Electron tubes

Book T5  1988

Cathode-ray tubes
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- quality
## Cathode-Ray Tubes

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### SELECTION GUIDE CATHODE-RAY TUBES

**preferred types**

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<th>Monoaccelerator tubes</th>
<th>standard phosphor</th>
<th>display area $\text{mm}^2$</th>
<th>accelerator voltage V</th>
<th>deflection coefficient $\text{V/cm}$</th>
<th>line width $\text{mm}$</th>
<th>max. bandwidth MHz</th>
<th>heater current at 6.3 V mA</th>
<th>max. overall length mm</th>
<th>special features</th>
</tr>
</thead>
<tbody>
<tr>
<td>D7-221..</td>
<td>GY</td>
<td>60 x 36</td>
<td>1000</td>
<td>12.5 (hor.), 20 (vert.)</td>
<td>0.28</td>
<td>10</td>
<td>100**</td>
<td>225</td>
<td>low profile screen, reversed x and y plates</td>
</tr>
<tr>
<td>D7-222..</td>
<td>GY</td>
<td>60 x 36</td>
<td>1000</td>
<td>12.5 (hor.), 20 (vert.)</td>
<td>0.28</td>
<td>10</td>
<td>240</td>
<td>225</td>
<td>low profile screen, reversed x and y plates</td>
</tr>
<tr>
<td>D10-180..</td>
<td>GY</td>
<td>70 x 56</td>
<td>2000</td>
<td>36 (hor.), 23 (vert.)</td>
<td>0.2</td>
<td>25</td>
<td>240</td>
<td>240</td>
<td>dynamic deflection defocusing correction, internal magnetic correction</td>
</tr>
<tr>
<td>D10-181..</td>
<td>GY</td>
<td>70 x 56</td>
<td>2000</td>
<td>36 (hor.), 23 (vert.)</td>
<td>0.2</td>
<td>25</td>
<td>100**</td>
<td>240</td>
<td>dynamic deflection defocusing correction, internal magnetic correction</td>
</tr>
<tr>
<td>D12-130.. /119</td>
<td>GY</td>
<td>80 x 64</td>
<td>2000</td>
<td>32 (hor.), 21 (vert.)</td>
<td>0.2</td>
<td>25</td>
<td>100**</td>
<td>257</td>
<td>internal magnetic correction</td>
</tr>
<tr>
<td>D12-160.. /119</td>
<td>GY</td>
<td>80 x 64</td>
<td>2000</td>
<td>23.8 (hor.), 13.8 (vert.)</td>
<td>0.25</td>
<td>25</td>
<td>100**</td>
<td>292</td>
<td>internal magnetic correction</td>
</tr>
<tr>
<td>D14-363.. /123</td>
<td>GY</td>
<td>100 x 80</td>
<td>2000</td>
<td>19 (hor.), 11.5 (vert.)</td>
<td>0.30</td>
<td>25</td>
<td>100**</td>
<td>333</td>
<td>vertical scan magnification, internal magnetic correction</td>
</tr>
<tr>
<td>D14-364.. /123</td>
<td>GY</td>
<td>100 x 80</td>
<td>2000</td>
<td>19 (hor.), 11.5 (vert.)</td>
<td>0.30</td>
<td>25</td>
<td>240</td>
<td>333</td>
<td>vertical scan magnification, internal magnetic correction</td>
</tr>
<tr>
<td>D18-180.. /127</td>
<td>GY</td>
<td>120 x 96</td>
<td>2000</td>
<td>21 (hor.), 15 (vert.)</td>
<td>0.30</td>
<td>25</td>
<td>100**</td>
<td>324</td>
<td>internal magnetic correction, dynamic deflection defocusing</td>
</tr>
</tbody>
</table>

* For the blanks in the type numbers insert phosphor code.
** Low-power heater.
### Post-deflection accelerator tubes

<table>
<thead>
<tr>
<th>type*</th>
<th>standard phosphor</th>
<th>display area mm²</th>
<th>first analyzer voltage kV</th>
<th>final analyzer voltage kV</th>
<th>deflection coefficient V/cm hor. vert.</th>
<th>line width mm</th>
<th>max. bandwidth MHz</th>
<th>heater current at 6.3 V mA</th>
<th>max. overall length mm</th>
<th>special features</th>
</tr>
</thead>
<tbody>
<tr>
<td>D12-150. /119</td>
<td>GH</td>
<td>80 x 64</td>
<td>1.5</td>
<td>10</td>
<td>5,8, 3</td>
<td>0,25</td>
<td>100</td>
<td>100**</td>
<td>299</td>
<td>internal magnetic correction</td>
</tr>
<tr>
<td>D14-371. /123</td>
<td>GH</td>
<td>100 x 80</td>
<td>2.2</td>
<td>16.5</td>
<td>8.3, 4</td>
<td>0,33</td>
<td>100</td>
<td>100**</td>
<td>338</td>
<td>internal magnetic correction</td>
</tr>
<tr>
<td>D14-372. /123</td>
<td>GH</td>
<td>100 x 80</td>
<td>2.2</td>
<td>16.5</td>
<td>8.3, 4</td>
<td>0,33</td>
<td>100</td>
<td>240</td>
<td>338</td>
<td>internal magnetic correction</td>
</tr>
<tr>
<td>D14-381. /123</td>
<td>GH</td>
<td>100 x 80</td>
<td>2.2</td>
<td>16.5</td>
<td>8.3, 4</td>
<td>0,33</td>
<td>150</td>
<td>100**</td>
<td>338</td>
<td>internal magnetic correction, side contacts</td>
</tr>
<tr>
<td>D14-382. /123</td>
<td>GH</td>
<td>100 x 80</td>
<td>2.2</td>
<td>16.5</td>
<td>8.3, 4</td>
<td>0,33</td>
<td>150</td>
<td>240</td>
<td>338</td>
<td>internal magnetic correction, side contacts</td>
</tr>
<tr>
<td>D14-400. /123</td>
<td>GH</td>
<td>100 x 80</td>
<td>3</td>
<td>24</td>
<td>7,3, 2</td>
<td>0,37</td>
<td>500</td>
<td>240</td>
<td>419</td>
<td>helical y-deflection, internal magnetic correction</td>
</tr>
<tr>
<td>D18-190. /127</td>
<td>GH</td>
<td>120 x 96</td>
<td>2</td>
<td>16</td>
<td>6,4, 3</td>
<td>0,35</td>
<td>100</td>
<td>240</td>
<td>348</td>
<td>internal magnetic correction</td>
</tr>
</tbody>
</table>

* For the blanks in the type numbers insert the phosphor code.
** Low-power heater.

### Direct-view storage tubes

<table>
<thead>
<tr>
<th>type</th>
<th>display area mm²</th>
<th>final accelerator voltage kV</th>
<th>writing speed div/µs</th>
<th>storage viewing times</th>
<th>deflection coefficient V/cm hor. vert.</th>
<th>line width mm</th>
<th>heater current at 6.3 V mA</th>
<th>max. overall length mm</th>
<th>special features</th>
</tr>
</thead>
<tbody>
<tr>
<td>L14-140GH/95</td>
<td>90 x 72</td>
<td>10</td>
<td>1000*</td>
<td>≥ 15*</td>
<td>18,5, 4</td>
<td>0,4</td>
<td>240</td>
<td>454</td>
<td>charge transfer, vertical-scan magnification with quadruple lenses</td>
</tr>
<tr>
<td>L14-150GH/55</td>
<td>90 x 72</td>
<td>8.5</td>
<td>2.5</td>
<td>≥ 90</td>
<td>9,5, 4</td>
<td>0.35</td>
<td>240</td>
<td>452</td>
<td></td>
</tr>
</tbody>
</table>

* In fast storage mode.
### Monitor and display tubes

<table>
<thead>
<tr>
<th>type*</th>
<th>standard phosphor</th>
<th>display area $\text{mm}^2$</th>
<th>minimum resolution</th>
<th>deflection angle</th>
<th>neck diameter $\text{mm}$</th>
<th>heater current at 6.3 V mA</th>
<th>max. overall length $\text{mm}$</th>
<th>special features</th>
</tr>
</thead>
<tbody>
<tr>
<td>M17-142..</td>
<td>WE</td>
<td>124 x 93</td>
<td>1050 lines</td>
<td>70°</td>
<td>28</td>
<td>240</td>
<td>234</td>
<td>electrostatic focusing</td>
</tr>
<tr>
<td>M17-143..</td>
<td>WE</td>
<td>124 x 93</td>
<td>1050 lines</td>
<td>70°</td>
<td>28</td>
<td>240</td>
<td>240</td>
<td>electrostatic focusing, bonded faceplate, metal-mounting band</td>
</tr>
<tr>
<td>M17-144..</td>
<td>WE</td>
<td>124 x 93</td>
<td>1050 lines</td>
<td>70°</td>
<td>28</td>
<td>240</td>
<td>234</td>
<td>electrostatic focusing, special version for photography</td>
</tr>
<tr>
<td>M17-145..</td>
<td>WE</td>
<td>124 x 93</td>
<td>1050 lines</td>
<td>70°</td>
<td>28</td>
<td>240</td>
<td>240</td>
<td>electrostatic focusing, bonded faceplate, metal-mounting band, special version for photography</td>
</tr>
<tr>
<td>M17-220..</td>
<td>WE</td>
<td>124 x 93</td>
<td>1800 lines</td>
<td>70°</td>
<td>28</td>
<td>240</td>
<td>269</td>
<td>electrostatic focusing, high resolution</td>
</tr>
<tr>
<td>M38-200..</td>
<td>WA, WE</td>
<td>200 x 270</td>
<td>1800 lines</td>
<td>70°</td>
<td>37</td>
<td>190</td>
<td>484.5</td>
<td>electrostatic focusing, high resolution</td>
</tr>
<tr>
<td>M38-201..**</td>
<td>WA, WE</td>
<td>290 x 225</td>
<td>1800 lines</td>
<td>70°</td>
<td>37</td>
<td>190</td>
<td>484.5</td>
<td>electrostatic focusing, very high resolution</td>
</tr>
</tbody>
</table>

* For the blanks in the type numbers insert the phosphor code.

** Includes adjusted deflection coil AT1991.

### Flying spot scanner tube

<table>
<thead>
<tr>
<th>type*</th>
<th>standard phosphor</th>
<th>useful screen diameter $\text{mm}$</th>
<th>accelerator voltage $\text{kV}$</th>
<th>resolution lines</th>
<th>deflection angle $^\circ$</th>
<th>heater current at 6.3 V mA mA</th>
<th>special features</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q13-110..</td>
<td>GU</td>
<td>108</td>
<td>25</td>
<td>1000</td>
<td>40°</td>
<td>300</td>
<td>magnetic deflection and focusing</td>
</tr>
</tbody>
</table>

* For the blanks in the type number insert the phosphor code.
GENERAL
LIST OF SYMBOLS

Symbols denoting electrodes and electrode connections

f  Heater
k  Cathode
g  Grid
    Grids are distinguished by means of an additional numeral;
    the electrode nearest to the cathode having the lowest number
x1, x2  Deflection plates intended for deflection in horizontal direction
y1, y2  Deflection plates intended for deflection in vertical direction
    Sectioned deflection plates are indicated by an additional
decimal e.g. y1 . 1 y1 . 2 and y2 . 1 y2 . 2
m  External conductive coating
l  Fluorescent screen
i.c.  Tube pin which must not be connected externally
n.c.  Tube pin which may be connected externally

Symbols denoting voltages

V  Symbol for voltage, followed by an index denoting the
    relevant electrode
Vf  Heater voltage (r.m.s. value)
Vp  Peak value of a voltage
V_{(p-p)}  Peak-to-peak value of a voltage

Symbols denoting currents

I  Symbol for current followed by an index denoting the
    relevant electrode
If  Heater current (r.m.s. value)

Symbols denoting powers

Wl  Dissipation of the fluorescent screen
Wg  Grid dissipation

Symbols denoting capacitances

See IEC Publication 100.

Symbols denoting resistances

R  Symbol for resistance followed by an index for the relevant
    electrode pair. When only one index is given the second
    electrode is the cathode
    When R is replaced by Z the “resistance” should read “impedance”
### Symbols denoting various quantities

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
<td>Luminance</td>
</tr>
<tr>
<td>f</td>
<td>Frequency</td>
</tr>
<tr>
<td>H</td>
<td>Magnetic field strength</td>
</tr>
<tr>
<td>M</td>
<td>Deflection coefficient</td>
</tr>
<tr>
<td>M_{sc}</td>
<td>Scan magnification</td>
</tr>
<tr>
<td>B</td>
<td>Bandwidth</td>
</tr>
<tr>
<td>l.w.</td>
<td>Line width</td>
</tr>
<tr>
<td>e</td>
<td>Eccentricity</td>
</tr>
<tr>
<td>t_p</td>
<td>Pulse duration</td>
</tr>
</tbody>
</table>
OPERATIONAL RECOMMENDATIONS

GENERAL
Unless otherwise stated the published data are typical values.

TYPICAL OPERATION
Under this heading in the data sheets, the conditions are given which result in the specified performance. This performance represents the best compromise for the intended applications of the tube.

LIMITING VALUES
Unless otherwise stated the tubes are rated according to the absolute maximum rating system.
Limiting values are in accordance with the applicable rating system as defined by IEC publication 134. Reference may be made to one of the following 3 rating systems.

Absolute maximum rating system. Absolute maximum ratings are limiting values of operating and environmental conditions applicable to any electronic device of a specified type as defined by its published data, and should not be exceeded under the worst probable conditions. These values are chosen by the device manufacturer to provide acceptable serviceability of the device, taking no responsibility for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the device under consideration and of all other electronic devices in the equipment.

The equipment manufacturer should design so that, initially and throughout life, no absolute maximum value for the intended service is exceeded with any device under the worst probable operating conditions with respect to supply voltage variation, equipment components spread and variation, equipment control adjustment, load variations, signal variation, environmental conditions, and spread or variations in characteristics of the device under consideration and of all other electronic devices in the equipment.

Design-maximum rating system. Design-maximum ratings are limiting values of operating and environmental conditions applicable to a bogey electronic device* of a specified type as defined by its published data, and should not be exceeded under the worst probable conditions.

These values are chosen by the device manufacturer to provide acceptable serviceability of the device, taking responsibility for the effects of changes in operating conditions due to variations in the characteristics of the electronic device under consideration.

The equipment manufacturer should design so that, initially and throughout life, no design-maximum value for the intended service is exceeded with a bogey device under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, variation in characteristics of all other devices in the equipment, equipment control adjustment, load variation, signal variation and environmental conditions.

* A bogey tube is a tube whose characteristics have the published nominal values for the type. A bogey tube for any particular application can be obtained by considering only those characteristics which are directly related to the application.
Design-centre rating system. Design-centre ratings are limiting values of operating and environmental conditions applicable to a bogey electronic device* of a specified type as defined by its published data, and should not be exceeded under average conditions.

These values are chosen by the device manufacturer to provide acceptable serviceability of the device in average applications, taking responsibility for normal changes in operating conditions due to rated supply-voltage variation, equipment component spread and variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations or spread in the characteristics of all electronic devices.

The equipment manufacturer should design so that, initially, no design-centre value for the intended service is exceeded with a bogey electronic device* in equipment operating at the stated normal supply voltage.

If the tube data specify limiting values according to more than one rating system the circuit has to be designed so that none of these limiting values is exceeded under the relevant conditions.

In addition to the limiting values given in the individual data sheets the directives in the following paragraphs should be observed.

HEATER SUPPLY
The heater voltage must be within ± 7% of the nominal value when the supply voltage is at its nominal value, and when a tube having the published heater characteristics is employed. This figure is permissible only if the voltage variation is dependent upon more than one factor. In these circumstances the total tolerance may be taken as the square root of the sum of the squares of the individual deviations arising from the effect of the tolerances of the separate factors, providing none of these deviations exceeds ± 5%. Should the voltage variation depend on one factor only, the voltage variation must not exceed ± 5%.

For maximum cathode life it is recommended that the heater supply be stabilized at the nominal heater voltage. Any deviation from this heater voltage has a detrimental effect on tube performance and life, and should therefore be kept to a minimum. Such deviations may be caused by:

• mains voltage fluctuations;
• spread in the characteristics of components such as transformers, resistors, capacitors, etc.;
• spread in circuit adjustments;
• operational variations.

Cathode-ray tubes with a quick-heating cathode should not be used in series with other tubes.

CATHODE TO HEATER VOLTAGE
The voltage between cathode and heater should be as low as possible and never exceed the limiting values given in the data sheets of the individual tubes. Operation with the heater positive with respect to the cathode is not recommended.

In order to avoid excessive hum the a.c. component of the heater to cathode voltage should be as low as possible and never exceed 20 V r.m.s. (mains frequency). A d.c. connection should always be present between heater and cathode. Unless otherwise specified the maximum resistance should not exceed 1 MΩ; the maximum impedance at mains frequency should be less than 100 kΩ.

INTERMEDIATE ELECTRODES (between cathode and final accelerator)
In no circumstances should the tube be operated without a d.c. connection between each electrode and the cathode. The total effective impedance between each electrode and the cathode should be as low as possible and never exceed the published maximum value.

* A bogey tube is a tube whose characteristics have the published nominal values for the type. A bogey tube for any particular application can be obtained by considering only those characteristics which are directly related to the application.
ELECTRODE VOLTAGES

The reference point for electrode voltages is the cathode. For cathode drive service the reference point is grid 1.

Grid cut-off voltages

Values are given for the limits of grid cut-off voltage at the specified first accelerator voltage. The brightness control voltage should be arranged so that it can handle any tube within the limits shown, at the appropriate first accelerator voltage.

First accelerator voltage

The first accelerator electrode of a so-called unipotential lens provides independent focus and brightness controls by applying a fixed voltage. Care should be taken not to exceed the maximum and minimum limits for reasons of reliability and performance.

Focusing voltage

The focusing voltage \(V_{g3}\) should be adjusted to optimum spot size; the voltage may depend on the beam current.
For automatic pre-adjustment (autofocus) of oscilloscope tubes, \(\Delta V_{g3}\) should be derived from the grid drive.

Astigmatism control voltage

To achieve optimum performance under all conditions it is desirable to apply a voltage for control of astigmatism (a difference in potential of this electrode and the \(y\) plates). The required range to cover any tube is given in the relevant data.

Deflection plate shield voltage

It is essential that the deflection plate shield voltage equals the mean \(y\) plate voltage.

Geometry control voltage

By varying the potential of the geometry control electrode, the necessary range of which is given in the relevant data, the occurrence of pin-cushion and barrel-pattern distortion can be controlled.

Deflection voltages

For optimum performance it is essential that true symmetrical voltages are applied. It should further be noted that the mean \(x\) and \(y\)-plate potentials must be equal. Moreover the deflection plate shield voltage, the mean astigmatism control voltage, if applicable the mean beam centring voltage and the geometry control voltage should also be equal to the mean \(x\) and \(y\)-plate potentials. If use is made of the full deflection capabilities of the tube, the deflection plates will intercept part of the electron beam near the edge of the scan. Therefore a low impedance deflection plate drive is necessary. (See also ELECTRODE CURRENTS AND CIRCUIT IMPEDANCES on the next page.)
Raster distortion and its determination

Limits of raster distortion are given for most tubes.

A graticule, consisting of concentric rectangles is aligned with the electrical x-axis of the tube. The edges of a raster will fall between these rectangles with optimum correction potentials applied.

Measuring procedure:
- Shift the x-trace to the centre of the graticule.
- Align horizontal centre line of graticule with the centre line of the x-trace.
- Shift x-trace vertically between upper and lower horizontal lines of graticule; the centre of the x-trace now will not fall outside the area bounded by the horizontal graticule lines.
- Without moving the graticule, switch to a vertical trace and shift this trace horizontally (left and right) between the pairs of vertical lines of the graticule; the centre of the y-trace will not fall outside the area bounded by the vertical graticule lines.
- Focus and astigmatism will be adjusted for optimum performance.
- Pattern geometry correction will be adjusted for optimum performance in the sense of minimizing simultaneously the deviation of the centre of x and y-trace respectively.

Linearity

Unless otherwise stated the linearity is defined as the sensitivity at a deflection of 75% of the useful scan with respect to deviations from the sensitivity at a deflection of 25% of the useful scan. These sensitivities will not differ by more than the indicated value.

Post deflection shield voltage

In order to optimize contrast in mesh tubes a fixed negative voltage with respect to the geometry control voltage should be applied. The range is given in the data.

Final accelerator voltage

Tubes with PDA are designed for a given range of final accelerator voltage to first accelerator voltage ratio. Operation at higher or lower ratios may result in changes in deflection uniformity, pattern distortion and useful scan.

High tension supply

In order to avoid damage to the screen it is important that a deflection voltage, e.g. the time base voltage, is applied prior to the high tension.

ELECTRODE CURRENTS AND CIRCUIT IMPEDANCES

In each electrode currents caused by interception of a part of the electron beam, leakage or secondary emission, may occur in both directions. For oscilloscope tubes currents up to 10 μA can be expected in the focusing electrode and the deflection plates. In addition, if use is made of the full deflection capabilities, each deflection plate may intercept up to 50% of the beam current.

For oscilloscope tubes with beam-limiting apertures, the grid 2 and/or grid 4 circuit impedance should be less than 10 kΩ.

For all tubes the control grid circuit resistance should be less than 1 MΩ.

CAPACITANCES

Unless otherwise stated the values given are nominal values measured at the contacts of a cold tube. The contacts and measuring leads are screened.
LINE WIDTH
The line width is measured with the shrinking raster method. Focusing and astigmatism voltages should be adjusted to minimize the horizontal and vertical trace widths simultaneously at the screen centre. The raster width should be reduced until the line structure is just discernible. This raster width, divided by the number of lines in the display, is the measure of the line width.

USEFUL SCREEN AREA (see tube alignment procedure)
This is the area on the inner side of the faceplate which is provided with phosphor and thus visible from the outside.

USEFUL SCAN AREA
This is the part of the useful screen area in which the specified performance applies.

LUMINESCENT SCREEN
To prevent permanent screen damage, care should be taken:
- not to operate the tube with a stationary picture at high beam currents for extended periods;
- not to operate the tube with a stationary or slowly moving spot except at extremely low beam currents.

MOUNTING
Unless otherwise stated the tubes can be mounted in any position. However, a tube 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 tube socket should not be rigidly mounted but should have flexible leads and be allowed to move freely. The mass of the mating socket with circuitry should not be more than 100 g; maximum permissible torque is 40 mNm.

Shielding
Oscilloscope tubes need a magnetic shielding for proper operation. Especially for types with an internal permanent magnetic lens system (IMC), a magnetic induction at the tube neck greater than 0,02 T (200 gauss), which corresponds to a magnetic field strength of 1,6 x 10^4 A/m, must be avoided.

HANDLING
Handling (or destroying) tubes should be done by qualified personnel.

The tubes are evacuated, which implies that mechanical damage must be avoided; care should be taken not to scratch or knock any part of the tube.

Remember when replacing or servicing a tube that a residual electrical charge may be carried by the final accelerator contact and also the external coating if not earthed. Before removing the tube from the equipment, earth the external coating and short the final accelerator contact to the coating.
TUBE ALIGNMENT PROCEDURE

FACEPLATE REFERENCE SYSTEM
The external surface of the faceplate defines the reference plane P.
Positioning of the faceplate is realized by accurate alignment of 3 reference points A, B and C on the
adjacent sides X and Y, at a distance h behind plane P (see Figs 1 and 2).
The three reference points are realized by 3 bolts touching the faceplate and having a circular flat
surface of 2 mm diameter, centred at distance h behind the plane P (see Fig. 2).

Fig. 1 Faceplate reference system (front view).

Fig. 2 Realization of reference points.
The centre of the faceplate is defined as the geometrical centre of the nominal rectangle of the faceplate aligned with respect to the reference points, that is, a point in plane P at distances g and j equal to one half of the nominal length and width of the faceplate (refer to Fig. 1).

The tube axis is defined as the line normal to plane P and through the centre of the faceplate. This axis serves as reference for bulb and neck alignment.

Table 1 Reference data for rectangular flat faced tubes

<table>
<thead>
<tr>
<th>tube size cm</th>
<th>X** mm</th>
<th>Y** mm</th>
<th>d mm</th>
<th>e mm</th>
<th>f mm</th>
<th>g mm</th>
<th>j mm</th>
<th>h mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>70</td>
<td>46,5</td>
<td>15</td>
<td>15</td>
<td>40</td>
<td>35</td>
<td>23,25</td>
<td>1,0</td>
</tr>
<tr>
<td>10</td>
<td>82</td>
<td>69</td>
<td>25</td>
<td>16</td>
<td>50</td>
<td>41</td>
<td>34,5</td>
<td>1,0</td>
</tr>
<tr>
<td>12</td>
<td>98</td>
<td>82 (86)*</td>
<td>27</td>
<td>24</td>
<td>50</td>
<td>49</td>
<td>41 (43)*</td>
<td>2,0</td>
</tr>
<tr>
<td>14</td>
<td>118</td>
<td>98</td>
<td>34</td>
<td>27,5</td>
<td>63</td>
<td>59</td>
<td>49</td>
<td>3,25</td>
</tr>
<tr>
<td>18</td>
<td>142</td>
<td>118</td>
<td>35</td>
<td>21,5</td>
<td>100</td>
<td>71</td>
<td>59</td>
<td>3,25</td>
</tr>
</tbody>
</table>

* values in brackets are for D12·120.../...
** values given in these columns are nominal

USEFUL SCREEN AREA

The useful screen is that part of the inner side of the faceplate which is covered with phosphor and visible from outside (see note 1).

The useful screen area is a rectangle with minimum side length x and y, of which the corners are rounded off by 90° of a circle with typical radius r (refer to Table 2 and Fig. 3).

This rectangle is not necessarily aligned with the faceplate.

Fig. 3 Useful screen area.
### Table 2 Useful screen area (not aligned; see note 2)

<table>
<thead>
<tr>
<th>Tube size cm</th>
<th>x (minimum) mm</th>
<th>y (minimum) mm</th>
<th>r (typical) mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>70</td>
<td>56</td>
<td>4</td>
</tr>
<tr>
<td>12</td>
<td>84</td>
<td>68</td>
<td>5</td>
</tr>
<tr>
<td>14</td>
<td>104</td>
<td>84</td>
<td>6</td>
</tr>
<tr>
<td>18</td>
<td>125</td>
<td>101</td>
<td>6</td>
</tr>
</tbody>
</table>

### Useful Screen Area (aligned to faceplate)

The aligned useful screen area is a rectangle with side length x and y, and corner radius r, positioned at specified distances a, b and c from the reference points on the faceplate (refer to Table 3 and Fig. 4).

![Diagram of useful screen area](image)

**Fig. 4 Useful screen area (aligned to faceplate).**

### Table 3 Useful screen area (aligned to faceplate)

<table>
<thead>
<tr>
<th>Tube size cm</th>
<th>x mm</th>
<th>y mm</th>
<th>a mm</th>
<th>b mm</th>
<th>c mm</th>
<th>r (typical) mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>69</td>
<td>55</td>
<td>6,5</td>
<td>7</td>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>12</td>
<td>82</td>
<td>66</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>5</td>
</tr>
<tr>
<td>14</td>
<td>102</td>
<td>82</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>6</td>
</tr>
<tr>
<td>18</td>
<td>124</td>
<td>100</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>6</td>
</tr>
</tbody>
</table>
INTERNAL GRATICULE ALIGNMENT

Internal graticules will be aligned by using the faceplate reference system. Unless otherwise specified the tolerances as given in table 4 are applicable. For tubes with internal graticule, the graticule serves as reference for electrical alignment and useful screen area, in particular for the latter, a margin of width \( w \) and corner radius \( r \) may be specified as being useful screen area around the graticule.

![Diagram of graticule alignment]

**Table 4** Standard graticule alignment (see note 3)

<table>
<thead>
<tr>
<th>screen size cm</th>
<th>graticule size mm</th>
<th>( a' ) mm</th>
<th>( b' ) mm</th>
<th>( c' ) mm</th>
<th>( b' - c' ) mm</th>
<th>( r ) (typ.) mm</th>
<th>( w ) (min.) mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>68 x 54,4</td>
<td>7,0 ± 0,4</td>
<td>7,3 ± 0,4</td>
<td>7,3 ± 0,4</td>
<td>0,25*</td>
<td>4</td>
<td>0,5</td>
</tr>
<tr>
<td>12</td>
<td>80 x 64</td>
<td>9,0 ± 0,5</td>
<td>9,0 ± 0,5</td>
<td>9,0 ± 0,5</td>
<td>0,25*</td>
<td>5</td>
<td>1,0</td>
</tr>
<tr>
<td>14</td>
<td>100 x 80</td>
<td>9,0 ± 0,5</td>
<td>9,0 ± 0,5</td>
<td>9,0 ± 0,5</td>
<td>0,30*</td>
<td>6</td>
<td>1,0</td>
</tr>
<tr>
<td>18</td>
<td>120 x 96</td>
<td>11,0 ± 0,5</td>
<td>11,0 ± 0,5</td>
<td>11,0 ± 0,5</td>
<td>0,35*</td>
<td>6</td>
<td>2,0</td>
</tr>
</tbody>
</table>

* The resultant values of \( b' - c' \) are maximum permissible deviations.
BULB AND NECK ALIGNMENT

Tolerances for bulb and neck alignment are specified in the plane P', at distance z from, and parallel to, the surface plane P of the faceplate. With the exception of the assemblies listed in Table 6, z is approximately 50 mm less than the nominal tube length including the socket (refer to Table 5 and Fig. 6).

Within plane P' the geometrical centre of the neck diameter will be within a circle of radius e' ("eccentricity") around the tube axis, as defined by the faceplate reference system.

Tubes with standard 51 mm diameter neck will fit into a circle of radius r' = e' + 26 mm, concentric with above axis and within plane P'.

![Fig. 6 Bulb and neck alignment.](image)

<table>
<thead>
<tr>
<th>Tube size (cm)</th>
<th>z (mm)</th>
<th>e' (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>L-50</td>
<td>1,7</td>
</tr>
<tr>
<td>12</td>
<td>L-50</td>
<td>1,3</td>
</tr>
<tr>
<td>14</td>
<td>L-50</td>
<td>1,1</td>
</tr>
<tr>
<td>18</td>
<td>L-50</td>
<td>1,3</td>
</tr>
</tbody>
</table>

Where:

L = typical length of the tubes, socket included (see data sheets for values).
e' = is expressed as a percentage of the typical seated height L of the tube (see note 5).
Table 6  Bulb and neck alignment (see note 4)

<table>
<thead>
<tr>
<th>type family</th>
<th>z  mm</th>
<th>e' mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>D7-22</td>
<td>173</td>
<td>2.2</td>
</tr>
<tr>
<td>L14-131</td>
<td>391</td>
<td>4.2</td>
</tr>
<tr>
<td>L14-140</td>
<td>391</td>
<td>4.2</td>
</tr>
<tr>
<td>L14-150</td>
<td>398</td>
<td>4.2</td>
</tr>
</tbody>
</table>

NOTES
1. The useful screen may be larger than the useful scan, and that its area is defined as projected to the outside of the faceplate so that parallax is excluded.
2. The data for useful screen area (not aligned) as given in Table 2, is not valid for storage tubes, which includes the following types: L14-111GH/55, L14-131GH/55, L14-140GH/95 and L14-150GH/95.
3. Some special graticules have deviating dimensions, in this event table 4 is not valid.
4. The tables cover all tolerances of both tilt and displacement of faceplate-cone-neck assembly.
   The cone is sealed to the faceplate to "best visual fit" in accordance with overall tube dimensions and useful screen.
5. Seated height is the sealing-in length, that is, the distance of screen to sealing.
# PHOTOMETRIC UNITS

### S.I. photometric units

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Symbol</th>
<th>S.I. Unit</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Luminous intensity</td>
<td>I</td>
<td>cd (candela)</td>
<td></td>
</tr>
<tr>
<td>Luminous flux</td>
<td>( \phi )</td>
<td>lm (lumen)</td>
<td></td>
</tr>
<tr>
<td>Quantity of light</td>
<td>Q</td>
<td>lm \cdot s</td>
<td></td>
</tr>
<tr>
<td>Luminance</td>
<td>L</td>
<td>cd/m(^2)</td>
<td>1 cd/m(^2) = 1 nit</td>
</tr>
<tr>
<td>Luminous exitance</td>
<td>M</td>
<td>lm/m(^2)</td>
<td>formerly luminous emittance</td>
</tr>
<tr>
<td>Illuminance</td>
<td>E</td>
<td>lx (lux)</td>
<td>formerly illumination</td>
</tr>
</tbody>
</table>

### Other photometric units; conversion factors

- 1 stib = \(1 \text{ cd/cm}^2 = 10^4 \text{ cd/m}^2 = 4 \pi \text{ lumen/cm}^2\)
- 1 lambert = \(\frac{1}{\pi} \text{ cd/cm}^2 = \frac{10^4}{\pi} \text{ cd/m}^2 = 4 \text{ lumen/cm}^2\)
- 1 foot lambert = \(\frac{1}{\pi} \text{ cd/ft}^2 = 3,426 \text{ cd/m}^2\)
- 1 foot candle = 10,764 lux
TYPE DESIGNATION

Pro Electron type designation code
The CRT type number begins with a single letter followed by two sets of digits, and ends with one or two letters.
The first letter indicates the prime application of the tube:
D : Oscilloscope tube, single trace
E : Oscilloscope tube, multiple trace
F : Radar display tube, direct view
L : Storage display tube
M : TV display tube for professional application, direct view
P : Display tube for professional application, projection
Q : Flying spot scanner tube
The first group of digits indicates the diameter or diagonal of the screen in cm.
The second group of digits is a two or three-figure serial number indicating a particular design or development.
The final group of letters indicates the properties of the phosphor screen (see section "Screen types").
For CRTs with internal graticule a suffix consisting of two or more figures follows the type designation, separated from it by an oblique stroke.
Example:

```
D14 - 372 GH/123
```

- oscilloscope tube, single trace
- face diagonal
- design number
- screen phosphor
- internal graticule
## SCREEN TYPES

<table>
<thead>
<tr>
<th>new system</th>
<th>old system</th>
<th>fluorescent colour</th>
<th>phosphorescent colour</th>
<th>persistence</th>
<th>equivalent JEDEC designation</th>
</tr>
</thead>
<tbody>
<tr>
<td>BA</td>
<td>C</td>
<td>purplish-blue</td>
<td>—</td>
<td>very short</td>
<td>—</td>
</tr>
<tr>
<td>BE</td>
<td>B</td>
<td>blue</td>
<td>blue</td>
<td>medium short</td>
<td>P11</td>
</tr>
<tr>
<td>BF</td>
<td>U</td>
<td>purplish-blue</td>
<td>—</td>
<td>medium short</td>
<td>—</td>
</tr>
<tr>
<td>GH</td>
<td>H</td>
<td>green</td>
<td>green</td>
<td>medium short</td>
<td>—</td>
</tr>
<tr>
<td>GK</td>
<td>G</td>
<td>yellowish-green</td>
<td>yellowish-green</td>
<td>long</td>
<td>P7</td>
</tr>
<tr>
<td>GM</td>
<td>P</td>
<td>purplish-blue</td>
<td>yellowish-green</td>
<td>long</td>
<td>P39</td>
</tr>
<tr>
<td>GR</td>
<td>—</td>
<td>green</td>
<td>green</td>
<td>very short</td>
<td>—</td>
</tr>
<tr>
<td>GU</td>
<td>—</td>
<td>white</td>
<td>white</td>
<td>medium</td>
<td>P43</td>
</tr>
<tr>
<td>GY</td>
<td>—</td>
<td>green</td>
<td>green</td>
<td>medium short</td>
<td>—</td>
</tr>
<tr>
<td>KC</td>
<td>—</td>
<td>yellow-green</td>
<td>yellow-green</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>SB</td>
<td>—</td>
<td>yellow-white</td>
<td>—</td>
<td>—</td>
<td>P4</td>
</tr>
<tr>
<td>W</td>
<td>W</td>
<td>white</td>
<td>—</td>
<td>medium short</td>
<td>P45</td>
</tr>
<tr>
<td>WA</td>
<td>—</td>
<td>white</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>WE</td>
<td>—</td>
<td>white</td>
<td>white</td>
<td>medium short</td>
<td>—</td>
</tr>
<tr>
<td>YA</td>
<td>Y</td>
<td>yellowish-orange</td>
<td>yellowish-orange</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

The phosphor information given in this section is based in general upon the original phosphor registration (TEPAC and/or PRO ELECTRON) and can be used as a selection guide. Slight differences may occur between the actual phosphor properties and the registered data.
## Survey of applications and persistence of screens

<table>
<thead>
<tr>
<th>application</th>
<th>phosphor</th>
<th>conditions (display: spot)</th>
<th>persistence</th>
<th>remark</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>screen voltage</td>
<td>screen current (peak value)</td>
<td>pulse width</td>
</tr>
<tr>
<td>oscilloscope tubes</td>
<td>BE</td>
<td>4 kV</td>
<td>20 μA</td>
<td>2 μs</td>
</tr>
<tr>
<td></td>
<td>GH</td>
<td>4 kV</td>
<td>20 μA</td>
<td>2 μs</td>
</tr>
<tr>
<td></td>
<td>GM</td>
<td>4 kV</td>
<td>2 μA</td>
<td>raster switched off after 5 s</td>
</tr>
<tr>
<td></td>
<td>GY</td>
<td>4 kV</td>
<td>20 μA</td>
<td>2 μs</td>
</tr>
<tr>
<td>monitor tubes</td>
<td>GR</td>
<td>see relevant curves for persistence</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>W</td>
<td>see relevant curves for persistence</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>WA</td>
<td>see relevant curves for persistence</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>WE</td>
<td>see relevant curves for persistence</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>KC</td>
<td>see relevant curves for persistence</td>
<td></td>
<td></td>
</tr>
<tr>
<td>projection tubes</td>
<td>BF</td>
<td>see relevant curves for persistence</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>YA</td>
<td>see relevant curves for persistence</td>
<td></td>
<td></td>
</tr>
<tr>
<td>flying-spot scanner</td>
<td>BA</td>
<td>see relevant curves for persistence</td>
<td></td>
<td></td>
</tr>
<tr>
<td>tubes</td>
<td>GU</td>
<td>see relevant curves for persistence</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
In flying spot scanner applications, the persistence is independent of the current density and excitation time.
This phosphor is not recommended for use below 20kV

Efficiency

V_{screen} = 25kV

High voltage

20kV

Current density (μA/cm²)

Luminance (nits)
CIE co-ordinates

x = 0.139
y = 0.148

Relative response

λ(μm)

0.4 0.45 0.5 0.55 0.6
Screen voltage: 4 kV
Screen current: 20 μA
Pulse width: 2 μs
Repetition time: 10 ms

Luminance (nits) vs. Current density (μA/cm²) for different Screen voltages (Low and High voltage regions).
High brightness
CIE co-ordinates
x = 0.193
y = 0.420

Low brightness
CIE co-ordinates
x = 0.245
y = 0.523
Screen voltage 4 kV
Screen current 20 μA
Pulse width 2 μs
Repetition time 10 ms

At lower screen voltage, lower screen loading or longer excitation time, the decay time will be longer.
GM SCREEN

Relative response vs. wavelength ($\lambda$ (Å))

CIE co-ordinates:
$X = 0.151, 0.357$
$Y = 0.032, 0.537$

$\%$
Screen voltage: 4 kV
Screen current: 2 μA
Raster: 2 cm x 2 cm
Scanning time: 5 s
Yellow filter: GG495
CIE co-ordinates

\( x = 0.200 \)

\( y = 0.713 \)
$V_{\text{screen}}: 4\, \text{kV}$

$J_{\text{screen}}: 5\, \mu\text{A/cm}^2$

Measured with defocused spot

Excitation time sufficient for complete build-up

---

$L_{\text{screen}}: 300$ nits

$L_{\text{screen}}: 1500$ nits

Current density ($\mu\text{A/cm}^2$)
high voltage
light transmission 75%

luminance [nits=cd/m²]

V_{screen} = 20 kV

V_{screen} = 18 kV

V_{screen} = 16 kV

V_{screen} = 14 kV

V_{screen} = 12 kV

current density [μA/cm²]
A: blue component
B: yellow component
V = 18 kV
I = 0.1 μA/cm²

Relative luminance

Time from cessation of excitation

0 10 20 30 40

0 1 10 100 1000
CIE co-ordinates \( x = 0.265 \), \( y = 0.285 \)

**Graph 1:**
- Relative response (%) vs. wavelength (\( \lambda \) nm)
- Peaks at various wavelengths indicating sensitivity

**Graph 2:**
- Relative luminance (%) vs. time from cessation of excitation (\( \mu s \))
- Logarithmic scale

Measured with defocused spot; pulse duration: 5 ms, \( V\text{screen} \): 5 kV, \( I\text{screen} \): 5 \( \mu A \).
INSTRUMENT TUBES
# Survey of Instrument Tubes

<table>
<thead>
<tr>
<th>monoaccelerator tubes</th>
<th>post-deflection accelerator tubes</th>
<th>large bandwidth tubes</th>
<th>direct-view storage tubes</th>
</tr>
</thead>
<tbody>
<tr>
<td>D7-221GY</td>
<td>D12-150GH/119</td>
<td>D14-400GH/123</td>
<td>L14-140GH/95</td>
</tr>
<tr>
<td>D7-222GY</td>
<td>D14-371GH/123</td>
<td></td>
<td>L14-150GH/95</td>
</tr>
<tr>
<td>D10-180GY</td>
<td>D14-372GH/123</td>
<td>D14-382GH/123</td>
<td></td>
</tr>
<tr>
<td>D10-181GY</td>
<td>D14-381GH/123</td>
<td>D18-190GH/127</td>
<td></td>
</tr>
<tr>
<td>D12-130GY/119</td>
<td>D14-382GH/123</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D12-160GY/119</td>
<td>D18-190GH/127</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D14-363GY/123</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D14-364GY/123</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D18-180GY/127</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Preferred Types:** recommended for new design

**Maintenance Types:** no longer recommended for equipment production

| D14-302GH/93          |                               |                       | L14-131GH/55             |

**Obsolescent Types:** available until present stocks are exhausted

| D7-190..              | D12-120GH/115                  | D14-240GH/37          | L14-111GH/55             |
| D7-191..              | D14-120GH                      |                       |                          |
| D10-160..             | D14-121GH                      | D14-292GH             |                          |
| D10-161..             | D14-122GH                      | D14-370GH/93          |                          |
| D13-480..             | D14-123GH                      | D14-380GH/93          |                          |
| D13-481..             | D14-182GH/09                   | D18-120..             |                          |
| D14-361..             | D14-261GH                      | E14-100GH             |                          |
| D14-361../93          | D14-262GH                      | E14-101GH             |                          |
| D14-362..             | D14-292GH                      |                       |                          |
| D14-362../93          | D14-370GH/93                   |                       |                          |
7 cm diameter flat faced monoaccelerator oscilloscope tube primarily intended for use in inexpensive oscilloscopes and monitoring devices.

<table>
<thead>
<tr>
<th>QUICK REFERENCE DATA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accelerator voltage</td>
</tr>
<tr>
<td>Display area</td>
</tr>
<tr>
<td>Deflection coefficient, horizontal</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Deflection coefficient, vertical</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

**SCREEN**

<table>
<thead>
<tr>
<th></th>
<th>colour</th>
<th>persistence</th>
</tr>
</thead>
<tbody>
<tr>
<td>D7-190GH</td>
<td>green</td>
<td>medium</td>
</tr>
<tr>
<td>D7-190GM</td>
<td>yellowish green</td>
<td>short</td>
</tr>
<tr>
<td></td>
<td></td>
<td>long</td>
</tr>
</tbody>
</table>

Useful screen diameter min. 64 mm

Useful scan

horizontal min. 60 mm

vertical min. 50 mm

The useful scan may be shifted vertically to a maximum of 4mm with respect to the geometric centre of the faceplate.

**HEATING:** Indirect by AC or DC; parallel supply

Heater voltage $V_f$ 6.3 V

Heater current $I_f$ 300 mA
Mounting position: any

The tube should not be supported by the base alone and under no circumstances should the socket be allowed to support the tube.

Dimensions and connections

See also outline drawing

Overall length

Face diameter

max. 225 mm

max. 77 mm

Base 14 pin all glass

Net weight

approx. 260 g

Accessories

Socket (supplied with tube) type 55566

Mu-metal shield type 55534
CAPACITANCES
x₁ to all other elements except x₂
x₂ to all other elements except x₁
y₁ to all other elements except y₂
y₂ to all other elements except y₁
x₁ to x₂
y₁ to y₂
Control grid to all other elements
Cathode to all other elements

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 intercept part of the electron beam, hence a low impedance deflection plate drive is desirable.

Angle between x and y traces 90 ± 10°

LINE WIDTH see note 3

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 I₁ = 10 μA. 1)

Line width
l.w. 0.28 mm

As the construction of this tube does not permit a direct measurement of the beam current, this current should be determined as follows:
a) under typical operating conditions, apply a small raster display (no overscan), adjust Vg₁ for a beam current of approx. 10 μA and adjust Vg₃ and Vg₂,g₄,g₅,₁ for optimum spot quality at the centre of the screen.
b) under these conditions, but no raster, the deflection plate voltages should be changed to
V₁ = V₂ = 1000 V; V₁ = 300 V; V₂ = 700 V, thus directing the total beam current to x₂.
Measure the current on x₂ and adjust Vg₁ for I₂ = 10 μA (being the beam current I₁)
c) set again for the conditions under a), without touching the Vg₁ control. Now a raster display with a true 10 μA screen current is achieved.
d) focus optimally in the centre of the screen (do not adjust the astigmatism control) and measure the line width.

1)
### TYPICAL OPERATING CONDITIONS 3)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accelerator voltage</td>
<td>( V_{g2,g4,g5,\ell} )</td>
<td>1000 V</td>
</tr>
<tr>
<td>Astigmatism control voltage</td>
<td>( \Delta V_{g2,g4,g5,\ell} )</td>
<td>( \pm 25 ) V</td>
</tr>
<tr>
<td>Focusing electrode voltage</td>
<td>( V_{g3} )</td>
<td>100 to 180 V</td>
</tr>
<tr>
<td>Control grid voltage for visual extinction</td>
<td>( V_{g1} )</td>
<td>max. (-35) V</td>
</tr>
<tr>
<td>Grid drive for 10 ( \mu )A screen current</td>
<td></td>
<td>approx. 10 V</td>
</tr>
<tr>
<td>Deflection coefficient, horizontal</td>
<td>( M_x )</td>
<td>max. 29 V/cm</td>
</tr>
<tr>
<td>Deviation of linearity of deflection</td>
<td>( M_y )</td>
<td>max. 11.5 V/cm</td>
</tr>
<tr>
<td>Geometry distortion</td>
<td></td>
<td>max. 12.5 V/cm</td>
</tr>
<tr>
<td>Useful scan, horizontal</td>
<td></td>
<td>max. 1 % 2</td>
</tr>
<tr>
<td>Deviation of linearity of deflection</td>
<td></td>
<td>see note 4</td>
</tr>
<tr>
<td>Useable scan, horizontal</td>
<td></td>
<td>min. 60 mm</td>
</tr>
<tr>
<td>Geometry distortion</td>
<td></td>
<td>min. 50 mm</td>
</tr>
<tr>
<td><strong>LIMITING VALUES</strong> (Absolute max. rating system)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accelerator</td>
<td>( V_{g2,g4,g5,\ell} )</td>
<td>max. 2200 V</td>
</tr>
<tr>
<td>Focusing electrode voltage</td>
<td>( V_{g3} )</td>
<td>max. 2200 V</td>
</tr>
<tr>
<td>Control grid voltage, negative</td>
<td>( -V_{g1} )</td>
<td>max. 200 V</td>
</tr>
<tr>
<td>Cathode to heater voltage</td>
<td>( V_{kf} )</td>
<td>max. 125 V</td>
</tr>
<tr>
<td>Grid drive, average</td>
<td>( -V_{kf} )</td>
<td>max. 125 V</td>
</tr>
<tr>
<td>Screen dissipation</td>
<td>( W_\ell )</td>
<td>max. 3 mW/cm²</td>
</tr>
<tr>
<td>Control grid circuit resistance</td>
<td>( R_{g1} )</td>
<td>max. 1 MΩ</td>
</tr>
</tbody>
</table>

1. All that will be necessary when putting the tube into operation is to adjust the astigmatism control voltage once for optimum spot shape in the screen centre. The control voltage will always be in the range stated, provided the mean x plate and certainly the mean y plate potential was made equal to \( V_{g2,g4,g5,\ell} \) with zero astigmatism correction.
2. 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.
3. The mean x and certainly the mean y plate potential should be equal to \( V_{g2,g4,g5,\ell} \) with astigmatism adjustment set to zero.
4. A graticule, consisting of concentric rectangles of 40 mm x 50 mm and 39.2 mm x 49 mm is aligned with the electrical x-axis of the tube. The edges of a raster will fall between these rectangles.
INSTRUMENT CATHODE-RAY TUBE

7 cm diameter flat-faced monoaccelerator oscilloscope tube with low heater consumption.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accelerator voltage</td>
<td>V_g2, g4, g5 (k) 1000 V</td>
</tr>
<tr>
<td>Display area</td>
<td>60 x 50 mm²</td>
</tr>
<tr>
<td>Deflection coefficient</td>
<td></td>
</tr>
<tr>
<td>horizontal</td>
<td>M_X 29 V/cm</td>
</tr>
<tr>
<td>vertical</td>
<td>M_Y 11.5 V/cm</td>
</tr>
</tbody>
</table>

The D7–191 is equivalent to the type D7–190., except for the following.

HEATING
Indirect by AC or DC; parallel supply

Heater voltage V_f 6.3 V
Heater current I_f 95 mA

LIMITING VALUES (Absolute maximum rating system)

Cathode to heater voltage
positive V_k/f max. 100 V
negative -V_k/f max. 15 V

CAPACITANCES
Cathode to all other elements C_k 2.3 pF

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INSTRUMENT CATHODE-RAY TUBE

7 cm diagonal, rectangular flat faced mono accelerator oscilloscope tube primarily for use in inexpensive oscilloscopes and monitors. This tube features a low heater power consumption.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accelerator voltage</td>
<td>$V_{g2, g4, g5(\ell)}$ 1000 V</td>
</tr>
<tr>
<td>Display area</td>
<td>60 mm x 36 mm</td>
</tr>
<tr>
<td>Deflection coefficient</td>
<td></td>
</tr>
<tr>
<td>horizontal</td>
<td>$M_x$ 12.5 V/cm</td>
</tr>
<tr>
<td>vertical</td>
<td>$M_y$ 20 V/cm</td>
</tr>
</tbody>
</table>

The D7—221GY is equivalent to the type D7—222GY except for the following.

HEATING

Indirect by a.c. or d.c.*

Heater voltage $V_f$ 6.3 V

Heater current $I_f$ 0.1 A

LIMITING VALUES (Absolute maximum rating system)

Cathode to heater voltage

positive $V_{kf}$ max. 100 V

negative $-V_{kf}$ max. 15 V

CAPACITANCES

Cathode to all other elements $C_k$ 3 pF

* Not to be connected in series with other tubes.
INSTRUMENT CATHODE-RAY TUBE

7 cm diagonal, rectangular flat faced mono accelerator oscilloscope tube primarily for use in inexpensive oscilloscopes and monitors. This tube features a 1,5 W cathode with short warm-up time (quick-heating cathode).

