DATA SHEET

A66EAK552X
‘Black Line FX S’
colour picture tube

Product specification
Supersedes data of 1998 Dec 01
File under Display Components, DC01

1999 Aug 27

Philips
Components

PHILIPS

‘Black Line FX S’ colour picture tube

A66EAK552X

FEATURES

‘Flatter’ and ‘squarer’ screen

- In-line, hi-bi potential ART (Aberration Reducing Triode) gun with quadrupole cathode lens
- INVAR mask with corner suspension
- BLACK MATRIX technology
- Improved Black level
- HIGH GLOSS screen finish
- Low transmission screen
- Cd-free phosphors
  - Highly pigmented deep red
  - Bright sulphide green
  - Highly pigmented sulphide blue
- Quick-heating low-power cathodes
- Slotted shadow mask optimized for minimum moiré at 525 and 625 line systems
- Internal magnetic shield
- Internal multipole.

QUICK REFERENCE DATA

PARAMETER	TYP.	UNIT
Deflection angle	110	deg
Useful screen diagonal	66	cm
Overall length	42	cm
Glass transmission	44	%
Neck diameter	29.1	mm
Heater voltage	6.15	V
Heater current	315	mA
Anode voltage	27.5	kV
Focus voltage	31% of anode voltage	

Black Line FX S

ELECTRICAL DATA

SYMBOL	PARAMETER	MIN.	TYP.	UNIT
Capacitances				
$C_{a(m + m')}$	anode to external conductive coating, including rimband	2000	–	pF
$C_{am'}$	anode to metal rimband	–	300	pF
C_k	cathodes of all guns (connected in parallel) to all other electrodes	–	15	pF
C_{kR}, C_{kG}, C_{kB}	cathode of any gun to all other electrodes	–	5	pF
C_{g1}	grid 1 to all other electrodes	–	17	pF
C_{g2}	grid 2 to all other electrodes	–	4.5	pF
C_{g3}	grid 3 (focusing electrode) to all other electrodes	–	6	pF
Heating				
V_f	heater voltage at average beam current: indirect AC (preferably mains or horizontal frequency) or DC	–	6.15	V
I_f	heater current	–	315	mA
Resistance				
R_{rim}	resistance between rimband and external conductive coating	50	–	MΩ

ELECTRO-OPTICAL DATA

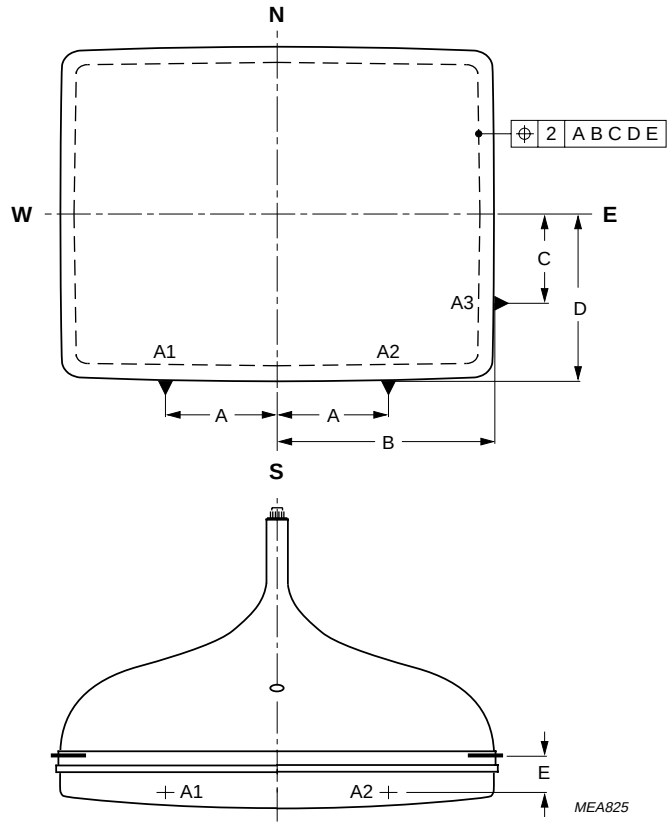
PARAMETER	VALUE
Electron gun system	unitized triple-aperture electrodes; aberration reducing triode
Focus method	electrostatic
Focus lens	hi-bi potential
Deflection method	magnetic
Deflection angles	
diagonal	110°
vertical	97°
horizontal	77°

OPTICAL DATA

PARAMETER	VALUE
Matrix	black opaque material, PVP technology
Screen	metal-backed vertical phosphor stripes
Screen finish	high gloss
Nominal useful screen dimensions	
diagonal axis	662.6 mm
vertical axis	406.9 mm
horizontal axis	536.8 mm
area	2184 cm^2
Phosphor alignment	see Fig.1
Phosphors	
red	highly pigmented europium activated rare earth
green	bright Cd-free sulphide type
blue	highly pigmented sulphide type
Persistence	medium short
Centre-to-centre distance of identical colour phosphor stripes at centre of screen	≈0.8 mm
Light transmission of face glass at screen centre	44%
Luminance at centre of screen; note 1	80 cd/m^2

Note

1. Tube settings adjusted to produce white D (x = 0.313, y = 0.329), focused raster, current density 0.4 $\mu A/cm^2$, V_a = 27.5 kV.



A = 203.2 mm.
B = 286.9 mm.
C = 140.2 mm.
D = 222.5 mm.
E = 27.5 mm.

Fig.1 Phosphor alignment.

