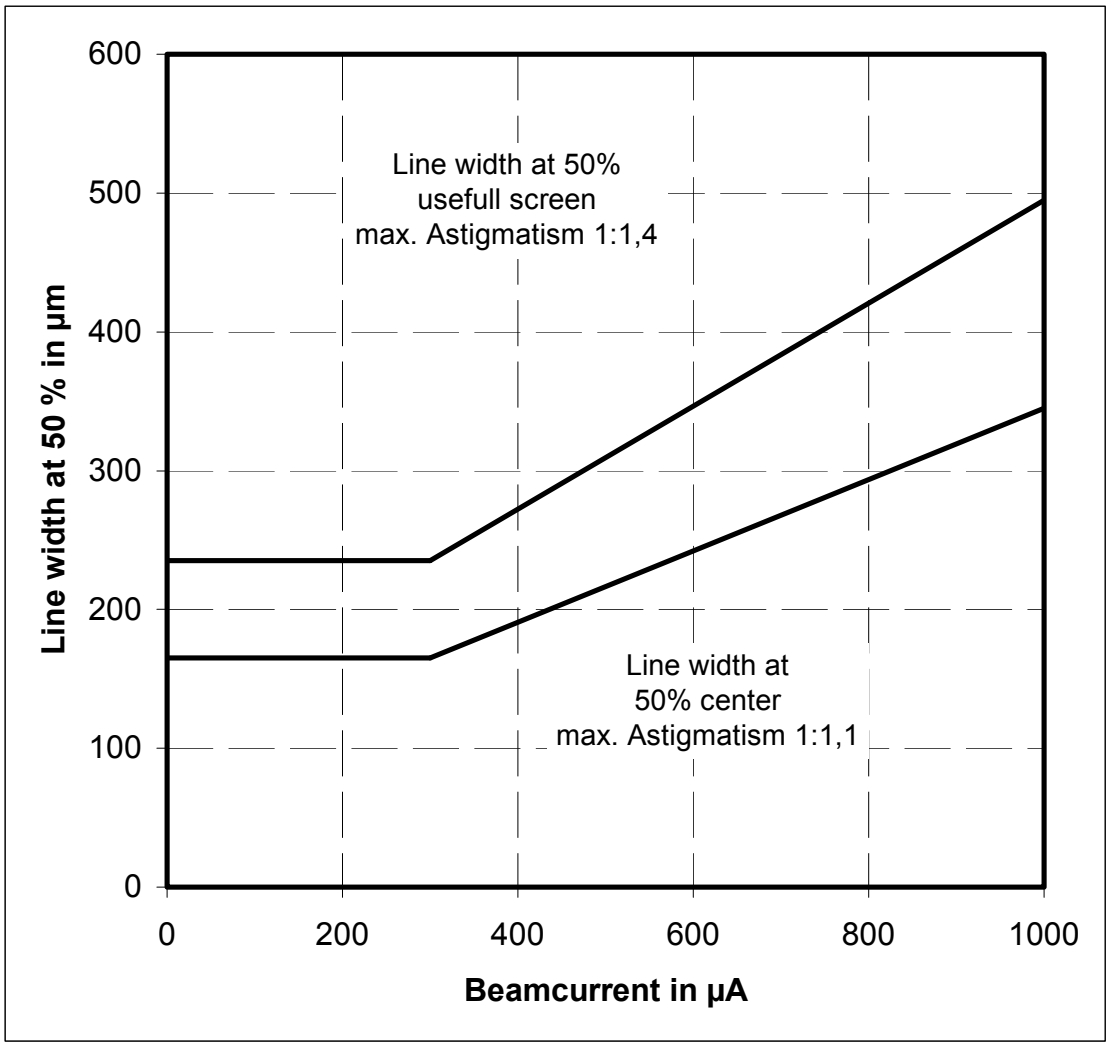
Sum ≤ 2
distance > 50 mm
max. length < 10 mm
max. width < 50 µm

Scratches <15 µm are permitted

Not allowed defects:
Open holes, stones, folts, cracks, accumulated defects, 'cloud'.

9 Resolution

50 % of peak value
Optimal focus: 300µA
Duty cycle 100 %

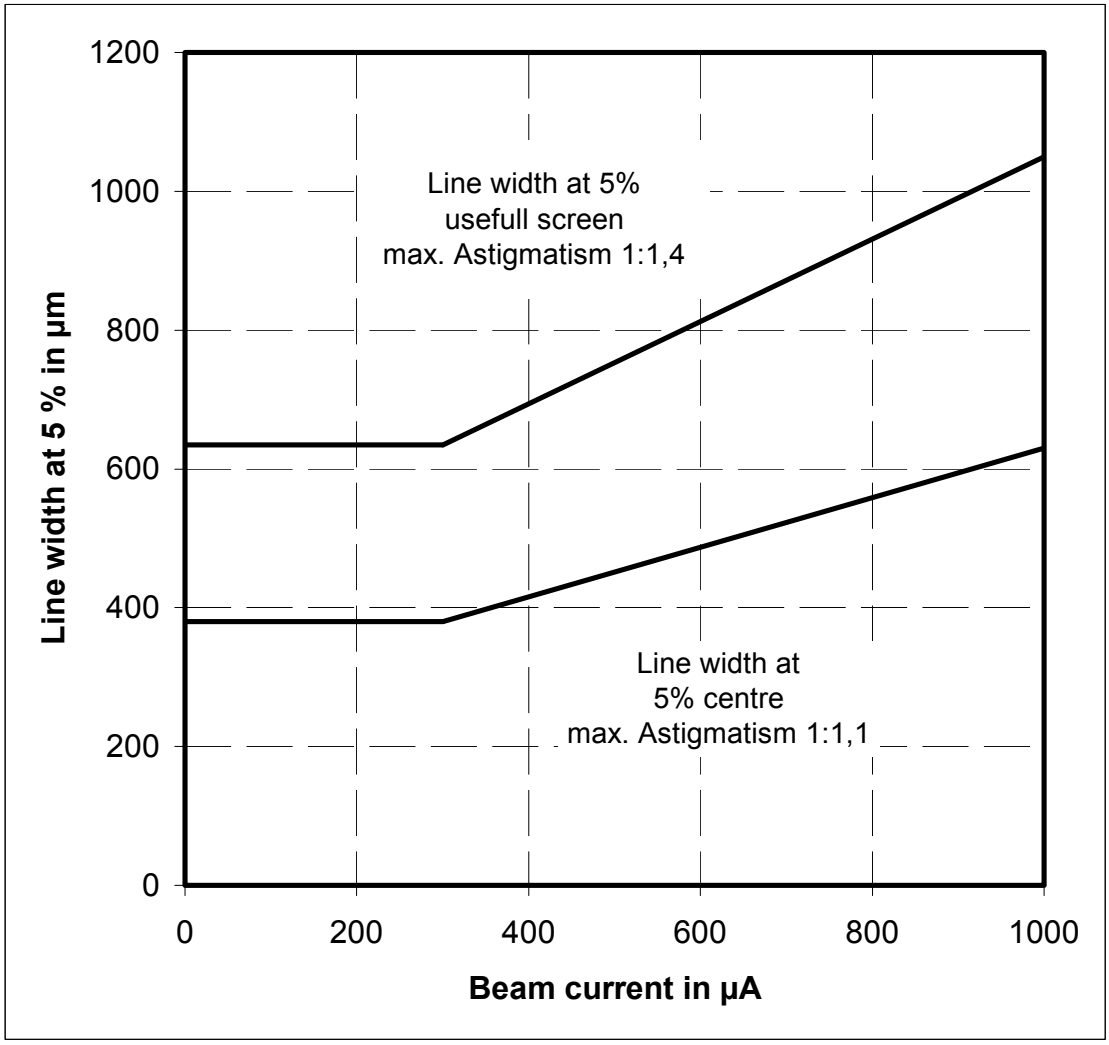


Measured with Microvision Superspot SS200 or PDS spot profile measuring system

- Astigmatism at 5% and 50%-line width has the same shape.
- Astigmatism is not allowed to turn at increased beam current
- The spot profile approximates the Gaussian distribution.

Resolution

5 % of peak value
Duty cycle 100 %



Measured with Microvision Superspot SS200 or PDS spot profile measuring system

10 Electrical Data

Deflection		**magnetically, deflection angle** **- horizontal ca. 78°** **- vertical ca. 60°** **- diagonal ca. 90°**	
Focussing		**electrostatic**	
Maximum currents (leakage)	I_{G1}	**± 1µA**	
	I_{G2a}	**± 1µA**	**max. 5 changes allowed**
	I_{Gsb}	**± 1µA**	
	I_{G3}	**± 2µA**	
Capacity *) (Grid 1 to all other electrodes)	$C_{G1\text{-}all}$	**5,3 pF ± 1 pF**	
Capacity *) (Cathode to all other electrodes)	C_K	**3.5 pF ± 1 pF**	
Capacity *) (Grid1 to cathode)	$C_{G1\text{-}K}$	**2,3 pF ± 0,7 pF**	
Capacity (Anode to outher coating)	$C_{A\text{-}M1}$	**1600 ... 3000 pF**	

Electrical Data from THOMSON-Coil		**Drawing nmbr. 250 898.ZZ** **THOMSON-YOKE Nr. 9294.xx**
Horizontal deflection	**Lx**	**49,5 µH ± 5 %**
	Rx	**150 mΩ ± 10 %**
Vertical deflection	**Ly**	**1.83 mH ± 5 %**
	Ry	**3.28 Ω ± 10 %**
Rotationcoil	**Rr**	**133 Ω ± 10 %**
	Ir	**47 mA / 1 °**
Astigmatism Axial	**La**	**23 µH ± 5 %**
	Ra	**< 6 Ω**
Astigmatism Diagonal	**Ld**	**23 µH ± 5 %**

	Rd	< 6 Ω

*) measured with PHILIPS RLC Meßbrücke PM6303

11 Absolute limiting values

Cathode is reference point for all voltage values

First accelerating voltage	$U_{G2\ I\&II}$	max. 1300 V min. - 400 V	
Second accelerating voltage	U_A	max. 29,9 kV	
Focus voltage	U_{G4}	max. 9 kV	
Grid 1 voltage	$-U_{G1}$	max. 150 V (200 V for 5 sec. after switch off) min. 2 V	
Heating against cathode	U_{HC}	negative negative peak positive positive peak	255 V 300 V 3 V 50 V
	I_{HC}	max. 15 µA	
Grid 1 leakage resistance	R_{G1}	1,5 MΩ	
Damping of deflection field:	The power consumption of the horizontal deflection is allowed to increase by max. 1.4 W when yoke is mounted to the CRT. (at 80 kHz horizontal frequency, a retrace time of $\leq$ 2,5 µs and a horizontal width of 400 mm at U_A = 27,5 kV).		

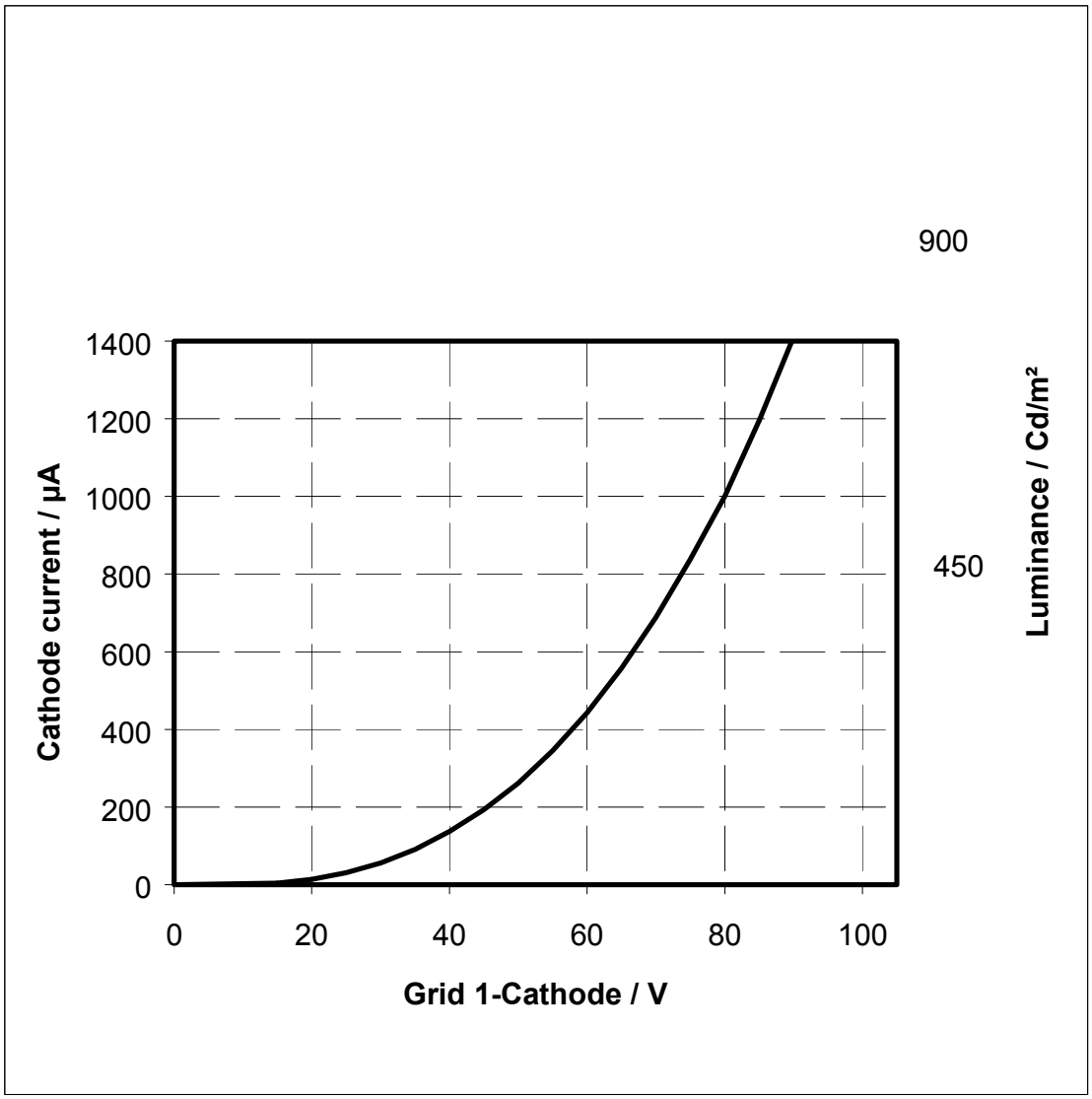
12 Operating values

Cathode heating	- indirect		
	- Heating voltage	U_h	5.65 – 5.85 V
	- Heating current,	I_h	approx. 100 mA;
		I_{hmax}	0,5 A (cold state)

Cathode is reference point vor all valtage values following

First accelerating voltage	$U_{G2\ I}$	600 - 930 V
Halo suppression voltage	$U_{G2\ II}$	0 - 200 V
Grid 1 voltage (for spot suppression)	$-U_{G1}$	105 V
second accelerating voltage	U_A	29,0 kV
Drive voltage (grid drive) (from I_C = 0 µA to I_C = 1200 µA[1)]	ΔU_{WE}	max. 85 V
Luminance drift over time		max. 18 minutes after switch on (an overshoot of max 10% of cutoff voltage is allowed during this time)
Focus voltage (at centre of screen at I_C = 300 µA	U_{G3}	min. 6,80 kV nom. 7,15 kV max. 7,50 kV
Dynamic focus voltage (with reference to Thomson-yoke Nr. 9294.xx)	$U_{G3\ dyn.}$	max. = 850 V
Brightness variation when changing from 100% white pattern to 10% square white pattern (same drive voltage)		No brightness variation allowed

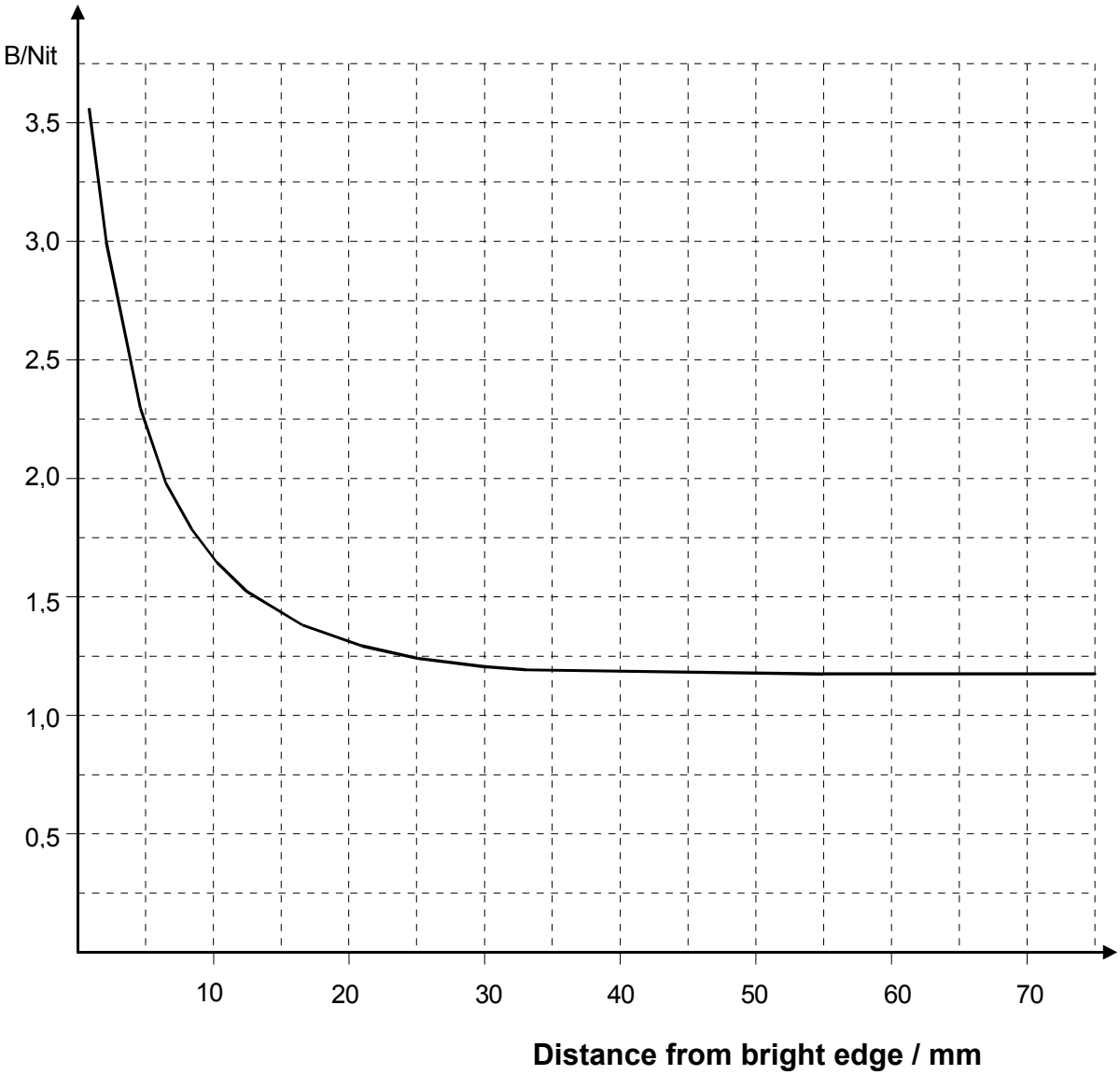
Grid drive characteristics



Luminance at 100% Transmission
Scan area 300*400 mm

14 Large area contrast

Max. value



To measure the large area contrast a bright rectangle is displayed on one half of the screen. This area must be 50% of the total screen area with an aspect ratio of x : y = 2:3, and a luminance of 400 Nit.
The luminance of the black area is adjusted in such way that no lines can be seen in dark room conditions (optical cut-off value).
With the Microvisionsystem Superspot (or similar) the brightness is measured in relation to the distance from the black/white edge.
The bright rectangle must be totally covered with a non reflecting cover during measuring.

15 Environmental conditions

Temperature range:

Operation	**0 to + 70 °C** **relative humidity 75 %** **non condensing**
Storage	**- 40 to 70 °C**
Temperature gradient	**20 °C/h**
Air pressure	**400 hPa to 1060 hPa**

16 Estimated life time

Decrease of the cathode current of 800 µA at 100 % duty cycle and constant Cut-Off-voltage (Grid 2-voltage adjusted)

after 20.000 hrs. < 10 %

Burning conditions:
The cathode current during testing is max. 500 µA at 100 % duty cycle over total scan area.

During life time of the CRT (20 000 hours) G2a voltage may be increased to max. 1250 V, to maintain G1-Cut-Off voltage of –105V.

