DATA SHEET

A59ESF002X
‘Black Line SF’ colour picture tube

Product specification
Supersedes data of 1997 Jun 27
File under Display Components, DC01

1998 Dec 01

Philips
Components

PHILIPS

‘Black Line SF’ colour picture tube A59ESF002X

FEATURES

- ‘Super Flat’ screen (R_v = 2050 mm)
- Quick-heating low-power impregnated cathodes
- In-line, IFL, ART (Aberration Reducing Triode) gun with quadrupole cathode lens
- Cd-free phosphors
  - Pigmented deep red
  - Sulphide green
  - Pigmented sulphide blue
- BLACK MATRIX technology
- INVAR mask with corner suspension
- Soft-flash
- Slotted shadow mask optimized for minimum moiré at 525 and 625 line systems
- Internal magnetic shield
- Internal multipole
- High contrast
- High gloss, low transmission screen.

QUICK REFERENCE DATA

PARAMETER	TYP.	UNIT
Deflection angle	110	deg
Useful screen diagonal	59	cm
Overall length	39	cm
Glass transmission	39	%
Neck diameter	29.1	mm
Heater voltage	6.15	V
Heater current	315	mA
Anode voltage at full load	29.5	kV
Focus voltage	25.3 to 29.3% of anode voltage	

Black Line SF

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_{R+G+B}	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 (focus electrode) to all other electrodes	–	6	pF
Heating				
V_f	heater voltage: indirect AC (preferably mains or line 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
Main lens	polygon
Convergence method	magnetic
Deflection method	magnetic
Deflection angles	
diagonal	110°
horizontal	97°
vertical	77°

OPTICAL DATA

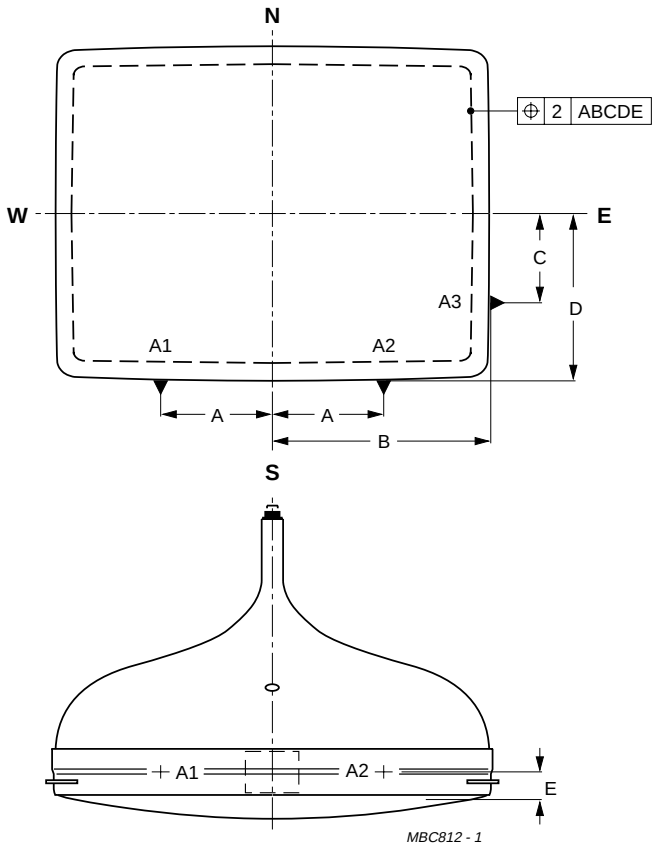
PARAMETER	VALUE
Screen	metal-backed vertical phosphor stripes
Matrix	black opaque material, PVP technology
Screen finish	high gloss
Nominal screen dimensions	
diagonal	591.6 mm
horizontal	475.2 mm
vertical	358.0 mm
area	1700 cm^2
Phosphor alignment	see Fig.1
Phosphors	
red	pigmented europium activated rare earth
green	Cd-free sulphide type
blue	pigmented sulphide type
Persistence	medium short
Centre-to-centre distance of identical colour phosphor stripes	
at screen centre	0.79 mm
at ends of long axis	0.95 mm
Light transmission of face glass at centre of screen	39%
Luminance at centre of screen; note 1	70 cd/m^2

Note

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

Colour coordinates

COLOUR COORDINATE	x	y
Red	0.630	0.330
Green	0.295	0.595
Blue	0.155	0.065



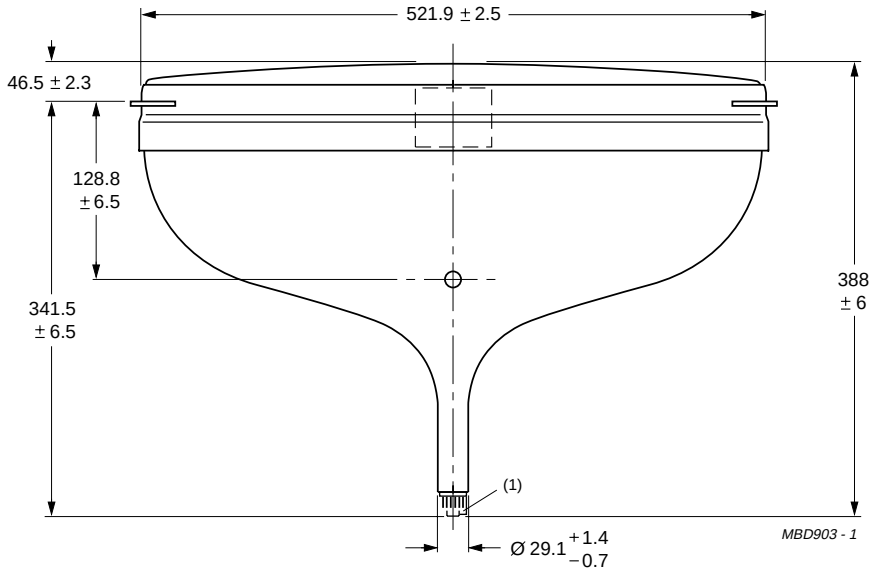
A = 180.3 mm.
B = 259.5 mm.
C = 123.0 mm.
D = 202.0 mm.
E = 25.2 mm.

Fig.1 Phosphor alignment.

MECHANICAL DATA

See Figs 2 to 12.

