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Data handbook

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Electronic components and materials

Electron tubes

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Power tubes for RF heating and communications

POWER TUBES FOR RF HEATING AND COMMUNICATIONS

GENERAL SECTION

RATING SYSTEM

(in accordance with IEC Publication 134)

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 life, no absolute maximum value for the intended service is exceeded with any device under the worst probable operating conditions with respect to supply 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.

LIST OF SYMBOLS

a	Anode
B	Bandwidth; magnetic flux density
C_a	Capacitance between anode and all other electrodes
C_{af}	Capacitance between anode and filament (all other electrodes being earthed)
C_{ag}	Capacitance between anode and grid (all other electrodes being earthed)
C_{ak}	Capacitance between anode and cathode (all other electrodes being earthed)
C_{gf}	Capacitance between grid and filament (all other electrodes being earthed)
C_{g1g2}	Capacitance between these two grids (all other electrodes being earthed)
C_{gk}	Capacitance between grid and cathode (all other electrodes being earthed)
C_i	Input capacitance
C_n	Neutralizing capacitance
C_o	Output capacitance
d	Harmonic distortion factor
d_n	n-th order intermodulation products
d_{tot}	Total harmonic distortion
f	Filament or heater; frequency
f_c	Filament or heater centre tap
f(k)	Filament (and cathode) RF connection
g	Grid
G	Power gain
h	Height above sea level
I_a	DC anode current
I_f	Filament or heater current
I_g	DC grid current
I_k	DC cathode current
IMP	Inter modulation products
I_p	Peak value of a current
k	Cathode
m	Modulation factor
p	Pressure
ΔP	Pressure drop of cooling air or cooling water
q	Rate of flow of cooling air or cooling water
R_a	Anode output AC resistance
R_{aa}	Anode to anode AC resistance
R_{fo}	Filament or heater resistance in cold condition
R_g	External grid resistor

R_k	External cathode resistor
R_{th}	Thermal resistance
s	Internal shield
S	Transconductance
T	Temperature
t	Duration
T_a	Temperature of anode body
T_{amb}	Ambient temperature
T_{bulb}	Bulb temperature
T_{env}	Envelope temperature
T_i	Inlet temperature of cooling air or cooling water
t_p	Pulse duration
T_o	Outlet temperature of cooling air or cooling water
T_{pin}	Pin temperature
T_s	Seal temperature
t_w	Waiting time (time which has to elapse between switching on the filament or heater voltage and switching on of the other voltages)
V_a	DC anode voltage
$V_{a\sim}$	Amplitude anode AC voltage
V_f	Filament or heater voltage
V_g	DC grid voltage
$V_{g\sim}$	Amplitude grid AC voltage
V_{kf}	Voltage between cathode and heater
V_p	Peak value of a voltage
V_{rms}	Root mean square value of a voltage
V_{tr}	Secondary transformer voltage
W_a	Anode dissipation
W_{dr}	Driving power
W_g	Grid dissipation
W_i	Input power
W_ℓ	Output power in the load
W_{mod}	Modulation power
W_o	Anode output power
W_{oPEP}	Peak envelope output power
W_{osc}	Oscillator output power
W_{Rg}	Grid resistor dissipation
δ	Duty factor
η	Efficiency
η_a	Anode efficiency
η_{osc}	Oscillator efficiency
λ	Wavelength
μ	Amplification factor
μ_{g2g1}	Amplification factor of grid 2 with respect to grid 1.

GENERAL OPERATIONAL RECOMMENDATIONS

1 PREFACE

1.1 In this handbook, data and curves are given for transmitting tubes for communications and tubes for RF heating.

1.2 The tubes are classified as follows:

D = **Design type.** Recommended for equipment design; production quantities available at date of publication.

C = **Current type.** No longer recommended for equipment design; available for equipment production and for use in existing equipment.

M = **Maintenance type.** No longer recommended for equipment production; available for maintenance of existing equipment.

O = **Obsolescent type.** Available until present stocks are exhausted.

Obsolescent types of which all stocks are exhausted are called **obsolete**; any data still published on these types is for reference purposes only.

The status of all types is given in a type survey at the end of the general section, together with data in condensed form. Full details are given of design and current types, divided into chapters as mentioned on the title page.

1.3 The characteristic data is general and independent of specific applications. This data, such as filament/heater current, amplification factor, transconductance and capacitances is given for a typical tube.

2 CHARACTERISTIC DATA

2.1 Inter-electrode capacitances

The published values of capacitances are average values measured on the cold tube with no operating voltages; individual deviations may however occur. The definitions of the capacitance symbols are given in the appropriate list in **IEC publication 100.**

2.2 Amplification factor μ and transconductance S

The published values are average values and individual deviations may occur. The conditions at which the values have been measured are stated.

2.3 Accessories

Proper functioning of the tubes can be guaranteed only if accessories (sockets, cooling devices etc.) have been supplied, or approved, by the tube manufacturer.

3 FILAMENT/HEATER SUPPLY

3.1 General

The published value of filament/heater voltage is that which should be present at the tube terminals. Filaments fed with direct current should have their supply polarity reversed at regular intervals (say monthly) to ensure uniform wear of the filament with consequent longer life. Reduction of filament/heater voltage is sometimes recommended to compensate for heating by back-bombardment at high frequencies; see the relevant data sheets. Special precautions must be taken when operating the filaments/heaters of transmitting tubes in series and the manufacturer should be consulted before doing so.

3.2 Thoriated tungsten cathodes (filaments)

To achieve satisfactory life the desired dynamic tube performance should be obtained at the nominal voltage specified in the relevant data sheet. Generally, in order to obtain prolonged tube life, the desired dynamic tube performance should initially be obtained at the nominal voltage. Then (e.g. after approximately 50 h), without changing anything else, the filament voltage may be reduced to the lowest value where satisfactory dynamic tube performance is still obtained. The heater voltage has to be closely regulated (about 1 per cent) and to be rechecked from time to time to avoid influence of the mains. The filament voltage should be checked with a precision instrument (with 1 per cent accuracy) of the iron-vane or thermo-couple type directly across the tube terminals. Deviations, even for short periods, in excess of +5% and −10% are not allowed under any circumstances. Reset filament voltage to the nominal value before running a new tube.

Waiting time should be read in conjunction with section 4.2 of these General Operational Recommendations.

3.3 Switching on the filament

Switching on at full filament voltage is permissible unless a maximum switch-on value of filament current is stated in the data sheet. For the published values of maximum permissible filament current during switch-on, refer to the absolute maximum of the instantaneous value under worst case conditions.

3.4 By-passing the filament

Tubes with directly heated cathodes must have the filament terminals at the same RF potential. For this purpose it is usual to connect a capacitor which has low reactance with respect to the operating frequency, close to and between the filament terminals. As an added safety precaution, it should be ensured that the resonance of this capacitor together with the inductance of the filament structure, falls well below the operating frequency.

3.5 Switching on electrode voltages

Unless stated otherwise (e.g. cathode heating time t_W), simultaneous switching on of filament, control grid, anode and screen grid voltages is permissible for tubes with an internal anode. Tubes with an external anode should in general not have their positive voltages applied until the cathode has reached its operating temperature. This can be checked by monitoring the filament current.

3.6 Effective cathode

If both filament limbs are marked 'f' in the data sheets, the filament may be regarded as being symmetrical in its function as cathode. If such a filament is fed with DC the anode return lead should be connected to the negative end of the filament. All other decoupling and circuit returns must then also be connected to this point.

If the filament is fed with AC, the anode return lead should be connected to the centre-tap of the filament transformer or to a tapped resistor shunted across the filament. The filament decoupling will then be symmetrical with regard to this point and all other circuit returns must also be made to this point.

If one filament limb is marked 'f' and the other 'f(k)', only the one marked 'f(k)' may be used as the circuit cathode. If such a filament is fed with DC, the negative side of the filament supply should be connected to this point.
For either AC or DC filament supply, the anode supply, as well as decoupling and other circuit returns, must be connected to 'f(k)' only.

4 INITIAL OPERATION OF TUBE

4.1 Switching on the heater voltage

Ensure that any necessary cooling system is operative.

Sections 3.5 and 3.6 are applicable. The grid bias may be applied simultaneously.

4.2 Conditioning a tube

Conditioning is recommended for new tubes, after transit and after a period of storage. It is carried out by running the filament/heater only for at least 15 minutes before energizing the other electrodes, see also section 5.6.

Industrial tubes with anode voltages above 5 kV should also be operated for approximately 15 minutes at reduced anode voltage before applying full input ($V_a \times I_a$).

Television triodes and tetrodes may be operated for 15 minutes with the specified anode current in a no-signal condition. This treatment will remove any traces of gases which could cause premature failure of the tube.

4.3 Application of screen grid voltage to tetrodes

The screen grid voltage, V_{g2}, should be applied only when the anode voltage is present. If the anode voltage is removed, a safety circuit in the anode supply should cause the simultaneous removal of drive and screen grid voltages. If high voltage transients are present, it may be necessary to protect the cathode and control grid from arcing by means of a spark gap or protection diode across the relevant electrodes.

5 LIMITING VALUES

5.1 Notation

Limiting values are the maximum or minimum permissible values of the parameters listed. These limits are given either for all operating conditions together, or for an individual application.
The limiting values are applicable up to the maximum frequency stated. When operating at higher frequencies the limiting values must be decreased in accordance with the published figures or curves.

5.2 Derating of limiting values

If no limiting values have been published for a specific application, the derating factors listed in the following table must be applied. The values for class C telegraphy have been expressed as unity; the limiting values for other applications have been expressed as a factor of this unity.
A rectified 3-phase supply with or without filtering is equivalent to a DC supply.
The derating factors are determined by the physical limits of the tube and contain no safety margins. Where mains voltage fluctuations occur, further derating must be applied (see section 5.4). The nature of operation, e.g. industrial applications of heating generators, may necessitate further safety derating.

Table 1 Derating factors

	V_a	I_a	I_g	W_{ia}	W_a	W_{g2}
RF class C telegraphy	1	1	1	1	1	1
Anode modulation	0.8	0.833	1	0.67	0.67	0.67
RF class B	1	0.833	1	0.833	1	0.67
AF class B	1	1	1	1	1	1
AF class AB	1	1	1	1	1	1
AF class A	1	1		W_a	1	1
Self-rectifying oscillator	1.13	0.53	0.53	0.665	1	
Two-phase half-wave without filter	0.9	0.89	0.89	1	1	

5.3 Rating system

The limiting values should be used in accordance with the 'Absolute maximum rating system' as defined by IEC publication 134.

5.4 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.

Absolute maximum rating system (continued)

The equipment manufacturer should design so that, initially and throughout life, no absolute maximum value for the intended service is exceeded with any device under the worst probable operating conditions with respect to supply voltage variation, equipment 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.

5.5 Limiting values

Each limiting value should be regarded independently of other values; under no circumstance is any limiting value to be exceeded (e.g. if the anode voltage is decreased to a value lower than its limiting value, it is not permissible to exceed the limiting value of anode current or anode dissipation).

5.6 Electrode voltages

The voltages (V_a, V_{g1}, V_{g2} etc.) listed under limiting values should not be exceeded even with a cold tube. Special attention should be paid to this point when a screen grid is supplied via a series resistor.

When designing equipment to be operated from an unstabilized mains supply, the maximum mains voltage which occurs determines the nominal operating voltages of the tube. These nominal voltages must be lower than the limiting values. Should the tube and thus the voltage supply, be temporarily under a lower load, these voltages may rise and these increased values, occurring at the highest mains voltage, determine the nominal operating voltages.

The limiting values of voltage are DC values. If an AC or an unsmoothed DC supply is used, the limiting values must be decreased in accordance with the derating factors shown in the table (section 5.2.).

5.7 Anode dissipation

The limiting value of the anode dissipation, W_a, should not be exceeded when fluctuations in the mains supply voltage occur, or when grid drive fails. To prevent damage to the tube in the latter case, adequate fixed bias or a quick action relay in the anode lead should be provided. When forced-air or water cooling is sufficient only for an anode dissipation smaller than the absolute maximum, the smaller value must be regarded as the limiting value.

5.8 Anode input power

Usually the data sheets show the limiting value of input power W_{ia} to be smaller than the product of limiting values of anode voltage and anode current; the latter two limits should not therefore occur simultaneously.

In practice, the input power W_{ia} is not always the product of the DC values of I_a and V_a. For pulsating supply voltages the form factor should be taken into account.

5.9 Screen grid dissipation, W_{g2}

The screen grid dissipation is the product of screen grid voltage and current. The screen grid should be protected against failure of anode voltage, see also section 4.3.

5.10 Control grid dissipation

The control grid dissipation W_g or W_{g1} can be approximated by subtracting the power supplied to the grid bias source ($-V_g \times I_g$) from the grid driving power (approx. $0.95 \times V_{gp} \times I_g$). When an AC or unsmoothed DC voltage supply is used, the form factor should be taken into account, see table in section 5.2 with the necessary derating factors.

5.11 Grid resistor

The maximum value of grid resistor, R_g max. (when published) should not be exceeded. This value is the maximum DC resistance in the grid circuit. A higher value may cause instability.

6 OPERATING CONDITIONS

6.1 General

In the published data, operating conditions for various applications have been given, stating the maximum frequency at which the conditions apply. If it is required to operate a tube at higher frequencies, the manufacturer should be consulted. The published values of operating conditions are average values derived from measurements made on a number of tubes of the same type, operating at optimum conditions.

Thus, small deviations from the published value may occur if measurements are made on an individual tube. However, some of the measured values of voltage or current must be adjusted to give the published figure. For example, the published value of output power is an average value which can be reached in practice by adjusting the RF or AF input voltage V_{gp}, when the published value of output power is not obtained at the nominal value of V_{gp}. When designing a multi-stage transmitter it is good practice to leave a margin in the output power and input voltage to allow for adjustments similar to that just described.

The published output power W_o of transmitting tubes is the tube's output, which may be determined by subtracting the anode dissipation W_a from the anode input W_{ia}. When a tube is used in a common grid circuit (grounded grid), the published value of the output power includes the power transferred from the driver.

Unless otherwise stated, losses in the anode circuit and coupling losses are not taken into account.

The quoted grid input power is assumed to be 0,95 x the product of the average grid current I_g and the positive amplitude of the grid voltage $V_{g\sim}$. Losses in the grid circuit and the bleeder are sometimes accounted for by stating the required driver output power.

At high frequencies where reduced ratings have to be applied, the required driving power will often be considerably higher than the grid input power, due to circuit losses.

6.2 RF class C telegraphy and FM telephony

A class C amplifier or oscillator is one in which the grid bias is appreciably greater than the cut-off voltage so that current flows for less than one half of each cycle of the alternating grid voltage. Working to the published operating conditions will ensure good output power and efficiency.

If a grid resistor is used for obtaining automatic bias, care must be taken that the anode current does not become too high if the RF driving power should fail. A safety device in the anode or screen grid lead should be incorporated for this purpose.

6.3 RF class C anode and screen grid modulation

In an RF class C anode modulated stage the anode voltage is modulated with AF and at 100% modulation the voltage is varied from zero to twice the DC value. The average values of grid bias and RF driving voltage remain constant during modulation. With 100% modulation the average anode dissipation is 1,5 times the value without modulation and this is taken into account, although the published limiting value of anode dissipation refers to the unmodulated power.

6.4 RF class B telephony

A class B amplifier is one in which the grid is biased to cut-off voltage so that the anode current flows for approximately one half of each cycle of the alternating grid voltage. The published data for RF class B telephony has been determined experimentally to give a linear modulation characteristic.

6.5 Industrial operating conditions

With a single phase mains supply, smoothing will sometimes be omitted as is normal in a three phase mains supply. Operating conditions and derating factors are given for this kind of operation (section 5.2.). It must be ensured that no limiting values are exceeded because of fluctuations in the mains supply or by tolerances in other components. The published value of W_o is the actual tube output power. The output power of a self-oscillating circuit W_{osc} is obtained by subtracting the grid dissipation W_g and the losses in the grid resistor W_{Rg} from the output power W_o. The power in the load W_l is obtained by subtracting the losses in the output circuit from W_{osc}. A favourable load output characteristic may be obtained by automatically controlling the grid voltage and current, depending on the matching. A non-linear device e.g. a tungsten lamp or a PTC thermistor may be used to perform this function adequately and help to prevent overloading the grid.

With self-oscillating circuits, the frequency must be held within the available frequency band. This may be done by having large circuit capacitance, small stable self inductance, undercritical inductive coupling with the output circuit, electrostatic screening between oscillator and output circuit, etc. If the frequency of an industrial generator is restricted to a very narrow band, crystal controlled driver stages may have to be used. It will then, however, be difficult to maintain a good match between tube and load over the whole of the processing cycle. Greater safety margins will have to be set for the tube, with the tube output very dependent on variations in the load. Special measures, such as automatic tuning and/or load matching, may have to be taken.

For smaller tubes in industrial applications, operating conditions have been given for an anode supply from a single phase full-wave rectifier, a three phase half-wave rectifier (which is nearly equivalent to DC) and with raw AC. In the latter case the output is about 0,6 times that obtained with DC and the peak inverse voltage is equal to the full anode voltage. With a single-phase, full-wave rectified anode voltage the useful output is nearly equal to that with a DC supply.

6.6 Intermittent service

When data concerning intermittent service is published, it is conditional that, although the cathode may be heated continuously, the on-period is no more than 5 minutes and that the off-period is equally long or longer.

7 COOLING

7.1 Temperature limits

The maximum temperatures given in the data should be heeded and operating temperatures should be kept well below these values in the interest of tube life. Surface (envelope) temperatures may be checked with the help of suitable thermocouples, thermocrayons, thermopaints or stick-on markers.

7.2 Cooling of the tube header

In order to maintain all parts of the tube header, i.e. contact surfaces and ceramic to metal or glass to metal seals, at temperatures below the limits given in the data, it may be necessary, depending on the surroundings and ambient temperatures, to provide some extra cooling even at low frequencies. At frequencies above 4 MHz such extra cooling becomes mandatory for all types. For this purpose an axial air stream is preferred since this will ensure a more even temperature around the circumference of the individual electrodes. This will already be assisted by also ensuring an even distribution of the high frequency currents around the seals.

7.2.1 Forced air cooled tubes

The anode cooler air will in most cases also effectively cool the seals, provided it is directed in such a way that the seals are not protected from this air stream.

7.2.2 Water cooled tubes

Unless environmental conditions make it necessary, additional cooling of the seals will be mandatory only at frequencies above 4 MHz. If some of the cooling water can be branched off, this may also serve as coolant through pipes that are in good thermal contact with the respective connectors. Such pipes are already integral with the filament connectors of industrial types YD1192 to YD1342. Their use with a reliable water flow is strongly recommended.

7.3 Minimum coolant quantities

When determining the minimum coolant flow through the cooler, account must be taken of the maximum inlet temperature and the maximum anode dissipation that may occur under the prevailing circumstances.

7.3.1 Minimum forced air flow

The temperature, dissipation and flow relationships are given in the published data, tables and curves. The temperature rise of the cooling air may be found from the following formula:

$$\Delta T = \frac{50 \times W_{tot}}{Q}$$

where Q = air flow in m^3/min

W_{tot} = anode + grid + filament dissipation in kW

ΔT = temperature rise in K

This formula holds for an ambient temperature of 20 °C at sea level. Whenever the ambient conditions (temperature, altitude) are beyond those shown in the published data, the tube supplier must be consulted.

COOLING (continued)

7.3.2 Minimum cooling water flow

The amount of cooling water required is given in the published data. The temperature rise of the cooling water may be found from the following formula:

$$\Delta T = \frac{14{,}4 \times W_{tot}}{Q}$$

where Q = water flow in litres/min

W_{tot} = anode + grid + filament dissipation in kW

ΔT = temperature rise in K

7.4 Natural cooling

This is applicable only to internal anode glass envelope tubes with a maximum anode dissipation of up to about 1 kW. A chimney around and extending above the tube will assist natural convection. For operation at higher frequencies additional cooling of the electrode pins, the tube socket and the bulb is often required. Temperature checks may be carried out as noted in section 7.1.

7.5 Forced air cooling

When using air as a cooling medium the intake must be properly filtered to prevent blockage of the anode radiator. All electrical supplies to the tube should be interlocked with a flow sensor in the exhaust stream. Temperature checks may be carried out as noted in section 7.1.

7.6 Water cooling

The direction of water flow, indicated by arrows near the water inlets and outlets of the tube are for when the tube is mounted 'anode down'. When reversing the position of the tube, i.e. 'anode up', the direction of flow should be reversed. Re-circulating systems are preferred, since, apart from saving water, they help to ensure a high standard of purity.

Some of the requirements for satisfactory cooling water are that it should not be corrosive or deposit scale, should not contain insoluble material that might cause blockages and should have a high electrical resistance to prevent electrolysis. Its mineral content and electrical conductivity should therefore be periodically checked, especially when it is not drawn from a circulating system.

In general a non-corrosive water should be low in chlorides, and dissolved oxygen and carbon dioxide.

Scale formation may be avoided by maintaining a low amount of silica and bicarnonates, especially calcium bicarbonate. The total carbonate hardness should not exceed a value of 6° dH.

No exact figures can be given for impurities as they are interdependent.

However, in a circulating system the water should be as free as possible from all solid matter, and the dissolved oxygen content should be low. Whenever possible a closed water system using distilled or demineralized water should be employed. In this case the following should be added:

1. 700 mg of a 24% solution hydrazin hydrate (approx. 0,7 ml per litre of water) to avoid corrosion.
2. Approximately 700 mg sodium silicate per litre of water to increase the pH value (hydrogen ion concentration).

The additives will reduce the electrical conductivity of the water well below 300 $\mu\Omega^{-1}cm^{-1}$ (resistivity > 3,3 kΩ per cm^3) and also increase the pH value. (A pH value of 7 to 9 is recommended). It is also recommended that the quality of the cooling water be checked after starting operations, and at regular intervals thereafter.

The cooling water must also be free from all traces of greasy substances since a small amount may form a dangerous heat barrier on the anode cooler, causing excessive anode temperatures despite an apparently adequate water flow. These greasy or oily films may be removed by repeated flushing of the cooling channels with a domestic liquid detergent or slightly soapy water to which a small quantity of industrial alcohol and 33% ammonia has been added (approx. 10 ml of each per litre of water). The cleaning process should be completed by repeated flushing with demineralized water. The cause of such greasy deposits will usually be found elsewhere in the cooling system as a result of, for example, leaking pump glands. After the necessary repairs have been carried out, the whole system must be cleaned in a similar manner to prevent deposits forming again. The cooling water system must be interlocked with all electrical supplies to the tube. As an added safeguard, the interlocks should be activated if the water outlet temperature exceeds the indicated upper limit. To prevent the tube from running dry in the event of minor leakages in the system, the reservoir should always be above the level of the tube.

8 CHECKING PROTECTION OF THE TUBE

To verify the operation of the safety circuits noted in section 4.3, as well as safeguarding against high and possibly destructive currents resulting from excessive transients, the following functional check is recommended.

With the tube removed and the anode voltage applied, the anode supply lines (anode - cathode) are shorted at the tube position with a copper wire of a specified diameter for the tube type used (see table 2) and has a length of approx. 2.5 cm per kV of applied anode potential. If this wire does not fuse, the speed of the safety circuit is adequate to protect the tube.

Table 2 Safety circuit testwire diameters

tube	testwire dia mm	tube	testwire dia mm	tube	testwire dia mm
TB4/1500	0,14	TB12/38	0,23	YD1180/82	0,20
TB5/2500	0,14	TB12/40	0,12	YD1185/87	0,20
TB6/14	0,23	YD1150A/52/54	0,12	YD1186	0,20
TB6/4000	0,14	YD1160/62	0,12	YD1190/92	0,20
TB6/6000	0,18	YD1170/72	0,20	YD1195/97	0,20
TB7/8000	0,14	YD1173	0,20	YD1202	0,25
TB7/9000	0,14	YD1174/78	0,15	YD1212	0,30
TB12/25	0,11	YD1175/77	0,20	YD1240/44	
				YD1342	0,32

9 CONNECTORS

9.1 Clean contact surface

Attention must be paid to a good fit on a clean contact surface of all electrode connectors as well as an even RF current distribution around their circumference.

9.2 Fastening the filament connector on industrial tubes

To ensure good seating of the filament connectors on industrial tubes, care should be taken that they are not crooked and that the applied clamping force is within the specified limits.
In the following table the minimum and maximum torque values are given for the different tubes concerned and the corresponding connector at room temperature.

Table 3 Filament connector mechanical data

Tube type	Cap dia. mm	Bolt size	Connector type	Min. torque Ncm	Max. torque Ncm
YD1150A YD1152/54 YD1160/62 YD1240/44	14.4	M5	40688	200	300
YD1170/77	25	M6	40692A	400	600
YD1180/87	32	M6	40708A	500	700
YD1190/97	42	M6	40705A	600	700
YD1202 YD1212 YD1342	54	M8	40695A	800	1000

After the system has been warmed up and cooled down several times, it is advisable to check the bolts for correct tightness and if necessary re-tighten to the correct value.

10 STORAGE AND MAINTENANCE

10.1 General

Whenever possible, the tubes should be transported and stored in their original packing in an upright position. If the tubes are to be stored in an unpacked condition they should be kept in a dry room placed in an upright position in a rack that is not subject to excessive vibration and does not exert any mechanical stress on other parts of the tube except those that normally serve for the support of the tube, e.g. the anode cooler or the anode mounting flange.
If a tube is stored for an extended period it should be subjected to the conditioning schedule outlined in section 4.2.
Care should be taken that the glass or ceramic parts of a tube are kept clean and do not contact metallic objects since a scratch on glass may initiate a fracture and metal rubbed against ceramic may leave a metallic trace that can lead to surface arcing when high tension is applied to the tube.
Soiled glass parts may be cleaned with conventional non-abrasive window cleaning agents and thoroughly rinsed and dried afterwards. Soiled ceramic parts are best cleaned with domestic cleaning powders applied with a moistened tooth brush. A final thorough rinse with clean water is essential to remove all traces of the cleaning powder and the loosened dirt.

10.2 Cleaning integrally water cooled tubes

If the water cooling channels or the helix of a tube become partially blocked (reduced flow and increased back pressure) by floating particles, these can be removed with compressed air or high pressure water, taking care that the water outlet of the tube is open to air and the maximum applied inlet pressure does not exceed 50 Pa. If the impurities adhere to the cooling channel walls or are of a sedimentary nature the cleaning will have to be assisted by a solvent. In the majority of cases these will be calcium deposits. They may be removed by flushing the tube, if necessary repeatedly, with a 5 to 10% solution of hydrochloric acid or 15% citric acid. This procedure should be followed by thoroughly rinsing with distilled or demineralized water.

11 SAFETY ASPECTS

11.1 X-radiation

Power electron tubes operating at voltages in excess of 5 kV are possible sources of X-radiation, progressively so with increasing voltage levels. The envelope of the tubes offers only a limited shielding for such radiation. The equipment manufacturer should provide suitable additional shielding in his design.

The level of X-radiation should be checked periodically.

11.2 RF-radiation

Exposure to strong RF fields may cause health-hazard, progressively so with increasing frequency. As such fields will exist in the vicinity of power electron tubes, the equipment manufacturer should provide suitable shielding in his design to reduce RF fields, in the neighbourhood of the equipment, to acceptable levels.

SELECTION GUIDE

RF Power Triodes

TB types

type	status	cooling	freq. MHz	W_{osc} kW	V_f V	V_a kV	I_a A	V_a max. kV	W_a max. kW	h x dia. max. mm
TBL2/300	C	FA	470	0.27	3.4	1.75	0.34	1.8	0.3	72 x 41.5
TB2.5/300	C	N	40	0.29	6.3	2	0.17	2.5	0.135	133 x 62
TB2.5/400	C	N	50	0.29	6.3	2	0.17	2.7	0.15	133 x 62
TBL2/400	C	FA	470	0.34	3.4	2	0.38	2.2	0.4	83 x 41.5
TB3/750	C	N	50	0.9	5	3.5	0.325	3.8	0.35	151 x 87
TB4/1250	C	N	100	1.55	10	4	0.535	4	0.45	213 x 118
TB4/1500	C	N	50	1.58	5	5	0.43	7	0.5	240 x 130
TB5/2500	C	N	50	2.73	6.3	6	0.6	7	0.8	256 x 155
TB6/4000	C	FA	50	4	6.3	7	0.9	8	1.7	177.5 x 86
TBH7/8000	C	WH	50	6	12.6	6	1.5	7	6	219 x 130
TBL7/8000	C	FA	50	6	12.6	6	1.5	7	6	195 x 122.6
TBW7/8000	C	W	50	6	12.6	6	1.5	7	6	190 x 70.5
TBL6/6000	C	FA	50	6.9	12.6	6	1.5	6	5	195 x 122.6
TBW6/6000	D	W	50	6.9	12.6	6	1.5	6	6	190 x 70.5
TBL6/14	C	FA	60	17.7	6.3	7	3.5	8	10	315 x 163
TBW6/14	C	W	60	17.7	6.3	7	3.5	8	15	330 x 163
TBL12/25	C	FA	30	25	8	12	3.2	13	15	386 x 198
TBW12/25	C	W	30	25	8	12	3.2	13	20	376 x 190
TBL12/38	C	FA	30	30	8	12	4.5	13	15	404 x 192
TBW12/38	C	W	30	30	8	12	4.5	13	20	422 x 190

COOLING: FA = forced air; W = water; WH = water (helix); N = natural.

SELECTION GUIDE

RF Power Triodes

YD types

type	sta-tus	cool-ing	freq. MHz	W_{osc} kW	V_f V	I_f A	V_a kV	I_a max. A	V_a max. kV	W_a kW	h x dia. max. mm
YD1240	C	FA	250	2.67	6.3	33	5	0.75	5.5	1.5	173 x 67.5
YD1244	C	FA	250	2.67	6.3	33	5	0.75	5.5	1.5	173 x 109.5
YD1154	D	FA	50	2.73	6.3	33	6	0.6	7	0.8	170 x 66
YD1150A	D	FA	85	4.75	6.3	33	6	1	7.2	2.5	173 x 122.8
YD1152	D	W	85	4.75	6.3	33	6	1	7.2	2.5	215 x 131
YD1160	D	FA	85	8.8	6.3	66	6.5	1.8	7.2	5	192 x 122.8
YD1162	D	W	85	8.8	6.3	66	6.5	1.8	7.2	5	235 x 131
YD1173	D	FA	50	13.2	5.4	65	10	1.75	12	10	219 x 160
YD1170	D	FA	120	15.4	5.8	130	6	3.4	7.2	10	219 x 160
YD1172	D	W	120	15.4	5.8	130	6	3.4	7.2	10	239 x 115
YD1175	D	FA	120	26.5	5.8	130	10	3.4	12	10	219 x 160
YD1177	D	W	120	26.5	5.8	130	10	3.4	12	15	251 x 131
YD1174	D	FA	50	30	5.8	130	10	4	12	10	220 x 160
YD1178	D	W	50	30	5.8	130	10	4	12	10	237 x 115
YD1180	D	FA	100	31.6	7	175	7.5	5.4	9	15	241 x 192
YD1182	D	W	100	31.6	7	175	7.5	5.4	9	20	282 x 130.5
YD1185	D	FA	100	50	7	175	12	5.33	14.4	15	241 x 192
YD1186	D	FA	100	50	7	175	12	5.33	14.4	15	241 x 192
YD1187	D	W	100	50	7	175	12	5.33	14.4	20	292 x 130.5
YD1195	D	FA	30	90	8.4	235	12	9.75	14.4	30	294 x 216
YD1190	D	FA	30	96	8.4	235	12	10	13	30	294 x 216
YD1192	D	W	30	110	8.4	235	12	13	13	50	351 x 160.5
YD1197	D	W	30	108	8.4	235	12	12	14.4	50	351 x 160.5
YD1202	D	W	30	163	12.2	250	12	18	15	80	460 x 191
YD1212	D	W	30	240	12.6	380	14	23.5	16.8	120	460 x 191
YD1342	D	W	30	530	14	555	16	43.5	18	240	625 x 230

COOLING: FA = forced air; W = water; N = natural

See overleaf for index of page numbers.

INDEX OF TYPE NUMBERS

RF POWER TRIODES

ASSOCIATED ACCESSORIES

RF TRIODES, TB TYPES

RF POWER TRIODE

QUICK REFERENCE DATA

λ (m)	Freq. (MHz)	C telegr. V_a (V)	C telegr. W_o (W)	C osc. V_a (V)	C osc. W_o (W)	B teleph. V_a (V)	B teleph. W_o (W)	C_a mod. V_a (V)	C_a mod. W_o (W)
4	75	2500	390			2500	65	2000	204
		2000	295			2000	64	1500	153
		1500	210			1500	59	1000	95
		1000	126						
2	150			2500	376				
				2000	282				
1.5	200			2000	198				

HEATING: direct; filament thoriated tungsten

Filament voltage	V_f	= 6.3	V
Filament current	I_f	= 5.4	A

CAPACITANCES

Anode to all other elements except grid	C_a	= 0.1	pF
Grid to all other elements except anode	C_g	= 4.3	pF
Anode to grid	C_{ag}	= 5.2	pF

TYPICAL CHARACTERISTICS

Amplification factor	μ	= 25	
Mutual conductance	S (I_a = 44 mA)	= 2.8	mA/V

COOLING: radiation/low-velocity air flow

It is necessary to direct a low-velocity air flow to the bottom and the top seal if the tube is used at or near the limiting values at frequencies above 50 MHz .

LIMITING VALUES

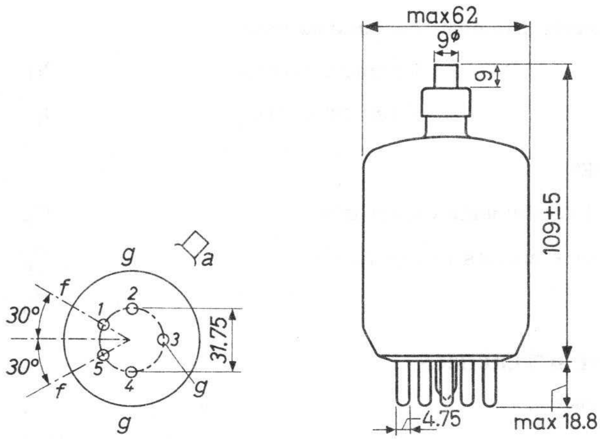
Absolute maximum rating system

Anode voltage	V_a	max.	2500	V
Anode dissipation*	W_a	max.	135	W
Grid dissipation	W_g	max.	16	W
Grid circuit resistance with fixed grid bias	R_g	max.	0,1	MΩ
Grid circuit resistance with automatic grid bias	R_g	max.	0,2	MΩ
Cathode current	I_k	max.	250	mA
Peak cathode current	I_{kp}	max.	1,6	A
Temperature of anode seal		max.	220	°C
Bottom temperature		max.	180	°C

MECHANICAL DATA

Base	giant 5 p
Anode connector	40624
Socket	2422 512 01001
Socket with grounded grid connections	40215/01
Net mass	110 g

Dimensions in mm



Mounting position | vertical with base up or down

Fig. 1 Mechanical outline.

* Anode red hot, temperature = 850 °C.

OPERATING CONDITIONS RF CLASS C TELEGRAPHY

Wavelength	λ	=	4	4	4	4	m
Anode voltage	V_a	=	2500	2000	1500	1000	V
Grid voltage	V_g	=	-200	-150	-110	-80	V
Anode current	I_a	=	205	205	205	205	mA
Grid current	I_g	=	40	40	40	40	mA
Peak grid AC voltage	V_{gp}	=	390	340	300	260	V
Grid input power	W_{ig}	=	14	13	11	10	W
Anode input power	W_{ia}	=	512	410	308	205	W
Anode dissipation	W_a	=	122	115	98	79	W
Output power	W_o	=	390	295	210	126	W
Efficiency	η	=	76	72	68	61.5	%

OPERATING CONDITIONS RF CLASS B TELEPHONY

Wavelength	λ	=	4	4	4	m
Anode voltage	V_a	=	2500	2000	1500	V
Grid voltage	V_g	=	-87	-67	-45	V
Anode current	I_a	=	77	97	120	mA
Peak grid AC voltage	V_{gp}	=	100	100	100	V
Anode input power	W_{ia}	=	193	194	180	W
Anode dissipation	W_a	=	128	130	121	W
Output power	W_o	=	65	64	59	W
Efficiency	η	=	34	33	33	%
Modulation depth	m	=	100	100	100	%
Grid current	I_g	=	20	28	52	mA
Grid input power	W_{ig}	=	3.6	5.1	9.4	W

OPERATING CONDITIONS RF CLASS C ANODE MODULATION; two tubes

Wavelength	λ	=	4	4	4	m
Anode voltage	V_a	=	2000	1500	1000	V
Grid voltage	V_g	=	−225	−180	−130	V
Anode current	I_a	=	255	255	255	mA
Grid current	I_g	=	80	80	80	mA
Peak grid AC voltage	V_{gp}	=	415	370	320	V
Grid input power	W_{ig}	=	30	27	23	W
Anode input power	W_{ia}	=	510	382	255	W
Anode dissipation	W_a	=	102	76	65	W
Output power	W_o	=	408	306	190	W
Efficiency	η	=	80	80	74.5	%
Modulation depth	m	=	100	100	100	%
Modulation power	W_{mod}	=	255	191	126	W

OPERATING CONDITIONS AS RF CLASS C OSCILLATOR; two tubes

Wavelength	λ	=	2	2	1.5	m
Anode voltage	V_a	=	2500	2000	2000	V
Anode current	I_a	=	410	410	346	mA
Grid current	I_g	=	80	80	80	mA
Grid resistor	R_g	=	2500	1875	1875	Ω
Anode input power	W_{ia}	=	1025	820	692	W
Anode dissipation	W_a	=	245	230	270	W
Grid input power	W_{ig}	=	28	26	26	W
Output power	W_o	=	752	564	396	W
Efficiency	η	=	73	69	57	%

OPERATING CONDITIONS AS RF CLASS C OSCILLATOR for high frequency heating and diathermy generators

A. With anode voltage from single-phase full-wave rectifier without filter

Wavelength	λ	=	7.3	m
Anode voltage	V_a	=	2000	V [1]
Anode current	I_a	=	170	mA
Grid current	I_g	=	34	mA
Grid resistor	R_g	=	3750	Ω
Anode input power	W_{ia}	=	420	W
Anode dissipation	W_a	=	120	W
Grid input power	W_{ig}	=	10	W
Output power	W_o	=	290	W
Efficiency	η	=	69	%

B. With anode and grid alternating voltage. Phase-shift of 180^o between V_a and V_g

Wavelength	λ	=	7.3	m
Anode voltage	V_a	=	2500	V_{RMS}
Anode current	I_a	=	90	mA
Grid current	I_g	=	20	mA
Grid resistor	R_g	=	1700	Ω
Grid voltage	V_g	=	85	V_{RMS}
Anode input power	W_{ia}	=	255	W
Anode dissipation	W_a	=	85	W
Output power	W_o	=	170	W
Efficiency	η	=	67	%

[1]) Mean value

OPERATING CONDITIONS RF CLASS C TELEGRAPHY

grounded grid, two tubes

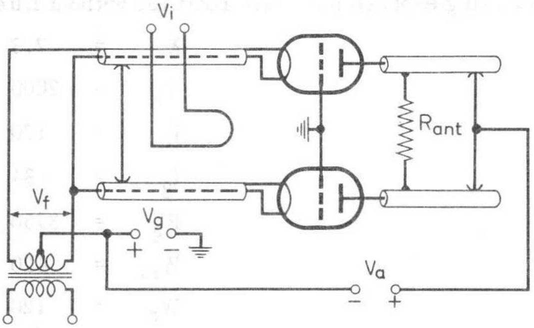


Fig. 2 Grounded-grid configuration.

Wavelength	λ	=	3	3	3	3	m
Anode voltage	V_a	=	2500	2000	1500	1000	V
Grid voltage	V_g	=	-200	-150	-110	-80	V
Anode current	I_a	=	410	410	410	410	mA
Grid current	I_g	=	80	80	80	80	mA
Peak grid AC voltage	V_{gp}	=	390	340	300	260	V
Grid input power	W_{ig}	=	158	136	118	100	W
Anode input power	W_{ia}	=	1025	820	615	410	W
Anode dissipation	W_a	=	245	230	195	158	W
Output power	W_o	=	780+130	590+110	420+96	252+80	W[1])
Efficiency	η	=	76	72	68	61.5	%[2])

[1]) Power transferred from driving stage included

[2]) Pure tube efficiency

AF CLASS B AMPLIFIER AND MODULATOR

LIMITING VALUES (Absolute limits)

Anode voltage	V_a	=	max.	2500	V
Anode dissipation	W_a	=	max.	135	W
Grid dissipation	W_g	=	max.	16	W
Cathode current	I_k	=	max.	250	mA
Peak cathode current	I_{kp}	=	max.	1.6	A

OPERATING CONDITIONS, two tubes

Anode voltage	V_a	=	2500		2000		V
Grid voltage	V_g	=	-86		-65		V
Load resistance	$R_{aa\sim}$	=	18.2		12.0		kΩ
Peak grid to grid voltage	V_{ggp}	=	0	412	0	394	V
Anode current	I_a	=	2x30	2x178	2x30	2x208	mA
Grid current	I_g	=	0	2x42	0	2x42	mA
Grid input power	W_{ig}	=	0	2x7.8	0	2x7.3	W
Anode input power	W_{ia}	=	2x75	2x445	2x60	2x416	W
Anode dissipation	W_a	=	2x75	2x95	2x60	2x101	W
Output power	W_o	=	0	700	0	630	W
Total harmonic distortion	d_{tot}	=	–	5.0	–	3.7	%
Efficiency	η	=	–	78.5	-	76	%

Anode voltage	V_a	=	1500		1000		V
Grid voltage	V_g	=	-46		-23		V
Load resistance	$R_{aa\sim}$	=	8.5		5.0		kΩ
Peak grid to grid voltage	V_{ggp}	=	0	340	0	295	V
Anode current	I_a	=	2x30	2x210	2x30	2x210	mA
Grid current	I_g	=	0	2x40	0	2x40	mA
Grid input power	W_{ig}	=	0	2x6.1	0	2x5.4	W
Anode input power	W_{ia}	=	2x45	2x315	2x30	2x210	W
Anode dissipation	W_a	=	2x45	2x90	2x30	2x73	W
Output power	W_o	=	0	450	0	274	W
Total harmonic distortion	d_{tot}	=	–	2.9	–	2.2	%
Efficiency	η	=	–	71.5	–	65	%

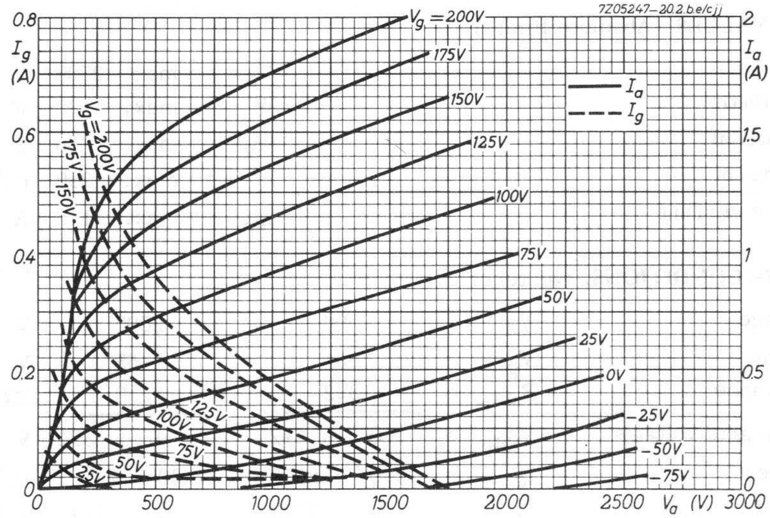


Fig. 3
I_a/I_g characteristics.

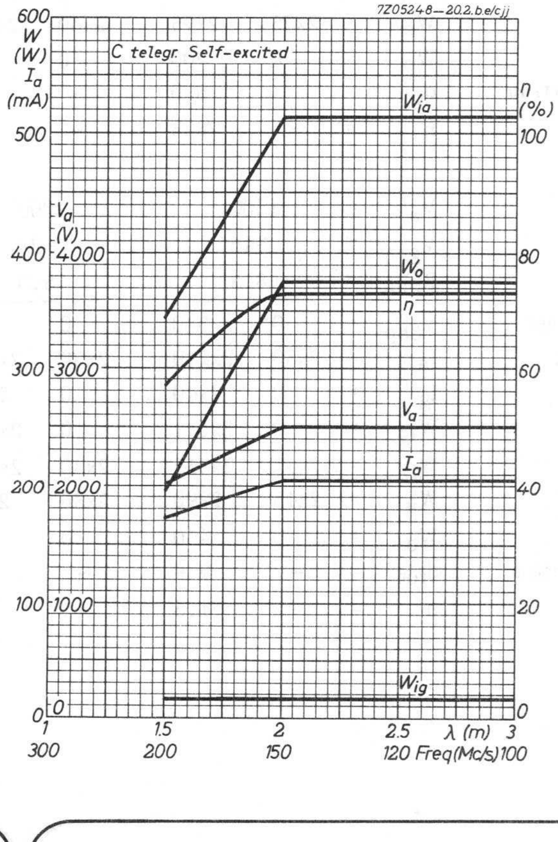


Fig. 4
Characteristics at frequencies above 150 MHz.

RF POWER TRIODE

QUICK REFERENCE DATA

λ (m)	Freq. (MHz)	C telegr. V_a (V)	C telegr. W_o (W)	C grounded grid V_a (V)	C grounded grid W_o (W)	B teleph. V_a (V)	B teleph. W_o (W)	C_a mod. V_a (V)	C_a mod. W_o (W)
2	150	2500	390			2500	65		
		2000	295			2000	64	2000	205
		1500	210			1500	59	1500	154
		1000	126					1000	96
3	100			2500	910				
				2000	700				
				1500	516				
				1000	332				

λ (m)	Freq. (MHz)	C osc. industrial V_a ∿∿ (V)	C osc. industrial W_o (W)	C osc. industrial V_a ∿ (V)	C osc. industrial W_o (W)	B mod. two tubes V_a (V)	B mod. two tubes W_o (W)
6	50	2000	290	2500	170	2500	700
						1000	274

HEATING: direct; filament thoriated tungsten

Filament voltage	V_f	=	6.3 V
Filament current	I_f	=	5.8 A

CAPACITANCES

Anode to all other elements except grid	C_a	=	0.1 pF
Grid to all other elements except anode	C_g	=	4.9 pF
Anode to grid	C_{ag}	=	5.0 pF

TYPICAL CHARACTERISTICS

Anode voltage	V_a	=	2500 V
Anode current	I_a	=	60 mA
Amplification factor	μ	=	25
Mutual conductance	S	=	2.8 mA/V

TEMPERATURE LIMITS

Absolute maximum rating system

Temperature of anode seal	=	max.	220 °C
Bottom temperature	=	max.	180 °C

It is recommended to direct a low-velocity air flow on bottom and top seal if the tube is used at or near the limiting values at frequencies above 50 MHz.

MECHANICAL DATA

Base	giant 5 p
Socket	2422 512 01001
Anode connector	40624
Net mass	125 g

Dimensions in mm

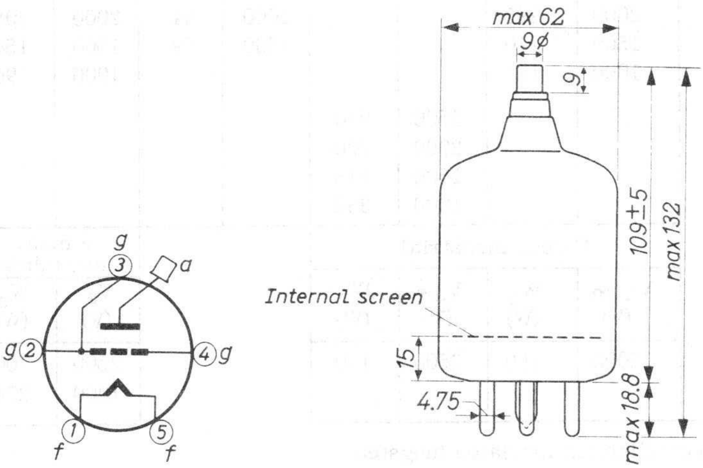


Fig. 1 Mechanical outline.

Mounting position vertical with base up or down

COOLING

Radiation/low-velocity air flow.

RF CLASS C TELEGRAPHY

LIMITING VALUES (Absolute limits)

Frequency	f		up to	150	MHz
Anode voltage	V_a	=	max.	3000	V
Anode current	I_a	=	max.	255	mA
Anode dissipation	W_a	=	max.	150	W
Anode input power	W_{ia}	=	max.	512	W
Negative grid voltage	$-V_g$	=	max.	300	V
Grid current	I_g	=	max.	45	mA
Grid circuit resistance with fixed grid bias	R_g	=	max.	0.1	MΩ
Grid circuit resistance with automatic grid bias	R_g	=	max.	0.2	MΩ

OPERATING CONDITIONS

Frequency	f	=	150	150	150	150	MHz
Anode voltage	V_a	=	2500	2000	1500	1000	V
Grid voltage	V_g	=	−200	−150	−110	−80	V
Anode current	I_a	=	205	205	205	205	mA
Grid current	I_g	=	40	40	40	40	mA
Peak grid AC voltage	V_{gp}	=	390	340	300	260	V
Grid input power	W_{ig}	=	14	13	11	10	W
Anode input power	W_{ia}	=	512	410	308	205	W
Anode dissipation	W_a	=	122	115	98	79	W
Output power	W_o	=	390	295	210	126	W
Efficiency	η	=	76	72	68	61.5	%

RF CLASS B TELEPHONY

LIMITING VALUES (Absolute limits)

Frequency	f		up to	150	MHz
Anode voltage	V_a	=	max.	3000	V
Anode current	I_a	=	max.	170	mA
Anode dissipation	W_a	=	max.	150	W
Anode input power	W_{ia}	=	max.	200	W
Grid current	I_g	=	max.	55	mA
Grid circuit resistance with fixed grid bias	R_g	=	max.	0.1	MΩ
Grid circuit resistance with automatic grid bias	R_g	=	max.	0.2	MΩ

OPERATING CONDITIONS

Frequency	f	=	150	150	150	MHz
Anode voltage	V_a	=	2500	2000	1500	V
Grid voltage	V_g	=	-87	-67	-45	V
Anode current	I_a	=	77	97	120	mA
Peak grid AC voltage	V_{gp}	=	100	100	100	V
Anode input power	W_{ia}	=	193	194	180	W
Anode dissipation	W_a	=	128	130	121	W
Output power	W_o	=	65	64	59	W
Efficiency	η	=	34	33	33	%
Modulation factor	m	=	100	100	100	%
Grid current	I_g	=	20	28	52	mA
Grid input power	W_{ig}	=	3.6	5.1	9.4	W

RF CLASS C ANODE MODULATION

LIMITING VALUES (Absolute limits)

Frequency	f		up to	150	MHz
Anode voltage	V_a	=	max.	2400	V
Anode current	I_a	=	max.	170	mA
Anode dissipation	W_a	=	max.	100	W
Anode input power	W_{ia}	=	max.	340	W
Negative grid voltage	$-V_g$	=	max.	300	V
Grid current	I_g	=	max.	45	mA
Grid circuit resistance with fixed grid bias	R_g	=	max.	0.1	MΩ
Grid circuit resistance with automatic grid bias	R_g	=	max.	0.2	MΩ

OPERATING CONDITIONS

Frequency	f	=	150	150	150	MHz
Anode voltage	V_a	=	2000	1500	1000	V
Grid voltage	V_g	=	−225	−180	−130	V
Anode current	I_a	=	128	128	128	mA
Grid current	I_g	=	40	40	40	mA
Peak grid AC voltage	V_{gp}	=	415	370	320	V
Grid input power	W_{ig}	=	15	14	12	W
Anode input power	W_{ia}	=	256	192	128	W
Anode dissipation	W_a	=	51	38	32	W
Output power	W_o	=	205	154	96	W
Efficiency	η	=	80	80	75	%
Modulation factor	m	=	100	100	100	%
Modulation power	W_{mod}	=	128	96	64	W

RF CLASS C TELEGRAPHY, grounded grid

LIMITING VALUES (Absolute limits)

Frequency	f		up to	150	MHz
Anode voltage	V_a	=	max.	3000	V
Anode current	I_a	=	max.	205	mA
Anode dissipation	W_a	=	max.	150	W
Anode input power	W_{ia}	=	max.	512	W
Negative grid voltage	$-V_g$	=	max.	300	V
Grid current	I_g	=	max.	45	mA
Grid circuit resistance with fixed grid bias	R_g	=	max.	0.1	MΩ
Grid circuit resistance with automatic grid bias	R_g	=	max.	0.2	MΩ

OPERATING CONDITIONS, two tubes

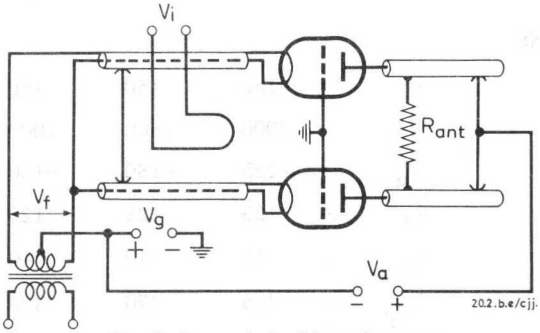


Fig. 2 Grounded grid configuration.

Frequency	f	=	100	100	100	100	MHz	
Anode voltage	V_a	=	2500	2000	1500	1000	V	
Grid voltage	V_g	=	−200	−150	−110	−80	V	
Anode current	I_a	=	410	410	410	410	mA	
Grid current	I_g	=	80	80	80	80	mA	
Peak grid A.C. voltage	V_{gp}	=	390	340	300	260	V	
Grid input power	W_{ig}	=	158	136	118	100	W	
Anode input power	W_{ia}	=	1025	820	615	410	W	
Anode dissipation	W_a	=	245	230	195	158	W	
Output power	W_o	=	780+130	590+110	420+96	252+80	W	1)
Efficiency	η	=	76	72	68	61.5	%	2)

1) Power transferred from driving stage included

2) Pure tube efficiency

RF CLASS C OSCILLATOR for high-frequency heating and diathermy generators, with anode voltage from single-phase full-wave rectifier without filter

LIMITING VALUES (Absolute limits)

Frequency	f		up to	150	MHz
Anode voltage	V_a	=	max.	2700	V [1]
Anode current	I_a	=	max.	180	mA
Anode dissipation	W_a	=	max.	150	W
Anode input power	W_{ia}	=	max.	512	W
Negative grid voltage	$-V_g$	=	max.	300	V
Grid current	I_g	=	max.	40	mA
Grid circuit resistance with fixed grid bias	R_g	=	max.	0.1	MΩ
Grid circuit resistance with automatic grid bias	R_g	=	max.	0.2	MΩ

OPERATING CONDITIONS

Frequency	f	=	50	MHz
Anode voltage	V_a	=	2000	V [1]
Anode current	I_a	=	170	mA
Grid current	I_g	=	34	mA
Grid resistor	R_g	=	3750	Ω
Anode input power	W_{ia}	=	420	W
Anode dissipation	W_a	=	120	W
Grid input power	W_{ig}	=	10	W
Output power	W_o	=	290	W
Efficiency	η	=	69	%

[1]) Mean value

RF CLASS C OSCILLATOR for industrial use **with** self-rectification. **Phase shift** of 180° between V_a and V_g

LIMITING VALUES (Absolute limits)

Frequency	f		up to	150	MHz
Anode voltage	V_a	=	max.	2825	V_{RMS}
Anode current	I_a	=	max.	110	mA
Anode dissipation	W_a	=	max.	150	W
Anode input power	W_{ia}	=	max.	340	W
Negative grid voltage	$-V_g$	=	max.	300	V
Grid current	I_g	=	max.	35	mA
Grid circuit resistance with fixed grid bias	R_g	=	max.	0.1	MΩ
Grid circuit resistance with automatic grid bias	R_g	=	max.	0.2	MΩ

OPERATING CONDITIONS

Frequency	f	=	50	MHz
Anode voltage	V_a	=	2500	V_{RMS}
Anode current	I_a	=	90	mA
Grid current	I_g	=	20	mA
Grid resistor	R_g	=	1700	Ω
Grid voltage	V_g	=	85	V_{RMS}
Anode input power	W_{ia}	=	255	W
Anode dissipation	W_a	=	85	W
Output power	W_o	=	170	W
Efficiency	η	=	67	%

AF CLASS B AMPLIFIER AND MODULATOR

LIMITING VALUES (Absolute limits)

Anode voltage	V_a	=	max.	3000	V
Anode current	I_a	=	max.	210	mA
Anode dissipation	W_a	=	max.	150	W
Anode input power	W_{ia}	=	max.	512	W
Grid current	I_g	=	max.	45	mA

OPERATING CONDITIONS, two tubes

Anode voltage	V_a	=	2500		1000		V
Grid voltage	V_g	=	-86		-23		V
Load resistance	$R_{aa\sim}$	=	18.2		5.0		kΩ
Peak grid to grid voltage	V_{ggp}	=	0	412	0	295	V
Anode current	I_a	=	2x30	2x178	2x30	2x210	mA
Grid current	I_g	=	0	2x42	0	2x40	mA
Grid input power	W_{ig}	=	0	2x7.8	0	2x5.4	W
Anode input power	W_{ia}	=	2x75	2x445	2x30	2x210	W
Anode dissipation	W_a	=	2x75	2x95	2x30	2x73	W
Output power	W_o	=	0	700	0	274	W
Total harmonic distortion	d_{tot}	=	–	5.0	–	2.2	%
Efficiency	η	=	–	78.5	–	65	%

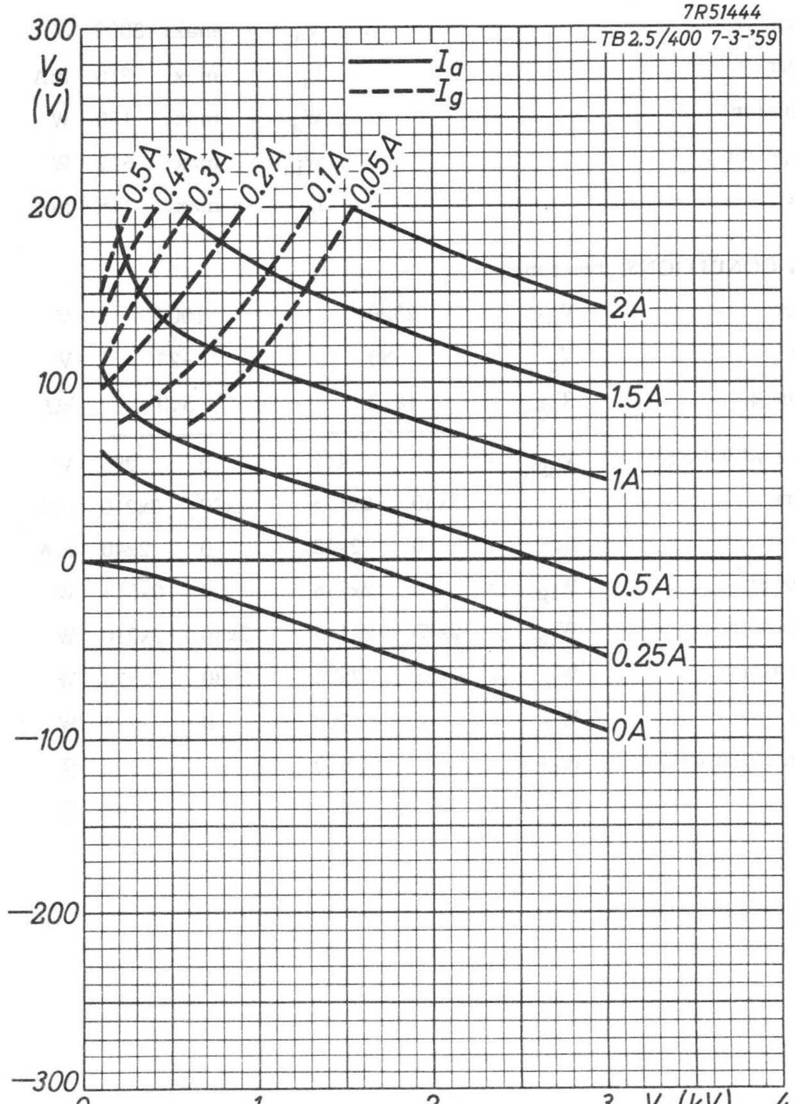


Fig. 3 Constant current characteristics.

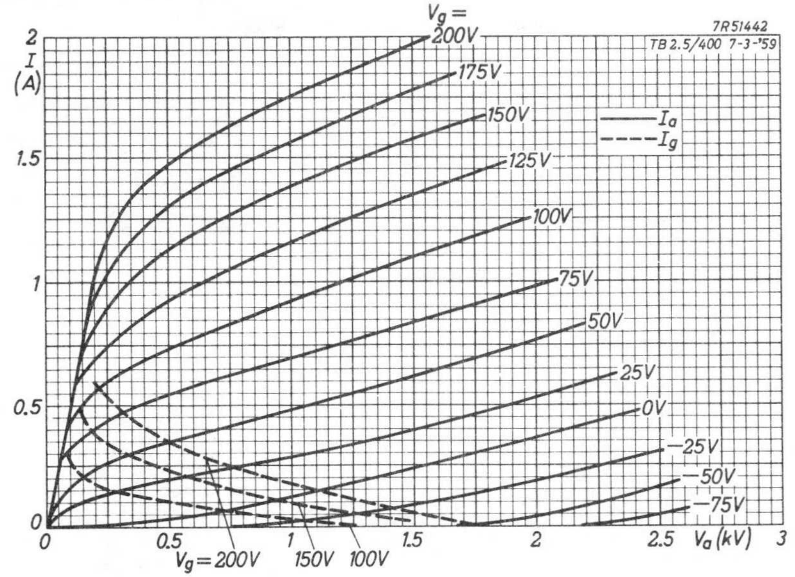


Fig. 4 I_g/V_a characteristics.

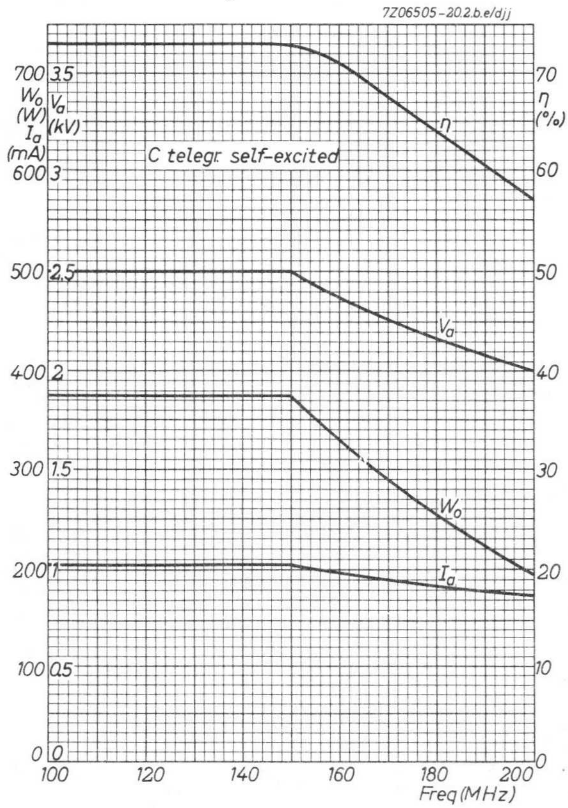


Fig. 5 Operating characteristics at higher frequencies.

RF POWER TRIODE

QUICK REFERENCE DATA

	class-C										class-B	
freq.	telegraphy		grounded grid		oscillator		oscillator, industrial				modulator	
MHz	V_a kV	W_o W	V_a kV	W_o* W	V_a kV	W_o* W	V_a kV	W_o W	V_a kV	W_o W	V_a kV	W_o* W
100	4	1200			4	2320					4	1500
	3	840	3	1936	3	1626					3	1360
	2,5	750	2,5	1747							2,5	1140
	2	585	2	1374								
	1,5	425	1,5	1040								
50							3,5	1100	4	630		
							2,25	685	3	415		

HEATING: direct, parallel supply; thoriated tungsten filament

Filament voltage	V_f	=	5 V
Filament current	I_f	=	14,1 A

The filament is designed to accept temporary fluctuations of +5% and −10%

CAPACITANCES

Anode to all other elements except grid	C_a	=	0,16 pF
Grid to all other elements except anode	C_g	=	6,3 pF
Anode to grid	C_{ag}	=	5,0 pF

TYPICAL CHARACTERISTICS

Anode voltage	V_a	=	3 kV
Anode current	I_a	=	90 mA
Mutual conductance	S	=	5 mA/V
Amplification factor	μ	=	25

* Two tubes.

TEMPERATURE LIMITS

Absolute maximum rating system

Bulb temperature	T_{bulb}	max.	350 °C
Anode seal temperature	T_a	max.	220 °C
Pin temperature	T_{pin}	max.	180 °C

COOLING

In cases where the maximum permissible temperatures are likely to be exceeded, as would normally be the case at frequencies above 30 MHz with full ratings, a low-velocity air flow has to be directed onto the anode seal and the bottom of the envelope. The cooling will be facilitated by the use of a blower and a glass chimney type 40666.

