

DATA SHEET

A51EAL135X “Black Line FX” colour picture tube

Product specification
Supersedes data of 1998 Dec 04
File under Display Components, DC01

2000 Jan 21

**“Black Line FX”
colour picture tube****A51EAL135X****FEATURES**

- ‘Flatter’ and ‘squarer’ screen
- In-line, hi-bi potential ART (Aberration Reducing Triode) gun
- Mask with corner suspension
- HIGH GLOSS screen finish
- Cd-free phosphors
 - Pigmented deep red
 - Bright sulphide green
 - Highly pigmented sulphide blue
- Quick-heating low-power cathodes
- Soft-flash
- Slotted shadow mask optimized for minimum moiré at 525 and 625 line systems
- Internal magnetic shield
- Internal multipole
- The tube is supplied with a matched hybrid saddle toroidal deflection unit of the AT6035 series which forms a self-converging and raster correction free assembly
- Black Matrix technology.

QUICK REFERENCE DATA

PARAMETER	TYP.	UNIT
Deflection angle	90	deg
Minimum useful screen diagonal	51	cm
Overall length	44.4	cm
Glass transmission	52	%
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	
Mass	≈14	kg

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ELECTRICAL DATA

SYMBOL	PARAMETER	MIN.	TYP.	UNIT
Capacitances				
$C_{a(m+m')}$	anode to external conductive coating, including rimband	1600	–	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_{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 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
Focus lens	hi-bi potential
Deflection method	magnetic
Deflection angles	
diagonal	90°
vertical	78°
horizontal	60°

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OPTICAL DATA

PARAMETER	VALUE
Matrix	black opaque material, PVP technology
Screen	metal-backed vertical phosphor stripes; phosphor lines follow glass contour
Screen finish	high gloss
Nominal useful screen dimensions	
diagonal axis	509.8 mm
horizontal axis	411.2 mm
vertical axis	308.9 mm
area	1270 cm ²
Phosphor alignment	see Fig.1
Phosphors	
red	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	≈0.78 mm
Light transmission of face glass at centre of screen	52%
Luminance at centre of screen; note 1	98 cd/m ²
Contrast	>20.1 dB

Note

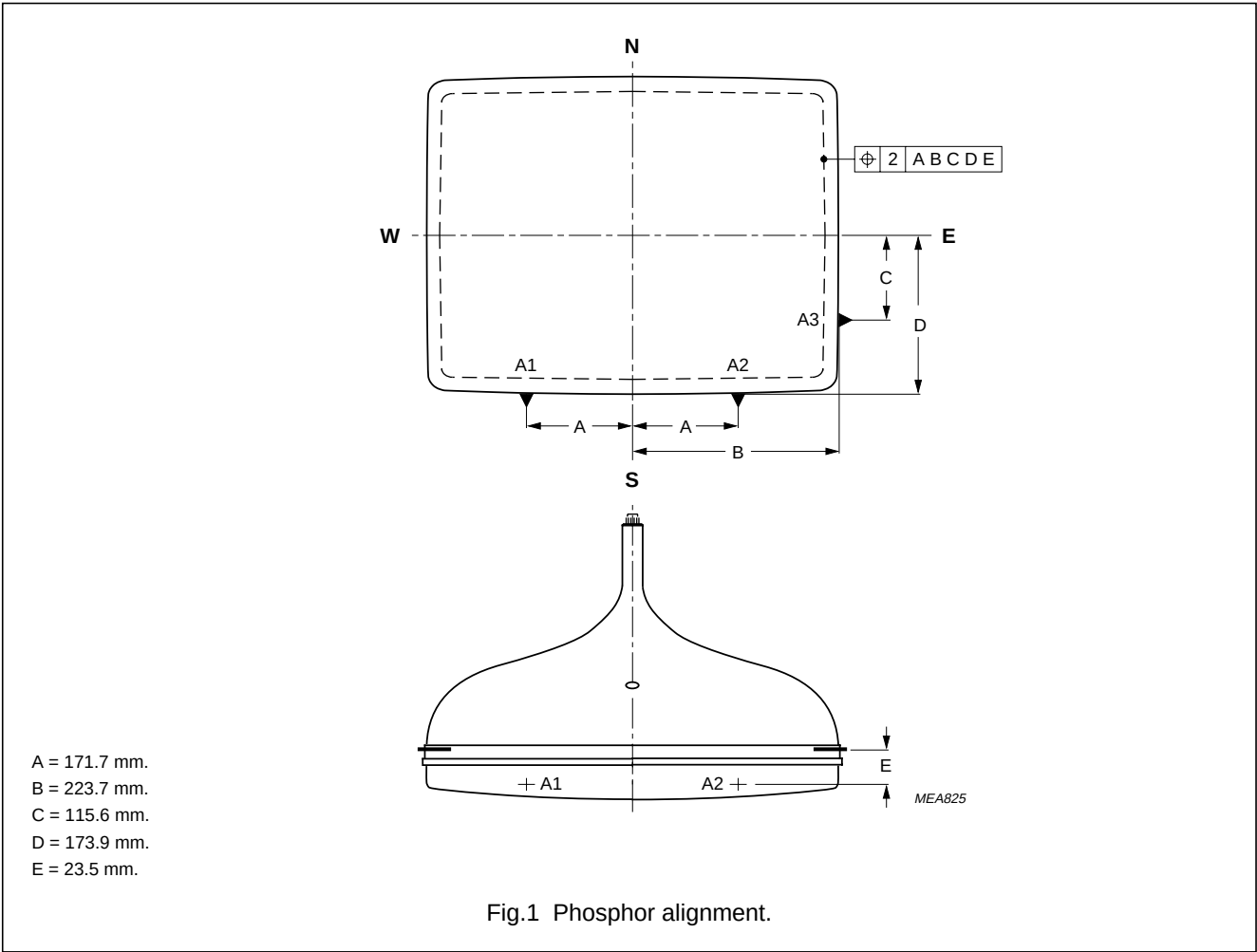
1. Tube settings adjusted to produce white D ($x = 0.313$, $y = 0.329$), focused raster, current density $0.4 \mu\text{A}/\text{cm}^2$.