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accelerator voltage</td>
<td>(V_{g2, g4, g5(x)}) 1000 V</td>
</tr>
<tr>
<td>Display area</td>
<td>60 mm x 36 mm</td>
</tr>
<tr>
<td>Deflection coefficient</td>
<td></td>
</tr>
<tr>
<td>horizontal</td>
<td>(M_X) 12,5 V/cm</td>
</tr>
<tr>
<td>vertical</td>
<td>(M_Y) 20 V/cm</td>
</tr>
</tbody>
</table>

OPTICAL DATA

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Screen</td>
<td>GY, colour green medium</td>
</tr>
<tr>
<td>phosphor type</td>
<td></td>
</tr>
<tr>
<td>persistence</td>
<td></td>
</tr>
<tr>
<td>Useful screen dimensions</td>
<td>(\geq 60) mm x 36 mm</td>
</tr>
<tr>
<td>Useful scan</td>
<td></td>
</tr>
<tr>
<td>horizontal</td>
<td>(\geq 60) mm</td>
</tr>
<tr>
<td>vertical</td>
<td>(\geq 36) mm</td>
</tr>
<tr>
<td>Spot eccentricity in horizontal and vertical directions</td>
<td>(&lt; 5) mm</td>
</tr>
</tbody>
</table>

HEATING

Indirect by a.c. or d.c.*

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heater voltage</td>
<td>(V_f) 6,3 V</td>
</tr>
<tr>
<td>Heater current</td>
<td>(I_f) 0,24 A</td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Mounting position: any

The tube should not be supported by the base alone and under no circumstances should the socket be allowed to support the tube.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Net mass</td>
<td>approx. 350 g</td>
</tr>
<tr>
<td>Base</td>
<td>12-pin all glass; JEDEC B12—246</td>
</tr>
</tbody>
</table>

* Not to be connected in series with other tubes.
Dimensions and connections
See also outline drawing
Overall length \( \leq 225 \text{ mm} \)
Faceplate dimensions \( \leq 72.5 \times 49 \text{ mm} \)

Accessories
Socket, supplied with tube type 55589/55594
Mu-metal shield type 55535

FOCUSING
Electrostatic

DEFLECTION
double electrostatic
symmetrical

Angle between \( x \) and \( y \)-traces \( 90 \pm 10^\circ \)
Angle between \( x \)-trace and horizontal axis of the face \( \leq 3^\circ \) •

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
\[ x_1 \text{ to all other elements except } x_2 \]
\[ C_{x1(x2)} = 3 \text{ pF} \]
\[ x_2 \text{ to all other elements except } x_1 \]
\[ C_{x2(x1)} = 3 \text{ pF} \]
\[ y_1 \text{ to all other elements except } y_2 \]
\[ C_{y1(y2)} = 4 \text{ pF} \]
\[ y_2 \text{ to all other elements except } y_1 \]
\[ C_{y2(y1)} = 4 \text{ pF} \]
\[ x_1 \text{ to } x_2 \]
\[ C_{x1x2} = 1.5 \text{ pF} \]
\[ y_1 \text{ to } y_2 \]
\[ C_{y1y2} = 1.8 \text{ pF} \]
Control grid to all other elements
\[ C_g = 5.5 \text{ pF} \]
Cathode to all other elements
\[ C_k = 3 \text{ pF} \]

* The tube is provided with a rotation coil, concentrically wound around the tube neck, enabling the alignment of the \( x \)-trace with the mechanical \( x \)-axis of the screen. The coil has 1000 turns and a maximum resistance of 250 \( \Omega \). Under typical operating conditions, a maximum of 10 ampere-turns are required for the maximum rotation of 30°. This means the required current is 10 mA maximum at a required voltage of 2.5 V maximum.
DIMENSIONS AND CONNECTIONS

1. The bulge at the frit seal does not exceed the maximum dimensions.
2. The coil is fixed to the envelope by means of adhesive tape.
3. The length of the connecting leads of the rotation coil is min. 350 mm.
### TYPICAL OPERATION

<table>
<thead>
<tr>
<th>Conditions</th>
<th>Note(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accelerator voltage</td>
<td>( V_{g2}, g4, g5(\xi) )</td>
</tr>
<tr>
<td>Astigmatism control voltage</td>
<td>( \Delta V_{g2}, g4, g5(\xi) )</td>
</tr>
<tr>
<td>Focusing electrode voltage</td>
<td>( V_{g3} )</td>
</tr>
<tr>
<td>Cut-off voltage for visual extinction of focused spot</td>
<td>(-V_{g1})</td>
</tr>
</tbody>
</table>

### Performance

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Useful scan</td>
<td></td>
</tr>
<tr>
<td>horizontal</td>
<td>&gt; 60 mm</td>
</tr>
<tr>
<td>vertical</td>
<td>&gt; 35 mm</td>
</tr>
<tr>
<td>Deflection coefficient</td>
<td></td>
</tr>
<tr>
<td>horizontal</td>
<td>( M_x )</td>
</tr>
<tr>
<td>vertical</td>
<td>( M_y )</td>
</tr>
<tr>
<td>Line width</td>
<td>l.w.</td>
</tr>
<tr>
<td>Deviation of linearity of deflection</td>
<td>&lt;</td>
</tr>
<tr>
<td>Grid drive for 10 ( \mu )A screen current</td>
<td>( V_d )</td>
</tr>
</tbody>
</table>

### Geometry distortion

- see note 5

### NOTES

1. The mean x-plate potential and the mean y-plate potential should be equal to \( V_{g2}, g4, g5(\xi) \) (with astigmatism control voltage set to zero).

2. When putting the tube into operation the astigmatism control voltage should be adjusted only once for optimum spot size in the centre of the screen. The control voltage will be within the stated range, provided the conditions of note 1 are adhered to.

3. 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 \( I_x = 10 \) \( \mu \)A.

   As the construction of the tube does not permit a direct measurement of the beam current, this current should be determined as follows.
   - a) Under typical operating conditions, apply a small raster display (no overscan), adjust \( V_{g1} \) for a beam current of approx. 10 \( \mu \)A and adjust \( V_{g3} \) and \( V_{g2}, g4, g5(\xi) \) for optimum spot quality at the centre of the screen.
   - b) Under these conditions, but without raster, the deflection plate voltages should be changed to:
     \[ V_{x1} = V_{x2} = 1000 \text{ V}; \ V_{y1} = 300 \text{ V}; \ V_{y2} = 700 \text{ V}, \]
     thus directing the total beam current to \( y_2 \).
     Measure the current on \( v_2 \) and adjust \( V_{g1} \) for \( I_{y2} = 10 \) \( \mu \)A.
   - c) Set again for the conditions under a), without touching the \( V_{g1} \) control. The screen current of the resulting raster display is now 10 \( \mu \)A.
   - d) Focus optimally in the centre of the screen (do not adjust the astigmatism control) and measure the line width.

4. 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.

5. A graticule, consisting of concentric rectangles of 57.0 mm x 33.0 mm and 56 mm x 31.6 mm is aligned with the electrical x-axis of the tube. The edges of a raster will fall between these rectangles.
**LIMITING VALUES** (Absolute maximum rating system)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol(s)</th>
<th>Max.</th>
<th>Min.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accelerator voltage</td>
<td>$V_{g2, g4, g5(\xi)}$</td>
<td>2200 V</td>
<td></td>
</tr>
<tr>
<td>Focusing electrode voltage</td>
<td>$V_{g3}$</td>
<td>2200 V</td>
<td></td>
</tr>
<tr>
<td>Control grid voltage</td>
<td>$-V_{g1}$</td>
<td>200 V</td>
<td>0 V</td>
</tr>
<tr>
<td>Cathode to heater voltage</td>
<td>$V_{kf}$</td>
<td>125 V</td>
<td></td>
</tr>
<tr>
<td>Cathode to heater voltage (negative)</td>
<td>$-V_{kf}$</td>
<td>125 V</td>
<td></td>
</tr>
<tr>
<td>Grid drive, averaged over 1 ms</td>
<td>$V_d$</td>
<td>20 V</td>
<td></td>
</tr>
<tr>
<td>Screen dissipation</td>
<td>$W_s$</td>
<td>3 mW/cm²</td>
<td></td>
</tr>
<tr>
<td>Control grid circuit resistance</td>
<td>$R_{g1}$</td>
<td>1 MΩ</td>
<td></td>
</tr>
</tbody>
</table>
INSTRUMENT CATHODE-RAY TUBE

10 cm diameter flat faced monoaccelerator oscilloscope tube primarily intended for use in inexpensive oscilloscopes and read-out devices.

<table>
<thead>
<tr>
<th>QUICK REFERENCE DATA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accelerator voltage</td>
</tr>
<tr>
<td>$V_{g2,g4,g5(l)}$</td>
</tr>
<tr>
<td>1500 V</td>
</tr>
<tr>
<td>Display area</td>
</tr>
<tr>
<td>80 x 60 mm$^2$</td>
</tr>
<tr>
<td>Deflection coefficient, horizontal</td>
</tr>
<tr>
<td>$M_X$</td>
</tr>
<tr>
<td>32 V/cm</td>
</tr>
<tr>
<td>vertical</td>
</tr>
<tr>
<td>$M_Y$</td>
</tr>
<tr>
<td>13.7 V/cm</td>
</tr>
</tbody>
</table>

SCREEN

<table>
<thead>
<tr>
<th>colour</th>
<th>persistence</th>
</tr>
</thead>
<tbody>
<tr>
<td>D10-160GH</td>
<td>green</td>
</tr>
<tr>
<td>D10-160GM</td>
<td>yellowish green</td>
</tr>
<tr>
<td></td>
<td>medium short</td>
</tr>
<tr>
<td></td>
<td>long</td>
</tr>
</tbody>
</table>

Useful screen diameter

min. 85 mm

Useful scan

horizontal

min. 80 mm

vertical

min. 60 mm

The useful scan may be shifted vertically to a max. of 5 mm with respect to the geometric centre of the faceplate.

HEATING: Indirect by AC or DC; parallel supply

<table>
<thead>
<tr>
<th>Heater voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_f$ 6.3 V</td>
</tr>
<tr>
<td>Heater current</td>
</tr>
<tr>
<td>$I_f$ 300 mA</td>
</tr>
</tbody>
</table>
MECHANICAL DATA

Dimensions in mm

Fig. 1 Outlines.

Mounting position
The tube should not be supported by the base alone and under no circumstances should the socket be allowed to support the tube.

Dimensions and connections
See also outline drawing

Overall length max. 260 mm
Face diameter max. 102 mm

Base 14 pin all glass

Net weight approx. 400 g

Accessories
Socket (supplied with tube) type 55566
Mu metal shield type 55547
CAPACITANCES

x₁ to all other elements except x₂
x₂ to all other elements except x₁
y₁ to all other elements except y₂
y₂ to all other elements except y₁
x₁ to x₂
y₁ to y₂
Control grid to all other elements
Cathode to all other elements

Cₚ₁(x₂)  4 pF
Cₚ₂(x₁)  4 pF
Cₚ₃(y₂)  3.5 pF
Cₚ₄(y₁)  3 pF
Cₚ₅(x₁x₂) 1.6 pF
Cₚ₆(y₁y₂) 1.1 pF
Cₚ₇  5.5 pF
Cₚ₈  4 pF

FOCUSING  electrostatic

DEFLECTION  double electrostatic  see note 3
x plates  symmetrical
y plates  symmetrical

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

Angle between x and y traces  90 ± 1°

LINE WIDTH

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 Iₒ = 10 μA.

Line width  l.w.  0.27 mm

As the construction of this tube does not permit a direct measurement of the beam current, this current should be determined as follows:

a) under typical operating conditions, apply a small raster display (no overscan), adjust V₉₁ for a beam current of approx. 10 μA and adjust V₉₃ and V₉₂, g₄, g₅, χ for optimum spot quality at the centre of the screen.

b) under these conditions, but no raster, the deflection plate voltages should be changed to:
   V₉₁ = V₉₂ = 1500 V; V₉₃ = 800 V; V₉₄ = 1200 V, thus directing the total beam current to x₂.
   Measure the current on x₂ and adjust V₉₁ for Iₓ₂ = 10 μA (being the beam current Iₒ).

c) set again for the conditions under a), without touching the V₉₁ control. Now a raster display with a true 10 μA screen current is achieved.

d) focus optimally in the centre of the screen (do not adjust the astigmatism control) and measure the line width.
TYPICAL OPERATING CONDITIONS  see note 3

Accelerator voltage \[ V_{g2,g4,g5,l} \] 1500 V
Astigmatism control voltage \[ \Delta V_{g2,g4,g5,l} \] \pm 30 V  see note 1
Focusing electrode voltage \[ V_{g3} \] 140 to 275 V
Control grid voltage for visual extinction of focused spot \[ V_{g1} \] max. \(-50\) V  approx. \(10\) V
Grid drive for 10 \(\mu\)A screen current \[ M_x \] max. \(32\) V/cm \
Deflection coefficient, horizontal \[ M_y \] max. \(13.7\) V/cm \(14.5\) V/cm
Deviation of linearity of deflection \[ \text{max. } 1\% \]  see note 2
Geometry distortion \[ \text{see note 4} \]
Useful scan, horizontal \[ \text{min. } 80\text{ mm} \]
vertical \[ \text{min. } 60\text{ mm} \]

LIMITING VALUES  (Absolute max. rating system)

Accelerator voltage \[ V_{g2,g4,g5,l} \] max. \(2200\) V  min. \(1350\) V
Focusing electrode voltage \[ V_{g3} \] max. \(2200\) V
Control grid voltage, negative \[ -V_{g1} \] max. \(200\) V  min. \(0\) V
Cathode to heater voltage \[ V_{kf} \] max. \(125\) V  \(-V_{kf} \) max. \(125\) V
Grid drive, average \[ W_f \] max. \(20\) V
Screen dissipation \[ R_{g1} \] max. \(3\) mW/cm\(^2\)

Notes
1. All that will be necessary when putting the tube into operation is to adjust the astigmatism control voltage once for optimum spot shape in the screen centre. The control voltage will always be in the range stated, provided the mean x plate and certainly the mean y plate potential was made equal to \(V_{g2,g4,g5,l}\) with zero astigmatism correction.
2. 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.
3. The mean x and certainly the mean y plate potentials should be equal to \(V_{g2,g4,g5,l}\) with astigmatism adjustment set to zero.
4. A graticule, consisting of concentric rectangles of 50 mm x 60 mm and 49 mm x 58.6 mm is aligned with the electrical x-axis of the tube. The edges of a raster will fall between these rectangles.
INSTRUMENT CATHODE-RAY TUBE

10 cm diameter flat-faced monoaccelerator oscilloscope tube with low heater consumption.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accelerator voltage</td>
<td>Vg2, g4, g5 (€)</td>
</tr>
<tr>
<td>Display area</td>
<td>80 x 60 mm²</td>
</tr>
<tr>
<td>Deflection coefficient</td>
<td></td>
</tr>
<tr>
<td>horizontal</td>
<td>MX</td>
</tr>
<tr>
<td>vertical</td>
<td>MY</td>
</tr>
</tbody>
</table>

The D10—161.. is equivalent to the type D10—160.. except for the following.

HEATING
Indirect by AC or DC; parallel supply

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heater voltage</td>
<td>Vf</td>
</tr>
<tr>
<td>Heater current</td>
<td>If</td>
</tr>
</tbody>
</table>

LIMITING VALUES (Absolute maximum rating system)

Cathode to heater voltage

<table>
<thead>
<tr>
<th>Voltage</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive</td>
<td>V + k/f – max.</td>
</tr>
<tr>
<td>Negative</td>
<td>V – k/f + max.</td>
</tr>
</tbody>
</table>

CAPACITANCES

Cathode to all other elements

<table>
<thead>
<tr>
<th>Capacitance</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ck</td>
<td>2.3 pF</td>
</tr>
</tbody>
</table>
INSTRUMENT CATHODE-RAY TUBE

- mono accelerator
- 10 cm diagonal rectangular flat face
- dynamic deflection defocusing correction
- internal magnetic correction for astigmatism and vertical eccentricity
- quick-heating cathode
- for portable oscilloscopes with up to 25 MHz bandwidth, and read-out devices

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accelerator voltage</td>
<td>$V_{g2(\xi)}$</td>
</tr>
<tr>
<td>Minimum useful scan area</td>
<td></td>
</tr>
<tr>
<td>Deflection coefficient</td>
<td></td>
</tr>
<tr>
<td>horizontal</td>
<td>$M_x$</td>
</tr>
<tr>
<td>vertical</td>
<td>$M_y$</td>
</tr>
</tbody>
</table>

OPTICAL DATA

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Screen type</td>
<td>GY, colour green medium</td>
</tr>
<tr>
<td>Persistence</td>
<td></td>
</tr>
<tr>
<td>Useful screen area</td>
<td>&gt;</td>
</tr>
<tr>
<td>Useful scan area</td>
<td>&gt;=</td>
</tr>
<tr>
<td>Spot eccentricity</td>
<td>=</td>
</tr>
<tr>
<td>in horizontal direction</td>
<td></td>
</tr>
<tr>
<td>in vertical direction</td>
<td></td>
</tr>
<tr>
<td>Note 2, last page</td>
<td></td>
</tr>
</tbody>
</table>

HEATING

Indirect by a.c. or d.c.*

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heater voltage</td>
<td>$V_f$</td>
</tr>
<tr>
<td>Heater current</td>
<td>$I_f$</td>
</tr>
<tr>
<td>Heating time to attain 10% of the cathode current at equilibrium conditions</td>
<td>approx.</td>
</tr>
</tbody>
</table>

* Not to be connected in series with other tubes.
MECHANICAL DATA

Dimensions and connections (see also outline drawing)

Overall length (socket included) ≤ 240 mm
Faceplate dimensions 82 ± 1 mm x 69 ± 1 mm

Net mass approx. 450 g

Base 12 pin, all glass,
JEDEC B12-246

Mounting

The tube can be mounted in any position. It must 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.

Accessories

Socket with solder tags type 55589/55594
Socket with printed-wiring pins type 55595

FOCUSBING

electrostatic

DEFLECTION

double electrostatic
symmetrical

x-plates symmetrical
y-plates

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.
DYNAMIC DEFLECTION DEFOCUSING CORRECTION

The tube has a special electrode, positioned between the x and y-plates, for dynamic correction of deflection defocusing, to improve the uniformity of the extremely good line width up to the screen edges. If use is made of this dynamic correction, a negative voltage proportional to, and approx. 50% of, the negative horizontal deflection plate voltage should be applied to this electrode (grid 6).

The correction-circuit impedance must be \( \leq 100 \, k\Omega \). To prevent distortion, the output impedances of the x-amplifiers should be \( \leq 10 \, k\Omega \).

If no correction is required, grid 6 should be connected to mean x-plate potential \( (V_{g2(y)}) \).

- Angle between x and y-traces: \( 90 \pm 1^\circ \)
- Angle between x-trace and x-axis of the face plate: \( \leq 5^\circ \)

CAPACITANCES (approx. values)

- \( x_1 \) to all other elements except \( x_2 \): \( C_{x1(x2)} = 4.5 \, pF \)
- \( x_2 \) to all other elements except \( x_1 \): \( C_{x2(x1)} = 4.5 \, pF \)
- \( y_1 \) to all other elements except \( y_2 \): \( C_{y1(y2)} = 3.5 \, pF \)
- \( y_2 \) to all other elements except \( y_1 \): \( C_{y2(y1)} = 3.5 \, pF \)
- \( x_1 \) to \( x_2 \): \( C_{x1x2} = 2 \, pF \)
- \( y_1 \) to \( y_2 \): \( C_{y1y2} = 1 \, pF \)
- Control grid to all other elements: \( C_{g1} = 6 \, pF \)
- Cathode to all other elements: \( C_{k} = 2.7 \, pF \)

* The tube has a trace rotation coil, fixed onto the lower cone part. The coil has 1000 turns and a typical resistance of 165 \( \Omega \) at 20 \( ^\circ \)C (max. 250 \( \Omega \) at 80 \( ^\circ \)C). Approx. 5 mA causes 1\(^\circ\) trace rotation. Thus maximum required voltage is approx. 11 V for tube tolerances (\( \pm 5^\circ \)) and earth magnetic field with reasonable shielding (\( \pm 2^\circ \)).
Fig. 1 Outlines; for notes see bottom of opposite page.
Instrument cathode-ray tube

Fig. 2 Pin arrangement; bottom view.

Fig. 3 Electrode configuration.

Notes to the drawing on opposite page.

1. Dimensions of face plate only. The complete assembly of face plate and cone (frit seal included) will pass through an opening of 85 mm x 72 mm (diagonal 107 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 face plate for screen alignment.
**TYPICAL OPERATION**

**Conditions (note 1)**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accelerator voltage</td>
<td>$V_{g2(x)}$</td>
</tr>
<tr>
<td>Astigmatism control voltage</td>
<td>$\Delta V_{g2(x)}$</td>
</tr>
<tr>
<td>Focusing electrode voltage</td>
<td>$V_{g3}$</td>
</tr>
<tr>
<td>Cut-off voltage for visual extinction of focused spot</td>
<td>$-V_{g1}$</td>
</tr>
</tbody>
</table>

**Performance**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Useful scan</td>
<td></td>
</tr>
<tr>
<td>horizontal</td>
<td>$\geq$</td>
</tr>
<tr>
<td>vertical</td>
<td>$\geq$</td>
</tr>
<tr>
<td>Deflection coefficient</td>
<td></td>
</tr>
<tr>
<td>horizontal</td>
<td>$M_X$</td>
</tr>
<tr>
<td>vertical</td>
<td>$M_Y$</td>
</tr>
<tr>
<td>Line width at 10 $\mu$A beam current</td>
<td>l.w.</td>
</tr>
<tr>
<td>Deviation of linearity of deflection</td>
<td>$\leq$</td>
</tr>
<tr>
<td>Geometry distortion</td>
<td></td>
</tr>
<tr>
<td>Grid drive for 10 $\mu$A screen current</td>
<td>$V_d$</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accelerator voltage</td>
<td>$V_{g2(x)}$</td>
</tr>
<tr>
<td>Focusing electrode voltage</td>
<td>$V_{g3}$</td>
</tr>
<tr>
<td>Voltage between accelerator electrode and grid 6</td>
<td>$V_{g2/g6}$</td>
</tr>
<tr>
<td>Voltage between accelerator electrode and any deflection plate</td>
<td>$V_{g2/x/y}$</td>
</tr>
<tr>
<td>Control grid voltage</td>
<td>$-V_{g1}$</td>
</tr>
<tr>
<td>Cathode to heater voltage</td>
<td></td>
</tr>
<tr>
<td>positive</td>
<td>$V_{kf}$</td>
</tr>
<tr>
<td>negative</td>
<td>$-V_{kf}$</td>
</tr>
<tr>
<td>Grid drive, averaged over 1 ms</td>
<td>$V_d$</td>
</tr>
<tr>
<td>Screen dissipation</td>
<td>$W_s$</td>
</tr>
<tr>
<td>Control grid circuit resistance</td>
<td>$R_{g1}$</td>
</tr>
</tbody>
</table>

* Notes are on the next page.
NOTES

1. The mean x-plate potential and the mean y-plate potential should be equal to $V_{g2}(\xi)$.

2. The tube features internal magnetic correction for spot shaping (astigmatism) and vertical eccentricity calibration. Correction is obtained at $V_{g2} = 1800$ to $2200$ V; optimum at $V_{g2} = 2000$ V.

3. Measured with the shrinking raster method within the useful scan under typical operating conditions, adjusted for optimum focus and dynamic correction applied.

   As the construction of the tube does not permit a direct measurement of the beam current, this current should be determined as follows:

   a) Under typical operating conditions, apply a small raster display (no overscan), adjust $V_{g1}$ for a beam current of approx. 10 $\mu$A and adjust $V_{g3}$ for smallest spot size at the centre of the screen. When measuring the beam current, grid 6 should be connected to $g2$ potential and the diodes should be disconnected from the x-plates.

   b) Under these conditions, but without raster, the deflection plate voltages should be changed to:

   $$V_{y1} = V_{y2} = 2000 \text{ V}; V_{x1} = 1300 \text{ V}; V_{x2} = 1700 \text{ V},$$

   thus directing the total beam current to $x_2$.

   Measure the current on $x_2$ and adjust $V_{g1}$ for $I_{x_2} = 10 \mu$A.

   c) Set again for the conditions under a), without touching the $V_{g1}$ control. The screen current of the resulting raster display is now 10 $\mu$A.

   Adjust $V_{g3}$ for optimum focus in the centre of the screen and apply dynamic correction to grid 6 for optimum vertical line width.

4. 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.

5. A graticule consisting of concentric rectangles of 70 mm x 56 mm and 68.4 mm x 54.4 mm is aligned with the face plate (using the reference points). With optimum trace rotation correction, horizontal and vertical lines will fall between these rectangles.
INSTRUMENT CATHODE-RAY TUBE

- mono accelerator
- 10 cm diagonal rectangular flat face
- dynamic deflection defocusing correction
- internal magnetic correction for astigmatism and vertical eccentricity
- low heater power consumption
- for portable oscilloscopes with up to 25 MHz bandwidth, and read-out devices

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accelerator voltage</td>
<td>$V_{g2}(\ell)$</td>
</tr>
<tr>
<td>Minimum useful scan area</td>
<td>2000 V</td>
</tr>
<tr>
<td>Deflection coefficient horizontal</td>
<td>$M_X$</td>
</tr>
<tr>
<td></td>
<td>70 x 56 mm</td>
</tr>
<tr>
<td>vertical</td>
<td>$M_Y$</td>
</tr>
<tr>
<td></td>
<td>36 V/cm</td>
</tr>
<tr>
<td></td>
<td>23 V/cm</td>
</tr>
</tbody>
</table>

The D10-181GY is equivalent to type D10-180GY except for the following.

HEATING
Indirect by a.c. or d.c.*

Heater voltage $V_f$ 6,3 V
Heater current $I_f$ 0,1 A

LIMITING VALUES (Absolute maximum rating system)

Cathode to heater voltage
positive $V_{kf}$ max. 100 V
negative $-V_{kf}$ max. 15 V

* Not to be connected in series with other tubes.
INSTRUMENT CATHODE-RAY TUBE

12 cm diagonal rectangular flat-faced oscilloscope tubes with mesh and metal-backed screen with internal graticule. For use in compact oscilloscopes.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final accelerator voltage</td>
<td>$V_{g8(L)}$ 10 kV</td>
</tr>
<tr>
<td>Minimum useful scan area</td>
<td>80 mm x 64 mm</td>
</tr>
<tr>
<td>Deflection coefficient</td>
<td>Mx 15,6 V/div</td>
</tr>
<tr>
<td></td>
<td>My 4,1 V/div</td>
</tr>
</tbody>
</table>

OPTICAL DATA

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Screen type</td>
<td>metal-backed phosphor</td>
</tr>
<tr>
<td>persistence</td>
<td>GH, colour green</td>
</tr>
<tr>
<td></td>
<td>medium short</td>
</tr>
<tr>
<td>Useful screen area</td>
<td>$\geq 80$ mm x 64 mm</td>
</tr>
<tr>
<td>Useful scan area</td>
<td>$\geq 80$ mm x 64 mm</td>
</tr>
<tr>
<td>Spot eccentricity in horizontal</td>
<td>$\leq 0,6$ div</td>
</tr>
<tr>
<td>and vertical directions</td>
<td></td>
</tr>
<tr>
<td>Internal graticule</td>
<td>type 115; see Fig. 5</td>
</tr>
</tbody>
</table>

HEATING

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indirect by AC or DC*</td>
<td></td>
</tr>
<tr>
<td>Heater voltage</td>
<td>$V_f$ 6,3 V</td>
</tr>
<tr>
<td>Heater current</td>
<td>$I_f$ 0,1 A</td>
</tr>
</tbody>
</table>

* Not to be connected in series with other tubes.
MECHANICAL DATA

Dimensions and connections (see also outline drawing)

Overall length (socket included)  335 mm
Faceplate dimensions 86 ± 2 mm x 98 ± 2 mm

Net mass approx. 700 g

Base 14 pin, all glass

Mounting

The tube can be mounted in any position. It should not be supported by the base alone and under no circumstances should the socket be allowed to support the tube.

Accessories

Socket, supplied with tube type 55566
Side contact connector (5 required) type 55561
Final accelerator contact connector type 55563A

FOCUSING

electrostatic

DEFLECTION

double electrostatic

x-plates symmetrical
y-plates symmetrical

Angle between x and y-traces 90 ± 1°

Angle between x-trace and x-axis of the internal graticule ≤ 5° *

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

\[ \begin{align*}
C_{x1} & = 2,1 \text{ pF} \\
C_{y1} & = 1,7 \text{ pF} \\
C_{g1} & = 5,5 \text{ pF} \\
C_{k} & = 4,5 \text{ pF} \\
\end{align*} \]

* The tube has a rotation coil, concentrically wound around the tube neck, to allow alignment of the x-trace with the mechanical x-axis of the screen. The coil has 1000 turns and a maximum resistance of 150 Ω. Under typical operating conditions, approx. 50 ampere-turns are required for the maximum rotation of 5°.
DIMENSIONS AND CONNECTIONS

Dimensions in mm

(1) The bulge at the frit seal may increase the indicated maximum dimensions by not more than 2.8 mm.
(2) The coil is fixed to the envelope by means of adhesive tape.
(3) Connection cable, comprising two wires for connection of the rotation coil, and one green wire for earthing the outer conductive coating. Minimum cable length is 120 mm.
(4) The centre of the final accelerator contact is situated within a square of 10 mm x 10 mm around the true geometrical position.

Fig. 1 Outlines.
DIMENSIONS AND CONNECTIONS (continued)

Fig. 2 Pin arrangement; bottom view.

Fig. 3 Side-contact arrangement; bottom view.

Fig. 4 Electrode configuration.
TYPICAL OPERATION

Conditions

Final accelerator voltage \( V_{g8}(\ell) \) 10 kV
Geometry control electrode voltage \( V_{g7} \) 1500 ± 100 V see note 1
Post deflection shield and interplate shield voltage \( V_{g6} \) 1500 V
Background illumination control voltage \( \Delta V_{g6} \) 0 to −15 V see note 1
Deflection plate shield voltage \( V_{g5} \) 1500 V see note 2
Focusing electrode voltage \( V_{g3} \) 250 to 350 V
First accelerator voltage \( V_{g2,g4} \) 1500 V
Astigmatism control electrode voltage \( \Delta V_{g2,g4} \) ± 50 V see note 3
Cut-off voltage for visual extinction of focused spot \( -V_{g1} \) 18 to 60 V

Performance

Useful scan
- horizontal \( \geq 80 \text{ mm} \)
- vertical \( \geq 64 \text{ mm} \)
Deflection coefficient
- horizontal \( M_x \) 15,6 V/div
- \( \leq 17 \text{ V/div} \)
- vertical \( M_y \) 4,1 V/div
- \( \leq 4,5 \text{ V/div} \)
Line width \( l.w. \) typ. 0,35 mm see note 4
Grid drive for 10 µA screen current \( V_d \) approx. 12 V
Geometry distortion see note 5
Deviation of deflection linearity \( \leq 2\%; \text{ see note 6} \)
LIMITING VALUES (Absolute maximum rating system)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final accelerator voltage</td>
<td>$V_{g8(\xi)}$</td>
<td>max. 11 kV</td>
</tr>
<tr>
<td>Control grid voltage</td>
<td>$-V_{g1}$</td>
<td>min. 0 V</td>
</tr>
<tr>
<td>Geometry control electrode voltage</td>
<td>$V_{g7}$</td>
<td>max. 2200 V</td>
</tr>
<tr>
<td>Post deflection shield and inter-plate shield voltage</td>
<td>$V_{g6}$</td>
<td>max. 2200 V</td>
</tr>
<tr>
<td>Deflection plate shield voltage</td>
<td>$V_{g5}$</td>
<td>max. 2200 V</td>
</tr>
<tr>
<td>Focusing electrode voltage</td>
<td>$V_{g3}$</td>
<td>max. 2200 V</td>
</tr>
<tr>
<td>First accelerator and astigmatism voltage</td>
<td>$V_{g2,g4}$</td>
<td>min. 1350 V</td>
</tr>
<tr>
<td>Control grid voltage</td>
<td>$-V_{g1}$</td>
<td>max. 200 V</td>
</tr>
<tr>
<td>Cathode to heater voltage</td>
<td>$V_{k_f}$</td>
<td>max. 100 V</td>
</tr>
<tr>
<td>Voltage between astigmatism control electrode and any deflection plate</td>
<td>$V_{g4,x}$</td>
<td>max. 500 V</td>
</tr>
<tr>
<td>Grid drive, averaged over 1 ms</td>
<td>$W_{G}$</td>
<td>max. 8 mW/cm²</td>
</tr>
<tr>
<td>Screen dissipation</td>
<td>$R_{g1}$</td>
<td>max. 1 MΩ</td>
</tr>
</tbody>
</table>

Notes

1. The tube is designed for optimum performance when operating at a ratio $V_{g8(\xi)}/V_{g2,g4} = 6.7$. The geometry control electrode voltage $V_{g7}$ should be adjusted within the indicated range (values with respect to the mean x-plate potential).

   A negative control voltage $V_{g6}$ (with respect to the mean x-plate potential) will cause some pincushion distortion and less background light, a positive control voltage will give some barrel distortion, and a slight increase of background light. By the use of the two voltages $V_{g6}$ and $V_{g7}$, the best compromise between background light and raster distortion can be found.

2. The deflection plate shield voltage should be equal to the mean y-plate potential. The mean x-plate and y-plate potentials should be equal for optimum spot quality.

3. The astigmatism control electrode voltage should be adjusted for optimum spot shape. For any necessary adjustment its potential will be within the stated range.

4. 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 of 10 µA.

5. A graticule consisting of concentric rectangles of 80 mm x 64 mm and 78.2 mm x 62.6 mm is aligned with the electrical x-axis of the tube. With optimum corrections applied, the edges of a raster will fall between these rectangles.

6. 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.
INSTRUMENT CATHODE-RAY TUBE

- mono accelerator
- 12 cm diagonal rectangular flat face
- dynamic deflection defocusing correction
- internal magnetic correction for astigmatism, vertical eccentricity and orthogonality
- low heater power consumption
- for portable oscilloscopes with up to 25 MHz bandwidth, and read-out devices

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Accelerator voltage</th>
<th>$V_{g2,g4,g5(f)}$</th>
<th>2000</th>
<th>V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum useful scan area</td>
<td>80 mm x 64 mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deflection coefficient</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>horizontal</td>
<td>$M_x$</td>
<td>32</td>
<td>V/cm</td>
</tr>
<tr>
<td>vertical</td>
<td>$M_y$</td>
<td>21</td>
<td>V/cm</td>
</tr>
</tbody>
</table>

OPTICAL DATA

Screen type | GY, colour green
Persistence | medium

Useful screen area | $\geq 82 \text{ mm x } 66 \text{ mm}$; note 1
Useful scan area | $\geq 80 \text{ mm x } 64 \text{ mm}$
Internal graticule | type 119; see Fig. 4

HEATING

Indirect by a.c. or d.c.*

Heater voltage | $V_f$ | 6.3 V |
Heater current | $I_f$ | 0.1 A |

Heating time to attain 10% of the cathode current at equilibrium conditions | approx. 7 s |

* Not to be connected in series with other tubes.
MECHANICAL DATA

Dimensions and connections (see also outline drawing)
Overall length (socket included) \( \leq 257 \text{ mm} \)
Faceplate dimensions \( 98 \pm 0.5 \text{ mm} \times 82 \pm 0.5 \text{ mm} \)

Net mass approx. 0.7 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
Socket with solder tags type 55594
Socket with printed-wiring pins type 55595
FOCUSING

DEFLECTION
electrostatic
double electrostatic
symmetrical
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.

DYNAMIC DEFLECTION DEFOCUSING CORRECTION

The tube has a special electrode, positioned between the x and y-plates, for dynamic correction of deflection defocusing, to improve the uniformity of the extremely good line width up to the screen edges. If use is made of this dynamic correction, a negative voltage proportional to, and approx. 50% of, the negative horizontal deflection plate voltage should be applied to this electrode (grid 6).
The correction-circuit impedance must be $\leq 100 \, \text{k}\Omega$. To prevent distortion, the output impedances of the x-amplifiers should be $\leq 10 \, \text{k}\Omega$.

If no correction is required, grid 6 should be connected to mean x-plate potential $(V_{g2})$.

CAPACITANCES (approx. values)

<table>
<thead>
<tr>
<th>Capacitance</th>
<th>Value (pF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$C_{x1x2}$</td>
<td>4.5</td>
</tr>
<tr>
<td>$C_{x2x1}$</td>
<td>4.5</td>
</tr>
<tr>
<td>$C_{y1y2}$</td>
<td>3.5</td>
</tr>
<tr>
<td>$C_{y2y1}$</td>
<td>3.5</td>
</tr>
<tr>
<td>$C_{x12}$</td>
<td>2</td>
</tr>
<tr>
<td>$C_{y1y2}$</td>
<td>1</td>
</tr>
<tr>
<td>$C_g$</td>
<td>6</td>
</tr>
<tr>
<td>$C_k$</td>
<td>2.7</td>
</tr>
<tr>
<td>$C_{g6}$</td>
<td>11</td>
</tr>
</tbody>
</table>
Fig. 1 Outlines.

(1) Dimensions of faceplate only. The complete assembly of faceplate and cone (frit seal included) will pass through an opening of 101 mm x 85 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.

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 119. Line thickness = 0.2 mm; dot diameter = 0.4 mm; colour: red.
**TYPICAL OPERATION** (voltages with respect to cathode)

<table>
<thead>
<tr>
<th>Conditions</th>
<th>Voltage (V)</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accelerator voltage</td>
<td>$V_{g2,g4,g5,(l)}$</td>
<td>2000</td>
</tr>
<tr>
<td>Astigmatism control voltage</td>
<td>$\Delta V_{g2,g4,g5,(l)}$</td>
<td>0</td>
</tr>
<tr>
<td>Focusing voltage</td>
<td>$V_{g3}$</td>
<td>220 to 360</td>
</tr>
<tr>
<td>Cut-off voltage for visual extinction</td>
<td>$-V_{g1}$</td>
<td>22 to 65</td>
</tr>
<tr>
<td>of focused spot</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Performance**

<table>
<thead>
<tr>
<th>Coefficient</th>
<th>Value (V/cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deflection coefficient</td>
<td></td>
</tr>
<tr>
<td>horizontal</td>
<td>32</td>
</tr>
<tr>
<td>vertical</td>
<td>35</td>
</tr>
<tr>
<td>$M_x$</td>
<td></td>
</tr>
<tr>
<td>$M_y$</td>
<td>21</td>
</tr>
<tr>
<td>Deviation of deflection linearity</td>
<td>2</td>
</tr>
<tr>
<td>Geometry distortion</td>
<td></td>
</tr>
<tr>
<td>Eccentricity of undeflected spot with</td>
<td></td>
</tr>
<tr>
<td>respect to internal graticule</td>
<td></td>
</tr>
<tr>
<td>horizontal</td>
<td>4</td>
</tr>
<tr>
<td>vertical</td>
<td>2</td>
</tr>
<tr>
<td>Angle between $x$ and $y$-traces</td>
<td>90°</td>
</tr>
<tr>
<td>Angle between $x$-trace and $x$-axis</td>
<td></td>
</tr>
<tr>
<td>of the internal graticule</td>
<td>5°</td>
</tr>
<tr>
<td>Grid drive voltage for 10 $\mu$A screen current</td>
<td>11</td>
</tr>
<tr>
<td>Line width</td>
<td>0.2</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Voltage</th>
<th>Value (V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accelerator voltage</td>
<td>$V_{g2,g4,g5,(l)}$</td>
</tr>
<tr>
<td>Focusing voltage</td>
<td>$V_{g3}$</td>
</tr>
<tr>
<td>Voltage between accelerator electrode</td>
<td>$V_{g2/g6}$</td>
</tr>
<tr>
<td>and grid 6</td>
<td></td>
</tr>
<tr>
<td>Voltage between accelerator electrode</td>
<td>$V_{g2/x/y}$</td>
</tr>
<tr>
<td>and any deflection plate</td>
<td></td>
</tr>
<tr>
<td>Control grid voltage</td>
<td>$-V_{g1}$</td>
</tr>
<tr>
<td>Cathode to heater voltage</td>
<td>$V_{k_f}$</td>
</tr>
<tr>
<td>positive</td>
<td></td>
</tr>
<tr>
<td>negative</td>
<td>$-V_{k_f}$</td>
</tr>
<tr>
<td>Heater voltage</td>
<td>$V_f$</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Grid drive voltage, averaged over 1 ms</td>
<td>$V_d$</td>
</tr>
<tr>
<td>Screen dissipation</td>
<td>$W_g$</td>
</tr>
<tr>
<td>Control grid circuit resistance</td>
<td>$R_{g1}$</td>
</tr>
</tbody>
</table>

April 1984
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. 82 mm x 66 mm is recommended. The internal graticule is aligned with the faceplate by using the faceplate reference points (see Fig. 4).

2. The mean x-plate potential and the mean y-plate potential should be equal to $V_{g2,g4,g5}(0)$. The tube features internal magnetic correction for astigmatism, orthogonality and eccentricity calibration. Optimum spot is obtained if $V_{g2,g4,g5}(0)$ is equal to mean y-potential.

3. An actual focus range of approx. 50 V should be provided on the front panel. $V_{g3}$ decreases with increasing grid drive (see also Fig. 5).

4. Intensity control on the front panel should be limited to the maximum useful screen current (approx. 80 µA; see also Fig. 5). It is to be adjusted either by the grid drive (up to 30 V) or for maximum acceptable line width. The corresponding cathode current or $I_{g2,g4,g5}$ (up to 500 µA) depend on the cut-off voltage and cannot be used for control settings.

5. 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.

6. A graticule consisting of concentric rectangles of 80 mm x 64 mm and 78,3 mm x 62,3 mm is aligned with the internal graticule. With optimum trace rotation correction the edges of a raster will fall between these rectangles.

7. The tube has a trace rotation coil, fixed onto the lower cone part. The coil has 1000 turns and a typical resistance of $180 \pm 25 \Omega$ at 20°C, which increases by 0.4%/K for rising temperature. Approx. 6 mA causes 1° trace rotation. Thus maximum required voltage is approx. 12 V for tube tolerances ($\pm 5^\circ$) and earth magnetic field with reasonable shielding ($\pm 2^\circ$).

8. Measured with the shrinking raster method within the useful scan under typical operating conditions, adjusted for optimum focus and dynamic correction applied.

As the construction of the tube does not permit a direct measurement of the beam current, this current should be determined as follows:

a) Under typical operating conditions, apply a small raster display (no overscan), adjust $V_{g1}$ for a beam current of approx. 10 µA and adjust $V_{g3}$ for smallest spot size at the centre of the screen. When measuring the beam current, grid 6 should be connected to g2-potential and the diodes should be disconnected from the x-plates.

b) Under these conditions, but without raster, the deflection plate voltages should be changed to:
   
   $V_y = 2000$ V; $V_x = 1300$ V; $V_{x2} = 1700$ V, thus directing the total beam current to $x_2$.

   Measure the current on $x_2$ and adjust $V_{g1}$ for $I_{x_2} = 10$ µA.

   c) Set again for the conditions under a), without touching the $V_{g1}$ control. The screen current of the resulting raster display is now 10 µA.

   Adjust $V_{g3}$ for optimum focus in the centre of the screen and apply dynamic correction to grid 6 for optimum vertical line width.
Fig. 5 Screen current ($I_{\text{screen}}$) and focusing voltage ($V_{\text{g3}}$) as a function of grid drive voltage ($V_d$): typical curves.
INSTRUMENT CATHODE-RAY TUBE

- 12 cm diagonal rectangular flat face
- domed mesh post-deflection acceleration
- internal magnetic lens system for correction of orthogonality, astigmatism and eccentricity
- low heater power consumption
- internal graticule
- high sensitivity and high brightness
- short overall length
- for compact oscilloscopes with up to 100 MHz bandwidth

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final accelerator voltage</td>
<td>$V_{g7(\ell)}$</td>
</tr>
<tr>
<td>First accelerator voltage</td>
<td>$V_{g4}$</td>
</tr>
<tr>
<td>Minimum useful scan area</td>
<td></td>
</tr>
<tr>
<td>Deflection coefficient</td>
<td></td>
</tr>
<tr>
<td>horizontal</td>
<td>$M_X$</td>
</tr>
<tr>
<td>vertical</td>
<td>$M_Y$</td>
</tr>
</tbody>
</table>

OPTICAL DATA

- Screen type: GH
- Screen colour: green
- Screen persistence: medium short
- Useful screen area: $\geq 82 \text{ mm} \times 66 \text{ mm}$; note 1
- Useful scan area: $\geq 80 \text{ mm} \times 64 \text{ mm}$
- Internal graticule: type 119; see Fig. 4

HEATING

- Indirect by AC or DC*
- Heater voltage: $V_f$ | 6.3 V
- Heater current: $I_f$ | 0.1 A
- Heating time to attain 10% of the cathode current at equilibrium conditions: approx. 7 s

* Not to be connected in series with other tubes.
MECHANICAL DATA
Dimensions and connections (see also outline drawings)
Overall length (socket included) \( \leq 299 \text{ mm} \)
Faceplate dimensions \( 98 \pm 0.5 \text{ mm} \times 82 \pm 0.5 \text{ mm} \)
Net mass approx. 750 g
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
Final accelerator contact connector type 55569/55597
to be established
Mu-metal shield electrostatic

FOCUSING

DEFLECTION
tax-plates double electrostatic
ty-plates symmetrical
**CAPACITANCES**

<table>
<thead>
<tr>
<th>Capacitance Description</th>
<th>Capacitance Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$x_1$ to all other elements except $x_2$</td>
<td>$C_{x1}(x2)$ 4.8 pF</td>
</tr>
<tr>
<td>$x_2$ to all other elements except $x_1$</td>
<td>$C_{x2}(x1)$ 3.6 pF</td>
</tr>
<tr>
<td>$y_1$ to all other elements except $y_2$</td>
<td>$C_{y1}(y2)$ 3.0 pF</td>
</tr>
<tr>
<td>$y_2$ to all other elements except $y_1$</td>
<td>$C_{y2}(y1)$ 3.0 pF</td>
</tr>
<tr>
<td>$x_1$ to $x_2$</td>
<td>$C_{x1x2}$ 3.3 pF</td>
</tr>
<tr>
<td>$y_1$ to $y_2$</td>
<td>$C_{y1y2}$ 1.4 pF</td>
</tr>
<tr>
<td>Control grid to all other elements</td>
<td>$C_{g1}$ 6.5 pF</td>
</tr>
<tr>
<td>Cathode to all other elements</td>
<td>$C_{k}$ 3.2 pF</td>
</tr>
<tr>
<td>Focusing electrode to all other elements</td>
<td>$C_{g3}$ 8.0 pF</td>
</tr>
<tr>
<td>Final accelerator electrode to all other elements</td>
<td>$C_{g7}$ 140 pF</td>
</tr>
</tbody>
</table>
1. Dimensions of faceplate only. The complete assembly of faceplate and cone (frit seal included) will pass through an opening of 101 mm x 85 mm (diagonal 125 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).

5. The centre of the final accelerator contact is situated within a square of 10 mm x 10 mm around the indicated position.
DIMENSIONS AND CONNECTIONS (continued)

Fig. 2 Pin arrangement; bottom view.

Fig. 3 Electrode configuration.

Fig. 4 Front view of tube with internal graticule, type 119 (final accelerator contact at right-hand side).
The faceplate reference points are used for aligning the graticule with the faceplate.
Line thickness = 0,2 mm; dot diameter = 0,4 mm; colour: red.
**TYPICAL OPERATION** (voltages with respect to cathode) *

<table>
<thead>
<tr>
<th>Conditions</th>
<th>Value 1</th>
<th>Value 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final accelerator voltage</td>
<td>$V_{g7}(\ell)$</td>
<td>10</td>
</tr>
<tr>
<td>Mean deflection plate potential</td>
<td>1,5</td>
<td>2,2 kV</td>
</tr>
<tr>
<td>Shield voltage for optimum geometry</td>
<td>$V_{g5}$</td>
<td>1,5</td>
</tr>
<tr>
<td>First accelerating and astigmatism control</td>
<td>$V_{g4}$</td>
<td>1,5</td>
</tr>
<tr>
<td>Focusing voltage</td>
<td>$V_{g3}$</td>
<td>0,19 × $V_{g4}$ to 0,26 × $V_{g4}$</td>
</tr>
<tr>
<td>Grid 2 voltage</td>
<td>$V_{g2}$</td>
<td>1,5</td>
</tr>
<tr>
<td>Cut-off voltage for visual extinction of focused spot</td>
<td>$-V_{g1}$</td>
<td>34 to 68</td>
</tr>
</tbody>
</table>

Outer conductive coating (m) and mu-metal shield to be earthed.

**Performance**

<table>
<thead>
<tr>
<th>Performance</th>
<th>$M_x$</th>
<th>$M_y$</th>
<th>Value 1</th>
<th>Value 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horizontal deflection coefficient</td>
<td>5,8</td>
<td></td>
<td>8,3 V/div ± 10%</td>
<td></td>
</tr>
<tr>
<td>Vertical deflection coefficient</td>
<td>3,0</td>
<td></td>
<td>4,3 V/div ± 5%</td>
<td></td>
</tr>
<tr>
<td>Deviation of deflection linearity</td>
<td>&lt; 2%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Geometry distortion</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eccentricity of undeflected spot</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>in horizontal direction</td>
<td></td>
<td></td>
<td>&lt; 4 mm</td>
<td></td>
</tr>
<tr>
<td>in vertical direction</td>
<td></td>
<td></td>
<td>&lt; 2 mm</td>
<td></td>
</tr>
<tr>
<td>Angle between x- and y-traces</td>
<td></td>
<td></td>
<td>90°</td>
<td>note 2</td>
</tr>
<tr>
<td>Angle between x-trace and x-axis of internal graticule</td>
<td></td>
<td></td>
<td>&lt; 5°</td>
<td>note 6</td>
</tr>
<tr>
<td>Luminance reduction with respect to screen centre</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>x-axis, outer graticule line</td>
<td></td>
<td></td>
<td>&lt; 30%</td>
<td></td>
</tr>
<tr>
<td>y-axis, outer graticule line</td>
<td></td>
<td></td>
<td>&lt; 30%</td>
<td></td>
</tr>
<tr>
<td>any corner</td>
<td></td>
<td></td>
<td>&lt; 50%</td>
<td></td>
</tr>
<tr>
<td>Grid drive for 10 µA screen current</td>
<td>$V_d$</td>
<td></td>
<td>approx. 20 V</td>
<td></td>
</tr>
<tr>
<td>Line width</td>
<td>l.w.</td>
<td></td>
<td>approx. 0.25 mm</td>
<td></td>
</tr>
</tbody>
</table>

* Notes are on last page but one.
**LIMITING VALUES** (Absolute maximum rating system)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Unit</th>
<th>Value</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final accelerator voltage</td>
<td>$V_{g7\text{(R)}}$</td>
<td>max.</td>
<td>18 kV</td>
<td></td>
</tr>
<tr>
<td>Shield voltage</td>
<td>$V_{g5}$</td>
<td>max.</td>
<td>3.3 kV</td>
<td></td>
</tr>
<tr>
<td>First accelerator and astigmatism control voltage</td>
<td>$V_{g4}$</td>
<td>max.</td>
<td>3.3 kV</td>
<td></td>
</tr>
<tr>
<td>Focusing electrode voltage</td>
<td>$V_{g3}$</td>
<td>max.</td>
<td>2.5 kV</td>
<td></td>
</tr>
<tr>
<td>Grid 2 voltage</td>
<td>$V_{g2}$</td>
<td>max.</td>
<td>2.5 kV</td>
<td></td>
</tr>
<tr>
<td>Control grid voltage</td>
<td>$-V_{g1}$</td>
<td>max.</td>
<td>200 V</td>
<td></td>
</tr>
<tr>
<td>min. 0 V</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cathode to heater voltage</td>
<td>$V_{kf}$</td>
<td>max.</td>
<td>125 V</td>
<td></td>
</tr>
<tr>
<td>negative</td>
<td>$-V_{kf}$</td>
<td>max.</td>
<td>125 V</td>
<td></td>
</tr>
<tr>
<td>Heater voltage</td>
<td>$V_{f}$</td>
<td>max.</td>
<td>6.6 V</td>
<td></td>
</tr>
<tr>
<td>min. 6.0 V</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Voltage between $g2$ and $g4$</td>
<td>$\Delta V_{g2,g4}$</td>
<td>max.</td>
<td>2 kV</td>
<td></td>
</tr>
<tr>
<td>Voltage between $g4,g5$ and any deflection plate</td>
<td>$\Delta V_{g4,g5,x,y}$</td>
<td>max.</td>
<td>500 V</td>
<td></td>
</tr>
<tr>
<td>Grid drive, averaged over 1 ms</td>
<td>$V_d$</td>
<td>max.</td>
<td>25 V</td>
<td></td>
</tr>
<tr>
<td>Screen dissipation</td>
<td>$W_{g}$</td>
<td>max.</td>
<td>8 mW/cm$^2$</td>
<td></td>
</tr>
<tr>
<td>Control grid circuit resistance</td>
<td>$R_{g1}$</td>
<td>max.</td>
<td>1 MΩ</td>
<td></td>
</tr>
</tbody>
</table>
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. 82 mm x 66 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; floating mean x- or y-potentials will result into non-uniform line width and geometry distortion. The mean x- and y-potentials should be equal; under this condition the tube will be within the specification without corrections for astigmatism and geometry. A range of \( \Delta V_{g5} = -50 \) to \( +50 \) V may be applied for pincushion/barrel correction. The tube features internal magnetic correction for orthogonality between x- and y-traces, spot shaping (astigmatism) and eccentricity calibration.

3. For some applications a mean x-potential up to 50 V positive with respect to mean y-potential is inevitable. In this case \( V_{g5} \) must be made equal to mean x-potential, and a range of 0 to \(-25 \) V with respect to mean y-potential will be required on \( g4 \) for astigmatism correction. The circuit resistance for \( V_{g4} \) should be \( \leq 10 \) k\( \Omega \).