MECHANICAL DATA

Socket	2422 512 01001	Base	Giant 5 p.
Anode connector (clip)	40624	Net mass	190 g
Chimney	40666		

Dimensions in mm

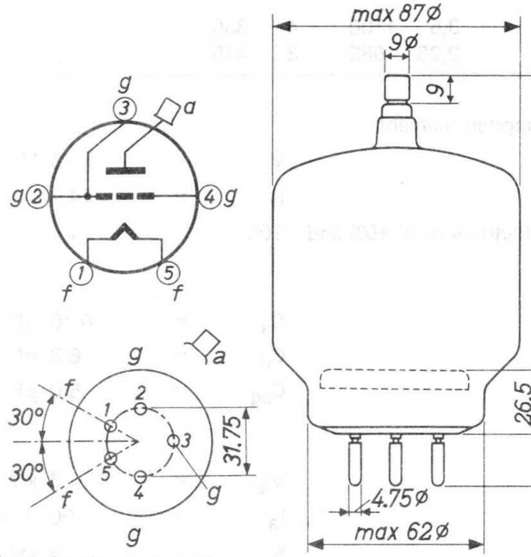
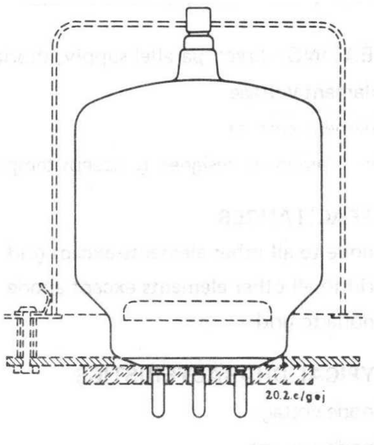


Fig. 1 Mechanical outline.



Mounting suggestion of tube with chimney.

Mounting position vertical with base up or down

In order to prevent overheating of the grid pins by high-frequency current it is recommended to include the three grid socket connections in the circuit.

RF CLASS C TELEGRAPHY OR F.M. TELEPHONY

LIMITING VALUES (Absolute limits)

Frequency	f		up to	100	MHz
Anode voltage	V_a	=	max.	4	kV
Anode input power	W_{ia}	=	max.	1550	W
Anode dissipation	W_a	=	max.	350	W
Negative grid voltage	$-V_g$	=	max.	500	V
Grid dissipation	W_g	=	max.	40	W
Grid circuit resistance	R_g	=	max.	100	kΩ
Cathode current	I_k	=	max.	500	mA

OPERATING CONDITIONS

Frequency	f	=	100	100	100	100	100	MHz
Anode voltage	V_a	=	4	3	2.5	2	1.5	kV
Grid voltage	V_g	=	-350	-250	-200	-150	-120	V
Peak grid AC voltage	V_{gp}	=	535	430	380	320	295	V
Anode current	I_a	=	380	363	400	400	400	mA
Grid current	I_g	=	80	69	69	80	80	mA
Driving power	W_{dr}	=	40	27	23.5	23	21.5	W
Anode input power	W_{ia}	=	1520	1090	1000	800	600	W
Anode dissipation	W_a	=	320	250	250	215	175	W
Output power	W_o	=	1200	840	750	585	425	W
Efficiency	η	=	79	77	75	73	71	%

RF CLASS C TELEGRAPHY OR FM TELEPHONY (continued)

OPERATING CONDITIONS, grounded grid, two tubes

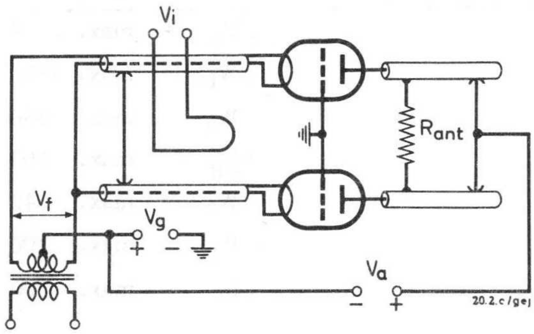


Fig. 2 Ground grid configuration.

Frequency	f	=	100	100	100	100	MHz
Anode voltage	V_a	=	3	2.5	2	1.5	kV
Grid voltage	V_g	=	-250	-200	-150	-120	V
Peak grid AC voltage	V_{gp}	=	430	380	320	295	V
Anode current	I_a	=	726	800	800	800	mA
Grid current	I_g	=	138	138	160	160	mA
Driving power	W_{dr}	=	310	294	250	233	W
Anode input power	W_{ia}	=	2180	2000	1600	1200	W
Anode dissipation	W_a	=	500	500	430	350	W
Output power	W_o	=	1680+256	1500+247	1170+204	850+190	W [1])
Efficiency	η	=	77	75	73	71	%

[1]) Power transferred from driving stage included

RF CLASS C OSCILLATOR

LIMITING VALUES (Absolute limits)

Frequency	f		up to	100	MHz
Anode voltage	V_a	=	max.	4	kV
Anode input power	W_{ia}	=	max.	1550	W
Anode dissipation	W_a	=	max.	350	W
Negative grid voltage	$-V_g$	=	max.	500	V
Grid dissipation	W_g	=	max.	40	W
Grid circuit resistance	R_g	=	max.	100	kΩ
Cathode current	I_k	=	max.	500	mA

OPERATING CONDITIONS, two tubes

Frequency	f	=	100	100	MHz
Anode voltage	V_a	=	4	3	kV
Anode current	I_a	=	760	726	mA
Grid current	I_g	=	160	138	mA
Grid resistor	R_g	=	2200	1800	Ω
Driving power	W_{dr}	=	80	54	W
Anode input power	W_{ia}	=	3040	2180	W
Anode dissipation	W_a	=	640	500	W
Output power	W_o	=	2320	1626	W
Efficiency	η	=	77	75	%

R F CLASS C OSCILLATOR FOR INDUSTRIAL USE with anode voltage from single-phase full-wave rectifier without filter

LIMITING VALUES (Absolute limits)

Frequency	f	up to 50	up to 100	up to 150	MHz
Anode voltage	V_a =	max. 3.8	max. 2.7	max. 1.8	kV
Anode input power	W_{ia} =	max. 1500	max. 975	max. 650	W
Anode dissipation	W_a =	max. 350	max. 350	max. 350	W
Negative grid voltage	$-V_g$ =	max. 500	max. 500	max. 500	V
Grid dissipation	W_g =	max. 40	max. 40	max. 40	W
Grid circuit resistance	R_g =	max. 100	max. 100	max. 100	kΩ
Cathode current	I_k =	max. 450	max. 450	max. 450	mA

OPERATING CONDITIONS

Frequency	f =	50	50	MHz
Anode voltage	V_a =	3.5	2.25	kV
Anode current	I_a =	325	340	mA
Grid current	I_g =	65	60	mA
Grid resistor	R_g =	4500	3330	Ω
Anode input power	W_{ia} =	1400	935	W
Anode dissipation	W_a =	300	250	W
Output power	W_o =	1100	685	W
Efficiency	η =	78	73	%
Output power in the load	W_ℓ =	900	560	W

RF CLASS C OSCILLATOR FOR INDUSTRIAL USE with self rectification, 180^{o} phase shift **between** V_a and V_g

LIMITING VALUES (Absolute limits)

Frequency	f		up to 50	up to 100	up to 150	MHz
Transformer voltage	V_{tr}	=	max. 4.5	max. 3.5	max. 2.25	kV_{RMS}
Anode input power	W_{ia}	=	max. 900	max. 730	max. 500	W
Anode dissipation	W_a	=	max. 350	max. 350	max. 350	W
Negative grid voltage	$-V_g$	=	max. 500	max. 500	max. 500	V
Grid dissipation	W_g	=	max. 40	max. 40	max. 40	W
Grid circuit resistance	R_g	=	max. 100	max. 100	max. 100	kΩ
Cathode current	I_k	=	max. 285	max. 285	max. 285	mA

OPERATING CONDITIONS

Frequency	f	=	50	50	MHz
Transformer voltage	V_{tr}	=	4	3	kV_{RMS}
Anode current	I_a	=	190	180	mA
Driving voltage	V_g	=	280	110	V_{RMS}
Grid current	I_g	=	35	32	mA
Grid resistor	R_g	=	5500	3000	Ω
Anode input power	W_{ia}	=	840	600	W
Anode dissipation	W_a	=	210	185	W
Output power	W_o	=	630	415	W
Efficiency	η	=	75	69	%
Output power in the load	W_{ℓ}	=	515	350	W

AF **CLASS B AMPLIFIER AND MODULATOR**, two tubes in push-pull

LIMITING VALUES (Absolute limits)

Anode voltage	V_a	= max. 4	kV
Anode input power	W_{ia}	= max. 1550	W
Anode dissipation	W_a	= max. 350	W
Negative grid voltage	$-V_g$	= max. 500	V
Grid dissipation	W_g	= max. 40	W
Grid circuit resistance	R_g	= max. 100	kΩ
Cathode current	I_k	= max. 500	mA

OPERATING CONDITIONS

V_a	=	4		3		2.5		kV
V_g	=	-135		-102		-77.5		V[1]
$R_{aa\sim}$	=	20		14.5		12		kΩ
V_{gg_p}	=	0	485	0	475	0	400	V
I_a	=	2x88	2x270	2x60	2x290	2x90	2x300	mA
I_g	=	0	2x30	0	2x60	0	2x55	mA
W_{dr}	=	0	2x7	0	2x13	0	2x10	W
W_{ia}	=	2x350	2x1080	2x180	2x870	2x225	2x750	W
W_a	=	2x350	2x305	2x180	2x190	2x225	2x180	W
W_o	=	0	1550	0	1360	0	1140	W
d_{tot}	=	–	< 2.5	–	< 2.5	–	< 2.5	%
η	=	–	71.7	–	78.1	–	76	%

[1]) To be adjusted for zero signal anode current

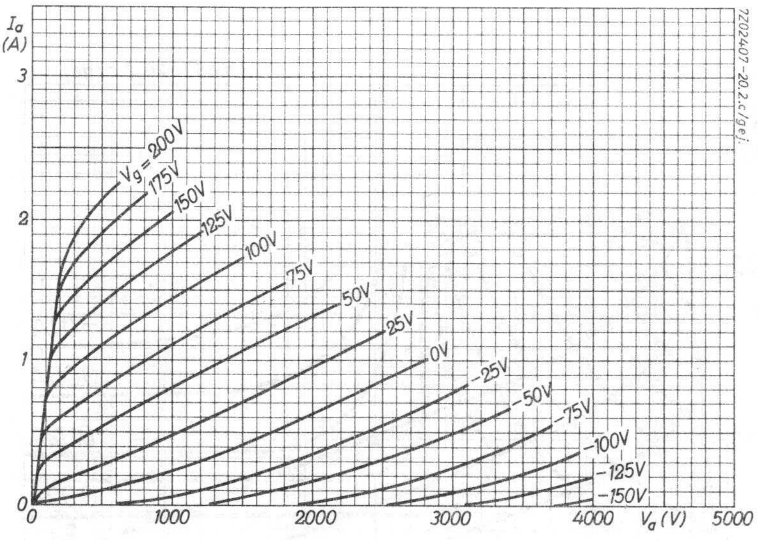


Fig. 3 I_a/V_a characteristics.

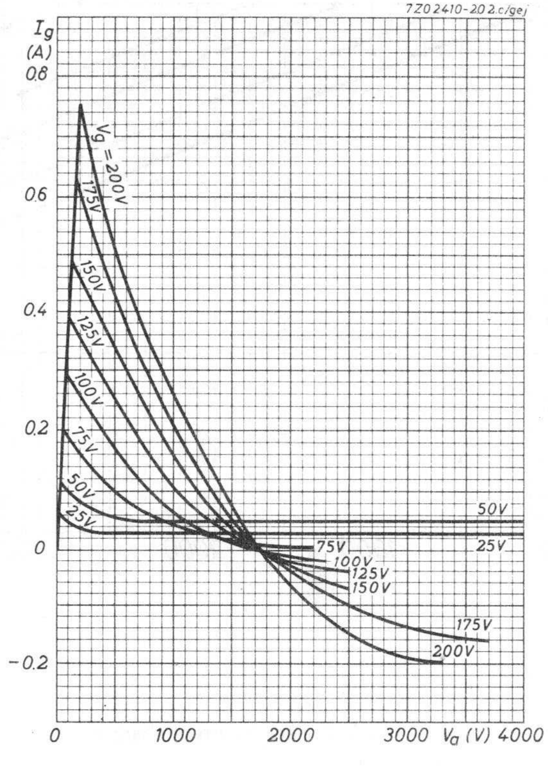


Fig. 4 I_g/V_a characteristics.

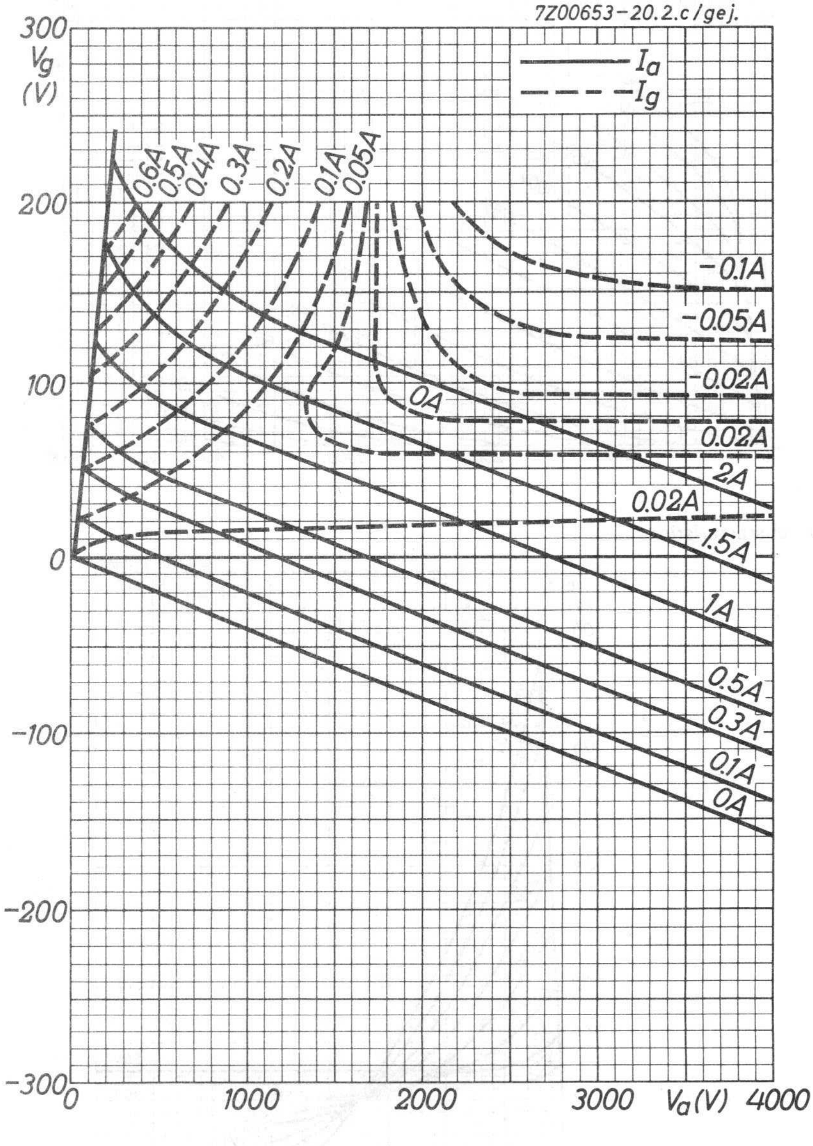


Fig. 5 Constant current characteristics.

RF POWER TRIODE

QUICK REFERENCE DATA										
λ (m)	Freq. (MHz)	C telegr.		C grounded grid		C_a mod.		B mod. [2]	
		V_a (V)	W_o (W)	V_a (V)	W_o [1] (W)	V_a (V)	W_o (W)	V_a (V)	W_o (W)
3	100	4000	1690	4000	1950	3000	1050	4000	2290
		3500	1430	3500	1650			3500	2440
		3000	1175	3000	1375			3000	2310
		2500	950	2500	1120			2500	2000

HEATING: direct; filament thoriated tungsten

Filament voltage	V_f	=	10 V
Filament current	I_f	=	9.9 A

CAPACITANCES

Anode to all other elements except grid	C_a	=	0.17 pF
Grid to all other elements except anode	C_g	=	8.0 pF
Anode to grid	C_{ag}	=	7.0 pF

TYPICAL CHARACTERISTICS

Amplification factor	μ	=	28
Mutual conductance	S (I_a = 125 mA)	=	4.5 mA/V

TEMPERATURE LIMITS (Absolute limits)

Temperature of anode seal	= max. 220 °C
Temperature of bottom pin seals	= max. 180 °C
Bulb temperature	= max. 250 °C

[1]) Power transferred from driving stage included
[2]) Two tubes

COOLING

In general cooling of the tube is not necessary at normal ambient temperature at frequencies below 50 MHz.

When the tube is used at or near the limiting values at frequencies above 50 Mc/s, it will be necessary to direct a low-velocity air flow on the anode seal and the bottom of the envelope.

MECHANICAL DATA

Dimensions in mm

Socket : 2422 512 00001

Anode connector: 40626

Net mass : 420 g

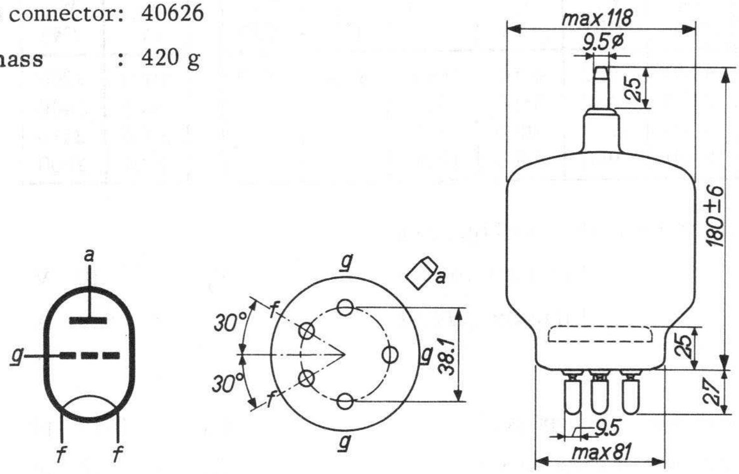


Fig. 1 Mechanical outline.

Mounting position: vertical with base up or down

RF CLASS C TELEGRAPHY

LIMITING VALUES (Absolute limits)

Frequency	f	up to	100	MHz
Anode voltage	V_a	= max.	4000	V
Anode dissipation	W_a	= max.	450	W
Grid dissipation	W_g	= max.	50	W
Grid current	I_g	= max.	115	mA
Cathode current	I_k	= max.	650	mA

OPERATING CONDITIONS (controlled)

Wavelength	λ	=	3	3	3	3	m
Anode voltage	V_a	=	4000	3500	3000	2500	V
Grid voltage	V_g	=	−350	−300	−250	−200	V
Anode current	I_a	=	535	535	535	535	mA
Grid current	I_g	=	115	115	115	115	mA
Peak grid AC voltage	V_{gp}	=	580	520	460	405	V
Grid input power	W_{ig}	=	60	54	48	42	W
Anode input power	W_{ia}	=	2140	1880	1600	1340	W
Anode dissipation	W_a	=	450	450	425	390	W
Output power	W_o	=	1690	1430	1175	950	W
Efficiency	η	=	79	76	73.5	71	%

OPERATING CONDITIONS (self excited)

Wavelength	λ	=	3	3	3	3	m
Anode voltage	V_a	=	4000	3500	3000	2500	V
Grid resistor	R_g	=	3000	2600	2200	1800	Ω
Anode current	I_a	=	535	535	535	535	mA
Grid current	I_g	=	115	115	115	115	mA
Peak grid AC voltage	V_{gp}	=	580	520	460	405	V
Grid input power	W_{ig}	=	60	54	48	42	W
Anode input power	W_{ia}	=	2140	1880	1600	1340	W
Anode dissipation	W_a	=	450	450	425	390	W
Output power	W_o	=	1630	1376	1127	908	W
Efficiency	η	=	76.5	73	70.5	67.5	%

OPERATING CONDITIONS RF CLASS C TELEGRAPHY (continued)
Grounded grid circuit, two tubes

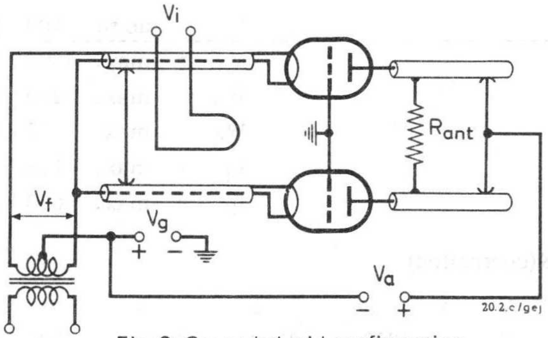


Fig. 2 Grounded grid configuration.

Wavelength	λ	=	3	3	3	3	m
Anode voltage	V_a	=	4000	3500	3000	2500	V
Grid voltage	V_g	=	-350	-300	-250	-200	V
Anode current	I_a	=	2x535	2x535	2x535	2x535	mA
Grid current	I_g	=	2x115	2x115	2x115	2x115	mA
Peak grid voltage	V_{gp}	=	580	520	460	405	V
Grid input power	W_{ig}	=	2x320	2x274	2x248	2x212	W
Anode input power	W_{ia}	=	2x2140	2x1880	2x1600	2x1340	W
Anode dissipation	W_a	=	2x450	2x450	2x425	2x390	W
Output power	W_o	=	3380+520	2860+440	2350+400	1900+340	W[1])
Efficiency	η	=	79	76	73.5	71	%[2])

[1]) Power transferred from driving stage included

[2]) Pure tube efficiency

* See Fig. 6 for operation above 100 MHz.

RF CLASS C ANODE MODULATION

LIMITING VALUES (Absolute limits)

Frequency	f		up to	100	MHz
Anode voltage	V_a	=	max.	3000	V
Anode dissipation	W_a	=	max.	300	W
Grid dissipation	W_g	=	max.	50	W
Grid current	I_g	=	max.	115	mA
Cathode current	I_k	=	max.	550	mA

OPERATING CONDITIONS

Wavelength	λ	=	3	m
Anode voltage	V_a	=	3000	V
Grid voltage	V_g	=	−375	V
Anode current	I_a	=	450	mA
Grid current	I_g	=	85	mA
Peak grid AC voltage	V_{gp}	=	580	V
Grid input power	W_{ig}	=	42	W
Anode input power	W_{ia}	=	1350	W
Anode dissipation	W_a	=	300	W
Output power	W_o	=	1050	W
Efficiency	η	=	78	%
Modulation factor	m	=	100	%
Modulation power	W_{mod}	=	675	W

AF CLASS B AMPLIFIER AND MODULATOR

LIMITING VALUES (Absolute limits)

Anode voltage	V_a	=	max.	4000	V
Anode dissipation	W_a	=	max.	450	W
Grid dissipation	W_g	=	max.	50	W
Cathode current	I_k	=	max.	700	mA
Peak cathode current	I_{kp}	=	max.	5	A
Grid current	I_g	=	max.	130	mA
Grid circuit resistance	R_g	=	max.	50	kΩ

OPERATING CONDITIONS, two tubes

Anode voltage	V_a	=	4000		3500		V
Grid voltage	V_g	=	-135		-114		V
Load resistance	$R_{aa\sim}$	=	14.5		10.2		kΩ
Peak grid to grid voltage	V_{ggp}	=	0	566	0	563	V
Anode current	I_a	=	2x70	2x368	2x70	2x442	mA
Grid current	I_g	=	0	2x93	0	2x115	mA
Grid input power	W_{ig}	=	0	2x24	0	2x29	W
Anode input power	W_{ia}	=	2x280	2x1474	2x245	2x1550	W
Anode dissipation	W_a	=	2x280	2x329	2x245	2x330	W
Output power	W_o	=	0	2290	0	2440	W
Total distortion	d_{tot}	=	–	5	–	5	%
Efficiency	η	=	–	77.7	–	78.8	%

Anode voltage	V_a	=	3000		2500		V
Grid voltage	V_g	=	-94		-75		V
Load resistance	$R_{aa\sim}$	=	7.5		5.2		kΩ
Peak grid to grid voltage	V_{ggp}	=	0	560	0	530	V
Anode current	I_a	=	2x70	2x500	2x70	2x555	mA
Grid current	I_g	=	0	2x130	0	2x126	mA
Grid input power	W_{ig}	=	0	2x33	0	2x30	W
Anode input power	W_{ia}	=	2x210	2x1500	2x175	2x1387	W
Anode dissipation	W_a	=	2x210	2x345	2x175	2x387	W
Output power	W_o	=	0	2310	0	2000	W
Total distortion	d_{tot}	=	–	5	–	3.5	%
Efficiency	η	=	–	77	–	72	%

RF CLASS C OSCILLATOR FOR INDUSTRIAL USE with anode voltage from two-phase half-wave rectifier without filter

LIMITING VALUES (Absolute limits)

Frequency	f		up to	100	MHz
Anode voltage	V_a	=	max.	3600	V
Negative grid voltage	$-V_g$	=	max.	320	V
Anode current	I_a	=	max.	475	mA
Grid current	I_g	=	max.	100	mA
Anode input power	W_{ia}	=	max.	2200	W
Anode dissipation	W_a	=	max.	450	W
Grid dissipation	W_g	=	max.	50	W

OPERATING CONDITIONS

Transformer voltage	V_{tr}	=	4000[1]	3350[2]	V_{RMS}
Anode voltage	V_a	=	3600	3000	V [3]
Anode current	I_a	=	450	400	mA
Grid current	I_g	=	100	85	mA
Grid resistor	R_g	=	3.0	3.0	kΩ
Anode input power	W_{ia}	=	2000	1480	W
Anode dissipation	W_a	=	450	400	W
Output power	W_o	=	1500	1040	W
Efficiency	η	=	75	70	%

1) Care must be taken that under these operating conditions the absolute limiting values are not exceeded by variation of the supply voltage or the load or by tolerances in the circuit elements.

2) Under these conditions normal deviations of voltages and load are permissible. The absolute limiting values of the tube must, however, not be exceeded.

3) DC value.

RF CLASS C OSCILLATOR FOR INDUSTRIAL USE with anode voltage from three-phase half-wave rectifier without filter

LIMITING VALUES (Absolute limits)

Frequency	f	up to	100	MHz
Anode voltage	V_a	= max.	4000	V
Negative grid voltage	$-V_g$	= max.	500	V
Anode current	I_a	= max.	535	mA
Grid current	I_g	= max.	115	mA
Anode input power	W_{ia}	= max.	2200	W
Anode dissipation	W_a	= max.	450	W
Grid dissipation	W_g	= max.	50	W

OPERATING CONDITIONS

Transformer voltage	V_{tr}	= 3400[1]	2900[2]	V_{RMS}
Anode voltage	V_a	= 4000	3400	V [3]
Anode current	I_a	= 535	450	mA
Grid current	I_g	= 115	100	mA
Grid resistor	R_g	= 3.0	3.0	kΩ
Anode input power	W_{ia}	= 2140	1530	W
Anode dissipation	W_a	= 450	390	W
Output power	W_o	= 1630	1090	W
Efficiency	η	= 76.5	71	%

[1]) Care must be taken that under these operating conditions the absolute limiting values are not exceeded by variation of the supply voltage or the load or by tolerances in the circuit elements.

[2]) Under these conditions normal deviations of voltages and load are permissible. The absolute limiting values of the tube must, however, not be exceeded.

[3]) DC value.

RF CLASS C OSCILLATOR FOR INDUSTRIAL USE with self rectification

LIMITING VALUES (Absolute limits)

Frequency	f		up to	100	MHz
Transformer voltage	V_{tr}	=	max.	4500	V_{RMS}
Negative grid voltage	$-V_g$	=	max.	500	V
Anode current	I_a	=	max.	280	mA
Grid current	I_g	=	max.	55	mA
Anode input power	W_{ia}	=	max.	1450	W
Anode dissipation	W_a	=	max.	450	W
Grid dissipation	W_g	=	max.	50	W

OPERATING CONDITIONS

Transformer voltage	V_{tr}	=	4500[1])	3800[2])	V_{RMS}
Anode current	I_a	=	280	240	mA
Grid current	I_g	=	55	47	mA
Grid resistor	R_g	=	3.4	3.4	kΩ
Anode input power	W_{ia}	=	1400	1010	W
Anode dissipation	W_a	=	350	295	W
Output power	W_o	=	1000	670	W
Efficiency	η	=	71.5	66	%

1) Care must be taken that under these operating conditions the absolute limiting values are not exceeded by variation of the supply voltage or the load or by tolerances in the circuit elements.

2) Under these conditions normal deviations of voltages and load are permissible. The absolute limiting values of the tube must, however, not be exceeded.

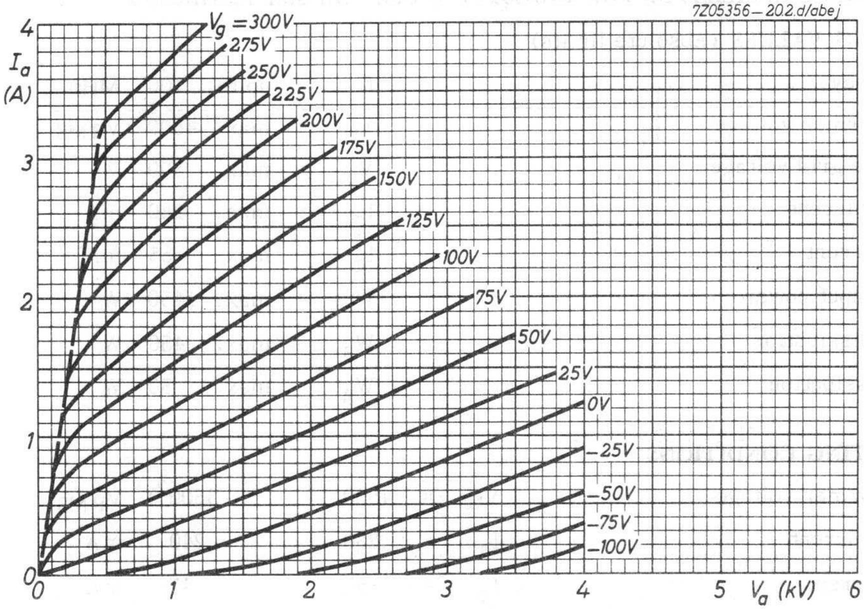


Fig. 3 I_a/V_a characteristics.

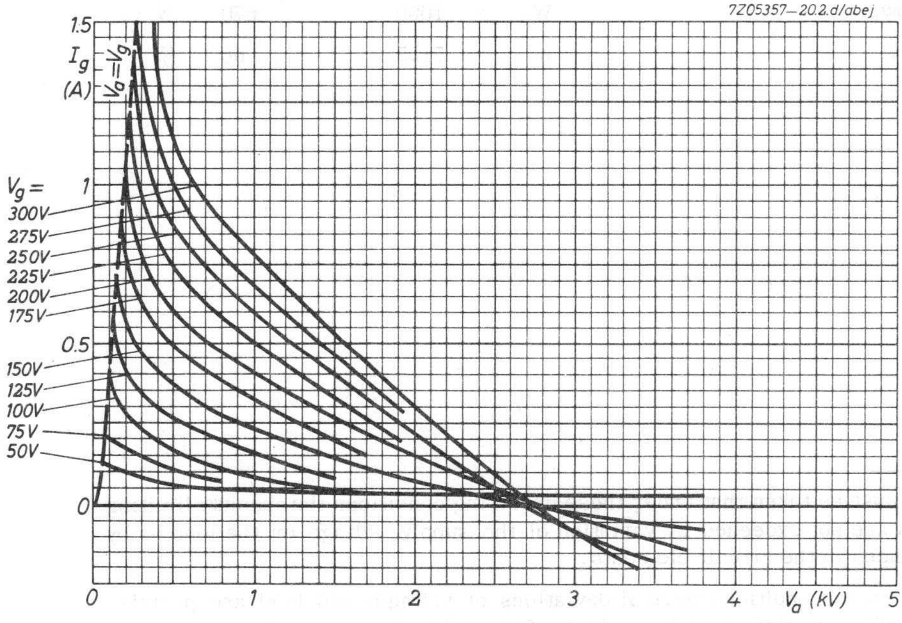


Fig. 4 I_a/V_a characteristics.

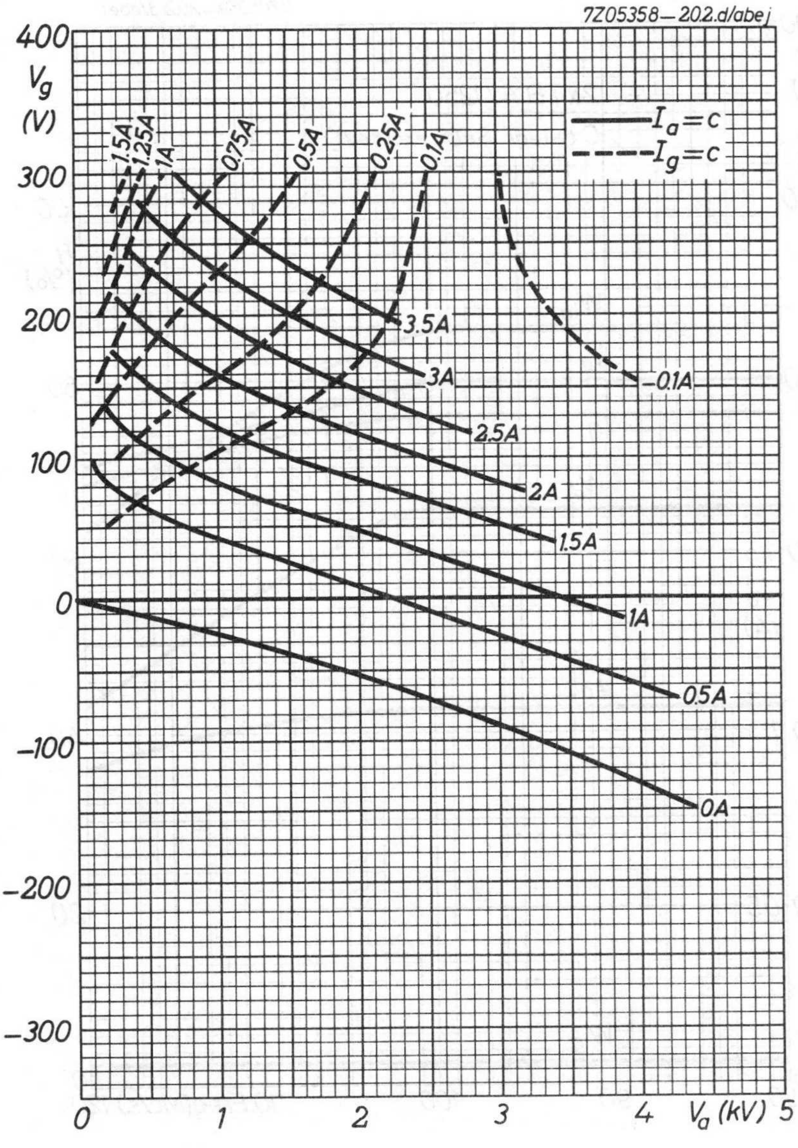


Fig. 5 Constant current characteristics.

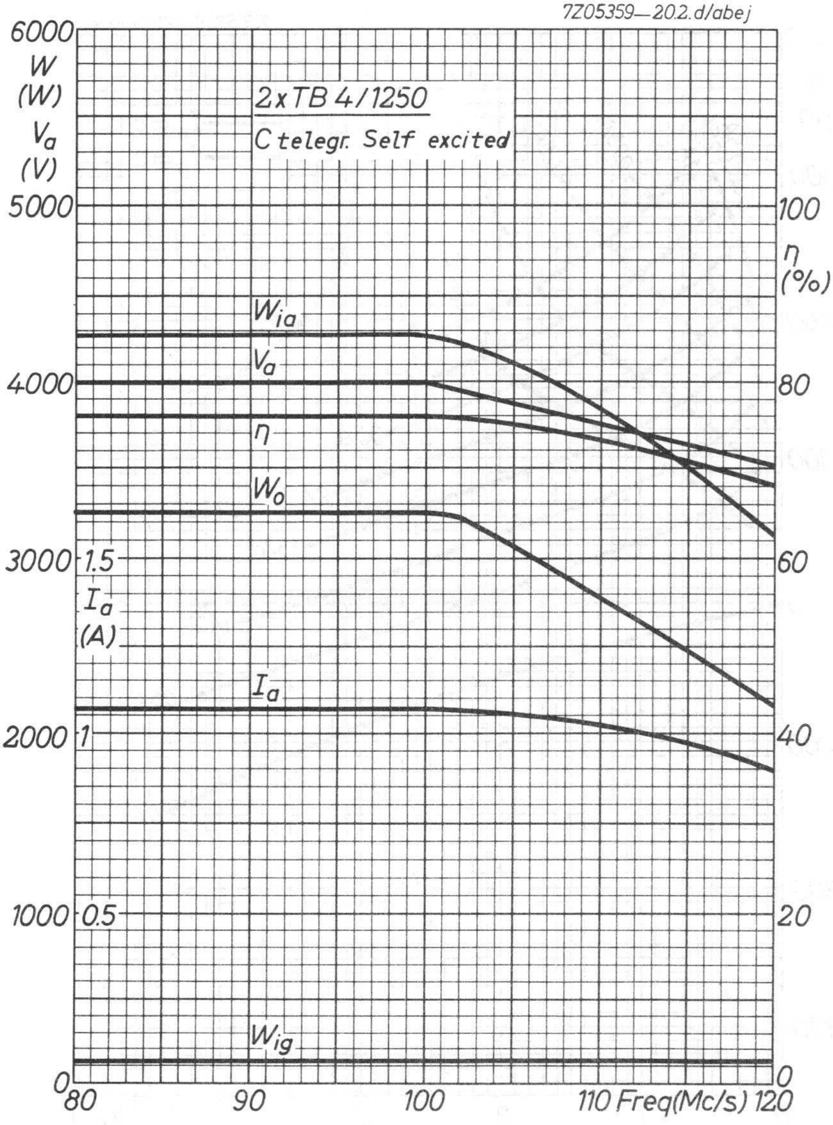


Fig. 6 Characteristics at frequencies above 100 MHz.

RF POWER TRIODE

Radiation cooled triode of metal-glass construction intended for use as an industrial oscillator

QUICK REFERENCE DATA				
Oscillator output power (W_o-W_{feedb}), typical	W_{osc}		1.58	kW
Frequency for full ratings	f	max.	50	MHz

To be read in conjunction with "General Operational Recommendations"

A. **RF CLASS C OSCILLATOR FOR INDUSTRIAL USE**

with anode voltage from a three-phase rectifier

OPERATING CONDITIONS continuous service

Frequency	f	50	50	50	MHz
Oscillator output power (W_o-W_{feedb})	W_{osc}	1.55	1.58	1.55	kW
Anode vootage	V_a	6	5	4	kV
Anode current	I_a	350	430	535	mA
Anode input power	W_{ia}	2100	2150	2140	W
Anode dissipation	W_a	460	480	490	W
Anode output power	W_o	1640	1670	1650	W
Anode efficiency	η_a	78	78	77	%
Oscillator efficiency	η_{osc}	74	73.5	72.5	%
Feedback ratio	V_{gp}/V_{ap}	15	15.5	20	%
Grid resistor	R_g	4.2	3.5	2.7	kΩ
Grid current, on load	I_g	120	130	150	mA
Grid voltage, negative	$-V_g$	500	456	405	V
Grid dissipation	W_g	23	29	41	W
Grid resistor dissipation	W_{Rg}	60	59	61	W

LIMITING VALUES (Absolute max. rating system)

Frequency for full ratings	f	up to	50	MHz
Anode voltage	V_a	max.	7	kV
Anode current	I_a	max.	560	mA
Anode input power	W_{ia}	max.	2.5	kW
Anode dissipation	W_a	max.	500	W
Grid voltage	$-V_g$	max.	1250	V
Grid current, on load	I_g	max.	210	mA
off load	I_g	max.	280	mA
Grid dissipation	W_g	max.	100	W
Grid circuit resistance	R_g	max.	15	kΩ
Cathode current, mean	I_k	max.	850	mA
Envelope temperature	T_{env}	max.	350	°C
Seal temperature	t	max.	220	°C

B. **RF CLASS C OSCILLATOR FOR INDUSTRIAL USE**,

with anode voltage from three-phase rectifier,

OPERATING CONDITIONS , intermittent service

Frequency	f	50	50	MHz
Oscillator output power ($W_o - W_{feedb}$)	W_{osc}	3.05	2.28	kW
Anode voltage	V_a	6	6	kV
Anode current	I_a	700	630	mA
Anode input power	W_{ia}	4200	3150	W
Anode dissipation	W_a	1000	750	W
Anode output power	W_o	3200	2400	W
Anode efficiency	η_a	76	76	%
Oscillator efficiency	η_{osc}	72.5	72.5	%
Feedback ratio	V_{gp}/V_{ap}	16	17	%
Grid resistor	R_g	3.3	2.7	kΩ
Grid current, on load	I_g	170	160	mA
Grid voltage, negative	$-V_g$	560	432	V
Grid dissipation	W_g	55	48	W
Grid resistor dissipation	W_{Rg}	95	69	W

LIMITING VALUES (Absolute max. rating system)

Frequency for full ratings	f	up to	50	MHz
Anode voltage	V_a	max.	7	kV
Anode current	I_a	max.	750	mA
Anode input power	W_{ia}	max.	5	kW
Anode dissipation	W_a	max.	See Fig. 2	
Grid voltage	$-V_g$	max.	1250	V
Grid current, on load	I_g	max.	185	mA
off load	I_g	max.	300	mA
Grid dissipation	W_g	max.	100	W
Grid circuit resistance	R_g	max.	15	kΩ
Cathode current, mean	I_k	max.	1.1	A
Envelope temperature	T_{env}	max.	330	°C
Seal temperature	t	max.	220	°C

C. **RF CLASS C OSCILLATOR FOR INDUSTRIAL USE,**

with anode voltage from single-phase rectifier without filter

OPERATING CONDITIONS , continuous service

Frequency	f	50	50	MHz
Oscillator output power (W_o-Wfeedb)	W_{osc}	1.565	1.525	kW
Anode voltage	V_a	5.4	4.5	kV
Anode current	I_a	320	380	mA
Anode input power	W_{ia}	2125	2100	W
Anode dissipation	W_a	490	500	W
Anode output power	W_o	1635	1600	W
Anode efficiency	η_a	77	76	%
Oscillator efficiency	η_{osc}	74	73	%
Feedback ratio	V_{gp}/V_{ap}	13	15.5	%
Grid resistor	R_g	4.2	3.5	kΩ
Grid current, on load	I_g	110	120	mA
Grid voltage, negative	$-V_g$	462	420	V
Grid dissipation	W_g	15	25	W
Grid resistor dissipation	W_{Rg}	50	50	W

LIMITING VALUES (Absolute max. rating system)

Frequency for full ratings	f	up to	50	MHz
Anode voltage	V_a	max.	6.3	kV
Anode current	I_a	max.	500	mA
Anode input power	W_{ia}	max.	2.5	kW
Anode dissipation	W_a	max.	500	W
Grid voltage	$-V_g$	max.	1250	V
Grid current, on load	I_g	max.	185	mA
off load	I_g	max.	280	mA
Grid dissipation	W_g	max.	100	W
Grid circuit resistance	R_g	max.	15	kΩ
Cathode current, mean	I_k	max.	780	mA
Envelope temperature	T_{env}	max.	330	°C
Seal temperature	t	max.	220	°C

D. RF CLASS C OSCILLATOR FOR INDUSTRIAL USE,

with self rectification

OPERATING CONDITIONS, continuous service

Frequency	f	50	MHz
Oscillator output power ($W_o - W_{feedb}$)	W_{osc}	990	W
Transformer voltage, RMS	V_{tr}	4.5	kV
Anode current	I_a	280	mA 1)
Anode input power	W_{ia}	1400	W
Anode dissipation	W_a	380	W
Anode output power	W_o	1020	W
Anode efficiency	η_a	78	%
Oscillator efficiency	η_{osc}	71	%
Feedback ratio	V_{gp}/V_{ap}	18	%
Grid resistor	R_g	2.7	kΩ
Grid current, on load	I_g	80	mA 1)
Grid voltage, negative	$-V_g$	216	V
Grid dissipation	W_g	14	W
Grid resistor dissipation	W_{Rg}	17	W

LIMITING VALUES (Absolute max. rating system)

Frequency for full ratings	f	up to	50	MHz
Transformer voltage, RMS	V_a	max.	5	kV
Anode current	I_a	max.	320	mA 1)
Anode input power	W_{ia}	max.	1600	W
Anode dissipation	W_a	max.	500	W
Grid voltage, at peak of mains frequency sine wave	$-V_g$	max.	1350	V
Grid current, on load	I_g	max.	110	mA 1)
off load	I_g	max.	150	mA 1)
Grid dissipation	W_g	max.	100	W
Grid circuit resistance	R_g	max.	15	kΩ
Cathode current, mean	I_k	max.	470	mA 1)
Envelope temperature	T_{env}	max.	330	°C
Seal temperature	t	max.	220	°C

1) Average over any mains frequency cycle.

HEATING : direct; filament thoriated tungsten

Filament voltage	V_f	5	V
Filament current	I_f	32.5	A

The filament is designed to accept temporary fluctuations of +5 % and −10 %.

CAPACITANCES

Anode to filament	C_{af}	0.2	pF
Grid to filament	C_{gf}	7.5	pF
Anode to grid	C_{ag}	5.1	pF

CHARACTERISTICS measured at V_a = 4 kV, I_a = 120 mA

Transconductance	S	3.3	mA/V
Amplification factor	μ	21	

COOLING

In general cooling of the tube working at the published operating conditions with matched load is not necessary. When the tube is mounted in a small cabinet adequate ventilation must be provided.

At non-matched load, combined with the highest operating frequencies a low-velocity air flow on the tube is necessary. A small fan will suffice; it is recommended to mount the fan underneath the tube socket.

ACCESSORIES

Socket	catalogue nr.	2422 511 05001
Anode connector	type	40665

MECHANICAL DATA

Dimensions in mm

Mounting position: vertical

Net weight: approx. 450 g

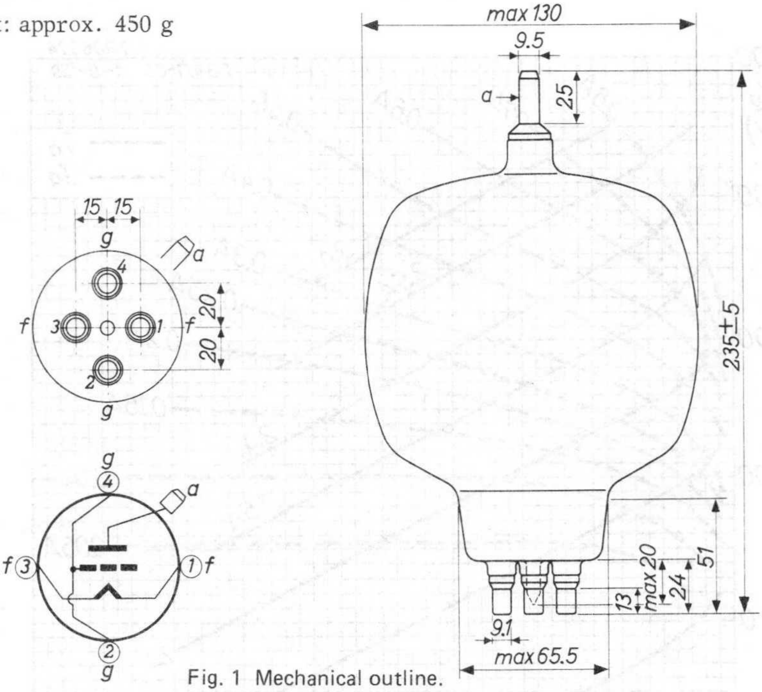


Fig. 1 Mechanical outline.

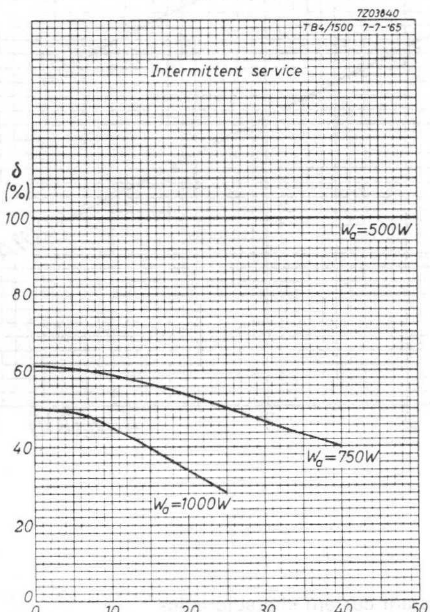


Fig. 2 Intermittent service. Limits of anode dissipation and cooling.

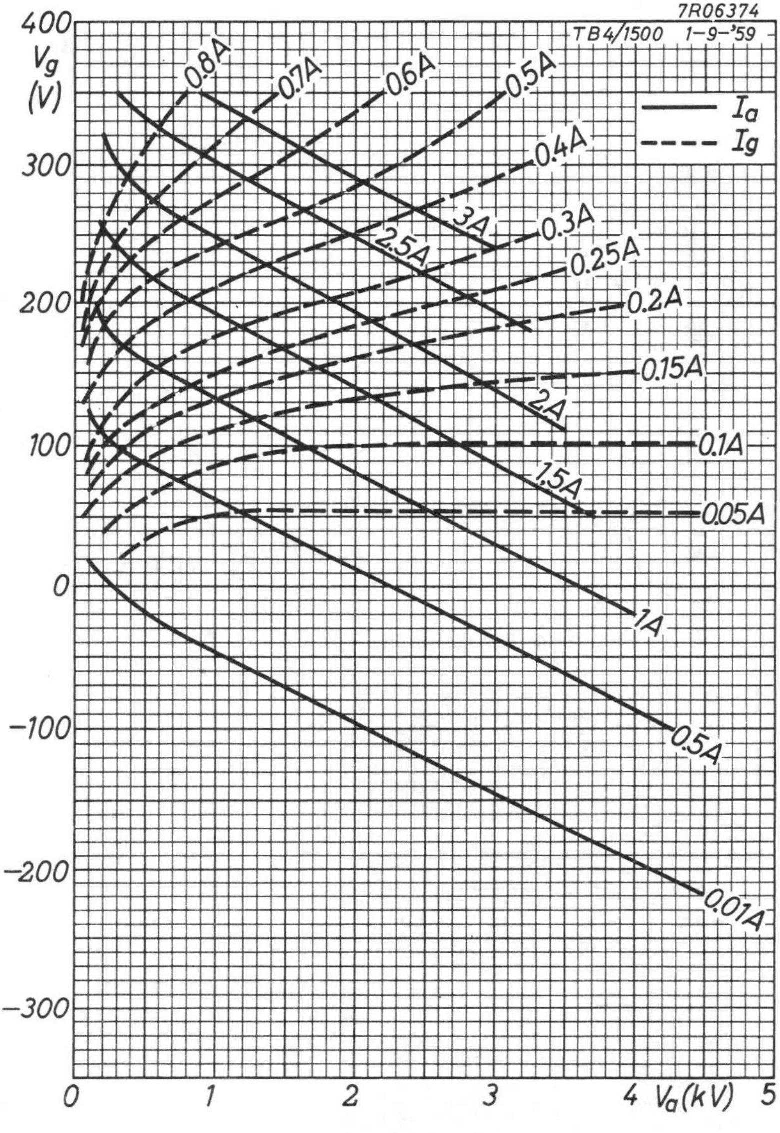


Fig. 3 Constant current characteristics.

RF POWER TRIODE

Radiation cooled triode of glass construction intended for use as an industrial oscillator

QUICK REFERENCE DATA				
Oscillator output power (W_o - W_{feedb}), typical	W_{osc}		2.73	kW
Frequency for full ratings	f	max.	50	MHz

To be read in conjunction with "General Operational Recommendations"

A. RF CLASS C OSCILLATOR FOR INDUSTRIAL USE

with anode voltage from a three-phase rectifier

OPERATING CONDITIONS , continuous service

Frequency	f	50	50	50	50	MHz
Oscillator output power (W_o-W_{feedb})	W_{osc}	2.73	2.61	2.04	1.44	kW
Anode voltage	V_a	6	5	4	3	kV
Anode current	I_a	600	700	700	700	mA
Anode input power	W_{ia}	3600	3500	2800	2100	W
Anode dissipation	W_a	760	780	640	540	W
Anode output power	W_o	2840	2720	2160	1560	W
Anode efficiency	η_a	79	78	77	74	%
Oscillator efficiency	η_{osc}	76	75	73	69	%
Feedback ratio	V_{gp}/V_{ap}	13	17	20	25	%
Grid resistor	R_g	3	2.5	2	1.5	kΩ
Grid current, on load	I_g	150	160	180	200	mA
Grid voltage, negative	$-V_g$	450	400	360	300	V
Grid dissipation	W_g	43	46	55	60	W
Grid resistor dissipation	W_{Rg}	67	64	65	60	W

Recommended grid blocking capacitor at high frequencies about 100 pF
at 1 MHz about 1000 pF

LIMITING VALUES (Absolute max. rating system)

Frequency for full ratings	f	up to	50	MHz
Anode voltage	V_a	max.	7	kV
Anode current	I_a	max.	750	mA
Anode input power	W_{ia}	max.	4000	W
Anode dissipation	W_a	max.	800	W
Grid voltage	$-V_g$	max.	1250	V
Grid current, on load	I_g	max.	300	mA
off load	I_g	max.	400	mA
Grid dissipation	W_g	max.	150	W
Grid circuit resistance	R_g	max.	10	kΩ
Cathode current, mean	I_k	max.	1.2	A
peak	I_{kp}	max.	4.3	A
Envelope temperature	T_{env}	max.	350	°C
Seal temperature	t	max.	220	°C

B. RF CLASS C OSCILLATOR FOR INDUSTRIAL USE

with anode voltage from a three-phase rectifier

OPERATING CONDITIONS , intermittent service

Frequency	f	50	50	MHz
Oscillator output power ($W_o - W_{feedb}$)	W_{osc}	4.25	3.24	kW
Anode voltage	V_a	6	5	kV
Anode current	I_a	950	900	mA
Anode input power	W_{ia}	5700	4500	W
Anode dissipation	W_a	1300	1125	W
Anode output power	W_o	4400	3375	W
Anode efficiency	η_a	77	75	%
Oscillator efficiency	η_{osc}	74	72	%
Feedback ratio	V_{gp}/V_{ap}	17	20	%
Grid resistor	R_g	2.5	2	kΩ
Grid current, on load	I_g	190	190	mA
Grid voltage, negative	$-V_g$	475	380	V
Grid dissipation	W_g	63	63	W
Grid resistor dissipation	W_{Rg}	90	72	W

LIMITING VALUES (Absolute max. rating system)

Frequency for full ratings	f	max.	50	MHz
Anode voltage	V_a	max.	7	kV
Anode current	I_a	max.	1000	mA
Anode -input power	W_{ia}	max.	7000	W
Anode dissipation	W_a	max.	See Fig. 2	
Grid voltage	$-V_g$	max.	1250	V
Grid current, on load	I_g	max.	300	mA
off load	I_g	max.	400	mA
Grid dissipation	W_g	max.	150	W
Grid circuit resistance	R_g	max.	10	kΩ
Cathode current, mean	I_k	max.	1.4	A
peak	I_{kp}	max.	4.3	A
Envelope temperature	T_{env}	max.	350	°C
Seal temperature	t	max.	220	°C

C. RF CLASS C OSCILLATOR FOR INDUSTRIAL USE

with anode voltage from single-phase rectifier without filter

OPERATING CONDITIONS , continuous service

Frequency	f	50	50	MHz
Oscillator output power ($W_o - W_{feedb}$)	W_{osc}	2655	2451	W
Anode voltage	V_a	5.4	4.5	kV
Anode current	I_a	530	600	mA
Anode input power	W_{ia}	3520	3320	W
Anode dissipation	W_a	770	770	W
Anode output power	W_o	2750	2550	W
Anode efficiency	η_a	78	77	%
Oscillator efficiency	η_{osc}	75	74	%
Feedback ratio	V_{gp}/V_{ap}	13	15.5	%
Grid resistor	R_g	3	2.5	kΩ
Grid current, on load	I_g	140	150	mA
Grid voltage, negative	$-V_g$	420	375	V
Grid dissipation	W_g	36	43	W
Grid resistor dissipation	W_{Rg}	59	56	W

LIMITING VALUES (Absolute max. rating system)

Frequency for full ratings	f	up to	50	MHz
Anode voltage	V_a	max.	6.3	kV
Anode current	I_a	max.	670	mA
Anode input power	W_{ia}	max.	4000	W
Anode dissipation	W_a	max.	800	W
Grid voltage	$-V_g$	max.	1250	V
Grid current, on load	I_g	max.	270	mA
off load	I_g	max.	400	mA
Grid dissipation	W_g	max.	150	W
Grid circuit resistance	R_g	max.	10	kΩ
Cathode current, mean	I_k	max.	1.0	A
peak	I_{kp}	max.	3.3	A
Envelope temperature	T_{env}	max.	350	°C
Seal temperature	t	max.	220	°C

D. RF CLASS C OSCILLATOR FOR INDUSTRIAL USE

with self rectification

OPERATING CONDITIONS

Frequency	f	50	MHz
Oscillator output power ($W_o - W_{feedb}$)	W_{osc}	1.49	kW
Transformer voltage, RMS	V_{tr}	5.2	kV
Anode current	I_a	360	mA 1)
Anode input power	W_{ia}	2080	W
Anode dissipation	W_a	520	W
Anode output power	W_o	1560	W
Anode efficiency	η_a	75	%
Oscillator efficiency	η_{osc}	72	%
Feedback ratio	V_{gp}/V_{ap}	17	%
Grid resistor	R_g	1.8	kΩ
Grid current, on load	I_g	100	mA 1)
Grid voltage, negative	$-V_g$	180	V
Grid dissipation	W_g	54	W
Grid resistor dissipation	W_{Rg}	18	W
Recommended grid blocking capacitor	at high frequencies about	100	pF
	at about 1 MHz about	1000	pF

LIMITING VALUES (Absolute max. rating system)

Frequency for full ratings	f	up to	50	MHz
Transformer voltage, RMS	V_{tr}	max.	5.6	kV
Anode current	I_a	max.	400	mA 1)
Anode input power	W_{ia}	max.	2250	W
Anode dissipation	W_a	max.	800	W
Grid voltage, at peak of mains frequency sine wave	$-V_g$	max.	1250	V
Grid current, on load	I_g	max.	160	mA 1)
off load	I_g	max.	210	mA 1)
Grid dissipation	W_g	max.	150	W
Grid circuit resistance	R_g	max.	10	kΩ
Cathode current, mean	I_k	max.	610	mA 1)
peak	I_{kp}	max.	4.3	A
Envelope temperature	T_{env}	max.	350	°C
Seal temperature	t	max.	220	°C

1) Averaged over any mains frequency cycle

HEATING : direct; filament thoriated tungsten

Filament voltage	Vf	6.3	V
Filament current	If	32.5	A

The filament is designed to accept temporary fluctuations of +5 % and −10 %.

CAPACITANCES

Anode to filament	Caf	0.25	pF
Grid to filament	Cgf	10.5	pF
Anode to grid	Cag	6.2	pF

CHARACTERISTICS measured at V_a = 4 kV, I_a = 190 mA

Transconductance	S	5.1	mA/V
Amplification factor	µ	22	

COOLING

In general cooling of the tube is not necessary at matched load. When the tube is mounted in a small cabinet adequate ventilation must be provided.

At non-matched load or at high anode voltages, combined with the highest operating frequencies a low-velocity air flow directed on the tube is necessary. A small fan will suffice; it is recommended to mount the fan underneath the tube socket.

ACCESSORIES

Socket	catalogue nr.	2422 511 05001
Anode connector	type	40665

MECHANICAL DATA

Dimensions in mm

Mounting positions: vertical

Net weight: approx. 600 g

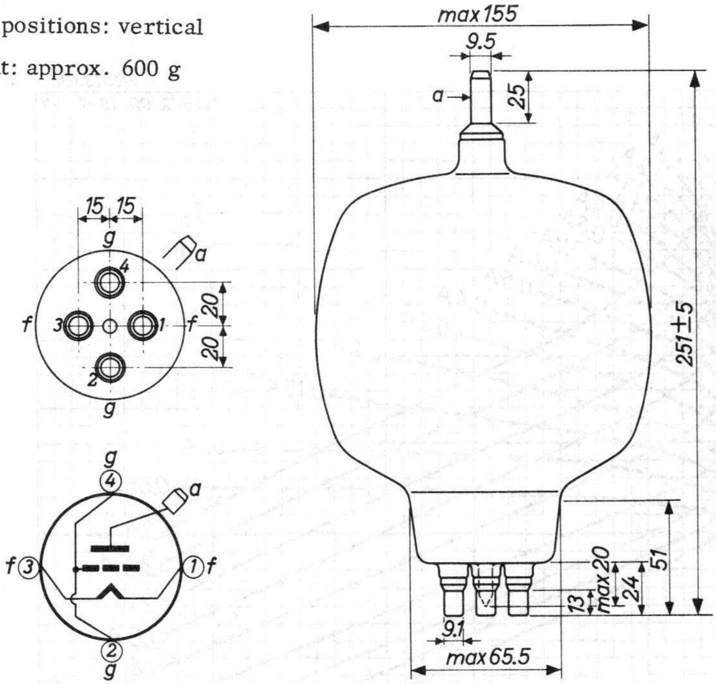


Fig. 1 Mechanical outline.

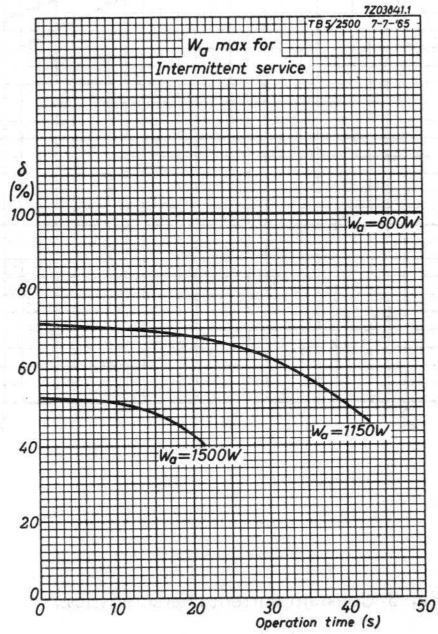


Fig. 2 Intermittent service. Limits of anode dissipation and cooling.

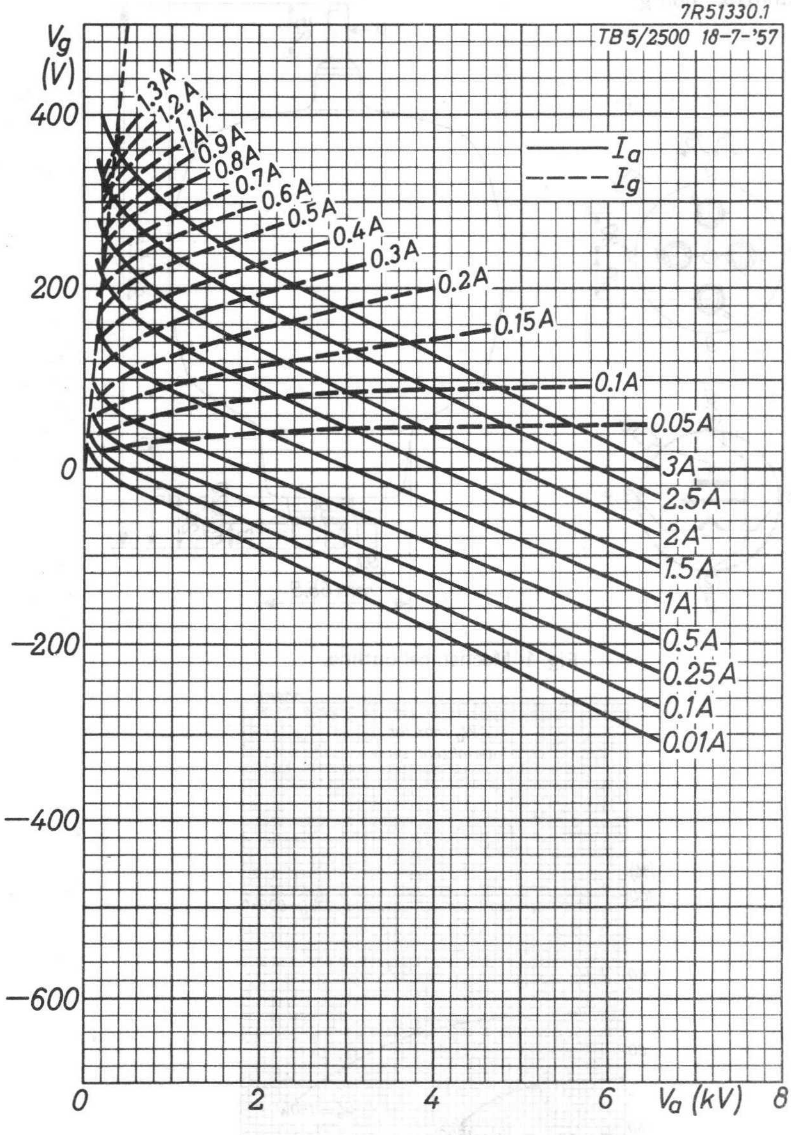


Fig. 3 Constant current characteristics.

RF POWER TRIODE

Water cooled triode with integral helical cooler intended for use as an industrial oscillator

QUICK REFERENCE DATA				
Oscillator output power (W_o - W_{feedb})	W_{osc}		6	kW
Frequency for full ratings	f	max.	55	MHz

To be read in conjunction with "General Operational Recommendations".

