DISPLAY COMPONENTS

Colour Monitor and Multimedia Tubes

1998

Data Handbook DC04

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PRODUCT SAFETY

In striving for state-of-the-art perfection, we continuously improve components and processes with respect to environmental demands. Our components offer no hazard to the environment in normal use when operated or stored within the limits specified in the data sheet.

Some components unavoidably contain substances that, if exposed by accident or misuse, are potentially hazardous to health. Users of these components are informed of the danger by warning notices in the data sheets supporting the components. Where necessary the warning notices also indicate safety precautions to be taken and disposal instructions to be followed. Obviously users of these components, in general the set-making industry, assume responsibility towards the consumer with respect to safety matters and environmental demands.

All used or obsolete components should be disposed of according to the regulations applying at the disposal location. Depending on the location, electronic components are considered to be 'chemical', 'special' or sometimes 'industrial' waste. Disposal as domestic waste is usually not permitted.

Colour Monitor and Multimedia Tubes

CONTENTS

DEFINITIONS

Data sheet status	
Objective specification	This data sheet contains target or goal specifications for product development.
Preliminary specification	This data sheet contains preliminary data; supplementary data may be published later.
Product specification	This data sheet contains final product specifications.
Limiting values	
Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 134). Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only and operation of the device at these or at any other conditions above those given in the Characteristics sections of the specification is not implied. Exposure to limiting values for extended periods may affect device reliability.	

LIFE SUPPORT APPLICATIONS

These products are not designed for use in life support appliances, devices, or systems where malfunction of these products can reasonably be expected to result in personal injury. Philips customers using or selling these products for use in such applications do so at their own risk and agree to fully indemnify Philips for any damages resulting from such improper use or sale.

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List of symbols

LIST OF SYMBOLS

SYMBOL	DESCRIPTION
Symbols denoting electrodes/elements and electrode/element connections	
f	heater
k	cathode
g	grid: grids are distinguished by means of an additional numeral; the electrode nearest to the cathode having the lowest number
a	anode
m	external conductive coating
m′	rimband or tension band (T-band)
i.c.	tube pin which must not be connected externally (internally connected)
n.c.	tube pin which may be connected externally (not connected)
Symbols denoting voltages; note 1	
V	symbol for voltage followed by a subscript denoting the relevant electrode/element
V_f	heater voltage
$V_{(p-p)}$	peak-to-peak value of a voltage
V_p	peak value of a voltage
V_{gr}	grid 1 voltage for visual extinction of focused raster (grid drive service)
V_{kr}	cathode voltage for visual extinction of focused raster (cathode drive service)
Symbols denoting currents; note 2	
I	symbol for current followed by a subscript denoting the relevant electrode
I_f	heater current (RMS value)
Symbols denoting powers	
P_l	fluorescent screen dissipation
P_g	grid dissipation
Symbols denoting capacitances	
	see *"IEC 100"*
Symbols denoting resistances and impedances	
R	Symbol for resistance followed by a subscript for the relevant electrode pair. When only one subscript is given the second electrode is the cathode.
Z	Symbol for impedance followed by a subscript for the relevant electrode pair. When only one subscript is given the second electrode is the cathode.
Symbols denoting various quantities	
L	luminance
f	frequency
H	magnetic field strength

Notes

1. The reference point for electrode voltages is the cathode, unless otherwise stated.
2. The symbols quoted represent the average value of the current, unless otherwise stated.

General operational recommendations

INTRODUCTION

Equipment design should be based on the characteristics as stated in the data sheets. Where deviations from these general recommendations are permissible or necessary, statements to that effect will be made.

If applications are considered which are not referred to in the data sheets of the relevant tube type, extra care should be taken with circuit design to prevent the tube being overloaded due to unfavourable operating conditions.

SPREAD IN TUBE CHARACTERISTICS

The spread in tube characteristics is the difference between maximum and minimum values. Values not qualified as maximum or minimum are nominal ones. It is evident that average or nominal values, as well as spread figures, may differ according to the number of tubes of a certain type that are being checked. No guarantee is given for values of characteristics in settings substantially differing from those specified in the data sheets.

SPREAD AND VARIATION IN OPERATING CONDITIONS

The operating conditions of a tube are subject to spread and/or variation.

Spread in an operating condition is a **permanent** deviation from an average condition due to, e.g., component value deviations. The average condition is found from such a large population, that further individual cases taken at random will have negligible influence.

Variation in an operating condition is **non-permanent** (occurs as a function of time), e.g., due to supply voltage fluctuations. The average value is calculated over a long enough period that this value is considered as stable.

LIMITING VALUES

Limiting values are in accordance with the applicable rating system as defined by *"IEC 134"*. Reference may be made to one of the following three rating systems.

Absolute maximum rating system

Absolute maximum ratings are limiting values of operating and environmental conditions applicable to any electronic device of a specified type, as defined by its published data, which should not be exceeded under the worst probable conditions.

These values are chosen by the device manufacturer to provide acceptable serviceability of the device, taking no responsibility for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the device under consideration and of all other electronic devices in the equipment.

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

Design maximum rating system

Design maximum ratings are limiting values of operating and environmental conditions applicable to a bogey electronic device[1] of a specified type as defined by its published data, and should not be exceeded under the worst probable conditions.

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

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

(1) A bogey electronic device is a device whose characteristics have the published nominal values for the type. A bogey device for any particular application can be obtained by considering only those characteristics which are directly related to the application.

General operational recommendations

Design centre rating system

Design centre ratings are limiting values of operating and environmental conditions applicable to a bogey electronic device of a specified type as defined by its published data, and should not be exceeded under normal conditions.

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

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

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

The expressions 'long-term' and 'short-term' are used to denote either the maximum time-averaged beam current for one gun to limit the cathode loading, or the maximum time-averaged anode current for three guns to limit the screen loading.

'Short-term' is not related to a specific period of time, but can be interpreted as the condition where the content and intensity of the displayed image vary continuously.

'Long-term' means that the image is stationary for an indefinite period of time, as during the display of test pictures, computer images or stationary monitor scenes lasting longer than 30 seconds.

Thermal conditions, like components ratings, heatsinks and cabinet design, should be based on the short-term average rating.

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

HEATER SUPPLY

For maximum cathode life and optimum performance the **operating heater voltage should be approximately 6.15 V**. Any deviation from this value has a detrimental effect on tube performance and life, and should therefore be kept to a minimum. In any case the deviations should be limited to the range of 5.7 to 6.6 V. To limit surges of the heater current during switch-on, a minimum source impedance of 2 Ω or a current limitation at maximum 700 mA is recommended. See for detailed information the relevant data sheet.

When the heater supply is an asymmetrical pulse, the heater voltage should be measured with a 'true RMS' meter with a sufficiently high crest factor.

In the past, the recommended heater voltage was always specified at zero beam current. This was because in older power supply designs, the voltage across the cathode would drop under operating conditions to a desirable level (6.15 V). Today's power supplies however, are more stable so under operating conditions the voltage across the cathode hardly drops and may remain at a level that could be non optimum for the best tube life.

To provide maximum protection for our customers, therefore, we have changed the way we define the recommended heater supply voltage from 6.3 V at zero beam current to 6.15 V under operating conditions. Essentially this is not a change of specification but an attempt to adapt our recommendations to the current state of power supply design and technology.

CATHODE TO HEATER VOLTAGE

The voltage between cathode and heater should be as low as possible and never exceed the limiting values given in the data sheets of the individual tubes. The limiting values relate to that side of the heater where the voltage between cathode and heater is greatest. The voltage between cathode and heater may be DC, AC or a combination of both. Unless otherwise stated, the maximum values quoted indicate the maximum permissible DC voltage.

In order to guarantee good electrical insulation between heater and cathode during lifetime, it is strongly recommended that the cathode is always operated at a potential which is positive with respect to that of the heater.

A DC connection should always be present between heater and cathode. Unless otherwise specified the maximum resistance should not exceed 1 MΩ.

INTERMEDIATE ELECTRODES (BETWEEN CATHODE AND ANODE)

In no circumstances should the tube be operated without a DC connection between each electrode and the cathode.

The total effective impedance between each electrode and the cathode should never exceed the published maximum value. However, no electrode should be connected directly to a high energy source. When such a connection is required, it should be made via a series resistor of not less than 1 kΩ. The circuit should be designed so that the focus voltage will never exceed the anode voltage during transient conditions.

CUT-OFF VOLTAGE

Curves showing the limits of the cut-off voltage as a function of the grid 2 voltage are generally included in the data. The published limits are determined at an ambient illumination level of 10 lux. Since the brightness of an undeflected spot is greater than that of a raster of the same current, the cut-off voltage determined with the aid of a focused spot will be more negative (by about 5 V) than with that of a focused raster. For optimum performance it is advised to adjust the gun with the highest cut-off voltage to the highest recommended cut-off value as specified in the relevant data sheet.

TUBE OPERATING PRECAUTIONS

To prevent permanent screen damage, care should be taken:

- Not to operate the tube with a stationary picture at high beam currents for extended periods.
- Not to operate the tube with a stationary or slowly moving spot except at extremely low beam currents.
- If no EHT bleeder is used, to choose the time constants of the cathode, grid 1, grid 2 and deflection circuits, such that sufficient beam current is maintained to discharge the EHT capacitance before deflection has ceased after equipment has been switched off.

To prevent stray emissions:

- The anode voltage should be less than 12 kV within 5 seconds of switch-off.

To prevent catastrophic tube failure:

- It is strongly advised to provide the video drive circuitry with a facility which blanks the tube automatically in the event of a deflection failure. This is particularly important in applications where the deflection coil is DC coupled to the vertical output stage, as a short-circuit fault in this circuit may otherwise lead to immediate de-evacuation of the tube (pierced neck).

EXTERNAL CONDUCTIVE COATING

The external conductive coating must be connected to the chassis. The capacitance of this coating to the final accelerating electrode may be used to provide smoothing for the EHT supply.

The coating is not a perfect conductor and in order to reduce electromagnetic radiation caused by the horizontal time base and the picture content it may be necessary to make multiple connections to the coating. See also Chapter "Flashover protection".

METAL RIMBAND

An appreciable capacitance exists between the metal rimband and the internal conductive coating of the tube; its value is quoted in the individual data sheets.

Mains isolated chassis

For use of the tube in mains isolated chassis it is advised to connect the rimband to the external conductive coatings.

Non-mains isolated chassis

In non-mains isolated chassis, where the rimband or connected conductive parts are accessible from outside the cabinet, a resistive DC connection shunted for AC, but suitable for mains separation, should be provided between rimband and external conductive coating. The resistor and capacitor (e.g. 2 MΩ shunted with 4.7 nF) must be adequately rated for the voltage transients which occur at flashover.

General operational recommendations

FLASHOVER PROTECTION

High electric field strengths are present between the gun electrodes of picture tubes. Voltages between gun electrodes may reach values of 20 kV over approximately 1 mm. Although the utmost precautions are taken in the design and manufacture of the tubes, there is always a chance that flashover will occur. The resulting transient currents and voltages may be of sufficient magnitude to cause damage to the tube itself and to various components on the chassis. Arcing terminates when the EHT capacitor is discharged. As our picture tubes are manufactured in Soft-Flash technology, the peak discharge currents are restricted, offering higher set reliability, optimum circuit protection and component savings. Primary protective circuitry using properly grounded spark gaps and series isolation resistors (preferably carbon composition) is still necessary to prevent tube damage. The spark gaps should be connected to all picture tube electrodes at the socket; they are not required on the heater pins. It is allowed to connect one of the heater pins directly to the chassis ground. Summarizing it is of vital importance to provide protective circuits with spark gaps and series resistors, which should be connected according to Fig.1. No other connections between the outer conductive coating and the chassis are advised, in order to prevent the injection of discharge currents into the circuitry.

To provide adequate protection against tube arcing, the spark gaps should be designed to ignite reliably under the most adverse condition. Sufficient safety margin should be taken to allow for tolerances on ignition voltage and tube operating voltages. An extra margin is required for operation under low atmospheric pressure at high altitude. As a common design rule the typical ignition voltage at sea level should be approximately 1.7 times the maximum operating voltage. See for detailed information the relevant data sheet.

The values of the series isolation resistors should be as high as possible without causing deterioration of the circuit performance. The resistors should be able to withstand an instantaneous surge of 20 kV for the focus circuit and 12 kV for the remaining circuits without arcing.

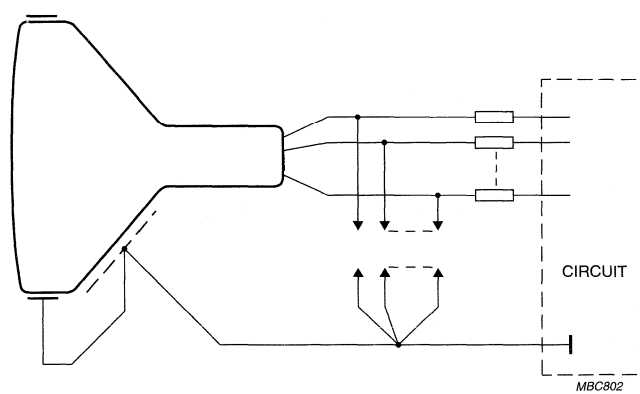


Fig.1 Flashover protection circuit.

IMPLOSION PROTECTION

All picture tubes employ integral implosion protection and must be replaced with a tube of the same type number or recommended replacement to assure continued safety.

HANDLING

Although all picture tubes are provided with integral implosion protection, which meets the intrinsic protection requirements stipulated in the relevant part of *"IEC 65"*, care should be taken not to scratch or knock any part of the tube. The tube assembly should never be handled by the neck, deflection unit or other neck components.

A picture tube assembly can be lifted from the edge-down position by using the two upper mounting lugs. Under no circumstances suspend the tube assembly from one lug. A vacuum chuck can be used on the screen, with adequate precautions against damage.

When placing a tube assembly face downwards ensure that the screen rests on a soft pad of suitable material, free from abrasive substances.

In all handling procedures prior to insertion in the monitor cabinet there is a risk of personal injury as a result of severe accidental damage to the tube. It is therefore recommended that protective clothing should be worn, particularly eye shielding.

If provided, the slots in the rimband of colour picture tubes are used in the mounting of the degaussing coils. It is **not allowed** to suspend the tube assembly from one or more of these slots as permanent deformation to the rimband can occur.

Remember when replacing or servicing the tube assembly, that a residual electrical charge may be carried by the anode contact and also the external coating if not earthed. Before removing the tube assembly from the equipment, earth the external coating and rimband and short circuit the anode contact to the coating. The tube should under no circumstances be subjected to accelerations greater than specified in the individual data sheets. Observe any instructions given on the packaging and handle accordingly.

MOUNTING

Unless otherwise specified in the data sheets for individual tubes there are no restrictions on the position of mounting.

The tube socket should not be rigidly mounted but should have flexible leads and be allowed to move freely.

DEGAUSSING

Colour picture tubes employ internal magnetic shielding. To be effective, the system must be properly degaussed by applying a strong alternating magnetic field which gradually and symmetrically decays to a sufficiently low value. The main characteristics of degaussing coils and circuitry for optimal results, are given in the individual data sheets.

Strong magnetic fields possibly existing during transportation of the tubes, and the manufacturing process of the monitor, may induce a residual magnetic field. This residual field cannot always be removed by the automatic degaussing circuitry of the set. It is therefore strongly recommended to apply an external degaussing field of sufficient magnitude (>1.5 mT) and uniformity on the assembly line, while the monitor is not active. This should be followed by activation of the internal set degaussing, with the set positioned in the same terrestrial orientation as for testing and performance judgement.

LOCAL MAGNETIC FIELDS

Care should be taken to avoid local AC or DC magnetic fields such as loudspeakers, transformers and linearity coils.

SOAK TESTING

To ensure that the operating conditions of the tube are optimized for the long term, a short stabilization period is required, after which the cut-off adjustment should be made and the performance assessed.

It is recommended that the tube should be operated for a minimum period of 30 minutes running time, before it is adjusted to its final operating conditions.

After soak testing, if the tube is switched off for a period of 90 seconds or more, a stabilization period of 15 minutes is required before making final cut-off adjustments and picture assessment. Where the tube is switched off for less than 90 seconds, the required stabilization period required is 10 times the switched-off period.

Recommendations générales d'emploi

INTRODUCTION

La conception d'un appareil équipé d'un tube image couleur doit être basée sur les caractéristiques publiées dans les notices techniques. Lorsque certaines de ces recommandations ne sont pas applicables, des indications complémentaires sont données.

Dans le cas d'applications non mentionnées dans les notices techniques du type de tube concerné, des précautions supplémentaires doivent être prises, au moment de la conception des circuits, pour éviter la surcharge du tube due à des conditions de fonctionnement défavorables.

DISPERSION DES CARACTÉRISTIQUES DES TUBES

La dispersion des caractéristiques des tubes est la différence entre les valeurs maximales et minimales. Les valeurs non qualifiées de maximales ou minimales sont des valeurs nominales. Il est évident que les valeurs moyennes ou minimales, ainsi que les dispersions, peuvent varier suivant la grandeur du lot de tubes mesurés. Aucune garantie n'est donnée pour les valeurs de caractéristiques lorsque les conditions d'emploi différent sensiblement de celles qui sont spécifiées dans les notices techniques.

DISPERSIONS ET VARIATIONS DES CONDITIONS DE FONCTIONNEMENT

Les conditions de fonctionnement d'un tube sont sujettes aux dispersions et/ou aux variations.

La dispersion des conditions de fonctionnement est un écart **permanent** par rapport à une condition moyenne, dû, par exemple, à des écarts de valeurs des composants.La condition moyenne est calculée sur un nombre de cas individuels pris au hasard et tel qu'une augmentation de ce nombre n'a pas d'influence significative.

La variation d'une condition de fonctionnement est **non permanente** (elle est fonction du temps) et peut être dû, par exemple, à des variations de la tension d'alimentation. La valeur moyenne est calculée sur une période telle qu'une prolongation de cette période n'a pas d'influence significative.

VALEURS LIMITES

Les systèmes de valeurs limites sont ceux recommandés par la *"Commission Electrotechnique Internationale (CEI 134)"*. Il peut être fait référence à l'un des trois systèmes de limites suivantes.

Systèmes des limites absolues

Les valeurs données dans ce système sont les limites concernant les conditions extérieures et les conditions de fonctionnement applicables à tout dispositif électronique d'un type déterminé défini par ses caractéristiques publiées, limites qui ne doivent pas être dépassées dans les pires conditions probables.

Le fabricant détermine ces limites pour obtenir un fonctionnement satisfaisant du dispositif, et n'assume aucune responsabilité en ce qui concerne les variations dues à l'appareil ou aux conditions extérieures ainsi que les effets des modifications de conditions de fonctionnement dues aux dispersions des caractéristiques du dispositif considéré et de tous les autres dispositifs électroniques de l'appareil.

L'utilisateur doit déterminer son appareil pour que, à sa mise en service, comme au cours de sa vie, aucune valeur limite concernant l'application envisagée ne soit dépassée pour tout dispositif, dans les pires conditions possibles d'utilisation, qui dépendent des variations de tension du réseau d'alimentation, des dispersions des composants de l'appareil, des modifications, des réglages, des variations de charge ou de signal, des conditions extérieures, ainsi que des dispersions des caractéristiques du dispositif considéré et de tous les autres dispositifs électroniques de l'appareil.

Systèmes des limites hybrides

Les valeurs données dans ce système sont les limites concernant les conditions extérieures et les conditions de fonctionnement applicables à un dispositif électronique moyen(1) d'un type déterminé, défini par ses caractéristiques publiées, limites qui ne doivent pas être dépassées dans les pires conditions probables.

Le fabricant détermine ces limites pour obtenir un fonctionnement satisfaisant du dispositif, et tenant compte, sous sa responsabilité, des effets provoqués par des modifications de conditions de fonctionnement dues aux dispersions des caractéristiques du dispositif électronique considéré.

L'utilisateur doit déterminer son appareil pour que, à sa mise en service, comme au cours de sa vie, aucune valeur limite concernant l'application envisagée ne soit dépassée pour un dispositif moyen, dans les pires conditions probables

(1) Un tube moyen est un tube dont les caractéristiques ont les valeurs nominales publiées pour le type concerné. Un tube moyen, pour une application déterminée, peut être recherché en ne tenant compte que des caractéristiques directement utiles pour cette application.

d'utilisation, qui dépendent des variations de tension du réseau d'alimentation, des dispersions des composants et des caractéristiques de tous les autres dispositifs électroniques de l'appareil, des modifications des réglages, des variations de charge ou de signal, et des conditions extérieures.

Systèmes des limites moyennes

Les valeurs données dans ce système sont les limites concernant les conditions extérieures et les conditions de fonctionnement applicables à un dispositif électronique moyen d'un type déterminé défini par les caractéristiques publiées, limites qui ne doivent pas être dépassées dans les conditions normales.

Le fabricant détermine ces limites pour obtenir un fonctionnement satisfaisant du dispositif dans des applications courantes, en tenant compte, sous sa responsabilité, des modifications normales des conditions de fonctionnement dues aux variations admises de la tension du réseau d'alimentation, des dispersions des composants de l'appareil, des modifications des réglages, des variations de charge ou de signal, des conditions extérieures, ainsi que des dispersions des caractéristiques de tous les dispositifs électroniques.

L'utilisateur doit déterminer son appareil pour que, à sa mise en service, aucune valeur limite concernant l'application envisagée ne soit dépassée pour un dispositif électronique moyen dans l'appareil fonctionnant sous la tension normale définie pour l'alimentation.

Si les valeurs limites spécifiées pour le tube appartiennent à plusieurs systèmes de valeurs limites, le circuit doit être conçu de manière qu'aucune de ces valeurs limites ne soit dépassée dans les conditions applicables.

Les expressions 'long terme' (long-term) et 'court terme' (short-term) sont employées pour indiquer soit le courant de faisceau moyen maximal d'un canon pour limiter la charge de cathode, soit le courant d'anode moyen maximal des trois canons pour limiter la charge d'écran.

'Court terme' ne concerne pas une période spécifique de temps, mais peut s'interpréter comme la condition dans laquelle le contenu et l'intensité de l'image affichée varient de manière continue.

'Long terme' signifie que l'image est fixe pendant une période indéterminée de temps, comme pour l'affichage de mires, d'images d'ordinateur ou de scènes fixes de moniteur durant plus de 30 secondes.

Dans les circuits de moniteur il est possible de limiter le courant d'anode moyen à la valeur moyenne court terme; lors de la conception thermique il convient donc de prendre en compte cette valeur.

Outre les valeurs limites spécifiées dans les notices techniques de chaque dispositif, les directives données aux paragraphes suivants doivent être observées.

ALIMENTATION DU FILAMENT

Pour obtenir une durée de vie maximale des cathodes et des performances optimales, **la tension de chauffage en fonctionnement doit être approximativement de 6,15 V.** Tout écart par rapport à cette valeur a des effets préjudiciables sur les performances et la durée de vie du tube, et doit par conséquent être limité au minimum. Dans tous les cas, les écarts doivent être limités à la plage de 5,7 à 6,6 V. Afin de limiter les pointes de courant à l'allumage, il est souhaitable que l'impédance de source du courant de chauffage soit au minimum de 2 Ω ou que le courant soit limité à 700 mA. Pour des informations plus détaillées voir les notices techniques correspondantes.

Si la tension d'alimentation du filament est une impulsion asymétrique, la tension doit être mesurée à l'aide d'un voltmètre mesurant la 'vraie valeur efficace' (true RMS) et ayant un facteur de crête suffisamment élevé.

Autrefois, la tension de chauffage recommandée était toujours spécifiée pour un courant de faisceau zéro car, dans les anciennes alimentations, la tension sur la cathode baisse, dans les conditions de fonctionnement, à un niveau désirable (6.15 V). Les alimentations actuelles sont toutefois plus stables si bien que la tension sur la cathode, dans les conditions de fonctionnement, baisse à peine et peut rester à un niveau qui pourrait ne pas être optimal pour la durée de vie du tube.

Pour pouvoir proposer à nos clients une protection maximale nous avons donc modifié notre manière de définir la tension de chauffage recommandée et ne la donnons plus à 6.3 V pour un courant de faisceau zéro, mais à 6.15 V dans les conditions de fonctionnement. Avant tout, il ne s'agit pas là d'un changement de spécification mais plutôt d'une tentative d'adaptation de nos recommandations à l'état actuel de la technique dans le domaine des alimentations.

TENSION ENTRE CATHODE ET FILAMENT

La tension entre la cathode et le filament doit être aussi réduite que possible et ne jamais dépasser les valeurs limites données dans les notices techniques particulières de chaque tube. Les valeurs limites s'appliquent à l'extrémité du filament ou la tension est la plus élevée. La tension entre cathode et filament peut être continue, alternative ou les deux à la fois. Sauf indication contraire, les valeurs maximales indiquent la tension continue maximale admissible.

Afin d'assurer une bonne isolation électrique entre chauffage et cathode pendant la durée de vie, il est fortement recommandé que les cathodes soient utilisées à un potentiel toujours positif par rapport à celui du chauffage.

Une tension électrique continue doit toujours être appliquée entre le filament et la cathode. Sauf indication contraire, la résistance maximale ne doit pas dépasser 1 MΩ.

ELECTRODES INTERMÉDIAIRES (ENTRE CATHODE ET ANODE)

Le tube ne devra être utilise en aucune circonstance sans liaison électrique continue entre chacune des électrodes et la cathode. L'impédance effective totale entre chacune des électrodes et la cathode ne doit jamais dépasser la valeur maximale publiée. Aucune électrode ne doit être directement connectée à une source de haute énergie. Si une telle connexion est nécessaire, elle doit être réalisée au moyen d'une résistance série d'au moins 1 kΩ. Le circuit doit être conçu de façon à ce que la tension de focalisation n'excède jamais la tension d'anode durant les périodes transitoires.

TENSION DE BLOCAGE

Les notices techniques contiennent généralement des courbes indiquant les limites de la tension de blocage (cut-off) en fonction de la tension de grille 2. Les limites publiées sont déterminées à un niveau d'éclairement ambiant de 10 Lux. La tension de blocage obtenue à l'aide d'un spot focalisé sera plus négative d'environ 5 V par rapport à celle obtenue à l'aide d'une trame focalisée; ceci parce que la brillance d'un spot non dévié est plus grande que celle d'une trame à même courant. Il est conseillé, pour une performance optimale, d'ajuster le canon ayant la plus haute tension de blocage sur la valeur maximum de la tension de blocage recommandée dans les notices technique correspondantes.

PRÉCAUTIONS D'UTILISATION DU TUBE

Les précautions suivantes doivent être prises pour éviter des dommages permanents de l'écran:

- Ne pas faire fonctionner le tube avec une image fixe à de forts courants de faisceau pendant de longues périodes.
- Ne pas faire fonctionner le tube avec un spot fixe ou se déplaçant lentement, sauf à des courants de faisceau extrêmement faibles.
- Décharger la THT, soit par une résistance (bleeder), soit en choisissant les constantes de temps des circuits de cathodes, de grille 1, de grille 2 et de déviation, de manière à maintenir un courant de faisceau suffisamment élevé, avant que la déviation ne cesse, après l'arrêt de l'appareil.

Pour éviter les 'rayons diffuses' (stray emissions):

- La tension d'anode doit être inférieure à 12 kV dans les 5 secondes suivant l'arrêt.

Pour éviter une détérioration catastrophique de l'écran:

- Il est fortement conseille de munir le circuit de commande vidéo d'un dispositif qui éteint le tube automatiquement en cas de panne de déviation. Ceci est particulièrement important dans les applications où la bobine de déviation est couplée en courant continu (DC coupled) à l'étage de sortie vertical, car un court-circuit sur cet étage peut provoquer une entrée d'air immédiate dans le tube (col percé).

COUCHE CONDUCTRICE EXTERNE

La couche conductrice externe doit être reliée à la masse du châssis. La capacité entre cette couche et l'anode peut servir à filtrer l'alimentation THT.

La couche n'étant pas un conducteur parfait, il peut être nécessaire d'effectuer cette liaison en plusieurs points afin de réduire le rayonnement électromagnétique de la base de temps de lignes et du contenu d'image.
Voir également "Arcs internes".

CEINTURE MÉTALLIQUE

Une capacité non négligeable existe entre la ceinture métallique et la couche conductrice interne du tube; sa valeur est donnée dans les notices techniques.

Recommendations générales d'emploi — General

Châssis isolé du secteur

Si le tube est utilisé dans un châssis isolé du secteur, il est conseillé de relier la ceinture á la couche conductrice externe.

Châssis non isolé du secteur

Dans le cas de châssis non isolé du secteur, où ceinture ou autres pièces conductrices reliées au châssis sont accessibles depuis l'extérieur du coffret, une liaison - résistive pour le continue court-circuitée pour l'alternatif mais garantissant l'isolement secteur - doit être placée entre la ceinture et la couche externe. La résistance et la capacité (2 MΩ en parallèle sur 4 nF) doivent être capables de supporter les tensions brèves apparaissant durant les arcs internes.

ARCS INTERNES

Des champs électriques élevés existent entre les électrodes des canons des tubes image, ils peuvent atteindre des valeurs de 20 kV par 1 mm environ. Bien que les plus grandes précautions soient prises dans la conception et la fabrication des tubes, il y a toujours un risque d'arcs (flash-over). Les courants et tensions transitoires résultants peuvent être suffisamment élevés pour endommager le tube et les composants associés. L'arc s'éteint lorsque le condensateur THT est déchargé. Dans nos tubes image qui sont fabriqués en technologie 'Soft Flash' les courants crêtes de décharge sont fortement réduits afin d'augmenter la fiabilité des appareils et d'assurer une protection optimale des circuits et des composants. Il est cependant nécessaire, afin d'éviter d'endommager le tube, de prévoir des circuits de protection comprenant des éclateurs convenablement mis à la masse et des résistances séries d'isolement (au carbone de préférence). Les éclateurs doivent être connectés sur le support à toutes les électrodes du tube, y compris sur les picots du chauffage. Il est permis de connecter directement une des bornes du chauffage à la masse du châssis. En résumé, il est d'une importance vitale d'utiliser des circuits de protection comprenant éclateurs et résistances séries, lesquels doivent être connectés comme la Fig.1. Aucune autre connexion entre la couche conductrice extérieure et le châssis n'est conseillée afin d'éviter l'injection de courants de décharge dans les circuits.

Afin d'assurer la protection adéquate contre les arcs internes les éclateurs doivent être conçus pour un amorçage fiable quelles que soient les conditions les plus défavorables.

Une marge de sécurité suffisante doit être prise pour tenir compte des tolérances sur l'amorçage et sur les tensions de fonctionnement du tube. Une marge supplémentaire est exigée pour un fonctionnement sous la faible pression atmosphérique des hautes altitudes. Les règles de conception communément admises pour la tension typique d'amorçage au niveau de la mer imposent approximativement 1,7 fois la tension maximum de fonctionnement. Pour plus d'informations, voir les notices techniques correspondantes.

La valeur des résistances séries d'isolation doit être aussi élevée que possible sans causer de détérioration des performances des circuits. Les résistances doivent être capables de supporter une surtension instantanée de 20 kV pour le circuit de focalisation et de 12 kV pour les autres circuits en l'absence d'arcs internes.

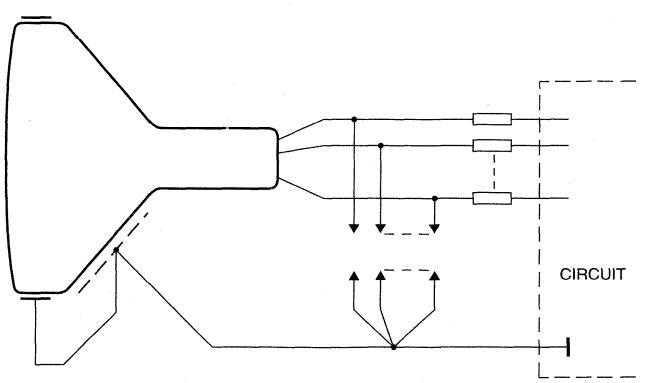


Fig.1 Circuit de protection contre les arcs internes.

Recommendations générales d'emploi

PROTECTION CONTRE LES RISQUES D'IMPLOSION

Tous les tubes image sont pourvus d'une protection intégrale contre les implosions et doivent être remplacés par un tube de même type ou d'un type équivalent recommandé pour la maintenance afin d'assurer une sécurité permanente.

MANUTENTION

Quoique tous les tubes image soient pourvus d'une protection intégrale contre l'implosion qui satisfasse aux exigences intrinsèques de protection, conformément au chapitre concernée de la *"CEI 65"*, il faut faire attention à ne pas rayer ni cogner une partie quelconque du tube. Lors du montage, le tube ne doit jamais être manipulé par le col, le déviateur ou un autre composant du col.

Un tube image peut être soulevé en utilisant les deux oreilles de fixation supérieures. En aucune circonstance, il ne doit être suspendu par une seule oreille. Une ventouse à dépression peut être utilisé sur l'écran si les précautions adéquates ont été prises pour ne pas abîmer l'écran.

Pour poser un tube sur son écran, placer en dessous un tissus doux, exempt de toute substance abrasive.

Dans toutes les opérations de manutention précédant la mise en coffret, il existe un risque d'être blessé lorsque le tube a été accidentellement et gravement endommagé. Il est par conséquent recommandé de porter des vêtements protecteurs, en particulier des lunettes de protection.

Des fentes, dans la ceinture métallique d'autoprotection de certains tubes image, servent à la fixation des bobines de désaimantation. Il est **interdit** de suspendre les tubes par une ou plusieurs de ces fentes car cela peut provoquer une déformation permanente de la ceinture métallique.

Rappelons que lors de l'entretien ou du remplacement du tube, une charge électrique résiduelle peut être présente entre le contact d'anode et la couche externe. Avant de retirer le tube de l'appareil, mettre la couche externe ainsi que la ceinture à la masse et court-circuiter le contact d'anode et la couche externe. Le tube ne doit jamais être soumis à des accélérations supérieures à celles spécifiées dans les notices techniques individuelles. Observer les consignes marquées sur l'emballage et manipuler le tube en conséquence.

MONTAGE

Sauf indication contraire dans les notices techniques des différents tubes, la position de montage est indifférente.

Le support du tube ne doit pas être monté de façon rigide, il doit être raccordé par des fils souples et avoir une certaine liberté de débattement.

DESAIMANTATION

Les tubes image couleur sont munis d'un blindage magnétique interne. Afin d'être efficace le système doit être convenablement désaimanté en appliquant un fort champ magnétique alternatif qui décroît graduellement et symétriquement jusqu'à une faible valeur. Les caractéristiques principales des bobines de désaimantation et des circuits permettant d'obtenir des résultats optimaux sont données dans les notices techniques individuelles.

De forts champs magnétiques peuvent être appliqués au tube durant le transport et les opérations de fabrication de l'appareil de moniteur et induire ainsi une rémanence magnétique. Ce champs rémanent ne peut pas toujours être éliminé par le circuit de désaimantation interne de l'appareil. Il est donc fortement recommandé d'appliquer un champs de désaimantation externe d'intensité (min. 1,5 mT) et d'uniformité convenables sur la ligne l'assemblage, lorsque l'appareil de moniteur n'est pas sous tension. Ceci doit être suivi par la mise en fonctionnement de la désaimantation interne, l'appareil étant orienté dans la même direction que pour les mesures et l'appréciation des performances.

CHAMPS MAGNÉTIQUE LOCAL

Il convient de porter le plus grand soin à éviter les champs magnétiques locaux alternatifs ou continus tels que ceux produits par transformateurs, haut-parleurs et correcteurs de linéarité. **L'induction magnétique ne doit pas excéder 0,05 mT sur la surface de l'enveloppe du tube.**

BANC DE CHAUFFE

Afin de s'assurer de l'optimalisation des conditions de fonctionnement du tube à long terme, une courte période de stabilisation est exigée, après laquelle il doit être procédé au réglage du blocage et à l'estimation des performances.

Il est recommande que le tube ait subi un temps de fonctionnement d'au moins 30 minutes consécutives avant d'être réglé pour ses conditions de fonctionnement finales.

Apres mesure sur banc de chauffe, si le tube a été éteint 90 secondes ou plus, une période de stabilisation de 15 minutes est exigée avant de procéder aux réglages du blocage et à l'estimation des performances.
Si le tube a été éteint moins de 90 secondes, la période de stabilisation requiert 10 fois le temps d'extinction.

ALLGEMEINE HINWEISE

Beim Entwurf von Monitor sollte von den in den Datenblättern angegebenen Kennwerten ausgegangen werden. Wenn Abweichungen von diesen allgemeinen Empfehlungen zulässig oder notwendig sind, werden entsprechende Hinweise gegeben. Werden Anwendungen in Betracht gezogen, bei denen die Betriebsbedingungen nicht mit den im Datenblatt gemachten Angaben übereinstimmen, so ist bei der Dimensionierung der Schaltung besondere Vorsicht geboten, um eine Überlastung der Bildröhre durch ungünstige Betriebsbedingungen zu vermeiden.

STREUUNGEN VON BILDRÖHREN-KENNDATEN

Die Streuungen der Bildröhren-Kenndaten erstrecken sich auf die Differenz zwischen Maximal- und Minimalwerten. Wertangaben, die nicht als Maximal- oder Minimalwert gekennzeichnet sind, sind Nennwerte. Abhängig von der betrachteten Anzahl von Röhren eines bestimmten Typs können sowohl die Mittel- oder Nennwerte als auch die Streuwerte voneinander abweichen. Bei Einstellungen, die wesentlich von den im Datenblatt gemachten Angaben abweichen, wird keine Garantie für Kenndaten übernommen.

STREUUNGEN UND ÄNDERUNGEN DER BETRIEBSBEDINGUNGEN

Die Betriebsbedingungen einer Bildröhre sind Streuungen und/oder Änderungen unterworfen.

Die **Streuung** einer Betriebsbedingung ist eine **ständige** Abweichung von der mittleren Bedingung, die z.B. durch Wertabweichungen von Bauelementen hervorgerufen wird. Die mittlere Bedingung ist als Durchschnittswert einer hinreichend hohen Anzahl von zufälligen Einzeleinstellungen definiert. Die **Änderung** einer Betriebsbedingung ist eine **nicht-ständige** Abweichung, hervorgerufen z.B. durch Schwankungen der Speisespannung. Der Mittelwert ist über eine solche Zeitspanne ermittelt, daß bei Verlängerung keine nennenswerten Veränderungen mehr eintreten

GRENZWERTE

Die Grenzwerte entsprechen dem eingeführten Maßsystem, wie es in der *"IEC 134"* definiert ist. Es kann auf eine der nachstehend beschriebenen drei Arten von Grenzdaten Bezug genommen werden.

Absolute-Grenzdaten

Absolute Grenzdaten sind Grenzwerte für Betriebs- und Umgebungsbedingungen, die auch unter ungünstigen Umstanden bei keiner Bildröhre überschritten werden dürfen. Die absoluten Grenzwerte werden zur Aufrechterhaltung der Betriebsfähigkeit vom Bildröhrenhersteller festgelegt. Für Abweichungen des Schaltungsentwurfes und der Umgebungsbedingungen sowie für Auswirkungen der Änderung von Betriebsbedingungen, die durch Abweichung die Röhreneigenschaften auch unter Berücksichtigung aller anderen Bauelemente der Schaltung eintreten können, übernimmt der Bildröhrenhersteller keine Verantwortung. Der Gerätehersteller sollte die Schaltung so auslegen, daß während der Lebensdauer der Bildröhre bei den vorgesehenen Einsatzbedingungen auch unter den ungünstigsten Umständen kein absoluter Grenzwert überschritten wird. Dabei sind zu berücksichtigen: Schwankungen der Speisespannung, Geräteeinstellungen, Streuungen und Änderungen der übrigen Bauelemente, Belastungsänderungen, Signaländerungen, Änderungen der Umgebungsbedingungen sowie Streuungen und Änderungen der Bildröhren-Eigenschaften.

Toleranz-Grenzdaten

Toleranz-Grenzdaten sind Grenzwerte von Betriebs- und Umgebungsbedingungen einer Nominalröhre(1) eines bestimmten Typs, die auch unter den ungünstigsten Umständen nicht überschritten werden dürfen. Die Toleranz-Grenzdaten werden zur Aufrechterhaltung der Betriebsfähigkeit vom Bildröhrenhersteller festgelegt. Änderungen der Betriebsbedingungen, die durch Kennwertabweichungen innerhalb der spezifizierten Toleranzgrenzen auftreten, sind zulässig. Der Geräte-Entwickler sollte die Schaltung so auslegen, daß bei einer Nominalröhre eines bestimmten Typs während ihrer Lebensdauer und bei den vorgesehenen Einsatzbedingungen auch unter den ungünstigsten Bedingungen kein Toleranz-Grenzwert überschritten wird. Dabei sind zu berücksichtigen: Schwankungen der Speisespannung, Abweichungen und Änderungen aller anderen Bauelemente, Schwankungen der Belastung, des Signals und der Umgebungsbedingungen.

(1) Eine Nominalröhre ist eine Röhre, deren Eigenschaften und Daten den publizierten Nennwerten entspricht.

Nennwert-Grenzdaten

Nennwert-Grenzdaten sind Grenzwerte von Betriebs- und Umgebungsbedingungen eines bestimmten Typs, die unter mittleren Bedingungen nicht überschritten werden dürfen. Die Nennwert-Grenzdaten werden zur Aufrechterhaltung der Betriebsfähigkeit der Bildröhre in mittleren Anwendungen festgelegt. Normale Abweichungen der Betriebsbedingungen, hervorgerufen durch die spezifizierte Schwankung der Speisespannung, der Einstellung und Steuerung sowie Änderungen der übrigen Bauelemente und auch Schwankungen der Belastung, des Signals und der Umgebungsbedingungen sind berücksichtigt und zulässig. Wenn die spezifizierten Grenzdaten sich auf mehr als ein Grenzdatensystem beziehen, muß die Schaltung so ausgelegt werden, daß keiner dieser Grenzwerte unter den entsprechenden Bedingungen überschritten wird. Die Begriffe 'long-term' und 'short-term' werden benutzt, um jeweils entweder den maximalen zeitlichen Durchschnitt des Strahlstromes für eine Kanone zu kennzeichnen und die Kathodenbelastung zu begrenzen oder den maximalen zeitlichen Durchschnitt des Strahlstromes für drei Kanonen, um die Schirmbelastung zu begrenzen. 'Short-term' bezieht sich nicht auf eine bestimmte Zeitdauer, sondern bezeichnet die Betriebsbedingung, bei der sich Inhalt und Intensität eines wiedergegebenen Bildes kontinuierlich ändern. 'Long-term' bedeutet, daß das Bild für eine unbestimmte Zeitperiode stillsteht wie z.B. bei der Wiedergabe von Testbildern, Computer-Bildern oder stehenden Monitor-Szenen, die länger als 30 s dauern.

Da bei Monitor-Schaltungen die Begrenzung des mittleren Strahlstromes auf den short term Wert zulässig ist, sollte der Wärmehaushalt des Gerätes auf diesem Wert basieren. Zusätzlich zu den in den einzelnen Datenblättern angegebenen Grenzwerten mussen die nachfolgenden Vorschriften beachtet werden.

HEIZUNG

Für maximale Lebensdauer der Kathode und optimale Performance sollte die Heizspannung bei Betrieb ca. 6,15 V betragen. Jede Abweichung von diesem Wert hat eine nachteilige Auswirkung auf Performance und Lebensdauer der Röhre und sollte daher auf ein Minimum begrenzt werden. Auf jeden Fall sollen Abweichungen im Bereich von 5,7 V bis 6,6 V bleiben. Um den Einschaltstrom des Heizers zu begrenzen wird eine minimale Quellenimpedanz von 2 Ω oder eine Strombegrenzung bei maximal 700 mA empfohlen. Details sind den jeweils gültigen Datenblättern zu entnehmen. Wenn die Heizspannung aus asymmetrischen Impulsen besteht, muß sie mit einem 'True RMS' Meßgerät mit ausreichend hohem Crestfaktor gemessen werden.

In der Vergangenheit wurde die empfohlene Heizspannung bei einem Strahlstrom von Null spezifiert, weil bei älteren Stromversorgungen die Spannung an der Kathode unter Betriebsbedingungen auf einen wünschenswerten Pegel (6,15 V) abfällt. Die heutigen Stromversorgungen sind jedoch stabiler, so daß die Spannung an der Kathode unter Betriebsbedingungen kaum abfällt und auf einem Pegel bleiben kann, der für die Lebensdauer der Röhre nicht besser sein könnte.

Um unseren Kunden maximalen Schutz zu bieten, geben wir daher die empfohlene Heizversorgungsspannung nicht mehr mit 6,3 V bei einem Strahlstrom von Null an, sondern mit 6,15 V unter Betriebsbedingungen. Im wesentlichen ist dies keine Änderung der Spezifikation, sondern der Versuch, unsere Empfehlungen an den aktuellen Stand der Technik auf dem Gebiet der Stromversorgungen anzupassen.

SPANNUNG ZWISCHEN HEIZFADEN UND KATHODE

Die Spannung zwischen Heizfaden und Kathode sollte so klein wie möglich sein und darf die im Datenblatt angegebenen Grenzwerte nicht überschreiten. Diese beziehen sich auf das Heizfadenende, welches die höhere Spannung gegen die Kathode fuhrt. Die Spannung zwischen Heizfaden und Kathode kann eine Gleichspannung, Wechselspannung oder eine Kombination aus beiden sein. Wenn nicht anders angegeben, gilt der maximale Wert der Spannung zwischen Heizfaden und Kathode als maximal zulässiger Wert (Gleichspannungskomponente).

Im Hinblick auf gute Isolation von Heizer und Kathode über die Lebensdauer der Röhre wird empfohlen, die Kathode stets auf positivem Potential gegenüber dem Heizer zu halten.

Eine Gleichstromverbindung zwischen Heizfaden und Kathode sollte immer vorhanden sein. Wenn nicht anders angegeben, darf der Widerstand dieser Verbindung 1 MΩ nicht übersteigen.

ELEKTRODEN ZWISCHEN HEIZFADEN UND BESCHLEUNIGUNGSANODE

Unter keinen Umständen darf die Bildröhre ohne Gleichstromverbindung zwischen jeder Elektrode und Kathode betrieben werden. Die zwischen jeder Elektrode und Kathode wirksame Impedanz darf die angegebenen Maximalwerte nicht überschreiten. Keine Elektrode darf direkt an eine Hochspannungsquelle angeschlossen werden. Wenn erforderlich, darf eine solche Verbindung nur über einen Serienwiderstand von minimal 1 kΩ hergestellt werden. Die Schaltung muß so ausgelegt sein, daß die Fokusspannung auch unter Übergangsbedingungen niemals die Anodenspannung übersteigt.

SPERRSPANNUNG

Im allgemeinen werden die Grenzdaten der Sperrspannung in Abhängigkeit von der G_2-Spannung als Kurven in den Datenblättern angegeben. Die spezifizierten Grenzen sind für eine Umgebungshelligkeit von 10 Lux festgelegt. Weil die Helligkeit eines unabgelenkten Leuchtpunktes größer ist als die eines Gitter-Testbildes bei gleichem Strom, ist die Sperrspannung bei Bestimmung mit Hilfe eines unabgelenkten Leuchtpunktes etwa 5 V negativer als die eines fokussierten Gitter-Testbildes. Für optimale Performance wird empfohlen, die Kathode mit der höchsten Sperrspannung auf den höchsten empfohlenen Sperrspannungswert des jeweils gültigen Datenblattes einzustellen.

VORSICHTSMAßNAHMEN BEIM BETRIEB DER BILDRÖHRE

Um bleibende Schirmbeschädigungen zu vermeiden, sollten folgende Sorgfaltsmaßnahmen getroffen werden:

- Die Bildröhre nicht mit stehendem Bild und hohem Strahlstrom über längere Zeit betreiben.
- Die Bildröhre nicht mit einem stehenden oder sich langsam bewegenden Punkt betreiben, außer mit extrem niedrigen Strahlströmen.
- Wenn kein Bleeder benutzt wird, sollen die Zeitkonstanten von Kathode, G1, G2 und Ablenkschaltungen so gewählt sein, daß genügend Strahlstrom aufrechterhalten bleibt, um die auf Hochspannung aufgeladenen Kapazitäten zu entladen, bevor die Ablenkung aufhört.

Um Streuemission zu verhindern:

- Die Anodenspannung soll innerhalb von 5 s nach Abschalten auf unter 12 kV absinken.

Um schwerste Schäden an der Bildröhre zu vermeiden, wird dringend empfohlen, die Videoansteuerstufe mit einer Schaltung zu versehen, die die Röhre automatisch dunkel steuert, wenn die Ablenkschaltung ausfällt. Dieses ist besonders wichtig in Applikationen, in denen die Vertikal-Ablenkspule DC-gekoppelt mit der Vertikalendstufe ist. Ein Kurzschlußfehler in dieser Stufe könnte sonst den Röhrenhals beschädigen und die Röhre dadurch belüften.

LEITENDER AUßENBELAG

Der leitende Außenbelag muß mit dem Massepunkt des Chassis verbunden werden. Die Kapazität zwischen dem Außenbelag und der letzten Beschleunigungsanode kann zur Glättung der Hochspannung verwendet werden. Der Außenbelag ist kein guter Leiter. Zur Reduzierung der durch Zeilenablenkung und Bildinhalt erzeugten elektromagnetischen Störstrahlung sollen deshalb mehrfache Kontakte zum Außenbelag, verteilt über diesen, angebracht werden (siehe auch Abschnitt "Schutz gegen Spannungsüberschlage").

METALLRAHMENVERSTÄRKUNG

Eine merkliche Kapazität besteht zwischen der Metallrahmenverstärkung und dem inneren leitenden Belag der Bildröhre, deren Wert in den Datenblattern angegeben ist.

Chassis mit Netztrennung

Bei Anwendung der Bildröhre in netzgetrennten Chassis wird empfohlen, die Metallrahmenverstärkung mit dem leitenden Außenbelag elektrisch zu verbinden.

Chassis ohne Netztrennung

In Chassis ohne Netztrennung, in denen die Metallrahmenverstärkung oder andere leitende Teile von Außerhalb des Gehäuses zugänglich sind, wird eine für Gleichspannung hochohmige elektrische Verbindung,

überbrückt für Wechselspannung aber für Netztrennung ausreichend, zwischen Metallrahmenverstärkung und leitendem Außenbelag empfohlen. Der Widerstand und der Kondensator (zum Beispiel 2 MΩ parallel mit 4,7 nF) müssen für Spannungsspitzen, wie sie während Hochspannungsüberschlägen auftreten, ausreichend dimensioniert sein.

SCHUTZ GEGEN SPANNUNGSÜBERSCHLÄGE (FLASHOVER)

Zwischen den Elektroden der Strahlsysteme bestehen hohe elektrische Feldstärken, wobei Werte von 20 kV/mm erreicht werden. Obwohl bei der Entwicklung und bei der Herstellung der Bildröhren mit äußerster Sorgfalt vorgegangen wird, besteht die Möglichkeit, daß Spannungsüberschläge in der Bildröhre vorkommen können. Die dabei kurzzeitig auftretenden Spitzen-Spannungen und -Ströme können so hohe Werte annehmen, daß die Bildröhre und verschiedene Bauelemente auf dem Chassis beschädigt werden. Der Überschlag endet, wenn die gesamte Hochspannungsladung abgeflossen ist. Da Philips Bildröhren in Soft Flash Technologie hergestellt werden, sind die Spitzenströme bei Überschlägen begrenzt, was größere Zuverlässigkeit der Geräte, optimalen Schutz der Schaltung und Einsparungsmöglichkeiten bei Bauteilen bietet.
Primäre Schutzschaltungen mit sachgerecht an Masse gelegten Funkenstrecken und Serien-Schutzwiderständen (vorzugsweise Kohleschicht Bauart) sind dennoch erforderlich um Beschädigungen der Bildröhre zu vermeiden. Mit Ausnahme der Heizeranschlüsse sind die Funkenstrecken mit sämtlichen Elektroden der Bildröhre am Sockel zu verbinden. Es ist zulässig, einen der Heizeranschlüsse direkt mit der Masse des Chassis zu verbinden. Zusammenfassend ist es von entscheidender Bedeutung, Funkenstrecken und Serienwiderstände entsprechend Abb.1 vorzusehen. Um das Eindringen von Entladeströmen in das Chassis zu verhindern, sind zwischen dem leitenden Außenbelag der Röhre und dem Chassis keine weiteren elektrischen Verbindungen zulässig. Um angemessenen Schutz bei Überschlägen zu bieten, müssen die Funkenstrecken so bemessen sein, daß sie unter allen Betriebsbedingungen verläßlich zünden. Beim Design sollen daher sowohl Streuungen der Zündspannung wie der Betriebsspannungen der Bildröhre berücksichtigt werden. Der Einfluß des Umgebungsluftdrucks ist ebenfalls zu bedenken. Eine allgemeine Regel ist, daß die typische Zündspannung auf Meeresniveau das ca. 1,7 fache der maximalen Betriebsspannung betragen soll. **Die Werte der Serienwiderstände sollen so hoch wie möglich sein, ohne dabei die Performance der Schaltung zu beeinträchtigen. Die Widerstände sollen in Lage sein, einem spontanen Spannungsanstieg auf 20 kV (Fokuselektrode) bzw. 12 kV (alle übrigen Elektroden) zu widerstehen, ohne Überzuschlagen.**

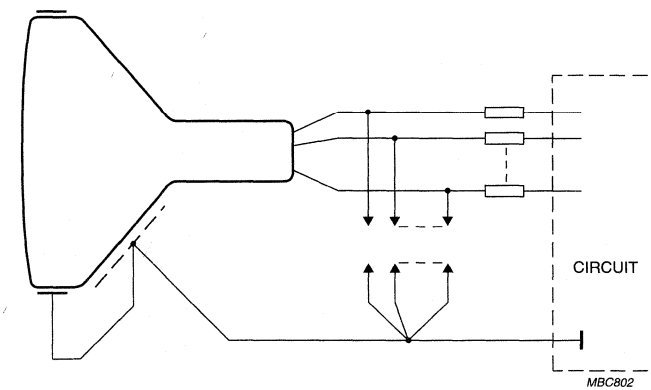


Abb.1 Schutz-Funkenstrecken.

IMPLOSIONSSCHUTZ

Alle von uns angebotenen Bildröhren sind implosionsgeschützt und dürfen daher nur durch Bildröhren des gleichen Typs oder eines empfohlenen Ersatztyps ausgetauscht werden. In diesem Zusammenhang wird auf das von der *"Berufsgenossenschaft Feinmechanik und Elektrotechnik"* herausgegebene *"Merkblatt über den Umgang mit Bildrohren"* hingewiesen.

HANDHABUNG

Obwohl die Bildröhren mit einem Implosionsschutz ausgerüstet sind, welcher die Sicherheitsanforderungen nach VDE 0860 und DIN 57860 bzw. IEC 65 erfüllt, ist Vorsicht geboten. Die Röhre sollte nicht zerkratzt oder hart angestoßen werden. Eine Belastung des Rohrenhalses muß vermieden werden. Beim Anheben eines Bildröhrenpaketes (Bildröhre mit fest montierter Ablenkeinheit und Mehrpoleinheit) aus der seitlichen Lage sollten die beiden oberen Befestigungswinkel benutzt werden. Eine weitere Möglichkeit zum Anheben besteht darin, fest mit den Händen an den senkrechten Seiten gegen das Spannband zu drücken. Beim Ablegen der Bildröhre mit dem Schirm nach unten muß dieser auf eine saubere weiche Unterlage gelegt werden. Bei allen Handhabungen, vor allem beim Einsetzen in das Monitorgehäuse, besteht Verletzungsgefahr, wenn aus Versehen die Bildrohre zerstört wird. Es wird daher empfohlen, daß Schutzkleidung und vor allem eine Schutzbrille getragen wird. Bei Aufhängung der Bildröhre muß sichergestellt werden, daß sie mindestens an zwei Befestigungswinkeln gehalten wird. Auf keinen Fall darf die Bildröhre an nur einen Befestigungswinkel gehängt werden.

Die Schlitze der Metallrahmenverstärkung sind für die Montage der Entmagnetisierungsspulen bestimmt. Es ist **unzulässig**, die Bildröhre an einem oder mehreren dieser Schlitze anzuheben, weil eine Verformung der Metallrahmenverstärkung die Folge ware.

Beim Ausbau der Bildröhre aus dem Monitorgehäuse ist zu beachten, daß am Anodenanschluß und am leitenden Außenbelag noch eine elektrische Ladung vorhanden sein kann. Zur Entladung soll daher der Anodenkontakt mit dem leitenden Außenbelag verbunden und dieser geerdet werden, bevor am Gerät gearbeitet oder die Bildröhre ausgebaut wird. In diesem Zusammenhang wird noch auf das von der *"Berufsgenossenschaft der Feinmechanik und Elektrotechniker"* herausgegebene *"Merkblatt über den Umgang mit Bildröhren mit Schirmdiagonalen großer als 160 mm"* hingewiesen.

MONTAGE

Wenn im Datenblatt nicht anders angegeben, bestehen keine Einschränkungen im Hinblick auf die Einbaulage. Die Röhrenfassung soll nicht starr, sondern mit flexiblen Leitungen angeschlossen werden. Für den Geräteentwurf sind die in den Zeichnungen angegebenen Toleranzen der mechanischen Abmessungen zu berücksichtigen.

Unter keinen Umständen sollte ein Gerät nach den Abmessungen einzelner Musterröhren entworfen werden.

ENTMAGNETISIERUNG

Farbbildröhren besitzen eine interne magnetische Abschirmung. Zur sicheren Funktion muß die Röhre jedoch durch Anlegen eines starken und langsam symmetrisch abnehmenden magnetischen Wechselfeldes entmagnetisiert werden. Für jeden Röhrentyp werden in den Datenblättern optimale Entmagnetisierungs-spulen und -Schaltungen empfohlen.

Während des Transportes der Bildröhre oder der Fertigung der Fernsehgeräte können möglicherweise starke Magnetfelder eine magnetische Remanenz induzieren. Diese Remanenz kann nicht in jedem Fall durch die automatische Entmagnetisierungsschaltung im Gerät allein beseitigt werden. Daher wird dringend empfohlen, eine externe Entmagnetisierung von hinreichender Stärke und Gleichförmigkeit am Fertigungsband der Geräte vorzusehen. Dieser externen Entmagnetisierung sollte dann die Geräte-interne automatische Entmagnetisierung folgen. Dabei sollte das Gerät in derselben Himmelsrichtung stehen, wie auch für die weitere Prüfung und Performance-Beurteilung.

EINFLÜSSE EXTERNER MAGNETFELDER

Externe magnetische Gleich- oder Wechselfelder wie die von Lautsprechern oder Transformatoren, müssen von der Röhre ferngehalten werden **und dürfen, außen auf der Röhre gemessen, 0,05 mT nicht überschreiten.**

OPTIMIERUNG BEI DER ERSTEN INBETRIEBNAHME UND BEURTEILUNG

Um sicherzustellen, daß die Betriebsbedingungen der Röhre langzeit-optimiert sind, ist eine kurze Stabilisierungszeit erforderlich. Danach können Sperr-Punkt-Abgleich und Performance Beurteilung durchgeführt werden. Es wird empfohlen, für diesen Stabilisierungsvorgang mindestens 30 Minuten Einlaufzeit vorzusehen, bevor das Gerät auf die endgültigen Betriebsbedingungen abgeglichen wird.

Nach der Stabilisierung, wenn die Röhre für eine Periode von 90 s oder mehr abgeschaltet war, ist eine erneute Anheizzeit von 15 Minuten oder mehr erforderlich, bevor der endgültige Sperrpunktabgleich und die Bildbeurteilung durchgeführt werden können. Wenn die Röhre für weniger als 90 s eingeschaltet war, beträgt die erforderliche Wiederanheizzeit das 10 fache der Ausschaltzeit.

General safety recommendations

GENERAL

When properly used and handled, electronic tubes do not constitute a risk to health or to the environment.

However, certain hazards may arise and it is important that the following recommendations are observed. Care should be taken to ensure that all personnel who may handle, use or dispose of these products are aware of the necessary safety precautions.

Individual product data sheets may indicate if any of the specific hazards given in Chapters "X-radiation" to "High voltage" are likely to be present.

BREAKAGE

If a tube is broken or otherwise damaged, precautions must be taken against the following hazards which may arise:

- Broken glass or ceramic (see Chapter "Implosion - handling of picture and cathode ray tubes"). Protective clothing such as gloves should be worn.
- Contamination by toxic materials and vapours. In particular skin contact and inhalation should be avoided.

DISPOSAL

Most electronic tubes contain toxic materials.

These products should be disposed of in accordance with relevant national legislation: in the United Kingdom the *"Deposit of Poisonous Waste Act 1972"* and the *"Control of Pollution Act 1974 amended 1980 special Waste Regulations"* apply.

When disposing of large quantities, the advice of the manufacturer's service department should be sought.

FIRE

Electronic tubes themselves do not present a fire hazard.

However, since most packaging materials are flammable, care should be taken in the disposal of such materials; some of which will emit toxic fumes if burned.

If packaged tubes are involved in a fire, implosion may occur (see Chapter "implosion - handling of picture and cathode ray tubes"), together with the consequent release of toxic vapours and materials.

X-RADIATION

All high voltage electronic tubes produce progressively more penetrating X-rays as the operating voltage is increased. The tube will satisfy the European Community permitted limit of 1 µSv/h, when driven within the maximum operating conditions denoted in the product published data.

The residual level of X-radiation depends upon the application. The tube envelope provides a measure of protection but under some equipment fault conditions, the X-ray hazard may be considerably increased.

This potential hazard will be present only when the tube is energized.

TOXIC COMPOUNDS

Small quantities of barium compounds are contained in the products and are toxic. In the event of accidental breakage, there is a risk that personnel might come into contact with these materials. Protective clothing should be worn and any fine debris should be mopped up with a damp cloth.

To protect the environment, materials which may have become contaminated should be sealed (e.g. in a bag) and disposed of in accordance with the relevant national legislation.

This potential hazard is present, if breakage occurs, at all times from receipt to disposal of tubes.

IMPLOSION - HANDLING OF PICTURE AND CATHODE RAY TUBES

All vacuum tubes store potential energy by virtue of their vacuum. The energy level represents a hazard.

Most modern tubes are provided with integral implosion protection which conforms to *"IEC 65, clause 18"*. With these tubes, no additional protection is needed. However, additional stresses due to mishandling may considerably increase the risk of implosion. Implosions may occur immediately or may be delayed.

The strength of the glass envelope will inevitably be impaired by surface damage, such as scratches or bruises (localized surface cracks caused by impact). When a tube is not in its equipment or original packing, it should be placed faceplate downwards on a pad of suitable ribbed material which is kept free from abrasive substances.

Under no circumstances should any attempt be made to remove the bonded faceplate or integral implosion protection band when fitted to a tube.

Stresses on the neck of the tube must be avoided. Handle by the recommended methods as illustrated:

Tube face-down

To lift a tube from the face-down position, the hands should be placed under the areas of faceplate close to the fixing lugs (if fitted), at diagonally opposite corners of the face-plate as shown in Fig.1. The tube must not be lifted from this position by the lugs themselves. **Under no circumstances should any force be applied to the neck of the tube.**

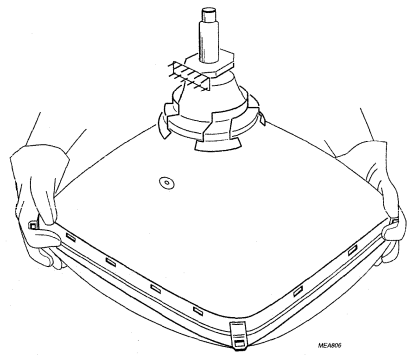


Fig.1 Lifting tube from face-down position.

Tube face-up

To lift a tube from the face-up position, the hands should be placed under the areas of the cone close to the fixing lugs (if fitted), at diagonally opposite corners of the cone as shown in Fig.2. The tube must not be lifted from this position by the lugs themselves. **Under no circumstances should any force be applied to the neck of the tube.**

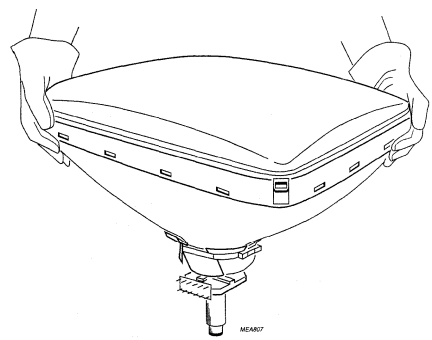


Fig.2 Lifting tube from face-up position.

If the handling procedures for tubes are such that as a consequence of severe accidental damage to the tube, there is a risk of injury to personnel, then it is recommended that protective clothing should be worn, particularly eye shielding. When fitted, lugs are provided for fixing in equipment. They must not be subjected to excessive forces. Adequate protection must be provided if there is a possibility of injury as a result of failure of a lug or lugs.

HIGH VOLTAGE

Attention is called to the fact that a high voltage may remain on the final anode connector and also on the external coating and rimband, if not earthed, even after a tube has been removed from equipment. Before handling a tube it is recommended to discharge the tube capacitance, by connection via a resistor of not less than 10 kΩ and capable of withstanding high voltages.

In equipment where the chassis can be connected directly to the mains without electrical separation, there may be a risk of electric shock if access can be gained to the metal rimband through the aperture at the front of the equipment. Consequently, it is recommended that a 2 MΩ resistor, capable of withstanding peak voltages of EHT values (as specified in *"IEC 65, clause 14.1"*) is inserted between the rimband and the braided earth contact to the external coating.

A significant capacitance is formed between the rimband and internal conductive layer of the tube. In the event of flashover, high voltages will be induced on the rimband. In order to bypass these voltages a capacitor of a few nanofarads (extra-high-voltage low-inductance in compliance with *"IEC 65, clause 14.2"*) should be inserted between the rimband and the braided earth contact to the external coating.

Recommendations générales de sécurité — General

INTRODUCTION

Les tubes électroniques ne font courir aucun danger ni pour la santé, ni pour l'environnement, s'ils sont employés et manipulés correctement.

Cependant, les tubes présentent certains risques et il est important que les recommandations suivantes soient observées. Il est important de s'assurer que toute personne qui est amenée à manipuler, employer ou se débarrasser de ces produits soit au courant des précautions de sécurité nécessaires.

Les notices techniques sur chacun des tubes peuvent préciser si certains des risques spécifiques indiqués dans les chapitres suivants ont une probabilité d'exister.

CASSÉ

Si un tube est cassé ou même endommagé, des précautions doivent être prises contre les risques suivants qui peuvent se produire:

- Verre ou céramique cassé (voir Chapitre "Implosion - manutention des tubes image de moniteur et des tubes a rayons cathodiques"). Un vêtement de protection tel que des gants doit être porté.
- Contamination par matières et vapeurs toxiques. En particulier, le contact avec la peau et l'inhalation doivent être évités.

MISE AU REBUT

La plupart des tubes électroniques contiennent des produits toxiques.

Il faut se débarrasser de ces produits en conformité avec la législation nationale en vigueur.

Quand il s'agit de mettre au rebut de grandes quantités, consulter le Service Après-Vente du fabricant.

INCENDIE

Les tubes électroniques en eux-mêmes ne présentent aucun risque d'incendie.

Toutefois, sachant que la plupart des matériaux d'emballage sont inflammables, il convient de prendre des précautions pour les jeter; certains, parmi eux, émettent des fumées toxiques en brûlant.

Si des tubes emballés sont impliqués dans un incendie, des implosions peuvent se produire (voir Chapitre "Implosion - manutention des tubes image de moniteur et des tubes a rayons cathodiques"), accompagnées d'un dégagement de vapeurs et de matières toxiques.

RAYONS X

Tous les tubes électroniques sous haute tension produisent des rayons X dont la pénétration augmente avec la tension de fonctionnement. Le tube satisfera à la limite autorisée par la Communauté Européenne, soit 1 µSv/h, s'il est utilisé dans les conditions de fonctionnement maximales figurant dans les notices techniques publiées.

Le niveau résiduel de rayon X dépend de l'application. L'ampoule du tube constitue un dispositif de protection, mais dans certaines conditions de panne de l'appareil, le danger de rayon X peut se trouver considérablement augmente.

Ce risque éventuel n'existe que lorsque le tube est sous tension.

PRODUITS TOXIQUES

Ces tubes contiennent de petites quantités de composés de baryum qui sont toxiques. En cas de casse accidentelle, il y a risque pour le personnel d'entrer en contact avec ces substances.

Des vêtements de protection doivent être portés et tous les débris doivent être soigneusement ramassés avec un chiffon humide.

Pour protéger l'environnement, les matériaux qui pourraient avoir été contaminés doivent être enveloppés hermétiquement (par exemple dans un sac) et jetés conformément à la législation nationale en vigueur.

Ce risque existe, en cas de casse, à tout moment depuis l'entrée jusqu'à l'élimination des tubes.

IMPLOSION - MANUTENTION DES TUBES IMAGE DE MONITEUR ET DES TUBES A RAYONS CATHODIQUES

Tous les tubes sous vide modernes comportent une protection intégrale contre l'implosion conforme à la *"CEI 65, paragraphe 18"*. Ces tubes ne nécessitent aucune protection supplémentaire. Toutefois, le risque d'implosion peut-être considérablement augmenté par des erreurs de manutention. Les implosions peuvent se produire immédiatement ou même ultérieurement.

La résistance de l'ampoule de verre sera inévitablement affaiblie par un dommage superficiel tel que des rayures ou des fêlures (craquelures superficielles et locales provoquées par impact). Quand un tube est hors de son appareil et de son emballage d'origine, il doit être placé face vers le bas sur une surface alvéolée, exempte de substances abrasives.

En aucune circonstance, on ne doit tenter de retirer du tube la dalle rapportée ou la ceinture d'autoprotection contre l'implosion.

Eviter tout effort sur le col du tube; manipuler le tube selon les méthodes recommandées, comme illustré:

Recommendations générales de sécurité

Tube face en bas

Pour soulever un tube dans sa position face en bas, les mains doivent être placées sous la dalleécran dans les zones proches des oreilles de fixation (si elles existent) et diagonalement opposées, comme montre sur la Fig.1. Le tube ne doit pas être soulevé dans cette position par les oreilles de fixation. **En aucune circonstance, une force quelconque ne doit être exercée sur le col du tube.**

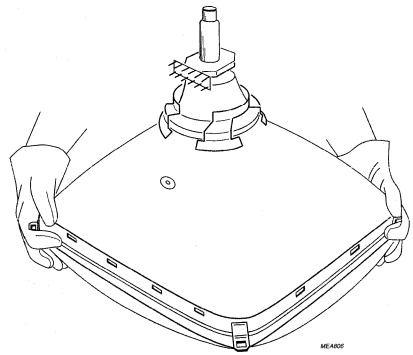


Fig.1 Tube face en bas.

Tube face en haut

Pour soulever un tube dans la position face en haut, les mains doivent être placées sous le cone dans les zones proches des oreilles de fixation (si elles existent) et diagonalement opposées (comme montre a la Fig.2). Le tube ne doit pas être soulevé dans cette position par les oreilles de fixation. **En aucune circonstance, une force quelconque ne doit être exercée sur le col du tube.**

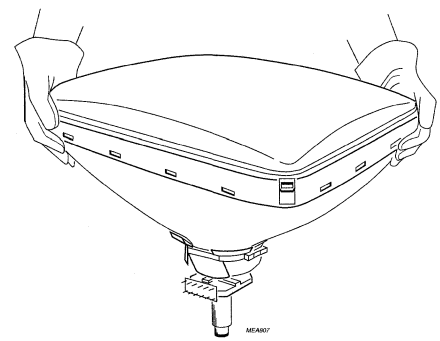


Fig.2 Tube face en haut.

Si dans les opérations de manutention des tubes, le personnel risque d'être blessé lorsque un tube a subi des dommages accidentels graves, il est alors recommandé de porter des vêtements protecteurs et des lunettes de protection, en particulier. Quand elles existent, les oreilles de fixation sont prévues pour la fixation du tube dans l'appareil. Elles ne doivent être soumises à aucun effort excessif. Si le personnel risque d'être blessé suite à la rupture d'une ou plusieurs oreilles de fixation, une protection adéquate doit être prévue.

HAUTE TENSION

L'attention est attirée sur le fait qu'une haute tension peut rester présente sur la prise d'anode ainsi que sur la couche externe et sur la ceinture d'auto-protection, si aucune d'elles n'ont été mises à la masse, même lorsque le tube est hors de l'appareil. Avant de manipuler un tube, il est recommandé de décharger la capacité du tube en connectant une résistance d'au moins 10 kΩ pouvant supporter une haute tension. Dans un appareil dont le châssis est connecté directement au secteur sans séparation électrique, il y a un risque de recevoir une décharge électrique si on peut atteindre la ceinture métallique d'autoprotection par l'ouverture située sur le devant de l'appareil. En conséquence, il est recommandé de connecter une résistance de 2 MΩ, capable de supporter des tensions crêtes de la valeur de la THT (conformément à la *"CEI 65, paragraphe 14.1"*), entre la ceinture et la tresse de masse placée sur la couche externe. La ceinture et la couche interne constituent les armatures d'une capacité de valeur importante. En cas d'arcs internes, des hautes tensions sont induites sur la ceinture. Afin de court-circuiter ces tensions, une capacité de quelques nanofarads (à très haute tension et faible inductance en conformité avec la *"CEI 65, paragraphe 14.2"*) doit être connectée entre la ceinture et la tresse de masse appliquée sur la couche externe.

Allgemeine Sicherheitshinweise — General

ALLGEMEINES

Bei Betrieb unter normalen Bedingungen und korrekter Handhabung gehen von Elektronenröhren keine gesundheitsgefährdenden oder umweltstorenden Einflüsse aus.

Bei mechanischer Beschädigung oder durch elektrische Überlastung können jedoch Gefahren auftreten. Daher ist es sehr wichtig, daß die folgenden Empfehlungen beachtet werden. Es ist sicherzustellen, daß alle Personen, die diese Bauelemente handhaben, benutzen, besitzen und entsorgen, die allgemeinen Sicherheits-empfehlungen kennen und beachten.