4. 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.

5. A graticule consisting of concentric rectangles of 80 mm x 64 mm and 78,4 mm x 62,4 mm is aligned with the internal graticule. With optimum trace rotation correction the edges of a raster will fall between these rectangles.

6. The tube has a trace rotation coil, fixed onto the lower cone part. The coil has 1000 turns and a typical resistance of 185 \( \pm 25 \) \( \Omega \) at 20 °C, which increases by approx. 0,4%/K for rising temperature. At typical operation (\( V_{g5} = 2200 \) V, \( V_{g7} = 16,5 \) kV) approx. 6,5 mA causes 1° trace rotation. Thus maximum required voltage is approx. 13 V for tube tolerances (\( \pm 50 \)) and earth magnetic field with reasonable shielding (\( \pm 20° \)). The required current for 1° trace rotation is related to approx. \( \sqrt{V_{g5}} \).

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 \( I_g = 10 \mu A \).

8. The X-ray dose rate remains below the acceptable value of 36 pA/kg (0,5 mR/h), when the tube is used within its limiting values (beam current \( I_g \leq 100 \mu A \)).
Fig. 5 Beam current ($I_{bx}$) and focusing voltage ($V_{g3}$) as a function of grid drive voltage ($V_d$) at $V_{g7} = 16.5$ kV, $V_{g5} = 2.2$ kV; typical curves.

$I_{bx}$ is the beam current, without scan, measured on x2, when the deflection plate potentials have been adjusted to $V_{y1} = V_{y2} = 2200$ V, $V_{x1} = 1500$ V, $V_{x2} = 1900$ V, thus directing the total beam current to x2.
INSTRUMENT CATHODE-RAY TUBE

- mono accelerator
- 12 cm diagonal rectangular flat face
- internal magnetic correction for astigmatism, vertical eccentricity and orthogonality
- low heater power consumption
- for portable oscilloscopes with up to 25 MHz bandwidth, and read-out devices

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th></th>
<th>V_{g2,g4,g5(f)}</th>
<th>2000 V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accelerator voltage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum useful scan area</td>
<td></td>
<td>80 mm x 64 mm</td>
</tr>
<tr>
<td>Deflection coefficient</td>
<td></td>
<td></td>
</tr>
<tr>
<td>horizontal</td>
<td>M_x</td>
<td>19 V/div (23.8 V/cm)</td>
</tr>
<tr>
<td>vertical</td>
<td>M_y</td>
<td>11 V/div (13.8 V/cm)</td>
</tr>
</tbody>
</table>

OPTICAL DATA

- Screen type: GY, colour green
- Screen persistence: medium
- Useful screen area: \( \geq 82 \text{ mm x 66 mm} \); note 1
- Useful scan area: \( \geq 80 \text{ mm x 64 mm} \)
- Internal graticule: type 119; see Fig. 4

HEATING

- Indirect by a.c. or d.c.*
- Heater voltage: \( V_f = 6.3 \text{ V} \)
- Heater current: \( I_f = 0.1 \text{ A} \)
- Heating time to attain 10% of the cathode current at equilibrium conditions: approx. 7 s

Not to be connected in series with other tubes.

July 1987
MECHANICAL DATA

Dimensions and connections (see also outline drawing)
Overall length (socket included) < 292 mm
Faceplate dimensions 98 ± 0,5 mm x 82 ± 0,5 mm
Net mass approx. 0,7 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 to be established

FOCUSING
electrostatic
deflection
x-plates double electrostatic
y-plates symmetrical

DEFLECTION
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 $x_2$

$x_2$ to all other elements except $x_1$

$y_1$ to all other elements except $y_2$

$y_2$ to all other elements except $y_1$

$x_1$ to $x_2$

$y_1$ to $y_2$

Control grid to all other elements

Cathode to all other elements

$C_{x1}(x2)$ 4.5 pF

$C_{x2}(x1)$ 4 pF

$C_{y1}(y2)$ 3.4 pF

$C_{y2}(y1)$ 3.4 pF

$C_{x1x2}$ 3.2 pF

$C_{y1y2}$ 1 pF

$C_{g1}$ 6 pF

$C_{k}$ 3 pF
(1) Dimensions of faceplate only. The complete assembly of faceplate and cone (frit seal included) will pass through an opening of 101 mm x 85 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.

Internal graticule

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

Fig. 3 Electrode configuration.

Fig. 4 Front view of tube with internal graticule, type 119.
Line thickness = 0.2 mm; dot diameter = 0.4 mm; colour: red.
TYPICAL OPERATION (voltages with respect to cathode)

Conditions
Mean deflection plate potential
Shield voltage for optimum geometry \( V_{g5} (l) \)
Accelerator and astigmatism control voltage \( V_{g2,g4} \)
Focusing voltage \( V_{g3} \)
Cut-off voltage for visual extinction of focused spot \(-V_{g1}\)

Performance
Deflection coefficient
horizontal \( M_x \) \(<\) 19 V/div (23,8 V/cm)
vertical \( M_y \) \(<\) 11 V/div (13,8 V/cm)

Deviation of deflection linearity \( \leq \) 2 %

Geometry distortion see note 8

Luminance reduction at the edges of the useful scan (100 mm x 80 mm),
with respect to screen centre \( \leq \) 30 %

Eccentricity of undeflected spot with respect to internal graticule
horizontal \( \leq 4 \text{ mm} \)
vertical \( \leq 2 \text{ mm} \)

Angle between x and y-traces \( 90^\circ \)
Angle between x-trace and x-axis of the internal graticule \( \leq 5^\circ \)
Grid drive voltage for 10 \( \mu \text{A} \) screen current \( V_d \) \( \approx \) 10 V

Line width \( l.w. \) \( \approx 0,25 \text{ mm} \)

LIMITING VALUES (Absolute maximum rating system)
Accelerator voltage \( V_{g2,g4} \) max. 2200 V
Shield voltage \( V_{g5} (l) \) max. 2200 V
Focusing electrode voltage \( V_{g3} \) max. 2200 V
Control grid voltage \(-V_{g1}\) max. 200 V
Cathode to heater voltage
positive \( V_{k_f} \) max. 125 V
negative \(-V_{k_f}\) max. 125 V
Heater voltage \( V_f \) max. 6,6 V
Grid drive voltage, averaged over 1 ms \( V_d \) max. 20 V
Screen dissipation \( W_{g} \) 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. 82 mm x 66 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 \( g_5 \) can be connected to \( g_2, g_4 \), 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 \( \pm 50 \) V around mean x-potential may be applied for further correction.

4. Optimum spot is obtained with \( V_{g2}, g_4 \) equal to mean y-potential (see note 2). In general a tolerance of \( \pm 4 \) V has no visible effect; \( V_{g2}, g_4 \) tends to be lower with \( V_{g5} \) more positive. The circuit impedance \( R_{g2}, g_4 \) should be less than 10 k\( \Omega \).

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 \( \mu \)A; 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 \( \mu \)A) 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 80 mm x 64 mm and 78,3 mm x 62,3 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 \( \pm 25 \) \( \Omega \) at 20 \( ^\circ \)C, which increases by approx. 0,4%/K for rising temperature. Approx. 5 mA causes 1\(^\circ\) trace rotation. Thus maximum required voltage is approx. 11 V for tube tolerances (\( \pm 5^\circ \)) and earth magnetic field with reasonable shielding (\( \pm 2^\circ \)).

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 \( I_g = 10 \) \( \mu \)A.
Fig. 5 Screen current ($I_{\text{screen}}$) and focusing voltage ($V_{g3}$) as a function of grid drive voltage ($V_d$): typical curves.
INSTRUMENT CATHODE-RAY TUBE

13 cm diameter flat faced monoaccelerator oscilloscope tube primarily intended for use in inexpensive oscilloscopes and read-out devices.

<table>
<thead>
<tr>
<th>QUICK REFERENCE DATA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accelerator voltage</td>
</tr>
<tr>
<td>Display area</td>
</tr>
<tr>
<td>Deflection coefficient, horizontal</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Deflection coefficient, vertical</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

SCREEN

<table>
<thead>
<tr>
<th></th>
<th>colour</th>
<th>persistence</th>
</tr>
</thead>
<tbody>
<tr>
<td>D13-480GH</td>
<td>green</td>
<td>medium short</td>
</tr>
<tr>
<td>D13-480GM</td>
<td>yellowish green</td>
<td>long</td>
</tr>
</tbody>
</table>

Useful screen diameter min. 114 mm

Useful scan

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>horizontal</td>
<td>min. 100 mm</td>
</tr>
<tr>
<td>vertical</td>
<td>min. 80 mm</td>
</tr>
</tbody>
</table>

The useful scan may be shifted vertically to a max. of 6 mm with respect to the geometric centre of the faceplate.

HEATING: Indirect by AC or DC; parallel supply

Heater voltage \( V_f \) 6.3 V
Heater current \( I_f \) 300 mA
MECHANICAL DATA

Fig. 1 Outlines.

Mounting position: any

The tube should not be supported by the base alone and under no circumstances should the socket be allowed to support the tube.

Dimensions and connections

See also outline drawing

Overall length

max. 310 mm

Face diameter

max. 135 mm

Base

14 pin all glass

Net weight

approx. 650 g

Accessories

Socket (supplied with tube) type 55566

Mu-metal shield type 55580
CAPACITANCES

- $x_1$ to all other elements except $x_2$: $C_{x1}(x2) = 4 \text{ pF}$
- $x_2$ to all other elements except $x_1$: $C_{x2}(x1) = 4 \text{ pF}$
- $y_1$ to all other elements except $y_2$: $C_{y1}(y2) = 3.5 \text{ pF}$
- $y_2$ to all other elements except $y_1$: $C_{y2}(y1) = 3 \text{ pF}$
- $x_1$ to $x_2$: $C_{x1x2} = 1.6 \text{ pF}$
- $y_1$ to $y_2$: $C_{y1y2} = 1.1 \text{ pF}$
- Control grid to all other elements: $C_{g1} = 5.5 \text{ pF}$
- Cathode to all other elements: $C_k = 4 \text{ pF}$

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 intercept part of the electron beam, hence a low impedance deflection plate drive is desirable.

Angle between $x$ and $y$ traces: $90 \pm 1^\circ$

LINE WIDTH

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 $I_g = 10 \mu A.1$.

Line width: $l.w. = 0.30 \text{ mm}$

As the construction of this tube does not permit a direct measurement of the beam current, this current should be determined as follows:

a) under typical operating conditions, apply a small raster display (no overscan), adjust $V_{g1}$ for a beam current of approx. $10 \mu A$ and adjust $V_{g3}$ and $V_{g2}, g4, g5, g6$ for optimum spot quality at the centre of the screen.

b) under these conditions, but no raster, the deflection plate voltages should be changed to $V_{y1} = V_{y2} = 2000 \text{ V}$; $V_{x1} = 1300 \text{ V}$; $V_{x2} = 1700 \text{ V}$, thus directing the total beam current to $x_2$.

Measure the current on $x_2$ and adjust $V_{g1}$ for $I_{x2} = 10 \mu A$ (being the beam current $I_g$)

c) set again for the conditions under a), without touching the $V_{g1}$ control. Now a raster display with a true $10 \mu A$ screen current is achieved.

d) focus optimally in the centre of the screen (do not adjust the astigmatism control) and measure the line width.
TYPICAL OPERATING CONDITIONS see note 3

Accelerator voltage \( V_{g2, g4, g5, l} \) 2000 V
Astigmatism control voltage \( \Delta V_{g2, g4, g5, l} \) \( \pm 50 \) V see note 1
Focusing electrode voltage \( V_{g3} \) 220 to 370 V
Control grid voltage for visual extinction of focused spot \( V_{g1} \) max. -65 V
Grid drive for 10 \( \mu A \) screen current approx.10 V
Deflection coefficient, horizontal \( M_x \) 31.3 V/cm max. 33 V/cm
vertical \( M_y \) 14.4 V/cm max. 15.5 V/cm
max. 1 % see note 2
Deviation of linearity of deflection Geometry distortion see note 4
Useful scan, horizontal min. 100 mm
vertical min. 80 mm

LIMITING VALUES (Absolute max., rating system)

Accelerator voltage \( V_{g2, g4, g5, l} \) max. 2200 V min. 1500 V
Focusing electrode voltage \( V_{g3} \) max. 2200 V
Control grid voltage, negative \( -V_{g1} \) max. 200 V min. 0 V
Cathode to heater voltage \( V_{kf} \) max. 125 V
\( -V_{kf} \) max. 125 V
Grid drive, average max. 20 V
Screen dissipation \( W_{f} \) max. 3 mW/cm²
Control grid circuit resistance \( R_{gl} \) max. 1 MΩ

Notes
1. All that will be necessary when putting the tube into operation is to adjust the astigmatism control voltage once for optimum spot shape in the screen centre. The control voltage will always be in the range stated, provided the mean \( x \) and certainly the mean \( y \) plate potential was made equal to \( V_{g2, g4, g5, l} \) with zero astigmatism correction.
2. 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.
3. The mean \( x \) and certainly the mean \( y \) plate potential should be equal to \( V_{g2, g4, g5, l} \) with astigmatism adjustment set to zero.
4. A graticule, consisting of concentric rectangles of 70 mm x 85 mm and 68.8 mm x 83 mm as aligned with the electrical \( x \)-axis of the tube. The edges of a raster will fall between these rectangles.
INSTRUMENT CATHODE-RAY TUBE

13 cm diameter flat-faced monoaccelerator oscilloscope tube with low heater consumption.

**QUICK REFERENCE DATA**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accelerator voltage</td>
<td>$V_{g2, g4, g6}$ (V)</td>
</tr>
<tr>
<td>Display area</td>
<td>$100 \times 80$ mm$^2$</td>
</tr>
<tr>
<td>Deflection coefficient</td>
<td></td>
</tr>
<tr>
<td>horizontal</td>
<td>$M_X$</td>
</tr>
<tr>
<td>vertical</td>
<td>$M_Y$</td>
</tr>
</tbody>
</table>

The D13–481.. is equivalent to the type D13–480.. except for the following.

**HEATING**

Indirect by AC or DC; parallel

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heater voltage</td>
<td>$V_f$</td>
</tr>
<tr>
<td>Heater current</td>
<td>$I_f$</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cathode to heater voltage</td>
<td>$V + k/f -$ max.</td>
</tr>
<tr>
<td>positive</td>
<td></td>
</tr>
<tr>
<td>negative</td>
<td>$V - k/f +$ max.</td>
</tr>
</tbody>
</table>

**CAPACITANCES**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cathode to all other elements</td>
<td>$C_k$</td>
</tr>
</tbody>
</table>
INSTRUMENT CATHODE-RAY TUBE

14 cm diagonal, rectangular flat faced oscilloscope tube with mesh and metal backed screen.

<table>
<thead>
<tr>
<th>QUICK REFERENCE DATA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final accelerator voltage $V_{g7(t)}$ 10 kV</td>
</tr>
<tr>
<td>Display area 100 x 80 mm²</td>
</tr>
<tr>
<td>Deflection coefficient, horizontal $M_x$ 15,5 V/cm</td>
</tr>
<tr>
<td>vertical $M_y$ 4,2 V/cm</td>
</tr>
</tbody>
</table>

SCREEN: Metal backed phosphor

<table>
<thead>
<tr>
<th>Colour</th>
<th>Persistence</th>
</tr>
</thead>
<tbody>
<tr>
<td>green</td>
<td>medium short</td>
</tr>
</tbody>
</table>

Useful screen area $> 100 \times 80$ mm²
Useful scan at $V_{g7(t)}/V_{g2, g4} = 6,7$ , horizontal $> 100$ mm
vertical $> 80$ mm
Spot eccentricity in horizontal and vertical directions $< 6$ mm

HEATING: Indirect by AC or DC: parallel supply
Heater voltage $V_f$ 6,3 V
Heater current $I_f$ 300 mA

MECHANICAL DATA
Dimensions and connections
See also outline drawing
Overall length (socket included) $< 385$ mm
Face dimensions $< 100 \times 120$ mm
Net mass approx. 900 g
Base 14-pin all-glass
Fig. 1 Outlines.

(1) The centre of the contact is located within a square of 10 mm x 10 mm around the true geometrical position.
(2) The bulge at the frit seal may increase the indicated maximum dimensions by not more than 2 mm.

Mounting position any
The tube should not be supported by the base alone; under no circumstances should the socket be allowed to support the tube.

Accessories
Socket (supplied with tube) type 55566
Final accelerator contact connector type 55563A
Mu-metal shield type 55581
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 intercept part of the electron beam; hence a low impedance deflection plate drive is desirable.

Angle between x and y traces  90° ± 1°
Angle between x trace and the horizontal axis of the face < 5°  see note 6

LINE WIDTH

Measured with the shrinking raster method under typical operating conditions, adjusted for optimum spot size at a beam current \( I_b = 10 \, \mu A \).

Line width at the centre of the screen
  over the whole screen area

<table>
<thead>
<tr>
<th>1. w.</th>
<th>0.40  mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. w.  av.</td>
<td>&lt; 0.45 mm</td>
</tr>
</tbody>
</table>

CAPACITANCES

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>( x_1 ) to all other elements except ( x_2 )</td>
<td>( C_{x1}(x2) ) 6.5 pF</td>
</tr>
<tr>
<td>( x_2 ) to all other elements except ( x_1 )</td>
<td>( C_{x2}(x1) ) 6.5 pF</td>
</tr>
<tr>
<td>( y_1 ) to all other elements except ( y_2 )</td>
<td>( C_{y1}(y2) ) 5.0 pF</td>
</tr>
<tr>
<td>( y_2 ) to all other elements except ( y_1 )</td>
<td>( C_{y2}(y1) ) 5.0 pF</td>
</tr>
<tr>
<td>( x_1 ) to ( x_2 )</td>
<td>( C_{x1x2} ) 2.2 pF</td>
</tr>
<tr>
<td>( y_1 ) to ( y_2 )</td>
<td>( C_{y1y2} ) 1.7 pF</td>
</tr>
<tr>
<td>Control grid to all other elements</td>
<td>( C_{g1} ) 5.5 pF</td>
</tr>
<tr>
<td>Cathode to all other elements</td>
<td>( C_k ) 4.5 pF</td>
</tr>
</tbody>
</table>

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### TYPICAL OPERATING CONDITIONS

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final accelerator voltage</td>
<td>$V_{g7(t)}$</td>
</tr>
<tr>
<td>Interplate shield voltage</td>
<td>$V_{g6}$</td>
</tr>
<tr>
<td>Geomtry control voltage</td>
<td>$\Delta V_{g6}$</td>
</tr>
<tr>
<td>Deflection plate shield voltage</td>
<td>$V_{g5}$</td>
</tr>
<tr>
<td>Focusing electrode voltage</td>
<td>$V_{g3}$</td>
</tr>
<tr>
<td>First accelerator voltage</td>
<td>$V_{g2,g4}$</td>
</tr>
<tr>
<td>Astigmatism control voltage</td>
<td>$\Delta V_{g2,g4}$</td>
</tr>
<tr>
<td>Control voltage for visual extinction of focused spot</td>
<td>$V_{g1}$</td>
</tr>
<tr>
<td>Grid drive for 10 µA screen current</td>
<td>approx.</td>
</tr>
<tr>
<td>Deflection coefficient, horizontal</td>
<td>$M_x$</td>
</tr>
<tr>
<td></td>
<td>$M_y$</td>
</tr>
<tr>
<td>Deviation of linearity of deflection</td>
<td>&lt; 2 %</td>
</tr>
<tr>
<td>Geometry distortion</td>
<td>See note 5</td>
</tr>
<tr>
<td>Useful scan, horizontal</td>
<td>&gt; 100 mm</td>
</tr>
<tr>
<td></td>
<td>&gt; 80 mm</td>
</tr>
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### LIMITING VALUES (Absolute max. rating system)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final accelerator voltage</td>
<td>$V_{g7(t)}$</td>
</tr>
<tr>
<td></td>
<td>min. 9 kV</td>
</tr>
<tr>
<td>Interplate shield voltage and geometry control electrode voltage</td>
<td>$V_{g6}$</td>
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<tr>
<td>Focusing electrode voltage</td>
<td>$V_{g3}$</td>
</tr>
<tr>
<td>First accelerator and astigmatism control electrode voltage</td>
<td>$V_{g2,g4}$</td>
</tr>
<tr>
<td></td>
<td>min. 1350 V</td>
</tr>
<tr>
<td>Control grid voltage</td>
<td>$-V_{g1}$</td>
</tr>
<tr>
<td></td>
<td>min. 0 V</td>
</tr>
<tr>
<td>Cathode to heater voltage</td>
<td>$V_{kf}$</td>
</tr>
<tr>
<td></td>
<td>$-V_{kf}$</td>
</tr>
<tr>
<td>Voltage between astigmatism control electrode and any deflection plate</td>
<td>$V_{g4/x}$</td>
</tr>
<tr>
<td></td>
<td>$V_{g4/y}$</td>
</tr>
<tr>
<td>Grid drive, average</td>
<td>max. 20 V</td>
</tr>
<tr>
<td>Screen dissipation</td>
<td>$W_L$</td>
</tr>
<tr>
<td>Ratio $V_{g7(t)}/V_{g2,g4}$</td>
<td>$V_{g7(t)}/V_{g4}$</td>
</tr>
<tr>
<td>Control grid circuit resistance</td>
<td>$R_{g1}$</td>
</tr>
</tbody>
</table>
Notes
1. This tube is designed for optimum performance when operating at a ratio $V_{g7(\xi)}/V_{g2}$, $g4 = 6.7$. The geometry electrode voltage should be adjusted within the indicated range (values with respect to the mean x-plate potential). A negative control voltage will cause some pincushion distortion and less background light, a positive control voltage will give some barrel distortion and a slight increase of background light.
2. The deflection plate shield voltage should be equal to the mean y-plate potential. The mean x-plate and y-plate potentials should be equal for optimum spot quality.
3. The astigmatism control electrode voltage should be adjusted for optimum spot shape. For any necessary adjustment its potential will be within the stated range.
4. 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.
5. A graticule, consisting of concentric rectangles of 95 mm x 75 mm and 93 mm x 73.6 mm is aligned with the electrical x-axis of the tube. With optimum correction potentials applied a raster will fall between these rectangles.
6. To align the x trace with the horizontal axis of the screen, the whole picture can be rotated by means of a rotation coil. This coil will have 50 ampere turns for the indicated maximum rotation of 5° and should be positioned as indicated in the drawing.
INSTRUMENT CATHODE-RAY TUBE

14 cm diagonal, rectangular flat-faced oscilloscope tube with mesh and metal backed screen. The tube has side connections to the x- and y-plates, and is intended for use in transistorized oscilloscopes up to a frequency of 50 MHz.

<table>
<thead>
<tr>
<th>QUICK REFERENCE DATA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final accelerator voltage ( V_{g8} )</td>
</tr>
<tr>
<td>Display area</td>
</tr>
<tr>
<td>Deflection coefficient, horizontal ( M_x )</td>
</tr>
<tr>
<td>vertical ( M_y )</td>
</tr>
</tbody>
</table>

SCREEN: Metal backed phosphor

<table>
<thead>
<tr>
<th>Colour</th>
<th>Persistence</th>
</tr>
</thead>
<tbody>
<tr>
<td>D14-121GH</td>
<td>green</td>
</tr>
</tbody>
</table>

Useful screen area \( > 100 \times 80 \) mm²

Useful scan at \( V_{g8}/V_{g2}, g_4 = 6, 7 \), horizontal \( > 100 \) mm

vertical \( > 80 \) mm

Spot eccentricity in horizontal and vertical directions \( < 6 \) mm

HEATING
Indirect by AC or DC; parallel supply
Heater voltage \( V_f \) 6, 3 V
Heater current \( I_f \) 300 mA
MECHANICAL DATA

(1) The bulge at the frit seal may increase the indicated maximum dimensions by not more than 2 mm.

(2) The centre of the contact is located within a square of 10 mm x 10 mm around the true geometrical position.

Fig. 1 Outlines.

Mounting position

The tube should not be supported by the base alone and under no circumstances should the socket be allowed to support the tube.
Dimensions and connections

See also outline drawing
Overall length (socket included)          <  385  mm
Face dimensions                            <  100 x  120  mm

Net mass                                     approx.  900  g

Base                                        14-pin all glass

Accessories
Socket (supplied with tube)      type  55566
Final accelerator contact connector type  55563A
Mu-metal shield                   type  55581A

CAPACITANCES

\[ x_1 \text{ to all other elements except } x_2 \]
\[ x_2 \text{ to all other elements except } x_1 \]
\[ y_1 \text{ to all other elements except } y_2 \]
\[ y_2 \text{ to all other elements except } y_1 \]
\[ x_1 \text{ to } x_2 \]
\[ y_1 \text{ to } y_2 \]
Control grid to all other elements
Cathode to all other elements

- \[ C_{x1}(x2) \]
- \[ 5,5 \text{ pF} \]
- \[ C_{x2}(x1) \]
- \[ 5,5 \text{ pF} \]
- \[ C_{y1}(y2) \]
- \[ 4 \text{ pF} \]
- \[ C_{y2}(y1) \]
- \[ 4 \text{ pF} \]
- \[ C_{x1x2} \]
- \[ 2,2 \text{ pF} \]
- \[ C_{y1y2} \]
- \[ 1,7 \text{ pF} \]
- \[ C_{g1} \]
- \[ 5,5 \text{ pF} \]
- \[ C_k \]
- \[ 4,5 \text{ pF} \]

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 intercept part of the electron beam; hence a low impedance deflection plate drive is desirable.

Angle between x and y traces  \[ 90 \pm 1^\circ \]
Angle between x trace and the horizontal axis of the face  \[ < 5^\circ \text{ see note 1} \]

LINE WIDTH

Measured with the shrinking raster method under typical operating conditions, adjusted for optimum spot size at a beam current \( I_b = 10 \mu A \).

Line width at screen centre \( l.w. \)  0,40  mm
Line width over the whole screen area \( l.w. \text{ av.} < 0,45 \text{ mm} \)
TYPICAL OPERATING CONDITIONS

Final accelerator voltage
Geometry-control electrode voltage
Post deflection and interplate shield voltage
Background illumination control voltage
Deflection plate shield voltage
Focusing electrode voltage
First accelerator voltage
Astigmatism control voltage
Control grid voltage for extinction of focused spot
Grid drive for 10 µA screen current
Deflection coefficient, horizontal
vertical
Deviation of linearity of deflection
Geometry distortion
Useful scan, horizontal
vertical

LIMITING VALUES (Absolute max. rating system)

Final accelerator voltage
Post deflection and interplate shield voltage and geometry control electrode voltage
Deflection plate shield voltage
Focusing electrode voltage
First accelerator and astigmatism control electrode voltage
Control grid voltage
Cathode to heater voltage
Voltage between astigmatism control electrode and any deflection plate
Grid drive, average
Screen dissipation
Ratio \( V_{g8}(\ell)/V_{g2,g4} \)
Control grid circuit resistance

<table>
<thead>
<tr>
<th>Voltage (V)</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>( V_{g8}(\ell) )</td>
<td>10 kV</td>
</tr>
<tr>
<td>( V_{g7} )</td>
<td>1500 ± 100 V</td>
</tr>
<tr>
<td>( V_{g6} )</td>
<td>1500 V</td>
</tr>
<tr>
<td>( \Delta V_{g6} )</td>
<td>0 to -15 V</td>
</tr>
<tr>
<td>( V_{g5} )</td>
<td>1500 V</td>
</tr>
<tr>
<td>( V_{g3} )</td>
<td>250 to 350 V</td>
</tr>
<tr>
<td>( V_{g2,g4} )</td>
<td>1500 V</td>
</tr>
<tr>
<td>( \Delta V_{g2,g4} )</td>
<td>±50 V</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Voltage (V)</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>( V_{g1} )</td>
<td>-20 to -60 V</td>
</tr>
<tr>
<td>( V_{g1} )</td>
<td>approx. 12 V</td>
</tr>
<tr>
<td>( V_{g1} )</td>
<td>avg. 15, 5 V/cm</td>
</tr>
<tr>
<td>( V_{g1} )</td>
<td>&lt; 16 V/cm</td>
</tr>
<tr>
<td>( V_{g1} )</td>
<td>avg. 4, 2 V/cm</td>
</tr>
<tr>
<td>( V_{g1} )</td>
<td>&lt; 4, 6 V/cm</td>
</tr>
<tr>
<td>( V_{g1} )</td>
<td>&gt; 2 %</td>
</tr>
</tbody>
</table>

See note 6

<table>
<thead>
<tr>
<th>Dimension (mm)</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Useable scan</td>
<td>&gt; 100</td>
</tr>
<tr>
<td>Useable scan</td>
<td>&gt; 80</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Voltage (V)</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>( V_{g8}(\ell)/V_{g2,g4} )</td>
<td>max. 6.7</td>
</tr>
<tr>
<td>( R_{g1} )</td>
<td>max. 1 MΩ</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Voltage (V)</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>( V_{g8}(\ell)/V_{g2,g4} )</td>
<td>max. 11 kV</td>
</tr>
<tr>
<td>( V_{g8}(\ell)/V_{g2,g4} )</td>
<td>min. 9 kV</td>
</tr>
<tr>
<td>( V_{g7}/V_{g6} )</td>
<td>max. 2200 V</td>
</tr>
<tr>
<td>( V_{g7}/V_{g6} )</td>
<td>max. 2200 V</td>
</tr>
<tr>
<td>( V_{g7}/V_{g6} )</td>
<td>max. 2200 V</td>
</tr>
<tr>
<td>( V_{g2,g4} )</td>
<td>min. 1350 V</td>
</tr>
<tr>
<td>( V_{g2,g4} )</td>
<td>max. 2200 V</td>
</tr>
<tr>
<td>( -V_{g1} )</td>
<td>min. 0 V</td>
</tr>
<tr>
<td>( V_{kf} )</td>
<td>max. 125 V</td>
</tr>
<tr>
<td>( -V_{kf} )</td>
<td>max. 125 V</td>
</tr>
<tr>
<td>( V_{g4/x} )</td>
<td>max. 500 V</td>
</tr>
<tr>
<td>( V_{g4/y} )</td>
<td>max. 500 V</td>
</tr>
<tr>
<td>( W_{k} )</td>
<td>max. 8 mW/cm²</td>
</tr>
<tr>
<td>( V_{g8}(\ell)/V_{g2,g4} )</td>
<td>max. 6.7</td>
</tr>
<tr>
<td>( R_{g1} )</td>
<td>max. 1 MΩ</td>
</tr>
</tbody>
</table>

April 1984
NOTES

1. In order to align the x-trace with the horizontal axis of the screen, the whole picture can be rotated by means of a rotation coil. This coil will have 50 amp. turns for the indicated max. rotation of 5° and should be positioned as indicated on the drawing.

2. This tube is designed for optimum performance when operating at a ratio 
\[ \frac{V_{g8}}{V_{g2, g4}} = 6.7 \]
The geometry control voltage \( V_{g7} \) should be adjusted within the indicated range (values with respect to the mean x-plate potential).
A negative control voltage on \( g6 \) (with respect to the mean x-plate potential) will cause some pincushion distortion and less background light.
By the use of the two voltages, \( V_{g6} \) and \( V_{g7} \), it is possible to find the best compromise between background light and raster distortion.

3. The deflection plate shield voltage should be equal to the mean y-plate potential. The mean x- and y-plate potentials should be equal for optimum spot quality.

4. The astigmatism control electrode voltage should be adjusted for optimum spot shape. For any necessary adjustment its potential will be within the stated range.

5. 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.

6. A graticule, consisting of concentric rectangles of 95 mm x 75 mm and 93 mm x 73.6 mm is aligned with the electrical x axis of the tube. With optimum correction potentials applied a raster will fall between these rectangles.

7. To avoid damage to the side contacts the narrower end of the Mu-metal shield should have an internal diameter of not less than 64 mm.
INSTRUMENT CATHODE-RAY TUBE

This type is equivalent with type D14-120GH but provided with a rotation coil as indicated in note 1 of D14-120GH.

COIL

| Number of turns | 1 - 2       | 850 turns |
|                | 1' - 2'     | 850 turns |
| Resistance of coils | 1 - 2       | 360 Ω + 10% |
|                  | 1' - 2'     | 375 Ω 10%  |

[Diagram showing the coil connections and dimensions]
INSTRUMENT CATHODE-RAY TUBE

This type is equivalent with type D14-121GH but provided with a rotation coil as indicated in note 1 of D14-121GH.

**COIL**

<table>
<thead>
<tr>
<th>Number of turns</th>
<th>Resistance of coils</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 – 2</td>
<td>360 Ω (± 10%)</td>
</tr>
<tr>
<td>1’ – 2’</td>
<td>375 Ω (± 10%)</td>
</tr>
<tr>
<td>850 turns</td>
<td>850 turns</td>
</tr>
</tbody>
</table>

**Base view**

- x-axis of trace
- 95 max
- 0.3
- 19.6
- 32x1099.3
- 1 2 1’ 2’
- 15
- 28
- base view
INSTRUMENT CATHODE-RAY TUBE

14 cm diagonal, rectangular flat faced oscilloscope tube with mesh and metal-backed screen. The tube has side connections to the x and y-plates and an internal graticule.

<table>
<thead>
<tr>
<th>QUICK REFERENCE DATA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final accelerator voltage $V_{g8(t)}$</td>
</tr>
<tr>
<td>Display area</td>
</tr>
<tr>
<td>Deflection coefficient, horizontal $M_x$</td>
</tr>
<tr>
<td>vertical $M_y$</td>
</tr>
</tbody>
</table>

SCREEN : Metal-backed phosphor

<table>
<thead>
<tr>
<th></th>
<th>Colour</th>
<th>Persistence</th>
</tr>
</thead>
<tbody>
<tr>
<td>D14-162GH/09</td>
<td>green</td>
<td>medium-short</td>
</tr>
</tbody>
</table>

Useful screen area > 100 x 80 mm²
Useful scan at $V_{g8(t)}/V_{g2, g4} = 6, 7$, horizontal > 100 mm
vertical > 80 mm
Spot eccentricity in horizontal direction < 6 mm

The x-trace can be aligned with the x-lines of the graticule by means of correction coils fitted around the tube by the manufacturer (see last page but one).

HEATING : Indirect by a.c. or d.c.; parallel supply

Heater voltage $V_f$ | 6, 3 V
Heater current $I_f$ | 300 mA

MECHANICAL DATA

Dimensions and connections

See also outline drawing

Overall length (socket included) < 407, 5 mm
Face dimensions < 100 x 120 mm
Net mass approx. 1200 g
(1) The bulge at the frit seal may increase the indicated maximum dimensions by not more than 2 mm.

* The centre of the contact is situated within a square of 10 mm x 10 mm around the true geometrical position.
Base

Mounting position: any

The tube should not be supported by the base alone and under no circumstances should the socket be allowed to support the tube.

Accessories

Socket (supplied with tube) type 55566
Final accelerator contact connector type 55563A
Mu-metal shield type 55585

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 intercept part of the electron beam; hence a low impedance deflection plate drive is desirable.

Angle between x and y-traces 90° ± 10°

Angle between x-trace and the horizontal axis of the face 0° See "Correction Coils".

LINE WIDTH

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 If = 10 μA.

Line width at the centre of the screen l.w. 0.3 mm

CAPACITANCES

x1 to all other elements except x2

x2 to all other elements except x1

y1 to all other elements except y2

y2 to all other elements except y1

x1 to x2

y1 to y2

Control grid to all other elements

Cathode to all other elements

C_{x1x2} 5.5 pF

C_{x2x1} 5.5 pF

C_{y1y1} 3.5 pF

C_{y2y1} 3.5 pF

C_{x1x2} 2 pF

C_{y1y2} 1.6 pF

C_{g1} 5.5 pF

C_{k} 4 pF

1) See "Notes".
### TYPICAL OPERATING CONDITIONS

<table>
<thead>
<tr>
<th>Condition</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final accelerator voltage</td>
<td>$V_{g8(t)}$</td>
</tr>
<tr>
<td>Geometry control electrode voltage</td>
<td>$V_{g7}$</td>
</tr>
<tr>
<td>Post deflection and interplate shield voltage</td>
<td>$V_{g6}$</td>
</tr>
<tr>
<td>Background illumination control voltage</td>
<td>$\Delta V_{g6}$</td>
</tr>
<tr>
<td>Deflection plate shield voltage</td>
<td>$V_{g5}$</td>
</tr>
<tr>
<td>Focusing electrode voltage</td>
<td>$V_{g3}$</td>
</tr>
<tr>
<td>First accelerator voltage</td>
<td>$V_{g2, g4}$</td>
</tr>
<tr>
<td>Astigmatism control voltage</td>
<td>$\Delta V_{g2, g4}$</td>
</tr>
<tr>
<td>Control grid voltage for visual extinction of focused spot</td>
<td>$V_{g1}$</td>
</tr>
<tr>
<td>Grid drive for 10 μA screen current</td>
<td>approx.</td>
</tr>
<tr>
<td>Deflection coefficient, horizontal</td>
<td>$M_x$</td>
</tr>
<tr>
<td></td>
<td>$M_y$</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Deviation of linearity of deflection</td>
<td></td>
</tr>
<tr>
<td>Geometry distortion</td>
<td></td>
</tr>
<tr>
<td>Useful scan, horizontal</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### LIMITING VALUES (Absolute max. rating system)

<table>
<thead>
<tr>
<th>Condition</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final accelerator voltage</td>
<td>$V_{g8(t)}$</td>
</tr>
<tr>
<td></td>
<td>min.</td>
</tr>
<tr>
<td>Post deflection and interplate shield voltage and geometry control electrode voltage</td>
<td>$V_{g7, g6}$</td>
</tr>
<tr>
<td>Deflection plate shield voltage</td>
<td>$V_{g5}$</td>
</tr>
<tr>
<td>Focusing electrode voltage</td>
<td>$V_{g3}$</td>
</tr>
<tr>
<td>First accelerator and astigmatism control electrode voltage</td>
<td>$V_{g2, g4}$</td>
</tr>
<tr>
<td></td>
<td>min.</td>
</tr>
<tr>
<td>Control grid voltage</td>
<td>$-V_{g1}$</td>
</tr>
<tr>
<td></td>
<td>min.</td>
</tr>
<tr>
<td>Cathode to heater voltage</td>
<td>$V_{KF}$</td>
</tr>
<tr>
<td></td>
<td>$-V_{KF}$</td>
</tr>
<tr>
<td>Voltage between astigmatism control electrode and any deflection plate</td>
<td>$V_{g4/x}$</td>
</tr>
<tr>
<td></td>
<td>$V_{g4/y}$</td>
</tr>
<tr>
<td>Grid drive, average</td>
<td></td>
</tr>
<tr>
<td>Screen dissipation</td>
<td>$W_{f}$</td>
</tr>
<tr>
<td>Ratio $V_{g8(t)}/V_{g2, g4}$</td>
<td>$V_{g8(t)}/V_{g2, g4}$</td>
</tr>
<tr>
<td>Control grid circuit resistance</td>
<td>$R_{g1}$</td>
</tr>
</tbody>
</table>

Notes see next page.
NOTES

1) To avoid damage to the side contacts the narrower end of the mu-metal shield should have an internal diameter of not less than 64 mm.

2) This tube is designed for optimum performance when operating at a ratio $V_{g8(\ell)}/V_{g2g4}$ $V_{g8(\ell)}/V_{g2g4} = 6, 7$.
   The geometry control voltage $V_{g7}$ should be adjusted within the indicated range (values with respect to the mean x-plate potential).
   A negative control voltage on $g6$ (with respect to the mean x-plate potential) will cause some pincushion distortion and less background light.
   By the use of two voltages, $V_{g6}$ and $V_{g7}$, it is possible to find the best compromise between background light and raster distortion.
   If a fixed voltage on $V_{g6}$ is required this voltage should be 10 V lower than the mean x-plate potential.

3) The deflection plate shield voltage should be equal to the mean y-plate potential.
   The mean x and y-plate potentials should be equal for optimum spot quality.

4) The astigmatism control electrode voltage should be adjusted for optimum spot shape.
   For any necessary adjustment its potential will be within the stated range.

5) 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.

6) A graticule, consisting of concentric rectangles of 95 mm x 75 mm and 93 mm x 73,6 mm is aligned with the electrical x-axis of the tube. With optimum corrections applied a raster will fall between these rectangles.

CORRECTION COILS

General

The D14-1626H/09 is provided with a pair of coils L1 and L2 for image rotation which enable the alignment of the x-trace with the x-lines of the graticule.

The image rotation coils are wound concentrically around the tube neck.
Under typical operating conditions 50 ampere-turns are required for the maximum rotation of 50°. Both coils have 850 turns. This means that a current of < 30 mA per coil is required which can be obtained by using a 24 V supply when the coils are connected in series, or a 12 V supply when they are in parallel.
Connecting the coils

The coils have been connected to the 4 soldering tags as follows:
INSTRUMENT CATHODE-RAY TUBE

14 cm diagonal rectangular flat-faced oscilloscope tube with domed post-deflection acceleration mesh, sectioned y-plates, and metal-backed screen with internal graticule.

<table>
<thead>
<tr>
<th>QUICK REFERENCE DATA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final accelerator voltage</td>
</tr>
<tr>
<td>Display area</td>
</tr>
<tr>
<td>Deflection coefficient, horizontal</td>
</tr>
<tr>
<td>vertical</td>
</tr>
</tbody>
</table>

SCREEN

Metal-backed phosphor

<table>
<thead>
<tr>
<th></th>
<th>colour</th>
<th>persistence</th>
</tr>
</thead>
<tbody>
<tr>
<td>D14-240GH/37</td>
<td>green</td>
<td>medium short</td>
</tr>
</tbody>
</table>

Useful screen dimensions | > 100 x 80 mm |
Spot eccentricity in horizontal and vertical directions | < 6 mm |

HEATING

Indirect by a.c. or d.c.; parallel supply

Heater voltage | $V_f$ | 6, 3 V |
Heater current | $I_f$ | 300 mA |

MECHANICAL DATA

Mounting position: any

The tube should not be supported by the base alone and under no circumstances should the socket be allowed to support the tube.

Dimensions and connections

See also outline drawing

Overall length (socket included) | < 385 mm |
Face dimensions | < 120 x 100 mm |
MECHANICAL DATA (continued)

Net mass = 900 g

Base
14 pin, all glass

Accessories
Socket (supplied with tube)
type 55566
Side contact connector (12 required)
type 55561
Final accelerator contact connector
note 1)
Mu-metal shield
note 2)

FOCUSING
electrostatic

DEFLECTION
double electrostatic

x-plates
symmetrical

y-plates
symmetrical

Angle between x and y traces 90°

Angle between x-trace and x-axis of
the internal graticule 0°

See also "Correction coils"

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

CAPACITANCES

\[ C_{x_1(x_2)} = 4.5 \text{ pF} \]
\[ C_{x_2(x_1)} = 4.5 \text{ pF} \]
\[ C_{y_{1.1}(y_{2.1})} = 1.3 \text{ pF} \]
\[ C_{y_{2.1}(y_{1.1})} = 1.3 \text{ pF} \]
\[ C_{x_1x_2} = 3 \text{ pF} \]
\[ C_{y_{1.1}y_{2.1}} = 0.7 \text{ pF} \]
\[ C_g = 5.5 \text{ pF} \]
\[ C_k = 4.5 \text{ pF} \]

1) The connection to the final accelerator electrode is made by means of an EHT cable
attached to the tube.

2) The diameter of the mu-metal shield should be large enough to avoid damage to the
side contacts.
DIMENSIONS AND CONNECTIONS

Dimensions in mm

1. Recommended position of correction coils.
2. See page 2.
3. Length of cable approx. 460 mm.
4. The bulge at the frit seal may increase the indicated maximum dimensions by not more than 2 mm.
### TYPICAL OPERATION

**Conditions**

<table>
<thead>
<tr>
<th>Condition</th>
<th>Voltage</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final accelerator voltage</td>
<td>$V_{g9}(t)$</td>
<td>20 kV</td>
</tr>
<tr>
<td>Post deflection accelerator mesh electrode voltage</td>
<td>$V_{g8}$</td>
<td>2000 V</td>
</tr>
<tr>
<td>Geometry control electrode voltage</td>
<td>$V_{g7}$</td>
<td>$2000 \pm 150$ V</td>
</tr>
<tr>
<td>Interplate shield voltage</td>
<td>$V_{g6}$</td>
<td>2000 V</td>
</tr>
<tr>
<td>Deflection plate shield voltage</td>
<td>$V_{g5}$</td>
<td>2000 V</td>
</tr>
<tr>
<td>Astigmatism control electrode voltage</td>
<td>$V_{g4}$</td>
<td>$2000 \pm 100$ V</td>
</tr>
<tr>
<td>Focusing electrode voltage</td>
<td>$V_{g3}$</td>
<td>500 to 800 V</td>
</tr>
<tr>
<td>First accelerator voltage</td>
<td>$V_{g2}$</td>
<td>2000 V</td>
</tr>
<tr>
<td>Control grid voltage for visual extinction of focused spot</td>
<td>$V_{g1}$</td>
<td>-55 to -110 V</td>
</tr>
<tr>
<td>Voltage on outer conductive coating</td>
<td>$V_m$</td>
<td>2000 V</td>
</tr>
</tbody>
</table>

**Performance**

<table>
<thead>
<tr>
<th>Performance</th>
<th>Value</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Useful scan, horizontal</td>
<td>$&gt; 100$</td>
<td>mm</td>
</tr>
<tr>
<td></td>
<td>$&gt; 80$</td>
<td>mm</td>
</tr>
<tr>
<td>Deflection coefficient, horizontal</td>
<td>$M_x &lt;$</td>
<td>9 V/cm</td>
</tr>
<tr>
<td></td>
<td>$&lt; 9,9$</td>
<td>V/cm</td>
</tr>
<tr>
<td></td>
<td>$M_y &lt;$</td>
<td>3 V/cm</td>
</tr>
<tr>
<td></td>
<td>$&lt; 3,3$</td>
<td>V/cm</td>
</tr>
<tr>
<td></td>
<td>$= 0.45$</td>
<td>mm</td>
</tr>
<tr>
<td></td>
<td>$&gt; 1.5$</td>
<td>cm/ns</td>
</tr>
<tr>
<td>Deviation of linearity of deflection</td>
<td>see note 8</td>
<td>%</td>
</tr>
<tr>
<td>Geometry distortion</td>
<td>see note 9</td>
<td></td>
</tr>
<tr>
<td>Grid drive for 10 μA screen current</td>
<td>$\approx 20$</td>
<td>V</td>
</tr>
</tbody>
</table>

1) The geometry control electrode voltage $V_{g7}$ should be adjusted within the indicated range (values with respect to the mean x-plate potential).

2) The interplate shield voltage should be equal to the mean x-plate potential.

3) The deflection plate shield voltage should be equal to the mean y-plate potential. The mean x-plate and y-plate potentials should be equal for optimum performance.

4) The astigmatism control electrode voltage should be adjusted for optimum spot shape. For any necessary adjustment its potential will be within the stated range.

5) If the tube is operated at a ratio $V_{g9}(t)/V_{g5} < 10$, the useful scan may be smaller than 100 mm x 80 mm. The scanned raster can be shifted and aligned with the internal graticule by means of correction coils fitted around the tube.
LIMITING VALUES (Absolute maximum rating system)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Voltage (V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final accelerator voltage</td>
<td>$V_{g9(l)}$</td>
</tr>
<tr>
<td>Post deflection acceleration mesh electrode voltage</td>
<td>$V_{g8}$</td>
</tr>
<tr>
<td>Geometry control electrode voltage</td>
<td>$V_{g7}$</td>
</tr>
<tr>
<td>Interplate shield voltage</td>
<td>$V_{g6}$</td>
</tr>
<tr>
<td>Deflection plate shield voltage</td>
<td>$V_{g5}$</td>
</tr>
<tr>
<td>Astigmatism control electrode voltage</td>
<td>$V_{g4}$</td>
</tr>
<tr>
<td>Focusing electrode voltage</td>
<td>$V_{g3}$</td>
</tr>
<tr>
<td>First accelerator voltage</td>
<td>$V_{g2}$</td>
</tr>
<tr>
<td>Control grid voltage</td>
<td>$-V_{g1}$</td>
</tr>
<tr>
<td>Cathode to heater voltage</td>
<td>$V_{kh}$</td>
</tr>
<tr>
<td>Voltage between astigmatism control</td>
<td>$V_{g4/x}$</td>
</tr>
<tr>
<td>electrode and any deflection plate</td>
<td>$V_{g4/y}$</td>
</tr>
<tr>
<td>Grid drive, average</td>
<td></td>
</tr>
<tr>
<td>Screen dissipation</td>
<td>$W_{S}$</td>
</tr>
<tr>
<td>Ratio $V_{g9}/V_{g5}$</td>
<td>$V_{g9}/V_{g5}$</td>
</tr>
<tr>
<td>Control grid circuit resistance</td>
<td>$R_{g1}$</td>
</tr>
</tbody>
</table>

$V_{g9(l)}$ max. 21 kV, min. 15 kV

$V_{g8}$ max. 2200 V

$V_{g7}$ max. 2400 V

$V_{g6}$ max. 2200 V

$V_{g5}$ max. 2200 V

$V_{g4}$ max. 2300 V, min. 1800 V

$V_{g3}$ max. 2200 V

$V_{g2}$ max. 2200 V, min. 1900 V

$-V_{g1}$ max. 200 V, min. 0 V

$V_{kh}$ max. 125 V

$V_{g4/x}$ max. 500 V

$V_{g4/y}$ max. 500 V

$-V_{kh}$ max. 125 V

$W_{S}$ max. 8 mW/cm²

$V_{g9}/V_{g5}$ max. 10

$V_{g9}/V_{g5}$ min. 8

$R_{g1}$ max. 1 MΩ

6. Measured with the shrinking raster method in the centre of the screen, with corrections adjusted for optimum spot size, at a beam current of 10 μA.

7. Writing speed measuring conditions:
   - Film: Polaroid 410 (10000 ASA)
   - Lens: F 1/1,2
   - Object to image ratio: 1/0,5
   - Modulation: $\Delta V_{g1} = 55$ V

8. The deflection coefficient over each division will not differ more than 5% from that over any other division; all these deflection coefficients being measured per division along the axes.

9. A graticule consisting of concentric rectangles of 95 mm x 75 mm and 93 mm x 73,6 mm is aligned with the electrical x-axis of the tube. With optimum corrections applied, the edges of a raster will fall between these rectangles.

March 1981

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CORRECTION COILS

On request a correction coil unit can be made available consisting of:
1. a pair of coils L1 and L2 which enable the angle between the x and y traces at the centre of the screen to be made exactly 90° (orthogonality correction).
2. a pair of coils L3 and L4 which enable the scanned area to be shifted up and down (vertical shift).
3. a coil L5 for image rotation which enables the alignment of the x trace with the x lines of the graticule.

Orthogonality (coils L1 and L2)

The current required under typical operating conditions with mu-metal shield being used is < 8 mA for complete correction of orthogonality.
The resistance of each coil is \( \approx 160 \, \Omega \).

Shift (coils L3 and L4)

The current required under typical operating conditions with mu-metal shield being used is < 12 mA for a maximum shift of 5 mm.
The resistance of each coil is \( \approx 160 \, \Omega \).

Image rotation (coil L5)

The image rotation coil is wound concentrically around the tube neck. Under typical operating conditions 27 ampere-turns are required for the maximum rotation of 5°.
The coil has 1560 turns. This means that a current of < 18 mA is required.
The resistance of the coil is \( \approx 185 \, \Omega \).
INSTRUMENT CATHODE-RAY TUBE

14 cm diagonal, rectangular flat faced oscilloscope tube with post-deflection acceleration mesh, primarily for use in compact oscilloscopes with 15 to 20 MHz bandwidth. This tube features a low heater consumption.

QUICK REFERENCE DATA

| Final accelerator voltage | \( V_{g7(x)} \) | 4 kV |
| Display area              | 100 mm x 80 mm |
| Deflection coefficient    |               |
| horizontal               | \( M_X \)     | 19,5 V/cm |
| vertical                 | \( M_Y \)     | 10,5 V/cm |

The D14-261GH is equivalent to the type D14-262GH except for the following.

HEATING

Indirect by AC or DC*

Heater voltage \( V_f \) 6,3 V
Heater current \( I_f \) 0,1 A

LIMITING VALUES (Absolute maximum rating system)

Cathode to heater voltage
- positive \( V_{kf} \) max. 100 V
- negative \( -V_{kf} \) max. 15 V

* Not to be connected in series with other tubes.
INSTRUMENT CATHODE-RAY TUBE

14 cm diagonal, rectangular flat-faced oscilloscope tube with post-deflection acceleration mesh, primarily for use in compact oscilloscopes with 15 to 20 MHz bandwidth. This tube features a 1.5 W cathode with short warm-up time (quick-heating cathode).

