PHILIPS

Data handbook

PHILIPS

Electronic components and materials

# Electron tubes

Part 2 February 1972

# Tubes for microwave equipment

# ELECTRON TUBES

**Part 2** **February 1972**

# DATA HANDBOOK SYSTEM

To provide you with a comprehensive source of information on electronic components, subassemblies and materials, our Data Handbook System is made up of three series of handbooks, each comprising several parts.
The three series, identified by the colours noted, are:

| | | |
|---|---|---|
| **ELECTRON TUBES** (9 parts) | | BLUE |
| **SEMICONDUCTORS AND INTEGRATED CIRCUITS** (6 parts) | | RED |
| **COMPONENTS AND MATERIALS** (7 parts) | | GREEN |

The several parts contain all pertinent data available at the time of publication, and each is revised and reissued annually; the contents of each series are summarized on the following pages.
We have made every effort to ensure that each series is as accurate, comprehensive and up-to-date as possible, and we hope you will find it to be a valuable source of reference. Where ratings or specifications quoted differ from those published in the preceding edition they will be pointed out by arrows. You will understand that we can not guarantee that all products listed in any one edition of the handbook will remain available, or that their specifications will not be changed, before the next edition is published. If you need confirmation that the published data about any of our products are the latest available, may we ask that you contact our representative. He is at your service and will be glad to answer your inquiries.

December **1971**

# ELECTRON TUBES (BLUE SERIES)

This series consists of the following parts, issued on the dates indicated.

**Part 1** — **January 1972**

Transmitting tubes (Tetrodes, Pentodes)
Amplifier circuit assemblies

**Part 2** — **February 1972**

Tubes for microwave equipment

**Part 3** — **March 1972**

Special Quality tubes
Miscellaneous devices

**Part 4** — **April 1971**

Receiving tubes

**Part 5** — **May 1971**

Cathode-ray tubes
Photo tubes
Camera tubes
Associated accessories

**Part 6** — **June 1971**

Photomultipliers tubes
Channel electron multipliers
Scintillators
Photoscintillators
Radiation counter tubes
Semiconductor radiation detectors
Neutron generator tubes
Photo diodes
Associated accessories

**Part 7** — **July 1971**

Voltage stabilizing and reference tubes
Counter, selector, and indicator tubes
Trigger tubes
Switching diodes
Thyratrons
Ignitrons
Industrial rectifying tubes
High-voltage rectifying tubes

**Part 8** — **August 1971**

T.V. Picture tubes

**Part 9** — **December 1971**

Transmitting tubes (Triodes)
Tubes for R.F. heating (Triodes)
Associated accessories

# SEMICONDUCTORS AND INTEGRATED CIRCUITS (RED SERIES)

This series consists of the following parts, issued on the dates indicated.

**Part 1 Diodes and Thyristors** **September 1971**

General
Signal diodes
Variable capacitance diodes
Voltage regulator diodes
Rectifier diodes
Thyristors, diacs, triacs
Rectifier stacks
Accessories
Heatsinks

**Part 2 Low frequency; Deflection** **October 1971**

General
Low frequency transistors (low power)
Low frequency power transistors
Deflection transistors
Accessories

**Part 3 High frequency; Switching** **November 1971**

General
High frequency transistors
Switching transistors
Accessories

**Part 4 Special types** **December 1971**

General
Transmitting transistors
Microwave devices
Field effect transistors
Dual transistors
Microminiature devices for thick- and thin-film circuits
Photoconductive devices
Photodiodes
Phototransistors
Light emitting diodes
Infra-red sensitive devices
Accessories

**Part 5 Linear Integrated Circuits** **February 1972**

General
Linear integrated circuits

**Part 6 Digital integrated circuits** **March 1972**

General
DTL (FC family)
TTL (FJ family)
TTL (GJ family)
MOS (FD family)
HNIL (FZ family)
CML (GH family)

# COMPONENTS AND MATERIALS (GREEN SERIES)

This series consists of the following parts, issued on the dates indicated.

**Part 1 Circuit Blocks, Input/Output Devices, Electro-mechanical Components *), Peripheral Devices** — **October 1971**

Circuit blocks 40-Series
Counter modules 50-Series
Norbits 60-Series, 61-Series
Circuit blocks 90-Series
Input/output devices
Electro-mechanical components *)
Peripheral devices

**Part 2 Resistors, Capacitors** — **December 1971**

Fixed resistors
Variable resistors
Non-linear resistors
Ceramic capacitors
Paper capacitors and film capacitors
Electrolytic capacitors
Variable capacitors

**Part 3 Radio, Audio, Television** — **February 1972**

FM tuners
Coil assemblies
Piezoelectric ceramic resonators and filters
Loudspeakers
Audio and mains transformers
Television tuners, aerial input assemblies
Components for black and white television
Components for colour television
Deflection assemblies for camera tubes

**Part 4 Magnetic Materials, Piezoelectric Ceramics** — **April 1971**

Ferrites for radio, audio and television
Small coils, assemblies and assembling parts
Ferroxcube potcores and square cores
Ferroxcube transformer cores
Piezoxide
Permanent magnet materials

**Part 5 Memory Products, Magnetic Heads, Quartz Crystals, Microwave Devices, Variable Transformers** — **June 1971**

Ferrite memory cores
Matrix planes, matrix stacks
Complete memories
Magnetic heads
Quartz crystal units, crystal filters
Isolators, circulators
Variable mains transformers

**Part 6 Electric Motors and Accessories, Timing and Control Devices** — **August 1971**

Stepper motors
Small synchronous motors
Asynchronous motors
Small d.c. motors
Tachogenerators and servomotors
Indicators for built-in test equipment

**Part 7 Circuit Blocks** — **September 1971**

Circuit blocks 100kHz Series
Circuit blocks 1-Series
Circuit blocks 10-Series
Circuit blocks for ferrite core memory drive

*) From October 1971 published in Part 1 instead of Part 5.

February 1972

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# General Section

List of symbols
Definitions
Waveguides
Rating system

# TUBES FOR MICROWAVE EQUIPMENT
# LIST OF SYMBOLS

1. Symbols denoting electrodes and electrode connections

| | |
|---|---|
| Anode | a |
| Accelerator electrode | acc |
| Collector electrode | coll |
| Anode of a detection diode | d |
| Filament or heater | f |
| Filament or heater tap | $f_c$ |
| Grid | g |
| Tube pin which must not be connected externally | i.c. |
| Cathode | k |
| Reflector electrode | refl |
| Resonator | res |
| Helical electrode | x |

2. Symbols denoting voltages

Remarks

a. In the case of indirectly heated tubes the voltages on the various electrodes are with respect to the cathode, in the case of directly heated, d.c. fed tubes with respect to the negative side of the filament, and in the case of directly heated, a.c. fed tubes with respect to the electrical centre of the filament, unless otherwise stated.
b. The symbols quoted below represent the average values of the concerning voltages, unless otherwise stated.

| | |
|---|---|
| Anode voltage | $V_a$ |
| Anode voltage in cut-off or in cold condition | $V_{ao}$ |
| Accelerator voltage | $V_{acc}$ |
| Supply voltage of tube electrodes | $V_b$ |
| Collector voltage | $V_{coll}$ |
| Anode voltage of a detection diode | $V_d$ |

2. Symbols denoting voltages (continued)

| | |
|---|---|
| Filament or heater voltage | $V_f$ |
| Filament or heater starting voltage | $V_{fo}$ |
| Grid voltage | $V_g$ |
| A.C. input voltage | $V_i$ |
| Ignition voltage (voltage necessary for breakdown to the concerning electrode) | $V_{ign}$ |
| Inverse voltage | $V_{inv}$ |
| Voltage between cathode and heater | $V_{kf}$ |
| A.C. output voltage | $V_o$ |
| Peak value of a voltage | $V_p$ |
| Reflector voltage | $V_{refl}$ |
| Resonator voltage | $V_{res}$ |
| Voltage on helical electrode | $V_x$ |

3. Symbols denoting currents

Remarks

a. The positive electrical current is directed opposite to the direction of the electron current.
b. The symbols quoted below represent the average values of the concerning currents, unless otherwise stated.

| | |
|---|---|
| Anode current | $I_a$ |
| Accelerator current | $I_{acc}$ |
| Collector current | $I_{coll}$ |
| Current of a detection diode | $I_d$ |
| Filament or heater current | $I_f$ |
| Filament or heater starting current | $I_{fo}$ |
| Peak filament or heater starting current | $I_{fsurge}$ |
| Grid current | $I_g$ |
| Cathode current | $I_k$ |
| Peak value of a current | $I_p$ |
| Resonator current | $I_{res}$ |
| Current to helical electrode | $I_x$ |

4. Symbols denoting powers

| | |
|---|---|
| Anode dissipation | $W_a$ |
| Collector dissipation | $W_{coll}$ |
| A.C. driving power | $W_{dr}$ |
| Grid dissipation | $W_g$ |
| Input power | $W_i$ |
| D.C. anode supply power | $W_{ia}$ |
| Peak input power | $W_{ip}$ |
| Output power | $W_o$ |
| Peak output power | $W_{op}$ |
| Resonator dissipation | $W_{res}$ |

5. Symbols denoting capacitances

Measured on the cold tubes.

| | |
|---|---|
| Capacitance between the anode and all other elements except the control grid | $C_a$ |
| Capacitance between anode and grid (all other elements being earthed) | $C_{ag}$ |
| Capacitance between anode and cathode (all other elements being earthed) | $C_{ak}$ |
| Capacitance between the anode of a detection diode and all other elements of the diode | $C_d$ |
| Capacitance between a grid and all other elements except anode | $C_g$ |
| Capacitance between a grid and cathode (all other elements being earthed) | $C_{gk}$ |

6. Symbols denoting resistances

| | |
|---|---|
| External a.c. resistance in anode lead or matching resistance | $R_a$ |
| Filament or heater resistance in cold condition | $R_{f_o}$ |
| External resistance in a grid lead | $R_g$ |
| Internal resistance of a tube | $R_i$ |
| External resistance in a cathode lead | $R_k$ |
| External resistance between cathode and heater | $R_{kf}$ |

7. Symbols denoting various quantities

| | |
|---|---|
| Bandwidth | B |
| Noise factor | F |
| Frequency | f |
| Pushing figure of a magnetron | $\frac{\Delta f}{\Delta I_a}$ |
| Frequency temperature coefficient | $\frac{\Delta f}{\Delta t}$ |
| Pulse repetition rate | $f_{imp}$ |
| Pulling figure of a magnetron | $\Delta f_p$ |
| Power gain | G |
| Height above sea level | h |
| Magnetic field strength | H |
| Pressure drop of cooling air or cooling water | $p_i$ |
| Required air flow or water flow for cooling | q |
| Mutual conductance | S |
| Temperature of anode or anode block | $t_a$ |
| Ambient temperature | $t_{amb}$ |
| Averaging time of current or voltage | $T_{av}$ |
| Inlet temperature of cooling air or cooling water | $t_i$ |
| Pulse duration | $T_{imp}$ |
| Time of rise of voltage | $T_{rv}$ |
| Outlet temperature of cooling air or cooling water | $t_o$ |
| Waiting time (= time which has to pass between switching on of the filament or heater voltage and switching on of the other voltages) | $T_w$ |
| Rated of rise of voltage | $\frac{dVa}{dT}, \frac{\Delta V}{\Delta T_{rv}}$ |
| Voltage standing wave ratio | V.S.W.R. |
| Reflection coefficient | $\alpha$ |
| Duty factor | $\delta$ |
| Efficiency | $\eta$ |
| Wavelength | $\lambda$ |
| Amplification factor | $\mu$ |

# TUBES FOR MICROWAVE EQUIPMENT
## DEFINITIONS

| | |
|---|---|
| B | Bandwidth |
| $\Delta f/\Delta t$ | The temperature coefficient $\Delta f/\Delta t$ is the change of frequency with temperature. |
| $f_{imp}$ | Pulse repetition rate. |
| $\Delta f_p$ | The pulling figure $\Delta f_p$ is the difference between the maximum and minimum frequencies, reached when the phase angle of the load with a VSWR of 1.5 is varied from $0^o$ - $360^o$. |
| H | Magnetic field strength. |
| $T_{imp}$ | The pulse duration $T_{imp}$ is defined as the time interval between the two points on the current pulse at which the current is 50% of the smooth peak current (see fig. 1). |

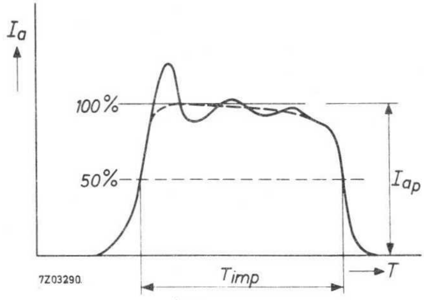



Fig. 1.
current pulse

The smooth peak is the max. value of a smooth curve through the average of the fluctuation over the top portion of the pulse.

| | |
|---|---|
| $T_{rv}$ | The time of rise of voltage $T_{rv}$ is defined as the time interval between points of 20 and 85 percent of the smooth peak value measured on the leading edge of the voltage pulse. |
| $t_a$ | Temperature of anode or anode block. |
| V.S.W.R. | The voltage standing-wave ratio in a waveguide is the ratio of the amplitude of the electrical field at a voltage maximum to that at an adjacent minimum. |

$dV_a/dT$ or $\Delta V_a/\Delta T_{rv}$ — Unless otherwise stated the rate of rise of voltage $dV_a/dT$ is defined by the steepest tangent to the leading edge of the voltage pulse above 80% of the smooth peak value (see Fig. 2)

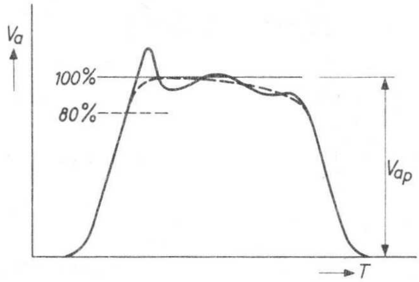



Fig. 2.
voltage pulse

$V_{fo}$ — Heater voltage before switching on of anode voltage. When the magnetron oscillates, not all electrons reach the anode. These off-phase electrons are driven back to the cathode. This back bombardment contributes to the heating power of the cathode. In order to maintain the total power to the cathode at the rated value, it is therefore in some cases necessary to reduce or even to switch off the heater voltage after application of high voltage.

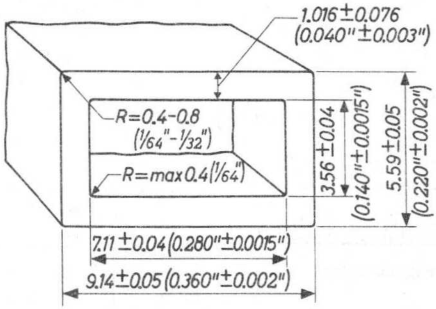
$\delta$ — The duty factor $\delta$ is the ratio of the pulse duration to the time between corresponding points of two successive pulses.

$$\delta = T_{imp}(sec) \times f_{imp}(Hz).$$

# WAVEGUIDES

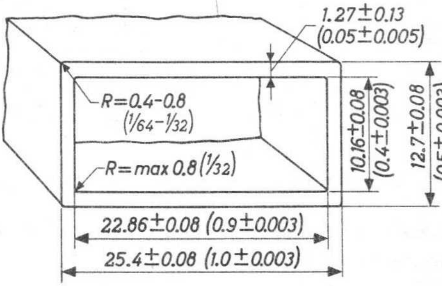
WAVEGUIDE RG-96/U

EIA designation WR 28
British designation WG 22



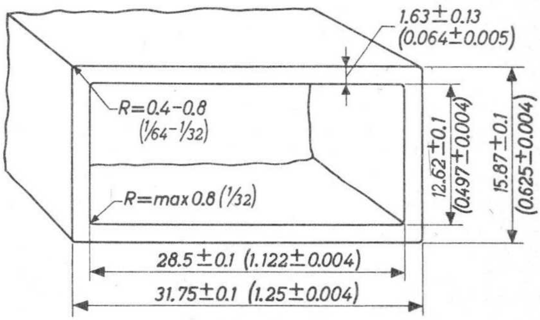

WAVEGUIDE RG-52/U

EIA designation WR 90
British designation WG 16




WAVEGUIDE RG-51/U

EIA designation WR 112
British designation WG 15

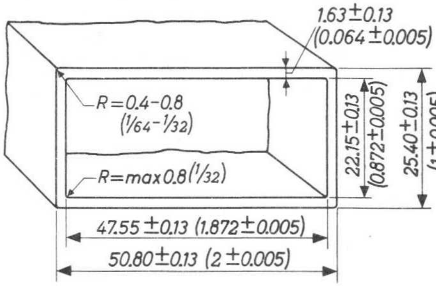



Dimensions in mm and in inches (between brackets)
The dimensions in inches are holding

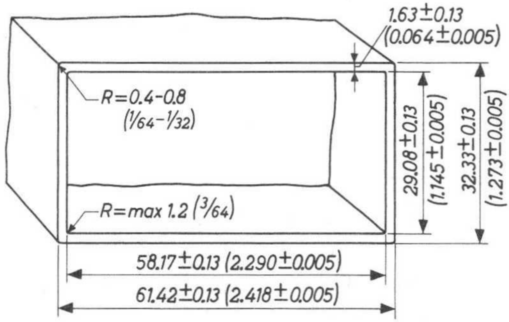
7Z2 4143

WAVEGUIDE RG-49/U

EIA designation WR 187
British designation WG12




WAVEGUIDE WR 229
(EIA designation)




Dimensions in mm and in inches (between brackets)
The dimensions in inches are holding

7Z2 4144

# RATING SYSTEM

## ( in accordance with I.E.C. 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 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.

7Z2 5065

# Communication Magnetrons

# PULSED MAGNETRONS FOR COMMUNICATION

ABRIDGED SURVEY

| Frequency range (MHz) | Output power, peak (kW) | Class | Type |
|---|---|---|---|
| 1220 - 1350 | 450 | Tunable | 5J26 |
| 2700 - 2900 | 800 | Tunable | 5586 |
| 5400 - 5900 | 0.16 | Tunable | YJ1030 |
| 8500 - 9600 | 60 | Tunable | 2J51A |
| 8500 - 9600 | 225 | Tunable | YJ1010 |
| 8500 - 9600 | 225 | Tunable | YJ1011 |
| 9003 - 9085 | 250 | Fixed freq. | 55032/01 |
| 9085 - 9168 | 250 | Fixed freq. | 55032/02 |
| 9168 - 9260 | 250 | Fixed freq. | 55031/01 |
| 9190 - 9320 | 3 | Fixed freq. | YJ1000 |
| 9210 - 9270 | 7.5 | Fixed freq. | JP9-7A |
| 9260 - 9345 | 250 | Fixed freq. | 55031/02 |
| 9345 - 9475 | 3 | Fixed freq. | 7028 |
| 9345 - 9405 | 7.5 | Fixed freq. | 2J42 |
| 9345 - 9405 | 10 | Fixed freq. | JP9-7D |
| 9345 - 9405 | 20 | Fixed freq. | YJ1060 |
| 9345 - 9405 | 20 | Fixed freq. | YJ1110 |
| 9345 - 9405 | 21 | Fixed freq. | JP9-15 |
| 9345 - 9405 | 50 | Fixed freq. | 2J55 |
| 9345 - 9405 | 50 | Fixed freq. | 725A |
| 9345 - 9405 | 50 | Fixed freq. | YJ1200 |
| 9345 - 9405 | 80 | Fixed freq. | 4J52A |
| 9345 - 9405 | 80 | Fixed freq. | 6972 |
| 9345 - 9405 | 225 | Fixed freq. | 4J50 |
| 9345 - 9405 | 250 | Fixed freq. | 55030 |
| 9380 - 9440 | 7 | Fixed freq. | YJ1300 |
| 9380 - 9440 | 10 | Fixed freq. | YJ1071 |
| 9380 - 9440 | 21 | Fixed freq. | JP9-18 |
| 9380 - 9440 | 25 | Fixed freq. | YJ1120 |
| 9405 - 9505 | 250 | Fixed freq. | 55029 |
| 9415 - 9475 | 4 | Fixed freq. | JP9-2.5D |
| 9415 - 9475 | 4 | Fixed freq. | JP9-2.5E |
| 9415 - 9475 | 21 | Fixed freq. | JP9-15B |
| 9415 - 9475 | 26 | Fixed freq. | YJ1121 |

| Frequency range (MHz) | Output power, peak (kW) | Class | Type |
|---|---|---|---|
| 9415 - 9475 | 65 | Fixed freq. | YJ1290 |
| 16350 - 16650 | 45 | Fixed freq. | YJ1140 |
| 32700 - 33400 | 25 | Fixed freq. | YJ1020 |
| 32700 - 33400 | 30 | Fixed freq. | YJ1021 |
| 34512 - 35208 | 40 | Fixed freq. | 7093 |

## C.W. MAGNETRON FOR COMMUNICATION

| Frequency range (MHz) | Output power (kW) | Class | Type |
|---|---|---|---|
| 9150 - 9600 | 0.01 | Tunable | JPT9-01 |

# GENERAL OPERATIONAL RECOMMENDATIONS MAGNETRONS

1. GENERAL

1.1 The following "Application Directions" apply in general to all types of magnetrons. Any deviations for a particular type will be indicated in the published data of the concerning type.

1.2 A magnetron is a cylindrical high-vacuum diode with a cavity resonator system embedded in the anode. In the presence of suitable crossed electric and magnetic fields the magnetron can be used for the generation of continuous-wave as well as pulsed signals in the higher frequency bands.

1.3 In practice the communication magnetrons comprise the pulsed type of magnetrons used as radar transmitter either at a fixed frequency or tunable over a frequency range.

1.4 The magnetron in a radar transmitter should not be looked upon as an independent unit. Owing to the interdependence of the characteristics of the magnetron and the associated circuitry the magnetron should rather be considered as an integral part of the whole system whose proper functioning depends on the degree the various sections are matched to each other.

2. LIMITING VALUES

2.1 General

Limiting values should be used in accordance with the absolute-maximum rating system. Each limiting value should be regarded independently of other values, so that under no circumstances it is permitted to exceed a limiting value whichsoever.

2.2 Absolute-maximum rating system

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

These values are chosen by the device manufacturer to provide acceptable serviceability of the device, taking no responsibility for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the device under consideration and of all other electronic devices in the equipment.
The equipment manufacturer should design so that, initially and throughout life, no absolute-maximum value for the intended service is exceeded with any de-

7Z2 9006

vice under the worst probable operating conditions with respect to supply voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in charcateristics of the device under consideration and of all other electronic devices in the equipment.

## 3. HEATER

### 3.1 General

A cathode temperature either too high or too low may lead to unsatisfactory operation such as moding and arcing, involving short life and loss of efficiency. During operation the heater voltage should, therefore, be set as near as possible at the prescribed value. Temporary fluctuations should not exceed the tolerances mentioned in the published data sheets of the individual types.
The heater voltage should be measured directly on the terminals of the tube.

### 3.2 Heater starting voltage and heater running voltage

During operation the cathode temperature is increased by electron back bombardement (back heating). Before the application of the h.t. supply the heater voltage should, therefore, be adjusted to the published value of the heater starting voltage, but immediately after the application of the h.t. supply the heater voltage should be reduced to the heater running voltage. The individual data sheets contain information relating the heater running voltage to the average anode input power or to the average anode current.

### 3.3 Warming-up time (waiting time)

Before the application of the h.t. supply the heater starting voltage should be applied for a time not less than the warming-up time (waiting time) stated in the individual data sheets. This ensures adequate electron density to start oscillation in the required mode.

### 3.4 Heater surge current

With some tubes it may be required to limit the peak value of the heater when switching on the heater supply. Individual data sheets give information on this, together with the cold heater resistance to assist in the design of a suitable surge current limiting circuit.

### 3.5 Heater supply frequency

When not mentioned specifically the heater supply should be D.C. or 50 to 60 Hz A.C.

## 4. OPERATING CHARACTERISTICS

The values published for these characteristics must be considered as the outcome of measurements on an average magnetron. Individual magnetrons may show a certain spread around the published values, whereas during life the values may be subject to variation. In the published data the spread and variation during life have in many cases be accounted for by mentioning maximum and/or minimum values of the characteristics.

The performance of a magnetron being greatly influenced by the load of the magnetron and by the characteristics of the input pulse, it is strongly recommended that the magnetron be operated at the published operating conditions only. Whenever it is considered to operate the magnetron at conditions substantially different from those indicated, the tube manufacturer should be consulted.

## 5. TYPICAL CHARACTERISTICS

The characteristics tabulated under this heading give general information on the magnetron independent of any specific kind of operation. The data should be regarded as pertaining to an average magnetron representative of the particular type. When necessary maximum and/or minimum values of the characteristics have been given to include the spread shown by individual samples and the variation which may occur during life.

## 6. H.T. SUPPLY AND MODULATORS

### 6.1 General

The dynamic impedance of magnetrons is in general low; thus small variations in the applied voltage can cause appreciable changes in operating current. In the equipment design it is necessary to ensure that such variations in operating current do not lead to operation outside the published limits.

Current changes result in variation of power, frequency and frequency spectrum quality and consequent deterioration of equipment performance. This factor should determine the maximum current change inherent in the equipment design under the worst operating conditions.

### 6.2 C.W. type magnetrons

For c.w. types the amount of smoothing required in the h.t. supply depends on the amount of modulation, resulting from operating current variation, which can be tolerated.

Under certain operational conditions a c.w. magnetron can develop a negative resistance characteristic and a minimum value of series resistance which should be adjacent to the magnetron is given in individual data sheets.

### 6.3 Pulse type magnetrons

To ensure a constant operating condition with a pulsed magnetron the modulator design must provide a pulse, the amplitude of which does not vary to any significant extent from pulse to pulse. Moreover, the energy per pulse delivered to the magnetron, if arcing occurs, should not considerably exceed the normal energy per pulse. Further design precautions depend on the type of modulator employed, and can not be generalised.

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The performance of a magnetron is often a sensitive function of the shape of the voltage pulse that it receives and it is necessary to control four distinct aspects: rate of rise, spike, flatness and rate of fall. In this connection it is important that any observation of the shape of the pulse, either of voltage or of current, supplied by the modulator should be made with a magnetron load and not with a dummy load, because a magnetron acts as a non-linear impedance. Furthermore, a magnetron is likely to be sensitive to a mismatched load.

6.3.1 Rate of rise of voltage

Both maximum and minimum rate of rise of voltage (and sometimes of current) may be specified. The most critical value is that just before and during the inition of oscillation. Too high or low a rate of rise may accentuate the tendency to moding.

Too high a rate of rise may cause operation in the wrong mode or even failure to oscillate, and either of these conditions may lead to arcing resulting in overheating or to excessive voltages.

Operation at too low a rate of rise of voltage may also cause oscillation in the wrong mode or oscillation in the normal mode at less than full current for an appreciable period and this will cause frequency pushing leading to a broad frequency spectrum.

Generally the rate of rise of voltage between the 20 and 80% points of the peak voltage is nearly linear and provides a good impression of the rate of rise at the onset of oscillation. In other cases, however, it may be necessary to measure the rate of rise above the 80% point.
For accuracy it is advisable to measure the rate of rise by means of a differentiating circuit or an oscilloscope. The total capacitance of the removable measuring device should be small with respect to the total stray capacitance of the modulator output circuit and in most cases not exceed 6pF.

6.3.2 Spike

It is important that the voltage pulse should not have a high spike on the leading edge. Such a spike may cause the magnetron to start in an undesired mode. Although this operation may not be sustained, the transient condition may lead to destructive arcing. Measures taken to reduce the spike must not also reduce the rate of rise below the specified minimum.

6.3.3 Flat

The top of the voltage pulse should be free from ripple or droop since small changes in voltage cause large current variations resulting in frequency pushing. This leads to frequency modulation of the r.f. pulse and consequent broadening of the spectrum or instability.

6.3.4 Rate of fall

The fall of voltage must be rapid at least to the point where oscillation ceases, to avoid appreciable periods of operation below full current, with the attendent frequency pushing. This point is normally reached when the voltage has fallen to about 80% of the peak value.

Beyond this point a lower rate of fall is generally permissible, but a significant amount of noise will be generated, which may be detrimental to radar systems with a very short minimum range. To prevent noise being generated especially in short wave radars the voltage tail must decay to zero before the radar receiver recovers.

A fast rate of fall is also important where a magnetron is operated at a high pulse recurrence frequency since any diode current which occurs after oscillations have ceased will add appreciably to the mean current and dissipation of the tube.

In certain applications it is desirable to return the cathode to a positive d.c. bias in order to speed up the rate of fall and to prevent diode current being passed during the inter-pulse period.

## 7. LOADING

The anode current range shown in the individual data sheets is related to a voltage standing wave ratio seen by the magnetron of maximum 1.5 to 1. Operation of the magnetron with a voltage standing wave ratio in excess of 1.5 is not recommended as this may reduce the current range for stable operation and can cause arcing and moding. A ratio near unity will benefit tube life and reliability.

When the length of the transmission line between the magnetron and the load is large compared with the wavelength the maximum permissible value of the voltage standing wave ratio may be reduced due to the occurence of socalled long line effects. When a long transmission line can not be avoided a load isolator must be inserted between the magnetron and the line.

## 8. LOAD DIAGRAM

In general the published data include a load diagram, a circle diagram in which for fixed input conditions the output power and the frequency change of the concerning magnetron are plotted against the magnitude and the phase (varied over 180 electrical degrees) of the voltage standing wave ratio representing the load as seen by the magnetron.

In some cases the magnitude of the voltage standing wave ratio (VSWR) has been replaced by the magnitude of the reflection coefficient ( $\gamma$ ) these magnitudes being related by the formulae:

$$\mathrm{VSWR} = \frac{1+\gamma}{1-\gamma} \qquad \gamma = \frac{\mathrm{VSWR}-1}{\mathrm{VSWR}+1}$$

The load diagram provides information on the behaviour of the magnetron to load conditions. The pulling figure for instance may be readily determined.

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With a load of bad mismatch and at a particular phase there is a region on the load diagram which is characterised by high power output and convergence of the frequency contours. This region is known as "the sink" and the phase of the load at which the magnetron behaves in this manner is known as "the phase of sink". Operation of the magnetron under this load condition will lead to instability and may cause failure of the magnetron. By matching the r.f. system such that the maximum permitted voltage standing wave ratio is not exceeded, the sink will be avoided.

## 9. OPERATION IN DUPLEXER SYSTEMS

### 9.1 Position of t.r. cell

Where the r.f. system incorporates a t.r. cell a bad load mismatch, which is unavoidable, is seen by the magnetron momentarily until the cell has been ionised. If the phase of this mismatch is such that it is in the phase of sink the build up of oscillation of the magnetron may be prevented. It is therefore essential that the t.r. cell is so positioned that its phase of mismatch as seen by the magnetron is remote from the sink region.

### 9.2 Position of minimum

In the non-oscillating condition the magnetron presents at its frequency of oscillation a bad mismatch of considerable magnitude to the r.f. system. This property is utilised in certain duplexer systems. In the design of such a system it is necessary to know the phase of the above load mismatch and this is designated as the position of the first minimum of the voltage standing wave in relation to a reference plane on the magnetron output system.

## 10. CONDITIONING

In new magnetrons and in magnetrons which have not been in use for some time a slight amount of gas may be present, which may give rise to excessive arcing and instability when the magnetron is put into operation at normal operating power. It is therefore recommended that after a period of idleness operation should be started at reduced voltage. The voltage is then increased gradually until arcing occurs. By this arcing gas in the tube is cleaned up so that after some time the magnetron will operate stably. The voltage is then increased again until arcing starts again. This procedure is repeated until normal operating conditions have been reached.

## 11. COOLING

The limiting values on temperatures mentioned in the individual data sheets should on no account be exceeded. It may be necessary in practical equipment to provide additional coolant on account of high environmental temperatures due to restrictions imposed by the cabinet and the associated components within the cabinet, and to high ambient temperatures at the equipment location.

For tubes with natural cooling mounting on a heat-conducting non-magnetic plate

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(heatsink) is recommended. To obtain an effective cooling a vertical position of the heatsink may be advantageous in most cases.

Where air or water cooling is necessary, interlock switches should be provided to prevent operation in the event of failure or reduction of cooling medium.

Cooling air should not contain dust, moisture or grease. Cooling 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 demineralised water should be employed.

## 12. PRESSURISATION

The limiting values and operating characteristics quoted in the published data are given for a pressure down to 650 mm of mercury unless otherwise stated. In the case of high power magnetrons it may be necessary to pressurise the output waveguide in order to prevent electrical breakdown. Advice is given in the individual data sheets. Precautionary steps should be taken to prevent operation in the event of failure of the pressurisation. In order to avoid dielectric breakdown, clean and dry air or suitable gas must be used.

## 13. INPUT AND OUTPUT CONNECTIONS

### 13.1 Input connection

The negative h.t. voltage line must be connected to the common heater-cathode terminal. When this connection is made to the other end of the heater the anode current will pass trough the heater, which may result in heater burn-out.

In order to prevent high transient voltages between heater and cathode a capacitor should be connected directly across the heater terminals. Generally a 1000 V rated capacitor of 4000 pF will do for this purpose.

The connections to the input terminals should make good electrical contact, but they should not be rigid and allow for some expansion to meet the rather high temperature differences which may occur in practice.

### 13.2 Output connection

The connection to the output must be designed to be sufficiently tight to avoid arcing and other poor contact effects. However, undue stress of the output section should be avoided as this may lead to deformation of the metal parts or to breakage of the glass or ceramic vacuum seals. Special attention should be paid in this connection to stress which may occur due to temperature differences.

It is important that the type of output coupling be as specified in the data sheets. Use of flat coupling instead of choke coupling, for instance, may upset the matching and possibly cause breakdown of the output system.

## 14. HANDLING AND MOUNTING

When handling and mounting a magnetron a distance of at least 5 cm should be maintained between the magnet and any piece of magnetic material to avoid mechanical shocks to the magnet or to the glass or ceramic seals. For this reason it is required to use non-magnetic tools during installation, such as non-magnetic stainless steel, brass, beryllium copper and aluminium. Furthermore, the user should be aware of the detrimental influence of the strong magnetic field around the magnet on watches and other precision instruments.

In general a magnetron is mounted by means of its mounting flange. The input assembly and the output system are usually not suited for supporting the magnetron. The mounting surface should be sufficiently flat to avoid deformation of the mounting flange and the mounting should be sufficiently flexible and adjustable so that no strain is exerted on the output system when the mounting nuts are tightened and the output system is coupled to the waveguide in the equipment.

When a dust cover is placed on the output flange it should be kept in place until the magnetron is mounted into the equipment. Before putting the magnetron into operation the user should make sure that the input and output are entirely clean and free from dust, moisture and grease.

## 15. STORAGE

Packaged magnetrons must be stored in such a way as to prevent a decrease of the field strength of the magnetron magnets due to interaction with adjacent magnets. When not otherwise mentioned in the individual data sheets it is advisable to maintain a minimum distance of 15 cm between the magnetrons.
The best protection for the tube is its original packing because this ensures an adequate spacing between the magnetrons and other magnets or ferrous objects and, moreover, protects the magnetron against reasonable vibrations and shocks. Despite this controlled spacing, magnetically - sensitive instruments such as compasses, electrical meters and watches should not be brought close to a bank of packaged magnetrons.

When a magnetron is protected by a moisture-proof container this fact is clearly stated on the outside. Unnecessary opening of the seal should be avoided so that the dessicant is not exhausted rapidly.

When a magnetron is temporarily taken out of the equipment it should be replaced immediately in its proper container. This is a good practice which obviates the risk of damage to the magnet or the glass or ceramic parts and prevents the entry of foreign matter into the output aperture.

Unpacked permanent-magnet tubes should never be placed on steel benches or shelves.

When storing the magnetrons normal conditions with regard to humidity and temperature should be maintained.

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## 16. RADIATION HAZARDS

In general the shorter the wavelength of an r.f. radiation the greater the absorption by body tissues and hence for comparable power, the greater the hazard. With magnetrons the power may be sufficient to cause danger, particularly to the eyes.

If it is necessary to look directly into a magnetron output, this should be performed through an attenuating tube or through a small hole set in the wall of the waveguide at a bend. Alternatively r.f. screening such as copper gauze of mesh small compared with the wavelength must be provided.

With high power magnetrons precautions may also be necessary to reduce the stray r.f. radiation emitted through the cathode stem and other apertures, especially when the magnetron is functioning incorrectly.

High voltage magnetrons (as well as the high voltage rectifier and pulse modulator tubes) can emit a significant intensity of X-rays and protection of the operator may be necessary. When magnetron behaviour is viewed through an aperture X-rays may be present. Protection of the eye is afforded by viewing through lead glass.

# PULSED MAGNETRON

Packaged magnetron for pulsed service at a fixed frequency.

| QUICK REFERENCE DATA | | | |
|---|---|---|---|
| Frequency, fixed within the band | f | 9.415 to 9.475 | GHz |
| Peak output power | $W_{op}$ | 4 | kW |
| Construction | | packaged, flying leads | |

**HEATING:** indirect

| | | | | | |
|---|---|---|---|---|---|
| Heater voltage | $V_f$ | | 6.3 | V | 1) |
| Heater current | $I_f$ | | 0.5 | A | |
| Waiting time at $t_{amb}$ above 0 °C | $T_w$ | min. | 2 | min | |
| Waiting time at $t_{amb}$ between 0 °C and -55 °C | $T_w$ | min. | 3 | min | |

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

| | | | | | |
|---|---|---|---|---|---|
| Pulse duration | $T_{imp}$ | min. | 0.02 | μs | 2) |
| | | max. | 1.0 | μs | 2) |
| Duty factor | $\delta$ | max. | 0.001 | | |
| Peak anode current | $I_{a_p}$ | min. | 2.5 | A | |
| | | max. | 3.5 | A | |
| Mean input power | $W_i$ | max. | 13.5 | W | |
| Peak input power | $W_{ip}$ | max. | 13.5 | kW | |
| Rate of rise of anode voltage | $\frac{dV_a}{dT}$ | max. | 70 | kV/μs | 3) |
| Voltage standing wave ratio | VSWR | max. | 1.5 | | |
| Anode temperature | $t_a$ | max. | 120 | °C | |
| Heater voltage | $V_f$ | min. | 5.7 | V | |
| | | max. | 6.9 | V | |

**COOLING:** natural

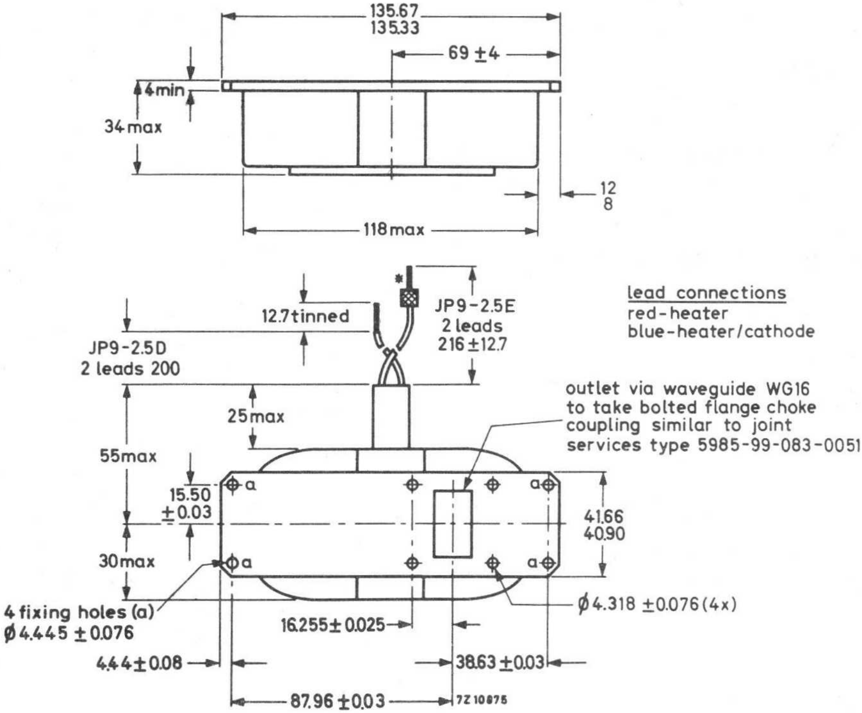
1) The magnetron is normally tested with a heater supply of 50 Hz and is suitable for operation at 1 kHz and 1.1 kHz. The manufacturer should be consulted if the magnetron is to be operated with a heater supply of any other frequency.

2) The tolerance of current pulse duration ($T_{imp}$) measured at 50% amplitude is ± 10%.

3) Defined as the steepest tangent to the leading edge of the voltage pulse above 80% amplitude.

**MECHANICAL DATA** Dimensions in mm

Net weight: 1.02 kg
Mounting position: any 8)




*JP9-2.5E wander plugs:-

Belling Lee
4 mm single pin 378/4/Red -Red lead
3 mm single pin 378A/3/Black-Blue lead

8) See page 4

## TEST CONDITIONS AND LIMITS

Test conditions

| | | | | | |
|---|---|---|---|---|---|
| Heater voltage | $V_f$ | | 6.3 | V | |
| Mean anode current | $I_a$ | | 3.0 | mA | |
| Duty factor | $\delta$ | | 0.001 | | |
| Pulse duration | $T_{imp}$ | | 1.0 | $\mu$s | 2) |
| Voltage standing wave ratio | VSWR | max. | 1.05 | | |
| Rate of rise of anode voltage | $\frac{dV_a}{dT}$ | | 70 | kV/$\mu$s | 3) |

Limits and characteristics

| | | min. | max. | | |
|---|---|---|---|---|---|
| Peak anode voltage | $V_{a_p}$ | 3.2 | 3.8 | kV | |
| Mean output power | $W_o$ | 3.0 | | W | |
| Frequency | f | 9.415 | 9.475 | GHz | |
| R.F. bandwidth at $\frac{1}{4}$ power | B | | $\frac{2.5}{T_{imp}}$ | MHz | 2) |
| Pulling figure (VSWR = 1.5) | $\Delta f_p$ | | 18 | MHz | |
| Minor lobe level (VSWR = 1.5) | | 6.0 | | dB | |
| Stability | | | 0.25 | % | 4) |
| Pushing figure | $\frac{\Delta f}{\Delta I_a}$ | | 2.5 | MHz/A | |
| Cold impedance | | see note 5 | | | |
| Frequency temperature coefficient | $-\frac{\Delta f}{\Delta t_a}$ | | 0.25 | MHz/degC | 6) |
| Input capacitance | Cak | | 9 | pF | 7) |
| Heater current at $V_f = 6.3$ V, $V_a = 0$ V | $I_f$ | 0.5 | 0.6 | A | |

## OPERATING CHARACTERISTICS

| | | | | |
|---|---|---|---|---|
| Heater voltage | $V_f$ | 6.3 | 6.3 | V |
| Pulse duration | $T_{imp}$ | 0.1 | 0.5 | $\mu$s |
| Pulse repetition rate | $f_{imp}$ | 2000 | 1000 | p.p.s. |
| Duty factor | $\delta$ | 0.0002 | 0.0005 | |
| Peak anode current | $I_{a_p}$ | 3.0 | 3.0 | A |
| Rate of rise of anode voltage | $\frac{dV_a}{dT}$ | 60 | 60 | kV/$\mu$s 3) |
| Peak anode voltage | $V_{a_p}$ | 3.6 | 3.6 | kV |
| Mean output power | $W_o$ | 0.8 | 2.0 | W |
| Peak output power | $W_{op}$ | 4.0 | 4.0 | kW |

2), 3) See page 1
4), 5), 6), 7) See page 4

## END OF LIFE PERFORMANCE

The quality of all production is monitored by the random selection of magnetrons which are then life tested under the stated test conditions. If the magnetron is to be operated under different conditions from those specified above, the manufacturer should be consulted to verify that the life will not be affected.
The magnetron is considered to have reached the end of life when it fails to meet the following limits when operated as specified under "Test conditions and limits".

| | | | | |
|---|---|---|---|---|
| Mean output power | $W_o$ | min. | 2.5 | W |
| Peak anode voltage | $V_{ap}$ | 3.2 to | 3.8 | kV |
| Frequency | f | 9.415 to | 9.475 | GHz |
| R.F. bandwidth at $\frac{1}{4}$ power | B | max. | $\frac{3.5}{T_{imp}}$ | MHz |
| Stability | | max. | 0.5 | % |

## VIBRATION

The magnetron is vibration tested to ensure that it will withstand normal conditions of service.

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4) With the magnetron operating into a VSWR of 1.5 varied through all phases over an anode current range of 2.5 mA to 3.5 mA mean. Pulses are defined as missing when the R.F. energy level is less than 70% of the normal level in the frequency range 9.415 to 9.475 GHz. Missing pulses are expressed as a percentage of the number of input pulses applied during the period of observation after a period of ten minutes operation.

5) The cold impedance of the magnetron is measured at the operating frequency and will give a VSWR of > 6. The position of voltage minimum from the face of the output flange into the magnetron is 3 mm to 9 mm for the JP9-2.5D and 0 mm to 6 mm for the JP9-2.5E.

6) Design test only. Maximum frequency change with anode temperature change after warming.

7) Design test only.

8) It is necessary to keep all magnetic material as far as possible, at least 50 mm, from the magnet and mounting plate. The inner polystyrene pack of the magnetron carton provides adequate separation between magnetrons, and it recommended that magnetrons not in use be kept in these packs.

# PULSED MAGNETRON

Packaged magnetron for pulsed service at a fixed frequency.

| QUICK REFERENCE DATA | | | |
|---|---|---|---|
| Frequency, fixed within the band | f | 9210 to 9270 | MHz |
| Peak power output | $W_{op}$ | 7.5 | kW |
| Construction | | packaged | |

**HEATING**: indirect

| | | | | | |
|---|---|---|---|---|---|
| Heater voltage | | $V_f$ | = | 6.3 | V |
| Heater current | | $I_f$ | = | 600 | mA |
| Waiting time | $t_{amb} > 0\ ^{o}C$ | $T_w$ | = min. | 2 | min. |
| | $t_{amb} < 0\ ^{o}C$ | $T_w$ | = min. | 3 | min. |

At input powers greater than 25 W the heater voltage should be reduced immediately after the application of high tension. See page 4

**COOLING**

In normal circumstances radiation and convection cooling is adequate, but where the ambient temperature is abnormally high a flow of cooling air between the radiator fins may be necessary.

**LIMITING VALUES** (Absolute limits)

| | | | | |
|---|---|---|---|---|
| Pulse duration | $T_{imp}$ | = max. | 2.5 | μs |
| Duty factor | δ | = max. | 0.0025 | |
| Peak anode current | $I_{ap}$ | = max. | 5.5 | A |
| | | = min. | 3.5 | A |
| Peak anode voltage | $V_{ap}$ | = max. | 6 | kV |
| | | = min. | 5 | kV |
| Input power | $W_{i_a}$ | = max. | 82.5 | W |
| Rate of rise of anode voltage | $\frac{\Delta V_a}{\Delta T_{rv}}$ | = max. | 60 | kV/μs |
| Voltage standing wave ratio | V.S.W.R. | = max. | 1.5 | |
| Temperature of anode block | $t_a$ | = max. | 120 | $^{o}C$ |

## TYPICAL CHARACTERISTICS

| | | | | | | |
|---|---|---|---|---|---|---|
| Frequency; fixed within the band (at anode block temperature of 45 °C) | f | = 9210 | to | 9270 | MHz |
| Peak anode voltage | $V_{a_p}$ | > | 5 kV | < | 6 | kV |
| Peak anode voltage at $I_{a_p}$ = 4.5 A | $V_{a_p}$ | > | 5.3 kV | < | 5.7 | kV |
| Peak output power at $I_{a_p}$ = 4.5 A | $W_{o_p}$ | > | 7 kW | | | |
| Pulling figure at V.S.W.R. = 1.5 | $\Delta f_p$ | | | < | 15 | MHz |
| Negative temperature coefficient | $-\frac{\Delta f}{\Delta t}$ | | | < | 0.25 | MHz per °C |
| Distance of voltage standing wave minimum from face of mounting plate inwards | d | > | 16.5 mm | < | 22.5 | mm |
| Input capacitance | $C_{ak}$ | | | < | 8 | pF |

## OPERATING CHARACTERISTICS

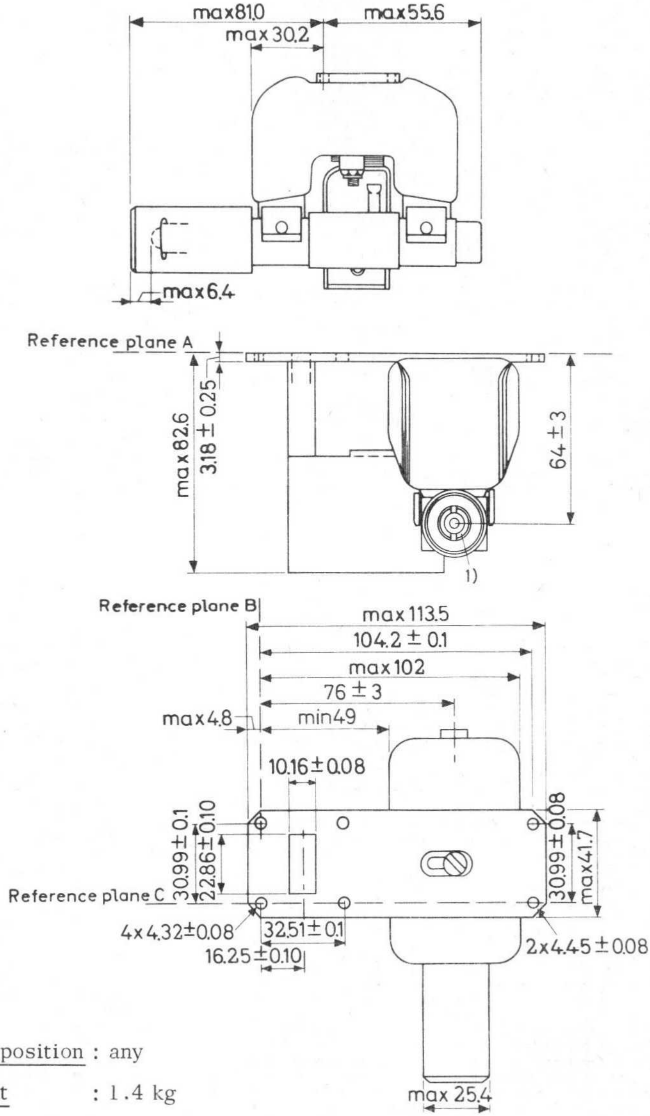
| | | | | |
|---|---|---|---|---|
| Heater voltage | $V_f$ | = | 6.3 | V |
| Pulse duration | $T_{imp}$ | = | 1.0 | µs |
| Pulse repetition frequency | $f_{imp}$ | = | 1000 | Hz |
| Duty factor | $\delta$ | = | 0.001 | |
| Peak anode current | $I_{a_p}$ | = | 4.5 | A |
| Peak anode voltage | $V_{a_p}$ | = | 5.5 | kV |
| Rate of rise of voltage | $\frac{\Delta V_a}{\Delta T_{rv}}$ | = | 50 | kV/µs |
| Average anode current | $I_a$ | = | 4.5 | mA |
| Average input power | $W_{i_a}$ | = | 24.7 | W |
| Peak output power | $W_{o_p}$ | = | 7.5 | kW |
| Pulling figure (V.S.W.R. = 1.5) | $\Delta f_p$ | = | 14 | MHz |

## MAGNETRON OUTPUT

To fasten the magnetron base plate to the RG-52/U waveguide the bolted flange choke coupling joint-services type 5985-99-0830051 should be used.

## MECHANICAL DATA

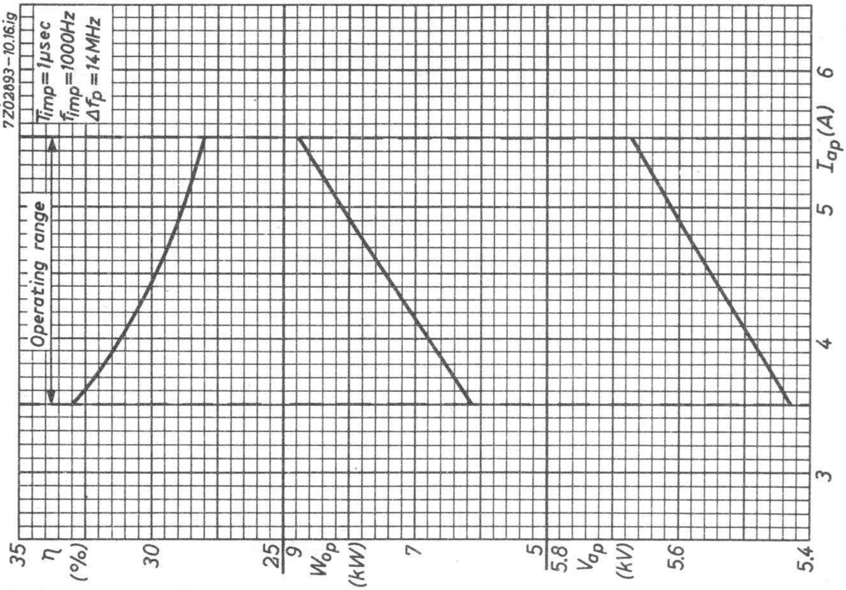
Dimensions in mm

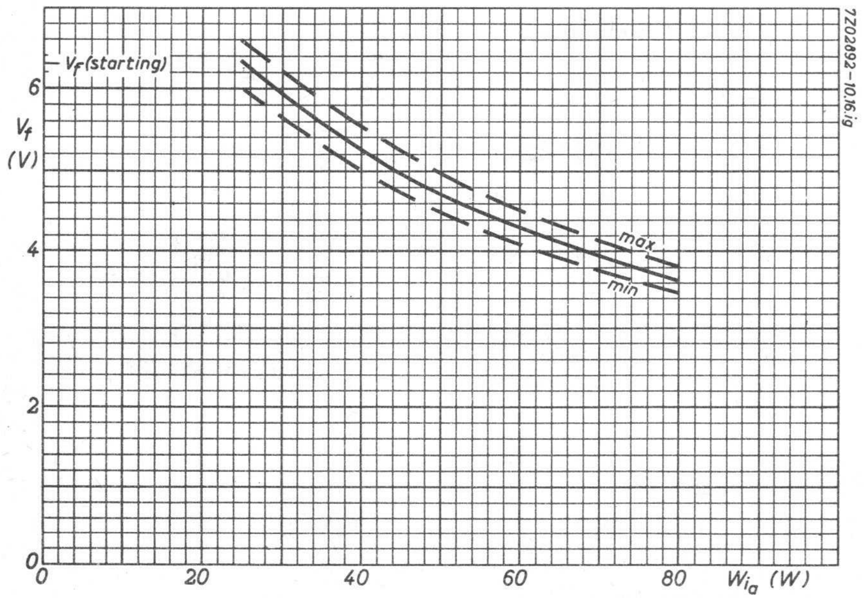



Mounting position : any

Net weight : 1.4 kg

1) Miniature bayonet cap


7Z02893-10.16.ig
$T_{imp}$ = 1μsec
$f_{imp}$ = 1000Hz
$\Delta f_p$ = 14MHz
Operating range
$I_{ap}$ (A)
6
5
4
3
35
η
(%)
30
25
9
$W_{op}$
(kW)
7
5
5.8
$V_{ap}$
(kV)
5.6
5.4


7Z02892-10.16.ig
$V_f$ (starting)
$V_f$
(V)
6
4
2
0
0
20
40
60
80
$W_{ia}$ (W)
max
min

# PULSED MAGNETRON

Packaged magnetron for pulsed service at a fixed frequency.

| QUICK REFERENCE DATA | | | |
|---|---|---|---|
| Frequency, fixed within the band | f | 9345 to 9405 | MHz |
| Peak power output | $W_{o_p}$ | 10 | kW |
| Construction | | packaged | |

**HEATING**: indirect

| | | | | | |
|---|---|---|---|---|---|
| Heater voltage | | $V_f$ | = | 6.3 | V ± 5% |
| Heater current | | $I_f$ | = | 550 | mA |
| Waiting time | $t_{amb} > 0$ °C | $T_w$ | = min. | 2 | min |
| | $t_{amb} < 0$ °C | $T_w$ | = min. | 3 | min |

At input powers greater than 25 W the heater voltage should be reduced immediately after the application of high tension. See page 4.

## COOLING

In normal circumstances radiation and convection cooling is adequate, but where the ambient temperature is abnormally high a flow of cooling air between the radiator fins may be necessary to keep the block temperature below the permitted maximum.

**LIMITING VALUES** (Absolute limits)

| | | | | |
|---|---|---|---|---|
| Pulse duration | $T_{imp}$ | = max. | 1.0 | μs |
| | | = min. | 0.05 | μs |
| Duty factor | δ | = max. | 0.002 | |
| Peak anode current at $T_{imp}$ = 0.1 to 1.0 μs | $I_{a_p}$ | = max. | 6.0 | A |
| | | = min. | 4.5 | A |
| Peak anode current at $T_{imp} < 0.1$ μs | $I_{a_p}$ | = max. | 7.0 | A |
| | | = min. | 4.5 | A |
| Peak anode voltage | $V_{a_p}$ | = max. | 6.2 | kV |
| | | = min. | 5.2 | kV |

**LIMITING VALUES** (continued)

| | | | |
|---|---|---|---|
| Input power | $W_{i_a}$ | = max. 83 | W |
| Rate of rise of anode voltage | $\frac{\Delta V_a}{\Delta T_{rv}}$ | = max. 120 | kV/$\mu$s |
| Voltage standing wave ratio | V.S.W.R. | = max. 1.5 | |
| Temperature of anode block | $t_a$ | = max. 100 | $^oC$ |

**TYPICAL CHARACTERISTICS**

| | | | | | |
|---|---|---|---|---|---|
| Frequency; fixed within the band (at anode block temperature of 45 $^oC$) | f | = | | 9345 to 9405 | MHz |
| Peak anode voltage at $I_{a_p}$ = 5.5 A | $V_{a_p}$ | > | 5.4 kV | < 5.9 | kV |
| Peak output power at $I_{a_p}$ = 5.5 A | $W_{o_p}$ | > | 8 kW | | |
| Pulling figure at V.S.W.R. = 1.5 | $\Delta f_p$ | | | < 15 | MHz |
| Distance of voltage standing wave minimum from face of mounting plate inwards | d | > | 16.5 mm | < 22.5 | mm |
| Input capacitance | $C_{ak}$ | | | < 8 | pF |

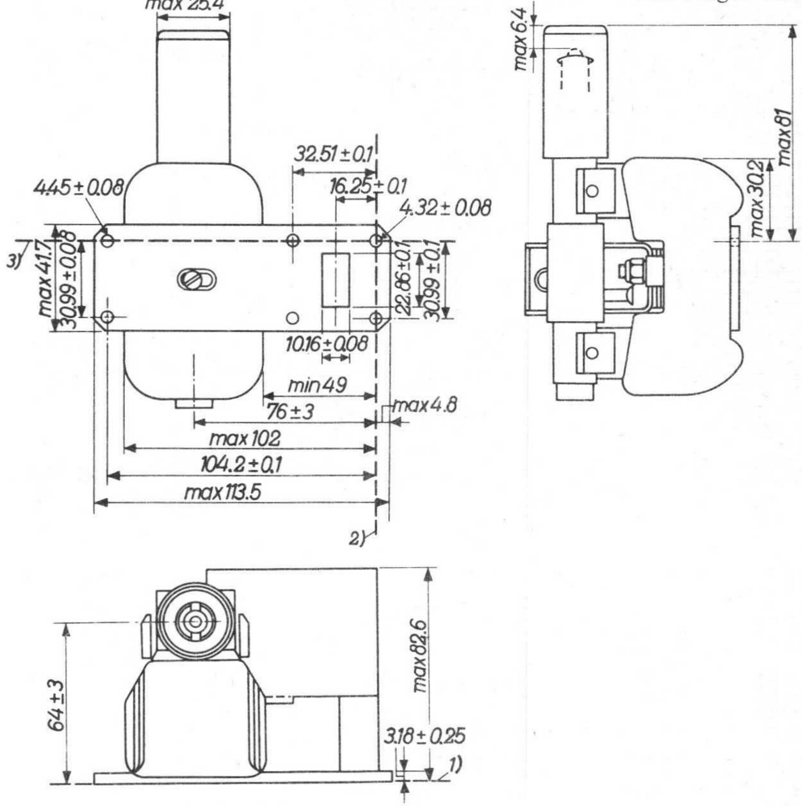
**OPERATING CHARACTERISTICS**

| | | | | | | |
|---|---|---|---|---|---|---|
| Heater voltage | $V_f$ | = | 6.3 | 6.3 | 5.8 | V |
| Pulse duration | $T_{imp}$ | = | 0.05 | 0.1 | 1.0 | $\mu$s |
| Pulse repetition frequency | $f_{imp}$ | = | 4000 | 1000 | 1000 | Hz |
| Duty factor | $\delta$ | = | 0.0002 | 0.0001 | 0.001 | |
| Peak anode current | $I_{a_p}$ | = | 7.0 | 6.0 | 5.5 | A |
| Average anode current | $I_a$ | = | 1.4 | 0.6 | 5.5 | mA |
| Peak anode voltage | $V_{a_p}$ | = | 5.9 | 5.7 | 5.6 | kV |
| Rate of rise of voltage | $\frac{\Delta V_a}{\Delta T_{rv}}$ | = | 110 | 110 | 80 | kV/$\mu$s |
| Average input power | $W_i$ | = | 8.3 | 3.4 | 31 | W |
| Peak input power | $W_{i_p}$ | = | 41.3 | 34.2 | 30.8 | kW |
| Average output power | $W_o$ | = | 2.1 | 0.95 | 9.0 | W |
| Peak output power | $W_{o_p}$ | = | 10.5 | 9.5 | 9.0 | kW |
| Pulling figure (V.S.W.R. = 1.5) | $\Delta f_p$ | = | 14 | 14 | 14 | MHz |

**MECHANICAL DATA**

Dimensions in mm

Net weight 1.4 kg




Mounting position: any

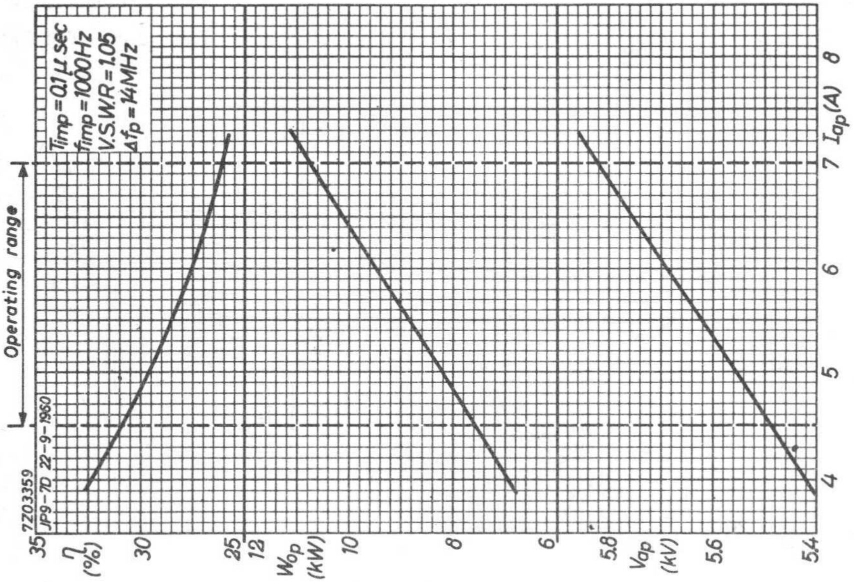
Magnetron output

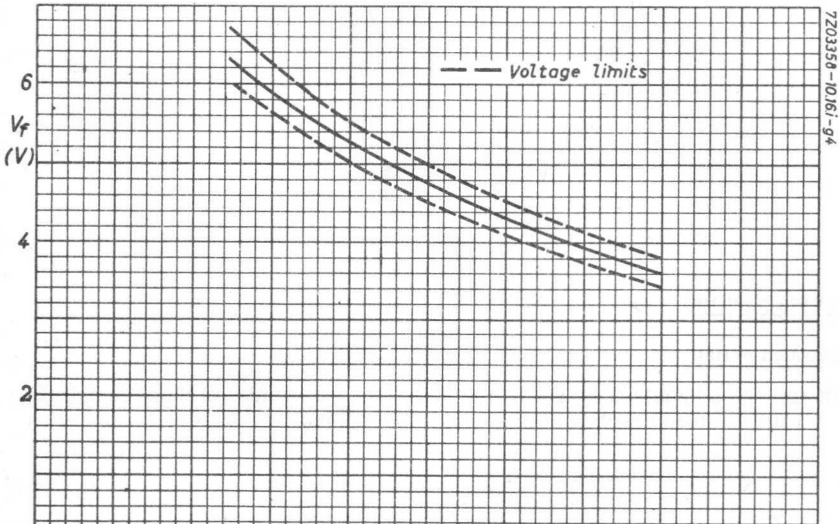
To fasten the magnetron output to the RG-52/U waveguide, a choke flange type I.S. Z83 00 51 should be inserted between these parts.

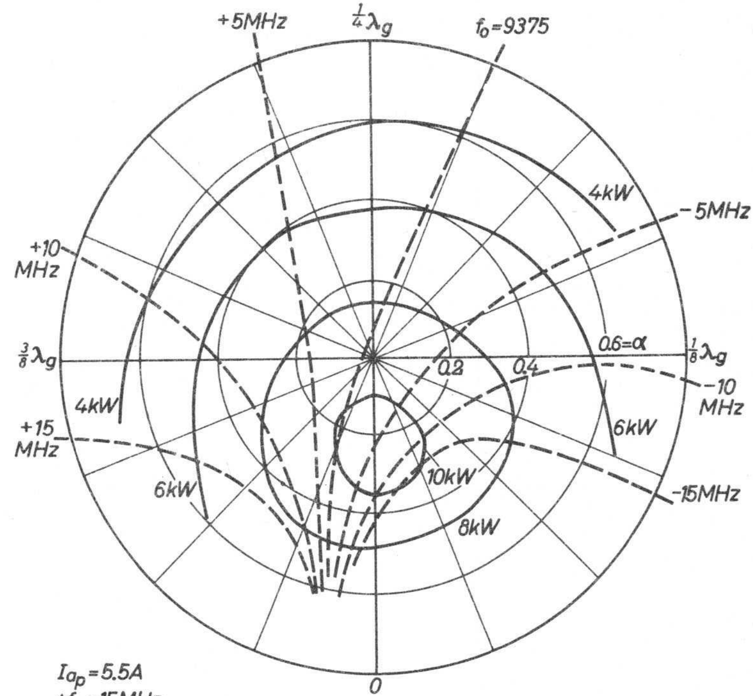
1) Reference plane A

2) Reference plane B

3) Reference plane C


Timp = 0.1 μ sec
fimp = 1000 Hz
V.S.W.R = 1.05
Δfp = 14 MHz
Operating range
7203359
JP9-7D 22-9-1960
η (%)
35
30
25
Wop (kW)
12
10
8
6
Vap (kV)
5.8
5.6
5.4
Iap (A)
4
5
6
7
8


Voltage limits
7203358-10.161-g4
Vf (V)
0
2
4
6
C
20
40
60
80
Wia (W)
100




$I_{a_p}$ = 5.5A
$\Delta f_p$ = 15MHz
α = reflection coefficient

Towards magnetron

7Z03357

# PULSED MAGNETRON

Packaged magnetron for pulsed service at a fixed frequency

| QUICK REFERENCE DATA | | | | |
|---|---|---|---|---|
| Frequency, fixed within the band | JP9-15 | f | 9345 to 9405 | MHz |
| | JP9-15B | f | 9415 to 9475 | MHz |
| Peak power output | | $W_{o_p}$ | 21 | kW |
| Construction | | | packaged | |

**HEATING:** indirect

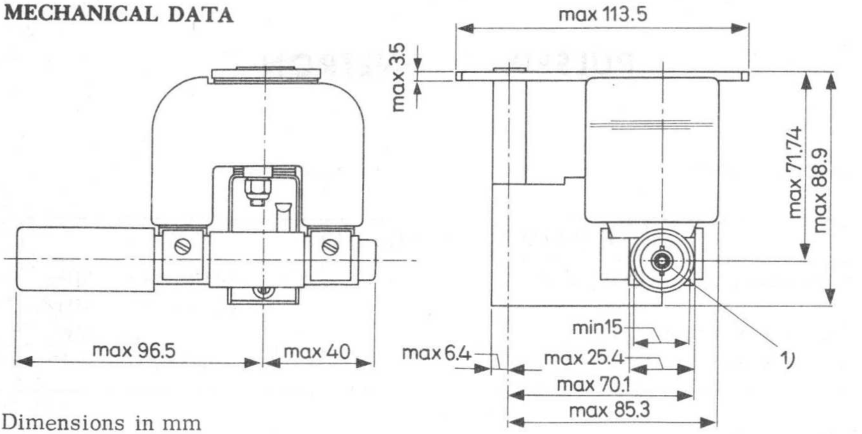
| | | | | |
|---|---|---|---|---|
| Heater voltage | $V_f$ | = | 6.3 | V |
| Heater current | $I_f$ | = | 0.55 | A |
| Cathode heating time at $t_{amb}$ above 0 °C | $T_w$ | = min. | 2 | min |
| Cathode heating time at $t_{amb}$ below 0 °C | $T_w$ | = min. | 3 | min |

For average input powers greater than 25 W it is necessary to reduce the heater voltage immediately after the application of high tension in accordance with the curve on page 5 .

**LIMITING VALUES** (Absolute limits)

| | | | | | |
|---|---|---|---|---|---|
| Pulse duration | | $T_{imp}$ | = max. | 2.5 | µs |
| Duty factor | | $\delta$ | = max. | 0.0015 | |
| Peak anode current | $T_{imp} \leqq 1\ \mu s$ | $I_{a_p}$ | = max. | 9.0 | A |
| | | | = min. | 6.0 | A |
| | $T_{imp} = 1$ to $2.5\ \mu s$ | $I_{a_p}$ | = max. | 7.5 | A |
| | | | = min. | 6.0 | A |
| Average input power | | $W_i$ | = max. | 83 | W |
| Rate of rise of anode voltage | | $\frac{\Delta V_a}{\Delta T_{rv}}$ | = max. | 100 | kV/µs |
| Voltage standing wave ratio | | VSWR | = max. | 1.5 | |
| Anode block temperature | | $t_a$ | = max. | 120 | °C |

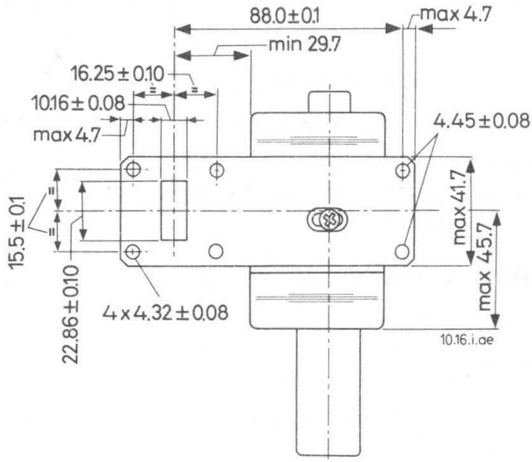
**MECHANICAL DATA**




Dimensions in mm

Net weight 1.7 kg

Mounting position: any




**MAGNETRON OUTPUT**

To fasten the magnetron base plate to the WG16 waveguide the bolted flange choke coupling inter-services type Z83 00 51 should be used.

1) Miniature bayonet cap 9.16 mm diameter

## TYPICAL CHARACTERISTICS

| | | | | | |
|---|---|---|---|---|---|
| Frequency, fixed within the band | JP9-15 | f | = | 9345 to 9405 | MHz |
| | JP9-15B | f | = | 9415 to 9475 | MHz |
| Peak anode voltage at $I_{a_p}$ = 7.5 A | | $V_{a_p}$ | = | 7.0 to 8.2 | kV |
| Peak output power at $I_{a_p}$ = 7.5 A | | $W_{op}$ | > | 17 | kW |
| Pulling figure at VSWR = 1.5 | | $\Delta f_p$ | < | 18 | MHz |
| Pushing figure | | $\frac{\Delta f}{\Delta I_{a_p}}$ | < | 1.5 | MHz per A |
| Frequency temperature coefficient | | $-\frac{\Delta f}{\Delta t}$ | < | 0.25 | MHz per $^{o}$C |
| Distance of VSW minimum from face of mounting plate inwards | | d | | > 16.5 < 22.5 | mm |
| Input capacitance | | $C_{ak}$ | < | 8.0 | pF |

## OPERATING CHARACTERISTICS

| | | | | | | |
|---|---|---|---|---|---|---|
| Heater voltage | $V_f$ | = | 6.3 | 6.3 | 6.3 | V |
| Pulse duration | $T_{imp}$ | = | 0.05 | 0.1 | 1.0 | $\mu$s |
| Pulse repetition frequency | $f_{imp}$ | = | 2500 | 2000 | 500 | Hz |
| Duty factor | $\delta$ | = | 0.000125 | 0.0002 | 0.0005 | |
| Peak anode current | $I_{a_p}$ | = | 8.0 | 7.5 | 7.0 | A |
| Average anode current | $I_a$ | = | 1.2 | 1.6 | 3.5 | mA [1]) |
| Peak anode voltage | $V_{a_p}$ | = | 7.7 | 7.6 | 7.5 | kV |
| Rate of rise of anode voltage | $\frac{\Delta V_a}{\Delta T_{rv}}$ | = | 95 | 90 | 80 | kV/$\mu$s |
| Average input power | $W_i$ | = | 7.75 | 11.4 | 26.5 | W |
| Peak input power | $W_{ip}$ | = | 62 | 57 | 53 | kW |
| Average output power | $W_o$ | = | 2.75 | 4.2 | 10 | W |
| Peak output power | $W_{op}$ | = | 22 | 21 | 20 | kW |
| Pulling figure (VSWR = 1.5) | $\Delta f_p$ | = | 17 | 17 | 17 | MHz |

[1]) Including pre-oscillation current. (In many applications involving short pulse durations and high pulse repetition frequencies the average current which would be calculated from the duty factor is increased by a pre-oscillation current.)

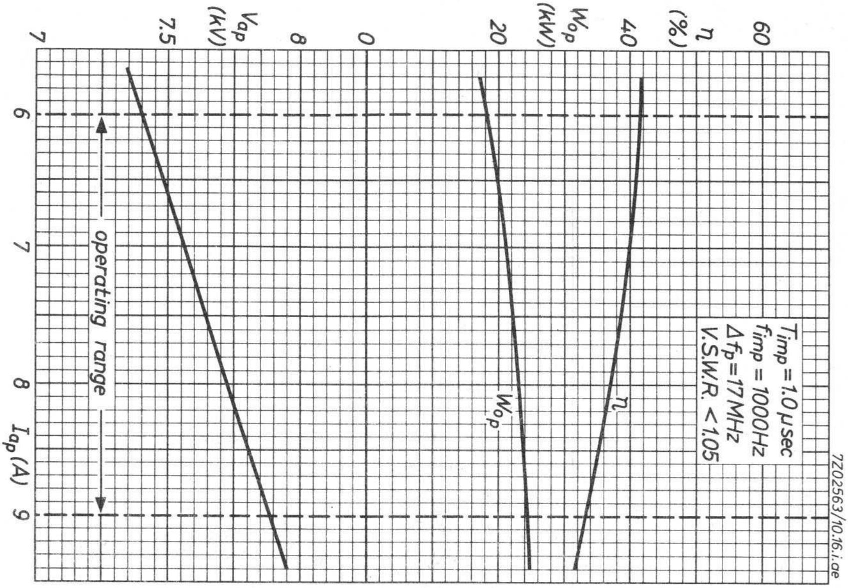
## END OF LIFE PERFORMANCE

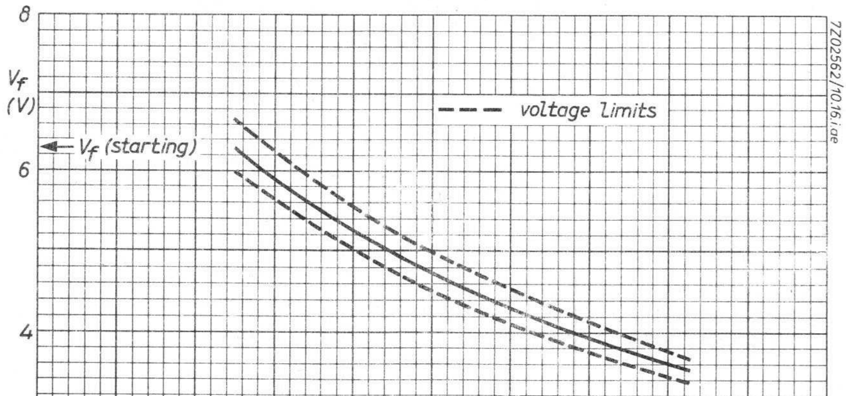
The tube is deemed to have reached the end of life when it fails to satisfy the following:

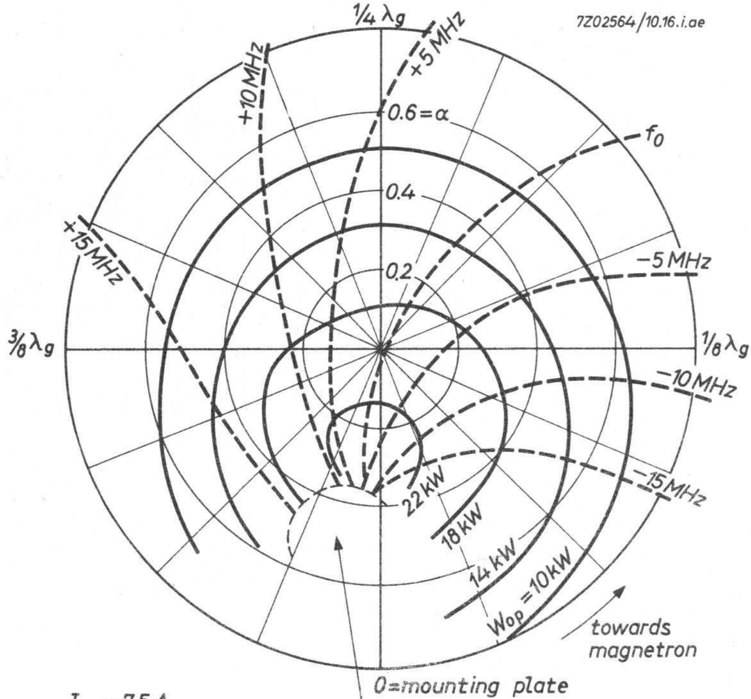
| | | | | | |
|---|---|---|---|---|---|
| Peak output power at $I_{ap}$ = 7.5 A | | $W_{op}$ | > | 15 | kW |
| Frequency within the band | JP9-15 | f | = | 9345 to 9405 | MHz |
| | JP9-15B | f | = | 9415 to 9475 | MHz |
| Peak anode voltage at $I_{ap}$ = 7.5 A | | $V_{ap}$ | = | 7.0 to 8.2 | kV |

## COOLING

In normal circumstances radiation and convection cooling is adequate, but where the ambient temperature is abnormally high, a flow of cooling air between the radiator fins may be necessary to keep the block temperature below the permitted maximum.


$V_{ap}$ (kV)
7
7.5
8
$W_{op}$ (kW)
0
20
40
η (%)
60
$I_{ap}$ (A)
6
7
8
9
operating range
$W_{op}$
η
$T_{imp}$ = 1.0 μsec
$f_{imp}$ = 1000Hz
$\Delta f_p$ = 17MHz
V.S.W.R. <1.05
7Z02563/10.16.i.ae


$V_f$ (V)
8
6
4
2
0
20
40
60
80
100
$W_i$ (W)
voltage limits
$V_f$ (starting)
7Z02562/10.16.i.ae




$I_{ap} = 7.5\,A$
$\Delta f_p = 17\,MHz$
α = reflection coefficient.
$f_0 = 9375\,MHz$ (JP9–15)
$f_0 = 9445\,MHz$ (JP9–15B)

# PULSED MAGNETRON

Packaged magnetron for pulsed service at a fixed frequency.

| QUICK REFERENCE DATA | | | |
|---|---|---|---|
| Frequency, fixed within the band | f | 9.380 to 9.440 | GHz |
| Peak output power | $W_{op}$ | 21 | kW |
| Construction | | packaged | |

**HEATING:** indirect

| | | | | |
|---|---|---|---|---|
| Heater voltage | $V_f$ | | 6.3 | V |
| Heater current | $I_f$ | | 0.55 | A |
| Peak heater starting current | $I_{fop}$ | max. | 5.0 | A |
| Cold heater resistance | $R_{fo}$ | | 1.75 | Ω |
| Waiting time at $t_{amb}$ above 0 °C | $T_w$ | min. | 2 | min |
| Waiting time at $t_{amb}$ below 0 °C | $T_w$ | min. | 3 | min |

For mean input powers greater than 25 W, it is necessary to reduce the heater voltage immediately after the application of high tension in accordance with the curve on page 4.

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

| | | | | |
|---|---|---|---|---|
| Pulse duration | $T_{imp}$ | max. | 2.5 | μs |
| Duty factor | $\delta$ | max. | 0.0015 | |
| Peak anode current | $I_{ap}$ | min. | 7.0 | A |
| | | max. | 10 | A |
| Mean input power | $W_i$ | max. | 83 | W |
| Rate of rise of anode voltage | $\frac{dV_a}{dT}$ | max. | 100 | kV/μs |
| Voltage standing wave ratio | VSWR | max. | 1.5 | |
| Anode block temperature | $t_a$ | max. | 120 | °C |

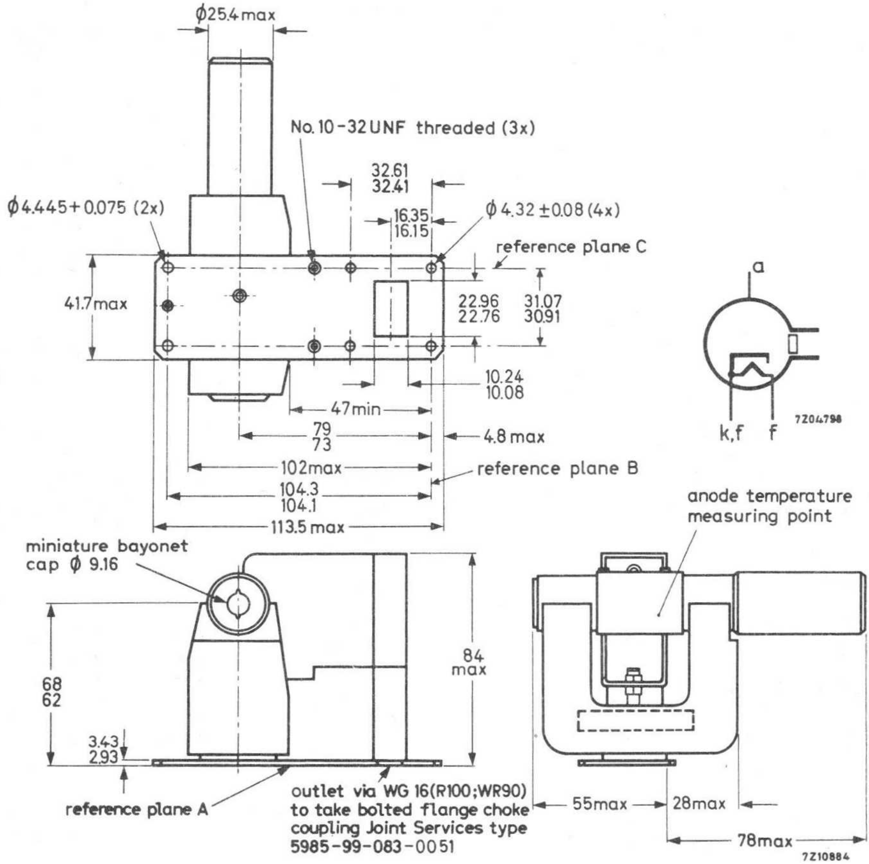
**COOLING**

In normal circumstances natural cooling is adequate, but where the ambient temperature is abnormally high, a flow of cooling air between the radiator fins may be necessary to keep the anode block temperature below the permitted maximum.

**MECHANICAL DATA**

Dimensions in mm

Net weight: 1.7 kg
Mounting position: any



## TYPICAL CHARACTERISTICS

| | | | | |
|---|---|---|---|---|
| Frequency, fixed within the band | f | 9.380 to | 9.440 | GHz |
| Peak anode voltage at $I_{ap}$ = 8.6 A | $V_{ap}$ | 7 to | 7.5 | kV |
| Peak output power at $I_{ap}$ = 8.6 A | $W_{op}$ | | > 19 | kW |
| Pulling figure at VSWR = 1.5 | $f_p$ | | < 18 | MHz |
| Pushing figure | $\frac{\Delta f}{\Delta I_{ap}}$ | | < 1.5 | MHz/A |
| Frequency temperature coefficient | $-\frac{\Delta f}{\Delta t}$ | | < 0.25 | MHz/degC |
| Distance of VSW minimum from face of mounting plate into tube | d | 16.5 to | 22.5 | mm |
| Input capacitance | Cak | | < 8 | pF |

## OPERATING CHARACTERISTICS

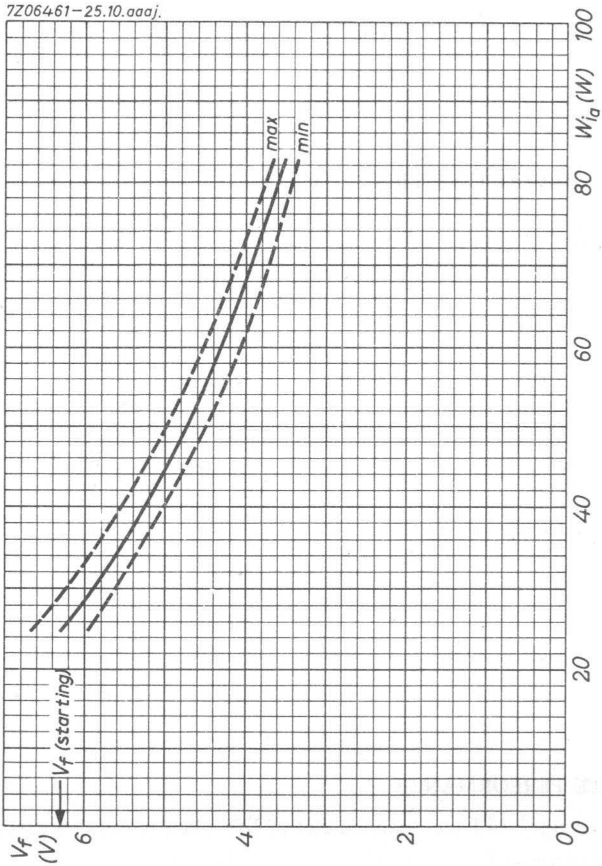
| | | | | | |
|---|---|---|---|---|---|
| Heater voltage (running) | $V_f$ | 6.3 | 5.8 | V | |
| Pulse duration | $T_{imp}$ | 0.1 | 1.0 | $\mu$s | |
| Pulse repetition rate | $f_{imp}$ | 2000 | 500 | p.p.s. | |
| Duty factor | $\delta$ | 0.0002 | 0.0005 | | |
| Peak anode current | $I_{ap}$ | 8.6 | 8.6 | A | |
| Mean anode current | $I_a$ | 1.8 | 4.3 | mA | 1) |
| Peak anode voltage | $V_{a_p}$ | 7.2 | 7.2 | kV | |
| Rate of rise of anode voltage | $\frac{dV_a}{dT}$ | 90 | 90 | kV/$\mu$s | |
| Mean input power | $W_i$ | 13 | 31 | W | |
| Peak input power | $W_{ip}$ | 62 | 62 | kW | |
| Mean output power | $W_o$ | 4.2 | 10.5 | W | |
| Peak output power | $W_{op}$ | 21 | 21 | kW | |
| Pulling figure (VSWR = 1.5) | $\Delta f_p$ | 16 | 16 | MHz | |

## END OF LIFE PERFORMANCE

The tube is deemed to have reached end of life when it fails to satisfy the following:

| | | | | |
|---|---|---|---|---|
| Peak output power at $I_{ap}$ = 8.6 A | $W_{op}$ | min. | 17 | kW |
| Frequency within the band | f | 9.380 to | 9.440 | GHz |
| Peak anode voltage at $I_{ap}$ = 8.6 A | $V_{ap}$ | 7.0 to | 7.5 | kV |

1) Including pre-oscillation current. In many applications involving short pulse durations and high pulse repetition rates the mean current which would be calculated from the duty factor is increased by a pre-oscillation current.


7Z06461-25.10.aaaj.
V_f (V)
6
4
2
0
0
20
40
60
80
100
W_ia (W)
max
min
V_f (starting)

# TUNABLE MAGNETRON

Air-cooled packaged tunable magnetron for continuous wave operation and suitable for amplitude modulation.

| QUICK REFERENCE DATA | | | |
|---|---|---|---|
| Frequency, tunable within the band | f | 9150 to 9600 | MHz |
| C.W. output power | $W_o$ | 10 | W |
| Construction | | packaged | |

**HEATING** indirect

| | | | | |
|---|---|---|---|---|
| Heater voltage | $V_f$ | = | 6.3 | V |
| Heater current | $I_f$ | = | 1.2 | A |
| Waiting time: | | | | |
| $t_{amb} < 0^oC$ | $T_w$ | = | min. 3 | min |
| $t_{amb} > 0^oC$ | $T_w$ | = | min. 2 | min |

For mean input powers greater than 20 W it is necessary to reduce the heater voltage immediately after the application of anode power in accordance with the input-power heater-voltage rating-chart on page 5.

**COOLING**

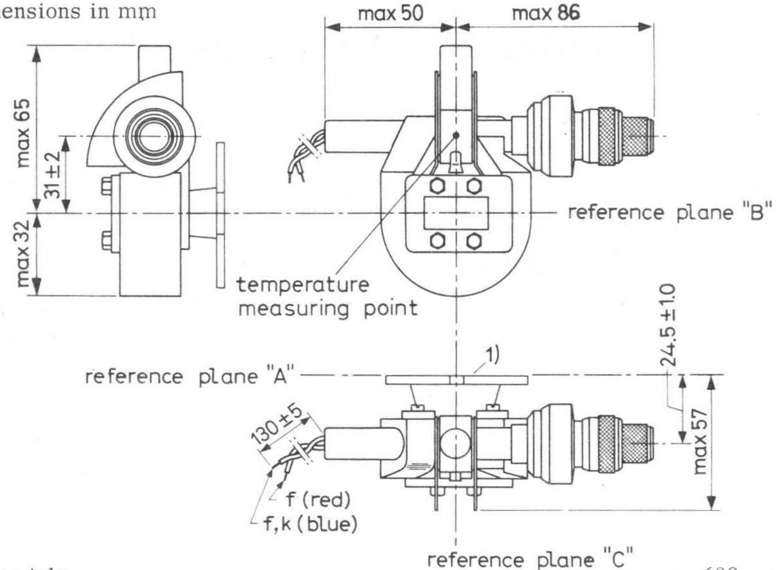
| | | | | |
|---|---|---|---|---|
| Air flow required for cooling to be directed between the radiator fins | q | > | 150 | $dm^3/min$ |

**TYPICAL CHARACTERISTICS**

| | | | | |
|---|---|---|---|---|
| Anode current | $I_a$ | = | 50 | mA |
| Anode voltage | $V_a$ | = | 900 to 1100 | V |
| Pulling figure (V.S.W.R. = 1.5) | $\Delta f_p$ | < | 20 | MHz |
| Frequency pushing | | < | 1 | MHz /mA |
| Negative temperature coefficient | | < | 0.5 | MHz /$^oC$ |
| Output power at f = 9150 to 9600 MHz | $W_o$ | > | 5 | W |

**MECHANICAL DATA**

Dimensions in mm




| | | | |
|---|---|---|---|
| Net weight | = | 680 | g |
| Number of turns to cover the tuning range | ><br>< | 4<br>8 | |
| Tuning torque | < | 2.3 | kgcm |
| Tuning backlash | < | 5 | MHz |

There is no limit to the number of tuning sweeps which may be carried out within the stated frequency range

**OPERATING CHARACTERISTICS**

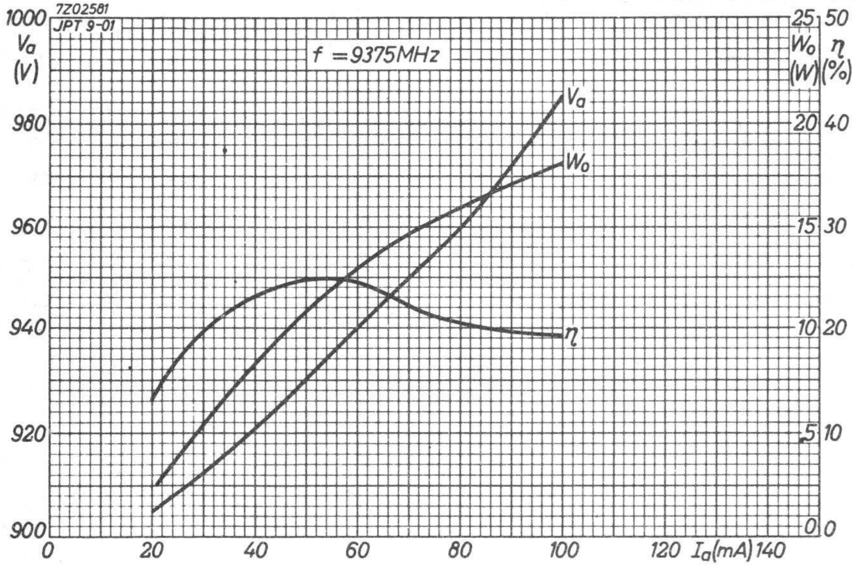
| | | | | | | |
|---|---|---|---|---|---|---|
| Limiting resistor in series with the magnetron | | | | | 1 | kΩ |
| Frequency | f | = | 9200 | 9400 | 9550 | MHz |
| Running heater voltage | $V_f$ | = | 4.5 | 4.5 | 4.5 | V |
| Anode voltage | $V_a$ | = | 920 | 930 | 930 | V |
| Anode current | $I_a$ | = | 50 | 50 | 50 | mA |
| Pulling figure (V.S.W.R. = 1.5) | $\Delta f_p$ | = | 19 | 16 | 14 | MHz |
| Output power | $W_o$ | = | 10.5 | 10.5 | 9.8 | W |

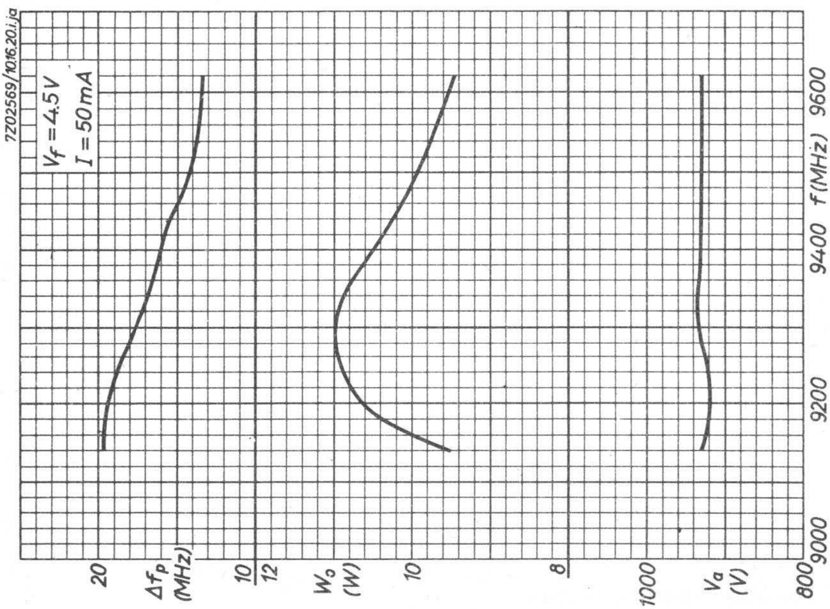
1) Wave guide output system RG-52/U (British designation WG16)
Wave guide coupling system Z 83 000 3 = 5985-99-083 000 3

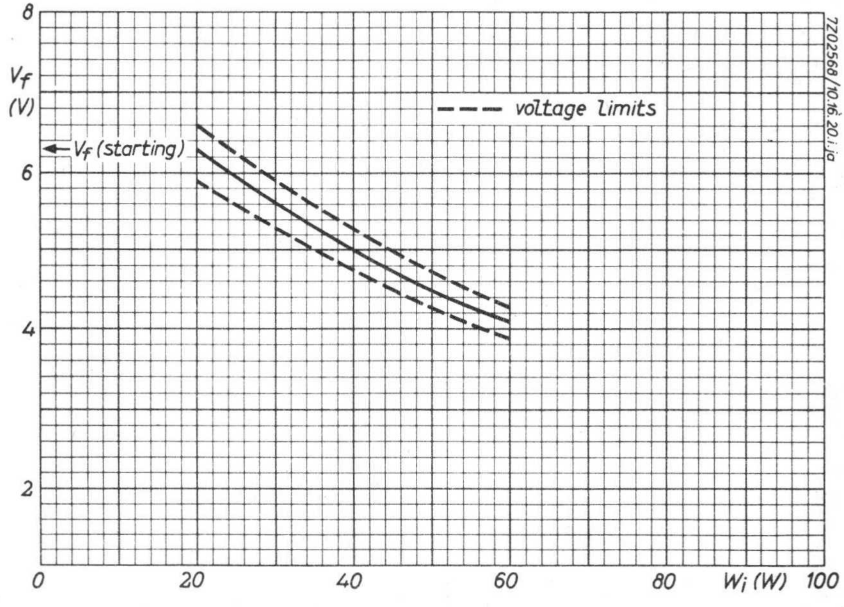
**LIMITING VALUES** (Absolute limits)

| | | | | | |
|---|---|---|---|---|---|
| Anode voltage | $V_a$ | = | max. | 1150 | V [1] |
| | | = | min. | 850 | V [1] |
| Anode current | $I_a$ | = | max. | 60 | mA |
| | | = | min. | 20 | mA |
| Peak anode current | $I_{ap}$ | = | max. | 100 | mA [1] |
| Anode supply D.C. power | $W_{ia}$ | = | max. | 60 | W |
| Voltage standing wave ratio | V.S.W.R. | = | max. | 1.5 | |
| Temperature of anode block | $t_a$ | = | max. | 140 | $^o$C |

[1]) Modulated continuous wave


7Z02581
JPT 9-01
f = 9375MHz
1000
$V_a$
(V)
980
960
940
920
900
0
20
40
60
80
100
120
$I_a$(mA)
140
$V_a$
$W_o$
η
25
50
$W_o$
(W)
η
(%)
20
40
15
30
10
20
5
10
0
0


7Z02569/1016.20.i.ja
$V_f$ = 4.5V
I = 50mA
20
$\Delta f_p$
(MHz)
10
12
$W_o$
(W)
10
8
1000
$V_a$
(V)
800
9000
9200
9400
f (MHz)
9600


8
$V_f$
(V)
6
4
2
0
20
40
60
80
100
$W_i$ (W)
--- voltage limits
← $V_f$ (starting)
7Z02568/10.16.20.i.ia

# PULSED MAGNETRON

Packaged magnetron for pulsed service at a fixed frequency. The output system has been designed for coupling to a standard rectangular waveguide RG-52/U (EIA designation WR90) with outside dimensions $\frac{1}{2}$ in x 1 in.

| QUICK REFERENCE DATA | | | |
|---|---|---|---|
| Frequency, fixed within the band | f | 9190 to 9320 | MHz |
| Peak output power | $W_{o_p}$ | 3 | kW |
| Construction | | packaged | |

**HEATING:** indirect

| | | | | |
|---|---|---|---|---|
| Heater voltage | $V_f$ | = | 6.3 | V ± 5% |
| Heater current at $V_f$ = 6.3 V | $I_f$ | = | 0.5 | A |

At ambient temperatures above 0 °C the cathode must be heated for at least 2 minutes before the application of high voltage. Below this temperature the heating time must be increased to at least 3 minutes.

**TYPICAL CHARACTERISTICS**

| | | | | |
|---|---|---|---|---|
| Frequency, fixed within the range | f | = | 9190 to 9320 | MHz |
| Negative temperature coefficient | $-\frac{\Delta f}{\Delta t}$ | < | 0.25 | MHz/°C |
| Pulling figure at voltage standing wave ratio 1.5 | $\Delta f_p$ | < | 18 | MHz |
| Pushing figure | $\frac{\Delta f}{\Delta I_{a_p}}$ | < | 2.5 | MHz/A |
| Distance of voltage standing wave minimum from face of mounting plate into magnetron | d | = | 0 to 6 | mm |
| Peak anode voltage at $I_{a_p}$ = 3 A | $V_{a_p}$ | = | 3.2 to 3.8 | kV |
| Input capacitance | $C_{ak}$ | < | 9 | pF |

**COOLING:** Radiation and convection

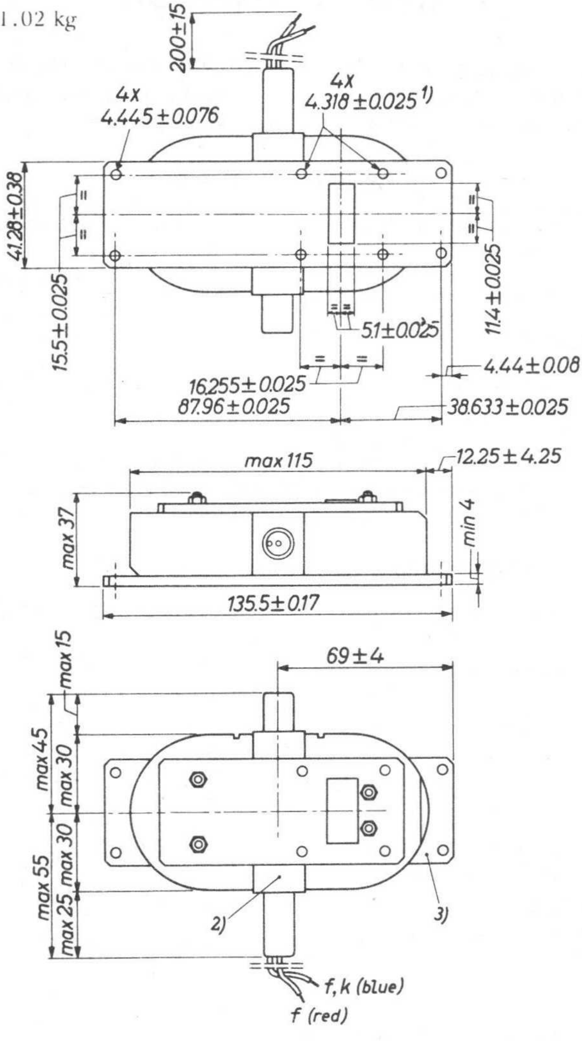
**MAGNETRON OUTPUT**

To fasten the magnetron base plate to the RG-52/U waveguide the bolted flange choke coupling joint-services type 5985-99-0830051 should be used.

## MECHANICAL DATA

Dimensions in mm

Net weight: 1.02 kg




Mounting position: any

---

[1]) Holes for locating pins, depth 4 mm

[2]) Point for temperature measurement

[3]) The anode is terminated at the base plate

**LIMITING VALUES** (Absolute limits)

Each limiting value should be regarded independently of other values, so that under no circumstances it is permitted to exceed a limiting value whichsoever.

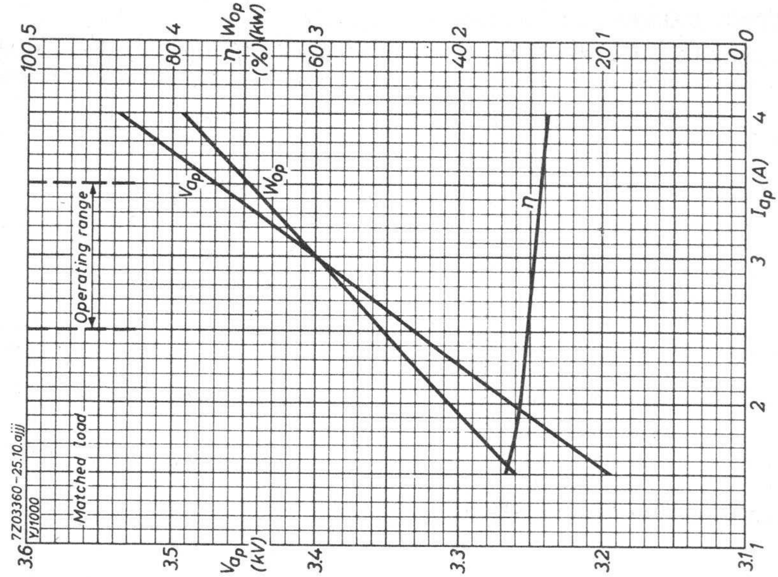
| | | | | |
|---|---|---|---|---|
| Pulse duration | $T_{imp}$ | = max. | 1 | μs |
| | | = min. | 0.02 | μs |
| Duty factor | δ | = max. | 0.001 | |
| Peak anode current | $I_{a_p}$ | = max. | 3.5 | A |
| | | = min. | 2.5 | A |
| Average input power | $W_i$ | = max. | 13 | W |
| Rate of rise of anode voltage | $\frac{\Delta V_a}{\Delta T_{r_v}}$ | = max. | 60 | kV/μs |
| Voltage standing wave ratio | V.S.W.R. | = max. | 1.5 | |
| Temperature of anode block (see note 2) page 2) | $t_a$ | = max. | 120 | °C |

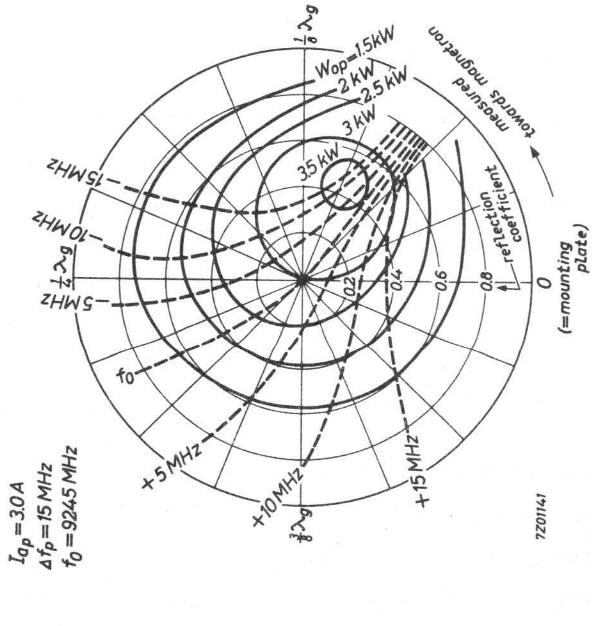
**OPERATING CHARACTERISTICS**

| | | | | |
|---|---|---|---|---|
| Heater voltage | $V_f$ | = | 6.3 | V |
| Pulse duration | $T_{imp}$ | = | 0.1 | μs |
| Duty factor | δ | = | 0.0002 | |
| Pulse repetition rate | $f_{imp}$ | = | 2000 | Hz |
| Peak anode voltage | $V_{a_p}$ | = | 3.4 | kV |
| Rate of rise of anode voltage | $\frac{\Delta V_a}{\Delta T_{r_v}}$ | = | 50 | kV/μs |
| Average anode current | $I_a$ | = | 600 | μA |
| Peak anode current | $I_{a_p}$ | = | 3 | A |
| Average input power | $W_i$ | = | 2 | W |
| Peak input power | $W_{i_p}$ | = | 10 | kW |
| Average output power | $W_o$ | = | 0.6 | W |
| Peak output power | $W_{o_p}$ | = | 3 | kW |
| Pulling figure at voltage standing wave ratio 1.5 | $\Delta f_p$ | = | 15 | MHz |

**END OF LIFE PERFORMANCE**

| | | | | |
|---|---|---|---|---|
| Peak output power at $I_{a_p}$ = 3 A | $W_{o_p}$ | = | 2 | kW |
| Frequency within the band | f | = | 9190 to 9320 | MHz |
| Peak anode voltage at $I_{a_p}$ = 3 A | $V_{a_p}$ | = | 3.2 to 3.8 | kV |


7Z03360-25.10.ajjj
YJ1000
Matched load
Operating range
$V_{ap}$ (kV)
η (%)
$W_{op}$ (kW)
$I_{ap}$ (A)
$V_{ap}$
$W_{op}$
η
3.6
3.5
3.4
3.3
3.2
3.1
100 5
80 4
60 3
40 2
20 1
0 0
1
2
3
4


$I_{ap}$ = 3.0 A
$\Delta f_p$ = 15 MHz
$f_0$ = 9245 MHz
$W_{op}$ = 1.5 kW
2 kW
2.5 kW
3 kW
3.5 kW
15 MHz
10 MHz
5 MHz
$f_0$
+5 MHz
+10 MHz
+15 MHz
$\frac{1}{8}\lambda_g$
$\frac{1}{4}\lambda_g$
$\frac{3}{8}\lambda_g$
0.2
0.4
0.6
0.8
reflection coefficient
0 (= mounting plate)
measured towards magnetron
7Z01141

# PULSED MAGNETRON

Servo-tunable air cooled packaged magnetron for use as a pulsed oscillator in navigational, search and fire-control radar systems. It can be pulsed by a hard-tube, line type or magnetic modulator.

| QUICK REFERENCE DATA | | | |
|---|---|---|---|
| Frequency, tunable within the band | $f$ | 8.5 to 9.6 | GHz |
| Peak output power | $W_{op}$ | 225 | kW |
| Construction | | packaged | |

**HEATING**: indirect by A.C. or D.C.

| | | | | | |
|---|---|---|---|---|---|
| Heater voltage, starting and stand-by | $V_{f_o}$ | = | 13.75 | V ± 10 | % |
| Heater current at $V_f$ = 13.75 V | $I_f$ | = | 3.1 | A ±0.2 | A |
| Heater surge peak current | $I_{f\,surge\,p}$ | = | max. | 12 | A |
| Cold heater resistance | $R_{f_o}$ | > | | 0.53 | Ω |
| Heating time before application of high voltage ($V_f$ = 13.75 V) | $T_w$ | = | min. | 2.5 | min |

Immediately after the high voltage has been applied, the heater voltage must be reduced in accordance with the formula:

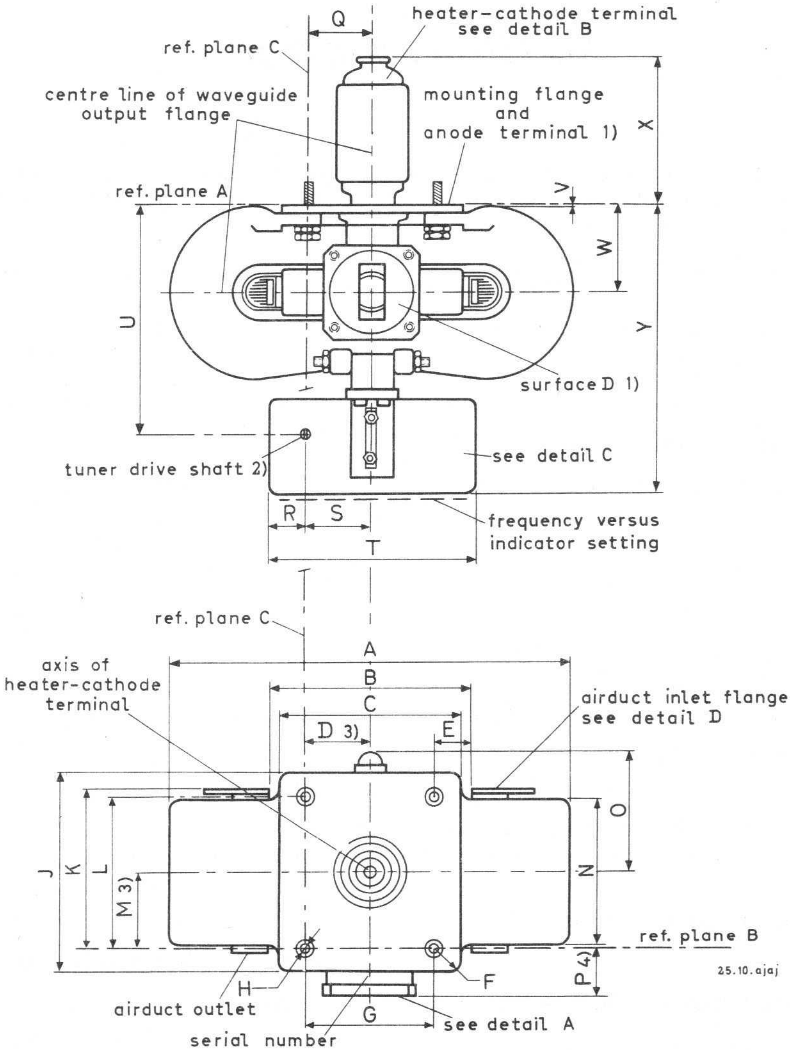
$$V_f = 13.75\left(1 - \frac{W_i}{450}\right) \text{ V}$$ (see page11)

where $W_i$ (in W) = duty factor x peak anode current (in A) x 21500.
When $W_i$ > 450 W the heater voltage should be switched off.

**TYPICAL CHARACTERISTICS**

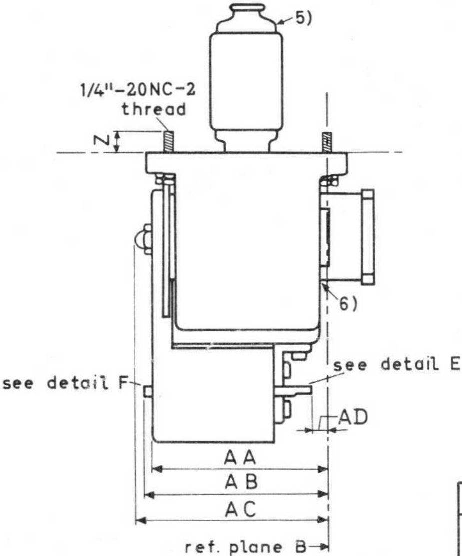
| | | | | |
|---|---|---|---|---|
| Frequency | $f$ | = | 8.5 to 9.6 | GHz |
| Pulling figure (V.S.W.R. = 1.5) | $\Delta f_p$ | < | 13.5 | MHz |
| Peak anode voltage at $I_{ap}$ = 27.5 A | $V_{ap}$ | = | 20 to 23 | kV |
| Capacitance anode to cathode | $C_{ak}$ | = | 9 to 13 | pF |

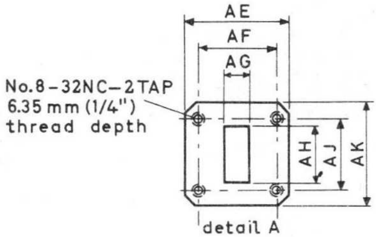
## MECHANICAL DATA




For notes see page 5

## MECHANICAL DATA (continued)



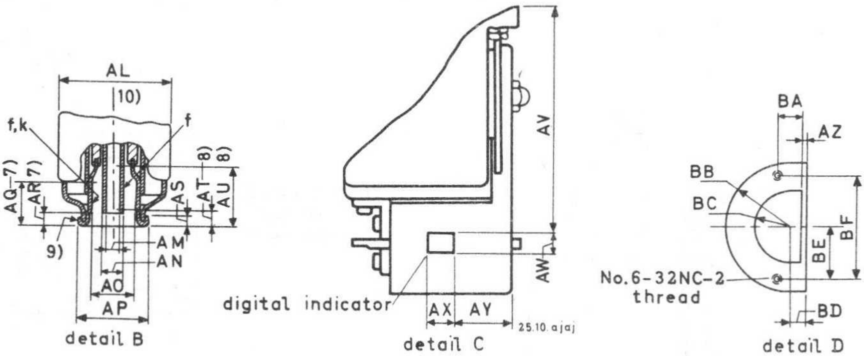



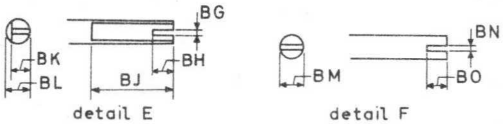

The millimeter dimensions have been derived from inches.

| | mm | inch |
|---|---|---|
| A | 195.25 max. | 7.687 max. |
| B | 95.94 ±1.19 | 3.777 ±.047 |
| C | 88.09 max. | 3.468 max. |
| D | 31.75 | 1.25 |
| E | 16.26 ±1.57 | .640 ±.062 |
| F | 10.31 ±0.79 | .406 ±.031 |
| G | 63.5 ±0.25 | 2.500 ±.010 |
| H | 7.14 ±0.12 | .281 ±.005 |
| J | 98.42 max. | 3.875 max. |
| K | 79.37 ±1.57 | 3.125 ±.062 |
| L | 76.20 ±0.25 | 3.000 ±.010 |
| M | 38.10 | 1.500 |
| N | 73.02 max. | 2.875 max. |
| O | 58.42 max. | 2.300 max. |

| | mm | inch |
|---|---|---|
| P | 23.01 ±0.79 | .906 ±.031 |
| Q | 31.75 ±1.19 | 1.250 ±.047 |
| R | 17.47 max. | .688 max. |
| S | 31.75 ±1.57 | 1.250 ±.062 |
| T | 101.6 max. | 4.000 max. |
| U | 109.52 ±2.39 | 4.312 ±.094 |
| V | 0.79 min. | .031 min. |
| W | 42.06 ±1.19 | 1.656 ±.047 |
| X | 68.25 ±1.57 | 2.687 ±.062 |
| Y | 139.7 max. | 5.500 max. |
| Z | 11.12 ±1.57 | .438 ±.062 |
| AA | 83.82 max. | 3.300 max. |
| AB | 92.30 max. | 3.633 max. |
| AC | 96.52 max. | 3.800 max. |
| AD | 7.92 ±1.57 | .312 ±.062 |
| AE | 46.48 ±0.76 | 1.830 ±.030 |
| AF | 37.44 ±0.10 | 1.474 ±.004 |
| AG | 12.62 ±0.25 | .497 ±.010 |
| AH | 28.50 ±0.25 | 1.122 ±.010 |
| AJ | 34.34 ±0.10 | 1.352 ±.004 |
| AK | 46.48 ±0.76 | 1.830 ±.030 |

**MECHANICAL DATA** (continued)




The millimeter dimensions have been derived from inches.

| | mm | inch |
|---|---|---|
| AL | 44.45 max. | 1.750 max. |
| AM | 4.29 ±0.12 | .169 ±.005 |
| AN | 6.35 ±0.38 | .250 ±.015 |
| AO | 13.72 +0.12 -0.20 | .540 +.005 -.008 |
| AP | 21.08 +0.20 -0.12 | .830 +.008 -.005 |
| AQ | 13.11 min. | .516 min. |
| AR | 3.96 max. | .156 max. |
| AS | 3.17 ±0.25 | .125 ±.010 |
| AT | 3.97 ±0.79 | .156 ±.031 |
| AU | 19.05 min. | .750 min. |
| AV | 105.08 ±3.81 | 4.137 ±.150 |
| AW | 9.13 ±0.79 | .359 ±.031 |
| AX | 12.70 ±1.57 | .500 ±.062 |
| AY | 28.19 ±1.57 | 1.110 ±.062 |
| AZ | 2.03 ±0.50 | .080 ±.020 |
| BA | 8.74 ±0.79 | .344 ±.031 |

| | mm | inch |
|---|---|---|
| BB | 25.4 max. | 1.000 max. |
| BC | 13.97 +0.43 -0.81 | .550 +.017 -.032 |
| BD | 6.35 ±0.79 | .250 ±.031 |
| BE | 19.05 ±0.38 | .750 ±.015 |
| BF | 38.10 ±0.79 | 1.500 ±.031 |
| BG | 1.01 +0.12 -0.00 | .040 +.005 -.000 |
| BH | 3.94 ±1.01 | .155 ±.040 |
| BJ | 15.88 ±0.79 | .625 ±.031 |
| BK | 3.96 ±0.25 | .156 ±.010 |
| BL | 4.77 ±0.025 | .188 ±.001 |
| BM | 4.77 ±0.025 | .188 ±.001 |
| BN | 1.01 +0.12 -0.00 | .040 +.005 -.000 |
| BO | 3.94 ±1.01 | .155 ±.040 |

**MECHANICAL DATA** (continued)

| | | | | |
|---|---|---|---|---|
| Mounting position: | any | | | |
| Support: | mounting flange | | | |

The waveguide output has been designed for coupling to standard rectangular waveguide RG-51/U

Waveguide output flange — couples to modified UG-52A/U or UG-52B/U flange

| | | | | |
|---|---|---|---|---|
| Tuner torque: max. permissible value | = | 13.8 | cm kg |
| running | typ. | 0.5 | cm kg |
| starting | max. | 1.5 | cm kg |
| Number of turns of drive shaft to cover the freq. range from 8.5 to 9.6 GHz | approx. | 160 | turns |
| Net weight | max. | 5.9 | kg |

---

1) Surface D (diameter 1.625", 41.3 mm) of the waveguide output flange, and the entire surface of the mounting flange are made so that they may be used to provide a hermetic seal.
All points of the mounting flange surface will be within 0.38 mm (.015") above or below reference plane A.

2) Viewing directly towards the waveguide flange, a clockwise rotation of the drive shaft decreases the frequency.

3) The axis of the heater-cathode terminal will be within the confines of a cylinder whose radius is 1.19 mm (.047") and whose axis is perpendicular to reference plane A at the specified location.

4) The limits include angular as well as lateral deviations.

5) Temperature of heater-cathode terminal measured here.

6) Anode temperature measured at junction of waveguide and anode block.

7) These dimensions define extremities of the 13.72 mm (.540") internal diameter of the cylindrical heater-cathode terminal.

8) These dimensions define extremities of the 4.29 mm (.169") internal diameter of the cylindrical heater terminal.

9) No part of the connector device for the heater and heater-cathode terminals should bear against the underside of this lip.

10) The heater terminal and the heater-cathode terminal are concentric to within 0.25 mm (.010").

**LIMITING VALUES** (Absolute limits)

Each limiting value should be regarded independently of other values, so that under no circumstances it is permitted to exceed a limiting value whichsoever.

| | | | | | |
|---|---|---|---|---|---|
| Pulse duration [1] | $T_{imp}$ | = | max. | 2.75 | μs |
| Duty factor | $\delta$ | = | max. | 0.0011 | |
| Heater starting voltage | $V_{fo}$ | = | max. | 15 | V |
| Heater surge peak current | $I_{f\,surge\,p}$ | = | max. | 12 | A |
| Peak anode current [1] | $I_{a_p}$ | = | min. | 15 | A |
| | | = | max. | 30 | A |
| Average anode input power | $W_i$ | = | max. | 630 | W |
| Peak anode input power | $W_{i_p}$ | = | max. | 630 | kW |
| Rate of rise of anode voltage [1] | | | | | |
| for pulse duration ≦ 1.5 μs | $\frac{\Delta V_a}{\Delta T_{r_v}}$ | = | min. | 70 | kV/μs |
| | | = | max. | 225 | kV/μs |
| for pulse duration > 1.5 μs | $\frac{\Delta V_a}{\Delta T_{r_v}}$ | = | min. | 70 | kV/μs |
| | | = | max. | 200 | kV/μs |
| Voltage standing wave ratio | V.S.W.R. | = | max. | 1.5 | |
| Anode temperature [2] | $t_a$ | = | max. | 150 | °C |
| Cathode and heater terminal temperature [3] | t | = | max. | 165 | °C |

The output assembly must always be pressurized. When the magnetron is not working into a matched load, the pressure on the output window must be higher than 1 kg/cm$^2$ absolute.

| | | | | | |
|---|---|---|---|---|---|
| Input pressurization | p | = | min. | 0.85 | kg/cm$^2$ abs. |
| | | | | (625 | mm Hg) |
| Output pressurization | p | = | max. | 3.2 | kg/cm$^2$ abs. |

[1]) See section "Pulse definitions".

[2]) For point of measurement see note 6 on the outline drawing.

[3]) For point of measurement see note 5 on the outline drawing.

## OPERATING CHARACTERISTICS

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Pulse duration [1] | $T_{imp}$ | = | 0.13 | 0.34 | 0.6 | 1 | μs |
| Pulse repetition frequency | $f_{imp}$ | = | 2000 | 2080 | 1670 | 1000 | Hz |
| Duty factor | $\delta$ | = | 0.00026 | 0.0007 | 0.001 | 0.001 | |
| Peak anode voltage [1] | $V_{ap}$ | = | 21 | 21 | 21.5 | 21.5 | kV |
| Rate of rise of voltage pulse | $\frac{\Delta V_a}{\Delta T_{rv}}$ | = | 200 | 200 | 200 | 200 | kV/μs |
| Peak anode current [1] | $I_{ap}$ | = | 24 | 24 | 27.5 | 27.5 | A |
| Heater voltage, running | $V_f$ | = | 9.7 | 3 | 0 | 0 | V |
| Average output power | $W_o$ | = | 52 | 140 | 225 | 225 | W |
| Peak output power | $W_{op}$ | = | 200 | 200 | 225 | 225 | kW |

The manufacturer should be consulted whenever it is considered to operate the magnetron at conditions substantially different from those given above.

## COOLING

An adequate flow of cooling air should be directed through the ducts in the magnetron to keep the temperature of the anode block below 150 °C under any condition of operation. If necessary, the heater-cathode terminal should also be cooled to keep its temperature below 165 °C.

## PRESSURE

The mounting flange and the output waveguide flange are designed to permit the use of pressure seals. For further particulars see under "Limiting values".

## LIFE

The life of the magnetron depends on the operating conditions, and is expected to be longer at shorter pulse lengths.

[1]) See section "Pulse definitions".

## STARTING A NEW MAGNETRON

This magnetron is provided with a getter, so that ageing of a new magnetron or of a magnetron that has been idle or stored for a period of time, will not be necessary in most cases. If, however, the magnetron is put into operation and some sparking and instability occur incidentally, it is recommended to increase the anode current gradually and to operate the magnetron with reduced input during 15 to 30 minutes. After this period sparking usually ceases.

## TUNING MECHANISM

The frequency of the magnetron decreases at clockwise rotation of the tuner drive shaft, as viewed directly towards the waveguide flange.

A digital indicator provides a visual indication of the magnetron frequency. A number of frequencies and the corresponding indicator settings are indicated on the wall of the tuner box (see outline drawing).

Axial stress on the tuning mechanism should be avoided. The tuner shaft should therefore be driven via a flexible coupling. The torque on the tuner shaft must never exceed 13.8 cm kg. Adjustment of the tuning mechanism beyond the stated frequency limits must not be attempted. The starting torque required to operate the tuner shaft is max. 1.5 cm kg. The tuner drive should be capable of supplying 2.3 cm kg.

## CIRCUIT NOTES

a. In order to prevent heater burn-out the negative high-voltage pulse must be applied to the common cathode-heater terminal.

b. If no load isolator is inserted between the magnetron and the transmission line, the latter should be as short as possible to prevent long-line effects. Under no circumstances should the magnetron be operated with a V.S.W.R. of the load exceeding 1.5. A ratio kept near unity will benefit tube life and reliability.

c. The modulator must be so designed that, if arcing occurs, the energy per pulse delivered to the magnetron does not considerably exceed the normal energy per pulse.

d. It is required to bypass the magnetron heater with a 1000 V rated capacitor of min. 4000 pF directly across the heater terminals.

e. Any diode current flowing during the intervals between the pulses should be taken into account when the peak anode current is calculated from the measured average anode current.
The occurrence of this diode current can be avoided by preventing that during the intervals between the pulses the anode voltage becomes positive with respect to the cathode.

f. The unwanted noise that may occur when the anode pulse voltage drops below the value required for oscillation can be minimized by making the trailing edge of the voltage pulse as steep as possible.

## PULSE CHARACTERISTICS AND DEFINITIONS

The smooth peak value ($V_{ap}$ or $I_{ap}$) of a pulse is the maximum value of a smooth curve through the average of the fluctuations over the top portion of the pulse as shown in the figures below.

The rate of rise of anode voltage is defined by the steepest tangent to the leading edge of the voltage pulse above 50 % of the smooth peak value (fig.1). Any capacitance used in a removable viewing system shall not exceed 6 pF. For calculation of the rate of rise of anode voltage the 100 % value must be taken as 21.5 kV.

The pulse duration ($T_{imp}$) is the time interval between the two points on the current pulse at which the current is 50 % of the smooth peak current (fig.2).

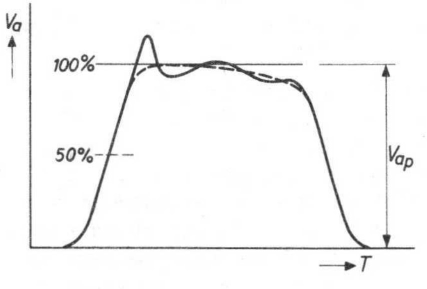



Fig.1

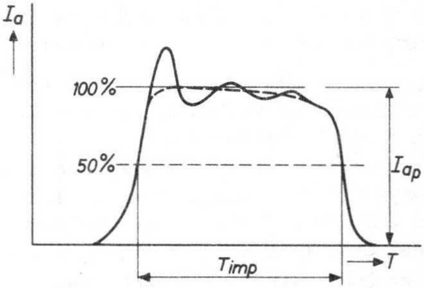



Fig.2

The current pulse must be substantially square and the ripple over the top portion of the current pulse must be kept as small as possible to avoid unwanted frequency modulation due to pushing effects. The spike on the top portion of the pulse must be small to avoid excessive peak pulse current. The leading edge of the pulse must be free from irregularities.

## STORAGE, HANDLING AND MOUNTING

The original packing should be used for the transport of the magnetron.

The magnetron should never be held by the heater-cathode stem. Rough treatment of the envelope and of the cooling fins may impair the electrical characteristics or may result in loss of vacuum.

When storing, the packaged magnetrons should be kept not less than 15 cm (6 inches) apart, to prevent a decrease of field strength of the magnetron magnet as a result of interaction with the adjacent magnets. If the magnetrons are stored in their original inner container, no special precautions need be taken with regard to the distance apart. If the magnetrons are stored without their inner container, they should be stored in non-magnetic surroundings e.g. on wooden shelves. When the tubes can not be stored at normal temperature and atmosphere they must be stored in protective packing.

When handling and mounting the magnetron, a minimum distance of 5 cm (2 inches) between the magnet and any piece of magnetic material should be maintained to avoid mechanical shocks to the magnet or to the glass of the heater-cathode stem. For this reason it is required to use non-magnetic tools during installation, such as non-magnetic stainless steel, brass, beryllium copper and aluminium. Furthermore, the user should be aware of the detrimental influence of the strong magnetic field around the magnet on watches and other precision instruments nearby.

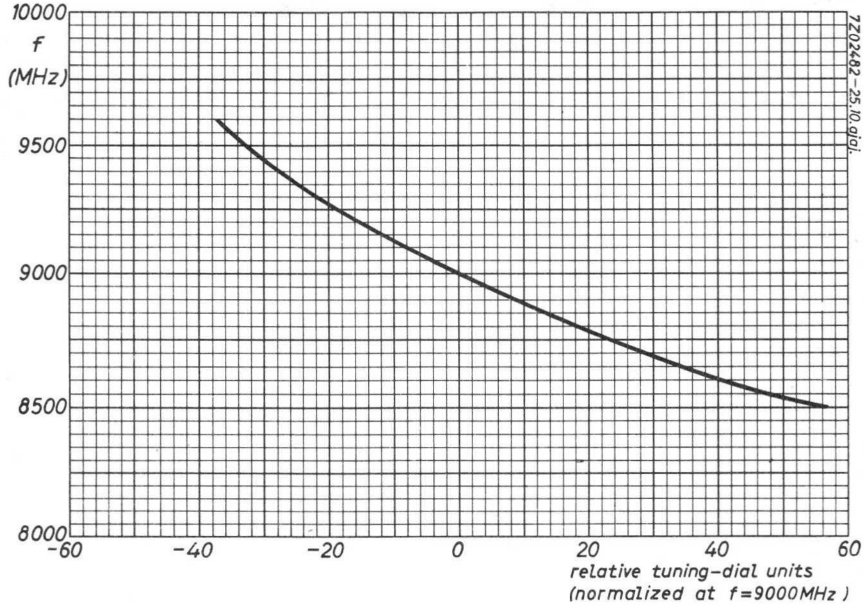
A dust-cover is placed on the output flange, to keep its opening closed until the tube is mounted into the equipment. Before putting the magnetron into operation, the user should make sure that the output waveguide and the recessed cathode terminal are entirely clean and free from dust and moisture.

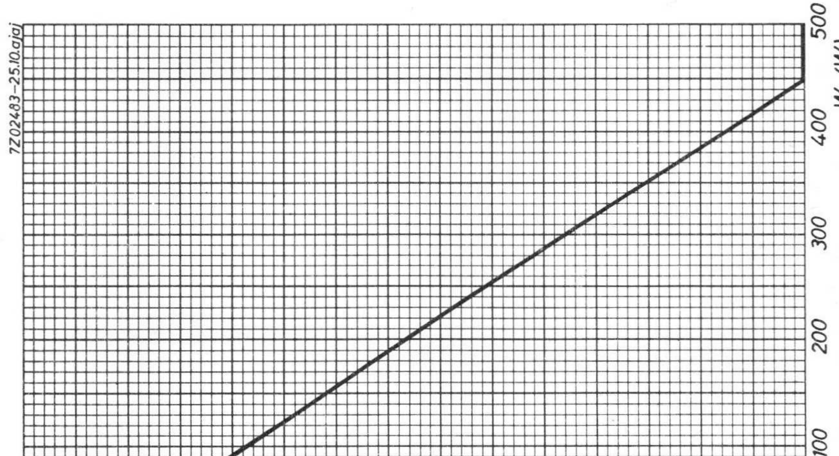
The magnetron should be mounted by means of its mounting flange; it should be secured to the chassis by means of the four captive screws (thread 1/4"-20NC-2). Special attention has been given to the flatness of the mounting flange so that, if necessary, a pressure seal can be made for the input assembly. Consequently, the mounting surface should be sufficiently flat to avoid deformation of the flange. Furthermore, the mounting should be sufficiently flexible and adjustable so that no strain is exerted on the output system when the mounting nuts are tightened and when the output system is being coupled to the waveguide in the equipment.

To fasten the magnetron output flange to the RG-51/U waveguide, a choke flange type UG-52A/U or UG-52B/U should be used. These flanges must be modified by reaming the four mounting holes with a No.15 drill. It can then be fastened to the magnetron output flange by means of four bolts of size 8-32. This connection should be such that a reliable contact is established, in order to avoid arcing and other bad contact effects.

Flexible non-magnetic conduits should be fastened to both air inlet flanges, by means of non-magnetic 6-32 screws.

A connector with flexible supply leads should be used for the connection of heater and heater-cathode terminals.


10000
f
(MHz)
9500
9000
8500
8000
-60
-40
-20
0
20
40
60
relative tuning-dial units
(normalized at f=9000MHz)
7Z02482-25.10.ajaj.


7Z02483-25.10.ajaj
500
$W_i$ (W)
400
300
200
100
0
14
$V_f$
(V)
12
10
8
6
4
2
0

# PULSED MAGNETRON

Tunable air cooled packaged magnetron for use as a pulsed oscillator at frequencies between 8.5 and 9.6 GHz. This magnetron is capable of delivering a peak output power of approximately 225 kW and can be pulsed by a hard tube, line type or magnetic modulator.
The YJ1011 differs mechanically from the YJ1010 in the location of the tuning control and the micrometer type indicator provided to facilitate frequency calibration of each tube. The tuning knob must be pushed in to engage the tuning mechanism.

| QUICK REFERENCE DATA | | | |
|---|---|---|---|
| Frequency, tunable within the band | f | 8.5 to 9.6 | GHz |
| Peak output power | $W_{op}$ | 225 | kW |
| Construction | | packaged | |

## GENERAL

Cathode

Heating: indirect by A.C. or D.C.

| | | | | |
|---|---|---|---|---|
| Heater voltage, starting and stand-by | $V_f$ | | 13.75 | V ± 10 % |
| Heater current at $V_f$ = 13.75 V | $I_f$ | | 3.1 | A ±0.2 A |
| Heater surge peak current | $I_{f\,surge_p}$ | max. | 12 | A |
| Cold heater resistance | $R_{fo}$ | min. | 0.53 | Ω |
| Heating time before application of high voltage ($V_f$ = 13.75 V) | $T_w$ | min. | 2.5 | min |

Immediately after the high voltage has been applied, the heater voltage must be reduced in accordance with the formula:

for $W_i$ up to 450 W: $V_f = 13.75\ (1 - \frac{W_i}{450})$ V (See sheet 9)

for $W_i > 450$ W : $V_f = 0$ V

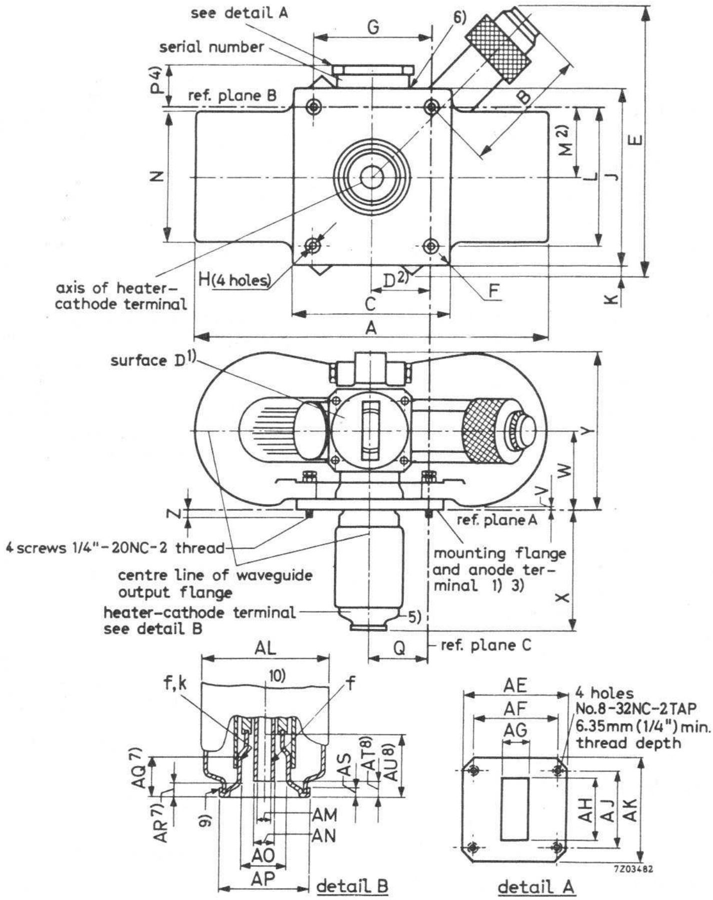
where $W_i$ (in W) = duty factor x peak anode current (in A) x 21500

Date based on pre-production tubes

**MECHANICAL DATA**

Support: Mounting flange

Net weight: approx. 5.5 kg




Mounting position: any

The waveguide output has been designed for coupling to standard rectangular waveguide RG-51/U.

Waveguide output flange: Couples to modified UG-52A/U or UG-52B/U flange.

Dimensional outline notes

1. Surface D (diameter 1.625", 41.3 mm) of the waveguide output flange, and the entire surface of the mounting flange are made so that they may be used to provide a hermetic seal.

## OUTLINE DIMENSIONS

Millimeter dimensions have been derived from inches.

| Dim. | mm | inch |
|---|---|---|
| A | 195.25 max. | 7.687 max. |
| B | 69.85 max. | 2.75 max. |
| C | 88.09 max. | 3.468 max. |
| D | 31.75 | 1.25 |
| E | 152.40 max. | 6.0 max. |
| F | 10.31 ± 0.79 | .406 ± .031 |
| G | 63.5 ± 0.25 | 2.500 ± .010 |
| H | 7.14 ± 0.12 | .281 ± .005 |
| J | 98.42 max. | 3.875 max. |
| K | 15.95 max. | 0.628 max. |
| L | 76.20 ± 0.25 | 3.000 ± .010 |
| M | 38.10 | 1.500 |
| N | 73.02 max. | 2.875 max. |
| P | 23.01 ± 0.79 | .906 ± .031 |
| Q | 31.75 ± 1.19 | 1.250 ± .047 |
| V | 0.79 min. | .031 min. |
| W | 42.06 ± 1.19 | 1.656 ± .047 |
| X | 68.25 ± 1.57 | 2.687 ± .062 |
| Y | 86.52 max. | 3.406 max. |
| Z | 11.12 ± 1.57 | .438 ± .062 |

| Dim. | mm | inch |
|---|---|---|
| AE | 46.48 ± 0.76 | 1.830 ± .030 |
| AF | 37.44 ± 0.10 | 1.474 ± .004 |
| AG | 12.62 ± 0.25 | .497 ± .010 |
| AH | 28.50 ± 0.25 | 1.122 ± .010 |
| AJ | 34.34 ± 0.10 | 1.352 ± .004 |
| AK | 46.48 ± 0.76 | 1.830 ± .030 |
| AL | 38.10 max. | 1.500 max. |
| AM | 4.29 ± 0.12 | .169 ± .005 |
| AN | 6.35 ± 0.38 | .250 ± .015 |
| AO | 13.72 + 0.12 | .540 + .005 |
| | - 0.20 | - .008 |
| AP | 21.08 + 0.20 | .830 + .008 |
| | - 0.12 | - .005 |
| AQ | 13.11 min. | .516 min. |
| AR | 3.96 max. | .156 max. |
| AS | 3.17 ± 0.25 | .125 ± .010 |
| AT | 3.97 ± 0.79 | .156 ± .031 |
| AU | 19.05 min. | .750 min. |

Dimensional outline notes (continued)

2. The axis of the heater-cathode terminal will be within the confines of a cylinder whose radius is 1.19 mm (.047") and whose axis is perpendicular to reference plane A at the specified location.
3. All points of the mounting flange surface will be within 0.38 mm (.015") above or below reference plane A.
4. The limits include angular as well as lateral deviations.
5. Temperature of heater-cathode terminal measured here.
6. Anode temperature measured at junction of waveguide and anode block.
7. These dimensions define extremities of the 13.72 (.540") internal diameter of the cylindrical heater-cathode terminal.
8. These dimensions define extremities of the 4.29 mm (.169") internal diameter of the cylindrical heater terminal.
9. No part of the connector device for the heater and heater-cathode terminals should bear against the underside of this lip.
10. The heater terminal and the heater-cathode terminal are concentric to within 0.25 mm (.010")

## MECHANICAL DATA (continued)

| | | | |
|---|---|---|---|
| Tuner torque, | | | |
| max. permissible at tuning-range stops | | 14.4 | cmkg |
| running torque | max. | 10.8 | cmkg |
| starting torque | max. | 10.8 | cmkg |
| Number of turns of tuning shaft with associated calibrated indicator to cover the frequency range of 8.5 to 9.6 GHz | approx. | 8.5 | turns |

## TYPICAL CHARACTERISTICS

| | | | | |
|---|---|---|---|---|
| Frequency | $f$ | | 8.5 to 9.6 | GHz |
| Pulling figure (V.S.W.R. = 1.5) | $\Delta fp$ | max. | 15 | MHz |
| Peak anode voltage at $I_{ap}$ = 27.5 A | $V_{ap}$ | | 20 to 23 | kV |
| Capacitance anode to cathode | $C_{ak}$ | | 9 to 13 | pF |

## LIMITING VALUES (Absolute max. rating system)

Each limiting value should be regarded independently of other values, so that under no circumstances it is permitted to exceed a limiting value whichsoever.

| | | | | | |
|---|---|---|---|---|---|
| Pulse duration | 1) | $T_{imp}$ | max. | 2.6 | µs |
| Duty factor | | $\delta$ | max. | 0.0011 | |
| Heater starting voltage | | $V_{f_o}$ | max. | 15 | V |
| Heater surge peak current | | $I_{f\,surgep}$ | max. | 12 | A |
| Peak anode current | 1) | $I_{ap}$ | min.<br>max. | 15<br>30 | A<br>A |
| Anode input power, average | | $W_i$ | max. | 630 | W |
| Anode input power, peak | | $W_{ip}$ | max. | 630 | kW |
| Rate of rise of anode voltage | 1) | $dV_a/dT$ | min.<br>max. | 70<br>200 | kV/µs<br>kV/µs |
| Voltage standing wave ratio | | | max. | 1.5 | |
| Anode temperature | 2) | $t_a$ | max. | 150 | °C |

1) See section "Pulse definitions"

2) For point of measurement see note 6 on the outline drawing.

**LIMITING VALUES** (continued)

| | | | | |
|---|---|---|---|---|
| Cathode and heater terminal temperature [1] | t | max. | 165 | °C |
| Input pressurization | p | min. | 0.85 | $kg/cm^2$ abs. (625 mm Hg) |
| Output pressurization | p | max. | 3.2 | $kg/cm^2$ abs. |

The output assembly must always be pressurized.
When the magnetron is not working into a matched load, the pressure on the output window must be higher than 1 $kg/cm^2$ abs.

**OPERATING CHARACTERISTICS**

| | | | | | | |
|---|---|---|---|---|---|---|
| Pulse duration [2] | $T_{imp}$ | 0.13 | 0.25 | 0.5 | 1 | µs |
| Pulse repetition frequency | $f_{imp}$ | 2000 | 4000 | 2000 | 1000 | Hz |
| Duty factor | $\delta$ | 0.00026 | 0.001 | 0.001 | 0.001 | |
| Peak anode voltage [2] | $V_{ap}$ | 21 | 21.5 | 21.5 | 21.5 | kV |
| Rate of rise of voltage pulse [2] | $dV_a/dT$ | 200 | 200 | 200 | 200 | kV/µs |
| Peak anode current [2] | $I_{ap}$ | 24 | 27.5 | 27.5 | 27.5 | A |
| Heater voltage, running | $V_f$ | 9.7 | 0 | 0 | 0 | V |
| Average output power | $W_o$ | 52 | 225 | 225 | 225 | W |
| Peak output power | $W_{op}$ | 200 | 225 | 225 | 225 | kW |

The manufacturer should be consulted whenever it is considered to operate the magnetron at conditions substantially different from those given above.

**COOLING**

An adequate flow of cooling air should be directed along the cooling fins toward the body of the tube to keep the temperature of the anode block below 150 °C under any condition of operation. If necessary, the heater-cathode terminal should also be cooled to keep its temperature below 165 °C.

**PRESSURE**

The mounting flange and the output waveguide flange are designed to permit the use of pressure seals. For further particulars see under "Limiting values"

[1]) For point of measurement see note 5 on the outline drawing.

[2]) See section "Pulse definitions"

## LIFE

The life of the magnetron depends on the operating conditions, and is expected to be longer at shorter pulse lengths.

## STARTING A NEW MAGNETRON

This magnetron is provided with a getter, so that aging (of a new magnetron or of a magnetron that has been idle or stored for a period of time) will not be necessary in most cases. If, however, the magnetron is put into operation and some sparking and instability occur incidentally, it is recommended to increase the anode current gradually and to operate the magnetron with reduced input during 15 to 30 minutes. After this period sparking usually ceases.

## TUNING MECHANISM

The frequency of the magnetron increases at clockwise rotation of the knurled tuning knob on the tuning shaft as viewed directly towards the waveguide flange. A micrometer-type indicator provides a visual indication of the magnetron frequency. A number of frequencies and the corresponding micrometer settings are marked on the tube. The YJ1011 is tuned by pushing in the knurled tuning knob and turning it until the desired setting of the calibrated indicator is reached.

Adjustment of the tuning mechanism beyond the stated frequency limits must not be attempted. The torque required to start the tuning shaft and to tune the tube over the required frequency range in each direction is max. 10.8 cmkg.

## CIRCUIT NOTES

a. In order to prevent heater burn-out the negative high-voltage pulse must be applied to the common cathode-heater terminal.

b. If no load isolator is inserted between the magnetron and the transmission line, the latter should be as short as possible to prevent long-line effects. Under no circumstances should the magnetron be operated with a V.S.W.R. of the load exceeding 1.5. A ratio kept near unity will benefit tube life and reliability.

c. The modulator must be so designed that, if arcing occurs, the energy per pulse delivered to the magnetron does not considerably exceed the normal energy per pulse.

d. It is required to bypass the magnetron heater with a 1000 V rated capacitor of min. 4 nF directly across the heater terminals.

CIRCUIT NOTES (continued)

e. Any diode current flowing during the intervals between the pulses should be taken into account when the peak anode current is calculated from the measured average anode current.
The occurrence of this diode current can be avoided by preventing that during these intervals the anode voltage becomes positive with respect to the cathode.

f. The unwanted noise that may occur when the anode pulse voltage drops below the value required for oscillation can be minimized by making the trailing edge of the voltage pulse as steep as possible.

PULSE CHARACTERISTICS AND DEFINITIONS

The smooth peak value ($V_{ap}$ or $I_{ap}$) of a pulse is the maximum value of a smooth curve through the average of the fluctuation over the top portion of the pulse as shown in the figures below.

The rate of rise of anode voltage is defined by the steepest tangent to the leading edge of the voltage pulse above 50 % of the smooth peak value (fig.1). Any capacitance used in a removable viewing system shall not exceed 6 pF. For calculation of the rate of rise of anode voltage the 100 % value must be taken as 21.5 kV.

The pulse duration ($T_{imp}$) is the time interval between the two points on the current pulse at which the current is 50 % of the smooth peak current (fig.2).

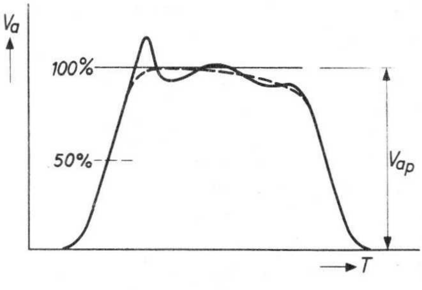



Fig.1

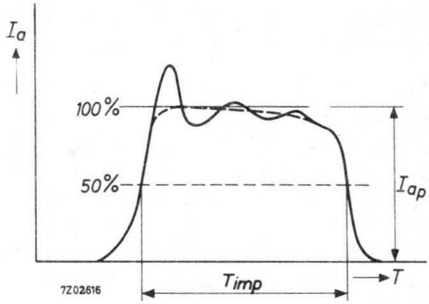



Fig.2

The current pulse must be substantially square and the ripple over the top portion of the current pulse must be kept as small as possible to avoid unwanted frequency modulation due to pushing effects. The spike on the top portion of the pulse must be small to avoid excessive peak pulse current. The leading edge of the pulse must be free from irregularities.

## STORAGE, HANDLING AND MOUNTING

The original packing should be used for the transport of the magnetron.

The magnetron should never be held by the heater-cathode stem. Rough treatment of the envelope and of the cooling fins may impair the electrical characteristics or may result in loss of vacuum.

When storing, the packaged magnetrons should be kept not less than 15 cm (6 inches) apart, to prevent a decrease of field strength of the magnetron magnet as a result of interaction with the adjacent magnets. If the magnetrons are stored in their original inner container, no special precautions need be taken with regard to the distance apart. If the magnetrons are stored without their inner container, they should be stored in non-magnetic surroundings e.g. on wooden shelves. When the tubes can not be stored at normal temperature and atmosphere they must be stored in protective packing.

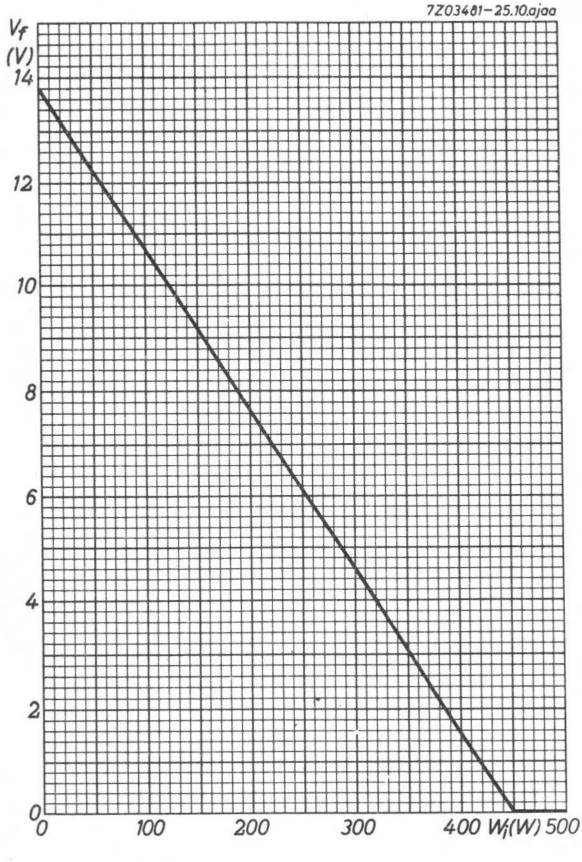
When handling and mounting the magnetron, a minimum distance of 5 cm (2 inches) between the magnet and any piece of magnetic material should be maintained to avoid mechanical shocks to the magnet or to the glass of the heater-cathode stem. For this reason it is required to use non-magnetic tools during installation, such as non-magnetic stainless steel, brass, beryllium copper and aluminium. Furthermore, the user should be aware of the detrimental influence of the strong magnetic field around the magnet on watches and other precision instruments nearby.

A dust-cover is placed on the output flange, to keep its opening closed until the tube is mounted into the equipment. Before putting the magnetron into operation, the user should make sure that the output waveguide and the recessed cathode terminal are entirely clean and free from dust and moisture.

The magnetron should be mounted by means of its mounting flange; it should be secured to the chassis by means of the four captive screws (thread 1/4" - 20NC-2). Special attention has been given to the flatness of the mounting flange so that, if necessary, a pressure seal can be made for the input assembly. Consequently, the mounting surface should be sufficiently flat to avoid deformation of the flange. Furthermore, the mounting should be sufficiently flexible and adjustable so that no strain is exerted on the output system when the mounting nuts are tightened and when the output system is being coupled to the waveguide in the equipment.

To fasten the magnetron output flange to the RG-51/U waveguide, a choke flange type UG-52A/U or UG-52B/U should be used. These flanges must be modified by reaming the four mounting holes with a No.15 drill. It can then be fastened to the magnetron output flange by means of four bolts of size 8-32. This connection should be such that a reliable contact is established, in order to avoid arcing and other bad contact effects.

A connector with flexible supply leads should be used for the connection of heater and heater-cathode terminals.


7Z03481-25.10.ajaa
$V_f$
(V)
14
12
10
8
6
4
2
0
0
100
200
300
400
$W_f$(W)
500

# PULSED MAGNETRON

Packaged magnetron intended for service as a pulsed oscillator at a fixed frequency. It has been designed for very short pulse operation and it is especially suited for use in high-definition short-range radar systems.

The YJ1020 incorporates a dispenser type of cathode to provide a long life. A getter to maintain a high vacuum minimizes any tendency towards arcing, even when the magnetron is taken into operation after a period of storage.

The waveguide output is designed for coupling to rectangular waveguide RG-96/U (E.I.A. designation WR28, British designation WG22) with outside dimensions 0.360" x 0.220".

| QUICK REFERENCE DATA | | | |
|---|---|---|---|
| Frequency, fixed within the band | f | 32.7 to 33.4 | GHz |
| Peak output power | $W_{o_p}$ | 25 | kW |
| Construction | | packaged | |

## GENERAL

Cathode dispenser type

Heating indirect

| | | | | | |
|---|---|---|---|---|---|
| Heater starting voltage | $V_{f_o}$ | = | | 4 | V $^{+10}_{-5}$ % |
| Heater current at $V_f$ = 4 V | $I_f$ | = | | 3.4 | A ±0.7 A |
| Heater surge peak current | $I_{f\,surge_p}$ | = | max. | 8 | A |
| Cold heater resistance | $R_{f_o}$ | = | min. | 0.16 | Ω |
| Heating time before application of high voltage ($V_f$ = 4 V) | $T_W$ | = | min. | 3 | min |

In case the input power will be greater than 22 W, it is necessary to prevent overheating of the cathode by reducing the heater voltage immediately when the magnetron starts oscillating after the high voltage has been switched on. See sheet 8

## TYPICAL CHARACTERISTICS

| | | | | | |
|---|---|---|---|---|---|
| Distance of voltage standing wave minimum [1] | | = | 0.05 to 0.25 | $\lambda g$ | |
| | | = | 0.58 to 3.15 | mm | |
| Stable range: peak anode current | $I_{ap}$ | = | 6 to 16 | A | |
| Peak anode voltage at $I_{ap}$ = 10.5 A | $V_{ap}$ | = | 11.5 to 13.5 | kV | |
| Negative temperature coefficient | $-\frac{\Delta f}{\Delta t}$ | = | max. 1 | MHz | per $^{o}C$ |
| Pulling figure (at V.S.W.R. = 1.5) | $\Delta f_p$ | = | typ. 40 | MHz | |
| | $\Delta f_p$ | = | max. 50 | MHz | |
| Pushing figure | $\frac{\Delta f}{\Delta I_{ap}}$ | = | max. 4 | MHz | per A |
| Capacitance anode to cathode | $C_{ak}$ | = | 7 | pF | |

## LIMITING VALUES (Absolute max. rating system)

Each limiting value should be regarded independently of other values, so that under no circumstances it is permitted to exceed a limiting value whichsoever. It does not necessarily follow that combination of limiting values can be attained simultaneously.

| | | | | | |
|---|---|---|---|---|---|
| Pulse duration [2] | $T_{imp}$ | = | max. | 0.05 | $\mu s$ |
| Duty factor | $\delta$ | = | max. | 0.0003 | |
| Heater starting voltage | $V_{f_o}$ | = | max. | 4.4 | V |
| Heater surge peak current | $I_{f\,surge_p}$ | = | max. | 8 | A |
| Peak anode current [2] | $I_{ap}$ | = | max. | 16 | A |
| Average anode input power | $W_{i_a}$ | = | max. | 60 | W |
| Rate of rise of anode voltage [2] | $dV_a/dT$ | = | min. | 200 | kV/$\mu s$ |
| | | = | max. | 400 | kV/$\mu s$ |
| Voltage standing wave ratio | V.S.W.R. | = | max. | 1.5 | |
| Anode temperature [3] | $t_a$ | = | max. | 150 | $^{o}C$ |
| Cathode and heater terminal temperature | t | = | max. | 150 | $^{o}C$ |
| Pressure | p | = | min. | 45 | cm Hg |

[1][2][3] See page 3.

## TYPICAL OPERATION

| | | | | |
|---|---|---|---|---|
| Heater voltage | $V_f$ | = | 4 | V |
| Pulse duration [2] | $T_{imp}$ | = | 0.04 x) | $\mu$s |
| Duty factor | $\delta$ | = | 0.0001 | |
| Peak anode voltage [2] | $V_{a_p}$ | = | 11.5 to 13.5 | kV |
| Rate of rise of voltage pulse [2] | $dV_a/dT$ | = | 300 | kV/$\mu$s |
| Average anode current, pre-oscillation current included | $I_a$ | = | 1.6 | mA |
| Peak anode current [2] | $I_{a_p}$ | = | 10.5 | A |
| Average output power | $W_o$ | = | 2.5 | W |
| Peak output power | $W_{o_p}$ | = | 25 | kW |

x) Magnetic modulator

The manufacturer should be consulted whenever it is considered to operate the magnetron at conditions substantially different from those given above.

## COOLING

Radiation and convection

For normal operating conditions no additional cooling of the magnetron will be required to keep the temperature of the anode block and of the heater seals below 150 °C.

## PRESSURE

The magnetron need not be pressurized when operating at atmospheric pressure. To prevent arcing the pressure must exceed 45 cm Hg (Absolute limit).

## LIFE

The life of the magnetron depends on the operating conditions, and is expected to be longer at shorter pulse durations.

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1) The distance of the V.S.W. minimum outside the tube is between 0.05 and 0.25 $\lambda g$ (0.58 and 3.15 mm) with respect to reference plane A (see outline drawing), measured with a standard cold test technique at the frequency of the oscillating magnetron operating into a matched load.

2) See section "Pulse definitions".

3) Measured on the anode block between the second and third cooling fin.

## STARTING A NEW MAGNETRON

This magnetron is provided with a getter, so that ageing (of a new magnetron or of a magnetron that has been idle or stored for a period of time) will not be necessary in most cases. If, however, the magnetron is put into operation and some sparking and instability occur incidentally, it is recommended to increase the anode current gradually and to operate the magnetron with reduced input during 15 to 30 minutes. After this period sparking usually ceases.

