INSTRUMENT CATHODE-RAY TUBE

14 cm diagonal, rectangular flat-faced direct-view charge transfer storage tube with internal graticule. The tube has vertical scan-magnification with 3 quadrupole lenses and is for wide-band (100 MHz) oscilloscopy with fast store mode and variable persistence.

QUICK REFERENCE DATA

Final accelerator voltage	$V_{g13(\ell)}$	10 kV
Minimum useful scan area		90 mm x 72 mm
Deflection coefficient		
horizontal	M_x	18,5 V/div
vertical	M_y	4,8 V/div
Writing speed		1 div/ns

OPTICAL DATA

Screen		metal backed phosphor
type		GH, colour green
persistence, non-store mode		medium-short
persistence, store mode		variable
Useful screen area		min. 90 mm x 72 mm
Useful scan area		min. 90 mm x 72 mm
Spot eccentricity		
in horizontal direction		max. 6 mm
in vertical direction		max. 8 mm
Internal graticule		type 95; see Fig. 6

HEATING

Writing section

Indirect by a.c. or d.c.*		
Heater voltage	V_f	6,3 V
Heater current	I_f	240 mA
Heating time to attain 10% of the cathode current at equilibrium conditions		approx. 5 s

Viewing section

Indirect by d.c.*		
Heater voltage	V_{FGf}	12,6 V
Heater current	I_{FGf}	240 mA
Heating time to attain 10% of the cathode current at equilibrium conditions		approx. 5 s

* Not to be connected in series with other tubes.

MECHANICAL DATA

Mounting position

The tube can be mounted in any position. It should not be supported by the base alone or near the base region, and under no circumstances should the socket be allowed to support the tube. The tags near the screen should not be subjected to mechanical stress. Avoid any force on the side contacts.

Net mass	approx.	1,3 kg
Base	14 pin, all glass	
Dimensions and connections (see also outline drawing)		
Overall length (socket included)	max.	454 mm
Faceplate dimensions	118 ± 0,5 mm x 98 ± 0,5 mm	
Accessories		
Socket (supplied with tube)	type	55572
Side contact connector (8 required)	type	55561
Small ball contact connected (6 required)	type	4022 102 21590
FOCUSING	electrostatic	note 1
DEFLECTION	double electrostatic	
x-plates	symmetrical	
y-plates	symmetrical	
Angle between x and y-traces	90 ± 1°	
Angle between y-trace and y-axis of the internal graticule	⩽ 5°	note 2

NOTES

1. Because of the use of a quadrupole lens for the magnification of the vertical deflection, two more quadrupole lenses are used for focusing. Therefore, controls for two voltages have to be provided.
2. The tube has a rotation coil, concentrically wound around the tube neck, to allow alignment of the y-trace with the mechanical y-axis of the screen. The coil has 2000 turns and a maximum resistance of 650 Ω. Under typical operating conditions, a maximum of 30 ampere-turns is required for the maximum rotation of 5°. This means the required supply is 15 mA maximum at 12 V maximum.

CAPACITANCES

x_1 to all other elements except x_2	$C_{x1(x2)}$	5,5 pF
x_2 to all other elements except x_1	$C_{x2(x1)}$	5,5 pF
y_1 to all other elements except y_2	$C_{y1(y2)}$	2,7 pF
y_2 to all other elements except y_1	$C_{y2(y1)}$	2,7 pF
x_1 to x_2	C_{x1x2}	3 pF
y_1 to y_2	C_{y1y2}	1,7 pF
g_1 to all other elements	C_{g1}	7 pF
k to all other elements	C_k	5 pF
g_{11} to all other elements	C_{g11}	80 pF
g_{12} to all other elements	C_{g12}	70 pF
g_{13} to all other elements	C_{g13}	85 pF
g_3 to all other elements	C_{g3}	17 pF
g_5 to all other elements	C_{g5}	17 pF
$g_{9\text{-}1}$ to all other elements	$C_{g9\text{-}1}$	30 pF
$g_{9\text{-}2}$ to all other elements	$C_{g9\text{-}2}$	70 pF
$g_{9\text{-}3}$ to all other elements	$C_{g9\text{-}3}$	60 pF
FGA to all other elements	C_{FGA}	20 pF
k', k'' to all other elements	$C_{k', k''}$	12 pF