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final accelerator voltage</td>
<td>$V_{g7}$</td>
</tr>
<tr>
<td>Display area</td>
<td>4 kV</td>
</tr>
<tr>
<td>Display area</td>
<td>100 mm x 80 mm</td>
</tr>
<tr>
<td>Deflection coefficient</td>
<td>$M_x$, $M_y$</td>
</tr>
<tr>
<td>Horizontal</td>
<td>19.5 V/cm</td>
</tr>
<tr>
<td>Vertical</td>
<td>10.5 V/cm</td>
</tr>
</tbody>
</table>

OPTICAL DATA

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Screen</td>
<td>GH, colour green</td>
</tr>
<tr>
<td>phosphor type</td>
<td>medium short</td>
</tr>
<tr>
<td>persistence</td>
<td></td>
</tr>
<tr>
<td>Useful screen dimensions</td>
<td>$\geq$ 100 mm x 80 mm</td>
</tr>
<tr>
<td>Useful scan</td>
<td>$\geq$</td>
</tr>
<tr>
<td>horizontal</td>
<td>100 mm</td>
</tr>
<tr>
<td>vertical</td>
<td>80 mm</td>
</tr>
<tr>
<td>Spot eccentricity in horizontal</td>
<td>$\leq$ 6.5 mm</td>
</tr>
<tr>
<td>and vertical directions</td>
<td></td>
</tr>
</tbody>
</table>

HEATING

Indirect by AC or DC*

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heater voltage</td>
<td>$V_f$, 6.3 V</td>
</tr>
<tr>
<td>Heater current</td>
<td>$I_f$, 0.24 A</td>
</tr>
</tbody>
</table>

MECHANICAL DATA

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mounting position: any</td>
<td></td>
</tr>
<tr>
<td>The tube should not be supported by the base alone and under no circumstances should the socket be allowed to support the tube.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Net mass</td>
<td>approx. 1 kg</td>
</tr>
<tr>
<td>Base</td>
<td>14-pin, all glass</td>
</tr>
<tr>
<td>Final accelerator contact</td>
<td>small ball</td>
</tr>
</tbody>
</table>

* Not to be connected in series with other tubes.
Dimensions and connections
See also outline drawing

Overall length ≤ 333 mm
Face dimensions ≤ 100 x 120 mm²

Accessories
Socket, supplied with tube type 55566
Mu-metal shield type 55591
Final accelerator contact connector type 55569

FOCUSING

DEFLECTION
double electrostatic
symmetrical

x-plates
symmetrical

y-plates

Angle between x and y-traces 90 ± 10°

Angle between x-trace and horizontal axis of the face ≤ 5° *

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

\[ \begin{align*}
C_{x1}(x2) & = 7 \text{ pF} \\
C_{x2}(x1) & = 6.5 \text{ pF} \\
C_{y1}(y2) & = 4 \text{ pF} \\
C_{y2}(y1) & = 3.5 \text{ pF} \\
C_{x1x2} & = 2.2 \text{ pF} \\
C_{y1y2} & = 1.1 \text{ pF} \\
C_g1 & = 6.1 \text{ pF} \\
C_k & = 2.7 \text{ pF}
\end{align*} \]

* The tube is provided with a rotation coil, concentrically wound around the tube neck, enabling the alignment of the x-trace with the mechanical x-axis of the screen. The coil has 1000 turns and a resistance of max. 400 Ω. Under typical operating conditions, max. 30 ampere-turns are required for the max. rotation of 5°. This means the required current is max. 30 mA at a required voltage of max. 12 V.
Notes to Fig. 1

(1) The bulge at the frit seal may increase the indicated maximum dimensions by not more than 2 mm.
(2) The coil is fixed to the envelope by means of adhesive tape.
(3) The centre of the contact is situated within a square of 10 mm x 10 mm around the true geometrical position.
(4) The length of the connecting leads of the rotation coil is min. 350 mm.
### TYPICAL OPERATION

#### Conditions
- Final accelerator voltage: $V_{g7}$, 4 kV
- Post deflection accelerator mesh electrode voltage: $V_{g6}$, 2000 V
- Interplate shield voltage: $V_{g5}$, 2000 V  
  **see note 1**
- First accelerator voltage: $V_{g2, g4}$, 2000 V
- Astigmatism control electrode voltage: $\Delta V_{g2, g4}$, ± 50 V  
  **see note 2**
- Focusing electrode voltage: $V_{g3}$, 300 to 480 V
- Cut-off voltage for visual extinction of focused spot: $-V_{g1}$, 30 to 70 V

#### Performance
- Useful scan:
  - horizontal: 100 mm  
  - vertical: 80 mm  
  **see note 3**
- Deflection coefficient:
  - horizontal: $M_x$, 19.5 V/cm
  - vertical: $M_y$, 21.5 V/cm
- Line width: $I_{w}$, 0.35 mm  
  **see note 4**
- Deviation of deflection linearity: 2 %  
  **see note 5**
- Grid drive for 10 μA screen current: $V_d$, 20 V
- Geometry distortion:  
  **see note 6**

### NOTES

1. The interplate shield voltage should be equal to the mean x-plate potential. The mean x-plate and y-plate potentials should be equal for optimum spot quality.
2. The astigmatism control electrode voltage should be adjusted for optimum spot shape. For any necessary adjustment its potential will be within the stated range.
3. The tube is designed for optimum performance when operating at a ratio $V_{g7}/V_{g2, g4} = 2$. If this ratio is smaller than 2, the useful scan may be smaller than 100 mm x 80 mm.
4. Measured with the shrinking raster method in the centre of the screen with corrections adjusted for optimum spot size, at a beam current of 10 μA.
5. 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.
6. A graticule consisting of concentric rectangles of 95 mm x 75 mm and 93 mm x 73 mm is aligned with the electrical x-axis of the tube. With optimum corrections applied, the edges of a raster will fall between these rectangles.
**LIMITING VALUES (Absolute maximum rating system)**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Unit</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final accelerator voltage</td>
<td>$V_{g7(x)}$</td>
<td>max.</td>
<td>4.4 kV</td>
</tr>
<tr>
<td>Post deflection accelerator mesh electrode voltage</td>
<td>$V_{g6}$</td>
<td>max.</td>
<td>2200 V</td>
</tr>
<tr>
<td>Interplate shield voltage</td>
<td>$V_{g5}$</td>
<td>max.</td>
<td>2200 V</td>
</tr>
<tr>
<td>First accelerator and astigmatism control electrode voltage</td>
<td>$V_{g2, g4}$</td>
<td>max.</td>
<td>2200 V</td>
</tr>
<tr>
<td></td>
<td>$V_{g2, g4}$</td>
<td>min.</td>
<td>1500 V</td>
</tr>
<tr>
<td>Focusing electrode voltage</td>
<td>$V_{g3}$</td>
<td>max.</td>
<td>2200 V</td>
</tr>
<tr>
<td>Control grid voltage</td>
<td>$-V_{g1}$</td>
<td>max.</td>
<td>200 V</td>
</tr>
<tr>
<td></td>
<td>$-V_{g1}$</td>
<td>min.</td>
<td>0 V</td>
</tr>
<tr>
<td>Cathode to heater voltage</td>
<td>$V_{kf}$</td>
<td>max.</td>
<td>125 V</td>
</tr>
<tr>
<td>positive</td>
<td>$-V_{kf}$</td>
<td>max.</td>
<td>125 V</td>
</tr>
<tr>
<td>negative</td>
<td>$V_{d}$</td>
<td>max.</td>
<td>20 V</td>
</tr>
<tr>
<td>Grid drive, averaged over 1 ms</td>
<td>$W_L$</td>
<td>max.</td>
<td>3 mW/cm²</td>
</tr>
<tr>
<td>Screen dissipation</td>
<td>$R_{g1}$</td>
<td>max.</td>
<td>1 MΩ</td>
</tr>
</tbody>
</table>
INSTRUMENT CATHODE-RAY TUBE

14 cm diagonal rectangular flat-faced oscilloscope tube with domed post-deflection acceleration mesh and metal-backed screen, primarily for use in compact oscilloscopes with 25 to 50 MHz bandwidth. This tube features a 1,5 W cathode with short warm-up time (quick-heating cathode).

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Final accelerator voltage ( V_{g8(t)} )</th>
<th>10 kV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Display area</td>
<td>100 mm x 80 mm</td>
</tr>
<tr>
<td>Deflection coefficient</td>
<td></td>
</tr>
<tr>
<td>horizontal</td>
<td>( M_X )</td>
</tr>
<tr>
<td>vertical</td>
<td>( M_Y )</td>
</tr>
</tbody>
</table>

OPTICAL DATA

<table>
<thead>
<tr>
<th>Screen</th>
<th>metal-backed phosphor GH, colour green medium short</th>
</tr>
</thead>
<tbody>
<tr>
<td>phosphor type</td>
<td></td>
</tr>
<tr>
<td>persistence</td>
<td></td>
</tr>
<tr>
<td>Useful screen dimensions</td>
<td>( \geq 100 \text{ mm x } 80 \text{ mm} )</td>
</tr>
<tr>
<td>Useful scan</td>
<td></td>
</tr>
<tr>
<td>horizontal</td>
<td>( \geq 100 \text{ mm} )</td>
</tr>
<tr>
<td>vertical</td>
<td>( \geq 80 \text{ mm} )</td>
</tr>
<tr>
<td>Spot eccentricity in horizontal and vertical directions</td>
<td>( \leq 6,5 \text{ mm} )</td>
</tr>
</tbody>
</table>

HEATING

Indirect by AC or DC*

| Heater voltage                        | \( V_f \) | 6,3 V |
| Heater current                        | \( I_f \) | 0,24 A |

* Not to be connected in series with other tubes.
MECHANICAL DATA
Mounting position
The tube should not be supported by the base alone and under no circumstances should the socket be allowed to support the tube.

Net mass approx. 1 kg
Base 14 pin, all glass
Final accelerator contact small ball

Dimensions and connections
See also outline drawing
Overall length \( \leq 343 \text{ mm} \)
Face dimensions \( \leq 100 \times 120 \text{ mm}^2 \)

Accessories
Socket, supplied with tube type 55566
Mu-metal shield type 55592
Final accelerator contact connector type 55569

FOCUSING
electrostatic
deflection
double electrostatic
x-plates symmetrical
y-plates symmetrical
Angle between x and y-traces \( 90 \pm 1^\circ \)
Angle between x-trace and horizontal axis of the face \( \leq 5^\circ \)

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 \( x_2 \)
\( x_2 \) to all other elements except \( x_1 \)
\( y_1 \) to all other elements except \( y_2 \)
\( y_2 \) to all other elements except \( y_1 \)
\( x_1 \) to \( x_2 \)
\( y_1 \) to \( y_2 \)
Control grid to all other elements
Cathode to all other elements

* The tube is provided with a rotation coil, concentrically wound around the tube neck, enabling the alignment of the x-trace with the mechanical x-axis of the screen. The coil has 1000 turns and a resistance of max. 350 \( \Omega \). Under typical operating conditions, max. 35 ampere-turns are required for the max. rotation of 5\(^\circ\). This means the required current is max. 35 mA at a required voltage of max. 12 V.
DIMENSIONS AND CONNECTIONS

Dimensions in mm

(1) The bulge at the frit seal may increase the indicated maximum dimensions by not more than 2 mm.

(2) The coil is fixed to the envelope by means of adhesive tape.

(3) The length of the connecting leads of the rotation coil is min. 350 mm.

Fig. 1 Outlines.
Fig. 2 Electrode configuration.

Fig. 3 Pin arrangement.

(1) The centre of the contact is situated within a square of 10 mm x 10 mm around the true geometrical position.
**TYPICAL OPERATION**

**Conditions**

<table>
<thead>
<tr>
<th>Voltage Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final accelerator voltage</td>
<td>$V_{g8}(\xi)$ 10 kV</td>
</tr>
<tr>
<td>Post deflection accelerator mesh electrode voltage</td>
<td>$V_{g7}$ 2000 V</td>
</tr>
<tr>
<td>Geometry control electrode voltage</td>
<td>$V_{g6}$ 2000 ± 100 V see note 1</td>
</tr>
<tr>
<td>Interplate shield voltage</td>
<td>$V_{g5}$ 2000 V see note 2</td>
</tr>
<tr>
<td>First accelerator voltage</td>
<td>$V_{g2, g4}$ 2000 V</td>
</tr>
<tr>
<td>Astigmatism control electrode voltage</td>
<td>$\Delta V_{g2, g4}$ ± 75 V see note 3</td>
</tr>
<tr>
<td>Focusing electrode voltage</td>
<td>$V_{g3}$ 400 to 560 V</td>
</tr>
<tr>
<td>Cut-off voltage for visual extinction of focused spot</td>
<td>$-V_{g1}$ 25 to 70 V</td>
</tr>
</tbody>
</table>

**Performance**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Useful scan</td>
<td>$\gg$ 100 mm $\ll$ 80 mm see note 4</td>
</tr>
<tr>
<td>Deflection coefficient</td>
<td>$M_X \ll 12.8$ V/cm $M_Y \ll 14$ V/cm</td>
</tr>
<tr>
<td></td>
<td>$\approx 6.3$ V/cm $\ll 7$ V/cm</td>
</tr>
<tr>
<td>Line width</td>
<td>$\approx 0.38$ mm see note 5</td>
</tr>
<tr>
<td>Deviation of deflection linearity</td>
<td>$\ll 2$ % see note 6</td>
</tr>
<tr>
<td>Grid drive for 10 $\mu$A screen current</td>
<td>$V_d \ll 20$ V</td>
</tr>
<tr>
<td>Geometry distortion</td>
<td>see note 7</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Voltage Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final accelerator voltage</td>
<td>$V_{g8}(\xi)$ max. 12 kV</td>
</tr>
<tr>
<td>Post deflection accelerator mesh electrode voltage</td>
<td>$V_{g7}$ max. 2200 V</td>
</tr>
<tr>
<td>Geometry control electrode voltage</td>
<td>$V_{g6}$ max. 2200 V</td>
</tr>
<tr>
<td>Interplate shield voltage</td>
<td>$V_{g5}$ max. 2200 V</td>
</tr>
<tr>
<td>Accelerator voltage</td>
<td>$V_{g2, g4}$ min. 1800 V</td>
</tr>
<tr>
<td>Focusing electrode voltage</td>
<td>$V_{g3}$ max. 2200 V</td>
</tr>
<tr>
<td>Control grid voltage</td>
<td>$-V_{g1}$ max. 200 V</td>
</tr>
<tr>
<td>Cathode to heater voltage</td>
<td>$V_{kf}$ max. 125 V</td>
</tr>
<tr>
<td>positive</td>
<td>$-V_{kf}$ max. 125 V</td>
</tr>
<tr>
<td>negative</td>
<td>$V_d$ max. 20 V</td>
</tr>
<tr>
<td>Grid drive, averaged over 1 ms</td>
<td>$W_e$ max. 8 mW/cm²</td>
</tr>
<tr>
<td>Screen dissipation</td>
<td>$V_{g4/x}$ max. 500 V</td>
</tr>
<tr>
<td>Voltage between astigmatism</td>
<td>$V_{g4/y}$ max. 500 V</td>
</tr>
<tr>
<td>control electrode and any deflection plate</td>
<td>$R_{g1}$ max. 1 MΩ</td>
</tr>
</tbody>
</table>

**November 1982 167**
NOTES

1. The geometry control electrode voltage $V_{g6}$ should be adjusted within the indicated range (values with respect to the mean x-plate potential).

2. The interplate shield voltage should be equal to the mean x-plate potential. The mean x-plate and y-plate potentials should be equal for optimum spot quality.

3. The astigmatism control electrode voltage should be adjusted for optimum spot shape. For any necessary adjustment its potential will be within the stated range.

4. The tube is designed for optimum performance when operating at a ratio $V_{g6}$/$V_{g2}$, $g4 = 5$. If this ratio is smaller than 5, the useful scan may be smaller than 100 mm x 80 mm.

5. Measured with the shrinking raster method in the centre of the screen with corrections adjusted for optimum spot size, at a beam current of 10 μA.

6. 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.

7. A graticule consisting of concentric rectangles of 95 mm x 75 mm and 93 mm x 73 mm is aligned with the electrical x-axis of the tube. With optimum corrections applied, the edges of a raster will fall between these rectangles.
INSTRUMENT CATHODE-RAY TUBE

14 cm diagonal rectangular flat-faced oscilloscope tube with domed mesh and metal-backed screen with internal graticule. The tube has side connections to the x and y-plates, and is intended for use in compact oscilloscopes with up to 150 MHz bandwidth. This tube features a 1.5 W cathode with short warm-up time (quick-heating cathode).

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final accelerator voltage</td>
<td>$V_{g8}$ 16.5 kV</td>
</tr>
<tr>
<td>Display area</td>
<td>100 x 80 mm$^2$</td>
</tr>
<tr>
<td>Deflection coefficient</td>
<td></td>
</tr>
<tr>
<td>horizontal</td>
<td>$M_x$ 8.7 V/cm</td>
</tr>
<tr>
<td>vertical</td>
<td>$M_y$ 4.7 V/cm</td>
</tr>
</tbody>
</table>

OPTICAL DATA

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Screen type</td>
<td>metal-backed phosphor</td>
</tr>
<tr>
<td>persistence</td>
<td>GH, colour green medium short</td>
</tr>
<tr>
<td>Useful screen dimensions</td>
<td>&gt; 100 x 80 mm$^2$</td>
</tr>
<tr>
<td>Useful scan</td>
<td>&gt; 100 mm</td>
</tr>
<tr>
<td>horizontal</td>
<td>&gt; 80 mm</td>
</tr>
<tr>
<td>vertical</td>
<td></td>
</tr>
<tr>
<td>Spot eccentricity in horizontal and vertical directions</td>
<td>&lt; 6.5 mm</td>
</tr>
</tbody>
</table>

HEATING

Indirect by a.c. or d.c.; parallel supply.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heater voltage</td>
<td>$V_f$ 6.3 V</td>
</tr>
<tr>
<td>Heater current</td>
<td>$I_f$ 0.24 A</td>
</tr>
</tbody>
</table>
MECHANICAL DATA

Dimensions and connections
See outline drawings
Overall length (socket included) ≤ 397 mm
Face dimensions ≤ 100 x 120 mm²
Net mass approx. 1 kg
Base 14 pin, all glass

Mounting position: any
The tube should not be supported by the base alone and under no circumstances should the socket be allowed to support the tube.

Accessories
Socket, supplied with tube type 55572
Side contact connector (7 required) type 55561
Final accelerator contact connector connection to final accelerating electrode is made via an EHT cable attached to the tube

FOCUSING
electrostatic

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° *

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.

* The tube is provided with a rotation coil, concentrically wound around the tube neck, enabling the 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 40 ampere-turns are required for the maximum rotation of 5°. This means the required current is 20 mA maximum at a required voltage of 13 V.
CAPACITANCES

- $x_1$ to all other elements except $x_2$
- $x_2$ to all other elements except $x_1$
- $y_1$ to all other elements except $y_2$
- $y_2$ to all other elements except $y_1$
- $x_1$ to $x_2$
- $y_1$ to $y_2$
- Control grid to all other elements
- Cathode to all other elements
- Focusing electrode to all other electrodes

<table>
<thead>
<tr>
<th>Capacitance</th>
<th>Value (pF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$C_{x1}(x2)$</td>
<td>5</td>
</tr>
<tr>
<td>$C_{x2}(x1)$</td>
<td>5</td>
</tr>
<tr>
<td>$C_{y1}(y2)$</td>
<td>1.7</td>
</tr>
<tr>
<td>$C_{y2}(y1)$</td>
<td>2</td>
</tr>
<tr>
<td>$C_{x1}x2$</td>
<td>3</td>
</tr>
<tr>
<td>$C_{y1}y2$</td>
<td>1.6</td>
</tr>
<tr>
<td>$C_g1$</td>
<td>6</td>
</tr>
<tr>
<td>$C_k$</td>
<td>2.7</td>
</tr>
<tr>
<td>$C_g3$</td>
<td>5</td>
</tr>
</tbody>
</table>
Fig. 1 Outlines; for notes see next page.
Instrument cathode-ray tube

Fig. 2 Pin arrangement; bottom view.

Fig. 3 Side-contact arrangement; bottom view.

Fig. 4 Electrode configuration.

Fig. 5 Internal graticule.
Line thickness = 0.2 mm;
dot diameter = 0.4 mm.

Notes to the drawing on opposite page.
1. The bulge at the frit seal may increase the indicated maximum dimensions by not more than 2 mm.
2. The coil is fixed to the envelope by means of adhesive tape.
3. EHT cable; minimum length is 530 mm.
4. Connection cable, comprising two wires for connection of the rotation coil, and one green wire for earthing the outer conductive coating. Minimum cable length is 400 mm.
5. The centre of the final accelerator contact is situated within a square of 10 mm x 10 mm around the true geometrical position.
TYPICAL OPERATION

Conditions
Final accelerator voltage \( V_{g8} \) 16.5 kV
Post deflection accelerator mesh electrode voltage \( V_{g7} \) 2200 V
Geometry control electrode voltage \( V_{g6} \) 2200 ± 100 V (note 1)
Interplate shield voltage \( V_{g5} \) 2200 V (note 2)
First accelerator voltage \( V_{g4} \) 2200 V
Astigmatism control electrode voltage \( V_{g4} \) 2200 ± 50 V (note 3)
Focusing electrode voltage \( V_{g3} \) 620 to 800 V
Cut-off voltage for visual extinction of focused spot \( -V_{g1} \) 60 to 110 V

Performance
Useful scan
   horizontal \( > \) 100 mm (note 4)
   vertical \( > \) 80 mm
Deflection coefficient
   horizontal \( M_x \) 8.7 V/cm
   vertical \( M_y \) 4.7 V/cm
Line width \( l.w. \) typ. 0.37 mm (note 5)
Grid drive for 10 \( \mu \)A screen current \( V_d \) approx. 30 V
Geometry distortion see note 6
Deviation of deflection linearity 3%; see note 7

NOTES
1. The geometry control electrode voltage \( V_{g6} \) should be adjusted within the indicated range (values with respect to the mean x-plate potential).
2. The interplate shield voltage should be equal to the mean x-plate and y-plate potentials for optimum spot quality.
3. The astigmatism control electrode voltage should be adjusted for optimum spot shape. For any necessary adjustment its potential will be within the stated range.
4. The tube is designed for optimum performance when operating at a ratio \( V_{g8}/V_{g2} = 7.5 \). If this ratio is smaller, the useful scan may be smaller than 100 mm x 80 mm.
5. Measured with the shrinking raster method in the centre of the screen with corrections adjusted for optimum spot size, at a beam current of 10 \( \mu \)A.
6. A graticule consisting of horizontal and vertical line pairs according to Fig. 6, is aligned with the electrical x-axis of the tube. With optimum corrections applied (including orthogonality correction), any horizontal or vertical trace will fall between these line pairs.
7. Deviation of linearity is defined as the proportional deviation of the deflection coefficient over any division on the x-axis and y-axis from the average values over the central eight (horizontal) and central six (vertical) divisions respectively.
Fig. 6 Quarter of graticule with horizontal and vertical line pairs, see note 6.
LIMITING VALUES (Absolute maximum rating system)

Final accelerator voltage \( V_{g8} \) max. 18 kV
Post deflection accelerator mesh electrode voltage \( V_{g7} \) max. 2500 V
Geometry control electrode voltage \( V_{g6} \) max. 2500 V
Interplate shield voltage \( V_{g5} \) max. 2500 V
Astigmatism control electrode voltage \( V_{g4} \) max. 2500 V
Focusing electrode voltage \( V_{g3} \) max. 2500 V
First accelerator voltage \( V_{g2} \) max. 2500 V
Control grid voltage \( -V_{g1} \) min. 200 V
Cathode to heater voltage
  positive \( V_{kf} \) max. 125 V
  negative \( -V_{kf} \) max. 125 V
Voltage between astigmatism control 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. 20 V
Screen dissipation \( W_s \) max. 8 mW/cm²
Control grid circuit resistance \( R_{g1} \) max. 1 MΩ
INSTRUMENT CATHODE-RAY TUBES

- mono accelerator
- 14 cm diagonal rectangular flat face
- internal magnetic lens system for vertical scan magnification, orthogonality, astigmatism and eccentricity correction
- low heater consumption
- 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

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accelerator voltage</td>
<td>$V_{g2,94}$</td>
</tr>
<tr>
<td>Minimum useful scan area</td>
<td>100 mm x 80 mm</td>
</tr>
<tr>
<td>Deflection coefficient</td>
<td></td>
</tr>
<tr>
<td>horizontal</td>
<td>$M_x$</td>
</tr>
<tr>
<td>vertical</td>
<td>$M_y$</td>
</tr>
</tbody>
</table>

The D14-361.. is equivalent to the type D14-362.. except for the following.

HEATING

Indirect by AC or DC*

Heater voltage $V_f$ 6.3 V
Heater current $I_f$ 0.1 A

Heating time to attain 10% of the cathode current at equilibrium conditions approx. 7 s

* Not to be connected in series with other tubes.
INSTRUMENT CATHODE-RAY TUBES

- 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

<table>
<thead>
<tr>
<th>Accelerator voltage</th>
<th>$V_{g2,g4}$</th>
<th>2000 V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum useful scan area</td>
<td>$100 \text{ mm } \times 80 \text{ mm}$</td>
<td></td>
</tr>
<tr>
<td>Deflection coefficient</td>
<td></td>
<td></td>
</tr>
<tr>
<td>horizontal</td>
<td>$M_x$</td>
<td>19 V/cm</td>
</tr>
<tr>
<td>vertical</td>
<td>$M_y$</td>
<td>11.5 V/cm</td>
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</table>

OPTICAL DATA

<table>
<thead>
<tr>
<th>Screen</th>
<th>type</th>
<th>colour</th>
<th>persistence</th>
</tr>
</thead>
<tbody>
<tr>
<td>GH</td>
<td>green</td>
<td>medium short</td>
<td></td>
</tr>
<tr>
<td>GY</td>
<td>yellowish-green</td>
<td>medium</td>
<td></td>
</tr>
<tr>
<td>GM</td>
<td>yellowish-green</td>
<td>long</td>
<td></td>
</tr>
</tbody>
</table>

Useful screen area
- $\geq 102 \text{ mm } \times 82 \text{ mm}; \text{ note 1}$
Useful scan area
- $\geq 100 \text{ mm } \times 80 \text{ mm}$
Internal graticule
- type 93; 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
symmetrical
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.
Instrument cathode-ray tubes

CAPACITANCES

\( x_1 \) to all other elements except \( x_2 \)
\( x_2 \) to all other elements except \( x_1 \)
\( y_1 \) to all other elements except \( y_2 \)
\( y_2 \) to all other elements except \( y_1 \)
\( x_1 \) to \( x_2 \)
\( y_1 \) to \( y_2 \)
Control grid to all other elements
Cathode to all other elements

\begin{align*}
C_{x1}(x2) & = 5.7 \text{ pF} \\
C_{x2}(x1) & = 5 \text{ pF} \\
C_{y1}(y2) & = 4 \text{ pF} \\
C_{y2}(y1) & = 4 \text{ pF} \\
C_{x1x2} & = 2.3 \text{ pF} \\
C_{y1y2} & = 1 \text{ pF} \\
C_g & = 6 \text{ pF} \\
C_k & = 3 \text{ pF}
\end{align*}
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).
Internal graticule

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

Fig. 2 Pin arrangement; bottom view.

Fig. 3 Electrode configuration.

Fig. 4 Front view of tube with internal graticule, type 93.
Line thickness = 0,2 mm; dot diameter = 0,4 mm; colour: red.
**TYPICAL OPERATION** (voltages with respect to cathode)*

**Conditions**

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean deflection plate potential</td>
<td>2000 V</td>
<td>see note 2</td>
</tr>
<tr>
<td>Shield voltage for optimum geometry</td>
<td>(V_{g5,4})</td>
<td>2000 V see note 3</td>
</tr>
<tr>
<td>Accelerator and astigmatism control voltage</td>
<td>(V_{g2,4})</td>
<td>2000 V see note 4</td>
</tr>
<tr>
<td>Focusing voltage</td>
<td>(V_{g3})</td>
<td>220 to 370 V see note 5</td>
</tr>
<tr>
<td>Cut-off voltage for visual extinction</td>
<td>(-V_{g1})</td>
<td>22 to 65 V see note 6</td>
</tr>
</tbody>
</table>

**Performance**

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deflection coefficient</td>
<td>(M_x)</td>
</tr>
<tr>
<td>horizontal</td>
<td>&lt; 21 V/cm</td>
</tr>
<tr>
<td>vertical</td>
<td>&lt; 11.5 V/cm</td>
</tr>
<tr>
<td>Deviation of deflection linearity</td>
<td>≤ 2 %</td>
</tr>
<tr>
<td>Geometry distortion</td>
<td>≤ 30 %</td>
</tr>
<tr>
<td>Luminance reduction at the edges of the useful scan (100 mm x 80 mm), with respect to screen centre</td>
<td>≤ 4 mm</td>
</tr>
<tr>
<td>Eccentricity of undeflected spot with respect to internal graticule</td>
<td>≤ 2 mm</td>
</tr>
<tr>
<td>Angle between x and y-traces</td>
<td>90°</td>
</tr>
<tr>
<td>Angle between x-trace and x-axis of the internal graticule</td>
<td>≤ 5°</td>
</tr>
<tr>
<td>Grid drive voltage for 10 µA screen current</td>
<td>(V_d)</td>
</tr>
<tr>
<td>Line width</td>
<td>l.w.</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accelerator voltage</td>
<td>(V_{g2,4}) max. 2200 V</td>
</tr>
<tr>
<td>Shield voltage</td>
<td>(V_{g5,4}) max. 2200 V</td>
</tr>
<tr>
<td>Focusing electrode voltage</td>
<td>(V_{g3}) max. 2200 V</td>
</tr>
<tr>
<td>Control grid voltage</td>
<td>(-V_{g1}) min. 0 V</td>
</tr>
<tr>
<td>Cathode to heater voltage</td>
<td>(V_{kf}) max. 125 V</td>
</tr>
<tr>
<td>negative</td>
<td>(-V_{kf}) max. 125 V</td>
</tr>
<tr>
<td>Heater voltage</td>
<td>(V_f) max. 6.6 V</td>
</tr>
<tr>
<td>min.</td>
<td>6.0 V</td>
</tr>
<tr>
<td>Grid drive voltage, averaged over 1 ms</td>
<td>(V_d) max. 20 V</td>
</tr>
<tr>
<td>Screen dissipation</td>
<td>(W_g) max. 3 mW/cm²</td>
</tr>
<tr>
<td>Control grid circuit resistance</td>
<td>(R_{g1}) max. 1 MΩ</td>
</tr>
</tbody>
</table>
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 $g_5$ can be connected to $g_2$, $g_4$, 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 ± 50 V around mean x-potential may be applied for further correction.

4. Optimum spot is obtained with $V_{g2}$, $g_4$ equal to mean y-potential (see note 2). In general a tolerance of ± 4 V has no visible effect; $V_{g2}$, $g_4$ tends to be lower with $V_{g5}$ more positive. The circuit impedance $R_{g2}$, $g_4$ 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 $I_{g2}$, $g_4$ (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 $185 \pm 25 \, \Omega$ 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 $I_B = 10 \, \mu A$. 

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

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accelerator voltage</td>
<td>V_{g2,g4} 2000 V</td>
</tr>
<tr>
<td>Minimum useful scan area</td>
<td>100 mm x 80 mm</td>
</tr>
<tr>
<td>Deflection coefficient</td>
<td></td>
</tr>
<tr>
<td>horizontal</td>
<td>M_x 19 V/cm</td>
</tr>
<tr>
<td>vertical</td>
<td>M_y 11.5 V/cm</td>
</tr>
</tbody>
</table>

The D14-363GY/123 is equivalent to the type D14-364GY/123 except for the following.

HEATING
Indirect by AC or DC*
Heater voltage                  | V_f 6.3 V     |
Heater current                  | I_f 0.1 A     |
Heating time to attain 10% of the cathode current at equilibrium conditions | approx. 7 s |

* Not to be connected in series with other tubes.
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

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accelerator voltage</td>
<td>$V_{g2,g4}$</td>
</tr>
<tr>
<td>Minimum useful scan area</td>
<td></td>
</tr>
<tr>
<td>Deflection coefficient</td>
<td></td>
</tr>
<tr>
<td>horizontal</td>
<td>$M_x$</td>
</tr>
<tr>
<td>vertical</td>
<td>$M_y$</td>
</tr>
</tbody>
</table>

OPTICAL DATA

- Screen type: GY
- Screen colour: yellowish-green
- Screen persistence: medium
- Useful screen area: $\geq 102$ mm x 82 mm; note 1
- Useful scan area: $\geq 100$ 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 $x_2$

$x_2$ to all other elements except $x_1$

$y_1$ to all other elements except $y_2$

$y_2$ to all other elements except $y_1$

$x_1$ to $x_2$

$y_1$ to $y_2$

Control grid to all other elements

Cathode to all other elements

$C_{x1}(x2)$ 4.8 pF

$C_{x2}(x1)$ 4 pF

$C_{y1}(y2)$ 3.4 pF

$C_{y2}(y1)$ 3.4 pF

$C_{x1x2}$ 3.3 pF

$C_{y1y2}$ 1 pF

$C_{g1}$ 6 pF

$C_{k}$ 3 pF
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).
**Internal graticule**

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

---

**Fig. 2** Pin arrangement; bottom view.

**Fig. 3** Electrode configuration.

**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

Shield voltage for optimum geometry

Accelerator and astigmatism control voltage

Focusing voltage

Cut-off voltage for visual extinction of focused spot

Performance

Deflection coefficient

horizontal

vertical

Deviation of deflection linearity

Geometry distortion

Luminance reduction at the edges of the useful scan (100 mm x 80 mm), with respect to screen centre

Eccentricity of undeflected spot with respect to internal graticule

horizontal

vertical

Angle between x and y-traces

Angle between x-trace and x-axis of the internal graticule

Grid drive voltage for 10 μA screen current

Line width

LIMITING VALUES (Absolute maximum rating system)

Accelerator voltage

Shield voltage

Focusing electrode voltage

Control grid voltage

Cathode to heater voltage

positive

negative

Heater voltage

Grid drive voltage, averaged over 1 ms

Screen dissipation

Control grid circuit resistance

2000 V

note 2

V_{g5,(t)}

2000 V

note 3

V_{g2,g4}

2000 V

note 4

V_{g3}

100 to 200 V

note 5

- V_{g1}

22 to 65 V

note 6

M_x

< 19 V/cm

< 21 V/cm

M_y

< 11.5 V/cm

< 12 V/cm

< 2 %

note 7

see note 8

< 30 %

< 4 mm

< 2 mm

note 9

V_d

≈ 10 V

note 6

l.w.

≈ 0.3 mm

note 11

V_{g2,g4}

max. 2200 V

V_{g5,(t)}

max. 2200 V

V_{g3}

max. 2200 V

- V_{g1}

max. 200 V

min. 0 V

V_{k_f}

max. 125 V

- V_{k_f}

max. 125 V

V_f

max. 6.6 V

min. 6.0 V

V_d

max. 20 V

W_{f}

max. 3 mW/cm²

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 pass-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 g5 (equal to mean x-potential) may be required.

3. The tube meets the geometry specification (see note 8) if Vg5 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 Vg2,g4 equal to mean y-potential (see note 2). In general a tolerance of ± 4 V has no visible effect; Vg2,g4 tends to be lower with Vg5 more positive. The circuit impedance Rg2,g4 should be less than 10 kΩ.

5. An actual focus range of 30 V should be provided on the front panel. Vg3 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 lg2,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 Ig = 10 μA.
Fig. 5 Screen current ($I_{\text{screen}}$) and focusing voltage ($V_{g3}$) as a function of grid drive voltage ($V_d$); typical curves.
INSTRUMENT CATHODE-RAY TUBE

- 14 cm diagonal rectangular flat face
- domed mesh post-deflection acceleration
- internal magnetic lens system for correction of orthogonality, astigmatism and eccentricity
- quick-heating cathode
- internal graticule
- high sensitivity and high brightness
- short overall length
- for compact oscilloscopes with up to 75 MHz bandwidth

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final accelerator voltage</td>
<td>$V_{g7(x)}$ 10</td>
</tr>
<tr>
<td>First accelerator voltage</td>
<td>$V_{g4}$ 2</td>
</tr>
<tr>
<td>Minimum useful scan area</td>
<td>100 mm x 80 mm</td>
</tr>
<tr>
<td>Deflection coefficient</td>
<td></td>
</tr>
<tr>
<td>horizontal</td>
<td>$M_X$ 8</td>
</tr>
<tr>
<td>vertical</td>
<td>$M_Y$ 4</td>
</tr>
</tbody>
</table>

OPTICAL DATA

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Screen type</td>
<td>metal-backed phosphor</td>
</tr>
<tr>
<td>colour</td>
<td>green</td>
</tr>
<tr>
<td>persistence</td>
<td>medium short</td>
</tr>
<tr>
<td>Useful screen area</td>
<td>$\geq 102$ mm x 82 mm; note 1</td>
</tr>
<tr>
<td>Useful scan area</td>
<td>$\geq 100$ mm x 80 mm</td>
</tr>
<tr>
<td>Internal graticule</td>
<td>type 93; see Fig. 4</td>
</tr>
</tbody>
</table>

HEATING

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indirect by AC or DC*</td>
<td></td>
</tr>
<tr>
<td>Heater voltage</td>
<td>$V_f$ 6.3 V</td>
</tr>
<tr>
<td>Heater current</td>
<td>$I_f$ 0.24 A</td>
</tr>
<tr>
<td>Heating time to attain 10% of the cathode current at equilibrium conditions</td>
<td>approx. 5 s</td>
</tr>
</tbody>
</table>

* Not to be connected in series with other tubes.
MECHANICAL DATA

Dimensions and connections (see also outline drawings)

Overall length (socket included) \(< 338 \text{ mm}\)
Faceplate dimensions \(118 \pm 0,5 \text{ mm} \times 98 \pm 0,5 \text{ mm}\)
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
Final accelerator contact connector type 55569/55597
Mu-metal shield 55599

FOCUSING

electrostatic

DEFLECTION

double electrostatic

x-plates symmetrical

y-plates symmetrical
**CAPACITANCES**

- $x_1$ to all other elements except $x_2$
- $x_2$ to all other elements except $x_1$
- $y_1$ to all other elements except $y_2$
- $y_2$ to all other elements except $y_1$
- $x_1$ to $x_2$
- $y_1$ to $y_2$
- Control grid to all other elements
- Cathode to all other elements
- Focusing electrode to all other elements

<table>
<thead>
<tr>
<th>Capacitance</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$C_{x1}(x2)$</td>
<td>4.2 pF</td>
</tr>
<tr>
<td>$C_{x2}(x1)$</td>
<td>4.2 pF</td>
</tr>
<tr>
<td>$C_{y1}(y2)$</td>
<td>3.1 pF</td>
</tr>
<tr>
<td>$C_{y2}(y1)$</td>
<td>3.1 pF</td>
</tr>
<tr>
<td>$C_{x1x2}$</td>
<td>2 pF</td>
</tr>
<tr>
<td>$C_{y1y2}$</td>
<td>1.6 pF</td>
</tr>
<tr>
<td>$C_{g1}$</td>
<td>6 pF</td>
</tr>
<tr>
<td>$C_{k}$</td>
<td>3.2 pF</td>
</tr>
<tr>
<td>$C_{g3}$</td>
<td>5 pF</td>
</tr>
</tbody>
</table>
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 (diagonal 153 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).

5. The centre of the final accelerator contact is situated within a square of 10 mm x 10 mm around the indicated position.
DIMENSIONS AND CONNECTIONS (continued)

Fig. 2 Pin arrangement; bottom view.

Fig. 3 Electrode configuration.

Fig. 4 Front view of tube with internal graticule, type 93. The faceplate reference points are used for aligning the graticule with the faceplate.

Line thickness = 0.2 mm; dot diameter = 0.4 mm; colour: red.
TYPICAL OPERATION (voltages with respect to cathode)

Conditions

<table>
<thead>
<tr>
<th>Voltage</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{g7}(\xi)$</td>
<td>10</td>
</tr>
<tr>
<td>$V_{g5}$</td>
<td>2</td>
</tr>
<tr>
<td>$V_{g4}$</td>
<td>2</td>
</tr>
<tr>
<td>$V_{g3}$</td>
<td>400 to 800 V</td>
</tr>
<tr>
<td>$V_{g2}$</td>
<td>2</td>
</tr>
<tr>
<td>$-V_{g1}$</td>
<td>45 to 90 V</td>
</tr>
</tbody>
</table>

Outer conductive coating (m) and mu-metal shield to be earthed.

Performance

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horizontal deflection coefficient $M_x$</td>
<td>8</td>
</tr>
<tr>
<td>Vertical deflection coefficient $M_y$</td>
<td>4.0</td>
</tr>
<tr>
<td>Deviation of deflection linearity $\leq 2%$</td>
<td></td>
</tr>
<tr>
<td>Geometry distortion</td>
<td></td>
</tr>
<tr>
<td>Eccentricity of undeflected spot</td>
<td></td>
</tr>
<tr>
<td>in horizontal direction $\leq 4 \text{ mm}$</td>
<td></td>
</tr>
<tr>
<td>in vertical direction $\leq 2 \text{ mm}$</td>
<td></td>
</tr>
<tr>
<td>Angle between x- and y-traces $90^\circ$</td>
<td></td>
</tr>
<tr>
<td>Angle between x-trace and x-axis of internal graticule $\leq 5^\circ$</td>
<td>note 2</td>
</tr>
<tr>
<td>Luminance reduction with respect to screen centre</td>
<td></td>
</tr>
<tr>
<td>x-axis, outer graticule line $\leq 30%$</td>
<td></td>
</tr>
<tr>
<td>y-axis, outer graticule line $\leq 30%$</td>
<td></td>
</tr>
<tr>
<td>any corner $\leq 50%$</td>
<td></td>
</tr>
<tr>
<td>Grid drive for 10 $\mu$A screen current $V_d$</td>
<td>approx. 20 V</td>
</tr>
<tr>
<td>Line width</td>
<td>approx. 0.35 mm</td>
</tr>
</tbody>
</table>

note 2, note 4, note 5, note 6, note 7
## LIMITING VALUES (Absolute maximum rating system)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final accelerator voltage</td>
<td>$V_{g7(l)}$</td>
<td>max. 18 kV note 8</td>
</tr>
<tr>
<td>Shield voltage</td>
<td>$V_{g5}$</td>
<td>max. 3.3 kV</td>
</tr>
<tr>
<td>First accelerator and astigmatism control voltage</td>
<td>$V_{g4}$</td>
<td>max. 3.3 kV</td>
</tr>
<tr>
<td>Focusing electrode voltage</td>
<td>$V_{g3}$</td>
<td>max. 2.5 kV</td>
</tr>
<tr>
<td>Grid 2 voltage</td>
<td>$V_{g2}$</td>
<td>max. 2.5 kV</td>
</tr>
<tr>
<td>Control grid voltage</td>
<td>$-V_{g1}$</td>
<td>max. 200 V, min. 0 V</td>
</tr>
<tr>
<td>Cathode to heater voltage</td>
<td>$V_{kf}$</td>
<td>max. 125 V</td>
</tr>
<tr>
<td>positive</td>
<td>$-V_{kf}$</td>
<td>max. 125 V</td>
</tr>
<tr>
<td>negative</td>
<td>$V_f$</td>
<td>max. 6.6 V, min. 6.0 V</td>
</tr>
<tr>
<td>Heater voltage</td>
<td>$\Delta V_{g2,g4}$</td>
<td>max. 2 kV</td>
</tr>
<tr>
<td>Voltage between g2 and g4</td>
<td>$\Delta V_{g4,g5,x,y}$</td>
<td>max. 500 V</td>
</tr>
<tr>
<td>Voltage between g4,g5 and any deflection plate</td>
<td>$V_d$</td>
<td>max. 25 V</td>
</tr>
<tr>
<td>Grid drive, averaged over 1 ms</td>
<td>$W_g$</td>
<td>max. 8 mW/cm²</td>
</tr>
<tr>
<td>Screen dissipation</td>
<td>$R_{g1}$</td>
<td>max. 1 MΩ</td>
</tr>
</tbody>
</table>
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; floating mean x- or y-potentials will result into non-uniform line width and geometry distortion. The mean x- and y-potentials should be equal; under this condition the tube will be within the specification without corrections for astigmatism and geometry.

   The tube features internal magnetic correction for orthogonality between x- and y-traces, spot shaping (astigmatism) and eccentricity calibration.

3. For some applications a mean x-potential up to 50 V positive with respect to mean y-potential is inevitable. In this case $V_{g5}$ must be made equal to mean x-potential, and a range of 0 to −25 V with respect to mean y-potential will be required on $g4$ for astigmatism correction. The circuit resistance for $V_{g4}$ should be $< 10 \, \text{k}\Omega$.

4. 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.

5. 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.

6. The tube has a trace rotation coil, fixed onto the lower cone part. The coil has 1000 turns and a typical resistance of $185 \pm 25 \, \Omega$ at 0 °C, which increases by approx. 0.4%/K for rising temperature. Approx. 6,5 mA causes 1° trace rotation. Thus maximum required voltage is approx. 13 V for tube tolerances (± 5°) and earth magnetic field with reasonable shielding (± 2°).

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 $I_g = 10 \, \mu A$.

8. The X-ray dose rate remains below the acceptable value of 36 pA/kg (0,5 mR/h), when the tube is used within its limiting values (beam current $I_g \ll 100 \, \mu A$).
INSTRUMENT CATHODE-RAY TUBE

- 14 cm diagonal rectangular flat face
- domed mesh post-deflection acceleration
- internal magnetic lens system for correction of orthogonality, astigmatism and eccentricity
- low heater consumption
- internal graticule
- high sensitivity and high brightness
- short overall length
- for compact oscilloscopes with up to 100 MHz bandwidth

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th></th>
<th>Vg7 (l)</th>
<th>10</th>
<th>16.5 kV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final accelerator voltage</td>
<td>Vg4</td>
<td>2</td>
<td>2.2 kV</td>
</tr>
<tr>
<td>First accelerator voltage</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum useful scan area</td>
<td></td>
<td></td>
<td>100 mm x 80 mm</td>
</tr>
<tr>
<td>Deflection coefficient</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>horizontal</td>
<td>Mx</td>
<td>8</td>
<td>8.3 V/cm</td>
</tr>
<tr>
<td>vertical</td>
<td>My</td>
<td>4</td>
<td>4 V/cm</td>
</tr>
</tbody>
</table>

The D14-371GH/123 is equivalent to the type D14-372GH/123 except for the following.

HEATING

Indirect by AC or DC *

Heater voltage Vf 6.3 V
Heater current If 0.1 A

Heating time to attain 10% of the cathode current at equilibrium conditions approx. 7 s

* Not to be connected in series with other tubes.
DEVELOPMENT DATA
This data sheet contains advance information and specifications are subject to change without notice.

INSTRUMENT CATHODE-RAY TUBE

• 14 cm diagonal rectangular flat face
• domed mesh post-deflection acceleration
• internal magnetic lens system for correction of orthogonality, astigmatism and eccentricity
• quick-heating cathode
• internal graticule
• high sensitivity and high brightness
• short overall length
• for compact oscilloscopes with up to 100 MHz bandwidth

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final accelerator voltage</td>
<td>Vg7(8)</td>
</tr>
<tr>
<td>First accelerator voltage</td>
<td>Vg4</td>
</tr>
<tr>
<td>Minimum useful scan area</td>
<td>100 mm x 80 mm</td>
</tr>
<tr>
<td>Deflection coefficient</td>
<td></td>
</tr>
<tr>
<td>horizontal</td>
<td>Mx</td>
</tr>
<tr>
<td>vertical</td>
<td>My</td>
</tr>
<tr>
<td></td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>8.3 V/cm</td>
</tr>
<tr>
<td></td>
<td>4 V/cm</td>
</tr>
</tbody>
</table>

OPTICAL DATA

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Screen type</td>
<td>metal-backed phosphor</td>
</tr>
<tr>
<td>colour</td>
<td>green</td>
</tr>
<tr>
<td>persistence</td>
<td>medium short</td>
</tr>
<tr>
<td>Useful screen area</td>
<td>≥ 102 mm x 82 mm; note 1</td>
</tr>
<tr>
<td>Useful scan area</td>
<td>≥ 100 mm x 80 mm</td>
</tr>
<tr>
<td>Internal graticule</td>
<td>type 123; see Fig. 4</td>
</tr>
</tbody>
</table>

HEATING

Indirect by AC or DC*

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heater voltage</td>
<td>Vf</td>
</tr>
<tr>
<td>Heater current</td>
<td>I_f</td>
</tr>
<tr>
<td>Heating time to attain 10% of the cathode current at equilibrium conditions</td>
<td>approx. 5 s</td>
</tr>
<tr>
<td></td>
<td>6.3 V</td>
</tr>
<tr>
<td></td>
<td>0.24 A</td>
</tr>
</tbody>
</table>

* Not to be connected in series with other tubes.
MECHANICAL DATA

Dimensions and connections (see also outline drawings)

Overall length (socket included) ≤ 338 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
Final accelerator contact connector type 55569/55597
Mu-metal shield 55599

FOCUSING

electrostatic

DEFLECTION

double electrostatic
symmetrical

x-plates
symmetrical

y-plates
### CAPACITANCES

- $x_1$ to all other elements except $x_2$
- $x_2$ to all other elements except $x_1$
- $y_1$ to all other elements except $y_2$
- $y_2$ to all other elements except $y_1$
- $x_1$ to $x_2$
- $y_1$ to $y_2$
- Control grid to all other elements
- Cathode to all other elements
- Focusing electrode to all other elements
- Final accelerator electrode to all other elements

<table>
<thead>
<tr>
<th>Capacitance</th>
<th>Value (pF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$C_{x1}(x2)$</td>
<td>4.8</td>
</tr>
<tr>
<td>$C_{x2}(x1)$</td>
<td>3.6</td>
</tr>
<tr>
<td>$C_{y1}(y2)$</td>
<td>3.0</td>
</tr>
<tr>
<td>$C_{y2}(y1)$</td>
<td>3.0</td>
</tr>
<tr>
<td>$C_{x1x2}$</td>
<td>3.3</td>
</tr>
<tr>
<td>$C_{y1y2}$</td>
<td>1.4</td>
</tr>
<tr>
<td>$C_{g1}$</td>
<td>6.5</td>
</tr>
<tr>
<td>$C_{k}$</td>
<td>3.2</td>
</tr>
<tr>
<td>$C_{g3}$</td>
<td>8</td>
</tr>
<tr>
<td>$C_{g7}$</td>
<td>480</td>
</tr>
</tbody>
</table>
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 (diagonal 153 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).

5. The centre of the final accelerator contact is situated within a square of 10 mm x 10 mm around the indicated position.
Fig. 2 Pin arrangement; bottom view.

Fig. 3 Electrode configuration.

Fig. 4 Front view of tube with internal graticule, type 123. The faceplate reference points are used for aligning the graticule with the faceplate.

Line thickness = 0.2 mm; dot diameter = 0.4 mm; colour: red.
**TYPICAL OPERATION** (voltages with respect to cathode)*

<table>
<thead>
<tr>
<th>Conditions</th>
<th>$V_g$</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final accelerator voltage</td>
<td>$V_{g7}(%)$</td>
<td>10</td>
</tr>
<tr>
<td>Mean deflection plate potential</td>
<td>$V_{g5}$</td>
<td>2</td>
</tr>
<tr>
<td>Shield voltage for optimum geometry</td>
<td>$V_{g4}$</td>
<td>2</td>
</tr>
<tr>
<td>First accelerator and astigmatism control voltage</td>
<td>$V_{g3}$</td>
<td>0.19 x $V_{g4}$ to 0.26 x $V_{g4}$</td>
</tr>
<tr>
<td>Focusing voltage</td>
<td>$V_{g2}$</td>
<td>2</td>
</tr>
<tr>
<td>Grid 2 voltage</td>
<td>$V_{g1}$</td>
<td>45 to 90</td>
</tr>
</tbody>
</table>

Outer conductive coating (m) and mu-metal shield to be earthed.