## CIRCUIT NOTES

a) In order to prevent heater burn-out the negative high-voltage pulse must be applied to the common cathode-heater terminal.

b) If no load isolator is inserted between the magnetron and the transmission line, the latter should be as short as possible to prevent long-line effects. Under no circumstances should the magnetron be operated with a V.S.W.R. of the load exceeding 1.5. A ratio kept near unity will benefit tube life and reliability.

c) The modulator must be so designed that, if arcing occurs, the energy per pulse delivered to the magnetron does not considerably exceed the normal energy per pulse. Modulators of the pulse-forming-network discharge type usually satisfy this requirement.

d) It is required to bypass the magnetron heater with a 1000 V rated capacitor of minimum 4 nF directly across the heater terminals.

e) Any diode current flowing during the intervals between the pulses should be taken into account when the peak anode current is calculated from the measured average anode current. The occurrence of this diode current can be avoided by preventing that during these intervals the anode voltage becomes positive with respect to the cathode.

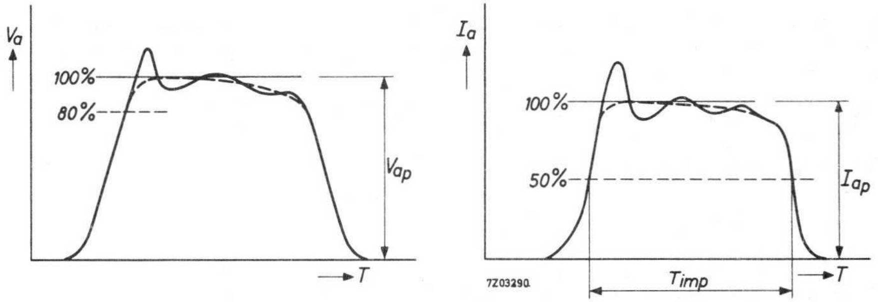
f) The unwanted noise that may occur when the anode pulse voltage drops below the value required for oscillation can be minimized by making the trailing edge of the voltage pulse as steep as possible.

## PULSE CHARACTERISTICS AND DEFINITIONS

The smooth peak value ($V_{ap}$ or $I_{ap}$) of a pulse is the maximum value of a smooth curve through the average of the fluctuation over the top portion of the pulse as shown in the figure below.

The rate of rise of anode voltage is defined by the steepest tangent to the leading edge of the voltage pulse above 80 % of the smooth peak value (fig.1). Any capacitance used in a removable viewing system shall not exceed 6 pF. For calculation of the rate of rise of anode voltage the 100 % value must be taken as 12.5 kV.

The pulse duration ($T_{imp}$) is the time interval between the two points on the current pulse at which the current is 50 % of the smooth peak current (fig.2).




The current pulse must be substantially square and the ripple over the top portion of the current pulse must be kept as small as possible to avoid unwanted frequency modulation due to pushing effects. The spike on the top portion of the pulse must be small to avoid excessive peak pulse current. The leading edge of the pulse must be free from irregularities.

## STORAGE, HANDLING AND MOUNTING

The original packing should be used for the transport of the magnetron.

The magnetron should never be held by the heater cathode stem.
Rough treatment of the metal envelope and of the cooling fins may impair the electrical characteristics or may result in loss of vacuum.

When storing, the packaged magnetrons should be kept not less than 15 cm (6 inches) apart, to prevent a decrease of field strength of the magnetron magnet as a result of interaction with the adjacent magnets. If the magnetrons are stored in their original inner container, no special precautions need be taken with regard to the distance apart. If the magnetrons are stored without their inner container, they should be stored in non-magnetic surroundings e.g. on wooden shelves.

STORAGE, HANDLING AND MOUNTING (continued)

When handling and mounting the magnetron, a minimum distance of 5 cm (2 inches) between the magnet and any piece of magnetic material should be maintained to avoid mechanical shocks to the magnet or the glass of the heater-cathode stem. For this reason it is required to use non-magnetic tools during installation, such as non-magnetic stainless steel, brass, beryllium copper and aluminium. Furthermore, the user should be aware of the detrimental influence of the strong magnetic field around the magnet on watches and other precision instruments nearby.

Mounting of the magnetron should be accomplished by means of its mounting flange. The tube should in no case be supported by the coupling to the waveguide output flange alone.

A dust-cover is placed on the output flange, to keep its opening closed until the tube is mounted into the equipment. Before putting the magnetron into operation, the user should make sure that the output waveguide and the recessed cathode terminal are entirely clean and free from dust and moisture.

**MECHANICAL DATA**

Mounting position : any

Net weight : 1.9 kg

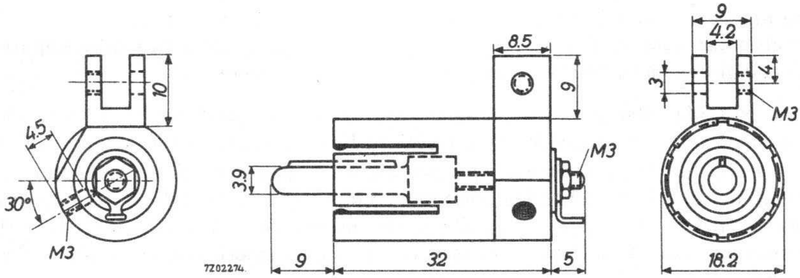
Waveguide output system : RG-96/U

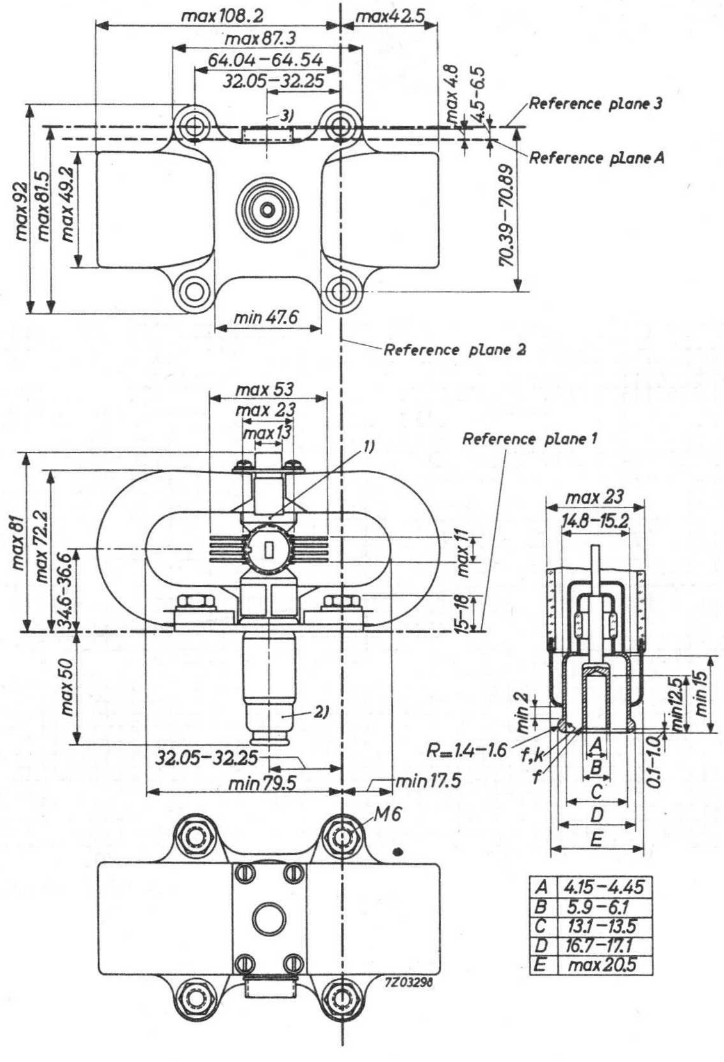
Waveguide coupling system: Z8 300 16

To facilitate this coupling the components Z8 300 17 and Z8 300 19 have been fixed permanently to the magnetron

Cathode connector : 55356

The mounting flange and the waveguide output system are so made that the magnetron can be used in applications requiring a pressure seal. They can be maintained at a pressure of maximum 3.1 kg/cm$^2$ (45 lbs/sq. in).



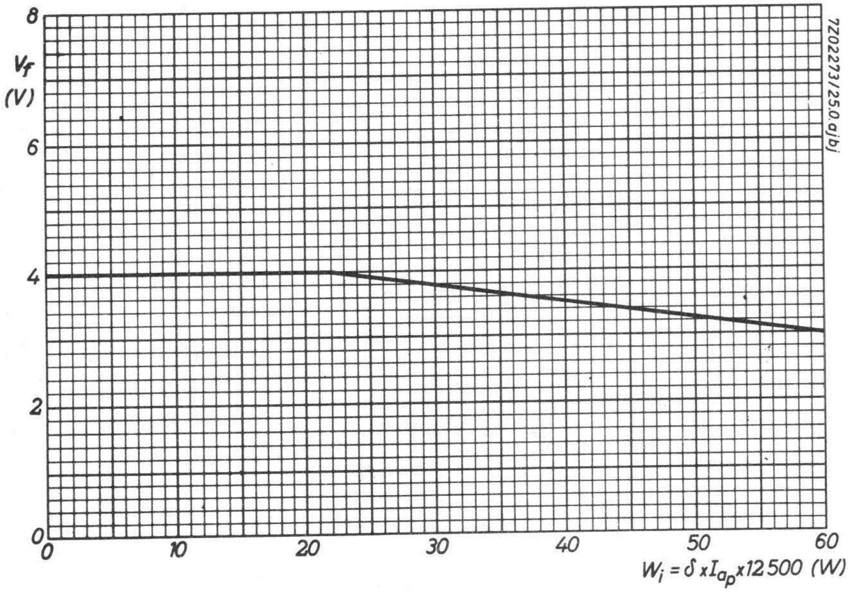



| | |
|---|---|
| A | 4.15−4.45 |
| B | 5.9−6.1 |
| C | 13.1−13.5 |
| D | 16.7−17.1 |
| E | max 20.5 |

1) Inscription of serial number.

2) The axis of the common cathode-heater terminal is within a radius 1.5 mm from the specified position. The eccentricity of the axis of the inner cylinder of the heater terminal with respect to the axis of the inner cylinder of the common cathode-heater terminal is max. 0.125 mm.

3) Centre of waveguide.


8
$V_f$
(V)
6
4
2
0
0
10
20
30
40
50
60
$W_i = \delta \times I_{a_p} \times 12500$ (W)
7Z02273/25.0.a(b)

# PULSED MAGNETRON

Packaged magnetron intended for service as a pulsed oscillator at a fixed frequency. It has been designed for very short pulse operation and it is especially suited for use in high-definition short-range radar systems.

The YJ1021 incorporates a dispenser type of cathode to provide a long life. A getter to maintain a high vacuum minimizes any tendency towards arcing, even when the magnetron is taken into operation after a period of storage.

The waveguide output is designed for coupling to rectangular waveguide RG-96/U (E.I.A. designation WR28, British designation WG22) with outside dimensions 0.360" x 0.220".

| QUICK REFERENCE DATA | | | |
|---|---|---|---|
| Frequency, fixed within the band | f | 32.7 to 33.4 | GHz |
| Peak output power | $W_{o_p}$ | 30 | kW |
| Construction | | packaged | |

## GENERAL

Cathode dispenser type

Heating indirect

| | | | | | |
|---|---|---|---|---|---|
| Heater starting voltage | $V_{f_o}$ | = | | 4 | V $^{+10}_{-5}$ % |
| Heater current at $V_f$ = 4 V | $I_f$ | = | | 3.4 | A ±0.7 A |
| Heater surge peak current | $I_{f\ surge_p}$ | = | max. | 8 | A |
| Cold heater resistance | $R_{f_o}$ | = | min. | 0.16 | Ω |
| Heating time before application of high voltage ($V_f$ = 4 V) | $T_w$ | = | min. | 3 | min |

In case the input power will be greater than 22 W, it is necessary to prevent overheating of the cathode by reducing the heater voltage immediately when the magnetron starts oscillating after the high voltage has been switched on. See sheet 8

## TYPICAL CHARACTERISTICS

| | | | | |
|---|---|---|---|---|
| Distance of voltage standing wave minimum [1] | | = 0.05 to 0.25 | | $\lambda g$ |
| | | = 0.58 to 3.15 | | mm |
| Stable range: peak anode current | $I_{a_p}$ | = 6 to | 16 | A |
| Peak anode voltage at $I_{a_p}$ = 12.5 A | $V_{a_p}$ | = 11.5 to 13.5 | | kV |
| Negative temperature coefficient | $-\frac{\Delta f}{\Delta t}$ | = max. | 1 | MHz per $^{o}C$ |
| Pulling figure (at V.S.W.R. = 1.5) | $\Delta f_p$ | = typ. | 40 | MHz |
| | $\Delta f_p$ | = max. | 50 | MHz |
| Pushing figure | $\frac{\Delta f}{\Delta I_{a_p}}$ | = max. | 4 | MHz per A |
| Capacitance anode to cathode | $C_{ak}$ | = | 7 | pF |

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

Each limiting value should be regarded independently of other values, so that under no circumstances it is permitted to exceed a limiting value whichsoever. It does not necessarily follow that combination of limiting values can be attained simultaneously.

| | | | | |
|---|---|---|---|---|
| Pulse duration [2] | $T_{imp}$ | = max. | 0.5 | $\mu$s |
| Duty factor | $\delta$ | = max. | 0.0003 | |
| Heater starting voltage | $V_{f_o}$ | = max. | 4.4 | V |
| Heater surge peak current | $I_{f\,surge_p}$ | = max. | 8 | A |
| Peak anode current [2] | $I_{a_p}$ | = max. | 16 | A |
| Average anode input power | $W_{i_a}$ | = max. | 60 | W |
| Rate of rise of anode voltage [2] for pulse duration < 0.1 $\mu$s | $dV_a/dT$ | = min. | 200 | kV/$\mu$s |
| | | = max. | 400 | kV/$\mu$s |
| for pulse duration ≥ 0.1 $\mu$s | $dV_a/dT$ | = max. | 300 | kV/$\mu$s |
| Voltage standing wave ratio | V.S.W.R. | = max. | 1.5 | |
| Anode temperature [3] | $t_a$ | = max. | 150 | $^{o}C$ |
| Cathode and heater terminal temperature | t | = max. | 150 | $^{o}C$ |
| Pressure | p | = min. | 45 | cm Hg |

1)2)3) See page 3.

## TYPICAL OPERATION

| | | | | | |
|---|---|---|---|---|---|
| Heater voltage | $V_f$ = | 4 | 3.8 | 3.8 | V |
| Pulse duration 2) | $T_{imp}$ = | 0.04 x) | 0.1 | 0.3 | μs |
| Duty factor | δ = | 0.0001 | 0.0002 | 0.0002 | |
| Peak anode voltage 2) | $V_{a_p}$ = | 11.5 to 13.5 | 11.5 to 13.5 | 11.5 to 13.5 | kV |
| Rate of rise of voltage pulse 2) | $dV_a/dT$ = | 300 | 250 | 250 | kV/μs |
| Average anode current, pre-oscillation current included | $I_a$ = | 1.6 | 2.5 | 2.5 | mA |
| Peak anode current 2) | $I_{a_p}$ = | 10.5 | 12.5 | 12.5 | A |
| Average output power | $W_o$ = | 2.5 | 6 | 6 | W |
| Peak output power | $W_{o_p}$ = | 25 | 30 | 30 | kW |

x) Magnetic modulator

The manufacturer should be consulted whenever it is considered to operate the magnetron at conditions substantially different from those given above.

## COOLING

**Radiation and convection**

For normal operating conditions no additional cooling of the magnetron will be required to keep the temperature of the anode block and of the heater seals below 150 °C.

## PRESSURE

The magnetron need not be pressurized when operating at atmospheric pressure. To prevent arcing the pressure must exceed 45 cm Hg. (Absolute limit).

## LIFE

The life of the magnetron depends on the operating conditions, and is expected to be longer at shorter pulse durations.

1) The distance of the V.S.W. minimum outside the tube is between 0.05 and 0.25 λg (0.58 and 3.15 mm) with respect to reference plane A (see outline drawing), measured with a standard cold test technique at the frequency of the oscillating magnetron operating into a matched load.

2) See section "Pulse definitions".

3) Measured on the anode block between the second and third cooling fin.

## STARTING A NEW MAGNETRON

This magnetron is provided with a getter, so that ageing (of a new magnetron or of a magnetron that has been idle or stored for a period of time) will not be necessary in most cases. If, however, the magnetron is put into operation and some sparking and instability occur incidentally, it is recommended to increase the anode current gradually and to operate the magnetron with reduced input during 15 to 30 minutes. After this period sparking usually ceases.

## CIRCUIT NOTES

a) In order to prevent heater burn-out the negative high-voltage pulse must be applied to the common cathode-heater terminal.

b) If no load isolator is inserted between the magnetron and the transmission line, the latter should be as short as possible to prevent long-line effects. Under no circumstances should the magnetron be operated with a V.S.W.R. of the load exceeding 1.5. A ratio kept near unity will benefit tube life and reliability.

c) The modulator must be so designed that, if arcing occurs, the energy per pulse delivered to the magnetron does not considerably exceed the normal energy per pulse. Modulators of the pulse-forming-network discharge type usually satisfy this requirement.

d) It is required to bypass the magnetron heater with a 1000 V rated capacitor of minimum 4 nF directly across the heater terminals.

e) Any diode current flowing during the intervals between the pulses should be taken into account when the peak anode current is calculated from the measured average anode current. The occurrence of this diode current can be avoided by preventing that during these intervals the anode voltage becomes positive with respect to the cathode.

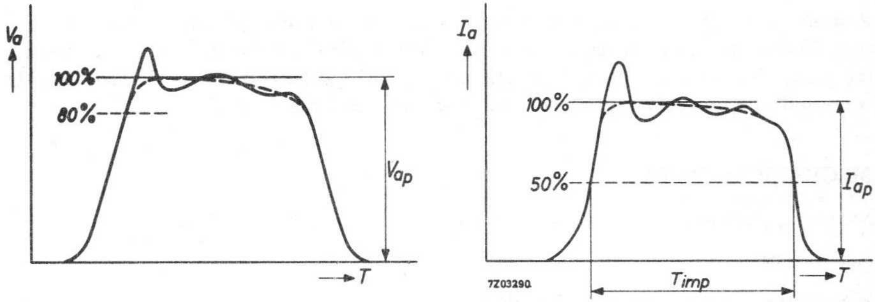
f) The unwanted noise that may occur when the anode pulse voltage drops below the value required for oscillation can be minimized by making the trailing edge of the voltage pulse as steep as possible.

## PULSE CHARACTERISTICS AND DEFINITIONS

The smooth peak value ($V_{ap}$ or $I_{ap}$) of a pulse is the maximum value of a smooth curve through the average of the fluctuation over the top portion of the pulse as shown in the figure below.

The rate of rise of anode voltage is defined by the steepest tangent to the leading edge of the voltage pulse above 80 % of the smooth peak value (fig.1). Any capacitance used in a removable viewing system shall not exceed 6 pF. For calculation of the rate of rise of anode voltage the 100 % value must be taken as 12.5 kV.

The pulse duration ($T_{imp}$) is the time interval between the two points on the current pulse at which the current is 50 % of the smooth peak current (fig.2).




The current pulse must be substantially square and the ripple over the top portion of the current pulse must be kept as small as possible to avoid unwanted frequency modulation due to pushing effects. The spike on the top portion of the pulse must be small to avoid excessive peak pulse current. The leading edge of the pulse must be free from irregularities.

## STORAGE, HANDLING AND MOUNTING

The original packing should be used for the transport of the magnetron.

The magnetron should never be held by the heater cathode stem.
Rough treatment of the metal envelope and of the cooling fins may impair the electrical characteristics or may result in loss of vacuum.

When storing, the packaged magnetrons should be kept not less than 15 cm (6 inches) apart, to prevent a decrease of field strength of the magnetron magnet as a result of interaction with the adjacent magnets. If the magnetrons are stored in their original inner container, no special precautions need be taken with regard to the distance apart. If the magnetrons are stored without their inner container, they should be stored in non-magnetic surroundings e.g. on wooden shelves.

STORAGE, HANDLING AND MOUNTING (continued)

When handling and mounting the magnetron, a minimum distance of 5 cm (2 inches) between the magnet and any piece of magnetic material should be maintained to avoid mechanical shocks to the magnet or the glass of the heater-cathode stem. For this reason it is required to use non-magnetic tools during installation, such as non-magnetic stainless steel, brass, beryllium copper and aluminium. Furthermore, the user should be aware of the detrimental influence of the strong magnetic field around the magnet on watches and other precision instruments nearby.

Mounting of the magnetron should be accomplished by means of its mounting flange. The tube should in no case be supported by the coupling to the waveguide output flange alone.

A dust-cover is placed on the output flange, to keep its opening closed until the tube is mounted into the equipment. Before putting the magnetron into operation, the user should make sure that the output waveguide and the recessed cathode terminal are entirely clean and free from dust and moisture.

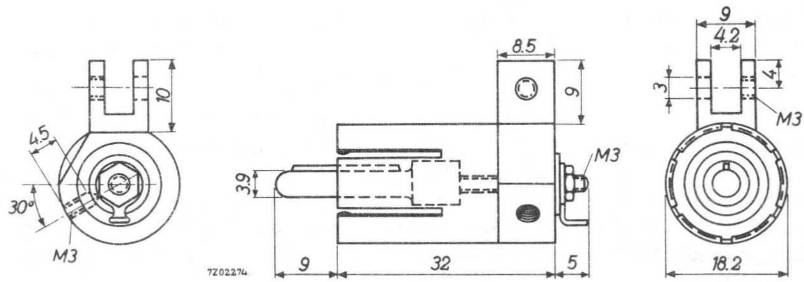
MECHANICAL DATA

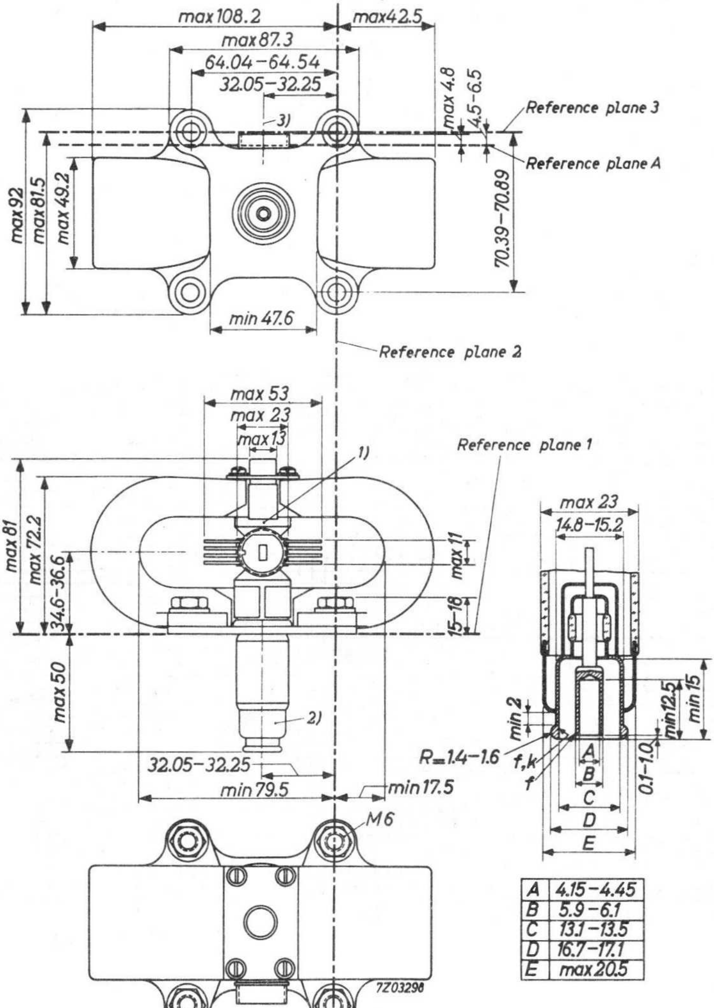
| | |
|---|---|
| Mounting position | : any |
| Net weight | : 1.9 kg |
| Waveguide output system | : RG-96/U |
| Waveguide coupling system | : Z8 300 16 |

To facilitate this coupling the components Z8 300 17 and Z8 300 19 have been fixed permanently to the magnetron

| | |
|---|---|
| Cathode connector | : 55356 |

The mounting flange and the waveguide output system are so made that the magnetron can be used in applications requiring a pressure seal. They can be maintained at a pressure of maximum 3.1 kg/cm$^2$ (45 lbs/sq. in).



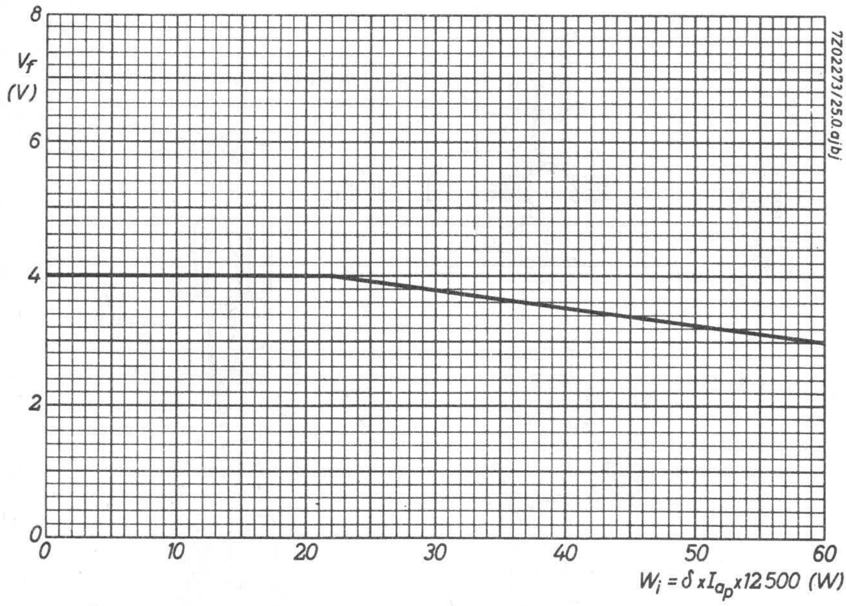



| | |
|---|---|
| A | 4.15−4.45 |
| B | 5.9−6.1 |
| C | 13.1−13.5 |
| D | 16.7−17.1 |
| E | max 20.5 |

1) Inscription of serial number.

2) The axis of the common cathode-heater terminal is within a radius 1.5 mm from the specified position. The eccentricity of the axis of the inner cylinder of the heater terminal with respect to the axis of the inner cylinder of the common cathode-heater terminal is max. 0.125 mm.

3) Centre of waveguide.


8
$V_f$
(V)
6
4
2
0
0
10
20
30
40
50
60
$W_i = \delta \times I_{ap} \times 12\,500$ (W)
7Z02273/25.0.a(b)

# PULSED MAGNETRON

Packaged rugged magnetron with low frequency temperature coefficient, suitable for high altitude operation.

| QUICK REFERENCE DATA | | |
|---|---|---|
| Frequency tunable within the band | f | 5.4 to 5.9 GHz |
| Peak output power | $W_{o_p}$ | 160 W |
| Construction | | packaged |

**HEATING** : Indirect by A.C. or D.C.

| | | | | |
|---|---|---|---|---|
| Heater voltage | Vf | | 5.0 | V |
| Heater current | $I_f$ | | 0.5 | A |
| Heating time before application of high voltage (waiting time) at $t_{amb}$ above 0 °C | $T_w$ | min. | 30 | s |

**COOLING**

In normal circumstances radiation and convection cooling is adequate but where the ambient temperature is abnormally high, or where convection cooling is restricted, provision for conduction cooling may be made by a clamp, of non magnetic material, around the body.

**TYPICAL CHARACTERISTICS**

| | | | | | |
|---|---|---|---|---|---|
| Frequency, tunable over the range | f | 5.4 | to | 5.9 | GHz |
| Peak anode voltage at $I_{a_p}$ = 0.8 A | $V_{a_p}$ | 1.0 | to | 1.35 | kV |
| Pulling figure (V.S.W.R. = 1.5) | $\Delta f_p$ | max. | | 12 | MHz |
| Frequency temperature coefficient | $\Delta f/\Delta t$ | max. | | -0.1 | MHz/°C ← |
| Input capacitance | $C_{ak}$ | max. | | 6.0 | pF |
| Pushing figure | $\Delta f/\Delta I_{a_p}$ | max. | | 15 | MHz/A |
| Frequency modulation under vibration of 12 g (50 to 2000 Hz) | | max. | | 2 | MHz |

## LIMITING VALUES (Absolute max. rating system)

| | | | | |
|---|---|---|---|---|
| Pulse duration | $T_{imp}$ | max. | 3.0 | μs |
| Duty factor | $\delta$ | max. | 0.002 | |
| Peak anode current | $I_{a_p}$ | max. | 1.0 | A |
| | | min. | 0.6 | A |
| Mean input power | $W_{i_a}$ | max. | 2.5 | W |
| Rate of rise of voltage pulse | dVa/dT | max. | 8 | kV/μs |
| Voltage standing wave ratio | V.S.W.R. | max. | 1.5 | |
| Temperature of anode block | $t_a$ | max. | 100 | °C |

## OPERATING CHARACTERISTICS

| | | | |
|---|---|---|---|
| Pulse duration | $T_{imp}$ | 1.0 | μs |
| Pulse repetition frequency | $f_{imp}$ | 2000 | Hz |
| Duty factor | $\delta$ | 0.002 | |
| Heater voltage running | $V_f$ | 5.0 | V |
| Anode current, peak | $I_{a_p}$ | 0.8 | A |
| mean | $I_a$ | 1.6 | mA |
| Peak anode voltage | $V_{a_p}$ | 1.2 | kV |
| Rate of rise of voltage pulse | dVa/dT | 6 | kV/μs |
| Input power, peak | $W_{ia_p}$ | 944 | W |
| mean | $W_{i_a}$ | 1.9 | W |
| Output power, peak | $W_{o_p}$ | 160 | W |
| mean | $W_o$ | 320 | mW |
| Pulling figure (V.S.W.R. = 1.5) | $\Delta f_p$ | 10 | MHz |

## MECHANICAL DATA

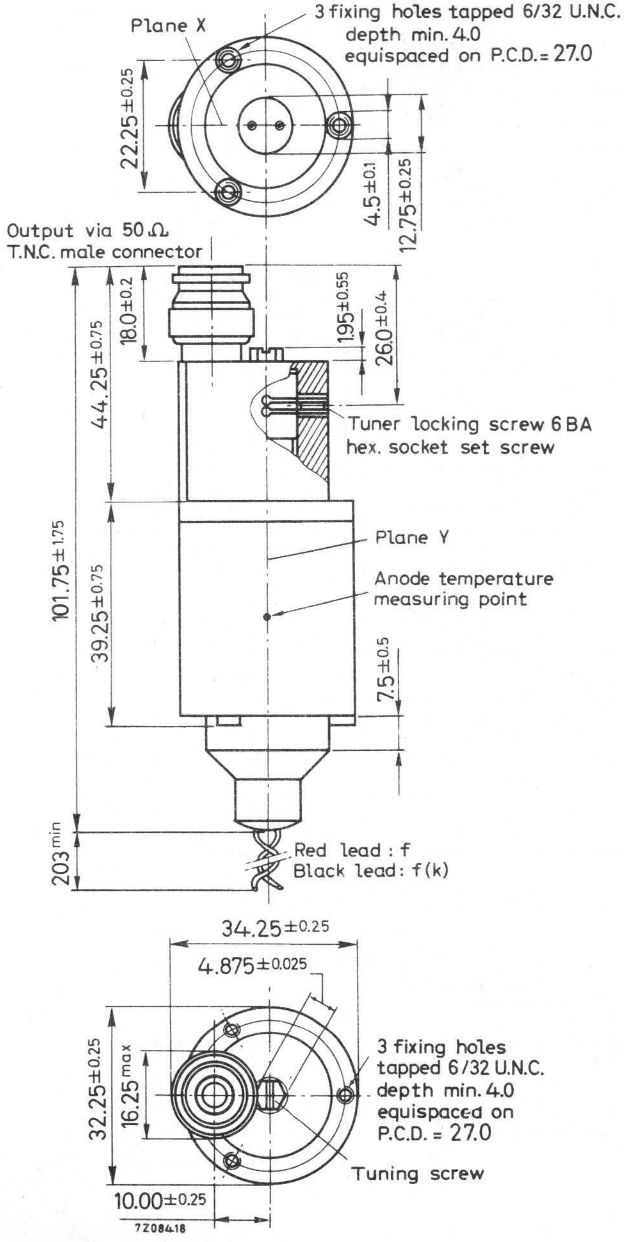
Mounting position : any

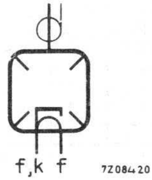
Net weight : approx 0.2 kg

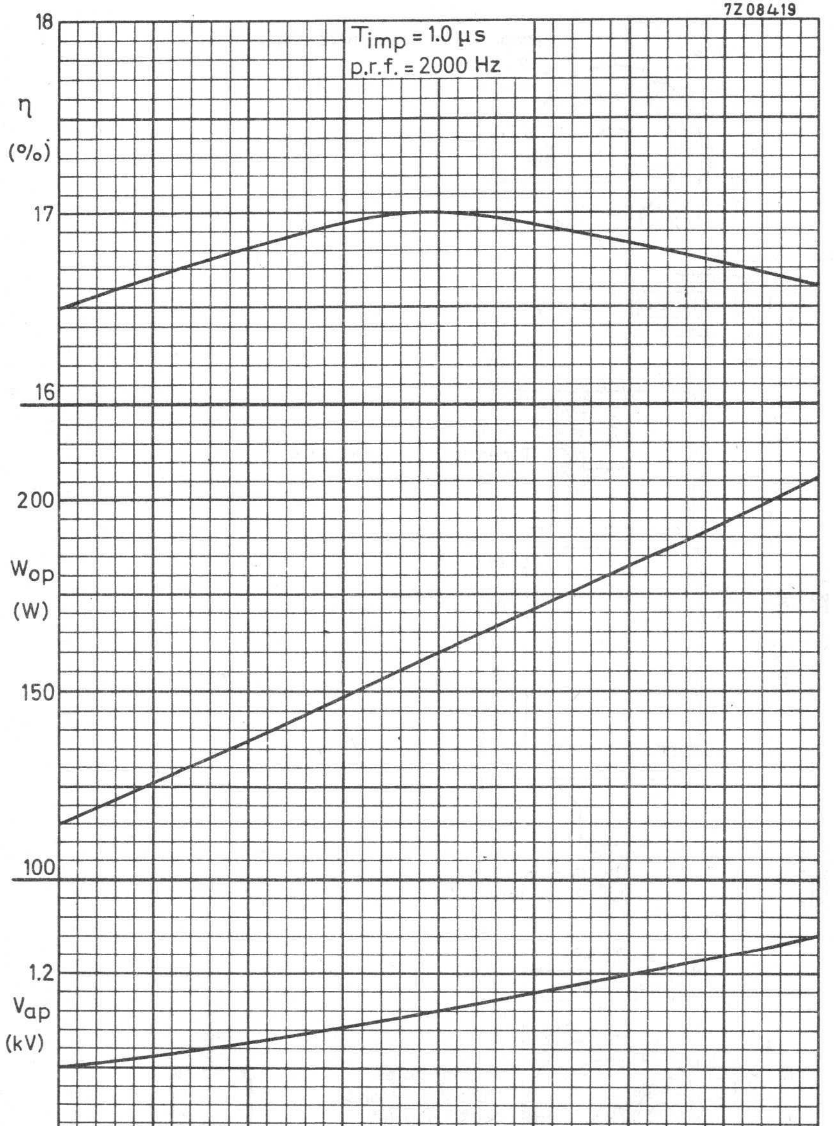
Output connection : Output via 50 Ω T.N.C. male connector

MECHANICAL DATA

Dimensions in mm




7Z08419
$T_{imp}$ = 1.0 µs
p.r.f. = 2000 Hz
η
(%)
18
17
16
200
$W_{op}$
(W)
150
100
1.2
$V_{ap}$
(kV)
1.1
0.6
0.7
0.8
0.9
$I_{ap}$ (A)
1.0

# PULSED MAGNETRON

Light weight packaged magnetron for pulse service at high altitudes operating at a fixed frequency within the range 9.345 to 9.405 GHz and capable of delivering a peak output power of 20 kW.

| QUICK REFERENCE DATA | | | |
|---|---|---|---|
| Frequency, fixed within the band | f | 9.345 to 9.405 | GHz |
| Peak output power | $W_{op}$ | 20 | kW |
| Construction | | packaged | |

**HEATING**: indirect by A.C. or D.C.

| | | | |
|---|---|---|---|
| Heater voltage, starting | $V_{fo}$ | 6.3 | V ±5 % |
| Heater current at $V_f$ = 6.3 V | $I_f$ | 0.55 | A |
| Heating time before application of high voltage, | | | |
| at ambient temperatures above 0 °C | $T_w$ | min. 2 | min |
| at ambient temperatures below 0 °C | $T_w$ | min. 3 | min |

For mean input powers > 25 W, the heater voltage must be reduced immediately after the application of the anode voltage in accordance with the chart given on page 6.

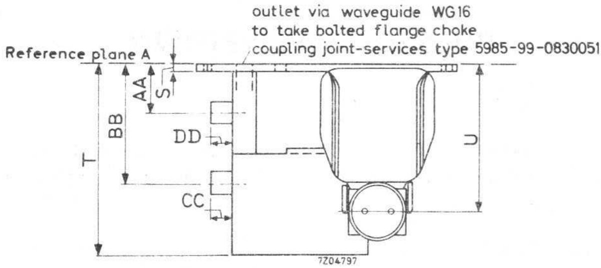
**MECHANICAL DATA**

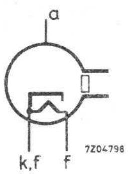
Mounting position: any

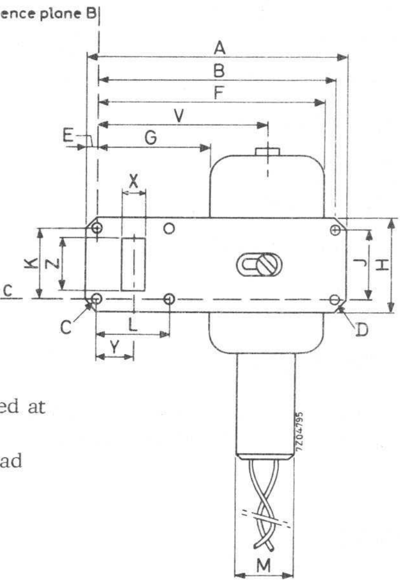
Net weight: 1.5 kg

The YJ1060 is electrically and mechanically interchangeable with type 6027H.

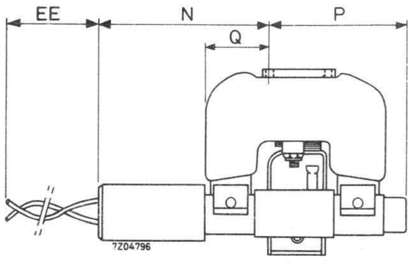
## MECHANICAL DATA (continued)




Anode connection terminated at
the base plate.
Common heater/cathode lead
indentified by a sleeve.



## OUTLINE DIMENSIONS

Inch dimensions are derived from the original millimetre dimensions.

| Dim. | Inches | mm |
|---|---|---|
| A | 4.47 max. | 113.5 max. |
| B | 4.103 ± 0.004 | 104.2 ± 0.1 |
| C | 0.17 ± 0.003 | 4.32 ± 0.08 |
| D | 0.175 ± 0.003 | 4.45 ± 0.08 |
| E | 0.19 max. | 4.8 max. |
| F | 4.0 max. | 102 max. |
| G | 1.93 min. | 49 min. |
| H | 1.64 max. | 41.7 max. |
| J | 1.22 ± 0.003 | 30.99 ± 0.08 |
| K | 1.22 ± 0.004 | 30.99 ± 0.1 |
| L | 1.28 ± 0.004 | 32.51 ± 0.1 |
| M | 1.0 max. | 25.4 max. |
| N | 3.19 max. | 81 max. |
| P | 2.19 max. | 55.6 max. |
| Q | 1.19 max. | 30.2 max. |
| S | 0.125 ± 0.01 | 3.18 ± 0.25 |
| T | 3.25 max. | 82.6 max. |
| U | 2.52 ± 0.118 | 64 ± 3 |
| V | 3.0 ± 0.118 | 76 ± 3 |
| X | 0.400 ± 0.003 | 10.16 ± 0.08 |
| Y | 0.640 ± 0.004 | 16.25 ± 0.10 |
| Z | 0.900 ± 0.004 | 22.86 ± 0.10 |
| AA | 0.88 ± 0.118 | 22 ± 3 |
| BB | 1.8 ± 0.197 | 53 ± 5 |
| CC | 0.39 max. | 10 max. |
| DD | 0.38 max. | 9.5 max. |
| EE | 6.0 | 152 |

## TYPICAL CHARACTERISTICS

| | | | | |
|---|---|---|---|---|
| Frequency, fixed within the band | f | | 9.345 to 9.405 | GHz |
| Peak anode voltage at $I_{ap}$ = 7.5 A | $V_{ap}$ | | 6.4 to 7.4 | kV |
| Peak output power at $I_{ap}$ = 7.5 A | $W_{op}$ | min. | 18 | kW |
| Pulling figure (V.S.W.R. = 1.5) | $\Delta fp$ | max. | 15 | MHz |
| Frequency temperature coefficient | $\Delta f/\Delta t$ | max. | -0.25 | MHz per $^{o}C$ |
| Capacitance anode to cathode | $C_{ak}$ | max. | 8 | pF |

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

| | | | | |
|---|---|---|---|---|
| Pulse duration | $T_{imp}$ | max. | 2.5 | μs |
| Duty factor | δ | max. | 0.002 | |
| Peak anode current | $I_{ap}$ | min. | 5 | A |
| | | max. | 8 | A |
| Anode input power, mean | $W_{ia}$ | max. | 80 | W |
| Rate of rise of anode voltage | $dV_a/dT$ | max. | 60 | kV/μs |
| Voltage standing wave ratio | V.S.W.R. | max. | 1.5 | |
| Anode block temperature | $t_a$ | max. | 120 | $^{o}$C |

**OPERATING CHARACTERISTICS**

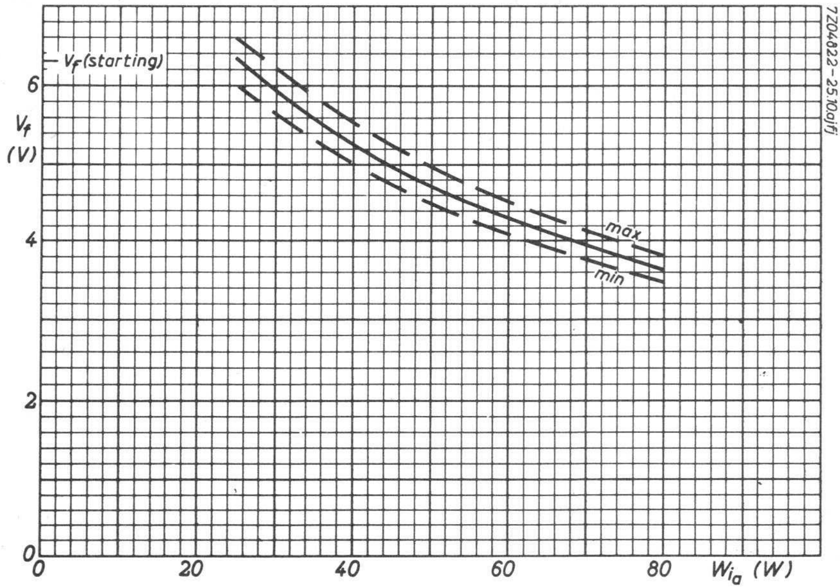
| | | | | | |
|---|---|---|---|---|---|
| Pulse duration | | $T_{imp}$ | 1.8 | 2.5 | μs |
| Pulse repetition frequency | | $f_{imp}$ | 400 | 400 | Hz |
| Duty factor | | δ | 0.0007 | 0.001 | |
| Heater voltage, running | | $V_f$ | 5.4 | 4.6 | V |
| Peak anode voltage | | $V_{ap}$ | 7.2 | 7.2 | kV |
| Rate of rise of voltage pulse | | $dV_a/dT$ | 50 | 50 | kV/μs |
| Anode current, | peak | $I_{ap}$ | 7.5 | 7.5 | A |
| | mean | $I_a$ | 5.3 | 7.5 | mA |
| Input power, | peak | $W_{iap}$ | 54 | 54 | kW |
| | mean | $W_{ia}$ | 38 | 54 | W |
| Output power, | peak | $W_{op}$ | 20 | 20 | kW |
| | mean | $W_o$ | 14 | 20 | W |
| Pulling figure (V.S.W.R. = 1.5) | | Δfp | 14 | 14 | MHz |

## COOLING

In normal circumstances radiation and convection cooling is adequate, but where the ambient temperature is abnormally high, or convection cooling is restricted artificial cooling may be necessary to keep the block temperature below the permitted maximum.

## PRESSURE

The tube is fitted with flying leads and the output waveguide is sealed with a vacuum tight window to allow operation at high altitude without pressurising. Operation to 18 km can be achieved.


7Z04822-25.10.a(f)
Vf (starting)
Vf
(V)
6
4
2
0
0
20
40
60
80
Wia (W)
max
min

# PULSED MAGNETRON

Packaged magnetron for pulsed service at a fixed frequency.

| QUICK REFERENCE DATA | | | |
|---|---|---|---|
| Frequency, fixed within the band | f | 9.380 to 9.440 | GHz |
| Peak output power | $W_{op}$ | 10.5 | kW |
| Construction | | packaged | |

**HEATING:** Indirect by A.C. or D.C.

| | | | | |
|---|---|---|---|---|
| Heater voltage | $V_f$ | | 6.3 | V ± 5% |
| Heater current at $V_f$ = 6.3 V | $I_f$ | | 0.55 | A |
| Heater surge peak current | $I_{f_{surge\,p}}$ | max. | 4 | A |
| Cold heater resistance | $R_{f_o}$ | | 1.75 | Ω |
| Heating time before application of high voltage (waiting time) | | | | |
| at $t_{amb}$ above 0 °C | $T_w$ | min. | 2 | min |
| at $t_{amb}$ below 0 °C | $T_w$ | min. | 3 | min |

For mean input powers greater than 25 W the heater voltage must be reduced immediately after application of high voltage. See page 5

## COOLING

In normal circumstances radiation and convection cooling is adequate, but where the ambient temperature is abnormally high a flow of cooling air between the cooling fins may be necessary to keep the anode block temperature below the permitted maximum.

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

| | | | | |
|---|---|---|---|---|
| Pulse duration | $T_{imp}$ | max. | 1.0 | μs |
| → Duty factor | δ | max. | 0.002 | |
| Peak anode current | $I_{ap}$ | min. | 4.5 | A |
| | | max. | 7 | A |
| Mean input power | $W_{ia}$ | max. | 85 | W |
| Rate of rise of voltage pulse | $dV_a/dT$ | max. | 120 | kV/μs |
| Voltage standing wave ratio | V.S.W.R. | max. | 1.5 | |
| Temperature of anode block | $t_a$ | max. | 120 | °C |

**TYPICAL CHARACTERISTICS**

| | | | | |
|---|---|---|---|---|
| Frequency, fixed within the band | f | 9.380 to | 9.440 | GHz |
| Peak anode voltage at $I_{ap}$ = 6 A | $V_{a_p}$ | 5.5 to | 5.9 | kV |
| Peak output power at $I_{ap}$ = 6 A | $W_{o_p}$ | min. | 9 | kW |
| Pulling figure (V.S.W.R. = 1.5) | $\Delta f_p$ | max. | 15 | MHz |
| Frequency temperature coefficient | $\frac{\Delta f}{\Delta t}$ | max. | -0.25 | MHz/°C |
| Distance of voltage standing wave minimum from face of mounting plate into tube | d | 16.5 to | 22.5 | mm |
| Input capacitance | $C_{ak}$ | max. | 8 | pF |
| Frequency pushing | $\frac{\Delta f}{\Delta I_{ap}}$ | max. | 2.0 | MHz/A |

## OPERATING CHARACTERISTICS

| | | | | |
|---|---|---|---|---|
| Pulse duration | $T_{imp}$ | 0.1 | 0.5 | $\mu$s |
| Pulse repetition frequency | $f_{imp}$ | 1000 | 1000 | Hz |
| Duty factor | $\delta$ | 0.0001 | 0.0005 | |
| Heater voltage (running) | $V_f$ | 6.3 | 6.3 | V |
| Anode current, peak | $I_{ap}$ | 6 | 6 | A |
| mean | $I_a$ | 0.65 [1]) | 3 | mA |
| Peak anode voltage | $V_{ap}$ | 5.7 | 5.7 | kV |
| Rate of rise of voltage pulse | $dV_a/dT$ | 110 | 100 | kV/$\mu$s |
| Input power, peak | $W_{iap}$ | 34.2 | 34.2 | kW |
| mean | $W_{ia}$ | 3.7 | 17.1 | W |
| Output power, peak | $W_{op}$ | 10.5 | 10.5 | kW |
| mean | $W_o$ | 1.1 | 5.5 | W |
| Pulling figure (V.S.W.R. = 1.5) | $\Delta f_p$ | 14 | 14 | MHz |

## END OF LIFE PERFORMANCE

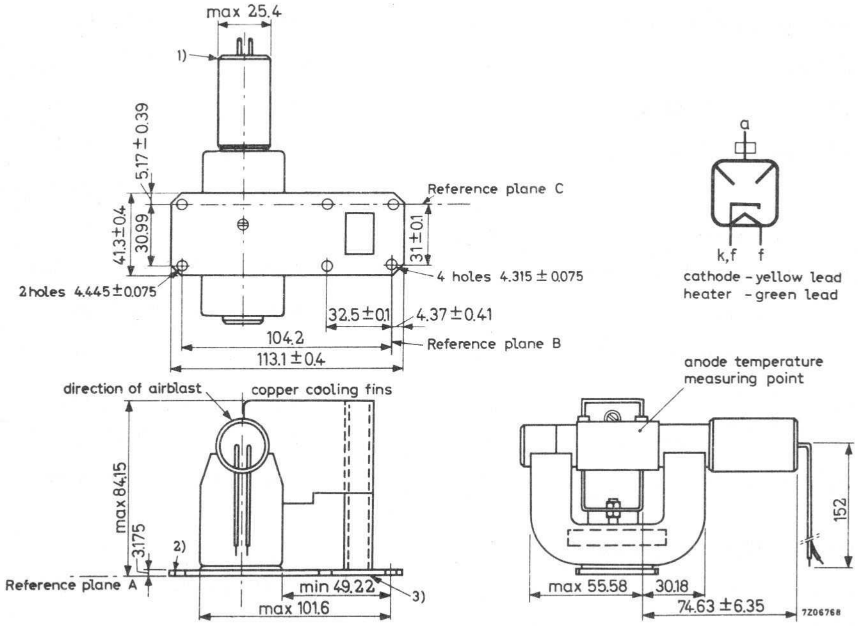
The tube is deemed to have reached end of life when it fails to satisfy the following:

| | | | |
|---|---|---|---|
| Peak output power at $I_{ap}$ = 6 A | $W_{op}$ | > 7 | kW |
| Frequency within the band | f | 9.380 to 9.440 | GHz |
| Peak anode voltage at $I_{ap}$ = 6 A | $V_{ap}$ | 5.5 to 6.0 | kV |

[1]) Includes pre-oscillation current.

MECHANICAL DATA

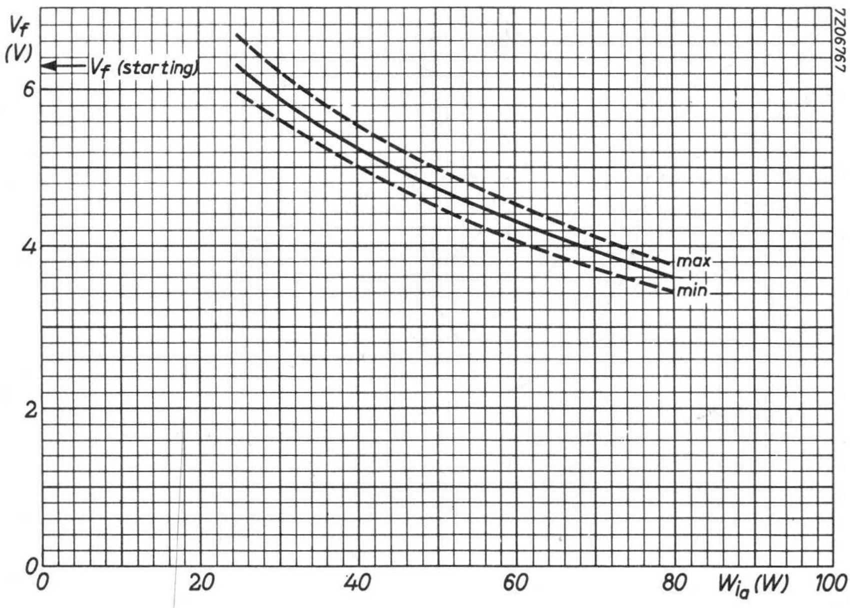
Dimensions in mm

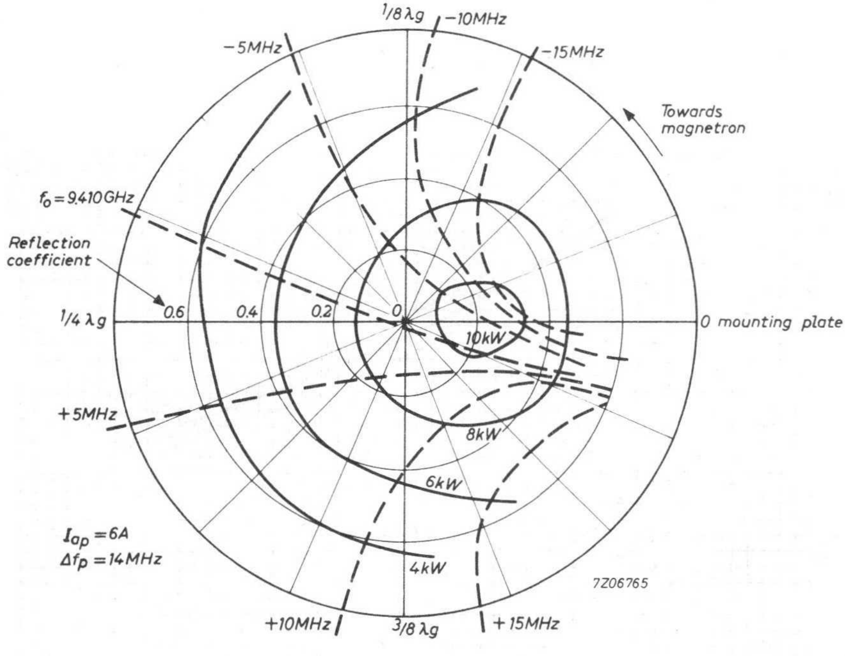



1) The protector sleeve shall be within 5° of a normal to reference plane C.

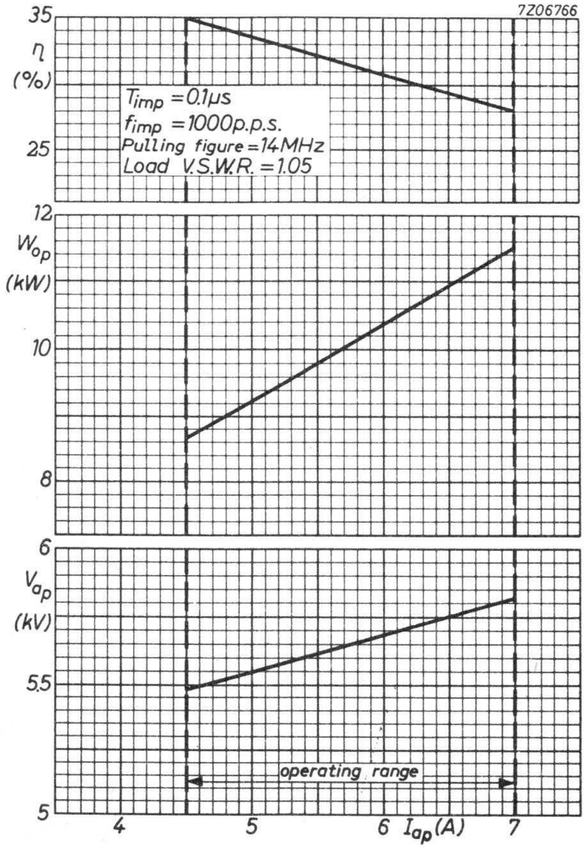
2) A cylinder 8.38 mm diameter centred in the holes shown shall clear the side of the magnet.

3) The outlet via the waveguide WG16 is to take a bolted flange choke coupling, Joint Services type 5985-99-0830051.


7206767
Vf
(V)
Vf (starting)
6
4
2
0
0
20
40
60
80
100
Wia (W)
max
min



1/8 λg
−10MHz
−5MHz
−15MHz
Towards magnetron
$f_o$ = 9.410 GHz
Reflection coefficient
1/4 λg
0.6
0.4
0.2
0
0 mounting plate
10kW
+5MHz
8kW
6kW
$I_{ap}$ = 6A
$\Delta f_p$ = 14MHz
4kW
7Z06765
+10MHz
3/8 λg
+15MHz



7Z06766
35
η
(%)
25
$T_{imp}$ = 0.1μs
$f_{imp}$ = 1000 p.p.s.
Pulling figure = 14MHz
Load V.S.W.R. = 1.05
12
$W_{op}$
(kW)
10
8
6
$V_{ap}$
(kV)
5.5
5
operating range
4
5
6
$I_{ap}$ (A)
7

# PULSED MAGNETRON

Packaged magnetron for pulsed service at a fixed frequency.

| QUICK REFERENCE DATA | | | |
|---|---|---|---|
| Frequency, fixed within the band | f | 9.345 to 9.405 | GHz |
| Peak output power | $W_{o_p}$ | 20 | kW |
| Construction | packaged | | |

**HEATING** : Indirect by A.C. or D.C.

| | | | | |
|---|---|---|---|---|
| Heater voltage, starting | $V_f$ | | 6.3 | V±5% |
| Heater current at $V_f$ = 6.3 V | $I_f$ | | 0.55 | A |
| Peak heater starting current | $I_{fo_p}$ | | 5 | A |
| Cold heater resistance | $R_{fo}$ | | 1.75 | Ω |
| Waiting time | | | | |
| at $t_{amb}$ above 0 °C | $T_w$ | min. | 2 | min |
| at $t_{amb}$ below 0 °C | $T_w$ | min. | 3 | min |

For mean input powers greater than 25 W the heater voltage must be reduced immediately after the application of high voltage. See page 5

**COOLING**

In normal circumstances radiation and convection cooling is adequate, but where the ambient temperature is abnormally high, a flow of cooling air between the radiator fins may be necessary to keep the anode block temperature below the permitted maximum.

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

| | | | | | |
|---|---|---|---|---|---|
| Pulse duration | | $T_{imp}$ | min. | 0.05 | μs |
| | | | max. | 2.5 | μs |
| Duty factor | | δ | max. | 0.0015 | |
| Peak anode current | $T_{imp} \leq 1$ μs | $I_{a_p}$ | min. | 6 | A |
| | | | max. | 9 | A |
| | $T_{imp} > 1$ μs | $I_{a_p}$ | min. | 6 | A |
| | | | max. | 7.5 | A |
| Mean input power | | $W_{ia}$ | max. | 85 | W |
| Rate of rise of voltage pulse | | $dV_a/dT$ | max. | 120 | kV/μs |
| Voltage standing wave ratio | | V.S.W.R. | max. | 1.5 | |
| Temperature of anode block | | $t_a$ | max. | 120 | $^oC$ |

**TYPICAL CHARACTERISTICS**

| | | | | |
|---|---|---|---|---|
| Frequency, fixed within the band | f | 9.345 to | 9.405 | GHz |
| Peak anode voltage at $I_{a_p}$ = 7.5 A | $V_{a_p}$ | 7.0 to | 8.2 | kV |
| Peak output power at $I_{a_p}$ = 7.5 A | $W_{o_p}$ | min. | 17 | kW |
| Pulling figure (V.S.W.R. = 1.5) | $\Delta f_p$ | max. | 18 | MHz |
| Frequency temperature coefficient | $\frac{\Delta f}{\Delta t}$ | max. | -0.25 | MHz/$^oC$ |
| Distance of voltage standing wave minimum from face of mounting plate into tube | d | 16.5 to | 22.5 | mm |
| Input capacitance | $C_{ak}$ | max. | 8.0 | pF |
| Frequency pushing | $\frac{\Delta f}{\Delta I_{a_p}}$ | max. | 1.5 | MHz/A |

## OPERATING CHARACTERISTICS

| | | | | | |
|---|---|---|---|---|---|
| Pulse duration | $T_{imp}$ | 0.5 | 0.5 | 0.05 | µs |
| Pulse repetition frequency | $f_{imp}$ | 1000 | 1000 | 1000 | Hz |
| Duty factor | $\delta$ | 0.0005 | 0.0001 | 0.00005 | |
| Heater voltage (running) | $V_f$ | 6.3 | 6.3 | 6.3 | V |
| Anode current, peak | $I_{a_p}$ | 7.5 | 7.5 | 7.5 | A |
| mean | $I_a$ | 3.75 | 0.8 | 0.425 | mA [1] |
| Peak anode voltage | $V_{a_p}$ | 7.8 | 7.8 | 7.8 | kV |
| Rate of rise of voltage pulse | $\frac{dVa}{dT}$ | 80 | 100 | 100 | kV/µs |
| Input power, peak | $W_{ia_p}$ | 58.5 | 58.5 | 58.5 | kW |
| mean | $W_{ia}$ | 29 | 6.2 | 3.3 | W |
| Output power, peak | $W_{o_p}$ | 20 | 20 | 20 | kW |
| mean | $W_o$ | 10 | 2.0 | 1.0 | W |
| Pulling figure (V.S.W.R. = 1.5) | $\Delta f_p$ | 16 | 16 | 16 | MHz |

## END OF LIFE PERFORMANCE

The tube is deemed to have reached end of life when it fails to satisfy the following:

| | | | |
|---|---|---|---|
| Peak output power at $I_{a_p}$ = 7.5 A | $W_{o_p}$ | > 14 | kW |
| Frequency within the band | f | 9.345 to 9.405 | GHz |
| Peak anode voltage at $I_{a_p}$ = 7.5 A | $V_{a_p}$ | 7.0 to 8.4 | kV |

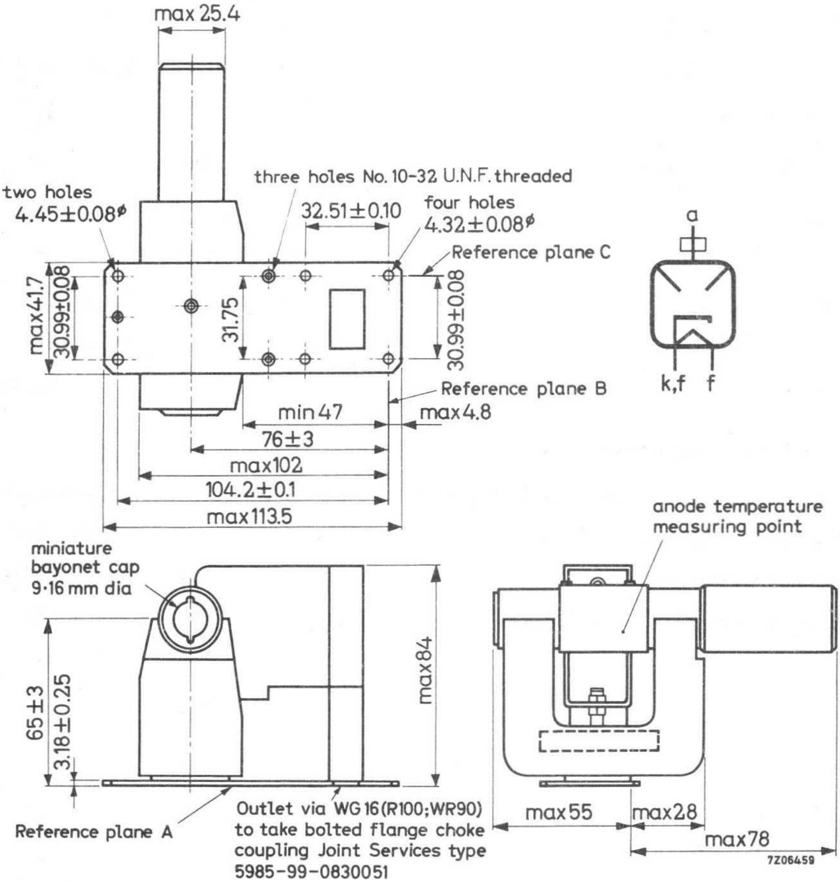
1) Includes pre-oscillation current.

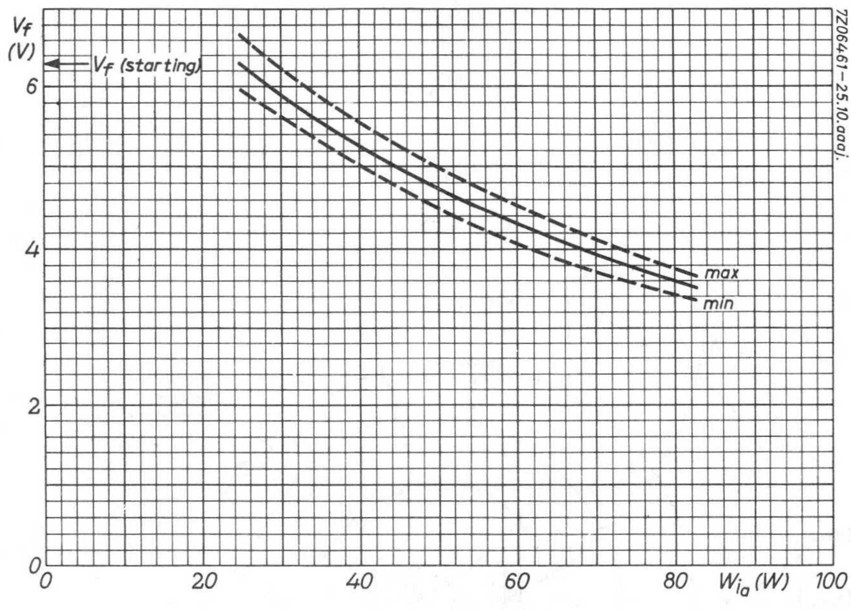
MECHANICAL DATA

Dimensions in mm

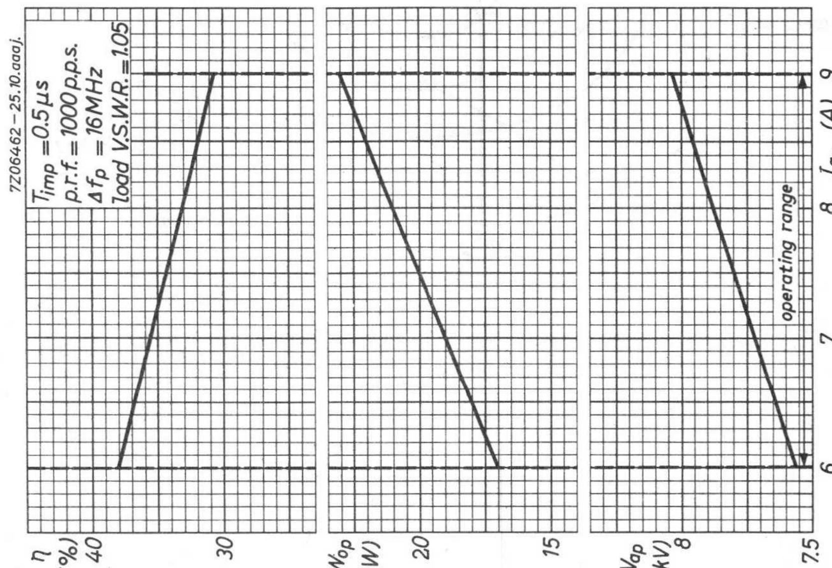
Mounting position: any

Net weight: 1.5 kg

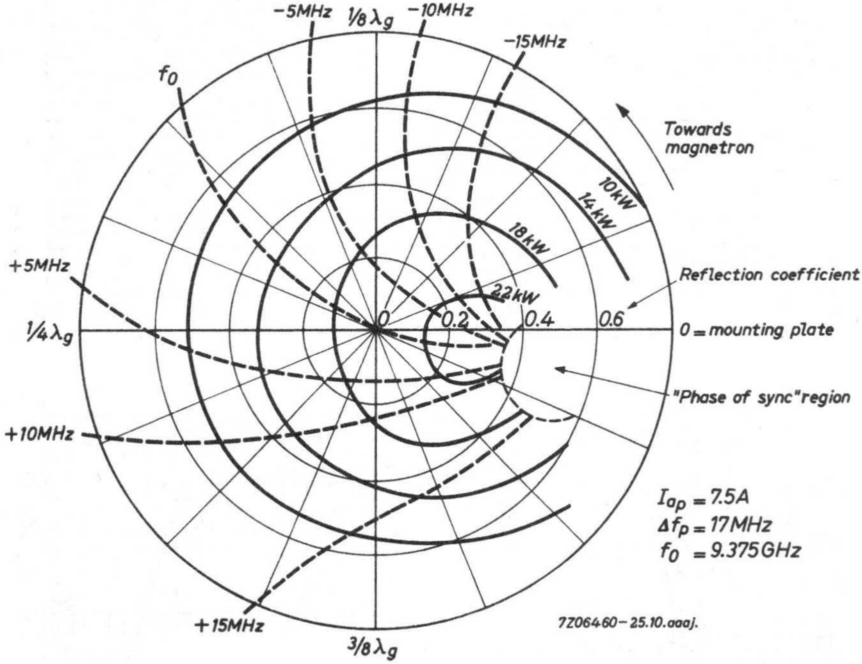




Vf
(V)
Vf (starting)
6
4
2
0
0
20
40
60
80
Wia (W)
100
max
min
7Z06461-25.10.aaaj.

7Z06462-25.10.aaaj.
Timp = 0.5 μs
p.r.f. = 1000 p.p.s.
Δfp = 16 MHz
load V.S.W.R. = 1.05
η (%)
40
30
Wop (kW)
20
15
Vap (kV)
8
7.5
Iap (A)
9
8
7
6
operating range


-5MHz
1/8 λg
-10MHz
-15MHz
f0
Towards magnetron
10kW
14kW
18kW
22kW
+5MHz
Reflection coefficient
1/4 λg
0
0.2
0.4
0.6
0 = mounting plate
"Phase of sync" region
+10MHz
Iap = 7.5A
Δfp = 17MHz
f0 = 9.375GHz
+15MHz
3/8 λg
7Z06460-25.10.aaaj.

# PULSED MAGNETRON

Packaged magnetron for pulsed service at a fixed frequency.

| QUICK REFERENCE DATA | | | |
|---|---|---|---|
| Frequency, fixed within the band | f | 9.380 to 9.440 | GHz |
| Peak output power | $W_{op}$ | 25 | kW |
| Construction | | packaged | |

**HEATING** : indirect

| | | | | |
|---|---|---|---|---|
| Heater voltage | $V_f$ | | 6.3 | V |
| Heater current | $I_f$ | | 0.55 | A |
| Peak heater starting current | $I_{f_{op}}$ | max. | 5 | A |
| Waiting time at $t_{amb}$ above 0 °C | $T_w$ | min. | 2 | min |
| Waiting time at $t_{amb}$ between 0°C and -55 °C | $T_w$ | min. | 3 | min |

For mean values of input power greater than 40 W the heater voltage must be reduced immediately after application of anode power.

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

| | | | | |
|---|---|---|---|---|
| Pulse duration | $T_{imp}$ | min. | 0.05 | μs |
| | | max. | 2.0 | μs |
| Duty factor | δ | max. | 0.0015 | |
| Peak anode current | $I_{ap}$ | min. | 6.0 | A |
| | | max. | 10 | A |
| Mean input power | $W_{ia}$ | max. | 85 | W |
| Peak input power | $W_{ia_p}$ | max. | 75 | kW |
| Peak anode voltage | $V_{ap}$ | min. | 7.5 | kV |
| | | max. | 8.5 | kV |
| Rate of rise of anode voltage | dVa/dT | max. | 120 | kV/μs [2)] |
| Voltage standing wave ratio | V.S.W.R. | max. | 1.5 | |
| Anode temperature at reference point (see outline drawing) | $t_a$ | max. | 120 | °C |
| Heater voltage | $V_f$ | min. | 5.9 | V |
| | | max. | 6.7 | V |

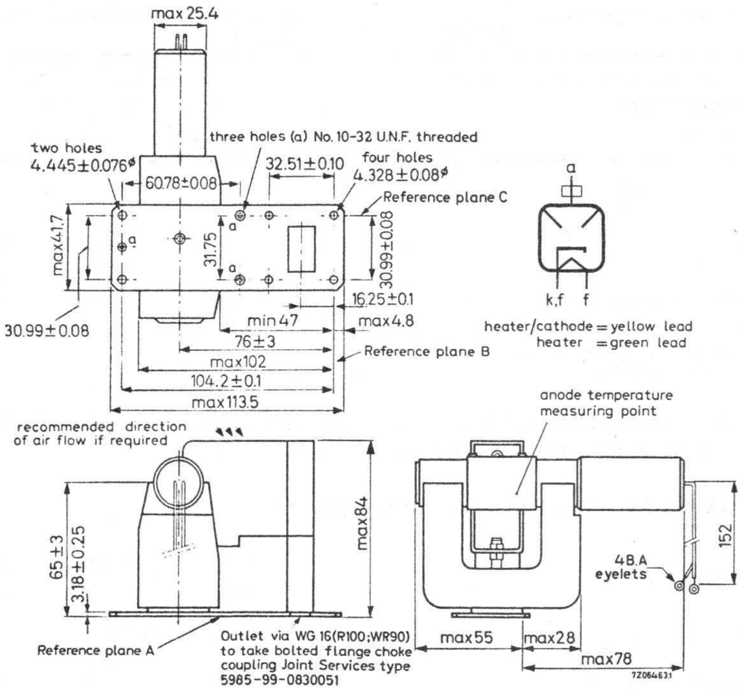
**COOLING**

Natural or forced-air as necessary to ensure that the temperature of the anode does not exceed the limiting value.

Note : see page 4

**MECHANICAL DATA** Dimensions in mm

Net weight: 1.4 kg




Output coupler: The output connection of the magnetron should be connected directly to a waveguide choke flange type UG-40B/U (5985-99-083-0051).

Mounting position : any

Mounting and storage precautions: When mounting and handling the magnetron, care must be taken to prevent demagnetisation. It is necessary to keep all magnetic materials as far as possible, at least 50 mm from the magnet.
When storing, magnetrons should be kept as far apart as possible, at least 150 mm. During shipment adequate separation between magnetrons is provided by the dimensions of the inner packs of the storage cartons and it is recommended that magnetrons not in use be kept in these packs.

## TEST CONDITIONS AND LIMITS

### Test conditions

| | | | | | |
|---|---|---|---|---|---|
| Heater voltage | $V_f$ | | 6.3 | V | 1) |
| Mean anode current | $I_a$ | | 4.0 | mA | |
| Duty factor | $\delta$ | | 0.0005 | | |
| Pulse duration | $T_{imp}$ | | 0.5 | μs | 3) |
| Voltage standing wave ratio | V.S.W.R. | max. | 1.05 | | |
| Rate of rise of anode voltage | dVa/dT | | 120 | kV/μs | 2) |

### Limits and characteristics

| | | min. | max. | | |
|---|---|---|---|---|---|
| Peak anode voltage | $V_{ap}$ | 7.5 | 8.5 | kV | |
| Mean output power | $W_o$ | 10 | | W | |
| Frequency | f | 9.380 | 9.440 | GHz | |
| R.F. bandwidth at 1/4 power | B | | $\frac{2.5}{T_{imp}}$ | MHz | 4) |
| Pulling figure at V.S.W.R. = 1.5 | $\Delta f_p$ | | 18 | MHz | 5) |
| Pushing figure | $\frac{\Delta f}{\Delta I_a}$ | | 1.5 | MHz/A | 9) |
| Stability | | | 0.25 | % | 6) |
| Minor lobe level | | 6 | | dB | 4) |
| Cold impedance | | See note 7) | | | |
| Frequency temperature coefficient (after warming) | $\Delta f/\Delta t_a$ | | -0.25 | MHz/°C | 8) |
| Input capacitance | $C_{ak}$ | | 9 | pF | 8) |
| Heater current at $V_f$ = 6.3 V, $W_i$ = 0 | $I_f$ | 0.43 | | A | 9) |

## OPERATING CHARACTERISTICS

| | | | | |
|---|---|---|---|---|
| Heater voltage | $V_f$ | 6.3 | 6.3 | V |
| Pulse duration | $T_{imp}$ | 0.05 | 1.0 | μs |
| Pulse repetition rate | $f_{imp}$ | 2000 | 500 | p.p.s. |
| Duty factor | $\delta$ | 0.0001 | 0.0005 | |
| Peak anode current | $I_{ap}$ | 8.0 | 8.0 | A |
| Rate of rise of anode voltage | $dV_a/dT$ | 110 | 110 | kV/μs |
| Peak anode voltage | $V_{ap}$ | 8.3 | 8.3 | kV |
| Mean output power | $W_o$ | 2.5 | 12.5 | W |
| Peak output power | $W_{op}$ | 25 | 25 | kW |

Notes: see page 4.

## END OF LIFE PERFORMANCE

The quality of all production is monitored by the random selection of magnetrons which are then life tested under the stated test conditions. If the magnetron is to be operated under different conditions from the stated test conditions, the manufacturer should be consulted to verify that the life will not be affected. The magnetron is considered to have reached the end of life when it fails to meet the following limits when operated under conditions specified under "Test conditions and limits".

| | | min. | max. | |
|---|---|---|---|---|
| Mean output power | $W_o$ | 8.0 | | W |
| Peak anode voltage | $V_{ap}$ | 7.5 | 8.5 | kV |
| Frequency | f | 9.380 | 9.440 | GHz |
| R.F. bandwidth at 1/4 power | B | | $\frac{3.0}{T_{imp}}$ | MHz |
| Stability | | | 0.5 | % |

## VIBRATION

The magnetron is vibration tested to ensure that it will withstand normal conditions of service.

## NOTES

1) The magnetron is normally tested with a sine wave heater supply of 50 Hz and is suitable for operation from 50 Hz to 1 kHz sine or square-wave supply.
The manufacturer should be consulted if the magnetron is to be operated with a heater supply having different frequency or waveform conditions.
2) Defined as the steepest tangent to the leading edge of the voltage pulse above 80% amplitude.
3) The tolerance of current pulse duration, $T_{imp}$, measured at 50 % amplitude is ±10 %.
4) Measured with the magnetron operating into a V.S.W.R. of 1.5 varied through all phases over a peak anode current range of 6 A to 10 A.
5) Measured at a peak anode current of 8 A under matched conditions. A mismatch of 1.5 is then varied through all phases.
6) Measured with the conditions described in note 4. Pulses are defined as missing when the R.F. energy level is less than 70 % of the normal level in the frequency range 9.380 GHz to 9.440 GHz. Missing pulses are expressed as a percentage of the number of input pulses applied during the period of observation after a period of ten minutes of operation.
7) The cold impedance of the magnetron is measured at the operating frequency and will give a V.S.W.R. of > 6 . The position of voltage minimum from the face of the output flange into the magnetron is 16.5 mm to 22.5 mm.
8) Design test only.
9) Measured over the peak anode current range of 6A to 10 A.

# PULSED MAGNETRON

Packaged magnetron for pulsed service at a fixed frequency.

| QUICK REFERENCE DATA | | | | | | |
|---|---|---|---|---|---|---|
| Frequency, fixed within the band | f | 9.415 | to | 9.475 | GHz | |
| Peak output power | $W_{o_p}$ | | | 26 | kW | |
| Construction | | packaged | | | | |

**HEATING** : indirect

| | | | | | |
|---|---|---|---|---|---|
| Heater voltage | $V_f$ | | 6.3 | V | 1) |
| Heater current | $I_f$ | | 0.55 | A | |
| Peak heater starting current | $I_{f_p}$ | max. | 5 | A | |
| Waiting time at $t_{amb}$ above 0 °C | $T_w$ | min. | 2 | min. | |
| Waiting time at $t_{amb}$ between 0 °C and −55 °C | $T_w$ | min. | 3 | min. | |

For mean values of input power greater than 45 W the heater voltage should be reduced.

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

| | | | | | |
|---|---|---|---|---|---|
| Pulse duration | $T_{imp}$ | max. | 2 | μs | |
| Duty factor | $\delta$ | max. | 0.0015 | | |
| Peak anode current | $I_{a_p}$ | min. | 6 | A | |
| | | max. | 10 | A | |
| Mean input power | $W_{ia}$ | max. | 85 | W | |
| Peak input power | $W_{ia_p}$ | max. | 75 | kW | |
| Peak anode voltage | $V_{a_p}$ | min. | 7.5 | kV | |
| | | max. | 8.5 | kV | |
| Rate of rise of anode voltage | $dV_a/dT$ | max. | 120 | kV/μs | 2) |
| Voltage standing wave ratio | V.S.W.R. | max. | 1.5 | | |
| Anode temperature | $t_a$ | max. | 120 | °C | |
| Heater voltage | $V_f$ | min. | 5.7 | V | |
| | | max. | 6.9 | V | 1) |

**COOLING**

Natural or forced-air as necessary to ensure that the temperature of the anode does not exceed the limiting value.

---

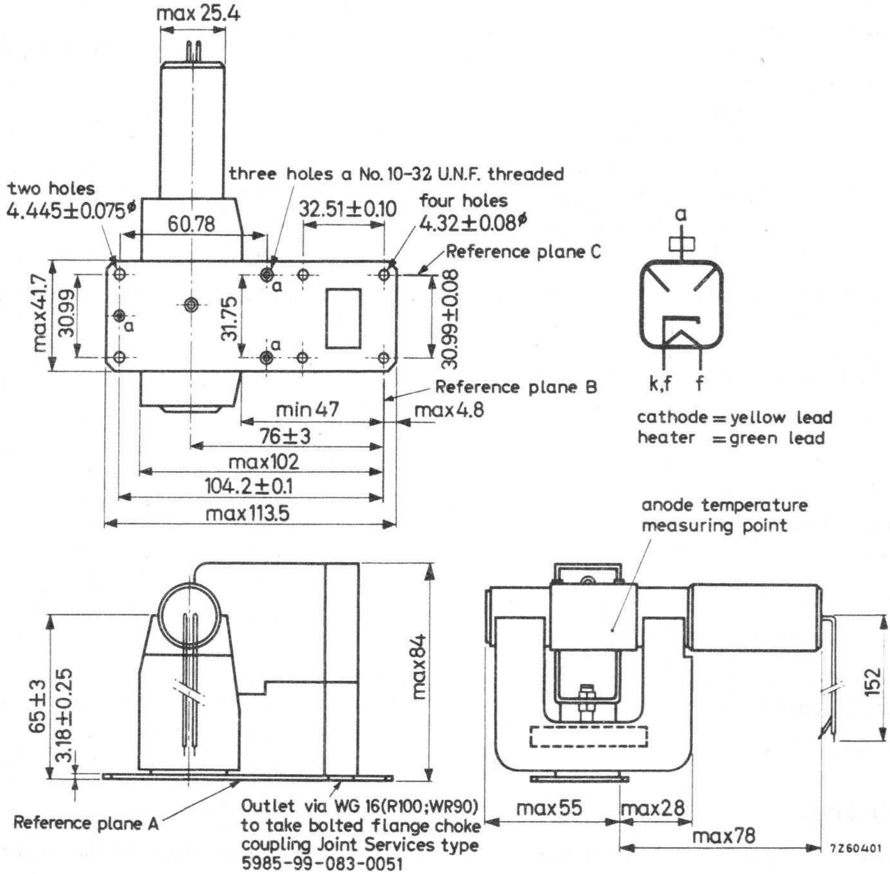
1) The magnetron is normally tested with a heater supply of 50 Hz and is suitable for operation at 800 Hz. The manufacturer should be consulted if the magnetron is to be operated with a heater supply of any other frequency.

2) Defined as the steepest tangent to the leading edge of the voltage pulse above 80 % amplitude.

## MECHANICAL DATA

Dimensions in mm

Net weight: 1.4 kg
Mounting position: any [7]




[7] see page 4

## TEST CONDITIONS AND LIMITS

Test conditions

| | | | | |
|---|---|---|---|---|
| Heater voltage | $V_f$ | 6.3 | V | 1) |
| Mean anode current | $I_a$ | 4.5 | mA | |
| Duty factor | $\delta$ | 0.0005 | | |
| Pulse duration | $T_{imp}$ | 0.5 | µs | 3) |
| Voltage standing wave ratio | V.S.W.R. | max. 1.05 | | |
| Rate of rise of anode voltage | dVa/dT | 120 | kV/µs | 2) |

Limits and characteristics

| | | min. | max. | | |
|---|---|---|---|---|---|
| Peak anode voltage | $V_{ap}$ | 7.5 | 8.5 | kV | |
| Mean output power | $W_o$ | 11 | | W | |
| Frequency | f | 9.415 | 9.475 | GHz | |
| R.F. bandwidth at $\frac{1}{4}$ power | B | | $\frac{2.5}{T_{imp}}$ | MHz | 3) |
| Pulling figure at V.S.W.R. = 1.5 | $\Delta f_p$ | | 18 | MHz | |
| Stability | | | 0.25 | % | 4) |
| Minor lobe level at V.S.W.R. = 1.5 | | 6 | | dB | |
| Cold impedance | | see note 5) | | | |
| Frequency temperature coefficient after warming | $\Delta f/\Delta t_a$ | | -0.25 | MHz/degC | 6) |
| Input capacitance | $C_{ak}$ | | 9 | pF | 6) |
| Heater current at $V_f = 6.3$ V | $I_f$ | 0.43 | 0.60 | A | |

## OPERATING CHARACTERISTICS

| | | | | |
|---|---|---|---|---|
| Heater voltage | $V_f$ | 6.3 | 6.3 | V |
| Pulse duration | $T_{imp}$ | 0.05 | 0.75 | µs |
| Pulse repetition rate | $f_{imp}$ | 2400 | 800 | p.p.s. |
| Peak anode current | $I_{ap}$ | 9 | 9 | A |
| Rate of rise of anode voltage | dVa/dT | 110 | 110 | kV/µs |
| Peak anode voltage | $V_{ap}$ | 8.3 | 8.3 | kV |
| Mean output power | $W_o$ | 3.12 | 15.6 | W |
| Peak output power | $W_{op}$ | 26 | 26 | kW |

1) 2) See page 1
3), 4), 5), 6), 7) See page 4

## END OF LIFE PERFORMANCE

The quality of all production is monitored by the random selection of magnetrons which are then life tested under the stated test conditions. If the magnetron is to be operated under different conditions from those specified above, the manufacturer should be consulted to verify that the life will not be affected. The magnetron is considered to have reached the end of life when it fails to meet the following limits when operated under the conditions specified under "Test conditions and limits."

| | | | | |
|---|---|---|---|---|
| Mean output power | $W_o$ | min. | 9 | W |
| Peak anode voltage | $V_{ap}$ | 7.5 to | 8.5 | kV |
| Frequency, fixed within the band | f | 9.415 to 9.475 | | GHz |

## VIBRATION

The magnetron is vibration tested to ensure that it will withstand normal conditions of service.

---

3) The tolerance of current pulse duration, $T_{imp}$, measured at 50% amplitude is ±10%.

4) With the magnetron operating into a V.S.W.R. of 1.5 varied through all phases over an peak anode current range of 6 to 10 A. Pulses are defined as missing when the R.F. energy level is less than 70% of the normal level in the frequency range 9.415 to 9.475 GHz.
Missing pulses are expressed as a percentage of the number of input pulses applied during the period of observation after a period of 10 minutes operation.

5) The cold impedance is measured at the operating frequency and will give a V.S.W.R. of > 6. The position of the voltage minimum from the face of the output flange into the magnetron is 16.5 mm to 22.5 mm.

6) Design test only.

7) It is necessary to keep all magnetic material as far as possible, at least 50 mm, from the magnet. The inner polysterene pack of the magnetron carton provides adequate separation between magnetrons, and it is recommended that magnetrons not in use be kept in these cartons.

# PULSED MAGNETRON

Air-cooled packaged magnetron intended for service as a pulsed oscillator at a fixed frequency. The YJ1140 incorporates a dispenser type of cathode to provide a long life. A getter to maintain a high vacuum minimizes any tendency towards arcing, even when the magnetron is taken into operation after a period of storage.

The waveguide output is designed for coupling to rectangular waveguide RG-91/U (British designation WG18) with outside dimensions 0.702" x 0.391".

| QUICK REFERENCE DATA | | | |
|---|---|---|---|
| Frequency, fixed within the band | f | 16.350 to 16.650 | GHz |
| Peak output power | $W_{o_p}$ | 45 | kW |
| Construction | | packaged | |

**CATHODE:** Dispenser type

**HEATING :** Indirect by A.C. or D.C.

| | | | | |
|---|---|---|---|---|
| Heater starting voltage | $V_f$ | | 12.6 | V $^{+10\%}_{-5\%}$ |
| Heater current at $V_f$ = 12.6 V | $I_f$ | | 3.2 ± 0.5 | A |
| Heater surge peak current | $I_{f_{surge_p}}$ | max. | 8 | A |
| Cold heater resistance | $R_{f_o}$ | min. | 0.45 | Ω |
| Heating time before application of high voltage (waiting time) | $T_w$ | min | 3 | min |

**COOLING**

Air cooling

An adequate flow of cooling air should be directed along the cooling fins towards the body of the tube to keep the temperature of the anode block below 150 °C under any condition of operation. If necessary, the heater-cathode terminal should also be cooled to keep its temperature below 165 °C.

Data based on pre-production tubes

## LIMITING VALUES (Absolute max. rating system)

| | | | | |
|---|---|---|---|---|
| Pulse duration | $T_{imp}$ | max. | 1 | μs |
| Duty factor | δ | max. | 0.001 | |
| Peak anode current | $I_{a_p}$ | max. | 15 | A |
| Mean input power | $W_{i_a}$ | max. | 200 | W |
| Rate of rise of voltage pulse | $dVa/_{dT}$ | max. | 160 | kV/μs |
| Voltage standing wave ratio | V.S.W.R. | max. | 1.5 | |
| Temperature of anode block | $t_a$ | max. | 150 | $^oC$ |
| Temperature of cathode and heater seals | $t_s$ | max. | 165 | $^oC$ |
| Input pressurization | | min. | 45 | cmHg |
| | | | (0.6 kg/cm$^2$ | abs.) |

The output assembly must always be pressurized. When the magnetron is working into a matched load, the pressure on the output window must be higher than 1 kg/cm$^2$ abs.

## TYPICAL CHARACTERISTICS

| | | | | |
|---|---|---|---|---|
| Frequency, fixed within the band | f | 16.350 to | 16.650 | GHz |
| Peak anode voltage at $I_{a_p}$ = 15 A | $V_{a_p}$ | 11 to | 13 | kV |
| Stable range at matched load: peak anode current | $I_{a_p}$ | 7.5 to | 15 | A |
| Pulling figure | $\Delta f_p$ | max. | 25 | MHz |
| Frequency temperature coefficient | $\frac{\Delta f}{\Delta t}$ | max. | - 0.5 | MHz/$^oC$ |
| Distance of voltage standing wave minimum 1) | d | 0.40 to | 0.54 | λg |
| Input capacitance | $C_{a_k}$ | | 9 | pF |
| Frequency pushing | $\frac{\Delta f}{\Delta I_{a_p}}$ | max. | 4 | MHz/A |

1) The distance of the V.S.W. minimum outside the tube is between 0.40 and 0.54 λg with respect to reference plane A. (see outline drawing), measured with a standard cold test technique at the frequency of the oscillating magnetron operating in a matched load.

## OPERATING CHARACTERISTICS

| | | | |
|---|---|---|---|
| Pulse duration | $T_{imp}$ | 0.5 | μs |
| Pulse repetition frequency | $f_{imp}$ | 800 | Hz |
| Duty factor | $\delta$ | 0.0004 | |
| Heater voltage (running) | $V_f$ | 10 | V |
| Anode current, peak | $I_{ap}$ | 15 | A |
| mean | $I_a$ | 6 | mA |
| Peak anode voltage | $V_{ap}$ | 11 to 13 | kV |
| Rate of rise of voltage pulse | dVa/dT | 100 to 160 | kV/μs |
| Output power, peak | $W_{op}$ | 45 | kW |
| mean | $W_o$ | 18 | W |

The manufacturer should be consulted whenever it is considered to operate the magnetron at conditions substantially different from those given above.

## STARTING A NEW MAGNETRON

This magnetron is provided with a getter, so that ageing (of a new magnetron or of a magnetron that has been idle or stored for a period of time) will not be necessary in most cases. If, however, the magnetron is put into operation and some sparking and instability occur incidentally, it is recommended to increase the anode current gradually and to operate the magnetron with reduced input during 15 to 30 minutes. After this period sparking usually ceases.

## CIRCUIT NOTES

a) In order to prevent heater burn-out the negative high-voltage pulse must be applied to the common cathode-heater terminal.

b) If no load isolator is inserted between the magnetron and the transmission line, the latter should be as short as possible to prevent long-line effects. Under no circumstances should the magnetron be operated with a V.S.W.R. of the load exceeding 1.5. A ratio kept near unity will benefit tube life and reliability.

c) The modulator must be so designed that, if arcing occurs, the energy per pulse delivered to the magnetron does not considerably exceed the normal energy per pulse. Modulators of the pulse-forming-network discharge type usually satisfy this requirement.

d) It is required to bypass the magnetron heater with a 1000 V rated capacitor of minimum 4 nF directly across the heater terminals.

e) Any diode current flowing during the intervals between the pulses should be taken into account when the peak anode current is calculated from the measured average anode current. The occurrence of this diode current can be avoided by preventing that during these intervals the anode voltage becomes positive with respect to the cathode.

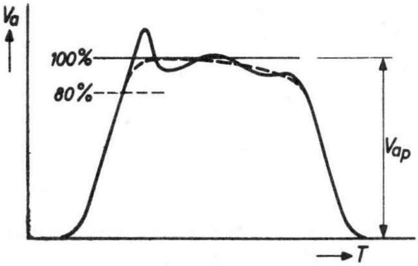
f) The unwanted noise that may occur when the anode pulse voltage drops below the value required for oscillation can be minimized by making the trailing edge of the voltage pulse as steep as possible.

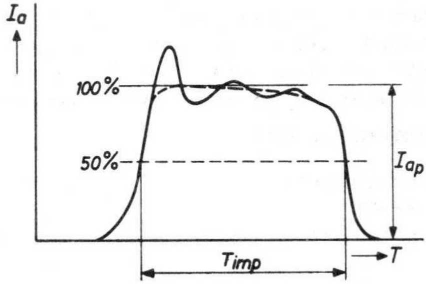
## PULSE CHARACTERISTICS AND DEFINITIONS

The smooth peak value ($V_{a_p}$ or $I_{a_p}$) of a pulse is the maximum value of a smooth curve through the average of the fluctuation over the top portion of the pulse as shown in the figure below.

The rate of rise of anode voltage is defined by the steepest tangent to the leading edge of the voltage pulse above 80 % of the smooth peak value (fig.1). Any capacitance used in a removable viewing system shall not exceed 6 pF. For calculation of the rate of rise of anode voltage the 100 % value must be taken as 12 kV.

The pulse duration ($T_{imp}$) is the time interval between the two points on the current pulse at which the current is 50 % of the smooth peak current (fig.2).




The current pulse must be substantially square and the ripple over the top portion of the current pulse must be kept as small as possible to avoid unwanted frequency modulation due to pushing effects. The spike on the top portion of the pulse must be small to avoid excessive peak pulse current. The leading edge of the pulse must be free from irregularities.

## STORAGE, HANDLING AND MOUNTING

The original packing should be used for the transport of the magnetron.

The magnetron should never be held by the heater cathode stem.
Rough treatment of the metal envelope and of the cooling fins may impair the electrical characteristics or may result in loss of vacuum.

When storing, the packaged magnetrons should be kept not less than 15 cm (6 inches) apart, to prevent a decrease of field strength of the magnetron magnet as a result of interaction with the adjacent magnets. If the magnetrons are stored in their original inner container, no special precautions need be taken with regard to the distance apart. If the magnetrons are stored without their inner container, they should be stored in non-magnetic surroundings e.g. on wooden shelves.

**STORAGE, HANDLING AND MOUNTING** (continued)

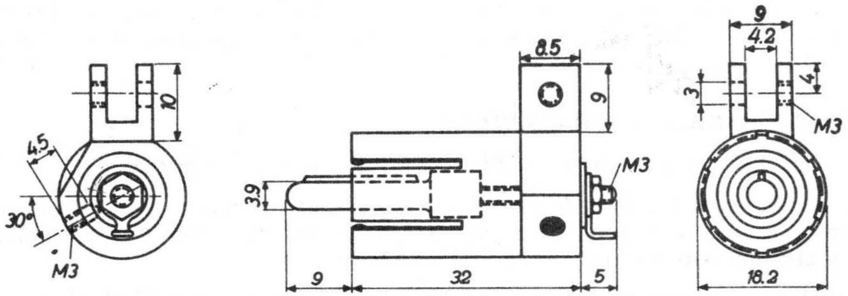
When handling and mounting the magnetron, a minimum distance of 5 cm (2 inches) between the magnet and any piece of magnetic material should be maintained to a-void mechanical shocks to the magnet or the glass of the heater-cathode stem. For this reason it is required to use non-magnetic tools during installation, such as non-magnetic stainless steel, brass, beryllium copper and aluminium. Further-more, the user should be aware of the detrimental influence of the strong magnetic field around the magnet on watches and other precision instruments nearby.

Mounting of the magnetron should be accomplished by means of its mounting flange. The tube should in no case be supported by the coupling to the waveguide output flange alone.

A dust-cover is placed on the output flange, to keep its opening closed until the tube is mounted into the equipment. Before putting the magnetron into operation, the user should make sure that the output waveguide and the recessed cathode terminal are entirely clean and free from dust and moisture.

**MECHANICAL DATA**

| | |
|---|---|
| Mounting position | any |
| Net weight | 2.1 kg |
| Waveguide output flange | WG18 plain flange drilled and tapped for four 6 - 32 UNC bolts (as in UG-541) to mate with UG-419. |
| Cathode connector | 55356 |

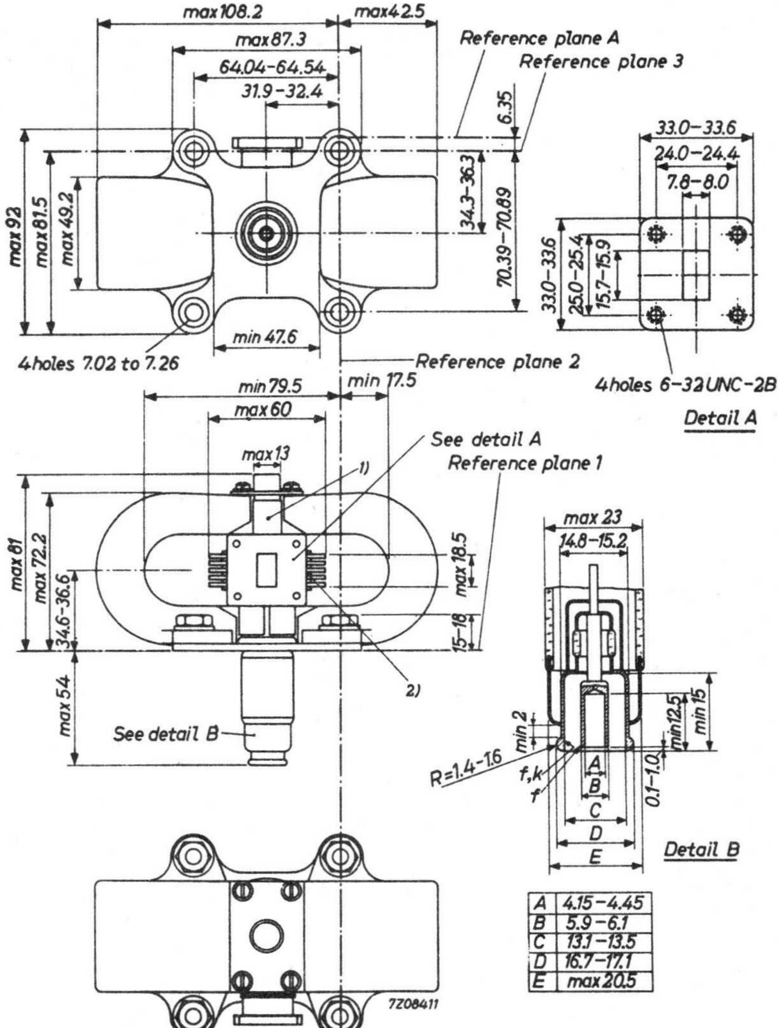



cathode connector 55356

The mounting flange and also the waveguide output system of the tube are made so that the magnetron can be used in applications requiring a pressure seal. They can be maintained at a pressure of max. 3.1 kg/cm$^2$ (45 lbs/sg. inch).

MECHANICAL DATA

Dimensions in mm




1) Inscription of serial number.

2) Point for anode block temperature measurement located near the output section where the central fin meets the anode block.

# PULSED MAGNETRON

Packaged magnetron for pulsed service at a fixed frequency.
This magnetron is suitable for operation at high altitudes.

| QUICK REFERENCE DATA | | | |
|---|---|---|---|
| Frequency, fixed within the band | f | 9.345 to 9.405 | MHz |
| Peak output power | $W_{op}$ | 50 | kW |
| Construction | packaged, flying leads | | |

**HEATING:** indirect

| | | | | |
|---|---|---|---|---|
| Heater voltage | $V_f$ | | 12.4 | V |
| Heater current | $I_f$ | | 2.2 $\pm$0.2 | A |
| Peak heater starting current | $I_{f_{op}}$ | max. | 10 | A |
| Waiting time | $T_w$ | min. | 90 | s |

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

| | | | | |
|---|---|---|---|---|
| Pulse duration | $T_{imp}$ | max. | 5.0 | μs |
| Duty factor | δ | max. | 0.0025 | |
| Peak anode current | $I_{ap}$ | min. | 8.0 | A |
| | | max. | 14 | A |
| Mean input power | $W_i$ | max. | 350 | W |
| Rate of rise of anode voltage | $\frac{dV_a}{dT}$ | max. | 80 | kV/μs |
| Voltage standing wave ratio | VSWR | max. | 1.5 | |
| Anode block temperature | $t_a$ | max. | 120 | $^{o}$C |
| Cathode and heater seals temperature | $t_s$ | max. | 150 | $^{o}$C |

**PRESSURISING**

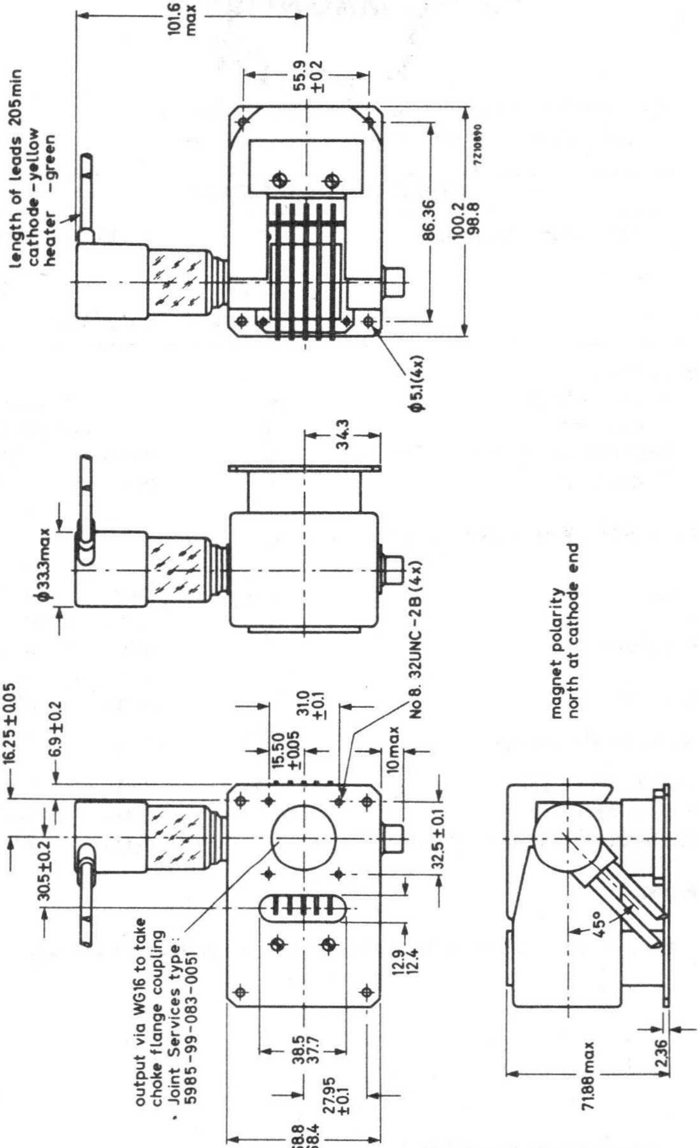
The magnetron is capable of unpressurised operation at altitudes up to 30 000 ft (≈9 km).

Data based on pre-production tubes.

MECHANICAL DATA

Dimensions in mm

Net weight: 1.9 kg
Mounting position: any



## TYPICAL CHARACTERISTICS

| | | | |
|---|---|---|---|
| Frequency, fixed within the band | $f$ | 9.345 to 9.405 | GHz |
| Peak anode voltage at $I_{ap}$ = 12 A | $V_{ap}$ | 11 to 12.5 | kV |
| Peak output power at $I_{ap}$ = 12 A | $W_{op}$ | > 40 | kW |
| Pulling figure at VSWR = 1.3 | $\Delta f_p$ | < 15 | MHz |
| Pushing figure | $\frac{\Delta f}{\Delta I_{ap}}$ | < 0.5 | MHz/A |
| Frequency temperature coefficient | $\frac{\Delta f}{\Delta t}$ | < 0.25 | MHz/degC |

## OPERATING CHARACTERISTICS

| | | | |
|---|---|---|---|
| Heater voltage (running) | $V_f$ | 7.7 | V |
| Pulse duration | $T_{imp}$ | 4.0 | $\mu$s |
| Pulse repetition rate | $f_{imp}$ | 400 | p.p.s. |
| Duty factor | $\delta$ | 0.0016 | |
| Peak anode current | $I_{ap}$ | 12 | A |
| Mean anode current | $I_a$ | 19.2 | mA |
| Peak anode voltage | $V_{ap}$ | 12 | kV |
| Rate of rise of anode voltage | $\frac{dV_a}{dT}$ | 60 | kV/$\mu$s |
| Mean input power | $W_i$ | 230 | W |
| Peak input power | $W_{ip}$ | 144 | kW |
| Mean output power | $W_o$ | 80 | W |
| Peak output power | $W_{op}$ | 50 | kW |
| Pulling figure (VSWR = 1.3) | $\Delta f_p$ | 10 | MHz |

## END OF LIFE PERFORMANCE

The magnetron is deemed to have reached end of life when it fails to satisfy the following:

| | | | |
|---|---|---|---|
| Peak anode power at $I_{ap}$ = 12 A | $W_{op}$ | min. 35 | kW |
| Frequency within the band | f | 9.345 to 9.405 | GHz |
| Peak anode voltage at $I_{ap}$ =12 A | $V_{ap}$ | 11 to 13.5 | kV |

# PULSED MAGNETRON

Packaged magnetron for pulsed service at a fixed frequency.

| QUICK REFERENCE DATA | | | |
|---|---|---|---|
| Frequency, fixed within the band | f | 9.415 to 9.475 | GHz |
| Peak output power | $W_{op}$ | 65 | kW |
| Construction | | packaged | |

**HEATING:** indirect

| | | | | | |
|---|---|---|---|---|---|
| Heater voltage | $V_f$ | | 6.3 | V | 1)2) |
| Heater current | $I_f$ | | 1.0 | A | |
| Peak heater starting current | $I_{f_{op}}$ | max. | 5.0 | A | |
| Waiting time at $t_{amb}$ above -15 °C | $T_w$ | min. | 2 | min | |
| Waiting time at $t_{amb}$ between -15 °C and -55 °C | $T_w$ | min. | 3 | min | |

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

| | | | | | |
|---|---|---|---|---|---|
| Pulse duration | $T_{imp}$ | max. | 1.0 | μs | 3) |
| Duty factor | $\delta$ | max. | 0.001 | | |
| Peak anode current | $I_{a_p}$ | min. | 12 | A | |
| | | max. | 16 | A | |
| Mean input power | $W_i$ | max. | 160 | W | |
| Peak anode voltage | $V_{a_p}$ | max. | 16 | kV | |
| Rate of rise of anode voltage | $\frac{dV_a}{dT}$ | min. | 100 | kV/μs | 4) |
| | | max. | 150 | kV/μs | 4) |
| Voltage standing wave ratio | VSWR | max. | 1.5 | | |
| Anode temperature | $t_a$ | max. | 120 | °C | |
| Heater voltage | $V_f$ | min. | 5.7 | V | |
| | | max. | 7.0 | V | |

**COOLING**

Adequate cooling is provided at maximum input power by an air flow of 0.43 $m^3$/min at $t_{amb}$ = 55 °C and standard pressure from an orifice of 31.75 mm diameter located at 6.35 mm from the cooling fins.

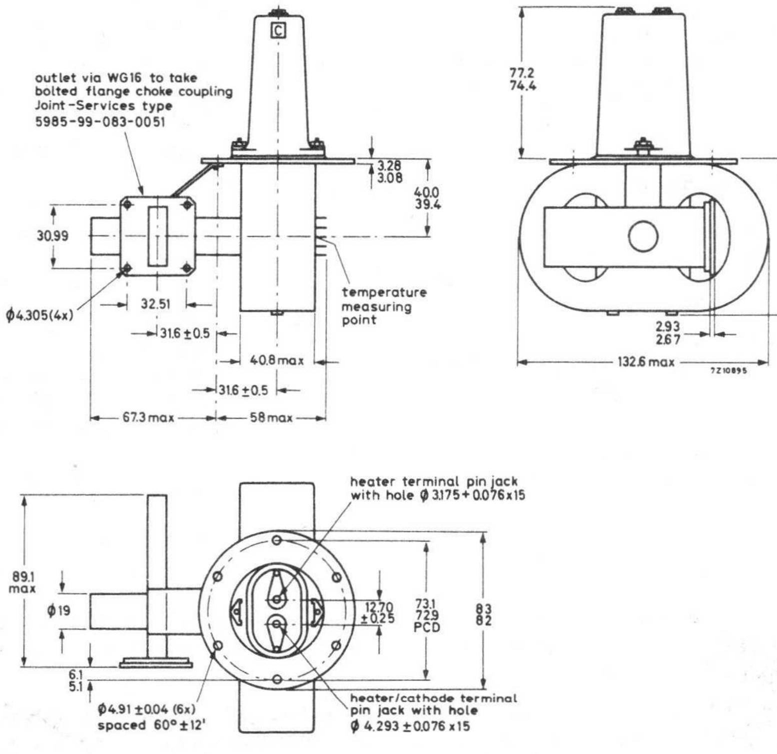
1) With no anode input power. The heater voltage during operation is very dependant on the application and should be agreed with the manufacturer.
2) The magnetron is normally tested with a heater supply of 50 Hz and is suitable for operation at 1.1 kHz. The manufacturer should be consulted if the magnetron is to be operated with a supply of any other frequency.
3) The tolerance of pulse current duration ($T_{imp}$) measured at 50% amplitude is ± 10%.
4) Defined as the steepest tangent to the leading edge of the anode voltage pulse above 80% amplitude.
5) Measured at a point indicated on the outline drawing.

Data based on pre-production tubes.

## MECHANICAL DATA

Dimensions in mm

Net weight: 2.1 kg
Mounting position: Any 8)




8) See page 4

## TEST CONDITIONS AND LIMITS

| Test conditions | | | | |
|---|---|---|---|---|
| Heater voltage (running) | $V_f$ | | 0 | V |
| Mean anode current | $I_a$ | | 8.8 | mA |
| Duty factor | $\delta$ | | 0.00062 | |
| Pulse duration | $T_{imp}$ | | 0.5 | $\mu$s 3) |
| Voltage standing wave ratio | VSWR | max. | 1.05 | |
| Rate of rise of anode voltage | $\frac{dV_a}{dT}$ | min. | 150 | kV/$\mu$s 4) |

| Limits and characteristics | | min. | max. | |
|---|---|---|---|---|
| Peak anode voltage | $V_{ap}$ | 12.5 | 15 | kV |
| Mean output power | $W_o$ | 34 | | W |
| Frequency | f | 9.415 | 9.475 | GHz 3) |
| R.F. bandwidth at $\frac{1}{4}$ power | B | | $\frac{2.5}{T_{imp}}$ | MHz |
| Pulling figure (VSWR = 1.5) | $\Delta f_p$ | | 15 | MHz |
| Minor lobe level | | 6.0 | | dB |
| Stability | | | 0.25 | % 6) |
| Frequency temperature coefficient | $\frac{\Delta f}{\Delta t_a}$ | | 0.25 | MHz/degC 7) |
| Heater current at $V_f$ = 6.3 V, $V_a$ = 0 V | $I_f$ | 0.9 | 1.1 | A |

## OPERATING CHARACTERISTICS

| | | | |
|---|---|---|---|
| Heater voltage (running) | $V_f$ | 1.0 | V |
| Pulse duration | $T_{imp}$ | 0.5 | $\mu$s |
| Pulse repetition rate | $f_{imp}$ | 1250 | p.p.s. |
| Duty factor | $\delta$ | 0.00062 | |
| Peak anode current | $I_{ap}$ | 14 | A |
| Rate of rise of anode voltage | $\frac{dV_a}{dT}$ | 145 | kV/$\mu$s 4) |
| Peak anode voltage | $V_{ap}$ | 14 | kV |
| Mean output power | $W_o$ | 40.5 | W |
| Peak output power | $W_{op}$ | 65 | kW |

3)4)5) See page 1

6)7) See page 4

## END OF LIFE PERFORMANCE

The quality of all production is monitored by random selection of magnetrons which are then lifetested under the stated test conditions. If the magnetron is to be operated under different conditions from those specified above, the manufacturer should be consulted to verify that the life will not be affected. The magnetron is considered to have reached the end of life when it falls to meet the following limits when tested as specified under "Test conditions and limits".

| | | | | |
|---|---|---|---|---|
| Peak output power | $W_{o_p}$ | min. | 50 | kW |
| Frequency | f | 9.415 to 9.475 | | GHz |
| R.F. bandwidth at $\frac{1}{4}$ power | B | max. | $\frac{3.5}{T_{imp}}$ | MHz |
| Stability | | max. | 0.5 | % |

6) With the magnetron operating into a VSWR of 1.5 varied through all phases over the anode current range of 12 A to 16 A peak. Pulses are defined as missing when the R.F. energy level is < 70% of the normal level in the frequency range 9.415 GHz to 9.475 GHz. Missing pulses are expressed as a percentage of the number of input pulses applied during the period of observation after a period of 3 minutes of operation.

7) Design test only. Maximum frequency change with anode temperature change after warming.

8) It is necessary to keep all magnetic material as far as possible, at least 50 mm away from the magnet.
The inner polystyrene pack of the carton provides adequate separation between magnetrons, and it is recommended that magnetrons not in use be kept in these packs.

# PULSED MAGNETRON

Packaged magnetron for pulsed service at a fixed frequency.

| QUICK REFERENCE DATA | | | |
|---|---|---|---|
| Frequency, fixed within the band | f | 9.380 to 9.440 | GHz |
| Peak output power | $W_{o_p}$ | 7.0 | kW |
| Construction | | packaged, flying leads | |

**HEATING** : indirect

| | | | | | |
|---|---|---|---|---|---|
| Heater voltage | $V_f$ | | 6.3 | V | 1) |
| Heater current | $I_f$ | | 0.55 | A | |
| Peak heater starting current | $I_{fo_p}$ | max. | 3.0 | A | |
| Waiting time at $t_{amb}$ above 0 °C | $T_w$ | min. | 30 | s | |
| Waiting time at $t_{amb}$ between 0 °C and -55 °C | $T_w$ | min. | 45 | s | |

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

| | | | | | |
|---|---|---|---|---|---|
| Pulse duration | $T_{imp}$ | max. | 1.0 | µs | |
| Duty factor | $\delta$ | max. | 0.001 | | |
| Peak anode current | $I_{a_p}$ | min. | 4.0 | A | |
| | | max. | 6.0 | A | |
| Mean input power | $W_i$ | max. | 20 | W | |
| Peak input power | $W_{i_p}$ | max. | 20 | kW | |
| Peak anode voltage | $V_{a_p}$ | min. | 4.0 | kV | |
| | | max. | 4.6 | kV | |
| Rate of rise of anode voltage | $\frac{dV_a}{dT}$ | max. | 75 | kV/µs | 2) |
| Voltage standing wave ratio | V.S.W.R. | max. | 1.5 | | |
| Anode temperature | $t_a$ | max. | 120 | °C | |
| Heater voltage | $V_f$ | min. | 5.7 | V | |
| | | max. | 6.9 | V | |

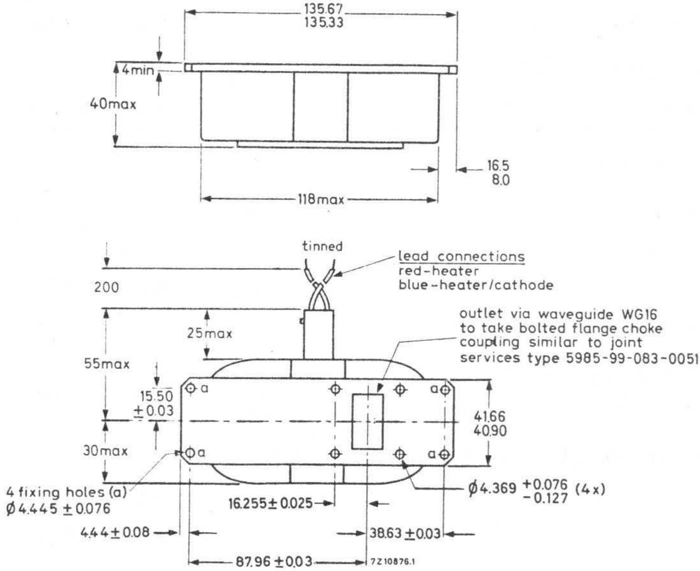
**COOLING** : natural

1)2) See page 4.

**MECHANICAL DATA**

Dimensions in mm

Net weight: 1.25 kg




Mounting position: any

Mounting and storage precautions

When mounting and handling the magnetron, care must be taken to prevent demagnetization. It is necessary to keep all magnetic materials as far as possible, at least 50 mm from the magnet.

When storing, magnetrons should be kept as far apart as possible, at least 15 cm. During shipment adequate separation is provided by the dimensions of the inner packs of the storage cartons and it is recommended that magnetrons not in use be kept in these packs.

## TEST CONDITIONS AND LIMITS

Test conditions

| | | | | | |
|---|---|---|---|---|---|
| Heater voltage | $V_f$ | | 6.3 | V | 1) |
| Mean anode current | $I_a$ | | 5.0 | mA | |
| Duty factor | $\delta$ | | 0.001 | | |
| Pulse duration | $T_{imp}$ | | 1.0 | μs | 3) |
| Voltage standing wave ratio | V.S.W.R. | | 1.05 | | |
| Rate of rise of anode voltage | $\frac{dV_a}{dT}$ | | 75 | kV/μs | 2) |

Limits and characteristics

| | | min. | max. | | |
|---|---|---|---|---|---|
| Peak anode voltage | $V_{ap}$ | 4.0 | 4.5 | kV | |
| Mean output power | $W_o$ | 6.0 | | W | |
| Frequency | f | 9.380 | 9.440 | GHz | |
| R.F. bandwidth at $\frac{1}{4}$ power | B | | $\frac{2.5}{T_{imp}}$ | MHz | 4) |
| Pulling figure | $\Delta f_p$ | | 18 | MHz | 5) |
| Stability | | | 0.25 | % | 6) |
| Minor lobe level | | 6.0 | | dB | |
| Cold impedance | | see note 7) | | | |
| Frequency temperature coefficient (after warming) | $\frac{\Delta f}{\Delta t_a}$ | | -0.25 | MHz/°C | 8) |
| Input capacitance | $C_{ak}$ | | 9.0 | pF | 8) |
| Heater current at $V_f$= 6.3 V, $W_i$ = 0 | $I_f$ | 0.5 | 0.6 | A | |

## OPERATING CONDITIONS

| | | | | |
|---|---|---|---|---|
| Heater voltage | $V_f$ | 6.3 | 6.3 | V |
| Pulse duration | $T_{imp}$ | 0.1 | 1.0 | μs |
| Pulse repetition rate | $f_{imp}$ | 2000 | 1000 | p.p.s. |
| Duty factor | $\delta$ | 0.0002 | 0.001 | |
| Peak anode current | $I_{ap}$ | 5.0 | 5.0 | A |
| Rate of rise of anode voltage | $dV_a/dT$ | 60 | 60 | kV/μs |
| Peak anode voltage | $V_{a_p}$ | 4.25 | 4.25 | kV |
| Mean output power | $W_o$ | 1.4 | 7.0 | W |
| Peak output power | $W_{o_p}$ | 7.0 | 7.0 | kW |

Notes: see page 4.

## END OF LIFE PERFORMANCE

The quality of all production is monitored by the random selection of magnetrons which are then life tested under the stated test conditions. If the magnetron is to be operated under different conditions from those specified above, the manufacturer should be consulted to verify that the life will not be affected.
The magnetron is considered to have reached the end of life when it fails to meet the following limits when operated under the conditions specified under "Test condition and limits".

| | | min. | max. | |
|---|---|---|---|---|
| Mean output power | $W_o$ | 5.0 | | W |
| Peak anode voltage | $V_{a_p}$ | 4.0 | 4.5 | kV |
| Frequency | f | 9.380 | 9.440 | GHz |

## VIBRATION

The magnetron is vibration tested to ensure that it will withstand normal conditions of service.

## NOTES

1) The magnetron is tested with a sinewave heater supply of 50 Hz and is suitable for operation from 50 Hz to 1 kHz sine or sqare wave supply. The manufacturer should be consulted if the magnetron is to be operated with a heater supply having different frequency or waveform conditions.
2) Defined as the steepest tangent to the leading edge of the voltage pulse above 80 % amplitude.
3) The tolerance of pulse current duration ($T_{imp}$) measured at 50% amplitude is $\pm$10%.
4) Measured with the magnetron operating into a V.S.W.R. of 1.5 phase adjusted for maximum degradation. The peak anode current is varied over the range of 4.0 A to 6.0 A.
5) Measured at a peak anode current of 5 A under matched conditions. A mismatch of 1.5 is then varied through all phases.
6) Measured with the mismatch conditions and most unfavourable current of note [4]). Pulses are defined as missing when the R.F. energy level is less than 70 % of the normal level in the frequency range 9.380 to 9.440 GHz. Missing pulses are expressed as a percentage of the number of input pulses applied during a period of observation of three minutes after an initial operating period of not more than three minutes.
7) The cold impedance of the magnetron is measured at the operating frequency and will give a V.S.W.R. of > 6 . The position of voltage minimum from the face of the output flange into the magnetron is 3.0 to 9.0 mm.
8) Design test only.

# PULSED MAGNETRON

Packaged magnetron for pulsed service at a fixed frequency.

| QUICK REFERENCE DATA | | | |
|---|---|---|---|
| Frequency, fixed within the band | f | 9345 to 9405 | MHz |
| Peak output power | $W_{op}$ | 7.5 | kW |
| Construction | packaged | | |

**HEATING**: indirect

| | | | | |
|---|---|---|---|---|
| Heater voltage | $V_f$ | | 6.3 | V |
| Heater current at $V_f$ = 6.3 V | $I_f$ | < | 600 | mA |
| Cathode heating time ($t_{amb}$ > 0 °C) | $T_w$ | min. | 120 | s |
| Cathode heating time ($t_{amb}$ < 0 °C) | $T_w$ | min. | 180 | s |

For average input powers greater than 25 W, it is necessary to reduce the heater voltage within 3 sec. of applying high tension in accordance with the formula $V_f = 6.3\ (1 - \frac{W_i}{180})$ V.

## TYPICAL CHARACTERISTICS

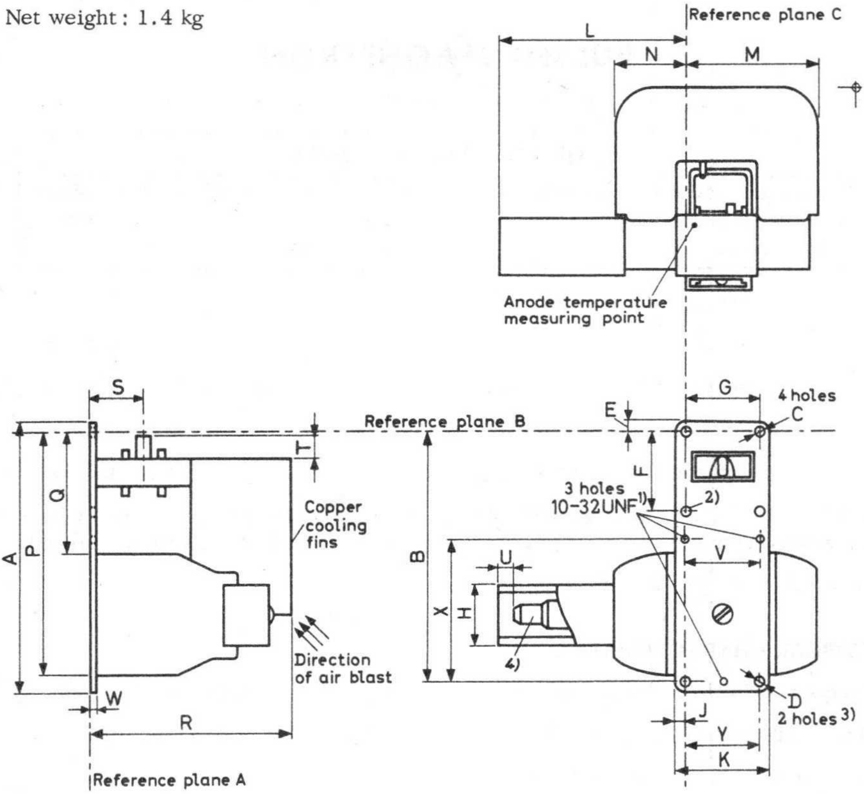
| | | | | |
|---|---|---|---|---|
| Frequency, fixed within the range | f | | 9345 to 9405 | MHz |
| Peak anode voltage at $I_{a_p}$ = 4.5 A | $V_{a_p}$ | | 5.3 to 5.7 | kV |
| Peak output power at $I_{a_p}$ = 4.5 A | $W_{o_p}$ | > | 7 | kW |
| Pulling figure | $\Delta f_p$ | < | 15 | MHz |
| Frequency temperature coefficient | $\frac{\Delta f}{\Delta t}$ | < | 0.25 | MHz/°C |
| Distance of voltage standing wave minimum from face of mounting plate into tube | d | ><br>< | 13.5<br>22.5 | mm<br>mm |
| Input capacitance | $C_i$ | < | 8.0 | pF |

## COOLING

In normal circumstances radiation and convection cooling is adequate, but where the ambient temperature is high, a flow of cooling air between the radiator fins is necessary to keep the anode block temperature below the permitted value

## MECHANICAL DATA

Net weight: 1.4 kg




Mounting position: any

Magnetron output designed for coupling to standard rectangular waveguide RG-52U. For drawing of this waveguide see front of this section.

1) Holes shall be within 0.015" (0.381 mm) of indicated centre

2) Centre of this hole is within 0.004" (0.1016 mm) of reference plane C

3) Holes shall be within 0.005" (0.127 mm) of indicated centre. A cylinder of 0.33" (8.382 mm) dia. centred in holes shown shall clear the side of the magnet

4) Base: miniature bayonet. Sleeve: f+k; centre: f.

**MECHANICAL DATA** (continued)

Dimensions

The millimetre dimensions are derived from the original inch dimensions

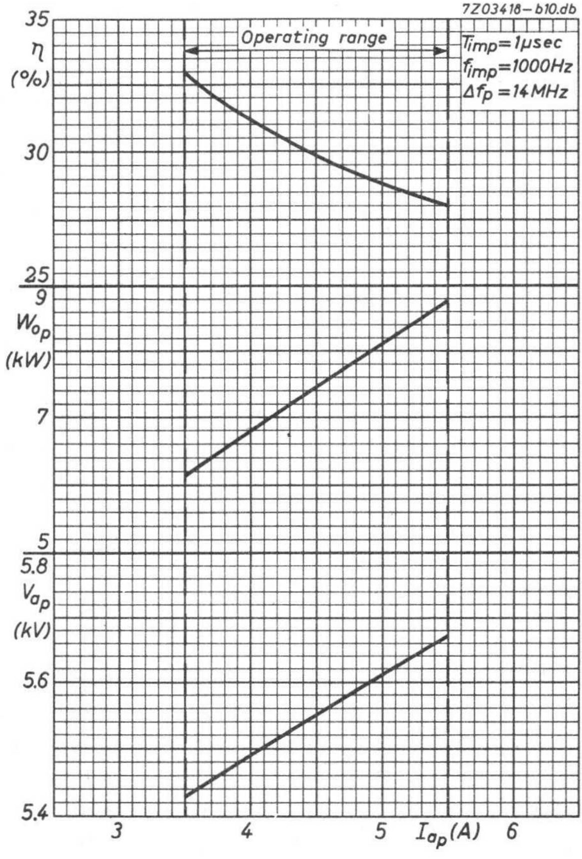
| Dim. | Inches | | | Millimetres | | |
|---|---|---|---|---|---|---|
| | Min. | Nom. | Max. | Min. | Nom. | Max. |
| A | 4.438 | - | 4.469 | 112.7 | - | 113.5 |
| B | - | 4.103 | - | - | 104.2 | - |
| C | 0.167 | - | 0.173 | 4.24 | - | 4.39 dia |
| D | 0.172 | - | 0.178 | 4.37 | - | 4.52 dia |
| E | 0.156 | - | 0.188 | 3.96 | - | 4.78 |
| F | 1.276 | - | 1.284 | 32.4 | - | 32.5 |
| G | 1.216 | - | 1.224 | 30.9 | - | 31.1 |
| H | - | - | 1.0 | - | - | 25.4 |
| J | 0.188 | - | 0.219 | 4.78 | - | 5.56 |
| K | 1.609 | - | 1.641 | 40.9 | - | 41.7 |
| L | 2.688 | - | 3.188 | 68.28 | - | 80.98 |
| M | - | - | 2.188 | - | - | 55.58 |
| N | - | - | 1.188 | - | - | 30.18 |
| P | - | - | 4.0 | - | - | 101.6 |
| Q | 1.938 | - | - | 49.22 | - | - |
| R | - | - | 3.313 | - | - | 84.15 |
| S | 0.750 | - | 1.0 | 19.05 | - | 25.40 |
| T | - | - | 0.375 | - | - | 9.52 |
| U | - | - | 0.250 | - | - | 6.35 |
| V | - | 1.250 | - | - | 31.75 | - |
| W | - | 0.125 | - | - | 3.175 | - |
| X | - | 2.393 | - | - | 60.78 | - |
| Y | - | 1.220 | - | - | 30.99 | - |

**LIMITING VALUES** (Absolute limits)

| | | | | | |
|---|---|---|---|---|---|
| Pulse duration | $T_{imp}$ | = | max. | 2.5 | μs |
| Duty factor | δ | = | max. | 0.0025 | |
| Peak anode voltage | $V_{a_p}$ | = | max. | 6.0 | kV |
| | | = | min. | 5.0 | kV |
| Peak anode current | $I_{a_p}$ | = | max. | 5.5 | A |
| | | = | min. | 3.5 | A |
| Average input power | $W_i$ | = | max. | 82.5 | W |
| Rate of rise of voltage pulse | $\Delta V/\Delta T_{rv}$ | = | max. | 75 | kV/μs |
| Voltage standing wave ratio | V.S.W.R. | = | max. | 1.5 | |
| Temperature of anode block | $t_a$ | = | max. | 120 | °C |

**OPERATING CHARACTERISTICS**

| | | | | |
|---|---|---|---|---|
| Running heater voltage | $V_f$ | = | 6.3 | V |
| Pulse duration | $T_{imp}$ | = | 1.0 | μs |
| Pulse repetition frequency | $f_{imp}$ | = | 1000 | Hz |
| Duty factor | δ | = | 0.001 | |
| Peak anode voltage | $V_{a_p}$ | = | 5.5 | kV |
| Rate of rise of voltage pulse | $\Delta V/\Delta T_{rv}$ | = | 50 | kV/μs |
| Peak anode current | $I_{a_p}$ | = | 4.5 | A |
| Average input current | $I_a$ | = | 4.5 | mA |
| Average input power | $W_i$ | = | 24.7 | W |
| Average output power | $W_o$ | = | 7.5 | W |
| Peak output power | $W_{o_p}$ | = | 7.5 | kW |
| Pulling figure (V.S.W.R. = 1.5) | $\Delta f_p$ | = | 14 | MHz |


7Z03418-b10.db
Operating range
$T_{imp}$ = 1 μsec
$f_{imp}$ = 1000 Hz
$\Delta f_p$ = 14 MHz
35
η
(%)
30
25
9
$W_{o_p}$
(kW)
7
5
5.8
$V_{a_p}$
(kV)
5.6
5.4
3
4
5
$I_{a_p}$ (A)
6

# PULSED MAGNETRON

Air cooled packaged tunable magnetron for pulsed service.

| QUICK REFERENCE DATA | | | |
|---|---|---|---|
| Frequency, tunable within the band | f | 8500 to 9600 | MHz |
| Peak output power | $W_{op}$ | 60 | kW |
| Pulse duration | $T_{imp}$ | 0.1 to 3.4 | µs |
| Construction | | packaged | |

**HEATING**: indirect

| | | | | |
|---|---|---|---|---|
| Heater starting voltage | $V_{f_o}$ | = | 6.3 | V ± 10% |
| Heater current at $V_f$ = 6.3 V | $I_f$ | = | 0.9 to 1.1 | A |
| Waiting time | $T_w$ | = | min. 2 | min |
| Heater resistance in cold condition | $R_{f_o}$ | > | 0.85 | Ω |

The heater voltage should be switched off for average input powers of more than 150 W immediately after the application of high voltage. For smaller input powers, the heater voltage must be reduced in accordance with the curve on page 11.
The heater should be bypassed with a 1000 V rated capacitor of min. 4000 pF directly across the heater terminals.

**TYPICAL CHARACTERISTICS**

| | | | | |
|---|---|---|---|---|
| Peak anode voltage at $I_{ap}$ = 14 A | $V_{ap}$ | = | 13 to 15.5 | kV |
| Increase of peak anode voltage at a frequency variation from 8500 to 9600 MHz with $I_{ap}$ constant | $\Delta V_{ap}$ | = | 0.9 | kV |
| Dynamic impedance | $R_i$ | = | 150 | Ω |
| Pulling figure at V.S.W.R. = 1.5 | $\Delta f_p$ | < | 18 | MHz |
| Negative temperature coefficient | $-\frac{\Delta f}{\Delta t}$ | < | 0.25 | MHz/°C [1]) |
| Input capacitance | $C_{ak}$ | = | 6 | pF |

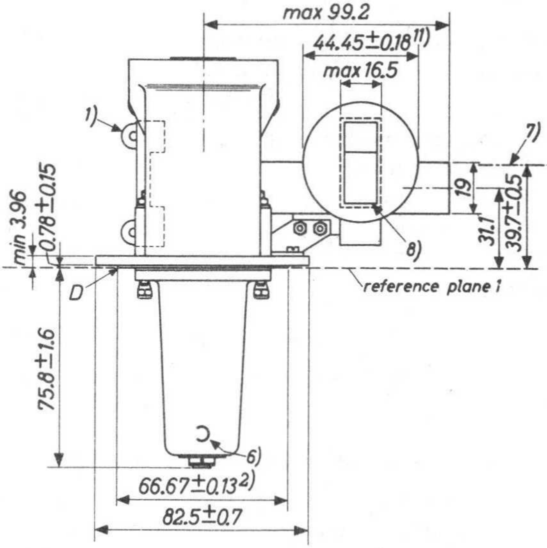
[1]) Measured with

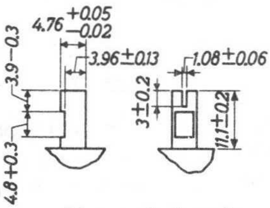
| | | | | |
|---|---|---|---|---|
| Anode current | $I_a$ | = | 10 | mA |
| Frequency | f | = | 9000 ± 10 | MHz |
| Anode block temperature | $t_a$ | = | 70 to 100 | °C |
| Four magnetic shunts | | | | |

**MECHANICAL DATA**

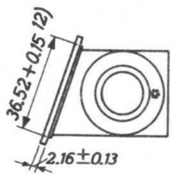
Dimensions in mm

Net weight: 2.3 kg

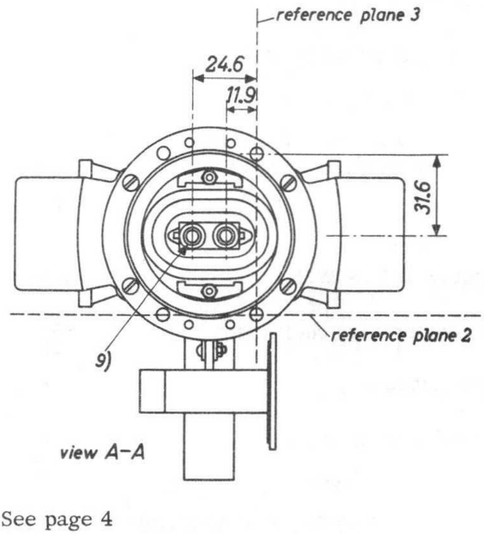



Worm shaft ends



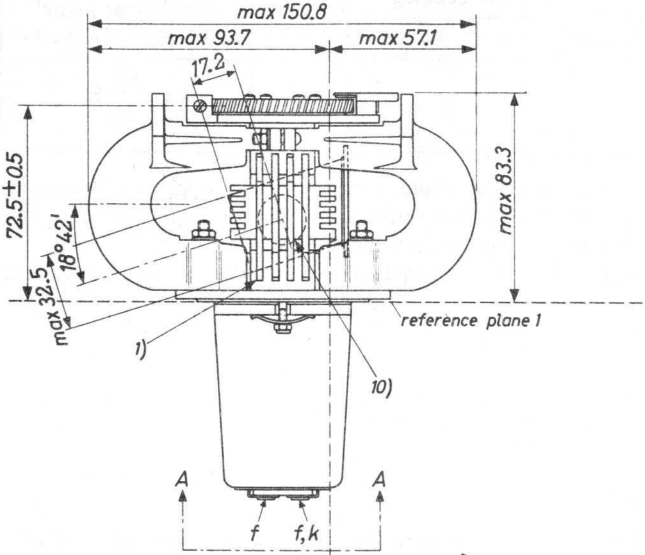

Magnetron output

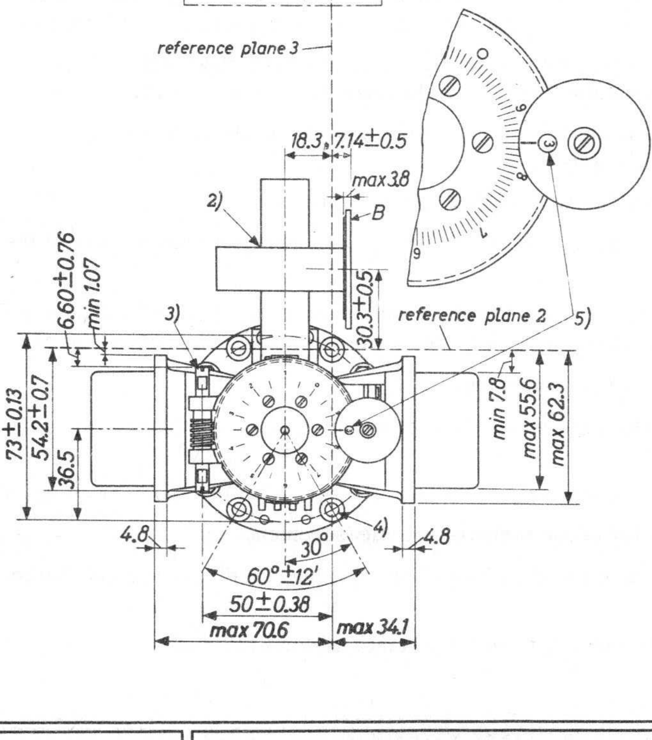



1)2)3)4)5)6)7)8)9)10)11)12) See page 4

**MECHANICAL DATA** (continued)

Dimensions in mm



## TUNING

| Frequency (MHz) | Scale reading | | Number of turns of the worm shaft |
|---|---|---|---|
| | Geneva wheel | Large gear dial | |
| 9600 | 1 | 2.5 | 61 |
| 9000 | 3 | 0 | 45 |
| 8500 | 4 | 3 | |

The tuning mechanism requires at room temperature a minimum torque of 700 g cm (10 inch ounces) applied at the worm shaft. The maximum permissible torque at the worm shaft is 2.8 kg cm (2.5 inch pounds).
About 110 turns of the worm shaft are required to cover the complete frequency range.

---

Notes from page 2 and 3

1) Four magnetic shunts. To remove surplus, grip firmly at tabs with suitable pliers and pull away from tube. The shunts are supplied loose with the tube.

2) All joints in the waveguide assembly and on the base plate within the specified diameter are soldered to provide hermetic seals at surfaces B and D.

3) To increase the frequency this end of the worm shaft should be driven in counter-clockwise direction.

4) Four holes with a diameter of 4.90 ± 0.07 mm.

5) Figure appearing here indicates the number of complete revolutions of the gear from 0 to 4.

6) The inscription C on the insulator which protects the heater lead-outs indicates that the adjacent jack is the common heater-cathode connection.

7) Centre line of waveguide opening.

8) The opening in the waveguide shall be enclosed by a dust cover when the tube is not in use.

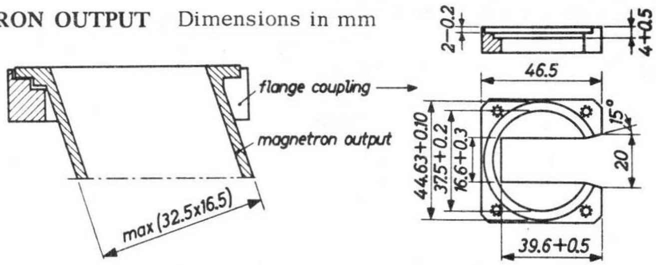
9) Banana pin jack, 15 mm long, diameter 4.29 ± 0.13 mm.

10) Reference point for anode temperature measurement.

11) This diameter is concentric with the opening in the waveguide within 0.25 mm.

12) This diameter is concentric with the flange within 0.12 mm.

**MAGNETRON OUTPUT** Dimensions in mm




The magnetron output has been designed for coupling to the standard rectangular waveguide RG-51/U by means of a special flange coupling which fits the magnetron to the standard choke flange type UG-52A/U.

**COOLING**

An adequate air flow should be directed at the cooling fins of the anode to keep its temperature below 150 °C under any condition of operation. An anode temperature below 100 °C is recommended. Continuous operation at the maximum permissible anode temperature of 150 °C involves the risk of a somewhat shortened tube life.

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

Each limiting value should be regarded independently of other values, so that under no circumstances it is permitted to exceed a limiting value whichsoever.

| | | | | |
|---|---|---|---|---|
| Peak anode current | $I_{ap}$ | max. | 15.5 | A |
| Average input power | $W_{i_a}$ | max. | 230 | W |
| Frequency | f | max. | 9650 | MHz |
| | | min. | 8450 | MHz |
| Voltage standing wave ratio | V.S.W.R. | max. | 1.5 | |
| Duty factor | $\delta$ | max. | 0.0012 | |
| Pulse duration | $T_{imp}$ | max. | 3.6 | µs |
| Pulse repetition rate | $f_{imp}$ | max. | 6000 | Hz |
| Rise time of voltage pulse | | | | |
| at pulse durations from 0.1 to 1 µs | $T_{rv}$ | min. | 0.08 | µs |
| at pulse duration of 3.6 µs | $T_{rv}$ | min. | 0.12 | µs |
| Heater starting voltage | $V_{f_o}$ | max. | 7 | V |
| Peak heater starting current | $I_{f_{surge}}$ | max. | 6 | A |
| Anode block temperature | $t_a$ | | −60 to +150 | °C [1] |

[1]) For reference point of temperature measurement see [10]) page 3

**OPERATING CHARACTERISTICS** (without magnetic shunts; V.S.W.R. $\leqq$ 1.05)

| | | | | | |
|---|---|---|---|---|---|
| Frequency | f | 9000 | 9000 | 9000 | MHz |
| Pulse duration | $T_{imp}$ | 0.1 | 1.0 | 3.4 | µs |
| Duty factor | $\delta$ | 0.00033 | 0.0010 | 0.0011 | |
| Heater voltage | $V_f$ | 5.0 | 0 | 0 | V [1] |
| Peak anode voltage | $V_{ap}$ | 14 | 14 | 14 | kV |
| Rise time of voltage pulse | $T_{rv}$ | 0.08 | 0.08 | 0.12 | µs |
| Peak anode current | $I_{ap}$ | 14 | 14 | 14 | A |
| Average output power | $W_o$ | 20 | 60 | 65 | W |
| Peak output power | $W_{op}$ | 60 | 60 | 60 | kW |
| Bandwidth at a V.S.W.R. = 1.5 [2] | B | 9 | 1.2 | 0.5 | MHz [3] |
| Stability at a V.S.W.R. = 1.5 [2] | | 0.01 | - | 0.1 | % |

The manufacturer should be consulted whenever it is considered to operate the magnetron at conditions substantially different from those given above.

[1]) See pages 1 and 11.

[2]) Mismatch at a distance of max. 500 mm from the output flange.

[3]) Within the range $I_{ap}$ = 12.5 to 15.5 A.

PRESSURE

Operation at pressures lower than 55 cm Hg may result in arcover with consequent damage to the magnetron.
The magnetron need not be pressurized when operating at atmospheric pressure.
The output assembly and the mounting flange permit applications at which pressurizing of the magnetron is required. They can be maintained at a pressure of max. 3.0 kg/cm$^2$ (43 lbs/sq.in.).

LIFE

Magnetron life depends on the operating conditions and is expected to be longer at shorter pulse lengths and smaller load mismatch.
After a long period of operation at a short pulse duration starting up at longer durations may result in unstable operation and should be avoided. Switching from minimum to maximum pulse duration with a working period at each pulse duration of more than one hour is not recommended.

**CIRCUIT NOTES**

a. The negative high voltage pulse should be applied to the common cathode-heater terminal.

b. If no load isolator is inserted between the magnetron and the transmission line, the latter should be as short as possible to prevent long-line effects. Under no circumstances should the magnetron be operated with a voltage standing wave ratio of the load exceeding 1.5. A ratio kept near unity will benefit tube life and reliability.

c. The modulator must be so designed that, if arcing occurs, the energy per pulse delivered to the magnetron does not considerably exceed the normal energy per pulse.

d. In order to prevent diode current from flowing during the interval between two pulses and to minimize unwanted noise during the region of the voltage pulse where the anode voltage has dropped below the value required to sustain oscillation, the trailing edge of the voltage pulse should be as steep as possible and the anode voltage should be prevented from becoming positive at any time in the interval between two pulses.

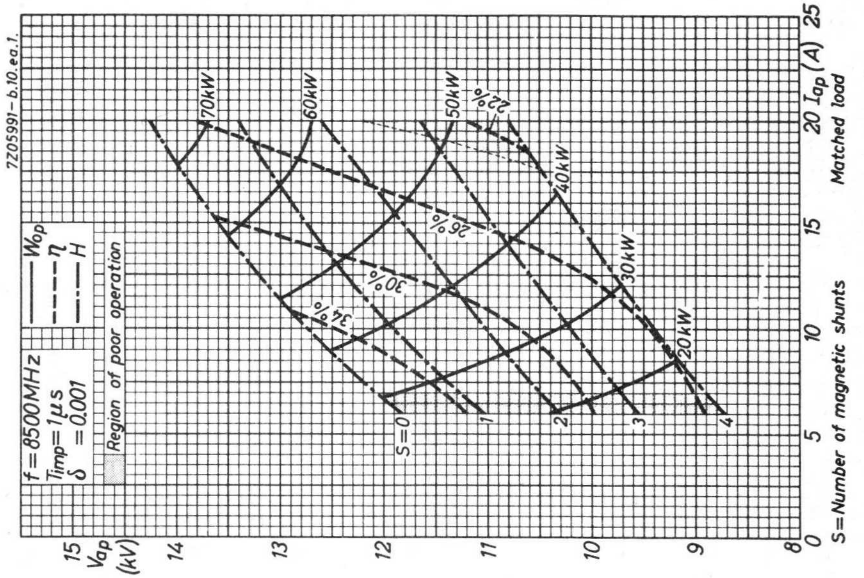
e. The current pulse must be sensibly square and the ripple over the top portion of the current pulse must be kept as small as possible to avoid unwanted frequency modulation due to pushing effects. The spike on the top portion of the pulse must be small to avoid excessive peak pulse current. The leading edge of the pulse must be free from irregularities. The voltage pulse rise time should not be too short, because moding and arcing may then occur.

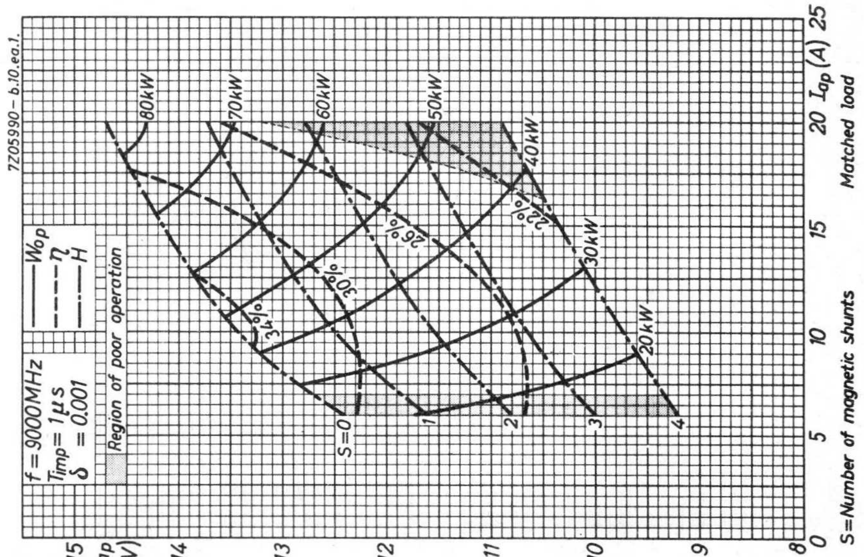
## STORAGE, HANDLING AND MOUNTING

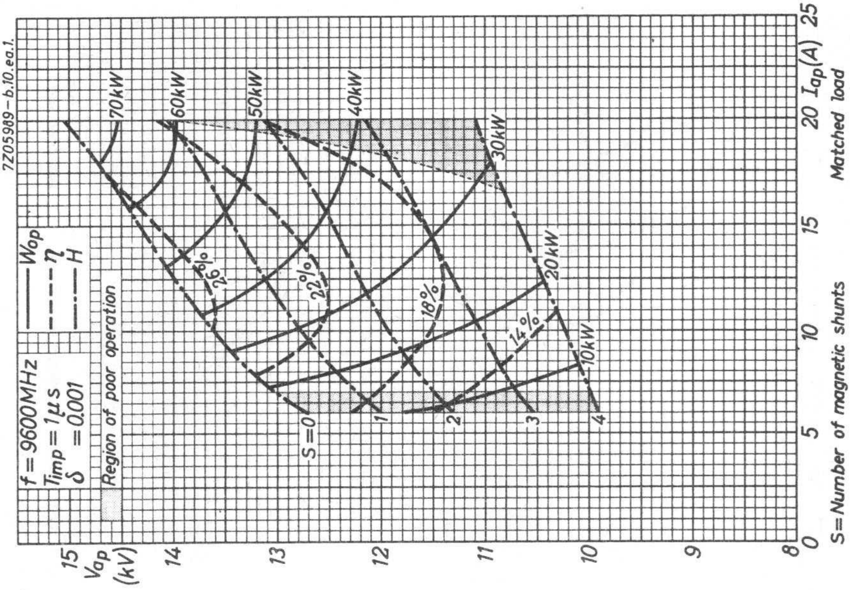
In storage sufficient distance should be maintained between the magnetrons to prevent decrease of field strength of the magnetron magnet due to the interaction with adjacent magnets. A minimum distance of 15 cm (6 inches) should be maintained between tubes. Magnetic materials should be kept away from the magnet a distance of at least 5 cm (2 inches) to avoid sharp mechanical shocks to the magnet. For this reason it is required to use non-magnetic tools during installation.
The opening in the waveguide output flange shall be protected by a dust cover until the tube is mounted into the equipment. Before putting the magnetron into operation, the user should make sure that the output waveguide is entirely clean and free from dust and moisture.
Mounting of the magnetron should be accomplished by means of its mounting flange. The tube should in no case be supported by the coupling to the waveguide output flange alone.

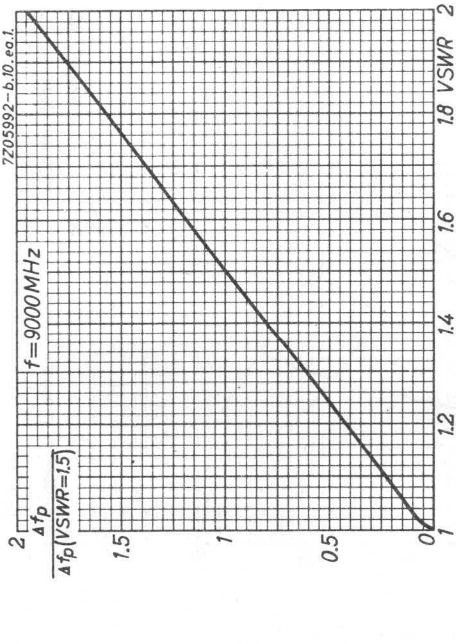
## DIAGRAMS

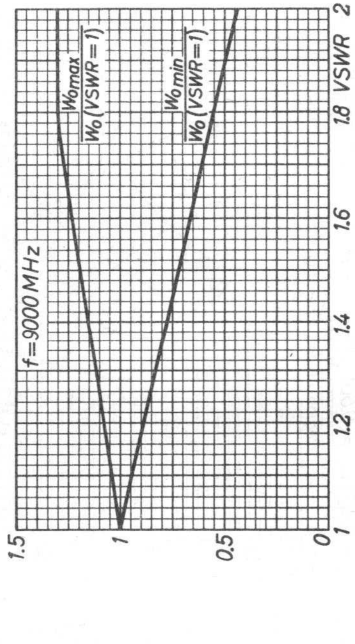
Average performance charts at a frequency of 8500, 9000 and 9600 MHz are given on page 9 and 10 respectively. The magnetron is operated into a matched load. These charts show contours of magnetic field strength (indicated by the number of magnetic shunts S), peak output power and efficiency as functions of peak anode voltage and peak anode current.
On page 10 the frequency pulling, compared with the frequency pulling at a V.S.W.R. of 1.5 is shown as a function of the voltage standing wave ratio for an average magnetron operating at 9000 MHz.
The lower part shows the output power, compared with the output power at a V.S.W.R. = 1, as a function of the voltage standing wave ratio for an average magnetron operating at 9000 MHz.
$W_{o\,max}$ = output power at phase adjusted for maximum power
$W_{o\,min}$ = output power at phase adjusted for minimum power

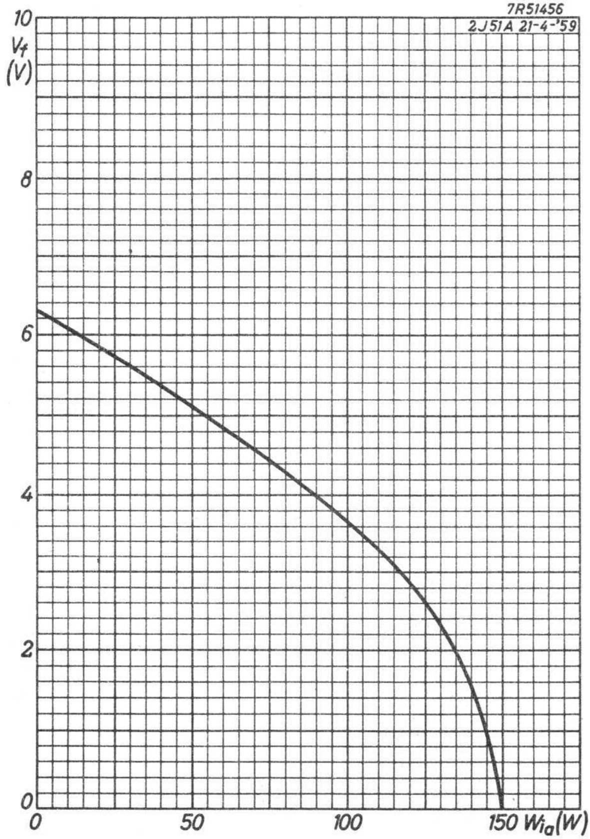

7Z05991-b.10.ea.1.
f = 8500 MHz
Timp = 1 μs
δ = 0.001
Wop
η
H
Region of poor operation
Vap (kV)
$I_{ap}$ (A)
Matched load
S = Number of magnetic shunts
70kW
60kW
50kW
40kW
30kW
20kW
22%
26%
30%
34%
S=0
1
2
3
4


7Z05990-b.10.ea.1.
f = 9000 MHz
Timp = 1 μs
δ = 0.001
Wop
η
H
Region of poor operation
Vap (kV)
$I_{ap}$ (A)
Matched load
S = Number of magnetic shunts
80kW
70kW
60kW
50kW
40kW
30kW
20kW
22%
26%
30%
34%
S=0
1
2
3
4


7Z05989-b.10.ea1.
f = 9600 MHz
$T_{imp}$ = 1 μs
δ = 0.001
Region of poor operation
$W_{op}$
η
H
70kW
60kW
50kW
40kW
30kW
20kW
10kW
26%
22%
18%
14%
S=0
1
2
3
4
$V_{ap}$ (kV)
15
14
13
12
11
10
9
8
0
5
10
15
20
25
$I_{ap}$(A)
Matched load
S=Number of magnetic shunts


7Z05992-b.10.ea1.
f=9000MHz
$\frac{\Delta f_p}{\Delta f_p(VSWR=1.5)}$
2
1.5
1
0.5
0
1
1.2
1.4
1.6
1.8
2
VSWR


f=9000MHz
$\frac{W_{o max}}{W_o(VSWR=1)}$
$\frac{W_{o min}}{W_o(VSWR=1)}$
1.5
1
0.5
0
1
1.2
1.4
1.6
1.8
2
VSWR


7R51456
2J51A 21-4-'59
10
$V_f$
(V)
8
6
4
2
0
0
50
100
150 $W_{ia}$(W)

# PULSED MAGNETRON

Packaged magnetron for pulsed service at a fixed frequency.

| QUICK REFERENCE DATA | | | |
|---|---|---|---|
| Frequency, fixed within the band | f | 9.345 to 9.405 | GHz |
| Peak output power | $W_{o_p}$ | 50 | kW |
| Construction | | packaged | |

**HEATING**: indirect

| | | | | |
|---|---|---|---|---|
| Heater voltage | $V_f$ | | 6.3 | V |
| Heater current | $I_f$ | | 1.0 | A |
| Peak heater starting current | $I_{f_{op}}$ | max. | 5.0 | A |
| Waiting time at $t_{amb}$ above 0 °C | $T_w$ | min. | 2 | min |
| Waiting time at $t_{amb}$ between 0 °C and -55 °C | $T_w$ | min. | 3 | min |

Immediately after the application of anode power the heater voltage must be reduced in accordance with the heater derating chart on page 6.

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

| | | | | |
|---|---|---|---|---|
| Pulse duration | $T_{imp}$ | max. | 2.5 | μs |
| Duty factor ($W_{ip} \leq 150$ kW) | δ | max. | 0.001 | |
| ($W_{i_p} > 150$ kW) | δ | max. | 0.0007 | |
| Peak anode current | $I_{a_p}$ | min. | 10 | A |
| | | max. | 16 | A |
| Mean input power | $W_i$ | max. | 180 | W |
| Peak anode voltage | $V_{a_p}$ | max. | 16 | kV |
| Rate of rise of anode voltage | $\frac{dV_a}{dT}$ | max. | 160 | kV/μs [1] |
| Voltage standing wave ratio | V.S.W.R. | max. | 1.5 | |
| Heater voltage ($W_i = 0$) | $V_f$ | min. | 5.7 | V |
| | | max. | 6.9 | V |
| Anode temperature at reference point (see outline drawing) | $t_a$ | max. | 120 | °C |
| Altitude | h | max. | 3 | km |
| | | | 10 000 | ft |
| Pressurising (input and output) | p | max. | $313 \times 10^3$ | Pa |
| | | | 3.2 | atm. |

1) see page 2.