In den einzelnen Datenblättern können spezielle Hinweise enthalten sein ob besondere Risiken, wie in den nachfolgenden Abschnitten beschrieben, vorliegen.

GLASBRUCH

Wenn eine Röhre zerbrochen oder beschädigt ist, müssen Vorsichtsmaßnahmen getroffen werden, falls nachfolgende Gefahren auftreten:

- Glas- oder Keramikbruch (siehe Abschnitt "Implosion - Handhabung von Monitor-Bild- und Kathodenstrahlröhren"). Schutzkleidung ist zu tragen, z.B. Handschuhe.
- Kontamination durch toxische Materialien und Dämpfe. Besonders Hautkontakt und Einatmen sind zu vermeiden.

ENTSORGUNG

Die meisten Bildröhren enthalten toxische Materialien.

Die Entsorgung dieser Bauelemente muß in Übereinstimmung mit den entsprechenden nationalen Vorschriften und Umweltschutzgesetzen erfolgen.

In der Bundesrepublik Deutschland ist dieses in den einzelnen Bundesländern unterschiedlich geregelt. Für die Entsorgung großer Mengen können Hinweise beim Röhrenhersteller eingeholt werden.

FEUER

Bildröhren an sich sind nicht entflammbar oder brennbar.

Das üblicherweise verwendete Verpackungsmaterial ist jedoch entflamm- und brennbar. Bei der Vernichtung dieser Materialien ist mit entsprechender Vorsicht vorzugehen, da bei einigen Materialien toxische Dämpfe beim Verbrennen freigesetzt werden.

Wenn Röhren direkt oder in Verpackung Feuer ausgesetzt sind, besteht Implosionsgefahr (siehe Abschnitt "Implosion - Handhabung von Monitor-Bild- und Kathodenstrahlröhren") mit der Gefahr der Freisetzung von toxischen Dampfen und Materialien.

RÖNTGENSTRAHLUNG

In allen mit Hochspannung betriebenen Elektronenröhren entsteht Röntgenstrahlung. Die Intensität der Röntgenstrahlung steigt mit der Anodenspannung an. Alle in diesem Datenbuch beschriebenen Bildröhren erfüllen bei Betrieb mit den im Datenblatt aufgeführten maximal zulässigen Betriebswerten die von der EG vorgegebenen Grenzwerte der Äquivalentdosis <1 µSv/S.

Der Röntgenstrahlungspegel ist von der Applikation abhängig. Der Glaskörper einer Röhre bietet im Normalfall hinreichend Schutz vor Röntgenstrahlung. Bei bestimmten Fehlfunktionen der Betriebsschaltung kann die Röntgenstrahlungsgefahr jedoch erheblich zunehmen.

In der Bundesrepublik Deutschland sind bei Spitzenspannungen von mehr als 5 kV die Vorschriften über den Schutz vor Schaden durch Röntgenstrahlung gemäß *"Röntgenverordnung (Röv) vom 8. Januar 1987"* zu beachten.

Diese potentielle Gefahr liegt nur bei Betrieb der Röhre vor.

TOXISCHE INHALTSSTOFFE

In den Röhren sind kleine Mengen von Bariumverbindungen mit toxischer Wirkung enthalten. Bei einem Glasbruch besteht das Risiko, daß Personen mit diesen Stoffen in Berührung kommen. Es ist daher in einem solchen Falle Schutzkleidung zu tragen, und alle feinen Teilchen sind mit einem feuchten Tuch aufzuwischen.

Zum Schutze der Umwelt sind Materialien, die verunreinigt wurden unter Verschluß zu halten (z.B. in einer Plastiktüte) und entsprechend den geltenden Vorschriften zu entsorgen.

Diese potentielle Gefahr im Falle eines Glasbruchs ist über die gesamte Lebensdauer bis hin zur Entsorgung der Röhre gegeben.

IMPLOSION - HANDHABUNG VON MONITOR-BILD- UND KATHODENSTRAHLRÖHREN

Alle Vakuum-Röhren enthalten aufgrund ihres Vakuums ein Potential an Energie. Dieses Energiepotential stellt eine latente Gefahrdung dar.

Die meisten modernen Röhren sind mit einem integrierten Implosionsschutz ausgerüstet, der die Anforderungen der *"IEC 65, Absatz 18"* erfüllt.

Allgemeine Sicherheitshinweise — General

Bei diesen Röhren ist kein zusätzlicher Schutz erforderlich. Mechanische Spannungen, hervorgerufen durch falsche Handhabung, erhöhen jedoch erheblich das Implosionsrisiko.Eine Implosion kann unmittelbar oder verzögert erfolgen.

Bei Beschädigung der Oberfläche der Röhre durch Kratzer oder Eindrückung (örtliche Flächeneindrückung hervorgerufen durch Stoß) wird die Festigkeit des Glaskolbens geschwächt. Wenn eine Röhre nicht im Gerätegehäuse eingebaut ist, bzw. sich nicht in ihrer Originalverpackung befindet, ist sie mit dem Schirm nach unten auf einer sauberen, weichen Unterlage ohne schleifende Substanzen abzulegen.

Es darf auf keinen Fall der Versuch gemacht werden die aufgebrachte Frontplatte oder das integrierte Implosions-Schutzband, falls vorhanden, zu entfernen.

Mechanische Spannungen am Hals der Röhre sind zu vermeiden. Das Anheben der Röhre ist den nachfolgenden Grafiken zu entnehmen.

Röhre mit Schirm nach unten

Beim Anheben der Röhre aus der Position Schirm nach unten, sind die Hände, unter der Flache des Schirms, bei den Befestigungswinkeln (wenn vorhanden) zu plazieren, diagonal an gegenüberliegenden Ecken des Kolbens (siehe Abb.1).
Die Röhre darf nicht allein an den Befestigungswinkeln gehoben werden.
Eine Belastung des Röhrenhalses muß unter allen Umständen vermieden werden.

Röhre mit Röhrenhals nach unten

Beim Anheben der Röhre aus der Position Röhrenhals nach unten, sind die Hände, unter der Flache des Kolbens bei den Befestigungswinkeln (wenn vorhanden) zu plazieren, diagonal an gegenüberliegenden Ecken des Kolbens (siehe Abb.2).

Die Röhre darf nicht allein an den Befestigungswinkeln gehoben werden, wenn sie aus dieser Position angehoben wird.
Eine Belastung des Röhrenhalses muß unter allen Umständen vermieden werden.

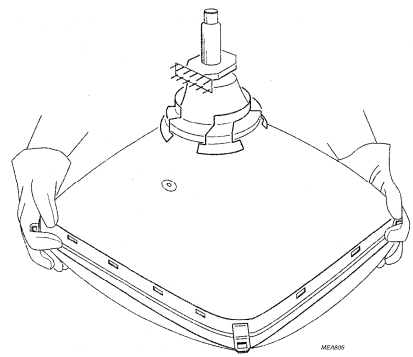


Abb.1 Anheben der Röhre aus der Position Schirm nach unten.

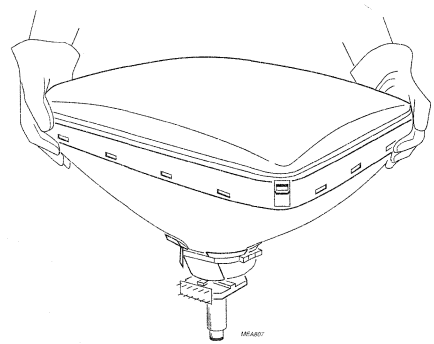


Abb.2 Anheben der Röhre aus der Position Röhrenhals nach unten.

Allgemeine Sicherheitshinweise — General

Wenn der Verarbeitungshinweis für Röhren darauf hinweist, daß als Konsequenz einer Beschädigung der Röhre Unfallgefahr besteht, die das Risiko der Verletzung von Personen nicht ausschließt, dann wird empfohlen schützende Kleidung zu tragen, insbesondere eine Schutzbrille.

In diesem Zusammenhang wird auf das von der "Berufsgenossenschaft Feinmechanik und Elektrotechnik" herausgegebene "*Merkblatt über den Umgang mit Bildröhren*" hingewiesen.

Die Befestigungswinkel, falls vorhanden, dienen der Röhrenmontage im Gehäuse. Sie dürfen nicht übermäßig beansprucht werden. Entsprechende Schutzmaßnahmen sind vorzusehen, wenn die Möglichkeit eines Unfalls, hervorgerufen durch Fehlfunktion eines oder mehrerer Haltewinkel, besteht.

HOCHSPANNUNG

Es wird darauf hingewiesen, daß am Anodenanschluß, am leitenden Außenbelag und am Spannband der Röhre ohne ausreichende Erdung sehr hohe Spannungen anliegen können, auch wenn die Röhre bereits aus dem Gerät ausgebaut wurde. Vor dem Berühren der Röhre ist daher eine Entladung der Röhrenkapazität vorzunehmen. Dies geschieht durch eine Verbindung über einen Widerstand >10 kΩ mit genügender Spannungsfestigkeit.

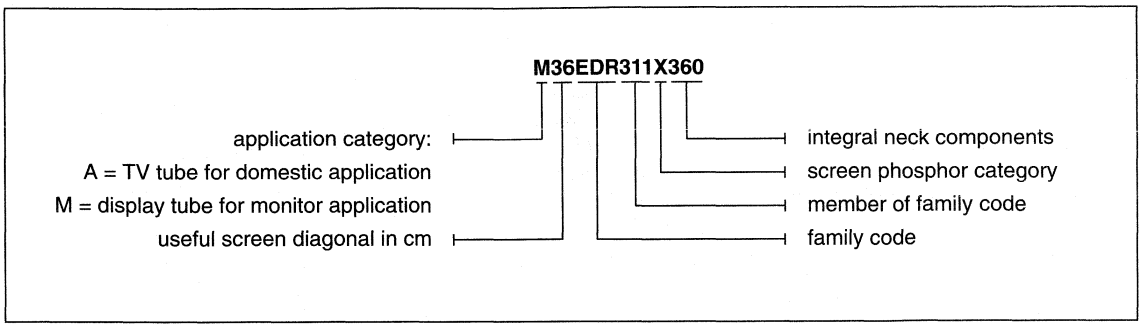
In Schaltungen, die es erlauben das Chassis direkt mit dem Netz zu verbinden, d.h. keine Netztrennung haben, ist das Risiko eines elektrischen Schlages gegeben, wenn das metallische Spannband an der Frontseite des Equipments zugänglich ist. Es wird daher empfohlen einen 2 MΩ-Widerstand, genügender Spannungsfestigkeit (spezifiziert in "*IEC 65, Absatz 14.1*") zur Entladung der Spitzenspannungen zwischen der Metallrahmenverstärkung und dem Kontaktpunkt mit dem leitenden Außenbelag einzuschalten. Eine merkliche Kapazität besteht zwischen der Metallrahmenverstärkung und dem inneren leitenden Belag der Röhre. Im Falle eines Spannungsüberschlages, wird Hochspannung auf das Spannband induziert. Zum Schutz gegen induzierte Spannungen bei Hochspannungsüberschlägen wird empfohlen, einen Kondensator mit einer Kapazität von einigen nF (Hochspannungsfestigkeit und kleine Induktivität entsprechend "*IEC 65, Absatz 14.2*") zwischen dem Spannband und dem Kontaktpunkt des äußeren leitenden Außenbelages einzufügen.

Type designation

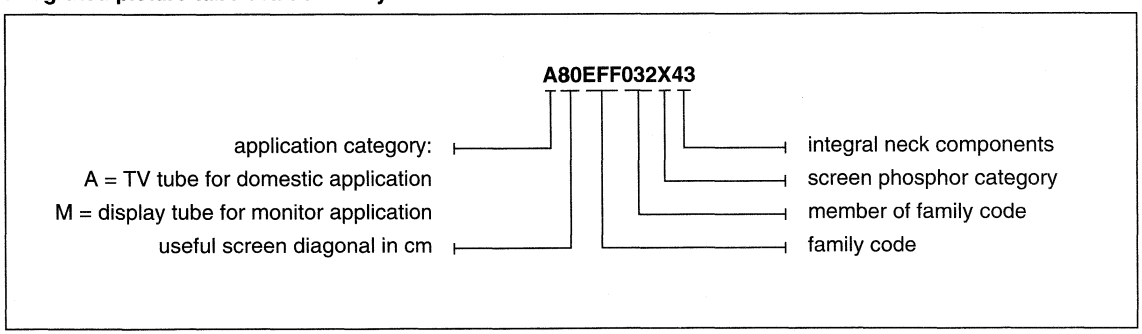
TYPE DESIGNATION

Worldwide type designation system.

Integrated monitor tube coil assembly



Integrated picture tube coil assembly



CHROMATICITY DIAGRAM

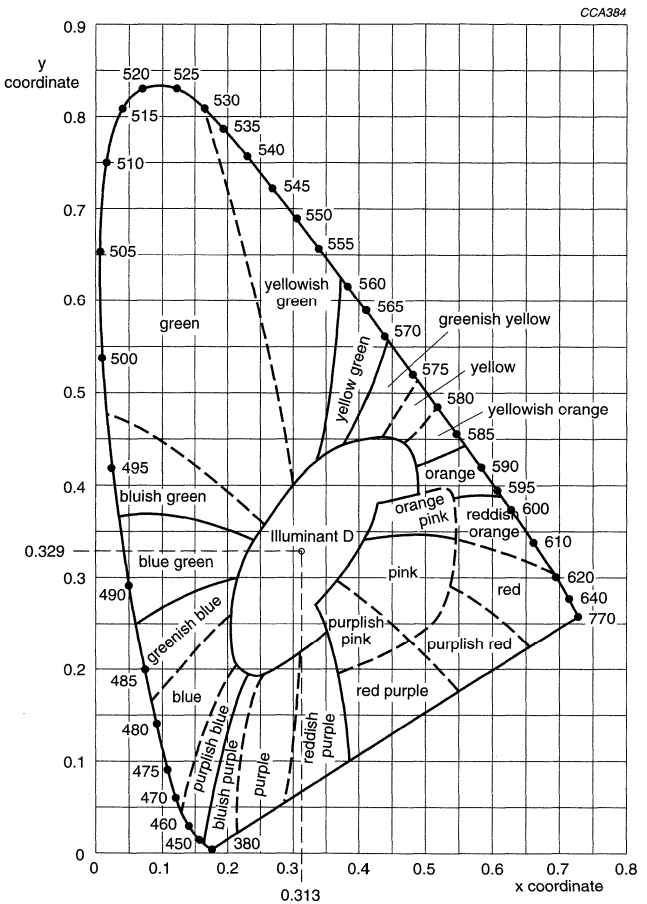


Fig.1 Kelly chart.

PRODUCT DATA

14" high resolution colour monitor tube assemblies

M34EDC

CONTENTS

14" high resolution colour monitor tube assemblies

M34EDC

1 HIGHLIGHTS

1.1 Features

1.1.1 HIGH PERFORMANCE DESIGN

- High resolution; higher pixel density possible by:
  - 'larger' effective screen area: 262 mm × 190 mm
  - high resolution polygon gun
  - 0.28 mm dot triplet pitch
- High brightness and contrast:
  - optimized black matrix process
- Excellent white uniformity and colour purity:
  - iron mask
  - inner magnetic shielding
- Accurate convergence and raster geometry:
  - double mussel coil technology
  - internal magnetostatic beam alignment
- Application friendly design:
  - worldwide useable design
  - East-West correction max. 4.5%
  - deflection units designed for minimal ringing
  - static convergence adjustment on monitor level: multipole for 4 and 6 pole correction
  - dynamic convergence adjustment on monitor level: horizontal balance coil; vertical symmetry potentiometer.

1.1.2 ERGONOMIC DESIGN

- Less ambient reflection:
  - AGAS (Anti-glare/anti-static) screen coating
- Less eye strain:
  - P22 medium/short persistence phosphor
  - high frequency yokes
- Green design:
  - CFC-free production process
  - Cd-free phosphors
- Fulfilling electric/magnetic radiation standards:
  - antistatic coatings
  - VLMF cancelling coils required to fulfil magnetic MPRII and TCO requirements
- Safety approved:
  - VDE; CSA; UL; BSI.

1.1.3 OPTIMUM DISPLAY SOLUTION

- PC applications
- Resolution standards up to 1024 × 768 pixels non-interlaced EVGA application.

1.2 Quick reference data

PARAMETER	TYP.	UNIT
Deflection angle	90	deg
Face diagonal	370	mm
Overall length	<352	mm
Neck diameter	29.1	mm
Dot triplet pitch	0.28	mm
Focus voltage	26.0% of anode voltage	

1.3 Deflection coil types

PARAMETER	COIL TYPE NUMBER										UNIT
	36/3	37/3	37	36	15	17	15/5	17/5	16	18	
Horizontal coil inductance	0.37	0.38	0.39	0.38	0.18	0.18	0.18	0.18	0.18	0.18	mH
Vertical coil resistance	6.6	6.6	6.6	6.6	6.6	6.6	5.9	5.9	6.6	6.6	Ω
Maximum advised frequency	48	48	48	48	48	48	57	57	64	64	kHz

1.4 Coding system

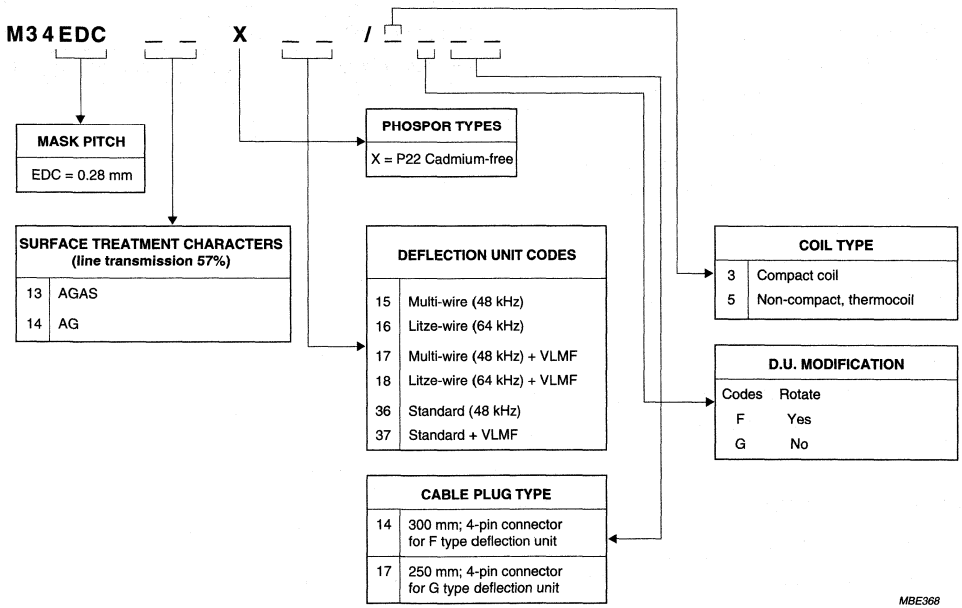


Fig.1 Available versions.

2 PERFORMANCE SPECIFICATION

2.1 Colour co-ordinates

Type P22 phosphor data

Persistence is medium short; $I_{a(av)}$ per gun = 200 μA; V_a = 25 kV; scanned area = 262 mm × 190 mm.

PHOSPHOR COLOUR	COLOUR CO-ORDINATES		MIN. BRIGHTNESS AT SCREEN CENTRE (Cd/m²)
	x	y	
Red	0.620	0.345	19.4
Green	0.305	0.600	59.6
Blue	0.155	0.065	10.1

2.2 Brightness variation

2.2.1 TEST PROCEDURE

Zero magnetic field; adjust the tube in accordance with the recommended operating conditions and to a centre-white brightness of 86 Cd/m² on a data raster of 262 mm × 190 mm (this should exclude chassis linearity influence).

2.2.2 LIMITS

Brightness decrease from centre to corner shall not exceed 35%.

2.3 Colour purity and white uniformity

2.3.1 TEST PROCEDURE

Zero magnetic field; adjust the tube in accordance with the recommended operating conditions and to a centre white brightness of 86 Cd/m², on a data raster of 262 mm × 190 mm. The screen should be viewed with blanked red, green, white raster at a distance of 1 metre at an ambient light level of 1 lux.

2.3.2 LIMITS

No severe discoloration or cross contamination allowed.

2.4 Resolution specification

With the settings given in Section 4.1, the displayed characters will be recognisable as individual $ characters on a data raster measuring 262 mm × 190 mm.

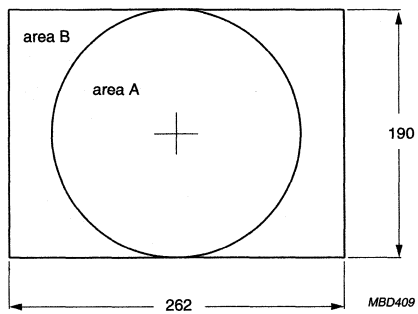
2.5 Convergence specification

2.5.1 TEST CONDITIONS

1. Set-up in accordance with Section 4.1.
2. Measure maximum misconvergence after 30 minutes operation.
3. To be adjusted for focus at half east or half west using cross-hatch pattern at anode current is 350 μA (peak value) per gun.
4. Misconvergence is the distance between the centres of the red, green and blue lines at the screen using a cross-hatch pattern.
5. Anode and/or focusing voltage and terrestrial magnetism may slightly affect the static convergence. Therefore, small re-adjustments to static convergence may be necessary.
6. Avoid stray magnetic fields etc. due to chassis influences which may affect convergence.

2.5.2 CONVERGENCE LIMITS

LOCATION (see Fig.2)	**TYPE OF ERROR**	**MAXIMUM ERROR BETWEEN ANY TWO COLOURS (mm)**
Area A	red-green-blue line separation in either the horizontal or vertical direction	0.30
Area B		0.40
Centre	vector	0.15



Dimensions in mm.

Fig.2 Maximum misconvergence.

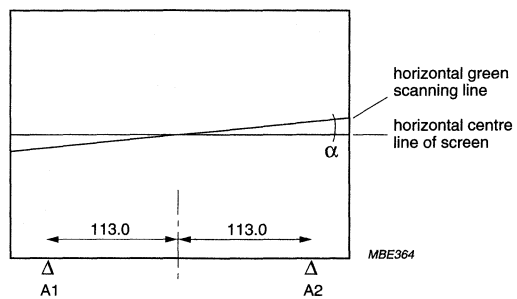
2.6 Raster geometry

2.6.1 RASTER CENTRING

CENTRING	MAX.	UNIT
Horizontal	±4	mm
Vertical	±4	mm

2.6.2 RASTER ROTATION

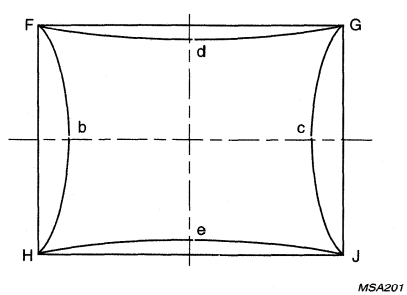
Zero magnetic field; measure the angle of the horizontal green scanning line with reference to a horizontal centre line that is drawn parallel to the tube reference points A1 and A2, see Fig.3. Chassis influences may affect raster rotation.



Dimensions in mm.
$\alpha \leq 0.35°$

Fig.3 Rotation measurement.

2.6.3 PIN-CUSHION DISTORTION



FG = HJ = 262 mm.
FH = GJ = 190 mm.
Measured with no pin-cushion correction applied, with 'b', 'c', 'd' and 'e' measured along the main axis.

Fig.4 Pin-cushion distortion.

2.6.4 DISTORTION NORTH - SOUTH

The following formulae define the pin-cushion distortion in the north and south directions.

$$\text{North} = \frac{4d}{FH+GJ} \times 100\% = 0\% \text{ to } \pm 1.6\%$$

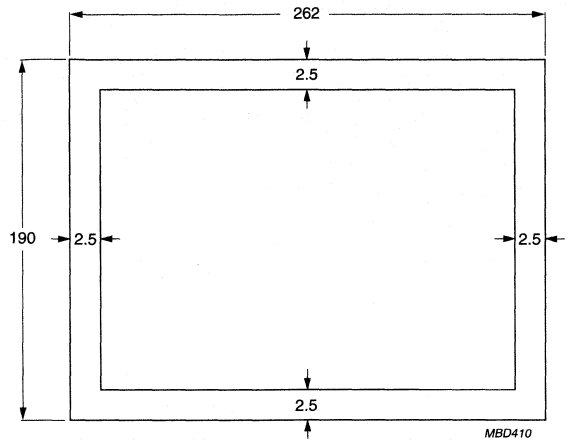
$$\text{South} = \frac{4e}{FH+GJ} \times 100\% = 0\% \text{ to } \pm 1.6\%$$

2.6.5 DISTORTION EAST- WEST

The following formulae define the pin-cushion distortion in the east and west directions.

$$\text{East} = \frac{4c}{FG+HJ} \times 100\% \leq 4.5\%$$

$$\text{West} = \frac{4b}{FG+HJ} \times 100\% \leq 4.5\%$$



Dimensions in mm.

Fig.5 General distortion.

2.7 Screen quality

2.7.1 GENERAL TEST PROCEDURE

Tests are to be done under the following general conditions:

- Viewing distance should be 50 cm minimum
- For an unactivated screen the diffuse ambient light level at the centre of the screen should be between 500 and 1000 lux
- The viewing angle relative to the tube axis should not exceed 45°
- Faults not visible under these general conditions are permitted
- The following quality areas are specified:
  - Area A: a rectangular area measuring 240 mm × 180 mm, of which the point of intersection of the diagonals coincides with the mechanical centre of the screen
  - Area B: the area between area A and the rimband.

2.7.2 ASSESSMENT OF THE GLASS AND THE UNACTIVATED SCREEN QUALITY

2.7.2.1 Definition of blemishes

Unless otherwise specified, the shape of a blemish is defined as: round and elliptical.

The size of a blemish is given by:

- (L + W)/2 or L/20 + 2W, whatever expression is the largest,
  where L = length and W = width.

2.7.2.2 Limits

Table 1 Limits of measurable glass blemishes

SIZE (mm)	MIN. PERMISSIBLE DISTANCE BETWEEN ANY 2 BLEMISHES (mm)	MAX. NUMBER OF BLEMISHES IN AREA A	MAX. NUMBER OF BLEMISHES IN AREAS A AND B
0.6	not applicable	0	not applicable
0.4 to <0.6	30	1	2
0.2 to <0.4	30	–	2
<0.2	limited only by cloud		–

Table 2 Limits of scratches

AREA	WIDTH (mm)	MAX. ALLOWABLE TOTAL LENGTH (mm)
A	>0.15	0
	>0.10 to <0.15	13
	>0.05 to <0.10	25
	<0.05	no limits
B	only as regards tube safety	

2.7.3 ASSESSMENT OF THE QUALITY OF THE ACTIVATED PHOSPHOR SCREEN

The assessment of the quality of the phosphor and matrix layer at area A should take place at typical operating conditions and a blanked raster. The current for each gun shall be 65 μA.

2.7.3.1 Definition of blemishes

- A blemish is a fault which is clearly visible within 5 seconds
- The size of a blemish is defined in terms of the number of missing phosphor dots
- A defect, which looks visually as one blemish should be regarded as a single blemish
- Missing phosphor dot: 50% or more of the complete dot is missing
- Partial missing phosphor dot: 25% to 49% of the complete dot missing
- Dots with less than 25% missing can be ignored.

2.7.3.2 Limits

1. A combination of blemishes of categories B and/or A within a distance of 50 mm should be regarded as adjacent and classified as a category A blemish. In that case category A2 should be read as one colour and category A3 as 2 or 3 colours.
2. A combination of category C blemishes with category A and/or B blemishes within a distance of 50 mm must not affect more than 6 dots.

Table 3 Limits of missing phosphor dots at high contrast

CATEGORY		BLEMISH SIZE IN MISSING PHOSPHOR DOTS		MAX. NUMBER OF BLEMISHES IN AREA			MIN. ACCEPTABLE DISTANCE BETWEEN ANY 2 BLEMISHES IN AREA (mm)	
				A	B	A/B	A	B
A	A1	4 and more adjacent dots		0	0	0	50	50
	A2	3 adjacent dots (1 or 2 colours)		0	0	0		
	A3	3 adjacent dots (3 colours)		1	1	1		
	A4	2 adjacent dots (1 or 2 colours)		1	2	2		
B		1 dot	green	3	2	8	–	–
		1 dot	red	5	4			
		1 dot	blue	5	4			
C		total number of blemishes		8		–	–	–

Table 4 Limits of missing phosphor dots at medium contrast

BLEMISH SIZE IN MISSING PHOSPHOR DOTS	MAX. NUMBER OF BLEMISHES IN AREA		MIN. ACCEPTABLE DISTANCE BETWEEN ANY 2 BLEMISHES IN AREA (mm)	
	A	A/B	A	A/B
3 adjacent dots	1	2	50	30
2 adjacent dots	3	6	50	20
1 dot	–	–	–	–

3 PRODUCT CHARACTERISTICS

3.1 Electrical data

SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNIT
Capacitances					
$C_{a(m+m')}$	anode to external conductive cone coating, including rimband (with and without screen coating)	800	1050	1300	pF
C_k	cathodes of all guns, connected in parallel, to all other electrodes	–	15	–	pF
C_{kR}, C_{kG}, C_{kB}	cathode of any gun to all other electrodes	–	5	–	pF
C_{g1}	grid 1 of any gun to all other electrodes	–	17	–	pF
C_{g2}	grid 2 to all other electrodes	–	17	–	pF
C_{g3}	grid 3a (focus electrode) to all other electrodes	–	6	–	pF
Heater					
V_f	heater voltage	–	6.3	–	V
I_f	heater current	295	315	335	mA
Deflection unit					
V_{max}	maximum permissible DC voltage				
	between horizontal and vertical coils	–	–	3000	V
	between vertical coils and core	–	–	300	V
R_{ins}	insulation resistance at 1 kV (DC)				
	between horizontal and vertical coils	500	–	–	MΩ
	between horizontal coil and core clamping ring	500	–	–	MΩ
	between vertical coil and core clamping ring	10	–	–	MΩ
	cross talk (1 V applied to the horizontal coils)	–	–	20	mV

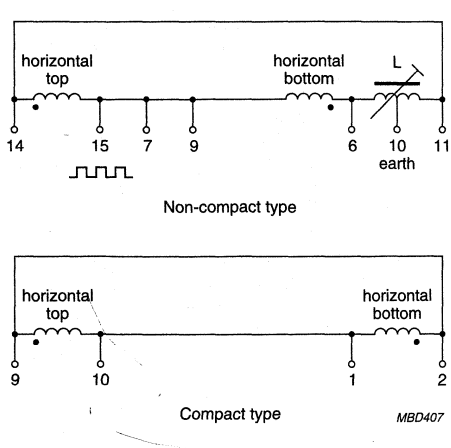
3.2 Deflection unit data

All values are valid at T_{amb} = 25 °C and V_a = 24 kV.

PARAMETER	DEFLECTION YOKE TYPE NUMBERS										TOLERANCE	UNIT
	36/3	37/3	36	37	15	17	15/5	17/5	16	18		
Advised frequency; note 1	38	38	38	38	48	48	57	57	64	64	–	kHz
VLMF	–	✓	–	✓	–	✓	–	✓	–	✓	–	
Horizontal deflection coil												
Inductance	0.37	0.38	0.38	0.39	0.18	0.18	0.18	0.18	0.18	0.18	±4%	mH
Resistance	0.49	0.80	0.51	0.96	0.28	0.58	0.28	0.58	0.32	0.64	±10%	Ω
Current (peak-to-peak value)	6.14	6.14	6.14	6.14	8.90	8.90	8.90	8.90	8.90	8.90	±4%	A
Used wire	normal						thermostable		litze			
Vertical deflection coil												
Inductance	6.6	6.6	6.6	6.6	6.6	6.6	5.9	5.9	6.6	6.6	±4%	mH
Resistance	5.8	5.8	5.8	5.8	5.8	5.8	5.3	5.3	5.8	5.8	±7%	Ω
Current (peak-to-peak value)	1.5	1.5	1.5	1.5	1.5	1.5	1.56	1.56	1.5	1.5	±5%	A
Used wire	normal								litze			

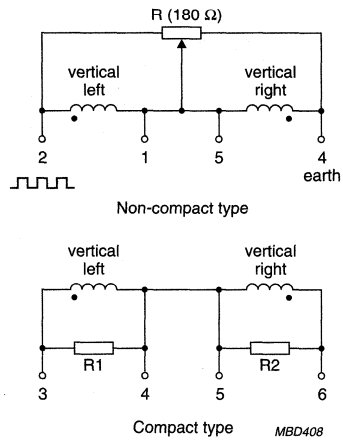
Note

1. Advised maximum frequency depends on the internal maximum set-temperature and used deflection-overscan.



The beginning of the windings is indicated with •

Fig.6 Horizontal deflection coils.



The beginning of the windings is indicated with •

Fig.7 Vertical deflection coils.

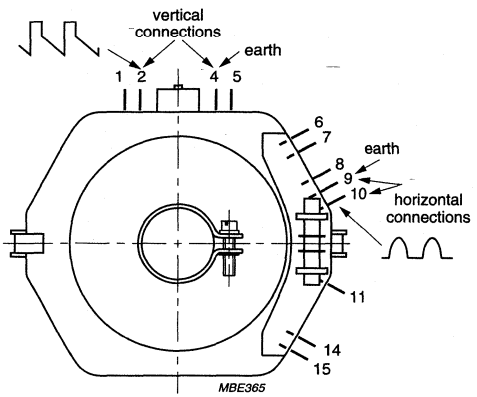


Fig.8 Location of deflection coil terminals for the non-compact F type.

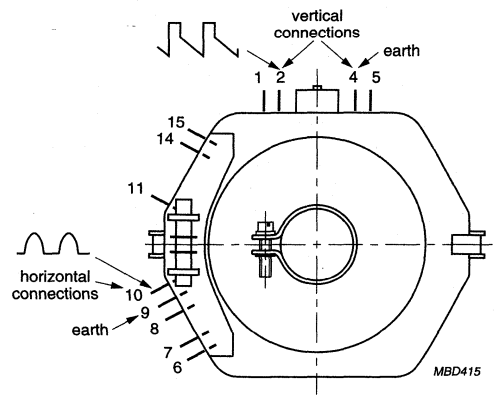


Fig.9 Location of deflection coil terminals for the non-compact G type.

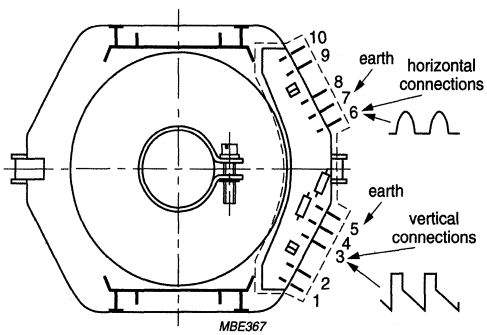


Fig.10 Location of deflection coil terminals for the compact F type.

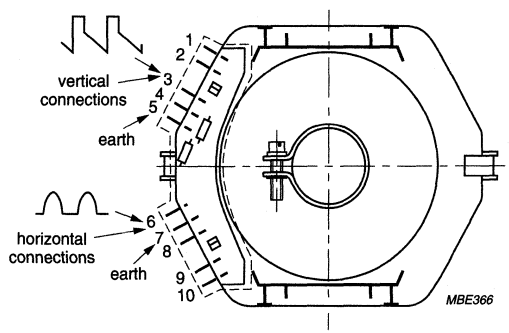


Fig.11 Location of deflection coil terminals for the compact G type.

3.2.1 DEFLECTION UNIT TEMPERATURE

SYMBOL	PARAMETER	WIRE	MAX.	UNIT
T_{copper}	operating copper temperature (resistance measurement)	normal multi	95	°C
		thermostable multi	110	°C
		litze	100	°C

3.3 Electron-optical data

PARAMETER	VALUE
Electron gun system	three in-line integrated guns
Focus method	electrostatic
Focus lens	hi-bi potential
Convergence method	magnetic
Deflection method	self converging
Deflection angle	
diagonal	≈90°
horizontal	≈78°
vertical	≈60°

3.4 Screen and coating properties

PARAMETER	VALUE
Screen	metal-backed phosphor dot triplets; Black Matrix
Screen finish	AG or AGAS
Recommended active screen area	
horizontal axis	262 mm
vertical axis	190 mm
Dot arrangement	hexagonal
Hexagonal dot pitch	0.28 mm

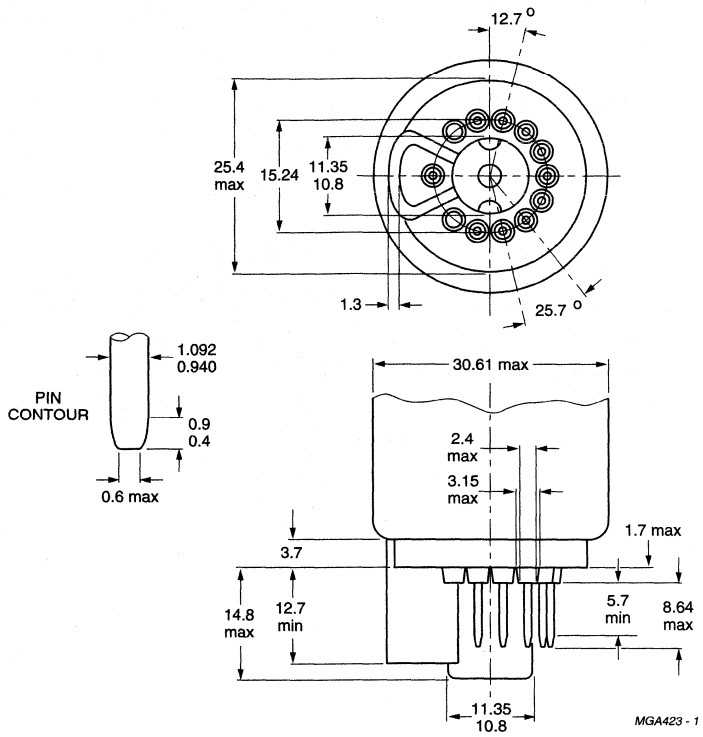
3.5 Screen finish

TYPE NUMBER	SCREEN FINISH	GLOSS
Light transmission at screen centre = 57%		
M34EDC13	Anti-Glare/Anti-Static (AGAS)	57% ±10%
M34EDC14	Anti-Glare (AG)	57% ±10%

3.6 Mechanical tube data

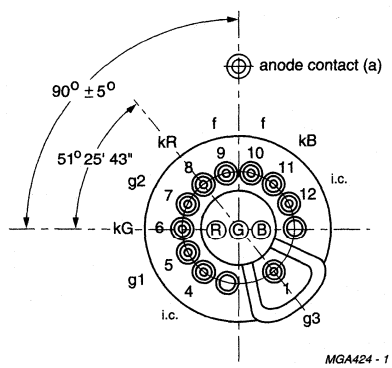
PARAMETER	VALUE
Overall length	347 ±5 mm
Neck diameter	29.1 +0.9/–0.7 mm
Maximum dimensions, excluding mounting lugs but including rimband	
diagonal	368.9 ±1.6 mm
width	318.9 ±1.6 mm
height	248.9 ±1.6 mm
Implosion protection	shrunk-on rimband; BSI, CSA, UL and VDE approved
Anode contact	JEDEC J1-21; IEC 67-III-2
Base designation	JEDEC B10-277
Base pin configuration	see Fig.13
Mass	≈6.4 kg
Magnetic shielding	internal
Mounting position	anode contact on top

3.7 Mechanical tube drawings



Dimensions in mm.

Fig.12 JEDEC B10-277 configuration.



i.c. = internally connected (not to be used).

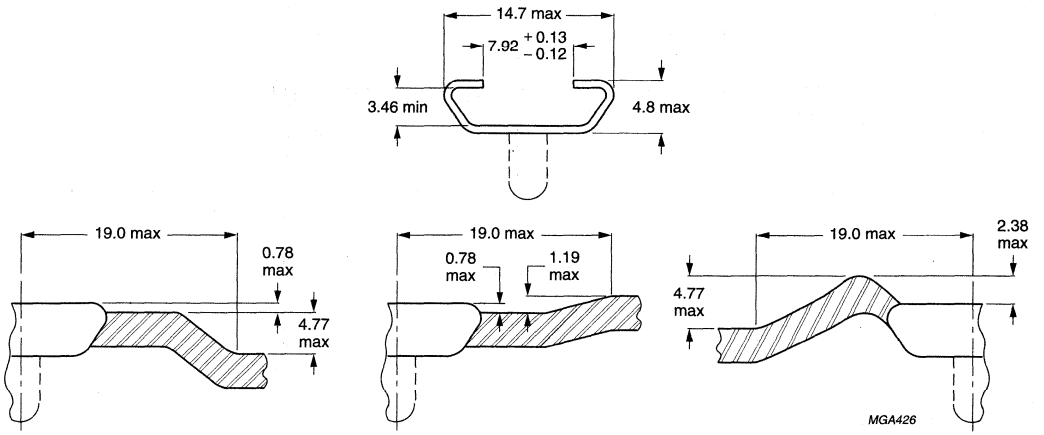
Fig.13 Pin configuration.

Remarks: to Figs 12 and 13.

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

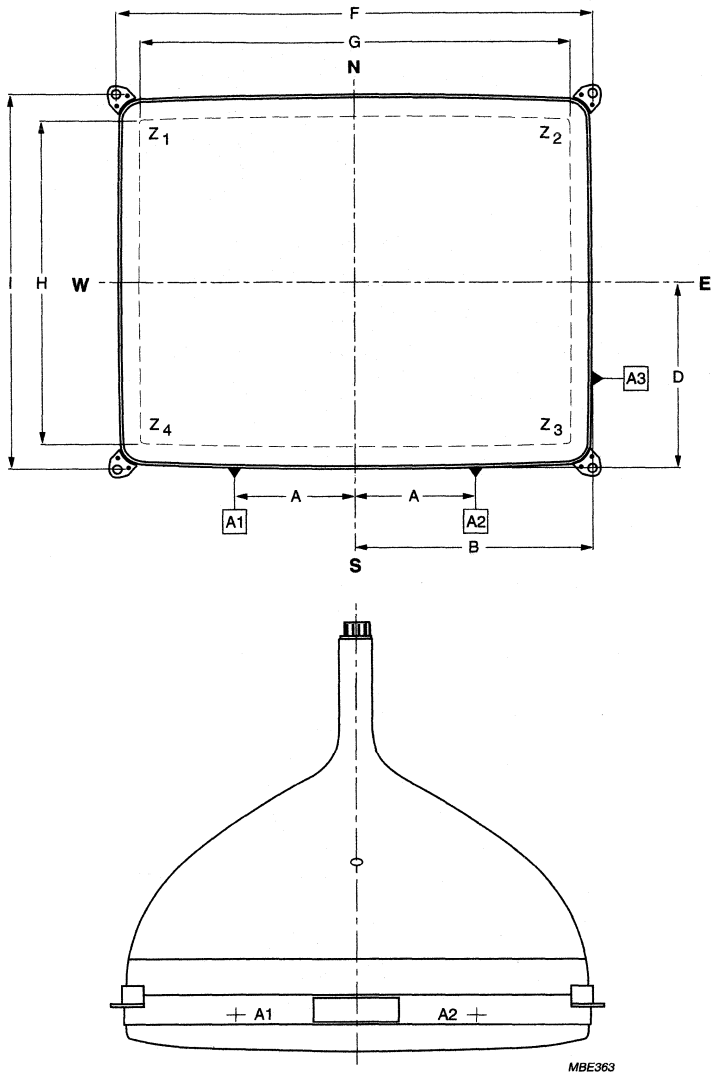
The mass of the mounting socket assembly should not exceed 450 g.

Maximum permissible torque on the tube neck is 0.04 Nm.



Dimensions in mm.

Fig.14 Cavity cap JEDEC J-21, IEC 67-III-2.

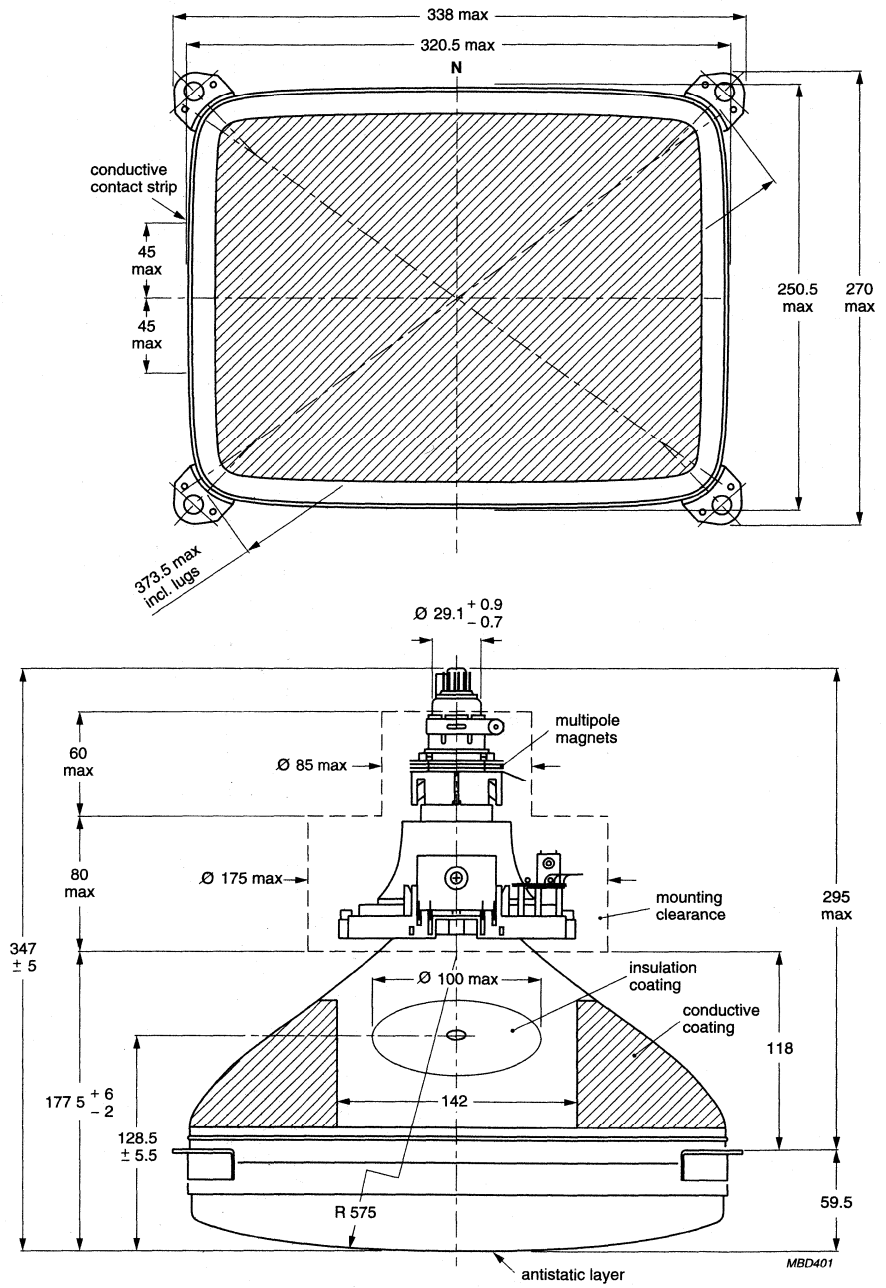


A = 113.0 mm.
B = 155.7 mm.
D = 120.1 mm.
F = 311.4 mm.
G = 280.8 mm.
H = 210.0 mm.
I = 243.2 mm.

Fig.15 Mechanical reference points.

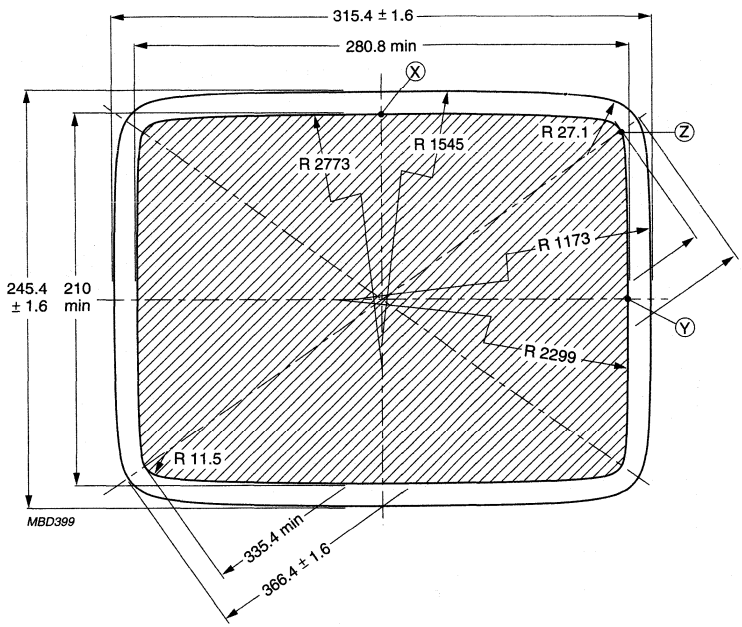
14" high resolution colour monitor tube assemblies

M34EDC



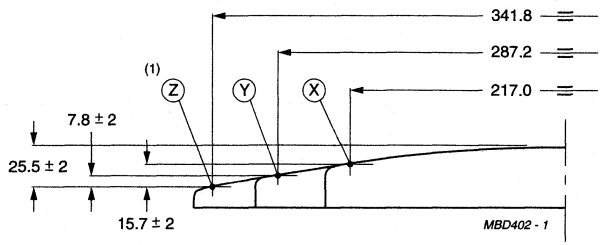
Dimensions in mm.

Fig.16 Top view.



Dimensions in mm.

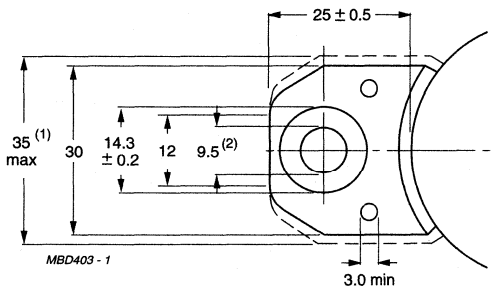
Fig.17 Screen dimensions.



Dimensions in mm.

(1) The X, Y and Z reference points are located on the outside surface of the face-plate.

Fig.18 Screen reference points.

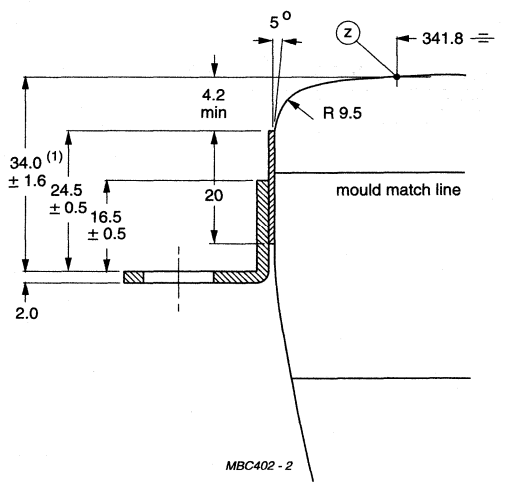


Dimensions in mm.

(1) Minimum space to be reserved for mounting the lug.

(2) The position of the mounting screw in the cabinet must be within a circle of 9.5 mm diameter drawn around the true geometrical positions, i.e. the corners of a rectangle of 311.4 mm × 243.2 mm.

Fig.19 Lug dimensions.



Dimensions in mm.

(1) The displacement of any lug with respect to the plane through the other 3 lugs is maximum 0.8 mm.

Fig.20 Lug position.

3.8 Sagittal heights of screen

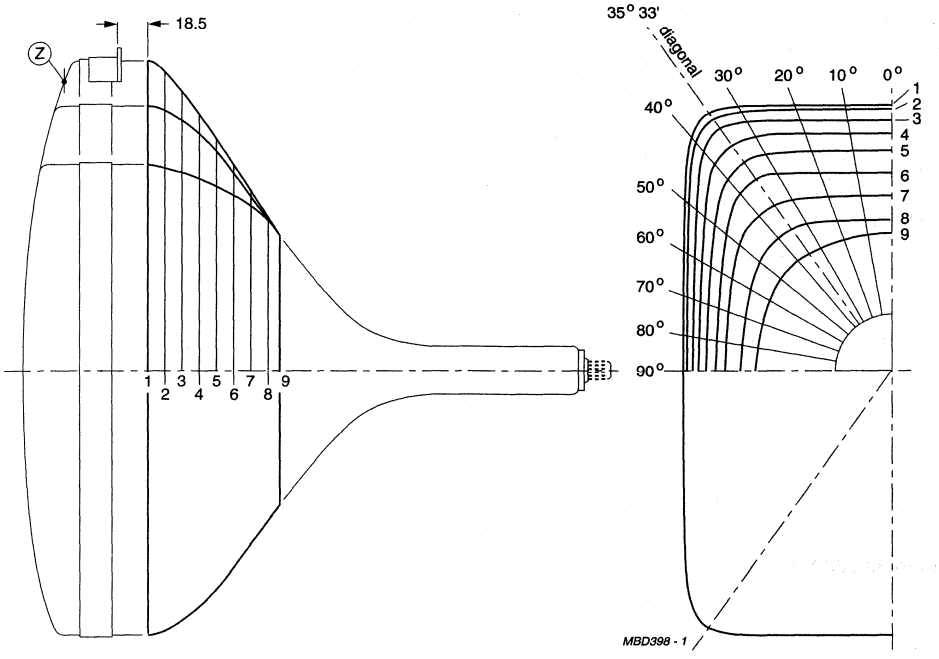
Sagittal heights with reference to the end of the diagonal axis

NOMINAL USEFUL SCREEN (NUS)			3 mm INSIDE NUS			5 mm OUTSIDE NUS		
CO-ORDINATES		SAGITTAL HEIGHT	CO-ORDINATES		SAGITTAL HEIGHT	CO-ORDINATES		SAGITTAL HEIGHT
X (mm)	Y (mm)	(mm)	X (mm)	Y (mm)	(mm)	X (mm)	Y (mm)	(mm)
0.0	0.0	25.2	0.0	0.0	25.3	0.0	0.0	28.7
0.0[1]	106.1	15.4	0.0	103.1	16.0	0.0	111.1	17.9
10.0	106.1	15.3	10.0	103.1	15.9	10.0	111.1	17.8
20.0	106.0	15.0	20.0	103.0	15.6	20.0	111.0	17.5
30.0	105.9	14.6	30.0	102.9	15.2	30.0	110.9	17.1
40.0	105.8	14.0	40.0	102.8	14.6	40.0	110.8	16.5
50.0	105.7	13.2	50.0	102.7	13.9	50.0	110.7	15.7
60.0	105.5	12.3	60.0	102.5	12.9	60.0	110.5	14.8
70.0	105.2	11.2	70.0	102.2	11.8	70.0	110.2	13.7
80.0	104.9	9.9	80.0	101.9	10.5	80.0	110.0	12.4
90.0	104.6	8.4	90.0	101.6	9.1	90.0	109.6	10.9
100.0	104.3	6.8	100.0	101.3	7.4	100.0	109.3	9.3
110.0	103.9	5.0	110.0	100.9	5.6	110.0	108.9	7.5
120.0	103.5	3.0	120.0	100.5	3.6	120.0	108.5	5.5
127.6	103.2	1.3	130.0	100.0	1.4	130.0	108.1	3.3
137.1[2]	98.0	0.0	136.0	99.8	0.0	140.0	107.6	0.9
139.4	91.2	0.6	–	–	–	143.7	107.4	0.0
–	–	–	–	–	–	144.0	100.0	1.3
139.4	90.0	0.8	136.4	90.0	1.6	144.5	90.0	2.9
139.8	80.0	2.2	136.8	80.0	3.0	144.8	80.0	4.4
140.1	70.0	3.5	137.1	70.0	4.3	145.1	70.0	5.7
140.4	60.0	4.6	137.4	60.0	5.4	145.4	60.0	6.8
140.7	50.0	5.5	137.7	50.0	6.3	145.7	50.0	7.7
140.9	40.0	6.3	137.9	40.0	7.1	145.9	40.0	8.5
141.0	30.0	6.9	138.0	30.0	7.7	146.0	30.0	9.0
141.1	20.0	7.3	138.1	20.0	8.1	146.1	20.0	9.5
141.2	10.0	7.6	138.2	10.0	8.4	146.2	10.0	9.7
141.2[3]	0.0	7.6	138.2	0.0	8.5	146.2	0.0	9.8

Notes

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

3.9 Cone contour



Dimensions in mm.

Fig.21 Maximum cone contour.

Cone contour data

SECTION	NOMINAL DISTANCE FROM SECTION 1 (mm)	MAXIMUM DISTANCE FROM TUBE AXIS (mm)										
		0°	10°	20°	30°	DIAG.	40°	50°	60°	70°	80°	90°
1	0	157.2	159.4	166.3	178.2	183.6	180.0	156.5	140.0	129.8	124.2	122.4
2	10	154.7	156.9	163.5	174.1	178.1	174.8	153.7	137.8	127.9	122.4	120.7
3	20	148.8	150.7	156.3	163.5	165.0	162.6	147.7	133.6	124.4	119.3	117.7
4	30	140.4	142.1	146.2	150.5	151.1	149.6	140.0	128.6	120.3	115.7	114.2
5	40	130.3	131.3	134.0	136.5	136.8	136.1	130.8	122.7	115.9	111.7	110.3
6	50	118.2	118.8	120.1	121.6	122.0	121.9	119.8	115.4	110.5	107.0	105.8
7	60	104.9	104.7	105.1	106.0	106.5	106.9	107.0	105.6	103.1	100.8	99.8
8	70	90.6	89.9	89.8	90.4	90.9	91.4	92.3	92.5	91.7	90.4	89.7
9	77	79.9	79.1	79.0	79.4	79.9	80.4	81.4	81.8	81.4	80.5	79.9

4 APPLICATION CONDITIONS

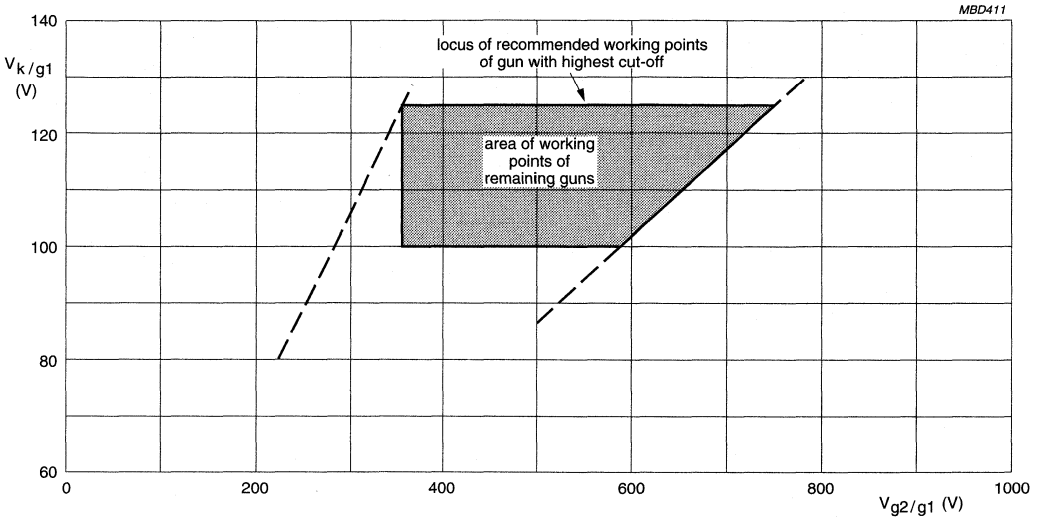
4.1 Recommended adjustment and operating conditions

The voltages are applied to each gun and are measured with respect to grid 1; RH = 40% to 60%; tube facing east at local magnetic field. Pre-heat the tube for 15 minutes minimum before tests. Avoid impurity, misconvergence, distortion etc. due to stray magnetic fields and chassis influences.

SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNIT
$V_{a,g4}$	anode voltage	23.8	25.0	26.3	kV
V_{g3}	grid 3 (focus electrode) voltage; note 1	6.0	–	7.0	kV
V_{g2}	grid 2 voltage at a spot cut-off voltage V_{co} = 125 V; note 2	see Fig.22			V
V_f	heater voltage	–	6.3(3)	–	V
T_{amb}	ambient temperature	–	25	–	°C

Notes

1. Focus adjustment procedure:
   a) Adjust anode current for 86 cd/m^2 and CIE x = 0.281; y = 0.311.
   b) Adjust for optimum focus at screen centre and screen edge on a test pattern of 7 × 9 dot $ characters (total 1024 × 768 dots).
2. Grid 2 adjustment procedure:
   a) Grid 2 voltage (V_{g2}) adjusted for highest gun spot cut-off voltage V_{co} = 125 V.
   b) Remaining guns adjusted for spot cut-off by means of cathode voltage.
   c) V_{g2} range: 360 V to 750 V at V_{co} = 125 V.
   d) Set the cathode voltage (V_k) for each gun at 125 V; increase the grid 2 voltage (V_{g2}) from ≈360 V to the value at which the spot of the gun with the lowest (V_{g2}) cut-off voltage becomes just visible, then decrease the cathode voltage of the remaining guns until the other colours become just visible.
3. For maximum cathode life it is recommended that the heater voltage is regulated.



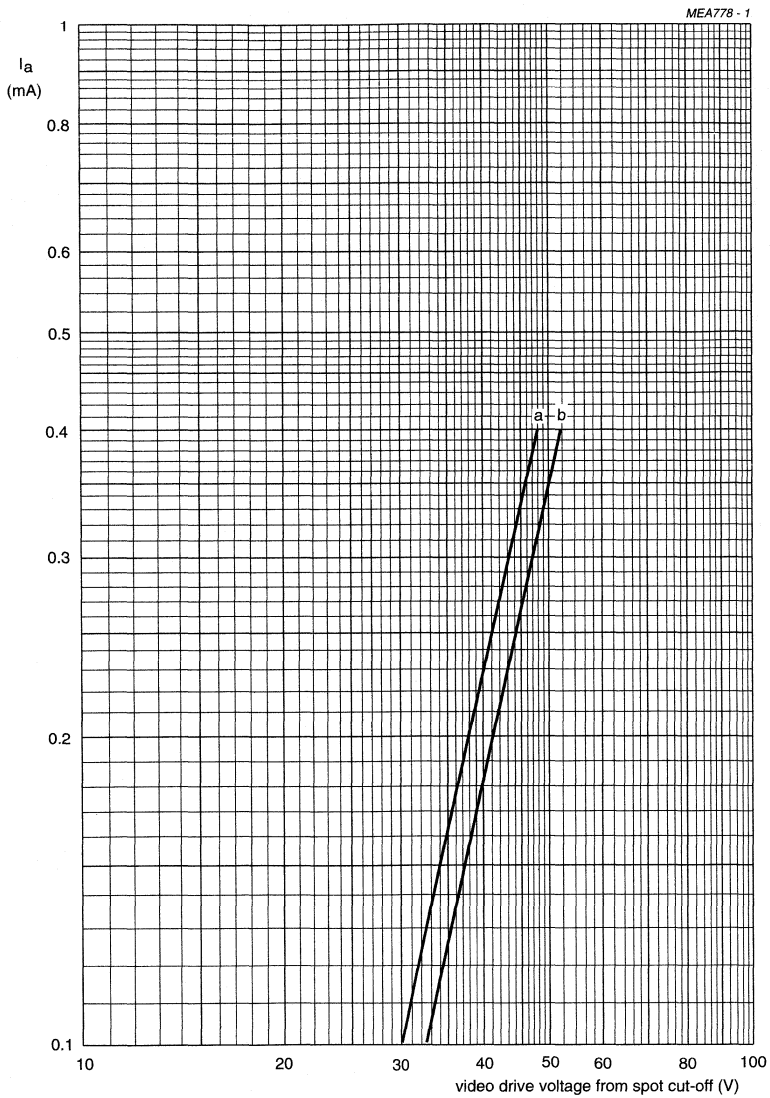
The voltages are specified with respect to grid 1.

Fig.22 Spot cut-off design chart.

4.2 Chassis design values

The values are valid for anode voltages between 20 and 27.5 kV. The voltages are specified with respect to grid 1.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
V_{g3}	grid 3 (static focus voltage) as a percentage of anode voltage		24	26	26	%
V_{g2}	grid 2 voltage	for visual extinction of focused spot	see Fig.22			
V_k	cathode voltage		see Figs 22 and 23			
ΔV_k	difference in cut-off voltage between guns in any tube (cathodes cut-off ratio)		highest value <1.25 × lowest value			
V_f	heater voltage	at zero beam current	–	6.3	–	V
I_{g3}	focus current	under cut-off conditions	−5	–	+5	μA
I_{g2}	grid 2 current	under cut-off conditions	−5	–	+5	μA
I_{g1}	grid 1 current	under cut-off conditions	−5	–	+5	μA
I_{kf}	cathode/heater current	V_{co} = 125 V	−3	–	+3	μA
Resistance						
R_{kgf}	insulation resistance between each cathode and all other electrodes and heater		50	–	–	MΩ
R_{g2}	grid 2 circuit impedance		–	–	5	MΩ
R_{g3}	grid 3 circuit impedance		–	–	50	MΩ



V_{co} = 100 V (curve a).
V_{co} = 125 V (curve b).

Fig.23 Typical cathode drive characteristics.

4.3 Limiting values

In accordance with the Absolute Maximum Rating System (IEC 134). Voltages are specified with respect to grid 1.

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
$V_{a,g4}$	anode voltage	note 1	20[2]	27.5[3]	kV
I_{ap}	anode current for each gun (peak value)		–	400	μA
I_a	long-term average anode current for each gun		–	200	μA
I_a	long-term average anode current for three guns		–	450	μA
V_{g3}	grid 3 (focus) voltage		–	10	kV
V_{g2p}	grid 2 voltage, including video signal voltage (peak value)		–	1000	V
V_f	heater voltage	note 4	5.7	6.6	V
Cathode voltage					
V_{kf}	DC component value		–	250	V
V_{kfp}	peak value		–	300[3]	V
Cathode to heater voltage					
V_{kf}	DC component value		–	–0	V

Notes

1. During adjustment on the production line this value is likely to be surpassed considerably. It is therefore strongly recommended to first make the necessary adjustments for normal operation without the picture tube.
2. Operation of the tube at lower voltages impairs the luminance and resolution and could impair the convergence.
3. This value is an absolute maximum.
4. For maximum cathode life, it is recommended that the heater supply is regulated.

4.4 Flashover protection

With the high voltage used with this tube (max. 27.5 kV) internal flashovers may occur. As a result of Soft-Flash technology these flashover currents are limited to approximately 60 A offering higher reliability, optimum circuit protection and component savings.

Primary protective circuitry using properly grounded spark gaps and series isolation resistors (preferably carbon composition) is still necessary to prevent tube damage. The spark gaps should be connected to all picture tube electrodes at the socket in accordance with Fig.24; they are not required on the heater pins. No other connections between the outer conductive coating and the chassis are permissible. The spark gaps should be designed for a breakdown voltage at the focus electrode (g3) of 11 kV and at the other electrodes of 1.5 to 2 kV, both at an atmospheric pressure of 100 kPa.

The values of the series isolation resistors should be as high as possible (min. 500 Ω) without causing deterioration of the circuit performance. The resistors should be able to withstand an instantaneous surge of 20 kV for the focus circuit and 12 kV for the remaining circuits without arcing.

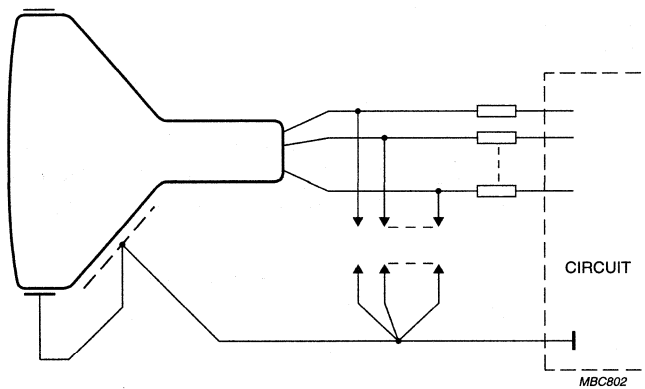


Fig.24 Flashover protection circuit.

4.5 Degaussing

The monitor tube is provided with an internal magnetic shield. This shield and the shadow mask with its suspension system may be provided with an automatic degaussing system, consisting of a coil mounted on the cone of the monitor tube as shown in Fig.26.

For proper degaussing an initial magnetomotive force (MMF) of 600 ampere-turns is required in the eight shaped coil. This MMF has to be gradually decreased (maximum 30% per half period) by appropriate circuitry. To prevent beam landing disturbance by horizontal frequency currents induced in the degaussing coils, these coils should be shunted by a capacitor of sufficiently high value. In steady state, no significant MMF should remain in the coils (≤0.6 ampere-turns).

If single-phase power rectification is employed in the monitor circuitry, provision should be included to prevent asymmetric distortion of the AC voltage applied to the degaussing circuit due to high DC inrush currents.

Incomplete degaussing may result in some out-of-specification characteristics.

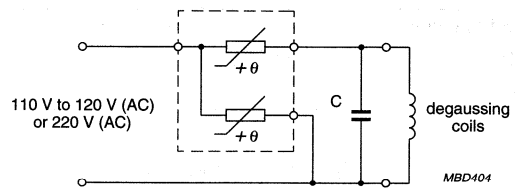


Fig.25 Degaussing circuit using a dual PTC thermistor.

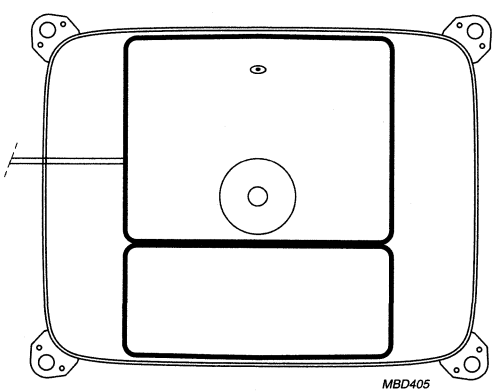


Fig.26 Mounting of the degaussing coil on the monitor tube.

5 ERGONOMIC, ENVIRONMENTAL DATA

5.1 Electromagnetic radiation performance

PARAMETER	WITH AGAS WITH VLMF	REQUIREMENT		UNIT
		MPR-II	TCO	
Electrostatic potential	<500	<500	<500	V
Magnetic field				
5 to 2000 Hz	<200(1)	<250(2)	<200(1)	nT
2 to 400 kHz	<20(2)	<25(2)	<25(2)	nT
Alternating electrical field				
5 to 2000 Hz	2.0(3)	25(2)	10(3)	V/m
2 to 400 kHz	<2.5(4)	2.5(2)	1(1)	V/m

Notes

1. Measuring distance: 30 cm from screen front; 50 cm from other sides.
2. Measuring distance: 50 cm from all sides.
3. Measuring distance: 30 cm from screen front.
4. Related to chassis design.

5.2 X-radiation

Maximum anode voltage at which the X-radiation emitted will not exceed 0.5 mR/h at an anode current of 300 μA.

PARAMETER	TYP.	UNIT
Entire tube; note 1	31	kV
Face plate only	33	kV

Note

1. This rating applies only if the anode connector used by the set maker provides the necessary attenuation to reduce the X-radiation from the anode contact by a factor equal to the difference between the anode button iso-exposure-rate limit curve and the iso-exposure-rate limit curve for the entire tube.

WARNING

If the value for the tube face only is used as design criterion, adequate shielding must be provided in the monitor for the anode contact and/or certain portions of the tube funnel and panel sidewalls to ensure that the X-radiation from the monitor is attenuated to a value equal to or lower than that specified for the face of the tube.

Maximum voltage difference between anode and focus electrode at which the X-radiation will not exceed 0.5 mR/h is 30 kV.

If this voltage can be exceeded in the monitor, additional attenuation of the X-radiation through the neck may be required.

The X-radiation emitted from this picture tube, as measured in accordance with the procedure of *"JEDEC Publications No.64D"* will not exceed 0.5 mR/h throughout the useful life of the tube when operated within the design-maximum ratings.

The tube should not be operated beyond its design-maximum ratings stated above, but its X-radiation will not exceed 0.5 mR/h for anode voltage and current combinations given by the iso-exposure-rate limit characteristics as shown in Fig.28.

Operation above the values shown by the curve may result in failure of the monitor to comply with the *"Federal Performance Standard of the U.S. for Television Receivers, Section 1020.10 of Part 1020 of Title 21, Code of Federal Regulation (PL90-602)"* as published in *"Federal Register Volume 38, No. 198,b Monday, October 15, 1973"*.

Maximum X-radiation as a function of anode voltage at 300 μA current is shown by Fig.27. X-radiation at a constant anode voltage varies linearly with anode current.

WARNING

The cathode ray tube is intrinsically safe in accordance with *"Appendix III Röntgenverordnung"*.

Eigensichere Kathodenstrahlröhre nach *"Anlage III Röntgenverordnung"*.