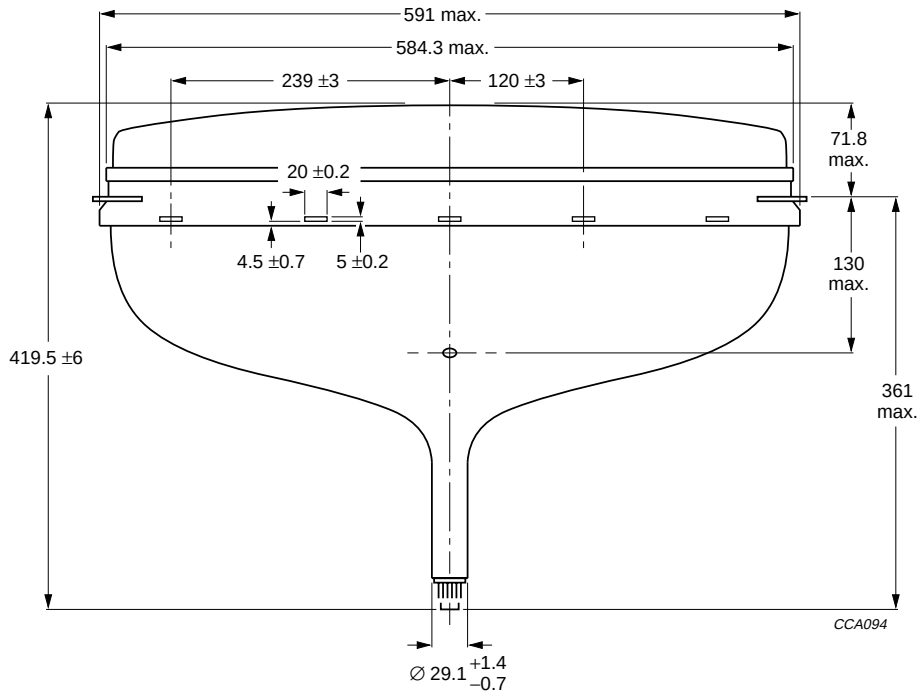
Colour coordinates

COLOUR	x	y
Red	0.640	0.335
Green	0.300	0.610
Blue	0.155	0.065

MECHANICAL DATA

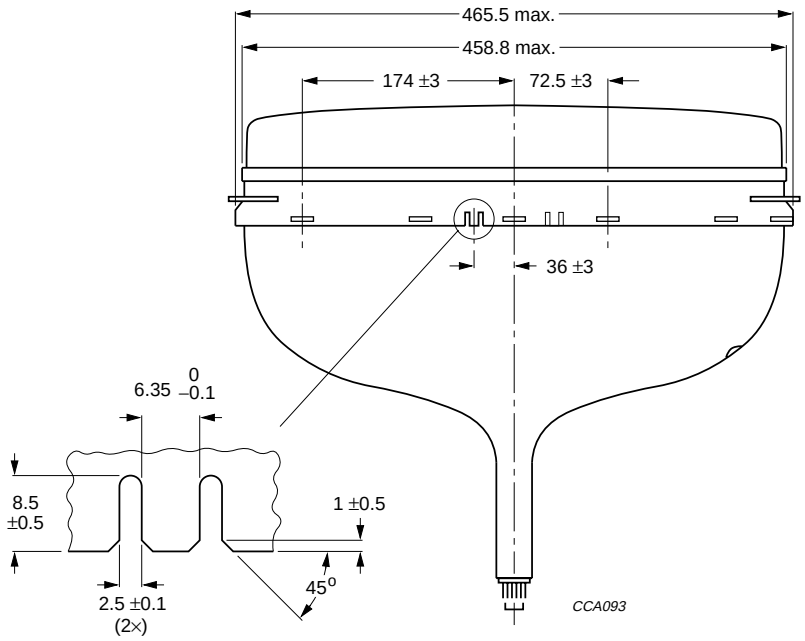
See Figs 2 to 12.

PARAMETER	VALUE
Base	Base JEDEC B10-277
Anode contact	small cavity contact JEDEC J1-21; IEC 60067-III-2
Mounting position	anode contact on top
Implosion protection	shrunk-on rimband provided with skirt and slots to accommodate clips for mounting of degaussing coils
Mass including deflection unit	≈24 kg



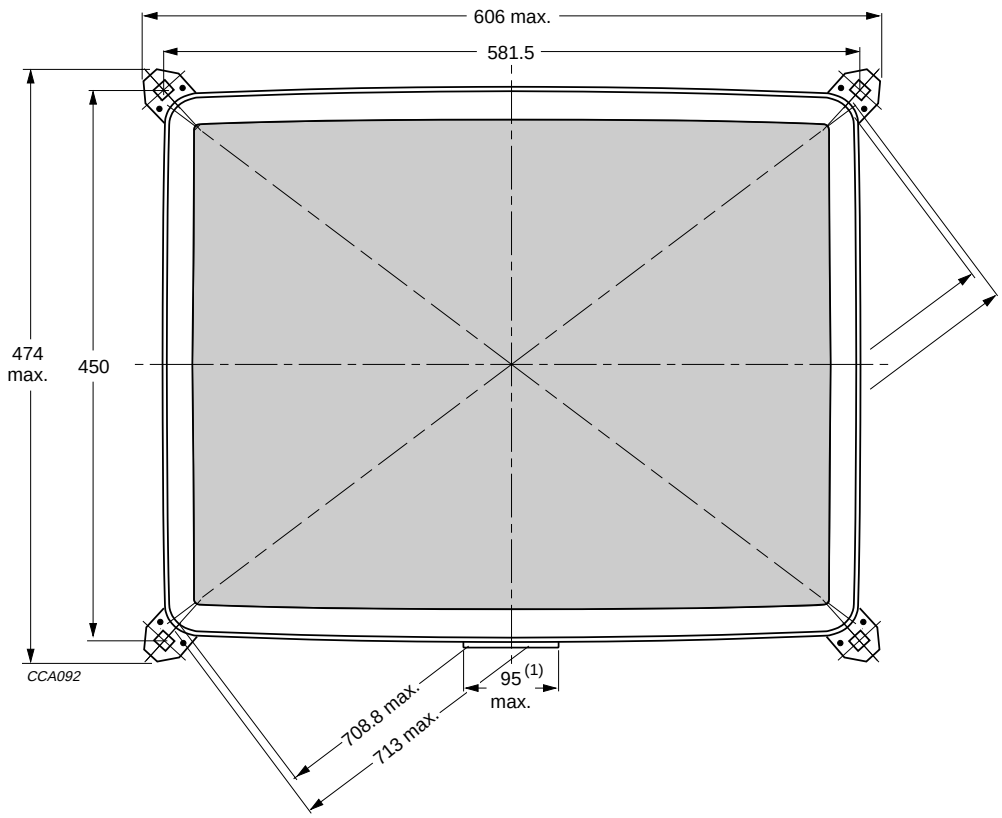
Dimensions in mm.