## COOLING

Forced air, sufficient to ensure that the maximum specified anode temperature is never exceeded.

## MECHANICAL DATA

Net weight: 1.81 kg

Mounting position: any

Mounting and storage precautions

When mounting and handling the magnetron, care must be taken to prevent demagnetisation. It is necessary to keep all magnetic materials as far as possible, at least 50 mm from the magnet.

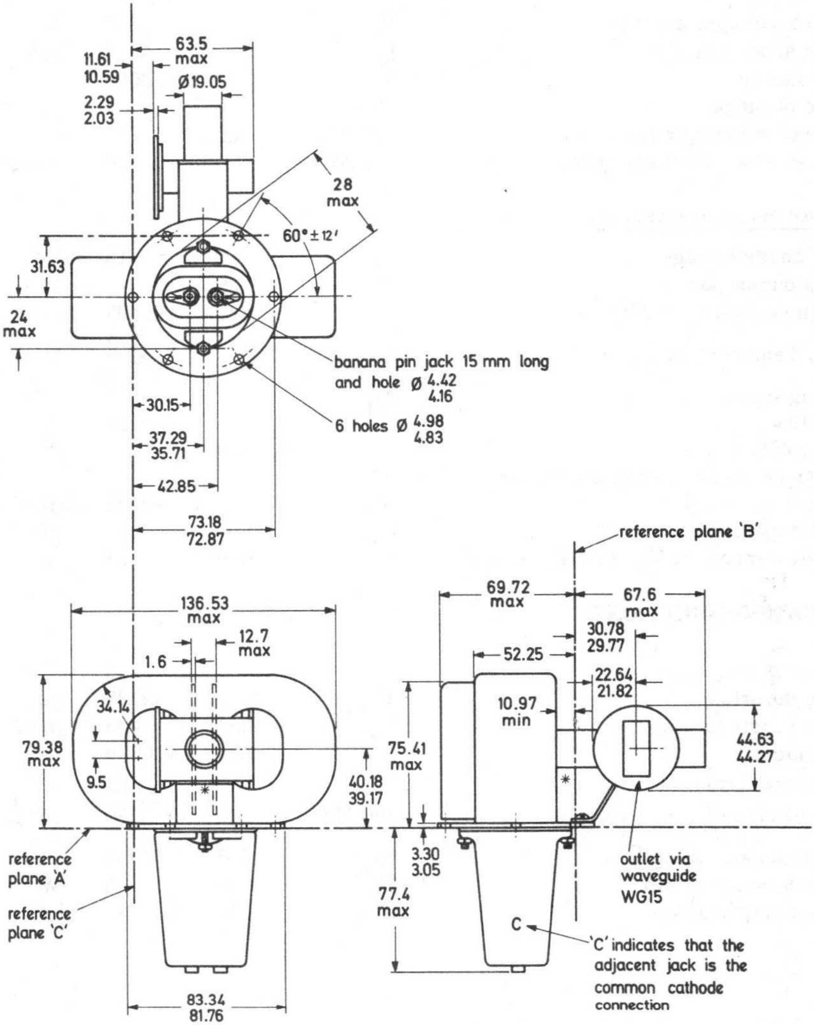
When storing, magnetrons should be kept as far apart as possible, at least 150 mm. During shipment adequate separation between magnetrons is provided by the dimensions of the inner pack of the storage carton, and it is recommended that magnetrons not in use be kept in these packs.

## NOTES

1) Defined as the steepest tangent to the leading edge of the voltage pulse above 80% amplitude.
2) The tolerance of pulse current duration ($T_{imp}$) measured at 50% amplitude is ±10%.
3) Measured with the magnetron operating into a V.S.W.R. of 1.5 varied through all phases over a peak anode current range of 10 A to 14 A.
4) Measured with the magnetron operating into a V.S.W.R. of 1.5 at a peak anode current of 12 A.
5) Measured under the conditions described in note 3). Pulses are defined as missing when the r.f. energy level is less than 70% of the normal level in the frequency range 9.345 to 9.405 GHz. Missing pulses are expressed as a percentage of the number of input pulses applied during a period of observation of three minutes after an initial operating period of not more than three minutes.
6) Design test only.

MECHANICAL DATA (continued)

Dimensions in mm




✳ Temperature measuring point

D1519

## TEST CONDITIONS AND LIMITS

Test conditions

| | | | | | |
|---|---|---|---|---|---|
| Heater voltage, running | $V_f$ | | 2.0 | V | |
| Mean anode current | $I_a$ | | 10.8 | mA | |
| Duty factor | $\delta$ | | 0.0009 | | |
| Pulse duration | $T_{imp}$ | | 2.2 | µs | 2) |
| Voltage standing wave ratio | V.S.W.R. | max. | 1.05 | | |
| Rate of rise of voltage pulse | dVa/dT | | 150 | kV/µs | 1) |

| Limits and characteristics | | min. | max. | | |
|---|---|---|---|---|---|
| Peak anode voltage | $V_{ap}$ | 11 | 13 | kV | |
| Mean output power | $W_o$ | 36 | | W | |
| Frequency (at $t_a \approx 80\ ^oC$) | f | 9.345 | 9.405 | GHz | |
| R.F. bandwidth at $\frac{1}{4}$ power | B | | $\frac{2.5}{T_{imp}}$ | MHz | 3) |
| Pulling figure | $\Delta f_p$ | | 15 | MHz | 4) |
| Stability | | | 0.25 | % | 5) |
| Minor lobe level | | 6.0 | | dB | 3) |
| Frequency temperature coefficient (after warming) | $\frac{\Delta f}{\Delta t_a}$ | | -0.25 | MHz/$^o$C | 6) |
| Input capacitance | $C_{ak}$ | | 10 | pF | 6) |
| Heater current at $V_f$ = 6.3 V, $W_i$ = 0 | $I_f$ | 0.9 | 1.1 | A | |

## OPERATING CONDITIONS

| | | | | |
|---|---|---|---|---|
| Heater voltage | $V_f$ | 0 | 2.0 | V |
| Pulse duration | $T_{imp}$ | 1.0 | 2.25 | µs |
| Pulse repetition rate | $f_{imp}$ | 1000 | 400 | p.p.s. |
| Duty factor | $\delta$ | 0.001 | 0.0009 | |
| Peak anode current | $I_{ap}$ | 12 | 12 | A |
| Rate of rise of anode voltage | $dV_a/dT$ | 150 | 150 | kV/µs |
| Peak anode voltage | $V_{ap}$ | 12.5 | 12.5 | kV |
| Mean output power | $W_o$ | 50 | 45 | W |
| Peak output power | $W_{op}$ | 50 | 50 | kW |

Notes see page 2

## END OF LIFE PERFORMANCE

The quality of all production is monitored by the random selection of magnetrons which are then life tested under the stated test conditions. If the magnetron is to be operated under different conditions from those specified above, the manufacturer should be consulted to verify that the life will not be affected. The magnetron is considered to have reached the end of life when it fails to meet the following limits when tested as indicated under "Test conditions and limits".

| | | min. | max. | |
|---|---|---|---|---|
| Mean output power | $W_o$ | 27 | - | W |
| Frequency | f | 9.345 | 9.405 | GHz |
| R.F. bandwidth at $\frac{1}{4}$ power | B | - | $\frac{3.0}{T_{imp}}$ | MHz |
| Stability | | | 0.5 | % |

## CIRCUIT NOTES

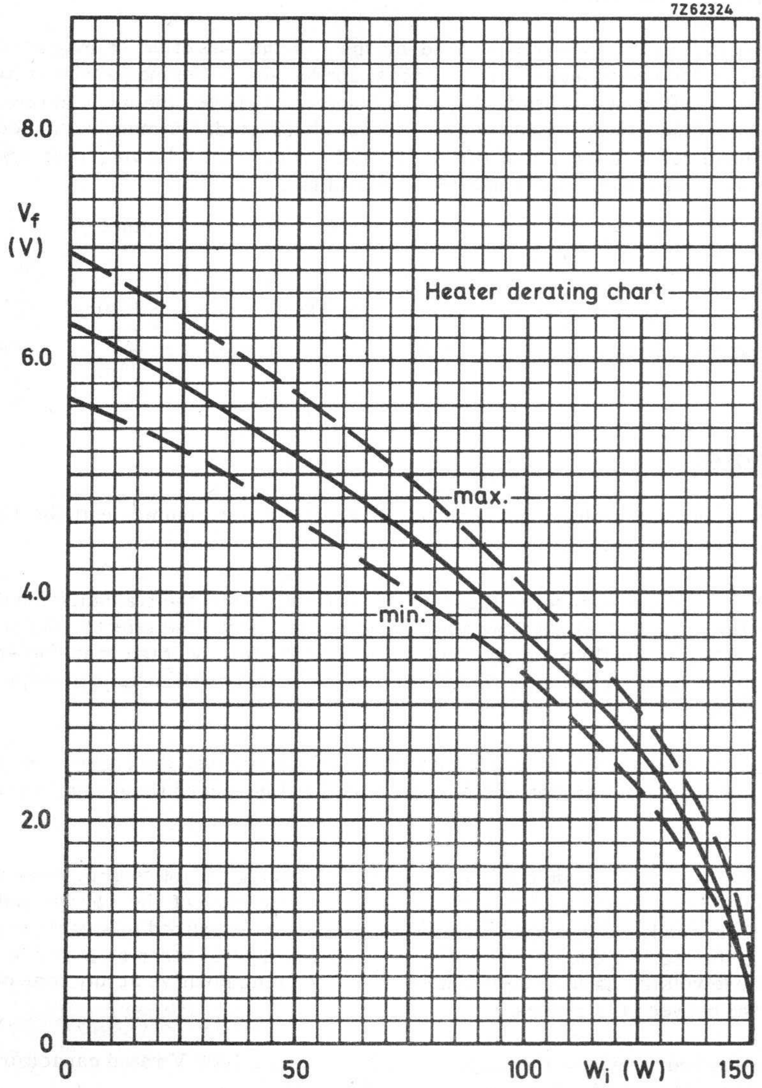
a. The negative high-voltage pulse should be applied to the common cathode-heater terminal.

b. If no load isolator is inserted between the magnetron and the transmission line, the latter should be as short as possible to prevent long-line effects. Under no circumstances should the magnetron be operated with a voltage standing wave ratio of the load exceeding 1.5. A ratio kept near unity will benefit tube life and reliability.

c. The modulator must be so designed that, if arcing occurs, the energy per pulse delivered to the magnetron does not considerably exceed the normal energy per pulse.

d. In order to prevent diode current from flowing during the interval between two pulses and to minimize unwanted noise during the region of the voltage pulse where the anode voltage has dropped below the value required to sustain oscillation, the trailing edge of the voltage pulse should be as steep as possible and the anode voltage should be prevented from becoming positive at any time in the interval between two pulses.

e. It is required to bypass the magnetron heater with a 1000 V rated capacitor of minimum 4000 pF directly across the heater terminals.




Heater voltage as a function of mean input power.

# PULSED MAGNETRON

Packaged magnetron for pulsed service at a fixed frequency

| QUICK REFERENCE DATA | | | |
|---|---|---|---|
| Frequency, fixed within the band | f | 9345 to 9405 | MHz |
| Peak output power | $W_{o_p}$ | 225 | kW |
| Construction | | packaged | |

**HEATING:** indirect

| | | | | |
|---|---|---|---|---|
| Heater starting voltage | $V_{f_o}$ | = | 13.75 | V |
| Heater current at $V_f$ = 13.75 V | $I_f$ | = | 3.5 | A |
| Waiting time | $T_w$ | = min. | 4 | min |

**COOLING :** Forced air

The heater voltage must be reduced immediately after the application of high voltage. Only when the average input power does not exceed 100 W the heater voltage need not be reduced. Above 100 W input power the required heater voltage can be calculated from the following equation:

$$V_f = 14 - 0.0125\, W_i \quad (V_f \text{ in volts, } W_i \text{ in watts}).$$

The heater current must never exceed a peak value of 15 A at any time during the initial energising schedule.

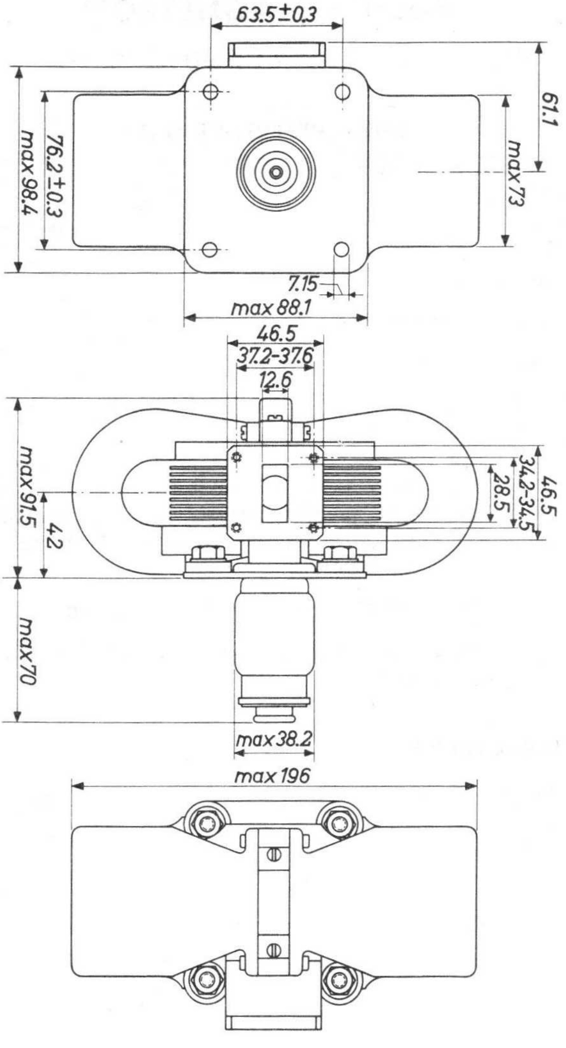
## TYPICAL CHARACTERISTICS

| | | | |
|---|---|---|---|
| Peak anode voltage | $V_{a_p}$ | < 23 | kV |
| Pulling figure | $\Delta f_p$ | < 15 | MHz |

**MECHANICAL DATA**

Dimensions in mm

Net weight: 4800 g




Mounting position: any

Magnetron output: designed for coupling to the standard rectangular waveguide RG-51/U. For drawing of this waveguide see front of this section.

**LIMITING VALUES** (Absolute limits)

Each limiting value should be regarded independently of other values so that under no circumstances it is permitted to exceed a limiting value whichsoever.

| | | | | |
|---|---|---|---|---|
| Heater starting voltage | $V_{f_o}$ | = max. | 14 | V |
| Rate of rise of voltage | $\frac{\Delta V}{\Delta T_{r_v}}$ | = min. | 70 | kV/μs |
| | | = max. | 110 | kV/μs |
| Pulse repetition rate | $f_{imp}$ | = min. | 175 | Hz |
| Voltage standing wave ratio | V.S.W.R. | = max. | 1.5 | |
| Anode block temperature | $t_a$ | = max. | 150 | °C |
| Cathode terminal temperature | t | = max. | 165 | °C |

| | | Duty factor δ = max.0.001 | | Duty factor δ = max.0.002 | | |
|---|---|---|---|---|---|---|
| Pulse duration [1] | $T_{imp}$ | = 0.3 to 1.2 | max. 6 | 0.3 to 1.2 | max. 6 | μs |
| Peak anode current | $I_{a_p}$ | = max.27.5 | max. 18 | max.14.5 | max.9.5 | A |
| Peak input power | $W_{i_p}$ | = max. 635 | max.380 | max. 320 | max.190 | kW |
| Average input power | $W_i$ | = max. 635 | max.380 | max. 635 | max.380 | W |

**OPERATING CHARACTERISTICS**

| | | | | |
|---|---|---|---|---|
| Heater voltage | $V_f$ | = | 6.5 | V [2] |
| Peak anode voltage | $V_{a_p}$ | = | 20 to 23 | kV |
| Average anode current | $I_a$ | = | 27.5 | mA |
| Pulse repetition rate | $f_{imp}$ | = | 1000 | Hz |
| Pulse duration | $T_{imp}$ | = | 1 | μs |
| Average output power | $W_o$ | > | 225 | W |
| Peak output power | $W_{o_p}$ | > | 225 | kW |
| Bandwidth | B | < | 3 | MHz |

[1]) Averaging time 1 sec. The total time of operation in any 100 μs interval should not exceed 6 μs.

[2]) The heater voltage must be reduced from 13.75V to 6.5V immediately after switching on the high voltage.

REMARK

If the magnetron has to operate at high power, it is necessary to pressurise the waveguide with an absolute pressure of 2.5 kg/cm$^2$ (35 lbs/sq.in.) to prevent arcing across the outside of the window.
Maximum absolute pressure 3.3 kg/cm$^2$ (47 lbs/sq.in.)

# PULSED MAGNETRON

Air cooled packaged magnetron for pulsed service at a fixed frequency

| QUICK REFERENCE DATA | | | |
|---|---|---|---|
| Frequency, fixed within the band | f | 9345 to 9405 | MHz |
| Peak output power | $W_{o_p}$ | 80 | kW |
| Construction | | packaged | |

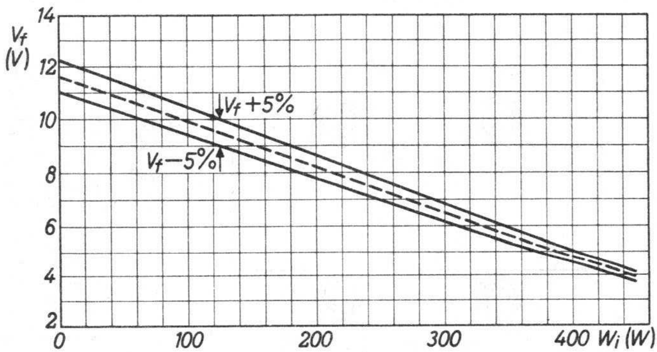
**HEATING**: indirect

| | | | | |
|---|---|---|---|---|
| Heater starting voltage | $V_{f_o}$ | = | 12.6 | V $^{+10\%}_{-5\%}$ |
| Heater current at $V_f$ = 12.6 V | $I_f$ | = | 2.2 ± 0.2 | A |
| Waiting time | $T_w$ | = | min. 90 | s |

The heater current must never exceed a peak value of 10 A at any time during the initial energising schedule.

The heater voltage should be reduced immediately after the application of the anode power according to the formula underneath or to the broken line in the figure underneath. The heater voltage should be adjusted to within 5 %. The contours of the 5 % area are given by the full-drawn lines in the figure.

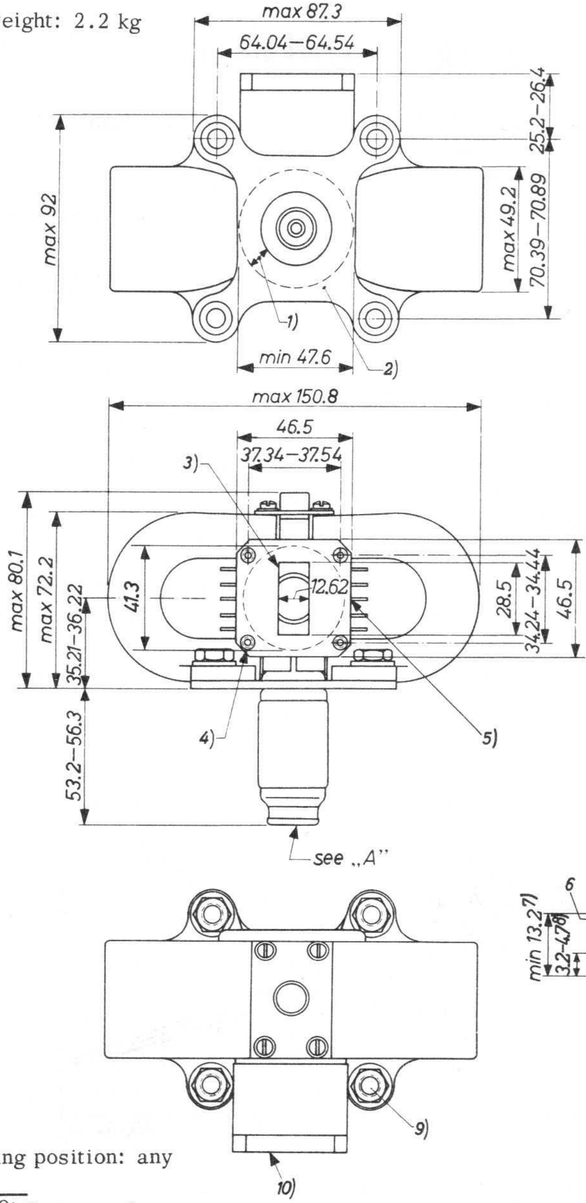
$$V_f = 11.6 - 0.017\, W_i, \text{ where } W_i = \delta \cdot I_{a_p} \cdot 15000$$



**MECHANICAL DATA**

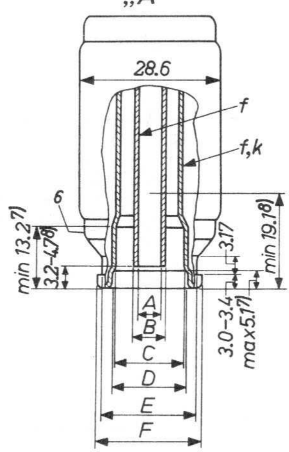
Dimensions in mm

Net weight: 2.2 kg




| | |
|---|---|
| A | 4.17–4.41 |
| B | 6.0–6.7 |
| C | 13.52–13.84 |
| D | 15.5 |
| E | 19 |
| F | 20.96–21.28 |

„A"




Mounting position: any

1) to 10) See page 3

Magnetron output

The output has been designed for coupling to the standard rectangular waveguide RG-51/U. For drawing of this waveguide see front of this section.

To fasten the magnetron output flange to the RG-51/U waveguide, a choke flange type Z83 00 33 (British designation) or type UG-52A/U should be inserted between these parts. The choke flange should be modified by reaming the four mounting holes with a drill of 4.5 mm. The choke flange can then be fastened to the magnetron output flange by means of four size 8 - 32 bolts.

Phase of sink 0.26 to 0.40 $\lambda_g$

Using a standard cold test technique, the phase of sink as measured from the reference plane A in the outline drawing to the first minimum outside the tube is within the limits 0.26 to 0.40 $\lambda_g$, where $\lambda_g$ is the wavelength of the waveguide.

Cooling

At an input power of 225 W and an air flow of 440 l/min (15.5 c.f.m.) at sea level the temperature rise of the anode block is 45 °C with respect to the temperature of the cooling air.

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1) Hermetic connections can be made to this surface.

2) Mounting flange.

3) The opening in the waveguide must be protected by a dust cover when the magnetron is not in use.

4) Four holes .164 dia 32 NC-2B.

5) Point for anode block temperature measurement located near the output section where the central fin meets the anode block.

6) Point for measurement of the temperature of the cathode terminal.

7) These two dimensions define the extremities of the cylindrical section given by dimension C.

8) These two dimensions define the extremities of the cylindrical section given by dimension A.

9) Four holes 7.02 to 7.26 mm.

10) Reference plane A.

**LIMITING VALUES** (Absolute limits)

| | | | | | |
|---|---|---|---|---|---|
| Pulse duration | $T_{imp}$ | = | max. | 5 | μs |
| Duty factor | δ | = | max. | 0.003 | |
| Heater starting voltage | $V_{f_o}$ | = | max. | 14 | V |
| Peak heater starting current | $I_{f_{surge}}$ | = | max. | 10 | A [1] |
| Peak anode current | $I_{a_p}$ | = | max. | 16 | A |
| Input power (= $\delta \times I_{a_p} \times 15000$) | $W_i$ | = | max. | 240 | W |
| Rate of rise of voltage pulse [2] | | | | | |
| at pulse duration of 0.4 μs | $\frac{\Delta V}{\Delta T_{r_v}}$ | = | min. | 120 | kV/μs |
| | | = | max. | 160 | kV/μs |
| at pulse duration of 1.0 μs | $\frac{\Delta V}{\Delta T_{r_v}}$ | = | min. | 100 | kV/μs |
| | | = | max. | 150 | kV/μs |
| at pulse duration of 4.5 μs | $\frac{\Delta V}{\Delta T_{r_v}}$ | = | min. | 70 | kV/μs |
| | | = | max. | 100 | kV/μs |
| Voltage standing wave ratio | VSWR | = | max. | 1.5 | |
| Anode block temperature | $t_a$ | = | -55 to +150 | | °C [3] |
| Temperature of cathode terminal | t | = | -55 to +175 | | °C [3] |
| Storage temperature | t | = | -55 to +85 | | °C |

Operation at pressures lower than 50 cm Hg may result in arcover with consequent damage to the magnetron.

[1] See section "Heating" page 1.

[2] See page 5.

[3] For points of temperature measurement on anode block and cathode terminal see notes [5] and [6] of the outline drawing.

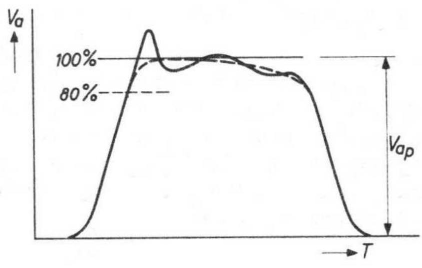
## OPERATING CHARACTERISTICS

| | | | | | |
|---|---|---|---|---|---|
| Frequency | $f$ | = | 9375 ± 30 | 9375 ± 30 | MHz |
| Heater voltage | $V_f$ | = | 1) | 1) | |
| Pulse duration | $T_{imp}$ | = | 0.35 to 0.45 | 4 to 5 | μs |
| Duty factor | $\delta$ | = | 0.00065 | 0.001 | |
| Peak anode voltage | $V_{ap}$ | = | 15 ± 1 | 15 ± 1 | kV |
| Rate of rise of voltage | $\frac{\Delta V_a}{\Delta T_{rv}}$ | = | 140 | 85 | kV/μs 2) |
| Peak anode current | $I_{ap}$ | = | 15 | 15 | A |
| Average output power | $W_o$ | = | 50 | 80 | W |
| Peak output power | $W_{op}$ | = | 80 | 80 | kW |

The manufacturer should be consulted whenever it is considered to operate the magnetron at conditions substantially different from those given above.

1) See section "Heating" page 1.

2) The rate of rise of anode voltage ($\frac{\Delta V_a}{\Delta T_{rv}}$) is defined by the steepest tangent to the leading edge of the voltage pulse above 80% of the smooth peak value. Any capacitance used in the viewing system shall not exceed 6 pF. For calculation of the rate of rise of voltage the 100% value must be taken as 15 kV. (The smooth peak value of a pulse is the maximum value of a smooth curve through the average of the fluctuation over the top portion of the pulse as shown by the dotted curve in the figure below.)



## OPERATING NOTES

PRESSURIZING

The mounting flange and the input and output assemblies permit applications at which pressurizing of the magnetron is required. The pressure can be maintained at a value of max. 3.1 $kg/cm^2$ (45 lbs/sq.in.)

LIFE

The magnetron life depends on the operating conditions and is expected to be longer at shorter pulse lengths.

STARTING A NEW MAGNETRON

This magnetron is provided with a getter. Owing to this, ageing of a new magnetron or of a magnetron that has been idle or stored for a period of time, will not be necessary in many cases. If, however, the magnetron is taken into operation and some sparking and instability occur incidentally, it is recommended to raise gradually the anode voltage and to operate the magnetron with reduced input during 15 to 30 minutes. After this period sparking usually ceases.

## CIRCUIT NOTES

a. The negative high voltage pulse should be applied to the common cathode-heater terminal. Otherwise, when applying the pulse to the other heater terminal, the heater will carry the total anode current and may burn out.

b. If no load isolator is inserted between the magnetron and the transmission line, the latter should be as short as possible to prevent long line effects. Under no circumstances should the magnetron be operated with a voltage standing wave ratio of the load exceeding 1.5. A ratio kept near unity will benefit tube life and reliability.

c. The modulator must be so designed that, if arcing occurs, the energy per pulse delivered to the magnetron does not considerably exceed the normal energy per pulse. Modulators of the pulse forming network discharge type usually satisfy this requirement.

d. It is required to bypass the magnetron heater with a 1000 V rated capacitor of minimum 4000 pF directly across the heater terminals.

e. The pulse current ripple, the maximum deviation from the smooth peak current over the top portion of the pulse must be kept as small as possible to avoid unwanted pushing effects. The current pulse must be sensibly square to prevent frequency modulation and must be free from irregularities on the leading edge of the pulse. The spike on the top portion of the pulse must be small. Otherwise the peak pulse current will be large and life of the magnetron will be impaired.

CIRCUIT NOTES (continued)

f. Many magnetrons carry a certain amount of diode current at voltages in the order of 100 V. Consequently, the anode current of the magnetron contains two components, namely one which builds up the R.F. field of the tube and the other, i.e. the diode current, which contributes to the heating of the anode only. To keep the diode current as low as possible, a short rise and decay time of the voltage pulse is required. The cathode, moreover, should be prevented from becoming negative again with respect to the anode during the backswing of the voltage pulse. If the above mentioned provisions are not made, the diode current can amount to ten percent or more of the total average current and this could lead to a false conclusion with regard to the actual peak anode current. Below a certain limit the diode current will not impair the proper functioning of the magnetron.

STORAGE, HANDLING

In handling the magnetron, it should never be held by the cathode assembly. Rough treatment of the metal envelope and of the cooling fins may impair the electrical characteristics or may result in loss of vacuum. In storage a minimum distance of 15 cm (6") should be maintained between the packaged magnetrons to prevent the decrease of field strength of the magnetron magnet due to the interaction with adjacent magnets. Magnetic materials should be kept away from the magnet a distance of at least 5 cm (2") to avoid sharp mechanical shocks to the magnet. For this reason it is required to use non-magnetic tools during installation.

The opening in the waveguide output flange shall be protected by a dust cover when the magnetron is not in use. Care should be taken, moreover, to prevent any foreign matter or corrosive substances from entering the cathode terminal.

# PULSED MAGNETRON

Air-cooled unpackaged tunable magnetron for pulsed service.

| QUICK REFERENCE DATA | | | |
|---|---|---|---|
| Frequency, tunable within the band | f | 1220 to 1350 | MHz |
| Peak output power | $W_{op}$ | 450 | kW |
| Construction | | unpackaged | |

**HEATING**: indirect

| | | | | |
|---|---|---|---|---|
| Heater starting voltage | $V_{fo}$ | = | 23.5 | V $^{+10\ \%}_{-5\ \%}$ |
| Heater current at $V_f$ = 23.5 V | $I_f$ | = | 2.2 | A |
| Cathode heating time | $T_w$ | = | min. 3 | min |

For M.T.I. application it is advised to feed the heater with D.C. voltage.

Immediately after the high voltage has been applied the heater voltage must be reduced in accordance with the formula: $V_f = 23.5\ (1 - \frac{I_a}{140})$ V,

where $I_a$ is the mean anode current in mA.
This formula is only valid for the magnetron when used with a magnetic field strength of 1400 oerstedt.

**TYPICAL CHARACTERISTICS**

| | | | | |
|---|---|---|---|---|
| Frequency | f | = | 1220 to 1350 | MHz |
| Pulling figure | $\Delta f_p$ | < | 5 | MHz |
| Peak anode voltage at $I_{ap}$ = 46 A and magnetic field strength = 1400 gauss | $V_{ap}$ | = | 26.5 to 31.5 | kV |
| Temperature coefficient | $\frac{\Delta f}{\Delta t}$ | < | 0.03 | MHz per $^{o}$C |

## MECHANICAL DATA

Dimensions in mm

Mounting position: any

Net weight : 9000 g

Accessories

Magnet type 55302
(see page 5)

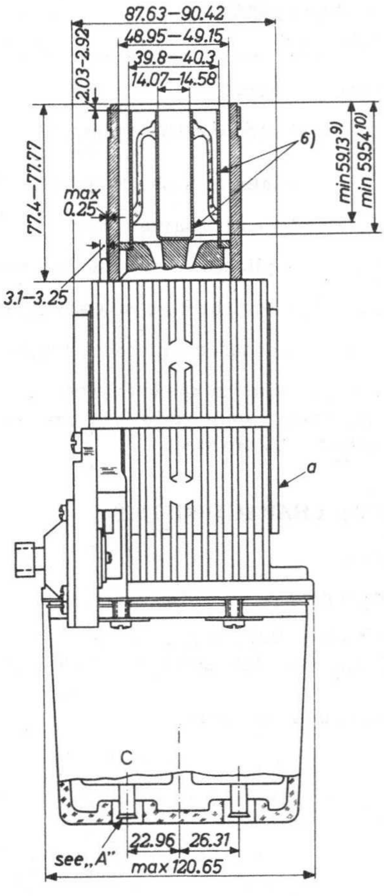
The magnetron output has been designed for coupling to a standard coaxial transmission line with an outer diameter of 1 5/8".

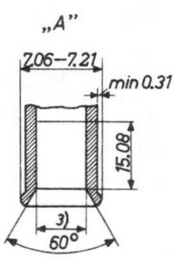
## COOLING

An adequate air flow should be directed along the cooling fins on the magnetron in order to keep the anode temperature preferably below 100 °C

## PRESSURE

To prevent electrical breakdown of the coaxial transmission line which can result in permanent damage to the magnetron, it is essential to pressurize this line for peak output powers greater than 400 kW. (max. 3.2 atm)

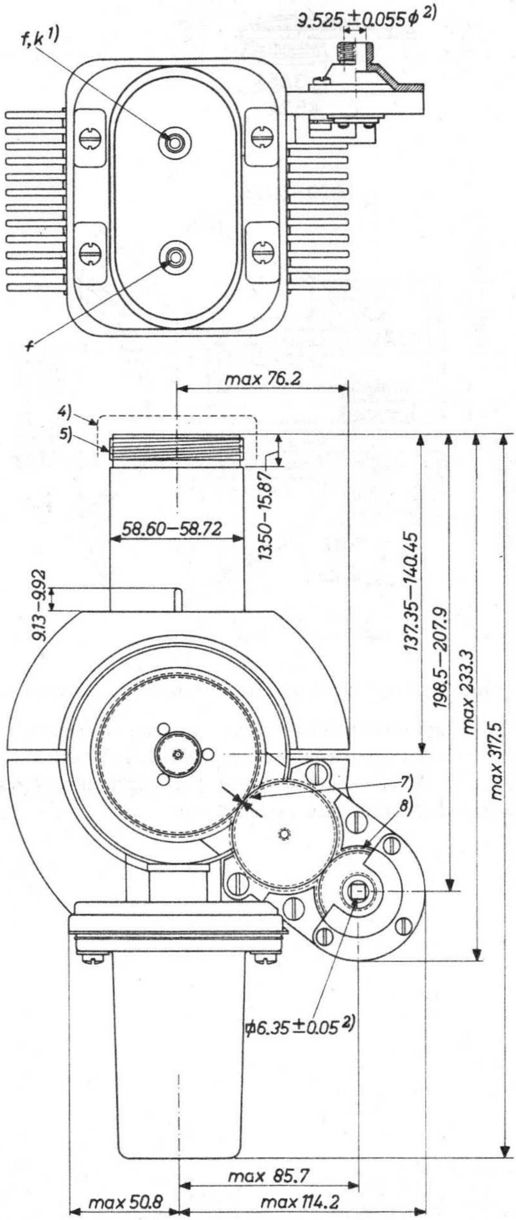


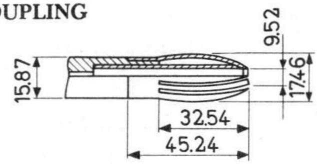

For footnotes see page 5.

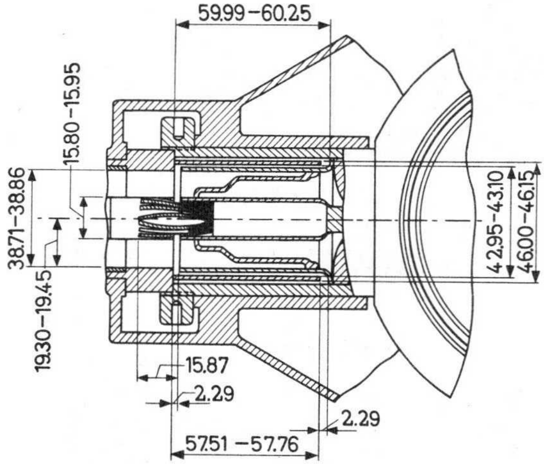
**MECHANICAL DATA** (continued)

Dimensions in mm



**RECOMMENDED COUPLING** Dimensions in mm



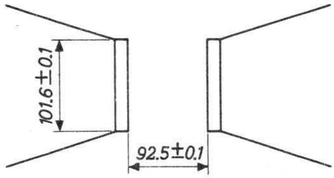




The dimensioned cylindrical surfaces shall be concentric within 0.076 mm

The connector should be constructed to require a force of between 2.7 and 5.5 kg to engage with the tube. Connectors constructed of 0.015" thick half hard beryllium copper strip (A.S.T.M. B-120 $\frac{1}{2}$H), having 12 segments separated by 1/32" sawcuts, have been found to meet this requirement.

**MAGNET**

The magnet's north-seeking pole should be located near the side of the magnetron which is provided with the tuning mechanism.
It is recommended to use circular pole tips for the magnet, with dimensions (in mm) as shown.




A typical value for the magnetic field between the pole tips is 1400 oerstedt. The tube should be located between the pole tips such that these are concentric with the axis of the tube. A small deviation from this position may result in lower output power.

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1) The common cathode heater terminal is located at the side of the magnetron which is provided with the tuning mechanism. It is, moreover, indicated by the inscription C on the glass boot which protects the heater lead-outs.

2) The round hole is concentric with the square hole within 0.076 mm.

3) Jack holes 4.3 ± 0.13 mm, deep min. 15 mm, not including the tapered section.

4) The opening in the support tubing should be protected by a dust cover when the magnetron is not in use.

5) Thread specification: 2.312"-16NS-5 full threads min.

| | |
|---|---|
| Max. major diameter 58.75 mm | Min. major diameter 58.37 mm |
| Max. pitch diameter 57.69 mm | Min. pitch diameter 57.48 mm |
| | Min. minor diameter 56.78 mm |

6) Output coaxial lead

7) Matched arrows on tuning gears indicate approximate midband frequencies.

8) This gear rotates clockwise when increasing frequency. The maximum torque to be applied to the driving gearwheel for tuning the magnetron does not exceed 9.2 cm kg (8 inch pounds). A mechanical stop is placed at either end of the tuning range to prevent damage to the tuning mechanism. Adjustment of the tuning mechanism beyond the stated frequency limits must not be attempted.

9) Depth of inside of outer conductor.

10) Depth of inner conductor.

**LIMITING VALUES** (Absolute limits)

Each limiting value should be regarded independently of other values, so that under no circumstances it is permitted to exceed a limiting value whichsoever.

| | | | | | |
|---|---|---|---|---|---|
| Heater starting voltage | $V_{fo}$ | = | max. | 26 | V |
| Peak heater surge current | $I_{f\,surge_p}$ | = | max. | 4 | A |
| Peak anode voltage | $V_{a_p}$ | = | max. | 34 | kV |
| Peak anode current | $I_{a_p}$ | = | max. | 55 | A |
| Duty factor | $\delta$ | = | max. | 0.0025 | |
| Pulse repetition rate | $f_{imp}$ | = | max. | 1000 | Hz |
| Pulse duration | $T_{imp}$ | = | | 1 to 6 | $\mu$s |
| Voltage rise time | | | | | |
| at $T_{imp}$ = 1 $\mu$s | $T_{rv}$ | = | min. | 0.3 | $\mu$s |
| at $T_{imp}$ = 4 $\mu$s | $T_{rv}$ | = | min. | 0.5 | $\mu$s |
| Peak input power | $W_{i_p}$ | = | max. | 1725 | kW |
| Average input power | $W_i$ | = | max. | 1725 | W |
| Voltage standing wave ratio | VSWR | = | max. | 1.5 | |
| Anode temperature | $t_a$ | = | max. | 125 | $^{o}$C |

**OPERATING CHARACTERISTICS**

| | | | | |
|---|---|---|---|---|
| Frequency | f | = | 1220 to 1350 | MHz |
| Pulse duration | $T_{imp}$ | = | 1 | $\mu$s |
| Pulse repetition rate | $f_{imp}$ | = | 1000 | Hz |
| Duty factor | $\delta$ | = | 0.001 | |
| Heater voltage | $V_f$ | = | 15.5 | V |
| Magnetic field strength | H | = | 1400 | Oe |
| Peak anode voltage | $V_{a_p}$ | = | 28 | kV |
| Peak anode current | $I_{a_p}$ | = | 46 | A |
| Average output power | $W_o$ | = | 450 | W |
| Peak output power | $W_{o_p}$ | = | 450 | kW |

## OPERATING NOTES

a. In order to prevent heater burn-out the negative high-voltage pulse must be applied to the common cathode-heater terminal.

b. The transmission line should be as short as possible to prevent long line effects, especially when the line is not matched. Under no circumstances should the magnetron be operated with a V.S.W.R. of the load exceeding 1.5. A ratio kept near unity will benefit tube life and reliability.

c. The modulator must be so designed that, if arcing occurs, the energy per pulse delivered to the magnetron does not considerably exceed the normal energy per pulse. Modulators of the pulse forming network discharge type usually satisfy this requirement.

d. It is required to bypass the magnetron heater with a 1000 V rated capacitor of min. 4000 pF directly across the heater terminals.

e. The unwanted noise that may occur when the anode pulse voltage drops below the value required for oscillation can be minimized by making the trailing edge of the voltage pulse as steep as possible and by removing residual negative and positive anode voltage immediately after the pulse.

## PULSE CHARACTERISTICS

The current pulse must be substantially square and the ripple over the top portion of the current pulse must be kept as small as possible to avoid unwanted frequency modulation due to pushing effects. The spike on the top portion of the pulse must be small to avoid excessive peak pulse current. The leading edge of the pulse must be free from irregularities.

## STARTING A NEW MAGNETRON

When a new magnetron, or a magnetron that has been idle or stored for a period of time, is taken into operation, some sparking and instability may occur. In that case it is recommended to start the magnetron in the following way:

1. Tune the magnetron to the higher frequency limit. Clockwise rotation of the driving gearwheel of the tuning mechanism results in higher magnetron frequency.

2. Apply heater voltage (23.5 V).

3. After a warming up time of three minutes at full heater voltage, raise anode voltage gradually (preferably at the shortest pulse duration) until one half of normal operating power is obtained. The heater voltage must be reduced in accordance with the heater voltage cutback schedule.

STARTING A NEW MAGNETRON(continued)

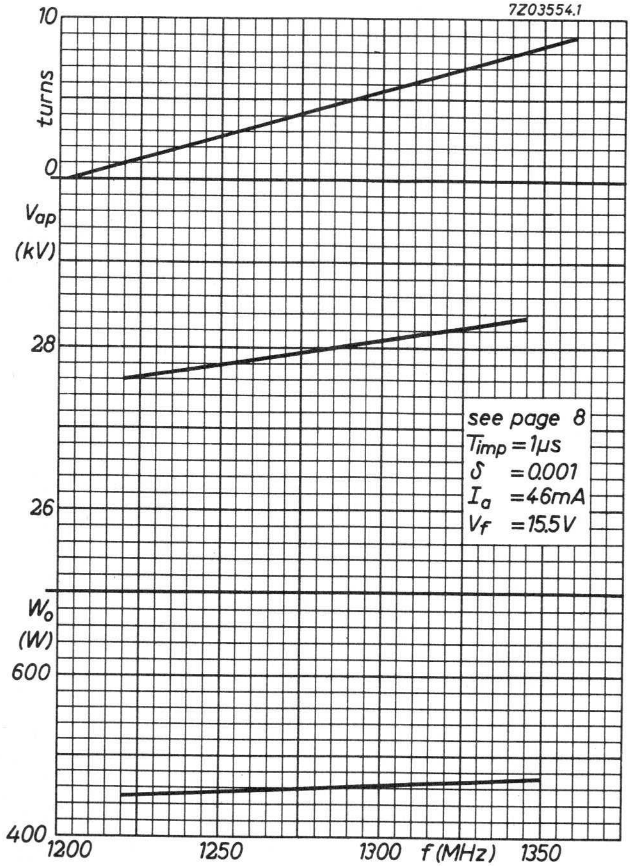
4. As soon as the magnetron operates stably, gradually raise the anode current until the normal operating conditions are reached. If sparking occurs stop raising anode current until the magnetron operates stably again. Care should be taken that the maximum ratings are not exceeded.

5. When stable operation at this frequency is reached, the magnetron should be gradually tuned to the lower frequency limit (1220 MHz). Operation at this frequency must be continued until the magnetron operates stably.

After this running-in schedule the magnetron can be put into use at the normal operating conditions.

DIAGRAM

Page 9 shows the tuning characteristics of an average magnetron 5J26. The number of (clockwise) turns of the driving gear is given as a function of the frequency. Moreover, the variation of the peak anode voltage and the average output power over the tuning range of the magnetron can be read off.


7Z03554.1
10
turns
0
Vap
(kV)
28
26
see page 8
Timp = 1μs
δ = 0.001
Ia = 46mA
Vf = 15.5V
Wo
(W)
600
400
1200
1250
1300
f (MHz)
1350

# PULSED MAGNETRON

Air-cooled unpackaged magnetron for pulsed service at a fixed frequency.

| QUICK REFERENCE DATA | | | |
|---|---|---|---|
| Frequency, fixed within the band | f | 9345 to 9405 | MHz |
| Peak output power | $W_{op}$ | 50 | kW |
| Construction | | unpackaged | |

**HEATING:** indirect

| | | | | | |
|---|---|---|---|---|---|
| Heater starting voltage | $V_{fo}$ | = | | 6.3 | V |
| Heater current at $V_f$ = 6.3 V | $I_f$ | = | | 1 | A |
| Waiting time | $T_w$ | = | min. | 2 | min |

For average input powers greater than 145 W the heater voltage should be switched off immediately after applying high voltage, except when the magnetron operates at a pulse repetition rate of 500 Hz or less. In that case the heater voltage should never be reduced below 1.5 V.

For input powers less than 145 W the heater voltage must be reduced in accordance with the formula

$$V_f = 6.3\sqrt{1 - \frac{W_i}{145}}\ (W_i \text{ in watts}).$$

**LIMITING VALUES** (Absolute limits)

Each limiting value should be regarded independently of other values, so that under no circumstances it is permitted to exceed a limiting value whichsoever

| | | | | | |
|---|---|---|---|---|---|
| Heater starting voltage | $V_{fo}$ | = | max. | 6.9 | V |
| Peak anode voltage | $V_{a_p}$ | = | max. | 16 | kV |
| Peak anode current | $I_{a_p}$ | = | max. | 16 | A |
| Average anode input power | $W_i$ | = | max. | 180 | W |
| Peak anode input power | $W_{i_p}$ | = | max. | 230 | kW |
| Duty factor | $\delta$ | = | max. | 0.0012 | |
| Pulse duration | $T_{imp}$ | = | max. | 2.5 | $\mu$s |
| Voltage standing wave ratio | VSWR | = | max. | 1.5 | |
| Anode temperature | $t_a$ | = | max. | 100 | °C[1] |

[1]) For short periods $t_a$ = max. 150 °C

## OPERATING CHARACTERISTICS

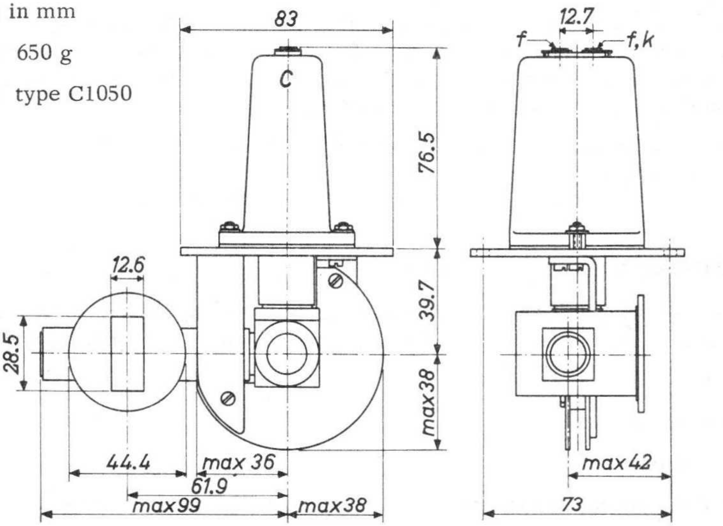
| | | | | |
|---|---|---|---|---|
| Magnetic field strength | H | = | 5400 | G |
| Heater starting voltage | $V_{f_o}$ | = | 6.3 | V [1]) |
| Peak anode current | $I_{a_p}$ | = | 12 | A |
| Peak anode voltage | $V_{a_p}$ | = | 12 | kV |
| Pulse repetition rate | $f_{imp}$ | = | 1000 | Hz |
| Pulse duration | $T_{imp}$ | = | 1 | $\mu$s |
| Average output power | $W_o$ | = | 50 | W |
| Peak output power | $W_{o_p}$ | = | 50 | kW |
| Bandwidth | B | < | 3 | MHz |

## MECHANICAL DATA

Dimensions in mm

Net weight: 650 g

Magnet : type C1050




Mounting position: any

Magnetron output. Designed for coupling to standard rectangular waveguide RG-51/U. For drawing of this waveguide see front of this section.

1) See section "Heating"

# PULSED MAGNETRON

Forced air-cooled unpackaged tunable magnetron for pulsed service.

| QUICK REFERENCE DATA | | | |
|---|---|---|---|
| Frequency, tunable within the band | f | 2700 to 2900 | MHz |
| Peak output power | $W_{o_p}$ | 800 | kW |
| Construction | | unpackaged | |

The magnetron is used with a 1 5/8" coaxial output transmission line and an external magnet having an air gap of 1.8" and a magnetic field strength of 216 A/mm (2700 Oe).

**HEATING:** indirect

| | | | | |
|---|---|---|---|---|
| Heater starting voltage | $V_{f_o}$ | = | 16.0 | V +10 % |
| Heater current at $V_f$ = 16.0 V | $I_f$ | = | 2.8 to 3.4 | A |
| Waiting time | $T_w$ | = | min. 2 | min |

During high voltage operation the heater voltage must be reduced according to the following schedule:

| $W_{i_a}$ (W) | $V_f$ (V) |
|---|---|
| < 400 | 16 |
| 400 to 600 | 15 |
| 600 to 800 | 13 |
| 800 to 1000 | 10.5 |
| 1000 to 1200 | 8 |

This schedule is valid only for repetition rates of 300 or more pulses per second

**MECHANICAL DATA**

Dimensions in mm

Net weight 2.3 kg

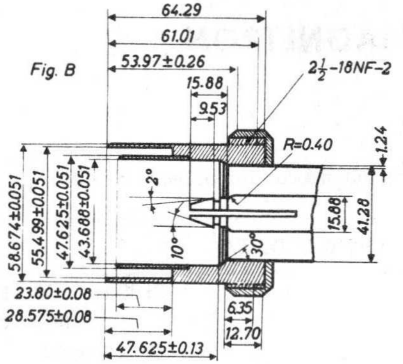


Fig. B

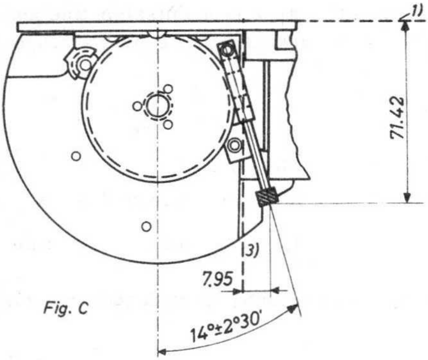
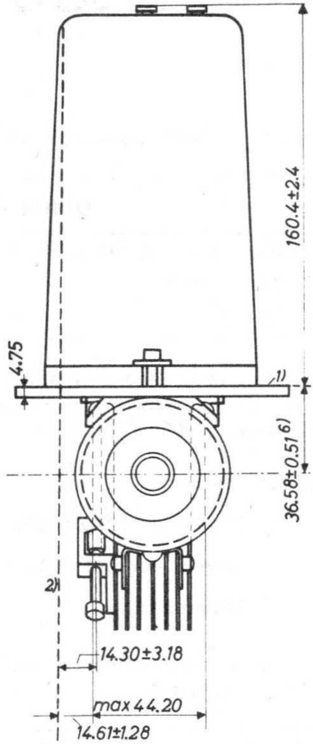


Fig. C



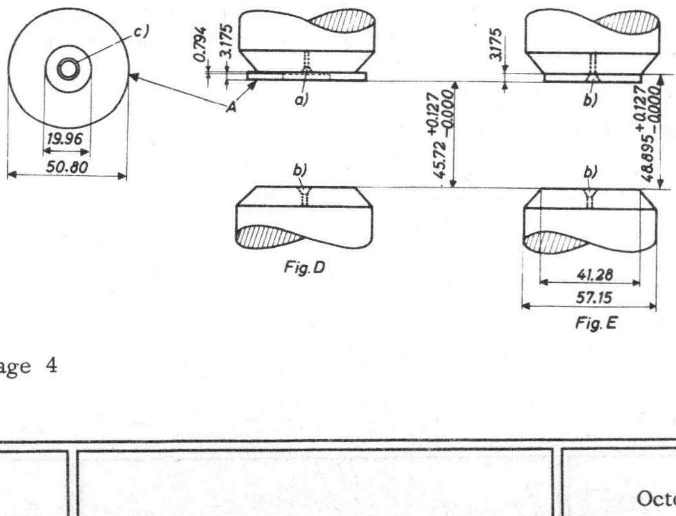
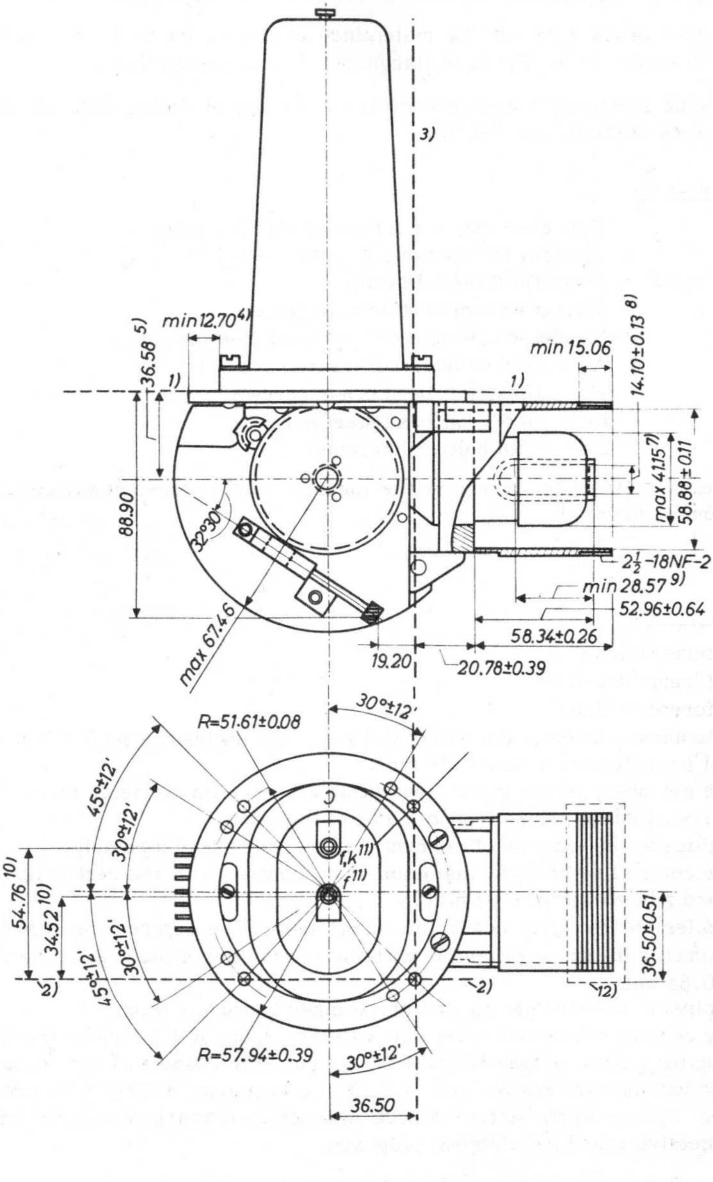



Fig. D

Fig. E

See also page 4

MECHANICAL DATA (continued) Dimensions in mm



**MECHANICAL DATA** (continued)

Mounting position: any

The tube may be supported by the mounting plate or by the guard pipe.

The output of the tube can be maintained at a pressure of 2.8 to 3.1 kg/cm$^2$ (40 to 45 lbs/sq.in.). The input flange can also be pressurized.

The tuning mechanism will provide the full range of tuning with 110 complete revolutions of the tuning spindle.

From page 2.

| | | |
|---|---|---|
| Fig.B | : | Test coupling, not furnished with the tube |
| Fig.C | : | Optional location of the tuning spindle |
| Fig.D and E | : | Magnetic field calibrators |
| Fig.D | : | Magnet with distortion pole piece |
| Fig.E | : | Magnet with single conventional pole piece |
| | | A = cold rolled steel insert |
| | | a) = 10-32 flat head brass screw |
| | | b) = 10-32 flat head steel screw |
| | | c) = 5/16 hole countersunk |

For the calibration procedure of the magnetic field please communicate with the manufacturer.

---

1) Reference plane A
2) Reference plane B
3) Reference plane C
4) This annular area is flat within 0.4 mm. A thickness gauge 3.175 mm wide will not enter more than 6.35 mm.
5) The periphery of the anode lies within a 54.87 mm diameter circle located as specified for the non tunable side of the anode.
6) Applies to the location of the centre line of the guard pipe only.
7) The centre line of max. diameter is concentric with the centre line of the guard pipe to within 1.02 mm.
8) Applies to the inner conductor insert only. The centre line of the inner conductor insert is concentric with the centre line of the guard pipe to within 0.64 mm.
9) Applies to the straight portion of the inner conductor wall.
10) The centres of the jack holes are within a radius of 2.54 mm of the location specified, but are spaced 20.24 ± 0.39 mm with respect to each other.
11) Hex locking head banana pin jack 15 mm long hole, 4.29 ± 0.13 mm diameter. The common heater-cathode connection is marked with the letter C.
12) Protective guard for shipping purposes.

**LIMITING VALUES** (Absolute limits)

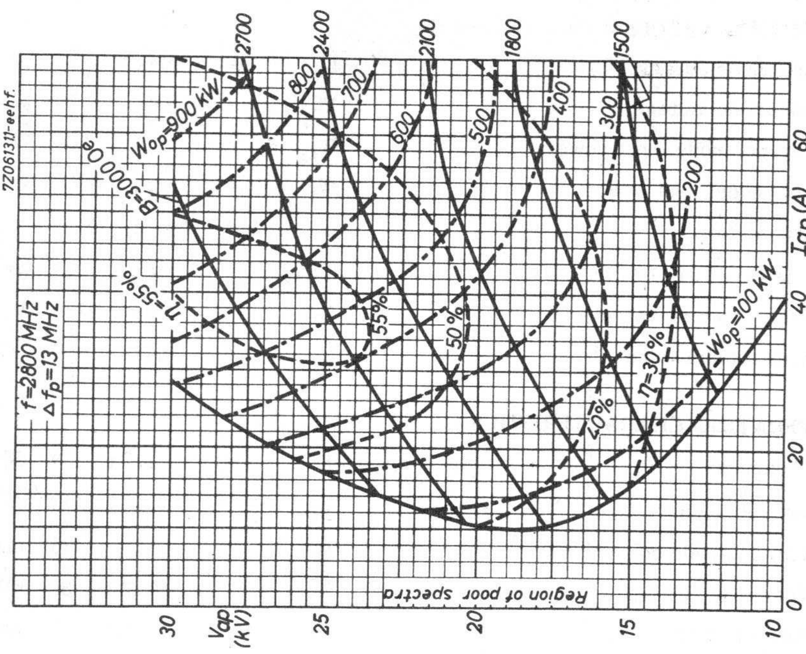
| | | | | | |
|---|---|---|---|---|---|
| Peak anode current | $I_{a_p}$ | = | max. | 70 | A |
| Peak anode voltage | $V_{a_p}$ | = | max. | 30 | kV |
| Average anode input power | $W_{i_a}$ | = | max. | 1200 | W |
| Peak anode input power | $W_{i_{a\,p}}$ | = | max. | 2000 | kW |
| Duty factor | $\delta$ | = | max. | 0.001 | |
| Pulse duration | $T_{imp}$ | = | max. | 2.5 | $\mu$s |
| Heater starting voltage | $V_{f_o}$ | = | max. | 17.6 | V |
| Anode temperature | $t_a$ | = | max. | 100 | $^o$C |

**OPERATING CHARACTERISTICS**

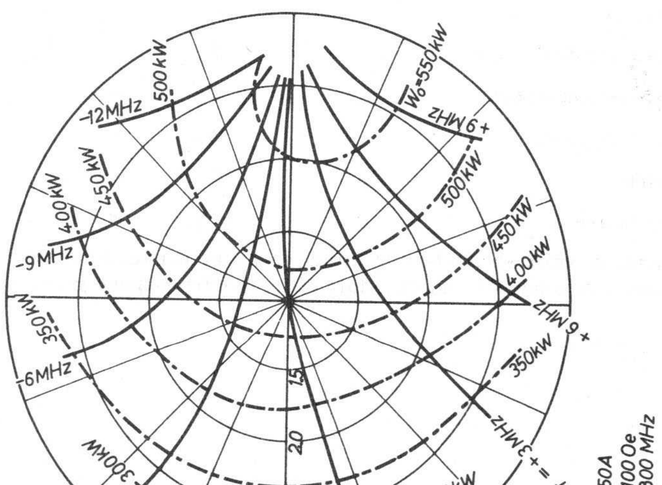
| | | | | |
|---|---|---|---|---|
| Frequency | f | = | 2.7 to 2.9 | GHz |
| Peak anode current | $I_{a_p}$ | = | 70 | A |
| Average anode current | $I_a$ | = | 35 | mA |
| Peak anode voltage | $V_{a_p}$ | = | 27 to 30 | kV |
| Pulse duration | $T_{imp}$ | = | 1 | $\mu$s |
| Duty factor | $\delta$ | = | 0.0005 | |
| Magnetic field strength | H | = | 2700 | G |
| Average output power | $W_o$ | = | 400 | W |
| Peak output power | $W_{o_p}$ | = | 800 | kW |
| Bandwidth | B | < | 2.5 | MHz |
| Pulling figure | $\Delta f_p$ | < | 15 | MHz |

The manufacturer should be consulted whenever it is considered to operate the magnetron at conditions substantially different from those given above.

7Z06131.1-eehf.




5586 7Z00334.1
28-9-60



# PULSED MAGNETRON

Forced air cooled packaged magnetron designed for very stable short pulse operation at pulse durations of 0.1 to 1 $\mu$s.

| QUICK REFERENCE DATA | | |
|---|---|---|
| Frequency, fixed within the band | f | 9345 to 9405 MHz |
| Peak output power | $W_{op}$ | 80 kW |
| Construction | | packaged |

**HEATING:** indirect

| | | | | |
|---|---|---|---|---|
| Heater starting voltage | $V_{f_o}$ | = | $10 \begin{smallmatrix}+1 \\ -0.5\end{smallmatrix}$ | V |
| Heater current at $V_f$ = 10 V | $I_f$ | = | 3.25 ± 0.35 | A |
| Heater resistance in cold condition | $R_{f_o}$ | = | 0.40 | Ω |
| Waiting time | $T_w$ | = | min. 3 | min |

The heater current must never exceed a peak value of 11.5 A at any time during the initial energizing schedule.

For $W_{i_a} > 50$ W it is necessary to reduce the heater voltage immediately after applying high voltage in accordance with the formula

$$V_f = 10.7 - 0.0143\, W_{i_a}$$

where $W_{i_a} = \delta \times I_{a_p} \times 15000$. See also lower fig. page 8.

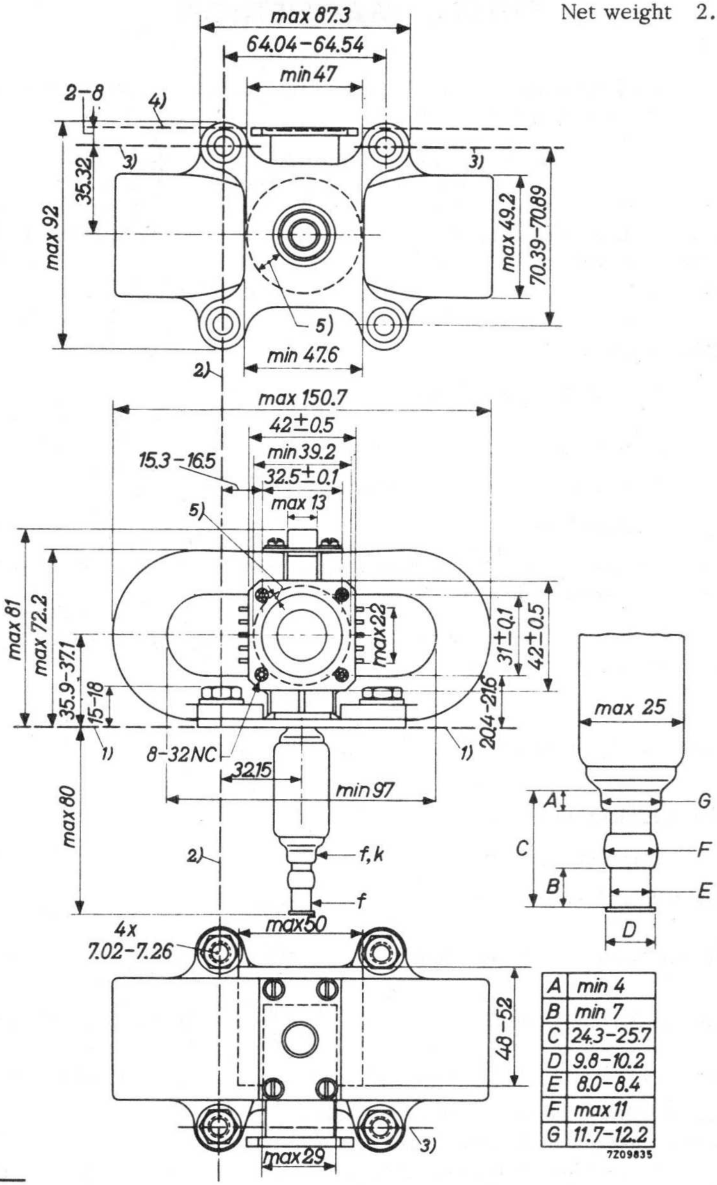
**TYPICAL CHARACTERISTICS**

| | | | | | |
|---|---|---|---|---|---|
| Anode to cathode capacitance | $C_{ak}$ | | | < 12 | pF |
| Pulling figure at VSWR = 1.5 | $\Delta f_p$ | = | 10 | < 15 | MHz |
| Pushing figure (see upper fig. page 8) | $\frac{\Delta f}{\Delta I_{a_p}}$ | = | 0.5 | | MHz/A |
| Negative temperature coefficient | $-\frac{\Delta f}{\Delta t}$ | = | 0.17 | < 0.25 | MHz/°C |
| Peak anode current in stable range | $I_{a_p}$ | = | | 10 to 18 | A |
| Distance of voltage standing wave minimum from reference plane A toward load (see lower fig. page 7) | d | = | | 7.5 ± 3 | mm |

**MECHANICAL DATA**

Dimensions in mm

Net weight 2.1 kg




| | |
|---|---|
| A | min 4 |
| B | min 7 |
| C | 24.3−25.7 |
| D | 9.8−10.2 |
| E | 8.0−8.4 |
| F | max 11 |
| G | 11.7−12.2 |

For notes see page 3.

## MECHANICAL DATA (continued)

Mounting position: arbitrary

## ACCESSORIES

Cathode connector with built-in capacitor 55308

## COOLING

See page 9. Under normal conditions no additional cooling is required for the input terminals.

## LIMITING VALUES

Each limiting value should be regarded independently of other values, so that under no circumstances it is permitted to exceed a limiting value whichsoever.

| | | | | |
|---|---|---|---|---|
| Pulse duration | $T_{imp}$ | = max. | 5.5 | $\mu$s |
| Duty factor | $\delta$ | = max. | 0.002 | |
| Heater starting voltage | $V_{f_o}$ | = max. | 11 | V |
| Peak heater starting current | $I_{f_{surge\ p}}$ | = max. | 11.5 | A |
| Peak anode current | $I_{a_p}$ | = max. | 18 | A |
| Anode input power | $W_{i_a}$ | = max. | 400 | W |
| Rate of rise of anode voltage [6] | | | | |
| at $T_{imp}$ = 0.1 $\mu$s | $\frac{\Delta V_a}{\Delta T_{r_v}}$ | = max. | 150 | kV/$\mu$s |
| at $T_{imp}$ = 1 to 5 $\mu$s | $\frac{\Delta V_a}{\Delta T_{r_v}}$ | = max. | 80 | kV/$\mu$s |
| Voltage standing wave ratio | VSWR | = max. | 1.5 | |
| Anode block temperature | $t_a$ | = max. | 175 | $^oC$ [7] |
| Seal temperature | $t_s$ | = max. | 150 | $^oC$ |

Page 2

[1]) Reference plane 1

[2]) Reference plane 2

[3]) Reference plane 3

[4]) Reference plane A (See also lower fig. page 7)

[5]) Hermetic connections can be made to this surface

[6]) See definitions page 6

[7]) To be measured on the anode block between the centre cooling fin and the adjacent fin.

## OPERATING CHARACTERISTICS

| | | | | | | |
|---|---|---|---|---|---|---|
| Frequency | $f$ | = | 9375 ± 30 | 9375 ± 30 | MHz | |
| Heater voltage | $V_f$ | = | 10 | 7.5 [1] | V | |
| Pulse duration | $T_{imp}$ | = | 0.1 (± 20%) | 1 to 5 (± 10%) | μsec | |
| Duty factor | $\delta$ | = | 0.0002 | 0.001 | | |
| Peak anode voltage | $V_{ap}$ | = | 15 ± 1 | 15 ± 1 | kV | |
| Rate of rise of anode voltage | $\frac{\Delta V_a}{\Delta T_{rv}}$ | = | 140 | 70 | kV/μs | 2) |
| Peak anode current | $I_{ap}$ | = | 15 | 15 | A | |
| Average output power | $W_o$ | = | 16 | 80 | W | |
| Peak output power | $W_{op}$ | = | 80 | 80 | kW | |

The manufacturer should be consulted whenever it is considered to operate the magnetron at conditions substantially different from those indicated.

## MOUNTING

To fasten the magnetron output flange to the RG-52/U waveguide, a choke flange type I.S. Z830051 (British designation) or type UG-40/U should be inserted between these parts. This choke flange should be modified to fit the magnetron output flange. This is accomplished by reaming the four mounting holes in the above choke flange with a drill of 4.5 mm. The choke flange can then be fastened to the magnetron output flange by means of four 8-32 NC bolts.

Mounting of the magnetron should be accomplished by means of its mounting flange. The tube should in no case be supported by the coupling to the waveguide output flange alone.

It is required to use non-magnetic tools during installation.

The opening in the output flange should be kept closed by the dust cover until the tube is mounted into the equipment.

Before putting the magnetron into operation, the user should make sure that the output waveguide is entirely clean and free from dust and moisture

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1) See lower fig. page 8

2) See definitions page 6

**PRESSURE**

The magnetron need not be pressurized when operating at atmospheric pressure.

Operation at pressures lower than 60 cm of Hg may result in arcover with consequent damage to the tube.

The mounting flange and also the waveguide output flange are made so that the magnetron can be used in applications requiring a pressure seal. They can be maintained at a pressure up to 3.1 $kg/cm^2$ (45 lbs/sq. in.).

**LIFE**

Magnetron life depends on the operating conditions and is expected to be longer at shorter pulse lengths.

**STARTING A NEW MAGNETRON**

The magnetron is provided with a getter. Owing to this ageing of a new magnetron that has been idle or stored for a period of time, will not be necessary in many cases. If, however, the magnetron is taken into operation and some sparking and instability occur incidentally it is recommended to raise gradually the anode voltage-starting at low values- and to operate the magnetron with reduced input during 15 to 30 minutes. After this period sparking usually ceases.

**CIRCUIT NOTES**

a. The negative high voltage pulse should be applied to the common cathode-heater terminal.

b. If no load isolator is inserted between the magnetron and the transmission line, the latter should be as short as possible to prevent long-line effects. Under no circumstances should the magnetron be operated with a voltage standing wave ratio of the load exceeding 1.5. A ratio kept near unity will benefit tube life and reliability.

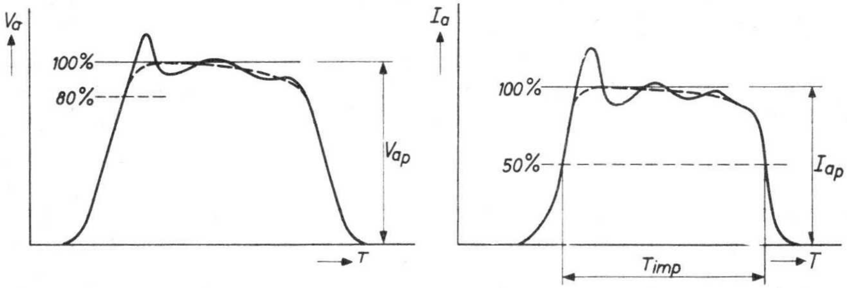
c. The modulator must be so designed that, if arcing occurs, the energy per pulse delivered to the magnetron does not considerably exceed the normal energy per pulse.

d. In order to prevent diode current from flowing during the interval between two pulses and to minimize unwanted noise during the region of the voltage pulse where the anode voltage has dropped below the value required to sustain oscillation, the trailing edge of the voltage pulse should be as steep as possible and the anode voltage should be prevented from becoming positive at any time in the interval between two pulses.

e. It is required to bypass the magnetron heater with a 1000 V rated capacitor of minimum 3500 pF across the heater terminals. The heater-cathode connector 55308 is recommended.

## PULSE CHARACTERISTICS AND DEFINITIONS

The smooth peak value (100%) of a pulse is the maximum value of a smooth curve through the average of the fluctuation over the top portion of the pulse as shown below




The rate of rise of anode voltage ($\frac{\Delta V}{\Delta T_{r_V}}$) is defined by the steepest tangent to the leading edge of the voltage pulse above 80% of the smooth peak value. Any capacitance used in a viewing system shall not exceed 6 pF. For calculation of the rate of rise of anode voltage the 100% value must be taken as 15 kV.

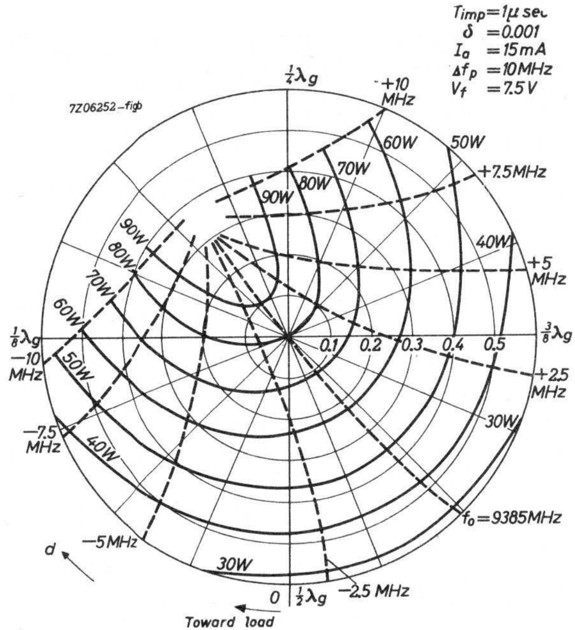
The pulse duration ($T_{imp}$) is defined as the time interval between the two points on the current pulse at which the current is 50% of the smooth peak current.

The current pulse must be sensibly square and the ripple over the top portion of the current pulse must be as small as possible to avoid unwanted frequency modulation due to pushing effects.
The spike on the top portion of the pulse must be small to avoid excessive peak pulse current. The leading edge of the pulse must be free from irregularities.

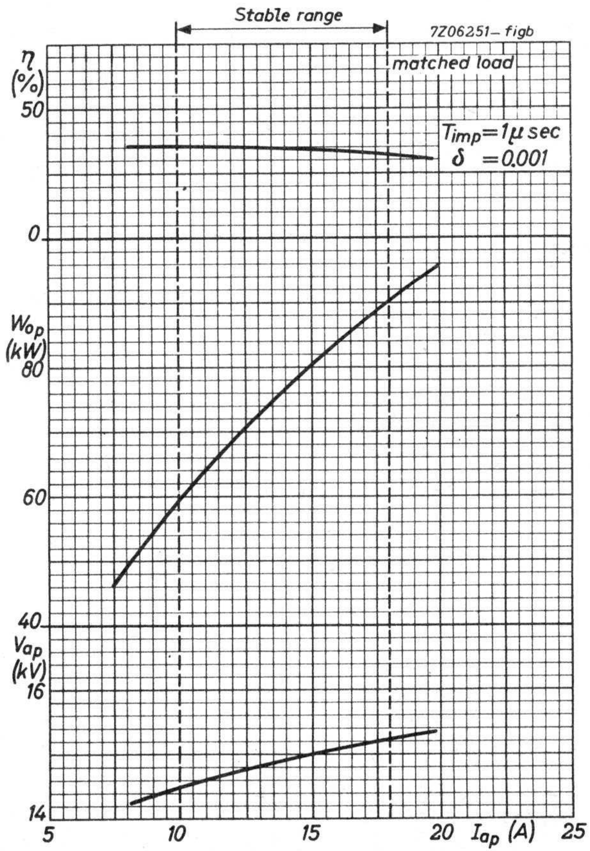
## STORAGE, HANDLING

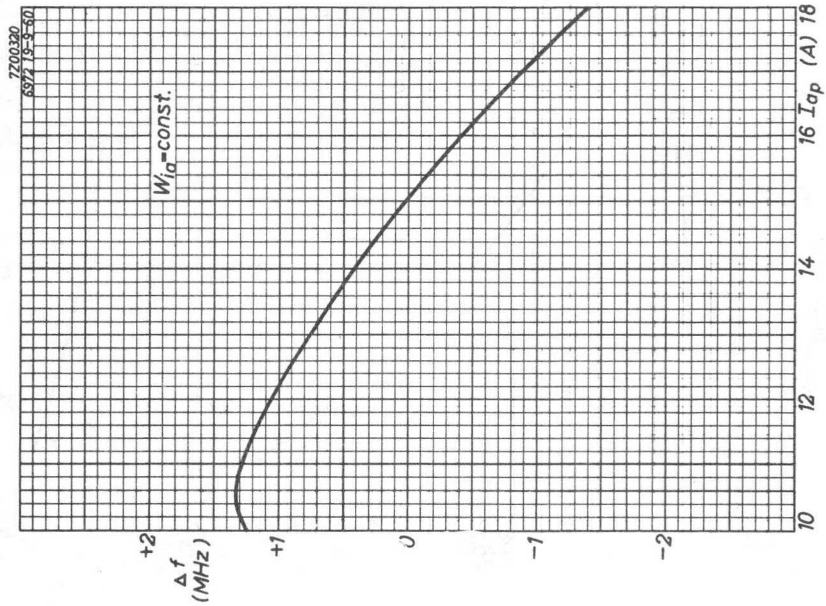
In handling the magnetron, it should never be held by the cathode assembly. Rough treatment of the metal envelope and of the cooling fins may impair the electrical characteristics or may result in loss of vacuum.

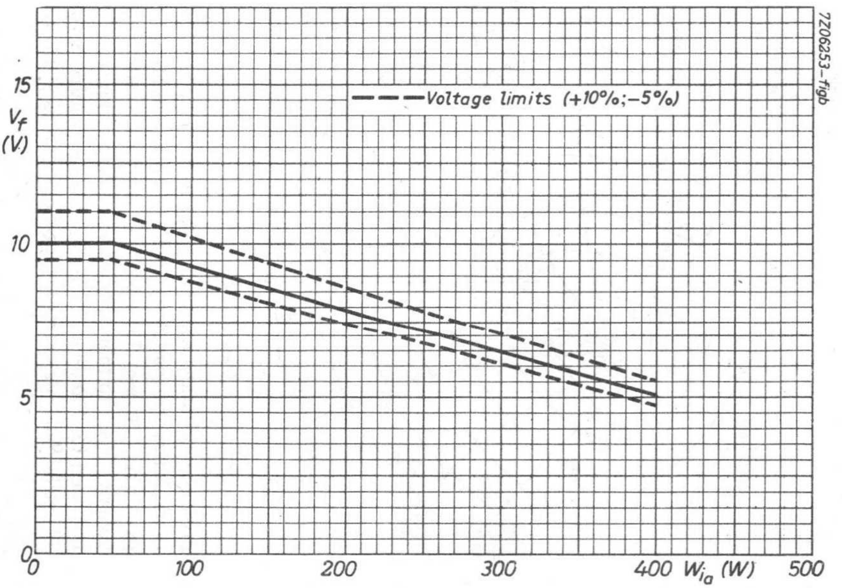
In storage a minimum distance of 15 cm (6 inches) should be maintained between the packaged magnetrons to prevent decrease of field strength of the magnetron magnet due to the interaction with adjacent magnets. If the magnetrons are stored in their original wooden box, no special precautions need be taken with regard to the proper distance between magnets.
Magnetic materials should be kept away from the magnet a distance of at least 5 cm (2 inches) to avoid mechanical shocks to the magnet.

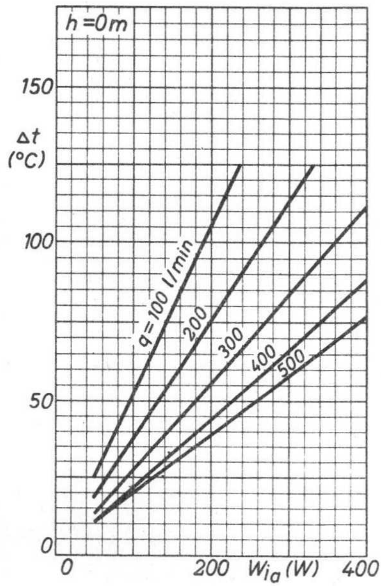



d = distance of standing wave minimum from reference plane A toward load. Measured at an anode block temperature between 15 and 20 °C with a test signal frequency equal to that of the oscillating magnetron with matched load and an anode block temperature between 70 and 80 °C. For reference plane A see page 2 note [4]).

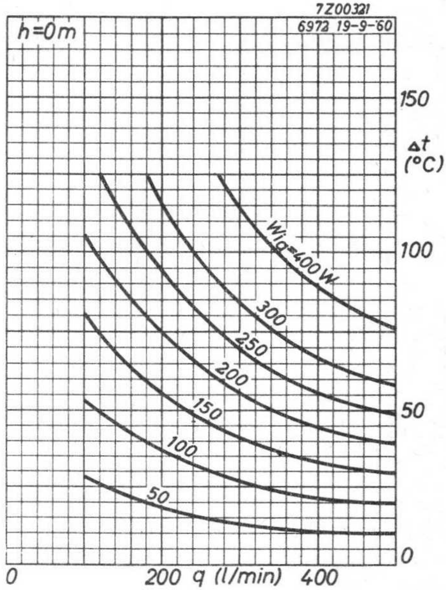



7Z00320
6972 19-9-60
$W_{ia}$=const.
16 $I_{ap}$ (A) 18
14
12
10
+2
Δf
(MHz)
+1
0
−1
−2


7Z06253-figb
15
$V_f$
(V)
10
5
0
0
100
200
300
400 $W_{ia}$ (W)
500
Voltage limits (+10%;−5%)



h = 0 m
150
Δt
(°C)
100
50
0
0
200 $W_{ia}$ (W) 400
q = 100 l/min
200
300
400
500

7Z00321
6972 19-9-60
h = 0 m
150
Δt
(°C)
100
50
0
0
200 q (l/min) 400
$W_{ia}$ = 400 W
300
250
200
150
100
50

# PULSED MAGNETRON

Packaged magnetron for pulsed service at a fixed frequency

| QUICK REFERENCE DATA | | | |
|---|---|---|---|
| Frequency, fixed within the band | f | 9345 to 9475 | MHz |
| Peak output power | $W_{o_p}$ | 3 | kW |
| Construction | | packaged | |

**HEATING:** indirect

| | | | | |
|---|---|---|---|---|
| Heater voltage | $V_f$ | = | 6.3 | V ± 5% |
| Heater current at $V_f$ = 6.3 V | $I_f$ | = | 0.5 | A |
| Waiting time at $t_{amb}$ > 0 °C | $T_w$ | = | min. 2 | min |
| at $t_{amb}$ < 0 °C | $T_w$ | = | min. 3 | min |

**TYPICAL CHARACTERISTICS**

| | | | | |
|---|---|---|---|---|
| Frequency, fixed within the range | f | = | 9345 to 9475 | MHz |
| Negative temperature coefficient | $-\frac{\Delta f}{\Delta t}$ | < | 0.25 | MHz/°C |
| Pulling figure at VSWR = 1.5 | $\Delta f_p$ | < | 18 | MHz |
| Pushing figure | $\frac{\Delta f}{\Delta I_a}$ | < | 2.5 | MHz/A |
| Distance of voltage standing wave minimum from face of mounting plate into magnetron | d | = | 0 to 6 | mm |
| Peak anode voltage at $I_{ap}$ = 3 A | $V_{a_p}$ | = | 3.2 to 3.8 | kV |
| Input capacitance | $C_{ak}$ | < | 9 | pF |

**COOLING:** radiation and convection

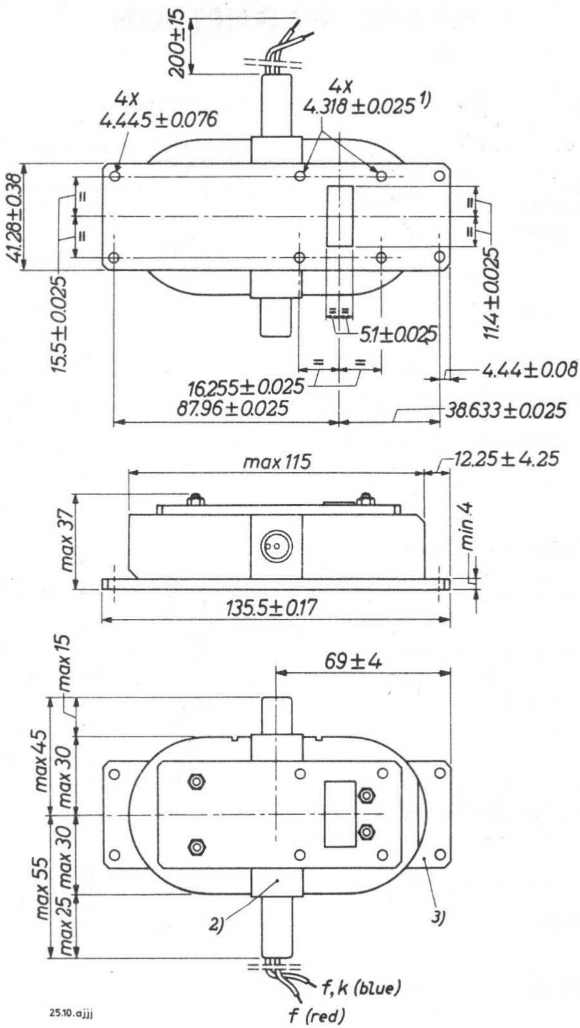
**MAGNETRON OUTPUT**

The output system has been designed for coupling to the standard rectangular waveguide RG-52/U (EIA designation WR90) with outside dimensions $\frac{1}{2}$" x 1". To fasten the magnetron base plate to the RG-52/U waveguide the bolted flange choke coupling joint-services type 5985-99-0830051 should be used.

**MECHANICAL DATA**

Dimensions in mm

Net weight: 1.02 kg




Mounting position: any

1) Holes for locating pins, depth 4 mm
2) Point for temperature measurement
3) The anode is terminated at the base plate

**LIMITING VALUES** (Absolute limits)

Each limiting value should be regarded independently of other values, so that under no circumstances it is permitted to exceed a limiting value whichsoever.

| | | | | |
|---|---|---|---|---|
| Pulse duration | $T_{imp}$ | = 0.02 to | 1 | µs |
| Duty factor | $\delta$ | = max. 0.001 | | |
| Peak anode current | $I_{a_p}$ | = | 2.5 to 3.5 | A |
| Average input power | $W_{i_a}$ | = max. | 13 | W |
| Rate of rise of anode voltage | $\frac{\Delta V_a}{\Delta T_{r_V}}$ | = max. | 60 | kV/µs |
| Voltage standing wave ratio | VSWR | = max. | 1.5 | |
| Temperature of anode block | $t_a$ | = max. | 120 | °C [1] |

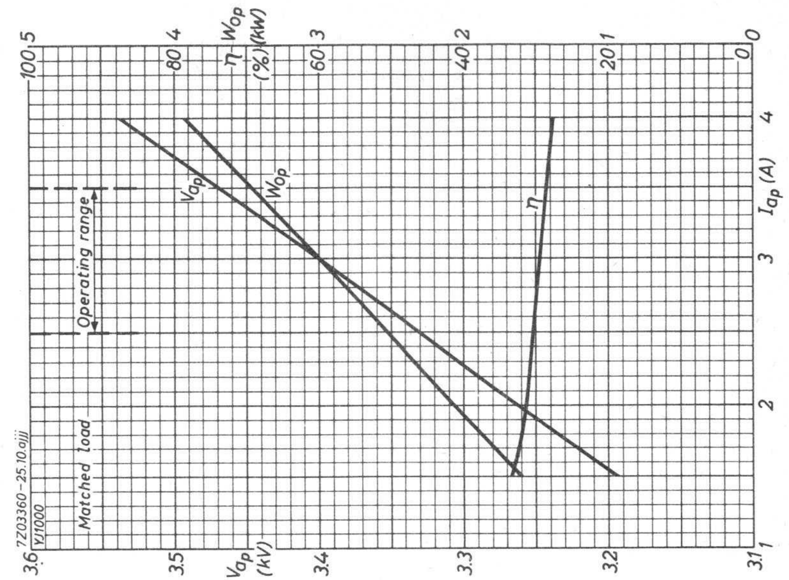
**OPERATING CHARACTERISTICS**

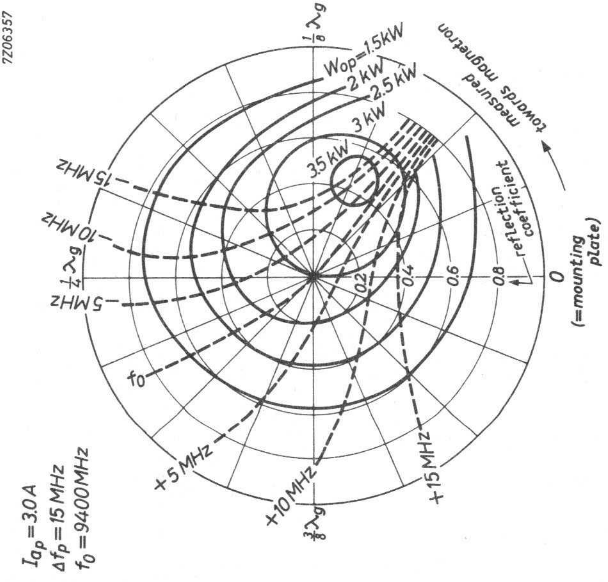
| | | | | |
|---|---|---|---|---|
| Heater voltage | $V_f$ | = | 6.3 | V |
| Pulse duration | $T_{imp}$ | = | 0.1 | µs |
| Duty factor | $\delta$ | = | 0.0002 | |
| Pulse repetition rate | $f_{imp}$ | = | 2000 | Hz |
| Peak anode voltage | $V_{a_p}$ | = | 3.4 | kV |
| Rate of rise of anode voltage | $\frac{\Delta V_a}{\Delta T_{r_V}}$ | = | 50 | kV/µs |
| Average anode current | $I_a$ | = | 600 | µA |
| Peak anode current | $I_{a_p}$ | = | 3 | A |
| Average input power | $W_{i_a}$ | = | 2 | W |
| Peak input power | $W_{i_{a\,p}}$ | = | 10 | kW |
| Average output power | $W_o$ | = | 0.6 | W |
| Peak output power | $W_{o_p}$ | = | 3 | kW |
| Pulling figure at VSWR = 1.5 | $\Delta f_p$ | = | 15 | MHz |

[1]) For point of measurement see note [2]) page 2.

## END OF LIFE PERFORMANCE

| | | | | |
|---|---|---|---|---|
| Peak output power at $I_{a_p}$ = 3 A | $W_{o_p}$ | = | 2 | kW |
| Frequency within the range | f | = | 9345 to 9475 | MHz |
| Peak anode voltage at $I_{a_p}$ = 3 A | $V_{a_p}$ | = | 3.2 to 3.8 | kV |


7Z03360-25.10.aijj
YJ1000
Matched load
Operating range
$V_{ap}$ (kV)
$\eta$ (%)
$W_{op}$ (kW)
$I_{ap}$ (A)
$V_{ap}$
$W_{op}$
$\eta$
3.6
3.5
3.4
3.3
3.2
3.1
100 5
80 4
60 3
40 2
20 1
0 0
1
2
3
4


7Z06357
$I_{ap}$ = 3.0 A
$\Delta f_p$ = 15 MHz
$f_0$ = 9400 MHz
$W_{op}$ = 1.5 kW
2 kW
2.5 kW
3 kW
3.5 kW
$\frac{1}{8}\lambda g$
$\frac{1}{4}\lambda g$
$\frac{3}{8}\lambda g$
-15 MHz
-10 MHz
-5 MHz
$f_0$
+5 MHz
+10 MHz
+15 MHz
0.2
0.4
0.6
0.8
reflection coefficient
0 (=mounting plate)
measured towards magnetron

# PULSED MAGNETRON

Air-cooled packaged magnetron for pulsed service at a fixed frequency, especially suited for use in high definition short range radar systems.

| QUICK REFERENCE DATA | | | |
|---|---|---|---|
| Frequency, fixed within the band | f | 34 512 to 35 208 | MHz |
| Peak output power | $W_{o_p}$ | 40 | kW |
| Construction | | packaged | |

**HEATING**: indirect; dispenser type cathode

| | | | | |
|---|---|---|---|---|
| Heater starting voltage | $V_{f_o}$ | = | 5 | V $^{+10\%}_{-5\%}$ |
| Heater current at $V_f$ = 5 V | $I_f$ | = | $3.9 \pm 0.7$ | A |
| Heater resistance in cold condition | $R_{f_o}$ | > | 0.16 | Ω |
| Waiting time | $T_w$ | = min. | 3 | min |

The heater current must never exceed a peak value of 8 A during the initial energizing schedule.
At an anode input power of more than 21 W the heater voltage must be reduced immediately after the application of the anode power according to the graph on page 8.

**TYPICAL CHARACTERISTICS**

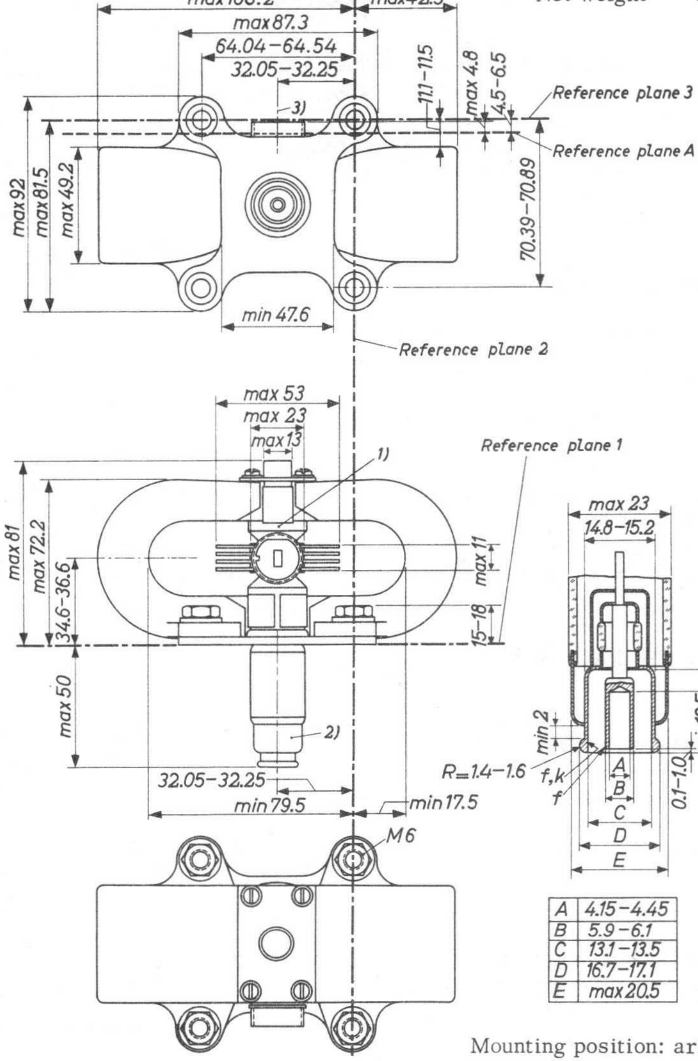
| | | | | |
|---|---|---|---|---|
| Peak anode current in the stable range | $I_{a_p}$ | = | 6 to 16 | A |
| Peak anode voltage at $I_{a_p}$ = 12.5 A | $V_{a_p}$ | = | 11.5 to 13.5 | kV |
| Negative temperature coefficient | $-\frac{\Delta f}{\Delta t}$ | | < 1 | MHz/°C |
| Pulling figure at VSWR = 1.5 | $\Delta f_p$ | = | 35 < 50 | MHz |
| Pushing figure | $\frac{\Delta f}{\Delta I_a}$ | | < 4 | MHz/A |
| Distance of the voltage standing wave minimum outside the tube from reference plane A | d | = | 0.25 to 0.4 | $\lambda_g$ [1]) |
| | | = | 2.6 to 4.4 | mm |
| Input capacitance | $C_{ak}$ | = | 6 | pF |

[1]) Measured with a standard cold test technique at the frequency of the oscillating magnetron operating into a matched load.
For reference plane A see page 2
$\lambda_g$ is the wavelength of the waveguide

## MECHANICAL DATA

Dimensions in mm

Net weight 1.9 kg




| | |
|---|---|
| A | 4.15−4.45 |
| B | 5.9−6.1 |
| C | 13.1−13.5 |
| D | 16.7−17.1 |
| E | max 20.5 |

Mounting position: arbitrary

**ACCESSORIES** Cathode connector 55356 (See figure page 3)

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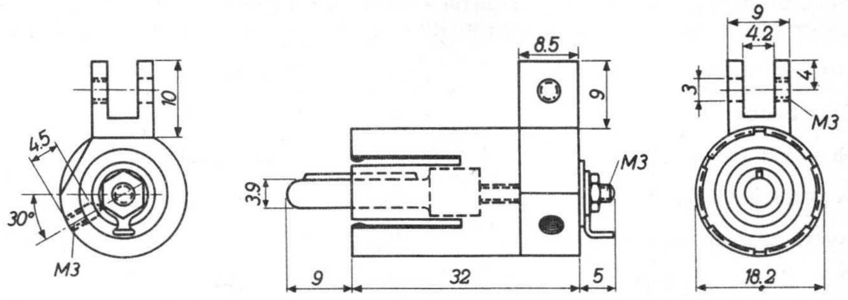
[1] [2] [3] See page 3

**MECHANICAL DATA** (continued) Dimensions in mm




Cathode connector 55356

## MAGNETRON OUTPUT

The magnetron output has been designed for coupling to the waveguide RG-96/U. To fasten the magnetron output to this waveguide, the coupling system Z830016 (American reference drawing number AS-2092) should be inserted between these parts. To facilitate this coupling the components Z830017 and Z830019 have been fixed permanently to the magnetron.

## COOLING

Under normal operating conditions cooling by a low velocity air flow is sufficient. If the anode temperature is kept below 150 °C no additional cooling of the input terminals will be required.

---

Page 2

1) Inscription of serial number

2) The axis of the common cathode-heater terminal is within a radius of 1.5 mm from the centre of the mounting plate. The eccentricity of the axis of the inner cylinder of the heater terminal with respect to the axis of the inner cylinder of the common cathode-heater terminal is max. 0.125 mm.

3) Centre of waveguide.

**LIMITING VALUES** (Absolute limits)

Each limiting value should be regarded independently of other values, so that under no circumstances it is permitted to exceed a limiting value whichsoever.

| | | | | | |
|---|---|---|---|---|---|
| Pulse duration | $T_{imp}$ | = max. | 0.4 | μs | |
| Duty factor | $\delta$ | = max. | 0.0003 | | |
| Heater starting voltage | $V_{f_o}$ | = max. | 5.5 | V | |
| Peak anode current | $I_{a_p}$ | = max. | 16 | A | |
| Average anode input power | $W_{i_a}$ | = max. | 60 | W | |
| Rate of rise of anode voltage at $T_{imp}$ = 0.1 or 0.3 μs | $\frac{\Delta V_a}{\Delta T_{r_v}}$ | = | 200 to 300 | kV/μs | [1] |
| Voltage standing wave ratio | VSWR | = max. | 1.5 | | |
| Anode block temperature | $t_a$ | = max. | 150 | °C | [2] |
| Seal temperature | $t_s$ | = max. | 150 | °C | |

**OPERATING CHARACTERISTICS**

| | | | | | |
|---|---|---|---|---|---|
| Heater voltage | $V_f$ [3] = | 4.0 [4] | 4.0 [4] | 5.0 | V |
| Pulse duration | $T_{imp}$ = | 0.3 | 0.1 | 0.02 | μs |
| Duty factor | $\delta$ = | 0.0002 | 0.0002 | 0.0001 | |
| Peak anode voltage | $V_{a_p}$ = | 11.5-13.5 | 11.5-13.5 | 11.5-13.5 | kV |
| Rate of rise of voltage | $\frac{\Delta V_a}{\Delta T_{r_v}}$ = | 250 | 250 | 600 | kV/μs |
| Average anode current | $I_a$ = | 2.5 | 2.5 | 1.55 | mA [5] |
| Peak anode current | $I_{a_p}$ = | 12.5 | 12.5 | 15.5 | A |
| Average output power | $W_o$ = | 8 | 8 | 3 | W |
| Peak output power | $W_{o_p}$ = | 40 | 40 | 30 | kW |

---

1) See pulse definitions page 6.

2) To be measured on the anode block between the second and the third cooling fin.

3) Tolerances of the heater voltage are +10% and −5% of the indicated values.

4) The heater voltage must be reduced from 5 V to the indicated value immediately after the application of the anode power.

5) Diode current suppressed by a suppressor voltage of about + 300 V on the cathode with respect to the anode

## MOUNTING

Mounting of the magnetron should be accomplished by means of its mounting flange. The tube should in no case be supported by the coupling to the waveguide output flange alone.

It is required to use non-magnetic tools during installation.

The opening in the output flange should be kept closed by the dust cover until the tube is mounted into the equipment.

Before putting the magnetron into operation, the user should make sure that the output waveguide is entirely clean and free from dust and moisture.

## PRESSURE

The magnetron need not be pressurized when operating at atmospheric pressure.

Operation at pressures lower than 45 cm of Hg may result in arcover with consequent damage to the tube.

The mounting flange and also the waveguide output flange are made so that the magnetron can be used in applications requiring a pressure seal. They can be maintained at a pressure up to 3.1 kg/cm$^2$ (45 lbs/sq. in.).

## LIFE

Magnetron life depends on the operating conditions and is expected to be longer at shorter pulse lengths.

## STARTING A NEW MAGNETRON

The magnetron is provided with a getter. Owing to this ageing of a new magnetron or of a magnetron that has been idle or stored for a period of time, will not be necessary in many cases. If, however, the magnetron is taken into operation and some sparking and instability occur incidentally it is recommended to raise gradually the anode voltage - starting at low values - and to operate the magnetron with reduced input during 15 to 30 minutes. After this period sparking usually ceases.

## CIRCUIT NOTES

a. The negative high voltage pulse should be applied to the common cathode-heater terminal.

b. If no load isolator is inserted between the magnetron and the transmission line, the latter should be as short as possible to prevent long-line effects. Under no circumstances should the magnetron be operated with a voltage standing wave ratio of the load exceeding 1.5. A ratio kept near unity will benefit tube life and reliability.

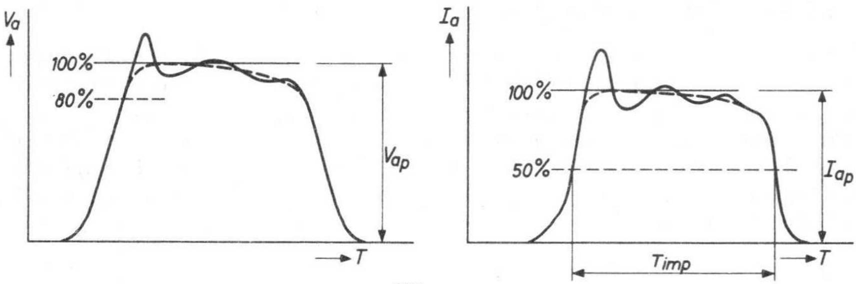
c. The modulator must be so designed that, if arcing occurs, the energy per pulse delivered to the magnetron does not considerably exceed the normal energy per pulse.

d. In order to prevent diode current from flowing during the interval between two pulses and to minimize unwanted noise during the region of the voltage pulse where the anode voltage has dropped below the value required to sustain oscillation, the trailing edge of the voltage pulse should be as steep as possible and the anode voltage should be prevented from becoming positive at any time in the interval between two pulses.

e. It is required to bypass the magnetron heater with a 1000 V rated capacitor of minimum 4000 pF directly across the heater terminals.

## PULSE CHARACTERISTICS AND DEFINITIONS

The smooth peak value (100%) of a pulse is the maximum value of a smooth curve through the average of the fluctuation over the top portion of the pulse as shown below




The rate of rise of anode voltage ($\frac{\Delta V}{\Delta T_{rv}}$) is defined by the steepest tangent to the leading edge of the voltage pulse above 80% of the smooth peak value. Any capacitance used in a removable viewing system shall not exceed 6 pF. For calculation of the rate of rise of anode voltage the smooth peak value must be taken as 12.5 kV.

## PULSE CHARACTERISTICS AND DEFINITIONS (continued)

The pulse duration ($T_{imp}$) is defined as the time interval between the two points on the current pulse at which the current is 50% of the smooth peak current.

The current pulse must be sensibly square and the ripple over the top portion of the current pulse must be as small as possible to avoid unwanted frequency modulation due to pushing effects.
The spike on the top portion of the pulse must be small to avoid excessive peak pulse current. The leading edge of the pulse must be free from irregularities.

## STORAGE, HANDLING

In handling the magnetron, it should never be held by the cathode assembly. Rough treatment of the metal envelope and of the cooling fins may impair the electrical characteristics or may result in loss of vacuum.

In storage a minimum distance of 15 cm (6 inches) should be maintained between the packaged magnetrons to prevent the decrease of field strength of the magnetron magnet due to the interaction with adjacent magnets. If the magnetrons are stored in their original wooden box, no special precautions need be taken with regard to the proper distance between magnets.
Magnetic materials should be kept away from the magnet a distance of at least 5 cm (2 inches) to avoid mechanical shocks to the magnet.


7Z01508/gjic
$V_f$(V)
0
1
2
3
4
5
6
7
0
10
20
30
40
50
60
$W_i$ (= δ x $I_{ap}$ x 12500)(W)

# PULSED MAGNETRON

Forced air-cooled packaged magnetrons intended for service as pulsed oscillator at a fixed frequency. They have been designed for operation at pulse durations of 1 $\mu$s down to 0.1 $\mu$s.

| QUICK REFERENCE DATA | | | |
|---|---|---|---|
| Type | Frequency band (MHz) | Peak output power (kW) | |
| | | $T_{imp}$ = 0.1 $\mu$s | $T_{imp}$ = 1 $\mu$s |
| 55029<br>55030<br>55031/02<br>55031/01<br>55032/02<br>55032/01 | 9405-9505<br>9345-9405<br>9260-9345<br>9168-9260<br>9085-9168<br>9003-9085 | $W_{o_p}$ 200 kW | $W_{o_p}$ 250 kW |
| Construction | | packaged | |

**HEATING**: indirect

| | | | | |
|---|---|---|---|---|
| Heater starting voltage | $V_f$ | = | 13.75 | V +10 % − 5 % |
| Heater current at $V_f$ = 13.75 V | $I_f$ | = | 3.0 to 3.75 | A |
| Heater surge current | $I_{fsurge_p}$ | = | max. 15 | A |
| Cold heater resistance | $R_{f_o}$ | > | 0.35 | Ω |
| Heating time before application of high tension ($V_f$ = 13.75 V) | $T_w$ | = | min. 4 | min |

It is necessary to reduce the heater voltage immediately after applying the high voltage. The reduced heater voltage is given under "Operating characteristics" and on page 7

**TYPICAL CHARACTERISTICS**

| | | | | |
|---|---|---|---|---|
| Peak anode voltage | $V_{a_p}$ | = | 20 to 23 | kV |
| Pulling figure at V.S.W.R. = 1.5 | $\Delta f_p$ | = 13 | < 17.5 | MHz |
| Pushing figure | $\frac{\Delta f}{\Delta I_{a_p}}$ | < | 0.25 | MHz per A |
| Negative temperature coefficient | $-\frac{\Delta f}{\Delta t}$ | < | 0.25 | MHz per °C |
| Anode to cathode capacitance | $C_{ak}$ | = | 14 | pF |

**LIMITING VALUES** (Absolute limits)

Each limiting value should be regarded independently of other values, so that under no circumstances it is permitted to exceed a limiting value whichsoever.

| | | | | | |
|---|---|---|---|---|---|
| Pulse duration | | $T_{imp}$ | = max. | 1 | μs |
| Duty factor | | $\delta$ | = max. | 0.001 | |
| Heater starting voltage | | $V_{f_o}$ | = max. | 15 | V |
| Heater surge current | | $I_{f\,surge_p}$ | = max. | 15 | A |
| Peak anode current | | $I_{a_p}$ | = max. | 27.5 | A |
| Average input power | | $W_i$ | = max. | 635 | W |
| Peak input power | | $W_{i_p}$ | = max. | 635 | kW |
| Rate of rise of voltage pulse [1] | | | | | |
| | for $T_{imp}$ = 1 μs | $\frac{\Delta V_a}{\Delta T_{rv}}$ | = max. | 110 | kV/μs |
| | | | = min. | 70 | kV/μs |
| | for $T_{imp}$ = 0.25 μs | $\frac{\Delta V_a}{\Delta T_{rv}}$ | = max. | 160 | kV/μs |
| | | | = min. | 120 | kV/μs |
| | for $T_{imp}$ = 0.1 μs | $\frac{\Delta V_a}{\Delta T_{rv}}$ | = max. | 220 | kV/μs |
| | | | = min. | 160 | kV/μs |
| Voltage standing wave ratio | | V.S.W.R. | = max. | 1.5 | |
| Anode temperature [2] | | $t_a$ | = max. | 150 | °C |
| Cathode-heater terminal temperature | | t | = max. | 165 | °C |
| Pressurization of input and output assemblies | | p | = max. | 45 | lbs/sq.in.abs. |
| | | | | ( 3.1 | $kg/cm^2$ ) |

Operation at pressures lower than 60 cm Hg may result in arc-over across the heater-cathode stem with consequent damage to the magnetron. The output assembly must always be pressurized. When the magnetron is not working into a matched load, the pressure on the output window must be higher than 1 $kg/cm^2$ (15 lbs/sq.in.).

---

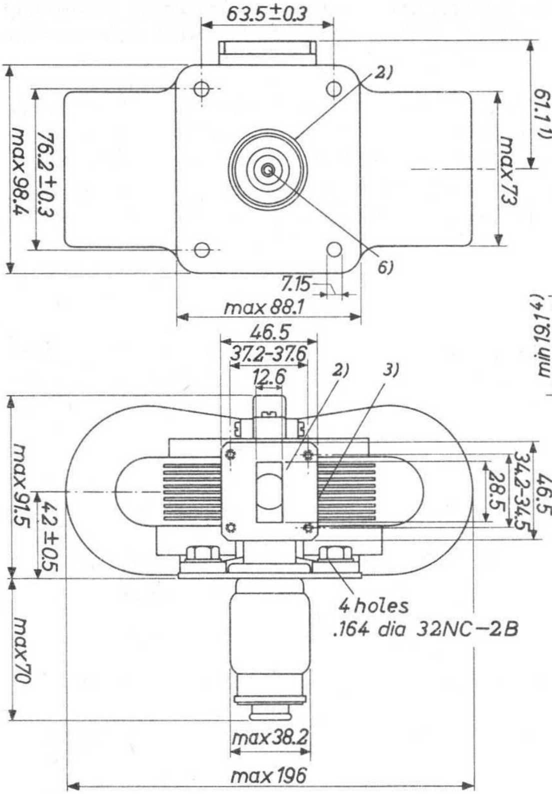
1) For the definition of the rate of rise of voltage pulse see under "Pulse definitions".

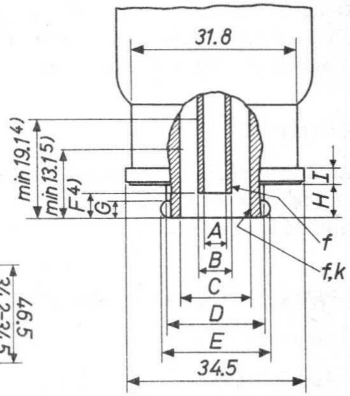
2) To be measured at the point specified on the outline drawing.

**MECHANICAL DATA**

Dimensions in mm

Net weight: 5 kg




| | |
|---|---|
| A | 4.17–4.42 |
| B | 5.95–6.75 |
| C | 13.51–13.84 |
| D | 19 |
| E | 20.95–21.29 |
| F | 3.17–4.75 |
| G | 3.17±0.25 |
| H | 6.35±0.25 |
| I | 3.17±0.25 |

Mounting position: any

[1]) This dimension applies to the magnetron types 55029, 55030 and 55031. The output system of the 55032 is 6 mm longer (67.1 mm)

[2]) Hermetic connections can be made to the mounting flange and the waveguide output flange

[3]) Anode temperature measuring point on the anode block in front of the cooling fins

[4]) These dimensions define the cylindrical part of the heater terminal

[5]) This dimension defines the cylindrical part of the common heater-cathode terminal

[6]) The axis of the common heater-cathode terminal is within a radius of 1.19 mm from the centre of the mounting plate.

**MECHANICAL DATA** (continued)

The waveguide output is designed for coupling to standard rectangular waveguide RG-51/U (E.I.A. designation WR112, British designation WG15) with outside dimensions 1 1/4 x 5/8".

To fasten the magnetron output flange to the RG-51/U waveguide, a choke flange Z83 00 33 (British designation) or type UG-52A/U should be inserted between these parts. This choke flange should be modified to fit the magnetron output flange. This is accomplished by reaming the four mounting holes in the above choke flange with a No.15 drill. The choke flange can then be fastened to the magnetron output flange by means of four size 8-32 bolts.

**COOLING**

An adequate air flow should be directed along the cooling fins towards the body of the tube to keep the anode block temperature below 150 °C under any condition of operation.

**OPERATING CHARACTERISTICS**

| | | | | | | |
|---|---|---|---|---|---|---|
| Frequency | | | see table page 1 | | | |
| Pulse duration | $T_{imp}$ | = | 0.1 | 0.25 | 1.0 | μs |
| Duty factor | $\delta$ | = | 0.0002 | 0.0005 | 0.001 | |
| Heater voltage [1] | $V_f$ | = | 12 | 9 | 6.5 | V |
| Peak anode voltage | $V_{a_p}$ | = | 21.5 ± 1.5 | 21.5 ± 1.5 | 21.5 ± 1.5 | kV |
| Rate of rise of voltage pulse [2] | $\frac{\Delta V_a}{\Delta T_{rv}}$ | = | 190 | 140 | 90 | kV/μs |
| Average anode current [3] | $I_a$ | = | 4.5 | 12 | 27.5 | mA |
| Peak anode current | $I_{a_p}$ | = | 22.5 | 24 | 27.5 | A |
| Average output power | $W_o$ | = | 41 | 110 | 250 | W |
| Peak output power | $W_{o_p}$ | = | 205 | 220 | 250 | kW |

The manufacturer should be consulted whenever it is considered to operate the magnetron at conditions substantially different from those given above.

[1]) The tolerance of the heater voltage is +10 and −5% of the indicated value. The heater voltage must be reduced from 13.75 V to the indicated value as soon as the magnetron starts oscillating.

[2]) For the definition of the rate of rise of voltage pulse see under "Pulse definitions".

[3]) See "Circuit notes"

## LIFE

The life of the magnetron depends on the operating conditions, and is expected to be longer at shorter pulse lengths.

## STARTING A NEW MAGNETRON

This magnetron is provided with a getter, so that aging (of a new magnetron or of a magnetron that has been idle or stored for a period of time) will not be necessary in most cases. If, however, the magnetron is put into operation and some sparking and instability occur incidentally, it is recommended to increase the anode current gradually and to operate the magnetron with reduced input during 15 to 30 minutes. After this period sparking usually ceases.

## CIRCUIT NOTES

a. In order to prevent heater burn-out the negative high-voltage pulse must be applied to the common cathode-heater terminal.

b. If no load isolator is inserted between the magnetron and the transmission line, the latter should be as short as possible to prevent long-line effects. Under no circumstances should the magnetron be operated with a V.S.W.R. of the load exceeding 1.5. A ratio kept near unity will benefit tube life and reliability.

c. The modulator must be so designed that, if arcing occurs, the energy per pulse delivered to the magnetron does not considerably exceed the normal energy per pulse.

d. It is required to bypass the magnetron heater with a 1000 V rated capacitor of min. 4000 pF directly across the heater terminals.

e. Any diode current flowing during the intervals between the pulses should be taken into account when the peak anode current is calculated from the measured average anode current.
The occurrence of this diode current can be avoided by preventing that during these intervals the anode voltage becomes positive with respect to the cathode. Modulators of the pulse forming network discharge type usually satisfy this requirement.

f. The unwanted noise that may occur when the anode pulse voltage drops below the value required for oscillation can be minimized by making the trailing edge of the voltage pulse as steep as possible.

## PULSE CHARACTERISTICS AND DEFINITIONS

The smooth peak value ($V_{ap}$ or $I_{ap}$) of a pulse is the maximum value of a smooth curve through the average of the fluctuation over the top portion of the pulse as shown in the figures below.

The rate of rise of anode voltage is defined by the steepest tangent to the leading edge of the voltage pulse above 80% of the smooth peak value (fig.1). Any capacitance used in a removable viewing system shall not exceed 6 pF. For calculation of the rate of rise of anode voltage the 100% value must be taken as 21.5 kV.

The pulse duration ($T_{imp}$) is the time interval between the two points on the current pulse at which the current is 50% of the smooth peak current (fig.2).

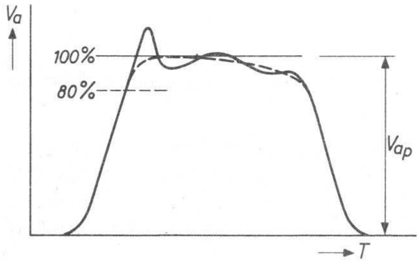



Fig. 1

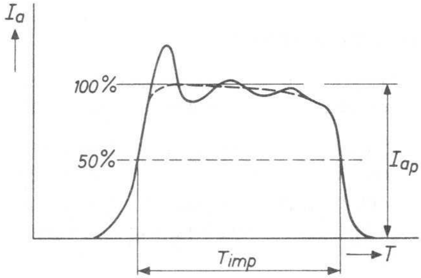



Fig.2

## STORAGE, HANDLING AND MOUNTING

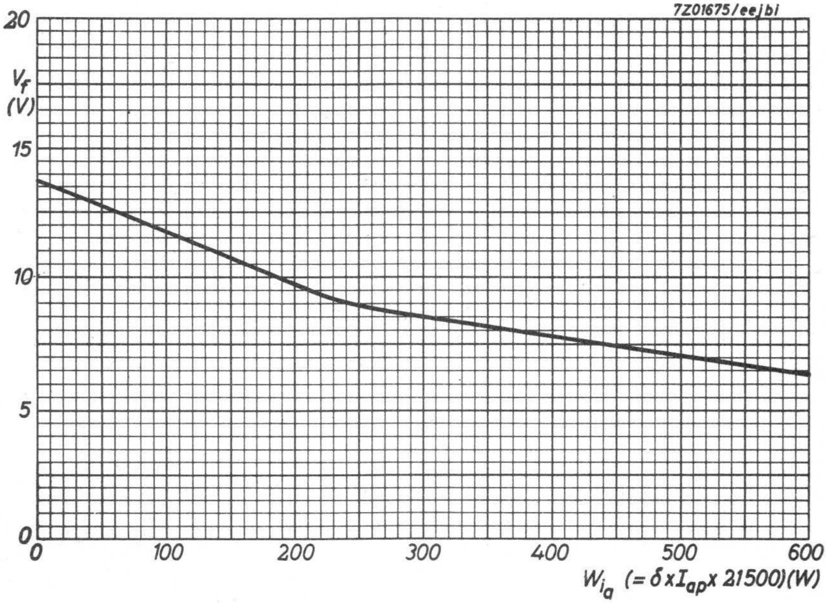
In handling the magnetron, it should never be held by the heater-cathode stem. Rough treatment of the metal envelope and of the cooling fins may impair the electrical characteristics or may result in loss of vacuum.

In storage a minimum distance of 15 cm (6") should be maintained between the packaged magnetrons to prevent the decrease of field strength of the magnetron magnet due to the interaction with adjacent magnets.

Magnetic materials should be kept away from the magnet a distance of at least 5 cm (2") to avoid mechanical shocks to the magnet. For this reason it is required to use non-magnetic tools during installation.

All tubes are delivered with a dust cover placed on the waveguide output flange. It is recommended to keep the opening in the flange closed by this dust cover until the tube is mounted into the equipment. Before putting the magnetron into operation, the user should make sure that the output waveguide is entirely clean and free from dust and moisture.

Mounting of the magnetron should be accomplished by means of its mounting flange. The tube should in no case be supported by the coupling to the waveguide output flange alone.


7Z01675/eejbi
20
$V_f$
(V)
15
10
5
0
0
100
200
300
400
500
600
$W_{i_a}$ (= $\delta$ x $I_{ap}$ x 21500)(W)

# Magnetrons for micro-wave heating

# MAGNETRONS FOR MICROWAVE HEATING

ABRIDGED SURVEY

| Frequency (MHz) | Output power (kW) | Type |
|---|---|---|
| 2450 ± 25 | 0.2 | 7090 |
| 2450 ± 25 | 1.5 | YJ1280 |
| 2450 ± 25 | 2.5 | YJ1160 |
| 2450 ± 25 | 2.5 | YJ1162 |
| 2450 ± 25 | 5 | YJ1191 |

# CONTINUOUS-WAVE MAGNETRON

Continuous-wave air-cooled packaged magnetron intended for microwave heating applications.

| QUICK REFERENCE DATA | | | |
|---|---|---|---|
| Frequency, fixed within the band | f | 2.425 to 2.475 | GHz |
| Output power | $W_o$ | 1.2 | kW |
| Construction | packaged | | |
| Anode supply | unfiltered single-phase full-wave rectification | | |

**CATHODE:** Thoriated tungsten

**HEATING:** direct by A.C. (50 or 60 Hz) or D.C.

| | | | | |
|---|---|---|---|---|
| Filament voltage, starting and operating | $V_f$ | | 4.0 | V +5 % −10 % |
| stand-by 1) | $V_f$ | | 4.0 | V +5 % −10 % |
| Filament current at $V_f$ = 4.0 V ($V_a$ = 0 V) | $I_f$ | approx. | 30 | A |
| | | max. | 35 | A |

The filament current should never exceed a peak value of 70 A when applying the filament voltage. The cold filament resistance is approximately 0.018 Ω.

| | | | | |
|---|---|---|---|---|
| Heating time before application of high voltage (waiting time) | $T_w$ | min. | 10 | s |

1) Stand-by operation is strongly recommended for proffessional applications where frequent switching of the tube occurs.

## MECHANICAL DATA

Mounting position

Axis of cathode (filament) vertical (see outline drawing)

Output coupling

The tube may be coupled by suitable means to either waveguide, coaxial line, or directly into a cavity. Recommendations for broadband coupling to a waveguide can be obtained from the manufacturer.

Dimensions

See outline drawing

Weight

| | |
|---|---|
| Net weight | approx. 4.2 kg |

Accessories

| | | |
|---|---|---|
| Filament/cathode connector 1) | | type 55325 |
| Filament connector 1) | | type 55325 |
| Thermoswitch for 4.5 A | | type S-32997 |
| for 25 A | | type S-330923 |
| R.F. gasket; supplied with the tube | | type S-330109 |
| Coaxial adaptor | for coupling of the tube to 16/39 coaxial line (characteristic impedance 53.4 Ω) | see fig.5 |
| Cap nut | | type 55312 |
| Spring ring | | type 55313 |
| Coupling adaptor, for measurement purposes only 2) | | type S-32990 3) |

1) See operating notes (input coupling)

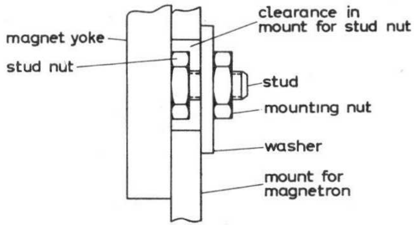
2) See operating notes (load impedance)

3) The coupling adaptor is used to determine the load impedance with reference to the published load diagram for the tube.

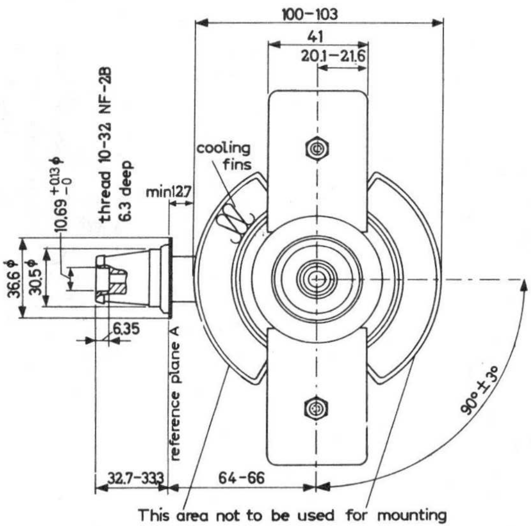
**MECHANICAL DATA** (continued)

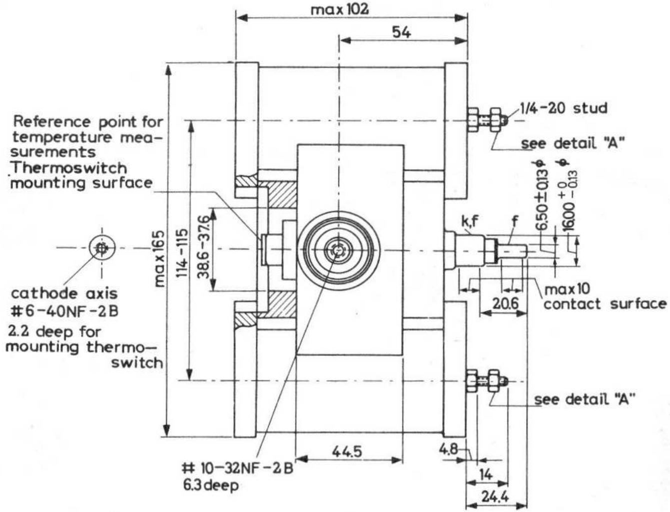
Outline drawing

Dimensions in mm



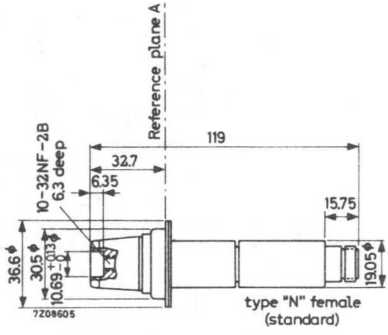

Detail "A"



ACCESSORIES

Dimensions in mm



Coupling adaptor S-32990

Fig. 1

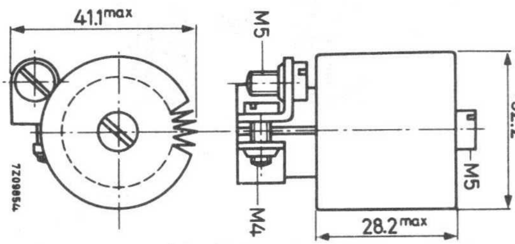
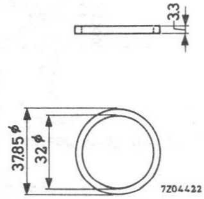



Fig.2

Filament and Filament/cathode connector 55325

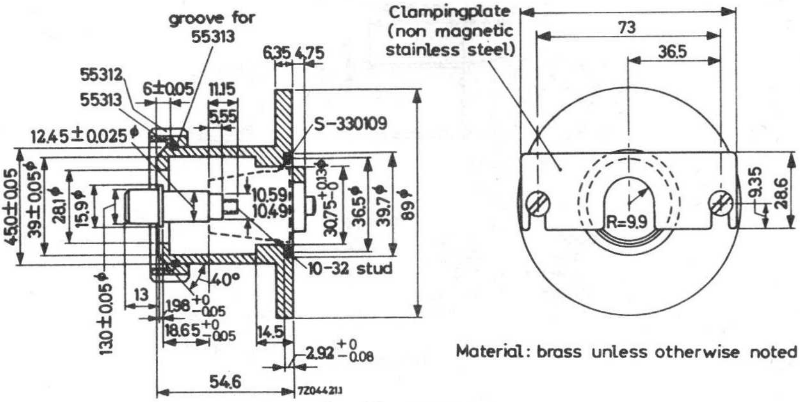


Material: monel mesh

RF gasket S-330109

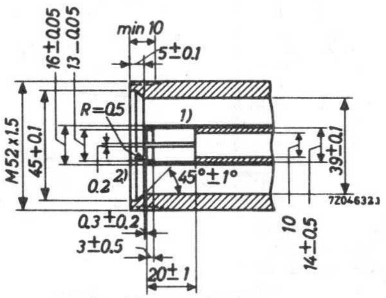
Fig.3

Accessories for coupling to 16/39 coaxial line (characteristic impedance 53.4 Ω)




Coaxial adaptor

fig. 4




Coaxial connector

fig. 5

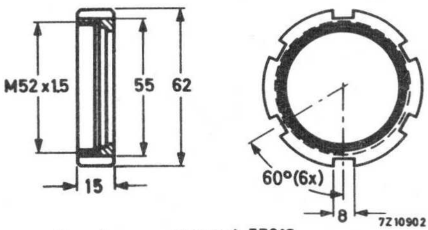
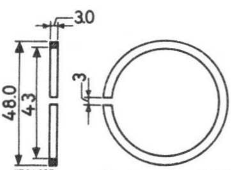



fig. 6 cap nut 55312



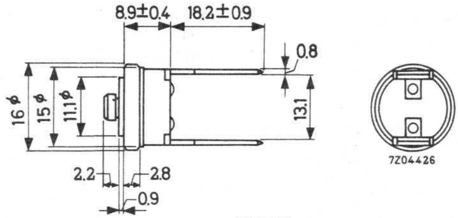

Spring ring 55313

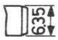
fig. 7

1) The inner conductor must be movable to accept the tolerances of the inner conductor screwed onto the tube.

2) Six slots 0.2 mm. The wall segments should be deburred and be pressed together after slotting.

Thermoswitches

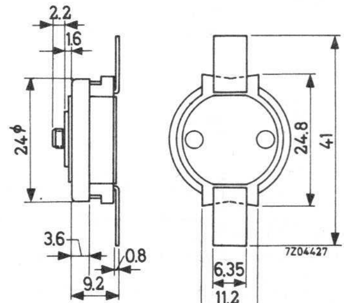



open 177°C
close 150°C
current max. 4.5A
voltage max. 240 $V_{a.c.}$

Thermoswitch S-32997

fig. 8




open 177°C
close 150°C
current max. 25A
voltage max. 240 $V_{a.c.}$

Thermoswitch S-330923

fig. 9

## TYPICAL CHARACTERISTICS

| | | | |
|---|---|---|---|
| Frequency, fixed within the band | $f$ | 2.425 to 2.475 | GHz [1] |
| Anode voltage at $I_{a\ mean}$ = 380 mA [2] | $V_a$ | 5.4 to 5.8 | kV [1][3] |

## LIMITING VALUES (Absolute max. rating system)

| | | | | | |
|---|---|---|---|---|---|
| Anode current, mean | $I_a$ | max. | 410 | mA | |
| | | min. | 100 | mA | |
| peak at $I_{a\ mean}$ = 380 mA [2] | $I_{ap}$ | min. | 600 | mA | |
| peak | $I_{ap}$ | max. | 1.3 | A | |
| Anode voltage, positive and negative | $\pm V_a$ | max. | 10 | kV | |
| Voltage standing wave ratio (determined with adaptor S-32990), | | | | | |
| continuous | V.S.W.R. | max. | 4 | | |
| intermittent (T = max. 0.02 s max. 20% of the time) | V.S.W.R. | max. | 10 | | [4] |
| Filament input terminal temperature at hottest point (including adjoining ceramic) | $t$ | max. | 250 | $^{o}$C | |
| Anode temperature at point indicated on outline drawing | $t_a$ | max. | 180 | $^{o}$C | |
| Temperature at any other point on tube | $t$ | max. | 200 | $^{o}$C | |

[1]) Measured at matched load (V.S.W.R. < 1.1)

[2]) Measured with moving coil instrument.

[3]) Anode voltage measured with d.c.
Although the anode voltage is measured under d.c. conditions it is not permitted to operate the tube in this manner.

[4]) The average reflected power for any one second period must not exceed the reflected power equivalent to a V.S.W.R. of 4. When operating under these conditions, the tube should not be permitted to mode.

## OPERATING CHARACTERISTICS

See "Operating notes" for load impedance definition and anode supply recommendations.

| | | | |
|---|---|---|---|
| Filament voltage | $V_f$ | 4.0 | V |
| Anode current, mean [1] | $I_a$ | 380 | mA |
| peak | $I_{ap}$ | 1.1 | A |
| Output power at matched load conditions | $W_o$ | 1.2 | kW [2] |
| Frequency | f | 2.425 to 2.475 | GHz |

## COOLING

| | | |
|---|---|---|
| Anode block | forced air | |
| Filament terminal structure | forced air | |
| Inlet air, typical | | |
| Temperature | 25 | $^oC$ |
| Quantity | 1.2 | $m^3$/min. |
| Pressure drop | 10 | mm $H_2O$ |

It is recommended that a duct be used which closely fits the cooling fin shell. Part of the air used for anode block cooling can be used for cooling the input terminals.

The use of a thermoswitch to be mounted on the anode shell at the point indicated is desirable for protection of the magnetron against overheating.
At stand-by with $V_f$ = 3.0 V no forced-air cooling is necessary.

[1] Measured with moving coil instrument.

[2] Minimum output 1.13 kW.

## OPERATING NOTES

### Anode supply

The magnetron should be operated from an unfiltered anode supply with single-phase full-wave rectification.

The anode voltage must be adjusted to provide the desired anode current level and the use of a current regulating device is strongly urged.

The anode supply unit should be designed so that for any operating condition no limiting value for the mean and peak anode current can be exceeded.

### Anode cooling

The magnetron anode is surrounded with a radiator which should be cooled with forced air. The air flow should be ducted to the radiator for efficient cooling and should be of sufficient volume to insure that the maximum anode temperature is not exceeded.

### Input cooling

Because of the high filament current required for the magnetron, it is important that the input connections make good electrical and mechanical contact with the magnetron input terminals. This will prevent the contribution of a resistive heating loss to the temperature of the input connectors. This resistance may cause a lower actual filament voltage and result in poor magnetron operation. Therefore, spring type or set screw type connectors should not be used. The input connector type 55325 is designed to give the required electrical and mechanical contact and will also aid in cooling the input of the magnetron. Connectors of this design or a similar clamping type design should be used to make the input connections to the magnetron.

Some of the anode cooling air should be directed on the input connections in order to cool them. A simple way to do this is to mount the tube with the input terminals within the inlet air duct for the anode cooling system.

The electrical conductor to the cathode and filament terminals should be of flexible construction in order to eliminate undue stress on the input terminals.

To prevent oxidation of the input contacts a high temperature-resistant silicon grease must be used.

### Load impedance

The load impedance for the magnetron is defined with respect to the coupling adaptor S-32990. This adaptor is coupled to the load in place of the magnetron. In both cases the gasket S-330109 should be used.
Using standard measuring techniques, the impedance of the load at the input to the coupling adaptor is determined. The reference plane for the impedance measurements and the load diagram is shown as reference plane A on the outline drawing. The equivalent to reference plane A can be found on the slotted line if the coupling adaptor is short circuited at reference plane A by suitable means.

The use of this coupling adaptor provides a rapid and accurate method for determining the value of the tube load impedance. It enables the designer of microwave heating equipment to easily arrive at the proper coupling conditions for the magnetron.

Method of coupling to coaxial line

If the magnetron output system is to be coupled to a 16/39 coaxial line (characteristic impedance 53.4 Ω) the coaxial adaptor as shown in fig.4 may be used. The inner conductor of the coaxial line should be flexible enough so that no strain will be placed on the output system. In addition, the connection should assure a reliable R.F. contact with the inner conductor part of the coaxial adaptor. A suitable coaxial line is shown in fig.5.

Shielding

Where required, R.F. radiation from the filament terminals may be reduced by external filtering and/or shielding. Detailed information may be readily obtained from the manufacturer.

Tube cleanliness

The ceramic parts of the tube must be kept clean during operation. A protective cover of suitable dielectric material should be placed over the tube output, if the tube is directly inserted into a cavity.

## STORAGE, HANDLING AND MOUNTING

High intensity magnetic fields associated with transformers and other magnetic equipment can demagnetize the DX206 magnets. These fields should be avoided when storing, handling, and maintaining the tube.

The user should be aware of the strong magnetic field around the magnet. When handling and mounting the magnetron, it is essential to use non-magnetic tools and to be extremely careful of watches and other precision instruments nearby. When handling and storing unpacked magnetrons, a minimum distance of 15 cm should be maintained between magnets.

When the magnetron is installed in equipment, the following should be observed:
For magnetic materials in planes parallel to the output system, a minimum distance of 10 cm must be maintained between these materials and the magnet. (Distances measured perpendicular to centre line of output system.)
For magnetic materials in planes perpendicular to the centre line of the output system a minimum distance of 13 cm must be maintained between magnetic materials and the magnet (distances measured parallel to centre line of output system). When magnetic materials are present in two or more planes, the minimum distance is 13 cm in all directions. In addition, stray magnetic fields at the tube due to transformers or inductances should be less than 1500 amp-turns.

In order to assure a good R.F. contact between the output of the tube and the circuit in which it is connected the use of the gasket S-330109 is essential. The gasket should be used as shown in fig.4

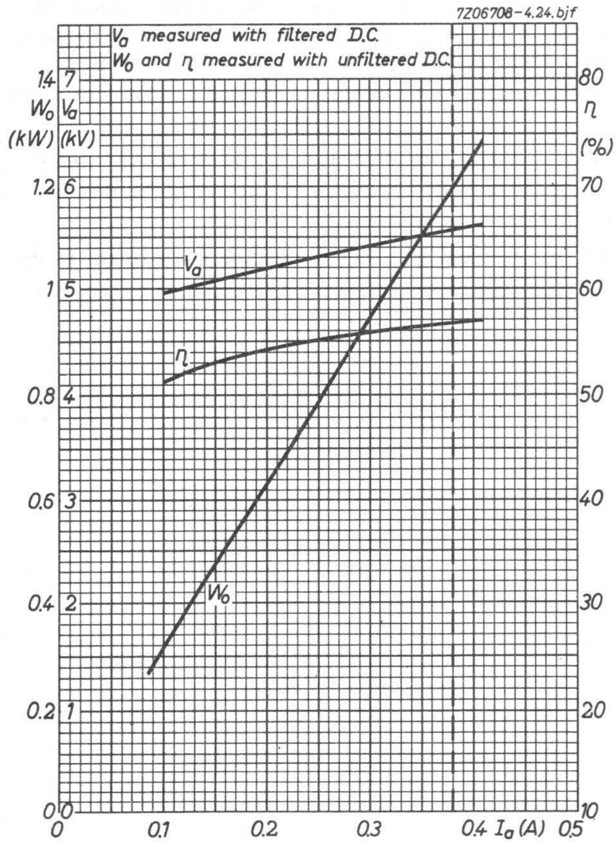
The tube should be supported by the yoke of the magnet when it is mounted and secured by the two studs provided for this purpose. The mounting should be sufficiently flexible and adjustable so that no strain is placed on the output system when the mounting nuts are tightened.

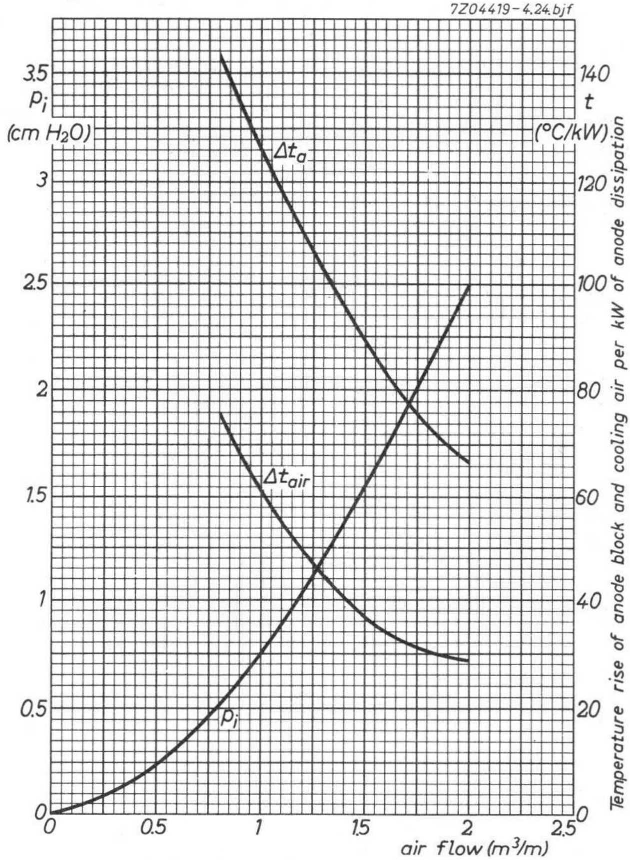
When mounting the magnetron, do not loosen the stud nut which holds the magnet system together. This can cause a demagnetization of the magnet which will degrade tube performance. For the purpose of mounting a second nut is provided and a recommended mounting procedure is shown in detail A of the outline drawing.

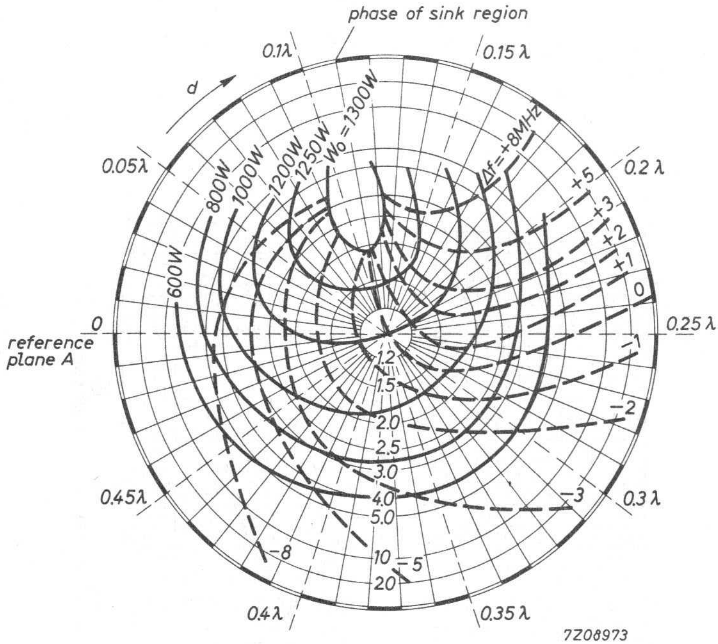
The output coupling shown in fig.4 is designed to obtain reliable R.F. contact and should not be used as the only means of mounting the magnetron. Neither should the radiator system be used for mounting.

The anode connection to the power supply shall be made to the mounting studs.

The original packing should be used for storing and transporting the tube.


7Z06708-4.24.bjf
$V_a$ measured with filtered D.C.
$W_o$ and $\eta$ measured with unfiltered D.C.
1.4 7
$W_o$ $V_a$
(kW) (kV)
1.2 6
1 5
0.8 4
0.6 3
0.4 2
0.2 1
0 0
80
$\eta$
(%)
70
60
50
40
30
20
10
$V_a$
$\eta$
$W_o$
0
0.1
0.2
0.3
0.4 $I_a$ (A) 0.5


7Z04419-4.24.bjf
3.5
$p_i$
(cm $H_2O$)
3
2.5
2
1.5
1
0.5
0
140
t
(°C/kW)
120
100
80
60
40
20
0
$\Delta t_a$
$\Delta t_{air}$
$p_i$
0
0.5
1
1.5
2
2.5
air flow ($m^3/m$)
Temperature rise of anode block and cooling air per kW of anode dissipation

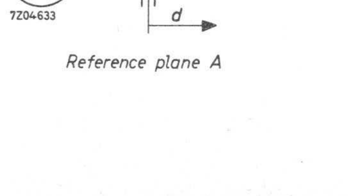



Load diagram

| | | |
|---|---|---|
| frequency | f | 2.45 GHz |
| mean anode current | $I_a$ | 380 mA |
| peak anode current | $I_{ap}$ | 1.1 A |

unfiltered rectified anode supply

d = distance of voltage standing wave minimum from reference plane A towards load.

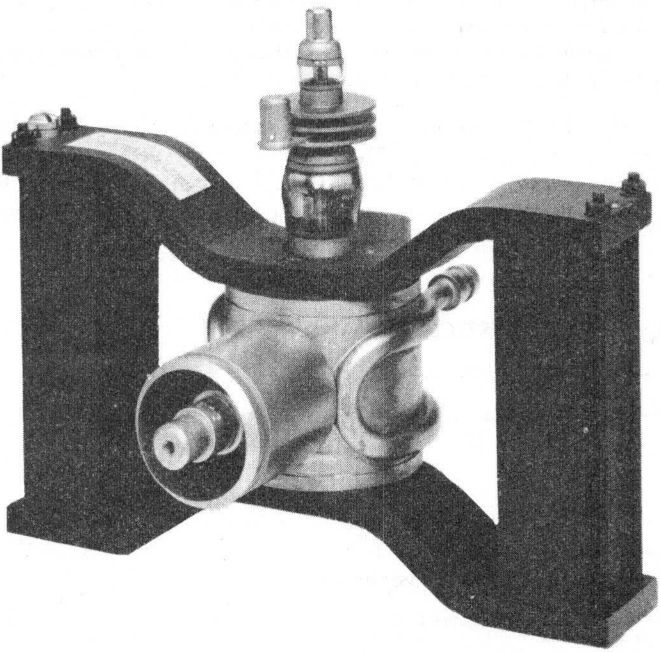



Reference plane A

# CONTINUOUS-WAVE MAGNETRON

Continuous-wave water-cooled packaged magnetron intended for microwave heating applications. It can produce up to 2.5 kW under various typical operating conditions.

| QUICK REFERENCE DATA | | |
|---|---|---|
| Frequency, fixed within the band | f | 2.425 to 2.475 GHz |
| Output power | $W_o$ | 2.0 or 2.5 kW |
| Construction | | packaged |
| Anode supply | | unfiltered single-phase full-wave or three-phase half-wave rectification |


RZ30269-9

**CATHODE:** Dispenser type

**HEATING:** Indirect by A.C. (50 to 60 Hz) or D.C.

| | | | |
|---|---|---|---|
| Heater voltage, starting | $V_{f_o}$ | 5.0 | V $^{+5\%}_{-10\%}$ |
| Heater voltage, stand-by (see operating notes) | $V_f$ | 4.8 | V $^{+5\%}_{-10\%}$ |
| Heater current at $V_f$ = 5.0 V | $I_f$ | approx. 35<br>max. 38 | A<br>A |

The heater current should never exceed a peak value of 140 A when applying the heater voltage. The cold heater resistance is approx. 0.02 Ω.

| | | | | |
|---|---|---|---|---|
| Heating time before application of high voltage (waiting time) at $V_f$ = 5.0 V | $T_w$ | min. | 120 | s |

Immediately after applying the anode voltage the heater voltage must be reduced as a function of the anode current according to the diagram on page 14. The life of the magnetron will be greatest if the heater voltage is reduced to a value given by the fully drawn line a. The heater voltage should be adjusted within +5 and −10% as given by the dashed lines which border the hatched area.
If it is intended to design the equipment for a predetermined number of steps of output power level, the reduced heater voltage for each step must be set to a value within the area bordered by the lines b and c, and preferably within or close to the hatched area. In no circumstances should the heater voltage reach a value outside the limits given by the curves b and c.

The limits $V_f$ = 5.0 V −10% and $T_w$ = 120 s should not be used simultaneously. With $V_f$ below the nominal value, $T_w$ should be increased in linear proportion up to min. 180 s at $V_f$ = 5.0 V −10%. It is also possible to preheat the tube at stand-by conditions if the waiting time is extended to at least 10 minutes.

**TYPICAL CHARACTERISTICS**

| | | | |
|---|---|---|---|
| Frequency, fixed within the band | f | 2.425 to 2.475 | GHz [3] |
| Anode voltage at $I_{a\,mean}$ = 750 mA [1] | $V_a$ | 4.45 to 4.85 | kV [2][3] |

[1]) Measured with moving coil instrument.

[2]) Anode voltage measured with d.c.

[3]) Measured at matched load (V.S.W.R. < 1.05).

## LIMITING VALUES AND OPERATING CHARACTERISTICS

The anode supply unit should be designed so that for any operation condition no limiting value for the mean and peak anode current will be exceeded.
The anode voltage should be obtained from a single-phase full-wave or three-phase half wave rectifier without smoothing filter. (see also operating notes).

### A. OPERATION WITH Wo = 2.0 kW (Load diagram see page 17)

Limiting values (Absolute max. rating system)

| | | | | |
|---|---|---|---|---|
| Anode current, mean 1) | $I_a$ | max. | 0.8 | A |
| | | min. | 0.1 | A |
| peak | $I_{a_p}$ | max. | 2.1 | A |
| Voltage standing-wave ratio | | | | |
| at $0.37\,\lambda < d < 0.44\lambda$ | V.S.W.R. | max. | 4.0 | |
| remaining region | V.S.W.R. | max. | 5.0 | |

Typical operation (into a matched load.)

| | | | |
|---|---|---|---|
| Heater voltage, running | $V_f$ | 2.0 | V |
| Anode current, mean 1) | $I_a$ | 0.75 | A |
| peak | $I_{a_p}$ | 2.0 | A |
| Anode voltage 2) | $V_a$ | 4.75 | kV |
| Output power | $W_o$ | 2.0 | kW 3) |
| Efficiency | $\eta$ | 55 | % |

1) Measured with moving coil instrument.

2) Anode voltage measured with d.c.

3) Minimum output 1.85 kW.

## B. OPERATION WITH Wo = 2.5 kW (Load diagram see page 18)

A fixed reflection element with a V.S.W.R. of 1.5 and a phase position of 0.41 λ should be inserted between magnetron and load. (Example see output coupling)

Limiting values (Absolute max. rating system)

| | | | | |
|---|---|---|---|---|
| Anode current, mean [1] | $I_a$ | max. | 0.9 | A |
| | | min. | 0.1 | A |
| peak | $I_{ap}$ | max. | 2.1 | A |
| Voltage standing-wave ratio [4] | | | | |
| at $0.37\,\lambda < d < 0.44\,\lambda$ | V.S.W.R. | max. | 2.5 | |
| remaining region | V.S.W.R. | max. | 4.0 | |

Typical operation (into a matched load.) [4]

| | | | | |
|---|---|---|---|---|
| Heater voltage, running | $V_f$ | | 1.5 | V |
| Anode current, mean [1] | $I_a$ | | 0.85 | A |
| peak | $I_{ap}$ | | 2.0 | A |
| Anode voltage [2] | $V_a$ | | 4.8 | kV |
| Output power | $W_o$ | | 2.5 | kW [3] |
| Efficiency | $\eta$ | approx. | 60 | % |

1) Measured with moving coil instrument.

2) Anode voltage measured with d.c.

3) Minimum output 2.3 kW.

4) With respect to reference plane B of fixed reflection element.

## C. OPERATION WITH Wo = 2.5 kW FOR MICROWAVE OVENS

(Load diagram see page 19). The average V.S.W.R. should be 3 at d = 0.41 λ.

Limiting values (Absolute max. rating system)

| | | | | |
|---|---|---|---|---|
| Anode current, mean [1] | $I_a$ | max. | 0.85 | A |
| | | min. | 0.1 | A |
| peak | $I_{a_p}$ | max. | 2.1 | A |
| Voltage standing-wave ratio | | | | |
| at 0.30 λ < d < 0.50 λ | V.S.W.R. | max. | 4.0 | |
| intermittent (T = max. 0.02 s max. 20% of the time) | V.S.W.R. | max. | 10 | [4] |
| remaining phase region | V.S.W.R. | max. | 4.0 | |

Typical operation

| | | | | |
|---|---|---|---|---|
| Heater voltage | $V_f$ | | 1.8 | V |
| Anode current, mean [1] | $I_a$ | | 0.80 | A |
| peak | $I_{a_p}$ | | 2.0 | A |
| Anode voltage [2][5] | $V_a$ | | 4.95 | kV |
| Voltage standing-wave ratio, average | | | | |
| at 0.30 λ < d < 0.50 λ | V.S.W.R. | | 3 | |
| Output power | $W_o$ | | 2.5 | kW [3] |
| Efficiency | $\eta$ | approx. | 60 | % |

[1] Measured with moving coil instrument.

[2] Anode voltage measured with d.c.

[3] Minimum output 2.3 kW.

[4] The average reflected power for any one-second period must not exceed the reflected power equivalent to a V.S.W.R. of 4. When operating under these conditions, the tube should not be permitted to mode.

[5] Measured at V.S.W.R.≐3 and d = 0.41 λ.

## COOLING

| | |
|---|---|
| Anode block | water |
| Required quantity of water | see page 15 |
| Cathode radiator, via airduct | low-velocity air-flow (> 0.2 $m^3$/min) |

## TEMPERATURE LIMITS (Absolute max. rating system)

(See also operating notes)

| | | | | |
|---|---|---|---|---|
| Anode temperature at reference point for temperature measurement | $t_a$ | max. | 125 | °C |
| Cathode radiator temperature | | max. | 180 | °C |

To safeguard the magnetron from overheating if the cooling fails, provision is made for mounting a thermoswitch. This switch should become operative at a temperature of 120 °C to 125 °C at the mounting plate.

## MECHANICAL DATA

Weight

| | | | |
|---|---|---|---|
| Net weight | approx. | 5.1 | kg |

Accessories

| | | |
|---|---|---|
| Cap nut | type | 55312 |
| Spring ring | type | 55313 |
| Heater connector | type | 40634 |
| Heater/cathode connector | type | 40649 |

Mounting position: any

## DESIGN AND OPERATING NOTES

### GENERAL DESIGN CONSIDERATIONS

The equipment should be designed around the tube specifications given in these data sheets and not around one particular tube since due to normal production variations the design parameters ($V_a$, $R_{f_0}$, f, $W_o$ etc.) will vary around the nominal values given.

### ANODE SUPPLY

The magnetron should be operated from an unfiltered single-phase full-wave or three-phase half-wave supply. Operation with filtered d.c. is possible but will result in lower output power due to lower input power and a decrease in efficiency. The manufacturer should be consulted if operation with d.c. or other supply schemes, e.g. mains frequencies other than 50 or 60 Hz, not published in these data is considered.

In order to achieve constant output power and to avoid exceeding the limiting values of mean anode current a current regulating device such as a saturable core reactor is recommended.

In order to keep the peak anode current below its limits it will be necessary to incorporate either a limiting resistance or reactance in the power supply.

### HEATER SUPPLY

The primary of the heater transformer must be high voltage isolated from the secondary since in normal magnetron operation the cathode will be at high negative potential and the anode should be grounded.
The transformer should be designed so that the heater voltage limits are adhered to.

### STAND-BY OPERATION

In order to avoid the time-consuming warm-up period of the heater of 2-3 minutes when frequent switching of the tube is intended, the heater should be switched back to stand-by conditions after the oscillation period instead of being switched off completely. The tube then remains ready for instantaneous operation. This also serves to increase life of the tube.

### COOLING

Overheating may seriously damage the tube. Therefore water must be supplied according to the cooling data diagram so that for the highest expected inlet temperature of the water adequate cooling of the tube will be guaranteed.
A closed-circuit cooling system can be used in order to save water and to become independent from a water tap.
Information on such a system is available on request.

Cooling of the cathode radiator must be assured by directing a moderate stream of air to the three disc-like cooling elements of the cathode structure.

In case of failure of the cooling system power should be switched off by means of a thermoswitch which can be mounted on a plate provided for this purpose (see outline drawing). In specifying the thermoswitch operating temperature the temperature drop across the thermoswitch holder should be taken into account with respect to the temperature limit. Information on suitable thermoswitches will be supplied upon request.

STABILITY OF OPERATING MODE (see also "operational checks")

Oscillation stability may be affected particularly by excessive microwave power reflections from the load, excessive peak anode currents, over- or underheating of the cathode, and by magnetic field changes. The resulting instability is referred to as "moding" of the tube and may lead to rapid failure. It should be a major design objective to keep the V.S.W.R. below the maximum limits for all possible load conditions. This problem is of particular importance in microwave ovens with their great variety of products to be heated. Further information concerning measures designed to avoid moding under various load conditions in specific equipment is available upon request.

MAGNETIC FIELD

When designing a power-pack and cabinet around the tube the influence of

1. ferromagnetic parts and
2. magnetically active components

on the magnetic field of the tube must be considered.

This is especially important when a very compact design (microwave oven) is desirable.

1. The following minimum distances must be maintained between the magnet and ferromagnetic parts (e.g. cavity or cabinet walls)

| | | |
|---|---|---|
| direction a - min. 80 mm | ) | |
| direction b - min. 100 mm | ) | see outline drawing |
| direction c - min. 130 mm | ) | |

The simultaneous use of these minimum distances in two or three directions is not admissible.

2. Transformers and reactors incorporate rather large volumes of iron so that the limits mentioned under 1. apply. In addition they generate stray electro magnetic fields while in operation.

To limit changes of the magnetic field as far as possible the following measures are advised.

1. Use of non-magnetic stainless steel, aluminium or non-metallic plates for the cabinet walls.
2. Use of non-magnetic stainless steel, aluminium or brass for the cavity resonator or microwave circuit components near the tube.
3. Location of transformers and reactors as far as possible from the magnetron.

If two or more tubes shall be operated close to each other the tube manufacturer should be consulted with regard to be applicable limits.

## COUPLING TO COAXIAL LINE OR WAVEGUIDE

The magnetron has a coaxial output coupling. In the section "output coupling", a dimensional drawing is given of a coaxial line which can be coupled to the magnetron.

If coupling directly to a waveguide is desired, the inner conductor of the output coupling can be extended by an antenna. The outer conductor can then be screwed to its ring-shaped counterpart that normally is soldered to the waveguide wall. Dimensional drawings of such a coaxial-to-waveguide transition can be supplied upon request.
It is advised that antennas be gold-plated to ensure best contact and to facilitate loosening when the magnetron needs to be replaced.

## FIXED REFLECTION ELEMENTS

For operation B a fixed reflection element must be joined to the magnetron output coupling. The shorter of the two elements drawn in this publication allows a more compact design. The longer of the two elements is of a simpler all-metal construction and does not comprise a teflon ring susceptible to temperature variations.

For operation C such an element may also be used when the overall mismatch of the cavity is not higher than a V.S.W.R. of approx. 2 in the phase-of-sink region. This serves to move the operating point of the tube to a region of more efficient operation.