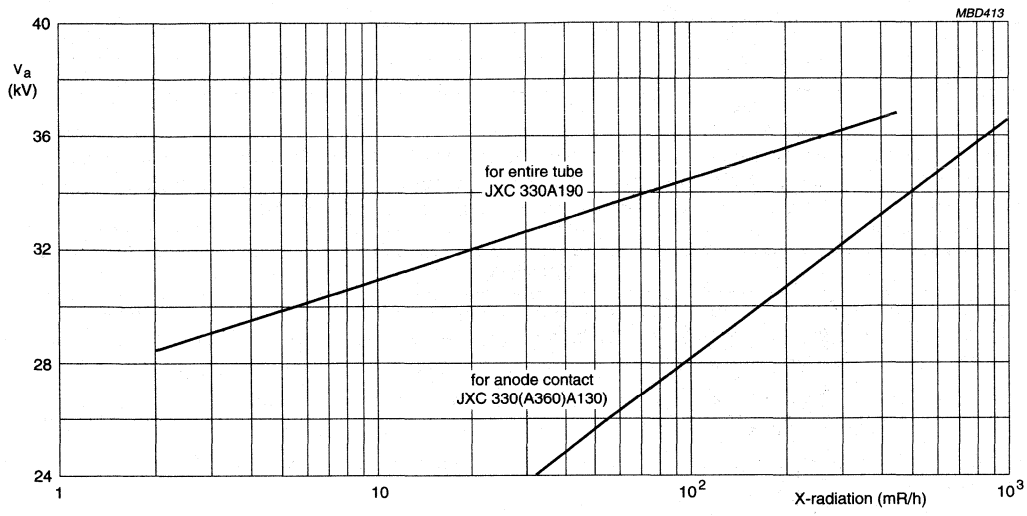


Fig.27 X-radiation limit curve at a constant anode current of 300 μA.

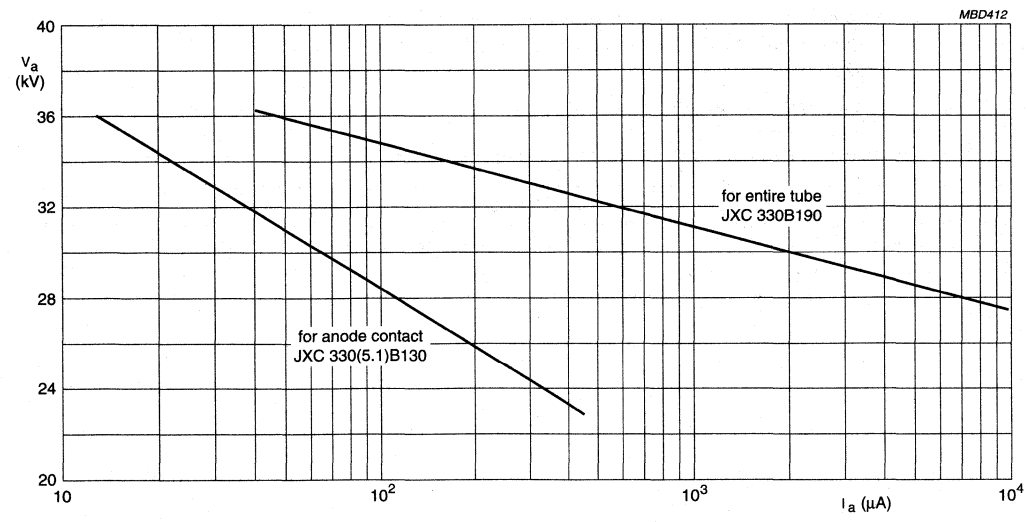
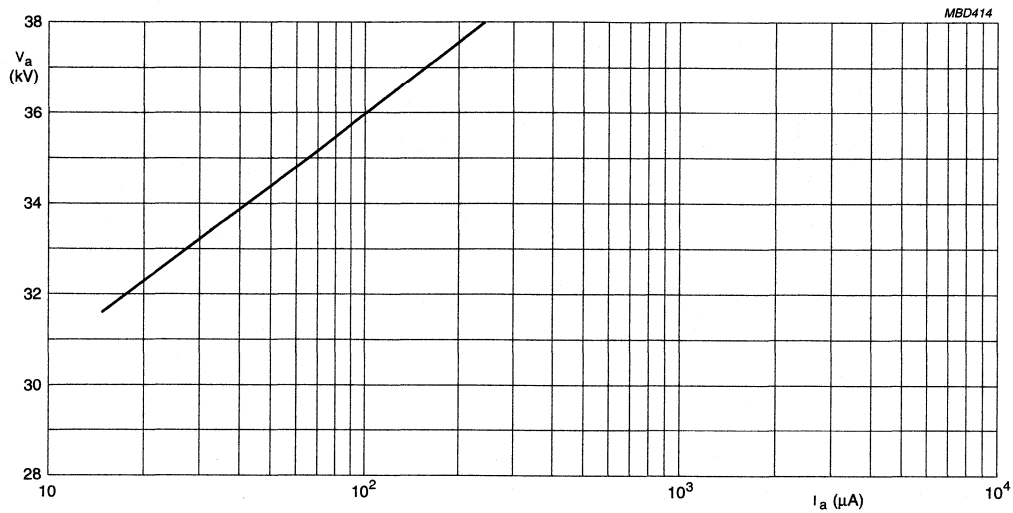


Fig.28 0.5 mR/h iso-exposure-rate limit curve.



The X-radiation emitted will also not exceed 1 μSv/h for anode voltage and current combinations shown in the iso-exposure-rate limit curve according to Eigensichere Kathodenstrahlröhre nach *"Anlage III Röntgenverordnung"*.

Fig.29 1 μSv/h iso-exposure-rate limit curve.

5.3 Warnings

X-radiation
Operation of the colour monitor tube under abnormal conditions that exceed the 0.5 mR/h iso-exposure-rate curve shown in Fig.28 may produce soft X-rays, which may constitute a health hazard on prolonged exposure at close range unless adequate external screening is provided. Precautions must therefore be exercised during servicing of monitors using this tube to ensure that the anode voltage and other tube voltages are adjusted to the recommended values so that the values stated in Section 4.3 are not exceeded.
Tube replacement
This monitor tube incorporates integral X-radiation and implosion protection and must be replaced with a tube of the same type number or recommended replacement to assure continued safety.
Shock hazard
The high voltage at which the tube is operated may be vary dangerous. The monitor should include safeguards to prevent the user from coming in contact with the high voltage. Extreme care should be taken in servicing or adjustment of any high-voltage circuit. Caution must be taken during replacement or servicing of the monitor tube since a residual electrical charge may be held by the high-voltage capacitor formed by the external and internal conductive coatings of the monitor tube funnel. To remove any residual charge, short the anode contact button, located in the funnel of the tube, to the external conductive coating before handling the tube. Discharging the high voltage to isolated metal parts such as cabinets and control brackets may produce a shock hazard.

5.4 Handling

The packaging provides protection against tube damage under normal conditions of shipment or handling. Observe any instructions given on the packaging and handle accordingly. Under no circumstances should the tube assembly be subjected to accelerations greater than the values given in Table "Accelerations".

Accelerations

PARAMETER	CONDITIONS	MAX.	UNIT
Pulse in cone direction	≤10 ms	350	m/s^2
	30 ms	200	m/s^2
Pulse in all other directions	30 ms	350	m/s^2

Monitor tubes should be kept in the shipping box or similar protective container prior to installation.

Although monitor tubes are provided with integral implosion protection which meets the intrinsic safety requirements stipulated in the relevant part of IEC 65, care should be taken not to scratch or knock any part of the tube. Particularly care should be taken to prevent damage to the seal area.

In all handling procedures prior to insertion in the cabinet, there is a risk of personal injury if severe accidental damage to the tube occurs. It is therefore recommended that in areas containing unpacked and unprotected tubes, protective clothing is worn, particularly, gloves and safety glasses with side-shields to prevent possible injury from flying glass in the event of such an accident.

Handle the tube with extreme care. Do not strike, scratch or subject the tube to more than moderate pressure.

The tube assembly should never be handled by the tube neck, deflection unit or other neck components.

If suspending the tube assembly from the mounting lugs, ensure that a **minimum of two** are used.
Under no circumstances suspend the tube assembly from one lug.

An alternative lifting method is to firmly grasp the assembly by the vertical sides of the rimband. Manually lifting the assembly from the face-down or face-up position is shown in Figs 30 and 31.

To protect the screen when placing the tube face-down, ensure that the tube face rests on a cushion kept free from abrasive substances.

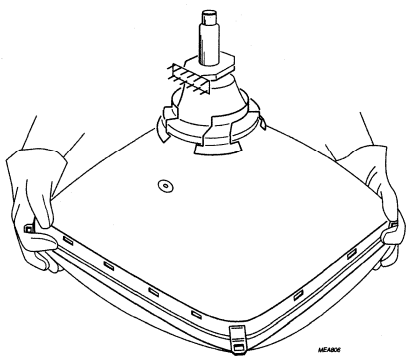


Fig.30 Lifting tube from face-down position.

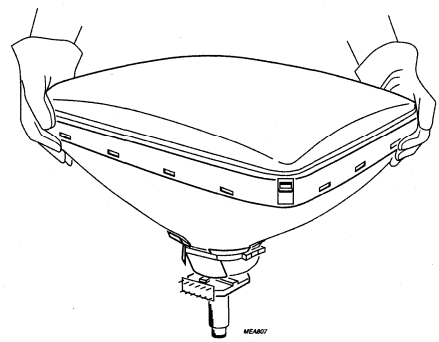


Fig.31 Lifting tube from face-up position.

15" high resolution colour monitor tube assemblies

M36EDR

CONTENTS

15" high resolution colour monitor tube assemblies

M36EDR

1 HIGHLIGHTS

1.1 Features

1.1.1 HIGH PERFORMANCE DESIGN

- High resolution; higher pixel density possible up to 1024 × 768 pixels (non-interlaced) displayable conforms to ISO 9241 with:
  - 'larger' effective screen area, 280 mm × 210 mm
  - high resolution polygon gun
  - 0.28 mm dot triplet pitch
- High brightness and contrast:
  - optimized black matrix process
- Excellent white uniformity and colour purity:
  - invar mask
  - inner magnetic shielding
- Accurate convergence and raster geometry:
  - double mussel coil technology
  - internal magnetostatic beam alignment
  - charge drift compensation by internal neck coating
- Application-friendly design:
  - worldwide useable design
  - East-West correction max. 5.5%
  - ringing-free deflection units
  - static convergence adjustment on monitor level: multipole for 4 and 6 pole correction
  - dynamic convergence adjustment on monitor level: horizontal balance coil; vertical balance potentiometer; vertical symmetry plates.

1.1.2 ERGONOMIC DESIGN

- Less ambient reflection:
  - 'flat' and 'square' design
  - IRIS (Improved Reflection Improved Sharpness)
- Less eye strain:
  - P22 medium/short persistence phosphor
  - high frequency yokes
- Fulfilling electric/magnetic radiation standards:
  - antistatic coatings
  - no VLMF cancelling coils required to fulfil magnetic MPRII and TCO requirements
- Safety approved:
  - VDE; CSA; UL; BSI.

1.1.3 OPTIMUM DISPLAY SOLUTION

- Window applications
- Multi-tasking graphic programmes
- Resolution standards up to 1024 × 768 pixels non-interlaced XGA application.

1.2 Applications

1.2.1 HIGH PERFORMANCE DESIGN

- VGA
  - 640 × 480 pixels
- SVGA
  - 800 × 600 pixels
- XGA
  - 1024 × 768 pixels.

1.3 Quick reference data

PARAMETER	TYP.	UNIT
Deflection angle	90	deg
Face diagonal	36 15	cm inch
Overall length	<356.8	mm
Neck diameter	29.4	mm
Dot triplet pitch	0.28	mm
Focus voltage	27% of anode voltage	

1.4 Deflection coil types

PARAMETER	COIL TYPE NUMBER				UNIT
	/360	/151	/131	/161	
Horizontal coil inductance	0.34	0.18	0.18	0.18	mH
Vertical coil inductance	6.9	5.6	5.6	5.6	mH
Maximum advised frequency	48	48	57	69	kHz

1.5 Coding system

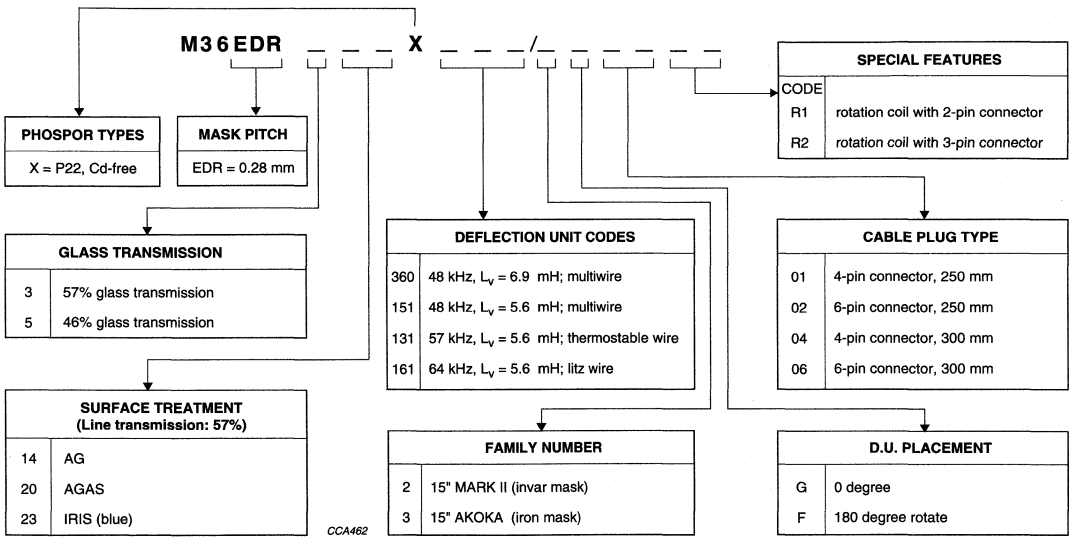


Fig.1 Available versions.

2 PERFORMANCE SPECIFICATION

2.1 Colour coordinates/luminance

Type P22 phosphor data; persistence is medium short; $I_{a(av)}$ = 200 μA (per gun); V_a = 24 kV; scan duty cycle = 75%; scanned area = 273 mm × 203 mm, resulting in an anode current (I_a) of 0.361 μA/cm^2.

PHOSPHOR COLOUR	COLOUR COORDINATES		MIN. BRIGHTNESS AT SCREEN CENTRE (Cd/m^2)
	x	y	
Red	0.620	0.350	24.9
Green	0.290	0.610	83.9
Blue	0.155	0.065	13.0

2.2 Brightness decrease

2.2.1 TEST PROCEDURE

Tube facing east; adjust the tube in accordance with the recommended operating conditions and to a centre-white brightness of 100 Cd/m^2 on a data raster of 273 mm × 203 mm.

2.2.2 LIMITS

Brightness decrease from centre to corner shall not exceed 30%.

2.3 Colour purity and white uniformity

2.3.1 TEST PROCEDURE

Tube facing east; adjust the tube in accordance with the recommended operating conditions and to a centre white brightness of 100 Cd/m^2, on a data raster of 273 mm × 203 mm. The screen should be viewed with blanked red, green, white raster at a distance of 1 metre at an ambient level of 1 lux.

2.3.2 LIMITS

No severe discoloration or cross contamination allowed. Maximum deviation in white x and y colour coordinates shall not exceed 0.015.

2.4 Resolution specification

With the settings given in Section 4.1, the displayed characters will be recognisable as individual $ characters on a data raster measuring 273 mm × 203 mm.

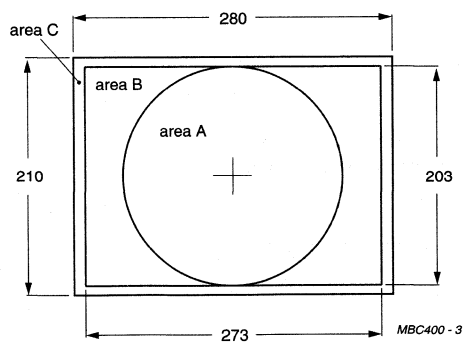
2.5 Convergence specification

2.5.1 TEST CONDITIONS

1. Set-up in accordance with Section 4.1.
2. Measure maximum misconvergence after 30 minutes operation.
3. To be adjusted for focus at half east or half west using cross-hatch pattern at anode current is 350 μA (peak value) per gun.
4. Misconvergence is the distance between the centres of the red, green and blue lines at the screen using a cross-hatch pattern.
5. Anode and/or focusing voltage and terrestrial magnetism may slightly affect the static convergence. Therefore, small re-adjustments to static convergence may be necessary.
6. Avoid stray magnetic fields etc. due to chassis influences which may affect convergence.

2.5.2 CONVERGENCE LIMITS

LOCATION (see Fig.2)	**TYPE OF ERROR**	**MAXIMUM ERROR BETWEEN ANY TWO COLOURS (mm)**
Area A	red-green-blue line separation in either the horizontal or vertical direction	0.25
Area B		0.35
Area C		0.40
Area B	vector	0.40



Dimensions in mm.

Fig.2 Maximum misconvergence.

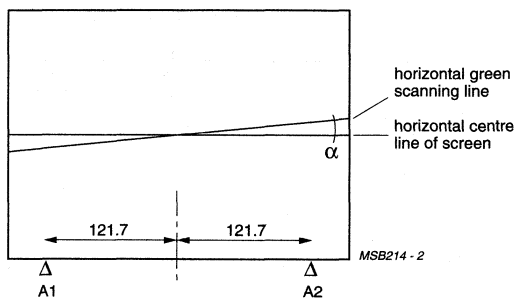
2.6 Raster geometry

2.6.1 RASTER CENTRING

CENTRING	MAX.	UNIT
Horizontal	±4	mm
Vertical	±4	mm

2.6.2 RASTER ROTATION

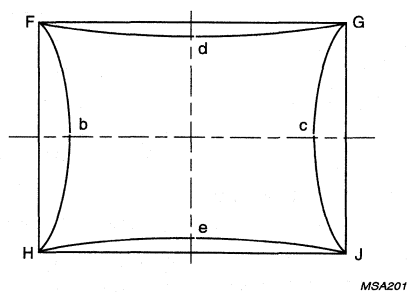
Measure the angle of the horizontal green scanning line with reference to a horizontal centre line that is drawn parallel to the tube reference points A1 and A2, see Fig.3. Chassis influences may affect raster rotation.



α = 0.35°

Fig.3 Rotation measurement.

2.6.3 PIN-CUSHION DISTORTION



FG = HJ = 280 mm.
FH = GJ = 210 mm.
Measured with no pin-cushion correction applied, with 'b', 'c', 'd' and 'e' measured along the main axis.

Fig.4 Pin-cushion distortion.

2.6.4 DISTORTION NORTH - SOUTH

The following formulae define the pin-cushion distortion in the north and south directions.

$$\text{North} = \frac{4d}{FH + GJ} \times 100\% = 0\% \text{ to } \pm 0.8\%$$

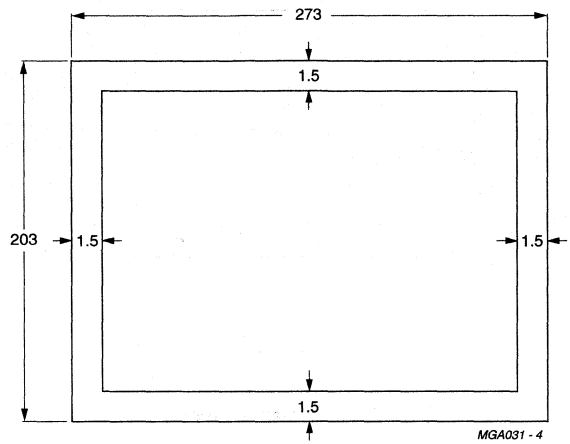
$$\text{South} = \frac{4e}{FH + GJ} \times 100\% = 0\% \text{ to } \pm 0.8\%$$

2.6.5 DISTORTION EAST - WEST

The following formulae define the pin-cushion distortion in the east and west directions.

$$\text{East} = \frac{4c}{FG + HJ} \times 100\% \leq 5.5\%$$

$$\text{West} = \frac{4b}{FG + HJ} \times 100\% \leq 5.5\%$$



Dimensions in mm.

Fig.5 General distortion.

2.7 Screen quality

2.7.1 GENERAL TEST PROCEDURE

Tests are to be done under the following general conditions:

- Viewing distance should be 60 cm minimum
- For an unactivated screen the diffuse ambient light level at the centre of the screen should be between 700 and 1000 lux
- The viewing angle relative to the tube axis should not exceed 45°
- Faults not visible under these general conditions are permitted
- The following quality areas are specified:
  - Area A: a rectangular area measuring 260.0 mm × 195.0 mm, of which the point of intersection of the diagonals coincides with the mechanical centre of the screen
  - Area B: the area between area A and the edge of the phosphor
  - Area C: the area between the edge of the phosphor and the rimband.

2.7.2 ASSESSMENT OF THE GLASS AND THE UNACTIVATED SCREEN QUALITY

2.7.2.1 Definition of blemishes

Unless otherwise specified, the shape of a blemish is defined as: round and elliptical.

The size of a blemish is given by:

- $\frac{L+W}{2}$ or $\frac{L}{20} + 2W$, whatever expression is the largest,

where L = length and W = width.

2.7.2.2 Limits

Table 1 Limits of measurable glass blemishes

SIZE (mm)	MAX. NUMBER OF BLEMISHES IN AREA A AND B	MIN. PERMISSIBLE DISTANCE BETWEEN ANY 2 BLEMISHES (mm)	AREA C
0.6	0	not applicable	only limits as regards tube safety
0.4 to <0.6	2	50	
0.2 to <0.4	3	50	
Total number	3	50	–
<0.2	limited only by cloud		–

Table 2 Limits of measurable coating blemishes (for AG and AGAS coating)

SIZE (mm)	MAX. NUMBER OF BLEMISHES IN AREA A + B	MIN. PERMISSIBLE DISTANCE BETWEEN ANY 2 BLEMISHES (mm)
0.4 to 0.6	3	50
0.2 to 0.4	5	20

Table 3 Limits of scratches

AREA	WIDTH (mm)	MAX. ALLOWABLE TOTAL LENGTH (mm)	MIN. SEPARATION (mm)
A and B	>0.15	0	not permitted
	>0.10 to <0.15	13	50
	>0.05 to <0.10	25	20
	<0.05	no limits	not applicable
C	only as regards tube safety		

2.7.3 ASSESSMENT OF THE QUALITY OF THE ACTIVATED PHOSPHOR SCREEN

The assessment of the quality of the phosphor and matrix layer at area A should take place at typical operating conditions and a blanked raster. The current for each gun shall be 100 μA.

2.7.3.1 Definition of blemishes

- A blemish is a fault which is clearly visible within 5 seconds.
- The size of a blemish is defined in terms of the number of missing phosphor dots.
- A defect, which looks visually as one blemish should be regarded as a single blemish.
- Missing phosphor dot: 50% or more of the complete dot is missing.
- Partial missing phosphor dot: 25% to 49% of the complete dot missing.
- Dots with less than 25% missing can be ignored, except for a concentration of such dots, having a diameter of more than 8 mm.

2.7.3.2 Limits

1. A combination of blemishes of categories B and/or A within a distance of 50 mm should be regarded as adjacent and classified as a category A blemish. In that case category A2 should be read as one colour and category A3 as 2 or 3 colours.
2. A combination of category C blemishes with category A and/or B blemishes within a distance of 50 mm must not affect more than 6 dots.

Table 4 Limits of missing phosphor dots

CATEGORY		BLEMISH SIZE IN MISSING PHOSPHOR DOTS		MAX. NUMBER OF BLEMISHES IN AREA			MIN. ACCEPTABLE DISTANCE BETWEEN ANY 2 BLEMISHES IN AREA (mm)	
				A	B	A/B	A	B
A	A1	4 and more adjacent dots		0	0	0	50	50
	A2	3 adjacent dots (1 or 2 colours)		0	0	0		
	A3	3 adjacent dots (3 colours)		1	1	1		
	A4	2 adjacent dots (1 or 2 colours)		1	2	2		
B		1 dot	green	3	2	8	–	–
		1 dot	red	5	4	8		
		1 dot	blue	5	4	8		
C		total number of blemishes		8		–	–	–

Table 5 Limits of missing phosphor dots at medium contrast

BLEMISH SIZE IN MISSING PHOSPHOR DOTS	MAX. NUMBER OF BLEMISHES IN AREA		MIN. ACCEPTABLE DISTANCE BETWEEN ANY 2 BLEMISHES IN AREA (mm)	
	A	A/B	A	A/B
3 and more adjacent dots	1	2	50	50
2 adjacent dots (1 or 2 colours)	3	6	50	50
1 dot (3 colours)	–	–	–	–

3 PRODUCT CHARACTERISTICS

3.1 Electrical data

SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNIT
Capacitances					
$C_{a(m+m')}$	anode to external conductive cone coating, including rimband (with and without screen coating)	900	1150	1400	pF
C_{g1}	grid 1 of any gun to all other electrodes	–	17	–	pF
C_k	cathodes of all guns, connected in parallel, to all other electrodes	–	15	–	pF
C_{kR}, C_{kG}, C_{kB}	cathode of any gun to all other electrodes	–	5	–	pF
C_{g3}	grid 3 (focus electrode) to all other electrodes	–	6	–	pF
Heater					
V_f	heater voltage	–	6.1	–	V
I_f	heater current	295	315	335	mA
t_{kwu}	cathode warm up time at 0-hour from 10% to 80% of end emission	–	–	8	s
Deflection unit					
V_{max}	maximum permissible DC voltage				
	between horizontal and vertical coils	–	–	2000	V
	between vertical coils and core	–	–	300	V
R_{ins}	insulation resistance at 1 kV (DC)				
	between horizontal and vertical coils	500	–	–	MΩ
	between horizontal coil and core clamping ring	500	–	–	MΩ
	between vertical coil and core clamping ring	10	–	–	MΩ
	cross talk (1 V applied to the horizontal coils)	–	–	30	mV

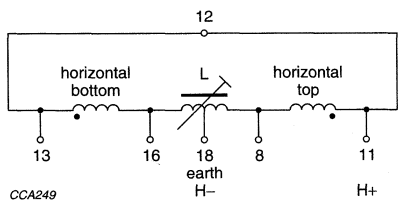
3.2 Deflection unit data

The deflection unit without VLMF compensation coil fulfils the TCO magnetic standard (see Section 5.1)
All values are valid at T_{amb} = 25 °C and V_a = 24 kV.

PARAMETER	CONDITIONS	DEFLECTION YOKE TYPE NUMBERS				TOLERANCE	UNIT
		360	151	131	161		
Advised frequency; note 1		48	48	57	69	–	kHz
Horizontal deflection coil, series connected							
Inductance	1 V (peak-to-peak value); 1 kHz	0.34	0.18	0.18	0.18	±4%	mH
Resistance		0.49	0.26	0.26	0.29	±7%	Ω
Current (peak-to-peak value)		5.80	8.14	8.14	8.07	±4%	A
Used wire		multiwire		thermostable	litz	–	
Vertical deflection coil, parallel connected							
Inductance	1 V (peak-to-peak value); 1 kHz	6.30	5.60	5.60	5.60	±4%	mH
Resistance		6.35	5.65	5.65	5.65	±7%	Ω
Current (peak-to-peak value)		1.44	1.55	1.55	1.55	±5%	A
Used wire		multiwire				–	

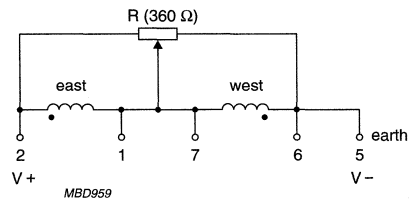
Note

1. Advised maximum frequency depends on the internal maximum set-temperature and used deflection-overscan.



The beginning of the windings is indicated with •

Fig.6 Type 131 horizontal coils.

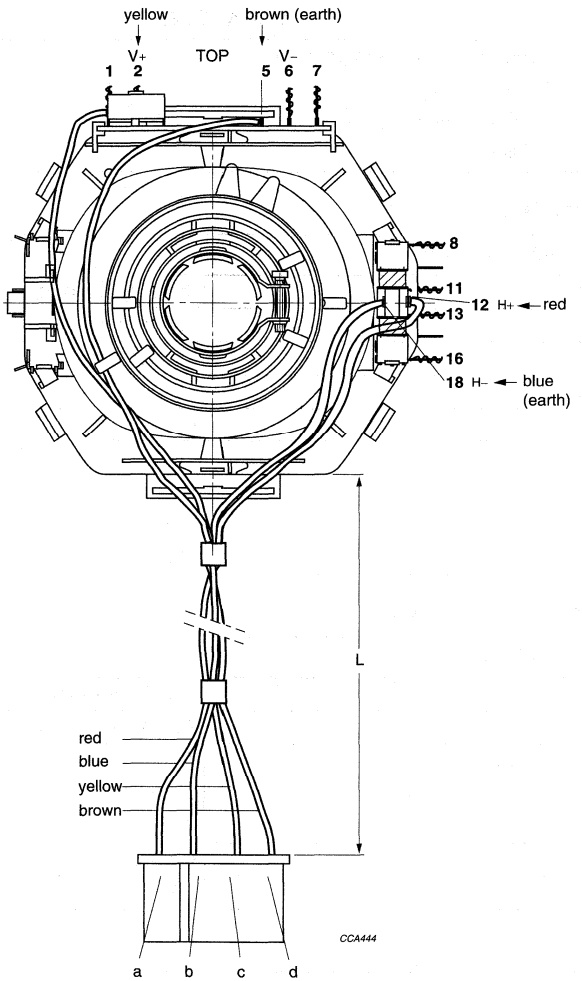


The beginning of the windings is indicated with •

Fig.7 Type 131 vertical coils.

15" high resolution colour monitor tube assemblies

M36EDR



Type number designation

M36EDR	CABLE LENGTH L (mm)	JUI FANG CONNECTOR					
		PLUG	SOCKET	PIN NO.			
				a	b	c	d
...X.../2F01	250	330582	260703	1	2	3	4
...X.../2F02	250	330231	260323	1	3	5	6
...X.../2F04	300	330582	260703	1	2	3	4
...X.../2F05	300	330231	260323	1	3	5	6

Fig.8 Type 131 deflection coil connections.

3.2.1 DEFLECTION UNIT TEMPERATURE

SYMBOL	PARAMETER	MAX.	UNIT
T_{copper}	average copper temperature		
	multiwire	95	°C
	thermostable wire	110	°C
	litz wire	100	°C

3.3 Electro-optical data

PARAMETER	VALUE
Electron gun system	three in-line integrated guns
Focus method	electrostatic
Focus lens	hi-bi potential
Convergence method	magnetic
Deflection method	self converging
Deflection angle	
diagonal	≈90°
horizontal	≈78°
vertical	≈60°

3.4 Screen and coating properties

PARAMETER	VALUE
Screen	metal-backed phosphor dot triplets; Black Matrix
Screen finish	AG, AGAS or IRIS
Recommended active screen area	
horizontal axis	273 mm
vertical axis	203 mm
Dot arrangement	hexagonal
Hexagonal dot pitch	0.28 mm

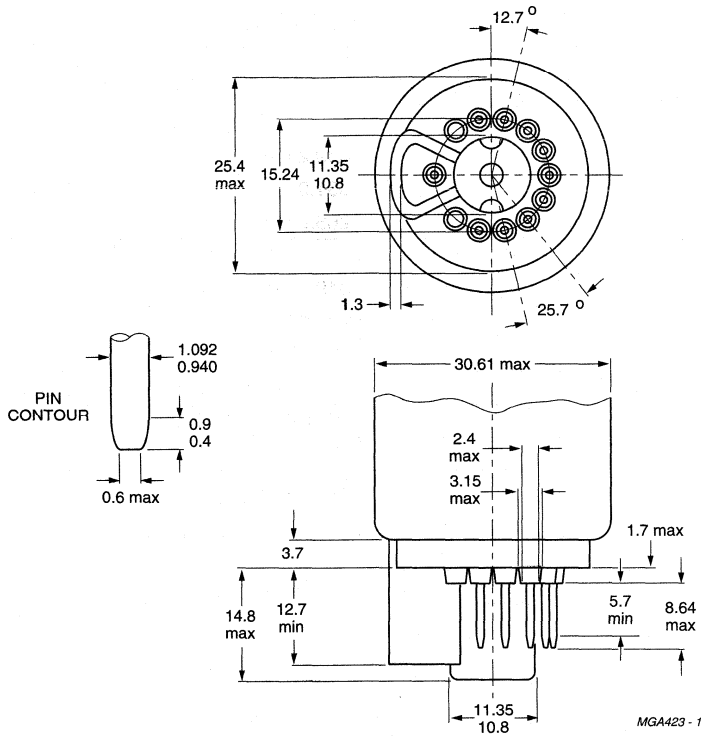
3.5 Screen finish

TYPE NUMBER	SCREEN FINISH	GLOSS
Light transmission at screen centre = 57%		
M36EDR314	Anti-Glare (AG)	55% ±12%
M36EDR320	Anti-Glare/Anti-Static (AGAS)	55% ±12%
M36EDR323	Improved-Reflection/Improved-Sharpnes (IRIS)	60% ±12%

3.6 Mechanical tube data

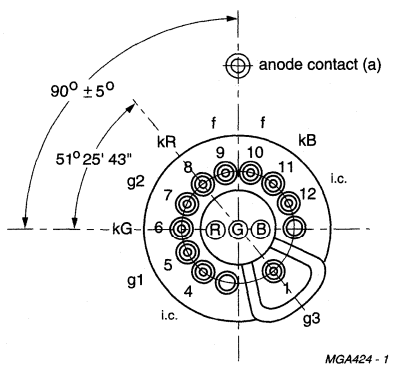
PARAMETER	VALUE
Overall length	354 ±2.8 mm
Neck diameter	29.4 mm
Maximum dimensions, excluding mounting lugs but including rimband	
diagonal	399.2 mm
width	331.0 mm
height	266.6 mm
Minimum useful screen dimensions	
diagonal	349.6 mm
horizontal axis	280.9 mm
vertical axis	211.1 mm
Implosion protection	shrunk-on rimband, BSI, CSA, UL and VDE approved
Anode contact	JEDEC J1-21; IEC 67-III-2
Base designation	JEDEC B10-277
Base pin configuration	see Fig.10
Mass	≈7.8 kg
Magnetic shielding	internal
Mounting position	anode contact on top

3.7 Mechanical tube drawings



Dimensions in mm.

Fig.9 JEDEC B10-277 configuration.



i.c. = internally connected (not to be used).

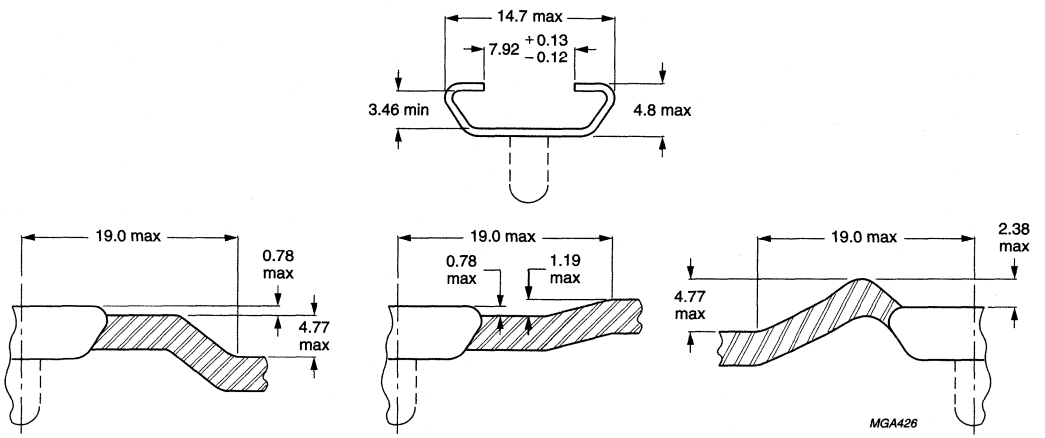
Fig.10 Pin configuration.

Remarks: to Figs 9 and 10.

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

The mass of the mounting socket assembly should not exceed 450 g.

Maximum permissible torque on the tube neck is 0.04 Nm.

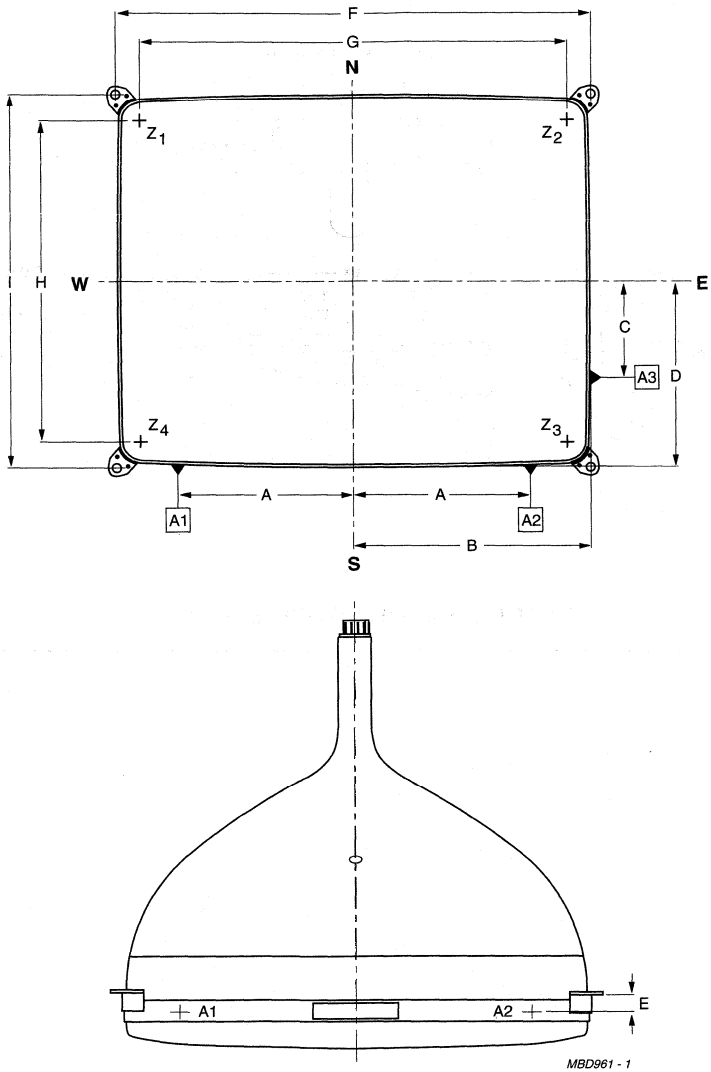


Dimensions in mm.

Fig.11 Cavity cap JEDEC J-21, IEC 67-III-2.

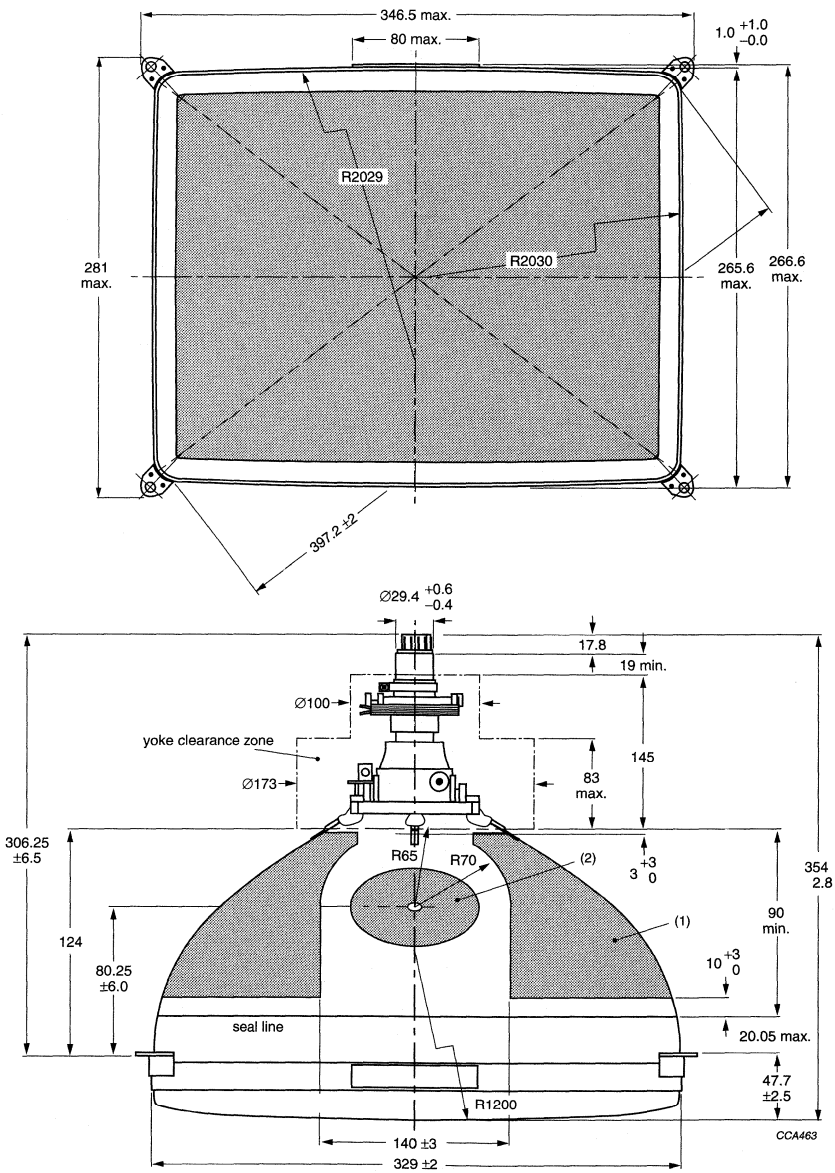
15" high resolution colour monitor tube assemblies

M36EDR



Dimensions in mm.
A = 121.7 mm.
B = 162.52 mm.
C = 87.5 mm.
D = 128.05 mm.
E = 7.35 mm.
F = 326.4 mm.
G = 289.6 mm.
H = 217.2 mm.
I = 261.0 mm.

Fig.12 Front view and mechanical reference points.

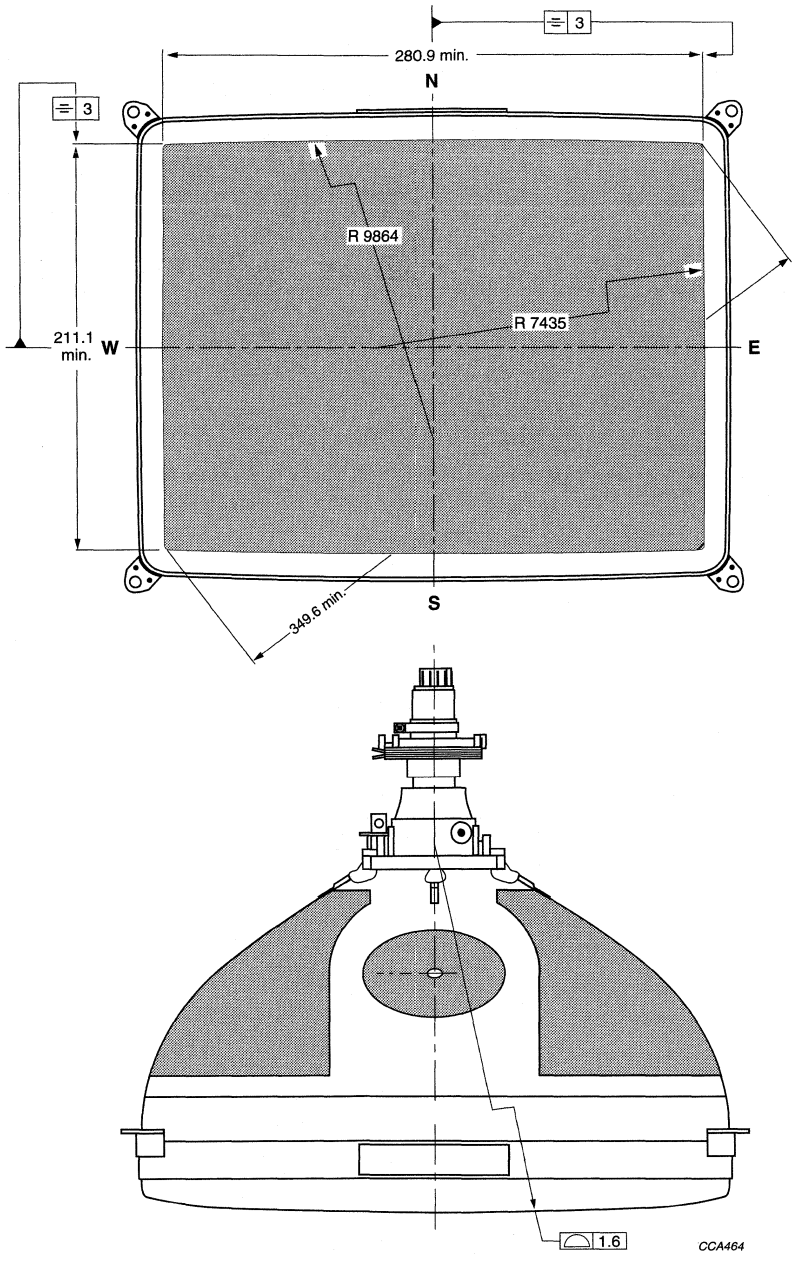


Dimensions in mm.

(1) Configuration of outer conductive coating may be different but will contain the contact area as shown in the drawing.

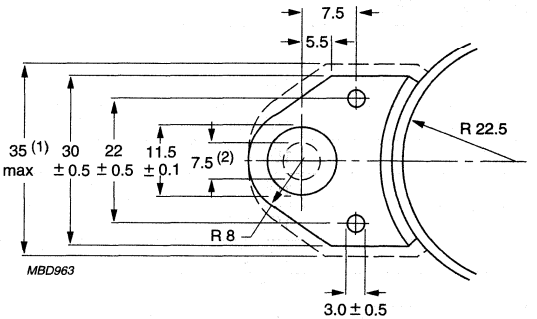
(2) To clean this area, wipe only with a soft lint-free cloth.

Fig.13 Top view.



Dimensions in mm.

Fig.14 Screen dimensions.

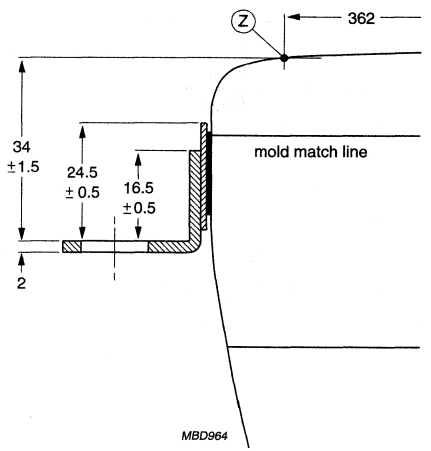


Dimensions in mm.

(1) Minimum space to be reserved for mounting lug in cabinet.

(2) The position of the mounting screw in the cabinet must be within a circle of 7.5 mm diameter drawn around the true geometrical positions, i.e. the corners of a rectangle of 326.4 mm × 261 mm.

Fig.15 Lug dimensions.



Dimensions in mm.

The maximum displacement of any lug with respect to the plane through the other 3 lugs is maximum 0.8 mm.

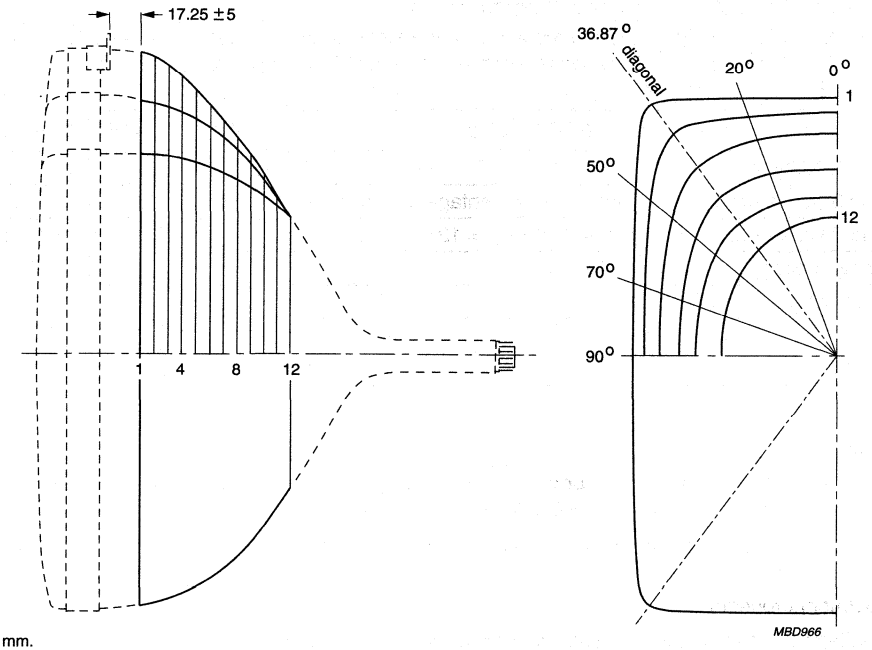
Fig.16 Lug position.

3.8 Sagittal heights of screen

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

COORDINATES		SAGITTAL HEIGHT
X (mm)	Y (mm)	(mm)
0.0	105.6	4.7
10.0	105.6	4.7
20.0	105.5	4.8
30.0	105.5	5.0
40.0	105.5	5.3
50.0	105.5	5.7
60.0	105.4	6.2
70.0	105.4	6.7
80.0	105.3	7.3
90.0	105.3	8.0
100.0	105.2	8.8
110.0	105.1	9.8
120.0	105.1	10.7
130.0	105.0	11.7
139.8	104.4	12.3
139.9	100.0	12.4
140.0	90.0	11.6
140.1	80.0	10.9
140.2	70.0	10.3
140.3	60.0	9.7
140.3	50.0	9.3
140.4	40.0	8.9
140.4	30.0	8.6
140.4	20.0	8.4
140.4	10.0	8.3
140.5	0.0	8.3

3.9 Cone contour



Dimensions in mm.

Fig.17 Maximum cone contour.

Cone contour data

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

SECTION	NOMINAL DISTANCE FROM SECTION 1 (mm)	MAXIMUM DISTANCE FROM TUBE AXIS (mm)										
		0°	10°	20°	30°	36.87°	40°	50°	60°	70°	80°	90°
1	0.0	163.3	165.6	173.0	186.4	195.8	193.4	166.9	149.1	138.2	132.2	130.3
2	10.0	162.0	164.4	171.7	184.9	193.6	190.8	164.8	147.5	136.8	130.9	129.1
3	20.0	158.8	161.2	168.4	180.2	187.0	184.6	160.9	144.2	133.8	128.1	126.3
4	30.0	153.9	156.0	162.3	171.9	176.9	175.1	154.7	139.4	129.8	124.5	122.8
5	40.0	147.2	148.9	154.0	161.4	164.0	162.0	145.9	133.0	124.7	120.0	118.5
6	50.0	138.6	139.8	143.6	148.6	149.2	147.3	135.5	125.3	118.4	114.5	113.3
7	60.0	128.0	128.7	131.4	134.5	134.1	132.6	124.1	116.4	111.1	108.0	107.0
8	70.0	115.2	115.9	117.8	119.6	118.7	117.4	111.7	106.4	102.5	100.2	99.5
9	80.0	100.7	101.0	102.1	103.0	102.5	101.9	98.7	95.3	92.7	91.2	90.6
10	90.0	84.7	84.5	84.8	85.3	85.4	85.3	84.4	83.0	81.5	80.5	80.2
11	100.0	67.8	67.5	67.4	67.6	67.9	68.0	68.3	68.3	68.0	67.5	67.3
12	103.4	62.0	62.0	62.0	62.0	62.0	62.0	62.0	62.0	62.0	62.0	62.0

4 APPLICATION CONDITIONS

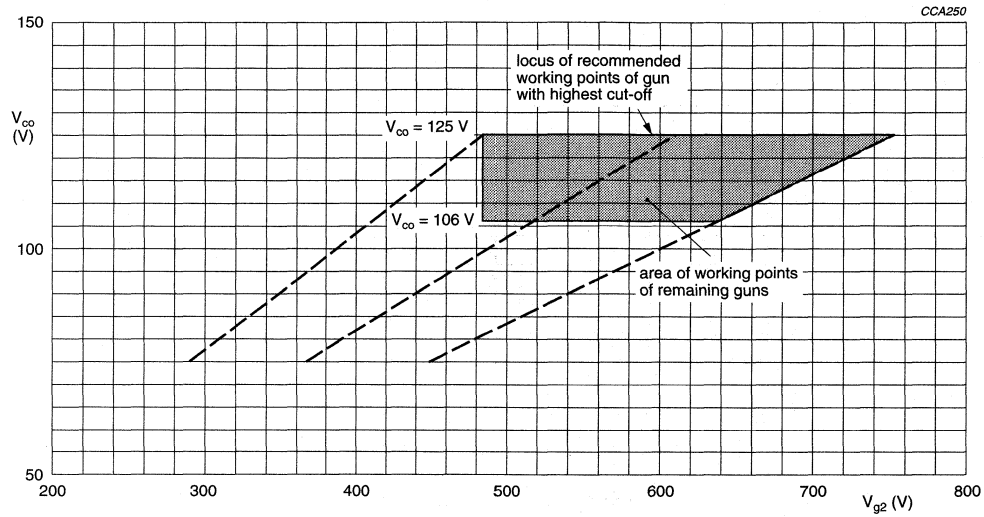
4.1 Recommended adjustment and operating conditions

The voltages are applied to each gun and are measured with respect to grid 1. Tube facing east; local magnetic field. Pre-heat the tube for 15 minutes minimum before tests. Avoid impurity, misconvergence, distortion etc. due to stray magnetic fields and chassis influences.

SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNIT
$V_{a,g4}$	anode voltage	–	24	–	kV
V_{g3}	grid 3 (focus electrode) voltage as a percentage of anode voltage; note 1	25	–	29	%
V_{g2}	grid 2 voltage at a spot cut-off voltage V_{co} = 125 V; note 2	see Fig.18			
V_f	heater voltage	–	6.1(3)	–	V
f_H	horizontal sweep frequency	≈48	–	≈69	kHz
f_V	vertical sweep frequency	–	≈70	–	Hz
T_{amb}	ambient temperature	–	25	–	°C

Notes

1. Focus adjustment procedure:
   a) Adjust beam current to 154.2 cd/m^2 for an area of 50 mm × 50 mm and 102.8 cd/m^2 for an area of 273 mm × 203 mm raster and CIE: x = 0.281; y = 0.311.
   b) Adjust for optimum focus at screen centre and screen edge on a test pattern of 7 × 9 dot $ characters (total 1024 × 768 dots).
2. Grid 2 adjustment procedure:
   a) Grid 2 voltage (V_{g2}) adjusted for highest gun raster cut-off voltage: V_{co} = 125 V.
   b) Remaining guns adjusted for raster cut-off by means of cathode voltage.
   c) V_{g2} range: 470 V to 740 V at V_{co} = 125 V.
   d) Set the cathode voltage (V_k) for each gun at 125 V; increase the grid 2 voltage (V_{g2}) from ≈450 V to the value at which the raster of the gun with the lowest (V_{g2}) cut-off voltage becomes just visible, then decrease the cathode voltage of the remaining guns until the other colours become just visible.
3. For maximum cathode life it is recommended that the heater voltage is regulated at 6.1 V.



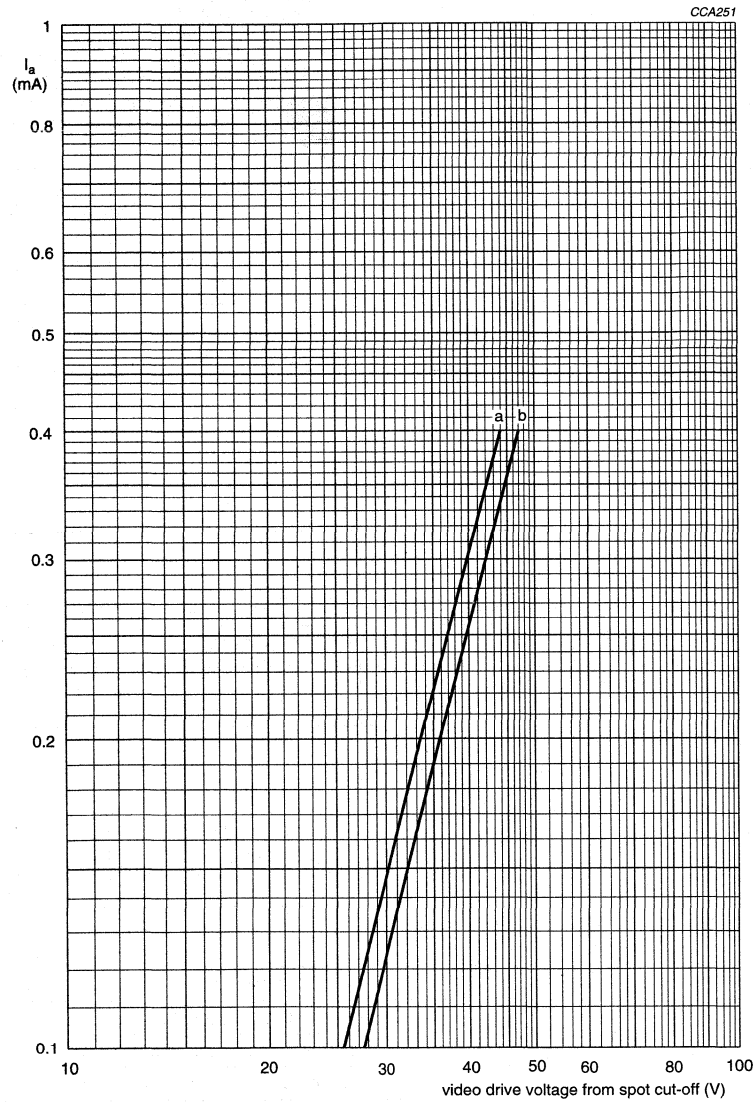
The voltages are specified with respect to grid 1.

Fig.18 Raster cut-off design chart.

4.2 Chassis design values

The values are valid for anode voltages between 20 and 27.5 kV. The voltages are specified with respect to grid 1.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
V_{g3}	grid 3 (focus voltage) as a percentage of anode voltage		25	–	29	%
ΔV_{g3}	difference in focus voltage between red, green and blue images when separately focused		–	200	–	V
V_{g2}	grid 2 voltage	for visual extinction of focused raster	see Fig.18			
V_k	cathode voltage		see Figs 18 and 19			
ΔV_k	difference in cut-off voltage between guns in any tube (cathodes cut-off ratio)		highest value <1.18 × lowest value			
V_f	heater voltage	at zero beam current	–	6.1	–	V
I_{g3}	focus current	under cut-off conditions	–3	–	+3	µA
I_{g2}	grid 2 current	under cut-off conditions	–2	–	+2	µA
I_{g1}	grid 1 current	under cut-off conditions	–5	–	+5	µA
I_{kf}	cathode/heater current	V_{co} = 125 V	–3	–	+3	µA
Resistance						
R_{kgf}	insulation resistance between each cathode and all other electrodes and heater		50	–	–	MΩ
R_{g2}	grid 2 circuit impedance		–	–	5	MΩ
R_{g3}	grid 3 circuit impedance		–	–	50	MΩ



V_{co} = 106 V (curve a).
V_{co} = 125 V (curve b).

Fig.19 Typical cathode drive characteristics.

4.3 Limiting values

In accordance with the Absolute Maximum Rating System (IEC 134). Voltages are specified with respect to grid 1.

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
$V_{a,g4}$	anode voltage	note 1	20[2]	27.5[3]	kV
I_{ap}	anode current for each gun (peak value)		–	400	µA
I_a	long-term average anode current for each gun		–	200	µA
I_a	long-term average anode current for three guns		–	550	µA
V_{g3}	grid 3 (focus) voltage		–	11	kV
V_{g2p}	grid 2 voltage, including video signal voltage (peak value)		–	1000	V
V_f	heater voltage	note 4	5.9	6.3[3]	V
Cathode voltage					
V_k	positive	operating	–	200	V
		operating cut-off	–	135	V
V_k	negative		–	0	V
V_{kp}	negative peak		–	–2	V
Cathode to heater voltage					
V_{kf}	positive		–	250	V
V_{kfp}	positive peak		–	300[3]	V
V_{kf}	negative		–	0	V

Notes

1. During adjustment on the production line this value is likely to be surpassed considerably. It is therefore strongly recommended to first make the necessary adjustments for normal operation without the picture tube.
2. Operation of the tube at lower voltages impairs the luminance and resolution and could impair the convergence.
3. This value is an absolute maximum.
4. For maximum cathode life it is required that the heater supply is designed for 6.1 V.

4.4 Flashover protection

With the high voltage used with this tube (max. 27.5 kV) internal flashovers may occur. As a result of Soft-Flash technology these flashover currents are limited to approximately 200 A offering higher reliability, optimum circuit protection and component savings.

Primary protective circuitry using properly grounded spark gaps and series isolation resistors (preferably carbon composition) is still necessary to prevent tube damage. The spark gaps should be connected to all picture tube electrodes at the socket in accordance with Fig.20; they are not required on the heater pins. No other connections between the outer conductive coating and the chassis are permissible. The spark gaps should be designed for a breakdown voltage at the focus electrode (g3) of 11 kV and at the other electrodes of 1.5 to 2 kV, both at an atmospheric pressure of 100 kPa.

The values of the series isolation resistors should be as high as possible (min. 1.5 kΩ) without causing deterioration of the circuit performance. The resistors should be able to withstand an instantaneous surge of 20 kV for the focusing circuit and 12 kV for the remaining circuits without arcing.

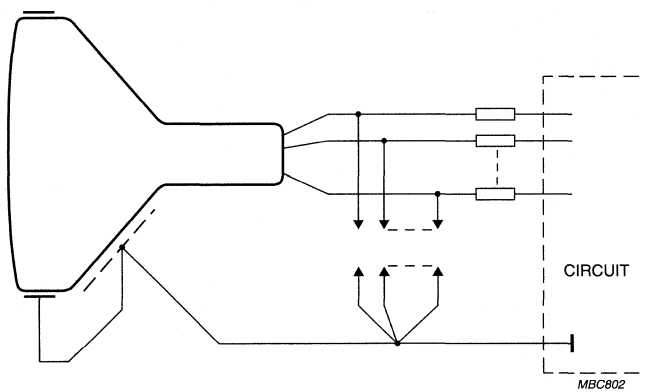


Fig.20 Flashover protection circuit.

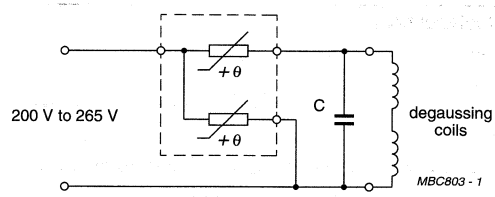
4.5 Degaussing

The monitor tube is provided with an internal magnetic shield. This shield and the shadow mask with its suspension system may be provided with an automatic degaussing system, consisting of a coil mounted on the cone of the monitor tube as shown in Fig.22.

For proper degaussing an initial magnetomotive force (MMF) of 400 ampere-turns is required in the tangential shaped coil. This MMF has to be gradually decreased (maximum 30% per half period) by appropriate circuitry. To prevent beam landing disturbance by horizontal frequency currents induced in the degaussing coils, these coils should be shunted by a capacitor of sufficiently high value. In steady state, no significant MMF should remain in the coils (≤0.6 ampere-turns).

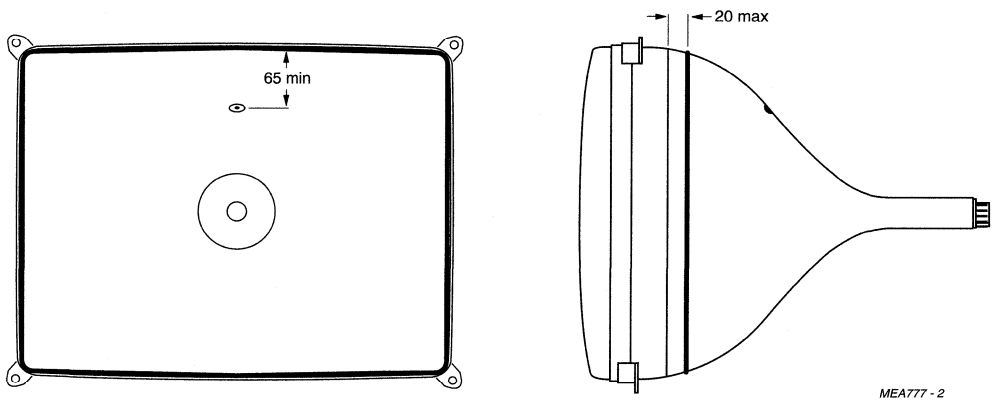
If single-phase power rectification is employed in the monitor circuitry, provision should be included to prevent asymmetric distortion of the AC voltage applied to the degaussing circuit due to high DC inrush currents.

Incomplete degaussing may result in some out-of-specification characteristics.



C = 100 nF.

Fig.21 Typical degaussing circuit using a dual PTC thermistor.



Dimensions in mm.

Fig.22 Position of double degaussing coils on the picture tube.

5 ERGONOMIC AND ENVIRONMENTAL DATA

5.1 Electromagnetic radiation performance

PARAMETER	WITH AS/AGAS WITHOUT VLMF	REQUIREMENT		UNIT
		MPR-II	TCO	
Electrostatic potential	<500	<500	<500	V
Magnetic field				
5 to 2000 Hz	<200(1)	<250(2)	<200(1)	nT
2 to 400 kHz	<20(2)	<25(2)	<25(2)	nT
Alternating electrical field				
5 to 2000 Hz	2.0(3)	25(2)	10(3)	V/m
2 to 400 kHz	t.b.f.(2)	2.5(2)	1(1)	V/m

Notes

1. Measuring distance: 30 cm from screen front; 50 cm from other sides.
2. Measuring distance: 50 cm from all sides.
3. Measuring distance: 30 cm from screen front.

5.2 X-radiation

Maximum anode voltage at which the X-radiation emitted will not exceed 0.5 mR/h at an anode current of 300 μA.

PARAMETER	TYP.	UNIT
Entire tube; note 1	31	kV
Face-plate only	33	kV

Note

1. This rating applies only if the anode connector used by the set maker provides the necessary attenuation to reduce the X-radiation from the anode contact by a factor equal to the difference between the anode button iso-exposure-rate limit curve and the iso-exposure-rate limit curve for the entire tube.

WARNING

If the value for the tube face only is used as design criterion, adequate shielding must be provided in the monitor for the anode contact and/or certain portions of the tube funnel and panel sidewalls to ensure that the X-radiation from the monitor is attenuated to a value equal to or lower than that specified for the face of the tube.

Maximum voltage difference between anode and focus electrode at which the X-radiation will not exceed 0.5 mR/h is 30 kV.

If this voltage can be exceeded in the monitor, additional attenuation of the X-radiation through the neck may be required.

The X-radiation emitted from this picture tube, as measured in accordance with the procedure of *"JEDEC Publications No.64D"* will not exceed 0.5 mR/h throughout the useful life of the tube when operated within the design-maximum ratings.

The tube should not be operated beyond its design-maximum ratings stated above, but its X-radiation will not exceed 0.5 mR/h for anode voltage and current combinations given by the iso-exposure-rate limit characteristics as shown in Fig.24.

Operation above the values shown by the curve may result in failure of the monitor to comply with the *"Federal Performance Standard of the U.S. for Television Receivers, Section 1020.10 of Part 1020 of Title 21, Code of Federal Regulation (PL90-602) as published in Federal Register Volume 38, No. 198 Monday, October 15, 1973"*.

Maximum X-radiation as a function of anode voltage at 300 μA current is shown by Fig.23. X-radiation at a constant anode voltage varies linearly with anode current.

WARNING

The cathode ray tube is intrinsically safe in accordance with *"Appendix III Röntgenverordnung"*.

Eigensichere Kathodenstrahlröhre nach *"Anlage III Röntgenverordnung"*.

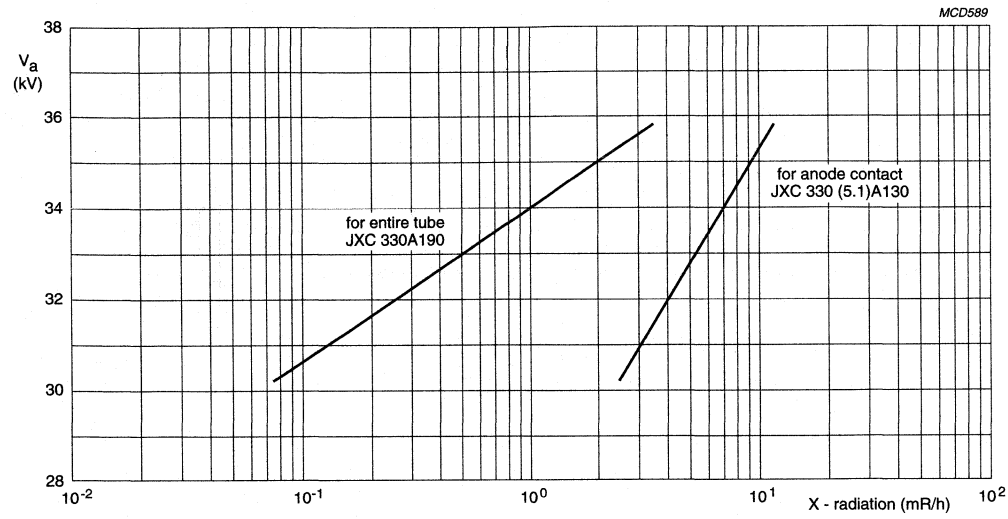


Fig.23 X-radiation limit curves at a constant anode current of 300 μA.

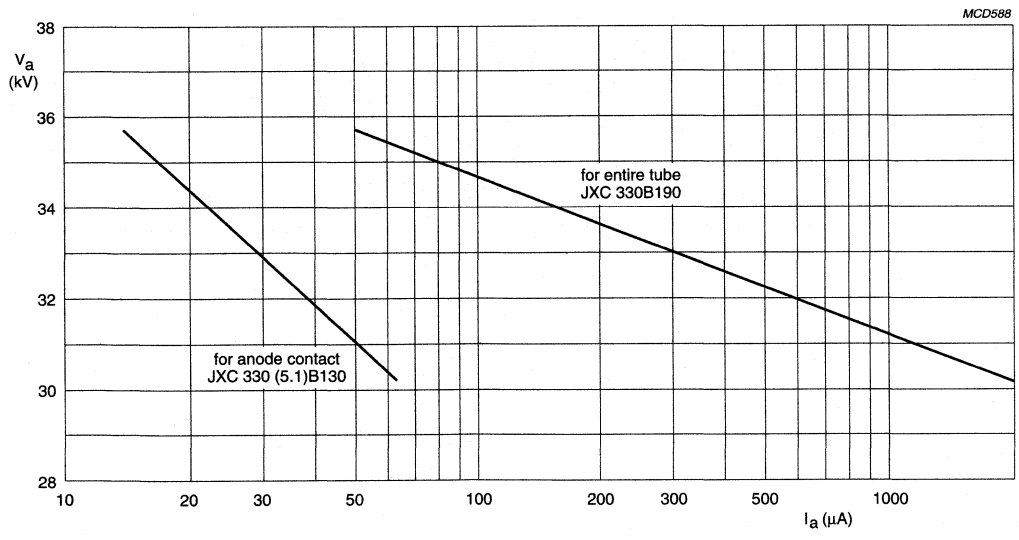


Fig.24 0.5 mR/h iso-exposure-rate limit curves.

5.3 Warnings

X-radiation

Operation of the colour monitor tube under abnormal conditions that exceed the 0.5 mR/h iso-exposure-rate curve shown in Fig.24 may produce soft X-rays, which may constitute a health hazard on prolonged exposure at close range unless adequate external screening is provided. Precautions must therefore be exercised during servicing of monitors using this tube to ensure that the anode voltage and other tube voltages are adjusted to the recommended values so that the values stated in Section 4.3 are not exceeded.

Tube replacement

This monitor tube incorporates integral X-radiation and implosion protection and must be replaced with a tube of the same type number or recommended replacement to assure continued safety.

Shock hazard

The high voltage at which the tube is operated may be vary dangerous. The monitor should include safeguards to prevent the user from coming in contact with the high voltage. Extreme care should be taken in servicing or adjustment of any high-voltage circuit.

Caution must be taken during replacement or servicing of the monitor tube since a residual electrical charge may be held by the high-voltage capacitor formed by the external and internal conductive coatings of the monitor tube funnel. To remove any residual charge, short the anode contact button, located in the funnel of the tube, to the external conductive coating before handling the tube. Discharging the high voltage to isolated metal parts such as cabinets and control brackets may produce a shock hazard.

Tube handling

Monitor tubes should be kept in the shipping box or similar protective container prior to installation. Observe any instructions on the packaging and handle accordingly.

Although monitor tubes are provided with integral implosion protection which meets the intrinsic safety requirements stipulated in the relevant part of IEC 65, care should be taken not to scratch or knock any part of the tube. Particularly care should be taken to prevent damage to the seal area.

In all handling procedures prior to insertion in the cabinet, there is a risk of personal injury if severe accidental damage to the tube occurs. It is therefore recommended that in areas containing unpacked and unprotected tubes, protective clothing is worn, particularly, gloves and safety glasses with side-shields to prevent possible injury from flying glass in the event of such an accident. Handle the tube with extreme care. Do not strike, scratch or subject the tube to more than moderate pressure.

The tube assembly should never be handled by the tube neck, deflection unit or other neck components.

If suspending the tube assembly from the mounting lugs, ensure that a **minimum of two** are used. **Under no circumstances suspend the tube assembly from one lug.**

If provided, the slots in the rimband of colour picture tubes are used in the mounting of the degaussing coils. It is not recommended to suspend the tube assembly from one or more of these slots as permanent deformation to the rimband can occur.

An alternative lifting method is to firmly grasp the assembly by the vertical sides of the rimband. Manually lifting the assembly from the face-down or face-up position is shown in Figs 25 and 26.

To protect the screen when placing the tube face-down, ensure that the tube face rests on a cushion kept free from abrasive substances.

The packaging should incorporate sufficient cushioning so that under normal conditions of shipment or handling an impact acceleration of maximal 350 m/s^2 at maximal 10 ms pulse width is never applied to the tube.