Fig.2 Tube dimensions; top view.



Dimensions in mm.

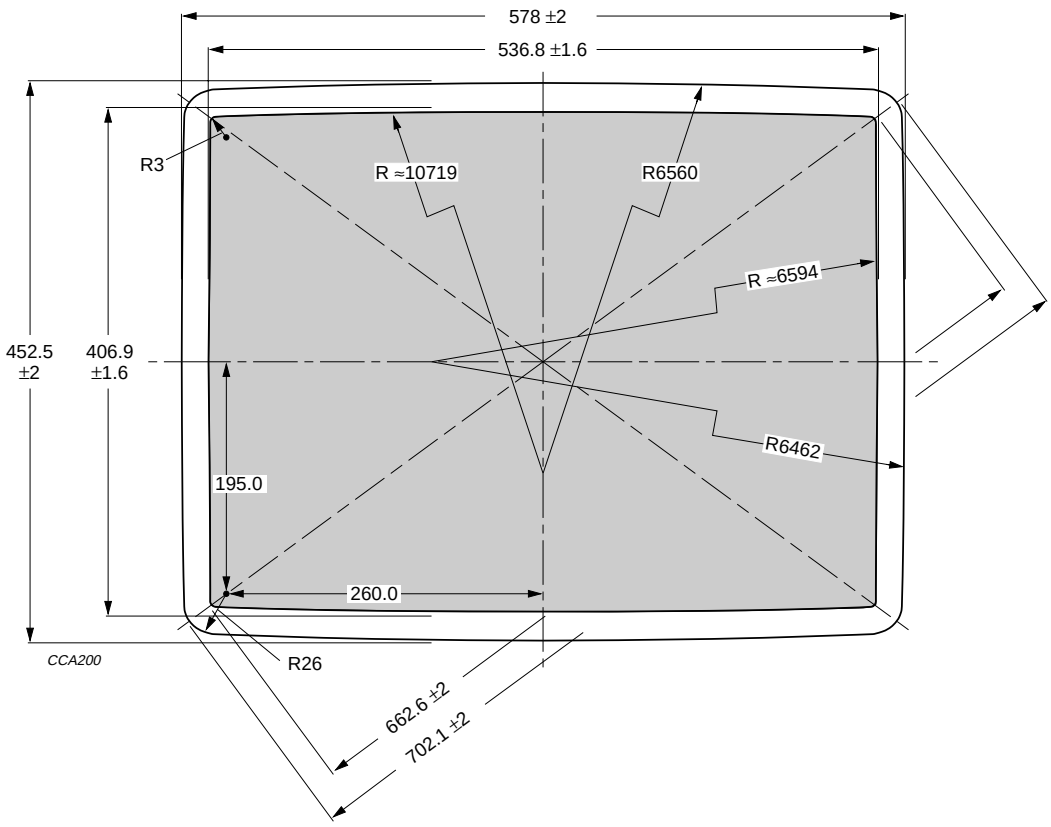
Fig.3 Tube dimensions; side view.



Dimensions in mm.

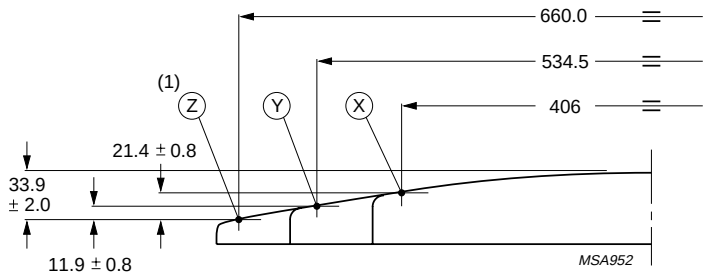
(1) Location of fishplate.

Fig.4 Tube dimensions; front view.



Dimensions in mm.

Fig.5 Phosphor and screen dimensions.



Dimensions in mm.

(1) Coordinates of Z-point: X = 264, Y = 198.

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

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

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

$$XB = XA - \frac{R2 \times XA}{R1}$$

$$ZA = R1 - \sqrt{R1^2 - XA^2}$$

$$ZB = R1 - R2 - ZC$$

$$ZC = \frac{(R1 - ZA) \times XB}{XA}$$

If $R < XA$ then $Z = R1 - \sqrt{R1^2 - R^2}$

else $Z = ZB + R2 - \sqrt{R2^2 - (R - XB)^2}$

R1 = 1688.40

R2 = 1568.29

XA = 93.62 (transition)

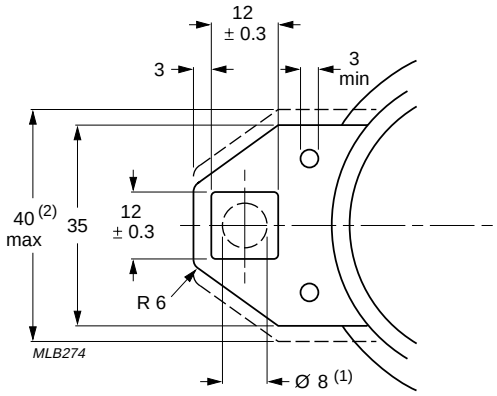
Fig.6 Screen reference points.