**Performance**

<table>
<thead>
<tr>
<th></th>
<th>$M_x$</th>
<th>$M_y$</th>
<th>$8$</th>
<th>$4.0$</th>
<th>$8.3$ V/cm ± 10%</th>
<th>$4.0$ V/cm ± 5%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deviation of deflection linearity</td>
<td>$\leq 2%$</td>
<td>note 4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Geometry distortion</td>
<td>note 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eccentricity of undeflected spot</td>
<td>$\leq 4$ mm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>in horizontal direction</td>
<td>$\leq 2$ mm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>in vertical direction</td>
<td>$\leq 5^\circ$</td>
<td>note 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Angle between x- and y-traces</td>
<td>$\leq 5^\circ$</td>
<td>note 6</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Angle between x-trace and x-axis of internal graticule</td>
<td>$\leq 30%$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Luminance reduction with respect to screen centre</td>
<td>$V_d$</td>
<td>approx.</td>
<td>20 V</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>x-axis, outer graticule line</td>
<td>approx.</td>
<td>0.33 mm</td>
<td>note 7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>y-axis, outer graticule line</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>any corner</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grid drive for 10 µA screen current</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Line width</td>
<td>l.w.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Notes are on last page but one.
LIMITING VALUES (Absolute maximum rating system)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Max.</th>
<th>Min.</th>
<th>Ref.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final accelerator voltage</td>
<td>$V_{g7(\ell)}$</td>
<td>18 kV</td>
<td></td>
<td>Fig. 6</td>
</tr>
<tr>
<td>Shield voltage</td>
<td>$V_{g5}$</td>
<td>3.3 kV</td>
<td></td>
<td></td>
</tr>
<tr>
<td>First accelerator and astigmatism control voltage</td>
<td>$V_{g4}$</td>
<td>3.3 kV</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Focusing electrode voltage</td>
<td>$V_{g3}$</td>
<td>2.5 kV</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grid 2 voltage</td>
<td>$V_{g2}$</td>
<td>2.5 kV</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control grid voltage</td>
<td>$-V_{g1}$</td>
<td>200 V</td>
<td>0 V</td>
<td></td>
</tr>
<tr>
<td>Cathode to heater voltage positive</td>
<td>$V_{kf}$</td>
<td>125 V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cathode to heater voltage negative</td>
<td>$-V_{kf}$</td>
<td>125 V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heater voltage</td>
<td>$V_f$</td>
<td>6.6 V</td>
<td>6.0 V</td>
<td></td>
</tr>
<tr>
<td>Voltage between g2 and g4</td>
<td>$\Delta V_{g2,g4}$</td>
<td>2 kV</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Voltage between g4, g5 and any deflection plate</td>
<td>$\Delta V_{g4,g5,x,y}$</td>
<td>500 V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grid drive, averaged over 1 ms</td>
<td>$V_d$</td>
<td>25 V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Screen dissipation</td>
<td>$W_s$</td>
<td>8 mW/cm²</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control grid circuit resistance</td>
<td>$R_{g1}$</td>
<td>1 MΩ</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
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; floating mean x- or y-potentials will result into non-uniform line width and geometry distortion. The mean x- and y-potentials should be equal; under this condition the tube will be within the specification without corrections for astigmatism and geometry. A range of $\Delta V_{g5} = -50$ to $+50$ V may be applied for pincushion/barrel correction. The tube features internal magnetic correction for orthogonality between x- and y-traces, spot shaping (astigmatism) and eccentricity calibration.

3. For some applications a mean x-potential up to 50 V positive with respect to mean y-potential is inevitable. In this case $V_{g5}$ must be made equal to mean x-potential, and a range of 0 to $-25$ V with respect to mean y-potential will be required on $g4$ for astigmatism correction. The circuit resistance for $V_{g4}$ should be $\leq 10$ k$\Omega$.

4. 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.

5. 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.

6. The tube has a trace rotation coil, fixed onto the lower cone part. The coil has 1000 turns and a typical resistance of $185 \pm 25$ $\Omega$ at 20°C, which increases by approx. 0.4%/K for rising temperature. At typical operation ($V_{g5} = 2200$ V, $V_{g7} = 16.5$ kV) approx. 6.5 mA causes $1^\circ$ trace rotation. Thus maximum required voltage is approx. 13 V for tube tolerances ($\pm 5^\circ$) and earth magnetic field with reasonable shielding ($\pm 2^\circ$). The required current for $1^\circ$ trace rotation is related to approx. $\sqrt{V_{g5}}$.

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 $I_e = 10$ $\mu$A.
Fig. 5 Beam current ($I_{bx}$) and focusing voltage ($V_{g3}$) as a function of grid drive voltage ($V_d$) at $V_{g7} = 16.5$ kV, $V_{g5} = 2.2$ kV; typical curves.

$I_{bx}$ is the beam current, without scan, measured on x2, when the deflection plate potentials have been adjusted to $V_{y1} = V_{y2} = 2200$ V, $V_{x1} = 1500$ V, $V_{x2} = 1900$ V, thus directing the total beam current to x2.

Fig. 6 0.5 mR/h isoexposure-rate limit curve, measured according to TEPAC104.
INSTRUMENT CATHODE-RAY TUBE

- 14 cm diagonal rectangular flat face
- domed mesh post-deflection acceleration
- internal magnetic lens system for correction of orthogonality, astigmatism and eccentricity
- quick-heating cathode
- side contacts to deflection plates
- internal graticule
- high sensitivity and high brightness
- short overall length
- for compact oscilloscopes with up to 150 MHz bandwidth

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final accelerator voltage</td>
<td>$V_{g7(k)}$</td>
</tr>
<tr>
<td>First accelerator voltage</td>
<td>$V_{g4}$</td>
</tr>
<tr>
<td>Minimum useful scan area</td>
<td></td>
</tr>
<tr>
<td>Deflection coefficient</td>
<td></td>
</tr>
<tr>
<td>horizontal</td>
<td>$M_x$</td>
</tr>
<tr>
<td>vertical</td>
<td>$M_y$</td>
</tr>
<tr>
<td>Photographic writing speed</td>
<td>p.w.s.</td>
</tr>
</tbody>
</table>

OPTICAL DATA

- Screen type: metal-backed phosphor
- Screen colour: green
- Screen persistence: medium short
- Useful screen area: $> 102$ mm x $82$ mm; note 1
- Useful scan area: $> 100$ mm x $80$ mm
- Internal graticule: type 93; see Fig. 5

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 drawings)

Overall length (socket included)  \( \leq 338 \text{ mm} \)
Faceplate dimensions  \( 118 \pm 0,5 \text{ mm} \times 98 \pm 0,5 \text{ mm} \)
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. 5) 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
Side contact connector for \( \phi \) 0,6 mm pin (4 required) type 55596 (AMP87313)
Final accelerator contact connector type 55569/55597
Mu-metal shield 55599

FOCUSBING

electrostatic

DEFLECTION

double electrostatic
symmetrical
symmetrical

x-plates
y-plates
CAPACITANCES

to all other elements except x2
x2 to all other elements except x1
y1 to all other elements except y2
y2 to all other elements except y1
x1 to x2
y1 to y2
Control grid to all other elements
Cathode to all other elements
Focusing electrode to all other elements

Cx1(x2)  2.4 pF
Cx2(x1)  2.4 pF
Cy1(y2)  1.9 pF
Cy2(y1)  1.9 pF
Cx1x2    1.8 pF
Cy1y2    1.5 pF
g1        6 pF
ck        3.2 pF
g3        5 pF
1. Dimensions of faceplate only. The complete assembly of faceplate and cone (frit seal included) will pass through an opening of 122 x 102 mm (diagonal 153 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. 5).

5. The centre of the final accelerator contact is situated within a square of 10 mm x 10 mm around the indicated position.
Instrument cathode-ray tube

Fig. 2 Pin arrangement; bottom view.

Fig. 3 Side-contact arrangement bottom view.

Fig. 4 Electrode configuration.

Fig. 5 Front view of tube with internal graticule, type 93. The faceplate reference points are used for aligning the graticule with the faceplate.

Line thickness = 0.2 mm; dot diameter = 0.4 mm; colour: red.
TYPICAL OPERATION (voltages with respect to cathode)

Conditions

Final accelerator voltage \( V_{g7} \) 16.5 kV
Mean deflection plate potential \( V_{g5} \) 2.2 kV note 2
Shield voltage for optimum geometry \( V_{g4} \) 2.2 kV note 3
First accelerator and astigmatism control voltage \( V_{g3} \) 2.2 kV note 3
Focusing voltage \( V_{g3} \) 400 to 800 V
Grid 2 voltage \( V_{g3} \) 2.2 kV
Cut-off voltage for visual extinction of focused spot \( -V_{g1} \) 50 to 100 V

Outer conductive coating (m) and mu-metal shield to be earthed.

Performance

Horizontal deflection coefficient \( M_x \) 8.3 V/cm ± 10%
Vertical deflection coefficient \( M_y \) 4.0 V/cm ± 5%
Deviation of deflection linearity \( \leq 2 \% \) note 4
Geometry distortion note 5
Eccentricity of undeflected spot
  in horizontal direction \( \leq 4 \text{ mm} \)
  in vertical direction \( \leq 2 \text{ mm} \)
Angle between \( x \) - and \( y \)-traces \( 90^\circ \) note 2
Angle between \( x \)-trace and \( x \)-axis of internal graticule \( \leq 5^\circ \) note 6
Luminance reduction with respect to screen centre
  \( x \)-axis, outer graticule line \( \leq 30 \% \)
  \( y \)-axis, outer graticule line \( \leq 30 \% \)
  any corner \( \leq 50 \% \)
Grid drive for 10 \( \mu \text{A} \) screen current \( V_d \) approx. 20 V
Line width
  \( \text{l.w.} \) approx. 0.35 mm note 7
Photographic writing speed (\( V_d = 50 \text{ V} \);
  Polaroid 612 film; GH phosphor;
  \( F = 1.2 \); magnification 0.5)
  \( p.w.s. \) 2.0 cm/ns
**LIMITING VALUES** (Absolute maximum rating system)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final accelerator voltage</td>
<td>$V_{g7(x)}$</td>
<td>max. 18 kV note 8</td>
</tr>
<tr>
<td>Shield voltage</td>
<td>$V_{g5}$</td>
<td>max. 3.3 kV</td>
</tr>
<tr>
<td>First accelerator and astigmatism control voltage</td>
<td>$V_{g4}$</td>
<td>max. 3.3 kV</td>
</tr>
<tr>
<td>Focusing electrode voltage</td>
<td>$V_{g3}$</td>
<td>max. 2.5 kV</td>
</tr>
<tr>
<td>Grid 2 voltage</td>
<td>$V_{g2}$</td>
<td>max. 2.5 kV</td>
</tr>
<tr>
<td>Control grid voltage</td>
<td>$-V_{g1}$</td>
<td>max. 200 V min. 0 V</td>
</tr>
<tr>
<td>Cathode to heater voltage</td>
<td>$V_{kf}$</td>
<td>max. 125 V</td>
</tr>
<tr>
<td>positive</td>
<td>$-V_{kf}$</td>
<td>max. 125 V</td>
</tr>
<tr>
<td>negative</td>
<td>$V_f$</td>
<td>max. 6.6 V min. 6.0 V</td>
</tr>
<tr>
<td>Heater voltage</td>
<td>$\Delta V_{g2,g4}$</td>
<td>max. 2 kV</td>
</tr>
<tr>
<td>Voltage between g2 and g4</td>
<td>$\Delta V_{g4,g5,x,y}$</td>
<td>max. 500 V</td>
</tr>
<tr>
<td>and any deflection plate</td>
<td>$V_d$</td>
<td>max. 25 V</td>
</tr>
<tr>
<td>Grid drive, averaged over 1 ms</td>
<td>$W_l$</td>
<td>max. 8 mW/cm²</td>
</tr>
<tr>
<td>Screen dissipation</td>
<td>$R_{g1}$</td>
<td>max. 1 MΩ</td>
</tr>
</tbody>
</table>

April 1984
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. 5).

2. The deflection plates must be operated symmetrically; floating mean x- or y-potentials will result into non-uniform line width and geometry distortion. The mean x- and y-potentials should be equal; under this condition the tube will be within the specification without corrections for astigmatism and geometry.

   The tube features internal magnetic correction for orthogonality between x- and y-traces, spot shaping (astigmatism) and eccentricity calibration.

3. For some applications a mean x-potential up to 50 V positive with respect to mean y-potential is inevitable. In this case $V_{g5}$ must be made equal to mean x-potential, and a range of 0 to $-25$ V with respect to mean y-potential will be required on $g4$ for astigmatism correction. The circuit resistance for $V_{g4}$ should be $\leq 10 \, \text{k}\Omega$.

4. 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.

5. 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.

6. The tube has a trace rotation coil, fixed onto the lower cone part. The coil has 1000 turns and a typical resistance of 185 $\pm 25$ $\Omega$ at 20 $^\circ$C, which increases by approx. 0.4%/K for rising temperature. Approx. 6.5 mA causes $1^\circ$ trace rotation. Thus maximum required voltage is approx. 13 V for tube tolerances ($\pm 5^\circ$) and earth magnetic field with reasonable shielding ($\pm 2^\circ$).

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 $I_g = 10 \, \mu$A.

8. The X-ray dose rate remains below the acceptable value of 36 pA/kg (0.5 mR/h), when the tube is used within its limiting values (beam current $I_g \leq 100 \, \mu$A).
INSTRUMENT CATHODE-RAY TUBE

- 14 cm diagonal rectangular flat face
- domed mesh post-deflection acceleration
- internal magnetic lens system for correction of orthogonality, astigmatism and eccentricity
- low heater consumption
- side contacts to deflection plates
- internal graticule
- high sensitivity and high brightness
- short overall length
- for compact oscilloscopes with up to 150 MHz bandwidth

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final accelerator voltage</td>
<td>$V_{g7}(\ell)$ 16.5 kV</td>
</tr>
<tr>
<td>First accelerator voltage</td>
<td>$V_{g4}$ 2.2 kV</td>
</tr>
<tr>
<td>Minimum useful scan area</td>
<td>100 mm x 80 mm</td>
</tr>
<tr>
<td>Deflection coefficient</td>
<td></td>
</tr>
<tr>
<td>horizontal</td>
<td>$M_X$ 8.3 V/cm</td>
</tr>
<tr>
<td>vertical</td>
<td>$M_Y$ 4 V/cm (max. 4.2 V/cm)</td>
</tr>
<tr>
<td>Photographic writing speed</td>
<td>p.w.s. 2.0 cm/ns</td>
</tr>
</tbody>
</table>

The D14-381GH/123 is equivalent to the type D14-382GH/123 except for the following.

HEATING
Indirect by a.c. or d.c.*

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heater voltage</td>
<td>$V_f$ 6.3 V</td>
</tr>
<tr>
<td>Heater current</td>
<td>$I_f$ 0.1 A</td>
</tr>
<tr>
<td>Heating time to attain 10% of the cathode current at equilibrium conditions</td>
<td>approx. 7 s</td>
</tr>
</tbody>
</table>

* Not to be connected in series with other tubes.
INSTRUMENT CATHODE-RAY TUBE

- 14 cm diagonal rectangular flat face
- domed mesh post-deflection acceleration
- internal magnetic lens system for correction of orthogonality, astigmatism and eccentricity
- quick-heating cathode
- side contacts to deflection plates
- internal graticule
- high sensitivity and high brightness
- short overall length
- for compact oscilloscopes with up to 150 MHz bandwidth

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final accelerator voltage</td>
<td>$V_{g7}(t)$ 18.5 kV</td>
</tr>
<tr>
<td>First accelerator voltage</td>
<td>$V_{g4}$ 2.2 kV</td>
</tr>
<tr>
<td>Minimum useful scan area</td>
<td>100 mm x 80 mm</td>
</tr>
<tr>
<td>Deflection coefficient</td>
<td></td>
</tr>
<tr>
<td>horizontal</td>
<td>$M_x$ 8.3 V/cm</td>
</tr>
<tr>
<td>vertical</td>
<td>$M_y$ 4 V/cm (max. 4.2 V/cm)</td>
</tr>
<tr>
<td>Photographic writing speed</td>
<td>p.w.s. 2.0 cm/ns</td>
</tr>
</tbody>
</table>

OPTICAL DATA

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Screen type</td>
<td>metal-backed phosphor</td>
</tr>
<tr>
<td>colour</td>
<td>green</td>
</tr>
<tr>
<td>persistence</td>
<td>medium short</td>
</tr>
<tr>
<td>Useful screen area</td>
<td>$\geq 102$ mm x 82 mm</td>
</tr>
<tr>
<td>Useful scan area</td>
<td>$\geq 100$ mm x 80 mm</td>
</tr>
<tr>
<td>Internal graticule</td>
<td>type 123; see Fig. 5</td>
</tr>
</tbody>
</table>

HEATING

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indirect by a.c. or d.c.*</td>
<td></td>
</tr>
<tr>
<td>Heater voltage</td>
<td>$V_f$ 6.3 V</td>
</tr>
<tr>
<td>Heater current</td>
<td>$I_f$ 0.24 A</td>
</tr>
<tr>
<td>Heating time to attain 10% of the cathode current at equilibrium conditions</td>
<td>approx. 5 s</td>
</tr>
</tbody>
</table>

* Not to be connected in series with other tubes.
MECHANICAL DATA

Dimensions and connections (see also outline drawings)

Overall length (socket included)  ≤ 338 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. 5) 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
Side contact connector for φ 0,65 mm pin (4 required) type 55596 (AMP87313)
Final accelerator contact connector type 55569/55597
Mu-metal shield 55599

FOCUSING

electrostatic

deflection

double electrostatic

DEFLECTION

x-plates symmetrical
y-plates symmetrical
CAPACITANCES

$C_{x1}(x2)$ 2.2 pF
$C_{x2}(x1)$ 2.3 pF
$C_{y1}(y2)$ 1.7 pF
$C_{y2}(y1)$ 1.8 pF
$C_{x1x2}$ 3 pF
$C_{y1y2}$ 1.3 pF
$C_{g1}$ 6.5 pF
$C_{k}$ 3.2 pF
$C_{g3}$ 8 pF
$C_{g7}$ 480 pF
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 x 102 mm (diagonal 153 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. 5).

5. The centre of the final accelerator contact is situated within a square of 10 mm x 10 mm around the indicated position.
Fig. 2 Pin arrangement; bottom view.

Fig. 3 Side-contact arrangement bottom view.

Fig. 4 Electrode configuration.

Fig. 5 Front view of tube with internal graticule, type 123. The faceplate reference points are used for aligning the graticule with the faceplate.

Line thickness = 0.2 mm; dot diameter = 0.4 mm; colour: red.
TYPICAL OPERATION (voltages with respect to cathode)*

Conditions
Final accelerator voltage \( V_{g7(\ell)} \) 16.5 kV
Mean deflection plate potential \( V_{g5} \) 2.2 kV note 2
Shield voltage for optimum geometry \( V_{g4} \) 2.2 kV note 3
First accelerator and astigmatism control voltage \( V_{g3} \) 0.19 \( \times V_{g4} \) to 0.26 \( \times V_{g4} \)
Focusing voltage \( V_{g2} \) 2.2 kV
Cut-off voltage for visual extinction of focused spot \( -V_{g1} \) 50 to 100 V

Outer conductive coating (m) and mu-metal shield to be earthed.

Performance
Horizontal deflection coefficient \( M_x \) 8.3 V/cm ± 10%
Vertical deflection coefficient \( M_y \) 4.0 V/cm ± 5%
Deviation of deflection linearity \( \leq \) 2 % note 4
Geometry distortion note 5
Eccentricity of undeflected spot
in horizontal direction \( \leq \) 4 mm
in vertical direction \( \leq \) 2 mm
Angle between \( x \)- and \( y \)-traces 90° note 2
Angle between \( x \)-trace and \( x \)-axis of internal graticule \( \leq \) 5° note 6
Luminance reduction with respect to screen centre
\( x \)-axis, outer graticule line \( \leq \) 30 %
\( y \)-axis, outer graticule line \( \leq \) 30 %
any corner \( \leq \) 50 %
Grid drive for 10 \( \mu \)A screen current \( V_d \) approx. 20 V
Line width \( * \) l.w. approx. 0.33 mm note 7
Photographic writing speed \( (V_d = 50 \text{ V}; \) Polaroid 612 film; GH phosphor; \( F = 1.2; \) magnification 0.5) \( \text{p.w.s.} \) 2.0 cm/ns

* Notes are on last page but one.
**LIMITING VALUES** (Absolute maximum rating system)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Unit</th>
<th>Value</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final accelerator voltage</td>
<td>$V_{g7(\ell)}$</td>
<td>max.</td>
<td>18 kV</td>
<td>Fig. 7</td>
</tr>
<tr>
<td>Shield voltage</td>
<td>$V_{g5}$</td>
<td>max.</td>
<td>3.3 kV</td>
<td></td>
</tr>
<tr>
<td>First accelerator and astigmatism control voltage</td>
<td>$V_{g4}$</td>
<td>max.</td>
<td>3.3 kV</td>
<td></td>
</tr>
<tr>
<td>Focusing electrode voltage</td>
<td>$V_{g3}$</td>
<td>max.</td>
<td>2.5 kV</td>
<td></td>
</tr>
<tr>
<td>Grid 2 voltage</td>
<td>$V_{g2}$</td>
<td>max.</td>
<td>2.5 kV</td>
<td></td>
</tr>
<tr>
<td>Control grid voltage</td>
<td>$-V_{g1}$</td>
<td>min.</td>
<td>200 V</td>
<td></td>
</tr>
<tr>
<td>Cathode to heater voltage</td>
<td>$V_{kf}$</td>
<td>max.</td>
<td>125 V</td>
<td></td>
</tr>
<tr>
<td>positive</td>
<td>$-V_{kf}$</td>
<td>max.</td>
<td>125 V</td>
<td></td>
</tr>
<tr>
<td>negative</td>
<td>$V_{f}$</td>
<td>min.</td>
<td>6.6 V</td>
<td></td>
</tr>
<tr>
<td>Heater voltage</td>
<td></td>
<td>min.</td>
<td>6.0 V</td>
<td></td>
</tr>
<tr>
<td>Voltage between $g_2$ and $g_4$</td>
<td>$\Delta V_{g2,g4}$</td>
<td>max.</td>
<td>2 kV</td>
<td></td>
</tr>
<tr>
<td>Voltage between $g_4,g_5$ and any deflection plate</td>
<td>$\Delta V_{g4,g5,x,y}$</td>
<td>max.</td>
<td>500 V</td>
<td></td>
</tr>
<tr>
<td>Grid drive, averaged over 1 ms</td>
<td>$V_d$</td>
<td>max.</td>
<td>25 V</td>
<td></td>
</tr>
<tr>
<td>Screen dissipation</td>
<td>$W_g$</td>
<td>max.</td>
<td>8 mW/cm²</td>
<td></td>
</tr>
<tr>
<td>Control grid circuit resistance</td>
<td>$R_{g1}$</td>
<td>max.</td>
<td>1 MΩ</td>
<td></td>
</tr>
</tbody>
</table>
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. 5).

2. The deflection plates must be operated symmetrically; floating mean x- or y-potentials will result into non-uniform line width and geometry distortion. The mean x- and y-potentials should be equal; under this condition the tube will be within the specification without corrections for astigmatism and geometry. A range of $\Delta V_{g5} = -50$ to $+50$ V may be applied for pincushion/barrel correction.

   The tube features internal magnetic correction for orthogonality between x- and y-traces, spot shaping (astigmatism) and eccentricity calibration.

3. For some applications a mean x-potential up to 50 V positive with respect to mean y-potential is inevitable. In this case $V_{g5}$ must be made equal to mean x-potential, and a range of 0 to $-25$ V with respect to mean y-potential will be required on $g4$ for astigmatism correction. The circuit resistance for $V_{g4}$ should be $\leq 10$ k$\Omega$.

4. 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.

5. 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.

6. The tube has a trace rotation coil, fixed onto the lower cone part. The coil has 1000 turns and a typical resistance of $185 \pm 25 \, \Omega$ at $20^\circ$C, which increases by approx. 0.4%/K for rising temperature. At typical operation ($V_{g5} = 2200$ V, $V_{g7} = 16.5$ kV) approx. 6.5 mA causes 1$^\circ$ trace rotation. Thus maximum required voltage is approx. 13 V for tube tolerances ($\pm 5^\circ$) and earth magnetic field with reasonable shielding ($\pm 2^\circ$).

   The required current for 1$^\circ$ trace rotation is related to approx. $\sqrt{V_{g5}}$.

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 $I_g = 10 \mu$A.
Fig. 6  Beam current ($I_{bx}$) and focusing voltage ($V_{g3}$) as a function of grid drive voltage ($V_d$); typical curves.

$I_{bx}$ is the beam current, without scan, measured on x2, when the deflection plate potentials have been adjusted to $V_{y1} = V_{y2} = 2200 \, V$, $V_{x1} = 1500 \, V$, $V_{x2} = 1900 \, V$, thus directing the total beam current to x2.

Fig. 7  0.5 mR/h isoexposure-rate limit curve, measured according to TEPAC104.
INSTRUMENT CATHODE-RAY TUBE

- 14 cm diagonal rectangular flat face
- domed mesh post-deflection acceleration
- symmetrical helix system for vertical deflection
- internal magnetic lens system for correction of orthogonality, astigmatism and eccentricity
- quick-heating cathode
- side contacts to deflection plates
- internal graticule
- high sensitivity and high brightness
- for oscilloscopes with up to 500 MHz bandwidth

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final accelerator voltage</td>
<td>$V_{g7}(t)$ 24 kV</td>
</tr>
<tr>
<td>First accelerator voltage</td>
<td>$V_{g2}$ 3 kV</td>
</tr>
<tr>
<td>Minimum useful scan area</td>
<td>100 mm x 80 mm</td>
</tr>
<tr>
<td>Deflection coefficient</td>
<td></td>
</tr>
<tr>
<td>horizontal</td>
<td>$M_x$ 7.3 V/cm (max. 8.0 V/cm)</td>
</tr>
<tr>
<td>vertical</td>
<td>$M_y$ 2.9 V/cm (max. 3.0 V/cm)</td>
</tr>
<tr>
<td>Photographic writing speed</td>
<td>p.w.s. min. 3 cm/ns</td>
</tr>
</tbody>
</table>

OPTICAL DATA

<table>
<thead>
<tr>
<th>Screen type</th>
<th>metal-backed phosphor</th>
</tr>
</thead>
<tbody>
<tr>
<td>colour</td>
<td>green</td>
</tr>
<tr>
<td>persistence</td>
<td>medium short</td>
</tr>
<tr>
<td>Useful screen area</td>
<td>$\geq 102$ mm x 82 mm; note 1 (last page)</td>
</tr>
<tr>
<td>Useful scan area</td>
<td>$\geq 100$ mm x 80 mm</td>
</tr>
<tr>
<td>Internal graticule</td>
<td>type 123; see Fig. 5</td>
</tr>
</tbody>
</table>

HEATING

Indirect by a.c. or d.c.*

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heater voltage</td>
<td>$V_f$ 6.3 V</td>
</tr>
<tr>
<td>Heater current</td>
<td>$I_f$ 0.24 A</td>
</tr>
<tr>
<td>Heating time to attain 10% of the cathode current at equilibrium conditions</td>
<td>approx. 5 s</td>
</tr>
</tbody>
</table>

* Not to be connected in series with other tubes.
MECHANICAL DATA

Dimensions and connections (see also outline drawings)
Overall length (socket included)  ≤ 419 mm
Faceplate dimensions  118 ± 1,0 mm x 98 ± 1,0 mm
Net mass  approx. 1,2 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. 5) 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
Side pin protection band  3322 027 10200
type 55594
type 55595
type 55596 (cat. no. 9390 299 90002) to be established
Socket with solder tags
Socket with printed-wiring pins
Side contact connector for ø 0,65 mm pin (2 required) connection to final accelerator electrode is made via an EHT cable attached to the tube
to be established
Side contact connector for ø 0,45 mm pin (4 required)
Final accelerator contact connector
electrostatic
ds double electrostatic
symmetrical
symmetrical (helix system)
(2 x 165 Ω) ± 3%
approx. 1000 MHz

Mu-metal shield

FOCUSING

DEFLECTION
x-plates
y-plates
Characteristic impedance of helix system
Bandwidth of helix system (−3 dB)
CAPACITANCES

$x_1$ to all other elements except $x_2$

$x_2$ to all other elements except $x_1$

$x_1$ to $x_2$

$x_1$ to $y_1$

$x_2$ to $y_1$

$x_1$ to $y_2$

$x_2$ to $y_2$

Control grid to all other elements

Cathode to all other elements

Focusing electrode to all other elements

$C_{x1x2}$ $3.2$ pF
$C_{x2x1}$ $3.2$ pF
$C_{x1y1}$ $< 0.2$ pF
$C_{x2y1}$ $< 0.2$ pF
$C_{x1y2}$ $< 0.2$ pF
$C_{x2y2}$ $< 0.2$ pF
$C_{g1}$ $6.2$ pF
$C_k$ $3.8$ pF
$C_{g3}$ $7.6$ pF
(1) Dimensions of faceplate only. The complete assembly of faceplate and cone (frit seal included) will pass through an opening of 122 x 102 mm (diagonal 153 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. 5).

(5) The centre of the final accelerator contact is situated within a square of 10 mm x 10 mm around the indicated position.

(6) The length of the E.H.T. cable is min. 900 mm.

Fig. 1 Outlines.

Fig. 2 Electrode configuration.
Fig. 3 Pin arrangement; bottom view.

Fig. 4 Side-contact arrangement, bottom view.

Fig. 5 Front view of tube with internal graticule, type 123 (final accelerator contact at left-hand side). The faceplate reference points are used for aligning the graticule with the faceplate.

Line thickness = 0.2 mm; dot diameter = 0.4 mm; colour: red.
TYPICAL OPERATION (voltages with respect to cathode)*

Conditions
Final accelerator voltage \(V_{g7}(\xi)\) 24 kV
First accelerator voltage \(V_{g2}\) 3 kV
Second accelerator voltage \(V_{g2-1}\) 3 kV
Focusing voltage \(V_{g3}\) 700 to 1100 V Fig. 6
Astigmatism control voltage \(V_{g4}\) 3 kV note 2
Shield voltage for optimum geometry \(V_{g5}\) 3 kV note 3
Deviation of mean y-plate potential from \(V_{g2-1}\) \(V_{y}\) max. 0.5 V note 4
Cut-off voltage for visual extinction of focused spot \(-V_{g1}\) 80 to 130 V

Outer conductive coating (m) and mu-metal shield to be earthed.

Grid g5 has two connections; the socket connection to be used for applying shield voltage \(V_{g5}\), the side pin connection to be used for proper earthing of g5 via a spark gap.

Performance
Horizontal deflection coefficient \(M_x\) 7.3 V/cm ± 10%
Vertical deflection coefficient \(M_y\) typ. 2.9 V/cm
\(\leq\) 2.7 V/cm
\(\leq\) 3.0 V/cm

Deviation of deflection linearity \(\leq\) 3% note 5
Geometry distortion note 6

Eccentricity of undeflected spot with respect to internal graticule
in horizontal direction \(\leq\) 4 mm note 2
in vertical direction \(\leq\) 2 mm note 2

Angle between x- and y-traces \(90 \pm 0.5^\circ\) note 2

Angle between x-trace and x-axis of internal graticule \(\leq\) 5° note 7

Luminance reduction with respect to screen centre
x-axis, at a scan of ± 50 mm \(\leq\) 30%
y-axis, at a scan of ± 40 mm \(\leq\) 30%
any corner \(\leq\) 50%

Grid drive for 10 \(\mu\)A screen current \(V_d\) approx. 20 V

Line width \(l.w.\) approx. 0.37 mm note 8

Photographic writing speed \((V_d = 75\, V;\)
Polaroid 612 film; GH phosphor;
F = 1.2; magnification 0.5)
\(p.w.s.\) min. 3.0 cm/ns

* Notes are on last page.
**LIMITING VALUES** (Absolute maximum rating system)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Unit</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final accelerator voltage</td>
<td>$V_{g7(\ell)}$</td>
<td>max.</td>
<td>26 kV Fig. 7</td>
</tr>
<tr>
<td>First accelerator voltage</td>
<td>$V_{g2}$</td>
<td>max.</td>
<td>3,4 kV</td>
</tr>
<tr>
<td>Focusing electrode voltage</td>
<td>$V_{g3}$</td>
<td>max.</td>
<td>3,4 kV</td>
</tr>
<tr>
<td>Control grid voltage</td>
<td>$-V_{g1}$</td>
<td>max.</td>
<td>200 V</td>
</tr>
<tr>
<td>Control grid voltage</td>
<td>$-V_{g1}$</td>
<td>min.</td>
<td>0 V</td>
</tr>
<tr>
<td>Cathode to heater voltage</td>
<td>$V_{kf}$</td>
<td>max.</td>
<td>125 V</td>
</tr>
<tr>
<td>Cathode to heater voltage</td>
<td>$-V_{kf}$</td>
<td>max.</td>
<td>125 V</td>
</tr>
<tr>
<td>Heater voltage</td>
<td>$V_f$</td>
<td>max.</td>
<td>6,6 V</td>
</tr>
<tr>
<td>Heater voltage</td>
<td>$V_f$</td>
<td>min.</td>
<td>6,0 V</td>
</tr>
<tr>
<td>Voltage between g4,g5 and any deflection plate</td>
<td>$\Delta V_{g4,g5,x,y}$</td>
<td>max.</td>
<td>500 V</td>
</tr>
<tr>
<td>Grid drive, averaged over 1 ms</td>
<td>$V_d$</td>
<td>max.</td>
<td>30 V</td>
</tr>
<tr>
<td>Screen dissipation</td>
<td>$W_k$</td>
<td>max.</td>
<td>8 mW/cm²</td>
</tr>
<tr>
<td>Control grid circuit resistance</td>
<td>$R_{g1}$</td>
<td>max.</td>
<td>1 MΩ</td>
</tr>
</tbody>
</table>
Fig. 6  Focusing voltage ($V_{g3}$) as a function of grid drive voltage ($V_d$); typical curve.

Fig. 7  0.5 mR/h isoexposure-rate limit curve, measured according to EIA standard RS-502 (formerly TEPAC104).
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. 5).
2. The tube features internal magnetic correction for orthogonality between x- and y-traces, spot shaping (astigmatism) and eccentricity calibration. Correction is obtained at $V_{g2.1,g4} = 2500$ to $3300$ V; optimum at $V_{g2.1,g4} = 3000$ V.
3. For some applications a mean x-potential up to 50 V positive with respect to mean y-potential is inevitable. In this case $V_{g5}$ must be made equal to mean x-potential, and a range of 0 to $-50$ V with respect to mean y-potential will be required on g4 for astigmatism correction. The circuit resistance for $V_{g4}$ should be $\leq 10$ kΩ.
4. Deviation of mean y-plate potential with respect to $V_{g2.1}$ will introduce spot distortion.
5. Deviation of linearity is defined as the proportional deviation of the deflection coefficient over any division on the x-axis and y-axis from the average values over the central eight (horizontal) and central six (vertical) divisions respectively.
6. 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.
7. The tube has a trace rotation coil, fixed onto the lower cone part. The coil has 1000 turns and a resistance of $185 \pm 20$ Ω at 20 °C, which increases by approx. 0.4%/K for rising temperature. Approx. 6.7 mA causes 1° trace rotation.
8. 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 $I_g = 10$ μA.
INSTRUMENT CATHODE-RAY TUBE

18 cm diagonal, rectangular flat faced oscilloscope tube with mesh and metal backed screen.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th></th>
<th>$V_g7(\xi)$</th>
<th>10 kV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Display area</td>
<td>120 x 100 mm$^2$</td>
<td></td>
</tr>
<tr>
<td>Deflection factor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>horizontal</td>
<td>$M_X$</td>
<td>15.5 V/cm</td>
</tr>
<tr>
<td>vertical</td>
<td>$M_Y$</td>
<td>4.5 V/cm</td>
</tr>
</tbody>
</table>

SCREEN

Metal backed phosphor
- type: D18-120GH
- colour: green
- persistence: medium short

Useful screen area
- min.: 120 x 100 mm$^2$

Useful scan at $V_g7(\xi)/V_{g2,g4} = 5$
- horizontal: min. 120 mm
- vertical: min. 100 mm

Spot eccentricity
- horizontal direction: $\pm$ 8 mm
- vertical direction: $\pm$ 6 mm

HEATING

Indirect by AC or DC; parallel supply

Heater voltage
- $V_f$: 6.3 V

Heater current
- $I_f$: 300 mA
MECHANICAL DATA
* The centre of the contact is located within a square of 10 mm x 10 mm around the true geometrical position.

Mounting position
The tube should not be supported by the base alone and under no circumstances should the socket be allowed to support the tube.

Dimensions and connections
See also outline drawing
Overall length (socket included) max. 454 mm
Face dimensions max. 146 x 121 mm²
Net weight approx. 1300 g
Base 14 pin all glass
Accessories
Socket (supplied with tube) type 55566
Final accelerator contact connector type 55563A
Mu-metal shield type 55584
CAPACITANCES

$x_1$ to all other elements except $x_2$
$x_2$ to all other elements except $x_1$
$y_1$ to all other elements except $y_2$
$y_2$ to all other elements except $y_1$
$x_1$ to $x_2$
$y_1$ to $y_2$
Control grid to all other elements
Cathode to all other elements

\[
\begin{align*}
C_{x1}(x2) & = 6.5 \text{ pF} \\
C_{x2}(x1) & = 6.5 \text{ pF} \\
C_{y1}(y2) & = 5 \text{ pF} \\
C_{y2}(y1) & = 5 \text{ pF} \\
C_{x1x2} & = 2.2 \text{ pF} \\
C_{y1y2} & = 1.7 \text{ pF} \\
C_{g1} & = 5.5 \text{ pF} \\
C_k & = 4.5 \text{ pF}
\end{align*}
\]

FOCUSING

electrostatic

deflecting

DEFLECTION

$x$ plates
$y$ plates

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

Angle between $x$ and $y$ traces $90 \pm 1^\circ$
Angle between $x$ trace and the horizontal axis of the face max. $5^\circ$ note 1

LINE WIDTH

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 $I_e = 10 \mu\text{A}$.

Line width
at screen centre l.w. $0.50 \text{ mm}$
in corner area l.w. approx. $0.60 \text{ mm}$

1. See last page.
### TYPICAL OPERATING CONDITIONS

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol(s)</th>
<th>Value(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final accelerator voltage</td>
<td>$V_{g7}(\xi)$</td>
<td>10000 V</td>
</tr>
<tr>
<td>Interplate shield voltage</td>
<td>$V_{g6}$</td>
<td>2000 V</td>
</tr>
<tr>
<td>Geometry control voltage</td>
<td>$\Delta V_{g6}$</td>
<td>± 20 V</td>
</tr>
<tr>
<td>Deflection plate shield voltage</td>
<td>$V_{g5}$</td>
<td>2000 V</td>
</tr>
<tr>
<td>Focusing electrode voltage</td>
<td>$V_{g3}$</td>
<td>350 to 500 V</td>
</tr>
<tr>
<td>First accelerator voltage</td>
<td>$V_{g2,g4}$</td>
<td>2000 V</td>
</tr>
<tr>
<td>Astigmatism control voltage</td>
<td>$\Delta V_{g2,g4}$</td>
<td>± 50 V</td>
</tr>
<tr>
<td>Control grid voltage for visual</td>
<td>$V_{g1}$</td>
<td>-25 to -80 V</td>
</tr>
<tr>
<td>extinction of focused spot</td>
<td>approx.</td>
<td>12 V</td>
</tr>
<tr>
<td>Grid drive for 10 $\mu$A screen current</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deflection factor, horizontal</td>
<td>$M_X$</td>
<td>av. 15.5 V/cm</td>
</tr>
<tr>
<td></td>
<td></td>
<td>max. 17 V/cm</td>
</tr>
<tr>
<td>Deflection factor, vertical</td>
<td>$M_Y$</td>
<td>av. 4.5 V/cm</td>
</tr>
<tr>
<td></td>
<td></td>
<td>max. 5 V/cm</td>
</tr>
<tr>
<td>Deviation of linearity of deflection</td>
<td></td>
<td>max. 2 %</td>
</tr>
<tr>
<td>Geometry distortion</td>
<td>See note 6</td>
<td></td>
</tr>
<tr>
<td>Useful scan</td>
<td></td>
<td>min. 120 mm</td>
</tr>
<tr>
<td>horizontal</td>
<td></td>
<td>min. 100 mm</td>
</tr>
<tr>
<td>vertical</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### LIMITING VALUES

Absolute maximum rating system

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol(s)</th>
<th>Value(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final accelerator voltage</td>
<td>$V_{g7}(\xi)$</td>
<td>max. 11000 V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>min. 9000 V</td>
</tr>
<tr>
<td>Interplate shield voltage and</td>
<td>$V_{g6}$</td>
<td>max. 2200 V</td>
</tr>
<tr>
<td>geometry control electrode voltage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deflection plate shield voltage</td>
<td>$V_{g5}$</td>
<td>max. 2200 V</td>
</tr>
<tr>
<td>Focusing electrode voltage</td>
<td>$V_{g3}$</td>
<td>max. 2200 V</td>
</tr>
<tr>
<td>First accelerator and astigmatism</td>
<td>$V_{g2,g4}$</td>
<td>max. 2200 V</td>
</tr>
<tr>
<td>control electrode voltage</td>
<td></td>
<td>min. 1350 V</td>
</tr>
<tr>
<td>Control grid voltage</td>
<td>$-V_{g1}$</td>
<td>max. 200 V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>min. 0 V</td>
</tr>
<tr>
<td>Cathode to heater voltage</td>
<td>$V_{kf}$</td>
<td>max. 125 V</td>
</tr>
<tr>
<td></td>
<td>$-V_{kf}$</td>
<td>min. 125 V</td>
</tr>
<tr>
<td>Voltage between astigmatism control</td>
<td>$V_{g4,x}$</td>
<td>max. 500 V</td>
</tr>
<tr>
<td>electrode and any deflection plate</td>
<td>$V_{g4,y}$</td>
<td>max. 500 V</td>
</tr>
<tr>
<td>Grid drive, average</td>
<td></td>
<td>max. 20 V</td>
</tr>
<tr>
<td>Screen dissipation</td>
<td>$W_s$</td>
<td>max. 8 mW/cm²</td>
</tr>
<tr>
<td>Ratio $V_{g7}(\xi)/V_{g2,g4}$</td>
<td>$V_{g7(\xi)}/V_{g2,g4}$</td>
<td>max. 6.7</td>
</tr>
<tr>
<td>Control grid circuit resistance</td>
<td>$R_{g1}$</td>
<td>max. 1 M$\Omega$</td>
</tr>
</tbody>
</table>
NOTES

1. In order to align the x-trace with the horizontal axis of the screen, the whole picture can be rotated by means of a rotation coil. This coil will have 50 amp. turns for the indicated maximum rotation of 5° and should be positioned as indicated in the drawing.

2. This tube is designed for optimum performance when operating at a ratio $V_{g7}/V_{g2}, g_4 = 5$.
   The geometry electrode voltage should be adjusted within the indicated range (values with respect to the mean x-plate potential).
   A negative control voltage will cause some pincushion distortion and less background light, a positive control voltage will give some barrel distortion and a slight increase of background light.

3. The deflection plate shield voltage should be equal to the mean y-plate potential. The mean x- and y-plate potentials should be equal for optimum spot quality.

4. The astigmatism control electrode voltage should be adjusted for optimum spot shape. For any necessary adjustment its potential will be within the stated range.

5. 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.

6. A graticule, consisting of concentric rectangles of 115 mm x 95 mm and 112,2 mm x 93,0 mm is aligned with the electrical x-axis of the tube, with optimum correction potentials applied, a raster will fall between these rectangles.
INSTRUMENT CATHODE-RAY TUBE

- mono accelerator
- 18 cm diagonal rectangular flat face
- dynamic deflection defocusing correction
- internal magnetic correction for astigmatism, vertical eccentricity and orthogonality
- low heater power consumption
- for oscilloscopes and general display up to 25 MHz bandwidth

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accelerator voltage</td>
<td>$V_{g2,g4,g5(x)}$</td>
</tr>
<tr>
<td>Minimum useful scan area</td>
<td>2000 V, 2500 V</td>
</tr>
<tr>
<td></td>
<td>120 mm x 96 mm</td>
</tr>
<tr>
<td>Deflection coefficient</td>
<td></td>
</tr>
<tr>
<td>horizontal</td>
<td>$M_x$, 21 V/cm</td>
</tr>
<tr>
<td>vertical</td>
<td>$M_y$, 15 V/cm</td>
</tr>
<tr>
<td></td>
<td>26 V/cm, 19 V/cm</td>
</tr>
</tbody>
</table>

OPTICAL DATA

- Screen type: GY, colour green
- Persistence: medium
- Useful screen area: $\geq 124$ mm x 100 mm; note 1
- Useful scan area: $\geq 120$ mm x 96 mm
- Internal graticule: type 127; see Fig. 4

HEATING

- Indirect by a.c. or d.c.*
- Heater voltage: $V_f$, 6.3 V
- Heater current: $I_f$, 0.1 A
- Heating time to attain 10% of the cathode current at equilibrium conditions: approx. 7 s

* Not to be connected in series with other tubes.
MECHANICAL DATA

Dimensions and connections (see also outline drawing)

Overall length (socket included) ≤ 324 mm
Faceplate dimensions 142 ± 0.5 mm x 118 ± 0.5 mm

Net mass approx. 1.3 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

Socket with solder tags type 55594
Socket with printed-wiring pins type 55595
Mu-metal shield to be established
Pin protector (required for shipping) supplied with tube
FOCUSING

electrostatic

deflection

double electrostatic

symmetrical

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.

DYNAMIC DEFLECTION DEFOCUSING CORRECTION

The tube has a special electrode, positioned between the x and y-plates, for dynamic correction of deflection defocusing, to improve the uniformity of the width of a vertical line up to the screen edges. If use is made of this dynamic correction, a negative voltage proportional to, and approx. 50% of, the negative horizontal deflection plate voltage should be applied to this electrode (grid 6).

The correction-circuit impedance must be $< 100 \, k\Omega$. To prevent distortion, the output impedances of the x-amplifiers should be $< 10 \, k\Omega$.

If no correction is required, grid 6 should be connected to mean x-plate potential ($V_{g2(\bar{x})}$).

CAPACITANCES (approx. values)

$C_{x1}(x2) \quad 4.5 \, pF$

$C_{x2}(x1) \quad 4.5 \, pF$

$C_{y1}(y2) \quad 3.5 \, pF$

$C_{y2}(y1) \quad 3.5 \, pF$

$C_{x1x2} \quad 2 \, pF$

$C_{y1y2} \quad 1 \, pF$

$C_{g1} \quad 5 \, pF$

$C_k \quad 2.7 \, pF$

$C_{g6} \quad 11 \, pF$

DEVELOPMENT DATA

$x_1$ to all other elements except $x_2$

$y_1$ to all other elements except $y_2$

$x_2$ to all other elements except $x_1$

$y_2$ to all other elements except $y_1$

$x_1$ to $x_2$

$y_1$ to $y_2$

Control grid to all other elements

Cathode to all other elements

Grid 6 to all other elements
Fig. 1 Outlines.

(1) Dimensions of faceplate only. The complete assembly of faceplate and cone (frit seal included) will pass through an opening of 146 mm x 122 mm (diagonal 182 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.
Fig. 4 Front view of tube with internal graticule, type 129. The faceplate reference points A1, A2 and A3 are used for aligning the graticule with the faceplate. 
\[|a_1 - a_2| \leq 0.4 \text{ mm}\].
Line thickness = 0.2 mm; dot diameter = 0.4 mm; colour: red.
**TYPICAL OPERATION** (voltages with respect to cathode)

<table>
<thead>
<tr>
<th>Conditions</th>
<th>Voltage</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accelerator voltage</td>
<td>$V_{g2,g4,g5,(\ell)}$</td>
<td>2000 V</td>
</tr>
<tr>
<td>Astigmatism control voltage</td>
<td>$\Delta V_{g2,g4,g5,(\ell)}$</td>
<td>0 V</td>
</tr>
<tr>
<td>Focusing voltage</td>
<td>$V_{g3}$</td>
<td>220 to 350 V</td>
</tr>
<tr>
<td>Cut-off voltage for visual extinction of focused spot</td>
<td>$-V_{g1}$</td>
<td>22 to 65 V</td>
</tr>
</tbody>
</table>

**Performance**

<table>
<thead>
<tr>
<th>Performance</th>
<th>Value</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deflection coefficient horizontal</td>
<td>$M_x$</td>
<td>21 V/cm</td>
</tr>
<tr>
<td>Deflection coefficient vertical</td>
<td>$M_y$</td>
<td>15 V/cm</td>
</tr>
<tr>
<td>Deviation of deflection linearity</td>
<td>$\leq$</td>
<td>2 %</td>
</tr>
<tr>
<td>Geometry distortion</td>
<td>see note 7</td>
<td></td>
</tr>
<tr>
<td>Eccentricity of undeflected spot with</td>
<td><code>horizontal</code></td>
<td>4 mm</td>
</tr>
<tr>
<td>respect to internal graticule</td>
<td><code>vertical</code></td>
<td>2 mm</td>
</tr>
<tr>
<td>Angle between x and y-traces</td>
<td>$\leq$</td>
<td>$90^\circ$</td>
</tr>
<tr>
<td>Angle between x-trace and x-axis</td>
<td>$\leq$</td>
<td>$5^\circ$</td>
</tr>
<tr>
<td>of the internal graticule</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grid drive voltage for 10 $\mu$A screen current</td>
<td>$V_d$</td>
<td>$\approx$</td>
</tr>
<tr>
<td>Line width</td>
<td>l.w.</td>
<td>$\approx$</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Limiting Values</th>
<th>Voltage</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accelerator voltage</td>
<td>$V_{g2,g4,g5,(\ell)}$</td>
<td>max. 3000 V</td>
</tr>
<tr>
<td>Focusing voltage</td>
<td>$V_{g3}$</td>
<td>max. 3000 V</td>
</tr>
<tr>
<td>Voltage between accelerator electrode and grid 6</td>
<td>$V_{g2/g6}$</td>
<td>max. $\pm$ 500 V</td>
</tr>
<tr>
<td>Voltage between accelerator electrode and any deflection plate</td>
<td>$V_{g2/x/y}$</td>
<td>max. $\pm$ 500 V</td>
</tr>
<tr>
<td>Control grid voltage</td>
<td>$-V_{g1}$</td>
<td>max. 200 V</td>
</tr>
<tr>
<td>Cathode to heater voltage positive</td>
<td>$V_{kf}$</td>
<td>max. 125 V</td>
</tr>
<tr>
<td>Cathode to heater voltage negative</td>
<td>$-V_{kf}$</td>
<td>max. 125 V</td>
</tr>
<tr>
<td>Heater voltage</td>
<td>$V_f$</td>
<td>max. 6.6 V</td>
</tr>
<tr>
<td>Grid drive voltage, averaged over 1 ms</td>
<td>$V_d$</td>
<td>max. 20 V</td>
</tr>
<tr>
<td>Screen dissipation</td>
<td>$W_\Omega$</td>
<td>max. 3 mW/cm$^2$</td>
</tr>
<tr>
<td>Control grid circuit resistance</td>
<td>$R_{g1}$</td>
<td>max. 1 M$\Omega$</td>
</tr>
</tbody>
</table>
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. 124 mm x 100 mm is recommended. The internal graticule is aligned with the faceplate by using the faceplate reference points (see Fig. 4).
2. The mean x-plate potential and the mean y-plate potential should be equal to \( V_{g2,94,95}(x) \).
3. The tube features internal magnetic correction for astigmatism, orthogonality and eccentricity calibration. Optimum spot is obtained if \( V_{g2,94,95}(x) \) is equal to mean y-potential.
4. An actual focus range of approx. 50 V should be provided on the front panel. \( V_{g3} \) decreases with increasing grid drive.
5. Intensity control on the front panel should be limited to the maximum useful screen current dependent on \( V_{g2,94,95}(x) \). It is to be adjusted either by the grid drive (up to 30 V) or for maximum acceptable line width. The corresponding cathode current or \( I_{g2,94,95} \) (up to 500 \( \mu \)A) depends on the cut-off voltage and cannot be used for control settings.
6. 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.
7. A graticule consisting of concentric rectangles of 120 mm x 96 mm and 117 mm x 93 mm is aligned with the internal graticule. With optimum trace rotation correction the edges of a raster will fall between these rectangles.
8. The tube has a trace rotation coil, fixed onto the lower cone part. The coil has a maximum resistance of 240 \( \Omega \) at 80 °C. The maximum required voltage is approx. 12 V for tube tolerances (± 5°) and earth magnetic field with reasonable shielding (± 2°).
9. Measured with the shrinking raster method within the useful scan under typical operating conditions, adjusted for optimum focus and dynamic correction applied.

