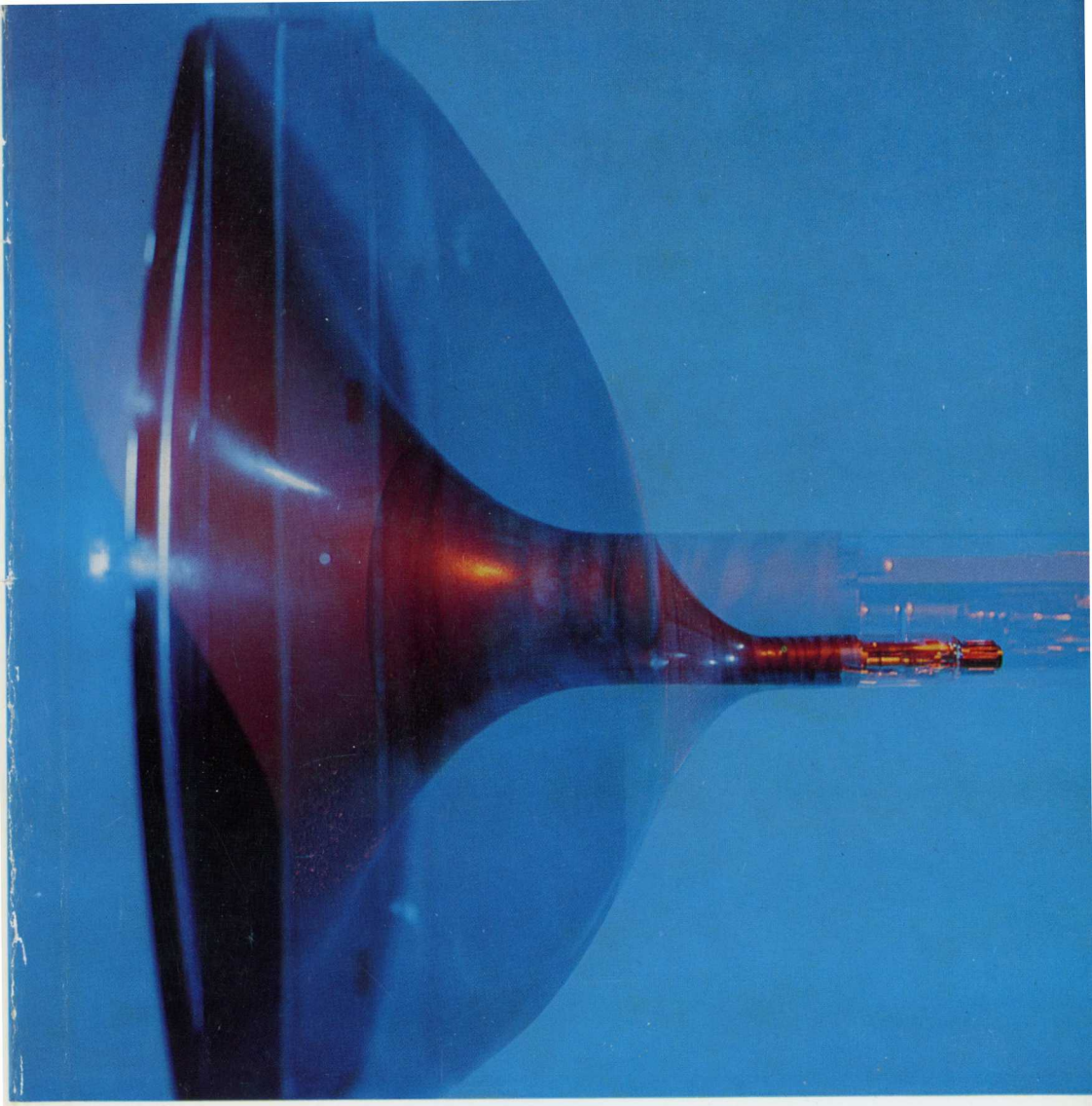

# Picture Tubes 1973/74

6370/346 E

Components ITT

# Picture Tubes 1973/74

**ITT Components Group Europe**

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Components ITT

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## 1. General hints on the handling of black and white tubes

### 1.1 Hazards

A television picture tube consists of an evacuated bulb. To operate the tube, a high tension is required for the anode and the metal coating on the inner surface of the screen. This involves some hazards, described briefly below:

When the bulb is broken, glass will fly in all directions with tremendous force. This is called an implosion and is described with more detail in connection with the respective safety procedures under chapter 2.

The high-voltage smoothing capacitor formed by the inner aluminium coating and the external graphite coating will remain charged for a considerable time even after the tube has been switched off. In order to avoid an electrical shock if the anode contact is accidentally touched, it is recommended to discharge the anode contact and the external conductive coating by means of a grounded shorting strap before work is started on the equipment and the tube.

The often feared dangerous X-ray hazard does not exist when the equipment is properly operated. It is true that during the operation of the tube weak X-ray and ultraviolet radiation is excited inside the tube, but most of this radiation is converted into visible light and heat on the screen. Moreover, the thick faceplate absorbs a considerable portion of the remaining radiation. Measurements have shown that a picture tube in operation produces only about 1/40 of the background radiation acting on the human organism. The X-ray energy produced by the tube is indeed less than that produced by the luminous dial of a wrist watch. Any fear of a detrimental effect of the radiation on the health of the viewer is absolutely unfounded.

### 1.2 Packing

When handling large tubes (heavy weight), it must be borne in mind that the bulb can be damaged by bruises and scratches. The bulb is of a high pressure resistent design, so not every scratch will result in the immediate destruction of the tube, though it may reduce the thermal and mechanical strength of the bulb. Also, damages to the faceplate (screen) will be detrimental to picture quality. For this reason the ITT packing for picture tubes is so designed that damage to the bulb during packing, unpacking, storage and transport is impossible. With a view to weight and volume, in particular with large television picture tubes, manual handling is only possible in the individual packing. Preferred for transporting large quantities is bulk packing, which can only be moved on pallets by means of fork lifts.

### 1.3 Storage and transport

Normally the picture tubes are stored and transported packed in cartons. For handling unpacked tubes special racks or transport carts with individual tube holders are used. High stacks of cartons are subdivided on pallets, which give the stack a firm stand and enable fork trucks to be used. Pallets are also employed for truck and rail transport.

### 1.4 Installation and removal

When installing or removing a tube care should be taken not to damage the fragile bulb. Grasp the tube diagonally, so that the weight is approximately balanced and the tube neck can always be seen. Do not pick up a picture tube by the neck, since the glass is very thin at this point and breaks easily.

When placing the tube face down on a level surface rest it on a support with four soft projections. When the tube is placed down on the panel skirt, the neck has to be supported separately to pre-

vent damage to the base pins or to the tubulation.
The picture tube is installed in the television receiver with the screen in a vertical position. This is normally achieved by a resilient rubber tape slipped over the panel skirt or by an elastic tightening strap with a soft intermediate layer to prevent the contacting glass surfaces from being scratched. When installing the tube make sure that the pressure is distributed uniformly over the supporting area and that it is not excessive.
Steel band reinforced picture tubes are bolted in place by means of the mounting lugs. The deflection yoke is slipped over the tube neck and must seat against the funnel. The deflection yoke is not provided for supporting the tube. The socket provided with flexible leads is also plugged into the tube base and is supported by it. Finally the high tension lead is connected to the anode contact.

### 1.5 Thermal stress

All parts of the tube are subjected to higher thermal stresses during manufacture than those encountered during normal operation. The tube withstands these stresses without damage, since heating and cooling is performed within a well proven and automatically controlled temperature cycle. The tube is designed to operate under both extreme arctic and tropical conditions. However cracks may occur when the tube is not operated properly, in particular in the case of excessive local temperature differences.

### 1.6 Contamination

When the tube is brought from a cold room into a heated room, the water vapour in the air will condense on the cold surfaces, which may result in leakage currents or flashovers at the tube base or the anode contact. The anode area is protected against humidity by water-repellent paint, which ensures a high degree of resistance against flashovers. In spite of this it is recommended to switch the tube on only after the temperature is approximately at equilibrium.
When the picture tube has been in use for a longer period of time, dust will settle on the surfaces of the tube due to electrostatic charges. Together with the humidity mentioned above the dust forms a film on the glass surfaces, which may likewise result in leakage currents and flashovers. On the screen it will also lower picture quality. On the neck it reduces heat radiation, thus causing considerable temperature differences, in particular in the glass. Therefore we recommend cleaning the tube at regular intervals or whenever the need arises, possibly together with the receiver.

### 1.7 Functional troubles

The highly automated production process with many intermediate inspections and a 100% final test by means of automatic test equipment ensure fault-free operation and long life for ITT picture tubes. If, in spite of this, a tube should fail due to a material or workmanship defect, replacement will be made free of charge during the first 12 months of service.
The life of a tube ends when, after several thousand hours of operation, there is a marked decrease in the cathode emission together with a reduction in the sharpness and brightness of the picture.

## 2. Implosion protection

### 2.1 Purpose of the implosion protection

Since the television picture tubes are evacuated, a high pressure takes effect upon the bulb. The weight acting on an area of the bulb with a diameter of approx. 50 cm ($19^3/_4$″) amounts to 2 tons. This extreme pressure has already been taken into consideration during manufacture through special precautions. Those parts of the bulb subjectet to very high stresses are provided with thicker walls. This prevents the bulb from being destroyed under normal conditions. In some isolated cases however – whether due to improper handling or adverse external influences – the bulb may be damaged. Fine fissures or checks as may be caused by shock or impact will then eventually result in the destruction of the picture tube due to the high difference in pressure. This is called an implosion, and the glass will fly in all directions with tremendous force. An **implosion** is the inward collapse of an evacuated container due to a sudden compensation of the pressure difference. From the above it is seen that a gradual compensation of pressure caused by a fine crack in the glass is not an implosion. Basing on this idea numerous techniques have been developed, all serving the same purpose, namely to prevent an implosion caused by defects in the glass and to protect the viewer and technician from the effects of such a sudden destruction of the bulb.

VDE Standard (Association of German Electrical Engineers) 0868, containing general specifications for implosion-protected picture tubes, has been in force in Germany since July 1, 1963. This standard is binding for all German picture tube manufacturers. The basic requirement of this standard is that **implosion-protected picture tubes** must be designed and rated so that implosion is impossible with **proper tube handling** and, hence, no hazard will exist for the user and the surroundings.

### 2.2 Implosion protection according to the SELBOND ® method

One method of obtaining implosion-proof picture tubes is the SELBOND implosion protection method developed by SEL (see illustration 1). With this method the mechanical stresses required for partial compensation of the strains within the glass are not obtained by means of a shrinking process, but by direct mechanical pressure on the critical zones of the bulb. The frame is fitted around the bulb with a high pre-tension. It is in direct contact with the glass and is given mechanical support by a sealing and filling material filled in between the SELBOND frame and the bulb.

This method ensures a high degree of protection against implosion.

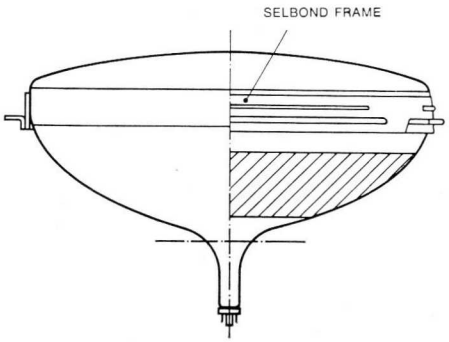



Figure 1: Implosion protection according to the SELBOND ® method

## 3. Symbols for the quantities listed under technical data

(example for tetrode with einzel-lens)

### 3.1 Typical Operating Conditions

| | |
|---|---|
| Heater | |
| Heater voltage | $U_f$ |
| Heater current | $I_f$ |
| Anode | |
| Voltage | $U_{g3g5a}$ |
| Screen grid | |
| Voltage | $U_{g2}$ |
| Grid-No. 4 | |
| Focusing voltage | $U_{g4}$ |
| Control grid | |
| Cutoff voltage | $(-U_{g1})_{cutoff}$ |

### 3.2 Maximum ratings

| | |
|---|---|
| Anode | |
| Maximum voltage | $U_{g3g5a\ max}$ |
| Minimum voltage | $U_{g3g5a\ min}$ |
| Current-limiting resistance | $R_{g3g5a\ min}$ |
| Screen grid | |
| Maximum voltage | $U_{g2\ max}$ |
| Minimum voltage | $U_{g2\ min}$ |
| Current-limiting resistance | $R_{g2\ min}$ |
| Grid-No. 4 | |
| Maximum focusing voltage | $U_{g4\ max}$ |
| Minimum focusing voltage | $U_{g4\ min}$ |
| Maximum negative focusing voltage | $(-U_{g4})_{max}$ |
| Maximum peak voltage | $U_{g4\ p\ max}$ |
| Current-limiting resistance | $R_{g4\ min}$ |
| Control grid | |
| Maximum bias voltage | $U_{g1\ max}$ |
| Minimum bias voltage | $(-U_{g1})_{max}$ |
| Maximum peak control voltage | $U_{g1\ p\ max}$ |
| Minimum peak control voltage | $(-U_{g1})_{p\ max}$ |
| Maximum grid leakage resistance | $R_{g1\ max}$ |
| Maximum grid leakage impedance (at 50 Hz) | $Z_{g1\ max}$ |
| Control grid current-limiting resistance | $R_{g1\ min}$ |
| Cathode | |
| Minimum cathode voltage | $U_{k\ min}$ |
| Maximum cathode voltage | $U_{k\ max}$ |
| Minimum peak cathode voltage | $(-U_k)_{p\ max}$ |
| Maximum peak cathode voltage | $U_{k\ p\ max}$ |
| Maximum grid leakage resistance | $R_{k/g1\ max}$ |
| Maximum impedance (at 50 Hz) | $Z_{k/g1\ max}$ |
| Screen | |
| Maximum screen dissipation load | $P_{lm\ max}$ |
| Heater/cathode | |
| Voltage | |
| Negative heater — during warm-up period | $U_{-f/k\ max}$ |
| Negative heater — after warm-up period | $U_{-f/k\ max}$ |
| Negative heater — peak voltage after warm-up period | $U_{-f/k\ p\ max}$ |
| Positive heater — after warm-up period | $U_{+f/k\ max}$ |
| Positive heater — peak voltage after warm-up period | $U_{+f/k\ p\ max}$ |
| Resistance | |
| External resistance | $R_{f/k\ max}$ |
| Maximum external impedance (at 50 Hz) | $Z_{f/k\ max}$ |

### 3.3 Capacitances

| | |
|---|---|
| Control grid to all other electrodes | $c_{g1}$ |
| Cathode to all other electrodes | $c_k$ |
| Anode to external conductive coating, maximum value | $c_{g3g5a/m\ max}$ |
| Anode to external conductive coating, minimum value | $c_{g3g5a/m\ min}$ |
| Anode to metal frame, maximum value | $c_{g3g5a/m'\ max}$ |
| Anode to metal frame, minimum value | $c_{g3g5a/m'\ min}$ |

## 4. Characteristic data of black and white picture tubes

### 4.1 Generalities

#### 4.1.1 Assembly

With similar types of picture tubes the higher number behind the hyphen indicates the latest development step.
The bulge at the splice may protrude over the nominal dimension of the screen at any point along the circumference. For the mounting system a zone at least 17 mm (43/64″) wide is provided below the mold-match line (on the straight part of the panel). The mounting system must be lined with suitable cushioning material and must be so designed that no strain is exerted on the bulge.
The reference line is determined by the designated plane of the reference line gauge when it is seated against the funnel of the bulb.
Depending on the geographical situation, the earth's magnetic field may cause a central spot deviation. The raster displacement may amount to 2 mm ($^5/_{64}$″) max.
The tube base may be within the designated tolerance circle with reference to the vertical line through the centre of the screen.
The tube is provided with a ring-shaped graphite coating. The designated field indicates the section provided for the grounding spring.
The metal frame is insulated from the ring-shaped graphite coating. The bare metal mounting lugs may be used for grounding the steel frame.

#### 4.1.2 Operating data

Operating values other than those quoted are not permitted. For special uses, write for additional information.
The operating values are the mean values of new picture tubes. All electrode voltages refer to cathode potential.
The oxide-coated cathode is of the indirectly heated type. Both alternating current and direct current may be used, with parallel or series connection.
The cutoff voltage is defined by the visual extinction of the focused raster. The undeflected spot disappears only by making the control grid voltage approx. 5 V more negative. This adjustment can easily cause damage to the screen. Therefore the raster measurement method is to be preferred.
The focusing voltage corresponds to the optimum overall focus. The voltage value to be set depends on the deflection yoke used and the beam current. For optimum focus at the centre of the screen the voltage value is normally 50 to 200 V lower.
The external coating of the tube is to be connected to the negative high voltage terminal.

#### 4.1.3 Maximum ratings

With series connection of the heater the heating voltage must not exceed 9,5 V during warm-up period.
The maximum permissible deviation of the heating currents is ± 6 % from the nominal value of 0,3 A.
The maximum permissible deviation of the heating voltage is ± 10% from the nominal value.
Unless stated otherwise, the standardized warm-up time applies for all picture tubes.
With regard to picture distortion the interference introduced by the heater circuit should be kept at the lowest possible value. Therefore the alternating voltage between heater and cathode should not exceed the value $U_{f/k\ rms} = 20$ V.
The circuit for generating the operating voltage must be so rated that the continuous current value at short-circuit is less than 5 mA.
If the peak value of the short-circuit current is equal to or higher than 1 A or if a charge of 250 µC or more is stored in the voltage source, the protective resistances indicated in the data sheets

should be inserted between the individual electrodes and the filter capacitor of the operating voltage source.
The maximum permissible current at grid-No. 4 may be 25 μA.
The maximum negative voltage required for focusing will not exceed 100 V.
When the anode voltage decreases below its permissible minimum value, dark screen areas may be produced, since the velocity of electrons is decreased by the aluminium coating. With decreasing anode voltage the picture sharpness diminishes.
The high field strenghts in the tube neck may cause fluorescence on the glass wall. However this is insignificant on the vacuum or the life of the tube.

### 4.2 Notes referring to the specifications given on the following pages

① For cathode drive service.
Unless otherwise specified, voltage values refer to grid-No. 1 potential.

② Standardized warm-up period.
Parallel or series connection.
With series connection of the heater, the heater voltage must not exceed 9,5 V during warm-up period.

③ The focusing voltage is set for optimum overall focus, and depends on beam current and on the deflection yoke used. For optimum focus in the centre of the screen the voltage is about 100 to 200 V lower.

④ The cutoff voltage is determined by the visual extinction of the raster.

⑤ For $I_{g3g5a} = 0$.

⑥ When the anode voltage falls below its minimum permissible value, dark screen areas may be produced, since the velocity of electrons is decreased by the aluminium coating. With decreasing anode voltage the sharpness of the picture diminishes.

⑦ Maximum duration 1,5 ms.

⑧ In order to avoid picture distortion the interference introduced by the heater circuit should be kept at the lowest possible value. Therefore the alternating voltage between heater and cathode must not exceed 20 $V_{rms}$.

⑨ During warm-up period, not exceeding 15 seconds, $U_{-f/k\ max}$ may increase to 410 V; within 15 and 45 seconds this value must decrease at least gradually to 250 V.

⑩ With separate transformer.

⑪ With series connection.

⑫ The voltage required for focusing will not be below −100 V.

⑬ With mains supply ± 15%.
With stabilized supply or with filament supply from the scanning transformer ± 10 %. With battery operation see characteristic paragraph 4.3.

⑭ The screen grid voltage $U_{g2}$ is set in such a manner that at a cathode voltage $U_{k\ cutoff} = 45$ V a focused raster will disappear. For visual extinction of focused spot the voltage $U_{k\ cutoff}$ is to increase by approx. 5 V.

⑮ Anode cavity cap 7, 92 according to DIN 41 543 (JEDEC No. J 1–21).

⑯ The reference line is determined by the designated plane of the reference line gauge, if the gauge is seated against the funnel.

⑰ This area is free of external conductive coating and must be kept clean.

⑱ The tube base will fall within a tolerance circle of max. 45 mm ($1^{49}/_{64}$″) diameter, with respect to the tube axis. The socket should not be rigidly mounted but must be connected by flexible leads.

⑲ The tube has an external conductive coating. The indicated field denotes the section provided for the connecting springs. The external conductive coating of the tube must be connected with the negative high voltage terminal.

⑳ Dimensions of the bulb, measured at the front edge of the implosion protection.

㉑ Nominal dimensions for the position of the mounting bolts. For the bolts a free passage of at least 4 mm ($^5/_{32}$″) diameter is guaranteed in normal mounting position.

㉒ Nominal dimensions of the mounting bolts. For the bolts a free passage of at least 5,7 mm ($^{15}/_{64}$″) diameter is guaranteed in normal mounting position.

㉓ Nominal dimensions of the mounting bolts. For the bolts a free passage of at least 8,0 mm ($^5/_{16}$″) diameter is guaranteed in normal mounting position.

㉔ Nominal dimensions of the mounting bolts. For the bolts a free passage of at least 8,5 mm ($^{11}/_{32}$″) diameter is guaranteed in normal mounting position.

㉕ Nominal dimensions of the mounting bolts. For the bolts a free passage of at least 9,5 mm ($^3/_8$″) diameter is guaranteed in normal mounting position.

㉖ Tolerance range of the mounting lug.

㉗ The bare metal mounting lugs may be used for grounding the metal frame. Metal frame and external coating are galvanically separated against each other. They may be connected mutually if it is allowed by the effective safety rules. The impedance between metal frame and external coating must not exceed 1 MΩ at 50 Hz and 5 kΩ at 15 kHz.

㉘ The maximum deviation between one screenside angle-seating and a plane through the other three angle-seatings will not exceed 2 mm ($^5/_{64}$″).

㉙ The Z points are reference points for the vertical position of the X and Y points.
The dimensions for the position of the X, Y and Z points count also for the border line of the minimum useful screen area.

㉚ Angular deviation between the anode cavity cap and a plane through the base pins.

㉛ Range of validity for the bending radius drawn in this section.

㉜ The dimensions specified refer to the bulb.

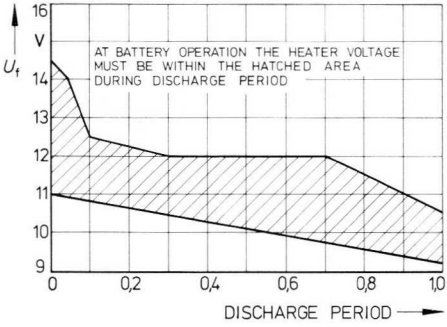
㉝ To avoid cracked stems only such sockets are allowed which cannot perform a point of contact with the pin closer than 2 mm to the base bottom.

㉞ Tentative ratings

㉟ Nominal dimensions of the mounting bolts. For the bolts a free passage of at least 7,5 mm ($^{19}/_{64}$″) diameter is guaranteed in normal mounting position.

㊱ Nominal dimensions of the mounting bolts. For the bolts a free passage of at least 7 mm ($^9/_{32}$″) diameter is guaranteed in normal mounting position.

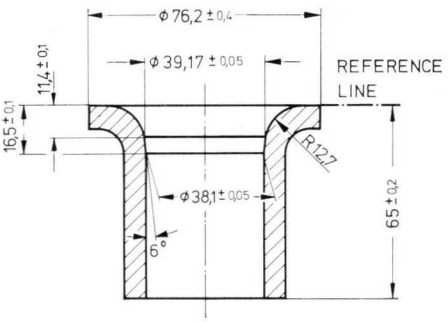
### 4.3 Specifications for A 28–13 W, A 31–19 W, A 31–120 W and A 31–250 W




Heater voltage at battery operation.

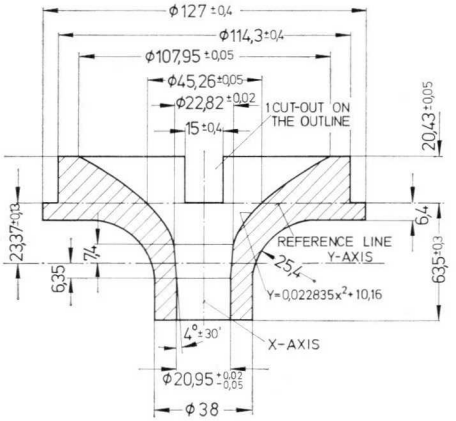
## 4.4 Reference line gauges

### 4.4.1 Reference line gauge L 1 DIN 41541 deflection angle 70° neck diameter 36,5 mm



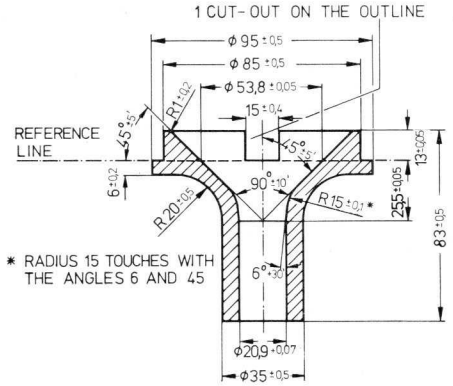

for picture tube AW 17–69

### 4.4.2 Reference line gauge deflection angle 110° neck diameter 20 mm



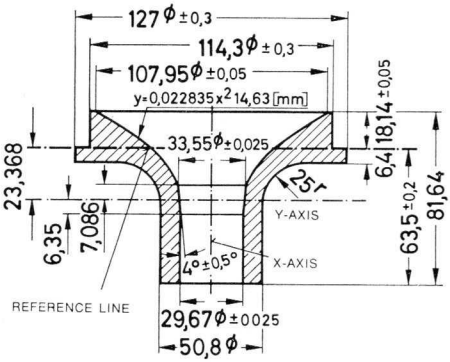

for picture tubes A 31–120 W
A 31–250 W
A 44–280 W

### 4.4.3 Reference line gauge deflection angle 90° neck diameter 20 mm




for picture tubes A 28–13 W
M 17–18 W
A 31–19 W

### 4.4.4 Reference line gauge L 1 DIN 44432 deflection angle 110° neck diameter 28,6 mm

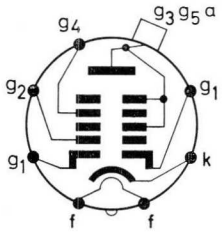



for picture tubes A 31–15 W
A 41–10 W
A 44–13 W/3
A 47–27 W/2
A 51–10 W
AW 59–91
A 59–22 W
A 61–120 W/2
A 65–13 W

# Black and White Picture Tubes

## AW 17–69

**Rectangular Picture Tube, aluminized screen, for industrial television**




| | |
|---|---|
| Base | Duodecal DIN 41536 with 7 pins |
| Focusing Method | Electrostatic |
| Deflection Method | Magnetic |
| Deflection Angles | Diagonal 70°<br>Horizontal 60°<br>Vertical 50° |
| Face Shape | Flat |
| Material | Clear Glas |
| Screen | Phosphor P4 Aluminized |
| Minimum Useful | 96 x 128 mm |
| Dimensions | Diagonal 170 mm |
| Overall Length | 256 ± 10 mm |
| Weight | 0,7 kg (approx.) |

### 1. Generalities

Electron Gun — Tetrode with Einzel Lens

| Type | Fluorescence Colour | Persistence | |
|---|---|---|---|
| AW 17–69 | Whitish | Medium | $10^{-3}$ . . . $10^{-1}$ s |
| A 17–69 BE | Blue | Medium Short | $10^{-5}$ . . . $10^{-3}$ s |
| A 17–69 GJ | Yellowish-green | Medium | $10^{-3}$ . . . $10^{-1}$ s |
| A 17–69 GM | Purplish-blue | Long | $10^{-1}$ . . . 1 s |
| A 17–69 LF | Orange | Long | $10^{-1}$ . . . 1 s |

### 2. Electrical Data

#### 2.1 Typical Operating Conditions

| | | |
|---|---|---|
| $U_f$ ② | | 6,3 V |
| $I_f$ | | 0,3 A |
| $U_{g3g5a}$ | | 14 kV |
| $U_{g2}$ | 300 | 400 V |
| $U_{g4}$ ③ | | 0 . . . 400 V |
| $(-U_{g1})$ cutoff ④ | 35 . . . 75 | 48 . . . 102 V |

#### 2.2 Maximum Ratings

| | |
|---|---|
| $U_{g3g5a\ max}$ ⑤ | 16 kV |
| $U_{g3g5a\ min}$ ⑥ | 12 kV |
| $R_{g3g5a\ min}$ | 16 kΩ |
| $U_{g4\ max}$ | 460 V |
| $R_{g4\ min}$ | 470 Ω |
| $U_{g2\ max}$ | 460 V |
| $U_{g2\ min}$ | 200 V |
| $U_{g1\ max}$ | 0 V |
| $(-U_{g1})_{max}$ | 150 V |
| $U_{g1\ p\ max}$ | 2 V |
| $(-U_{g1})_{p\ max}$ ⑦ | 400 V |
| $R_{g1\ max}$ | 1,0 MΩ |
| $Z_{g1\ max}$ | 0,5 MΩ |
| $R_{g1\ min}$ | 150 Ω |
| $P_{Im\ max}$ | 10 mW/cm² |
| $U_{-f/k\ max}$ ⑧ ⑨ | 410 V |
| $U_{-f/k\ max}$ | 250 V |
| $U_{-f/k\ p\ max}$ | 300 V |
| $U_{+f/k\ max}$ | 135 V |
| $U_{+f/k\ p\ max}$ | 180 V |
| $R_{f/k\ max}$ ⑩ | 1,0 MΩ |
| $Z_{f/k\ max}$ ⑪ | 0,1 MΩ |

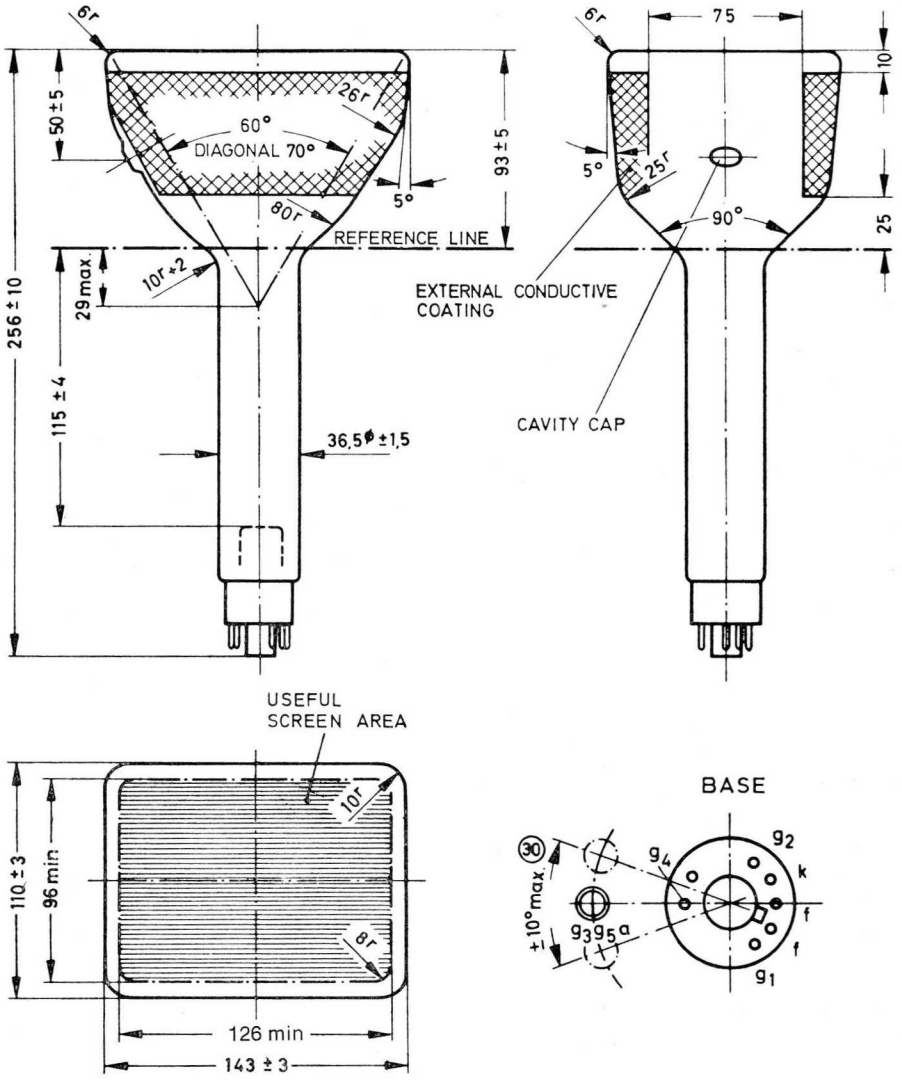
#### 2.3 Ratings for Circuit Design

| | |
|---|---|
| $I_{g2}$ | ≦ ± 5 µA |
| $I_{g4}$ | ≦ ± 25 µA |

#### 2.4 Capacitances

| | |
|---|---|
| $c_{g1}$ (approx.) | 7 pF |
| $c_k$ (approx.) | 5 pF |
| $c_{g3g5a/m\ min}$ | 400 pF |
| $c_{g3g5a/m\ max}$ | 800 pF |