RF CLASS C OSCILLATOR FOR INDUSTRIAL USE *

OPERATING CONDITIONS

Frequency	f	50	MHz
Oscillator output power (W_o - W_{feedb})	W_{osc}	6	kW
Transformer voltage, RMS	V_{tr}	5,1	kV
Anode voltage	V_a	6	kV
Anode current	I_a	1,5	A
Anode input power	W_{ia}	9	kW
Anode dissipation	W_a	2,7	kW
Anode output power	W_o	6,3	kW
Anode efficiency	η_a	70	%
Oscillator efficiency	η_{osc}	67	%
Grid current, on load	I_g	0,4	A
Grid input power	W_{ig}	300	W

* With anode voltage from three-phase half-wave rectifier without filter.

LIMITING VALUES (Absolute max. rating system)

Frequency	f	up to	55	MHz
Anode voltage	V_a	max.	7	kV
Anode current	I_a	max.	1,8	A
Anode input power	W_{ia}	max.	11	kW
Anode dissipation	W_a	max.	6	kW
Grid voltage	$-V_g$	max.	1250	V
Grid current, on load	I_g	max.	0,5	A
off load	I_g	max.	0,7	A
Grid resistor	R_g	max.	10	kΩ
Temperature of filament seals	T	max.	210	^oC
Temperature of anode and grid seals	T	max.	180	^oC

HEATING: direct ; filament thoriated tungsten

Filament voltage	V_f	12,6	V
Filament current	I_f	33	A

The filament is designed to accept temporary fluctuations of +5% and −10%.

CAPACITANCES

Anode to all other elements except grid	C_a	0,3	pF
Grid to all other elements except anode	C_g	16	pF
Anode to grid	C_{ag}	11	pF

CHARACTERISTICS measured at V_a = 6 kV, I_a = 1 A

Transconductance	S	15	mA/V
Amplification factor	μ	32	

Table 1 Cooling characteristics

W_a (kW)	T_i (°C)	q_{min} (l/min)	ΔP (kPa)*	T_o (°C)
2	20	1,5	6	44
	50	3	22	62
4	20	3	22	42
	50	6	73	61
6	20	5	54	39
	50	10	180	59

Absolute max. water inlet temperature T_i max. 50 °C

At water inlet temperatures between 20 °C and 50 °C the required quantity of water can be found by linear interpolation.

In general no air cooling will be required at frequencies up to 30 MHz and at ambient temperatures below 35 °C. At higher temperatures or at higher frequencies a low velocity air flow to the grid and filament seals will be necessary.

ACCESSORIES

Filament connectors	type	40634
Connector for centre pin of the filament		40649
Grid connector	40650 or	40622

The centre filament pin f_c must not be used for filament current supply. The connector type 40649 should, however, be used for cooling of this pin.

The grid connector type 40650 must not be used at frequencies higher than 30 MHz.

* 100 kPa ≈ 1 at

MECHANICAL DATA

Dimensions in mm

Mounting position: vertical with anode down

Net mass : approx. 0, 8 kg

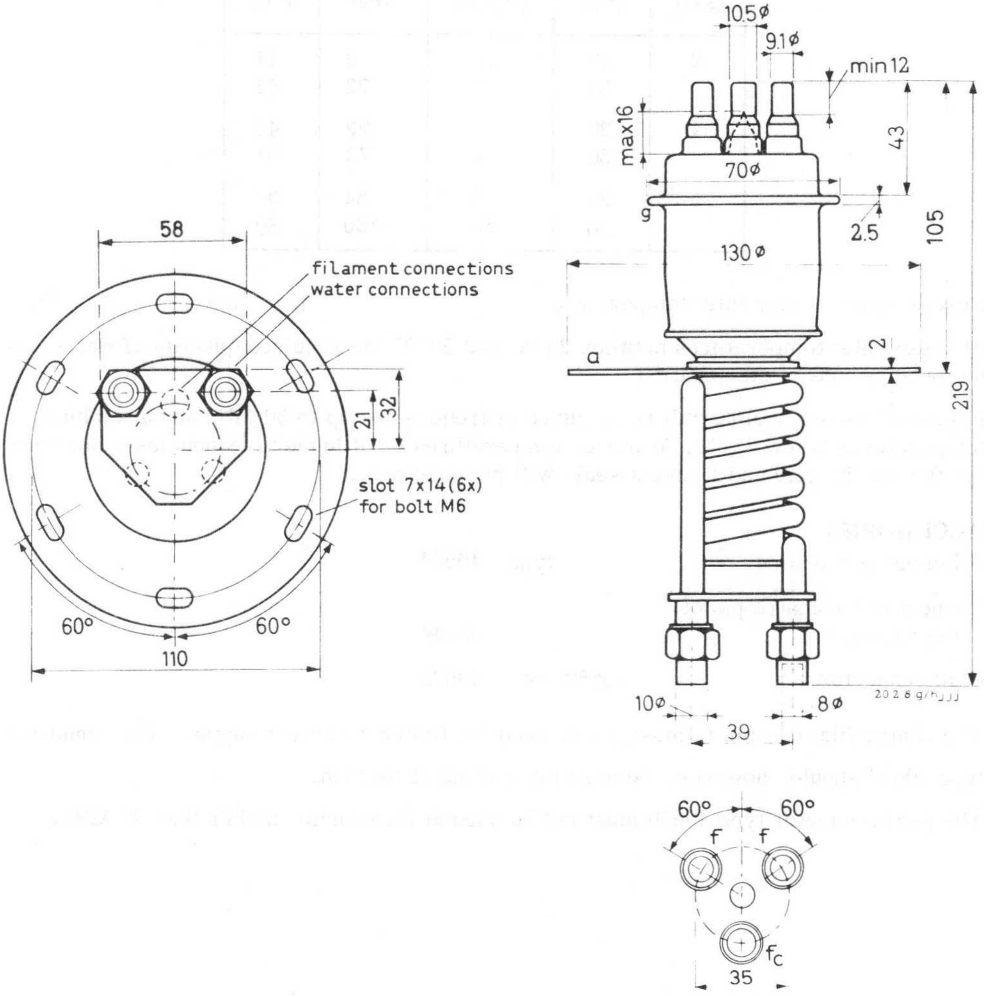


Fig. 1 Mechanical outline.

The use of wing nuts for the water connections should be avoided.

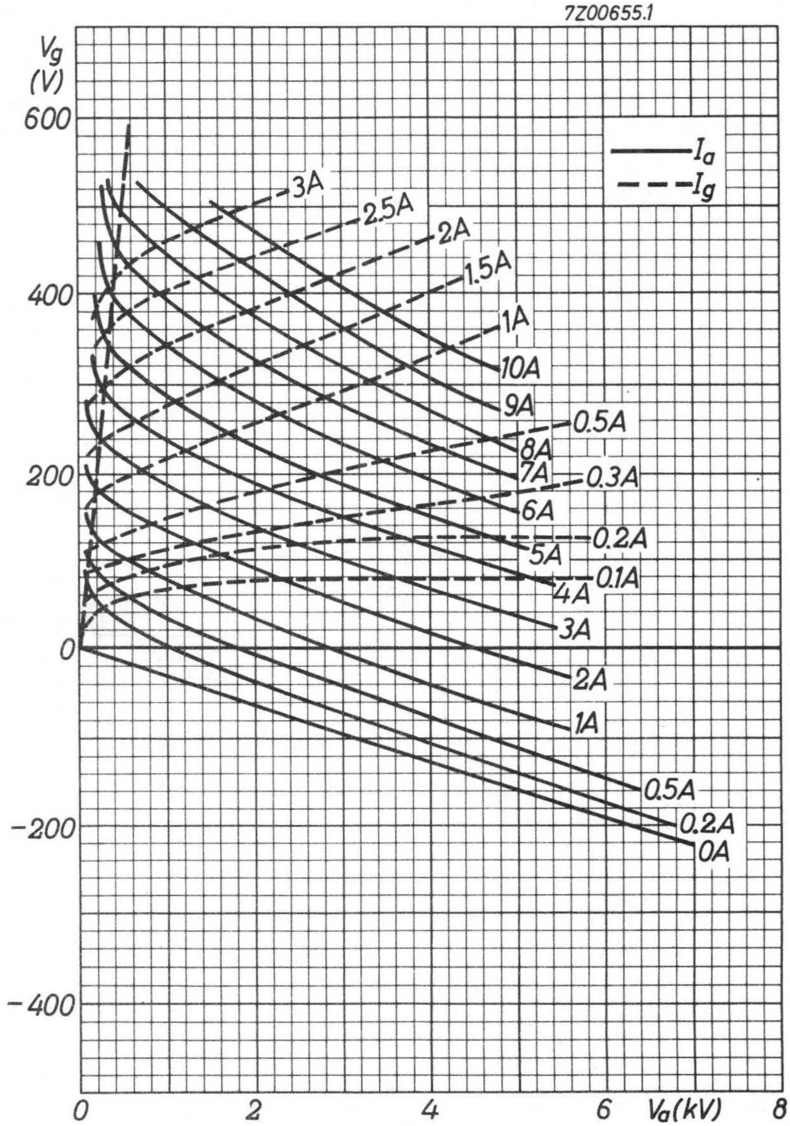


Fig. 2 Constant current characteristics.

RF POWER TRIODE

QUICK REFERENCE DATA				
Frequency (MHz)	C telegr.		C an.mod.	
	V_a (V)	W_o (W)	V_a (V)	W_o (W)
175	2500	475	2000	505
300	2000	460	1600	370
470	1750	405	1400	275
600	1600	350	1280	225
900	1300	155	1040	107

Industrial oscillator class C				
Frequency (MHz)	AC operation		Single-phase full-wave with filter	
	V_{tr} (V)	W_o (W)	V_a (V)	W_o (W)
470	1750	235	1750	385

HEATING: direct; filament thoriated tungsten

Frequency	f	< 600	600 to 750	750 to 900	MHz
Filament voltage	V_f	= 3.4	3.3	3.2	V
Filament current	I_f	= 19	–	–	A

CAPACITANCES

Anode to all except grid	C_a	< 0.12	pF
Grid to all except anode	C_g	= 9	pF
Anode to grid	C_{ag}	= 4	pF

TYPICAL CHARACTERISTICS

Anode voltage	V_a	= 2000	V
Anode current	I_a	= 150	mA
Amplification factor	μ	= 32	
Mutual conductance	S	= 10	mA/V

Table 1 Air cooling characteristics

W_a (W)	h (m)	t_i (^oC)	q_{min} (m^3/min)	ΔP Pa*
< 300	0	45	0.45	240
	1500	35	0.46	225
	3000	25	0.49	215

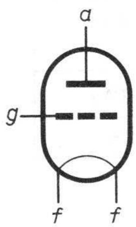
Temperature of envelope = max. 200 ^oC

Generally it will be necessary to direct an air flow to the centre filament seal.

MECHANICAL DATA

Dimensions in mm

Net weight: 143 g



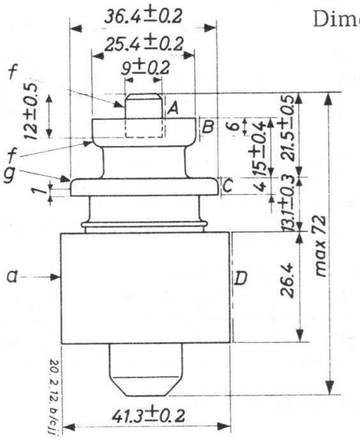


Fig. 1 Mechanical outline.

Eccentricity of the electrode connections: The electrode connections A, B and C are within cylindrical surfaces having a diameter of 9.5, 25.9 and 36.9 mm respectively and being coaxial with the cylindrical surface D.

Mounting position: vertical with anode up or down

* 1 Pa ≈ 0,1 mm H_2O.

RF CLASS C OSCILLATOR FOR INDUSTRIAL USE with self-rectification

LIMITING VALUES (Absolute limits)

Frequency	f	up to	470	MHz
Transformer voltage	V_{tr}	= max.	1800	V(RMS)
Anode current	I_a	= max.	210	mA
Anode input power	W_{i_a}	= max.	400	W
Anode dissipation	W_a	= max.	170	W
Negative grid voltage	$-V_g$	= max.	500	V
Grid current, loaded	I_g	= max.	85	mA
Grid current, unloaded	I_g	= max.	120	mA
Grid circuit resistance	R_g	= max.	5	kΩ

OPERATING CONDITIONS

Frequency	f	=	470	MHz
Transformer voltage	V_{tr}	=	1750	V(RMS)
Anode current, loaded	I_a	=	185	mA
Anode current, unloaded	I_a	=	105	mA
Grid current, loaded	I_g	=	75	mA
Grid current, unloaded [1]	I_g	=	80	mA
Grid circuit resistance under matched conditions	R_g	=	400	Ω
Anode input power	W_{i_a}	=	365	W
Anode dissipation	W_a	=	130	W
Tube output power	W_o	=	235	W
Tube efficiency	η	=	64	%
Output power in the load [2]	W_ℓ	=	165	W

[1]) The grid resistance is obtained by a current stabilising device

[2]) Measured by a calorimetric method

RF CLASS C OSCILLATOR FOR INDUSTRIAL USE with anode voltage from a single-phase full-wave rectifier with filter.

LIMITING VALUES (Absolute limits)

Frequency	f	up to	470	MHz
Anode voltage	V_a	= max.	1800	V
Anode current	I_a	= max.	400	mA
Anode input power	W_{i_a}	= max.	700	W
Anode dissipation	W_a	= max.	300	W
Negative grid voltage	$-V_g$	= max.	300	V
Grid current, loaded	I_g	= max.	110	mA
Grid current, unloaded	I_g	= max.	120	mA
Grid circuit resistance	R_g	= max.	5	kΩ

OPERATING CONDITIONS

Frequency	f	=	470	MHz
Anode voltage	V_a	=	1750	V
Anode current, loaded	I_a	=	340	mA
Anode current, unloaded	I_a	=	170	mA
Grid current, loaded	I_g	=	95	mA
Grid current, unloaded [1]	I_g	=	100	mA
Grid circuit resistance under matched conditions	R_g	=	1000	Ω
Anode input power	W_{i_a}	=	595	W
Anode dissipation	W_a	=	210	W
Tube output power	W_o	=	385	W
Tube efficiency	η	=	65	%
Output power in the load	W_ℓ	=	270	W

[1]) The grid resistance is obtained by a current stabilising device.

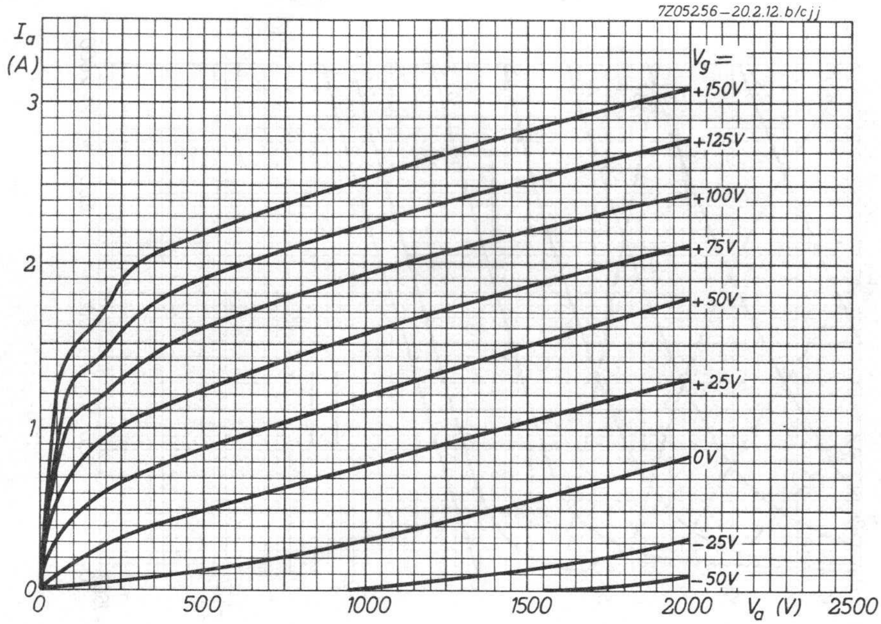


Fig. 2 I_a/V_a characteristics.

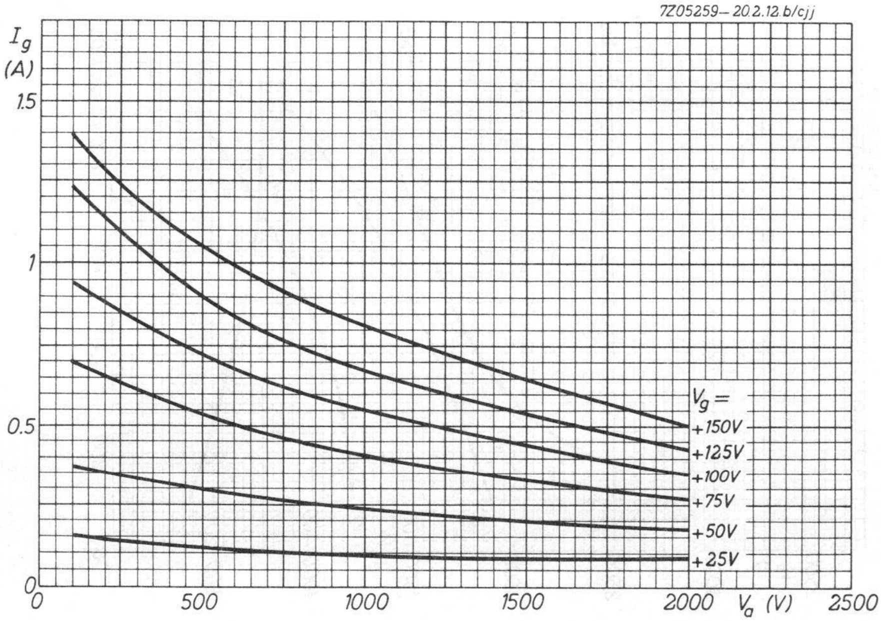


Fig. 3 I_g/V_a characteristics.

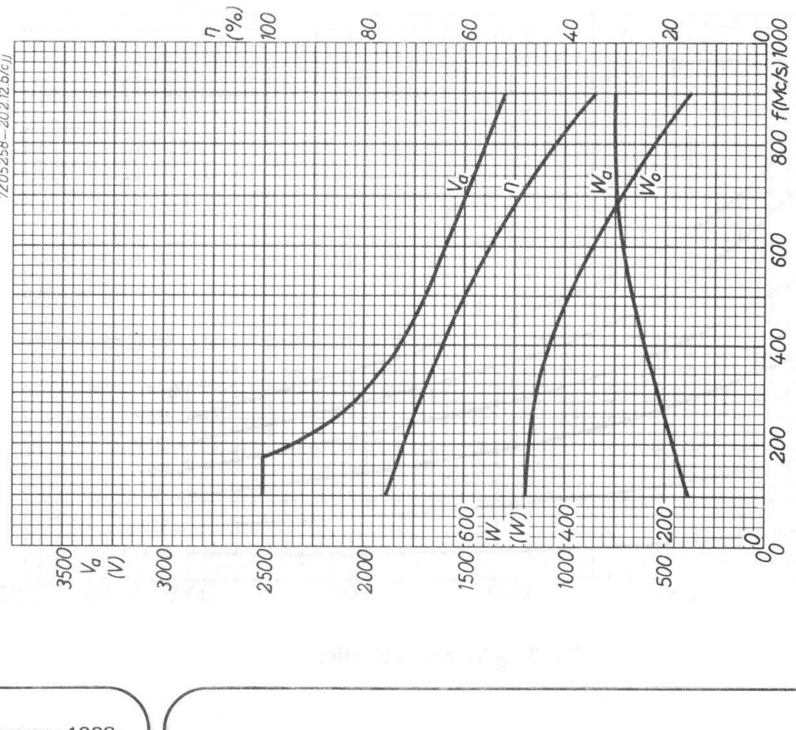


Fig. 4 Frequency dependant characteristics.

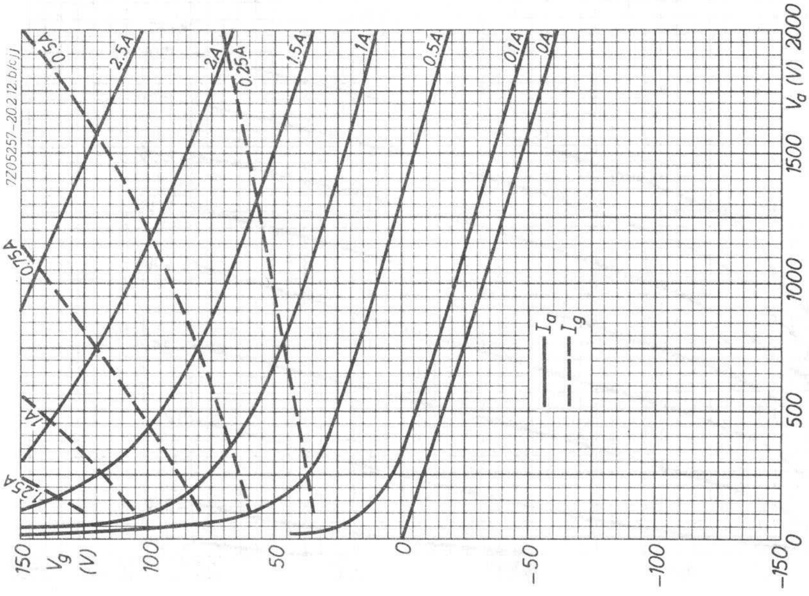


Fig. 5 Constant current characteristics.

RF POWER TRIODE

QUICK REFERENCE DATA						
Frequency (MHz)	C telegr. grounded grid		Industrial oscillator class C			
			DC operation		AC operation	
	V_a (V)	W_o (W)	V_a (V)	W_o (W)	V_{tr} (V)	W_o (W)
470	2000	595	2000	480	1800	230
640	1800	490				
730	1800	460				
810	1800	408	1800	284		

HEATING: direct; filament thoriated tungsten

Frequency	f	< 600	600 to 750	750 to 900	MHz
Filament voltage	V_f	= 3.4	3.3	3.2	V
Filament current	I_f	= 19	–	–	A

CAPACITANCES

Anode to all except grid	C_a	<	0.12	pF
Grid to all except anode	C_g	=	11.5	pF
Anode to grid	C_{ag}	=	6.5	pF

TYPICAL CHARACTERISTICS

Anode voltage	V_a	=	2000	V
Anode current	I_a	=	200	mA
Amplification factor	μ	=	33	
Mutual conductance	S	=	10	mA/V

TEMPERATURE LIMITS (Absolute limits)

Temperature of seal between filament terminals = max. 200 °C

Temperature of other seals = max. 250 °C

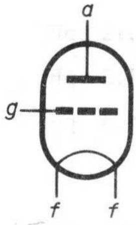
Table 1 Cooling characteristics

W_a (W)	h (m)	t_i (°C)	q_{min} (m^3/min)	ΔP (Pa)*
400	0	45	0.65	12
	1500	35	0.65	12
	3000	25	0.65	12

The required quantity of air is independent of the anode dissipation and the frequency.

MECHANICAL DATA Dimensions in mm

Net weight: 157 g



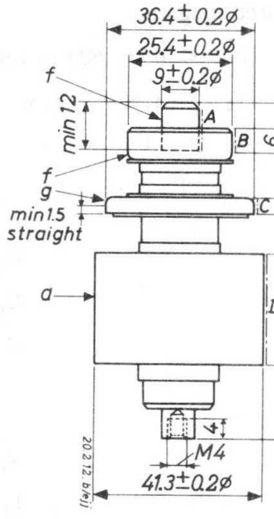


Fig. 1 Mechanical outline.

Eccentricity of the electrode connections: The electrode connections A, B and C are within cylindrical surfaces having a diameter of 9.5, 25.9 and 36.9 mm respectively and being concentric with the cylindrical surface D.

Mounting position: vertical with the anode up or down.

* 1 Pa ≈ 0,1 mm H_2O.

RF CLASS C OSCILLATOR FOR INDUSTRIAL USE

LIMITING VALUES (Absolute limits)

Frequency	f	up to	470	900	MHz
Anode voltage	V_a	= max.	2200	2000	V
Anode current	I_a	= max.	400	400	mA
Anode input power	W_{i_a}	= max.	880	800	W
Anode dissipation	W_a	= max.	400	400	W
Negative grid voltage	$-V_g$	= max.	300	300	V
Grid current, loaded	I_g	= max.	120	120	mA
Grid current, unloaded	I_g	= max.	130	130	mA
Grid circuit resistance	R_g	= max.	10	10	kΩ

OPERATING CONDITIONS

Frequency	f	=	470	810	MHz
Anode voltage	V_a	=	2000	1800	V
Anode current, loaded	I_a	=	380	380	mA
Anode current, unloaded	I_a	=	170	–	mA
Grid circuit resistance	R_g	=	1000	1000	Ω [1]
Grid current, loaded	I_g	=	110	110	mA
Grid current, unloaded	I_g	=	120	120	mA
Anode input power	W_{i_a}	=	760	684	W
Anode dissipation	W_a	=	280	400	W
Tube output power	W_o	=	480	284	W
Tube efficiency	η	=	63	41	%
Output power in the load	W_ℓ	=	340	200	W

[1]) The grid circuit resistance is obtained by a current stabilising device. The stated value applies to loaded conditions.

RF CLASS C OSCILLATOR FOR INDUSTRIAL USE in grounded grid circuit with self rectification

LIMITING VALUES (Absolute limits)

Voltages with respect to cathode

Frequency	f		up to	470	MHz
Transformer voltage	V_{tr}	=	max.	2000	V(RMS)
Anode current	I_a	=	max.	210	mA
Anode input power	W_{i_a}	=	max.	450	W
Anode dissipation	W_a	=	max.	170	W
Negative grid voltage	$-V_g$	=	max.	300	V
Grid current, loaded	I_g	=	max.	85	mA
Grid current, unloaded	I_g	=	max.	120	mA
Grid circuit resistance	R_g	=	max.	5	kΩ

OPERATING CHARACTERISTICS

Voltages with respect to cathode

Frequency	f	=	470	MHz
Transformer voltage	V_{tr}	=	1800	V(RMS)
Anode current, loaded	I_a	=	190	mA
Anode current, unloaded	I_a	=	110	mA
Grid current, loaded	I_g	=	70	mA
Grid current, unloaded	I_g	=	100	mA
Grid circuit resistance	R_g	=	400	Ω
Anode input power	W_{i_a}	=	380	W
Anode dissipation	W_a	=	150	W
Tube output power	W_o	=	230	W
Tube efficiency	η	=	60	%
Output power in the load	W_ℓ	=	160	W

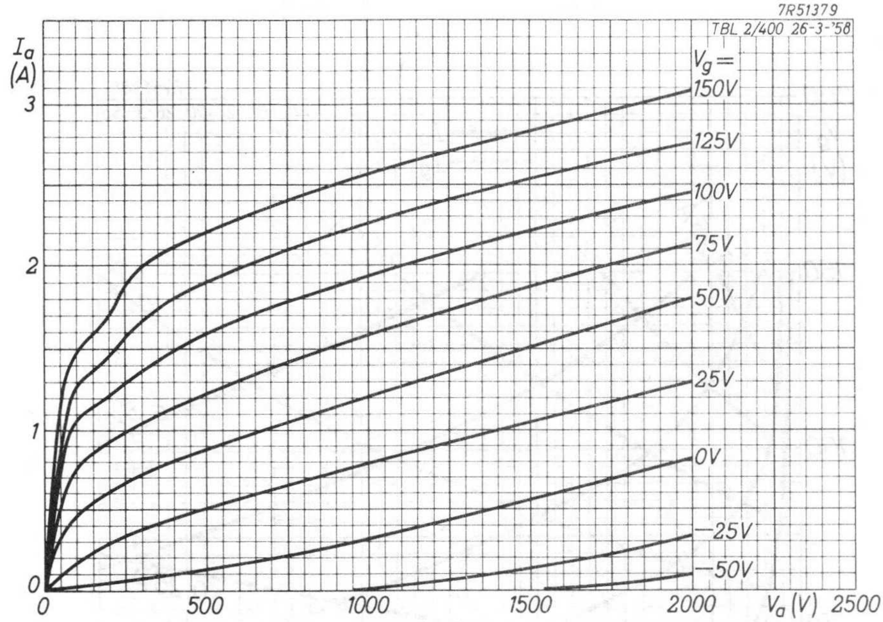


Fig. 2 I_a/V_a characteristics.

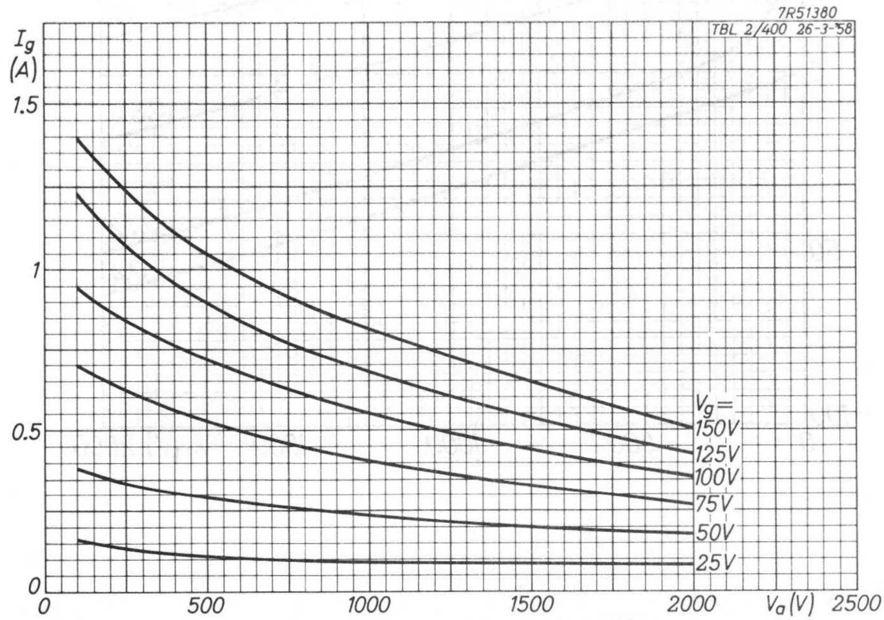


Fig. 3 I_g/V_a characteristics.

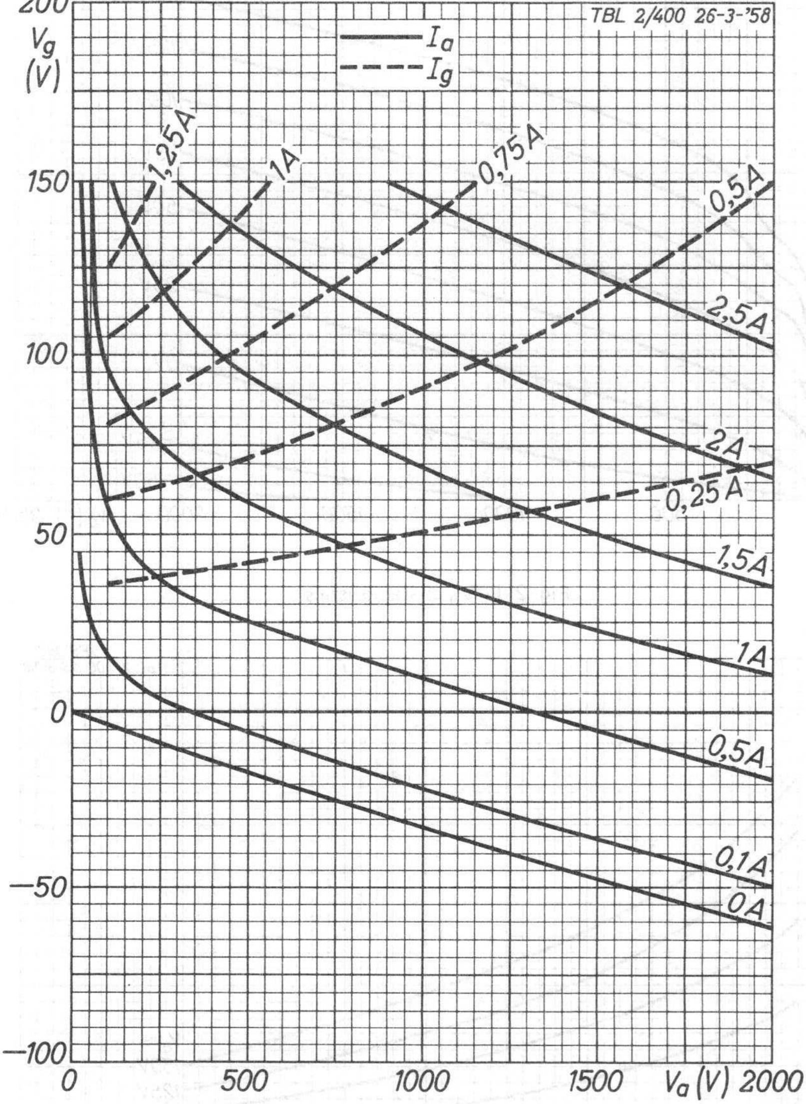


Fig. 4 Constant current characteristics.

RF POWER TRIODE

- Air cooled

QUICK REFERENCE DATA

Industrial RF oscillator, class-C

freq. MHz	three phase V_a kV	W_o kW
30	7	17,7
	6	14,3

HEATING: direct; thoriated tungsten filament

Filament voltage	V_f	=	6,3 V
Filament current	I_f	=	136 A
Cold filament resistance	R_{fo}	=	0,005 Ω

The filament is designed to accept temporary fluctuations of +5% and −10%

The filament current must never exceed a peak value of 280 A at any time during the initial energizing schedule.

CAPACITANCES

Anode to all other elements except grid	C_a	=	1,2 pF
Grid to all other elements except anode	C_g	=	44,5 pF
Anode to grid	C_{ag}	=	33,5 pF

TYPICAL CHARACTERISTICS

Anode voltage	V_a	=	6 kV
Anode current	I_a	=	2,5 A
Mutual conductance	S	=	23 mA/V
Amplification factor	μ	=	17,5

TEMPERATURE LIMIT (Absolute limit)

Temperature of all seals	max.	220 °C

Table 1 Cooling

anode dissipation W_a kW	altitude h m	inlet temperature T_i °C	rate of flow q_{min} m^3/min	pressure drop ΔP Pa*	outlet-temperature T_o max °C
10	0	35	11	500	90
7,5	0	35	8,0	270	90
5	0	35	5,2	120	95
10	0	45	12,3	630	95
7,5	0	45	9,0	340	95
5	0	45	5,9	150	100
10	1500	35	13	590	90
7,5	1500	35	9,5	320	90
5	1500	35	6,2	140	95
10	3000	25	14	640	85
7,5	3000	25	10,2	340	85
5	3000	25	6,6	150	90

ACCESSORIES

Filament connectors with cable 40662
Grid connector 40664
Insulating pedestal K508
or air distributor K509

The rounded side of the grid connector should face the anode. To ensure a uniform R.F. current distribution in the grid seal at frequencies higher than 4 MHz, the grid lead should be connected as shown below.

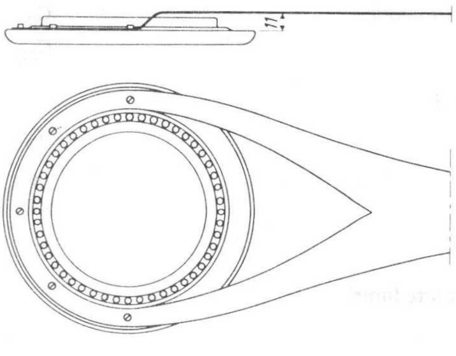
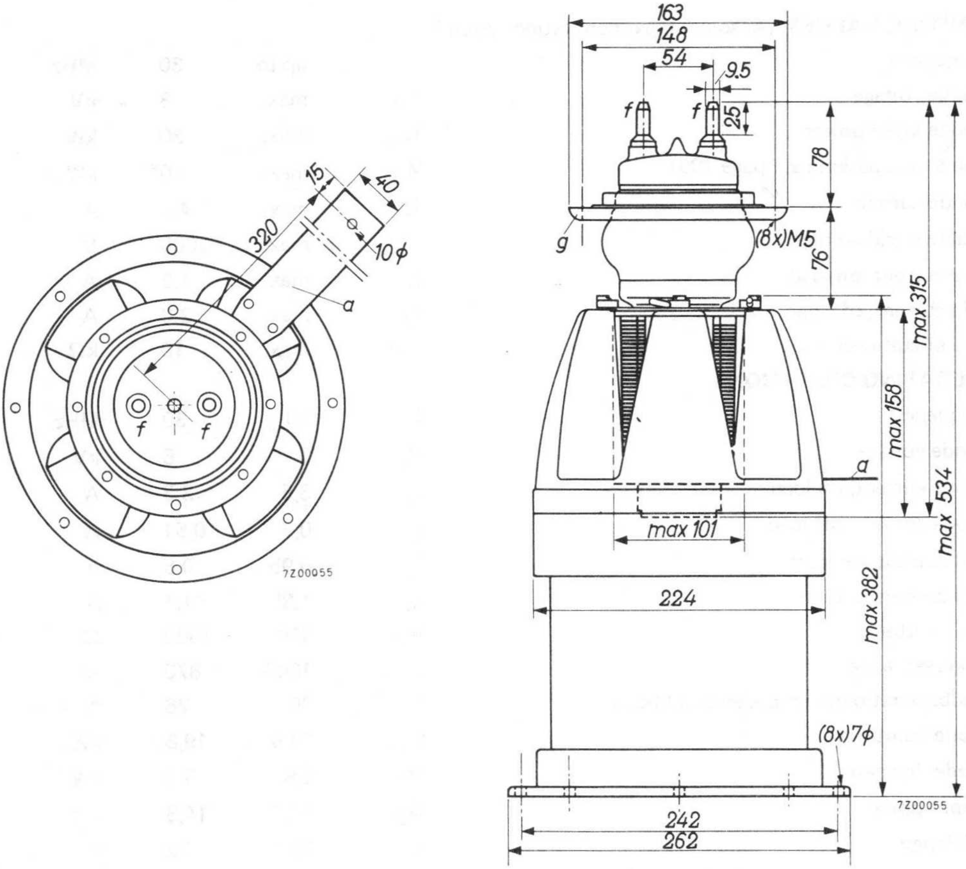


Fig. 1 Connection of the grid lead.

* 1 Pa ≈ 0,1 mm H_2O.

MECHANICAL DATA

Dimensions in mm



Mounting position : vertical with anode down
Net mass of tube : 3,8 kg
Net mass of pedestal : 7,4 kg

Fig. 2 Mechanical outline.

RF CLASS-C OSCILLATOR FOR INDUSTRIAL USE with anode voltage from three-phase rectifier without filter

LIMITING VALUES (Absolute maximum rating system)

Frequency	f	up to	30	MHz
Anode voltage	V_a	max.	8	kV
Anode input power	W_{ia}	max.	30	kW
Anode dissipation (See page 106)	W_a	max.	10*	kW
Anode current	I_a	max.	4,0	A
Negative grid voltage	$-V_g$	max.	1600	V
Grid current, on load	I_g	max.	1,5	A
Grid current, off load	I_g	max.	2,0	A
Grid circuit resistance	R_g	max.	10	kΩ

OPERATING CONDITIONS

Frequency	f	30	30	MHz
Anode voltage	V_a	7	6	kV
Anode current, on load	I_a	3,5	3,3	A
Anode current, off load	I_a	0,7	0,51	A
Grid current, on load	I_g	0,95	0,8	A
Grid current, off load	I_g	1,35	1,1	A
Grid resistor	R_g	950	1000	Ω
Load resistance	$R_{a\sim}$	1000	870	Ω
Feedback ratio under loaded conditions	$V_{g\sim}/V_{a\sim}$	25	26	%
Anode input power	W_{ia}	24,5	19,8	kW
Anode dissipation	W_a	6,8	5,5	kW
Output power	W_o	17,7	14,3	kW
Efficiency	η	72	72	%
Output power in the load **	W_ℓ	14	11	kW

* TBW6/14: $W_{a\,max}$ = 15 kW
** Useful power in the load, measured in a circuit having an efficiency of approx. 85%.

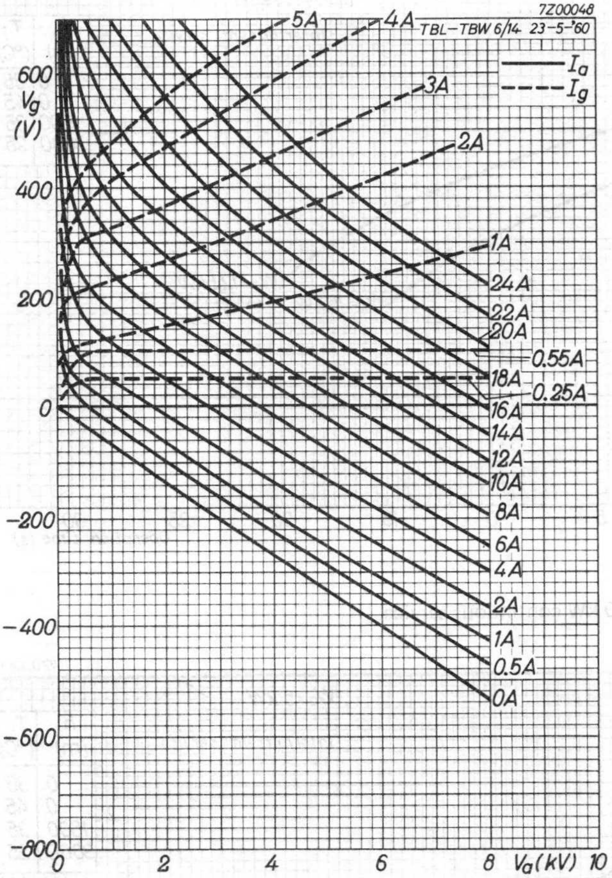
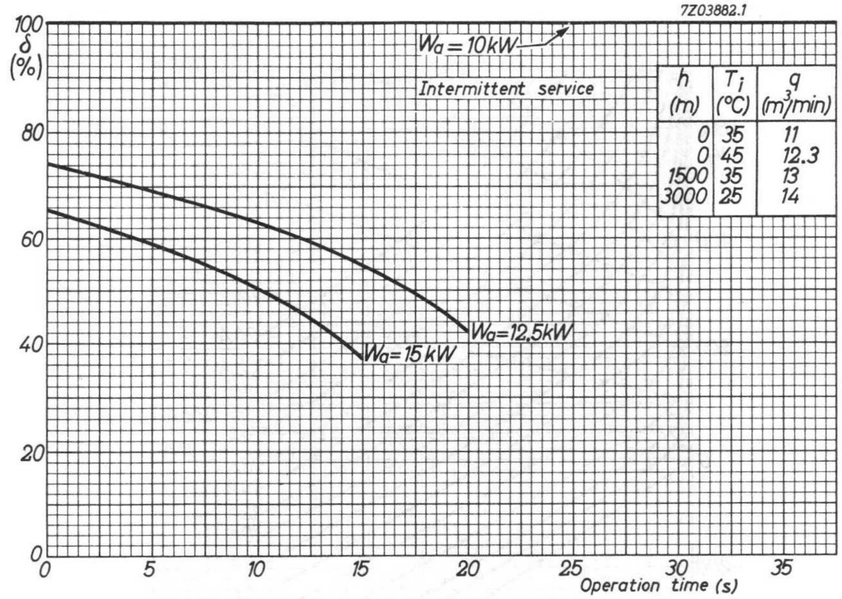
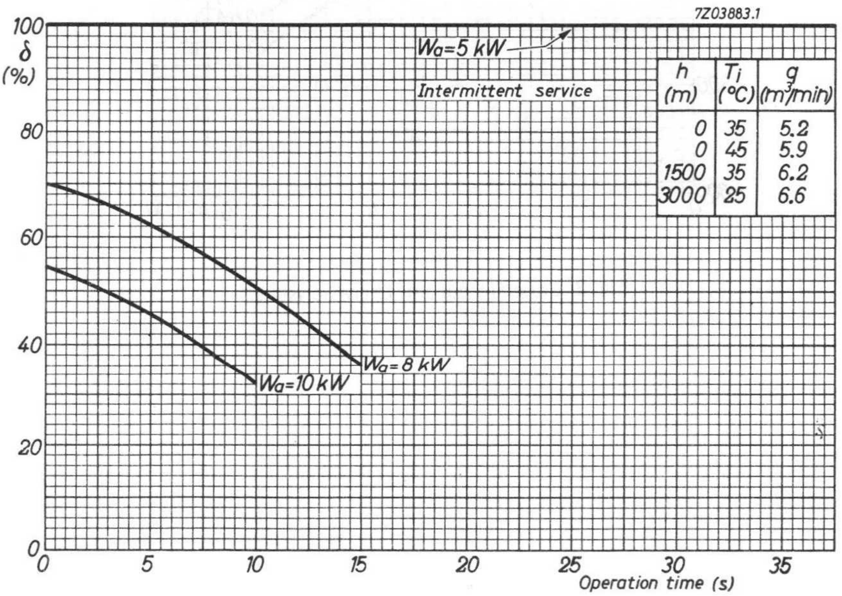


Fig. 3 Constant current characteristics.

Fig. 4 Intermittent service. Limits of anode dissipation and cooling.



(a) For cooling see 10 kW continuous service.



(b) For cooling see 5 kW continuous service.

RF POWER TRIODE

- Air cooled

QUICK REFERENCE DATA

Industrial RF oscillator, class-C

	three-phase rectifier			
freq.	continuous		intermittent	
	V_a	W_o	V_a	W_o
MHz	kV	kW	kV	kW
50	7	4,85		
	6	4,1	6	5,9

HEATING: direct; thoriated tungsten filament

Filament voltage	V_f	=	6,3 V
Filament current	I_f	=	65 A

The filament is designed to accept temporary fluctuations of +5% and −10%

CAPACITANCES

Anode to all other elements except grid	C_a	<	0,5 pF
Grid to all other elements except anode	C_g	=	13 pF
Anode to grid	C_{ag}	=	7,5 pF

TYPICAL CHARACTERISTICS

Anode voltage	V_a	=	6 kV
Anode current	I_a	=	0,24 A
Mutual conductance	S	=	7 mA/V
Amplification factor	μ	=	23

TEMPERATURE LIMITS (Absolute limits)

Temperature of all seals	max.	220 °C
Temperature of external parts of anode	max.	270 °C

Table 1 Cooling

Continuous service	W_a (kW)	q_{min} (m^3/min)	ΔP (Pa)*
	1.3	1.6	160
	1.7	2.1	250

For intermittent service see figure page 113

At higher altitudes and/or temperatures a corresponding higher amount of air should be applied

RECOMMENDED COOLING DEVICE

(1) = metal housing (see page 3)

(2) = glass cylinder

(3) = socket 2422 511 05001

(4) = ground plate (see page 3)

Dimensions of the glass cylinder:

Height : 118 mm

Outside diameter : 150 mm

Inside diameter : 144 mm

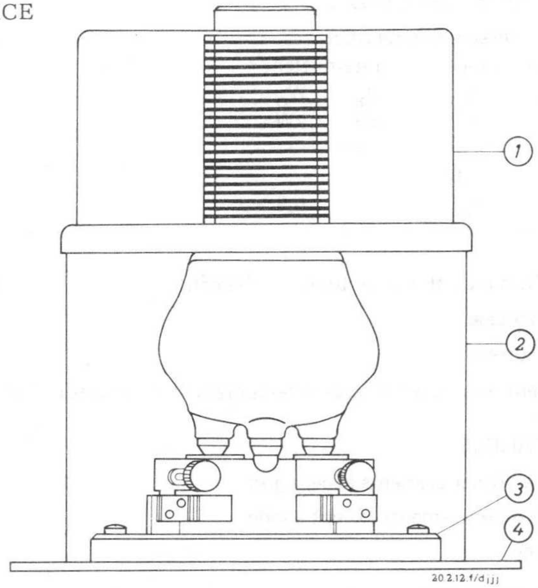


Fig. 1 Recommended cooling device.

The cooling air should preferably be supplied through the space under the ground plate (4). This ground plate should have holes of sufficient cross section to pass the required air flow.

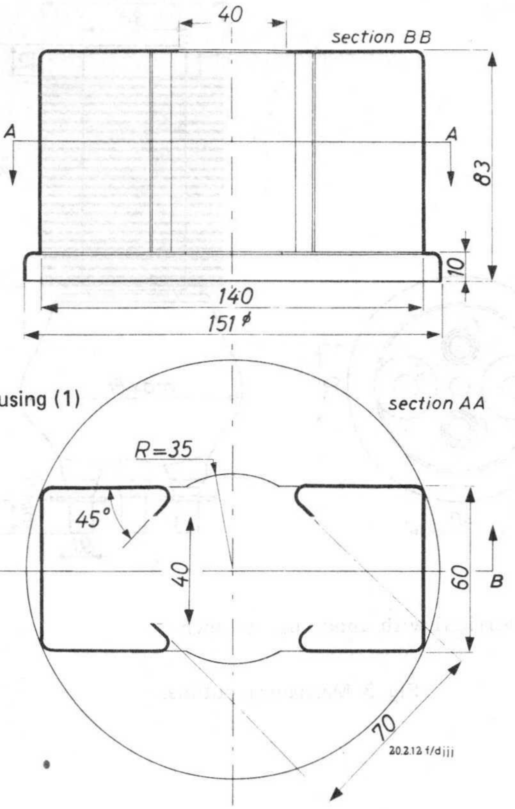
The housing (1) should be connected to the anode connector. At frequencies above 4 MHz both grid terminals should be connected in parallel. At the highest frequencies care should be taken to distribute the RF current equally between both grid terminals to avoid excessive grid seal temperatures.

7Z2 8655

* 1 Pa ≈ 0,1 mm H_2O.

RECOMMENDED COOLING DEVICE (continued)

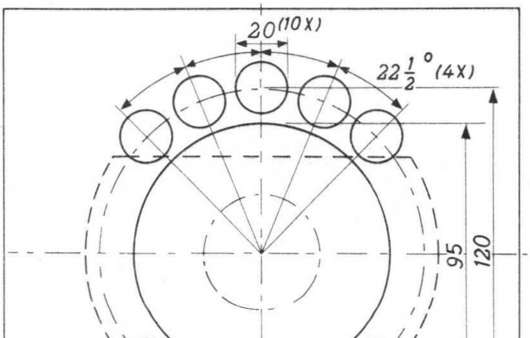
Dimensions in mm



Metal housing (1)

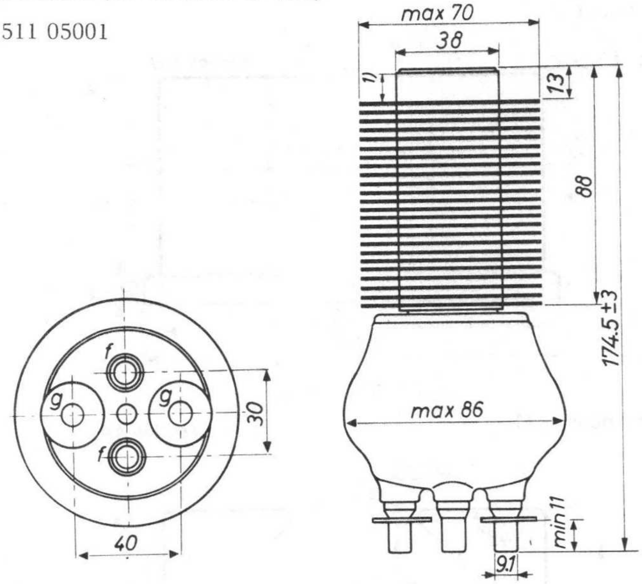
Fig. 2 Cooling device details.

Ground plate (4)



MECHANICAL DATA (dimensions in mm)

Socket: 2422 511 05001



Mounting position: vertical with anode up or down

Fig. 3 Mechanical outline.

1) Area for anode connector

RF CLASS C OSCILLATOR FOR INDUSTRIAL USE with anode voltage from three-phase rectifier without filter

LIMITING VALUES (Absolute limits) continuous service

Frequency	f	up to	50	MHz
Anode voltage	V_a	= max.	8	kV
Anode current	I_a	= max.	1	A
Anode input power	W_{ia}	= max.	7	kW
Anode dissipation	W_a	= max.	1.7	kW
Negative grid voltage	$-V_g$	= max.	1250	V
Grid current, loaded	I_g	= max.	0.4	A
Grid current, unloaded	I_g	= max.	0.5	A
Grid resistor	R_g	= max.	10	kΩ

OPERATING CONDITIONS, continuous service

Frequency	f	=	50	50	MHz
Transformer voltage	V_{tr}	=	6.0	5.1	kV_{RMS}
Anode voltage	V_a	=	7	6	kV
Anode current, loaded	I_a	=	0.9	0.9	A
Anode current, unloaded	I_a	=	0.2	0.2	A [1]
Grid current, loaded	I_g	=	0.25	0.28	A
Grid current, unloaded	I_g	=	0.30	0.35	A [1]
Grid resistor	R_g	=	2.5	2	kΩ
Load resistance	$R_{a\sim}$	=	3.85	3.3	kΩ
Feedback ratio under loaded conditions	$V_{g\sim}/V_{a\sim}$	=	15	16	%
Anode input power	W_{ia}	=	6.3	5.4	kW
Anode dissipation	W_a	=	1.45	1.3	kW
Output power	W_o	=	4.85	4.1	kW
Efficiency	η	=	77	76	%
Output power in the load	W_ℓ	=	4.0	3.3	kW [2]

[1] In a typical circuit
[2] Useful power in the load measured in a circuit having an efficiency of 85%.

7Z2 3535

RF CLASS C OSCILLATOR FOR INDUSTRIAL USE with anode voltage from three-phase rectifier without filter

LIMITING VALUES (Absolute limits) intermittent service

Frequency	f	up to	50	MHz
Anode voltage	V_a	= max.	8	kV
Anode current	I_a	= max.	1.5	A
Anode input power	W_{ia}	= max.	9	kW
Anode dissipation	W_a	= max.	2.1	kW [1])
Negative grid voltage	$-V_g$	= max.	1250	V
Grid current, loaded	I_g	= max.	0.4	A
Grid current, unloaded	I_g	= max.	0.5	A
Grid resistor	R_g	= max.	10	kΩ

OPERATING CONDITIONS, intermittent service

Frequency	f	=	50	MHz
Transformer voltage	V_{tr}	=	5.1	kV_{RMS}
Anode voltage	V_a	=	6	kV
Anode current, loaded	I_a	=	1.33	A
Anode current, unloaded	I_a	=	0.33	A [2])
Grid current, loaded	I_g	=	0.38	A
Grid current, unloaded	I_g	=	0.48	A [2])
Grid resistor	R_g	=	1450	Ω
Load resistance	$R_{a\sim}$	=	2200	Ω
Feedback ratio under loaded conditions	$V_{g\sim}/V_{a\sim}$	=	17	%
Anode input power	W_{ia}	=	8	kW
Anode dissipation	W_a	=	2.1	kW [1])
Output power	W_o	=	5.9	kW
Efficiency	η	=	74	%
Output power in the load	W_ℓ	=	4.75	kW [3])

[1]) See Fig. 4
[2]) In a typical circuit
[3]) Useful power in the load measured in a circuit having an efficiency of 85%.

7Z2 4051

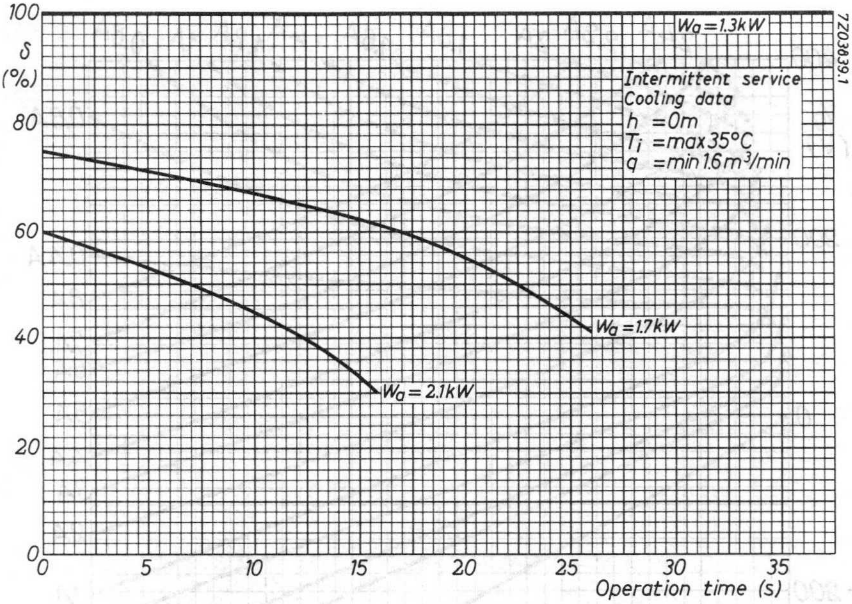


Fig. 4 Intermittent service. Limits of anode dissipation and cooling.

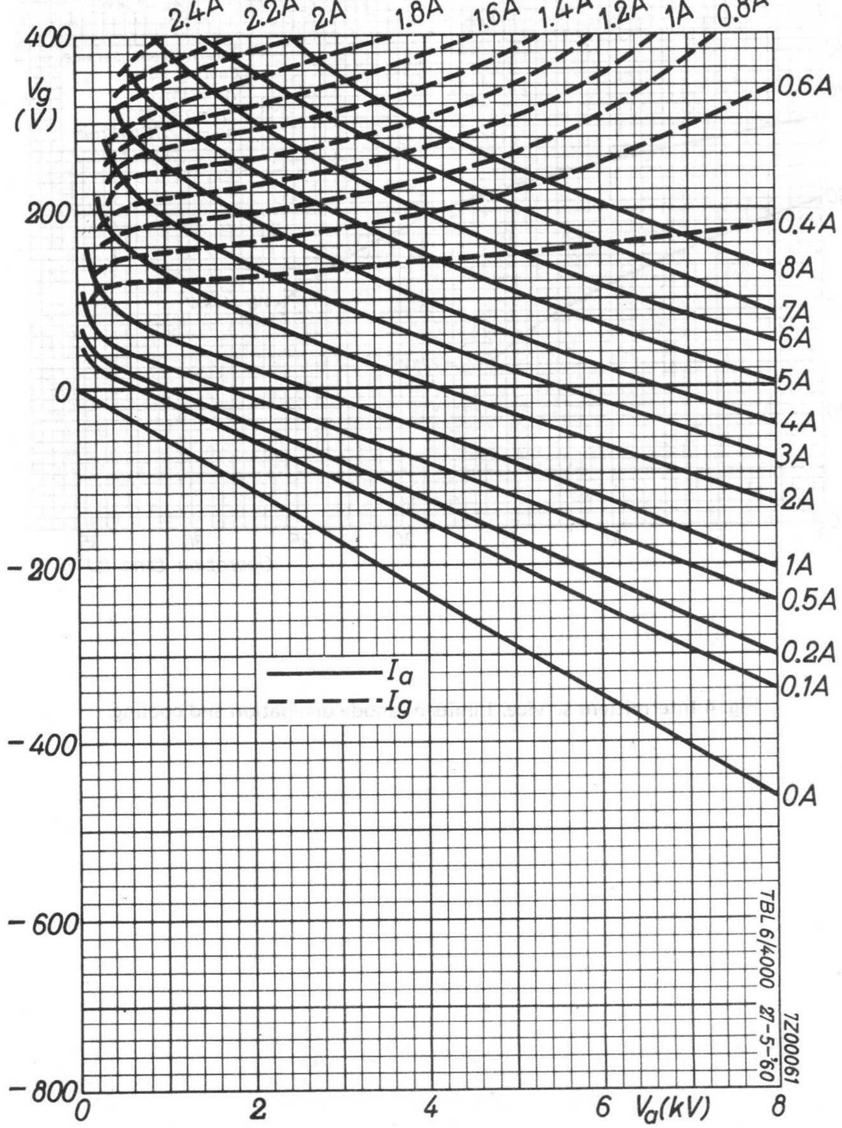


Fig. 5 Constant current characteristics.

RF POWER TRIODE

QUICK REFERENCE DATA										
General purposes										
λ (m)	Freq. (MHz)	C telegr.		B teleph.		C_a mod.			B mod. [1]	
		V_a (kV)	W_o (kW)	V_a (kV)	W_o (kW)	V_a (kV)	W_o (kW)		V_a (kV)	W_o (kW)
4	75	6	6.9	6	1.9				6	13.3
		5	5.6	5	1.45	5	4.7		5	6.6
		4	4			4.5	4.1		4.5	6.0
						4	3.5		4	5.3
						3.5	3		3.5	4.6
						3	2.2		3	3.3

Television service					
Freq. (MHz)	Neg. mod. Pos. sync.			Pos. mod. Neg. sync.	
	V_a (kV)	W_o sync (kW)	W_o black (kW)	V_a (kV)	W_o white (kW)
75	5	9	5.35	5	9

HEATING: direct; filament thoriated tungsten

Filament voltage	V_f	12.6	V
Filament current	I_f	33	A

CAPACITANCES

Anode to all other elements except grid	C_a	0.3	pF
Grid to all other elements except anode	C_g	16	pF
Anode to grid	C_{ag}	11	pF

COOLING: forced air

[1]) Two tubes

TYPICAL CHARACTERISTICS

Anode voltage	V_a	4	kV
Anode current	I_a	1	A
Amplification factor	μ	32	
Mutual conductance	S	17	mA/V

Table 1 Air cooling characteristics

W_a (kW)	h (m)	T_i max. (°C)	$q_{min.}$ (m^3/min)	ΔP (Pa)*
1	0	35	3	80
	0	45	3.1	80
	1500	35	3.7	90
	3000	25	4.1	100
3	0	35	5.2	230
	0	45	6.1	290
	1500	35	6.2	260
	3000	25	6.6	260
5	0	35	9.2	680
	0	45	10.7	900
	1500	35	11.2	810
	3000	25	11.6	790

TEMPERATURE LIMITS (Absolute limits)

Temperature of seals = max. 180 °C

* 1 Pa ≈ 0,1 mm H_2O.

MECHANICAL DATA

Mounting position: Vertical with anode up or down.
The centre tap f_c must not be used for filament current supply. The connectors type 40634, however, must be used for cooling of all three filament pins.

Net **mass** : approx. 4.6 kg

Dimensions in mm

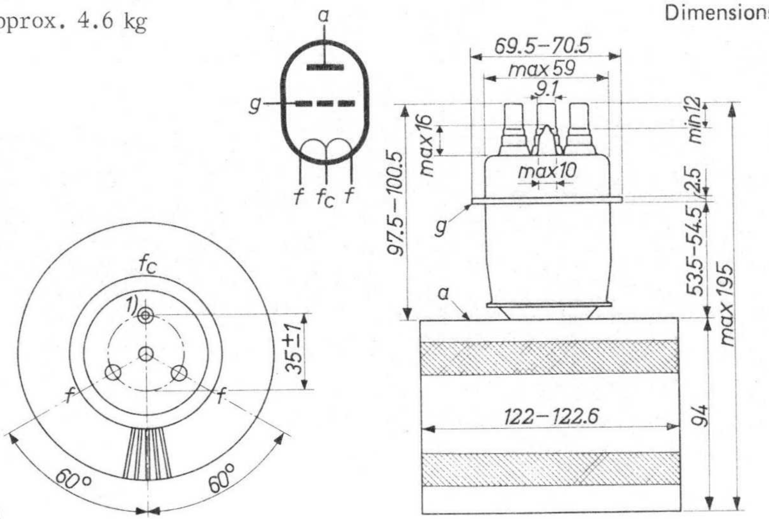


Fig. 1 Mechanical outline.

ACCESSORIES

Grid connector	type 40650 [2]	
or	40622	
Filament connectors	40634	
Insulating pedestal	40630	

For further data and curves (except cooling curves) please refer to type TBW6/6000

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[1]) This pin is marked "O"

[2]) The connector 40650 should be used only below 30 MHz.

RF POWER TRIODE

Air-cooled triode for use in industrial RF generators and in telegraphy and telephony transmitters.

QUICK REFERENCE DATA

		class-C				class-B	
		telegraphy		oscillator		modulator*	
λ	freq.	V_a	W_o	V_a	W_o	V_a	W_o
m	MHz	kV	kW	kV	kW	kV	kW
10	30	6,5	9,5			7,0	20
		6,0	8,5			5,0	9,0
		5,0	7,1			4,0	7,1
6	50			6,0	6,0		

COOLING: forced air

HEATING: direct; thoriated tungsten filament

Filament voltage	V_f	=	12,6 V
Filament current	I_f	=	33 A

The filament is designed to accept temporary fluctuations of +5% and −10%

CAPACITANCES

Anode to all other elements except grid	C_a	=	0,3 pF
Grid to all other elements except anode	C_g	=	16 pF
Anode to grid	C_{ag}	=	11 pF

TYPICAL CHARACTERISTICS

Anode voltage	V_a	=	6 kV
Anode current	I_a	=	1 A
Mutual conductance	S	=	15 mA/V
Amplification factor	μ	=	32

* Two tubes.

Table 1 Air cooling characteristics

W_a kW	h m	T_i max. °C	q min. m^3/min	ΔP Pa*
2	0	35	4,8	200
	0	45	5,7	250
	1500	35	5,7	230
	3000	25	6,1	230
3,5	0	35	6,2	320
	0	45	7,3	420
	1500	35	7,3	360
	3000	25	7,8	360
6	0	35	9,2	680
	0	45	10,7	910
	1500	35	11,2	810
	3000	25	11,7	800

Temperature of filament seals max. 210 °C

Temperature of grid and anode seals max. 180 °C

ACCESSORIES

Filament connectors	40634
Connector for centre pin of filament	40649*
Grid connector	40650** or 40622
Insulating pedestal	40630

* 1 pA ≈ 0,1 mm H_2O.