Colour coordinates

COLOUR COORDINATE	x	y
Red	0.630	0.330
Green	0.300	0.610
Blue	0.155	0.065

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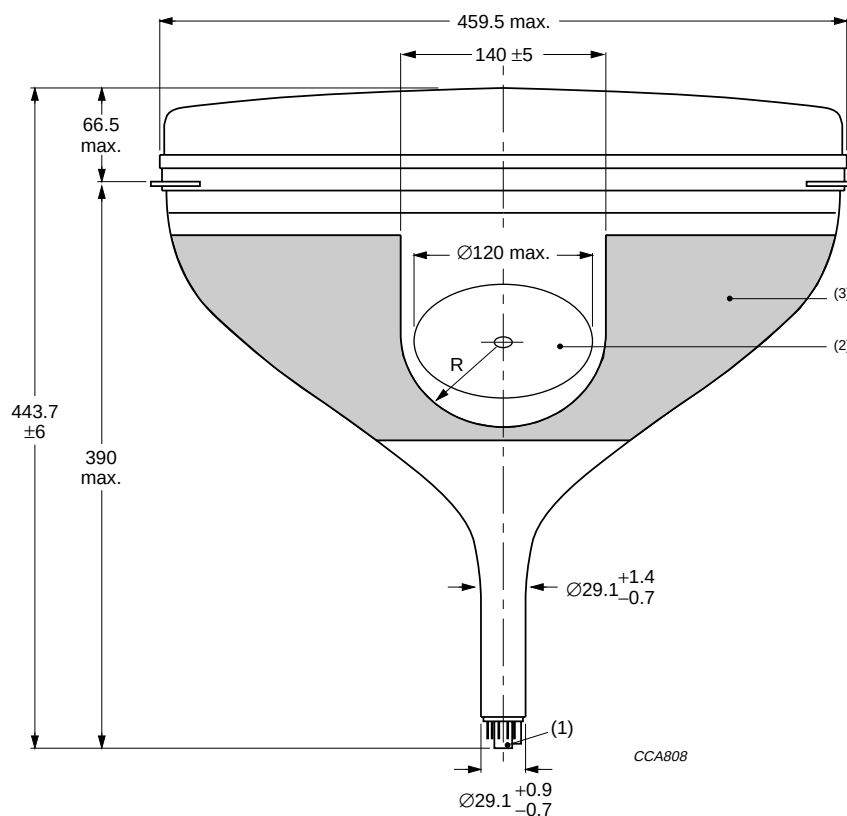
MECHANICAL DATA

See Figs 2 to 12.

PARAMETER	VALUE
Overall length	443.7 ±6 mm
Bulb dimensions	
diagonal	<546.1 mm
horizontal	<455.6 mm
vertical	<359.6 mm
Neck diameter; note 1	29.1 +1.4/-0.7 mm
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 with integral mounting lugs
Mass	≈14 kg

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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.
- (2) To clean this area, wipe only with a soft lint-free cloth.
- (3) Configuration of the outer conductive coating may vary but will contain the contact area as shown.

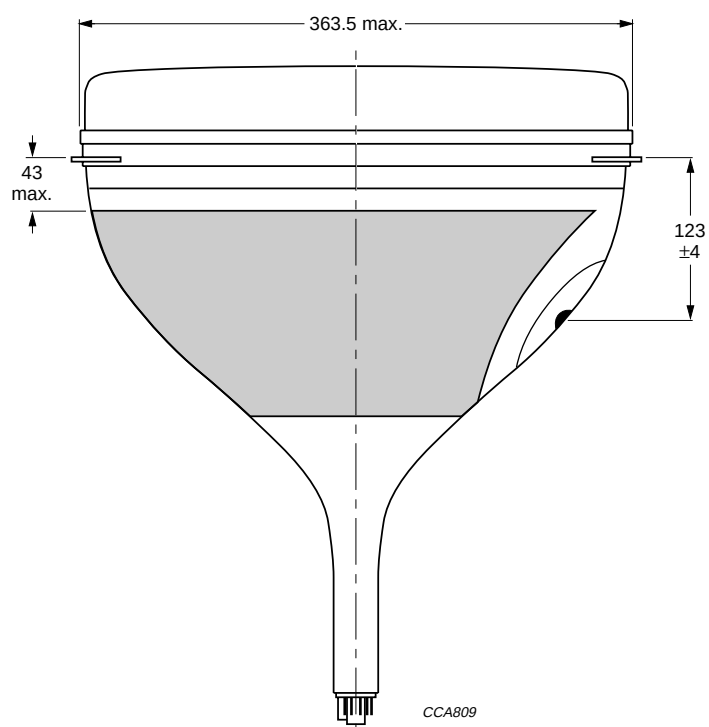
Fig.2 Tube dimensions; top view.

Note

1. In the region of 78.5 mm from the neck end, the maximum diameter is 30 mm.

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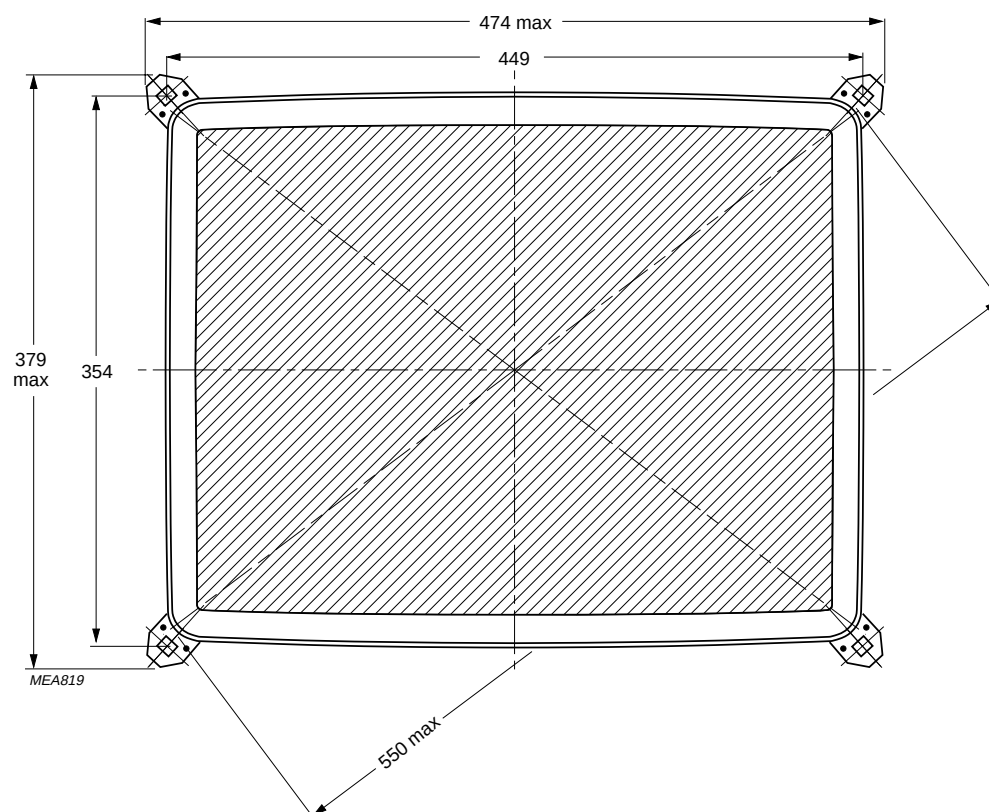


Dimensions in mm.