As the construction of the tube does not permit a direct measurement of the beam current, this current should be determined as follows:
a) Under typical operating conditions, apply a small raster display (no overscan), adjust \( V_{g1} \) for a beam current of approx. 10 \( \mu \)A and adjust \( V_{g3} \) for smallest spot size at the centre of the screen. When measuring the beam current, grid 6 should be connected to g2-potential and the diodes should be disconnected from the x-plates.
b) Under these conditions, but without raster, the deflection plate voltages should be changed to: \( V_{y1} = V_{y2} = 2000 \) V; \( V_{x1} = 1300 \) V; \( V_{x2} = 1700 \) V, thus directing the total beam current to \( x_2 \). Measure the current on \( x_2 \) and adjust \( V_{g1} \) for \( I_{x2} = 10 \) \( \mu \)A.
c) Set again for the conditions under a), without touching the \( V_{g1} \) control. The screen current of the resulting raster display is now 10 \( \mu \)A. Adjust \( V_{g3} \) for optimum focus in the centre of the screen and apply dynamic correction to grid 6 for optimum width of a vertical line.
INSTRUMENT CATHODE-RAY TUBE

- 18 cm diagonal rectangular flat face
- domed mesh post-deflection acceleration
- internal magnetic lens system for correction of orthogonality, astigmatism and eccentricity
- quick-heating cathode
- internal graticule
- high sensitivity and high brightness
- short overall length
- for oscilloscopes and general display up to 100 MHz bandwidth

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final accelerator voltage</td>
<td>$V_{g7(6)}$</td>
</tr>
<tr>
<td>First accelerator voltage</td>
<td>$V_{g4}$</td>
</tr>
<tr>
<td>Minimum useful scan area</td>
<td></td>
</tr>
<tr>
<td>Deflection coefficient</td>
<td></td>
</tr>
<tr>
<td>horizontal</td>
<td>$M_x$</td>
</tr>
<tr>
<td>vertical</td>
<td>$M_y$</td>
</tr>
</tbody>
</table>

OPTICAL DATA

Screen type: GH
Colour: green
Persistence: medium short
Useful screen area: $\geq 124 \text{ mm} \times 100 \text{ mm};$ note 1
Useful scan area: $\geq 120 \text{ mm} \times 96 \text{ mm}
Internal graticule: type 127; see Fig. 4

HEATING

Indirect by AC or DC*
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

* Not to be connected in series with other tubes.
MECHANICAL DATA

Dimensions and connections (see also outline drawings)

Overall length (socket included) ≤ 348 mm
Faceplate dimensions 142 ± 0,5 mm x 118 ± 0,5 mm

Net mass approx. 1,3 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
Final accelerator contact connector type 55569/55597
Mu-metal shield to be established

FOCUSING

electrostatic

DEFLECTION

double electrostatic

x-plates symmetrical

y-plates symmetrical
**CAPACITANCES**

- $x_1$ to all other elements except $x_2$: $C_{x1}(x2)$, 4.8 pF
- $x_2$ to all other elements except $x_1$: $C_{x2}(x1)$, 3.6 pF
- $y_1$ to all other elements except $y_2$: $C_{y1}(y2)$, 3.0 pF
- $y_2$ to all other elements except $y_1$: $C_{y2}(y1)$, 3.0 pF
- $x_1$ to $x_2$: $C_{x1x2}$, 3.3 pF
- $y_1$ to $y_2$: $C_{y1y2}$, 1.4 pF
- Control grid to all other elements: $C_{g1}$, 6.5 pF
- Cathode to all other elements: $C_k$, 3.2 pF
- Focusing electrode to all other elements: $C_{g3}$, 8 pF
1. Dimensions of faceplate only. The complete assembly of faceplate and cone (frit seal included) will pass through an opening of 146 mm x 122 mm (diagonal 182 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).

5. The centre of the final accelerator contact is situated within a square of 10 mm x 10 mm around the indicated position.
DIMENSIONS AND CONNECTIONS (continued)

![Diagram](image)

Fig. 2 Pin arrangement; bottom view.

![Diagram](image)

(1) G5 impedance to all other elements 25 kΩ maximum.

Fig. 3 Electrode configuration
Fig. 4 Front view of tube with internal graticule, type 129. The faceplate reference points A1, A2 and A3 are used for aligning the graticule with the faceplate.

$|a_1 - a_2| \leq 0.4 \text{ mm}$.

Line thickness = 0.2 mm; dot diameter = 0.4 mm; colour: red.
TYPICAL OPERATION (voltages with respect to cathode) *

Conditions
Final accelerator voltage $V_{g7}$ 16 kV
Mean deflection plate potential 2 kV note 2
Shield voltage for optimum geometry $V_{g5}$ 2 kV note 3
First accelerator and astigmatism control voltage $V_{g4}$ 2 kV note 3
Focusing voltage $V_{g3}$ 400 to 800 V
Grid 2 voltage $V_{g2}$ 2 kV
Cut-off voltage for visual extinction of focused spot $-V_{g1}$ 45 to 90 V

Outer conductive coating (m) and mu-metal shield to be earthed.

Performance
Horizontal deflection coefficient $M_X$ 6,4 V/cm ± 10%
Vertical deflection coefficient $M_Y$ 3,4 V/cm ± 5%
Deviation of deflection linearity ≤ 2% note 4
Geometry distortion
Eccentricity of undeflected spot in horizontal direction ≤ 4 mm
in vertical direction ≤ 2 mm
Angle between x- and y-traces 90° note 2
Angle between x-trace and x-axis of tube/graticule ≤ 5° note 6
Luminance reduction with respect to screen centre
x-axis, ± 60 mm scan ≤ 30%
y-axis, ± 48 mm scan ≤ 30%
any corner ≤ 50%
Grid drive for 10 μA screen current $V_d$ approx. 20 V
Line width l.w. approx. 0,35 mm note 7

DEVELOPMENT DATA

July 1987
LIMITING VALUES (Absolute maximum rating system)

<table>
<thead>
<tr>
<th>Description</th>
<th>Symbol</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final accelerator voltage</td>
<td>(V_{g7(x)})</td>
<td>max. 18 kV note 8</td>
</tr>
<tr>
<td>Shield voltage</td>
<td>(V_{g5})</td>
<td>max. 3.3 kV</td>
</tr>
<tr>
<td>First accelerator and astigmatism control voltage</td>
<td>(V_{g4})</td>
<td>max. 3.3 kV</td>
</tr>
<tr>
<td>Focusing electrode voltage</td>
<td>(V_{g3})</td>
<td>max. 2.5 kV</td>
</tr>
<tr>
<td>Grid 2 voltage</td>
<td>(V_{g2})</td>
<td>max. 3.3 kV</td>
</tr>
<tr>
<td>Control grid voltage</td>
<td>(-V_{g1})</td>
<td>max. 200 V</td>
</tr>
<tr>
<td>min. 0 V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cathode to heater voltage</td>
<td>(V_{kf})</td>
<td>max. 125 V</td>
</tr>
<tr>
<td>positive</td>
<td>(-V_{kf})</td>
<td>max. 125 V</td>
</tr>
<tr>
<td>negative</td>
<td>(V_{f})</td>
<td>max. 6.6 V</td>
</tr>
<tr>
<td>min. 6.0 V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heater voltage</td>
<td>(\Delta V_{g2,g4})</td>
<td>max. 2 kV</td>
</tr>
<tr>
<td>Voltage between g2 and g4</td>
<td>(\Delta V_{g4,g5,x,y})</td>
<td>max. 500 V</td>
</tr>
<tr>
<td>Voltage between g4, g5 and any deflection plate</td>
<td>(V_{d})</td>
<td>max. 25 V</td>
</tr>
<tr>
<td>Screen dissipation</td>
<td>(W_{d})</td>
<td>max. 8 mW/cm²</td>
</tr>
<tr>
<td>Control grid circuit resistance</td>
<td>(R_{g1})</td>
<td>max. 1 MΩ</td>
</tr>
</tbody>
</table>
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. 124 mm x 100 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; floating mean x- or y-potentials will result into non-uniform line width and geometry distortion. The mean x- and y-potentials should be equal; under this condition the tube will be within the specification without corrections for astigmatism and geometry.

   The tube features internal magnetic correction for orthogonality between x- and y-traces, spot shaping (astigmatism) and eccentricity calibration.

3. For some applications a mean x-potential up to 50 V positive with respect to mean y-potential is inevitable. In this case $V_{g5}$ must be made equal to mean x-potential, and a range of 0 to $-25$ V with respect to mean y-potential will be required on $g4$ for astigmatism correction. The circuit resistance for $V_{g4}$ should be $\leq 10 \, k\Omega$.

4. 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.

5. A graticule consisting of concentric rectangles of 120 mm x 96 mm and 117.4 mm x 93.4 mm is aligned with the internal graticule. With optimum trace rotation correction the edges of a raster will fall between these rectangles.

6. The tube has a trace rotation coil, fixed onto the lower cone part. The coil has a maximum resistance of 240 $\Omega$ at 80 °C. The maximum required voltage is approx. 13 V for tube tolerances (± 5°) and earth magnetic field with reasonable shielding (± 2°).

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 $I_g = 10 \, \mu A$.

8. The X-ray dose rate remains below the acceptable value of 36 pA/kg (0.5 mR/h), when the tube is used within its limiting values (beam current $I_g \leq 100 \, \mu A$).
14 cm diagonal, rectangular flat faced, split-beam oscilloscope tube with mesh and metal-backed screen.

<table>
<thead>
<tr>
<th>QUICK REFERENCE DATA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final accelerator voltage $V_{g7(t)}$</td>
</tr>
<tr>
<td>Display area</td>
</tr>
<tr>
<td>Deflection coefficient, horizontal vertical $M_x$, $M_y'$, $M_y''$</td>
</tr>
<tr>
<td>Overlap of the systems</td>
</tr>
</tbody>
</table>

**SCREEN**: Metal-backed phosphor

<table>
<thead>
<tr>
<th>E14-100GH</th>
<th>Colour</th>
<th>Persistence</th>
</tr>
</thead>
<tbody>
<tr>
<td>green</td>
<td></td>
<td>medium short</td>
</tr>
</tbody>
</table>

Useful screen dimensions

Useful scan at $V_{g7(t)}/V_{g2, g4} = 6.7$

| horizontal | min. | 100 mm |
| vertical (each system) | min. | 80 mm |
| overlap | 100 % |

Spot eccentricity in horizontal direction in vertical direction

| max. | 7 mm |
| max. | 10 mm |

**HEATING**: indirect by AC or DC; parallel supply

Heater voltage

| $V_f$ | 6.3 V |

Heater current

| $I_f$ | 300 mA |
Fig. 1 Outlines.

(1) The external conductive coating should be earthed.
(2) The bulge at the frit seal may increase the indicated maximum dimensions by not more than 2 mm.
(3) The centre of the contact is located within a square of 10 mm x 10 mm around the true geometrical position.

Mounting position

The tube should not be supported by the base alone and under no circumstances should the socket be allowed to support the tube.
MECHANICAL DATA (continued)

Dimensions and connections
See also outline drawing.
Overall length (socket included) max. 425 mm
Face dimensions max. 120 x 100 mm²
Net weight approx. 900 g
Base
14-pin all glass

Accessories
Socket (supplied with tube) type 55566
Final accelerator contact connector type 55563A

FOCUSING Electrostatic

DEFLECTION Double electrostatic
x-plates symmetrical
y-plates symmetrical
If the full deflection capacity of the tube is used, part of the beam is intercepted by the deflection plates; hence a low-impedance deflection plate drive is desirable.
Angle between x and y traces (each beam) 90 ± 1 °
Angle between corresponding y traces at screen centre max. 45 °
Angle between x trace and horizontal axis of the face max. 0 °

LINE WIDTH
Measured with the shrinking raster method under typical operating conditions, and adjusted for optimum spot size at a beam current of 5 µA per system.
Line width at screen centre l.w approx. 0.35 mm

CAPACITANCES
x₁ to all other elements except x₂ Cₓ₁(x₂) 8 pF
x₂ to all other elements except x₁ Cₓ₂(x₁) 8 pF
y₁ to all other elements except y₂ Cₜ₁(y₂) 4 pF
y₂ to all other elements except y₁ Cₜ₂(y₁) 5.5 pF
y₁′ to all other elements except y₂′ Cₜ₁′(y₂′) 5 pF
y₂′ to all other elements except y₁′ Cₜ₂′(y₁′) 4 pF
y₁ ″ to all other elements except y₂ ″ Cₜ₁ ″(y₂ ″) 5 pF
y₂ ″ to all other elements except y₁ ″ Cₜ₂ ″(y₁ ″) 4 pF
External conductive coating to all other elements Cₘ 800 pF
CAPACITANCES (continued)

\( x_1 \) to \( x_2 \)  
\( y_1' \) to \( y_2' \)  
\( y_1'' \) to \( y_2'' \)  
Control grid to all other elements  
Cathode and heater to all other elements

\( C_{x_1x_2} \)  3 pF  
\( C_{y_1'y_2'} \)  1 pF  
\( C_{y_1''y_2''} \)  1 pF  
\( C_{g1} \)  6 pF  
\( C_{kf/R} \)  3 pF

NOTES

1. This tube is designed for optimum performance when operating at a ratio 
\( V_{g7(t)}/V_{g2,g4} = 6,7. \)

   The geometry control voltage \( V_{g6} \) should be adjusted within the indicated range 
   (values with respect to the mean x-plate potential).

2. A negative control voltage on \( g_5 \) (with respect to the mean x-plate potential) will cause 
some pincushion distortion and less background light. By varying the two voltages \( V_{g5} \) 
and \( V_{g6} \), it is possible to find the best compromise between background light and 
raster distortion.

3. The astigmatism control electrode voltage should be adjusted for optimum spot shape. 
   For any necessary adjustment its potential will be within the stated range.

4. 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.

5. A graticule, consisting of concentric rectangles of 100 mm x 80 mm and 96 mm x 
77 mm is aligned with the electrical x-axis of the tube. With optimum correction 
potentials applied a raster of each system will fall between these rectangles.
### TYPICAL OPERATING CONDITIONS

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final accelerator voltage</td>
<td>$V_{g7}(t)$</td>
<td>10 kV</td>
</tr>
<tr>
<td>Geometry control electrode voltage</td>
<td>$V_{g6}$</td>
<td>1500 ± 100 V</td>
</tr>
<tr>
<td>Interplate shield voltage</td>
<td>$V_{g5}$</td>
<td>1500 V</td>
</tr>
<tr>
<td>Background illumination control voltage</td>
<td>$\Delta V_{g5}$</td>
<td>0 to -15 V</td>
</tr>
<tr>
<td>Focusing electrode voltage</td>
<td>$V_{g3}$</td>
<td>350 to 650 V</td>
</tr>
<tr>
<td>First accelerator voltage</td>
<td>$V_{g2', g4}$</td>
<td>1500 V</td>
</tr>
<tr>
<td>Astigmatism control voltage</td>
<td>$\Delta V_{g2', g4}$</td>
<td>±75 V</td>
</tr>
<tr>
<td>Control grid voltage for extinction of focused spot</td>
<td>$V_{g1}$</td>
<td>-20 to -70 V</td>
</tr>
</tbody>
</table>

#### Deflection coefficient, horizontal

<table>
<thead>
<tr>
<th>Coefficient</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$M_x$</td>
<td>&lt; 12.5 V/cm</td>
</tr>
<tr>
<td>$M_y'$</td>
<td>&lt; 9 V/cm</td>
</tr>
<tr>
<td>$M_y''$</td>
<td>&lt; 9 V/cm</td>
</tr>
</tbody>
</table>

#### Deflection coefficient, vertical

<table>
<thead>
<tr>
<th>Coefficient</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$M_x$</td>
<td>&lt; 14 V/cm</td>
</tr>
<tr>
<td>$M_y'$</td>
<td>&lt; 10 V/cm</td>
</tr>
<tr>
<td>$M_y''$</td>
<td>&lt; 10 V/cm</td>
</tr>
</tbody>
</table>

#### Deviation of deflection linearity

< 2 % | see note 4 | see note 5

#### Geometry distortion

Useful scan, horizontal > 100 mm
Useful scan, vertical > 80 mm

Overlap of the two systems, horizontal 100 %
Overlap of the two systems, vertical 100 %

### LIMITING VALUES (Absolute max. rating system)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final accelerator voltage</td>
<td>$V_{g7}(t)$</td>
<td>max. 12 kV</td>
</tr>
<tr>
<td>Geometry control electrode voltage</td>
<td>$V_{g6}$</td>
<td>max. 2200 V</td>
</tr>
<tr>
<td>Interplate shield voltage</td>
<td>$V_{g5}$</td>
<td>max. 2200 V</td>
</tr>
<tr>
<td>Focusing electrode voltage</td>
<td>$V_{g3}$</td>
<td>max. 2200 V</td>
</tr>
<tr>
<td>First accelerator and astigmatism control voltage</td>
<td>$V_{g2', g4}$</td>
<td>max. 2200 V</td>
</tr>
<tr>
<td>Control grid voltage</td>
<td>$-V_{g1}$</td>
<td>max. 200 V</td>
</tr>
<tr>
<td>Voltage between astigmatism control electrode and any deflection plate</td>
<td>$V_{g4/x}$</td>
<td>max. 500 V</td>
</tr>
<tr>
<td>Grid drive average</td>
<td>$W_1$</td>
<td>max. 8 mW/cm²</td>
</tr>
<tr>
<td>Screen dissipation</td>
<td></td>
<td>max. 30 V</td>
</tr>
<tr>
<td>Ratio $V_{g7(t)}/V_{g2', g4}$</td>
<td>$V_{g7(t)}/V_{g2', g4}$</td>
<td>max. 6.7</td>
</tr>
<tr>
<td>Control grid circuit resistance</td>
<td>$R_{g1}$</td>
<td>max. 1 MΩ</td>
</tr>
</tbody>
</table>

March 1981 275
CORRECTION COILS

General

The E14-100GH is provided with a pair of coils for image rotation which enable the alignment of the x-trace with the x-lines of the graticule.

![Diagram of coil unit.](image)

The image rotating coils are wound concentrically around the tube neck. Under typical operating conditions 50 A turns are required for the maximum rotation of 5°. Both coils have 850 turns. This means that a current of max. 30 mA per coil is required which can be obtained by using a 24 V supply when the coils are connected in series, or a 12 V supply when they are in parallel.

Connecting the coils

The coils have been connected to the 4 soldering tags as follows:

![Dimensions and connections.](image)
BEAM CENTRING MAGNET

Inherent to the split-beam system a slight difference between the two beam currents can occur after splitting, resulting in different intensities of the two traces. In order to equalize the beam currents, a beam centring magnet should be mounted near the base of the gun and adjusted for the required field direction and field strength.
INSTRUMENT CATHODE-RAY TUBE

The E14-101GH is equivalent to the E14-100GH but has no rotating coil.
14 cm diagonal, rectangular flat-faced direct-view storage tube with variable persistence and internal graticule, intended for oscilloscope applications.

**QUICK REFERENCE DATA**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final accelerator voltage ( V_{g10}(l) )</td>
<td>8.5 kV</td>
</tr>
<tr>
<td>Display area (10 x 8 divisions of 9 mm)</td>
<td>90 x 72 mm²</td>
</tr>
<tr>
<td>Deflection coefficient</td>
<td></td>
</tr>
<tr>
<td>horizontal ( M_X )</td>
<td>9.5 V/div</td>
</tr>
<tr>
<td>vertical ( M_Y )</td>
<td>4.1 V/div</td>
</tr>
<tr>
<td>Writing speed</td>
<td>2.5 div/µs</td>
</tr>
</tbody>
</table>

**OPTICAL DATA**

<table>
<thead>
<tr>
<th>Screen type</th>
<th>metal backed phosphor GH, colour green medium-short variable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Persistence, non-store mode</td>
<td>min. 90 x 72 mm</td>
</tr>
<tr>
<td>Persistence, store mode</td>
<td>min. 90 mm</td>
</tr>
<tr>
<td>min. 72 mm</td>
<td></td>
</tr>
<tr>
<td>Spot eccentricity in horizontal and vertical directions</td>
<td>max. 6 mm</td>
</tr>
</tbody>
</table>

The scanned raster can be shifted and aligned with the internal graticule by means of correction coils fitted around the tube by the manufacturer.

**HEATING**

**Writing section**

Indirect by a.c. or d.c.; parallel supply

- Heater voltage \( V_f \) 6.3 V
- Heater current \( I_f \) 300 mA

**Viewing section**

Indirect by d.c.; parallel supply

- Heater voltage \( V_{f'} \) 6.3 V
- Heater current \( I_{f'} \) 300 mA
- Heater voltage \( V_{f''} \) 6.3 V
- Heater current \( I_{f''} \) 300 mA
MECHANICAL DATA

Mounting position  any

The tube should not be supported by the base alone 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.

Net mass  approx. 1,1 kg
Base  14 pin, all glass

Dimensions and connections

See also outline drawing

Overall length (socket included)  max. 445 mm
Face dimensions  max. 100 x 120 mm

Accessories

Socket (supplied with tube)  type 55566
Side contact connector (14 required)  type 55561
Small ball contact connector (3 required)  type 4022 102 21590

FOCUSING
DEFLECTION

x-plates
y-plates
Angle between x and y-traces  90°
Angle between x-trace and x-axis of the internal graticule  0°

See also Correction coils
### Capacitances

<table>
<thead>
<tr>
<th>Connection</th>
<th>Symbol</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$x_1$ to all other elements except $x_2$</td>
<td>$C_{X1}(x_2)$</td>
<td>6.5</td>
<td>pF</td>
</tr>
<tr>
<td>$x_2$ to all other elements except $x_1$</td>
<td>$C_{X2}(x_1)$</td>
<td>6.5</td>
<td>pF</td>
</tr>
<tr>
<td>$y_1$ to all other elements except $y_2$</td>
<td>$C_{Y1}(y_2)$</td>
<td>3</td>
<td>pF</td>
</tr>
<tr>
<td>$y_2$ to all other elements except $y_1$</td>
<td>$C_{Y2}(y_1)$</td>
<td>3</td>
<td>pF</td>
</tr>
<tr>
<td>$x_1$ to $x_2$</td>
<td>$C_{X1x2}$</td>
<td>2.5</td>
<td>pF</td>
</tr>
<tr>
<td>$y_1$ to $y_2$</td>
<td>$C_{Y1y2}$</td>
<td>2</td>
<td>pF</td>
</tr>
<tr>
<td>$g_1$ to all other elements</td>
<td>$C_{g1}$</td>
<td>5.5</td>
<td>pF</td>
</tr>
<tr>
<td>$g_1'$ to all other elements</td>
<td>$C_{g1'}$</td>
<td>5.5</td>
<td>pF</td>
</tr>
<tr>
<td>$g_1''$ to all other elements</td>
<td>$C_{g1''}$</td>
<td>5.5</td>
<td>pF</td>
</tr>
<tr>
<td>$k$ to all other elements</td>
<td>$C_k$</td>
<td>4.5</td>
<td>pF</td>
</tr>
<tr>
<td>$k'$ to all other elements</td>
<td>$C_{k'}$</td>
<td>5</td>
<td>pF</td>
</tr>
<tr>
<td>$k''$ to all other elements</td>
<td>$C_{k''}$</td>
<td>5</td>
<td>pF</td>
</tr>
<tr>
<td>$g_7$ to all other elements</td>
<td>$C_{g7}$</td>
<td>40</td>
<td>pF</td>
</tr>
<tr>
<td>$g_9$ to all other elements</td>
<td>$C_{g9}$</td>
<td>75</td>
<td>pF</td>
</tr>
</tbody>
</table>
(1) The bulge at the frit seal may increase the indicated maximum dimensions by not more than 3 mm.

(2) Minimum length of cable: 420 mm.
Instrument cathode-ray tube

Fig. 2 Bottom view and side-contact arrangement.

Fig. 3 Top view.

Fig. 4 Electrode configuration.

Fig. 5 Pin arrangement; bottom view.

Fig. 6 Detail of side contact

Fig. 7 Internal graticule
colour of graticule: brown-black;
line width : 0.15 mm;
dot diameter : 0.3 mm.
**TYPICAL OPERATION** (for notes see page 284)

**Conditions**

*Writing section* (voltages with respect to writing gun cathode k)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Voltage</th>
<th>Unit</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final accelerator voltage</td>
<td>$V_{g10}^{(k)}$</td>
<td>8500</td>
<td>V</td>
</tr>
<tr>
<td>Geometry control electrode voltage</td>
<td>$V_{g6}$</td>
<td>1500 ± 100</td>
<td>V</td>
</tr>
<tr>
<td>Deflection plate shield voltage</td>
<td>$V_{g5}$</td>
<td>1500</td>
<td>V</td>
</tr>
<tr>
<td>Astigmatism control electrode voltage</td>
<td>$V_{g4}$</td>
<td>1500 ± 50</td>
<td>V</td>
</tr>
<tr>
<td>Focusing electrode voltage</td>
<td>$V_{g3}$</td>
<td>400 to 600</td>
<td>V</td>
</tr>
<tr>
<td>First accelerator voltage</td>
<td>$V_{g2}$</td>
<td>1500</td>
<td>V</td>
</tr>
<tr>
<td>Control grid voltage for visual extinction of focused spot</td>
<td>$V_{g1}$</td>
<td>-40 to -80</td>
<td>V</td>
</tr>
</tbody>
</table>

*Viewing section* (voltages with respect to viewing gun cathodes k' and k'’)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Voltage</th>
<th>Unit</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final accelerator voltage</td>
<td>$V_{g10}^{(k)}$</td>
<td>7050</td>
<td>V</td>
</tr>
<tr>
<td>Backing electrode voltage, storage operation</td>
<td>$V_{g9}$</td>
<td>0 to 5</td>
<td>V</td>
</tr>
<tr>
<td>Backing electrode voltage, non-storage operation</td>
<td>$V_{g9}$</td>
<td>-35</td>
<td>V</td>
</tr>
<tr>
<td>Collector voltage</td>
<td>$V_{g8}$</td>
<td>150</td>
<td>V</td>
</tr>
<tr>
<td>Collimator voltage</td>
<td>$V_{g7}$</td>
<td>30 to 120</td>
<td>V</td>
</tr>
<tr>
<td>First accelerator voltage</td>
<td>$V_{g2}^{', ; V_{g2}''}$</td>
<td>50</td>
<td>V</td>
</tr>
<tr>
<td>Control grid voltage for cut-off</td>
<td>$V_{g1}^{', ; V_{g1}''}$</td>
<td>-30 to -70</td>
<td>V</td>
</tr>
<tr>
<td>Cathode current (each viewing gun)</td>
<td>$I_{k}', ; I_{k}''$</td>
<td>0,4</td>
<td>mA</td>
</tr>
</tbody>
</table>

**Performance**

**Useful scan**

<table>
<thead>
<tr>
<th>Direction</th>
<th>Minimum Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>horizontal</td>
<td>min.</td>
<td>90 mm</td>
</tr>
<tr>
<td>vertical</td>
<td>min.</td>
<td>72 mm</td>
</tr>
</tbody>
</table>

**Deflection coefficient**

<table>
<thead>
<tr>
<th>Direction</th>
<th>Maximum Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>horizontal</td>
<td>max.</td>
<td>9.5 V/div</td>
</tr>
<tr>
<td>vertical</td>
<td>max.</td>
<td>4.4 V/div</td>
</tr>
</tbody>
</table>

**Line width at the centre of the screen**

<table>
<thead>
<tr>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.35</td>
<td>mm</td>
</tr>
</tbody>
</table>

**Writing speed in store mode**

<table>
<thead>
<tr>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>greater than</td>
<td>250 div/ms</td>
</tr>
</tbody>
</table>

**Storage time**

<table>
<thead>
<tr>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>greater than</td>
<td>1.5 min</td>
</tr>
</tbody>
</table>

**Deviation of linearity of deflection**

<table>
<thead>
<tr>
<th>Value</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>max.</td>
<td>2</td>
</tr>
</tbody>
</table>

**Geometry distortion**

<table>
<thead>
<tr>
<th>Value</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>see note 9</td>
<td></td>
</tr>
</tbody>
</table>

**Grid drive for 10 μA beam current**

<table>
<thead>
<tr>
<th>Value</th>
<th>V</th>
</tr>
</thead>
<tbody>
<tr>
<td>≈ 25</td>
<td></td>
</tr>
</tbody>
</table>

---

286 April 1984
### LIMITING VALUES (Absolute maximum rating system)

**Writing section (voltages with respect to writing gun cathode k)**

<table>
<thead>
<tr>
<th>Component</th>
<th>Symbol</th>
<th>Max.</th>
<th>Min.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final accelerator voltage</td>
<td>$V_{g10(k)}$</td>
<td>9500 V</td>
<td>7000 V</td>
</tr>
<tr>
<td>Geometry control electrode voltage</td>
<td>$V_{g6}$</td>
<td>2100 V</td>
<td></td>
</tr>
<tr>
<td>Deflection plate shield voltage</td>
<td>$V_{g5}$</td>
<td>2000 V</td>
<td></td>
</tr>
<tr>
<td>Astigmatism control electrode voltage</td>
<td>$V_{g4}$</td>
<td>2100 V</td>
<td>1200 V</td>
</tr>
<tr>
<td>Focusing electrode voltage</td>
<td>$V_{g3}$</td>
<td>1000 V</td>
<td></td>
</tr>
<tr>
<td>First accelerator voltage</td>
<td>$V_{g2}$</td>
<td>2000 V</td>
<td>1250 V</td>
</tr>
<tr>
<td>Control grid voltage</td>
<td>$V_{g1}$</td>
<td>0 V</td>
<td>200 V</td>
</tr>
<tr>
<td>Cathode to heater voltage</td>
<td>$V_{kf}$</td>
<td>125 V</td>
<td></td>
</tr>
<tr>
<td>Voltage between astigmatism control electrode and any deflection plate</td>
<td>$V_{g4/x}$</td>
<td>500 V</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$V_{g4/y}$</td>
<td>500 V</td>
<td></td>
</tr>
</tbody>
</table>

**Average grid drive**

### Viewing section (voltages with respect to viewing gun cathodes k' and k'' unless otherwise specified)

<table>
<thead>
<tr>
<th>Component</th>
<th>Symbol</th>
<th>Max.</th>
<th>Min.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final accelerator voltage</td>
<td>$V_{g10(k)}$</td>
<td>8000 V</td>
<td>5500 V</td>
</tr>
<tr>
<td>Backing electrode voltage, storage operation</td>
<td>$V_{g9}$</td>
<td>5 V</td>
<td>0 V</td>
</tr>
<tr>
<td></td>
<td>$-V_{g9}$</td>
<td>50 V</td>
<td>25 V</td>
</tr>
<tr>
<td>Collector voltage</td>
<td>$V_{g8}$</td>
<td>180 V</td>
<td>120 V</td>
</tr>
<tr>
<td>Collimator voltage</td>
<td>$V_{g7}$</td>
<td>200 V</td>
<td>0 V</td>
</tr>
<tr>
<td>First accelerator voltage</td>
<td>$V_{g2}', V_{g2}''$</td>
<td>60 V</td>
<td>40 V</td>
</tr>
<tr>
<td>Cathode to heater voltage</td>
<td>$V_{k'f}', V_{k''f}''$</td>
<td>125 V</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$-V_{k'f}', -V_{k''f}''$</td>
<td>125 V</td>
<td></td>
</tr>
<tr>
<td>Control grid voltage</td>
<td>$V_{g1}', V_{g1}''$</td>
<td>0 V</td>
<td>200 V</td>
</tr>
<tr>
<td></td>
<td>$-V_{g1}', -V_{g1}''$</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
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 adequately dimensioned RC-network must be connected in series with the screen terminal lead (Fig. 8).

\[
\begin{align*}
\text{HT supply} & \quad 15 \, \text{M\Omega \ min} \quad 1 \, \text{M\Omega} \quad V_{g10} \, \text{(L) terminal} \\
\text{typ.} & \quad 500 \, \text{pF} \\
\end{align*}
\]

Fig. 8.

2. This voltage should be equal to the mean y-plate potential. The mean x and y-plate potentials should be equal for optimum spot quality.

3. The collimator electrode voltage should be adjusted for optimum uniformity of background illumination.

4. The voltage $V_{g2}$, $V_{g2''}$ should be equal to the mean x-plate potential.

5. 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 $I_B = 10 \, \mu\text{A}$ (measured against x-plates).

6. 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 total graticule area, with the exception of maximum 5% in each corner. The writing speed can be increased to approx. 2.5 div/\mu s if some background is tolerated.

7. The storage time is defined as the time required for the brightness of the unwritten background to rise from just 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.

8. 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.

9. A graticule, consisting of concentric rectangles of 88 mm x 70 mm and 86 mm x 68.5 mm is aligned with the electrical x-axis of the tube. With optimum corrections applied, a raster will fall between these rectangles.

CORRECTION COILS

General

The L14-111GH/55 is provided with a coil unit (see Fig. 9) consisting of:

- a pair of coils L3 and L4 which enable the angle between the x and y-traces at the centre of the screen to the made exactly 90° (orthogonality correction);

- a pair of coils L1 and L2 for image rotation which enable the alignment of the x-trace with the x-lines of the graticule.
Orthogonality (coils L3 and L4)
The current required under typical operating conditions without a mu-metal shield being used is max. 20 mA for complete correction of orthogonality. It will be 30% to 50% lower with shield, depending on the shield diameter. The resistance of the coil is approx. 225 Ω.

Image rotation (coils L1 and L2)
The image rotation coils are wound concentrically around the tube neck. Under typical operating conditions 22 ampere-turns are required for maximum rotation of 5°. Both coils have 850 turns. This means that a current of max. 12.5 mA per coil is required which can be obtained by using a 12 V supply when the coils are connected in series or a 6 V supply when they are in parallel.

Connecting the coils
The coils have been connected to 8 solder tags according to Fig. 10.

With L3 and L4 connected in series according to Fig. 11 a current in the direction indicated will produce a clockwise rotation of the vertical trace and an anti-clockwise rotation of the horizontal trace.
OPERATING NOTES

Modes of operation

Store mode

a. Dynamic erasure (variable persistence)
   Dynamic erasure can be achieved by applying erasing pulses of positive polarity to the backing electrode. The pulse amplitude required is approximately 9 V (< 15 V) and the persistence of a stored display can be controlled by varying the duty factor of these pulses.

b. 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, the backing electrode should first be connected to the collector electrode voltage and then returned to its original potential for about 100 ms; after that, an erasing pulse of positive polarity and a duration of not less than 300 ms should be applied. For the adjustment of the amplitude of this pulse see Procedure of adjustment.

Non-store mode

For non-store operation, it is sufficient to make the backing electrode about 35 V negative with respect to the viewing gun cathodes. 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.

Procedure of adjustment

a. Adjust the cathode current of each viewing gun to 0.4 mA by means of its control grid voltage.

b. Adjustment of the erasing pulse amplitude (static erasure)
   The pulse amplitude should be just sufficient to suppress any background illumination at the centre of the display area (this adjustment should be done under low ambient light conditions). Data on storage time and maximum writing speed are based on erasure to "just black". A larger pulse amplitude (erasure to "blacker than black") yields a longer storage time at the expense of maximum writing speed. On the other hand, writing speed can be increased if some background illumination is tolerated. To erase to "just black" the amplitude of this pulse is approximately 9 V.

c. Adjustment of the collimator voltage
   With dynamic erasing pulses applied and a persistence control setting that yields a convenient background illumination intensity, the collimator voltage is adjusted for optimum background uniformity. This voltage will be approximately 80 V with respect to the viewing gun cathode potential. If this voltage is too high or too low, there is a decrease of intensity at the four corners or at the centres of the vertical edges of the display area respectively. For a good erasure of the display, the collimator voltage should be as low as possible.
INSTRUMENT CATHODE-RAY TUBE

14 cm-diagonal rectangular flat-faced direct-view storage tube with split-beam writing gun, variable persistence and internal graticule, intended for oscilloscope applications.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final accelerator voltage</td>
<td>$V_{g10}$ ($\xi$)</td>
</tr>
<tr>
<td>Useful scan (10 x 8 divisions of 9 mm)</td>
<td>90 x 72 mm</td>
</tr>
<tr>
<td>Deflection coefficient</td>
<td></td>
</tr>
<tr>
<td>horizontal</td>
<td>$M_x$</td>
</tr>
<tr>
<td>vertical, system 1</td>
<td>$M_y'$</td>
</tr>
<tr>
<td>vertical, system 2</td>
<td>$M_y''$</td>
</tr>
<tr>
<td>Overlap of the systems</td>
<td>100 %</td>
</tr>
<tr>
<td>Writing speed</td>
<td>1.25 div/µs</td>
</tr>
</tbody>
</table>

OPTICAL DATA

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Screen type</td>
<td>metal-backed phosphor GH, colour green medium short variable</td>
</tr>
<tr>
<td>persistence, non-store mode</td>
<td></td>
</tr>
<tr>
<td>persistence, store mode</td>
<td></td>
</tr>
<tr>
<td>Useful screen dimensions</td>
<td>min. 90 x 72 mm</td>
</tr>
<tr>
<td>Useful scan</td>
<td></td>
</tr>
<tr>
<td>horizontal</td>
<td>min. 90 mm</td>
</tr>
<tr>
<td>vertical (each system)</td>
<td>min. 72 mm</td>
</tr>
<tr>
<td>overlap</td>
<td>100 %</td>
</tr>
<tr>
<td>Spot eccentricity</td>
<td></td>
</tr>
<tr>
<td>in horizontal direction</td>
<td>max. 6 mm</td>
</tr>
<tr>
<td>in vertical direction</td>
<td>max. 9 mm</td>
</tr>
</tbody>
</table>

The scanned raster can be aligned with the internal graticule by means of correction coils fitted around the tube by the manufacturer.

HEATING

Writing section

Indirect by AC or DC; parallel supply

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heater voltage</td>
<td>$V_f$</td>
</tr>
<tr>
<td>Heater current</td>
<td>$I_f$</td>
</tr>
</tbody>
</table>

Viewing section

Indirect by DC; parallel supply

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heater voltage</td>
<td>$V_{f'}$</td>
</tr>
<tr>
<td>Heater current</td>
<td>$I_{f'}$</td>
</tr>
<tr>
<td>Heater voltage</td>
<td>$V_{f''}$</td>
</tr>
<tr>
<td>Heater current</td>
<td>$I_{f''}$</td>
</tr>
</tbody>
</table>
MECHANICAL DATA

Mounting position
The tube should not be supported by the base alone 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.

Net mass approx. 1.1 kg
Base 14 pin, all glass
Dimensions and connections
See also outline drawing
Overall length (socket included) max. 445 mm
Face dimensions max. 100 x 120 mm

Accessories
Socket (supplied with tube) type 55566
Side contact connector (16 required) type 55561
Small ball contact connector (3 required) type 4022 102 21590

FOCUSING
DEFLECTION
x-plates electrostatic
y-plates double electrostatic

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

Angle between x and y traces, each beam 90°
Angle between x-trace and x-axis of the internal graticule 0°
Angle between corresponding y-traces at the centre max. 45° of the screen
CAPACITANCES

Writing section

\( x_1 \) to all other elements except \( x_2 \)
\( x_2 \) to all other elements except \( x_1 \)
\( y_1' \) to all other elements except \( y_2' \)
\( y_2' \) to all other elements except \( y_1'' \)
\( y_1'' \) to all other elements except \( y_2'' \)
\( y_2'' \) to all other elements except \( y_1'' \)

\( x_1 \) to \( x_2 \)
\( y_1' \) to \( y_2' \)
\( y_1'' \) to \( y_2'' \)
\( g_1 \) to all other elements
\( k \) to all other elements

Viewing section

\( g_1' \) to all other elements
\( g_1'' \) to all other elements
\( k' \) to all other elements
\( k'' \) to all other elements
\( g_7 \) to all other elements
\( g_9 \) to all other elements


\( C_{x1}(x2) \) 6.5 pF
\( C_{x2}(x1) \) 6.5 pF
\( C_{y1'}(y2') \) 5 pF
\( C_{y2'}(y1') \) 6 pF
\( C_{y1''}(y2'') \) 6 pF
\( C_{y2''}(y1'') \) 5 pF

\( C_{x1 \times 2} \) 2.5 pF
\( C_{y1'\times y2'} \) 0.6 pF
\( C_{y1''\times y2''} \) 0.6 pF
\( C_{g1} \) 5.5 pF
\( C_{k} \) 4.5 pF

\( C_{g1'} \) 5.5 pF
\( C_{g1''} \) 5.5 pF
\( C_{k'} \) 5 pF
\( C_{k''} \) 5 pF
\( C_{g7} \) 45 pF
\( C_{g9} \) 75 pF
Fig. 1 Outlines.

(1) The bulge at the frit seal may increase the indicated maximum dimensions (Fig. 3) by not more than 3 mm.

(2) Minimum length of cable: 420 mm.
Fig. 2 Bottom view and side-contact arrangement.

Fig. 3 Top view.

Fig. 4 Electrode configuration.

Fig. 5 Pin arrangement; bottom view.

Fig. 6 Detail of side contact.

Fig. 7 Internal graticule. Colour: brown-black; line width: 0.15 mm; dot diameter: 0.3 mm.
### TYPICAL OPERATION

#### Conditions

**Writing section** (voltages with respect to writing gun cathode k)

<table>
<thead>
<tr>
<th>Voltage Description</th>
<th>Voltage (V)</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final accelerator voltage</td>
<td>$V_{g10}$</td>
<td>8500</td>
</tr>
<tr>
<td>Geometry control electrode voltage</td>
<td>$V_{g6}$</td>
<td>1500 ± 100</td>
</tr>
<tr>
<td>Deflection plate shield voltage</td>
<td>$V_{g5}$</td>
<td>1500</td>
</tr>
<tr>
<td>Astigmatism control electrode voltage</td>
<td>$V_{g4}$</td>
<td>1500 ± 75</td>
</tr>
<tr>
<td>Focusing electrode voltage</td>
<td>$V_{g3}$</td>
<td>400 to 650</td>
</tr>
<tr>
<td>First accelerator voltage</td>
<td>$V_{g2}$</td>
<td>1500</td>
</tr>
<tr>
<td>Control grid voltage for visual extinction of focused spot</td>
<td>$V_{g1}$</td>
<td>-40 to -80</td>
</tr>
</tbody>
</table>

**Viewing section** (voltages with respect to viewing gun cathode k' and k'')

<table>
<thead>
<tr>
<th>Voltage Description</th>
<th>Voltage (V)</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final accelerator voltage</td>
<td>$V_{g10}$</td>
<td>7050</td>
</tr>
<tr>
<td>Backing electrode voltage, storage operation</td>
<td>$V_{g9}$</td>
<td>1</td>
</tr>
<tr>
<td>Backing electrode voltage, non-storage operation</td>
<td>$V_{g9}$</td>
<td>-35</td>
</tr>
<tr>
<td>Collector voltage</td>
<td>$V_{g8}$</td>
<td>150</td>
</tr>
<tr>
<td>Collimator voltage</td>
<td>$V_{g7}$</td>
<td>30 to 120</td>
</tr>
<tr>
<td>First accelerator voltage</td>
<td>$V_{g2'}$,$V_{g2''}$</td>
<td>50</td>
</tr>
<tr>
<td>Control grid voltage for cut-off</td>
<td>$V_{g1'}$,$V_{g1''}$</td>
<td>-30 to -70</td>
</tr>
<tr>
<td>Cathode current (each viewing gun)</td>
<td>$I_{k'}$, $I_{k''}$</td>
<td>0.4 mA</td>
</tr>
</tbody>
</table>

#### Performance

<table>
<thead>
<tr>
<th>Parameter Description</th>
<th>Value</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Useful scan</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Horizontal</td>
<td>min. 90 mm</td>
<td></td>
</tr>
<tr>
<td>Vertical</td>
<td>min. 72 mm</td>
<td></td>
</tr>
<tr>
<td>Deflection coefficient</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Horizontal</td>
<td>$M_X$</td>
<td>9.5 V/div</td>
</tr>
<tr>
<td>Vertical, system 1</td>
<td>$M_{Y'}$</td>
<td>8.5 V/div</td>
</tr>
<tr>
<td>Vertical, system 2</td>
<td>$M_{Y''}$</td>
<td>8.5 V/div</td>
</tr>
<tr>
<td>Line width at the centre of the screen</td>
<td>$l_w.$</td>
<td>0.40 mm</td>
</tr>
<tr>
<td>Writing speed in store mode</td>
<td>greater than 125 div/ms</td>
<td>note 6</td>
</tr>
<tr>
<td>Storage time</td>
<td>greater than 1.5 min</td>
<td>note 7</td>
</tr>
<tr>
<td>Deviation of linearity of deflection</td>
<td>max. 2 %</td>
<td>note 8</td>
</tr>
<tr>
<td>Geometry distortion</td>
<td>see note 9</td>
<td></td>
</tr>
<tr>
<td>Grid drive for 5 $\mu$A beam current, per system</td>
<td>approx. 30 V</td>
<td></td>
</tr>
</tbody>
</table>
### LIMITING VALUES (Absolute maximum rating system)

**Writing section** (voltages with respect to writing gun cathode k)

<table>
<thead>
<tr>
<th>Voltage Description</th>
<th>Symbol</th>
<th>Min.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final accelerator voltage</td>
<td>( V_{g10} )</td>
<td>7000 V</td>
<td>9500 V</td>
</tr>
<tr>
<td>Geometry control electrode voltage</td>
<td>( V_{g6} )</td>
<td>2100 V</td>
<td>5000 V</td>
</tr>
<tr>
<td>Deflection plate shield voltage</td>
<td>( V_{g5} )</td>
<td>2000 V</td>
<td>5000 V</td>
</tr>
<tr>
<td>Astigmatism control electrode voltage</td>
<td>( V_{g4} )</td>
<td>1200 V</td>
<td>5000 V</td>
</tr>
<tr>
<td>Focusing electrode voltage</td>
<td>( V_{g3} )</td>
<td>1000 V</td>
<td>5000 V</td>
</tr>
<tr>
<td>First accelerator voltage</td>
<td>( V_{g2} )</td>
<td>1250 V</td>
<td>5000 V</td>
</tr>
<tr>
<td>Control grid voltage positive</td>
<td>( V_{g1} )</td>
<td>0 V</td>
<td>200 V</td>
</tr>
<tr>
<td>Control grid voltage negative</td>
<td>( -V_{g1} )</td>
<td>200 V</td>
<td>5000 V</td>
</tr>
<tr>
<td>Cathode to heater voltage positive</td>
<td>( V_{kf} )</td>
<td>125 V</td>
<td>5000 V</td>
</tr>
<tr>
<td>Cathode to heater voltage negative</td>
<td>( -V_{kf} )</td>
<td>125 V</td>
<td>5000 V</td>
</tr>
<tr>
<td>Voltage between astigmatism control electrode and any deflection plate</td>
<td>( V_{g4/x} )</td>
<td>500 V</td>
<td>5000 V</td>
</tr>
<tr>
<td>Voltage between astigmatism control electrode and any deflection plate</td>
<td>( V_{g4/y} )</td>
<td>500 V</td>
<td>5000 V</td>
</tr>
<tr>
<td>Average grid drive</td>
<td></td>
<td>5 V</td>
<td>30 V</td>
</tr>
</tbody>
</table>

**Viewing section** (voltages with respect to viewing gun cathodes k' and k'' unless otherwise specified)

<table>
<thead>
<tr>
<th>Voltage Description</th>
<th>Symbol</th>
<th>Min.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final accelerator voltage</td>
<td>( V_{g10} )</td>
<td>5500 V</td>
<td>8000 V</td>
</tr>
<tr>
<td>Backing electrode voltage, storage operation</td>
<td>( V_{g9} )</td>
<td>5 V</td>
<td>200 V</td>
</tr>
<tr>
<td>Backing electrode voltage, non-storage operation</td>
<td>( -V_{g9} )</td>
<td>0 V</td>
<td>200 V</td>
</tr>
<tr>
<td>Collector voltage</td>
<td>( V_{g8} )</td>
<td>120 V</td>
<td>180 V</td>
</tr>
<tr>
<td>Collimator voltage</td>
<td>( V_{g7} )</td>
<td>0 V</td>
<td>200 V</td>
</tr>
<tr>
<td>First accelerator voltage</td>
<td>( V_{g2'}, V_{g2''} )</td>
<td>40 V</td>
<td>60 V</td>
</tr>
<tr>
<td>Cathode to heater voltage positive</td>
<td>( V_{k'f'}, V_{k''f''} )</td>
<td>125 V</td>
<td>5000 V</td>
</tr>
<tr>
<td>Cathode to heater voltage negative</td>
<td>( -V_{k'f'}, -V_{k''f''} )</td>
<td>125 V</td>
<td>5000 V</td>
</tr>
<tr>
<td>Control grid voltage positive</td>
<td>( V_{g1'}, V_{g1''} )</td>
<td>0 V</td>
<td>200 V</td>
</tr>
<tr>
<td>Control grid voltage negative</td>
<td>( -V_{g1'}, -V_{g1''} )</td>
<td>0 V</td>
<td>200 V</td>
</tr>
</tbody>
</table>
NOTES
1. These values are valid at cut-off of both viewing (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 adequately dimensioned RC-network must be connected in series with the screen terminal lead (Fig. 8).

2. This voltage should be equal to the mean y-plate potential. The mean x and y-plate potentials should be equal for optimum spot quality.
3. The collimator electrode voltage should be adjusted for optimum uniformity of background illumination.
4. The voltage $V_{g2^*}$, $V_{g2^*}$ should be equal to the mean x-plate potential.
5. 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 $I_B = 5 \mu A$ per system (measured against x-plates).
6. 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 total graticule area, with the exception of maximum 5% in each corner. The writing speed can be increased to approx. 1.25 div/μs if some background is tolerated.
7. The storage time is defined as the time required for the brightness of the unwritten background to rise from just 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.
8. 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.
9. A graticule, consisting of concentric rectangles of 88 mm x 70 mm and 84.8 mm x 67.6 mm is aligned with the electrical x-axis of the tube. With optimum corrections applied, a raster will fall between these rectangles.

CORRECTION COILS
General
The L14-131GH/55 is provided with a coil unit (see Fig. 9) consisting of:
1. A pair of coils L3 and L4 which enable the angle between the x and y-traces at the centre of the screen to be made exactly 90° (orthogonality correction).
2. A pair of coils L1 and L2 for image rotation which enable the alignment of the x-trace with the x-lines of the graticule.
Instrument cathode-ray tube

![Diagram of coil unit](image)

**Fig. 9 Diagram of coil unit.**

**Orthogonality (coils L3 and L4)**

The current required under typical operating conditions without a mu-metal shield being used is max. 20 mA for complete correction of orthogonality. It will be 30% to 50% lower with shield, depending on the shield diameter. The resistance of the coil is approx. 225 Ω.

**Image rotation (coils L1 and L2)**

The image rotation coils are wound concentrically around to the tube neck. Under typical operating conditions 22 ampere-turns are required for maximum rotation of 50°. Both coils have 850 turns. This means that a current of max. 12.5 mA per coil is required which can be obtained by using a 12 V supply when the coils are connected in series or a 6 V supply when they are in parallel.

**Connecting the coils**

The coils have been connected to 8 solder tags according to Fig. 10.

![Bottom view](image)

**Fig. 10 Bottom view.**

With L3 and L4 connected in series according to Fig. 11 a current in the direction indicated will produce a clockwise rotation of the vertical trace and an anti-clockwise rotation of the horizontal trace.

![Diagram](image)

**Fig. 11.**
BEAM CENTRING MAGNET

Inherent to the split-beam system a slight difference between the two beam currents can occur after splitting, resulting in different intensities of the two traces. In order to equalize the beam currents, a beam centring magnet should be mounted near the base of the gun and adjusted for the required field direction and field strength.

OPERATING NOTES

Modes of operation

Store mode

a. Dynamic erasure (variable persistence).

Dynamic erasure can be achieved by applying erasing pulses of positive polarity to the backing electrode. The pulse amplitude required is approximately 9 V (< 15 V) and the persistence of a stored display can be controlled by varying the duty factor of these pulses.

b. 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, the backing electrode should first be connected to the collector electrode voltage and then returned to its original potential for about 100 ms; after that, an erasing pulse of positive polarity and a duration of not less than 300 ms should be applied. For the adjustment of the amplitude of this pulse see Procedure of adjustment.

Non-store mode

For non-store operation, it is sufficient to make the backing electrode about 35 V negative with respect to the viewing gun cathodes. 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.

Procedure of adjustment

a. Adjust the cathode current of each viewing gun to 0.4 mA by means of its control grid voltage.

b. Adjustment of the erasing pulse amplitude (static erasure)

The pulse amplitude should be just sufficient to suppress any background illumination at the centre of the display area (this adjustment should be done under low ambient light conditions). Data on storage time and maximum writing speed are based on erasure to "just black". A larger pulse amplitude (erasure to "blacker than black") yields a longer storage time at the expense of maximum writing speed. On the other hand, writing speed can be increased if some background illumination is tolerated. To erase to "just black" the amplitude of this pulse is approximately 9 V.

c. Adjustment of the collimator voltage.