RF SHIELDING

Where required, R.F. radiation from the filament terminals may be reduced by external filtering and/or shielding. Two holes with thread M5 are provided for mounting a filter. Detailed information may be readily obtained from the manufacturer.

SUPPORT

In the equipment the tube should be mounted by fastening the magnet yoke to a supporting structure. Two holes with thread M6 are provided in each yoke for this purpose. Adjusting possibilities must be allowed so that the output coupling of the tube can be fitted to the coaxial line or waveguide without exerting mechanical strain. This is especially important for the replacement procedure in the field.

The tube should never be supported by the output coupling alone.

## HANDLING, STORAGE, MOUNTING, AND OPERATIONAL CHECKS

HANDLING AND STORAGE

The original packing should be used for transporting and storing the tube. Shipment of the tube mounted in the equipment is not permitted unless specifically authorized by the tube manufacturer.

The strong magnetic field necessary for the operation of the tube must not be weakened permanently. Therefore the tube should never be placed directly on any piece of ferromagnetic material (steel shelfs etc.). The best protection for the tube is its original packing. When the tubes have to be unpacked, e.g. at an assembly line or for measuring purposes, care should be taken that the tubes are not placed closer to each other than they would be placed when still packed.

Watches and sensitive measuring instruments may be influenced and damaged by exposure to the magnetic field.

The RF output coupling should be kept carefully clean, since foreign matter, especially metal particles inside the coaxial line and dirt on the ceramic insulator may cause electrical breakdown during high-power operation. Cleanliness should be checked and the coupling cleaned if necessary.

The magnetron should never be held by the cathode radiator because this might result in mechanical damage to the tube.

MOUNTING

All tools (screwdrivers, wrenches etc.) used close to or in contact with the magnetron should be made of non-magnetic material (e.g. beryllium copper, brass or plastics) to avoid unwanted attraction and possible mechanical damage to glass or ceramic parts as well as short-circuiting of the magnetic flux.

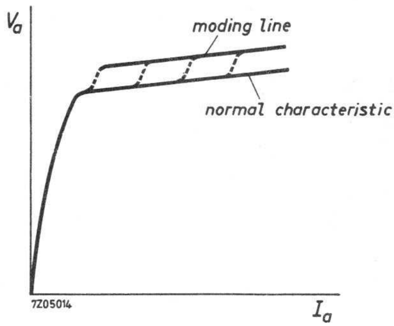
OPERATIONAL CHECKS

Excessive V.S.W.R. and/or current may lead to moding of the magnetron (see "stability of operating mode") which can be detected by displaying the $V_a/I_a$ characteristic of the magnetron on an oscilloscope.

This should be done in the equipment at various load conditions and should be part of production line inspection as well as of field service inspection before and after tube replacement.

For x-y display on a service oscilloscope the anode voltage can be sampled from a voltage divider chain connected between ground and the cathode connector, and the anode current from a sampling resistor of a few ohms which may be permanently including into the ground connection of the high-voltage rectifier.

The normal characteristic should be one fairly straight line that may be a little wavy. Appearance of a second line or parts thereof above the first line indicate undesired modes of oscillation that can rapidly lead to failure of the tube. Operating conditions indicated V.S.W.R. must at once be checked and the tube replaced if under correct conditions moding still continues.



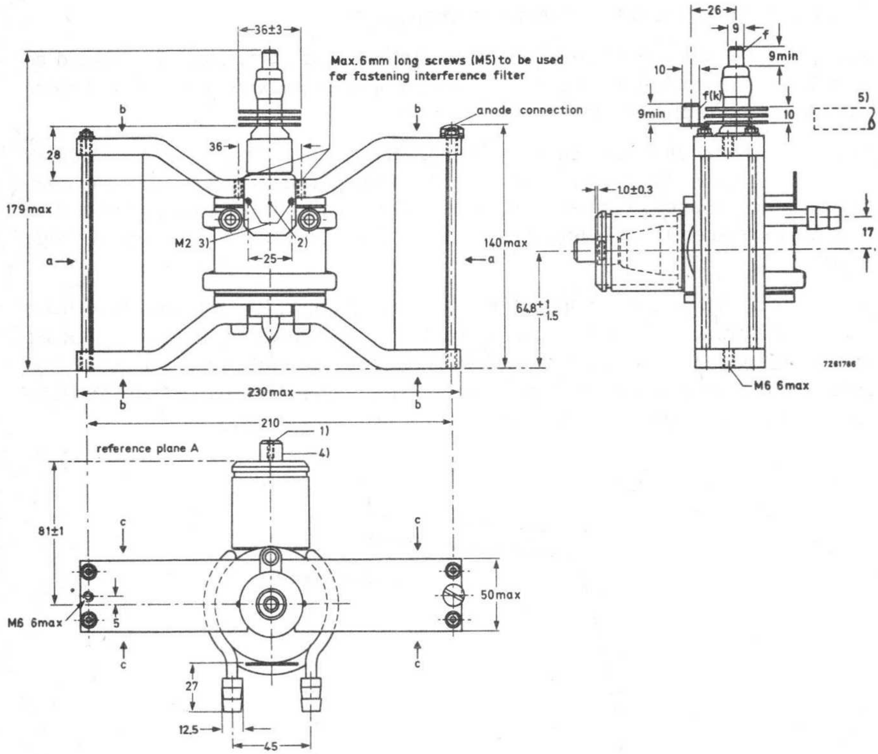

*X–Y display of magnetron characteristic (unfiltered supply)*

The mean current may be measured indirectly across the above mentioned resistor.

**MECHANICAL DATA**

Dimensions in mm

Outline drawing




1) Axial hole for short antenna: M4, depth 9 mm minimum.

2) Reference point for temperature measurements.

3) Mounting holes for thermoswitch.

4) Excentricity of inner conductor with respect to the outer conductor max. 0.4 mm.

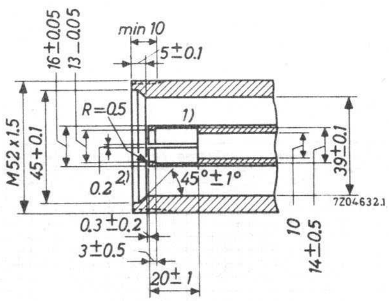
5) Non-metallic circular air duct, inner diameter 13 mm.

**OUTPUT COUPLING**

The tube may be coupled by suitable means to a coaxial line or waveguide, either directly or through a fixed reflection elements.

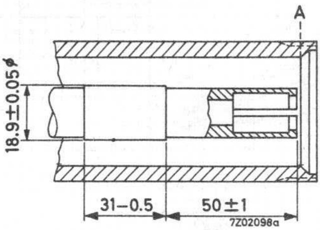
16/39 Coaxial line [3]) (characteristic impedance 53.4 Ω)

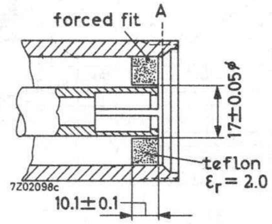
(See operating notes) Dimensions in mm




Coaxial connector

Fixed reflection elements [3]) V.S.W.R. approx. 1.5, d approx. 0.41 λ (examples). (See operating notes).

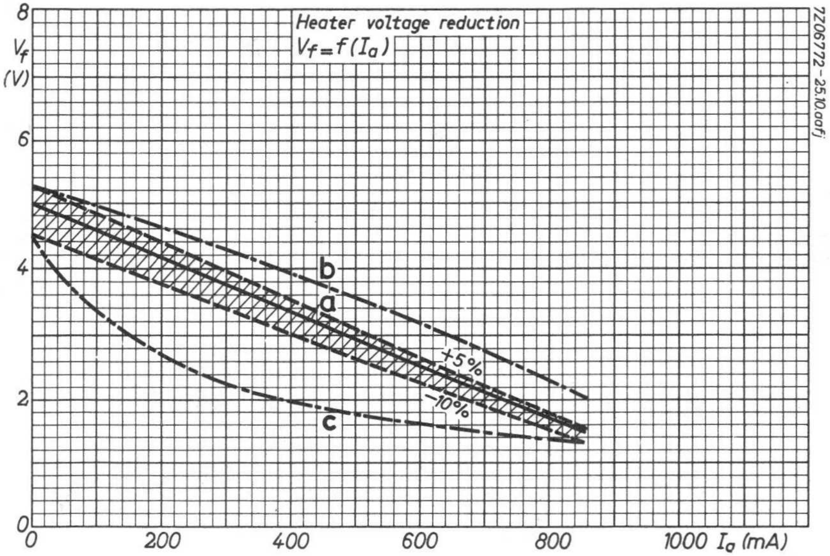


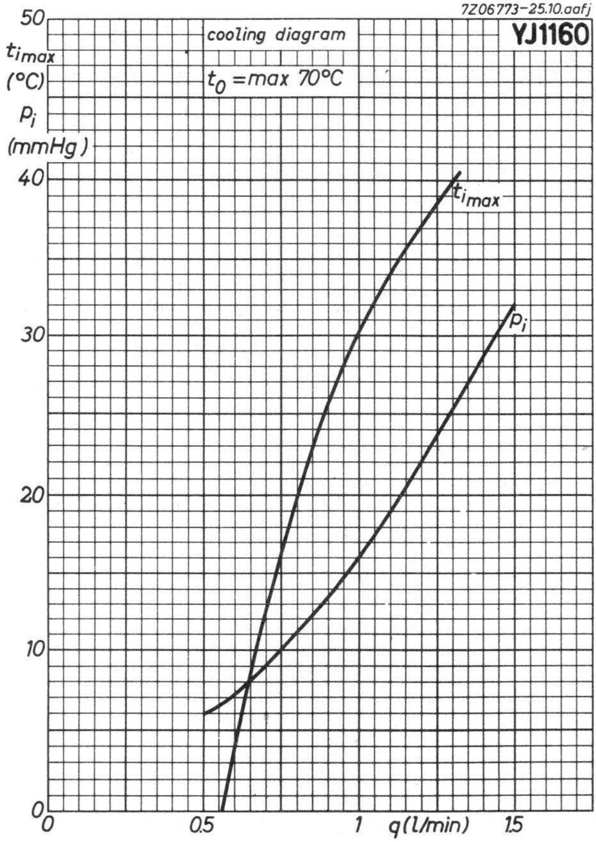

1) The inner conductor must be movable to accept the tolerances of the tube.

2) 6 Slots 0.2 mm; the wall segments should be deburred and be pressed together after slotting.

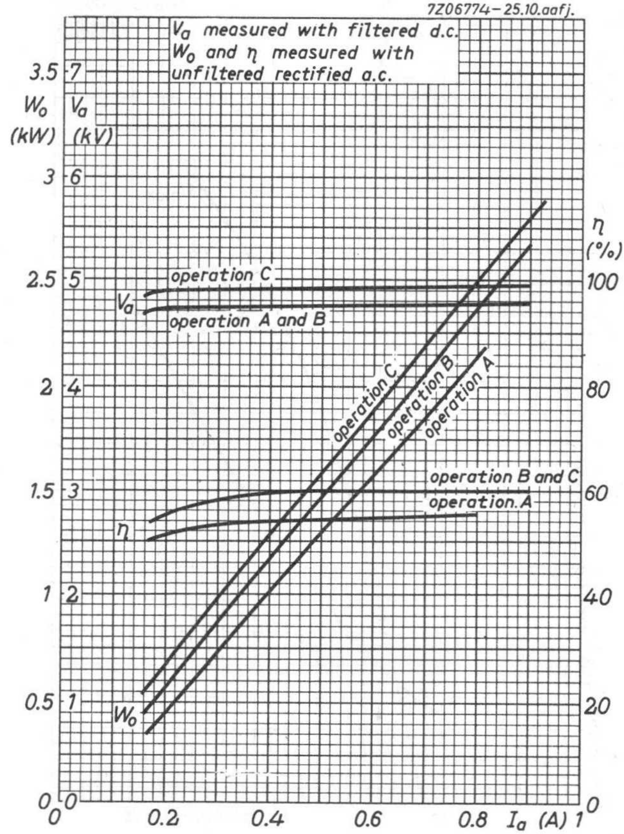
3) Not supplied by tube manufacturer.

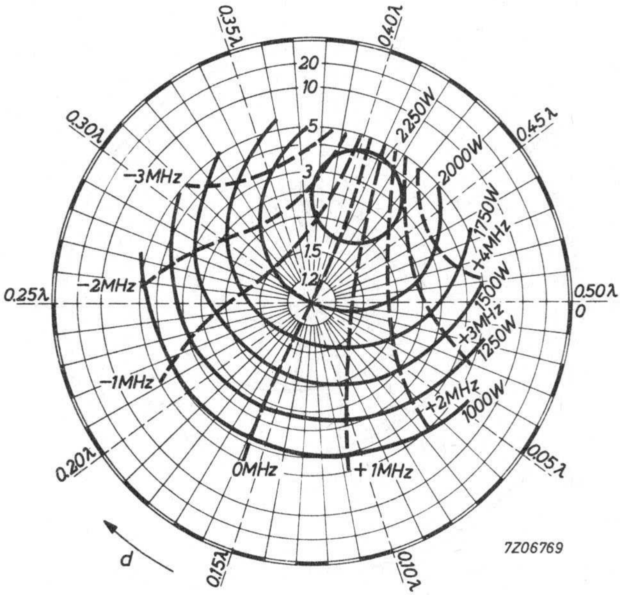


Heater voltage reduction
$V_f = f(I_a)$
8
$V_f$
(V)
6
4
2
0
0
200
400
600
800
1000 $I_a$ (mA)
b
a
c
+5%
-10%
7Z06772-25.10.aafj


7Z06773-25.10.aafj
YJ1160
cooling diagram
$t_0$ = max 70°C
50
$t_{imax}$
(°C)
$p_i$
(mmHg)
40
30
20
10
0
0
0.5
1
q (l/min)
1.5
$t_{imax}$
$p_i$

Performance chart

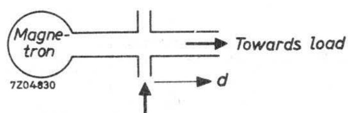


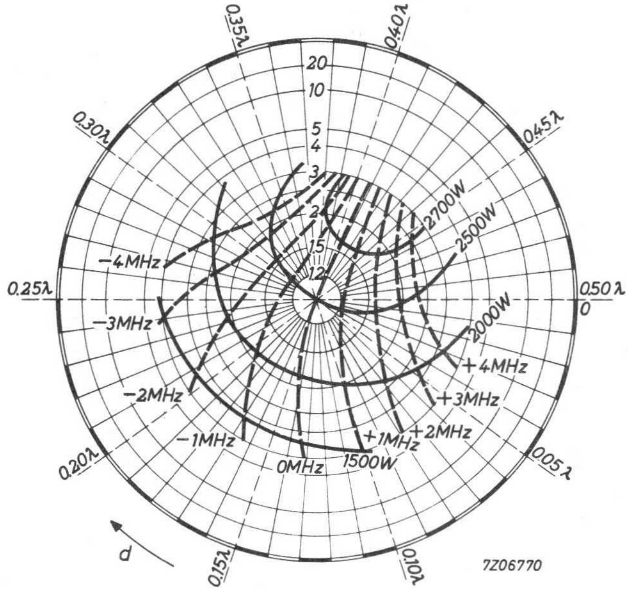



*Load diagram Operation A*
*Mean anode current 0.75A*
*Peak anode current 2A*

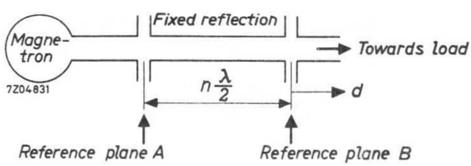
*d=distance of standing wave minimum from reference plane A towards load*

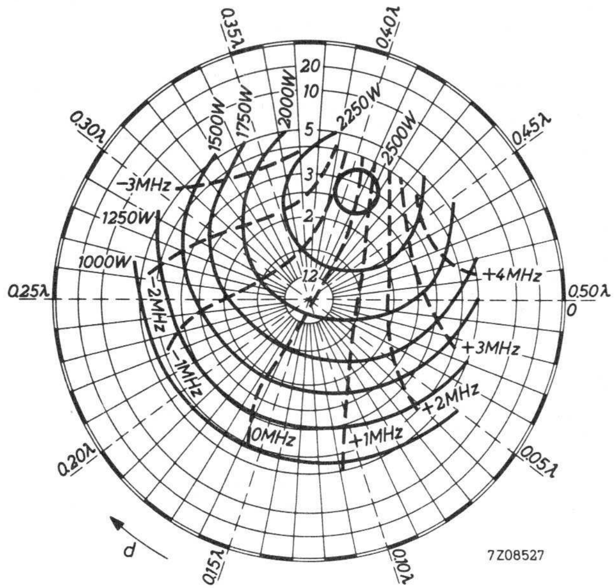
*Temperature at reference point 85°C*





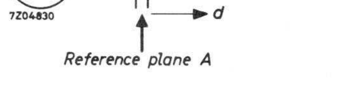

*Load diagram Operation B*
*Mean anode current 0.85A*
*Peak anode current 2A*
*Fixed reflection VSWR = 1.5 d = 0.41λ*
*d = distance of standing wave minimum from reference plane B towards load*
*Temperature at reference point 85°C*






*Load diagram Operation C*
*Mean anode current 0.8A*
*Peak anode current 2A*

*a = distance of standing wave minimum from reference plane A towards load*
*Temperature at reference point 85 °C*



# CONTINUOUS-WAVE MAGNETRON

Continuous-wave air-cooled packaged magnetron intended for microwave heating applications. It can produce up to 2.5 kW under various typical operating conditions.

| QUICK REFERENCE DATA | | | |
|---|---|---|---|
| Frequency, fixed within the band | f | 2.425 to 2.475 | GHz |
| Output power | $W_o$ | 2.0 or 2.5 | kW |
| Construction | | | packaged |
| Anode supply | | unfiltered single-phase full-wave or three-phase half-wave rectification | |

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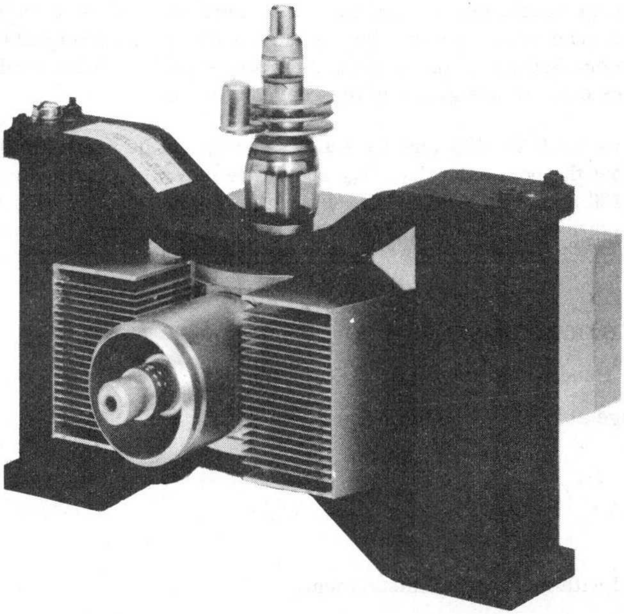


**CATHODE:** Dispenser type

**HEATING:** Indirect by A.C. (50 to 60 Hz) or D.C.

| | | | |
|---|---|---|---|
| Heater voltage, starting | $V_{f_o}$ | | 5.0 V $^{+5\%}_{-10\%}$ |
| Heater voltage, stand-by (see operating notes) | $V_f$ | | 4.8 V $^{+5\%}_{-10\%}$ |
| Heater current at $V_f$ = 5.0 V | $I_f$ | approx. | 35 A |
| | | max. | 38 A |

The heater current should never exceed a peak value of 140 A when applying the heater voltage. The cold heater resistance is approx. 0.02 Ω.

| | | | |
|---|---|---|---|
| Heating time before application of high voltage (waiting time) at $V_f$ = 5.0 V | $T_w$ | min. | 120 s |

Immediately after applying the anode voltage the heater voltage must be reduced as a function of the anode current according to the diagram on page 14. The life of the magnetron will be greatest if the heater voltage is reduced to a value given by the fully drawn line a. The heater voltage should be adjusted within +5 and −10% as given by the dashed lines which border the hatched area.
If it is intended to design the equipment for a predetermined number of steps of output power level, the reduced heater voltage for each step must be set to a value within the area bordered by the lines b and c, and preferably within or close to the hatched area. In no circumstances should the heater voltage reach a value outside the limits given by the curves b and c.

The limits $V_f$ = 5.0 V −10% and $T_w$ = 120 s should not be used simultaneously. With $V_f$ below the nominal value, $T_w$ should be increased in linear proportion up to min. 180 s at $V_f$ = 5.0 V −10%. It is also possible to preheat the tube at stand-by conditions if the waiting time is extended to at least 10 minutes.

**TYPICAL CHARACTERISTICS**

| | | | |
|---|---|---|---|
| Frequency, fixed within the band | f | 2.425 to 2.475 | GHz [3] |
| Anode voltage at $I_{a\,mean}$ = 750 mA [1] | $V_a$ | 4.45 to 4.85 | kV [2][3] |

[1]) Measured with moving coil instrument.

[2]) Anode voltage measured with d.c.

[3]) Measured at matched load (V.S.W.R. < 1.05).

## LIMITING VALUES AND OPERATING CHARACTERISTICS

The anode supply unit should be designed so that for any operating condition no limiting value for the mean and peak anode current will be exceeded.
The anode voltage should be obtained from a single-phase full-wave or three-phase half-wave rectifier without smoothing filter. (see also operating notes).

### A. OPERATION WITH Wo = 2.0 kW (Load diagram see page 17)

Limiting values (Absolute max. rating system)

| | | | | |
|---|---|---|---|---|
| Anode current, mean [1] | $I_a$ | max. | 0.8 | A |
| | | min. | 0.1 | A |
| peak | $I_{a_p}$ | max. | 2.1 | A |
| Voltage standing-wave ratio | | | | |
| at $0.37\,\lambda < d < 0.44\,\lambda$ | V.S.W.R. | max. | 4.0 | |
| remaining region | V.S.W.R. | max. | 5.0 | |

Typical operation (into a matched load)

| | | | |
|---|---|---|---|
| Heater voltage (running) | $V_f$ | 2.0 | V |
| Anode current, mean [1] | $I_a$ | 0.75 | A |
| peak | $I_{a_p}$ | 2.0 | A |
| Anode voltage [2] | $V_a$ | 4.75 | kV |
| Output power | $W_o$ | 2.0 | kW [3] |
| Efficiency | $\eta$ | 55 | % |

[1]) Measured with moving coil instrument.

[2]) Anode voltage measured with d.c.

[3]) Minimum output 1.85 kW.

## B. OPERATION WITH Wo = 2.5 kW (Load diagram see page 18)

A fixed reflection element with a V.S.W.R. of 1.5 and a phase position of 0.41 λ should be inserted between magnetron and load. (Example see output coupling).

Limiting values (Absolute max. rating system)

| | | | | |
|---|---|---|---|---|
| Anode current, mean [1] | $I_a$ | max. | 0.9 | A |
| | | min. | 0.1 | A |
| peak | $I_{ap}$ | max. | 2.1 | A |
| Voltage standing-wave ratio [4] | | | | |
| at $0.37\,\lambda < d < 0.44\,\lambda$ | V.S.W.R. | max. | 2.5 | |
| remaining region | V.S.W.R. | max. | 4.0 | |

Typical operation (into a matched load) [4]

| | | | | |
|---|---|---|---|---|
| Heater voltage, running | $V_f$ | | 1.5 | V |
| Anode current, mean [1] | $I_a$ | | 0.85 | A |
| peak | $I_{ap}$ | | 2.0 | A |
| Anode voltage [2] | $V_a$ | | 4.8 | kV |
| Output power | $W_o$ | | 2.5 | kW [3] |
| Efficiency | $\eta$ | approx. | 60 | % |

[1]) Measured with moving coil instrument.

[2]) Anode voltage measured with d.c.

[3]) Minimum output 2.3 kW.

[4]) With respect to reference plane B of fixed reflection element.

## C. OPERATION WITH Wo = 2.5 kW FOR MICROWAVE OVENS

(Load diagram see page 19). The average V.S.W.R. should be 3 at d = 0.41 λ.

Limiting values (Absolute max. rating system)

| | | | | |
|---|---|---|---|---|
| Anode current, mean [1] | $I_a$ | max.<br>min. | 0.85<br>0.1 | A<br>A |
| peak | $I_{ap}$ | max. | 2.1 | A |
| Voltage standing-wave ratio | | | | |
| at 0.30 λ < d < 0.50 λ | V.S.W.R. | max. | 4.0 | |
| intermittent (T = max. 0.02 s max. 20% of the time) | V.S.W.R. | max. | 10 | [4] |
| remaning phase region | V.S.W.R. | max. | 4.0 | |

Typical operation

| | | | | |
|---|---|---|---|---|
| Heater voltage, running | $V_f$ | | 1.8 | V |
| Anode current, mean [1] | $I_a$ | | 0.80 | A |
| peak | $I_{ap}$ | | 2.0 | A |
| Anode voltage [2][5] | $V_a$ | | 4.95 | kV |
| Voltage standing-wave ratio, average | | | | |
| at 0.30 λ < d < 0.50 λ | V.S.W.R. | | 3 | |
| Output power | $W_o$ | | 2.5 | kW [3] |
| Efficiency | $\eta$ | approx. | 60 | % |

[1]) Measured with moving coil instrument.

[2]) Anode voltage measured with d.c.

[3]) Minimum output 2.3 kW.

[4]) The average reflected power for any one-second period must not exceed the reflected power equivalent to a V.S.W.R. of 4. When operating under these conditions, the tube should not be permitted to mode.

[5]) Measured at V.S.W.R. = 3 and d = 0.41 λ.

## COOLING

| | |
|---|---|
| Anode block | forced air |
| Required quantity of air | see page 15 |
| Cathode radiator, via airduct | low velocity air-flow ($> 0.2\ m^3/min$) |

## TEMPERATURE LIMITS (Absolute max. rating system)

(See also operating notes)

| | | | |
|---|---|---|---|
| Anode temperature at reference point for temperature measurement | $t_a$ | max. 125 | °C |
| Cathode radiator temperature | | max. 180 | °C |

To safeguard the magnetron from overheating if the cooling fails, provision is made for mounting a thermoswitch. This switch should become operative at a temperature of 105 °C to 110 °C at the mounting plate.

## MECHANICAL DATA

Weight

| | | | |
|---|---|---|---|
| Net weight | approx. | 7.9 | kg |

Accessories

| | | |
|---|---|---|
| Cap nut | type | 55312 |
| Spring ring | type | 55313 |
| Heater connector | type | 40634 |
| Heater/cathode connector | type | 40649 |

Mounting position: any

## DESIGN AND OPERATING NOTES

### GENERAL DESIGN CONSIDERATIONS

The equipment should be designed around the tube specifications given in these data sheets and not around one particular tube since due to normal production variations the design parameters ($V_a$, $Rf_0$, f, $W_0$ etc.) will vary around the nominal values given.

### ANODE SUPPLY

The magnetron should be operated from an unfiltered single-phase full-wave or three-phase half-wave supply. Operation with filtered d.c. is possible but will result in lower output power due to lower input power and a decrease in efficiency. The manufacturer should be consulted if operation with d.c. or other supply schemes, e.g. mains frequencies other than 50 or 60 Hz, not published in these data is considered.

In order to achieve constant output power and to avoid exceeding the limiting values of mean anode current a current regulating device such as a saturable core reactor is recommended.

In order to keep the peak anode current below its limits it will be necessary to incorporate either a limiting resistance or reactance in the power supply.

### HEATER SUPPLY

The primary of the heater transformer must be high voltage isolated from the secondary since in normal magnetron operation the cathode will be at high negative potential and the anode should be grounded.
The transformer should be designed so that the heater voltage limits are adhered to.

### STAND-BY OPERATION

In order to avoid the time-consuming warm-up period of the heater of 2 - 3 minutes when frequent switching of the tube is intended, the heater should be switched back to preheat conditions after the oscillation period instead of being switched off completely. The tube then remains ready for instantaneous operation. This also serves to increase life of the tube.

### COOLING

Overheating may seriously damage the tube. Therefore forced air must be supplied according to the cooling data diagram so that for the highest expected inlet air temperature and for the highest possible ambient temperature adequate cooling of the tube will be guaranteed. It is recommended to use inlet temperatures below 40 °C.

The cooling air must be free from dirt and grease. Before installing a tube it must be checked that the ducts of the cooler are clean and free from foreign particles.
Cooling of the cathode radiator must be assured by directing a moderate stream of air to the three disc-like cooling elements of the cathode structure. This may be realized by means of a by-pass duct from the main stream of cooling air.

In case of failure of the cooling system power should be switched off by means of a thermoswitch which can be mounted on the cooling fins (see outline drawing). In specifying the thermoswitch operating temperature the temperature drop across the thermoswitch holder should be taken into account with respect to the temperature limit.
Information on suitable thermoswitches will be supplied upon request.

STABILITY OF OPERATING MODE (see also "operational checks")

Oscillation stability may be affected particularly by excessive microwave power reflections from the load, excessive peak anode currents, over- or underheating of the cathode, and by magnetic field changes. The resulting instability is referred to as "moding" of the tube and may lead to rapid failure. It should be a major design objective to keep the V.S.W.R. below the maximum limits for all possible load conditions. This problem is of particular importance in microwave ovens with their great variety of products to be heated. Further information concerning measures designed to avoid moding under various load conditions in specific equipment is available upon request.

MAGNETIC FIELD

When designing a power-pack and cabinet around the tube the influence of

1. ferromagnetic parts and
2. magnetically active components

on the magnetic field of the tube must be considered.

This is especially important when a very compact design (microwave oven) is desirable.

1. The following minimum distances must be maintained between the magnet and ferromagnetic parts (e.g. cavity or cabinet walls)

| | | |
|---|---|---|
| direction a - min. 80 mm | ) | see outline drawing |
| direction b - min. 100 mm | ) | |
| direction c - min. 130 mm | ) | |

The simultaneous use of these minimum distances in two or three directions is not admissible.

2. Transformers and reactors incorporate rather large volumes of iron so that the limits mentioned under 1. apply. In addition they generate stray electro magnetic fields while in operation.

To limit changes of the magnetic field as far as possible the following measures are advised:

1. Use of non-magnetic stainless steel, aluminium or non-metallic plates for the cabinet walls.
2. Use of non-magnetic stainless steel, aluminium or brass for the cavity resonator or microwave circuit components near the tube.
3. Location of transformers and reactors as far as possible from the magnetron.

If two or more tubes shall be operated close to each other the tube manufacturer should be consulted with regard to the applicable limits.

COUPLING TO COAXIAL LINE OR WAVEGUIDE

The magnetron has a coaxial output coupling. In the section "output coupling", a dimensional drawing is given of a coaxial line which can be coupled to the magnetron.

If coupling directly to a waveguide is desired, the inner conductor of the output coupling can be extended by an antenna. The outer conductor can then be screwed to its ring-shaped counterpart that normally is soldered to the waveguide wall. Dimensional drawings of such a coaxial-to-waveguide transition can be supplied upon request.
It is advised that antennas be gold-plated to ensure best contact and to facilitate loosening when the magnetron needs to be replaced.

FIXED REFLECTION ELEMENTS

For operation B a fixed reflection element must be joined to the magnetron output coupling. The shorter of the two elements drawn in this publication allows a more compact design. The longer of the two elements is of a simpler all-metal construction and does not comprise a teflon ring susceptible to temperature variations.

For operation C such an element may also be used when the overall mismatch of the cavity is not higher than a V.S.W.R. of approx. 2 in the phase-of-sink region. This serves to move the operating point of the tube to a region of more efficient operation.

RF SHIELDING

Where required, R.F. radiation from the filament terminals may be reduced by external filtering and/or shielding. Two holes with thread M5 are provided for mounting a filter. Detailed information may be readily obtained from the manufacturer.

SUPPORT

In the equipment the tube should be mounted by fastening the magnet yoke to a supporting structure. Two holes with thread M6 are provided in each yoke for this purpose. Adjusting possibilities must be allowed so that the output coupling of the tube can be fitted to the coaxial line or waveguide without exerting mechanical strain. This is especially important for the replacement procedure in the field.

The tube should never be supported by the output coupling alone.

## HANDLING, STORAGE, MOUNTING, AND OPERATIONAL CHECKS

HANDLING AND STORAGE

The original packing should be used for transporting and storing the tube.

Shipment of the tube mounted in the equipment is not permitted unless specifically authorized by the tube manufacturer.

The strong magnetic field necessary for the operation of the tube must not be weakened permanently. Therefore the tube should never be placed directly on any piece of ferromagnetic material (steel shelfs etc.). The best protection for the tube is its original packing. When the tubes have to be unpacked, e.g. at an assembly line or for measuring purposes, care should be taken that the tubes are not placed closer to each other than they would be placed when still packed.

Watches and sensitive measuring instruments may be influenced and damaged by exposure to the magnetic field.

The RF output coupling should be kept carefully clean, since foreign matter, especially metal particles inside the coaxial line and dirt on the ceramic insulator may cause electrical breakdown during high-power operation. Cleanliness should be checked and the coupling cleaned if necessary.

The magnetron should never be held by the cathode radiator because this might result in mechanical damage to the tube.

MOUNTING

All tools (screwdrivers, wrenches etc.) used close to or in contact with the magnetron should be made of non-magnetic material (e.g. beryllium copper, brass or plastics) to avoid unwanted attraction and possible mechanical damage to glass or ceramic parts as well as short-circuiting of the magnetic flux.

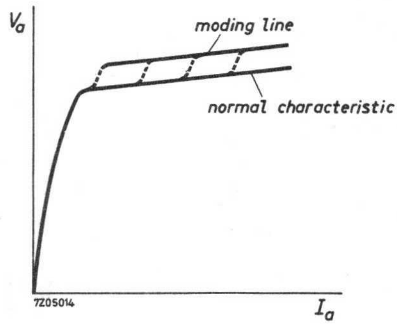
OPERATIONAL CHECKS

Excessive V.S.W.R. and/or current may lead to moding of the magnetron (see "stability of operating mode") which can be detected by displaying the $V_a/I_a$ characteristic of the magnetron on an oscilloscope.

This should be done in the equipment at various load conditions and should be part of production line inspection as well as of field service inspection before and after tube replacement.

For x-y display on a service oscilloscope the anode voltage can be sampled from a voltage divider chain connected between ground and the cathode connector, and the anode current from a sampling resistor of a few ohms which may be permanently inserted into the ground connection of the high-voltage rectifier.

The normal characteristic should be one fairly straight line that may be a little wavy. Appearance of a second line or parts thereof above the first line indicate undesired modes of oscillation that can rapidly lead to failure of the tube. Operating conditions including V.S.W.R. must at once be checked and the tube replaced if under correct conditions moding still continuous.

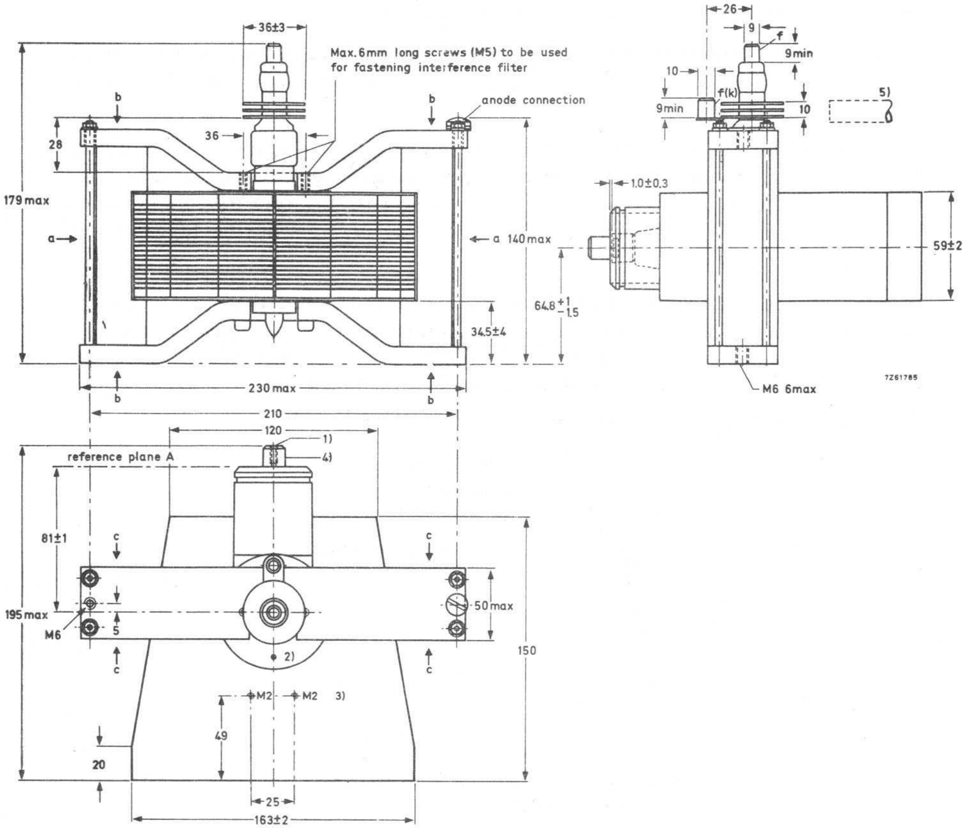



*X–Y display of magnetron characteristic (unfiltered supply)*

The mean current may be measured indirectly across the above mentioned resistor.

**MECHANICAL DATA** Dimensions in mm

Outline drawing




1) Axial hole for short antenna: M4, depth 9 mm minimum.

2) Reference point for temperature measurements.

3) Mounting holes for thermoswitch.

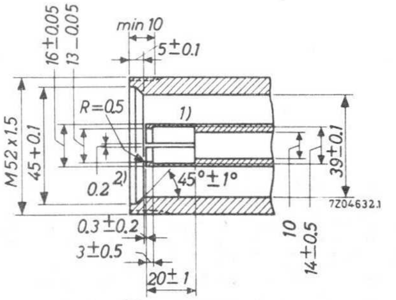
4) Excentricity of inner conductor with respect to the outer conductor max. 0.4 mm.

5) Non-metallic circular air duct, inner diameter 13 mm.

## OUTPUT COUPLING

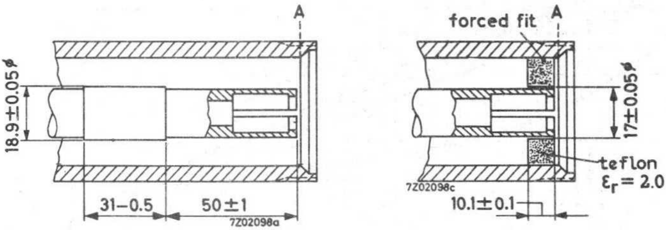
The tube may be coupled by suitable means to a coaxial line or waveguide, either directly or through a fixed reflection element.

16/39 coaxial line [3] (characteristic impedance 53.4 Ω).
(See operating notes) Dimensions in mm




Coaxial connector

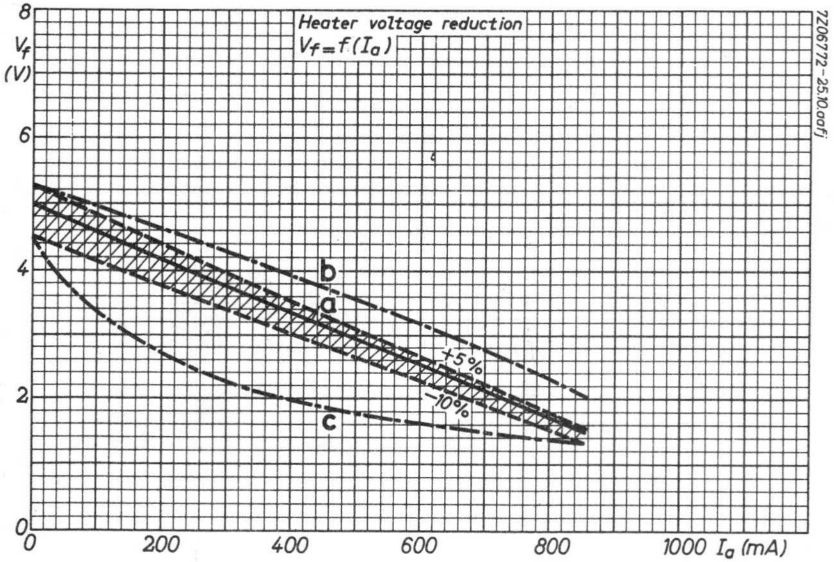
Fixed reflection elements [3] V.S.W.R. approx. 1.5, d approx. 0.41 λ (examples). (See operating notes).

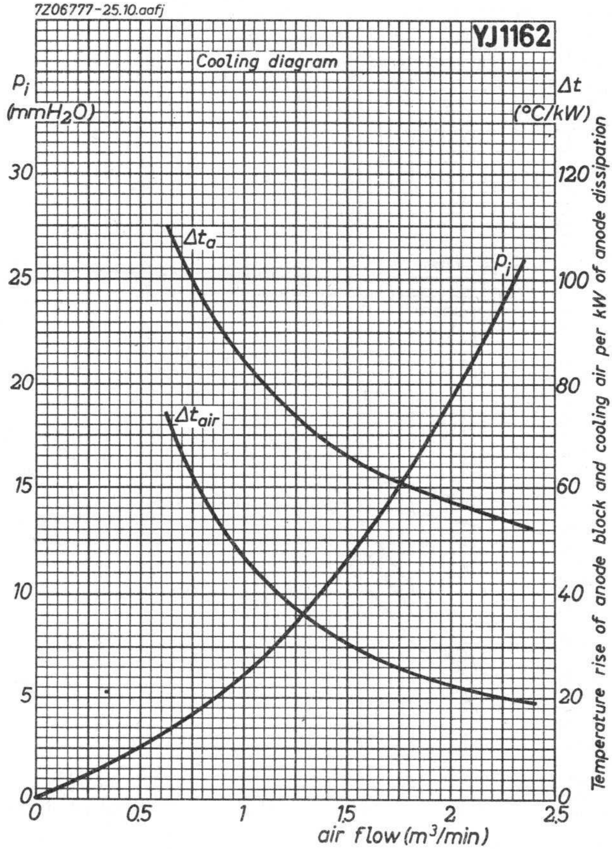



[1] The inner conductor must be movable to accept the tolerances of the tube.

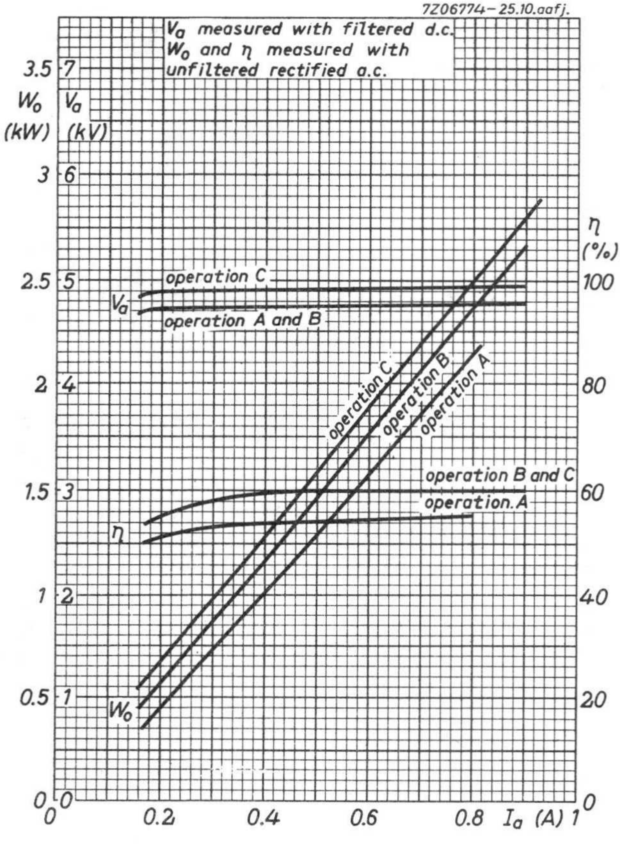
[2] 6 Slots 0.2 mm; the wall segments should be deburred and be pressed together after slotting.

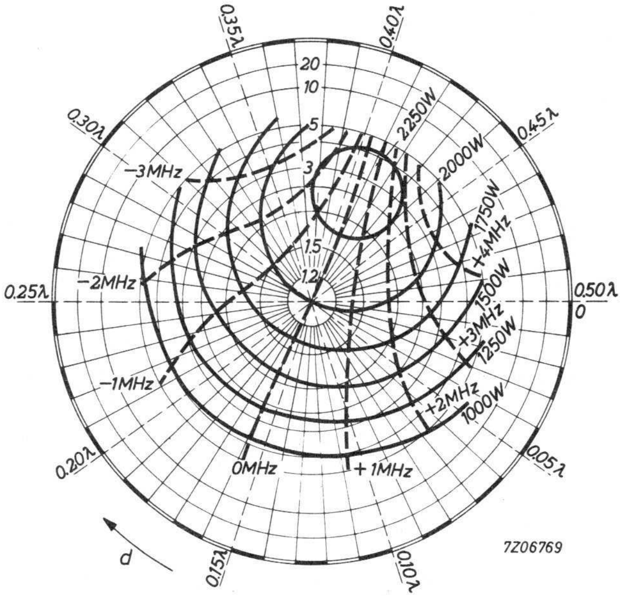
[3] Not supplied by tube manufacturer.


Heater voltage reduction
$V_f = f(I_a)$
7Z06772-25.10.aafj
8
$V_f$
(V)
6
4
2
0
0
200
400
600
800
1000 $I_a$ (mA)
b
a
c
+5%
−10%


7Z06777-25.10.aafj
YJ1162
Cooling diagram
$p_i$
($mmH_2O$)
$\Delta t$
(°C/kW)
$\Delta t_a$
$\Delta t_{air}$
$p_i$
30
25
20
15
10
5
0
120
100
80
60
40
20
0
0
0.5
1
1.5
2
2.5
air flow ($m^3/min$)
Temperature rise of anode block and cooling air per kW of anode dissipation

Performance chart

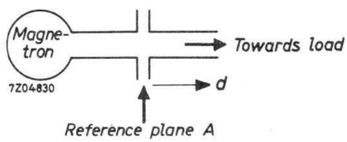


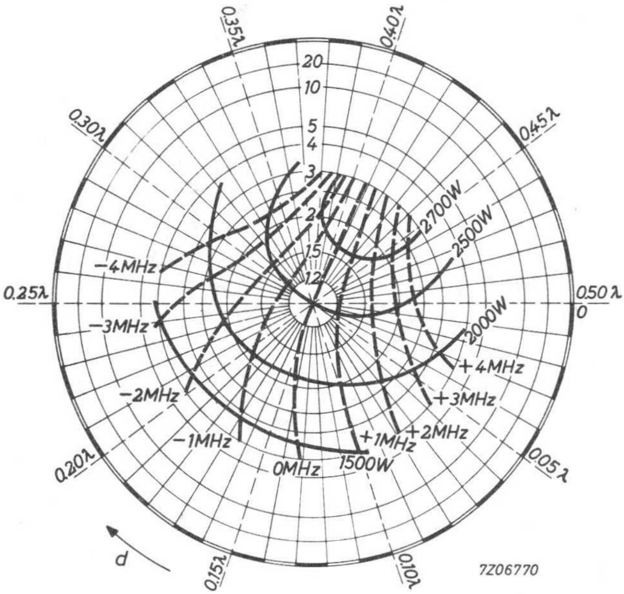



*Load diagram Operation A*
*Mean anode current 0.75A*
*Peak anode current 2A*

*d = distance of standing wave minimum from reference plane A towards load*

*Temperature at reference point 95 °C*

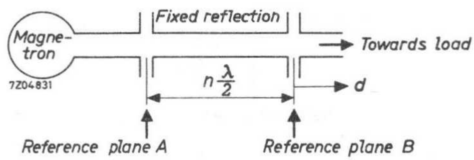


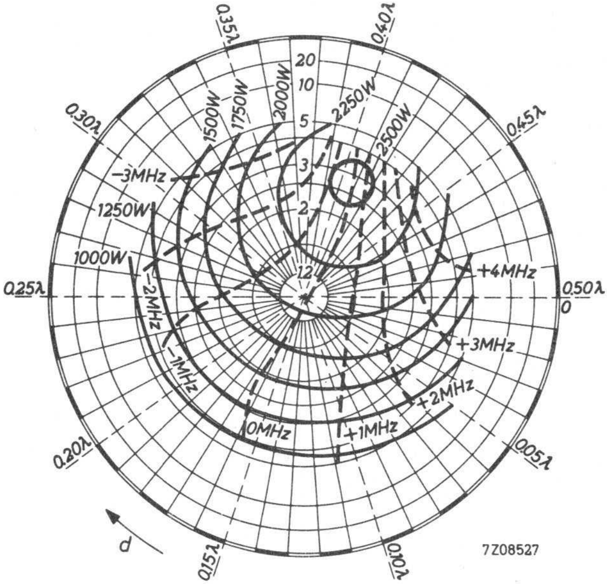



*Load diagram Operation B*
*Mean anode current 0.85A*
*Peak anode current 2A*
*Fixed reflection VSWR = 1.5 d = 0.41λ*

*d = distance of standing wave minimum from reference plane B towards load*

*Temperature at reference point 95°C*



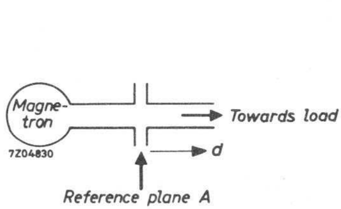



*Load diagram Operation C*
*Mean anode current 0.8A*
*Peak anode current 2A*

*d = distance of standing wave minimum from reference plane A towards load*

*Temperature at reference point 85 °C*

*Temperature at reference point 95 °C*



# CONTINUOUS-WAVE MAGNETRON

Continuous-wave water and air-cooled packaged magnetron intended for microwave heating applications.

| QUICK REFERENCE DATA | | |
|---|---|---|
| Frequency, fixed within the band | f | 2.425 to 2.475 GHz |
| Output power | $W_o$ | 5 kW |
| Construction | | packaged |
| Anode supply | | unfiltered three-phase half-wave or three-phase full-wave rectification |

**CATHODE:** Dispenser type

**HEATING**

Indirect by A.C. 50 or 60 Hz or D.C.

| | | | | |
|---|---|---|---|---|
| Heater voltage, starting and stand-by | $V_{f_o}$ | | 5.5 | V $^{+5\%}_{-10\%}$ |
| Heater current at $V_f$ = 5.5 V | $I_{f_o}$ | approx. | 66 | A |

The heater current should never exceed a peak value of 280 A when applying the heater voltage. The cold heater resistance is approx. 0.01 Ω.

| | | | | |
|---|---|---|---|---|
| Heating time before application of high voltage (waiting time) | $T_w$ | min. | 240 | s |

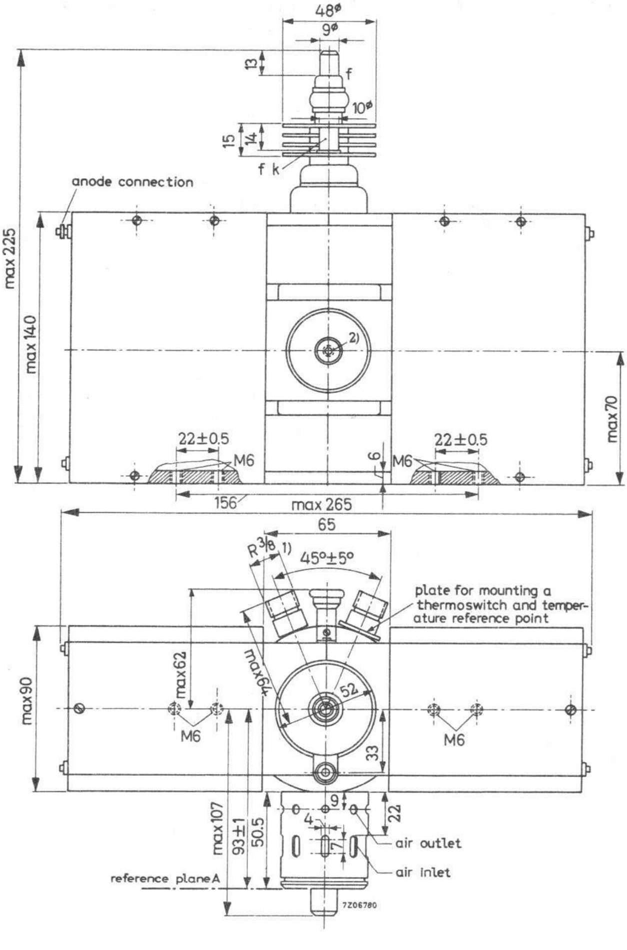
The heater voltage must be reduced immediately after applying the anode voltage according to the following schedule:

| | | |
|---|---|---|
| $I_a$ = 300 to 500 mA | $V_f$ | 3.5 V |
| $I_a \geq$ 500 mA | $V_f$ | 1.0 V |

MECHANICAL DATA

Dimensions in mm

Outline drawing



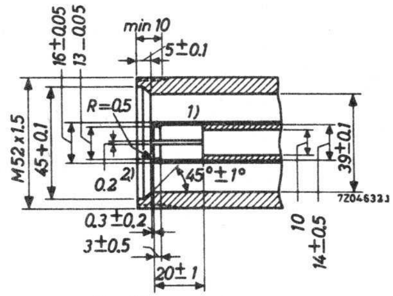

1) To be connected to hose nipple (DIN44415) for 9 mm hose with cap nut (CR3/8" DIN8542 Ms).

2) Axial hole for short antenna: M4 depth 9 mm min.

## OUTPUT COUPLING

The tube may be coupled by suitable means to a coaxial line or waveguide.

16/39 Coaxial line (Characteristic impedance 53.4 Ω) [3]



Coaxial connector

---

1) The inner conductor should be movable to accept the tolerence of the tube.
2) 6 Slots 0.2 mm; the wall segments should be deburred and be pressed together after slotting.
3) Not supplied by manufacturer.

Mounting position: any

Weight

| | |
|---|---|
| Net weight | approx. 9.4 kg |

Accessories

| | |
|---|---|
| Heater | type 40634 |
| Heater/cathode connector | type 40649 |
| Cap nut | type 55312 |
| Spring ring | type 55313 |

## COOLING

| | |
|---|---|
| Anode block | water |
| Cathode radiator | low-velocity air flow |
| R.F. output system | air flow of min. 0.1 $m^3$/min. |

To safeguard the magnetron from overheating if the cooling fails, provision is made for mounting a thermoswitch. This switch should become operative at a temperature of 120 to 125 °C of the mounting plate.

The R.F. output system of the magnetron is provided with air inlet and outlet holes for the application of at least 0.1 $m^3$/min. of cooling air to the ceramic part inside the outer conductor.
The cooling air must be free from dust, water, and oil.

## TEMPERATURE LIMITS

| | | |
|---|---|---|
| Anode temperature at reference point | $t_a$ | max. 125 °C |
| Temperature of cathode radiator | | max. 180 °C |

## TYPICAL CHARACTERISTICS

| | | | |
|---|---|---|---|
| Frequency, fixed within the band | f | 2.425 to 2.475 | GHz 4) |
| Anode voltage at $I_{a\,mean}$ = 1.25 A 1) | $V_a$ | 6.8 to 7.2 | kV 2)4) |

## LIMITING VALUES AND OPERATING CHARACTERISTICS

The anode supply unit should be so designed that for any operating condition no limiting value for the mean and peak anode current will be exceeded.
The anode voltage should be obtained from a three-phase half-wave or three-phase full-wave rectified supply without smoothing filter.

## LIMITING VALUES (Absolute max. rating system)

| | | | | |
|---|---|---|---|---|
| Anode current, mean 1) | $I_a$ | max. | 1.3 | A |
| three-phase half-wave | $I_a$ | min. | 0.3 | A |
| three-phase full-wave | $I_a$ | min. | 0.6 | A |
| peak | $I_{ap}$ | max. | 2.7 | A |
| Voltage standing wave ratio | V.S.W.R. | max. | 2.5 | |

## TYPICAL OPERATION (three-phase half-wave rectified power supply)

| | | | |
|---|---|---|---|
| Heater voltage | $V_f$ | 1.0 | V $^{+5\%}_{-10\%}$ |
| Anode current, mean 1) | $I_a$ | 1.25 | A |
| peak | $I_{ap}$ | 2.6 | A |
| Anode voltage | $V_a$ | 7.0 | kV |
| Output power | $W_o$ | 5.0 | kW 3)4) |
| Efficiency | $\eta$ | 60 | % |

1) Measured with moving-coil instrument

2) Anode voltage measured with D.C.

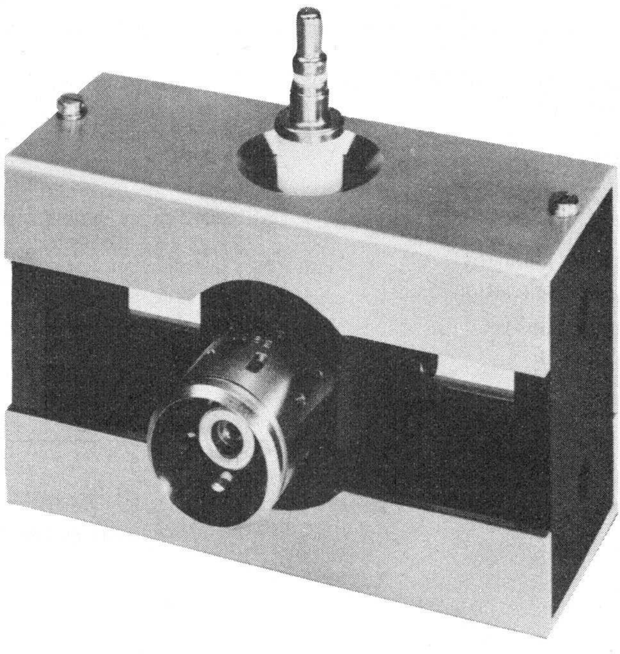
3) Minimum output 4.65 kW

4) Measured at matched load (V.S.W.R. < 1.1)

# CONTINUOUS-WAVE MAGNETRON

Continuous-wave metal-ceramic water and air-cooled packaged magnetron intended for microwave heating applications. It can produce up to 5.5 kW under typical operating conditions.

| QUICK REFERENCE DATA | | | |
|---|---|---|---|
| Frequency, fixed within the band | f | 2.425 to 2.475 | GHz |
| Output power | $W_o$ | 5.5 | kW |
| Construction | | packaged | |



A 53763 5

Data based on pre-production tubes.

**CATHODE** : Thoriated tungsten

**HEATING**: direct by A.C. (50 Hz or 60 Hz) or D.C. [1])

| | | | | |
|---|---|---|---|---|
| Filament voltage, starting and stand-by | $V_f$ | | 5.5 | V±10% |
| Filament current at $V_f$ = 5.5 V and $V_a$ = 0V | $I_f$ | approx. | 46 | A |
| | | max. | 50 | A |
| Filament peak starting current | $I_{f_p}$ | max. | 120 | A |
| Cold filament resistance | $R_{fo}$ | approx. | 0.015 | Ω |
| Waiting time (time before application of high voltage) | $T_w$ | min. | 30 | s |

Immediately after applying the anode voltage the filament voltage must be reduced as a function of the anode current according to the diagram on page 12. The life of the magnetron will be greatest if the filament voltage is reduced to a value given by the fully drawn line a. The filament voltage should be adjusted within ±10% as given by the dashed lines which border the hatched area.
If it is intended to design the equipment for a predetermined number of steps in output power level, the reduced filament voltage for each step must be set to a value within the area bordered by the lines b and c, and preferably within or close to the hatched area.
In no circumstances should the filament voltage reach a value outside the limits given by the lines b and c.

**TYPICAL OPERATION**

| | | | | |
|---|---|---|---|---|
| Anode supply | Unfiltered three-phase full-wave rect. | | | |
| Filament voltage, stand-by | $V_f$ | 5.5 V | | |
| operation | $V_f$ | 1.0 V | | |
| Anode current, mean[2]) | $I_a$ | 1.25 A | | |
| peak | $I_{ap}$ | 1.5 A | | |
| Load impedance | | V.S.W.R. 1.5 in direction of sink | matched | |
| Anode voltage | $V_a$ | 7.25 | 7.1 | kV |
| Output power | $W_o$ | 5.5 (see also page 14) | 5 | kW |

1) With D.C. heating the filament connector must have positive polarity.
2) Measured with a moving coil instrument.

## TYPICAL CHARACTERISTICS

| | | | |
|---|---|---|---|
| Frequency, fixed within the band | f | 2.425 to 2.475 | GHz [1] |
| Anode voltage at $I_a$ mean = 1.25 A [2] | $V_a$ | $7.2^{+0.0}_{-0.4}$ | kV [1][3] |
| Distance of voltage standing-wave minimum [4] | | 0.36 to 0.42 | λguide |

## LIMITING VALUES (Absolute max. rating system)

| | | | | |
|---|---|---|---|---|
| Anode current, mean | $I_a$ | max. | 1.3 | A |
| | $I_a$ | min. | 0.3 | A |
| peak | $I_{ap}$ | max. | 2.6 | A |
| Anode voltage, positive and negative | $V_a$ | max. | 12 | kV [5] |
| Anode input power | $W_{ia}$ | max. | 9.6 | kW |
| Temperature at reference point, closed circuit | $t_a$ | max. | 85 | °C |
| open circuit | $t_a$ | max. | 70 | °C |
| Temperature at any other point on the tube | t | max. | 200 | °C |
| Cooling water outlet temperature, closed circuit | $t_o$ | max. | 75 | °C |
| open circuit | $t_o$ | max. | 60 | °C |
| Voltage standing wave ratio from 0.30 λ to 0.50 λ | VSWR | max. | 2.5 | |
| remaining region | VSWR | max. | 1.5 | |

[1] Measured at matched load. (VSWR $\leq$ 1.05)
[2] Measured with moving coil instrument.
[3] Measurement on a filtered anode supply.
[4] This distance is measured, in the direction of the load, starting at the reference plane for electrical measurements using standard cold measurement techniques and a 16/39 coaxial line.
[5] It is recommended that a suitable spark gap be connected between the filament connectors and the anode (earth) to prevent the maximum anode voltage being exceeded.

## MECHANICAL DATA

Mounting position: axis of cathode/filament vertical (see outline drawing)

Weight

| | |
|---|---|
| Net weight | approx. 6 kg |

Accessories

| | |
|---|---|
| Filament connector | type 55323 |
| Filament/ cathode connector | type 55324 |
| Cap nut for output coupling | type 55312 |
| Spring ring | type 55313 |
| Mounting plate (optional)Only if YJ1191 is to replace YJ1190 | type 55327 |
| Soft copper washer (supplied with each tube) | type 55328 |
| Hose nipple and cap nut | types TE 1051c and TE 1051b |

## COOLING

| | |
|---|---|
| Anode block | water |
| Minimum required quantity of water and pressure drop | see page 13 |
| Filament and filament/cathode connectors | low-velocity air-flow perpendicular to the cathode axis |
| R.F. output system | air flow of min. 0.1 $m^3$/min at room temperature |

To safeguard the magnetron against overheating if the anode cooling fails, provision is made for mounting a thermoswitch. This switch should operate at a mounting disc temperature of 70 $^oC$ for an open and 85 $^oC$ for a closed water cooling circuit.

The R.F. output system of the magnetron is provided with air inlet and outlet holes for the application of at least 0.1$m^3$/min of cooling air to the ceramic part inside the outer conductor. For an example of a cooling device around the output system see "Output Coupling". All inlet holes must be used for the entrance of air to obtain the required uniform cooling.
The cooling air must be filtered to be free from dust, water and oil.

## DESIGN AND OPERATING NOTES

### General

Designers should consult the manufacturer whenever they consider to operate the magnetron under conditions substantially different from those given on the foregoing pages.

The equipment should be designed around the magnetron specifications given in this data and not around one particular magnetron since, due to normal production variations, the design parameters ($V_a$, $Rf_o$, f, $W_o$ etc.) will vary around the nominal values.

### Anode supply

It is recommended that the magnetron be operated from an unfiltered three-phase full-wave supply unit. This unit should be designed so that no limiting value for the mean and peak anode currents is exceeded, whatever the operating conditions. The use of a current regulating and limiting device is recommended.

### Filament supply

The secondary of the filament transformer must be well insulated from the primary since in normal magnetron operation the cathode will be at high negative potential and the anode will be earthed.
The transformer should be so designed that the filament voltage and surge current limits are not exceeded.

### Input connections

Because of the high filament current required for the magnetron, it is important that the connectors make good electrical and mechanical contact. This will prevent the temperature of the input system from rising due to contact resistance losses, and poor heat removal. Bad electrical contacts also cause a voltage drop and thus lower the filament voltage which may result in poor operation.
The connectors shown in the drawings have been designed to give the required electrical and mechanical contact and will also aid in cooling the input of the magnetron. Connectors of this design should be used for input connections to the magnetron.
The electrical conductors to the cathode and filament terminals should be flexible in order to eliminate undue stress on the input terminals.

### Load impedance

Optimum output power and life will be obtained when the magnetron is loaded with an impedance giving a VSWR of approximately 1.5 in the phase of sink region. This phase condition is reached when the position of the voltage standing wave minimum is at a distance of about 0.39 $\lambda$ guide from the reference plane for electrical measurements (see outline drawing) in the direction of the load.

### Cooling

To avoid overheating during operation and stand-by the cooling of

a) the anode must be effected by water according to the cooling data diagram so that adequate cooling of the tube will be guaranteed at the highest expected water inlet temperature; a thermoswitch can be fitted on the mounting disc ( see outline drawing) which switches the power off automatically when the anode block temperature limit at the reference point is exceeded; when specifying this switch the thermal resistance of the complete switch should be taken into account.

b) the input structure must be effected by a moderate stream of air (perpendicular to the cathode axis) directed at the input connectors;

c) the output coupling must be effected by forced air as specified in the cooling data; this air must be clean and dry to avoid arc-over.

The type TE1051c hose nipple is suitable for connecting a flexible hose or soldering a metal water pipe.

Shielding

R.F. radiation from the filament terminals may be reduced by external filtering and/or shielding. A filter box of non-magnetic material can be mounted on the aluminium top cover plate of the magnetron. (See under "Handling etc.").

Magnetic fields

Designers should bear in mind that the strong magnetic fields around the magnetron may have a detrimental effect on other magnetrons and precision instruments nearby. Also that the presence of magnetic material may affect the operation of the magnetron.

The minimum distance of the magnetron and any nearby ferromagnetic material should therefore be 13 cm.

Finally, high-intensity magnetic fields associated with transformers and other magnetic equipment (or another magnetron) can disturb the magnetic field of the magnetron. If such fields are present the distance should be minimum 15 cm.

Tube cleanliness

The ceramic insulation between the terminals of the magnetron must be kept clean. The output terminal should be adequately protected against contamination.

The cooling air should be filtered and ducted to prevent deposits forming on the insulation during operation.

## HANDLING, STORAGE AND MOUNTING; OPERATIONAL CHECKS

As the best protection for a magnetron is its original packing, this should be used for transporting and storing. Shipping magnetrons mounted in equipment is not permitted unless specifically authorized by the manufacturer.

When magnetrons have to be unpacked, care should be taken that the minimum distance of 15 cm mentioned above is maintained. More generally, magnetic fields associated with transformers or other magnetic equipment should not be present when a magnetron is stored, handled or operated.

The thoriated tungsten filaments are rather sensitive to shocks and vibrations, so magnetrons should always be handled gently.

Mounting

It should be borne in mind that the magnetron must not come closer to any ferromagnetic material than 13 cm to avoid mechanical damage to ceramic parts and/or short-circuiting of the magnetic flux. Especially mounting tools must be of non-magnetic material. On the other hand, extreme care must be taken not to cause any damage to watches and other precision instruments.

To mount a filter box on the aluminium top cover plate (see under "Shielding" above) this plate must be removed, after which the mounting holes can be drilled and tapped in it. The filter box mounting screws must not penetrate through the cover plate, which has a thickness of 6 mm.

For mounting the magnetron in the equipment, holes may be drilled and tapped in the bottom cover plate after this has been removed. Again the mounting screws must not penetrate through the bottom cover plate (which is also 6 mm thick).
The special mounting plate (type 55327) with 4 mounting holes, see "Accessories", can be screwed to the bottom cover plate of the magnetron by removing the two existing M4 screws and replacing them by screws 15 mm long.

The power supply lead to the anode should be connected to the anode terminal (see outline drawing) or to one of the mounting screws.

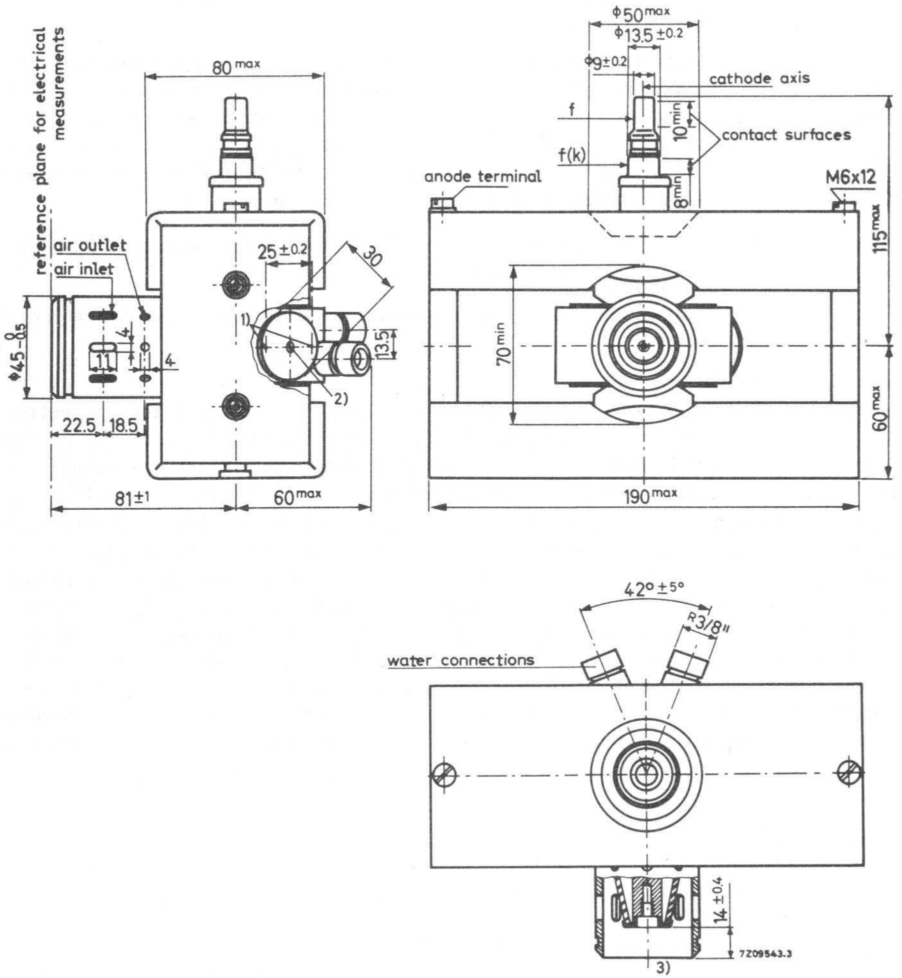
A high temperature resistant silicone grease should be applied to the filament contacts to prevent oxidation.

Operational checks

Excessive VSWR and/or current values may lead to moding of the magnetron which can be detected by displaying the $V_a/I_a$ characteristic on an oscilloscope for the various load conditions. This should be part of production line inspection but should also be checked during field inspection and after tube replacement. For x-y display on a service oscilloscope the anode voltage can be sampled from a voltage divider chain connected between earth and the cathode connector, and the anode current from a sampling resistor of a few ohms which may be permanently inserted into the earth connection of the high-voltage supply unit. The normal $V_a/I_a$ characteristic should be a fairly straight line when using a three-phase full-wave supply. The appearance of a second line or parts thereof distinctly above the first line indicates undesired modes of oscillation that can rapidly lead to failure of the tube. In such cases the operating conditions, including the VSWR, must be checked and the tube replaced if, under correct operating conditions, moding still occurs.

**MECHANICAL DATA** (continued) Dimensions in mm

Outline drawing




1) Two screws M2 for mounting a thermoswitch are supplied with each magnetron

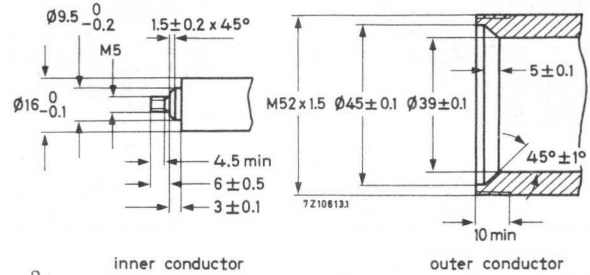
2) Plate for mounting thermoswitch, temperature reference point.

3) Eccentricity of inner conductor with respect to the outer conductor is max. 0.4 mm

## OUTPUT COUPLING

The coaxial output system of the magnetron may be coupled by suitable means to a coaxial line or to a waveguide.

16/39 Coaxial line (Characteristic impedance 53.4 Ω) [1][2]　　　Dimensions in mm

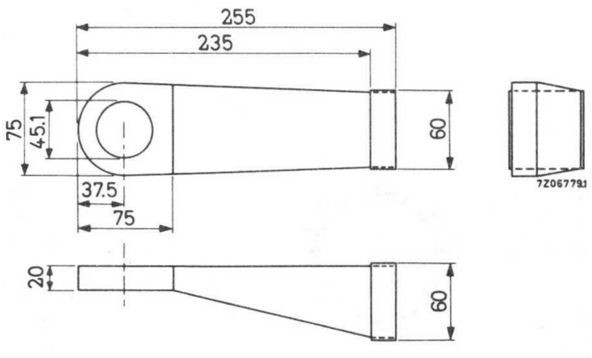



Antenna coupling [2]

An antenna can be screwed directly into the output system of the magnetron. The part of the antenna inside the outer conductor of the magnetron output system must be according to the drawing of the inner conductor of the coaxial line coupling.

Example of a cooling device for output system [3]

Material: non-magnetic




Pressure loss at 0.1 $m^3$/min:

About 60 mm $H_2O$ with air outlet only via outlet holes

About 30 mm $H_2O$ if air can also escape towards the load through the waveguide or coaxial line.

---

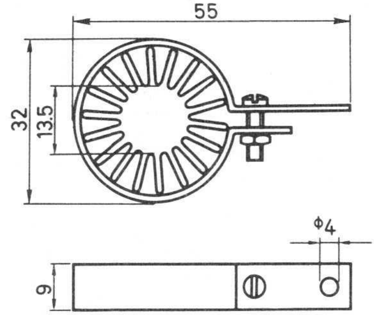
1) The inner conductor should be free to accept the tolerances of the magnetron output system (see outline drawing) and thermal expansion.

2) A soft copper washer of 0.5 mm thickness is required between the inner conductor and the magnetron output system R.F. contact.
When screwing the inner conductor into the magnetron output system the max. permissible torque is 15 cm kg.

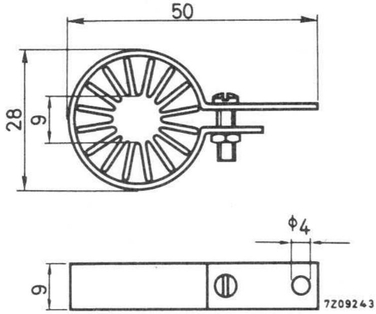
3) Not supplied by the manufacturer.

## ACCESSORIES

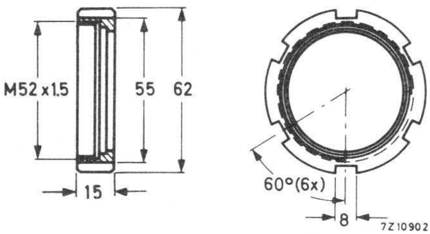
Dimensions in mm



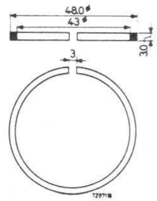

Filament/ cathode connector 55324




Filament connector 55323



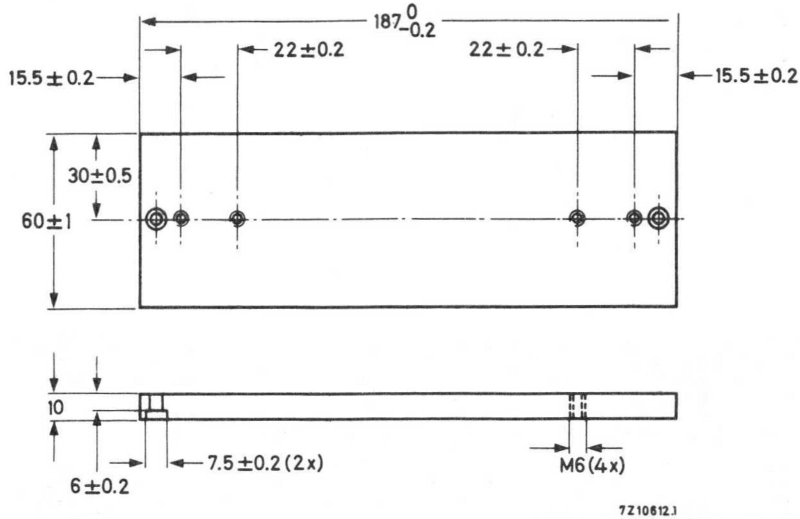

Cap nut 55312



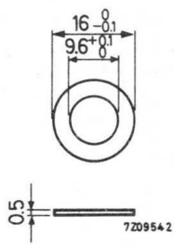

Spring ring 55313

**ACCESSORIES** (continued)

Dimensions in mm

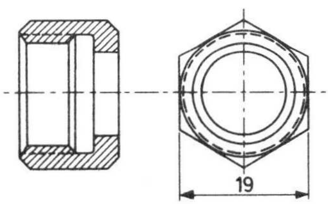


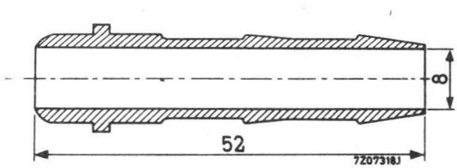

Mounting plate 55327 Material: Aluminium




washer 55328

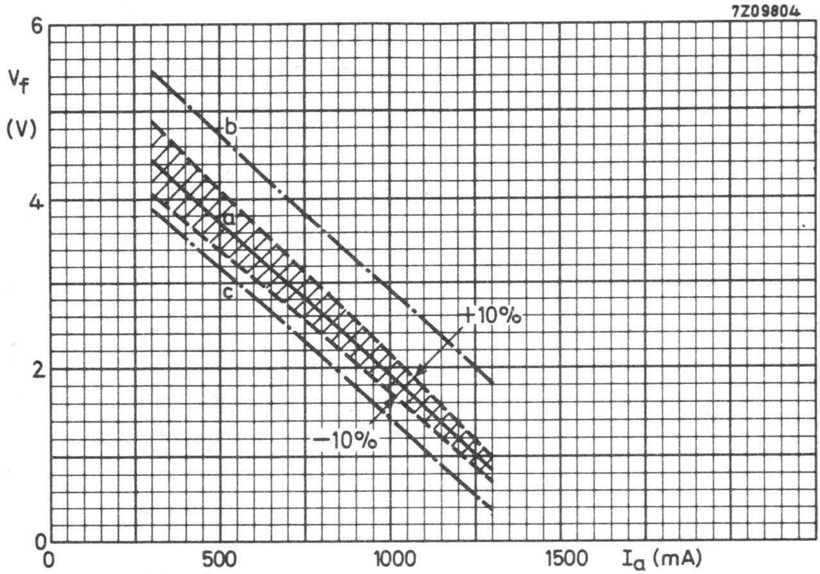
Material: Soft copper



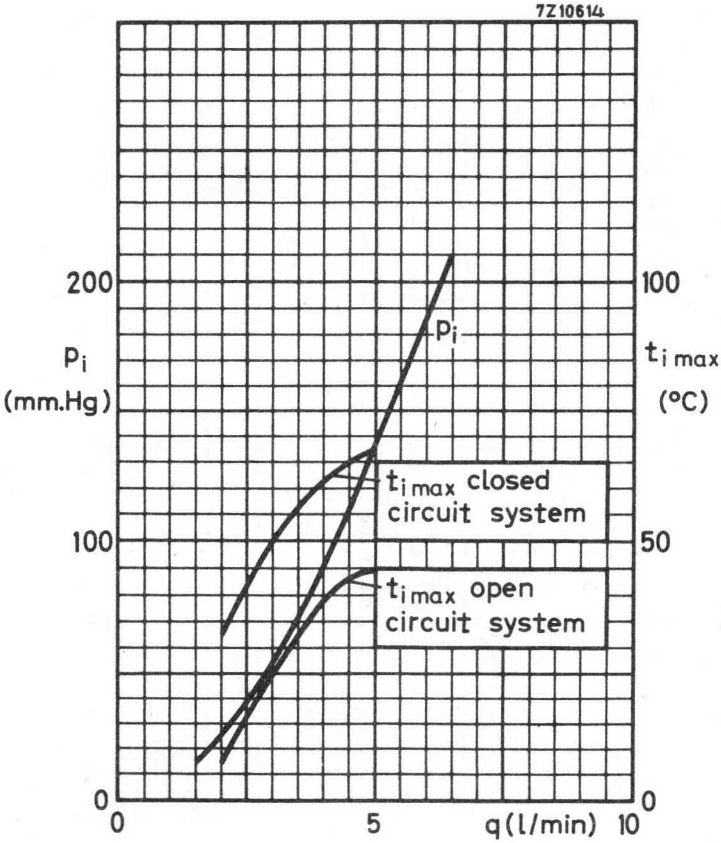




TE 1051b Cap Nut (Thread 3/8" gas)

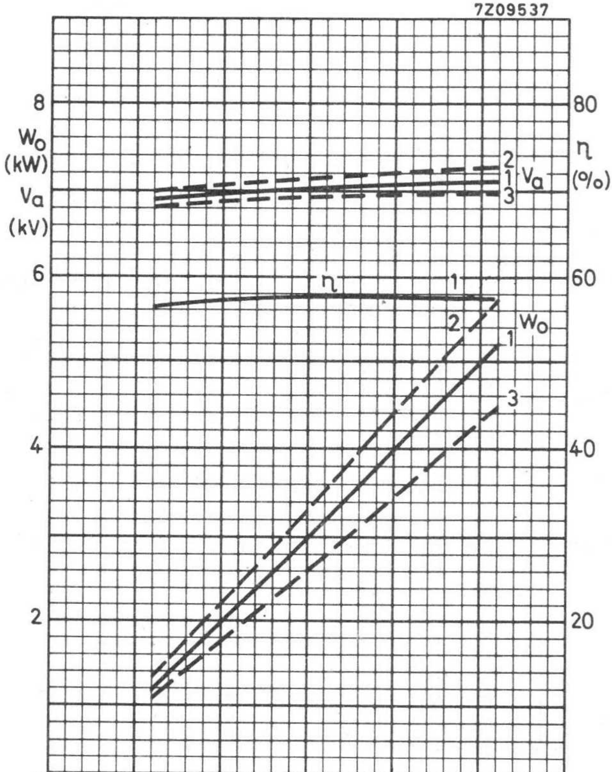
TE 1051c 9 mm hose nipple



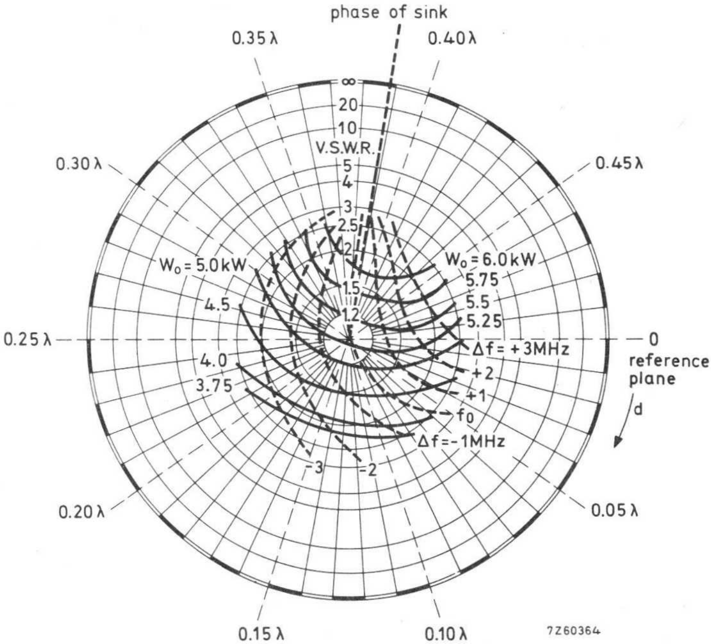

Filament voltage reduction curve . See also page 2.




Minimum required quantity of water q, and pressure drop $p_i$ as a function of water inlet temperature $t_i$. Water supplied via hose nipple type TE 1051c
When additional information is required please contact the manufacturer.




1 with V.S.W.R. ≤ 1.05 (matched load)
2 with V.S.W.R. 1.5 in sink region
3 with V.S.W.R., 1.5 in antisink region




Load diagram

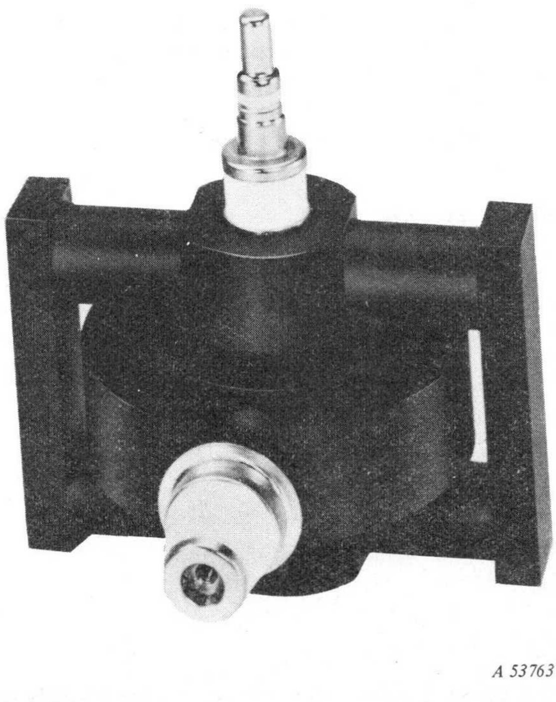
| | |
|---|---|
| Mean anode current | 1.25 A |
| Peak anode current | 1.5 A |

d = distance of standing wave minimum from reference plane towards load

# CONTINUOUS WAVE MAGNETRON

The YJ1280 is an integral magnet c.w. magnetron designed for use in microwave heating applications. With an LC stabilised power supply, it can produce up to 1.5 kW under typical operating conditions. The magnetron is air-cooled and is of a metal-ceramic construction.

| QUICK REFERENCE DATA | | | | | |
|---|---|---|---|---|---|
| Frequency, fixed within the band | f | 2.425 | to | 2.475 | GHz |
| Output power | $W_o$ | | | 1.5 | kW |
| Construction | metal-ceramic, packaged | | | | |



A 53763 4

**CATHODE** Thoriated tungsten

**HEATING** : direct by A.C. (50 Hz or 60 Hz) or D.C. [1]

| | | | |
|---|---|---|---|
| Filament voltage, starting and stand-by | $V_f$ | | 5.0 V±10% |
| Filament voltage, operating at $I_a$ mean = 380 mA | $V_f$ | | 3.5 V±10% |
| Filament current at $V_f$ = 5.0 V and $V_a$ = 0 V | $I_f$ | typ. | 28 A |
| | | max. | 32 A |
| Filament peak starting current | $I_{f_p}$ | max. | 70 A |
| Cold filament resistance | $R_{f_o}$ | approx. | 0.020 Ω |
| Waiting time (time before application of high voltage) | $T_w$ | min. | 10 s |

**TYPICAL OPERATION**

| | | | | | |
|---|---|---|---|---|---|
| Anode supply | | L-C stabilized | | | |
| Filament voltage, stand-by | $V_f$ | 5.0 V | | | |
| operation | $V_f$ | 3.5 V | | | |
| Anode current, mean [2] | $I_a$ | 380 mA | | | |
| peak | $I_{a_p}$ | 650 mA | | | |
| Load impedance | | V.S.W.R. 2.5 in direction of sink | | matched | |
| Anode voltage [2] | $V_a$ | 5.7 | | 5.7 | kV |
| Output power | $W_o$ | 1.5 | | 1.3 | kW |
| | | | min. | 1.15 | kW |

For other load impedance and anode current conditions see pages 10 and 11.

1) In case of D.C. heating the filament connector must have positive polarity.

2) Measured with a moving coil instrument.

## TYPICAL CHARACTERISTICS

| | | | | |
|---|---|---|---|---|
| Frequency, fixed within the band | f | | 2.425 to 2.475 | GHz 1) |
| Anode voltage at $I_a$ mean = 380 mA 2) | $V_a$ | 5.8 | +0.0 / −0.4 | kV 1)3) |
| Output power into matched load | $W_o$ | | 1.3 | kW |

## LIMITING VALUES (Absolute max. rating system)

| | | | | |
|---|---|---|---|---|
| Anode current, mean 2) | $I_a$ | max. | 450 | mA |
| | $I_a$ | min. | 100 | mA |
| peak at $I_a$ mean = 380 mA 2) | $I_{ap}$ | max. | 800 | mA |
| Anode voltage, positive and negative | $V_a$ | max. | 10 | kV 4) |
| Anode input power | $W_{ia}$ | max. | 2.7 | kW |
| Voltage standing wave ratio (measured with probe 55336) | | | | |
| continuous | V.S.W.R. | max. | 4 | |
| during max. 0.02 s, and max. 20% of the time 5) | V.S.W.R. | max. | 10 | |
| Anode temperature at reference point indicated on outline drawing | $t_a$ | max. | 180 | $^{o}C$ |
| Temperature at any other point on the tube | t | max. | 200 | $^{o}C$ |

1) Measured under matched load conditions. (V.S.W.R. $\leq$ 1.05)

2) Measured with a moving coil instrument.

3) Measured on a filtered anode voltage supply ($I_{ap} \leq$ 480 mA).

4) It is recommended that a suitable spark gap be connected between the filament connectors and the anode (earth) to prevent the maximum anode voltage being exceeded.

5) This means: Any period of time up to 0.02 s during which the V.S.W.R. is between 4 and 10 must be followed by a period four times as long during which the V.S.W.R. is < 4. When operated under these conditions the magnetron should not be permitted to mode.

## COOLING

| | | | |
|---|---|---|---|
| Anode block | forced air | | |
| Filament terminal structure | forced air | | |
| Inlet air, typical | | | |
| Temperature | $t_i$ | 35 | $^oC$ |
| Quantity | q | 1.2 | $m^3/min$ |
| Pressure drop | $p_i$ | 10 | $mmH_2O$ |

It is recommended to mount a thermoswitch at the place indicated in the outline drawing to protect the magnetron against overheating.

On stand-by, with $V_f$ = 5.0 V, some air-cooling is necessary to keep the temperature of the filament terminal, the filament/cathode terminal and the anode block below the maximum limit.

## MECHANICAL DATA

Mounting position

Axis of cathode (filament) — Vertical (see outline drawing)

Output coupling

The tube may be coupled by suitable means to a wave guide, a coaxial line, or directly into a cavity.

Weight

Net weight — approx. 2.3 kg

Accessories

| | | |
|---|---|---|
| Filament/cathode connector | type | 55324 |
| Filament connector | type | 55323 |
| R.F. gasket; supplied with the tube | type | 55341 |
| Washer; for antenna connection only (see page 6) | type | 55328 |
| Measuring probe; for cold measurements only (see page 6) | type | 55336 |

## DESIGN AND OPERATING NOTES

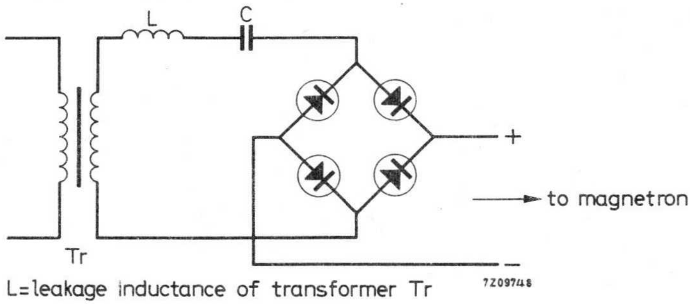
### General

Whenever it is considered necessary to operate the magnetron at conditions substantially different from those indicated under "Typical operation" the tube manufacturer should be consulted.

The equipment should be designed around the tube specifications given in this data and not around one particular tube since, due to normal production variations, the design parameters ($V_a$, $Rf_0$, f, $W_0$ etc.) will vary around the nominal values.

### Anode supply

It is recommended that the magnetron be operated from an L-C stabilized anode supply unit. The unit should be designed so that the limiting values for mean and peak anode current are not exceeded.




Basic series resonant circuit of an L-C power supply.

### Filament supply

The secondary of the filament transformer must be well insulated from the primary since in normal magnetron operation the cathode will be at high negative potential and the anode will be earthed.

The transformer should be designed so that the filament voltage and surge current limits are not exceeded.

### Filament/cathode connectors

The magnetron has a high filament current and losses in filament voltage caused by bad connections, will result in poor operation. Therefore, it is important to ensure that the filament and filament/cathode connectors make good electrical and thermal contact with their respective terminals.

The connectors, type nos. 55323 and 55324, shown in the drawings have been designed to give the required contact and are recommended for use with this magnetron.

A coating of a high temperature resistant silicone grease is recommended to prevent oxidation.

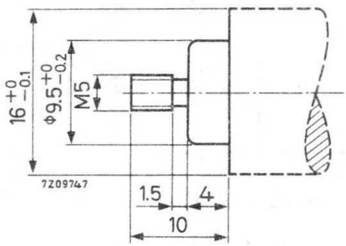
The electrical conductors of the cathode and filament connectors should be of flexible construction in order to eliminate undue stress on the terminals.

Load impedance, measured with measuring probe.

The probe 55336 simulates the R.F. output system of the magnetron; it may be coupled to a wave guide, a coaxial line, or directly into a cavity in place of the magnetron; in all cases the type 55341 gasket should be used. The termination of the probe matches a standard male N-type connector.
The use of this measuring probe enables the designer of microwave heating equipment to determine the value of the load impedance (V.S.W.R. and phase of reflection), using standard cold measuring techniques, and to arrive at the correct coupling for the magnetron.

Antenna

When an antenna is used, the part of the antenna screwed into the magnetron should be according to the figure below:




A soft copper washer of 0.5 mm thickness type nr. 55328 is required between the antenna and the tube to ensure reliable R.F. contact. The maximum torque applied when screwing the antenna into the tube is 15 cmkg.

Stand-by operation
Without anode voltage, the filament voltage during any stand-by period should be kept at $V_f = 5.0$ V. Some forced-air cooling will be required to prevent overheating. The full anode voltage may be applied without further waiting time.

Shielding
Where required, R.F. radiation from the filament terminals may be reduced by external filtering and/or shielding. Detailed information may be obtained from the manufacturer.

Tube cleanliness
The ceramic parts of the input and output structures of the tube must be kept clean during operation. A protective cover of suitable material should be placed over the tube output if the tube is inserted directly into a cavity.
The cooling air should be filtered and ducted to prevent deposits forming on the insulation during operation.

## HANDLING, STORAGE, MOUNTING

Handling and storage

The original pack should be used for transporting and storing the tube.
Shipment of the tube mounted in the equipment is not permitted unless specifically authorized by the tube manufacturer.
When the tubes have to be unpacked, e.g. at an assembly line or for measurement purposes, care should be taken that a minimum distance of 15 cm is maintained between magnets. As the thoriated tungsten filament is sensitive to shocks and vibration, care should be taken when handling and storing unpacked tubes that such shocks and vibration are avoided.
High intensity magnetic fields associated with transformers and other magnetic equipment can demagnetize the magnets. Such fields should not be present when the tube is stored, handled or serviced.
The best protection of the tube is its original pack.

The user should be aware of the strong magnetic fields around the magnet. When handling and mounting the magnetron, he must use non-magnetic tools and be extremely careful not to have watches and other precision instruments nearby.

Mounting

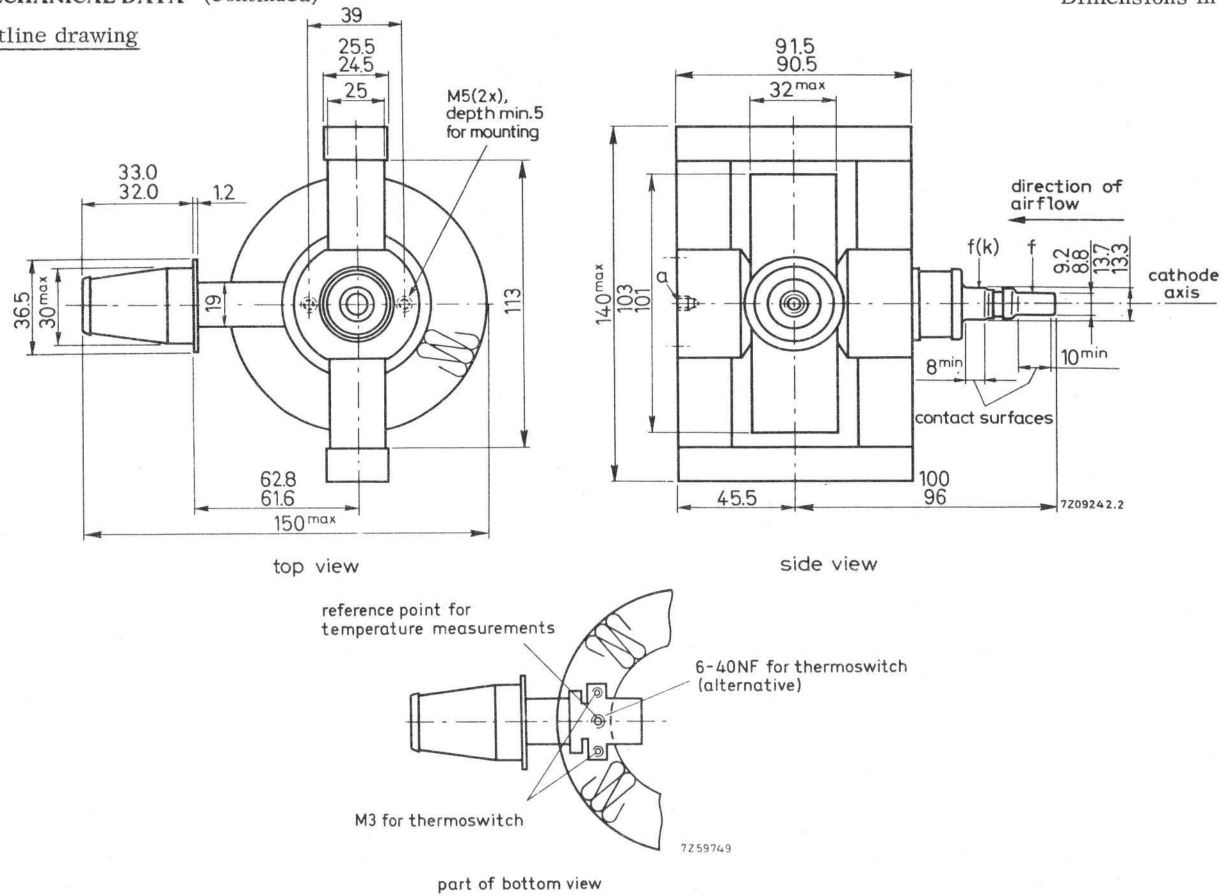
When magnetic materials are present in two or more planes, the minimum distance from the magnet shall be 13 cm in all directions.

In order to assure a good R.F. contact between the output of the tube and the circuit in which it is connected, the use of the gasket 55341 is essential.
The output coupling of the tube should not be used as the only means of mounting the magnetron. The magnetron should be mounted and secured by the two mounting holes indicated on the outline drawing. When mounting the magnetron, all tools (screwdrivers, wrenches etc.) used close to or in contact with the magnetron must be made of non-magnetic material to avoid unwanted attraction and possible mechanical damage to ceramic parts as well as short circuiting of the magnetic flux.
The power supply lead to the anode shall be connected to one of the mounting holes (see "a" on the outline drawing).

**MECHANICAL DATA** (continued)

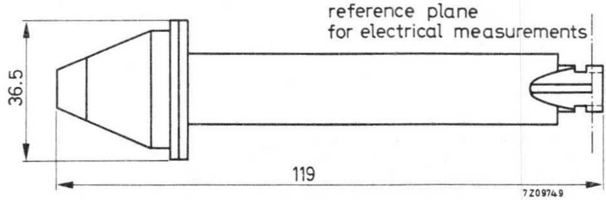
Dimensions in mm

Outline drawing

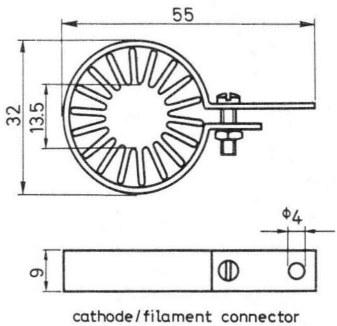


**ACCESSORIES**

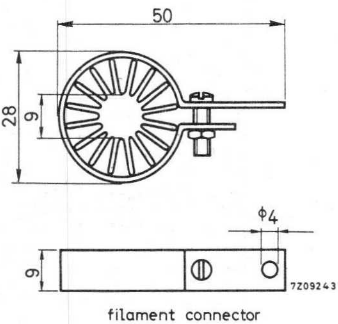
Dimensions in mm



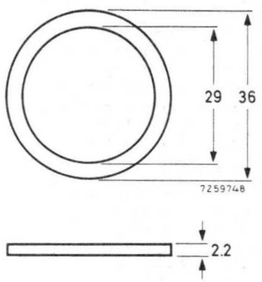

Measuring probe 55336




Filament/cathode connector 55324

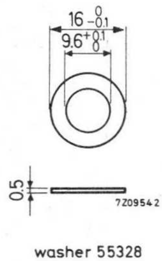



Filament connector 55323



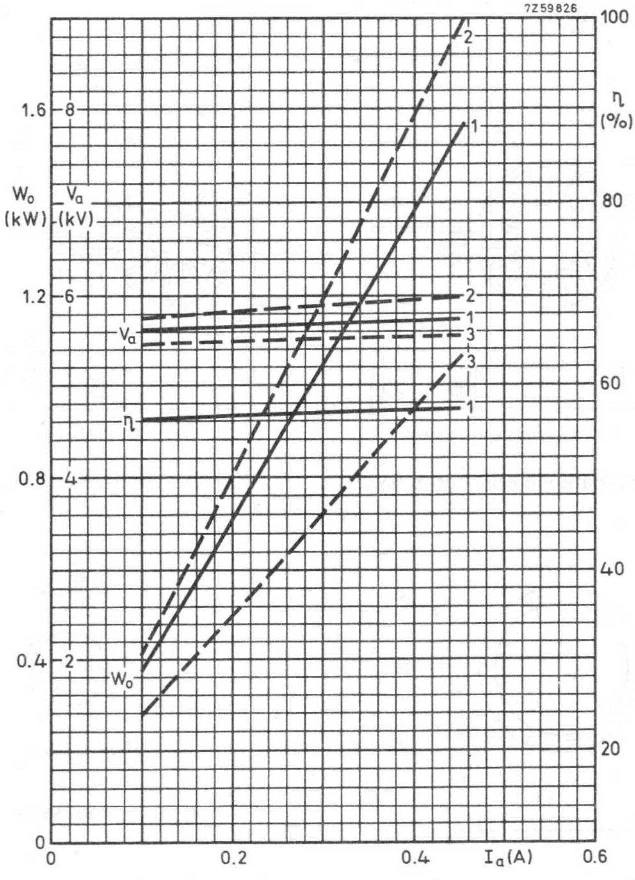

Material : monel mesh

R. F. gasket 55341

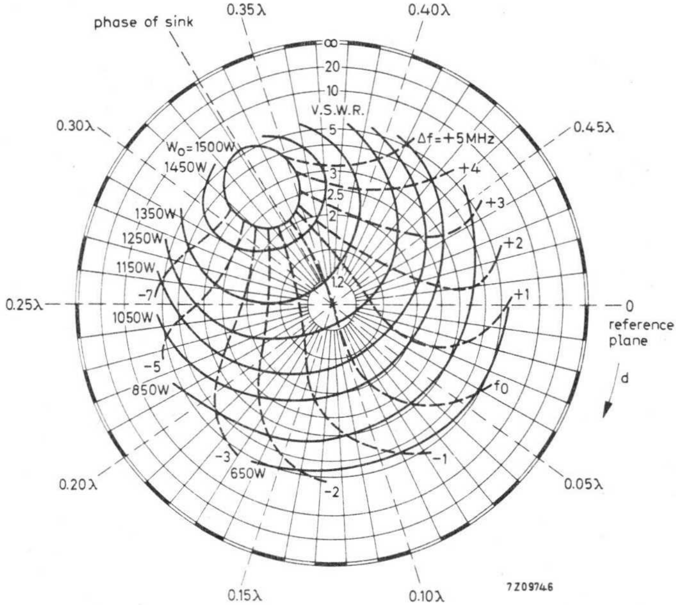



Material : soft copper

Washer 55328




1) with V.S.W.R. ≤ 1.05
2) with V.S.W.R. = 3 in sink region
3) with V.S.W.R. = 3 in anti sink region




Load diagram

Mean anode current 380 mA
Frequency $f_0$ 2.450 GHz
Constant air cooling
d = distance of voltage standing wave minimum from the reference plane for electrical measurements (measuring probe 55336) towards load

# CONTINUOUS-WAVE MAGNETRON

Continuous-wave contact-cooled packaged magnetron intended for diathermy and other low-power microwave heating applications.

| QUICK REFERENCE DATA | | |
|---|---|---|
| Frequency, fixed within the band | f | 2.425 to 2.475 GHz |
| Output power | $W_o$ | 200 W |
| Construction | | packaged |
| Anode supply | | A.C., or unfiltered single phase full-wave rectification, or D.C. |

**CATHODE**: nickel matrix type

**HEATING**: indirect by A.C. 50 or 60 Hz or D.C.

| | | Operation A and B | Operation C |
|---|---|---|---|
| Heater voltage, starting and stand-by | $V_{f_o}$ | 5.3 V $^{+5\%}_{-10\%}$ | 4.8 V $^{+5\%}_{-10\%}$ |
| Heater current at starting voltage | $I_f$ | approx. 3.5 A | 3.3 A |

The heater current must never exceed a peak value of 8.5 A at any time during the initial energizing schedule.

| | | | |
|---|---|---|---|
| Cold heater resistance | $R_{f_o}$ approx. | 0.2 Ω | |
| Heating time before application of high voltage (waiting time) | $T_W$ min. | 180 s | 240 s |

Immediately after applying the anode voltage the heater voltage must be reduced as a function of the anode current according to the diagram on page 9.

**TYPICAL CHARACTERISTICS**

| | | |
|---|---|---|
| Frequency, fixed within the band | f | 2.425 to 2.475 GHz |
| Anode voltage at $I_{a_{mean}}$ = 200 mA [1] | $V_a$ | $1.65^{+0.05}_{-0.10}$ kV [2][3] |

[1]) Measured with moving coil instrument

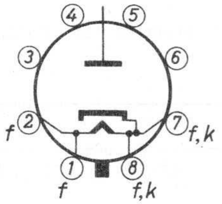
[2]) Anode voltage measured with D.C.

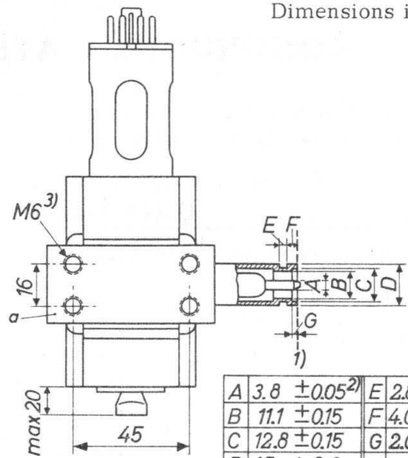
[3]) Measured at matched load (V.S.W.R. < 1.05)

## MECHANICAL DATA

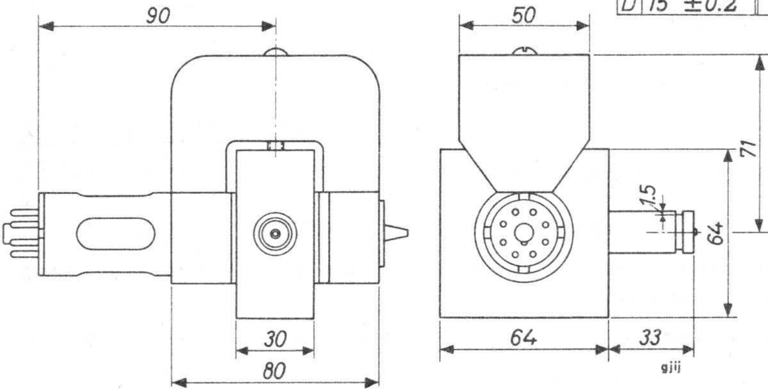
Dimensions in mm

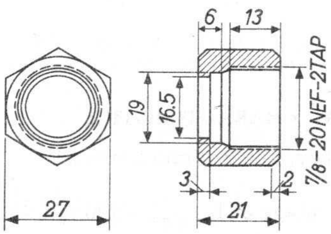
Outline drawing




| | | | |
|---|---|---|---|
| A | 3.8 ±0.05 2) | E | 2.8±0.2 |
| B | 11.1 ±0.15 | F | 4.0±0.2 |
| C | 12.8 ±0.15 | G | 2.0±0.15 |
| D | 15 ±0.2 | | |




1) Reference plane A.

2) The diameter of the excentricity of the inner conductor is max. 1.6 mm.

3) Holes M6 (10 mm depth) for mounting tube onto heatsink.

**MECHANICAL DATA** (continued)

Net weight : approx. 2.4 kg

Mounting position: arbitrary

Base : octal

Accessory

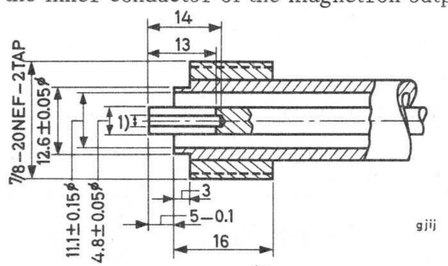
Socket 2422 501 03001

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

**OUTPUT COUPLING**

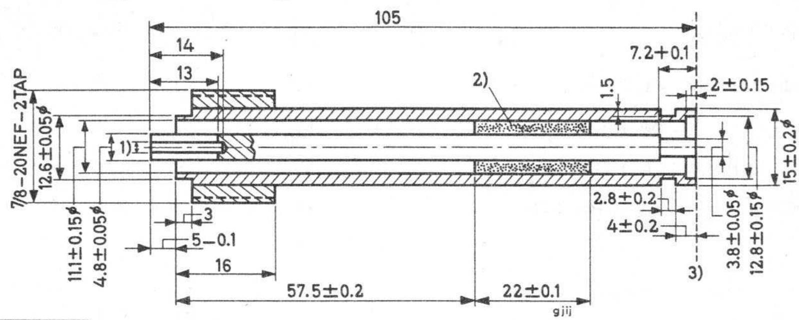
4.8/11.1 coaxial line (50.3 Ω) 4)

The inner conductor should be sufficiently flexible to take up the excentricity of the inner conductor of the magnetron output.




Fixed reflection element 4)

V.S.W.R. approx. 2.0; d approx. 0.45 λ




1) Hole 3.85 + 0.05 mm with 2 slots. The wall segments should be pressed together after slotting.

2) Teflon, $\varepsilon_r$ = 2.0; driving fit.

3) Reference plane B.

4) Not supplied by manufacturer.

## COOLING

The tube does not require any extra cooling provided it is effectively mounted on a heat-conducting non-magnetic plate (heatsink). To obtain an effective natural cooling of the tube, a vertical position of this plate may be advantageous.

## TEMPERATURE LIMITS (Absolute max. rating system)

| | | | | |
|---|---|---|---|---|
| Temperature of any part of the metal envelope | t | max. | 125 | °C |

The temperature of the metal-glass seal of the cathode feedthrough may then reach 210 °C.

## LIMITING VALUES AND TYPICAL OPERATION

The anode supply should be designed so that for any operating condition no limiting value for the mean and peak anode current will be exceeded.

Operation A: A.C. ANODE SUPPLY

## LIMITING VALUES (Absolute max. rating system)

| | | | | |
|---|---|---|---|---|
| Anode current, mean [1] | $I_a$ | max. | 230 | mA |
| peak | $I_{ap}$ | max. | 1.4 | A |
| Voltage standing wave ratio | V.S.W.R. | max. | 2.0 | |

## TYPICAL OPERATION

| | | | |
|---|---|---|---|
| Heater voltage | $V_f$ | 4.5 | V $^{+5\%}_{-10\%}$ |
| Anode current, mean [1] | $I_a$ | 200 | mA |
| peak | $I_{ap}$ | 1.3 | A |
| Anode voltage at matched load [2] | $V_a$ | 1.65 | kV |
| Output power at matched load | $W_o$ | 200 | W |

[1]) Measured with moving coil instrument.

[2]) Measured with filtered D.C. anode supply.

Operation B: ANODE SUPPLY FROM SINGLE-PHASE FULL-WAVE RECTIFIER WITHOUT SMOOTHING FILTER

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

| | | | | |
|---|---|---|---|---|
| Anode current, mean [1] | $I_a$ | max. | 230 | mA |
| peak | $I_{ap}$ | max. | 1.4 | A |
| Voltage standing wave ratio | V.S.W.R. | max. | 2.0 | |

**TYPICAL OPERATION**

| | | | |
|---|---|---|---|
| Heater voltage | $V_f$ | 4.5 | V $^{+5\%}_{-10\%}$ |
| Anode current, mean [1] | $I_a$ | 200 | mA |
| peak | $I_{ap}$ | 0.7 | A |
| Anode voltage at matched load [2] | $V_a$ | 1.65 | kV |
| Output power at matched load | $W_o$ | 200 | W |

Operation C: FILTERED D.C. ANODE SUPPLY

A fixed reflection element must be inserted between the magnetron and the load with the following approximate characteristics:

| | | | |
|---|---|---|---|
| Voltage standing wave ratio | V.S.W.R. | = | 2.0 |
| Phase position | d | = | 0.45 λ (phase of sink region) |

For an example see under "OUTPUT COUPLING"

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

| | | | | |
|---|---|---|---|---|
| Anode current [1] | $I_a$ | max. | 125 | mA |
| Voltage standing wave ratio [3] | V.S.W.R. | max. | 3.0 | |

**TYPICAL OPERATION**

| | | | |
|---|---|---|---|
| Heater voltage | $V_f$ | 4.8 | V $^{+5\%}_{-10\%}$ |
| Anode current [1] | $I_a$ | 100 | mA |
| Anode voltage at matched load | $V_a$ | 1.65 | kV |
| Output power at matched load | $W_o$ | 100 | W |

---

[1]) Measured with moving coil instrument.
[2]) Measured with filtered D.C. anode supply.
[3]) With respect to reference plane B of fixed reflection element.

## DESIGN AND OPERATING NOTES

### GENERAL DESIGN CONSIDERATIONS

Equipment design should be oriented around the tube specifications given in these data sheets and not around one particular tube since due to normal production variations the design parameters ($V_a$, $R_{f_0}$, f, $W_0$ etc.) will vary around the nominal values given.

### ANODE SUPPLY

The magnetron may be operated from an A.C. supply, or an unfiltered single-phase full-wave supply, or from a filtered D.C. supply. In the latter case, however, a fixed reflection element must be used.

In order to keep the peak anode current below its limits it may be necessary to incorporate either a limiting resistance or reactance in the power supply.

### HEATER SUPPLY

The primary of the heater transformer must be high-voltage isolated from the secondary since in normal magnetron operation the cathode will be at high negative potential and the anode should be grounded.
The transformer should be designed so that the heater voltage limits are adhered to.

### STAND-BY OPERATION

In order to avoid the time-consuming warm-up period of the heater of 3-4 minutes when frequent switching of the tube is intended, the heater should be switched back to preheat conditions after the oscillation period instead of being switched off completely. The tube then remains ready for instantaneous operation. This also serves to increase life of the tube.

### STABILITY OF OPERATING MODE

Oscillation stability may be affected particularly by excessive microwave power reflections from the load, excessive peak anode currents, over- or underheating of the cathode, and by magnetic field changes. The resulting instability is referred to as "moding" of the tube and may lead to rapid failure. It should be a major design objective to keep the V.S.W.R. below the maximum limits for all possible load conditions. At very low power settings, it may be possible to relax the V.S.W.R. limits after consulting the tube manufacturer.

## MAGNETIC FIELD

When designing a power supply and cabinet around the tube the influence of

1. ferromagnetic parts and
2. magnetically active components

on the magnetic field of the tube must be considered.

This is especially important when a very compact design is desirable.

1. A minimum distance of 50 mm must be maintained in all directions between the magnet and ferromagnetic parts (e.g. cabinet walls).
2. Transformers and reactors incorporate rather large volumes of iron so that the limits mentioned under 1. apply. In addition they generate stray electro-magnetic fields while in operation. It is therefore recommended to place these elements as far away as possible from the magnetron.

## R.F. SHIELDING

Where required, R.F. radiation from the filament terminals may be reduced by external filtering and/or shielding. Detailed information may be readily obtained from the manufacturer.

## STORAGE, HANDLING, AND MOUNTING

### HANDLING AND STORAGE

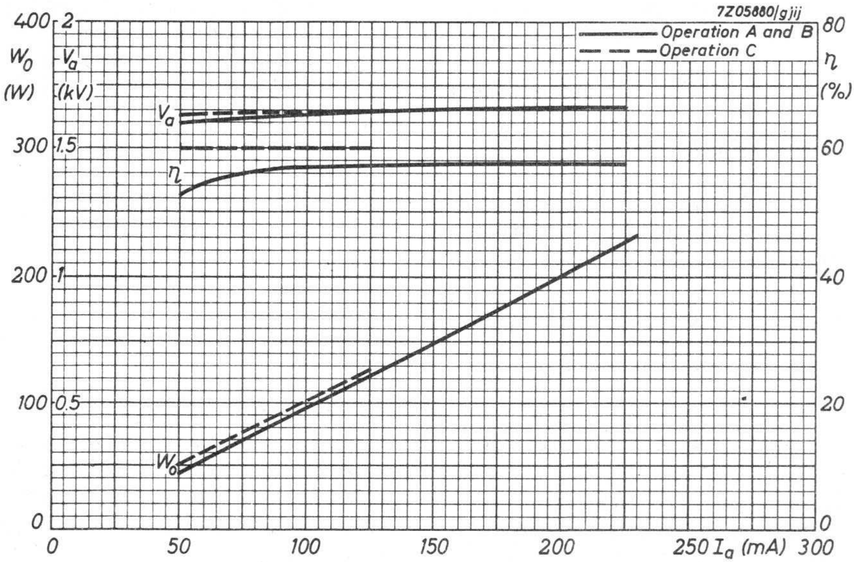
The original packing should be used for transporting and storing the tube.

The strong magnetic field necessary for the operation of the tube must not be weakened permanently. Therefore the tube should never be placed directly on any piece of ferromagnetic material (steel shelfs etc.). The best protection for the tube is its original packing. When the tubes have to be unpacked, e.g. at an assembly line or for measuring purposes, care should be taken that the tubes are not placed closer to each other than 15 cm.

Watches and sensitive measuring instruments may be influenced and damaged by exposure to the magnetic field.

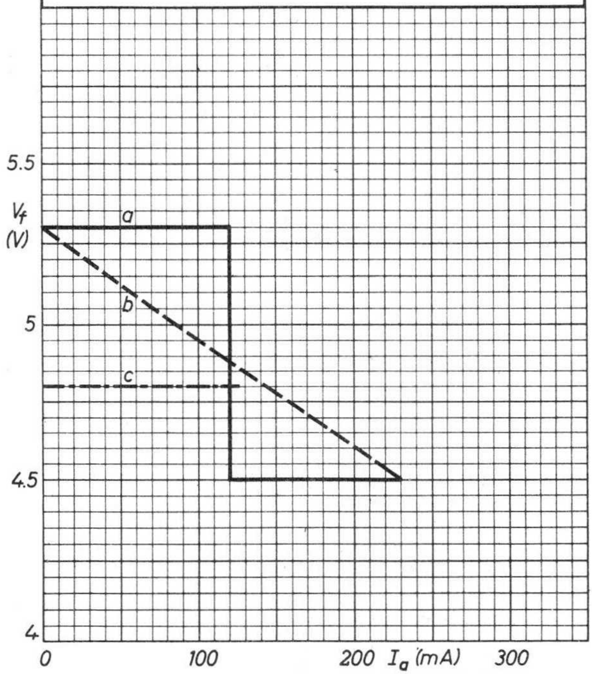
### MOUNTING

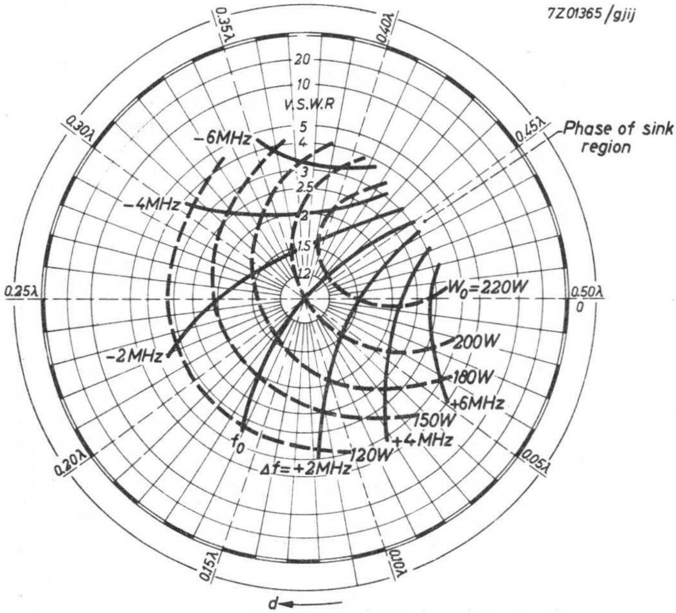
All tools (screwdrivers, wrenches etc.) used close to or in contact with the magnetron should be made of non-magnetic material (e.g. beryllium copper, or brass) to avoid unwanted attraction and possible mechanical damage to glass parts as well as short-circuiting of the magnetic flux.


7Z05880/gjij
Operation A and B
Operation C
400
W_o
(W)
300
200
100
0
2
V_a
(kV)
1.5
1
0.5
V_a
η
W_o
80
η
(%)
60
40
20
0
0
50
100
150
200
250 I_a (mA) 300

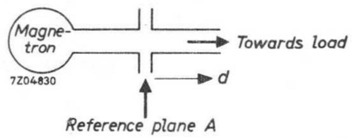
7Z03483/gjij

The heater voltage should be adjusted according to curve a or b for A.C. anode voltage and for unfiltered single-phase full-wave rectified anode voltage and according to curve c for filtered D.C. anode voltage






*Load diagram Operation A*
*Mean anode current 0.2A*
*Peak anode current 1.3A*
*d=distance of standing wave minimum from reference plane A towards load*
*For reference plane see outline drawing*



# Klystrons, high power

# KLYSTRONS, HIGH POWER

ABRIDGED SURVEY

| Frequency range (MHz) | Power gain (dB) | Output power (kW) | Type |
|---|---|---|---|
| 400 - 620 | 30 | 11 | YK1000 |
| 470 - 860 | 30 | 11 | YK1001 |
| 470 - 860 | 30 | 11 | YK1002 |
| 470 - 860 | 40 | 11 | YK1005 |
| 610 - 790 | 30 | 11 | YK1004 |
| 2998 ± 5 | 30 | 6000 [1]) | YK1110 |

[1]) Peak output power

# GENERAL OPERATIONAL RECOMMENDATIONS KLYSTRONS

1. GENERAL

1.1. Data

The characteristic data, operational data, capacitance values and curves apply to an average tube which is characteristic of the type of tube in question.

1.2. Reference point of the electrode voltages

If not otherwise stated the electrode voltages are given with respect to the cathode.

1.3. Operational data

The operational data stated in the data sheets do not relate to any fixed setting instructions. They should rather be regarded as recommendations for the effective use of the tube. On account of the tolerances prevailing, deviations from the settings stated may occur.
It is also possible to use other settings, for which purpose the graphs can be used for finding the operational data, or for which purpose interpolation between the settings stated can be performed. If one wishes to deviate from the settings recommended in the data sheets, one should take great care not to exceed the permissible limiting values. If appreciable deviations occur, the manufacturer should be consulted.
A general rule for multi-cavity klystrons is that the focusing voltage must be adjusted so that the cathode current stated will flow.

1.4. D.C. connections

At all times there should be a D.C. connection between each electrode and the cathode. If necessary, limiting values have been stated for the resistance of these connections.

1.5. Mounting and removal

Large klystrons must be mounted in a vertical position, the cathode terminals pointing upwards. Reflex klystrons may as a rule be mounted in any desired position. The instructions relating to each type of tube can be found in the data sheets and the "Instructions for operation and maintenance".
The mounting and removal should be effected with extreme care to avoid damage to the tube. This also applies to rejected tubes, where claims are made under guarantee.
Ferromagnetic parts must not be used in the vicinity of klystrons equipped with a permanent magnet, as this might have a detrimental effect on the operation

of the klystron. If necessary, the ceramic insulators and windows must be carefully cleaned, as dirt may damage the klystron on account of local overheating. Naturally the flange of the output cavity must also be thoroughly cleaned so as to prevent arcing.
The "Instructions for Operation and Maintenance" should in all cases be followed.

1.6. Accessories

Perfect operation of the tubes can only be guaranteed if use is made of the accessories which the manufacturer designed for the tube.

1.7. Supply leads

The supply leads to the connections and terminals must be of such a quality that no mechanical stresses, due to differences in temperature or other causes, can occur.

1.8. Danger of radiation

In general the absorption in the tissues of the body, and hence the danger, is the greater the shorter the wavelength of the H.F. radiation at equal output. The output of klystrons may be so high that injuries (in particular of the eye) can be inflicted.
Klystrons operated at a high voltage (exceeding 16 kV) may moreover emit X-rays of appreciable intensity, which call for protection of the operators.

## 2. LIMITING VALUES

### 2.1. Absolute limiting values

In all cases the limiting values stated are absolute maximum or minimum values. They apply either to all settings or to the various modes of operation. The values stated should in no case be exceeded, neither on account of mains-voltage fluctuations and load variations, nor on account of production tolerances in the various building elements (resistors, capacitors, etc.) and tubes, or as a result of meter tolerances when setting the voltages and currents.
Every limiting value should be regarded as the permissible absolute maximum independent of other values. It is not permitted to exceed one limiting value because another is not reached. For instance, one should not allow the limiting value of the collector current to be surpassed while reducing the collector voltage below the permissible limiting value.
If in special cases it should be necessary to exceed a specific limiting value, it is advisable to consult the tube manufacturer, as otherwise no claims can be made.

### 2.2. Protective circuit

To prevent the limiting values of voltages, currents, outputs and temperatures from being exceeded, fast-operating protective circuits must be provided.

2.3. Drift current

The limiting value indicated for the drift current is an arithmetical mean value.

## 3. NOTES ON OPERATION

### 3.1. Operational data and variations

When developing electrical equipment the spread in the tube data must be taken into account; if necessary, the tube tolerances can be applied for.
With respect to the spread in the operational data and the average values stated in the data sheets it is recommended to allow for a certain margin in the output and input powers when designing equipment intended for series production.

### 3.2. Input power, required driving power

In the data sheets the power stated is the input power $W_{dr}$ fed to the input cavity and measured between the circulator and this cavity at a 50-ohm resistor serving as a substitute for the load presented by the cavity.

### 3.3. Output power

As a general principle the effective output power is stated.

### 3.4. Sequence of application of the electrode voltages

With multi-cavity klystrons the electrode voltages must be connected in the order given in the operating instructions.

### 3.5. Drift current

When the klystron is driven by an A.M. signal (for instance a video signal), the drift current fluctuates with the modulation. Consequently, the power-supply unit must be designed so as to be suitable for the peak values occurring, which may be appreciably higher than the arithmetical mean values stated.

## 4. HEATING

### 4.1. Type of current

Klystrons can be heated by means of either standard alternating current or direct current. At other frequencies the tube manufacturer should be consulted.

### 4.2. Adjusting the heater voltage

The heater voltage generally governs the adjustment of the heating, while the heater current may deviate from its nominal value within fixed tolerances. The heater voltage should be maintained as accurately as possible. For measuring the heater voltage an R.M.S. voltmeter is required. This meter must be directly connected to the filament terminals of the tube and have an inaccuracy $< 1.5\ \%$ in the voltage range concerned. The indicated measuring value should lie in the uppermost third part of the scale.

7Z2 9003

4.3. Switching on the heater current

If the data sheet does not contain special data concerning the heater current during switch-on, the tube may be switched on at full heater voltage.
If maximum values are stated for the heater current during switch-on, they relate to the absolute maximum instantaneous value under unfavourable conditions. In the case of A.C. supply this value will occur if the tube is switched on at the maximum amplitude of the highest mains voltage. It is possible to calculate the maximum current during switch-on if the cold resistance and the relationship between the heater current and the heater voltage are known. In practice a heater transformer more or less acting as a leakage transformer is mostly used for limiting the starting current, or a choke coil or resistor is connected in series with the primary of the heater transformer. This choke coil or resistor can be short-circuited by a relay whose action is delayed by about 15 seconds. By means of a calibrated oscilloscope it can be checked whether the starting current remains within the permissible limits; the supply lead may, if necessary, be used as precision resistance.

## 5. COOLING

5.1. Forced-air cooling

It is essential that the faces of tubes that are to be cooled by an air-blast should be hit as evenly as possible by the air stream, so as to prevent large differences in temperature which may give rise to mechanical stresses. In many cases (in particular with the large types of tubes) an additional air stream must be directed to the metal-to-glass or metal-to-ceramic seals. The cooling air is usually supplied from a fan via an insulating duct. This air should be filtered, so that all impurities and moisture are removed; in addition to this the radiator must be cleaned at regular intervals. The data concerning the cooling can be found in the data sheets. The cooling must be switched on together with the heating. After the klystron has been switched off cooling air must be supplied for some time; this period depends on the size of the tube and the load. If the cooling of whatever part of the tube is interrupted or if the quantity of cooling air is too small, the collector voltage and the heating must be switched off automatically.

5.2. Water-cooling

With water-cooled klystrons the cooling equipment is rigidly attached to the tube. If the equipment should be live, the cooling water must be supplied through insulating pipes, of sufficient lenght.
The water-cooling and air-cooling for other parts of the tube must be switched on together with the heating. The cooling-water circuit must be arranged so that the water always enters at the bottom, no matter how the tube is mounted. If the pumps should be out of operation, the water jacket(s) of the tube must always be full. In that case after-cooling may in general be done away with.
In many cases the metal-to-glass or metal-to-ceramic seals require additional cooling by a low velocity air flow. If the cooling water supply or additional

air-cooling should fail, the collector voltage and heating must immediately be switched off. Further cooling data can be found in the data sheets.
The specific resistance of the cooling water must be min. 20 kΩ-cm, the temporary hardness must be max. 6 German degrees of hardness. On principle destilledwater shouldbe used in the circulation cooler; to reduce the corrosive effect of the distilled water about 700 mg of 24-% dyamide hydrate and 700 mg sodium silicate must be added per litre. The pH-value should range from 7 to 9.
If frost is to be expected, a suitable anti-freezing mixture should be added.

## 6. STORAGE

Klystrons may only be stored in their original packing and according to the instructions, so as to avoid damage. For fitting the tubes must be removed from the packing and directly inserted into the support. In all cases the "Instructions for operation and maintenance" must be adhered to.
In the case of prolonged storage the vacuum of high-power klystrons should be checked at intervals of about three months and improved if necessary, both being possible with the aid of the built-in getter ion pump and a suitable power supply / test unit. During this operation the heater supply should preferably be turned on slowly.

# U.H.F. POWER KLYSTRON

Power amplifier klystron in metal-ceramic construction designed for four external resonant cavities, magnetic beam focusing, continuous operating getter ion pump. The tubes are intended for use as U.H.F. power amplifier in T.V. transmitters.

| QUICK REFERENCE DATA | | | |
|---|---|---|---|
| Frequency | YK 1000 | 400 to 620 | MHz |
| | YK 1004 | 610 to 790 | MHz |
| Power output | | 11 | kW |
| Power gain | | 30 | dB |
| Cooling | water and air. | | |

**HEATING** : Indirect by A.C. or D.C.

| | | | |
|---|---|---|---|
| Cathode | | dispenser type | |
| Heater voltage | $V_f$ | 7.5 to 8 | V 1) |
| Heater current | $I_f$ | 32 ($\leq$ 36) | A |

The heater current should never exceed a peak value of 80 A when applying a A.C. heater voltage or 65 A when applying a D.C. heater voltage.

| | | | | |
|---|---|---|---|---|
| Cold heater resistance | $R_{f_o}$ | | 28 | mΩ |
| Heating time before application of high voltage (waiting time) | $T_w$ | unit | 180 | s |

GETTER ION PUMP POWER SUPPLY

| | | | | |
|---|---|---|---|---|
| Pump voltage, unloaded (cathode reference) | $V_{pump}$ | | 3.9 | kV |
| loaded ($\approx$ 3 mA) | $V_{pump}$ | | 3.0 | kV |
| Internal resistance | $R_i$ | approx. | 300 | kΩ |
| Pump current as a function of pressure | $I_{pump}$ | See page 7 | | |

1) During operation the applied heater voltage should not fluctuate more than $\pm$ 3%.

POWER SUPPLY FOR FOCUSING COILS

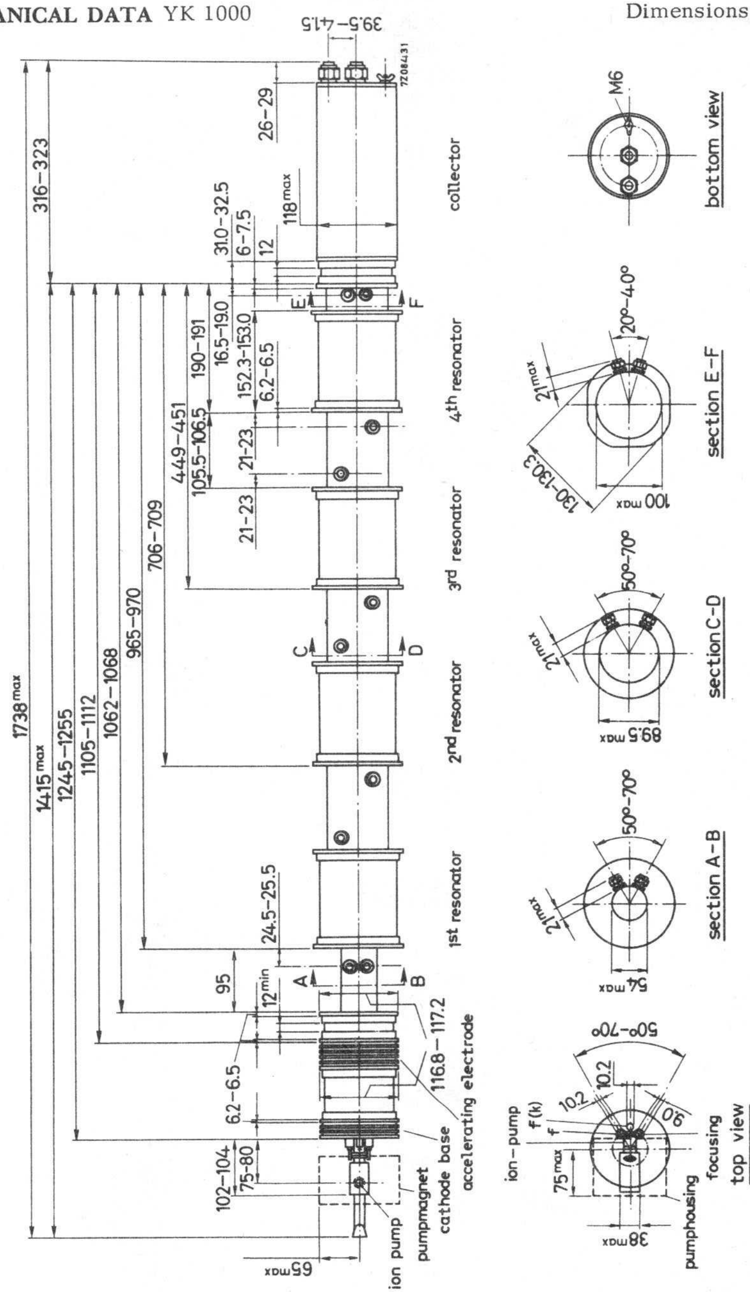
| | | | |
|---|---|---|---|
| Focusing coil | V | 35 to 50 | V |
| | I | 1.0 to 1.5 | A |
| Focusing coils for drift tubes (connected in series) | V | 250 to 500 | V |
| | I | 1.8 to 2.8 | A |

**COOLING**

| | |
|---|---|
| Cathode base | low velocity air flow |
| Accelerating electrode | low velocity air flow |
| Drift tubes | water or glycol solution (30%)<br>$q = 2\ l/min$, $t_i$ = max. 60 $^oC$ |
| Output resonator | forced air<br>$q = 2\ m^3/min$ at $t_i = 20\ ^oC$ |
| Collector | water or glycol solution (30%)<br>See cooling curves |

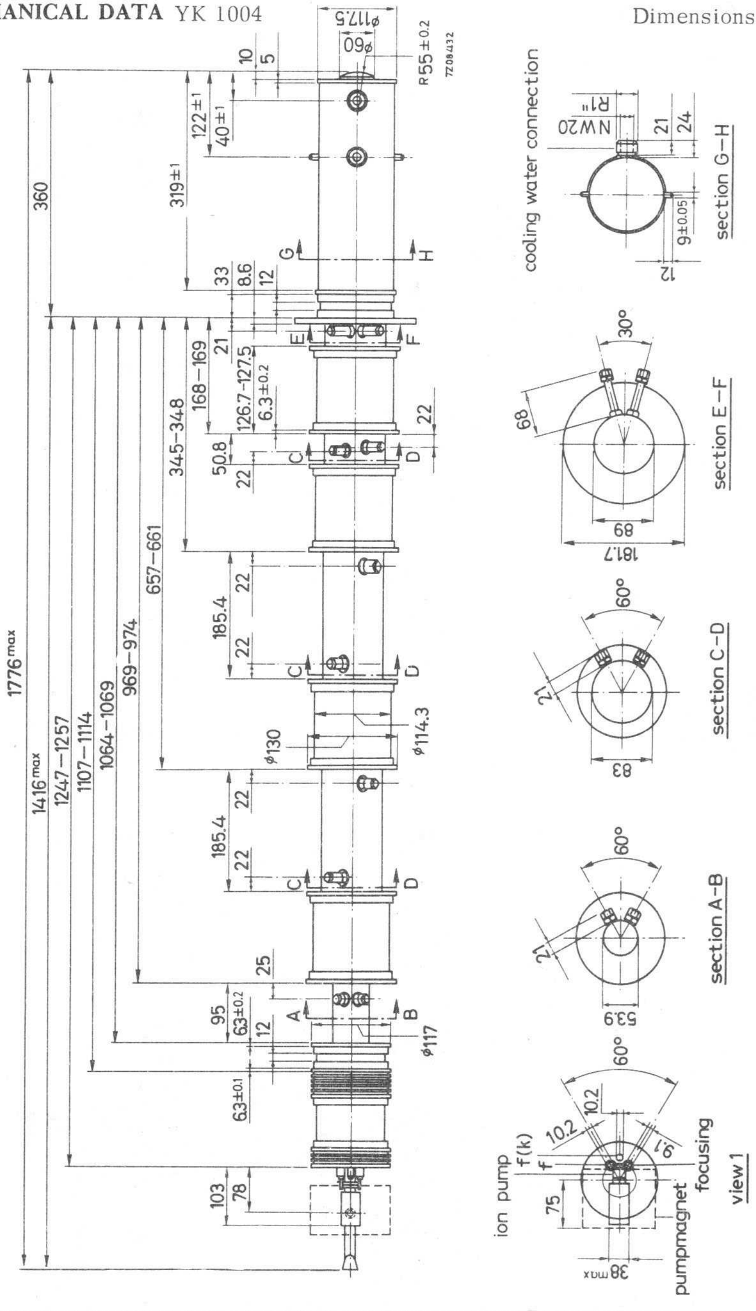
**MECHANICAL DATA** YK 1000

Dimensions in mm



**MECHANICAL DATA** YK 1004

Dimensions in mm



Mounting

Vertical, cathode up
All connections should be free from strain.

Accessories

| | |
|---|---|
| Heater connector | type 40649 |
| Heater/cathode connector | type 40649 |
| Focusing electrode connector | type 40634 |
| Accelerating electrode connector | type TE 1052 |
| Ion pump connector | type 55351 |
| Magnet unit for ion pump | type TE 1053 |
| Collector connector for YK1004 only | type 40634 |

Weight

| | | | | |
|---|---|---|---|---|
| Net weight | YK 1000 | approx. | 30 | kg |
| | YK 1004 | approx. | 40 | kg |

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

Unless otherwise mentioned all voltages are specified with respect to ground.

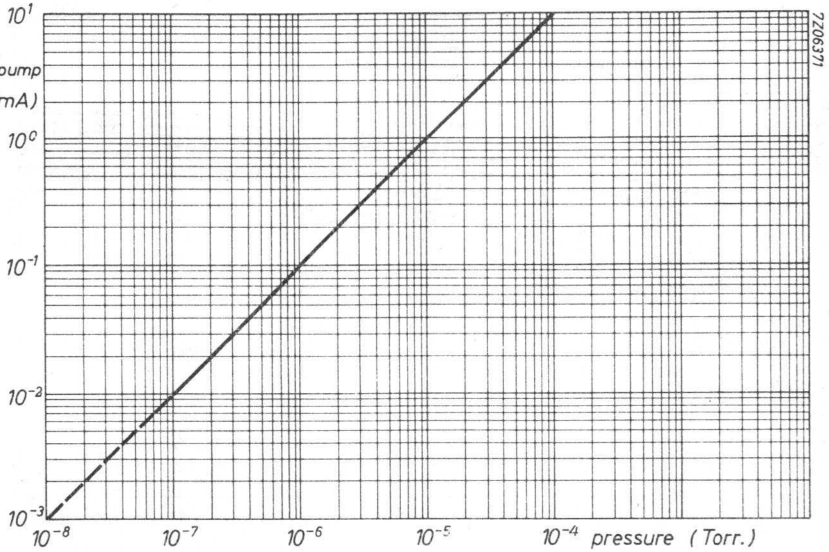
| | | | | |
|---|---|---|---|---|
| Cathode voltage | $-V_k$ | max. | 20 | kV |
| Cathode voltage at zero current | $-V_{k_o}$ | max. | 21 | kV |
| Cathode current | $I_k$ | max. | 2.1 | A |
| Total drift tube current | I | max. | 100 | mA |
| Focusing electrode to cathode voltage | $-V_{foc/k}$ | max. | 500 | V |
| Pump voltage (cathode reference) | $V_{pump/k}$ | max. | 4 | kV |
| Pump current | $I_{pump}$ | max. | 15 | mA |
| Temperature limits | | | | |
| cathode base | $t_k$ | max. | 125 | °C |
| accelerating electrode | $t_{acc.}$ | max. | 125 | °C |
| Collector dissipation | $W_c$ | max. | 50 | kW |

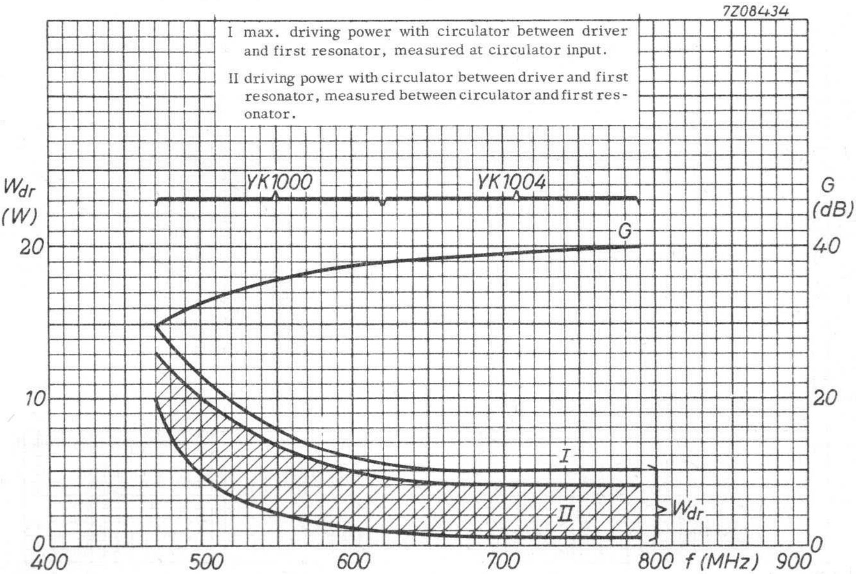
**OPERATING CONDITIONS**

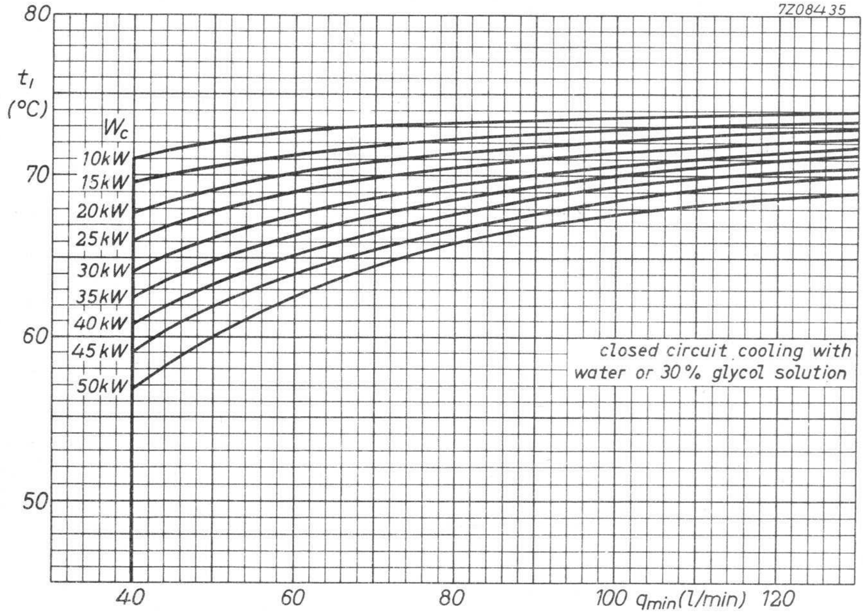
As a 10 kW T.V. picture amplifier in the band 470 MHz to 790 MHz according to the C.C.I.R. system with negative modulation. Unless otherwise mentioned all voltages are specified with respect to ground.

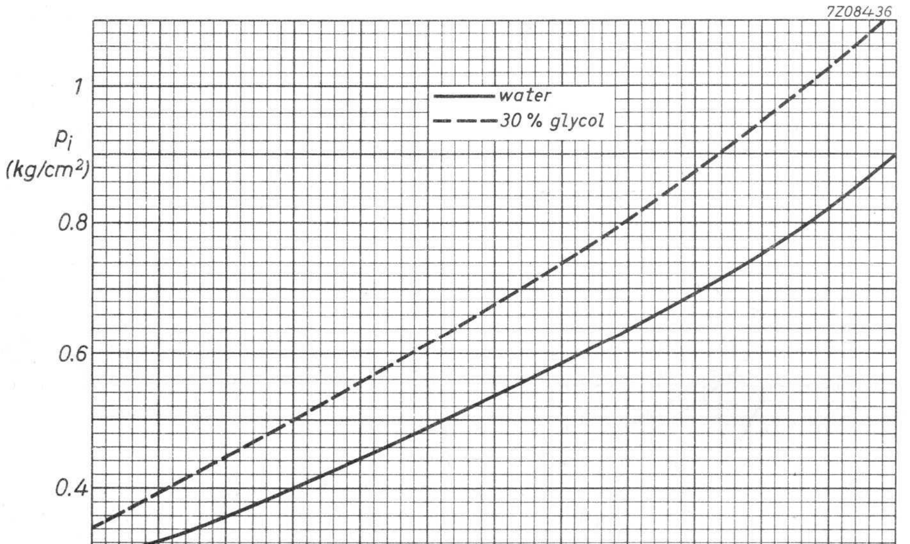
| | | | | |
|---|---|---|---|---|
| Cathode voltage | $V_k$ | 19.0 | 18.0 | kV |
| Focusing electrode to cathode voltage | $V_{foc/k} \approx$ | -250 | -200 | V |
| Cathode current | $I_k$ | 2.05 | 2.0 | A |
| Drift tube current, static 1) | $I \approx$ | 40 | 40 | mA |
| dynamic 2) | $I \approx$ | 50 | 50 | mA |
| Driving power, sync | | See curve | | |
| Output power, sync | $W_o$ | 11 | 11 | kW |
| Power gain | $G \approx$ | 30 | 30 | dB |

1) For optimum operating conditions the electron beam should be focused for minimum drift tube current.


7Z06371
$I_{pump}$ (mA)
$10^1$
$10^0$
$10^{-1}$
$10^{-2}$
$10^{-3}$
$10^{-8}$
$10^{-7}$
$10^{-6}$
$10^{-5}$
$10^{-4}$
pressure (Torr.)


7Z08434
I max. driving power with circulator between driver and first resonator, measured at circulator input.
II driving power with circulator between driver and first resonator, measured between circulator and first resonator.
YK1000
YK1004
$W_{dr}$ (W)
G (dB)
G
I
II
$W_{dr}$
0
10
20
20
40
400
500
600
700
800
f (MHz)
900


7Z08435
80
$t_l$
(°C)
$W_c$
10kW
15kW
20kW
25kW
30kW
35kW
40kW
45kW
50kW
70
60
50
closed circuit cooling with
water or 30 % glycol solution
40
60
80
100 $q_{min}$(l/min) 120


7Z08436
1
$p_i$
(kg/cm²)
0.8
0.6
0.4
water
30 % glycol
40
45
50
55
60
65 $q_{min}$(l/min)70

# U.H.F. POWER KLYSTRON

Power amplifier klystron in metal-ceramic construction for the frequency band 470 MHz to 860 MHz designed for four external resonant cavities, beam focusing by means of permanent magnets, continuously operating getter ion pump and operation with a depressed collector potential. This klystron is intended for use as U.H.F. power amplifier in vision and/or sound transmitters for the T.V. bands IV and V.

| QUICK REFERENCE DATA | |
|---|---|
| Frequency | 470 to 860 MHz |
| Power output | 11 kW |
| Power gain | 30 dB |
| YK1001 air cooled drift tubes and air cooled collector | |
| YK1002 air cooled drift tubes and water cooled collector 1) | |

**HEATING**: Indirect by A.C. or D.C.

| | | | |
|---|---|---|---|
| Cathode | | dispenser type | |
| Heater voltage | $V_f$ | 7.5 to 8.0 | V 2) |
| Heater current | $I_f$ | 32 (≤ 36) | A |

The heater current should never exceed a peak value of 80 A when applying an A.C. heater voltage or 65 A when applying a D.C. heater voltage.

| | | | |
|---|---|---|---|
| Cold heater resistance | $R_{f_o}$ | 28 | mΩ |
| Heating time before application of high voltage (waiting time) | $T_w$ | min. 180 | s |

GETTER ION PUMP POWER SUPPLY

| | | | |
|---|---|---|---|
| Pump voltage, unloaded (cathode reference) | $V_{pump}$ | 4.0 | kV |
| Internal resistance | $R_i$ | approx. 300 | kΩ |
| Pump current as a function of pressure | $I_{pump}$ | see page 8 | |

1) On request the YK1002 can also be delivered with vapour cooled collector.
2) During operation the applied heater voltage should not fluctuate more than ± 3%. It is advised to operate the klystron at 8 to 8.5 V (including mains fluctuations) during the first 300 hours. Then the heater voltage should be reduced to 7.5 to 8.0 V.

## COOLING

Except collector applicable up to an air-inlet temperature $t_i$ of 40 °C and an altitude h of 3000 m. (values refer to air inlet)

| | |
|---|---|
| Cathode base | air, q = approx. 0.5 $m^3$/min |
| Accelerating electrode | air, q = approx. 0.5 $m^3$/min |
| Drift tubes 1, 2 and 3 | air, q = approx. 1.0 $m^3$/min each |
| Drift tube 4 | air, q = approx. 1.5 $m^3$/min |
| Drift tube 5 | forced air, q = approx. 1.5 $m^3$/min ($p_i$ = 90 mm $H_2O$) |
| Resonant cavity D | forced air, q = approx. 2.0 $m^3$/min ($p_i$ = 90 mm $H_2O$) |
| Collector YK1001 | forced air, see cooling curves pages 9 and 10 |
| Collector YK1002 | water, see cooling curves page 11 |

## MOUNTING

Vertical, cathode up. In order to prevent distortion of the magnetic focusing field ferromagnetic material should not be applied within a radius of 35 cm from the tube axis. All connections should be free from strain.

## ACCESSORIES

| | |
|---|---|
| Heater connector | type 40649 |
| Heater/cathode connector | type 40649 |
| Focusing electrode connector | type 40634 |
| Accelerating electrode connector | type 40634 |
| Collector connector | type 40634 |
| Ion pump connector | type 55351 |
| Magnet unit for ion pump | type TE1053 |
| Set of five pairs of focusing magnets | type TE1065 (2xA, 2xB, 2xC, 2xD, 2xE) [2] |
| Set of four resonant cavities for 470 MHz to 790 MHz | type TE1066 (3xA, 1xD) |
| or | |
| Set of four resonant cavities for 700 MHz to 860 MHz | type TE1067 (3xA, 1xD) |
| 2 Magnet field adaptor plates for collector (YK1001 only) [1] | type TE1073 |
| Circulators, temperature compensated up to 70 °C (optional) | type 2722 162 01061 (470 MHz to 600 MHz)<br>01071 (590 MHz to 720 MHz)<br>01081 (710 MHz to 860 MHz)<br>01101 (608 MHz to 790 MHz) |

---

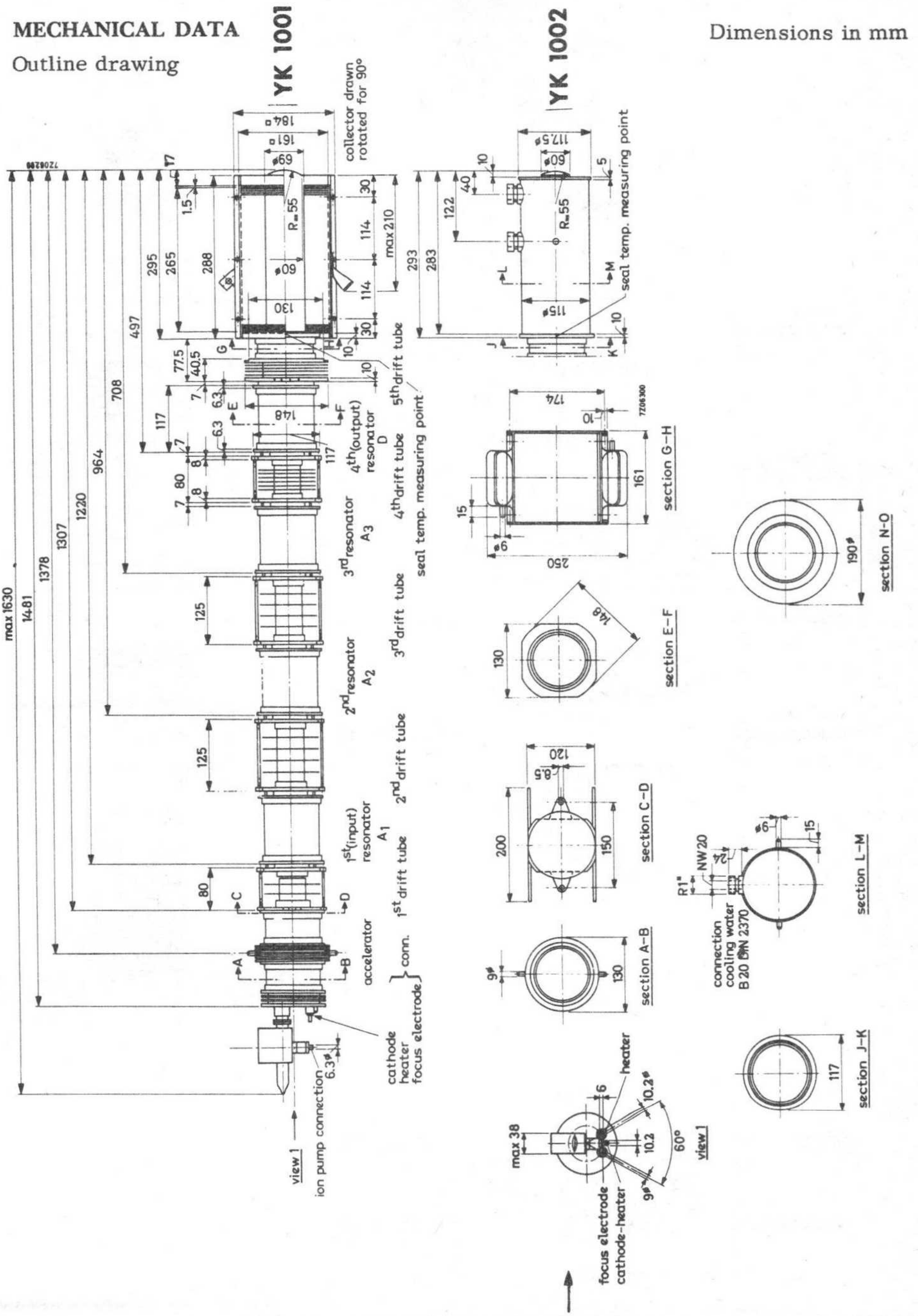
[1] In case of operation with a collector voltage less than -2kV these plates should be fitted along the collector in order to keep the collector temperatures below the max. values. See "Instructions for operation and maintenance".

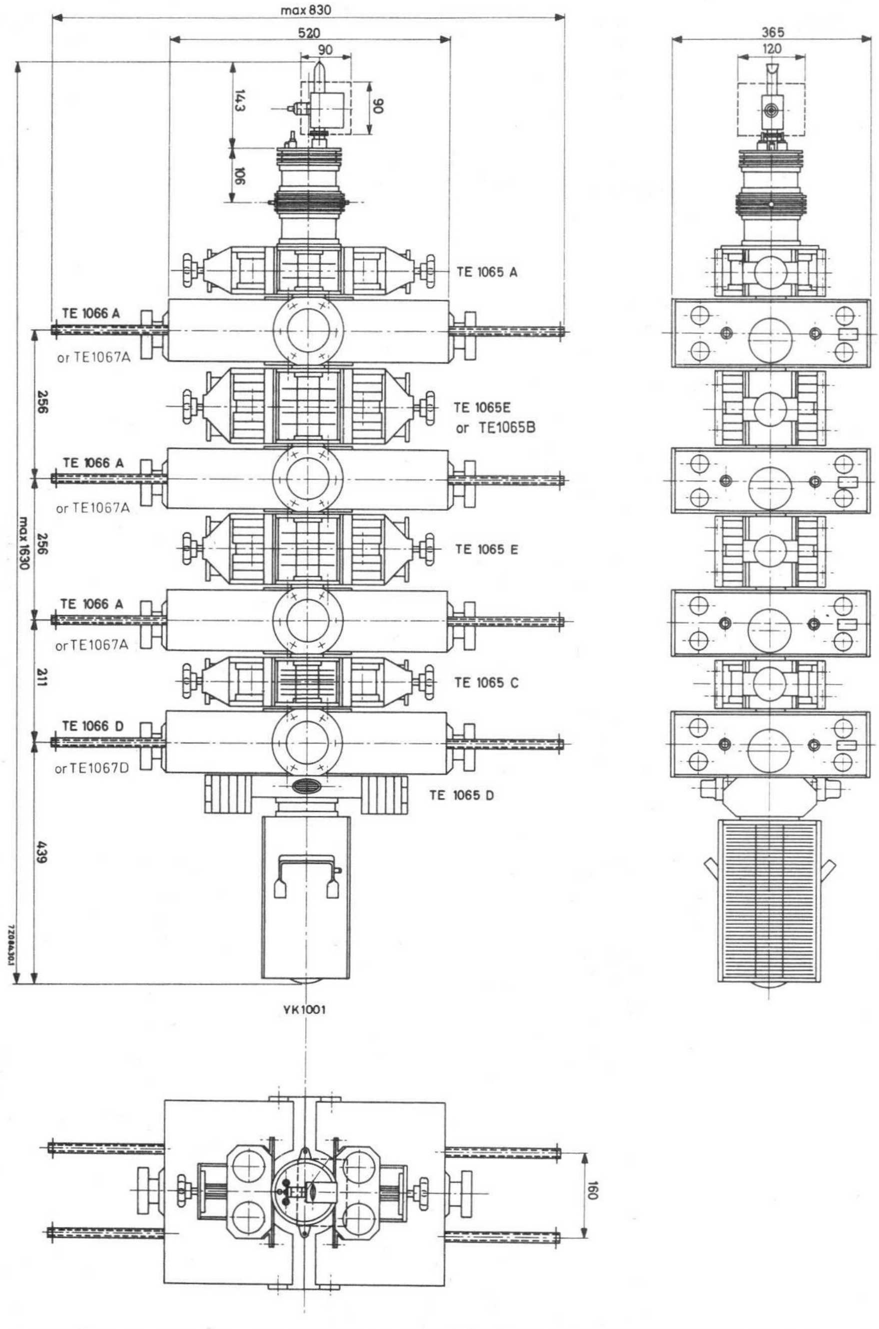
[2] If the klystron is used under T.V. transposer conditions replace 2xB by 2xE.