At a maximum luminance level of 350 Nit, after 20.000 hours of operation ,the maximum decrease in phosphor luminance is 15 %.

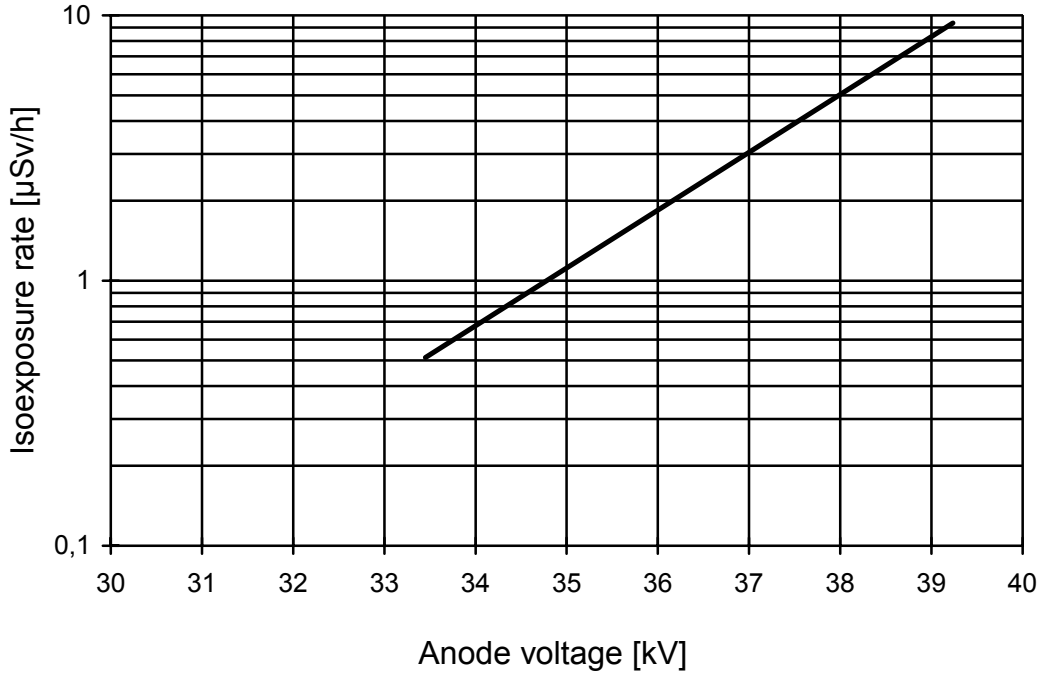
Stray emission : Maximum anode current in cut-off condition Uc- Ug1 > Uco after 10.000 hrs. : < 1 µA

17 X-radiation

X-Radiation Limit Curve

Conditions:

Cathode current I_C = 250 µA

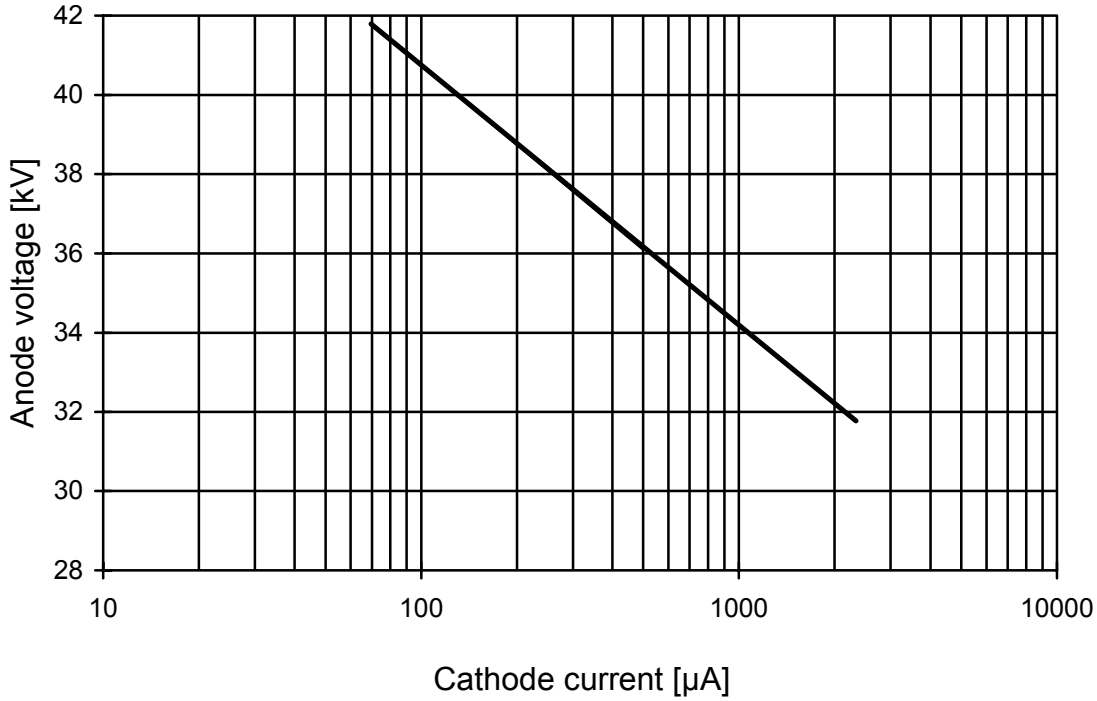


X-Radiation exposure rate vs. anode voltage at a constant value of cathode current measured at 5 cm from the CRT.

The measurement is according:
"Röntgenverordnung der Bundesrepublik Deutschland vom 8. Januar 1987"

Isoexposure - Rate Limit Curve

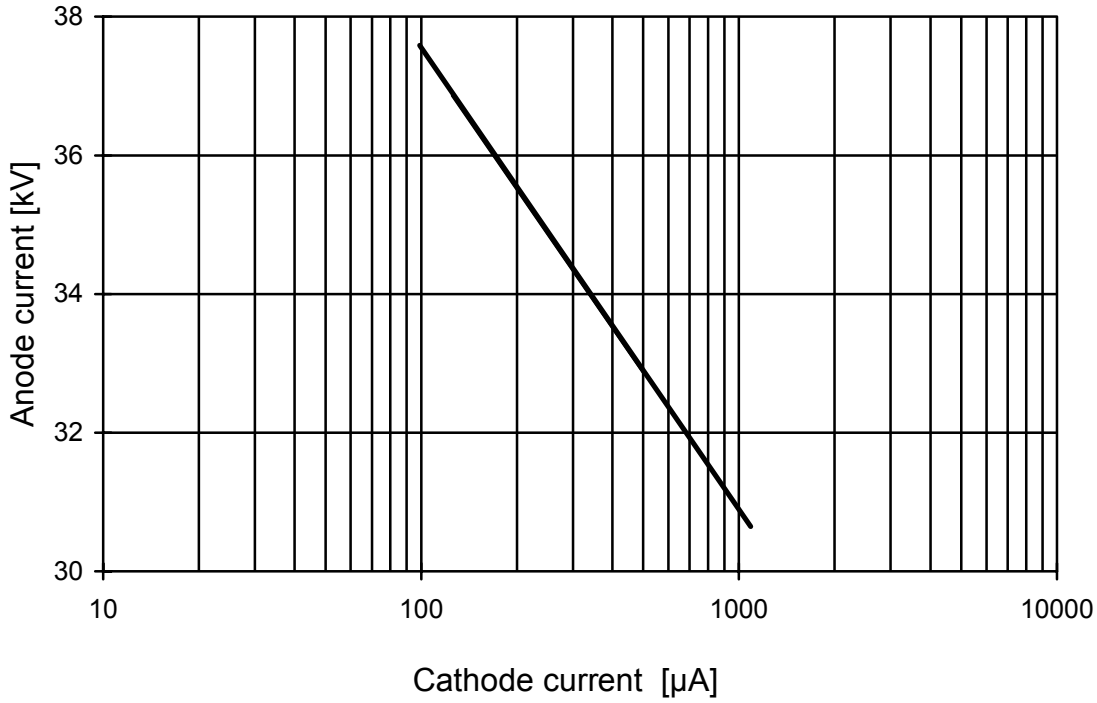
Calculated for 5 µSv/h



This limit curve is plotted at an isoexposure rate of 5 µSv/h (0,5 mR/h) measured at 5 cm from the CRT.

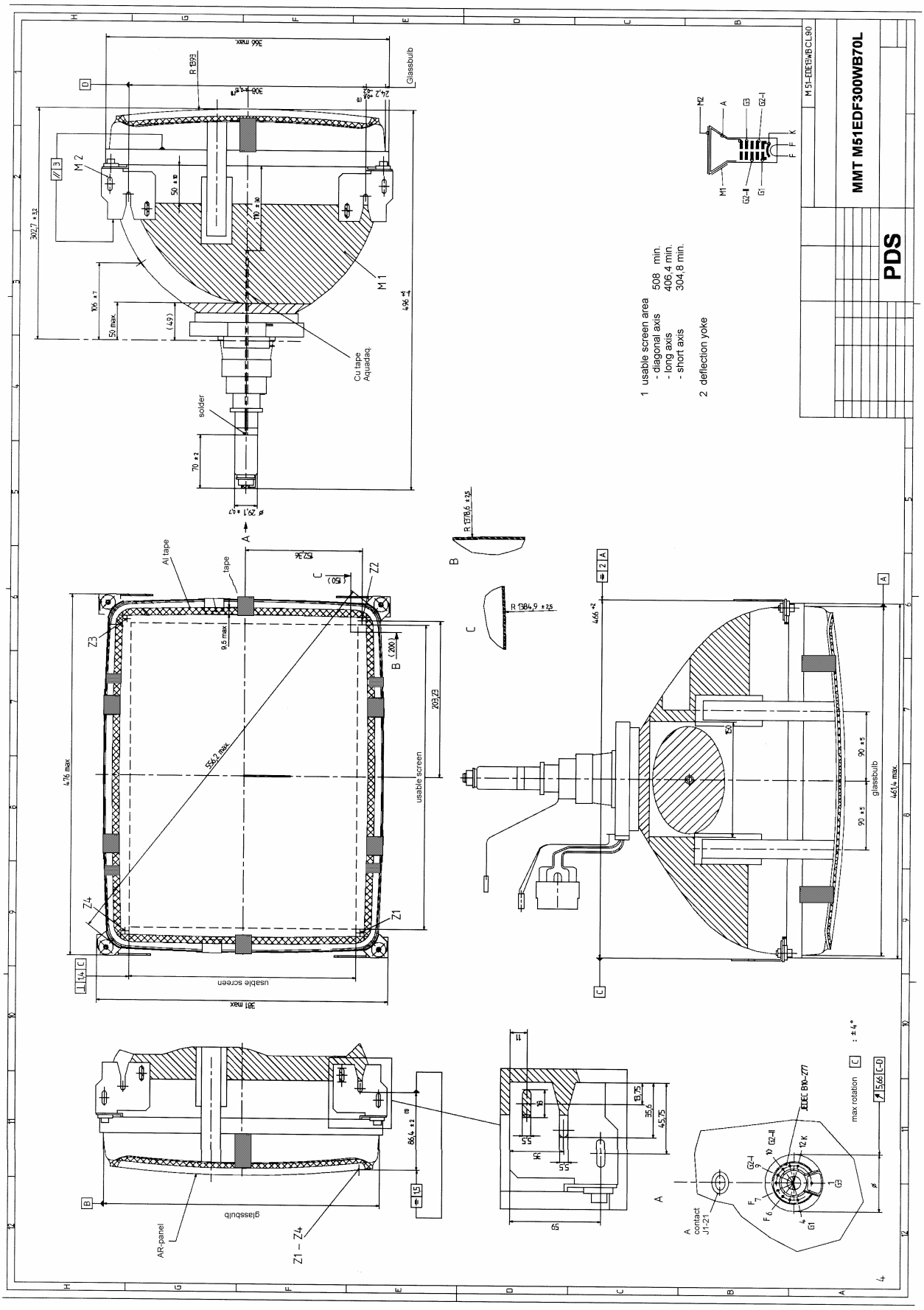
Isoexposure - Rate Limit Curve

Calculated for 1 µSv/h



This limit curve is plotted at an isoexposure rate of 1 µSv/h (0,1 mR/h) measured at 5 cm from the CRT.

Attachment 1



Specification

M 51EDF300WB70L

51 cm / 21 inch rectangular monochrome CRT

Landscape format

Status: Preliminary
Modifications may be agreed upon after evaluation of about 200 products.

CONTENTS

1 VIEW OF CHANGES
2 APPLICATION
3 CHARACTERISTICS
4 IMPORTANT NOTES
5 MECHANICAL DATA
6 MAXIMUM OF NOT DEFLECTED SPOT LANDING
7 OPTICAL DATA
8 PERMISSIBLE GLASS AND SCREEN DEFECTS
9 RESOLUTION
10 ELECTRICAL DATA
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Siemens
A&D SE BT E

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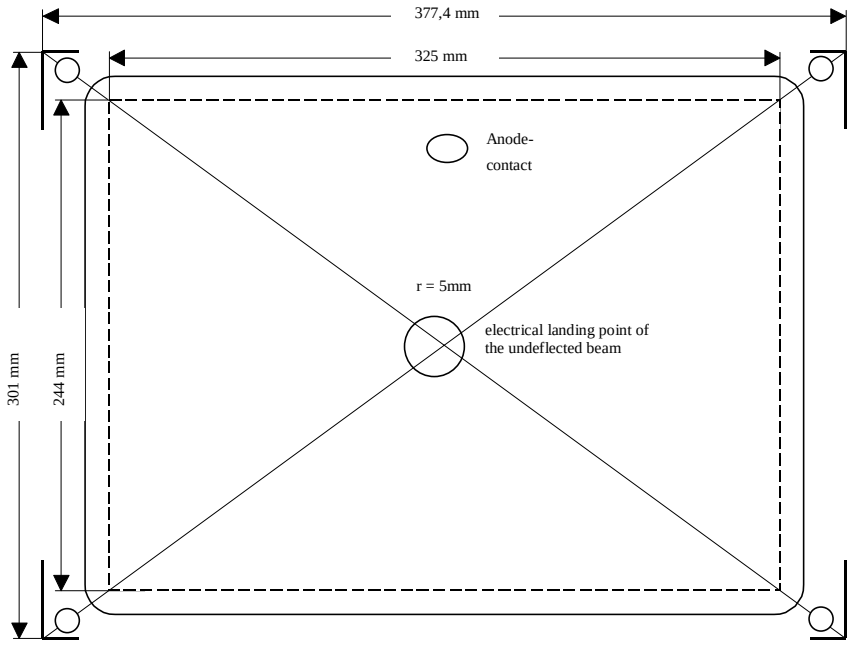
4 Important notes

Implosion hazard	**CRT is evacuated. In case of mechanical damage (e.g. by shock or scratches) implosion can occur.**
CRT is labeled according:	**UL 1418** **MPR II**
High voltage	**For reasons of the CRT's capacities the anode connection can conduct high voltage for a long time after high voltage is switches off.**
X-ray emission	**Operating the tube within the limits the x-ray dose rate will be under the allowed value of 1 µSv/h (adequate to: 0,1 mR/h)** **The tube is an intrinsic CRT type according the RöV (German Röntgenverordnung) dated Jan, 8th 1987, Part I; Attechment III, paragraph 6.**

5 Mechanical Data

Screen	**rectangular, R = 1370 mm**
Useable screen	**• Screen diagonal min. 508,0 mm • Screen width min. 304,8 mm • Screen height min. 406,4 mm**
Position of operation	**anode connector on top of tube**
Socket	**JEDEC B10-277 or equal**
Neck diameter	**29,1 mm ± 0,7 mm**
Anode connector	**Bulb contact 7,92 DIN 41543**
Deflection yoke	**Drawing nmbr. 250 898.ZZ THOMSON-Yoke No.: 9294.xx**
Weight	**Approx. 17,0 kg incl. Deflection yoke**
Mechanical outlines	**see attachment 1**

6 Maximum of not deflected spot landing



- **The CRT is mounted by angle brackets to an apparatus (see schematic in enclosure 1) whose pick-up holes meet those of the monitor chassis.**

- **The CRT has to be moved in its fitting ears in such a way, that finally the centre of the glass bulb matches the mechanical centre of the jig ± 1 mm.**

- **Phosphor material must be everywhere within a window of 300 × 400 mm. The centre of that phosphor window matches the mechanical centre of the CRT.**

- **The spot or the deflection yoke will be adjusted, so that symmetrical and equal focus exists.**

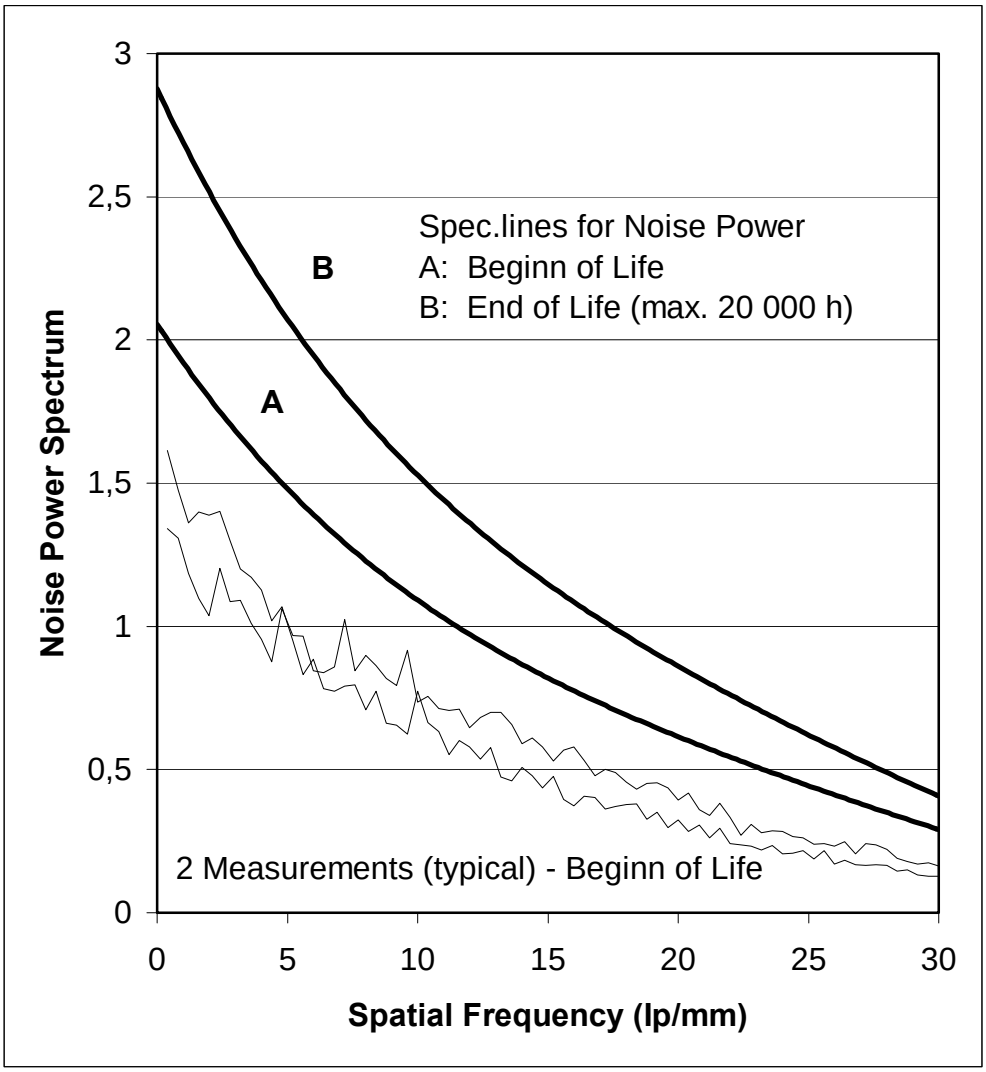
- **The non-deflected spot landing must be within a circle with a radius of 2 mm around a point 3 mm left and 2 mm down from the mechanical centre of the CRT, provided that:**
  - **the CRT axis is in east-west direction and the front panel is facing east,**
  - **the anode connector is located on top of the tube,**
  - **the deflection unit has been mounted to the tube,**
  - **there is a metal shield behind the deflection unit around the tube's neck**

- **The maximum rotation angle of the deflection unit may not exceed 0.2°.**

7 Optical data

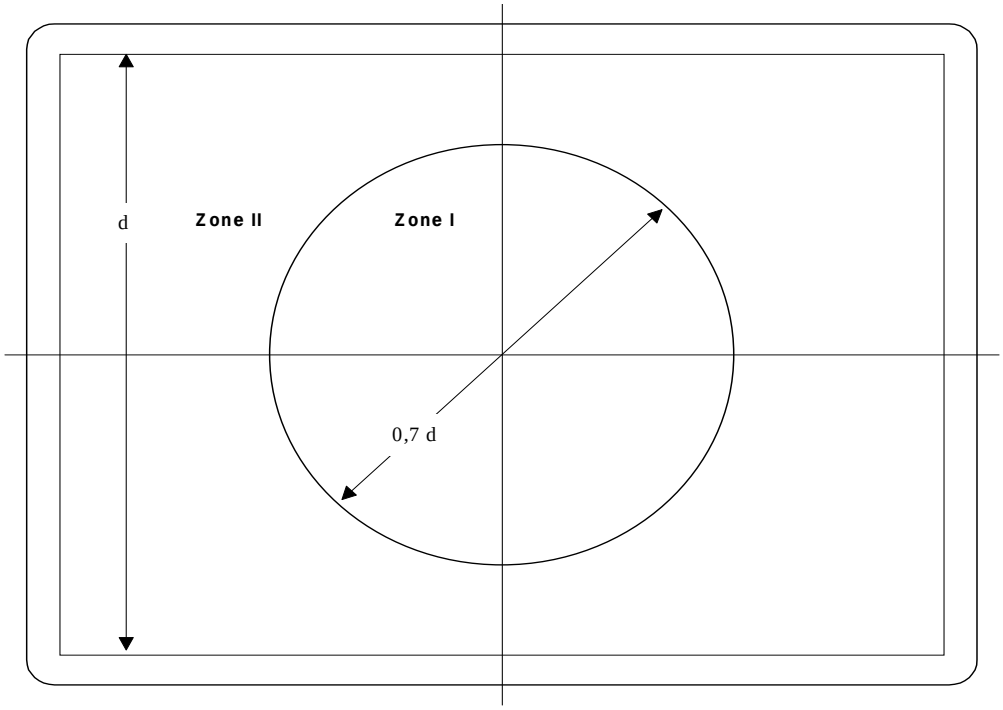
Total transmission of bulb including coating/panel:	**49 % ± 3 % at 546 nm**	
Phosphor	**P45**	
7.1	**Noise Power (see fig.)**	
Color coordinates: (during operation)	**P45-Phosphor**	
at a luminance of 250 Cd/m^2 (Nit) with CL60-Filter, (measured with LMT Color meter or Minolta CA100)	**X = (0,250 ± 0,01)**	**Y = (0,305 ± 0,01)**
Front panel	**Transmission at 546 nm ca. 95% Coating Flabeg OEL-95** **Direct coating alternative after agreement with customer. The connection with the mounting device aluminium strips are mounted on front panel.**	
Uniformity of luminance from centre to any corner	**At a luminance of 50 Nit the overall deviation of luminance from centre to any corner may not exceed 12 Cd/m^2 (Nit) at any point of the screen.**	
Glass bulb	**Drawingnmbr. 252 907.GZ or equivalent bulb after agreement with customer.**	

7.1 Noise power



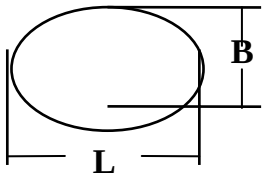
Noise Power measured with SIEMENS Measurement system.