With dynamic erasing pulses applied and a persistence control setting that yields a convenient background illumination intensity, the collimator voltage is adjusted for optimum background uniformity. This voltage will be approximately 80 V with respect to the viewing gun cathode potential. If this voltage will be approximately 80 V with respect to the viewing gun cathode potential. If this voltage is too high or too low, there is a decrease of intensity at the four corners or at the centres of the vertical edges of the display area respectively.
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

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final accelerator voltage</td>
<td>$V_{g13(l)}$</td>
</tr>
<tr>
<td>Minimum useful scan area</td>
<td>10 kV</td>
</tr>
<tr>
<td>Deflection coefficient</td>
<td></td>
</tr>
<tr>
<td>horizontal</td>
<td>$M_x$</td>
</tr>
<tr>
<td>vertical</td>
<td>$M_y$</td>
</tr>
<tr>
<td>Writing speed</td>
<td>90 mm x 72 mm</td>
</tr>
<tr>
<td></td>
<td>18.5 V/div</td>
</tr>
<tr>
<td></td>
<td>4.8 V/div</td>
</tr>
<tr>
<td></td>
<td>1 div/ns</td>
</tr>
</tbody>
</table>

OPTICAL DATA

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Screen type</td>
<td>metal backed phosphor</td>
</tr>
<tr>
<td>persistence, non-store mode</td>
<td>GH, colour green</td>
</tr>
<tr>
<td>persistence, store mode</td>
<td>medium-short variable</td>
</tr>
<tr>
<td>Useful screen area</td>
<td>min.90 mm x 72 mm</td>
</tr>
<tr>
<td>Useful scan area</td>
<td>min.90 mm x 72 mm</td>
</tr>
<tr>
<td>Spot eccentricity</td>
<td></td>
</tr>
<tr>
<td>in horizontal direction</td>
<td>max. 6 mm</td>
</tr>
<tr>
<td>in vertical direction</td>
<td>max. 8 mm</td>
</tr>
<tr>
<td>Internal graticule</td>
<td>type 95; see Fig. 6</td>
</tr>
</tbody>
</table>

HEATING

Writing section

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indirect by a.c. or d.c.*</td>
<td></td>
</tr>
<tr>
<td>Heater voltage</td>
<td>$V_f$</td>
</tr>
<tr>
<td>Heater current</td>
<td>$I_f$</td>
</tr>
<tr>
<td>Heating time to attain 10% of the cathode current at equilibrium conditions</td>
<td>approx. 5 s</td>
</tr>
</tbody>
</table>

Viewing section

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indirect by d.c.*</td>
<td></td>
</tr>
<tr>
<td>Heater voltage</td>
<td>$V_{FGf}$</td>
</tr>
<tr>
<td>Heater current</td>
<td>$I_{FGf}$</td>
</tr>
<tr>
<td>Heating time to attain 10% of the cathode current at equilibrium conditions</td>
<td>approx. 5 s</td>
</tr>
</tbody>
</table>

* 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

DEFLECTION
x-plates electrostatic note 1
y-plates double electrostatic

Angle between x and y-traces symmetrical
90 ± 1°

Angle between y-trace and y-axis of symmetrical
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**

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>( x_1 ) to all other elements except ( x_2 )</td>
<td>( C_{x1}(x2) ) 5.5 pF</td>
</tr>
<tr>
<td>( x_2 ) to all other elements except ( x_1 )</td>
<td>( C_{x2}(x1) ) 5.5 pF</td>
</tr>
<tr>
<td>( y_1 ) to all other elements except ( y_2 )</td>
<td>( C_{y1}(y2) ) 2.7 pF</td>
</tr>
<tr>
<td>( y_2 ) to all other elements except ( y_1 )</td>
<td>( C_{y2}(y1) ) 2.7 pF</td>
</tr>
<tr>
<td>( x_1 ) to ( x_2 )</td>
<td>( C_{x1x2} ) 3 pF</td>
</tr>
<tr>
<td>( y_1 ) to ( y_2 )</td>
<td>( C_{y1y2} ) 1.7 pF</td>
</tr>
<tr>
<td>( g_1 ) to all other elements</td>
<td>( C_{g1} ) 7 pF</td>
</tr>
<tr>
<td>( k ) to all other elements</td>
<td>( C_{k} ) 5 pF</td>
</tr>
<tr>
<td>( g_{11} ) to all other elements</td>
<td>( C_{g11} ) 80 pF</td>
</tr>
<tr>
<td>( g_{12} ) to all other elements</td>
<td>( C_{g12} ) 70 pF</td>
</tr>
<tr>
<td>( g_{13} ) to all other elements</td>
<td>( C_{g13} ) 85 pF</td>
</tr>
<tr>
<td>( g_{3} ) to all other elements</td>
<td>( C_{g3} ) 17 pF</td>
</tr>
<tr>
<td>( g_{5} ) to all other elements</td>
<td>( C_{g5} ) 17 pF</td>
</tr>
<tr>
<td>( g_{9-1} ) to all other elements</td>
<td>( C_{g9-1} ) 30 pF</td>
</tr>
<tr>
<td>( g_{9-2} ) to all other elements</td>
<td>( C_{g9-2} ) 70 pF</td>
</tr>
<tr>
<td>( g_{9-3} ) to all other elements</td>
<td>( C_{g9-3} ) 60 pF</td>
</tr>
<tr>
<td>FGA to all other elements</td>
<td>( C_{FGA} ) 20 pF</td>
</tr>
<tr>
<td>( k', k'' ) to all other elements</td>
<td>( C_{k', k''} ) 12 pF</td>
</tr>
</tbody>
</table>
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 \( V_{g13(l)} \) 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)

<table>
<thead>
<tr>
<th>non-store mode</th>
<th>variable persistence mode</th>
<th>fast-store mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final accelerator voltage (with respect to first accelerator FGA)</td>
<td>( V_{g13(l)} ) 7000 V 7000 V 7000 V note 1</td>
<td></td>
</tr>
<tr>
<td>Backing electrode voltages (d.c.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>front mesh ( V_{g12} ) −50 V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>fast mesh ( V_{g11} ) 140 V 140 V 140 V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collector mesh voltage (d.c.) ( V_{g10} ) 130 V 130 V 130 V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collimator voltage (d.c.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C3 ( V_{g9-3} ) 65 V 65 V 65 V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C2 ( V_{g9-2} ) ≈ 65 V 65 V 65 V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C1 ( V_{g9-1} ) 30 V 30 V 30 V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>First accelerator voltage (d.c.) ( V_{FGA} ) 20 V 20 V 20 V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flood gun cathode voltage (d.c.) ( V_{FGK} ) 0 V 0 V 0 V</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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
Instrument cathode-ray tube

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:  \( \geq 250 \) div/ms
  max. write:  \( \geq 2.5 \) div/\( \mu \)s
Fast-store mode
  max. write:  \( \geq 1 \) div/ns

Storage viewing time  (note 9)
Variable persistence mode
  just black:  \( \geq 60 \) s
  max. write:  \( \geq 15 \) s
Fast-store mode
  max. write:  \( \geq 15 \) 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.

   \[ \begin{array}{c}
   \text{HT supply} \\
   \text{15 to 20 MΩ} \\
   \text{1 MΩ} \\
   \text{500 pF typ.} \\
   \end{array} \]

   \[ V_g \text{13 (L) terminal} \]

   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 transferring 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).
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)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Units</th>
<th>Min.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final accelerator voltage</td>
<td>( V_{g13(l)} )</td>
<td>max.</td>
<td>10500 V</td>
<td></td>
</tr>
<tr>
<td>Geometry control voltage</td>
<td>( V_{g8} )</td>
<td>max.</td>
<td>500 V</td>
<td></td>
</tr>
<tr>
<td>(with respect to ( g_2 ))</td>
<td></td>
<td>min.</td>
<td>-500 V</td>
<td></td>
</tr>
<tr>
<td>Scan magnifier electrode voltage (with respect to ( g_2 ))</td>
<td>( V_{g7} )</td>
<td>max.</td>
<td>550 V</td>
<td></td>
</tr>
<tr>
<td>Horizontal alignment electrode voltage (with respect to ( g_2 ))</td>
<td>( V_{g6} )</td>
<td>max.</td>
<td>500 V</td>
<td></td>
</tr>
<tr>
<td>Vertical focusing electrode voltage (with respect to ( g_2 ))</td>
<td>( V_{g5} )</td>
<td>max.</td>
<td>-750 V</td>
<td></td>
</tr>
<tr>
<td>Correction electrode voltage (with respect to ( g_2 ))</td>
<td>( V_{g4} )</td>
<td>max.</td>
<td>500 V</td>
<td></td>
</tr>
<tr>
<td>Horizontal focusing electrode voltage (with respect to ( g_2 ))</td>
<td>( V_{g3} )</td>
<td>min.</td>
<td>0 V</td>
<td></td>
</tr>
<tr>
<td>First accelerator voltage</td>
<td>( V_{g2} )</td>
<td>max.</td>
<td>3500 V</td>
<td></td>
</tr>
<tr>
<td>Control grid voltage</td>
<td>( V_{g1} )</td>
<td>max.</td>
<td>0 V</td>
<td></td>
</tr>
<tr>
<td>positive</td>
<td>(-V_{g1})</td>
<td>max.</td>
<td>200 V</td>
<td></td>
</tr>
<tr>
<td>negative</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cathode to heater voltage</td>
<td>( V_{k_f} )</td>
<td>max.</td>
<td>125 V</td>
<td></td>
</tr>
<tr>
<td>positive</td>
<td>(-V_{k_f})</td>
<td>max.</td>
<td>125 V</td>
<td></td>
</tr>
<tr>
<td>negative</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Voltage between correction electrode and any deflection plate</td>
<td>( V_{g4/x} )</td>
<td>max.</td>
<td>500 V</td>
<td></td>
</tr>
<tr>
<td>Grid drive, averaged over 1 ms</td>
<td>( V_d )</td>
<td>max.</td>
<td>30 V</td>
<td></td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Units</th>
<th>Min.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Screen voltage</td>
<td>( V_{g13(l)} )</td>
<td>max.</td>
<td>7500 V</td>
<td></td>
</tr>
<tr>
<td>Backing electrode voltage (d.c.)</td>
<td>( V_{g12} )</td>
<td>max.</td>
<td>600 V</td>
<td></td>
</tr>
<tr>
<td>front mesh</td>
<td></td>
<td>min.</td>
<td>-50 V</td>
<td></td>
</tr>
<tr>
<td>fast mesh</td>
<td>( V_{g11} )</td>
<td>max.</td>
<td>200 V</td>
<td></td>
</tr>
<tr>
<td>Collector mesh voltage (d.c./a.c.)</td>
<td>( V_{g10} )</td>
<td>max.</td>
<td>200 V</td>
<td></td>
</tr>
<tr>
<td>Collimator voltages (d.c./a.c.)</td>
<td>( V_{g9-1; 9-2; 9-3} )</td>
<td>max.</td>
<td>150 V</td>
<td></td>
</tr>
<tr>
<td>First accelerator voltage</td>
<td>( V_{FGA} )</td>
<td>max.</td>
<td>100 V</td>
<td></td>
</tr>
<tr>
<td>Cathode to heater voltage</td>
<td>( V_{k'FGf}, V_{k''FGf} )</td>
<td>max.</td>
<td>125 V</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(-V_{k'FGf}, -V_{k''FGf})</td>
<td>max.</td>
<td>125 V</td>
<td></td>
</tr>
</tbody>
</table>
OPERATING NOTES

Scan magnifier

A scan magnification $M_S \approx 1.8$ 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 $\mu$A) and grid 5 (max. 50 $\mu$A).

Normal current direction from beam interception is to be expected on the horizontal correction electrode $g_6$ (up to 500 $\mu$A) 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 then 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 equality can be optimized by balancing the viewing gun cathodes by means of a potentiometer of 2.2 k$\Omega$, proper collimator adjustment, and by increasing $V_{FGA}$, $V_{g9-1}$ and $V_{g9-3}$ 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.
INSTRUMENT CATHODE-RAY TUBE

- 14 cm diagonal rectangular flat face
- direct-view storage tube
- internal graticule
- for oscilloscope applications

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final accelerator voltage</td>
<td>$V_{g10}$</td>
</tr>
<tr>
<td>Minimum useful scan area</td>
<td>90 mm x 72 mm</td>
</tr>
<tr>
<td>Deflection coefficient</td>
<td></td>
</tr>
<tr>
<td>horizontal</td>
<td>$M_x$</td>
</tr>
<tr>
<td>vertical</td>
<td>$M_y$</td>
</tr>
<tr>
<td>Writing speed</td>
<td>2.5 div/µs</td>
</tr>
<tr>
<td></td>
<td>9.5 V/div</td>
</tr>
<tr>
<td></td>
<td>4.1 V/div</td>
</tr>
</tbody>
</table>

OPTICAL DATA

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

HEATING

Writing section

- Indirect by AC or DC*
- 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 DC*
- 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

Dimensions and connections (see also outline drawings)
Overall length (socket included) \( \leq 452 \text{ mm} \)
Faceplate dimensions (final accelerator contact excluded) \( 118 \pm 0.5 \text{ mm} \times 98 \pm 0.5 \text{ mm} \)

Net mass approx. 1,3 kg
Mass 14 pin, all glass

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.

Accessories
Socket (supplied with tube) type 55566
Side contact connector (7 required) type 55561
Small ball contact connector (5 required) type 4022 102 21590

FOCUSBING

def electrostatic

definition

definition

DEFLECTION

x-plates
y-plates
Angle between x and y-traces
\( 90 \pm 1^\circ \)
Angle between x-trace and x-axis of the internal graticule \( \leq 5^\circ \)

CAPACITANCES

\( C_{x1(x2)} \) 5,5 pF
\( C_{x2(x1)} \) 5,5 pF
\( C_{y1(y2)} \) 3,5 pF
\( C_{y2(y1)} \) 3,5 pF
\( C_{x1x2} \) 2,5 pF
\( C_{y1y2} \) 2 pF
\( C_g1 \) 6 pF
\( C_k \) 3,5 pF
\( C_g3 \) 4,5 pF
\( C_g7.1 \) 30 pF
\( C_g7.2 \) 65 pF
\( C_g7.3 \) 60 pF
\( C_g9 \) 60 pF
\( C_g10 \) 80 pF
\( C_{FGA} \) 15 pF
\( C_{FGK} \) 8 pF
\( C_{FGK''} \) 8 pF
Fig. 1 Outlines.

(1) Minimum cable length is 420 mm.
(2) Minimum length of connecting leads is 350 mm.
Fig. 2 Top view.

(1) The bulge at the frit seal may increase the indicated maximum dimensions by not more than 3 mm.

Fig. 3 Bottom view and side-contact arrangement.

Fig. 4 Electrode configuration.

Fig. 5 Pin arrangement; bottom view.

Fig. 6 Internal graticule
colour of graticule: black;
line width: 0.2 mm;
dot diameter: 0.4 mm.
INTERNAL GRATICULE ALIGNMENT
The internal graticule is aligned with the faceplate by using the faceplate reference points A1, A2 and A3, see Fig. 7.

Fig. 7 Front view of tube with internal graticule. |a1 - a2| ≤ 0,3 mm.

TYPICAL OPERATION
Conditions
Writing section *
Final accelerator voltage \[ V_{g10}(\xi) \] 8500 V see note 1
Geometry control electrode voltage \[ V_{g6} \] 1500 ± 100 V
Deflection plate shield voltage \[ V_{g5} \] 1500 V see note 2
Astigmatism control electrode voltage \[ V_{g4} \] 1500 ± 50 V see note 3
Focusing electrode voltage \[ V_{g3} \] 400 to 600 V
First accelerator voltage \[ V_{g2} \] 1500 V
Cut-off voltage for visual extinction of focused spot \[ -V_{g1} \] 45 to 85 V

* Above voltages are with respect to writing gun cathode k.

Viewing section
Refer to Fig. 8 for typical operating values.
Fig. 8 Diagram of non-storage and storage operation.

(1) With respect to FGA, all other voltages with respect to viewing gun cathode FGK (see Fig. 4 and note 11).
Performance

Useful scan
  horizontal min. 90 mm
  vertical min. 72 mm

Deflection coefficient
  horizontal
    $M_X$ max. 9.5 V/div
    $M_Y$ max. 4.4 V/div
  vertical

Line width at the centre of the screen
  l.w. 0.35 mm see note 5

Writing speed in storage operation
  just black $\geq 250$ div/ms see note 6
  max. write $\geq 2.5$ div/μs

Storage viewing time
  just black $\geq 90$ s see note 7
  max. write $\geq 15$ s

Deviation of deflection linearity
  max. 2 % see note 8

Geometry distortion
  see note 9

Grid drive for 10 μA beam current
  $V_d$ approx. 25 V

Grid drive for specified writing speed
  $V_d$ max. 45 V

Total cathode current of both viewing guns
  at FGA = 28 V approx. 1 mA
  at FGA = 50 V approx. 2 mA
LIMITING VALUES (Absolute maximum rating system)

Writing section (voltages with respect to writing gun cathode k)

- Final accelerator voltage \( V_{g10}^{(k)} \)
  - max. 9000 V
  - min. 7000 V
- Geometry control electrode voltage \( V_{g6} \)
  - max. 2100 V
- Deflection plate shield voltage \( V_{g5} \)
  - max. 2000 V
- Astigmatism control electrode voltage \( V_{g4} \)
  - max. 2100 V
  - min. 1200 V
- Focusing electrode voltage \( V_{g3} \)
  - max. 1000 V
- First accelerator voltage \( V_{g2} \)
  - max. 2000 V
  - min. 1250 V
- Control grid voltage
  - positive \( V_{g1} \)
    - max. 0 V
  - negative \( -V_{g1} \)
    - max. 200 V
- Cathode to heater voltage
  - positive \( V_{k_f} \)
    - max. 125 V
  - negative \( -V_{k_f} \)
    - max. 125 V
- Voltage between astigmatism control 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
- Screen dissipation \( W_{s} \)
  - max. 8 mW/cm²

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

- Final accelerator voltage \( V_{g10}^{(k)} \)
  - max. 7500 V
  - min. 5500 V
- Backing electrode voltage
  - storage operation \( V_{g9} \)
    - max. +150 V
    - min. -5 V
  - non-storage operation \( -V_{g9} \)
    - max. 50 V
    - min. 25 V
- Collector voltage \( V_{g8} \)
  - max. 180 V
  - min. 120 V
- Collimator voltage \( V_{g7-1}, V_{g7-2}, V_{g7-3} \)
  - max. 200 V
  - min. 0 V
- First accelerator voltage \( V_{FGA} \)
  - max. 60 V
  - min. 0 V
- Cathode to heater voltage
  - positive \( V_{k_f}F_g, V_{k''f}F_g \)
    - max. 125 V
  - negative \( -V_{k_f}F_g, -V_{k''f}F_g \)
    - max. 125 V
OPERATING NOTES

Modes of operations

Non-storage mode

For non-storage operation the front mesh $V_{gg}$ 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.

Variable persistence mode

a. Dynamic erasure

Dynamic erasure can be achieved by applying extra erasing pulses of positive polarity to the backing electrode $V_{gg}$. 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.

b. Static erasure (Fig. 8)

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, $V_{gg}$ is increased to 150 V for 100 ms and than returned to its original potential for about 500 ms; after that, an erasing pulse of positive polarity (max. 15 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 equality can be optimized by balancing the viewing gun cathodes by means of a potentiometer of 2.2 kΩ, proper collimator adjustment, and by increasing $V_{FGA}$, $V_{g7.1}$, $V_{g7.2}$ and $V_{g7.3}$ in positive direction during erasure.

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

1. These values are valid at cut-off of both flood guns and the writing gun. The HT 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. 9 must be connected in series with the screen terminal lead; the resistance of 15 to 20 MΩ includes the internal resistance of the HT supply.

![RC network diagram]

Fig. 9 RC network.

2. This voltage should be equal to the mean γ-plate potential. The mean x and γ-plate potentials should be equal for optimum spot quality.

3. When putting the tube into operation, the astigmatism control voltage should be adjusted only once for optimum spot size in the screen centre. The control voltage will be within the stated range, provided the conditions of note 2 are adhered to.

4. The collimator electrode voltage $V_{g7-2}$ and $V_{g7-3}$ should be adjusted for optimum uniformity of background illumination.

5. 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 $I_B = 10 \mu A$ (measured on x-plates).

6. 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 75% of the minimum screen area, except the outmost 4 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.

7. 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 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 is related to the writing speed.

8. 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.

9. A graticule, consisting of concentric rectangles of 72 mm x 54 mm and 69.8 mm x 52.5 mm is aligned with the electrical x-axis of the tube. With optimum corrections applied, a raster will fall between these rectangles.

10. The tube has a rotation coil, concentrically wound around the tube neck, to allow alignment of the x-trace with the mechanical x-axis of the screen. The coil has 2000 turns and a maximum resistance of 650 Ω. Under typical operating conditions, a maximum of 20 ampere-turns is required for the maximum rotation of 5°. This means the required supply is 10 mA maximum at 8 V, maximum.

11. The d.c. voltage on the first accelerator of the flood guns (FGA) should be equal to the mean x-plate potential.
MONITOR AND DISPLAY TUBES
SURVEY OF MONITOR AND DISPLAY TUBES

PREFERRED TYPES: recommended for new design.
M17-142WE
M17-143WE
M17-144WE
M17-145WE
M17-220WE
M38-200
M38-201

MAINTENANCE TYPES: no longer recommended for equipment production.
M24-100W
M24-101W
M31-130W
M31-131W

OBSOLETE TYPES: available until present stocks are exhausted.
M17-140W
M17-141W
M38-120W
M38-121W

SCREENS
Although WA and WE are the standard screens certain applications require screens of a different persistence and/or colour (e.g. GH, GR, GM). Tubes with such screens are supplied to special order.

BONDED FACEPLATES
Tubes with bonded faceplates are supplied to special order.
SPECIAL OPTIONS FOR MONITOR AND DISPLAY TUBES

MONITOR TUBE M31-340 and M38-328
HIGH RESOLUTION MONOCHROME DISPLAY TUBES

In addition to the types of phosphor available on the display tubes type M31-340 and M38-328 (see Handbook T16), the following phosphor options are also available:

<table>
<thead>
<tr>
<th>new system</th>
<th>old system</th>
<th>fluorescent colour</th>
<th>phosphorescent colour</th>
<th>persistence</th>
<th>equivalent JEDEC designation</th>
</tr>
</thead>
<tbody>
<tr>
<td>BE</td>
<td>B</td>
<td>blue</td>
<td>blue</td>
<td>medium short</td>
<td>P11</td>
</tr>
<tr>
<td>BF</td>
<td>U</td>
<td>purplish-blue</td>
<td>—</td>
<td>medium short</td>
<td>—</td>
</tr>
<tr>
<td>GK</td>
<td>G</td>
<td>yellowish-green</td>
<td>yellowish-green</td>
<td>medium</td>
<td>—</td>
</tr>
<tr>
<td>GM</td>
<td>P</td>
<td>purplish-blue</td>
<td>yellowish-green</td>
<td>long</td>
<td>P7</td>
</tr>
<tr>
<td>GU</td>
<td>—</td>
<td>white</td>
<td>white</td>
<td>very short</td>
<td>—</td>
</tr>
<tr>
<td>GY</td>
<td>—</td>
<td>green</td>
<td>green</td>
<td>medium</td>
<td>P43</td>
</tr>
<tr>
<td>LB</td>
<td>P26</td>
<td>orange</td>
<td>orange</td>
<td>very long</td>
<td>—</td>
</tr>
<tr>
<td>LC</td>
<td>P12</td>
<td>orange</td>
<td>orange</td>
<td>long</td>
<td>—</td>
</tr>
<tr>
<td>SB*</td>
<td>—</td>
<td>yellow-white</td>
<td>yellow-white</td>
<td>medium short</td>
<td>—</td>
</tr>
<tr>
<td>WA</td>
<td>—</td>
<td>white</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>WE</td>
<td>—</td>
<td>white</td>
<td>white</td>
<td>medium short</td>
<td>P45</td>
</tr>
</tbody>
</table>

* Note: for use with LCD colour shutter.

The phosphor information given in this section is based in general upon the original phosphor registration (TEPAC and/or ELECTRON) and can be used as a selection guide. Slight differences may occur between the actual phosphor properties and the registered data.

Other options, such as special lugs etc., available on request.
MONITOR TUBE

17 cm diagonal rectangular flat face monitor tube primarily for use as a viewfinder in television cameras. This tube has been replaced by type M17-142WE, which features a 1,5 W cathode (6,3 V/240 mA) with short warm-up time (quick-heating cathode), and an improved phosphor, type WE.

The data of M17-140W are equivalent to those of type M17-142WE, except for the following.

HEATING
Indirect by a.c. or d.c.*
Heater voltage
Heater current

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_f$</td>
<td>6,3 V</td>
</tr>
<tr>
<td>$I_f$</td>
<td>300 mA</td>
</tr>
</tbody>
</table>

SCREEN
Phosphor type
fluorescent colour

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>white</td>
</tr>
</tbody>
</table>

* Not to be connected in series with other tubes.
MONITOR TUBE

17 cm diagonal rectangular flat face monitor tube primarily for use as a viewfinder in television cameras. It has a bonded face plate and a metal mounting band. This tube has been replaced by type M17-143WE, which features a 1.5 W cathode (6.3 V/240 mA) with short warm-up time (quick-heating cathode), and an improved phosphor, type WE.

The data of M17-141W are equivalent to those of type M17-143WE, except for the following.

HEATING
Indirect by a.c. or d.c. *
Heater voltage $V_f$ 6.3 V
Heater current $I_f$ 300 mA

SCREEN
Phosphor type W
fluorescent colour white

* Not to be connected in series with other tubes.
MONITOR TUBES

- 17 cm diagonal rectangular flat face
- 70° deflection angle
- high resolution
- quick heating cathode
- M17-142WE: for use in precision monitors and as a viewfinder in television cameras
  M17-144WE: for use in photographic equipment (see Optical Data)

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deflection angle, diagonal</td>
<td>70°</td>
</tr>
<tr>
<td>Face diagonal</td>
<td>17 cm</td>
</tr>
<tr>
<td>Neck diameter</td>
<td>28 mm</td>
</tr>
<tr>
<td>Overall length</td>
<td>max. 234 mm</td>
</tr>
<tr>
<td>Screen dimensions</td>
<td>min. 124 mm x 93 mm</td>
</tr>
<tr>
<td>Resolution</td>
<td>min. 1050 TV lines</td>
</tr>
</tbody>
</table>
ELECTRICAL DATA

Capacitances
- final accelerator to external conductive coating
- cathode to all other elements
- grid 1 to all other elements

Cg3, g5 (l) / m 300 pF
Ck 3.6 pF
Cg1 7 pF
electrostatic
magnetic*

Focusing method
Deflection method
Deflection angle, diagonal
Heating
- heater voltage
- heater current

70°
indirect by AC or DC**
Vf 6.3 V
If 240 mA

approx. 5 s

Heating time to attain 10% of the cathode
current at equilibrium conditions

OPTICAL DATA

Screen
- metal-backed phosphor
- WE ▲
- white
- medium short

Phosphor type
- fluorescent colour
- persistence

Useful screen dimensions
- diagonal
- horizontal axis
- vertical axis

min. 155 mm
min. 124 mm
min. 93 mm

approx. 92%

Light transmission of screen

Note: The M17-144WE has an improved screen blemish specification, to meet the extreme requirements of photographic recording equipment.

* To obtain the best tube performance, use either the AT1071/05 or the AT1071/07 deflection unit.
** Not to be connected in series with other tubes.
▲ Other phosphors available to special order.
Monitor tubes

MECHANICAL DATA (see also the figures on the next page)

Overall length 227 ± 7 mm
Neck diameter min. 27.8 mm
Base neo eightar, B8H; IEC67-I-31a
cavity contact, CT8; IEC67-III-2
Net mass approx. 0.7 kg

Mounting
The tube can be mounted in any position. It must not be supported by the socket and not by the base region alone.

Accessories
Final accelerator contact connector 55563A
(1) Reference line, determined by the plane of the upper edge of the flange of the reference line gauge when the gauge is resting on the cone.

(2) The maximum dimension is determined by the reference line gauge.
RECOMMENDED OPERATING CONDITIONS

Final accelerator voltage

Focusing electrode voltage

First accelerator voltage

Cut-off voltage for visual extinction of focused spot

RESOLUTION

Resolution at screen centre, measured with beam centring magnet**

at $V_{g3,g5(\xi)} = 14$ kV, $V_{g2} = 400$ V,

$I_g = 20$ $\mu$A, luminance = 400 cd/m² ▲

min. 1050 TV lines

LIMITING VALUES

Final accelerator voltage

Focusing electrode voltage

First accelerator voltage

Control grid voltage

negative

positive

positive peak

Cathode to heater voltage

positive

negative

$V_{k1}$ max. 150 V

$V_g1$ max. 0 V

$V_g1p$ max. 2 V

$V_{kf}$ max. 125 V

$-V_{kf}$ max. 125 V

For optimum focus at a beam-current of 50 $\mu$A.

** Catalogue number 3322 142 11401; supplied with directions for use with each tube.

▲ Luminance is measured with a photocell, of which the spectral response curve is identical to that of the human eye, on a 312-lines raster with dimensions 70 mm x 70 mm.
X-radiation limit curves, at a constant anode current of 250 µA, measured according to TEPAC103A.
0.5 mR/h isoexposure-rate limit curves, measured according to TEPAC103A.

Product safety
X-ray shielding of the cone is advisable to give protection against possible danger of personal injury arising from prolonged exposure at close range to this tube when operated above 14 kV.

FLASHOVER PROTECTION
With the high voltage used with this tube internal flashovers may occur. These may destroy the cathode of the tube. Therefore it is necessary to provide protective circuits, using spark gaps. The spark gaps must be connected as follows:

No other connections between the outer conductive coating and the chassis are permissible.
MONITOR TUBES

- 17 cm diagonal rectangular flat face
- 70° deflection angle
- high resolution
- quick heating cathode
- bonded face plate
- metal band for mounting
- M17-143WE: for use in precision monitors and as a viewfinder in television cameras
  M17-145WE: for use in photographic equipment (see Optical Data)

<table>
<thead>
<tr>
<th>QUICK REFERENCE DATA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deflection angle, diagonal</td>
</tr>
<tr>
<td>Face diagonal</td>
</tr>
<tr>
<td>Neck diameter</td>
</tr>
<tr>
<td>Overall length</td>
</tr>
<tr>
<td>Screen dimensions</td>
</tr>
<tr>
<td>Resolution at $V_a = 16$ kV</td>
</tr>
</tbody>
</table>
ELECTRICAL DATA

Capacitances
- final accelerator to metal band
- final accelerator to external conductive coating
- cathode to all other elements
- grid 1 to all other elements

C<sub>g3,g5</sub> (l)/m'  135 pF
C<sub>g3,g5</sub> (l)/m  240 pF
C<sub>k</sub>  3,6 pF
C<sub>g1</sub>  7 pF

electrostatic
magnetic*

70°
indirect by AC or DC**

V<sub>f</sub>  6,3 V
I<sub>f</sub>  240 mA

approx.  5 s

Deflection method

Deflection angle, diagonal

Heating
- heater voltage
- heater current

Heating time to attain 10% of the cathode current at equilibrium conditions

OPTICAL DATA

Screen
metal-backed phosphor

Phosphor type
WE ▲
white

Useful screen dimensions
- diagonal
- horizontal axis
- vertical axis

min. 155 min.
min. 124 min.
min. 93 min.

approx. 88%

Light transmission of screen

Note: The M17-145WE has an improved screen blemish specification, to meet the extreme requirements of photographic recording equipment.

* To obtain the best tube performance, deflection unit AT1071/05 should be used.
** Not to be connected in series with other tubes.
▲ Other phosphors available to special order.
Monitor tubes

MECHANICAL DATA (see also the figures on the next page)

Overall length 232 ± 8 mm
Neck diameter min. 27.8 mm
Base neo eightar, B8H; IEC 67-I-31a
Final accelerator contact cavity contact, CT8; IEC 67-III-2
Implosion protection bonded face plate
Net mass approx. 1 kg

Mounting
The tube can be mounted in any position. It must not be supported by the socket and not by the base region alone.

Accessories
Final accelerator contact connector 55563 A
(1) Reference line, determined by the plane of the upper edge of the flange of the reference line gauge when the gauge is resting on the cone.

(2) The maximum dimension is determined by the reference line gauge.
### RECOMMENDED OPERATING CONDITIONS

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Value 1</th>
<th>Value 2</th>
<th>Value 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final accelerator voltage</td>
<td>$V_{g3,g5(\xi)}$</td>
<td>14</td>
<td>16 kV</td>
<td></td>
</tr>
<tr>
<td>Focusing electrode voltage</td>
<td>$V_{g4}$</td>
<td>0 to 400*</td>
<td>0 to 400 V*</td>
<td></td>
</tr>
<tr>
<td>First accelerator voltage</td>
<td>$V_{g2}$</td>
<td>400</td>
<td>600 V</td>
<td></td>
</tr>
<tr>
<td>Cut-off voltage for visual extinction of focused spot</td>
<td>$-V_{g1}$</td>
<td>30 to 62</td>
<td>40 to 90 V</td>
<td></td>
</tr>
</tbody>
</table>

### RESOLUTION

Resolution at screen centre, measured with beam centring magnet**

- at $V_{g3,g5(\xi)} = 14$ kV, $V_{g2} = 400$ V,
  - $I_\xi = 20$ μA, luminance = 400 cd/m² ▲
  - min. 1050 TV lines
- at $V_{g3,g5(\xi)} = 16$ kV, $V_{g2} = 600$ V,
  - $I_\xi = 20$ μA, luminance = 500 cd/m² ▲
  - min. 1250 TV lines

### LIMITING VALUES

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Value 1</th>
<th>Value 2</th>
<th>Value 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final accelerator voltage</td>
<td>$V_{g3,g5(\xi)}$</td>
<td>max. 18 kV</td>
<td>min. 12 kV</td>
<td></td>
</tr>
<tr>
<td>Focusing electrode voltage</td>
<td>$V_{g4}$</td>
<td>max. 1 kV</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$-V_{g4}$</td>
<td>max. 0.5 kV</td>
<td></td>
<td></td>
</tr>
<tr>
<td>First accelerator voltage</td>
<td>$V_{g2}$</td>
<td>max. 800 V</td>
<td>min. 300 V</td>
<td></td>
</tr>
<tr>
<td>Control grid voltage</td>
<td>$-V_{g1}$</td>
<td>max. 150 V</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$V_{g1}$</td>
<td>max. 0 V</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$V_{g1p}$</td>
<td>max. 2 V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cathode to heater voltage</td>
<td>$V_{kf}$</td>
<td>max. 125 V</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$-V_{kf}$</td>
<td>max. 125 V</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

** For optimum focus at a beam current of 50 μA.

** Catalogue number 3322 142 11401; supplied with directions for use with each tube.

▲ Luminance is measured with a photocell, of which the spectral response curve is identical to that of the human eye, on a 312-lines raster with dimensions 70 mm x 70 mm.
X-radiation limit curves, at a constant anode current of 250 μA, measured according to TEPAC103A.
0.5 mR/h isoexposure-rate limit curves, measured according to TEPAC103A.

FLASHOVER PROTECTION

With the high voltage used with this tube internal flashovers may occur. These may destroy the cathode of the tube. Therefore it is necessary to provide protective circuits, using spark gaps.

The spark gaps must be connected as follows:

No other connections between the outer conductive coating and the chassis are permissible.
VERY HIGH RESOLUTION FLAT CATHODE-RAY TUBE

- 17 cm diagonal rectangular flat face
- 70° deflection angle
- very high resolution
- quick heating cathode

QUICK REFERENCE DATA

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Deflection angle, diagonal</td>
<td>70°</td>
</tr>
<tr>
<td>Face diagonal</td>
<td>17 cm</td>
</tr>
<tr>
<td>Neck diameter</td>
<td>28 mm</td>
</tr>
<tr>
<td>Overall length</td>
<td>max. 269 mm</td>
</tr>
<tr>
<td>Screen dimensions</td>
<td>min. 124 mm x 93 mm</td>
</tr>
<tr>
<td>Resolution</td>
<td>approx 2500 TV lines</td>
</tr>
<tr>
<td></td>
<td>1800 lines (shrinking raster)</td>
</tr>
</tbody>
</table>

APPLICATION *

This tube has been designed for use in photographic applications where screen current is generally limited to a maximum of 20 μA. At these relatively low screen currents, the extremely good resolution together with the excellent screen quality, makes this tube ideal for use in photographic equipment.

* Application support is available on request.
ELECTRICAL DATA

Capacitances
- final accelerator to external conductive coating
- cathode to all other elements
- grid 1 to all other elements

Focusing method: electrostatic
Deflection method: magnetic
Deflection angle, diagonal: 70°
Heating method: indirect by AC or DC
- 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

OPTICAL DATA

Screen type: metal-backed phosphor
Phosphor type: WE *
- fluorescent colour: white
- persistence: medium short

Useful screen dimensions:
- diagonal: min. 155 mm
- horizontal axis: min. 124 mm
- vertical axis: min. 93 mm

Light transmission of screen glass: approx. 92%

The M17-220WE has an improved screen blemish and uniformity specification, to meet the extreme requirements of photographic recording equipment.

* Other phosphors available to special order.
MECHANICAL DATA

Overall length
262 ± 7 mm
Neck diameter
min. 27.8 mm
Base
JEDEC B10-277
Final accelerator contact
cavity contact, CT8; IEC67-III-2
Net mass
approx. 0.8 kg

Mounting
The tube should not be mounted in a vertical position, screen downwards, such that its longitudinal axis makes an angle of less than 20° with the vertical. This is the only restriction on mounting.

Accessories
Final accelerator contact connector
Deflection coils*

Options
- customer designed suspension system
- implosion protection
- other phosphors

55563A
Syntronic type deflection coils are highly recommended.
e.g. 15330/1

* The tube has internal magnetic correction for astigmatism. To avoid changing this correction, the coil must be at zero potential, before being moved on the tube neck.
MECHANICAL DATA

Dimensions in mm

Fig. 1.

(1) Reference line, determined by the plane of the upper edge of the flange of the reference line gauge when the gauge is resting on the cone.
(2) The maximum dimension is determined by the reference line gauge.
Very high resolution flat cathode-ray tube

Fig. 2.

Fig. 3.

Reference line gauge

Fig. 4.
RECOMMENDED OPERATING CONDITIONS

Final accelerator voltage
Focusing electrode voltage
Dynamic focusing
First accelerator voltage
Second accelerator voltage
Cut-off voltage for visual extinction of focused spot

\[ V_{g4}(\xi) \]
\[ V_{g3} \]
\[ \Delta V_{g3} \]
\[ V_{g2} \]
\[ V_{g2.2} \]
\[ -V_{g1} \]

15 kV
3.05 kV
400 V
800 V
3.05 kV
50 to 80 V

RESOLUTION

Resolution at screen centre, measured with shrinking raster method (non-interlaced raster)

\[ V_{g4}(\xi) = 15 \text{ kV}; V_{g2} = 800 \text{ V}; V_{g2.2} = 3.05 \text{ kV} \]
\[ I_\xi = 10 \mu\text{A}; \text{luminance} = 200 \text{ cd/m}^2 \text{(see Fig. 6)} \]

approx 2500 TV lines
1800 lines (shrinking raster)

LIMITING VALUES

Final accelerator voltage
Focusing electrode voltage
First accelerator voltage
Second accelerator voltage
Screen current
Grid G2.2
maximum interception of cathode current
at screen current = 20 \mu A

\[ V_{g4} \]
\[ V_{g3} \]
\[ V_{g2} \]
\[ V_{g2.2} \]
\[ I_{g4}(\xi) \]

max.
min.
max.
min.
max.
min.
max.

17 kV
13 kV
3.2 kV
2.9 kV
1.2 kV
0.6 kV
3.2 kV
2.0 kV

20 \mu A

Control grid voltage
negative
positive
positive peak

\[ -V_{g1} \]
\[ V_{g1} \]
\[ V_{g1p} \]

max.
max.
max.

150 V
0 V
2 V

Cathode to heater voltage
positive
negative

\[ V_{kf} \]
\[ -V_{kf} \]

max.
max.

125 V
125 V

FLASHOVER PROTECTION

With the high voltage used with this tube internal flashovers may occur. These may destroy the cathode of the tube. Therefore it is necessary to provide protective circuits, using spark gaps.
The spark gaps must be connected as follows:

No other connections between the outer conductive coating and the chassis are permissible.

Fig. 5.
Luminance is measured with a photo-cell, the spectral response of which is identical to that of the human eye, on a 312-lines non-interlaced raster with screen dimensions 70 mm x 70 mm, frame frequency 50 Hz and $V_{g4} = 15$ kV.

Fig. 6 Luminance.
X-RADIATION LIMIT

Fig. 7 X-radiation limit curves, at a constant anode current of 50 μA, measured in accordance with TEPAC164.

Fig. 8 0.5 mR/h isoexposure-rate limit curves, measured in accordance with TEPAC164.
MONITOR TUBE

The M24-100W is a 24 cm-diagonal rectangular television tube with metal-backed screen primarily intended for use as a monitor or display tube.

<table>
<thead>
<tr>
<th>QUICK REFERENCE DATA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deflection angle</td>
</tr>
<tr>
<td>Focusing</td>
</tr>
<tr>
<td>Resolution</td>
</tr>
<tr>
<td>Overall length</td>
</tr>
</tbody>
</table>

SCREEN

Metal-backed phosphor

Luminescence white

Light transmission of face glass 52 %

Useful diagonal min. 225 mm

Useful width min. 190 mm

Useful height min. 140 mm

HEATING

Indirect by a.c. or d.c.; parallel supply

Heater voltage \( V_f \) 6.3 V

Heater current \( I_f \) 300 mA

CAPACITANCES

Final accelerator to external conductive coating \( C_{g3, g5(t)/m} \) 420 pF

Cathode to all other elements \( C_k \) 5 pF

Control grid to all other elements \( C_{g1} \) 7 pF

FOCUSBING

For focusing voltage providing optimum focus at a beam current of 100 µA see under "Typical operating conditions".
DEFLECTION
Diagonal deflection angle

MECHANICAL DATA

magnetic
90°

Dimensions in mm

Notes see next page.
Mounting position: any, except vertical with the screen downward and the axis of the tube making an angle of less than 20° with the vertical.

Base
Neo eightar (B311)

Cavity contact
CT8

Accessories
Socket
2422 501 06001
Final accelerator contact connector
type 55563A

PICTURE CENTRING MAGNET
Field intensity perpendicular to the tube axis adjustable from 0 to 800 A/m (0 to 10 Oe). Adjustment of the centring magnet should not be such that a general reduction in brightness or shading of the raster occurs.

NOTES
1) The reference line is determined by the plane of the upper edge of the of the flange of reference line gauge when the gauge is resting on the cone.

2) The maximum dimension is determined by the reference line gauge.

3) Deflection coil AT1071/03 is recommended. If another coil is considered, it is advisable to contact the local tube supplier.

4) The bulge at the spliceline seal may increase the indicated maximum values for envelope width, diagonal and height by not more than 6.4 mm, but at any point around the seal the bulge will not protrude more than 3.2 mm beyond the envelope surface.
TYPICAL OPERATING CONDITIONS

Final accelerator voltage \( V_{g3}, g5(t) \) 16 kV
Focusing electrode voltage \( V_{g4} \) 0 to 400 V
First accelerator voltage \( V_{g2} \) 600 V
Grid no. 1 voltage for extinction of focused raster \( V_{g1} \) -32 to -85 V

RESOLUTION

Resolution at screen centre measured with the shrinking raster method (non-interlaced raster), under typical operating conditions, at a beam current of 50 μA (200 cd/m² = 200 nit). The resolution can be improved by the use of beam centring magnet catalogue number 3322 142 11401, supplied on request. 900 lines

LIMITING VALUES (Absolute max. rating system)

Final accelerator voltage \( V_{g3}, g5(t) \)
  max. 18 kV
  min. 10 kV
Focusing electrode voltage \( V_{g4}, -V_{g4} \)
  max. 1 kV
  max. 0.5 kV
First accelerator voltage \( V_{g2} \)
  max. 800 V
  min. 300 V
Grid no. 1 voltage, negative \( -V_{g1} \)
  max. 150 V
positive \( V_{g1} \)
  max. 0 V
positive peak \( V_{g1p} \)
  max. 2 V
Cathode to heater voltage, positive \( V_{kf}, V_{kf^p} \)
  max. 250 V
  max. 300 V 1)
positive peak \( V_{kf^p} \)
  max. 135 V
negative \( -V_{kf} \)
  max. -135 V
negative peak \( -V_{kf^p} \)
  max. -180 V

REFERENCE LINE GAUGE

1) During a warm-up period not exceeding 15 s the heater may be 410 V negative with respect to the cathode.
MONITOR TUBE

The M24-101W is a 24 cm-diagonal rectangular television tube with integral protection primarily intended for use as a monitor or display tube.

### QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deflection angle</td>
<td>90 °</td>
</tr>
<tr>
<td>Focusing</td>
<td>electrostatic</td>
</tr>
<tr>
<td>Resolution</td>
<td>900 lines</td>
</tr>
<tr>
<td>Overall length</td>
<td>≤ 260 mm</td>
</tr>
</tbody>
</table>

### SCREEN

Metal backed phosphor

Luminescence white

Light transmission of face glass 52 %

Useful diagonal ≥ 225 mm

Useful width ≥ 190 mm

Useful height ≥ 140 mm

### HEATING

Indirect by a.c. or d.c.; parallel supply

Heater voltage \( V_f \) 6.3 V

Heater current \( I_f \) 300 mA

### FOCUSING

Electrostatic

For focusing voltage providing optimum focus at a beam current of 100 µA see under "Typical operating conditions".

### DEFLECTION

Magnetic

Diagonal deflection angle 90 °

Horizontal deflection angle 80 °

Vertical deflection angle 65 °

Deflection coil AT1071/03 is recommended.
MECHANICAL DATA  (continued)

Mounting position : any

Base
Cavity contact
Accessories
Socket
Final accelerator contact connector

PICTURE CENTRING MAGNET

Field intensity perpendicular to the tube axis adjustable from 0 to 800 A/m (0 to 10 Oe). Adjustment of the centring magnet should not cause a general reduction in brightness or shading of the raster.

NOTES TO OUTLINE DRAWINGS

1) The reference line is determined by the plane of the upper edge of the flange of the reference line gauge with the gauge resting on the cone.

2) The maximum dimension is determined by the reference line gauge.

3) This tube has an external conductive coating (m), which must be earthed. The capacitance of this coating to the final accelerator is used for smoothing the EHT. The tube marking and warning labels are on the side of the cone opposite the final accelerator contact, and this side should not be used for making contact to the conductive coating.

4) This area must be kept clean.

5) Minimum space to be reserved for mounting lugs.

6) The mounting screws in the cabinet must be situated within a circle with a diameter of 4 mm drawn around the true geometrical position (corners of a rectangle of 207, 4 mm x 158, 5 mm).

7) The maximum displacement of any lug with respect to the plane through the other three lugs is 2 mm.

8) The metal rim-band must be earthed. The hole of 2, 5 mm diameter in each lug is provided for this purpose.

9) The bulge at the spliceline seal may increase the indicated maximum values for envelope width, diagonal and height by not more than 6, 4 mm, but at any point around the seal the bulge will not protrude more than 3, 2 mm beyond the envelope surface.
CAPACITANCES

Final accelerator to external conductive coating \( C_{g3}, g_{5}(\ell)/m \) 420 pF
Final accelerator to metal band \( C_{g3}, g_{5}(\ell)/m' \) 200 pF
Cathode to all other elements \( C_k \) 5 pF
Control grid to all other elements \( C_{g1} \) 7 pF

TYPICAL OPERATING CONDITIONS

Final accelerator voltage \( V_{g3}, g_{5}(\ell) \) 16 kV
Focusing electrode voltage \( V_{g4} \) 0 to 400 V
First accelerator voltage \( V_{g2} \) 600 V
Grid 1 voltage for extinction of focused raster \( V_{g1} \) -32 to -85 V

RESOLUTION

Resolution at screen centre measured with the shrinking raster method (non-interlaced raster), under typical operating conditions, and at a beam current of 50 \( \mu \)A: 900 lines (luminance \( \approx \) 200 cd/m²).

If necessary, the picture quality can be improved by using a beam centring magnet. This magnet, catalogue number 3322 142 11401, can be supplied on request.

LIMITING VALUES (Absolute max. rating system)

Final accelerator voltage
\( V_{g3}, g_{5}(\ell) \) max. 18 kV
min. 10 kV

Focusing electrode voltage, positive
\( V_{g4} \) max. 1000 V
negative \( -V_{g4} \) max. 500 V

First accelerator voltage
\( V_{g2} \) max. 800 V
min. 300 V

Grid 1 voltage, negative
\( -V_{g1} \) max. 150 V
positive \( V_{g1} \) max. 0 V
positive peak \( V_{g1p} \) max. 2 V

Cathode to heater voltage, positive
\( V_{kf} \) max. 250 V
positive peak \( V_{kf p} \) max. 300 V
negative \( -V_{kf} \) max. 135 V
negative peak \( -V_{kf p} \) max. 180 V

1) During a warm-up period not exceeding 15 s the heater may be 410 V negative with respect to the cathode.
REFERENCE LINE GAUGE

Dimensions in mm
MONITOR TUBE

The M31-130W is a 31 cm-diagonal rectangular television tube with metal-backed screen primarily intended for use as a monitor or display tube.

<table>
<thead>
<tr>
<th>QUICK REFERENCE DATA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deflection angle</td>
</tr>
<tr>
<td>Focusing</td>
</tr>
<tr>
<td>Resolution</td>
</tr>
<tr>
<td>Overall length</td>
</tr>
</tbody>
</table>

SCREEN
Metal-backed phosphor
Luminescence white
Light transmission of face glass approx. 50 %
Useful diagonal min. 295 mm
Useful width min. 257 mm
Useful height min. 195 mm

HEATING
Indirect by a.c. or d.c.; parallel supply
Heater voltage $V_f = 6.3 \text{ V}$
Heater current $I_f = 300 \text{ mA}$

FOCUSBING
For focusing voltage providing optimum focus at a beam current of 100 μA see under "Typical operating conditions".

DEFLECTION
Diagonal deflection angle 90°
Deflection coil AT1071/03 is recommended.
MECHANICAL DATA

Dimensions in mm

[Diagram with dimensions and annotations]

Reference line 1

278 ± 3

166.4 ± 0.5

90 min

25 max

60 min

27.8 mm 2

257 min

195 min

295 min

394.3 ± 3

129194

366 November 1972
MECHANICAL DATA (continued)

Mounting position: any, except vertical with the screen down and the axis of the tube making an angle of less than 20° with the vertical.

Base
Cavity contact
Accessories
Socket
Final accelerator contact connector

CAPACITANCES
Final accelerator to external conductive coating
Cathode to all other elements
Control grid to all other elements

C_{g3}, g_{5(t)}/m = 1100 \text{ pF}
C_{k} = 5 \text{ pF}
C_{g1} = 7 \text{ pF}

1) The reference line is determined by the plane of the upper edge of the flange of the reference line gauge with the gauge resting on the cone.

2) The maximum dimension is determined by the reference line gauge.
TYPICAL OPERATING CONDITIONS

Final accelerator voltage \( V_{g3, g5(t)} \) 16 kV
Focusing electrode voltage \( V_{g4} \) 0 to 400 V
First accelerator voltage \( V_{g2} \) 600 V
Grid no. 1 voltage for extinction of focused raster \( V_{g1} \) -32 to -85 V

RESOLUTION

Resolution at screen centre measured with the shrinking raster method (non-interlaced raster), under typical operating conditions, and at a beam current of 50 μA: 900 lines. The resolution can be improved by the use of beam centring magnet, catalogue number 3322 142 11401, supplied on request.