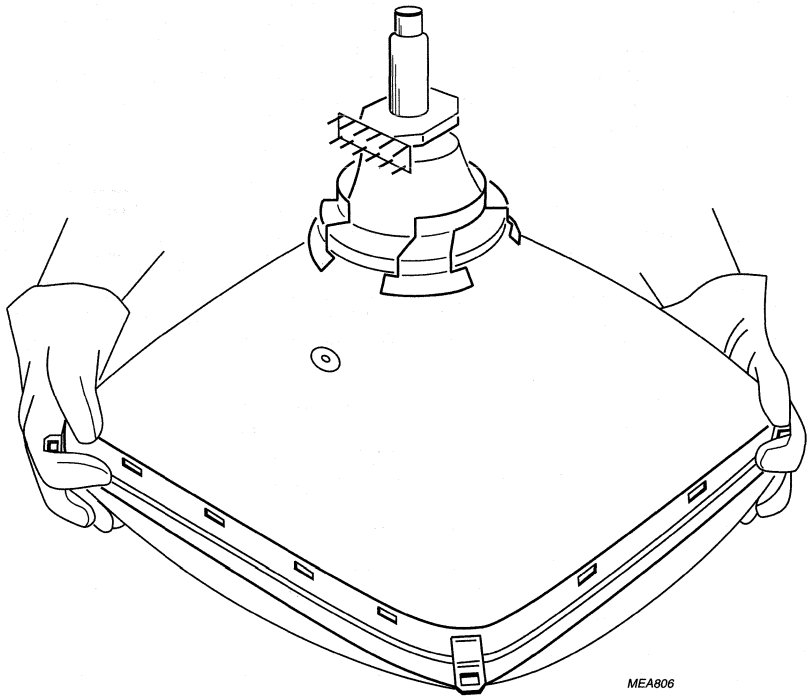


Fig.25 Lifting the tube assembly from the face-down position.

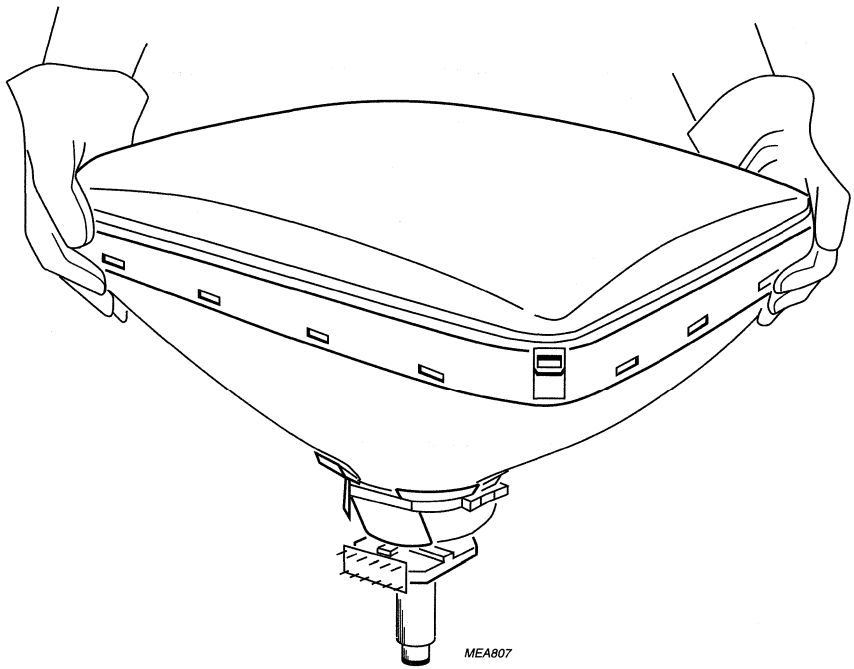


Fig.26 Lifting the tube assembly from the face-up position.

6 LABELLING

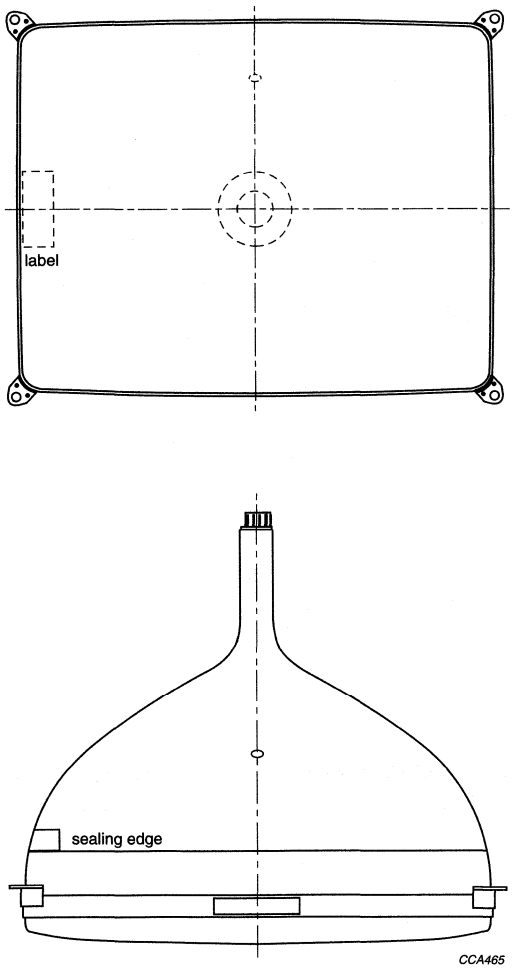


Fig.27 Label positioning.

17" high resolution colour monitor tube assemblies

M41EHN

CONTENTS

17" high resolution colour monitor tube assemblies

M41EHN

1 HIGHLIGHTS

1.1 Features

1.1.1 HIGH PERFORMANCE DESIGN

- High resolution; higher pixel density possible up to 1280 × 1024 pixels (non-interlaced) displayable conform ISO 9241 by:
  - high resolution DAF gun
  - 0.27 mm dot triplet pitch
- High brightness and contrast:
  - optimized black matrix process
- Excellent white uniformity and colour purity:
  - invar mask
  - axial 3-pin suspension
  - inner magnetic shielding
- Accurate convergence and raster geometry:
  - double mussel coil technology
  - internal magnetostatic beam alignment
  - additional vertical symmetry adjustment for optional and easy convergence touch-up
- Application friendly design:
  - worldwide useable design
  - East-West correction max. 8.0%
  - deflection units designed for minimal ringing
  - static convergence adjustment on monitor level: multipole for 4 and 6 pole correction
  - dynamic convergence adjustment on monitor level: horizontal balance coil; vertical balance potentiometer; vertical symmetry plates and potentiometer (optional)
  - rotation coil for adjustment of axial magnetic fields (optional).

1.1.2 ERGONOMIC DESIGN

- Less ambient reflection:
  - 'flat' and 'square' design
  - IRIS (Improved Reflection Improved Sharpness)
- Less eye strain:
  - P22 medium/short persistence phosphor
  - high frequency yokes
- Green design:
  - CFC-free production process
  - Cd-free phosphors
  - 0.65 W power saving cathode
- Fulfilling electric/magnetic radiation standards:
  - antistatic coatings
  - no VLMF cancelling coils required to fulfil magnetic MPRII and TCO requirements
- Safety approved:
  - VDE; CSA; UL; BSI.

1.1.3 OPTIMUM DISPLAY SOLUTION

- High-end PC applications
- Workstation applications
- Resolution standards up to 1280 × 1024 pixels non-interlaced application.

1.2 Quick reference data

PARAMETER	TYP.	UNIT
Deflection angle	90	deg
Face diagonal	444	mm
Overall length	<388	mm
Neck diameter	29.4	mm
Dot triplet pitch	0.27	mm
Focus voltage	27.5% of anode voltage	

1.3 Deflection coil types

PARAMETER	COIL TYPE NUMBER				UNIT
	140	145	160	165	
Horizontal coil inductance	0.13	0.13	0.18	0.18	mH
Vertical coil resistance	6.1	7.7	6.1	7.7	Ω
Maximum advised frequency	84	84	66	66	kHz

1.4 Coding system

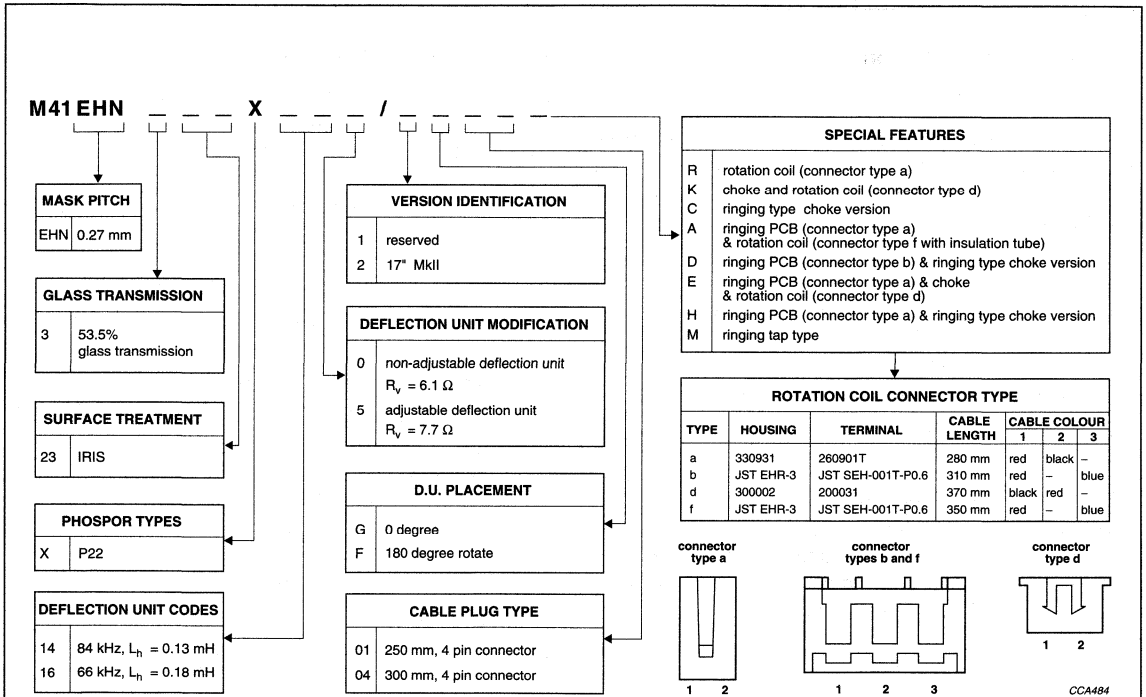


Fig.1 Available versions.

2 PERFORMANCE SPECIFICATION

2.1 Phosphor colour coordinates

Persistence is medium/short; $I_{a(av)}$ per gun = 200 μA; V_a = 26 kV; scanned area = 300 mm × 225 mm.

PHOSPHOR COLOUR	COLOUR COORDINATES		MIN. BRIGHTNESS AT SCREEN CENTRE (Cd/m²)
	x	y	
Red	0.620	0.345	18.7
Green	0.290	0.610	63.0
Blue	0.155	0.065	9.8

2.2 Brightness variation

2.2.1 TEST PROCEDURE

Zero magnetic field; adjust the tube in accordance with the recommended operating conditions and to a centre-white brightness of 100 Cd/m² on a data raster of 300 mm × 225 mm.

2.2.2 LIMITS

Brightness decrease from centre to corner shall not exceed 30%.

2.3 Colour purity and white uniformity

2.3.1 TEST PROCEDURE

Zero magnetic field; adjust the tube in accordance with the recommended operating conditions and to a centre white brightness of 100 Cd/m², on a data raster of 300 mm × 225 mm. The screen should be viewed with blanked red, green, blue, white raster at a distance of 1 metre at an ambient level of 1 lux.

2.3.2 LIMITS

No severe discoloration or cross contamination allowed. Maximum deviation in white x and y colour coordinates shall not exceed 0.015.

2.4 Resolution specification

With the settings given in Section 4.1, the displayed characters will be recognisable as individual 8 characters on a data raster measuring 300 mm × 225 mm.

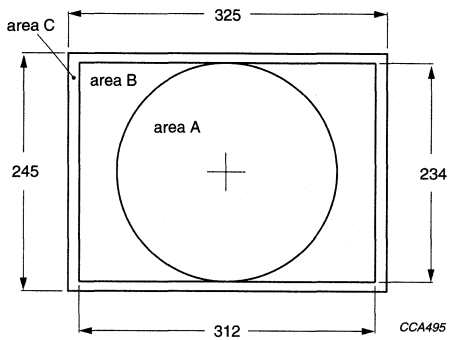
2.5 Convergence specification

2.5.1 TEST CONDITIONS

1. Set-up in accordance with Section 4.1.
2. Measure maximum misconvergence after 30 minutes operation.
3. Misconvergence is the distance between the centres of the red, green and blue lines at the screen using a cross-hatch pattern.
4. Anode and/or focusing voltage and terrestrial magnetism may slightly affect the static convergence. Therefore, small re-adjustments to static convergence may be necessary.
5. Avoid stray magnetic fields etc. due to chassis influences which may affect convergence.

2.5.2 CONVERGENCE LIMITS

LOCATION (see Fig.2)	**TYPE OF ERROR**	**MAXIMUM ERROR BETWEEN ANY TWO COLOURS (mm)**
Area A	red-green-blue line separation in either the horizontal or vertical direction	0.25
Area B		0.35
Area C		0.40



Dimensions in mm.

Fig.2 Maximum misconvergence.

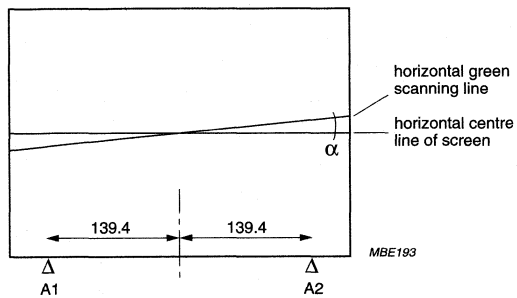
2.6 Raster geometry

2.6.1 RASTER CENTRING

CENTRING	MAX.	UNIT
Horizontal	±5.0	mm
Vertical	±5.0	mm

2.6.2 RASTER ROTATION

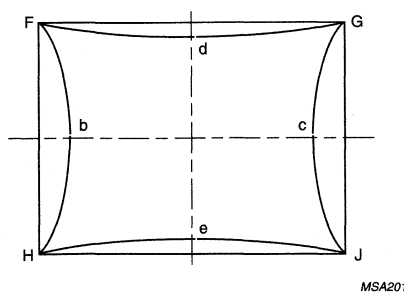
Zero magnetic field; measure the angle of the horizontal green scanning line with reference to a horizontal centre line that is drawn parallel to the tube reference points A1 and A2, see Fig.3. Chassis influences may affect raster rotation.



$\alpha \leq 0.35°$

Fig.3 Rotation measurement.

2.6.3 PIN-CUSHION DISTORTION



FG = HJ = 312 mm.
FH = GJ = 234 mm.
Measured with no pin-cushion correction applied, with 'b', 'c', 'd' and 'e' measured along the main axis.

Fig.4 Pin-cushion distortion.

2.6.4 DISTORTION NORTH - SOUTH

The following formulae define the pin-cushion distortion in the north and south directions.

$$\text{North} = \frac{4d}{FH + GJ} \times 100\% = 0\% \text{ to } \pm 0.8\%$$

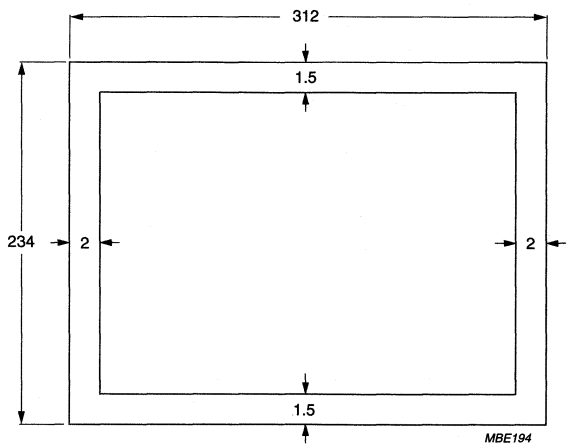
$$\text{South} = \frac{4e}{FH + GJ} \times 100\% = 0\% \text{ to } \pm 0.8\%$$

2.6.5 DISTORTION EAST- WEST

The following formulae define the pin-cushion distortion in the east and west directions.

$$\text{East} = \frac{4c}{FG + HJ} \times 100\% \leq 8.0\%$$

$$\text{West} = \frac{4b}{FG + HJ} \times 100\% \leq 8.0\%$$



Dimensions in mm.

Fig.5 General distortion.

2.7 Screen quality

2.7.1 GENERAL TEST PROCEDURE

Tests are to be done under the following general conditions:

- Viewing distance should be 60 cm minimum
- For an unactivated screen the diffuse ambient light level at the centre of the screen should be between 700 and 1000 lux
- The viewing angle relative to the tube axis should not exceed 45°
- Faults not visible under these general conditions are permitted
- The following quality areas are specified:
  - Area A: a rectangular area measuring 300 mm × 225 mm, of which the point of intersection of the diagonals coincides with the mechanical centre of the screen
  - Area B: the area between area A and the edge of the phosphor
  - Area C: the area between the edge of the phosphor and the rimband.

2.7.2 ASSESSMENT OF THE GLASS AND THE UNACTIVATED SCREEN QUALITY

2.7.2.1 Definition of blemishes

Unless otherwise specified, the shape of a blemish is defined as: round and elliptical.

The size of a blemish is given by:

- (L + W)/2 or L/20 + 2W, whatever expression is the largest, where L = length and W = width.

2.7.2.2 Limits

Table 1 Limits of measurable glass blemishes

SIZE (mm)	MAX. NUMBER OF BLEMISHES IN AREA A AND B	MIN. PERMISSIBLE DISTANCE BETWEEN ANY 2 BLEMISHES (mm)	AREA C
0.6	0	not applicable	only limits as regards tube safety
0.4 to <0.6	2	50	
0.2 to <0.4	3	50	
Total number	3	50	–
<0.2	limited only by cloud		–

Table 2 Limits of measurable coating blemishes for IRIS coating

SIZE (mm)	MAX. NUMBER OF BLEMISHES IN AREA A + B	MIN. PERMISSIBLE DISTANCE BETWEEN ANY 2 BLEMISHES (mm)
>1.5	–	not allowed
1.0 to 1.5	2	50
0.5 to 1.0	3	30

Table 3 Limits of scratches without coating

AREA	WIDTH (mm)	MAX. ALLOWABLE TOTAL LENGTH (mm)	MIN. SEPARATION (mm)
A and B	>0.15	0	not permitted
	>0.10 to <0.15	13	50
	>0.05 to <0.10	25	20
	<0.05	no limits	not applicable
C	only as regards tube safety		

Table 4 Limits of scratches with coating

AREA	WIDTH (mm)	MAX. ALLOWABLE TOTAL LENGTH (mm)	MIN. SEPARATION (mm)
A and B	>0.10	0	20
	>0.05 to ≤0.10	38 (max. 2 scratches)	
	≤0.05	no limits	
C	only as regards tube safety		

2.7.3 ASSESSMENT OF THE QUALITY OF THE ACTIVATED PHOSPHOR SCREEN

The assessment of the quality of the phosphor and matrix layer at area A should take place at typical operating conditions and a blanked raster. The current for each gun shall be 100 μA.

2.7.3.1 Definition of blemishes

- A blemish is a fault which is clearly visible within 5 seconds.
- The size of a blemish is defined in terms of the number of missing phosphor dots.
- A defect, which looks visually as one blemish should be regarded as a single blemish.
- Missing phosphor dot: 50% or more of the complete dot is missing.
- Partial missing phosphor dot: 25% to 49% of the complete dot missing.
- Dots with less than 25% missing can be ignored, except for a concentration of such dots, having a diameter of more than 8 mm.

2.7.3.2 Limits

1. A combination of blemishes of categories B and/or A within a distance of 50 mm should be regarded as adjacent and classified as a category A blemish. In that case category A2 should be read as one colour and category A3 as 2 or 3 colours.
2. A combination of category C blemishes with category A and/or B blemishes within a distance of 50 mm must not affect more than 6 dots.

Table 5 Limits of missing phosphor dots

CATEGORY		SIZE IN MISSING PHOSPHOR DOTS		MAX. NUMBER IN AREA			MIN. ACCEPTABLE DISTANCE BETWEEN ANY 2 BLEMISHES IN AREA (mm)	
				A	B	A/B	A	B
A	A1	4 and more adjacent dots		0	0	0	50	50
	A2	3 adjacent dots (1 or 2 colours)		0	0	0		
	A3	3 adjacent dots (3 colours)		1	2	2		
	A4	2 adjacent dots (1 or 2 colours)		2	2	3		
B		1 dot	green	4	3	8	–	–
		1 dot	red	6	5			
		1 dot	blue	6	5			
C		total number of blemishes		8		–	–	–

3 PRODUCT CHARACTERISTICS

3.1 Electrical data

SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNIT
Capacitances					
$C_{a(m+m')}$	anode to external conductive cone coating, including rimband (with and without screen coating)	1000	1300	1600	pF
C_k	cathodes of all guns, connected in parallel, to all other electrodes	–	10	15	pF
C_{kR}, C_{kG}, C_{kB}	cathode of any gun to all other electrodes	–	4	–	pF
C_{g1}	grid 1 of any gun to all other electrodes	–	22	–	pF
C_{g2}	grid 2 to all other electrodes	–	17	–	pF
C_{g3a}	grid 3a (focus electrode) to all other electrodes	–	12	–	pF
C_{g3b}	grid 3b (dynamic focus electrode) to all other electrodes	–	10	–	pF
$C_{(g3a-g3b)}$	grid 3a to grid 3b	–	9	–	pF
$C_{(g3a/g3b)}$	grids 3a + 3b to all other electrodes	–	8	–	pF
Heater					
V_f	heater voltage	–	6.1	–	V
I_f	heater current	289	309	329	mA
t_{kwu}	cathode warm up time at 0-hour from 10% to 80% of end emission	–	–	8	s
Deflection unit					
V_{max}	maximum permissible DC voltage				
	between horizontal and vertical coils	–	–	2000	V
	between vertical coils and core	–	–	300	V
R_{ins}	insulation resistance at 1 kV (DC)				
	between horizontal and vertical coils	500	–	–	MΩ
	between horizontal coil and core clamping ring	500	–	–	MΩ
	between vertical coil and core clamping ring	10	–	–	MΩ
	cross-talk (1 V applied to the horizontal coils)	–	–	30	mV

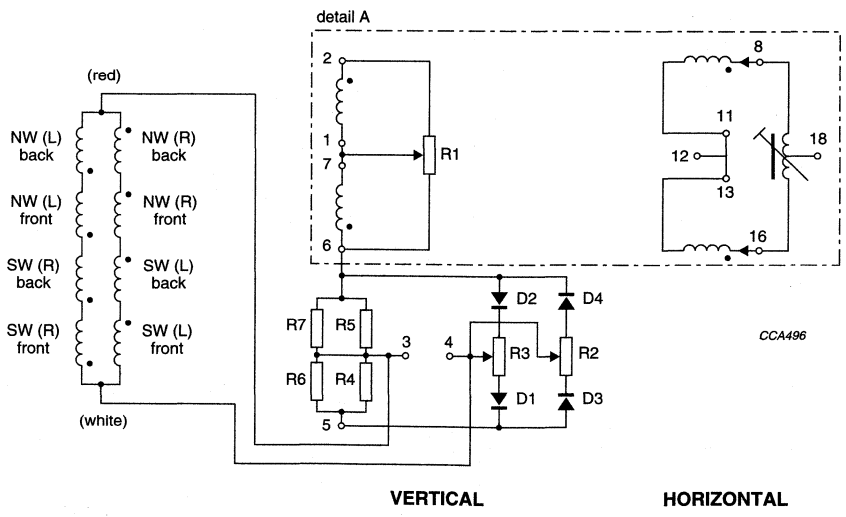
3.2 Deflection unit data

All values are valid at T_{amb} = 25 °C and V_a = 26 kV.

PARAMETER	DEFLECTION YOKE TYPE NUMBERS				TOLERANCE	UNIT
	140	145	160	165		
Advised frequency; notes 1 and 2	84	84	66	66	–	kHz
Horizontal deflection coil						
Inductance	0.13	0.13	0.18	0.18	±4%	mH
Resistance	0.21	0.21	0.30	0.30	±7%	Ω
Current (peak-to-peak value)	11.1	11.1	9.3	9.3	±4%	A
Used wire	litz				–	
Vertical deflection coil						
Inductance	5.9	5.9	5.9	5.9	±4%	mH
Resistance	6.1	7.7	6.1	7.7	±7%	Ω
Current (peak-to-peak value)	1.46	1.46	1.46	1.46	±5%	A
Used wire	normal				–	

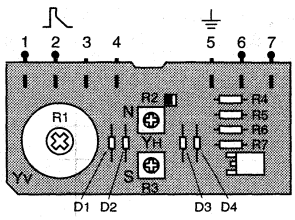
Notes

1. Advised maximum frequency depends on the internal maximum set-temperature and used deflection-overscan.
2. No annoying ringing with 0% overscan.

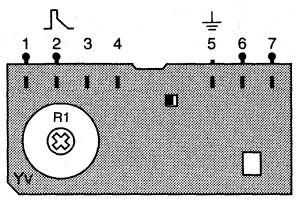


The beginning of the windings is indicated with •
Detail A is applicable to deflection coil types 140 and 160 only.

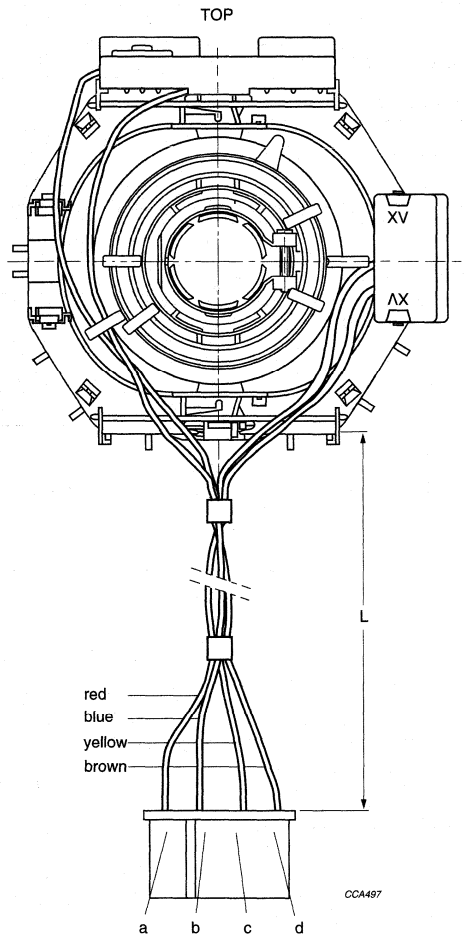
Fig.6 Electrical details of deflection coils.



with adjustable vertical symmetry



without adjustable vertical symmetry



Type number designation

M41EHN	CABLE LENGTH L (mm)	JUI FANG CONNECTOR					
		PLUG	SOCKET	PIN NO.			
				a	b	c	d
...X.../.F01.	250	330582	260703	1	2	3	4
...X.../.F04.	300	330582	260703	1	2	3	4

Fig.7 Deflection coil connections.

3.2.1 ROTATION COIL

SYMBOL	PARAMETER	TYP.	UNIT
R_C	resistance	55	Ω
I_C	current	100	mA
α	raster correction	11	deg/A

3.2.2 DEFLECTION UNIT TEMPERATURE

SYMBOL	PARAMETER	MAX.	UNIT
T_{copper}	average copper temperature of horizontal coil	110	°C
ΔT	maximum temperature rise of wire used	50	°C

3.3 Electro-optical data

PARAMETER	VALUE
Electron gun system	three in-line integrated guns
Focus method	electrostatic
Focus lens	hi-bi potential
Convergence method	magnetic
Deflection method	self converging
Deflection angle	
diagonal	≈90°
horizontal	≈78°
vertical	≈60°

3.4 Screen and coating properties

PARAMETER	VALUE
Screen	metal-backed phosphor dot triplets; Black Matrix
Screen finish	IRIS
Recommended active screen area	
horizontal axis	312 mm
vertical axis	234 mm
Dot arrangement	hexagonal
Hexagonal dot pitch	0.27 mm

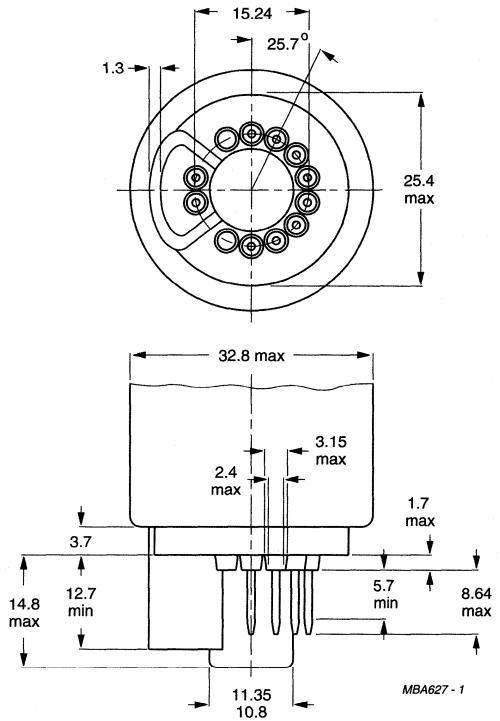
3.5 Screen finish

TYPE NUMBER	SCREEN FINISH	GLOSS
Light transmission at screen centre = 53.5%		
M41EHN323	Improved-Reflection/Improved-Sharpnes (IRIS)	60 ±12%

3.6 Mechanical tube data

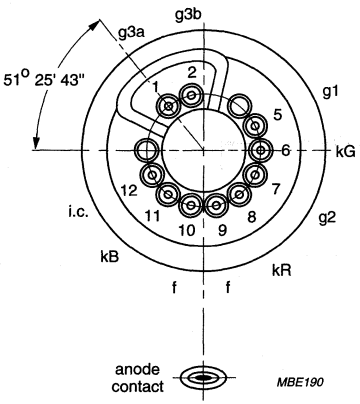
PARAMETER	VALUE
Overall length	383.5 ±4.5 mm
Neck diameter	29.4 +0.6/–0.4 mm
Maximum dimensions, excluding mounting lugs but including rimband	
diagonal	446.2 mm
width	387.9 mm
height	297.6 mm
Implosion protection	pre-stressed banded Mini-P shrunk-on rimband; BSI, CSA, UL and VDE approved
Anode contact	JEDEC J1-21; IEC 67-III-2
Base designation	JEDEC B10-301
Base pin configuration	see Fig.9
Mass	≈10 kg
Magnetic shielding	internal
Mounting position	anode contact on top

3.7 Mechanical tube drawings



Dimensions in mm.

Fig.8 Base JEDEC B10-301.



i.c. = internally connected and not to be used.

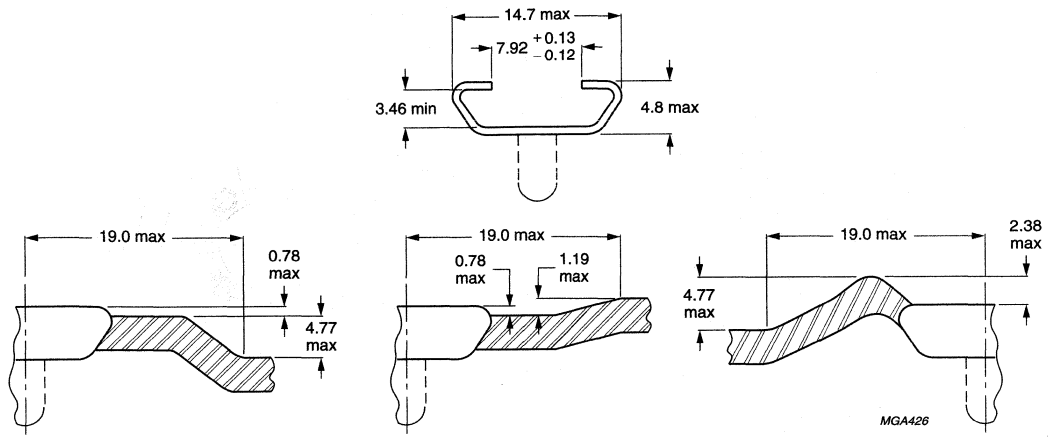
Fig.9 Pin arrangement.

Remarks: to Figs 8 and 9.

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

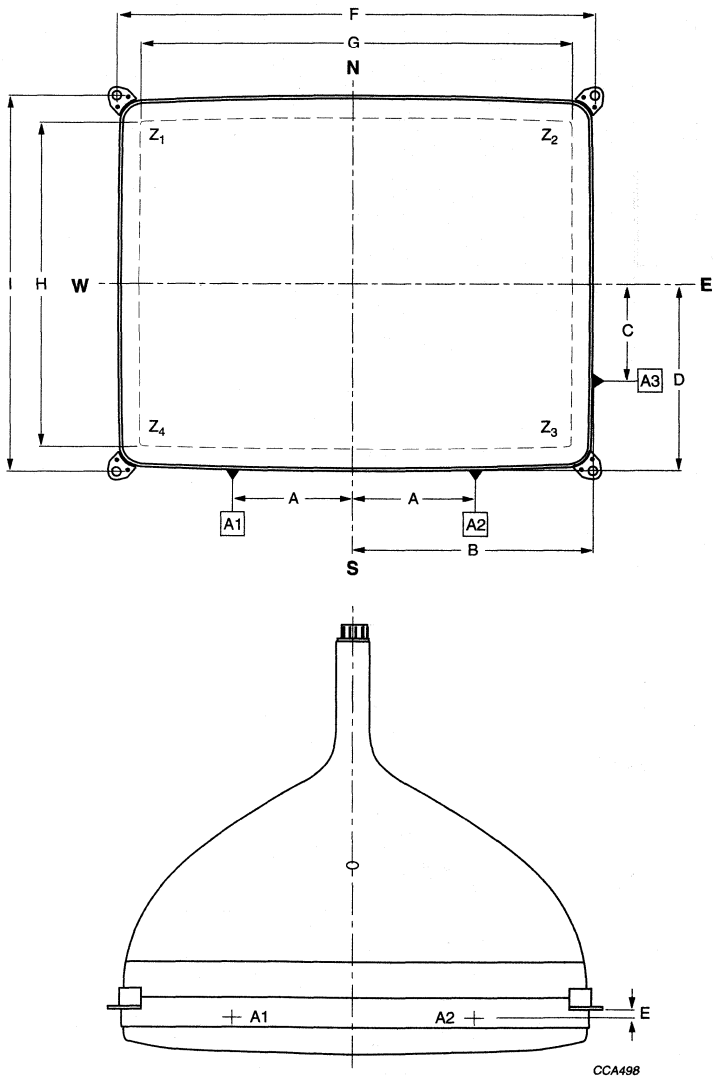
The mass of the mounting socket assembly should not exceed 450 g.

Maximum permissible torque on the tube neck is 0.14 Nm.



Dimensions in mm.

Fig.10 Cavity cap JEDEC J1-21, IEC 67-III-2.



A = 139.4 mm.
B = 183.60 mm.
C = 100.00 mm.
D = 143.80 mm.
E = 0.58 mm.
F = 366.90 mm.
G = 330.24 mm.
H = 247.68 mm.
I = 290.60 mm.

Fig.11 Mechanical reference points.

17" high resolution colour monitor tube assemblies

M41EHN

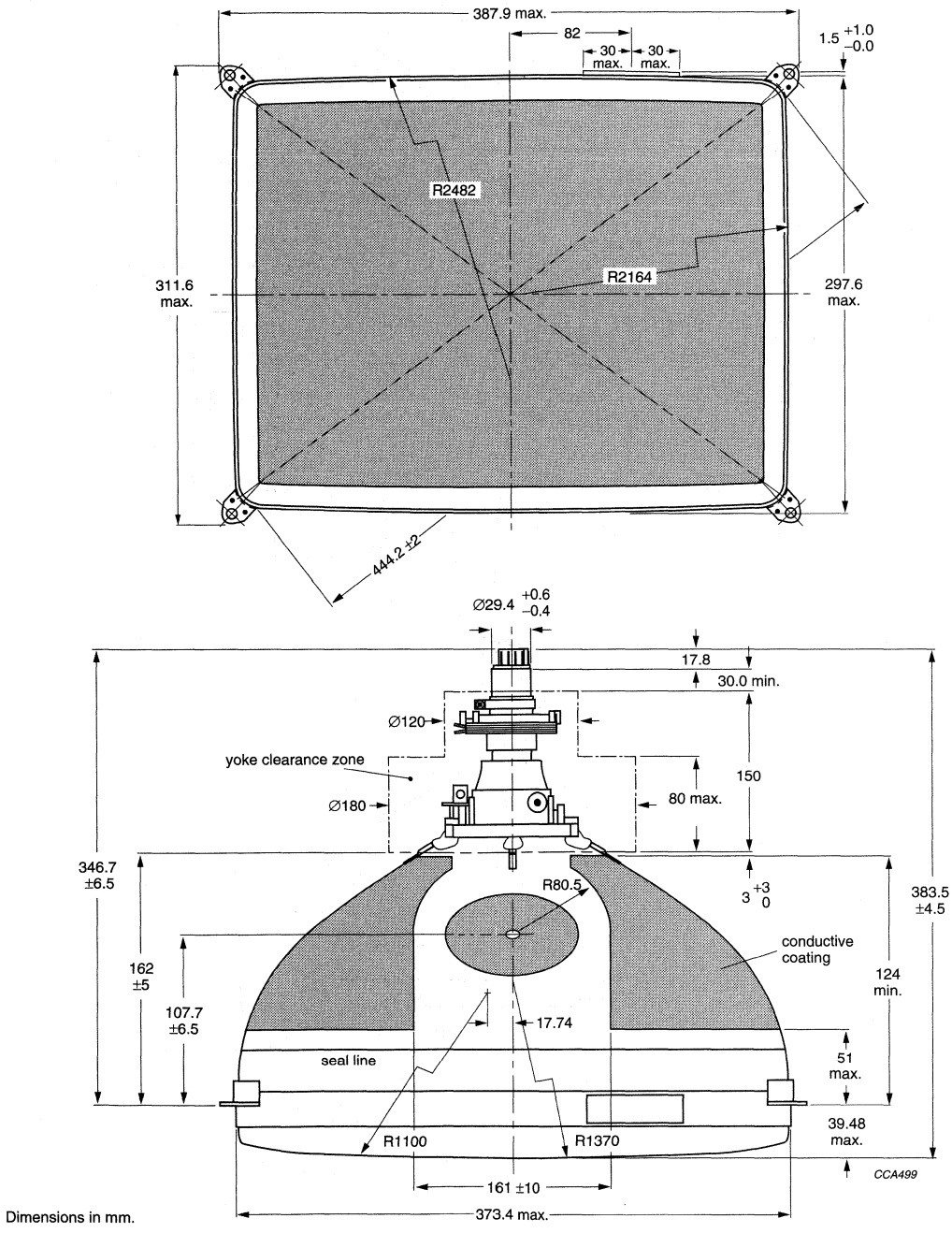
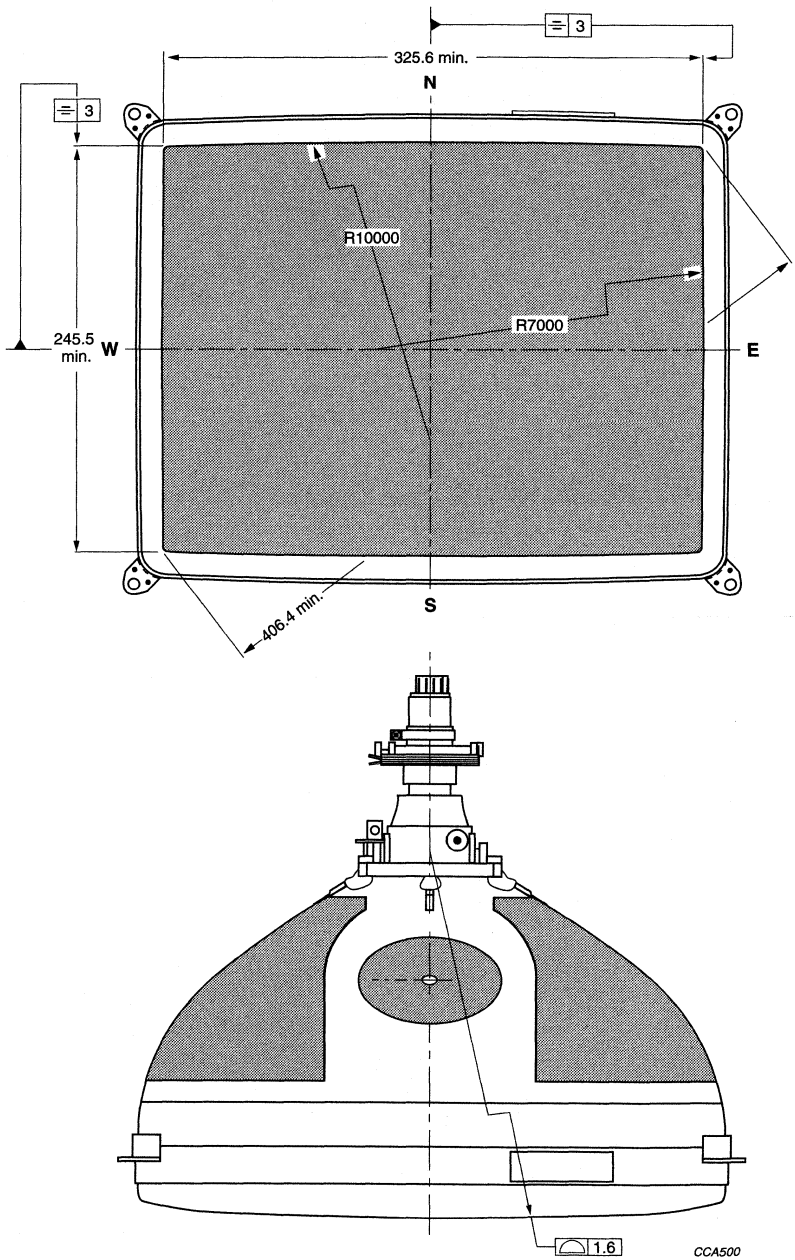
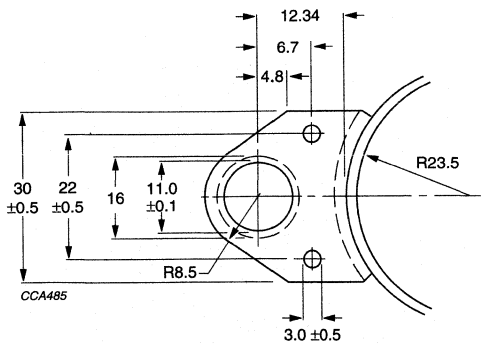


Fig.12 Top view.



Dimensions in mm.

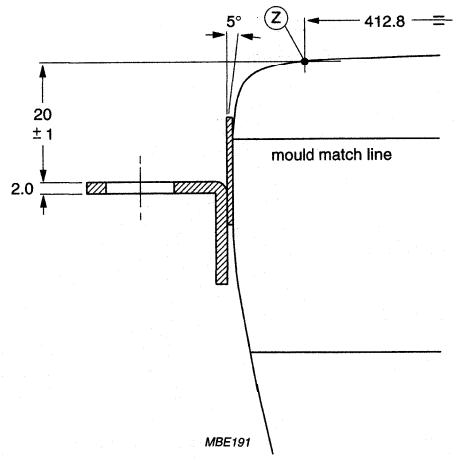
Fig.13 Dimensions of phosphor area on screen.



Dimensions in mm.

The mounting screw in the cabinet must be within a circle of 6.5 mm diameter drawn around the true geometrical positions, i.e. the corners of a rectangle of 366.9 mm × 290.6 mm.

Fig.14 Lug dimensions.



Dimensions in mm.

Fig.15 Lug position.

3.8 Sagittal heights of screen

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

COORDINATES		SAGITTAL HEIGHT
X (mm)	Y (mm)	(mm)
0.0	0.0	16.3
0.0(1)	123.0	10.6
10.0	123.0	10.6
20.0	123.0	10.5
30.0	123.0	10.3
40.0	122.9	10.0
50.0	122.9	9.7
60.0	122.8	9.2
70.0	122.8	8.7
80.0	122.7	8.1
90.0	122.6	7.4
100.0	122.5	6.7
110.0	122.4	5.8
120.0	122.3	4.9
130.0	122.2	3.9
140.0	122.0	2.8
150.0	121.9	1.6
160.0	121.7	0.3
162.2(2)	121.7	0.0
162.3	120.0	0.2
162.4	110.0	1.1
162.5	100.0	2.0
162.7	90.0	2.8
162.8	80.0	3.4
162.9	70.0	4.1
162.9	60.0	4.6
163.0	50.0	5.0
163.1	40.0	5.4
163.1	30.0	5.7
163.1	20.0	5.9
163.1	10.0	6.0
163.2(3)	0.0	6.0

Notes

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

3.9 Cone contour

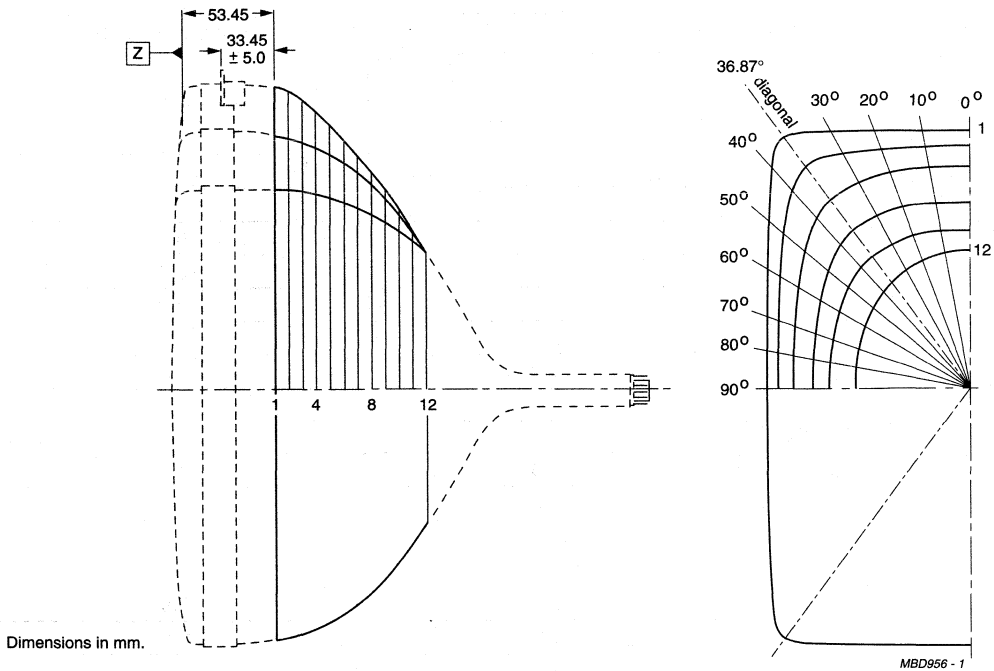


Fig.16 Maximum cone contour.

Cone contour data

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

SECTION	NOMINAL DISTANCE FROM SECTION 1 (mm)	MAXIMUM DISTANCE FROM TUBE AXIS (mm)										
		0°	10°	20°	30°	36.87°	40°	50°	60°	70°	80°	90°
1	0.0	184.3	186.9	195.1	210.1	221.0	217.9	187.3	167.2	154.9	148.2	146.1
2	10.0	182.9	185.4	193.5	208.2	218.6	215.8	185.8	165.8	153.5	146.9	144.7
3	20.0	179.5	181.7	188.6	201.0	209.2	207.1	181.0	162.2	150.6	144.3	142.2
4	30.0	175.0	176.8	182.2	191.6	197.6	196.1	174.9	157.8	147.1	141.2	139.4
5	40.0	169.3	170.6	174.5	181.2	185.5	184.4	167.8	152.8	143.2	137.9	136.2
6	50.0	162.0	162.9	165.6	170.0	172.9	172.2	159.8	147.1	138.9	134.2	132.7
7	60.0	152.6	153.2	155.0	158.0	160.0	159.4	150.6	140.6	133.9	130.1	128.8
8	70.0	141.7	142.1	143.3	145.2	146.4	146.1	140.1	132.8	127.8	124.8	123.9
9	80.0	129.8	130.0	130.6	131.7	132.4	132.1	128.6	123.7	120.3	118.3	117.6
10	90.0	116.7	116.8	117.0	117.4	117.7	117.6	115.7	113.1	111.2	110.1	109.7
11	100.0	102.3	102.3	102.4	102.4	102.5	102.4	101.5	100.7	100.2	99.8	99.7
12	103.4	86.4	86.4	86.4	86.4	86.4	86.4	86.4	86.4	86.4	86.4	86.4

4 APPLICATION CONDITIONS

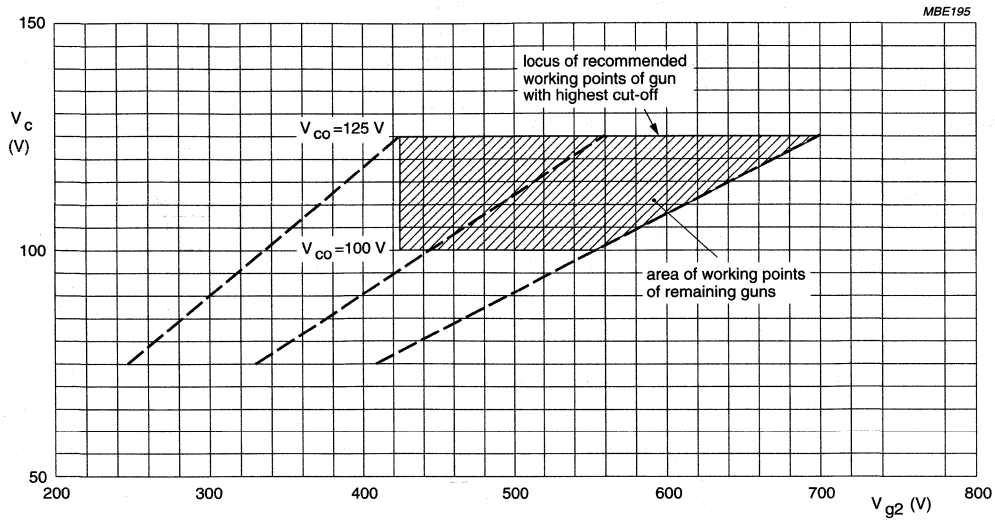
4.1 Recommended adjustment and operating conditions

The voltages are applied to each gun and are measured with respect to grid 1; RH = 40% to 60%; zero magnetic field. Pre-heat the tube for 15 minutes minimum before tests. Avoid impurity, misconvergence, distortion etc. due to stray magnetic fields and chassis influences.

SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNIT
$V_{a,g4}$	anode voltage	–	26.0	–	kV
V_{g2}	grid 2 voltage at a raster cut-off voltage V_{co} = 125 V; note 1		see Fig.17		V
V_{g3a}	grid 3a (static focus electrode) voltage; note 2	6.6	–	7.7	kV
V_{g3b}	grid 3b (dynamic focus electrode) voltage				
	DC voltage	6.6	–	7.7	kV
	horizontal parabola	–	300	–	V
	vertical parabola	–	150	–	V
V_f	heater voltage	–	6.1(3)	–	V
I_a	long term average current for three cathodes	–	–	700	µA
f_H	horizontal sweep frequency	–	66 to 84	–	kHz
f_V	vertical sweep frequency	–	≈70	–	Hz
T_{amb}	ambient temperature	–	25	–	°C

Notes

1. Grid 2 adjustment procedure:
   a) Grid 2 voltage (V_{g2}) adjusted for highest gun raster cut-off voltage V_{co} = 125 V.
   b) Remaining guns adjusted for raster cut-off by means of cathode voltage.
   c) V_{g2} range: 425 V to 700 V at V_{co} = 125 V.
   d) Set the cathode voltage (V_k) for each gun at 125 V; increase the grid 2 voltage (V_{g2}) from ≈400 V to the value at which the raster of the gun with the lowest (V_{g2}) cut-off voltage becomes just visible, then decrease the cathode voltage of the remaining guns until the other colours become just visible.
2. Focus adjustment procedure:
   a) Adjust anode current for 100 cd/m^2 for small square and 60 cd/m^2 for raster (small square = 50 × 50 mm, full raster = 300 × 225 mm). CIE: x = 0.281; y = 0.311.
   b) In 1280 × 1024 mode with crosshatch pattern and parabola applied as recommended, adjust V_{g3a} by optimizing horizontal line in centre.
   c) In 1280 × 1024 mode with crosshatch pattern and parabola applied as recommended, adjust V_{g3b} by optimizing horizontal line in centre.
   d) Switch to character 8 (6 × 9) and assess focus.
   e) If necessary, lower the horizontal parabola to compromise focus/moiré.
3. For maximum cathode life it is recommended that the heater voltage is regulated at 6.1 V.



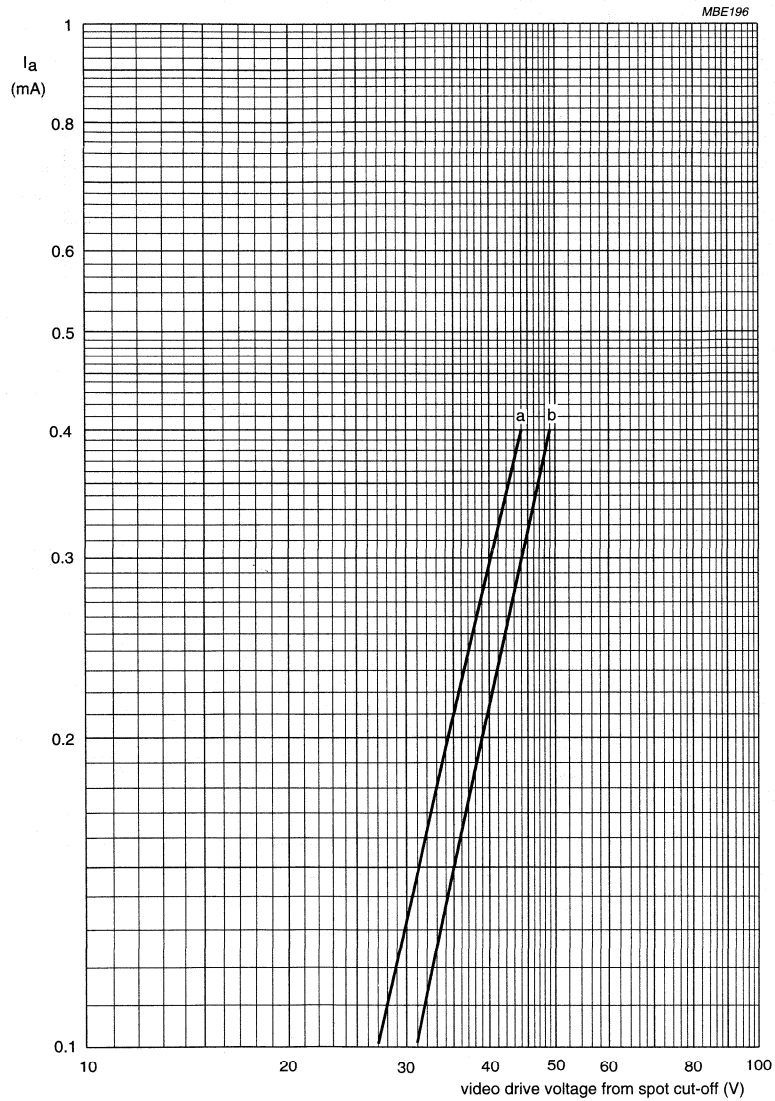
The voltages are specified with respect to grid 1.

Fig.17 Raster cut-off design chart.

4.2 Chassis design values

The values are valid for anode voltages between 20 and 27.5 kV. The voltages are specified with respect to grid 1.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
V_{g3a}	grid 3a (static focus voltage) as a percentage of anode voltage		25.5	27.5	29.5	%
V_{g3b}	grid 3b (dynamic focus voltage)	raster size = 300 × 225 mm				
	DC voltage as a percentage of anode voltage		25.5	27.5	29.5	%
	horizontal parabola		–	300	–	V
	vertical parabola		–	150	–	V
ΔV_{g3a}	difference in focus voltage between red, green and blue images when separately focused		–	–	300	V
ΔV_{g3b}	difference in dynamic focus voltage between red, green and blue images when separately focused		–	–	200	V
V_{g2}	grid 2 voltage	for visual extinction of focused spot	see Fig.17			
V_k	cathode voltage		see Figs 17 and 18			
ΔV_k	difference in cut-off voltage between guns in any tube (cathodes cut-off ratio)		highest value <1.18 × lowest value			
V_f	heater voltage	at zero beam current	–	6.1	–	V
I_{g3}	focus current	under cut-off conditions	–3	–	+3	μA
I_{g2}	grid 2 current	under cut-off conditions	–2	–	+2	μA
I_{g1}	grid 1 current	under cut-off conditions	–5	–	+5	μA
I_{kf}	cathode/heater current	V_{co} = 125 V	–3	–	+3	μA
Resistance						
R_{kgf}	insulation resistance between each cathode and all other electrodes and heater		50	–	–	MΩ
R_{g2}	grid 2 circuit impedance		–	–	5	MΩ
R_{g3}	grid 3 circuit impedance		–	–	50	MΩ



V_{co} = 106 V (curve a).
V_{co} = 125 V (curve b).

Fig.18 Typical cathode drive characteristics.

4.3 Limiting values

In accordance with the Absolute Maximum Rating System (IEC 134). Voltages are specified with respect to grid 1.

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
$V_{a,g4}$	anode voltage	note 1	20[2]	28.5[3]	kV
I_{ap}	anode current for each gun (peak value)		–	400	μA
I_a	long-term average anode current for each gun		–	250	μA
I_a	long-term average anode current for three guns		–	700	μA
V_{g3a}	grid 3a (focus) voltage		–	10	kV
V_{g3b}	grid 3b (focus) voltage		–	10	kV
$\Delta V_{g3a-g3b}$	grid 3 (focus) differential voltage		–	1	kV
V_{g2p}	grid 2 voltage, including video signal voltage (peak value)		–	1000	V
V_f	heater voltage	note 4	5.9	6.3[3]	V
Cathode voltage					
V_k	positive	peak value	–	200	V
		operating	–	135	V
V_k	negative		–	0	V
V_{kp}	negative peak		–	–2	V
Cathode to heater voltage					
V_{kf}	positive		–	250	V
V_{kfp}	positive peak		–	300[3]	V
V_{kf}	negative		–	0	V

Notes

1. During adjustment on the production line this value is likely to be surpassed considerably. It is therefore strongly recommended to first make the necessary adjustments for normal operation without the picture tube.
2. Operation of the tube at lower voltages impairs the luminance and resolution and could impair the convergence.
3. This value is an absolute maximum.
4. For maximum cathode life it is required that the heater supply is designed for 6.1 V at zero beam current.

4.4 Flashover protection

With the high voltage used with this tube (max. 28.5 kV) internal flashovers may occur. As a result of Soft-Flash technology these flashover currents are limited to approximately 200 A offering higher reliability, optimum circuit protection and component savings.

Primary protective circuitry using properly grounded spark gaps and series isolation resistors (preferably carbon composition) is still necessary to prevent tube damage. The spark gaps should be connected to all picture tube electrodes at the socket in accordance with Fig.19; they are not required on the heater pins. No other connections between the outer conductive coating and the chassis are permissible. The spark gaps should be designed for a breakdown voltage at the focus electrode (g3a and g3b) of 11 kV and at the other electrodes of 1.5 to 2 kV, both at an atmospheric pressure of 100 kPa.

The values of the series isolation resistors should be as high as possible (min. 1.5 kΩ) without causing deterioration of the circuit performance. The resistors should be able to withstand an instantaneous surge of 20 kV for the focusing circuit and 12 kV for the remaining circuits without arcing.

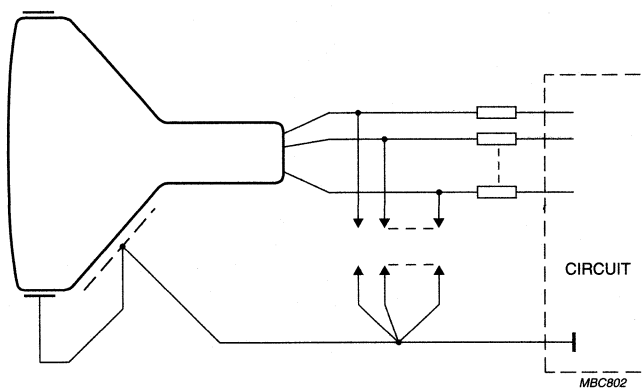


Fig.19 Flashover protection circuit.

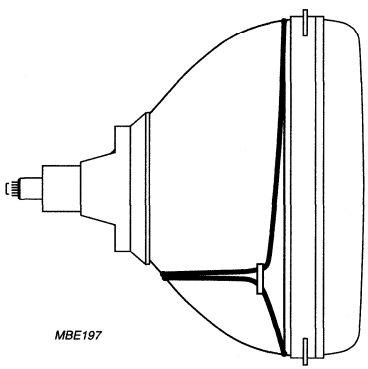
4.5 Degaussing

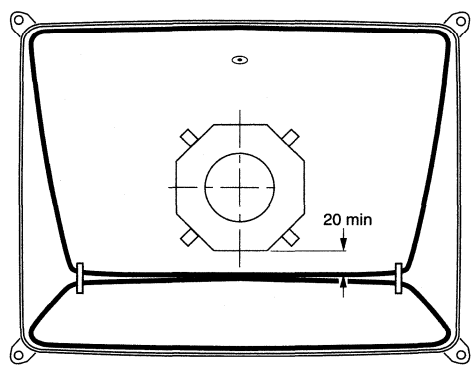
The monitor tube is provided with an internal magnetic shield. This shield and the shadow mask with its suspension system may be provided with an automatic degaussing system, consisting of a coil mounted on the cone of the monitor tube as shown in Fig.20.

For proper degaussing an initial peak magnetomotive force (MMF) of 600 ampere-turns is required in the eight shaped coil. This MMF has to be gradually decreased (maximum 25% per half period) by appropriate circuitry. To prevent beam landing disturbance by horizontal frequency currents induced in the degaussing coils, these coils should be shunted by a capacitor of sufficiently high value. In steady state, no significant MMF should remain in the coils (peak value ≤0.3 ampere-turns).

If single-phase power rectification is employed in the monitor circuitry, provision should be included to prevent asymmetric distortion of the AC voltage applied to the degaussing circuit due to high DC inrush currents.

Incomplete degaussing may result in some out-of-specification characteristics.





Dimensions in mm.
Length of the eight shaped coil is 190 cm.

Fig.20 Mounting of the degaussing coil on the picture tube.

5 ERGONOMIC, ENVIRONMENTAL DATA

5.1 X-radiation

Maximum anode voltage at which the X-radiation emitted will not exceed 0.5 mR/h at an anode current of 300 μA.

PARAMETER	TYP.	UNIT
Entire tube; note 1	34	kV

Note

1. This rating applies only if the anode connector used by the set maker provides the necessary attenuation to reduce the X-radiation from the anode contact by a factor equal to the difference between the anode button iso-exposure-rate limit curve and the iso-exposure-rate limit curve for the entire tube.

WARNING
If the value for the tube face only is used as design criterion, adequate shielding must be provided in the monitor for the anode contact and/or certain portions of the tube funnel and panel sidewalls to ensure that the X-radiation from the monitor is attenuated to a value equal to or lower than that specified for the face of the tube.
Maximum voltage difference between anode and focus electrode at which the X-radiation will not exceed 0.5 mR/h is 30 kV.
If this voltage can be exceeded in the monitor, additional attenuation of the X-radiation through the neck may be required.
The X-radiation emitted from this picture tube, as measured in accordance with the procedure of *"JEDEC Publications No.64D"* will not exceed 0.5 mR/h throughout the useful life of the tube when operated within the design-maximum ratings.
The tube should not be operated beyond its design-maximum ratings stated above, but its X-radiation will not exceed 0.5 mR/h for anode voltage and current combinations given by the iso-exposure-rate limit characteristics as shown in Fig.22.
Operation above the values shown by the curve may result in failure of the monitor to comply with the *"Federal Performance Standard of the U.S. for Television Receivers, Section 1020.10 of Part 1020 of Title 21, Code of Federal Regulation (PL90-602)"* as published in *"Federal Register Volume 38, No. 198,b Monday, October 15, 1973"*.
Maximum X-radiation as a function of anode voltage at 300 μA current is shown by Fig.21. X-radiation at a constant anode voltage varies linearly with anode current.

WARNING
The cathode ray tube is intrinsically safe in accordance with *"Appendix III Röntgenverordnung"*.
Eigensichere Kathodenstrahlröhre nach *"Anlage III Röntgenverordnung"*.

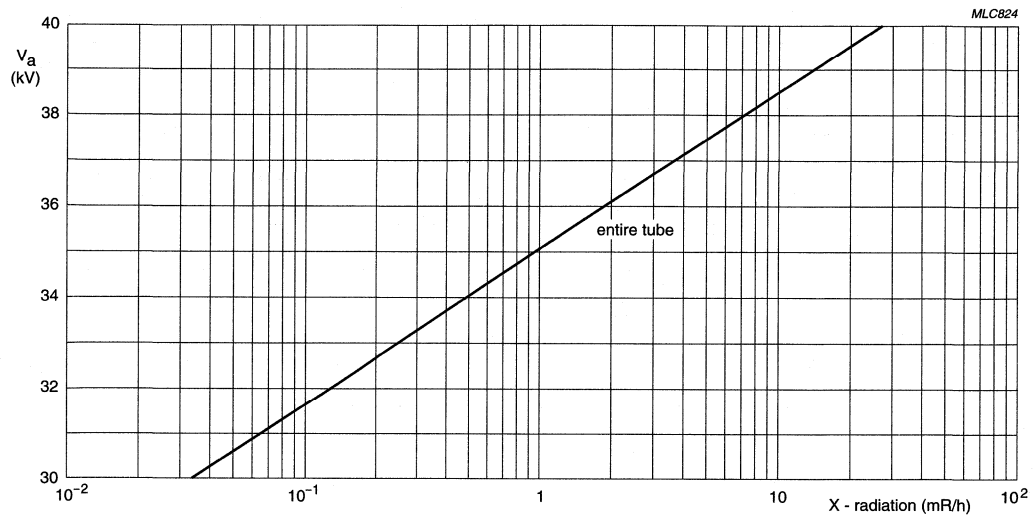


Fig.21 X-radiation limit curve at a constant anode current of 300 μA.

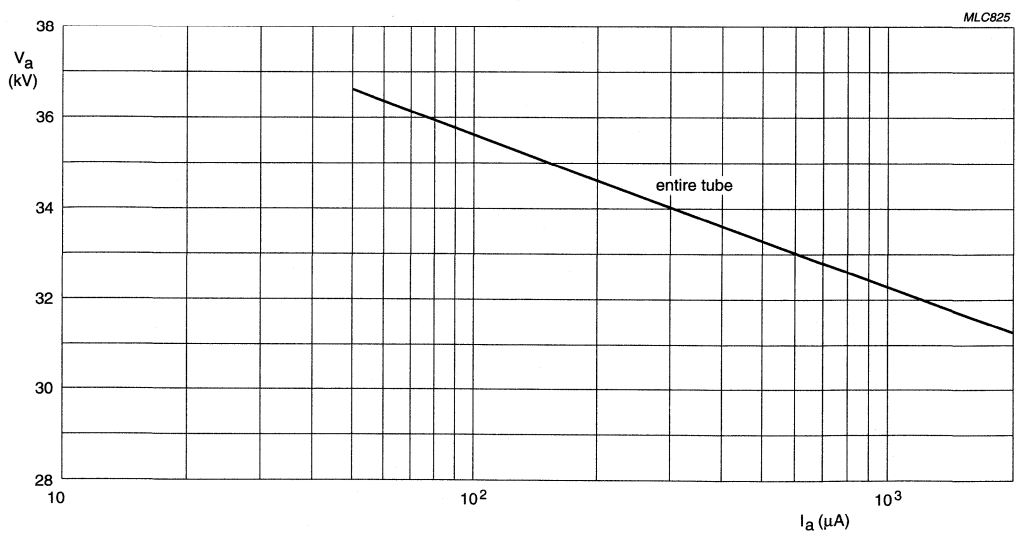
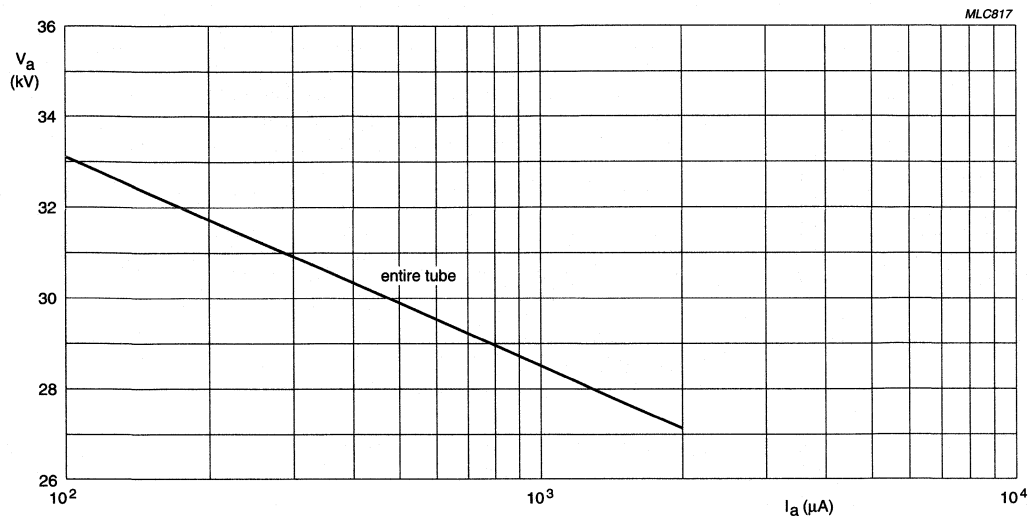


Fig.22 0.5 mR/h iso-exposure-rate limit curve.



The X-radiation emitted will also not exceed 1 μSv/h for anode voltage and current combinations shown in the iso-exposure-rate limit curve according to Eigensichere Kathodenstrahlröhre nach *"Anlage III Röntgenverordnung"*.

Fig.23 1 μSv/h iso-exposure-rate limit curve.

5.2 Warnings

X-radiation
Operation of the colour monitor tube under abnormal conditions that exceed the 0.5 mR/h iso-exposure-rate curve shown in Fig.22 may produce soft X-rays, which may constitute a health hazard on prolonged exposure at close range unless adequate external screening is provided. Precautions must therefore be exercised during servicing of monitors using this tube to ensure that the anode voltage and other tube voltages are adjusted to the recommended values so that the values stated in Section 4.3 are not exceeded.
Tube replacement
This monitor tube incorporates integral X-radiation and implosion protection and must be replaced with a tube of the same type number or recommended replacement to assure continued safety.
Shock hazard
The high voltage at which the tube is operated may be vary dangerous. The monitor should include safeguards to prevent the user from coming in contact with the high voltage. Extreme care should be taken in servicing or adjustment of any high-voltage circuit. Caution must be taken during replacement or servicing of the monitor tube since a residual electrical charge may be held by the high-voltage capacitor formed by the external and internal conductive coatings of the monitor tube funnel. To remove any residual charge, short the anode contact button, located in the funnel of the tube, to the external conductive coating before handling the tube. Discharging the high voltage to isolated metal parts such as cabinets and control brackets may produce a shock hazard.

5.3 Handling

The packaging provides protection against tube damage under normal conditions of shipment or handling. Observe any instructions given on the packaging and handle accordingly. Under no circumstances should the tube assembly be subjected to accelerations greater than the values given in Table "Accelerations".

Accelerations

PARAMETER	PULSE DURATION	MAX.	UNIT
Acceleration in cone direction	≤10 ms	350	m/s^2
	25 ms	300	m/s^2
Acceleration in all other directions	25 ms	350	m/s^2

Monitor tubes should be kept in the shipping box or similar protective container prior to installation.

Although monitor tubes are provided with integral implosion protection which meets the intrinsic safety requirements stipulated in the relevant part of IEC 65, care should be taken not to scratch or knock any part of the tube. Particularly care should be taken to prevent damage to the seal area.

In all handling procedures prior to insertion in the cabinet, there is a risk of personal injury if severe accidental damage to the tube occurs. It is therefore recommended that in areas containing unpacked and unprotected tubes, protective clothing is worn, particularly, gloves and safety glasses with side-shields to prevent possible injury from flying glass in the event of such an accident.
Handle the tube with extreme care. Do not strike, scratch or subject the tube to more than moderate pressure.

The tube assembly should never be handled by the tube neck, deflection unit or other neck components.

If suspending the tube assembly from the mounting lugs, ensure that a **minimum of two** are used.
Under no circumstances suspend the tube assembly from one lug.

An alternative lifting method is to firmly grasp the assembly by the vertical sides of the rimband. Manually lifting the assembly from the face-down or face-up position is shown in Figs 24 and 25.

To protect the screen when placing the tube face-down, ensure that the tube face rests on a cushion kept free from abrasive substances.

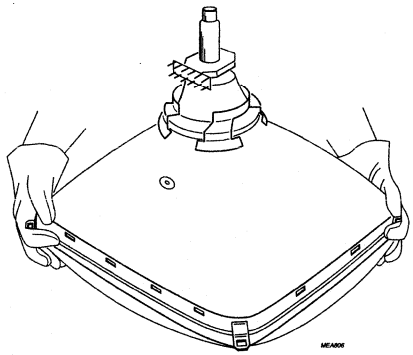


Fig.24 Lifting tube from face-down position.

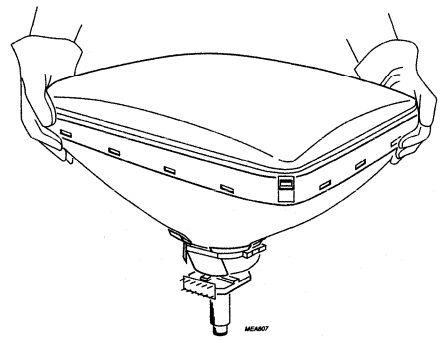


Fig.25 Lifting tube from face-up position.