DIMENSIONS AND CONNECTIONS

Dimensions in mm

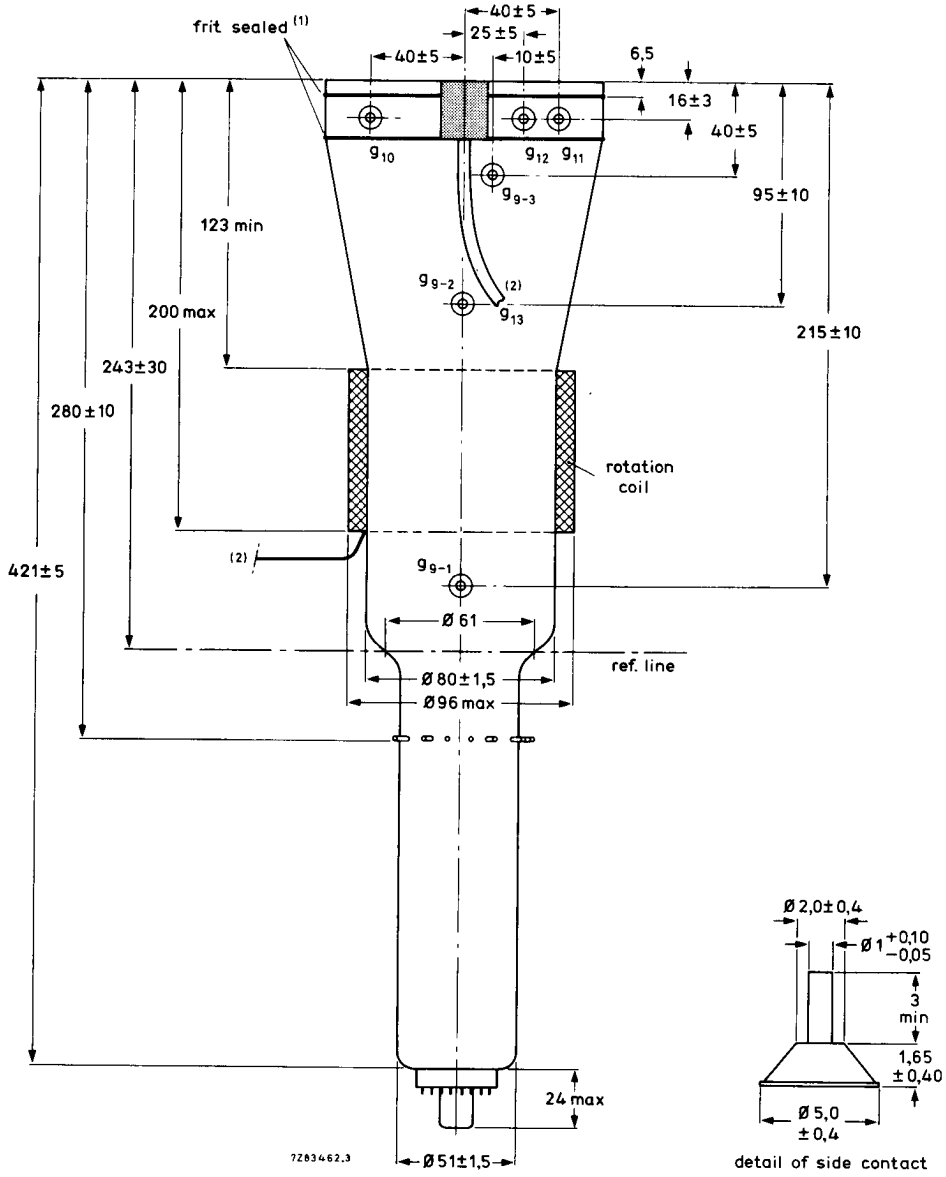

Fig. 1 Outlines

(1) Dimensions of faceplate only. The bulge at the frit seal may increase the indicated maximum dimensions by not more than 3 mm.
(2) Minimum length of cable: 350 mm.

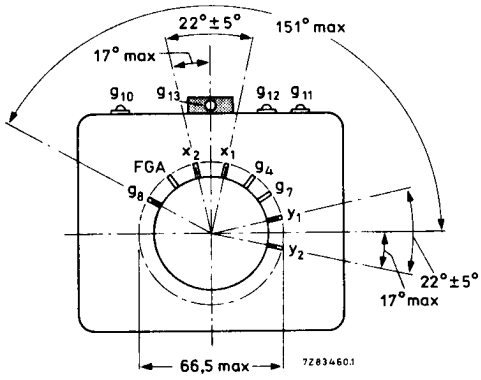

Fig. 2 Bottom view and side-contact arrangement.