### 3. **Dimensional Drawings** in mm



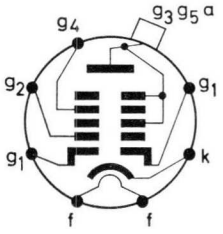

Reference line gauge see page 10

O Notes see page 8

# Black and White Picture Tubes

## M 17–18 W

**17 cm Rectangular Monitor Tube with 70° deflection angle, electrostatic focusing, and aluminized screen**




| | |
|---|---|
| Base | Special Miniature (7 Pins) |
| Focusing Method | Electrostatic |
| Deflection Method | Magnetic |
| Deflection Angles (approx.) | Diagonal 70°<br>Horizontal 60°<br>Vertical 50° |
| Neck Diameter | 20 mm |
| Face Shape | Flat |
| Material | Clear Glass |
| Screen | Phosphor P 4 Aluminized |
| Minimum Useful Dimensions | 95 x 125 mm<br>Diagonal 155 mm |
| Overall Length | 205 mm max. |
| Weight | 0,7 kg (approx.) |

### 1. Generalities

Electron Gun — Tetrode with Einzel Lens

| Type | Fluorescence Colour | Persistence | |
|---|---|---|---|
| M 17 – 18 W | Whitish | Medium | $10^{-3}$ ... $10^{-1}$ s |
| M 17 – 18 BE | Blue | Medium Short | $10^{-5}$ ... $10^{-3}$ s |
| M 17 – 18 GJ | Yellowish-green | Medium | $10^{-3}$ ... $10^{-1}$ s |
| M 17 – 18 GM | Purplish-blue | Long | $10^{-1}$ ... 1 s |
| M 17 – 18 LF | Orange | Long | $10^{-1}$ ... 1 s |

### 2. Electrical Data

#### 2.1 Typical Operating Conditions ①

| | | |
|---|---|---|
| $U_f$ ⑬ | | 11 V |
| $I_f$ | | approx. 74 mA |
| $U_{g3g5a}$ | 11 | 11 kV |
| $U_{g2}$ | 200–350 | 250 V |
| $U_{g4}$ ③ | -100 ... + 300 | -100 ... + 300 V |
| $U_{k\ cutoff}$ ④ | 45 ⑭ | 32 ... 58 V |

#### 2.2 Maximum Ratings ①

| | |
|---|---|
| $U_{g3g5a\ max}$ ⑤ | 12 kV |
| $U_{g3g5a\ min}$ ⑥ | 7,5 kV |
| $U_{g4\ max}$ | 450 V |
| $(-U_{g4})_{\ max}$ | 100 V |
| $U_{g2\ max}$ | 450 V |
| $U_{g2\ min}$ | 180 V |
| $U_{k\ max}$ | 100 V |
| $U_{k\ min}$ | 0 V |
| $U_{k\ p\ max}$ ⑦ | 350 V |
| $(-U_k)_{\ p\ max}$ | 2 V |
| $R_{g1\ max}$ | 1,5 MΩ |
| $Z_{g1}$ (50 Hz) $_{max}$ | 0,5 MΩ |
| $U \pm_{f/k\ max}$ ⑧ | 110 V |
| $U \pm_{f/k\ p\ max}$ | 130 V |
| $R_{f/k\ max}$ ⑩ | 1 MΩ |
| $Z_{f/k}$ (50 Hz) $_{max}$ ⑪ | 0,1 MΩ |

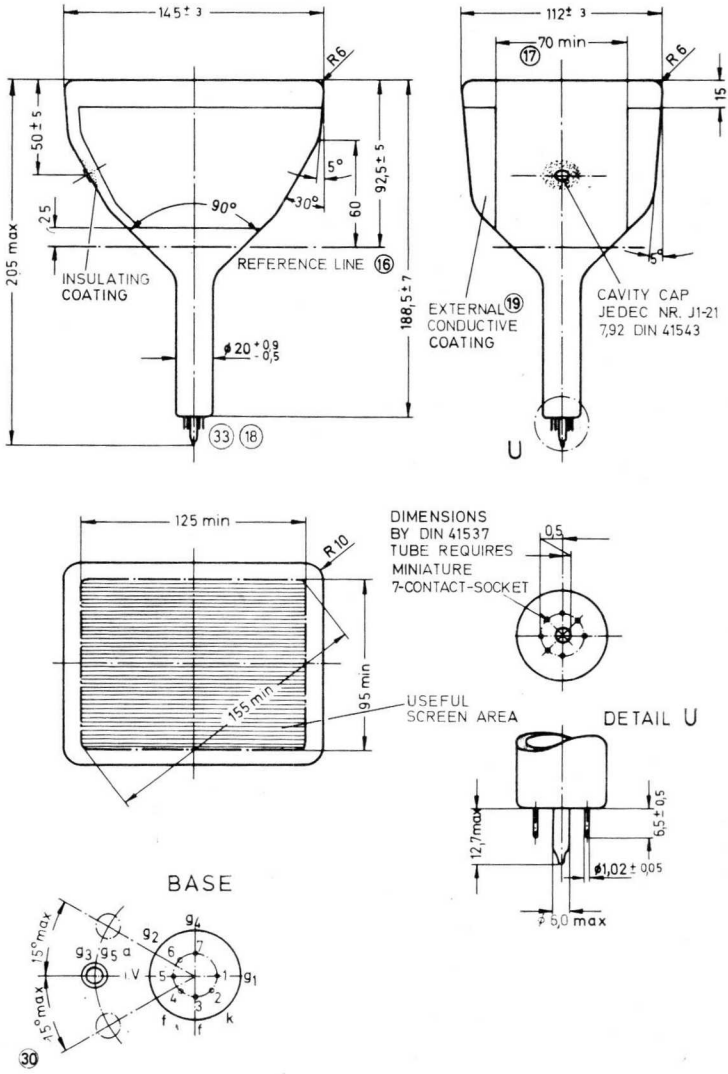
#### 2.3 Ratings for Circuit Design

| | |
|---|---|
| $I_{g2}$ | $\leqq \pm$ 5 µA |
| $I_{g4}$ | $\leqq \pm$25 µA |

#### 2.4 Capacitances (approx.)

| | |
|---|---|
| $c_{g1}$ | 6 pF |
| $c_k$ | 3 pF |
| $c_{g3g5a/m}$ | 350 pF |

**3. Dimensional Drawings** in mm



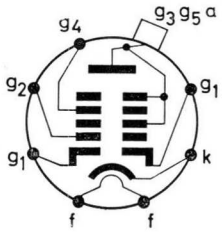

Reference line gauge see page 11

O Notes see page 8

# Black and White Picture Tubes

## A 28–13 W

**28 cm Rectangular TV Picture Tube with 90° deflection angle, electrostatic focusing, aluminized screen and tension band including tube mount for battery-operated television sets**




### 1. Generalities

| | | |
|---|---|---|
| Electron Gun | | Tetrode with Einzel-Lens |
| Bulb | | All-glass Type |
| Base | | Special Miniature (7 Pins) |
| Focusing Method | | Electrostatic |
| Deflection Method | | Magnetic |
| Deflection Angles | Diagonal | 90° |
| | Horizontal | 80° |
| | Vertical | 63° |
| Neck Diameter | | 20 mm |
| Face | Shape | Spherical |
| | Material | Filter-glass (Light transmission 57 % approx.) |
| Screen | | Phosphor P 4 Aluminized |
| Fluorescence Colour | | White |
| Colour Temperature | | 12 000 °K |
| Minimum Useful Dimensions | | 228 x 171 mm Diagonal 262,5 mm |
| Overall Length | | 245 ± 5 mm |
| Weight | | 2,0 kg (approx.) |

Implosion protection by steel reinforcement. Admitted by Association of German Electrical Engineers, VDE.

### 2. Electrical Data

#### 2.1 Typical Operating Conditions ①

| | |
|---|---|
| $U_f$ ⑬ | 11 V |
| $I_f$ | approx. 74 mA |
| $U_{g3g5a}$ ㉞ | 13 kV |
| $U_{g2}$ | 250 V |
| $U_{g4}$ ③ | 0 . . . 350 V |
| $U_{k\ cutoff}$ ④ | 32 . . . 58 V |

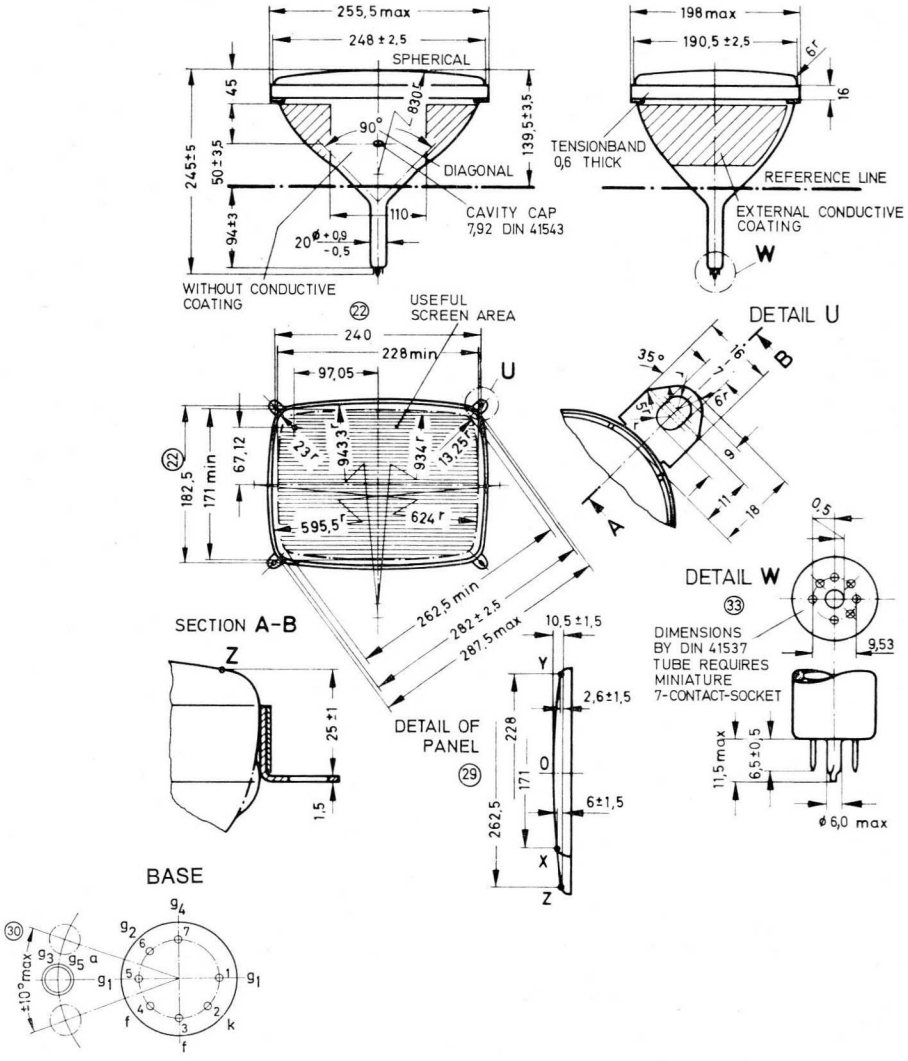
#### 2.2 Maximum Ratings ①

| | |
|---|---|
| $U_{g3g5a\ max}$ ⑤ ㉞ | 14 kV |
| $U_{g3g5a\ min}$ ⑥ ㉞ | 10 kV |
| $U_{g4\ max}$ | 450 V |
| $(-U_{g4})_{max}$ | 100 V |
| $(\pm I_{g4})_{max}$ | 25 µA |
| $U_{g2\ max}$ | 450 V |
| $U_{g2\ min}$ | 180 V |
| $U_{k\ max}$ | 100 V |
| $U_{k\ min}$ | 0 V |
| $U_{k\ p\ max}$ ⑦ | 350 V |
| $R_{k/g1\ max}$ | 1,5 MΩ |
| $Z_{k/g1\ max}$ | 0,5 MΩ |
| $P_{lm\ max}$ | 10 mW/cm² |
| $U\pm_{f/k\ max}$ ⑧ | 110 V |
| $U\pm_{f/k\ p\ max}$ | 130 V |
| $R_{f/k\ max}$ ⑩ | 1,0 MΩ |
| $Z_{f/k\ max}$ ⑪ | 0,1 MΩ |

#### 2.3 Capacitances (approx.)

| | |
|---|---|
| $c_{g1}$ | 6 pF |
| $c_k$ | 5 pF |
| $c_{g3g5a/m}$ | 700 pF |
| $c_{g3g5a/m'}$ | 150 pF |

### 3. **Dimensional Drawings** in mm



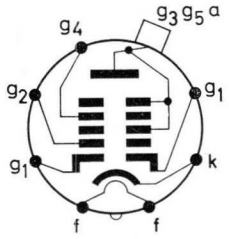

Reference line gauge see page 11

O Notes see page 8

# Black and White Picture Tubes

## A 31–15 W

**31 cm Rectangular TV Picture Tube with 110° deflection angle, electrostatic focusing, aluminized screen and tension band including tube mount**




### 1. Generalities

| | |
|---|---|
| Electron Gun | Tetrode with Einzel-Lens |
| Bulb | All-glass Type |
| Base | German Standard DIN 44431 (short design) |
| Focusing Method | Electrostatic |
| Deflection Method | Magnetic |
| Deflection Angles | Diagonal 110°<br>Horizontal 99°<br>Vertical 80° |
| Face Shape | Spherical |
| Face Material | Filter-glass (Light transmission 53 % approx.) |
| Screen | P 4 Aluminized |
| Fluorescence Colour | White |
| Colour Temperature | 12 000 °K |
| Minimum Useful Dimensions | 257 x 195 mm<br>Diagonal 295 mm |
| Overall Length | 237,6 ± 6,4 mm |
| Weight | 2,7 kg (approx.) |

Implosion protection by steel reinforcement. Admitted by Association of German Electrical Engineers, VDE.

### 2. Electrical Data

#### 2.1 Typical Operating Conditions ①

| | |
|---|---|
| $U_f$ ② | 6,3 V |
| $I_f$ | 0,3 A |
| $U_{g3g5a}$ | 12 kV |
| $U_{g2}$ | 300 V |
| $U_{g4}$ ③ | 0 . . . 400 V |
| $U_{k\ cutoff}$ ④ | 35 . . . 69 V |

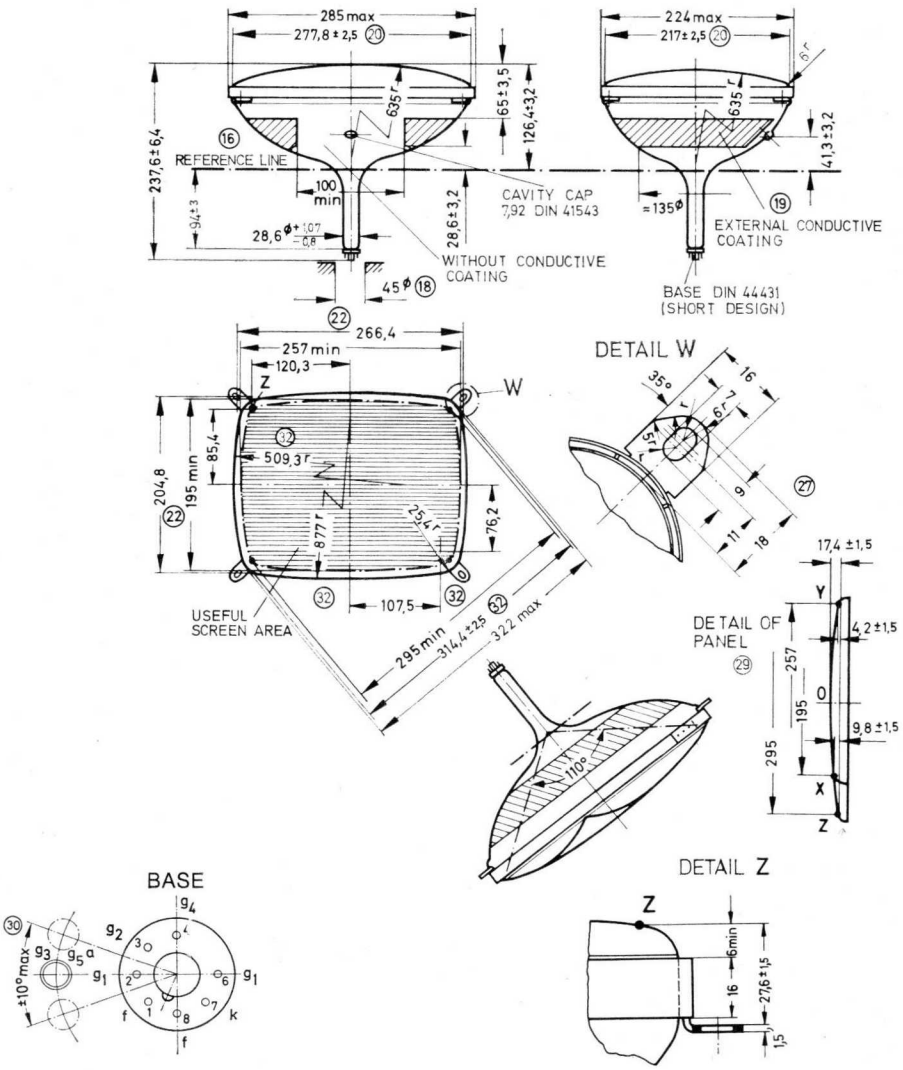
#### 2.2 Maximum Ratings

| | |
|---|---|
| $U_{g3g5a\ max}$ | 18 kV |
| $U_{g3g5a\ min}$ | 12 kV |
| $R_{g3g5a\ min}$ | 16 kΩ |
| $U_{g4\ max}$ | 1000 V |
| $(-U_{g4})_{max}$ | 500 V |
| $(\pm I_{g4})_{max}$ | 25 µA |
| $R_{g4\ min}$ | 470 Ω |
| $U_{g2\ max}$ | 550 V |
| $U_{g2\ min}$ | 200 V |
| $R_{g2\ min}$ | 470 Ω |
| $U_{k\ max}$ | 150 V |
| $U_{k\ min}$ | 0 V |
| $U_{k\ p\ max}$ | 220 V |
| $(-U_k)_{p\ max}$ | 2 V |
| $R_{g1\ max}$ | 1,5 MΩ |
| $Z_{g1\ max}$ | 0,5 MΩ |
| $R_{g1\ min}$ | 150 Ω |
| $P_{lm\ max}$ | 10 mW/cm² |
| $U_{-f/k\ max}$ ⑧ ⑨ | 410 V |
| $U_{-f/k\ max}$ | 200 V |
| $U_{+f/k\ max}$ | 135 V |
| $R_{f/k\ max}$ ⑩ | 1,0 MΩ |
| $Z_{f/k\ max}$ ⑪ | 0,1 MΩ |

#### 2.3 Capacitances (approx.)

| | |
|---|---|
| $c_{g1}$ | 6 pF |
| $c_k$ | 5 pF |
| $c_{g3g5a/m}$ | 650 pF |
| $c_{g3g5a/m'\ max}$ | 200 pF |

### 3. **Dimensional Drawings** in mm



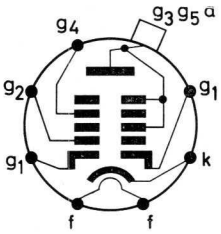

Reference line gauge see page 11

O Notes see page 8

# Black and White Picture Tubes

## A 31–19 W

**31 cm Rectangular TV Picture Tube with 90° deflection angle, electrostatic focusing, aluminized screen and tension band including tube mount for battery-operated television sets**




### 1. Generalities

| | |
|---|---|
| Electron Gun | Tetrode with Einzel-Lens |
| Bulb | All-glass Type |
| Base | Special Miniature (7 Pins) |
| Focusing Method | Electrostatic |
| Deflection Method | Magnetic |
| Deflection Angles | Diagonal 90°<br>Horizontal 80°<br>Vertical 63° |
| Neck Diameter | 20 mm |
| Face Shape | Spherical |
| Face Material | Filter-glass (Light transmission 53 % approx.) |
| Screen | P 4 Aluminized |
| Fluorescence Colour | White |
| Colour Temperature | 12 000 °K (approx.) |
| Minimum Useful Dimensions | 257 x 195 mm<br>Diagonal 295 mm |
| Overall Length | 268 ± 9,6 mm |
| Weight | 3 kg (approx.) |

Implosion protection by steel reinforcement. Admitted by Association of German Electrical Engineers, VDE.

### 2. Electrical Data

#### 2.1 Typical Operating Conditions ①

| | | | |
|---|---|---|---|
| $U_f$ ⑬ | | | 11,0 V |
| $I_f$ | | approx. | 74 mA |
| $U_{g3g5a}$ ㉞ | | 13 | 13 kV |
| $U_{g2}$ | 200 . . . 350 | ⑭ | 250 V |
| $U_{g4}$ ③ | 0 . . . 350 | 0 . . . 350 | V |
| $U_{k\ cutoff}$ ④ | | 45 32 . . . | 58 V |

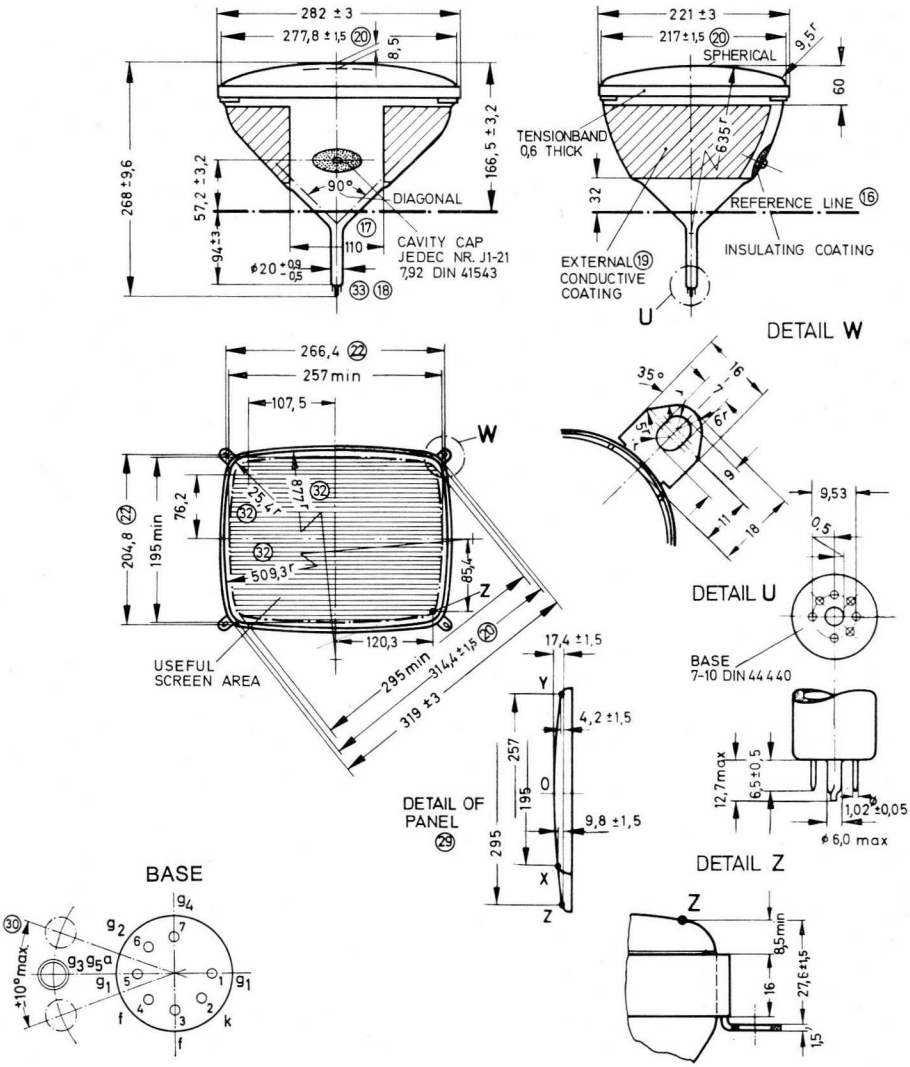
#### 2.2 Maximum Ratings ①

| | |
|---|---|
| $U_{g3g5a\ max}$ ⑤ ㉞ | 14 kV |
| $U_{g3g5a\ min}$ ⑥ ㉞ | 10 kV |
| $U_{g4\ max}$ | 450 V |
| $(-U_{g4})_{max}$ | 100 V |
| $(\pm I_{g4})_{max}$ | 25 µA |
| $U_{g2\ max}$ | 450 V |
| $U_{g2\ min}$ | 180 V |
| $U_{k\ max}$ | 100 V |
| $U_{k\ min}$ | 0 V |
| $U_{k\ p\ max}$ | 350 V |
| $(-U_k)_{p\ max}$ | 2 V |
| $R_{k/g1\ max}$ | 1,5 MΩ |
| $Z_{k/g1\ max}$ | 0,5 MΩ |
| $P_{lm\ max}$ | 10 mW/cm² |
| $U\pm_{f/k\ max}$ ⑧ | 110 V |
| $U\pm_{f/k\ p\ max}$ | 130 V |
| $R_{f/k\ max}$ ⑩ | 1,0 MΩ |
| $Z_{f/k\ max}$ ⑪ | 0,1 MΩ |

#### 2.3 Capacitances (approx.)

| | |
|---|---|
| $c_{g1}$ | 6 pF |
| $c_k$ | 5 pF |
| $c_{g3g5a/m}$ | 700 pF |
| $c_{g3g5a/m'}$ | 125 pF |

### 3. **Dimensional Drawings** in mm



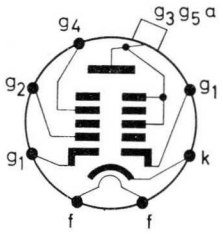

Reference line gauge see page 11

O Notes see page 8

# Black and White Picture Tubes

## A 31–120 W

**31 cm Rectangular TV Picture Tube with 110° deflection angle, electrostatic focusing, aluminized screen and steel reinforcement including tube mount**




### 1. Generalities

| | |
|---|---|
| Electron Gun | Tetrode with Einzel-Lens |
| Bulb | All-glass Type |
| Base | Special Miniature (7 Pins) |
| Focusing Method | Electrostatic |
| Deflection Method | Magnetic |
| Deflection Angles (approx.) | Diagonal 110°<br>Horizontal 99°<br>Vertical 82° |
| Neck Diameter | 20 mm |
| Face Shape | Spherical |
| Face Material | Filter-glass (Light transmission 52 % approx.) |
| Screen | Phosphor P 4 Aluminized |
| Fluorescence Colour | White |
| Colour Temperature | 12 000 °K (approx.) |
| Minimum Useful Dimensions | 257 x 195 mm<br>Diagonal 295 mm |
| Overall Length | 233 mm max. |
| Weight | 2,7 kg (approx.) |

Implosion protection by steel reinforcement. Admitted by Association of German Electrical Engineers, VDE.

### 2. Electrical Data

#### 2.1 Typical Operating Conditions ①

| | | | |
|---|---|---|---|
| $U_f$ ⑬ | | | 11 V |
| $I_f$ | | approx. | 74 mA |
| $U_{g3g5a}$ ㉞ | 13 | | 13 kV |
| $U_{g2}$ | 200 . . . 350 | ⑭ | 250 V |
| $U_{g4}$ ③ | 0 . . . 350 | 0 . . . | 350 V |
| $U_{k\ cutoff}$ | 45 | 32 . . . | 58 V |

#### 2.2 Maximum Ratings ①

| | |
|---|---|
| $U_{g3g5a\ max}$ ㉞ | 14 kV |
| $U_{g3g5a\ min}$ ⑥ ㉞ | 10 kV |
| $U_{g4\ max}$ | 450 V |
| $(-U_{g4})_{max}$ | 50 V |
| $U_{g2\ max}$ | 350 V |
| $U_{g2\ min}$ | 200 V |
| $U_{k\ max}$ | 100 V |
| $U_{k\ min}$ | 0 V |
| $U_{k\ p\ max}$ ⑦ | 350 V |
| $R_{k/g1\ max}$ | 1,5 MΩ |
| $Z_{k/g1\ max}$ | 0,5 MΩ |
| $U\pm_{f/k\ max}$ ⑧ | 110 V |
| $U\pm_{f/k\ p\ max}$ | 130 V |
| $R_{f/k\ max}$ ⑩ | 1,0 MΩ |
| $Z_{f/k\ max}$ ⑪ | 0,1 MΩ |

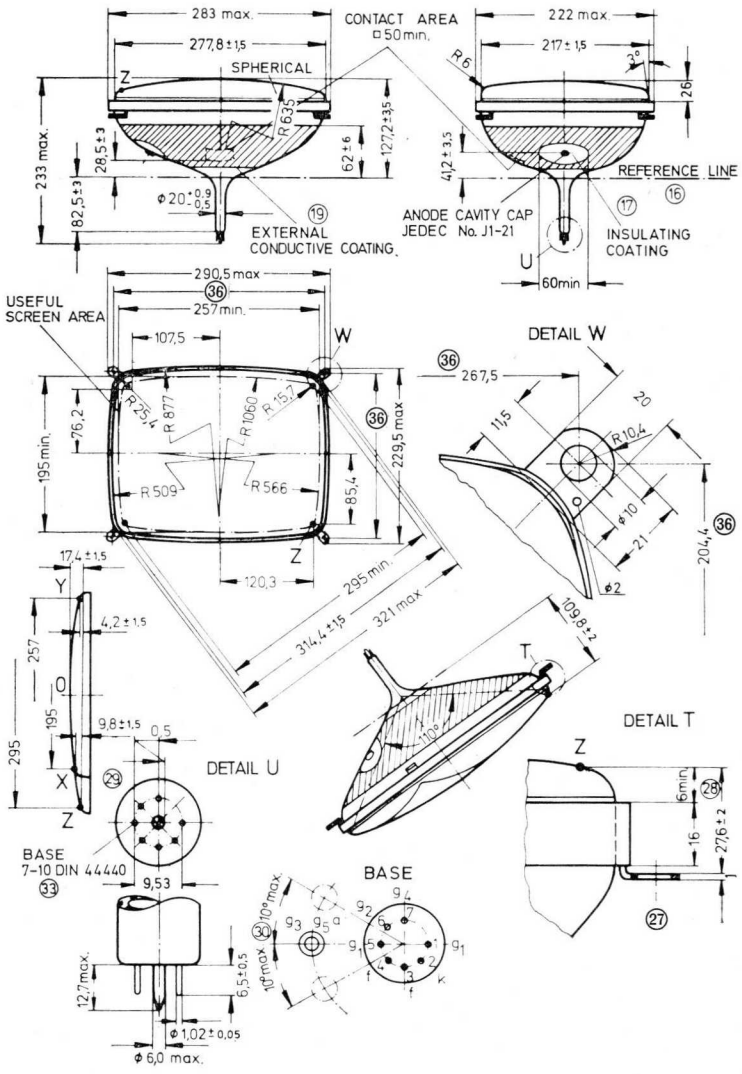
#### 2.3 Ratings for Circuit Design

| | | | |
|---|---|---|---|
| $I_{g2}$ | ≦ | ± | 5 µA |
| $I_{g4}$ | ≦ | ± | 25 µA |
| $r_{m/m'}$ | ≧ | | 2 MΩ |

#### 2.4 Capacitances

| | |
|---|---|
| $c_{g1}$ (approx.) | 6 pF |
| $c_k$ (approx.) | 5 pF |
| $c_{g3g5a/m\ max}$ | 850 pF |
| $c_{g3g5a/m\ min}$ | 550 pF |
| $c_{g3g5a/m'\ max}$ | 200 pF |

### 3. **Dimensional Drawings** in mm



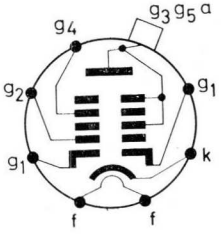

Reference line gauge see page 10

O Notes see page 8

# Black and White Picture Tubes

## A 31–250 W

**31 cm Rectangular TV Picture Tube with 110° deflection angle, electrostatic focusing, aluminized screen and steel reinforcement including tube mount**




### 1. Generalities

| | |
|---|---|
| Electron Gun | Tetrode with Einzel-Lens |
| Bulb | All-glass Type |
| Base | Special Miniature (7 Pins) |
| Focusing Method | Electrostatic |
| Deflection Method | Magnetic |
| Deflection Angles (approx.) | Diagonal 110°<br>Horizontal 99°<br>Vertical 82° |
| Neck Diameter | 20 mm |
| Face Shape | Spherical |
| Face Material | Filter-glass (Light transmission 52 % approx.) |
| Screen | Phosphor P 4 Aluminized |
| Fluorescence Colour | White |
| Colour Temperature | 12 000 °K (approx.) |
| Minimum Useful Dimensions | 257 x 195 mm<br>Diagonal 295 mm |
| Overall Length | 229 mm max. |
| Weight | 2,7 kg (approx.) |

Implosion protection by steel reinforcement. Admitted by Association of German Electrical Engineers, VDE.