* The centre-tap f_c (diameter 10,5 mm, marked O) must not be used for filament current supply. Connector type 40649, however, must be used for the cooling of this pin.

** Connector 40650 should only be used below 30 MHz.

MECHANICAL DATA

Dimensions in mm

Mounting position: vertical with anode up or down

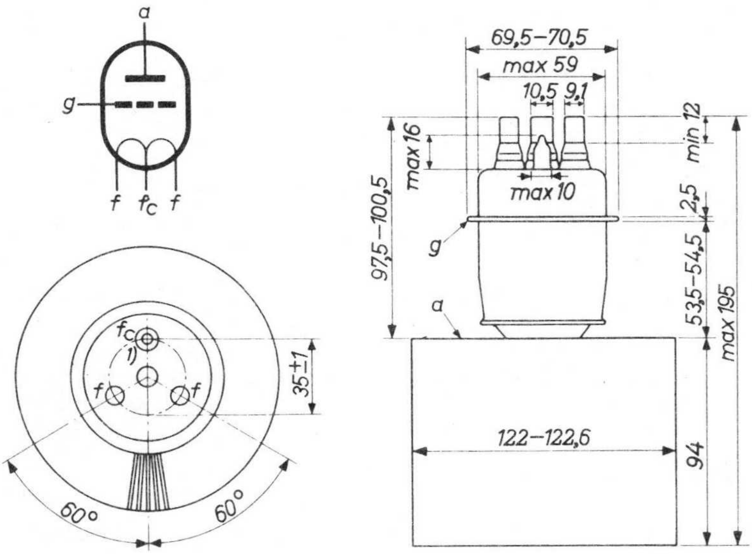


Fig. 1 Mechanical outline.

For further data and curves (except cooling curves) please refer to type TBW7/8000

RF POWER TRIODE

- Air cooled

QUICK REFERENCE DATA

Industrial RF oscillator, class-C

freq. MHZ	three phase V_a kV	W_o kW
30	12	29,0
	10	23,3
	8	17,9

HEATING: direct; thoriated tungsten filament

Filament voltage	V_f	=	8,0 V
Filament current	I_f	=	98 A
Cold filament resistance	R_{fo}	=	0,008 Ω

The filament is designed to accept temporary fluctuations of +5% and −10%

The filament current must never exceed a peak value of 210 A instantaneously at any time during the initial energizing schedule.

CAPACITANCES

Anode to all other elements except grid	C_a	=	0,4 pF
Grid to all other elements except anode	C_g	=	37 pF
Anode to grid	C_{ag}	=	30 pF

TYPICAL CHARACTERISTICS

Anode voltage	V_a	=	12 kV
Anode current	I_a	=	2 A
Mutual conductance	S	=	20 mA/V
Amplification factor	μ	=	34

TEMPERATURE LIMIT (Absolute limit)

Seal temperature	max.	220 °C

Table 1 Air cooling characteristics

W_a (kW)	h (m)	T_i (°C)	q_{min} (m^3/min)	ΔP (Pa)*	max. outlet temperature T_o (°C)
7	0	35	6.6	100	100
	0	45	7.7	130	100
	1500	35	7.9	120	100
	3000	25	8.3	120	95
10	0	35	10.5	230	90
	0	45	12.3	310	90
	1500	35	12.6	280	90
	3000	25	13.2	270	85
15	0	35	18.1	600	80
	0	45	21.2	790	80
	1500	35	21.7	730	80
	3000	25	22.8	700	75

To ensure a uniform RF current distribution in the grid seal especially at frequencies higher then 4 MHz, the grid lead should be connected as shown below

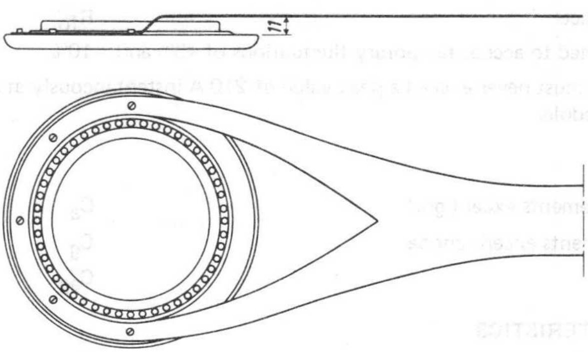


Fig. 1 Grid lead detail.

* 1 Pa ≈ 0,1 mm H_2O.

7Z2 3548

MECHANICAL DATA Dimensions in mm

Net mass of tube 17,3 kg

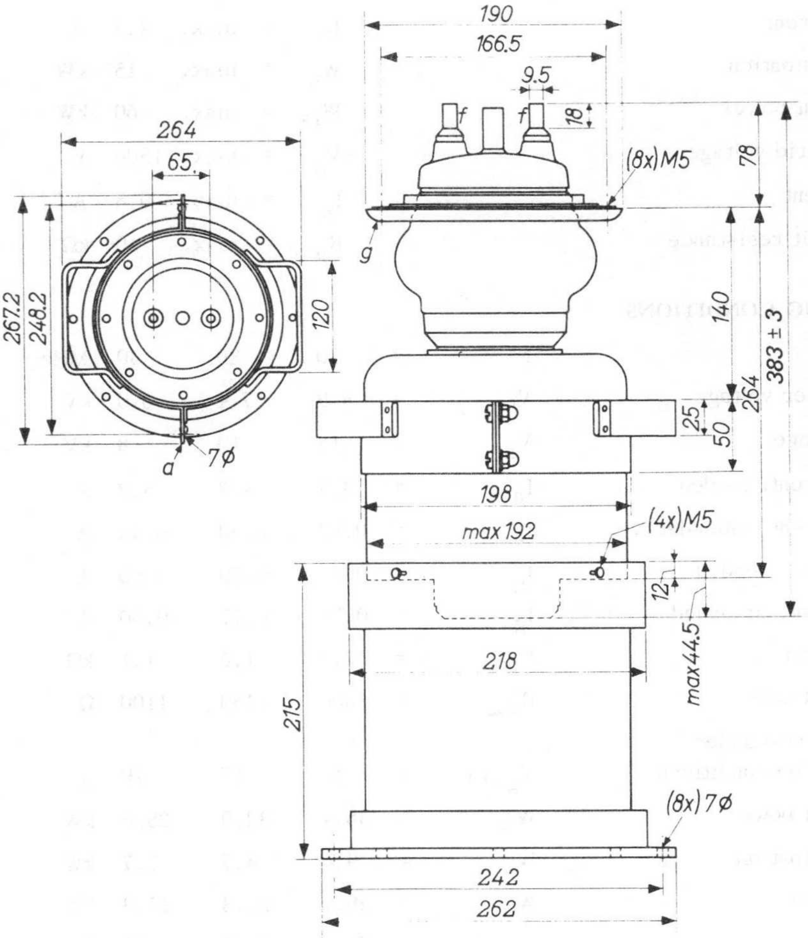


Fig. 2 Mechanical outline.

Mounting position: vertical with anode down

ACCESSORIES

Filament connectors, with cable	40662
Grid connector	40663
Insulating pedestal	40648

RF CLASS C OSCILLATOR FOR INDUSTRIAL USE with anode voltage from three-phase half-wave rectifier without filter

LIMITING VALUES (Absolute limits)

Frequency	f		up to	30	MHz
Anode voltage	V_a	=	max.	13	kV
Anode current	I_a	=	max.	4.8	A
Anode dissipation	W_a	=	max.	15	kW
Anode input power	W_{ia}	=	max.	60	kW
Negative grid voltage	$-V_g$	=	max.	1500	V
Grid current	I_g	=	max.	0.8	A
Grid circuit resistance	R_g	=	max.	10	kΩ

OPERATING CONDITIONS

Frequency	f	=	30	30	30	MHz
Transformer voltage	V_{tr}	=	8.9	7.4	6.0	kV
Anode voltage	V_a	=	12	10	8	kV
Anode current, loaded	I_a	=	3.2	3.2	3.2	A
Anode current, unloaded	I_a	=	0.52	0.50	0.48	A
Grid current, loaded	I_g	=	0.50	0.50	0.50	A
Grid current, unloaded	I_g	=	0.74	0.77	0.80	A
Grid resistor	R_g	=	2.0	1.6	1.1	kΩ
Load resistance	$R_{a\sim}$	=	1800	1450	1100	Ω
Feedback ratio under loaded conditions	$V_{g\sim}/V_{a\sim}$	=	16	17	19	%
Anode input power	W_{ia}	=	38.4	32.0	25.6	kW
Anode dissipation	W_a	=	9.4	8.7	7.7	kW
Output power	W_o	=	29.0	23.3	17.9	kW
Efficiency	η	=	75.5	72.5	70	%
Output power in the load	W_ℓ	=	25	20	15.5	kW [1])

[1]) Useful power in the load measured in a circuit having an efficiency of about 90%

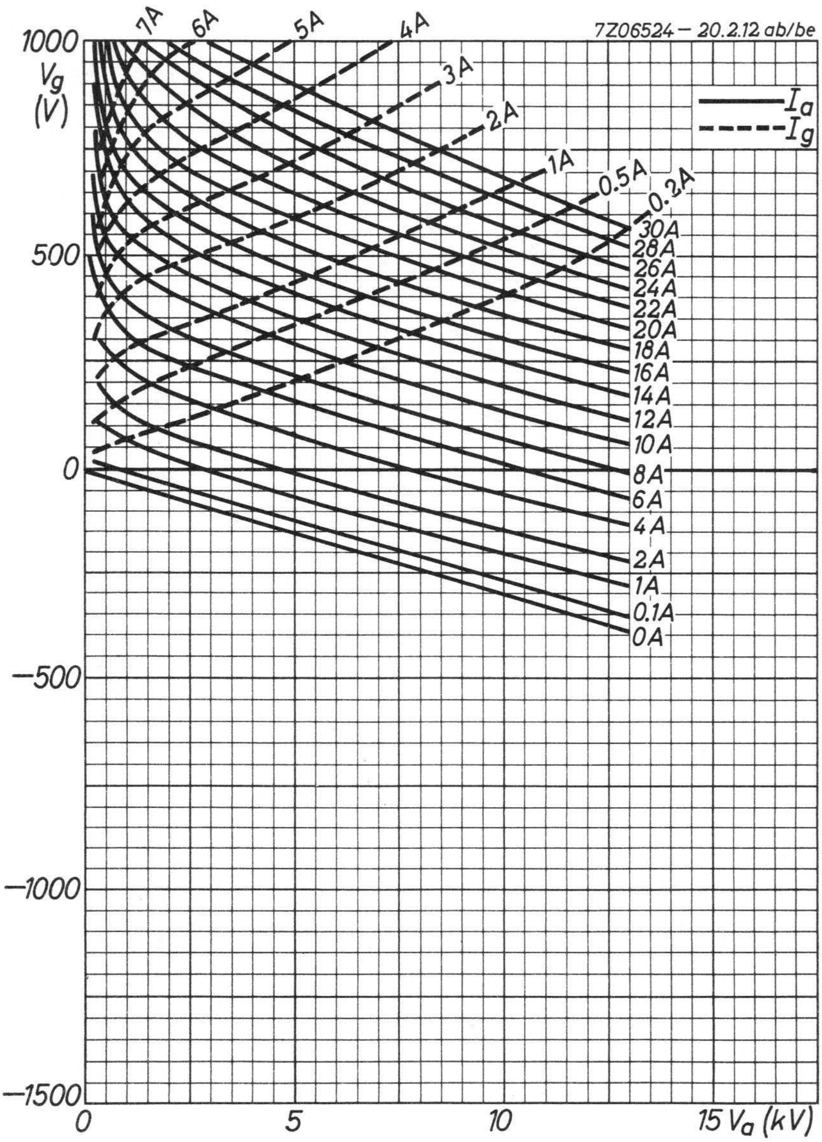


Fig. 3 Constant current characteristics.

RF POWER TRIODE

- Air cooled

QUICK REFERENCE DATA

Industrial RF oscillator, class-C

freq. MHz	three phase V_a kV	W_o kW
30	12	39
	10	31,3
	8	23,2

HEATING: direct; thoriated tungsten filament

Filament voltage	V_f	=	8 V
Filament current	I_f	=	130 A
Cold filament resistance	R_{fo}	=	0,006 Ω

The filament is designed to accept temporary fluctuations of +5% and −10%.

The filament current must never exceed a peak value of 280 A at any time during the initial energizing schedule.

CAPACITANCES

Anode to all other elements except grid	C_a	=	0,9 pF
Grid to all other elements except anode	C_g	=	45 pF
Anode to grid	C_{ag}	=	23,5 pF

TYPICAL CHARACTERISTICS

Anode voltage	V_a	=	12 kV
Anode current	I_a	=	2 A
Mutual conductance	S	=	22 mA/V
Amplification factor	μ	=	21

TEMPERATURE LIMIT (Absolute limit)

Temperature of all seals	max.	220 °C

Table 1 Cooling characteristics

anode dissipation W_a kW	altitude h m	inlet temperature T_i °C	rate of flow q_{min} m^3/min	pressure drop ΔP Pa*	outlet temperature T_o max °C
15	0	35	18,1	600	90
10	0	35	10,5	230	90
7	0	35	6,6	100	95
15	0	45	21,2	790	90
10	0	45	12,3	310	90
7	0	45	7,7	130	100
15	1500	35	21,7	730	90
10	1500	35	12,6	280	90
7	1500	35	7,9	120	100
15	3000	25	22,8	700	80
10	3000	25	13,2	270	80
7	3000	25	8,3	120	95

ACCESSORIES

Filament connectors	40662
Grid connector*	40663
Insulating pedestal	40648

The rounded side of the grid connector should face the anode. To ensure a uniform RF current distribution in the grid seal at frequencies higher than 4 MHz, the grid lead should be connected as shown below.

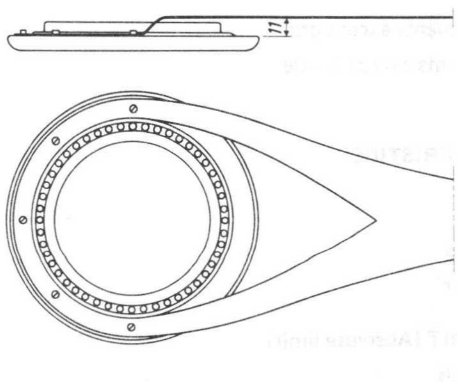


Fig. 1 Grid lead detail.

* 1 Pa ≈ 0,1 mm H_2O.

MECHANICAL DATA

Dimensions in mm

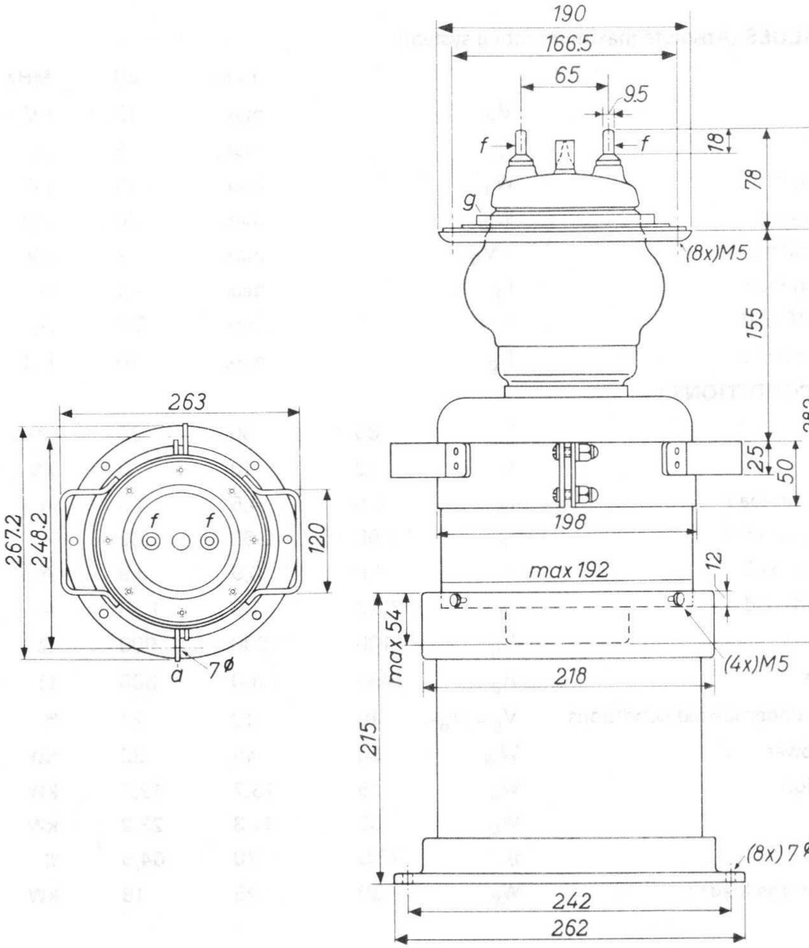


Fig. 2 Mechanical outline.

Mounting position	:	vertical
Net mass of the tube	:	approx. 16,1 kg
Net mass of pedestal	:	7,15 kg

RF CLASS-C OSCILLATOR FOR INDUSTRIAL USE with anode voltage from three-phase rectifier without filter.

LIMITING VALUES (Absolute maximum rating system)

Frequency	f	up to	30	MHz
Anode voltage	V_a	max.	13	kV
Anode current	I_a	max.	5	A
Anode dissipation	W_a	max.	15*	kW
Anode input power	W_{ia}	max.	60	kW
Negative grid voltage	$-V_g$	max.	2	kV
Grid current, on load	I_g	max.	1,5	A
Grid current, off load	I_g	max.	2,0	A
Grid circuit resistance	R_g	max.	10	kΩ

OPERATING CONDITIONS

Frequency	f	30	30	30	MHz
Anode voltage	V_a	12	10	8	kV
Anode current, on load	I_a	4,5	4,5	4,5	A
Anode current, off load	I_a	0,65	0,63	0,62	A
Grid current, on load	I_g	0,9	0,9	0,9	A
Grid current, off load	I_g	1,22	1,3	1,35	A
Grid resistor	R_g	1100	1000	900	Ω
Load resistance	$R_{a\sim}$	1450	1100	800	Ω
Feedback ratio under loaded conditions	$V_{g\sim}/V_{a\sim}$	16	19	24	%
Anode input power	W_{ia}	54	45	36	kW
Anode dissipation	W_a	15	13,7	12,8	kW
Output power	W_o	39	31,3	23,2	kW
Efficiency	η	72,5	70	64,5	%
Output power in the load**	W_ℓ	30	25	18	kW

* TBW12/38: W_a max. = 20 kW (for intermittent service see Fig. 3).
** Useful power in the load, measured in a circuit having an efficiency of about 85%.

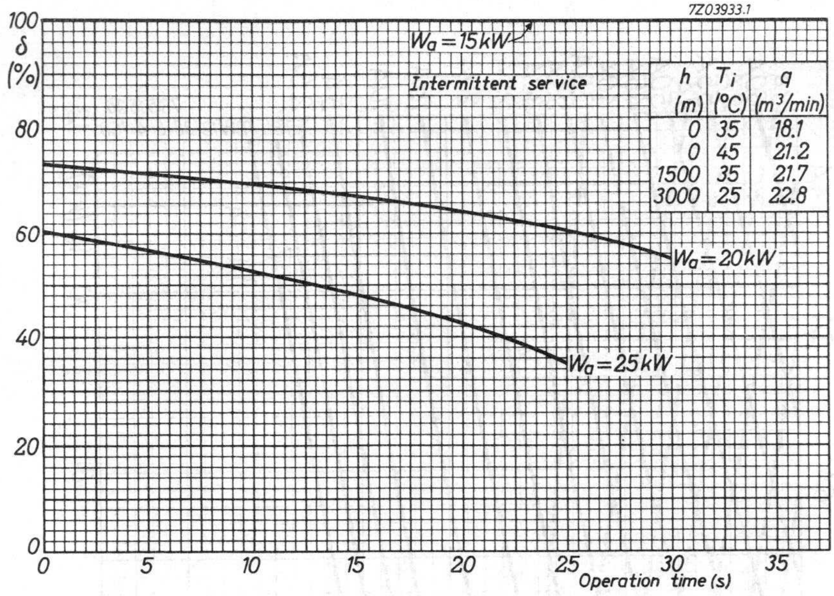


Fig. 3 Intermittent service. Limits of anode dissipation and cooling.

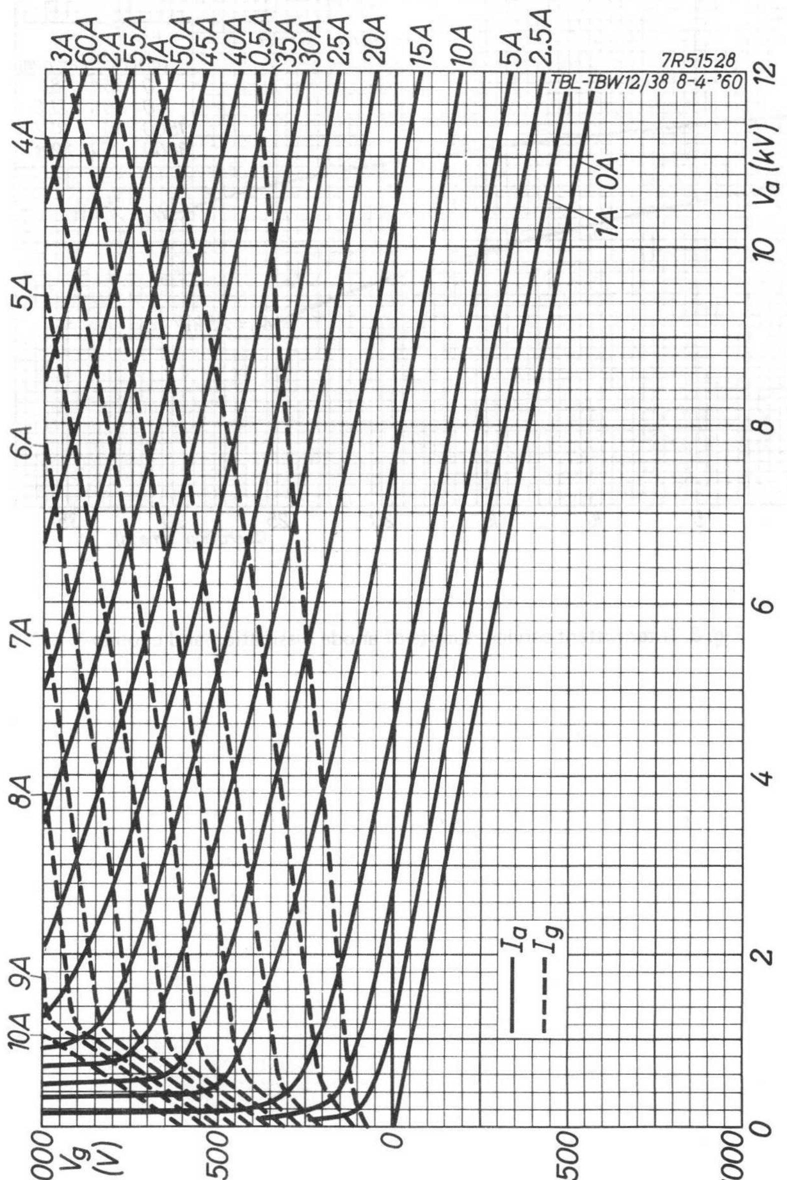


Fig 4 Constant current characteristics.

RF POWER TRIODE

- Water cooled

QUICK REFERENCE DATA

Industrial RF oscillator, class-C

freq. MHz	three phase V_a kV	W_o kW
30	7	17,7
	6	14,3

HEATING: direct; thoriated tungsten filament

Filament voltage	V_f	=	6,3 V
Filament current	I_f	=	136 A
Cold filament resistance	R_{fo}	=	0,005 Ω

The filament is designed to accept temporary fluctuations of +5% and −10%

The filament current must never exceed a peak value of 280 A at any time during the initial energizing schedule.

CAPACITANCES

Anode to all other elements except grid	C_a	=	1,2 pF
Grid to all other elements except anode	C_g	=	44,5 pF
Anode to grid	C_{ag}	=	33,5 pF

TYPICAL CHARACTERISTICS

Anode voltage	V_a	=	6 kV
Anode current	I_a	=	2,5 A
Mutual conductance	S	=	23 mA/V
Amplification factor	μ	=	17,5

TEMPERATURE LIMIT (Absolute limit)

Temperature of all seals
Water inlet temperature

max. 50 °C

Table 1 Cooling characteristics

anode dissipation W_a kW	inlet temperature T_i ^oC	rate of flow q_{min} l/min	pressure drop ΔP kPa	max. outlet temperature T_o (^oC)
15	20	15	30	35
	50	34	140	60
10	20	9,5	15	37
	50	22	60	57
5	20	4,5	3	40
	50	12	20	60

ACCESSORIES

Filament clips with cable	40662
Grid connector	40664
Water jacket	K720
O-ring, large	2622 080 30889
small	2622 080 30736

* 100 kPa ≈ 1 at

MECHANICAL DATA

Dimensions in mm

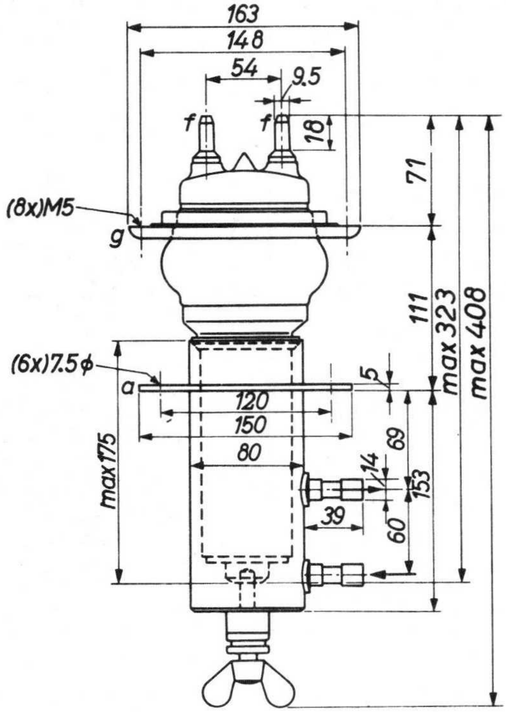


Fig. 1 Mechanical outline.

Mounting position : vertical with anode down.
Net mass of tube : 2 kg
Net mass of water jacket : 2,2 kg

For further data and curves (except cooling curves) please refer to type TBL 6/14

RF POWER TRIODE

QUICK REFERENCE DATA									
General purposes									
λ (m)	Freq. (MHz)	C telegr.		B teleph.		C_a mod.		B mod. 1)	
		V_a (kV)	W_o (kW)	V_a (kV)	W_o (kW)	V_a (kV)	W_o (kW)	V_a (kV)	W_o (kW)
4	75	6	6.9	6	1.9			6	13.3
		5	5.6	5	1.45	5	4.7	5	6.6
		4	4			4.5	4.1	4.5	6.0
						4	3.5	4	5.3
						3.5	3	3.5	4.6
						3	2.2	3	3.3

Television service					
Freq. (MHz)	Neg. mod. Pos. sync.			Pos. mod. Neg. sync.	
	V_a (kV)	W_o sync (kW)	W_o black (kW)	V_a (kV)	W_o white (kW)
75	5	9	5.35	5	9

HEATING: direct, filament thoriated tungsten

Filament voltage	V_f	12.6	V
Filament current	I_f	33	A

CAPACITANCES

Anode to all other elements except grid	C_a	0.3	pF
Grid to all other elements except anode	C_g	16	pF
Anode to grid	C_{ag}	11	pF

1) Two tubes

TYPICAL CHARACTERISTICS

Anode voltage	V_a	4	kV
Anode current	I_a	1	A
Mutual conductance	S	17	mA/V
Amplification factor	μ	32	

COOLING: water/low-velocity air flow

Table 1 Water cooling characteristics

W_a (kW)	T_i (°C)	q_{min} 1) (l/min)	ΔP (kPa)*	max. outlet temperature T_o (°C)
1	20	2.5	8	28
	50	3	10	57
2	20	2.5	8	34
	50	5	30	57
4	20	4	18	36
	50	9	90	57
6	20	6	40	31
	50	14	250	55

It is necessary to direct a low-velocity air flow to the anode and the grid seal at frequencies above 30 MHz
The air flow must be started upon or before application of the filament voltage

TEMPERATURE LIMITS (Absolute limits)

Water inlet temperature	T_i	max. 50	°C
Temperature of seals	T	max. 180	°C

1) At inlet temperatures between 20 and 50 °C the required quantity of water can be found by proportional interpolation

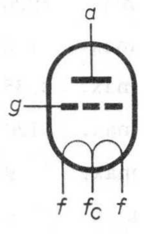
* 100 kPa ≈ 1 at

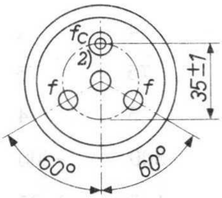
MECHANICAL DATA

Dimensions in mm

Mounting position: vertical with anode down

Net mass : 0.45 kg





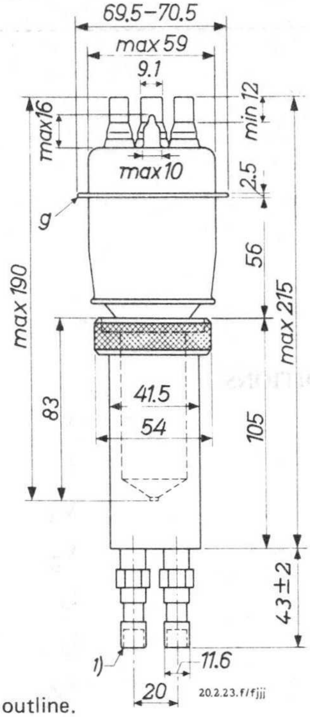


Fig. 1 Mechanical outline.

Tube mounted in water jacket K713

The centre tap f_c must not be used for filament current supply. The connectors type 40634, however, must be used for the cooling of all three filament pins, thus also of pin f_c

ACCESSORIES

Grid connector	type	40650 [3]) or 40622
Water jacket		K713
Filament connector		40634
"O" ring		3322 026 82801

1) 1/8 in pipe thread

2) This pin is marked "O"

3) The connector 40650 should be used only below 30 MHz.
When the tube is used with this connector at maximum ratings additional cooling of the grid seals will be required.

RF CLASS C TELEGRAPHY, grounded grid

LIMITING VALUES (Absolute limits)

Frequency	f	up to	75	MHz
Anode voltage	V_a	max.	6	kV
Negative grid voltage	$-V_g$	max.	1000	V
Anode current	I_a	max.	1.5	A
Grid current	I_g	max.	0.35	A
Grid dissipation	W_g	max.	120	W
Anode input power	W_{ia}	max.	9	kW
Anode dissipation	W_a	max.	6	kW 1)

OPERATING CONDITIONS

Wavelength	λ	4	4	4	m
Frequency	f	75	75	75	MHz
Anode voltage	V_a	6	5	4	kV
Grid voltage	V_g	-400	-300	-200	V
Anode current	I_a	1.5	1.5	1.37	A
Grid current	I_g	0.31	0.33	0.35	A
Peak grid AC voltage	V_{g_p}	740	640	500	V
Grid input power	W_{ig}	210	190	160	W
Anode input power	W_{ia}	9	7.5	5.5	kW
Anode dissipation	W_a	2.1	1.9	1.5	kW
Output power	W_o	6.9	5.6	4	kW
Efficiency	η	76.5	75	73	%

1) TBL6/6000 W_a max. = 5 kW

RF CLASS C TELEGRAPHY, grounded grid

LIMITING VALUES (Absolute limits)

Frequency	f	up to	75	MHz
Anode voltage	V_a	max.	6	kV
Positive cathode to grid voltage	V_{kg}	max.	1000	V
Anode current	I_a	max.	1.5	A
Grid current	I_g	max.	0.35	A
Grid dissipation	W_g	max.	120	W
Anode input power	W_{ia}	max.	9	kW
Anode dissipation	W_a	max.	6	kW 1)

For frequencies from 75 MHz up to 220 MHz , see Fig. 4

OPERATING CONDITIONS, two tubes

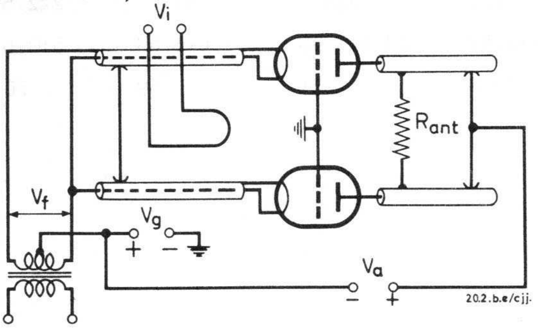


Fig. 2 Grounded grid configuration.

1) TBL6/6000 W_a max.= 5 kW

RF CLASS C TELEGRAPHY, grounded grid (continued)

OPERATING CONDITIONS, two tubes (continued)

λ	4	2.7[1]	2.7[1]	1.36[1]	m
f	75	110	110	220	MHz
V_a	6	5	4	4	kV
V_g	-400	-300	-200	-200	V
I_a	2x1.5	2x1.5	2x1.37	2x1.25	A
I_g	2x0.31	2x0.33	2x0.35	2x0.2	A
V_{g_p}	740	640	500	450	V
W_{ig}	2x1120	2x920	2x675	2x380	W
W_{ia}	2x9	2x7.5	2x5.5	2x5	kW
W_a	2x2.1	2x2.2	2x1.7	2x2.5	kW
W_o	13.8+1.82	10.6+1.46	7.6+1.03	5+0.6	kW [2]
η	76.5	71	69	50	% [3]

1) When using the tube above 108 MHz, particular attention must be paid to a careful design of the installation, otherwise the tube may be damaged. Therefore, our guarantee for the tubes operating at frequencies above 108 MHz can only be given after approval of the installation.

2) Power transferred from driving stage included.

3) Pure tube efficiency.

RF CLASS B TELEPHONY

LIMITING VALUES (Absolute limits)

Frequency	f	up to	75	MHz
Anode voltage	V_a	max.	6	kV
Anode current	I_a	max.	1.1	A
Anode input power	W_{ia}	max.	6.6	kW
Anode dissipation	W_a	max.	6	kW [1]

OPERATING CONDITIONS

Wavelength	λ	4	4	m
Frequency	f	75	75	MHz
Anode voltage	V_a	6	5	kV
Grid voltage	V_g	-180	-145	V
Anode current	I_a	0.99	0.9	A
Peak grid AC voltage	V_{gp}	250	225	V
Anode input power	W_{ia}	5.9	4.5	kW
Anode dissipation	W_a	4	3.05	kW
Output power	W_o	1.9	1.45	kW
Efficiency	η	32	32	%
Modulation factor	m	100	100	%
Grid current	I_g	0.3	0.32	A
Grid input power	W_{ig}	140	130	W

[1]) TBL6/6000 W_a max. = 5 kW

RF CLASS C ANODE MODULATION

LIMITING VALUES (Absolute limits)

Frequency	f	up to	75	MHz
Anode voltage	V_a	max.	5	kV
Negative grid voltage	$-V_g$	max.	1000	V
Anode current	I_a	max.	1.3	A
Grid current	I_g	max.	0.35	A
Grid dissipation	W_g	max.	120	W
Anode input power	W_{ia}	max.	6.5	kW
Anode dissipation	W_a	max.	4	kW 2)

OPERATING CONDITIONS

Wavelength	λ	4	4	4	4	4	m
Frequency	f	75	75	75	75	75	MHz
Anode voltage	V_a	5	4.5	4	3.5	3	kV
Grid voltage	V_g	-400	-350	-300	-300	-250	V 1)
Anode current	I_a	1.2	1.2	1.2	1.2	1	A
Grid current	I_g	0.3	0.3	0.3	0.3	0.3	A
Peak grid AC voltage	V_{g_p}	690	650	600	600	510	V
Grid input power	W_{ig}	190	180	165	165	140	W
Anode input power	W_{ia}	6	5.4	4.8	4.2	3	kW
Anode dissipation	W_a	1.3	1.3	1.3	1.2	0.8	kW
Output power	W_o	4.7	4.1	3.5	3.0	2.2	kW
Efficiency	η	78	76	73	71.5	73	%
Modulation factor	m	100	100	100	100	100	%
Modulation power	W_{mod}	3.0	2.7	2.4	2.1	1.5	kW

1) Grid bias partially obtained by the grid resistor

2) TBL6/6000 W_a max. = 3.4 kW

RF CLASS B TELEPHONY for television service (American and European system).

LIMITING VALUES (Absolute limits)

Frequency	f		up to 75	up to 220	MHz
Anode voltage	V_a		max. 5	max. 4	kV
Anode input power	W_{ia}	sync	max. 9.5	max. 6.5	kW
Anode dissipation	W_a	sync	max. 5	max. 4	kW
Anode current	I_a	sync	max. 1.9	max. 1.6	A
Grid dissipation	W_g	sync	max. 120	max. 120	W

OPERATING CONDITIONS, two tubes in push-pull

Frequency	f		48 to 75	170 to 220[1]	MHz
Bandwidth (-1.5 db)	B		5.25	6.5	MHz [2]
Bandwidth (-3 db)	B		8	10	MHz [2]
Anode voltage	V_a		5	4	kV
Grid voltage	V_g		-200	-150	V
Peak grid to grid voltage	V_{ggp}	sync	1000	1000	V [3]
		black	800	750	V [3]
		white	0	200	V [3]
Anode current	I_a	sync	3.8	3.2	A
		black	3	2.6	A
		white	0.2	-	A
Grid current	I_g	sync	0.5	0.4	A
		black	0.22	0.22	A
		white	0	-	A
Grid input power	W_{ig}	sync	250	350 to 450	W [4]
Output power	W_o	sync	9	6	kW
		black	5.35	3.37	kW

1) When using the tube above 108 MHz, particular attention must be paid to a careful design of the installation, otherwise the tube may be damaged Therefore, our guarantee for the tubes operating at frequencies above 108 MHz can only be given after approval of the installation

2) These values are based on measurements on a circuit with a single LC section

3) Measured by the slide back method

4) Driving power is accounted for largely by circuit losses. The indicated driving power is required to take care of losses in damping resistors, circuit losses and tube driving power

RF CLASS C OSCILLATOR FOR INDUSTRIAL USE with anode voltage from three-phase half-wave rectifier without filter

LIMITING VALUES (Absolute limits)

Frequency	f	up to	75	MHz
Anode voltage	V_a	max.	6000	V
Negative grid voltage	$-V_g$	max.	1000	V
Anode current	I_a	max.	1.5	A
Grid current	I_g	max.	0.35	A
Anode input power	W_{ia}	max.	9	kW
Anode dissipation	W_a	max.	6	kW 4)
Grid dissipation	W_g	max.	120	W

OPERATING CONDITIONS

Frequency	f	75	75	MHz
Transformer voltage, RMS	V_{tr}	5.1 1)	4.4 2)	kV
Anode voltage	V_a	6.0	5.1	kV 3)
Anode current	I_a	1.5	1.25	A
Grid current	I_g	0.31	0.28	A
Grid resistor	R_g	1300	1100	Ω
Grid input power	W_{ig}	210	160	W
Anode input power	W_{ia}	9	6.4	kW
Anode dissipation	W_a	1.9	1.74	kW
Output power	W_o	6.9	4.5	kW
Efficiency	η	76.5	70	%

1) Care must be taken that under these operating conditions the absolute limiting values are not exceeded by variation of the supply voltage or the load or by tolerances in the circuit elements

2) Under these conditions normal deviations of voltages and load are permissible. The absolute limiting values of the tube must, however, not be exceeded

3) DC value

4) TBL6/6000 W_a max. 5 kW

RF CLASS C OSCILLATOR FOR INDUSTRIAL USE with self rectification

LIMITING VALUES (Absolute limits)

Frequency	f	up to	75	MHz
Transformer voltage, RMS	V_{tr}	max.	6800	V
Negative grid voltage	$-V_g$	max.	640	V
Anode current	I_a	max.	0.8	A
Grid current	I_g	max.	0.19	A
Anode input power	W_{ia}	max.	9	kW
Anode dissipation	W_a	max.	6	kW 3)
Grid dissipation	W_g	max.	120	W

OPERATING CONDITIONS

Frequency	f	75	75	MHz
Transformer voltage, RMS	V_{tr}	6.8[1])	5.9[2])	kV
Anode current	I_a	0.8	0.7	A
Grid current	I_g	0.19	0.165	A
Grid resistor	R_g	1050	1050	
Grid input power	W_{ig}			W
Anode input power	W_{ia}	6.05	4.6	kW
Anode dissipation	W_a	1.5	1.24	kW
Output power	W_o	4.55	3.36	kW
Efficiency	η	75	73	%

1) Care must be taken that under these operating conditions the absolute limiting values are not exceeded by variation of the supply voltage or the load or by tolerances in the circuit elements

2) Under these conditions normal deviations of voltages and load are permissible. The absolute limiting values of the tube must, however, not be exceeded

3) TBL6/6000 W_a max. = 5 kW

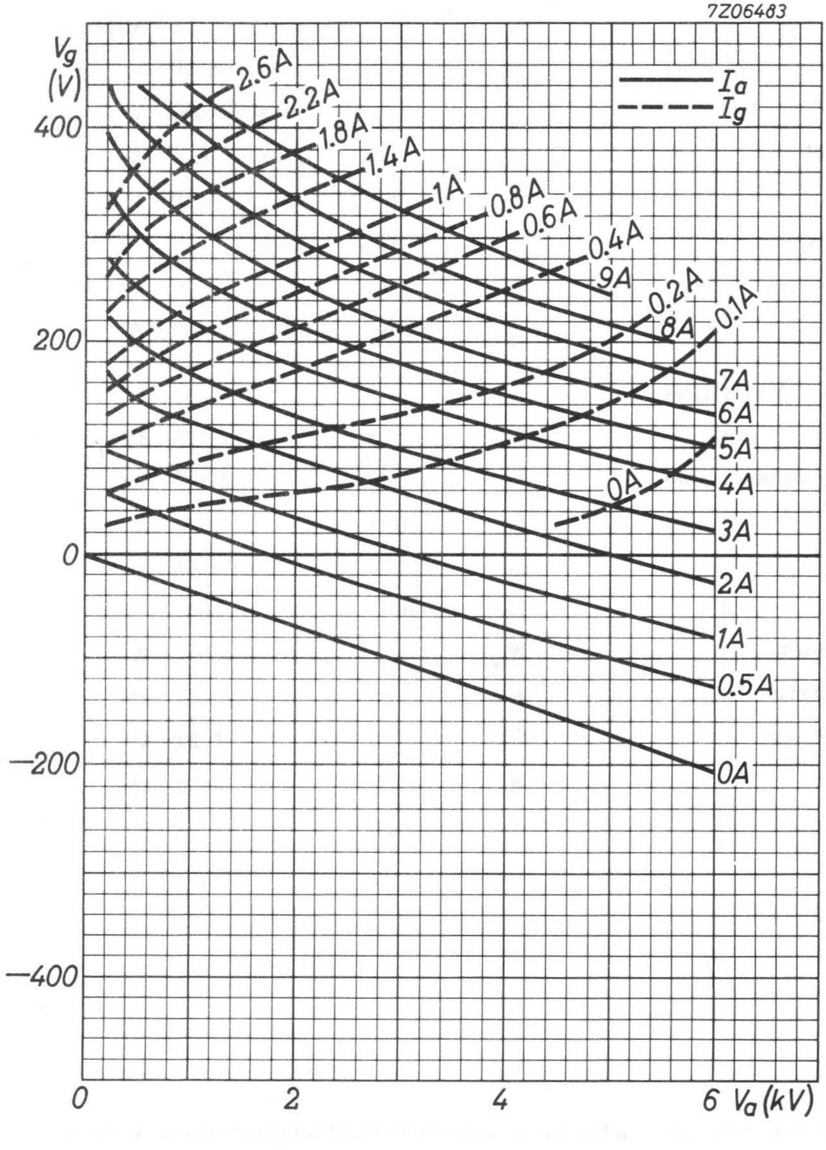


Fig. 3 Constant current characteristics.

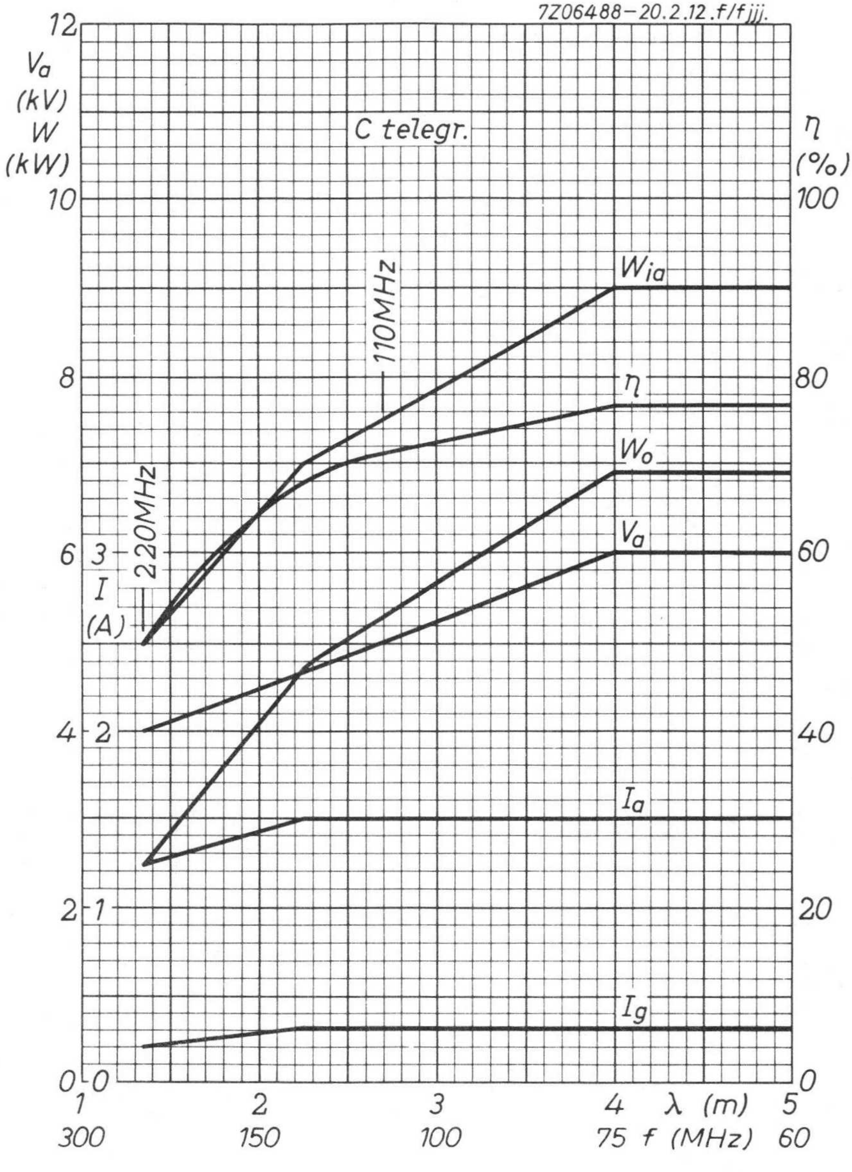


Fig. 4 Frequency dependant characteristics.

RF POWER TRIODE

QUICK REFERENCE DATA							
λ (m)	Freq. (MHz)	C telegr.		C osc.		B mod. 1)	
		V_a (kV)	W_o (kW)	V_a (kV)	W_o (kW)	V_a (kV)	W_o (kW)
10	30	6.5	9.5			7.0	20
		6.0	8.5			5.0	9.0
		5.0	7.1			4.0	7.1
6	50			6.0	6.0		

COOLING: water/low velocity air flow

HEATING: direct; filament thoriated tungsten

Filament voltage	V_f	12.6 V
Filament current	I_f	33 A

CAPACITANCES

Anode to all other elements except grid	C_a	0.3 pF
Grid to all other elements except anode	C_g	16 pF
Anode to grid	C_{ag}	11 pF

TYPICAL CHARACTERISTICS

Anode voltage	V_a	6 kV
Anode current	I_a	1 A
Amplification factor	μ	32
Mutual conductance	S	15 mA/V

1) Two tubes

Table 1 Water cooling characteristics

W_a (kW)	T_i (°C)	q_{min} [1] (l/min)	ΔP (kPa)*	max. outlet temperature T_o (°C)
1	20	2.5	8	30
	50	3	10	56
2	20	2.5	8	35
	50	5	30	57
4	20	4	18	36
	50	9	90	57
6	20	6	40	35
	50	14	250	57

TEMPERATURE LIMITS (Absolute limits)

Inlet temperature	T_i	max.	50	°C
Temperature of filament seals		max.	210	°C
Temperature of grid and anode seals		max.	180	°C

ACCESSORIES

Filament connectors	40634
Connector centre pin of filament	40649 [2]
Grid connector	40622
Water jacket	K713

In general, no air cooling will be required at frequencies up to 30 MHz **and at** ambient temperatures below 35 °C.
At higher frequencies or at higher ambient temperatures a low-velocity air flow to the grid and filament seals will be necessary.

1) At water inlet temperatures between 20 and 50 °C the required quantity of water can be found by proportional interpolation

2) The centre tap f_c (diameter 10.5 mm; marked O) must not be used for filament current supply. The connector type 40649, however, must be used for the cooling of this pin

* 100 kPa ≈ 1 at

MECHANICAL DATA

Dimensions in mm

Mounting position: vertical with anode down

Net mass: 0,45 kg

O-ring: 3322 026 82801

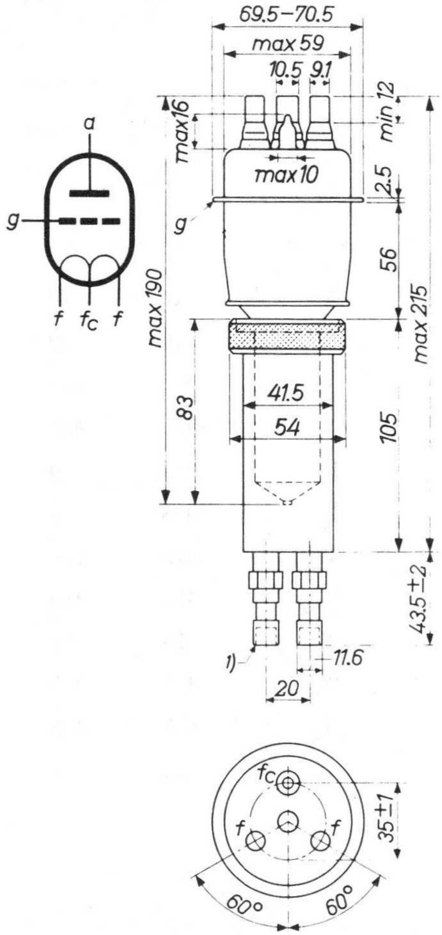


Fig. 1 Mechanical outline.

(1) 1/8-in pipe thread

RF CLASS C TELEGRAPHY

LIMITING VALUES (Absolute limits)

Frequency	f	up to	30	MHz
Anode voltage	V_a	max.	7.2	kV
Negative grid voltage	$-V_g$	max.	1250	V
Anode current	I_a	max.	2.2	A
Grid current	I_g	max.	0.6	A
Anode input power	W_{ia}	max.	14	kW
Anode dissipation	W_a	max.	6	kW

OPERATING CONDITIONS

Wavelength	λ	10	10	10	m
Frequency	f	30	30	30	MHz
Anode voltage	V_a	6.5	6.0	5.0	kV
Grid voltage	V_g	-450	-400	-300	V
Anode current	I_a	2.0	2.0	2.0	A
Grid current	I_g	0.5	0.5	0.5	A
Peak grid AC voltage	V_{gp}	820	780	660	V
Grid input power	W_{ig}	370	350	297	W
Anode input power	W_{ia}	13	12	10	kW
Anode dissipation	W_a	3.5	3.5	2.9	kW
Output power	W_o	9.5	8.5	7.1	kW
Efficiency	η	73	71	71	%

AF CLASS B AMPLIFIER AND MODULATOR

LIMITING VALUES (Absolute limits)

Anode voltage	V_a	max.	7.2	kV
Anode current	I_a	max.	2.2	A
Anode input power	W_{ia}	max.	14	kW
Anode dissipation	W_a	max.	6	kW
Grid circuit resistance	R_g	max.	15	kΩ

OPERATING CONDITIONS, two tubes

V_a	7		5		5		4		kV
V_g	-250		-165		-165		-135		V
$R_{aa\sim}$	4150		4800		5500		3800		Ω
V_{gg_p}	0	1300	0	880	0	730	0	930	V
I_a	2x0.2	2x2.0	2x0.15	2x1.25	2x0.15	2x1.1	2x0.1	2x1.25	A
I_g	0	2x0.53	0	2x0.33	0	2x0.22	0	2x0.36	A
I_{g_p}	–	2x2.8	–	2x1.75	–	2x1.2	–	2x1.8	A
W_{ig}	0	2x310	0	2x130	0	2x70	0	2x135	W
W_{ia}	2x1.4	2x14	2x0.75	2x6.2	2x0.75	2x5.5	2x0.4	2x5.0	kW
W_a	2x1.4	2x4.0	2x0.75	2x1.7	2x0.75	2x1.5	2x0.4	2x1.45	kW
W_o	0	20	0	9	0	8.0	0	7.1	kW
η	–	71.5	–	72.5	–	72.5	–	71	%

RF CLASS C OSCILLATOR FOR INDUSTRIAL USE with anode voltage from three-phase half-wave rectifier without filter

LIMITING VALUES (Absolute limits)

Frequency	f	up to	55	MHz
Anode voltage	V_a	max.	7	kV
Negative grid voltage	$-V_g$	max.	1250	V
Anode current	I_a	max.	1.8	A
Grid current , off load	I_g	max.	0.5	A [1]
Anode input power	W_{ia}	max.	11	kW
Anode dissipation	W_a	max.	6	kW
Grid circuit resistance	R_g	max.	10	kΩ

OPERATING CONDITIONS

Frequency	f	50	MHz
Transformer voltage	V_{tr}	5100	V_{RMS}
Anode voltage	V_a	6.0	kV
Anode current	I_a	1.5	A
Grid current , on load	I_g	0.4	A
Grid resistor	R_g	1000	Ω
Grid input power	W_{ig}	300	W
Anode input power	W_{ia}	9	kW
Anode dissipation	W_a	2.7	kW
Output power	W_o	6	kW [2]
Efficiency	η	67	%

[1]) Off load max. 0.7 A

[2]) Available power (load + circuit losses)

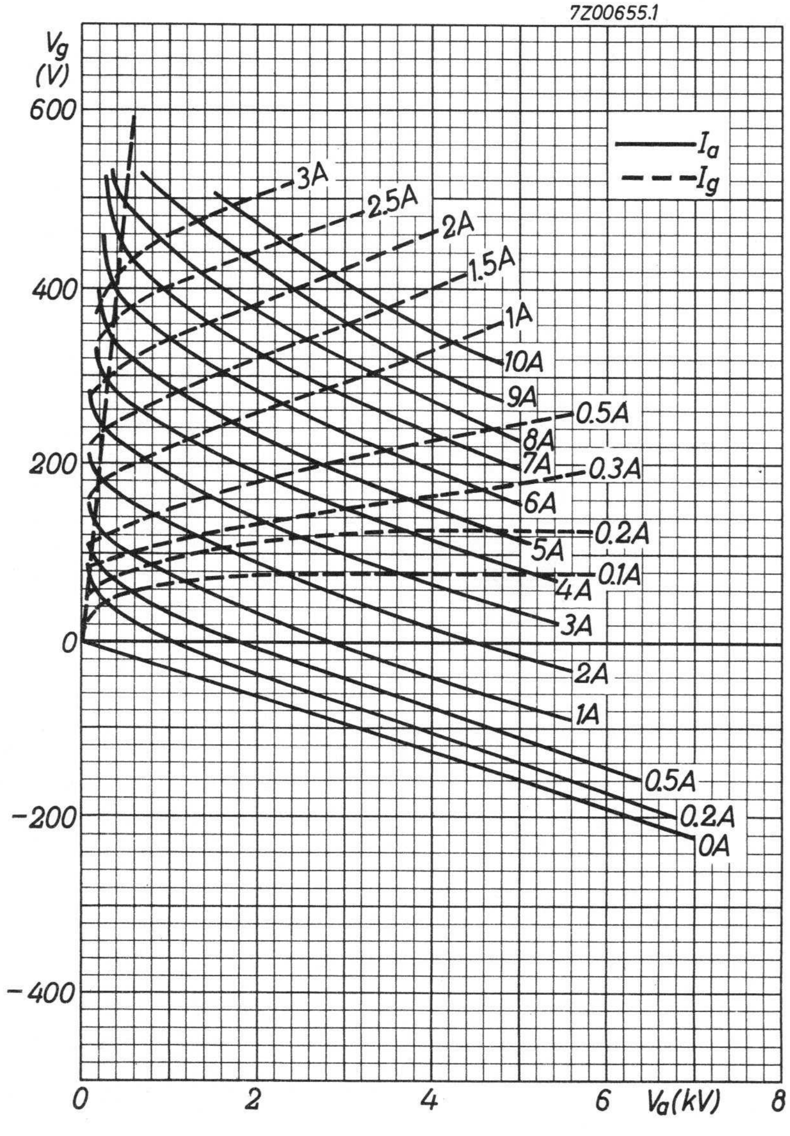


Fig. 2 Constant current characteristics.

RF POWER TRIODE

- Water cooled

QUICK REFERENCE DATA

Industrial RF oscillator; class-C

freq. MHz	three phase V_a kV	W_o kW
30	12	29,0
	10	23,3
	8	17,9

HEATING: direct; thoriated tungsten filament

Filament voltage	V_f	=	8,0 V
Filament current	I_f	=	98 A
Cold filament resistance	R_{fo}	=	0,008 Ω

The filament is designed to accept temporary fluctuations of +5% and −10%

The filament current must never exceed a peak value of 210 A instantaneously at any time during the initial energizing schedule.

CAPACITANCES

Anode to all other elements except grid	C_a	=	0,4 pF
Grid to all other elements except anode	C_g	=	37 pF
Anode to grid	C_{ag}	=	30 pF

TYPICAL CHARACTERISTICS

Anode voltage	V_a	=	12 kV
Anode current	I_a	=	2 A
Mutual conductance	S	=	20 mA/V
Amplification factor	μ	=	34

TEMPERATURE LIMIT (Absolute limit)

Seal temperature max. 220 °C

Generally, a low velocity air flow to the seals is required.

Table 1 Water cooling characteristics T_i = max. 50 °C

W_a (kW)	T_i (°C)	q_{min} 1) (l/min)	ΔP (kPa)*	max. outlet temperature T_o (°C)
5	20	6	2	35
	50	15	22	56
10	20	11	10	35
	50	25	70	56
15	20	16	25	35
	50	37	130	56
20	20	22	50	35
	50	49	230	56

To ensure a uniform RF current distribution in the grid seal especially at frequencies higher than 4 MHz, the grid lead should be connected as shown below.

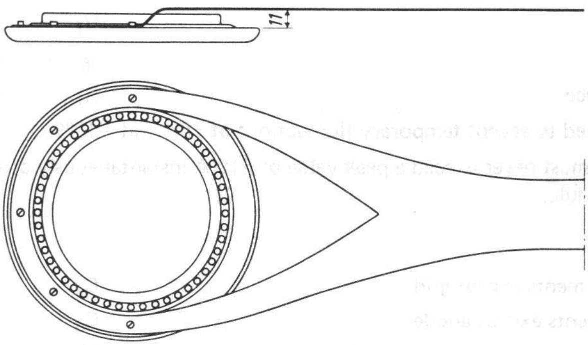


Fig. 1 Grid lead detail.

1) At inlet temperatures between 20 and 50 °C the required quanity of water can be found by proportional interpolation

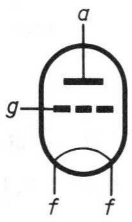
* 100 kPa ≈ 1 at

MECHANICAL DATA

Dimensions in mm

Net weight of the tube : 2.8 kg

Net weight of water jacket: 2.1 kg



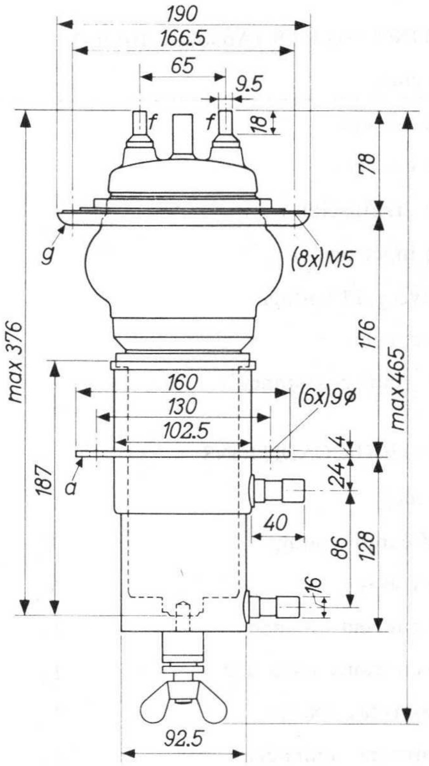


Fig. 2 Mechanical outline.

Tube with grid connector
and water jacket

Mounting position: vertical with anode down

ACCESSORIES

Filament connectors with cable		: 40662
Grid connector		: 40663
Water jacket		: K717
O-ring	large	: 2622 080 30895
	small	: 2622 080 30736

RF CLASS C OSCILLATOR FOR INDUSTRIAL USE with anode voltage from three-phase half-wave rectifier without filter

LIMITING VALUES (Absolute limits)

Frequency	f		up to	30	MHz
Anode voltage	V_a	=	max.	13	kV
Anode current	I_a	=	max.	4.8	A
Anode dissipation	W_a	=	max.	20	kW
Anode input power	W_{ia}	=	max.	60	kW
Negative grid voltage	$-V_g$	=	max.	1500	V
Grid current	I_g	=	max.	0.8	A
Grid circuit resistance	R_g	=	max.	10	kΩ

OPERATING CONDITIONS

Frequency	f	=	30	30	30	MHz
Transformer voltage	V_{tr}	=	8.9	7.4	6.0	kV
Anode voltage	V_a	=	12	10	8	kV
Anode current, loaded	I_a	=	3.2	3.2	3.2	A
Anode current, unloaded	I_a	=	0.52	0.50	0.48	A
Grid current, loaded	I_g	=	0.50	0.50	0.50	A
Grid current, unloaded	I_g	=	0.74	0.77	0.80	A
Grid resistor	R_g	=	2.0	1.6	1.1	kΩ
Load resistance	$R_{a\sim}$	=	1800	1450	1100	Ω
Feedback ratio under loaded conditions	$V_{g\sim}/V_{a\sim}$	=	16	17	19	%
Anode input power	W_{ia}	=	38.4	32.0	25.6	kW
Anode dissipation	W_a	=	9.4	8.7	7.7	kW
Output power	W_o	=	29.0	23.3	17.9	kW
Efficiency	η	=	75.5	72.5	70	%
Output power in the load	W_ℓ	=	25	20	15.5	kW[1]

[1]) Useful power in the load measured in a circuit having an efficiency of 90%

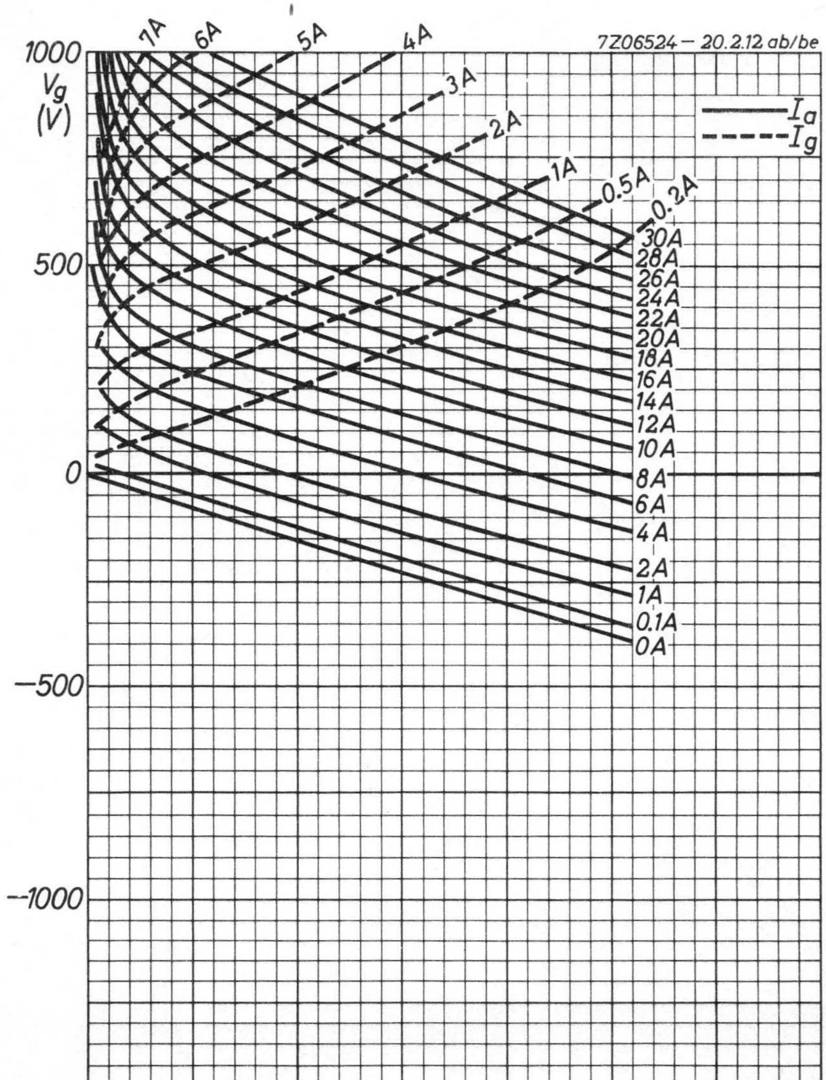


Fig. 3 Constant current characteristics.