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

NOMINAL USEFUL SCREEN (NUS)			3 mm INSIDE NUS			10 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]	203.5	12.6	0.0	200.5	12.2	0.0	213.5	13.9
20.0	203.4	12.7	20.0	200.4	12.3	20.0	213.4	14.0
40.0	203.4	13.1	40.0	200.4	12.7	40.0	213.4	14.4
60.0	203.3	13.7	60.0	200.3	13.3	60.0	213.3	15.0
80.0	203.2	14.5	80.0	200.2	14.2	80.0	213.2	15.8
100.0	203.0	15.6	100.0	200.0	15.3	100.0	213.0	16.9
120.0	202.8	17.0	120.0	199.8	16.6	120.0	212.8	18.3
140.0	202.5	18.6	140.0	199.5	18.2	140.0	212.5	19.9
160.0	202.3	20.4	160.0	199.3	20.1	160.0	212.3	21.7
180.0	201.9	22.5	180.0	198.9	22.2	180.0	211.9	23.9
200.0	201.6	24.9	200.0	198.6	24.5	200.0	211.6	26.2
220.0	201.2	27.5	220.0	198.2	27.1	220.0	211.2	28.8
240.0	200.8	30.4	240.0	197.8	30.0	240.0	210.8	31.7
260.0	200.3	33.5	260.0	197.3	33.1	260.0	210.3	34.8
262.5	200.2	33.9	–	–	–	275.1	209.9	37.3
264.9[2]	199.0	34.2	262.5	197.2	33.5	275.4	200.0	36.1
265.5	197.3	34.0	–	–	–	–	–	–
265.9	180.0	32.0	262.9	180.0	31.5	276.0	180.0	33.8
266.5	160.0	30.0	263.5	160.0	29.5	276.5	160.0	31.7
266.9	140.0	28.1	263.9	140.0	27.6	276.9	140.0	29.9
267.3	120.0	26.6	264.3	120.0	26.0	277.3	120.0	28.3
267.6	100.0	25.2	264.6	100.0	24.7	277.6	100.0	26.9
267.9	80.0	24.1	264.9	80.0	23.6	277.9	80.0	25.9
268.1	60.0	23.3	265.1	60.0	22.8	278.1	60.0	25.0
268.3	40.0	22.7	265.3	40.0	22.2	278.3	40.0	24.4
268.4	20.0	22.3	265.4	20.0	21.8	278.4	20.0	24.0
268.4[3]	0.0	22.2	265.4	0.0	21.7	278.4	0.0	23.9

Notes

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

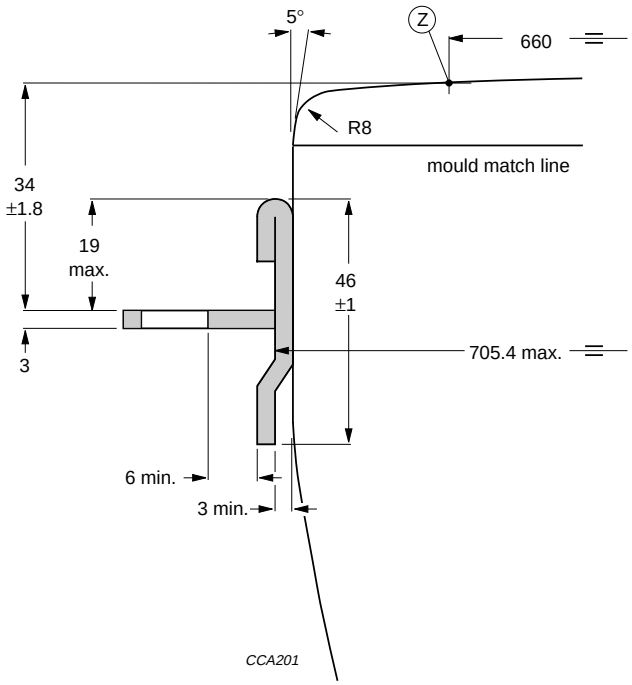


Dimensions in mm.

(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 581.5 mm × 450.0 mm.

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

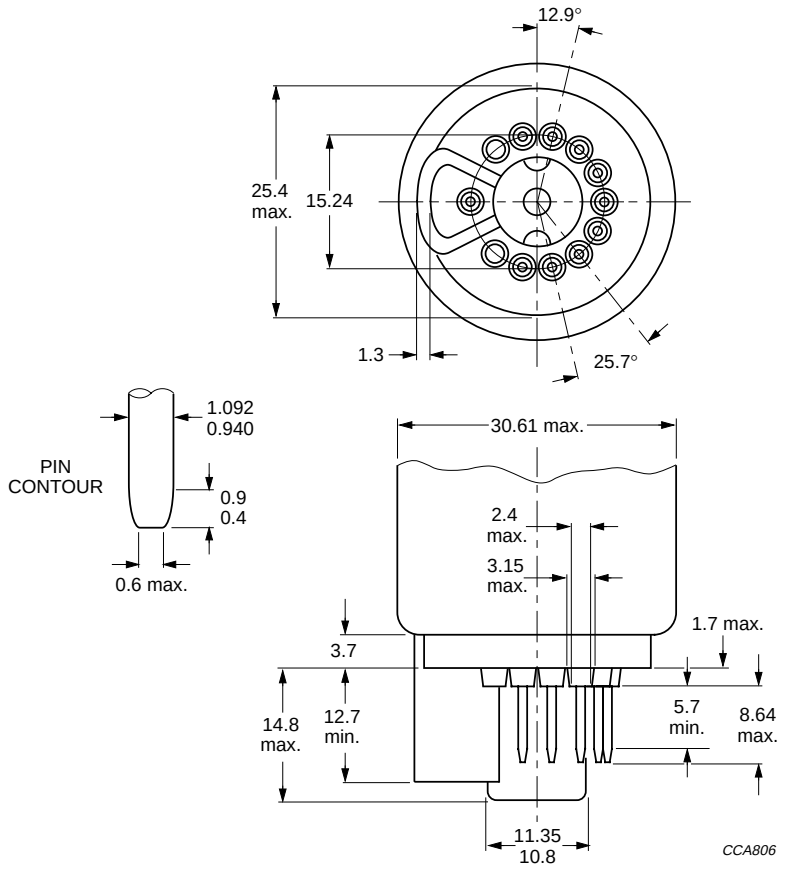
Fig.7 Lug dimensions.



Dimensions in mm.

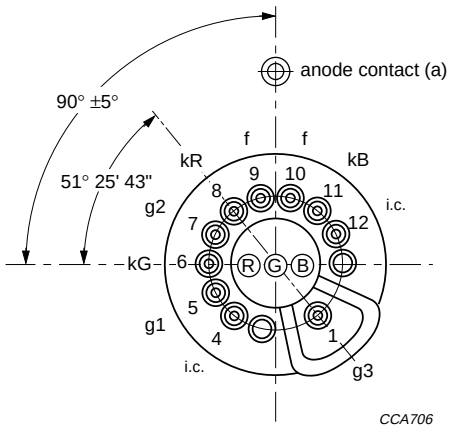
The displacement of any lug with respect to the plane through the three other lugs is max. 1.5 mm. This deviation is incorporated in the tolerance of ±1.8 mm.