LIMITING VALUES (Absolute max. rating system)

<table>
<thead>
<tr>
<th>Component</th>
<th>Symbol</th>
<th>Min.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final accelerator voltage</td>
<td>( V_{g3, g5(t)} )</td>
<td>10 kV</td>
<td>18 kV</td>
</tr>
<tr>
<td>Focusing electrode voltage, positive</td>
<td>( V_{g4} )</td>
<td>500 V</td>
<td>1000 V</td>
</tr>
<tr>
<td>Focusing electrode voltage, negative</td>
<td>( -V_{g4} )</td>
<td>500 V</td>
<td></td>
</tr>
<tr>
<td>First accelerator voltage</td>
<td>( V_{g2} )</td>
<td>300 V</td>
<td>800 V</td>
</tr>
<tr>
<td>Grid no. 1 voltage, negative positive</td>
<td>( -V_{g1} )</td>
<td>0 V</td>
<td>150 V</td>
</tr>
<tr>
<td>Grid no. 1 voltage, negative positive peak</td>
<td>( V_{g1} )</td>
<td>2 V</td>
<td></td>
</tr>
<tr>
<td>Grid no. 1 voltage, negative peak</td>
<td>( V_{g1p} )</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cathode to heater voltage, positive</td>
<td>( V_{kf} )</td>
<td>300 V</td>
<td>250 V</td>
</tr>
<tr>
<td>Cathode to heater voltage, positive peak</td>
<td>( V_{kfp} )</td>
<td>135 V</td>
<td></td>
</tr>
<tr>
<td>Cathode to heater voltage, negative</td>
<td>( -V_{kf} )</td>
<td>180 V</td>
<td></td>
</tr>
<tr>
<td>Cathode to heater voltage, negative peak</td>
<td>( -V_{kfp} )</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

REFERENCE LINE GAUGE

1) During a warm-up period not exceeding 15 s the heater may be 410 V negative with respect to the cathode.
MONITOR TUBE

The M31-131W is a 31 cm-diagonal rectangular television tube with integral protection primarily intended for use as a monitor or display tube.

<table>
<thead>
<tr>
<th>QUICK REFERENCE DATA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deflection angle</td>
</tr>
<tr>
<td>Focusing</td>
</tr>
<tr>
<td>Resolution</td>
</tr>
<tr>
<td>Overall length</td>
</tr>
</tbody>
</table>

SCREEN
Metal backed phosphor
Luminescence white
Light transmission of face glass approx. 50 %
Useful diagonal ≥ 295 mm
Useful width ≥ 257 mm
Useful height ≥ 195 mm

HEATING
Indirect by a.c. or d.c.; parallel supply

<table>
<thead>
<tr>
<th>Heater voltage</th>
<th>6.3 V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heater current</td>
<td>300 mA</td>
</tr>
</tbody>
</table>

FOCUSBING
electrostatic
For focusing voltage providing optimum focus at a beam current of 100 μA see under "Typical operating conditions".

DEFLECTION
magnetic
Diagonal deflection angle 90°
Deflection coil AT1071/03 is recommended.
M31-131W

Monitor tube

MECHANICAL DATA (continued)

Dimensions in mm

See "Notes to outline drawings".
MECHANICAL DATA  (continued)

Mounting position: any
Base
Cavity contact
Accessories
Socket
Final accelerator contact connector

Neo eightar (B8H), IEC 67-1-31a
CT8, IEC 67-III-2

PICTURE CENTRING MAGNET

Field intensity perpendicular to the tube axis adjustable from 0 to 800 A/m (0 to 10 Oe). Adjustment of the centring magnet should not cause a general reduction in brightness or shading the raster.

NOTES TO OUTLINE DRAWINGS

1) The reference line is determined by the plane of the upper edge of the flange of the reference line gauge with the gauge resting on the cone.

2) The maximum dimension is determined by the reference line gauge.

3) This tube has a external conductive coating (m), which must be earthed.
The capacitance of this coating to the final accelerator is used for smoothing the EHT. The tube marking and warning labels are on the side of the cone opposite the final accelerator contact, and this side should not be used for making contact to the conductive coating.

4) This area must be kept clean.

5) Minimum space to be reserved for mounting lugs.

6) The mounting screws in the cabinet must be situated within a circle with a diameter of 6 mm drawn around the true geometrical position (corners of a rectangle of 267,5 mm x 204,4 mm).

7) The maximum displacement of any lug, with respect to the plane through the other three lugs is 2 mm.

8) The metal rim-band must be earthed. For this purpose the band is provided with a tag.

9) The bulge of the spliceline seal may increase the indicated maximum values for envelope width, diagonal, and height by not more than 6,4 mm, but at any point around the seal the bulge will not protrude more than 3,2 mm beyond the envelope surface.
CAPACITANCES

Final accelerator to external conductive coating $C_{g3}, g_5(\ell)/m \quad 1200 \quad \text{pF}$
Final accelerator to metal band $C_{g3}, g_5(\ell)/m \quad 150 \quad \text{pF}$
Cathode to all other elements $C_k \quad 5 \quad \text{pF}$
Control grid to all other elements $C_{g1} \quad 7 \quad \text{pF}$

TYPICAL OPERATING CONDITIONS

Final accelerator voltage $V_{g3}, g_5(\ell) \quad 16 \quad \text{kV}$
Focusing electrode voltage $V_{g4} \quad 0 \text{ to } 400 \quad \text{V}$
First accelerator voltage $V_{g2} \quad 600 \quad \text{V}$
Grid 1 voltage for extinction of focused raster $V_{g1} \quad -32 \text{ to } -85 \quad \text{V}$

RESOLUTION

Resolution at screen centre measured with the shrinking raster method (non-interlaced raster), under typical operating conditions, and at a beam current of 50 $\mu$A: 900 lines

If necessary, the picture quality can be improved by using a beam centring magnet.
This magnet, catalogue number 3322 142 11401, can be supplied on request.

LIMITING VALUES (Absolute max. rating system)

Final accelerator voltage $V_{g3}, g_5(\ell)$
\[ \begin{align*}
V_{g3} & \quad \text{max.} \quad 18 \quad \text{kV} \\
V_{g3} & \quad \text{min.} \quad 10 \quad \text{kV}
\end{align*} \]

Focusing electrode voltage, positive $V_{g4}$ negative $-V_{g4}$
\[ \begin{align*}
V_{g4} & \quad \text{max.} \quad 1000 \quad \text{V} \\
-V_{g4} & \quad \text{max.} \quad 500 \quad \text{V}
\end{align*} \]

First accelerator voltage $V_{g2}$
\[ \begin{align*}
V_{g2} & \quad \text{min.} \quad 300 \quad \text{V}
\end{align*} \]

Grid voltage, negative positive peak $-V_{g1}$ positive $V_{g1}$
\[ \begin{align*}
-V_{g1} & \quad \text{max.} \quad 150 \quad \text{V} \\
V_{g1} & \quad \text{max.} \quad 0 \quad \text{V}
\end{align*} \]

Cathode to heater voltage, positive positive peak $V_{k_f}$ negative $-V_{k_f}$
\[ \begin{align*}
V_{k_f} & \quad \text{max.} \quad 250 \quad \text{V} \\
-V_{k_f} & \quad \text{max.} \quad 300 \quad \text{V}
\end{align*} \]

1) During a warm-up period not exceeding 15 s the heater may be 410 V negative with respect to the cathode.
REFERENCE LINE GAUGE

Dimensions in mm

[Diagram with dimensions and notes]
MONITOR TUBE

The M38-120W is a 38 cm-diagonal rectangular television tube with metal backed screen and integral protection primarily intended for use as a monitor tube. On request this tube can also be supplied with a WA screen phosphor.

<table>
<thead>
<tr>
<th>QUICK REFERENCE DATA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deflection angle</td>
</tr>
<tr>
<td>Focusing</td>
</tr>
<tr>
<td>Resolution</td>
</tr>
<tr>
<td>Overall length</td>
</tr>
</tbody>
</table>

SCREEN
Metal backed phosphor
Luminescence white
Light transmission of face glass 50 %
Useful diagonal min. 350 mm
Useful width min. 290 mm
Useful height min. 226 mm

HEATING
Indirect by a.c. or d.c.; parallel or series supply
Heater voltage $V_f$ 6.3 V
Heater current $I_f$ 300 mA

FOCUSBING
electrostatic
For focusing voltage providing optimum focus at screen centre at a beam current of 100 μA see under "Typical operating conditions".

DEFLECTION
magnetic
Diagonal deflection angle $110^\circ$
Horizontal deflection angle $93^\circ$
Vertical deflection angle $76^\circ$
Deflection coil AT1038/40A or AT1039/.. is recommended.

April 1984
MECHANICAL DATA (continued)

Mounting position: any

Base

Cavity contact

Accessories

Final accelerator contact connector
Socket
type 55563A

2422 501 06001

NOTE TO OUTLINE DRAWING

1) The reference line is determined by the plane of the upper edge of the flange of reference line gauge, (JEDEC126) when the gauge is resting on the cone.

2) End of guaranteed contour. The maximum neck and cone contour is given by the Reference line gauge.

3) Bulge at splice-line seal may increase the indicated maximum value for envelope width, diagonal and height by not more than 6.4 mm, but at any point around the seal, the bulge will not protrude more than 3.2 mm beyond the envelope surface at the location specified for dimensioning the envelope width, diagonal and height.

4) The tube should be supported on both sides of the bulge. The mechanism used should provide clearance for the maximum dimensions of the bulge.

5) The maximum dimension is determined by the reference line gauge
PICTURE CENTRING MAGNET

Field intensity perpendicular to the tube axis adjustable from 0 to 800 A/m (0 to 10 oersted). Adjustment of the centring magnet should not be such that a general reduction in brightness or shading of the raster occurs.

CAPACITANCE

| Control grid to all other elements | $C_{g1}$ | 6.0 | pF |
| Cathode to all other elements | $C_k$ | 5.0 | pF |
| Final accelerator to external conductive coating | $C_{g3,g5(t)}/m$ | 600 | pF |

TYPICAL OPERATING CONDITIONS

| Final accelerator voltage | $V_{g3,g5(t)}$ | 16 | kV |
| Focusing electrode voltage | $V_{g4}$ | 0 to 400 | V |
| First accelerator voltage | $V_{g2}$ | 400 | V |
| Grid No. 1 voltage for visual extinction of a focused raster | $-V_{g1}$ | 40 to 85 | V |

RESOLUTION

Resolution at screen centre, measured with the shrinking raster method (non-interlaced raster), under typical operating conditions, a beam current of 100 μA, and focusing voltage adjusted for optimum spot size min. 650 lines

LIMITING VALUES (Absolute max. rating system)

Voltages are specified with respect to cathode unless otherwise stated.

| Final accelerator voltage | $V_{g3,g5(t)}$ max. | 18 | kV |
| min. | 13 | kV |
| Focusing electrode voltage | $V_{g4}$ max. | 1 | kV |
| $-V_{g4}$ max. | 0.5 | kV |
| First accelerator voltage | $V_{g2}$ max. | 550 | V |
| min. | 350 | V |
| Control grid voltage, negative | $-V_{g1}$ max. | 150 | V |
| positive | $V_{g1}$ max. | 0 | V |
| positive peak | $V_{g1,p}$ max. | 2 | V |
| Cathode to heater voltage, positive | $V_{kf}$ max. | 250 | V |
| positive peak | $V_{kf,p}$ max. | 300 | V |
| negative | $-V_{kf}$ max. | 135 | V |
| negative peak | $-V_{kf,p}$ max. | 180 | V |

1) With the small change in focus spot size with variation of focus voltage the limit of 0 to 400 V is such that an acceptable focus quality is obtained within this range. If it is required to pass through the point of focus, a voltage of at least $-100$ V to $+500$ V will be required.
CIRCUIT DESIGN VALUES

Focusing electrode current, positive negative

\[ I_{g4} \quad \text{max.} \quad 25 \quad \mu A \]

\[ -I_{g4} \quad \text{max.} \quad 25 \quad \mu A \]

Grid no. 2 current, positive negative

\[ I_{g2} \quad \text{max.} \quad 5 \quad \mu A \]

\[ -I_{g2} \quad \text{max.} \quad 5 \quad \mu A \]

MAXIMUM CIRCUIT VALUES

Resistance between cathode and heater \( R_{k_f} \)

\[ \text{max.} \quad 1 \quad \text{M} \Omega \]

Impedance between cathode and heater

\( Z_{k_f} \)

(f = 50 Hz)

\[ \text{max.} \quad 500 \quad \text{k} \Omega \]

Resistance between grid no. 1 and earth \( R_{g1} \)

\[ \text{max.} \quad 1,5 \quad \text{M} \Omega \]

Impedance between cathode and earth

\( Z_k \)

(f = 50 Hz)

\[ \text{max.} \quad 100 \quad \text{k} \Omega \]

WARNING

X-ray shielding is advisable to give protection against possible danger of personal injury arising from prolonged exposure at close range to this tube when operated above 16 kV.

EXTERNAL CONDUCTIVE COATING

This tube has an external conductive coating (m), which must be earthed and capacitance of this to the final electrode is used to provide smoothing for the EHT supply. The tube marking and warning labels are on the side of the cone opposite the final electrode connector and this side should not be used for making contact to the external conductive coating.

REFERENCE LINE GAUGE

JEDEC 126

Dimensions in mm
REMARK
With the high voltage used with this tube internal flash-overs may occur. These may destroy the cathode of the tube. Therefore it is necessary to provide protective circuits, using spark gaps.
The spark gaps must be connected as follows:

No other connections between the outer conductive coating and the chassis are permissible.
On request the tube can be supplied with spark traps mounted in the base (ring trap base).
MONITOR TUBE

The M38-121 is a 38 cm-diagonal rectangular television tube with metal backed screen and integral protection primarily intended for use as a monitor or display tube.

<table>
<thead>
<tr>
<th>QUICK REFERENCE DATA</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Deflection angle</td>
<td>110°</td>
</tr>
<tr>
<td>Focusing</td>
<td>electrostatic</td>
</tr>
<tr>
<td>Resolution</td>
<td>min. 650 lines</td>
</tr>
<tr>
<td>Overall length</td>
<td>max. 279.5 mm</td>
</tr>
</tbody>
</table>

SCREEN
Metal backed phosphor
Luminescence white
Light transmission of face glass 50 %
Useful diagonal min. 350 mm
Useful width min. 290 mm
Useful height min. 226 mm

HEATING
Indirect by a.c. or d.c.; parallel or series supply
Heater voltage $V_f$ 6.3 V
Heater current $I_f$ 300 mA

FOCUSBUSING
electrostatic
For focusing voltage providing optimum focus at screen centre at a beam current of 100 μA see under "Typical operating conditions".

DEFLECTION magnetic
Diagonal deflection angle 110°
Horizontal deflection angle 93°
Vertical deflection angle 76°
Deflection coil AT1038/40A or AT1039/... is recommended.
MECHANICAL DATA (continued)

Dimensions in mm

bulb and screen dimensions

January 1975
MECHANICAL DATA (continued)

Mounting position: any

Base  Neo eightr (B8H), IEC67-I-31a
Cavity contact  CT8, IEC67-III-2
Accessories

Socket  2422 501 06001
Final accelerator contact connector  type 55563

PICTURE CENTRING MAGNET

Field intensity perpendicular to the tube axis from 0 to 800 A/m (0 to 10 Oe). Adjustment of the centring magnet should not cause a general reduction in brightness or shading of the raster.

NOTES TO OUTLINE DRAWING

1) The reference line is determined by the plane of the upper edge of the flange of the reference line gauge, (JEDEC 126) when the gauge is resting on the cone.

2) End of guaranteed contour. The maximum neck and cone countour is given by the reference line gauge.

3) The maximum dimension is given by the reference line gauge.

4) This area must be kept clean.

5) Minimum space to the reserved for mounting lugs.

6) The mounting screws in the cabinet must be situated within a circle with a diameter of 7,5 mm drawn around the true geometrical positions of corners of a rectangle of 327 mm x 247,7 mm.

7) The maximum displacement of any lug with respect to the plane trough the other three lugs is 2 mm.

8) The metal rimband must be earthed. Holes of 3 mm diameter in each lug are provided for this purpose.

9) The bulge at the pliceline seal may increase the indicated maximum value for envelope width, diagonal and height by not more than 6,4 mm, but at any point around the seal the bulge will not protrude more than 3,2 mm beyond the envelope surface.
CAPACITANCES

Final accelerator to external conductive coating \[ C_{g3 \cdot g5(t)/m} \] 450 to 650 pF
Final accelerator to metal band \[ C_{g3 \cdot g58f9/m'} \] 240 pF
Cathode to all other elements \[ C_k \] 5 pF
Control grid to all other elements \[ C_{g1} \] 6 pF

TYPICAL OPERATING CONDITIONS

Final accelerator voltage \[ V_{g3 \cdot g5(t)} \] 16 kV
Focusing electrode voltage \[ V_{g4} \] 0 to 400 V 1)
First accelerator voltage \[ V_{g2} \] 400 V
Grid No. 1 voltage for visual extinction of a focused raster \[ -V_{g1} \] 40 to 85 V

RESOLUTION

Resolution at screen centre, measured with the shrinking raster method (non-interlaced raster), under typical operating conditions, a beam current of 100 μA, and focusing voltage adjusted for optimum spot size, min. 650 lines.

LIMITING VALUES (Absolute max. rating system)

Voltages are specified with respect to cathode unless otherwise stated.

Final accelerator voltage \[ V_{g3 \cdot g5(t)} \] max. 18 kV min. 13 kV
Focusing electrode voltage \[ V_{g4} \] max. 1000 V max. 500 V
First accelerator voltage \[ V_{g2} \] max. 550 V min. 350 V
Control grid voltage, negative \[ -V_{g1} \] max. 150 V
positive \[ V_{g1} \] max. 0 V
positive peak \[ V_{g1p} \] max. 2 V
Cathode to heater voltage, positive \[ V_{kf} \] max. 250 V
positive peak \[ V_{kfp} \] max. 300 V
negative \[ -V_{kf} \] max. 135 V
negative peak \[ -V_{kfp} \] max. 180 V

---

1) With the small change in focus spot size with variation of focus voltage the limit of 0 to 400 V is such that an acceptable focus quality is obtained within this range. If it is required to pass through the point of focus, a voltage range of at least -100 to +500 V will be required.
CIRCUIT DESIGN VALUES

Focusing electrode current, positive negative
\[ I_g^4 \quad I_g^2 \]
max. 25 \( \mu A \)
max. 5 \( \mu A \)

Grid No.2 current, positive negative
\[ -I_g^4 \quad -I_g^2 \]
max. 25 \( \mu A \)
max. 5 \( \mu A \)

MAXIMUM CIRCUIT VALUES

Resistance between cathode and heater
\[ R_{k_f} \]
max. 1 M\( \Omega \)

Impedance between cathode and heater (f = 50 Hz)
\[ Z_{k_f} \]
max. 500 k\( \Omega \)

Resistance between grid no. 1 and earth
\[ R_{g_1} \]
max. 1.5 M\( \Omega \)

Impedance between cathode and earth (f = 50 Hz)
\[ Z_k \]
max. 100 k\( \Omega \)

WARNING

X-ray shielding is advisable to give protection against possible danger of personal injury arising from prolonged exposure at close range to this tube when operated above 16 kV.

EXTERNAL CONDUCTIVE COATING

This tube has an external conductive coating (m), which must be earthed and capacitance of this to the final electrode is used to provide smoothing for the EHT supply. The tube marking and warning labels are on the side of the cone opposite the final electrode connector and this side should not be used for making contact to the external conductive coating.

REFERENCE LINE GAUGE

JEDEC 126

Dimensions in mm

\[ y = 0.022835 x^2 + 14.63 \]
REMARK

With the high voltage used with this tube internal flash-overs may occur. These may destroy the cathode of the tube. Therefore it is necessary to provide protective circuits, using spark gaps.

The spark gaps must be connected as follows:

```
  +---------------------------------+
  |                                |
  | short connections to electrodes |
  |                                |
  +---------------------------------+
          to chassis

  +-----------------------------+
  | short connection to outer conductive coating |
  +-----------------------------+
```

No other connections between the outer conductive coating and the chassis are permissible.

On request the tube can be supplied with spark traps mounted in the base (ring trap base).
VERY HIGH RESOLUTION CATHODE-RAY TUBE

The M38-200 is a 38 cm, 70° data graphic display tube with a resolution of more than 6,6 line pairs per mm (corresponding to 3000 TV lines). Used in conjunction with deflection unit AT1991 it is eminently suitable for full page document display.

The resolution easily meets the stringent requirements of the CCITT recommendations for digital group III, high resolution facsimile transmission, and those of graphic displays for computer-aided design.

Tubes with white (WA and WE) or green (GH) screen phosphors are standard; the WE phosphor is recommended for photographic applications. Other phosphors are available to special order. The tubes have a metal-backed screen and rim band for implosion protection.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Deflection angle</th>
<th>70°</th>
</tr>
</thead>
<tbody>
<tr>
<td>Face diagonal</td>
<td>38 cm</td>
</tr>
<tr>
<td>Overall length</td>
<td>478 mm</td>
</tr>
<tr>
<td>Neck diameter</td>
<td>36,8 mm</td>
</tr>
<tr>
<td>Screen dimensions</td>
<td>226 mm x 291 mm</td>
</tr>
<tr>
<td>Resolution</td>
<td>3000 TV lines*</td>
</tr>
<tr>
<td></td>
<td>1800 lines* (shrinking raster)</td>
</tr>
</tbody>
</table>

* Landscape format.
ELECTRICAL DATA

Capacitances
- cathode to all other electrodes
- grid 1 to all other electrodes
- final accelerator to external conductive coating
- final accelerator to tension band

Focusing method
Deflection method
Deflection angle
Heating
- heater voltage
- heater current

C_k  4 pF
C_g1  12 pF
C_{g3, g5(I)/m}  1000 pF
C_{g3, g5(I)/m'}  220 pF

electrostatic
magnetic*
approx. 70°
indirect by AC or DC

V_f  6.3 V ± 5 %
l_f  190 mA**

OPTICAL DATA

Screen
Phosphor type
- fluorescent colour
- persistence

Screen dimensions
Minimum useful screen diagonal
Preferable useful scanning area
Reduction for A4 size (297 mm x 210 mm)
Reduction for 11" x 8½" size (279 mm x 216 mm)
Light transmission of screen

GH   WA   WE
green  white  white
medium medium medium
short  short  short

226 mm x 291 mm
352 mm
200 mm x 270 mm
9%
7.4%
approx. 50%

* To obtain the best tube performance, deflection unit AT1991 should be used.
** Liable to be modified into 240 mA.
**MECHANICAL DATA**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall length</td>
<td>478 ± 6.5 mm</td>
</tr>
<tr>
<td>Neck diameter</td>
<td>36.8 ± 0.8 mm</td>
</tr>
<tr>
<td>Base</td>
<td>JEDEC B12-246</td>
</tr>
<tr>
<td>Final accelerator contact</td>
<td>cavity contact, CT8; IEC 67-III-2</td>
</tr>
<tr>
<td>Mounting position</td>
<td>any</td>
</tr>
<tr>
<td>Implosion protection</td>
<td>rim band</td>
</tr>
<tr>
<td>Net mass</td>
<td>approx. 6 kg</td>
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<tr>
<td>Accessories</td>
<td></td>
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<tr>
<td>socket</td>
<td>type 55589</td>
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<tr>
<td>final accelerator contact connector</td>
<td>type 55563A</td>
</tr>
<tr>
<td>deflection unit</td>
<td>type AT1991</td>
</tr>
</tbody>
</table>
MECHANICAL DATA (continued)

Dimensions in mm

Fig. 1a.

Fig. 1b.
Very high resolution cathode-ray tube

Fig. 1c.

Fig. 2.
MECHANICAL DATA (continued)

Fig. 3.

Fig. 4.

Fig. 5.

Fig. 6.

Fig. 7.

**Notes**

1. Minimum space to be reserved for mounting lugs.
2. The mounting screws in the cabinet must be situated within a circle with a diameter 7,5 mm drawn around the true geometrical positions (corners of a rectangle of 314,5 mm x 247,6 mm).
Very high resolution cathode-ray tube

Reference line gauge, JEDEC 110

RECOMMENDED OPERATING CONDITIONS; voltages with respect to cathode*

- Final accelerator voltage
  \[ V_{g3, g5} = 18 \text{ kV} \]
- Focusing electrode voltage
  \[ V_{g4} = 5 \text{ to } 7 \text{ kV}** \]
- Dynamic focusing
  \[ \Delta V_{g4} = 200 \text{ to } 300 \text{ V}$^\Delta$ \]
- First accelerator voltage
  \[ V_{g2} = 800 \text{ V} \]
- Cut-off voltage for visual extinction of focused spot
  \[ -V_{g1} = 50 \text{ to } 110 \text{ V} \]
- Grid drive for 30 $\mu$A screen current
  \[ V_d = \text{approx. } 20 \text{ V} \]

RESOLUTION

With a beam current ($I_a$) of 30 $\mu$A, the spot diameter at a brightness level of 50% is approx. 120 $\mu$m (see Fig. 9).

CIRCUIT DESIGN VALUES

- Grid 4 current
  - Positive
    \[ I_{g4} \text{ max.} = 6 \text{ $\mu$A} \]
  - Negative
    \[ -I_{g4} \text{ max.} = 6 \text{ $\mu$A} \]
- Grid 2 current
  - Positive
    \[ I_{g2} \text{ max.} = 5 \text{ $\mu$A} \]
  - Negative
    \[ -I_{g2} \text{ max.} = 5 \text{ $\mu$A} \]

* The tube has internal magnetic correction for astigmatism. To avoid changing this correction, the coil must be at zero potential, before being moved on the tube neck.

** For optimum focus at screen centre.

$^\Delta$ To obtain optimum focus over the whole useful screen area, dynamic correction voltages should be applied in N-S and E-W directions; these voltages should be adjustable separately within the indicated range.
Luminance is measured with a photo-cell, the spectral response of which is identical to that of the human eye, on a 312 lines non-interlaced raster, screen dimensions 226 mm x 291 mm, frame frequency 50 Hz.

Fig. 10 Luminance.
$V_{co} = 74.5$ V, $V_{g2} = 800$ V, $V_{g3,g5} = 18$ kV.

Fig. 11 Grid drive.
LIMITING VALUES (Absolute maximum rating system)

Voltages are specified with respect to cathode unless otherwise stated.

Final accelerator voltage
\[ V_{g3}, g5(\infty) \] max. 20 kV

Focusing electrode voltage
\[ V_{g4} \] min. 8 kV

First accelerator voltage
\[ V_{g2} \] max. 1,2 kV

Control grid voltage
- negative
  \[ -V_{g1} \] max. 140 V
- positive, non-repetitive
  \[ V_{g1} \] max. 0 V

Cathode to heater voltage
- positive
  \[ V_{kf} \] max. 250 V
- positive peak
  \[ V_{kfp} \] max. 300 V
- negative
  \[ -V_{kf} \] max. 135 V
- negative peak
  \[ -V_{kfp} \] max. 180 V

LIMITING CIRCUIT VALUES

Resistance between cathode and heater
\[ R_{kf} \] max. 1 MΩ

Impedance between cathode and heater (f = 50 Hz)
\[ Z_{kf} \] max. 500 kΩ

Grid 1 circuit resistance
\[ R_{g1} \] max. 1,5 MΩ

Impedance between cathode and earth
\[ Z_{k} \] max. 100 kΩ

X-RADIATION

See Figs 13 and 14.

FLASHOVER PROTECTION

With the high voltage used with this tube internal flashovers may occur. These may destroy the cathode of the tube. Therefore it is necessary to provide protective circuits, using spark gaps.

The spark gaps must be connected as follows:

![Diagram of flashover protection](7275269)

Fig. 12.

No other connections between the outer conductive coating and the chassis are permissible.
X-RADIATION LIMIT

Anode button has no measureable radiation up to 30 kV.

Fig. 13 X-radiation limit curves, at a constant anode current of 250 μA, measured in accordance with TEPAC164.

Anode button has no measureable radiation up to 30 kV and 1500 μA.

Fig. 14 0.5 mR/h isoexposure-rate limit curves, measured according to TEPAC164.
VERY HIGH RESOLUTION CATHODE-RAY TUBE/COIL ASSEMBLY

This tube/coil assembly consists of the very high resolution tube M38-200 and the deflection unit AT1991. The assembly is adjusted for astigmatism correction of the spot, over the entire screen. For further information see the data sheets of M38-200 and AT1991.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deflection angle</td>
<td>70°</td>
</tr>
<tr>
<td>Face diagonal</td>
<td>38 cm</td>
</tr>
<tr>
<td>Overall length</td>
<td>478 mm</td>
</tr>
<tr>
<td>Neck diameter</td>
<td>36,8 mm</td>
</tr>
<tr>
<td>Screen dimensions</td>
<td>226 mm x 291 mm</td>
</tr>
<tr>
<td>Resolution</td>
<td>3000 TV lines*</td>
</tr>
<tr>
<td></td>
<td>1800 lines*</td>
</tr>
<tr>
<td></td>
<td>(shrinking raster)</td>
</tr>
</tbody>
</table>
Fig. 1 M38-201 tube assembly.
Fig. 2 AT1991 deflection unit.
ELECTRICAL DATA (for landscape format: 290 mm x 225 mm scan)

Line deflection coils, parallel connected; (see Fig. 3)
  inductance (at 1 kHz) 140 μH
  resistance (DC) 0,23 Ω

Line deflection current, for 290 mm scan, at 18 kV 7,6 A

Field deflection coils, parallel connected; (see Fig. 3)
  inductance (at 1 kHz) 5 mH
  resistance (DC) 5,6 Ω

Field deflection current, for 225 mm scan, at 18 kV 940 mA

Maximum voltage between line and field coils 2500 V (DC)

Fig. 3 Diagram of the coils. The beginning of the windings are indicated with ●.

Geometric distortion measured without centring magnets.

\[
\begin{align*}
F_y : & \pm 1,0^{+1,5} \quad -1,0 \\
G_y : & \pm 1,0^{+1,5} \quad -1,0 \\
J_y : & -1,0^{+1,0} \quad -1,5 \\
H_y : & -1,0^{+1,0} \quad -1,5 \\
F_x : & -1,0^{+1,0} \quad -1,5 \\
G_x : & +1,0^{+1,5} \quad -1,0 \\
J_x : & +1,0^{+1,5} \quad -1,0 \\
H_x : & -1,0^{+1,0} \quad -1,5
\end{align*}
\]

Fig. 4.
Fig. 5 Resolution.
CENTRING CORRECTION

The eccentricity of the CRT and the deflection unit can be corrected by two independently movable centring magnets, which are magnetized diametrically (see Fig. 2). By turning the magnets with respect to each other the resulting field strength is varied. The direction of the resulting magnetic field is adjusted by turning the magnets simultaneously. The magnets must be adjusted so that the curvature of the horizontal and vertical axes disappears; in general the picture will be centred at the same time, otherwise this should be corrected electronically.

ASTIGMATISM CORRECTION

The astigmatism of the undeflected beam can be corrected by two independently movable quadripole magnets, which are placed next to the centring magnets (see Fig. 2). By turning the quadripole magnets with respect to each other the resulting four-pole field strength varies. The direction of the resulting four-pole field is adjusted by turning the quadripole magnets simultaneously. The astigmatism of the undeflected beam is examined during a slow variation of the focusing voltage; the beam is free of astigmatism when the size, and not the shape, of the beam changes when the focusing voltage is varied around its optimum (Figs 7 and 8).

Fig. 7 Beam with astigmatism.
Fig. 8 Beam free of astigmatism.

a. Focusing voltage < optimum value.
b. Focusing voltage at optimum value.
c. Focusing voltage > optimum value.

* See "Precautions for use" overleaf.
PRECAUTIONS FOR USE

To avoid possible deterioration of the astigmatism correction quality of the assembly, the recommendations listed below should be adhered to:

- To avoid changing the tube's internal magnetic correction, the coil must be at zero potential before being moved on the tube neck.
- If centring correction is necessary, adjust the coil dipole magnets so that the spot shift at the screen centre does not exceed 1 cm from its original position.
- For picture geometric distortion correction, an electrical correction is preferable to magnetic adjustment.
- When used in portrait format it may be necessary to adjust the position of the coil quadripole magnets, in order to achieve optimum astigmatism correction.
- When used in landscape format no adjustment for astigmatism correction is necessary as optimum astigmatism correction is set in the factory.

* The spot astigmatism correction quality is guaranteed for beam currents up to 250 µA, provided these recommendations are followed.
FLYING SPOT SCANNER TUBE
FLYING SPOT SCANNER TUBE

The Q13-110GU is a 13 cm diameter cathode-ray tube intended for flying spot applications.

<table>
<thead>
<tr>
<th>QUICK REFERENCE DATA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accelerator voltage</td>
</tr>
<tr>
<td>Deflection angle</td>
</tr>
<tr>
<td>Resolution</td>
</tr>
</tbody>
</table>

SCREEN

Metal backed phosphor
Type : GU
Colour : white
Persistance : very short

Useful screen diameter min. 108 mm

HEATING

Indirect by A.C. or D.C.; series or parallel supply

Heater voltage
\[ V_f \quad 6.3 \text{ V} \]
Heater current
\[ I_f \quad 300 \text{ mA} \]

CAPACITANCES

Grid No.1 to all other electrodes \[ C_{g1} \quad 6.5 \text{ pF} \]
Cathode to all other electrodes \[ C_k \quad 6.5 \text{ pF} \]
Accelerator to outer conductive coating \[ C_{g2}(\ell)/m \quad 250 \text{ to } 450 \text{ pF} \]
Mounting position: any, except with screen downwards and the axis of the tube making an angle of less than 50° with the vertical.

Base

Duodecal 7p.

1) Reference line, determined by the plane of the upper edge of the reference line gauge when the gauge is resting on the cone.

2) Insulating outer coating; should not be in close proximity to any metal part.

3) Conductive outer coating; to be grounded.

4) Recessed cavity contact.

5) Spark trap; to be grounded.

6) The distance between the deflection centre and the reference line should not exceed 31 mm.

7) Distance between the centre of the magnetic length of the focusing unit and the reference line.
FOCUSING  magnetic

DEFLECTION  magnetic

REFERENCE LINE GAUGE

Dimensions in mm

OPERATING CHARACTERISTICS

Accelerator voltage

Beam current

Negative grid No. 1 cut-off voltage

Resolution at centre of screen better than 1000 lines

\[ V_{g2(t)} = 25 \text{ kV} \]

\[ I_t = 50 \text{ to } 150 \mu\text{A} \]

\[ -V_{g1(I_t=0)} = 50 \text{ to } 100 \text{ V} \]
**LIMITING VALUES** (Absolute max. rating system)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Unit</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accelerator voltage</td>
<td>$V_{g2}(t)$</td>
<td></td>
<td>max. 27 kV, min. 20 kV</td>
</tr>
<tr>
<td>Grid No. 1 voltage,</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>negative value</td>
<td>$-V_{g1}$</td>
<td></td>
<td>max. 200 V</td>
</tr>
<tr>
<td>positive value</td>
<td>$+V_{g1}$</td>
<td></td>
<td>max. 0 V</td>
</tr>
<tr>
<td>peak positive value</td>
<td>$+V_{g1p}$</td>
<td></td>
<td>max. 2 V</td>
</tr>
<tr>
<td>Cathode current</td>
<td>$I_k$</td>
<td>$\mu$A</td>
<td>max. 150 $\mu$A</td>
</tr>
<tr>
<td>Voltage between heater and cathode</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>cathode negative</td>
<td>$V_{kf\text{ (k neg.)}}$</td>
<td></td>
<td>max. 125 V</td>
</tr>
<tr>
<td>cathode positive</td>
<td>$V_{kf\text{ (k pos.)}}$</td>
<td></td>
<td>max. 200 V</td>
</tr>
<tr>
<td>peak value, cathode positive</td>
<td>$V_{kf\text{p (k pos.)}}$</td>
<td></td>
<td>max. 410 V</td>
</tr>
<tr>
<td>External resistance between heater and cathode</td>
<td>$R_{kf}$</td>
<td>M$\Omega$</td>
<td>max. 1 M$\Omega$</td>
</tr>
<tr>
<td>External grid No. 1 resistance</td>
<td>$R_{g1}$</td>
<td>M$\Omega$</td>
<td>max. 1.5 M$\Omega$</td>
</tr>
<tr>
<td>External grid No. 1 impedance at a frequency of 50 Hz</td>
<td>$Z_{g1\text{ (f = 50 Hz)}}$</td>
<td></td>
<td>max. 0.5 M$\Omega$</td>
</tr>
</tbody>
</table>

**REMARKS**

Measures should be taken for the beam current to be switched off immediately when one of the time-base circuits becomes defective.

An X-ray radiation shielding with an equivalent lead thickness of 0.5 mm is required to protect the observer.

---

1) In order to avoid excessive hum, the A.C. component of the heater to cathode voltage should be as low as possible and should not exceed 20 V$_{RMS}$.

2) During a heating-up period not exceeding 45 sec.
# DEFLECTION UNIT

## QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monitor tube</td>
<td>17 cm (7 in)</td>
</tr>
<tr>
<td>diagonal</td>
<td>28.6 mm</td>
</tr>
<tr>
<td>neck diameter</td>
<td></td>
</tr>
<tr>
<td>Deflection angle</td>
<td>90°</td>
</tr>
<tr>
<td>Line deflection current, edge to edge at 15 kV</td>
<td>6.85 A (p-p)</td>
</tr>
<tr>
<td>Inductance of line coils (parallel connected)</td>
<td>84.5 µH</td>
</tr>
<tr>
<td>Field deflection current, edge to edge at 15 kV</td>
<td>0.35 A (p-p)</td>
</tr>
<tr>
<td>Resistance of field coils (series connected)</td>
<td>16.8 Ω</td>
</tr>
</tbody>
</table>

## APPLICATION

This deflection unit is for use with 17 cm (7 in) 70° monitor tube M17-142 in conjunction with:
- line output transformer AT2102/02;
- linearity control unit AT4036/00A;
- line driver transformer AT4043/56.

## DESCRIPTION

The saddle-shaped line deflection coils are moulded so that the deflection centre is well within the conical part of the monitor tube. The field deflection coils are wound on a Ferroxcube yoke ring which is flared so that the frame and line deflection centres coincide. Provisions are made for centring, and correction of pin-cushion distortion. The unit meets the self-extinguishing and non-dripping requirements of IEC 65.

## MOUNTING

The unit should be mounted as far forward as possible on the neck of the monitor tube, so that it touches the cone.

To orient the raster correctly, the unit may be rotated by hand on the neck of the monitor tube, with which it makes a slip fit. A screw-tightened clamping ring permits it to be locked, both axially and radially, in the desired position.
MECHANICAL DATA

Dimensions in mm

Fig. 1 Deflection unit AT1071/07; Facilities for fitting correction magnets:
(1) for plastic-bonded FXD magnet rods catalogue number 3122 104 90360;
(2) for plastic-bonded FXD magnets, catalogue number 3122 104 94120.

The unit is provided with solder pins for connection. The pin numbering in Fig. 1 corresponds to that in the connection diagram (Figs 2a and 2b).

ELECTRICAL DATA

Line deflection coils (Fig. 2a);
- Inductance (parallel connected coils) 84,5 μH ± 3,5%
- Resistance (parallel connected coils) 0,14 Ω ± 8%
- Line deflection current, edge to edge (116 mm) at 15 kV 6,85 A (p-p)

Field deflection coils, series connected (Fig. 2b);
- Inductance 41,6 mH ± 8%
- Resistance 16,8 Ω ± 8%
- Field deflection current, edge to edge (87 mm) at 15 kV 0,35 A (p-p)

Maximum d.c. voltage between terminals of line and field coils 2000 V
Maximum operating temperature 95 °C
Deflection unit

Fig. 2a Line coils.

The beginning of the windings is indicated with ●.

**Sensitivity** measured at an e.h.t. of 15 kV on a 17 cm (7 in) 70° reference tube.

- Deflection current edge to edge
  - in line direction
  - in field direction (parallel connected coils)
  - 6.85 A (p-p)
  - 0.35 A (p-p)

**Geometric distortion** measured without correction and centring magnets on a 17 cm (7 in) 70° reference tube (dimensions in mm)

The spreads in raster geometry are tabulated below as deviations from the ideal rectangle at the points indicated. Cartesian coordinates are used to show the extent of deviation resolved along x and y areas. Points A, B, C, D, E are fixed and hence zero spreads.

**Spreads (x,y) per point**

F (-0.5 ± 2.0, +1.0 ± 1.5)
G (+0.5 ± 2.0, +1.0 ± 1.5)
H (-0.5 ± 2.0, -1.0 ± 1.5)
J (+0.5 ± 2.0, -1.0 ± 1.5)

Fig. 2b Field coils.

Fig. 3.
CORRECTION FACILITIES

For centring

After adjustment of the linearity of the deflection current, the eccentricity of the monitor tube and the deflection unit can be corrected by means of two independently movable centring magnets of plastic-bonded Ferroxdure. These magnets are magnetized diametrically. By turning the magnets with respect to each other the resulting field strength is varied. The direction of the resulting magnetic field is adjusted by turning the magnets simultaneously.

These centring magnets cannot be used for compensating the effects of non-linearity or of phase differences between the synchronization and time base, as otherwise the correction needed becomes excessive. Even if the correction is within the range of the magnets, curved lines may appear in the centre of the raster.

![Diagram of centring magnets](image)

Fig. 4.

For pin-cushion distortion

Pin-cushion distortion can be corrected by two Ferroxdure magnets with pole-shoe brackets, which have been mounted on the deflection unit. Limited correction of asymmetrical pin-cushion distortion can be achieved by unequal movement of these magnets. The field strength can be adjusted by rotation of these magnets. To correct the top and bottom of the raster, two plastic-bonded Ferroxdure magnet rods* can be fitted (Fig. 1). To correct the corners of the raster, four plastic-bonded Ferroxdure magnets** (Fig. 1) can be fitted.

* Available under catalogue number 3122 104 90360.
** Available under catalogue number 3122 104 94120.
DEFLECTION UNIT

- For use with very high resolution CRTs (15 to 20 inch)

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inductance of line deflection coils, parallel connected, at 1 kHz</td>
<td>140 μH</td>
</tr>
<tr>
<td>Resistance of line deflection coils (DC), parallel connected</td>
<td>0,23 Ω</td>
</tr>
<tr>
<td>Inductance of field deflection coils, parallel connected, at 1 kHz</td>
<td>5 mH</td>
</tr>
<tr>
<td>Resistance of field deflection coils (DC)</td>
<td>5,6 Ω</td>
</tr>
<tr>
<td>Maximum voltage between line and field coils (DC)</td>
<td>2500 V</td>
</tr>
<tr>
<td>Line scan frequency</td>
<td>max. 125 kHz</td>
</tr>
</tbody>
</table>

DESCRIPTION

The saddle-shaped line and field deflection coils are surrounded by a Ferroxcube yoke ring in such a way that the line and field deflection centres coincide. Provisions are made for centring correction, and astigmatism correction of the spot at the screen centre. The field coils have internal damping resistors. The unit has a non-magnetic metal clamping ring for fixing to the tube neck.

The deflection unit meets the self-extinguishing requirements of UL.
MECHANICAL DATA

Dimensions in mm

Fig. 1.

Tightening torque on clamping ring
1.3 to 1.5 Nm

Torque on centring magnets
35 to 250 mNm

Mounting
The unit should be mounted as far forward as possible on the neck of the tube, so that it touches the cone.

To orient the raster correctly, the unit may be manually rotated around the neck. The screw-tightened clamping ring permits it to be locked, both axially and radially, in the desired position.

ENVIRONMENTAL DATA

Maximum operating temperature (average copper temperature) 95 °C

Storage temperature range
-25 to + 90 °C

Flame retardant
according to UL94, category V-1

Flammability
according to UL94, category V-1
ELECTRICAL DATA

Line deflection coils, parallel connected; (see Fig. 2)
  inductance (at 1 kHz)  140 μH
  resistance (DC)  0,23 Ω
Line deflection current, for 290 mm scan, at 18 kV*
  7,6 A
Field deflection coils, parallel connected; (see Fig. 2)
  inductance (at 1 kHz)  5 mH
  resistance (DC)  5,6 Ω
Field deflection current, for 225 mm scan, at 18 kV*
  940 mA
Maximum voltage between line and field coils
  2500 V (DC)

Note: The field deflection coils may be connected in series.
  (terminals 1 and 5 linked)
Field deflection coils, series connected
  inductance at 1 kHz  17 mH
  resistance (DC)  20,1 Ω
  resistances connected in parallel
Field deflection current, for 303 mm scan, at 18 kV
  150 Ω
  650 mA

Fig. 2 Diagram of the coils. The beginning of the windings are indicated with ●.

* Values obtained using the M38-201 assembly.
CENTRING CORRECTION
The eccentricity of the CRT and the deflection unit can be corrected by two independently movable centring magnets, which are magnetized diametrically (see Fig. 1). By turning the magnets with respect to each other the resulting field strength is varied. The direction of the resulting magnetic field is adjusted by turning the magnets simultaneously. The magnets must be adjusted so that the curvature of the horizontal and vertical axes disappears; in general the picture will be centred at the same time, otherwise this should be corrected electronically.

Fig. 3.

ASTIGMATISM CORRECTION
The astigmatism of the undeflected beam can be corrected by two independently movable quadripole magnets, which are placed next to the centring magnets (see Fig. 1). By turning the quadripole magnets with respect to each other the resulting four-pole field strength varies. The direction of the resulting four-pole field is adjusted by turning the quadripole magnets simultaneously. The astigmatism of the undeflected beam is examined during a slow variation of the focusing voltage; the beam is free of astigmatism when the size, and not the shape, of the beam changes when the focusing voltage is varied around its optimum (Figs 4 and 5).

Fig. 4 Beam with astigmatism.  Fig. 5 Beam free of astigmatism.

a. Focusing voltage < optimum value.
b. Focusing voltage at optimum value.
c. Focusing voltage > optimum value.
MU-METAL SCREEN

Material: Mu-metal 0.35 mm thick
MU-METAL SCREEN
**MU-METAL SCREEN**

Material: Mu-metal, 0.35 mm thick
FINAL ACCELERATOR CONTACT CONNECTOR

Type 55563A supersedes type 55563.
TUBE SOCKET

- For 14-pin bases
- Synthetic resin insulating material
- 14 gold-plated fork-shaped contacts
- Catalogue number for ordering: 9390 017 30000
FINAL ACCELERATOR CONTACT CONNECTOR

Insulating material: silicon rubber.
TUBE SOCKET
MU-METAL SCREEN

Type 55580A with 4 mounting lugs
Type 55580 without mounting lugs

Material: Mu-metal, 0.35 mm thick
MU-METAL SCREEN

Type 55581A with hole H
Type 55581 without hole H

Material: Mu-metal, 0.5 mm thick.
MU-METAL SCREEN

* Dimensions are in millimeters.*

- **External Diameter:** 98 mm
- **Height:** 140 mm
- **Internal Diameter:** 3 and 20 mm
- **Axial Length:** 78 mm
- **Axial Height:** 128 mm
- **Internal Diameter (for 55591):** 65 mm
- **Axial Length (for 55591):** 106 mm
- **Height:** 285 mm

Note: Dimensions marked with *internal* indicate internal measurements.
TUBE SOCKET

- For 12-pin all glass base, JEDEC B12-246
- Solder tags
- Tinned contact springs
- Catalogue number for ordering: 9390 298 20008

Dimensions in mm

Fig. 1 Dimensions.
TUBE SOCKET

- For 12-pin all glass base, JEDEC B12-246
- Printed-wiring pins; required hole diameter is 1,3 mm
- Tinned contact springs
- Catalogue number for ordering: 9390 298 30008

Dimensions in mm

Fig. 1 Dimensions.
SIDE CONTACT CONNECTOR

- For Ø 0.65 mm side contacts

Dimensions in mm

Fig. 1 Dimensions.
FINAL ACCELERATOR CONTACT CONNECTOR

Insulating material: silicon rubber.
MU-METAL SCREEN

- Material: mu-metal, 0.35 mm thick

Dimensions:
- Width: 40 mm
- Height: 150 mm
- Thickness: 4.3 mm
- Internal diameter: 63 mm
- External diameter: 122 mm
- Radius: 35 mm

Angles:
- 45° angle

Date: April 1984
MU-METAL SCREEN

- Material: mu-metal, 0.35 mm thick
BEAM CENTRING MAGNET

INSTRUCTIONS FOR USE

To obtain the best performance from an electrostatically focussed tube, it is important that the axis of the beam should coincide with that of the lens. In practice this is not always so because of small errors in geometry. By means of this magnet it is possible to adjust, if necessary, the position of the beam and so produce a true alignment in every case. The effect is illustrated in Figs 1a and 1b which show enlarged views of a single element in a spot raster under the special operating conditions given in the directions for setting. With a well aligned beam, an image such as that in Fig. 1a can be seen. Very small errors will produce a spot as shown in Fig. 1b where the brightest part of the image does not appear in the centre of the diffused area or haze. In such a case, the picture quality would be good but with only a small adjustment of the beam, so that the brightest part becomes central, a noticeable improvement can be made.

The unit has a non-magnetic ring containing a diametrically magnetized Ferroxdure core and two soft-iron pole pieces covered with plastic material to protect the glass surface.

Fig. 1a

Fig. 1b

The field strength can be altered by turning the core as indicated in Fig. 2, and the direction by turning the whole unit. Moving the unit along the neck of the tube will cause a small change in the position of the beam but it is most effective at about 20 mm from the cap (Fig. 3).

Fig. 2

a) minimum
b) maximum
c) intermediate
SETTING

This can best be done with a spot raster on the screen, and by observing one of the elements near the centre. A suitable raster would have, for instance, a spot duration of 1/6 μs with a repetition time of 6 μs and an image as in Fig. 1 can then be produced with the following conditions.

\[
\begin{align*}
V_f^* & = 6.3 \text{ V} \\
V_{g1} & = 0 \\
V_{g2} & = 600 \text{ V} \\
V_{g3, g5(1)} & = 16 \text{ kV} \\
g^4 & = -300 \text{ to } -500 \text{ V}
\end{align*}
\]

or other conditions if required

*) To avoid burning the screen, adjust slowly from -50 V to zero

Set the unit on the neck at about 20 mm from the cap and turn it until the brightest part of the image appears central in the haze.

Fig. 4
The diagrams in Fig. 4 show the process of adjusting the brightest part from its original position to the centre. The distance between the two points will be determined by the field strength, and the position of the new point along the dotted line will depend on the direction of the field.

If the magnet is under or over-correcting as in (Figs 4a and 4b), the field strength must be changed. To do this, remove the unit from the neck, push the core out sufficiently to get a finger grip and turn it towards maximum or minimum Figs 2a and 2b as required. Return it to the stop in the clamp and set the unit once again on the neck.

If the means of producing a spot raster are not available, a test pattern or suitable picture can be used when setting. It is not easy with this method, however, to assess the degree of change needed in field strength or direction but if a start is made with the line on the core set at about 20° from the minimum position in Fig. 2, an improvement can be made in most cases where it is required. In others, it may be necessary to try one or two further core settings, but with a little experience it is not difficult to find an arrangement which gives the best vertical and horizontal resolution.

The unit should be sufficiently tight on the neck to prevent movement during transit but if, for some reason, this does not appear to be so, the bends on the ring should be compressed slightly.
SMALL BALL CONTACT CONNECTOR

[Diagram with measurements: 2.15 ± 0.1, 3.1 ± 0.2, 2.4 ± 0.3, R0.4 ± 0.2, R1.25 ± 0.15, R0.6 ± 0.3, 6 ± 0.3, 11.5 ± 0.15, Ø0.8 ± 0.03]
DATA HANDBOOK SYSTEM
DATA HANDBOOK SYSTEM

Our Data Handbook System comprises more than 60 books with specifications on electronic components, subassemblies and materials. It is made up of four series of handbooks:

ELECTRON TUBES

SEMICONDUCTORS

INTEGRATED CIRCUITS

COMPONENTS AND MATERIALS

The contents of each series are listed on pages iv to vii.
The data handbooks contain all pertinent data available at the time of publication, and each is revised and reissued periodically.
When ratings or specifications differ from those published in the preceding edition they are indicated with arrows in the page margin. Where application information is given it is advisory and does not form part of the product specification.
Condensed data on the preferred products of Philips Electronic Components and Materials Division is given in our Preferred Type Range catalogue (issued annually).
Information on current Data Handbooks and on how to obtain a subscription for future issues is available from any of the Organizations listed on the back cover.
Product specialists are at your service and enquiries will be answered promptly.
ELECTRON TUBES (BLUE SERIES)

The blue series of data handbooks comprises:

T1  Tubes for r.f. heating
T2a  Transmitting tubes for communications, glass types
T2b  Transmitting tubes for communications, ceramic types
T3  Klystrons
T4  Magnetrons for microwave heating
T5  Cathode-ray tubes
    Instrument tubes, monitor and display tubes, C.R. tubes for special applications
T6  Geiger-Müller tubes
T8  Colour display systems
    Colour TV picture tubes, colour data graphic display tube assemblies, deflection units
T9  Photo and electron multipliers
T10  Plumbicon camera tubes and accessories
T11  Microwave semiconductors and components
T12  Vidicon and Newvicon camera tubes
T13  Image intensifiers and infrared detectors
T15  Dry reed switches
T16  Monochrome tubes and deflection units
    Black and white TV picture tubes, monochrome data graphic display tubes, deflection units
SEMICONDUCTORS (RED SERIES)

The red series of data handbooks comprises:

S1  Diodes
    Small-signal silicon diodes, voltage regulator diodes (< 1.5 W), voltage reference diodes,
    tuner diodes, rectifier diodes

S2a  Power diodes

S2b  Thyristors and triacs

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