### 2. Electrical Data

#### 2.1 Typical Operating Conditions ①

| | | | |
|---|---|---|---|
| $U_f$ ⑬ | | | 11,0 V |
| $I_f$ | | | approx. 74 mA |
| $U_{g3g5a}$ ㉞ | 13 | | 13 kV |
| $U_{g2}$ | 200 . . . 350 | ⑭ | 250 V |
| $U_{g4}$ ③ | 0 . . . 350 | | 0 . . . 350 V |
| $U_{k\ cutoff}$ ④ | 45 | | 32 . . . 58 V |

#### 2.2 Maximum Ratings ①

| | |
|---|---|
| $U_{g3g5a\ max}$ ⑤ ㉞ | 14 kV |
| $U_{g3g5a\ min}$ ⑥ ㉞ | 10 kV |
| $U_{g4\ max}$ | 450 V |
| $(-U_{g4})\ max$ | 50 V |
| $U_{g2\ max}$ | 350 V |
| $U_{g2\ min}$ | 200 V |
| $U_{k\ max}$ | 100 V |
| $U_{k\ min}$ ⑦ | 0 V |
| $U_{k\ p\ max}$ | 350 V |
| $R_{k/g1\ max}$ | 1,5 MΩ |
| $Z_{k/g1\ max}$ | 0,5 MΩ |
| $P_{lm\ max}$ | 10 mW/cm² |
| $U\pm_{f/k\ max}$ ⑧ | 110 V |
| $U\pm_{f/k\ p\ max}$ | 130 V |
| $R_{f/k\ max}$ ⑩ | 1,0 MΩ |
| $Z_{f/k\ max}$ ⑪ | 0,1 MΩ |

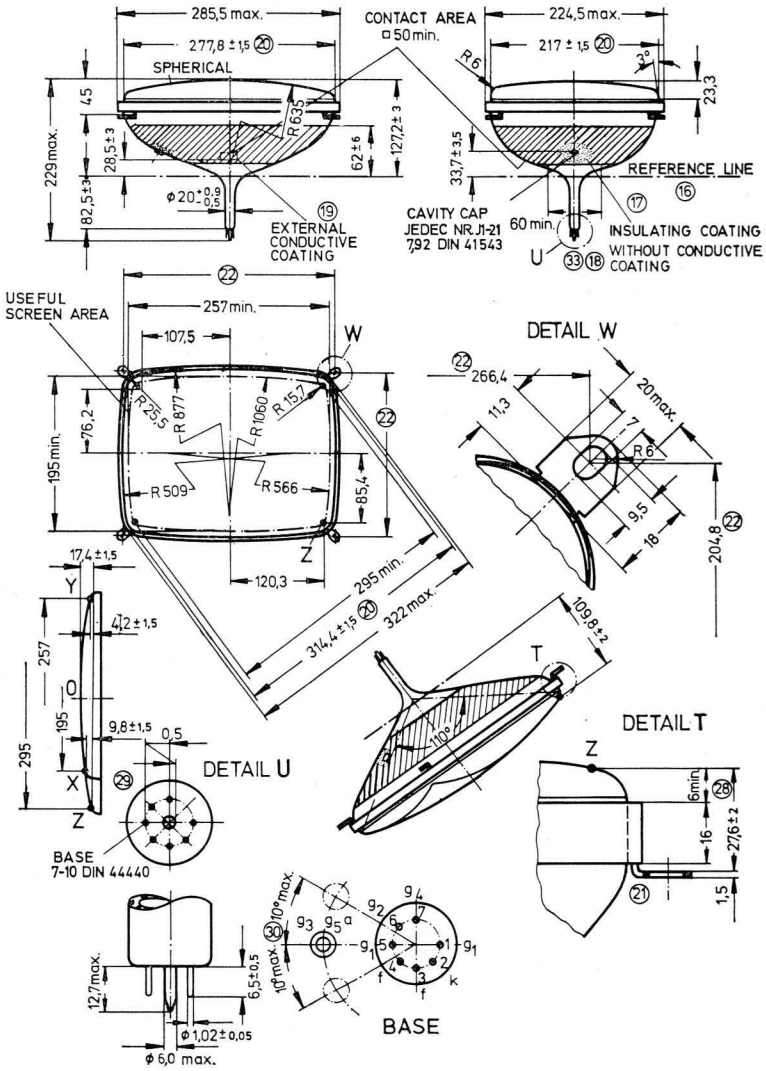
#### 2.3 Ratings for Circuit Design

| | |
|---|---|
| $I_{g2}$ | $\leqq \pm$ 5 µA |
| $I_{g4}$ | $\leqq \pm$ 25 µA |
| $r_{m/m'}$ | $\geqq$ 2 MΩ |

#### 2.4 Capacitances

| | |
|---|---|
| $c_{g1}$ (approx.) | 6 pF |
| $c_k$ (approx.) | 5 pF |
| $c_{g3g5a/m\ max}$ | 850 pF |
| $c_{g3g5a/m\ min}$ | 550 pF |
| $c_{g3g5a/m'\ max}$ | 200 pF |

### 3. **Dimensional Drawings** in mm



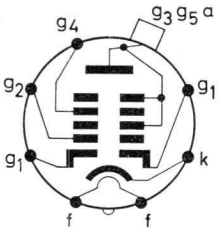

Reference line gauge see page 10

O Notes see page 8

# Black and White Picture Tubes

## A 44–13 W/3

**44 cm Rectangular TV Picture Tube with 110° deflection angle, electrostatic focusing, aluminized screen and steel reinforcement including tube mount**




### 1. Generalities

| | | |
|---|---|---|
| Electron Gun | | Tetrode with Einzel-Lens |
| Bulb | | All-glass Type |
| Base | | German Standard DIN 44431 (short design) JEDEC B 7–208 |
| Focusing Method | | Electrostatic |
| Deflection Method | | Magnetic |
| Deflection Angle | | Diagonal 110° |
| Face | Shape | Spherical |
| | Material | Filter-glass (Light transmission 53 % approx.) |
| Screen | | P 4 Aluminized |
| Fluorescence Colour | | White |
| Colour Temperature | | 12 000 °K (approx.) |
| Minimum Useful Dimensions | | 346 x 270 mm Diagonal 413 mm |
| Overall Length | | 293,2 ± 6,5 mm |
| Weight | | 5,6 kg (approx.) |

Implosion protection by steel reinforcement. Admitted by Association of German Electrical Engineers, VDE.

### 2. Electrical Data

#### 2.1 Typical Operating Conditions ①

| | | | |
|---|---|---|---|
| $U_f$ ② | | | 6,3 V |
| $I_f$ | | | 0,3 ± 6 % A |
| $U_{g3g5a}$ | | | 20 kV |
| $U_{g2}$ | 400 | | 500 V |
| $U_{g4}$ ③ | 0 . . . 400 | 0 . . . | 400 V |
| $U_{k\ cutoff}$ ④ | 36 . . . 66 | 45 . . . | 79 V |

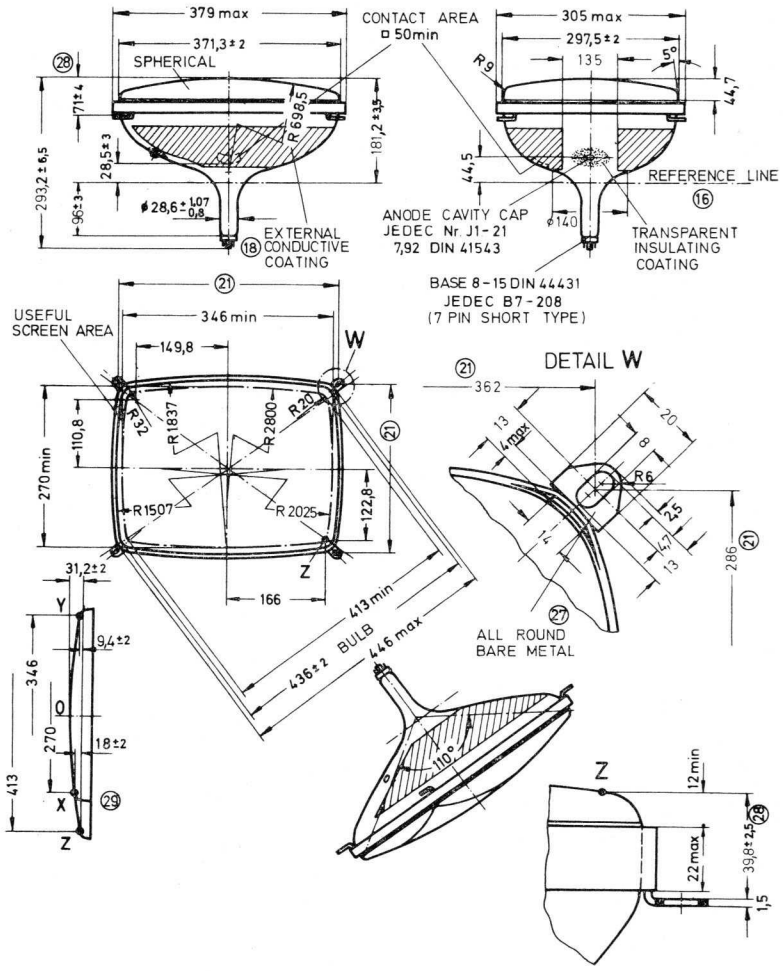
#### 2.2 Maximum Ratings

| | |
|---|---|
| $U_{g3g5a\ max}$ ⑤ | 20 kV |
| $U_{g3g5a\ min}$ ⑥ | 13 kV |
| $R_{g3g5a\ min}$ | 16 kΩ |
| $U_{g4\ max}$ | 1000 V |
| $(-U_{g4})_{max}$ | 500 V |
| $(\pm I_{g4})_{max}$ | 25 µA |
| $R_{g4\ min}$ | 470 Ω |
| $U_{g2\ max}$ | 550 V |
| $U_{g2\ min}$ | 350 V |
| $R_{g2\ min}$ | 470 Ω |
| $U_{k\ max}$ | 150 V |
| $U_{k\ min}$ | 0 V |
| $U_{k\ p\ max}$ ⑦ | 400 V |
| $(-U_k)_{p\ max}$ | 2 V |
| $R_{k/g\ 1\ max}$ | 1,5 MΩ |
| $Z_{k/g\ 1\ max}$ | 0,5 MΩ |
| $R_{g1\ min}$ | 150 Ω |
| $P_{lm\ max}$ | 10 mW/cm² |
| $U_{-f/k\ max}$ ⑧ ⑨ | 410 V |
| $U_{-f/k\ max}$ | 200 V |
| $U_{+f/k\ max}$ | 135 V |
| $R_{f/k\ max}$ ⑩ | 1,0 MΩ |
| $Z_{f/k\ max}$ ⑪ | 0,1 MΩ |

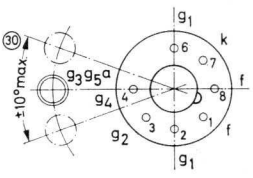
#### 2.3 Capacitances

| | |
|---|---|
| $c_{g1}$ (approx.) | 6 pF |
| $c_k$ (approx.) | 5 pF |
| $c_{g3g5a/m\ max}$ | 1200 pF |
| $c_{g3g5a/m\ min}$ | 800 pF |
| $c_{g3g5a/m'}$ (approx.) | 300 pF |

### 3. **Dimensional Drawings** in mm




BASE

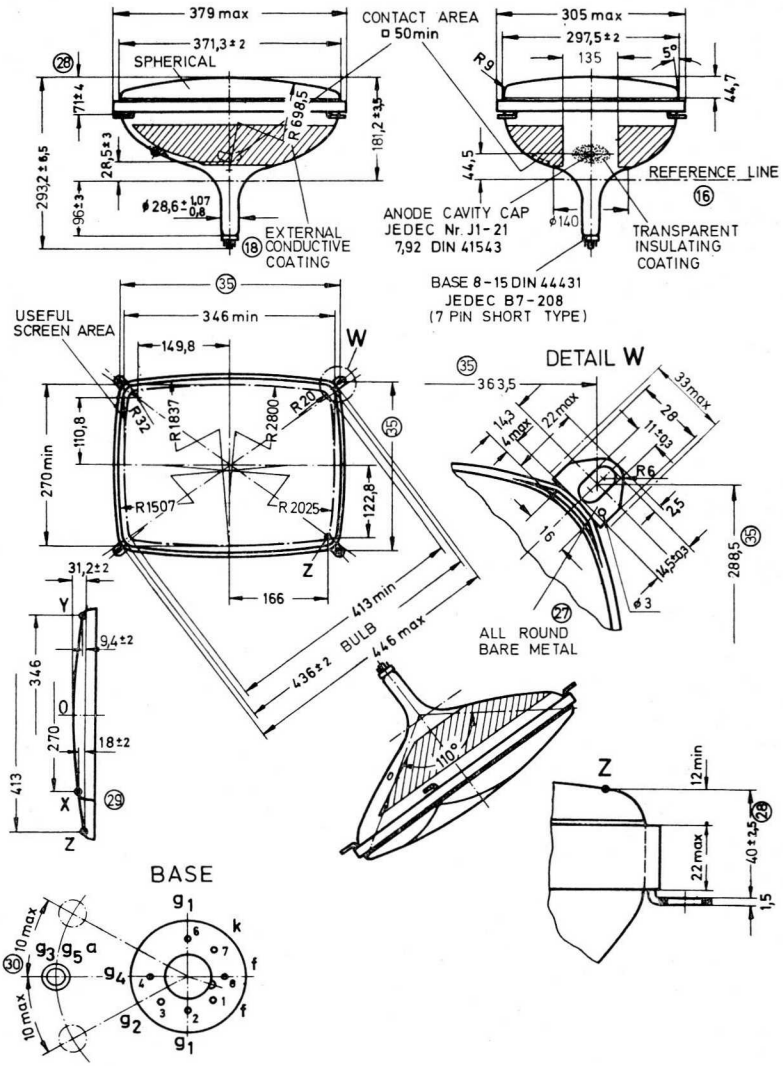



Reference line gauge see page 11

O Notes see page 8

# Black and White Picture Tubes

## 4. **Dimensional Drawings** in mm



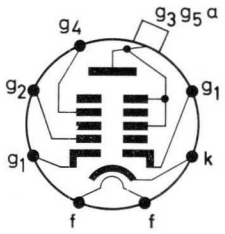

Reference line gauge see page 11

O Notes see page 8

# Black and White Picture Tubes

## A 44–280 W

**44 cm Rectangular TV Picture Tube with 110° deflection angle, electrostatic focusing, aluminized screen and steel reinforcement**




### 1. Generalities

| | |
|---|---|
| Electron Gun | Tetrode with Einzel-Lens |
| Bulb | All-glass Type |
| Base | Special Miniature (7 Pins) |
| Focusing Method | Electrostatic |
| Deflection Method | Magnetic |
| Deflection Angles (approx.) | Diagonal 110°<br>Horizontal 99°<br>Vertical 82° |
| Neck Diameter | 20 mm |
| Face Shape<br>Material | Spherical<br>Filter-glass (Light transmission 52 % approx.) |
| Screen | P4 Aluminized |
| Fluorescence Colour | White |
| Colour Temperature | 12 000 °K (approx.) |
| Minimum Useful Dimensions | 346 x 270 mm<br>Diagonal 413 mm |
| Overall Length | 284 mm |
| Weight | 5,6 kg (approx.) |

Implosion protection by steel reinforcement.

### 2. Electrical Data

#### 2.1 Typical Operating Conditions ①

| | | | |
|---|---|---|---|
| $U_f$ ⑬ | | | 11 V |
| $I_f$ | | approx. | 74 mA |
| $U_{g3g5a}$ ㉞ | 13 | | 13 kV |
| $U_{g2}$ | 200 . . . 350 | ⑭ | 250 V |
| $U_{g4}$ ③ | 0 . . . 350 | 0 . . . | 350 V |
| $U_{k\ cutoff}$ | 45 | 32 . . . | 58 V |

#### 2.2 Maximum Ratings

| | |
|---|---|
| $U_{g3g5a\ max}$ ㉞ | 14 kV |
| $U_{g3g5a\ min}$ ⑥ ㉞ | 10 kV |
| $U_{g4\ max}$ | 450 V |
| $(-U_{g4})_{max}$ | 50 V |
| $U_{g2\ max}$ | 350 V |
| $U_{g2\ min}$ | 200 V |
| $U_{k\ max}$ | 100 V |
| $U_{k\ min}$ | 0 V |
| $U_{k\ p\ max}$ ⑦ | 350 V |
| $R_{k/g1\ max}$ | 1,5 MΩ |
| $Z_{k/g1\ max}$ | 0,5 MΩ |
| $U\pm_{f/k\ max}$ ⑧ | 110 V |
| $U\pm_{f/k\ p\ max}$ | 130 V |
| $R_{f/k\ max}$ ⑩ | 1 MΩ |
| $Z_{f/k\ max}$ ⑪ | 0,1 MΩ |

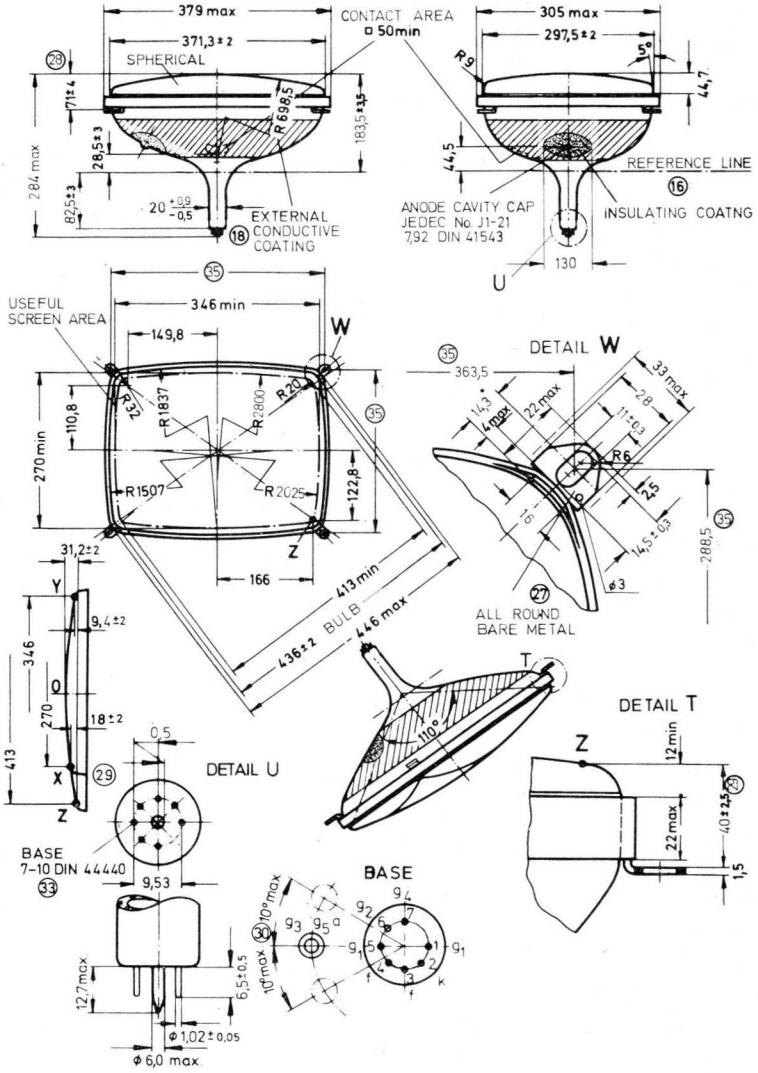
#### 2.3 Ratings for Circuit Design

| | | | |
|---|---|---|---|
| $I_{g2}$ | ≦ | ± | 5 µA |
| $I_{g4}$ | ≦ | ± | 25 µA |
| $r_{m/m'}$ | ≧ | | 2 MΩ |

#### 2.4 Capacitances

| | |
|---|---|
| $c_{g1}$ (approx.) | 6 pF |
| $c_k$ (approx.) | 5 pF |
| $c_{g3g5a\ max}$ | 1500 pF |
| $c_{g3g5a\ min}$ | 1000 pF |
| $c_{g3g5a/m'\ max}$ | 550 pF |

### 3. **Dimensional Drawings** in mm



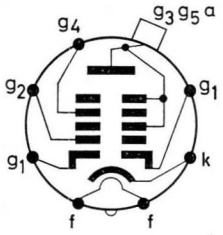

Reference line gauge see page 10

O Notes see page 8

# Black and White Picture Tubes

## A 51–10 W

**51 cm Rectangular TV Picture Tube with 110° deflection angle, electrostatic focusing, aluminized screen and steel reinforcement including tube mount**




### 1. Generalities

| | | |
|---|---|---|
| Electron Gun | | Tetrode with Einzel-Lens |
| Bulb | | All-glass Type |
| Base | | German Standard DIN 44431 (short design) |
| Focusing Method | | Electrostatic |
| Deflection Method | | Magnetic |
| Deflection Angles | | Diagonal 110°<br>Horizontal 99°<br>Vertical 82° |
| Face | Shape | Spherical |
| | Material | Filter-glass (Light transmission 49 % approx.) |
| Screen | | Phosphor P 4 Aluminized |
| Fluorescence Colour | | White |
| Colour Temperature | | 12 000 °K (approx.) |
| Minimum Useful Dimensions | | 394 x 308 mm<br>Diagonal 473 mm |
| Overall Length | | 321,5 ± 6,5 mm |
| Weight | | 10 kg (approx.) |

Implosion protection by steel reinforcement. Admitted by Association of German Electrical Engineers, VDE.

### 2. Electrical Data

#### 2.1 Typical Operating Conditions

| | | |
|---|---|---|
| $U_f$ ② | | 6,3 V |
| $I_f$ | | 0,3 ± 6% A |
| a) Grid drive service | | |
| $U_{g3g5a}$ | | 20 kV |
| $U_{g2}$ | 400 | 500 V |
| $U_{g4}$ ③ | 0 . . . 400 | 0 . . . 400 V |
| $(-U_{g1})$ cutoff ④ | 40 . . . 77 | 50 . . . 93 V |
| b) Cathode drive service | | |
| $U_{g3g5a}$ | | 20 kV |
| $U_{g2}$ | 400 | 500 V |
| $U_{g4}$ ③ | 0 . . . 400 | 0 . . . 400 V |
| $U_{k\ cutoff}$ ④ | 36 . . . 66 | 45 . . . 79 V |

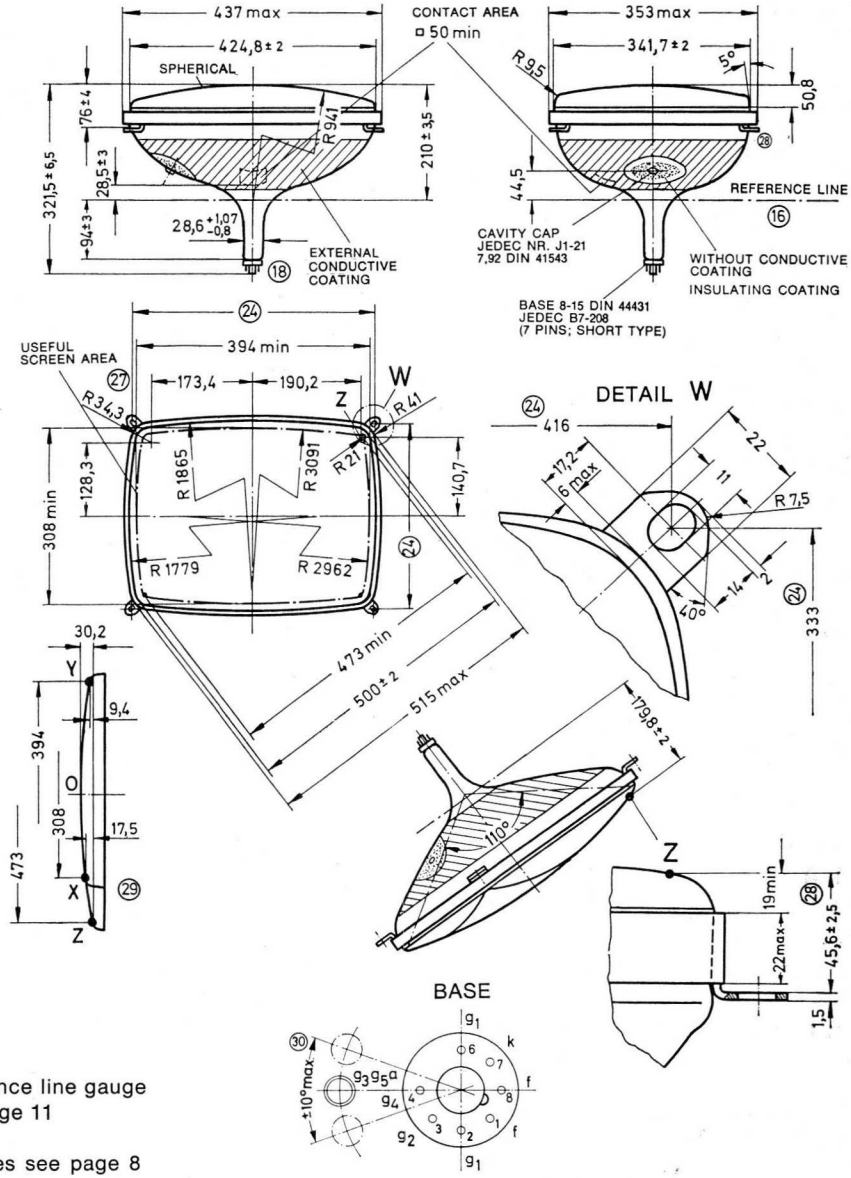
#### 2.2 Maximum Ratings

| | |
|---|---|
| $U_{g3g5a\ max}$ ⑤ | 20 kV |
| $U_{g3g5a\ min}$ ⑥ | 13 kV |
| $R_{g3g5a\ min}$ | 16 kΩ |
| $U_{g4\ max}$ | 1000 V |
| $(-U_{g4})_{\ max}$ ⑫ | 500 V |
| $(\pm I_{g4})_{\ max}$ | 25 µA |
| $R_{g4\ min}$ | 470 Ω |
| $U_{g2\ max}$ | 550 V |
| $U_{g2\ min}$ | 350 V |
| $R_{g2\ min}$ | 470 Ω |
| $U_{g1\ max}$ | 0 V |
| $(-U_{g1})_{\ max}$ | 150 V |
| $U_{g1\ p\ max}$ | 2 V |
| $(-U_{g1})_{\ p\ max}$ | 400 V |
| $R_{g1\ max}$ | 1,5 MΩ |
| $Z_{g1\ max}$ | 0,5 MΩ |
| $R_{g1\ min}$ | 150 Ω |
| $P_{lm\ max}$ | 10 mW/cm² |
| $U_{-f/k\ max}$ ⑧ ⑨ | 410 V |
| $U_{-f/k\ max}$ | 250 V |
| $U_{-f/k\ p\ max}$ | 300 V |
| $U_{+f/k\ max}$ | 135 V |
| $R_{f/k\ max}$ ⑩ | 1,0 MΩ |
| $Z_{f/k\ max}$ ⑪ | 0,1 MΩ |

#### 2.3 Capacitances

| | |
|---|---|
| $c_{g1}$ (approx.) | 6 pF |
| $c_k$ (approx.) | 5 pF |
| $c_{g3g5a/m\ min}$ | 1400 pF |
| $c_{g3g5a/m\ max}$ | 2100 pF |
| $c_{g3g5a/m'}$ (approx.) | 390 pF |

### 3. **Dimensional Drawings** in mm



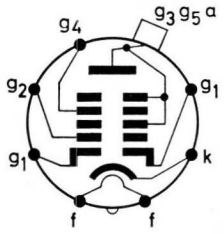

Reference line gauge
see page 11

O Notes see page 8

# Black and White Picture Tubes

## A 59–22 W

**59 cm Rectangular TV Picture Tube with 110° deflection angle, electrostatic focusing, aluminized screen and steel reinforcement including tube mount**




### 1. Generalities

| | |
|---|---|
| Electron Gun | Tetrode with Einzel-Lens |
| Bulb | All-glass Type |
| Base | German Standard DIN 44431 (short design) |
| Focusing Method | Electrostatic |
| Deflection Method | Magnetic |
| Deflection Angles | Diagonal 110°<br>Horizontal 99°<br>Vertical 82° |
| Face Shape | Spherical |
| Face Material | Filter-glass (Light transmission 44 % approx.) |
| Screen | Phosphor P 4 Aluminized |
| Fluorescence Colour | White |
| Colour Temperature | 12 000 °K (approx.) |
| Minimum Useful Dimensions | 489 x 385 mm<br>Diagonal 566 mm |
| Overall Length | 360 ± 8 mm |
| Weight | 13 kg (approx.) |

Implosion protection by steel reinforcement. Admitted by Association of German Electrical Engineers, VDE.