Fig.8 Lug position.



Dimensions in mm.

Fig.9 Base JEDEC B10-277.



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

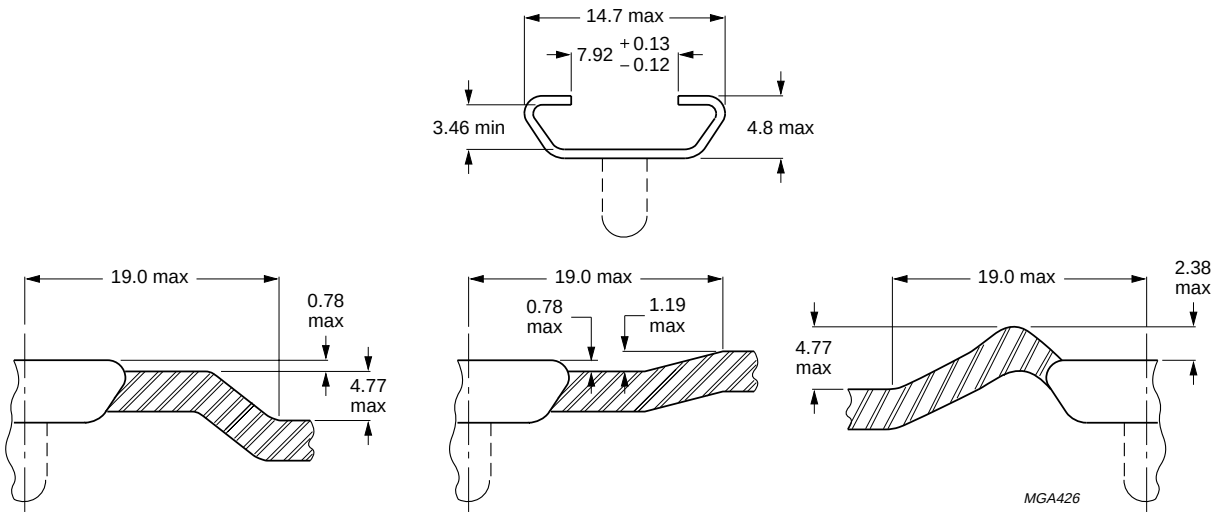
Fig.10 Pin arrangement.

Remarks: to Figs 9 and 10.

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. 55 mm concentric with an imaginary tube axis.

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

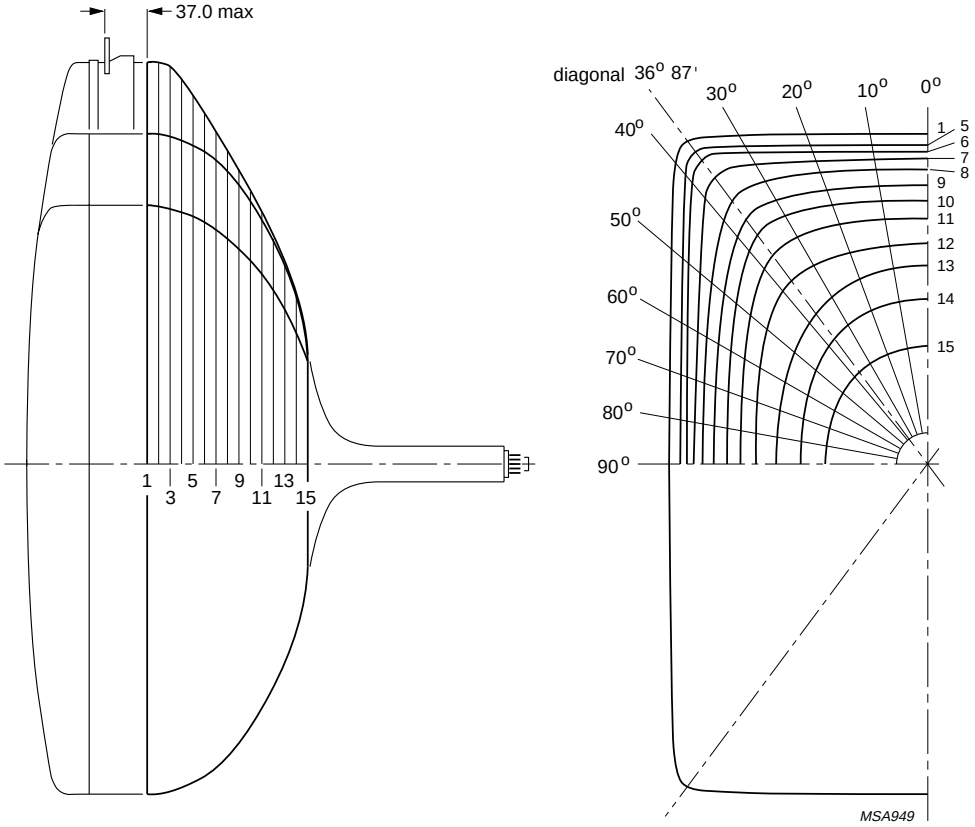
Maximum permissible torque on the tube neck is 0.04 Nm.



Dimensions in mm.

Fig.11 Cavity cap JEDEC J1-21, IEC 60067-III-2.

Cone contour



Dimensions in mm.