21" medium resolution colour monitor tube assemblies

M51EHS series

CONTENTS

21" medium resolution colour monitor tube assemblies

M51EHS series

1 HIGHLIGHTS

1.1 Features

1.1.1 HIGH PERFORMANCE DESIGN

- High resolution; higher pixel density possible up to 800 × 600 pixels (non-interlaced) displayable conform ISO 9241 by:
  - 'larger' effective screen area: 380 mm × 285 mm
  - HiBi potential IFL (improved field lens) gun
  - 0.46 mm slot mask pitch
- High brightness and contrast optimized black matrix process
- Excellent white uniformity and colour purity:
  - invar mask
  - corner pin suspension
  - inner magnetic shielding
- Accurate convergence and raster geometry:
  - double mussel coil technology
  - internal magnetostatic beam alignment
  - additional vertical symmetry adjustment for optional and easy convergence touch-up
- Application friendly design:
  - worldwide useable design
  - East-West correction max. 8.0%
  - deflection units designed for minimal ringing.

1.2 Quick reference data

PARAMETER	TYP.	UNIT
Deflection angle	90	deg
Face diagonal	51	cm
Overall length	45	cm
Glass transmission	41	%
Neck diameter	29.1	mm
Heater voltage	6.15	V
Heater current	315	mA
Focus voltage	27% of anode voltage	
Anode voltage	27.5	kV
Mass	≈15	kg

1.1.2 ERGONOMIC DESIGN

- Less ambient reflection:
  - 'flat' and 'square' design
- Less eye strain:
  - P22 medium/short persistence phosphor
  - high frequency yokes
- Green design:
  - CFC-free production process
  - Cd-free phosphors
  - 0.65 W power saving cathode
- Safety approved:
  - VDE; CSA; UL; BSI.

1.1.3 OPTIMUM DISPLAY SOLUTION

- PC applications, multimedia, TV PC
- Resolution standards up to 800 × 600 pixels.

1.3 Deflection coil types

PARAMETER	COIL TYPE NUMBER			UNIT
	10	36	60	
Horizontal coil inductance	0.092	0.380	0.530	mH
Vertical coil inductance	4.4	4.4	10.2	mH
Maximum advised frequency	57	57	57	kHz

1.4 Coding system

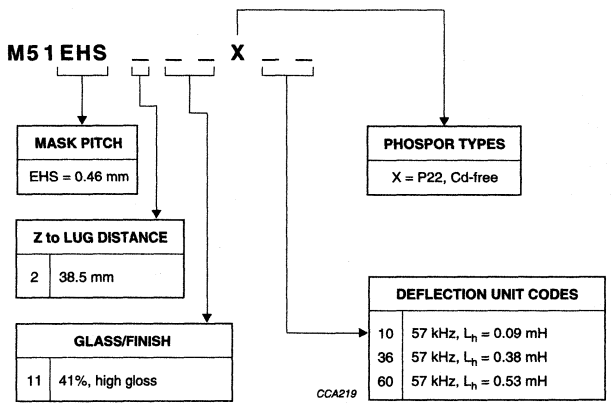


Fig.1 Available versions.

2 PERFORMANCE SPECIFICATION

2.1 Colour coordinates

2.1.1 TYPE P22 PHOSPHOR DATA

Persistence is medium short; $I_{a(av)}$ = 300 µA (per gun); V_a = 27.5 kV; scanned duty cycle = 75%; scanned area = 380 mm × 285 mm; screen finish high gloss.

PHOSPHOR COLOUR	COLOUR COORDINATES		MIN. BRIGHTNESS AT SCREEN CENTRE (Cd/m²)
	x	y	
Red	0.630	0.330	t.b.f.
Green	0.295	0.595	t.b.f.
Blue	0.155	0.065	t.b.f.

2.2 Colour purity and white uniformity

2.2.1 TEST PROCEDURE

Tube facing east (magnetic field see Section 4.1); adjust the tube in accordance with the recommended operating conditions and to a centre-white brightness of 100 Cd/m² on a data raster of 380 mm × 285 mm. The screen should be viewed with blanked red, green, white raster at a distance of 1 metre at an ambient level of 1 lux.

2.2.2 LIMITS

No severe discoloration or cross contamination allowed. Maximum deviation in white x and y colour coordinates shall not exceed 0.010 with respect to the average white point of this screen.

2.3 Brightness variation

2.3.1 TEST PROCEDURE

Tube facing east (magnetic field see Section 4.1); adjust the tube in accordance with the recommended operating conditions and to a centre-white brightness of 100 Cd/m² on a data raster of 380 mm × 285 mm.

2.3.2 LIMITS

Brightness decrease from centre to corner shall not exceed 35%.

2.4 Resolution specification

With the settings given in Section 4.1, the displayed characters will be recognizable as individual $ characters on a data raster measuring 300 mm × 225 mm spot size 5% (size of the spot in mm where the brightness is decreased to 5% of the brightness in the centre of the spot).

ANODE CURRENT	SPOT SIZE CENTRE (NOMINAL)		SPOT SIZE CORNER (NOMINAL)		UNIT
	X	Y	X	Y	
100 µA	t.b.f.	t.b.f.	t.b.f.	t.b.f.	mm
200 µA	t.b.f.	t.b.f.	t.b.f.	t.b.f.	mm
400 µA	t.b.f.	t.b.f.	t.b.f.	t.b.f.	mm

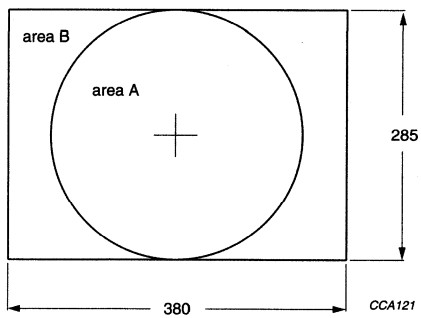
2.5 Convergence specification

2.5.1 TEST CONDITIONS

1. Set-up in accordance with Section 4.1.
2. Measure maximum misconvergence after 30 minutes operation.
3. To be adjusted for focus at half east or half west using crosshatch pattern at anode current is 400 μA (peak value) per gun.
4. Misconvergence is the distance between the centres of the red, green and blue lines at the screen using a crosshatch pattern.
5. Anode and/or focusing voltage and terrestrial magnetism may slightly affect the static convergence. Therefore, small re-adjustments to static convergence may be necessary.
6. Avoid stray magnetic fields etc. due to chassis influences which may affect convergence.

2.5.2 CONVERGENCE LIMITS

LOCATION (see Fig.2)	**TYPE OF ERROR**	**MAXIMUM ERROR BETWEEN ANY TWO COLOURS (mm)**
Centre	red-green-blue line separation in either the horizontal or vertical direction	0.2
Area A		0.5
Area B		0.7



Dimensions in mm.

Fig.2 Maximum misconvergence.

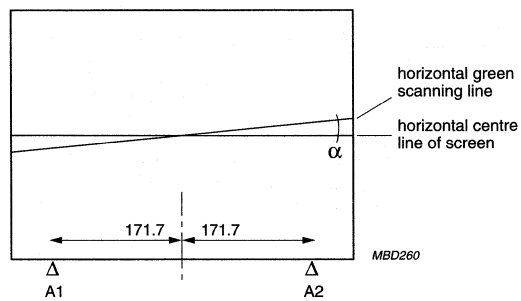
2.6 Raster geometry

2.6.1 RASTER CENTRING

CENTRING	MAX.	UNIT
Horizontal	±4	mm
Vertical	±4	mm

2.6.2 RASTER ROTATION

Measure the angle of the horizontal green scanning line with reference to a horizontal centre line that is drawn parallel to the tube reference points A1 and A2, see Fig.3. Chassis influences may affect raster rotation.



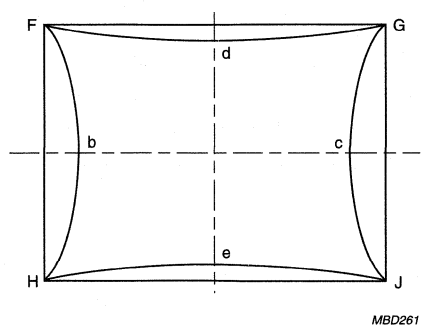
$\alpha \leq 0.3°$

Fig.3 Rotation measurement.

2.6.3 RASTER ORTHOGONALITY

Orthogonality of the horizontal/vertical scan axis is ±0.5°.

2.6.4 PINCUSHION DISTORTION



FG = HJ = 380 mm.
FH = GJ = 285 mm.
Measured with no pincushion correction applied, with 'b', 'c', 'd' and 'e' measured along the main axis.

Fig.4 Pincushion distortion.

2.6.5 DISTORTION NORTH - SOUTH

The following formulae define the pincushion distortion in the north and south directions.

$$\text{North} = \frac{4d}{FH + GJ} \times 100\% = 0\% \text{ to } +1.3\%$$

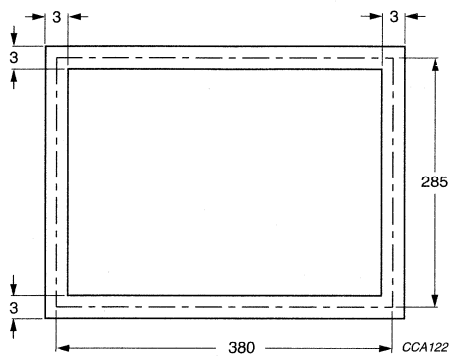
$$\text{South} = \frac{4e}{FH + GJ} \times 100\% = 0\% \text{ to } +1.3\%$$

2.6.6 DISTORTION EAST - WEST

The following formulae define the pincushion distortion in the east and west directions.

$$\text{East} = \frac{4b}{FG + HJ} \times 100\% \leq 10\%$$

$$\text{West} = \frac{4c}{FG + HJ} \times 100\% \leq 10\%$$



Dimensions in mm.

Fig.5 General distortion.

2.7 Screen quality

2.7.1 GENERAL TEST PROCEDURE

Tests are to be done under the following general conditions:

- Viewing distance should be 50 cm minimum.
- For an activated screen the diffuse ambient light level at the centre of the screen should be between 2 and 5 lux.
- For an unactivated screen the diffuse ambient light level at the centre of the screen should be between 700 and 1000 lux.
- The viewing angle relative to the tube axis should not exceed 45°.
- Faults not visible under these general conditions are permitted.
- Quality areas A and B are defined in Fig.6.

2.7.2 ASSESSMENT OF THE GLASS AND THE UNACTIVATED SCREEN QUALITY

2.7.2.1 Definition of blemishes

Unless otherwise specified, the shape of a blemish is defined as: round and elliptical.

The size of a blemish is given by:

- $\frac{L + W}{2}$ or $\frac{L}{20} + 2W$, whatever expression is the largest,

  where L = length and W = width.

2.7.2.2 Limits

Table 1 Limits of measurable glass blemishes and unactivated screen blemishes (see Fig.6)

BLEMISH SIZE (mm)	MAXIMUM PERMISSIBLE NUMBER OF BLEMISHES		DIAMETER OF MINIMUM ENCLOSING CIRCLE (mm)
	AREA A	AREA B	
>1.0	0	0	–
>0.7 to 1.0	0	2	40
>0.4 to 0.7	2	5	40
≤0.4	limited only by cloud		–

Table 2 Limits of scratches

WIDTH OF SCRATCHES (mm)	MAXIMUM PERMISSIBLE LENGTH OF SCRATCHES (mm)
>0.15	none
>0.1 to ≤0.15	10
>0.05 to ≤0.1	40
≤0.05	no limit

2.7.3 QUALITY OF ACTIVATED SCREEN

Measurable blemishes are faults affecting the illuminance of the phosphor layer, which are clearly visible immediately (within 5 seconds) at viewing distance.

The size of a measurable blemish is given by:

$\frac{L+W}{2}$ (for $L < 4W$) or,

$\frac{L}{20} + 2W$ (for $L \geq 4W$),

where:

L = length of the blemish.

W = width of the blemish.

Blemishes are classified according to contrast degree:

- High contrast:
  - Blemishes which are clearly visible immediately (within 5 seconds). Missing or unlit green phosphor stripes fall into this category.
- Medium contrast:
  - Blemishes which are just visible. Missing or unlit blue and/or red phosphor stripes fall into this category.

To determine the contrast category it is advisable to use the *"Philips Graticule"*. This graticule is held at arms length over the blemish and then moved from the 0.7 to the 1.3 filter. The following criteria are used to determine the contrast categories:

- High contrast:
  - Blemishes which are visible through the 0.7 filter and are immediately visible upon entering the 1.3 filter.
- Medium contrast:
  - Blemishes which are visible through the 0.7 filter but disappear momentarily upon entering the 1.3 filter.

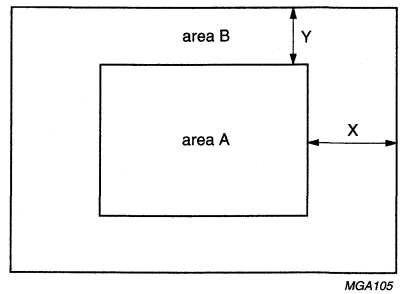
In those size categories where a minimum enclosing circle is indicated, the blemishes lying within this circle shall be regarded as one fault equal in size to the sum of the individual blemish sizes.

If blemishes falling under different contrast categories are visible simultaneously, apply the larger minimum enclosing circle rule and treat all such enclosed blemishes as being in the lower contrast category, provided that the individual blemishes are within the limits for their own contrast category.

If blemishes falling under different size categories are visible simultaneously, then the total quantity of blemishes should not exceed the maximum number of blemishes allowable for the least critical of these categories.

The quality assessment should take place at nominal conditions. The beam current is adjusted to 60% of the long term average value. The assessment is performed at a viewing distance of approximately 5 × screen height, in an ambient light of approximately 1 lux, using a white raster.

The useful screen area is bounded by the edge of the phosphor screen. The area is divided into areas A and B, located as shown in Fig.6.



X = 100 mm, Y = 75 mm.

Fig.6 Dimensions of areas A and B.

2.7.4 ACCEPTANCE LIMITS AND CLASSIFICATION OF BLEMISHES

Maximum permissible number of blemishes for activated screen (see Fig.6 for area definitions).

BLEMISH SIZE (mm)	MAXIMUM PERMISSIBLE NUMBER OF BLEMISHES				DIAMETER OF MINIMUM ENCLOSING CIRCLE (mm)
	HIGH CONTRAST		MEDIUM CONTRAST		
	AREA A	AREA A + B	AREA A	AREA A + B	
>2.5	0	0	0	0	–
>1.8 to 2.5	0	0	1	2	40
>1.2 to 1.8	0	0	2	3	40
>1.0 to 1.2	0	1	4	6	40 (high contrast) 15 (medium contrast)
>0.7 to 1.0	0	2			
>0.4 to 0.7	2	5			
≤0.4	limited only by cloud				–

3 PRODUCT CHARACTERISTICS

3.1 Electrical data

SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNIT
Capacitances					
$C_{a(m+m')}$	anode to external conductive cone coating, including rimband (with and without screen coating)	1600	–	–	pF
C_{kR}, C_{kG}, C_{kB}	cathode of any gun to all other electrodes	–	5	–	pF
C_{g1}	grid 1 of any gun to all other electrodes	–	17	–	pF
C_{g3}	grid 3 (focus electrode) to all other electrodes	–	6	–	pF
Heater					
V_f	heater voltage	–	6.1	–	V
I_f	heater current	295	315	335	mA
Deflection unit					
V_{max}	maximum permissible DC voltage				
	between horizontal and vertical coils	–	–	2000	V
	between vertical coils and core	–	–	300	V
R_{ins}	insulation resistance at 1 kV (DC)				
	between horizontal and vertical coils	500	–	–	MΩ
	between horizontal coil and core clamping ring	500	–	–	MΩ
	between vertical coil and core clamping ring	10	–	–	MΩ
	cross -talk (1 V applied to the horizontal coils)	–	–	30	mV
	average copper temperature; note 1	–	–	90	°C
T_{stg}	storage temperature	–25	–	+90	°C
Deflection unit safety					
	flame retardant	in accordance with UL1413, category 94-V1			

Note

1. Measured by the resistance method.

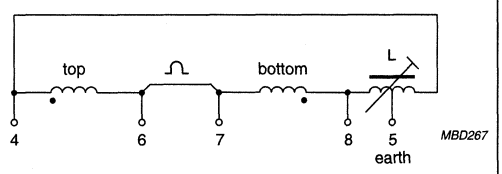
3.2 Deflection unit data

All values are valid at T_{amb} = 25 °C and V_a = 27.5 kV; deflection units fulfil the MPRII and TCO magnetic requirements; the deflection coil is designed for a positive pulse on the horizontal coil.

PARAMETER	COIL TYPE NUMBER			TOLERANCE	UNIT
	10	36	60		
Advised maximum frequency; notes 1 and 2	57	57	57	–	kHz
Horizontal deflection coil					
Inductance	0.092	0.380	0.530	±4%	mH
Resistance	0.15	0.54	0.69	±7%	Ω
Current (peak-to-peak value)	13.5	6.33	5.35	±4%	A
Used wire	multiwire			–	
Vertical deflection coil					
Inductance	5.00	5.00	10.2	±4%	mH
Resistance	4.20	4.20	8.20	±7%	Ω
Current (peak-to-peak value)	1.67	1.67	1.22	±5%	A
Used wire	multiwire			–	

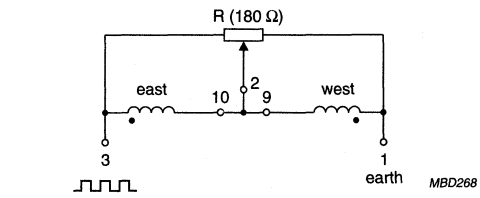
Notes

1. Advised maximum frequency depends on the internal maximum set temperature and used deflection-overscan.
2. No annoying ringing with 0% overscan.



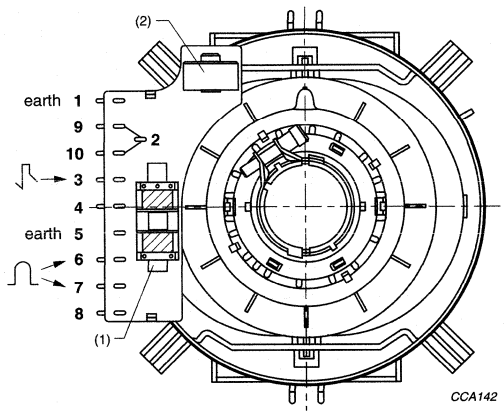
The beginning of the windings is indicated with •

Fig.7 Horizontal coils.



The beginning of the windings is indicated with •

Fig.8 Vertical coils.

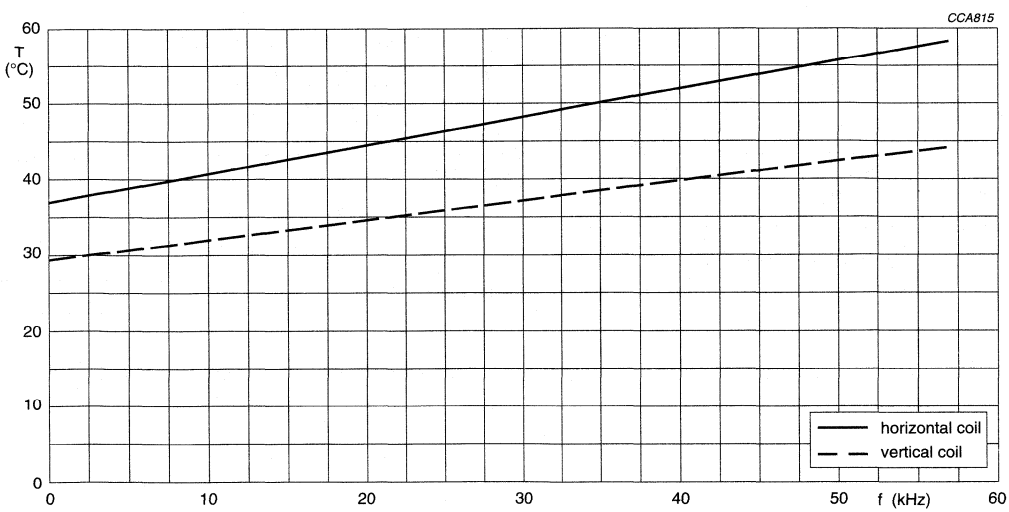


(1) Horizontal balance coil.
(2) Vertical balance potentiometer.

Fig.9 Deflection coil connections.

3.2.1 DEFLECTION UNIT TEMPERATURE

SYMBOL	PARAMETER	MAX.	UNIT
T_{copper}	average copper temperature of horizontal coil	110	°C
ΔT	maximum temperature rise of used wire	60	°C



Maximum operating copper temperature (resistance measurement) is 110 °C.

Fig.10 Temperature rise as a function of frequency at 0% overscan.

3.3 Electro-optical data

PARAMETER	VALUE
Electron gun system	three in-line integrated guns
Focus method	electrostatic
Focus lens	hi-bi potential
Convergence method	magnetic
Deflection method	self converging
Deflection angle	
diagonal	≈90°
horizontal	≈78°
vertical	≈60°

3.4 Screen properties

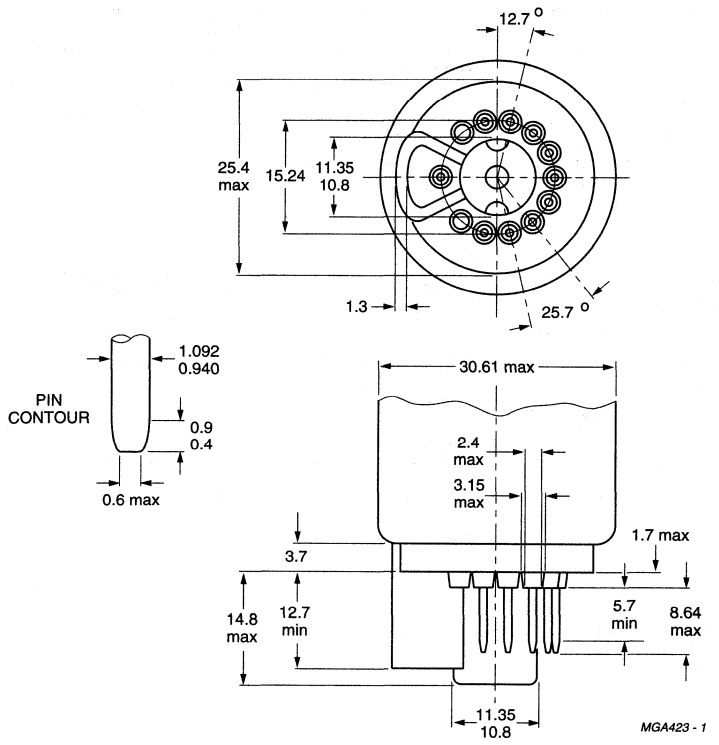
PARAMETER	VALUE
Screen	metal-backed vertical phosphor stripes; phosphor lines follow glass contour; black matrix
Screen finish	high gloss
Useful screen dimensions	
diagonal axis	508.6 mm
vertical axis	409.5 mm
horizontal axis	308.0 mm
area	1255 cm^2
Phosphor alignment	see Fig.14
Phosphors	
red	pigmented europium activated rare earth
green	Cd-free sulphide type
blue	pigmented sulphide type
Persistence	medium short
Centre-to-centre distance of identical colour phosphor stripes at centre of screen	0.48 mm
Light transmission at screen centre	41%
Luminance at centre of screen; note 1	66 cd/m^2
Contrast	>20.1 dB

Note

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

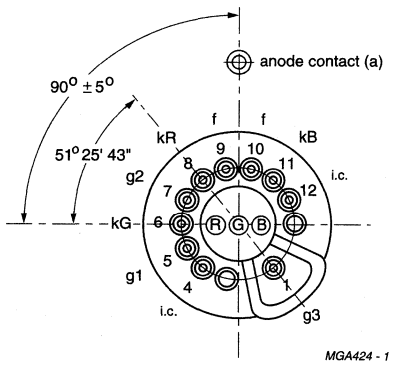
3.5 Mechanical data

PARAMETER	VALUE
Overall length	444 ±6 mm
Neck diameter	29.1 +0.9/–0.7 mm
Maximum dimensions, excluding mounting lugs but including rimband	
diagonal	549.2 mm
width	458.8 mm
height	362.7 mm
Implosion protection	pre-stressed banded Mini-P shrunk-on rimband; UL, CSA, BSI and VDI approved
Anode contact	JEDEC J1-21; IEC 67-III-2
Base designation	JEDEC B10-277
Base pin configuration	see Fig.12
Mass	≈15 kg
Mounting position	anode contact on top



Dimensions in mm.

Fig.11 Base JEDEC B10-277.



i.c. = internally connected and not to be used.

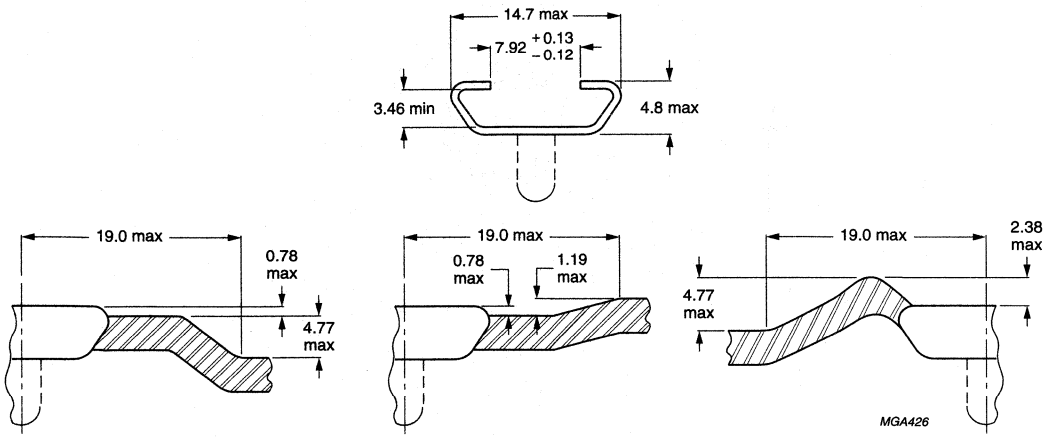
Fig.12 Pin arrangement.

Remarks: to Figs 11 and 12.

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

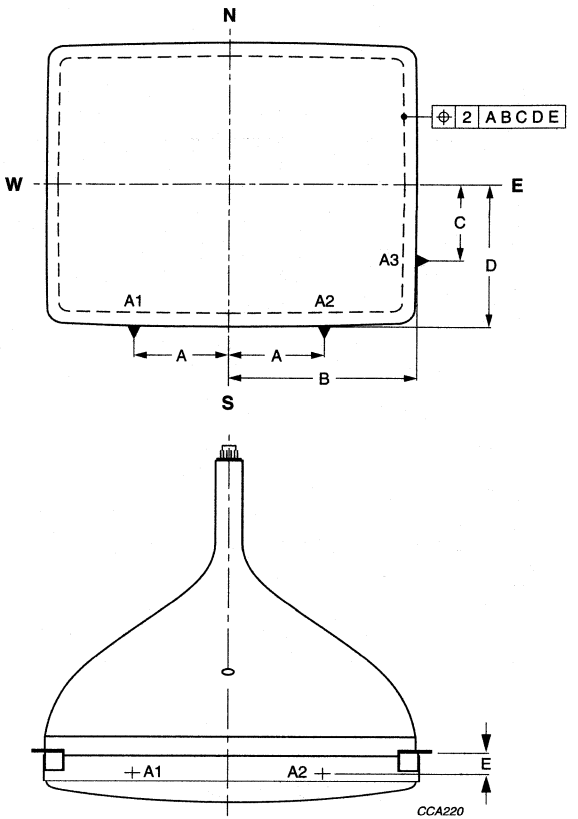
The mass of the mounting socket assembly should not exceed 150 g.

Maximum permissible torque on the tube neck is 0.04 Nm.



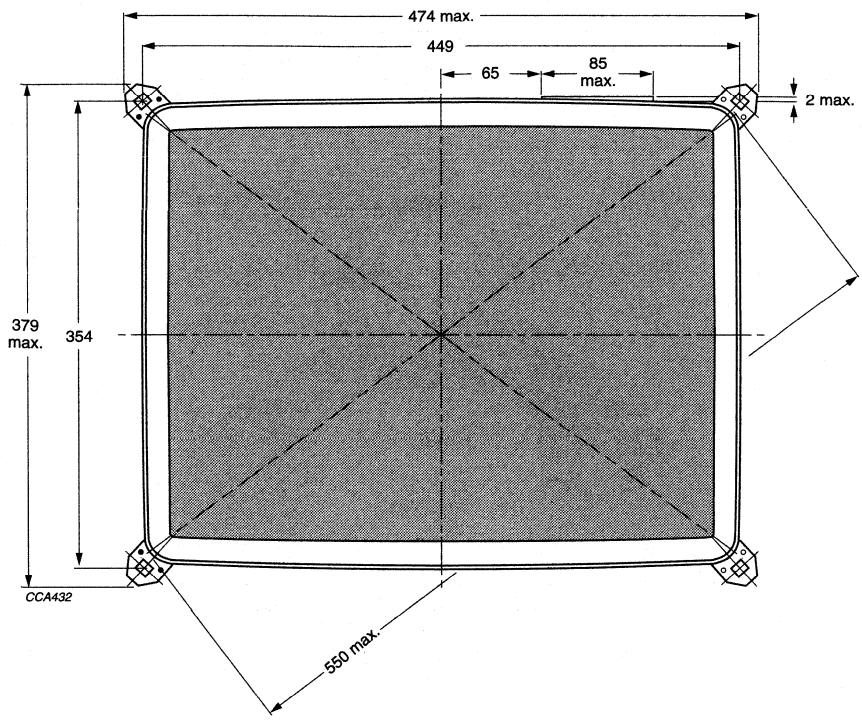
Dimensions in mm.

Fig.13 Cavity cap JEDEC J1-21, IEC 67-III-2.



A = 171.7 mm.
B = 225.5 mm.
C = 115.6 mm.
D = 175.7 mm.
E = 10.4 mm.

Fig.14 Phosphor alignment.

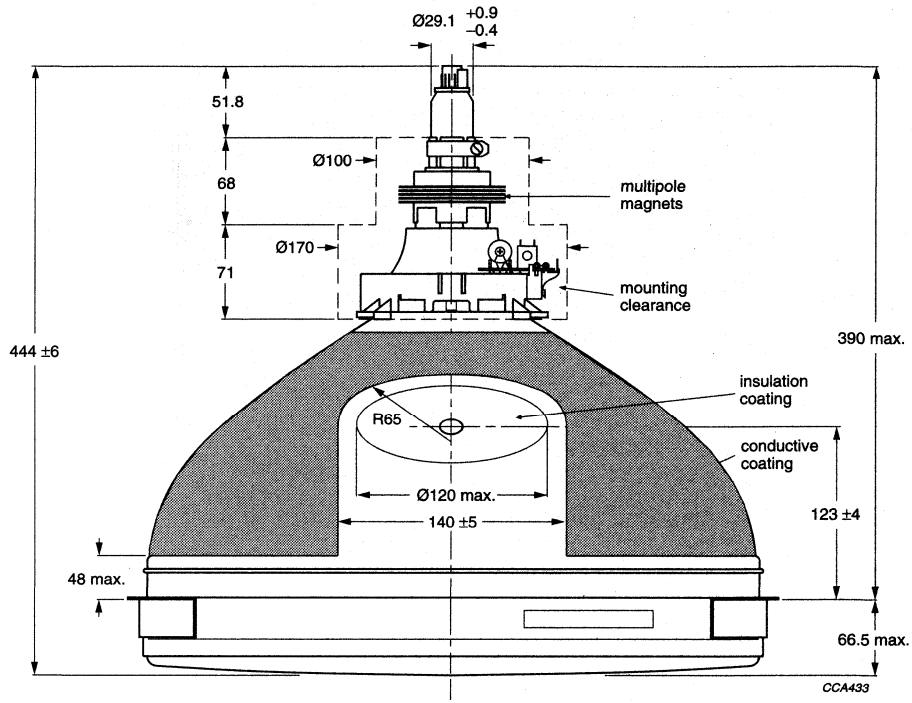


Dimensions in mm.

Fig.15 Tube dimensions; front view.

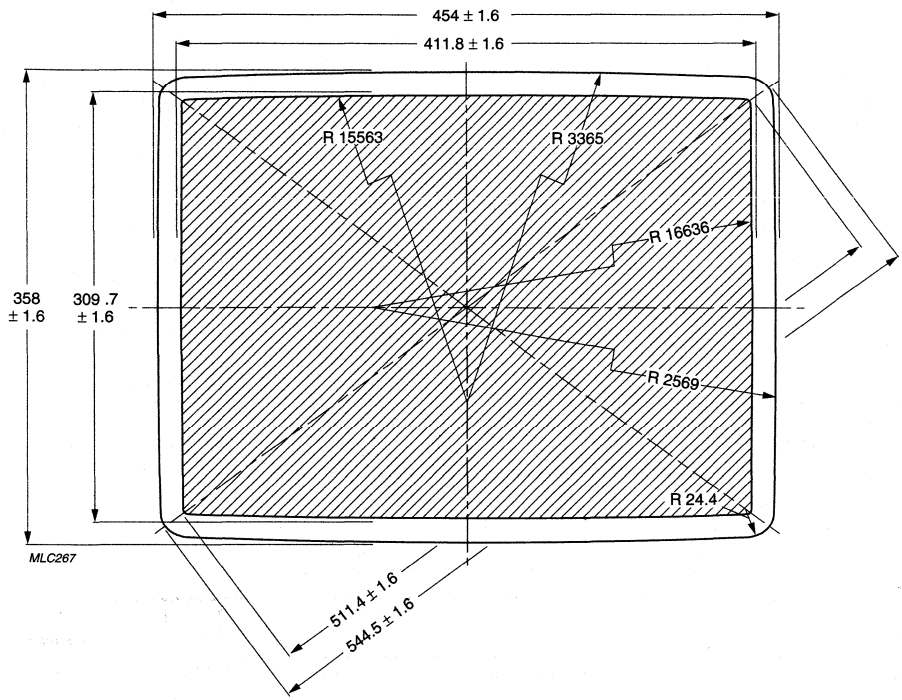
21" medium resolution colour monitor tube assemblies

M51EHS series



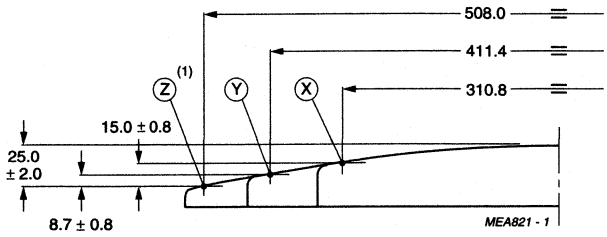
Dimensions in mm.

Fig.16 Top view.



Dimensions in mm.

Fig.17 Phosphor and screen dimensions.



Dimensions in mm.

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

The X, Y and Z reference points are located on the outside surface of the face plate on the minor, major and diagonal screen axis respectively.

The distance Z from any point on the screen to the centre can be calculated using the following formula:

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

Where:

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

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

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

$B_1 = 2.1$

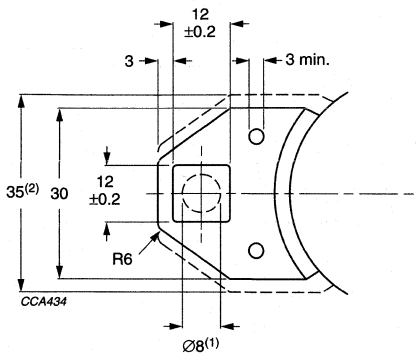
$B_2 = 2.1$

$B_3 = 1.84082$

$B_4 = 2.65536$

Fig.18 Screen reference points.

3.5.1 LUG DATA

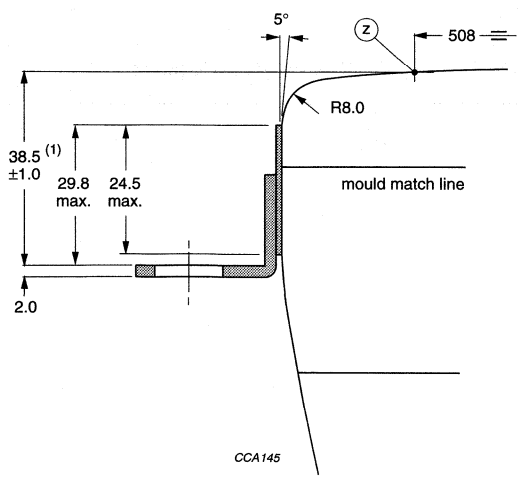


Dimensions in mm.

(1) The position of the mounting screw in the cabinet must be within a circle of 8 mm diameter drawn around the true geometrical positions, i.e. the corners of a rectangle of 354.0 mm × 449.0 mm.

(2) Minimum space to be reserved for mounting lug in cabinet.

Fig.19 Lug dimensions.



Dimensions in mm.

(1) The displacement of any lug with respect to the plane through the other 3 lugs is maximum 0.8 mm.

Fig.20 Lug position M51EHS2..X..

3.5.2 SAGITTAL HEIGHTS OF SCREEN

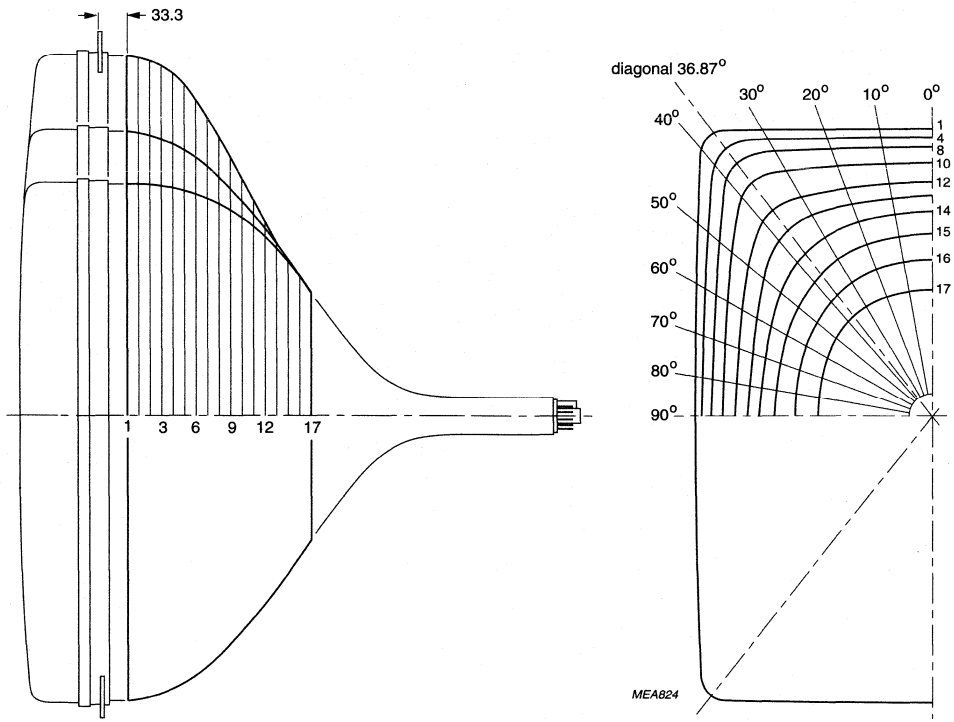
Sagittal heights measured with reference to the end of the diagonal axis of the nominal useful screen.

NOMINAL USEFUL SCREEN (NUS)			3 mm INSIDE NUS			5 mm OUTSIDE NUS		
COORDINATES		SAGITTAL HEIGHT	COORDINATES		SAGITTAL HEIGHT	COORDINATES		SAGITTAL HEIGHT
X (mm)	Y (mm)	(mm)	X (mm)	Y (mm)	(mm)	X (mm)	Y (mm)	(mm)
0.0	0.0	25.0	0.0	0.0	24.2	0.0	0.0	26.4
0.0[1]	154.0	15.2	0.0	151.0	14.8	0.0	159.0	15.9
20.0	154.0	15.1	20.0	151.0	14.7	20.0	159.0	15.8
40.0	154.0	14.7	40.0	151.0	14.3	40.0	159.0	15.4
60.0	153.9	14.1	60.0	150.9	13.6	60.0	158.9	14.8
80.0	153.8	13.1	80.0	150.8	12.7	80.0	158.8	13.8
100.0	153.7	11.8	100.0	150.7	11.4	100.0	158.7	12.5
120.0	153.5	10.2	120.0	150.5	9.8	120.0	158.5	11.0
140.0	153.3	8.3	140.0	150.3	7.9	140.0	158.3	9.1
160.0	153.1	6.1	160.0	150.1	5.6	160.0	158.1	6.8
180.0	152.9	3.5	180.0	149.9	3.0	180.0	157.9	4.2
200.0	152.6	0.5	200.0	149.6	0.1	200.0	157.6	1.3
203.4[2]	152.6	0.0	200.5	149.6	0.0	208.4	157.5	0.0
203.7	140.0	1.4	200.7	140.0	1.0	208.7	140.0	1.9
203.9	120.0	3.3	200.9	120.0	2.9	208.9	120.0	3.8
204.2	100.0	4.9	201.2	100.0	4.5	209.2	100.0	5.4
204.4	80.0	6.2	201.4	80.0	5.9	209.4	80.0	6.7
204.6	60.0	7.2	201.6	60.0	6.9	209.6	60.0	7.7
204.7	40.0	7.9	201.7	40.0	7.6	209.7	40.0	8.4
204.7	20.0	8.3	201.7	20.0	8.0	209.7	20.0	8.8
204.8[3]	0.0	8.4	201.8	0.0	8.1	209.8	0.0	8.9

Notes

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

3.5.3 CONE CONTOUR



Dimensions in mm.

Fig.21 Maximum cone contour.

21" medium resolution colour monitor tube assemblies

M51EHS series

Cone contour data

SECTION	NOMINAL DISTANCE FROM SECTION 1 (mm)	MAXIMUM DISTANCE FROM TUBE AXIS (mm)										
		0°	10°	20°	30°	36.87°	40°	50°	60°	70°	80°	90°
1	0.0	225.7	228.9	239.1	257.6	271.8	267.2	227.9	203.1	187.9	179.6	177.0
2	10.0	224.6	227.7	237.7	255.9	270.0	265.3	226.7	201.9	186.8	178.6	175.9
3	20.0	221.8	224.8	234.3	251.1	264.3	259.6	222.9	198.9	184.2	176.1	173.5
4	30.0	218.1	220.9	229.6	244.5	254.7	250.6	217.9	195.1	180.9	173.1	170.6
5	40.0	213.8	216.4	224.1	236.5	243.1	239.6	212.0	190.9	177.3	169.9	167.5
6	50.0	208.7	211.0	217.7	227.5	231.3	228.4	205.6	186.3	173.6	166.5	164.2
7	60.0	202.6	204.5	210.0	217.5	219.5	217.0	198.5	181.0	169.3	162.6	160.5
8	70.0	195.1	196.8	201.3	206.9	207.6	205.4	190.3	175.1	164.4	158.3	156.3
9	80.0	186.2	187.6	191.4	195.6	195.4	193.5	181.3	168.4	158.9	153.3	151.5
10	90.0	175.6	176.9	180.1	183.3	182.8	181.1	171.4	160.7	152.5	147.6	146.0
11	100.0	163.6	164.6	167.4	169.9	169.2	167.9	160.4	151.9	145.2	141.0	139.6
12	110.0	150.3	151.3	153.8	155.7	154.7	153.6	147.9	141.7	136.6	133.4	132.3
13	120.0	136.4	137.3	139.3	140.4	139.5	138.6	134.5	130.3	126.8	124.6	123.9
14	130.0	122.1	122.8	124.4	124.9	124.0	123.3	120.7	118.2	116.1	114.7	114.3
15	140.0	107.5	107.7	108.2	108.6	108.4	108.2	107.0	105.7	104.5	103.8	103.5
16	150.0	92.6	92.3	92.3	92.6	92.8	92.9	92.9	92.6	92.1	91.6	91.4
17	159.5	78.1	78.1	78.1	78.1	78.1	78.1	78.1	78.1	78.1	78.1	78.1

4 APPLICATION CONDITIONS

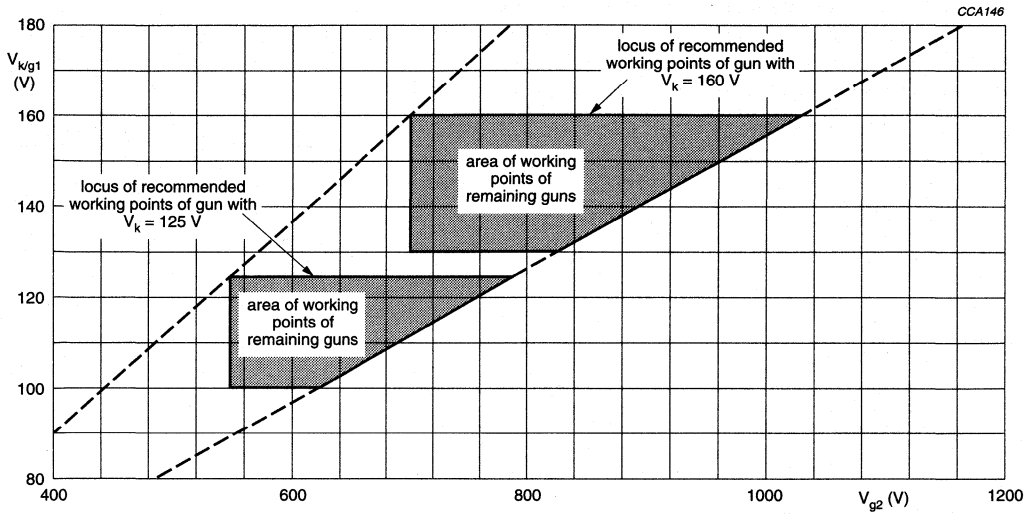
4.1 Recommended adjustment and operating conditions

The voltages are applied to each gun and are measured with respect to grid 1; RH = 40% to 60%; tube facing east; local magnetic field: 0.03 mT vertical, 0.00 mT lateral, 0.00 mT axial. Pre-heat the tube for 15 minutes minimum before tests. Avoid impurity, misconvergence, distortion etc. due to stray magnetic fields and chassis influences.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
$V_{a,g4}$	anode voltage		–	27.5	–	kV
V_{g3}	grid 3 (focus electrode) voltage; note 1		7.35	–	7.65	kV
V_{g2}	grid 2 voltage	V_k = 160 V; note 2	700	–	1020	V
		V_k = 125 V; note 2	550	–	800	kV
V_f	heater voltage		–	6.15(3)	–	V
f_H	horizontal sweep frequency		–	t.b.f.	–	kHz
f_V	vertical sweep frequency		–	t.b.f.	–	Hz
T_{amb}	ambient temperature		–	25	–	°C

Notes

1. Focus adjustment procedure:
   a) Adjust anode current for 100 Cd/m^2 and CIE: x = 0.281; y = 0.311.
   b) Adjust for optimum focus at screen centre.
2. Grid 2 adjustment procedure:
   a) Grid 2 voltage (V_{g2}) adjusted for highest gun spot cut-off voltage: V_k = 160 V.
   b) Remaining guns adjusted for spot cut-off by means of cathode voltage.
   c) V_{g2} range: 700 V to 1020 V at V_k = 130 to 160 V.
   d) Set the cathode voltage (V_k) for each gun at 160 V; increase the grid 2 voltage (V_{g2}) from ≈700 V to the value at which the spot of the gun with the lowest (V_{g2}) cut-off voltage becomes just visible, then decrease the cathode voltage of the remaining guns until the other colours become just visible.
3. For maximum cathode life it is recommended that the heater voltage is regulated at 6.15 V at average beam current, for most applications this equals 6.3 V at zero beam current.



The voltages are specified with respect to grid 1.

Fig.22 Spot cut-off design chart.

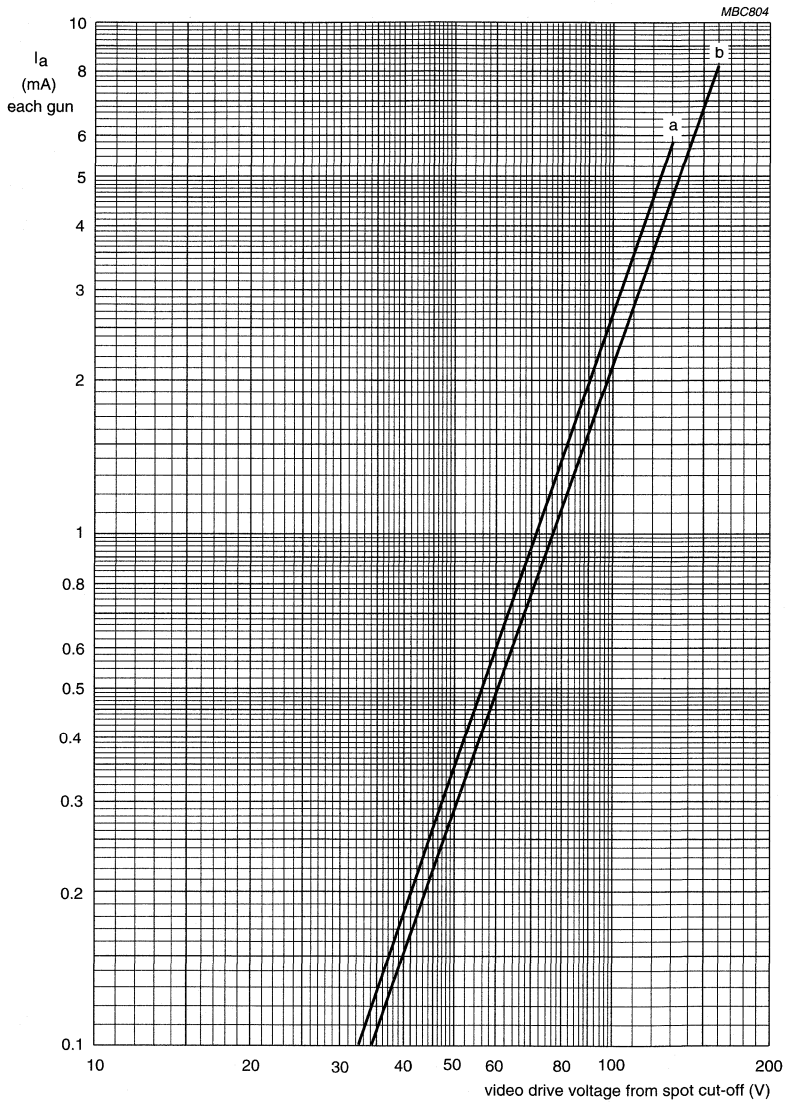
4.2 Chassis design values

The values are valid for anode voltages between 20 and 29.9 kV. The voltages are specified with respect to grid 1.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
V_{g3}	grid 3 (focus electrode) voltage as a percentage of anode voltage		25	–	29	%
V_{g2} and V_k	grid 2 voltage and cathode voltage	for visual extinction of focused spot	see Fig.22			
ΔV_k	difference in cut-off voltage between guns in any tube		lowest value >80% of highest value			
V_f	heater voltage	at average beam current	–	6.15	–	V
	video drive characteristics		note 1 and Fig.23			
I_{g3}	grid 3 (focus electrode) current		–2	–	+2	μA
I_{g2}	grid 2 current		–2	–	+2	μA
I_{g1}	grid 1 current	under cut-off conditions	–2	–	+2	μA
R_{ins}	insulation resistance	each cathode to grid 1 and heater	50	–	–	MΩ
Anode currents to produce white of 6500 K + 7 MPCD (CIE coordinates: x = 0.313; y = 0.329)						
PERCENTAGE OF THE TOTAL ANODE CURRENT SUPPLIED BY EACH GUN (TYPICAL)						
	red gun		–	41.3	–	%
	green gun		–	34.4	–	%
	blue gun		–	24.3	–	%
RATIO OF ANODE CURRENTS						
	red gun to green gun		0.85	–	1.55	
	red gun to blue gun		1.20	–	2.20	
	blue gun to green gun		0.40	–	1.00	

Note

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



V_f = 6.15 V.
$V_{a,g4}$ = 27.5 kV.
V_{g3} adjusted for focus.
V_{g2} (each gun) adjusted to provide spot cut-off for V_k = 130 V (curve a) and V_k = 160 V (curve b).

Fig.23 Typical cathode drive characteristics.

4.3 Limiting values

In accordance with the Absolute Maximum Rating System (IEC 134). The voltages are specified with respect to grid 1.

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
$V_{a,g4}$	anode voltage	notes 1 and 2	22(3)	31.0(4)	kV
I_a	long-term average current for three guns	note 5	–	1000	μA
V_{g3}	grid 3 (focus electrode) voltage		–	11	kV
V_{g2}	grid 2 voltage	note 6	–	1200	V
V_f	heater voltage	note 7	5.7	6.6(4)	V
Cathode voltage					
V_k	positive	operating	–	250	V
		during blanking	–	400	V
V_k	positive operating cut-off		–	200	V
V_k	negative		–	0	V
V_{kp}	negative peak		–	–2	V
Cathode to heater voltage					
V_{kf}	positive		–	250	V
V_{kfp}	positive peak		–	300	V
V_{kf}	negative		–	–135	V
V_{kfp}	negative peak		–	–180	V
Circuit values					
R_{g3}	grid 3 circuit resistance		–	70	MΩ
R_{g2}	grid 2 circuit resistance		–	7	MΩ
R_{g1k}	grid 1 to cathode circuit resistance (each gun)		–	750	kΩ

Notes

1. During adjustment on the production line this value is likely to be surpassed considerably. It is therefore strongly recommended to first make the necessary adjustments for normal operation without the picture tube.
2. The picture tube does not emit X-radiation above 1 μSv/h when operated at 31.0 kV and 1.5 mA.
3. Operation of the tube at lower voltages impairs the luminance and resolution and may impair the convergence.
4. This value is an absolute maximum.
5. The short-term average anode current should be limited by circuitry to 1500 μA.
6. During adjustment on the production line maximum 1500 V is permitted.
7. For maximum cathode life and optimum performance it is recommended that the heater supply is designed for 6.15 V at average beam current, for most applications this equals 6.3 V at zero beam current. **The heater supply source impedance must not be less than 2 Ω.**

4.4 Beam centring

Maximum centring error is 4 mm in any direction after colour purity, static convergence and horizontal centre line correction (measured with deflection coils at nominal position).

4.5 Flashover protection

The high voltages used with this tube (absolute max. 31.0 kV) may produce internal flashovers. Soft-flash technology limits these flashover currents to approximately 60 A offering higher reliability, optimum circuit protection and component savings.

Primary protective circuitry using properly grounded spark gaps and series isolation resistors (preferably carbon composition) is still necessary to prevent tube damage. The spark gaps should be connected to all picture tube electrodes (except the tube heaters) at the tube socket in accordance with Fig.24. No other connections between the outer conductive coating and the chassis are permissible. The spark gaps should be designed for a maximum breakdown voltage at the focus electrode (g_3) of approximately 11.5 kV ($1.5 \times V_{g3}$ max. at $V_{a,g4}$ = 27.5 kV) and at the other electrodes of 1.5 to 2 kV at the lowest operating atmospheric pressure.

The values of the series isolation resisters should be as high as possible (min. 1.5 kΩ) without causing deterioration of circuit performance. The resistors should be able to withstand an instantaneous surge of 20 kV for the focus circuit and 12 kV for the remaining circuits without arcing.

Additional information is available on request.

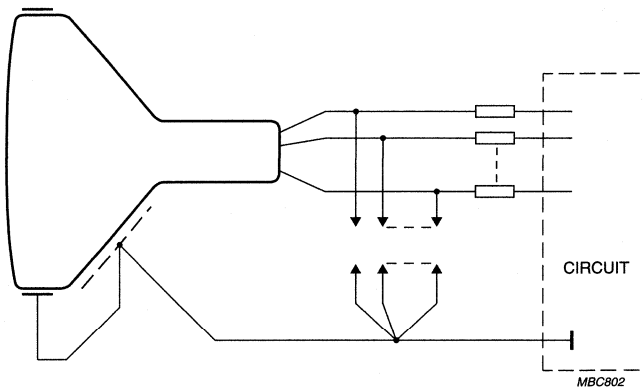


Fig.24 Flashover protection circuit.

4.6 Degaussing

The monitor tube is provided with an internal magnetic shield. This shield and the shadow mask with its suspension system may be provided with an automatic degaussing system, consisting of a coil mounted on the cone of the monitor tube as shown in Fig.26.

For proper degaussing an initial magnetomotive force (MMF) of 400 ampere-turns is required in the double shaped coil system (total 1600 ampere-turns peak-to-peak value). This MMF has to be gradually decreased (maximum 30% per half period) by appropriate circuitry. To prevent beam landing disturbance by horizontal frequency currents induced in the degaussing coils, these coils should be shunted by a capacitor of sufficiently high value. In steady state, no significant MMF should remain in the coils (≤0.6 ampere-turns).

If single-phase power rectification is employed in the monitor circuitry, provision should be included to prevent asymmetric distortion of the AC voltage applied to the degaussing circuit due to high DC inrush currents. Incomplete degaussing may result in some out-of-specification characteristics.

Degaussing coil data

PARAMETER	115 V (AC) MAINS	220 V (AC) MAINS	UNIT
Circumference	120	120	cm
Number of turns	65	65	
Copper wire diameter	0.55	0.55	mm
Resistance	7.5(1)	7.5(1)	Ω
Catalogue number of an appropriate dual PTC thermistor	Murata PT451C147	Philips 2322 662 96009	

Note

1. T_{amb} = 25 °C.

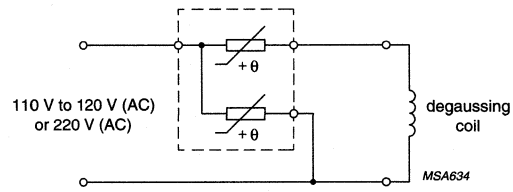
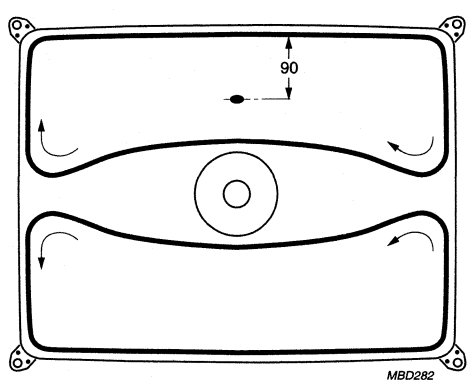


Fig.25 Degaussing circuit using dual PTC thermistor.



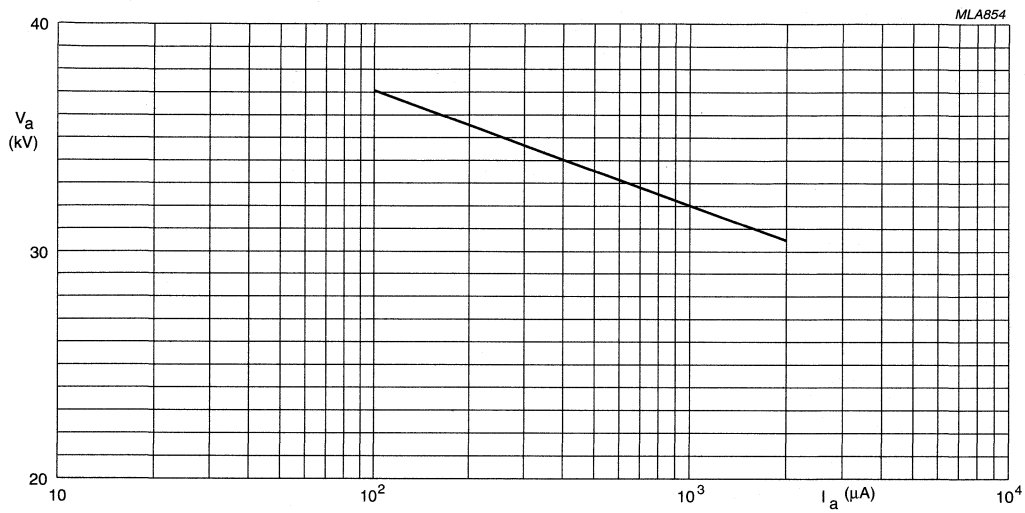
Dimensions in mm.
Length of the double shaped coil is 120 cm.

Fig.26 Position of the double degaussing coils on the monitor tube.

5 ERGONOMIC AND ENVIRONMENTAL DATA

5.1 X-radiation

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



The X-radiation emitted will also not exceed 1 μSv/h for anode voltage and current combinations shown in the iso-exposure-rate limit curve.

Fig.27 1 μSv/h iso-exposure-rate limit curve.

WARNING
The cathode ray tube is intrinsically safe in accordance with *"Appendix III Röntgenverordnung"*. Eigensichere Kathodenstrahlröhre nach *"Anlage III Röntgenverordnung"*.

5.2 Warnings

X-radiation
Operation of the colour monitor tube under abnormal conditions that exceed the 1 μSv/h iso-exposure-rate limit curve shown in Fig.27 may produce soft X-rays, which may constitute a health hazard on prolonged exposure at close range unless adequate external screening is provided. Precautions must therefore be exercised during servicing of monitors using this tube to ensure that the anode voltage and other tube voltages are adjusted to the recommended values so that the values stated in Section 4.3 are not exceeded.
Tube replacement
This monitor tube incorporates integral X-radiation and implosion protection and must be replaced with a tube of the same type number or recommended replacement to assure continued safety.
Shock hazard
The high voltage at which the tube is operated may be very dangerous. The monitor should include safeguards to prevent the user from coming in contact with the high voltage. Extreme care should be taken in servicing or adjustment of any high-voltage circuit. Caution must be taken during replacement or servicing of the monitor tube since a residual electrical charge may be held by the high-voltage capacitor formed by the external and internal conductive coatings of the monitor tube funnel. To remove any residual charge, short the anode contact button, located in the funnel of the tube, to the external conductive coating before handling the tube. Discharging the high voltage to isolated metal parts such as cabinets and control brackets may produce a shock hazard.

5.3 Handling

The packaging provides protection against tube damage under normal conditions of shipment or handling. Observe any instructions given on the packaging and handle accordingly. Under no circumstances should the tube assembly be subjected to accelerations greater than the values given in Table "Accelerations".

Accelerations

PARAMETER	PULSE DURATION	MAX.	UNIT
Acceleration in cone direction	≤10 ms	350	m/s^2
	30 ms	200	m/s^2
Acceleration in all other directions	30 ms	350	m/s^2

Monitor tubes should be kept in the shipping box or similar protective container prior to installation.

Although monitor tubes are provided with integral implosion protection which meets the intrinsic safety requirements stipulated in the relevant part of *"IEC 65"*, care should be taken not to scratch or knock any part of the tube. Particularly care should be taken to prevent damage to the seal area.

In all handling procedures prior to insertion in the cabinet, there is a risk of personal injury if severe accidental damage to the tube occurs. It is therefore recommended that in areas containing unpacked and unprotected tubes, protective clothing is worn, particularly, gloves and safety glasses with side-shields to prevent possible injury from flying glass in the event of such an accident.
Handle the tube with extreme care. Do not strike, scratch or subject the tube to more than moderate pressure.

The tube assembly should never be handled by the tube neck, deflection unit or other neck components.

If suspending the tube assembly from the mounting lugs, ensure that a **minimum of two** are used.
Under no circumstances suspend the tube assembly from one lug.

An alternative lifting method is to firmly grasp the assembly by the vertical sides of the rimband. Manually lifting the assembly from the face-down or face-up position is shown in Figs 28 and 29.

To protect the screen when placing the tube face-down, ensure that the tube face rests on a cushion kept free from abrasive substances.

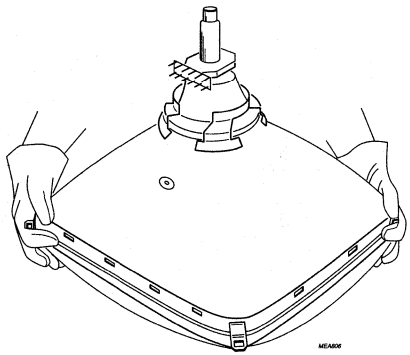


Fig.28 Lifting tube from face-down position.

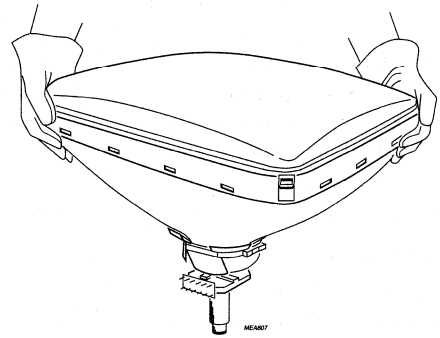


Fig.29 Lifting tube from face-up position.

5.4 Environmental conditions

The tube assembly must be capable of meeting the requirements of this specification under/after the following environmental conditions.

5.4.1 AMBIENT TEMPERATURE

- Tube operating +10 °C to +53 °C
- Storage and shipment –20 °C to +60 °C with a thermal shock up to 24 °C
- 50% relative humidity at either limit with the tube assembly inside the shipping container.

5.4.2 RELATIVE HUMIDITY

- Operating 8% to 80%
- Storage and shipment 5% to 100% (including condensation, but excluding rain).

5.4.3 BAROMETRIC PRESSURE

- Operating and storage 769 hPa to 1060 hPa
- Shipment 91 hPa to 1060 hPa.

5.4.4 WET BULB TEMPERATURE

- Operating maximum 26.7 °C
- Storage and shipment 29.4 °C.

'Black Line SF' colour picture tube A68ESF032X

FEATURES

- 'Superflat' screen (R_v = 4150 mm)
- Quick-heating low-power impregnated cathodes
- DAF gun with IFL main lens, dynamic astigmatism and focus, and multi-stage prefocusing
- Cd-free phosphors
  - Pigmented deep red
  - Sulphide green
  - Pigmented sulphide blue
- BLACK MATRIX technology
- INVAR mask with corner suspension
- Soft-flash
- Slotted shadow mask optimized for minimum moiré at 525 and 625 line systems
- Internal magnetic shield
- Internal multipole
- High contrast
- High gloss, low transmission screen.

QUICK REFERENCE DATA

PARAMETER	TYP.	UNIT
Deflection angle	110	deg
Useful screen diagonal	68	cm
Overall length	43.2	cm
Glass transmission	36.5	%
Neck diameter	29.1	mm
Heater voltage	6.15	V
Heater current	315	mA
Anode voltage (full load)	29.5	kV
Focus voltage	29% of anode voltage	

Black Line SF

ELECTRICAL DATA

SYMBOL	PARAMETER	MIN.	TYP.	UNIT
Capacitances				
$C_{a(m+m')}$	anode to external conductive coating, including rimband	2000	2400	pF
$C_{am'}$	anode to metal rimband	–	300	pF
C_k	cathodes of all guns (connected in parallel) to all other electrodes	–	15	pF
C_{kR}, C_{kG}, C_{kB}	cathode of any gun to all other electrodes	–	4	pF
C_{kdiff}	differential cathode capacitance	0.5	–	pF
C_{g1}	grid 1 to all other electrodes	–	20	pF
C_{g5a}	grid 5a to all other electrodes	–	18	pF
$C_{g5(a-b)}$	grid 5a to grid 5b	–	8	pF
C_{g5ab}	grids 5a and 5b to all other electrodes	–	15	pF
C_{g5b}	grid 5b to all other electrodes	–	9	pF
Heating				
V_f	heater voltage: indirect AC (preferably mains or line frequency) or DC	–	6.15	V
I_f	heater current	–	315	mA
Resistance				
R_{rim}	resistance between rimband and external conductive coating	50	–	MΩ

ELECTRO-OPTICAL DATA

PARAMETER	VALUE
Electron gun system	unitized in-line
Focus method	electrostatic
Main lens	IFL (Integrated Focus Lens) main lens with dynamic astigmatism and focusing
Convergence method	self-converging
Deflection angles	
diagonal	110°
horizontal	97°
vertical	77°

'Black Line SF' colour picture tube A68ESF032X

OPTICAL DATA

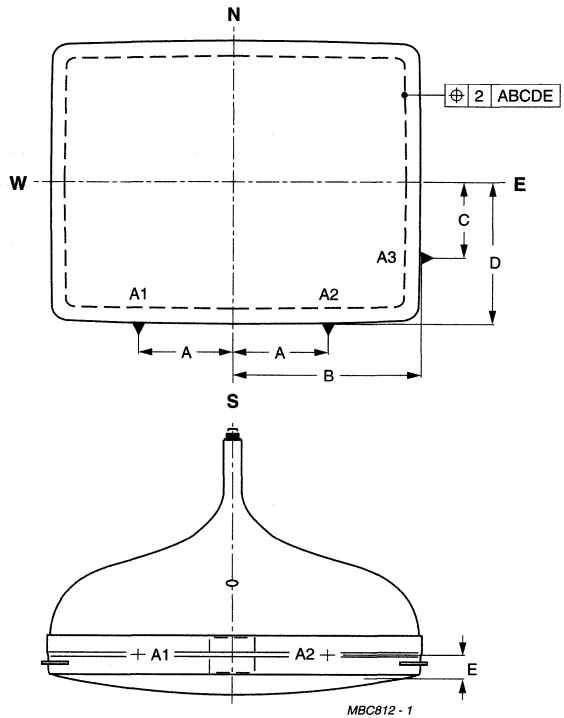
PARAMETER	VALUE
Matrix	black opaque material, PVP technology
Screen	metal-backed vertical phosphor stripes
Screen finish	high gloss
Nominal screen dimensions	
diagonal	679.6 mm
horizontal axis	545.0 mm
vertical axis	409.4 mm
area	2231 cm^2
Phosphor alignment	see Fig.1
Phosphors	
red	pigmented europium activated rare earth
green	Cd-free sulphide type
blue	pigmented sulphide type
Persistence	medium short
Centre-to-centre distance of identical colour phosphor stripes	
at screen centre	≈0.80 mm
at ends of long axis	≈0.99 mm
Light transmission of face glass at centre of screen	36.5%
Luminance at centre of screen; note 1	70 cd/m^2

Note

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

Colour coordinates

COLOUR	x	y
Red	0.630	0.330
Green	0.295	0.595
Blue	0.155	0.065



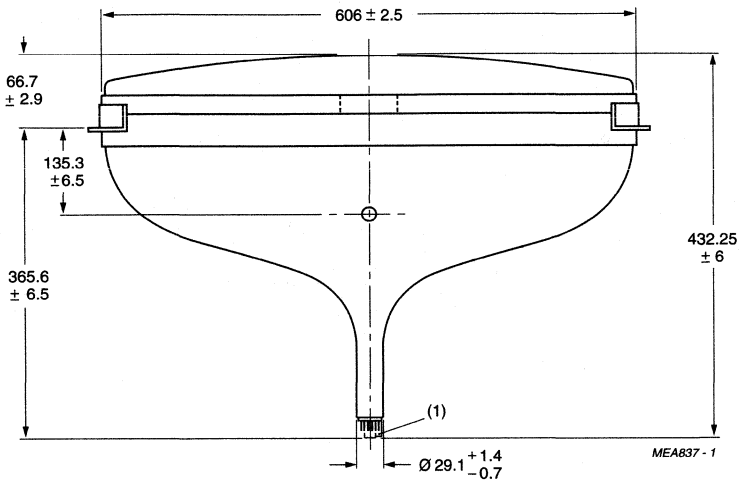
A = 204.2 mm.
B = 300.4 mm.
C = 141.0 mm.
D = 234.3 mm.
E = 28.9 mm.

Fig.1 Phosphor alignment.

MECHANICAL DATA

See Figs 2 to 12.

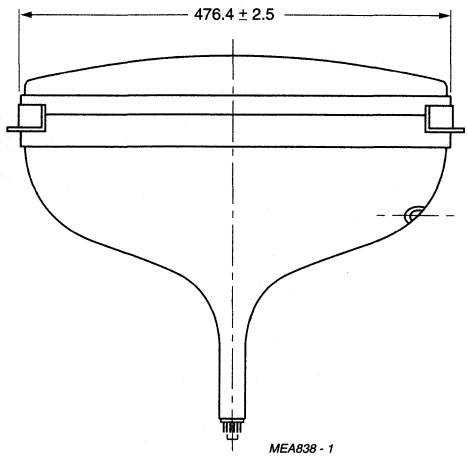
PARAMETER	VALUE
Base	JEDEC B10-304
Anode contact	small cavity contact JEDEC J1-21; IEC 67-III-2
Mounting position	anode contact on top
Implosion protection	shrunk-on rimband
Mass including deflection unit	≈31 kg



Dimensions in mm.

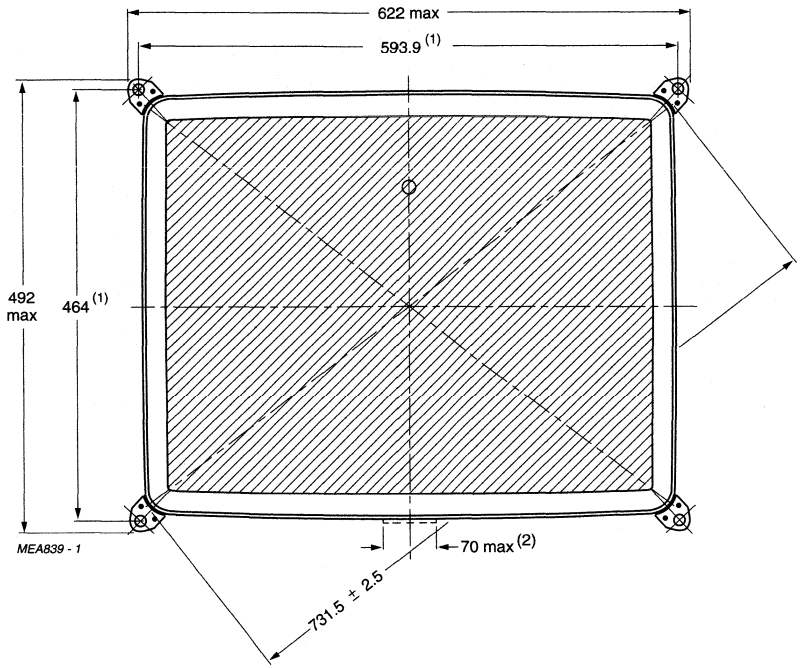
(1) The socket for this base should not be rigidly mounted; it should have flexible leads and be allowed to move freely. After mounting of the tube in the cabinet note that the position of the base can fall within a circle, having a diameter of max. 50 mm concentric with an imaginary tube axis.