8 Permissible Glass and screen defects



L: max. length of defects

B: max. width of defects



d = 300 mm

Defect size G for the screen and glass specification

for a side ratio of L/B ≤ 3 G = ½ (L + B)
for a side ratio of L/B > 3 G = L/20 + 2 B

Permissible defect (Panel included)

Defect size G in mm	Number of defects Zone I	Number of defects Zone II	Number of defects Sum [1)]
< 0,2	Within any area of 30 *30 mm only 3 phosphor defects with size 0.1 – 0.2 mm are allowed.		
0,2 < G < 0,4	2	3	4
0,4 < G < 0,6	-	3	3
Distance between defects	> 50 mm	> 50 mm	

[1)] Maximum number of defects in zone I and II : 4

Scratches

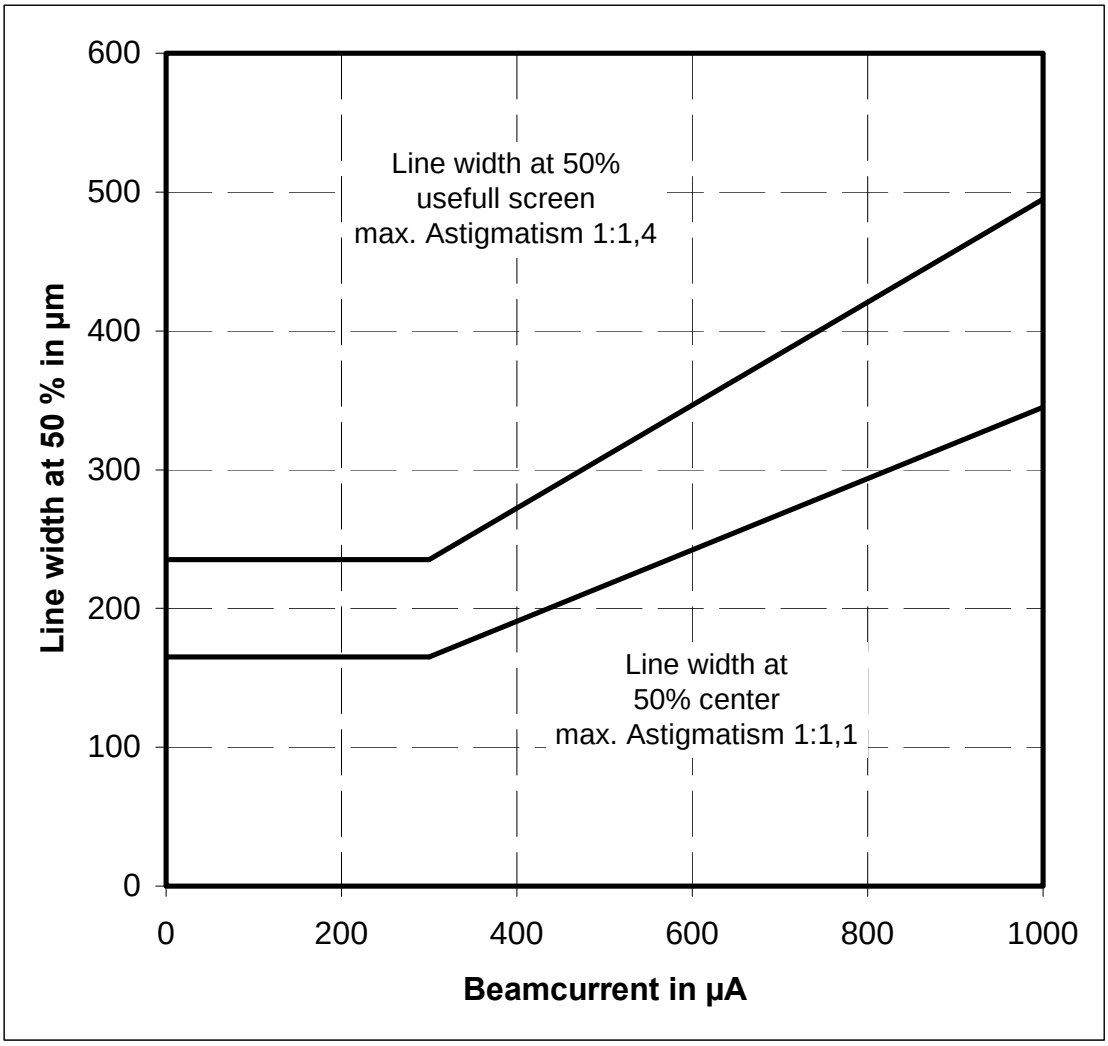
Sum ≤ 2
distance > 50 mm
max. length < 10 mm
max. width < 50 µm

Scratches <15 µm are permitted

Not allowed defects:
Open holes, stones, folts, cracks, accumulated defects, 'cloud'.

9 Resolution

50 % of peak value
Optimal focus: 300µA
Duty cycle 100 %

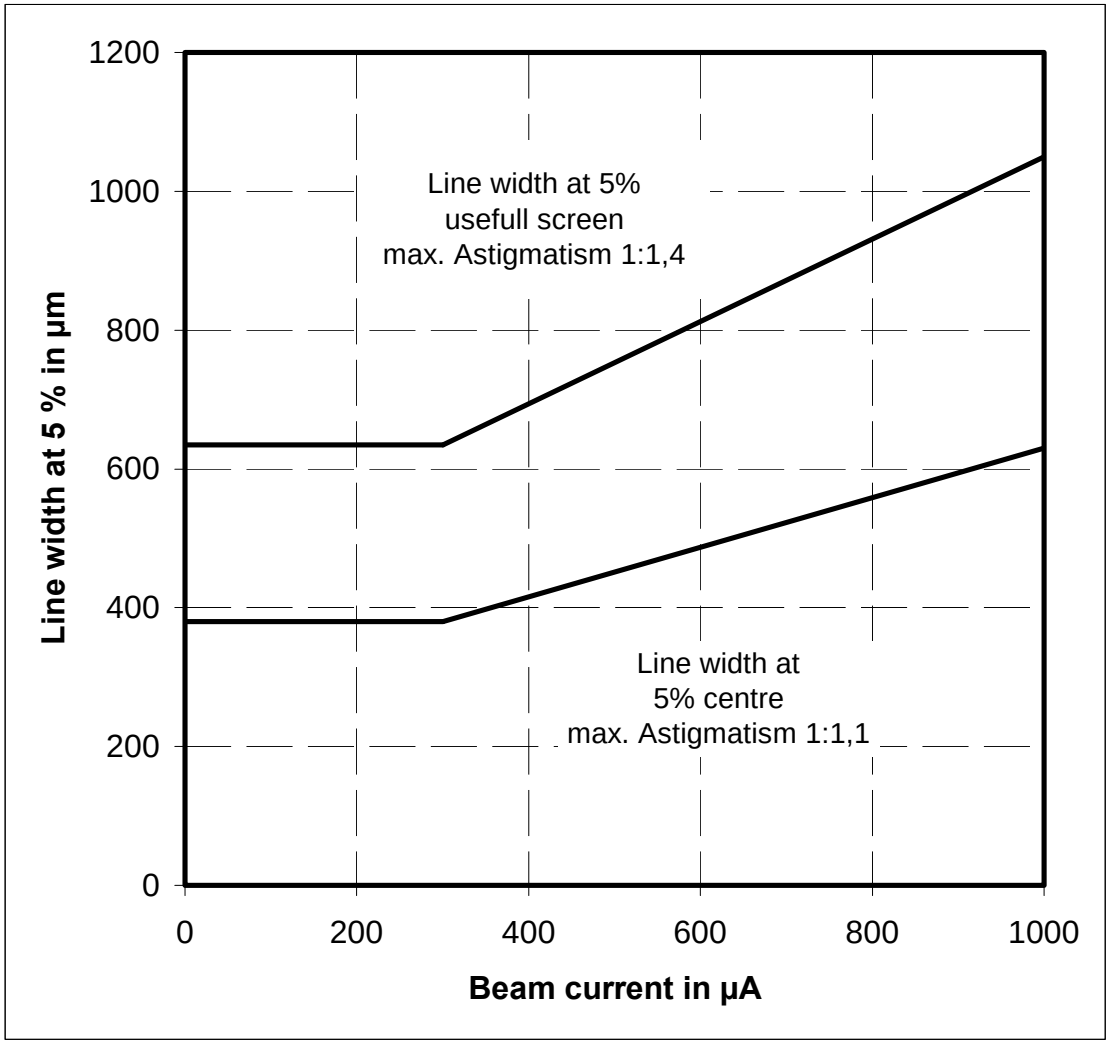


Measured with Microvision Superspot SS200 or PDS spot profile measuring system

- Astigmatism at 5% and 50%-line width has the same shape.
- Astigmatism is not allowed to turn at increased beam current
- The spot profile approximates the Gaussian distribution.

Resolution

5 % of peak value
Duty cycle 100 %



Measured with Microvision Superspot SS200 or PDS spot profile measuring system

10 Electrical Data

Deflection		**magnetically, deflection angle** **- horizontal ca. 78°** **- vertical ca. 60°** **- diagonal ca. 90°**	
Focussing		**electrostatic**	
Maximum currents (leakage)	I_{G1}	**± 1µA**	
	I_{G2a}	**± 1µA**	**max. 5 changes allowed**
	I_{Gsb}	**± 1µA**	
	I_{G3}	**± 2µA**	
Capacity *) (Grid 1 to all other electrodes)	$C_{G1\text{-}all}$	**5,3 pF ± 1 pF**	
Capacity *) (Cathode to all other electrodes)	C_K	**3.5 pF ± 1 pF**	
Capacity *) (Grid1 to cathode)	$C_{G1\text{-}K}$	**2,3 pF ± 0,7 pF**	
Capacity (Anode to outher coating)	$C_{A\text{-}M1}$	**1600 ... 3000 pF**	

Electrical Data from THOMSON-Coil		**Drawing nmbr. 250 898.ZZ** **THOMSON-YOKE Nr. 9294.xx**
Horizontal deflection	**Lx**	**49,5 µH ± 5 %**
	Rx	**150 mΩ ± 10 %**
Vertical deflection	**Ly**	**1.83 mH ± 5 %**
	Ry	**3.28 Ω ± 10 %**
Rotationcoil	**Rr**	**133 Ω ± 10 %**
	Ir	**47 mA / 1 °**
Astigmatism Axial	**La**	**23 µH ± 5 %**
	Ra	**< 6 Ω**
Astigmatism Diagonal	**Ld**	**23 µH ± 5 %**

	Rd	< 6 Ω

*) measured with PHILIPS RLC Meßbrücke PM6303

11 Absolute limiting values

Cathode is reference point for all voltage values

First accelerating voltage	$U_{G2\ I\&II}$	max. 1300 V min. - 400 V	
Second accelerating voltage	U_A	max. 29,9 kV	
Focus voltage	U_{G4}	max. 9 kV	
Grid 1 voltage	$-U_{G1}$	max. 150 V (200 V for 5 sec. after switch off) min. 2 V	
Heating against cathode	U_{HC}	negative negative peak positive positive peak	255 V 300 V 3 V 50 V
	I_{HC}	max. 15 µA	
Grid 1 leakage resistance	R_{G1}	1,5 MΩ	
Damping of deflection field:	The power consumption of the horizontal deflection is allowed to increase by max. 1.4 W when yoke is mounted to the CRT. (at 80 kHz horizontal frequency, a retrace time of $\leq$ 2,5 µs and a horizontal width of 400 mm at U_A = 27,5 kV).		

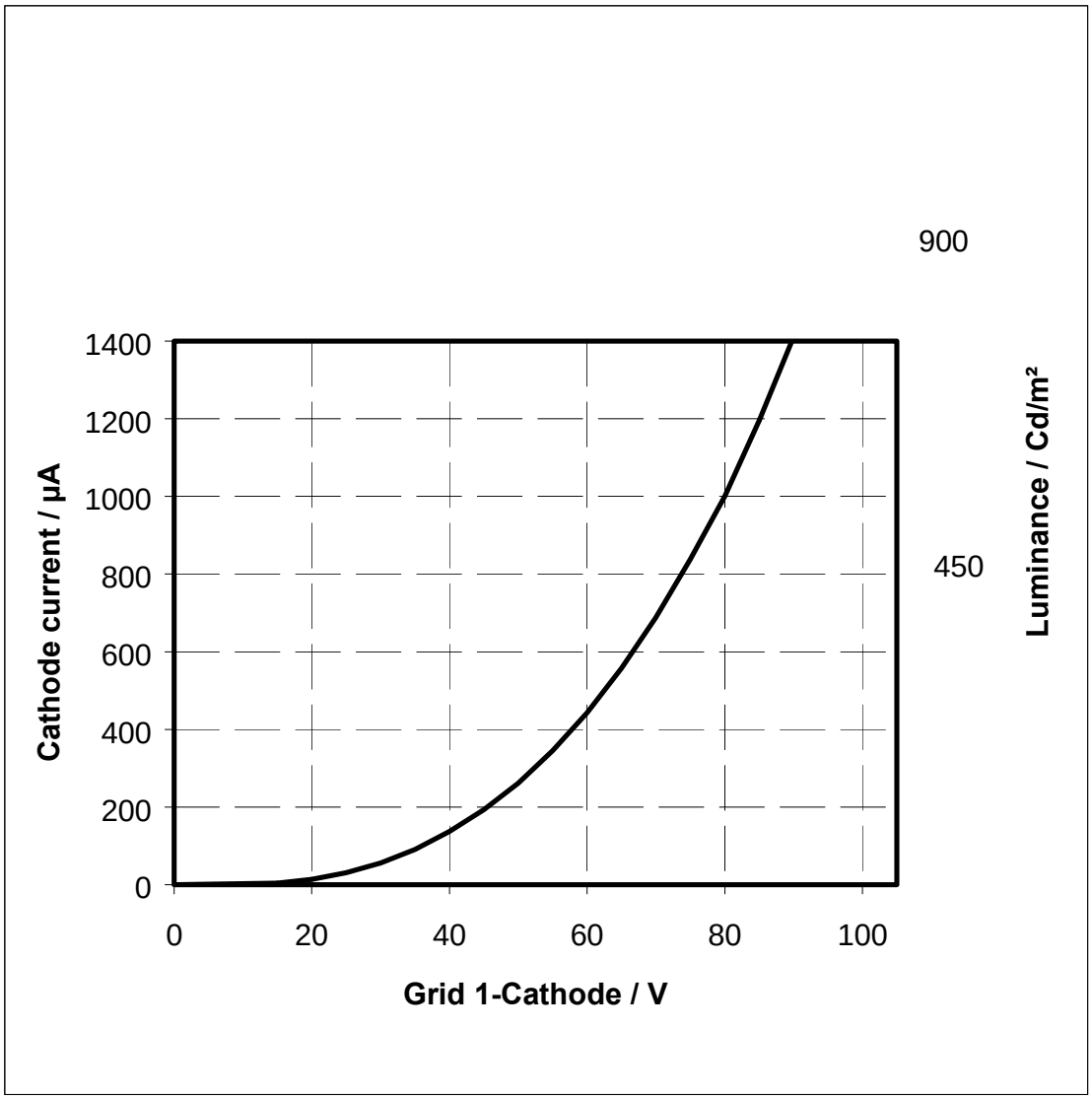
12 Operating values

Cathode heating	**- indirect**		
	- Heating voltage	**U_h**	**6,1 V ± 2%**
	- Heating current,	**I_h**	**approx. 100 mA;**
		I_{hmax}	**0,5 A (cold state)**

Cathode is reference point vor all valtage values following

First accelerating voltage	**$U_{G2\ I}$**	**600 - 930 V**
Halo suppression voltage	**$U_{G2\ II}$**	**0 - 200 V**
Grid 1 voltage (for spot suppression)	**- U_{G1}**	**105 V**
second accelerating voltage	**U_A**	**29,0 kV**
Drive voltage (grid drive) (from I_C = 0 µA to I_C = 1200 µA[1])	**ΔU_{WE}**	**max. 85 V**
Luminance drift over time		**max. 18 minutes after switch on (an overshoot of max 10% of cutoff voltage is allowed during this time)**
Focus voltage (at centre of screen at I_C = 300 µA	**U_{G3}**	**min. 6,80 kV nom. 7,15 kV max. 7,50 kV**
Dynamic focus voltage (with reference to Thomson-yoke Nr. 9294.xx)	**$U_{G3\ dyn.}$**	**max. = 850 V**

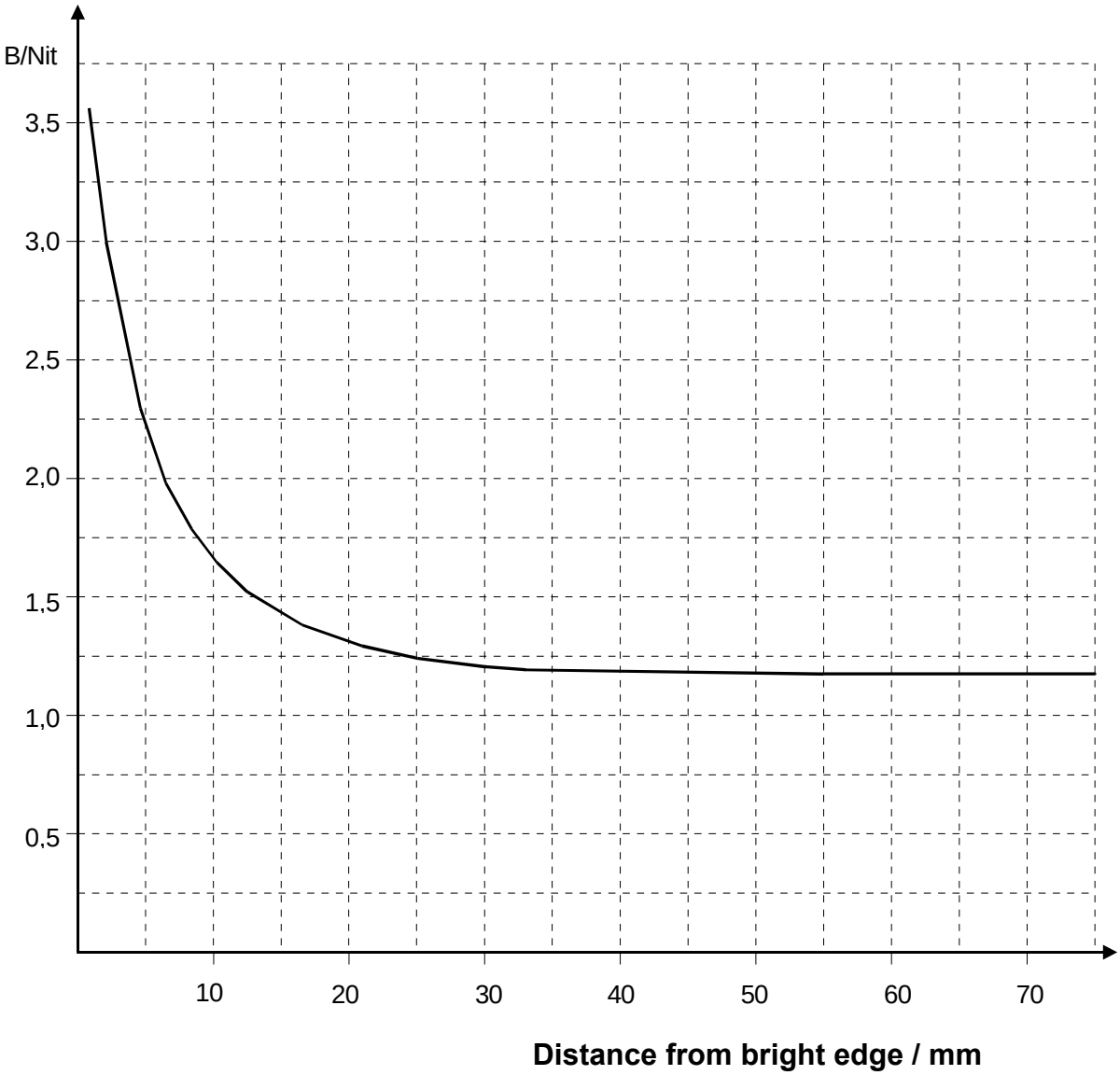
13 Grid drive characteristics



Luminance at 100% Transmission
Scan area 300*400 mm

14 Large area contrast

Max. value



To measure the large area contrast a bright rectangle is displayed on one half of the screen. This area must be 50% of the total screen area with an aspect ratio of x : y = 2:3, and a luminance of 400 Nit.
The luminance of the black area is adjusted in such way that no lines can be seen in dark room conditions (optical cut-off value).
With the Microvisionsystem Superspot (or similar) the brightness is measured in relation to the distance from the black/white edge.
The bright rectangle must be totally covered with a non reflecting cover during measuring.