### 2. Electrical Data

#### 2.1 Typical Operating Conditions

| | | |
|---|---|---|
| $U_f$ ② | | 6,3 V |
| $I_f$ | | 0,3 ± 6% A |
| a) Grid drive service | | |
| $U_{g3g5a}$ | | 20 kV |
| $U_{g2}$ | 400 | 500 V |
| $U_{g4}$ ③ | 0 ... 400 | 0 ... 400 V |
| $(-U_{g1})$ cutoff ④ | 40 ... 77 | 50 ... 93 V |
| b) Cathode drive service | | |
| $U_{g3g5a}$ | | 20 kV |
| $U_{g2}$ | 400 | 500 V |
| $U_{g4}$ ③ | 0 ... 400 | 0 ... 400 V |
| $U_k$ cutoff ④ | 36 ... 66 | 45 ... 79 V |

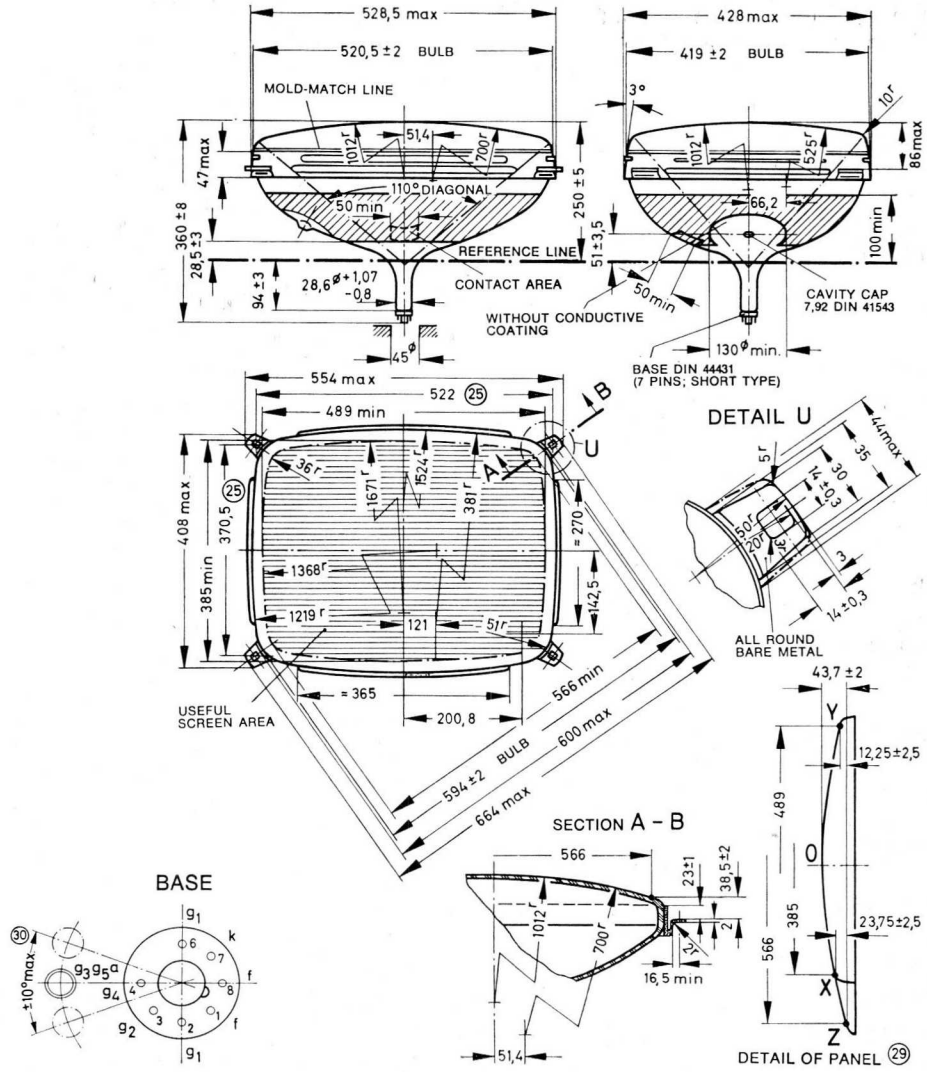
#### 2.2 Maximum Ratings

| | |
|---|---|
| $U_{g3g5a\ max}$ ⑤ | 20 kV |
| $U_{g3g5a\ min}$ ⑥ | 13 kV |
| $R_{g3g5a\ min}$ | 16 kΩ |
| $U_{g4\ max}$ | 1000 V |
| $(-U_{g4})_{max}$ | 500 V |
| $U_{g4\ p\ max}$ ⑦ | 2500 V |
| $R_{g4\ min}$ | 470 Ω |
| $U_{g2\ max}$ | 550 V |
| $U_{g2\ min}$ | 350 V |
| $R_{g2\ min}$ | 470 Ω |
| $U_{g1\ max}$ | 0 V |
| $(-U_{g1})_{max}$ | 150 V |
| $U_{g1\ p\ max}$ | 2 V |
| $(-U_{g1})_{p\ max}$ ⑦ | 400 V |
| $R_{g1\ max}$ | 1,5 MΩ |
| $Z_{g1\ max}$ | 0,5 MΩ |
| $R_{g1\ min}$ | 150 Ω |
| $P_{lm\ max}$ | 10 mW/cm² |
| $U_{-f/k\ max}$ ⑧ ⑨ | 410 V |
| $U_{-f/k\ max}$ | 250 V |
| $U_{-f/k\ p\ max}$ | 300 V |
| $U_{+f/k\ max}$ | 135 V |
| $U_{+f/k\ p\ max}$ | 180 V |
| $R_{f/k\ max}$ ⑩ | 1,0 MΩ |
| $Z_{f/k\ max}$ ⑪ | 0,1 MΩ |

#### 2.3 Capacitances

| | |
|---|---|
| $c_{g1}$ (approx.) | 6 pF |
| $c_k$ (approx.) | 5 pF |
| $c_{g3g5a/m\ max}$ | 2600 pF |
| $c_{g3g5a/m\ min}$ | 1700 pF |
| $c_{g3g5a/m'\ max}$ | 580 pF |
| $c_{g3g5a/m'\ min}$ | 380 pF |

### 3. **Dimensional Drawings** in mm



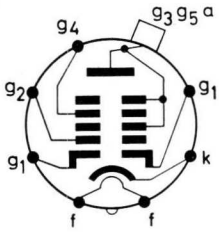

Reference line gauge see page 11

O Notes see page 8

# Black and White Picture Tubes

## A 61–120 W/2

**61 cm Rectangular TV Picture Tube with 110° deflection angle, electrostatic focusing, aluminized screen and steel-reinforcement including tube mount**




### 1. Generalities

| | | |
|---|---|---|
| Electron Gun | | Tetrode with Einzel-Lens |
| Bulb | | All-glass Type |
| Base | | German Standard DIN 44431 (short design) |
| Focusing Method | | Electrostatic |
| Deflection Method | | Magnetic |
| Deflection Angles | | Diagonal 110°<br>Horizontal 99°<br>Vertical 82° |
| Face | Shape | Spherical |
| | Material | Filter-glass (Light transmission 44 % approx.) |
| Screen | | Phosphor P 4 Aluminized |
| Fluorescence Colour | | White |
| Colour Temperature | | 12 000 °K (approx.) |
| Minimum Useful Dimensions | | 481 x 375 mm<br>Diagonal 577,5 mm |
| Overall Length | | 362 ± 8 mm |
| Weight | | 13 kg (approx.) |

Implosion protection by steel reinforcement. Admitted by Association of German Electrical Engineers, VDE.

### 2. Electrical Data

#### 2.1 Typical Operating Conditions

| | | |
|---|---|---|
| $U_f$ ② | | 6,3 V |
| $I_f$ | | 0,3 ± 6% A |
| a) Grid drive service | | |
| $U_{g3g5a}$ | | 20 kV |
| $U_{g2}$ | 400 | 500 V |
| $U_{g4}$ ③ | 0 ... 400 | 0 ... 400 V |
| $(-U_{g1})$ cutoff ④ | 40 ... 77 | 50 ... 93 V |
| b) Cathode drive service | | |
| $U_{g3g5a}$ | | 20 kV |
| $U_{g2}$ | 400 | 500 V |
| $U_{g4}$ ③ | 0 ... 400 | 0 ... 400 V |
| $U_{k\ cutoff}$ ④ | 36 ... 66 | 45 ... 79 V |

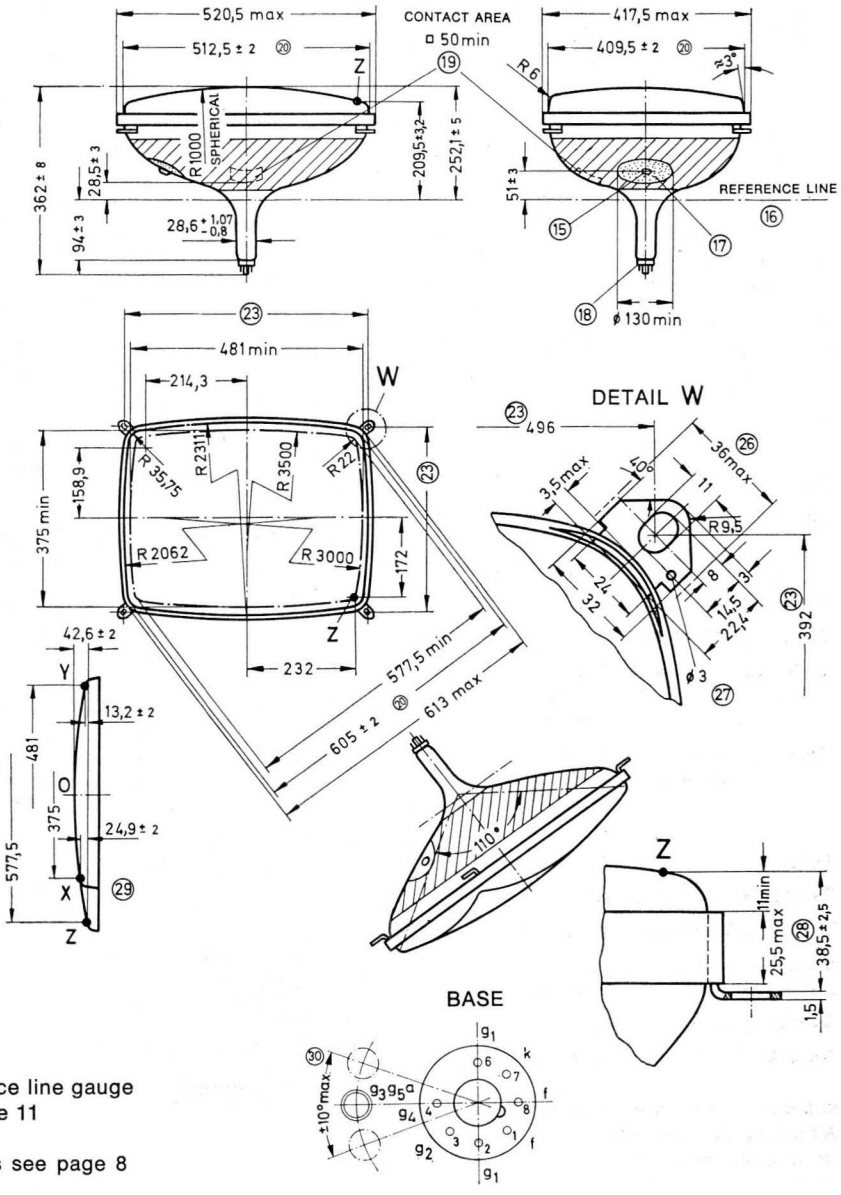
#### 2.2 Maximum Ratings

| | |
|---|---|
| $U_{g3g5a\ max}$ ⑤ | 20 kV |
| $U_{g3g5a\ min}$ ⑥ | 13 kV |
| $R_{g3g5a\ min}$ | 16 kV |
| $U_{g4\ max}$ | 1000 V |
| $U_{g4\ p\ max}$ ⑦ | 2500 V |
| $(-U_{g4})_{max}$ | 500 V |
| $R_{g4\ min}$ | 470 Ω |
| $U_{g2\ max}$ | 550 V |
| $U_{g2\ min}$ | 350 V |
| $R_{g2\ min}$ | 470 Ω |
| $U_{g1\ max}$ | 0 V |
| $(-U_{g1})_{max}$ | 150 V |
| $U_{g1\ p\ max}$ | 2 V |
| $(-U_{g1})_{p\ max}$ ⑦ | 400 V |
| $R_{g1\ max}$ | 1,5 MΩ |
| $Z_{g1\ max}$ | 0,5 MΩ |
| $R_{g1\ min}$ | 150 Ω |
| $P_{lm\ max}$ | 10 mW/cm² |
| $U_{-f/k\ max}$ ⑧ ⑨ | 410 V |
| $U_{-f/k\ max}$ | 250 V |
| $U_{-f/k\ p\ max}$ | 300 V |
| $U_{+f/k\ max}$ | 135 V |
| $U_{+f/k\ p\ max}$ | 180 V |
| $R_{f/k\ max}$ ⑩ | 1,0 MΩ |
| $Z_{f/k\ max}$ ⑪ | 0,1 MΩ |

#### 2.3 Capacitances

| | |
|---|---|
| $c_{g1}$ (approx.) | 6 pF |
| $c_k$ (approx.) | 5 pF |
| $c_{g3g5a/m\ max}$ | 2600 pF |
| $c_{g3g5a/m\ min}$ | 1700 pF |
| $c_{g3g5a/m'\ max}$ | 580 pF |
| $c_{g3g5a/m'\ min}$ | 380 pF |

### 3. **Dimensional Drawings** in mm



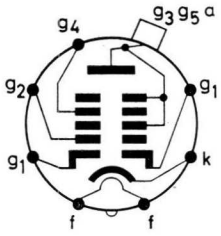

Reference line gauge
see page 11

O Notes see page 8

# Black and White Picture Tubes

## A 65–13 W

**65 cm Rectangular TV Picture Tube with 110° deflection angle, electrostatic focusing, aluminized screen and steel jacket including tube mount**




### 1. Generalities

| | | |
|---|---|---|
| Electron Gun | | Tetrode with Einzel-Lens |
| Bulb | | All-glass Type |
| Base | | German Standard DIN 44431 (short design) |
| Focusing Method | | Electrostatic |
| Deflection Method | | Magnetic |
| Deflection Angles | | Diagonal 110°<br>Horizontal 99°<br>Vertical 82° |
| Face | Shape | Spherical |
| | Material | Filter-glass (Light transmission 40 % approx.) |
| Screen | | P 4 Aluminized |
| Fluorescence Colour | | White |
| Colour Temperature | | 12 000 °K (approx.) |
| Minimum Useful Dimensions | | 530 x 416 mm<br>Diagonal 616,5 mm |
| Overall Length | | 383 ± 8 mm |
| Weight | | 18 kg (approx.) |

Implosion protection by steel reinforcement. Admitted by Association of German Electrical Engineers, VDE.

### 2. Electrical Data

#### 2.1 Typical Operating Conditions

| | | |
|---|---|---|
| $U_f$ ② | | 6,3 V |
| $I_f$ | | 0,3 ± 6 % A |
| $U_{g3g5a}$ | | 20 kV |
| $U_{g2}$ | 400 | 500 V |
| $U_{g4}$ ③ | 0 . . . 400 | 0 . . . 400 V |
| $(-U_{g1})$ cutoff ④ | 40 . . . 77 | 50 . . . 93 V |

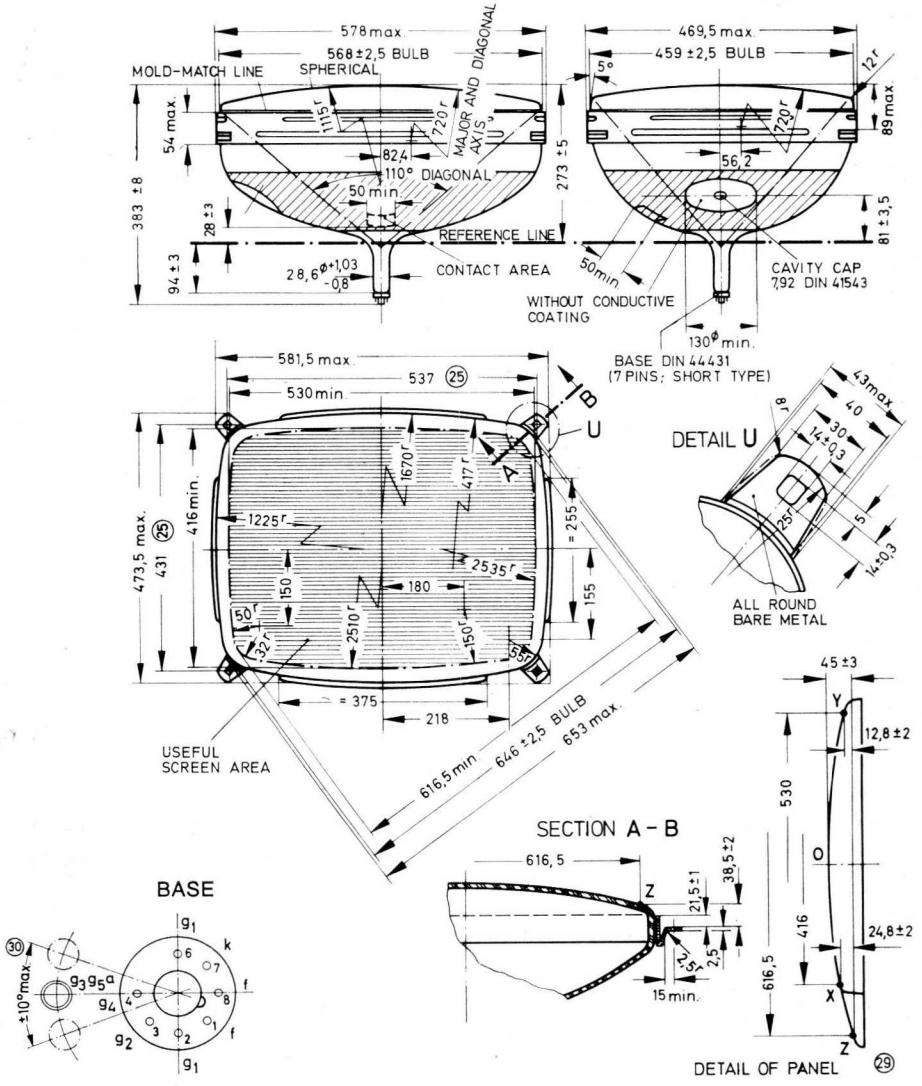
#### 2.2 Maximum Ratings

| | |
|---|---|
| $U_{g3g5a\ max}$ ⑤ | 20 kV |
| $U_{g3g5a\ min}$ ⑥ | 13 kV |
| $R_{g3g5a\ min}$ | 16 kΩ |
| $U_{g4\ max}$ | 1000 V |
| $(-U_{g4})_{max}$ | 500 V |
| $U_{g4\ p\ max}$ ⑦ | 2500 V |
| $(\pm I_{g4})_{max}$ | 25 µA |
| $R_{g4\ min}$ | 470 Ω |
| $U_{g2\ max}$ | 500 V |
| $U_{g2\ min}$ | 350 V |
| $R_{g2\ min}$ | 470 Ω |
| $U_{g1\ max}$ | 0 V |
| $(-U_{g1})_{max}$ | 150 V |
| $U_{g1\ p\ max}$ | 2 V |
| $(-U_{g1})_{p\ max}$ ⑦ | 400 V |
| $R_{g1\ max}$ | 1,5 MΩ |
| $Z_{g1\ max}$ | 0,5 MΩ |
| $R_{g1\ min}$ | 150 Ω |
| $P_{lm\ max}$ | 10 mW/cm² |
| $U_{-f/k\ max}$ ⑧ ⑨ | 410 V |
| $U_{-f/k\ max}$ | 250 V |
| $U_{-f/k\ p\ max}$ | 300 V |
| $U_{+f/k\ max}$ | 135 V |
| $U_{+f/k\ p\ max}$ | 180 V |
| $R_{f/k\ max}$ ⑩ | 1,0 MΩ |
| $Z_{f/k\ max}$ ⑪ | 0,1 MΩ |

#### 2.3 Capacitances

| | |
|---|---|
| $c_{g1}$ (approx.) | 6 pF |
| $c_k$ (approx.) | 5 pF |
| $c_{g3g5a/m\ max}$ | 2900 pF |
| $c_{g3g5a/m\ min}$ | 1900 pF |
| $c_{g3g5a/m'}$ (approx.) | 600 pF |

### 3. **Dimensional Drawings** in mm




Reference line gauge see page 11

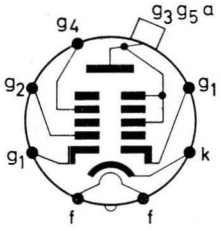
O Notes see page 8

# Black and White Picture Tubes

## A 41–10 W

**For Replacement**

**41 cm Rectangular TV Picture Tube with 110° deflection angle, electrostatic focusing, aluminized screen and steel jacket including tube mount**




### 1. Generalities

| | |
|---|---|
| Electron Gun | Tetrode with Einzel-Lens |
| Bulb | All-glass Type |
| Base | German Standard DIN 44431 (short design) |
| Focusing Method | Electrostatic |
| Deflection Method | Magnetic |
| Deflection Angles | Diagonal 110°<br>Horizontal 99°<br>Vertical 82° |
| Face Shape<br>Material | Spherical<br>Filter-glass (Light transmission 63 % approx.) |
| Screen | Phosphor P 4 Aluminized |
| Fluorescence Colour | White |
| Colour Temperature | 12 000 °K (approx.) |
| Minimum Useful Dimensions | 322 x 254 mm<br>Diagonal 372 mm |
| Overall Length | 273 ± 7 mm |
| Weight | 4,2 kg (approx.) |

Implosion protection by steel reinforcement. Admitted by Association of German Electrical Engineers, VDE.

### 2. Electrical Data

#### 2.1 Typical Operating Conditions

| | | |
|---|---|---|
| $U_f$ ② | | 6,3 V |
| $I_f$ | | 0,3 ± 6% A |
| a) Grid drive service | | |
| $U_{g3g5a}$ | | 18 kV |
| $U_{g2}$ | | 400 V |
| $U_{g4}$ ③ | 0 ... | 400 V |
| $(-U_{g1})$ cutoff ④ | 40 ... | 77 V |
| b) Cathode drive service | | |
| $U_{g3g5a}$ | | 18 kV |
| $U_{g2}$ | | 400 V |
| $U_{g4}$ ③ | 0 ... | 400 V |
| $U_{k\ cutoff}$ ④ | 30 ... | 66 V |

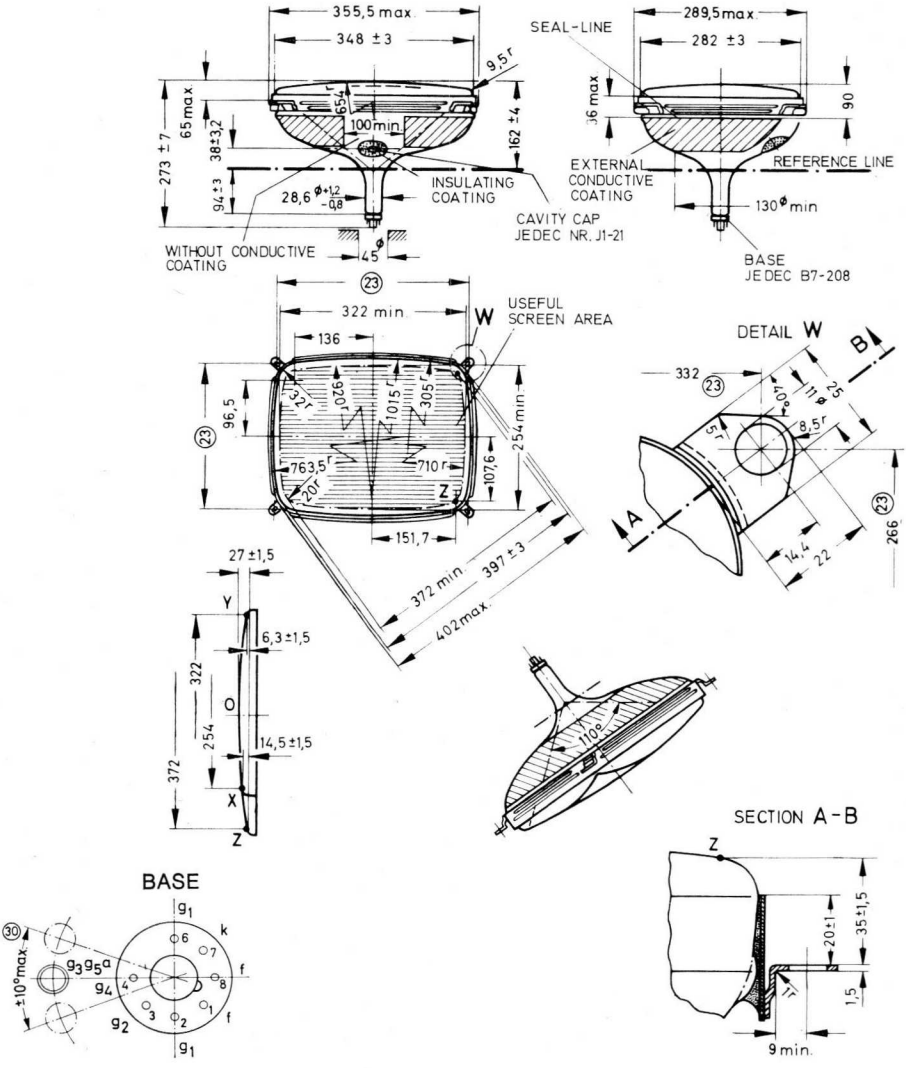
#### 2.2 Maximum Ratings

| | |
|---|---|
| $U_{g3g5a\ max}$ ⑤ | 18 kV |
| $U_{g3g5a\ min}$ ⑥ | 13 kV |
| $U_{g4\ max}$ | 1000 V |
| $(-U_{g4})_{max}$ | 500 V |
| $(\pm I_{g4})_{max}$ | 25 µA |
| $U_{g2\ max}$ | 550 V |
| $U_{g2\ min}$ | 200 V |
| $U_{g1\ max}$ | 0 V |
| $(-U_{g1})_{max}$ ⑦ | 150 V |
| $U_{g1\ p\ max}$ | 2 V |
| $R_{g1\ max}$ | 1,5 MΩ |
| $Z_{g1\ max}$ | 0,5 MΩ |
| $P_{lm\ max}$ | 10 mW/cm² |
| $U_{-f/k\ max}$ ⑧ ⑨ | 410 V |
| $U_{-f/k\ max}$ | 200 V |
| $U_{+f/k\ max}$ | 135 V |
| $R_{f/k\ max}$ ⑩ | 1,0 MΩ |
| $Z_{f/k\ max}$ ⑪ | 0,1 MΩ |

#### 2.3 Capacitances

| | |
|---|---|
| $c_{g1}$ (approx.) | 6 pF |
| $c_k$ (approx.) | 5 pF |
| $c_{g3g5a/m\ max}$ | 1500 pF |
| $c_{g3g5a/m\ min}$ | 800 pF |

## 3. **Dimensional Drawings** in mm





Reference line gauge see page 11

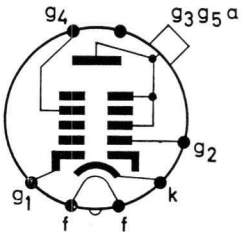
O Notes see page 8

# Black and White Picture Tubes

## A 47–27 W/2

**For Replacement**

**47 cm Rectangular TV Picture Tube with 110° deflection angle, electrostatic focusing, aluminized screen and steel-reinforcement including tube mount**




### 1. Generalities

| | |
|---|---|
| Electron Gun | Tetrode with Einzel-Lens |
| Bulb | All-glass Type |
| Base | German Standard DIN 44431 (short design) |
| Focusing Method | Electrostatic |
| Deflection Method | Magnetic |
| Deflection Angles | Diagonal 110°<br>Horizontal 99°<br>Vertical 82° |
| Face Shape<br>Material | Spherical<br>Filter-glass (Light transmission 49 % approx.) |
| Screen | Phosphor P 4 Aluminized |
| Fluorescence Colour | White |
| Colour Temperature | 12 000 °K (approx.) |
| Minimum Useful Dimensions | 384 x 305 mm<br>Diagonal 446 mm |
| Overall Length | 302,5 ± 6,5 mm |
| Weight | 8 kg (approx.) |

Implosion protection by steel reinforcement.