Fig.3 Tube dimensions; side view.

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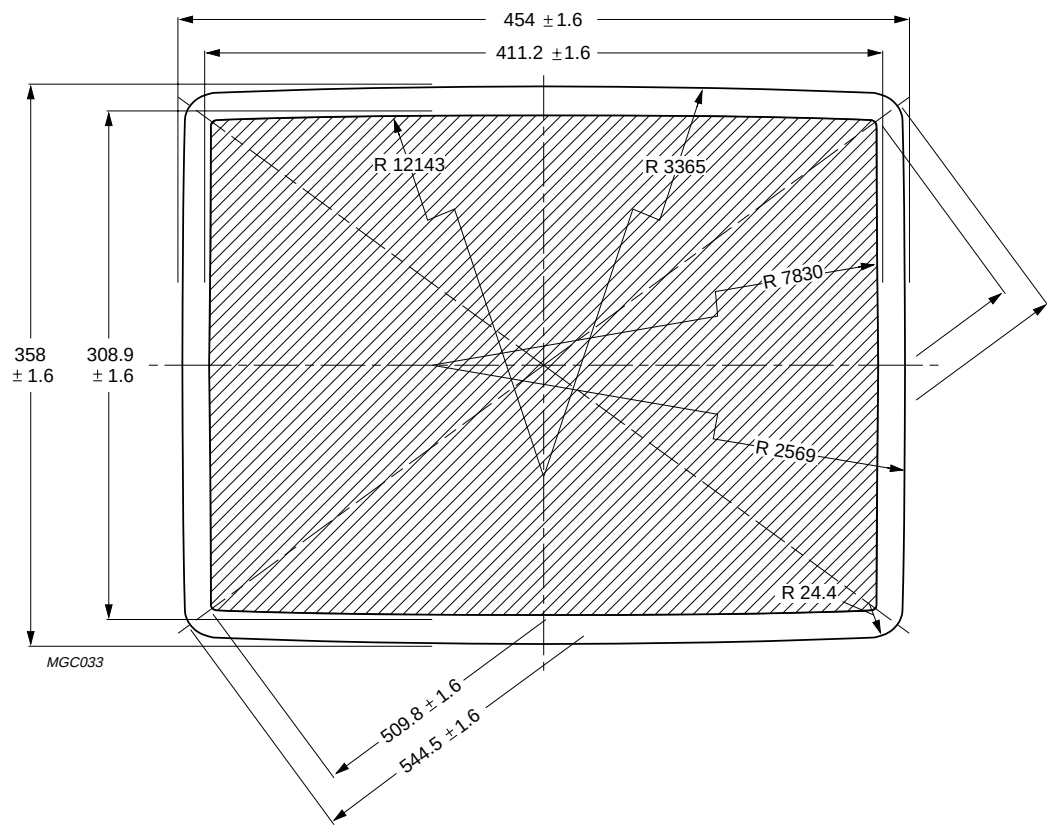


Dimensions in mm.

Fig.4 Tube dimensions; front view.

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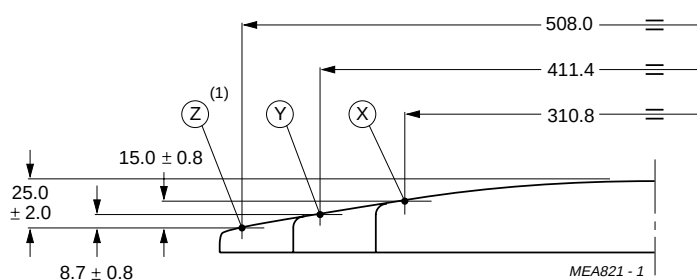


Dimensions in mm.

Fig.5 Phosphor and screen dimensions.

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Dimensions in mm.

(1) Coordinates for Z-point: $X = 203.2$, $Y = 152.4$.

The X, Y and Z reference points are located on the outside surface of the face plate on 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:

$$Z = (A_1 \times X^{B_1}) + (A_2 \times Y^{B_2}) + (A_3 \times X^{B_3} \times Y^{B_4})$$

Where:

$$A_1 = 2.33161 \times 10^{-4}$$

$$A_2 = 2.50647 \times 10^{-4}$$

$$A_3 = -9.31800 \times 10^{-11}$$

$$B_1 = 2.1$$

$$B_2 = 2.1$$

$$B_3 = 1.84082$$

$$B_4 = 2.65536$$

Fig.6 Screen reference points.

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

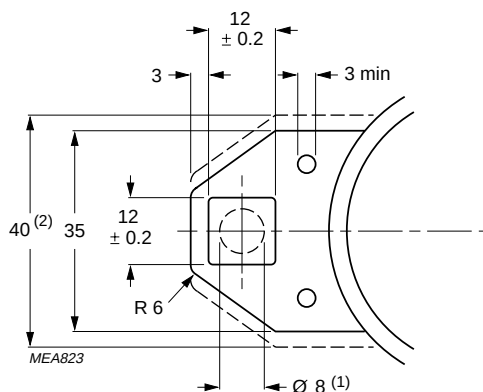
NOMINAL USEFUL SCREEN (NUS)			3 mm INSIDE NUS			5 mm OUTSIDE NUS		
COORDINATES		SAGITTAL HEIGHT (mm)	COORDINATES		SAGITTAL HEIGHT (mm)	COORDINATES		SAGITTAL HEIGHT (mm)
X (mm)	Y (mm)		X (mm)	Y (mm)		X (mm)	Y (mm)	
0.0	0.0	25.1	0.0	0.0	24.3	0.0	0.0	26.5
0.0 ⁽¹⁾	154.5	15.2	0.0	151.5	14.8	0.0	159.5	15.9
20.0	154.5	15.1	20.0	151.5	14.7	20.0	159.5	15.8
40.0	154.4	14.8	40.0	151.4	14.3	40.0	159.4	15.4
60.0	154.4	14.1	60.0	151.4	13.7	60.0	159.4	14.8
80.0	154.2	13.1	80.0	151.2	12.7	80.0	159.2	13.8
100.0	154.1	11.9	100.0	151.1	11.5	100.0	159.1	12.6
120.0	153.9	10.3	120.0	150.9	9.9	120.0	158.9	11.0
140.0	153.7	8.4	140.0	150.7	7.9	140.0	158.7	9.1
160.0	153.5	6.1	160.0	150.5	5.7	160.0	158.5	6.9
180.0	153.2	3.5	180.0	150.2	3.1	180.0	158.2	4.3
200.0	152.9	0.6	200.0	149.9	0.2	200.0	157.9	1.4
203.9 ⁽²⁾	152.8	0.0	201.0	149.8	0.0	208.8	157.7	0.0
204.0	150.0	0.3	—	—	—	—	—	—
204.3	130.0	2.4	201.3	130.0	2.0	209.3	130.0	2.9
204.6	110.0	4.1	201.6	110.0	3.8	209.6	110.0	4.6
204.9	90.0	5.5	201.9	90.0	5.2	209.9	90.0	6.1
205.1	70.0	6.7	202.1	70.0	6.4	210.1	70.0	7.2
205.2	50.0	7.5	202.2	50.0	7.2	210.2	50.0	8.0
205.3	30.0	8.1	202.3	30.0	7.8	210.3	30.0	8.6
205.4	10.0	8.3	202.4	10.0	8.1	210.4	10.0	8.8
205.4 ⁽³⁾	0.0	8.4	202.4	0.0	8.1	210.4	0.0	8.9