## MECHANICAL DATA

Outline drawing

Dimensions in mm




max 830
520
90
14.3
90
106
365
120
TE 1065 A
TE 1066 A
or TE1067A
TE 1065E
or TE1065B
TE 1066 A
or TE1067A
TE 1065 E
TE 1066 A
or TE1067A
TE 1065 C
TE 1066 D
or TE1067D
TE 1065 D
256
256
211
439
max 1630
7Z08430.1
YK1001
160

**LIMITING VALUES AND OPERATING CONDITIONS**

Unless otherwise mentioned all voltages are specified with respect to ground.

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

| | | | |
|---|---|---|---|
| Heater voltage | max. | 8.5 | V |
| Cathode voltage | max. | -22 | kV |
| Cathode voltage at zero current | max. | -25 | kV |
| Accelerating electrode voltage at zero current | max. | -25 | kV |
| Collector voltage | max. | -7 | kV |
| | min. | -0.5 | kV |
| Focusing electrode to cathode voltage | max. | -700 | V |
| | min. | -100 | V |
| Series resistance in accelerating electrode circuit | max. | 20 | kΩ |
| | min. | 10 | kΩ |
| Cathode current | max. | 2.3 | A |
| Drift tube current [1] | max. | 150 | mA |
| Beam power | max. | 42 | kW |
| Collector dissipation | max. | 40 | kW |
| Voltage standing wave ratio | max. | 1.5 | |
| Pump voltage | max. | 4.5 | kV |
| Pump current | max. | 15 | mA |
| Temperature of | | | |
| cathode base and accelerating electrode | max. | 125 | °C |
| drift tubes 1, 2 and 3 | max. | 80 | °C |
| drift tubes 4 and 5 | max. | 150 | °C |
| resonant cavity D | max. | 125 | °C |
| collector seal YK1001 | max. | 200 | °C |
| collector body YK1001 [2] | max. | 300 | °C |
| outlet cooling water YK1002 | max. | 75 | °C |

1) The limiting values for various operating conditions are given on page 12

2) For safeguarding this temperature limit it is recommended to measure the air outlet temperature at least at two places, viz. one at 5 cm and one at 15 cm from the upper collector plate and at a distance of 5cm from the cooling fins. See also "Instructions for operation and maintenance".

## OPERATING CONDITIONS

During operation the applied voltages should not fluctuate more than ± 3%. [1]

A. As 5 kW and 10 kW vision amplifier in the band 470 MHz to 860 MHz in accordance with the C.C.I.R. system with negative modulation. [2][3]
Bandwidth (-1 dB): 6 MHz

| | | | | | | |
|---|---|---|---|---|---|---|
| Output power, peak sync | | 5.5 | 5.5 | 11 | 11 | kW |
| Driving power, peak sync [4][5][6] | | 8 | 8 | 10 | 10 | W |
| Power gain [4] | | 30 | 30 | 30 | 30 | dB |
| Cathode to collector voltage [7] | | -16.0 | -11.5 | -18 | -13.5 | kV |
| Collector voltage [8] | | -0.5 | -5 | -0.5 | -5 | kV |
| Accelerating electrode voltage [9] | | 0 | 0 | 0 | 0 | kV |
| Focusing electrode to cathode voltage [16] | ≈ | -400 | -400 | -400 | -400 | V |
| Cathode current | | 1.6 | 1.6 | 1.9 | 1.9 | A |
| Drift tube current, static [10] | | 25 | 30 | 25 | 30 | mA |
| black level [11] | ≈ | 40 | 80 | 40 | 100 | mA |
| Differential gain [12] | ≈ | 80 | 80 | 80 | 80 | % |
| Sync compression [13] | ≤ | 45/25 | 45/25 | 45/25 | 45/25 | |
| V.S.B. suppression [14] | ≤ | -20 | -20 | -20 | -20 | dB |
| Noise with ref. to black level [15] | ≤ | -46 | -46 | -46 | -46 | dB |

Tuning of cavities with respect to carrier frequency

| | | | |
|---|---|---|---|
| Cavity A1 | approx. | + 3 | MHz |
| Cavity A2 | approx. | -0.5 | MHz |
| Cavity A3 | approx. | +4.5 | MHz |
| Cavity D | approx. | 0 | MHz |

External cavity loading at black level for 11 kW sync power output

| | | | |
|---|---|---|---|
| Cavity A1 | max. | 5 | W |
| Cavity A2 | max. | 100 | W |
| Cavity A3 | max. | 200 | W |

B. As 1 kW, 2 kW and 4 kW TV sound amplifier in the band 470 to 860 MHz [2][3]

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Output power | | 1.1 | 1.1 | 2.2 | 2.2 | 4.4 | 4.4 | kW |
| Driving power [4][5] | ≤ | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | W |
| Cathode to coll. voltage [7] | | -18 | -13.5 | -18 | -13.5 | -18 | -13.5 | kV |
| Collector voltage | | -0.5 | -5 | -0.5 | -5 | -0.5 | -5 | kV |
| Acc. electr. voltage | | -9 | -9 | -7.5 | -7.5 | -5.5 | -5.5 | kV |
| Foc. electr. to cath. voltage | ≈ | -400 | -400 | -400 | -400 | -400 | -400 | V |
| Cathode current | | 0.5 | 0.5 | 0.7 | 0.7 | 1.0 | 1.0 | A |
| Drift tube current dyn [10] | ≈ | 40 | 50 | 40 | 50 | 50 | 70 | mA |

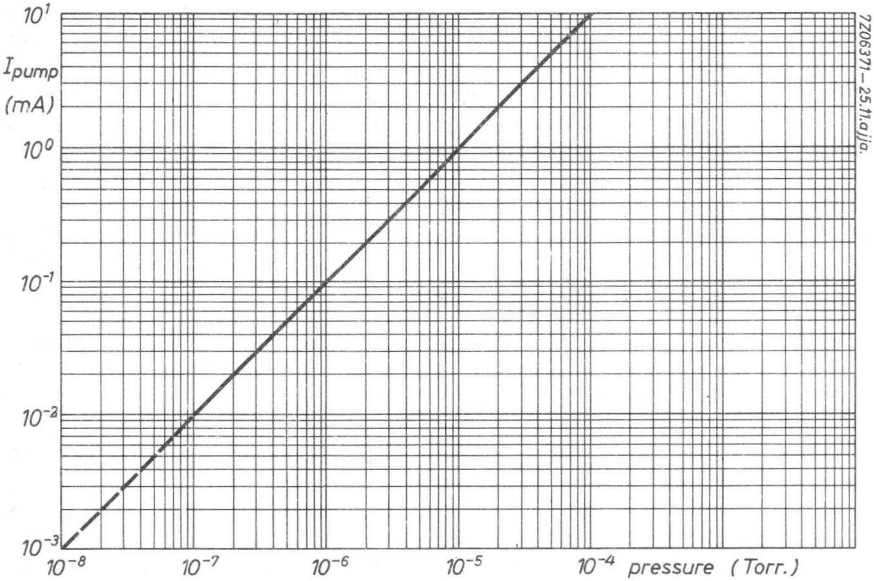
Notes see page 7

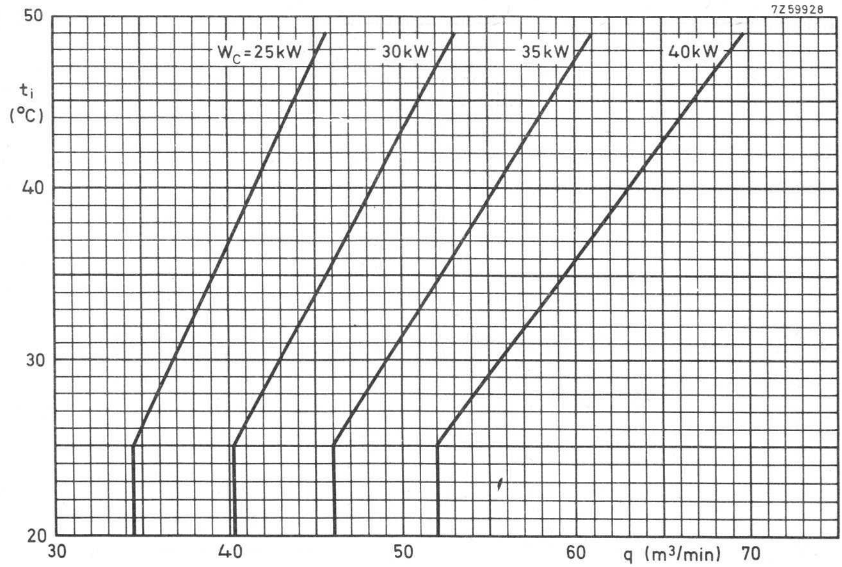
Notes to page 6

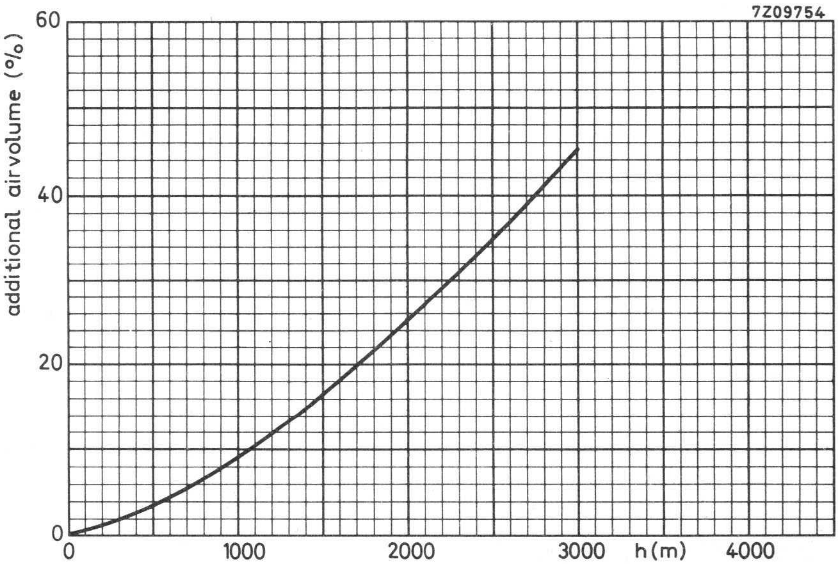
1) Fluctuations of the beam voltage up to ± 3% will not damage the tube; to meet the signal-transfer quality requirements the nominal beam voltage should not vary more than ± 1%.
2) With the appropriate focusing magnets TE1065, cavities TE1066 and a circulator between the driver and input cavity A1.
3) In case of a failure all electrode voltages for the klystron except the pump and heater voltages should be switched off, and reduced to less than 5% of the nominal value within 500 ms after the failure has occurred.
4) Dependent on operating frequency, see page 12
5) The driving power Wdr is measured between the circulator and the first cavity at a 50 ohm resistance and represents the sum of the forward and the reflected power in the first cavity.
6) A pre-correction is to be introduced in the pre-stage to compensate for the level dependency of the bandpass curve caused by non-linearities of the klystron, see "Instructions for operation and maintenance".
7) At frequencies above 790 MHz a higher beam power is required to meet the nominal output requirement. Operating data on request.
8) In case of operation with a collector voltage less than - 2kV the temperature-compensating plates TE1073 should be fitted along the collector. See "Instructions for operation and maintenance".
9) It is recommended to obtain this voltage from a voltage divider between cathode and ground, which should carry a quiescent current of minimum 3 mA.
10) To be focused for minimum drift tube current.
11) At black level to be focused for minimum drift tube current.
If necessary to obtain the required signal transfer quality, a deviation of max. 10% from this minimum current is permitted. The lim. value, see page 12, may, however, not be exceeded.
12) Measured with a sawtooth voltage with amplitude between 17 and 75% of the peak sync value, on which is superimposed a 4.43 MHz sine wave with a 10% peak-to-peak value.
13) A picture/sync ratio of 75/25 for the outgoing signal of the klystron requires a ratio of max. 55/45 for the incoming signal.
14) Measured with 10 to 70% modulation, without compensation. V.S.B. filter between driver and klystron.
15) Produced by the klystron itself, without hum from power supplies.
16) **The power supply should be adjustable from −100 V to −700 V and be preloaded with min. 10 mA at −700 V.**

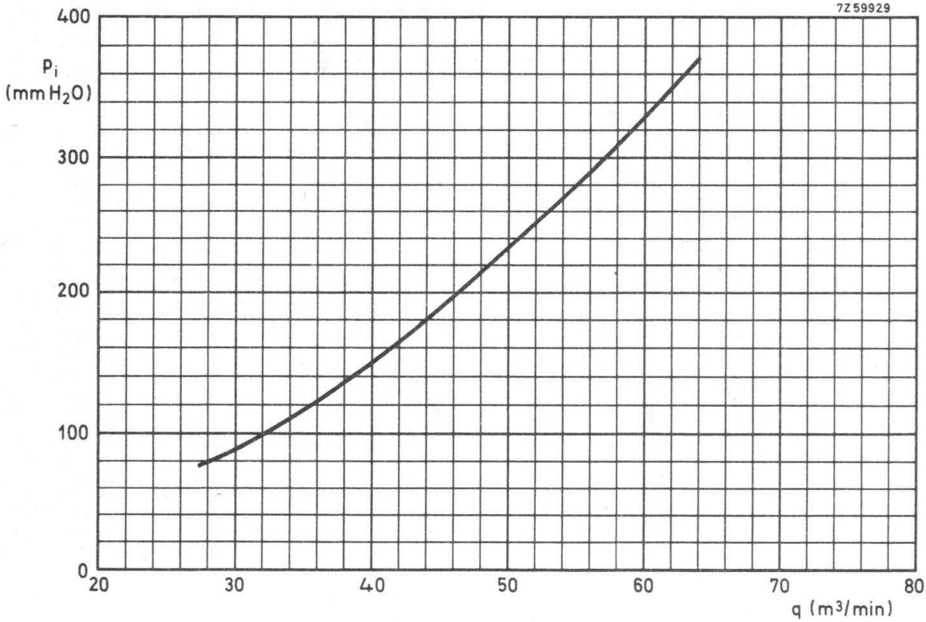
Weight

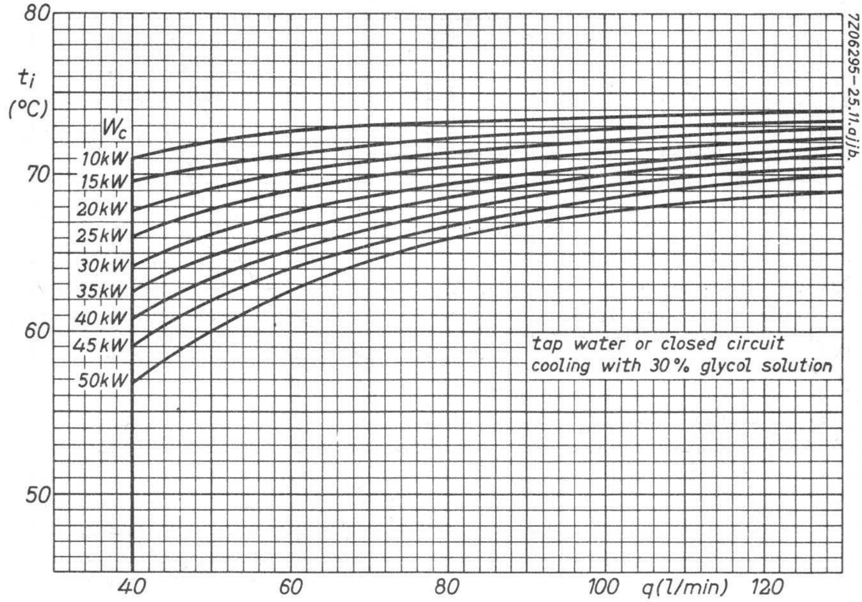
| | | | |
|---|---|---|---|
| Net weight | YK1001 | approx. | 55 kg |
| | YK1002 | approx. | 45 kg |
| Total weight of accessories | | approx. | 125 kg |


$10^1$
$I_{pump}$
(mA)
$10^0$
$10^{-1}$
$10^{-2}$
$10^{-3}$
$10^{-8}$
$10^{-7}$
$10^{-6}$
$10^{-5}$
$10^{-4}$
pressure (Torr.)
7Z06371-25.11.ajja.

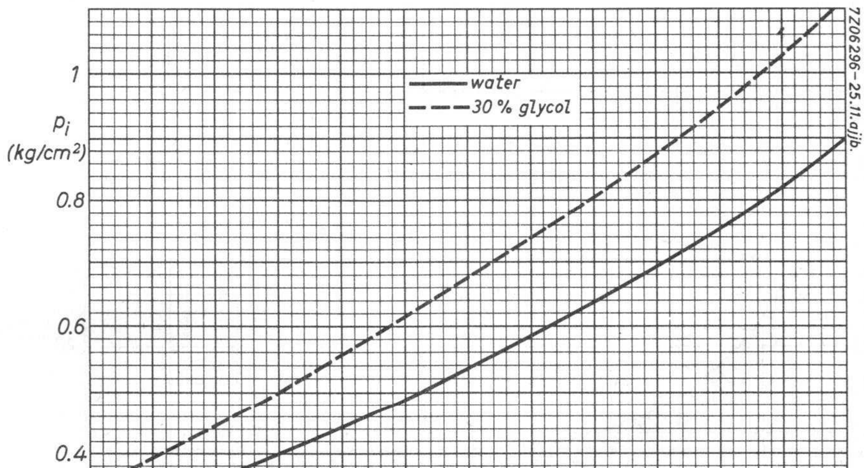

7Z59928
50
40
30
20
$t_i$
(°C)
$W_C$=25kW
30kW
35kW
40kW
30
40
50
60
70
q (m³/min)


7Z09754
additional airvolume (%)
60
40
20
0
0
1000
2000
3000
4000
h(m)

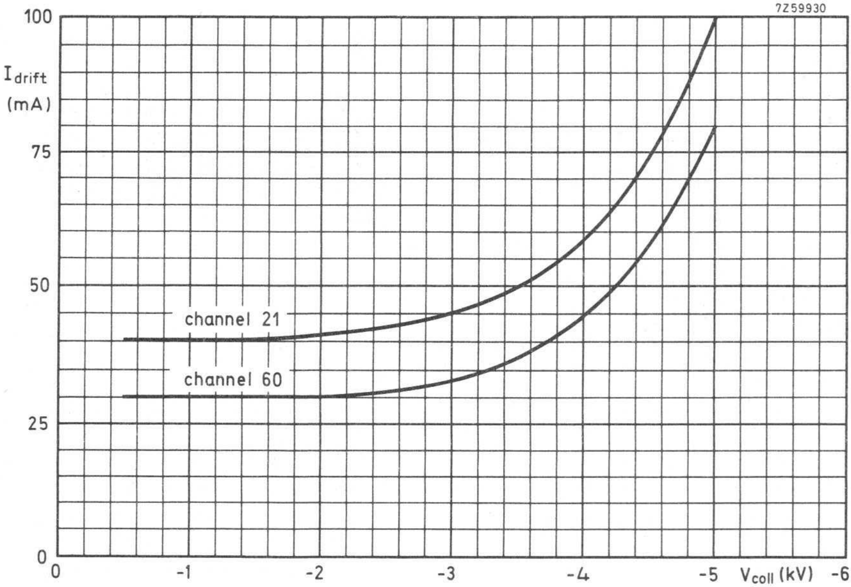

7Z59929
400
$p_i$
($mm\,H_2O$)
300
200
100
0
20
30
40
50
60
70
80
q ($m^3$/min)

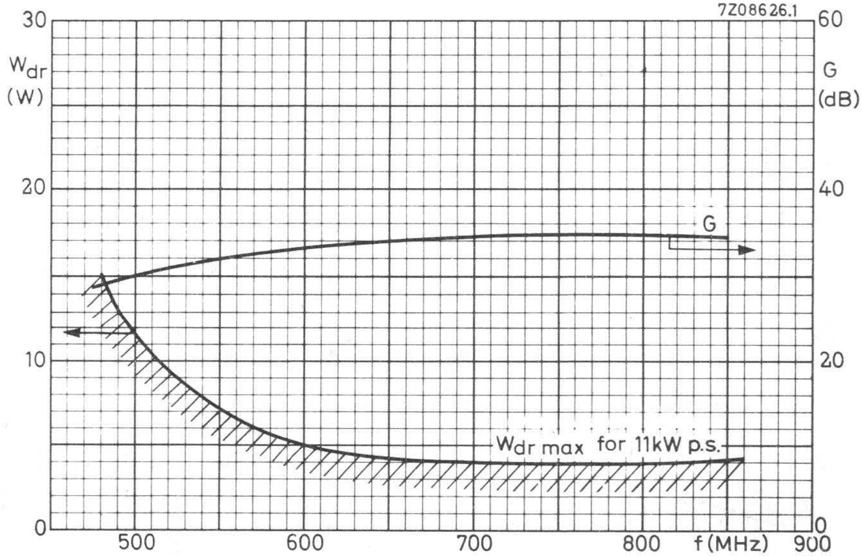


80
70
60
50
$t_i$
(°C)
$W_c$
10kW
15kW
20kW
25kW
30kW
35kW
40kW
45kW
50kW
tap water or closed circuit
cooling with 30% glycol solution
7Z06295-25.11.ajb.
40
60
80
100
q(l/min)
120

1
$p_i$
(kg/cm²)
0.8
0.6
0.4
water
30% glycol
7Z06296-25.11.ajb.
40
45
50
55
60
65
q(l/min)
70


7Z59930
100
$I_{drift}$
(mA)
75
50
25
0
channel 21
channel 60
0
-1
-2
-3
-4
-5
$V_{coll}$ (kV)
-6


7Z08626.1
30
$W_{dr}$
(W)
20
10
0
60
G
(dB)
40
20
0
G
$W_{dr\,max}$ for 11kW p.s.
500
600
700
800
f (MHz)
900

# U.H.F. POWER KLYSTRON

Air cooled power amplifier klystron in metal-ceramic construction for the frequency range 470 to 860 MHz, designed for four external resonant cavities, beam focusing by means of permanent magnets, continuously operating getter ion pump and operation with depressed collector potential. This klystron is intended for use as U.H.F. power amplifier in vision and/or sound transmitters as well as in translators for the T.V. bands IV and V.

| QUICK REFERENCE DATA | | |
|---|---|---|
| Frequency [1] | 470 to 860 | MHz |
| Power output (vision amplifier) | 11 | kW |
| Power gain | ≈ 40 | dB |

**HEATING**: Indirect by A.C. or D.C.

| | | | |
|---|---|---|---|
| Cathode | | dispenser type | |
| Heater voltage | $V_f$ | 7.5 to 8.0 | V [2] |
| Heater current | $I_f$ | 32 (≤ 36) | A |

The heater current should never exceed a peak value of 80 A when applying an A.C. heater voltage or 65 A when applying a D.C. heater voltage.

| | | | |
|---|---|---|---|
| Cold heater resistance | $R_{f_o}$ | 28 | mΩ |
| Heating time before application of high voltage (waiting time) | $T_w$ | min. 180 | s |

GETTER ION PUMP POWER SUPPLY

| | | | |
|---|---|---|---|
| Pump voltage, unloaded (cathode reference) | $V_{pump}$ | 4.0 | kV |
| Internal resistance | $R_i$ | approx. 300 | kΩ |
| Pump current as function of pressure | $I_{pump}$ | see page 8 | |

[1] Covered with two sets of resonators.

[2] During operation the applied heater voltage should not fluctuate more than ± 3%. It is advised to operate the klystron at 8.0 to 8.5 V (including mains fluctuations) during the first 300 hours. Then the heater voltage should be reduced to 7.5 to 8.0 V.

## COOLING

Applicable up to an air-inlet temperature $t_i$ of 40 °C and an altitude h of 3000 m (values refer to air-inlet).

| | |
|---|---|
| Cathode base | air, q = approx. 0.5 $m^3$/min |
| Accelerating electrode | air, q = approx. 0.5 $m^3$/min |
| Drift tubes 1, 2 and 3 | air, q = approx. 1.0 $m^3$/min each |
| Drift tube 4 | air, q = approx. 1.5 $m^3$/min |
| Drift tube 5 | forced air, q = approx. 1.5 $m^3$/min ($p_i$ = 90 mm $H_2O$) |
| Resonant cavity (output) | forced air, q = approx. 2.0 $m^3$/min ($p_i$ = 90 mm $H_2O$) |
| Collector | forced air, see cooling curves pages 9, 10 |

## MOUNTING

Vertical, cathode up. In order to prevent distortion of the magnetic focusing field, ferromagnetic material should not be applied within a radius of 35 cm from the tube axis. All connections should be free from strain.

## ACCESSORIES

| | |
|---|---|
| Heater connector | type 40649 |
| Heater/cathode connector | type 40649 |
| Focusing electrode connector | type 40634 |
| Accelerating electrode connector | type 40634 |
| Collector connector | type 40634 |
| Ion pump connector | type 55351 |
| Magnet unit for ion pump | type TE1053 (1x) |
| Set of four resonant cavities | type TE1056G (3x) |
| for 470 MHz to 650 MHz, or | type TE1056H (1x) |
| Set of four resonant cavities | type TE1067A (3x) |
| for 650 MHz to 860 MHz | type TE1067D (1x) |
| Focusing magnets | type TE1065A (2x) |
| | TE1065C (2x) |
| | TE1065E (4x) |
| | TE1065G (2x) |
| | TE1065H (2x) |
| Air duct | type TE1071 (1x) |
| Circulators, temperature compensated up to 70 °C (optional) | type 2722 162 01061 (470 MHz to 600 MHz) |
| | 162 01071 (590 MHz to 720 MHz) |
| | 162 01081 (710 MHz to 860 MHz) |
| | 162 01101 (608 MHz to 790 MHz) |

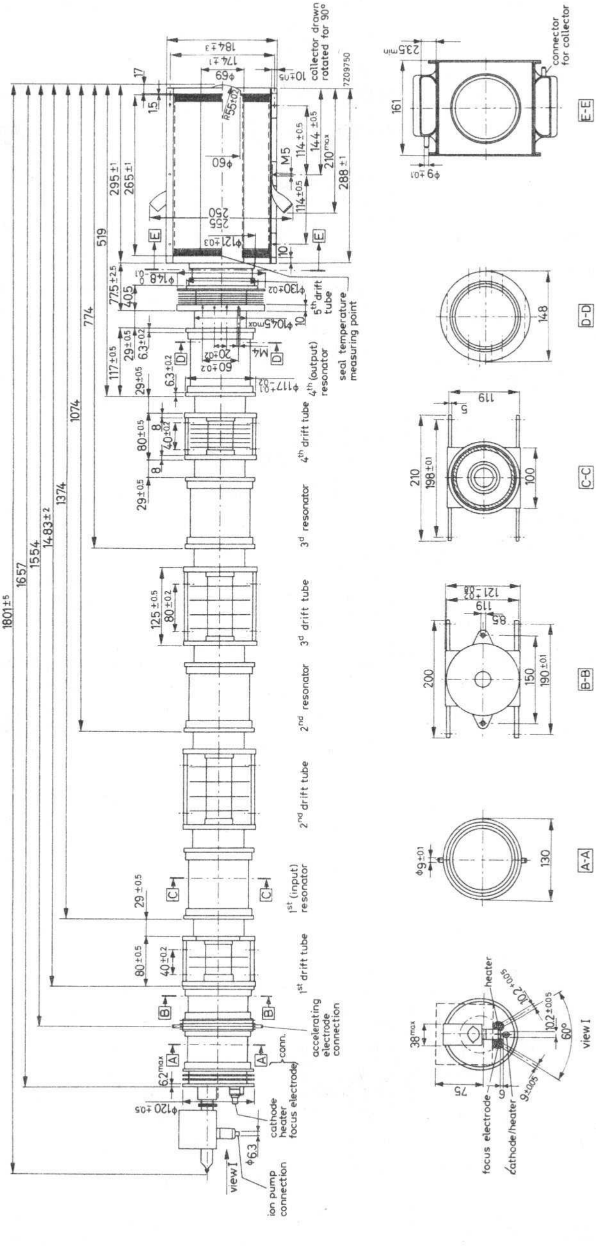
## WEIGHT

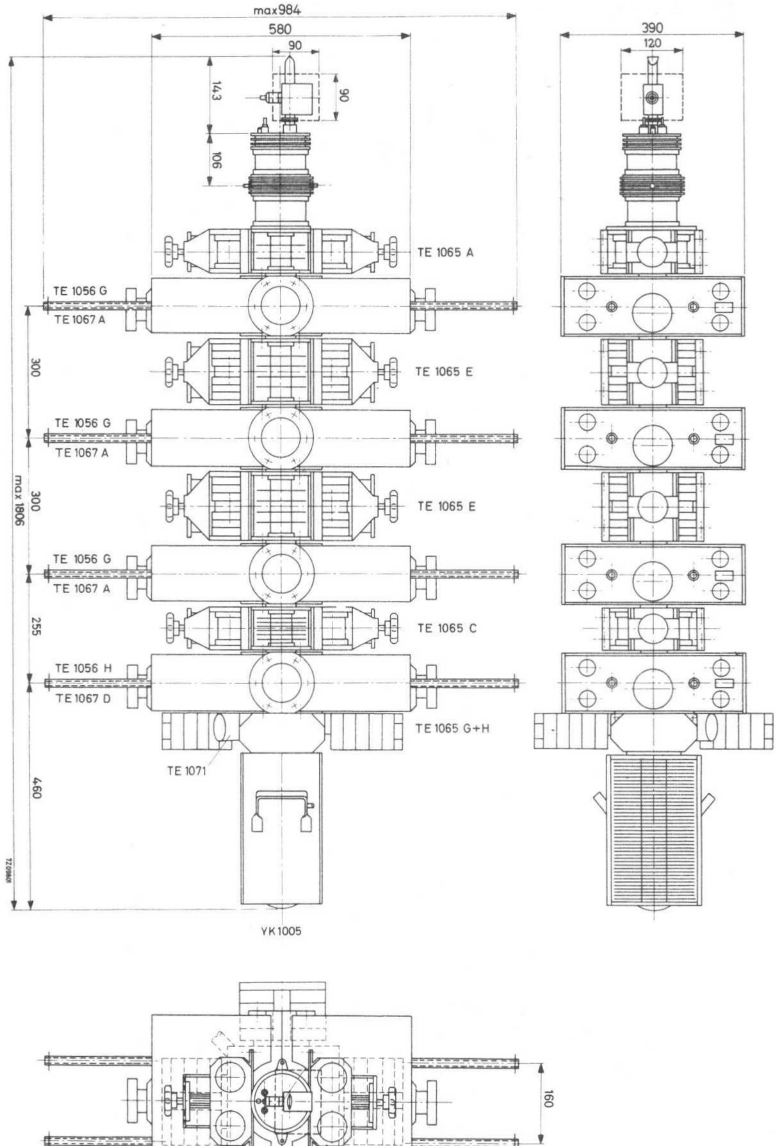
| | |
|---|---|
| Net weight YK1005 | approx. 60 kg |
| Accessories, total | approx. 130 kg |

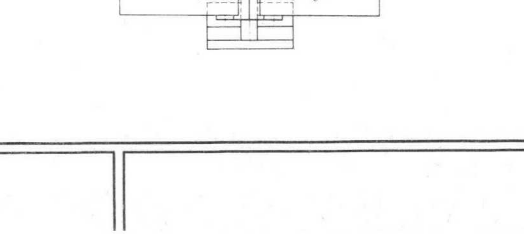
## MECHANICAL DATA

Dimensions in mm

Outline drawing




max984
580
90
14.3
90
106
390
120
TE 1065 A
TE 1056 G
TE 1067 A
300
TE 1065 E
TE 1056 G
TE 1067 A
300
max 1806
TE 1065 E
TE 1056 G
TE 1067 A
255
TE 1065 C
TE 1056 H
TE 1067 D
TE 1065 G+H
TE 1071
460
YK1005


160

## LIMITING VALUES AND OPERATING CONDITIONS

Unless otherwise mentioned all voltages are specified with respect to ground.

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

| | | | |
|---|---|---|---|
| Heater voltage | max. | 8.5 | V |
| Cathode voltage | max. | -22 | kV |
| Cathode voltage at zero current | max. | -25 | kV |
| Accelerating electrode voltage at zero current | max. | -25 | kV |
| Collector voltage | max. | -7 | kV |
| | min. | -0.5 | kV |
| Focusing electrode voltage (cathode reference) | max. | -700 | V |
| | min. | -100 | V |
| Series resistance in accelerating electrode circuit | max. | 20 | kΩ |
| | min. | 10 | kΩ |
| Cathode current | max. | 2.3 | A |
| Drift tube current | max. | 150 | mA |
| Collector dissipation | max. | 40 | kW |
| Voltage standing wave ratio | max. | 1.5 | |
| Pump voltage | max. | 4.5 | kV |
| Pump current | max. | 15 | mA |
| Temperature of | | | |
| cathode and accelerating electrode | max. | 125 | °C |
| drift tubes 1, 2 and 3 | max. | 80 | °C |
| drift tubes 4 and 5 | max. | 150 | °C |
| resonant cavity (output) | max. | 125 | °C |
| collector seal | max. | 200 | °C |
| collector body [1] | max. | 300 | °C |

[1] For safeguarding this temperature limit it is recommended to measure the air outlet temperature at least at two places, viz. one at 5 cm and one at 15 cm from the upper collector plate and at a distance of 5 cm from the cooling fins.

**OPERATING CONDITIONS** for depressed collector operation.

During operation the applied voltages should not fluctuate more than ±3% 1). Measured with focusing magnets TE1065 and cavities TE1056 or TE1067.

A. As 10 kW vision amplifier in the band 470 MHz to 860 MHz in accordance with the C.C.I.R. system with negative modulation. 2)3)
Bandwidth (-1 dB): 6 MHz

| | | | |
|---|---|---|---|
| Frequency | 470 | 790 | MHz |
| Output power, peak sync | 11 | 11 | kW |
| Driving power, peak sync 4)5)6) | 2 | < 1 | W |
| Power gain 4) | 38 | > 40 | dB |
| Cathode to collector voltage | -13.5 | -16 | kV |
| Collector to body voltage | -4 | -4 | kV |
| Accelerating electrode to body voltage 7) | 0 | 0 | kV |
| Focusing electrode to cathode voltage 14) | -240 | -600 | V |
| Cathode current | 2.0 | 1.85 | A |
| Body current, static 8) | 30 | 30 | mA |
| , black level 9) | 80 | 60 | mA |
| Linearity 10) | 80 | 80 | % |
| Sync compression 11) | ≤ 45/25 | ≤ 45/25 | |
| V.S.B. suppression 12) | -20 | -20 | dB |
| Noise with reference to black level 13) | -46 | -46 | dB |

Tuning of cavities with respect to carrier frequency

| | | | |
|---|---|---|---|
| Cavity 1 | approx. | +3 | MHz |
| Cavity 2 | approx. | -0.5 | MHz |
| Cavity 3 | approx. | +4.5 | MHz |
| Cavity 4 | approx. | 0 | MHz |

External cavity loading at black level for 11 kW sync power output

| | | |
|---|---|---|
| Cavity 1 | max. | 5 |
| Cavity 2 | max. | 100 |
| Cavity 3 | max. | 200 |

B. As 2 or 4 kW sound amplifier in the band 470 MHz to 860 MHz 2) 3)

| | | | |
|---|---|---|---|
| Output power | 2.2 | 4.4 | kW |
| Driving power | ≤ 0.5 | ≤ 0.5 | W |
| Cathode to collector voltage | -13.5 | -13.5 | kV |
| Collector to body voltage | -5 | -5 | kV |
| Accelerating electrode to body voltage | -7.5 | -5.5 | kV |
| Focusing electrode to cathode voltage | -400 | -400 | V |
| Cathode current | 0.7 | 1.0 | A |
| Body current 8) | 50 | 70 | mA |

Notes see page 7

Notes to page 6

1) Fluctuations of the beam voltage up to $\pm$ 3% will not damage the tube; to obtain a good signal-transfer quality the nominal beam voltage should not vary more than $\pm$1%.

2) With a circulator between the driver stage and input cavity 1.

3) In case of operating failures all klystron-electrode voltages except the pump and heater voltages should be switched off and made to drop to less than 5% of the nominal value within 500 ms after occurrence of this failure.

4) Dependent on operating frequency see page 10 below.

5) The driving power $W_{dr}$ is measured between the circulator and first cavity at a 50 $\Omega$ resistance and represents the sum of the forward and the reflected power in the first cavity.

6) A pre-correction network is to be incorporated in the pre-stage to compensate for the level dependency of the band pass characteristic caused by non-linearities of the klystron.

7) It is recommended to obtain this voltage from a voltage divider between cathode and ground, which should carry a quiescent current of min. 3 mA.

8) To be focused for minimum body current.

9) At black level to be focused for minimum body current.
If necessary to obtain the required signal-transfer quality a deviation of max. 10% from this minimum current is permitted.

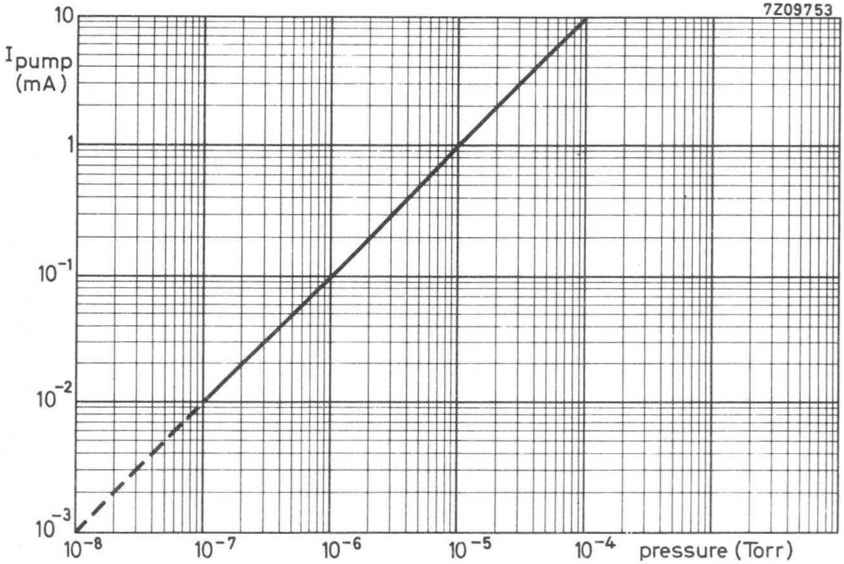
10) Measured with a sawtooth voltage with amplitude between 17% and 75% of the peak sync value, on which is superimposed a 4.43 MHz sine wave with a 10% peak-to-peak value.

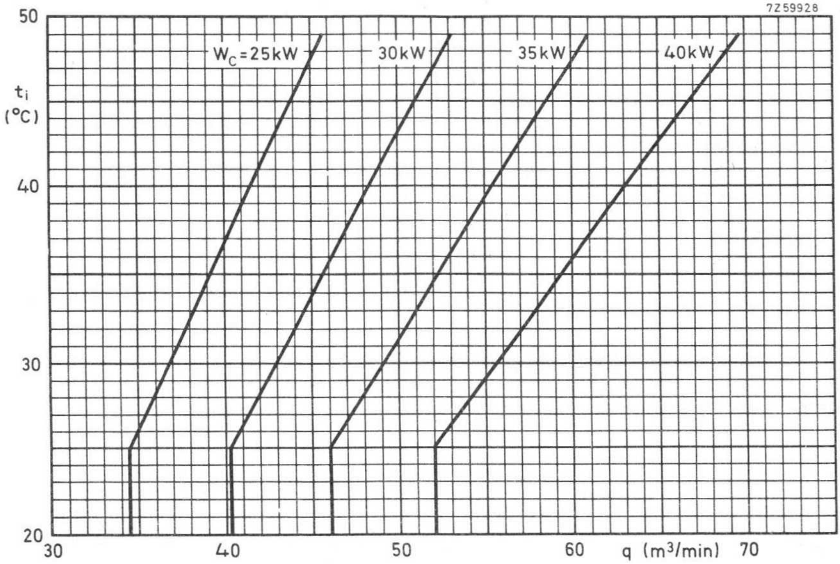
11) A picture/sync ratio of 75/25 for the outgoing signal of the klystron requires a ratio of max. 55/45 for the incoming signal.

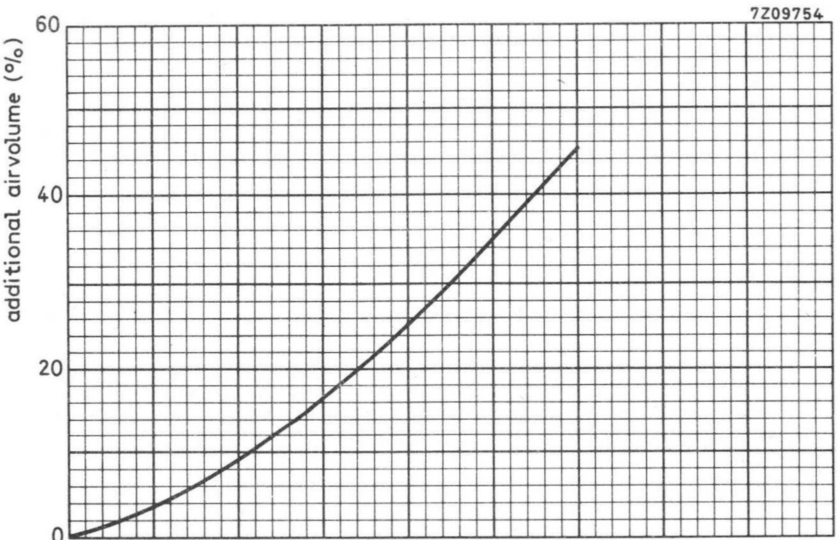
12) Measured with modulation 10 to 75%, without compensation, VSB filter between driver and klystron.

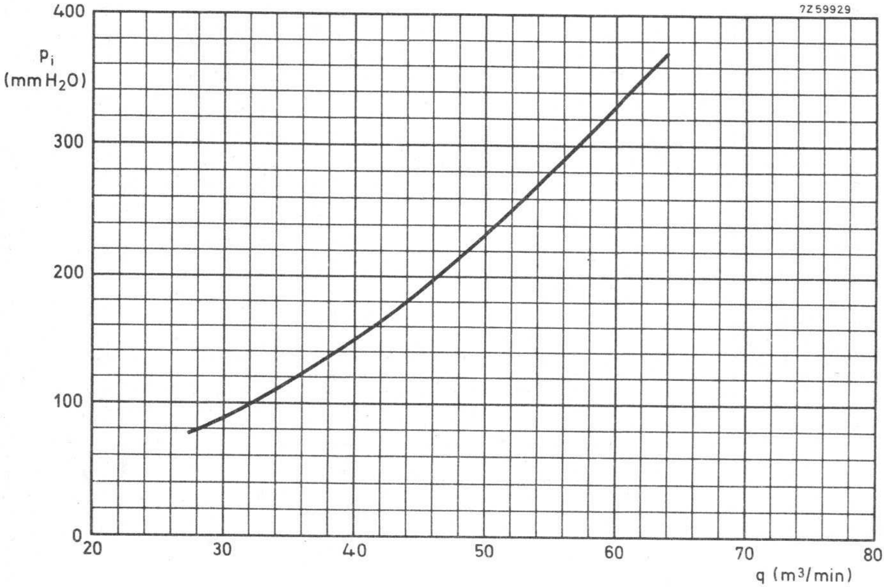
13) Produced by the klystron itself; excluded hum from power supplies.

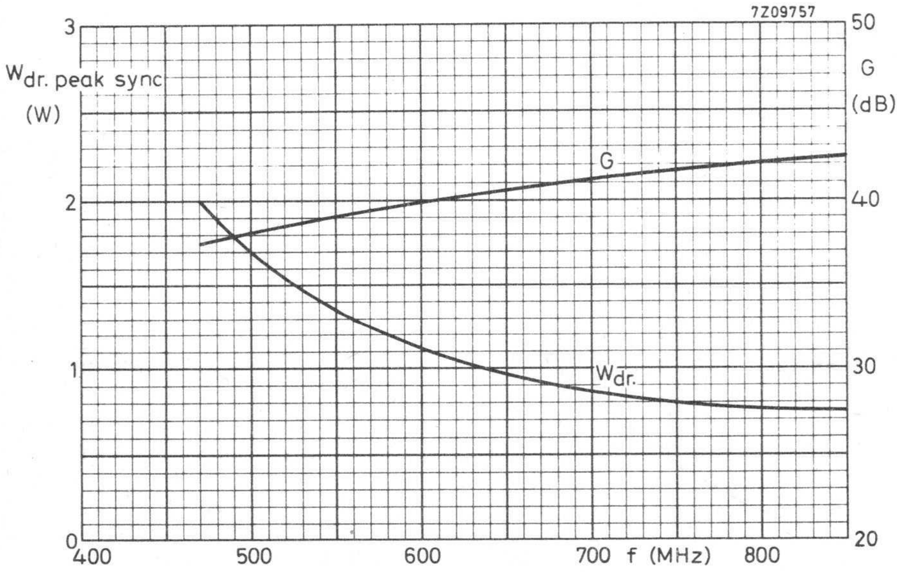
14) The power supply should be adjustable from-100 V to-700 V and be pre-loaded with min. 10 mA at-700 V.


7Z09753
10
$I_{pump}$ (mA)
1
$10^{-1}$
$10^{-2}$
$10^{-3}$
$10^{-8}$
$10^{-7}$
$10^{-6}$
$10^{-5}$
$10^{-4}$
pressure (Torr)


7Z59928
50
40
30
20
$t_i$
(°C)
$W_C$=25kW
30kW
35kW
40kW
30
40
50
60
q (m³/min)
70


7Z09754
60
40
20
0
additional air volume (%)
0
1000
2000
3000
h (m)
4000


7Z59929
400
$p_i$
($mm H_2O$)
300
200
100
0
20
30
40
50
60
70
80
q ($m^3$/min)


7Z09757
3
$W_{dr.\ peak\ sync}$
(W)
2
1
0
50
G
(dB)
40
30
20
G
$W_{dr.}$
400
500
600
700
f (MHz)
800

# PULSED POWER KLYSTRON

Fixed frequency pulsed power klystron in metal-ceramic construction for the range 2998 ± 5 MHz, with 3 internal cavities, electromagnetic focusing, continuously operating getter-ion pump, coaxial input connector and S-band output wave guide, water cooled, intended as amplifier in linear accelerators and similar applications.

**QUICK REFERENCE DATA**

| | | | |
|---|---|---|---|
| Frequency 1) | f | 2998 ± 5 | MHz |
| Peak power output | $W_{o_p}$ | 6 | MW |
| Power gain | G | 30 | dB |
| Focusing | | electromagnetic | |
| Focusing coils and cavities | | integral | |
| Cooling | | water | |
| R.F. input connector | | coax type N 2) | |
| R.F. output flange | | on request | |

**HEATING** : Indirect by A.C. or D.C.

Cathode : oxide coated

| | | | | |
|---|---|---|---|---|
| Heater voltage | $V_f$ | 3 to 4.6 | V | |
| Heater current | $I_f$ | 70 to 82 | A | 3) |

The heater current should never exceed a peak value of 150 A when applying an A.C. heater voltage or 100 A when applying a D.C. heater voltage.

| | | | |
|---|---|---|---|
| Cold heater resistance | $R_{f_o}$ | 6 | mΩ |
| Heating time before application of high voltage (waiting time) | $T_w$ | min. 45 | min. |

GETTER-ION PUMP POWER SUPPLY

| | | | |
|---|---|---|---|
| Pump voltage, unloaded | $V_{pump}$ | 4 | kV |
| Internal resistance | $R_i$ | approx. 300 | kΩ |
| Pump current as a function of pressure | $I_{pump}$ | See page A | |

1) The klystron is factory tuned to 2998 MHz but can be delivered for any frequency within the range 2993 MHz to 3003 MHz. Other frequencies on request

2) Other types on request

3) The correct heater current is marked on each tube

**COOLING** (valid for a pulse repetition rate up to 50 p.p.s.) [1)]

| | | | | |
|---|---|---|---|---|
| Drift tubes and focusing coils | q | min. | 4 | l/min. |
| | p | max. | 3.5 | $kg/cm^2$ |
| Collector | q | min. | 7 | l/min. |
| | p | max. | 3.5 | $kg/cm^2$ |
| Specific resistance of cooling water | $\rho$ | min. | 20.000 | Ωcm |

**MECHANICAL DATA**

Mounting   Vertical.

To be supported from mounting flange with cathode down. Although the collector and output cavity are provided with a lead shield, adequate additional shielding is required for protection against personal injury due to X-ray radiation.

Accessories

Magnet and housing for getter-ion pump   type TE 1053A and TE 1053B

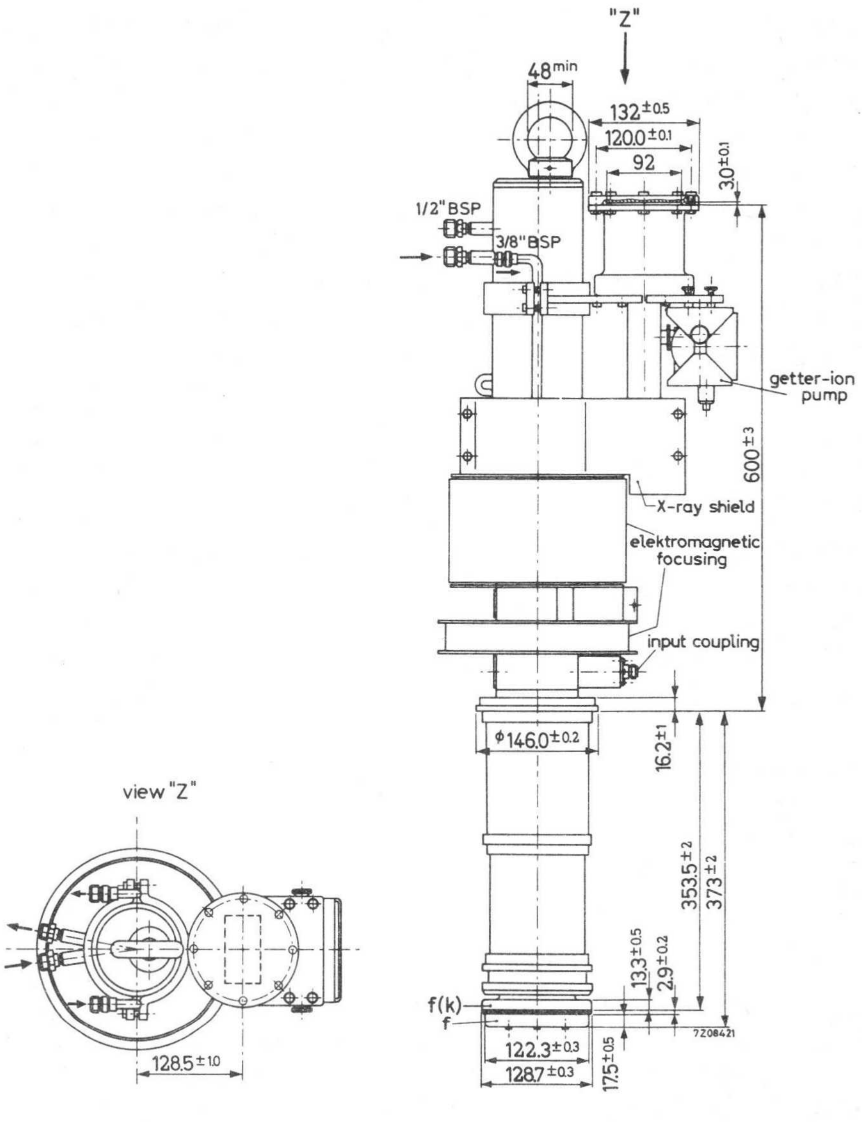
Weight

Net weight   approx. 110 kg

1) Data for operation at p.r.r. higher than 50 p.p.s. on request.

MECHANICAL DATA

Dimensions in mm



**LIMITING VALUES** (Absolute max. rating system) for pulsed operation.

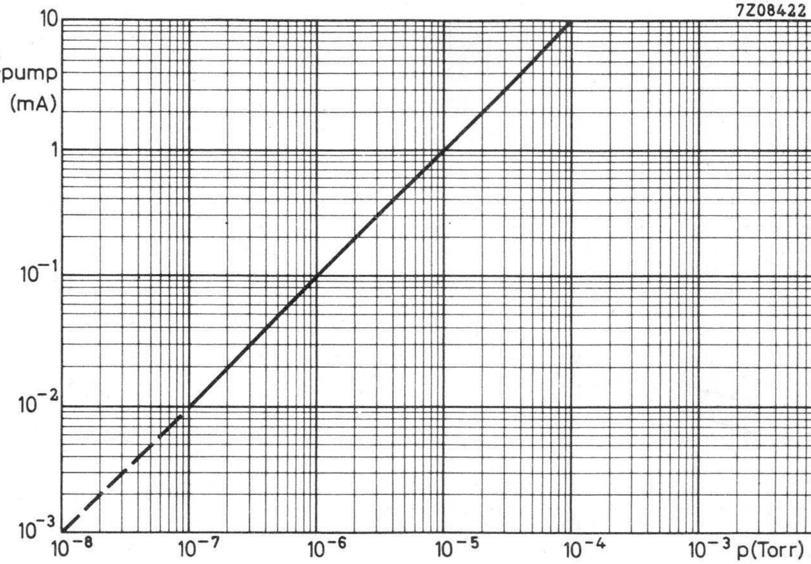
All voltages are specified with respect to ground.

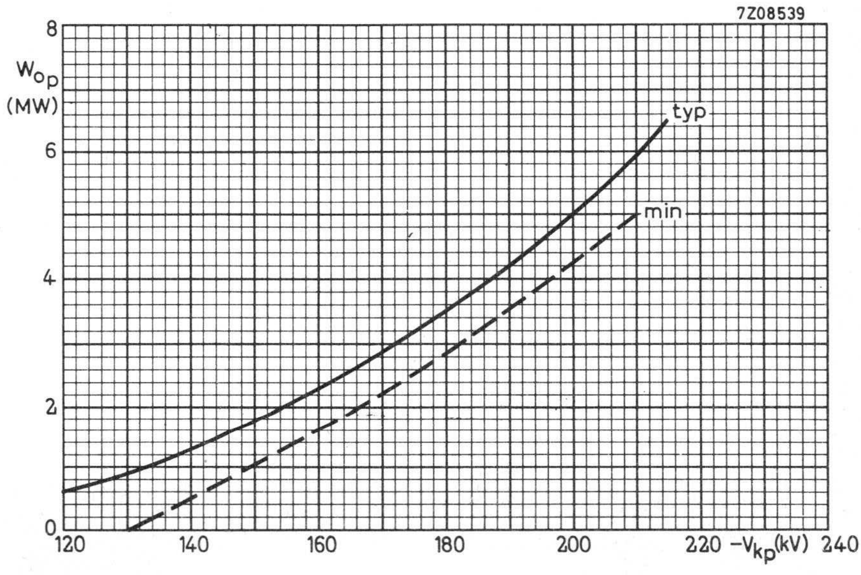
| | | | | |
|---|---|---|---|---|
| Cathode voltage, peak | $-V_{k_p}$ | max. | 220 | kV |
| Cathode current, peak | $I_{k_p}$ | max. | 120 | A |
| Beam input power, peak | $W_i$ | max. | 25 | MW |
| R.F. input power, peak | $W_{dr}$ | max. | 10 | kW |
| R.F. output power, peak | $W_{o_p}$ | max. | 8 | MW |
| Pulse repetition rate | p.r.r. | max. | 600 | p.p.s. |
| Pulse duration | $T_{imp}$ | max. | 3 | μs |
| Voltage standing wave ratio of load | V.S.W.R. | max. | 1.5 | |
| Focusing magnet voltage | $V_{magn}$ | max. | 50 | V |
| Focusing magnet current | $I_{magn}$ | max. | 32 | A |
| | $I_{magn}$ | min. | 24 | A |
| Pump voltage | $V_{pump}$ | max. | 4.5 | kV |
| Pump current | $I_{pump}$ | max. | 15 | mA |
| Water outlet temperature | $t_o$ | max. | 75 | °C |

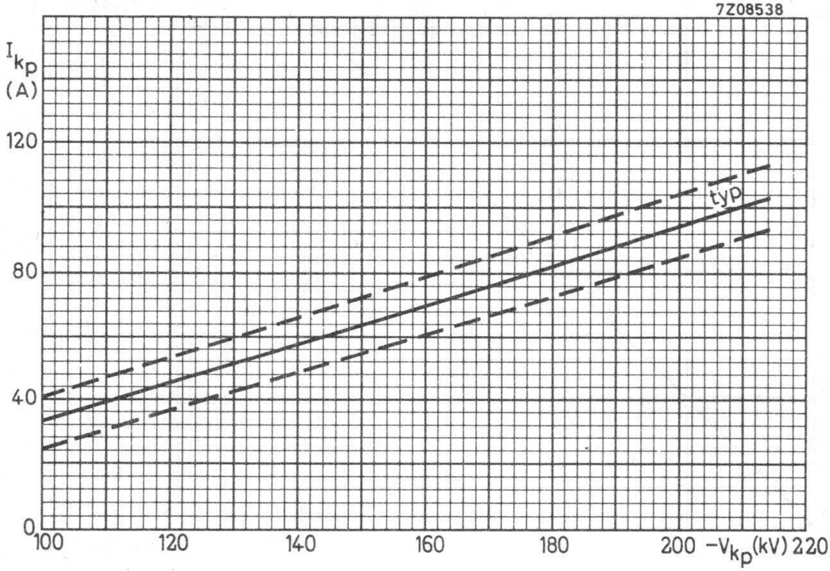
**OPERATING CONDITIONS** 1)

| | | | |
|---|---|---|---|
| Frequency | f | 2998 | MHz |
| Heater current | If | 2) | |
| Cathode voltage, peak 3) | $V_{k_p}$ | - 210 | kV |
| Cathode current, peak | $I_{k_p}$ | 100 | A |
| mean | $I_k$ | 10 | mA |
| Focusing magnet voltage | $V_{magn}$ | 40 | V |
| Focusing magnet current 4) | $I_{magn}$ | 29 | A |
| Pulse repetition rate 5) | p.r.r. | 50 | p.p.s. |
| Pulse duration | $T_{imp}$ | 2.2 | μs |
| R.F. input power | $W_{dr}$ | 5 | kW |
| R.F. output power, peak | $W_{o_p}$ | 6 | MW |
| mean | $W_o$ | 0.66 | kW |

1) When the klystron has not been in operation for some time, conditioning might be required. This should be done by gradually increasing the cathode voltage until in each step stable operation is obtained. Stored tubes require pumping at intervals of approx. 3 month.
2) To be adjusted at the value marked on each tube.
3) For maintaining a minimum output power of 5 MW during life the cathode voltage may be increased to - 215 kV.
4) To be adjusted for max. R.F. output power.
5) Data for operation at p.r.r. higher than 50 p.p.s. on request.


7Z08422
Ipump (mA)
10
1
10⁻¹
10⁻²
10⁻³
10⁻⁸
10⁻⁷
10⁻⁶
10⁻⁵
10⁻⁴
10⁻³ p(Torr)


7Z08539
Wop (MW)
8
6
4
2
0
typ
min
120
140
160
180
200
220 −Vkp(kV) 240


7Z08538
$I_{kp}$
(A)
120
80
40
0
100
120
140
160
180
200
$-V_{kp}$(kV)
220
typ

# Klystrons, medium and low power

# KLYSTRONS, MEDIUM AND LOW POWER, MECHANICALLY TUNABLE

ABRIDGED SURVEY

| Frequency range (MHz) | Output power (mW) | Type |
|---|---|---|
| 8500 - 9660 | 45 | 2K25 |
| 8702 - 9548 | 40 | 723A/B |
| 9300 - 9500 | 40 | KS9-40 |
| 9320 - 9550 | 45 | KS9-20B |
| 9325 - 9500 | 45 | KS9-20D |
| 9350 - 9550 | 45 | KS9-40B |
| 9380 - 9510 | 40 | KS9-40D |
| 10500 - 12200 | 400 | YK1090 |
| 10500 - 12200 | 400 | YK1091 |
| 31000 - 36000 | 150 | 55335 |
| 67000 - 74000 | 130 | YK1010 |

# GENERAL OPERATIONAL RECOMMENDATIONS KLYSTRONS

1. GENERAL

1.1. Data

The characteristic data, operational data, capacitance values and curves apply to an average tube which is characteristic of the type of tube in question.

1.2. Reference point of the electrode voltages

If not otherwise stated the electrode voltages are given with respect to the cathode.

1.3. Operational data

The operational data stated in the data sheets do not relate to any fixed setting instructions. They should rather be regarded as recommendations for the effective use of the tube. On account of the tolerances prevailing, deviations from the settings stated may occur.
It is also possible to use other settings, for which purpose the graphs can be used for finding the operational data, or for which purpose interpolation between the settings stated can be performed. If one wishes to deviate from the settings recommended in the data sheets, one should take great care not to exceed the permissible limiting values. If appreciable deviations occur, the manufacturer should be consulted.
A general rule for multi-cavity klystrons is that the focusing voltage must be adjusted so that the cathode current stated will flow.

1.4. D.C. connections

At all times there should be a D.C. connection between each electrode and the cathode. If necessary, limiting values have been stated for the resistance of these connections.

1.5. Mounting and removal

Large klystrons must be mounted in a vertical position, the cathode terminals pointing upwards. Reflex klystrons may as a rule be mounted in any desired position. The instructions relating to each type of tube can be found in the data sheets and the "Instructions for operation and maintenance".
The mounting and removal should be effected with extreme care to avoid damage to the tube. This also applies to rejected tubes, where claims are made under guarantee.
Ferromagnetic parts must not be used in the vicinity of klystrons equipped with a permanent magnet, as this might have a detrimental effect on the operation

of the klystron. If necessary, the ceramic insulators and windows must be carefully cleaned, as dirt may damage the klystron on account of local overheating. Naturally the flange of the output cavity must also be thoroughly cleaned so as to prevent arcing.
The "Instructions for Operation and Maintenance" should in all cases be followed.

1.6. Accessories

Perfect operation of the tubes can only be guaranteed if use is made of the accessories which the manufacturer designed for the tube.

1.7. Supply leads

The supply leads to the connections and terminals must be of such a quality that no mechanical stresses, due to differences in temperature or other causes, can occur.

1.8. Danger of radiation

In general the absorption in the tissues of the body, and hence the danger, is the greater the shorter the wavelength of the H.F. radiation at equal output. The output of klystrons may be so high that injuries (in particular of the eye) can be inflicted.
Klystrons operated at a high voltage (exceeding 16 kV) may moreover emit X-rays of appreciable intensity, which call for protection of the operators.

## 2. LIMITING VALUES

### 2.1. Absolute limiting values

In all cases the limiting values stated are absolute maximum or minimum values. They apply either to all settings or to the various modes of operation. The values stated should in no case be exceeded, neither on account of mains-voltage fluctuations and load variations, nor on account of production tolerances in the various building elements (resistors, capacitors, etc.) and tubes, or as a result of meter tolerances when setting the voltages and currents.
Every limiting value should be regarded as the permissible absolute maximum independent of other values. It is not permitted to exceed one limiting value because another is not reached. For instance, one should not allow the limiting value of the collector current to be surpassed while reducing the collector voltage below the permissible limiting value.
If in special cases it should be necessary to exceed a specific limiting value, it is advisable to consult the tube manufacturer, as otherwise no claims can be made.

### 2.2. Protective circuit

To prevent the limiting values of voltages, currents, outputs and temperatures from being exceeded, fast-operating protective circuits must be provided.

2.3. Drift current

The limiting value indicated for the drift current is an arithmetical mean value.

3. NOTES ON OPERATION

3.1. Operational data and variations

When developing electrical equipment the spread in the tube data must be taken into account; if necessary, the tube tolerances can be applied for.
With respect to the spread in the operational data and the average values stated in the data sheets it is recommended to allow for a certain margin in the output and input powers when designing equipment intended for series production.

3.2. Input power, required driving power

In the data sheets the power stated is the input power $W_{dr}$ fed to the input cavity and measured between the circulator and this cavity at a 50-ohm resistor serving as a substitute for the load presented by the cavity.

3.3. Output power

As a general principle the effective output power is stated.

3.4. Sequence of application of the electrode voltages

With multi-cavity klystrons the electrode voltages must be connected in the order given in the operating instructions.

3.5. Drift current

When the klystron is driven by an A.M. signal (for instance a video signal), the drift current fluctuates with the modulation. Consequently, the power-supply unit must be designed so as to be suitable for the peak values occurring, which may be appreciably higher than the arithmetical mean values stated.

4. HEATING

4.1. Type of current

Klystrons can be heated by means of either standard alternating current or direct current. At other frequencies the tube manufacturer should be consulted.

4.2. Adjusting the heater voltage

The heater voltage generally governs the adjustment of the heating, while the heater current may deviate from its nominal value within fixed tolerances. The heater voltage should be maintained as accurately as possible. For measuring the heater voltage an R.M.S. voltmeter is required. This meter must be directly connected to the filament terminals of the tube and have an inaccuracy $< 1.5\ \%$ in the voltage range concerned. The indicated measuring value should lie in the uppermost third part of the scale.

7Z2 9003

4.3. Switching on the heater current

If the data sheet does not contain special data concerning the heater current during switch-on, the tube may be switched on at full heater voltage.
If maximum values are stated for the heater current during switch-on, they relate to the absolute maximum instantaneous value under unfavourable conditions. In the case of A.C. supply this value will occur if the tube is switched on at the maximum amplitude of the highest mains voltage. It is possible to calculate the maximum current during switch-on if the cold resistance and the relationship between the heater current and the heater voltage are known. In practice a heater transformer more or less acting as a leakage transformer is mostly used for limiting the starting current, or a choke coil or resistor is connected in series with the primary of the heater transformer. This choke coil or resistor can be short-circuited by a relay whose action is delayed by about 15 seconds. By means of a calibrated oscilloscope it can be checked whether the starting current remains within the permissible limits; the supply lead may, if necessary, be used as precision resistance.

5. COOLING

5.1. Forced-air cooling

It is essential that the faces of tubes that are to be cooled by an air-blast should be hit as evenly as possible by the air stream, so as to prevent large differences in temperature which may give rise to mechanical stresses. In many cases (in particular with the large types of tubes) an additional air stream must be directed to the metal-to-glass or metal-to-ceramic seals. The cooling air is usually supplied from a fan via an insulating duct. This air should be filtered, so that all impurities and moisture are removed; in addition to this the radiator must be cleaned at regular intervals. The data concerning the cooling can be found in the data sheets. The cooling must be switched on together with the heating. After the klystron has been switched off cooling air must be supplied for some time; this period depends on the size of the tube and the load. If the cooling of whatever part of the tube is interrupted or if the quantity of cooling air is too small, the collector voltage and the heating must be switched off automatically.

5.2. Water-cooling

With water-cooled klystrons the cooling equipment is rigidly attached to the tube. If the equipment should be live, the cooling water must be supplied through insulating pipes, of sufficient lenght.
The water-cooling and air-cooling for other parts of the tube must be switched on together with the heating. The cooling-water circuit must be arranged so that the water always enters at the bottom, no matter how the tube is mounted. If the pumps should be out of operation, the water jacket(s) of the tube must always be full. In that case after-cooling may in general be done away with.
In many cases the metal-to-glass or metal-to-ceramic seals require additional cooling by a low velocity air flow. If the cooling water supply or additional

7Z2 9004

air-cooling should fail, the collector voltage and heating must immediately be switched off. Further cooling data can be found in the data sheets.
The specific resistance of the cooling water must be min. 20 kΩ-cm, the temporary hardness must be max. 6 German degrees of hardness. On principle destilled water should be used in the circulation cooler; to reduce the corrosive effect of the distilled water about 700 mg of 24-% dyamide hydrate and 700 mg sodium silicate must be added per litre. The pH-value should range from 7 to 9.
If frost is to be expected, a suitable anti-freezing mixture should be added.

## 6. STORAGE

Klystrons may only be stored in their original packing and according to the instructions, so as to avoid damage. For fitting the tubes must be removed from the packing and directly inserted into the support. In all cases the "Instructions for operation and maintenance" must be adhered to.
In the case of prolonged storage the vacuum of high-power klystrons should be checked at intervals of about three months and improved if necessary, both being possible with the aid of the built-in getter ion pump and a suitable power supply / test unit. During this operation the heater supply should preferably be turned on slowly.

# TUNABLE REFLEX KLYSTRON

Mechanically tunable reflex klystron for local oscillator applications.

| QUICK REFERENCE DATA | | | | | |
|---|---|---|---|---|---|
| Frequency, tunable within the band | f | 9.32 | to | 9.55 | GHz |
| Output power | $W_o$ | | 45 | | mW |
| Construction | metal, with octal base | | | | |
| Output connection | coaxial probe for insertion to standard WG 16 launching section | | | | |

**HEATING**: Indirect

| | | | |
|---|---|---|---|
| Heater voltage | $V_f$ | 6.3 | V |
| Heater current | $I_f$ | 0.45 | A |

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

| | | | | |
|---|---|---|---|---|
| Heater voltage | $V_f$ | max. | 6.8 | V |
| | | min. | 5.8 | V |
| Resonator voltage | $V_{res}$ | max. | 330 | V |
| Resonator current | $I_{res}$ | max. | 37 | mA |
| Reflector voltage [1] | $V_{refl}$ | max. | -400 | V |
| | | min. | 0 | V |
| Cathode to heater voltage | $V_{kf}$ | max. | 50 | V |
| Body temperature | t | max. | 110 | $^o$C |
| Voltage standing-wave ratio | V.S.W.R. | max. | 1.5 | |
| Impedance of the reflector/cathode circuit | $Z_{refl/k}$ | max. | 500 | kΩ |

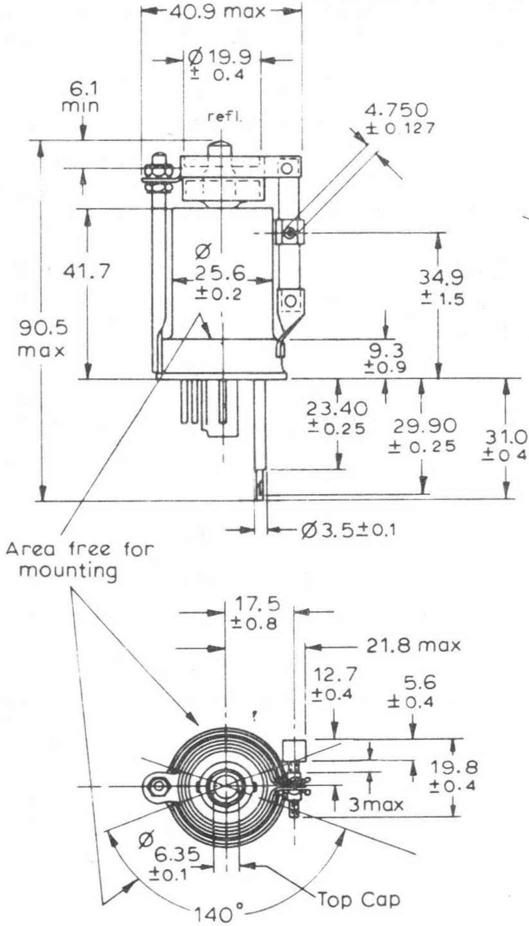
**COOLING**: natural

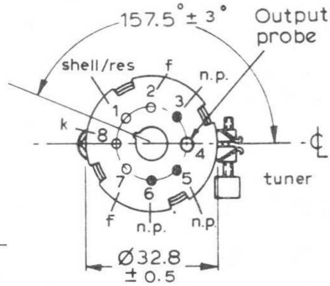
[1]) The klystron must not be operated without the reflector supply while the resonator voltage is applied.
Care should be taken in the design of the power supply to ensure that the reflector potential never becomes positive with respect to the cathode.

## MECHANICAL DATA

Dimensions in mm

Base : Octal, IEC67-I-5f, type 2
Top cap : 6, 35 ± 0.1 ϕ
Net weight : approx. 65 g
Mounting position: Any




7Z60181

## TEST CONDITIONS AND LIMITS

The klystron is tested to comply with the following electrical specification.

Test conditions [2]

| | | | |
|---|---|---|---|
| Heater voltage | $V_f$ | 6.3 | V |
| Resonator voltage | $V_{res}$ | 300 | V |
| Reflector voltage [1] | $V_{refl}$ | adjust | |
| Voltage standing-wave ratio | V.S.W.R. | 1.1 | |

Limits and characteristics

| | | Min. | Max. | |
|---|---|---|---|---|
| Heater current | $I_f$ | 0.41 | 0.47 | A |
| Resonator current | $I_{res}$ | | 25 | mA |
| Reflector voltage [3] | | | | |
| Mode A, f = 9.32 GHz | $V_{refl}$ | -135 | -175 | V |
| Mode A, f = 9.55 GHz | $V_{refl}$ | -135 | -175 | V |
| Output power [3] | | | | |
| Mode A, f = 9.32 GHz | $W_o$ | 30 | | mW |
| Mode A, f = 9.55 GHz | $W_o$ | 30 | | mW |
| Electronic tuning range to ½ power points | | | | |
| Mode A, f = 9.32 GHz | $\Delta f$ | 20 | | MHz |
| Mode A, f = 9.55 GHz | $\Delta f$ | 20 | | MHz |
| Load effect [4] | | 10 | | mW |
| Hysteresis [5] | | | 0.5 | |
| Frequency temperature coefficient | $-\frac{\Delta f}{\Delta t}$ | | 0.25 | MHz/degC |
| Mechanical tuning range [6] | f | 9.32 | 9.55 | GHz |

[1]) See page 1
[2]) ... [6]) See page 4

**OPERATING CHARACTERISTICS** Mode A at 9.37 GHz

| | | | |
|---|---|---|---|
| Conditions [2] | | | |
| Heater voltage | $V_f$ | 6.3 | V |
| Resonator voltage | $V_{res}$ | 300 | V |
| Reflector voltage [1] [3] | $V_{refl}$ | -155 | V |
| Voltage standing-wave ratio | V.S.W.R. | 1.1 | |
| Typical performance | | | |
| Resonator current | $I_{res}$ | 22 | mA |
| Output power | $W_o$ | 45 | mW |
| Electronic tuning range to ½ power points | $\Delta f$ | 35 | MHz |

**END OF LIFE PERFORMANCE**

The quality of all production is monitored by the random selection of klystrons which are then life tested under the stated test conditions. If the klystron is to be operated under different conditions from those specified above, the manufacturer should be consulted to verify that the life will not be affected. The klystron is considered to have reached the end of life when it fails to meet the following limits when operated as specified on page 3.

| | | | |
|---|---|---|---|
| Output power | $W_o$ | min. 10 | mW |

**NOTES**

1) See page 1.

2) With the klystron operated in a standard waveguide launching section as shown on pages 5 and 6.

3) Reflector voltage adjusted for the maximum power point of the mode.

4) There shall be no discontinuities at the maximum power points nor shall the power fall below that specified as a mismatch represented by a V.S.W.R. of 2.5 is varied through all phases.

5) The ratio of the power at which hysteresis is present shall not exceed the limit specified.

6) Damage to the tuner may occur if it is adjusted beyond these frequency limits.

## INSTALLATION

For good broadband performance the tube should be inserted in a suitable mount. The mount recommended is shown in Fig. 1. It consists of a section of 3 cm waveguide (RG-52/U; outside dimensions 25.4 x 12.7), shortcircuited at one side, into which the aerial of the tube penetrates. The position of the aerial with respect to the waveguide is shown in Fig. 2.
The outer conductor of the output line should reach to the inner side of the waveguide. The broadband R. F. choke provides a good H. F. contact between the output line and the guide.
The tube socket, a modified octal type of which the hole corresponding to the pin No. 4 of the base has been drilled in order to pass the coaxial output line, is fixed rigidly to the waveguide to ensure a correct installation.
The tube should be fixed firmly in the socket by clamps which make contact at the lower platform of the tube only. It may happen that the waveguide is not terminated in a matched load, which will give rise to frequency instability. When a very good frequency stability is required an attenuator of minimum 6 dB may be inserted in the guide between the aerial and the load.

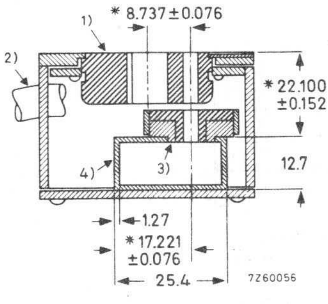



Fig. 1 Cross section of the mount (coupler)

All high frequency surfaces to be silver or gold plated.
Dimensions indicated with * determine the broad band characteristics of the coupler and should be held to the tolerances shown.

---

1) Modified octal socket. Individual pin sockets must be deeper than 12.014 mm.
2) Cable to socket connections
3) R. F. choke
4) Waveguide

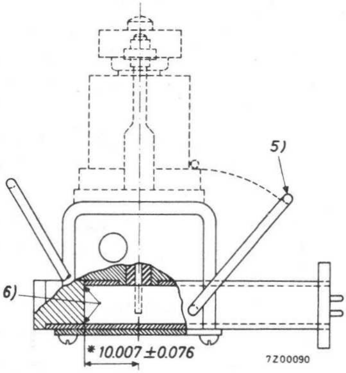



Fig. 2 Side-view of the mount

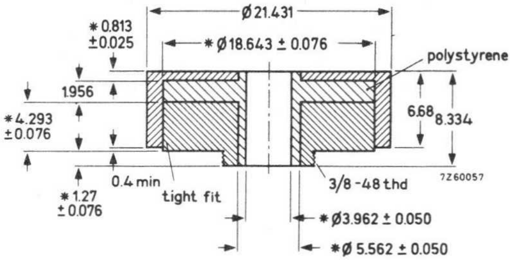



Fig. 4 Cross-section of the R.F. choke
* See under Fig. 1

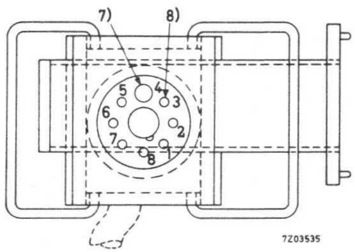



Fig. 3 Top-view of the mount

Remark: The mount and the R.F. choke are not supplied by the tube manufacturer

---

5) Tube clamp

6) Inner edges of plug must be brazed to waveguide

7) 4.75 mm drill

8) Remove socket terminals 3, 4, 5 and 6

# TUNABLE REFLEX KLYSTRON

Mechanically tunable reflex klystron for local oscillator applications.

| QUICK REFERENCE DATA | | | |
|---|---|---|---|
| Frequency, tunable within the band | f | 9.325 to 9.500 | GHz |
| Output power | $W_o$ | 45 | mW |
| Construction | metal, with octal base | | |
| Output connection | coaxial probe for insertion to standard WG 16 launching section | | |

**HEATING:** Indirect

| | | | |
|---|---|---|---|
| Heater voltage | $V_f$ | 6.3 | V |
| Heater current | $I_f$ | 0.5 | A |

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

| | | | | |
|---|---|---|---|---|
| Heater voltage | $V_f$ | max. | 6.8 | V |
| | | min. | 5.8 | V |
| Resonator voltage | $V_{res}$ | max. | 330 | V |
| Resonator current | $I_{res}$ | max. | 37 | mA |
| Reflector voltage [1] | $V_{refl}$ | max. | −400 | V |
| | | min. | 0 | V |
| Cathode to heater voltage | $V_{kf}$ | max. | 50 | V |
| Body temperature | t | max. | 110 | °C |
| Voltage standing-wave ratio | V.S.W.R. | max. | 1.5 | |
| Impedance of the reflector/cathode circuit | $Z_{refl/k}$ | max. | 500 | kΩ |

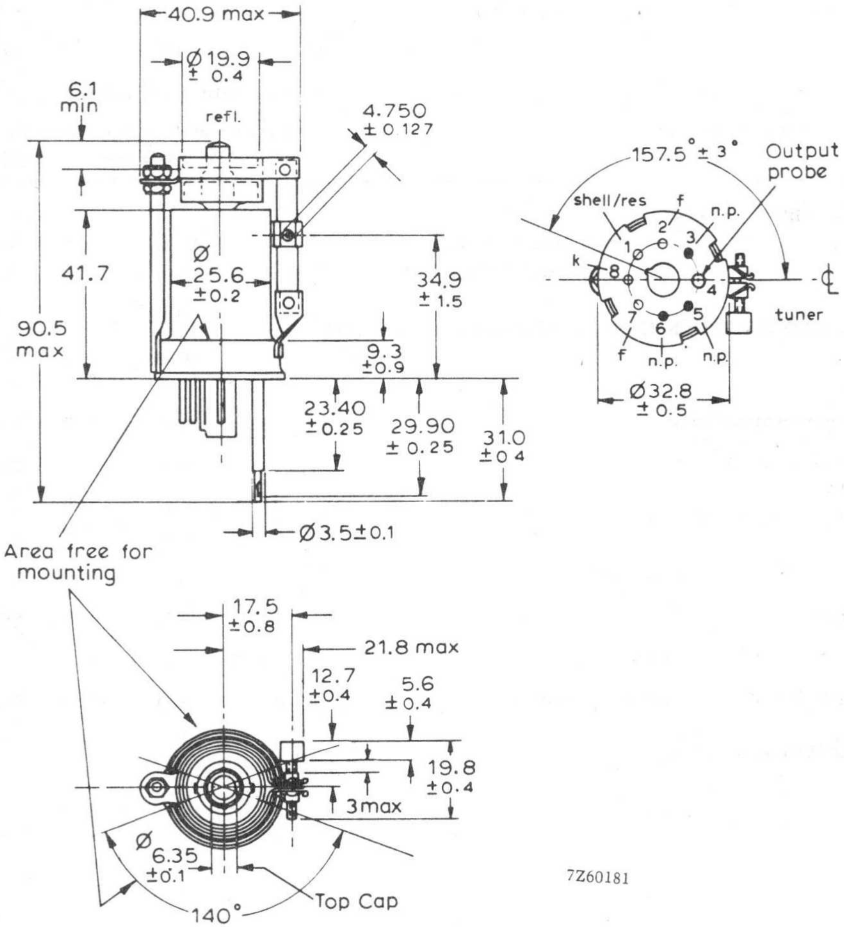
**COOLING:** natural

[1]) The klystron must not be operated without the reflector supply while the resonator voltage is applied.
Care should be taken in the design of the power supply to ensure that the reflector potential never becomes positive with respect to the cathode.

## MECHANICAL DATA

Dimensions in mm

| | |
|---|---|
| Base | : Octal, IEC67-I-5f, type 2 |
| Top cap | : 6,35 ±0.1 ϕ |
| Net weight | : approx. 65 g |
| Mounting position | : Any |




7Z60181

**TEST CONDITIONS AND LIMITS**

The klystron is tested to comply with the following electrical specification.

Test conditions [2]

| | | | |
|---|---|---|---|
| Heater voltage | $V_f$ | 6.3 | V |
| Resonator voltage | $V_{res}$ | 300 | V |
| Reflector voltage [1] | $V_{refl}$ | adjust | |
| Voltage standing-wave ratio | V.S.W.R. | 1.1 | |

Limits and characteristics

| | | Min. | Max. | |
|---|---|---|---|---|
| Heater current | $I_f$ | 0.41 | 0.55 | A |
| Resonator current | $I_{res}$ | | 32 | mA |
| Reflector voltage [3] | | | | |
| f = 9.325 GHz | $V_{refl}$ | -125 | | V |
| f = 9.500 GHz | $V_{refl}$ | | -190 | V |
| Output power [3] | | | | |
| f = 9.325 GHz | $W_o$ | 20 | | mW |
| f = 9.500 GHz | $W_o$ | 20 | | mW |
| Electronic tuning range to ½ power points | | | | |
| f = 9.325 GHz | $\Delta f$ | 30 | | MHz |
| f = 9.500 GHz | $\Delta f$ | 30 | | MHz |
| Load effect [4] | | 10 | | mW |
| Hysteresis [5] | | | 0.5 | |
| Frequency temperature coefficient | $-\frac{\Delta f}{\Delta t}$ | | 0.25 | MHz/degC |
| Mechanical tuning range [6] | f | 9.325 | 9.500 | GHz |

[1]) See page 1
[2]) ... [6]) See page 4

**OPERATING CHARACTERISTICS** Mode A at 9.37 GHz

| | | | |
|---|---|---|---|
| Conditions [2] | | | |
| Heater voltage | $V_f$ | 6.3 | V |
| Resonator voltage | $V_{res}$ | 300 | V |
| Reflector voltage [1] [3] | $V_{refl}$ | -155 | V |
| Voltage standing-wave ratio | V.S.W.R. | 1.1 | |
| Typical performance | | | |
| Resonator current | $I_{res}$ | 23 | mA |
| Output power | $W_o$ | 45 | mW |
| Electronic tuning range to ½ power points | $\Delta f$ | 35 | MHz |

**END OF LIFE PERFORMANCE**

The quality of all production is monitored by the random selection of klystrons which are then life tested under the stated test conditions. If the klystron is to be operated under different conditions from those specified above, the manufacturer should be consulted to verify that the life will not be affected. The klystron is considered to have reached the end of life when it fails to meet the following limits when operated as specified on page 3.

| | | | |
|---|---|---|---|
| Output power | $W_o$ | min. 10 | mW |

**NOTES**

1) See page 1.

2) With the klystron operated in a standard waveguide launching section as shown on pages 5 and 6.

3) Reflector voltage dajusted for the maximum power point of the mode.

4) There shall be no discontinuities at the maximum power points nor shall the power fall below that specified as a mismatch represented by a V.S.W.R. of 2.5 is varied through all phases.

5) The ratio of the power at which hysteresis is present shall not exceed the limit specified.

6) Damage to the tuner may occur if it is adjusted beyond these frequency limits.

## INSTALLATION

For good broadband performance the tube should be inserted in a suitable mount. The mount recommended is shown in Fig. 1. It consists of a section of 3 cm waveguide (RG-52/U; outside dimensions 25.4 x 12.7), shortcircuited at one side, into which the aerial of the tube penetrates. The position of the aerial with respect to the waveguide is shown in Fig. 2.
The outer conductor of the output line should reach to the inner side of the waveguide. The broadband R.F. choke provides a good H.F. contact between the output line and the guide.
The tube socket, a modified octal type of which the hole corresponding to the pin No. 4 of the base has been drilled in order to pass the coaxial output line, is fixed rigidly to the waveguide to ensure a correct installation.
The tube should be fixed firmly in the socket by clamps which make contact at the lower platform of the tube only. It may happen that the waveguide is not terminated in a matched load, which will give rise to frequency instability. When a very good frequency stability is required an attenuator of minimum 6 dB may be inserted in the guide between the aerial and the load.

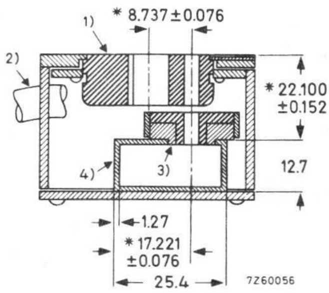



Fig. 1 Cross section of the mount (coupler)

All high frequency surfaces to be silver or gold plated.
Dimensions indicated with * determine the broadband characteristics of the coupler and should be held to the tolerance shown.

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1) Modified octal socket. Individual pin sockets must be deeper than 12.014 mm.
2) Cable to socket connections
3) R.F. choke
4) Wave guide

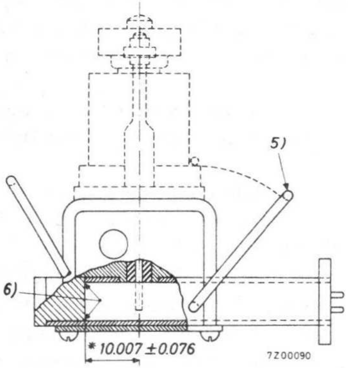



Fig. 2 Side-view of the mount

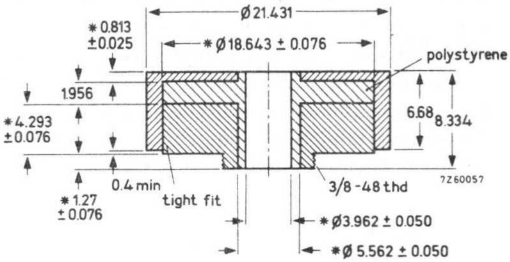



Fig. 4 Cross-section of the R.F. choke

* See under Fig. 1

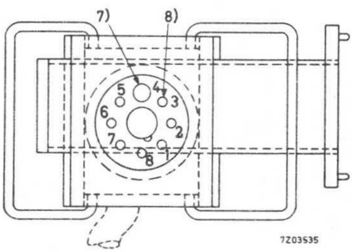



Fig. 3 Top-view of the mount

Remark: The mount and the R.F. choke are not supplied by the tube manufacturer.

---

5) Tube clamp

6) Inner edges of plug must be brazed to waveguide

7) 4.75 mm drill

8) Remove socket terminals 3, 4, 5 and 6

# TUNABLE REFLEX KLYSTRON

Mechanically tunable klystron for local oscillator applications.

| QUICK REFERENCE DATA | | | | |
|---|---|---|---|---|
| Frequency, tunable within the band | KS9-40 | f | 9.30 to 9.50 | GHz |
| | KS9-40D | f | 9.38 to 9.51 | GHz |
| Power output | | $W_o$ | 40 | mW |
| Construction | | Waveguide output | | |

**HEATING** : indirect

| | | | |
|---|---|---|---|
| Heater voltage | $V_f$ | 6.3 | V |
| Heater current | $I_f$ | 0.5 | A |

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

| | | | | |
|---|---|---|---|---|
| Heater voltage | $V_f$ | max. | 6.9 | V |
| | | min. | 5.7 | V |
| Resonator voltage | $V_{res}$ | max. | 350 | V |
| Resonator current | $I_{res}$ | max. | 45 | mA |
| Reflector voltage 1) | $-V_{refl}$ | max. | 400 | V |
| | | min. | 10 | V |
| Body temperature, measured at temperature measuring point | t | max. | 150 | $^{o}C$ |
| Voltage standing-wave ratio | V.S.W.R. | max. | 1.5 | |
| Impedance of the reflector/cathode circuit | $Z_{refl/k}$ | max. | 100 | kΩ |
| Cathode to heater voltage | $V_{kf}$ | max. | 50 | V |

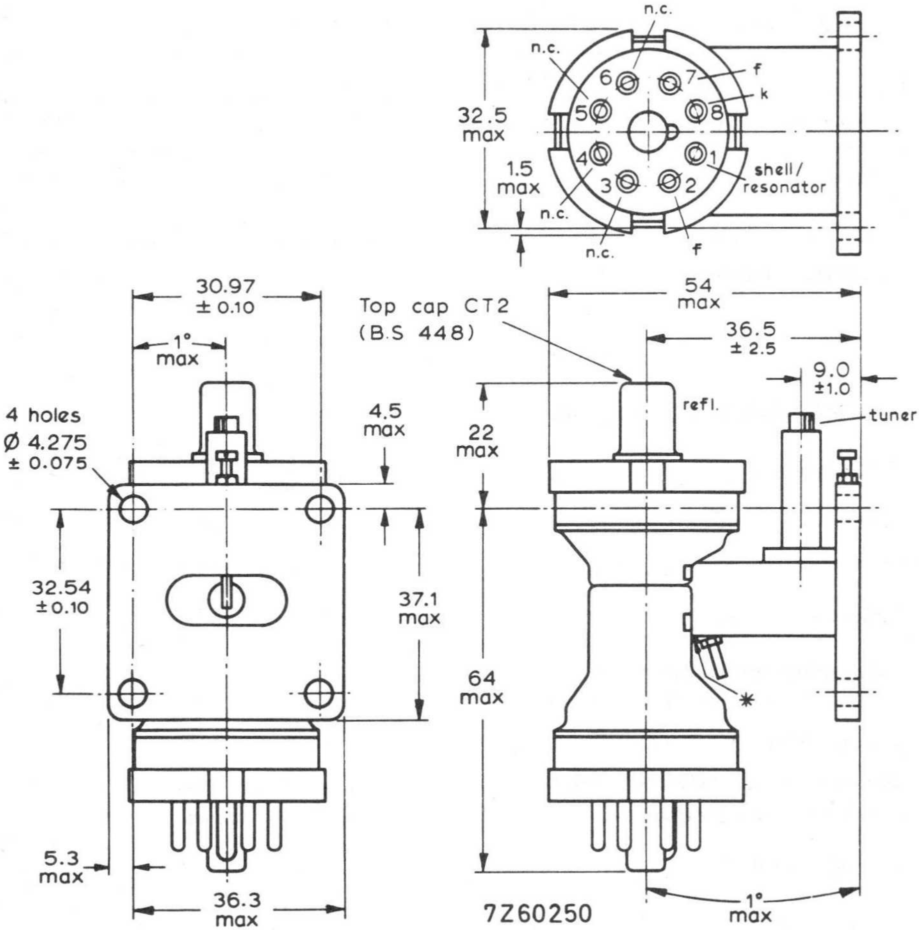
COOLING : natural

1) The klystron must not be operated without the reflector supply while the resonator voltage is applied. Care must be taken to ensure that the reflector potential never becomes positive with respect to the cathode.

**MECHANICAL DATA**

Dimensions in mm

Base : Octal, IEC67-I-5a
Top cap : CT2, IEC67-III-1a, type 2
Net weight : approx. 130 g
Mounting position: Any




* Temperature measuring point

## TEST CONDITIONS AND LIMITS

The klystron is tested to comply with the following electrical specification.

Test conditions [1])

| | | | |
|---|---|---|---|
| Heater voltage | $V_f$ | 6.3 | V |
| Resonator voltage | $V_{res}$ | 300 | V |
| Reflector voltage [2]) | $V_{refl}$ | adjust | V |
| Voltage standing-wave ratio | V.S.W.R. | $\leq 1.1$ | |

Limits and characteristics

| | | Frequency (GHz) | | Min. | Max. | |
|---|---|---|---|---|---|---|
| Heater current | | | $I_f$ | 0.41 | 0.55 | A |
| Resonator current | KS9-40 | | $I_{res}$ | - | 45 | mA |
| | KS9-40D | | $I_{res}$ | - | 40 | mA |
| Reflector voltage [2]) | KS9-40 | 9.30 to 9.50 | $V_{refl}$ | -65 | -115 | V |
| | KS9-40D | 9.38 to 9.51 | $V_{refl}$ | -70 | -120 | V |
| Output power [2]) | KS9-40 | 9.30 to 9.50 | $W_o$ | 25 | 50 | mW |
| | KS9-40D | 9.38 to 9.51 | $W_o$ | 25 | 45 | mW |
| Electronic tuning range to ½ power points | | | | | | |
| | KS9-40 | 9.30 to 9.50 | | 28 | | MHz |
| | KS9-40D | 9.38 to 9.51 | | 30 | | MHz |
| Load effect [3]) | | | | 10 | | mW |
| Hysteresis [4]) | | | | | 0.5 | |
| Frequency temperature coefficient | | | $-\frac{\Delta f}{\Delta t}$ | | 200 | kHz/degC |
| Peak frequency modulation with vibration at 10 g from 30 to 1000 Hz | | | | | 200 | kHz |
| Mechanical tuning range | KS9-40 | | f | 9.30 | 9.50 | GHz |
| | KS9-40D | | f | 9.38 | 9.51 | GHz |
| Mechanical tuning rate [5]) | | | | | 150 | MHz/turn |
| Electronic tuning rate at mode centre | | | | 2.0 | 3.0 | MHz/V |

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Notes: See page 4

**OPERATING CHARACTERISTICS** at 9.45 GHz

| | | | |
|---|---|---|---|
| Conditions [1] | | | |
| Heater voltage | $V_f$ | 6.3 | V |
| Resonator voltage | $V_{res}$ | 300 | V |
| Reflector voltage [2] | $V_{refl}$ | -90 | V |
| V.S.W.R. | V.S.W.R. | 1.1 | |
| Typical performance | | | |
| Resonator current | $I_{res}$ | 28 | mA |
| Output power | $W_o$ | 40 | mW |
| Electronic tuning range to ½ power points | $\Delta f$ | 40 | MHz |

**END OF LIFE PERFORMANCE**

The quality of all production is monitored by the random selection of klystrons which are then life tested under the stated test conditions. If the klystron is to be operated under different conditions from those specified above, the manufacturer should be consulted to verify that the life will not be affected. The klystron is considered to have reached the end of life when it fails to meet the following limits when operated as specified under "Test conditions and limits".

| | | | | |
|---|---|---|---|---|
| Output power | $W_o$ | min. | 20 | mW |

**NOTES**

1) With the klystron rigidly connected to and in good thermal contact with a UG-39/U flange on an appropriate RG-52/U (W.G. 16) waveguide.

2) Reflector voltage adjusted for the maximum power point of the mode.

3) There shall be no discontinuities at the maximum power points nor shall the power fall below that specified as a mismatch represented by a V.S.W.R. of 1.5 is varied through all phases.

4) The ratio of the power at which hysteresis is present must not exceed the limit specified.

5) Average over the frequency range. The frequency is decreased when tuner is rotated in a clockwise direction.

# TUNABLE REFLEX KLYSTRON

Mechanical tunable klystron for local oscillator applications.

| QUICK REFERENCE DATA | | | |
|---|---|---|---|
| Frequency, tunable within the band | f | 9.35 to 9.55 | GHz |
| Output power | $W_o$ | 45 | mW |
| Construction | Waveguide output, flying leads | | |

**HEATING** : indirect

| | | | |
|---|---|---|---|
| Heater voltage | $V_f$ | 6.3 | V |
| Heater current | $I_f$ | 0.5 | A |

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

| | | | | |
|---|---|---|---|---|
| Heater voltage | $V_f$ | max. | 6.9 | V |
| | | min. | 5.7 | V |
| Resonator voltage | $V_{res}$ | max. | 350 | V |
| Resonator current | $I_{res}$ | max. | 45 | mA |
| Reflector voltage [1] | $V_{refl}$ | max. | -400 | V |
| | | min. | -10 | V |
| Body temperature measured at temperature measuring point | t | max. | 150 | $^{o}C$ |
| Voltage standing-wave ratio | V.S.W.R. | max. | 1.5 | |
| Impedance of the reflector/cathode circuit | $Z_{refl/k}$ | max. | 100 | kΩ |

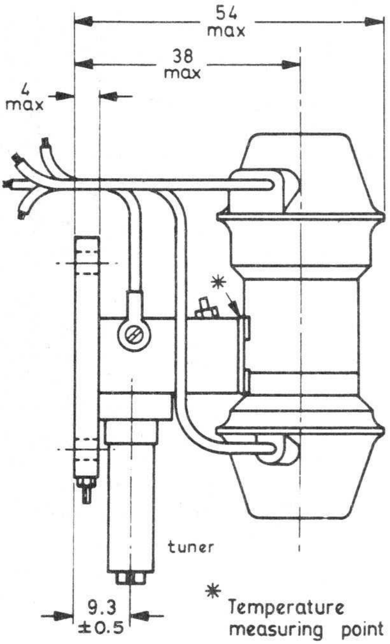
**COOLING** : natural

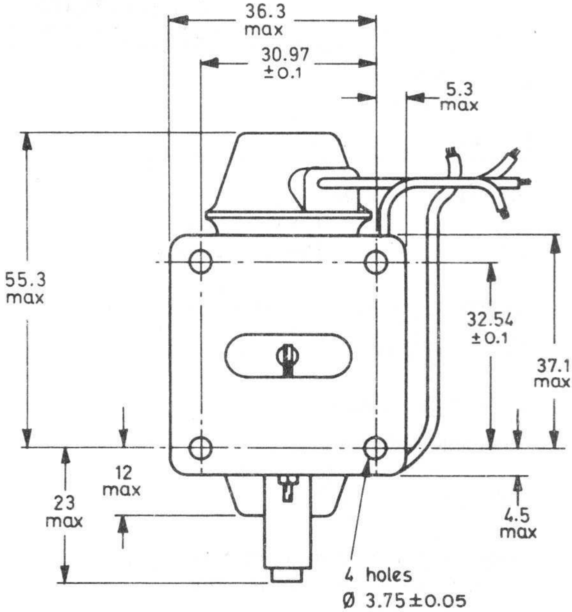
[1]) The klystron must not be operated without the reflector supply while the resonator voltage is applied. Care must be taken to ensure that the reflector potential never becomes positive with respect to the cathode.

## MECHANICAL DATA

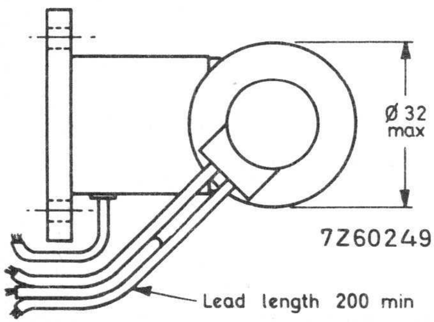
Dimensions in mm

Net weight: approx. 130 g
Mounting position: Any




Outlet via waveguide RG-52 / U (W.G.16) to take bolted plain flange similar to UG-39 / U




| Lead colour code | |
|---|---|
| White | Heater / cathode |
| Yellow | Heater |
| Grey | Reflector |
| Brown | Resonator |

## TEST CONDITIONS AND LIMITS

The klystron is tested to comply with the following electrical specification.

Test conditions 1)

| | | | |
|---|---|---|---|
| Heater voltage | $V_f$ | 6.3 | V |
| Resonator voltage | $V_{res}$ | 300 | V |
| Reflector voltage 2) | $V_{refl}$ | adjust | |
| Voltage standing-wave ratio | V.S.W.R. | $\leq$ 1.1 | |

Limits and characteristics

| | Frequency (GHz) | | min. | max. | |
|---|---|---|---|---|---|
| Heater current | | $I_f$ | 0.41 | 0.55 | A |
| Resonator current | | $I_{res}$ | 15 | 25 | mA |
| Reflector voltage 2) | 9.35 to 9.55 | $V_{refl}$ | -60 | -115 | V |
| Output power 2) | 9.35 | $W_o$ | 30 | | mW |
| | 9.55 | $W_o$ | 30 | | mW |
| Electronic tuning range to ½ power points | 9.35 | $\Delta f$ | 20 | 50 | MHz |
| | 9.55 | $\Delta f$ | 20 | 50 | MHz |
| Load effect 3) | | | 10 | | mW |
| Hysteresis 4) | | | | 0.5 | |
| Frequency temperature coefficient | | $-\frac{\Delta f}{\Delta t}$ | | 200 | kHz/degC |
| Peak frequency modulation with vibration at 10 g from 30 to 1000 Hz | | | | 200 | kHz |
| Mechanical tuning range | | f | 9.35 | 9.55 | GHz |
| Mechanical tuning rate 5) | | | | 150 | MHz/turn |
| Electronic tuning rate at mode centre | | $\Delta f$ | 2.0 | 3.0 | MHz/V |

Notes: See page 4

**OPERATING CHARACTERISTICS** at 9.45 GHz

Conditions [1]

| | | | |
|---|---|---|---|
| Heater voltage | $V_f$ | 6.3 | V |
| Resonator voltage | $V_{res}$ | 300 | V |
| Reflector voltage [2] | $V_{refl}$ | -90 | V |
| Voltage standing-wave ratio | V.S.W.R. | 1.1 | |

Typical performance

| | | | |
|---|---|---|---|
| Resonator current | $I_{res}$ | 21 | mA |
| Output power | $W_o$ | 45 | mW |
| Electronic tuning range to ½ power points | $\Delta f$ | 40 | MHz |
| Mechanical tuning rate | | 100 | MHz/turn |

**END OF LIFE PERFORMANCE**

The quality of all production is monitored by the random selection of klystrons which are then life tested under the stated test conditions. If the klystron is to be operated under different conditions from those specified above, the manufacturer should be consulted to verify that the life will not be affected. The klystron is considered to have reached the end of life when it fails to meet the following limits when operated as specified under "Test conditions and limits".

| | | | |
|---|---|---|---|
| Output power | $W_o$ min. | 20 | mW |

**NOTES**

1) With the klystron rigidly connected to and in good thermal contact with a UG-39/U flange on an appropriate RG-52/U (W.G.16) waveguide.

2) Reflector voltage adjusted for the maximum power point of the mode.

3) There shall be no discontinuities at the maximum power points nor shall the power fall below that specified as a mismatch represented by a V.S.W.R. of 1.5 is varied through all phases.

4) The ratio of the power at which hysteresis is present shall not exceed the limit specified.

5) Average over the frequency range. The frequency is decreased when the tuner is rotated in a clockwise direction.

# TUNABLE REFLEX KLYSTRON

Forced-air cooled mechanically tunable reflex klystron in metal construction with micrometer tuning and waveguide output for local oscillator applications.

| QUICK REFERENCE DATA | | | |
|---|---|---|---|
| Frequency, tunable within the band | f | 67 to 74 | GHz |
| Power output | $W_o$ | 130 | mW |
| Construction | Waveguide output | | |

**HEATING**: indirect; dispenser type cathode

| | | | | | |
|---|---|---|---|---|---|
| Heater voltage | $V_f$ | = | | 3.5 | V |
| Heater current | $I_f$ | = | | 1.75 ± 0.02 | A |
| Cold heater resistance | $R_{f_o}$ | = | | 0.3 | Ω |
| Waiting time | $T_w$ | = | min. | 15 | min |

**LIMITING VALUES** (Absolute limits)

| | | | | | |
|---|---|---|---|---|---|
| Heater surge current | $I_{f\,surge}$ | = | max. | 4 | A |
| Resonator voltage | $V_{res}$ | = | max. | 2.6 | kV |
| Resonator current | $I_{res}$ | = | max. | 20 | mA |
| Resonator dissipation | $W_{res}$ | = | max. | 45 | W |
| Negative grid voltage | $-V_g$ | = | | 0 to 200 | V |
| Negative reflector voltage | $-V_{refl}$ | = | | 20 to 500 | V |
| Resonator block temperature | $t_{res}$ | = | max. | 80 | °C [1] |

**TYPICAL CHARACTERISTICS**

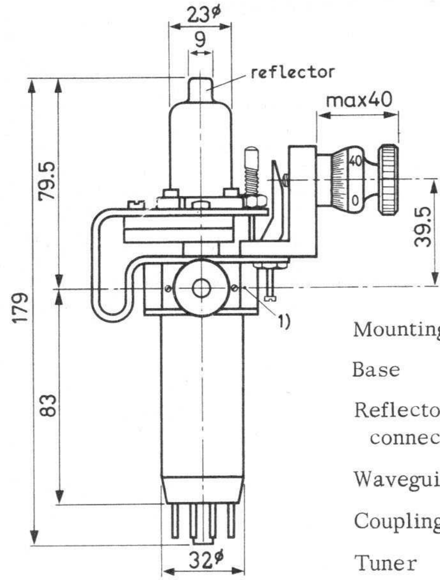
| | | | | |
|---|---|---|---|---|
| Mechanical tuning range | f | = | 67 to 74 | GHz |
| Mechanical tuning rate, average over range | | = | 3.5 GHz | per turn |

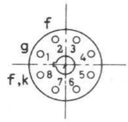
All voltages are given with respect to the cathode

[1]) For temperature measuring point see outline drawing

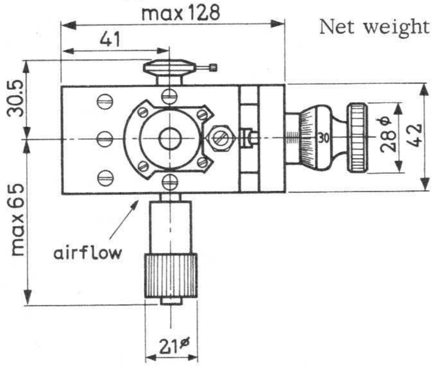
**MECHANICAL DATA**

Dimensions in mm




| | |
|---|---|
| Mounting position: | any |
| Base | Octal |
| Reflector connection | I.E.C. 67-III-1a type 2 |
| Waveguide | I.E.C.-R740 (RG99U) |
| Coupling | Claw flange I.E.C.-F-R740 |
| Tuner | Single micrometer screw |
| Net weight | 1 kg |




The tube is equipped with the output waveguide I.E.C.-R740 (RG99U) with claw flange I.E.C.-F-R740 and clamping ring. A loose claw flange is added for adaptation to other coupling systems if necessary.

**COOLING**

Forced air, min. 200 l/min, nozzle 30 mm ∅

---

1) Temperature measuring point

## OPERATING CHARACTERISTICS

| | | | | |
|---|---|---|---|---|
| Frequency | $f$ | = | 70 | GHz |
| Resonator voltage | $V_{res}$ | = | 2.5 | kV |
| Resonator current | $I_{res}$ | = | 18 | mA |
| Reflector voltage | $V_{refl}$ | = | -330 | V |
| Grid voltage | $V_g$ | = | -50 | V |
| Output power | $W_o$ | = | 130 | mW |
| Electronic tuning range between half-power points | $\Delta f$ | = | 100 | MHz |

## INSTALLATION AND OPERATION NOTES

As the resonator is integral with the tuner, backplunger and waveguide, it is preferred to operate the resonator at earth potential. If the cathode is earthed and resonator, etc. placed at H.T. adequate shielding is necessary to protect the operator against injuries.

With earthed resonator the heater transformer should be insulated for the maximum resonator voltage, whereas the reflector power supply should be insulated to withstand the total resonator and reflector voltage.

Where the tube is to be operated in the presence of strong magnetic fields, shielding of the resonator and reflector leads may be required, so as to avoid undesirable modulation of the output.

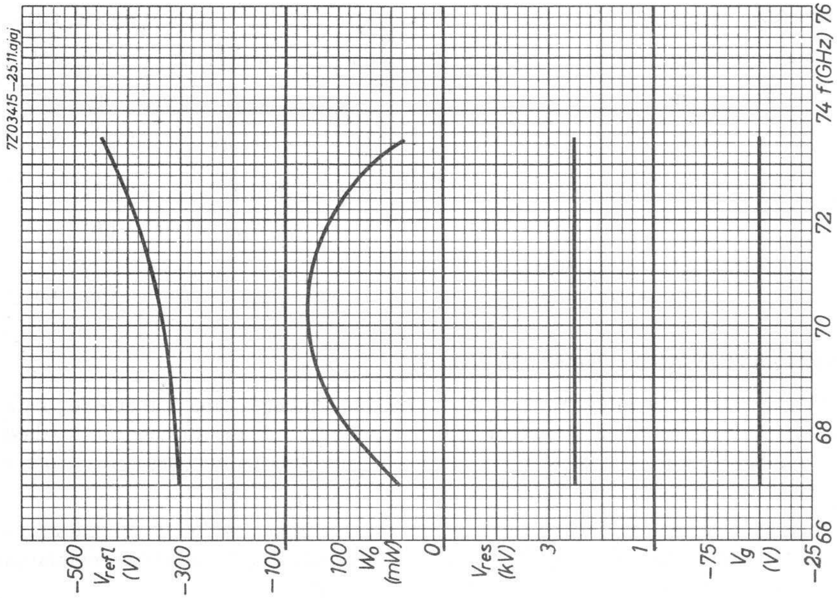
Before applying any voltage be sure that the reflector is connected and the series impedance between reflector and cathode does not exceed 75 kΩ.
The reflector voltage must never be allowed to become positive with respect to the cathode. In doubtful cases a diode should be applied between the reflector and cathode to prevent the reflector from becoming positive.
Further the reflector voltage must be applied prior to the resonator voltage.

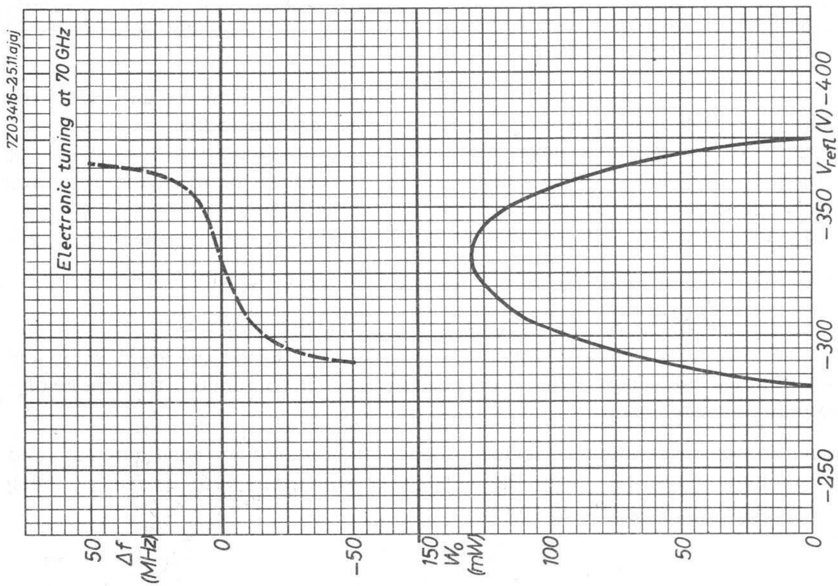
The internal impedance of the grid supply should not exceed 10 kΩ.

Neglecting these precautions will damage the tube

The heater current should be gradually increased up to the specified value and kept within its tolerance. After a preheating time of 15 minutes the other voltages may be switched on.

At each frequency grid and reflector voltages and the plunger should be adjusted for maximum output. Moreover the output may sometimes be increased by using an additional matching transformer.


7Z03415-25.11.ajaj
-500
Vrefl
(V)
-300
-100
100
Wo
(mW)
0
Vres
(kV)
3
1
-75
Vg
(V)
-25
66
68
70
72
74 f(GHz) 76


7Z03416-25.11.ajaj
Electronic tuning at 70 GHz
50
Δf
(MHz)
0
-50
150
Wo
(mW)
100
50
0
-250
-300
-350 Vrefl (V) -400

# RUGGEDIZED TUNABLE REFLEX KLYSTRON

Mechanically tunable light weight rugged reflex klystron with integral cavity, waveguide output and flying leads, suitable for operation at low pressures.

| QUICK REFERENCE DATA | | |
|---|---|---|
| Frequency, tunable within the band | f | 10.5 to 12.2 GHz |
| Power output | $W_o$ | 400 mW |
| Construction | | waveguide output |

**HEATING:** indirect

| | | | | | |
|---|---|---|---|---|---|
| Heater voltage | $V_f$ | = | | 6.3 V | ±10 % |
| Heater current at $V_f$ = 6.3 V | $I_f$ | = | | 1.2 A | |
| Cathode heating time | $T_w$ | = | min. | 15 s | |

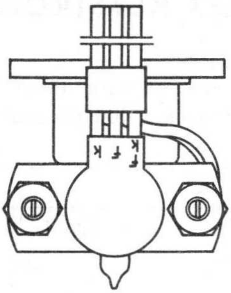
**LIMITING VALUES** (Absolute limits)

| | | | | |
|---|---|---|---|---|
| Resonator voltage | $V_{res}$ | = | max. | 450 V |
| Resonator current | $I_{res}$ | = | max. | 70 mA |
| Negative reflector voltage | $-V_{refl}$ | = | | 20 to 1000 V |
| Body temperature | t | = | max. | 200 °C [1] |

[1]) For maximum life the body temperature should be kept below 100 °C

**MECHANICAL DATA**

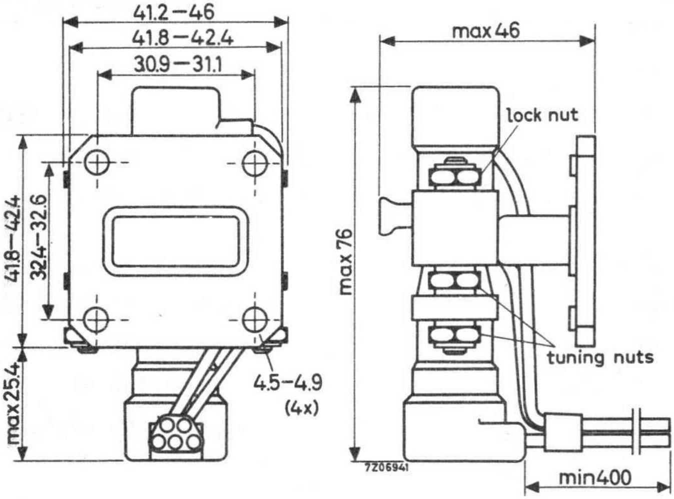
Dimensions in mm



Warning

Do not apply the heater voltage to the green connector as this will result in the destruction of the tube.

| | |
|---|---|
| Output waveguide | RG-52/U (WI-90) |
| Plane flange | UG-39/U |




**CONNECTIONS**

Yellow - heater

White - heater + cathode

Green - I.C. (cathode)

Grey - reflector

Marroon - cavity

Net weight : 200 g

Mounting position: any

Mechanical tuning with bolt and nut

**TUNING**

Loosen both tuning nuts at socket side. Turn both nuts in centre in small steps to the left or to the right until required frequency is obtained.
Then fix lower nuts again.
Do not touch lock nut at reflector side.

**COOLING:** natural or forced air

Forced air cooling is necessary for a resonator input greater than 10 W

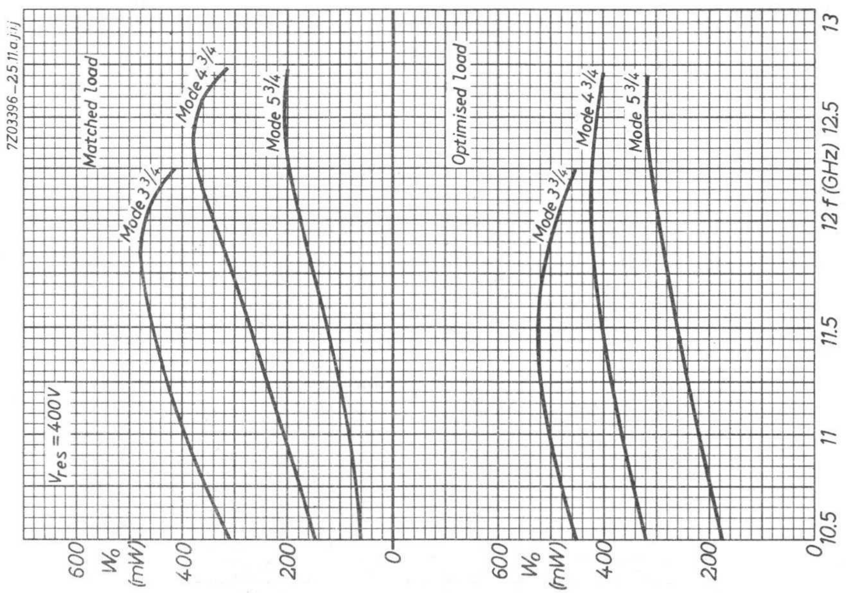
**TYPICAL CHARACTERISTICS**

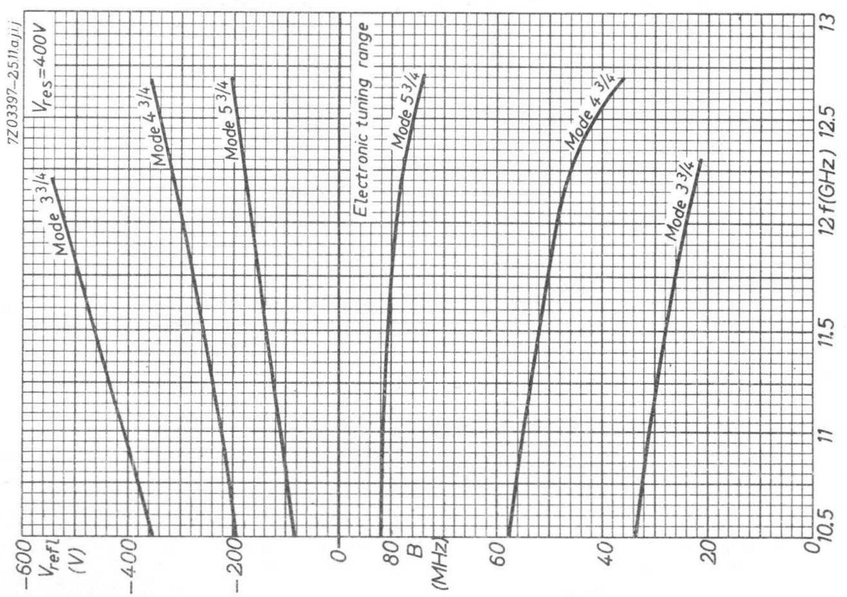
| | | | | |
|---|---|---|---|---|
| Mechanical tuning range | $f$ | = | 10.5 to 12.2 | GHz |
| Electronic tuning range between half-power points at any point in the mechanical tuning range at $V_{res} = 400$ V | $\Delta f$ | | > 30 | MHz |
| Reflector modulation sensitivity at f = 10.5 to 12.2 GHz | $\frac{\Delta f}{\Delta V_{refl}}$ | = | 0.8 to 2.0 | MHz per V |
| Power output at any frequency in the mechanical tuning range with reflector voltage optimised at $V_{res} = 400$ V | $W_o$ | | > 50 | mW |
| Reflector voltage range for maximum power output over the mechanical tuning range | $V_{refl}$ | = | −120 to −370 | V |
| Reflector voltage for maximum power output at centre frequency in principal mode at $V_{res} = 400$ V | $V_{refl}$ | = | −260 | V |
| Frequency drift after first 5 minutes of operation | $\Delta f$ | = | 0.5 | MHz |
| Temperature coefficient in the range $t_{amb} = -10$ to $+40$ °C | $\frac{\Delta f}{\Delta t}$ | | < 0.25 | MHz per °C |
| Frequency change with atmospherique pressure change equivalent to operation at 0 to 20 km altitude | $\Delta f$ | = 1 | < 3 | MHz |
| 0 to 30 km altitude | $\Delta f$ | = 2 | < 10 | MHz |
| Frequency modulation under vibration of 5 g applied to the flange (50 to 5000 Hz in three planes) | $\Delta f$ | | < 4 | MHz |

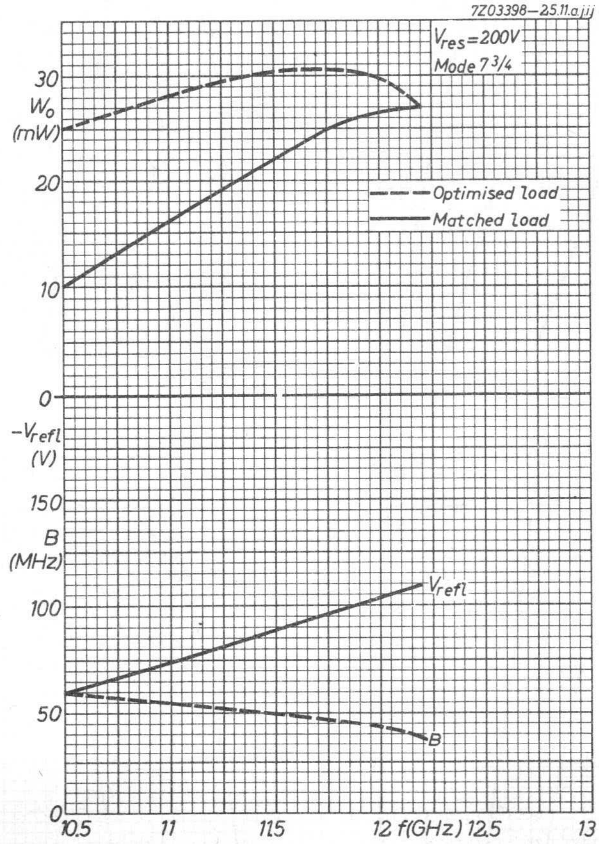
## OPERATING CHARACTERISTICS

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Frequency | | $f$ | = | 10.5 | 11.5 | 12.2 | GHz |
| Resonator voltage | | $V_{res}$ | = | 400 | 400 | 400 | V |
| Resonator current | | $I_{res}$ | = | 65 | 65 | 65 | mA |
| Reflector voltage | | $V_{refl}$ | = | -190 | -260 | -315 | V |
| Output power | matched load | $W_o$ | = | 150 | 270 | 370 | mW |
| | optimised load | $W_o$ | = | 320 | 400 | 420 | mW |
| Electronic tuning range between half-power points | | $\Delta f$ | = | 58 | 52 | 47 | MHz |
| Reflector modulation coefficient | | $\frac{\Delta f}{\Delta V_{refl}}$ | = | 1.0 | 1.0 | 1.0 | MHz /V |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Frequency | | $f$ | = | 10.5 | 11.5 | 12.2 | GHz |
| Resonator voltage | | $V_{res}$ | = | 200 | 200 | 200 | V |
| Resonator current | | $I_{res}$ | = | 23 | 23 | 23 | mA |
| Reflector voltage | | $V_{refl}$ | = | -60 | -90 | -110 | V |
| Output power | matched load | $W_o$ | = | 10 | 22 | 27 | mW |
| | optimised load | $W_o$ | = | 25 | 30 | 27 | mW |
| Electronic tuning range between half-power points | | $\Delta f$ | = | 60 | 50 | 38 | MHz |


7Z03396-2511a,j,i,j
Matched load
Optimised load
$V_{res}$ = 400V
Mode 3 3/4
Mode 4 3/4
Mode 5 3/4
Wo (mW)
600
400
200
0
10.5
11
11.5
12 f (GHz) 12.5
13


7Z03397-2511a,j,i,j
$V_{res}$=400V
Electronic tuning range
Mode 3 3/4
Mode 4 3/4
Mode 5 3/4
$V_{refl}$ (V)
-600
-400
-200
0
B (MHz)
80
60
40
20
0
10.5
11
11.5
12 f(GHz) 12.5
13


7Z03398—25.11.a.j.i.j
$V_{res}$=200V
Mode 7 3/4
Optimised load
Matched load
30
$W_o$
(mW)
20
10
0
$-V_{refl}$
(V)
150
B
(MHz)
100
50
0
$V_{refl}$
B
10.5
11
11.5
12 f(GHz) 12.5
13

# TUNABLE REFLEX KLYSTRON

Mechanically tunable light weight reflex klystron with integral cavity and waveguide output

| QUICK REFERENCE DATA | | | |
|---|---|---|---|
| Frequency, tunable within the band | f | 10.5 to 12.2 | GHz |
| Power output | $W_o$ | 400 | mW |
| Construction | | waveguide output | |

**HEATING:** indirect

| | | | | | | |
|---|---|---|---|---|---|---|
| Heater voltage | $V_f$ | = | | 6.3 | V | ±10 % |
| Heater current at $V_f$ = 6.3 V | $I_f$ | = | | 1.2 | A | |
| Cathode heating time | $T_w$ | = | min. | 15 | s | |

**LIMITING VALUES** (Absolute limits)

| | | | | | | |
|---|---|---|---|---|---|---|
| Resonator voltage | $V_{res}$ | = | max. | 450 | V | |
| Resonator current | $I_{res}$ | = | max. | 70 | mA | |
| Negative reflector voltage | $-V_{refl}$ | = | | 20 to 1000 | V | |
| Body temperature | t | = | max. | 200 | °C | [1] |

**TYPICAL CHARACTERISTICS**

| | | | | |
|---|---|---|---|---|
| Mechanical tuning range | f | = | 10.5 to 12.2 | GHz |
| Electronic tuning range between half-power points at any point in the mechanical tuning range at $V_{res}$ = 400 V | $\Delta f$ | | > 30 | MHz |
| Reflector modulation sensitivity at f = 10.5 to 12.2 GHz | $\frac{\Delta f}{\Delta V_{refl}}$ | = | 0.8 to 2.0 | MHz per V |
| Power output at any frequency in the mechanical tuning range with reflector voltage optimised at $V_{res}$ = 400 V | $W_o$ | | > 50 | mW |

[1]) For maximum life the body temperature should be kept below 100 °C

## TYPICAL CHARACTERISTICS (continued)

| | | | | |
|---|---|---|---|---|
| Reflector voltage range for maximum power output over the mechanical tuning range | $V_{refl}$ | = | -100 to -400 | V |
| Reflector voltage for maximum power output at centre frequency in principal mode at $V_{res}$ = 400 V | $V_{refl}$ | = | -260 | V |
| Frequency drift after first 5 minutes of operation | $\Delta f$ | = | 0.5 | MHz |
| Temperature coefficient in the range $t_{amb}$ = -10 to +40 $^{o}$C | $\frac{\Delta f}{\Delta t}$ | | < 0.25 | MHz per $^{o}$C |

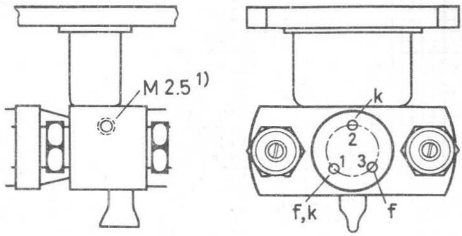
## OPERATING CHARACTERISTICS

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Frequency | | f | = | 10.5 | 11.5 | 12.2 | GHz |
| Resonator voltage | | $V_{res}$ | = | 400 | 400 | 400 | V |
| Resonator current | | $I_{res}$ | = | 65 | 65 | 65 | mA |
| Reflector voltage | | $V_{refl}$ | = | -190 | -260 | -315 | V |
| Output power | matched load | $W_o$ | = | 150 | 270 | 370 | mW |
| | optimised load | $W_o$ | = | 320 | 400 | 420 | mW |
| Electronic tuning range between half-power points | | $\Delta f$ | = | 58 | 52 | 47 | MHz |
| Reflector modulation coefficient | | $\frac{\Delta f}{\Delta V_{refl}}$ | = | 1.0 | 1.0 | 1.0 | MHz /V |

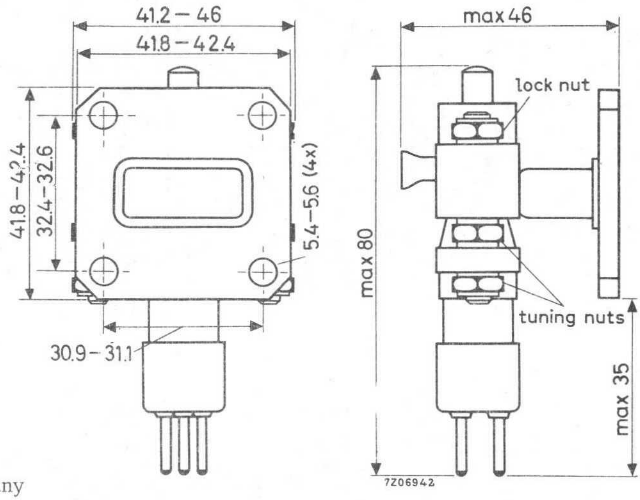
| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Frequency | | f | = | 10.5 | 11.5 | 12.2 | GHz |
| Resonator voltage | | $V_{res}$ | = | 200 | 200 | 200 | V |
| Resonator current | | $I_{res}$ | = | 23 | 23 | 23 | mA |
| Reflector voltage | | $V_{refl}$ | = | -60 | -90 | -110 | V |
| Output power | matched load | $W_o$ | = | 10 | 22 | 27 | mW |
| | optimised load | $W_o$ | = | 25 | 30 | 27 | mW |
| Electronic tuning range between half-power points | | $\Delta f$ | = | 60 | 50 | 38 | MHz |

## MECHANICAL DATA

Dimensions in mm




Net weight: 200 g
Base: Pee Wee 3 pin (A3-1)
Socket: E2 555 37
Connector for reflector: 55316




Mounting position: any

Mechanical tuning with bolt and nut

## TUNING

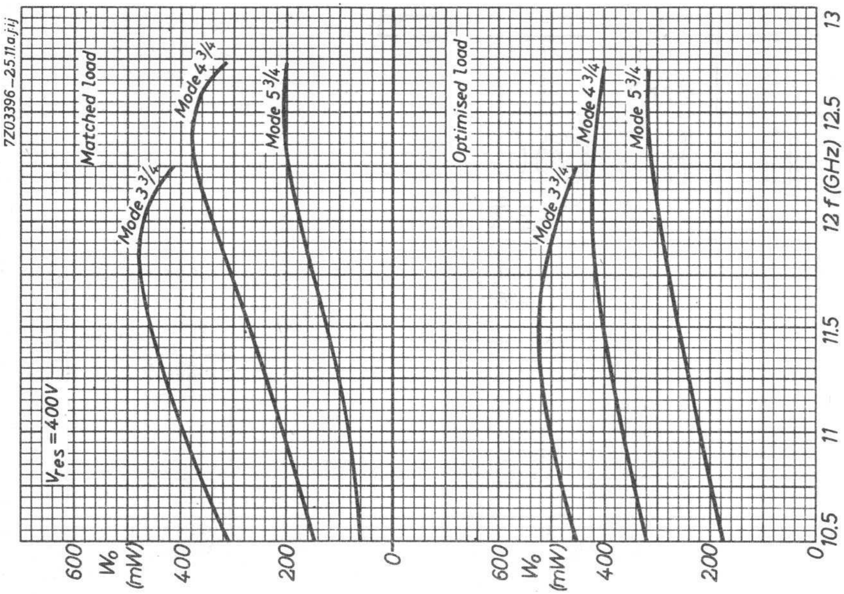
Loosen both tuning nuts at socket side. Turn both nuts in centre in small steps to the left or to the right until required frequency is obtained.
Then fix lower nuts again.
Do not touch lock nut at reflector side.

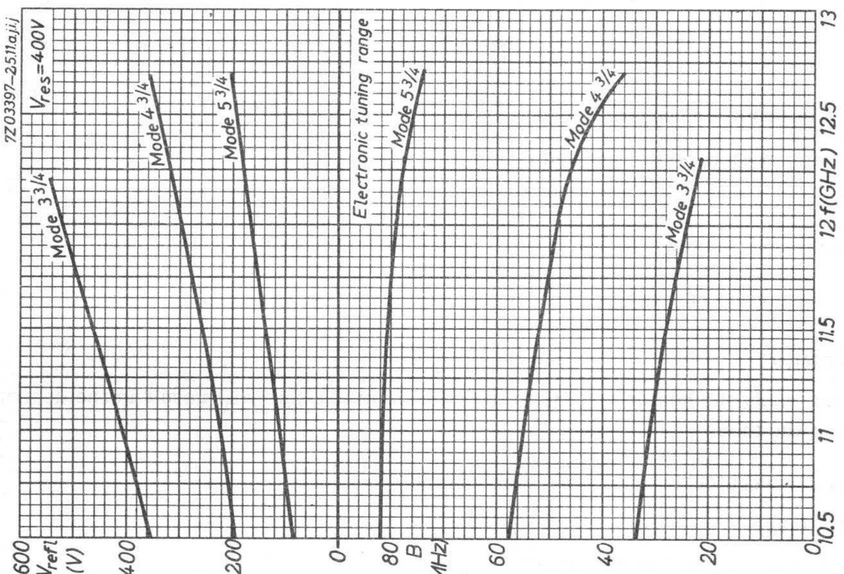
## WARNING

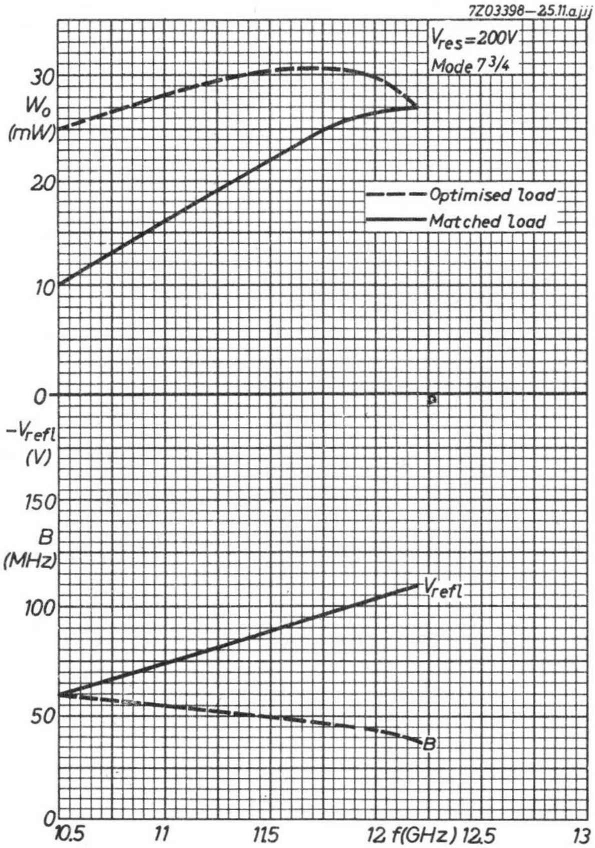
Do not apply the heater voltage to the cathode pin as this will result in the destruction of the tube.

| | |
|---|---|
| Output waveguide | RG-52/U (WR90) |
| Plain flange | UG-39/U |

**COOLING** : natural or forced air
Forced air cooling is necessary for a resonator input greater than 10 W


7Z03396-25.11.a.j.i.j
Matched load
Optimised load
$V_{res}$ = 400V
Mode 3 3/4
Mode 4 3/4
Mode 5 3/4
$W_o$
(mW)
600
400
200
0
10.5
11
11.5
12 f (GHz) 12.5
13


7Z03397-25.11.a.j.i.j
$V_{res}$=400V
Electronic tuning range
Mode 3 3/4
Mode 4 3/4
Mode 5 3/4
$V_{refl}$
(V)
-600
-400
-200
0
B
(MHz)
80
60
40
20
0
10.5
11
11.5
12 f(GHz) 12.5
13


7Z03398—2.5.11.a.jjj
$V_{res}$=200V
Mode 7 3/4
30
$W_o$
(mW)
20
10
0
$-V_{refl}$
(V)
150
B
(MHz)
100
50
0
Optimised load
Matched load
$V_{refl}$
B
10.5
11
11.5
12 f(GHz) 12.5
13

# TUNABLE REFLEX KLYSTRON

Mechanically tunable reflex klystron for local oscillator applications.

| QUICK REFERENCE DATA | | | | | |
|---|---|---|---|---|---|
| Frequency, tunable within the band | f | 8.5 | to | 9.66 | GHz |
| Output power | $W_o$ | | 45 | | mW |
| Construction | metal, with octal base | | | | |
| Output connection | coaxial probe for insertion to standard WG 16 launching section | | | | |

**HEATING** : Indirect

| | | | |
|---|---|---|---|
| Heater voltage | $V_f$ | 6.3 | V |
| Heater current | $I_f$ | 0.45 | A |

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

| | | | | |
|---|---|---|---|---|
| Heater voltage | $V_f$ | max. | 6.8 | V |
| | | min. | 5.8 | V |
| Resonator voltage | $V_{res}$ | max. | 330 | V |
| Resonator current | $I_{res}$ | max. | 37 | mA |
| Reflector voltage [1]) | $V_{refl}$ | max. | -400 | V |
| | | min. | 0 | V |
| Cathode to heater voltage | $V_{kf}$ | max. | 50 | V |
| Body temperature | t | max. | 110 | °C |
| Voltage standing-wave ratio | V.S.W.R. | max. | 1.5 | |
| Impedance of the reflector/cathode circuit | $Z_{refl/k}$ | max. | 500 | kΩ |

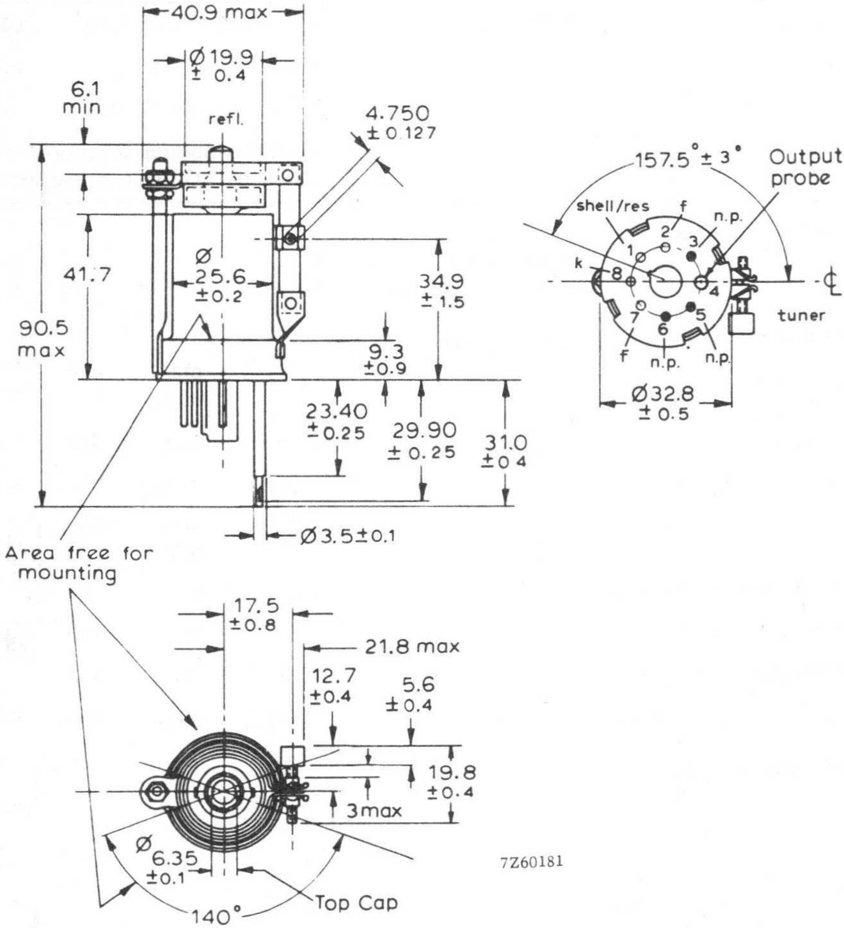
**COOLING:** natural

1) The klystron must not be operated without the reflector supply while the resonator voltage is applied.
Care should be taken in the design of the power supply to ensure that the reflector potential never becomes positive with respect to the cathode.

**MECHANICAL DATA**

Dimensions in mm

Base : Octal, IEC67-I-5f, type 2
Top cap : 6, 35 ±0.1 ϕ
Net weight : approx. 65 g
Mounting position : Any




7Z60181

## TEST CONDITIONS AND LIMITS

The klystron is tested to comply with the following electrical specification.

Test conditions [2]

| | | | |
|---|---|---|---|
| Heater voltage | $V_f$ | 6.3 | V |
| Resonator voltage | $V_{res}$ | 300 | V |
| Reflector voltage [1] | $V_{refl}$ | adjust | |
| Voltage standing-wave ratio | V.S.W.R. | < 1.1 | |

Limits and characteristics [7]

| | | Min. | Max. | |
|---|---|---|---|---|
| Heater current | $I_f$ | 0.41 | 0.47 | A |
| Resonator current | $I_{res}$ | | 32 | mA |
| Reflector voltage [3] | | | | |
| Mode A, f = 8.5 GHz | $V_{refl}$ | -85 | -135 | V |
| Mode A, f = 9.66 GHz | $V_{refl}$ | -143 | -200 | V |
| Mode B, f = 9.37 GHz | $V_{refl}$ | -75 | -120 | V |
| Output power [3] | | | | |
| Mode A, f = 8.5 GHz | $W_o$ | 20 | | mW |
| Mode A, f = 9.66 GHz | $W_o$ | 20 | | mW |
| Mode A, f = 9.37 GHz | $W_o$ | 35 | | mW |
| Mode B, f = 9.37 GHz | $W_o$ | 15 | | mW |
| Electronic tuning range to $\frac{1}{2}$ power points | | | | |
| Mode A, f = 8.5 GHz | $\Delta f$ | 28 | | MHz |
| Mode A, f = 9.37 GHz | $\Delta f$ | 35 | | MHz |
| Mode A, f = 9.66 GHz | $\Delta f$ | 28 | | MHz |
| Load effect [4] | | 10 | | mW |
| Hysteresis [5] | | | 0.5 | |
| Frequency temperature coefficient | $-\frac{\Delta f}{\Delta t}$ | | 0.2 | MHz/degC |
| Mechanical tuning range [6] | f | 8.5 | 9.66 | GHz |

[1]) See page 1
[2])...[7]) See page 4

**OPERATING CHARACTERISTICS** Mode A at 9.37 GHz

Conditions 2)

| | | | |
|---|---|---|---|
| Heater voltage | $V_f$ | 6.3 | V |
| Resonator voltage | $V_{res}$ | 300 | V |
| Reflector voltage 1) 3) | $V_{refl}$ | -150 | V |
| Voltage standing-wave ratio | V.S.W.R. | < 1.1 | |

Typical performance

| | | | |
|---|---|---|---|
| Resonator current | $I_{res}$ | 22 | mA |
| Output power | $W_o$ | 45 | mW |
| Electronic tuning range to ½ power points | $\Delta f$ | 38 | MHz |

**END OF LIFE PERFORMANCE**

The quality of all production is monitored by the random selection of klystrons which are then life tested under the stated test conditions. If the klystron is to be operated under different conditions from those specified above, the manufacturer should be consulted to verify that the life will not be affected. The klystron is considered to have reached the end of life when it fails to meet the following limits when operated as specified on page 3.

| | | | |
|---|---|---|---|
| Output power | $W_o$ | min. 10 | mW |

**NOTES**

1) See page 1

2) With the klystron operated in a standard waveguide launching section as shown on pages 5 and 6.

3) Reflector voltage adjusted for the maximum power point of the mode. If it is required to operate the klystron over the entire width of either mode at the extreme frequency limits, it is recommended that the reflector voltage supply cover the range -55 to -220 Volts.

4) There shall be no discontinuities at the maximum power points nor shall the power fall below that specified as a mismatch represented by a V.S.W.R. of 2.5 is varied through all phases.

5) The ratio of the power at which hysteresis is present shall not exceed the limit specified.

6) Damage to the tuner may occur if it is adjusted beyond these frequency limits.

7) Measurements are made 2 minutes after the application of heater voltage. The heater and H.T. supplies may be applied simultaneously.

## INSTALLATION

For good broadband performance the tube should be inserted in a suitable mount. The mount recommended is shown in Fig. 1. It consists of a section of 3 cm waveguide (RG-52/U; outside dimensions 25.4 x 12.7), shortcircuited at one side, into which the aerial of the tube penetrates. The position of the aerial with respect to the waveguide is shown in fig. 2.
The outer conductor of the output line should reach to the inner side of the waveguide. The broadband R.F. choke provides a good H.F. contact between the output line and the guide.
The tube socket, a modified octal type of which the hole corresponding to the pin No. 4 of the base has been drilled in order to pass the coaxial output line, is fixed rigidly to the waveguide to ensure a correct installation.
The tube should be fixed firmly in the socket by clamps which make contact at the lower platform of the tube only. It may happen that the waveguide is not terminated in a matched load, which will give rise to frequency instability. When a very good frequency stability is required an attenuator of minimum 6 dB may be inserted in the guide between the aerial and the load.

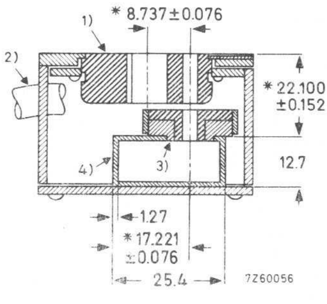



Fig. 1 Cross section of the mount (coupler)

All high frequency surfaces to be silver or gold plated.
Dimensions indicated with * determine the broad band characteristics of the coupler and should be held to the tolerances shown.

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1) Modified octal socket. Individual pin sockets must be deeper than 12.014 mm.
2) Cable to socket connections
3) R.F. choke
4) Waveguide

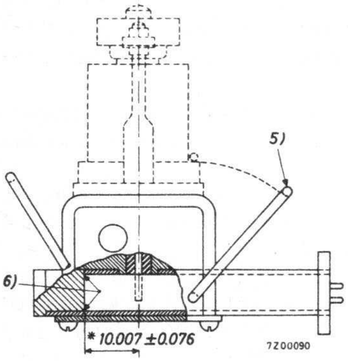


Fig. 2 Side-view of the mount

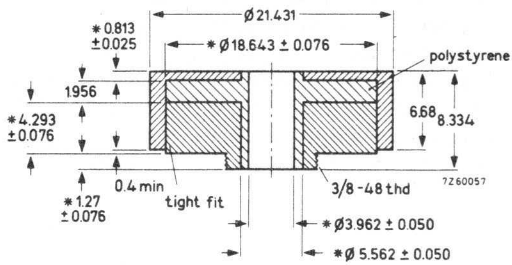


Fig. 4 Cross-section of the R.F. choke
* See under Fig. 1

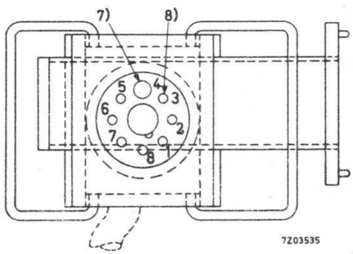


Fig. 3 Top-view of the mount

Remark: The mount and the R.F. choke are not supplied by the tube manufacturer

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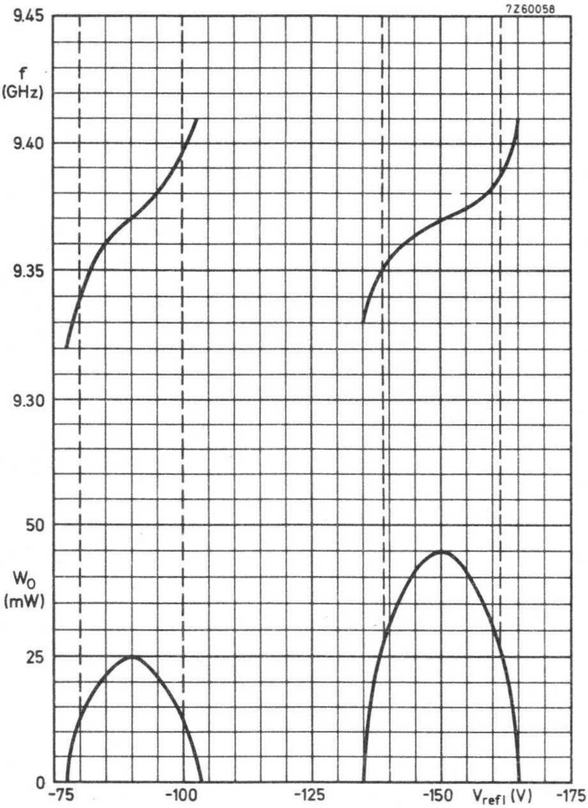
5) Tube clamp

6) Inner edges of plug must be brazed to waveguide

7) 4.75 mm drill

8) Remove socket terminals 3, 4, 5 and 6




TYPICAL CURVES OF POWER AND FREQUENCY
AGAINST REFLECTOR VOLTAGE

# TUNABLE REFLEX KLYSTRON

Mechanically tunable reflex klystron for local oscillator applications.

| QUICK REFERENCE DATA | | | |
|---|---|---|---|
| Frequency, tunable within the band | f | 8.702 to 9.548 | GHz |
| Output power | $W_o$ | 40 | mW |
| Construction | metal, with octal base | | |
| Output connection | coaxial probe for insertion to standard WG 16 launching section | | |

**HEATING**: Indirect

| | | | |
|---|---|---|---|
| Heater voltage | $V_f$ | 6.3 | V |
| Heater current | $I_f$ | 0.45 | A |

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

| | | | | |
|---|---|---|---|---|
| Heater voltage | $V_f$ | max. | 6.8 | V |
| | | min. | 5.8 | V |
| Resonator voltage | $V_{res}$ | max. | 330 | V |
| Resonator current | $I_{res}$ | max. | 37 | mA |
| Reflector voltage [1]) | $V_{refl}$ | max. | -400 | V |
| | | min. | 0 | V |
| Cathode to heater voltage | $V_{kf}$ | max. | 50 | V |
| Body temperature | t | max. | 110 | $^{o}$C |
| Voltage standing-wave ratio | V.S.W.R. | max. | 1.5 | |
| Impedance of the reflector/cathode circuit | $Z_{refl/k}$ | max. | 500 | kΩ |

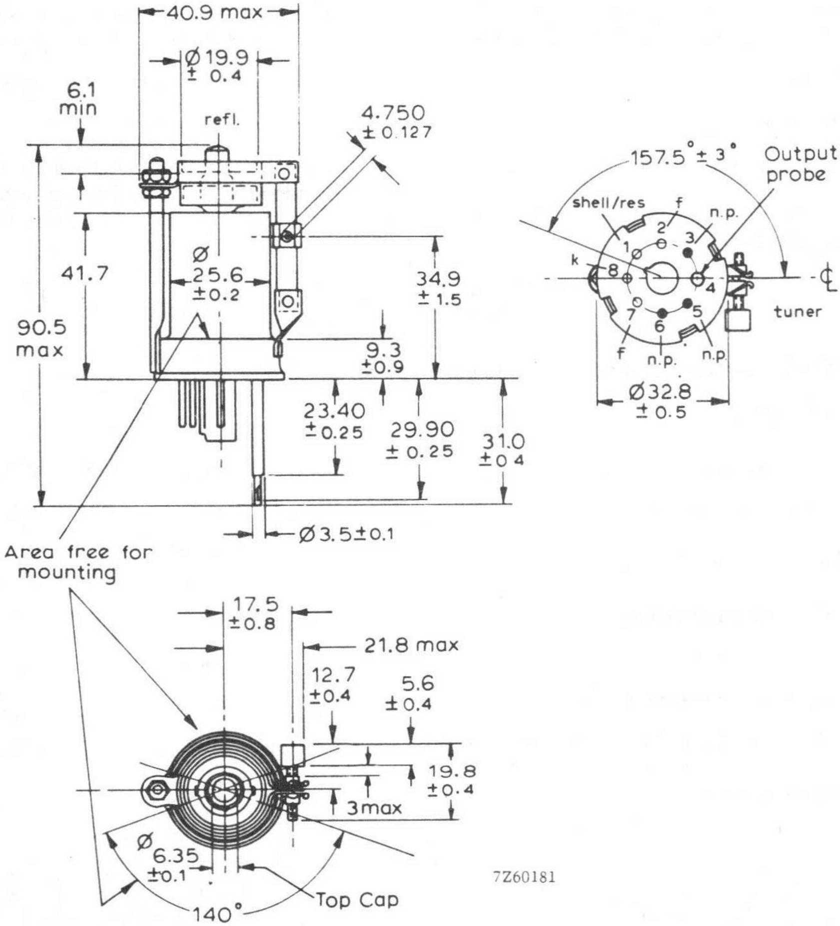
**COOLING**: natural

[1]) The klystron must not be operated without the reflector supply while the resonator voltage is applied.
Care should be taken in the design of the power supply to ensure that the reflector potential never becomes positive with respect to the cathode.

**MECHANICAL DATA**

Dimensions in mm

Base : Octal, IEC67-I-5f, type 2
Top cap : 6.35 ± 0.1 ϕ
Net weight : approx. 65 g
Mounting position : Any




7Z60181

## TEST CONDITIONS AND LIMITS

The klystron is tested to comply with the following electrical specification.

Test conditions [2]

| | | | | | |
|---|---|---|---|---|---|
| Heater voltage | $V_f$ | 6.3 | | V |
| Resonator voltage | $V_{res}$ | 300 | | V |
| Reflector voltage [1] | $V_{refl}$ | adjust | | |
| Voltage standing-wave ratio | V.S.W.R. | < 1.1 | | |

Limits and characteristics [7]

| | | Min. | Max. | |
|---|---|---|---|---|
| Heater current | $I_f$ | 0.41 | 0.47 | A |
| Resonator current | $I_{res}$ | | 32 | mA |
| Reflector voltage [3] | | | | |
| Mode A, f = 8.702 GHz | $V_{refl}$ | -90 | -150 | V |
| Mode A, f = 9.548 GHz | $V_{refl}$ | -140 | -200 | V |
| Mode B | $V_{refl}$ | -75 | -120 | V |
| Output power [3] | | | | |
| Mode A, f = 8.702 GHz | $W_o$ | 20 | | mW |
| Mode A, f = 9.548 GHz | $W_o$ | 20 | | mW |
| Mode B | $W_o$ | 15 | | mW |
| Electronic tuning range to ½ power points | | | | |
| Mode A, f = 9.370 GHz | $\Delta f$ | 35 | | MHz |
| Load effect [4] | | 10 | | mW |
| Hysteresis [5] | | | 0.5 | |
| Frequency temperature coefficient | $-\frac{\Delta f}{\Delta t}$ | | 0.2 | MHz/degC |
| Mechanical tuning range [6] | f | 8.702 | 9.548 | GHz |

[1]) See page 1
[2]) ... [7]) See page 4

**OPERATING CHARACTERISTICS** Mode A at 9.37 GHz

Conditions [2]

| | | | |
|---|---|---|---|
| Heater voltage | $V_f$ | 6.3 | V |
| Resonator voltage | $V_{res}$ | 300 | V |
| Reflector voltage [1] [3] | $V_{refl}$ | -150 | V |
| Voltage standing-wave ratio | V.S.W.R. | < 1.1 | |

Typical performance

| | | | |
|---|---|---|---|
| Resonator current | $I_{res}$ | 20 | mA |
| Output power | $W_o$ | 40 | mW |
| Electronic tuning range to ½ power points | $\Delta f$ | 35 | MHz |

**END OF LIFE PERFORMANCE**

The quality of all production is monitored by the random selection of klystrons which are then life tested under the stated test conditions. If the klystron is to be operated under different conditions from those specified above, the manufacturer should be consulted to verify that the life will not be affected. The klystron is considered to have reached the end of life when it fails to meet the following limits when operated as specified on page 3.

| | | | |
|---|---|---|---|
| Output power | $W_o$ | min. 10 | mW |

**NOTES**

[1]) See page 1.

[2]) With the klystron operated in a standard waveguide launching section as shown on pages 5 and 6.

[3]) Reflector voltage adjusted for the maximum power point of the mode. If it is required to operate the klystron over the entire width of either mode at the extreme frequency limits, it is recommended that the reflector voltage supply cover the range −55 to −220 Volts.

[4]) There shall be no discontinuities at the maximum power points nor shall the power fall below that specified as a mismatch represented by a V.S.W.R. of 2.5 is varied through all phases.

[5]) The ratio of the power at which hysteresis is present shall not exceed the limit specified.

[6]) Damage to the tuner may occur if it is adjusted beyond these frequency limits.

[7]) Measurements are made 2 minutes after the application of heater voltage. The heater and H.T. supplies may be applied simultaneously.

## INSTALLATION

For good broadband performance the tube should be inserted in a suitable mount. The mount recommended is shown in Fig. 1. It consists of a section of 3 cm waveguide (RG-52/U; outside dimensions 25.4 x 12.7), shortcircuited at one side, into which the aerial of the tube penetrates. The position of the aerial with respect to the waveguide is shown in Fig. 2.
The outer conductor of the output line should reach to the inner side of the waveguide. The broadband R.F. choke provides a good H.F. contact between the output line and the guide.
The tube socket, a modified octal type of which the hole corresponding to the pin No. 4 of the base has been drilled in order to pass the coaxial output line, is fixed rigidly to the waveguide to ensure a correct installation.
The tube should be fixed firmly in the socket by clamps which make contact at the lower platform of the tube only. It may happen that the waveguide is not terminated in a matched load, which will give rise to frequency instability. When a very good frequency stability is required an attenuator of minimum 6 dB may be inserted in the guide between the aerial and the load.

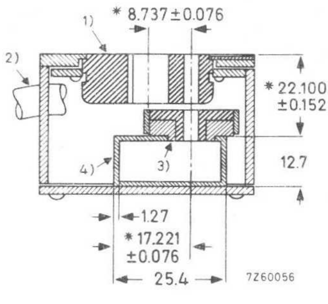



Fig. 1 Cross section of the mount (coupler)

All high frequency surfaces to be silver or gold plated.
Dimensions indicated with * determine the broad band characteristics of the coupler and should be held to the tolerances shown.