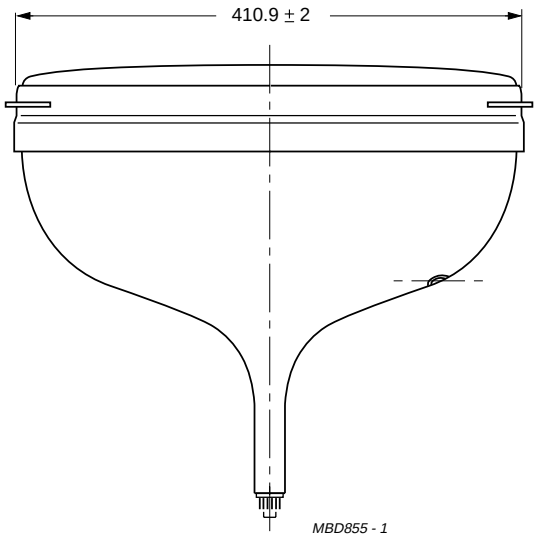
PARAMETER	VALUE
Base	JEDEC B10-277
Anode contact	small cavity contact JEDEC J1-21; IEC 60067-III-2
Mounting position	anode contact on top
Implosion protection	shrunk-on rimband
Mass including deflection unit	≈20.5 kg



Dimensions in mm.

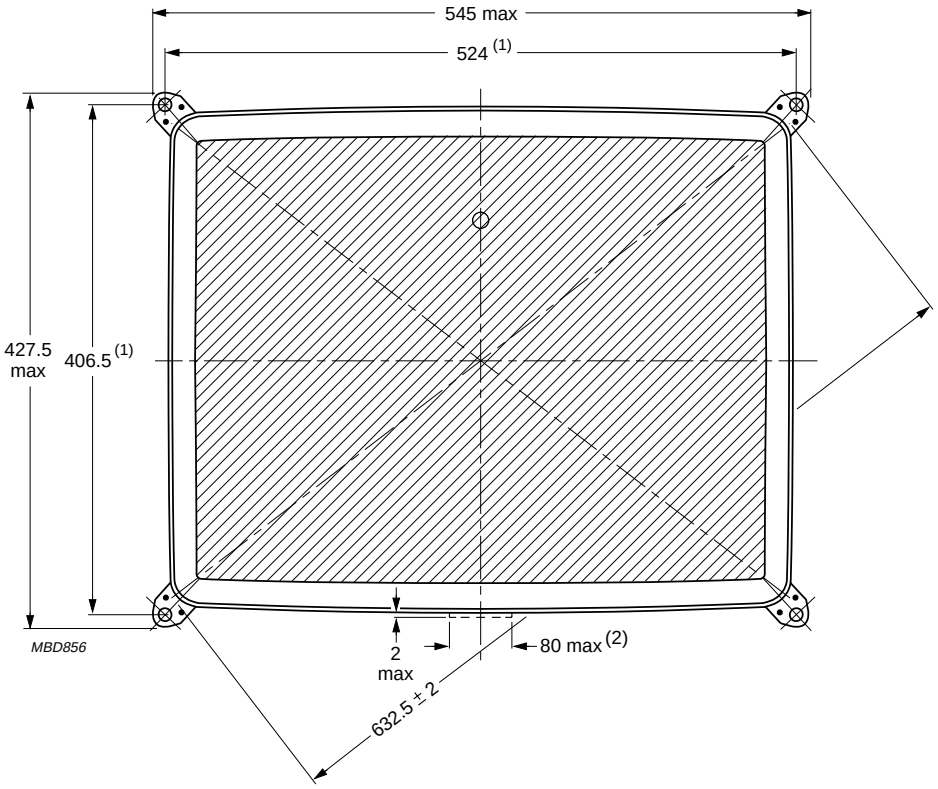
(1) The socket for this base should not be rigidly mounted; it should have flexible leads and be allowed to move freely. After mounting of the tube in the cabinet note that the position of the base can fall within a circle, having a diameter of max. 50 mm concentric with an imaginary tube axis.

Fig.2 Tube dimensions; top view.



Dimensions in mm.

Fig.3 Tube dimensions; side view.

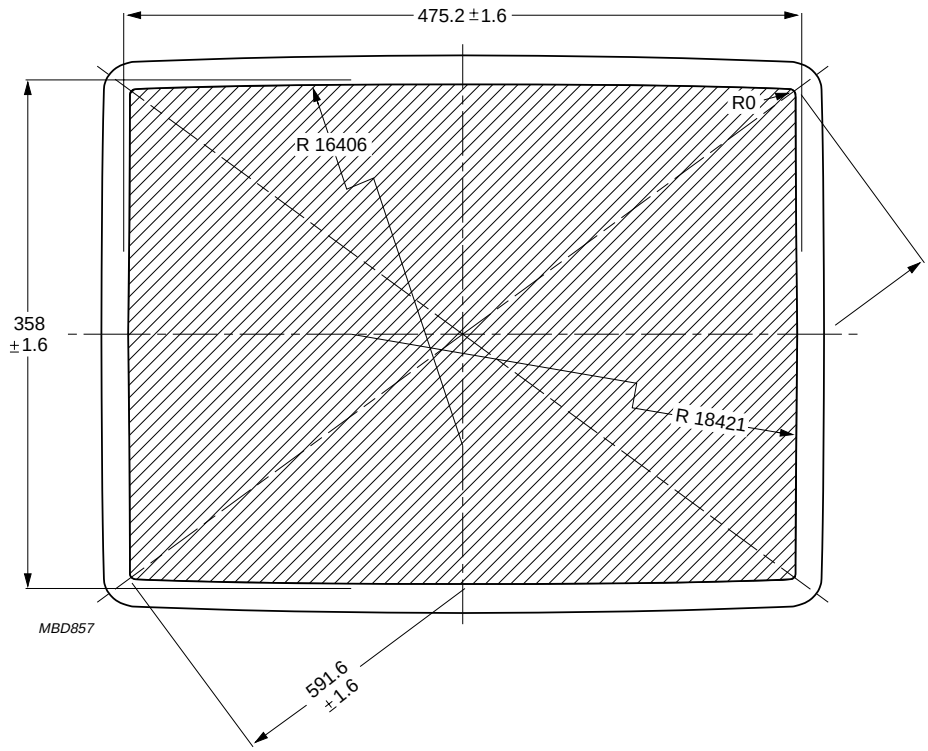


Dimensions in mm.