RF POWER TRIODE

- Water cooled

QUICK REFERENCE DATA

Industrial RF oscillator, class-C

freq. MHz	V_a kV	W_o kW
30	12	39
	10	31,3
	8	23,2

HEATING: direct; thoriated tungsten filament

Filament voltage	V_f	=	8 V
Filament current	I_f	=	130 A
Cold filament resistance	R_{fo}	=	0,006 Ω

The filament is designed to accept temporary fluctuations of +5% and −10%.

The filament current must never exceed a peak value of 280 A at any time during the initial energizing schedule.

CAPACITANCES

Anode to all other elements except grid	C_a	=	0,9 pF
Grid to all other elements except anode	C_g	=	45 pF
Anode to grid	C_{ag}	=	23,5 pF

TYPICAL CHARACTERISTICS

Anode voltage	V_a	=	12 kV
Anode current	I_a	=	2 A
Mutual conductance	S	=	22 mA/V
Amplification factor	μ	=	21

TEMPERATURE LIMITS (Absolute limits)

Temperature of all seals	max.	220 °C
Water inlet temperature	max.	50 °C

COOLING Generally a low velocity air flow to the seals is required.

Table 1 Cooling characteristics

anode dissipation W_a kW	inlet temperature T_i °C	rate of flow q_{min} l/min	pressure drop ΔP kPa*	max. outlet temperature T_o (°C)
20	20	22	50	35
	50	49	230	56
15	20	16	25	35
	50	37	130	56
10	20	11	10	35
	50	25	70	56
5	20	6	2	35
	50	15	22	56

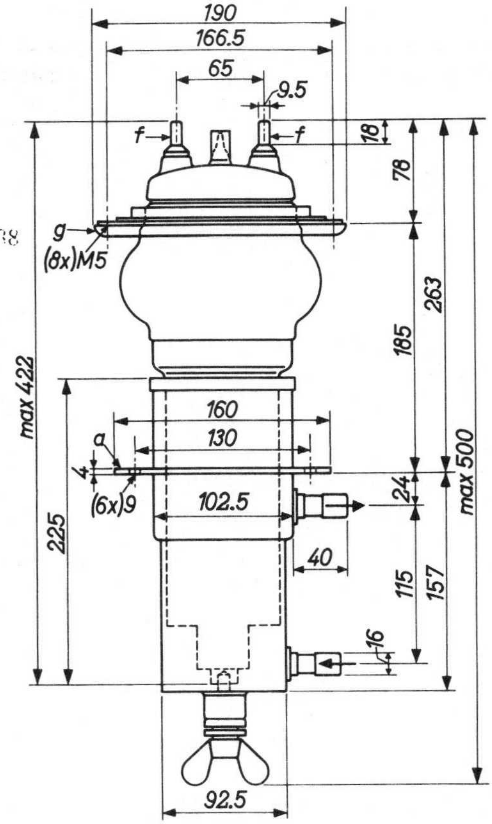
ACCESSORIES

Filament connectors	40662
Grid connector	40663
Water jacket	K722
O-ring, large	2622 080 30895
small	2622 080 30736

* 100 kPa ≈ 1 at

MECHANICAL DATA

Dimensions in mm



Mounting position	: vertical with anode down.
Net mass of tube	: 3,0 kg
Net mass of water jacket	: 2,7 kg

For further data and curves (except cooling curves)
please refer to type TBL12/38

Fig. 1 Mechanical outline.

RF TRIODES, YD TYPES

RF POWER TRIODE

Triode in metal-ceramic construction, intended for use as industrial oscillator.
The tube is forced-air cooled, with integral cooler.

QUICK REFERENCE DATA

Oscillator output power ($W_o - W_{feedb}$), typical	W_{osc}		4,75 kW
Frequency for full ratings	f	max.	85 MHz

To be read in conjunction with "General Operational Recommendations".

RF CLASS C OSCILLATOR FOR INDUSTRIAL USE

OPERATING CONDITIONS

Frequency	f	30	30 MHz
Filament voltage	V_f	6,3	6,3 V
Oscillator output power ($W_o - W_{feedb}$)	W_{osc}	4,7	3,8 kW
Anode voltage	V_a	6	5 kV
Anode current	I_a	1	1 A
Anode input power	W_{ia}	6	5 kW
Anode dissipation	W_a	1,1	1,0 kW
Anode output power	W_o	4,9	4 kW
Anode efficiency	η_a	81,5	80 %
Oscillator efficiency	η_{osc}	78	76 %
Feedback ratio	V_{gp}/V_{ap}	17,6	19,4 %
Grid resistor	R_g	3,1	2,75 kΩ
Grid current, on load	I_g	205	200 mA
Grid voltage, negative	$-V_g$	640	550 V
Grid dissipation	W_g	60	60 W
Grid resistor dissipation	W_{Rg}	130	110 W

LIMITING VALUES (Absolute maximum rating system)

Frequency	f	up to	85	MHz *
Anode voltage	V_a		7,2	kV
Anode current	I_a		1,1	A
Anode input power	W_{ia}		6,5	kW
Anode dissipation	W_a		2,5	kW
Grid voltage	$-V_g$		1	kV
Grid current, on load	I_g		250	mA
off load	I_g		350	mA
Grid dissipation	W_g		140	W
Grid circuit resistance	R_g		20	kΩ
Cathode current, mean	I_k		1,4	A
peak	I_{kp}		7,5	A
Envelope temperature	T_{env}		240	°C

HEATING: direct; thoriated tungsten filament

Filament voltage	V_f	6,3	V
Filament current at $V_f = 6,3$ V	I_f	33	A

The filament is designed to accept temporary fluctuations of + 5% and −10%.

It is extremely important that the filament be properly decoupled. This should be done so that the resonance of the circuit formed by the filament and the decoupling elements remain below the fundamental oscillator frequency. In grounded-grid circuits this resonance should be below the grid-cathode resonance. For further information please see Application Book "Tubes for RF Heating" or contact the manufacturer.

CAPACITANCES

Anode-to-filament	C_{af}	0,4	pF
Grid to filament	C_{gf}	15	pF
Anode to grid	C_{ag}	12	pF

CHARACTERISTICS measured at $V_a = 2,0$ kV, $I_a = 0,5$ A

Transconductance	S	10	mA/V
Amplification factor	μ	17	

* For operation above 85 MHz the tube manufacturer should be consulted.

COOLING

To obtain optimum life, the temperature of the seals and the envelope should, under normal operating conditions, be kept below 200 °C.

Table 1 Air cooling characteristics with insulating pedestal type 40630

anode + grid dissipation $W_a + W_g$ kW	altitude h m	inlet temperature T_i °C	rate of flow q_{min} m^3/min	pressure drop ΔP Pa*	max. outlet temperature T_o °C
1	0	35	1,5	35	80
	0	45	1,9	50	81
1,5	0	35	2,7	83	70
	0	45	3,1	85	75
2,5	0	35	5,0	140	65
	0	45	5,4	160	73

ACCESSORIES

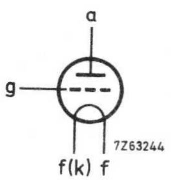
Filament connector	type 40688
Filament/cathode connector	type 40689
Grid connector	type 40686
Insulating pedestal	type 40630

* 1 Pa ≈ 0,1 mm H_2O.

MECHANICAL DATA Dimensions in mm

Mounting position: vertical with anode up or down

Net mass: 2,6 kg



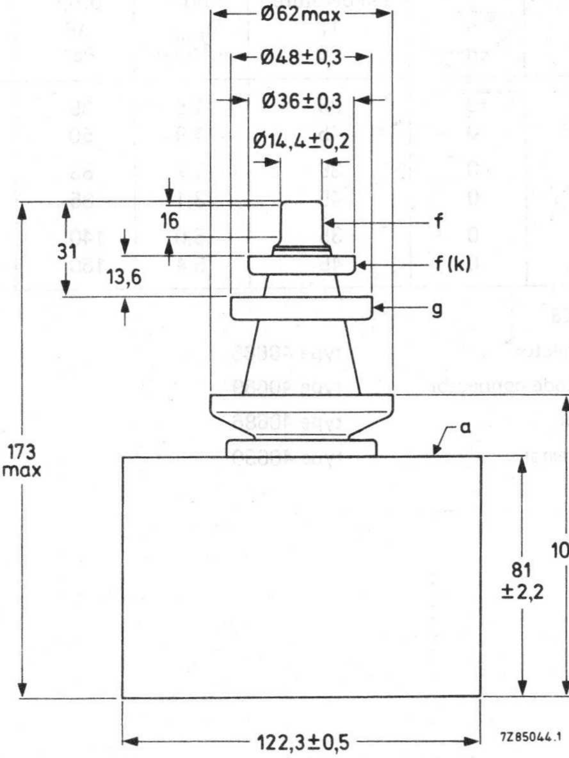


Fig. 1 Mechanical outline.

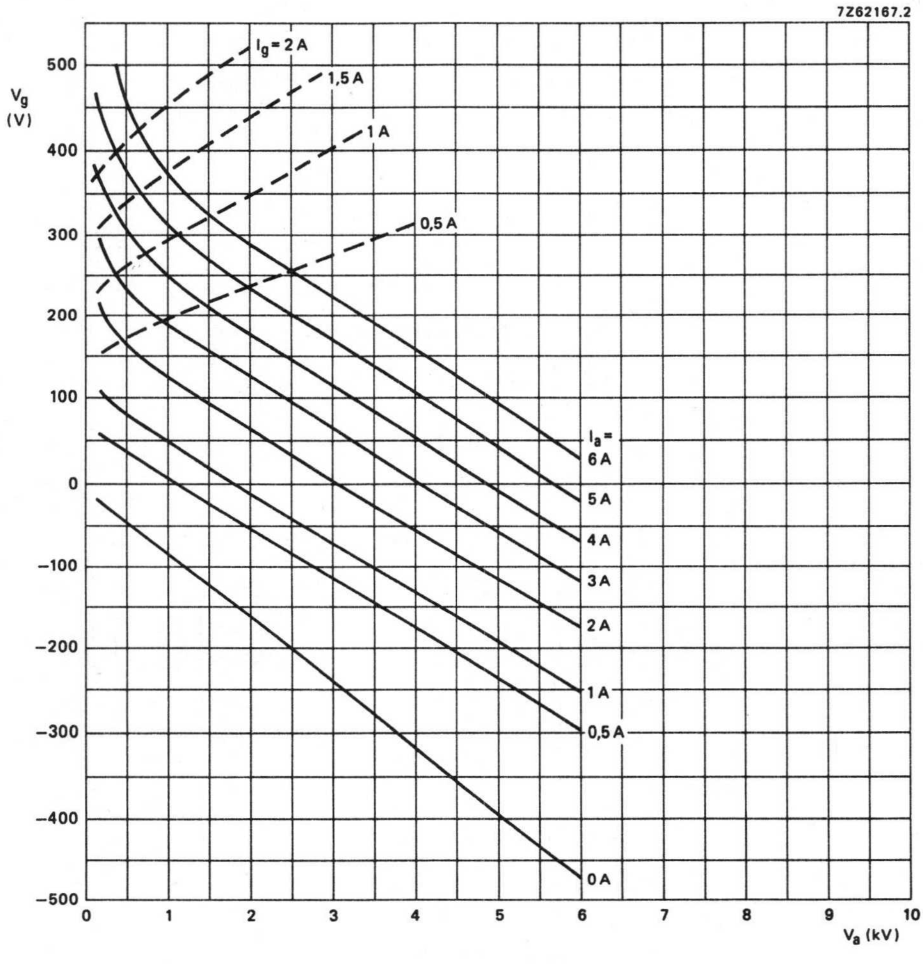


Fig. 2 Constant current characteristics.

RF POWER TRIODE

Triode in metal-ceramic construction, intended for use as industrial oscillator.

The tube has an integral water cooler.

QUICK REFERENCE DATA

Oscillator output power ($W_o - W_{feedb}$), typical	W_{osc}		4,75 kW
Frequency for full ratings	f	max.	85 MHz

To be read in conjunction with "General Operational Recommendations".

RF CLASS C OSCILLATOR FOR INDUSTRIAL USE

OPERATING CONDITIONS

Frequency	f	160	27,12	27,12	MHz
Filament voltage	V_f	6,0	6,3	6,3	V
Oscillator output power ($W_o - W_{feedb}$)	W_{osc}	3,75	4,75	3,85	kW
Anode voltage	V_a	5	6	5	kV
Anode current	I_a	1	1	1	A
Anode input power	W_{ia}	5	6	5	kW
Anode dissipation	W_a	1,03	1,0	0,93	kW
Anode output power	W_o	3,97	5,0	4,07	kW
Anode efficiency	η_a	79,4	83,3	81,4	%
Oscillator efficiency	η_{osc}	75,0	79,1	77,0	%
Feedback ratio	V_{gp}/V_{ap}	19	17	19	%
Grid resistor	R_g	2,0	2,5	2,0	kΩ
Grid current, on load	I_g	260	250	260	mA
Grid voltage, negative	$-V_g$	520	625	520	V
Grid dissipation	W_g	80	90	80	W
Grid resistor dissipation	W_{Rg}	135	156	135	W

LIMITING VALUES (Absolute maximum rating system)

Frequency	f	up to	160	85	MHz
Anode voltage	V_a		6,0	7,2	kV
Anode current	I_a		1,1	1,1	A
Anode input power	W_{ia}		6,0	6,5	kW
Anode dissipation	W_a		2,5	2,5	kW
Grid voltage	$-V_g$		1	1	kV
Grid current, on load	I_g		280	280	mA
off load	I_g		400	400	mA
Grid dissipation	W_g		150	150	W
Grid circuit resistance	R_g		20	20	kΩ
Cathode current, mean	I_k		1,4	1,4	A
peak	I_{kp}		7,5	7,5	A
Envelope temperature	T_{env}		240	240	°C

HEATING: direct; thoriated tungsten filament

Filament voltage (< 120 MHz)	V_f	6,3	V
(> 120 MHz)	V_f	6,0	V
Filament current at V_f = 6,3 V	I_f	33	A

The filament is designed to accept temporary fluctuations of +5% and −10%.

It is extremely important that the filament be properly decoupled. This should be done so that the resonance of the circuit formed by the filament and the decoupling elements remain below the fundamental oscillator frequency. In grounded-grid circuits this resonance should be below the grid-cathode resonance. For further information please see Application Book "Tubes for RF Heating" or contact the manufacturer.

CAPACITANCES

Anode-to-filament	C_{af}	0,4	pF
Grid to filament	C_{gf}	17	pF
Anode to grid	C_{ag}	14	pF

CHARACTERISTICS measured at V_a = 2,0 kV, I_a = 0,5 A

Transconductance	S	10	mA/V
Amplification factor	μ	20	

COOLING

To obtain optimum life, the temperature of the seals and of the envelope should, under normal operating conditions, be kept below 200 °C.

Table 1 Water cooling characteristics

anode + grid dissipation $W_a + W_g$ kW	inlet temperature T_i °C	rate of flow q_{min} l/min	pressure drop ΔP kPa*	outlet temperature T_o °C
1	20	0,9	5	40
	50	1,4	6	62
2	20	1,6	10	40
	50	2,8	15	61
3	20	2,2	14	40
	50	4,1	27	61

Absolute max. water inlet temperature	T_i	max.	50 °C
Absolute max. water pressure	P	max.	600 kPa

ACCESSORIES

Filament connector	type 40688
Filament/cathode connector	type 40689
Grid connector	type 40686

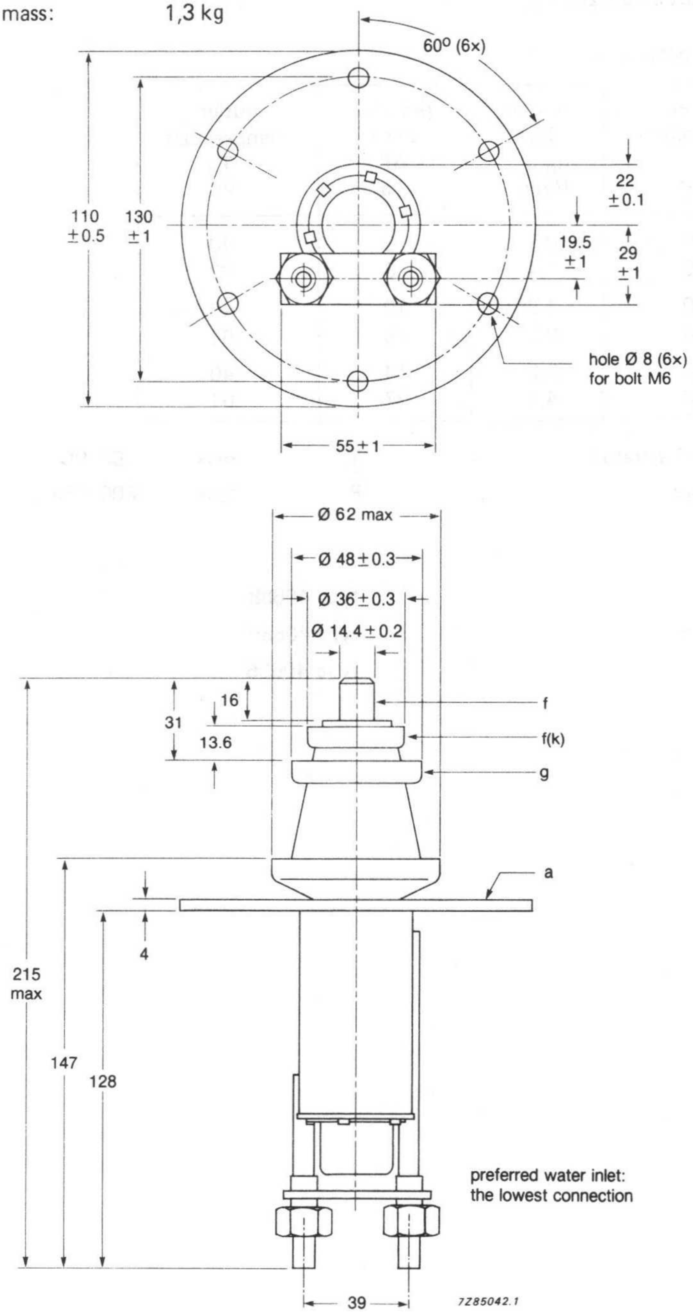
* 100 kPa ≈ 1 at

MECHANICAL DATA

Dimensions in mm

Mounting position: vertical with anode down

Net mass: 1,3 kg



Thread of water connections BSP 1/4 in.

Fig. 1 Mechanical outline.

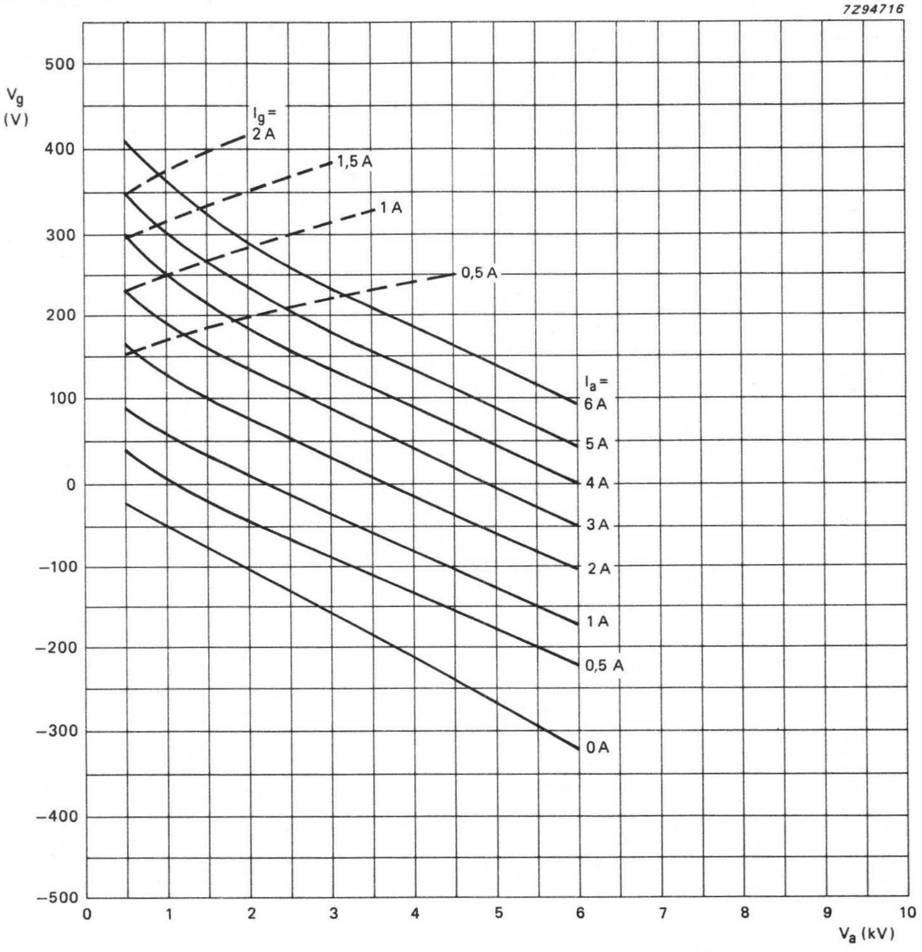


Fig. 2 Constant current characteristics.

RF POWER TRIODE

Forced air cooled triode of metal-ceramic construction with integral cooler intended for use as an industrial oscillator.

QUICK REFERENCE DATA

Oscillator output power ($W_o - W_{feedb}$), typical	W_{osc}		2,73	kW
Frequency for full ratings	f	max.	50	MHz

To be read in conjunction with chapter "General Operational Recommendations".

RF CLASS C OSCILLATOR FOR INDUSTRIAL USE

with anode voltage from a three-phase rectifier

OPERATING CONDITIONS, continuous service

Frequency	f	50	50	50	50	MHz
Oscillator output power ($W_o - W_{feedb}$)	W_{osc}	2,73	2,61	2,04	1,44	kW
Anode voltage	V_a	6	5	4	3	kV
Anode current	I_a	600	700	700	700	mA
Anode input power	W_{ia}	3600	3500	2800	2100	W
Anode dissipation	W_a	760	780	640	540	W
Anode output power	W_o	2840	2720	2160	1560	W
Anode efficiency	η_a	79	78	77	74	%
Oscillator efficiency	η_{osc}	76	75	73	69	%
Feedback ratio	V_{gp}/V_{ap}	13	17	20	25	%
Grid resistor	R_g	3	2,5	2	1,5	kΩ
Grid current, on load	I_g	150	160	180	200	mA
Grid voltage, negative	$-V_g$	450	400	360	300	V
Grid dissipation	W_g	43	46	55	60	W
Grid resistor dissipation	W_{Rg}	67	64	65	60	W

Note

For other operating conditions contact the manufacturer.

LIMITING VALUES (Absolute maximum rating system)

Frequency for full ratings	f	up to	50	MHz
Anode voltage	V_a	max.	7	kV
Anode current	I_a	max.	750	mA
Anode input power	W_{ia}	max.	4000	W
Anode dissipation	W_a	max.	800	W
Grid voltage	$-V_g$	max.	1250	V
Grid current, on load	I_g	max.	300	mA
off load	I_g	max.	400	mA
Grid dissipation	W_g	max.	150	W
Grid circuit resistance	R_g	max.	10	kΩ
Cathode current, mean	I_k	max.	1,2	A
peak	I_{kp}	max.	4,3	A
Envelope temperature	T_{env}	max.	240	°C

HEATING: direct; filament thoriated tungsten

Filament voltage	V_f	6,3 V
Filament current	I_f	33 A

The filament is designed to accept temporary fluctuations of + 5% and −10%.

CAPACITANCES

Anode to filament	C_{af}	0.3 pF
Grid to filament	C_{gf}	17 pF
Anode to grid	C_{ag}	11,3 pF

CHARACTERISTICS measured at V_a = 4 kV, I_a = 190 mA

Transconductance	S	5 mA/V
Amplification factor	μ	22

COOLING

To obtain optimum life, the temperature of the seals and the envelope should, under normal operating conditions, be kept below 200 °C.

Rate of airflow q min = 1 m^3 at $W_g + W_a$ 800 W

ACCESSORIES

Filament connector	type 40688
Filament/cathode connector	type 40689
Grid connector	type 40686

MECHANICAL DATA

Mounting position: vertical with anode up or down

Net mass: 1,3 kg

Dimensions in mm

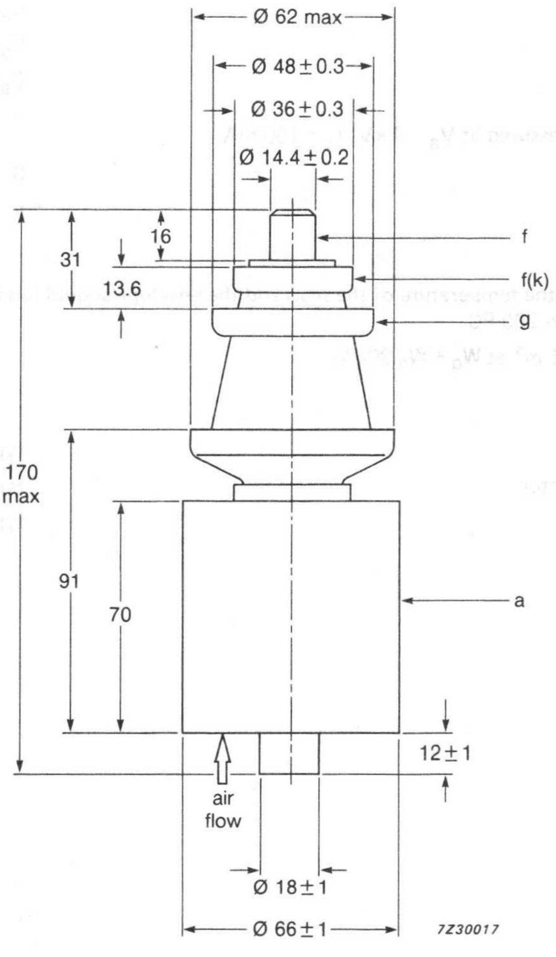


Fig. 1 Mechanical outline.

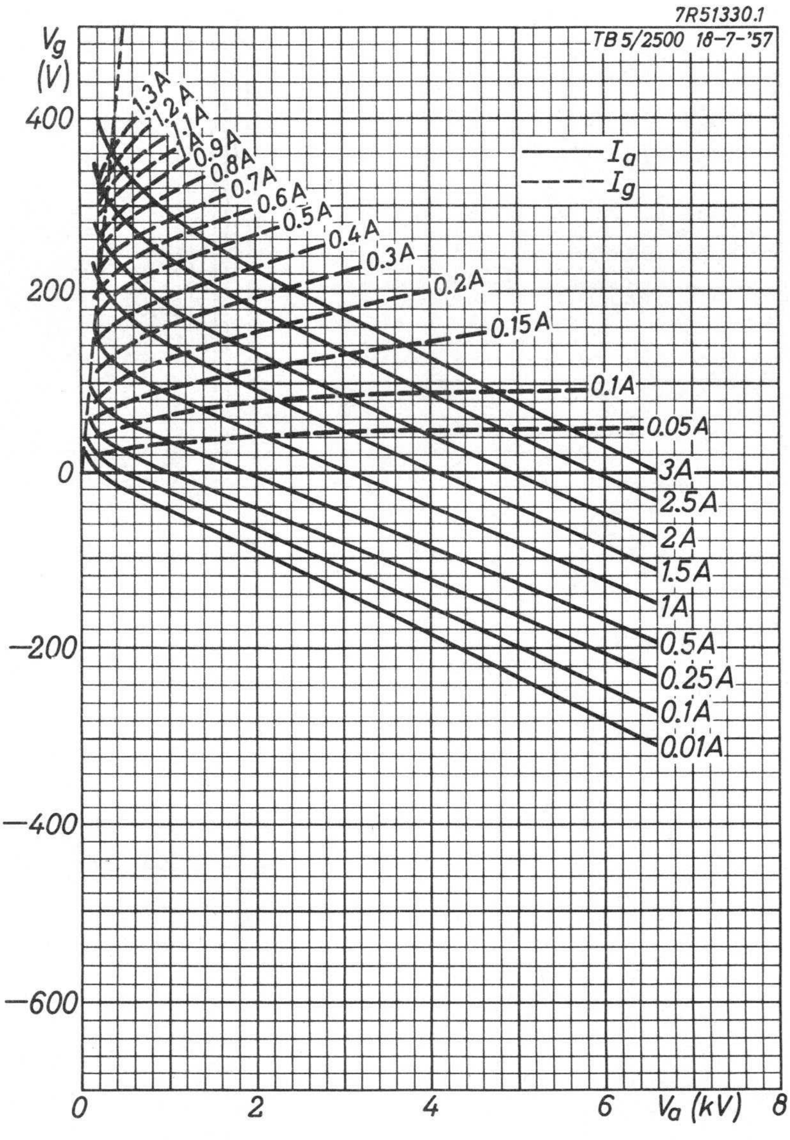


Fig. 1 Constant current characteristics.

RF POWER TRIODE

Triodes in metal-ceramic construction intended for use as industrial oscillators.
The YD1160 is forced-air cooled, with integral cooler.
The YD1162 has an integral water cooler.

QUICK REFERENCE DATA

Oscillator output power ($W_o - W_{feedback}$), typical	W_{osc}		8,8 kW
Frequency for full ratings	f	max.	85 MHz

To be read in conjunction with "General Operational Recommendations".

RF CLASS C OSCILLATOR FOR INDUSTRIAL USE

OPERATING CONDITIONS

Frequency	f	150	27,12	27,12	MHz
Filament voltage	V_f	5,8	6,3	6,3	V
Oscillator output power (W_o-W_{feedb})	W_{osc}	7,15	8,8	7,5	kW
Anode voltage	V_a	5,0	6,5	6,0	kV
Anode current	I_a	2,0	1,8	1,6	A
Anode input power	W_{ia}	10,0	11,7	9,6	kW
Anode dissipation	W_a	2,45	2,5	1,7	kW*
Anode output power	W_o	7,55	9,2	7,9	kW
Anode efficiency	η_a	75,5	78,6	82,3	%
Oscillator efficiency	η_{osc}	71,5	75,2	78,1	%
Feedback ratio	V_{gp}/V_{ap}	15	16	15	%
Grid resistor	R_g	1,0	1,6	1,3	kΩ
Grid current, on load	I_g	480	430	480	mA
Grid voltage, negative	$-V_g$	480	688	624	V
Grid dissipation	W_g	100	110	120	W
Grid resistor dissipation	W_{Rg}	230	296	300	W

LIMITING VALUES (Absolute maximum rating system)

Frequency	f	up to	85	150 MHz
Anode voltage	V_a	max.	7,2	6,0 kV
Anode current	I_a	max.	2,2	2,2 A
Anode input power	W_{ia}	max.	12,5	11 kW
Anode dissipation	W_a	max.	5	5 kW
Grid voltage	$-V_g$	max.	1	1 kV
Grid current				
on load	I_g	max.	550	550 mA
off load	I_g	max.	750	750 mA
Grid dissipation	W_g	max.	250	250 W
Grid circuit resistance	R_g	max.	20	20 kΩ
Cathode current				
mean	I_k	max.	2,8	2,8 A
peak	I_{kp}	max.	15	15 A
Envelope temperature	T_{env}	max.	240	240 °C

HEATING: direct; filament thoriated tungsten

Filament voltage		
(f = 150 MHz)	V_f	5,8 V
(f < 150 MHz)	V_f	6,3 V
Filament current at V_f = 6,3 V	I_f	66 A

The filament is designed to accept temporary fluctuations of +5% and −10%.

It is extremely important that the filament be properly decoupled. This should be done so that the resonance of the circuit formed by the filament and the decoupling elements remain below the fundamental oscillator frequency. In grounded-grid circuits this resonance should be below the grid-cathode resonance. For further information please see Application Book "Tubes for RF heating" or contact the manufacturer.

CAPACITANCES

Anode to filament	C_{af}	0,5 pF
Grid to filament	C_{gf}	19 pF
Anode to grid	C_{ag}	14,5 pF

CHARACTERISTICS measured at V_a = 2 kV, I_a = 1 A.

Transconductance	S	22 mA/V
Amplification factor	μ	20

COOLING

To obtain optimum life, the seal/envelope temperature under normal operating conditions should be kept below 200 °C.

Table 1 Air cooling characteristics

YD1160

anode + grid dissipation $W_a + W_g$ kW	inlet temperature T_i °C	rate of flow q_{min} m^3/min	pressure drop ΔP Pa*	outlet temperature T_o °C
3	35	3,6	90	82
3	45	4,2	110	87

Table 2 Water cooling characteristics

YD1162

anode + grid dissipation $W_a + W_g$ kW	inlet temperature T_i °C	rate of flow q_{min} ℓ/min	pressure drop ΔP kPa**	max. outlet temperature T_o °C
3	20	2,2	18	42
	50	4,3	38	61
5	20	4,0	40	40
	50	8,0	140	60

Absolute max. water inlet temperature	T_i	max.	50 °C
Absolute max. water pressure	P	max.	600 kPa(abs)

A low velocity air flow may be required for cooling of the seals

* 1 Pa ≈ 0,1 mm H_2O.

** 100 kPa ≈ 1 at

ACCESSORIES

Filament connector	type	40688
Filament/cathode connector	type	40689
Grid connector	type	40686
Insulating pedestal (YD1160 only)	type	40630

MECHANICAL DATA

Dimensions in mm

YD1160

Mounting position: vertical, with anode up or down

Net mass: approx. 3,5 kg

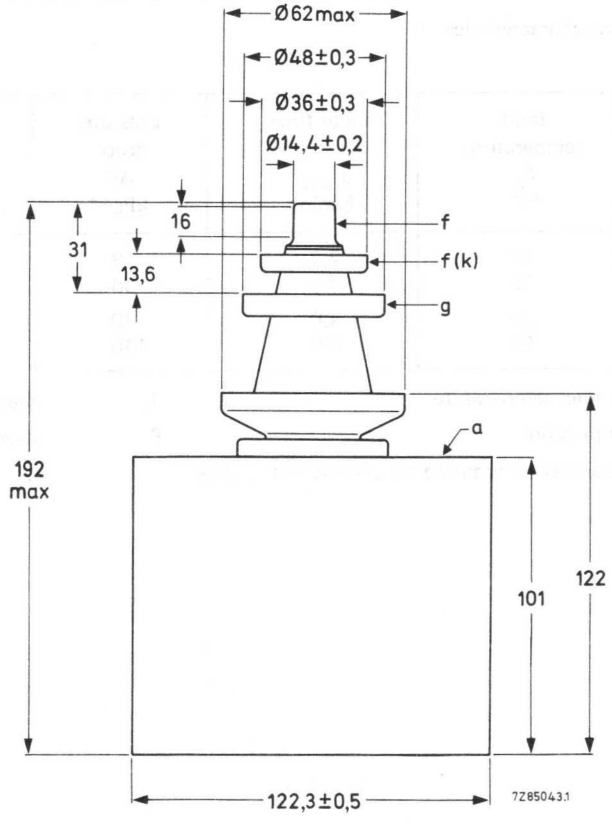


Fig. 1 Mechanical outline – YD1160.

YD1162

Mounting position: vertical with anode down

Net mass: approx. 1,6 kg

Dimensions in mm

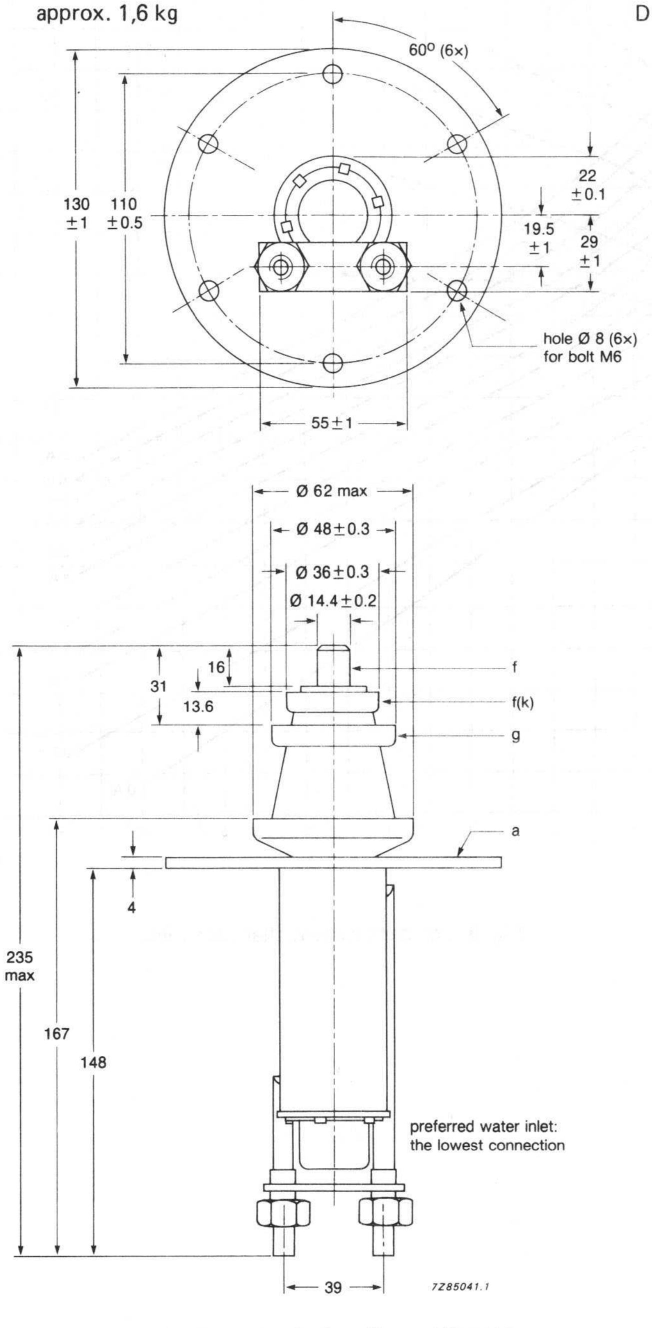


Fig. 2 Mechanical outline – YD1162.

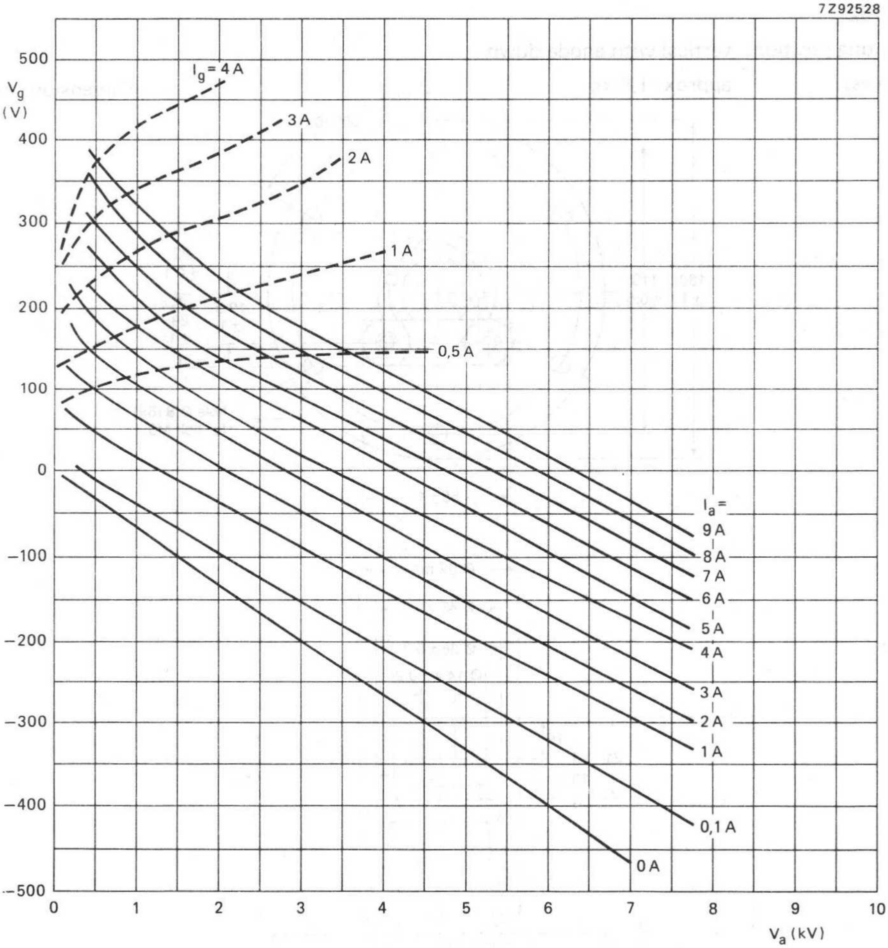


Fig. 3 Constant current characteristics.

RF POWER TRIODE

Triodes in metal-ceramic construction intended for use as industrial oscillators. The YD1170 is forced-air cooled. The YD1172 has an integral helical water cooler.

QUICK REFERENCE DATA

Oscillator output power ($W_o - W_{feedback}$), typical	W_{osc}		15,4 kW
Frequency for full ratings	f	max.	120 MHz

To be read in conjunction with "General Operational Recommendations Transmitting Tubes for Communication; Tubes for R.F. Heating".

RF CLASS C OSCILLATOR FOR INDUSTRIAL USE

OPERATING CONDITIONS

Frequency	f	120 MHz
Filament voltage	V_f	5,8 V
Oscillator output power ($W_o - W_{feedback}$)	W_{osc}	15,4 kW
Anode voltage	V_a	6 kV
Anode current	I_a	3,4 A
Anode input power	W_{ia}	20,4 kW
Anode dissipation	W_a	4,3 kW
Anode output power	W_o	16,1 kW
Anode efficiency	η_a	78,9 %
Oscillator efficiency	η_{osc}	75,5 %
Feedback ratio	V_{gp}/V_{ap}	15,5 %
Grid resistor	R_g	500 Ω
Grid current, on load	I_g	920 mA
Grid voltage, negative	$-V_g$	460 V
Grid dissipation	W_g	280 W
Grid resistor dissipation	W_{Rg}	423 W

LIMITING VALUES (Absolute maximum rating system)

Frequency for full ratings	f	up to	120 MHz
Anode voltage	V_a	max.	7,2 kV
Anode current	I_a	max.	4 A
Anode input power	W_{ia}	max.	24 kW
Anode dissipation	W_a	max.	10 kW
Grid voltage	$-V_g$	max.	1,5 kV
Grid current			
on load	I_g	max.	1 A
off load	I_g	max.	1,5 A
Grid dissipation	W_g	max.	350 W
Grid circuit resistance	R_g	max.	10 kΩ
Cathode current			
mean	I_k	max.	5 A
peak	I_{kp}	max.	25 A
Envelope temperature	T_{env}	max.	240 °C

HEATING: direct; thoriated tungsten filament

Filament voltage	V_f		5,8 V
Filament current	I_f		130 A
Peak filament starting current	I_{fp}	max.	800 A
Cold filament resistance	R_{fo}		5,6 mΩ

The filament is designed to accept temporary fluctuations of + 5% and −10%.

To ensure that the cathode temperature remains constant irrespective of the operating frequency, it may be necessary to reduce the filament voltage at higher frequencies. When doing so it must be borne in mind that the filament voltage-to-current ratio measured with only the filament voltage applied should remain constant under all operating conditions.

It is extremely important that the filament be properly decoupled. This should be done so that the resonance of the circuit formed by the filament and the decoupling elements remain below the fundamental oscillator frequency. In grounded-grid circuits this resonance should be below the grid-cathode resonance. For further information please see Application Book "Tubes for RF heating" or contact the manufacturer.

CAPACITANCES

Anode to filament	C_{af}	0,8 pF
Grid to filament	C_{gf}	47 pF
Anode to grid	C_{ag}	25 pF

CHARACTERISTICS measured at V_a = 6 kV, I_a = 2 A

Transconductance	S	40 mA/V
Amplification factor	μ	30

COOLING

To obtain optimum life, the temperature of the seals and of the envelope should, under normal operating conditions, be kept below 200 °C.

To maintain these temperatures additional cooling may be necessary. At frequencies higher than about 4 MHz cooling of the seals becomes mandatory.

YD1170

Table 1 Air cooling characteristics

anode + grid dissipation $W_a + W_g$ kW	altitude h m	inlet temperature T_i °C	rate of flow q_{min} m³/min	pressure drop ΔP P_a*	outlet temperature T_o °C
10	0	35	9,5	550	94
8	0	35	6,5	280	105
6	0	35	4,5	150	113
4	0	35	3,0	80	117
10	0	45	11,0	690	98
8	0	45	7,6	350	108
6	0	45	5,2	190	115
4	0	45	3,5	100	119
10	1500	35	11,4	630	94
8	1500	35	7,8	320	105
6	1500	35	5,5	170	113
4	1500	35	3,6	90	117
10	3000	25	12,0	620	90
8	3000	25	8,2	320	102
6	3000	25	5,7	170	111
4	3000	25	3,8	90	116

Absolute max. air inlet temperature	T_i	max. 45 °C
Direction of air flow		arbitrary

* 1 Pa ≈ 0,1 mm H_2O.

YD1172

Table 2 Water cooling characteristics

anode + grid dissipation $W_a + W_g$ kW	inlet temperature T_i °C	rate of flow q_{min} ℓ/min	pressure drop ΔP kPa*	outlet temperature T_o °C
10	20	6,0	25	46
	50	9,0	52	67
8	20	4,5	15	49
	50	6,7	31	69
6	20	3,0	7	53
	50	4,5	15	72

Absolute max. water inlet temperature T_i max. 50 °C

Absolute max. water pressure P max. 600 kPa

ACCESSORIES

Filament connector with cable	40692A
Filament/cathode connector with cable	40693A
Grid connector f ⩽ 4 MHz	40690
f > 4 MHz	40691
Insulating pedestal (YD1170 only)	40654

* 100 kPa ≈ 1 at

MECHANICAL DATA

YD1170

Mounting position: vertical with anode up or down

Net mass approx. 7 kg

Dimensions in mm

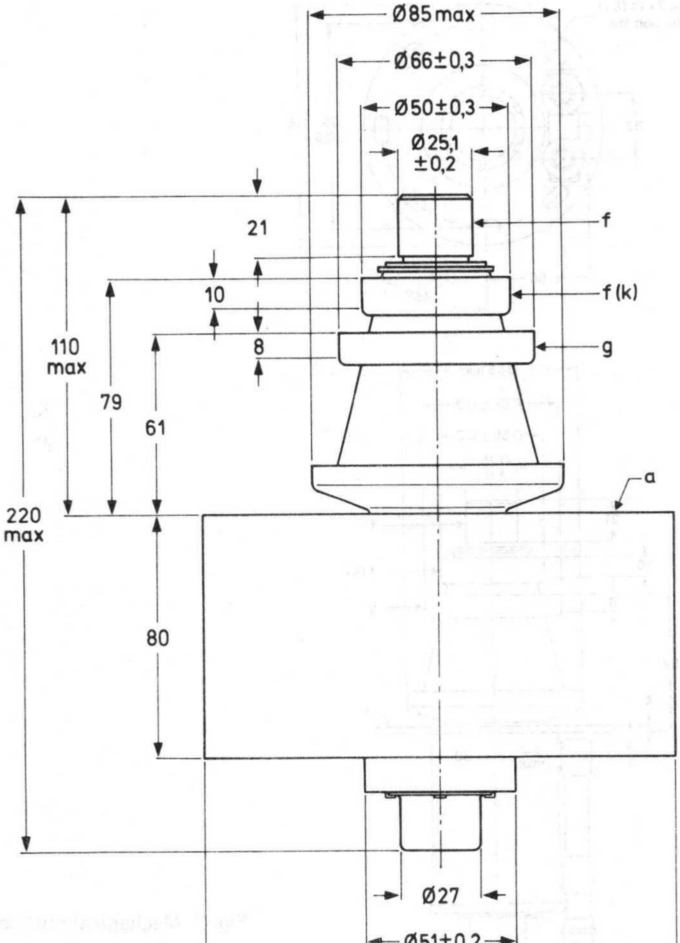


Fig. 1 Mechanical outline – YD1170.

YD1172

Mounting position: vertical with anode up or down

Net mass: approx. 1,85 kg

Dimensions in mm

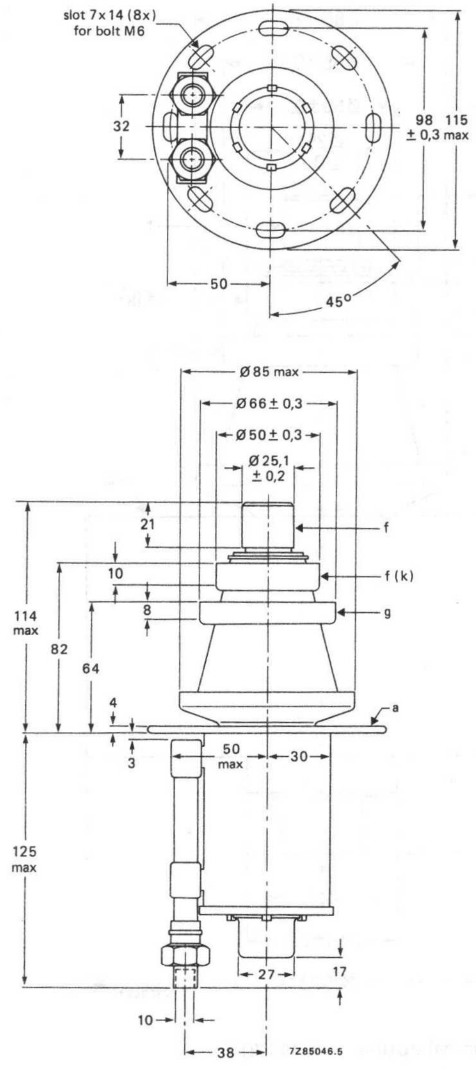


Fig. 2 Mechanical outline – YD1172.

Preferred water inlet
the lowest connections

Thread of water connections BSP 3/8 in

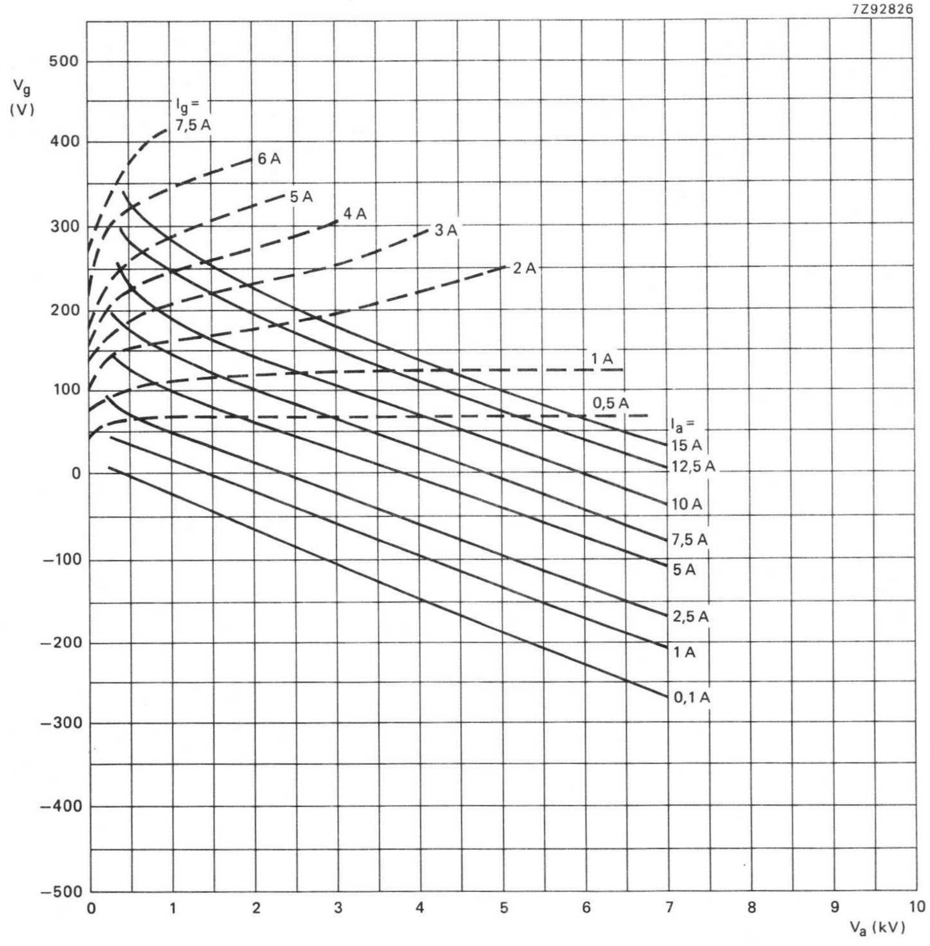


Fig. 3 Constant current characteristics.

RF POWER TRIODE

Forced air cooled triode of metal-ceramic construction with integral cooler intended for use as an industrial oscillator.

QUICK REFERENCE DATA				
Oscillator output power (W_o-W_{feedb}), typical	W_{osc}		13.22	kW
Frequency fur full ratings	f	max.	50	MHz

To be read in conjunction with "General Operational Recommendations".

RF CLASS C OSCILLATOR FOR INDUSTRIAL USE

OPERATING CONDITIONS

Frequency	f	50	MHz
Oscillator output power (W_o-W_{feedb})	W_{osc}	13.22	kW
Anode voltage	V_a	10.0	kV
Anode current	I_a	1.75	A
Anode input power	W_{ia}	17.5	kW
Anode dissipation	W_a	3.8	kW
Anode output power	W_o	13.7	kW
Anode efficiency	η_a	78.3	%
Oscillator efficiency	η_{osc}	75.6	%
Feedback ratio	V_{gp}/V_{ap}	12.0	%
Grid resistor	R_g	1.5	kΩ
Grid current, on load	I_g	450	mA
Grid voltage, negative	$-V_g$	675	V
Grid dissipation	W_g	180	W
Grid resistor dissipation	W_{Rg}	304	W

LIMITING VALUES (Absolute max. rating system)

Frequency for full ratings	f	up to	50	MHz
Anode voltage	V_a	max.	12	kV
Anode current	I_a	max.	2.0	A
Anode input power	W_{ia}	max.	20	kW
Anode dissipation	W_a	max.	10	kW
Grid voltage	$-V_g$	max.	1.5	kV
Grid current, on load	I_g	max.	0.6	A
off load	I_g	max.	0.8	A
Grid dissipation	W_g	max.	300	W
Grid circuit resistance	R_g	max.	10	kΩ
Cathode current, mean	I_k	max.	2.5	A
peak	I_{kp}	max.	10	A
Envelope temperature	T_{env}	max.	240	°C

HEATING : direct; filament thoriated tungsten

Filament voltage	V_f		5.4	V
Filament current	I_f		65	A
Peak filament starting current	I_{fp}	max.	400	A
Cold filament resistance	R_{fo}		10	mΩ

The filament is designed to accept temporary fluctuations of +5 % and −10 %.

It is extremely important that the filament be properly decoupled. This should be done so that the resonance of the circuit formed by the filament and the decoupling elements remain below the fundamental oscillator frequency. In grounded-grid circuits this resonance should be below the grid-cathode resonance. For further information please see Application Book "Tubes for RF heating" or contact the manufacturer.

CAPACITANCES

Anode to filament	C_{af}	0.4	pF
Grid to filament	C_{gf}	42	pF
Anode to grid	C_{ag}	17	pF

CHARACTERISTICS measured at V_a = 10 kV, I_a = 1 A

Transconductance	S	22	mA/V
Amplification factor	μ	45	

COOLING

Table 1 Air cooling characteristics

With insulating pedestal type 40654.

Anode + grid dissipation $W_a + W_g$ (kW)	Altitude h (m)	Inlet temperature T_i (°C)	Rate of flow qmin (m^3/min)	Pressure drop ΔP (Pa)*	Outlet temperature T_o (°C)
10	0	35	9,5	550	94
8	0	35	6,5	280	105
6	0	35	4,5	150	113
4	0	35	3,0	80	117
10	0	45	11	690	98
8	0	45	7,6	350	108
6	0	45	5,2	190	115
4	0	45	3,5	100	119
10	1500	35	11,4	630	94
8	1500	35	7,8	320	105
6	1500	35	5,5	170	113
4	1500	35	3,6	90	117
10	3000	25	12	620	90
8	3000	25	8,2	320	102
6	3000	25	5,7	170	111
4	3000	25	3,8	90	116

To obtain optimum life, the temperatures of the seals and of the envelope should, under normal operating conditions, be kept below 200 °C.

ACCESSORIES

Filament connector with cable	type	40692A	net mass	450	g
Filament/cathode connector with cable	type	40693A	net mass	490	g
Grid connector f ≤ 4 MHz	type	40690	net mass	55	g
f > 4 MHz	type	40691	net mass	240	g
Insulating pedestal	type	40654	net mass	4,25	kg

* 1 Pa ≈ 0,1 mm H_2O.

MECHANICAL DATA

Mounting position : vertical with anode up or down

Net mass : approx. 7 kg

Dimensions in mm

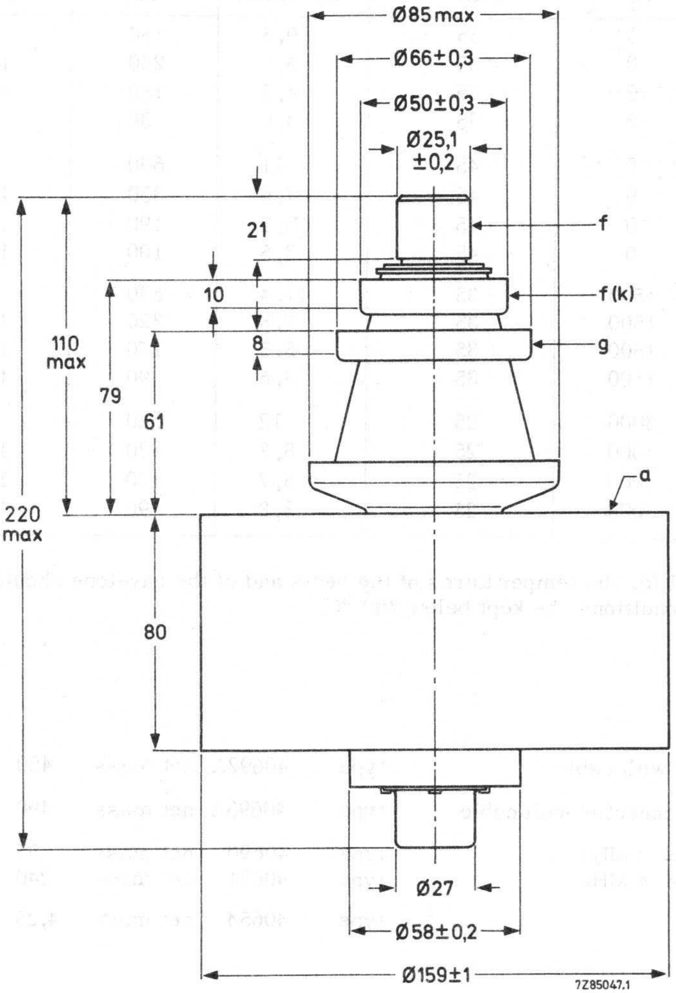


Fig. 1 Mechanical outline.

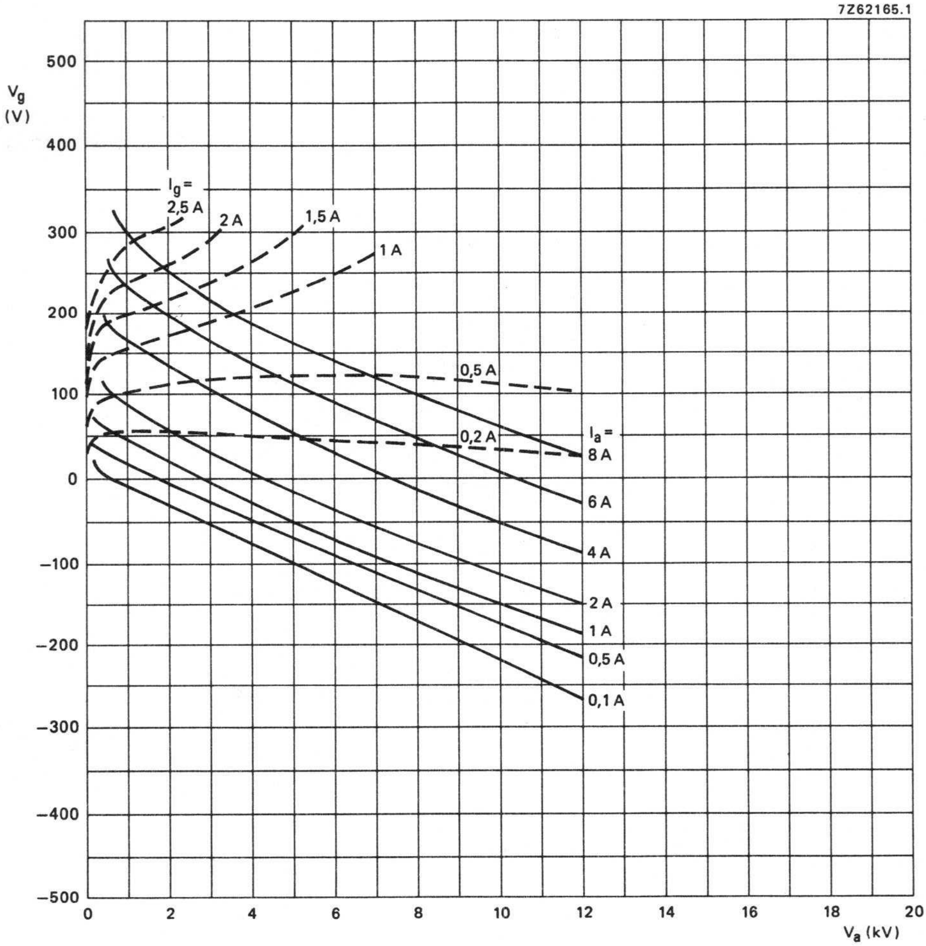


Fig. 2 Constant current characteristics.

RF POWER TRIODE

Triodes in metal-ceramic construction with flying leads intended for use as industrial oscillators. The YD1174 is forced-air cooled. The YD1178 has an integral water cooler.

QUICK REFERENCE DATA

Oscillator output power ($W_o - W_{feedb}$)	W_{osc}		30 kW
Frequency for full ratings	f	max.	50 MHz

To be read in conjunction with "General Operational Recommendations".

RF CLASS C OSCILLATOR FOR INDUSTRIAL USE
OPERATING CONDITIONS

Frequency	f	30	30	MHz
Oscillator output power ($W_o - W_{feedb}$)	W_{osc}	25,7	30,3	kW
Anode voltage	V_a	10	10	kV
Anode current	I_a	3,4	4,0	A
Anode input power	W_{ia}	34	40	kW
Anode dissipation	W_a	7,6	9,2	kW
Anode output power	W_o	26,4	30,8	kW
Anode efficiency	η_a	77,6	77,0	%
Oscillator efficiency	η_{osc}	75,6	75,8	%
Feedback ratio	V_{gp}/V_{ap}	12	10	%
Grid resistor	R_g	1440	900	Ω
Grid current, on load	I_g	600	690	mA
Grid voltage, negative	$-V_g$	864	621	V
Grid dissipation	W_g	150	180	W
Grid resistor dissipation	W_{Rg}	518	428	W

LIMITING VALUES (Absolute maximum rating system)

Frequency	f	up to	120	MHz*
Anode voltage	V_a	max.	12	kV
Anode current	I_a	max.	5	A
Anode dissipation	W_a	max.	10	kW
Grid voltage	$-V_g$	max.	1,8	kV
Grid current, on load	I_g	max.	1	A
off load	I_g	max.	1,5	A
Grid dissipation	W_g	max.	300	W
Grid circuit resistance	R_g	max.	10	kΩ
Cathode current, mean	I_k	max.	6	A
peak	I_{kp}	max.	25	A
Envelope temperature	T_{env}	max.	240	°C

HEATING: direct; thoriated tungsten filament

Filament voltage	V_f		5,8	V
Filament current	I_f		130	A
Peak filament starting current	I_{fp}	max.	800	A
Cold filament resistance	R_{fo}		5,6	mΩ

The filament is designed to accept temporary fluctuations of +5% and −10%.

To ensure that the cathode temperature remains constant irrespective of the operating frequency, it may be necessary to reduce the filament voltage at higher frequencies. When doing so it must be borne in mind that the filament voltage-to-current ratio measured with only the filament voltage applied should remain constant under all operating conditions.

It is extremely important that the filament be properly decoupled. This should be done so that the resonance of the circuit formed, by the filament and the decoupling elements remain below the fundamental oscillator frequency. In grounded-grid circuits this resonance should be below the grid-cathode resonance. For further information please see Application Book "Tubes for RF heating" or contact the manufacturer.

CAPACITANCES

Anode to filament	C_{af}	1	pF
Grid to filament	C_{gf}	47	pF
Anode to grid	C_{ag}	25	pF

* When the tube is to be used at frequencies above 50 MHz the manufacturer should be consulted for more detailed information.

CHARACTERISTICS measured at $V_a = 6$ kV, $I_a = 2$ A

Transconductance	S	55 mA/V
Amplification factor	μ	24

COOLING

To obtain optimum life, the temperature of the seals and of the envelope should, under normal operating conditions, be kept below 200 °C.

To maintain these temperatures additional cooling may be necessary. At frequencies higher than about 4 MHz cooling of the seals becomes mandatory.