Notes

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

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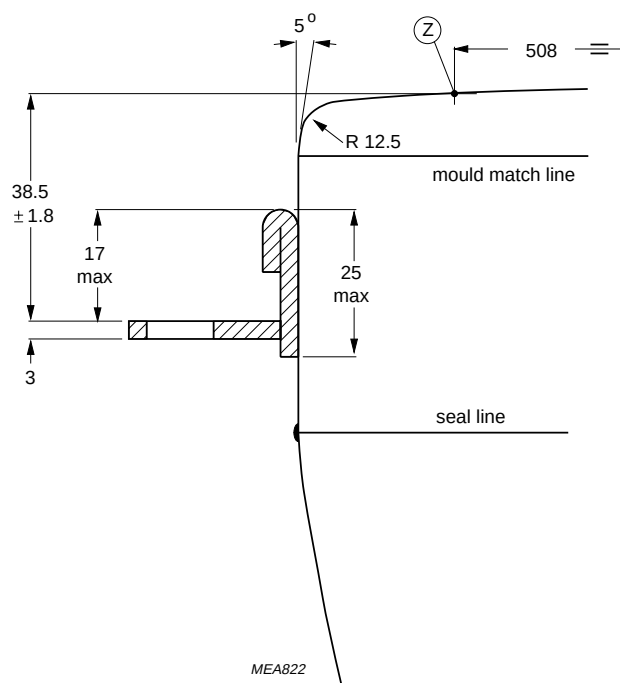
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Dimensions in mm.

- (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.7 Lug dimensions.



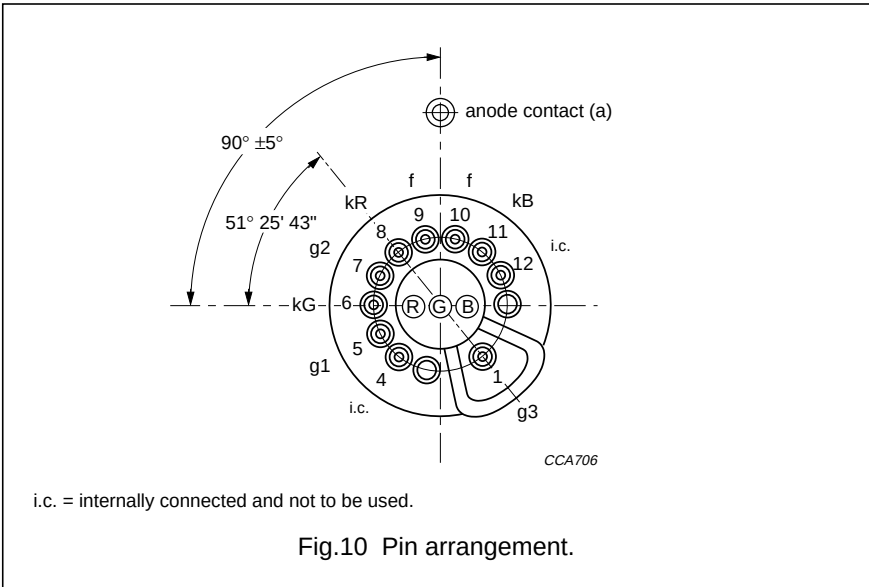
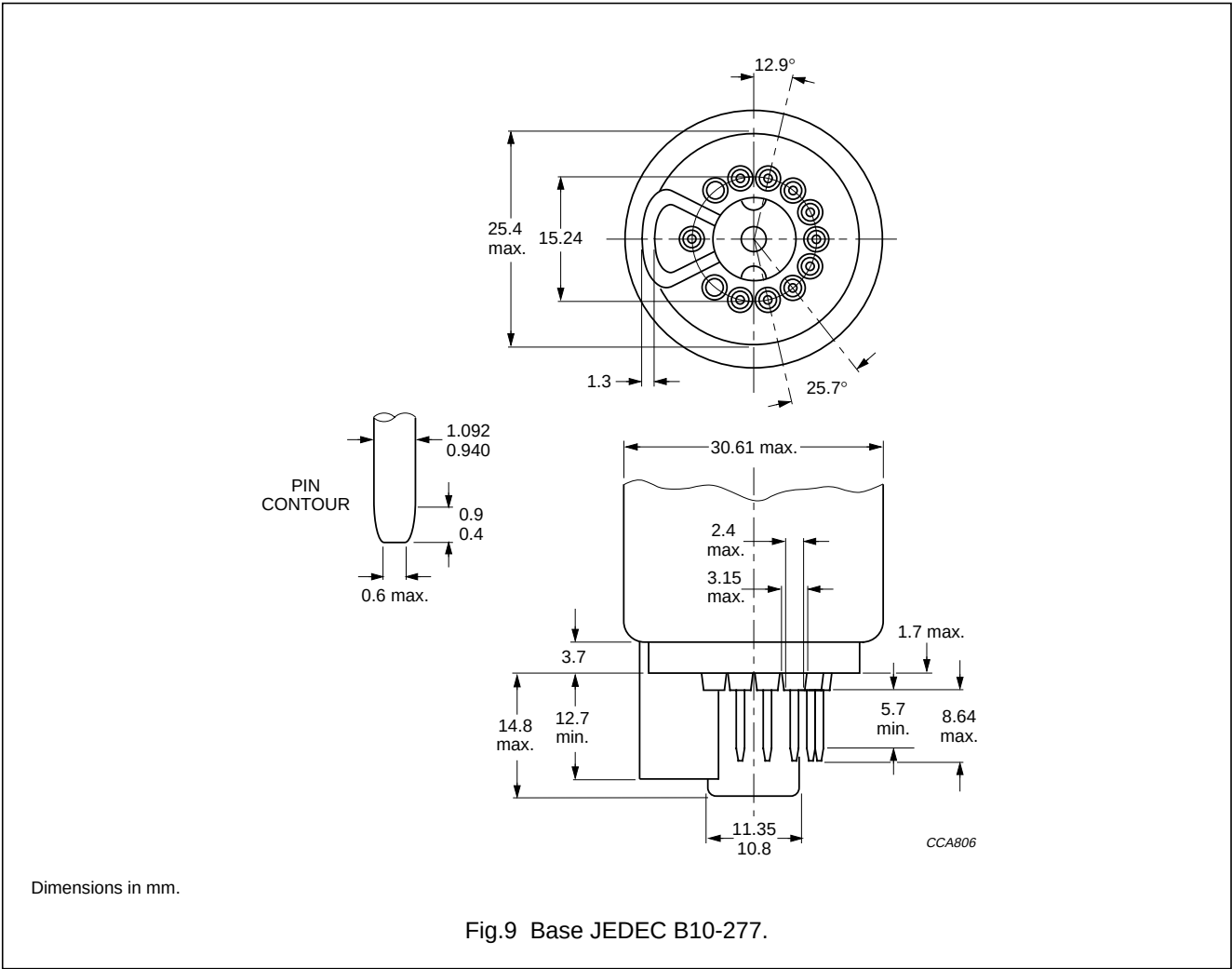
Dimensions in mm.