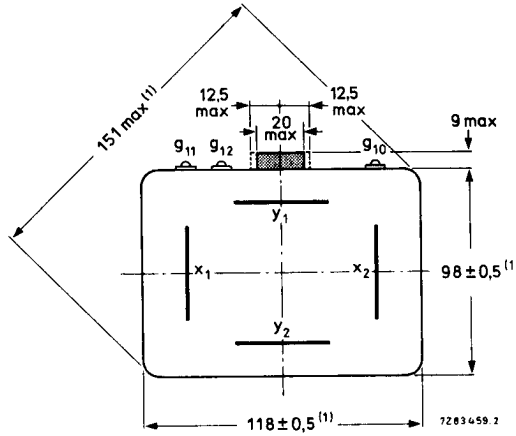

Fig. 3 Top view. For note (1) see opposite page.

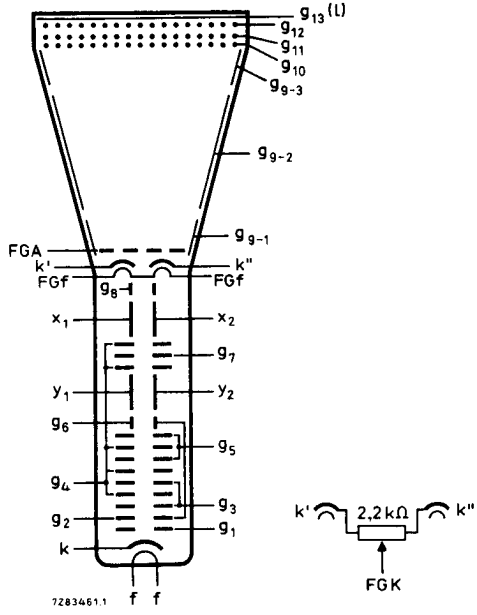

Fig. 4 Electrode configuration.

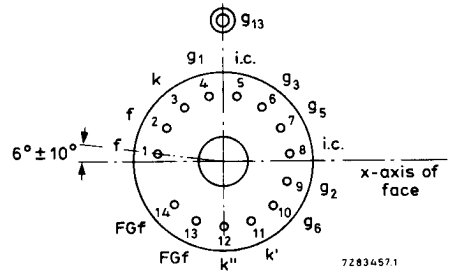

Fig. 5 Pin arrangement; bottom view.

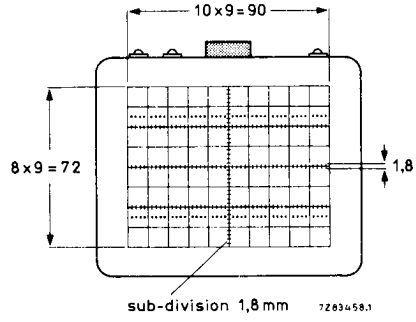

Fig. 6 Internal graticule
colour of graticule: brown-black;
line width : 0,2 mm;
dot diameter : 0,4 mm.

TYPICAL OPERATION (for notes see next pages)

Conditions

Writing section (voltages with respect to writing gun cathode k, unless otherwise stated for optimum scan magnification ≈ 1,8).

Final accelerator voltage	$V_{g13(I)}$	10 000 V	note 1
Geometry control voltage	V_{g8}	3000 ± 100 V	
Scan magnifier electrode voltage (with respect to g_2)	V_{g7}	−600 V	
Horizontal alignment electrode voltage (with respect to g_2)	V_{g6}	± 100 V	note 2
Vertical focusing electrode voltage (with respect to g_2)	V_{g5}	−860 to −1100 V	
Correction electrode voltage (with respect to g_2)	V_{g4}	200 V	note 3
Horizontal focusing electrode voltage (with respect to g_2)	V_{g3}	−1300 to −1650 V	
First accelerator voltage	V_{g2}	3000 V	
Cut-off voltage for visual extinction of focused spot	$-V_{g1}$	75 to 130 V	

Viewing section (voltages with respect to viewing gun cathode FGK, Fig. 4)

		non-store mode	variable persistance mode	fast-store mode	
Final accelerator voltage (with respect to first accelerator FGA)	$V_{g13(I)}$	7000 V	7000 V	7000 V	note 1
Backing electrode voltages (d.c.)					
front mesh	V_{g12}	−50 V			note 4
fast mesh	V_{g11}	140 V	140 V	140 V	
Collector mesh voltage (d.c.)	V_{g10}	130 V	130 V	130 V	
Collimator voltage (d.c.)					
C3	V_{g9-3}	65 V	65 V	65 V	
C2	V_{g9-2}	≈ 65 V	65 V	65 V	
C1	V_{g9-1}	30 V	30 V	30 V	
First accelerator voltage (d.c.)	V_{FGA}	20 V	20 V	20 V	
Flood gun cathode voltage (d.c.)	V_{FGK}	0 V	0 V	0 V	

The first accelerator voltage should be equal to the mean x-plate potential.