15 Environmental conditions

Temperature range:

Operation	**0 to + 70 °C** **relative humidity 75 %** **non condensing**
Storage	**- 40 to 70 °C**
Temperature gradient	**20 °C/h**
Air pressure	**400 hPa to 1060 hPa**

16 Estimated life time

Decrease of the cathode current of 800 µA at 100 % duty cycle and constant Cut-Off-voltage (Grid 2-voltage adjusted)

after	**20.000 hrs. < 10 %**

Burning conditions:
The cathode current during testing is max. 500 µA at 100 % duty cycle over total scan area.

During life time of the CRT (20 000 hours) G2a voltage may be increased to max. 1250 V, to maintain G1-Cut-Off voltage of –105V.

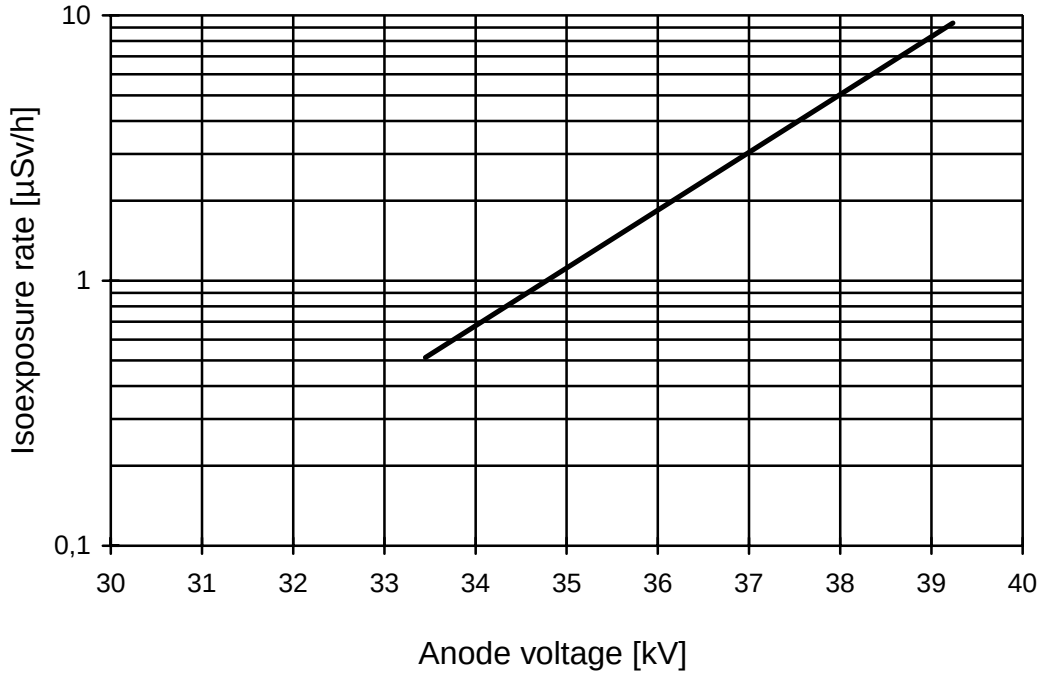
At a maximum luminance level of 350 Nit, after 20.000 hours of operation ,the maximum decrease in phosphor luminance is 15 %.

17 X-radiation

X-Radiation Limit Curve

Conditions:

Cathode current I_C = 250 µA

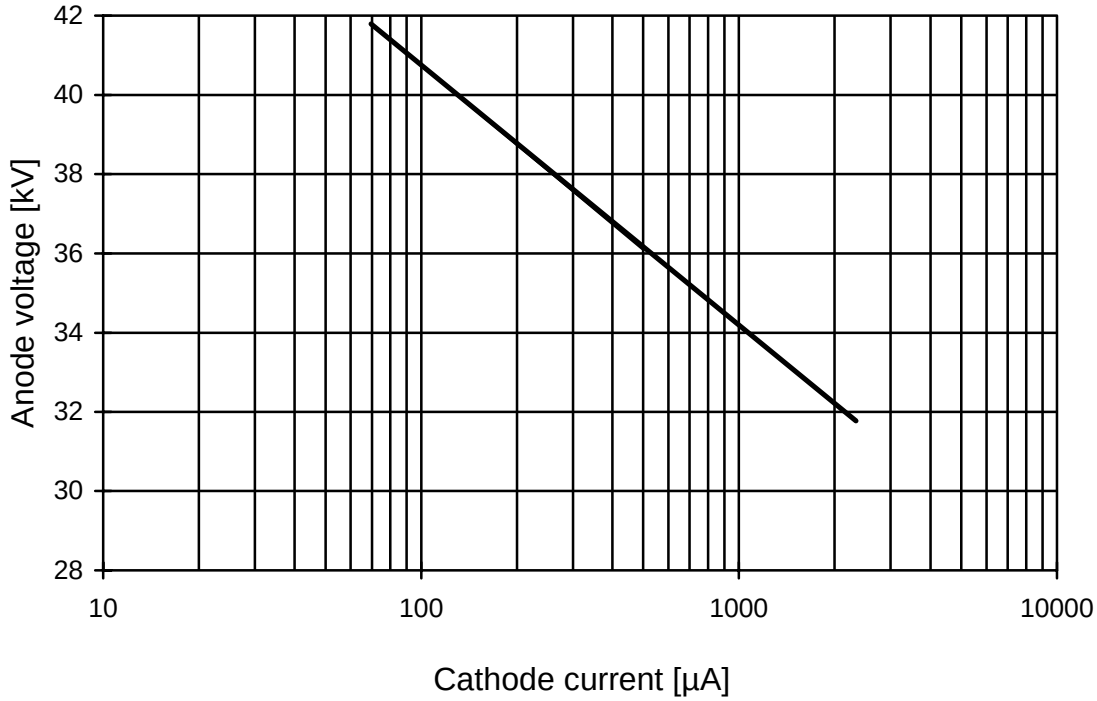


X-Radiation exposure rate vs. anode voltage at a constant value of cathode current measured at 5 cm from the CRT.

The measurement is according:
"Röntgenverordnung der Bundesrepublik Deutschland vom 8. Januar 1987"

Isoexposure - Rate Limit Curve

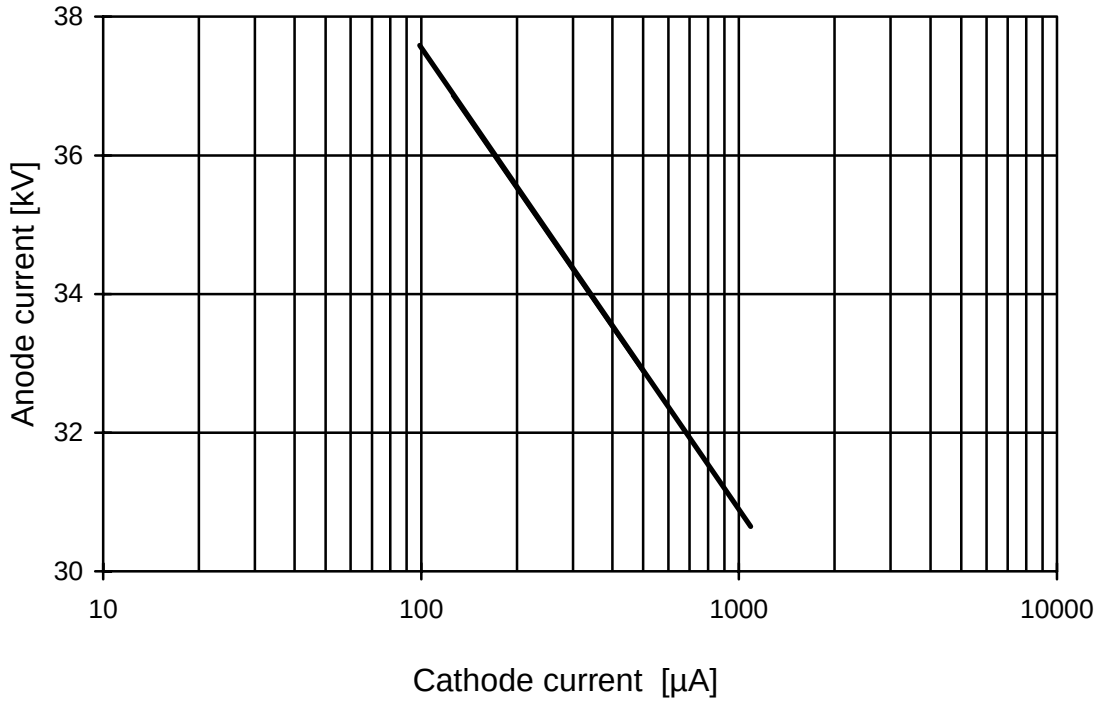
Calculated for 5 µSv/h



This limit curve is plotted at an isoexposure rate of 5 µSv/h (0,5 mR/h) measured at 5 cm from the CRT.

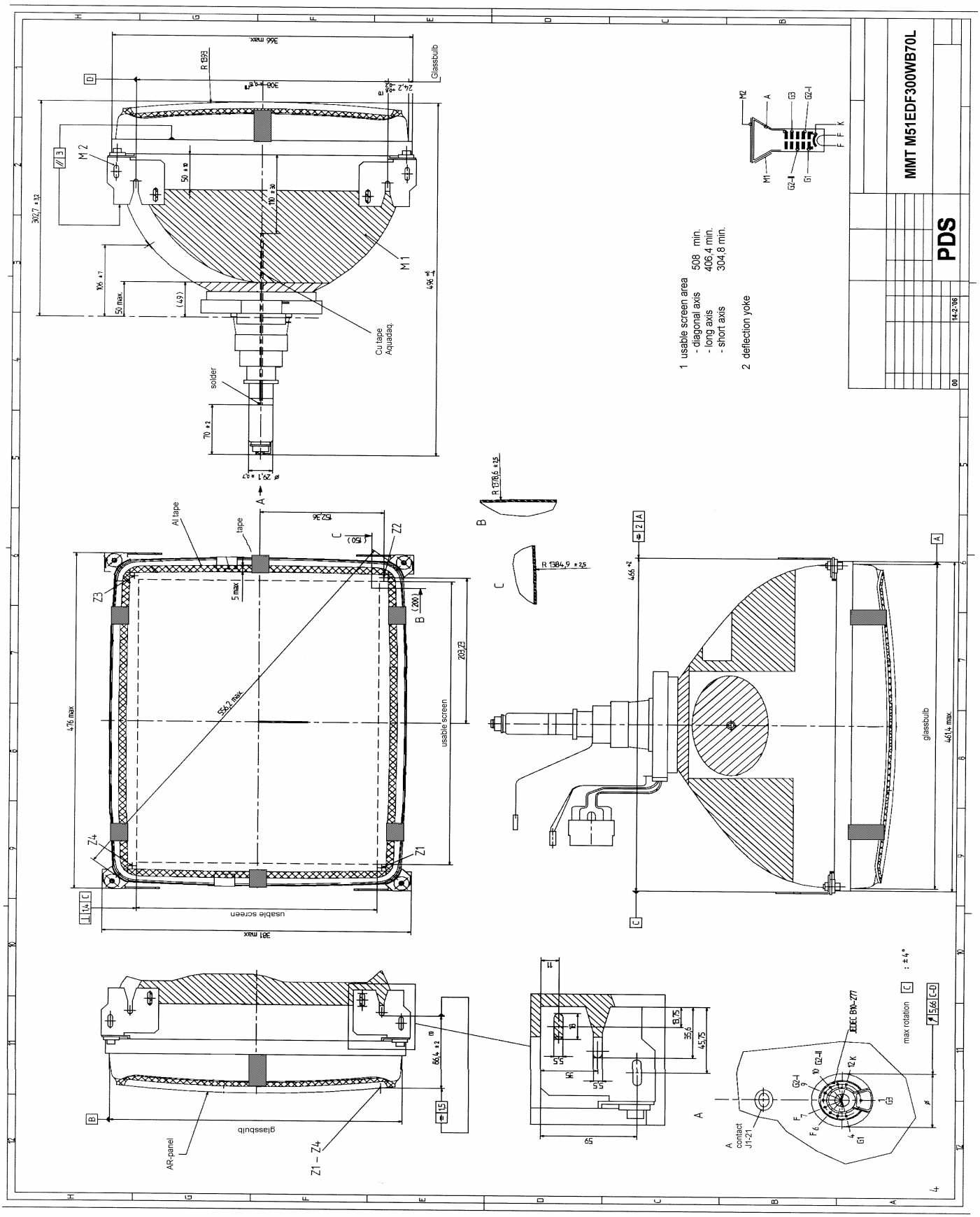
Isoexposure - Rate Limit Curve

Calculated for 1 µSv/h



This limit curve is plotted at an isoexposure rate of 1 µSv/h (0,1 mR/h) measured at 5 cm from the CRT.

Attachment 1



Specification

M 51EDF300WB70L

51 cm / 21 inch rectangular monochrome CRT

Landscape format

Status: Preliminary
Modifications may be agreed upon after evaluation of about 200 products.

CONTENTS

1 VIEW OF CHANGES
2 APPLICATION
3 CHARACTERISTICS
4 IMPORTANT NOTES
5 MECHANICAL DATA
6 MAXIMUM OF NOT DEFLECTED SPOT LANDING
7 OPTICAL DATA
8 PERMISSIBLE GLASS AND SCREEN DEFECTS
9 RESOLUTION
10 ELECTRICAL DATA
11 ABSOLUTE LIMITING VALUES
12 OPERATING VALUES
13 GRID DRIVE CHARACTERISTICS
14 LARGE AREA CONTRAST
15 ENVIRONMENTAL CONDITIONS
16 ESTIMATED LIFE TIME
17 X-RADIATION

1 View of changes

- The first release will be "01" .
- Changes and supplements to this specification during the development require the agreement of all persons responsible.

Responsible for the contents of this document are:

Company/Department	*Name*	*Tel.*	*Date*	*Signature*
PDS	P.Aerssens	+31 45 5439331		

Siemens
A&D SE BT E

ChangeNr.				
Date	11-1-2006	2-2-2006	21-6-2006	23-7-2007
Release	01	02	03	04

ChangeNr.				
Date	11-10-2007			
Release	05	06	07	08

Changed pages:

Release:	Pages:
02	01 : Type designation changed
	10 : Blemish specification changed
	15 : Heater Cathode voltage
	22 : Drawing : brackets added
03	15 : Heater voltage specification , Brightness variation
	18 : Stray emission
	22 : Drawing
04	16 : Drawing. 15 : Heater voltage
05	07 : delete -with CL60 filter-

2 Aplication

CRT for displays in medical and alphanumerical applications

3 Characteristics

high resolution
90° -deflection
flat & square colour bulb (low browning glass)
multicoated
conductive coated against charging
intrinsically safe
high contrast
high luminance
long life time

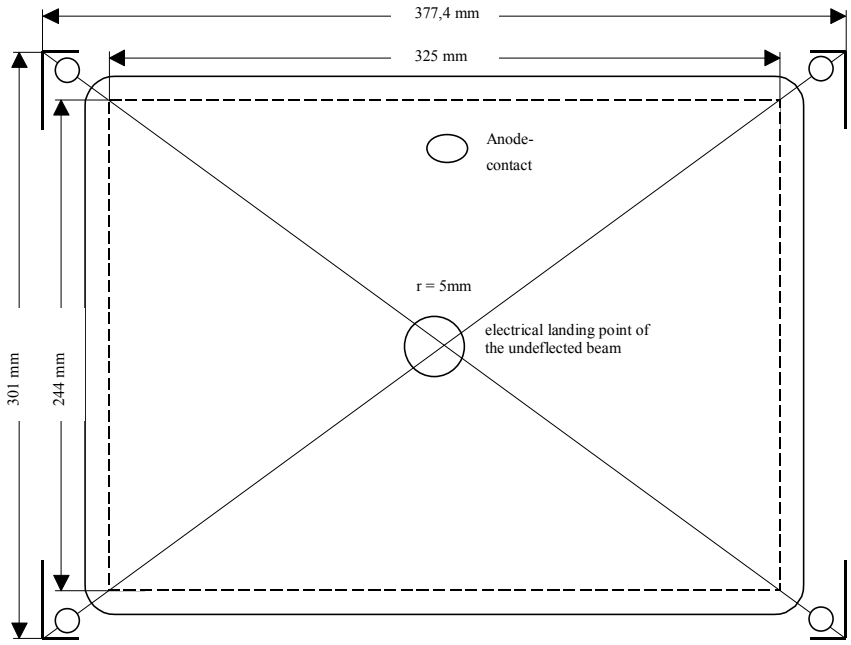
4 Important notes

Implosion hazard	**CRT is evacuated. In case of mechanical damage (e.g. by shock or scratches) implosion can occur.**
CRT is labelled according:	**UL 1418** **MPR II**
High voltage	**For reasons of the CRT's capacities the anode connection can conduct high voltage for a long time after high voltage is switches off.**
X-ray emission	**Operating the tube within the limits the x-ray dose rate will be under the allowed value of 1 µSv/h (adequate to: 0,1 mR/h)** **The tube is an intrinsic CRT type according the RöV (German Röntgenverordnung) dated Jan, 8th 1987, Part I; Attachment III, paragraph 6.**

5 Mechanical Data

Screen	**rectangular, R = 1370 mm**
Useable screen	**• Screen diagonal min. 508,0 mm • Screen width min. 304,8 mm • Screen height min. 406,4 mm**
Position of operation	**anode connector on top of tube**
Socket	**JEDEC B10-277 or equal**
Neck diameter	**29,1 mm ± 0,7 mm**
Anode connector	**Bulb contact 7,92 DIN 41543**
Deflection yoke	**Drawing nr. 250 898.ZZ THOMSON-Yoke No.: 9294.xx**
Weight	**Approx. 17,0 kg incl. Deflection yoke**
Mechanical outlines	**see attachment 1**