Fig.12 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	286.7	290.9	304.2	328.7	348.8	340.3	288.9	257.1	237.8	227.3	223.9
2	10.0	285.6	289.8	303.1	327.4	347.1	337.5	286.7	255.3	236.2	225.8	222.5
3	20.0	283.7	287.8	300.8	324.7	341.6	333.3	283.2	252.2	233.2	223.0	219.7
4	30.0	281.0	285.1	297.8	321.1	331.3	325.0	278.5	247.9	229.3	219.2	216.0
5	40.0	276.6	280.4	292.4	314.2	318.4	312.4	270.5	241.4	223.6	213.9	210.8
6	50.0	270.5	274.1	285.2	303.6	303.9	298.4	261.3	233.9	216.9	207.7	204.7
7	60.0	262.6	265.9	275.8	289.7	287.8	282.9	251.3	225.6	209.7	200.9	198.1
8	70.0	252.5	255.3	264.0	273.5	270.5	266.3	240.2	216.4	201.5	193.3	190.7
9	80.0	239.7	242.0	249.3	255.6	252.2	248.5	227.1	205.4	191.7	184.1	181.7
10	90.0	224.0	226.0	232.0	236.0	232.5	229.2	211.2	191.6	179.1	172.2	170.0
11	100.0	206.2	207.9	213.0	215.7	212.1	208.9	192.3	174.6	163.3	157.0	155.0
12	110.0	185.8	187.2	191.4	192.7	189.0	186.0	171.1	155.4	145.4	139.8	138.0
13	120.0	161.7	162.7	165.5	165.5	162.0	159.5	147.8	134.7	126.3	121.6	120.1
14	130.0	131.3	132.0	134.1	133.9	131.5	129.9	122.3	112.6	106.0	102.3	101.1
15	140.0	93.2	93.3	93.5	93.2	92.4	91.9	89.6	86.4	83.8	82.3	81.8

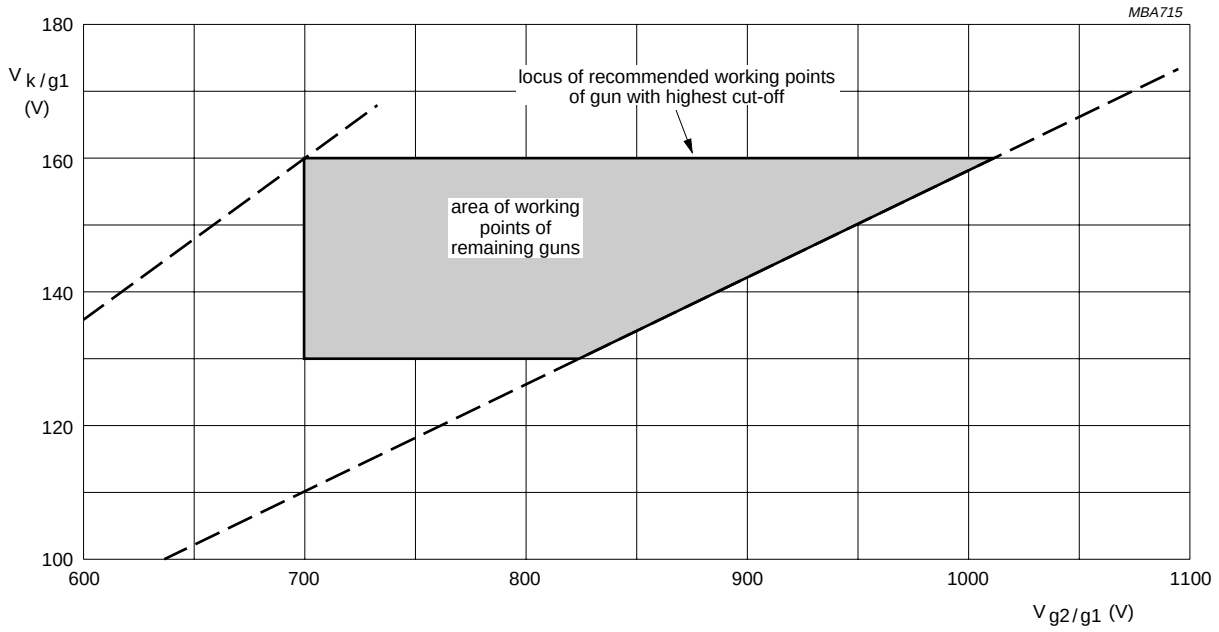
HANDLING

During shipment and handling the tube should not be subjected to accelerations greater than 350 m/s^2 in any direction (at pulse ≤10 ms).

OPERATING DATA

The voltages are specified with respect to grid 1.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
$V_{a,g4}$	anode voltage	at full screen load	–	27.5	–	kV
V_{g3}	grid 3 (focus electrode) voltage		8.0	–	9.1	kV
V_{g2}	grid 2 voltage	for spot cut-off voltage V_k = 160 V	700	–	1020	V
V_f	heater voltage	tube operating	–	6.15	–	V



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

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

V_{g2} range: 700 to 1020 V.

V_k range: 130 to 160 V.

Adjustment procedure:

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

Fig.13 Spot cut-off design chart.