Performance

Useful scan area		min. 90 mm x 72 mm	
Deflection coefficient			
horizontal	M_x	typ. 18,5 V/div	
		max. 20,5 V/div	
vertical	M_y	typ. 4,8 V/div	
		max. 5,5 V/div	

Deviation of deflection linearity		max.	2 %	note 5
Geometry distortion		see note 6		
Grid drive for 10 μA beam current	V_d	approx.	20 V	
Grid drive for specified writing speed	V_d	max.	80 V	
Line width at the centre of the screen	l.w.		0,4 mm	note 7

Writing speed (note 8)

Variable persistence mode
just black: $\geqslant$ 250 div/ms
max. write: $\geqslant$ 2,5 div/μs

Fast-store mode
max. write: $\geqslant$ 1 div/ns

Storage viewing time (note 9)

Variable persistence mode
just black: $\geqslant$ 60 s
max. write: $\geqslant$ 15 s

Fast-store mode
max. write: $\geqslant$ 15 s

NOTES

1. These values are valid at cut-off of both flood guns and the writing gun. The H.T. unit must be capable of supplying 0,5 mA. To protect the tube against excessive surge current during erasure, an RC-network as shown in Fig. 7 must be connected in series with the screen terminal lead; the resistance of 15 to 20 MΩ includes the internal resistance of the H.T. supply.

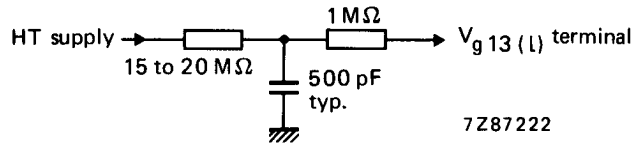

Fig. 7.

2. This voltage should be adjusted for equal brightness in the x-direction with respect to the electrical centre of the tube.
3. For minimum defocusing of vertical lines near the upper and lower edges of the scanned area this voltage should be the value indicated.
4. The indicated values concern the d.c. levels; during the erasing, preparing and transfering operation these electrodes are pulsed.
5. The sensitivity at a deflection 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.
6. A graticule, consisting of concentric rectangles of 90 mm x 72 mm and 87,8 mm x 70,5 mm is aligned with the electrical x-axis of the tube. With optimum corrections applied, 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 I_b = 10 μA (measured against x-plates).

NOTES (continued)

8. The writing speed is defined as the maximum speed at which a written trace is just visible starting from a background which is just black. The indicated value is guaranteed for the central 80% of the minimum screen area, except the outmost 3 mm of the screen. However, in any corner not more than 4 square divisions fall outside the guaranteed area. The writing speed can be increased, if some background is tolerated. Within the same area, a trace, written with the indicated value of max. write, remains just visible within the indicated storage time of max. write.

   The writing speed in max. write, with background, is defined as the maximum speed at which the written trace remains just visible within the indicated storage time.

9. The storage time in just black mode is defined as the time required for the brightness of the unwritten background to rise from zero brightness (viewing beam cut-off) to 10% of saturated brightness. At reduced intensity (by pulsing the flood beams) the storage time can be increased.

   The storage time in max. write and fast is related to the writing speed.

LIMITING VALUES (absolute maximum rating system)

Writing section (Voltages with respect to writing gun cathode k, unless otherwise stated)

Final accelerator voltage	$V_{g13(l)}$	max.	10500 V
		min.	8500 V
Geometry control voltage (with respect to g_2)	V_{g8}	max.	500 V
		min.	−500 V
Scan magnifier electrode voltage (with respect to g_2)	V_{g7}	max.	550 V
		min.	−700 V
Horizontal alignment electrode voltage (with respect to g_2)	V_{g6}	max.	500 V
		min.	−500 V
Vertical focusing electrode voltage (with respect to g_2)	V_{g5}	max.	−750 V
		min.	−1200 V
Correction electrode voltage (with respect to g_2)	V_{g4}	max.	500 V
		min.	0 V
Horizontal focusing electrode voltage (with respect to g_2)	V_{g3}	max.	−1200 V
		min.	−1800 V
First accelerator voltage	V_{g2}	max.	3500 V
		min.	2500 V
Control grid voltage			
positive	V_{g1}	max.	0 V
negative	$-V_{g1}$	max.	200 V
Cathode to heater voltage			
positive	V_{kf}	max.	125 V
negative	$-V_{kf}$	max.	125 V
Voltage between correction electrode and any deflection plate	$V_{g4/x}$	max.	500 V
	$V_{g4/y}$	max.	500 V
Grid drive, averaged over 1 ms	V_d	max.	30 V