(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 524 mm × 406.5 mm.

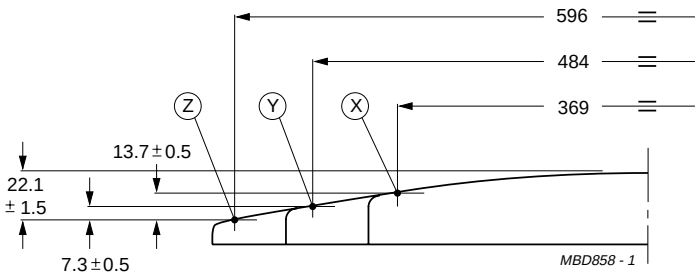
(2) Location of fishplate.

Fig.4 Tube dimensions; front view.



Dimensions in mm.

Fig.5 Phosphor dimensions.



Dimensions in mm.

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

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

$$Z_1 = 2.517069 \times 10^{-4} \times X^2 + 2.214350 \times 10^{-11} \times X^4$$
$$+ 2.456974 \times 10^{-4} \times Y^2 - 7.329235 \times 10^{-11} \times X^2 \times Y^2 - 1.967559 \times 10^{-16} \times X^4 \times Y^2$$
$$+ 1.490628 \times 10^{-11} \times Y^4 - 1.340310 \times 10^{-17} \times X^2 \times Y^4 - 3.028320 \times 10^{-23} \times X^4 \times Y^4$$

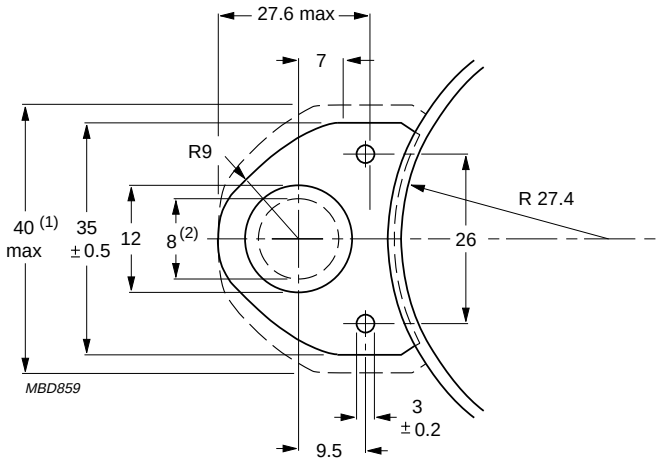
Fig.6 Screen reference points.

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

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	0.0	21.8	0.0	0.0	21.2	0.0	0.0	22.8
0.0(1)	179.0	13.9	0.0	176.0	13.5	0.0	184.0	14.5
20.0	179.0	13.8	20.0	176.0	13.4	20.0	184.0	14.4
40.0	179.0	13.5	40.0	176.0	13.2	40.0	184.0	14.1
60.0	178.9	13.0	60.0	175.9	12.7	60.0	183.9	13.6
80.0	178.8	12.3	80.0	175.8	12.0	80.0	183.8	12.9
100.0	178.7	11.4	100.0	175.7	11.1	100.0	183.7	12.0
120.0	178.6	10.3	120.0	175.6	10.0	120.0	183.6	10.9
140.0	178.5	9.0	140.0	175.5	8.7	140.0	183.5	9.6
160.0	178.3	7.6	160.0	175.3	7.2	160.0	183.3	8.1
180.0	178.1	5.9	180.0	175.1	5.5	180.0	183.1	6.5
200.0	177.9	4.0	200.0	174.9	3.6	200.0	182.9	4.6
220.0	177.7	1.9	220.0	174.7	1.5	220.0	182.7	2.5
236.6	177.5	0.0	–	–	–	240.0	182.4	0.2
236.6(2)	177.5	0.0	233.7	174.5	0.0	241.6	182.4	0.0
236.6	177.5	0.0	–	–	–	241.6	180.0	0.2
236.8	160.0	1.4	233.8	160.0	1.2	241.8	160.0	1.8
237.0	140.0	2.8	234.0	140.0	2.6	242.0	140.0	3.3
237.2	120.0	4.1	234.2	120.0	3.8	242.2	120.0	4.5
237.3	100.0	5.1	234.3	100.0	4.9	242.3	100.0	5.5
237.4	80.0	6.0	234.4	80.0	5.7	242.4	80.0	6.4
237.5	60.0	6.6	234.5	60.0	6.4	242.5	60.0	7.1
237.6	40.0	7.1	234.6	40.0	6.9	242.6	40.0	7.5
237.6	20.0	7.4	234.6	20.0	7.2	242.6	20.0	7.8
237.6(3)	0.0	7.5	234.6	0.0	7.3	242.6	0.0	7.9

Notes

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

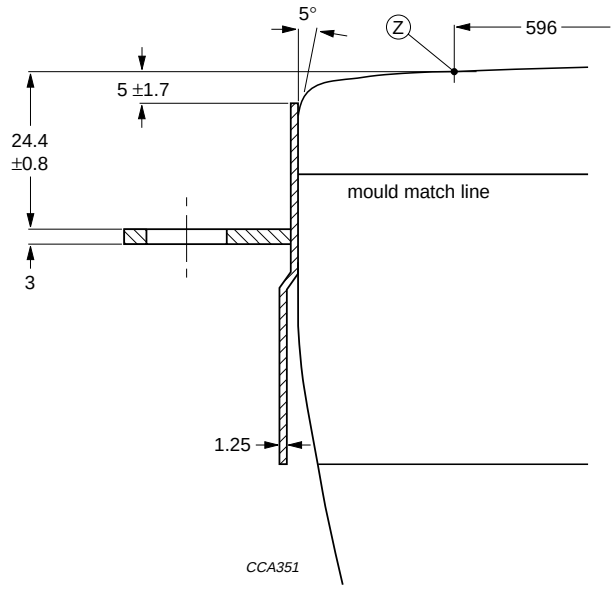


Dimensions in mm.

(1) Minimum space to be reserved for mounting lug.

