# INSTRUMENT CATHODE-RAY TUBE

- mono accelerator
- 14 cm diagonal rectangular flat face
- internal magnetic lens system for vertical scan magnification, orthogonality, astigmatism and eccentricity correction
- quick-heating cathode
- with or without internal graticule
- flat screen edges facilitate graticule illumination
- reference points on faceplate for graticule alignment
- for inexpensive oscilloscopes 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 | $I_f$ | 0,24 A |
| 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

**Dimensions and connections** (see also outline drawing)

| | |
|---|---|
| Overall length (socket included) | ⩽ 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 on adjoining edges of the faceplate (see Fig. 4) enable the tube to be mounted accurately in the front panel, thus providing 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 |
| Mu-metal shield | 55598 |

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

If use is made of the full deflection capabilities of the tube the deflection plates will block part of the electron beam, hence a low impedance deflection plate drive is desirable.

## 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 |

## DIMENSIONS AND CONNECTIONS

Dimensions in mm

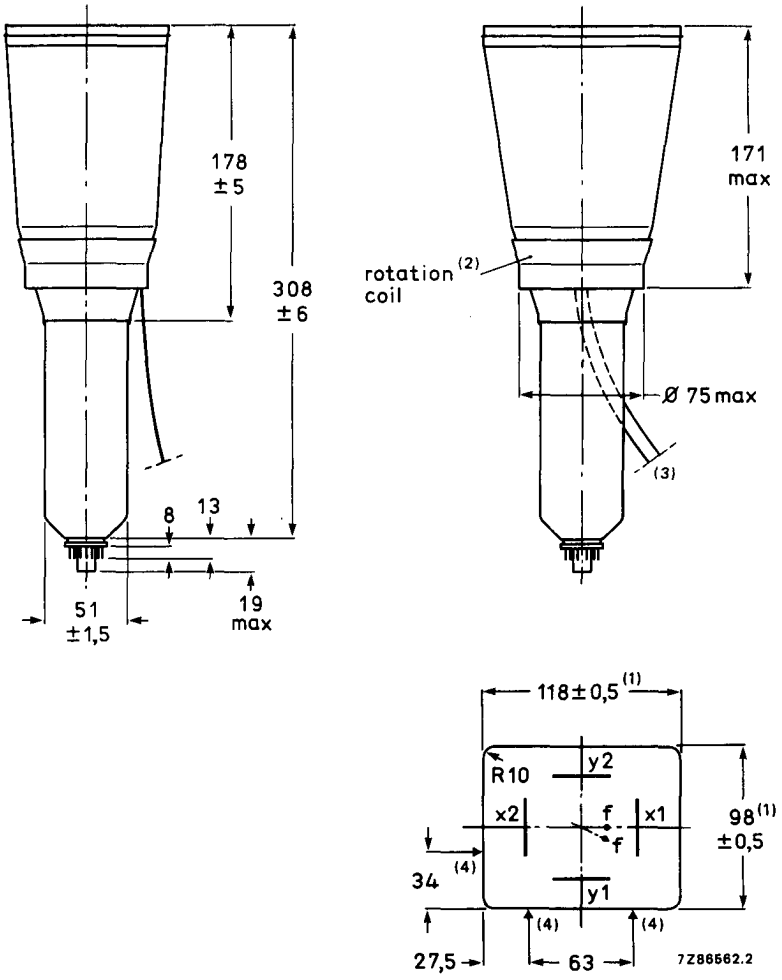


Fig. 1 Outlines.

(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 and adhesive tape.
(3) The length of the connecting leads of the rotation coil is min. 350 mm.
(4) Reference points on faceplate for graticule alignment (see Fig. 4).

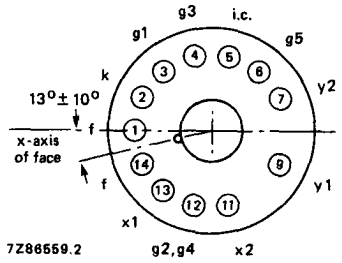


Fig. 2 Pin arrangement; bottom view.

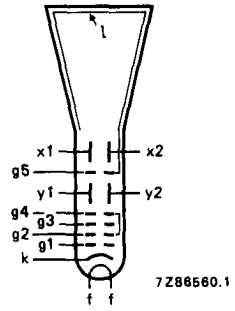


Fig. 3 Electrode configuration.

**Internal graticule**

The internal graticule is aligned with the faceplate by using the faceplate reference points, see Fig. 4. See also note 1.