### 2. Electrical Data

#### 2.1 Typical Operating Conditions

| | | |
|---|---|---|
| $U_f$ ② | | 6,3 V |
| $I_f$ | | 0,3 ± 6% A |
| a) Grid drive service | | |
| $U_{g3g5a}$ | | 20 kV |
| $U_{g2}$ | 400 | 500 V |
| $U_{g4}$ ③ | 0 . . 400 | 0 . . . 400 V |
| $(-U_{g1})$ cutoff ④ | 40 . . . 77 | 50 . . . 93 V |
| b) Cathode drive service | | |
| $U_{g3g5a}$ | | 20 kV |
| $U_{g2}$ | 400 | 500 V |
| $U_{g4}$ ③ | 0 . . . 400 | 0 . . . 400 V |
| $U_{k\ cutoff}$ ④ | 36 . . . 66 | 45 . . . 79 V |

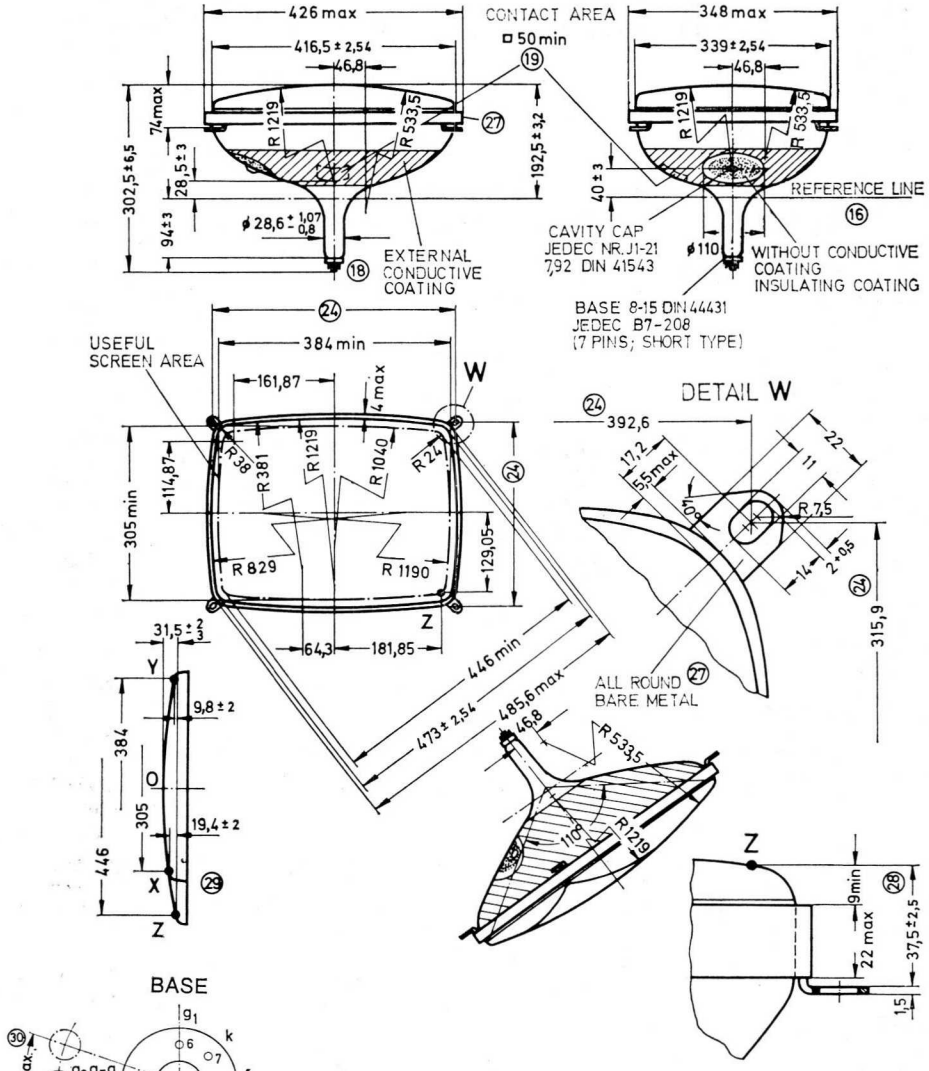
#### 2.2 Maximum Ratings

| | |
|---|---|
| $U_{g3g5a\ max}$ ⑤ | 20 kV |
| $U_{g3g5a\ min}$ ⑥ | 13 kV |
| $R_{g3g5a\ min}$ | 16 kΩ |
| $U_{g4\ max}$ | 1000 V |
| $(-U_{g4})_{max}$ | 500 V |
| $R_{g4\ min}$ | 470 Ω |
| $U_{g2\ max}$ | 550 V |
| $U_{g2\ min}$ | 350 V |
| $R_{g2\ min}$ | 470 Ω |
| $U_{g1\ max}$ | 0 V |
| $(-U_{g1})_{max}$ | 150 V |
| $U_{g1\ p\ max}$ | 2 V |
| $(-U_{g1})_{p\ max}$ | 400 V |
| $R_{g1\ max}$ | 1,5 MΩ |
| $Z_{g1\ max}$ | 0,5 MΩ |
| $R_{g1\ min}$ | 150 Ω |
| $P_{lm\ max}$ | 10 mW/cm² |
| $U_{-f/k\ max}$ ⑧ ⑨ | 410 V |
| $U_{-f/k\ max}$ | 200 V |
| $U_{-f/k\ p\ max}$ | 300 V |
| $U_{+f/k\ max}$ | 135 V |
| $R_{f/k\ max}$ ⑩ | 1,0 MΩ |
| $Z_{f/k\ max}$ ⑪ | 0,1 MΩ |

#### 2.3 Capacitances

| | |
|---|---|
| $c_{g1}$ (approx.) | 6 pF |
| $c_k$ (approx.) | 5 pF |
| $c_{g3g5a/m\ max}$ | 1500 pF |
| $c_{g3g5a/m\ min}$ | 1000 pF |
| $c_{g3g5a/m'}$ (approx.) | 350 pF |

## 3. Dimensional Drawings in mm





Reference line gauge see page 11

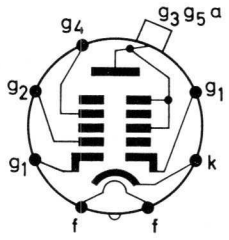
O Notes see page 8

# Black and White Picture Tubes

## AW 59–91

**For Replacement**

**59 cm Rectangular TV Picture Tube with 110° deflection angle, electrostatic focusing and aluminized screen.**




### 1. Generalities

| | | |
|---|---|---|
| Electron Gun | | Tetrode with Einzel-Lens |
| Base | | German Standard DIN 44431 (short design) |
| Focusing Method | | Electrostatic |
| Deflection Method | | Magnetic |
| Deflection Angles | | Diagonal 110°<br>Horizontal 99°<br>Vertical 82° |
| Face | Shape | Spherical |
| | Material | Filter-glass (Light transmission 75 % approx.) |
| Screen | | Aluminized |
| Fluorescence Colour | | White |
| Colour Temperature | | 12 000 °K (approx.) |
| Minimum Useful Dimensions | | 489 x 385 mm<br>Diagonal 566 mm |
| Overall Length | | 358 ± 8 mm |
| Weight | | 12 kg (approx.) |

### 2. Electrical Data

#### 2.1 Typical Operating Conditions

| | | | |
|---|---|---|---|
| $U_f$ ② | | | 6,3 V |
| $I_f$ | | | 0,3 ± 6 % A |
| $U_{g3g5a}$ | | | 20 kV |
| $U_{g2}$ | 400 | | 500 V |
| $U_{g4}$ ③ | 0 . . . 400 | 0 . . . | 400 V |
| $(-U_{g1})$ cutoff ④ | 40 . . . 77 | 50 . . . | 93 V |

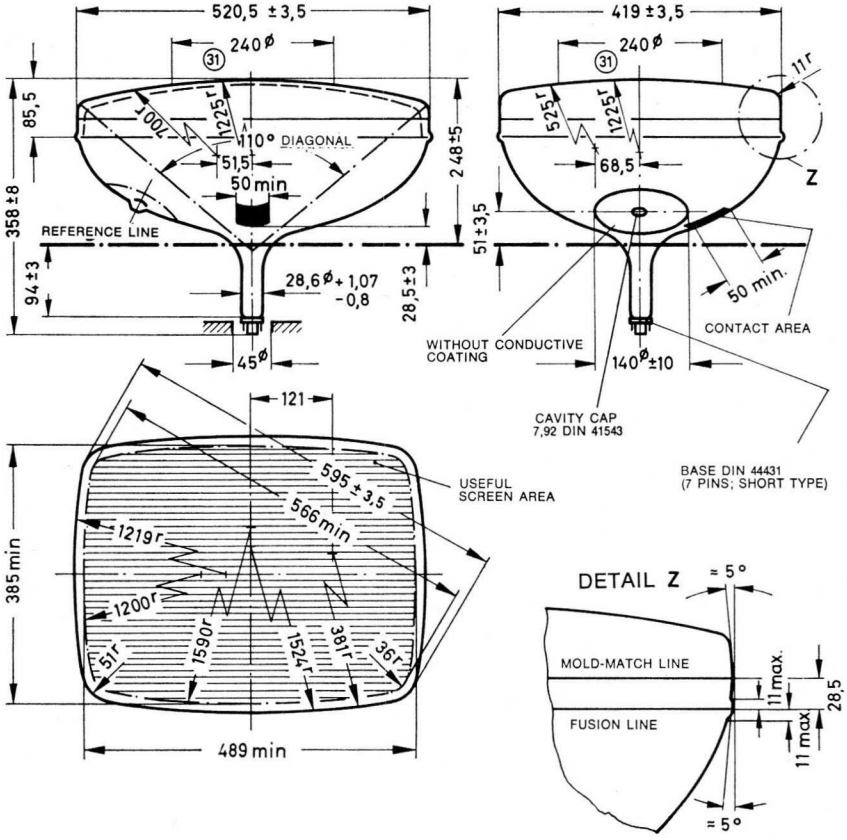
#### 2.2 Maximum Ratings

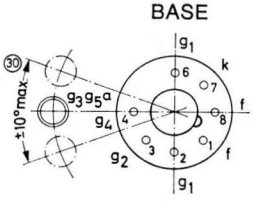
| | |
|---|---|
| $U_{g3g5a\ max}$ ⑤ | 20 kV |
| $U_{g3g5a\ min}$ ⑥ | 13 kV |
| $R_{g3g5a\ min}$ | 16 kΩ |
| $U_{g4\ max}$ | 1000 V |
| $(-U_{g4})_{max}$ | 500 V |
| $U_{g4\ p\ max}$ ⑦ | 2500 V |
| $R_{g4\ min}$ | 470 Ω |
| $U_{g2\ max}$ | 550 V |
| $U_{g2\ min}$ | 350 V |
| $R_{g2\ min}$ | 470 Ω |
| $U_{g1\ max}$ | 0 V |
| $(-U_{g1})_{max}$ | 150 V |
| $U_{g1\ p\ max}$ | 2 V |
| $(-U_{g1})_{p\ max}$ ⑦ | 400 V |
| $R_{g1\ max}$ | 1,5 MΩ |
| $Z_{g1\ max}$ | 0,5 MΩ |
| $R_{g1\ min}$ | 150 Ω |
| $P_{lm\ max}$ | 10 mW/cm² |
| $U_{-f/k\ max}$ ⑧ ⑨ | 410 V |
| $U_{-f/k\ max}$ | 200 V |
| $U_{-f/k\ p\ max}$ | 300 V |
| $U_{+f/k\ max}$ | 125 V |
| $U_{+f/k\ p\ max}$ | 180 V |
| $R_{f/k\ max}$ ⑩ | 1,0 MΩ |
| $Z_{f/k\ max}$ ⑪ | 0,1 MΩ |

#### 2.3 Capacitances

| | |
|---|---|
| $c_{g1}$ (approx.) | 6 pF |
| $c_k$ (approx.) | 5 pF |
| $c_{g3g5a/m\ min}$ | 1500 pF |
| $c_{g3g5a/m\ max}$ | 2000 pF |

### 3. Dimensional Drawings in mm




Reference line gauge see page 11

O Notes see page 8

# Black and White Picture Tubes

## 1. Scope

### 1.1 General

At least three primary colours are required for the reproduction of colour pictures. In colour television, these are the colours red, green and blue. Depending on the intensity of the individual components other colour combinations can be produced. Therefore, unlike the black-and-white picture tube, the screen must contain three different phosphor materials which can be separately excited. In order to ensure proper scanning and excitation of the colour dots, a perforated metal mask, called shadow mask, is provided behind the phosphor-dot screen.
Other techniques are possible but are not described in this booklet, which only deals with the shadow mask tube. This tube, based on the principle of three different colour dots (triplets), has three electron guns using electrostatic focus. One of the three primary colours is assigned to each gun. Proper metal shields are provided to protect the tube against interferring external magnetic fields (e.g. earth's field).

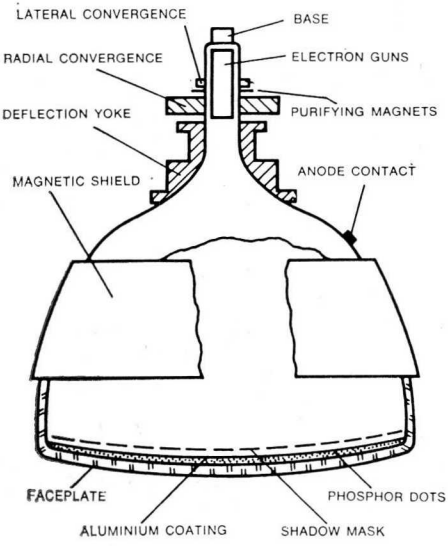



Figure 1: Schematic representation of a shadow-mask tube with associated components

### 1.2 Handling colour picture tubes

The information in paragraphs 1.1 through 1.7 regarding storage, transport, packing etc. for the black-and-white picture tubes applies analogously to the handling of colour picture tubes. Colour picture tubes are highly sensitive to shock, impact and rapid temperature changes because of the frit seal by which the panel is joined to the funnel.

### 1.3 Functional troubles

In addition to the information in paragraph 1.7 for the black-and-white picture tube, colour picture tubes have to be shielded against the influence of external stray magnetic fields. It may be necessary to correct the colour purity when the television set is moved to another location. This readjustment of the television receiver is not equipment or picture tube defect, but a fine correction of the electron beams striking the screen. The three electron beams are adjusted to land on the screen through the shadow mask at such angles that only the phosphor dots intended for them will be excited. If the electron beams are deflected from their initial path by an interferring stray magnetic field (e.g. earth's magnetic field, transformers, etc.), they will not land on the associated phosphor dots. This results in a distortion of the colour content of the received picture, which can be compensated for by the purifying magnets placed on the tube neck.

## 2. Mechanical and physical characteristics of the colour picture tube

### 2.1 Bulb

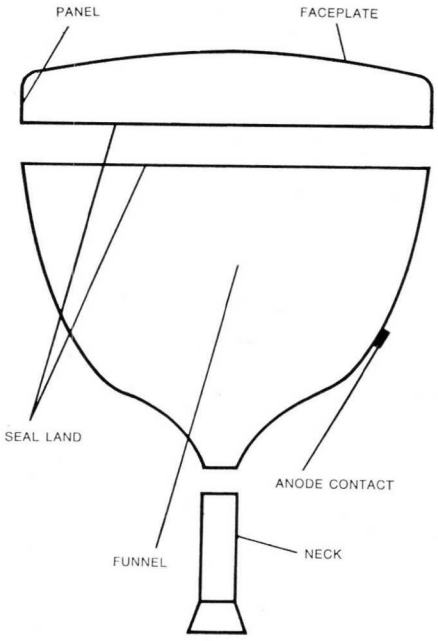



Figure 2: Basic elements of the bulb of a colour picture tube

#### 2.1.1 Mechanical data

As with the black-and-white picture tube, the bulb of the colour picture tube is made of glass. Unlike the black-and-white tube, however, the panel and the funnel are supplied as single parts which are joined by fritting at the tube manufacturer's plant, **bonding funnel and neck.**

The three main parts of the bulb for colour picture tubes, which are briefly described below, are made as separate units – as with the black-and-white picture tube. These parts are:

**The panel** with faceplate, on the inner side of which the phosphor material will be applied later in a highly complex and difficult process and the shadow mask will be fixed. The panel also has four pins (one on each side) for mounting and fixing the shadow mask.

**The funnel** with sealed-in anode contact, through which the high voltage will be supplied for the three electron guns. The funnel also has three ground faces which serve for centering purposes during frit-sealing.

**The neck,** which houses the three electron guns and also carries the deflection yoke.

##### 2.1.1.1 The panel

With the colour picture tube it is essential that the skirt of the panel be plane, since after application of the phosphor material and fixing of the shadow mask in the panel this surface is joined to the funnel at high temperatures by frit-sealing. The bulb of the colour picture tube has thicker walls than those of the black-and-white tube, so that a 25-inch colour tube is heavier than a corresponding black-and-white tube. Similar to the funnel, the panel has three ground marks on its outer surface, which serve as reference marks during frit-sealing and assembly of the electron guns.

##### 2.1.1.2 The funnel

With all types of colour picture tubes the funnel is made of glass. The deflection angle is 90° or 110°. The anode contact sealed into the small face of the funnel serves in the finished tube for feeding the high voltage to the electron guns. As with the black-and-white picture tube, the funnel serves as the link between the screen and the neck of the tube. The edge facing the panel must also be very accurately machined in order to ensure a durable, vacuum-sealed joint between the two parts when the panel is fritted to the funnel.

### 2.1.2 Physical data of the colour picture tube

Regarding absorption, contrast and halo the same applies analogously as for the black-and-white picture tube. Some types of colour picture tubes have an integral protection window sealed to the faceplate with a clear resin. This PPG window is tinted gray. External stray light has to pass the window twice due to reflection on the screen, while the light from the screen suffers considerably less absorption because it only passes the window once.
In future colour picture tubes a special filter glass will be used as faceplate material offering high light transmittance to the wavelengths of the three primary colours but absorbing most of the other wavelengths. Through this method an improvement in the contrast of the colour picture will be achieved.

#### 2.1.2.1 The screen

The screen of a shadow-mask colour picture tube consists of a large number of adjacent dots, approx. 1,2 million phosphor dots in the case of a 63 cm (25″) tube, each 0,4 mm (0,0157″) in diameter and 0,020 mm (0,00079″) thick. Zinc sulphides, which are activated by traces of heavy material and rare earth oxides, are used as phosphor material. By means of these activators the zinc sulphide crystal is converted into a semiconductor. When energy is applied to the semiconductor material this can be excited into emitting a particular light wavelength. The phosphor material is not only excited by fast electrons but also by ultraviolet radiation. This light stimulation is used for the numerous inspections during the manufacture of the screen. Three adjacent colour dots on the screen of the colour picture tube form a colour triplet (see figure 3) comprising a red, a green and a blue light emitting dot.

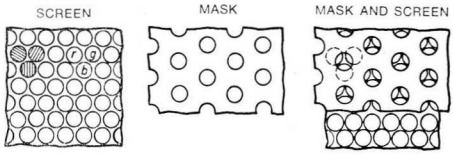



Figure 3: Screen and mask of a shadow-mask type colour picture tube

A hole in the shadow mask corresponds to each colour triplet. Each of the three electron beams passing through this hole excites one of these phosphor dots (see figure 3). By additive mixing of the three primary colours the desired colour impression is obtained. Since the hole diameter in the mask and, hence, that of the individual electron beam is smaller than the diameter of a dot (0,3 mm [0,0118″] as against 0,4 mm [0,0157″]), accurate registration is ensured, preventing one beam (e.g. the red beam) from exciting part of the area of the other two phosphor dots and causing colour purity errors.
During the manufacture of the screen a light-sensitive substance (polyvinyl alcohol) is added to the respective phosphor material, e.g. green, and is then applied to the tube panel. Then, by means of an intensive punctiform ultraviolet light source and with the shadow mask as a matrix, a dot pattern is exposed in the tube panel. At the exposed areas the polyvinyl alcohol polymerizes, thereby bonding the phosphor material to the glass surface. It is washed away with water on the remaining surface which has not been exposed. The same process is repeated in an analogous manner for the other two colours. In the process the light source is placed in the future location of the beam deflection point. Thus a pattern of triangular groups of three small phosphor dots is produced on the screen. It is essential that the individual phosphor dots are adjacent to each other without overlapping, which would result in colour contamination.

### 2.1.2.2 Aluminization

Structure and purpose of the aluminium coating in the colour picture tube are the same as with the black-and-white picture tube.

### 2.1.2.3 Colour vision

The retina of the human eye contains rods for registering differences in brightness and less sensitive cones for colour impression. Different types of cones react in different ways to light of the same wavelength and intensity. Only the totality of all stimuli provides the colour impression. This makes it possible to perceive the same colour in spite of different spectral compositions of the light. Thus, by mixing any three independent primary colours in various proportions, it is possible to produce all the other colours (the human eye is able to differentiate between some 1 million colours).
For practical reasons three colours are chosen as primary colours which are as far separated in the frequency spectrum as possible, e.g. red, green and blue. This combination is used in colour television for the reproduction of the vast multitude of colours.

### 2.1.2.4 Colorimetry

For the unambiguous determination of a colour a scheme is used in which the three primary colours are arranged at the vertex of an isosceles triangle. Each colour corresponds to a specific point of the triangle, the so-called spectrum locus. The spectrum locus is a measure for the hue. A second characteristic of colour is the **saturation.** The saturation reaches the maximum value of 1, e.g. for a saturated red, and decreases, as white increases, via pink to zero (white or grey). Hue and saturation are often expressed by the term **„chromaticity".** A third element for the description of the colour is the **brightness.** For primary source elements (the screen is considered a primary source) the luminance is a direct measure of the brightness.

### 2.1.2.5 Influence of colour area and surroundings

A colour impression can only be obtained if several cones in the retina are stimulated. If the angle at which a coloured area is viewed by the eye is smaller than 6', only a brightness impression is produced. When a large number of very small colour dots are close together, the human eye is only able to record the compound colour. The diameter of the phosphor dots has been chosen so that at a normal viewing distance the compound colour is perceived by the observer's eye.
The above holds true only if the observed area is situated in a sufficiently dark room. If the surrounding room is considerably brighter than the screen area, all colours appear as if black were added to them. Therefore it is essential for good colour television reception that the ambient room be sufficiently dark in order to ensure good colour fidelity.

### 2.1.2.6 The shadow mask

The purpose of the shadow mask in a colour picture tube is twofold. During the manufacture of the screen it serves as the negative for the three colour rasters. In the finished tube it serves as diaphragm for the deflected electron beams, allowing each beam only to land on the associated phosphor dots.

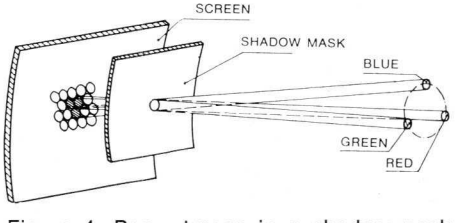



Figure 4: Beam traces in a shadow-mask type colour picture tube

The mask consists of a sheet-steel plate which is 0,15 mm (0,0059″) thick and contains about 400 000 round holes, each 0,3 mm (0,0118″) in diameter. The shape of the mask is matched to the curvature of the faceplate. The average distance from the faceplate of the picture tube is about 13 mm (1/2″). This distance is important for good colour reproduction (colour purity) (see figure 4). If the specified distance is not accurately maintained, electron beams which are assigned to a particular colour raster might excite neighbouring phosphor dots, which would result in colour impurities.

The transparency of the shadow mask is about 17%. As a result the mask has to dissipate power during the absorption of the electron beams that cannot be neglected. Assuming a mean continuous beam current of 1 mA at 25 kV, which is still tolerable, this power dissipation amounts to about 22 W. As a result the mask will be heated and will expand. Since it is not possible to eliminate the occurring heat quickly enough by heat conduction, the mask is blackened by an oxidation process, thus improving the heat radiation. At high beam currents (max. 1,5 mA), however, this is no longer sufficient. But even under these conditions the movement of the mask holes due to temperature influence is still compensated for in modern colour picture tubes. The holding springs which fix the mask in the screen panel are so arranged that the mask moves towards the screen when heated. This ensures that the movement of the mask holes does not exceed the permissible value.

#### 2.1.2.7 Electron gun assembly

In a colour picture tube, three electron guns are used for the generation of the electron beams. The design of each individual electron gun is similar to that in a black-and-white picture tube. Instead of the einzel-lens however, a bi-potential lens is used. The reason for this is the required high dielectric strength (high anode voltage) at small gun diameter. The bipotential lens is formed by the electrostatic field between screen grid, focus and anode electrode. In the case of the electron guns for colour picture tubes, the three cathodes, control grids and screen grids are brought out separately, while the focus electrodes and the anodes are interconnected within the tube. The focus electrodes are joined to a base pin and the anodes receive their anode supply voltage via the anode contact sealed into the funnel.

## 3. Principle of operation of the shadow-mask type colour picture tube

### 3.1 Principle of the colour picture tube

In the shadow mask type colour picture tube three electron beams are generated independently of each other. Due to the straight propagation path of the electrons in free space, each beam would excite only one point on the phosphor-dot screen into light emission. For this reason the electron beams have to be deflected from their straight path across the whole screen, as in the black-and-white picture tube. In order for each beam to hit the associated phosphor dots on the screen in spite of the distortions due to the deflection yoke, a so-called dynamic convergence unit is needed, which ensures that the triplet geometry is directly reproduced on the mask. By intensity modulation of the individual electron beams the different colour phosphor dots on the screen are excited with varying intensities, depending on the picture content to be transmitted. By additive mixing of the excited primary colours – red, green and blue – the transmitted colour picture is reproduced on the screen. An essential factor for the faithful colour reproduction is the so-called colour purity. This is the requirement that each electron beam of an electron gun in a three-colour system only be allowed to excite the phosphor dots of the associated colour. This is ensured by the absorption effect of the shadow mask. As a result, however, current is continuously flowing in the mask during operation, which causes it to run hot. The resulting expansion of the shadow mask would cause a movement of the mask holes with respect to the colour phosphor dots. This thermal movement of the mask is compensated for by a corresponding fixing arrangement.
The design of the electron guns is similar to that of the black-and-white picture tubes. Unlike the black-and-white picture tube, however, bi-potential lenses are used for electrostatic focusing instead of einzel-lenses. With the exception of the combined lens electrodes, the control electrodes of the three electron guns are brought out individually, so that optimum adjustment of the colour triplet register and of the brightness are possible.

### 3.2 Electrical characteristics

Since the colour picture tubes differ in principle only negligibly from the black-and-white picture tubes, it is sufficient to point out some design and functional differences and the consequences resulting for application.

#### 3.2.1 Limit value of the overall anode current for the three electron guns

It is an inherent functional characteristic of the shadow-mask principle (see paragraph 2.1.2.6) that about 80% of the anode current is absorbed by the mask where it is converted into heat. At an anode voltage of 25 kV and an overall anode current of 1,25 mA the mask is loaded with about 80% of the resulting dissipated power, i.e. 25 W. Therefore, by limiting the anode current to a maximum permissible value in addition to choosing a suitable mask design, it must be ensured that no undue displacement of the mask with respect to the screen will take place when the mask is heated during operation. This would be detrimental to the colour purity. Experience has shown that a limitation of the beam current for the three electron guns to 1,5 mA (arithmetic mean value) in a picture tube with 63 cm (25″) screen diagonal has proved satisfactory.

#### 3.2.2 Flashovers

Since colour picture tubes are operated with a considerably higher anode voltage than black-and-white picture tubes, the anode voltage and grid-No. 3 voltage sup-

plies should be so rated that the current produced at flashovers and short-circuits is limited to a maximum value in order to avoid damages to the cathode. Particularly exposed electrodes in the colour picture tube, such as grid-No. 3, grid-No. 2, grid-No. 1 and the cathode, are suitably protected by spark gaps connected to the external conductive coating of the tube. The connection with the external coating should be made with great care and using the shortest possible leads.

### 3.2.3 Interferring magnetic fields

In order to shield the tube against the disturbing influence of stray magnetic fields which may affect colour purity, the manufacturer recommends the use of a metal shield (sheet steel) over the funnel between the metal frame reinforcement and the deflection yoke if the tube is not supplied with an inner magnetic shield. Furthermore, colour purity errors may also be produced by residual magnetism of the shadow mask which may be due to the transport or storage. This residual magnetism can easily be removed by degaussing the shadow mask by means of an air-core coil, through which an exponentially decreasing alternating current with a frequency of 50 Hz flows. Modern television receivers already incorporate a degaussing coil which is automatically connected into circuit when the set is turned on.

## 3.3 Initial operation and adjustment of the colour picture tube

The basic conditions for accurate adjustment of the colour purity and convergence are:

**3.3.1** The focus of the three electron guns must be optimally adjusted, which is achieved by the application of a direct voltage to grid-No. 3.

**3.3.2** The colour picture tube must have been previously degaussed. This is done automatically by means of a degaussing coil when the set is turned on. This removes local colour impurity areas, which may be due to the magnetization of the metal frame and the mask.

**3.3.3** The use of crosshatch or dot video patterns for the convergence adjustment. The following sequence should be observed for this adjustment:

#### 3.3.3.1 Adjustment of static convergence

By means of the radial permanent magnets or electromagnets and the lateral converging unit the red, green and blue patterns must be made to coincide at the centre of the screen. Normally the blue beam is turned off first while the red and the green patterns are aligned. Optimum adjustment is obtained if a yellow raster appears at the centre of the screen. The blue beam is then turned on and aligned with the yellow raster by means of the respective magnets.

#### 3.3.3.2 Colour purity

Move the deflection yoke as far back as possible towards the convergence unit.
With the red raster on, the most possible uniform red field is adjusted in the centre of the screen by turning and adjusting the two colour purity magnets on the convergence unit. Then the deflection yoke is moved forward until a uniform red field is observed over the entire screen.
The colour purity of the green and blue raster is then checked. In order to achieve optimum colour purity for the red, green and blue rasters, it may be necessary to make some compromises. The static convergence has to be checked before and after each colour purity adjustment.

#### 3.3.3.3 Dynamic convergence

For the adjustment of the dynamic convergence a bright crosshatch or dot video pattern is needed. The intensity of the three colours should be approximately the same. By varying of the line and raster

frequency alternating currents flowing through the convergence coils the three colour rasters must be made to coincide over the entire screen, so that only white dots or raster lines are observed. First the red and green lines or dots are aligned. Then the blue raster is adjusted to the yellow one produced by convergence of the red and green rasters. During the adjustment of the dynamic convergence it is recommended that the colour purity and the static convergence be checked repeatedly and readjusted if required.

#### 3.3.3.4 Pincushion correction

Correction of the vertical and horizontal pincushion distortion is performed by means of a transductor. The horizontal correction is achieved by modulation of the horizontal deflection current with the vertical frequency; vertical correction is achieved by modulation of the vertical deflection current with the horizontal frequency.

## 4. Implosion protection

### 4.1 Purpose of the implosion protection

The information and definitions given in paragraph 2.0 for the black-and-white picture tube apply for the implosion protection of the evacuated colour picture tubes.

### 4.2 Implosion protection by means of metal frame

Similar to the black-and-white picture tube, implosion protection can be achieved for the colour picture tubes by the application of a metal frame over the critical zones. To accomplish this the space between the correspondingly shaped metal frame and the tube is filled with a sealing and filling material. After cooling, the shrinking of the assembly provides the desired implosion protection.

### 4.3 Implosion protection according to the SELBOND ® method

The SELBOND method is a variation of the metal frame method. By means of the SELBOND method the critical zones of the tube are prestressed to an adjustable, measurable value. In addition it permits push-through presentation with a corresponding reduction of the metal frame dimensions.

## 5. Manufacturing a colour picture tube

As has already been mentioned in the functional description of the shadow-mask type colour picture tube, the colour picture tube differs in four essential aspects from a black-and-white picture tube; namely the existence of a shadow mask, the screen with phosphor dot pattern, the two-piece bulb and the three electron guns. These differences are also reflected in the production process. Figure 5 shows a schematic representation of the sequence of manufacturing operations.
The washed panels arrive at the automatic screening machine, where they are clamped on a holding device and rotated. By means of a dispensing and control

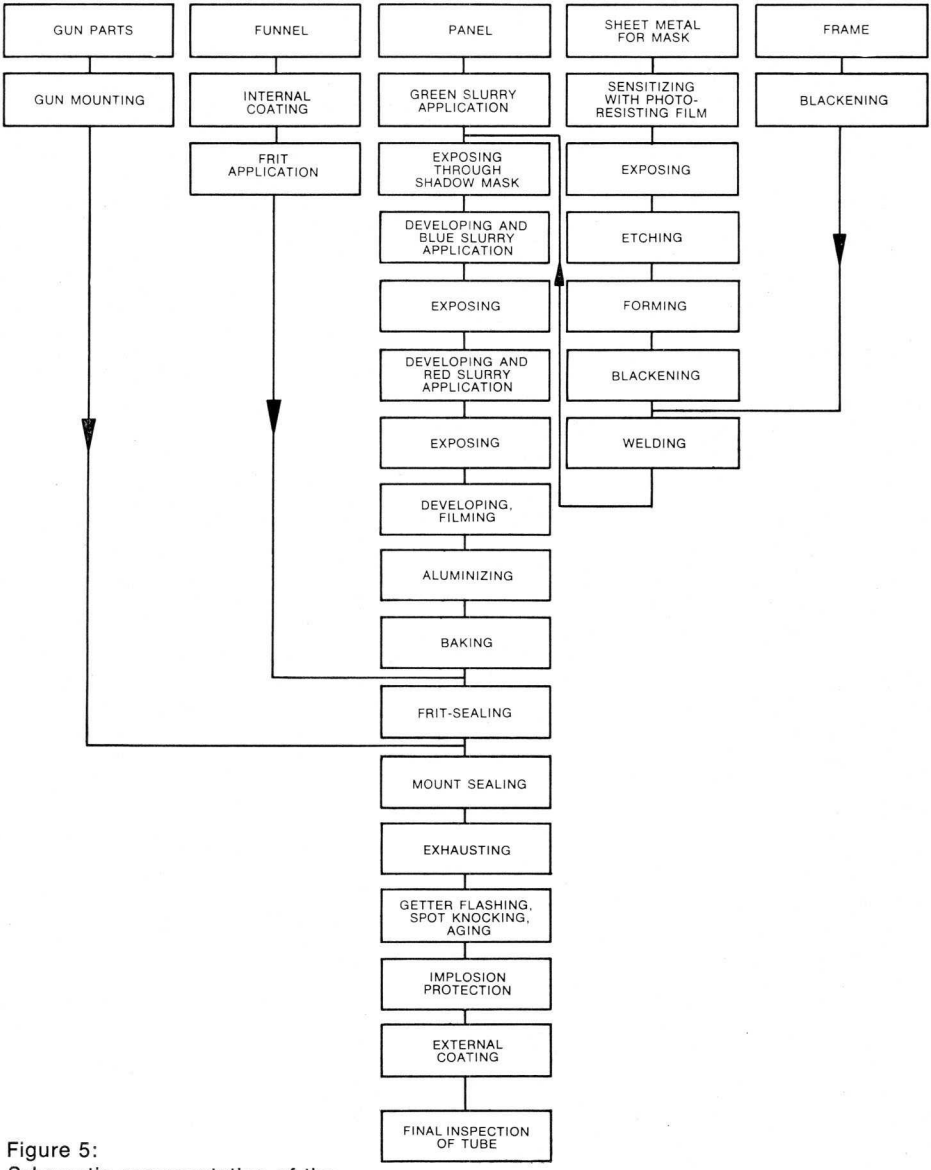



Figure 5:
Schematic representation of the manufacturing sequence

unit the light-sensitive green phosphor slurry is filled into the centre of the panel. Due to the rotation of the panel the slurry spreads uniformly over the entire screen surface. The phosphor coating is then dried by means of ultrared radiators and the coated panels are transferred to the green lighthouse. There a shadow mask is assigned to each panel. During the exposure and in the finished tube, the same mask must be used since due to manufacturing tolerances it is not possible to achieve the required 10 µm accuracy of reproduction if different masks are used. The shadow mask is produced according to a method which is closely related to photo-printing. After the sheet metal has been chemically cleaned of surface contamination it is coated on both sides with a light-sensitive film similar to that used in photography. The coated metal sheet is then pressed between two plane glass plates which contain the desired hole pattern and which are required to coincide to an accuracy of some microns from one side of the sheet to the other.