Table 1 Cooling parameters – YD1174

anode + grid dissipation $W_a + W_g$ kW	altitude h m	inlet temperature T_i °C	rate of flow q_{min} m^3/min	pressure drop ΔP Pa*	max. outlet temperature T_o °C
10	0	35	9,5	550	94
8	0	35	6,5	280	105
6	0	35	4,5	150	113
4	0	35	3,0	80	117
10	0	45	11,0	690	98
8	0	45	7,6	350	108
6	0	45	5,2	190	115
4	0	45	3,5	100	119
10	1500	35	11,4	630	94
8	1500	35	7,8	320	105
6	1500	35	5,5	170	113
4	1500	35	3,6	90	117
10	3000	25	12,0	620	90
8	3000	25	8,2	320	102
6	3000	25	5,7	170	111
4	3000	25	3,8	90	116

Absolute max. air inlet temperature	T_i	max. 45 °C
Direction of airflow		arbitrary

* 1 Pa ≈ 0,1 mm H_2O.

Table 2 Cooling parameters – YD1178

anode + grid dissipation $W_a + W_g$ kW	inlet temperature T_i °C	rate of flow q_{min} ℓ/min	pressure drop ΔP kPa*	outlet temperature T_o °C
10	20	6,0	25	46
	50	9,0	52	67
8	20	4,5	15	49
	50	6,7	31	69
6	20	3,0	7	53
	50	4,5	15	72

Absolute max. water inlet temperature T_i max. 50 °C

Absolute max. water pressure P max. 600 kPa*

ACCESSORY

Insulating pedestal (YD1174 only) type 40654

* 100 kPa ≈ 1 at

Mounting position: vertical with anode up or down

Net mass: approx. 7,3 kg

Dimensions in mm

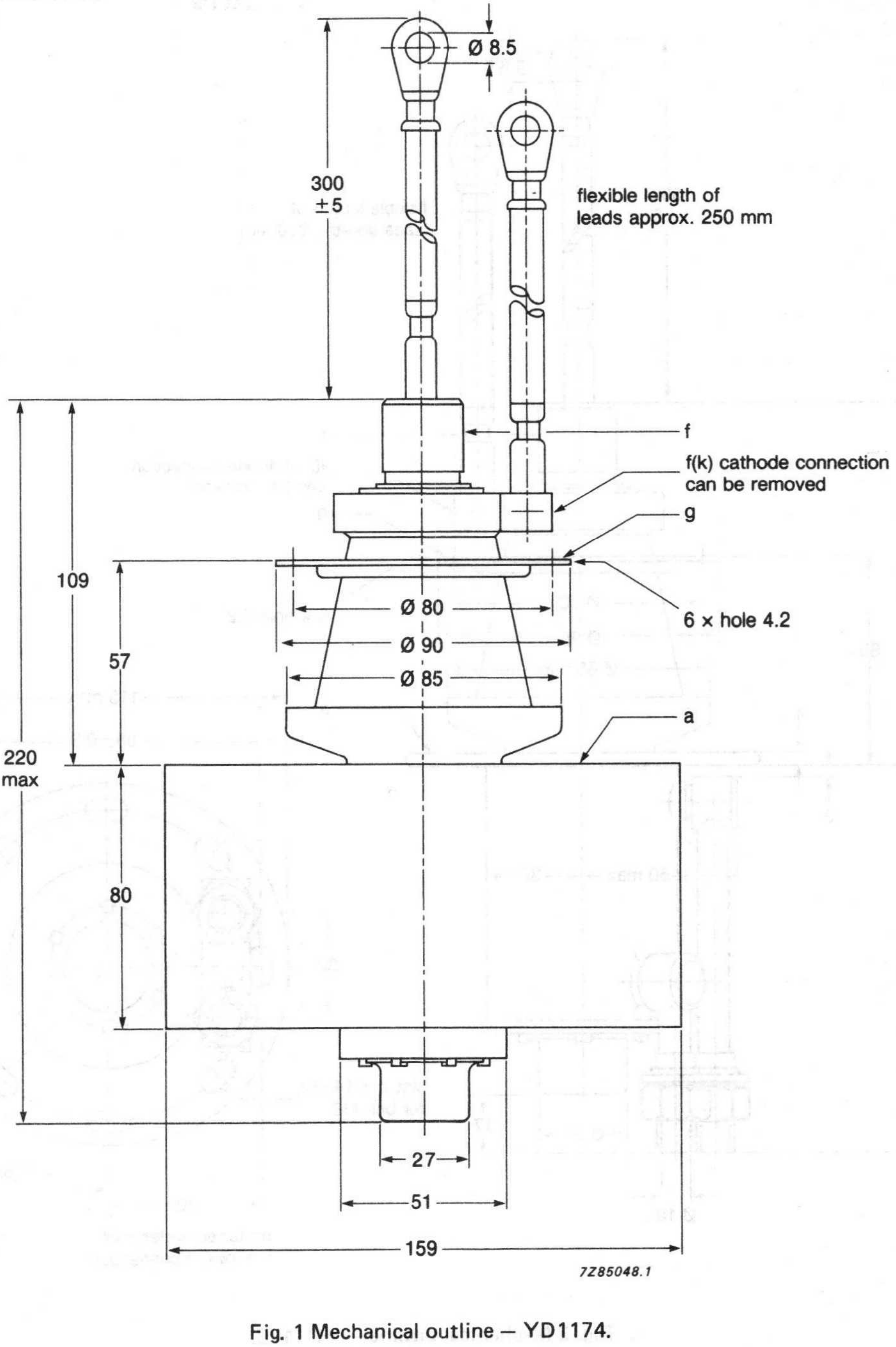


Fig. 1 Mechanical outline – YD1174.

Mounting position: vertical with anode up or down

Net mass: approx. 2,2 kg

Dimensions in mm

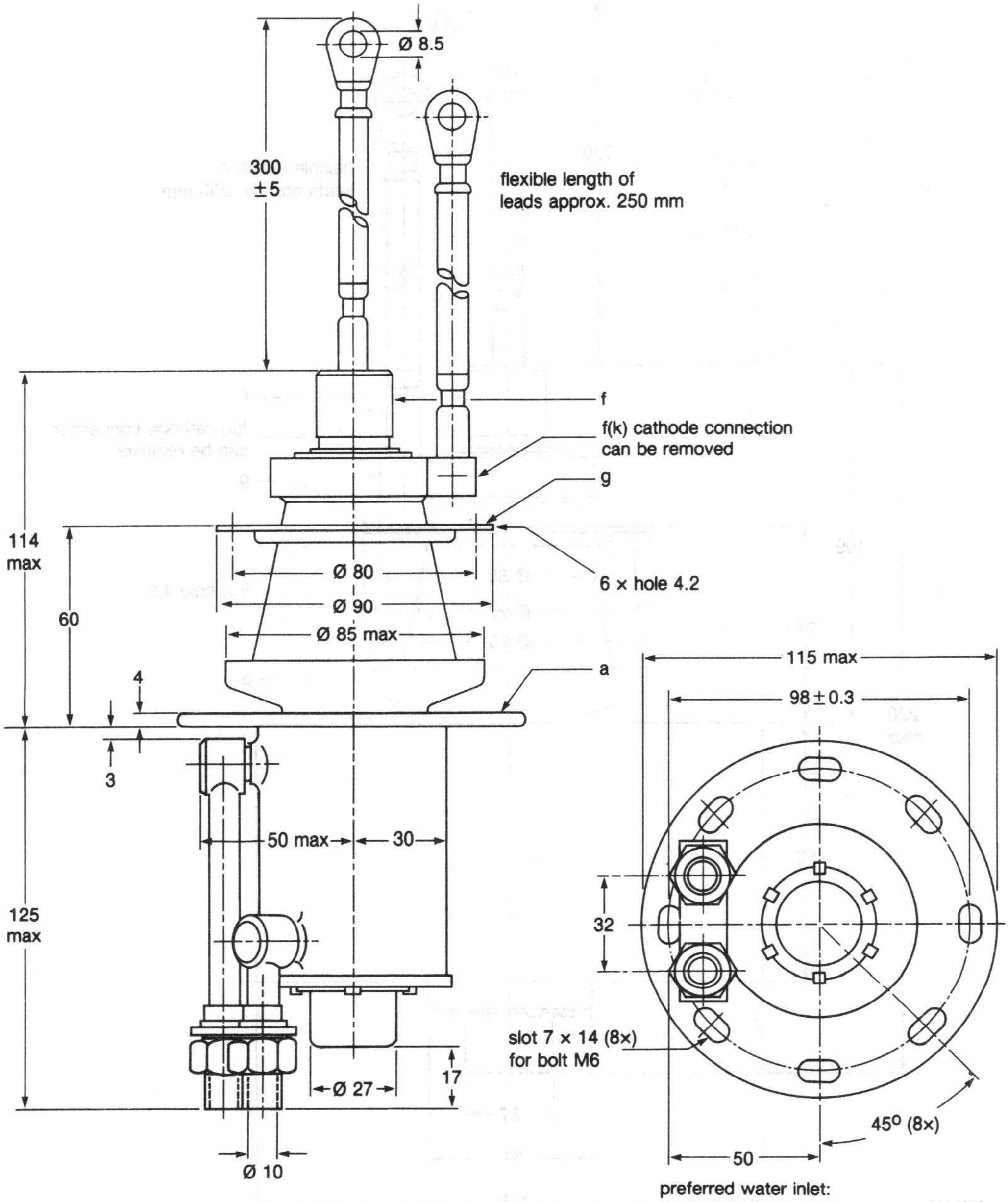


Fig. 2 Mechanical outline – YD1178.

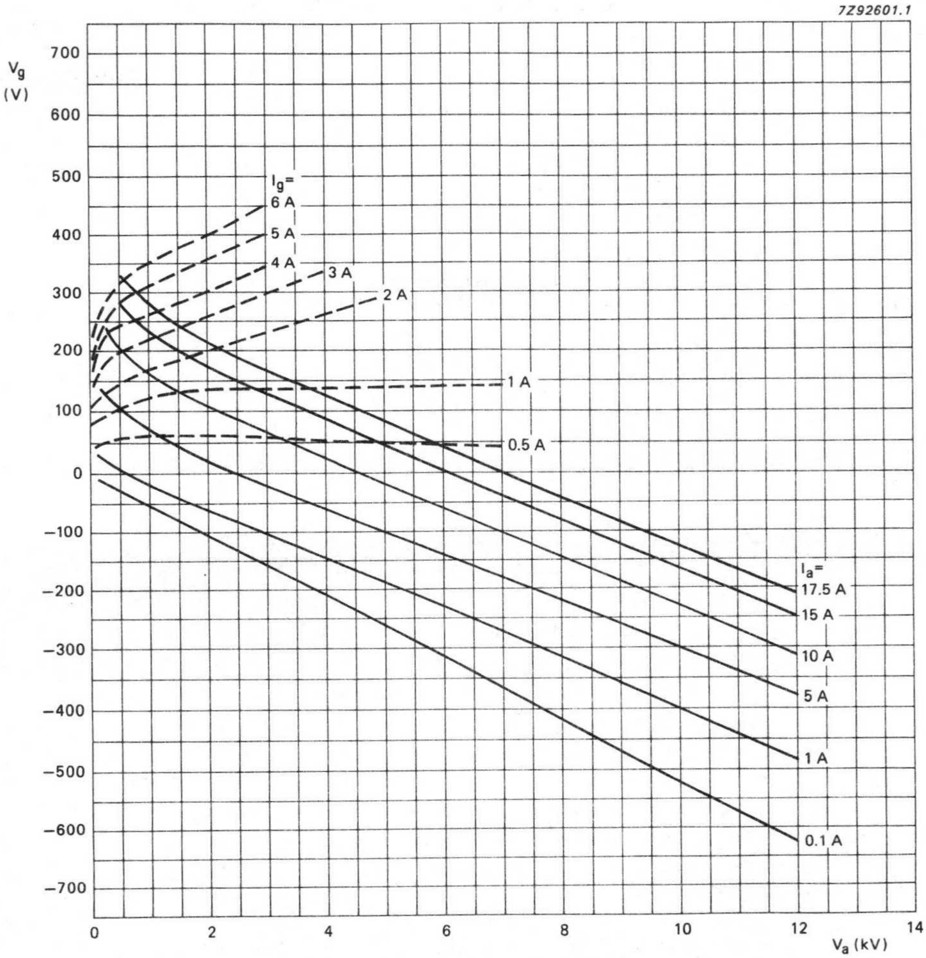


Fig. 3 Constant current characteristics.

RF POWER TRIODE

Triodes in metal-ceramic construction intended for use as industrial oscillators.
The YD1175 is forced-air cooled.
The YD1177 has an integral water cooler.

QUICK REFERENCE DATA

Oscillator output power ($W_o - W_{feedb}$), typical	W_{osc}	26,5	kW
Frequency for full ratings	f max	120	MHz

To be read in conjunction with "General Operational Recommendations".

RF CLASS C OSCILLATOR FOR INDUSTRIAL USE

Operating conditions

Frequency	f	120	120	120	MHz
Oscillator output power ($W_o - W_{feedb}$)	W_{osc}	15,6	22,0	26,5	kW
Anode voltage	V_a	6	8	10	kV
Anode current	I_a	3,6	3,6	3,4	A
Anode input power	W_{ia}	21,6	28,8	34,0	kW
Anode dissipation	W_a	5,4	6,1	6,8	kW
Anode output power	W_o	16,2	22,7	27,2	kW
Anode efficiency	η_a	75	78,8	80	%
Oscillator efficiency	η_{osc}	72,2	76,3	78,0	%
Feedback ratio	Vg_p/Va_p	12	10	9	%
Grid resistor	R_g	300	400	560	Ω
Grid current, on load	I_g	1,0	1,0	0,9	A
Grid voltage, negative	$-V_g$	300	400	500	V
Grid dissipation	W_g	290	290	240	W
Grid resistor dissipation	W_{Rg}	300	400	450	W

LIMITING VALUES (Absolute maximum rating system)

Frequency for full ratings		f	up to	120 MHz*
Anode voltage		V_a	max.	12 kV
Anode current		I_a	max.	4 A
Anode input power		W_{ia}	max.	40 kW
Anode dissipation	YD1175	W_a	max.	10 kW
	YD1177	W_a	max.	15 kW
Grid voltage		$-V_g$	max.	1,5 kV
Grid current, on load		I_g	max.	1,1 A
off load		I_g	max.	1,6 A
Grid dissipation		W_g	max.	350 W
Grid circuit resistance		R_g	max.	10 kΩ
Cathode current, mean		I_k	max.	5 A
peak		I_{kp}	max.	25 A
Envelope temperature		T_{env}	max.	240 °C

HEATING: direct; filament thoriated tungsten

Filament voltage	V_f		5,8 V
Filament current	I_f		130 A
Peak filament starting current	I_{fp}	max.	800 A
Cold filament resistance	R_{fo}		5,6 mΩ

The filament is designed to accept temporary fluctuations of + 5% and −10%.

To ensure that the cathode temperature remains constant irrespective of the operating frequency it may be necessary to reduce the filament voltage at higher frequencies. When doing so it must be borne in mind that the filament voltage-to-current ratio, as measured with only the filament voltage applied, should remain constant under all operating conditions.

It is extremely important that the filament be properly decoupled. This should be done so that the resonance of the circuit formed by the filament and the decoupling elements remain below the fundamental oscillator frequency. In grounded-grid circuits this resonance should be below the grid-cathode resonance. For further information please see Application Book "Tubes for RF heating" or contact the manufacturer.

* When the tubes are to be used at frequencies above 30 MHz the manufacturer should be consulted for more detailed information.

CAPACITANCES

Anode to filament	C_{af}	0,4 pF
Grid to filament	C_{gf}	47 pF
Anode to grid	C_{ag}	17 pF

CHARACTERISTICS measured at V_a = 8 kV, I_a = 1,2 A

Transconductance	S	35 mA/V
Amplification factor	μ	45

COOLING

To obtain optimum life, the temperatures of the seals and of the envelope should, under normal operating conditions, be kept below 200 °C.

To maintain these temperatures additional cooling may be necessary. At frequencies higher than about 4 MHz, cooling of the seals becomes mandatory.

YD1175

Table 1 Air cooling characteristics

anode + grid dissipation $W_a + W_g$ kW	altitude h m	inlet temperature T_i °C	rate of flow q_{min} m³/min	pressure drop ΔP Pa*	max. outlet temperature T_o °C
10	0	35	9,5	550	94
8	0	35	6,5	280	105
6	0	35	4,5	150	113
4	0	35	3,0	80	117
10	0	45	11,0	690	98
8	0	45	7,6	350	108
6	0	45	5,2	190	115
4	0	45	3,5	100	119
10	1500	35	11,4	630	94
8	1500	35	7,8	320	105
6	1500	35	5,5	170	113
4	1500	35	3,6	90	117
10	3000	25	12,0	620	90
8	3000	25	8,2	320	102
6	3000	25	5,7	170	111
4	3000	25	3,8	90	116

Absolute max. air inlet temperature — T_i max. 45 °C

Direction of airflow: arbitrary.

* 1 Pa ≈ 0,1 mm H_2O.

YD1177

Table 2 Water cooling characteristics

anode + grid dissipation $W_a + W_g$ kW	inlet temperature T_i ^oC	rate of flow q_{min} ℓ/min	pressure drop ΔP kPa*	max. outlet temperature T_o ^oC
15	20	7,5	50	50
	50	11,0	100	71
10	20	5,0	24	51
	50	7,2	47	72
5	20	2,5	7	53
	50	3,7	17	73

Absolute max. water inlet temperature T_i max. 50 ^oC

Absolute max. water pressure P_{max} 600 kPa*

ACCESSORIES

Filament connector with cable type 40692A

Filament/cathode connector with cable type 40693A

Grid connector $f \leqslant 4$ MHz type 40690

$f > 4$ MHz type 40691

Insulating pedestal (YD1175 only) type 40654

* 100 kPa ≈ 1 at

MECHANICAL DATA

Dimensions in mm

YD1175

Mounting position: vertical with anode up or down

Net mass: 7,5 kg

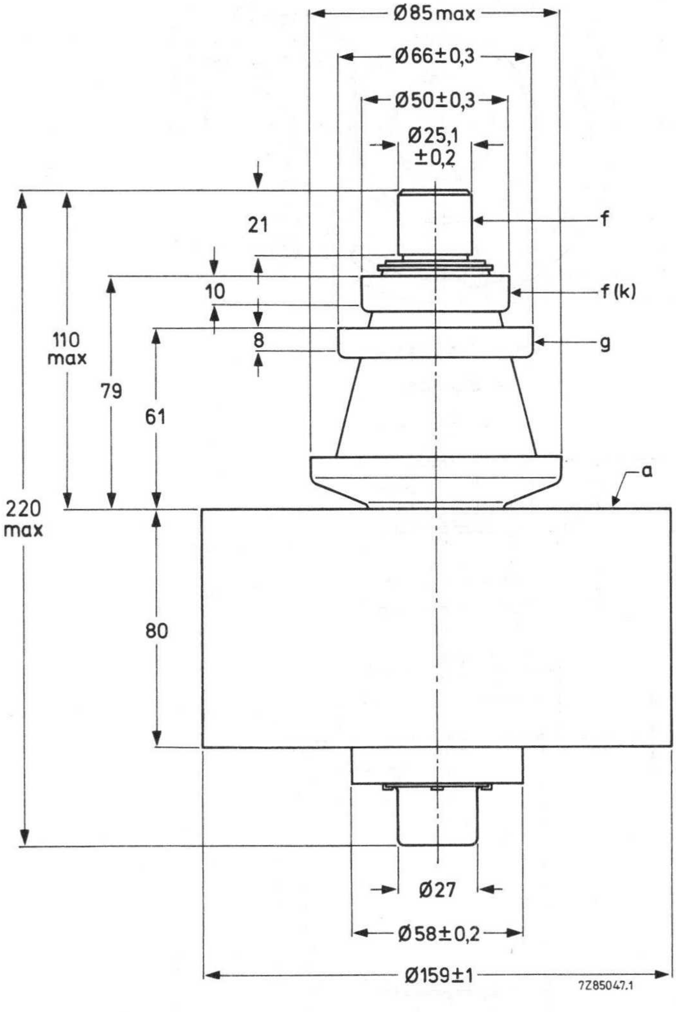


Fig. 1 Mechanical outline — YD1175.

YD1177

Mounting position: vertical with anode up or down

Net mass: approx. 2,4 kg

Dimensions in mm

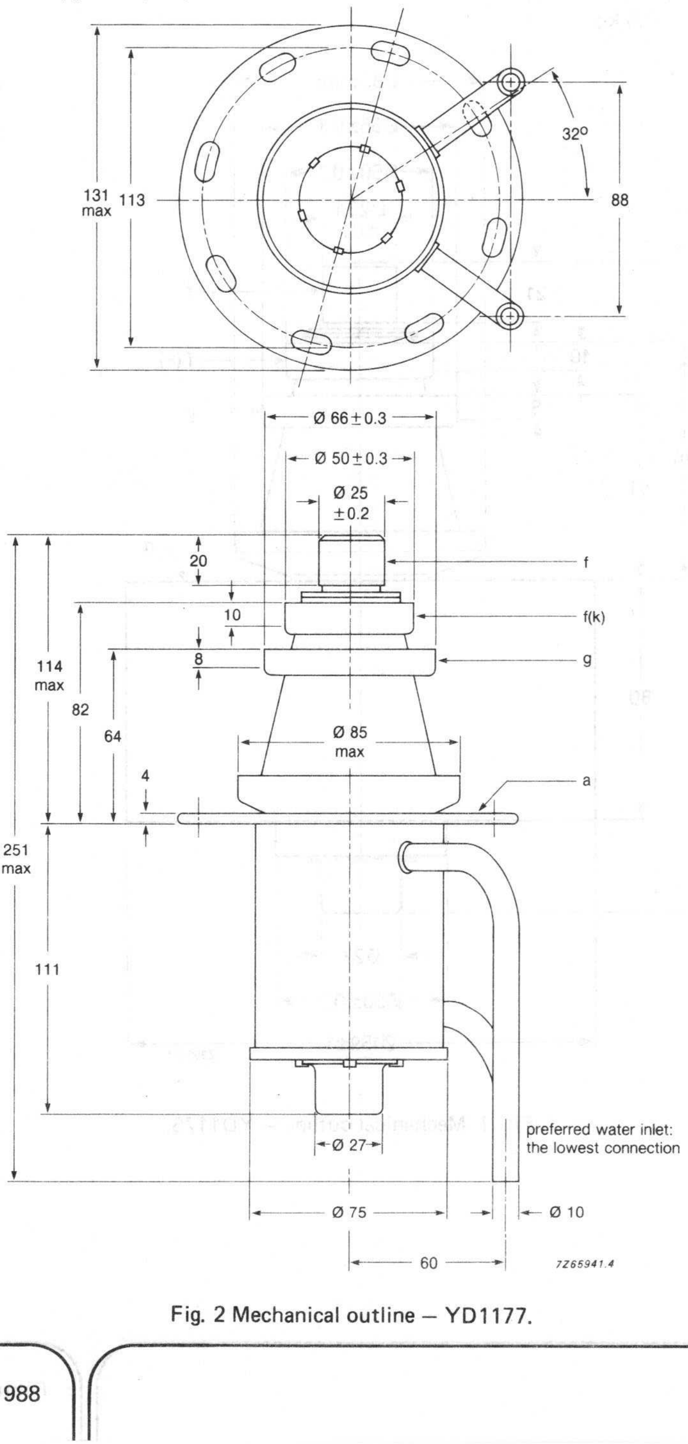


Fig. 2 Mechanical outline – YD1177.

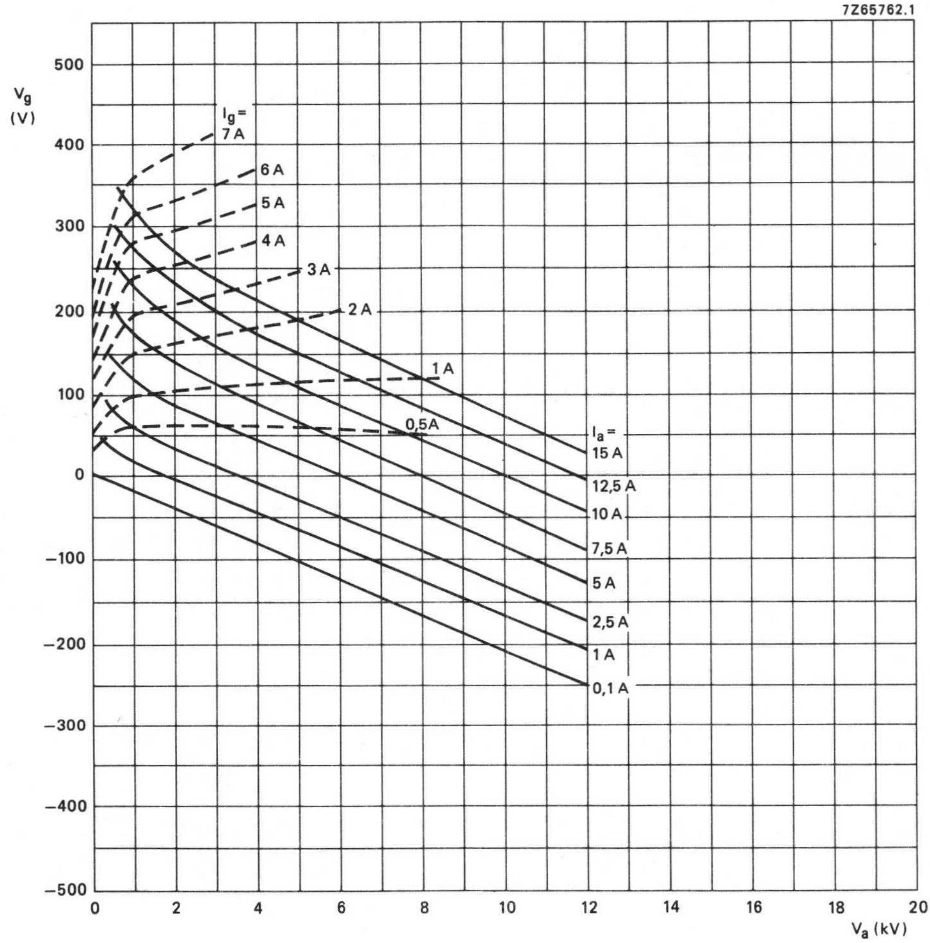


Fig. 3 Constant current characteristics.

RF POWER TRIODE

Triodes in metal-ceramic construction intended for use as industrial oscillators.

The YD1180 is forced-air cooled
The YD1182 is water cooled by an integral cooler.

QUICK REFERENCE DATA				
Oscillator output power (W_o-W_{feedb}), typical	W_{osc}		31,6	kW
Frequency for full ratings	f	max.	100	MHz

To be read in conjunction with "General Operational Recommendations".

RF CLASS C OSCILLATOR FOR INDUATRIAL USE
OPERATING CONDITIONS

Frequency	f	90	MHz
Oscillator output power (W_o -W_{feedb})	W_{osc}	31, 6	kW
Anode voltage	V_a	7, 5	kV
Anode current	I_a	5, 4	A
Anode input power	W_{ia}	40, 5	kW
Anode dissipation	W_a	7, 5	kW
Anode output power	W_o	33	kW
Anode efficiency	η_a	81, 5	%
Oscillator efficiency	η_{osc}	78	%
Feedback ratio	V_{gp}/V_{ap}	14, 8	%
Grid resistor	R_g	450	Ω
Grid current, on load	I_g	1, 45	A
Grid voltage, negative	$-V_g$	652	V
Grid dissipation	W_g	450	W
Grid resistor dissipation	W_{Rg}	946	W

LIMITING VALUES (Absolute max. rating system)

Frequency		f	up to	100	MHz
Anode voltage		V_a	max.	9	kV
Anode current		I_a	max.	6	A
Anode input power		W_{ia}	max.	45	kW
Anode dissipation: continuous service	(YD1180)*	W_a	max.	15	kW
	(YD1182)		max.	20	kW
Grid voltage		$-V_g$	max.	1,5	kV
Grid current, on load		I_g	max.	1,6	A
of load		I_g	max.	2,4	A
Grid dissipation		W_g	max.	500	W
Grid circuit resistance		R_g	max.	10	kΩ
Cathode current, mean		I_k	max.	7,5	A
peak		I_{kp}	max.	40	A
Envelope temperature		t_{env}	max.	240	°C

HEATING : direct; thoriated tungsten filament, mesh construction

Filament voltage	V_f		7	V
Filament current	I_f		175	A
Peak filament starting current	I_{fp}	max.	1000	A
Cold filament resistance	R_{fo}		4,2	mΩ

The filament is designed to accept temporary fluctuations of +5% and −10%.
To ensure that the cathode temperature remains constant irrespective of the operating frequency, it may be necessary to reduce the filament voltage at higher frequencies. When doing so it must be borne in mind that the filament voltage-to-current ratio measured with only the filament voltage applied should remain constant under all operating conditions.

It is extremely important that the filament be properly decoupled. This should be done so that the resonance of the circuit formed by the filament and the decoupling elements remain below the fundamental oscillator frequency. In grounded-grid circuits this resonance should be below the grid-cathode resonance. For further information please see Application Book "Tubes for RF heating" or contact the manufacturer.

CAPACITANCES

Anode to filament	C_{af}	1	pF
Grid to filament	C_{gf}	66	pF
Anode to grid	C_{ag}	32	pF

* See Fig. 4.

CHARACTERISTICS measured at V_a = 7 kV, I_a = 2, 4 A

Transconductance	S	40 mA/V
Amplification factor	μ	33

COOLING

To obtain optimum life, the temperature of the seals and of the envelope should, under normal operating conditions, be kept below 200 °C.

To maintain these temperatures additional cooling may be necessary.
At frequencies higher than about 4 MHz cooling of the seals becomes mandatory.

YD1180

Direction of airflow: see outline drawing.

See also cooling curves

With insulating pedestal type 40648

Table 1 Air cooling characteristics

Anode+grid dissipation W_a+W_g (kW)	Altitude h (m)	Inlet temperature T_i (°C)	Rate of flow q_{min} (m³/min)	Pressure drop ΔP (Pa*)	Outlet temperature T_o (°C)
15	0	35	15	850	92
10	0	35	9, 3	320	99
8	0	35	7	200	104
15	0	45	17, 3	1060	98
10	0	45	10, 7	400	104
8	0	45	8, 1	250	108
15	1500	35	18	970	93
10	1500	35	11, 2	460	100
8	1500	35	8, 4	230	104
15	3000	25	19	950	90
10	3000	25	11, 8	450	95
8	3000	25	8, 9	230	99

* 1 Pa ≈ 0, 1 mm H_2O

YD1182

Table 2 Water cooling characteristics

Anode + grid dissipation $W_a + W_g$ (kW)	Inlet temperature t_i (°C)	Rate of flow q_{min} (ℓ/min)	Pressure drop p_i (kPa*)	Outlet temperature t_o (°C)
20	20	10	40	51
	50	15	80	71
15	20	7,5	22	54
	50	10,5	43	73
10	20	4,5	10	58
	50	6,7	20	75

Absolute max. water inlet temperature T_i max. 50 °C

Absolute max. water pressure P max. 600 kPa(abs)

ACCESSORIES

Filament connector with cable	type 40708A net mass	600	g
Filament /cathode connector with cable	type 40709A net mass	640	g
Grid connector f ≤ 4 MHz	type 40710 net mass	60	g
f > 4 MHz	type 40711 net mass	310	g
Insulating pedestal (YD1180 only)	type 40648 net mass	7,15	kg

* 100 kPa ≈ 1 at.

MECHANICAL DATA

Dimensions in mm

YD1180

Mounting position : vertical with anode up or down

Net mass : approx. 12 kg

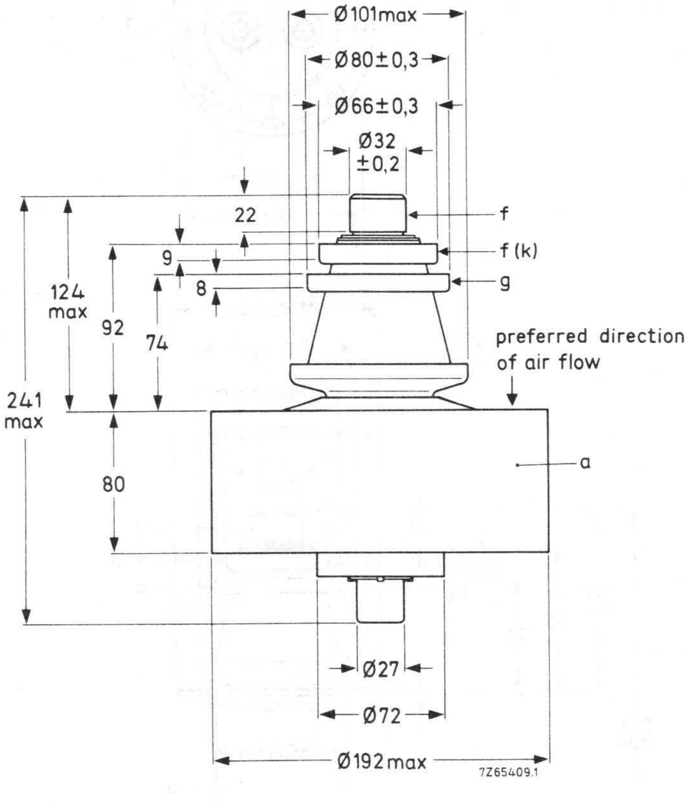


Fig. 1 Mechanical outline.

YD1182

Mounting position : vertical with anode up or down

Net mass : approx. 3,5 kg

Dimensions in mm

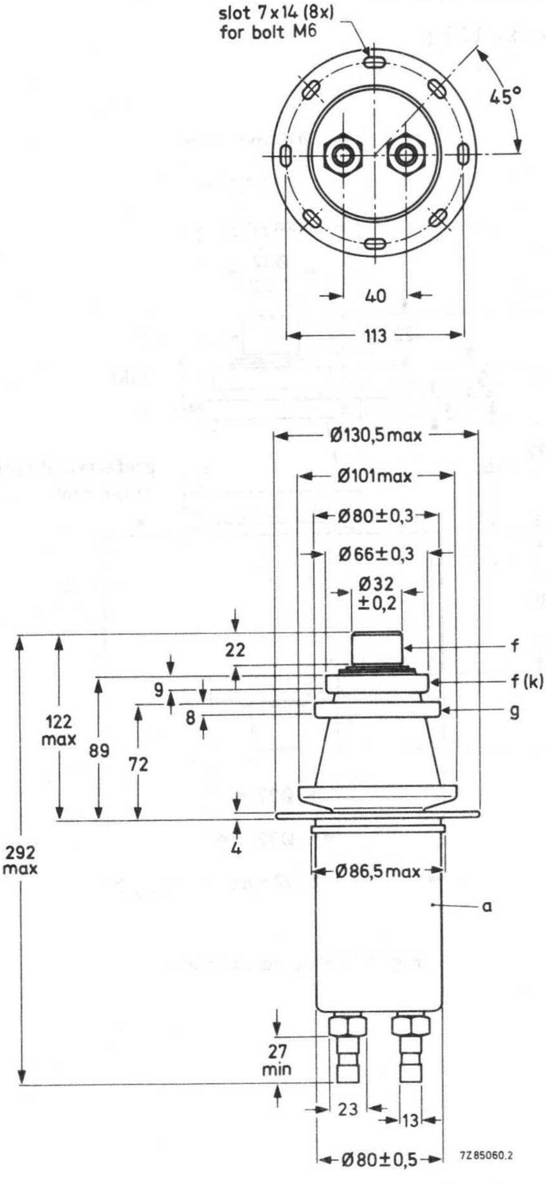


Fig. 2 Mechanical outline – YD1182.

Thread of water connections BSP 1/2 in

With anode up the inlet and outlet connections should be interchanged.

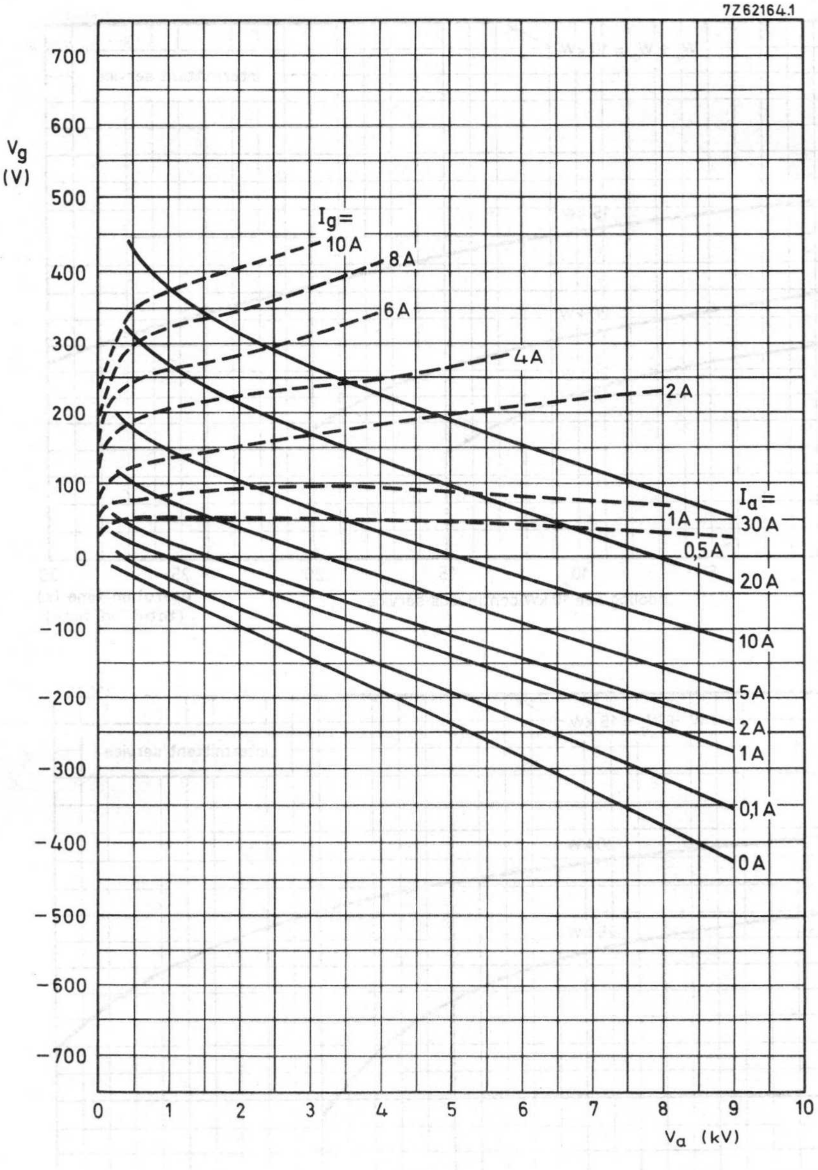
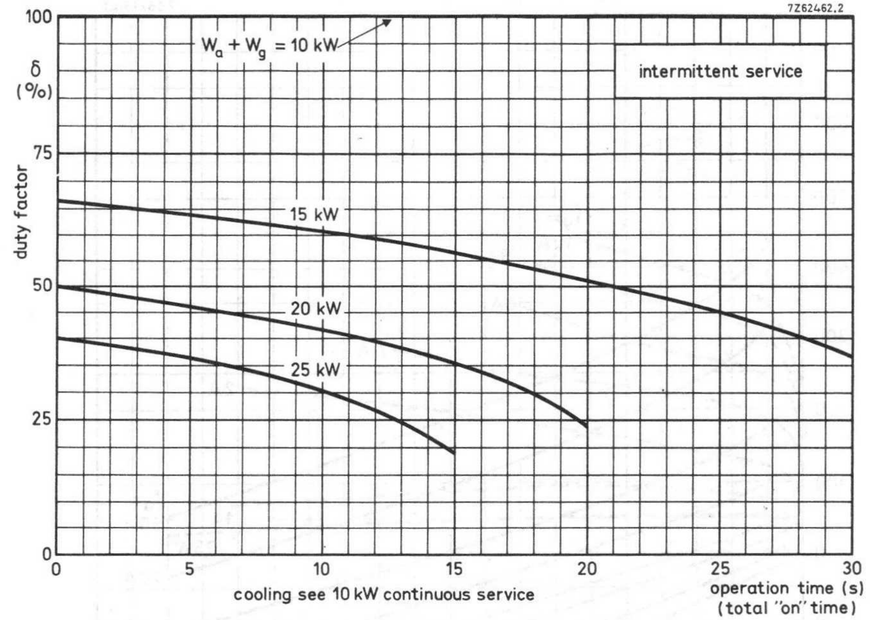
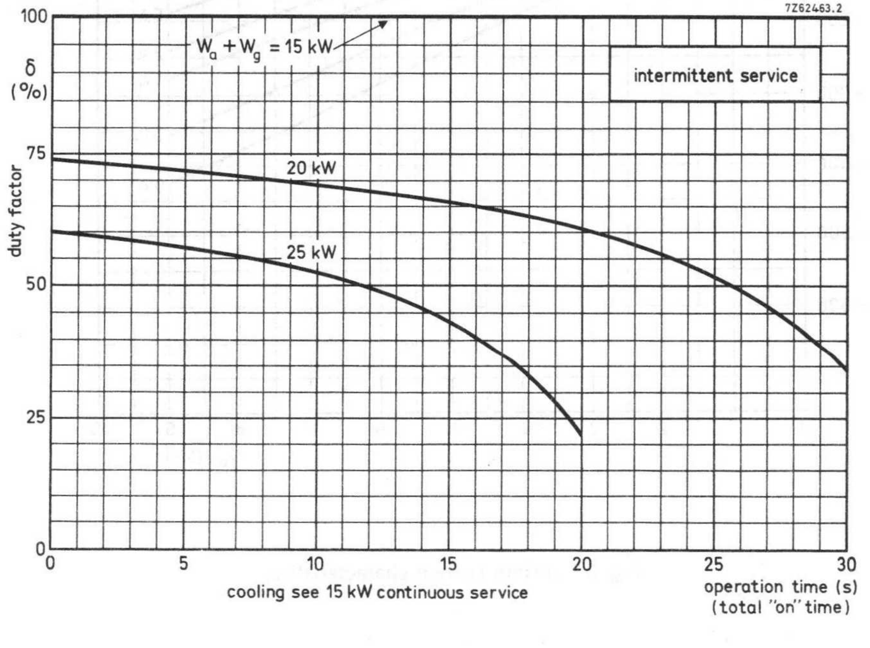


Fig. 3 Constant current characteristics.

Fig. 4 (YD1180 only). Intermittent service. Limits of anode dissipation and cooling.

YD1180





RF POWER TRIODE

Triodes in metal-ceramic construction intended for use as industrial oscillators.
The YD1185 is forced-air cooled
The YD1187 is water cooled by an integral cooler.

QUICK REFERENCE DATA				
Oscillator output power (W_o-W_{feedb}), typical	W_{osc}		50	kW
Fequency for full ratings	f	max.	100	MHz

To be read in conjunction with "General Operational Recommendations".

RF CLASS C OSCILLATOR FOR INDUSTRIAL USE

OPERATING CONDITIONS

Frequency	f	90	90	90	MHz
Oscillator output power (W_o-W_{feedb})	W_{osc}	33, 4	40	50	kW
Anode voltage	V_a	8, 5	10	12	kV
Anode current	Ia	5, 4	5, 33	5, 33	A
Anode input power	W_{ia}	45, 9	53, 3	64	kW
Anode dissipation	W_a	11, 4	12, 1	12, 8	kW
Anode output power	W_o	34, 5	41, 2	51, 2	kW
Anode efficiency	η_a	75, 1	77, 3	80, 0	%
Oscillator efficiency	η_{osc}	72, 7	75, 0	78, 1	%
Feedback ratio	V_{gp}/V_{ap}	11	10, 2	9	%
Grid resistor	R_g	330	400	430	Ω
Grid current, on load	I_g	1, 5	1, 45	1, 4	A
Grid voltage, negative	$-V_g$	495	580	600	V
Grid dissipation	W_g	400	380	360	W
Grid resistor dissipation	W_{R_g}	740	840	840	W

LIMITING VALUES (Absolute max. rating system)

Frequency for full ratings	f	up to	100	MHz
Anode voltage	V_a	max.	14,4	kV
Anode current	I_a	max.	6	A
Anode input power	W_{ia}	max.	72	kW
Anode dissipation, continuous service (YD1185)*	W_a	max.	15	kW
(YD1187)	W_a	max.	20	kW
Grid voltage	$-V_g$	max.	1,5	kV
Grid current, on load	I_g	max.	1,6	A
off load	I_g	max.	2,4	A
Grid dissipation	W_g	max.	500	W
Grid circuit resistance	R_g	max.	10	kΩ
Cathode current, mean	I_k	max.	7,5	A
peak	I_{kp}	max.	40	A
Envelope temperature	T_{env}	max.	240	°C

HEATING : direct; thoriated tungsten filament, mesh construction

Filament voltage	V_f		7	V
Filament current	I_f		175	A
Peak filament staring current	I_{fp}	max.	1000	A
Cold filament resistance	R_{f_o}		4,2	mΩ

The filament is designed to accept temporary fluctuations of +5% and -10%.

To ensure that the cathode temperature remains constant irrespective of the operating frequency, it may be necessary to reduce the filament voltage at higher frequencies. When doing so it must be borne in mind that the filament voltage-to-current ratio measured with only the filament voltage applied should remain constant under all operating conditions

It is extremely important that the filament be properly decoupled. This should be done so that the resonance of the circuit formed by the filament and decoupling elements remain below the fundamental oscillator frequency. In grounded-grid circuits this resonance should be below the grid-cathode resonance. For further information please see Application Book "Tubes for RF heating" or consult the manufacturer.

CAPACITANCES

Anode to filament	C_{af}	0,8	pF
Grid to filament	C_{gf}	66	pF
Anode to grid	C_{ag}	22	pF

* See Fig. 4.

CHARACTERISTICS measured at V_a = 11 kV, I_a = 1,5 A

Transconductance	S	40	mA/V
Amplification factor	μ	50	

COOLING

To obtain optimum life, the temperature of the seals and of the envelope should, under normal operating conditions, be kept below 200 °C.

To maintain these temperatures additional cooling may be necessary.
At frequencies higher than about 4 MHz cooling of the seals becomes mandatory.

YD1185

Table 1 Air cooling characteristics

With insulating pedestal type 40648

Anode + grid dissipation $W_a + W_g$ (kW)	Altitude h (m)	Inlet temperature T_i (°C)	Rate of flow q_{min} (m^3/min)	Pressure drop ΔP (Pa *)	Outlet temperature T_o (°C)
15	0	35	15	850	92
10	0	35	9,3	350	99
8	0	35	7	220	104
15	0	45	17,3	1060	98
10	0	45	10,7	440	104
8	0	45	8,1	270	108
15	1500	35	18	970	93
10	1500	35	11,2	400	100
8	1500	35	8,4	250	104
15	3000	25	19	950	90
10	3000	25	11,8	390	95
8	3000	25	8,9	250	99

* 1 Pa ≈ 0,1 mm H_2O

YD1187

Table 2 Water cooling characteristics

Anode + grid dissipation $W_a + W_g$ (kW)	Inlet temperature T_i (°C)	Rate of flow q_{min} (ℓ/min)	Pressure drop ΔP (kPa*)	Outlet temperature T_o (°C)
20	20	10	40	51
	50	15	80	71
15	20	7	22	54
	50	10, 5	43	73
10	20	4, 5	10	58
	50	6, 7	20	75

Absolute max. water inlet temperature	T_i	50	°C
Absolute max. water pressure	P	600	kPa* (abs)

ACCESSORIES

Filament connector with cable	type	40708A	net mass	600	g
Filament/cathode connector with cable	type	40709A	net mass	640	g
Grid connector ⩽ 4 MHz	type	40710	net mass	60	g
Grid connector > 4 MHz	type	40711	net mass	310	g
Insulating pedestal (YD1185 only)	type	40648	net mass	7, 15	kg

* 100 kPa ≈ 1 at.

MECHANICAL DATA

YD1185

Mounting position: vertical with anode up or down
Net mass: approx. 12 kg

Dimensions in mm

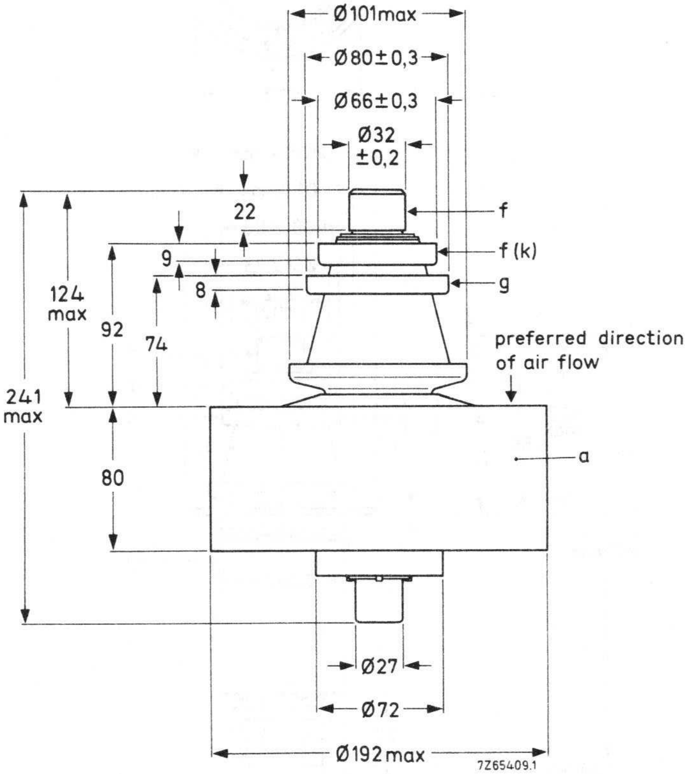


Fig. 1 Mechanical outline – YD1185.

YD1187

Mounting position : vertical, with anode up or down

Net mass : approx. 3, 4 kg

Dimensions in mm

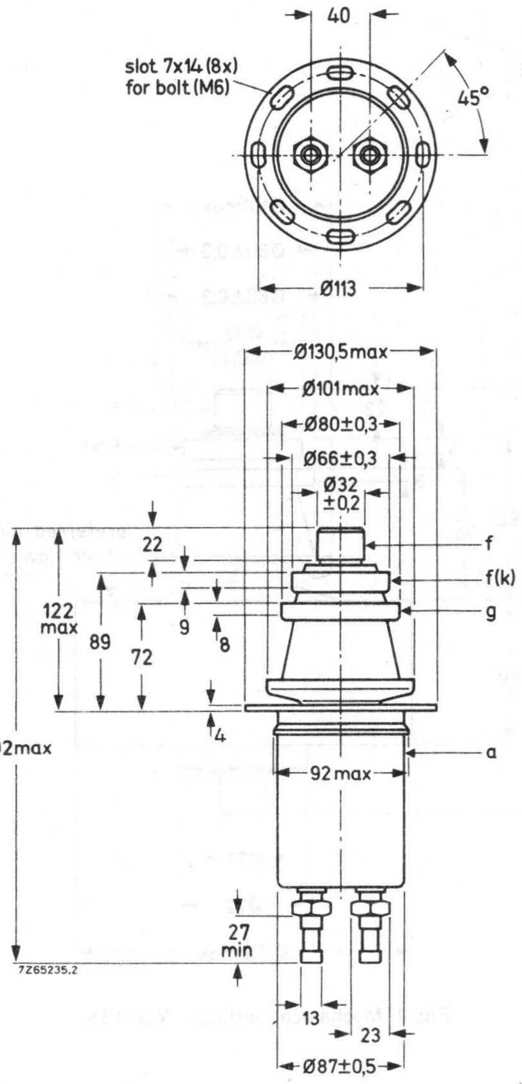


Fig. 2 Mechanical outline – YD1187.

Thread of water connections BSP 1/2 in

With the anode up the inlet and outlet connections should be interchanged.

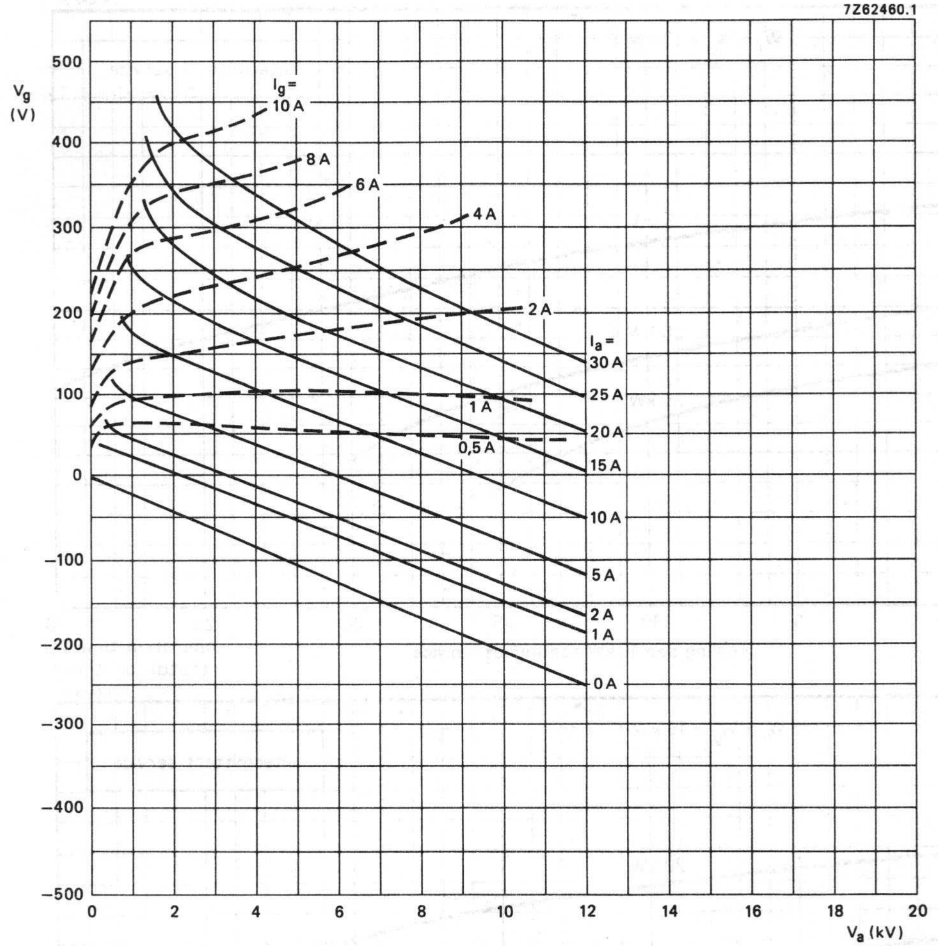
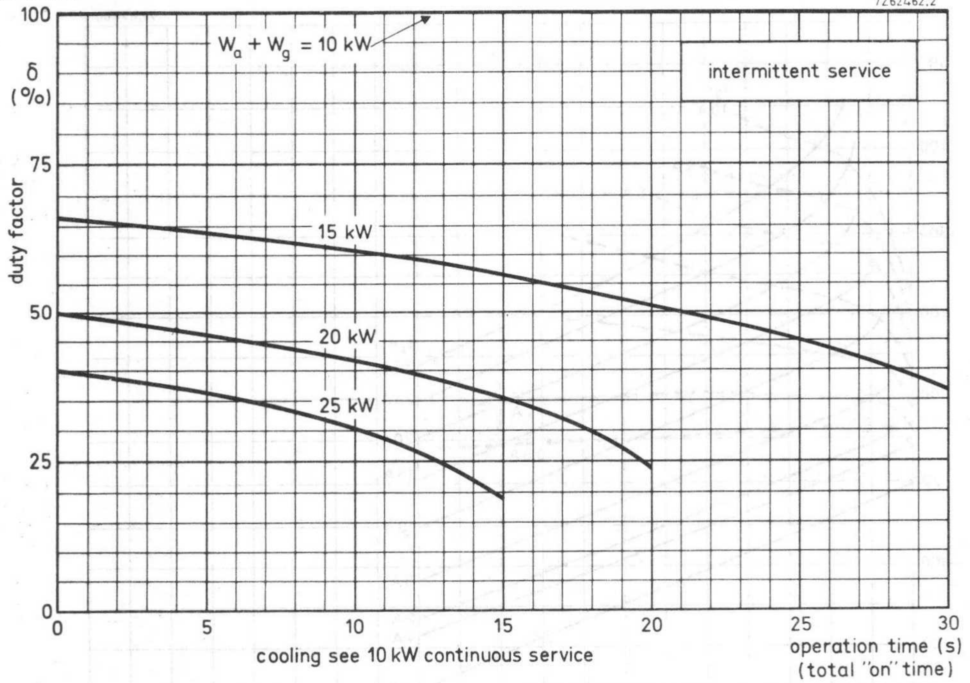


Fig. 3 Constant current characteristics.

YD1185



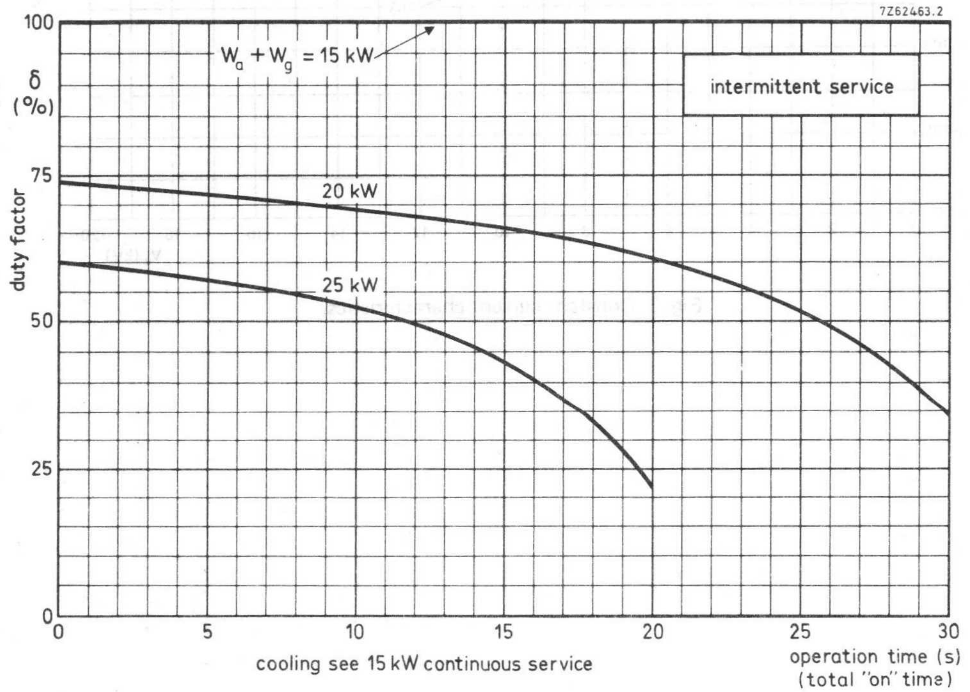


Fig. 4 (YD1185 only). Intermittent service. Limits of anode dissipation and cooling.

RF POWER TRIODE

Forced-air-cooled triode in metal-ceramic construction intended for use as industrial oscillator.

QUICK REFERENCE DATA

Oscillator output power (W_o–W_{feedb}), typical	W_{osc}		50 kW
Frequency for full ratings	f	max.	100 MHz

To be read in conjunction with "General Operational Recommendations".

RF CLASS C OSCILLATOR FOR INDUSTRIAL USE

OPERATING CONDITIONS

Frequency	f	90	90	90 MHz
Oscillator output power (W_o-W_{feedb})	W_{osc}	33	40	50 kW
Anode voltage	V_a	8,5	10	12 kV
Anode current	I_a	5,4	5,4	5,4 A
Anode input power	W_{ia}	45,9	54,0	64,8 kW
Anode dissipation	W_a	11,6	12,5	13,2 kW
Anode output power	W_o	34,4	41,5	51,6 kW
Anode efficiency	η_a	75	77	80 %
Oscillator efficiency	η_{osc}	72	74	77 %
Feedback ratio	V_{gp}/V_{ap}	17	16	14 %
Grid resistor	R_g	700	900	1100 Ω
Grid current, on load	I_g	1,2	1,1	1,0 A
Grid voltage, negative	$-V_g$	840	1000	1100 V
Grid dissipation	W_g	360	340	320 W
Grid resistor dissipation	W_{Rg}	1000	1100	1200 W

LIMITING VALUES (Absolute maximum rating system)

Frequency for full ratings	f	up to	100 MHz
Anode voltage	V_a	max.	14,5 kV
Anode current	I_a	max.	7 A
Anode input power	W_{ia}	max.	72 kW
Anode dissipation, continuous service *	W_a	max.	15 kW
Grid voltage	$-V_g$	max.	2 kV
Grid current			
on load	I_g	max.	1,2 A
off load	I_g	max.	1,6 A
Grid dissipation	W_g	max.	400 W
Grid circuit resistance	R_g	max.	15 kΩ
Cathode current			
mean	I_k	max.	8 A
peak	I_{kp}	max.	40 A
Envelope temperature	T_{env}	max.	240 °C

HEATING: direct; thoriated tungsten filament, mesh construction

Filament voltage	V_f		7 V
Filament current	I_f		175 A
Peak filament staring current	I_{fp}	max.	1000 A
Cold filament resistance	R_{fo}		4,2 mΩ

The filament is designed to accept temporary fluctuations of +5% and −10%.

To ensure that the cathode temperature remains constant irrespective of the operating frequency, it may be necessary to reduce the filament voltage at higher frequencies. When doing so it must be borne in mind that the filament voltage-to-current ratio measured with only the filament voltage applied should remain constant under all operating conditions.

It is extremely important that the filament be properly decoupled. This should be done so that the resonance of the circuit formed by the filament and the decoupling elements remain below the fundamental oscillator frequency. In grounded-grid circuits this resonance should be below the grid-cathode resonance. For further information please see Application Book "Tubes for RF Heating" or consult the manufacturer.

CAPACITANCES

Anode to filament	C_{af}	0,8 pF
Grid to filament	C_{gf}	60 pF
Anode to grid	C_{ag}	21 pF

* See Fig. 3.

CHARACTERISTICS measured at V_a = 11 kV, I_a = 1,5 A

Transconductance	S	22 mA/V
Amplification factor	μ	24

COOLING

To obtain optimum life, the temperature of the seals and of the envelope should, under normal operating conditions, be kept below 200 °C.

To maintain these temperatures additional cooling may be necessary. At frequencies higher than about 4 MHz cooling of the seals becomes mandatory.

Table 1 Air cooling characteristics

If used with insulating pedestal type 40648:

Anode + grid dissipation $W_a + W_g$ kW	Altitude h m	Inlet temperature T_i °C	Rate of flow q_{min} m^3/min	Pressure drop ΔP Pa *	Outlet temperature T_o °C
15	0	35	15	850	92
10	0	35	9,3	350	99
8	0	35	7	220	104
15	0	45	17,3	1060	98
10	0	45	10,7	440	104
8	0	45	8,1	270	108
15	1500	35	18	970	93
10	1500	35	11,2	400	100
8	1500	35	8,4	250	104
15	3000	25	19	950	90
10	3000	25	11,8	390	95
8	3000	25	8,9	250	99

* 1 Pa ≈ 0,1 mm H_2O.

MECHANICAL DATA Dimensions in mm

Mounting position: vertical with anode up or down

Net mass: approx. 12 kg

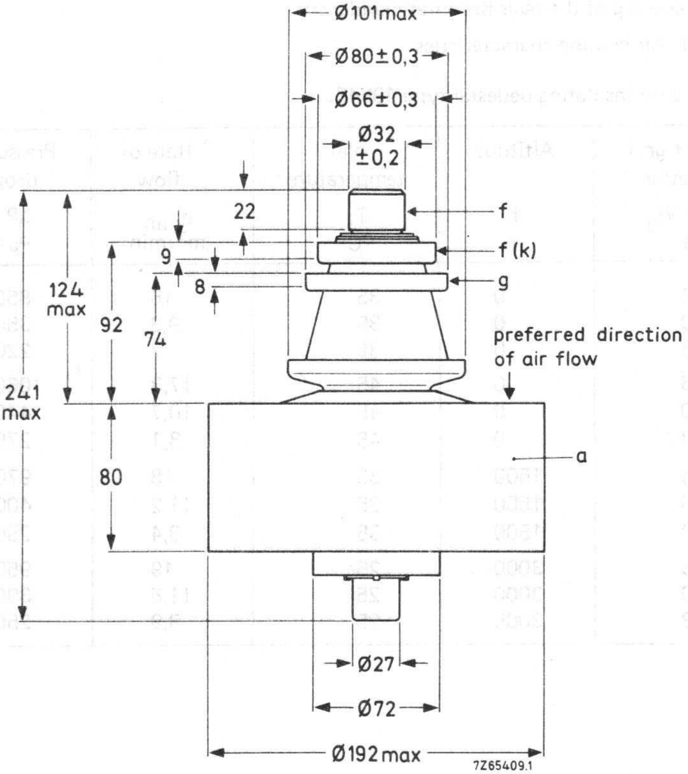


Fig. 1 Mechanical outline.