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.

Fig.8 Lug position.

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Remarks: to Figs 9 and 10.

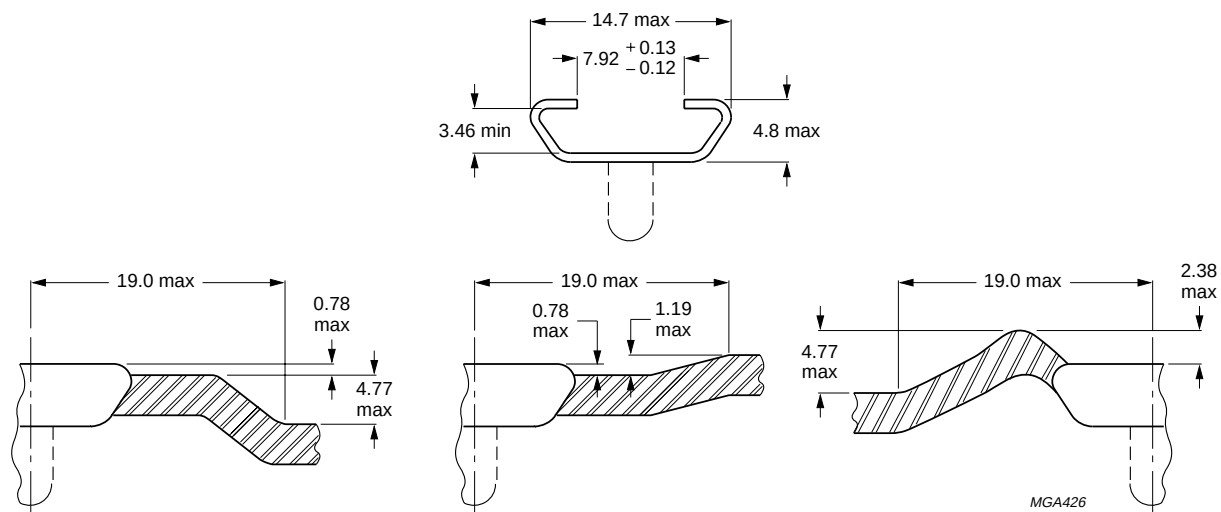
The socket for this base should not be rigidly mounted, it should have flexible leads and be allowed to move freely. After mounting the tube in the cabinet, note that the position of the base can fall within a circle, having a diameter of max. 40 mm concentric with an imaginary tube axis.

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

Maximum permissible torque on the tube neck is 0.04 Nm.

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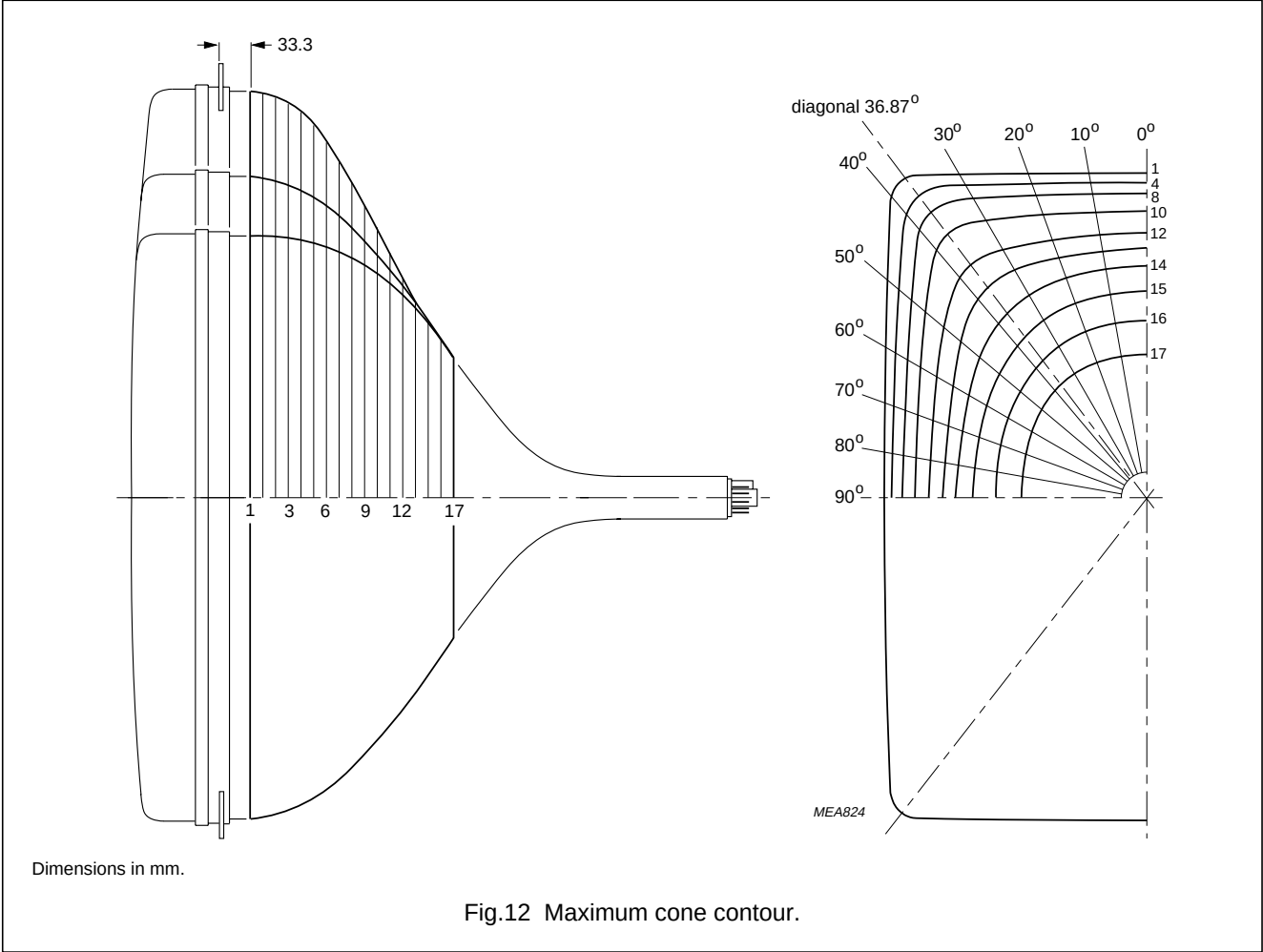
Dimensions in mm.