Two high intensity arc lamps, arranged on either side of the mask, are used for the exposure itself. After exposure, the pattern is developed and the remaining film is hardened in an oven. Then the holes are etched into the metal sheet from both sides by means of an acid shower. Finally the remaining light-sensitive layers and acid are removed and the mask is brought into its definite shape by means of a forming tool. Prior to the precision welding of mask and frame both parts are blackened by an oxidation process.

For the exposure of the phosphor layer the panel with the inserted mask is placed on the lighthouse. Since the location of the exposed dots is fixed by lighting with a punctiform ultraviolet light source, it is necessary for the position of the panel with regard to the light source to be closely maintained. To this end ground surfaces on the edge of the panel are made to coincide with reference points on the lighthouse. Then after exposure the mask is removed again and the panel goes back to the automatic screening machine. There the panel is again rotated and the unexposed areas of the phosphor layer are washed away with warm water (see also paragraph 2.1.2.1). Then the blue and the red phosphor slurry is dispensed, with the same procedures as described with regard to the application of the green phosphor slurry being repeated each time. After the screening procedure, the filming and aluminizing processes follow, as with the black-and-white picture tube. To remove the organic materials (film, phosphor binder) the panel is baked in air.

Before frit sealing the shadow mask is fitted into the tube panel for the last time. The glass solder is applied to the seal lands of the funnel, which is coated on its inner side with a graphite layer, and funnel and panel are placed into a device which serves to align the two parts accurately by means of stops and to hold them in place during frit-sealing. The assembly is then passed through an oven in which the frit is changed into a glassy state, thus producing a vacuum-tight joint of high mechanical strength between panel and funnel.

Finally sealing of the electron gun assembly follows; its orientation must be in agreement with the configuration of the colour triplets. The remaining operations and tests involved in the tube manufacture are similar to those of the black-and-white picture tube and constitute the end of the production process.

## 1. General

### X-rays

At a maximum permissible anode voltage of 27,5 kV and an average beam current of 1,5 mA X-radiation remains below the maximum permissible value of 0,5 mR/h.

### Mounting instructions

Operating position:
The tube must be operated with its axis in a horizontal position and with the blue electron gun up. The data concerning beam deviation and convergence apply to this operating position.
The deflection yoke must not be used to support the tube.
Tube socket:
A flexible connection should be used for the tube socket. The base is allowed to be within a circle of 55 mm ($2^3/_{16}$") diameter, with reference to the perpendicular through the centre of the screen.

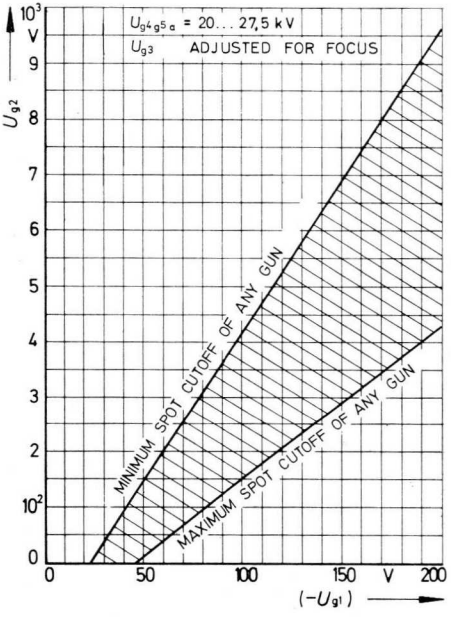
## 2. Application instructions

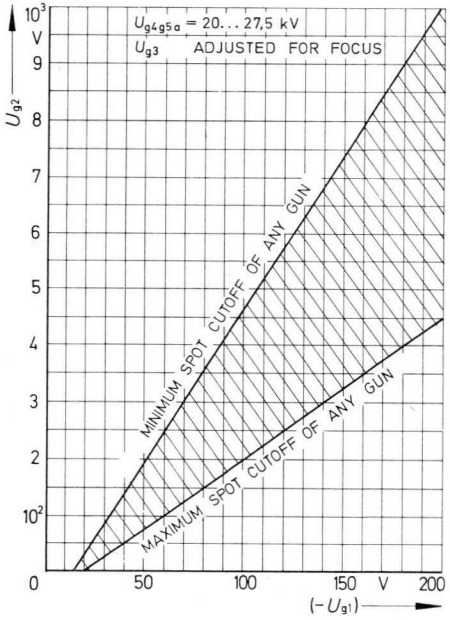
Voltage reference point
Unless otherwise specified, the voltage valuess refer to cathode potential and apply to each individual electron gun.
Focus electrode
At an anode voltage of 20 to 27,5 kV, for the focus electrode $g_3$ a voltage has to be set amounting to 16,8 to 20% of the anode voltage.

Operating point adjustment
The grid-No. 2 and grid-No. 1 voltages for disappearance of the focused spot (cutoff voltage) can be derived from the cutoff design chart.

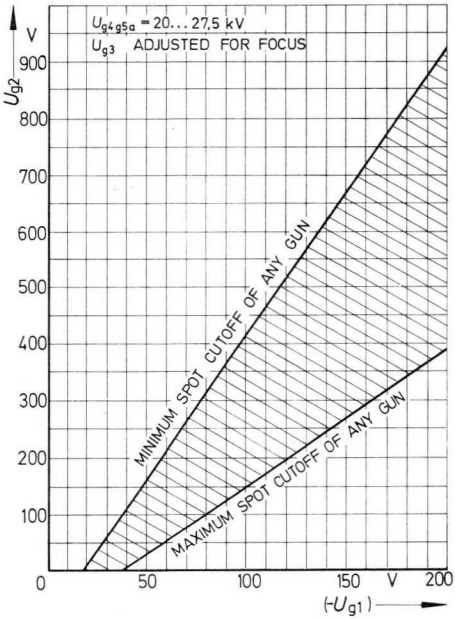
Cutoff Design Chart — A 55–14 X, A 63–11 X, A 63–200 X

Metal frame:
The mounting lugs on the mental frame are provided for fixing the tube in the television set. For the respective dimensions, reference is made to the dimensional outline.
External conductive coating:
The external conductive coating should be connected by means of multiple contacts in order to avoid overheating of a contact and consequent damage to the tube.
Metal frame and external coating are electrically isolated from each other. They may be joined if the applicable safety rules permit this. The impedance between the frame and the external coating should not exceed 1 MΩ at 50 Hz and 5 kΩ at 15 kHz.
Anode contact:
The area around the anode contact is sprayed with transparent water-repellent paint. Only a dry, soft, lint-free cloth should be used for cleaning it.






Cutoff Design Chart A 56–120 X
A 66–120 X
A 66–140 X




Cutoff Design Chart A 67–150 X

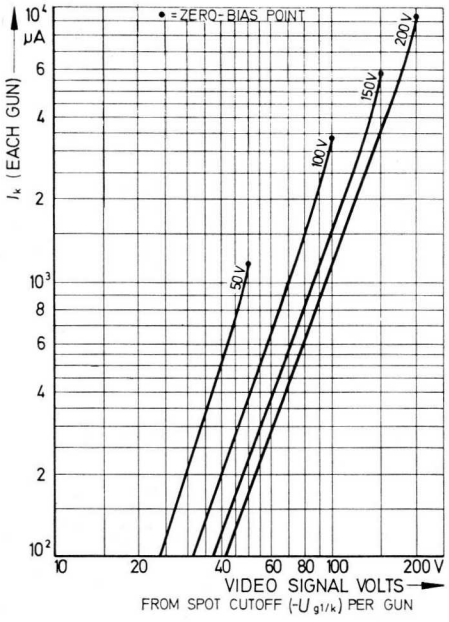
Beam landing correction
In spite of external or internal magnetic shield and due to manufacturing variations which may produce misregister, it is necessary for pure colour operation to correct for remaining magnetic effects and for manufacturing variations by an additional static magnetic field (purifying magnet).
Displacement, measured at centre of screen: see corresponding tube type.
Position of the components for convergence adjustment, see dimensional drawings for the different types.
Grounding
The external conductive coating and the external magnetic shield are to connect with the negative high-voltage terminal.

Flashover protection
In order to avoid possible damage to the tube due to internal flashovers, a suitable current limitation is recommended in the high-voltage supplies for the anode and grid-No. 3, as well as the use of spark gaps.
Maximum ratings
The circuit should be so rated that the indicated maximum ratings are not exceeded during tube life, even under the worst possible operating conditions with regard to supply voltage variation, signal variations, components tolerances and ambient conditions.
The high-voltage maximum ratings are absolute values which must not be exceeded even when the tube is first placed in operation. Do not connect the tube before the high voltage is adjusted within the specified limits.

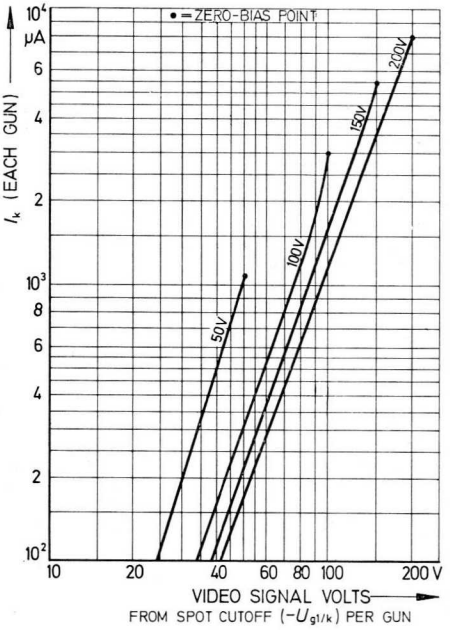
Typical grid-drive and cathode-drive characteristics

Grid-drive characteristics

| | |
|---|---|
| $U_f$ | 6,3 V |
| $U_{g4g5a/k}$ | 20 to 27,5 kV |
| $U_{g3/k}$ | adjusted for focus |
| $U_{g2/k}$ | adjusted for each gun to provide spot cutoff for desired fixed ($-U_{g1/k}$) |
| Parameter | cutoff voltage |




A 55–14 X
A 63–11 X
A 63–200 X

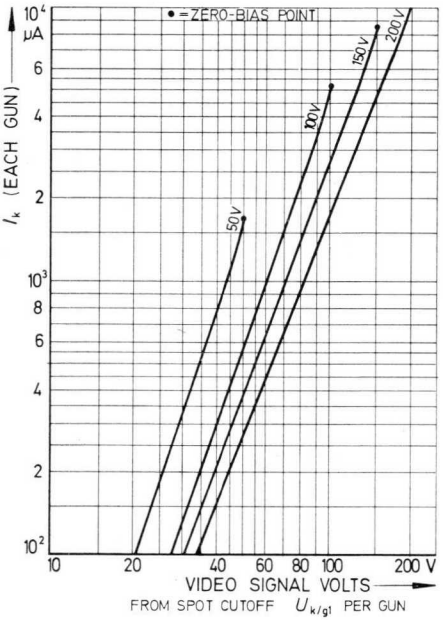



A 56–120 X
A 66–120 X
A 66–140 X

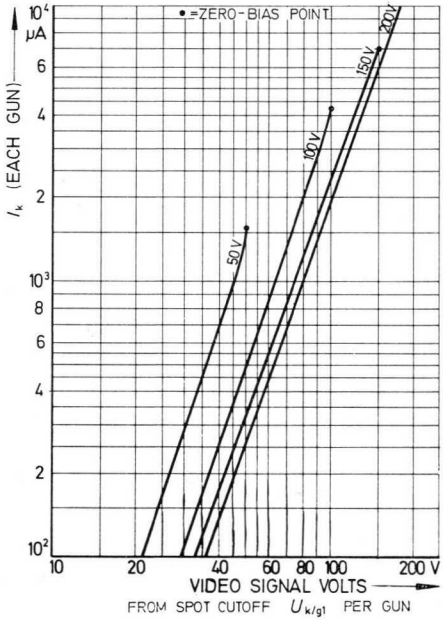
# Colour Picture Tubes

## Technical Survey

| Cathode-drive characteristics | |
|---|---|
| $U_f$ | 6,3 V |
| $U_{g4g5a/g1}$ | 20 to 27,5 kV |
| $U_{g3/g1}$ | adjusted for focus |
| $U_{g2/g1}$ | adjusted for each gun to provide spot cutoff for desired fixed ($U_{k/g1}$) |
| Parameter | cutoff voltage |




A 55–14 X
A 63–11 X
A 63–200 X




A 56–120 X
A 66–120 X
A 66–140 X

## 3. Associated components

### Deflection yoke

The deflection yoke must not be used to support the picture tube. The axes of the deflection yoke and of the tube must coincide. The deflection coils should be able to be moved about 1,5 cm ($^5/_8$″) along the tube neck for the adjustment of colour purity. The deflection yoke should be able to be rotated slightly. Centering of the raster can be made by superimposing a direct current of the required magnitude on the deflection current through each coil pair. Pin-cushion correction can be achieved by superimposing of a correspondingly shaped correcting current on the deflection current.

### Colour purity magnet

The colour purity magnet is required in order to compensate for the effects of uniform external magnetic fields that would cause beam landing errors. The colour purity magnet must be placed on the tube neck as indicated in the data sheets. For varying the beam landing point, the produced magnetic field should be at right angles to the tube axis and should be adjustable in magnitude and direction. By means of the colour purity magnet it must be possible to adjust all indicated tolerance values.

### Magnetic shield

To reduce the effects of external stray magnetic fields and of the earth's magnetic field, a cold-rolled steel sheet of about 0,75 mm (0,0295″) should be placed as a shield around the funnel of the tube, provided the tube has no internal shield.
The shield is only effective if the metal sheet is degaussed. This is possible by means of a degaussing coil which is automatically connected into circuit when the television set is turned on. In order to avoid weakening the magnetic field excessively during degaussing, the air gap between shield and metal frame as well as between shield and funnel should not exceed 10 mm ($^{25}/_{64}$″).

### Radial converging unit

The radial converging unit, in conjunction with the associated circuit, produces the magnetic fields which are necessary for the dynamic convergence of the three electron beams when moving over the screen. In addition, the radial converging unit, together with the lateral converging unit, generates the magnetic fields needed for the static convergence. The three convergence magnets are fitted on the neck of the tube in such a manner that they face the pole pieces within the tube neck. The requisite horizontal and vertical currents flow through the associated windings of the converging unit thus ensuring the dynamic convergence of the deflected beams. Static magnetic fields for the convergence of the three beams at the centre of the screen are produced either by direct currents in the convergence windings or by magnets with variable field strength. The riadial converging unit must be able to adjust the indicated tolerance values.

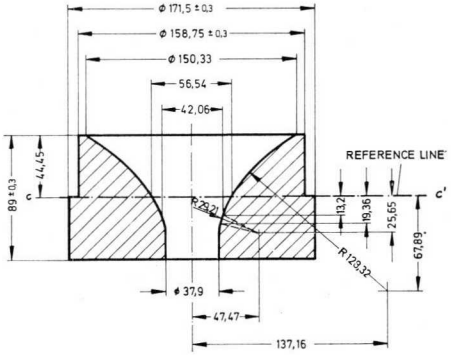
### Lateral converging unit

The lateral converging unit serves to complement the correction of the static convergence of the three electron beams at the centre of the screen performed by the radial converging unit. It is fitted on the neck of the tube between the colour purity magnet and the radial converging unit. The task of the magnetic field is to produce a lateral (horizontal) movement of the blue beam opposite to the movement of the converged red and green beams. Therefore the magnetic field strength must be variable to permit adjustment of the indicated tolerance values.

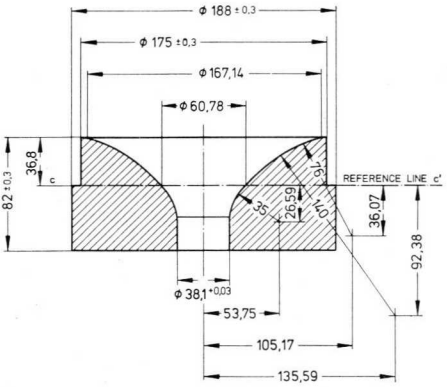
## 4. Reference line gauge

The reference line is determined by the flange plane of the reference line gauge, if it is seated against the funnel of the bulb.

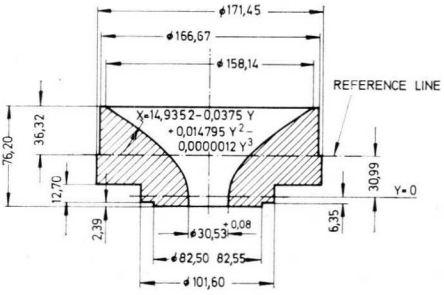
Reference line and neck-funnel-contour gauge




for colour picture tubes A 55–14 X
A 56–120 X
A 63–11 X
A 63–200 X
A 66–120 X




for colour picture tube A 66–140 X




for colour picture tube A 67–150 X

## 5. Explanation of symbols for the quantities listed under Electrical Data

### Typical Operating Conditions

| | |
|---|---|
| Heater voltage | $U_f$ |
| Heater current | $I_f$ |
| Anode voltage | $U_{g4g5a}$ |
| Focusing voltage | $U_{g3}$ |
| Screen grid cutoff voltage (for $(-U_{g1}) = 150$ V) | $U_{g2\ cutoff}$ |
| Control grid voltage (for $U_{g2} = 400$ V) | $(-U_{g1})_{cutoff}$ |

### Maximum ratings

| | |
|---|---|
| Anode | |
| Voltage | $U_{g4g5a\ max}$ |
| | $U_{g4g5a\ min}$ |
| Current | $I_{g4g5a\ max}$ |
| Focusing electrode | |
| Voltage | $U_{g3\ max}$ |
| Screen grid | |
| Peak voltage | $U_{g2\ p\ max}$ |
| Control grid | |
| Negative peak voltage | $(-U_{g1})_{p\ max}$ |
| Negative operating voltage | $(-U_{g1})_{max}$ |
| Positive operating voltage | $U_{g1\ max}$ |
| Positive peak voltage | $U_{g1\ p\ max}$ |

Heater/cathode

| | |
|---|---|
| Voltage | |
| Negative heater — during warm-up time | $U_{-f/k\ max}$ |
| Negative heater — after warm-up time | $U_{-f/k\ max}$ |
| Negative heater — peak voltage after warm-up time | $U_{-f/k\ p\ max}$ |
| Positive heater — after warm-up time | $U_{+f/k\ max}$ |
| Positive heater — peak voltage after warm-up time | $U_{+f/k\ p\ max}$ |

### Ratings for circuit design

| | |
|---|---|
| Leakage current | $I_{g3}$ |
| | $I_{g2}$ |
| | $I_{g1}\ (-U_{g1} = 150\text{V})$ |

### Capacitances

| | |
|---|---|
| Between control grid of one gun and all other electrodes | $c_{g1}$ |
| Between cathode of one gun and all other electrodes | $c_k$ |
| Between grid No. 3 and all other electrodes | $c_{g3}$ |
| Between anode and external conductive coating | $c_{g4g5a/m\ max}$ |
| | $c_{g4g5a/m\ min}$ |
| Between anode and metal frame | $c_{g4g5a/m'}$ |

## 6. Notes to dimensional drawings

① Anode cavity cap according to German Industrial Standard DIN 41 543.

② The reference line is determined by the flange plane of the reference line gauge if it is seated against the funnel.

③ This zone is free of external conductive coating.

④ For the mounting bolts a free passage of at least 9,5 mm (3/8″) diameter is guaranteed in nominal position.

⑤ The maximum deviation of any mounting lug from the plane formed by the three other lugs is 2 mm (5/64″).

⑥ The Z points are reference points for the vertical position of the X and Y points.
The dimensions for the position of the X, Y and Z points also apply to the border line of the minimum useful screen area.

## 7. Notes to the technical data on the following pages

① For grid-drive service. The voltage values refer to cathode potential and apply to each individual gun.

② Maximum heater voltage variations of ± 10 % are tolerated, optimum cathode life is achieved by stabilization of the heater voltage at 6,3 V.

③ The ratio between the maximum and the minimum cutoff voltage at grid-No. 2 of an individual gun does not exceed the value of 1,86 with equal control grid voltage.

④ Visual extinction of focused spot, see Cutoff Design Charts.
Relation: line cutoff voltage = spot cutoff x 1,01 + 1 V,
raster cutoff voltage = spot cutoff x 1,05 + 7 V,

⑤ If the anode current exceeds the nominal value for a prolonged period of time, deformation of the shadow mask may occur due to thermal overloads, which will result in colour purity errors. Beam current limitation to 1,5 mA for the three-gun assembly is sufficient for practical purposes.

⑥ Absolute limit value which must not be exceeded under the worst possible operating conditions.

⑦ These values indicate the leakage currents that may occur at the respective electrodes. Their influence on the voltage across the electrode concerned has to be taken into consideration in the design of the circuit.

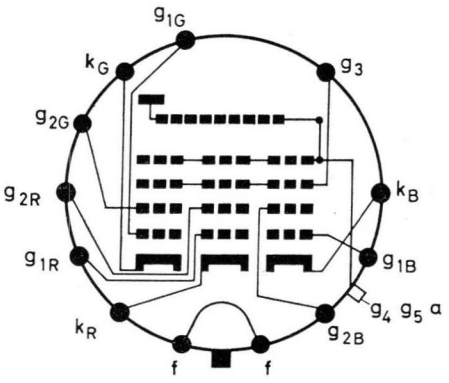
⑧ The circuit design of the equipment – both from a mechanical and electrical viewpoint – should be such that no energy source, alone or in connection with others, can cause a discharge current greater than 750 mA to flow through the heater as a result of a flashover.
The current limitation prevents the heater from burning out in the case of a flashover within the colour picture tube.

⑨ In order to avoid picture distortions the hum component from the heater circuit should be as low as possible. Therefore the alternating voltage between heater and cathode should not exceed the effective value of 20 V.

⑩ During the warm-up period of max. 15 seconds $U_{-f/k}$ may rise to max. 410 V. Between 15 and 45 seconds after switch-on the voltage must decrease proportionally with time to 250 V.

# Colour Picture Tubes

## A 55–14 X




ITT-Picture Tube A 55–14 X is a rectangular colour picture tube with 90° deflection angle and 36 mm neck diameter.
The useful screen area of 1465 cm² (appr.) has nearly straight sides of 44 x 35 cm (appr.). The filter-glass of the faceplate has a light transmission of 52 % (appr.).
The phosphor screen is composed of triangular dot groups – colour triplets – each consisting of a red-, green- and blue-emitting phosphor dot. The green- and blue-emitting phosphors are silver activated sulfide phosphors, the red emitting phosphor is composed of yttrium compounds activated with rare-earths.
The tube uses three electrostatically focused guns and operates on the shadow mask principle.
The gun axes are tilted slightly toward the tube axis to facilitate convergence to the shadow mask. Beam-convergence and deflection are provided magnetically.
Implosion protection by steel reinforcement.

### 1. Mechanical data

| | | |
|---|---|---|
| Bulb | All-glass Type with convex rectangular Faceplate Filter-glass | |
| Implosion Protection | Steel-Jacket including Tube Mount | |
| Minimum Useful Screen Dimensions | Diagonal | 514 mm |
| | Horizontal | 443 mm |
| | Vertical | 346 mm |
| Deflection Angles | Diagonal | 90° |
| | Horizontal | 79° |
| | Vertical | 63° |
| Overall Length | 483 ± 9,5 mm | |
| Weight | 16 kg (appr.) | |
| Base | JEDEC B 12-244 | |

### 2. Electrical data

#### 2.1. Typical operating conditions ①

| | |
|---|---|
| $U_f$ ② | 6,3 V |
| $I_f$ | 900 mA |
| $U_{g4g5a}$ | 25 kV |
| $U_{g3}$ | 4,2 . . . 5,0 kV |
| $U_{g2\ cutoff}$ ③ ④ (at $(-U_{g1}) = 150$ V) | 285 . . . 685 V |
| $(-U_{g1})_{cutoff}$ ④ (at $U_{g2} = 400$ V) | 95 . . . 190 V |

#### 2.2. Maximum ratings ① ⑧

| | | |
|---|---|---|
| $U_{g4g5a}$ | max ⑥ | 27,5 kV |
| $U_{g4g5a}$ | min | 20 kV |
| $I_{g4g5a}$ | max ⑤ | 1,0 mA |
| $U_{g3}$ | max | 6,0 kV |
| $U_{g2\ p}$ | max | 1,0 kV |
| $(-U_{g1})_p$ | max | 400 V |
| $(-U_{g1})$ | max | 200 V |
| $U_{g1}$ | max | 0 V |
| $U_{g1\ p}$ | max | 2 V |
| $U_{-f/k}$ | max ⑨ ⑩ | 410 V |
| $U_{-f/k}$ | max | 250 V |
| $U_{-f/k\ p}$ | max | 300 V |
| $U_{+f/k\ p}$ | max | 180 V |
| $U_{+f/k}$ | max | 135 V |

### 2.3. Ratings for circuit design

| | | |
|---|---|---|
| $I_{g3}$ | ⑦ ≦ −45 . . . + 15 | µA |
| $I_{g2}$ | ⑦ ≦ ± 5 | µA |
| $I_{g1}$ $(-U_{g1})$ = 150 V | ⑦ ≦ ± 5 | µA |

### 2.4. Capacitances (approx.)

| | | |
|---|---|---|
| $c_{g1}$ | 6 | pF |
| $c_k$ | 5 | pF |
| $c_{g3}$ | 6,5 | pF |
| $c_{g4g5a/m\ max}$ | 2500 | pF |
| $c_{g4g5a/m\ min}$ | 2000 | pF |
| $c_{g4g5a/m'}$ | 280 | pF |

### 3. Optical Data

Faceplate: Filter-glass
Light Transmission (appr.) 52 %

Screen:
Three separate phosphor dots – Colour-triplets – arranged in triangular groups and aluminized.
Spacing between centres of adjacent triplets nearest centre of screen 0,64 mm appr.

| Colour dot Coordinates | x | y |
|---|---|---|
| Red | 0,630 | 0,340 |
| Green | 0,300 | 0,600 |
| Blue | 0,150 | 0,060 |
| Coordinates for White | 0,281 | 0,311 |

| Average percentage of total cathode current to produce White | |
|---|---|
| Red | 34 % |
| Green | 34 % |
| Blue | 32 % |

| Ratio of cathode currents for White | | |
|---|---|---|
| Red to Green | 1,0 | (0,65 . . . 1,5) |
| Red to Blue | 1,1 | (0,75 . . . 1,5) |
| Blue to Green | 0,9 | (0,6 . . . 1,3) |

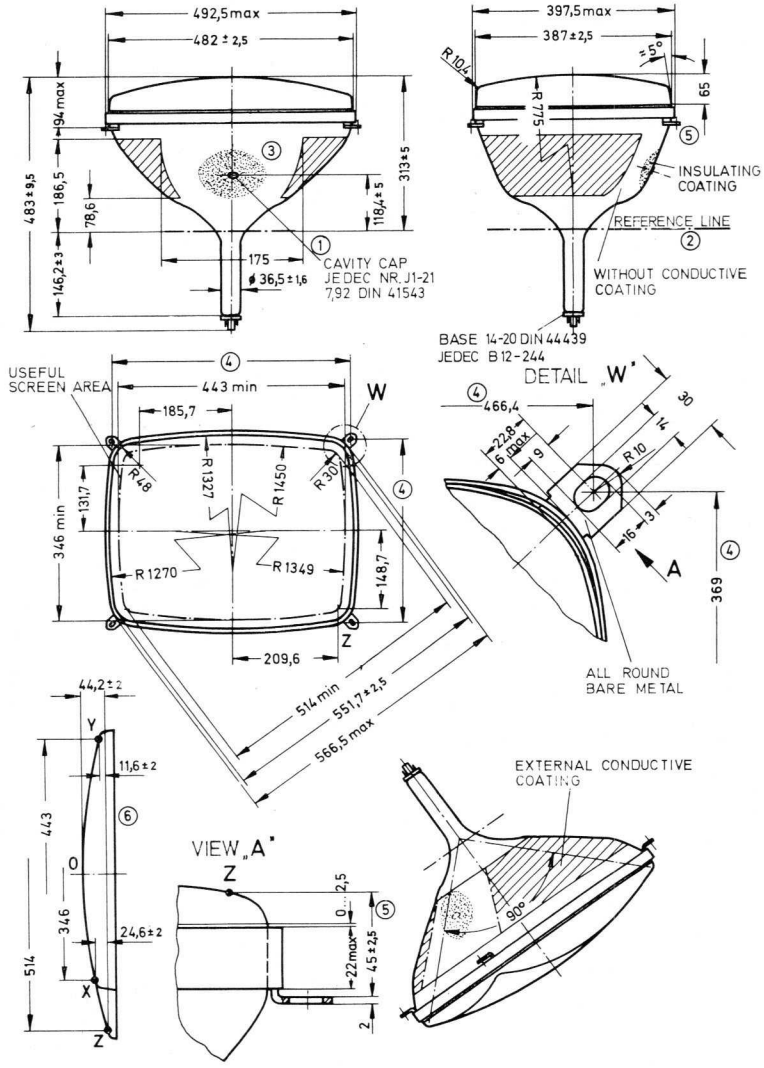
### 4. Application Data

| Displacements, measured at centre of screen: | | |
|---|---|---|
| Raster displacement | max | 12 mm |
| Lateral convergence displacement<br>blue beam with respect to converged red and green beams | max ± | 6 mm |
| Radial convergence displacement<br>excluding effects of dynamic convergence (each beam) | max ± | 9,5 mm |

# Colour Picture Tubes

## A 55–14 X

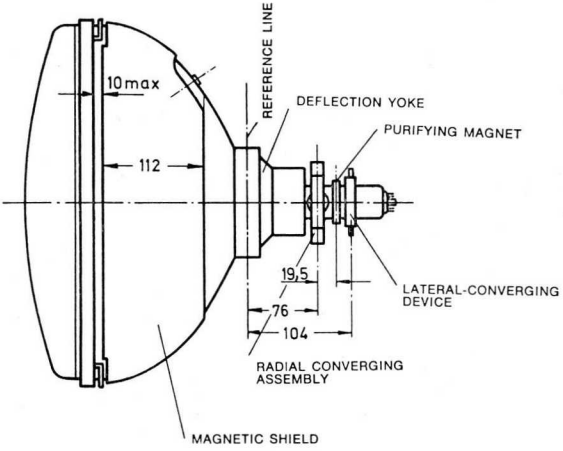
### 5. **Dimensional Drawings** in mm



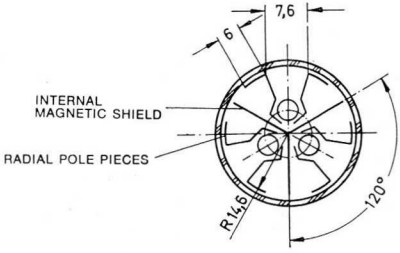

Reference line gauge see page 62

O Notes see page 63

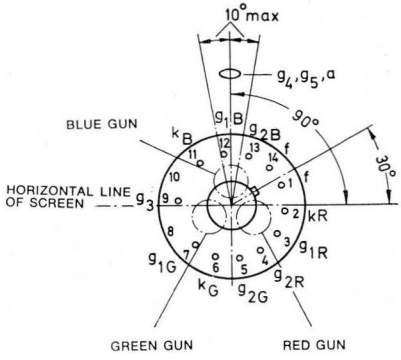
RELATIVE PLACEMENT
OF TYPICAL COMPONENTS




LOCATION OF RADIAL-CONVERGING
POLE PIECES

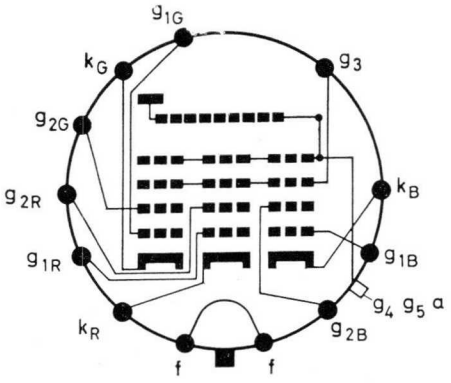



BOTTOM VIEW OF BASE



# Colour Picture Tubes

## A 56–120 X




ITT-Picture Tube A 56–120 X is a rectangular colour picture tube with 90° deflection angle and 36 mm neck diameter.
The useful screen area of 1465 cm² (appr.) has nearly straight sides of 44 x 35 cm (appr.) with 3 x 4 aspect ratio. The filter-glass of the faceplate has a light transmission of 52 % (appr.).
The phosphor screen is composed of triangular dot groups – colour triplets – each consisting of a red-, green- and blue-emitting phosphor dot. The green- and blue-emitting phosphors are silver activated sulfide phosphors, the red emitting phosphor is composed of yttrium compounds activated with rare-earths.
The tube uses three electrostatically focused guns and operates on the shadow mask principle.
The gun axes are tilted slightly toward the tube axis to facilitate convergence to the shadow mask. Beam-convergence and deflection are provided magnetically.
Implosion protection by steel reinforcement. Admitted by Association of German Electrical Engineers, VDE.