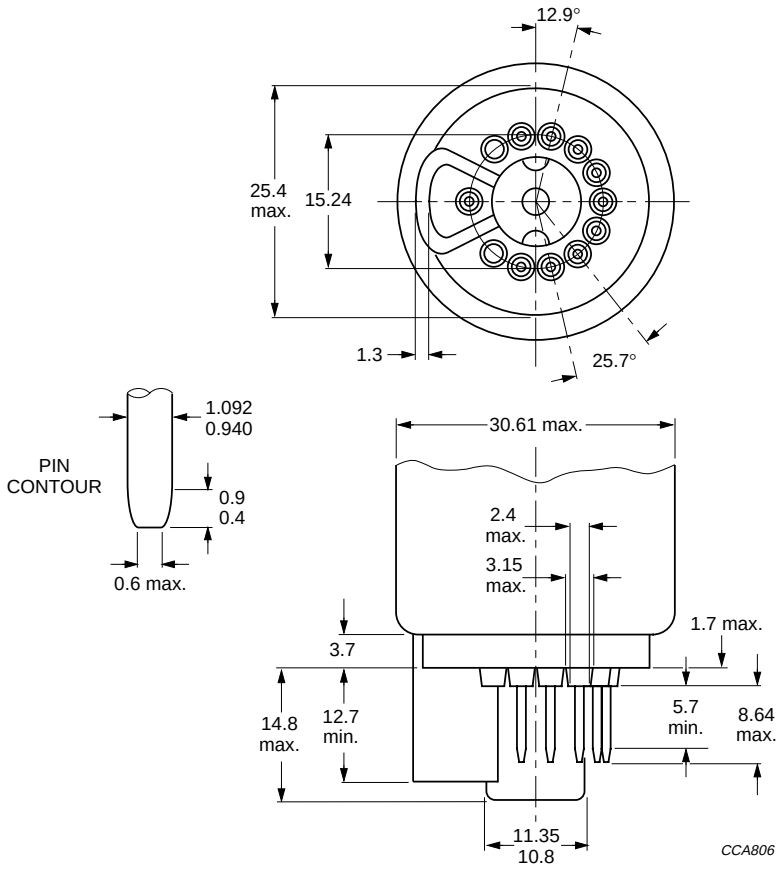
(2) The position of the mounting screw in the cabinet must be within a circle of 8 mm diameter drawn around the true geometrical positions, i.e. the corners of a rectangle of 524 mm × 406.5 mm.

Fig.7 Lug dimensions.



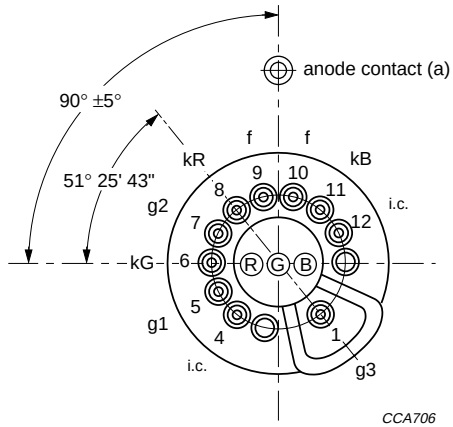
Dimensions in mm.

Fig.8 Lug position.



Dimensions in mm.

Fig.9 Base JEDEC B10-277.



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

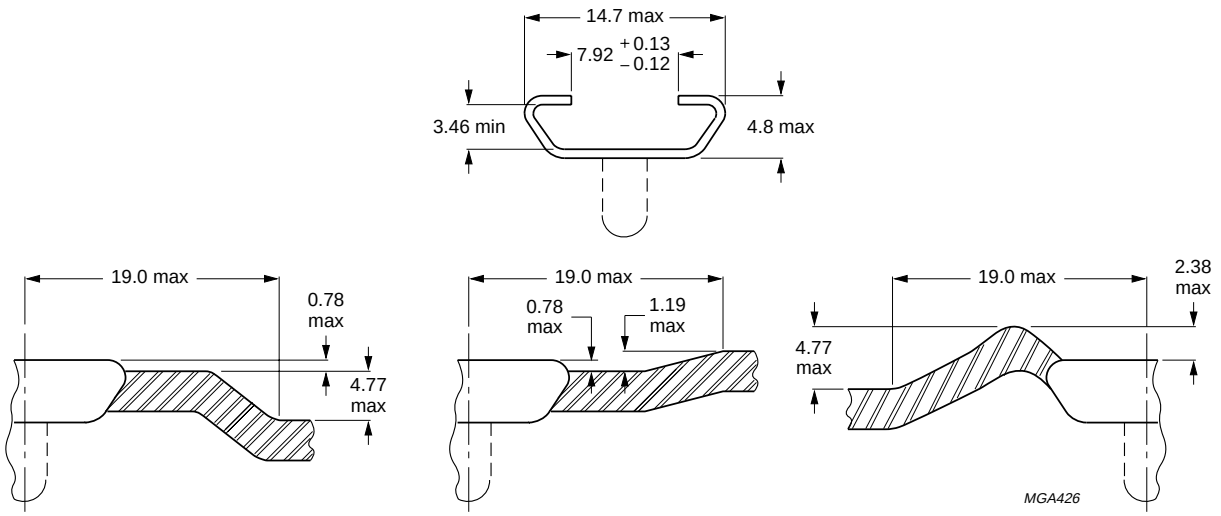
Fig.10 Pin arrangement.

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. 50 mm concentric with an imaginary tube axis.