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1) Modified octal socket. Individual pin sockets must be deeper than 12.014 mm.
2) Cable to socket connections
3) R.F. choke
4) Waveguide

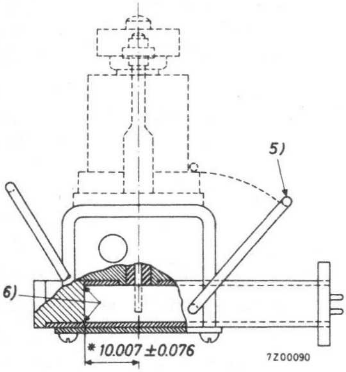



Fig. 2 Side-view of the mount

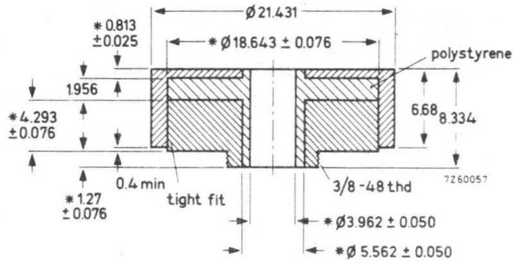



Fig. 4 Cross-section of the R. F. choke
* See under Fig. 1

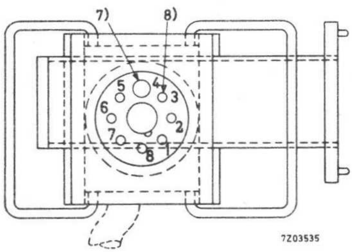



Fig. 3 Top-view of the mount

Remark: The mount and the R. F. choke are not supplied by the tube manufacturer

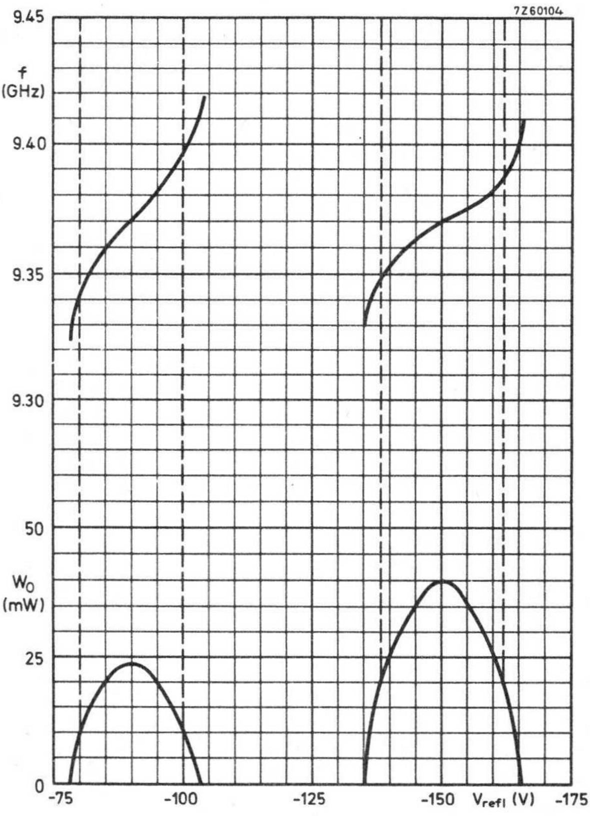
---

5) Tube clamp

6) Inner edges of plug must be brazed to waveguide

7) 4.75 mm drill

8) Remove socket terminals 3, 4, 5 and 6




TYPICAL CURVES OF POWER AND FREQUENCY AGAINST REFLECTOR VOLTAGE

# TUNABLE REFLEX KLYSTRON

| QUICK REFERENCE DATA | | | |
|---|---|---|---|
| Frequency, tunable within the band | f | 31 to 36 | GHz |
| Output power | $W_o$ | 150 | mW |
| Construction | waveguide output | | |

**HEATING**: indirect by A.C. or D.C.; dispenser type cathode

| | | | | |
|---|---|---|---|---|
| Heater voltage | $V_f$ | = | 6.3 | V |
| Heater current | $I_f$ | = | 800 ± 200 | mA |
| Waiting time | $T_w$ | = | min. 5 | min |

**COOLING**

| | | | | |
|---|---|---|---|---|
| Air flow | q | = | 0.135 | $m^3$/min |
| Pressure loss | $p_i$ | = | 2 | mm $H_2O$ |

**LIMITING VALUES** (Absolute limits)

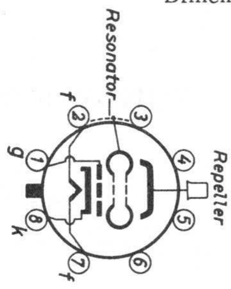
| | | | | |
|---|---|---|---|---|
| Heater voltage | $V_f$ | = | 6.3 | V $^{+10\%}_{-2\%}$ |
| Resonator voltage | $V_{res}$ | = | max. 2500 | V |
| Resonator current | $I_{res}$ | = | max. 18 | mA |
| Resonator dissipation | $W_{res}$ | = | max. 45 | W |
| Negative grid voltage | $-V_g$ | = | 0 to 100 | V |
| Internal impedance of grid bias supply | $Z_i$ | = | max. 1000 | Ω |
| Negative reflector voltage | $-V_{refl}$ | = | 50 to 600 | V |
| Body temperature | t | = | max. 80 | °C |

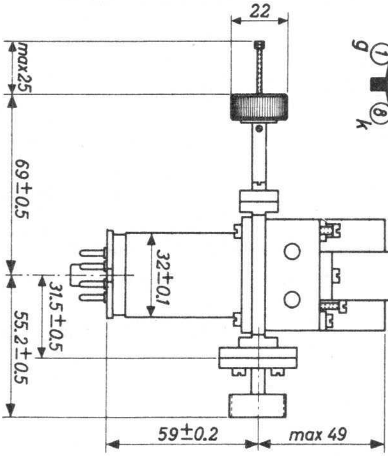
**MECHANICAL DATA**

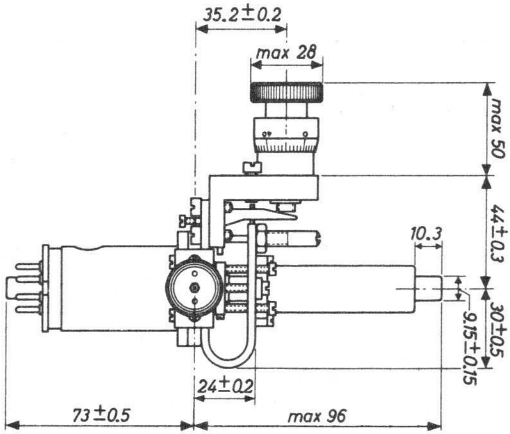
Dimensions in mm

Net weight: 1.5 kg

Base : Octal 8 p.




Mounting position: arbitrary

Output waveguide RG-96/U

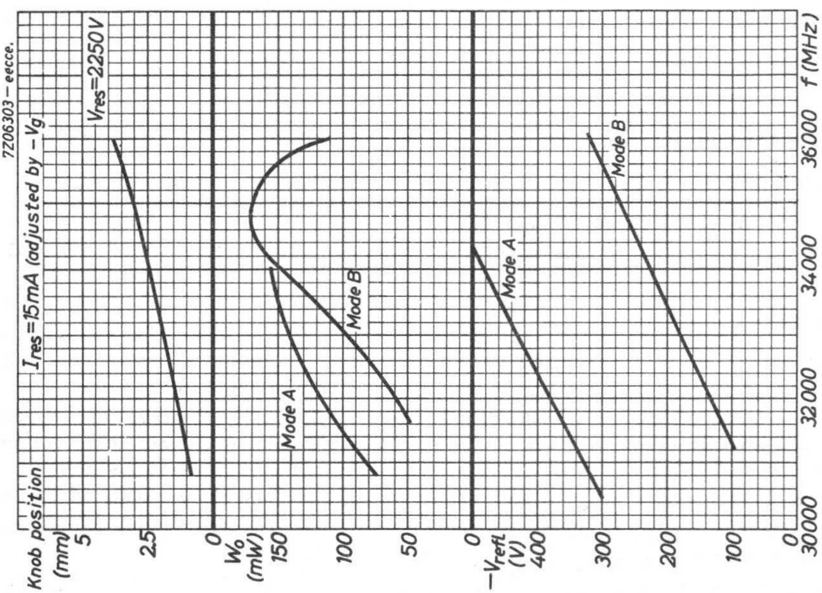
Waveguide coupling system Z830016 (American reference drawing AS-2092) The parts Z830017 and Z830019 of this coupling system are an integral part of the tube.

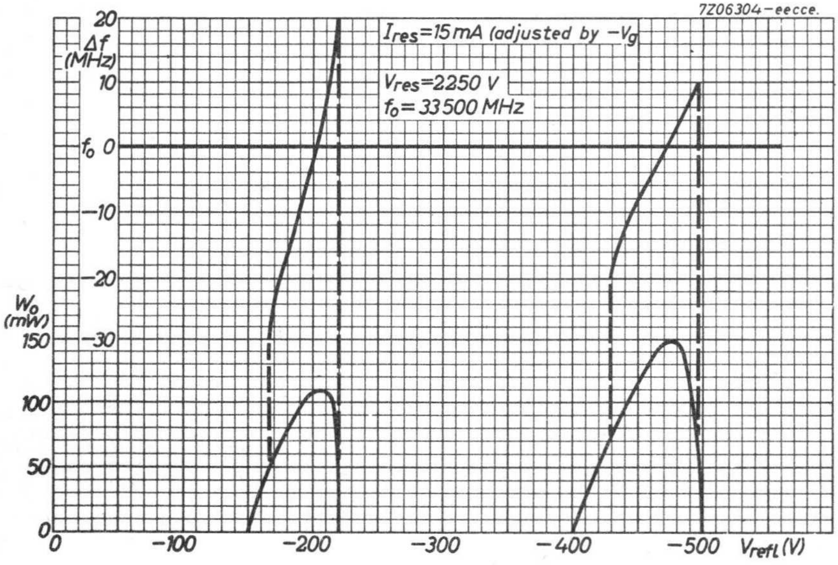
## OPERATING CHARACTERISTICS

| | | | | |
|---|---|---|---|---|
| Frequency | f | = | 31 to 36 | GHz |
| Resonator voltage | $V_{res}$ | = | 2250 | V |
| Resonator current | $I_{res}$ | = | 15 | mA |
| Reflector voltage | $V_{refl}$ | = | -100 to -500 | V |
| Output power | $W_o$ | | see page 4 | |
| Electronic tuning range between half power points | $\Delta f$ | = | 60 | MHz |

## REMARKS

The tube is normally operated with the resonator at ground potential. The resonator is integral with the tuner, the output wave guide and the plunger.
The internal resistance of the reflector power supply should preverably not exceed 1 MΩ. Resonator voltage should only be applied when the reflector voltage is present. Neglecting these precautions will result in damage to the tube.
At each frequency the grid and reflector voltages and the plunger should be adjusted for obtaining maximum output. Moreover the output may sometimes be increased by using an additional matching transformer.
There is a possibility of drawing grid current when the tube is oscillating. This current may amount up to 2 mA.


7Z06303 – eecce.
$I_{res}$=15 mA (adjusted by $-V_g$)
$V_{res}$=2250 V
Knob position (mm)
5
2.5
0
$W_o$ (mW)
150
100
50
0
$-V_{refl}$ (V)
400
300
200
100
0
Mode A
Mode B
Mode A
Mode B
30000
32000
34000
36000
f (MHz)


7Z06304 – eecce.
$I_{res}$=15 mA (adjusted by $-V_g$
$V_{res}$=2250 V
$f_o$= 33500 MHz
20
Δf (MHz)
10
$f_o$ 0
–10
–20
–30
$W_o$ (mW)
150
100
50
0
0
–100
–200
–300
–400
–500
$V_{refl}$ (V)

# Travelling-wave tubes

# TRAVELLING-WAVE TUBES

ABRIDGED SURVEY

| Frequency range (MHz) | Gain (dB) | Output power (W) | Type |
|---|---|---|---|
| 3400 - 4200 | 42 | 25 | YH1090 |
| 3800 - 4200 | 39 | 10 | 55340 |
| 4400 - 5000 | 36 | 8 | 7537 |
| 5800 - 8500 | 45 | 22 | YH1170 |
| 5925 - 6425 | 38 | 25 | LB6-25 |
| 7000 - 8500 | 45 | 22 | YH1172 |

# TRAVELLING-WAVE TUBE

6 GHz travelling-wave tube with a periodic permanent magnet mount intended for use in the power output stages of wideband microwave links.

| QUICK REFERENCE DATA | | | |
|---|---|---|---|
| Frequency | f | 5.925 to 6.425 | GHz |
| Saturation output power | $W_o$ | 25 | W |
| Gain | G | 38 | dB |
| Construction | | unpackaged with periodic permanent magnet focusing | |

**CATHODE:** Dispenser type

**HEATING :** Indirect by A.C. or D.C.[1])

| | | | | |
|---|---|---|---|---|
| Heater voltage | $V_f$ | | 6.3 | V ±2% |
| Heater current | $I_f$ | | 0.85 to 1.05 | A |
| Waiting time | $T_w$ | min. | 2 | min |

**TEMPERATURE LIMITS AND COOLING**

| | | | | |
|---|---|---|---|---|
| Absolute max. temperature of collector seal | $t_s$ | max. | 200 | °C |
| Absolute max. temperature at reference point | t | max. | 140 | °C |

Cooling: tube installed in mount type P6L-11 ( convection cooled )

| | |
|---|---|
| horizontally mounted | natural |
| vertically mounted | natural assisted by convection duct or low velocity air flow |

A conduction cooled mount is available

**MECHANICAL DATA**

Mounting position: any

Weight

| | |
|---|---|
| Net weight of tube | approx. 0.2 kg |
| Net weight of mount | approx. 5.5 kg |

1) When operated on D.C. the heater must be negative with respect to cathode.

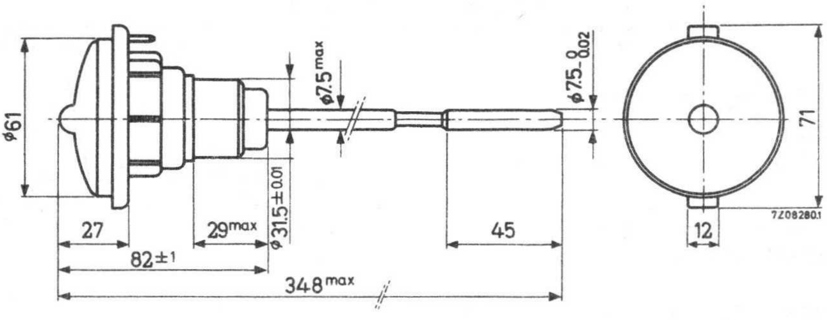
**MECHANICAL DATA** (continued)

Accessories

Mount type P6L-11, convection cooled, with IEC R70 waveguide input and output (34.84 x 15.80 $mm^2$)

Dimensions and connections

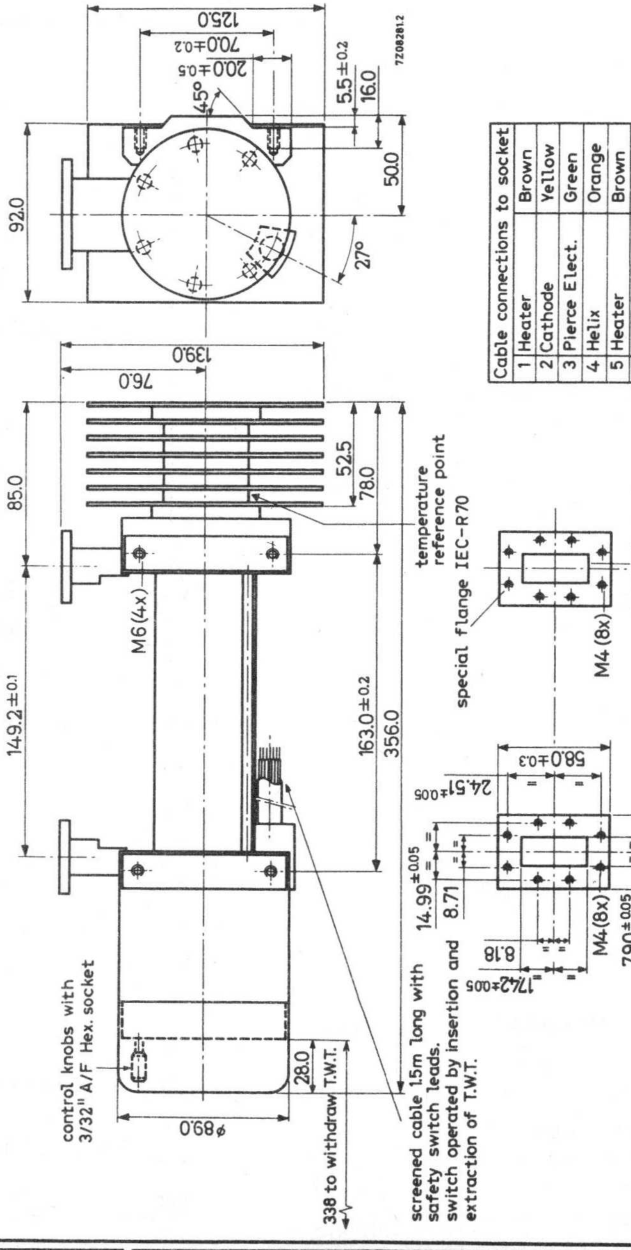
Dimensions in mm



**MECHANICAL DATA** (continued)

Dimensions of mount P6L-11

Dimensions in mm




| Cable connections to socket | | |
|---|---|---|
| 1 | Heater | Brown |
| 2 | Cathode | Yellow |
| 3 | Pierce Elect. | Green |
| 4 | Helix | Orange |
| 5 | Heater | Brown |
| 6 | Acc. Elect. | Blue |
| 7 | Safety switch | Red |
| 8 | Safety switch | Red. |

Collector and screening earthed (black)

## TYPICAL CHARACTERISTICS

Tube in mount P6L-11

| | | min. | max. | |
|---|---|---|---|---|
| Frequency band | f | 5.925 | 6.425 | GHz |
| Gain ($W_o$ = 15 W) | G | 37 | 40 | dB |
| Noise figure ($W_o$ = 15 W) | F | | 30 | dB |
| Saturation power output | $W_o$ | 23 | | W |
| Attenuation at $I_k$ = 0 mA | | 60 | | dB |
| Hot input match | V.S.W.R. | | 1.8 | |
| Hot output match | V.S.W.R. | | 2.0 | |

**TYPICAL OPERATION** as a power amplifier with the collector earthed and tube focused in a mount type P6L-11.
Voltages are specified with respect to the cathode

| | | | |
|---|---|---|---|
| Frequency | f | 6.0 | GHz |
| Collector voltage | $V_{coll}$ | 2.0 | kV |
| Helix voltage | $V_x$ | 3.4 | kV |
| Accelerator voltage | $V_{acc}$ | 2.2 | kV |
| Pierce electrode voltage | $V_{g_1}$ | -15 | V |
| Collector current | $I_{coll}$ | 45 | mA |
| Helix current | $I_x$ | 0.4 | mA |
| Accelerator current | $I_{acc}$ | 5.0 | μA |
| Pierce electrode current | $I_{g_1}$ | 1.0 | μA |
| Gain | G | 38 | dB |
| Power output | $W_o$ | 15 | W |
| Noise figure (including ion noise) | F | 28 | dB |
| Hot input match | V.S.W.R. | 1.2 | |
| Hot output match | V.S.W.R. | 1.4 | |

**ENVIRONMENTAL CONDITIONS** ( for mount )

| | | | |
|---|---|---|---|
| Ambient temperature range for operation to full specification | $t_{amb}$ | -10 to +65 | °C |
| Ambient temperature range for operation without damage to tube | $t_{amb}$ | -20 to +65 | °C |
| Storage temperature | $t_{stg}$ | -60 to +85 | °C |

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

Voltages are specified with respect to the cathode.

| | | | | |
|---|---|---|---|---|
| Collector voltage | $V_{coll}$ | max. | 2.2 | kV |
| | | min. | 1.8 | kV |
| Helix voltage | $V_x$ | max. | 4.0 | kV |
| Accelerator voltage | $V_{acc}$ | max. | 3.0 | kV |
| Pierce electrode voltage | $-V_{g_1}$ | max. | 250 | V |
| | | min. | 0 | V |
| Collector current | $I_{coll}$ | max. | 50 | mA |
| Helix current, during focusing (transient) | $I_x$ | max. | 2.0 | mA |
| during operation | $I_x$ | max. | 1.5 | mA |
| Accelerator current | $I_{acc}$ | max. | 1.0 | mA |
| Pierce electrode current | $I_{g_1}$ | max. | 1.0 | mA |
| Collector dissipation | $W_{coll}$ | max. | 100 | W |
| Signal input power (driving power) | $W_{dr}$ | max. | 0.25 | W |
| Cathode to heater voltage | $V_{kf}$ | max. | 50 | V |

**DESIGN RANGES FOR POWER SUPPLY**

Voltages are specified with respect to the cathode.

| | | min. | max. | |
|---|---|---|---|---|
| Collector voltage | $V_{coll}$ | 1.8 | 2.2 | kV |
| Helix voltage | $V_x$ | 3.2 | 3.8 | kV |
| Accelerator voltage | $V_{acc}$ | 1.9 | 2.8 | kV [1] |
| Pierce electrode voltage | $V_{g_1}$ | −20 | 0 | V |
| Collector current | $I_{coll}$ | 40 | 50 | mA |
| Helix current | $I_x$ | | 2.0 | mA |
| Accelerator current | $I_{acc}$ | −250 | +250 | μA |
| Pierce electrode current | $I_{g_1}$ | | 100 | μA |
| Heater voltage | $V_f$ | 6.15 | 6.45 | V |

[1]) For adjustment of focus it is necessary for the accelerator voltage to be made adjustable over the range 0 kV to 2.8 kV.

# TRAVELLING-WAVE TUBE

4 GHz travelling-wave tube with a periodic permanent magnet mount designed for wide-band microwave link applications.

**QUICK REFERENCE DATA**

| | | | | |
|---|---|---|---|---|
| Frequency | 3.4 | to | 4.2 | GHz |
| Saturation output power at midband | | | 25 | W |
| Low-level gain | | | 42 | dB |
| Interchangeability | plug-in focus, plug-in match | | | |
| Construction | unpackaged | | | |
| tube | glass-metal envelope, metal-ceramic base | | | |
| mount | periodic permanent magnet | | | |

**CATHODE :** Dispenser type

**HEATING:** Indirect by A.C. or D.C.

When operated on D.C. the cathode must be connected to the positive side of the heater power supply.

| | | | |
|---|---|---|---|
| Heater voltage | $V_f$ | 6.3 | V ± 2% |
| Heater current at $V_f$ = 6.3 V | $I_f$ approx. | 1 | A |
| Waiting time (Heating time before application of high voltage) | $T_W$ min. | 2 | min |

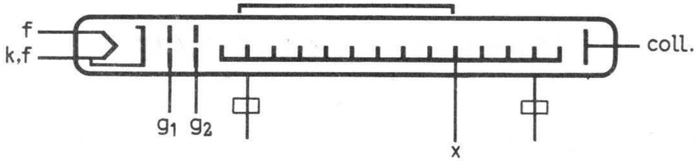
For shorter waiting time when the tube already has been in operation see "Application of voltages".

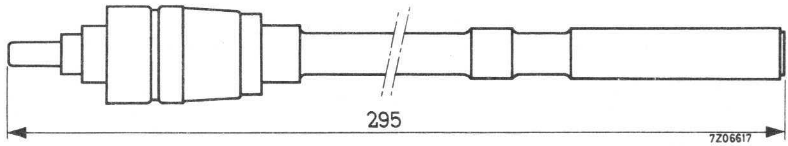
**COOLING:** Natural cooling
by convection with mount 55329 or
by conduction with mount 55332

**MECHANICAL DATA** Dimensions in mm

Mounting position : Any. See "Design and operating notes" under "Cooling"

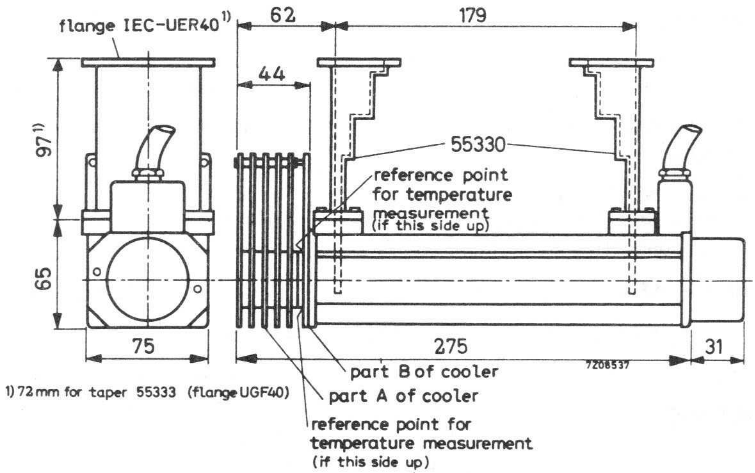
| | | | |
|---|---|---|---|
| Weight of tube | approx. | 60 | g |
| Weight of mount | approx. | 4.5 | kg |



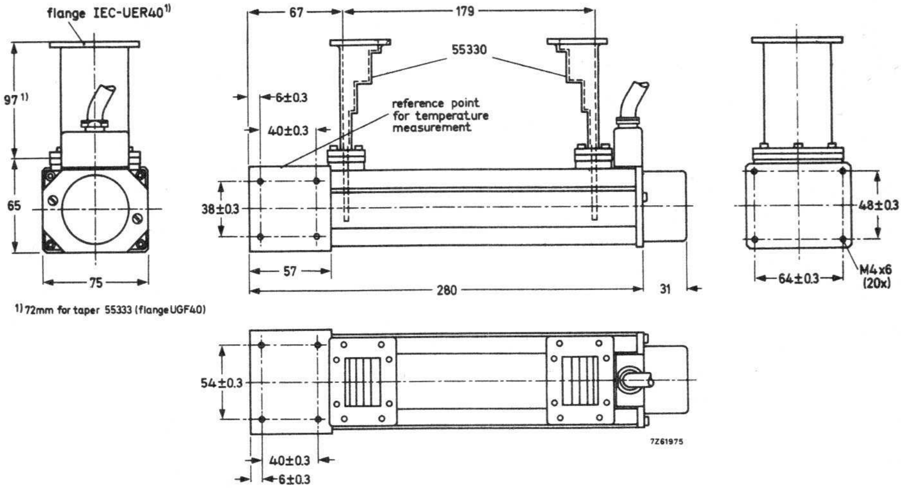

**ACCESSORIES** (to be ordered separately)

| | |
|---|---|
| PPM mount for convection cooling | type 55329 |
| PPM mount for conduction cooling | type 55332 |
| Waveguide taper (two required) to waveguide IEC-R40 (58.17 x 29.08 $mm^2$) with flange IEC-UER40 | type 55330 |
| Waveguide taper (two required) to waveguide IEC-F40 (58.17 x 7 $mm^2$) with flange IEC-UGF40 | type 55333 |
| Clamp for fastening of mount (two required) | type 55331 |




Mount 55329 with convection cooling and waveguide tapers 55330.

**MECHANICAL DATA** (continued) Dimensions in mm

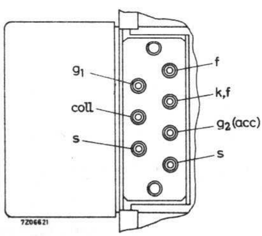



Connections

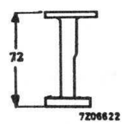
The mount is provided with flying leads, marked with colours

| | |
|---|---|
| Heater, cathode | yellow |
| Heater | brown |
| Focusing electrode | green |
| Accelerator | blue |
| Helix | to be eathed via mount |
| Collector | red |
| Safety circuit (closed or opened, when putting on or off the mount cap) | two violet leads |

Connections in cable housing




1) Waveguide taper 55333




Flange UGF40

## GENERAL CHARACTERISTICS

| | | | | |
|---|---|---|---|---|
| Frequency range | f | 3.4 to 4.2 | GHz | |
| Saturation output power (CW) | $W_{sat}$ | 25 | W | 1) |
| Low-level gain | G | 42 | dB | 2) |
| Gain at $W_o$ = 15 W | G | 38 | dB | 3) |
| Thermal noise factor at $W_o$ = 15 W | F | 24 | dB | 4) |
| AM to PM conversion at $W_o$ = 15 W | | 3 | °/dB | 4) |
| Cold match at input and output (f = 3.4 to 4.2 GHz) | V.S.W.R. | max. 1.5 | | 5) |

1) Typical value measured at f = 3.8 GHz, $I_{coll}$ = 60 mA, $W_i$ and $V_x$ optimally adjusted for saturation output power.

2) Typical value measured at f = 3.8 GHz, $I_{coll}$ = 60 mA, $W_o$ < 1 W, $V_x$ optimally adjusted for low-level gain.

3) Typical value measured at f = 3.8 GHz, $I_{coll}$ = 60 mA, $V_x$ adjusted for optimum gain.

4) Typical value measured at f = 4 GHz, $I_{coll}$ = 60 mA, $V_x$ adjusted for optimum gain.

5) Measured on the cold tube, i.e. with the beam switched off and without use of any matching device (Plug-in match).

## TYPICAL OPERATION

(Voltages are specified with respect to the cathode)

| | | | | | |
|---|---|---|---|---|---|
| Frequency | f | | 3.6 | | GHz |
| Output power | $W_o$ | 15 | 10 | 5 | W |
| Helix voltage (adjusted for optimum gain) | $V_x$ approx. | 2250 | 2200 | 2150 | V |
| Collector voltage | $V_{coll}$ | 1500 | 1300 | 1100 | V |
| Focusing electrode voltage | $V_{g_1}$ | - 5 | - 5 | - 5 | V |
| Collector current | $I_{coll}$ | 60 | 60 | 60 | mA |
| Gain | G | 38 | 40 | 41 | dB |
| Accelerator voltage [1] | $V_{g_2}$ approx. | 1550 | 1550 | 1550 | V |
| Accelerator current | $I_{g_2}$ | < 0.1 | < 0.1 | < 0.1 | mA |
| Helix current (plug-in focus) | $I_x$ | 0.3 | 0.3 | 0.2 | mA |
| Thermal noise factor | F | 24 | 21.5 | 20.5 | dB |
| AM to PM conversion | | 3 | 2.5 | 1.5 | °/dB |

| | | | | | |
|---|---|---|---|---|---|
| Frequency | f | | 4.0 | | GHz |
| Output power | $W_o$ | 15 | 10 | 5 | W |
| Helix voltage (adjusted for optimum gain) | $V_x$ approx. | 2150 | 2100 | 2050 | V |
| Collector voltage | $V_{coll}$ | 1500 | 1300 | 1100 | V |
| Focusing electrode voltage | $V_{g_1}$ | - 5 | - 5 | - 5 | V |
| Collector current | $I_{coll}$ | 60 | 60 | 60 | mA |
| Gain | G | 38 | 40 | 41 | dB |
| Accelerator voltage [1] | $V_{g_2}$ approx. | 1550 | 1550 | 1550 | V |
| Accelerator current | $I_{g_2}$ | < 0.1 | < 0.1 | < 0.1 | mA |
| Helix current (plug-in focus) | $I_x$ | 0.3 | 0.3 | 0.2 | mA |
| Thermal noise factor | F | 24 | 21.5 | 20.5 | dB |
| AM to PM conversion | | 3 | 2.5 | 1.5 | °/dB |

[1] To be adjusted for indicated collector current.

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

(Voltages are specified with respect to the cathode unless otherwise specified)

| | | | | |
|---|---|---|---|---|
| Focusing electrode voltage | $-V_{g_1}$ | min. | 0 | V |
| | | max. | 50 | V |
| Accelerator voltage | $V_{g_2}$ | max. | 2000 | V |
| Helix voltage | $V_x$ | max. | 2700 | V |
| Collector to helix voltage | $V_{coll-x}$ | max. | 2500 | V |
| Cathode current | $I_k$ | max. | 65 | mA |
| Accelerator current | $I_{g_2}$ | max. | 0.3 | mA |
| Helix current | $I_x$ | max. | 3 | mA |
| R.F. input level | $W_i$ | max. | 200 | mW |
| Collector dissipation at $t_{amb}$ = 65 °C | $W_{coll}$ | $I_{coll} \times V_{coll} - W_o$ = max. | 90 | W |
| Power reflected from load | | max. | 2 | W [1] |
| Cooler temperature at reference point | | | | |
| mount type 55329 | t | max. | 140 | °C |
| mount type 55332 | t | max. | 150 | °C |

[1]) To avoid overheating of the helix.

# DESIGN AND OPERATING NOTES

## 1. GENERAL DESIGN CONSIDERATIONS

Equipment design should be oriented around the tube specifications given in these data sheets and not around one particular tube since due to normal production variations the design parameters will vary around the nominal values given.

## 2. INSTALLATION OF THE MOUNT

Two main methods may be discerned:

a) Fixing the mount relative to the microwave circuit by only connecting the waveguide tapers to the input and output sides of the circuit.
b) Employing a) and establishing additional support by fastening the mount to the rack with two clamps 55331. In this case it is recommended to use a short piece of flexible waveguide at input and output side to prevent excessive strain on the mount via the tapers, unless very careful alignment of the waveguide components can be assured.

Possible forces on the waveguides must not produce a moment greater than 2 mkg at the flanges.

### 2.1 Mount type 55329

The cooler of the mount consists of the parts A and B (see drawing). Part A is slightly movable and should be handled with special care. The mount should be installed in such a way, that is is not resting on the parts A or B of the cooler, and that part A always remains freely movable. When a tube is in the mount, no forces should be exerted on part A, since they would be directly transferred to the collector.

### 2.2 Mount type 55332

This mount has no movable parts. If clamps are used (method b) the slightly larger dimensions of the cooler with regard to the main part of the mount must be considered.

### 2.3 Magnetic shielding

The periodic permanent magnet mount is completely shielded. This implies that no additional measures need be taken to prevent the magnetic properties of the mount from being affected by external magnetic fields. The mount will not influence surrounding equipment which is susceptible to stray magnetic fields.
Several mounts may be placed side by side without disturbance of the focusing qualities. Isolators may be installed quite near to the mount.

Warning

If any part of the shielding is removed, the magnetic properties of the mount may be disturbed irreversibly.

3. INSTALLATION OF THE TUBE

Unlock the mount cap (see outline drawing) by turning it slightly counter-clockwise. The cap can then easily be removed, and the tube inserted by carefully pushing it in. Finally put the cap on the mount again, and lock by turning it clockwise.
The above instructions are also a guide for taking the tube out of the mount.

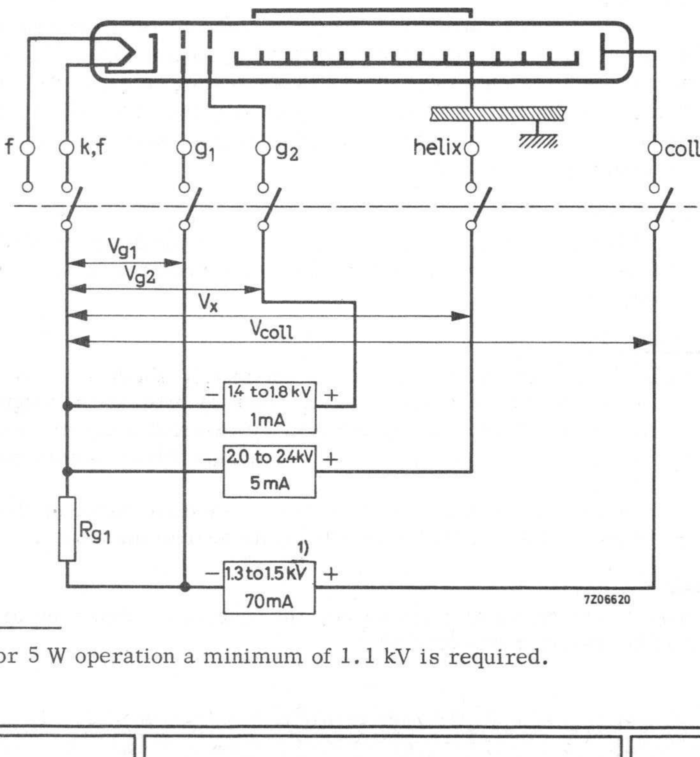
4. SAFETY

The supply voltages are fed to the tube via the mount cap. When the cap is unlocked all voltages are removed from the tube.
The two violet leads can be incorporated into an additional safety circuit which switches the voltages off at the power supply if the cap is unlocked. Thus the voltages can also be removed from the mount.

The mount should always be earthed.

5. POWER SUPPLY

The design of the power supply depends on whether 5, 10 or/and 15 W operation is desired. An example of a supply circuit for 10 and 15 W operation is given in the figure.




[1]) For 5 W operation a minimum of 1.1 kV is required.

The design of the power supply should be so that

$V_{g_2}$ can be varied between 1.4 and 1.8 kV, $V_x$ can be varied between 2.0 and 2.4 kV. $V_{g_1}$ is -5 V at $I_{coll}$ = 60 mA.

The collector voltage must be 1.1 kV, 1.3 kV, or 1.5 kV at $I_{coll}$ = 60 mA for a desired output of 5 W, 10 W, or 15 W respectively.

For measurements of saturation output power the collector voltage should be 1.7 kV (between 3.8 and 4.2 GHz) and 1.85 kV (between 3.4 and 3.8 GHz)

The helix voltage may then reach 2.7 kV.

6. COOLING

Tube and mount need no artificial means of cooling. The natural cooling of the collector has been made possible by depression of the collector potential with respect to the helix and by ensuring adequate heat transfer from the collector to the environment.

6.1 Mount 55329

Under typical operating conditions and at an ambient temperature of not more than 65 °C, the cooler temperature at the reference point (see drawing) is well below the limit, provided the tube is mounted horizontally, and free air circulation is possible.

Under less favourable conditions a slight additional cooling by a low-velocity air flow may be required. Checking the temperature at the reference point then is strongly advised.

6.2 Mount 55332

Under typical operating conditions and at an ambient temperature of not more than 65 °C, the cooler temperature at the reference point (see drawing) is well below the limit, provided an aluminium heatsink of 300 mm x 300 mm x 6 mm is mounted on one of the cooler surfaces. The heatsink should be fixed with its centre contacting the cooler and in a vertical position. The mount itself may have any position in the equipment.
This is only an example and other heatsink configurations may be employed. It will then be necessary to check the temperatures reached at the reference point under extreme conditions e.g. 65 °C ambient temperature.

## 7 APPLICATION OF VOLTAGES

### 7.1 Switching-on procedure for new tubes

7.1.1 Apply the heater voltage for the specified waiting time.

7.1.2 Apply the rated voltages to the collector, to the helix, to the accelerator and to the focusing electrode in case of a separate supply simultaneously (see Remarks).

7.1.3 Adjust the accelerator voltage to obtain a collector current of 60 mA.

7.1.4 Apply the R.F. input signal, adjust the level to obtain the required output power while simultaneously adjusting the helix voltage for optimum gain.

### 7.2 Readjustment during life

During life the collector current may decrease.
A readjustment of the accelerator voltage to obtain $I_{coll}$ = 60 mA will then be necessary.

### 7.3 Switching-off procedure

All voltages may be switched off simultaneously (see Remarks).

### 7.4 Switching-on procedure after interruption of voltage

7.4.1 Interruption of less than 40 s:
All voltages may be switched on simultaneously.

7.4.2 Interruption of more than 40 s but less than 1 week:
Apply the heater voltage for min. 40 s, then apply all other voltages simultaneously.

7.4.3 Interruption of more than 1 week:
Apply the heater voltage for the specified waiting time of 2 min.
Apply all other voltages simultaneously.

### Remarks

If the voltages cannot be switched simultaneously the possibility exists that all the cathode current is flowing to the accelerator or the helix. This condition may never last for more than 10 ms, otherwise it will cause permanent damage to the tube. This may be avoided by switching the accelerator voltage on after the other electrode voltages, or off before the other electrode voltages.

## 8 INPUT AND OUTPUT CIRCUIT AND GROUP DELAY

In order to avoid phase distortions due to long-line effect, the insertion of an isolator between tube and antenna, and between tube and pre-stage is strongly recommended. The isolators should be positioned as close to the tube as possible.
If isolators with a V.S.W.R. of less than 1.05 are used at a short distance from the tube, the reflections result in a variation of group delay of less than 0.2 nanoseconds over a band of 20 MHz.

It may be noted that the difference between the voltage reflection coefficients of the hot and cold (i.e. without beam) tube is less than 0.2 for the input as well as the output side.

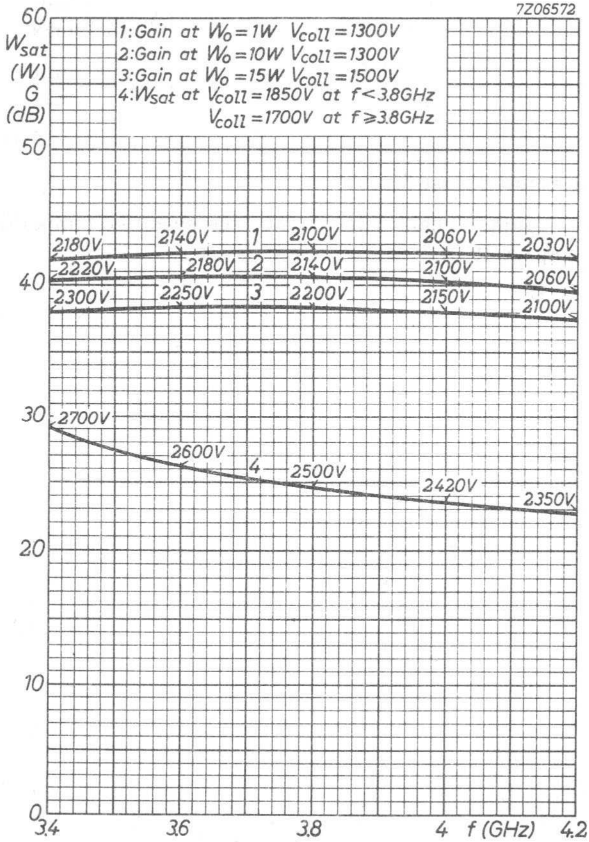
9 ENVIRONMENTAL CONDITIONS

Ambient temperature

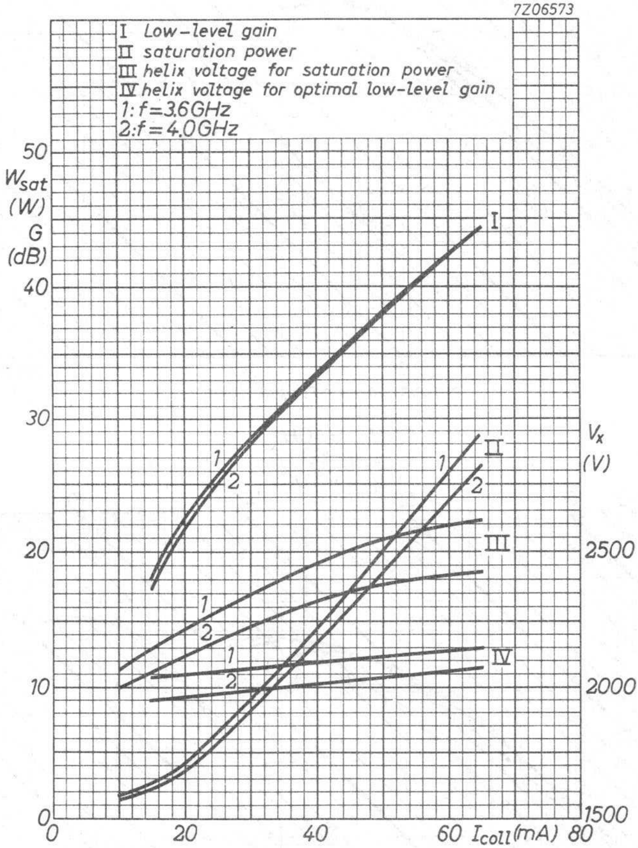
| | | | | |
|---|---|---|---|---|
| storage | $t_{amb}$ | min. | -60 | °C |
| | | max. | +65 | °C |
| operation | $t_{amb}$ | min. | -30 | °C |
| | | max. | +65 | °C |
| Relative humidity | | | 0 to 95 | % |

The tube and mount resist fungus attack.

For changes in gain and helix current over the specified temperature range see curves on page 19

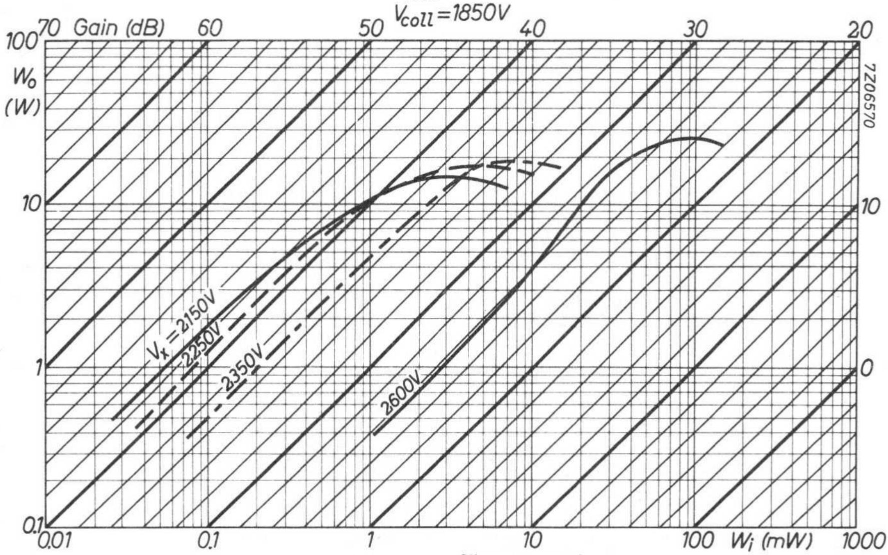


Gain and saturation power = f(frequency)



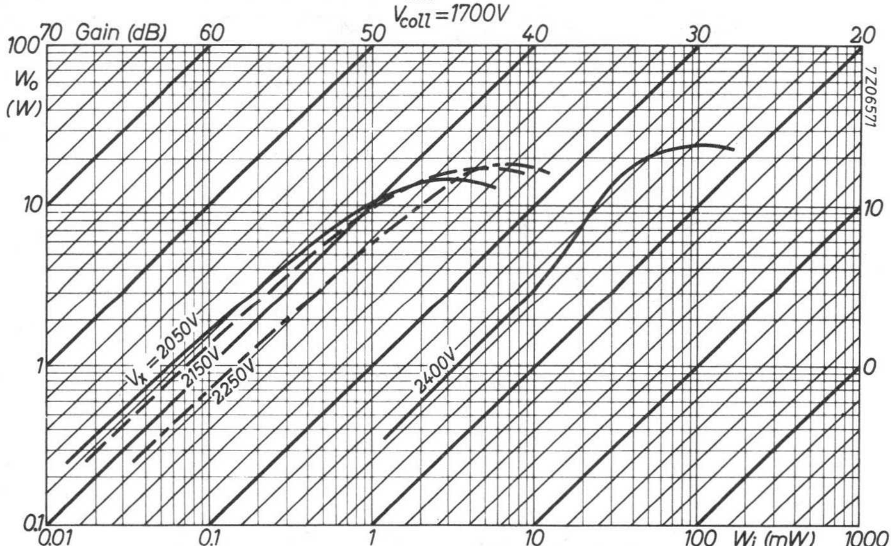

Gain and saturation power = f(collector current)

f = 3.6GHz
$I_{coll}$ = 60mA
$V_{coll}$ = 1850V

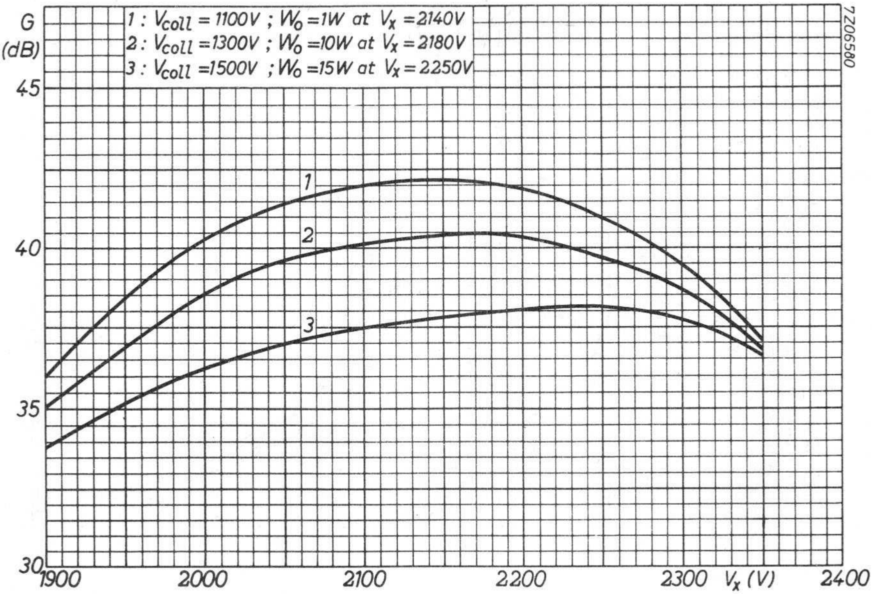



output power = f(input power)

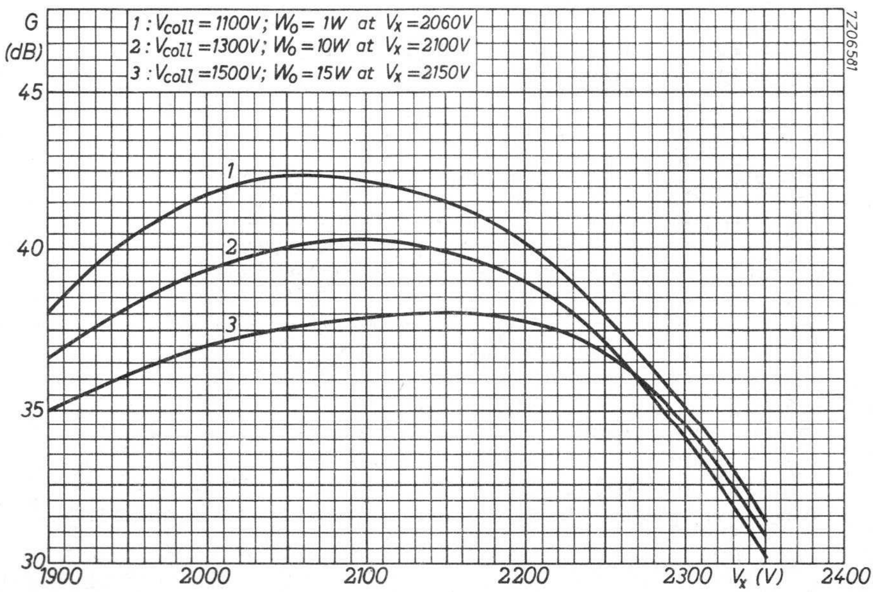
f = 4GHz
$I_{coll}$ = 60mA
$V_{coll}$ = 1700V



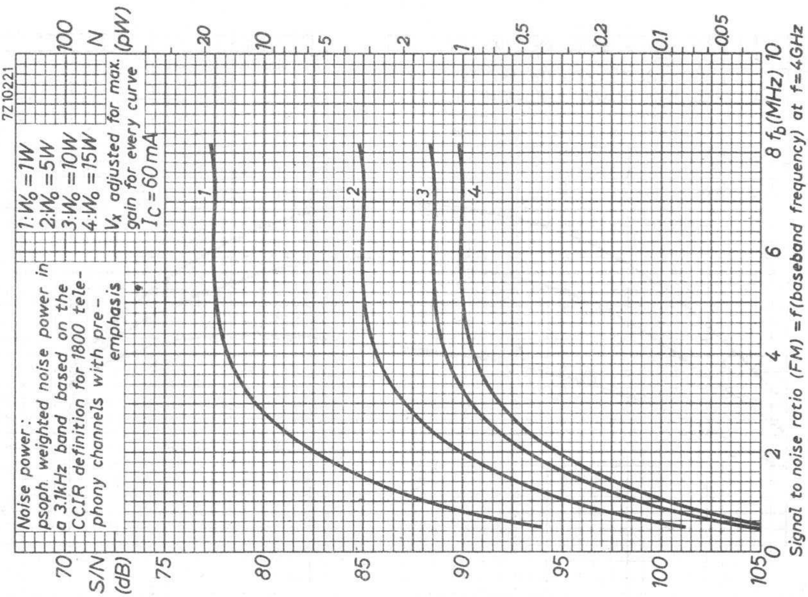

output power = f(input power)

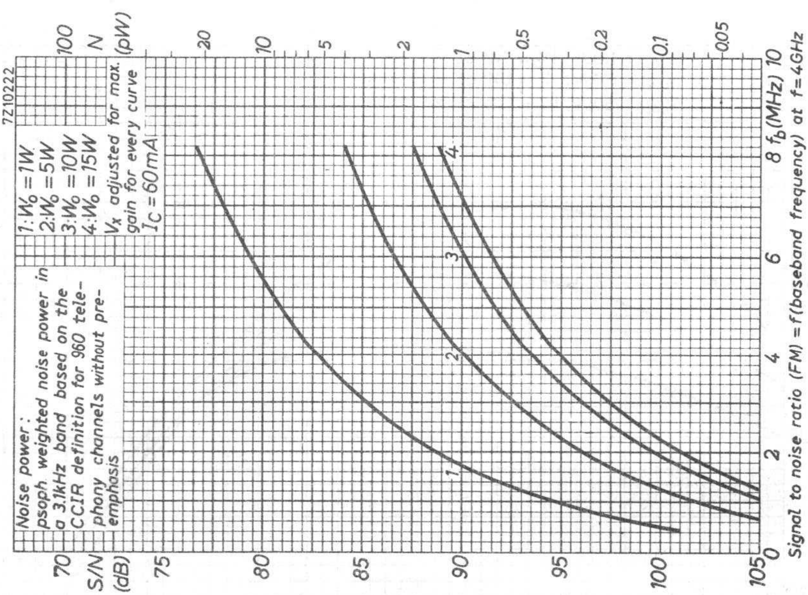


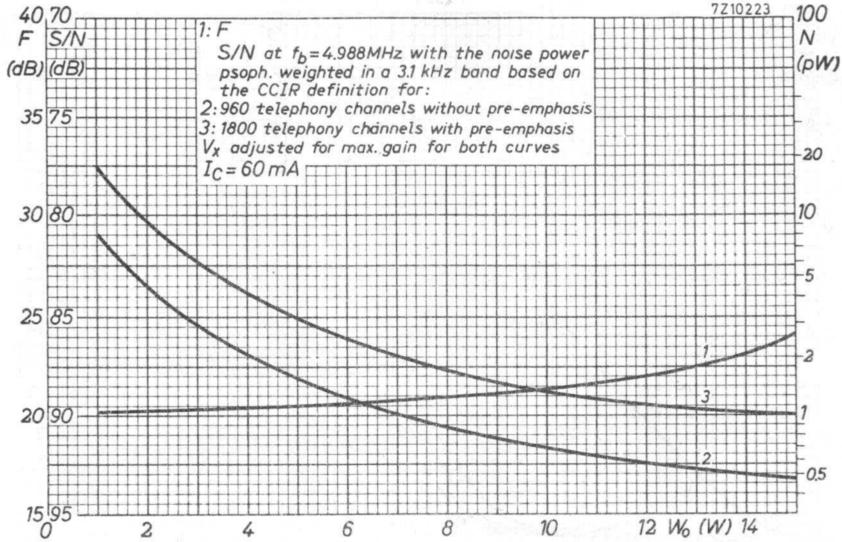

Gain = f(helix voltage) f = 3.6GHz



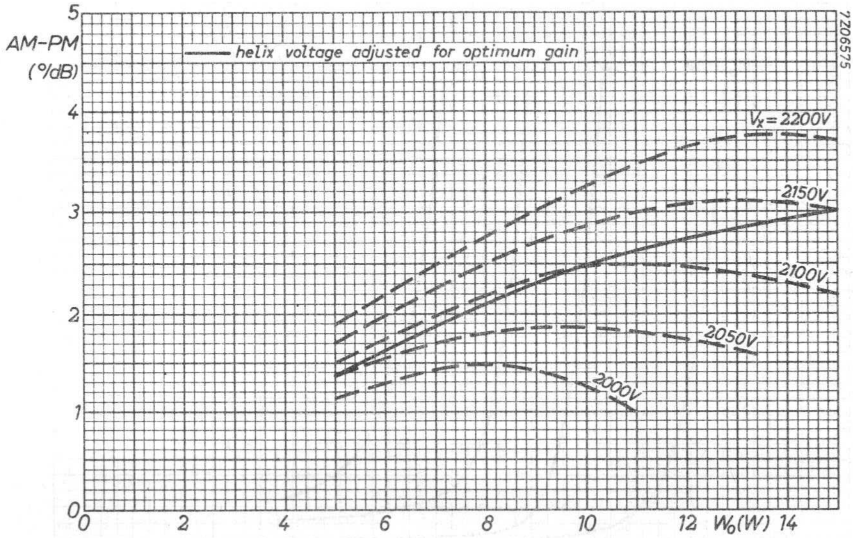

Gain = f(helix voltage) f = 4GHz


7Z10221
Noise power:
psoph. weighted noise power in a 3.1kHz band based on the CCIR definition for 1800 telephony channels with pre-emphasis
1: $W_o$ = 1W
2: $W_o$ = 5W
3: $W_o$ = 10W
4: $W_o$ = 15W
$V_x$ adjusted for max. gain for every curve
$I_C$ = 60mA
S/N (dB)
70
75
80
85
90
95
100
105
N (pW)
100
20
10
5
2
1
0.5
0.2
0.1
0.05
0
2
4
6
8
$f_b$(MHz) 10
Signal to noise ratio (FM) = f(baseband frequency) at f = 4GHz

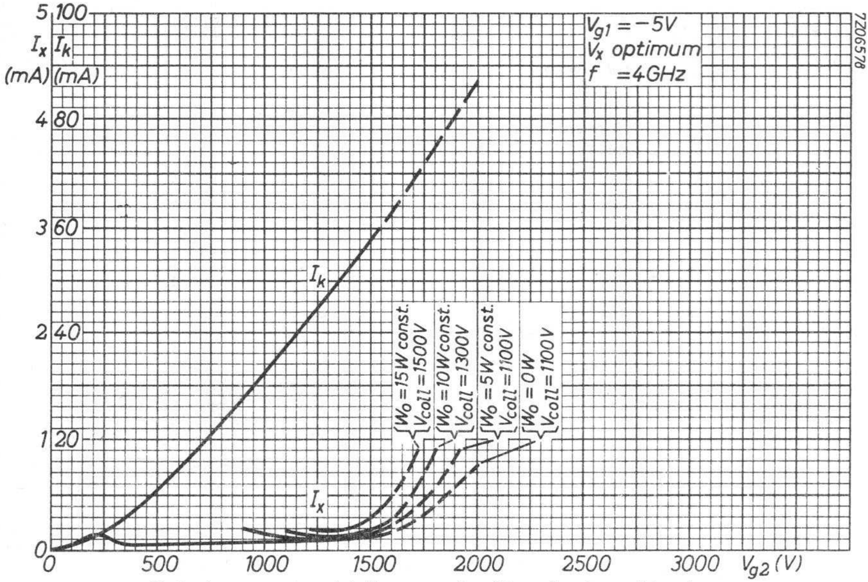

7Z10222
Noise power:
psoph. weighted noise power in a 3.1kHz band based on the CCIR definition for 960 telephony channels without pre-emphasis
1: $W_o$ = 1W
2: $W_o$ = 5W
3: $W_o$ = 10W
4: $W_o$ = 15W
$V_x$ adjusted for max. gain for every curve
$I_C$ = 60mA
S/N (dB)
70
75
80
85
90
95
100
105
N (pW)
100
20
10
5
2
1
0.5
0.2
0.1
0.05
0
2
4
6
8
$f_b$(MHz) 10
Signal to noise ratio (FM) = f(baseband frequency) at f = 4GHz



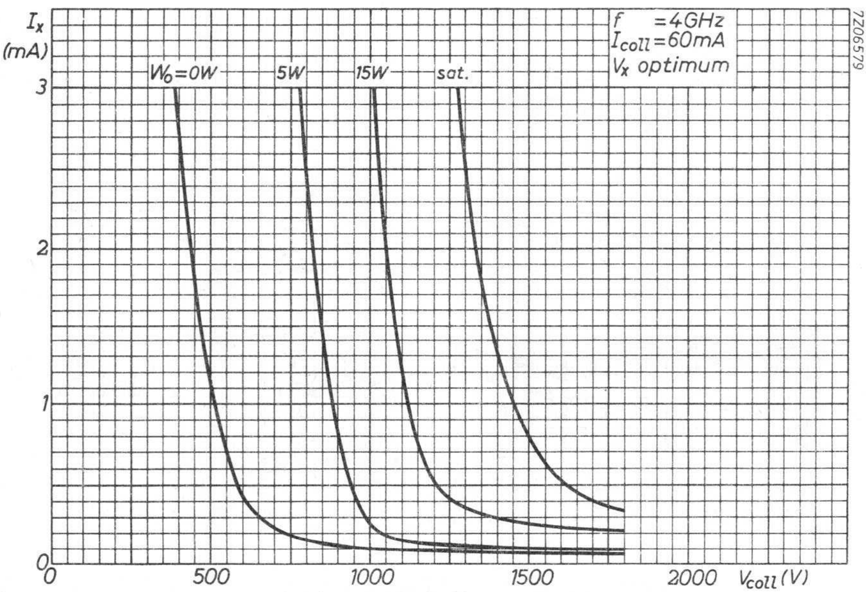

Thermal noise (FM) = f(output power) at f = 4 GHz



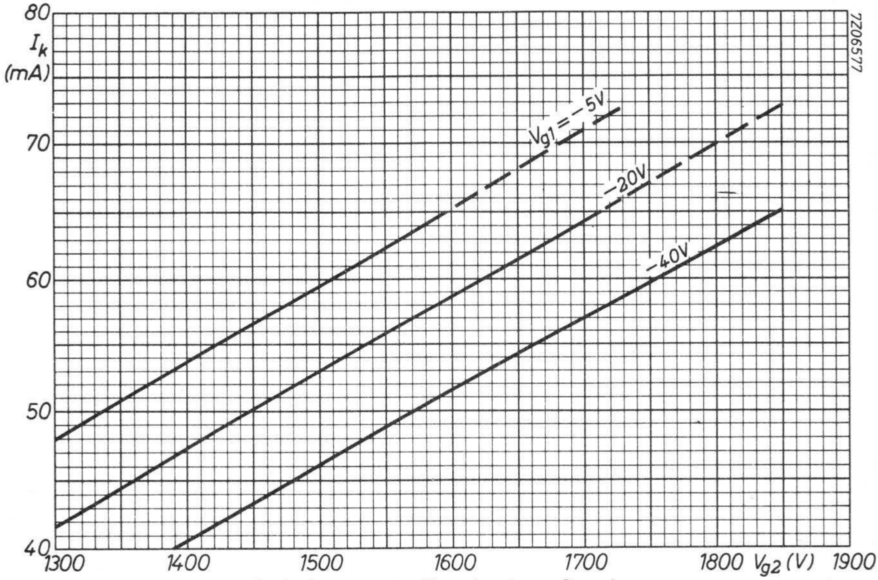

AM to PM conversion = f(output power) at f = 4 GHz



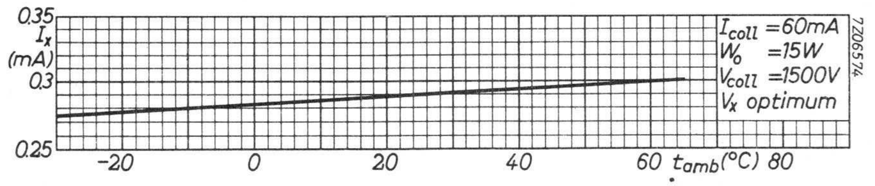

Cathode current and helix current = f(accelerator voltage)

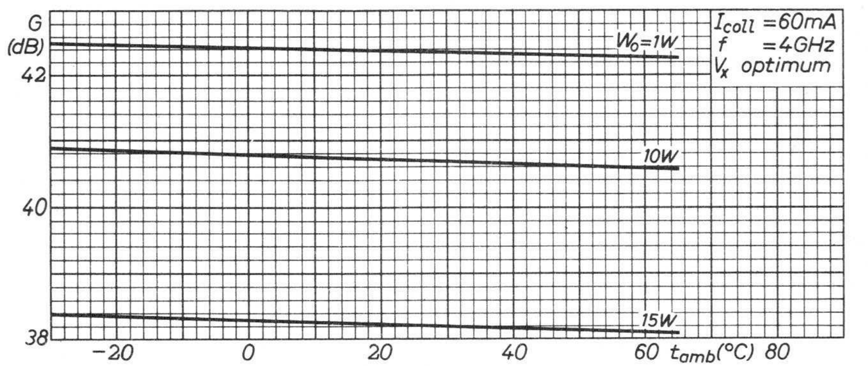



Helix current = f(collector voltage)




Cathode current = f(accelerator voltage)




Helix current and gain = f(ambient temperature)

# TRAVELLING-WAVE TUBE

Travelling-wave tube with a periodic permanent magnet mount designed for wide-band microwave link applications.

| QUICK REFERENCE DATA | |
|---|---|
| Frequency | 5.8 to 8.5 GHz |
| Saturation output power at midband | 20 W |
| Low-level gain at midband | 45 dB |
| Interchangeability | plug-in focus, plug-in match |
| Construction | unpackaged |
| tube | glass-metal envelope, metal-ceramic base |
| mount | periodic permanent magnet |
| Cooling | conduction |

**CATHODE** : Dispenser type

**HEATING** : Indirect by A.C. or D.C.

When operated on D.C. the cathode must be connected to the positive side of the heater power supply.

| | | | | |
|---|---|---|---|---|
| Heater voltage | $V_f$ | | 6.3 | V ± 2% |
| Heater current at $V_f$ = 6.3 V | $I_f$ | approx. | 1 | A |
| Waiting time (Heating time before application of high voltage) | $T_w$ | min. | 2 | min |

For shorter waiting time when the tube already has been in operation see "Application of voltages".

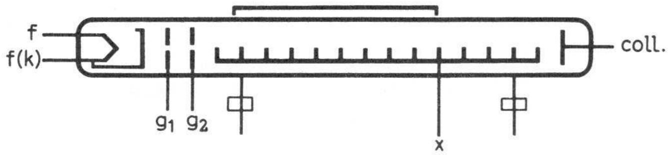
**COOLING** : By conduction. See also page 9.

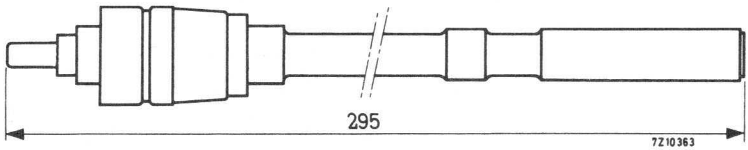
**MECHANICAL DATA** Dimensions in mm

Mounting position: Any. See "Design and operating notes" under "Cooling"

Weight of tube approx. 60 g

Weight of mount approx. 4.5 kg



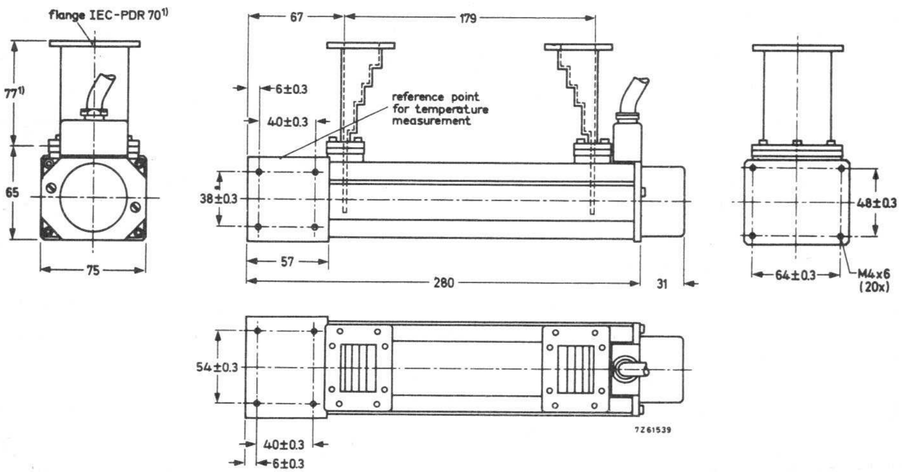

**ACCESSORIES** (to be ordered separately)

PPM mount for conduction cooling — type 55337

Waveguide taper (two required)
to waveguide IEC-R70 (34.85 x 15.80 $mm^2$)
with flange mating IEC-PDR70 — type 55338

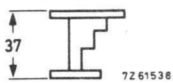
Waveguide taper (two required)
to waveguide IEC-R84 (28.50 x 12.62 $mm^2$)
with flange mating IEC-UER84 — type 55342

Mount with conduction (heatsink) cooling and waveguide tapers 55338




1) Flange IEC-UER-84

Waveguide taper 55342

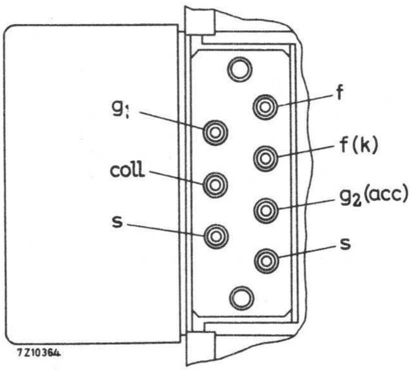


Connections

The mount is provided with flying leads, marked by colours

| | |
|---|---|
| Heater/cathode | yellow |
| Heater | brown |
| Focusing electrode | green |
| Accelerator | blue |
| Helix | to be earthed via mount |
| Collector | red |
| Safety circuit (closed or opened, when putting on respectively off the mount cap) | two violet leads |

Connections in cable housing



## GENERAL CHARACTERISTICS

| | | | | |
|---|---|---|---|---|
| Frequency range | f | 5.8 to 8.5 | GHz | |
| Saturation output power (CW) | $W_{sat}$ | 20 | W | [1] |
| Low-level gain | G | 45 | dB | [2] |
| Gain at $W_o$ = 15 W | G | 39 | dB | [3] |
| Thermal noise factor at $W_o$ = 15 W | F | 25 | dB | [4] |
| AM to PM conversion at $W_o$ = 15 W | $k_p$ | 3 | °/dB | [4] |
| Cold match at input and output (f = 5.8 to 8.5 GHz) | V.S.W.R. | max. 1.5 | | 5 |

[1] Typical value measured at f = 7.2 GHz, $I_{coll}$ = 55 mA, $W_i$ and $V_x$ optimally adjusted for saturation output power.

[2] Typical value measured at f = 7.2 GHz, $I_{coll}$ = 55 mA, $W_o$ < 1 W, $V_x$ optimally adjusted for low level gain.

[3] Typical value measured at f = 7.2 GHz, $I_{coll}$ = 55 mA, $V_x$ adjusted for optimum gain.

[4] Typical value measured at f = 6 GHz, $I_{coll}$ = 55 mA, $V_x$ adjusted for optimum gain.

[5] Measured on the cold tube, i.e. with the beam switched off and without use of any matching device (plug-in match).

**TYPICAL OPERATION**

(Voltages are specified with respect to the cathode)

| | | | | | | |
|---|---|---|---|---|---|---|
| Frequency | f | | | 6.0 | | GHz |
| Output power | $W_o$ | | 15 | 10 | 5 | W |
| Helix voltage (adjusted for optimum gain) | $V_x$ | approx. | 2950 | 2900 | 2900 | V |
| Collector voltage | $V_{coll}$ | | 1500 | 1450 | 1300 | V |
| Focusing electrode voltage | $V_{g1}$ | | −6 | −6 | −6 | V |
| Collector current | $I_{coll}$ | | 55 | 55 | 55 | mA |
| Gain | G | | 41 | 43 | 45 | dB |
| Accelerator voltage 1) | $V_{g2}$ | approx. | 2050 | 2050 | 2050 | V |
| Accelerator current | $I_{g2}$ | | $<0.1$ | $<0.1$ | $<0.1$ | mA |
| Helix current (plug-in focus) | $I_x$ | | 0.8 | 0.8 | 0.5 | mA |
| Thermal noise factor | F | | 25 | 23 | 22 | dB |
| AM to PM conversion | $k_p$ | | 3.0 | 2.5 | 1.5 | °/dB |
| Frequency | f | | | 7.0 | | GHz |
| Output power | $W_o$ | | 15 | 10 | 5 | W |
| Helix voltage (adjusted for optimum gain) | $V_x$ | approx. | 2850 | 2800 | 2800 | V |
| Collector voltage | $V_{coll}$ | | 1500 | 1450 | 1300 | V |
| Focusing electrode voltage | $V_{g1}$ | | −6 | −6 | −6 | V |
| Collector current | $I_{coll}$ | | 55 | 55 | 55 | mA |
| Gain | G | | 39 | 42 | 44 | dB |
| Accelerator voltage 1) | $V_{g2}$ | approx. | 2050 | 2050 | 2050 | V |
| Accelerator current | $I_{g2}$ | | $<0.1$ | $<0.1$ | $<0.1$ | mA |
| Helix current (plug-in focus) | $I_x$ | | 0.8 | 0.8 | 0.5 | mA |
| Thermal noise factor | F | | 25 | 23 | 22 | dB |
| AM to PM conversion | $k_p$ | | 3.0 | 2.5 | 1.5 | °/dB |

1) To be adjusted for indicated collector current.

| | | | | | |
|---|---|---|---|---|---|
| Frequency | $f$ | | 8.0 | | GHz |
| Output power | $W_o$ | | 10 | 5 | W |
| Helix voltage (adjusted for optimum gain) | $V_x$ | approx. | 2750 | 2750 | V |
| Collector voltage | $V_{coll}$ | | 1450 | 1300 | V |
| Focusing electrode voltage | $V_{g_1}$ | | −6 | −6 | V |
| Collector current | $I_{coll}$ | | 55 | 55 | mA |
| Gain | G | | 38 | 40 | dB |
| Accelerator voltage 2) | $V_{g_2}$ | approx. | 2050 | 2050 | V |
| Accelerator current | $I_{g_2}$ | | <0.1 | <0.1 | mA |
| Helix current (plug-in focus) | $I_x$ | | 0.8 | 0.5 | mA |
| Thermal noise factor | F | | 23 | 22 | dB |
| AM to PM conversion | $k_p$ | | 2.5 | 1.5 | °/dB |

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

(Voltages are specified with respect to the cathode unless otherwise specified)

| | | | | |
|---|---|---|---|---|
| Focusing electrode voltage | $-V_{g_1}$ | min. | 0 | V |
| | | max. | 50 | V |
| Accelerator voltage | $V_{g_2}$ | max. | 2700 | V |
| Helix voltage | $V_x$ | max. | 3300 | V |
| Collector to helix voltage | $V_{coll-x}$ | max. | 2500 | V |
| Cathode current | $I_k$ | max. | 60 | mA |
| Accelerator current | $I_{g_2}$ | max. | 0.3 | mA |
| Helix current | $I_x$ | max. | 3 | mA |
| R.F. input level | $W_i$ | max. | 100 | mW |
| Collector dissipation at $t_{amb}$ = 65 °C $I_{coll} \times V_{coll} - W_o$ | $W_{coll}$ | max. | 90 | W |
| Power reflected from load | | max. | 2 | W 1) |
| Cooler temperature at reference point | t | max. | 150 | °C |

1) To avoid overheating of the helix.
2) To be adjusted for indicated collector current.

## DESIGN AND OPERATING NOTES

### 1. INSTALLATION OF THE MOUNT

Two main methods may be discerned:

a) Fixing the mount relative to the microwave circuit by only connecting the waveguide tapers to the input and output sides of the circuit.

b) Employing a) and establishing additional support by fastening the mount to the rack with clamps. In this case it is recommended to use a short piece of flexible waveguide at the input and output sides to prevent excessive strain on the mount via the tapers, unless very careful alignment of the waveguides can be assured.

Possible forces on the waveguides must not produce a moment greater than 2 mkg at the flanges.

#### 1.1 Mount

The mount has no movable parts. If clamps are used (method b) the slightly larger dimensions of the cooler as compared to the main part of the mount must be considered.

#### 1.2 Magnetic shielding

The periodic permanent magnet is completely shielded. This implies that no additional measures need be taken to prevent the magnetic properties of the mount from being affected by external magnetic fields. The mount will not influence surrounding equipment which is susceptible to stray magnetic fields. Several mounts may be placed side by side without disturbing the focusing qualities. Isolators may be installed quite near to the mount.

Warning

If any part of the shielding is removed, the magnetic properties of the mount may be disturbed irreversibly.

### 2. INSTALLATION OF THE TUBE

Unlock the mount cap (see outline drawing) by turning it slightly counterclockwise. The cap can then easily be removed, and the tube inserted by carefully pushing it in.
Finally put the cap on the mount again, and lock by turning it clockwise.
These instructions also apply (in the reverse order) for taking the tube out of the mount.

### 3. SAFETY

The supply voltages are fed to the tube via the mount cap. When the cap is unlocked all voltages are removed from the tube. The two violet leads can be incorporated into an additional safety circuit which switches the voltages off at the power supply if the cap is unlocked. Thus the voltages can also be removed from the mount.

The mount should always be earthed.

4. POWER SUPPLY

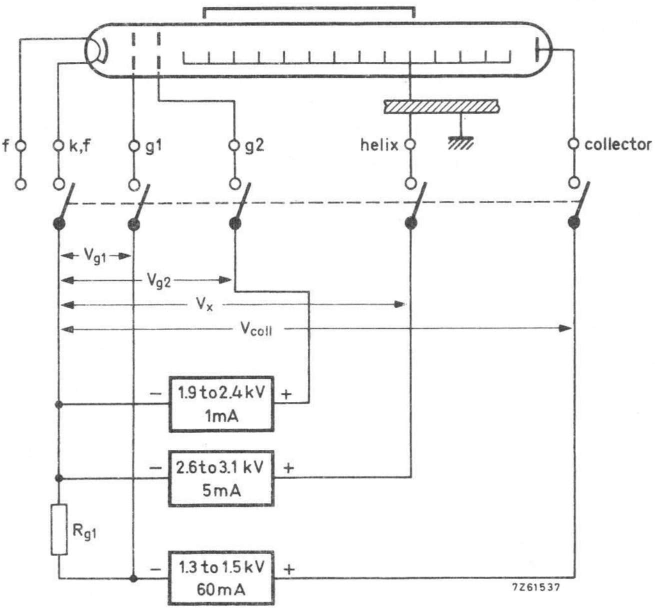
An example of a supply circuit for 5, 10 and 15 W operation is given in the figure.

Design ranges for the power supply
(electrode voltages with respect to cathode)

| | Min. | Max. | |
|---|---|---|---|
| Accelerator voltage | 1900 | 2400 | V |
| Accelerator current | | 0.3 | mA |
| Helix voltage | 2600 | 3100 | V [1] |
| Helix current | | 3 | mA |

The collector voltage is set at a fixed voltage dependent on the output power level.

| | | | | | | |
|---|---|---|---|---|---|---|
| Output power level | $W_o$ | 5 | 10 | 15 | $W_{sat}$ | W |
| Collector voltage | $V_{coll}$ | 1300 | 1450 | 1500 | 1700 | V |
| Collector current | $I_{coll}$ | 55 | 55 | 55 | 55 | mA |
| Focusing electrode voltage | $V_{g_1}$ | −6 | −6 | −6 | −6 | V |




[1]) At saturation the helix voltage may reach 3200 V

5. COOLING

Tube and mount need no artificial means of cooling. Natural cooling of the collector has been made possible by depression of the collector potential with respect to the helix and by ensuring adequate heat transfer from the collector to the environment.

Under typical operating conditions and at an ambient temperature of not more than 65 $^{o}$C, the cooler temperature at the reference point (see drawing) is well below the limit, provided an aluminium heatsink of 300 mm x 300 mm x 6 mm is mounted on one of the cooler surfaces. The heatsink is best fixed with its centre coinciding with that of the cooler, and in a vertical position. The mount itself may have any position in the equipment.
Other heatsink configurations may be employed. It will then be necessary to check the temperatures reached at the reference point under extreme conditions e.g. 65 $^{o}$C ambient temperature.

6. APPLICATION OF VOLTAGES

6.1 Switching-on procedure for new tubes

6.1.1 Apply the heater voltage for the specified waiting time.
6.1.2 Apply the rated voltages to the collector, the helix, the accelerator (and in case of a separate supply to the focusing electrode) simultaneously (see Remarks).
6.1.3 Adjust the accelerator voltage to obtain a collector current of 55 mA.
6.1.4 Apply the R.F. input signal, adjust the level to obtain the required output power while simultaneously adjusting the helix voltage for optimum gain.

6.2 Readjustment during life

During life the collector current may decrease.
A readjustment of the accelerator voltage to obtain $I_{coll}$ = 55 mA will then be necessary.

6.3 Switching-off procedure

All voltages should be switched off simultaneously.
If this is not feasible, do as described under "Remarks".

6.4 Switching-on procedure after interruption of voltage (also see the Remarks)

6.4.1 Interruption of less than 40 s:
Switch on all voltages simultaneously.
6.4.2 Interruption of more than 40 s but less than 1 week:
Apply the heater voltage for min. 40 s, then apply all other voltages simultaneously.
6.4.3 Interruption of more than 1 week:
Apply the heater voltage for the specified waiting time of 2 min.
Apply all other voltages simultaneously.

Remarks

When the voltages cannot be switched simultaneously all the cathode current may flow to the accelerator or the helix. If this condition lasts for more than 10 ms, it **may** cause permanent damage to the tube. The remedy is to switch the accelerator voltage on after the other electrode voltages, or off before the other electrode voltages.

7. INPUT AND OUTPUT CIRCUIT AND GROUP DELAY

In order to avoid phase distortions due to long-line effect, the insertion of an isolator between tube and antenna, and another between tube and pre-stage is strongly recommended. The isolators should be positioned as close to the tube as possible.

If isolators with a V.S.W.R. of less than 1.05 are used at a short distance from the tube, the reflections result in a variation of the group delay of less than 0.2 nanoseconds over a band of 20 MHz.

**It may be noted that the difference between the voltage reflection coefficients of the hot and the cold tube (i.e. with respectively without electron beam) is less than 0.2 for the input as well as the output side, measured at an output power level of 5 W or more.**

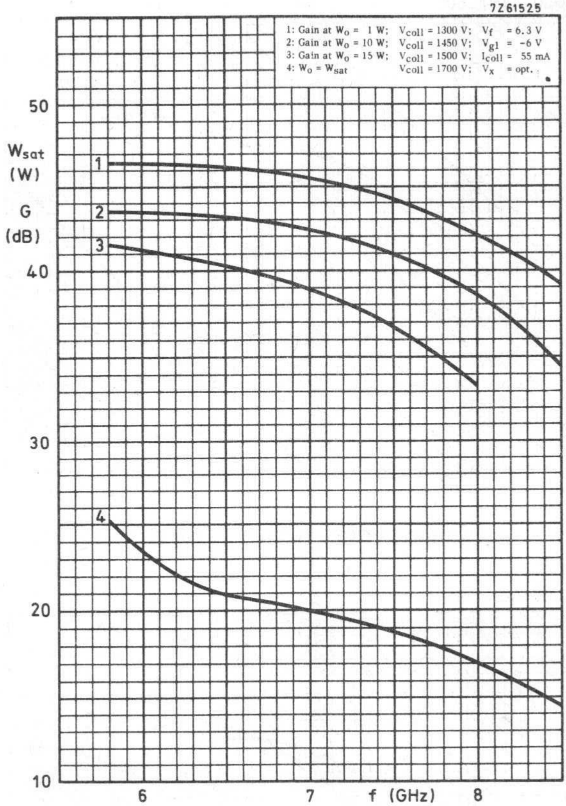
8. ENVIRONMENTAL CONDITIONS

Ambient temperature

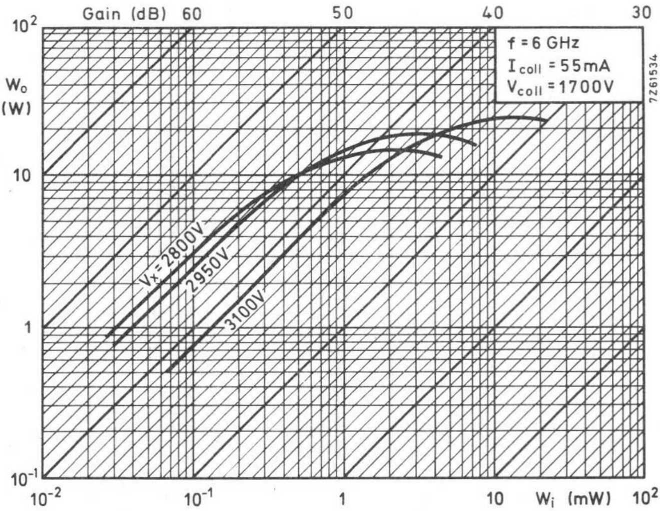
| | | | | |
|---|---|---|---|---|
| storage | $t_{amb}$ | min. | -60 | °C |
| | | max. | +65 | °C |
| operation | $t_{amb}$ | min. | -30 | °C |
| | | max. | +65 | °C |

Relative humidity 0 to 95 %

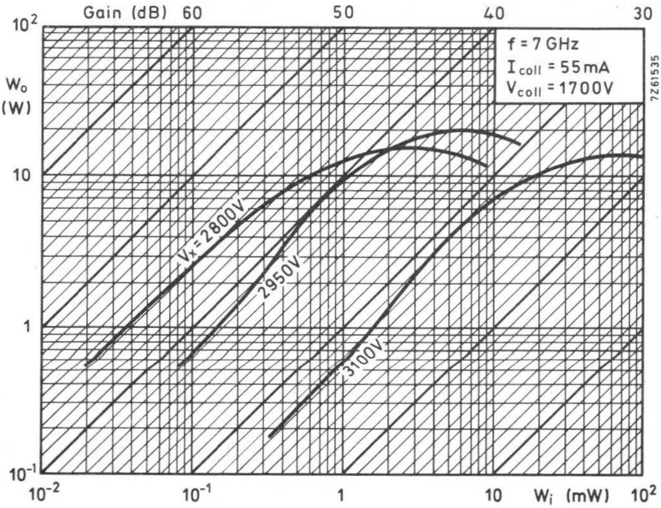
The tube and mount resist fungus attack.



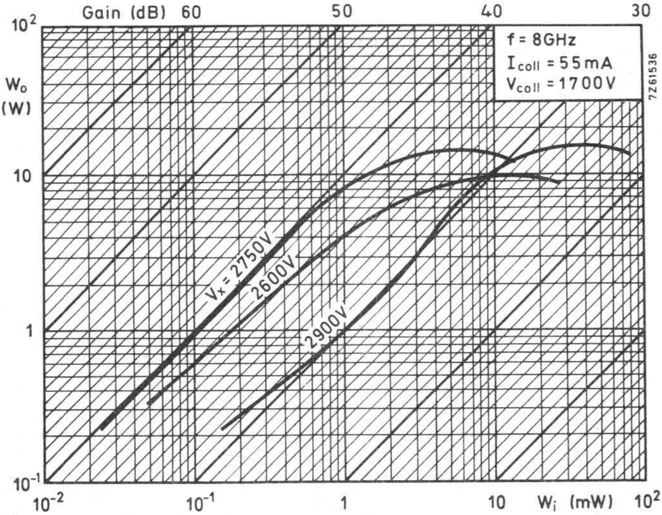

Gain and saturation power = f (frequency)



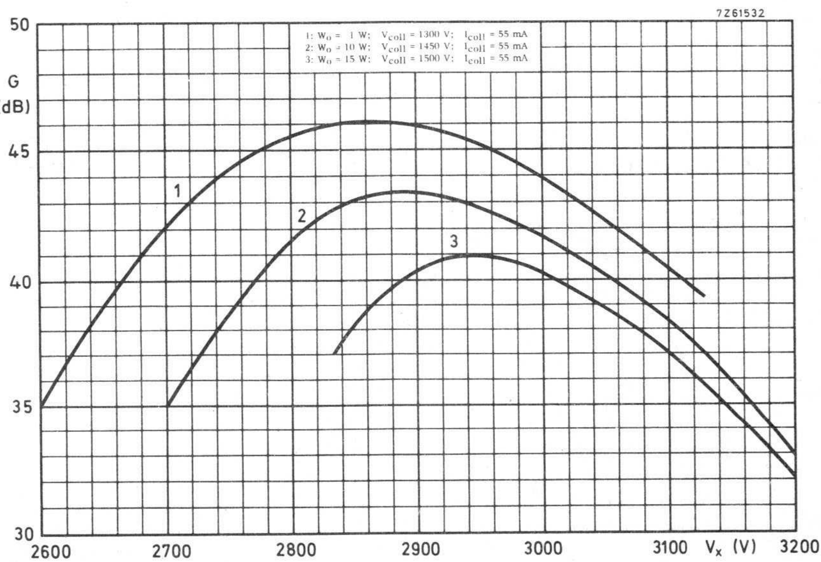

Output power = f (input power)



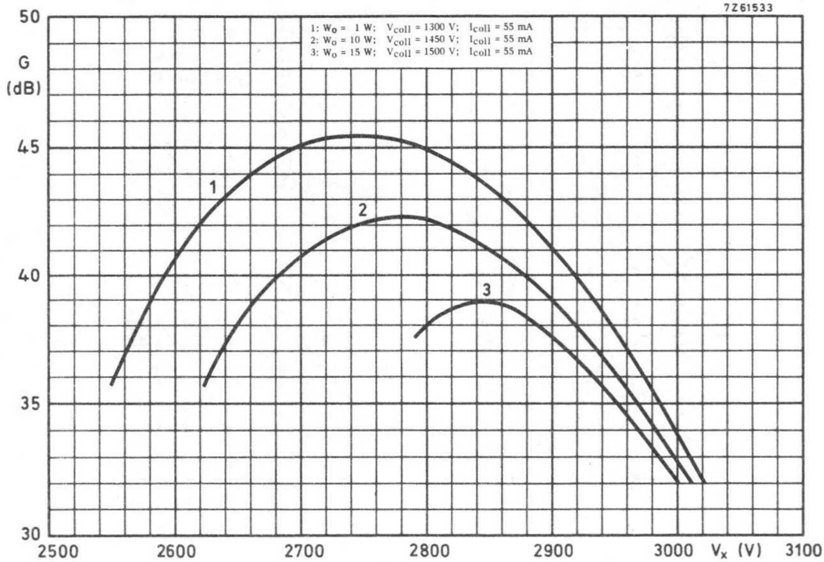

Output power = f (input power)



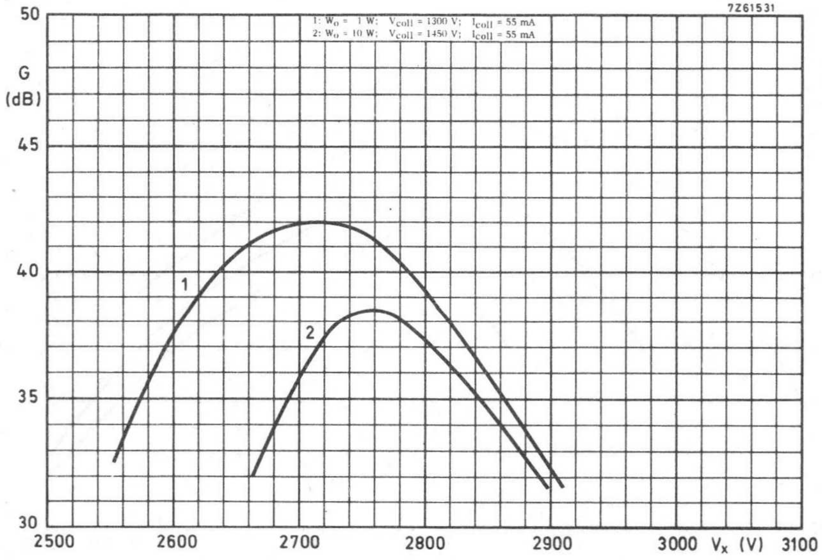

Output power = f (input power)



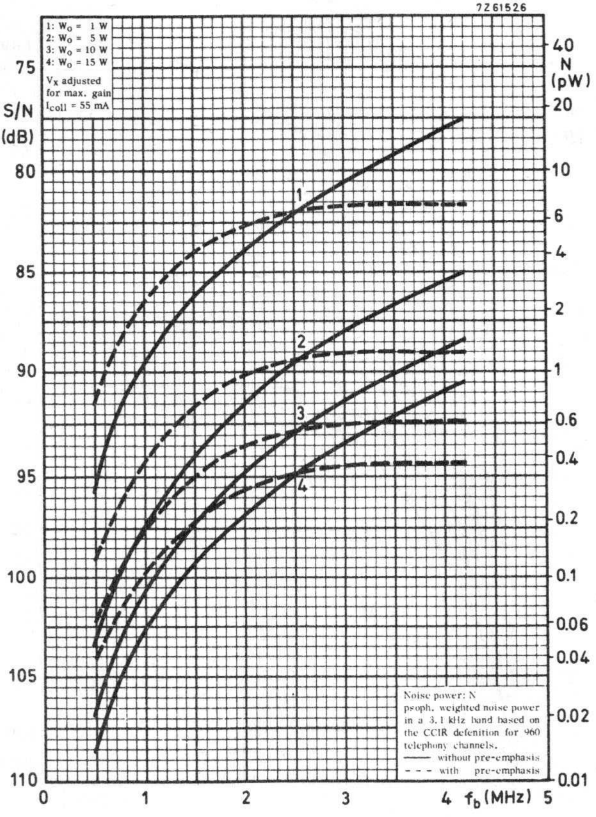

Gain = f (helix voltage) f = 6 GHz



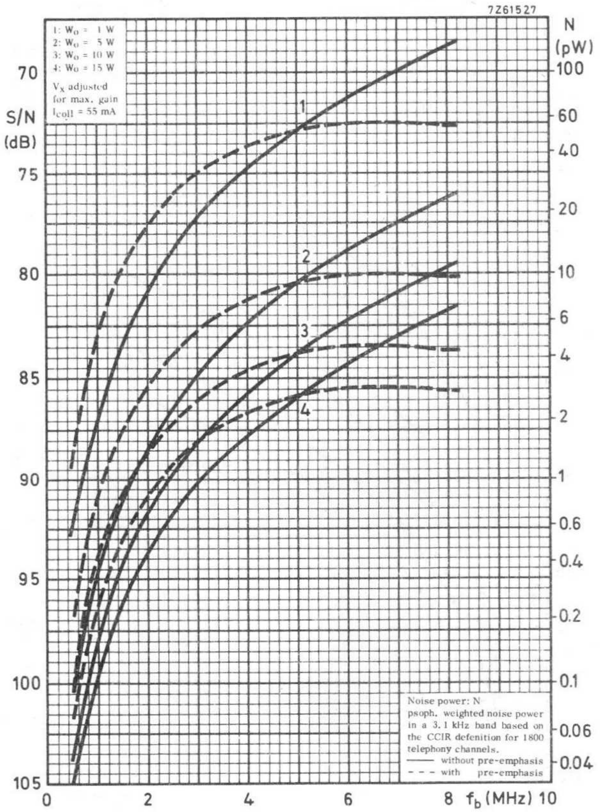

Gain = f (helix voltage) f = 7 GHz



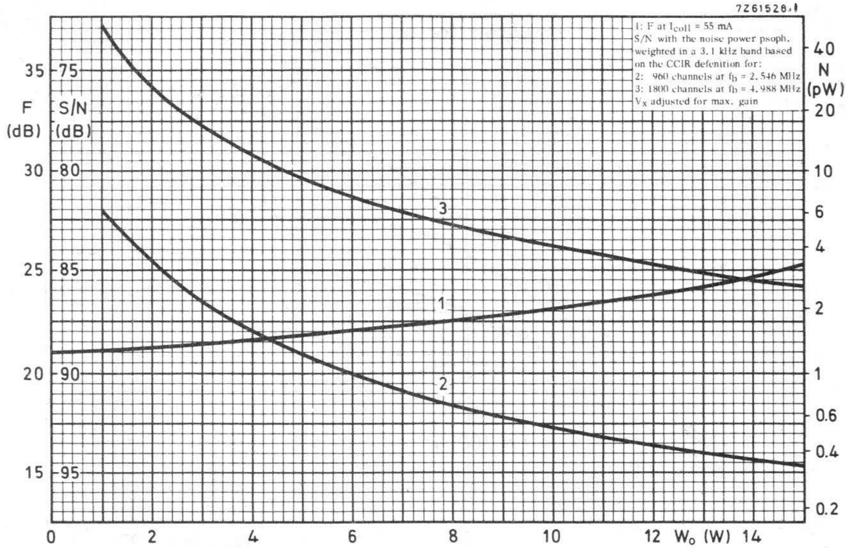

Gain = f (helix voltage) f = 8 GHz



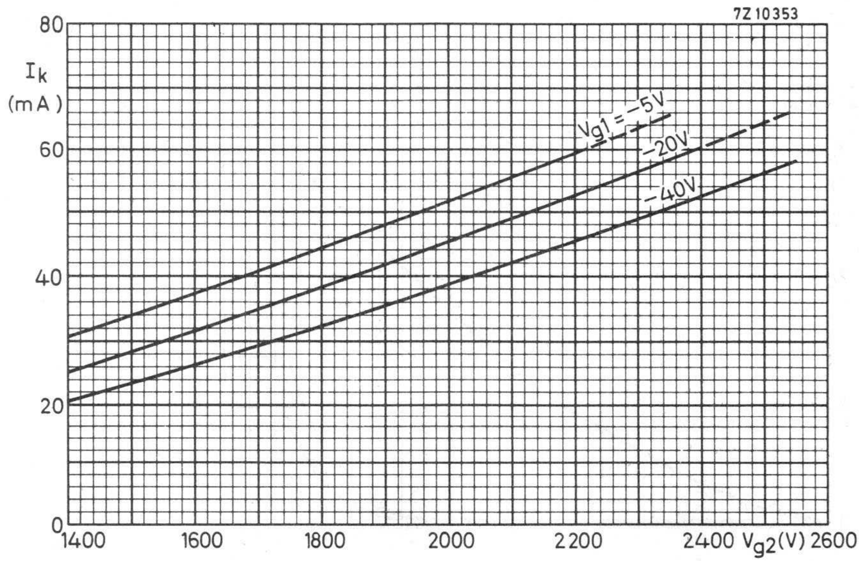

Signal to noise ratio (FM) = f (baseband freq.) at f = 6 GHz



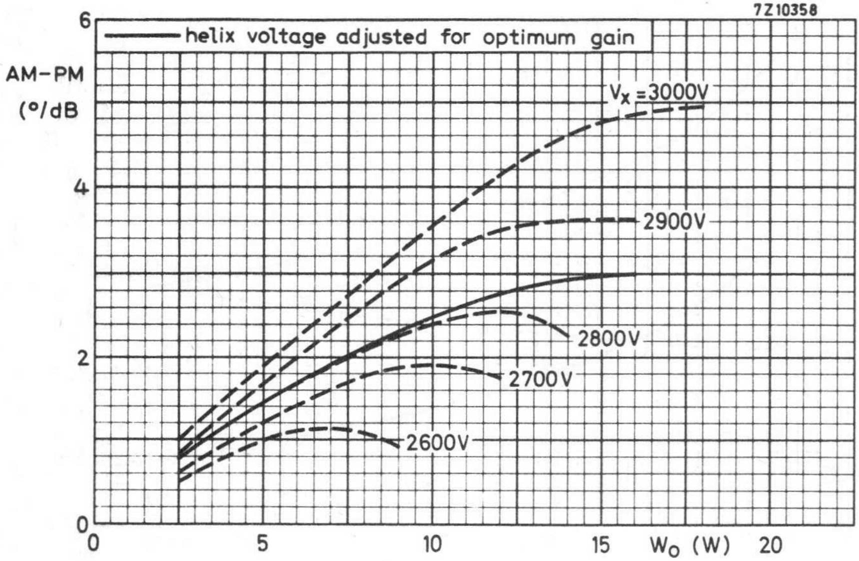

Signal to noise ratio (FM) = f (baseband freq.) at f = 6 GHz



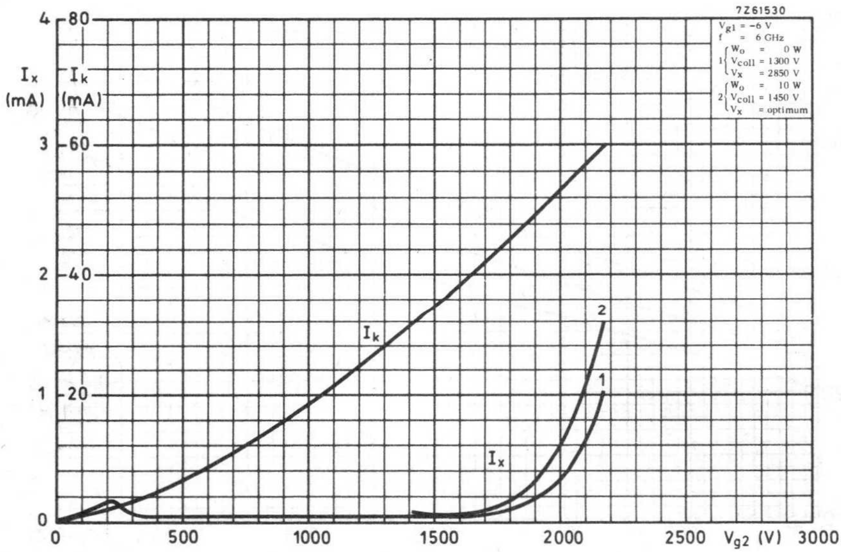

Thermal noise (FM) = f (output power) at f = 6 GHz



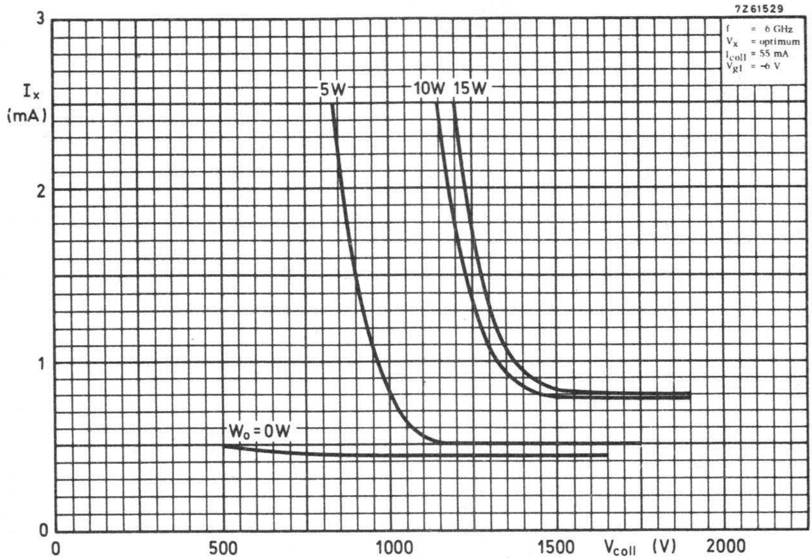

Cathode current = f (accelerator voltage)




AM to PM conversion = f (output power) at f = 6 GHz




Cathode current and helix current = f (accelerator voltage)




Helix current = f (collector voltage)

# TRAVELLING-WAVE TUBE

Travelling-wave tube with a periodic permanent magnet mount designed for wide-band microwave link applications.

| QUICK REFERENCE DATA | | | |
|---|---|---|---|
| Frequency | 7.0 to 8.0 | 8.0 to 8.5 | GHz |
| Saturation output power at midband | 22 | 17 | W |
| Low-level gain at midband | 45 | 42 | dB |
| Interchangeability | plug-in focus, plug-in match | | |
| Construction | unpackaged | | |
| tube | glass-metal envelope, metal-ceramic base | | |
| mount | periodic permanent magnet | | |
| Cooling | conduction | | |

**CATHODE** : Dispenser type

**HEATING** : Indirect by A.C. or D.C.

When operated on D.C. the cathode must be connected to the positive side of the heater power supply.

| | | | | |
|---|---|---|---|---|
| Heater voltage | $V_f$ | | 6.3 | V ± 2% |
| Heater current at $V_f$ = 6.3 V | $I_f$ | approx. | 1 | A |
| Waiting time (Heating time before application of high voltage) | $T_w$ | min. | 2 | min |

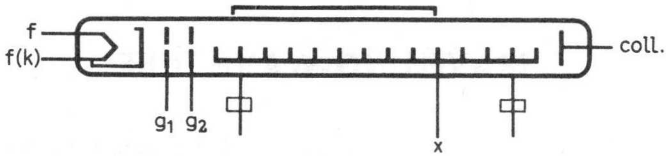
For shorter waiting time when the tube already has been in operation see "Application of voltages".

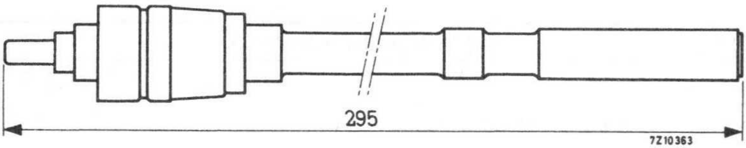
**COOLING** : By conduction. See also page 9.

**MECHANICAL DATA** Dimensions in mm

Mounting position: Any. See "Design and operating notes" under "Cooling"

| | | | |
|---|---|---|---|
| Weight of tube | approx. | 60 | g |
| Weight of mount | approx. | 4.5 | kg |

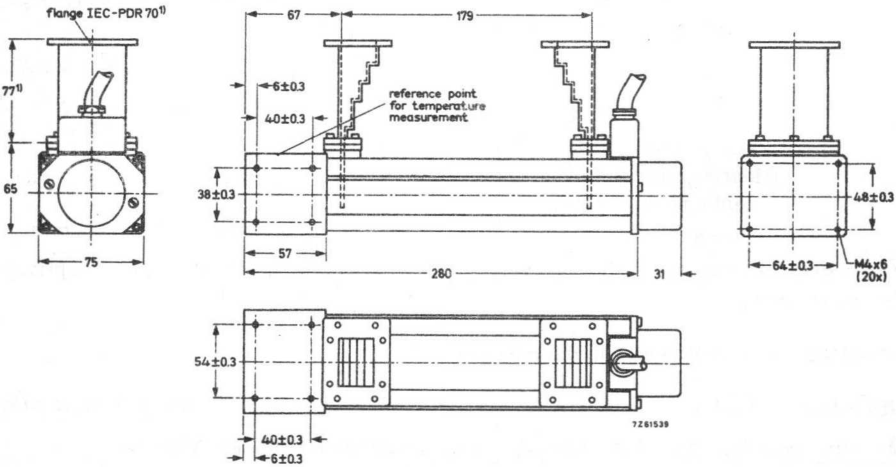


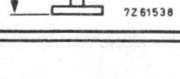

**ACCESSORIES** (to be ordered separately)

| | |
|---|---|
| PPM mount for conduction cooling | type 55337 |
| Waveguide taper (two required)<br>to waveguide IEC-R70 (34.85 x 15.80 mm$^2$)<br>with flange mating IEC-PDR70 | type 55338 |
| Waveguide taper (two required)<br>to waveguide IEC-R84 (28.50 x 12.62 mm$^2$)<br>with flange mating IEC-UER84 | type 55342 |

Mount with conduction (heatsink) cooling and waveguide tapers 55338




1)
Waveguide taper 55432



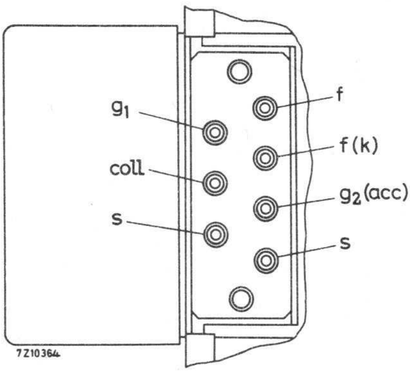

Flange IEC-UER84

Connections

The mount is provided with flying leads, marked by colours

| | |
|---|---|
| Heater/cathode | yellow |
| Heater | brown |
| Focusing electrode | green |
| Accelerator | blue |
| Helix | to be earthed via mount |
| Collector | red |
| Safety circuit (closed or opened, when putting on respectively off the mount cap) | two violet leads |

Connections in cable housing



## GENERAL CHARACTERISTICS

| | | | | | |
|---|---|---|---|---|---|
| Frequency range | f | 7.0 to 8.0 | 8.0 to 8.5 | GHZ | |
| Saturation output power (CW) | $W_{sat}$ | 22 | 17 | W | 1) |
| Low-level gain | G | 45 | 42 | dB | 2) |
| Gain at $W_o$ = 15 W | G | 41 | | dB | 3) |
| at $W_o$ = 10 W | G | | 39 | dB | 3) |
| Thermal noise factor at $W_o$ = 15 W | F | 24 | | dB | 3) |
| at $W_o$ = 10 W | F | | 24 | dB | 3) |
| AM to PM conversion at $W_o$ = 15 W | $k_p$ | 3 | | $^o$/dB | 3) |
| Cold match at input and output (f = 7.0 to 8.5 GHz) | V.S.W.R. | | max. 1.5 | | 4) |

1) Typical values measured at f = 7.5 GHz, $I_{coll}$ = 55 mA, or f = 8.3 GHz, $I_{coll}$ = 52.5 mA respectively, $W_i$ and $V_x$ optimally adjusted for saturation output power.

2) Typical values measured at f = 7.5 GHz, $I_{coll}$ = 55 mA, or f = 8.3 GHz, $I_{coll}$ = 52.5 mA respectively, $W_o$ < 1 W, $V_x$ optimally adjusted for low level gain.

3) Typical value measured at f = 7.5 GHz, $I_{coll}$ = 55 mA, or f = 8.3 GHz, $I_{coll}$ = 52.5 mA respectively, $V_x$ adjusted for optimum gain.

4) Measured on the cold tube, i.e. with the beam switched off and without use of any matching device (plug-in match).

**TYPICAL OPERATION**

(Voltages are specified with respect to the cathode)

| | | | | | | |
|---|---|---|---|---|---|---|
| Frequency | f | | | 7.0 | | GHz |
| Output power | $W_o$ | | 15 | 10 | 5 | W |
| Helix voltage (adjusted for optimum gain) | $V_x$ | approx. | 3100 | 3000 | 2950 | V |
| Collector voltage | $V_{coll}$ | | 1500 | 1450 | 1300 | V |
| Focusing electrode voltage | $V_{g_1}$ | | −6 | −6 | −6 | V |
| Collector current | $I_{coll}$ | | 55.0 | 52.5 | 52.5 | mA |
| Gain | G | | 42 | 43 | 45 | dB |
| Accelerator voltage 1) | $V_{g_2}$ | approx. | 2050 | 2000 | 2000 | V |
| Accelerator current | $I_{g_2}$ | | <0.1 | <0.1 | <0.1 | mA |
| Helix current (plug-in focus) | $I_x$ | | 1.0 | 0.7 | 0.5 | mA |
| Thermal noise factor | F | | 24 | 24 | 22 | dB |
| AM to PM conversion | $k_p$ | | 3.0 | 2.5 | 1.5 | $^o$/dB |

| | | | | | | |
|---|---|---|---|---|---|---|
| Frequency | f | | | 8.0 | | GHz |
| Output power | $W_o$ | | 15 | 10 | 5 | W |
| Helix voltage (adjusted for optimum gain) | $V_x$ | approx. | 3050 | 2950 | 2900 | V |
| Collector voltage | $V_{coll}$ | | 1500 | 1450 | 1300 | V |
| Focusing electrode voltage | $V_{g_1}$ | | −6 | −6 | −6 | V |
| Collector current | $I_{coll}$ | | 55.0 | 52.5 | 52.5 | mA |
| Gain | G | | 39 | 40 | 43 | dB |
| Accelerator voltage 1) | $V_{g_2}$ | approx. | 2050 | 2000 | 2000 | V |
| Accelerator current | $I_{g_2}$ | | <0.1 | <0.1 | <0.1 | mA |
| Helix current (plug-in focus) | $I_x$ | | 1.0 | 0.7 | 0.5 | mA |
| Thermal noise factor | F | | 24 | 24 | 22 | dB |
| AM to PM conversion | $k_p$ | | 3.0 | 2.5 | 1.5 | $^o$/dB |

1) To be adjusted for indicated collector current.

| | | | | | |
|---|---|---|---|---|---|
| Frequency | f | | 8.5 | | GHz |
| Output power | $W_o$ | | 10 | 5 | W |
| Helix voltage (adjusted for optimum gain) | $V_x$ | approx. | 2900 | 2900 | V |
| Collector voltage | $V_{coll}$ | | 1450 | 1300 | V |
| Focusing electrode voltage | $V_{g1}$ | | −6 | −6 | V |
| Collector current | $I_{coll}$ | | 52.5 | 52.5 | mA |
| Gain | G | | 37 | 40 | dB |
| Accelerator voltage 2) | $V_{g2}$ | approx. | 2000 | 2000 | V |
| Accelerator current | $I_{g2}$ | | <0.1 | <0.1 | mA |
| Helix current (plug-in focus) | $I_x$ | | 0.7 | 0.5 | mA |
| Thermal noise factor | F | | 24 | 22 | dB |
| AM to PM conversion | $k_p$ | | 2.5 | 1.5 | $^o$/dB |

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

(Voltages are specified with respect to the cathode unless otherwise specified)

| | | | | |
|---|---|---|---|---|
| Focusing electrode voltage | $-V_{g1}$ | min. | 0 | V |
| | | max. | 50 | V |
| Accelerator voltage | $V_{g2}$ | max. | 2700 | V |
| Helix voltage | $V_x$ | max. | 3300 | V |
| Collector to helix voltage | $V_{coll-x}$ | max. | 2500 | V |
| Cathode current | $I_k$ | max. | 58 | mA |
| Accelerator current | $I_{g2}$ | max. | 0.3 | mA |
| Helix current | $I_x$ | max. | 3 | mA |
| R.F. input level | $W_i$ | max. | 100 | mW |
| Collector dissipation at $t_{amb} = 65\,^oC$ $I_{coll} \times V_{coll} - W_o$ | $W_{coll}$ | max. | 90 | W |
| Power reflected from load | | max. | 2 | W 1) |
| Cooler temperature at reference point | t | max. | 150 | $^oC$ |

1) To avoid overheating of the helix.
2) To be adjusted for indicated collector current.

## DESIGN AND OPERATING NOTES

1. INSTALLATION OF THE MOUNT

Two main methods may be discerned:
a) Fixing the mount relative to the microwave circuit by only connecting the waveguide tapers to the input and output sides of the circuit.
b) Employing a) and establishing additional support by fastening the mount to the rack with clamps. In this case it is recommended to use a short piece of flexible waveguide at the input and output sides to prevent excessive strain on the mount via the tapers, unless very careful alignment of the waveguides can be assured.

Possible forces on the waveguides must not produce a moment greater than 2 mkg at the flanges.

1.1 Mount

The mount has no movable parts. If clamps are used (method b) the slightly larger dimensions of the cooler as compared to the main part of the mount must be considered.

1.2 Magnetic shielding

The periodic permanent magnet is completely shielded. This implies that no additional measures need be taken to prevent the magnetic properties of the mount from being affected by external magnetic fields. The mount will not influence surrounding equipment which is susceptible to stray magnetic fields. Several mounts may be placed side by side without disturbing the focusing qualities. Isolators may be installed quite near to the mount.

Warning

If any part of the shielding is removed, the magnetic properties of the mount may be disturbed irreversibly.

2. INSTALLATION OF THE TUBE

Unlock the mount cap (see outline drawing) by turning it slightly counterclockwise. The cap can then easily be removed, and the tube inserted by carefully pushing it in.
Finally put the cap on the mount again, and lock by turning it clockwise.
These instructions also apply (in the reverse order) for taking the tube out of the mount.

3. SAFETY

The supply voltages are fed to the tube via the mount cap. When the cap is unlocked all voltages are removed from the tube. The two violet leads can be incorporated into an additional safety circuit which switches the voltages off at the power supply if the cap is unlocked. Thus the voltages can also be removed from the mount.

The mount should always be earthed.

4. POWER SUPPLY

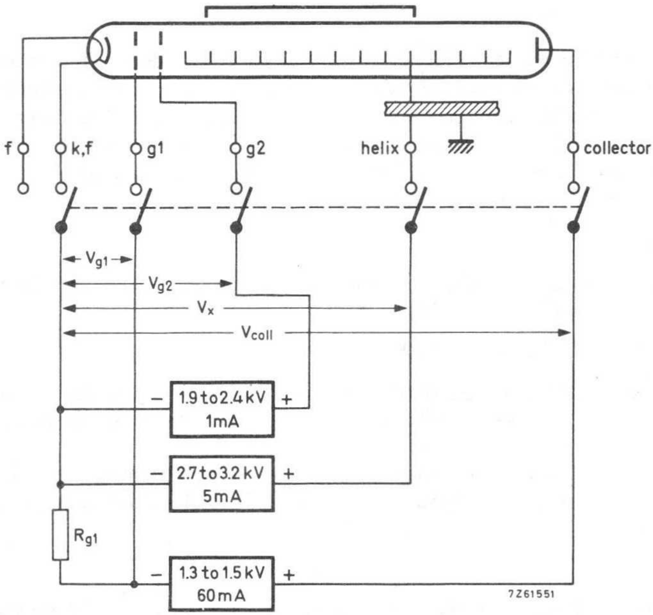
An example of a supply circuit for 5, 10 and 15 W operation is given in the figure.

Design ranges for the power supply
(electrode voltages with respect to cathode)

| | Min. | Max. | |
|---|---|---|---|
| Accelerator voltage | 1900 | 2400 | V |
| Accelerator current | | 0.3 | mA |
| Helix voltage | 2700 | 3200 | V [1] |
| Helix current | | 3 | mA |

The collector voltage is set at a fixed voltage dependent on the output power level.

| | | | | | | |
|---|---|---|---|---|---|---|
| Output power level | $W_o$ | 5 | 10 | 15 | $W_{sat}$ | W |
| Collector voltage | $V_{coll}$ | 1300 | 1450 | 1500 | 1700 | V |
| Collector current | $I_{coll}$ | 52.5 | 52.5 | 55.0 | 52.5/55.0 | mA |
| Focusing electrode voltage | $V_{g_1}$ | −6 | −6 | −6 | −6 | V |




[1] At saturation the helix voltage may reach 3300 V.

## 5. COOLING

Tube and mount need no artificial means of cooling. Natural cooling of the collector has been made possible by depression of the collector potential with respect to the helix and by ensuring adequate heat transfer from the collector to the environment.

Under typical operating conditions and at an ambient temperature of not more than 65 °C, the cooler temperature at the reference point (see drawing) is well below the limit, provided an aluminium heatsink of 300 mm x 300 mm x 6 mm is mounted on one of the cooler surfaces. The heatsink is best fixed with its centre coinciding with that of the cooler, and in a vertical position. The mount itself may have any position in the equipment.
Other heatsink configurations may be employed. It will then be necessary to check the temperatures reached at the reference point under extreme conditions e.g. 65°C ambient temperature.

## 6. APPLICATION OF VOLTAGES

### 6.1 Switching-on procedure for new tubes

6.1.1 Apply the heater voltage for the specified waiting time.

6.1.2 Apply the rated voltages to the collector, the helix, the accelerator (and in case of a separate supply to the focusing electrode) simultaneously (see Remarks).

6.1.3 Adjust the accelerator voltage to obtain the collector current of 52.5 or 55.0 mA.

6.1.4 Apply the R.F. input signal, adjust the level to obtain the required output power while simultaneously adjusting the helix voltage for optimum gain.

### 6.2 Readjustment during life

During life the collector current may decrease.
A readjustment of the accelerator voltage to obtain $I_{coll}$ = 52.5 (55.0) mA will then be necessary.

### 6.3 Switching-off procedure

All voltages should be switched off simultaneously.
If this is not feasible, do as described under "Remarks".

### 6.4 Switching-on procedure after interruption of voltage (also see the Remarks)

6.4.1 Interruption of less than 40 s:
Switch on all voltages simultaneously.

6.4.2 Interruption of more than 40 s but less than 1 week:
Apply the heater voltage for min. 40 s, then apply all other voltages simultaneously.

6.4.3 Interruption of more than 1 week:
Apply the heater voltage for the specified waiting time of 2 min.
Apply all other voltages simultaneously.

Remarks

When the voltages cannot be switched simultaneously all the cathode current may flow to the accelerator or the helix. If this condition lasts for more than 10 ms, it may cause permanent damage to the tube. The remedy is to switch the accelerator voltage on after the other electrode voltages, or off before the other electrode voltages.

7. INPUT AND OUTPUT CIRCUIT AND GROUP DELAY

In order to avoid phase distortions due to long-line effect, the insertion of an isolator between tube and antenna, and another between tube and pre-stage is strongly recommended. The isolators should be positioned as close to the tube as possible.
If isolators with a V.S.W.R. of less than 1.05 are used at a short distance from the tube, the reflections result in a variation of the group delay of less than 0.2 nanoseconds over a band of 20 MHz.

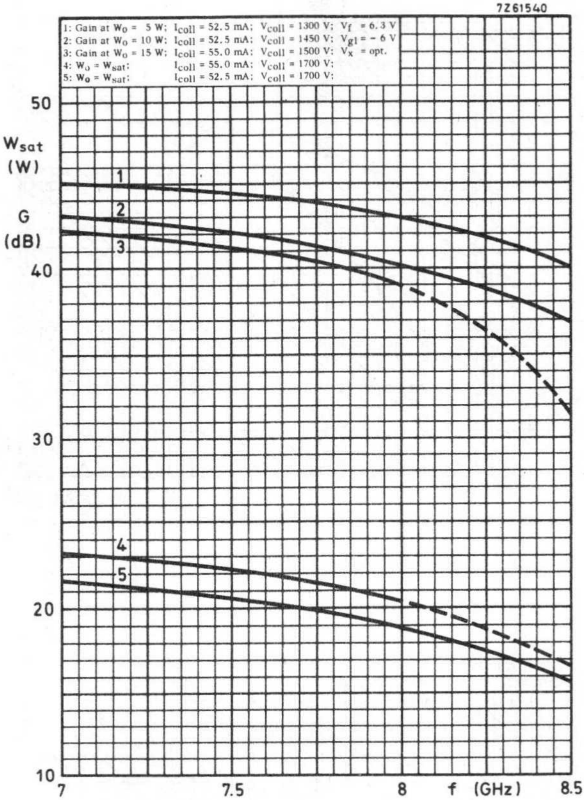
It may be noted that the difference between the voltage reflection coefficients of the hot and the cold (i.e. with respectively without electron beam) tube is less than 0.2 for the input as well as the output side, measured at an output power level of 5 W or more.

8. ENVIRONMENTAL CONDITIONS

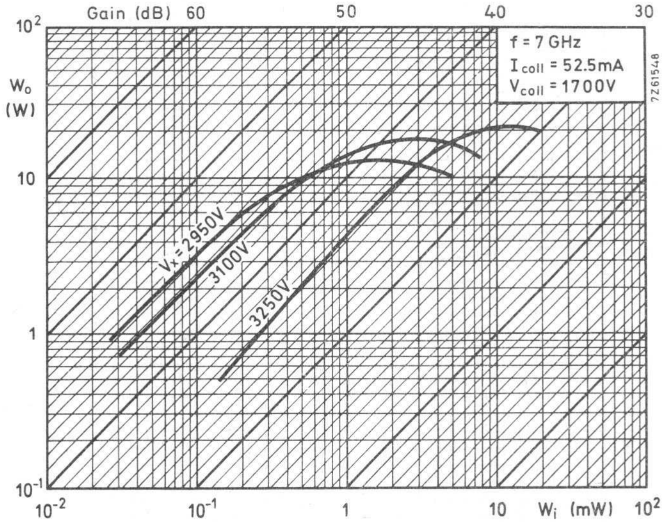
Ambient temperature,

| | | | | |
|---|---|---|---|---|
| storage | $t_{amb}$ | min. | −60 | °C |
| | | max. | +65 | °C |
| operation | $t_{amb}$ | min. | −30 | °C |
| | | max. | +65 | °C |
| Relative humidity | | | 0 to 95 | % |

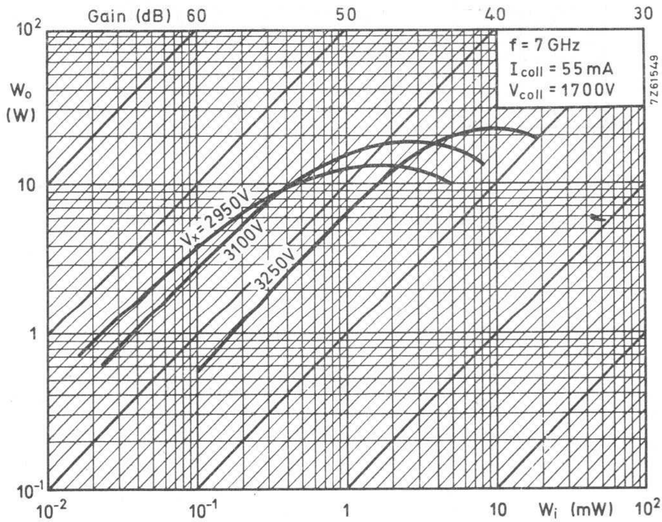
The tube and mount resist fungus attack.



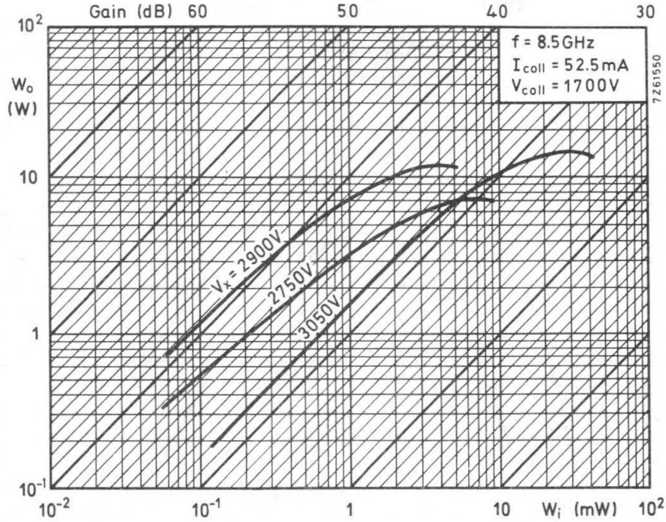

Gain and saturation power = f (frequency)



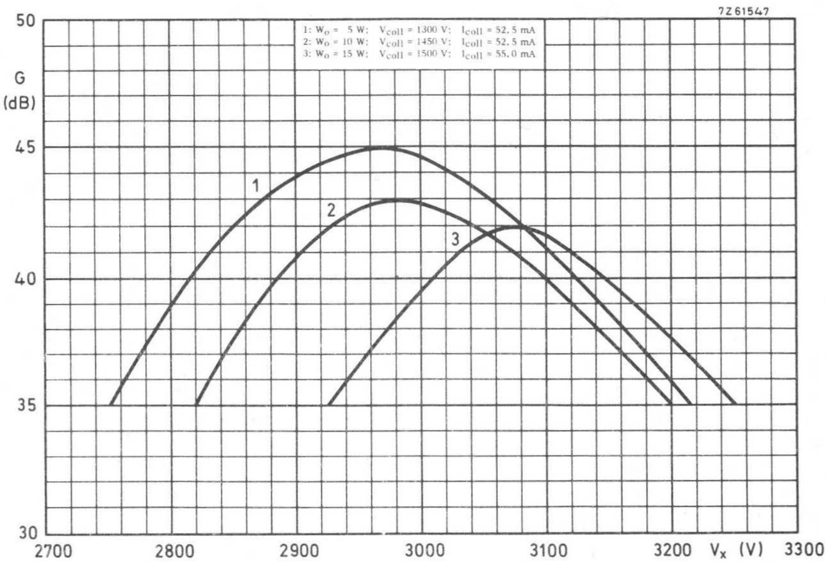

Output power = f (input power)



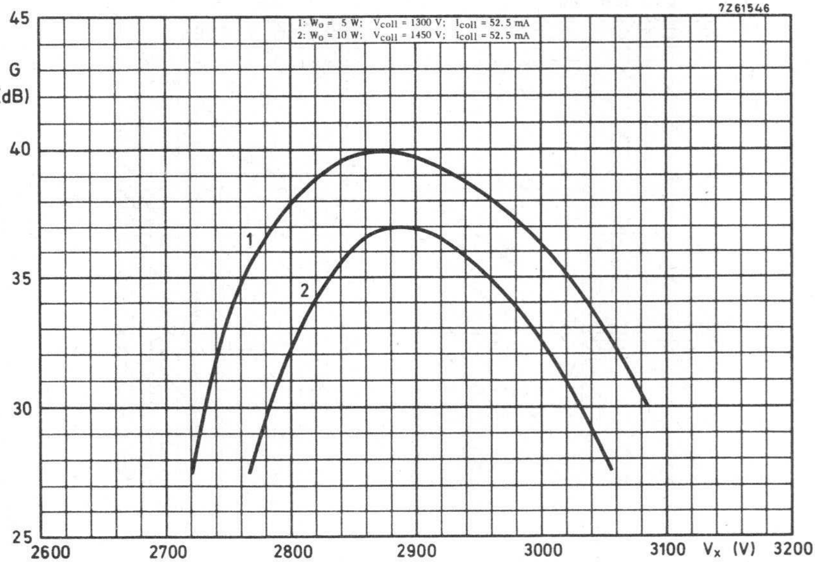

Output power = f (input power)



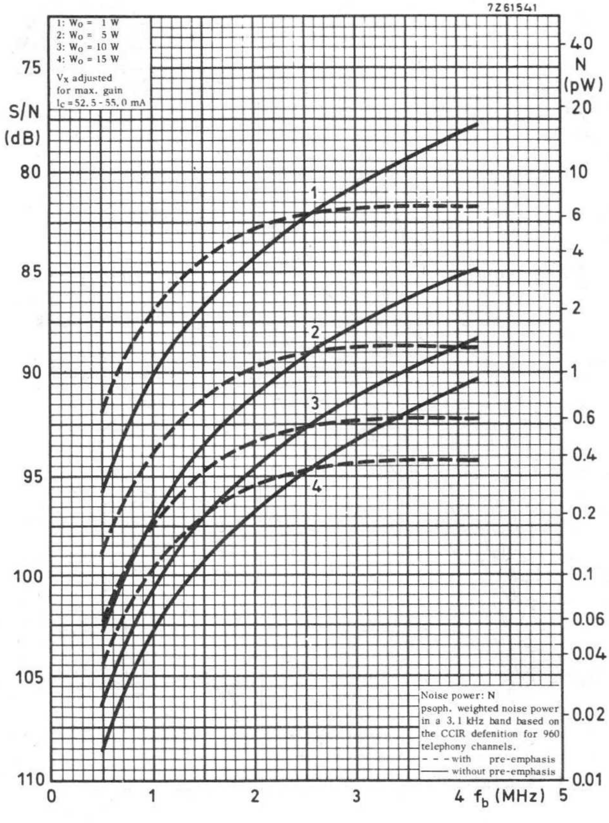

Output power = f (input power)



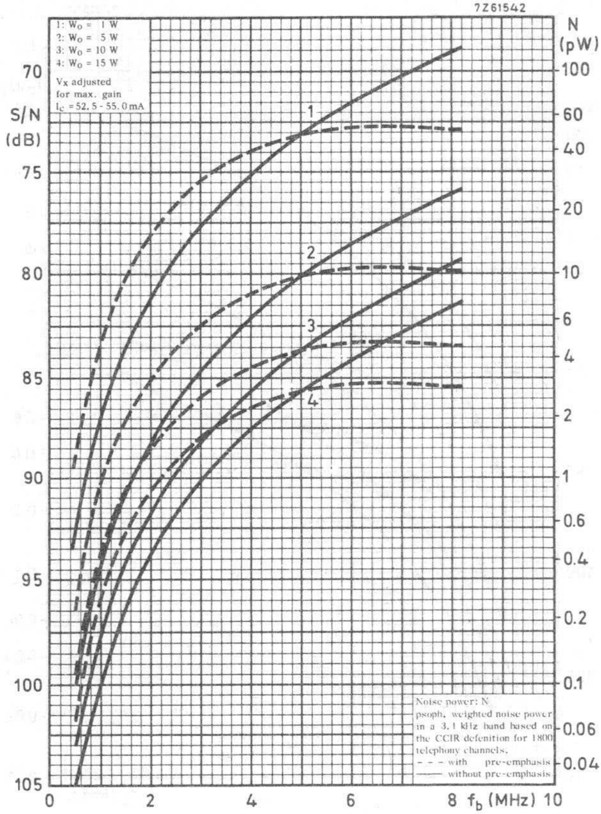

Gain = f (helix voltage); f = 7.0 GHz



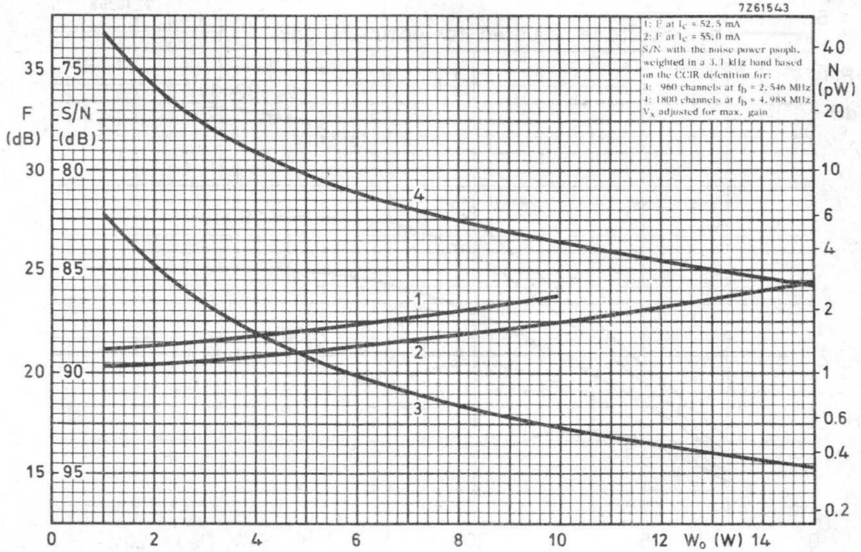

Gain = f (helix voltage); f = 8.5 GHz



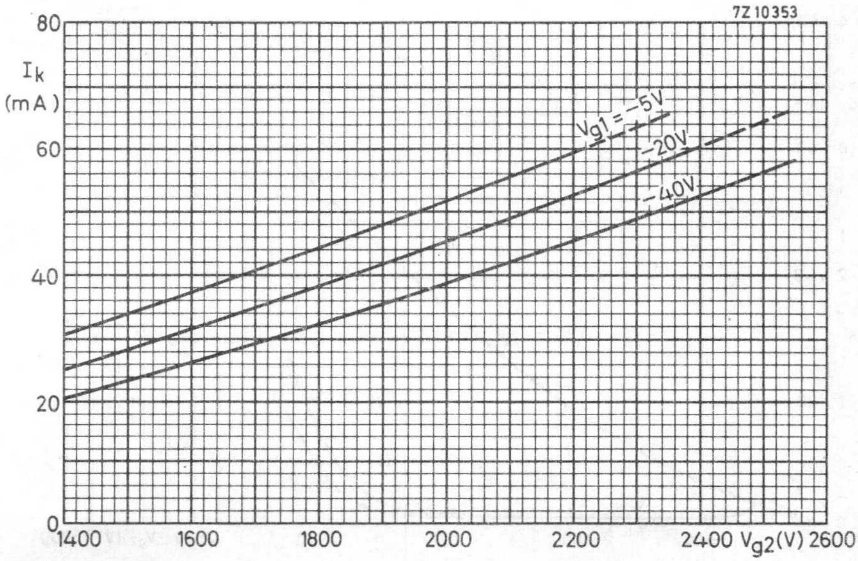

Signal to noise ratio (FM) = f (baseband freq.) at f = 7 GHz



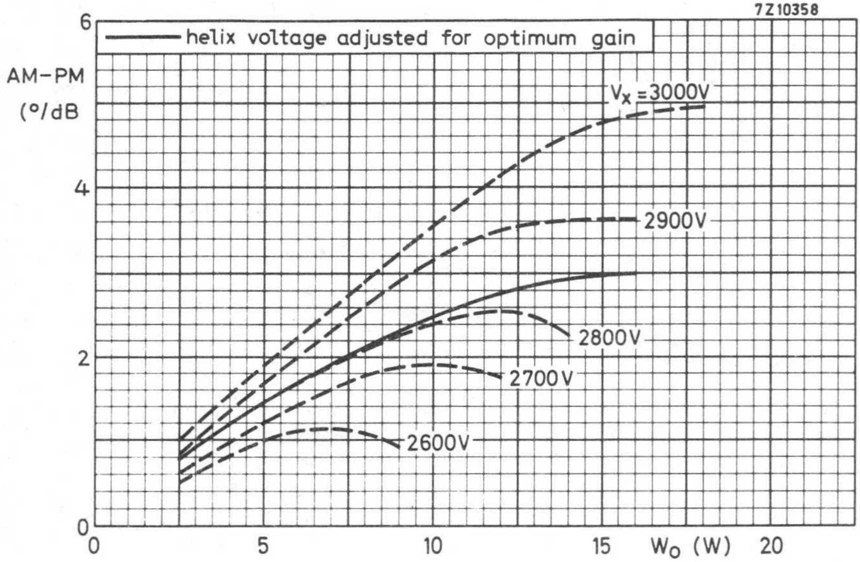

Signal to noise ratio (FM) = f (baseband freq.) at f = 7 GHz



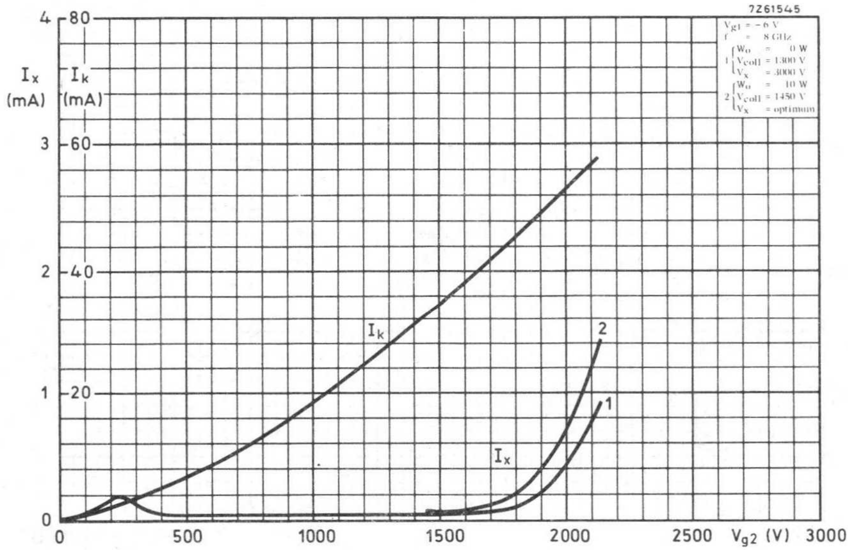

Thermal noise (FM) = f (output power) at 7 GHz



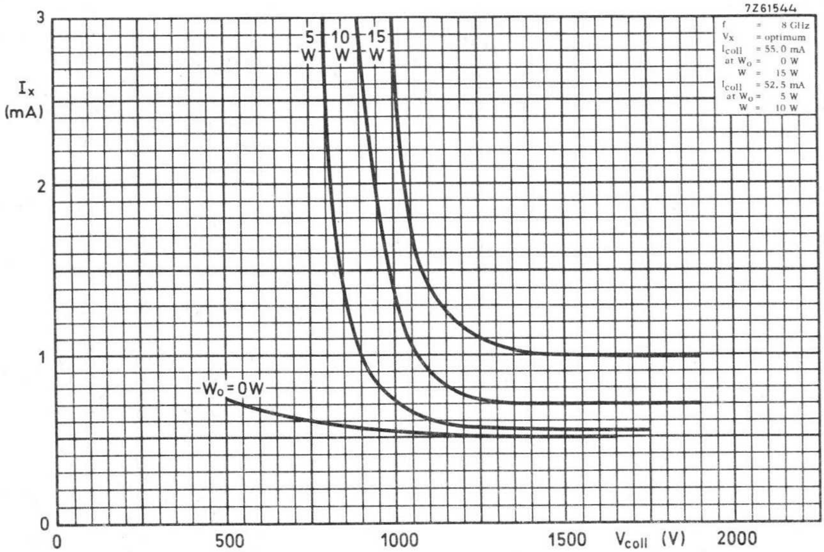

Cathode current = f (accelerator voltage)




AM to PM conversion = f (output power) at f = 7 GHz




Cathode current and helix current = f (accelerator voltage)




Helix current = f (collector voltage)

# TRAVELLING WAVE TUBE

| QUICK REFERENCE DATA | | | | |
|---|---|---|---|---|
| Frequency | f | = | 4.4 to 5.0 | GHz |
| Low level gain at 5.0 GHz | G | > | 36 | dB |
| Saturated output power | $W_o$ | > | 6 | W |
| Construction | unpackaged with uniform field permanent magnet focusing | | | |

**DESCRIPTION**

The wave propagating structure is of the helical type. The separate mount for the tube with r.f. conductors for coupling to the input and output waveguides contains a permanent magnet of the uniform field type, which is completely shielded by means of the surrounding box.
The tube is designed for plug-in match in the waveguide circuit. This gives the advantage that, after changing tubes, no tuning will be necessary, nor will the voltages on the tube have to be reestablished, apart from the starting procedure. Only a slight adjustment of the tube in the magnetic field will be required.

**HEATING:** indirect; dispenser type cathode

| | | | | |
|---|---|---|---|---|
| Heater voltage | $V_f$ | = | 6.3 | V |
| Heater current | $I_f$ | = | 800 | mA |
| Waiting time | $T_w$ | = | min. 5 | min |

**GENERAL CHARACTERISTICS**

| | | | | |
|---|---|---|---|---|
| Magnetic field strength | H | = | 600 | Oe |
| Cold transmission loss (f = 4.4 to 5.0 GHz) | | > | 55 | dB |
| Saturated output power ($I_{coll}$ = 50 mA) | $W_o$ | > | 6 | W |
| Frequency | f | = | 5.0 | GHz |
| Helix voltage | $V_x$ | = | optimal | |
| Collector current | $I_{coll}$ | = | 50 | mA |
| Output power | $W_o$ | = | 100 | mW |
| Low level gain | G | > | 36 | dB |

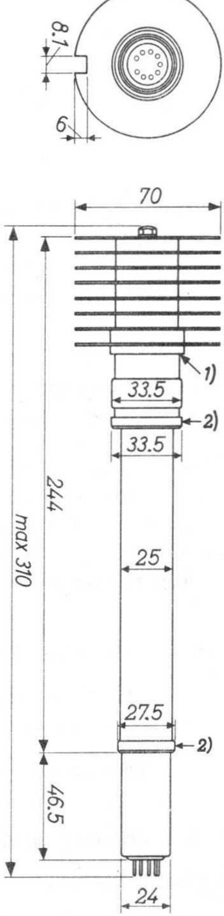
**MECHANICAL DATA**

Dimensions in mm

Net weight 0.5 kg

Net weight of mount 30 kg

Input and output
waveguides RG-49/U




Connections of the plug of the mount

1, 2 } Helix (x)

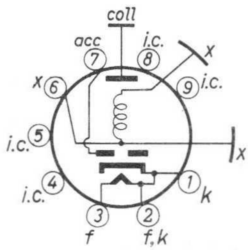
3 -

4 Collector (coll)

5 Accelerator (acc)

6 Heater (f)

7 Heater and cathode (f, k)




Tube base (Noval)

Mounting position: arbitrary

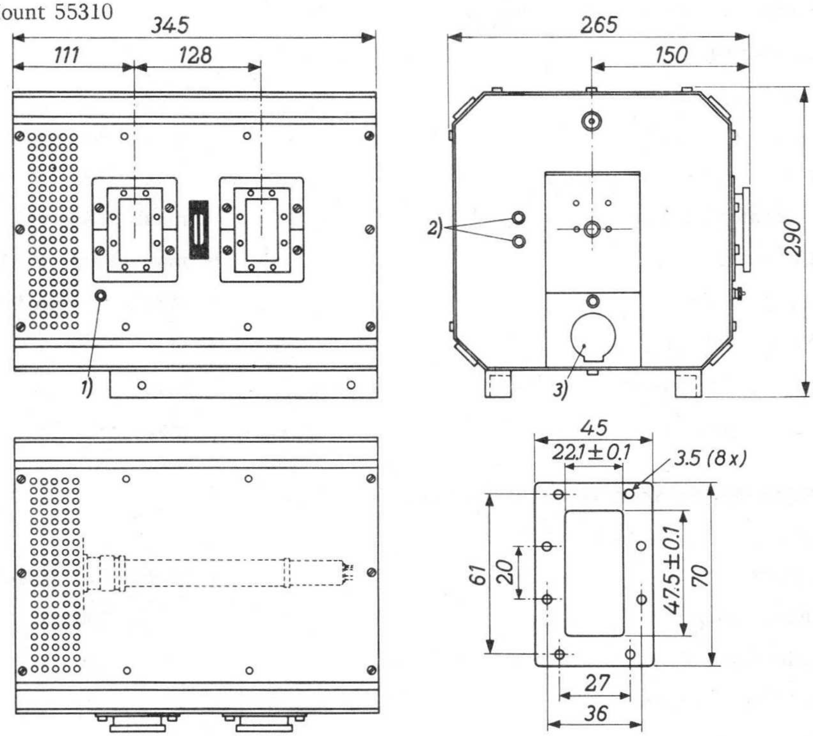
---

[1]) Reference point for collector temperature measurement

[2]) Contact rings

**MECHANICAL DATA** (continued) Dimensions in mm

Mount 55310




**ATTENTION**

Do not apply voltages to the tube when the door is open
Do not remove any part of the shielding box, nor introduce ferro-magnetic materials into the mount.

**NOTE**

A socket wrench for the alignment screws is fixed near the fastener on the door.

---

1) Earth connection

2) Alignment screws

3) Connector to power supply

## LIMITING VALUES (Absolute limits)

Voltages with respect to cathode

| | | | | |
|---|---|---|---|---|
| Heater voltage | $V_f$ | = | 6.3 V ± 2% | |
| Cathode current | $I_k$ | = | max. 55 | mA |
| Accelerator voltage | $V_{acc}$ | = | max. 1500 | V |
| Accelerator to helix voltage | $V_{acc-x}$ | = | max. 500 | V |
| Accelerator current | $I_{acc}$ | = | max. 0.35 | mA |
| Helix voltage | $V_x$ | = | max. 1500 | V [1] |
| Helix current | $I_x$ | = | max. 4 | mA |
| Collector voltage | $V_{coll}$ | = | max. 1500 | V |
| Collector dissipation | $W_{coll}$ | = | max. 70 | W |
| Collector temperature | $t_{coll}$ | = | max. 175 | °C [2] |

## OPERATING CHARACTERISTICS as power amplifier

Voltages with respect to helix

| | | | | |
|---|---|---|---|---|
| Frequency | f | = | 4.4 to 5.0 | GHz |
| Cathode voltage | $V_k$ | = | -1100 | V |
| Accelerator voltage | $V_{acc}$ | = | -30 | V |
| Accelerator current | $I_{acc}$ | < | 0.35 | mA |
| Helix current | $I_x$ | < | 3 | mA |
| Collector voltage | $V_{coll}$ | = | +50 | V |
| Collector current | $I_{coll}$ | = | 47 to 53 | mA |
| Power gain at f = 5.0 GHz | | | | |
| at $W_o$ = 100 mW | G | > | 34 | dB |
| at $W_o$ = 2.5 W | G | > | 32 | dB |
| Voltage standing wave ratio | VSWR | < | 1.5 | [3] |
| Noise figure | F | < | 30 | dB |

[1]) The helix is galvanically connected to the mount.

[2]) For reference point of the collector temperature see note [1]) page 2.

[3]) For input and output. Measured cold, i.e. with beam switched off.
For further particulars see paragraph "Transmission line".

## Cooling

The tube is convection cooled by natural air circulation. Under normal operating conditions and at $t_{amb} < 55\ ^{o}C$ no forced air cooling is required to keep the collector temperature below the maximum permissible value of 175 °C, provided the tube is mounted horizontally and no obstructions are offered for the air circulation through the ventilation holes in the mount. For less favourable conditions a slight additional air flow will be necessary.

## Shielding

Nowhere along the box surface a magnetic field strength of 2000 Oe close to the shielding plates extended over a cross sectional area of 30 $cm^2$ and directed perpendicular to the box surface, causes a change, worth mentioning, in the focus quality. Several mounts may be placed on top of or next to each other, without mutual disturbance of focusing qualities.
The stray field of the mount, measured at a distance of 1 cm from the box, is in general less than 10 Oe. On a few spots, e.g. near the ventilation holes and the alignment screws this value is exceeded with max. 20 Oe, but then the 10 Oe value is still reached within a distance of 4 cm from the box.

## Transmission line

To obtain the full benefit of the broadband characteristics of the tube, the insertion of an isolator between the tube and the prestage and between the tube and the antenna is strongly recommended. The isolators should be positioned as close as possible to the tube. By these provisions phase distortion by long line effects is avoided.
The difference between the reflection coefficients at input and output sides of the cold tube (i.e. without beam) and the warm tube is less than 0.2.
Provided an isolator with a VSWR of less than 1.05 is placed at a short distance (10 to 20 cm) at either side of the tube, the reflections result in a variation of group delay of less than 0.1 mμsec over a band of 20 MHz.

## Operating instructions

The mount is provided with an alignment device for the proper positioning of the tube with respect to the magnetic field in the mount.
For alignment screws see drawing of the mount.
As the helix current depends on the position of the tube with respect to the magnetic field, special attention must be given to the proper alignment of the tube during the steps c and d of the starting procedure given below. To prevent tube damage it is essential to observe the 4 mA maximum limit on the helix current.

1. Starting procedure

1.1 Remove the plug, loosen the fastener and open the door.

1.2 Insert the tube into the mount as shown in the drawing of the mount (take care, the tube is subject to magnetic forces). When the tube is blocked by some parts of the mount, a small correction in the position of the tube will be sufficient to avoid the obstacles.

1.3 Close the door, lock the fastener and put on the plug.

1.4 Switch on the supply voltages in the following sequence (the voltages mentioned below are with respect to the helix, which is normally at ground potential):
   a. Apply the rated heater voltage for at least 5 minutes.
   b. Apply +50 V to the collector and -30 V to the accelerator. These voltages may be applied simultaneously.
   c. Apply the cathode voltage gradually, adjusting the alignment of the tube in order not to exceed 4 mA helix current.
   d. Apply the H.F. signal to the input of the tube and adjust the alignment of the tube until the helix current reaches a minimum.

2. Switching procedure after interruption of voltages

2.1 Interruption less than 1 second. All voltages can be applied simultaneously. The output will reach 95% of the stable end value within 0.2 sec after the application of the voltages.

2.2 Interruption 1 sec or more. The voltages must be applied in the following sequence:
   a. Apply the rated heater voltage for at least 40 seconds.
   b. Apply +50 V to the collector and -30 V to the accelerator. These voltages may be applied simultaneously.
   c. Apply the rated cathode voltage. Voltages mentioned under b) and c) can be applied simultaneously.

The H.F. voltage can be applied at any time.
The output will reach 95% of the stable end value within 60 sec after the application of the heater voltage.

Remark

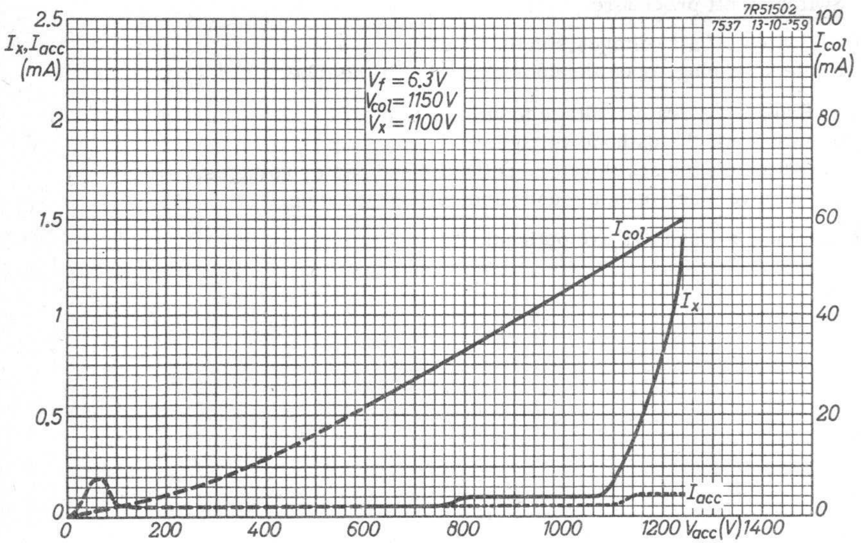
The procedure described under 2.2 can be followed without any risk of disturbing the properties of the tube. It should be noted, however, that normally about 5 minutes cathode heating time is required to obtain completely stable operation of the tube.

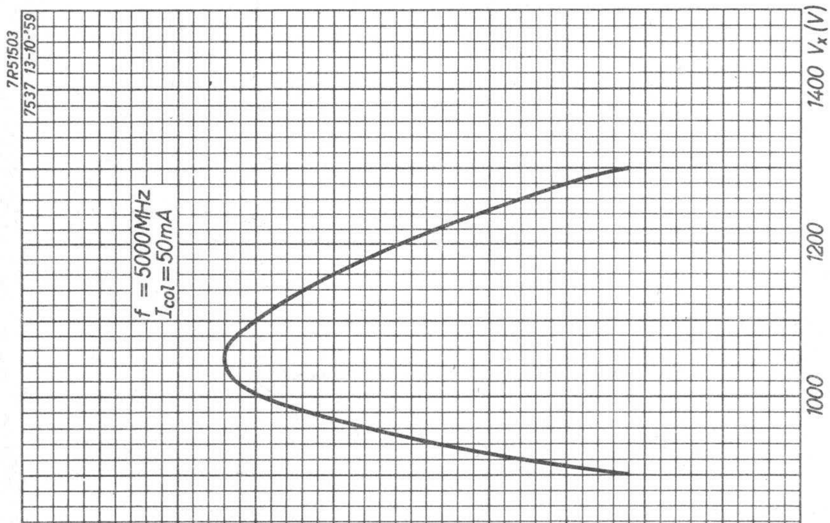
3. Switching off procedure

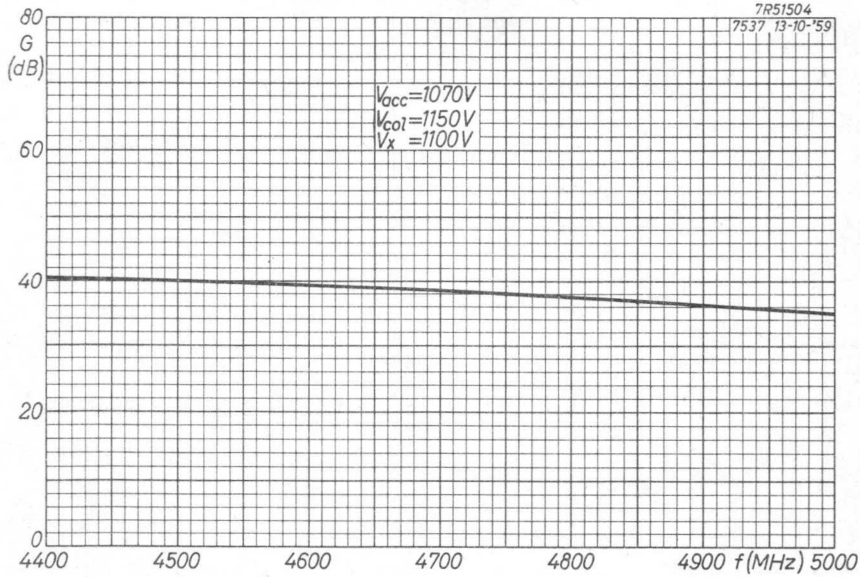
3.1 a. Switch off all voltages simultaneously.
b. Remove plug, open the door and pull out the tube.

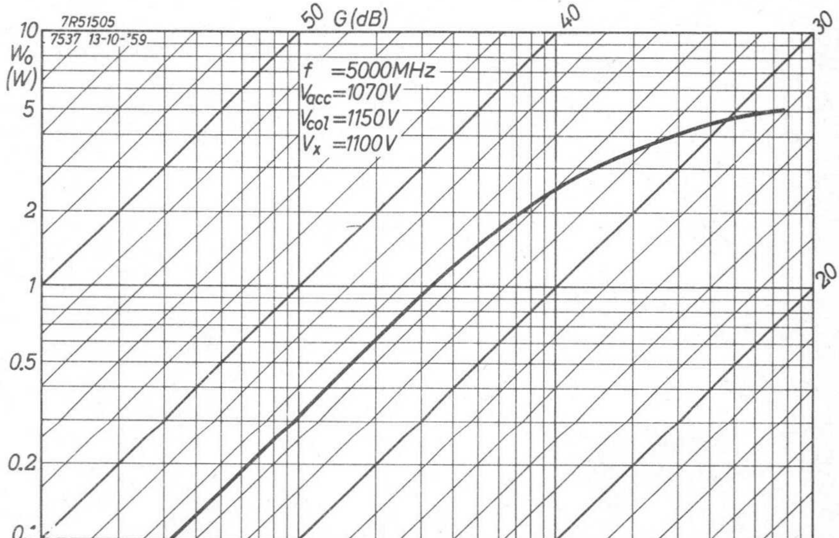
3.2 a. Bring accelerator voltage to helix potential.
b. Switch off the cathode voltage.
c. Switch off the accelerator, collector and heater voltages.
d. Remove plug, open the door and pull out the tube.

The methods 3.1 and 3.2 are optional.


7R51502
7537 13-10-'59
2.5
$I_x, I_{acc}$ (mA)
2
1.5
1
0.5
0
100
$I_{col}$ (mA)
80
60
40
20
0
$V_f = 6.3V$
$V_{col} = 1150V$
$V_x = 1100V$
$I_{col}$
$I_x$
$I_{acc}$
0
200
400
600
800
1000
1200
$V_{acc}$ (V)
1400


7R51503
7537 13-10-'59
f = 5000 MHz
$I_{col} = 50mA$
50
G (dB)
40
30
20
10
0
800
1000
1200
1400
$V_x$ (V)


7R51504
7537 13-10-'59
80
G
(dB)
60
40
20
0
4400
4500
4600
4700
4800
4900 f (MHz) 5000
Vacc=1070V
Vcol=1150V
Vx =1100V


7R51505
7537 13-10-'59
10
Wo
(W)
5
2
1
0.5
0.2
0.1
50 G (dB)
40
30
20
f =5000MHz
Vacc=1070V
Vcol=1150V
Vx =1100V
0.01
0.02
0.05
0.1
0.2
0.5
1
2
5
10
Wi (mW)

# TRAVELLING WAVE TUBE

| QUICK REFERENCE DATA | | | | |
|---|---|---|---|---|
| Frequency | f | = | 3.8 to 4.2 | GHz |
| Low level gain at 4.2 GHz | G | > | 39 | dB |
| Saturated output power | $W_o$ | > | 8 | W |
| Construction | unpackaged with uniform field permanent magnet focusing | | | |

**DESCRIPTION**

The wave propagating structure is of the helical type. The separate mount for the tube with r.f. conductors for coupling to the input and output waveguides contains a permanent magnet of the uniform field type, which is completely shielded by means of the surrounding box.
The tube is designed for plug-in match in the waveguide circuit. This gives the advantage that, after changing tubes, no tuning will be necessary, nor will the voltages on the tube have to be reestablished, apart from the starting procedure. Only a slight adjustment of the tube in the magnetic field will be required.