Fig.2 Tube dimensions; top view.



Dimensions in mm.

Fig.3 Tube dimensions; side view.

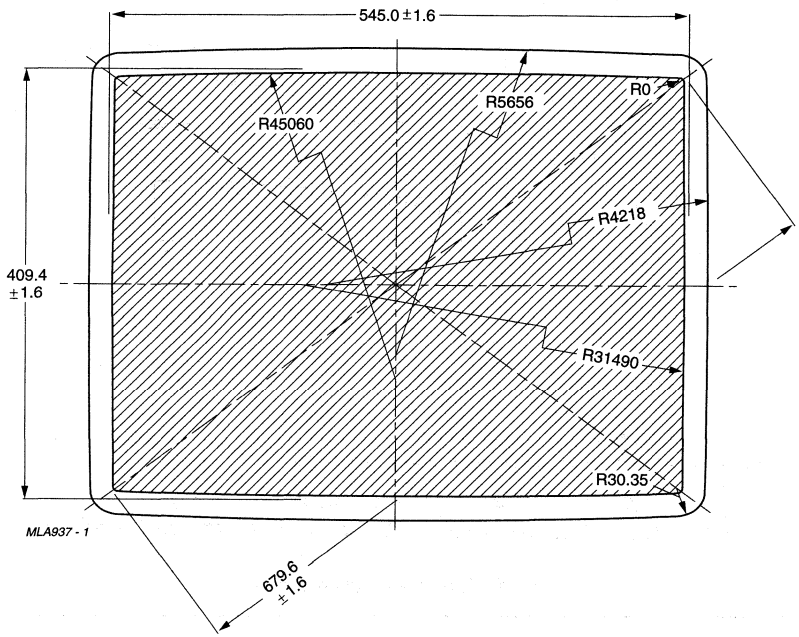


Dimensions in mm.

(1) The position of the mounting screw in the cabinet must be within a circle of 12 mm drawn around the true geometrical positions (i.e. the corners of a rectangle 593.9 × 464 mm).

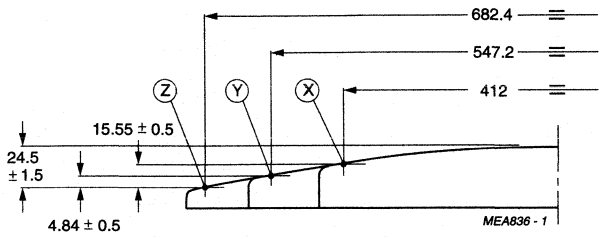
(2) Location of fishplate.

Fig.4 Tube dimensions; front view.



Dimensions in mm.

Fig.5 Phosphor and screen dimensions.



Dimensions in mm.

Coordinates of Z-point: X = 272.96, Y = 204.72.

Nominal sagittal height (mm) of the bezel with respect to the screen centre is described by:

$$Z = (2.119181 \times 10^{-4} \times X^2) + (6.750876 \times 10^{-10}) \times X^4 + (2.106018 \times 10^{-4} \times Y^2) + (-8.56111 \times 10^{-10} \times X^2 \times Y^2) + (-9.520334 \times 10^{-15} \times X^4 \times Y^2) + (7.781627 \times 10^{-15} \times X^2 \times Y^4)$$

Fig.6 Screen reference points.

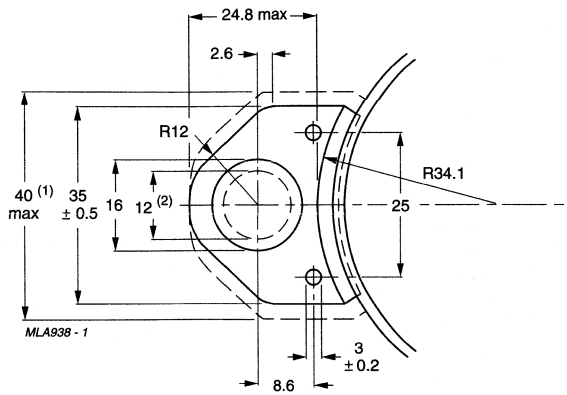
Sagittal heights

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

NOMINAL USEFUL SCREEN (NUS)			3 mm INSIDE NUS			10 mm OUTSIDE NUS		
COORDINATES		SAGITTAL HEIGHT	COORDINATES		SAGITTAL HEIGHT	COORDINATES		SAGITTAL HEIGHT
X (mm)	Y (mm)	(mm)	X (mm)	Y (mm)	(mm)	X (mm)	Y (mm)	(mm)
0.0	0.0	24.3	0.0	0.0	23.8	0.0	0.0	26.1
272.5[1]	0.0	4.8	269.5	0.0	4.8	282.5	0.0	4.9
272.5	20.0	4.8	269.5	20.0	4.8	282.5	20.0	4.9
272.5	40.0	4.7	269.5	40.0	4.6	282.5	40.0	4.8
272.4	60.0	4.5	269.4	60.0	4.5	282.4	60.0	4.6
272.4	80.0	4.2	269.4	80.0	4.2	282.4	80.0	4.4
272.3	100.0	3.9	269.3	100.0	3.8	282.3	100.0	4.1
272.3	120.0	3.4	269.3	120.0	3.3	282.3	120.0	3.7
272.2	140.0	2.8	269.2	140.0	2.7	282.2	140.0	3.1
272.1	160.0	2.1	269.1	160.0	2.0	282.1	160.0	2.5
272.0	180.0	1.2	269.0	180.0	1.1	282.0	180.0	1.7
271.9	200.0	0.2	268.9	200.0	0.1	281.9	200.0	0.8
271.8[2]	203.9	0.0	268.9	200.9	0.0	281.8	213.8	0.0
270.0	203.9	0.2	–	–	–	280.0	213.8	0.2
260.0	203.9	1.4	260.0	200.9	1.1	260.0	214.0	2.6
240.0	204.1	3.7	240.0	201.1	3.3	240.0	214.1	4.8
220.0	204.2	5.7	220.0	201.2	5.4	220.0	214.2	6.8
200.0	204.3	7.5	200.0	201.3	7.2	200.0	214.3	8.5
180.0	204.3	9.1	180.0	201.3	8.8	180.0	214.3	10.1
160.0	204.4	10.5	160.0	201.4	10.2	160.0	241.4	11.5
140.0	204.5	11.7	140.0	201.5	11.4	140.0	214.5	12.7
120.0	204.5	12.7	120.0	201.5	12.4	120.0	214.5	13.7
100.0	204.6	13.6	100.0	201.6	13.3	100.0	214.6	14.5
80.0	204.6	14.3	80.0	201.6	14.0	80.0	214.6	15.2
60.0	204.7	14.8	60.0	201.7	14.5	60.0	214.7	15.8
40.0	204.7	15.2	40.0	201.7	14.9	40.0	214.7	16.1
20.0	204.7	15.4	20.0	201.7	15.1	20.0	214.7	16.4
0.0[3]	204.7	15.5	0.0	201.7	15.2	0.0	214.7	16.4

Notes

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

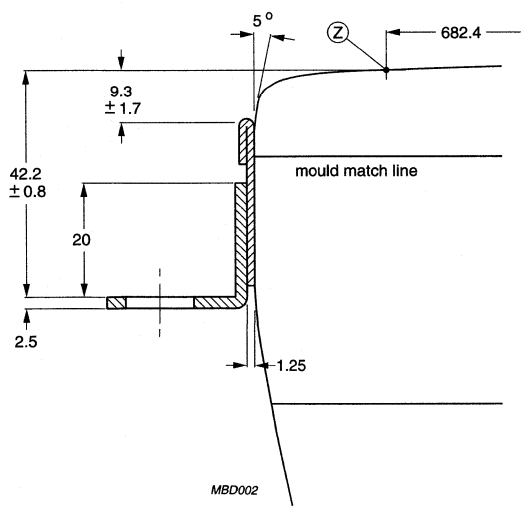


Dimensions in mm.

(1) Minimum space to be reserved for mounting lug.

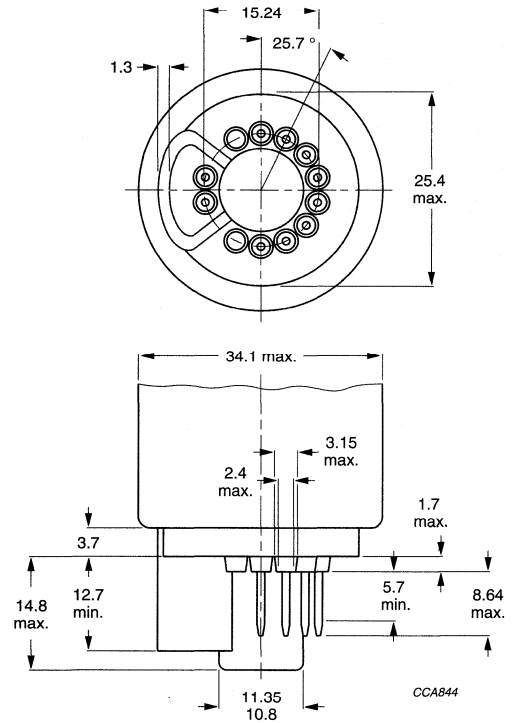
(2) The position of the mounting screw in the cabinet must be within a circle of 12 mm diameter drawn around the true geometrical positions, i.e. the corners of a rectangle of 593.9 mm × 464 mm.

Fig.7 Lug dimensions.



Dimensions in mm.

Fig.8 Lug position.



Dimensions in mm.

Fig.9 Base JEDEC B10-304.

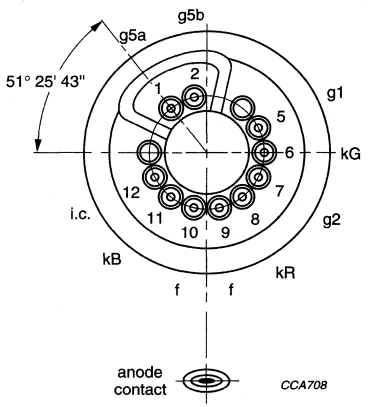


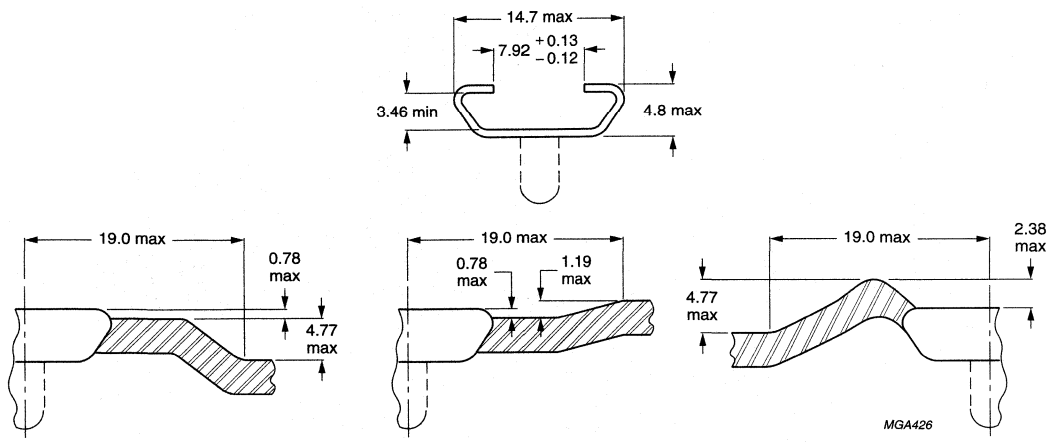
Fig.10 Pin arrangement.

Remarks: to Figs 9 and 10.

The socket for this base should not be rigidly mounted, it should have flexible leads and be allowed to move freely. After mounting the tube in the cabinet, note that the position of the base can fall within a circle, having a diameter of max. 50 mm concentric with an imaginary tube axis.

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

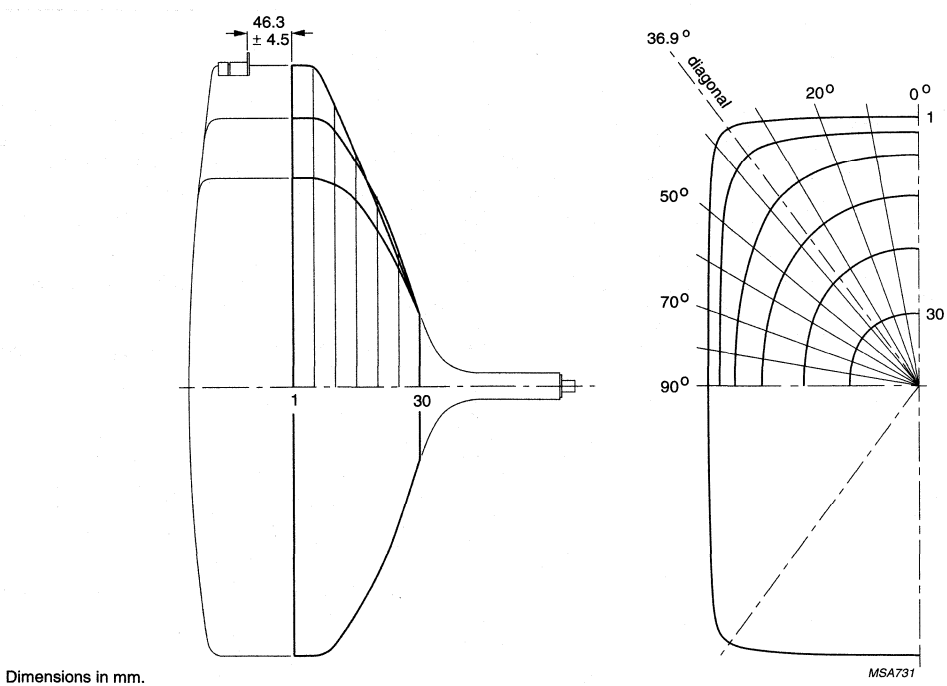
Maximum permissible torque on the tube neck is 0.04 Nm.



Dimensions in mm.

Fig.11 Cavity cap JEDEC J1-21, IEC 67-III-2.

Cone contour



Dimensions in mm.

Fig.12 Maximum cone contour.

Cone contour data

SECTION	NOMINAL DISTANCE FROM SECTION 1 (mm)	MAXIMUM DISTANCE FROM TUBE AXIS (mm)										
		0°	10°	20°	30°	36.9°	40°	50°	60°	70°	80°	90°
1	0	299.4	303.7	317.0	341.4	360.7	353.8	301.6	268.9	248.9	238.0	234.6
2	5	299.2	303.5	316.8	341.0	360.5	353.0	301.3	268.7	248.7	237.8	234.4
3	10	298.7	303.0	316.3	340.4	360.0	351.8	300.8	268.3	248.3	237.5	234.0
4	15	297.9	302.2	315.6	339.4	359.0	350.1	300.1	267.7	247.7	236.8	233.4
5	20	296.8	301.0	314.4	338.0	356.9	347.8	299.0	266.8	246.8	236.0	232.5
6	25	295.2	299.4	312.7	335.9	353.4	344.3	297.5	265.5	245.7	234.9	231.4
7	30	293.1	297.3	310.4	332.8	347.8	339.1	295.2	263.8	244.2	233.5	230.1
8	35	290.7	294.8	307.3	328.3	339.7	331.6	291.3	261.2	242.2	231.7	228.4
9	40	287.8	291.7	303.3	322.0	329.4	321.8	285.8	257.8	239.6	229.6	226.3
10	45	284.5	288.1	298.7	314.8	318.8	311.8	279.5	253.6	236.6	227.0	223.9
11	50	280.8	284.0	293.6	307.0	308.0	301.6	272.7	248.9	233.0	224.0	221.0
12	55	276.5	279.4	287.6	298.0	297.0	291.4	265.6	243.8	229.0	220.5	217.8
13	60	271.7	274.1	281.0	288.3	285.7	280.9	258.3	238.3	224.6	216.6	214.1
14	65	266.2	268.2	273.7	278.0	274.5	270.2	250.8	232.6	219.8	212.4	209.9
15	70	259.8	261.5	265.5	267.3	263.2	259.4	242.7	226.4	214.6	207.7	205.4
16	75	252.4	253.7	256.4	256.2	251.8	248.5	234.2	219.8	209.0	202.5	200.4
17	80	243.9	244.9	246.4	244.8	240.4	237.5	225.3	212.7	202.9	196.9	194.9
18	85	234.5	235.1	235.5	233.2	228.9	226.3	215.9	205.1	196.3	190.8	189.0
19	90	224.0	224.4	224.1	221.3	217.3	215.0	206.2	196.9	189.2	184.2	182.5
20	95	212.9	213.1	212.2	209.2	205.5	203.5	195.9	188.0	181.3	176.9	175.3
21	100	201.4	201.3	200.1	196.9	193.6	191.8	185.2	178.5	172.7	168.8	167.4
22	105	189.6	189.3	187.7	184.6	181.4	179.8	174.1	168.2	163.2	159.8	158.6
23	110	177.5	177.0	175.2	172.0	169.0	167.6	162.5	157.5	153.2	150.2	149.1
24	115	165.0	164.4	162.4	159.2	156.4	155.0	150.5	146.2	142.6	140.1	139.2
25	120	152.1	151.3	149.2	146.0	143.4	142.2	138.3	134.6	131.7	129.7	128.9
26	125	138.8	137.8	135.5	132.3	130.0	128.9	125.5	122.6	120.3	118.8	118.3
27	130	124.9	123.6	121.1	118.1	115.9	115.0	112.2	110.0	108.4	107.5	107.3
28	135	109.6	108.1	105.7	103.0	101.2	100.5	98.4	96.9	96.1	95.8	95.9
29	140	91.2	90.2	88.7	87.0	86.0	85.6	84.5	83.8	83.5	83.7	84.0
30	142.8	78.9	78.7	78.2	77.7	77.4	77.2	76.9	76.7	76.7	76.8	76.9

HANDLING

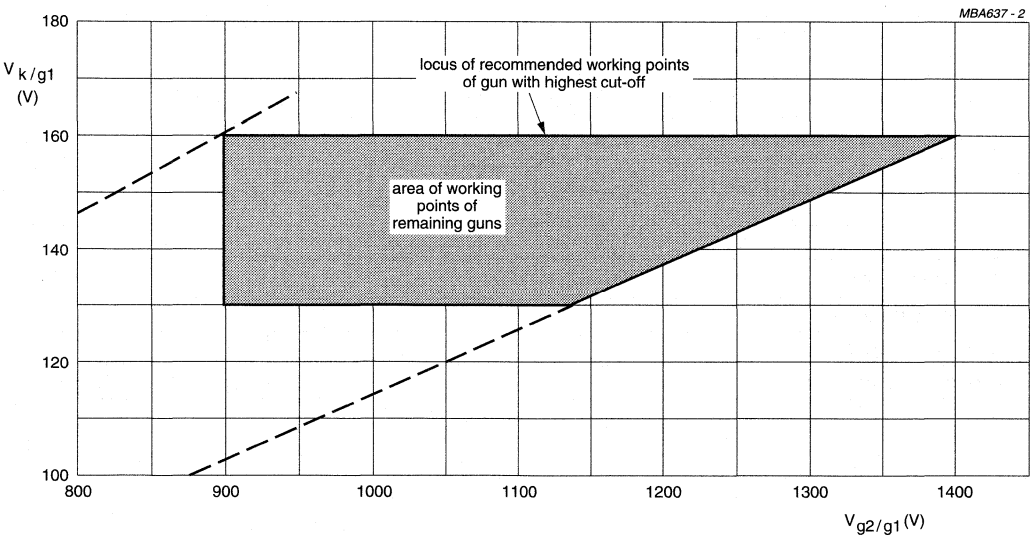
During shipment and handling the tube should not be subjected to acceleration greater than 350 m/s^2 in any direction (at pulse ≤10 ms).

TYPICAL OPERATING CONDITIONS

SYMBOL	PARAMETER	CONDITION	MIN.	TYP.	MAX.	UNIT
V_a	anode voltage	full screen load	–	29.5	–	kV
V_{g5a}	horizontal focus voltage	screen centre	7.9	–	9.1	kV
V_{g5b}	vertical focus voltage	screen centre	7.7	–	8.9	kV
$V_{g5b\ dyn}$	horizontal parabola voltage	screen edge to edge	–	1000	–	V
$V_{g5b\ dyn}$	vertical parabola voltage	screen edge to edge; note 1	–	120	–	V
V_{g2}	grid 2 voltage		see Fig.13			
V_f	heater voltage	tube operating	5.7	6.15	6.6	V

Note

1. Only required for optimization. A good focus quality can also be obtained by omitting the vertical parabola and increasing the voltage on grid 5b (V_{g5b}) by approximately 50 V.



Grid 2 voltage (V_{g2}) adjusted for highest gun spot cut-off voltage V_k = 160 V.

Remaining guns adjusted for spot cut-off by means of cathode voltage.

V_{g2} range: 900 to 1400 V.

V_k range: 130 to 160 V.

Adjustment procedure:

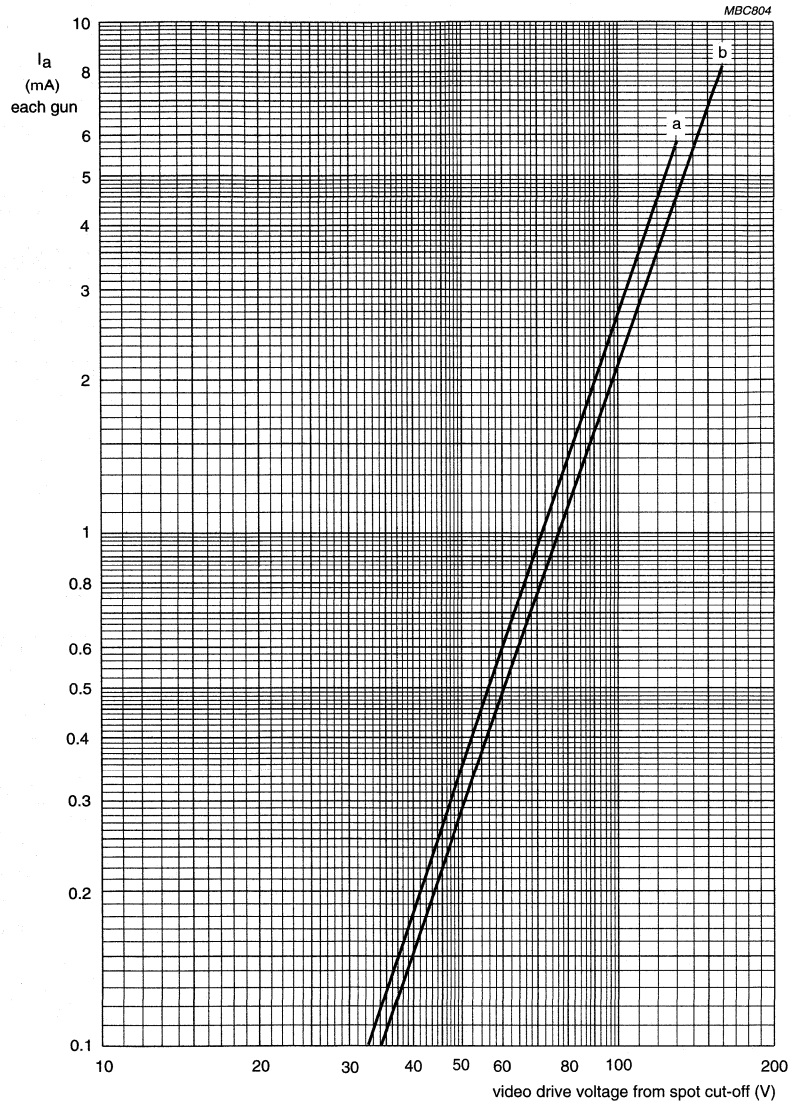
Set the cathode voltage (V_k) for each gun at 160 V; increase the grid 2 voltage (V_{g2}) from approximately 850 V to the value at which one of the colours becomes just visible. Now decrease the cathode voltage of the remaining guns so that the other colours also become visible.

Fig.13 Spot cut-off design chart.

CHASSIS DESIGN VALUES

The values are valid for anode voltages between 28 and 33 kV. The voltages are specified with respect to grid 1. For optimum picture performance it is recommended that the cathodes are not driven below +1 V.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
V_{g5a}	grid 5a focus voltage as a percentage of anode voltage		26.7	–	30.7	%
V_{g5b}	grid 5b focus voltage as a percentage of anode voltage		26.3	–	30.3	%
V_{g2}	grid 2 voltage	for visual extinction of focusing spot	see Fig.13			
V_k	cathode voltage		see Figs 13 and 14			
ΔV_k	difference in cut-off voltage in any tube		lowest value >80% of highest value			
V_f	heater voltage	tube operating	–	6.15	–	V
$I_{g5a,g5b}$	focus current		–2	–	+2	μA
I_{g2}	grid 2 current		–2	–	+2	μA
I_{g1}	grid 1 current	at cut-off	–2	–	+2	μA
I_{kf}	cathode/heater current		–2	–	+2	μA
R_{ins}	insulation resistance between each cathode and all other electrodes and heater		50	–	–	MΩ
Anode currents to produce white of 6500 K + 7 MPCD (CIE coordinates x = 0.313; y = 0.329)						
PERCENTAGE OF THE TOTAL ANODE CURRENT SUPPLIED BY EACH GUN						
	red gun		–	41.3	–	%
	green gun		–	34.4	–	%
	blue gun		–	24.3	–	%
RATIO OF ANODE CURRENTS						
	red gun to green gun		1.00	1.20	1.40	
	red gun to blue gun		1.40	1.70	2.00	
	blue gun to green gun		0.59	0.70	0.83	



V_f = 6.15 V.
V_a = 29.5 kV.
V_{g5a} and V_{g5b} adjusted for focus.
V_{g2} (each gun) adjusted to provide spot cut-off for V_k = 130 V (curve a) and V_k = 160 V (curve b).

Fig.14 Typical cathode voltage drive characteristic.

LIMITING VALUES

In accordance with the Absolute Maximum Rating System (IEC 134). Voltages are specified with respect to grid 1.

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_a	anode voltage	notes 1 and 2	25	36	kV
I_a	long-term average anode current for three guns		–	1300	μA
	short-term average anode current for three guns		–	1800	μA
$V_{g5a/g5b}$	focus voltage	note 3	–	12	kV
$\Delta V_{g5a-g5b}$	differential focus voltage		–	3	kV
V_{g2}	grid 2 voltage		–	1800	V
V_f	heater voltage	note 4	5.7	6.6	V
Cathode voltage					
V_{kp}	positive peak		–	250	V
V_k	during switch-off		–	250	V
V_k	positive operating cut-off		–	180	V
V_k	negative		–	0	V
V_{kp}	negative peak		–	–2	V
Cathode to heater voltage					
V_{kfZ}	positive		–	250	V
V_{kfp}	positive peak		–	300	V
V_{kf}	negative		–	0	V
V_{kfp}	negative peak		–	–50	V
Circuit limiting values					
R_{g5a}, R_{g5b}	grid 5a, grid 5b circuit resistance		–	70	MΩ
R_{g2}	grid 2 circuit resistance		–	7	MΩ
R_{g1-k}	grid 1 to cathode circuit resistance		–	750	kΩ

Notes

1. During adjustment on the production line this value is likely to be surpassed considerably. It is therefore strongly recommended to first make the necessary adjustments for normal operation without the picture tube.
2. Operation of the tube at lower voltages impairs the luminance and resolution and could impair convergence.
3. During flash-over maximum 20 kV is allowed.
4. For maximum cathode life and optimum performance it is recommended that the heater supply is designed for 6.15 V at average beam current, for most applications this equals 6.3 V at zero beam current. **The heater supply source impedance must not be less than 2 Ω.**

BEAM CENTRING

Maximum centring error in any direction is 4 mm.

FLASHOVER PROTECTION

With the high voltage used with this tube (max. 34 kV) internal flashovers may occur. As a result of Soft-flash technology these flashover currents are limited to approximately 60 A offering higher reliability, optimum circuit protection and component savings.

Primary protective circuitry using properly grounded spark gaps and series isolation resistors (preferably carbon composition) is still necessary to prevent tube damage.

The spark gaps should be connected to all picture tube electrodes at the socket in accordance with Fig.15; they are not required on the heater pins. No other connections between the outer conductive coating and the chassis are permissible. The spark gaps should be designed for a breakdown voltage at the focus electrode (g3) of approximately 19 to 20 kV and at the other electrodes of 2 kV at the lowest operating atmospheric pressure.

The values of the series isolation resistors should be as high as possible (min. 0.5 kΩ) without causing deterioration of the circuit performance. The resistors should be able to withstand an instantaneous surge of 20 kV for the focusing circuit and 12 kV for the remaining circuits without arcing.

To guarantee the soft flash behaviour, the internal dynamic resistance of the tube during flashover is a minimum 400 Ω and a maximum 800 Ω.

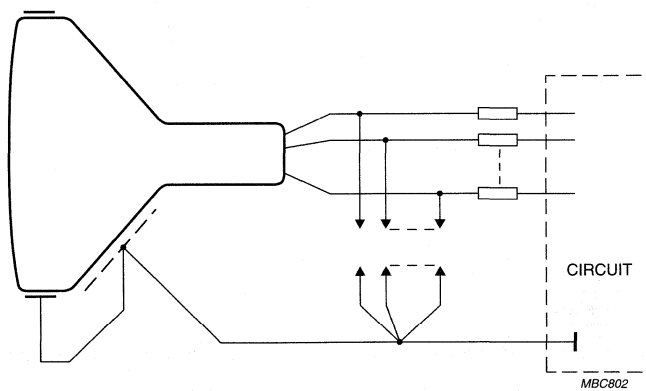
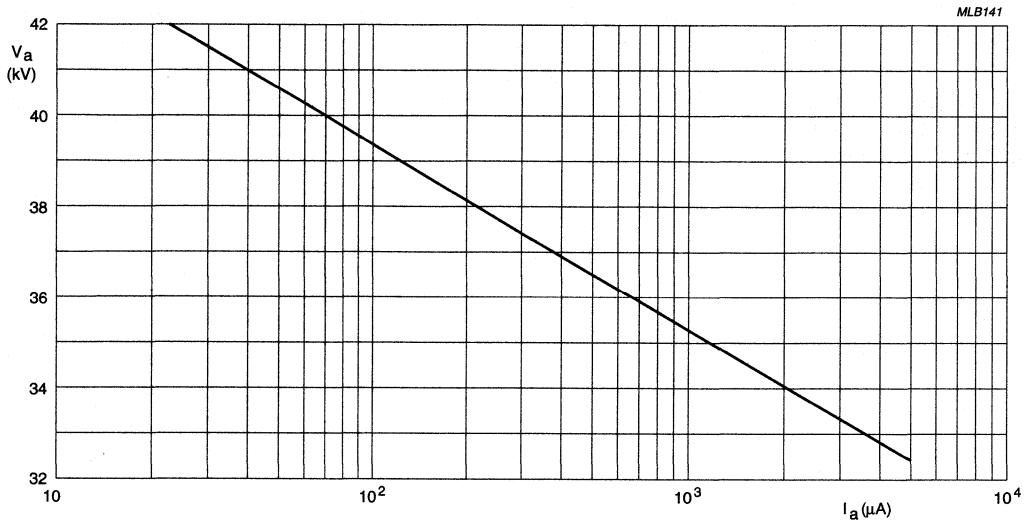


Fig.15 Flashover protection circuit.

X-RADIATION

The tube does not emit X-radiation above 1 μSv/h when operated at 34 kV and 1.8 mA.



The X-radiation emitted will also not exceed 1 μSv/h for anode voltage and current combinations shown in the iso-exposure-rate limit curve.

Fig.16 1 μSv/h iso-exposure-rate limit curve.

DEGAUSSING

The picture tube is provided with an internal magnetic shield. This shield and the shadow mask with its suspension system may be provided with an automatic degaussing system, consisting of two coil windings mounted on the cone of the picture tube.

For proper degaussing an initial magnetomotive force (MMF) of 400 ampere-turns is required in each coil. This MMF has to be gradually decreased using appropriate degaussing circuitry. In the steady state, no significant MMF should remain in the coils (≤0.15 ampere-turns).

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

If single-phase power rectification is employed in the TV circuitry, provision should be included to prevent asymmetric distortion of the AC voltage applied to the degaussing circuit due to high DC inrush currents.

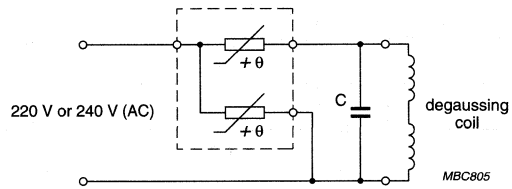
In principle, degaussing should be carried out during the 'off' scanning period (especially, the vertical scanning should be 'off'). If degaussing is attempted during 'on' scanning condition, beam register of the tube may be affected.

An example of a degaussing circuit and coil data is given in Fig.17 and Table "Degaussing coil data".

To ease mounting the coils, the rimband is provided with slots.

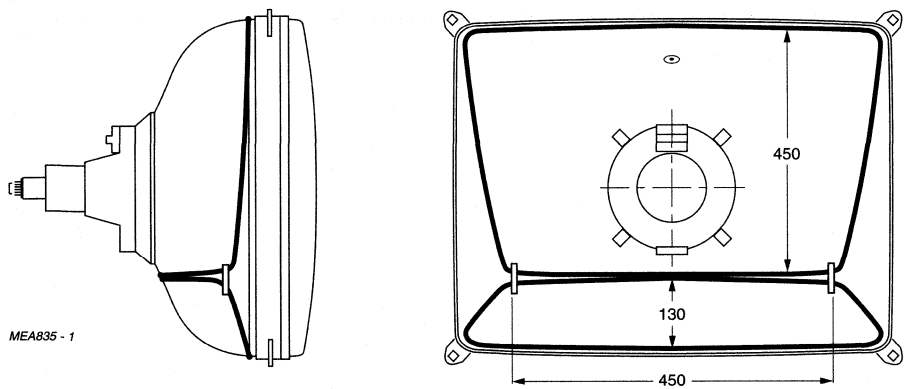
Degaussing coil data

PARAMETER	TYP.	UNIT
Circumference	325	cm
Number of turns	70	
Copper wire diameter	0.45	mm
Resistance	25	Ω



C = 220 nF.

Fig.17 Degaussing circuit using dual PTC thermistor 2322 662 96616.



Dimensions in mm.

Fig.18 Mounting of degaussing coils on the picture tube.

'Black Line SF' colour picture tube assembly

A68ESF032X043

FEATURES

- 100 Hz field repetition
- Factory preset tube/coil assembly
- Self-converging
- 68 cm, 110° colour picture tube A68ESF032X
- Double saddle deflection unit
- Scan Velocity Modulation (SVM) for improved picture sharpness.

QUICK REFERENCE DATA

PARAMETER	TYP.	UNIT
Deflection angle	110	deg
Useful screen diagonal	68	cm
Overall length	43.2	cm
Neck diameter	29.1	mm
Anode voltage	29.5	kV

'Black Line SF' colour picture tube assembly

A68ESF032X043

DEFLECTION UNIT DATA

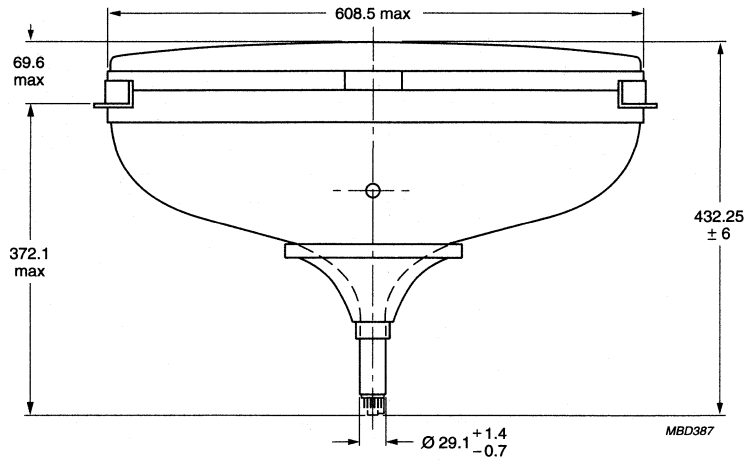
PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Horizontal coils, parallel connected					
Inductance	1 V (RMS); 1 kHz	0.297	0.309	0.321	mH
Resistance	T_{amb} = 25 °C	0.30	0.34	0.37	Ω
Magnetic flux		–	3.6	–	mWb
Deflection current (peak-to-peak value)	edge-to-edge; V_a = 29.5 kV	–	11.5	–	A
Average copper temperature	note 1	–	–	110	°C
Temperature rise (ΔT)	V_a = 29.5 kV; I_a = long term average value	–	51	–	°C
Vertical coils, series connected					
Inductance	1 V (RMS); 1 kHz	4.7	5.2	5.7	mH
Resistance	T_{amb} = 25 °C	4.52	4.86	5.20	Ω
Vertical voltage		10.1	11.0	11.9	V
Deflection current (peak-to-peak value)	edge-to-edge; V_a = 29.5 kV	–	2.27	–	A
Average copper temperature	note 1	–	–	97	°C
Temperature rise (ΔT)	V_a = 29.5 kV; I_a = long term average value	–	37	–	°C
SVM coil					
Inductance	1 V (RMS); 1 kHz	–	2.4	–	µH
Resistance	T_{amb} = 25 °C	–	0.8	–	Ω
Sensitivity in X-direction	at screen centre	–	1.2	–	mm/A
Sensitivity in X-direction	at screen edge	–	2.3	–	mm/A
Deflection unit					
Permissible DC voltage					
between horizontal and vertical coils		–	–	2000	V
between horizontal and yoke ring		–	–	2000	V
between vertical coils and yoke ring		–	–	300	V
Insulation resistance	1 kV				
between horizontal and vertical coils		500	–	–	MΩ
between horizontal coil and yoke ring		500	–	–	MΩ
between vertical coil and yoke ring		10	–	–	MΩ
Cross-talk from horizontal to vertical coils	1 V; 500 Hz applied to the horizontal deflection coils	–	–	20	mV

Note

1. Measured by the resistance method.

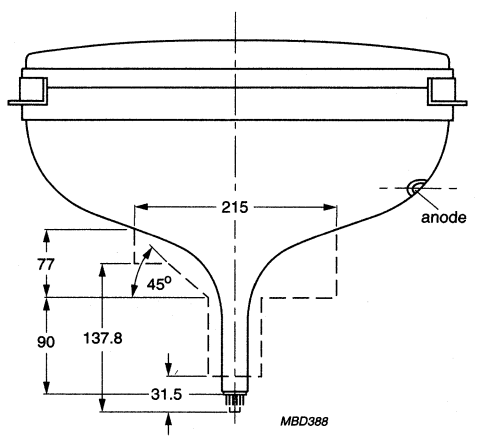
'Black Line SF' colour picture tube assembly

A68ESF032X043



Dimensions in mm.

Fig.1 Tube assembly.

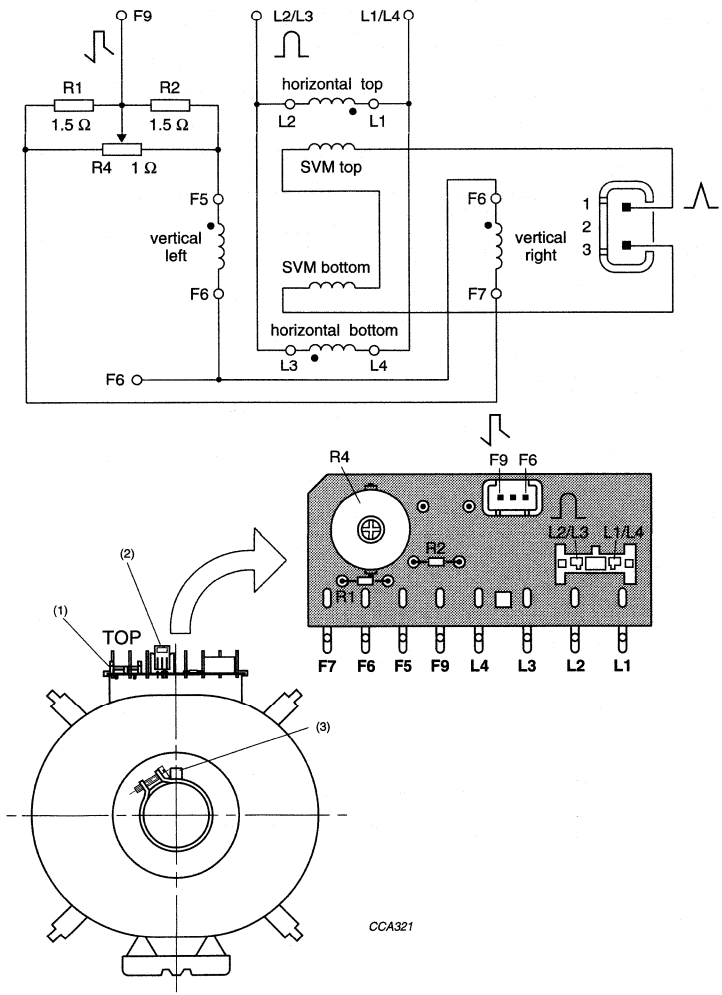


Dimensions in mm.

Fig.2 Yoke clearance.

'Black Line SF' colour picture tube assembly

A68ESF032X043



The beginning of the windings is indicated with •

(1) Horizontal connector: AMP Ultrex connection system; connector 2-173270-2; matching connector 2-173268-2.

(2) Vertical connector: Stocko system RFK1 (MKS series); matching connector MKF17033, MKF17330 or MKF17360 series.

(3) SVM connector: Stocko system RFK1 (MKS series); matching connector MKF17033, MKF17330 or MKF17360 series, actual position of this connector is on top.

Fig.3 Deflection coil connections.

'Black Line S' colour picture tube A80EFF032X

FEATURES

- 'Flatter' and 'squarer' screen
- DAF gun with IFL main lens, dynamic astigmatism and focus, and multi-stage prefocusing
- INVAR mask with corner suspension
- BLACK MATRIX technology
- Pigmented phosphors
  - Cd-free green
  - Deep red
- Quick-heating low-power impregnated cathodes
- Soft-flash
- Slotted shadow mask optimized for minimum moiré at 525 and 625 line systems
- Internal magnetic shield
- Application for northern hemisphere
- Internal multipole
- Reinforced envelope for re-entrant mounting

QUICK REFERENCE DATA

PARAMETER	TYP.	UNIT
Deflection angle	110	deg
Useful screen diagonal	80	cm
Overall length	50	cm
Glass transmission	36.7	%
Neck diameter	29.1	mm
Heater voltage	6.15	V
Heater current	315	mA
Anode voltage	27.5	kV
Focus voltage	29% of anode voltage	

Black Line S

ELECTRICAL DATA

SYMBOL	PARAMETER	MIN.	TYP.	UNIT
Capacitances				
$C_{a(m+m')}$	anode to external conductive coating, including rimband	3000	–	pF
$C_{am'}$	anode to metal rimband	–	300	pF
C_k	cathodes of all guns (connected in parallel) to all other electrodes	–	15	pF
C_{kR}, C_{kG}, C_{kB}	cathode of any gun to all other electrodes	–	5	pF
C_{kdiff}	differential cathode capacitance	0.5	–	pF
C_{g1}	grid 1 to all other electrodes	–	20	pF
C_{g5a}	grid 5a to all other electrodes	–	18	pF
$C_{g5(a-b)}$	grid 5a to grid 5b	–	8	pF
C_{g5ab}	grids 5a and 5b to all other electrodes	–	15	pF
C_{g5b}	grid 5b to all other electrodes	–	9	pF
Heating				
V_f	heater voltage: indirect AC (preferably mains or line frequency) or DC	–	6.15	V
I_f	heater current	–	315	mA
Resistance				
R_{rim}	resistance between rimband and external conductive coating	50	–	MΩ

ELECTRO-OPTICAL DATA

PARAMETER	VALUE
Electron gun system	unitized in-line
Focus method	electrostatic
Main lens	IFL (Integrated Focus Lens) main lens with dynamic astigmatism and focusing
Convergence method	self converging
Deflection angles	
diagonal	110°
horizontal	97°
vertical	77°

'Black Line S' colour picture tube A80EFF032X

OPTICAL DATA

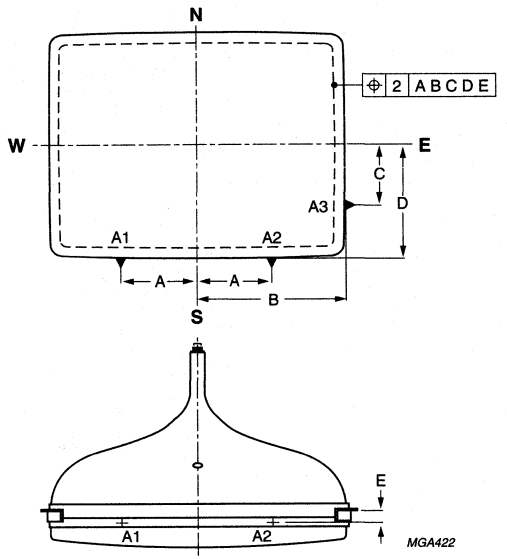
PARAMETER	VALUE
Screen	metal-backed vertical phosphor stripes; phosphor lines follow glass contour
Matrix	black opaque material, PVP technology
Screen finish	high gloss
Useful screen dimensions	
diagonal	800.9 mm
horizontal axis	647.2 mm
vertical axis	489.3 mm
area	≈3150 cm^2
Phosphor alignment	see Fig.1
Phosphors	
red	pigmented europium activated rare earth
green	Cd-free sulphide type
blue	pigmented sulphide type
Persistence	medium short
Centre-to-centre distance of identical colour phosphor stripes	≈0.9 mm
Light transmission of face glass at centre of screen	36.7%
Luminance at centre of screen; note 1	60 cd/m^2

Note

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

Colour coordinates

COLOUR	x	y
Red	0.630	0.330
Green	0.295	0.595
Blue	0.155	0.065



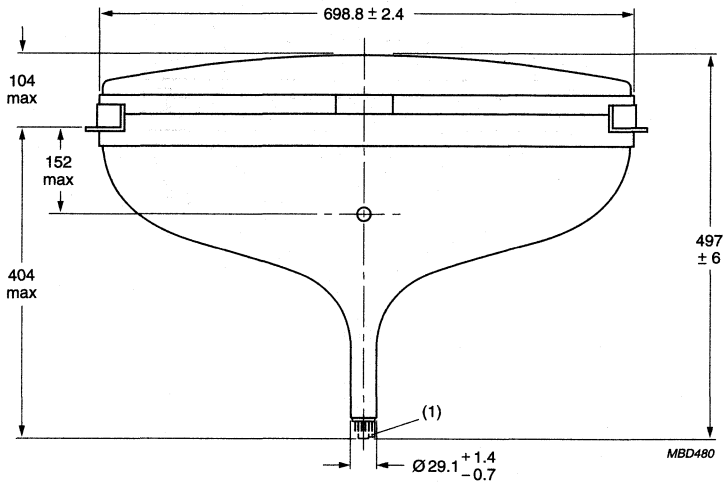
A = 256.0 mm.
B = 346.4 mm.
C = 174.0 mm.
D = 269.9 mm.
E = 24.1 mm.

Fig.1 Phosphor alignment.

MECHANICAL DATA

See Figs 2 to 12.

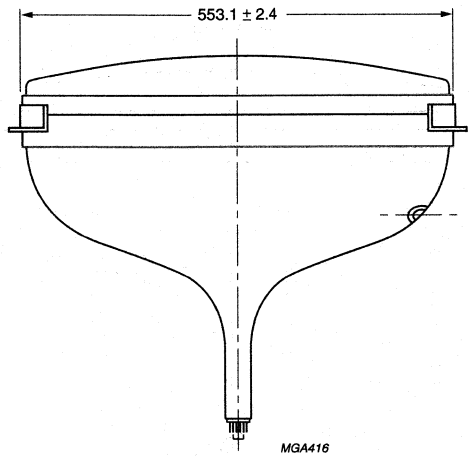
PARAMETER	VALUE
Overall length	498 ±6 mm
Neck diameter	29.1 +1.4/–0.7 mm
Base	Base JEDEC B10-301
Anode contact	small cavity contact JEDEC J1-21; IEC 67-III-2
Mounting position	anode contact on top
Implosion protection	shrunk-on rimband
Mass including deflection unit	≈40.5 kg



Dimensions in mm.

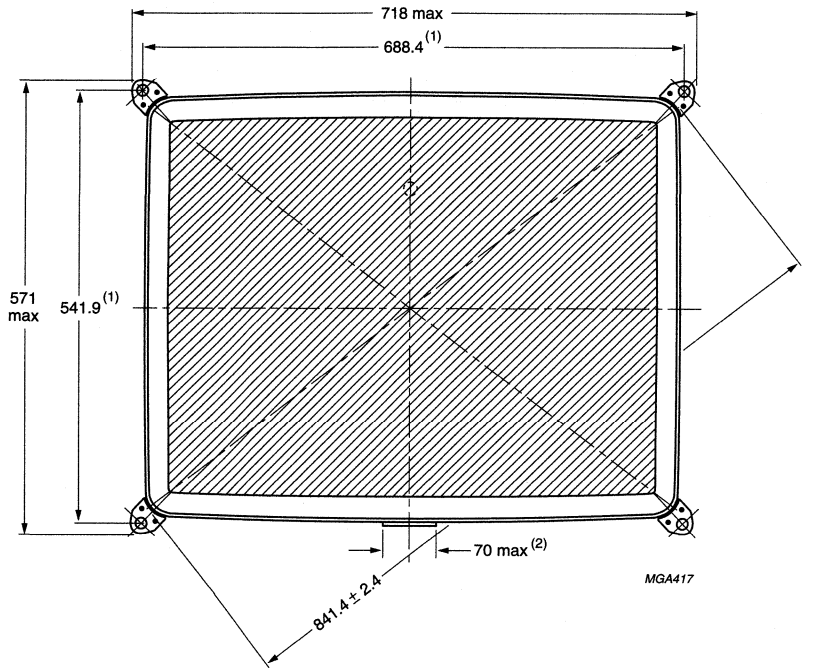
(1) The socket for this base should not be rigidly mounted; it should have flexible leads and be allowed to move freely. After mounting the tube in the cabinet, note that the position of the base can fall within a circle having a diameter of max. 55 mm concentric with an imaginary tube axis.

Fig.2 Tube dimensions; top view.



Dimensions in mm.

Fig.3 Tube dimensions; side view.

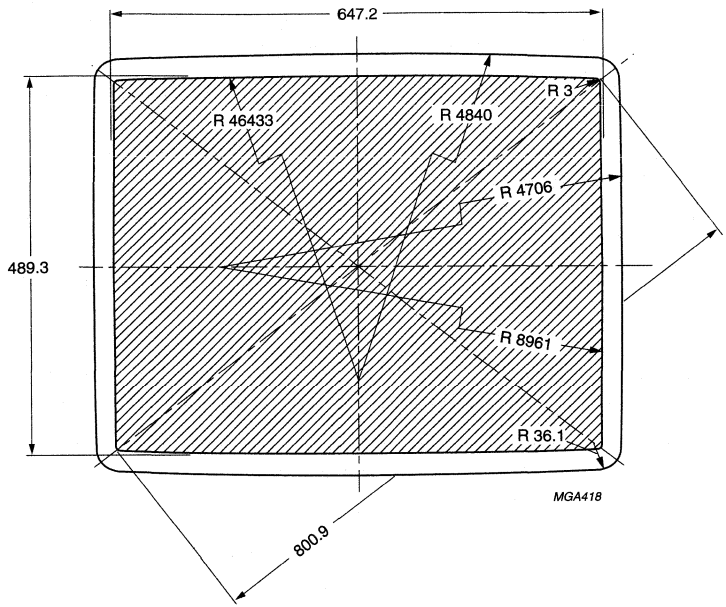


Dimensions in mm.

(1) The position of the mounting screw in the cabinet must be within a circle of 10.5 mm drawn around the true geometrical positions (i.e. the corners of a rectangle 688.4 mm × 541.9 mm).

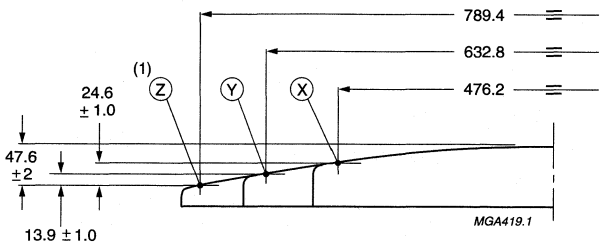
(2) Location of fishplate.

Fig.4 Tube dimensions; front view.



Dimensions in mm.

Fig.5 Phosphor and screen dimensions.



Dimensions in mm.

(1) Coordinates of Z-point: X = 315.76, Y = 236.82.

The X, Y and Z reference points are located on the outside surface of the face plate at the intersection of the minor, major and diagonal screen axis respectively, with the minimum published screen.

The distance Z from any point on the screen to the centre can be calculated using the following formula:

$$R = \sqrt{X^2 + Y^2}$$

$$A = \tan^{-1}\left(\frac{Y}{X}\right)$$

$$P = \sum_{i=0}^{5} \{B_1 \times \cos(2 \times i \times A)\}$$

$$Q = \left[\sum_{i=0}^{5} \{K_1 \times \cos(2 \times i \times A)\}\right]^{-1}$$

$$Z = \left\{\frac{\sqrt{(Q^2 + R^2)} - Q}{P}\right\}$$

$B_0 = 1.5212766$
$B_1 = 0.4812777$
$B_2 = -1.3812790$
$B_3 = -0.3712766$
$B_4 = 2.3713430 \times 10^{-6}$
$B_5 = -1.0992640 \times 10^{-6}$

$K_0 = 1.0898877 \times 10^{-3}$
$K_1 = 3.0225573 \times 10^{-4}$
$K_2 = -1.0012023 \times 10^{-3}$
$K_3 = -2.3277834 \times 10^{-4}$
$K_4 = 7.6873502 \times 10^{-6}$
$K_5 = 2.6051020 \times 10^{-6}$

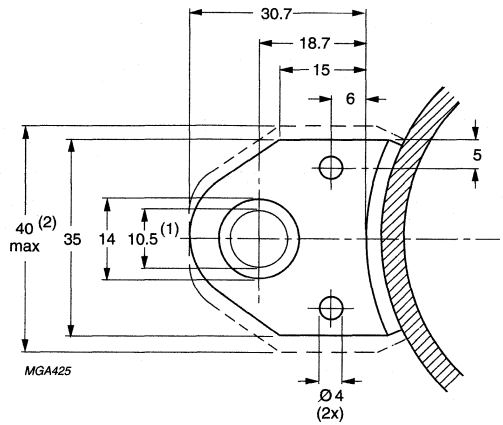
Fig.6 Screen reference points.

Sagittal heights with reference to screen centre at edge of the nominal useful screen

NOMINAL USEFUL SCREEN (NUS)			3 mm INSIDE NUS			10 mm OUTSIDE NUS		
COORDINATES		SAGITTAL HEIGHT	COORDINATES		SAGITTAL HEIGHT	COORDINATES		SAGITTAL HEIGHT
X (mm)	Y (mm)	(mm)	X (mm)	Y (mm)	(mm)	X (mm)	Y (mm)	(mm)
0.0	0.0	48.9	0.0	0.0	48.3	0.0	0.0	52.2
0.0[1]	244.5	24.7	0.0	241.5	24.7	0.0	254.5	25.9
10.0	244.5	24.7	10.0	241.5	24.7	10.0	254.5	25.9
20.0	244.5	24.6	20.0	241.5	24.6	20.0	254.5	25.9
40.0	244.4	24.4	40.0	241.4	24.3	40.0	254.4	25.6
60.0	244.4	23.9	60.0	241.4	23.9	60.0	254.4	25.1
80.0	244.4	23.2	80.0	241.4	23.2	80.0	254.4	24.5
100.0	244.4	22.3	100.0	241.4	22.3	100.0	254.4	23.6
120.0	244.3	21.2	120.0	241.3	21.2	120.0	254.3	22.5
140.0	244.3	19.9	140.0	241.3	19.9	140.0	254.3	21.2
160.0	244.2	18.5	160.0	241.2	18.4	160.0	254.2	19.8
180.0	244.1	16.9	180.0	241.1	16.8	180.0	254.1	18.2
200.0	244.0	15.1	200.0	241.0	15.0	200.0	254.0	16.4
220.0	243.9	13.1	220.0	240.9	13.0	220.0	253.9	14.5
240.0	243.8	10.9	240.0	240.8	10.8	240.0	253.8	12.4
260.0	243.7	8.5	260.0	240.7	8.3	260.0	253.7	10.1
280.0	243.6	5.8	280.0	240.6	5.7	280.0	253.6	7.5
300.0	243.5	2.9	300.0	240.5	2.7	300.0	253.5	4.7
317.3	243.4	0.2	310.0	240.4	1.2	320.0	253.4	1.6
319.7[2]	242.2	0.0	317.3	240.4	0.0	329.9	253.3	0.0
320.3	240.0	0.2	317.3	240.0	0.1	330.3	240.0	1.7
320.6	230.0	1.4	317.6	230.0	1.3	330.6	230.0	2.9
320.8	220.0	2.6	317.8	220.0	2.5	330.8	220.0	4.0
321.3	200.0	4.6	318.3	200.0	4.6	331.3	200.0	6.0
321.7	180.0	6.4	318.7	180.0	6.3	331.7	180.0	7.7
322.1	160.0	7.9	319.1	160.0	7.8	332.1	160.0	9.1
322.4	140.0	9.1	319.4	140.0	9.1	332.4	140.0	10.3
322.7	120.0	10.2	319.7	120.0	10.2	332.7	120.0	11.3
322.9	100.0	11.2	319.9	100.0	11.2	332.9	100.0	12.3
323.1	80.0	12.0	320.1	80.0	12.0	333.1	80.0	13.1
323.3	60.0	12.8	320.3	60.0	12.8	333.3	60.0	13.8
323.4	40.0	13.3	320.4	40.0	13.3	333.4	40.0	14.4
323.5	20.0	13.6	320.5	20.0	13.6	333.5	20.0	14.7
323.5	10.0	13.7	320.5	10.0	13.7	333.5	10.0	14.7
323.5[3]	0.0	13.7	320.5	0.0	13.7	333.5	0.0	14.7

Notes

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

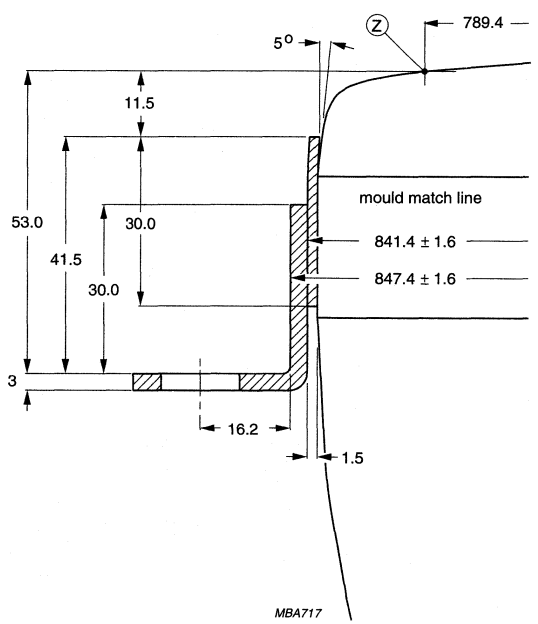


Dimensions in mm.

(1) The position of the mounting screw in the cabinet must be within a circle of 10.5 mm diameter drawn around the true geometrical positions, i.e. the corners of a rectangle of 688.4 mm × 541.9 mm.

(2) Minimum space to be reserved for mounting lug.

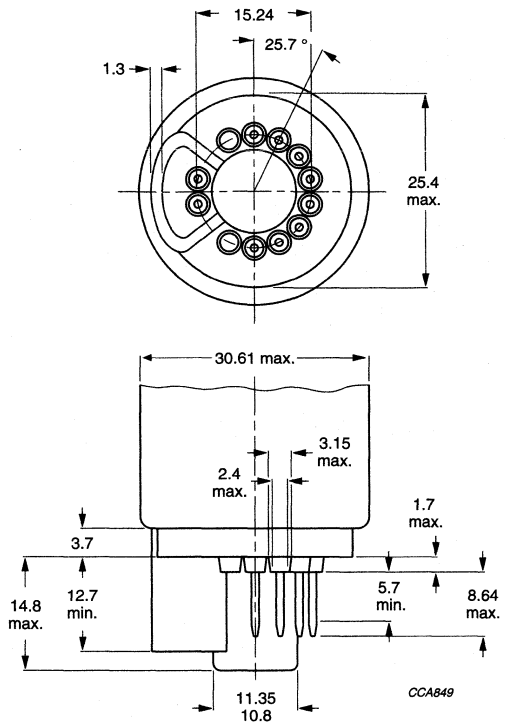
Fig.7 Lug dimensions.



Dimensions in mm.

The displacement of any lug with respect to the plane through the three other lugs is max. 1.0 mm.

Fig.8 Lug position.



Dimensions in mm.

Fig.9 Base JEDEC B10-301.

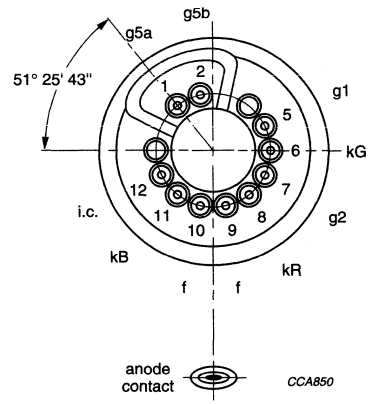


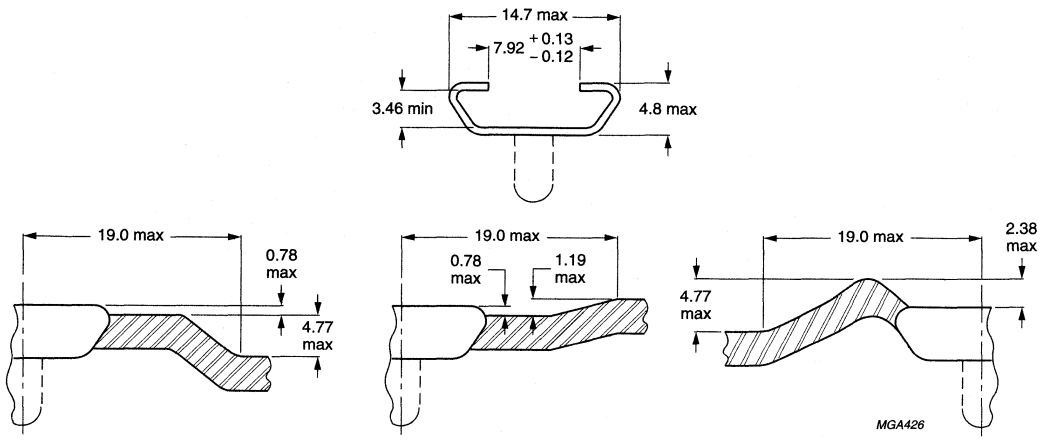
Fig.10 Pin arrangement.

Remarks: to Figs 9 and 10.

The socket for this base should not be rigidly mounted, it should have flexible leads and be allowed to move freely. After mounting the tube in the cabinet, note that the position of the base can fall within a circle, having a diameter of max. 55 mm concentric with an imaginary tube axis.

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

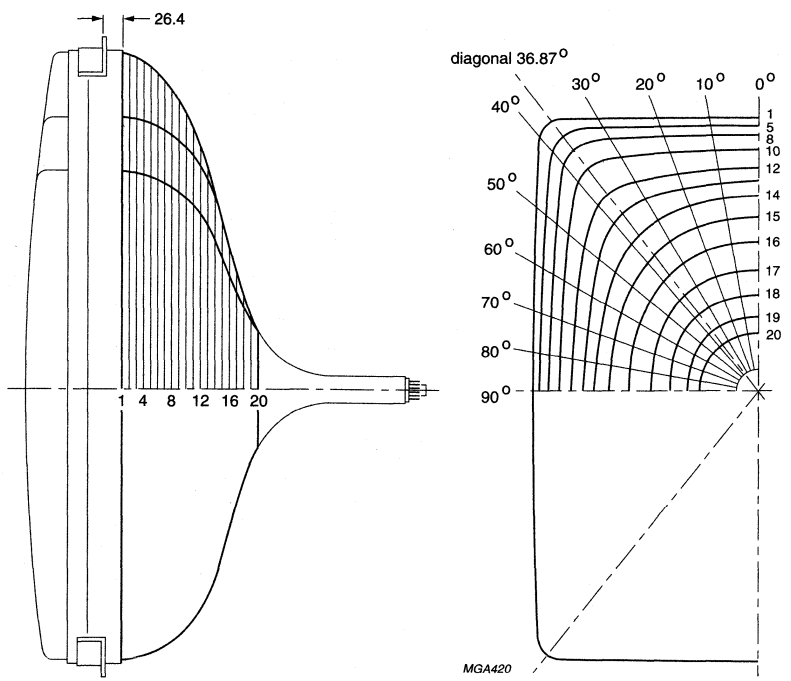
Maximum permissible torque on the tube neck is 0.04 Nm.



Dimensions in mm.

Fig.11 Cavity cap JEDEC J1-21, IEC 67-III-2.

Cone contour



Dimensions in mm.

Fig.12 Maximum cone contour.

Cone contour data

SECTION	NOMINAL DISTANCE FROM SECTION 1 (mm)	MAXIMUM DISTANCE FROM TUBE AXIS (mm)										
		0°	10°	20°	30°	36.87°	40°	50°	60°	70°	80°	90°
1	0	345.9	350.9	366.4	394.9	417.6	409.2	349.6	312.1	289.2	276.6	272.7
2	10.0	344.6	349.6	365.3	393.9	416.3	407.7	348.8	311.3	288.2	275.6	271.6
3	20.0	341.3	346.4	362.1	390.6	412.8	404.2	346.4	308.9	285.8	273.3	269.3
4	30.0	336.9	341.8	357.3	385.2	406.6	398.6	342.1	305.2	282.5	270.2	266.2
5	40.0	332.0	336.8	351.8	378.7	397.7	390.4	336.9	301.0	278.9	266.8	262.9
6	50.0	326.6	311.3	345.7	370.8	385.8	379.3	330.6	296.2	274.8	263.1	259.4
7	60.0	320.8	325.2	338.7	361.2	371.5	365.9	323.1	290.6	270.1	258.9	255.2
8	70.0	314.2	318.3	330.4	350.2	356.6	351.6	314.5	284.0	264.5	253.7	250.2
9	80.0	306.5	310.4	321.9	337.9	341.4	336.8	304.9	276.3	257.9	247.6	244.3
10	90.0	297.7	301.3	311.6	324.3	325.7	321.5	294.0	267.8	250.3	240.6	237.4
11	100.0	287.5	290.7	299.6	309.4	309.2	305.4	282.0	258.2	241.9	232.7	229.7
12	110.0	275.3	278.2	285.8	293.0	291.9	288.5	260.9	247.7	232.6	223.9	221.1
13	120.0	261.1	263.6	269.9	275.1	273.6	270.7	254.5	236.1	222.3	214.2	211.6
14	130.0	244.9	247.1	252.2	256.0	254.5	252.2	239.0	223.2	210.8	203.4	201.0
15	140.0	227.2	229.1	233.2	236.1	234.7	232.8	222.1	208.8	197.9	191.2	189.0
16	150.0	208.1	209.6	213.0	215.0	213.7	212.2	203.6	192.6	183.2	177.3	175.3
17	160.0	187.1	188.5	191.1	192.5	191.4	190.1	183.3	174.4	166.5	161.3	159.6
18	170.0	164.0	165.0	167.0	168.0	167.0	166.0	160.7	153.8	147.4	143.1	141.6
19	180.0	137.9	138.7	140.0	140.5	139.7	139.0	135.3	130.4	125.7	122.5	121.2
20	190.0	108.6	109.0	109.7	109.8	109.3	108.8	106.9	104.2	101.5	99.5	98.7
21	200.0	76.3	76.4	76.5	76.5	76.4	76.3	76.0	75.6	75.2	74.9	74.7
22	200.82	73.6	73.6	73.7	73.6	73.6	73.6	73.4	73.2	73.0	72.8	72.7

HANDLING

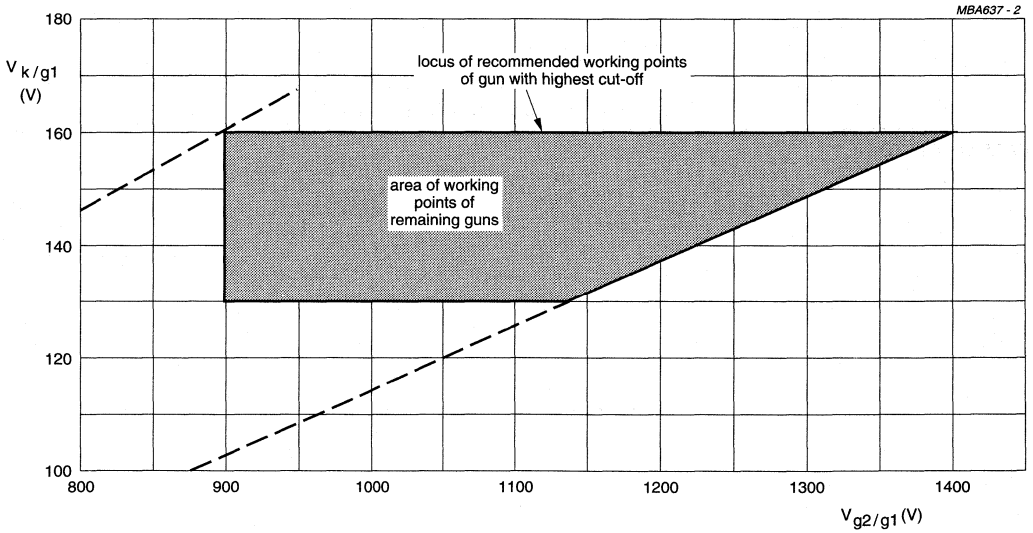
During shipment and handling the tube should not be subjected to accelerations greater than 200 m/s^2 in cone direction and 350 m/s^2 in any other direction.

TYPICAL OPERATING CONDITIONS

SYMBOL	PARAMETER	CONDITION	MIN.	TYP.	MAX.	UNIT
V_a	anode voltage	full screen load	–	27.5	–	kV
V_{g5a}	horizontal focus voltage	screen centre	7.3	–	8.4	kV
V_{g5b}	vertical focus voltage	screen centre	7.2	–	8.3	kV
$V_{g5b\ dyn}$	horizontal parabola voltage	screen edge to edge	–	1000	–	V
$V_{g5b\ dyn}$	vertical parabola voltage	screen edge to edge; note 1	–	120	–	V
V_{g2}	grid 2 voltage		see Fig.13			
V_f	heater voltage	tube operating	5.7	6.15	6.6	V

Note

1. Only required for optimization. A good focus quality can also be obtained by omitting the vertical parabola and increasing the voltage on grid 5b (V_{g5b}) by approximately 50 V.



Grid 2 voltage (V_{g2}) adjusted for highest gun spot cut-off voltage V_K = 160 V.

Remaining guns adjusted for spot cut-off by means of cathode voltage.

V_{g2} range: 900 to 1400 V.

V_K range: 130 to 160 V.

Adjustment procedure:

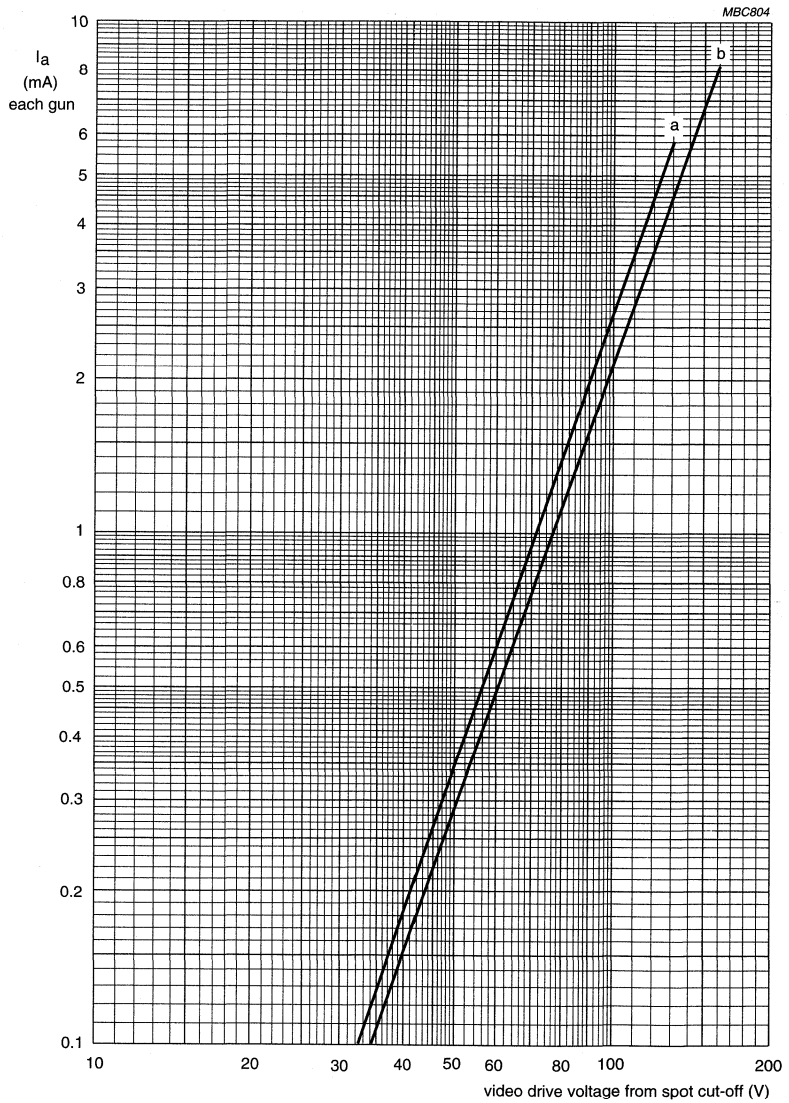
Set the cathode voltage (V_K) for each gun at 160 V; increase the grid 2 voltage (V_{g2}) from approximately 850 V to the value at which one of the colours becomes just visible. Now decrease the cathode voltage of the remaining guns so that the other colours also become visible.