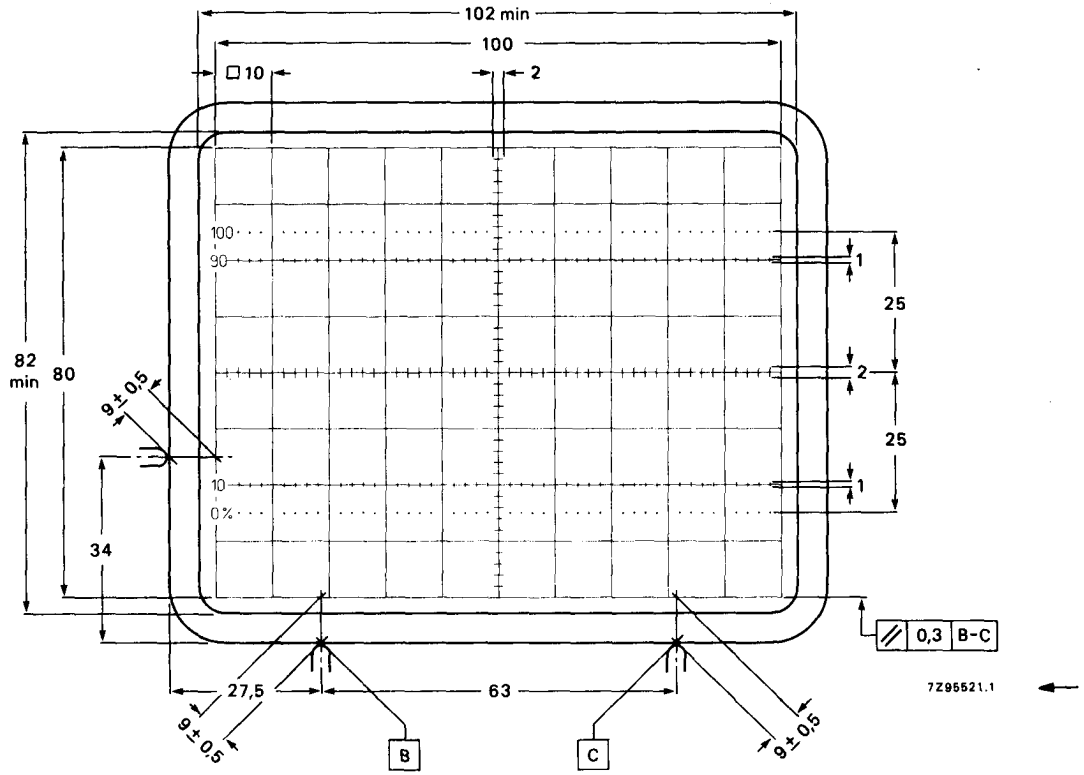


Fig. 4 Front view of tube with internal graticule, type 123.
Line thickness = 0,2 mm; dot diameter = 0,4 mm; colour: red.

**TYPICAL OPERATION** (voltages with respect to cathode)

**Conditions**

| | | | | | |
|---|---|---|---|---|---|
| Mean deflection plate potential | | | 2000 | V | note 2 |
| Shield voltage for optimum geometry | $V_{g5,(\ell)}$ | | 2000 | V | note 3 |
| Accelerator and astigmatism control voltage | $V_{g2,g4}$ | | 2000 | V | note 4 |
| Focusing 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**

| | | | | | |
|---|---|---|---|---|---|
| Deflection coefficient | | | | | |
| horizontal | $M_x$ | | 19 | V/cm | |
| | | < | 21 | V/cm | |
| vertical | $M_y$ | | 11,5 | V/cm | |
| | | < | 12 | V/cm | |
| Deviation of deflection linearity | | ⩽ | 2 | % | note 7 |
| Geometry distortion | | see note 8 | | | |
| Luminance reduction at the edges of the useful scan (100 mm x 80 mm), with respect to screen centre | | ⩽ | 30 | % | |
| Eccentricity of undeflected spot with respect to internal graticule | | | | | |
| horizontal | | ⩽ | 4 | mm | note 9 |
| vertical | | ⩽ | 2 | mm | |
| Angle between x and y-traces | | | 90° | | note 9 |
| Angle between x-trace and x-axis of the internal graticule | | ⩽ | 5° | | note 10 |
| Grid drive voltage for 10 $\mu$A screen current | $V_d$ | ≈ | 10 | V | note 6 |
| Line width | l.w. | ≈ | 0,3 | mm | note 11 |

**LIMITING VALUES** (Absolute maximum rating system)

| | | | | |
|---|---|---|---|---|
| Accelerator voltage | $V_{g2,g4}$ | max. | 2200 | V |
| Shield voltage | $V_{g5(\ell)}$ | max. | 2200 | V |
| Focusing electrode voltage | $V_{g3}$ | max. | 2200 | V |
| 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 voltage, averaged over 1 ms | $V_d$ | max. | 20 | V |
| Screen dissipation | $W_\ell$ | max. | 3 | mW/cm² |
| Control grid circuit resistance | $R_{g1}$ | max. | 1 | MΩ |

NOTES

1. As the frit seal is visible through the faceplate, and not necessarily aligned with the internal graticule, application of an external passe-partout with 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 be operated with equal mean x- and y-potentials, in order to minimize tube adjustments. Under this condition g5 can be connected to g2,g4, and 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 a separate voltage on $g_5$ (equal to mean x-potential) may be required.
3. The tube meets 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). In general 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 is to be adjusted either by the grid drive (up to 22 V) or for maximum acceptable line width. The corresponding cathode current or $I_{g2,g4}$ (up to 500 μA) depend on the cut-off voltage and 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 edges of a 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 onto the lower cone part. The coil has 1000 turns and a resistance of 185 ± 25 Ω at 20 °C, which increases by approx. 0,4%/K for rising temperature. Approx. 5 mA causes 1° trace rotation. Thus maximum required voltage is approx. 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 a beam current $I_{\ell}$ = 10 μA.

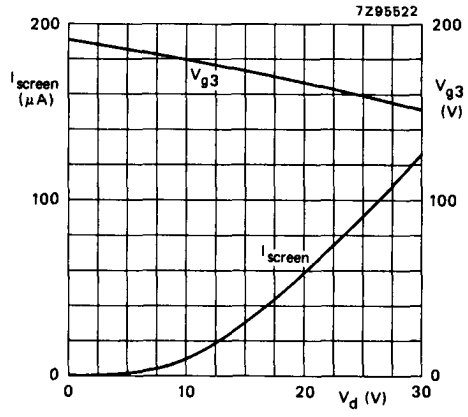


Fig. 5 Screen current ($I_{screen}$) and focusing voltage ($V_{g3}$) as a function of grid drive voltage ($V_d$); typical curves.