6 Maximum of not deflected spot landing

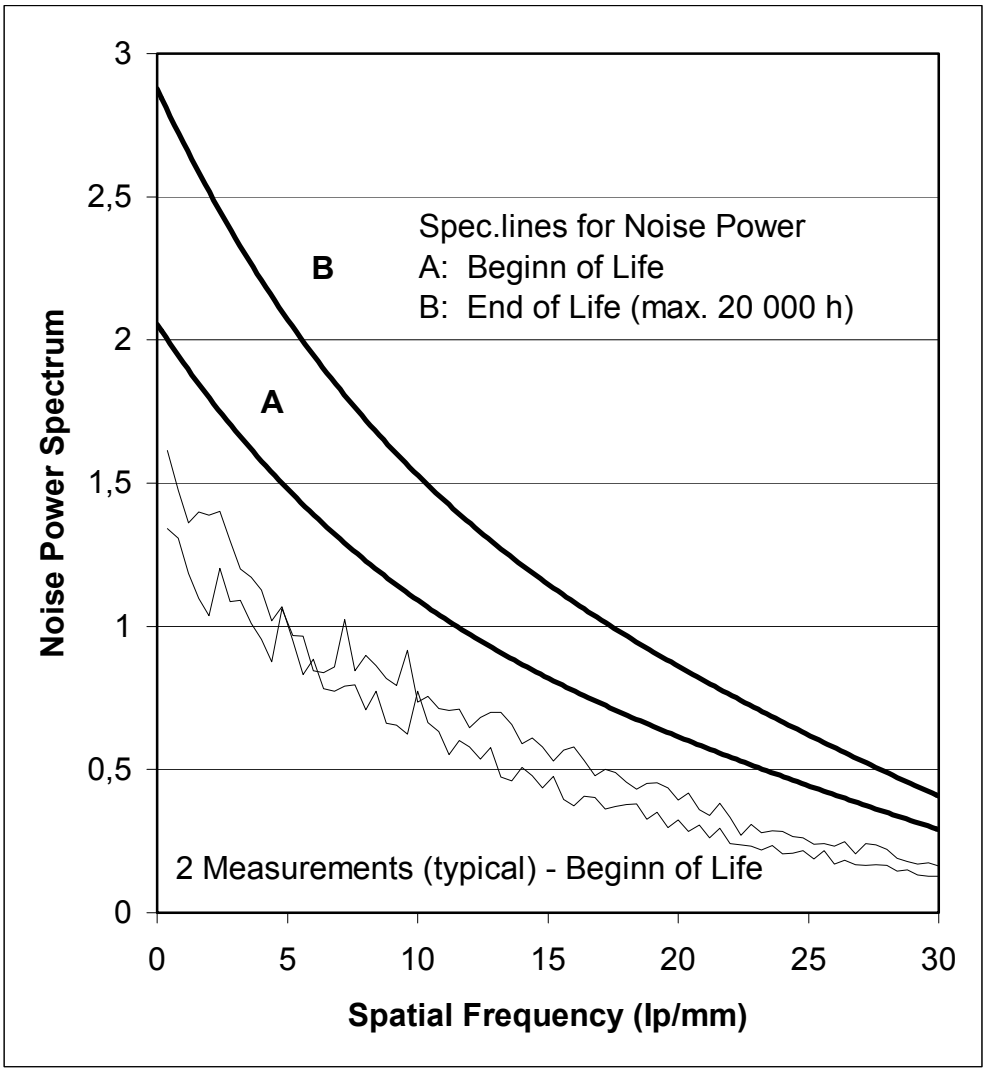


- **The CRT is mounted by angle brackets in a jig (see schematic) whose pick-up holes meet those of the monitor chassis.**
- **The CRT has to be moved in its fitting ears in such a way, that finally the centre of the glass bulb matches the mechanical centre of the jig ± 1 mm.**
- **Phosphor material must be everywhere within a window of 300 × 400 mm. The centre of that phosphor window matches the mechanical centre of the CRT.**
- **The spot or the deflection yoke will be adjusted, so that equal and symmetrical focus exists.**
- **The non-deflected spot landing must be within a circle with a radius of 2 mm around a point 3 mm left and 2 mm down from the mechanical centre of the CRT, provided that:**
  - **the CRT axis is in east-west direction and the front panel is facing east,**
  - **the anode connector is located on top of the tube,**
  - **the deflection unit has been mounted to the tube,**
  - **there is a metal shield behind the deflection unit around the tube's neck**
- **The maximum rotation angle of the deflection unit may not exceed 0.2°.**

7 Optical data

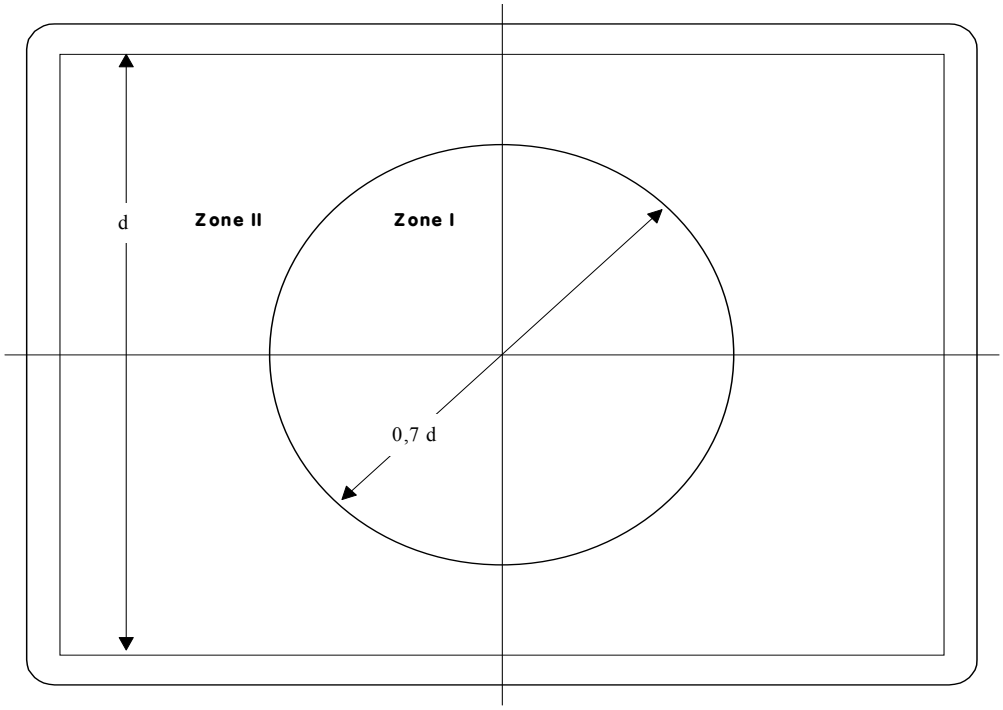
Total transmission of bulb including coating/panel:	**49 % ± 3 % at 546 nm**	
Phosphor	**P45**	
7.1	**Noise Power (see fig.)**	
Color coordinates: (during operation)	**P45-Phosphor**	
at a luminance of 250 Cd/m^2 (Nit) with CL60-Filter, (measured with LMT Color meter or Minolta CA100)	**X = (0,250 ± 0,01)**	**Y = (0,305 ± 0,01)**
Front panel	**Transmission at 546 nm ca. 95% Coating : Flabeg OEL-95** **Direct coating alternative after agreement with customer. The connection with the mounting device aluminium strips are mounted on front panel.**	
Uniformity of luminance from centre to any corner	**At a luminance of 50 Nit the overall deviation of luminance from centre to any corner may not exceed 12 Cd/m^2 (Nit) at any point of the screen.**	
Glass bulb	**Drawingnmbr. 252 907.GZ or equivalent bulb after agreement with customer.**	

7.1 Noise power



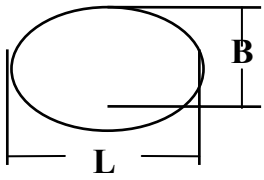
Noise Power measured with SIEMENS Measurement system.

8 Permissible Glass and screen defects



L: max. length of defects

B: max. width of defects



d = 300 mm

Defect size G for the screen and glass specification

for a side ratio of L/B ≤ 3 G = ½ (L + B)
for a side ratio of L/B > 3 G = L/20 + 2 B

Permissible defect (Panel included)

Defect size G in mm	Number of defects Zone I	Number of defects Zone II	Number of defects Sum [1)]
< 0,2	Within any area of 30 *30 mm only 3 phosphor defects with size 0.1 – 0.2 mm are allowed.		
0,2 < G < 0,4	2	3	4
0,4 < G < 0,6	-	3	3
Distance between defects	> 50 mm	> 50 mm	

[1)] Maximum number of defects in zone I and II : 4

Scratches

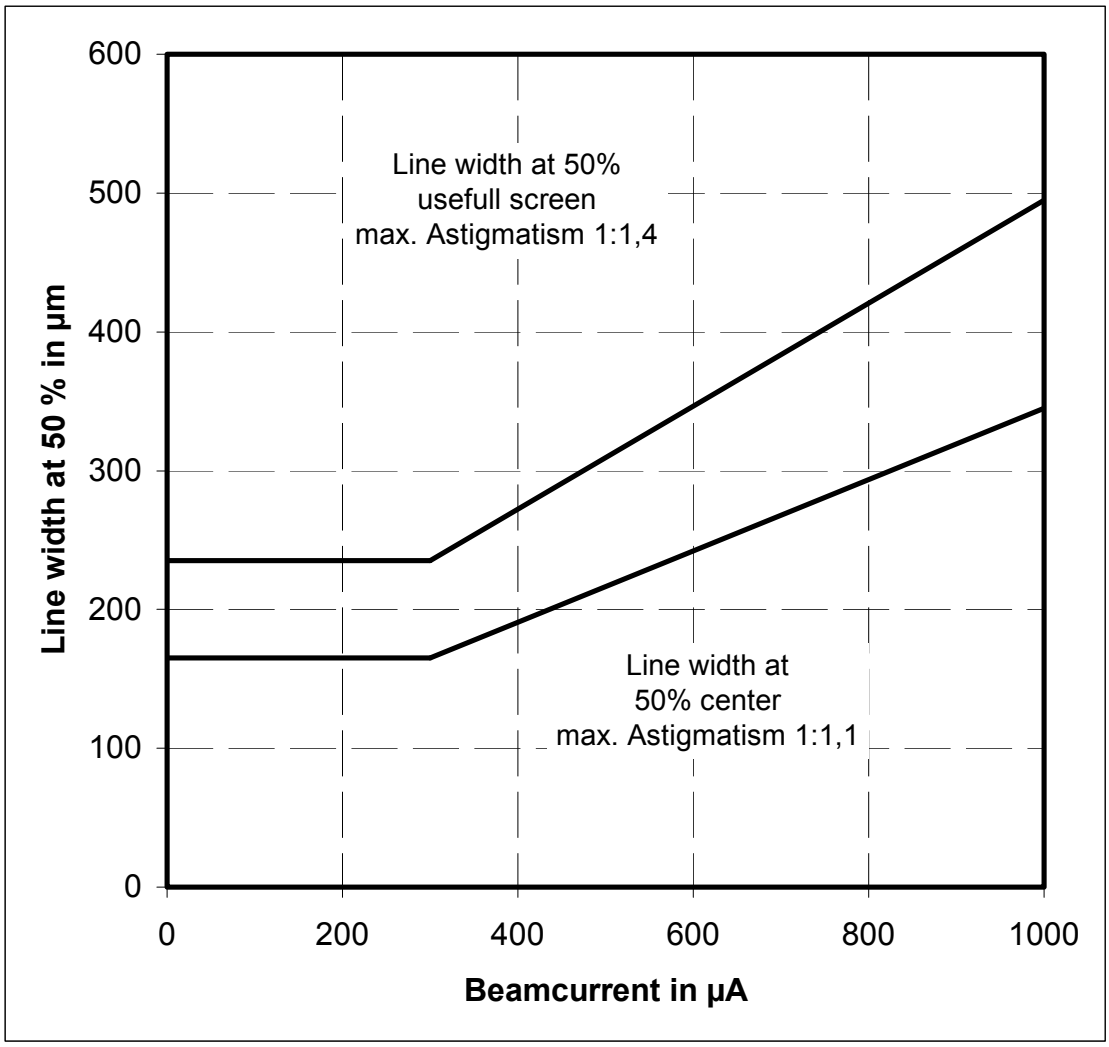
Sum ≤ 2
distance > 50 mm
max. length < 10 mm
max. width < 50 µm

Scratches <15 µm are permitted

Not allowed defects:
Open holes, stones, folds, cracks, accumulated defects, 'cloud'.

9 Resolution

50 % of peak value
Optimal focus: 300µA
Duty cycle 100 %

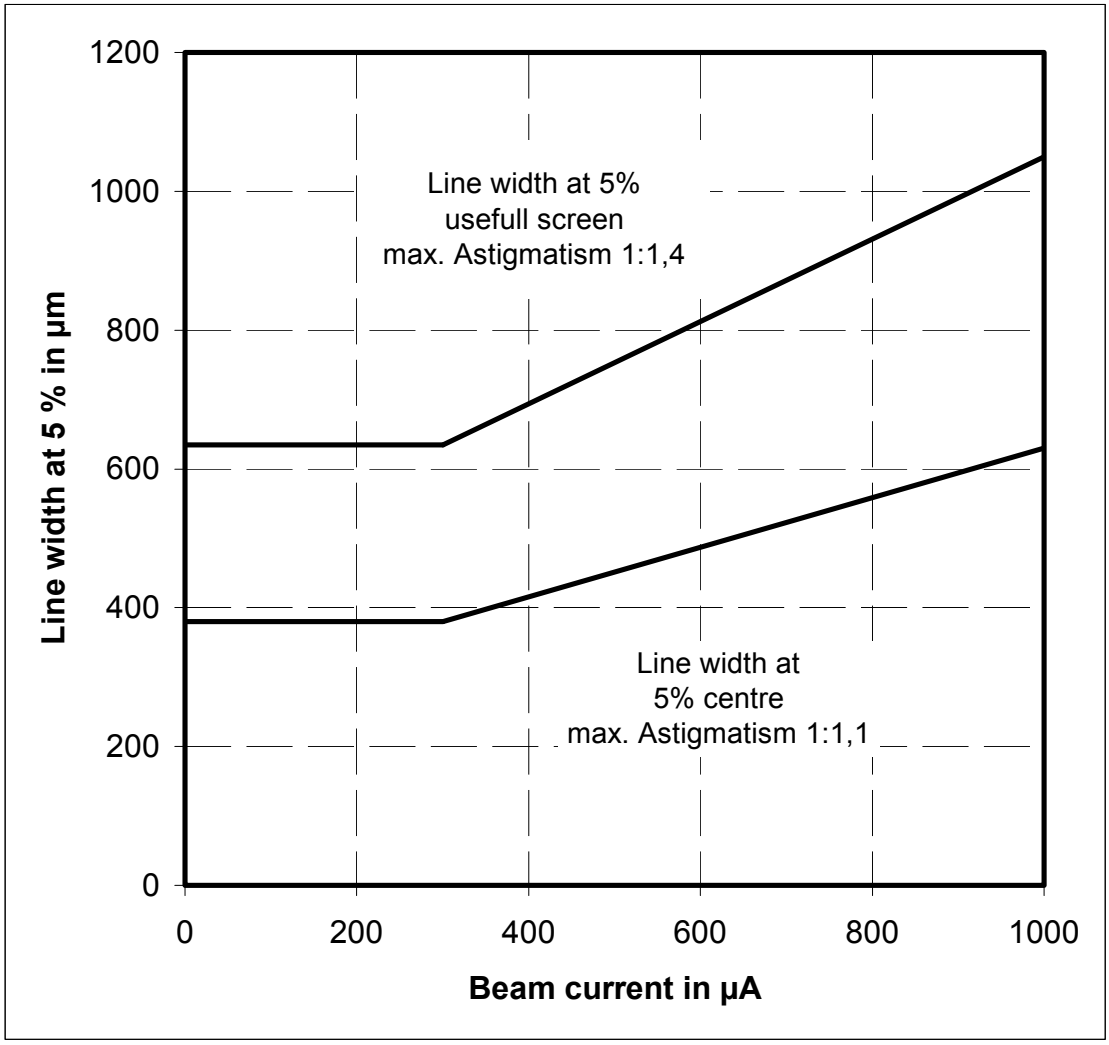


Measured with Microvision Superspot SS200 or PDS spot profile measuring system

- Astigmatism at 5% and 50 %-line width has the same shape.
- Astigmatism is not allowed to turn at increased beam current
- The spot profile approximates the Gaussian distribution.

Resolution

5 % of peak value
Duty cycle 100 %



Measured with Microvision Superspot SS200 or PDS spot profile measuring system

10 Electrical Data

Deflection		**magnetically, deflection angle**	
		- horizontal	**ca. 78°**
		- vertical	**ca. 60°**
		- diagonal	**ca. 90°**
Focussing		**electrostatic**	
Maximum currents (leakage)	I_{G1}	**± 1µA**	
	I_{G2a}	**± 1µA**	**max. 5 changes allowed**
	I_{G2b}	**± 1µA**	
	I_{G3}	**± 2µA**	
Capacity *) (Grid 1 to all other electrodes)	$C_{G1\text{-}all}$	**5,3 pF ± 1 pF**	
Capacity *) (Cathode to all other electrodes)	C_K	**3.5 pF ± 1 pF**	
Capacity *) (Grid1 to cathode)	$C_{G1\text{-}K}$	**2,3 pF ± 0,7 pF**	
Capacity (Anode to outer coating)	$C_{A\text{-}M1}$	**1600 ... 3000 pF**	

Electrical Data from THOMSON-Coil		**Drawing nmbr. 250 898.ZZ THOMSON-YOKE Nr. 9294.xx**
Horizontal deflection	**Lx**	**49,5 µH ± 5 %**
	Rx	**150 mΩ ± 10 %**
Vertical deflection	**Ly**	**1.83 mH ± 5 %**
	Ry	**3.28 Ω ± 10 %**
Rotationcoil	**Rr**	**133 Ω ± 10 %**
	Ir	**47 mA / 1 °**
Astigmatism Axial	**La**	**23 µH ± 5 %**
	Ra	**< 6 Ω**
Astigmatism Diagonal	**Ld**	**23 µH ± 5 %**
	Rd	**< 6 Ω**

***) measured with PHILIPS RLC Meßbrücke PM6303**

11 Absolute limiting values

Cathode is reference point for all voltage values

First accelerating voltage	$U_{G2\ I\&II}$	max. 1300 V min. - 400 V	
Second accelerating voltage	U_A	max. 29,9 kV	
Focus voltage	U_{G4}	max. 9kV	
Grid 1 voltage	$-U_{G1}$	max. 150 V (200 V for 5 sec. after switch off) min. 2 V	
Heating against cathode	U_{HC}	negative negative peak positive positive peak	255 V 300 V 3 V 50 V
	I_{HC}	max. 15 µA	
Grid 1 leakage resistance	R_{G1}	1,5 MΩ	
Damping of deflection field:	The power consumption of the horizontal deflection is allowed to increase by max. 1.4 W when yoke is mounted to the CRT. (at 80 kHz horizontal frequency, a retrace time of $\leq$ 2,5 µs and a horizontal width of 400 mm at U_A = 27,5 kV).		