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

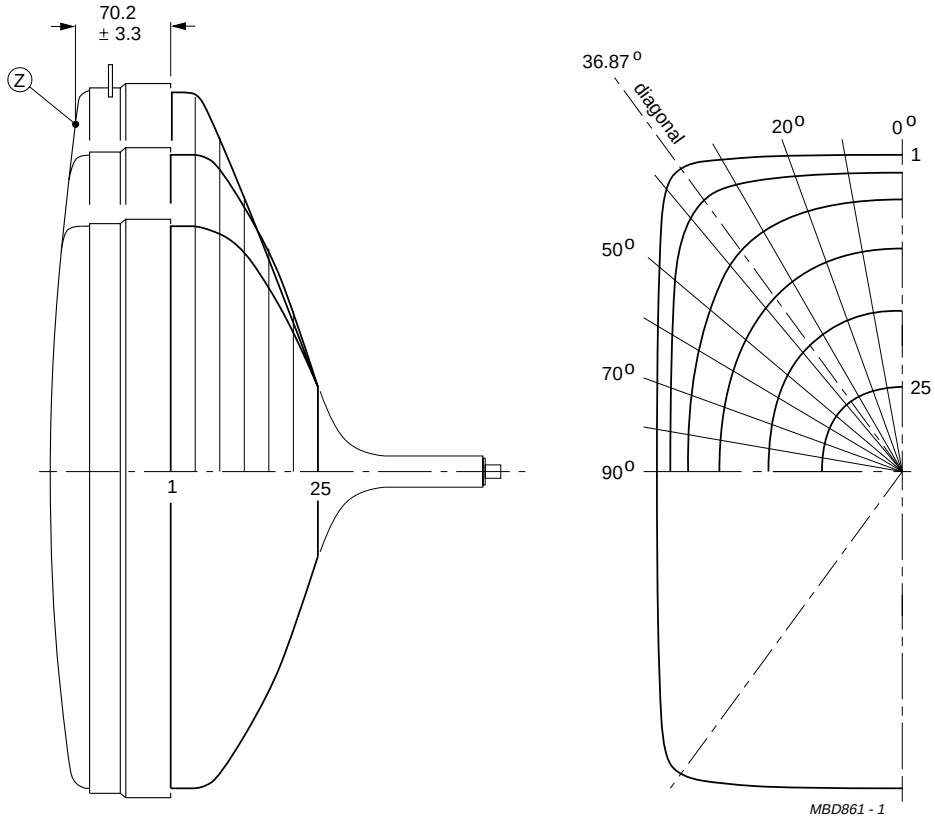
Maximum permissible torque on the tube neck is 0.04 Nm.



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	258.5	262.4	274.5	296.9	314.4	308.5	261.6	232.4	214.7	205.2	202.1
2	5	257.9	261.7	273.8	296.2	313.5	307.2	260.3	231.4	213.8	204.2	201.2
3	10	257.1	260.9	272.9	295.0	311.7	305.4	258.8	230.0	212.5	203.0	200.0
4	15	256.1	259.8	271.7	293.6	308.8	302.7	257.0	228.4	211.0	201.6	198.6
5	20	254.8	258.5	270.2	291.8	304.7	299.0	254.7	226.4	209.2	199.9	196.9
6	25	253.1	256.7	268.2	289.2	299.4	294.0	251.7	223.9	207.0	197.9	194.9
7	30	250.9	254.5	265.6	285.9	293.0	287.8	248.1	221.0	204.5	195.5	192.6
8	35	248.3	251.7	262.4	281.7	285.5	280.6	243.9	217.6	201.5	192.8	190.0
9	40	245.1	248.4	258.6	276.0	277.4	272.8	239.2	213.8	198.2	189.7	187.0
10	45	241.4	244.5	254.1	269.1	268.9	264.5	234.0	209.7	194.6	186.4	183.7
11	50	237.0	239.9	248.9	261.4	260.1	255.9	228.3	205.0	190.6	182.7	180.1
12	55	231.8	234.5	242.8	253.0	250.8	246.9	222.0	199.9	186.1	178.5	176.1
13	60	225.8	228.2	235.7	243.8	241.1	237.5	215.0	194.2	181.2	174.0	171.7
14	65	218.8	221.0	227.7	234.0	231.0	227.5	207.4	188.0	175.7	168.9	166.7
15	70	210.7	212.7	218.7	223.5	220.4	217.1	199.1	181.1	169.5	163.1	161.1
16	75	201.6	203.3	208.6	212.3	209.2	206.2	190.1	173.4	162.7	156.7	154.8
17	80	191.7	193.1	197.6	200.3	197.3	194.6	180.2	165.0	155.2	149.7	147.9
18	85	181.2	182.3	185.7	187.5	184.6	182.1	169.3	155.7	146.9	141.9	140.2
19	90	170.1	170.8	173.0	173.9	171.1	168.8	157.5	145.7	137.8	133.4	131.9
20	95	158.4	158.7	159.6	159.6	156.8	154.7	144.9	134.9	128.2	124.3	123.1
21	100	145.8	145.6	145.3	144.3	141.6	139.8	131.5	123.4	117.9	114.8	113.7
22	105	131.4	131.0	129.8	127.8	125.5	124.0	117.6	111.5	107.4	104.9	104.1
23	110	115.2	114.7	113.2	110.7	108.5	107.3	102.9	99.1	96.5	95.0	94.4
24	115	95.9	95.5	94.4	92.6	91.1	90.3	88.4	86.8	85.6	84.9	84.7
25	120	75.3	75.3	75.2	75.2	75.2	75.1	75.1	75.0	75.0	74.9	74.9