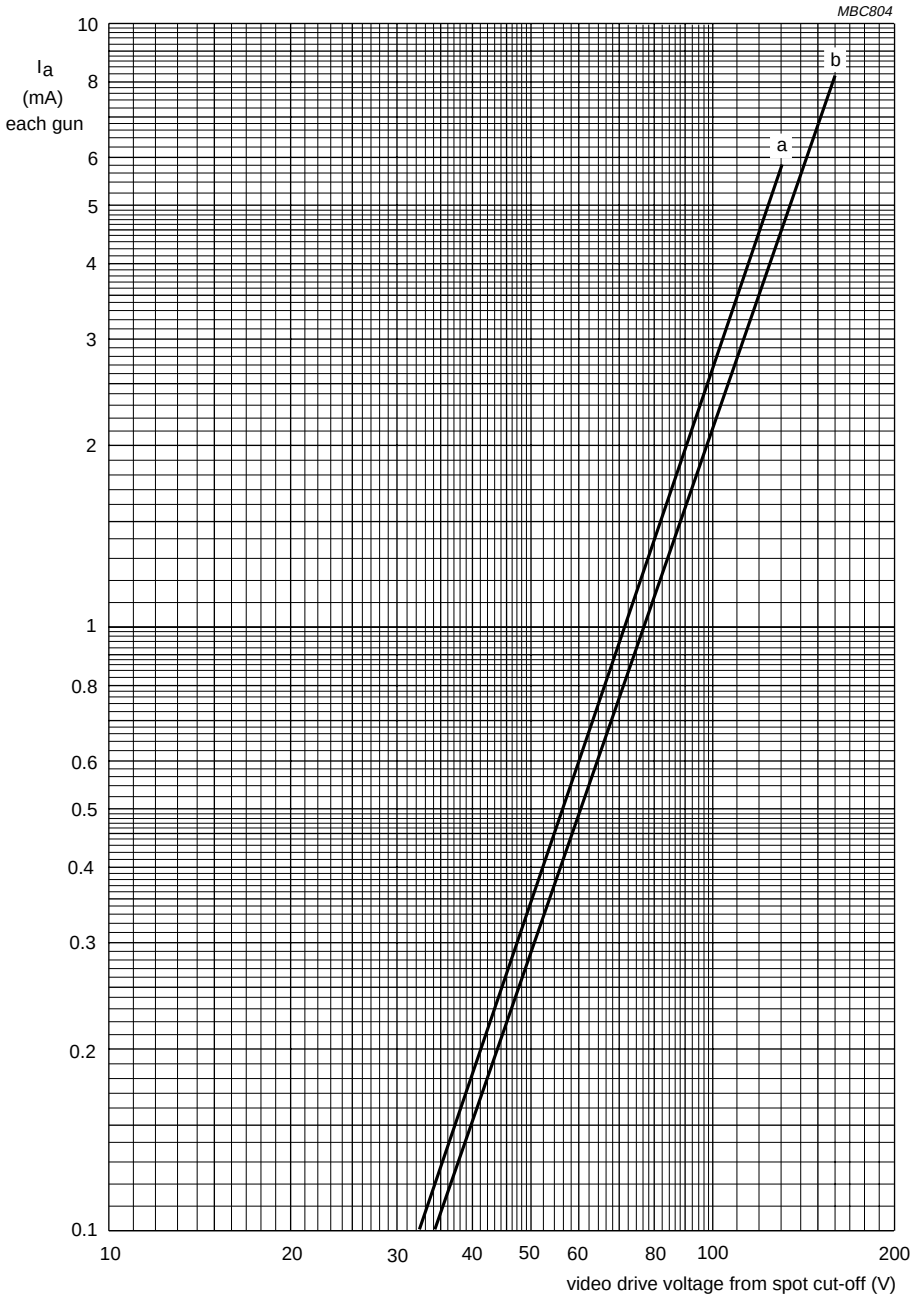
CHASSIS DESIGN VALUES

The values are valid for anode voltages between 25 and 30 kV. The voltages are specified with respect to grid 1.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
V_{g3}	grid 3 (focus electrode) voltage as a percentage of anode voltage		29	–	33	%
V_{g2} and V_k	grid 2 voltage and cathode voltage	for visual extinction of focused spot	see Fig.13			
ΔV_k	difference in cut-off voltage between guns in any tube		lowest value >80% of highest value			
V_f	heater voltage	operating	–	6.15	–	V
	video drive characteristics		note 1 and Fig.14			
I_{g3}	grid 3 (focus electrode) 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
Anode currents to produce white of 6500 K + 7 MPCD (CIE coordinates: x = 0.313; y = 0.329)						
PERCENTAGE OF THE TOTAL ANODE CURRENT SUPPLIED BY EACH GUN (TYPICAL)						
	red gun		–	39	–	%
	green gun		–	31	–	%
	blue gun		–	30	–	%
RATIO OF ANODE CURRENTS						
	red gun to green gun		1.05	1.25	1.45	
	red gun to blue gun		1.10	1.40	1.70	
	blue gun to green gun		0.80	0.90	1.00	

Note

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



V_f = 6.15 V.
$V_{a,g4}$ = 27.5 kV.
V_{g3} adjusted for focus.
V_{g2} (each gun) adjusted to provide spot cut-off for V_k = 130 V (curve a) and V_k = 160 V (curve b).

Fig.14 Typical cathode drive characteristics.

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	note 1	25 (2)	32(3)	kV
I_a	long-term average current for three guns	note 4	–	1300	μA
V_{g3}	grid 3 (focus electrode) voltage	note 5	–	12	kV
V_{g2}	grid 2 voltage	note 6	–	1200	V
V_f	heater voltage	note 7	5.7	6.6(3)	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 values					
R_{g3}	grid 3 circuit resistance		–	70	MΩ
R_{g2}	grid 2 circuit resistance		–	7	MΩ
R_{g1k}	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. Operation of the tube at lower voltages impairs the luminance and resolution and may impair the convergence.
3. This value is an absolute maximum.
4. The short-term average anode current should be limited by circuitry to 1800 μA.
5. During flashover conditions maximum 20 kV is permitted (see Chapter “Flashover protection”).
6. During adjustment on the production line maximum 1500 V is permitted.
7. 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.

BEAM CENTRING

Maximum centring error in any direction is 4 mm.

FLASHOVER PROTECTION

The high voltages used with this tube (absolute max. 32 kV) may produce internal flashovers. Soft-flash technology limits these flashover currents 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 (except the tube heaters) at the tube socket in accordance with Fig.15. No other connections between the outer conductive coating and the chassis are permissible. The spark gaps should be designed for a maximum breakdown voltage at the focus electrode (g_3) of approximately 19 to 20 kV and at the other electrodes of 2 kV at the lowest operating atmospheric pressure.

The values of the series isolation resisters should be as high as possible (min. 0.5 kΩ) without causing deterioration of circuit performance. The resistors should be able to withstand an instantaneous surge of 20 kV for the focus 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 minimum 400 Ω and maximum 800 Ω.