12 Operating values

Cathode heating	- indirect		
	- Heating voltage	U_h	6.0 – 6.2 V
	- Heating current,	I_h	approx. 100 mA;
		$I_{h\ max}$	0,5 A (cold state)

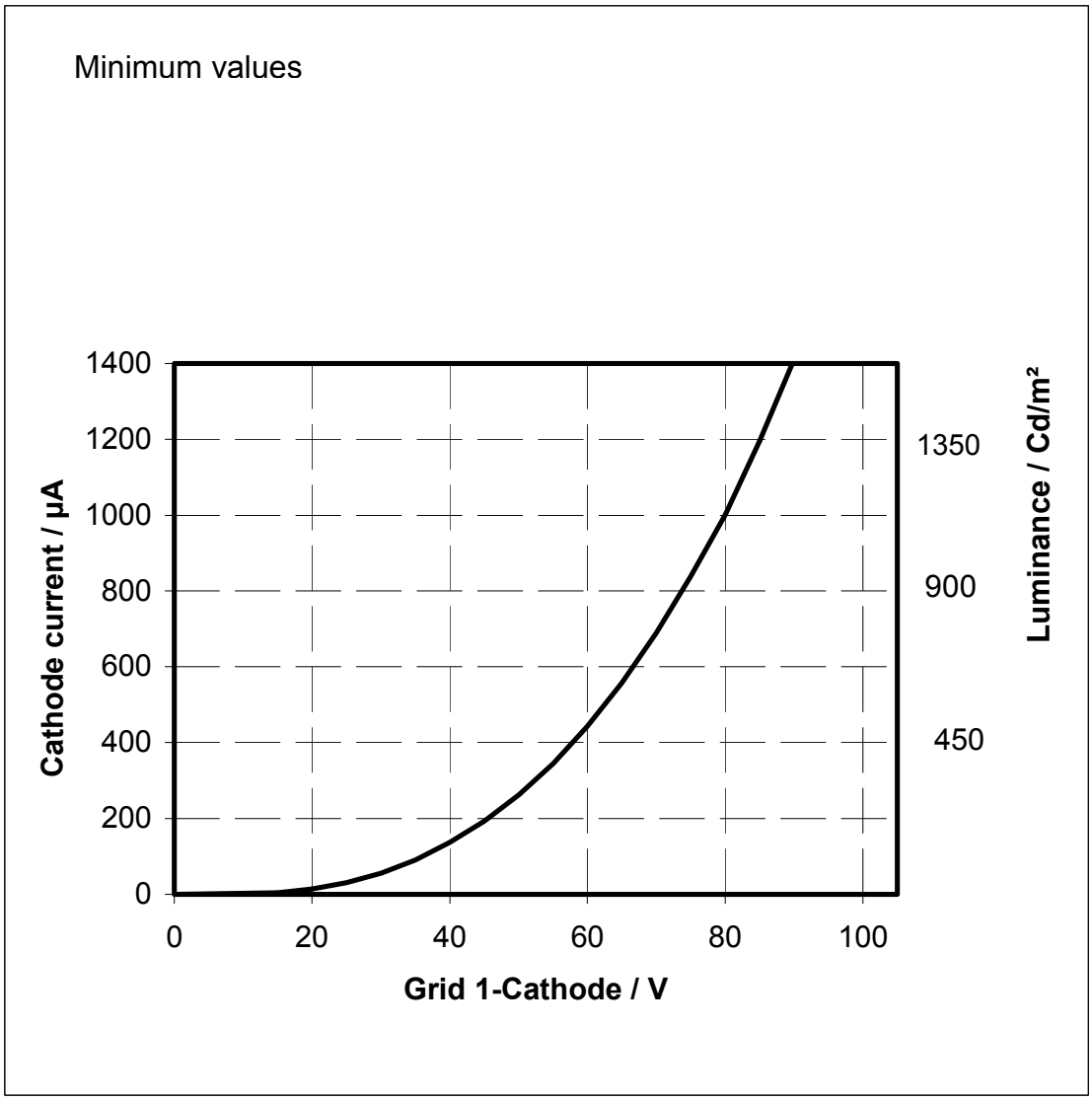
An integrated series resistor of 0.39 Ω reduces the effective heater voltage to 5.6-5.8V.

Cathode is reference point for all voltage values following

First accelerating voltage	$U_{G2\ I}$	600 - 930 V
Halo suppression voltage	$U_{G2\ II}$	0 - 200 V

Grid 1 voltage (for spot suppression)	$-U_{G1}$	105 V
second accelerating voltage	U_A	29,0 kV
Drive voltage (grid drive) (from I_C = 0 µA to I_C = 1200 µA[1)]	ΔU_{WE}	max. 85 V
Luminance drift over time		max. 18 minutes after switch on (an overshoot of max 10% of cut-off voltage is allowed during this time)
Focus voltage (at centre of screen at I_C = 300 µA	U_{G3}	min. 6,80 kV nom. 7,15 kV max. 7,50 kV
Dynamic focus voltage (with reference to Thomson-yoke Nr. 9294.xx)	$U_{G3\ dyn.}$	max. = 850 V
Brightness variation when changing from 100% white pattern to 10% square white pattern (same drive voltage)		No brightness variation allowed

Grid drive characteristics

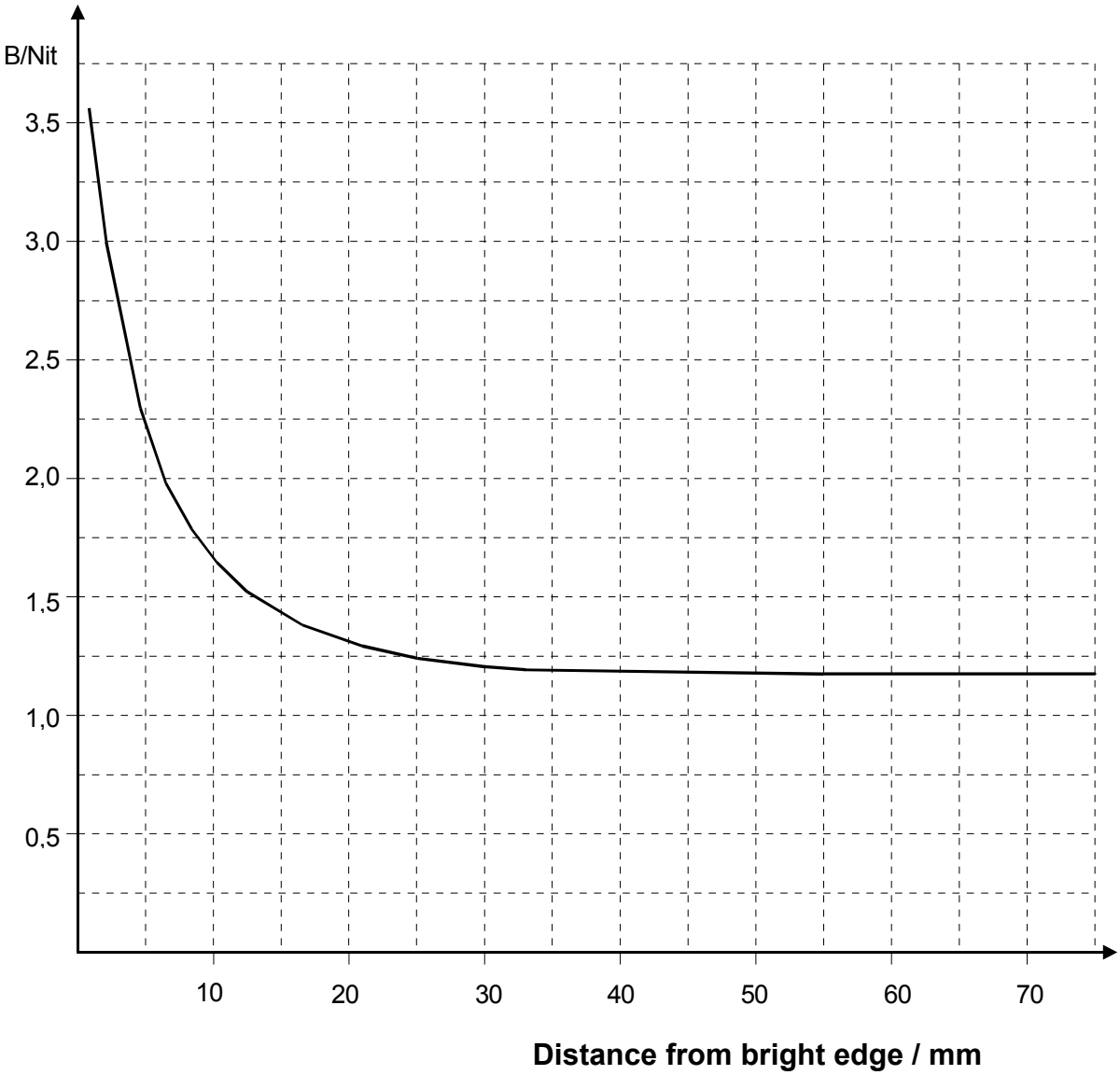


Luminance at 100% duty cycle. Horizontal freq: 64 kHz; Vertical freq: 50 Hz.

Scan area 300*400 mm

14 Large area contrast

Max. value



To measure the large area contrast a bright rectangle is displayed on one half of the screen. This area must be 50% of the total screen area with an aspect ratio of x : y = 2:3, and a luminance of 400 Nit.
The luminance of the black area is adjusted in such way that no lines can be seen in dark room conditions (optical cut-off value).
With the Microvisionsystem Superspot (or similar) the brightness is measured in relation to the distance from the black/white edge.
The bright rectangle must be totally covered with a non reflecting cover during measuring.

15 Environmental conditions

Temperature range:

Operation	**0 to + 70 °C** **relative humidity 75 %** **non condensing**
Storage	**- 40 to 70 °C**
Temperature gradient	**20 °C/h**
Air pressure	**400 hPa to 1060 hPa**

16 Estimated life time

Decrease of the cathode current of 800 µA at 100 % duty cycle and constant Cut-Off-voltage (Grid 2-voltage adjusted)

after	**20.000 hrs. < 10 %**

Burning conditions:
The cathode current during testing is max. 500 µA at 100 % duty cycle over total scan area.

During life time of the CRT (20 000 hours) G2a voltage may be increased to max. 1250 V, to maintain G1-Cut-Off voltage of –105V.

At a maximum luminance level of 350 Nit, after 20.000 hours of operation ,the maximum decrease in phosphor luminance is 15 %.

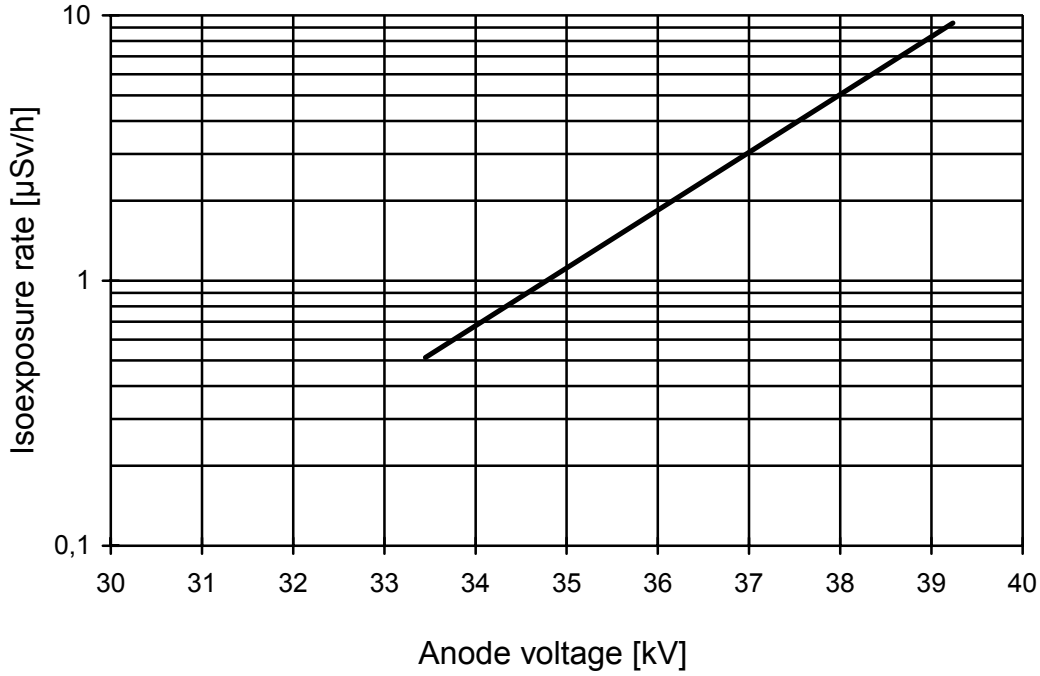
Stray emission : Maximum anode current in cut-off condition Uc- Ug1 > Uco after 10.000 hrs. : < 1 µA

17 X-radiation

X-Radiation Limit Curve

Conditions:

Cathode current I_C = 250 µA

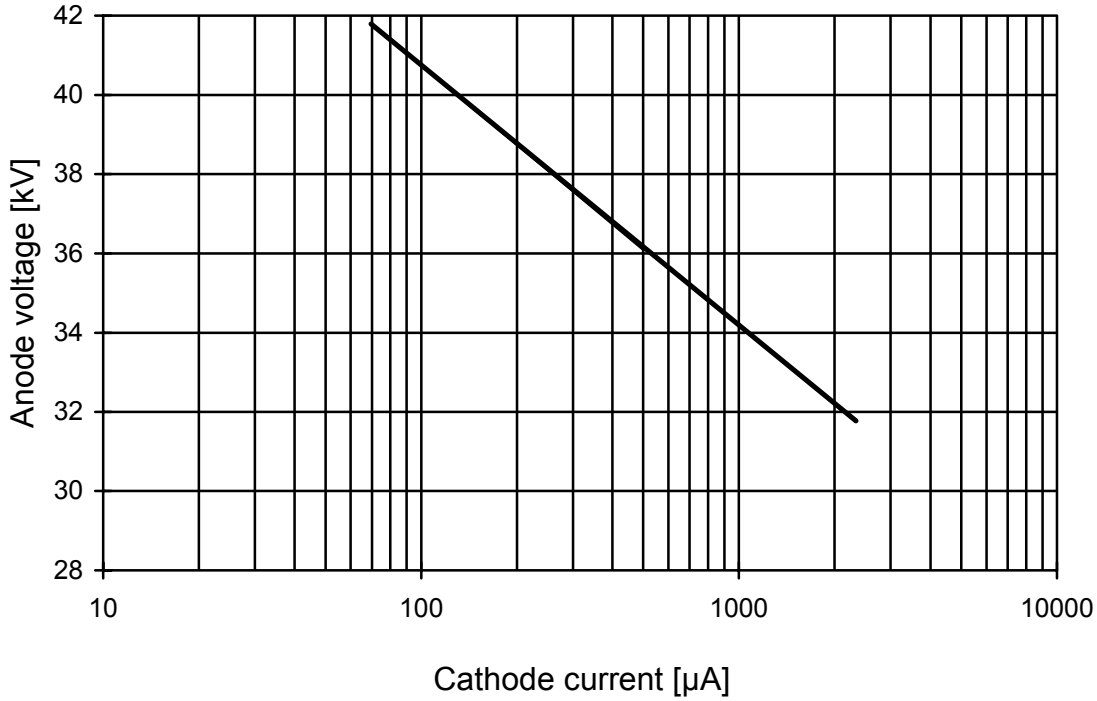


X-Radiation exposure rate vs. anode voltage at a constant value of cathode current measured at 5 cm from the CRT.

The measurement is according:
"Röntgenverordnung der Bundesrepublik Deutschland vom 8. Januar 1987"

Isoexposure - Rate Limit Curve

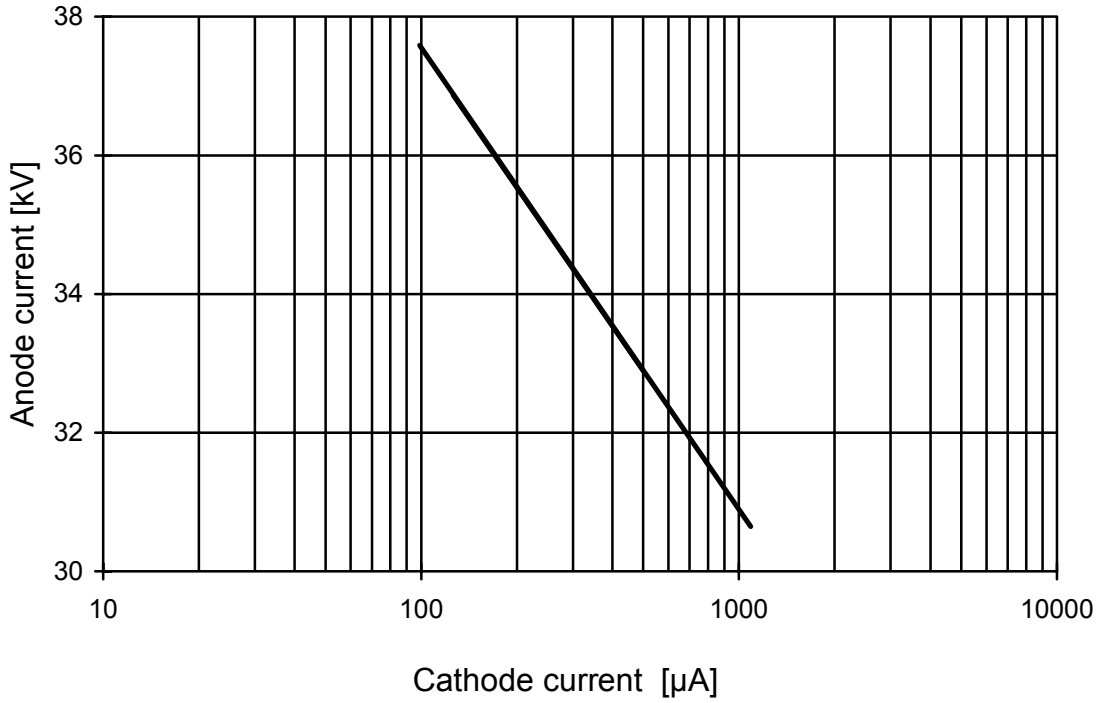
Calculated for 5 µSv/h



This limit curve is plotted at an isoexposure rate of 5 µSv/h (0,5 mR/h) measured at 5 cm from the CRT.

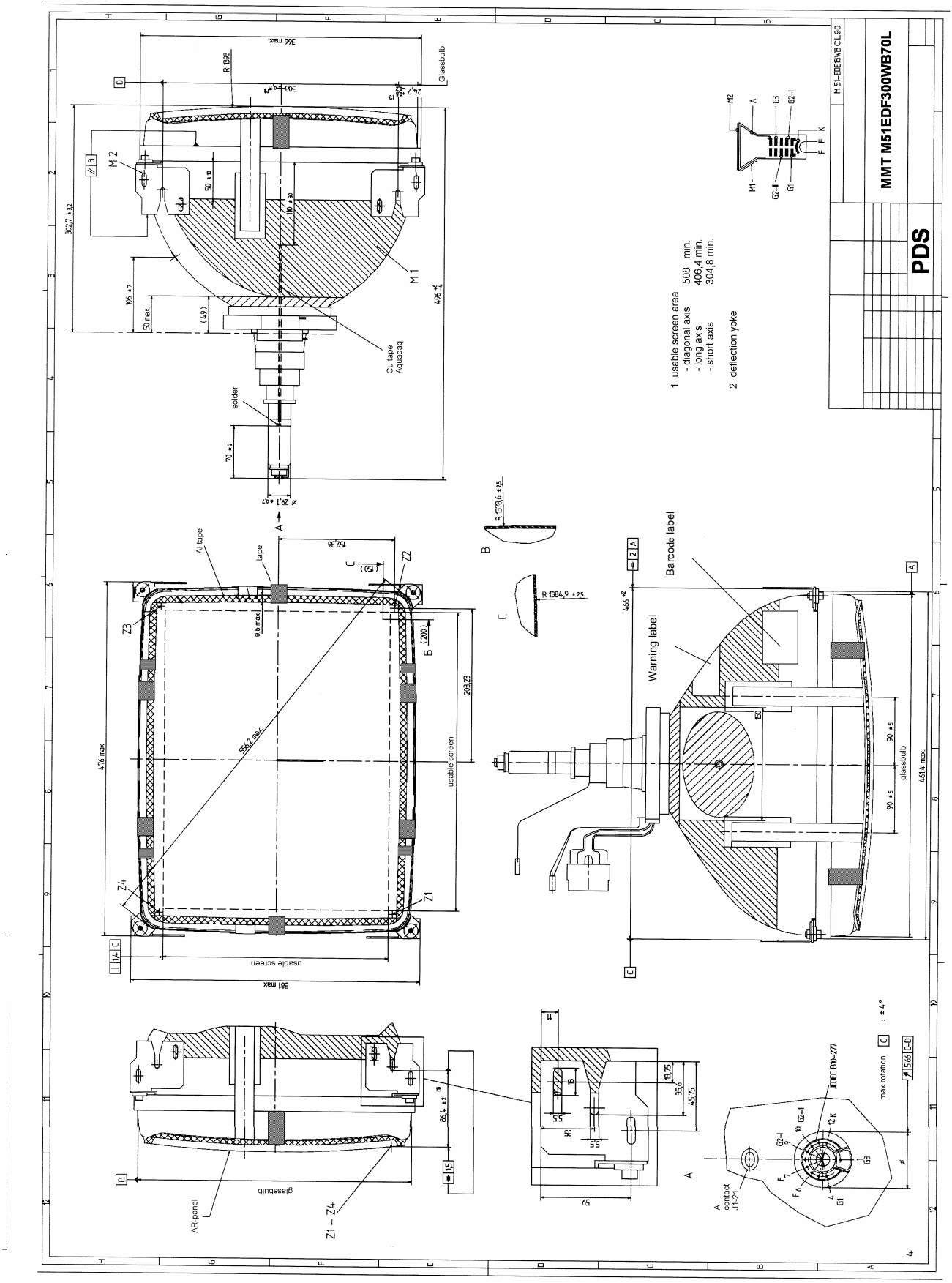
Isoexposure - Rate Limit Curve

Calculated for 1 µSv/h



This limit curve is plotted at an isoexposure rate of 1 µSv/h (0,1 mR/h) measured at 5 cm from the CRT.