### 1. Mechanical data

| | | |
|---|---|---|
| Bulb | All-glass Type with convex rectangular Faceplate Filter-glass | |
| Implosion Protection | Steel-Jacket including Tube Mount | |
| Minimum Useful Screen Dimensions Aspect Ratio 3 x 4 | Diagonal | 533 mm |
| | Horizontal | 447 mm |
| | Vertical | 337 mm |
| Deflection Angles | Diagonal | 90° |
| | Horizontal | 79° |
| | Vertical | 63° |
| Overall Length | 472 ± 9,5 mm | |
| Weight | 15 kg (appr.) | |
| Base | JEDEC B 12-244 | |

### 2. Electrical data

#### 2.1. Typical operating conditions ①

| | |
|---|---|
| $U_f$ ② | 6,3 V |
| $I_f$ | 900 mA |
| $U_{g4g5a}$ | 25 kV |
| $U_{g3}$ | 4,2 . . . 5,0 kV |
| $U_{g2\ cutoff}$ ③ ④ (at $(-U_{g1}) = 105$ V) | 210 . . . 495 V |
| $(-U_{g1})_{cutoff}$ ④ (at $U_{g2} = 300$ V) | 70 . . . 140 V |

#### 2.2. Maximum ratings ① ⑧

| | | |
|---|---|---|
| $U_{g4g5a}$ | max ⑥ | 27,5 kV |
| $U_{g4g5a}$ | min | 20 kV |
| $I_{g4g5a}$ | max ⑤ | 1,0 mA |
| $U_{g3}$ | max | 6,0 kV |
| $U_{g2\ p}$ | max | 1,0 kV |
| $(-U_{g1})_p$ | max | 400 V |
| $(-U_{g1})$ | max | 200 V |
| $U_{g1}$ | max | 0 V |
| $U_{g1\ p}$ | max | 2 V |
| $U_{-f/k}$ | max ⑨ ⑩ | 410 V |
| $U_{-f/k}$ | max | 250 V |
| $U_{-f/k\ p}$ | max | 300 V |
| $U_{+f/k\ p}$ | max | 180 V |
| $U_{+f/k}$ | max | 135 V |

### 2.3. Ratings for circuit design

| | | |
|---|---|---|
| $I_{g3}$ | ⑦ ≦ ± | 15 µA |
| $I_{g2}$ | ⑦ ≦ ± | 5 µA |
| $I_{g1}$ $(-U_{g1})$ = 150 V | ⑦ ≦ ± | 5 µA |

### 2.4. Capacitances (appr.)

| | | |
|---|---|---|
| $c_{g1}$ | 6 | pF |
| $c_k$ | 5 | pF |
| $c_{g3}$ | 6,5 | pF |
| $c_{g4g5a/m\ max}$ | 2300 | pF |
| $c_{g4g5a/m\ min}$ | 1700 | pF |
| $c_{g4g5a/m'}$ | 280 | pF |

### 3. Optical Data

Faceplate: Filter-glass
Light Transmission (appr.) 52 %

Screen:
Three separate phosphor dots – Colour-triplets – arranged in triangular groups and aluminized.
Spacing between centres of adjacent triplets nearest centre of screen 0,64 mm appr.

| Colour dot Coordinates | x | y |
|---|---|---|
| Red | 0,630 | 0,340 |
| Green | 0,300 | 0,600 |
| Blue | 0,150 | 0,060 |
| Coordinates for White | 0,281 | 0,311 |

| Average percentage of total cathode current to produce White | |
|---|---|
| Red | 34 % |
| Green | 34 % |
| Blue | 32 % |

| Ratio of cathode currents for White | | |
|---|---|---|
| Red to Green | 1,0 | (0,65 . . . 1,5) |
| Red to Blue | 1,1 | (0,75 . . . 1,5) |
| Blue to Green | 0,9 | (0,6 . . . 1,3) |

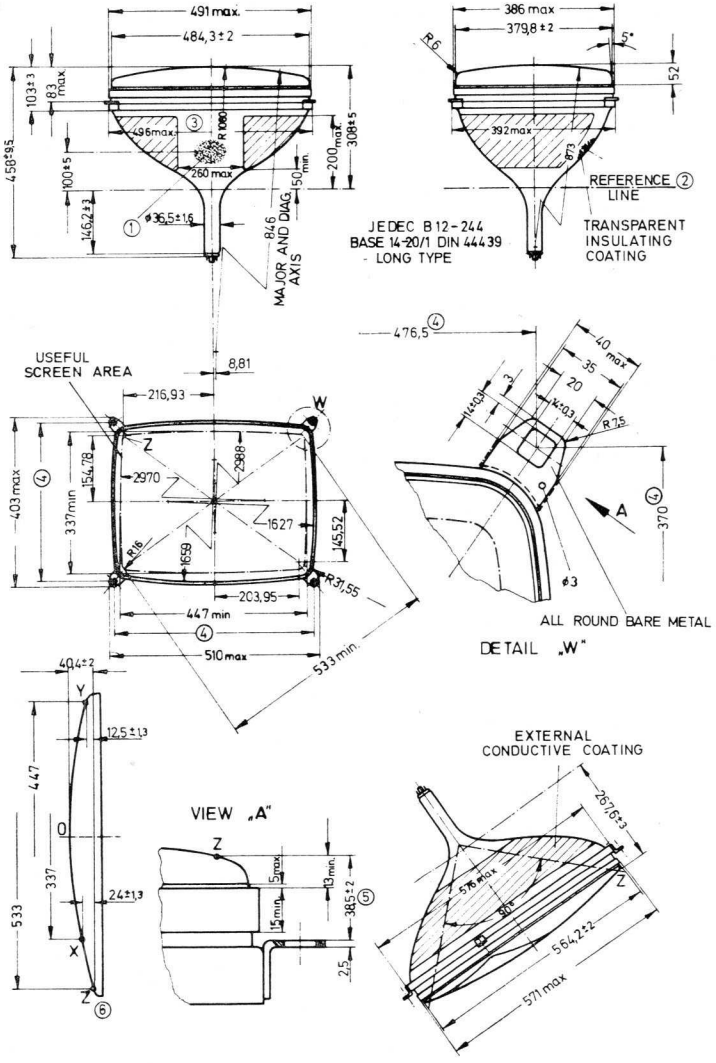
### 4. Application Data

| Displacements, measured at centre of screen: | | |
|---|---|---|
| Raster displacement | max | 12 mm |
| Lateral convergence displacement<br>blue beam with respect to converged red and green beams | max ± | 6 mm |
| Radial convergence displacement<br>excluding effects of dynamic convergence (each beam) | max ± | 9,5 mm |

# Colour Picture Tubes

## A 56–120 X

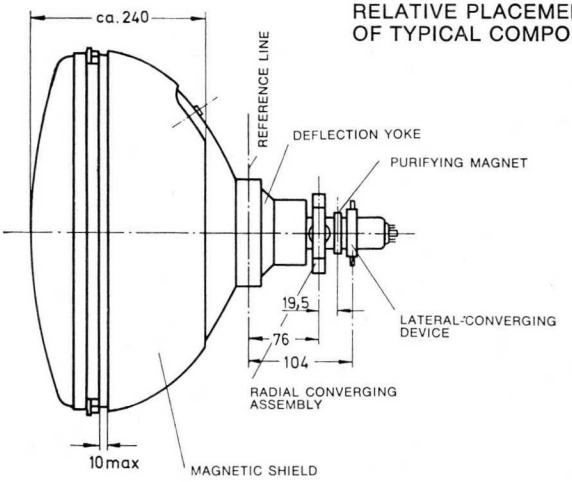
### 5. Dimensional Drawings in mm



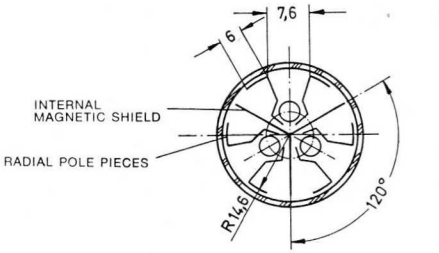

Reference line gauge see page 62

O Notes see page 63

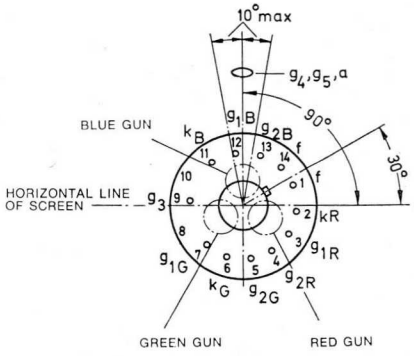
## RELATIVE PLACEMENT OF TYPICAL COMPONENTS




## LOCATION OF RADIAL-CONVERGING POLE PIECES

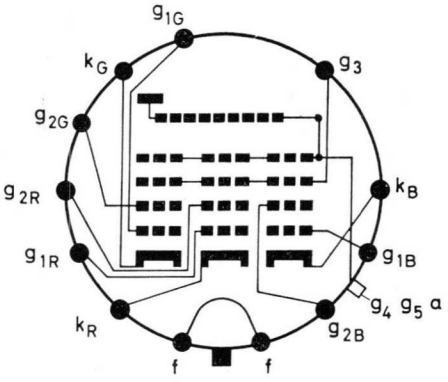



## BOTTOM VIEW OF BASE



# Colour Picture Tubes

## A 63–11 X




ITT-Picture Tube A 63–11 X is a rectangular colour picture tube with 90° deflection angle and 36 mm neck diameter.
The useful screen area of 2000 cm² (appr.) has nearly straight sides of 50 x 40 cm (appr.). The filter-glass of the faceplate has a light transmission of 52 % (appr.).
The phosphor screen is composed of triangular dot groups – colour triplets – each consisting of a red-, green- and blue-emitting phosphor dot. The green- and blue-emitting phosphors are silver activated sulfide phosphors, the red emitting phosphor is composed of yttrium compounds activated with rare-earths.
The tube uses three electrostatically focused guns and operates on the shadow mask principle.
The gun axes are tilted slightly toward the tube axis to facilitate convergence to the shadow mask. Beam-convergence and deflection are provided magnetically.
Implosion protection by steel reinforcement. Admitted by Association of German Electrical Engineers, VDE.

### 1. Mechanical data

| | | |
|---|---|---|
| Bulb | All-glass Type with convex rectangular Faceplate Filter-glass | |
| Implosion Protection | Steel-Jacket including Tube Mount | |
| Minimum Useful Screen Dimensions | Diagonal | 584 mm |
| | Horizontal | 504 mm |
| | Vertical | 396 mm |
| Deflection Angles | Diagonal | 89° |
| | Horizontal | 78° |
| | Vertical | 63° |
| Overall Length | 526 ± 9,5 mm | |
| Weight | 19 kg (appr.) | |
| Base | JEDEC B 12-244 | |

### 2. Electrical data

#### 2.1. Typical operating conditions ①

| | |
|---|---|
| $U_f$ ② | 6,3 V |
| $I_f$ | 900 mA |
| $U_{g4g5a}$ | 25 kV |
| $U_{g3}$ | 4,2 . . . 5,0 kV |
| $U_{g2\ cutoff}$ ③ ④ (at $(-U_{g1}) = 150$ V) | 285 . . . 685 V |
| $(-U_{g1})_{cutoff}$ ④ (at $U_{g2} = 400$ V) | 95 . . . 190 V |

#### 2.2. Maximum ratings ① ⑧

| | | |
|---|---|---|
| $U_{g4g5a}$ | max ⑥ | 27,5 kV |
| $U_{g4g5a}$ | min | 20 kV |
| $I_{g4g5a}$ | max ⑤ | 1,0 mA |
| $U_{g3}$ | max | 6,0 kV |
| $U_{g2\ p}$ | max | 1,0 kV |
| $(-U_{g1})_p$ | max | 400 V |
| $(-U_{g1})$ | max | 200 V |
| $U_{g1}$ | max | 0 V |
| $U_{g1\ p}$ | max | 2 V |
| $U_{-f/k}$ | max ⑨ ⑩ | 410 V |
| $U_{-f/k}$ | max | 250 V |
| $U_{-f/k\ p}$ | max | 300 V |
| $U_{+f/k\ p}$ | max | 180 V |
| $U_{+f/k}$ | max | 135 V |

### 2.3. Ratings for circuit design

| | | |
|---|---|---|
| $I_{g3}$ | ⑦ ≦ −45 . . . + 15 | µA |
| $I_{g2}$ | ⑦ ≦ ± 5 | µA |
| $I_{g1}$ $(-U_{g1})$ = 150 V | ⑦ ≦ ± 5 | µA |

### 2.4. Capacitances (approx.)

| | | |
|---|---|---|
| $c_{g1}$ | 6 | pF |
| $c_k$ | 5 | pF |
| $c_{g3}$ | 6,5 | pF |
| $c_{g4g5a/m\ max}$ | 3000 | pF |
| $c_{g4g5a/m\ min}$ | 2000 | pF |
| $c_{g4g5a/m'}$ | 400 | pF |

### 3. Optical Data

Faceplate: Filter-glass
Light Transmission (appr.) 52 %

Screen:
Three separate phosphor dots – Colour-triplets – arranged in triangular groups and aluminized.
Spacing between centres of adjacent triplets nearest centre of screen 0,74 mm appr.

| Colour dot Coordinates | x | y |
|---|---|---|
| Red | 0,630 | 0,340 |
| Green | 0,300 | 0,600 |
| Blue | 0,150 | 0,060 |
| Coordinates for White | 0,281 | 0,311 |

| Average percentage of total cathode current to produce White | |
|---|---|
| Red | 34 % |
| Green | 34 % |
| Blue | 32 % |

| Ratio of cathode currents for White | | |
|---|---|---|
| Red to Green | 1,0 | (0,65 . . . 1,5) |
| Red to Blue | 1,1 | (0,75 . . . 1,5) |
| Blue to Green | 0,9 | (0,6 . . . 1,3) |

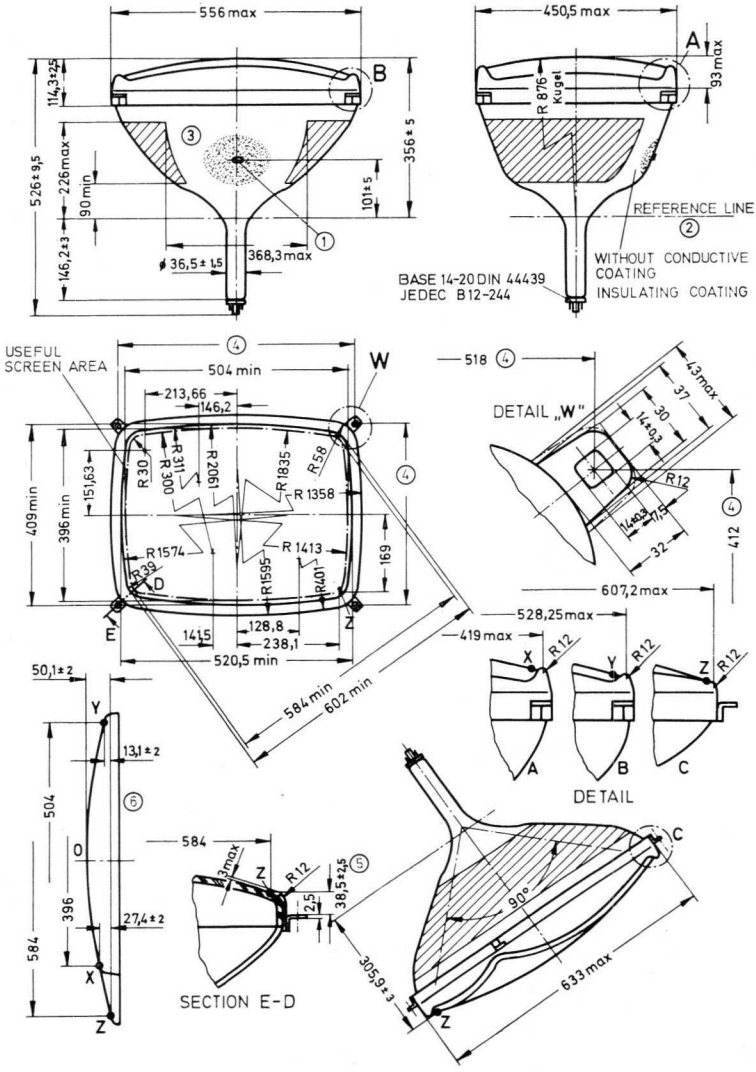
### 4. Application Data

| Displacements, measured at centre of screen: | | |
|---|---|---|
| Raster displacement | max | 15 mm |
| Lateral convergence displacement<br>blue beam with respect to converged red and green beams | max ± 6,5 mm | |
| Radial convergence displacement<br>excluding effects of dynamic convergence (each beam) | max ± 9,5 mm | |

# Colour Picture Tubes

## A 63–11 X

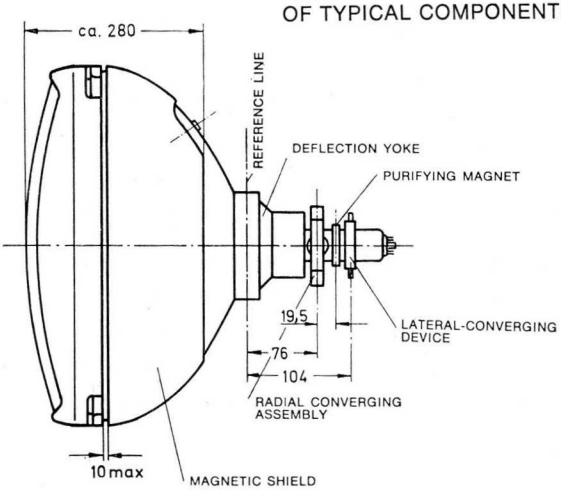
### 5. Dimensional Drawings in mm



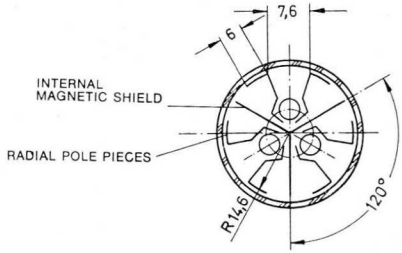

Reference line gauge see page 62

O Notes see page 63

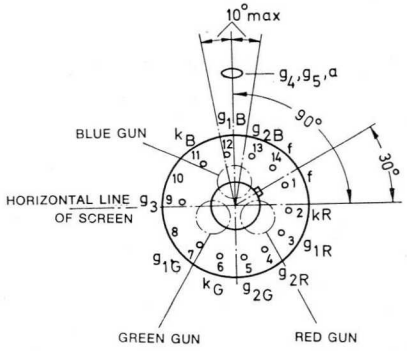
## RELATIVE PLACEMENT OF TYPICAL COMPONENTS




## LOCATION OF RADIAL-CONVERGING POLE PIECES

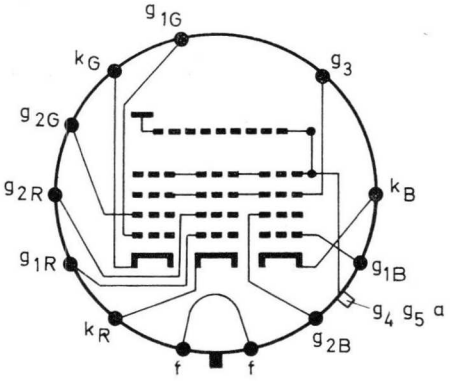



## BOTTOM VIEW OF BASE



# Colour Picture Tubes

## A 63–200 X




ITT-Picture Tube A 63–200 X is a rectangular colour picture tube with 90° deflection angle and 36 mm neck diameter.
The useful screen area of 2000 cm² (appr.) has nearly straight sides of 50 x 40 cm (appr.). The filterglass of the faceplate has a light transmission of 52 % (appr.).
The phosphor screen is composed of triangular dot groups – colour triplets – each consisting of a red-, green- and blue-emitting phosphor dot. The green- and blue-emitting phosphors are silver activated sulfide phosphors, the red emitting phosphor is composed of yttrium compounds activated with rare-earths.
The tube uses three electrostatically focused guns and operates on the shadow mask principle.
The gun axes are tilted slightly towards the tube axis to facilitate convergence to the shadow mask. Beam-convergence and deflection are provided magnetically.
Implosion protection by steel reinforcement.

### 1. Mechanical data

| | | |
|---|---|---|
| Bulb | All-glass Type with convex rectangular Faceplate Filter-glass | |
| Implosion Protection | Steel-Jacket including Tube Mount | |
| Minimum Useful Screen Dimensions | Diagonal | 584 mm |
| | Horizontal | 504 mm |
| | Vertical | 396 mm |
| Deflection Angles | Diagonal | 89° |
| | Horizontal | 78° |
| | Vertical | 63° |
| Overall Length | 526 ± 9,5 mm | |
| Weight | 19 kg (appr.) | |
| Base | JEDEC B 12-244 | |

### 2. Electrical data

#### 2.1. Typical operating conditions ①

| | | |
|---|---|---|
| $U_f$ ② | 6,3 | V |
| $I_f$ | 900 | mA |
| $U_{g4g5a}$ | 25 | kV |
| $U_{g3}$ | 4,2 . . . 5,0 | kV |
| $U_{g2\ cutoff}$ ③ ④ (at $(-U_{g1})$ = 150 V) | 285 . . . 685 | V |
| $(-U_{g1})_{\ cutoff}$ ④ (at $U_{g2}$ = 400 V) | 95 . . . 190 | V |

#### 2.2. Maximum ratings ① ⑧

| | | | |
|---|---|---|---|
| $U_{g4g5a}$ | max ⑥ | 27,5 | kV |
| $U_{g4g5a}$ | min | 20 | kV |
| $I_{g4g5a}$ | max ⑤ | 1,0 | mA |
| $U_{g3}$ | max | 6,0 | kV |
| $U_{g2\ p}$ | max | 1,0 | kV |
| $(-U_{g1})_{\ p}$ | max | 400 | V |
| $(-U_{g1})$ | max | 200 | V |
| $U_{g1}$ | max | 0 | V |
| $U_{g1\ p}$ | max | 2 | V |
| $U_{-f/k}$ | max ⑨ ⑩ | 410 | V |
| $U_{-f/k}$ | max | 250 | V |
| $U_{-f/k\ p}$ | max | 300 | V |
| $U_{+f/k\ p}$ | max | 180 | V |
| $U_{+f/k}$ | max | 135 | V |

### 2.3. Ratings for circuit design

| | | |
|---|---|---|
| $I_{g3}$ | ⑦ ≦ | −45 . . . + 15 µA |
| $I_{g2}$ | ⑦ ≦ | ± 5 µA |
| $I_{g1}$ $(-U_{g1})$ = 150 V | ⑦ ≦ | ± 5 µA |

### 2.4. Capacitances

| | |
|---|---|
| $C_{g1}$ | 6 pF |
| $C_k$ | 5 pF |
| $C_{g3}$ | 6,5 pF |
| $C_{g4g5a/m\ max}$ | 3000 pF |
| $C_{g4g5a/m\ min}$ | 2000 pF |
| $C_{g4g5a/m'}$ | 280 pF |

### 3. Optical Data

Faceplate: Filter-glass
Light Transmission (appr.) 52 %

Screen:
Three separate phosphor dots – Colour-triplets – arranged in triangular groups and aluminized.
Spacing between centres of adjacent triplets nearest centre of screen 0,74 mm appr.

| Colour dot Coordinates | x | y |
|---|---|---|
| Red | 0,630 | 0,340 |
| Green | 0,300 | 0,600 |
| Blue | 0,150 | 0,060 |
| Coordinates for White | 0,281 | 0,311 |

Average percentage of total cathode current to produce White

| | |
|---|---|
| Red | 34 % |
| Green | 34 % |
| Blue | 32 % |

Ratio of cathode currents for White

| | | |
|---|---|---|
| Red to Green | 1,0 | (0,65 . . . 1,5) |
| Red to Blue | 1,1 | (0,75 . . . 1,5) |
| Blue to Green | 0,9 | (0,6 . . . 1,3) |

### 4. Application Data

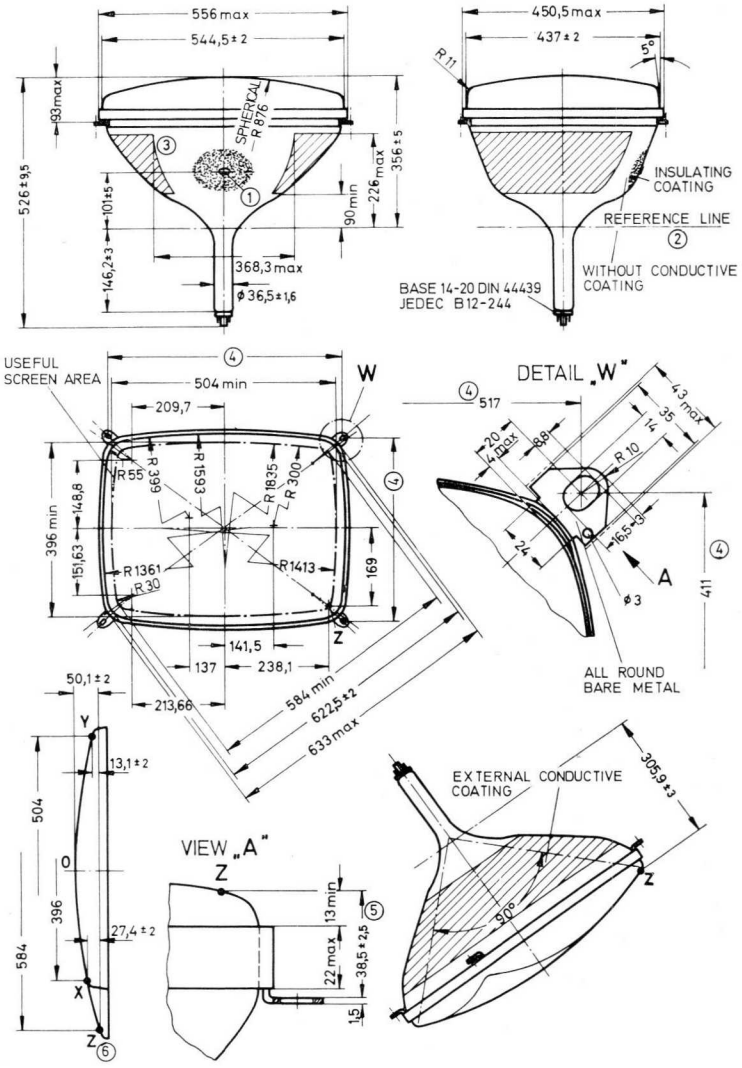
Displacements, measured at centre of screen:

| | | |
|---|---|---|
| Raster displacement | max | 15 mm |
| Lateral convergence displacement<br>blue beam with respect to converged red and green beams | max ± 6,5 mm | |
| Radial convergence displacement<br>excluding effects of dynamic convergence (each beam) | max ± 9,5 mm | |

# Colour Picture Tubes

## A 63–200 X

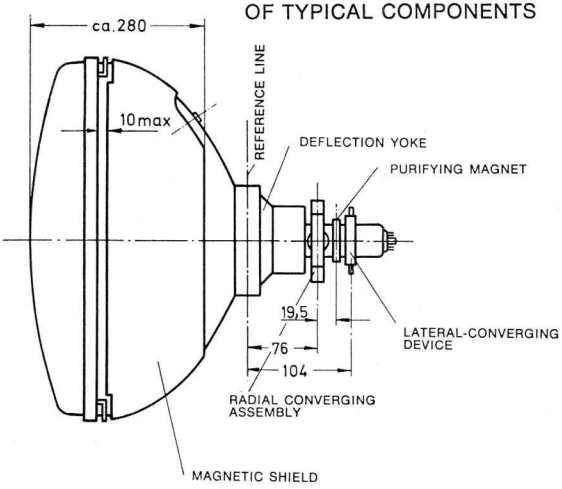
### 5. Dimensional Drawings in mm



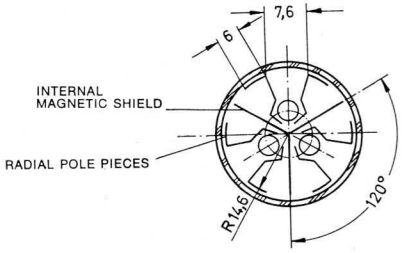

Reference line gauge see page 62

O Notes see page 63

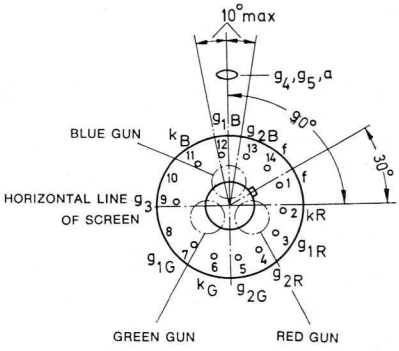
## RELATIVE PLACEMENT OF TYPICAL COMPONENTS




## LOCATION OF RADIAL-CONVERGING POLE PIECES

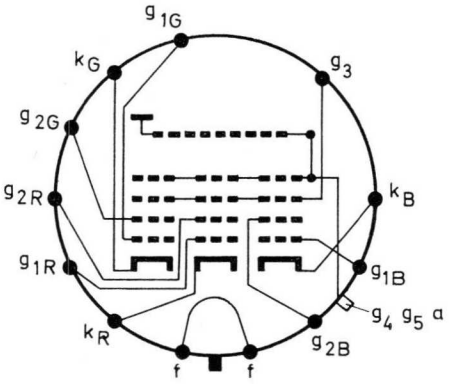



## BOTTOM VIEW OF BASE



# Colour Picture Tubes

## A 66–120 X




### 1. Mechanical data

| | | |
|---|---|---|
| Bulb | All glass Type with convex rectangular Faceplate Filter-glass | |
| Implosion Protection | Steel-Jacket including Tube Mount | |
| Minimum Useful Screen Dimensions Aspect Ratio 3 x 4 | Diagonal | 618 mm |
| | Horizontal | 518 mm |
| | Vertical | 390 mm |
| Deflection Angles | Diagonal | 90° |
| | Horizontal | 79° |
| | Vertical | 62° |
| Weight | 21 kg (appr.) | |
| Base | JEDEC B 12-244 | |

ITT-Picture Tube A 66–120 X is a rectangular colour picture tube with 90° deflection angle and 36 mm neck diameter.
The useful screen area of 2030 cm² (appr.) has nearly straight sides of 52 x 39 cm (appr.) with 3 x 4 aspect ratio. The filterglass of the faceplate has a light transmission of 52 % (appr.).
The phosphor screen is composed of triangular dot groups – colour triplets – each consisting of a red-, green- and blue-emitting phosphor dot. The green- and blue-emitting phosphors are silver activated sulfide phosphors, the red emitting phosphor is composed of yttrium compounds activated with rare-earths.
The tube uses three electrostatically focused guns and operates on to the shadow mask principle.
The gun axes are tilted slightly towards the tube axis to facilitate convergence to the shadow mask. Beam-convergence and deflection are provided magnetically.
Implosion protection by steel reinforcement. Admitted by Association of German Electrical Engineers, VDE.