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

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Cone contour



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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

HANDLING

During shipment and handling the tube should not be subjected to accelerations greater than 350 m/s² in any direction (at pulse ≤10 ms).

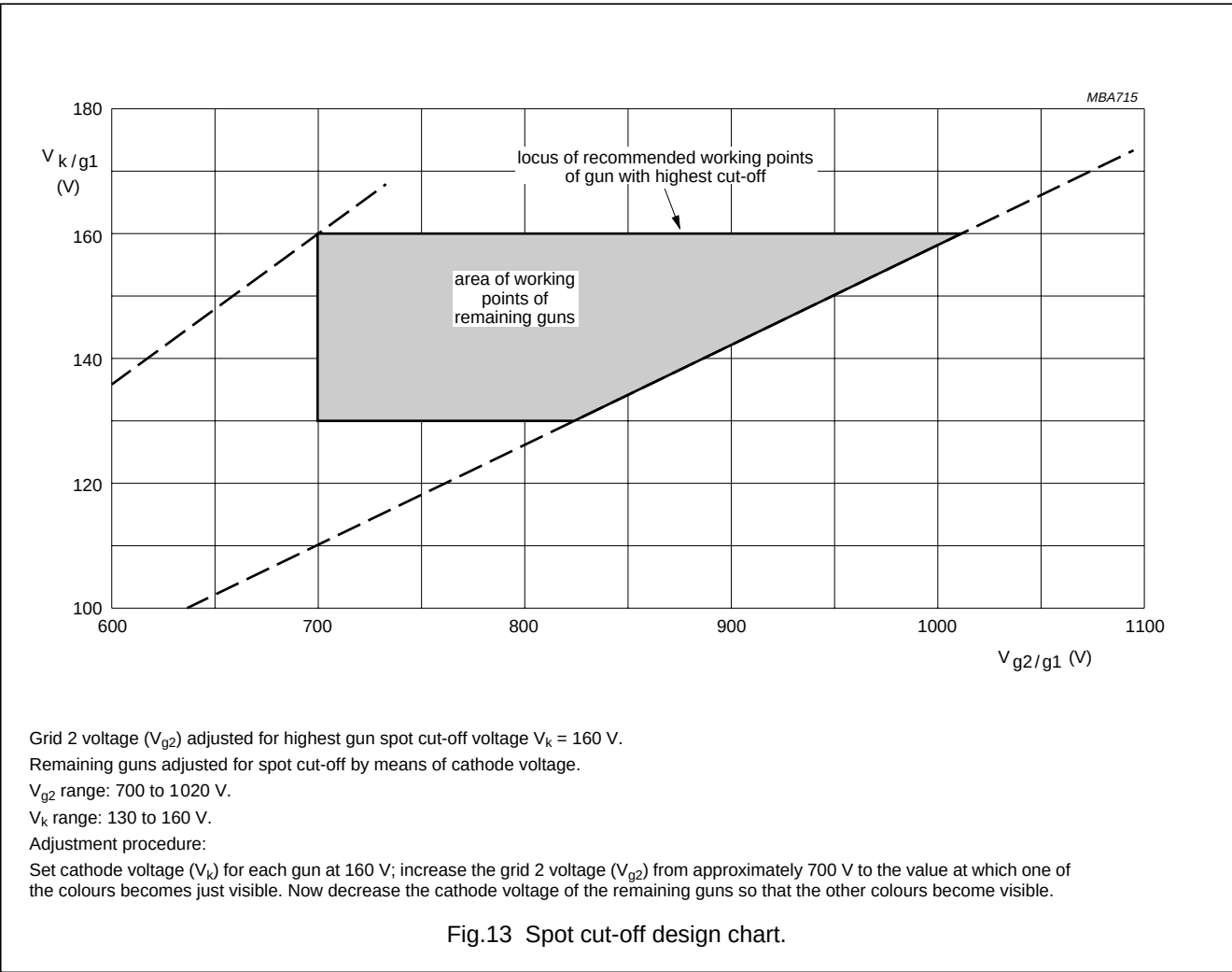
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OPERATING DATA

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 $V_k = 160\text{ V}$	700	–	1020	V
V_f	heater voltage	tube operating	–	6.15	–	V



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CHASSIS DESIGN VALUES

The values are valid for anode voltages between 22 and 29.5 kV. The voltages are specified with respect to grid 1.