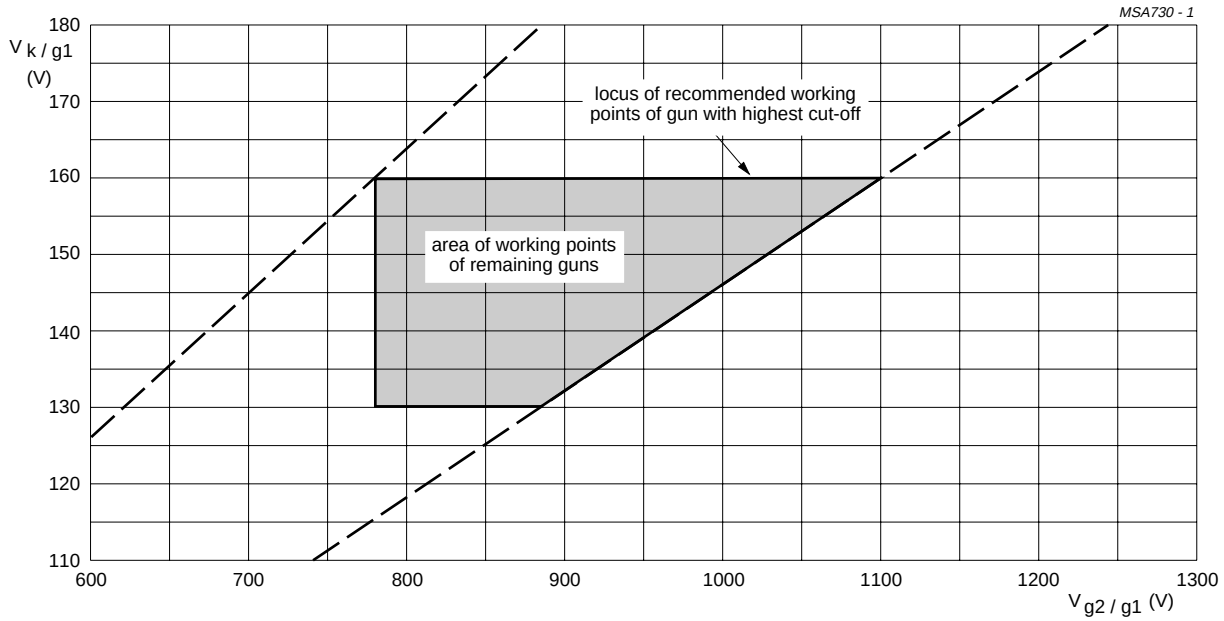
HANDLING

During shipment and handling the tube should not be subjected to acceleration 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	full screen load	–	29.5	–	kV
V_{g3}	grid 3 (focus electrode) voltage		7.5	–	8.6	kV
V_{g2}	grid 2 voltage	for spot cut-off voltage V_k = 160 V	780	–	1100	V
V_f	heater voltage	tube operating	5.70	6.15	6.60	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: 780 to 1100 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.

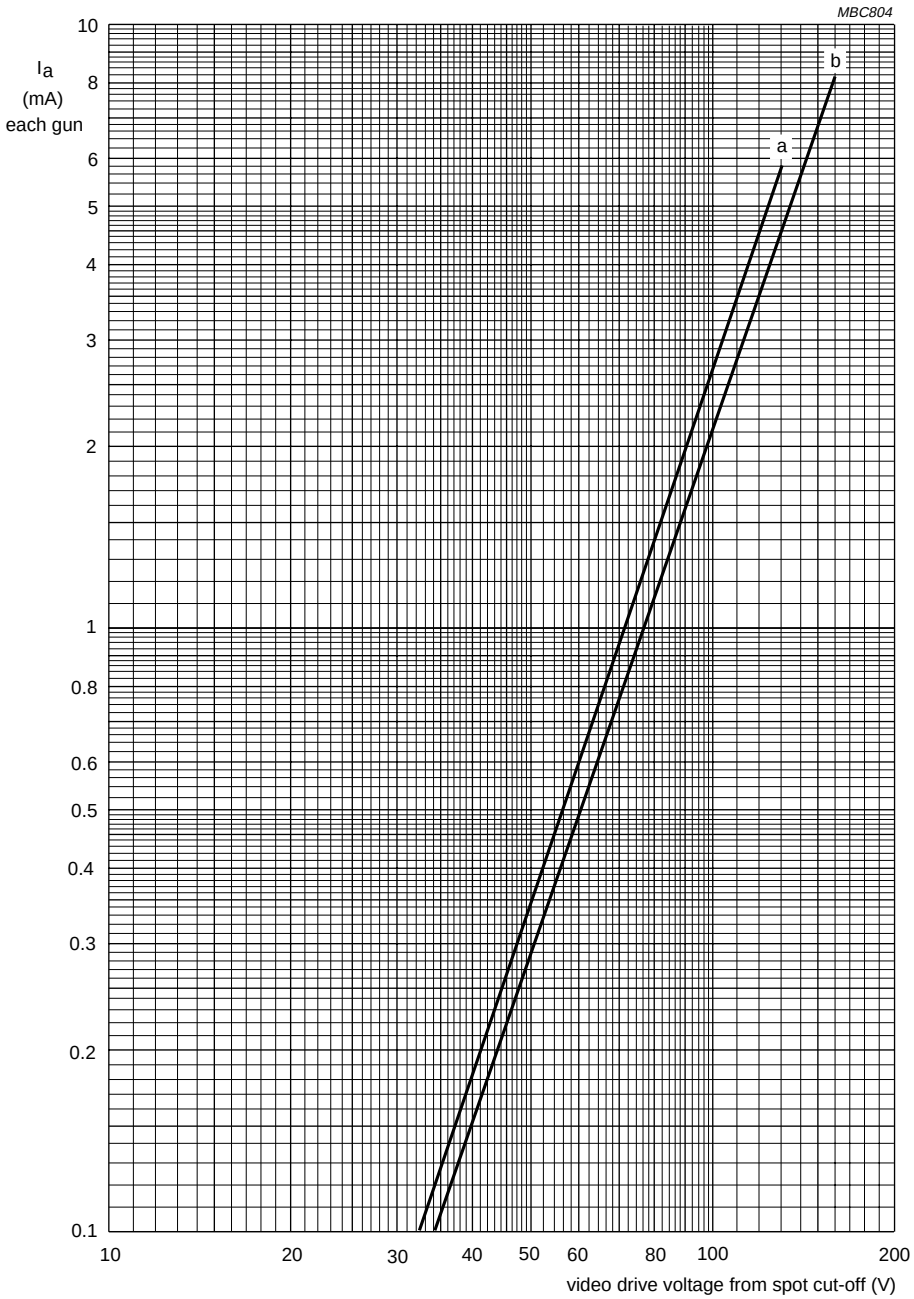
CHASSIS DESIGN VALUES

The values given are valid for anode voltages between 25 and 32 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		25.3	–	29.3	%
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	at average beam current	5.70	6.15	6.60	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/or 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		–	41.3	–	%
	green gun		–	34.4	–	%
	blue gun		–	24.3	–	%
RATIO OF ANODE CURRENTS						
	red gun to green gun		1.00	1.20	1.40	
	red gun to blue gun		1.40	1.70	2.00	
	blue gun to green gun		0.59	0.70	0.83	

Note

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



V_f = 6.15 V.
$V_{a,g4}$ = 29.5 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]	36[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 (peak value)	note 6	–	1400	V
V_f	heater voltage	note 7	5.7	6.6	V
Cathode voltage					
V_k	positive operating		–	250	V
V_k	during switch-off		–	250	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_{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 allowed (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. **The heater supply source impedance must not be less than 2 Ω.**

BEAM CENTRING

Maximum centring error in any direction is 3.5 mm.

FLASHOVER PROTECTION

With the high voltage used with this tube (max. 34 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.15; 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 (g3) 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 resistors should be as high as possible (min. 0.5 kΩ) without causing deterioration of the circuit performance. The resistors should be able to withstand an instantaneous surge of 20 kV for the focusing circuit and 12 kV for the remaining circuits without arcing.