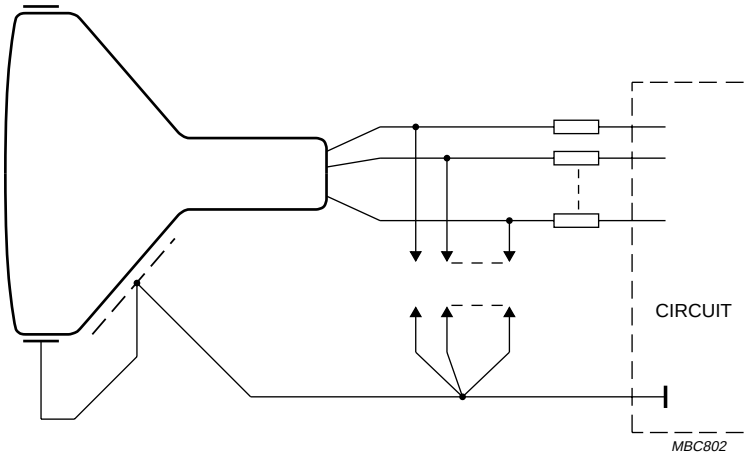
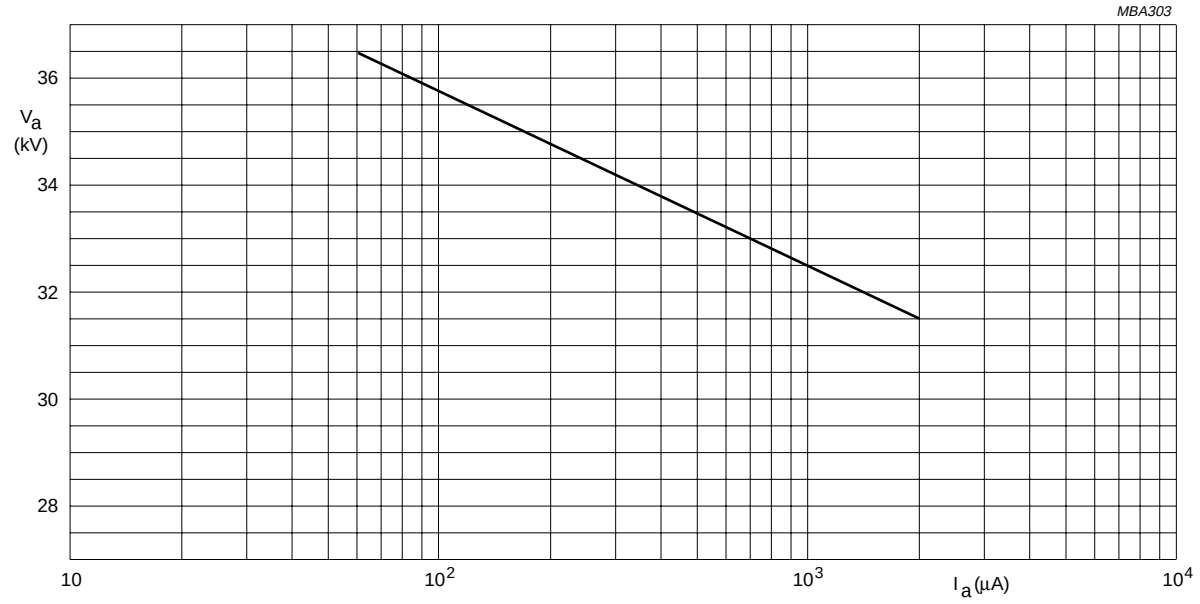


Fig.15 Flashover protection circuit.

X-RADIATION

The tube does not emit X-radiation above 1 μSv/h when operated at 30 kV and 1.8 mA.



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.16 1 μSv/h iso-exposure-rate limit curve.

DEGAUSSING

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

For proper degaussing an initial peak magnetomotive force (MMF) of 400 ampere-turns is required in the coil. This MMF must be gradually decreased (maximum 25% per half period) by appropriate circuitry. At an initial peak magnetomotive force (MMF) of 500 ampere-turns or more, the MMF has to be gradually decreased with a maximum 30% per half period. In the steady state, no significant peak-to-peak MMF should remain in the coils (≤0.33 ampere-turns). Switch-off is permitted at a peak MMF ≤ 5 ampere-turns.

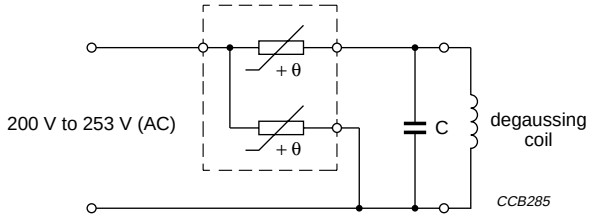
To prevent beam landing disturbance by horizontal frequency currents induced in the degaussing coil, this coil should be shunted by a capacitor of sufficiently high value.

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

An example of a degaussing circuit and coil data is given in Fig.17 and Table “Degaussing coil data”.

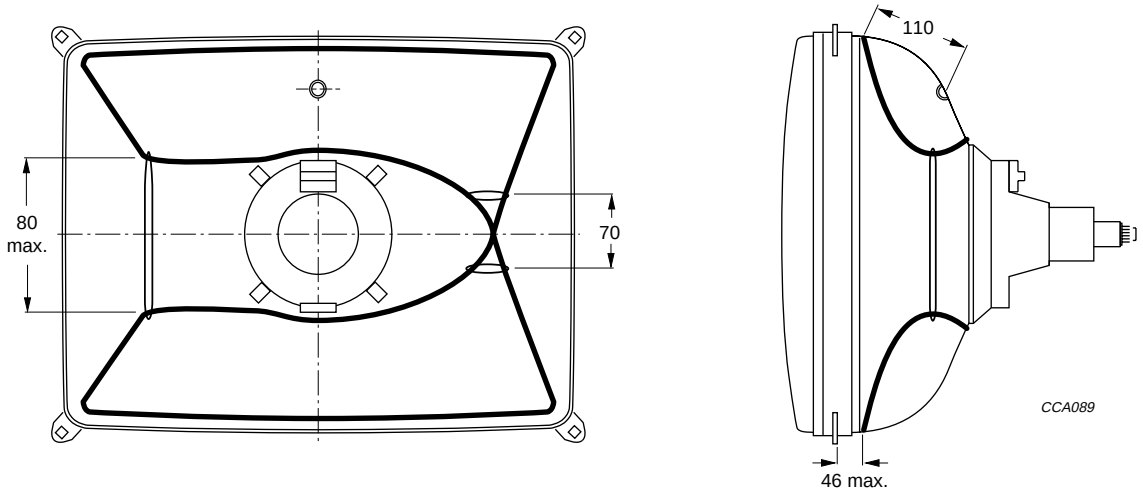
Degaussing coil data

PARAMETER	TYP.	UNIT
Circumference	317	cm
Number of turns	70	
Copper wire diameter	0.4	mm
Resistance	30.0	Ω
PTC thermistor	2322 662 96706	



C = 220 nF.

Fig.17 Degaussing circuit using a dual PTC thermistor.



Dimensions in mm.

Fig.18 Position of the degaussing coil on the picture tube.

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.	

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