Fig.13 Spot cut-off design chart.

CHASSIS DESIGN VALUES

The values are valid for anode voltages between 28 and 33 kV. The voltages are specified with respect to grid 1. For optimum picture performance it is recommended that the cathodes are not driven below +1 V.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
V_{g5a}	grid 5a focus voltage as a percentage of anode voltage		26.7	–	30.7	%
V_{g5b}	grid 5b focus voltage as a percentage of anode voltage		26.3	–	30.3	%
V_{g2}	grid 2 voltage	for visual extinction of focusing spot	see Fig.13			
V_k	cathode voltage		see Figs 13 and 14			
ΔV_k	difference in cut-off voltage in any tube		lowest value >80% of highest value			
V_f	heater voltage	tube operating	–	6.15	–	V
$I_{g5a,g5b}$	focus current		–2	–	+2	µA
I_{g2}	grid 2 current		–2	–	+2	µA
I_{g1}	grid 1 current	at cut-off	–2	–	+2	µA
I_{kf}	cathode/heater current		–2	–	+2	µA
R_{ins}	insulation resistance between each cathode and all other electrodes and heater		50	–	–	MΩ
Anode currents to produce white of 6500 K + 7 MPCD (CIE coordinates x = 0.313; y = 0.329)						
PERCENTAGE OF THE TOTAL ANODE CURRENT SUPPLIED BY EACH GUN						
	red gun		–	41.3	–	%
	green gun		–	34.4	–	%
	blue gun		–	24.3	–	%
RATIO OF ANODE CURRENTS						
	red gun to green gun		0.85	1.20	1.55	
	red gun to blue gun		1.20	1.70	2.20	
	blue gun to green gun		0.40	0.70	1.00	



V_f = 6.15 V.
V_a = 27.5 kV.
V_{g5a} and V_{g5b} adjusted for focus.
V_{g2} (each gun) adjusted to provide spot cut-off for V_k = 130 V (curve a) and V_k = 160 V (curve b).

Fig.14 Typical cathode voltage drive characteristic.

LIMITING VALUES

In accordance with the Absolute Maximum Rating System (IEC 134). Voltages are specified with respect to grid 1.

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_a	anode voltage	notes 1 and 2	25	33	kV
I_a	long-term average anode current for three guns		–	1300	μA
	short-term average anode current for three guns		–	1800	μA
$V_{g5a/g5b}$	focus voltage	note 3	–	12	kV
$\Delta V_{g5a-g5b}$	differential focus voltage		–	3	kV
V_{g2}	grid 2 voltage		–	1800	V
V_f	heater voltage	note 4	5.7	6.6	V
Cathode voltage					
V_{kp}	positive peak		–	250	V
V_k	during switch-off		–	250	V
V_k	positive operating cut-off		–	180	V
V_k	negative		–	0	V
V_{kp}	negative peak		–	–2	V
Cathode to heater voltage					
V_{kf}	positive		–	250	V
V_{kfp}	positive peak		–	300	V
V_{kf}	negative		–	0	V
V_{kfp}	negative peak		–	–50	V
Circuit limiting values					
R_{g5a}, R_{g5b}	grid 5a, grid 5b circuit resistance		–	70	MΩ
R_{g2}	grid 2 circuit resistance		–	7	MΩ
R_{g1-k}	grid 1 to cathode circuit resistance		–	750	kΩ

Notes

1. During adjustment on the production line this value is likely to be surpassed considerably. It is therefore strongly recommended to first make the necessary adjustments for normal operation without the picture tube.
2. Operation of the tube at lower voltages impairs the luminance and resolution and could impair convergence.
3. During flash-over maximum 20 kV is allowed.
4. For maximum cathode life and optimum performance it is recommended that the heater supply is designed for 6.15 V at average beam current, for most applications this equals 6.3 V at zero beam current. **The heater supply source impedance must not be less than 2 Ω.**

BEAM CENTRING

Maximum centring error in any direction is 5 mm.

FLASHOVER PROTECTION

The high voltages used with this tube (absolute max. 33.0 kV) may produce internal flashovers. Soft-flash technology limits these flashover currents to approximately 60 A offering higher reliability, optimum circuit protection and component savings.

Primary protective circuitry using properly grounded spark gaps and series isolation resistors (preferably carbon composition) is still necessary to prevent tube damage. The spark gaps should be connected to all picture tube electrodes (except the tube heaters) at the tube socket in accordance with Fig.15. No other connections between the outer conductive coating and the chassis are permissible. The spark gaps should be designed for a maximum breakdown voltage at the focus electrode (g_3) of approximately 19 to 20 kV and at the other electrodes of 1.5 to 2 kV at the lowest operating atmospheric pressure.

The values of the series isolation resisters should be as high as possible (min. 1.5 kΩ) without causing deterioration of circuit performance. The resistors should be able to withstand an instantaneous surge of 20 kV for the focus circuit and 12 kV for the remaining circuits without arcing.

Additional information is available on request.

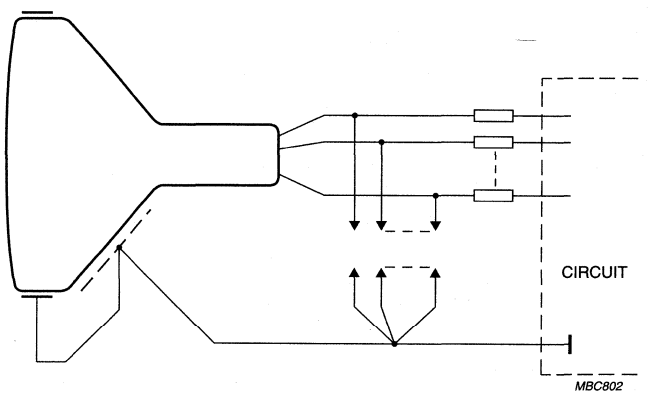


Fig.15 Flashover protection circuit.

X-RADIATION

Maximum anode voltage at which the X-radiation emitted will not exceed 0.5 mR/h at an anode current of 300 μA.

PARAMETER	VALUE
Entire tube; note 1	46 kV

Note

1. This rating applies only if the anode connector used by the set maker provides the necessary attenuation to reduce the X-radiation from the anode contact by a factor equal to the difference between the anode button iso-exposure-rate limit curve and the iso-exposure limit curve for the entire tube.

WARNING

If the value for the tube face only is used as design criteria, adequate shielding must be provided in the TV receiver for the anode contact and/or certain portions of the tube funnel and panel sidewalls to ensure that the X-radiation from the TV receiver is attenuated to a value equal to or lower than that specified for the face of the tube.

The X-radiation emitted from this picture tube, as measured in accordance with the procedure of *"JEDEC Publications No.64D"* will not exceed 0.5 mR/h throughout the useful life of the tube when operated within the design-maximum ratings.

The tube should not be operated beyond its design-maximum ratings stated above, but its X-radiation will not exceed 0.5 mR/h for anode voltage and current combinations given by the iso-exposure-rate limit characteristics as shown in Fig.16.

Operation above the values shown by the curve may result in failure of the TV receiver to comply with the *"Federal Performance Standard of the U.S. for Television Receivers, Section 1020.10 of Part 1020 of Title 21, Code of Federal Regulation (PL90-602)"* as published in *"Federal Register Volume 38, No. 198 Monday, October 15, 1973"*.

Maximum X-radiation as a function of anode voltage at 300 μA current is shown by Fig.17. X-radiation at a constant anode voltage varies linearly with anode current.

WARNING

The cathode ray tube is intrinsically safe in accordance with *"Appendix III Röntgenverordnung"*.

Eigensichere Kathodenstrahlröhre nach *"Anlage III Röntgenverordnung"*.

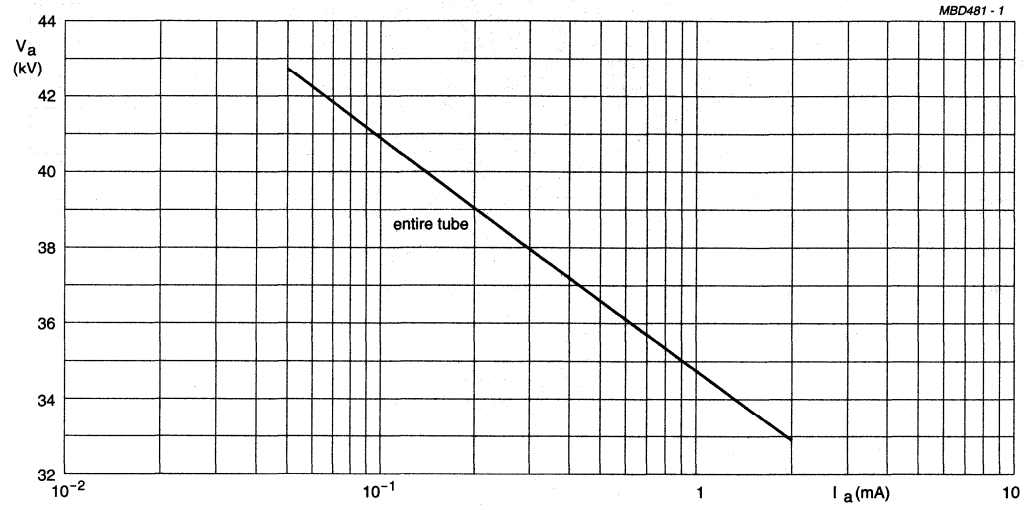


Fig.16 0.5 mR/h iso-exposure-rate limit curve.

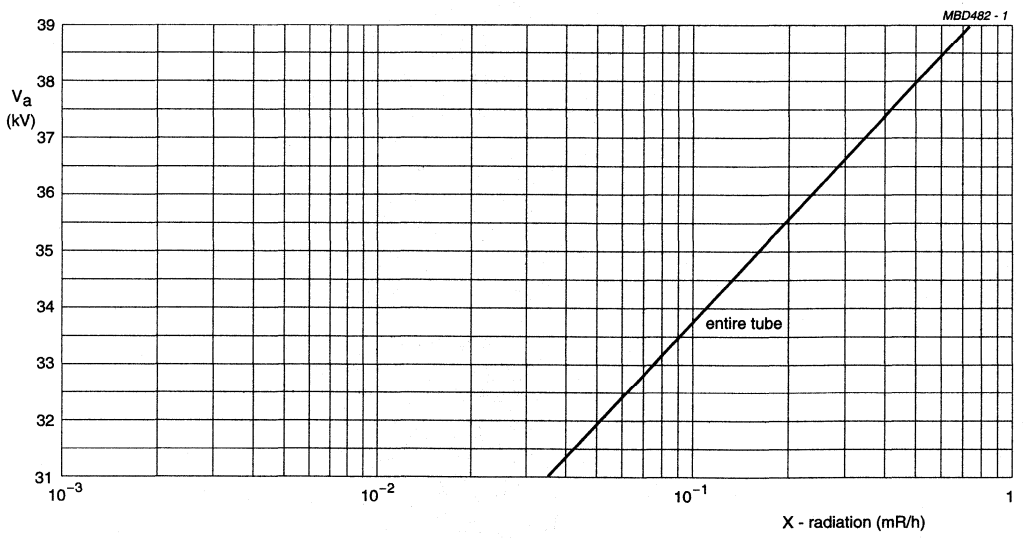
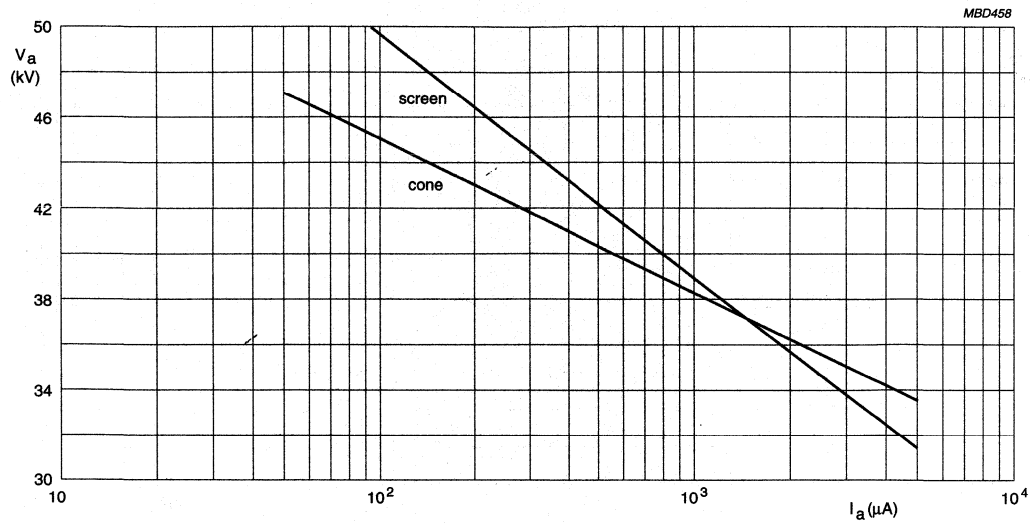


Fig.17 X-radiation limit curve at a constant anode current of 300 μA.



The tube does not emit X-radiation above 1 μSv/h when operated at 30 kV and 1.5 mA.
The X-radiation emitted will also not exceed 1 μSv/h for anode voltage and current combinations shown in the iso-exposure-rate limit curve.

Fig.18 1 μSv/h iso-exposure-rate limit curve.

DEGAUSSING

The picture tube is provided with an internal magnetic shield. This shield and the shadow mask with its suspension system may be provided with an automatic degaussing system, consisting of two coil windings mounted on the cone of the picture tube.

For proper degaussing an initial magnetomotive force (MMF) of 600 ampere-turns is required in each coil. This MMF has to be gradually decreased using appropriate degaussing circuitry. In the steady state, no significant MMF should remain in the coils (≤0.25 ampere-turns).

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

If single-phase power rectification is employed in the TV circuitry, provision should be included to prevent asymmetric distortion of the AC voltage applied to the degaussing circuit due to high DC inrush currents.

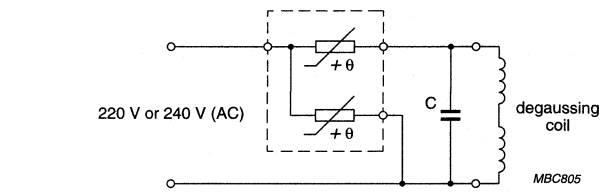
In principle, degaussing should be carried out during the 'off' scanning period (especially, the vertical scanning should be 'off'). If degaussing is attempted during 'on' scanning condition, beam register of the tube may be affected.

An example of a degaussing circuit and coil data is given in Fig.19 and Table "Degaussing coil data".

To ease mounting the coils, the rimband is provided with rectangular holes.

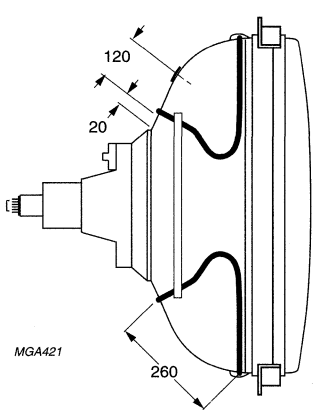
Degaussing coil data

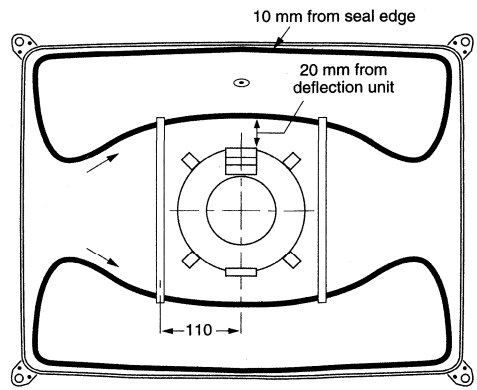
PARAMETER	TYP.	UNIT
Circumference	170	cm
Number of turns	120	
Copper wire diameter	0.63	mm
Resistance	11	Ω



C = 100 nF.

Fig.19 Degaussing circuit using dual PTC thermistor 2322 662 98009.





Dimensions in mm.

length of degaussing coil : 1.7 m

Fig.20 Position of double degaussing coils on the picture tube.

'Black Line S' colour picture tube assembly

A80EFF032X43

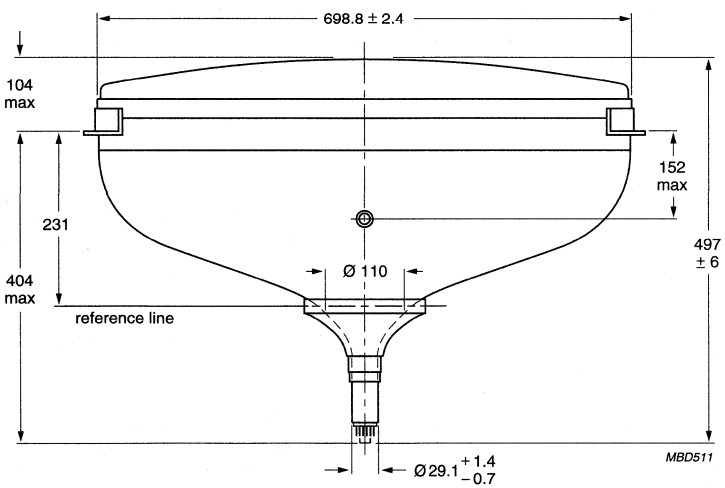
FEATURES

- 100 Hz vertical repetition
- Factory preset tube/coil assembly
- Self-converging and north-south raster correction free
- Scan Velocity Modulation (SVM) for improved picture sharpness
- 80 cm, 110° colour picture tube A80EFF032X
- Double saddle deflection unit.

QUICK REFERENCE DATA

PARAMETER	TYP.	UNIT
Deflection angle	110	deg
Minimum useful screen diagonal	80	cm
Overall length	50	cm
Glass transmission	36.7	%
Neck diameter	29.1	mm
Anode voltage	27.5	kV

MECHANICAL DATA

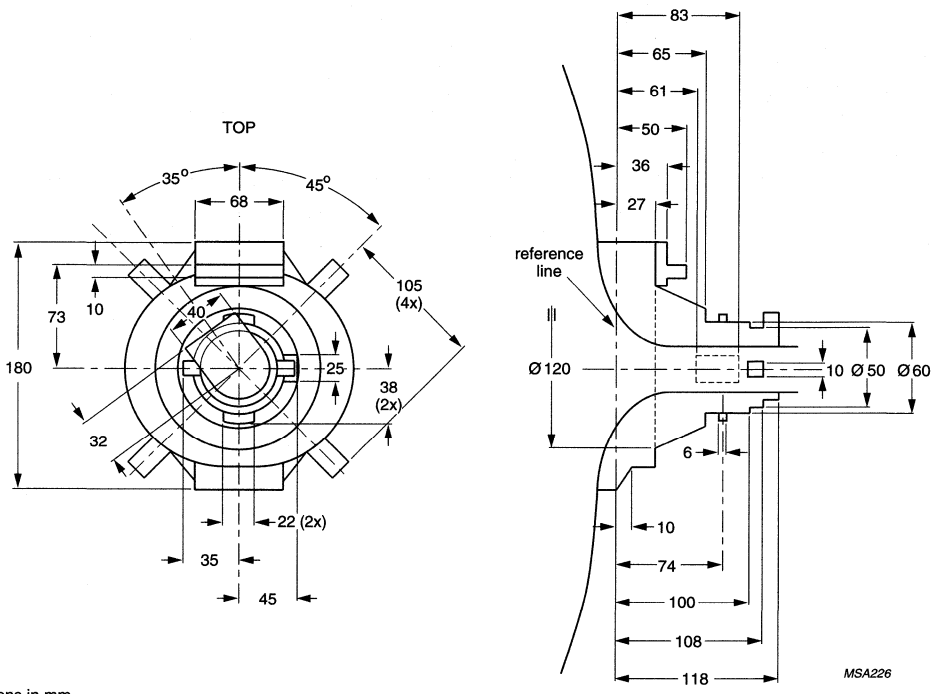


Dimensions in mm.

Fig.1 Tube assembly.

'Black Line S' colour picture tube assembly

A80EFF032X43

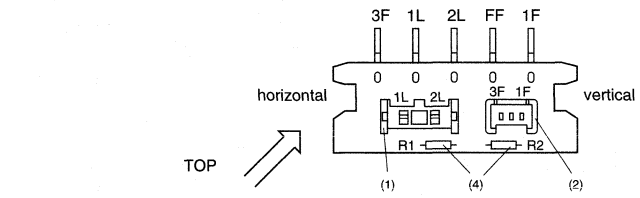


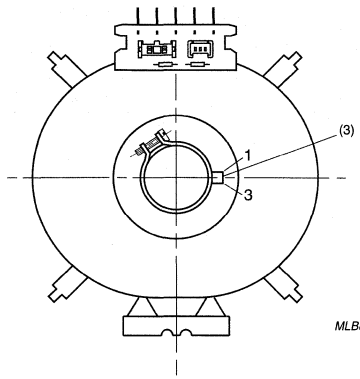
Dimensions in mm.

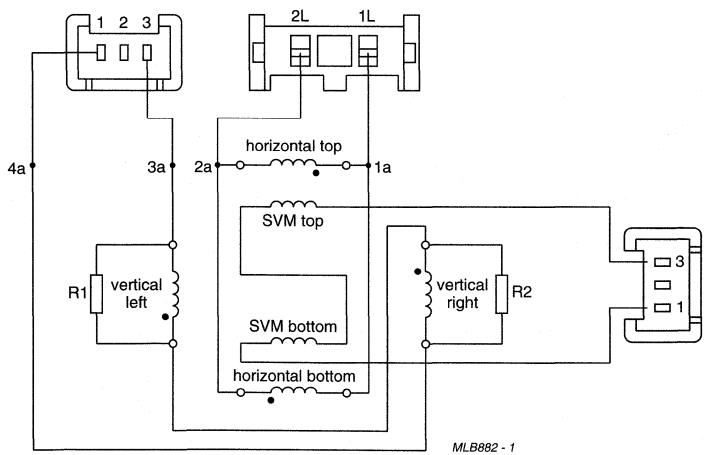
Fig.2 Yoke clearance.

DEFLECTION COIL DATA

PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Horizontal coils, parallel connected					
Inductance	1 V (RMS); 1 kHz	0.34	0.35	0.36	mH
Resistance	T_{amb} = 25 °C	0.45	0.50	0.55	Ω
Magnetic flux		3.38	3.48	3.58	mWb
Horizontal deflection current (peak-to-peak value)	edge-to-edge; V_a = 27.5 kV	–	10.0	–	A
Vertical coils, series connected					
Inductance	1 V (RMS); 1 kHz	6.03	6.70	7.37	mH
Resistance	T_{amb} = 25 °C	3.70	4.00	4.30	Ω
Vertical deflection current (peak-to-peak value)	edge-to-edge; V_a = 27.5 kV	–	2.06	–	A
SVM coils					
Inductance	1 V (RMS); 10 kHz	1.62	1.80	1.98	µH
Resistance	T_{amb} = 25 °C	0.8	1.0	1.2	Ω
Sensitivity in X-direction	at screen centre	–	2.1	–	mm/A







The beginning of the windings is indicated with •

(1) Horizontal connector: AMP Ultrex connection system; connector 2-173270-2; matching connector 2-173268-2.

(2) Vertical connector: Stocko system RFK1 (MKS series); matching connector MKF17033, MKF17330 or MKF17360 series.

(3) SVM connector: Stocko system RFK1 (MKS series); matching connector MKF17033, MKF17330 or MKF17360 series.

(4) R1 = R2 = 100 Ω, 0.25 W.

Fig.3 Deflection coil connections.

'Black Line WSF' colour picture tube

W66ESF032X

FEATURES

- 'Super flat' screen
- Screen contour F2
- New 16 : 9 screen ratio
- BLACK MATRIX technology
- High contrast
- High gloss, low transmission screen
- DAF gun with IFL main lens, dynamic astigmatism and focus, and multi-stage prefocusing
- Invar Plus mask with corner suspension
- Pigmented phosphors
  - Cd-free green
  - Deep red
- Quick-heating low-power cathodes
- Soft-flash
- Slotted shadow mask optimized for minimum moiré at 525 and 625 line systems
- Internal magnetic shield
- Worldwide application
- Internal multipole
- Rimband type mini-P
- N/S raster correction free.

QUICK REFERENCE DATA

PARAMETER	TYP.	UNIT
Deflection angle	106	deg
Nominal useful screen diagonal	66	cm
Overall length	<47.3	cm
Glass transmission	40	%
Neck diameter	32.8	mm
Heater voltage	6.15	V
Heater current	315	mA
Anode voltage	30	kV
Focus voltage	27% of anode voltage	

Black Line WSF

ELECTRICAL DATA

SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNIT
Capacitances					
$C_{a(m+m')}$	anode to external conductive coating, including rimband	2000	–	–	pF
$C_{am'}$	anode to metal rimband	–	250	–	pF
$C_{k\,(R+G+B)}$	cathodes of all guns (connected in parallel) to all other electrodes	–	–	15	pF
C_{kR}, C_{kG}, C_{kB}	cathode of any gun to all other electrodes	–	5	–	pF
C_{g1}	grid 1 to all other electrodes	–	17	–	pF
C_{g3}	grid 3 (focus electrode) to all other electrodes	–	6	–	pF
Heating, indirect by AC (preferably mains or line frequency) or DC					
V_f	heater voltage	–	6.15	–	V
I_f	heater current	–	315	–	mA
Resistance					
R_{rim}	between rimband and external conductive coating	50	–	–	MΩ

ELECTRO-OPTICAL DATA

PARAMETER	VALUE
Electron gun system	unitized in-line
Focus method	electrostatic
Main lens	IFL (Integrated Focus Lens)
Convergence method	self converging
Deflection angles	
diagonal	106°
horizontal	97°
vertical	62°

'Black Line WSF' colour picture tube

W66ESF032X

OPTICAL DATA

PARAMETER	VALUE
Screen	vertical matrix and phosphor stripes
Matrix	black opaque material; PVP technology
Screen finish	high gloss
Nominal useful screen dimensions	
diagonal	660.0 mm
horizontal axis	578.1 mm
vertical axis	326.5 mm
area	≈1880 cm^2
Phosphors	
red	pigmented europium activated rare earth
green	Cd-free sulphide type
blue	pigmented sulphide type
Persistence	medium short
Centre-to-centre distance of identical colour phosphor stripes (at screen centre)	≈0.70 mm
Light transmission of face glass at centre of screen	40%
Intrinsic luminance (L) at screen centre; at 30 kV; note 1	73.5 cd/m^2

Note

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

Colour coordinates

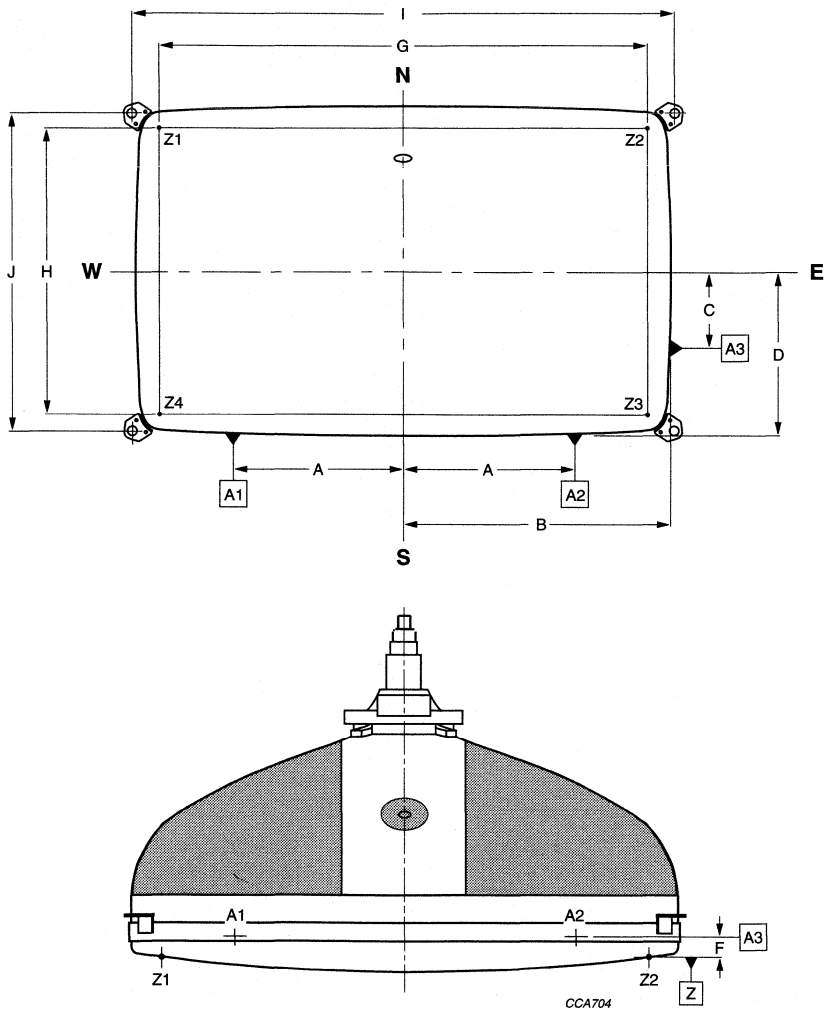
COLOUR	x	y
Red	0.630	0.330
Green	0.295	0.595
Blue	0.155	0.065

MECHANICAL DATA

PARAMETER	VALUE
Mass including deflection unit	≈24.5 kg
Base	JEDEC B10-304
Anode contact	small cavity contact; JEDEC J1-21; IEC 67-III-2
Mounting position	anode contact on top
Implosion protection	mini-P shrink system
Bulb design	
Funnel	EIA/JEDEC J-699A
Panel	EIA/JEDEC F-704B

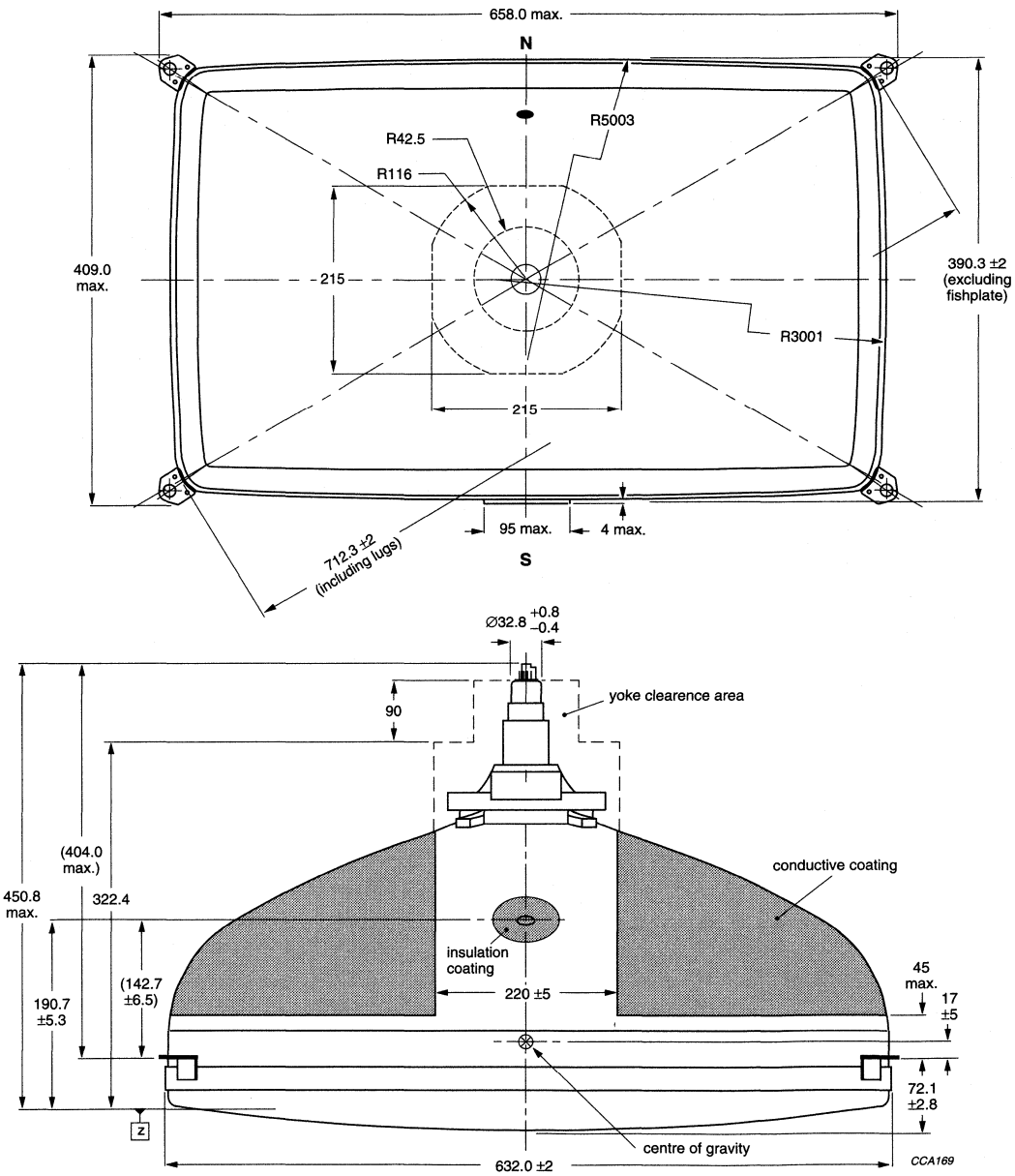
'Black Line WSF' colour picture tube

W66ESF032X



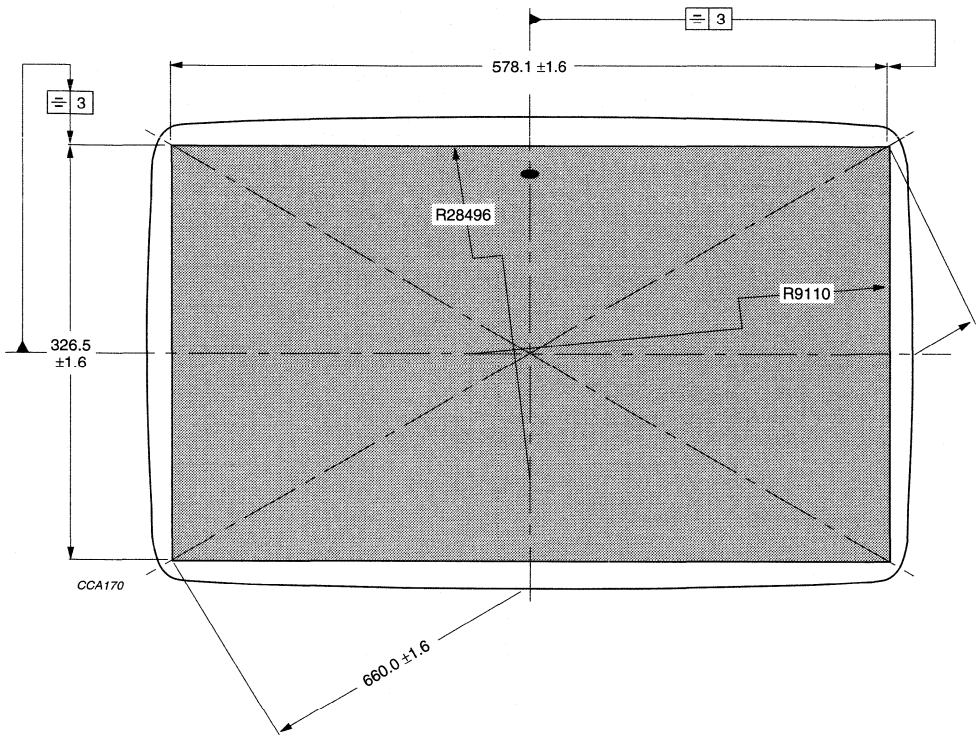
A = 235.0 mm.
B = 312.71 mm.
C = 135.0 mm.
D = 189.37 mm.
F = 30.5 mm.
G = 575.22 mm.
H = 323.6 mm.
I = 630 mm.
J = 381 mm.
Z1 and Z3 are part of plane 'Z'.
Z2 and Z4 have the same distance to 'Z' and lie at the same side of plane 'Z'.

Fig.1 Mechanical reference points.



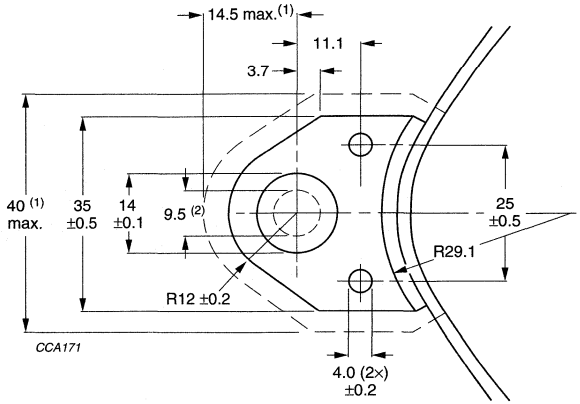
Dimensions in mm.

Fig.2 Tube dimensions.



Dimensions in mm.

Fig.3 Phosphor dimensions.

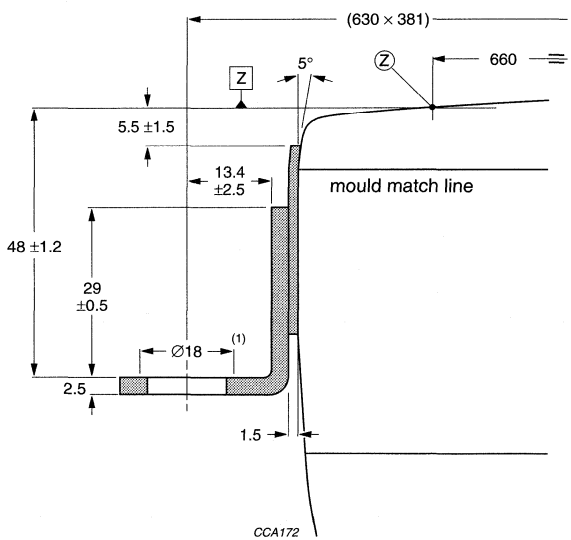


Dimensions in mm.

(1) Minimum space to be reserved for mounting lug in cabinet.

(2) The position of the mounting screw in the cabinet must be within a circle of 9.5 mm diameter drawn around the true geometrical positions, i.e. the corners of a rectangle of 630 mm × 381 mm.

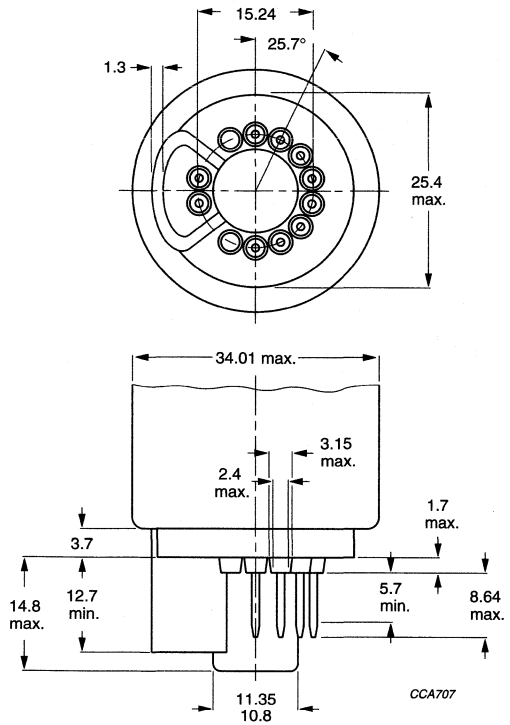
Fig.4 Lug dimensions.



Dimensions in mm.

(1) Plane of reference for 'Z' to lug distance.

Fig.5 Lug position.



Dimensions in mm.

Fig.6 Base JEDEC B10-304.

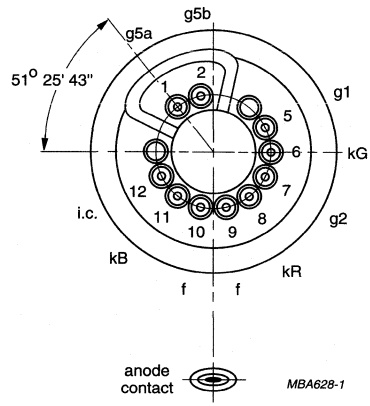


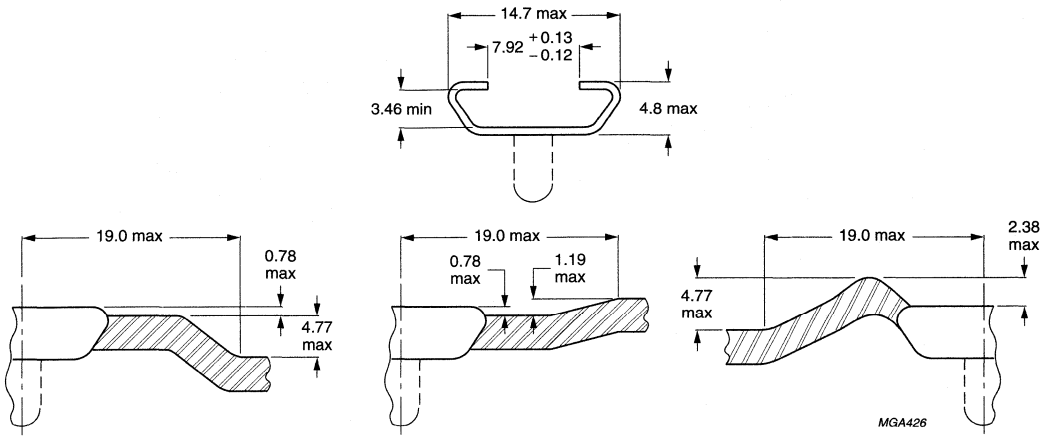
Fig.7 Pin arrangement.

Remarks: to Figs 6 and 7.

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

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

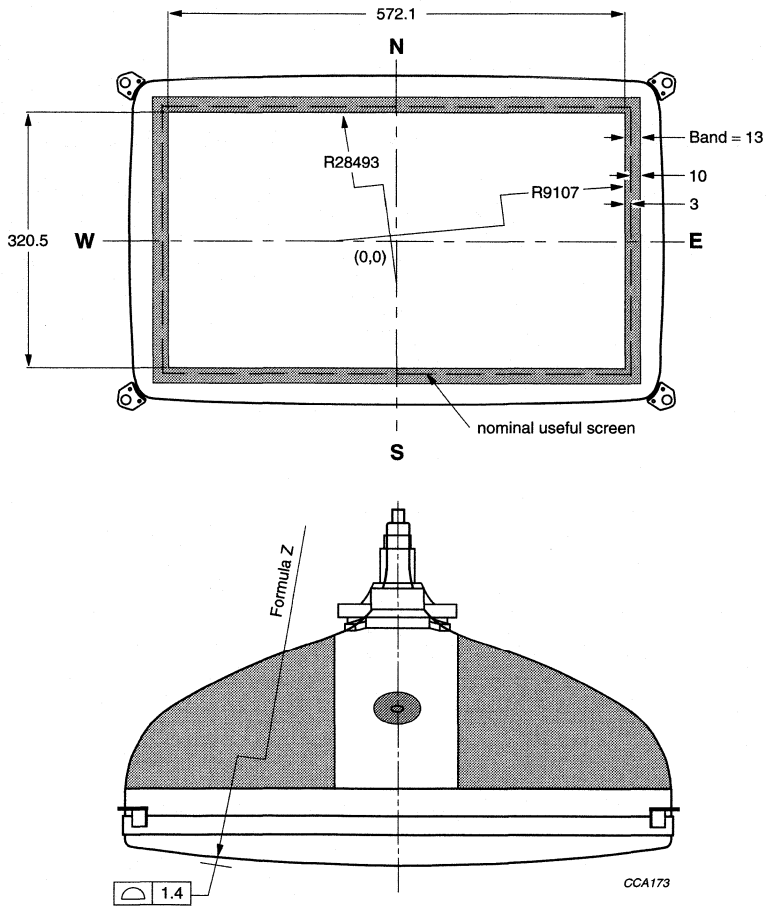
Maximum permissible torque on the tube neck is 0.04 Nm.



Dimensions in mm.

Fig.8 Cavity cap JEDEC J1-21, IEC 67-III-2.

Bezel contour data



Dimensions in mm.

Nominal sagittal height (mm) of the screen with respect to the screen centre is described by the following formula:

$$Z = 2.211601 \times 10^{-4} \times X^2 + 2.205565 \times 10^{-4} \times Y^2 + 1.632638 \times 10^{-11} \times X^2 \times Y^2 - 1.105459 \times 10^{-15} \times X^2 \times Y^4 + 1.563738 \times 10^{-20} \times X^4 \times Y^4$$

Fig.9 Bezel contour details.

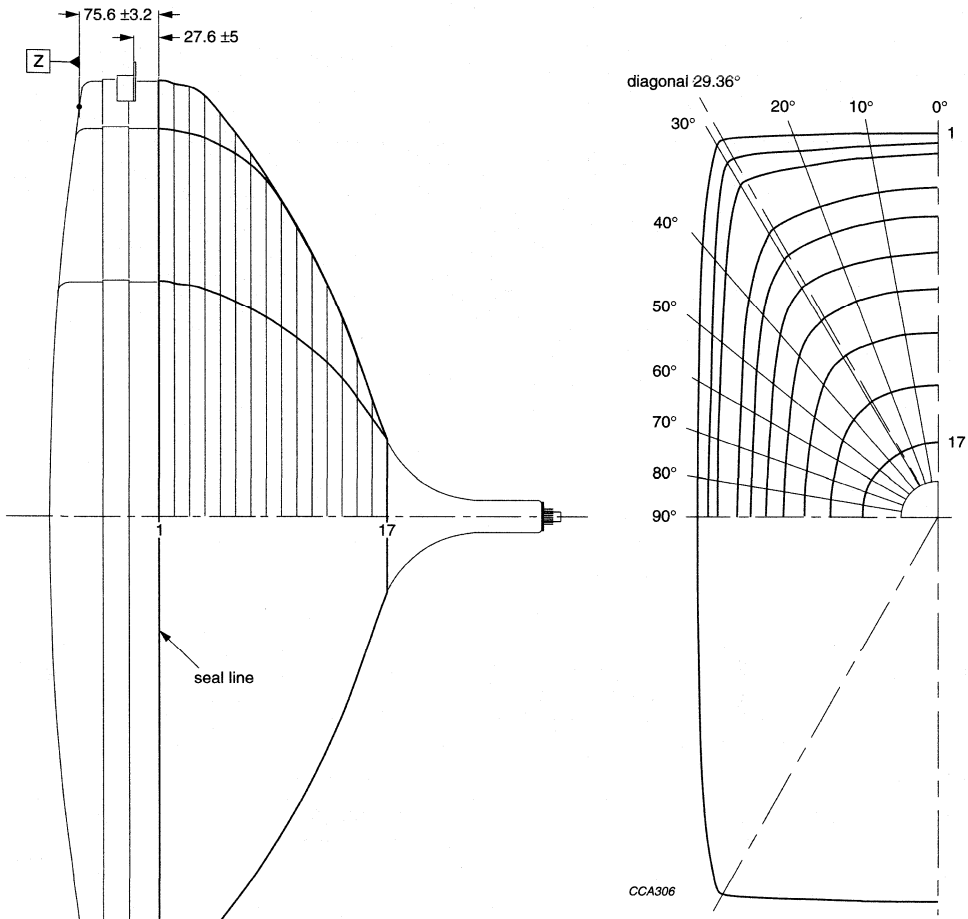
Sagittal heights of the useful screen measured with respect to the end of the diagonal axis

NOMINAL USEFUL SCREEN (NUS)			3 mm INSIDE NUS			10 mm OUTSIDE NUS		
COORDINATES		SAGITTAL HEIGHT	COORDINATES		SAGITTAL HEIGHT	COORDINATES		SAGITTAL HEIGHT
X (mm)	Y (mm)	(mm)	X (mm)	Y (mm)	(mm)	X (mm)	Y (mm)	(mm)
0.0	0.0	24.1	0.0	0.0	23.5	0.0	0.0	26.1
0.0[1]	163.3	18.2	0.0	160.3	17.9	0.0	173.3	19.5
20.0	163.2	18.2	20.0	160.2	17.8	20.0	173.2	19.4
40.0	163.2	17.9	40.0	160.2	17.5	40.0	173.2	19.2
60.0	163.2	17.5	60.0	160.2	17.1	60.0	173.2	18.7
80.0	163.1	16.8	80.0	160.1	16.5	80.0	173.1	18.1
100.0	163.1	16.0	100.0	160.1	15.7	100.0	173.1	17.3
120.0	163.0	15.1	120.0	160.0	14.7	120.0	173.0	16.4
140.0	162.9	13.9	140.0	159.9	13.6	140.0	172.9	15.2
160.0	162.8	12.6	160.0	159.8	12.2	160.0	172.8	13.9
180.0	162.7	11.1	180.0	159.7	10.7	180.0	172.7	12.4
200.0	162.6	9.4	200.0	159.6	9.1	200.0	172.6	10.7
220.0	162.4	7.6	220.0	159.4	7.2	220.0	172.4	8.9
240.0	162.2	5.6	240.0	159.2	5.2	240.0	172.2	6.8
260.0	162.1	3.3	260.0	159.1	3.0	260.0	172.1	4.6
280.0	161.9	1.0	280.0	158.9	0.6	280.0	171.9	2.2
287.6[2]	161.8	0.0	284.7	158.8	0.0	297.4	171.7	0.0
287.6	160.0	0.1	284.8	150.0	0.6	297.7	160.0	0.8
288.0	140.0	1.4	285.0	140.0	1.2	298.0	140.0	2.1
288.3	120.0	2.5	285.3	120.0	2.3	298.3	120.0	3.3
288.5	100.0	3.5	285.5	100.0	3.3	298.5	100.0	4.2
288.7	80.0	4.3	285.7	80.0	4.1	298.7	80.0	5.0
288.9	60.0	4.9	285.9	60.0	4.7	298.9	60.0	5.6
289.0	40.0	5.3	286.0	40.0	5.1	299.0	40.0	6.0
289.0	20.0	5.6	286.0	20.0	5.3	299.0	20.0	6.3
289.1[3]	0.0	5.6	286.1	0.0	5.4	299.1	0.0	6.4

Notes

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

Cone contour



Dimensions in mm.

Fig.10 Maximum cone contour.

Cone contour data

SECTION	NOMINAL DISTANCE FROM SECTION 1 (mm)	MAXIMUM DISTANCE FROM TUBE AXIS (mm)										
		0°	10°	20°	29.36°	30°	40°	50°	60°	70°	80°	90°
1	0	312.7	317.0	330.5	350.4	350.0	290.7	247.1	220.1	203.6	194.7	191.8
2	10	311.8	316.1	329.3	348.8	348.5	289.8	246.3	219.4	203.0	194.0	191.2
3	20	309.8	313.9	326.4	344.5	344.2	287.2	244.4	217.8	201.5	192.7	189.9
4	30	306.3	310.1	321.6	335.8	335.0	280.6	240.0	214.5	198.8	190.3	187.5
5	40	301.2	304.2	313.3	322.8	321.7	270.8	233.4	209.6	194.7	186.6	184.0
6	50	294.8	296.9	303.1	308.2	307.0	260.1	225.6	203.3	189.3	181.7	179.2
7	60	287.1	288.2	291.5	292.8	291.6	248.8	216.9	196.0	182.9	175.6	173.3
8	70	277.9	278.0	278.4	276.6	275.5	236.8	207.3	187.8	175.5	168.7	166.5
9	80	266.9	266.1	263.9	259.5	258.4	224.2	197.1	179.0	167.5	161.1	159.1
10	90	253.5	252.0	247.7	241.0	240.2	210.7	186.1	169.6	159.0	153.1	151.2
11	100	237.2	235.3	229.8	221.5	220.8	196.4	174.5	159.6	150.0	144.6	142.8
12	110	217.5	215.6	209.9	201.5	200.8	181.4	162.2	149.0	140.4	135.6	134.0
13	120	193.8	192.2	187.5	180.5	178.0	165.5	149.2	137.8	130.3	126.0	124.6
14	130	166.4	165.4	162.2	157.4	157.0	147.5	134.5	125.3	119.1	115.5	114.4
15	140	136.9	136.3	134.6	132.1	131.9	126.6	117.8	111.2	106.6	104.0	103.1
16	150	106.8	106.7	106.2	105.5	105.5	103.8	99.7	95.7	93.0	91.3	90.8
17	160	77.3	77.3	77.3	77.3	77.3	77.3	77.3	77.4	77.4	77.5	77.5

HANDLING

The packaging provides protection against tube damage under normal conditions of shipment or handling. Observe any instructions given on the packaging and handle accordingly. Under no circumstances should the tube assembly be subjected to accelerations greater than the values given in Table "Acceleration limits".

Acceleration limits

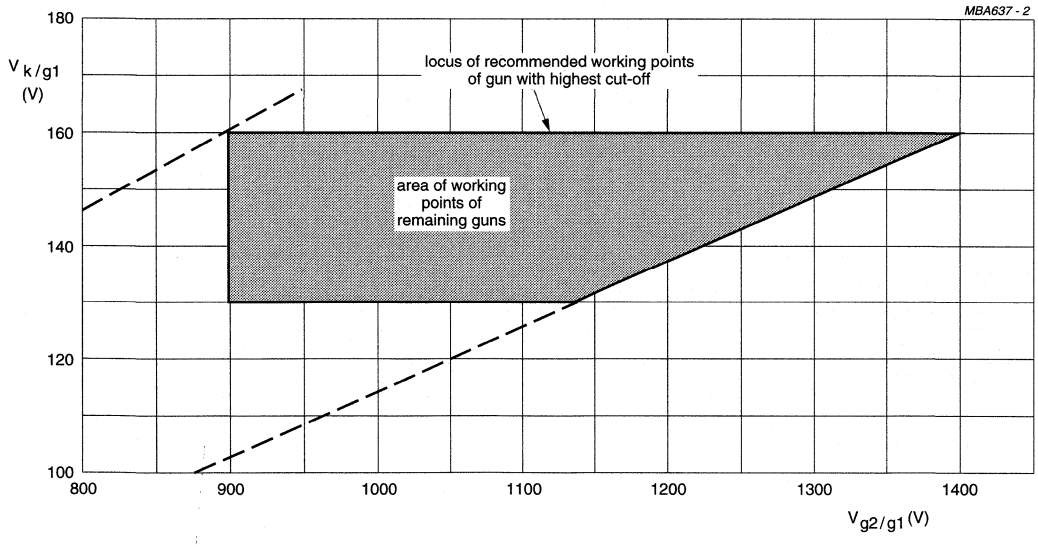
PARAMETER	CONDITIONS	MAX.	UNIT
Pulse in cone direction	≤10 ms	350	m/s^2
	≥10 ms	200	m/s^2
Pulse in all other directions		350	m/s^2

TYPICAL OPERATING CONDITIONS

SYMBOL	PARAMETER	CONDITION	MIN.	TYP.	MAX.	UNIT
V_a	anode voltage	full screen load	–	30	–	kV
V_{g5a}	horizontal focus voltage	screen centre	8.0	–	9.2	kV
V_{g5b}	vertical focus voltage	screen centre	7.9	–	9.1	kV
$V_{g5b\ dyn}$	horizontal parabola voltage	screen edge to edge	–	1000	–	V
$V_{g5b\ dyn}$	vertical parabola voltage	screen edge to edge; note 1	–	120	–	V
V_{g2}	grid 2 voltage		see Fig.11			
V_f	heater voltage	tube operating	5.7	6.15	6.6	V

Note

1. Only required for optimization. A good focus quality can also be obtained by omitting the vertical parabola and increasing the voltage on grid 5b (V_{g5b}) by approximately 50 V.



Grid 2 voltage (V_{g2}) adjusted for highest gun spot cut-off voltage V_k = 160 V.

Remaining guns adjusted for spot cut-off by means of cathode voltage.

V_{g2} range: 900 to 1400 V.

V_K range: 130 to 160 V.

Adjustment procedure:

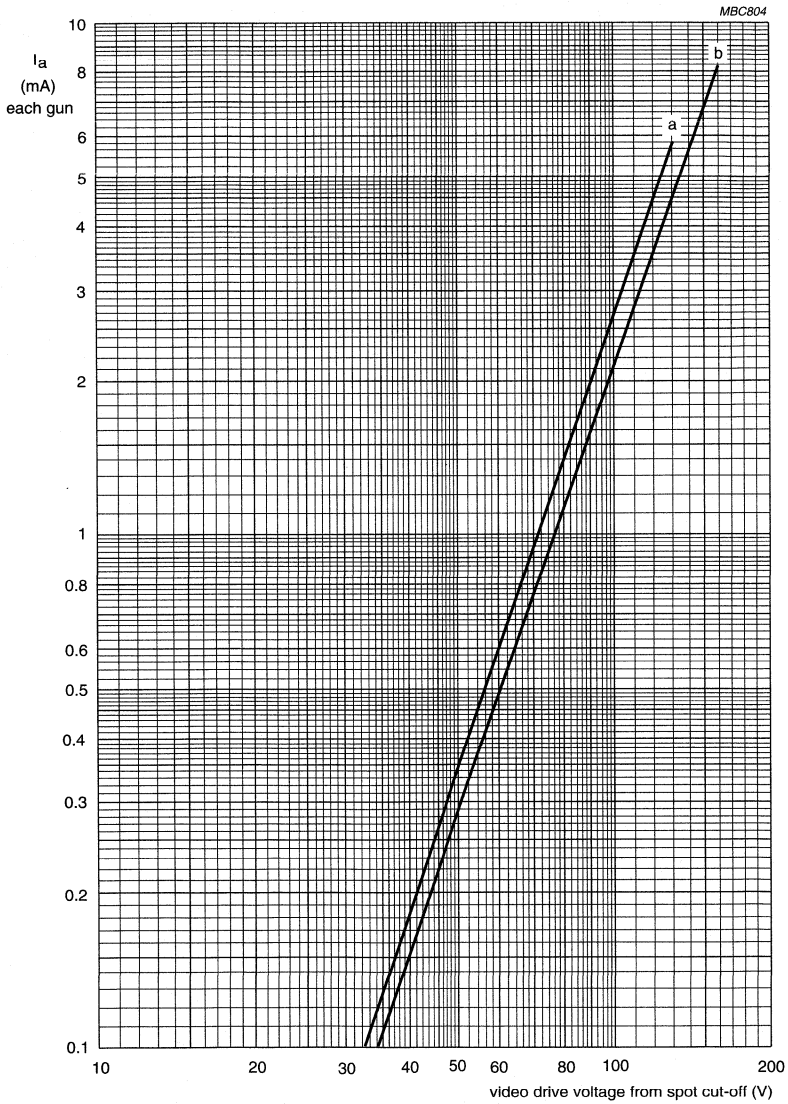
Set the cathode voltage (V_k) for each gun at 160 V; increase the grid 2 voltage (V_{g2}) from approximately 850 V to the value at which one of the colours becomes just visible. Now decrease the cathode voltage of the remaining guns so that the other colours also become visible.

Fig.11 Spot cut-off design chart.

CHASSIS DESIGN VALUES

The values are valid for anode voltages between 28 and 33 kV. The voltages are specified with respect to grid 1. For optimum picture performance it is recommended that the cathodes are not driven below +1 V.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
V_{g5a}	grid 5a focus voltage as a percentage of anode voltage		26.7	–	30.7	%
V_{g5b}	grid 5b focus voltage as a percentage of anode voltage		26.3	–	30.3	%
V_{g2}	grid 2 voltage	for visual extinction of focusing spot	see Fig.11			
V_k	cathode voltage		see Figs 11 and 12.			
ΔV_k	difference in cut-off voltage in any tube		lowest value >80% of highest value			
V_f	heater voltage	tube operating	–	6.15	–	V
$I_{g5a,g5b}$	focus current		–2	–	+2	μA
I_{g2}	grid 2 current		–2	–	+2	μA
I_{g1}	grid 1 current	at cut-off	–2	–	+2	μA
I_{kf}	cathode/heater current		–2	–	+2	μA
R_{ins}	insulation resistance between each cathode and all other electrodes and heater		50	–	–	MΩ
Anode currents to produce white of 6500 K + 7 MPCD (CIE coordinates x = 0.313; y = 0.329)						
PERCENTAGE OF THE TOTAL ANODE CURRENT SUPPLIED BY EACH GUN						
	red gun		–	41.3	–	%
	green gun		–	34.4	–	%
	blue gun		–	24.3	–	%
RATIO OF ANODE CURRENTS						
	red gun to green gun		0.85	1.20	1.55	
	red gun to blue gun		1.20	1.70	2.20	
	blue gun to green gun		0.40	0.70	1.00	



V_f = 6.15 V.
V_a = 30 kV.
V_{g5a} and V_{g5b} adjusted for focus.
V_{g2} (each gun) adjusted to provide spot cut-off for V_k = 130 V (curve a) and V_k = 160 V (curve b).

Fig.12 Typical cathode voltage drive characteristic.

LIMITING VALUES

In accordance with the Absolute Maximum Rating System (IEC 134). Voltages are specified with respect to grid 1.

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_a	anode voltage	notes 1 and 2	28	33	kV
		at zero beam current	–	36(3)	kV
I_a	long-term average anode current for three guns		–	1300	μA
	short-term average anode current for three guns		–	1800	μA
$V_{g5a/g5b}$	focus voltage	note 4	–	12	kV
$\Delta V_{g5a-g5b}$	differential focus voltage		–	3	kV
V_{g2}	grid 2 voltage	note 5	–	1600	V
V_f	heater voltage	note 6	5.7	6.6	V
Cathode voltage					
V_{kp}	positive peak		–	250	V
V_k	during switch-off		–	250	V
V_k	positive operating cut-off		–	180	V
V_k	negative		–	0	V
V_{kp}	negative peak		–	–2	V
Cathode to heater voltage					
V_{kf}	positive		–	250	V
V_{kfp}	positive peak		–	300	V
V_{kf}	negative		–	0	V
V_{kfp}	negative peak		–	–50	V
Circuit limiting values					
R_{g5a}, R_{g5b}	grid 5a, grid 5b circuit resistance		–	70	MΩ
R_{g2}	grid 2 circuit resistance		–	7	MΩ
R_{g1-k}	grid 1 to cathode circuit resistance		–	750	kΩ

Notes

1. During adjustment on the production line this value is likely to be surpassed considerably. It is therefore strongly recommended to first make the necessary adjustments for normal operation without the picture tube.
2. Operation of the tube at lower voltages impairs the luminance and resolution and could impair convergence.
3. This value is an absolute maximum.
4. During flash-over maximum 20 kV is allowed.
5. During adjustment on the production line a maximum value of 1800 V is allowed.
6. For maximum cathode life and optimum performance it is recommended that the heater supply is designed for 6.15 V at average beam current, for most applications this equals 6.3 V at zero beam current. **The heater supply source impedance must not be less than 2 Ω.**

FLASHOVER PROTECTION

With the high voltage used with this tube (max. 36 kV) internal flashovers may occur. As a result of Soft-Flash technology these flashover currents are limited to approximately 100 A offering higher reliability, optimum circuit protection and component savings.

Primary protective circuitry using properly grounded spark gaps and series isolation resistors (preferably carbon composition) is still necessary to prevent tube damage.

The spark gaps should be connected to all picture tube electrodes at the socket in accordance with Fig.13; they are not required on the heater pins. No other connections between the outer conductive coating and the chassis are permissible. The spark gaps should be designed for a breakdown voltage of less than 20 kV at the focus electrode (g3) and less than 2 kV at the other electrodes, both at an atmospheric pressure of 100 kPa.

The values of the series isolation resistors should be as high as possible (min. 0.5 kΩ) without causing deterioration of the circuit performance. The resistors should be able to withstand an instantaneous surge of 20 kV for the focusing circuit and 12 kV for the remaining circuits without arcing.

To guarantee the soft flash behaviour, the internal dynamic resistance of the tube during flashover is a minimum 400 Ω and a maximum 800 Ω.

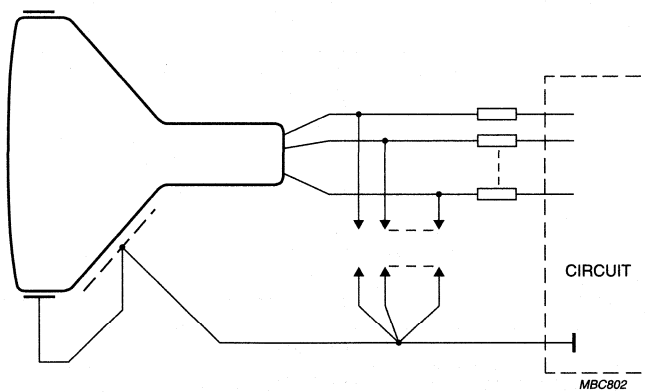


Fig.13 Flashover protection circuit.

X-RADIATION

Maximum anode voltage at which the X-radiation emitted will not exceed 0.5 mR/h at an anode current of 300 μA.

PARAMETER	VALUE
Entire tube; note 1	38.1 kV
Face-plate only	38.9 kV

Note

1. This rating applies only if the anode connector used by the set maker provides the necessary attenuation to reduce the X-radiation from the anode contact by a factor equal to the difference between the anode button iso-exposure-rate limit curve and the iso-exposure-rate limit curve for the entire tube.

WARNING
If the value for the tube face only is used as design criteria, adequate shielding must be provided in the TV receiver for the anode contact and/or certain portions of the tube funnel and panel sidewalls to ensure that the X-radiation from the TV receiver is attenuated to a value equal to or lower than that specified for the face of the tube.
The X-radiation emitted from this picture tube, as measured in accordance with the procedure of *"JEDEC Publications No.64D"* will not exceed 0.5 mR/h throughout the useful life of the tube when operated within the design-maximum ratings.
The tube should not be operated beyond its design-maximum ratings stated above, but its X-radiation will not exceed 0.5 mR/h for anode voltage and current combinations given by the iso-exposure-rate limit characteristics as shown in Fig.15.
Operation above the values shown by the curve may result in failure of the TV receiver to comply with the *"Federal Performance Standard of the U.S. for Television Receivers, Section 1020.10 of Part 1020 of Title 21, Code of Federal Regulation"*.
Maximum X-radiation as a function of anode voltage at 300 μA current is shown by Fig.14. X-radiation at a constant anode voltage varies linearly with anode current.

WARNING
The cathode ray tube is intrinsically safe in accordance with *"Appendix III Röntgenverordnung"*.
Eigensichere Kathodenstrahlröhre nach *"Anlage III Röntgenverordnung"*.

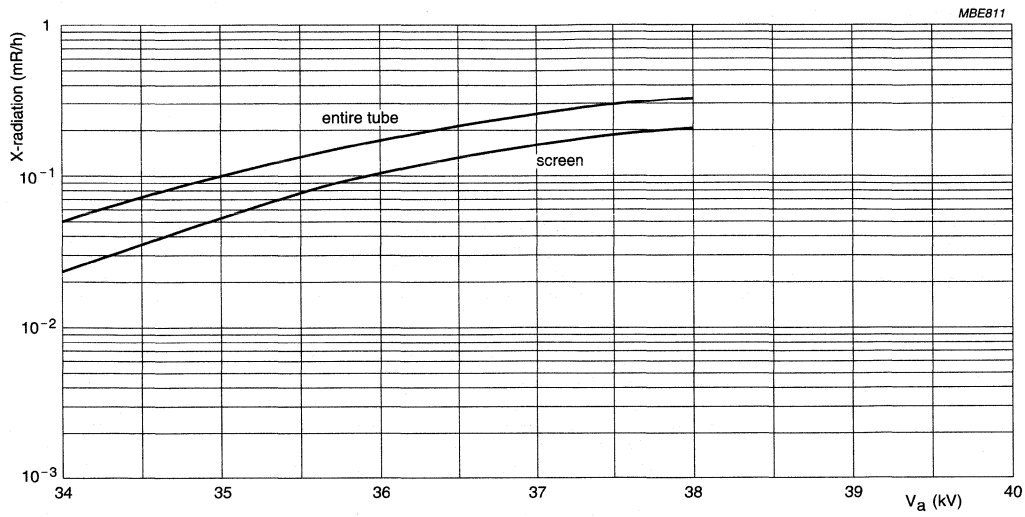


Fig.14 X-radiation limit curves at a constant anode current of 300 μA.

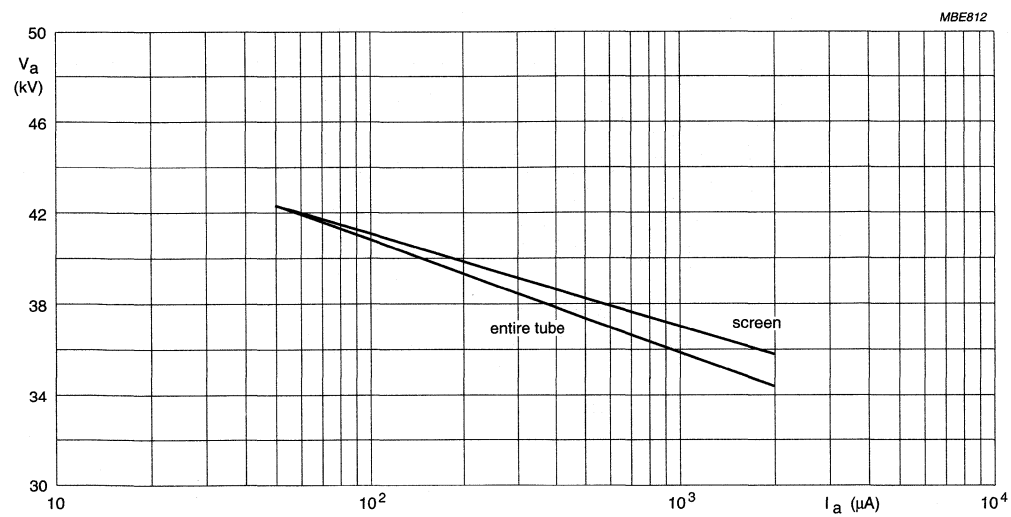
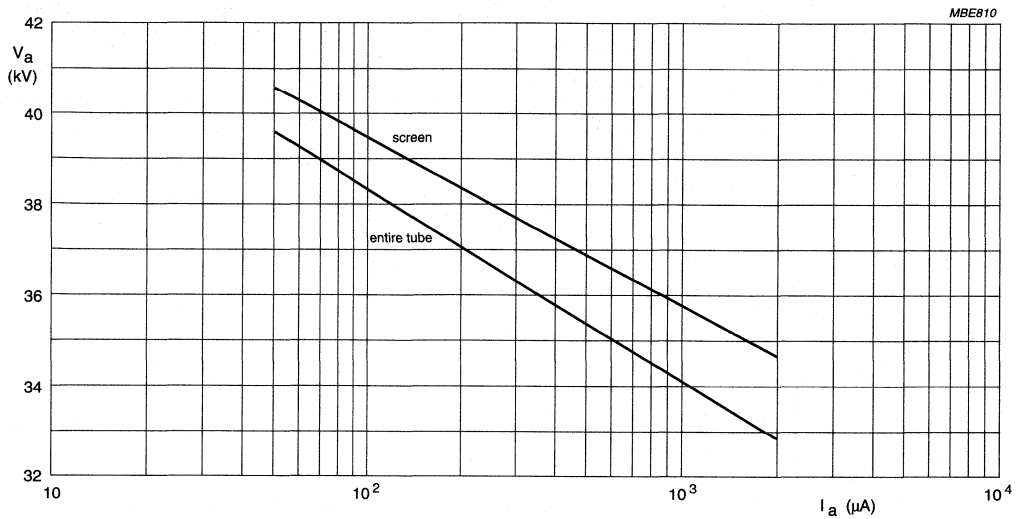


Fig.15 Iso-exposure-rate limit curves at 0.5 mR/h.



The tube does not emit X-radiation above 1 μSv/h when operated at 33 kV and 1.8 mA. The X-radiation emitted will also not exceed 1 μSv/h for anode voltage and current combinations shown in the iso-exposure-rate limit curve.

Fig.16 1 μSv/h iso-exposure-rate limit curve.

MAGNETIC FIELD CONDITIONS

This tube is designed for world wide use.

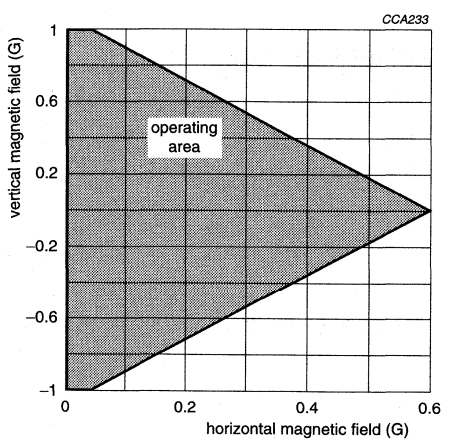


Fig.17 Allowable horizontal and vertical magnetic fields operation area.