### 2. Electrical data

#### 2.1. Typical operating conditions ①

| | | |
|---|---|---|
| $U_f$ ② | 6,3 | V |
| $I_f$ | 900 | mA |
| $U_{g4g5a}$ | 25 | kV |
| $U_{g3}$ | 4,2 . . . 5,0 | kV |
| $U_{g2\ cutoff}$ ③ ④ (at $(-U_{g1}) = 105$ V) | 210 . . . 495 | V |
| $(-U_{g1})_{cutoff}$ ④ (at $U_{g2} = 300$ V) | 70 . . . 140 | V |

#### 2.2. Maximum ratings ① ⑧

| | | | |
|---|---|---|---|
| $U_{g4g5a}$ | max ⑥ | 27,5 | kV |
| $U_{g4g5a}$ | min | 20 | kV |
| $I_{g4g5a}$ | max ⑤ | 1,0 | mA |
| $U_{g3}$ | max | 6,0 | kV |
| $U_{g2\ p}$ | max | 1,0 | kV |
| $(-U_{g1})_{p}$ | max | 400 | V |
| $(-U_{g1})$ | max | 200 | V |
| $U_{g1}$ | max | 0 | V |
| $U_{g1\ p}$ | max | 2 | V |
| $U_{-f/k}$ | max ⑨⑩ | 410 | V |
| $U_{-f/k}$ | max | 250 | V |
| $U_{-f/k\ p}$ | max | 300 | V |
| $U_{+f/k\ p}$ | max | 180 | V |
| $U_{+f/k}$ | max | 135 | V |

### 2.3. Ratings for circuit design

| | | |
|---|---|---|
| $I_{g3}$ | ⑦ ≦ | ± 15 µA |
| $I_{g2}$ | ⑦ ≦ | ± 5 µA |
| $I_{g1}$ $(-U_{g1})$ = 150 V | ⑦ ≦ | ± 5 µA |

### 2.4. Capacitances

| | |
|---|---|
| $C_{g1}$ | 7 pF |
| $C_k$ | 5 pF |
| $C_{g3}$ | 7 pF |
| $C_{g4g5a/m\ max}$ | 2500 pF |
| $C_{g4g5a/m\ min}$ | 2000 pF |
| $C_{g4g5a/m'}$ | 500 pF |

### 3. Optical Data

Faceplate: Filter-glass
Light Transmission (appr.) 52 %

Screen: Aspect Ratio 3 x 4.
Three separate phosphor dots – Colour-triplets – arranged in triangular groups and aluminized.
Spacing between centres of adjacent triplets nearest centre of screen 0,81 mm appr.

| Colour dot Coordinates | x | y |
|---|---|---|
| Red | 0,630 | 0,340 |
| Green | 0,300 | 0,600 |
| Blue | 0,150 | 0,060 |
| Coordinates for White | 0,281 | 0,311 |

Average percentage of total cathode current to produce White

| | |
|---|---|
| Red | 34 % |
| Green | 34 % |
| Blue | 32 % |

Ratio of cathode currents for White

| | | |
|---|---|---|
| Red to Green | 1,0 | (0,65 . . . 1,5) |
| Red to Blue | 1,1 | (0,75 . . . 1,5) |
| Blue to Green | 0,9 | (0,6 . . . 1,3) |

### 4. Application Data

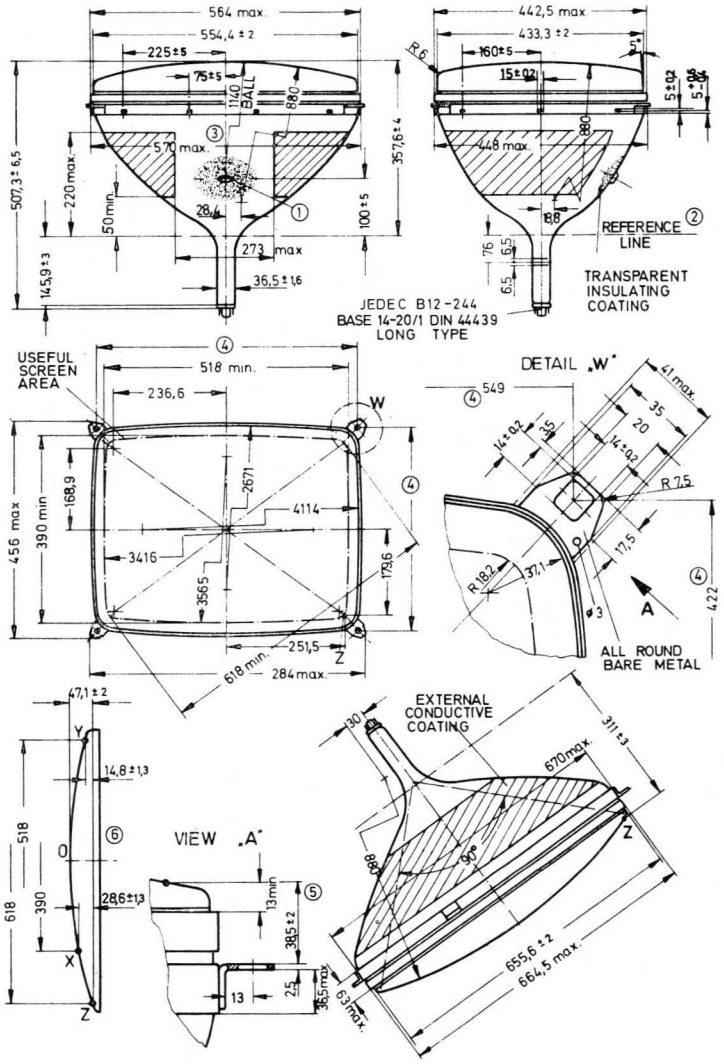
Displacements, measured at centre of screen:

| | |
|---|---|
| Raster displacement | max 15 mm |
| Lateral convergence displacement<br>blue beam with respect to converged red and green beams | max ± 6,5 mm |
| Radial convergence displacement<br>excluding effect of dynamic convergence (each beam) | max ± 9,5 mm |

# Colour Picture Tubes

## A 66–120 X

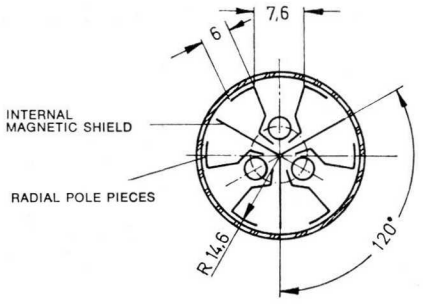
### 5. **Dimensional Drawings** in mm



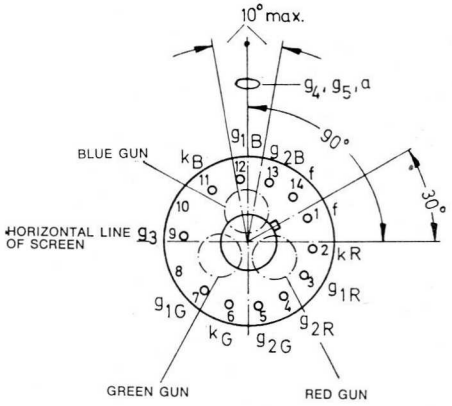

Reference line gauge see page 62

O Notes see page 63

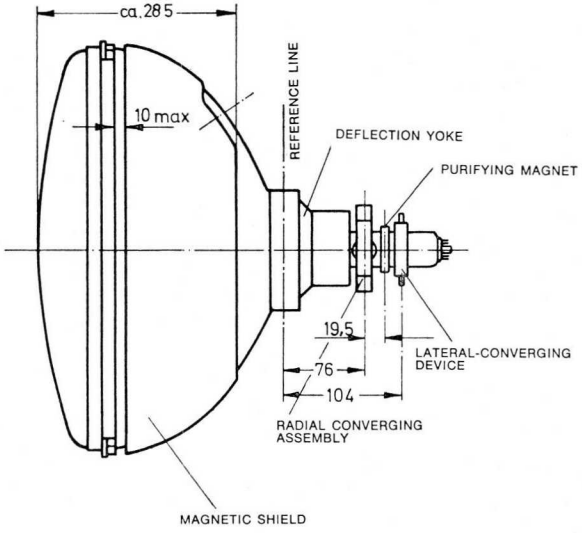
LOCATION OF RADIAL-CONVERGING POLE PIECES




BOTTOM VIEW OF BASE

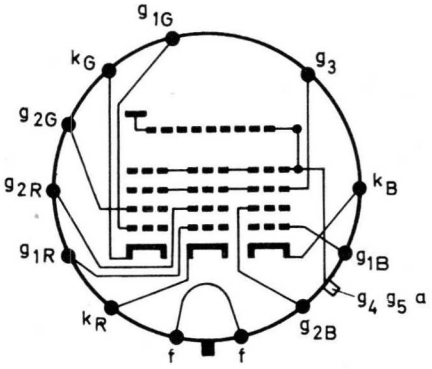



RELATIVE PLACEMENT OF TYPICAL COMPONENTS



# Colour Picture Tubes

## A 66–140 X




### 1. Mechanical Data

| | | |
|---|---|---|
| Bulb | All-glas Type with convex rectangular Faceplate Filter-glass | |
| Implosion Protection | Steel-reinforcement including mounting lugs | |
| Minimum Useful Screen Dimensions | Diagonal | 618 mm |
| | Horizontal | 518 mm |
| | Vertical | 390 mm |
| | Aspect ratio | 3 x 4 |
| Deflection Angles | Diagonal | 110° |
| | Horizontal | 97° |
| | Vertical | 77° |
| Weight | 20 kg (appr.) | |
| Base | JEDEC B 12-244 | |

ITT-Picture Tube A 66–140 X is a rectangular colour picture tube with 110° deflection angle and 36 mm neck diameter. The useful screen area of 2030 cm² (appr.) has nearly straight sides of 52 x 39 cm (appr.) with 3 x 4 aspect ratio. The filterglass of the faceplate has a light transmission of 52% (appr.).

The phosphor screen is composed of triangular dot groups – colour triplets – each consisting of a red-, green- and blue-emitting phosphor dot. The green- and blue-emitting phosphors are silver activated sulfide phosphors, the red emitting phosphor is composed of yttrium compounds activated with rare-earths.

The tube uses three electrostatically focused guns and operates on the shadow mask principle.

The gun axes are tilted slightly towards the tube axis to facilitate convergence to the shadow mask. Beam-convergence and deflection are provided magnetically.

Implosion protection by steel reinforcement. Admitted by Association of German Electrical Engineers, VDE.

### 2. Electrical Data

#### 2.1. Typical Operating Conditions ①

| | |
|---|---|
| $U_f$ ② | 6,3 V |
| $I_f$ | 900 mA |
| $U_{g4g5a}$ | 25 kV |
| $U_{g3}$ | 4,2 . . . 5,0 kV |
| $U_{g2\ cutoff}$ ③ ④ (at $(-U_{g1}) = 105$ V) | 210 . . . 495 V |
| $(-U_{g1})_{cutoff}$ ④ (at $U_{g2} = 300$ V) | 70 . . . 140 V |

#### 2.2. Maximum Ratings ① ⑧

| | |
|---|---|
| $U_{g4g5a\ max}$ ⑥ | 27,5 kV |
| $U_{g4g5a\ min}$ | 20 kV |
| $I_{g4g5a\ max}$ ⑤ | 1,0 mA |
| $U_{g3\ max}$ | 6,0 kV |
| $U_{g2\ p\ max}$ | 1,0 kV |
| $(-U_{g1})_{p\ max}$ | 400 V |
| $(-U_{g1})_{max}$ | 200 V |
| $U_{g1\ max}$ | 0 V |
| $U_{g1\ p\ max}$ | 2 V |
| $U_{-f/k\ max}$ ⑨ ⑩ | 410 V |
| $U_{-f/k\ max}$ | 250 V |
| $U_{-f/k\ p\ max}$ | 300 V |
| $U_{+f/k\ p\ max}$ | 180 V |
| $U_{+f/k\ max}$ | 135 V |

### 2.3. Ratings for Circuit Design

| | |
|---|---|
| $I_{g3}$ ⑦ | $\leqq \pm 15\ \mu A$ |
| $I_{g2}$ ⑦ | $\leqq \pm 5\ \mu A$ |
| $I_{g1}\ (-U_{g1}) = 150\ V$ ⑦ | $\leqq \pm 5\ \mu A$ |

### 2.4. Capacitances (appr.)

| | |
|---|---|
| $C_{g1}$ | 7 pF |
| $C_k$ | 5 pF |
| $C_{g3}$ | 7 pF |
| $C_{g4g5a/m\ max}$ | 2500 pF |
| $C_{g4g5a/m\ min}$ | 2000 pF |
| $C_{g4g5a/m}$ ' | 500 pF |

### 3. Optical Data

Faceplate: Filter-glass
Light Transmission (appr.) 52 %

Screen: Aspect Ratio 3 x 4.
Three separate phosphor dots – Colour-triplets – arranged in triangular groups and aluminized.
Spacing between centres of adjacent triplets nearest centre of screen 0,81 mm appr.

| Colour dot Coordinates | x | y |
|---|---|---|
| Red | 0,630 | 0,340 |
| Green | 0,300 | 0,600 |
| Blue | 0,150 | 0,060 |
| Coordinates for White | 0,281 | 0,311 |

Average percentage of total cathode current to produce White

| | |
|---|---|
| Red | 34% |
| Green | 34% |
| Blue | 32% |

Ratio of cathode currents for White

| | |
|---|---|
| Red to Green | 1,0 (0,65 . . . 1,5) |
| Red to Blue | 1,1 (0,75 . . . 1,5) |
| Blue to Green | 0,9 (0,6 . . . 1,3) |

### 4. Application Data

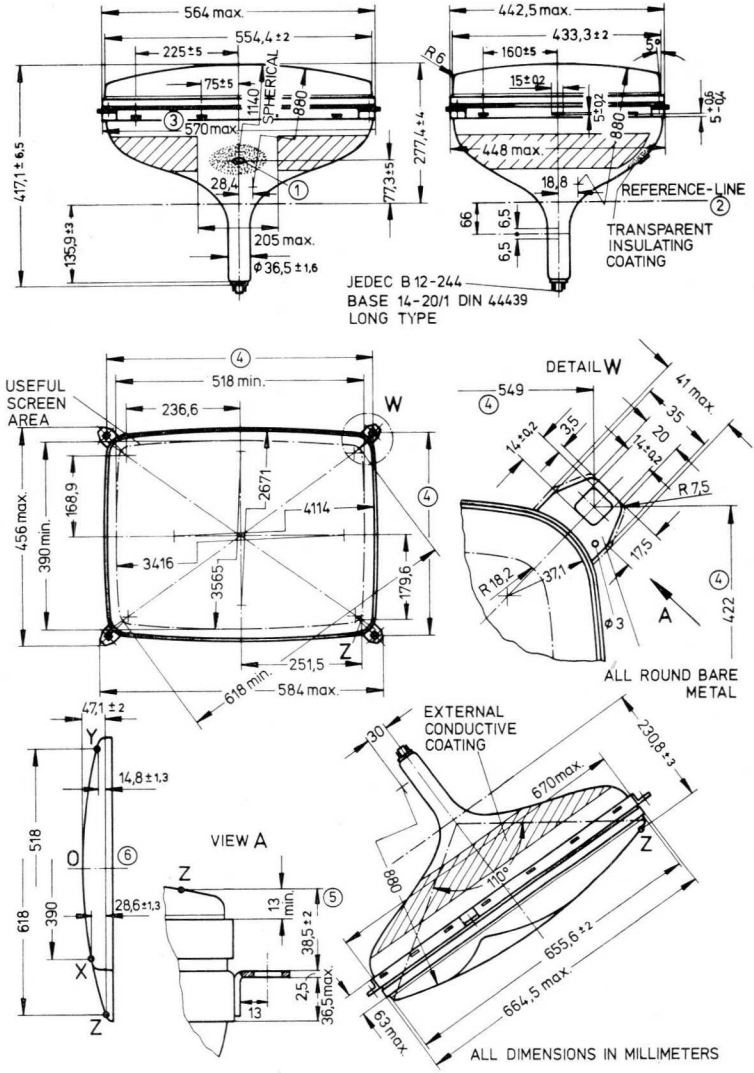
Displacements, measured at centre of screen:

| Raster displacement | max | 15 mm |
|---|---|---|
| Lateral convergence displacement<br>blue beam with respect to converged red and green beams | max ± | 5 mm |
| Radial convergence displacement<br>excluding effects of dynamic convergence (each beam) | max ± | 8 mm |

# Colour Picture Tubes

## A 66–140 X

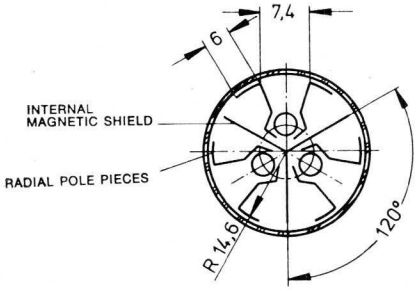
### 5. Dimensional Drawings in mm



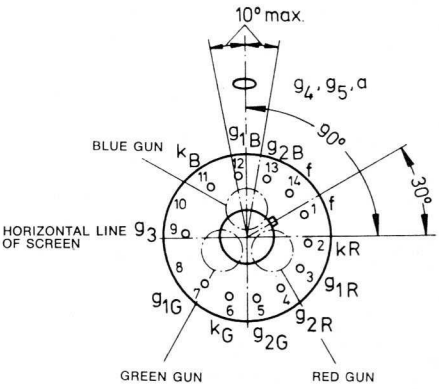

Reference line gauge see page 62

O Notes see page 63

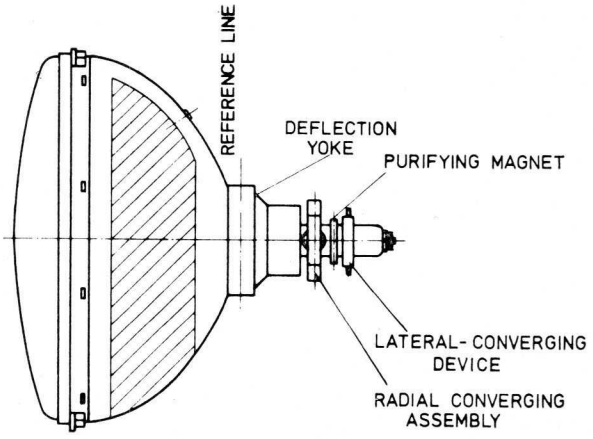
LOCATION OF RADIAL-CONVERGING POLE PIECES




BOTTOM VIEW OF BASE

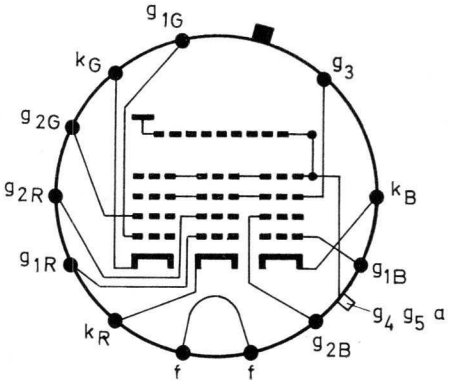



RELATIVE PLACEMENT OF TYPICAL COMPONENTS



# Colour Picture Tubes

## A 67–150 X




### 1. Mechanical Data

| | | |
|---|---|---|
| Bulb | All-glass Type with convex rectangular Faceplate Filter-glass | |
| Implosion Protection | Steel-Jacket including Tube Mount | |
| Minimum Useful Screen Dimensions Aspect Ratio 3 x 4 | Diagonal | 626 mm |
| | Horizontal | 528 mm |
| | Vertical | 396 mm |
| Deflection Angles | Diagonal | 110° |
| | Horizontal | 97° |
| | Vertical | 77° |
| Weight | 20 kg (appr.) | |
| Base | JEDEC B 12–260 | |

ITT-Picture Tube A 67 – 150 X is a rectangular colour picture tube with 110° deflection angle and 29 mm neck diameter. The useful screen area of 2100 cm² (appr.) has nearly straight sides of 53 x 40 cm (appr.) with 3 x 4 aspect ratio. The filterglass of the faceplate has a light transmission of 49,5% (appr.).

The phosphor screen is composed of triangular dot groups – colour triplets – each consisting of a red-, green- and blue-emitting phosphor dot. The green- and blue-emitting phosphors are silver activated sulfide phosphors, the red emitting phosphor is composed of yttrium compounds activated with rare-earths.

The tube uses three electrostatically focused guns and operates on the shadow mask principle.

The gun axes are tilted slightly towards the tube axis to facilitate convergence to the shadow mask. Beam-convergence and deflection are provided magnetically.

Implosion protection by steel reinforcement.

### 2. Electrical Data

#### 2.1. Typical Operating Conditions ①

| | |
|---|---|
| $U_f$ ② | 6,3 V |
| $I_f$ | 900 mA |
| $U_{g4g5a}$ | 25 kV |
| $U_{g3}$ | 4,2 . . . 5,0 kV |
| $U_{g2\ cutoff}$ ③ ④ (at $(-U_{g1}) = 105$ V) | 160 . . . 445 V |
| $(-U_{g1})_{cutoff}$ ④ (at $U_{g2} = 300$ V) | 76 . . . 162 V |

#### 2.2. Maximum Ratings ① ⑧

| | |
|---|---|
| $U_{g4g5a\ max}$ ⑥ | 27,5 kV |
| $U_{g4g5a\ min}$ | 20 kV |
| $I_{g4g5a\ max}$ ⑤ | 1,0 mA |
| $U_{g3\ max}$ | 6,0 kV |
| $U_{g2\ p\ max}$ | 1,0 kV |
| $(-U_{g1})_{p\ max}$ | 400 V |
| $(-U_{g1})_{max}$ | 200 V |
| $U_{g1\ max}$ | 0 V |
| $U_{g1\ p\ max}$ | 2 V |
| $U_{-f/k\ max}$ ⑨ ⑩ | 450 V |
| $U_{-f/k\ max}$ | 200 V |
| $U_{-f/k\ p\ max}$ | 200 V |
| $U_{+f/k\ p\ max}$ | 200 V |
| $U_{+f/k\ max}$ | 0 V |

### 2.3. Ratings for Circuit Design

| | |
|---|---|
| $I_{g3}$ ⑦ | $\leqq \pm 15$ µA |
| $I_{g2}$ ⑦ | $\leqq \pm 5$ µA |
| $I_{g1}$ $(-U_{g1}) = 150$ V ⑦ | $\leqq \pm 5$ µA |

### 2.4. Capacitances (appr.)

| | |
|---|---|
| $C_{g1}$ | 3,8 pF |
| $C_k$ | 6,3 pF |
| $C_{g3}$ | 2,6 pF |
| $C_{g4g5a/m\ max}$ | 2500 pF |
| $C_{g4g5a/m\ min}$ | 2000 pF |
| $C_{g4g5a/m}$ ' | 450 pF |

### 3. Optical Data

Faceplate: Filter-glass
Light Transmission (appr.) 49,5 %

Screen: Aspect Ratio 3 x 4.
Three separate phosphor dots – Colour-triplets – arranged in triangular groups and aluminized.
Spacing between centres of adjacent triplets nearest centre of screen 0,66 mm appr.

| Colour dot Coordinates | x | y |
|---|---|---|
| Red | 0,630 | 0,340 |
| Green | 0,300 | 0,600 |
| Blue | 0,150 | 0,060 |
| Coordinates for White | 0,281 | 0,311 |

| Average percentage of total cathode current to produce White | |
|---|---|
| Red | 34% |
| Green | 34% |
| Blue | 32% |

| Ratio of cathode currents for White | |
|---|---|
| Red to Green | 1,0 (0,65 . . . 1,50) |
| Red to Blue | 1,1 (0,75 . . . 1,50) |
| Blue to Green | 0,9 (0,6 . . . 1,30) |

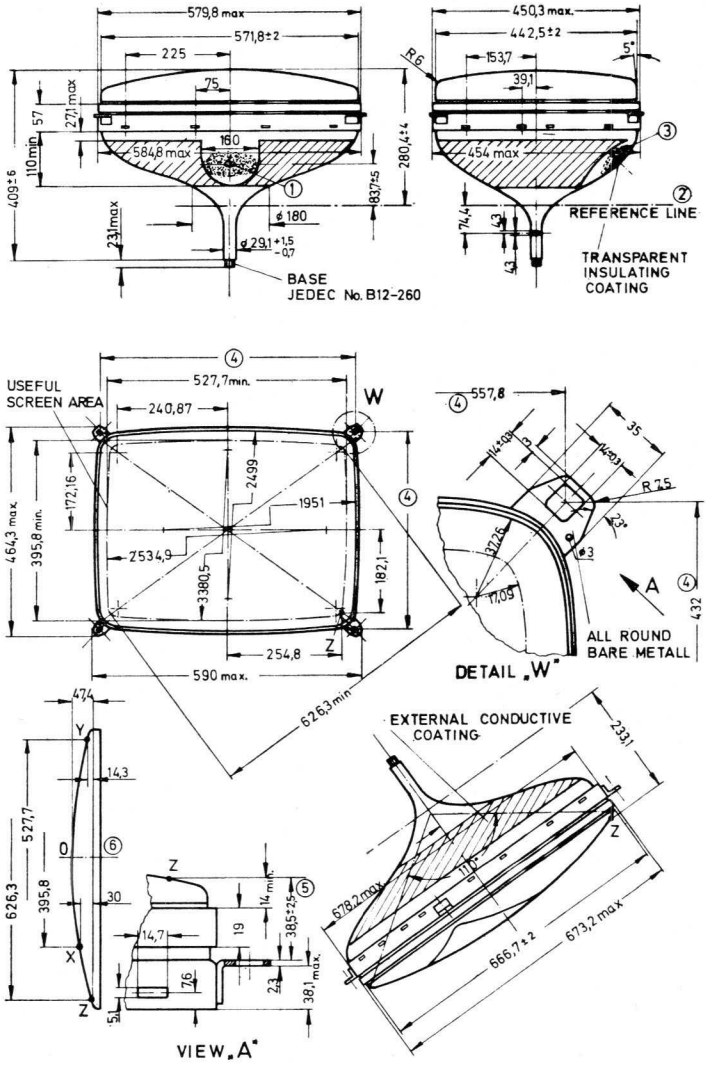
### 4. Application data

| Displacements, measured at centre of screen: | | |
|---|---|---|
| Raster displacement | max | 12 mm |
| Lateral convergence displacement<br>blue beam with respect to converged red and green beams | max | ± 6 mm |
| Radial convergence displacement<br>excluding effects of dynamic convergence (each beam) | max | ± 8 mm |

# Colour Picture Tubes

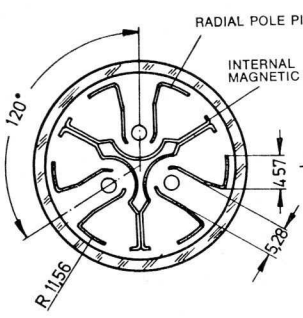
## A 67–150 X

### 5. **Dimensional Drawings** in mm

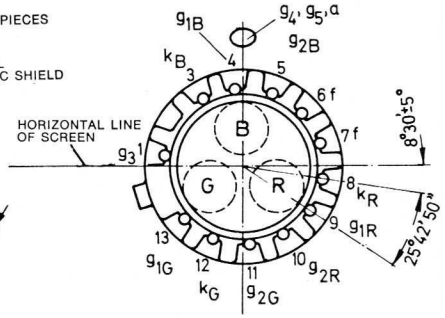



Reference line gauge see page 62

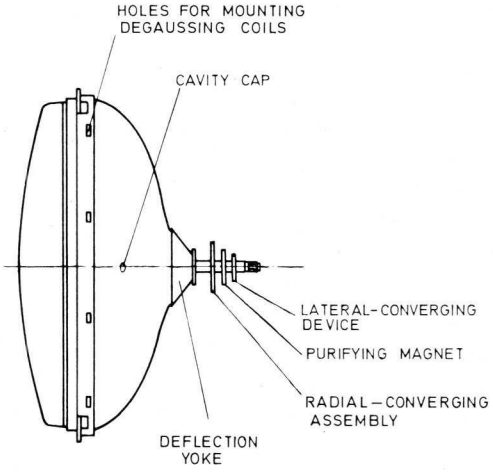
O Notes see page 63




LOCATION OF RADIAL-CONVERGING POLE PIECES




BOTTOM VIEW OF BASE




RELATIVE PLACEMENT OF TYPICAL COMPONENTS

# Colour Picture Tubes

ITT Components are available from:

or directly from:

**ITT Components Group Europe**

Standard Elektrik Lorenz AG
Components Group
D-7300 Eßlingen
P.O. Box 807 · Fritz-Müller-Straße 112
Telephone (07 11) 35 14-1 · Telex 7 256 545

L 3099-273-2. S+K