ACCESSORIES

Filament connector with cable	type	40708A
Filament/cathode connector with cable	type	40709A
Grid connector ⩽ 4 MHz	type	40710
Grid connector > 4 MHz	type	40711
Insulating pedestal	type	40648

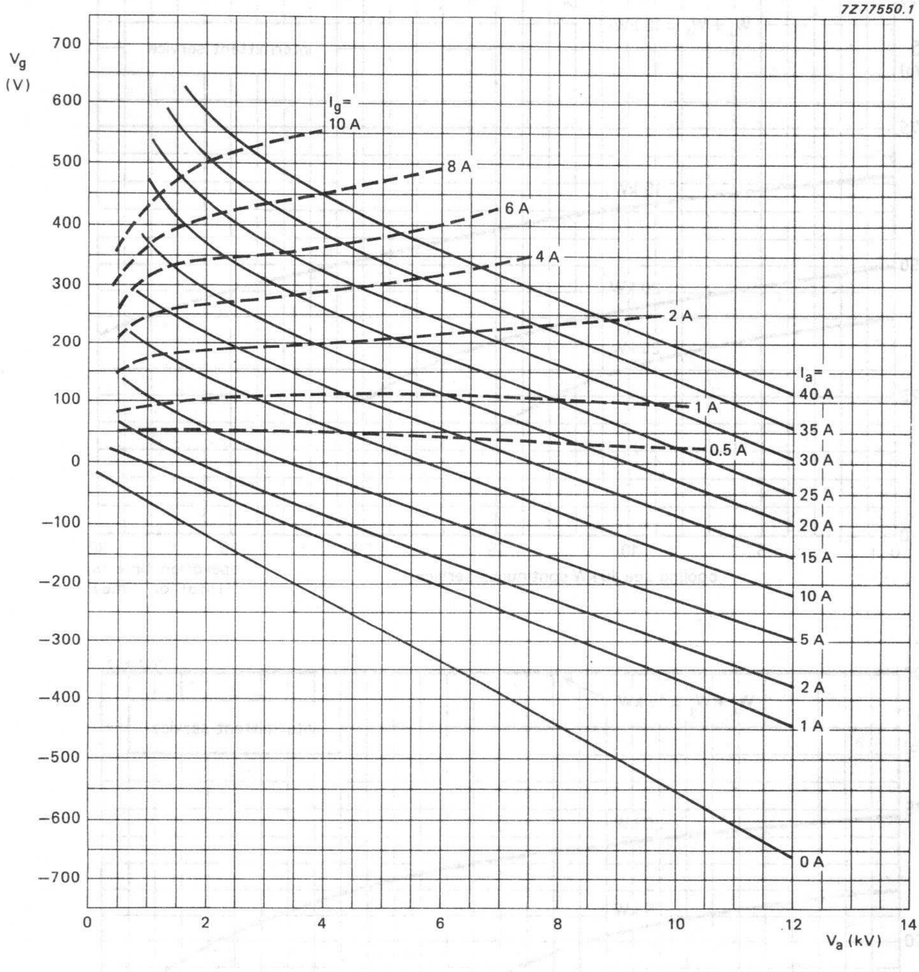
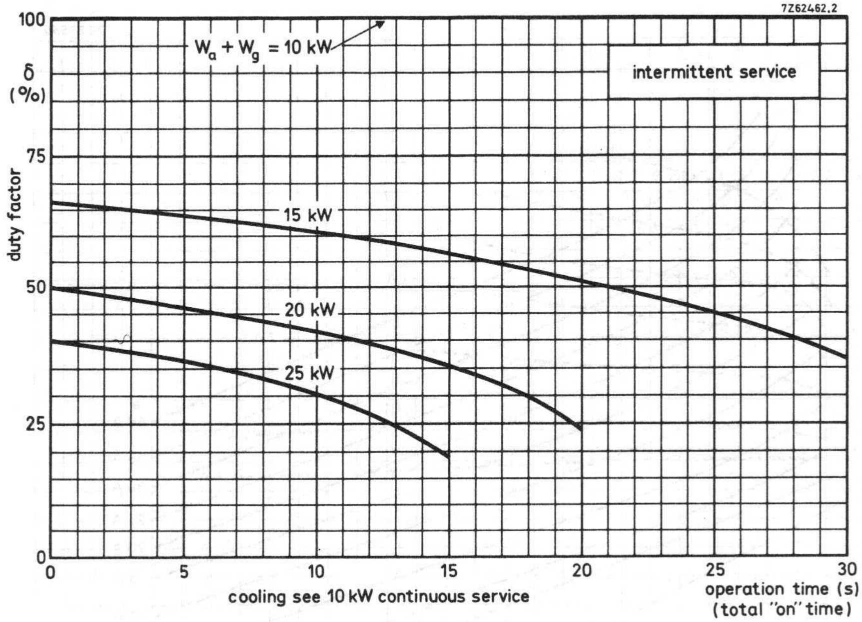


Fig. 2 Constant current characteristics.



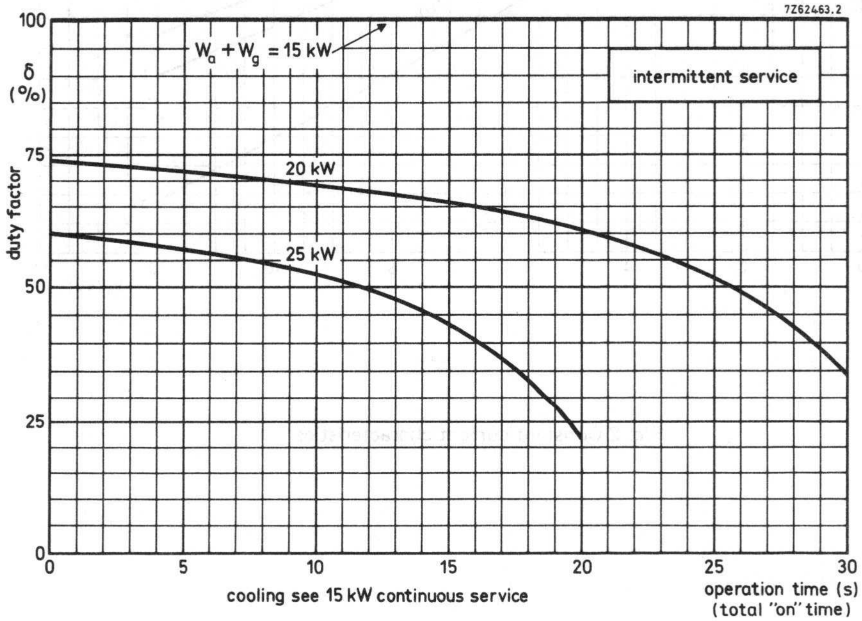


Fig. 3 Intermittent service. Limits of anode dissipation and cooling.

RF POWER TRIODE

Triodes in metal-ceramic construction intended for use as industrial oscillators.
The YD1190 is forced-air cooled.
The YD1192 has an integral water cooler.

QUICK REFERENCE DATA

Oscillator output power ($W_o - W_{feedb}$), typical	YD1190	W_{osc}		96 kW
	YD1192	W_{osc}		110 kW
Frequency for full ratings		f	max.	30 MHz

RF CLASS C OSCILLATOR FOR INDUSTRIAL USE

OPERATING CONDITIONS

		YD1190/YD1192			YD1192	
Frequency	f	30	30	30	30	MHz
Oscillator output power ($W_o - W_{feedb}$)	W_{osc}	62,7	84	96	110	kW
Anode voltage	V_a	8	10	12	12	kV
Anode current	I_a	10	11	10	12	A
Anode input power	W_{ia}	80	110	120	144	kW
Anode dissipation	W_a	15	23,4	22	31	kW
Anode output power	W_o	65	86,6	98	113	kW
Anode efficiency	η_a	81,2	78,7	81,7	78,5	%
Oscillator efficiency	η_{osc}	78,4	76,4	80	76,4	%
Feedback ratio	V_{gp}/V_{ap}	14,6	13,5	11	11,8	%
Grid resistor	R_g	300	333	400	364	Ω
Grid current, on load	I_g	2,25	2,25	2	2,2	A
Grid voltage, negative	$-V_g$	675	750	800	800	V
Grid dissipation	W_g	750	810	676	814	W
Grid resistor dissipation	W_{Rg}	1,52	1,7	1,6	1,76	kW

LIMITING VALUES (Absolute maximum rating system)

Frequency		f	up to	100	MHz*
Anode voltage		V_a	max.	13	kV
Anode current		I_a	max.	14	A
Anode input power	YD1190	W_{ia}	max.	144	kW
	YD1192	W_{ia}	max.	150	kW
Anode dissipation, continuous service	YD1190	W_a	max.	30	kW
Anode dissipation	YD1192	W_a	max.	50	kW
Grid voltage		$-V_g$	max.	1,5	kV
Grid current, on load		I_g	max.	2,8	A
Grid current, off load		I_g	max.	3,8	A
Grid dissipation		W_g	max.	1	kW
Grid circuit resistance		R_g	max.	10	kΩ
Cathode current, mean		I_k	max.	17,5	A
Cathode current, peak		I_{kp}	max.	70	A
Envelope temperature**		T_{env}	max.	240	°C

HEATING: direct; thoriated tungsten filament, mesh construction

Filament voltage	V_f		8,4	V
Filament current	I_f		235	A
Peak filament starting current	I_{fp}	max.	1500	A
Gold filament resistance	R_{fo}		3,9	mΩ

The filament is designed to accept temporary fluctuations of + 5% and −10%.

* When the tubes are to be used at frequencies above 30 MHz the manufacturer should be consulted for more detailed information.

** To obtain optimum life, the temperature of the seals and the envelope should, under normal operating conditions, be kept below 200 °C.

To ensure that the cathode temperature remains constant irrespective of the operating frequency it may be necessary to reduce the filament voltage at higher frequencies. When doing so it must be borne in mind that the filament voltage-to-current ratio measured with only the filament voltage applied should remain constant under all operating conditions.
It is extremely important that the filament be properly decoupled. This should be done so that the resonance of the circuit formed by the filament and the decoupling elements remain below the fundamental oscillator frequency. In grounded-grid circuits this resonance should be below the grid-cathode resonance. For further information please see Application Book "Tubes for RF heating" or contact the manufacturer.

CAPACITANCES

Anode to filament	C_{af}	1,3 pF
Grid to filament	C_{gf}	100 pF
Anode to grid	C_{ag}	45 pF

CHARACTERISTICS measured at $V_a = 8$ kV, $I_a = 6$ A

Transconductance	S	90 mA/V
Amplification factor	μ	30

COOLING

Table 1 Air cooling characteristics

YD1190

anode + grid dissipation $W_a + W_g$ kW	altitude h m	inlet temperature T_i °C	rate of flow q_{min} m^3/min	pressure drop ΔP Pa*	outlet temperature T_o °C
30	0	35	34	1200	84
25	0	35	27,2	780	87
20	0	35	21,4	480	89
30	0	45	38	1500	91
25	0	45	30,4	980	93
20	0	45	23,9	600	95
30	1500	35	41	1380	84
25	1500	35	32,7	900	87
20	1500	35	25,7	550	89
30	3000	25	43	1350	79
25	3000	25	34,4	880	83
20	3000	25	27	540	85

The above cooling conditions apply to the air flow direction as indicated in the ouline drawing. In case of reversed flow direction a larger air volume will be required to keep the anode temperature below the limiting value.

* 1 Pa ≈ 0,1 mm H_2O.

Table 2 Water cooling characteristics

YD1192

anode + grid dissipation $W_a + W_g$ kW	inlet temperature T_i °C	rate of flow q_{min} ℓ/min	pressure drop ΔP kPa*	outlet temperature T_o °C
50	20	26	60	49
	50	39	123	69
40	20	20	40	51
	50	30	80	71
30	20	14	21	53
	50	21	43	72
20	20	9	10	56
	50	13,5	20	74

Absolute maximum water inlet temperature	T_i	max.	50 °C
Absolute maximum water pressure	P	max.	600 kPa

To obtain optimum life, the temperature of the seals and the envelope should, under continuously loaded conditions, be kept below 200 °C.

At low frequencies the seals are sufficiently cooled when the filament connectors are water cooled with a flow of about 0,5 ℓ/min. At higher frequencies, however, an additional air flow of about 1 m³/min must be led along the seals from a 30 mm diameter nozzle positioned at a distance of 200 mm from the tube header.

ACCESSORIES

Filament connector with cable	type 40705A
Filament/cathode connector with cable	type 40706A
Grid connector, f > 4 MHz	type 40736
f ⩽ 4 MHz	type 40707
Insulating pedestal (YD1190 only)	type 40729

* 100 kPa ≈ 1 at.

YD1190

MECHANICAL DATA

Dimensions in mm

Mounting position: vertical with anode up or down

Net mass: approx. 20 kg

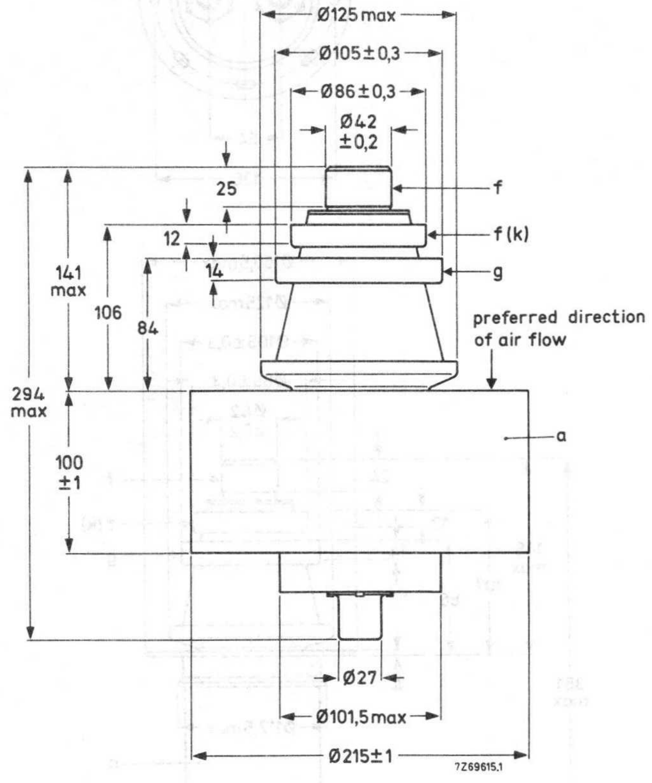


Fig. 1 Mechanical outline – YD1190.

YD1192

MECHANICAL DATA

Dimensions in mm

Mounting position: vertical with anode up or down

Net mass: ≈ 5,8 kg

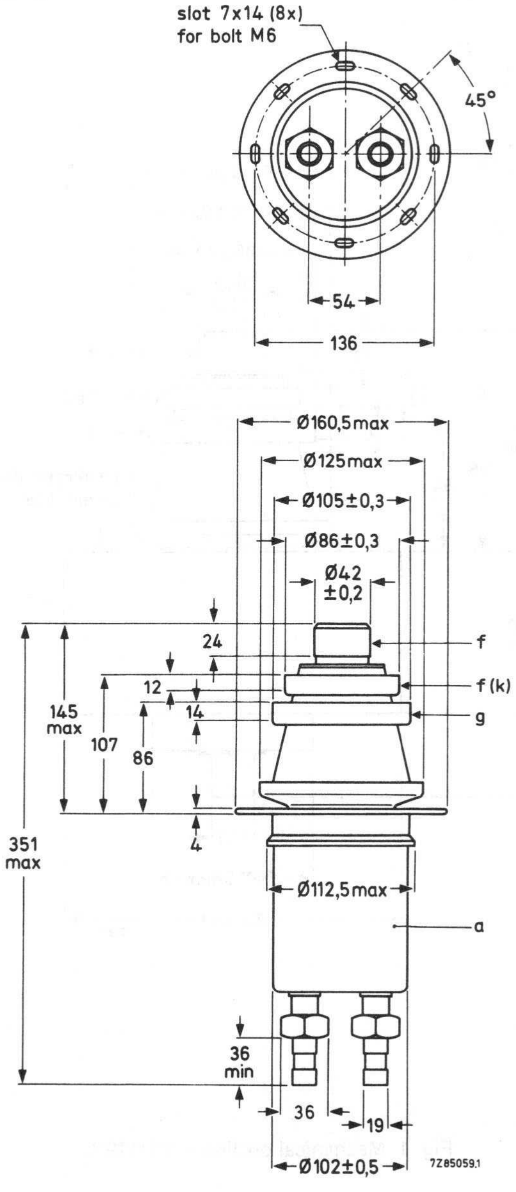


Fig. 2 Mechanical outline – YD1192.

Thread of water connections BSP 1 in

With anode up the inlet and outlet connections should be interchanged.

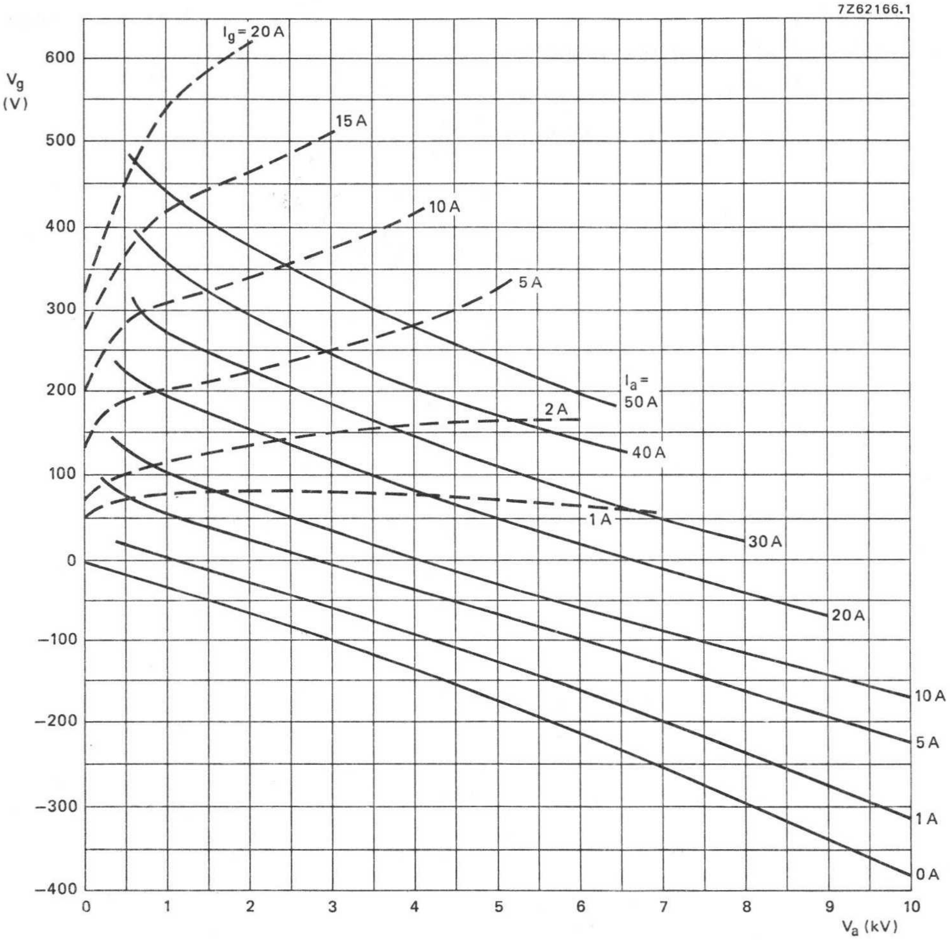


Fig. 3 Constant current characteristics.

RF POWER TRIODE

Triodes in metal-ceramic construction intended for use as industrial oscillators.
The YD1195 is forced-air cooled.
The YD1197 has an integral water cooler.

QUICK REFERENCE DATA					
Oscillator output power (W_o-W_{feedb}), typical	YD1195	W_{osc}		90	kW
	YD1197	W_{osc}		107,6	kW
Frequency for full ratings		f	max.	30	MHz

RF CLASS C OSCILLATOR FOR INDUSTRIAL USE

OPERATING CONDITIONS

		YD1195/YD1197			YD1197	
Frequency	f	30	30	30	30	MHz
Oscillator output power (W_o-W_{feedb})	W_{osc}	60,6	74	90	107,6	kW
Anode voltage	V_a	8,5	10	12	12	kV
Anode current	I_a	10	10	9,75	12	A
Anode input power	W_{ia}	85	100	117	144	kW
Anode dissipation	W_a	22,4	24	24,9	34	kW
Anode output power	W_o	62,6	76	92,1	110	kW
Anode efficiency	η_a	73,6	76	78,8	76,4	%
Oscillator efficiency	η_{osc}	71,2	74	77	74,7	%
Feedback ratio	V_{gp}/V_{ap}	12,5	10,9	9,4	11	%
Grid resistor	R_g	210	240	260	230	Ω
Grid current, on load	I_g	2,4	2,3	2,3	2,6	A
Grid voltage, negative	$-V_g$	500	550	600	600	V
Grid dissipation	W_g	760	730	720	840	W
Grid resistor dissipation	W_{Rg}	1,2	1,27	1,38	1,56	kW

LIMITING VALUES (Absolute max. ratings system)

Frequency		f	up to	100	MHz[1])
Anode voltage		V_a	max.	14,4	kV
Anode current		I_a	max.	15	A
Anode input power	YD1195	W_{ia}	max.	144	kW
	YD1197	W_{ia}	max.	150	kW
Anode dissipation, continuous service	YD1195	W_a	max.	30	kW
intermittent service	YD1195 *				
Anode dissipation	YD1197	W_a	max.	50	kW
Grid voltage		$-V_g$	max.	1,5	kV
Grid current, on load		I_g	max.	2,8	A
off load		I_g	max.	3,8	A
Grid dissipation		W_g	max.	1	kW
Grid circuit resistance		R_g	max.	10	kΩ
Cathode current, mean		I_k	max.	17,5	A
peak		I_{kp}	max.	70	A
Envelope temperature		T_{env}	max.	240	°C

HEATING : direct; thoriated tungsten filament, mesh construction

Filament voltage	V_f		8,4	V
Filament current	I_f		235	A
Peak filament starting current	I_{fp}	max.	1500	A
Cold filament resistance	R_{fo}		3,9	mΩ

The filament is designed to accept temporary fluctuations of +5% and −10%.

* See Fig. 4.

1) When the tubes are to be used at frequencies above 30 MHz the manufacturer should be consulted for more detailed information.

To ensure that the cathode temperature remains constant irrespective of the operating frequency it may be necessary to reduce the filament voltage at higher frequencies. When doing so it must be borne in mind that the filament voltage-to-current ratio measured with only the filament voltage applied should remain constant under all operating conditions.

It is extremely important that the filament be properly decoupled. This should be done so that the resonance of the circuit formed by the filament and the decoupling elements remain below the fundamental oscillator frequency. In grounded-grid circuits this resonance should be below the grid-cathode resonance. For further information please see Application Book "Tubes for RF heating" or contact the manufacturer.

CAPACITANCES

Anode to filament	C_{af}	1,2	pF
Grid to filament	C_{gf}	100	pF
Anode to grid	C_{ag}	33	pF

CHARACTERISTICS measured at V_a = 12 kV, I_a = 3 A

Transconductance	S	80	mA/V
Amplification factor	μ	50	

COOLING

Table 1 Air cooling characteristics

YD1195

Anode + grid dissipation $W_a + W_g$ kW	Altitude h m	Inlet temperature T_i °C	Rate of flow q_{min} m^3/min	Pressure drop ΔP Pa*	Outlet temperature T_o °C
30	0	35	34	1200	84
25	0	35	27,2	780	87
20	0	35	21,4	480	89
30	0	45	38	1500	91
25	0	45	30,4	980	93
20	0	45	23,9	600	95
30	1500	35	41	1380	84
25	1500	35	32,7	900	87
20	1500	35	25,7	550	89
30	3000	25	43	1350	79
25	3000	25	34,4	880	83
20	3000	25	27	540	85

* 1 Pa ≈ 0,1 mm H_2O.

The above cooling conditions apply to the air flow direction as indicated in the outline drawing. In case of reversed flow direction a larger air volume will be required to keep the anode temperature below the limiting value.

To obtain optimum life, the temperature of the seals and the envelope should, under normal operating conditions, be kept below 200 °C.

YD1197

Table 2 Water cooling characteristics

Anode + grid dissipation $W_a + W_g$ kW	Inlet temperature t_i °C	Rate of flow qmin ℓ/min	Pressure drop p_i kPa	Outlet temperature t_i °C
50	20	26	60	49
	50	39	123	69
40	20	20	40	51
	50	30	80	71
30	20	14	24	53
	50	21	43	72
20	20	9	10	56
	50	13,5	20	74

Absolute max. water inlet temperature	T_i	max.	50	°C
Absolute max. water pressure	p	max.	600	kPa(abs)

To obtain optimum life, the temperature of the seals and the envelope should, under continuously loaded conditions, be kept belwo 200 °C.

At low frequencies the seals are sufficiently cooled when the filament connectors are water cooled with a flow of about 0,5 ℓ/min. At higher frequencies, however, an additional air flow of about 1 m^3/min must be led along the seals from a 30 mm diameter nozzle positioned at a distance of 200 mm from the tube header.

ACCESSORIES

Filament connector with cable	type	40705A
Filament/cathode connector with cable	type	40706A
Grid connector, f > 4 MHz	type	40736
f ≤ 4 MHz	type	40707
Insulating pedestal (YD1195 only)	type	40729

*100 kPa ≈ 1 at.

YD1195

MECHANICAL DATA

Dimensions in mm

Mounting position : vertical with anode up or down

Net mass : approx. 20 kg

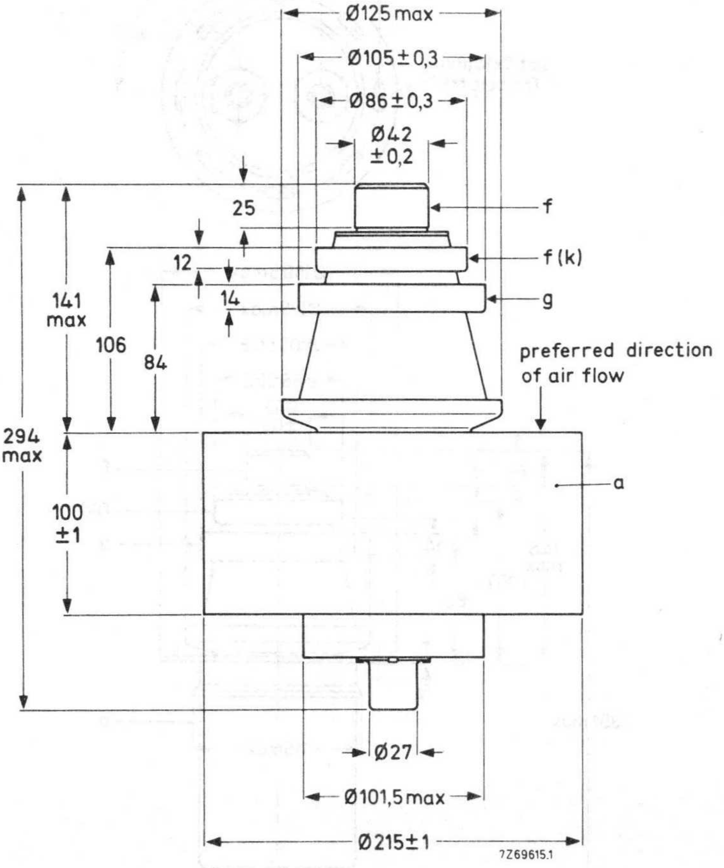


Fig. 1 Mechanical outline – YD1195.

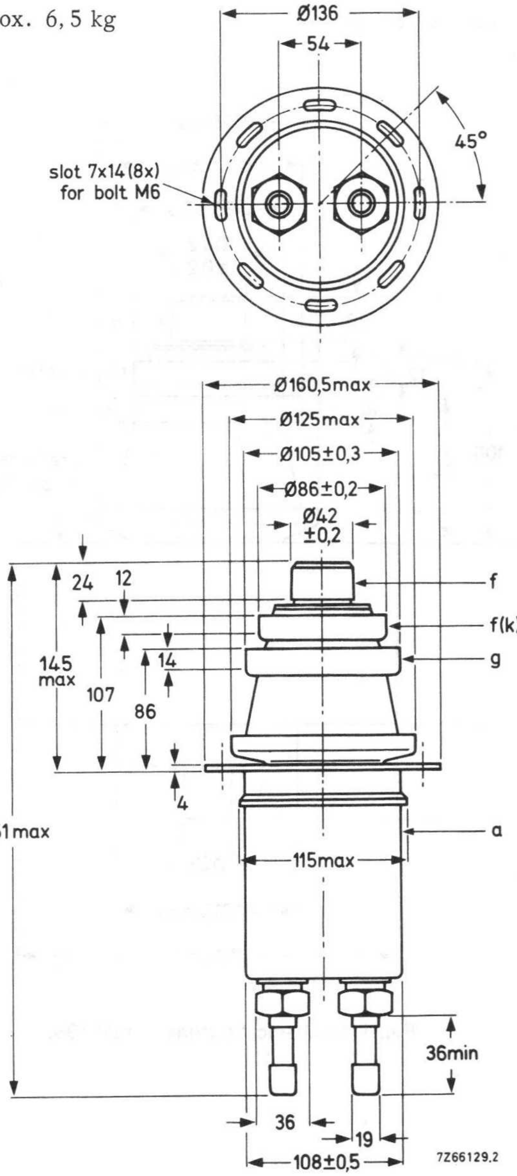
YD1197

MECHANICAL DATA

Dimensions in mm

Mounting position : vertical with anode up or down

Net mass : approx. 6,5 kg



Thread of water connections BSP 1 in.

Fig. 2 Mechanical outline – YD1197.

With the anode up the water connections should be interchanged.

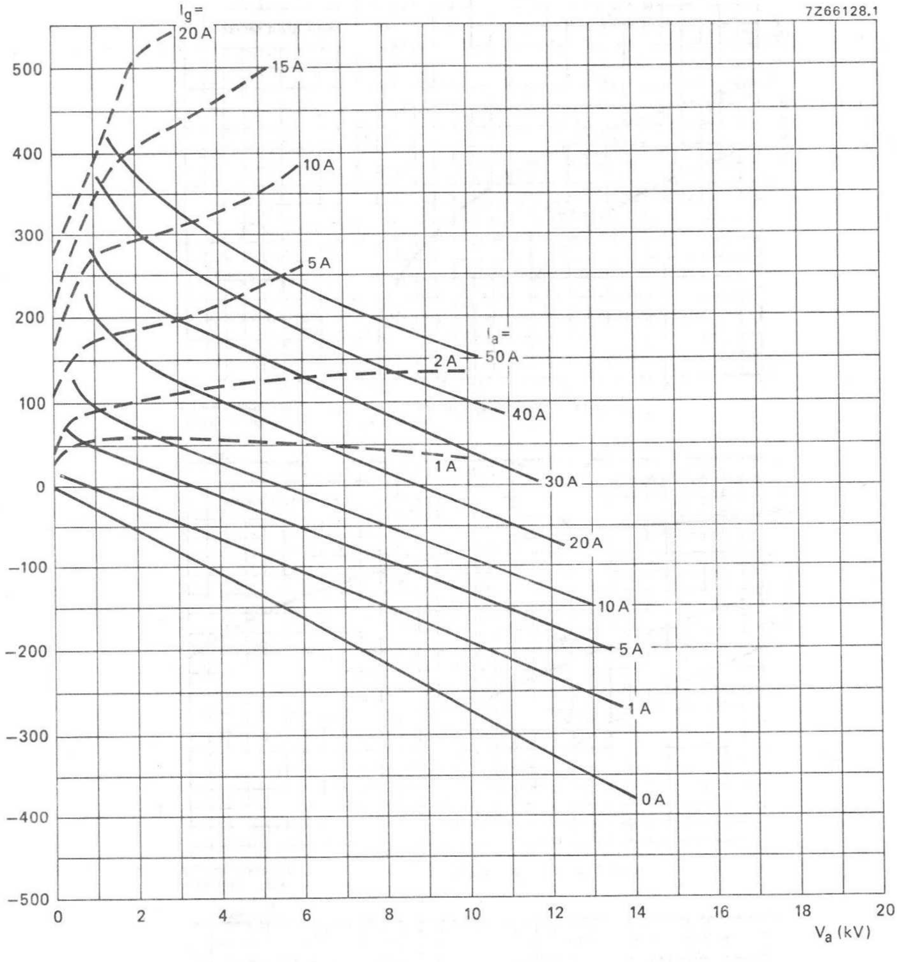
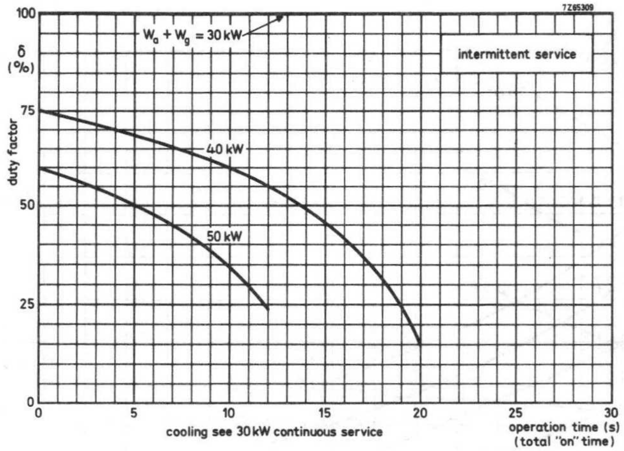
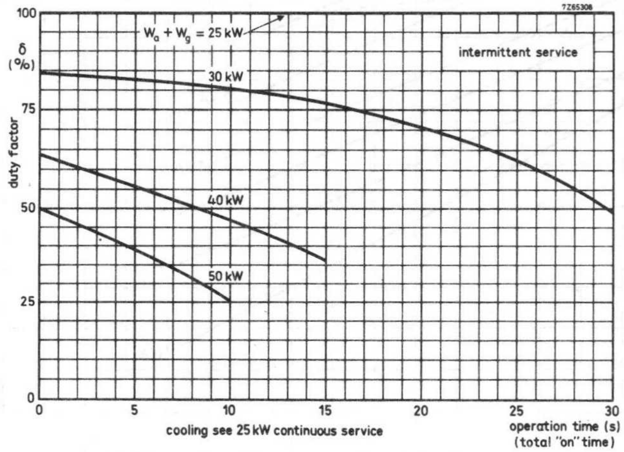


Fig. 3 Constant current characteristics.





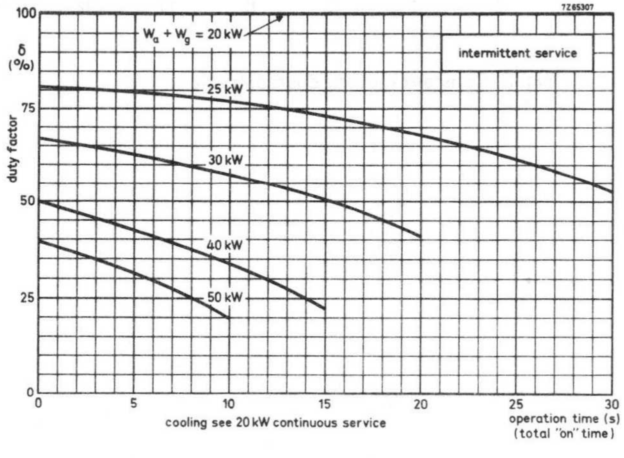


Fig. 4 Intermittent service. Limits of anode dissipation and cooling.

RF POWER TRIODE

Triode in metal-ceramic construction intended for use as industrial oscillator. The YD1202 has an integral water cooler.

QUICK REFERENCE DATA

Oscillator output power ($W_o - W_{feedb}$), typical	W_{osc}		163 kW
Frequency for full ratings	f	max	30 MHz

To be read in conjunction with "General Operational Recommendations Transmitting Tubes for Communication, Tubes for R.F. Heating".

RF CLASS C OSCILLATOR FOR INDUSTRIAL USE

OPERATING CONDITIONS

Frequency	f	30	30	MHz
Oscillator output power ($W_o - W_{feedb}$)	W_{osc}	120	163	kW
Anode voltage	V_a	10	12	kV
Anode current	I_a	16	18	A
Anode input power	W_{ia}	160	216	kW
Anode dissipation	W_a	36	47	kW
Anode output power	W_o	124	169	kW
Anode efficiency	η_a	77,5	78	%
Oscillator efficiency	η_{osc}	75	75,4	%
Feedback ratio	V_{gp}/V_{ap}	11,5	12,5	%
Grid resistor	R_g	200	225	Ω
Grid current, on load	I_g	3,5	4	A
Grid voltage, negative	$-V_g$	700	900	V
Grid dissipation	W_g	1,5	2	kW
Grid resistor dissipation	W_{Rg}	2,45	3,6	kW

LIMITING VALUES (Absolute maximum rating system)

Frequency	f	up to	100	MHz*
Anode voltage	V_a	max	15	kV
Anode current	I_a	max	19	A
Anode input power	W_{ia}	max	220	kW
Anode dissipation	W_a	max	80	kW
Grid voltage	$-V_g$	max	2	kV
Grid current, on load	I_g	max	5	A
Grid current, off load	I_g	max	7	A
Grid dissipation	W_g	max	2,5	kW
Grid circuit resistance	R_g	max	10	kΩ
Cathode current, mean	I_k	max	24	A
Cathode current, peak	I_{kp}	max	110	A
Envelope temperature	T_{env}	max	240	°C

HEATING: direct; thoriated tungsten filament

Filament voltage	V_f		12,2	V
Filament current	I_f		250	A
Peak filament starting current	I_{fp}	max	1500	A
Cold filament resistance	R_{fo}		5,3	mΩ

The filament is designed to accept temporary fluctuations of +5% and −10%.

To ensure that the cathode temperature remains constant irrespective of the operating frequency, it may be necessary to reduce the filament voltage at higher frequencies. When doing so it must be borne in mind that the filament voltage-to-current ratio measured with only the filament voltage applied should remain constant under all operating conditions.

It is extremely important that the filament be properly decoupled. This should be done so that the resonance of the circuit formed by the filament and the decoupling elements remain below the fundamental oscillator frequency. In grounded-grid circuits this resonance should be below the grid-cathode resonance. For further information please see Application Book "Tubes for RF heating" or contact the manufacturer.

* When the tubes are to be used at frequencies above 30 MHz the manufacturer should be consulted for more detailed information.

CAPACITANCES

Anode to filament	C_{af}	2,4 pF
Grid to filament	C_{gf}	160 pF
Anode to grid	C_{ag}	57 pF

CHARACTERISTICS measured at $V_a = 10$ kV, $I_a = 8$ A

Transconductance	S	140 mA/V
Amplification factor	μ	36

COOLING

To obtain optimum life, the temperature of the seals and the envelope should, under continuously loaded conditions, be kept below 200 °C.

At frequencies up to about 4 MHz the seals are sufficiently cooled if the filament connectors are water-cooled by a flow of about 0,5 ℓ/min.
At higher frequencies however, an additional airflow of about 4 m^3/min must be led along the seals from a 50 mm diameter nozzle positioned at a distance of 250 mm from the tube header.

Table 1 Water cooling characteristics

anode + grid dissipation $W_a + W_g$ kW	inlet temperature T_i °C	rate of flow q_{min} ℓ/min	pressure drop ΔP kPa*	outlet temperature T_o °C
100	20	52	55	49
	50	78	105	69
80	20	39	32	51
	50	60	65	70
60	20	29	19	52
	50	42	32	72
40	20	18	8	54
	50	27	15	73

Absolute maximum water inlet temperature	T_i	max	50	°C
Absolute maximum water pressure	P	max	600	kPa

ACCESSORIES

Filament connector with cable	type 40695A
Filament/cathode connector with cable	type 40696A
Grid connector f > 4 MHz	type 40737
f ⩽ 4 MHz	type 40694

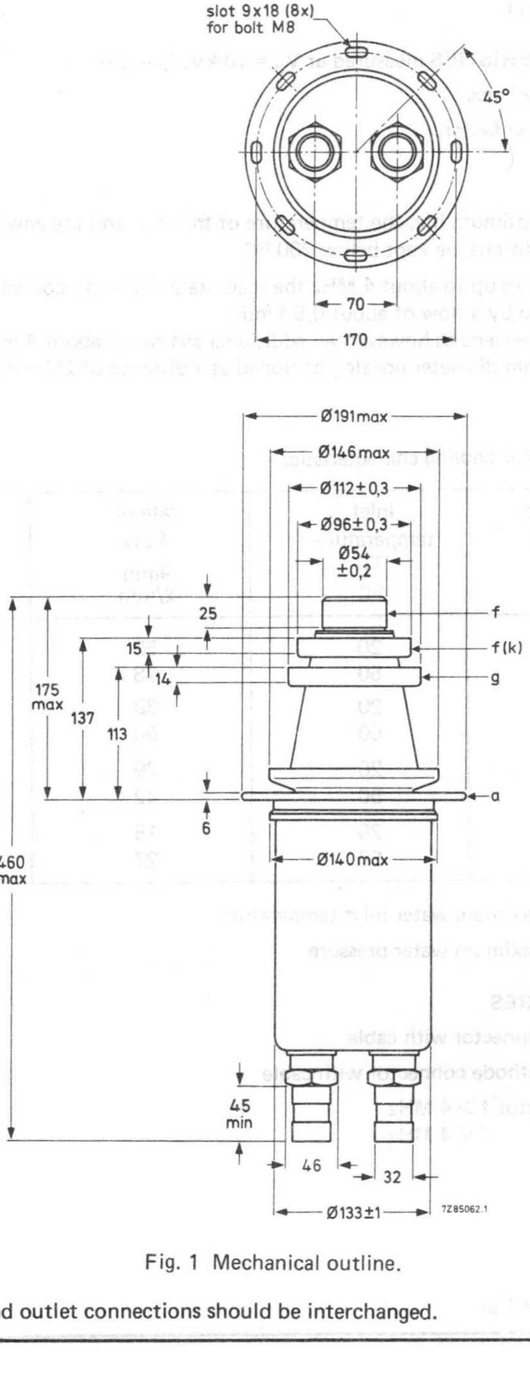
* 100 kPa ≈ 1 at.

MECHANICAL DATA

Dimensions in mm

Mounting position: vertical, anode up or down

Net mass: approx. 11,5 kg



Thread of water connections 1¼ in.

Fig. 1 Mechanical outline.

With the anode up the water inlet and outlet connections should be interchanged.

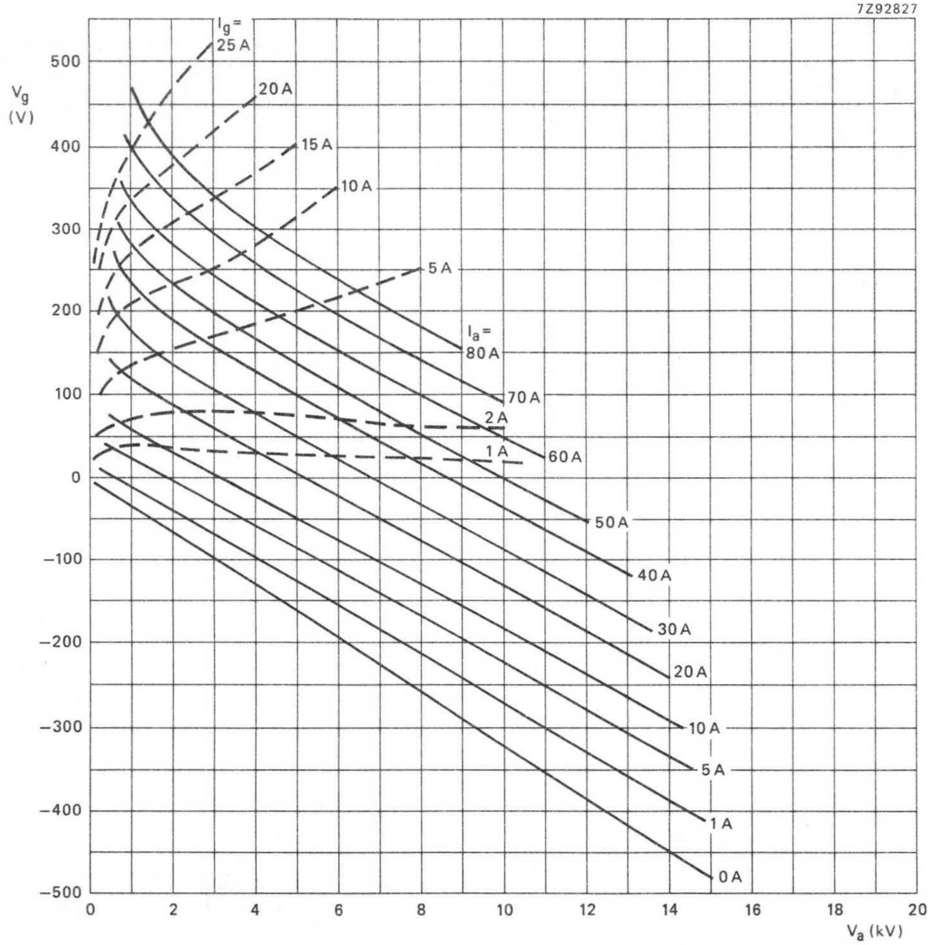


Fig. 2 Constant current characteristics.

RF POWER TRIODE

Triode in metal-ceramic construction intended for use as industrial oscillator. The YD1212 has an integral water cooler.

QUICK REFERENCE DATA

Oscillator output power (W_o - W_{feedb}), typical	W_{osc}		240	kW
Frequency for full ratings	f	max.	30	MHz

To be read in conjunction with "General Operational Recommendations Transmitting Tubes for Communication, Tubes for R.F. Heating".

RF CLASS C OSCILLATOR FOR INDUSTRIAL USE

OPERATING CONDITIONS

Frequency	f	30	MHz
Oscillator output power (W_o - W_{feedb})	W_{osc}	240	kW
Anode voltage	V_a	14	kV
Anode current	I_a	23,5	A
Anode input power	W_{ia}	329	kW
Anode dissipation	W_a	81,5	kW
Anode output power	W_o	247,5	kW
Anode efficiency	η_a	75,2	%
Oscillator efficiency	η_{osc}	73	%
Feedback ratio	V_{gp}/V_{ap}	10,4	%
Grid resistor	R_g	135	Ω
Grid current, on load	I_g	6	A
Grid voltage, negative	V_g	–810	V
Grid dissipation	W_g	2,6	kW
Grid resistor dissipation	W_{Rg}	4,86	kW

LIMITING VALUES (Absolute maximum rating system)

Frequency	f	up to	100	MHz*
Anode voltage	V_a	max.	16,8	kV
Anode current	I_a	max.	25	A
Anode input power	W_{ia}	max.	375	kW
Anode dissipation	W_a	max.	120	kW
Grid voltage	$-V_g$	max.	2	kV
Grid current				
on load	I_g	max.	7	A
off load	I_g	max.	8,5	A
Grid dissipation	W_g	max.	3	kW
Grid circuit resistance	R_g	max.	10	kΩ
Cathode current				
mean	I_k	max.	31	A
peak	I_{kp}	max.	175	A
Envelope temperature	T_{env}	max.	240	°C

HEATING: direct; filament thoriated tungsten

Filament voltage	V_f		12,6	V
Filament current	I_f		380	A
Peak filament starting current	I_{fp}	max.	2000	A
Cold filament resistance	R_{fo}		3,6	mΩ

The filament is designed to accept temporary fluctuations of + 5% and −10%.

To ensure that the cathode temperature remains constant irrespective of the operating frequency, it may be necessary to reduce the filament voltage at higher frequencies. When doing so it must be borne in mind that the filament voltage-to-current ratio measured with only the filament voltage applied should remain constant under all operating conditions.

It is extremely important that the filament be properly decoupled. This should be done so that the resonance of the circuit formed by the filament and the decoupling elements remain below the fundamental oscillator frequency. In grounded-grid circuits this resonance should be below the grid-cathode resonance. For further information please see Application Book "Tubes for RF heating" or contact the manufacturer.

CAPACITANCES

Anode to filament	C_{af}	3	pF
Grid to filament	C_{gf}	185	pF
Anode to grid	C_{ag}	60	pF

* When the tubes are to be used at frequencies above 30 MHz the manufacturer should be consulted for more detailed information.

CHARACTERISTICS measured at V_a = 14 kV, I_a = 10 A

Transconductance	S	190 mA/V
Amplification factor	μ	40

COOLING

To obtain optimum life, the seal/envelope temperature under normal operating conditions should be kept below 200 °C.

At low frequencies the seals are sufficiently cooled if the filament connectors are water-cooled by a flow of about 0,5 ℓ/min. At higher frequencies, however, an additional air flow of about 4 m^3/min must be led along the seals from a 50 mm diameter nozzle positioned at a distance of 250 mm from the tube header.

Table 1 Air cooling characteristics

anode + grid dissipation $W_a + W_g$ kW	inlet temperature T_i °C	rate of flow q_{min} ℓ/min	pressure drop ΔP kPa*	outlet temperature T_o °C
120	20	60	70	50
	50	90	130	70
80	20	34	30	56
	50	54	55	72
40	20	15	7	63
	50	24	13	77

Absolute max. water inlet temperature	T_i	50 °C
Absolute max. water pressure	P	600 kPa*

ACCESSORIES

Filament connector with cable	type	40695A
Filament/cathode connector with cable	type	40696A
Grid connector		
f ⩽ 4 MHz	type	40694
f > 4 MHz	type	40737

* 100 kPa ≈ 1 at

MECHANICAL DATA

Dimensions in mm

Mounting position: vertical with anode up or down

Net mass: approx. 15,6 kg

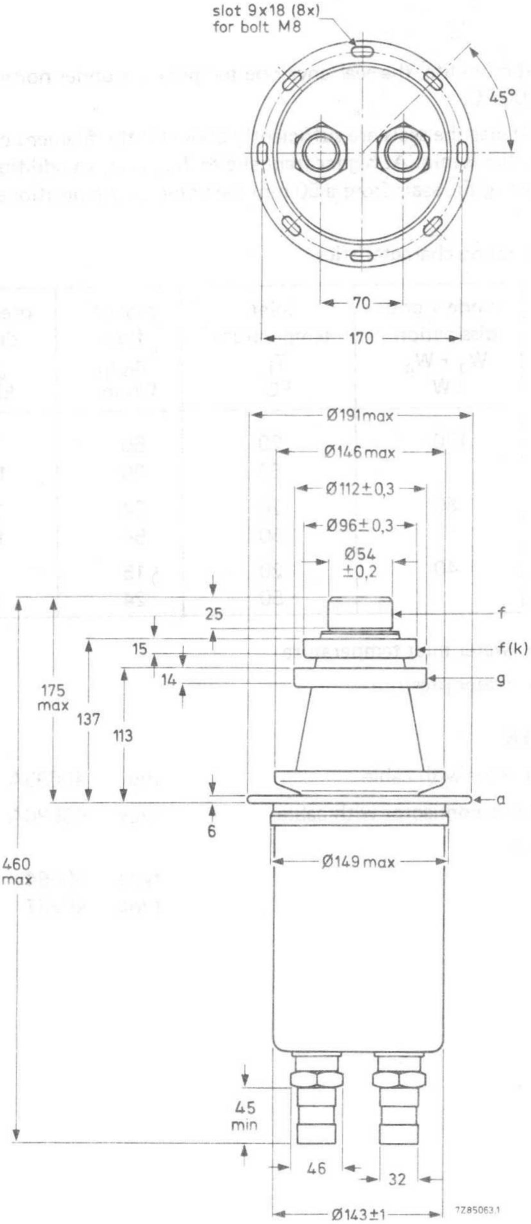


Fig. 1 Mechanical outline.

Thread of water connections BSP 1¼ in.

With anode up the water inlet and outlet connections should be interchanged.

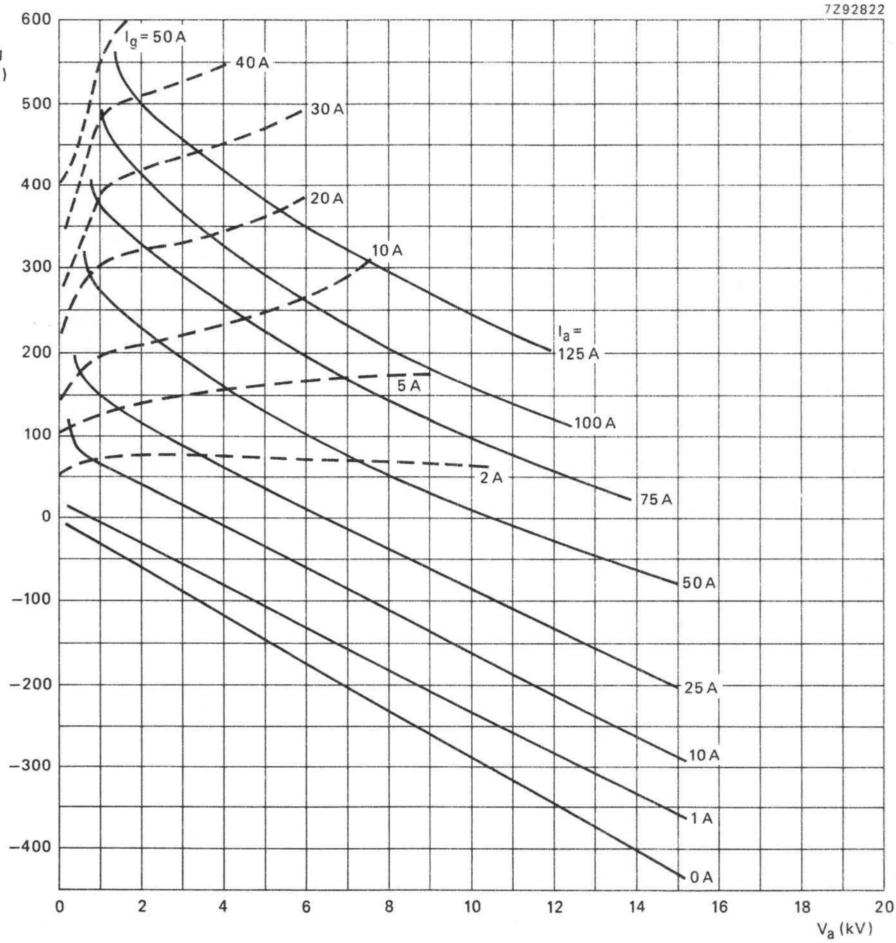


Fig. 2 Constant current characteristics.

RF POWER TRIODE

Air-cooled triodes of metal-ceramic construction with integral cooler intended for use as industrial oscillators.

QUICK REFERENCE DATA

Oscillator output power (W_o-W_{feedb}), typical	W_{osc}		2,67 kW
Frequency for full ratings	f	max.	250 MHz*

To be read in conjunction with "General Operational Recommendations".

RF CLASS C OSCILLATOR FOR INDUSTRIAL USE

OPERATING CONDITIONS

Frequency	f	160	27,12 MHz
Filament voltage	V_f	6,0	6,3 V
Oscillator output power (W_o-W_{feedb})	W_{osc}	2,22	2,67 kW
Anode voltage	V_a	4,5	5,0 kV
Anode current	I_a	700	750 mA
Anode input power	W_{ia}	3,15	3,75 kW
Anode dissipation	W_a	0,75	0,83 kW
Anode output power	W_o	2,4	2,9 kW
Anode efficiency	η_a	76	78 %
Oscillator efficiency	η_{osc}	71	71 %
Feedback ratio	V_{gp}/V_{ap}	17	17 %
Grid resistor	R_g	2,2	2,2 kΩ
Grid current, on load	I_g	225	235 mA
Grid voltage, negative	$-V_g$	495	517 V
Grid dissipation	W_g	70	80 W
Grid resistor dissipation	W_{Rg}	111	121 W

* When used at frequencies above 160 MHz consult the manufacturer for more detailed information.

LIMITING VALUES (Absolute maximum rating system)

Frequency for full ratings	f	up to	250 MHz
Anode voltage	V_a		5,5 kV
Anode current	I_a		1,1 A
Anode input power	W_{ia}		6,0 kW
Anode dissipation	W_a		1,5 kW
Grid voltage	$-V_g$		1,0 kV
Grid current			
on load	I_g		280 mA
off load	I_g		400 mA
Grid dissipation	W_g		150 W
Grid circuit resistance	R_g		20 kΩ
Cathode current			
mean	I_k		1,4 A
peak	I_{kp}		8 A
Envelope temperature	T_{env}		240 °C

HEATING: direct; filament thoriated tungsten

Filament voltage		
f ⩽ 120 MHz	V_f	6,3 V
f > 120 MHz	V_f	6,0 V
Filament current at V_f = 6,3 V	I_f	33 A

The filament is designed to accept temporary fluctuations of + 5% and −10%.

It is extremely important that the filament be properly decoupled. This should be done so that the resonance of the circuit formed by the filament and the decoupling elements remain below the fundamental oscillator frequency. In grounded-grid circuits this resonance should be below the grid-cathode resonance. For further information please see Application Book "Tubes for RF heating" or contact the manufacturer.

CAPACITANCES

Anode to filament	C_{af}	0,4 pF
Grid to filament	C_{gf}	17 pF
Anode to grid	C_{ag}	14 pF

CHARACTERISTICS measured at V_a = 2,0 kV, I_a = 0,5 A

Transconductance	S	10 mA/V
Amplification factor	μ	20

COOLING

See cooling curves.

A low velocity air flow directed to the seals may be required.

To obtain optimum life, the temperature of the seals and of the envelope should, under normal operating conditions, be kept below 200 °C.

To maintain these temperatures additional cooling may be necessary. At frequencies higher than about 4 MHz cooling of the seals becomes mandatory.

ACCESSORIES

Filament connector	type 40688
Filament/cathode connector	type 40689
Grid connector	type 40686

MECHANICAL DATA

Dimensions in mm

YD1240

Mounting position: vertical with anode up or down

Net mass: approx. 1,3 kg

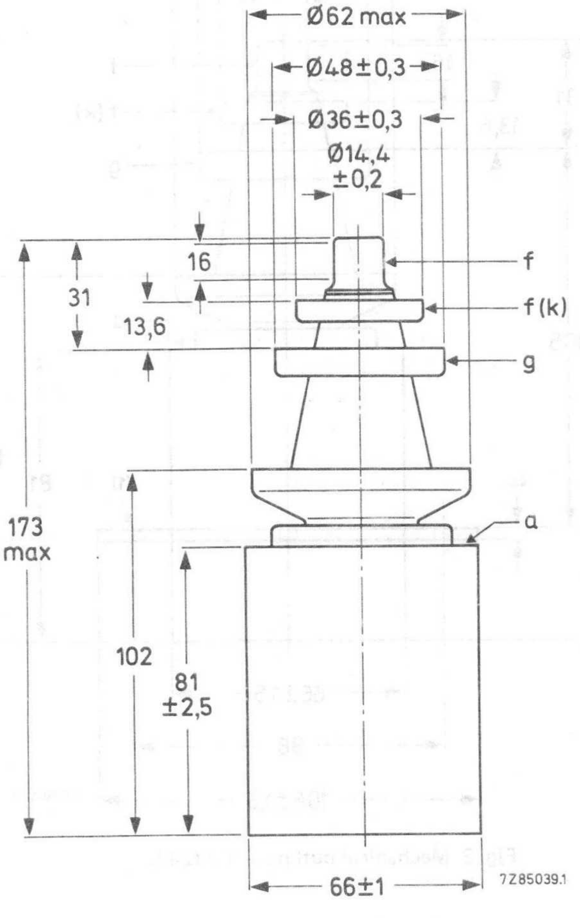


Fig. 1 Mechanical outline – YD1240.

YD1244

Dimensions in mm

Mounting position: vertical with anode up or down

Net mass: approx. 1,4 kg

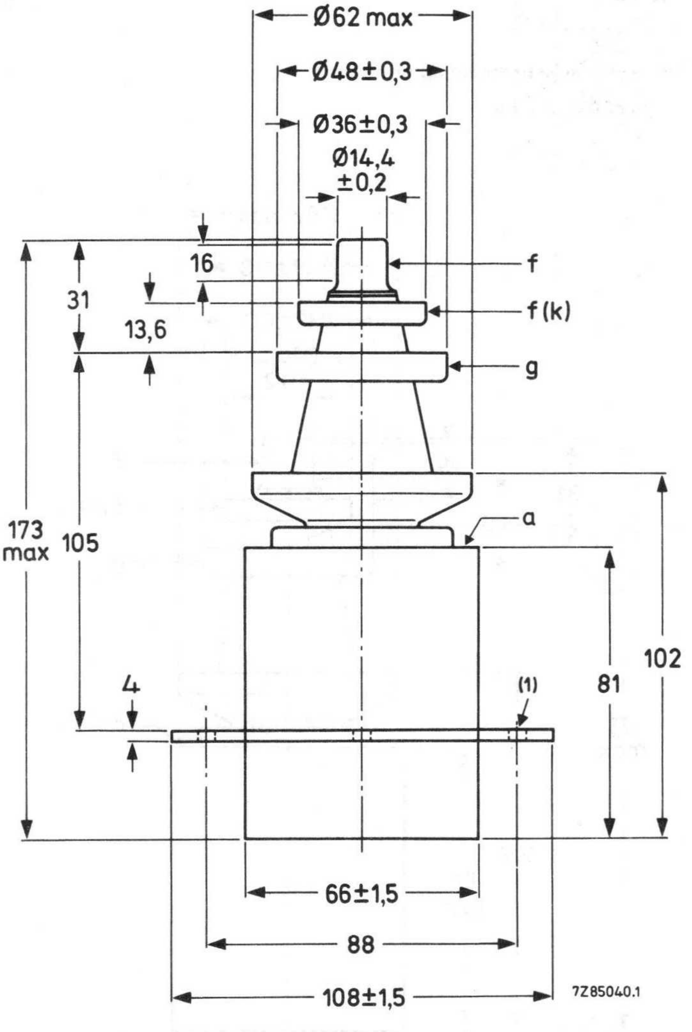


Fig. 2 Mechanical outline – YD1244.

(1) 4 x 5 mm ϕ holes.

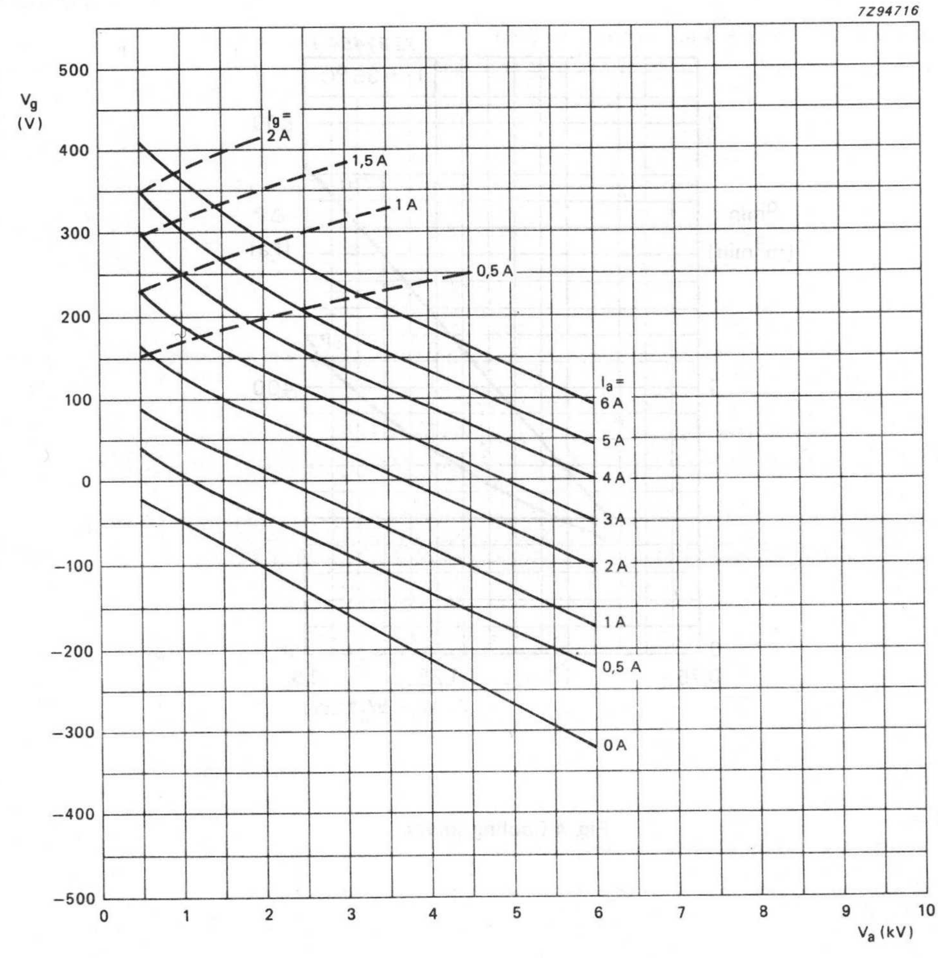


Fig. 3 Constant current characteristics.

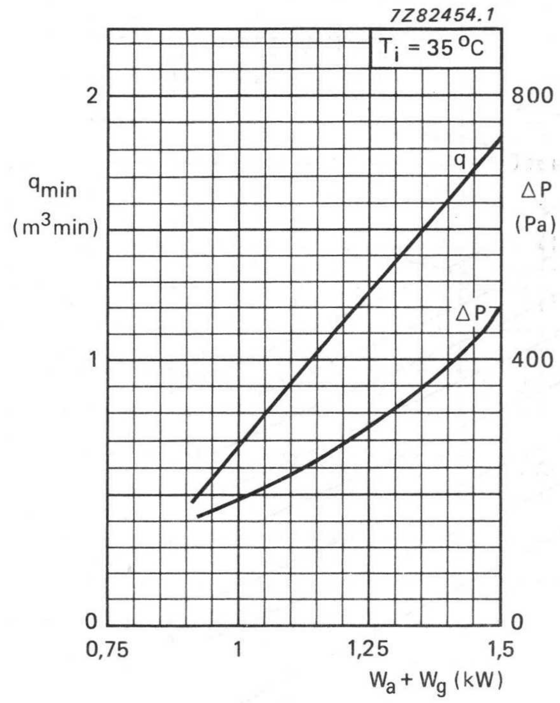


Fig. 4 Cooling curves.

RF POWER TRIODE

Triode in metal-ceramic construction intended for use as industrial oscillator. The YD1342 has an integral water cooler.