**HEATING:** indirect; dispenser type cathode

| | | | | |
|---|---|---|---|---|
| Heater voltage | $V_f$ | = | 6.3 | V |
| Heater current | $I_f$ | = | 800 | mA |
| Waiting time | $T_w$ | = | min. 5 | min |

**GENERAL CHARACTERISTICS**

| | | | | |
|---|---|---|---|---|
| Magnetic field strength | H | = | 600 | Oe |
| Cold transmission loss (f = 3.8 to 4.2 GHz) | | > | 60 | dB |
| Saturated output power ($I_{coll}$ = 50 mA) | $W_o$ | > | 8 | W |
| Frequency | f | = | 4.2 | GHz |
| Helix voltage | $V_x$ | = | optimal | |
| Collector current | $I_{coll}$ | = | 50 | mA |
| Output power | $W_o$ | = | 100 | mW |
| Low level gain | G | > | 39 | dB |

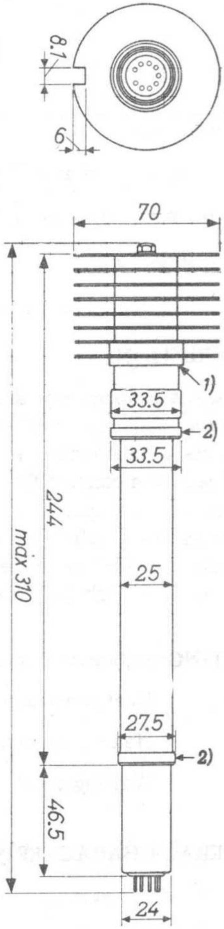
**MECHANICAL DATA**

Dimensions in mm

Net weight 0.5 kg

Net weight of mount 30 kg

Input and output
waveguides WR229




Connections of the plug of the mount

1, 2 } Helix (x)

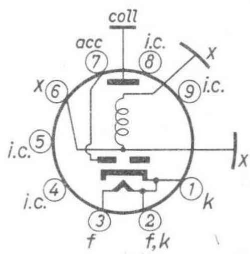
3

4 Collector (coll)

5 Accelerator (acc)

6 Heater (f)

7 Heater and cathode (f, k)




Tube base (Noval)

Mounting position: arbitrary

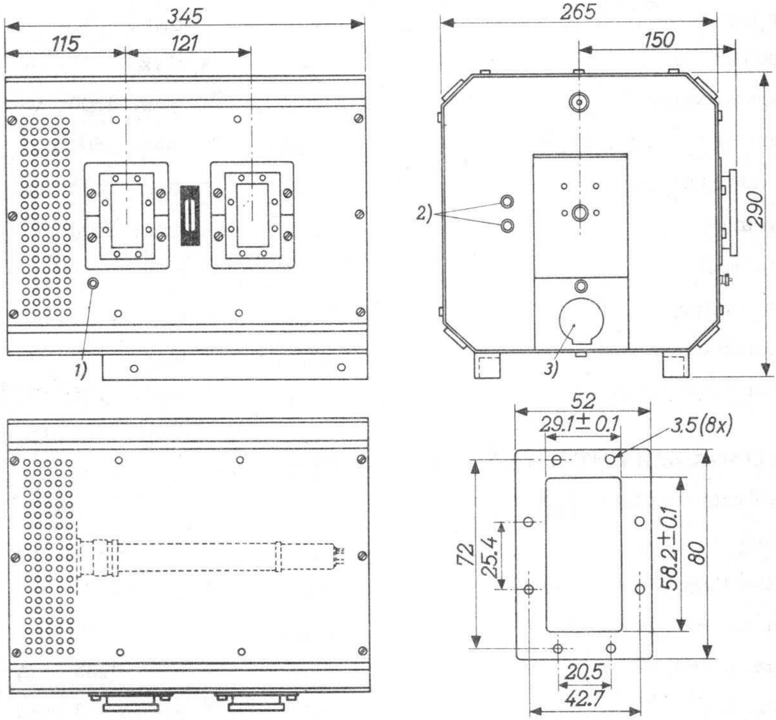
---

[1]) Reference point for collector temperature measurement

[2]) Contact rings

**MECHANICAL DATA** (continued) Dimensions in mm

Mount 55309




**ATTENTION**

Do not apply voltages to the tube when the door is open
Do not remove any part of the shielding box, nor introduce ferro-magnetic materials into the mount.

**NOTE**

A socket wrench for the alignment screws is fixed near the fastener on the door.

---

1) Earth connection

2) Alignment screws

3) Connector to power supply

**LIMITING VALUES** (Absolute limits)

Voltages with respect to cathode

| | | | | |
|---|---|---|---|---|
| Heater voltage | $V_f$ | = | 6.3 V ± 2% | |
| Cathode current | $I_k$ | = | max. 55 | mA |
| Accelerator voltage | $V_{acc}$ | = | max. 1500 | V |
| Accelerator to helix voltage | $V_{acc-x}$ | = | max. 500 | V |
| Accelerator current | $I_{acc}$ | = | max. 0.35 | mA |
| Helix voltage | $V_x$ | = | max. 1500 | V [1] |
| Helix current | $I_x$ | = | max. 4 | mA |
| Collector voltage | $V_{coll}$ | = | max. 1500 | V |
| Collector dissipation | $W_{coll}$ | = | max. 70 | W |
| Collector temperature | $t_{coll}$ | = | max. 175 | °C [2] |

**OPERATING CHARACTERISTICS** as power amplifier

Voltages with respect to helix

| | | | | |
|---|---|---|---|---|
| Frequency | f | = | 3.8 to 4.2 | GHz |
| Cathode voltage | $V_k$ | = | -1100 | V |
| Accelerator voltage | $V_{acc}$ | = | -30 | V |
| Accelerator current | $I_{acc}$ | < | 0.35 | mA |
| Helix current | $I_x$ | < | 3 | mA |
| Collector voltage | $V_{coll}$ | = | +50 | V |
| Collector current | $I_{coll}$ | = | 47 to 53 | mA |
| Power gain at f = 4.2 GHz | | | | |
| at $W_o$ = 100 mW | G | > | 37 | dB |
| at $W_o$ = 3.0 W | G | > | 35 | dB |
| Voltage standing wave ratio | VSWR | < | 1.5 | [3] |
| Noise figure | F | < | 30 | dB |

---

[1]) The helix is galvanically connected to the mount.

[2]) For reference point of the collector temperature see note [1]) page 2.

[3]) For input and output. Measured cold, i.e. with beam switched off. For further particulars see paragraph "Transmission line".

## Cooling

The tube is convection cooled by natural air circulation. Under normal operating conditions and at $t_{amb} < 55\ ^{o}C$ no forced air cooling is required to keep the collector temperature below the maximum permissible value of $175\ ^{o}C$, provided the tube is mounted horizontally and no obstructions are offered for the air circulation through the ventilation holes in the mount. For less favourable conditions a slight additional air flow will be necessary.

## Shielding

Nowhere along the box surface a magnetic field strength of 2000 Oe close to the shielding plates extended over a cross sectional area of 30 $cm^2$ and directed perpendicular to the box surface, causes a change, worth mentioning, in the focus quality. Several mounts may be placed on top of or next to each other, without mutual disturbance of focusing qualities.
The stray field of the mount, measured at a distance of 1 cm from the box, is in general less than 10 Oe. On a few spots, e.g. near the ventilation holes and the alignment screws this value is exceeded with max. 20 Oe, but then the 10 Oe value is still reached within a distance of 4 cm from the box.

## Transmission line

To obtain the full benefit of the broadband characteristics of the tube, the insertion of an isolator between the tube and the prestage and between the tube and the antenna is strongly recommended. The isolators should be positioned as close as possible to the tube. By these provisions phase distortion by long line effects is avoided.
The difference between the reflection coefficients at input and output sides of the cold tube (i.e. without beam) and the warm tube is less than 0.2.
Provided an isolator with a VSWR of less than 1.05 is placed at a short distance (10 to 20 cm) at either side of the tube, the reflections result in a variation of group delay of less than 0.1 mμsec over a band of 20 MHz.

## Operating instructions

The mount is provided with an alignment device for the proper positioning of the tube with respect to the magnetic field in the mount.
For alignment screws see drawing of the mount.
As the helix current depends on the position of the tube with respect to the magnetic field, special attention must be given to the proper alignment of the tube during the steps c and d of the starting procedure given below. To prevent tube damage it is essential to observe the 4 mA maximum limit on the helix current.

1. Starting procedure

1.1 Remove the plug, loosen the fastener and open the door.

1.2 Insert the tube into the mount as shown in the drawing of the mount (take care, the tube is subject to magnetic forces). When the tube is blocked by some parts of the mount, a small correction in the position of the tube will be sufficient to avoid the obstacles.

1.3 Close the door, lock the fastener and put on the plug.

1.4 Switch on the supply voltages in the following sequence (the voltages mentioned below are with respect to the helix, which is normally at ground potential):

a. Apply the rated heater voltage for at least 5 minutes.

b. Apply +50 V to the collector and −30 V to the accelerator. These voltages may be applied simultaneously.

c. Apply the cathode voltage gradually, adjusting the alignment of the tube in order not to exceed 4 mA helix current.

d. Apply the H.F. signal to the input of the tube and adjust the alignment of the tube until the helix current reaches a minimum.

2. Switching procedure after interruption of voltages

2.1 Interruption less than 1 second. All voltages can be applied simultaneously. The output will reach 95% of the stable end value within 0.2 sec after the application of the voltages.

2.2 Interruption 1 sec or more. The voltages must be applied in the following sequence:

a. Apply the rated heater voltage for at least 40 seconds.

b. Apply +50 V to the collector and −30 V to the accelerator. These voltages may be applied simultaneously.

c. Apply the rated cathode voltage. Voltages mentioned under b) and c) can be applied simultaneously.

The H.F. voltage can be applied at any time.
The output will reach 95% of the stable end value within 60 sec after the application of the heater voltage.

Remark

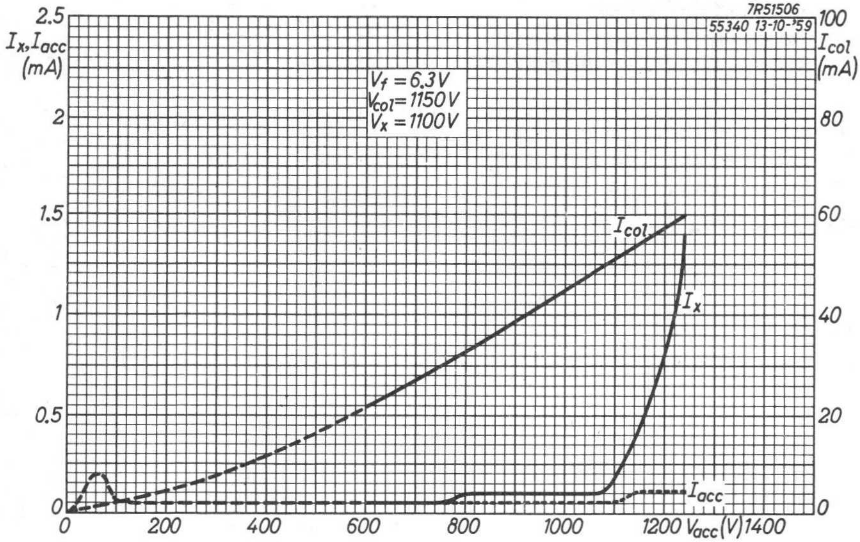
The procedure described under 2.2 can be followed without any risk of disturbing the properties of the tube. It should be noted, however, that normally about 5 minutes cathode heating time is required to obtain completely stable operation of the tube.

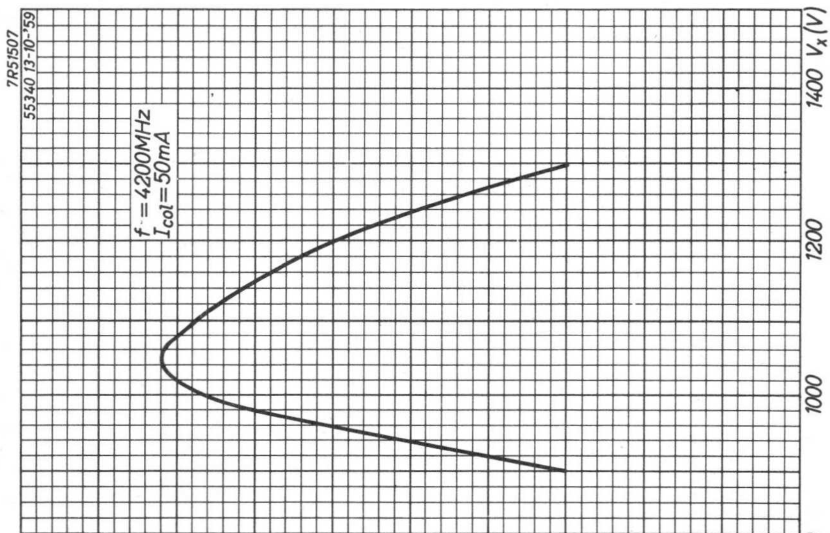
3. Switching off procedure

3.1 a. Switch off all voltages simultaneously.
b. Remove plug, open the door and pull out the tube.

3.2 a. Bring accelerator voltage to helix potential.
b. Switch off the cathode voltage.
c. Switch off the accelerator, collector and heater voltages.
d. Remove plug, open the door and pull out the tube.

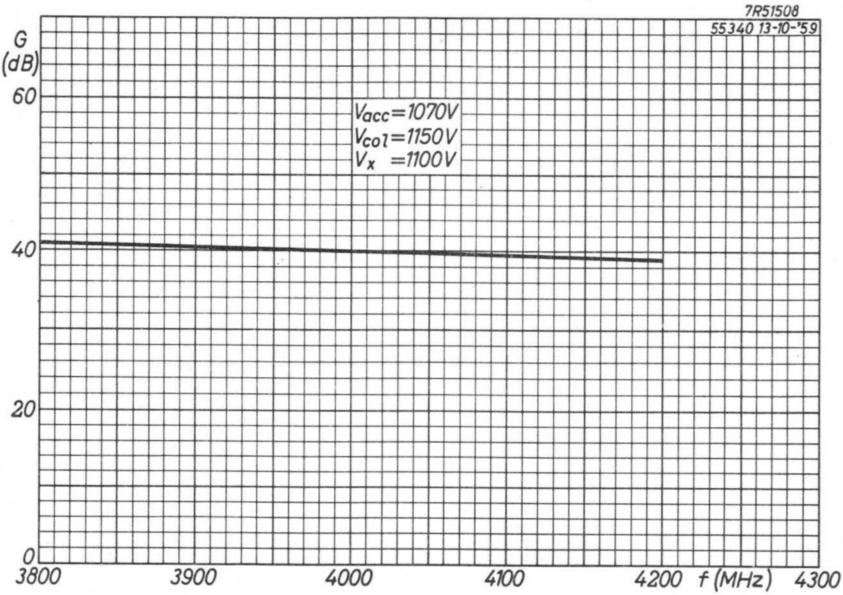
The methods 3.1 and 3.2 are optional.

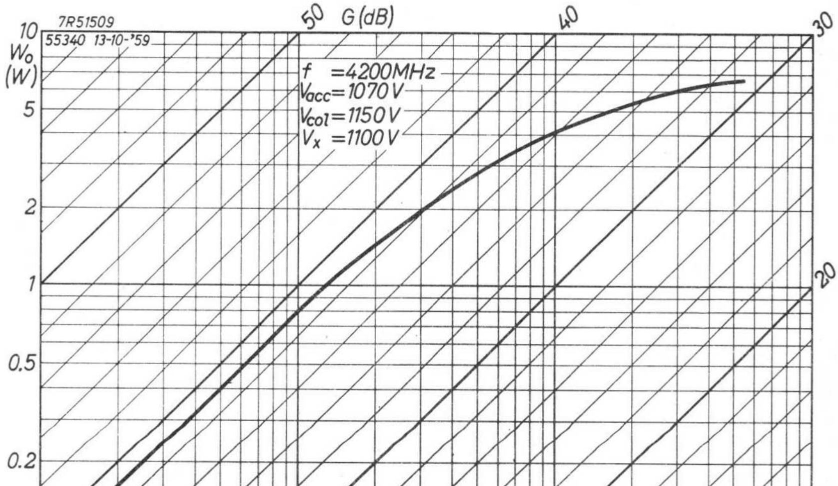





**MAINTENANCE TYPE**


7R51508
55340 13-10-'59
G (dB)
60
40
20
0
$V_{acc}$=1070V
$V_{col}$=1150V
$V_x$ =1100V
3800
3900
4000
4100
4200
f (MHz)
4300


7R51509
55340 13-10-'59
10
$W_o$ (W)
5
2
1
0.5
0.2
0.1
50
G (dB)
40
30
20
f =4200MHz
$V_{acc}$=1070V
$V_{col}$=1150V
$V_x$ =1100V
0.01
0.02
0.05
0.1
0.2
0.5
1
2
5
10
$W_i$ (mW)

# Diodes

# DIODES

ABRIDGED SURVEY

| | |
|---|---|
| U.H.F. measuring diode | type EA52 |
| U.H.F. measuring diode | type EA53 |
| Noise diode 3cm wave band | type K50A |
| Noise diode 10 cm wave band | type K51A |
| High voltage rectifier diode | type 8020 |

# MEASURING DIODE

| QUICK REFERENCE DATA | | | | |
|---|---|---|---|---|
| Frequency | f | | 1000 | MHz |
| Peak inverse voltage | $V_{d\,inv_p}$ | max. | 1000 | V |

**HEATING** : indirect by A.C. or D.C.; series or parallel supply

| | | | | |
|---|---|---|---|---|
| Heater voltage | $V_f$ | = | 6.3 | V |
| Heater current | $I_f$ | = | 300 | mA |

**CAPACITANCE** Between anode and cathode $C_d$ < 0.5 pF

**TYPICAL CHARACTERISTICS**

| | | | | |
|---|---|---|---|---|
| Heater voltage | $V_f$ | = | 6.3 | V |
| Diode current | $I_d$ | = | 0.5 | mA |
| Diode voltage | $V_d$ | < | 3 | V |

**LIMITING VALUES** (Absolute limits)

Peak inverse voltage

at frequencies lower than 100 MHz

$V_{d\,inv_p}$ (f < 100 MHz) = max. 1000 V

at frequencies higher than 100 MHz

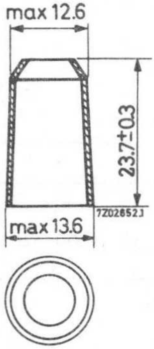
$V_{d\,inv_p}$ (f > 100 MHz) = max. $\frac{100}{f}$ x 1000 V [1]

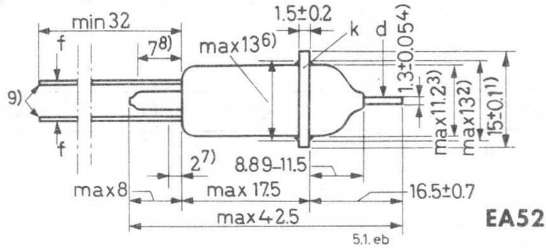
| | | | | | |
|---|---|---|---|---|---|
| Cathode current (heater voltage from 5.6 to 7.0 V) | $I_k$ | = | max. | 0.3 | mA |
| Peak cathode current (heater voltage from 5.6 to 7.0 V) | $I_{k_p}$ | = | max. | 5 | mA [2] |
| Voltage between heater and cathode | $V_{kf}$ | = | max. | 50 | V |
| External resistance between heater and cathode | $R_{kf}$ | = | max. | 20 | kΩ |
| Heater voltage | $V_f$ | = | max. | 7.0 | V |
| | | = | min. | 5.6 | V |

[1]) f in MHz

[2]) For frequencies lower than 100 Hz $I_{k_p}$ = max. 0.3 + 0.047f mA (f in Hz)

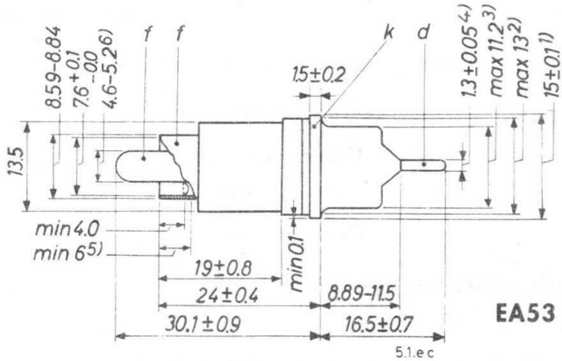
Dimensions in mm

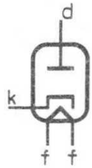



Protective cap for EA52

For protection during transport the EA52 is fitted with a plastic cap which should preferably be removed when the tube is mounted into position. If the cap is not removed, make sure that its temperature does never exceed 100 °C.




1) In order to avoid strain, the connection to the cathode disc should be sufficiently flexible.

2) Maximum diameter of the glass seal.

3) Eccentricity with respect to the cathode disc max. 0.35 mm.

4) Eccentricity with respect to the cathode disc max. 0.25 mm.

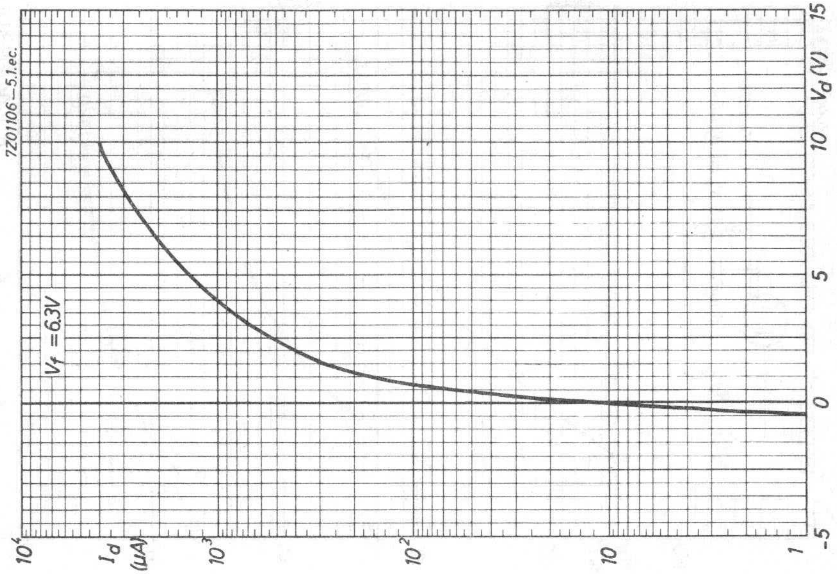
5) This dimension defines the length of the cylindrical section.

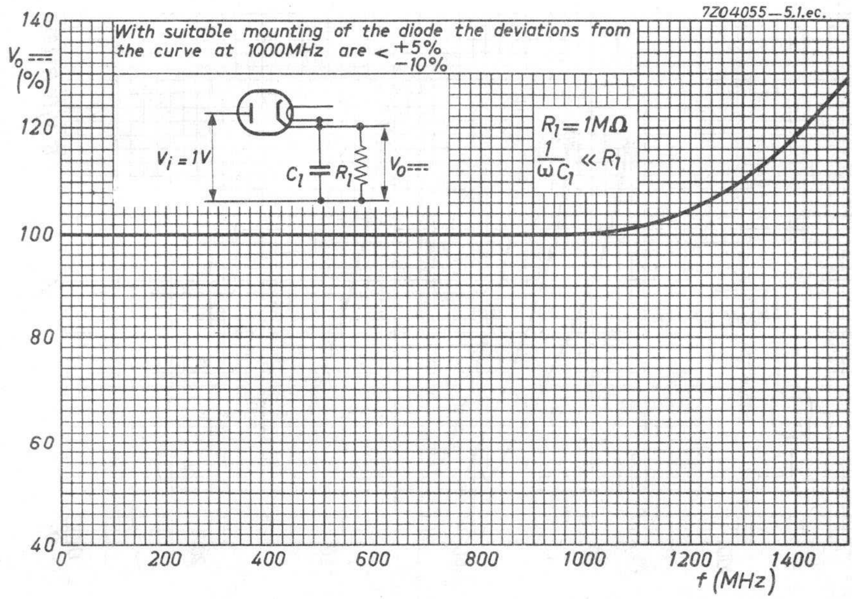
6) The max. dimension includes the eccentricity.

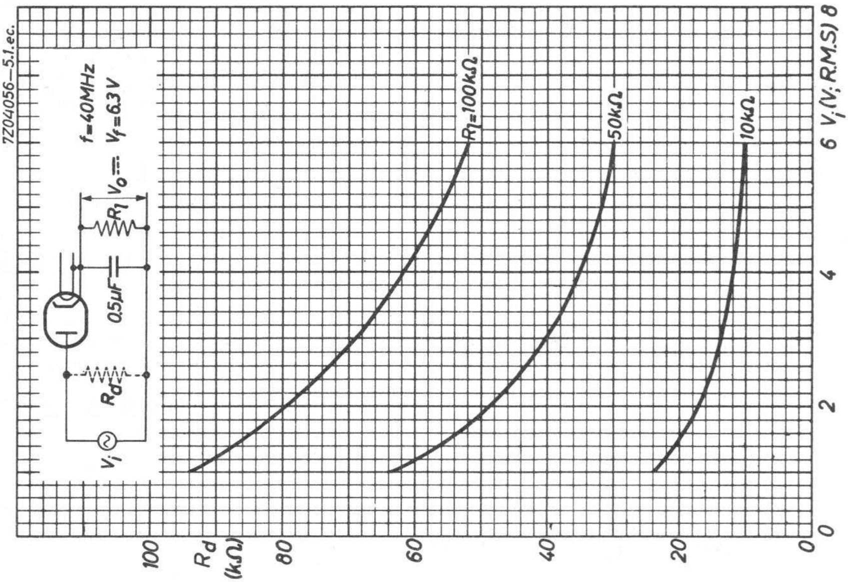
7) This part of the leads should not be bent.

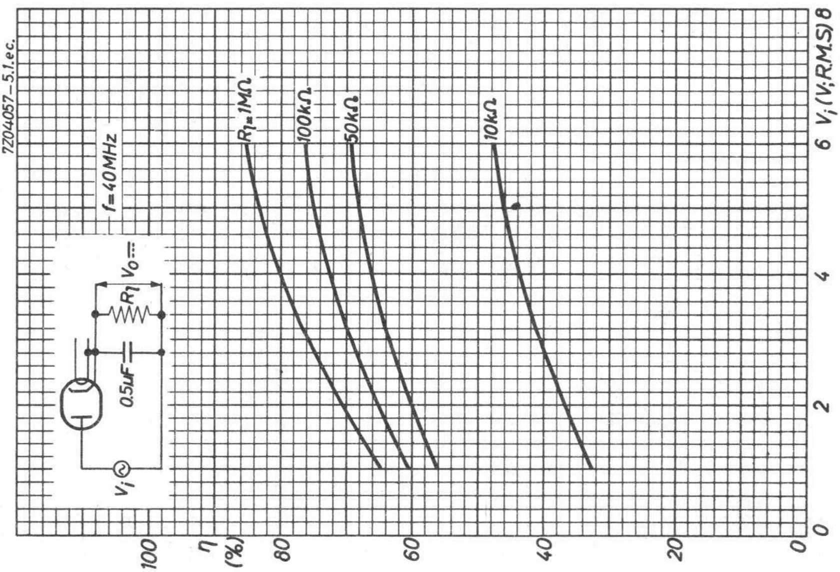
8) This part of the leads should not be soldered.

9) Gold plated leads, 0.4 mm diameter.


7Z01106—5.1.ec.
$V_f$ = 6.3V
$V_d$ (V)
15
10
5
0
−5
$10^4$
$I_d$ (µA)
$10^3$
$10^2$
10
1


7Z04055—5.1.ec.
With suitable mounting of the diode the deviations from the curve at 1000MHz are < +5% −10%
$V_o$ (%)
$V_i$ = 1V
$C_1$
$R_1$
$V_o$
$R_1$ = 1MΩ
$\frac{1}{\omega C_1} \ll R_1$
140
120
100
80
60
40
0
200
400
600
800
1000
1200
1400
f (MHz)


7Z04056—5.1.ec.
f=40MHz
$V_o$ ═ $V_f$=6.3V
0.5µF
$R_l$
$R_d$
$V_i$
$R_l$=100kΩ
50kΩ
10kΩ
$R_d$ (kΩ)
100
80
60
40
20
0
0
2
4
6 $V_i$ ($V_i$ R.M.S) 8


7Z04057—5.1.ec.
f=40MHz
$V_o$ ═
0.5µF
$R_l$
$V_i$
$R_l$=1MΩ
100kΩ
50kΩ
10kΩ
η (%)
100
80
60
40
20
0
0
2
4
6 $V_i$ ($V_i$ R.M.S) 8

# NOISE DIODE

Rare gas filled noise diode for use in waveguide systems in the 3 cm wave band

| QUICK REFERENCE DATA | | | | |
|---|---|---|---|---|
| Noise level above 290 °K | F | = | 18.75 | dB |
| Ignition voltage | $V_{ign}$ | > | 6000 | V |
| Anode current | $I_a$ | = max. | 150 | mA |

**HEATING:** direct, parallel supply

| | | | | |
|---|---|---|---|---|
| Filament voltage | $V_f$ | = | 2 | V ± 10% |
| Filament current | $I_f$ | = | 2 | A |
| Heating time | $T_w$ | = min. | 15 | sec |

**TYPICAL CHARACTERISTICS**

| | | | | |
|---|---|---|---|---|
| Anode voltage | $V_a$ | = | 165 | V |
| Anode current | $I_a$ | = | 125 | mA |
| Noise temperature | $t_F$ | = | 21700 | °K ± 5% |
| Noise level above 290 °K [1] | F | = | 18.75 | ±0.2 dB |
| Ignition voltage [2] | $V_{ign}$ | > | 6000 | V |

**LIMITING VALUES** (Absolute limits)

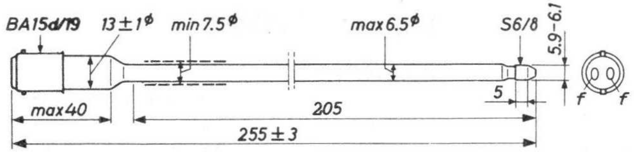
| | | | | |
|---|---|---|---|---|
| Anode current | $I_a$ | = max. | 150 | mA |
| | | = min. | 50 | mA |
| Ambient temperature | $t_{amb}$ | = | -55 to +75 | °C |

**REMARKS**

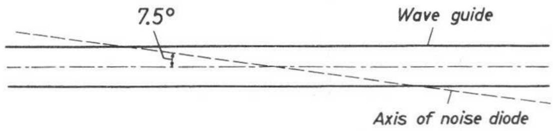
It is recommended that the noise diode and the microwave part of the mount are not touching (min. diameter of pipe 7.5 mm).
The V.S.W.R. in the test mount with the noise diode in operation should not be more than 1.1

[1] Change in noise level over 200 hours of operation is negligible.
[2] For recommended ignition circuit see page 2.

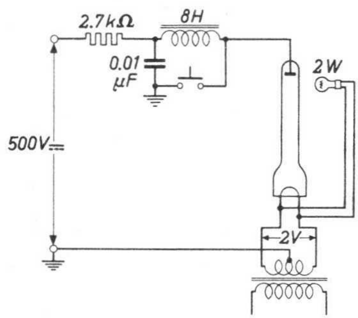
**MECHANICAL DATA** Dimensions in mm




**MOUNTING POSITION:** Cathode at receiver side

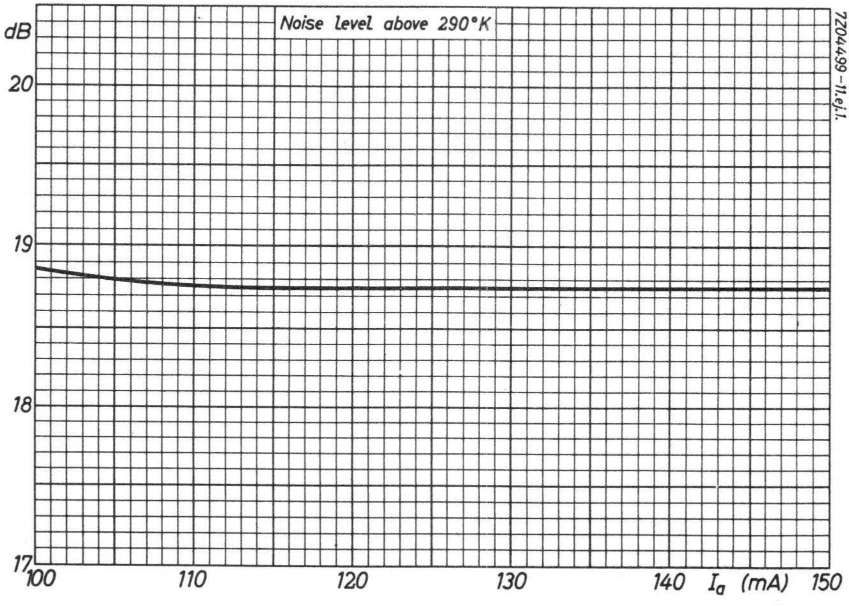



RECOMMENDED IGNITION CIRCUIT




The minimum value if $V_{ign}$ is only valid if some ambient illumination is present. Hence in darkness the presence of a small light-source (about 2W) is necessary.

The inductance of 8H should be of proper construction in order to be able to produce the minimum value of $V_{ign}$.



dB
20
19
18
17
100
110
120
130
140
150
$I_a$ (mA)
Noise level above 290°K
7Z04499-11.ej.1.

# NOISE DIODE

Rare gas filled noise diode for use in waveguide systems in the 10 cm wave band

| QUICK REFERENCE DATA | | | | |
|---|---|---|---|---|
| Noise level above 290 °K | F | = | 17.58 | dB |
| Ignition voltage | $V_{ign}$ | > | 6000 | V |
| Anode current | $I_a$ | = max. | 300 | mA |

**HEATING**: direct, parallel supply

| | | | | |
|---|---|---|---|---|
| Filament voltage | $V_f$ | = | 2 | V ± 10% |
| Filament current | $I_f$ | = | 3.5 | A |
| Heating time | $T_w$ | = min. | 15 | sec |

**TYPICAL CHARACTERISTICS**

| | | | | |
|---|---|---|---|---|
| Anode voltage | $V_a$ | = | 140 | V |
| Anode current | $I_a$ | = | 200 | mA |
| Noise temperature | $t_F$ | = | 16600 | °K ± 5% |
| Noise level above 290 °K [1] | F | = | 17.58 | ±0.2 dB |
| Ignition voltage [2] | $V_{ign}$ | > | 6000 | V |

**LIMITING VALUES** (Absolute limits)

| | | | | |
|---|---|---|---|---|
| Anode current | $I_a$ | = max. | 300 | mA |
| | | = min. | 100 | mA |
| Ambient temperature | $t_{amb}$ | = | −55 to +75 | °C |

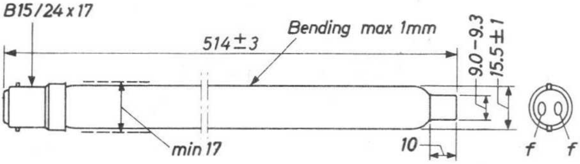
**REMARKS**

It is recommended that the noise diode and the microwave part of the mount are not touching (min. diameter of pipe 17 mm).
The V.S.W.R. in the test mount with the noise diode in operation should not be more than 1.1

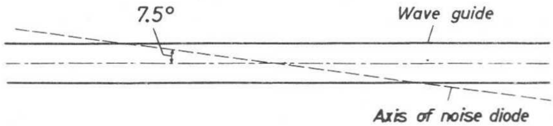
[1]) Change in noise level over 200 hours of operation is negligible.
[2]) For recommended ignition circuit see page 2.

**MECHANICAL DATA**

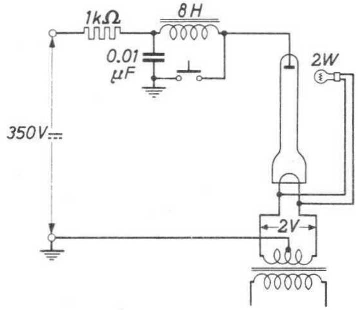
Dimensions in mm
Small top cap




**MOUNTING POSITION:** Cathode at receiver side

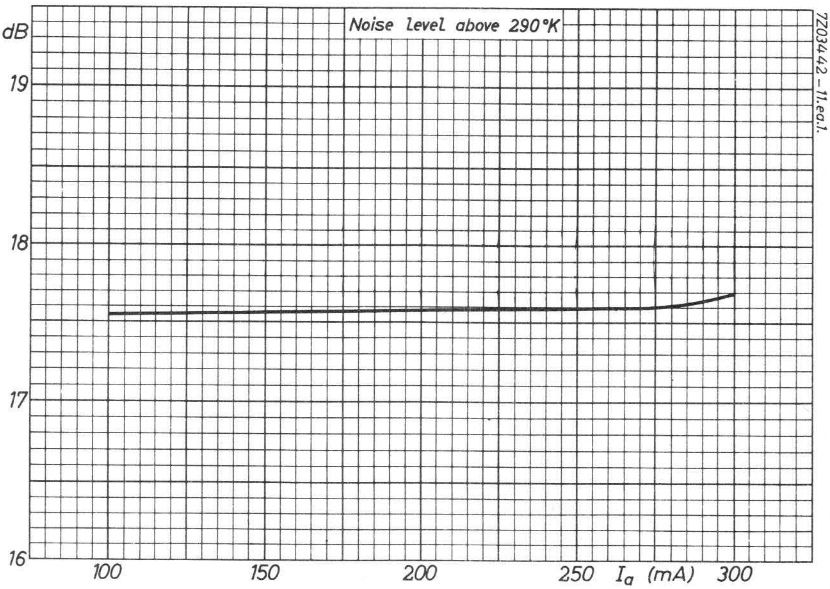



RECOMMENDED IGNITION CIRCUIT




The minimum value of $V_{ign}$ is only valid if some ambient illumination is present. Hence in darkness the presence of a small light-source (about 2 W) is necessary.

The inductance of 8H should be of proper construction in order to be able to produce the minimum value of $V_{ign}$.



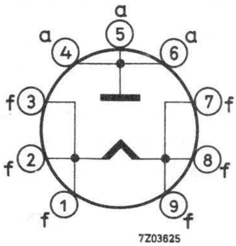
Noise level above 290°K
dB
19
18
17
16
100
150
200
250
$I_a$ (mA)
300
7Z03442-11.ea.1.

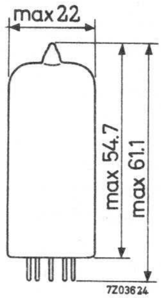
# NOISE DIODE

Noise diode for use as a standard noise source for metric waves.

**DIMENSIONS AND CONNECTIONS** Dimensions in mm

Base: Noval




**HEATING**

Direct by A.C. or D.C.

**CAPACITANCE**

| | | | |
|---|---|---|---|
| Anode to filament | $C_{af}$ | 2.2 | pF |

**TYPICAL CHARACTERISTICS**

| | | | |
|---|---|---|---|
| Filament voltage | $V_f$ | 1.85 | V |
| Filament current | $I_f$ | 2.5 | A |
| Anode voltage | $V_a$ | 100 | V |
| Anode current | $I_a$ | 15 | mA |

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

| | | | | |
|---|---|---|---|---|
| Filament voltage | $V_f$ | max. | 2 | V |
| Anode voltage | $V_a$ | max. | 150 | V |
| Anode current | $I_a$ | max. | 20 | mA |
| Anode dissipation | $W_a$ | max. | 3 | W |

## REMARKS

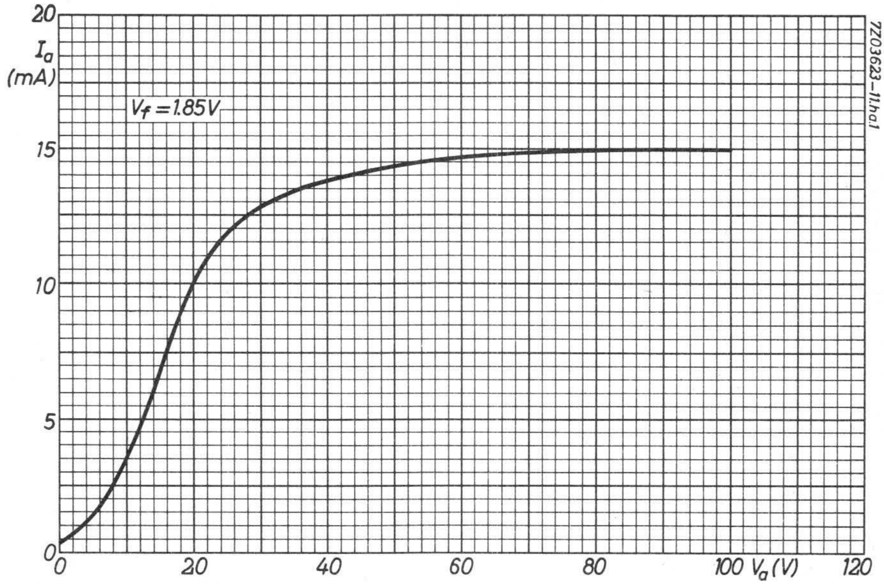
The tube having a tungsten cathode, the emission and consequently the noise voltage at the anode resistor can be varied by adjusting the filament voltage. Care should be taken that the anode voltage is sufficiently high to maintain saturation at the entire control range of the filament voltage.

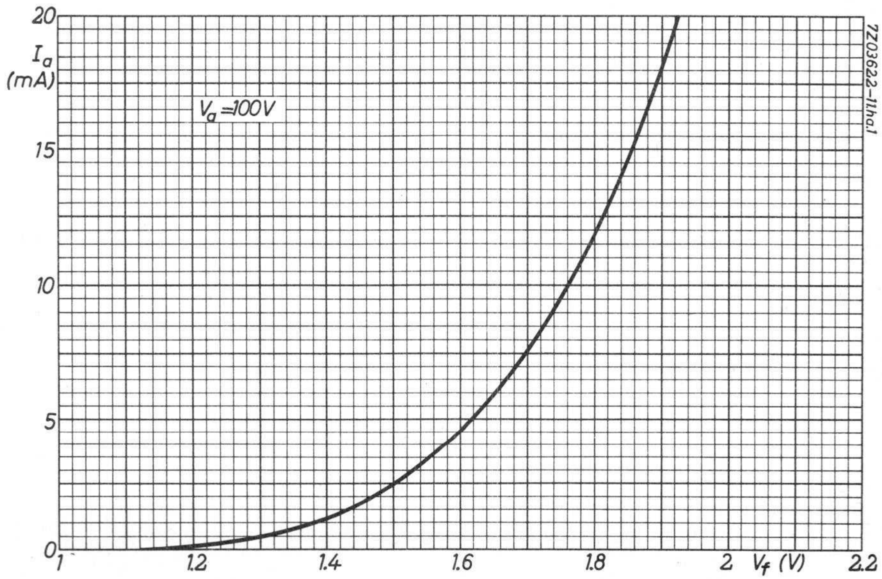
In order to realize small self-inductance of the electrode leads, both the extremities of the filament and the anode are each connected to three pins of the base (see fig. p.1).

The thermal inertia consequent upon the thickness of the filament is sufficient to prevent fluctuations in the saturation current when an A.C. supply is used. In this case the filament voltage should be very well stabilised.

As a result of the diode's high internal resistance the anode voltage need not be stabilised.

When a load resistor of 50 Ω is employed, a noise factor of 20 (13 dB) can be measured without exceeding the maximum permissible anode current and anode dissipation. When the load resistor is enlarged, it is possible to measure higher noise factors.


20
$I_a$
(mA)
$V_f$ = 1.85V
15
10
5
0
0
20
40
60
80
100 $V_a$ (V)
120
7Z03623-11.ha.1


20
$I_a$
(mA)
$V_a$ = 100V
15
10
5
0
1
1.2
1.4
1.6
1.8
2 $V_f$ (V)
2.2
7Z03622-11.ha.1

# HIGH-VACUUM HIGH-VOLTAGE DIODE

Half-wave vacuum rectifier diode for high voltage rectifying and surge limiting purposes.

| QUICK REFERENCE DATA | | | | |
|---|---|---|---|---|
| Tube voltage drop at $I_a$ = 100 mA | $V_a$ | = | 200 | V |
| Peak current at $V_{a_p}$ = 10 kV | $I_{a_p}$ | > | 2 | A |
| Maximum permissible peak inverse voltage | $V_{a_{invp}}$ | = max. | 40 | kV |
| Maximum permissible rectified current | $I_a$ | = max. | 100 | mA |

## APPLICATION

In radar equipment for protection of the modulator circuit and the magnetron against excessive voltages, as high voltage rectifier, charging diode, etc. and in dust precipitation equipment.

**HEATING:** direct; filament thoriated tungsten

| | | | |
|---|---|---|---|
| Filament voltage | $V_f$ | = | 5.0 V ± 5 % |
| Filament current | $I_f$ | = | 6.0 A ±0.5 A |
| Waiting time | $T_w$ | = | min. 5 s |

In surge limiting service the filament voltage may be raised to max. 5.8 V.

## CAPACITANCES

| | | | | |
|---|---|---|---|---|
| Capacitance between anode and filament | $C_{af}$ | = | 1.4 | pF |

## TYPICAL CHARACTERISTICS

| | | | | |
|---|---|---|---|---|
| Tube voltage drop at $I_a$ = 100 mA | $V_a$ | = | 200 | V |

## OPERATING CHARACTERISTICS as surge limiter

| | | | | |
|---|---|---|---|---|
| Heater voltage | $V_f$ | = | 5.5 | V |
| Peak forward anode voltage | $V_{ap}$ | = | 10 | kV |
| Peak anode current | $I_{a_p}$ | > | 2 | A |

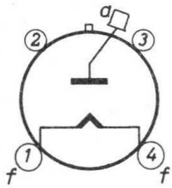
**MECHANICAL DATA**

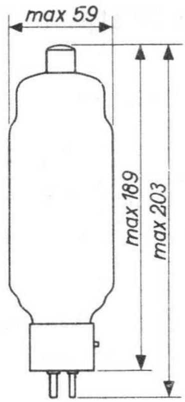
Dimensions in mm

Net weight: 90 g

Base: Medium 4p. with bayonet

Cap : Medium




Mounting position: vertical with base down

**ACCESSORIES**

Anode clip 40619

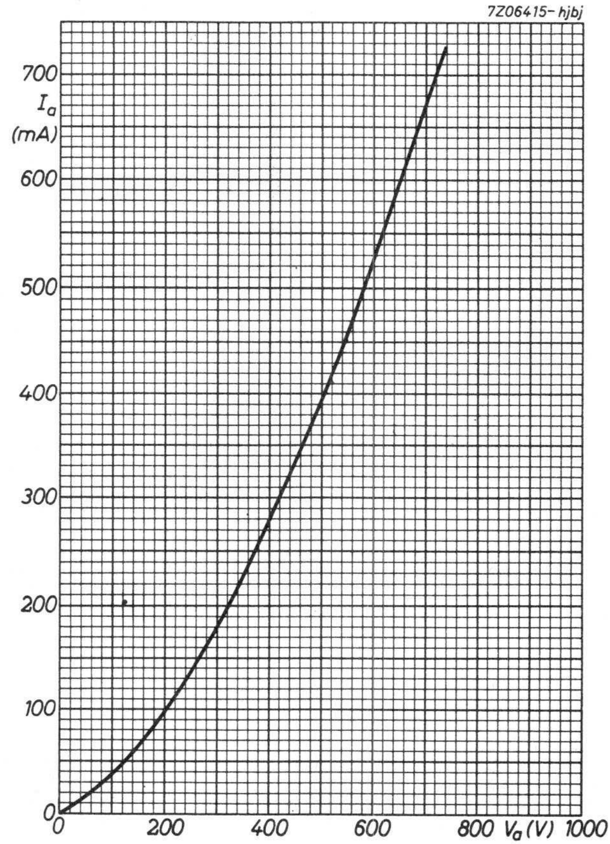
At voltages above 2 kV the socket must be insulated from the chassis.

**LIMITING VALUES** as surge limiter (Absolute limits)

| | | | | | |
|---|---|---|---|---|---|
| Filament voltage | $V_f$ | = | max. | 5.8 | V |
| Peak forward anode voltage | $V_{a_p}$ | = | max. | 12.5 | kV |
| Peak inverse anode voltage | $V_{a_{inv_p}}$ | = | max. | 40 | kV |
| Anode dissipation | $W_a$ | = | max. | 75 | W |

**LIMITING VALUES** as rectifier (Absolute limits)

| | | | | | |
|---|---|---|---|---|---|
| Peak inverse anode voltage | $V_{a_{inv_p}}$ | = | max. | 40 | kV |
| Peak anode current | $I_{a_p}$ | = | max. | 750 | mA |
| Average rectified current | $I_a$ | = | max. | 100 | mA |


7Z06415-hjbj
700
$I_a$
(mA)
600
500
400
300
200
100
0
0
200
400
600
800 $V_a$ (V) 1000

# Triodes

# DISC-SEAL TRIODES

ABRIDGED SURVEY

| Frequency range (MHz) | Small signal gain (dB) | Output power (W) | Type |
|---|---|---|---|
| up to 2500 | – | 16 | YD1050 |
| up to 3000 | – | 0.5 | EC55 |
| up to 3000 | 8 | 8.5 | 2C39A |
| up to 3000 | – | 24 | 7289 |
| up to 3500 | 8 | 6.5 | 2C39BA |
| up to 4200 | 13 | 1.8 | EC157 |
| up to 4200 | 11.5 | 5.3 | EC158 |
| up to 4200 | 13 | 1.8 | 8108 |

# PENCIL TRIODES

ABRIDGED SURVEY

| Frequency range | Osc. output power (W) | Type |
|---|---|---|
| U.H.F. | 3 | 5876<br>5876A |
| U.H.F. | 5 | 5893 |
| U.H.F. | 5 | 6263<br>6263A |
| U.H.F. | 5 | 6264<br>6264A |

# DISC SEAL TRIODE

| QUICK REFERENCE DATA | | | | |
|---|---|---|---|---|
| Output power | at 1000 MHz | $W_o$ | 3 | W |
| | at 2500 MHz | $W_o$ | 1 | W |
| Mutual conductance | | S | 6 | mA/V |
| Amplification factor | | $\mu$ | 30 | |
| Construction | | metal-glass | | |

**HEATING:** indirect by A.C. or D.C.; parallel supply

| | | | | |
|---|---|---|---|---|
| Heater voltage | $V_f$ | = | 6.3 | V ±5 % |
| Heater current | $I_f$ | = | 0.4 | A |

**CAPACITANCES**

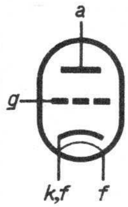
| | | | | |
|---|---|---|---|---|
| Anode to all other elements except grid | $C_a$ | = | 0.03 | pF |
| Grid to all other elements except anode | $C_g$ | = | 1.8 | pF |
| Anode to grid | $C_{ag}$ | < | 1.3 | pF |

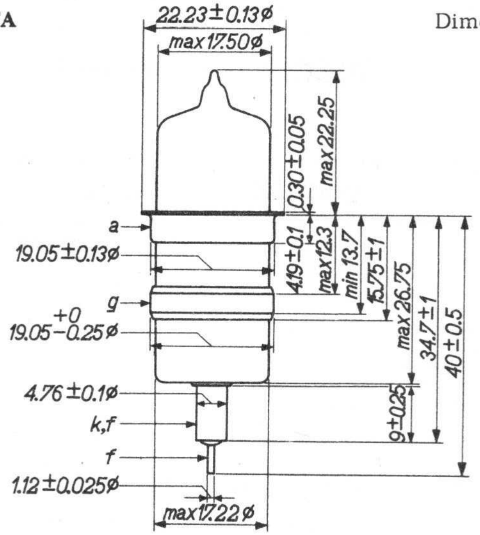
**TYPICAL CHARACTERISTICS**

| | | | | |
|---|---|---|---|---|
| Anode voltage | $V_a$ | = | 250 | V |
| Grid voltage | $V_g$ | = | -3.5 | V |
| Anode current | $I_a$ | = | 20 | mA |
| Mutual conductance | S | = | 6 | mA/V |
| Amplification factor | $\mu$ | = | 30 | |

MECHANICAL DATA

Dimensions in mm

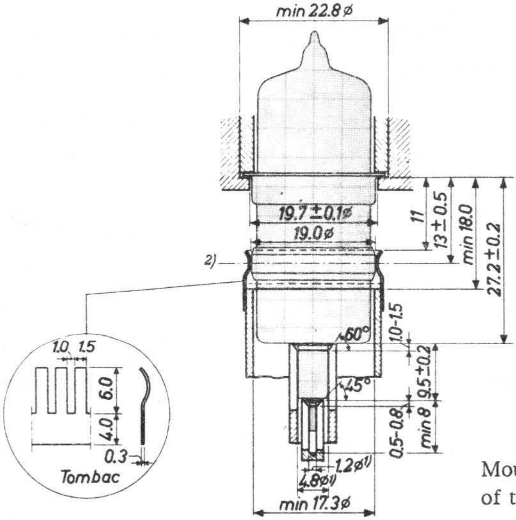



Eccentricity

Distance between the axes of the electrodes

| | | | |
|---|---|---|---|
| | g and a | max. 0.38 | mm |
| | k and a | max. 0.38 | mm |
| | f and k | max. 0.12 | mm |



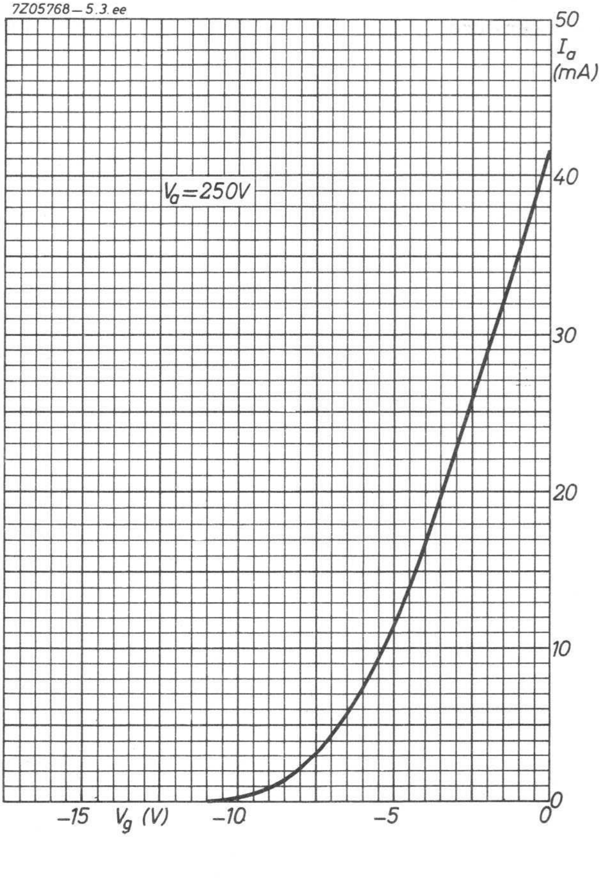

Mounting of the tube

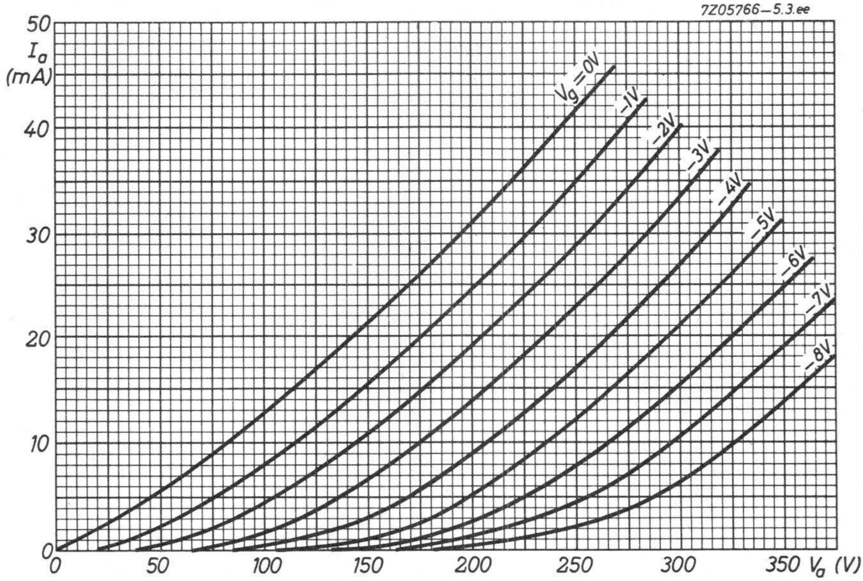
---

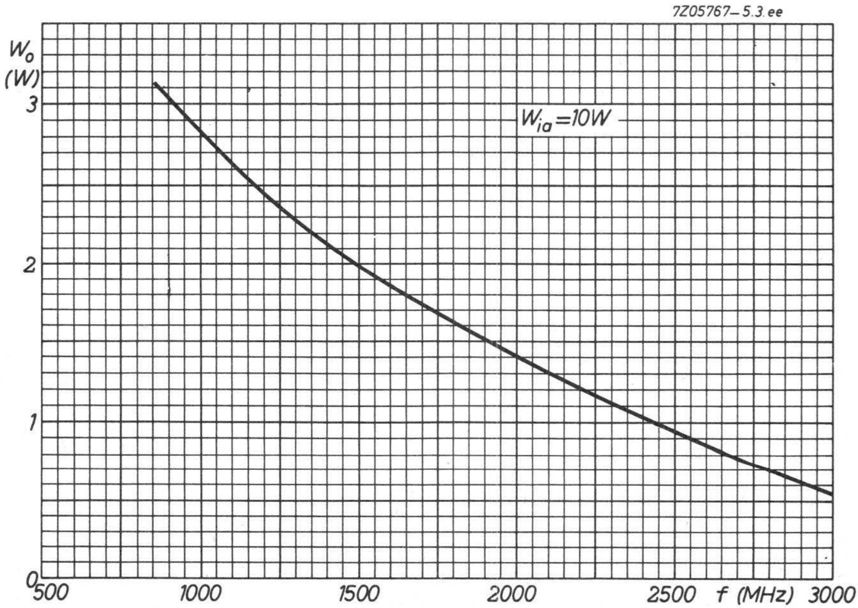
[1]) In order to make good contact these sockets should be slotted.
[2]) Line of contact.

**LIMITING VALUES** (Absolute limits)

| | | | | |
|---|---|---|---|---|
| Anode voltage | $V_a$ | = | max. 350 | V |
| Anode dissipation | $W_a$ | = | max. 10 | W |
| Grid dissipation | $W_g$ | = | max. 0.1 | W |
| Cathode current | $I_k$ | = | max. 40 | mA |
| Negative grid voltage | $-V_g$ | = | max. 50 | V |
| Anode seal temperature | | = | max. 140 | $^{o}C$ |


7Z05768—5.3.ee
50
$I_a$
(mA)
40
$V_a$=250V
30
20
10
0
−15
$V_g$ (V)
−10
−5
0


7Z05766—5.3.ee
50
$I_a$
(mA)
40
30
20
10
0
0
50
100
150
200
250
300
350 $V_a$ (V)
$V_g$=0V
–1V
–2V
–3V
–4V
–5V
–6V
–7V
–8V


7Z05767—5.3.ee
$W_o$
(W)
3
2
1
0
500
1000
1500
2000
2500
f (MHz)
3000
$W_{ia}$=10W

# DISC SEAL TRIODE

Disc seal triode for use as power amplifier, oscillator or frequency multiplier in microwave applications up to 4.2 GHz.

| QUICK REFERENCE DATA | | | | |
|---|---|---|---|---|
| Output power at f = 4 GHz, B = 50 MHz, G = 8 dB | $W_o$ | = | 1.8 | W |
| Low level gain at f = 4 GHz, B = 50 MHz | G | = | 13 | dB |
| Mutual conductance | S | = | 21 | mA/V |
| Amplification factor | $\mu$ | = | 43 | |
| Construction | | | metal-glass | |

**HEATING:** Indirect by A.C. or D.C.; parallel supply. Dispenser type cathode.

| | | | | |
|---|---|---|---|---|
| Heater voltage | $V_f$ | = | 6.3 | V ±2% |
| Heater current | $I_f$ | = | 750 | mA |

With due observance of the limiting values all supply voltages may be switched on at the same time and no preheating will be necessary.

**CAPACITANCES** ($V_f$ = 6.3 V; $I_k$ = 0)

| | | | | |
|---|---|---|---|---|
| Anode to grid | $C_{ag}$ | = | 1.4 | pF [1] |
| Anode to cathode | $C_{ak}$ | = | 0.035 | pF |
| Grid to cathode | $C_{gk}$ | = | 3.0 | pF [2] |

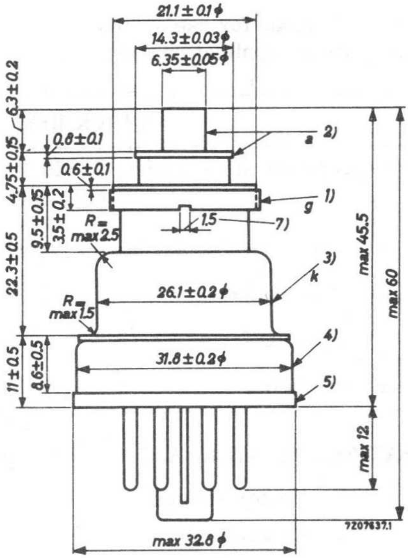
1) Measured with a shield of 1 mm thickness and with a hole of 15 mm diameter

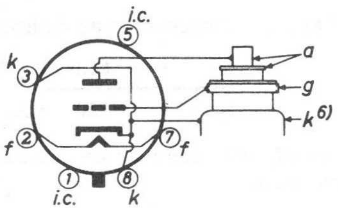
2) Measured with a shield of 1 mm thickness and with a hole of 23 mm diameter

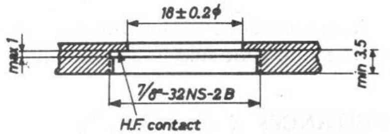
## MECHANICAL DATA

Dimensions in mm

Fig. 1




Base : octal

Mounting position : any

Fig.2
Recommended mount

Data of the thread of the grid disc and of the recommended mount, 32 turns per inch, thread angle 60°

| | Minor diameter | Major diameter | Effective diameter |
|---|---|---|---|
| Grid disc | 21.22 +0 −0.15 mm | 22.2 +0 −0.15 mm | 21.68 +0 −0.09 mm |
| mount. fig.2 | 21.51 +0 −0.15 mm | min. 22.23 mm | 21.83 +0 −0.12 mm |

1) 2) 3) 4) 5) 6) 7) See page 3.

For screwing the tube into the cavity a key with a slip torque of max. 25 cm kg ought to be used. This should be a key with studs which fit into the notches in the tube base. One should never use a device which utilises the pins of the tube.

## SHOCK AND VIBRATION

The tube can withstand:

Vibrations: 2.5 g peak, 25 Hz in all directions.

Shocks : 25 g peak, 10 msec in all directions.

The above environmental conditions are test conditions, which however should not be interpreted as continuous operating conditions.

## TYPICAL CHARACTERISTICS

| | | | | | | |
|---|---|---|---|---|---|---|
| Anode voltage | $V_a$ | = | 180 | | 180 | V |
| Anode current | $I_a$ | = | 60 | | 30 | mA |
| Negative grid voltage | $-V_g$ | = | 1.25 | > 0<br><2.5 | 2.8 | V |
| Mutual conductance | S | = | 21 | > 15 | 18 | mA/V |
| Amplification factor | $\mu$ | = | 43 | > 33<br>< 52 | 43 | |

---

1) The eccentricities are given with respect to the axis of the threaded hole of the recommended mount (see fig. 2) in which the tube is screwed firmly against the flange.

2) Eccentricity of the axis of the anode max. 0.15 mm.

3) Eccentricity of the axis of the cathode max. 0.20 mm.

4) The tolerance of the eccentricity of the axis of the base is such, that this base fits into a hole with a diameter of 32.5 mm., provided this hole is correctly centred with respect to the axis of the threaded hole of the recommended mount of fig.2.

5) The tolerance of the eccentricity of the axis of the base flange is such, that this flange fits into a hole with a diameter of 33.5 mm., provided this hole is correctly centred with respect to the axis of the threaded hole of the recommended mount of fig.2.

6) H.F. and D.C. connections of the cathode. Pins 3 and 8 are connected internally to this terminal.

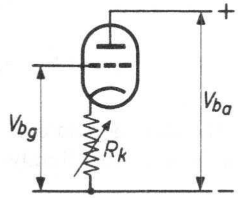
7) Two identical slots opposite each other facilitate the removal of the grid/anode part of the tube from the cavity in case of glass breakage.

**OPERATING CHARACTERISTICS** as power amplifier

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Frequency | f | = | 4 | | 4 | | GHz |
| Anode supply voltage | $V_{ba}$ | = | 200 | | 200 | | V |
| Anode current | $I_a$ | = | 60 | | 30 | | mA |
| Grid supply voltage | $V_{bg}$ | = | +20 | | +20 | | V |
| Cathode resistor | $R_k$ | = | [1] | | [1] | | |
| Bandwidth | B | = | 50 [2] | | 50 [2] | | MHz |
| Output power { G = 8 dB, $V_f$ = 6.3 V | $W_o$ | = | 1.8 | >1.5 | – | | W |
| Output power { G = 6 dB, $V_f$ = 6.3 V | $W_o$ | = | – | | 0.5 | >0.35 | W |
| Low level gain { $W_{dr}$ = 1 mW, $V_f$ = 6.3 V | G | = | 13 | >10 | 13 | >10 | dB |

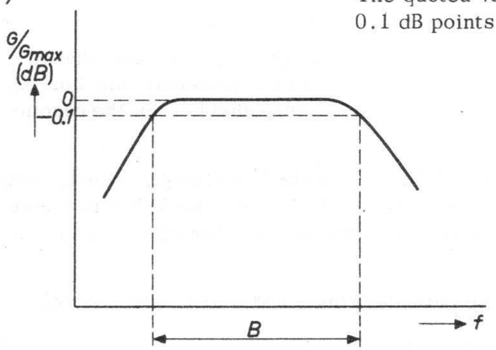
---

[1]) Recommended D.C. circuit




A variable resistor of max. 500 Ω ($I_a$ = 60 mA) or max. 1000 Ω ($I_a$ = 30 mA) is to be employed. It should be adjusted for the desired anode current.

[2])




The quoted value is the bandwidth between the 0.1 dB points of the flattened response curve.

**LIMITING VALUES** (Absolute limits)

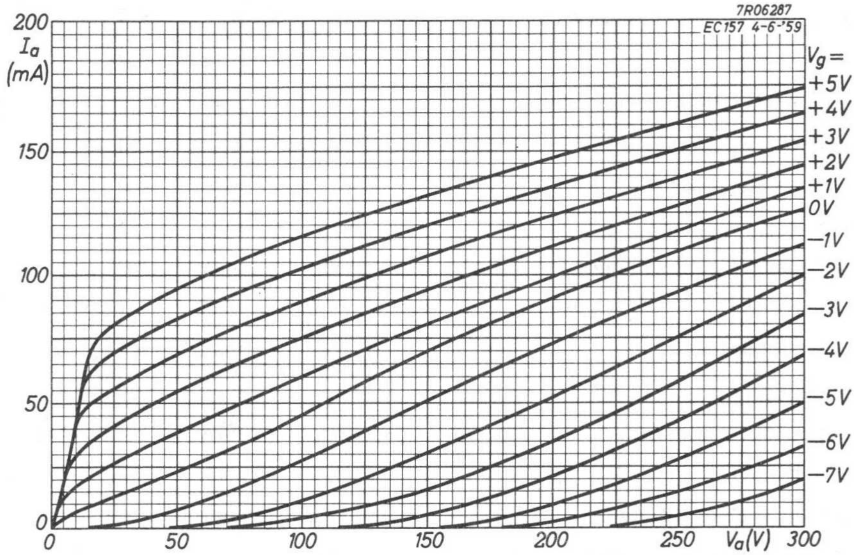
| | | | | | | |
|---|---|---|---|---|---|---|
| Anode voltage in cold condition | | $V_{a_o}$ | = | max. | 500 | V |
| Anode voltage | | $V_a$ | = | max. | 300 | V |
| Anode dissipation | | $W_a$ | = | max. | 12.5 | W |
| Negative grid voltage | | $-V_g$ | = | max. | 50 | V |
| Peak negative grid voltage | | $-V_{gp}$ | = | max. | 100 | V |
| Positive grid voltage | | $+V_g$ | = | max. | 5 | V |
| Peak positive grid voltage | | $+V_{gp}$ | = | max. | 20 | V |
| Driving power | | $W_{dr}$ | = | max. | 1 | W [1] |
| Grid dissipation | | $W_g$ | = | max. | 200 | mW |
| Grid current | | $I_g$ | = | max. | 10 | mA |
| Grid circuit resistance | | $R_g$ | = | max. | 3 | kΩ [2] |
| Cathode current | | $I_k$ | = | max. | 70 | mA |
| Cathode to heater voltage | | $V_{kf}$ | = | max. | 50 | V |
| Cathode to heater circuit resistance | | $R_{kf}$ | = | max. | 20 | kΩ |
| Heater voltage | | $V_f$ | = | | 6.3 | V ± 2 % |
| Seal temperatures: | anode | $t_a$ | = | max. | 150 | °C [3] [4] |
| | grid | $t_g$ | = | max. | 100 | °C [3] [4] |
| | cathode | $t_k$ | = | max. | 100 | °C [3] [4] |
| Mounting torque | | | = | min. | 20 | cm kg |
| | | | = | max. | 25 | cm kg |

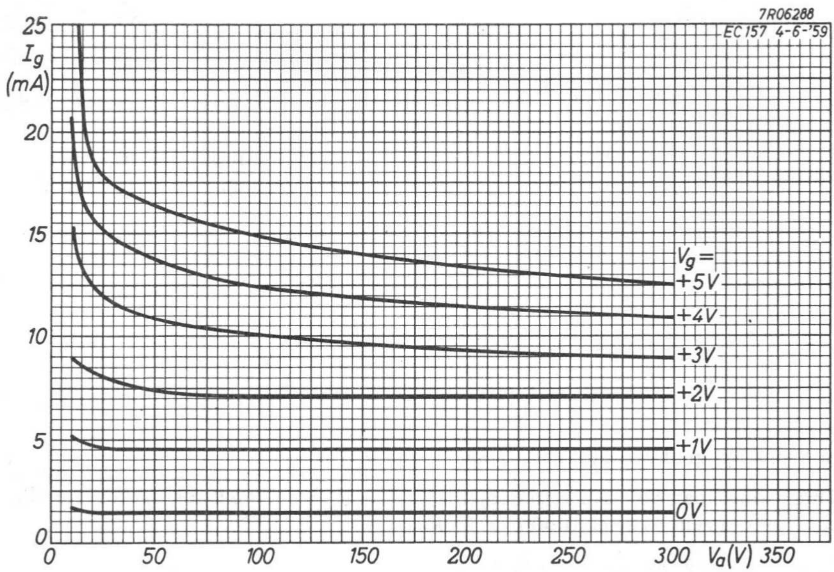
[1] In grounded grid circuits at a frequency of 4 GHz.

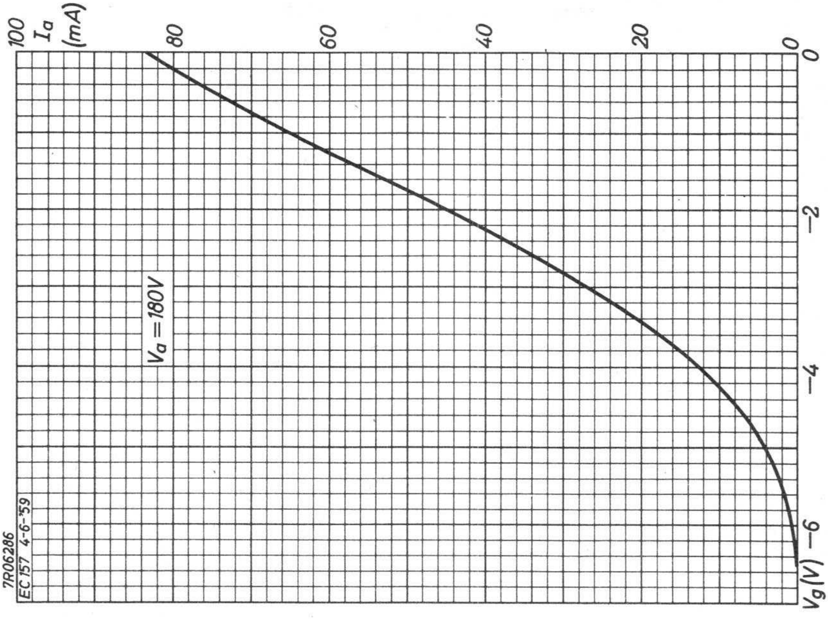
[2] This value may be multiplied by the D.C. inverse feedback factor for the cathode current to a maximum of 25 kΩ.

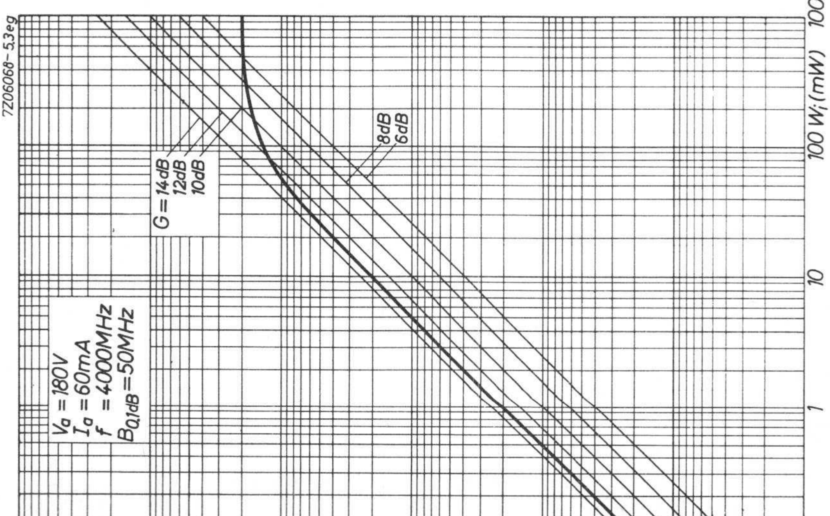
[3] A low-velocity air flow may be required.

[4] To be measured with a temperature sensitive paint e.g. Tempilaq.


7R06287
EC157 4-6-'59
200
$I_a$
(mA)
150
100
50
0
0
50
100
150
200
250
$V_a$(V)
300
$V_g$ =
+5V
+4V
+3V
+2V
+1V
0V
−1V
−2V
−3V
−4V
−5V
−6V
−7V


7R06288
EC157 4-6-'59
25
$I_g$
(mA)
20
15
10
5
0
0
50
100
150
200
250
300
$V_a$(V)
350
$V_g$ =
+5V
+4V
+3V
+2V
+1V
0V


7R06286
EC 157 4-6-'59
$V_a = 180V$
$I_a$ (mA)
100
80
60
40
20
0
$V_g$ (V)
−6
−4
−2
0


7Z06068-5.3eg
$V_a = 180V$
$I_a = 60mA$
$f = 4000MHz$
$B_{0.1dB} = 50MHz$
G = 14dB
12dB
10dB
8dB
6dB
$W_o$ (mW)
$10^5$
$10^4$
$10^3$
$10^2$
10
1
$10^{-1}$
$W_i$ (mW)
0.1
1
10
100
1000

# DISC SEAL TRIODE

Disc seal triode for use as power amplifier, oscillator or frequency multiplier in microwave applications up to 4.2 GHz

| QUICK REFERENCE DATA | | | | |
|---|---|---|---|---|
| Output power at f = 4.2 GHz, B = 50 MHz G = 6 dB | $W_o$ | = | 5.3 | W |
| Low level gain at f = 4.2 GHz, B = 50 MHz | G | = | 11.5 | dB |
| Mutual conductance | S | = | 28 | mA/V |
| Amplification factor | $\mu$ | = | 30 | |
| Construction | | | metal-glass | |

**HEATING**: Indirect by A.C. or D.C.; parallel supply. Dispenser type cathode.

| | | | | |
|---|---|---|---|---|
| Heater voltage | $V_f$ | = | 6.3 | V ±2% |
| Heater current | $I_f$ | = | 900 | mA |

With due observance of the limiting values all supply voltages may be switched on at the same time and no preheating will be necessary.

**CAPACITANCES** ($V_f$ = 6.3 V; $I_k$ = 0)

| | | | | |
|---|---|---|---|---|
| Anode to grid | $C_{ag}$ | = | 1.7 | pF [1]) |
| Anode to cathode | $C_{ak}$ | = | 0.036 | pF |
| Grid to cathode | $C_{gk}$ | = | 3.5 | pF [2]) |

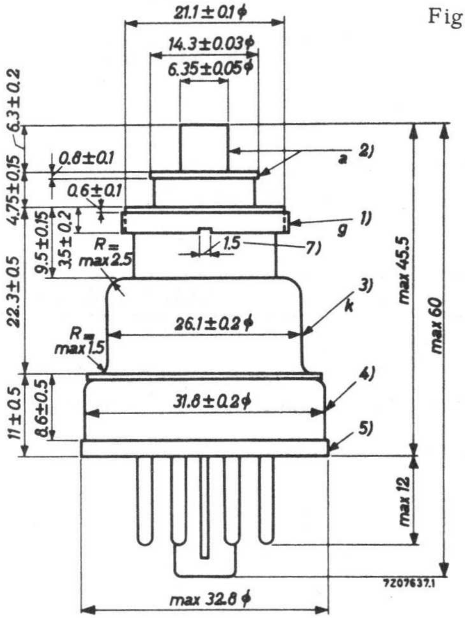
[1]) Measured with a shield of 1 mm thickness and with a hole of 15 mm diameter

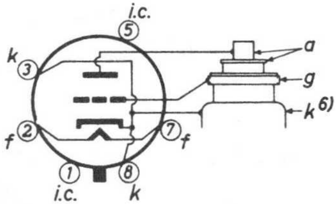
[2]) Measured with a shield of 1 mm thickness and with a hole of 23 mm diameter

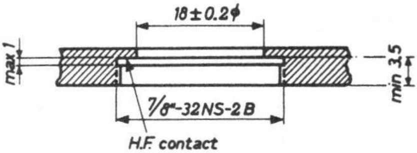
**MECHANICAL DATA**

Dimensions in mm

Fig. 1




Base : octal

Mounting position : any

Fig. 2
Recommended mount

Data of the thread of the grid disc and of the recommended mount, 32 turns per inch, thread angle 60°

| | Minor diameter | Major diameter | Effective diameter |
|---|---|---|---|
| Grid disc | 21.22 $^{+0}_{-0.15}$ mm | 22.2 $^{+0}_{-0.15}$ mm | 21.68 $^{+0}_{-0.09}$ mm |
| mount. fig.2 | 21.51 $^{+0}_{-0.15}$ mm | min. 22.23 mm | 21.83 $^{+0}_{-0.12}$ mm |

[1][2][3][4][5][6][7] See page 3.

For screwing the tube into the cavity a key with a slip torque of max. 25 cm kg ought to be used. This should be a key with studs which fit into the notches in the tube base. One should never use a device which utilises the pins of the tube.

## SHOCK AND VIBRATION

The tube can withstand:

Vibrations: 2.5 g peak, 25 Hz in all directions.

Shocks : 25 g peak, 10 msec in all directions.

The above environmental conditions are test conditions, which however should not be interpreted as continuous operating conditions.

## TYPICAL CHARACTERISTICS

| | | | | | | |
|---|---|---|---|---|---|---|
| Anode voltage | $V_a$ | = | 180 | | 180 | V |
| Anode current | $I_a$ | = | 140 | | 60 | mA |
| Grid voltage | $V_g$ | = | 0 | $> -2.0$ <br> $< +1.5$ | -3.5 | V |
| Mutual conductance | S | = | 28 | $>$ 18 | 22 | mA/V |
| Amplification factor | $\mu$ | = | 30 | $>$ 20 <br> $<$ 40 | 30 | |

[1]) The eccentricities are given with respect to the axis of the threaded hole of the recommended mount (see fig. 2) in which the tube is screwed firmly against the flange.

[2]) Eccentricity of the axis of the anode max. 0.15 mm.

[3]) Eccentricity of the axis of the cathode max. 0.20 mm.

[4]) The tolerance of the eccentricity of the axis of the base is such, that this base fits into a hole with a diameter of 32.5 mm., provided this hole is correctly centred with respect to the axis of the threaded hole of the recommended mount of fig.2.

[5]) The tolerance of the eccentricity of the axis of the base flange is such, that this flange fits into a hole with a diameter of 33.5 mm., provided this hole is correctly centred with respect to the axis of the threaded hole of the recommended mount of fig.2.

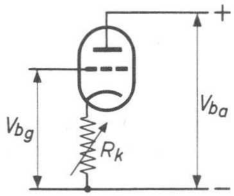
[6]) H.F. and D.C. connections of the cathode. Pins 3 and 8 are connected internally to this terminal.

[7]) Two identical slots opposite each other facilitate the removal of the grid/anode part of the tube from the cavity in the case of glass breakage.

**OPERATING CHARACTERISTICS** as power amplifier

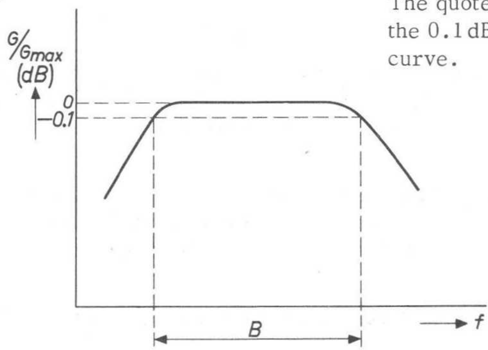
| | | | | | |
|---|---|---|---|---|---|
| Frequency | f | = | 4 | | GHz |
| Anode supply voltage | $V_{ba}$ | = | 200 | | V |
| Grid supply voltage | $V_{bg}$ | = | +20 | | V |
| Anode current | $I_a$ | = | 140 | | mA |
| Cathode resistor | $R_k$ | = | 1) | | |
| Bandwidth | B | = | 50 | 2) | MHz |
| Output power (G = 6 dB) | $W_o$ | = | 5.3 | >4.5 | W |
| Low level gain ($W_{dr}$ = 10 mW) | G | = | 11.5 | >9.5 | dB |

1) Recommended D.C. circuit




A variable resistor of max. 200 Ω is to be employed. It should be adjusted for the desired anode current.

2)




The quoted value is the bandwidth between the 0.1 dB points of the flattened response curve.

**LIMITING VALUES** (Absolute limits)

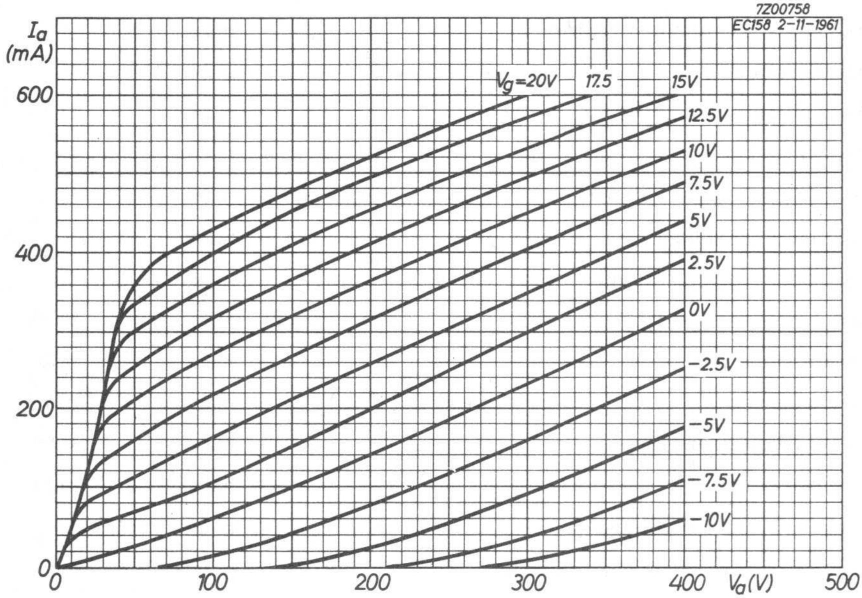
| | | | | | |
|---|---|---|---|---|---|
| Anode voltage in cold condition | | $V_{a_o}$ | = max. | 500 | V |
| Anode voltage | | $V_a$ | = max. | 300 | V |
| Anode dissipation | | $W_a$ | = max. | 30 | W [1] |
| Negative grid voltage | | $-V_g$ | = max. | 50 | V |
| Peak negative grid voltage | | $-V_{g_p}$ | = max. | 100 | V |
| Positive grid voltage | | $+V_g$ | = max. | 10 | V |
| Peak positive grid voltage | | $+V_{g_p}$ | = max. | 30 | V |
| Driving power | | $W_{dr}$ | = max. | 2.0 | W [2] |
| Grid dissipation | | $W_g$ | = max. | 350 | mW |
| Grid current | | $I_g$ | = max. | 25 | mA |
| Grid circuit resistance | | $R_g$ | = max. | 3 | kΩ [3] |
| Cathode current | | $I_k$ | = max. | 170 | mA |
| Cathode to heater voltage | | $V_{kf}$ | = max. | 50 | V |
| Cathode to heater circuit resistance | | $R_{kf}$ | = max. | 20 | kΩ |
| Heater voltage | | $V_f$ | = | 6.3 | V ± 2% |
| Seal temperatures: | anode | $t_a$ | = max. | 150 | °C [1] [4] |
| | grid | $t_g$ | = max. | 100 | °C [1] [4] |
| | cathode | $t_k$ | = max. | 100 | °C [1] [4] |
| Mounting torque | | | = min. | 20 | cm kg |
| | | | = max. | 25 | cm kg |

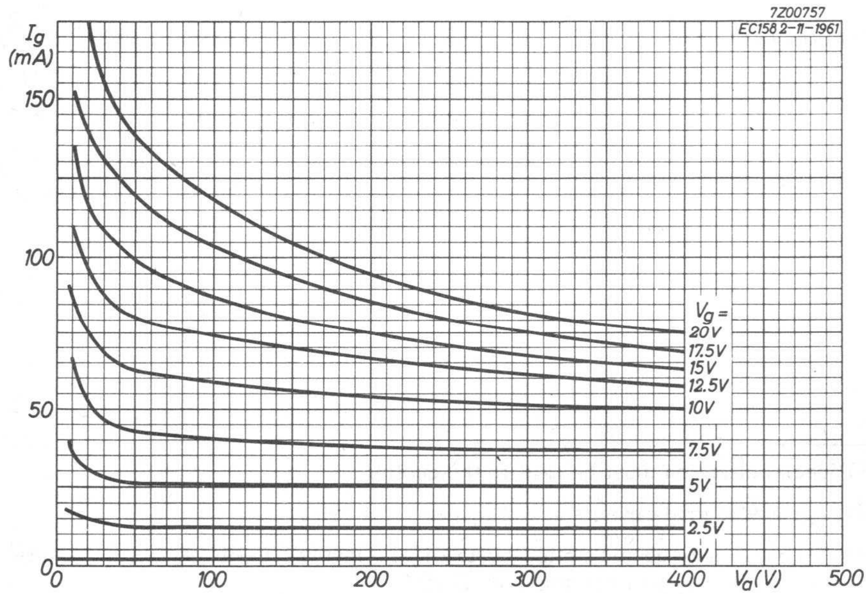
[1] Special attention must be paid to the cooling.

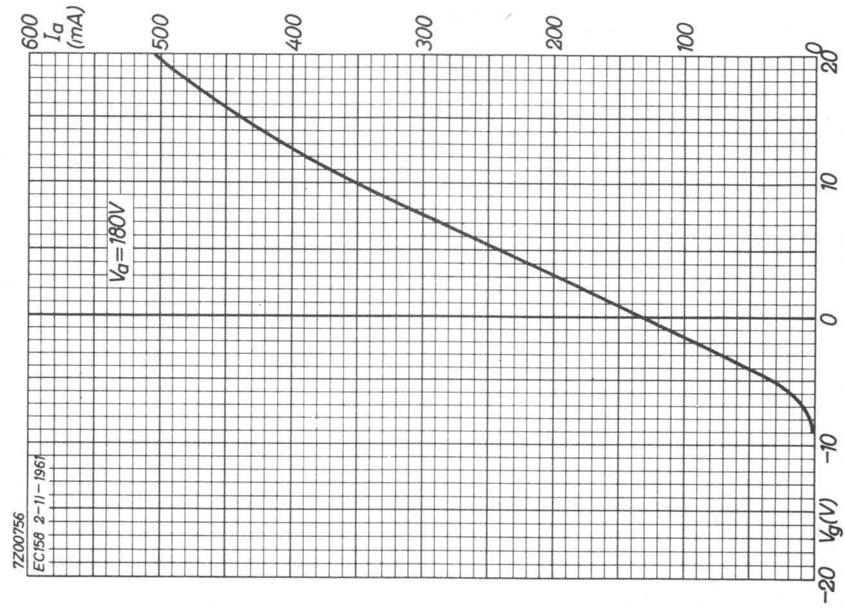
[2] In grounded grid circuits at a frequency of 4 GHz.

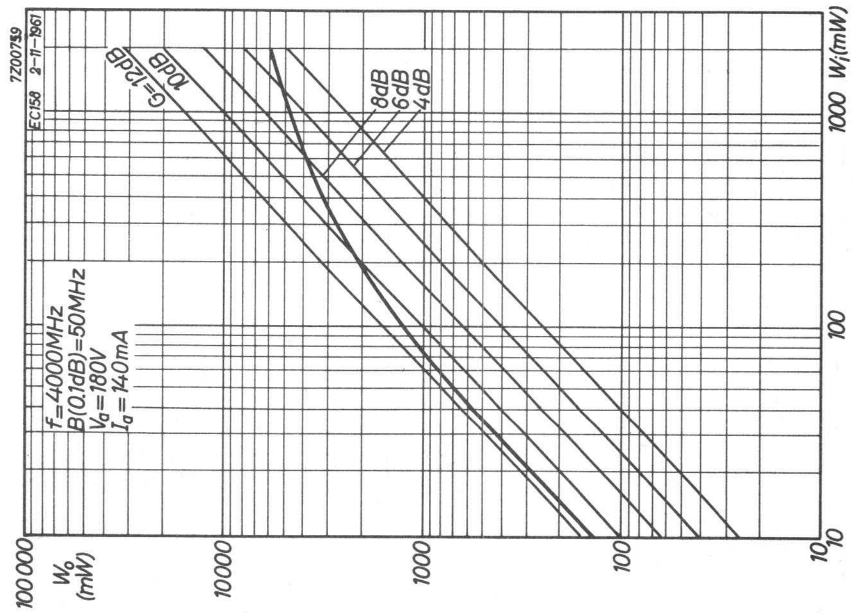
[3] This value may be multiplied by the D.C. inverse feedback factor for the cathode current to a maximum of 25 kΩ.

[4] To be measured with a temperature sensitive paint e.g. Tempilaq.


7Z00758
EC158 2-11-1961
$I_a$ (mA)
600
400
200
0
$V_g$=20V
17.5
15V
12.5V
10V
7.5V
5V
2.5V
0V
−2.5V
−5V
−7.5V
−10V
0
100
200
300
400
$V_a$(V)
500


7Z00757
EC158 2-11-1961
$I_g$ (mA)
150
100
50
0
$V_g$ =
20V
17.5V
15V
12.5V
10V
7.5V
5V
2.5V
0V
0
100
200
300
400
$V_a$(V)
500


7Z00756
EC158 2-11-1961
Va=180V
Ia (mA)
Vg(V)


7Z00759
EC158 2-11-1961
G=12dB
10dB
8dB
6dB
4dB
f=4000MHz
B(0.1dB)=50MHz
Va=180V
Ia=140mA
Wi(mW)
Wo (mW)

# DISC SEAL TRIODE

Air cooled disc seal power triode of metal-ceramic construction intended for use as oscillator, mixer, frequency multiplier and amplifier.

| QUICK REFERENCE DATA | | | |
|---|---|---|---|
| Output power at f = 2500 MHz | $W_o$ | 16 | W |
| Output power at f = 500 MHz | $W_o$ | 26 | W |
| Transconductance | S | 27 | mA/V |
| Amplification factor | $\mu$ | 60 | |
| Construction | | metal-ceramic | |

**HEATING:** Indirect by A.C. or D.C., parallel supply.

| | | | |
|---|---|---|---|
| Heater voltage | $V_f$ | 6.0 | V [1] |
| Heater current | $I_f$ | 0.9 to 1.05 | A |
| Waiting time | $T_w$ | min. 1 | min |

**CAPACITANCES**

| | | | |
|---|---|---|---|
| Anode to cathode | $C_{ak}$ | < 0.045 | pF |
| Anode to grid | $C_{ag}$ | 2.2 to 2.5 | pF |
| Grid to cathode | $C_{gk}$ | 6.3 to 7.0 | pF |

**TYPICAL CHARACTERISTICS**

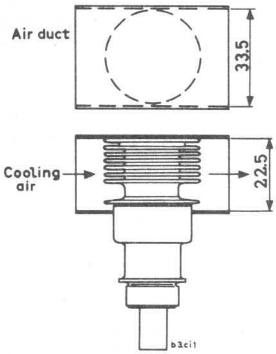
| | | min. | nom. | max. | |
|---|---|---|---|---|---|
| Anode voltage | $V_a$ | | 500 | | V |
| Cathode resistor | $R_k$ | | 30 | | Ω |
| Anode current | $I_a$ | 83 | 100 | 125 | mA |
| Transconductance | S | 22 | 27 | 32 | mA/V |
| Amplification factor | $\mu$ | | 60 | | |

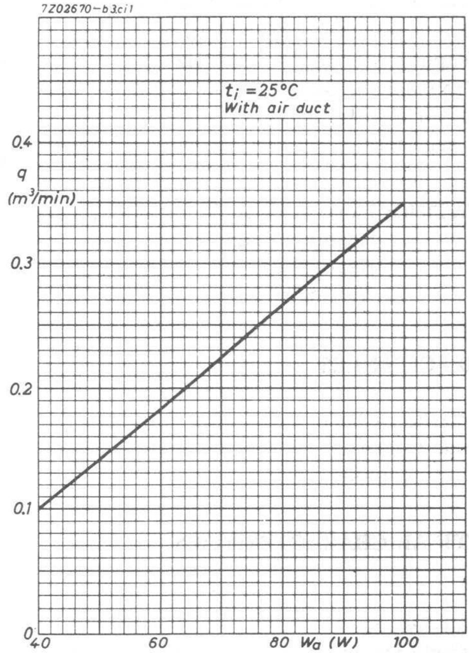
[1] The heater voltage should be reduced to a value depending on the cathode current and frequency. See curve page 5. The maximum fluctuation should not exceed ±5%.

Data based on pre-production tubes.

## COOLING

At maximum anode dissipation, an air duct of the dimensions indicated below being used and the inlet temperature being 25 °C, an air flow of approx. 350 l/min should be directed at the radiator. If necessary, the other surfaces should be cooled as well with a low-velocity air flow. As the ventilation system has to be adapted to the particular transmitter in which the tube will be used, it cannot be furnished as an accessory.



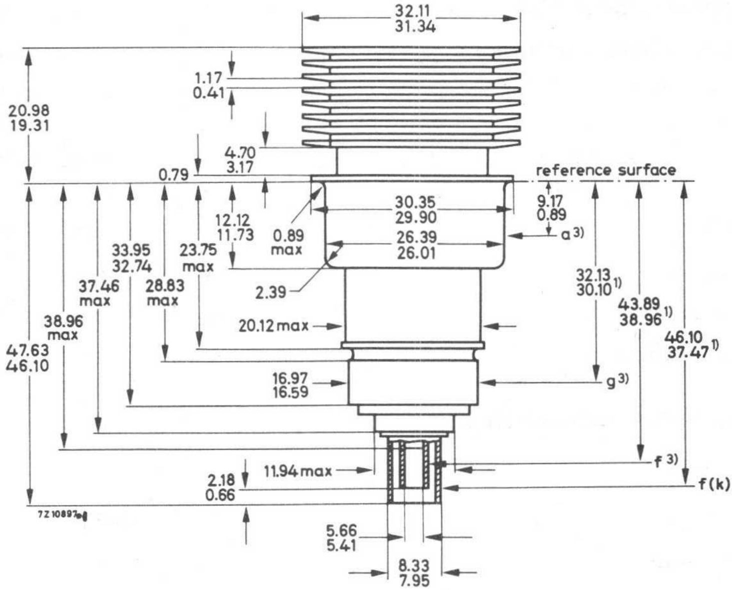



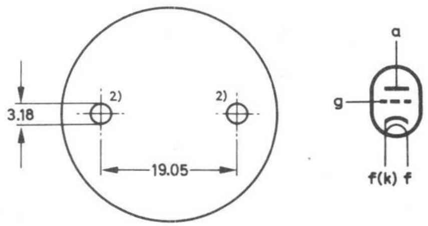

## LIFE EXPECTANCY

The life of the tube depends on the operating conditions and particularly on the tube temperature and the anode voltage. It is therefore recommended that the tube output required be attained with the lowest possible anode voltage, and that the tube temperature be kept as low as possible by adequate cooling.

MECHANICAL DATA

Dimensions in mm
The mm dimensions are derived from the original inch dimensions.




Mounting position: any
Net weight: approx. 70 g

1) Electrode contact areas
2) Holes for tube extractor in top fin only.
3) Eccentricity of contact surfaces: Reference: Cathode

| | |
|---|---|
| Anode | TIR max. 0.5 mm |
| Grid | TIR max. 0.5 mm |
| Heater | TIR max. 0.3 mm |

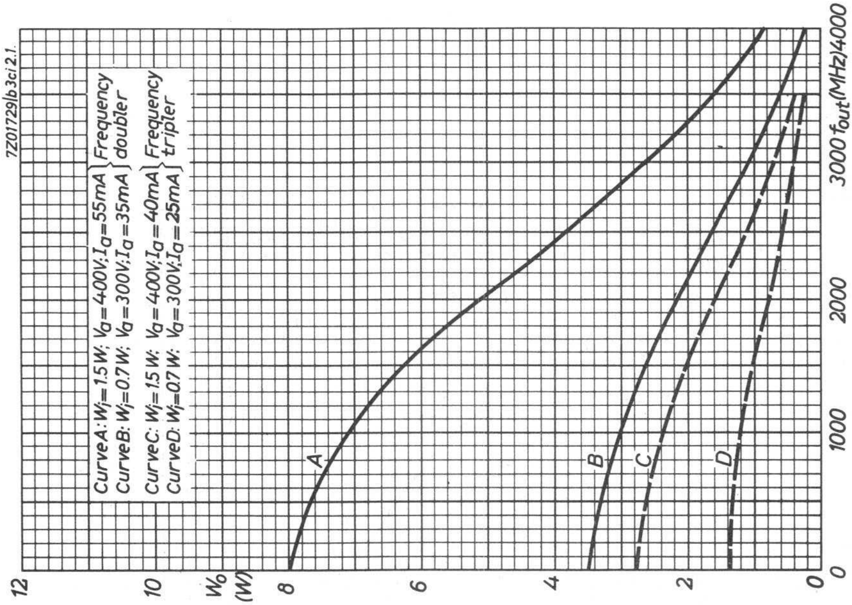
**LIMITING VALUES** (Absolute max. rating system)

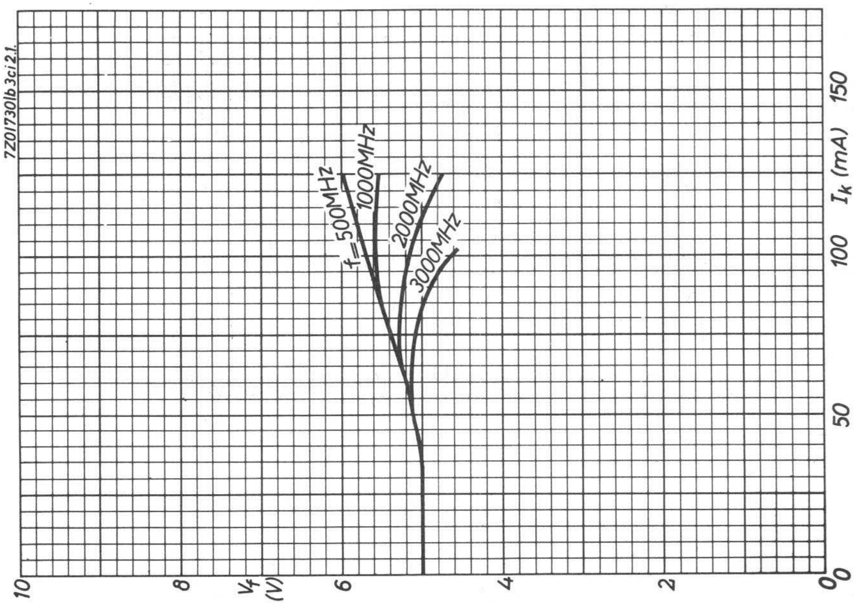
| | | | | |
|---|---|---|---|---|
| Frequency | f | up to | 2500 | MHz |
| Anode voltage (unmodulated) | $V_a$ | max. | 1000 | V |
| Anode voltage (100% modulated) | $V_a$ | max. | 800 | V |
| Anode dissipation | $W_a$ | max. | 100 | W |
| Grid voltage negative | $-V_g$ | max. | 150 | V |
| negative peak | $-V_{gp}$ | max. | 400 | V |
| positive peak | $V_{gp}$ | max. | 25 | V |
| Grid current | $I_g$ | max. | 50 | mA |
| Grid dissipation | $W_g$ | max. | 2 | W |
| Cathode current | $I_k$ | max. | 125 | mA |
| Envelope temperature | $t_{env}$ | max. | 250 | $^oC$ |

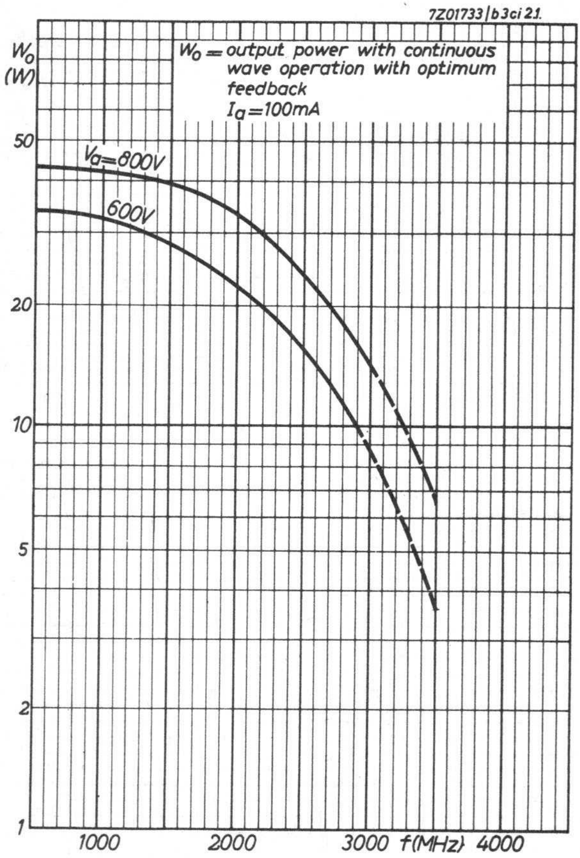
**OPERATING CHARACTERISTICS**

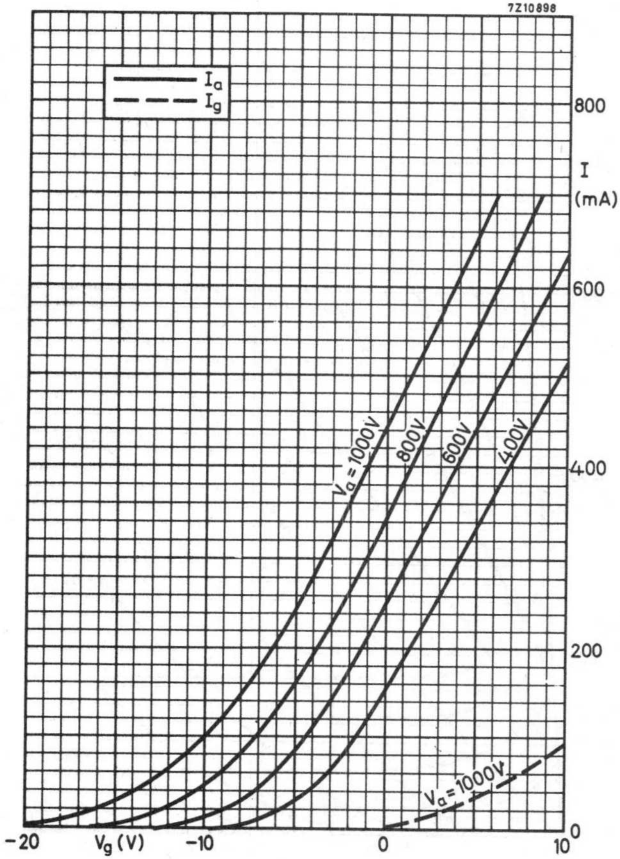
C.W. Oscillator

| | | | | |
|---|---|---|---|---|
| Frequency | f | 500 | 2500 | MHz |
| Heater voltage | $V_f$ | 5.8 | 4.8 | V |
| Anode voltage | $V_a$ | 600 | 600 | V |
| Anode current | $I_a$ | 80 | 100 | mA |
| Grid current | $I_g$ | 25 | 6 | mA |
| Output power | $W_o$ | 26 | 16 | W |

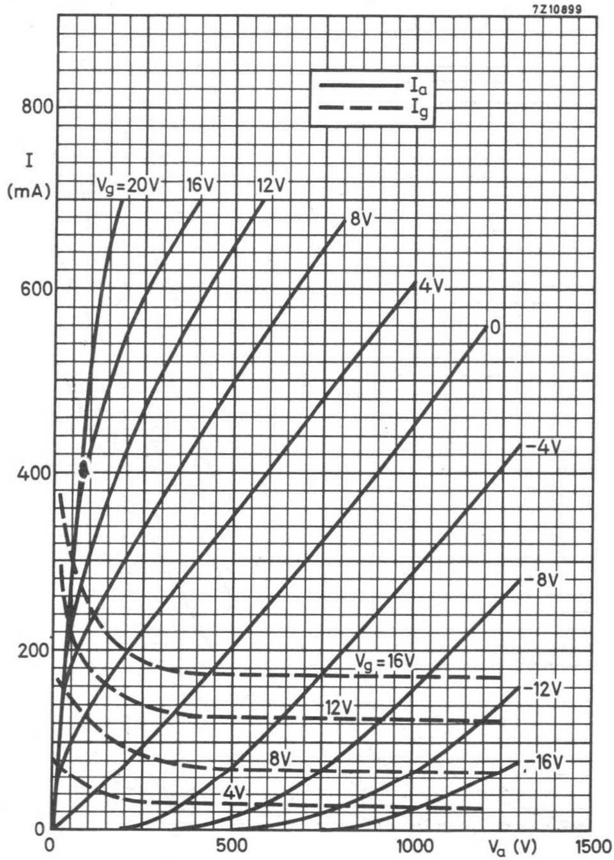

7Z01729lb3ci 2.1.
Curve A: $W_i$ = 1.5 W; $V_a$ = 400V; $I_a$ = 55mA
Curve B: $W_i$ = 0.7 W; $V_a$ = 300V; $I_a$ = 35mA
Frequency doubler
Curve C: $W_i$ = 1.5 W; $V_a$ = 400V; $I_a$ = 40mA
Curve D: $W_i$ = 0.7 W; $V_a$ = 300V; $I_a$ = 25mA
Frequency tripler
A
B
C
D
$W_o$ (W)
12
10
8
6
4
2
0
0
1000
2000
3000
$f_{out}$ (MHz)
4000


7Z01730lb3ci 2.1.
f = 500MHz
1000MHz
2000MHz
3000MHz
$V_f$ (V)
10
8
6
4
2
0
0
50
100
150
$I_k$ (mA)


7Z01733 | b3ci 2.1.
$W_o$ (W)
$W_o$ = output power with continuous wave operation with optimum feedback
$I_a$ = 100mA
$V_a$ = 800V
600V
50
20
10
5
2
1
1000
2000
3000
f (MHz)
4000



7Z10898
Ia
Ig
800
I
(mA)
600
400
200
0
Va=1000V
800V
600V
400V
Va=1000V
-20
Vg (V)
-10
0
10


7Z10899
$I_a$
$I_g$
800
600
400
200
0
I
(mA)
$V_g$=20V
16V
12V
8V
4V
0
−4V
−8V
−12V
−16V
$V_g$=16V
12V
8V
4V
0
500
1000
$V_a$ (V)
1500

# DISC SEAL TRIODE

Air cooled disc seal triode of metal-glass design, for use as oscillator, modulator, mixer, amplifier and frequency multiplier up to 3000 MHz.

| QUICK REFERENCE DATA | | | | |
|---|---|---|---|---|
| Output power at 2500 MHz | $W_o$ | = | 18 | W |
| Mutual conductance | S | = | 25 | mA/V |
| Amplification factor | $\mu$ | = | 100 | |
| Construction | | | metal-glass | |

## HEATING

Indirect by A.C. or D.C.; parallel supply

| | | | | |
|---|---|---|---|---|
| Heater voltage | $V_f$ | = | 6.3 | V |
| Heater current | $I_f$ | = | 0.95 to 1.1 | A |
| Waiting time | $T_w$ | = | min. 1 | min |

Remarks

1. In the interest of long tube life, the heater voltage should be matched to the required cathode current. Under dynamic operation, the back heating of the cathode which occurs at frequencies in the region of transit time must be compensated for by a reduction of heater voltage. Standard values should be taken from the curves on page 8. The maximum heater voltage fluctuation should not exceed $\pm 5\%$.

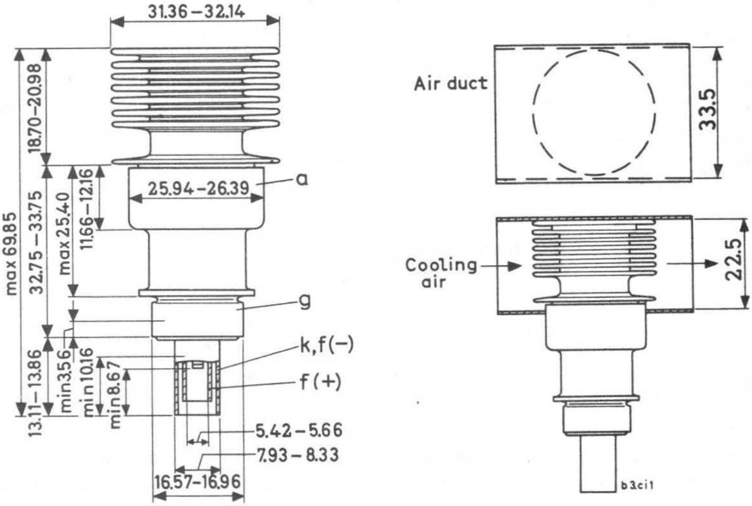
2. For pulsed operation, 6.3 V is normally required for preheating. For C.W. operation preheating should be effected at the voltage indicated by the curve for f = 500 MHz on page 8. In the case of power off periods of up to 5 sec or C.W. operation with $V_a$ = max. 300 V and $I_k$ = max. 30 mA, preheating is not necessary.

**CAPACITANCES**

| | | | | | | |
|---|---|---|---|---|---|---|
| Anode to grid | $C_{ag}$ | > | 1.86 | < | 2.16 | pF |
| Anode to cathode | $C_{ak}$ | | | < | 0.035 | pF |
| Grid to cathode | $C_{gk}$ | > | 5.6 | < | 7.6 | pF |
| Anode to cathode ($V_f$ = 6.3 V; $I_k$ = 0) | $C_{ak}$ | | | < | 0.045 | pF |
| Grid to cathode ($V_f$ = 6.3 V; $I_k$ = 0) | $C_{gk}$ | | | < | 8.8 | pF |

**MECHANICAL DATA** Dimensions in mm

Net weight: 75 g




The eccentricity of the contact surfaces is max. 0.5 mm

Mounting position: any

Mounting: where possible, the tube should be mounted in the coaxial resonators with the aid of adequately resilient spring contacts.

## COOLING

For maximum anode dissipation and assuming the use of an air duct of the dimensions indicated, an air flow of approx. 350 l/min is required for cooling the radiator in case of an inlet temperature of 25 $^oC$. If necessary, the other surfaces should be cooled as well with a low-velocity air flow. As the constructional design of the ventilation system has to be adapted to the particular type of equipment in use, it cannot be furnished as an accessory together with the tube. The dimensions indicated in the diagram are recommended for the guiding piece for cooling the radiator.

## LIMITING VALUES (Absolute limits)

| | | | | | |
|---|---|---|---|---|---|
| Frequency | f | | up to | 2500 | MHz |
| Anode voltage (unmodulated) | $V_a$ | = | max. | 1000 | V |
| Anode voltage (100% modulated) | $V_a$ | = | max. | 600 | V |
| Anode dissipation | $W_a$ | = | max. | 100 | W |
| Negative grid voltage | $-V_g$ | = | max. | 150 | V |
| Peak negative grid voltage | $-V_{g_p}$ | = | max. | 400 | V |
| Peak positive grid voltage | $+V_{g_p}$ | = | max. | 30 | V |
| Grid dissipation | $W_g$ | = | max. | 2 | W |
| Grid current | $I_g$ | = | max. | 50 | mA |
| Cathode current | $I_k$ | = | max. | 125 | mA |
| Bulb temperature | $t_{bulb}$ | = | max. | 175 | $^oC$ |

## TYPICAL CHARACTERISTICS

| | | | | | | |
|---|---|---|---|---|---|---|
| Anode voltage | $V_a$ | = | 600 | | | V |
| Cathode resistor | $R_k$ | = | 30 | | | Ω |
| Anode current | $I_a$ | = | 75 | > 60 | < 95 | mA |
| Mutual conductance | S | = | 25 | > 20 | < 30 | mA/V |
| Amplification factor | $\mu$ | = | 100 | | | |

## OPERATING CHARACTERISTICS

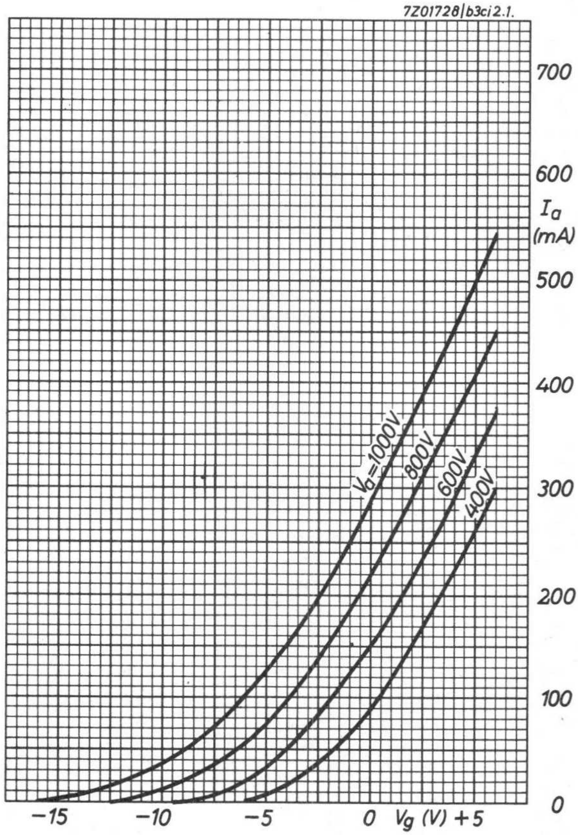
C.W. oscillator

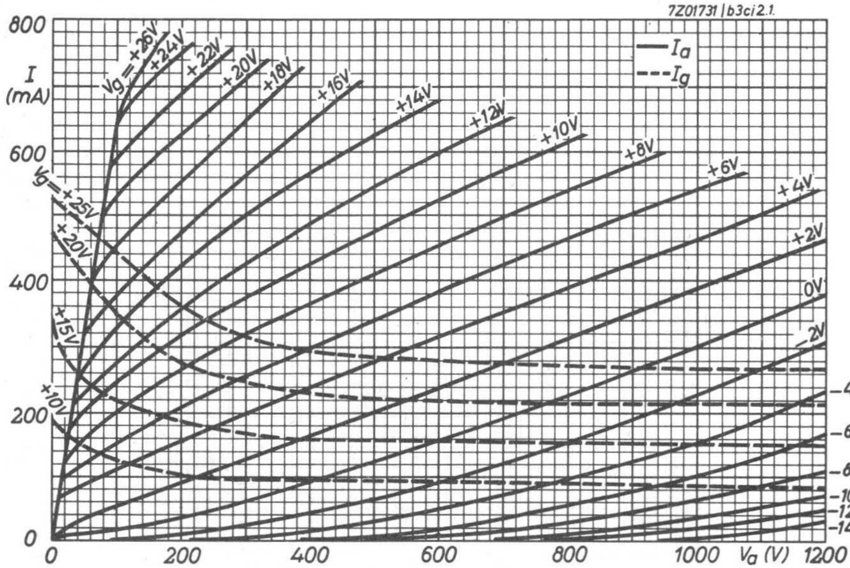
| | | | | | |
|---|---|---|---|---|---|
| Frequency | f | = | 2500 | 2500 | MHz |
| Heater voltage | $V_f$ | = | 4.5 | 4.5 | V |
| Anode voltage | $V_a$ | = | 600 | 800 | V |
| Anode current | $I_a$ | = | 100 | 100 | mA |
| Grid current | $I_g$ | = | 10 | 8 | mA |
| Output power | $W_o$ | = | 12 | 18 | W |

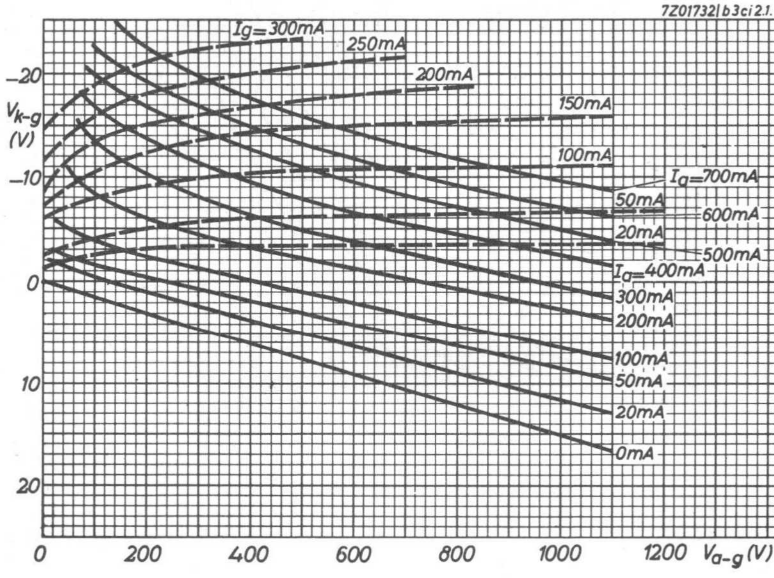
Frequency doubler

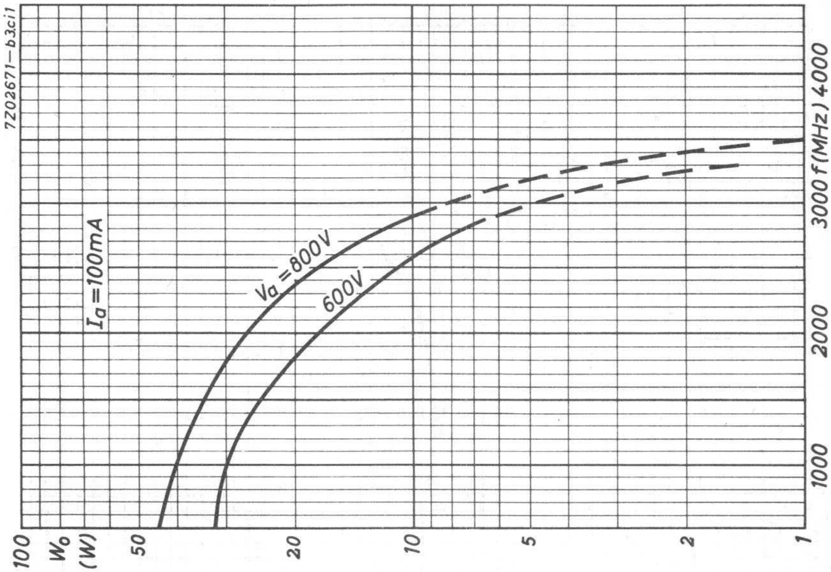
| | | | | |
|---|---|---|---|---|
| Frequency | f | = | 1000/2000 | MHz |
| Heater voltage | $V_f$ | = | 5.6 | V |
| Anode voltage | $V_a$ | = | 400 | V |
| Grid voltage | $V_g$ | = | -15 | V |
| Anode current | $I_a$ | = | 55 | mA |
| Grid input power | $W_{ig}$ | = | 1.5 | W |
| Output power | $W_o$ | = | 4.1 | W |

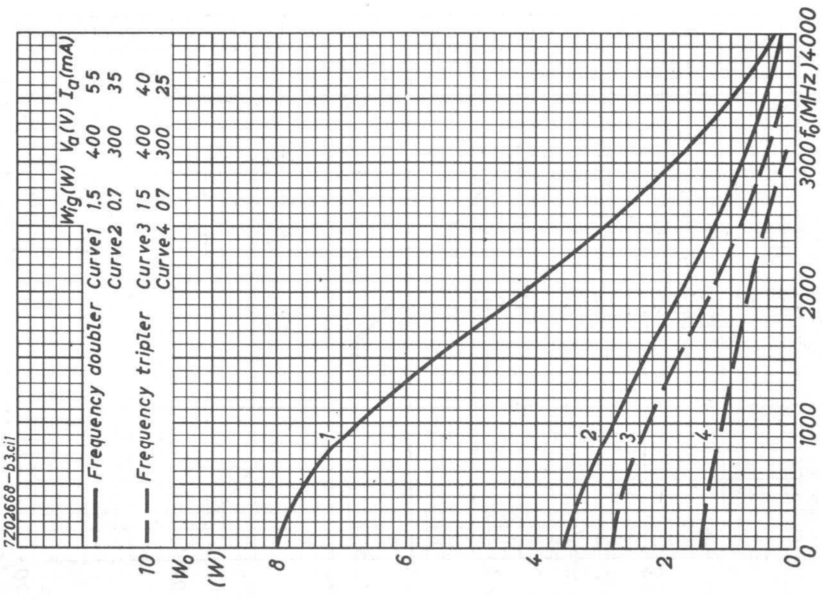
The life of the tube depends on the load and particularly on the tube temperature and the anode voltage. It is therefore recommended that the tube output required be attained with the lowest possible anode voltage, and that the tube temperature be kept as low as,possible by adequate cooling.

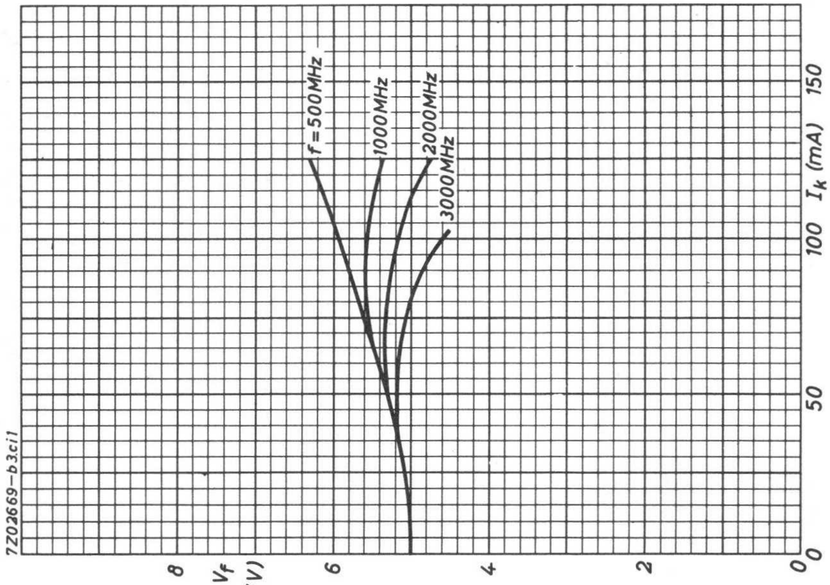

7Z01728|b3ci2.1.
700
600
$I_a$
(mA)
500
400
300
200
100
0
$V_a$=1000V
800V
600V
400V
−15
−10
−5
0
$V_g$ (V) +5

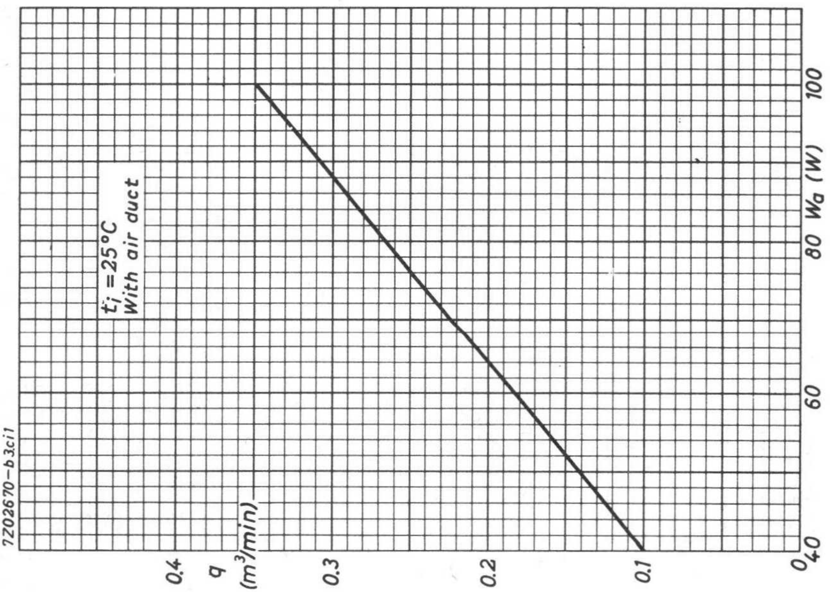

7Z01731 | b3ci 2.1.
800
I
(mA)
600
400
200
0
0
200
400
600
800
1000
Va (V)
1200
Ia
Ig
Vg = +26V
+24V
+22V
+20V
+18V
+16V
+14V
+12V
+10V
+8V
+6V
+4V
+2V
0V
-2V
-4V
-6V
-8V
-10V
-12V
-14V
Vg = +25V
+20V
+15V
+10V


7Z01732 | b3ci 2.1.
-20
Vk-g
(V)
-10
0
10
20
0
200
400
600
800
1000
1200
Va-g (V)
Ig = 300mA
250mA
200mA
150mA
100mA
50mA
20mA
Ia = 700mA
600mA
500mA
Ia = 400mA
300mA
200mA
100mA
50mA
20mA
0mA


7Z02671—b3.ci1
$I_a$=100mA
$V_a$=800V
600V
$W_o$ (W)
100
50
20
10
5
2
1
1000
2000
3000 f(MHz) 4000


7Z02668—b3.ci1
Frequency doubler Curve1 1.5 400 55
Curve2 0.7 300 35
Frequency tripler Curve3 1.5 400 40
Curve4 0.7 300 25
$W_{ig}$(W) $V_a$(V) $I_a$(mA)
1
2
3
4
$W_o$ (W)
10
8
6
4
2
0
0
1000
2000
3000 $f_o$(MHz) 4000


7Z02669-b3ci1
f = 500MHz
1000MHz
2000MHz
3000MHz
$V_f$ (V)
$I_k$ (mA)
0
2
4
6
8
50
100
150


7Z02670-b3ci1
$t_i$ = 25°C
With air duct
q ($m^3$/min)
$W_a$ (W)
0
0.1
0.2
0.3
0.4
40
60
80
100

# DISC SEAL TRIODE

Air cooled disc seal triode of metal-ceramic design, for use as oscillator, modulator, mixer, amplifier and frequency multiplier up to 3500 MHz.

| QUICK REFERENCE DATA | | | | |
|---|---|---|---|---|
| Output power at 2500 MHz | $W_o$ | = | 24 | W |
| Mutual conductance | S | = | 25 | mA/V |
| Amplification factor | $\mu$ | = | 100 | |
| Construction | | | metal-ceramic | |

## HEATING

Indirect by A.C. or D.C.; parallel supply

| | | | | |
|---|---|---|---|---|
| Heater voltage | $V_f$ | = | 6.0 | V |
| Heater current | $I_f$ | = | 0.9 to 1.05 | A |
| Waiting time | $T_w$ | = | min. 1 | min |

Remarks

1. In the interest of long tube life, the heater voltage should be matched to the required cathode current. Under dynamic operation, the back heating of the cathode which occurs at frequencies in the region of transit time must be compensated for by a reduction of heater voltage. Standard values should be taken from the curves on page 9. The maximum heater voltage fluctuation should not exceed ±5%.
2. For pulsed operation, 6 V is normally required for preheating. For C.W. operation preheating should be effected at the voltage indicated by the curve for f = 500 MHz on page 9. In the case of power off periods of up to 5 sec or C.W. operation with $V_a$ = max. 300 V and $I_k$ = max. 30 mA, preheating is not necessary.

## CAPACITANCES

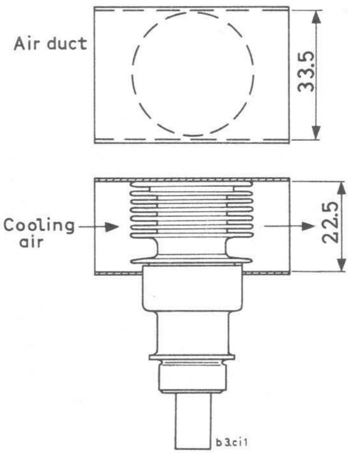
| | | | | | |
|---|---|---|---|---|---|
| Anode to grid | $C_{ag}$ = | 2.05 | > 1.95 | < 2.15 | pF |
| Anode to cathode | $C_{ak}$ < | 0.035 | | | pF |
| Grid to cathode | $C_{gk}$ = | 6.3 | > 5.6 | < 7.0 | pF |
| Anode to cathode ($V_f$ = 6.0 V; $I_k$ = 0) | $C_{ak}$ < | 0.045 | | | pF |
| Grid to cathode ($V_f$ = 6.0 V; $I_k$ = 0) | $C_{gk}$ = | 7.5 | | | pF |

## COOLING

For maximum anode dissipation and assuming the use of an air duct of the dimensions indicated, an air flow of approx. 350 l/min is required for cooling the radiator in case of an inlet temperature of 25 $^{o}$C. If necessary, the other surfaces should be cooled as well with a low-velocity air flow. As the constructional design of the ventilation system has to be adapted to the particular type of equipment in use, it cannot be furnished as an accessory together with the tube. The dimensions indicated in the diagram are recommended for the guiding piece for cooling the radiator.

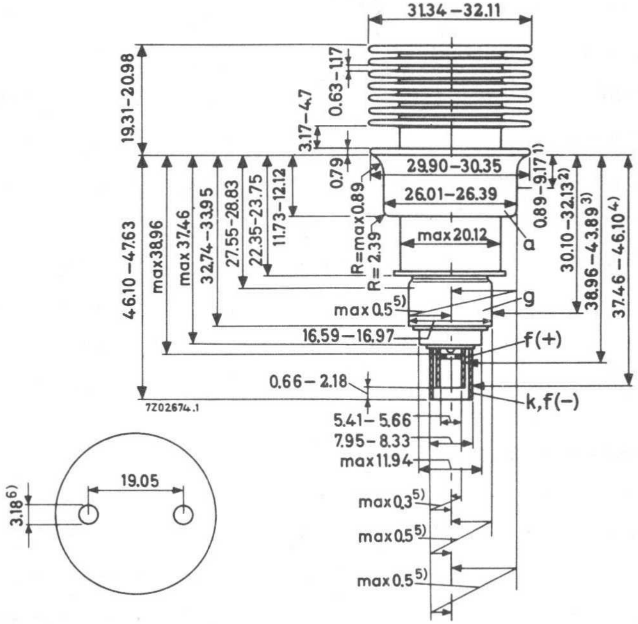
## MECHANICAL DATA

Dimensions in mm



**MECHANICAL DATA** (continued) Dimensions in mm

Net weight: 70 g




Mounting: where possible, the tube should be mounted in the coaxial resonators with the aid of adequately resilient spring contacts.

---

1) Anode contact surface

2) Grid contact surface

3) Heater contact surface

4) Cathode – heater contact surface

5) Centre variation

6) Holes for extractor

**LIMITING VALUES** (Absolute limits)

| | | | | |
|---|---|---|---|---|
| Frequency | f | | up to 3000 | MHz |
| Anode voltage (unmodulated) | $V_a$ | = | max. 1000 | V |
| Anode voltage (100% modulated) | $V_a$ | = | max. 600 | V |
| Anode dissipation | $W_a$ | = | max. 100 | W |
| Negative grid voltage | $-V_g$ | = | max. 150 | V |
| Peak negative grid voltage | $-V_{g_p}$ | = | max. 400 | V |
| Peak positive grid voltage | $+V_{g_p}$ | = | max. 30 | V |
| Grid dissipation | $W_g$ | = | max. 2 | W |
| Grid current | $I_g$ | = | max. 50 | mA |
| Cathode current | $I_k$ | = | max. 125 | mA |
| Bulb temperature | $t_{bulb}$ | = | max. 250 | $^oC$ |

**TYPICAL CHARACTERISTICS**

| | | | | | | |
|---|---|---|---|---|---|---|
| Anode voltage | $V_a$ | = | 600 | | | V |
| Cathode resistor | $R_k$ | = | 30 | | | Ω |
| Anode current | $I_a$ | = | 75 | > 60 | < 95 | mA |
| Mutual conductance | S | = | 25 | > 20 | < 30 | mA/V |
| Amplification factor | $\mu$ | = | 100 | | | |

## OPERATING CHARACTERISTICS

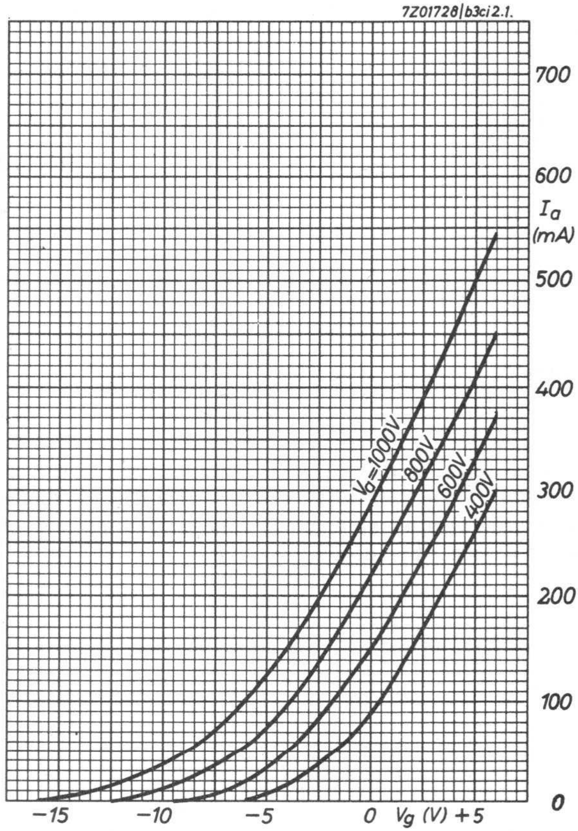
C.W. oscillator

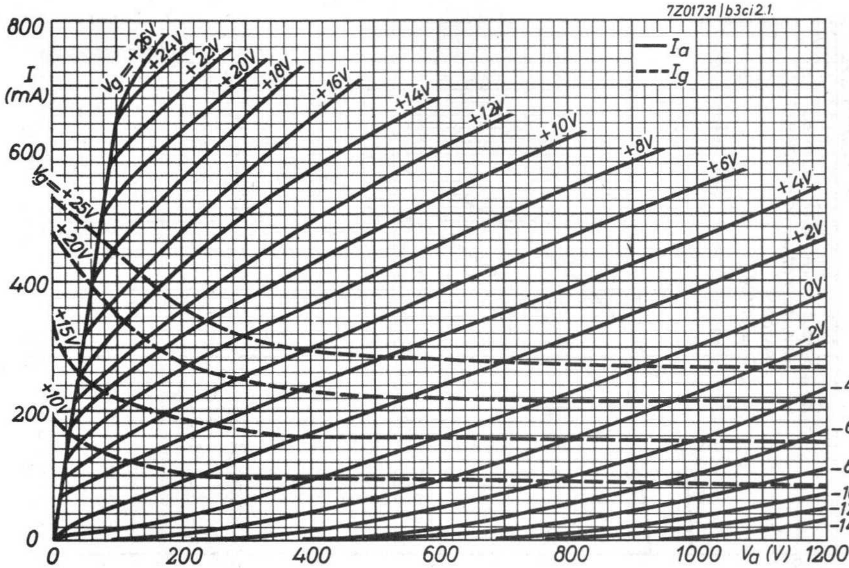
| | | | | | |
|---|---|---|---|---|---|
| Frequency | f | = | 2500 | 2500 | MHz |
| Heater voltage | $V_f$ | = | 4.5 | 4.5 | V |
| Anode voltage | $V_a$ | = | 600 | 800 | V |
| Anode current | $I_a$ | = | 100 | 100 | mA |
| Grid current | $I_g$ | = | 10 | 8 | mA |
| Output power | $W_o$ | = | 16 | 24 | W |

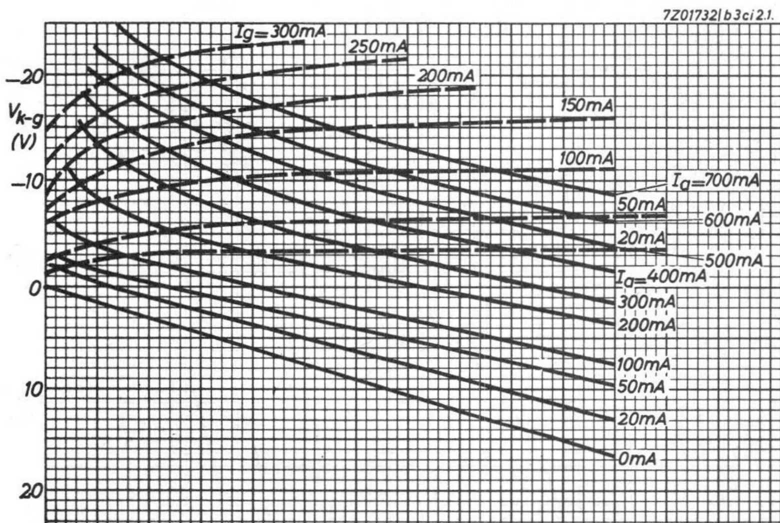
Frequency doubler

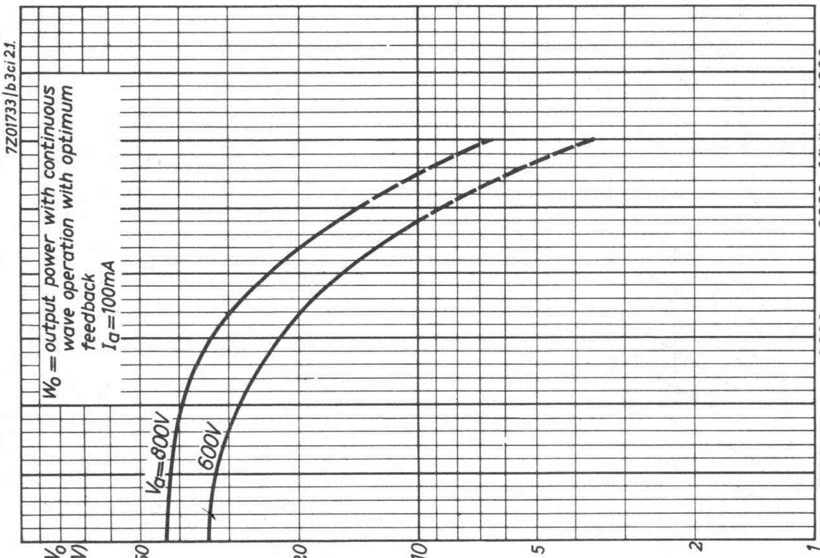
| | | | | |
|---|---|---|---|---|
| Frequency | f | = | 1000/2000 | MHz |
| Heater voltage | $V_f$ | = | 5.6 | V |
| Anode voltage | $V_a$ | = | 400 | V |
| Grid voltage | $V_g$ | = | -15 | V |
| Anode current | $I_a$ | = | 55 | mA |
| Grid input power | $W_{ig}$ | = | 1.5 | W |
| Output power | $W_o$ | = | 5.2 | W |

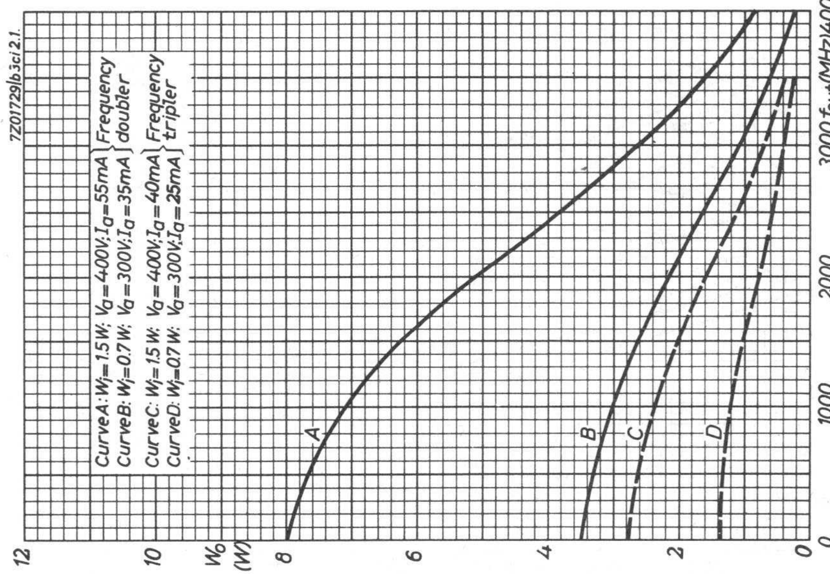
The life of the tube depends on the load and particularly on the tube temperature and the anode voltage. It is therefore recommended that the tube output required be attained with the lowest possible anode voltage, and that the tube temperature be kept as low as possible by adequate cooling.

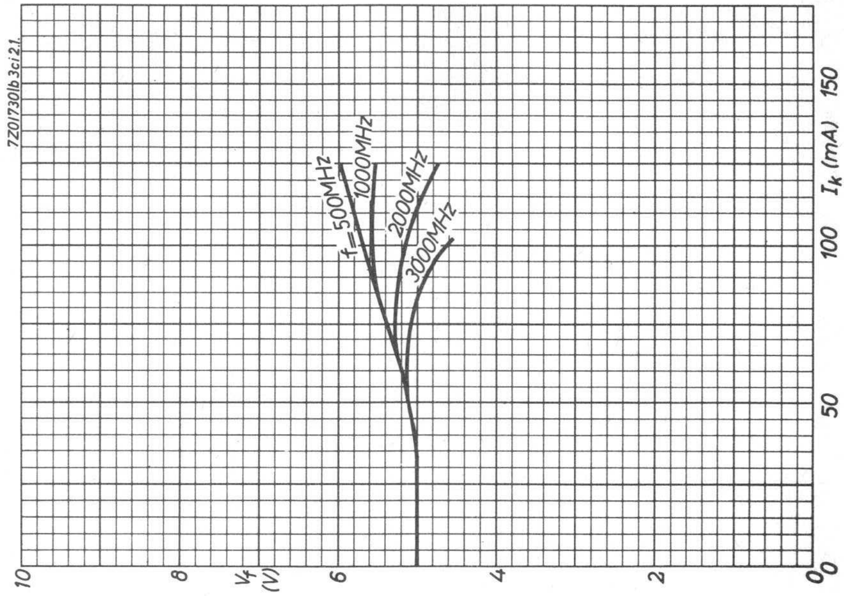

7Z01728/b3ci2.1.
700
600
$I_a$
(mA)
500
400
300
200
100
0
−15
−10
−5
0
$V_g$ (V)
+5
$V_a$=1000V
800V
600V
400V

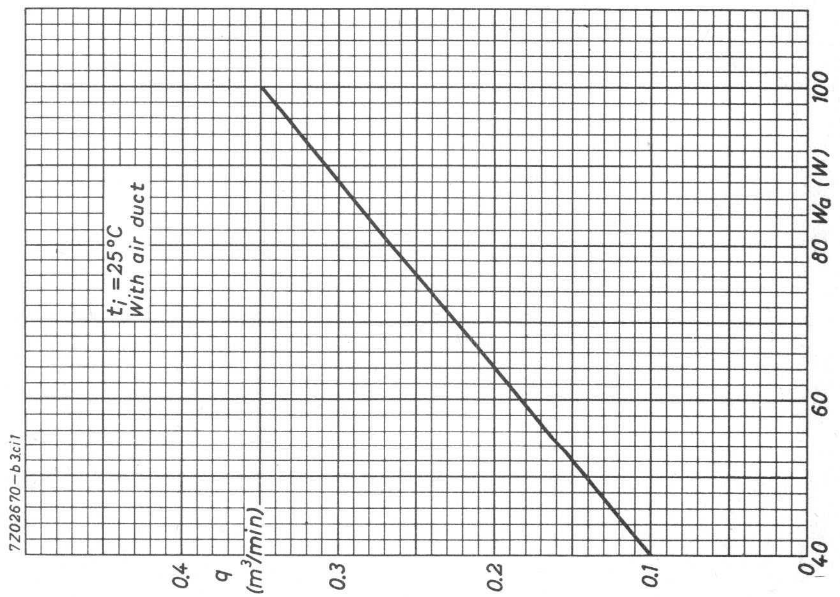

7Z01731 | b3ci 2.1.
800
600
400
200
0
I (mA)
Ia
Ig
Vg = +26V
+24V
+22V
+20V
+18V
+16V
+14V
+12V
+10V
+8V
+6V
+4V
+2V
0V
-2V
-4V
-6V
-8V
-10V
-12V
-14V
Vg = +25V
+20V
+15V
+10V
0
200
400
600
800
1000
Va (V)
1200


7Z01732 | b3ci 2.1.
-20
-10
0
10
20
Vk-g (V)
Ig = 300mA
250mA
200mA
150mA
100mA
50mA
20mA
Ia = 700mA
600mA
500mA
Ia = 400mA
300mA
200mA
100mA
50mA
20mA
0mA
0
200
400
600
800
1000
1200
Va-g (V)


7Z01733/b3ci 2.1.
$W_o$ = output power with continuous wave operation with optimum feedback
$I_a$=100mA
$V_a$=800V
600V
$W_o$ (W)
50
20
10
5
2
1
1000
2000
3000
4000
f(MHz)


7Z01729/b3ci 2.1.
Curve A: $W_i$=1.5 W; $V_a$=400V; $I_a$=55mA
Curve B: $W_i$=0.7 W; $V_a$=300V; $I_a$=35mA
Frequency doubler
Curve C: $W_i$=1.5 W; $V_a$=400V; $I_a$=40mA
Curve D: $W_i$=0.7 W; $V_a$=300V; $I_a$=25mA
Frequency tripler
A
B
C
D
$W_o$ (W)
12
10
8
6
4
2
0
0
1000
2000
3000
4000
$f_{out}$(MHz)


7Z01730lb3ci2.1
f = 500MHz
1000MHz
2000MHz
3000MHz
Vf (V)
10
8
6
4
2
0
Ik (mA)
0
50
100
150


7Z02670-b3ci1
ti = 25°C
With air duct
q (m3/min)
0.4
0.3
0.2
0.1
0
Wa (W)
40
60
80
100

# PENCIL TYPE UHF HIGH MU TRIODE

Pencil type UHF high mu triode for use in grounded grid service as RF amplifier, IF amplifier or mixer in receivers operating at frequencies up to about 1000 MHz, as frequency multiplier up to about 1500 MHz and as oscillator up to 1700 MHz. The tube can be used at altitudes up to 20 km without pressurized chambers.

| QUICK REFERENCE DATA | | | | |
|---|---|---|---|---|
| Amplification factor | $\mu$ | = | 56 | |
| Mutual conductance | S | = | 6.5 | mA/V |
| Maximum anode dissipation | $W_a$ | = | max. 6.25 | W |

**HEATING:** indirect by AC or DC

| | | | | |
|---|---|---|---|---|
| Heater voltage | $V_f$ | = | 6.3 | V |
| Heater current | $I_f$ | = | 135 | mA |

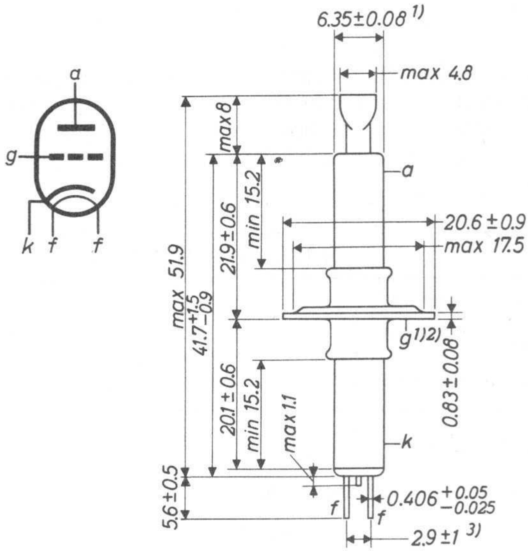
**CAPACITANCES**

| | | | | |
|---|---|---|---|---|
| Anode to all except grid | $C_a$ | < | 0.035 | pF |
| Grid to all except anode | $C_g$ | = | 2.5 | pF |
| Anode to grid | $C_{ag}$ | = | 1.4 | pF |

**TYPICAL CHARACTERISTICS**

| | | | | |
|---|---|---|---|---|
| Anode voltage | $V_a$ | = | 250 | V |
| Anode current | $I_a$ | = | 18 | mA |
| Amplification factor | $\mu$ | = | 56 | |
| Mutual conductance | S | = | 6.5 | mA/V |
| Internal resistance | $R_i$ | = | 8625 | Ω |

**MECHANICAL DATA** Dimensions in mm




Mounting position: arbitrary

**INSTALLATION NOTES**

Connections to the cathode cylinder, the grid disc and the anode cylinder should be made by flexible spring contacts only. The connectors must make firm, large surface contact, yet must be sufficiently flexible so that no part of the tube is subjected to strain. Unless this recommendation is observed, the glass to metal seals may be damaged.

---

1) Maximum eccentricity of the axis of the anode terminal or the grid terminal flange with respect to the axis of the cathode terminal is 0.204 mm.

2) The tilt of the grid terminal flange with respect to the rotational axis of the cathode terminal is determined by chucking the cathode terminal, rotating the tube and gauging the total travel distance of the grid terminal flange parallel to the axis at a point approximately 0.5 mm inward from its edge for one complete revolution. The total travel distance will not exceed 0.51 mm.

3) Distance at the terminal tips.

## CLASS A AMPLIFIER

**LIMITING VALUES** (Absolute limits)

| | | | | |
|---|---|---|---|---|
| Anode voltage | $V_a$ | = max. | 300 | V |
| Anode current | $I_a$ | = max. | 25 | mA |
| Anode dissipation | $W_a$ | = max. | 6.25 | W [1] |
| Negative grid voltage | $-V_g$ | = max. | 100 | V |
| Grid circuit resistance | $R_g$ | = max. | 0.5 | MΩ |
| Heater to cathode voltage | $V_{kf}$ | = max. | 90 | V |
| Anode seal temperature | t | = max. | 175 | °C |

**OPERATING CHARACTERISTICS**

| | | | | |
|---|---|---|---|---|
| Anode voltage | $V_a$ | = | 250 | V |
| Anode current | $I_a$ | = | 18 | mA |
| Cathode resistor | $R_k$ | = | 75 | Ω |

[1]) In applications where $W_a$ is more than 2.5 W it is important that a large area of contact be provided between the anode cylinder and the terminal to provide adequate heat conduction.

## R.F. CLASS C TELEGRAPHY, GROUNDED GRID CIRCUIT

Key down conditions per tube without amplitude modulation. Modulation essentially negative may be used if the positive peak of the audio frequency does not exceed 115% of the carrier conditions.

**LIMITING VALUES** (Absolute limits; continuous service)

| | | | | |
|---|---|---|---|---|
| Anode voltage | $V_a$ | = max. | 360 | V |
| Anode current | $I_a$ | = max. | 25 | mA |
| Anode input power | $W_{i_a}$ | = max. | 9 | W |
| Anode dissipation | $W_a$ | = max. | 6.25 | W [1]) |
| Negative grid voltage | $-V_g$ | = max. | 100 | V |
| Grid current | $I_g$ | = max. | 8 | mA |
| Grid circuit resistance | $R_g$ | = max. | 0.1 | MΩ |
| Heater to cathode voltage | $V_{kf}$ | = max. | 90 | V |
| Anode seal temperature | t | = max. | 175 | °C |

**OPERATING CHARACTERISTICS AS POWER AMPLIFIER**

| | | | | |
|---|---|---|---|---|
| Anode voltage | $V_a$ | = | 275 | V |
| Anode current | $I_a$ | = | 23 | mA |
| Grid voltage, obtained from grid resistor | $V_g$ | = | -51 | V |
| Grid current | $I_g$ | = | 7 | mA [2]) |
| Driving power | $W_{dr}$ | = | 2 | W [2]) |
| Output power | $W_o$ | = | 5 | W [3]) |

**OPERATING CHARACTERISTICS AS OSCILLATOR**

| | | | | | |
|---|---|---|---|---|---|
| Frequency | f | = | 500 | 1700 | MHz |
| Anode voltage | $V_a$ | = | 250 | 250 | V |
| Anode current | $I_a$ | = | 23 | 23 | mA |
| Grid voltage, obtained from grid resistor | $V_g$ | = | -12 | -2 | V |
| Grid current | $I_g$ | = | 6 | 3 | mA [2]) |
| Output power | $W_o$ | = | 3 | 0.75 | W |

[1]) In applications where $W_a$ is more than 2.5 W it is important that a large area of contact be provided between the anode cylinder and the terminal to provide adequate heat conduction.

[2]) The typical values of $I_g$ and the input power $W_{dr}$ are subject to variations depending on the impedance of the load circuit.

[3]) Power transferred from driving stage included.

## R.F. CLASS C ANODE MODULATED POWER AMPLIFIER

Carrier conditions per tube for use with a maximum modulation factor of 1.0

**LIMITING VALUES** (Absolute limits; continuous service)

| | | | | |
|---|---|---|---|---|
| Anode voltage | $V_a$ | = max. | 275 | V |
| Anode current | $I_a$ | = max. | 22 | mA |
| Anode input power | $W_{i_a}$ | = max. | 6 | W |
| Anode dissipation | $W_a$ | = max. | 4.25 | W [1]) |
| Negative grid voltage | $-V_g$ | = max. | 100 | V |
| Grid current | $I_g$ | = max. | 8 | mA |
| Grid circuit resistance | $R_g$ | = max. | 0.1 | MΩ |
| Heater to cathode voltage | $V_{kf}$ | = max. | 90 | V |
| Anode seal temperature | t | = max. | 175 | °C |

[1]) In applications where $W_a$ is more than 2.5 W it is important that a large area of contact be provided between the anode cylinder and the terminal to provide adequate heat conduction.

## FREQUENCY MULTIPLIER, GROUNDED GRID CIRCUIT

**LIMITING VALUES** (Absolute limits; continuous service)

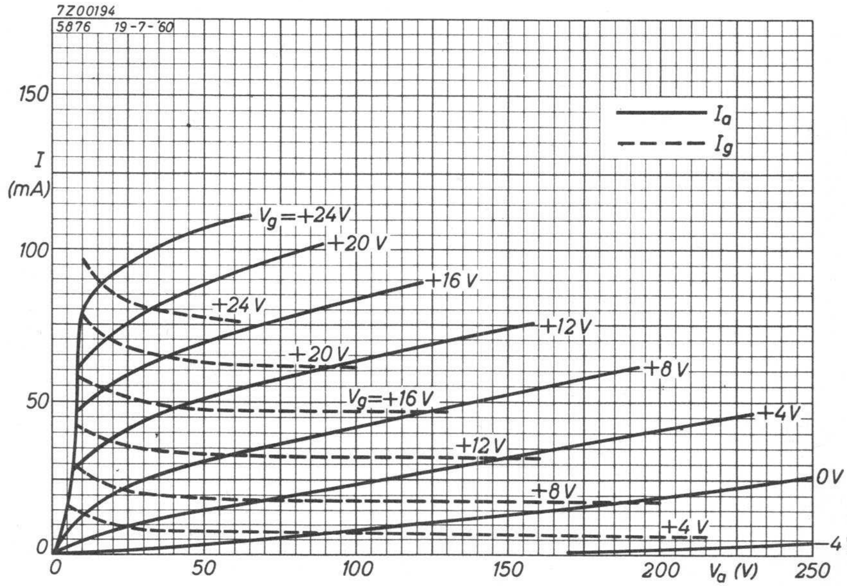
| | | | | |
|---|---|---|---|---|
| Anode voltage | $V_a$ | = max. | 330 | V |
| Anode current | $I_a$ | = max. | 22 | mA |
| Anode input power | $W_{i_a}$ | = max. | 7.5 | W |
| Anode dissipation | $W_a$ | = max. | 6.25 | W [1] |
| Negative grid voltage | $-V_g$ | = max. | 100 | V |
| Grid current | $I_g$ | = max. | 8 | mA |
| Grid circuit resistance | $R_g$ | = max. | 0.1 | MΩ |
| Heater to cathode voltage | $V_{kf}$ | = max. | 90 | V |
| Anode seal temperature | t | = max. | 175 | °C |

**OPERATING CHARACTERISTICS**

| | | | | | |
|---|---|---|---|---|---|
| Frequency | f | = | 160/480 | 480/960 | MHz |
| Anode voltage | $V_a$ | = | 300 | 300 | V |
| Anode current | $I_a$ | = | 18 | 17.3 | mA |
| Grid voltage, obtained from grid resistor | $V_g$ | = | -90 | -70 | V |
| Grid current | $I_g$ | = | 6 | 7 | mA [2] |
| Driving power | $W_{dr}$ | = | 2.1 | 2.0 | W [2] |
| Output power | $W_o$ | = | 2.1 | 2.0 | W |

[1]) In applications where $W_a$ is more than 2.5 W it is important that a large area of contact be provided between the anode cylinder and the terminal to provide adequate heat conduction.

[2]) The typical values of $I_g$ and the input power $W_{dr}$ are subject to variations depending on the impedance of the load circuit.


7Z00194
5876 19-7-'60
150
100
50
0
I
(mA)
0
50
100
150
200
$V_a$ (V)
250
$I_a$
$I_g$
$V_g$=+24V
+20 V
+16 V
+12 V
+8 V
+4V
0V
-4V
+24 V
+20 V
$V_g$=+16 V
+12 V
+8 V
+4 V

# PENCIL TYPE UHF HIGH MU TRIODE

The 5876A is the ruggedized version of the 5876

# PENCIL TYPE UHF MEDIUM MU TRIODE

Pencil type UHF medium-mu triode for use in grounded grid service as anode pulsed oscillator up to 3300 MHz and altitudes up to 3 km, or as class A amplifier, RF amplifier, RF oscillator or frequency doubler up to 1000 MHz and altitudes up to 30 km.

| QUICK REFERENCE DATA | | | | | |
|---|---|---|---|---|---|
| Amplification factor | | $\mu$ | = | 27 | |
| Mutual conductance | | S | = | 6 | mA/V |
| Maximum anode dissipation, class C telegraphy | CCS | $W_a$ | = max. | 7 | W |
| | ICAS | $W_a$ | = max. | 8 | W |

**HEATING:** indirect by AC or DC

| | | | | |
|---|---|---|---|---|
| Heater voltage | | | | |
| under transmitting conditions | $V_f$ | = | 6.0 | V $^{+5\%}_{-10\%}$ |
| under stand-by conditions | $V_f$ | = | 6.3 | V |
| Heater current at $V_f$ = 6.0 V | $I_f$ | = | 0.28 | A |

**CAPACITANCES**

| | | | | |
|---|---|---|---|---|
| Anode to cathode | $C_a$ | < | 0.07 | pF |
| Grid to cathode | $C_g$ | = | 2.5 | pF |
| Anode to grid | $C_{ag}$ | = | 1.75 | pF |

**TYPICAL CHARACTERISTICS**

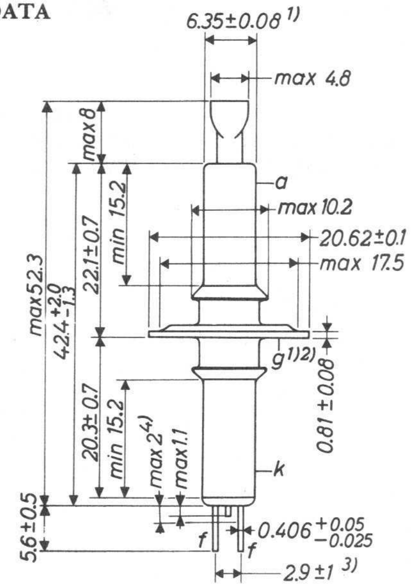
| | | | | |
|---|---|---|---|---|
| Anode voltage | $V_a$ | = | 200 | V |
| Anode current | $I_a$ | = | 25 | mA |
| Mutual conductance | S | = | 6 | mA/V |
| Amplification factor | $\mu$ | = | 27 | |
| Internal resistance | $R_i$ | = | 4500 | Ω |

**TEMPERATURE LIMITS** (Absolute limits)

Anode seal temperature = max. 175 °C

**MECHANICAL DATA**

Dimensions in mm




Mounting position: arbitrary

INSTALLATION NOTES

Connections to the cathode cylinder, grid flange and anode cylinder should be made by flexible spring contacts only. The connectors must make firm, large-surface contact, yet must be sufficiently flexible so that no part of the tube is subjected to strain. Unless this recommendation is observed, the glass-to-metal seals may be damaged. The heater leads fit to the Cinch socket No.54A1 1953. They should not be soldered to circuit elements. The heat of the soldering operation may crack the glass seals of the heater leads and damage the tube.