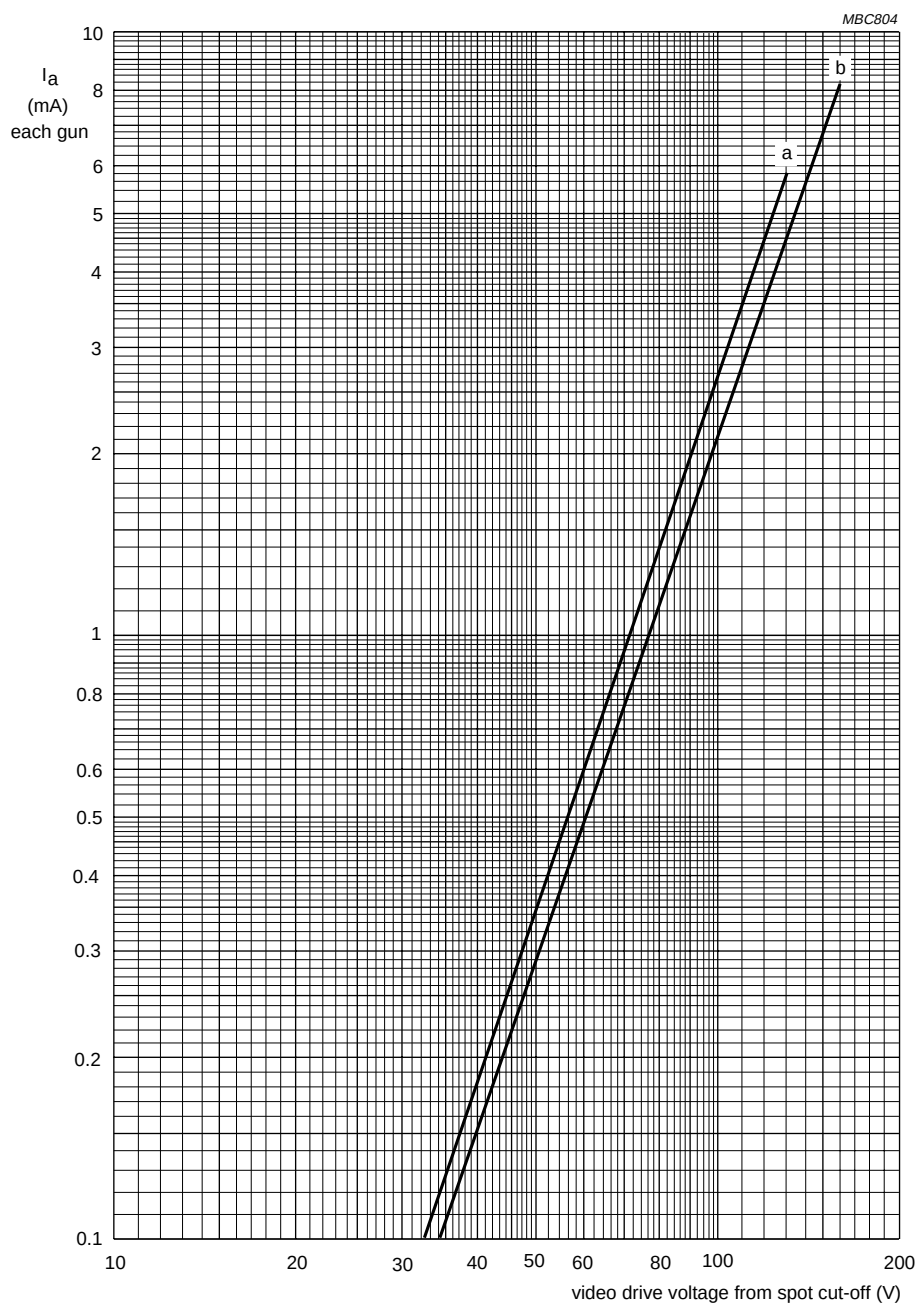
SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
V_{g3}	grid 3 (focus electrode) voltage as a percentage of anode voltage		29	–	33	%
V_{g2} and V_k	grid 2 voltage and cathode voltage	for visual extinction of focused spot	see Fig.13			
ΔV_k	difference in cut-off voltage between guns in any tube		lowest value >80% of highest value			
V_f	heater voltage	tube 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	–	–	M Ω
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

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

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$V_f = 6.15$ 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.

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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	notes 1 and 2	22 ⁽³⁾	31.0 ⁽⁴⁾	kV
I_a	long-term average current for three guns	note 5	–	1000	μA
V_{g3}	grid 3 (focus electrode) voltage		–	11	kV
V_{g2}	grid 2 voltage	note 6	–	1200	V
V_f	heater voltage	note 7	5.7	6.6 ⁽⁴⁾	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		–	–135	V
V_{kfp}	negative peak		–	–180	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. The picture tube does not emit X-radiation above 1 μSv/h when operated at 31.0 kV and 1.5 mA.
3. Operation of the tube at lower voltages impairs the luminance and resolution and may impair the convergence.
4. This value is an absolute maximum.
5. The short-term average anode current should be limited by circuitry to 1500 μA.
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 is 4 mm in any direction after colour purity, static convergence and horizontal centre line correction (measured with deflection coils at nominal position).

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FLASHOVER PROTECTION

The high voltages used with this tube (absolute max. 31.0 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 11.5 kV ($1.5 \times V_{g3}$ max. at $V_{a,g4} = 27.5$ kV) and at the other

electrodes of 1.5 to 2 kV at the lowest operating atmospheric pressure.

The values of the series isolation resistors should be as high as possible (min. 1.5 k Ω) 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.

Additional information is available on request.

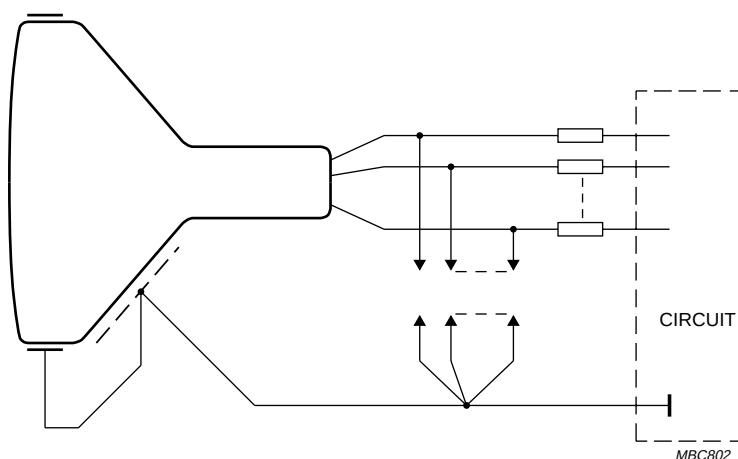


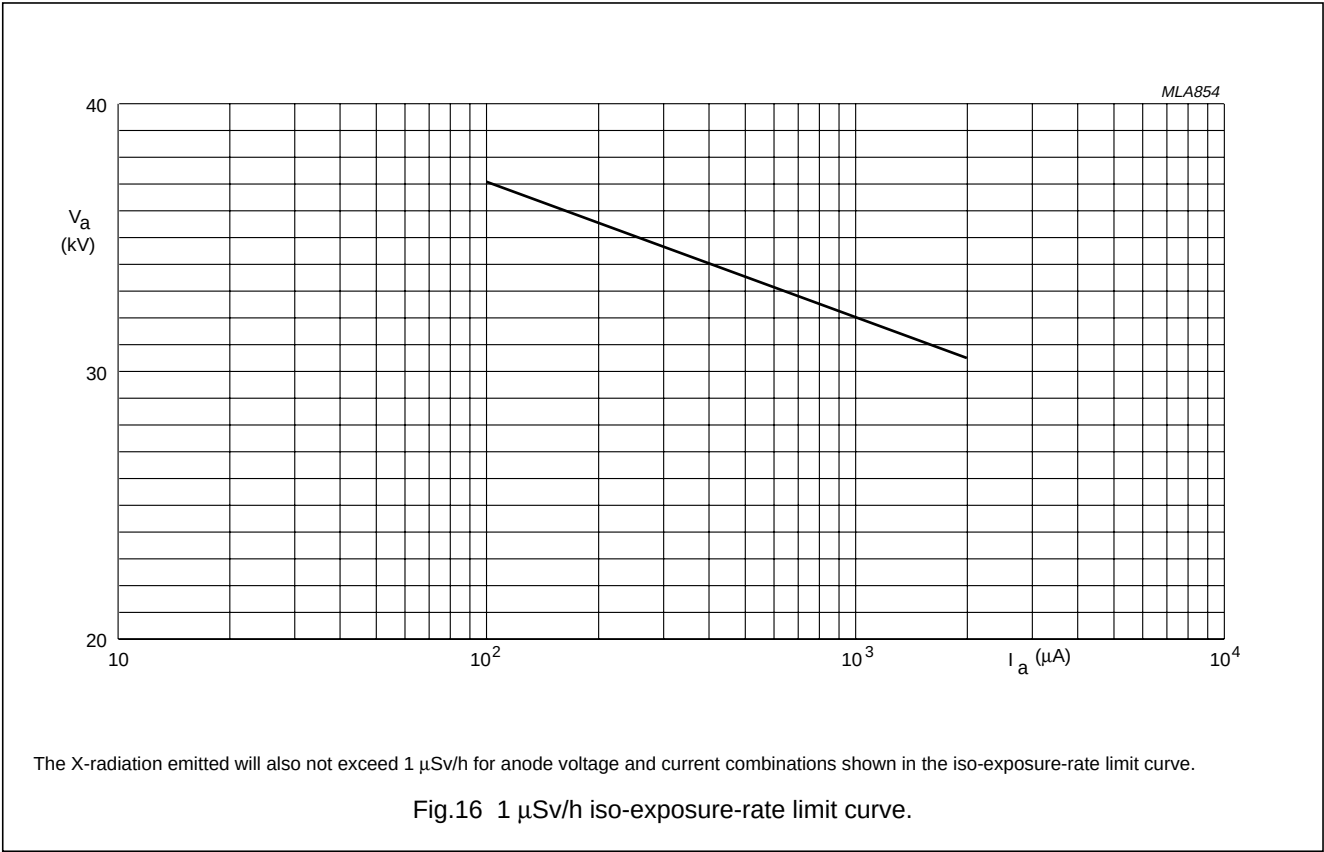
Fig.15 Flashover protection circuit.