Viewing section (voltages with respect to viewing gun cathode FGK)

Screen voltage	$V_{g13(l)}$	max.	7500 V
		min.	5500 V
Backing electrode voltage (d.c.) front mesh	V_{g12}	max.	600 V
		min.	−50 V
fast mesh	V_{g11}	max.	200 V
		min.	−50 V
Collector mesh voltage (d.c./a.c.)	V_{g10}	max.	200 V
		min.	100 V
Collimator voltages (d.c./a.c.)	$V_{g9\text{-}1;\ 9\text{-}2;\ 9\text{-}3}$	max.	150 V
		min.	0 V
First accelerator voltage	V_{FGA}	max.	100 V
		min.	0 V
Cathode to heater voltage	$V_{k'FGf}$, $V_{k''FGf}$	max.	125 V
	$-V_{k'FGf}$, $-V_{k''FGf}$	max.	125 V

OPERATING NOTES

Scan magnifier

A scan magnification $M_{sc} \approx 1{,}8$ is the best compromise between line width and sensitivity. This is obtained with $V_{g7} = -600$ V and $V_{g4} = 200$ V. Performance is tested and specified under this condition and no adjustment will be necessary for individual tubes.

Focusing is separate for horizontal and vertical directions with V_{g3} and V_{g5} respectively. Both focus settings may depend on beam current with different steepness. Although both electrodes are positive with respect to cathode, reverse current may result from secondary electrons leaving grid 3 (max. 5 μA) and grid 5 (max. 50 μA).

Normal current direction from beam interception is to be expected on the horizontal correction electrode g_6 (up to 500 μA) and, as usual, on g_2 and deflection plates.

Modes of operations

Non-store mode

For non-store operation the front mesh V_{g12} is set to -50 V with respect to FGK.

The viewing guns should not be switched off in this mode of operation since slight variations in raster geometry and deflection sensitivity might otherwise be caused. Care should be taken, especially when switching from store mode to non-store mode, that excessive writing beam current is avoided, as otherwise the storage layer may be damaged.

Variable persistence mode

The fast mesh is switched off for this operation and used as collector by setting $V_{g11} = 140$ V.

a. Static erasure

If no dynamic erasing pulses are applied the storage time is limited by the potential shift of the storage layer due to landing of positive ions.

In order to erase a stored display, V_{g12} is increased to 500 V for 100 ms and than returned to its original potential for about 500 ms; after that, an erasing pulse of positive polarity (max. 20 V) and a duration of 600 ms should be applied.

While the erasing pulse amplitude is to be adjusted with zero d.c. level for "just black", the background illumination can be changed – even with a stored signal – by varying the d.c. level for optimum contrast or maximum writing speed.

Background egality can be optimized by balancing the viewing gun cathodes by means of a potentiometer of 2,2 kΩ, proper collimator adjustment, and by increasing V_{FGA}. $V_{g9\text{-}1}$ and $V_{g9\text{-}3}$ in positive direction during erasure.

Before first installation, depending on transport conditions, demagnetization of the tube face region may be necessary.

b. Dynamic erasure

Dynamic erasure can be achieved by applying extra erasing pulses of positive polarity to the backing electrode of the front mesh (g_{12}). The amplitude of these extra pulses is equal to that of the original erasing pulse, the frequency is 120 Hz and the persistence of the display can be controlled by varying the duty factor.

Fast-store mode

For erasure in the fast mode the front mesh has to be erased first in the same way as in the variable persistence mode but separate adjustments should be foreseen.

The fast mesh is to be prepared by reducing V_{g11} from 140 V to the stabilizing level (0 to max. 20 V) during the erasing pulse on the front mesh.

After writing, at the end of the unblanking pulse, a transfer pulse (500 V, 100 ms) is to be applied on the front mesh.

During the transfer pulse, V_{g11} is further reduced about 1 V for enhanced transmission during transfer. This reduction has to be carefully adjusted for optimum contrast and writing speed.

During the whole cycle, FGA, V_g9-1 and V_g9-3 may be increased for more viewing gun current. Details on the adjustment procedure and the voltage range to be provided for can be made available.