Attachment 1



Specification

M 51EDF300WB70L

51 cm / 21 inch rectangular monochrome CRT

Landscape format

Status: Preliminary
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Responsible for the contents of this document are:

Company/Department	*Name*	*Tel.*	*Date*	*Signature*
PDS	P.Aerssens	+31 45 5439331		

Siemens
A&D SE BT E

ChangeNr.				
Date	11-1-2006	2-2-2006	21-6-2006	23-7-2007
Release	01	02	03	04

ChangeNr.				
Date	11-10-2007			
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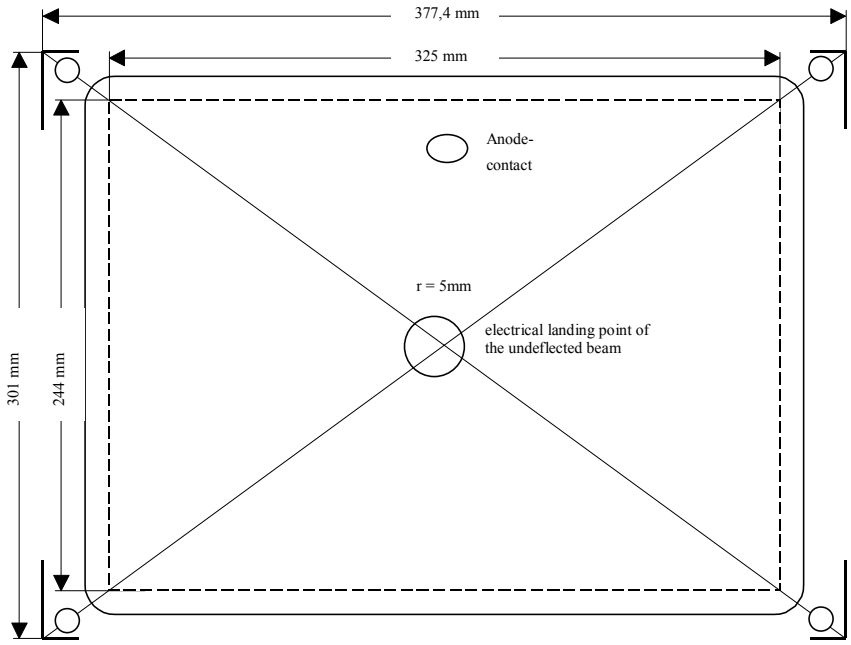
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CRT is labelled according:	**UL 1418** **MPR II**
High voltage	**For reasons of the CRT's capacities the anode connection can conduct high voltage for a long time after high voltage is switches off.**
X-ray emission	**Operating the tube within the limits the x-ray dose rate will be under the allowed value of 1 µSv/h (adequate to: 0,1 mR/h)** **The tube is an intrinsic CRT type according the RöV (German Röntgenverordnung) dated Jan, 8th 1987, Part I; Attachment III, paragraph 6.**

5 Mechanical Data

Screen	**rectangular, R = 1370 mm**
Useable screen	**• Screen diagonal min. 508,0 mm • Screen width min. 304,8 mm • Screen height min. 406,4 mm**
Position of operation	**anode connector on top of tube**
Socket	**JEDEC B10-277 or equal**
Neck diameter	**29,1 mm ± 0,7 mm**
Anode connector	**Bulb contact 7,92 DIN 41543**
Deflection yoke	**Drawing nr. 250 898.ZZ THOMSON-Yoke No.: 9294.xx**
Weight	**Approx. 17,0 kg incl. Deflection yoke**
Mechanical outlines	**see attachment 1**

6 Maximum of not deflected spot landing

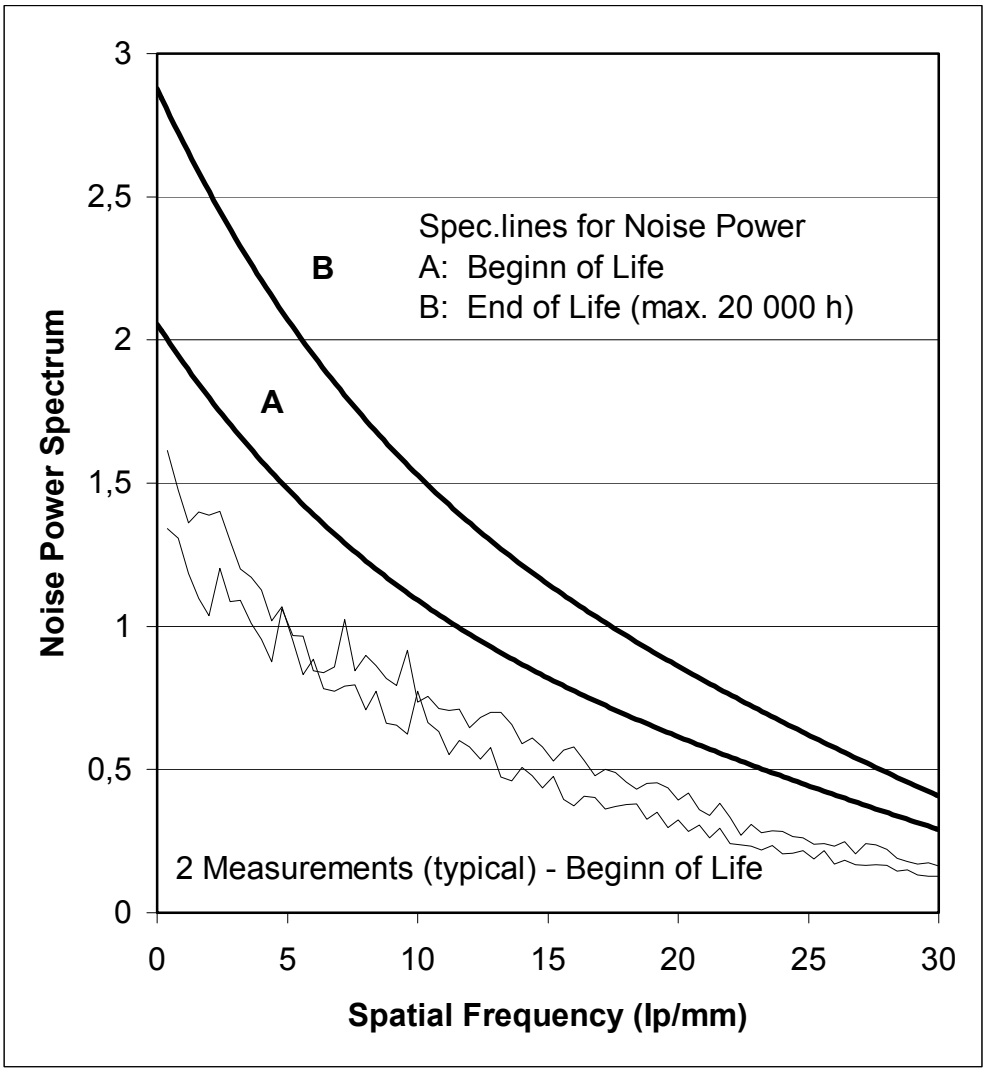


- **The CRT is mounted by angle brackets in a jig (see schematic) whose pick-up holes meet those of the monitor chassis.**
- **The CRT has to be moved in its fitting ears in such a way, that finally the centre of the glass bulb matches the mechanical centre of the jig ± 1 mm.**
- **Phosphor material must be everywhere within a window of 300 × 400 mm. The centre of that phosphor window matches the mechanical centre of the CRT.**
- **The spot or the deflection yoke will be adjusted, so that equal and symmetrical focus exists.**
- **The non-deflected spot landing must be within a circle with a radius of 2 mm around a point 3 mm left and 2 mm down from the mechanical centre of the CRT, provided that:**
  - **the CRT axis is in east-west direction and the front panel is facing east,**
  - **the anode connector is located on top of the tube,**
  - **the deflection unit has been mounted to the tube,**
  - **there is a metal shield behind the deflection unit around the tube's neck**
- **The maximum rotation angle of the deflection unit may not exceed 0.2°.**

7 Optical data

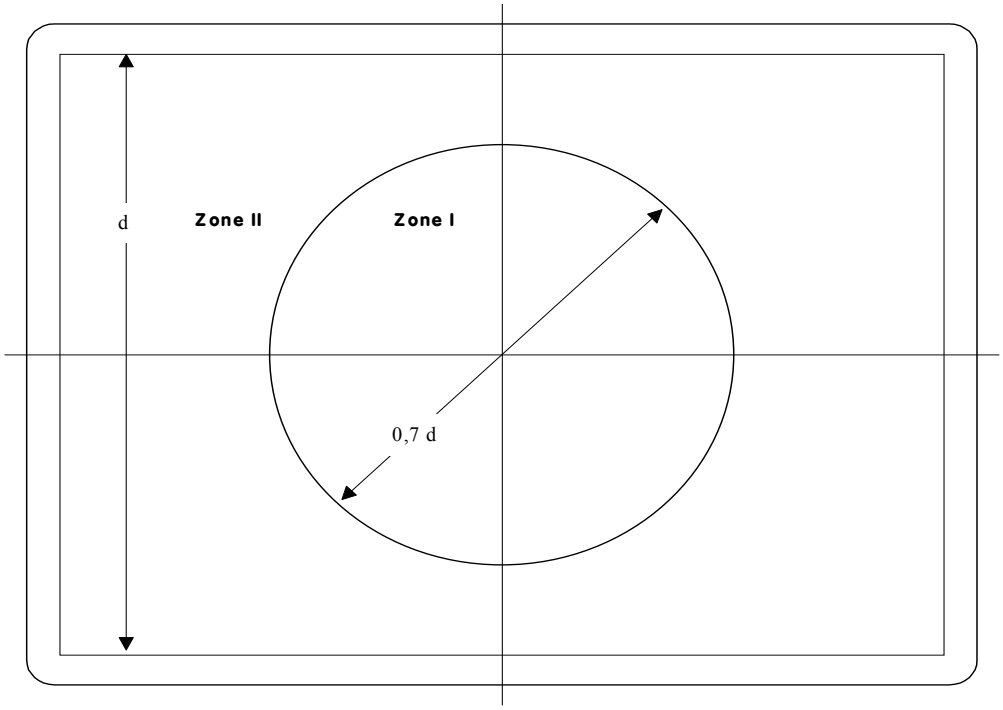
Total transmission of bulb including coating/panel:	**49 % ± 3 % at 546 nm**	
Phosphor	**P45**	
7.1	**Noise Power (see fig.)**	
Color coordinates: (during operation)	**P45-Phosphor**	
at a luminance of 250 Cd/m^2 (Nit). (measured with LMT Color meter or Minolta CA100)	**X = (0,250 ± 0,01)**	**Y = (0,305 ± 0,01)**
Front panel	**Transmission at 546 nm ca. 95% Coating : Flabeg OEL-95** **Direct coating alternative after agreement with customer. The connection with the mounting device aluminium strips are mounted on front panel.**	
Uniformity of luminance from centre to any corner	**At a luminance of 50 Nit the overall deviation of luminance from centre to any corner may not exceed 12 Cd/m^2 (Nit) at any point of the screen.**	
Glass bulb	**Drawingnmbr. 252 907.GZ or equivalent bulb after agreement with customer.**	

7.1 Noise power



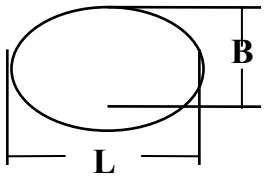
Noise Power measured with SIEMENS Measurement system.

8 Permissible Glass and screen defects



L: max. length of defects

B: max. width of defects



d = 300 mm

Defect size G for the screen and glass specification

for a side ratio of L/B ≤ 3 G = ½ (L + B)
for a side ratio of L/B > 3 G = L/20 + 2 B

Permissible defect (Panel included)

Defect size G in mm	Number of defects Zone I	Number of defects Zone II	Number of defects Sum [1]
< 0,2	Within any area of 30 *30 mm only 3 phosphor defects with size 0.1 – 0.2 mm are allowed.		
0,2 < G < 0,4	2	3	4
0,4 < G < 0,6	-	3	3
Distance between defects	> 50 mm	> 50 mm	

[1] Maximum number of defects in zone I and II : 4

Scratches

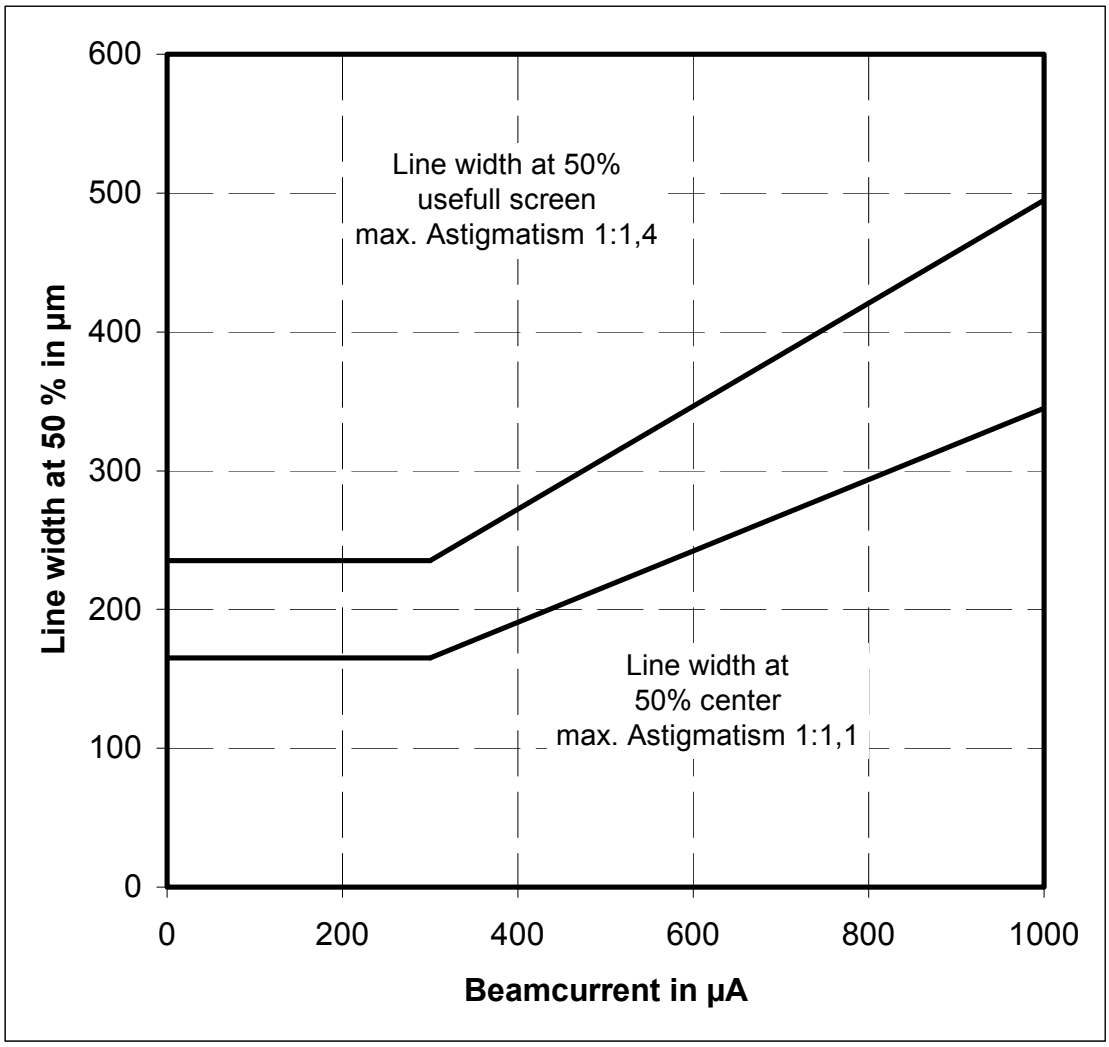
Sum ≤ 2
distance > 50 mm
max. length < 10 mm
max. width < 50 µm

Scratches <15 µm are permitted

Not allowed defects:
Open holes, stones, folds, cracks, accumulated defects, 'cloud'.

9 Resolution

50 % of peak value
Optimal focus: 300µA
Duty cycle 100 %

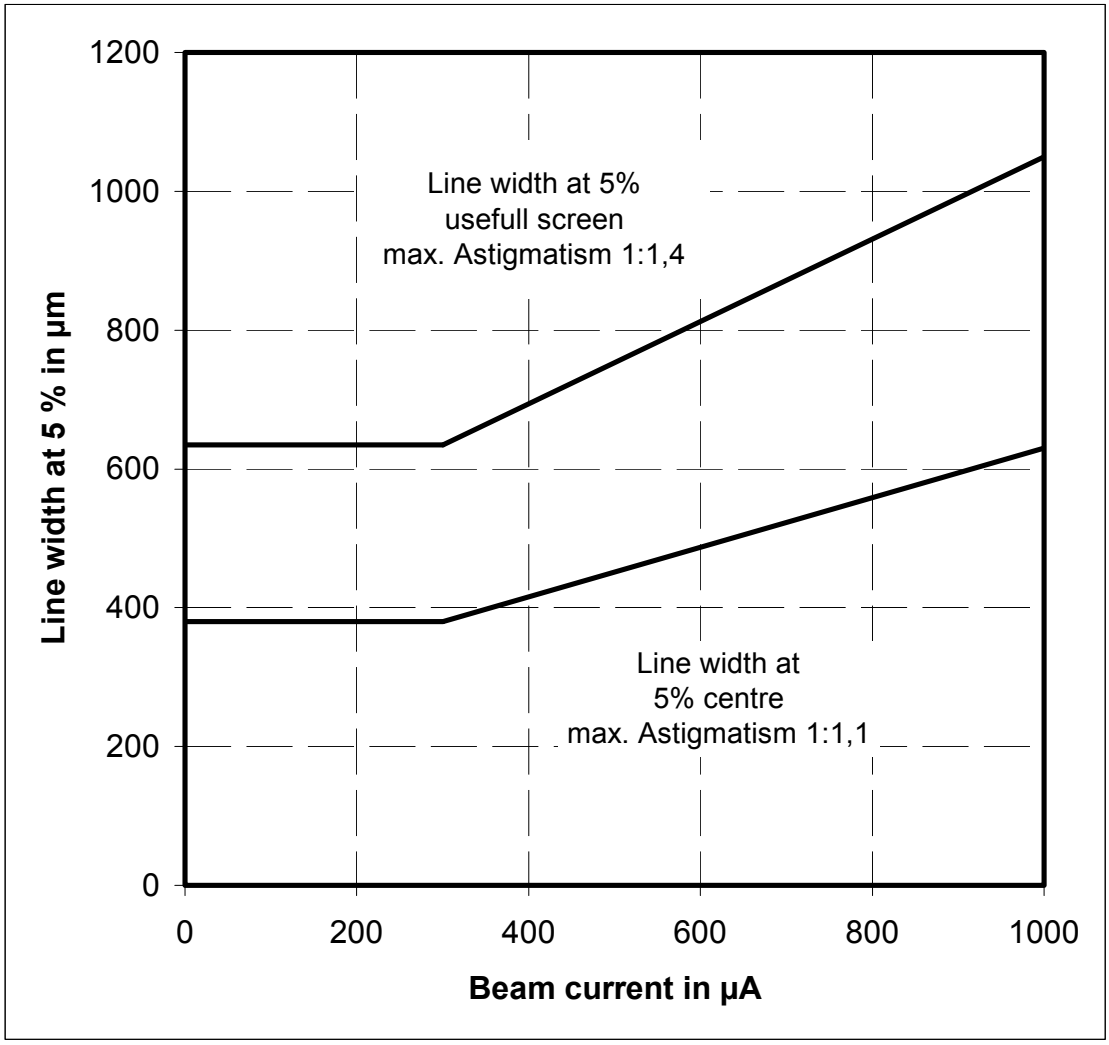


Measured with Microvision Superspot SS200 or PDS spot profile measuring system

- Astigmatism at 5% and 50 %-line width has the same shape.
- Astigmatism is not allowed to turn at increased beam current
- The spot profile approximates the Gaussian distribution.