DEGAUSSING

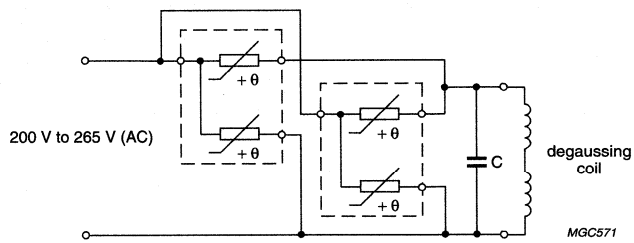
The picture tube is provided with an internal magnetic shield. This shield and the shadow mask with its suspension system should be provided with an automatic degaussing system, consisting of coil(s) covering the top and bottom cone parts.

For proper degaussing an initial magnetomotive force (MMF) of 450 ampere-turns is required in each coil. This MMF must be gradually decreased (maximum 20% per half period) by appropriate circuitry. To prevent beam landing disturbance by line frequency currents induced in the degaussing coils, these coils should be shunted by a capacitor of sufficiently high value. In steady state, no significant MMF should remain in the coils (≤0.15 ampere-turns).

If single-phase power rectification is employed in the TV circuitry, provision should be included to prevent asymmetric distortion of the AC voltage applied to the degaussing circuit due to high DC inrush currents.

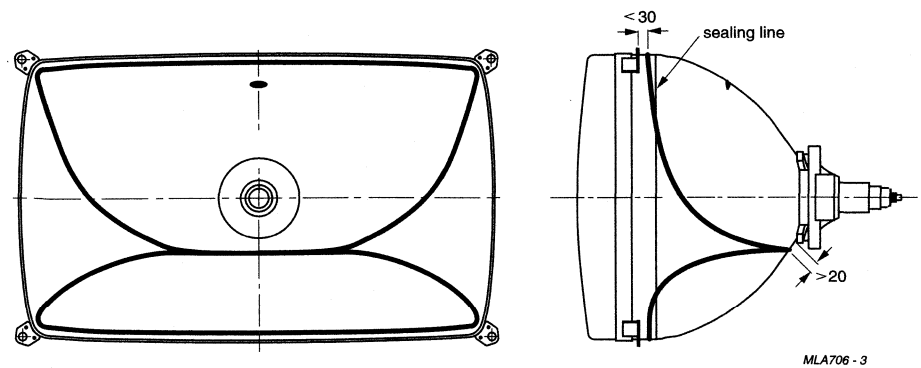
Data of degaussing coils

PARAMETER	TYP.	UNIT
Circumference	308	cm
Number of turns	60	
Copper wire diameter	0.45	mm
Resistance	21.5	Ω



C = 100 nF.

Fig.18 Typical degaussing circuit using two paralleled dual PTC thermistors 2322 662 96126.



Dimensions in mm.

Fig.19 Position of eight-shaped degaussing coil on the picture tube.

'Black Line WSF' colour picture tube assembly

W66ESF032X44

FEATURES

- 100 Hz vertical repetition
- Factory preset tube/coil assembly
- Self-converging and north-south raster correction free
- Scan Velocity Modulation (SVM) for improved picture sharpness
- 66 cm, 106° colour picture tube W66ESF032X
- Double mussel deflection unit.

QUICK REFERENCE DATA

PARAMETER	TYP.	UNIT
Deflection angle	106	deg
Nominal useful screen diagonal	66	cm
Overall length	<47.3	cm
Glass transmission	40	%
Neck diameter	32.8	mm
Anode voltage	30	kV

Black Line WSF

DEFLECTION UNIT DATA

All measurements are performed at a horizontal frequency of 32 kHz.

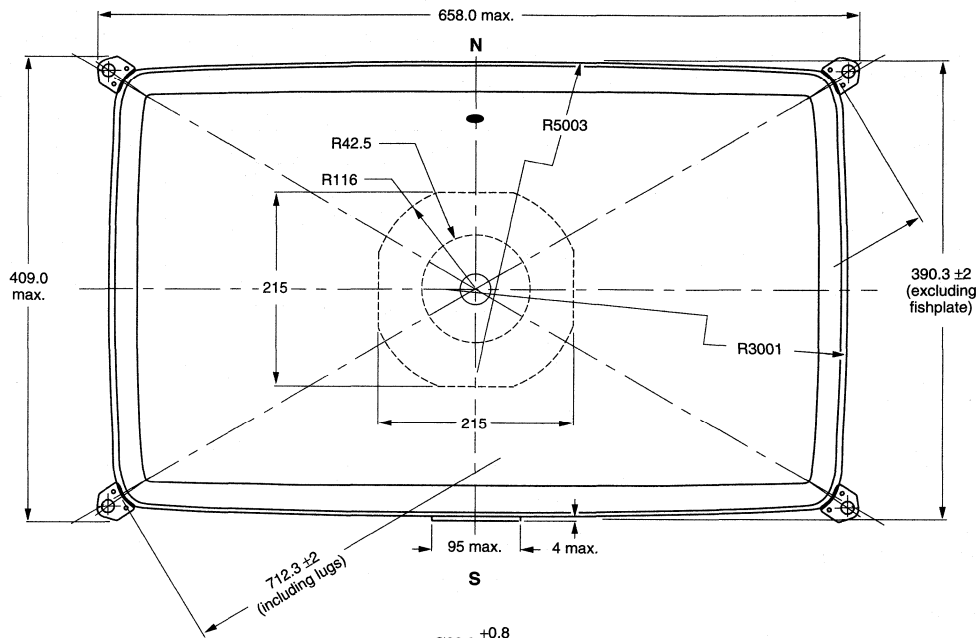
PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Horizontal deflection coils					
Inductance		0.29	0.30	0.31	mH
Resistance	T_{amb} = 25 °C	0.32	0.34	0.36	Ω
Magnetic flux		3.17	3.37	3.57	mWb
Deflection current (peak-to-peak value)	edge-to-edge; V_a = 30 kV	–	11.2	–	A
Average copper temperature	note 1	–	–	110	°C
Temperature rise (ΔT)	V_a = 30 kV; I_a = short term average value	–	50	–	°C
Vertical deflection coils					
Inductance		8.38	8.82	9.26	mH
Resistance	T_{amb} = 25 °C	5.96	6.27	6.58	Ω
Vertical voltage		7.99	8.59	9.19	V
Deflection current (peak-to-peak value)	edge-to-edge; V_a = 30 kV	–	1.37	–	A
Average copper temperature	note 1	–	–	110	°C
Temperature rise (ΔT)	V_a = 30 kV; I_a = short term average value	–	35	–	°C
SVM coils					
Inductance		1.81	1.85	1.89	µH
Resistance		0.63	0.90	1.17	Ω
Sensitivity					
centre		1.39	1.45	1.51	mm/A
edge		2.98	3.14	3.30	mm/A
Deflection unit					
Permissible DC voltage					
between horizontal and vertical coils		–	–	2000	V
between horizontal and yoke ring		–	–	2000	V
between vertical coils and yoke ring		–	–	300	V
Insulation resistance	1 kV (DC)				
between horizontal and vertical coils		500	–	–	MΩ
between horizontal coil and yoke ring		500	–	–	MΩ
between vertical coil and yoke ring		10	–	–	MΩ
Cross-talk from horizontal to vertical coils	1 V; 500 Hz applied to the horizontal deflection coils	–	–	45	mV

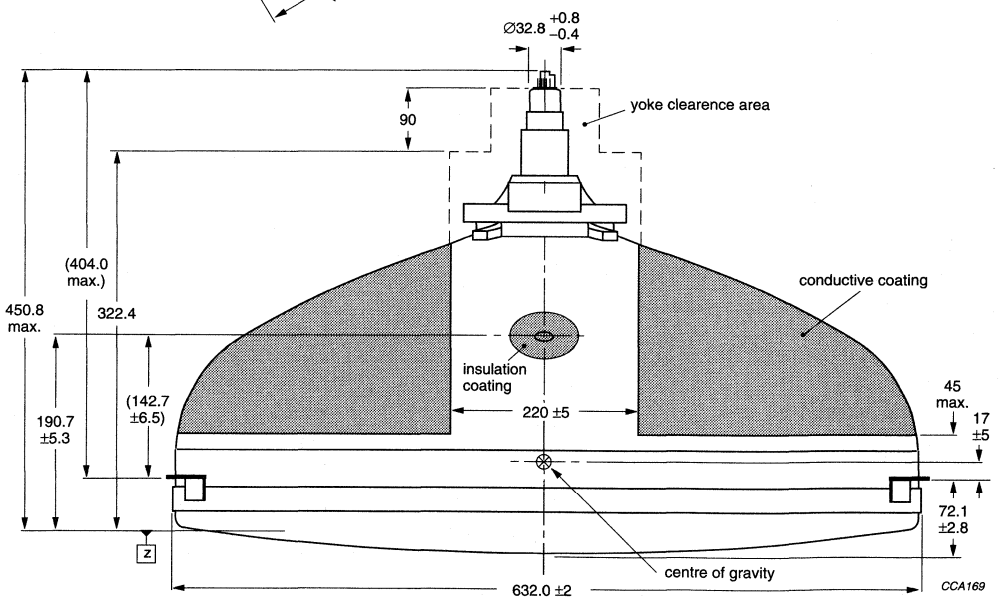
Note

1. Measured by the resistance method.

'Black Line WSF' colour picture tube assembly

W66ESF032X44



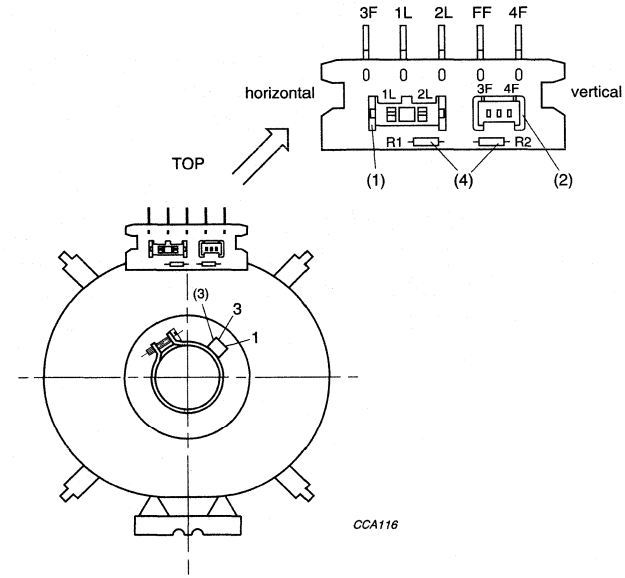


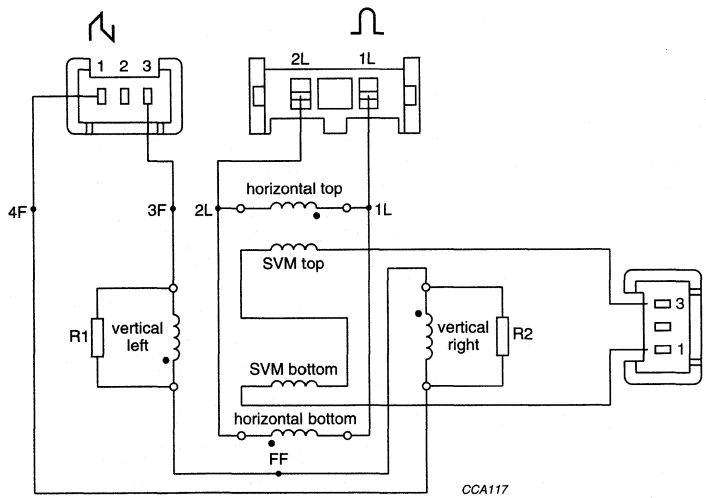
Dimensions in mm.

Fig.1 Assembly dimensions.

'Black Line WSF' colour picture tube assembly

W66ESF032X44





The beginning of the windings is indicated with •

(1) Horizontal connector: AMP Ultrex connection system; connector 2-173270-2; matching connector 2-173268-2.

(2) Vertical connector: Stocko system RFK1 (MKS series); matching connector MKF17033, MKF17330 or MKF17360 series.

(3) SVM connector: Stocko system RFK1 (MKS series); matching connector MKF17033, MKF17330 or MKF17360 series.

(4) R1 = R2 = 100 Ω, 0.25 W.

Fig.2 W66ESF032X44 deflection coils.

'Black Line WSF' colour picture tube

W76ESF031X

FEATURES

- 'Super flat' screen
- Screen contour F2
- New 16 : 9 screen ratio
- BLACK MATRIX technology
- High contrast
- High gloss, low transmission screen
- DAF gun with IFL main lens, dynamic astigmatism and focus, and multi-stage prefocusing
- Invar Plus mask with corner suspension
- Pigmented phosphors
  - Cd-free green
  - Deep red
- Quick-heating low-power cathodes
- Soft-flash
- Slotted shadow mask optimized for minimum moiré at 525 and 625 line systems
- Internal magnetic shield
- Worldwide application
- Internal multipole
- Rimband type mini-P
- N/S raster correction free.

QUICK REFERENCE DATA

PARAMETER	TYP.	UNIT
Deflection angle	106	deg
Nominal useful screen diagonal	76	cm
Overall length	<52.4	cm
Glass transmission	45.7	%
Neck diameter	32.8	mm
Heater voltage	6.15	V
Heater current	315	mA
Anode voltage	30	kV
Focus voltage	29% of anode voltage	

ELECTRICAL DATA

SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNIT
Capacitances					
$C_{a(m+m')}$	anode to external conductive coating, including rimband	2500	–	–	pF
$C_{am'}$	anode to metal rimband	–	400	–	pF
$C_{k(R+G+B)}$	cathodes of all guns (connected in parallel) to all other electrodes	–	–	15	pF
C_{kR}, C_{kG}, C_{kB}	cathode of any gun to all other electrodes	–	4	–	pF
C_{kdiff}	differential cathode capacitance	–	–	0.5	pF
C_{g1}	grid 1 to all other electrodes	–	20	–	pF
C_{g5a}	grid 5a to all other electrodes	–	18	–	pF
$C_{(g5a-g5b)}$	grid 5a to grid 5b	–	8	–	pF
$C_{(g5a/g5b)}$	grids 5a + 5b to all other electrodes	–	15	–	pF
C_{g5b}	grid 5b to all other electrodes	–	9	–	pF
Heating, indirect by AC (preferably mains or line frequency) or DC					
V_f	heater voltage	–	6.15	–	V
I_f	heater current	–	315	–	mA
Resistance					
R_{rim}	between rimband and external conductive coating	50	–	–	MΩ

ELECTRO-OPTICAL DATA

PARAMETER	VALUE
Electron gun system	unitized in-line
Focus method	electrostatic
Main lens	IFL (Integrated Focus Lens) main lens with dynamic astigmatism and focusing
Convergence method	self converging
Deflection angles	
diagonal	106°
horizontal	97°
vertical	62°

OPTICAL DATA

PARAMETER	VALUE
Screen	vertical matrix and phosphor stripes
Matrix	black opaque material; PVP technology
Screen finish	high gloss
Nominal useful screen dimensions	
diagonal	759.0 mm
horizontal axis	665.5 mm
vertical axis	374.3 mm
area	≈2500 cm^2
Phosphors	
red	pigmented europium activated rare earth
green	Cd-free sulphide type
blue	pigmented sulphide type
Persistence	medium short
Centre-to-centre distance of identical colour phosphor stripes (at screen centre)	≈0.72 mm
Light transmission of face glass at centre of screen	45.7%
Intrinsic luminance (L) at screen centre; at 30 kV; note 1	80 cd/m^2

Note

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

Colour coordinates

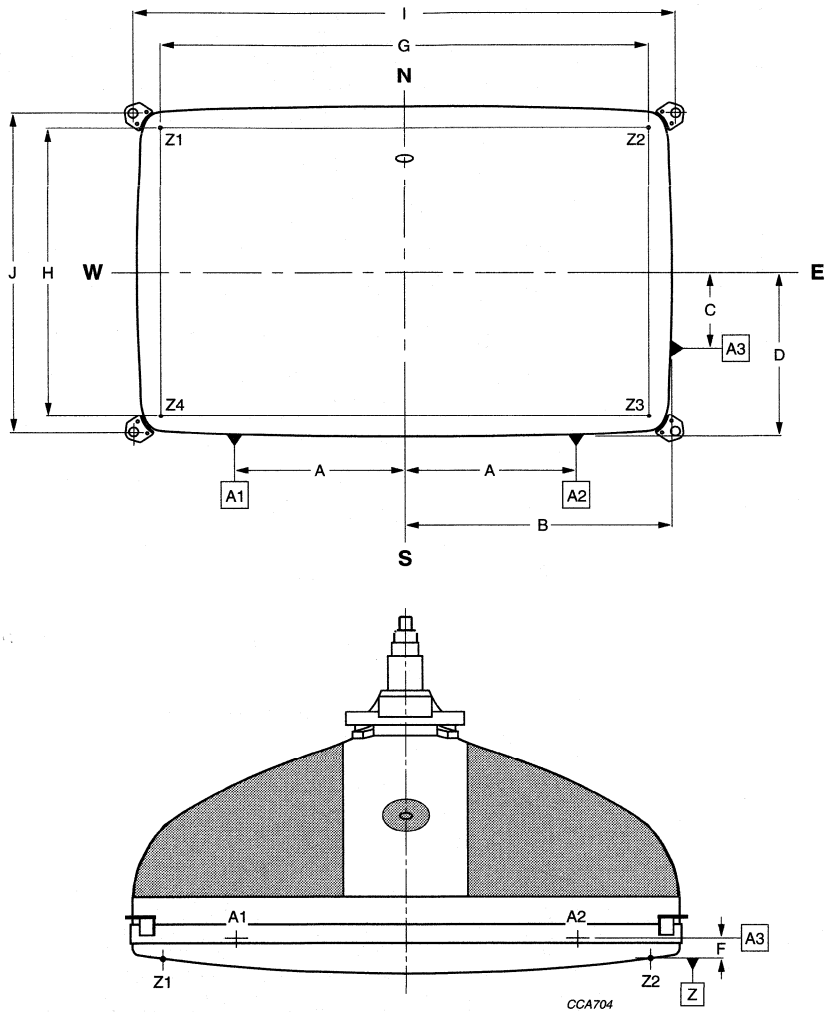
COLOUR	x	y
Red	0.630	0.330
Green	0.295	0.595
Blue	0.155	0.065

MECHANICAL DATA

PARAMETER	VALUE
Mass including deflection unit	≈34.5 kg
Base	JEDEC B10-304
Anode contact	small cavity contact; JEDEC J1-21; IEC 67-111-2
Mounting position	anode contact on top
Implosion protection	mini-P shrink system
Bulb design	
Funnel	EIA/JEDEC J-813A
Panel	EIA/JEDEC F-813B

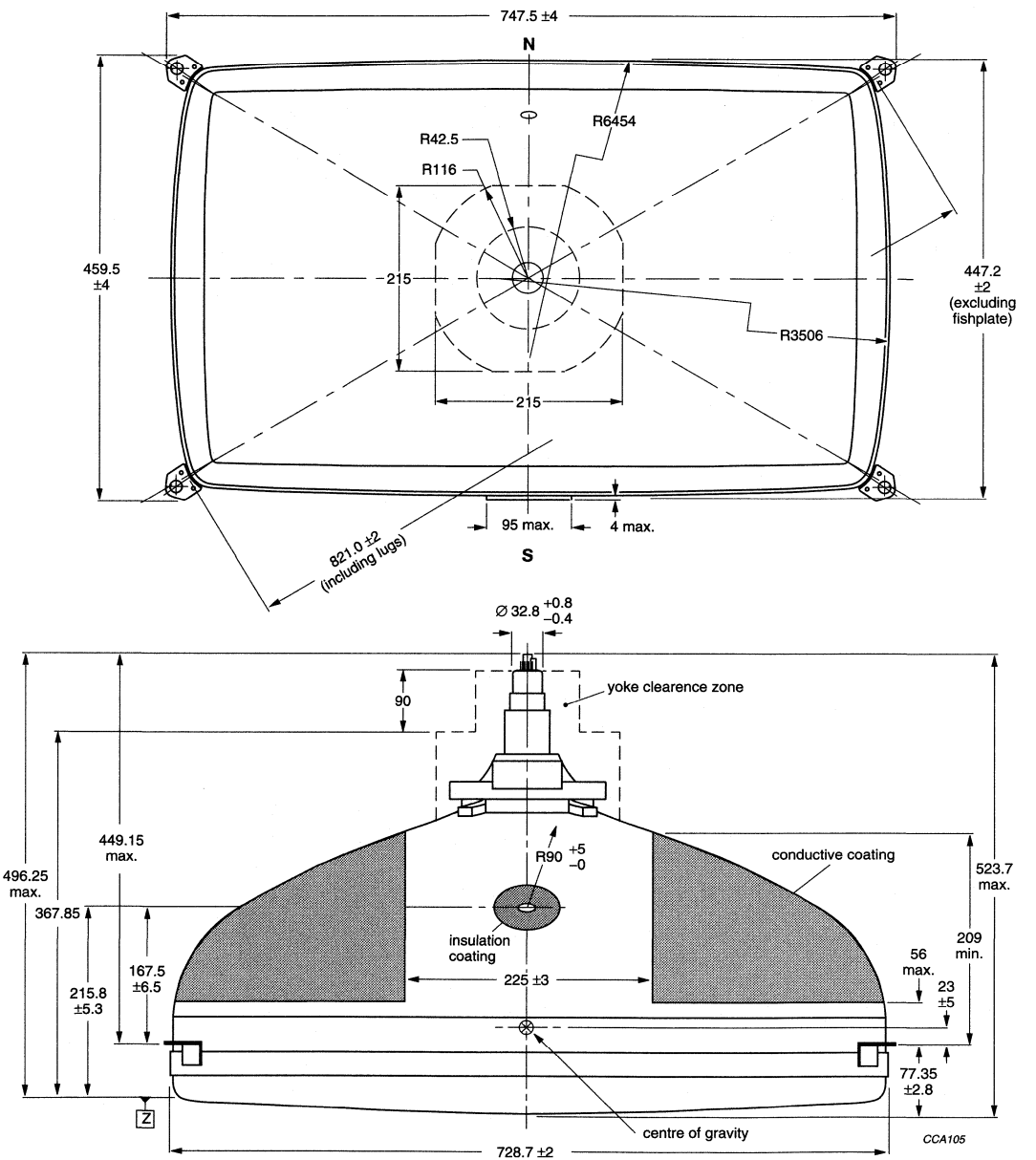
'Black Line WSF' colour picture tube

W76ESF031X



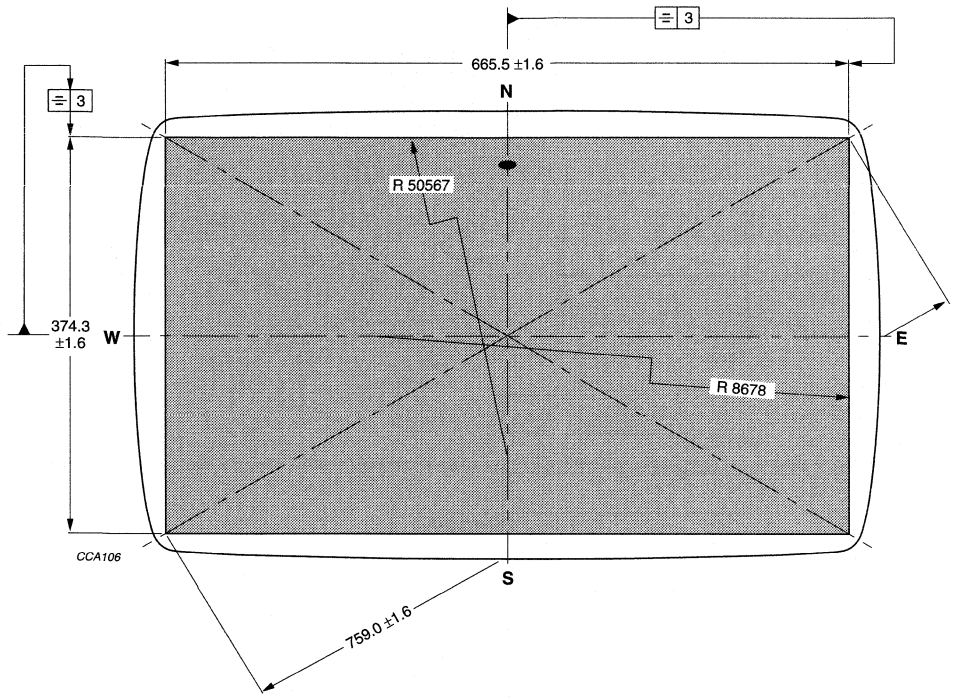
A = 270.0 mm.
B = 361.35 mm.
C = 145.0 mm.
D = 217.95 mm.
F = 31.25 mm.
G = 662.4 mm.
H = 372.6 mm.
I = 723.5 mm.
J = 435.5 mm.
Z1 and Z3 are part of plane 'Z'.
Z2 and Z4 have the same distance to 'Z' and lie at the same side of plane 'Z'.

Fig.1 Mechanical reference points.



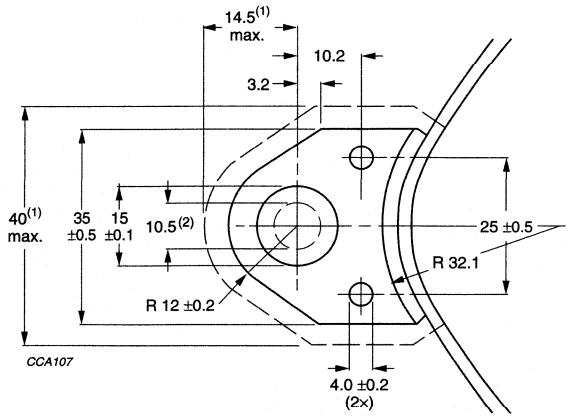
Dimensions in mm.

Fig.2 Tube dimensions.



Dimensions in mm.

Fig.3 Phosphor dimensions.

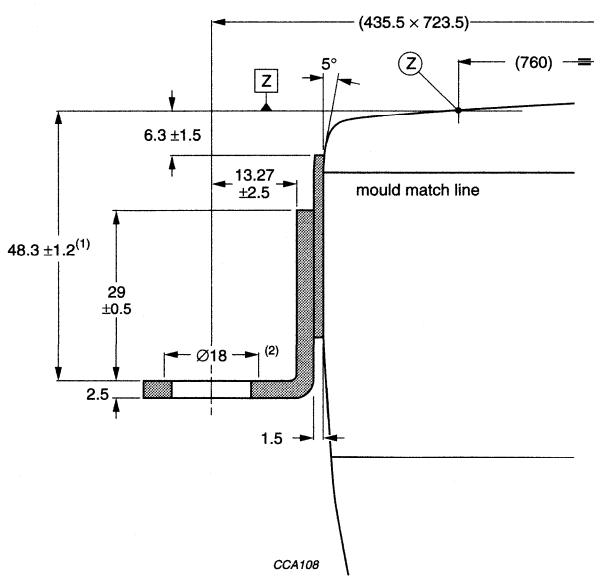


Dimensions in mm.

(1) Minimum space to be reserved for mounting lug.

(2) The position of the mounting screw in the cabinet must be within a circle of 10.5 mm diameter drawn around the true geometrical positions, i.e. the corners of a rectangle of 723.5 mm × 435.5 mm.

Fig.4 Lug dimensions.

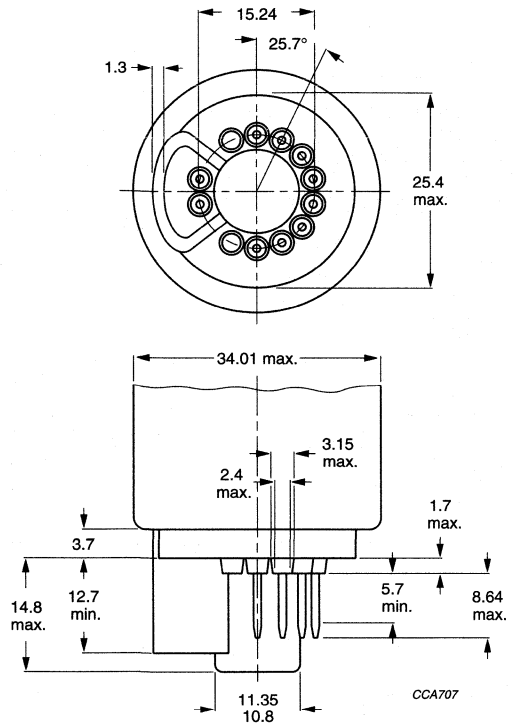


Dimensions in mm.

(1) The maximum displacement of all lugs with respect to a plane parallel to plane 'Z' is 1.0 mm max. This deviation is incorporated in the tolerance of ±1.2 mm.

(2) Plane of reference for 'Z' to lug distance.

Fig.5 Lug position.



Dimensions in mm.

Fig.6 Base JEDEC B10-304.

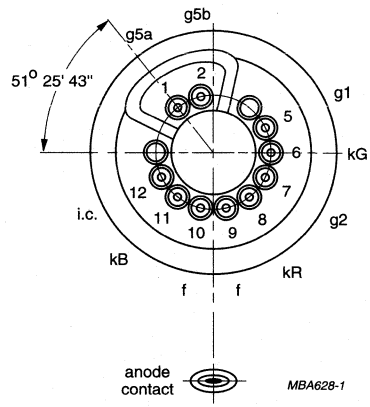


Fig.7 Pin arrangement.

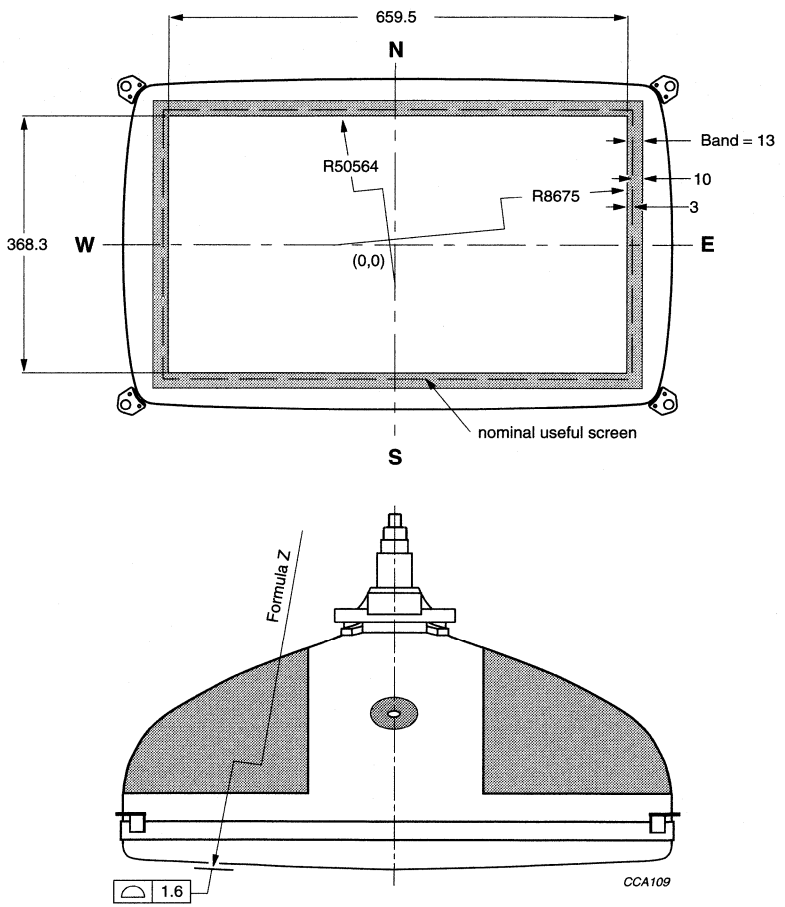
Remarks: to Figs 6 and 7.

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

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

Maximum permissible torque on the tube neck is 0.04 Nm.

Bezel contour data



Dimensions in mm.

Nominal sagittal height (mm) of the screen with respect to the screen centre is described by the following formula:

$$Z = 2.008872 \times 10^{-4} \times X^2 + 2.002726 \times 10^{-4} \times Y^2 + 1.314517 \times 10^{-11} \times X^2 \times Y^2 - 6.563159 \times 10^{-16} \times X^2 \times Y^4 + 6.807958 \times 10^{-21} \times X^4 \times Y^4$$

Fig.8 Bezel contour details.

Sagittal heights

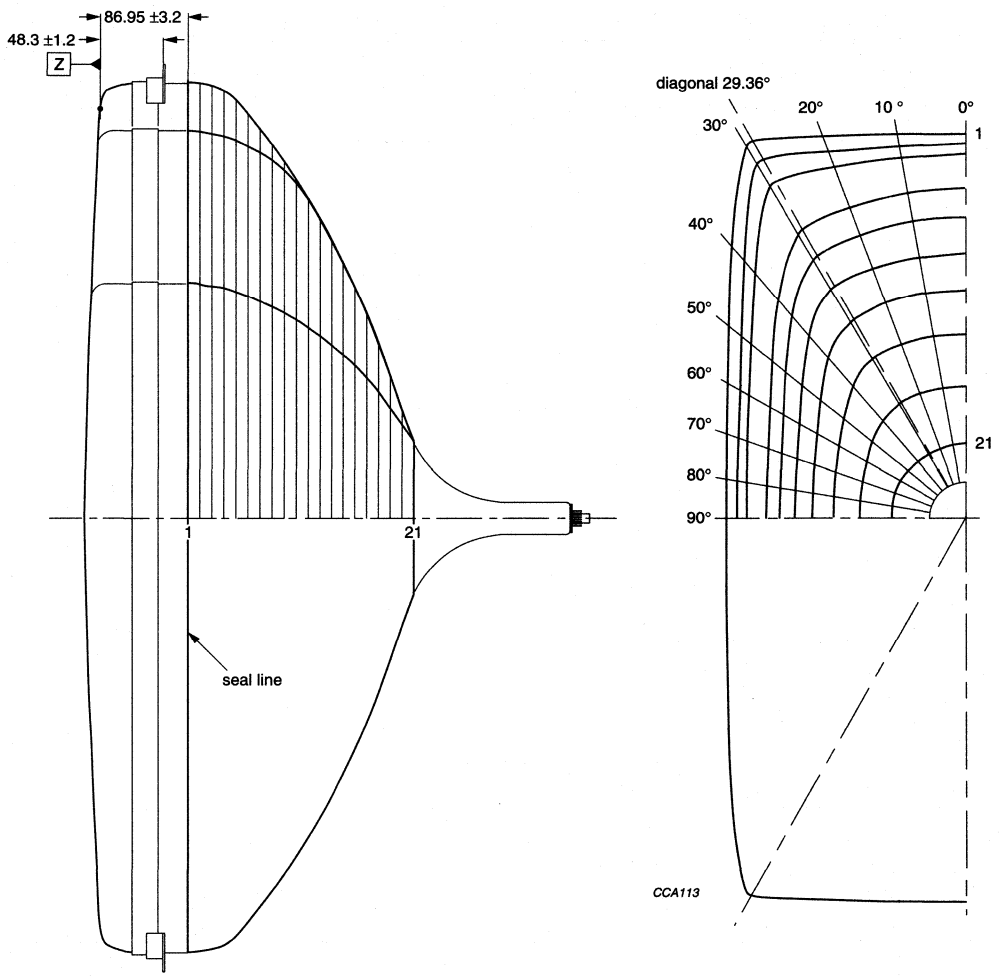
Sagittal heights of the useful screen measured with respect to the end of the diagonal axis.

NOMINAL USEFUL SCREEN (NUS)			3 mm INSIDE NUS			10 mm OUTSIDE NUS		
COORDINATES		SAGITTAL HEIGHT	COORDINATES		SAGITTAL HEIGHT	COORDINATES		SAGITTAL HEIGHT
X (mm)	Y (mm)	(mm)	X (mm)	Y (mm)	(mm)	X (mm)	Y (mm)	(mm)
0.0	0.0	29.0	0.0	0.0	28.4	0.0	0.0	31.1
0.0[1]	187.2	22.0	0.0	184.2	21.6	0.0	197.2	23.3
20.0	187.2	21.9	20.0	184.2	21.5	20.0	197.2	23.2
40.0	187.1	21.6	40.0	184.1	21.3	40.0	197.1	23.0
60.0	187.1	21.2	60.0	184.1	20.9	60.0	197.1	22.6
80.0	187.1	20.7	80.0	184.1	20.3	80.0	197.1	22.0
100.0	187.1	20.0	100.0	184.1	19.6	100.0	197.1	21.3
120.0	187.0	19.1	120.0	184.0	18.7	120.0	197.0	20.4
140.0	187.0	18.0	140.0	184.0	17.7	140.0	197.0	19.4
160.0	186.9	16.8	160.0	183.9	16.5	160.0	196.9	18.2
180.0	186.8	15.5	180.0	183.8	15.1	180.0	196.8	16.8
200.0	186.8	14.0	200.0	183.8	13.6	200.0	196.8	15.3
220.0	186.7	12.3	220.0	183.7	11.9	220.0	196.7	13.6
240.0	186.6	10.4	240.0	183.6	10.0	240.0	196.6	11.8
260.0	186.5	8.4	260.0	183.5	8.0	260.0	196.5	9.8
280.0	186.4	6.2	280.0	183.4	5.9	280.0	196.4	7.6
300.0	186.3	3.9	300.0	183.3	3.5	300.0	196.3	5.2
320.0	186.1	1.4	320.0	183.1	1.0	320.0	196.1	2.7
330.8[2]	186.1	0.0	327.8	183.1	0.0	340.5	196.0	0.0
330.9	180.0	0.4	327.9	180.0	0.2	340.9	180.0	1.2
331.3	160.0	1.8	328.3	160.0	1.5	341.3	160.0	2.5
331.6	140.0	2.9	328.6	140.0	2.7	341.6	140.0	3.7
331.9	120.0	3.9	328.9	120.0	3.7	341.9	120.0	4.7
332.2	100.0	4.8	329.2	100.0	4.6	342.2	100.0	5.5
332.4	80.0	5.5	329.4	80.0	5.3	342.4	80.0	6.2
332.5	60.0	6.0	329.5	60.0	5.8	342.5	60.0	6.8
332.7	40.0	6.4	329.7	40.0	6.2	342.7	40.0	7.2
332.7	20.0	6.7	329.7	20.0	6.4	342.7	20.0	7.4
332.8[3]	0.0	6.7	329.8	0.0	6.5	342.8	0.0	7.5

Notes

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

Cone contour



Dimensions in mm.

Fig.9 Cone contour.

Cone contour data

SECTION	NOMINAL DISTANCE FROM SECTION 1 (mm)	MAXIMUM DISTANCE FROM TUBE AXIS (mm)										
		0°	10°	20°	29.36°	30°	40°	50°	60°	70°	80°	90°
1	0.0	362.2	367.2	382.2	405.9	405.5	336.5	285.6	254.2	235.1	224.7	221.4
2	10.0	360.9	365.9	381.5	404.5	404.2	334.9	284.1	252.8	233.7	223.4	220.1
3	20.0	358.8	363.6	378.7	400.6	400.2	331.5	281.3	250.2	231.4	221.1	217.9
4	30.0	356.4	361.0	375.0	395.4	395.1	327.8	278.0	247.4	228.7	218.6	215.4
5	40.0	353.4	357.3	369.2	386.6	386.2	321.5	273.4	243.6	225.4	215.6	212.4
6	50.0	349.7	352.3	360.5	371.9	371.4	311.2	266.7	238.6	221.3	211.9	208.8
7	60.0	344.7	346.1	350.0	354.8	354.0	299.0	258.4	232.2	216.0	207.1	204.2
8	70.0	338.4	338.4	338.6	337.9	336.9	286.6	249.1	224.8	209.5	201.0	198.3
9	80.0	329.8	328.8	325.8	320.7	319.5	273.7	239.2	216.6	202.2	194.3	191.8
10	90.0	318.5	316.7	311.3	303.2	302.0	260.3	228.9	208.0	194.7	187.2	184.9
11	100.0	304.5	302.2	295.5	285.4	284.2	246.5	218.1	199.0	186.7	179.8	177.6
12	110.0	289.3	286.7	278.9	267.3	266.1	232.3	206.8	189.5	178.2	171.9	169.9
13	120.0	273.2	270.3	261.7	248.9	247.7	217.6	195.1	179.5	169.3	163.5	161.7
14	130.0	255.8	252.8	243.7	230.2	228.9	202.5	182.8	168.9	159.8	154.6	152.9
15	140.0	237.1	234.0	224.8	211.1	209.8	186.9	169.9	157.8	149.7	145.1	143.6
16	150.0	216.4	213.4	204.7	191.4	190.1	170.8	156.3	145.9	138.9	134.9	133.6
17	160.0	193.1	190.5	182.6	170.6	169.5	153.8	141.9	133.2	127.3	123.9	122.8
18	170.0	165.9	163.7	157.3	147.8	146.9	135.2	126.1	119.3	114.7	112.0	111.1
19	180.0	124.9	123.9	120.9	116.3	115.9	110.3	105.7	102.2	99.7	98.2	97.7
20	190.0	89.1	88.9	88.3	87.3	87.3	86.2	85.2	84.4	83.9	83.5	83.4
21	193.0	80.3	80.2	80.1	79.9	79.9	79.6	79.4	79.2	79.1	79.1	79.0

HANDLING

The packaging provides protection against tube damage under normal conditions of shipment or handling. Observe any instructions given on the packaging and handle accordingly. Under no circumstances should the tube assembly be subjected to accelerations greater than the values given in Table "Acceleration limits".

Acceleration limits

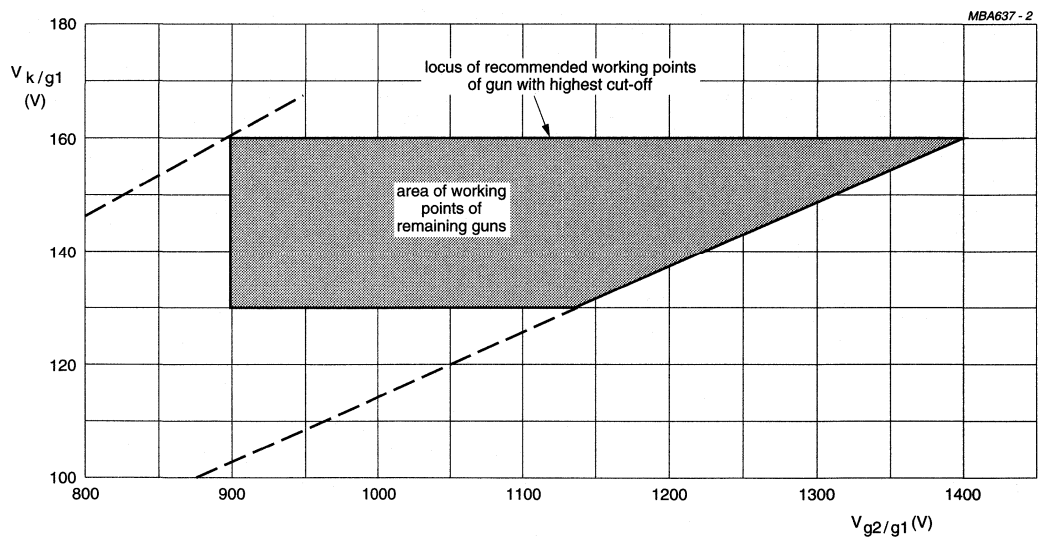
PARAMETER	CONDITIONS	MAX.	UNIT
Pulse in cone direction	≤10 ms	350	m/s^2
	>10 ms	150	m/s^2
Pulse in all other directions	30 ms	350	m/s^2

TYPICAL OPERATING CONDITIONS

SYMBOL	PARAMETER	CONDITION	MIN.	TYP.	MAX.	UNIT
V_a	anode voltage	full screen load	–	30	–	kV
V_{g5a}	horizontal focus voltage	screen centre	8.0	–	9.2	kV
V_{g5b}	vertical focus voltage	screen centre	7.9	–	9.1	kV
$V_{g5b\ dyn}$	horizontal parabola voltage	screen edge to edge	–	1000	–	V
$V_{g5b\ dyn}$	vertical parabola voltage	screen edge to edge; note 1	–	120	–	V
V_{g2}	grid 2 voltage		see Fig.10			
V_f	heater voltage	tube operating	5.7	6.15	6.6	V

Note

1. Only required for optimization. A good focus quality can also be obtained by omitting the vertical parabola and increasing the voltage on grid 5b (V_{g5b}) by approximately 50 V.



Grid 2 voltage (V_{g2}) adjusted for highest gun spot cut-off voltage V_k = 160 V.

Remaining guns adjusted for spot cut-off by means of cathode voltage.

V_{g2} range: 900 to 1400 V.

V_k range: 130 to 160 V.

Adjustment procedure:

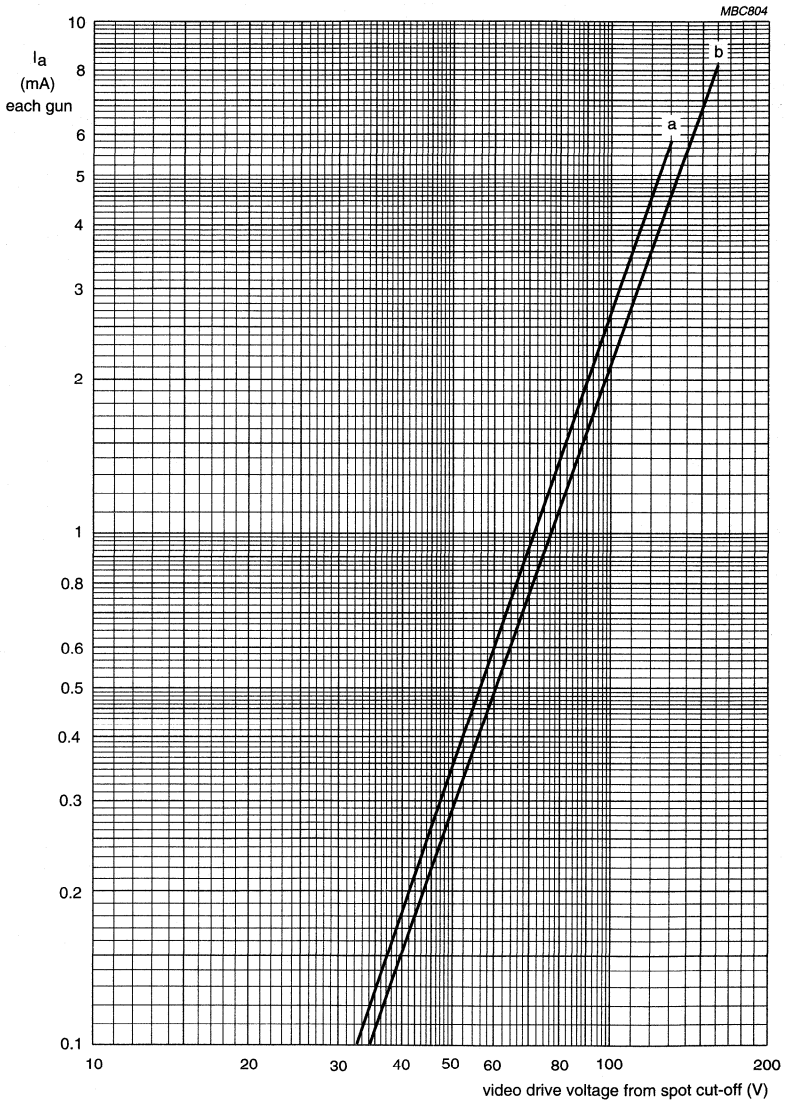
Set the cathode voltage (V_k) for each gun at 160 V; increase the grid 2 voltage (V_{g2}) from approximately 850 V to the value at which one of the colours becomes just visible. Now decrease the cathode voltage of the remaining guns so that the other colours also become visible.

Fig.10 Spot cut-off design chart.

CHASSIS DESIGN VALUES

The values are valid for anode voltages between 28 and 33 kV. The voltages are specified with respect to grid 1. For optimum picture performance it is recommended that the cathodes are not driven below +1 V.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
V_{g5a}	grid 5a focus voltage as a percentage of anode voltage		26.7	–	30.7	%
V_{g5b}	grid 5b focus voltage as a percentage of anode voltage		26.3	–	30.3	%
V_{g2}	grid 2 voltage	for visual extinction of focusing spot	see Fig.10			
V_k	cathode voltage		see Figs 10 and 11			
ΔV_k	difference in cut-off voltage in any tube		lowest value >80% of highest value			
V_f	heater voltage	tube operating	–	6.15	–	V
$I_{g5a,g5b}$	focus current		–2	–	+2	µA
I_{g2}	grid 2 current		–2	–	+2	µA
I_{g1}	grid 1 current	at cut-off	–2	–	+2	µA
I_{kf}	cathode/heater current		–2	–	+2	µA
R_{ins}	insulation resistance between each cathode and all other electrodes and heater		50	–	–	MΩ
Anode currents to produce white of 6500 K + 7 MPCD (CIE coordinates x = 0.313; y = 0.329)						
PERCENTAGE OF THE TOTAL ANODE CURRENT SUPPLIED BY EACH GUN						
	red gun		–	41.3	–	%
	green gun		–	34.4	–	%
	blue gun		–	24.3	–	%
RATIO OF ANODE CURRENTS						
	red gun to green gun		0.85	1.20	1.55	
	red gun to blue gun		1.20	1.70	2.20	
	blue gun to green gun		0.40	0.70	1.00	



V_f = 6.15 V.
V_a = 30 kV.
V_{g5a} and V_{g5b} adjusted for focus.
V_{g2} (each gun) adjusted to provide spot cut-off for V_k = 130 V (curve a) and V_k = 160 V (curve b).

Fig.11 Typical cathode voltage drive characteristic.

LIMITING VALUES

In accordance with the Absolute Maximum Rating System (IEC 134). Voltages are specified with respect to grid 1.

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_a	anode voltage	notes 1 and 2	28	33	kV
		at zero beam current	–	36[3]	kV
I_a	long-term average anode current for three guns		–	1600	μA
	short-term average anode current for three guns		–	2000	μA
$V_{g5a/g5b}$	focus voltage	note 4	–	12	kV
$\Delta V_{g5a-g5b}$	differential focus voltage		–	3	kV
V_{g2}	grid 2 voltage	note 5	–	1600	V
V_f	heater voltage	note 6	5.7	6.6	V
Cathode voltage					
V_{kp}	positive peak		–	250	V
V_k	during switch-off		–	250	V
V_k	positive operating cut-off		–	180	V
V_k	negative		–	0	V
V_{kp}	negative peak		–	–2	V
Cathode to heater voltage					
V_{kf}	positive		–	250	V
V_{kfp}	positive peak		–	300	V
V_{kf}	negative		–	0	V
V_{kfp}	negative peak		–	–50	V
Circuit limiting values					
R_{g5a}, R_{g5b}	grid 5a, grid 5b circuit resistance		–	70	MΩ
R_{g2}	grid 2 circuit resistance		–	7	MΩ
R_{g1-k}	grid 1 to cathode circuit resistance		–	750	kΩ

Notes

1. During adjustment on the production line this value is likely to be surpassed considerably. It is therefore strongly recommended to first make the necessary adjustments for normal operation without the picture tube.
2. Operation of the tube at lower voltages impairs the luminance and resolution and could impair convergence.
3. This value is an absolute maximum.
4. During flash-over maximum 20 kV is allowed.
5. During adjustment on the production line a maximum value of 1800 V is allowed.
6. For maximum cathode life and optimum performance it is recommended that the heater supply is designed for 6.15 V at average beam current, for most applications this equals 6.3 V at zero beam current. **The heater supply source impedance must not be less than 2 Ω.**

FLASHOVER PROTECTION

With the high voltage used with this tube (max. 36 kV) internal flashovers may occur. As a result of Soft-Flash technology these flashover currents are limited to approximately 100 A offering higher reliability, optimum circuit protection and component savings.

Primary protective circuitry using properly grounded spark gaps and series isolation resistors (preferably carbon composition) is still necessary to prevent tube damage. The spark gaps should be connected to all picture tube electrodes at the socket in accordance with Fig.12; they are not required on the heater pins. No other connections between the outer conductive coating and the chassis are permissible. The spark gaps should be designed for a breakdown voltage of less than 20 kV at the focus electrode (g5) and less than 2 kV at the other electrodes, both at an atmospheric pressure of 100 kPa.

The values of the series isolation resistors should be as high as possible (min. 0.5 kΩ) without causing deterioration of the circuit performance. The resistors should be able to withstand an instantaneous surge of 20 kV for the focusing circuit and 12 kV for the remaining circuits without arcing.

To guarantee the soft flash behaviour, the internal dynamic resistance of the tube during flashover is a minimum 400 Ω and a maximum 800 Ω.

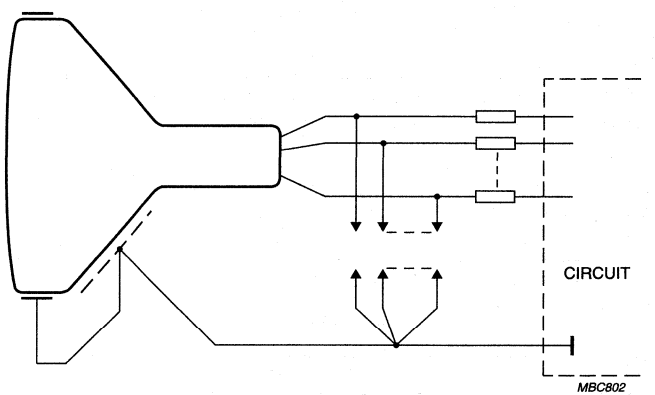


Fig.12 Flashover protection circuit.

X-RADIATION

Maximum anode voltage at which the X-radiation emitted will not exceed 0.5 mR/h at an anode current of 300 μA.

PARAMETER	VALUE
Entire tube; note1	40.6 kV
Face-plate only	42.0 kV

Note

1. This rating applies only if the anode connector used by the set maker provides the necessary attenuation to reduce the X-radiation from the anode contact by a factor equal to the difference between the anode button iso-exposure-rate limit curve and the iso-exposure-rate limit curve for the entire tube.

WARNING
If the value for the tube face only is used as design criteria, adequate shielding must be provided in the TV receiver for the anode contact and/or certain portions of the tube funnel and panel sidewalls to ensure that the X-radiation from the TV receiver is attenuated to a value equal to or lower than that specified for the face of the tube.
The X-radiation emitted from this picture tube, as measured in accordance with the procedure of *"JEDEC Publications No.64D"* will not exceed 0.5 mR/h throughout the useful life of the tube when operated within the design-maximum ratings.
The tube should not be operated beyond its design-maximum ratings stated above, but its X-radiation will not exceed 0.5 mR/h for anode voltage and current combinations given by the iso-exposure-rate limit characteristics as shown in Fig.14.
Operation above the values shown by the curve may result in failure of the TV receiver to comply with the *"Federal Performance Standard of the U.S. for Television Receivers, Section 1020.10 of Part 1020 of Title 21, Code of Federal Regulation".*
Maximum X-radiation as a function of anode voltage at 300 μA current is shown by Fig.13. X-radiation at a constant anode voltage varies linearly with anode current.

WARNING
The cathode ray tube is intrinsically safe in accordance with *"Appendix III Röntgenverordnung".*
Eigensichere Kathodenstrahlröhre nach *"Anlage III Röntgenverordnung".*

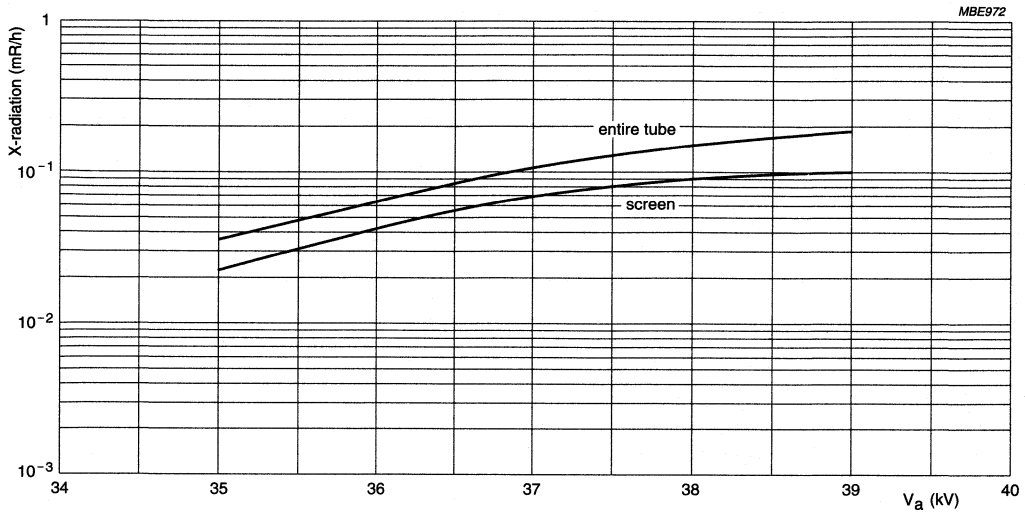


Fig.13 X-radiation limit curves at a constant anode current of 300 μA.

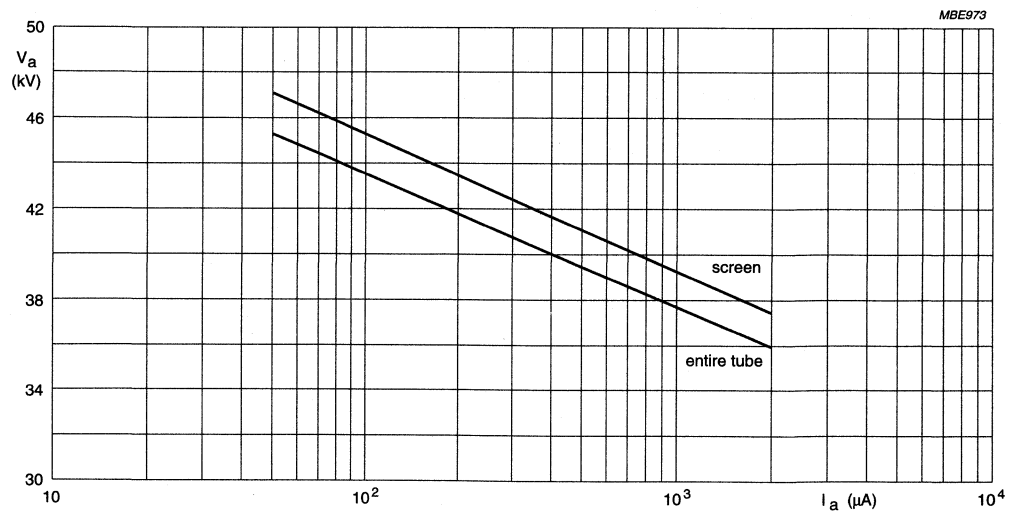
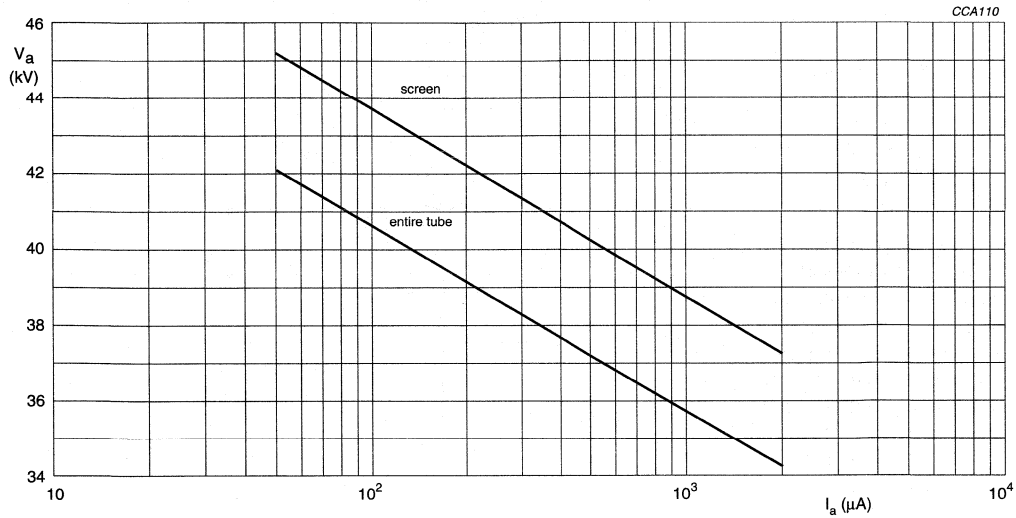


Fig.14 Iso-exposure-rate limit curves at 0.5 mR/h.



The tube does not emit X-radiation above 1 μSv/h when operated at 33 kV and 2.0 mA. The X-radiation emitted will also not exceed 1 μSv/h for anode voltage and current combinations shown in the iso-exposure-rate limit curve.

Fig.15 1 μSv/h iso-exposure-rate limit curve.

MAGNETIC FIELD CONDITIONS

This tube is designed for world wide use.

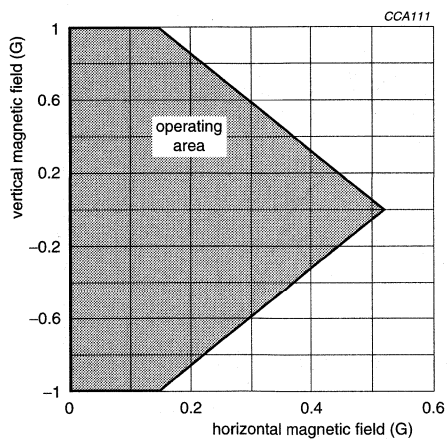


Fig.16 Allowable horizontal and vertical magnetic fields operation area.

DEGAUSSING

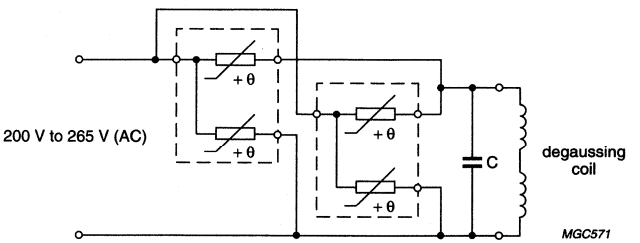
The picture tube is provided with an internal magnetic shield. This shield and the shadow mask with its suspension system should be provided with an automatic degaussing system, consisting of coil(s) covering the top and bottom cone parts.

For proper degaussing an initial magnetomotive force (MMF) of 500 ampere-turns is required in each coil. This MMF must be gradually decreased (maximum 20% per half period) by appropriate circuitry. To prevent beam landing disturbance by line frequency currents induced in the degaussing coils, these coils should be shunted by a capacitor of sufficiently high value. In steady state, no significant MMF should remain in the coils (≤0.15 ampere-turns).

If single-phase power rectification is employed in the TV circuitry, provision should be included to prevent asymmetric distortion of the AC voltage applied to the degaussing circuit due to high DC inrush currents.

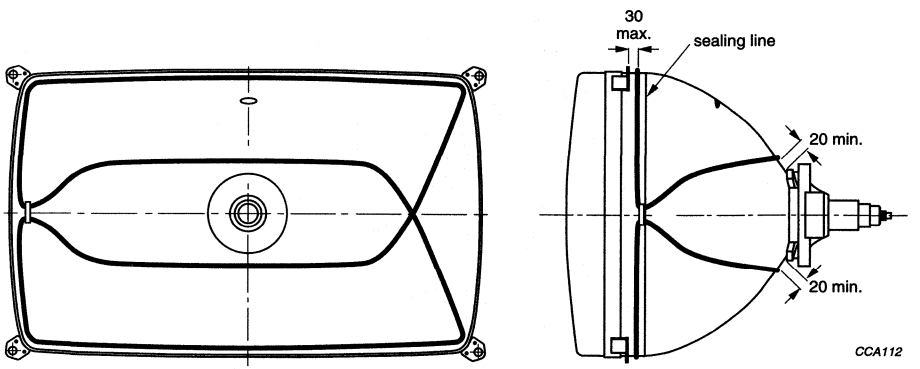
Data of degaussing coils

PARAMETER	TYP.	UNIT
Circumference	365	cm
Number of turns	70	
Copper wire diameter	0.45	mm
Resistance	29	Ω



C = 100 nF.

Fig.17 Typical degaussing circuit using two paralleled dual PTC thermistors 2322 662 96126.



Dimensions in mm.

Fig.18 Asymmetrically positioned degaussing coils.

'Black Line WSF' colour picture tube assembly

W76ESF031X44

FEATURES

- 100 Hz vertical repetition
- Factory preset tube/coil assembly
- Self-converging and north-south raster correction free
- Scan Velocity Modulation (SVM) for improved picture sharpness
- 76 cm, 106° colour picture tube W76ESF031X
- Double mussel deflection unit.

QUICK REFERENCE DATA

PARAMETER	TYP.	UNIT
Deflection angle	106	deg
Nominal useful screen diagonal	76	cm
Overall length	<52.4	cm
Glass transmission	45.7	%
Neck diameter	32.8	mm
Anode voltage	30	kV

Black Line WSF

'Black Line WSF' colour picture tube assembly

W76ESF031X44

DEFLECTION UNIT DATA

All measurements are performed at a horizontal frequency of 32 kHz.

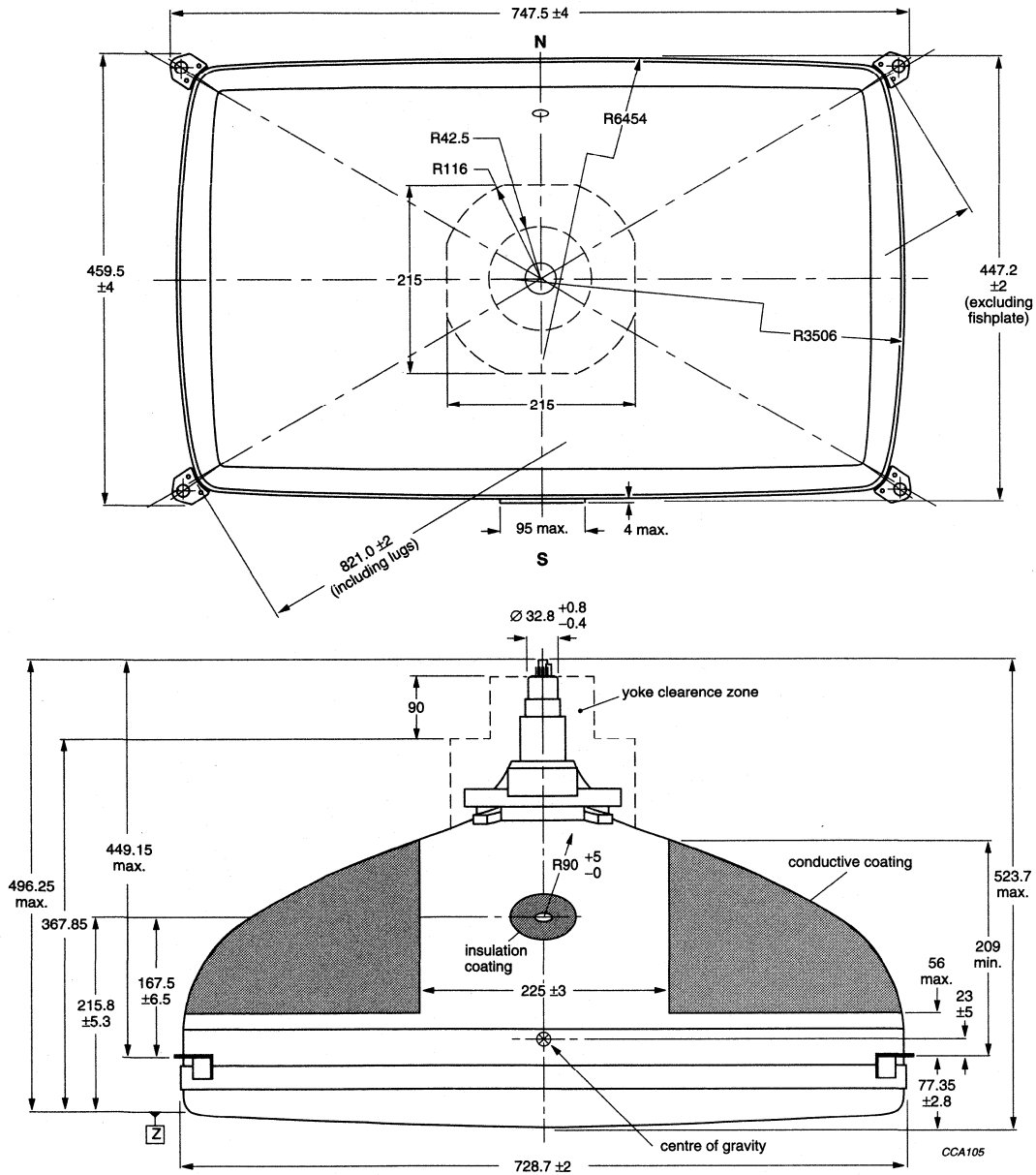
PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Horizontal deflection coils					
Inductance		0.29	0.30	0.31	mH
Resistance	T_{amb} = 25 °C	0.32	0.34	0.36	Ω
Magnetic flux		3.25	3.46	3.67	mWb
Deflection current (peak-to-peak value)	edge-to-edge; V_a = 30 kV	–	11.5	–	A
Average copper temperature	note 1	–	–	110	°C
Temperature rise (ΔT)	V_a = 30 kV; I_a = short term average value	–	50	–	°C
Vertical deflection coils					
Inductance		8.38	8.82	9.26	mH
Resistance	T_{amb} = 25 °C	5.99	6.31	6.63	Ω
Vertical voltage		8.04	8.64	9.25	V
Deflection current (peak-to-peak value)	edge-to-edge; V_a = 30 kV	–	1.37	–	A
Average copper temperature	note 1	–	–	110	°C
Temperature rise (ΔT)	V_a = 30 kV; I_a = short term average value	–	35	–	°C
SVM coils					
Inductance		1.81	1.85	1.89	μH
Resistance		0.63	0.90	1.17	Ω
Sensitivity					
centre		1.56	1.63	1.70	mm/A
edge		3.28	3.45	3.62	mm/A
Deflection unit					
Permissible DC voltage					
between horizontal and vertical coils		–	–	2000	V
between horizontal and yoke ring		–	–	2000	V
between vertical coils and yoke ring		–	–	300	V
Insulation resistance	1 kV (DC)				
between horizontal and vertical coils		500	–	–	MΩ
between horizontal coil and yoke ring		500	–	–	MΩ
between vertical coil and yoke ring		10	–	–	MΩ
Cross-talk from horizontal to vertical coils	1 V; 500 Hz applied to the horizontal deflection coils	–	–	45	mV

Note

1. Measured by the resistance method.

'Black Line WSF' colour picture tube assembly

W76ESF031X44

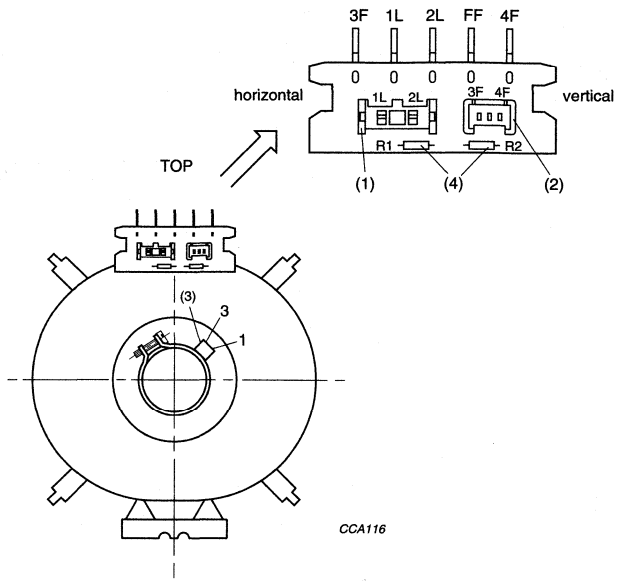


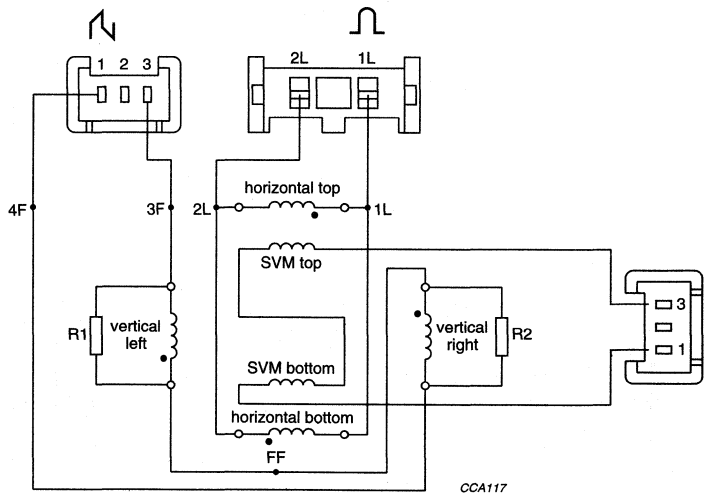
Dimensions in mm.

Fig.1 Assembly dimensions.

'Black Line WSF' colour picture tube assembly

W76ESF031X44





The beginning of the windings is indicated with •

(1) Horizontal connector: AMP Ultrex connection system; connector 2-173270-2; matching connector 2-173268-2.

(2) Vertical connector: Stocko system RFK1 (MKS series); matching connector MKF17033, MKF17330 or MKF17360 series.

(3) SVM connector: Stocko system RFK1 (MKS series); matching connector MKF17033, MKF17330 or MKF17360 series.

(4) R1 = R2 = 100 Ω, 0.25 W.

Fig.2 W76ESF031X44 deflection coils.

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Data handbook system

DATA HANDBOOK SYSTEM

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IC04	HE4000B Logic Family CMOS
IC05	Advanced Low-power Schottky (ALS) Logic
IC06	High-speed CMOS Logic Family
IC11	General-purpose/Linear ICs
IC12	I^2C Peripherals
IC13	Programmable Logic Devices (PLD)
IC14	8048-based 8-bit Microcontrollers
IC15	FAST TTL Logic Series
IC16	CMOS ICs for Clocks and Watches
IC17	Semiconductors for Wireless Communications
IC18	Semiconductors for In-Car Electronics
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SC08b	RF Power Transistors for UHF
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