QUICK REFERENCE DATA

Oscillator output power ($W_o - W_{feedb}$)	W_{osc}		530 kW
Frequency for full ratings	f.	max.	30 MHz

To be read in conjunction with "General Operational Recommendations"

RF CLASS C OSCILLATOR FOR INDUSTRIAL USE

OPERATING CONDITIONS

Frequency	f	30	30	30 MHz
Oscillator output power ($W_o - W_{feedb}$)	W_{osc}	355	440	530 kW
Anode voltage	V_a	12	14	16 kV
Anode current	I_a	39,1	41	43,5 A
Anode input power	W_{ia}	470	574	696 kW
Anode dissipation	W_a	106	125	156 kW
Anode output power	W_o	364	449	540 kW
Anode efficiency	η_a	77,4	78,2	77,6 %
Oscillator efficiency	η_{osc}	75,5	76,6	76,1 %
Feedback ratio	V_{gp}/V_{ap}	10	9,5	9,3 %
Grid resistor	R_g	65	79	97 Ω
Grid current, on load	I_g	8,4	8,2	7,7 A
Grid voltage, negative	$-V_g$	550	650	750 V
Grid dissipation	W_g	3,8	3,8	3,8 kW
Grid resistor dissipation	W_{Rg}	4,6	5,3	5,8 kW

LIMITING VALUES

(Absolute maximum rating system)

Frequency for full ratings	f	up to	30 MHz
Anode voltage	V_a	max.	18 kV
Anode current	I_a	max.	45 A
Anode input power	W_{ia}	max.	750 kW
Anode dissipation	W_a	max.	240 kW
Grid voltage	$-V_g$	max.	2,5 kV
Grid current, on load	I_g	max.	9 A
Grid current, off load	I_g	max.	11 A
Grid dissipation	W_g	max.	6 kW
Grid circuit resistance	R_g	max.	10 kΩ
Cathode current, mean	I_k	max.	55 A
Cathode current, peak	I_{kp}	max.	250 A
Envelope temperature	T_{env}	max.	240 °C

HEATING; direct; thoriated tungsten filament, mesh construction

Filament voltage	V_f		14 V
Filament current	I_f		555 A
Peak filament starting current	I_{fp}	max.	3500 A
Cold filament resistance	R_{fo}		2,6 mΩ

The filament is designed to accept temporary fluctuations of + 5% and − 10%.

It is extremely important that the filament be properly decoupled. This should be done so that the resonance of the circuit formed by the filament and the decoupling elements remain below the fundamental oscillator frequency. In grounde-grid circuits this resonance should be below the grid-cathode resonance. For further information please see Application Book "Tubes for RF heating" or contact the manufacturer.

CAPACITANCES

Anode to filament	C_{af}	4,5 pF
Grid to filament	C_{gf}	250 pF
Anode to grid	C_{ag}	70 pF

CHARACTERISTICS

Measured at V_a = 16 kV, I_a = 18 A

Transconductance	S	230 mA/V
Amplification factor	μ	35

COOLING

To obtain optimum life, the temperature of the seals and of the envelope should, under normal operating conditions, be kept below 200 °C.

At low frequencies the seals are sufficiently cooled if the filament connectors are water-cooled by a flow of about 1 l/min. At high frequencies, however, an additional air flow of about 6 m^3/min must be led along the seals from a 60 mm diameter nozzle positioned at a distance of 300 mm from the tube header.

Table 1 Water cooling characteristics

anode + grid dissipation $W_a + W_g$ kW	inlet temperature T_i °C	rate of flow q_{min} l/min	pressure drop ΔP kPa*	outlet temperature T_o °C
240	20	120	100	50
	50	180	180	70
200	20	95	65	52
	50	144	120	71
160	20	72	42	54
	50	110	75	72
110	20	47	23	56
	50	73	44	73

Absolute max. water inlet temperature T_i max. 50 °C

Absolute max. water pressure P max. 600 kPa

ACCESSORIES

Filament connector with cable — type 40695A

Filament/cathode connector with cable — type 40696A

Grid connector
- f ≤ 4 MHz — type 40694
- f > 4 MHz — type 40737

* 100 kPa ≈ 1 at

MECHANICAL DATA

Dimensions in mm

Mounting position vertical with anode up or down

Net mass approx. 30 kg

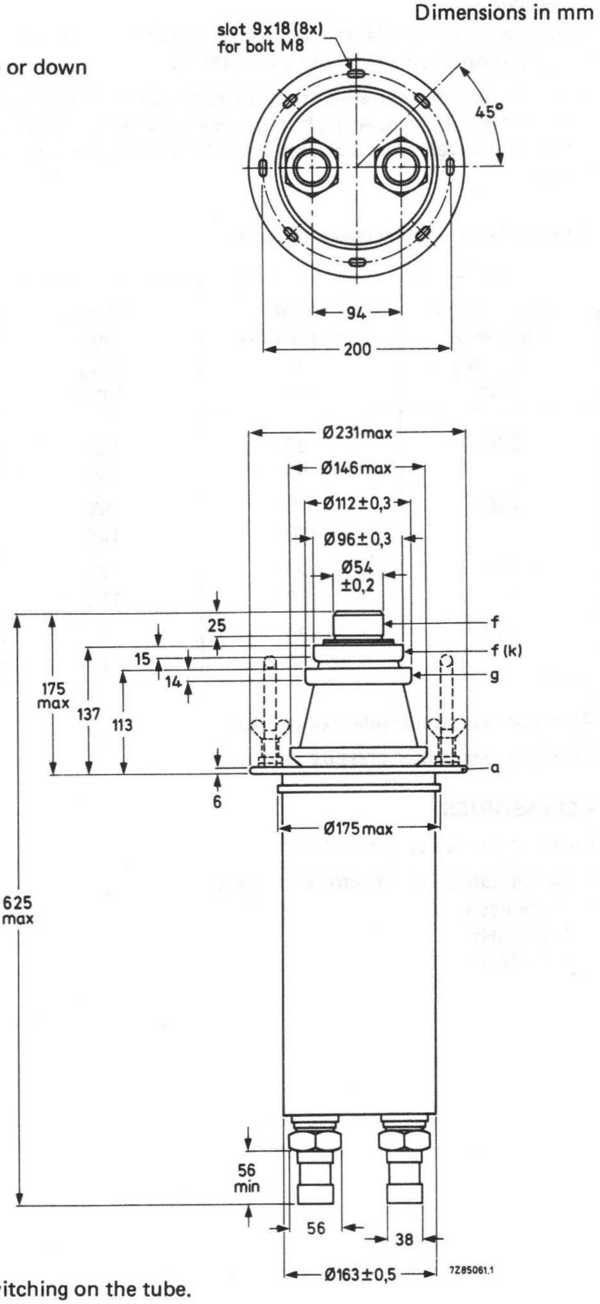


Fig. 1 Mechanical outline.

The handles should be removed before switching on the tube.

When using the tube in the anode up position the input and output water connections should be reversed.

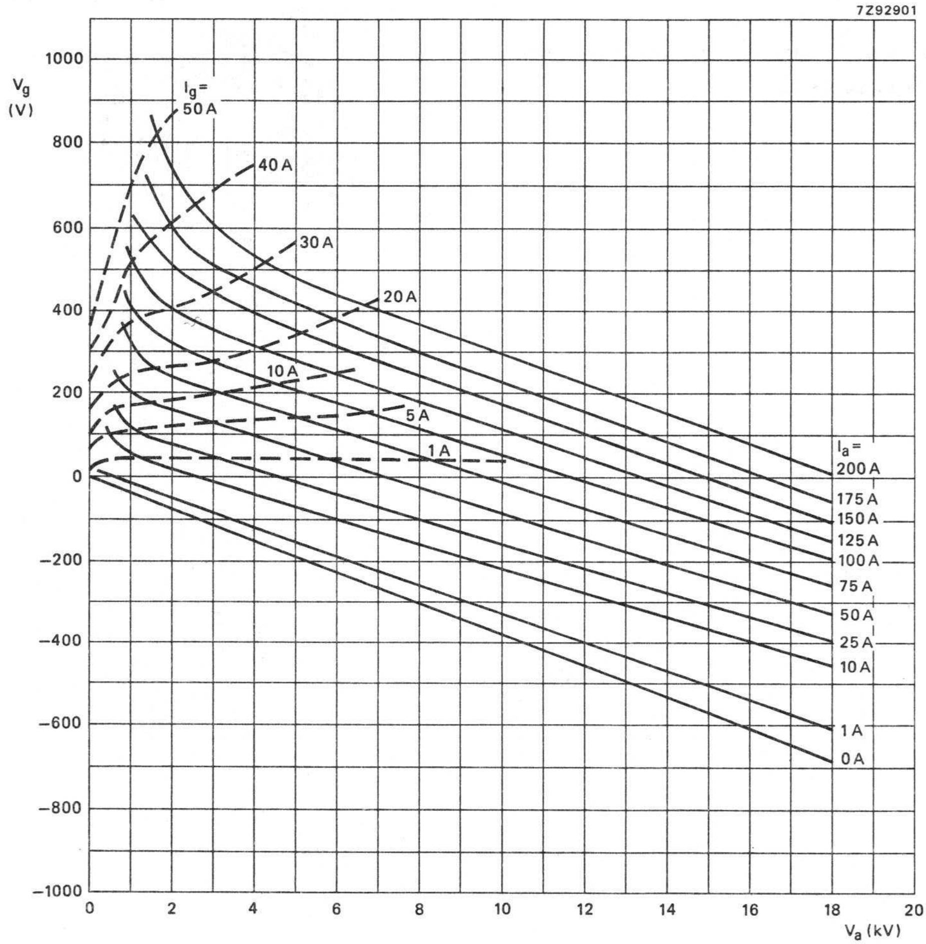


Fig. 2 Constant current characteristics.

ASSOCIATED ACCESSORIES

WATER JACKET

Dimensions in mm

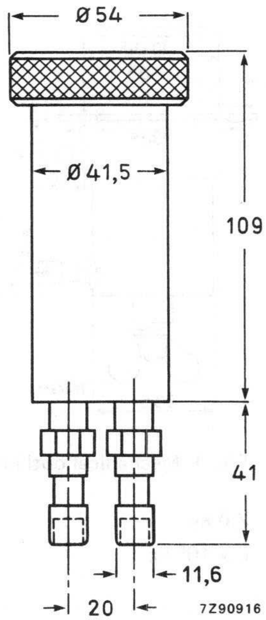


Fig. 1 Mechanical outline.

Net mass	0,52 kg
Absolute maximum water pressure	6×10^5 Pa

WATER JACKET

Dimensions in mm

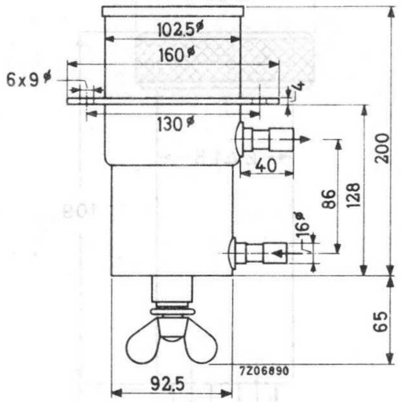


Fig. 1 Mechanical outline.

Net mass	2,6 kg
Absolute maximum water pressure	6×10^5 Pa

WATER JACKET

Dimensions in mm

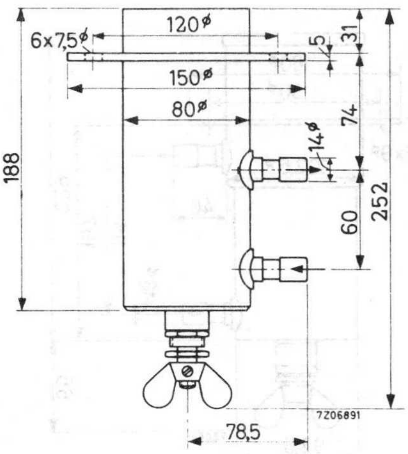


Fig. 1 Mechanical outline.

Net mass	2,2 kg
Absolute maximum water pressure	6×10^5 Pa

WATER JACKET

Dimensions in mm

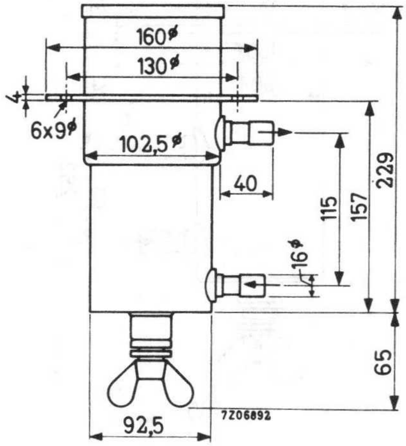


Fig. 1 Mechanical outline.

Net mass	2,7 kg
Absolute maximum water pressure	6×10^5 Pa

GRID CONNECTOR
for 70 mm dia. terminals

Dimensions in mm

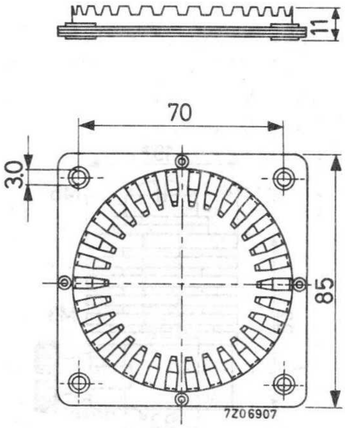


Fig. 1 Mechanical outline.

Material: Brass, silver plated

ANODE CONNECTOR
for 9 mm dia. terminals

Dimensions in mm

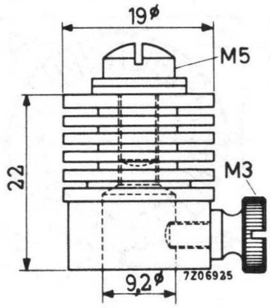


Fig. 1 Mechanical outline.

Material: brass, nickel plated

ANODE CONNECTOR
for 9,5 mm dia. terminals

Dimensions in mm

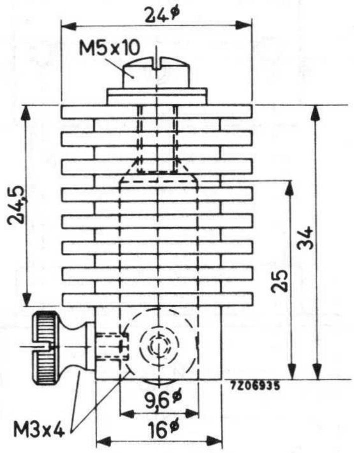
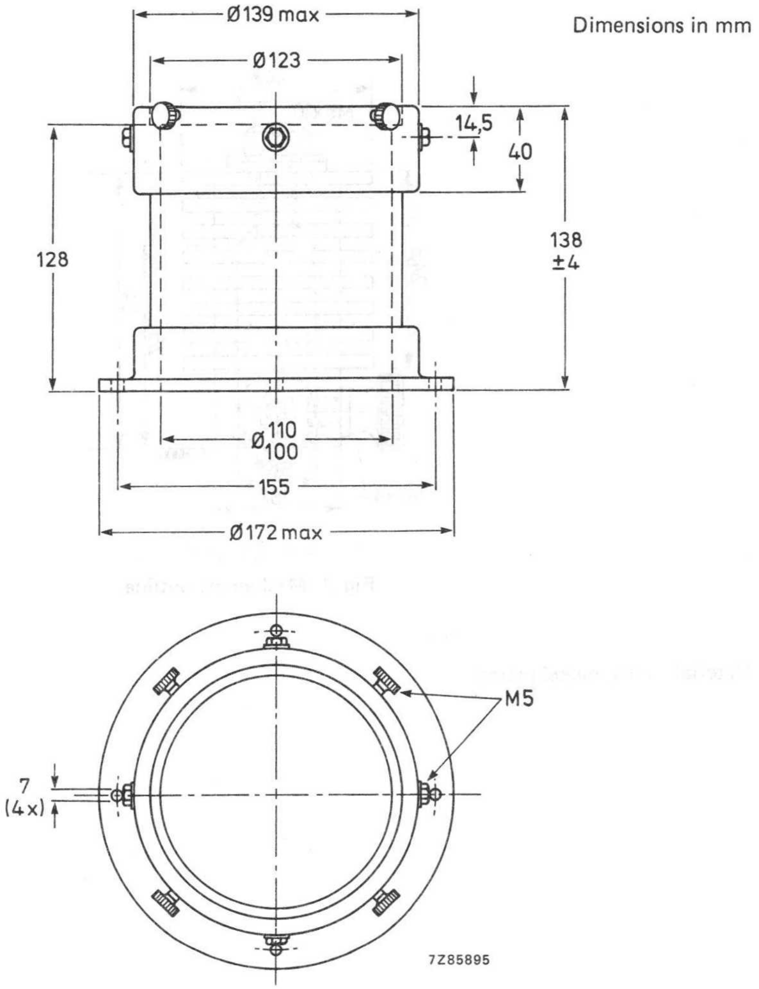


Fig. 1 Mechanical outline.

Material: brass, nickel plated

INSULATING PEDESTAL



Material: ceramic

Net mass: 2,1 kg

Fig. 1 Mechanical outline.

FILAMENT CONNECTOR
for 9,1 mm dia. terminals

Dimensions in mm

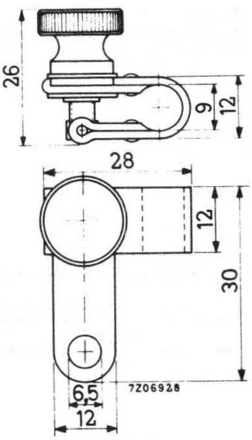
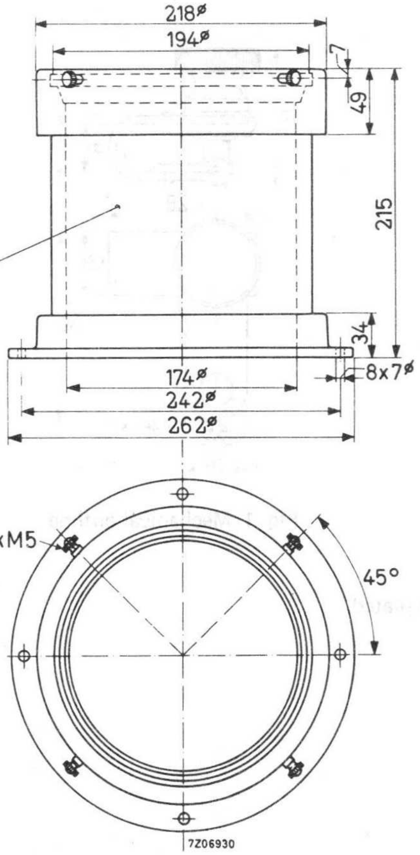


Fig. 1 Mechanical outline.

Material: brass, nickel plated

INSULATING PEDESTAL

Dimensions in mm



Material: ceramic

Net mass: 7,15 kg

Fig. 1 Mechanical outline.

FILAMENT CONNECTOR
for 10,5 mm dia. terminals

Dimensions in mm

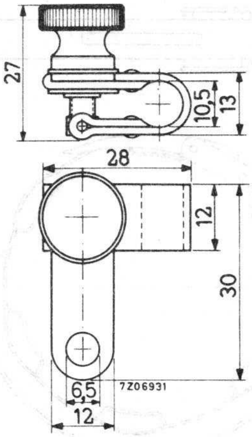


Fig. 1 Mechanical outline.

Material: brass, nickel plated

GRID CONNECTOR
for 70 mm dia. terminals

Dimensions in mm

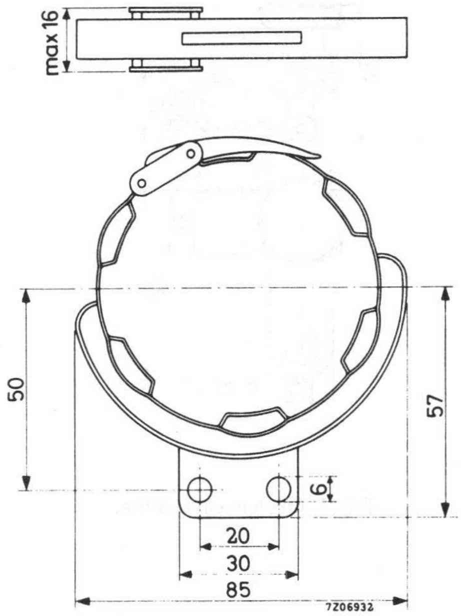
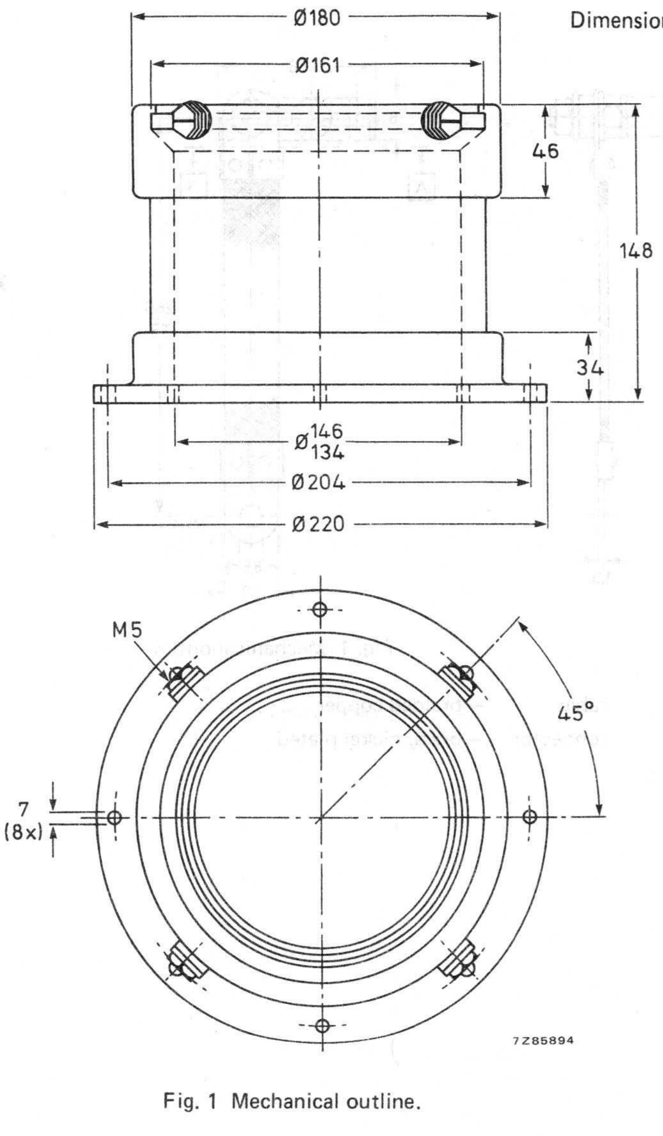


Fig. 1 Mechanical outline.

Material: brass, nickel plated

INSULATING PEDESTAL

Dimensions in mm



Material: ceramic

Net mass: 4,25 kg

Fig. 1 Mechanical outline.

FILAMENT CONNECTOR WITH CABLE

Dimensions in mm

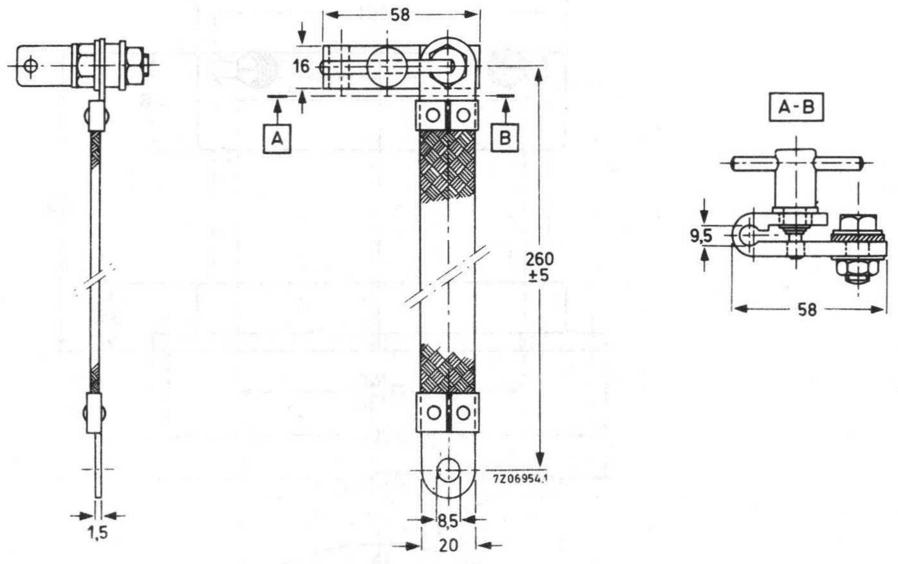


Fig. 1 Mechanical outline.

Material: cable – braided copper
connector – brass, nickel plated

GRID CONNECTOR
for 114 mm dia. terminals

Dimensions in mm

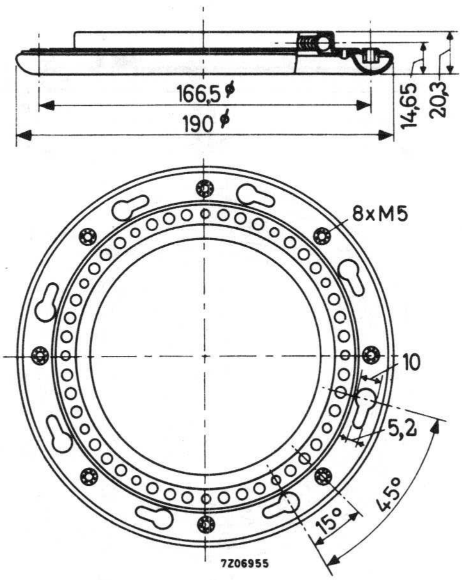


Fig. 1 Mechanical outline.

Material: brass, silver plated.

GRID CONNECTOR
for 96 mm dia. terminals

Dimensions in mm

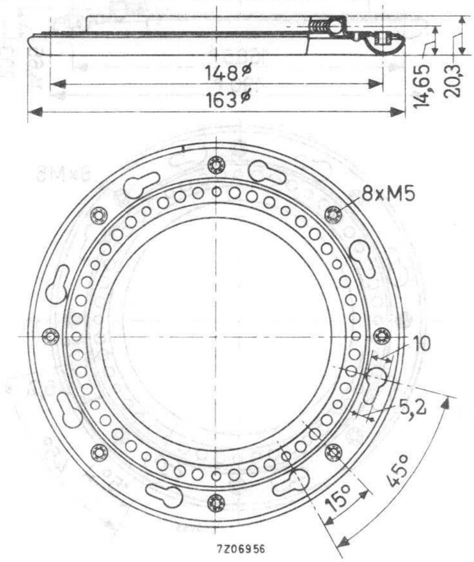


Fig. 1 Mechanical outline.

Material: brass, silver plated

Net mass: ≈ 415 g

ANODE CONNECTOR
for 9,5 mm dia. terminals

Dimensions in mm

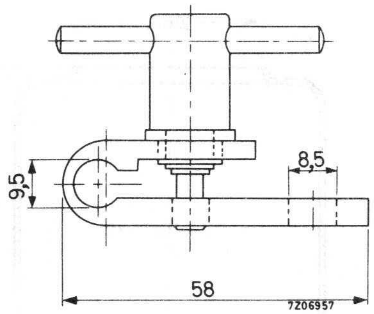


Fig. 1 Mechanical outline.

Material: brass, nickel plated
Net mass: 100 g

CHIMNEY

Dimensions in mm

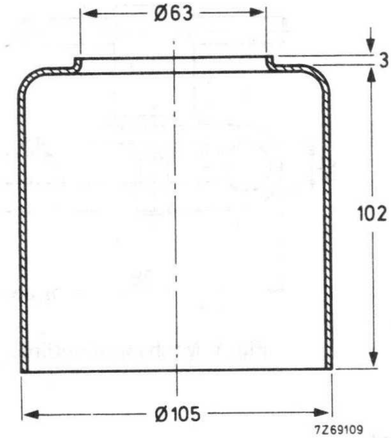


Fig. 1 Mechanical outline.

Material: glass

Net mass: ≈ 200 g

GRID CONNECTOR
for 48 mm dia. terminals

Dimensions in mm

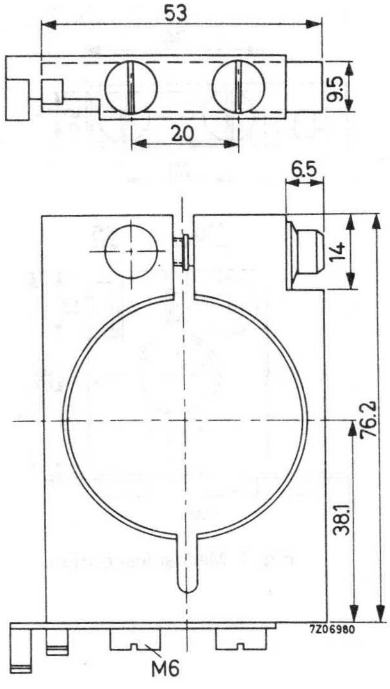


Fig. 1 Mechanical outline.

Material: brass, silver plated

FILAMENT CONNECTOR
for 14,4 mm dia. terminals

Dimensions in mm

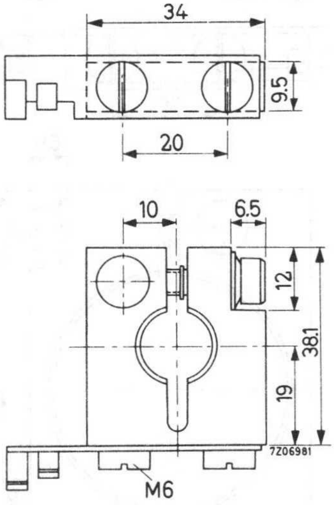


Fig. 1 Mechanical outline.

Material: brass, nickel plated

FILAMENT CONNECTOR
for 36 mm dia. terminals

Dimensions in mm

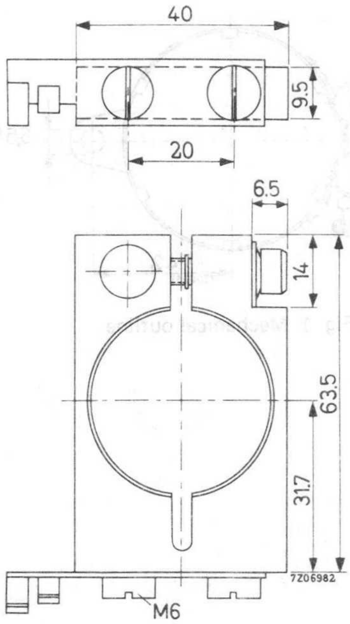


Fig. 1 Mechanical outline.

Material: brass, nickel plated

GRID CONNECTOR

for 66 mm dia. terminals

Dimensions in mm

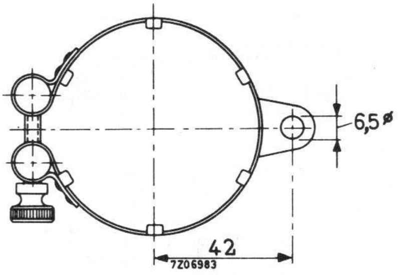


Fig. 1 Mechanical outline.

Material: brass, nickel plated
Net mass: 55 g

GRID CONNECTOR

for 66 mm dia. terminals

Dimensions in mm

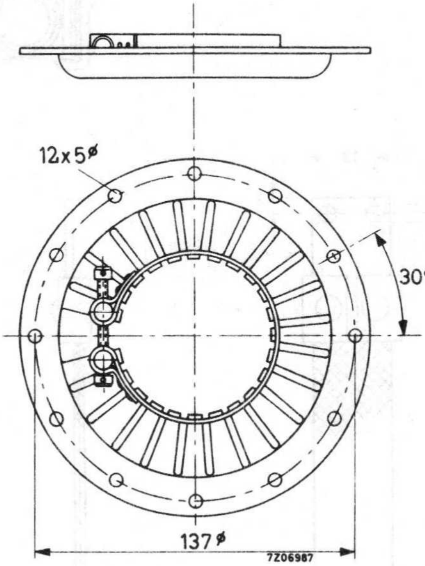


Fig. 1 Mechanical outline.

Material: brass, silver plated
Net mass: 240 g

FILAMENT CONNECTOR
for 25 mm dia. terminals

Dimensions in mm

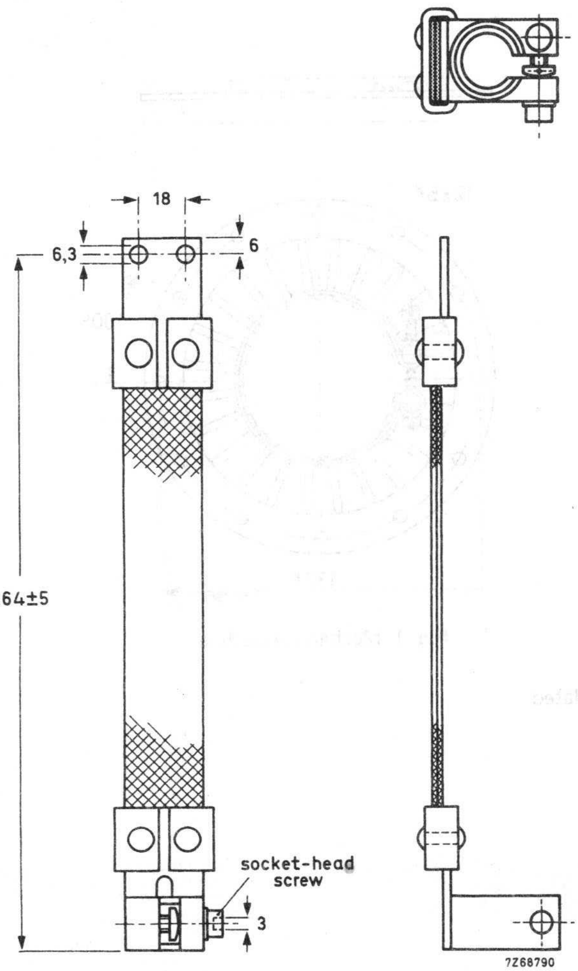
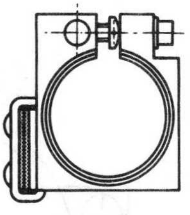


Fig. 1 Mechanical outline.

Net mass: ≈ 450 g
Material: cable – braided copper
connector – brass, nickel plated

FILAMENT CONNECTOR
for 50 mm dia. terminals

Dimensions in mm



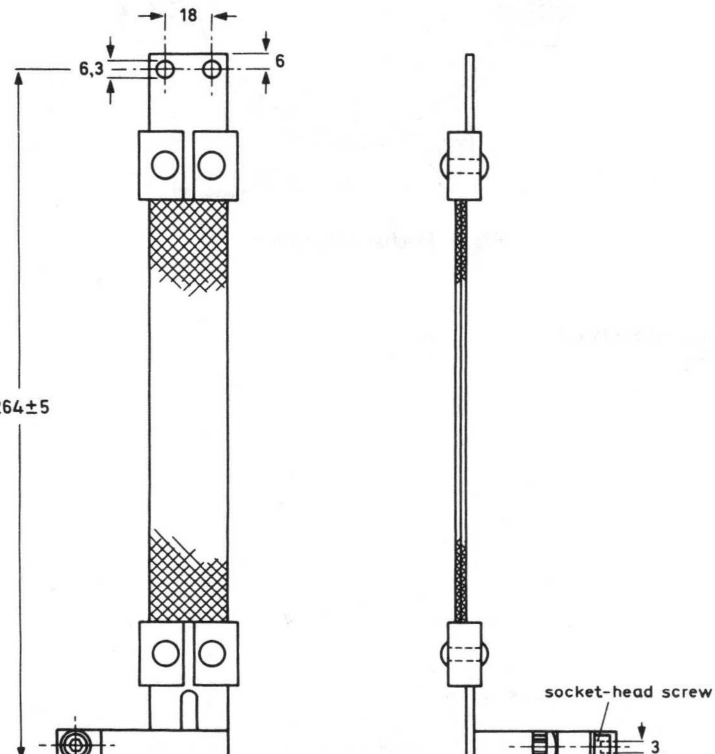


Fig. 1 Mechanical outline.

Net mass: ≈ 480 g
Material: cable – braided copper
connector – brass, nickel plated

GRID CONNECTOR
for 112 mm dia. terminals

Dimensions in mm

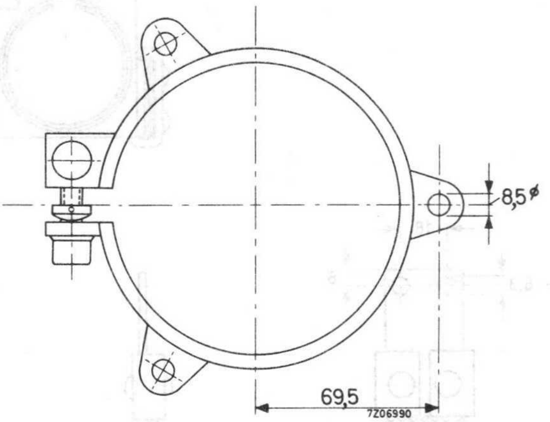


Fig. 1 Mechanical outline.

Material: brass, nickel plated
Net mass: 270 g

WATER-COOLED FILAMENT CONNECTOR

for 54 mm dia. terminals

Net mass: ≈ 1380 g
Material: cable – braided copper
connector – brass, nickel plated

Dimensions in mm

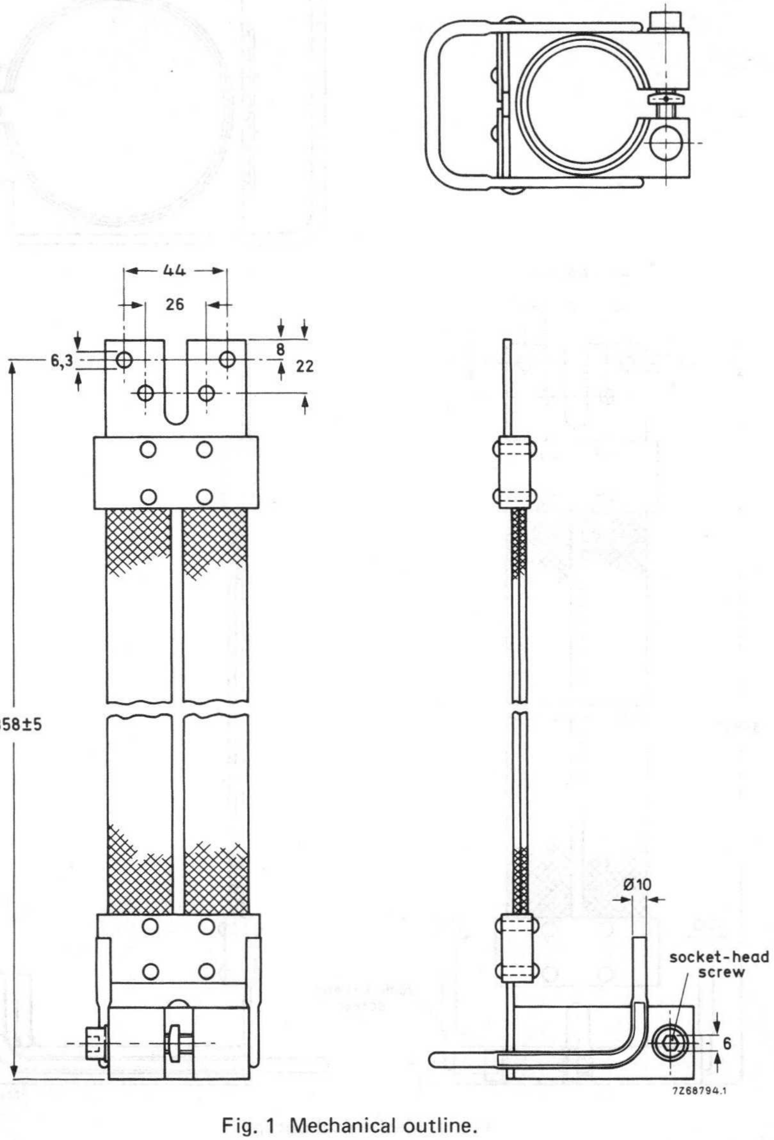


Fig. 1 Mechanical outline.

WATER-COOLED FILAMENT CONNECTOR

for 96 mm dia. terminals

Net mass: ≈ 1550 g
Material: cable — braided copper
connector — brass, nickel plated

Dimensions in mm

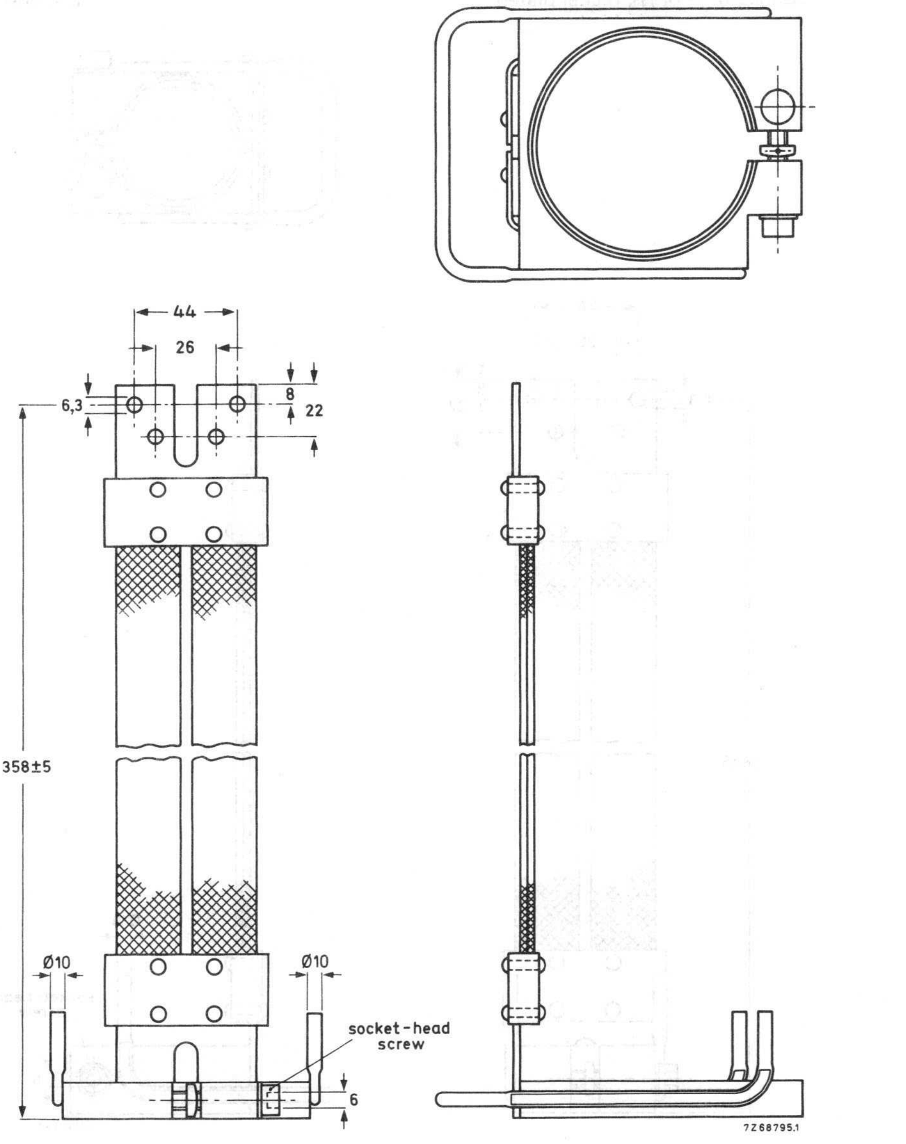
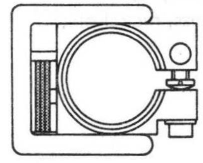


Fig. 1 Mechanical outline.

FILAMENT CONNECTOR
for 42 mm dia. terminals

Net mass: ≈ 700 g
Material: cable – braided copper
connector – brass, nickel plated

Dimensions in mm



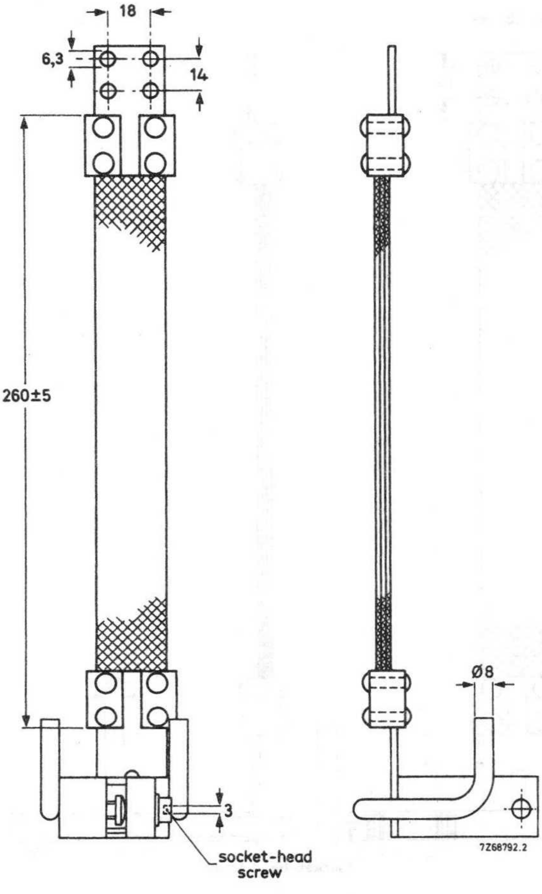
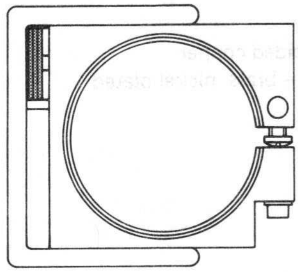


Fig. 1 Mechanical outline.

FILAMENT CONNECTOR
for 86 mm dia. terminals

Net mass: ≈ 830 g
Material: cable — braided copper
connector — brass, nickel plated



Dimensions in mm

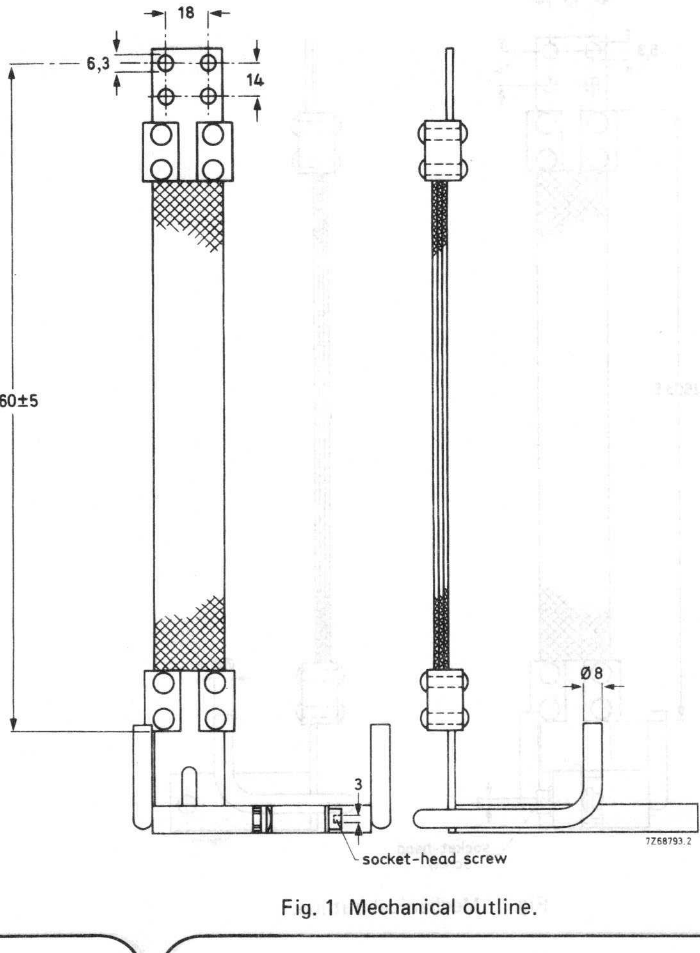


Fig. 1 Mechanical outline.

GRID CONNECTOR
for 105 mm dia. terminals

Dimensions in mm

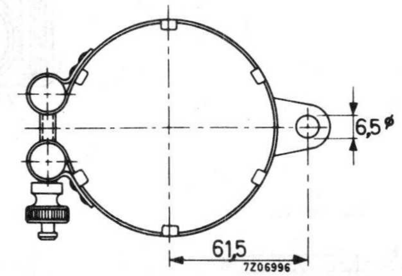


Fig. 1 Mechanical outline.

Material: brass, nickel plated

FILAMENT CONNECTOR
for 32 mm dia. terminals

Dimensions in mm

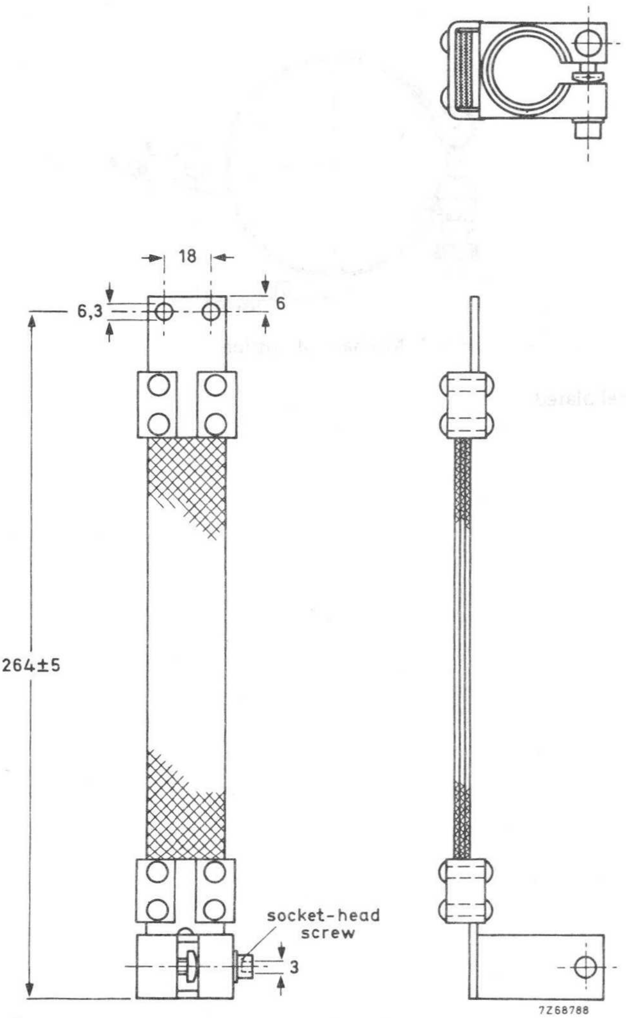


Fig. 1 Mechanical outline.

Net mass: ≈ 600 g
Material: cable – braided copper
connector – brass, nickel plated

FILAMENT CONNECTOR
for 66 mm dia. terminals

Dimensions in mm

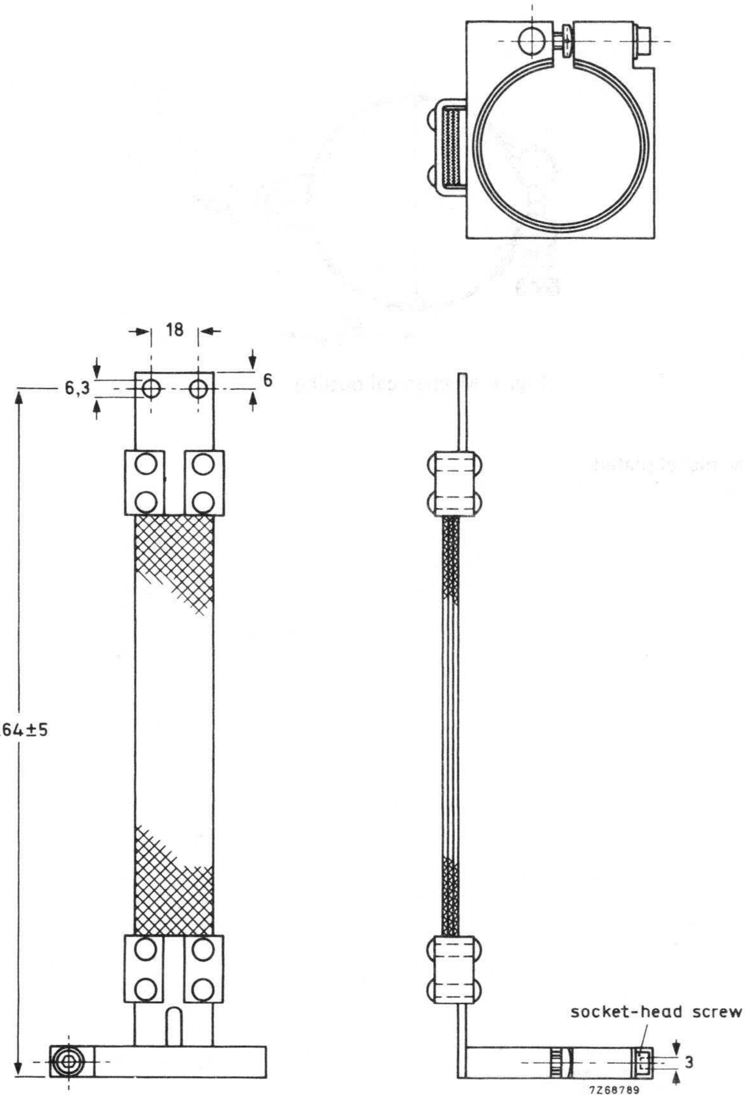


Fig. 1 Mechanical outline.

Net mass: ≈ 640 g
Material: cable – braided copper
connector – brass, nickel plated

GRID CONNECTOR
for 80 mm dia. terminals

Dimensions in mm

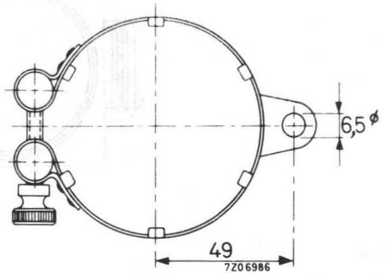


Fig. 1 Mechanical outline.

Material: brass, nickel plated
Net mass: 60 g

GRID CONNECTOR
for 80 mm dia. terminals

Dimensions in mm

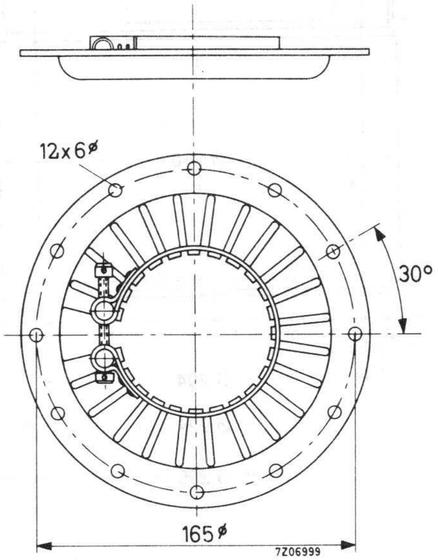
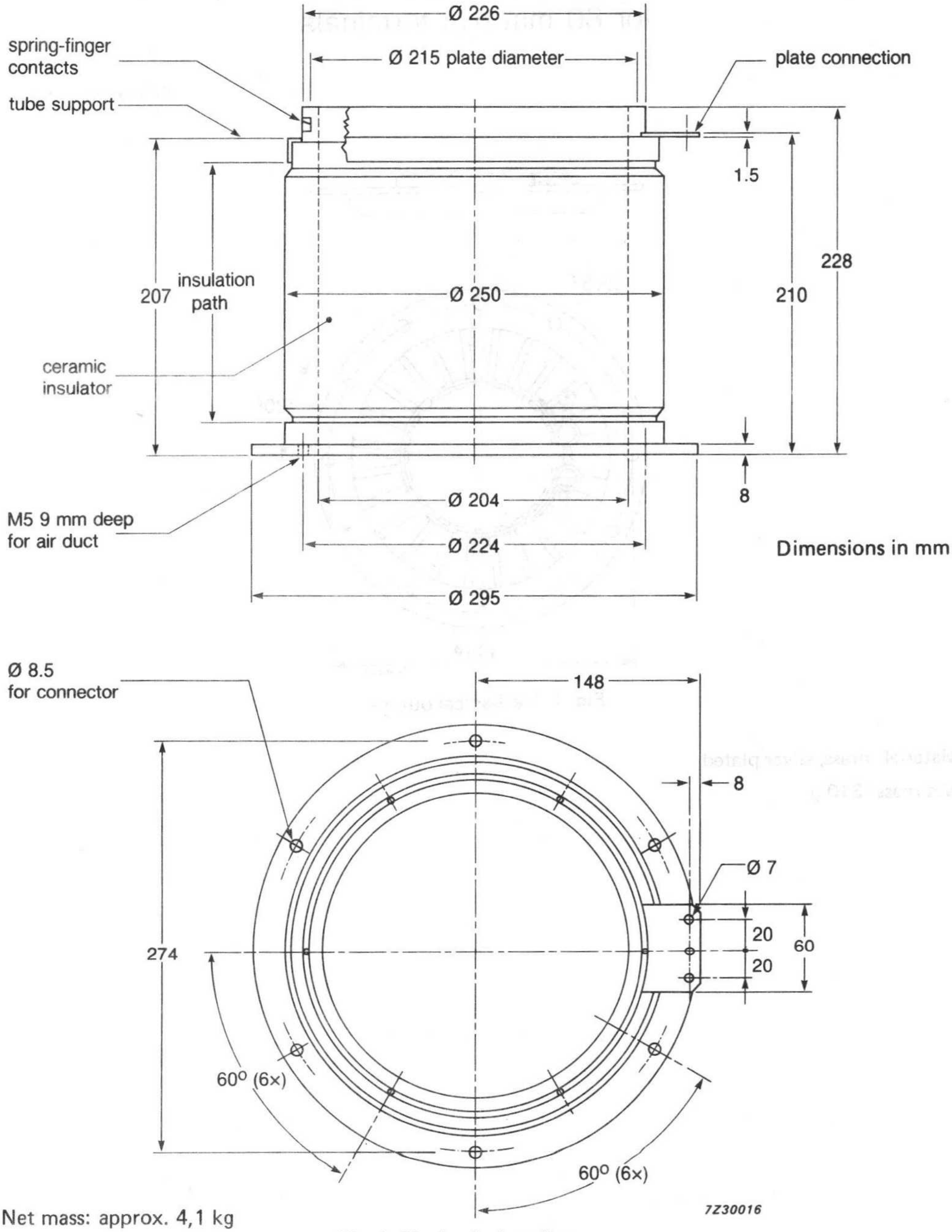


Fig. 1 Mechanical outline.

Material: brass, silver plated

Net mass: 310 g

INSULATING PEDESTAL



Net mass: approx. 4,1 kg

Fig. 1 Mechanical outline.

GRID CONNECTOR
for 105 mm dia. terminals

Dimensions in mm

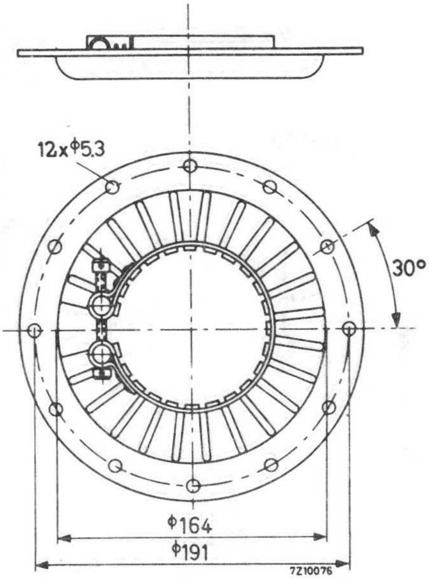


Fig. 1 Mechanical outline.

Material: brass, silver plated

Net mass: 450 g

GRID CONNECTOR
for 112 mm dia. terminals

Dimensions in mm

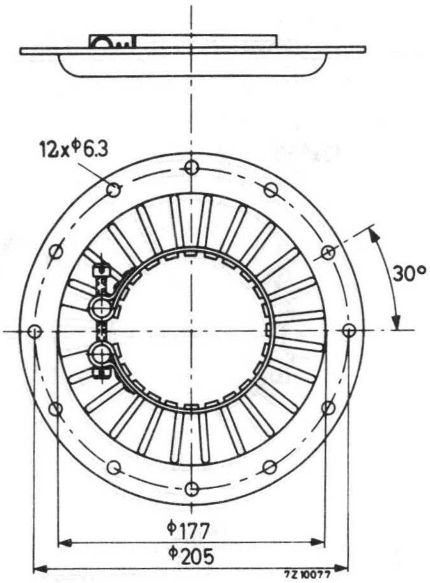


Fig. 1 Mechanical outline.

Material: brass, silver plated

Net mass: 525 g

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RF POWER TRIODES

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DATA HANDBOOK SYSTEM

DATA HANDBOOK SYSTEM

Our Data Handbook System comprises more than 60 books with specifications on electronic components, subassemblies and materials. It is made up of four series of handbooks:

ELECTRON TUBES	BLUE
SEMICONDUCTORS	RED
INTEGRATED CIRCUITS	PURPLE
COMPONENTS AND MATERIALS	GREEN

The contents of each series are listed on pages iv to vii.

The data handbooks contain all pertinent data available at the time of publication, and each is revised and reissued periodically.

When ratings or specifications differ from those published in the preceding edition they are indicated with arrows in the page margin. Where application information is given it is advisory and does not form part of the product specification.

Condensed data on the preferred products of Philips Electronic Components and Materials Division is given in our Preferred Type Range catalogue (issued annually).

Information on current Data Handbooks and on how to obtain a subscription for future issues is available from any of the Organizations listed on the back cover.
Product specialists are at your service and enquiries will be answered promptly.

ELECTRON TUBES (BLUE SERIES)

The blue series of data handbooks comprises:

T1	**Power tubes for RF heating and communications**
T2a	**Transmitting tubes for communications, glass types**
T2b	**Transmitting tubes for communications, ceramic types**
T3	**Klystrons**
T4	**Magnetrons for microwave heating**
T5	**Cathode-ray tubes** Instrument tubes, monitor and display tubes, C.R. tubes for special applications
T6	**Geiger-Müller tubes**
T8	**Colour display systems** Colour TV picture tubes, colour data graphic display tube assemblies, deflection units
T9	**Photo and electron multipliers**
T10	**Plumbicon camera tubes and accessories**
T11	**Microwave semiconductors and components**
T12	**Vidicon and Newvicon camera tubes**
T13	**Image intensifiers and infrared detectors**
T15	**Dry reed switches**
T16	**Monochrome tubes and deflection units** Black and white TV picture tubes, monochrome data graphic display tubes, deflection units

SEMICONDUCTORS (RED SERIES)

The red series of data handbooks comprises:

S1	**Diodes** Small-signal silicon diodes, voltage regulator diodes (< 1,5 W), voltage reference diodes, tuner diodes, rectifier diodes
S2a	**Power diodes**
S2b	**Thyristors and triacs**
S3	**Small-signal transistors**
S4a	**Low-frequency power transistors and hybrid modules**
S4b	**High-voltage and switching power transistors**
S5	**Field-effect transistors**
S6	**R.F. power transistors and modules**
S7	**Surface mounted semiconductors**
S8a	**Light-emitting diodes**
S8b	**Devices for optoelectronics** Optocouplers, photosensitive diodes and transistors, infrared light-emitting diodes and infrared sensitive devices, laser and fibre-optic components
S9	**PowerMos transistors**
S10	**Wideband transistors and wideband hybrid IC modules**
S11	**Microwave transistors**
S12	**Surface acoustic wave devices**
S13	**Semiconductor sensors**
S14	**Liquid Crystal Displays**

INTEGRATED CIRCUITS (PURPLE SERIES)

The purple series of handbooks comprises:

IC01	**Radio, audio and associated systems** Bipolar, MOS	
IC02a/b	**Video and associated systems** Bipolar, MOS	
IC03	**Integrated circuits for telephony** Bipolar, MOS	
IC04	**HE4000B logic family** CMOS	
IC05N	**HE4000B logic family – uncased ICs** CMOS	
IC06	**High-speed CMOS; PC74HC/HCT/HCU** Logic family	
IC08	**ECL 10K and 100K logic families**	
IC09N	**TTL logic series**	
IC10	**Memories** MOS, TTL, ECL	
IC11	**Linear Products**	
Supplement to IC11	**Linear Products**	
IC12	**I^2C-bus compatible ICs**	
IC13	**Semi-custom** Programmable Logic Devices (PLD)	
IC14	**Microcontrollers and peripherals** Bipolar, MOS	
IC15	**FAST TTL logic series**	
IC16	**CMOS integrated circuits for clocks and watches**	
IC17	**Integrated Services Digital Networks (ISDN)**	not yet issued
IC18	**Microprocessors and peripherals**	
IC19	**Data communication products**	

COMPONENTS AND MATERIALS (GREEN SERIES)

The green series of data handbooks comprises:

C2	**Television tuners, coaxial aerial input assemblies**
C3	**Loudspeakers**
C4	**Ferroxcube potcores, square cores and cross cores**
C5	**Ferroxcube for power, audio/video and accelerators**
C6	**Synchronous motors and gearboxes**
C7	**Variable capacitors**
C8	**Variable mains transformers**
C9	**Piezoelectric quartz devices**
C11	**Varistors, thermistors and sensors**
C12	**Potentiometers, encoders and switches**
C13	**Fixed resistors**
C14	**Electrolytic and solid capacitors**
C15	**Ceramic capacitors**
C16	**Permanent magnet materials**
C17	**Stepping motors and associated electronics**
C18	**Direct current motors**
C19	**Piezoelectric ceramics**
C20	**Wire-wound components for TVs and monitors**
C22	**Film capacitors**

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