Resolution

5 % of peak value
Duty cycle 100 %



Measured with Microvision Superspot SS200 or PDS spot profile measuring system

10 Electrical Data

Deflection		**magnetically, deflection angle**	
		- horizontal	**ca. 78°**
		- vertical	**ca. 60°**
		- diagonal	**ca. 90°**
Focussing		**electrostatic**	
Maximum currents (leakage)	I_{G1}	**± 1µA**	
	I_{G2a}	**± 1µA**	**max. 5 changes allowed**
	I_{G2b}	**± 1µA**	
	I_{G3}	**± 2µA**	
Capacity *) (Grid 1 to all other electrodes)	$C_{G1\text{-}all}$	**5,3 pF ± 1 pF**	
Capacity *) (Cathode to all other electrodes)	C_K	**3.5 pF ± 1 pF**	
Capacity *) (Grid1 to cathode)	$C_{G1\text{-}K}$	**2,3 pF ± 0,7 pF**	
Capacity (Anode to outer coating)	$C_{A\text{-}M1}$	**1600 ... 3000 pF**	

Electrical Data from THOMSON-Coil		**Drawing nmbr. 250 898.ZZ THOMSON-YOKE Nr. 9294.xx**
Horizontal deflection	**Lx**	**49,5 µH ± 5 %**
	Rx	**150 mΩ ± 10 %**
Vertical deflection	**Ly**	**1.83 mH ± 5 %**
	Ry	**3.28 Ω ± 10 %**
Rotationcoil	**Rr**	**133 Ω ± 10 %**
	Ir	**47 mA / 1 °**
Astigmatism Axial	**La**	**23 µH ± 5 %**
	Ra	**< 6 Ω**
Astigmatism Diagonal	**Ld**	**23 µH ± 5 %**
	Rd	**< 6 Ω**

***) measured with PHILIPS RLC Meßbrücke PM6303**

11 Absolute limiting values

Cathode is reference point for all voltage values

First accelerating voltage	$U_{G2\ I\&II}$	max. 1300 V min. - 400 V	
Second accelerating voltage	U_A	max. 29,9 kV	
Focus voltage	U_{G4}	max. 9kV	
Grid 1 voltage	$-U_{G1}$	max. 150 V (200 V for 5 sec. after switch off) min. 2 V	
Heating against cathode	U_{HC}	negative negative peak positive positive peak	255 V 300 V 3 V 50 V
	I_{HC}	max. 15 µA	
Grid 1 leakage resistance	R_{G1}	1,5 MΩ	
Damping of deflection field:	The power consumption of the horizontal deflection is allowed to increase by max. 1.4 W when yoke is mounted to the CRT. (at 80 kHz horizontal frequency, a retrace time of $\leq$ 2,5 µs and a horizontal width of 400 mm at U_A = 27,5 kV).		

12 Operating values

Cathode heating	- indirect		
	- Heating voltage	U_h	6.0 – 6.2 V
	- Heating current,	I_h	approx. 100 mA;
		$I_{h\ max}$	0,5 A (cold state)

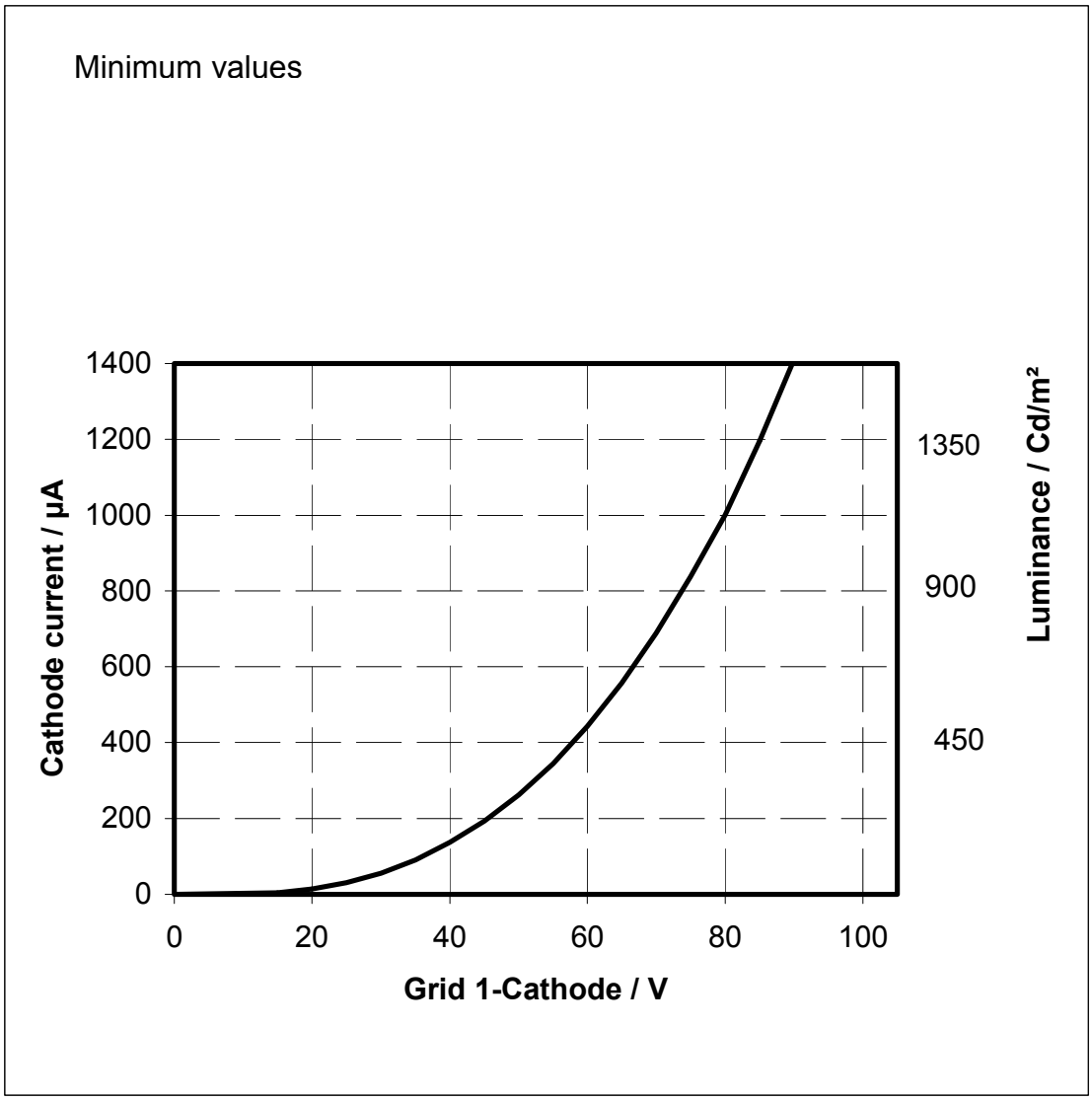
An integrated series resistor of 0.39 Ω reduces the effective heater voltage to 5.6-5.8V.

Cathode is reference point for all voltage values following

First accelerating voltage	$U_{G2\ I}$	600 - 930 V
Halo suppression voltage	$U_{G2\ II}$	0 - 200 V

Grid 1 voltage (for spot suppression)	$-U_{G1}$	105 V
second accelerating voltage	U_A	29,0 kV
Drive voltage (grid drive) (from I_C = 0 µA to I_C = 1200 µA[1)]	ΔU_{WE}	max. 85 V
Luminance drift over time		max. 18 minutes after switch on (an overshoot of max 10% of cut-off voltage is allowed during this time)
Focus voltage (at centre of screen at I_C = 300 µA	U_{G3}	min. 6,80 kV nom. 7,15 kV max. 7,50 kV
Dynamic focus voltage (with reference to Thomson-yoke Nr. 9294.xx)	$U_{G3\ dyn.}$	max. = 850 V
Brightness variation when changing from 100% white pattern to 10% square white pattern (same drive voltage)		No brightness variation allowed

Grid drive characteristics

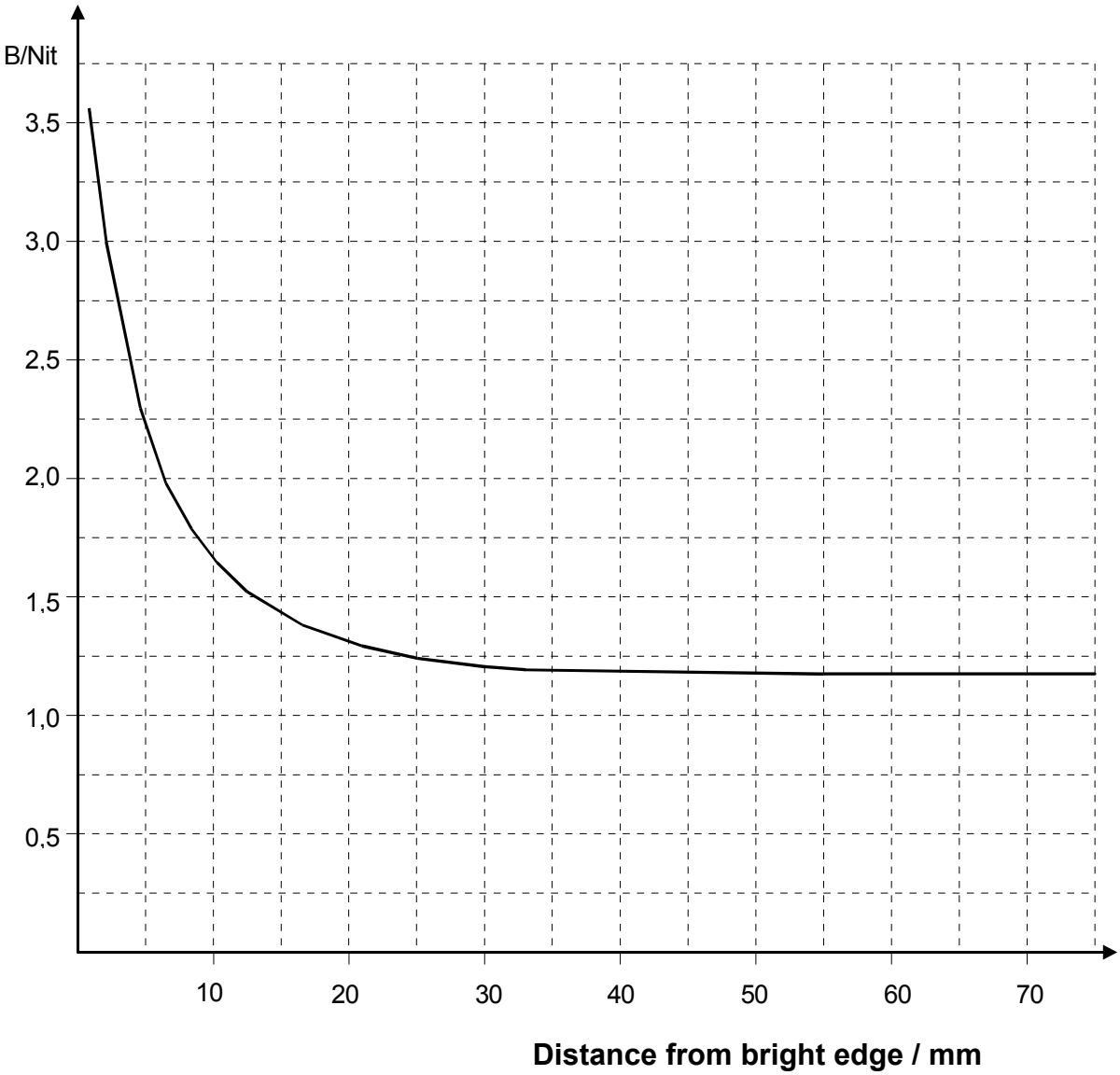


Luminance at 100% duty cycle. Horizontal freq: 64 kHz; Vertical freq: 50 Hz.

Scan area 300*400 mm

14 Large area contrast

Max. value



To measure the large area contrast a bright rectangle is displayed on one half of the screen. This area must be 50% of the total screen area with an aspect ratio of x : y = 2:3, and a luminance of 400 Nit.
The luminance of the black area is adjusted in such way that no lines can be seen in dark room conditions (optical cut-off value).
With the Microvisionsystem Superspot (or similar) the brightness is measured in relation to the distance from the black/white edge.
The bright rectangle must be totally covered with a non reflecting cover during measuring.

15 Environmental conditions

Temperature range:

Operation	**0 to + 70 °C** **relative humidity 75 %** **non condensing**
Storage	**- 40 to 70 °C**
Temperature gradient	**20 °C/h**
Air pressure	**400 hPa to 1060 hPa**

16 Estimated life time

Decrease of the cathode current of 800 µA at 100 % duty cycle and constant Cut-Off-voltage (Grid 2-voltage adjusted)

after	**20.000 hrs. < 10 %**

Burning conditions:
The cathode current during testing is max. 500 µA at 100 % duty cycle over total scan area.

During life time of the CRT (20 000 hours) G2a voltage may be increased to max. 1250 V, to maintain G1-Cut-Off voltage of –105V.

At a maximum luminance level of 350 Nit, after 20.000 hours of operation ,the maximum decrease in phosphor luminance is 15 %.

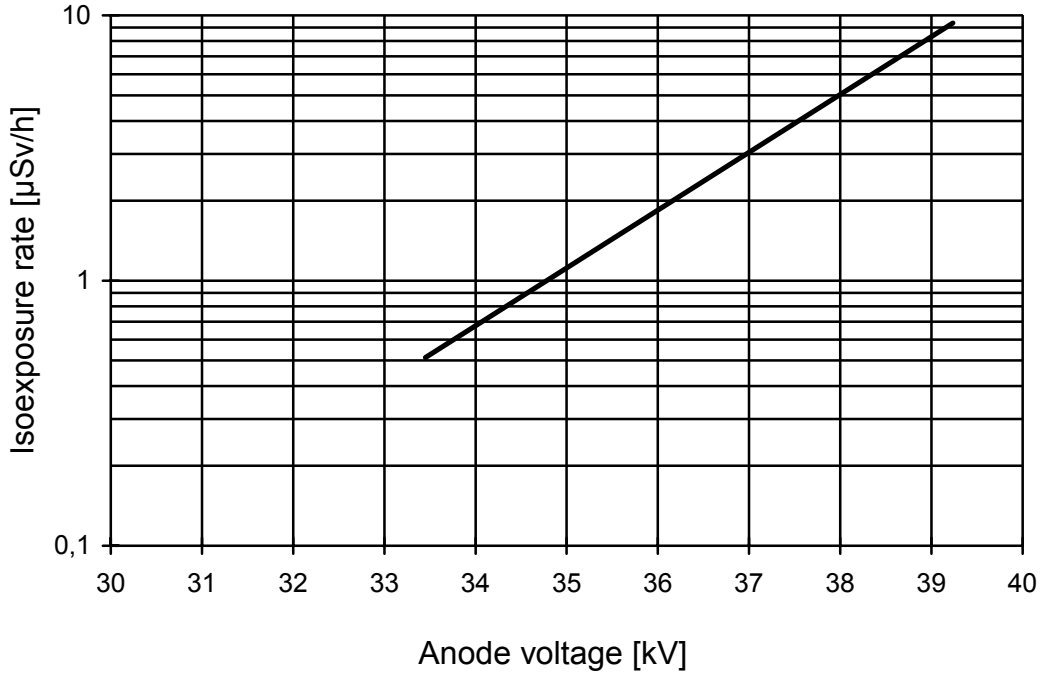
Stray emission : Maximum anode current in cut-off condition Uc- Ug1 > Uco after 10.000 hrs. : < 1 µA

17 X-radiation

X-Radiation Limit Curve

Conditions:

Cathode current I_C = 250 µA

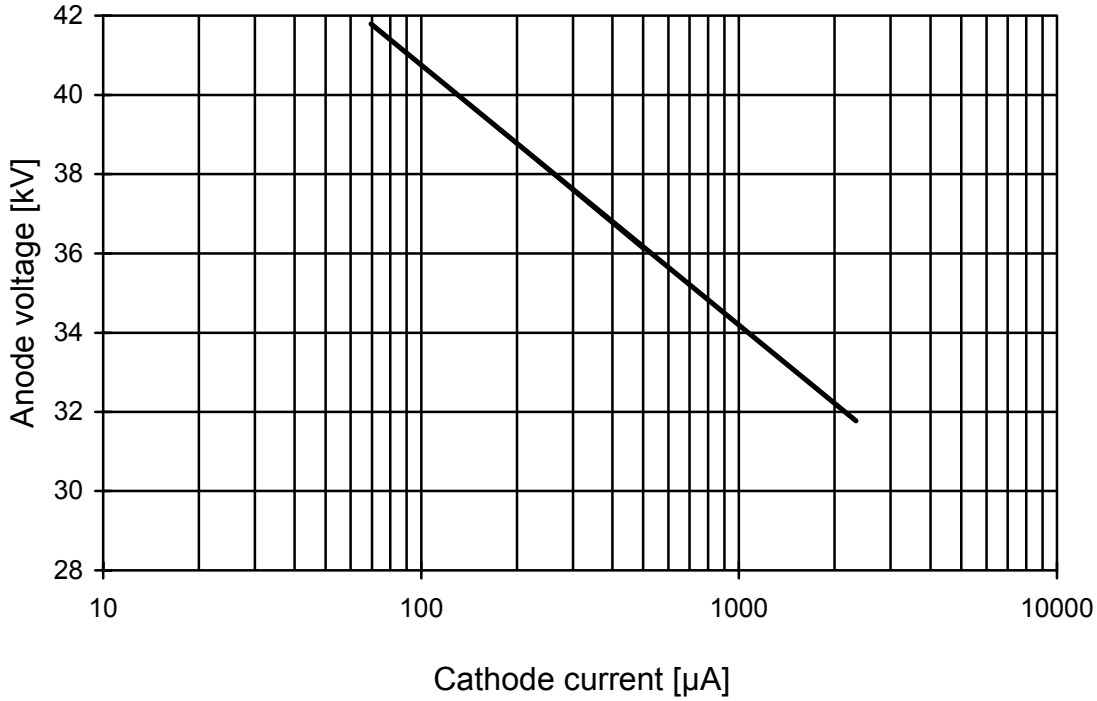


X-Radiation exposure rate vs. anode voltage at a constant value of cathode current measured at 5 cm from the CRT.

The measurement is according:
"Röntgenverordnung der Bundesrepublik Deutschland vom 8. Januar 1987"

Isoexposure - Rate Limit Curve

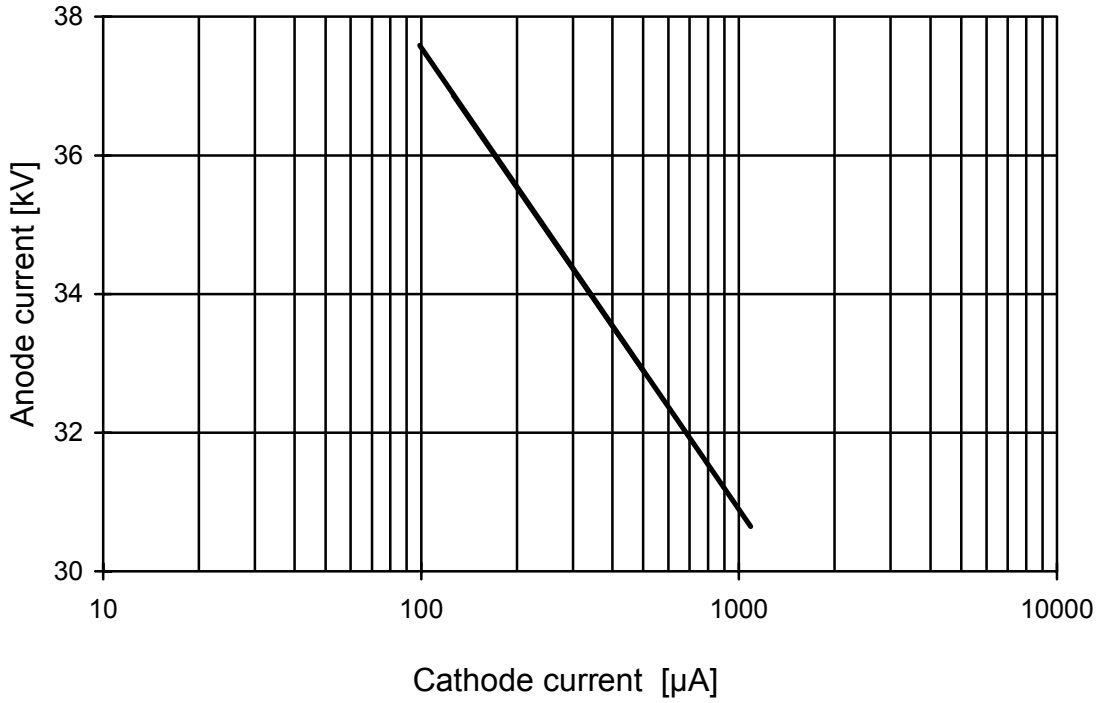
Calculated for 5 µSv/h



This limit curve is plotted at an isoexposure rate of 5 µSv/h (0,5 mR/h) measured at 5 cm from the CRT.

Isoexposure - Rate Limit Curve

Calculated for 1 µSv/h



This limit curve is plotted at an isoexposure rate of 1 µSv/h (0,1 mR/h) measured at 5 cm from the CRT.

Attachment 1