To guarantee the soft flash behaviour, the internal dynamic resistance of the tube during flashover is a minimum 400 Ω and a maximum 800 Ω.

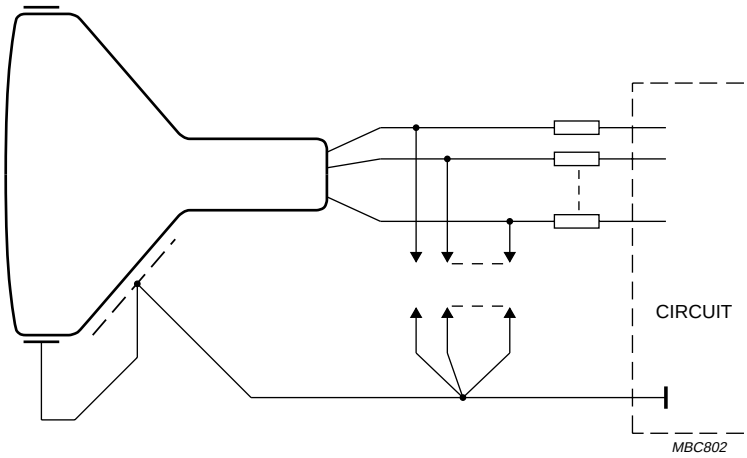


Fig.15 Flashover protection circuit.

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	VALUE
Entire tube; note 1	40.8 kV
Face-plate only	40.3 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 criteria, adequate shielding must be provided in the TV receiver for the anode contact and/or certain portions of the tube funnel and panel sidewalls to ensure that the X-radiation from the TV receiver is attenuated to a value equal to or lower than that specified for the face of the tube.
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.17.
Operation above the values shown by the curve may result in failure of the TV receiver 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”*.
Maximum X-radiation as a function of anode voltage at 300 μA current is shown by Fig.16. 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”*.

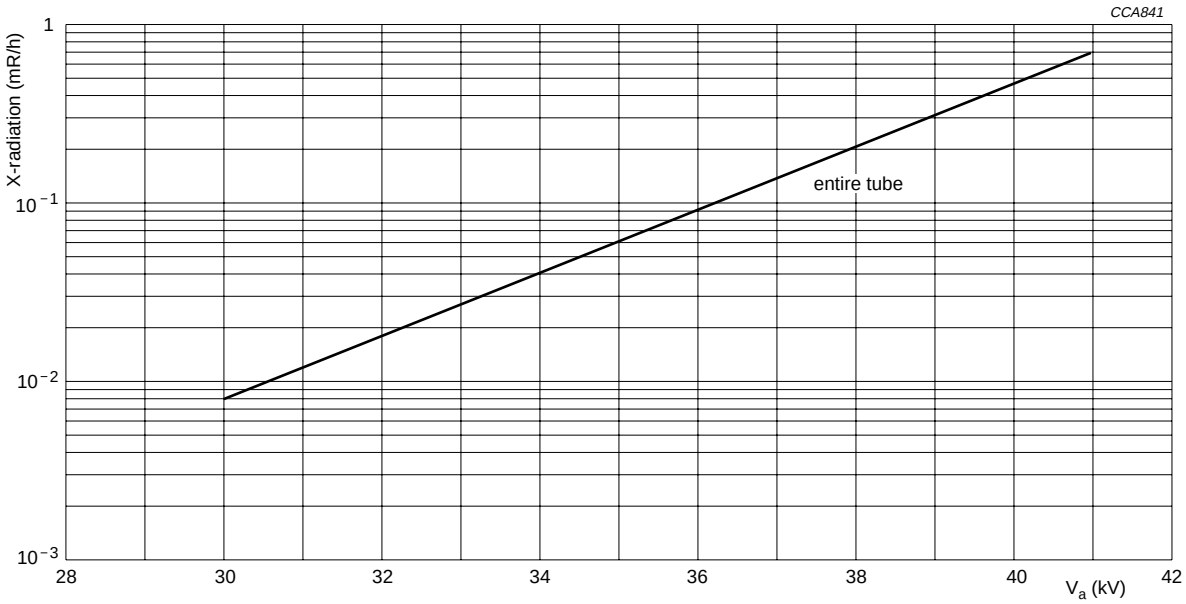


Fig.16 X-radiation limit curves at a constant anode current of 300 μA.