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X-RADIATION

The tube does not emit X-radiation above 1 µSv/h when operated at 31.0 kV and 1.5 mA.



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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 single coil mounted on the cone of the picture tube.

For proper degaussing an initial peak magnetomotive force (MMF) of 700 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 >900 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 (≤ 0.36 ampere-turns). Switch-off is permitted at a peak MMF of ≤ 8 ampere-turns.

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

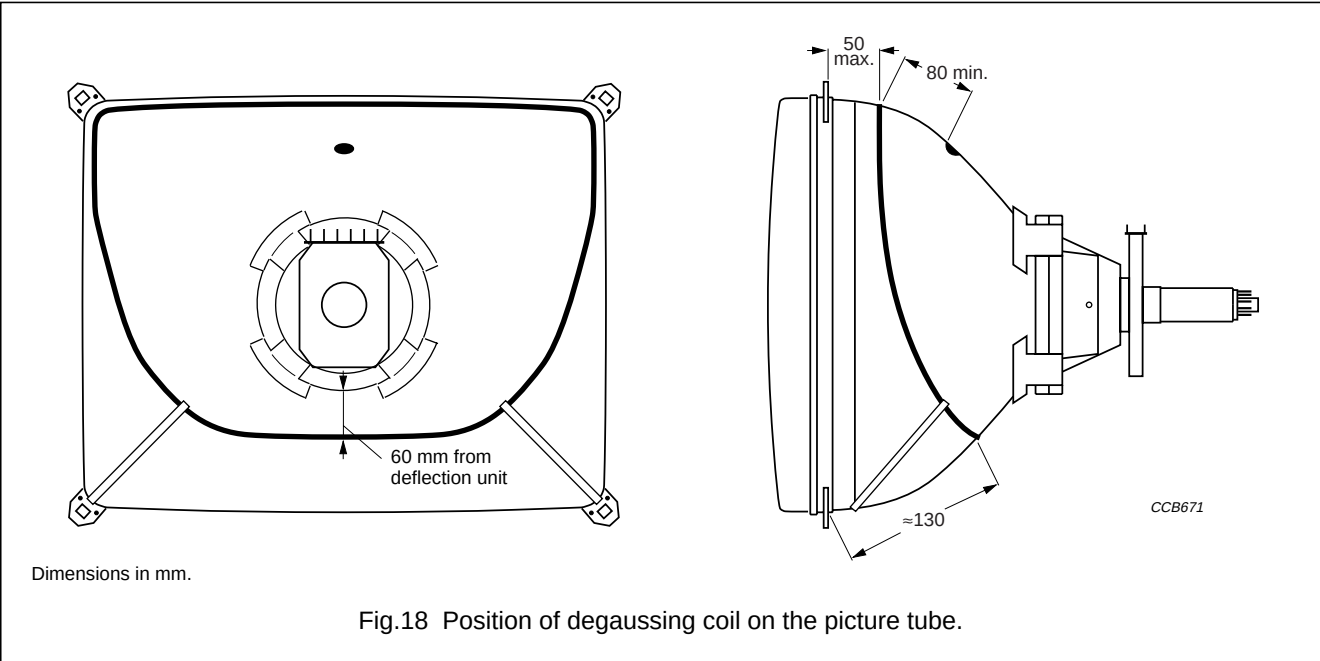
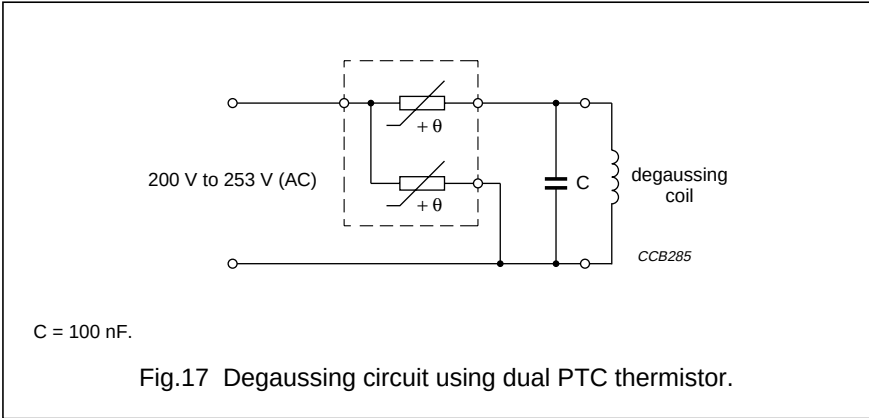
If single-phase power rectification is employed in the TV circuitry, provision should be included to prevent asymmetric distortion of the

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	139	cm
Number of turns	115	
Copper wire diameter	0.355	mm
Resistance	27.5	Ω
PTC thermistor	2322 662 96616	



**“Black Line FX”
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A51EAL135X**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.	

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. Philips customers using or selling these products for use in such applications do so at their own risk and agree to fully indemnify Philips for any damages resulting from such improper use or sale.

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NOTES

“Black Line FX”
colour picture tube

A51EAL135X

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colour picture tube

A51EAL135X

NOTES

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