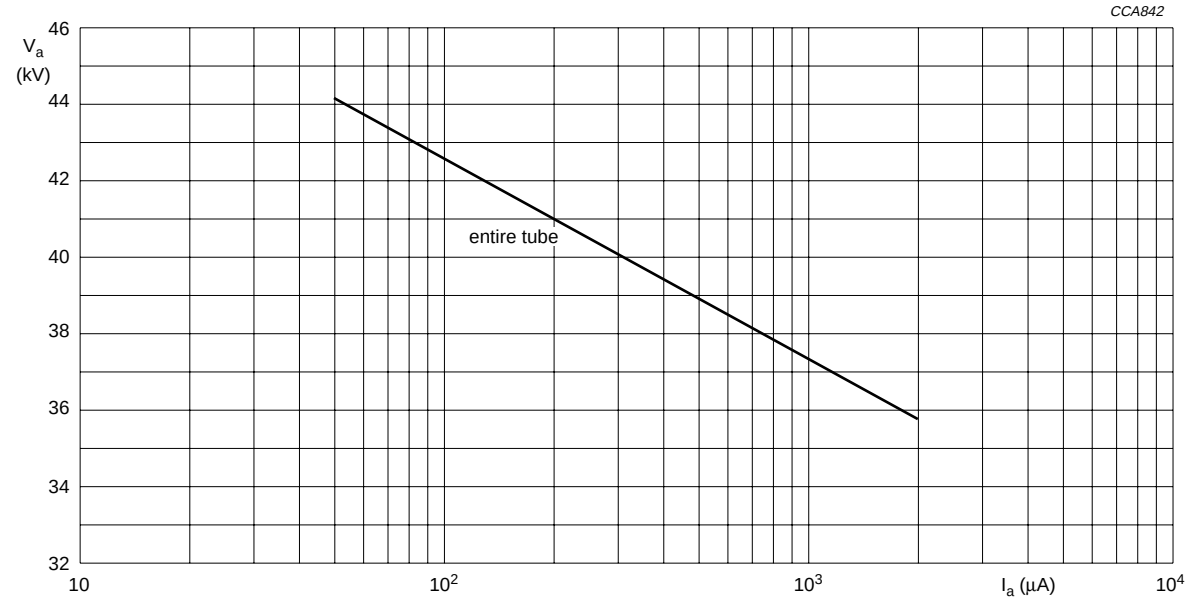
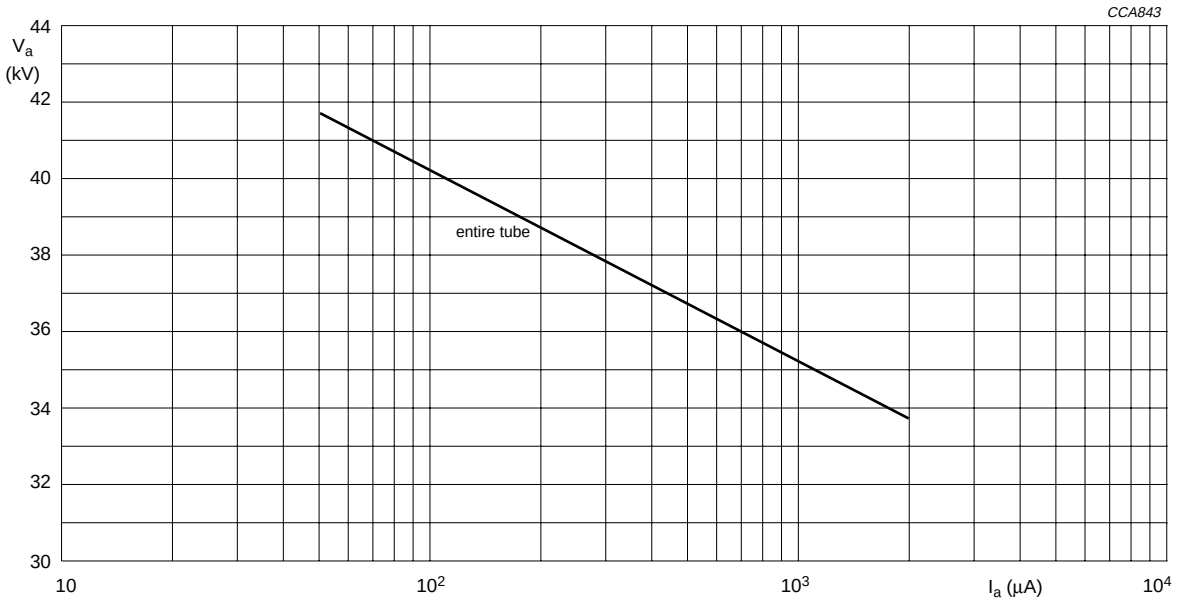


Fig.17 Iso-exposure-rate limit curves at 0.5 mR/h.



The tube does not emit X-radiation above 1 μSv/h when operated at 33 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.18 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 an eight-shaped coil mounted on the cone of the picture tube.

For proper degaussing an initial peak magnetomotive force (MMF) of 350 ampere-turns is required. This MMF has to be gradually decreased with a maximum of 25% per half period, using appropriate degaussing circuitry. At an initial peak MMF of >450 ampere-turns, the MMF has to be gradually decreased with a maximum of 30% per half period. In the steady state, no significant MMF should remain in the degaussing coil (≤0.33 ampere-turns). Switch-off is permitted at a peak MMF of ≤5 ampere-turns.

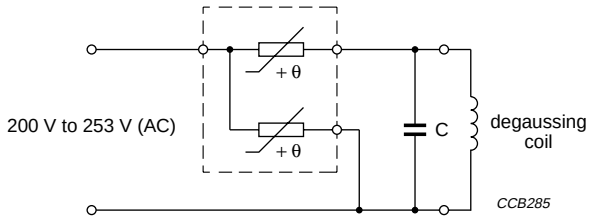
To prevent beam landing disturbances by horizontal frequency currents induced in the degaussing coil, the coil should be shunted by a capacitor of sufficiently high value.

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.19 and Table “Degaussing coil data”.

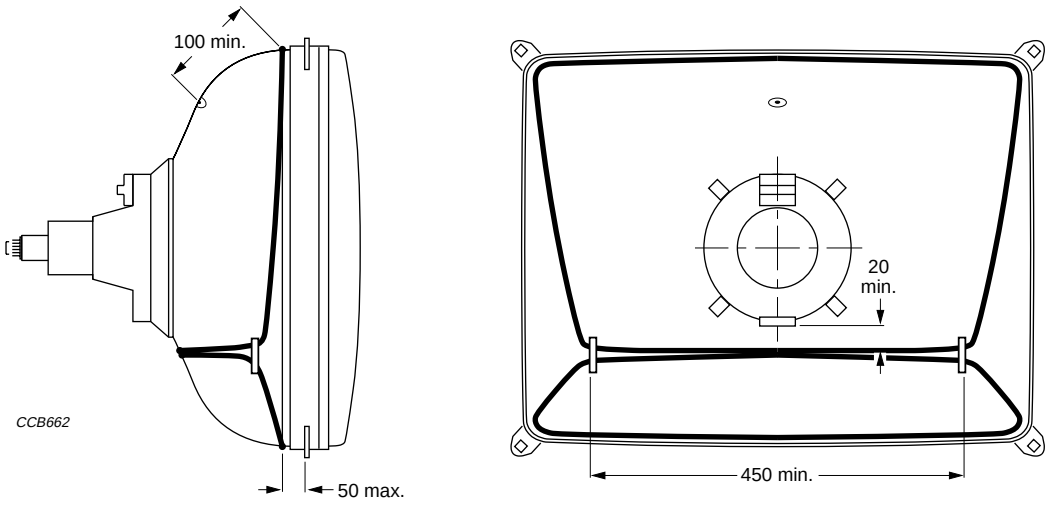
Degaussing coil data

PARAMETER	TYP.	UNIT
Circumference	276	cm
Number of turns	60	
Copper wire diameter	0.355	mm
Resistance	28.4	Ω
PTC thermistor	2322 662 96616	



C = 100 nF.

Fig.19 Degaussing circuit using a dual PTC thermistor.



Dimensions in mm.

Fig.20 Mounting of degaussing coils 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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