1) Max. eccentricity of the axis of the anode terminal or grid terminal flange with respect to the axis of the cathode terminal is 0.204 mm.

2) The tilt of the grid terminal flange with respect to the rotational axis of the cathode terminal is determined by chucking the cathode terminal, rotating the tube and gauging the total travel distance of the grid terminal flange parallel to the axis at a point approximately 0.5 mm inward from its edge for one complete rotation. The total travel distance will not exceed 0.51 mm.

3) Distance at the terminal tips.

4) Not tinned.

## CLASS A AMPLIFIER WITHOUT GRID CURRENT

**LIMITING VALUES** (Absolute limits)

For altitudes up to 30 km

| | | | | | |
|---|---|---|---|---|---|
| Anode voltage | $V_a$ | = | max. | 330 | V |
| Negative grid voltage | $-V_g$ | = | max. | 100 | V |
| Anode current | $I_a$ | = | max. | 35 | mA |
| Anode dissipation | $W_a$ | = | max. | 7 | W |
| Cathode to heater voltage | $V_{kf}$ | = | max. | 90 | V |
| | $-V_{kf}$ | = | max. | 90 | V |

**OPERATING CONDITIONS**

| | | | | |
|---|---|---|---|---|
| Anode voltage | $V_a$ | = | 200 | V |
| Anode current | $I_a$ | = | 25 | mA |
| Cathode resistance | $R_k$ | = | 100 | Ω |

---

Page 4

1) The "on" time is the sum of the durations of all the individual pulses which occur during any 5000 μsec interval. The pulse duration is defined as the time interval between the two points on the pulse at which the instantaneous value is 70% of the peak value. The peak value is defined as the maximum value of a smooth curve through the average of the fluctuations over the top portion of the pulse.

2) The magnitude of any spike on the anode voltage pulse should not exceed a value of 2000 volts with respect to the cathode and its duration should not exceed 0.01 μsec measured at the peak value level.

3) In applications where the anode dissipation exceeds 2.5 watts it is important that a large area of contact be provided between the anode cylinder and the connector in order to provide adequate heat conduction.

4) The power output at the peak of a pulse is obtained from the average power output using the duty factor of the pulses. This procedure is necessary since the output power pulse duty factor may be less than the applied voltage pulse duty factor because of a delay in the start of RF output power.

5) The duty factor is the product of the pulse duration and the repetition frequency. For variable pulse durations and pulse repetition frequencies, the duty factor is defined as the ratio of the time "on" to total elapsed time in any 5000 μsec interval.

ANODE PULSED OSCILLATOR, CLASS C

**LIMITING VALUES** (Absolute limits)

For altitudes up to 3 km

For a maximum "on" time of 5 μs in any 5000 μs interval [1]

| | | | | |
|---|---|---|---|---|
| Peak positive anode voltage | $V_{ap}$ | = max. | 1750 | V [2] |
| Peak negative grid voltage | $-V_{g_p}$ | = max. | 150 | V |
| Peak anode current | $I_{a_p}$ | = max. | 3 | A |
| Peak rectified grid current | $I_{g_p}$ | = max. | 1.3 | A |
| Anode current | $I_a$ | = max. | 3 | mA |
| Grid current | $I_g$ | = max. | 1.3 | mA |
| Anode dissipation | $W_a$ | = max. | 6 | W [3] |
| Pulse duration | $T_{imp}$ | = max. | 1.5 | μs |
| Grid circuit resistance | $R_g$ | = max. | 0.5 | MΩ |

**OPERATING CONDITIONS** with rectangular wave shape in grounded grid circuit at 3300 MHz

The heater should be allowed to warm up for at least 60 s before anode voltage is applied.

| | | | | |
|---|---|---|---|---|
| Peak positive anode voltage | $V_{ap}$ | = | 1750 | V [2] |
| Peak negative bias voltage | $V_{g_p}$ | = | -110 | V |
| Grid resistor | $R_g$ | = | 100 | Ω |
| Peak anode current | $I_{a_p}$ | = | 3 | A |
| Peak rectified grid current | $I_{g_p}$ | = | 1.1 | A |
| Anode current | $I_a$ | = | 3 | mA |
| Grid current | $I_g$ | = | 1.1 | mA |
| Peak output power | $W_{o_p}$ | = | 1200 | W [4] |
| Pulse duration | $T_{imp}$ | = | 1 | μs |
| Pulse repetition frequency | $f_{imp}$ | = | 1000 | Hz |
| Duty factor | $\delta$ | = | 0.001 | [5] |

[1][2][3][4][5] See page 3.

## ANODE MODULATED R.F. AMPLIFIER, CLASS C TELEPHONY

Carrier conditions per tube for use with a max. modulation factor of 1.0

**LIMITING VALUES** (Absolute limits)

For altitudes up to 30 km

| | | | CCS | ICAS | |
|---|---|---|---|---|---|
| Anode voltage | $V_a$ | = max. | 260 | 320 | V |
| Negative grid voltage | $-V_g$ | = max. | 100 | 100 | V |
| Anode current | $I_a$ | = max. | 33 | 33 | mA |
| Grid current | $I_g$ | = max. | 15 | 15 | mA |
| Anode input power | $W_{ia}$ | = max. | 8.5 | 10.5 | W |
| Anode dissipation | $W_a$ | = max. | 5 | 5.5 | W [1]) |
| Grid circuit resistance | $R_g$ | = max. | 0.1 | 0.1 | MΩ |
| Cathode to heater voltage | $V_{kf}$ | = max. | 90 | 90 | V |
| | $-V_{kf}$ | = max. | 90 | 90 | V |

**OPERATING CONDITIONS** in grounded grid circuit at 500 MHz

| | | | CCS | ICAS | |
|---|---|---|---|---|---|
| Anode voltage | $V_a$ | = | 250 | 300 | V |
| Grid voltage | $V_g$ | = | -36 | -45 | V [2]) |
| Anode current | $I_a$ | = | 30 | 30 | mA |
| Grid current | $I_g$ | = | 11 | 12 | mA |
| Driver output power | $W_{dr}$ | = | 1.8 | 2.0 | W |
| Output power | $W_o$ | = | 5.5 | 6.5 | W |

[1]) In applications where the anode dissipation exceeds 2.5 watts, it is important that a large area of contact be provided between the anode cylinder and the connector in order to provide adequate heat conduction

[2]) Obtained from grid resistor.

## R. F. POWER AMPLIFIER AND OSCILLATOR CLASS C TELEGRAPHY

Key down conditions per tube without amplitude modulation. Modulation essentially negative may be used if the peak of the audio frequency envelope does not exceed 115% of the carrier conditions.

**LIMITING VALUES** (Absolute limits)

For altitudes up to 30 km

| | | | | CCS | ICAS | |
|---|---|---|---|---|---|---|
| Anode voltage | $V_a$ | = | max. | 320 | 400 | V |
| Negative grid voltage | $-V_g$ | = | max. | 100 | 100 | V |
| Anode current | $I_a$ | = | max. | 35 | 40 | mA |
| Grid current | $I_g$ | = | max. | 15 | 15 | mA |
| Anode input power | $W_{ia}$ | = | max. | 11 | 16 | W |
| Anode dissipation | $W_a$ | = | max. | 7 | 8 | W [1]) |
| Grid circuit resistance | $R_g$ | = | max. | 0.1 | 0.1 | MΩ |
| Cathode to heater voltage | $V_{kf}$ | = | max. | 90 | 90 | V |
| | $-V_{kf}$ | = | max. | 90 | 90 | V |

**OPERATING CONDITIONS** as RF amplifier in grounded grid circuit at 500 MHz

| | | | CCS | ICAS | |
|---|---|---|---|---|---|
| Anode voltage | $V_a$ | = | 300 | 350 | V |
| Grid voltage | $V_g$ | = | -47 | -51 | V [2]) |
| Anode current | $I_a$ | = | 33 | 35 | mA |
| Grid current | $I_g$ | = | 13 | 13 | mA |
| Driver output power | $W_{dr}$ | = | 2.0 | 2.5 | W |
| Output power | $W_o$ | = | 7.5 | 8.5 | W |

---

[1]) In applications where the anode dissipation exceeds 2.5 watts, it is important that a large area of contact be provided between the anode cylinder and the connector in order to provide adequate heat conduction.

[2]) Obtained from grid resistor.

**R. F. POWER AMPLIFIER AND OSCILLATOR CLASS C TELEGRAPHY**
(continued)

**OPERATING CONDITIONS** as RF amplifier in grounded grid circuit at 1000 MHz

| | | | CCS | ICAS | |
|---|---|---|---|---|---|
| Anode voltage | $V_a$ | = | 300 | 350 | V |
| Grid voltage | $V_g$ | = | -30 | -33 | V [2] |
| Anode current | $I_a$ | = | 33 | 33 | mA |
| Grid current | $I_g$ | = | 12 | 13 | mA |
| Driver output power | $W_{dr}$ | = | 1.9 | 2.4 | W |
| Output power | $W_o$ | = | 5.5 | 6.5 | W |

**OPERATING CONDITIONS** as oscillator in grounded grid circuit at 500 MHz

| | | | CCS | ICAS | |
|---|---|---|---|---|---|
| Anode voltage | $V_a$ | = | 300 | 350 | V |
| Grid voltage | $V_g$ | = | -47 | -51 | V [2] |
| Anode current | $I_a$ | = | 33 | 35 | mA |
| Grid current | $I_g$ | = | 13 | 13 | mA |
| Output power | $W_o$ | = | 5 | 6 | W |

[1]) In applications where the anode dissipation exceeds 2.5 watts, it is important that a large area of contact be provided between the anode cylinder and the connector in order to provide adequate heat conduction.

[2]) Obtained from grid resistor.

## FREQUENCY DOUBLER

**LIMITING VALUES** (Absolute limits)

For altitudes up to 30 km

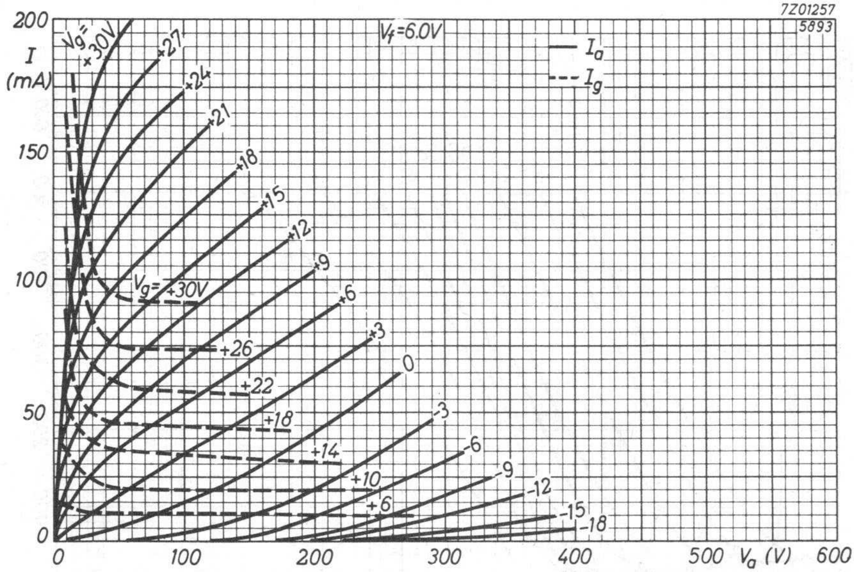
| | | | CCS | ICAS | |
|---|---|---|---|---|---|
| Anode voltage | $V_a$ | = max. | 260 | 320 | V |
| Negative grid voltage | $-V_g$ | = max. | 100 | 100 | V |
| Anode current | $I_a$ | = max. | 33 | 33 | mA |
| Grid current | $I_g$ | = max. | 12 | 12 | mA |
| Anode input power | $W_{i_a}$ | = max. | 8.5 | 10.5 | W |
| Anode dissipation | $W_a$ | = max. | 6 | 7.5 | W [1]) |
| Grid circuit resistance | $R_g$ | = max. | 0.1 | 0.1 | MΩ |
| Cathode to heater voltage | $V_{kf}$ | = max. | 90 | 90 | V |
| | $-V_{kf}$ | = max. | 90 | 90 | V |

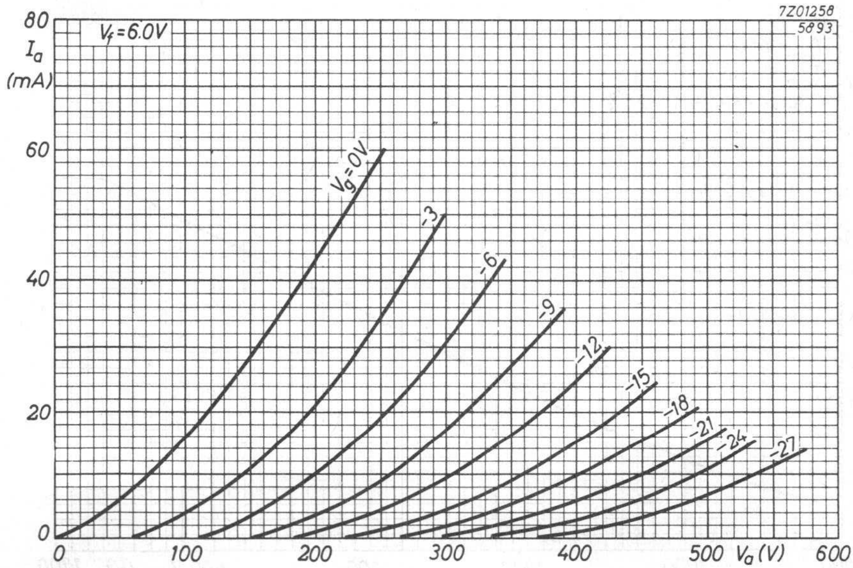
**OPERATING CONDITIONS** as frequency doubler up to 1000 MHz in grounded grid circuit

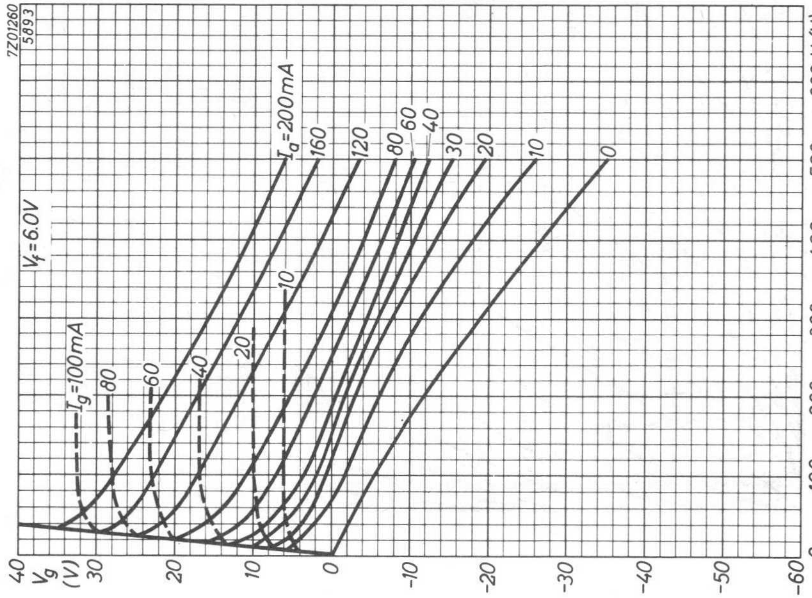
| | | | CCS | ICAS | |
|---|---|---|---|---|---|
| Anode voltage | $V_a$ | = | 250 | 300 | V |
| Grid voltage | $V_g$ | = | -40 | -50 | V [2]) |
| Anode current | $I_a$ | = | 33 | 33 | mA |
| Grid current | $I_g$ | = | 7 | 8 | mA |
| Driver output power | $W_{dr}$ | = | 3.2 | 3.5 | W |
| Output power | $W_o$ | = | 2.75 | 3.0 | W |

1) In applications where the anode dissipation exceeds 2.5 watts, it is important that a large area of contact be provided between the anode cylinder and the connector in order to provide adequate heat conduction.

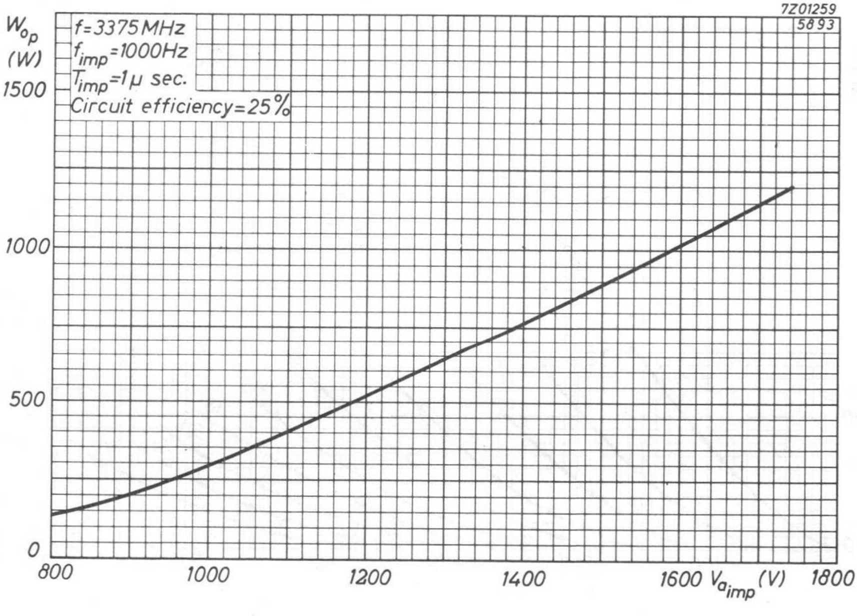
2) Obtained from grid resistor.


7Z01257
5893
Vf=6.0V
Ia
Ig
I (mA)
Va (V)
Vg= +30V
+27
+24
+21
+18
+15
+12
+9
+6
+3
0
-3
-6
-9
-12
-15
-18
Vg= +30V
+26
+22
+18
+14
+10
+6
200
150
100
50
0
0
100
200
300
400
500
600


7Z01258
5893
Vf=6.0V
Ia (mA)
Va (V)
Vg=0V
-3
-6
-9
-12
-15
-18
-21
-24
-27
80
60
40
20
0
0
100
200
300
400
500
600



7Z01260
5893
$I_a$=200mA
160
120
80
60
40
30
20
10
0
$V_f$=6.0V
$I_g$=100mA
80
60
40
20
10
$V_g$ (V)
40
30
20
10
0
-10
-20
-30
-40
-50
-60
$V_a$(V)
0
100
200
300
400
500
600

$W_{o_p}$ (W)
1500
1000
500
0
f=3375 MHz
$f_{imp}$=1000Hz
$T_{imp}$=1μ sec.
Circuit efficiency=25%
7Z01259
5893
800
1000
1200
1400
1600
$V_{a_{imp}}$ (V)
1800

# PENCIL TYPE UHF MEDIUM MU TRIODE

Pencil type UHF medium mu triode with external anode radiator for use in grounded grid service as RF power amplifier and oscillator. The tube can be used at altitudes up to 20 km without pressurized chambers.

| QUICK REFERENCE DATA | | | | | |
|---|---|---|---|---|---|
| Amplification factor | | $\mu$ | = | 27 | |
| Mutual conductance | | S | = | 7 | mA/V |
| Maximum anode dissipation | CCS | $W_a$ | = max. | 8 | W |
| | ICAS | $W_a$ | = max. | 13 | W |

**HEATING:** indirect by A.C. or D.C.

| | | | |
|---|---|---|---|
| Heater voltage under stand by conditions | $V_f$ | = 6.3 | V |
| Heater voltage under transmitting conditions | $V_f$ | = 6.0 | V ± 10% |
| Heater current at $V_f$ = 6.0 V | $I_f$ | = 280 | mA |

**CAPACITANCES**

| | | | | |
|---|---|---|---|---|
| Anode to all except grid without external shield | $C_a$ | < | 0.08 | pF |
| Grid to all except anode without external shield | $C_g$ | = | 2.9 | pF |
| Anode to grid without external shield | $C_{ag}$ | = | 1.7 | pF |
| Anode to grid with external shield [1]) | $C_{ag}$ | = | 1.5 | pF |

**TYPICAL CHARACTERISTICS**

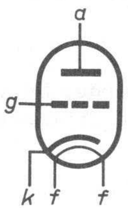
| | | | | |
|---|---|---|---|---|
| Anode voltage | $V_a$ | = | 200 | V |
| Anode current | $I_a$ | = | 27 | mA |
| Amplification factor | $\mu$ | = | 27 | |
| Mutual conductance | S | = | 7 | mA/V |

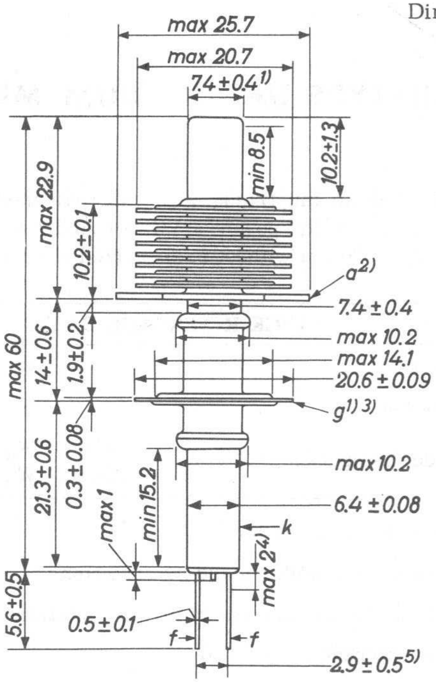
[1]) Flat plate shield 31.75 mm diameter located parallel to the plane of the grid flange and midway between the grid flange and the anode terminal fin of the radiator. The shield is tied to the cathode.

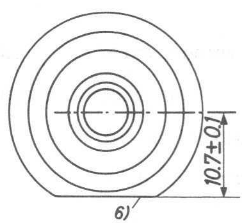
**MECHANICAL DATA**

Dimensions in mm

Net weight: 24 g




Mounting position: arbitrary

---

1) Maximum eccentricity of the axes of the radiator core cap and the grid terminal flange with respect to the axis of the cathode terminal is 0.38 mm.

2) The tilt of the anode terminal fin of the radiator with respect to the rotational axis of the cathode cylinder is determined by chucking the cathode terminal, rotating the tube and gauging the total travel distance of the anode terminal fin parallel to the axis at a point approximately 0.5 mm inward from the straight edge of the anode terminal fin for one complete rotation. The total travel distance will not exceed 0.9 mm.

## COOLING

To keep the anode seal temperature below the maximum admissible value of 175 °C generally no forced air cooling will be required. Under conditions of free circulation of air an adequate cooling will be provided by means of the radiator in combination with a connector having adequate heat conduction capability. Under less favourable environmental conditions provision should be made to direct a blast of cooling air from a small blower through the radiator fins. The quantity of air should be sufficient to limit the anode seal temperature to 175 °C.
See also the cooling curves page 8.

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Page 2

3) The tilt of the grid terminal flange with respect to the rotational axis of the cathode terminal is determined by chucking the cathode terminal, rotating the tube and gauging the total travel distance of the grid terminal flange parallel to the axis at a point approximately 0.5 mm inward from its edge for one complete rotation. The total travel distance will not exceed 0.64 mm.

4) Not tinned.

5) Distance at the terminal tips.

6) The straight edge on the perimeter of the large fin (anode terminal) is parallel to a plane through the centres of the heater leads at their seals within 15°.

## R.F. CLASS C TELEGRAPHY

Key down conditions per tube without amplitude modulation. Modulation essentially negative may be used if the positive peak of the audio frequency does not exceed 115% of the carrier conditions.

**LIMITING VALUES** (Absolute limits)

The tube can be operated with full ratings at frequencies up to 500 MHz and at pressures down to 46 mm of Hg (corresponding to an altitude of about 20 km). With reduced ratings the tube can be operated at frequencies as high as 1700 MHz.

| | | | CCS | ICAS | |
|---|---|---|---|---|---|
| Anode voltage | $V_a$ | = | max. 330 | max. 400 | V |
| Anode current | $I_a$ | = | max. 40 | max. 55 | mA |
| Anode input power | $W_{ia}$ | = | max. 13 | max. 22 | W |
| Anode dissipation | $W_a$ | = | max. 8 | max. 13 | W |
| Negative grid voltage | $-V_g$ | = | max. 100 | max. 100 | V |
| Grid current | $I_g$ | = | max. 25 | max. 25 | mA |
| Grid circuit resistance | $R_g$ | = | max. 0.1 | max. 0.1 | MΩ |
| Cathode current | $I_k$ | = | max. 55 | max. 70 | mA |
| Heater to cathode voltage | $V_{kf}$ | = | max. 90 | max. 90 | V |
| Anode seal temperature | t | = | max. 175 | max. 175 | °C |

**OPERATING CHARACTERISTICS AS POWER AMPLIFIER** in grounded grid circuit

| | | | CCS | ICAS | |
|---|---|---|---|---|---|
| Frequency | f | = | 500 | 500 | MHz |
| Anode voltage | $V_a$ | = | 300 | 350 | V |
| Anode current | $I_a$ | = | 35 | 40 | mA |
| Grid voltage | $V_g$ | = | −48 | −58 | V [1] |
| Grid current | $I_g$ | = | 13 | 15 | mA |
| Driving power | $W_{dr}$ | = | 2.2 | 3.0 | W |
| Output power in the load | $W_\ell$ | = | 7 | 10 | W [2][3] |

---

[1] From a grid resistor or from a suitable combination of grid resistor and fixed supply or grid resistor and cathode resistor.

[2] Measured in a circuit having an efficiency of about 75%.

[3] Power transferred from driving stage included.

R.F. CLASS C TELEGRAPHY (continued)

OPERATING CHARACTERISTICS AS OSCILLATOR

| | | | CCS | ICAS | |
|---|---|---|---|---|---|
| Frequency | f | = | 500 | 500 | MHz |
| Anode voltage | $V_a$ | = | 300 | 350 | V |
| Anode current | $I_a$ | = | 35 | 40 | mA |
| Grid voltage | $V_g$ | = | -30 | -35 | V [1]) |
| Grid current | $I_g$ | = | 11 | 14 | mA |
| Output power in the load | $W_\ell$ | = | 5 | 7 | W [2]) |

[1]) From a grid resistor or from a suitable combination of grid resistor and fixed supply or grid resistor and cathode resistor.

[2]) Measured in a circuit having an efficiency of about 75 %

R.F. CLASS C ANODE MODULATED POWER AMPLIFIER

**LIMITING VALUES** (Absolute limits)

The tube can be operated with full ratings at pressures down to 46 mm of Hg (corresponding to an altitude of about 20 km)

| | | | CCS | ICAS | |
|---|---|---|---|---|---|
| Anode voltage | $V_a$ | = | max. 275 | max. 320 | V |
| Anode current | $I_a$ | = | max. 33 | max. 46 | mA |
| Anode input power | $W_{i_a}$ | = | max. 9 | max. 15 | W |
| Anode dissipation | $W_a$ | = | max. 5.5 | max. 9 | W |
| Negative grid voltage | $-V_g$ | = | max. 100 | max. 100 | V |
| Grid current | $I_g$ | = | max. 25 | max. 25 | mA |
| Grid circuit resistance | $R_g$ | = | max. 0.1 | max. 0.1 | MΩ |
| Cathode current | $I_k$ | = | max. 50 | max. 60 | mA |
| Heater to cathode voltage | $V_{kf}$ | = | max. 90 | max. 90 | V |
| Anode seal temperature | t | = | max. 175 | max. 175 | °C |

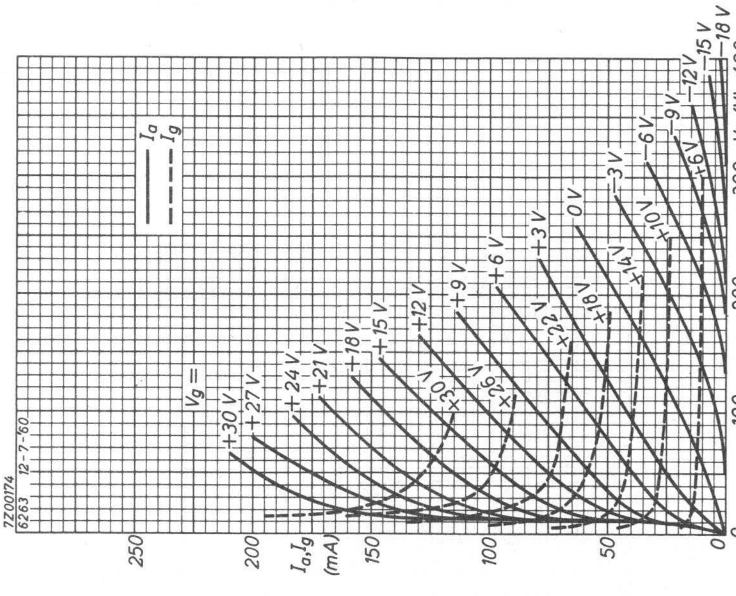
**OPERATING CHARACTERISTICS** in grounded grid circuit

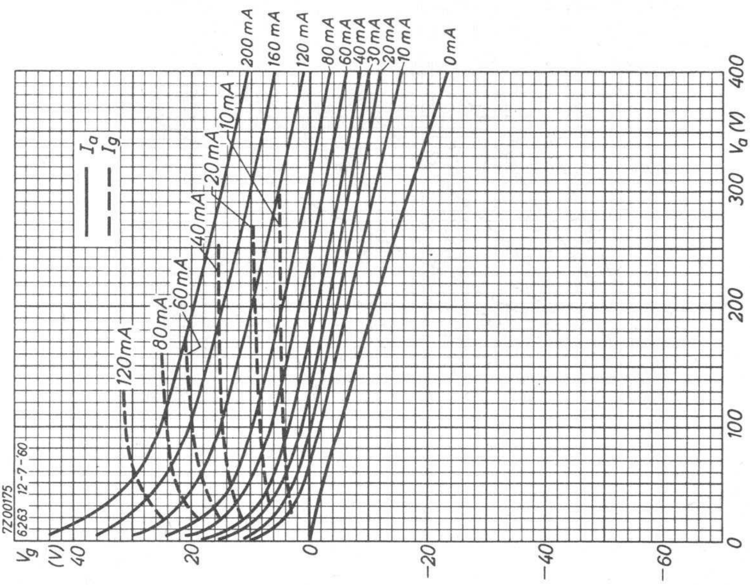
| | | | CCS | ICAS | |
|---|---|---|---|---|---|
| Frequency | f | = | 500 | 500 | MHz |
| Anode voltage | $V_a$ | = | 275 | 320 | V |
| Anode current | $I_a$ | = | 33 | 35 | mA |
| Grid voltage | $V_g$ | = | -42 | -52 | V [1] |
| Grid current | $I_g$ | = | 13 | 12 | mA |
| Driving power | $W_{dr}$ | = | 2.0 | 2.4 | W |
| Output power in the load | $W_\ell$ | = | 6.7 | 8 | W [2][3] |

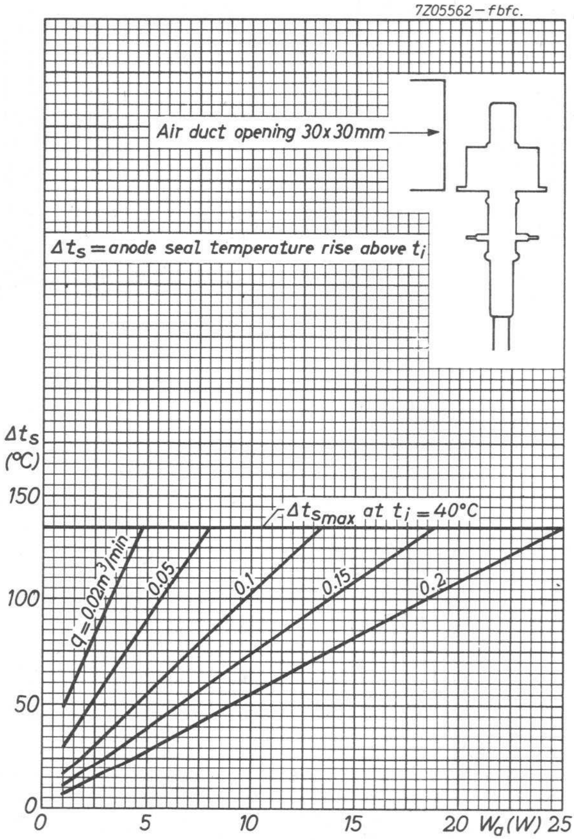
[1] From a grid resistor or from a suitable combination of grid resistor and fixed supply or grid resistor and cathode resistor.

[2] Measured in a circuit having an efficiency of about 75%.

[3] Power transferred from driving stage included.


7Z00174
6263 12-7-'60
$V_g$ =
+30 V
+27 V
+24 V
+21 V
+18 V
+15 V
+12 V
+9 V
+6 V
+3 V
0 V
−3 V
−6 V
−9 V
−12 V
−15 V
−18 V
+30 V
+26 V
+22 V
+18 V
+14 V
+10 V
+6 V
$I_a$
$I_g$
$I_a, I_g$ (mA)
$V_a$ (V)
0
50
100
150
200
250
0
100
200
300
400


7Z00175
6263 12-7-'60
$V_g$ (V)
40
20
0
−20
−40
−60
$I_a$
$I_g$
120mA
80mA
60mA
40mA
20mA
10mA
200 mA
160 mA
120 mA
80 mA
60 mA
40 mA
30 mA
20 mA
10 mA
0 mA
$V_a$ (V)
0
100
200
300
400


7Z05562 – fbfc.
Air duct opening 30x30mm
Δts = anode seal temperature rise above ti
Δts
(°C)
150
100
50
0
Δtsmax at ti = 40°C
q = 0.02m3/min
0.05
0.1
0.15
0.2
0
5
10
15
20 Wa(W) 25

# PENCIL TYPE UHF MEDIUM MU TRIODE

The 6263A is the ruggedized version of the 6263

# PENCIL TYPE UHF MEDIUM MU TRIODE

Pencil type UHF medium mu triode with external anode radiator for use in grounded grid service as frequency multiplier; also useful as RF power amplifier and oscillator. The tube can be used at altitudes up to 20 km without pressurized chambers.

| QUICK REFERENCE DATA | | | | | |
|---|---|---|---|---|---|
| Amplification factor | | $\mu$ | = | 40 | |
| Mutual conductance | | S | = | 6.8 | mA/V |
| Maximum anode dissipation | CCS | $W_a$ | = | max. 8 | W |
| | ICAS | $W_a$ | = | max. 13 | W |

**HEATING**: indirect by A.C. or D.C.

| | | | |
|---|---|---|---|
| Heater voltage under stand by conditions | $V_f$ | = 6.3 | V |
| Heater voltage under transmitting conditions | $V_f$ | = 6.0 | V ±10% |
| Heater current at $V_f$ = 6.0 V | $I_f$ | = 280 | mA |

**CAPACITANCES**

| | | | |
|---|---|---|---|
| Anode to all except grid without external shield | $C_a$ | < 0.07 | pF |
| Grid to all except anode without external shield | $C_g$ | = 2.95 | pF |
| Anode to grid without external shield | $C_{ag}$ | = 1.75 | pF |
| Anode to grid with external shield [1]) | $C_{ag}$ | = 1.5 | pF |

**TYPICAL CHARACTERISTICS**

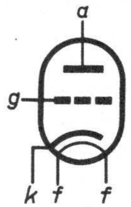
| | | | |
|---|---|---|---|
| Anode voltage | $V_a$ | = 200 | V |
| Anode current | $I_a$ | = 18.5 | mA |
| Amplification factor | $\mu$ | = 40 | |
| Mutual conductance | S | = 6.8 | mA/V |

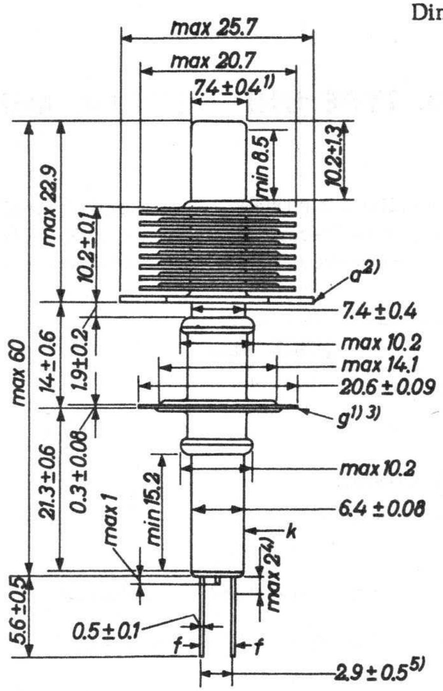
[1]) Flat plate shield 31.75 mm diameter located parallel to the plane of the grid flange and midway between the grid flange and the anode terminal fin of the radiator. The shield is tied to the cathode.

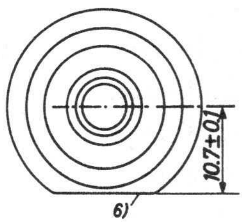
## MECHANICAL DATA

Dimensions in mm

Net weight: 24 g




Mounting position: arbitrary

---

1) Maximum eccentricity of the axes of the radiator core cap and the grid terminal flange with respect to the axis of the cathode terminal is 0.38 mm.

2) The tilt of the anode terminal fin of the radiator with respect to the rotational axis of the cathode cylinder is determined by chucking the cathode terminal, rotating the tube and gauging the total travel distance of the anode terminal fin parallel to the axis at a point approximately 0.5 mm inward from the straight edge of the anode terminal fin for one complete rotation. The total travel distance will not exceed 0.9 mm.

## COOLING

To keep the anode seal temperature below the maximum admissible value of 175 °C generally no forced air cooling will be required. Under conditions of free circulation of air an adequate cooling will be provided by means of the radiator in combination with a connector having adequate heat conduction capability. Under less favourable environmental conditions provision should be made to direct a blast of cooling air from a small blower through the radiator fins. The quantity of air should be sufficient to limit the anode seal temperature to 175 °C.
See also the cooling curves page 8.

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Page 2

3) The tilt of the grid terminal flange with respect to the rotational axis of the cathode terminal is determined by chucking the cathode terminal, rotating the tube and gauging the total travel distance of the grid terminal flange parallel to the axis at a point approximately 0.5 mm inward from its edge for one complete rotation. The total travel distance will not exceed 0.64 mm.

4) Not tinned.

5) Distance at the terminal tips.

6) The straight edge on the perimeter of the large fin (anode terminal) is parallel to a plane through the centres of the heater leads at their seals within 15°.

## R.F. CLASS C TELEGRAPHY

Key down conditions per tube without amplitude modulation. Modulation essentially negative may be used if the positive peak of the audio frequency does not exceed 115% of the carrier conditions.

**LIMITING VALUES** (Absolute limits)

The tube can be operated with full ratings at frequencies up to 500 MHz and at pressures down to 46 mm of Hg (corresponding to an altitude of about 20 km). With reduced ratings the tube can be operated at frequencies as high as 1700 MHz

| | | | CCS | ICAS | |
|---|---|---|---|---|---|
| Anode voltage | $V_a$ | = | max. 330 | max. 400 | V |
| Anode current | $I_a$ | = | max. 40 | max. 50 | mA |
| Anode input power | $W_{i_a}$ | = | max. 13 | max. 22 | W |
| Anode dissipation | $W_a$ | = | max. 8 | max. 13 | W |
| Negative grid voltage | $-V_g$ | = | max. 100 | max. 100 | V |
| Grid current | $I_g$ | = | max. 25 | max. 25 | mA |
| Grid circuit resistance | $R_g$ | = | max. 0.1 | max. 0.1 | MΩ |
| Cathode current | $I_k$ | = | max. 55 | max. 70 | mA |
| Heater to cathode voltage | $V_{kf}$ | = | max. 90 | max. 90 | V |
| Anode seal temperature | t | = | max. 175 | max. 175 | °C |

**OPERATING CHARACTERISTICS AS POWER AMPLIFIER** in grounded grid circuit

| | | | CCS | ICAS | |
|---|---|---|---|---|---|
| Frequency | f | = | 500 | 500 | MHz |
| Anode voltage | $V_a$ | = | 300 | 350 | V |
| Anode current | $I_a$ | = | 35 | 40 | mA |
| Grid voltage | $V_g$ | = | -42 | -45 | V [1]) |
| Grid current | $I_g$ | = | 13 | 15 | mA |
| Driving power | $W_{dr}$ | = | 2.4 | 3.0 | W |
| Output power in the load | $W_\ell$ | = | 7.5 | 10 | W [2])[3]) |

---

[1]) From a grid resistor or from a suitable combination of grid resistor and fixed supply or grid resistor and cathode resistor.

[2]) Measured in a circuit having an efficiency of about 75 %

[3]) Power transferred from driving stage included.

R.F. CLASS C TELEGRAPHY (continued)

OPERATING CHARACTERISTICS AS OSCILLATOR

| | | | CCS | ICAS | |
|---|---|---|---|---|---|
| Frequency | f | = | 500 | 500 | MHz |
| Anode voltage | $V_a$ | = | 300 | 350 | V |
| Anode current | $I_a$ | = | 35 | 35 | mA |
| Grid voltage | $V_g$ | = | -25 | -30 | V [1] |
| Grid current | $I_g$ | = | 11 | 13 | mA |
| Output power in the load | $W_\ell$ | = | 5 | 6 | W [2] |

[1] From a grid resistor or from a suitable combination of grid resistor and fixed supply or grid resistor and cathode resistor.

[2] Measured in a circuit having an efficiency of about 75 %

## R.F. CLASS C FREQUENCY TRIPLER

**LIMITING VALUES** (Absolute limits)

The tube can be operated with full ratings at pressures down to 46 mm of Hg (corresponding to an altitude of about 20 km)

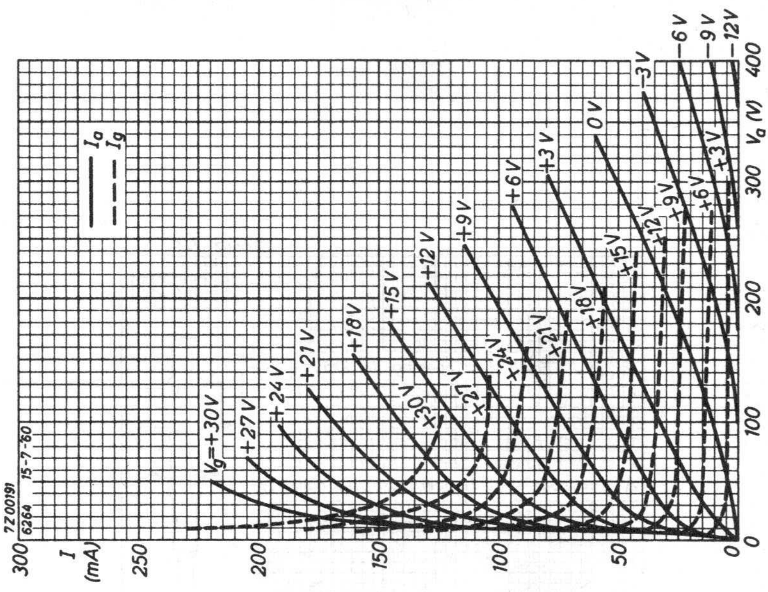
| | | | CCS | ICAS | |
|---|---|---|---|---|---|
| Anode voltage | $V_a$ | = | max. 300 | max. 350 | V |
| Anode current | $I_a$ | = | max. 33 | max. 45 | mA |
| Anode input power | $W_{i_a}$ | = | max. 9.9 | max. 15.8 | W |
| Anode dissipation | $W_a$ | = | max. 6 | max. 9.5 | W |
| Negative grid voltage | $-V_g$ | = | max. 125 | max. 140 | V |
| Grid current | $I_g$ | = | max. 15 | max. 15 | mA |
| Grid circuit resistance | $R_g$ | = | max. 0.1 | max. 0.1 | MΩ |
| Cathode current | $I_k$ | = | max. 45 | max. 55 | mA |
| Heater to cathode voltage | $V_{kf}$ | = | max. 90 | max. 90 | V |
| Anode seal temperature | t | = | max. 175 | max. 175 | °C |

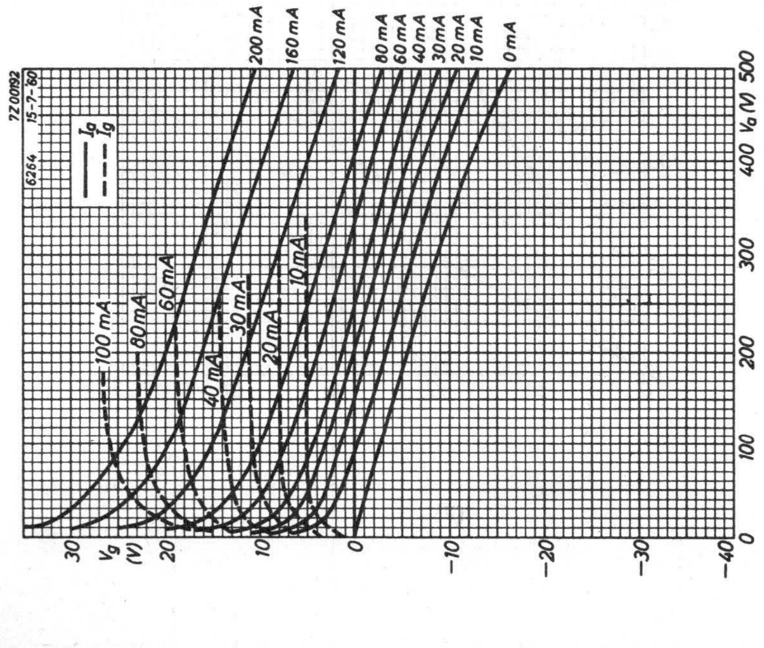
**OPERATING CHARACTERISTICS** in grounded grid circuit

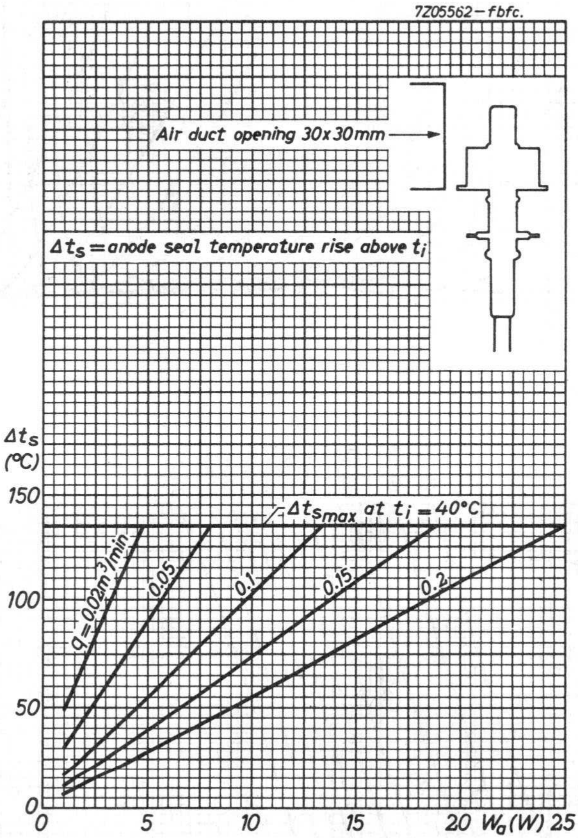
| | | | CCS | ICAS | |
|---|---|---|---|---|---|
| Frequency | f | = | 170/510 | 170/510 | MHz |
| Anode voltage | $V_a$ | = | 300 | 350 | V |
| Anode current | $I_a$ | = | 26 | 36.5 | mA |
| Grid voltage | $V_g$ | = | -110 | -122 | V [1]) |
| Grid current | $I_g$ | = | 4.1 | 5.8 | mA |
| Driving power | $W_{dr}$ | = | 2.75 | 4.5 | W |
| Output power in the load | $W_\ell$ | = | 2.1 | 3.4 | W [2]) |

1) From a grid resistor or from a suitable combination of grid resistor and fixed supply or grid resistor and cathode resistor.

2) Measured in a circuit having an efficiency of about 75%.


7Z00191
6264
15-7-'60
$I_a$
$I_g$
$V_g$=+30V
+27V
+24V
+21V
+18V
+15V
+12V
+9V
+6V
+3V
0V
−3V
−6V
−9V
−12V
+30V
+27V
+24V
+21V
+18V
+15V
+12V
+9V
+6V
+3V
I (mA)
300
250
200
150
100
50
0
0
100
200
300
400
$V_a$ (V)


7Z00192
6264
15-7-'60
$I_a$
$I_g$
200mA
160mA
120mA
80mA
60mA
40mA
30mA
20mA
10mA
0mA
100mA
80mA
60mA
40mA
30mA
20mA
10mA
$V_g$ (V)
30
20
10
0
−10
−20
−30
−40
0
100
200
300
400
500
$V_a$ (V)


7Z05562-fbfc.
Air duct opening 30x30mm
Δts = anode seal temperature rise above ti
Δts (°C)
150
100
50
0
Δtsmax at ti = 40°C
q = 0.02m3/min
0.05
0.1
0.15
0.2
0
5
10
15
20 Wa(W) 25

# PENCIL TYPE UHF MEDIUM MU TRIODE

The 6264A is the ruggedized version of the 6264

# DISC SEAL TRIODE

Air cooled disc seal triode of metal-ceramic construction intended for use as oscillator, modulator, mixer, frequency multiplier and amplifier up to a frequency of 3000 MHz. Rugged construction.

| QUICK REFERENCE DATA | | | |
|---|---|---|---|
| Output power at f = 2500 MHz | $W_o$ | 24 | W |
| Transconductance | S | 25 | mA/V |
| Amplification factor | $\mu$ | 100 | |
| Construction | metal-ceramic | | |

**HEATING:** Indirect by A.C., parallel supply.

| | | | |
|---|---|---|---|
| Heater voltage | $V_f$ | 6.0 | V 1) 2) |
| Heater current | $I_f$ | 0.9 to 1.05 | A |
| Cathode heating time | $T_h$ | min. 1 | min |

**CAPACITANCES**

| | | | |
|---|---|---|---|
| Anode to cathode | $C_{ak}$ | < 0.035 | pF |
| Anode to grid | $C_{ag}$ | 1.95 to 2.15 | pF |
| Grid to cathode | $C_{gk}$ | 5.6 to 7.0 | pF |
| Anode to cathode ($V_f$ = 6.0 V, $I_k$ = 0) | $C_{ak}$ | < 0.045 | pF |
| Grid to cathode ($V_f$ = 6.0 V, $I_k$ = 0) | $C_{gk}$ | 7.5 | pF |

**TYPICAL CHARACTERISTICS**

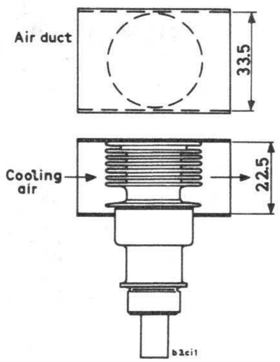
| | | | |
|---|---|---|---|
| Anode voltage | $V_a$ | 600 | V |
| Cathode resistor | $R_k$ | 30 | Ω |
| Anode current | $I_a$ | 60 to 95 | mA |
| Transconductance | S | 20 to 30 | mA/V |
| Amplification factor | $\mu$ | 100 | |

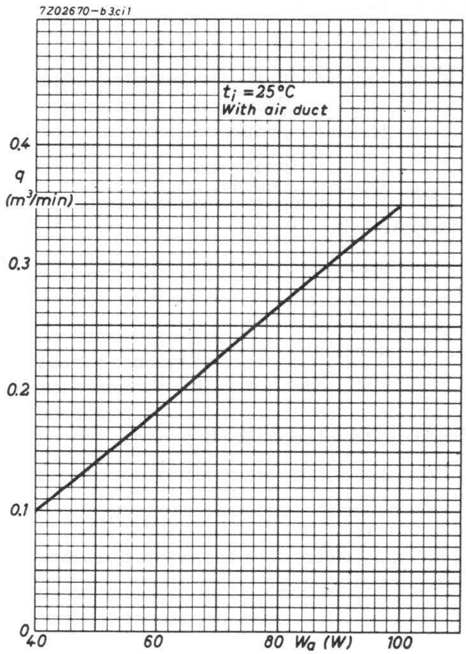
1) The heater voltage should be reduced to a value depending on the cathode current and frequency. See curve on page 6 . The maximum fluctuation should not exceed ± 5%.

2) For pulsed operation, 6 V is normally required for preheating. For C.W. operation preheating should be effected at the voltage indicated by the curve for f = 500 MHz on page 6. In the case of power-off periods of up to 5 s or C.W. operation with $V_a$ = max. 300 V and $I_k$ = max. 30 mA, preheating is not necessary.

## COOLING

At maximum anode dissipation, an air duct of the dimensions indicated below being used and the inlet temperature being 25 °C, an air flow of approx. 350 l/min should be directed at the radiator. If necessary, the other surfaces should be cooled as well with a low-velocity air flow. As the ventilation system has to be adapted to the particular transmitter in which the tube will be used, it cannot be furnished as an accessory.



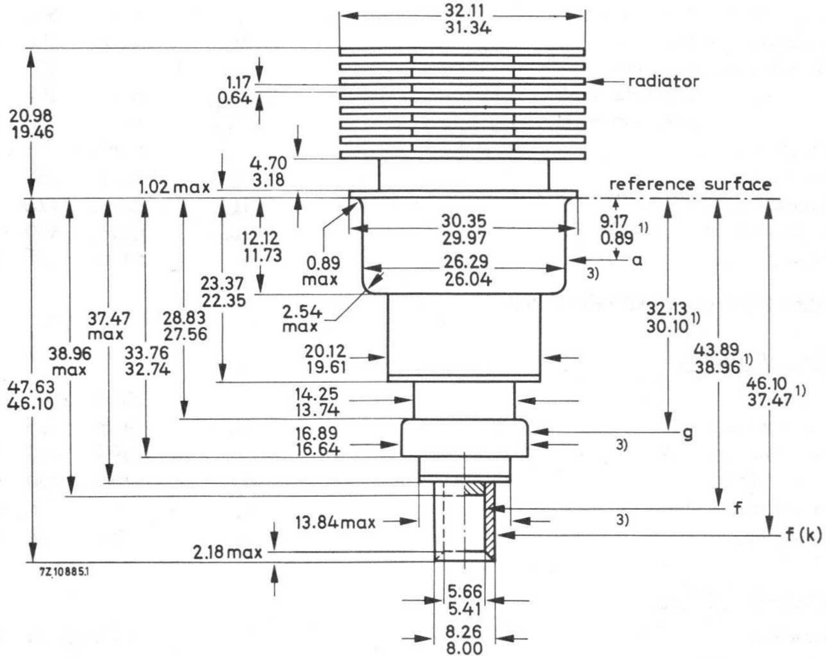



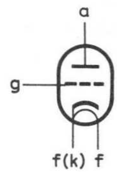

## LIFE EXPECTANCY

The life of the tube depends on the operating conditions and particularly on the tube temperature and the anode voltage. It is therefore recommended that the tube output required be attained with the lowest possible anode voltage, and that the tube temperature be kept as low as possible by adequate cooling.

**MECHANICAL DATA**

Dimensions in mm
The mm dimensions are derived from the original inch dimensions.




Mounting position: any
Net weight: approx. 70 g

1) Electrode contact areas.
2) Holes for tube extractor through top fin only.
3) Eccentricity of contact surfaces:
Reference: cathode
Anode TIR max. 0.5 mm
Grid TIR max. 0.5 mm
Heater TIR max. 0.3 mm

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

| | | | | |
|---|---|---|---|---|
| Frequency | $f$ | up to | 3000 | MHz |
| Anode voltage (unmodulated) | $V_a$ | max. | 1000 | V |
| Anode voltage (100% modulated) | $V_a$ | max. | 600 | V |
| Anode dissipation | $W_a$ | max. | 100 | W |
| Grid voltage, negative | $-V_g$ | max. | 150 | V |
| negative peak | $-V_{gp}$ | max. | 400 | V |
| positive peak | $V_{gp}$ | max. | 30 | V |
| Grid dissipation | $W_g$ | max. | 2 | W |
| Grid current | $I_g$ | max. | 50 | mA |
| Cathode current | $I_k$ | max. | 125 | mA |
| Envelope temperature | $t_{env}$ | max. | 300 | $^oC$ |
| Altitude | $h$ | max. | 20 | km |

**OPERATING CHARACTERISTICS**

C.W. Oscillator

| | | | | |
|---|---|---|---|---|
| Frequency | $f$ | 2500 | 2500 | MHz |
| Heater voltage | $V_f$ | 4.5 | 4.5 | V |
| Anode voltage | $V_a$ | 600 | 800 | V |
| Anode current | $I_a$ | 100 | 100 | mA |
| Grid current | $I_g$ | 10 | 8 | mA |
| Output power | $W_o$ | 16 | 24 | W |

Frequency doubler

| | | | |
|---|---|---|---|
| Frequency | $f$ | 1000/2000 | MHz |
| Heater voltage | $V_f$ | 5.6 | V |
| Anode voltage | $V_a$ | 400 | V |
| Grid voltage | $V_g$ | -15 | V |
| Anode current | $I_a$ | 55 | mA |
| Grid input power | $W_{ig}$ | 1.5 | W |
| Output power | $W_o$ | 5.2 | W |

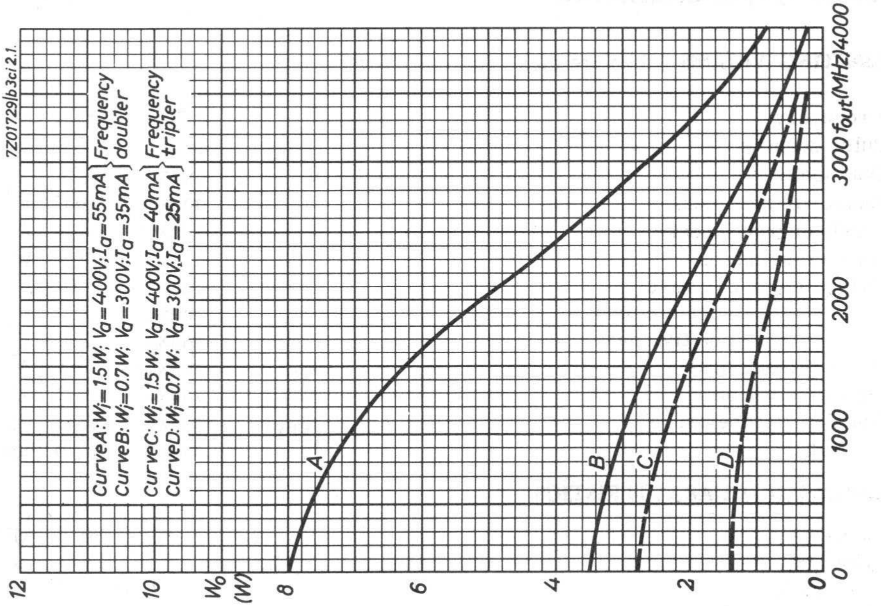
## ANODE PULSED OSCILLATOR

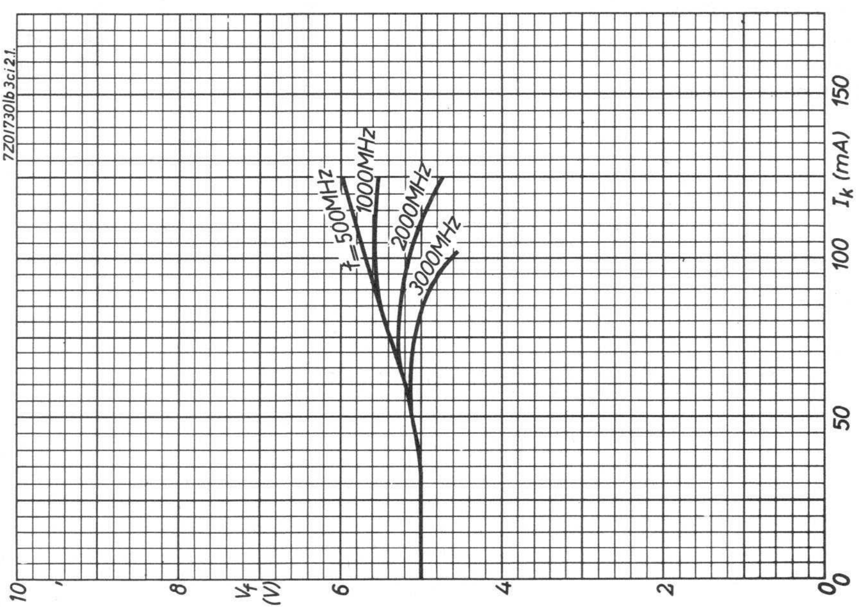
**LIMITING VALUES** (Absolute max. rating system)

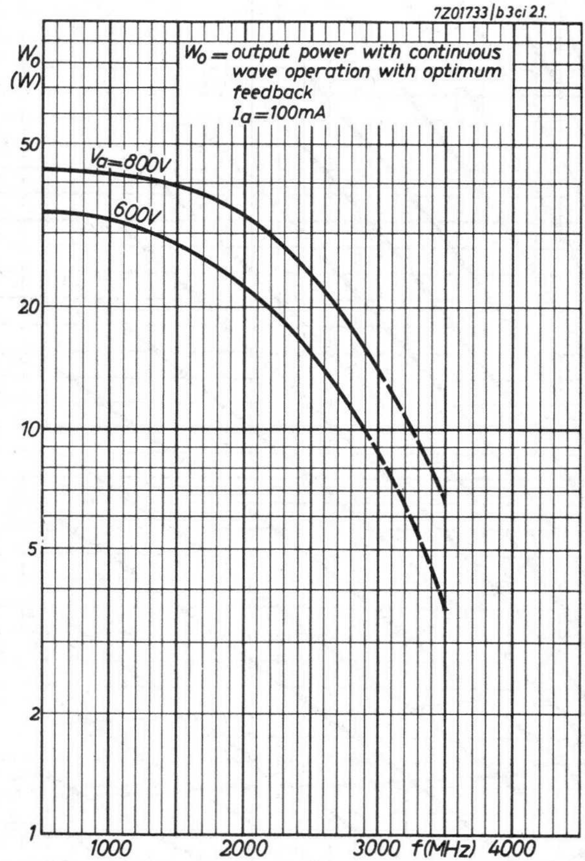
| | | | | |
|---|---|---|---|---|
| Frequency | f | max. | 3000 | MHz |
| Pulse duration | $T_{imp}$ | max. | 3 | $\mu$s |
| Duty cycle | $\delta$ | max. | 0.0025 | |
| Anode voltage, peak | $V_{a_p}$ | max. | 3500 | V |
| Anode current, peak | $I_{a_p}$ | max. | 3 | A |
| Anode dissipation | $W_a$ | max. | 27 | W |
| Grid voltage, negative | $-V_g$ | max. | 150 | V |
| negative peak | $-V_{g_p}$ | max. | 750 | V |
| positive peak | $V_{g_p}$ | max. | 250 | V |
| Grid voltage, peak | $I_{g_p}$ | max. | 1.8 | A |
| Grid dissipation | $W_g$ | max. | 2 | W |
| Envelope temperature | $t_{env}$ | max. | 300 | $^o$C |
| Altitude | h | max. | 20 | km |

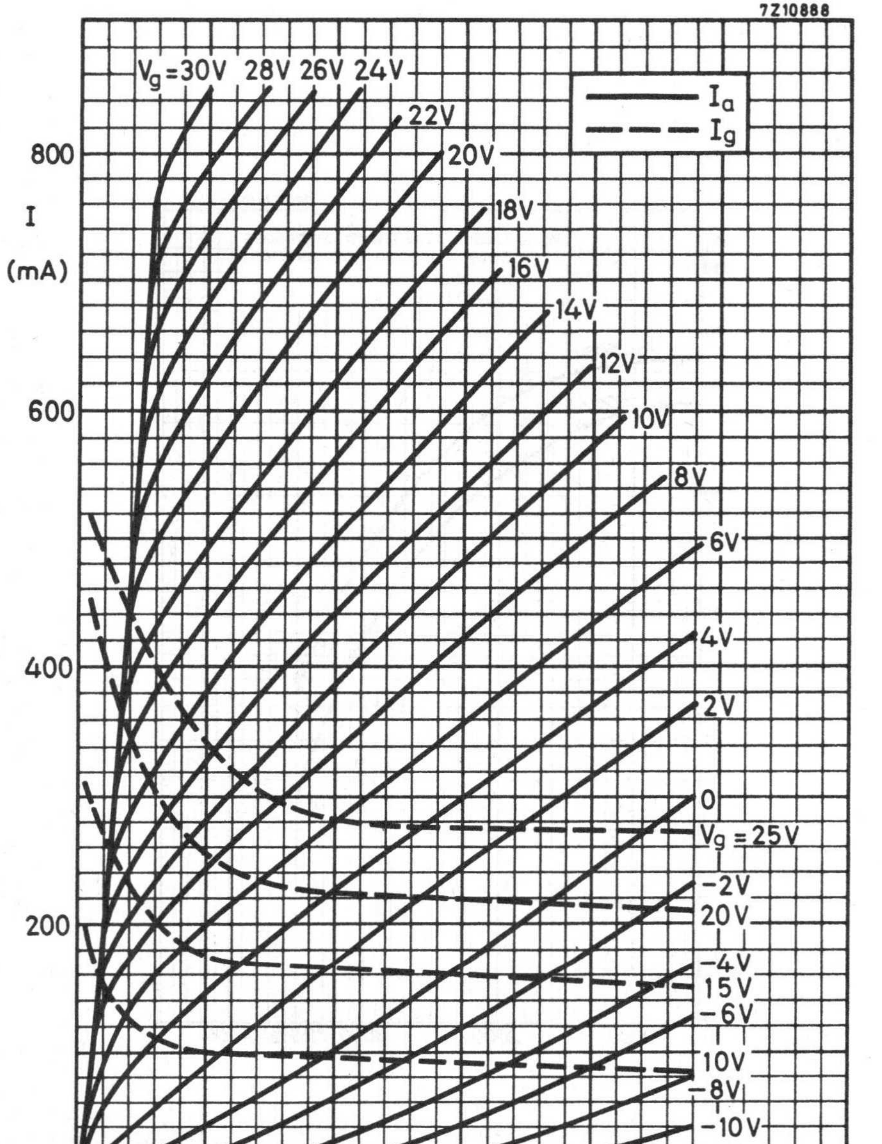
**OPERATING CHARACTERISTICS**

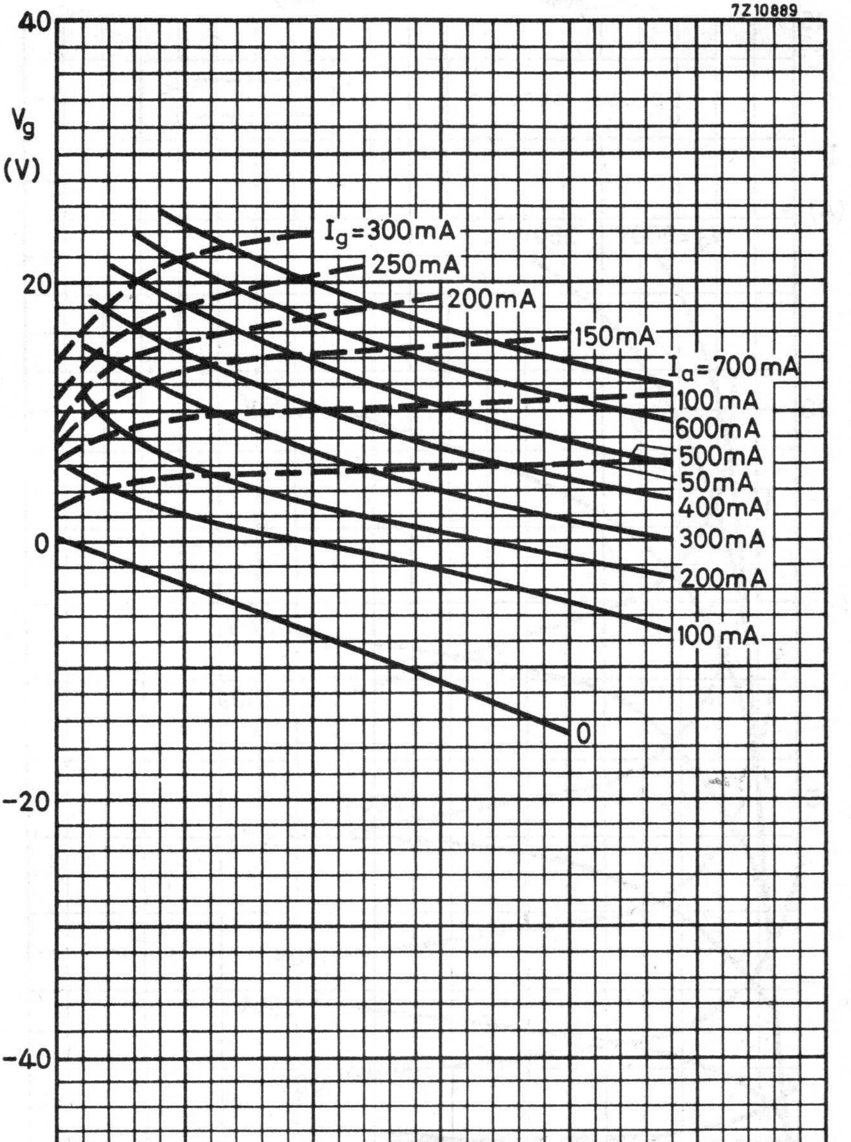
| | | | |
|---|---|---|---|
| Frequency | f | 3000 | MHz |
| Pulse duration | $T_{imp}$ | 3 | $\mu$s |
| Duty cycle | $\delta$ | 0.0025 | |
| Heater voltage | $V_f$ | 5.8 | V |
| Anode voltage, peak | $V_{a_p}$ | 3500 | V |
| Anode current | $I_a$ | 7.5 | mA |
| Grid current | $I_g$ | 4.5 | mA |
| Output power, peak | $W_{o_p}$ | 2 | kW |

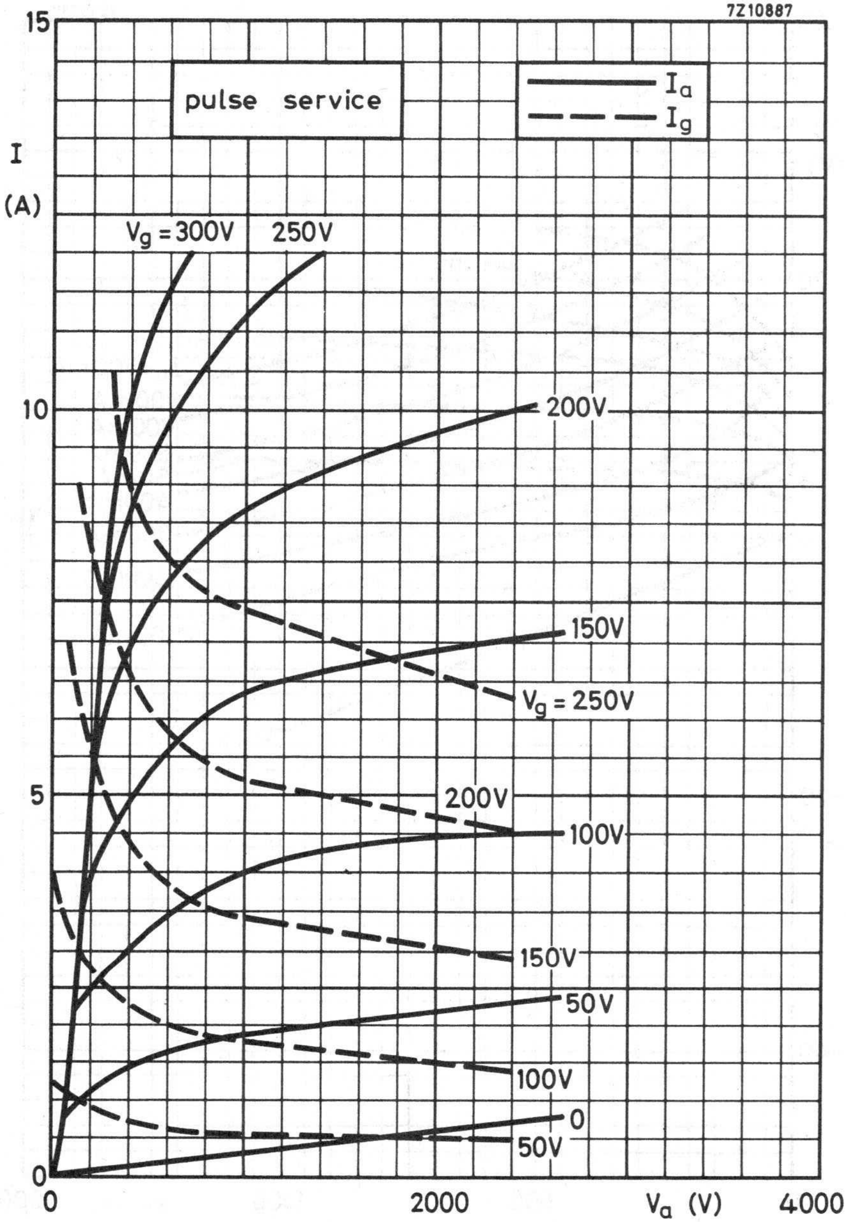

7Z01729/b3ci2.1.
Curve A: Wi = 1.5 W; Va = 400 V; Ia = 55 mA } Frequency doubler
Curve B: Wi = 0.7 W; Va = 300 V; Ia = 35 mA
Curve C: Wi = 1.5 W; Va = 400 V; Ia = 40 mA } Frequency tripler
Curve D: Wi = 0.7 W; Va = 300 V; Ia = 25 mA
A
B
C
D
Wo (W)
12
10
8
6
4
2
0
0
1000
2000
3000
fout (MHz) 4000

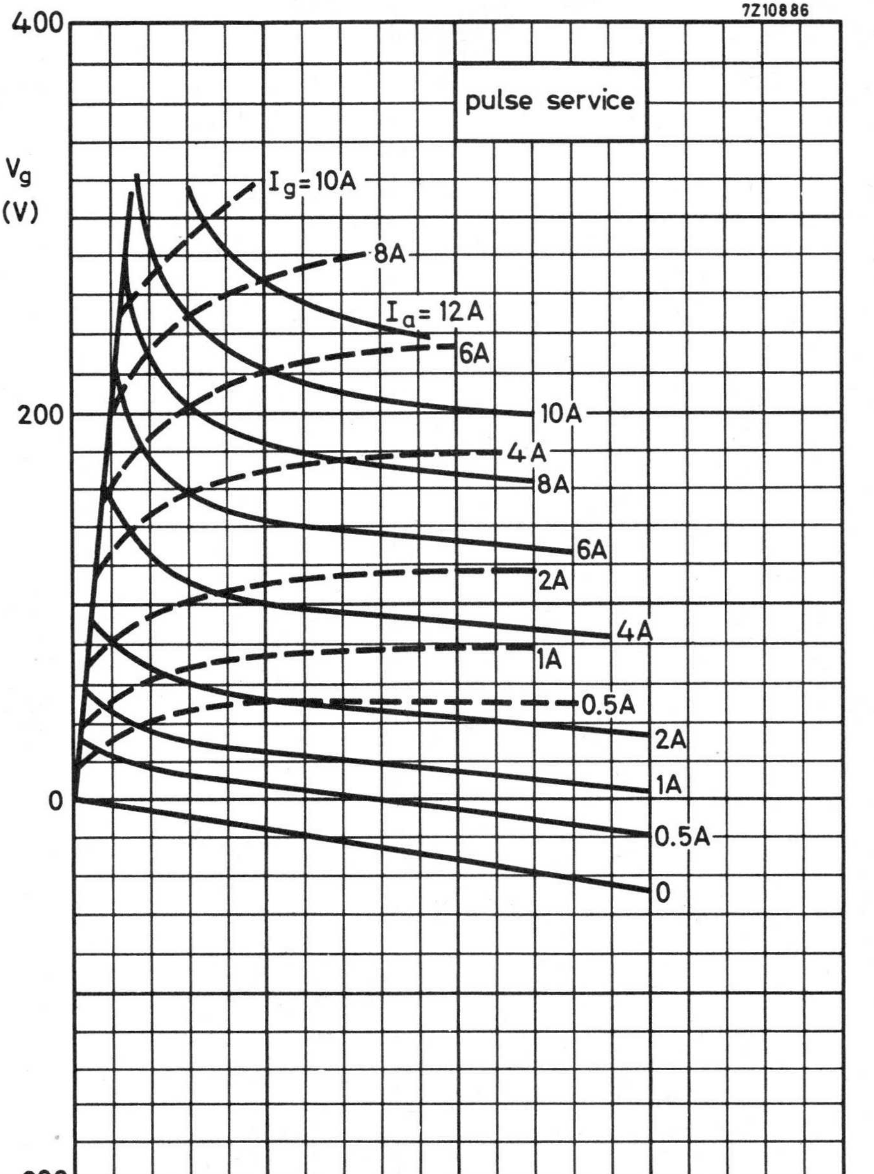

7Z01730/b3ci2.1.
f = 500MHz
1000MHz
2000MHz
3000MHz
Vf (V)
10
8
6
4
2
0
0
50
100
Ik (mA)
150


7Z01733/b3ci 2.1.
$W_o$ (W)
$W_o$ = output power with continuous wave operation with optimum feedback
$I_a$ = 100mA
$V_a$ = 800V
600V
50
20
10
5
2
1
1000
2000
3000
f(MHz)
4000


7Z10888
$V_g$ = 30V 28V 26V 24V
22V
20V
18V
16V
14V
12V
10V
8V
6V
4V
2V
0
$V_g$ = 25V
−2V
20V
−4V
15V
−6V
10V
−8V
−10V
−12V
$I_a$
$I_g$
I
(mA)
800
600
400
200
0
0
500
1000
$V_a$ (V)
1500


7Z10889
40
20
0
-20
-40
$V_g$
(V)
$I_g$=300mA
250mA
200mA
150mA
$I_a$=700mA
100 mA
600mA
500mA
50mA
400mA
300mA
200mA
100 mA
0
0
500
1000
$V_a$ (V)
1500


7Z10887
pulse service
$I_a$
$I_g$
I
(A)
15
10
5
0
$V_g$ = 300V
250V
200V
150V
$V_g$ = 250V
200V
100V
150V
50V
100V
0
50V
0
2000
$V_a$ (V)
4000


7Z10886
pulse service
400
200
0
-200
$V_g$
(V)
$I_g$=10A
8A
6A
4A
2A
1A
0.5A
$I_a$= 12A
10A
8A
6A
4A
2A
1A
0.5A
0
0
2000
4000
$V_a$ (V)

# DISC SEAL TRIODE

Disc seal triode for use as power amplifier, oscillator or frequency multiplier for frequencies up to 4.3 GHz.
The 8108 is a ruggedized tube and is suitable for use at altitudes up to 18 km.

Mounting torque: max. 15 cmkg

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For further data refer to data EC157

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# T-R Switches

# DUAL T-R SWITCH

Broad band gas-filled dual T-R switch covering the 8490 to 9580 MHz frequency band. It consists basically of two single switches forming one unit with a common flange arrangement. The 56032 is designed for operation in slot-hybrid duplexers, based on waveguide RG-52/U(WR90).

**ELECTRICAL DATA**

**LIMITING VALUES** (Absolute max. rating system) **AND CHARACTERISTICS**

| | | | |
|---|---|---|---|
| Peak power | min. | 3 | kW |
| | max. | 250 | kW |
| Ignitor D.C. supply voltage | min. | -600 | V [1] |
| Ignitor current | max. | 200 | µA |
| Ignitor voltage drop at an | min. | 170 | V |
| ignitor current of 100 µA | max. | 300 | V |

**LOW-LEVEL CHARACTERISTICS**

| | | | |
|---|---|---|---|
| Voltage standing-wave ratio [2] | | | |
| at 8490 MHz | max. | 1.4 | |
| at 9580 MHz | max. | 1.4 | |
| at 8560 to 9490 MHz | max. | 1.2 | |
| Duplexer loss [3] | | | |
| at 8490 MHz | max. | 1.1 | dB |
| at 9580 MHz | max. | 1.1 | dB |
| at 8560 to 9490 MHz | max. | 1.0 | dB |

**HIGH-LEVEL CHARACTERISTICS** [3]

| | | | |
|---|---|---|---|
| Flat leakage power | max. | 15 | mW |
| Spike leakage energy | max. | 15 | nJ |
| | | (0.15 erg) | |
| Arc loss | max. | 1.0 | dB |
| Recovery time | max. | 7.0 | µs |

---

[1] The ignitor voltage shall be applied to each electrode via a suitable resistor giving 80 to 150 µA ignitor current.

[2] When measuring the V.S.W.R. the short-slot hybrids used shall have a V.S.W.R. of 1.10 max. over the specified frequency band. Each hybrid shall split the power evenly to within 0.25 dB and shall have a minimum isolation of 25 dB.

[3] 100 µA D.C. through each ignitor electrode.

## MECHANICAL DATA

| | |
|---|---|
| Mounting position | any |
| Dimensions | See Fig. 1 |
| Net weight | 175 g |
| Accessories (supplied with switch) | 2 gaskets, Fig. 3 |
| Mating flange | See Fig. 2 |

A gasket should be placed between each flange and the mating flanges of the short-slot hybrid junctions. See Figs. 2 and 3.

| | | | |
|---|---|---|---|
| Pressurization | max. | 3.5 | $kg/cm^2$ |
| | min. | 0.5 | $kg/cm^2$ |
| Altitude | max. | 3 | km |

Dimensions in mm

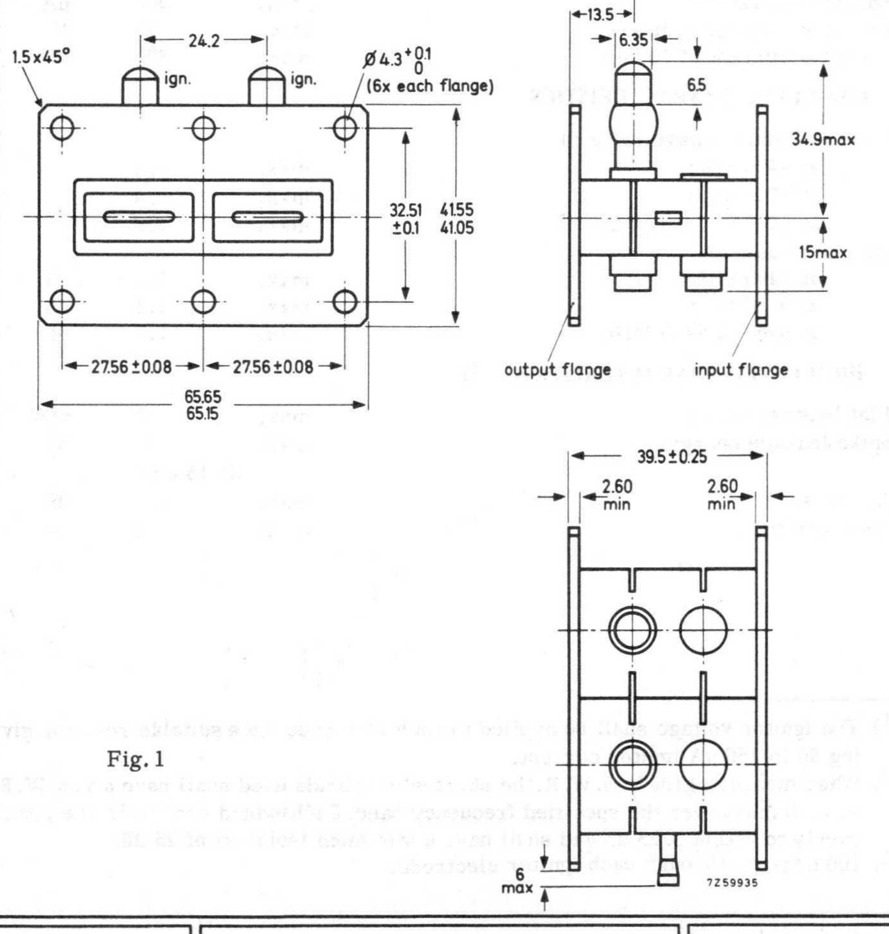



Fig. 1

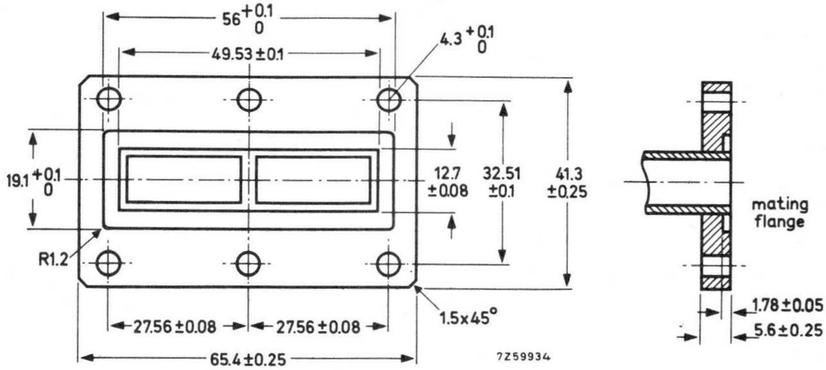



Fig. 2 Gasket assembly

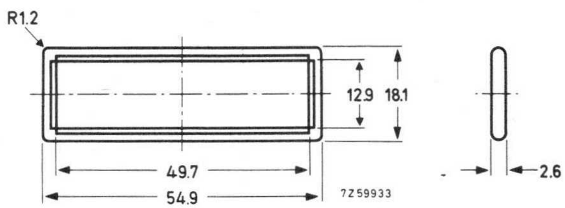



Fig. 3 Gasket

# APPENDIX

## Microwave devices

**For latest information see**

**Handbook Components and materials Part 5,**

**and Green binder**

# Microwave devices

# SURVEY

## WAVEGUIDE ISOLATORS

| frequency | catalogue number |
|---|---|
| 3.65 - 3.95 GHz | 2722 161 01011 |
| 3.8 - 4.2 GHz | 01081 |
| 3.8 - 4.2 GHz | 01071 |
| 3.9 - 4.2 GHz | 01021 |
| 4.2 - 4.6 GHz | 01091 |
| 4.6 - 5.0 GHz | 01101 |
| 5.925- 6.425 GHz | 01191 |
| 6.425- 7.150 GHz | 01251 |
| 6.825- 7.425 GHz | 01231 |
| 7.125- 7.750 GHz | 01291 |
| 7.125- 7.750 GHz | 01281 |
| 7.25 - 7.75 GHz | 01241 |
| 7.400- 8.025 GHz | 01151 |
| 7.7 - 8.5 GHz | 01161 |
| 7.7 - 8.5 GHz | 01051 |
| 8.5 - 9.6 GHz | 01211 |
| 8.5 - 9.6 GHz | 01221 |
| 8.5 - 9.6 GHz | 01261 |
| 8.5 - 9.6 GHz | 01271 |
| 10.7 -11.7 GHz | 01171 |
| 12.5 -13.5 GHz | 01181 |

## COAXIAL ISOLATORS

| frequency | catalogue number |
|---|---|
| 0.740- 0.810 GHz | 2722 162 02001 |
| 0.890- 0.970 GHz | 02011 |
| 1.48 - 1.95 GHz | 02041 |
| 2.96 - 3.22 GHz | 02021 |
| 3.56 - 3.90 GHz | 02031 |

## WAVEGUIDE 3 PORT CIRCULATORS

| frequency | catalogue number |
|---|---|
| 3.4 - 3.7 GHz | 2722 161 02031 |
| 3.6 - 3.9 GHz | 02041 |
| 3.6 - 4.2 GHz | 02001 |
| 3.6 - 4.2 GHz | 02011 |
| 5.925- 6.425 GHz | 02051 |
| 5.925- 6.425 GHz | 02101 |
| 6.425- 7.125 GHz | 02081 |
| 7.125- 7.750 GHz | 02091 |
| 7.7 - 8.5 GHz | 02021 |

## WAVEGUIDE 4 PORT CIRCULATORS

| frequency | catalogue number |
|---|---|
| 5.925- 6.175 GHz | 2722 161 03081 |
| 6.125- 6.425 GHz | 03091 |
| 6.575- 6.875 GHz | 03031 |
| 6.825- 7.125 GHz | 03011 |
| 7.125- 7.425 GHz | 03001 |
| 7.425- 7.725 GHz | 03041 |
| 10.700-11.700 GHz | 03061 |
| 12.500-13.500 GHz | 03051 |

## COAXIAL 3 PORT CIRCULATORS

| frequency | catalogue number |
|---|---|
| 170- 200 MHz | 2722 162 01191 |
| 200- 230 MHz | 01201 |
| 370- 402 MHz | 01221 |
| 406- 470 MHz | 01051 |
| 406- 470 MHz | 01151 |
| 445- 485 MHz | 01231 |
| 450- 550 MHz | 01091 |
| 470- 600 MHz | 01061 |
| 470- 600 MHz | 01121 |
| 590- 720 MHz | 01131 |
| 590- 720 MHz | 01071 |
| 590- 720 MHz | 01171 |
| 608- 783 MHz | 01101 |
| 710- 860 MHz | 01081 |
| 710- 860 MHz | 01141 |
| 710- 860 MHz | 01181 |
| 710- 860 MHz | 01241 |
| 1900-2300 MHz | 01001 |
| 3600-4200 MHz | 01111 |

On the following pages the various components are arranged according to catalogue numbers.

INTRODUCTION

An isolator is a passive non-reciprocal device which permits microwave energy to pass through it in one direction whilst absorbing energy in the reverse direction.

In the forward direction, that is the direction in which the energy is passed, the insertion loss is usually 0.3 to 0.5 dB in the frequency range for which the isolator has been designed. In the opposite direction the isolation is normally 30 dB but for certain applications isolation can be made as high as 55 to 60 dB.

In the field displacement type of isolator, which is described underneath, a ferrite bar is mounted in a waveguide and biassed by a magnetic field. The non-reciprocal behaviour of this type of isolator is produced by gyromagnetic effects which occur between the high frequency magnetic field and the electrons in the ferrite.

For the coaxial isolators in this section, which are coaxial 3-port circulators with a matched load on one port, we refer to section "Circulators, general".

APPLICATION

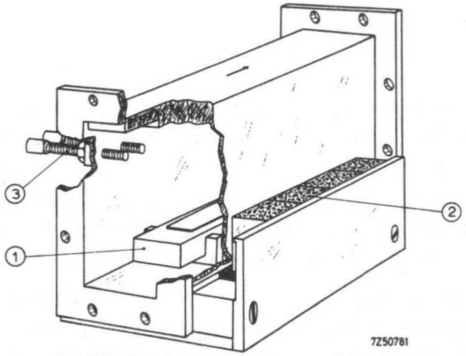
The main application of an isolator is to improve the behaviour of klystrons, magnetrons or travelling wave tubes by isolating the source from the load. The main factor is that an antenna or amplifier can not be ideally matched to the preceding function over the required frequency range so that energy would be reflected back into the tube and upset the frequency stability. The isolator will absorb this reflected energy so that the tube is effectively protected from these disturbing influences.

The isolators, provided with matching screws, offer the possibility to match the isolator so that over a certain frequency range the VSWR is minimum. It is therefore possible to optimise the efficiency of waveguide runs by matching the isolator to minimum reflection. This means that long line effects can be drastically reduced.

CONSTRUCTION

Waveguide isolator

In the fig. below a field displacement isolator is shown. In the waveguide the ferrite bar (1) can be seen, flanked by two sets of magnets (2) outside the waveguide. These magnets bias the ferrite bar.




Field displacement type of isolator

The screws (3) protruding into the waveguide are used to match the isolator for minimum voltage standing wave ratio.

Coaxial isolator

For construction and mounting see section "Circulators, general" at Fig.8.

TERMS AND DEFINITIONS

Frequency range is the range within which the isolator meets the guaranteed specification.
Outside this range the electrical properties deteriorate rapidly.

Isolation is the ratio, expressed in dB, of the input power to the output power in the reverse direction, measured with matched source and matched load.

Insertion loss is the attenuation resulting from the insertion of an isolator into a transmission system, expressed in dB, of the power delivered to a matched load before insertion of the isolator, to the power delivered to that load after insertion of the isolator.

Voltage standing wave ratio (VSWR) is the ratio of the maximum to the minimum voltages along the line.

Typical data. These data are derived by taking the mean measured values of several production runs of the component.

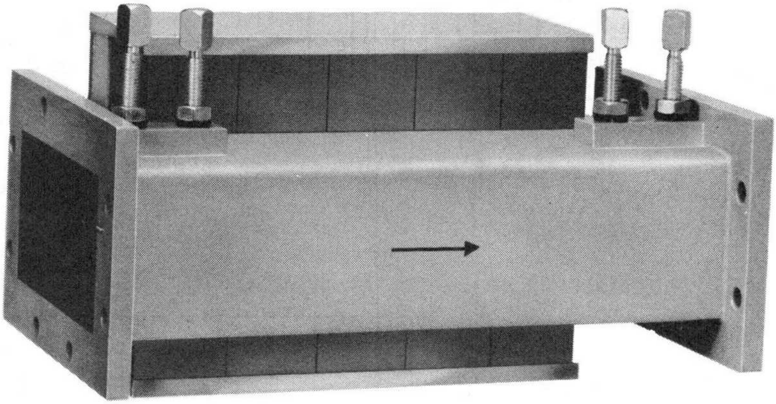
Maximum power is the largest power that may be passed through the isolator in forward direction into a load with a VSWR of 2. This power value should under no circumstances be exceeded.

Temperature range is the ambient temperature range within which the isolators function to specification.
The isolator will continue to function outside the given temperature range, but some of its characteristics may change.
The storage temperature of the isolators may be from -40 °C to +125 °C.

CAUTION

The isolators have rather strong internal magnetic fields which are carefully adjusted for optimal operation. They are not to be subjected to strong external magnetic fields.

# ISOLATOR



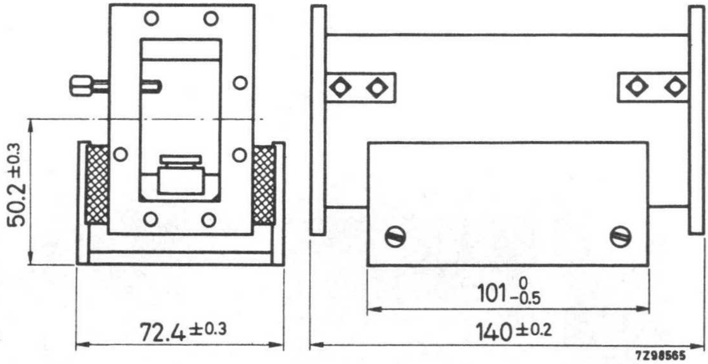
RZ 21478-5

ELECTRICAL DATA

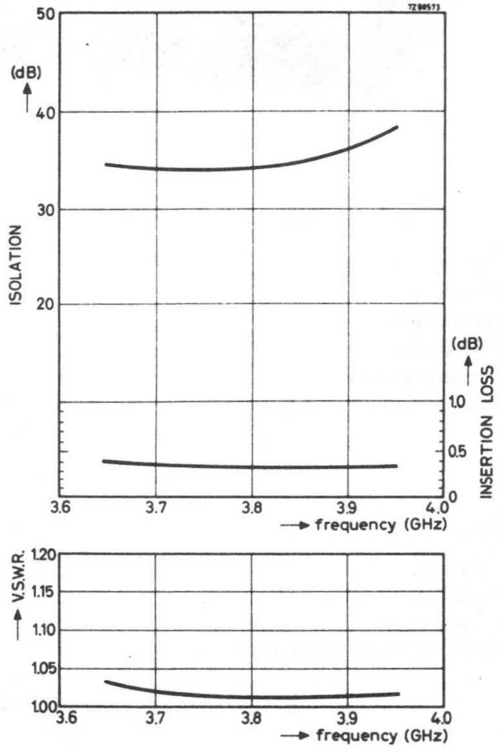
| | |
|---|---|
| Frequency range | 3.65-3.95 GHz |
| Isolation | > 30 dB |
| Insertion loss | < 0.5 dB |
| V.S.W.R. | < 1.05 |
| Nominal power (c.w.) | 15 W |
| Temperature range | +10 to +70 °C<br>For other temperature ranges please inquire |

MECHANICAL DATA

| | |
|---|---|
| Material | brass |
| Waveguide type | R40 (I.E.C.) |
| Flange type | UER40 (I.E.C.); other flanges to order |
| Finish of waveguide and flanges | goldplated upon silverplated<br>outside enamelled grey |
| of magnet system | nickel standard mat |

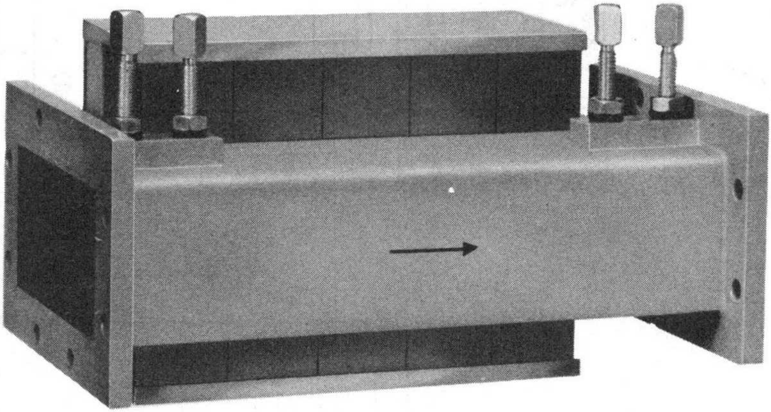



Dimensions in mm




Typical performance as a function of frequency at a working temperature of 20 °C.

# ISOLATOR



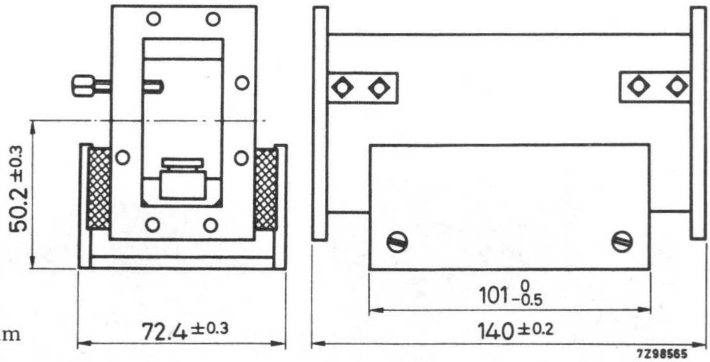
RZ 21478-5

ELECTRICAL DATA

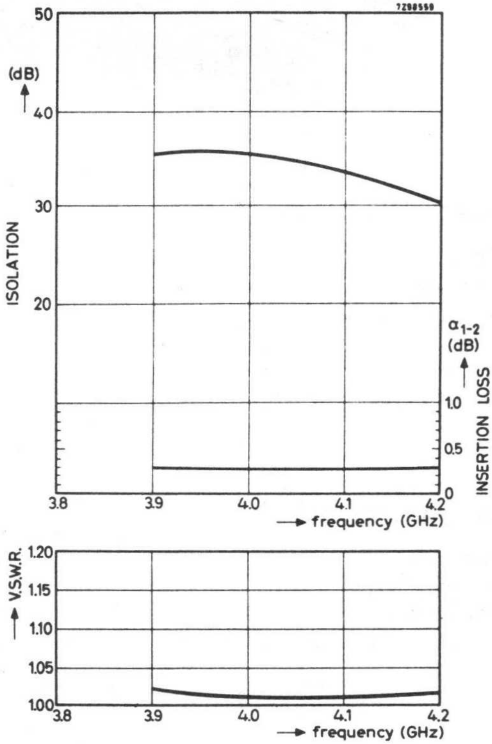
| | |
|---|---|
| Frequency range | 3.9-4.2 GHz |
| Isolation | > 30 dB |
| Insertion loss | < 0.5 dB |
| V.S.W.R. | < 1.05 |
| Nominal power (c.w.) | 15 W |
| Temperature range | +10 to +80 °C<br>For other temperature ranges please inquire |

MECHANICAL DATA

| | |
|---|---|
| Material | brass |
| Waveguide type | R40 (I.E.C.) |
| Flange type | UER40 (I.E.C.); other flanges to order |
| Finish of waveguide and flanges | goldplated upon silverplated<br>outside enamelled grey |
| of magnet system | nickel standard mat |

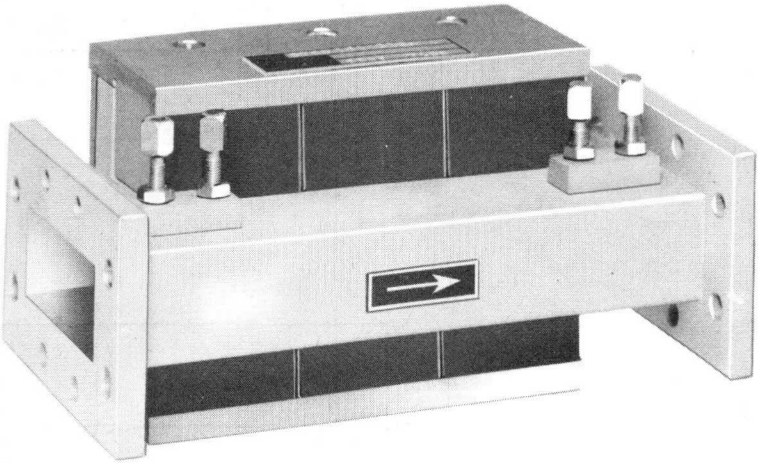



Dimensions in mm




Typical performance as a function of frequency at a working temperature of 20 °C.

# ISOLATOR



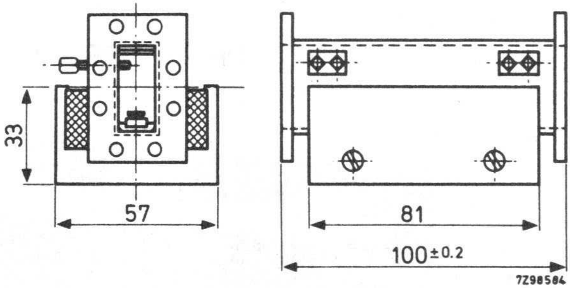
RZ 25233-3

ELECTRICAL DATA

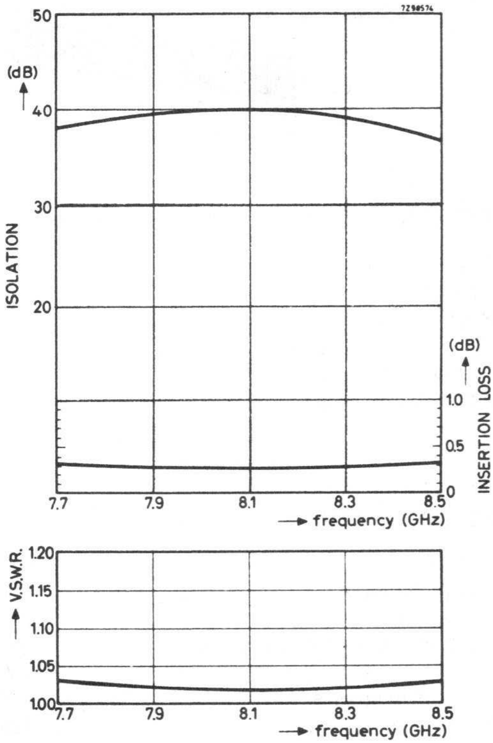
| | |
|---|---|
| Frequency range | 7.7-8.5 GHz |
| Isolation | > 30 dB |
| Insertion loss | < 0.5 dB |
| V.S.W.R. | < 1.05 |
| Nominal power (c.w.) | 10 W |
| Temperature range | +10 to +70 °C<br>For other temperature ranges please inquire |

MECHANICAL DATA

| | |
|---|---|
| Material | brass |
| Waveguide type | R84 (I.E.C.) |
| Flange type | UER84 (I.E.C.); other flanges to order |
| Finish of waveguide and flanges | goldplated upon silverplated<br>outside enamelled grey |
| of magnet system | nickel standard mat |
| Weight | 1260 g |



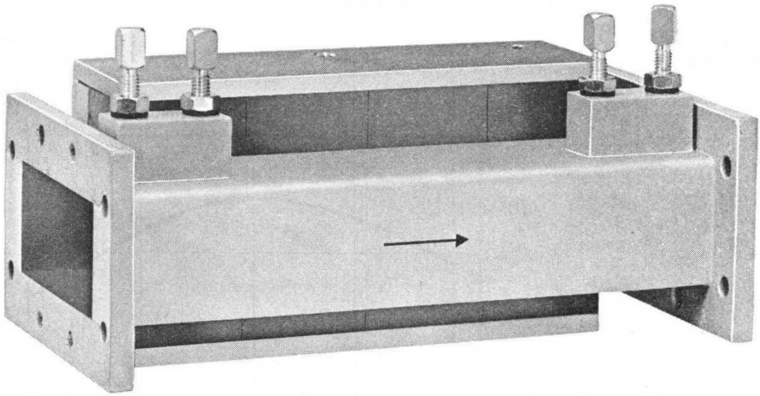

Dimensions in mm




Typical performance as a function of frequency at a working temperature of 20 °C.

# ISOLATOR

RZ 21478-21

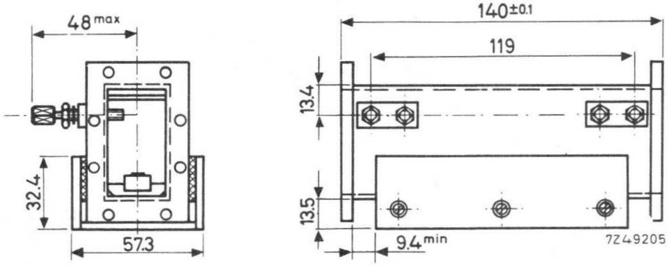


## ELECTRICAL DATA

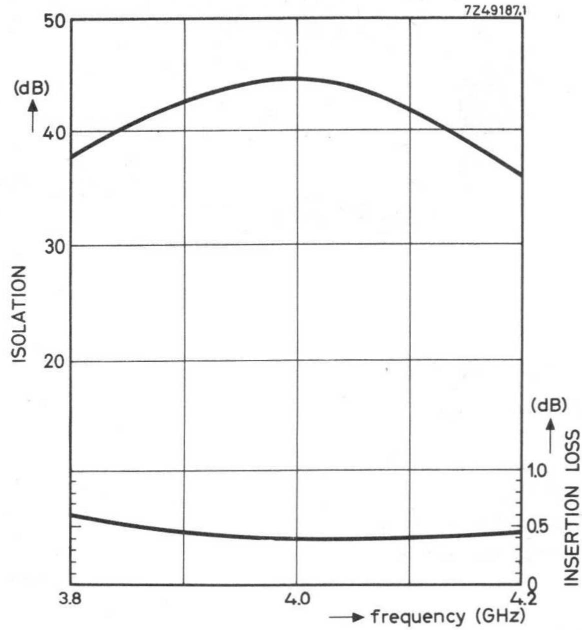
| | |
|---|---|
| Frequency range | 3.8 - 4.2 GHz |
| Isolation | > 30 dB |
| Insertion loss | < 0.8 dB |
| V.S.W.R. | < 1.05 |
| Nominal power (c.w.) | 10 W |
| Temperature range | + 10 to + 40 °C |
| | For other temperature ranges please inquire |

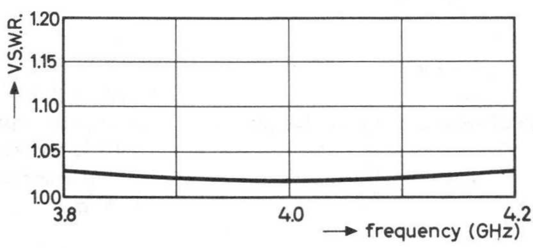
## MECHANICAL DATA

| | |
|---|---|
| Material | brass |
| Waveguide type | R 48 (I.E.C.) |
| Flange type | UER 48 (I.E.C.); other flanges to order |
| Finish of waveguide and flanges | goldplated upon silverplated |
| | outside enamelled grey |
| of magnet system | nickel standard mat |
| Weight | 1700 g |




Dimensions in mm.

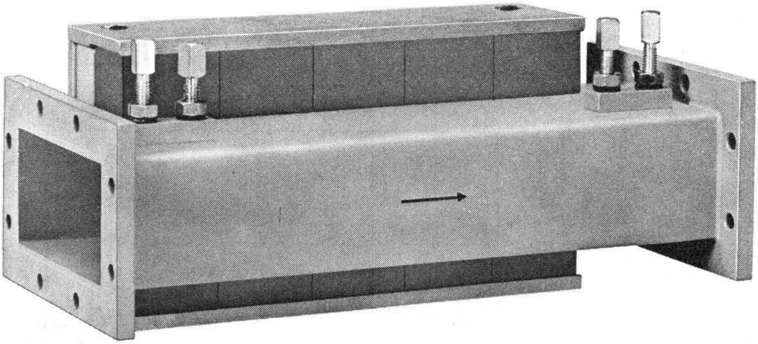



Typical performance as a function of frequency at a working temperature of 20 °C.

# ISOLATOR

RZ 21478-22

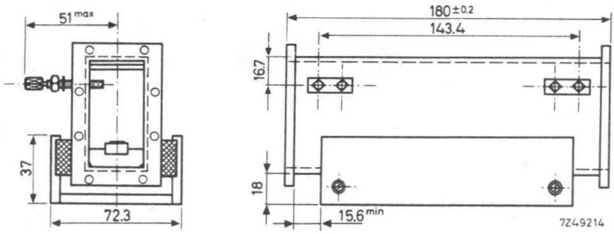


## ELECTRICAL DATA

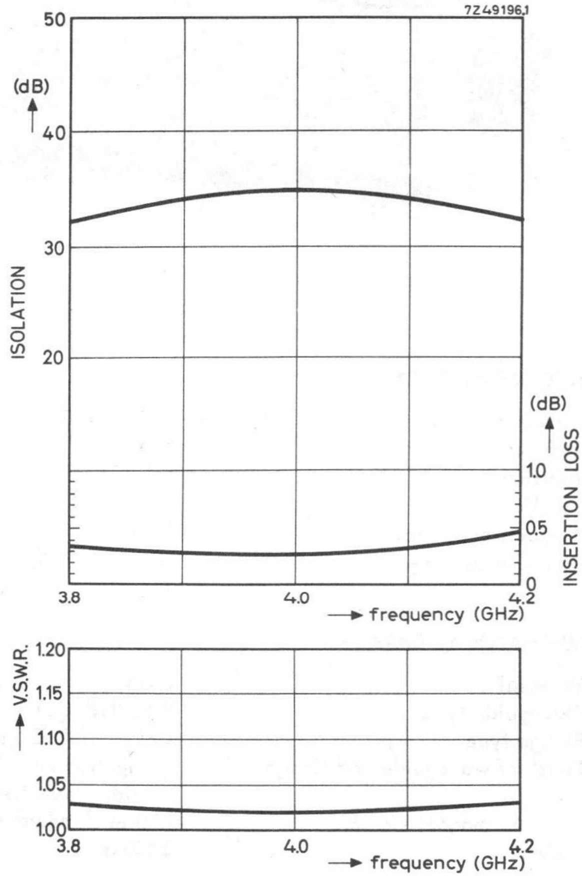
| | |
|---|---|
| Frequency range | 3.8 - 4.2 GHz |
| Isolation | > 30 dB |
| Insertion loss | < 0.5 dB |
| V.S.W.R. | < 1.05 |
| Nominal power (c.w.) | 10 W |
| Temperature range | + 10 to + 80 °C<br>For other temperature ranges please inquire |

## MECHANICAL DATA

| | |
|---|---|
| Material | brass |
| Waveguide type | R 40 (I.E.C.) |
| Flange type | UER 40 (I.E.C.); other flanges to order |
| Finish of waveguide and flanges | goldplated upon silverplated<br>outside enamelled grey |
| of magnet system | nickel standard mat |
| Weight | 2450 g |



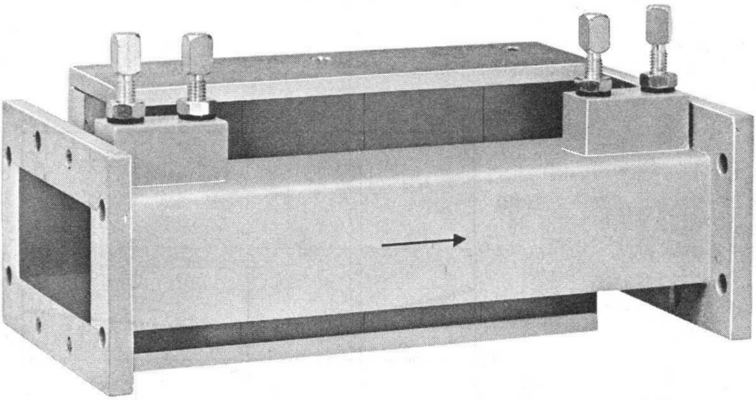

Dimensions in mm.




Typical performance as a function of frequency at a working temperature of 20 °C.

# ISOLATOR

RZ 21478-21

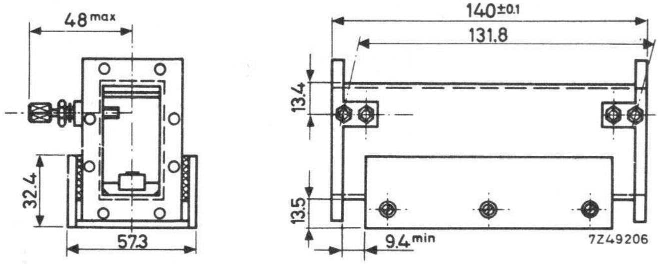


## ELECTRICAL DATA

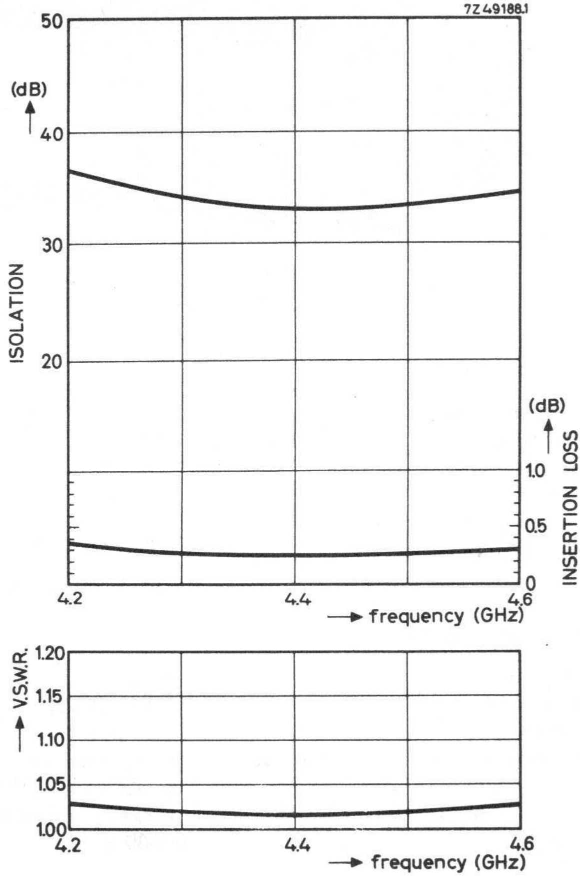
| | |
|---|---|
| Frequency range | 4.2-4.6 GHz |
| Isolation | > 30 dB |
| Insertion loss | <0.5 dB |
| V.S.W.R. | < 1.05 |
| Nominal power (c.w.) | 10 W |
| Temperature range | + 10 to + 40 °C<br>For other temperature ranges please inquire |

## MECHANICAL DATA

| | |
|---|---|
| Material | brass |
| Waveguide type | R 48 (I.E.C.) |
| Flange type | UER 48 (I.E.C.); other flanges to order |
| Finish of waveguide and flanges | goldplated upon silverplated<br>outside enamelled grey |
| of magnet system | nickel standard mat |
| Weight | 1680 g |



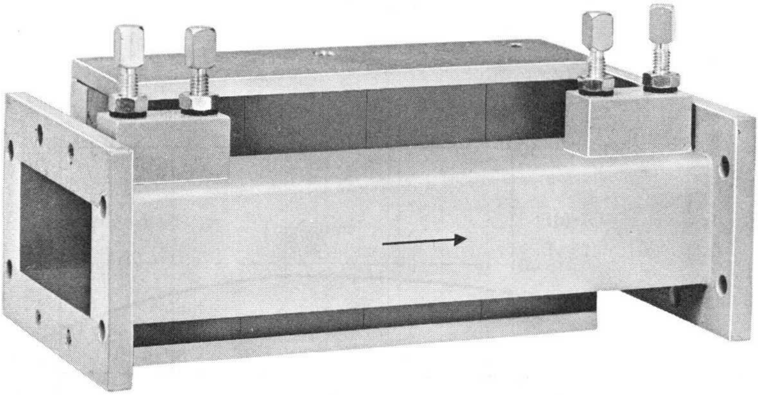

Dimensions in mm.




Typical performance as a function of frequency at a working temperature of 20 °C.

# ISOLATOR

RZ 21478-21

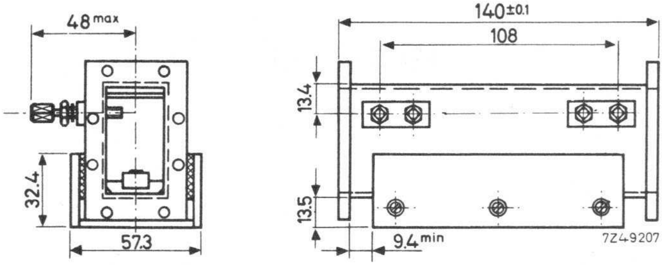


## ELECTRICAL DATA

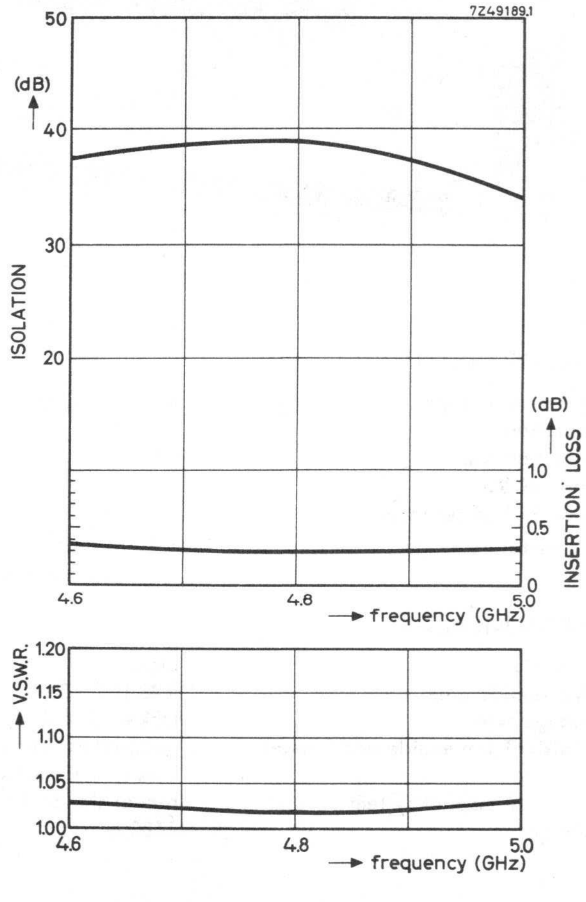
| | |
|---|---|
| Frequency range | 4.6 - 5.0 GHz |
| Isolation | > 30 dB |
| Insertion loss | < 0.8 dB |
| V.S.W.R. | < 1.05 |
| Nominal power (c.w.) | 10 W |
| Temperature range | + 10 to + 40 °C |
| | For other temperature ranges please inquire |

## MECHANICAL DATA

| | |
|---|---|
| Material | brass |
| Waveguide type | R 48 (I.E.C.) |
| Flange type | UER 48 (I.E.C.); other flanges to order |
| Finish of waveguide and flanges | goldplated upon silverplated |
| | outside enamelled grey |
| of magnet system | nickel standard mat |
| Weight | 1680 g |

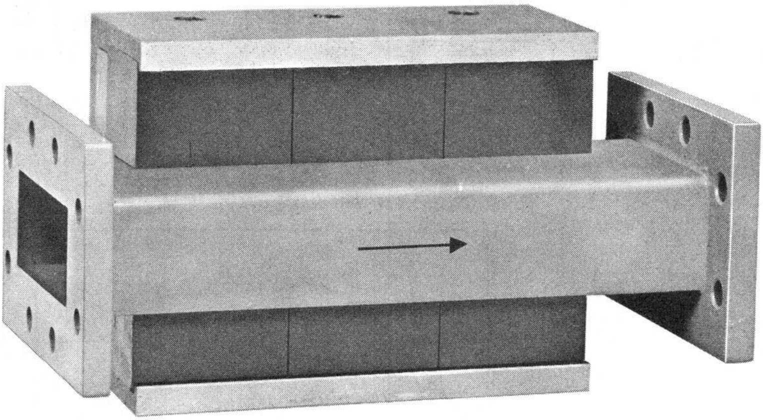



Dimensions in mm.




Typical performance as a function of frequency at a working temperature of 20 °C.

# ISOLATOR



RZ 21478-16

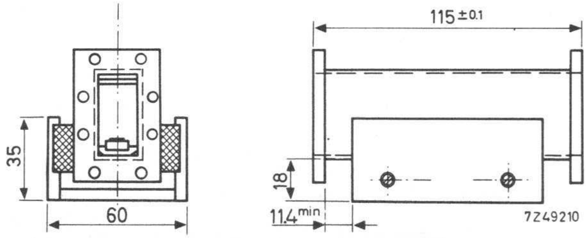
ELECTRICAL DATA

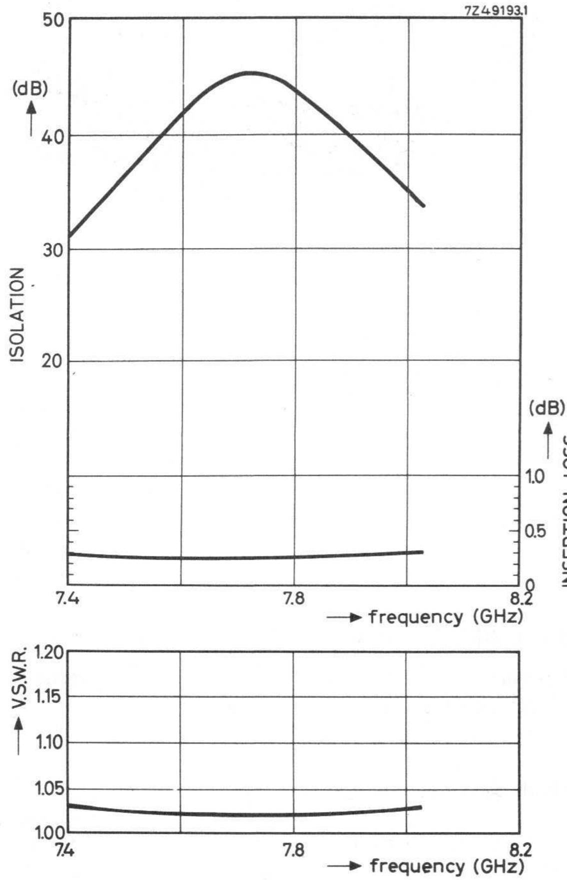
| | |
|---|---|
| Frequency range | 7.4-8.025 GHz |
| Isolation | > 30 dB |
| Insertion loss | < 0.5 dB |
| V.S.W.R. | < 1.05 |
| Nominal power (c.w.) | 10 W |
| Temperature range | -10 to +70 °C<br>For other temperature ranges please inquire |

MECHANICAL DATA

| | |
|---|---|
| Material | brass |
| Waveguide type | R70 (I.E.C.) |
| Flange type | UER70 (I.E.C.); other flanges to order |
| Finish of waveguide and flanges | goldplated upon silverplated<br>outside enamelled grey |
| of magnet system | nickel standard mat |
| Weight | 1450 g |

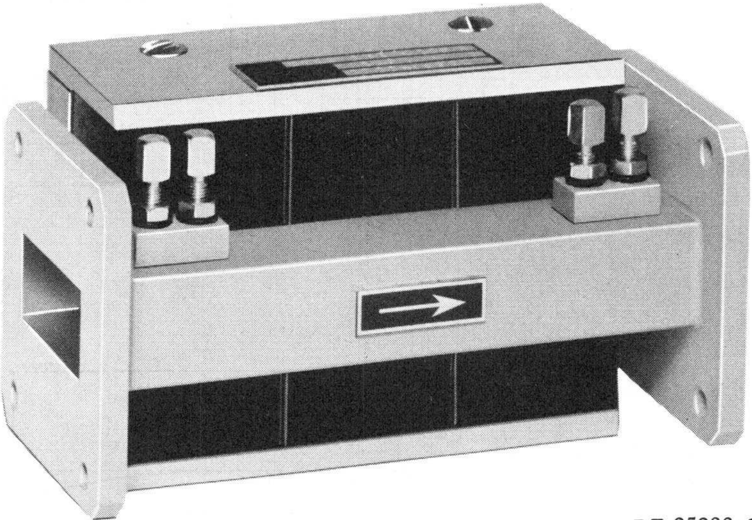
Dimensions in mm




Typical performance as a function of frequency at a working temperature of 20 °C.

# ISOLATOR



RZ 25233-12

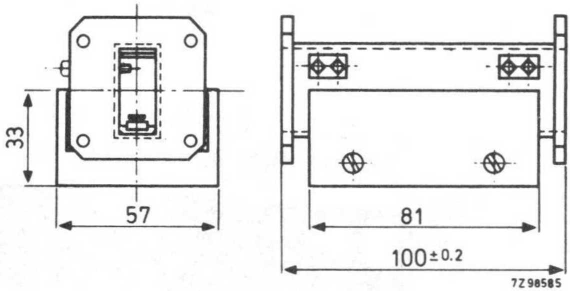
ELECTRICAL DATA

| | |
|---|---|
| Frequency range | 7.7-8.5 GHz |
| Isolation | > 30 dB |
| Insertion loss | < 0.5 dB |
| V.S.W.R. | < 1.05 |
| Nominal power (c.w.) | 10 W |
| Temperature range | +10 to +70 °C<br>For other temperature ranges please inquire |

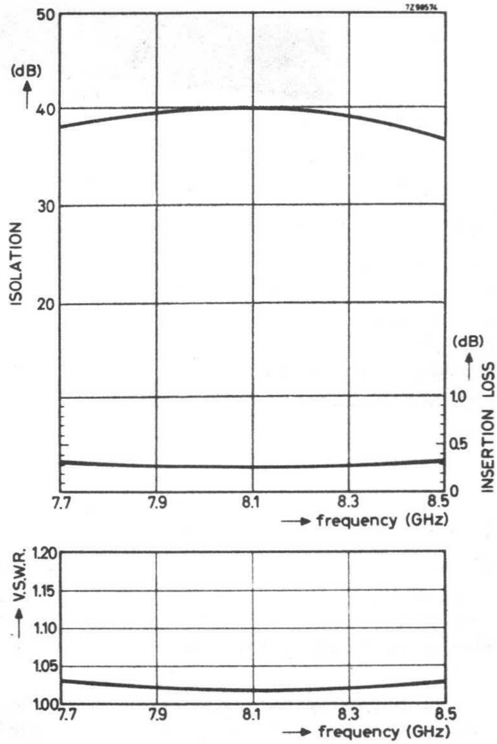
MECHANICAL DATA

| | |
|---|---|
| Material | brass |
| Waveguide type | R84 (I.E.C.) |
| Flange type | UBR84 (I.E.C.); other flanges to order |
| Finish of waveguide and flanges | goldplated upon silverplated<br>outside enamelled grey |
| of magnet system | nickel standard mat |
| Weight | 1260 g |

ISOLATOR

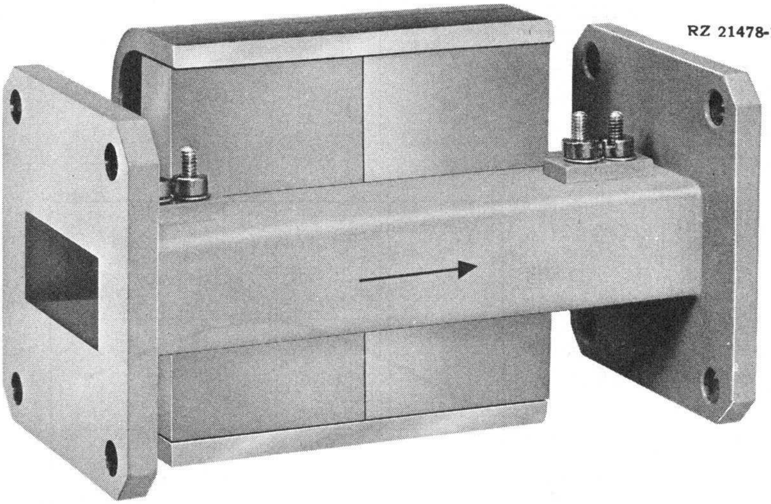



Dimensions in mm




Typical performance as a function of frequency at a working temperature of 20 °C.

# ISOLATOR

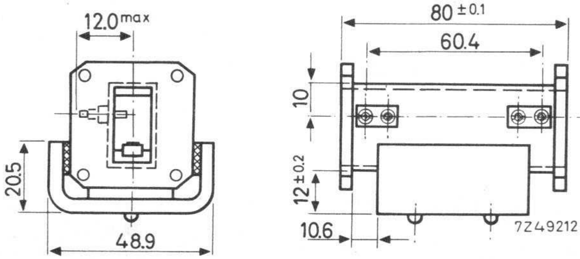

RZ 21478-17

ELECTRICAL DATA

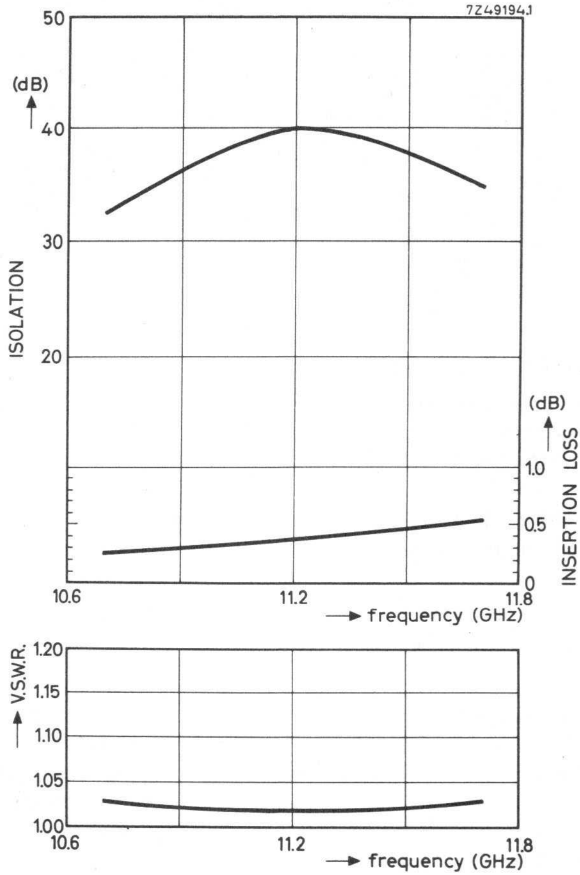
| | |
|---|---|
| Frequency range | 10.7 - 11.7 GHz |
| Isolation | > 30 dB |
| Insertion loss | < 0.8 dB |
| V.S.W.R. | < 1.05 |
| Nominal power (c.w.) | 5 W |
| Temperature range | +10 to +70 °C<br>For other temperature ranges please inquire |

MECHANICAL DATA

| | |
|---|---|
| Material | brass |
| Waveguide type | R 100 (I.E.C.) |
| Flange type | UBR 100 (I.E.C.); other flanges to order |
| Finish of waveguide and flanges | goldplated upon silverplated<br>outside enamelled grey |
| of magnet system | nickel standard mat |
| Weight | 430 g |

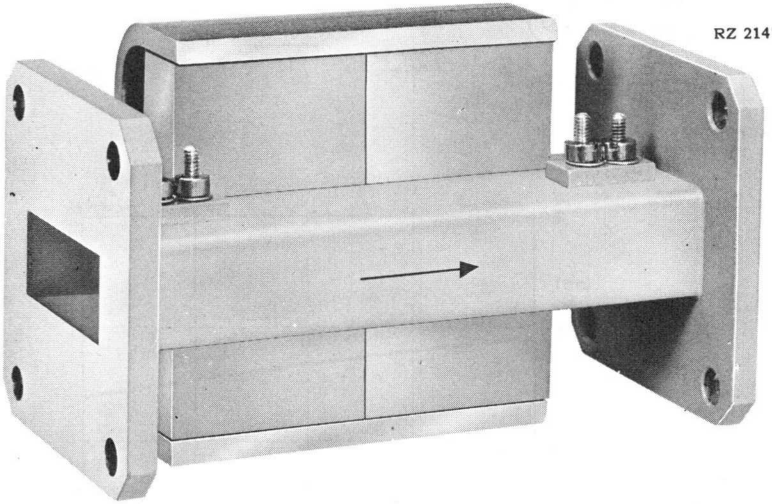



Dimensions in mm.




Typical performance as a function of frequency at a working temperature of 20 °C.

# ISOLATOR



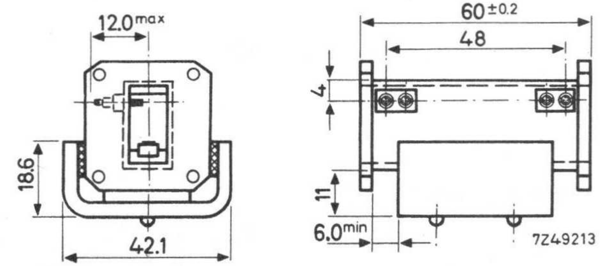
RZ 21478-17

## ELECTRICAL DATA

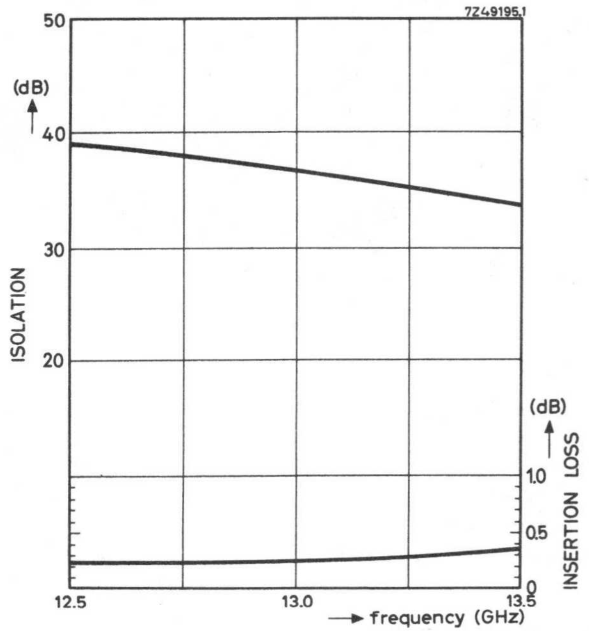
| | |
|---|---|
| Frequency range | 12.5 - 13.5 GHz |
| Isolation | > 30 dB |
| Insertion loss | < 0.5 dB |
| V.S.W.R. | < 1.05 |
| Nominal power (c.w.) | 10 W |
| Temperature range | + 10 to + 70 °C<br>For other temperature ranges please inquire |

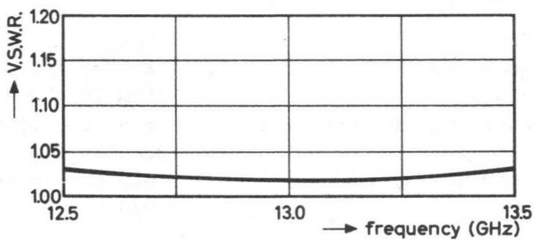
## MECHANICAL DATA

| | |
|---|---|
| Material | brass |
| Waveguide type | R 140 (I.E.C.) |
| Flange type | UBR 140 (I.E.C.); other flanges to order |
| Finish of waveguide and flanges | goldplated upon silverplated<br>outside enamelled grey |
| of magnet system | nickel standard mat |
| Weight | 220 g |



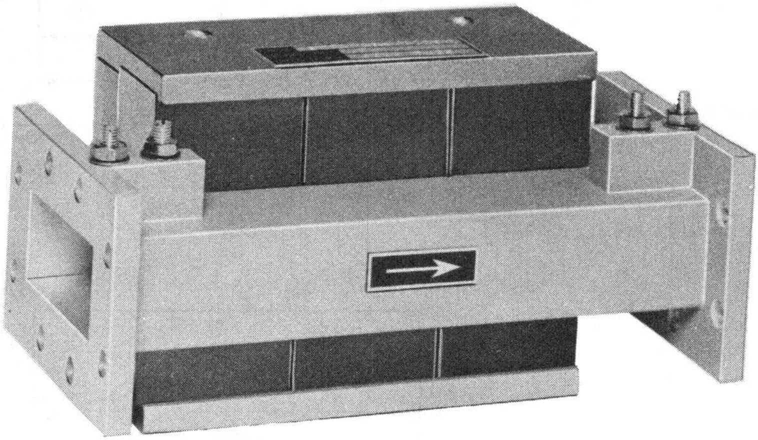

Dimensions in mm.




Typical performance as a function of frequency at a working temperature of 20 °C.

# ISOLATOR



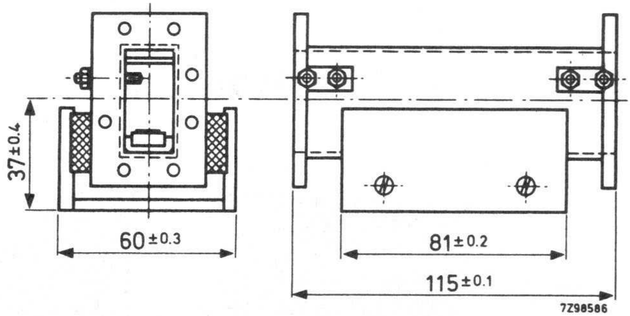
RZ 25233-15

ELECTRICAL DATA

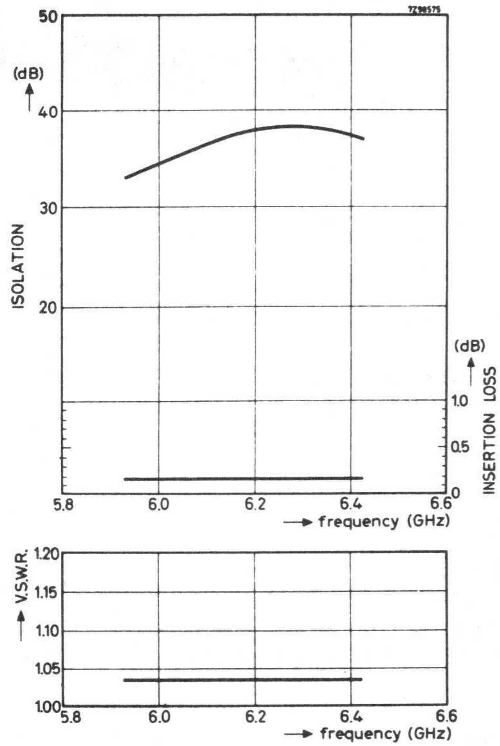
| | |
|---|---|
| Frequency range | 5.925-6.425 GHz |
| Isolation | > 30 dB |
| Insertion loss | < 0.3 dB |
| V.S.W.R. | < 1.05 |
| Nominal power (c.w.) | 20 W |
| Temperature range | -10 to +70 °C<br>For other temperature ranges please inquire |

MECHANICAL DATA

| | |
|---|---|
| Material | brass |
| Waveguide type | R70 (I.E.C.) |
| Flange type | UER70 (I.E.C.); other flanges to order |
| Finish of waveguide and flanges | goldplated upon silverplated<br>outside enamelled grey |
| of magnet system | nickel standard mat |
| Weight | 1450 g |

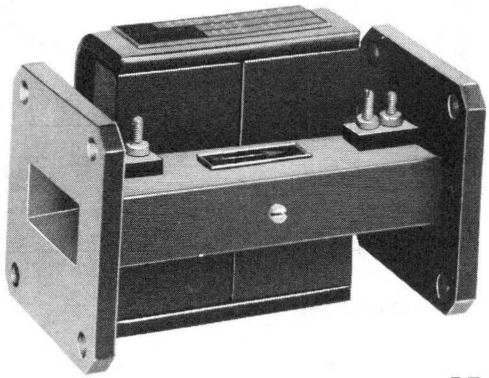



Dimensions in mm




Typical performance as a function of frequency at a working temperature of 20 °C.

# ISOLATOR



RZ 25233-11

ELECTRICAL DATA

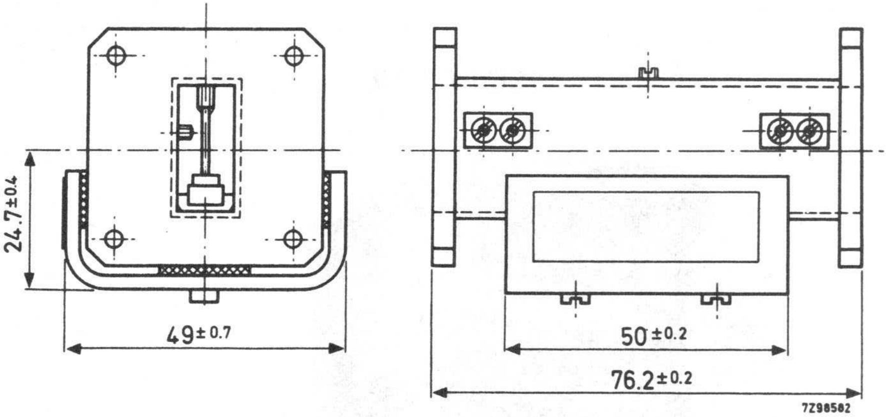
| | |
|---|---|
| Frequency range | 8.5-9.6 GHz |
| Isolation | > 30 dB |
| Insertion loss | < 0.5 dB |
| V.S.W.R. | < 1.05 |
| Nominal power (c.w.) | 10 W |
| Temperature range | −10 to +70 °C<br>For other temperature ranges please inquire |

MECHANICAL DATA

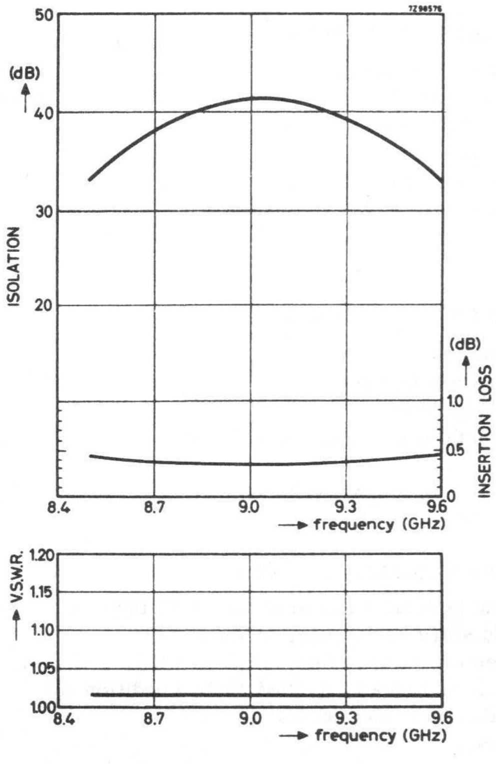
| | |
|---|---|
| Material | brass |
| Waveguide type | R100 (I.E.C.) |
| Flange type | UBR100 (I.E.C.); other flanges to order |
| Finish of waveguide and flanges | nickelplated<br>outside enamelled black |
| of magnet system | nickel standard mat |
| Weight | 420 g |

ENVIRONMENTAL DATA

The isolator withstands the following environmental tests of MIL-STD-202C:
Moisture resistance, method 106B
Temperature cycling, method 102A, condition D
Thermal shock, method 107B, condition A
Vibration, method 201A
Shock, method 202B

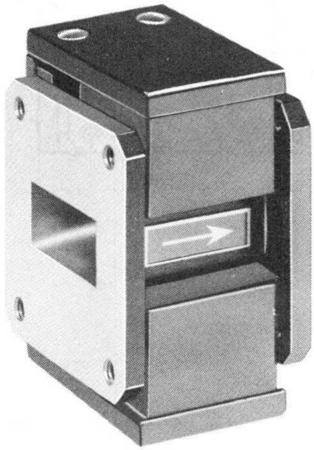



Dimensions in mm




Typical performance as a function of frequency at a working temperature of 20 °C.

# ISOLATOR



RZ 25233-6

ELECTRICAL DATA

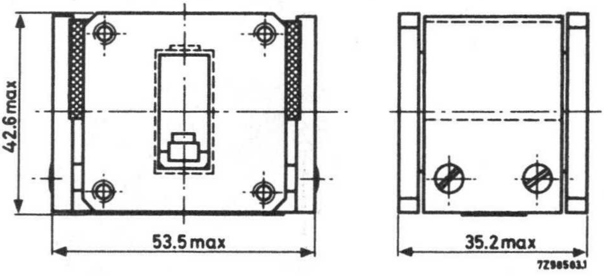
| | |
|---|---|
| Frequency range | 8.5-9.6 GHz |
| Isolation | > 15 dB |
| Insertion loss | < 0.6 dB |
| V.S.W.R. | < 1.15 |
| Nominal power (c.w.) | 1 W |
| Temperature range | +10 to +70 °C<br>For other temperature ranges please inquire |

MECHANICAL DATA

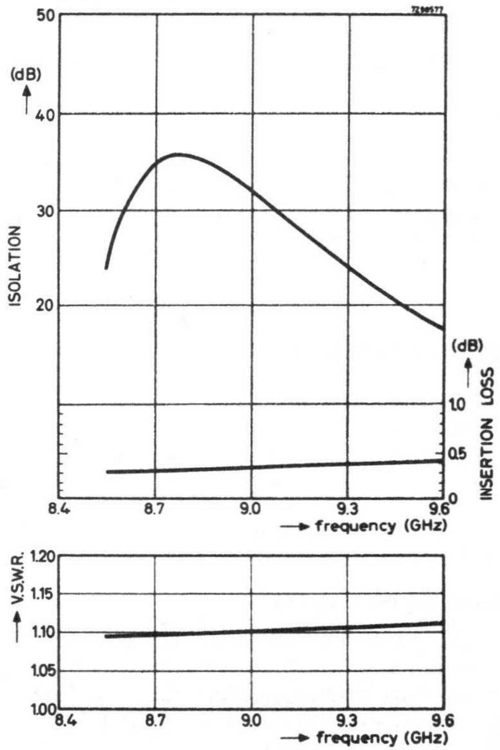
| | |
|---|---|
| Material | brass |
| Waveguide type | R100 (I.E.C.) |
| Flange type | UBR100 (I.E.C.); other flanges to order |
| Finish of waveguide and flanges | nickelplated<br>outside enamelled black |
| of magnet system | nickel standard mat |
| Weight | 400 g |

ENVIRONMENTAL DATA

The isolator withstands the following environmental tests of MIL-STD-202C:
Moisture resistance, method 106B
Temperature cycling, method 102A, condition D
Thermal shock, method 107B, condition A
Vibration, method 201A
Shock, method 202B




Dimensions in mm




Typical performance as a function of frequency at a working temperature of 20 °C.

# ISOLATOR

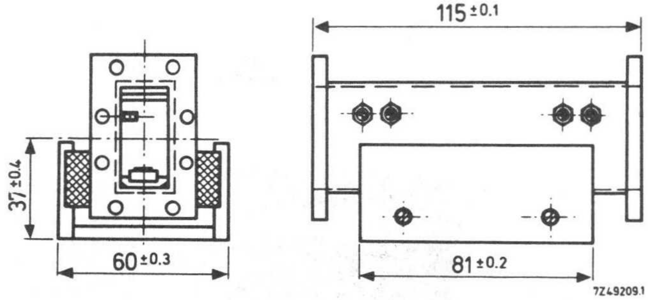
RZ 25233-16

ELECTRICAL DATA

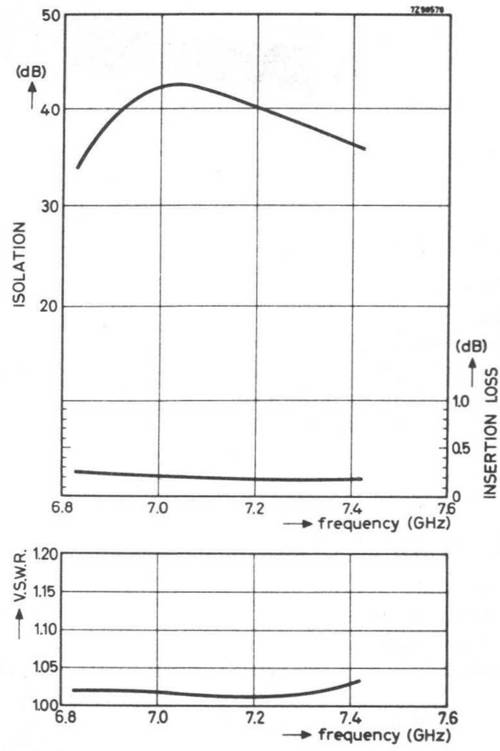
| | |
|---|---|
| Frequency range | 6.825-7.425 GHz |
| Isolation | > 30 dB |
| Insertion loss | < 0.3 dB |
| V.S.W.R. | < 1.05 |
| Nominal power (c.w.) | 20 W |
| Temperature range | −10 to +70 °C<br>For other temperature ranges please inquire |

MECHANICAL DATA

| | |
|---|---|
| Material | brass |
| Waveguide type | R70 (I.E.C.) |
| Flange type | UER70 (I.E.C.); other flanges to order |
| Finish of waveguide and flanges | goldplated upon silverplated<br>outside enamelled grey |
| of magnet system | nickel standard mat |
| Weight | 1450 g |




Dimensions in mm




Typical performance as a function of frequency at a working temperature of 20 °C.

# ISOLATOR

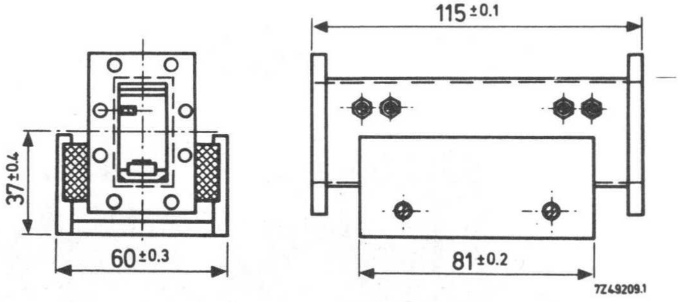
RZ 25233-16

## ELECTRICAL DATA

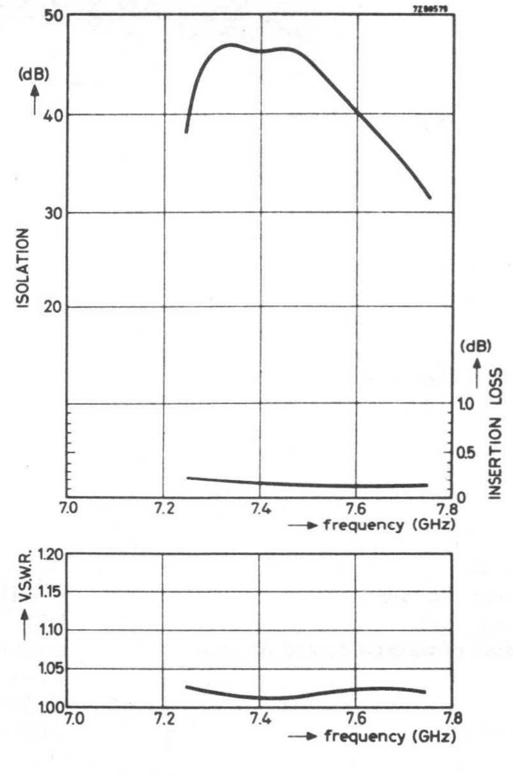
| | |
|---|---|
| Frequency range | 7.25-7.75 GHz |
| Isolation | > 30 dB |
| Insertion loss | < 0.3 dB |
| V.S.W.R. | < 1.05 |
| Nominal power (c.w.) | 20 W |
| Temperature range | -10 to +70 °C<br>For other temperature ranges please inquire |

## MECHANICAL DATA

| | |
|---|---|
| Material | brass |
| Waveguide type | R70 (I.E.C.) |
| Flange type | UER70 (I.E.C.); other flanges to order |
| Finish of waveguide and flanges | goldplated upon silverplated<br>outside enamelled grey |
| of magnet system | nickel standard mat |
| Weight | 1450 g |

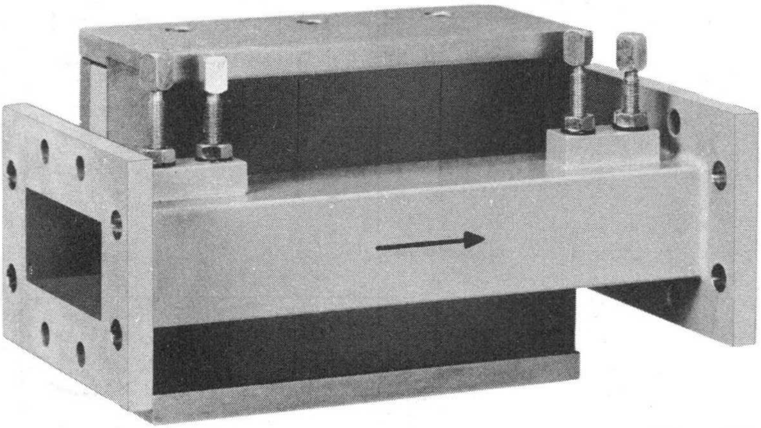



Dimensions in mm




Typical performance as a function of frequency at a working temperature of 20 °C.

# ISOLATOR



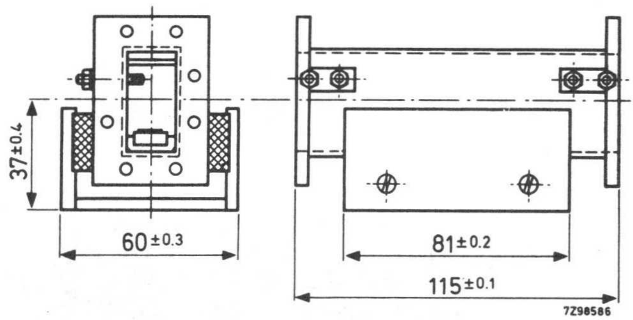
RZ 21478-11

ELECTRICAL DATA

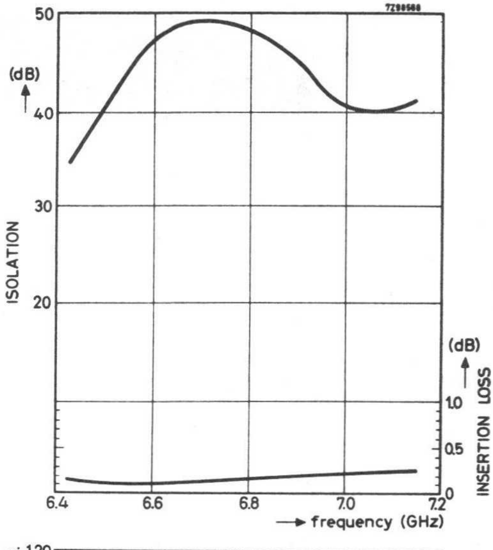
| | |
|---|---|
| Frequency range | 6.425-7.150 GHz |
| Isolation | > 30 dB |
| Insertion loss | < 0.3 dB |
| V.S.W.R. | < 1.05 |
| Nominal power (c.w.) | 20 W |
| Temperature range | -10 to +70 °C<br>For other temperature ranges please inquire |

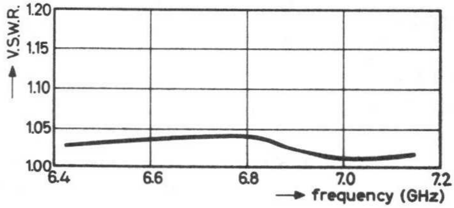
MECHANICAL DATA

| | |
|---|---|
| Material | brass |
| Waveguide type | R70 (I.E.C.) |
| Flange type | UER70 (I.E.C.); other flanges to order |
| Finish of waveguide and flanges | goldplated upon silverplated<br>outside enamelled grey |
| of magnet system | nickel standard mat |
| Weight | 1450 g |




Dimensions in mm




Typical performance as a function of frequency at a working temperature of 20 °C.

# WAVEGUIDE ISOLATOR

Frequency 8.5 to 9.6 GHz

**DIMENSIONS** (in mm)

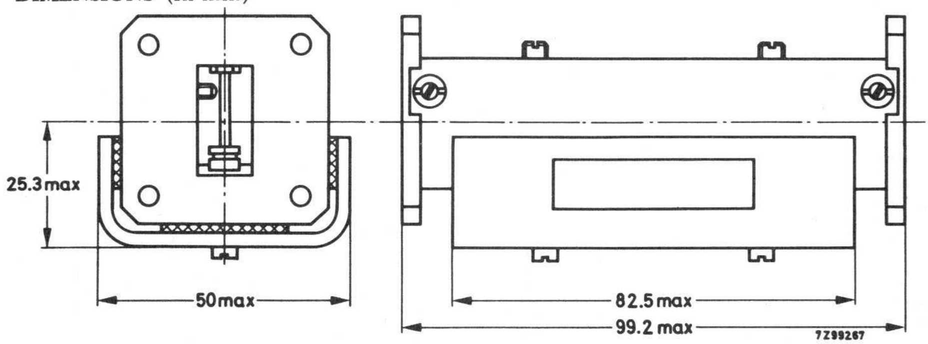



Fig.1

**ELECTRICAL DATA** (see also Fig.2)

| | |
|---|---|
| Frequency range | 8.5 to 9.6 GHz |
| Isolation | > 55 dB |
| Insertion loss | < 1.2 dB |
| V.S.W.R. | < 1.2 |
| Maximum power | 10 W |
| Temperature range | −10 to +70 °C<br>For other temperature ranges please inquire. |

**MECHANICAL DATA**

| | |
|---|---|
| Material of waveguide and flange | brass |
| Mating flange type | 154 IEC-UER 100 |
| Finish of flanges | nickel plated |
| Colour | black |
| Weight | 600 g. |

Typical performance as a function of frequency at an operating temperature of 20 °C.

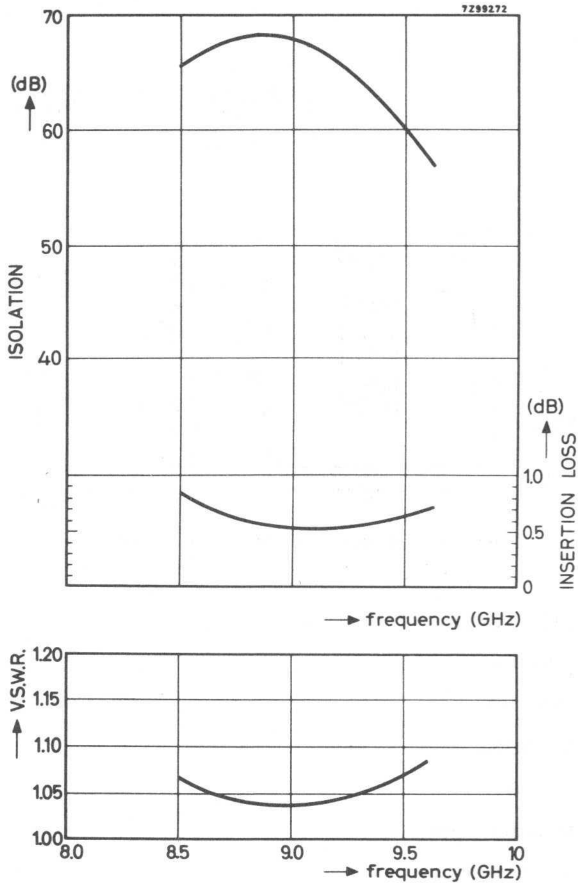



Fig. 2

## ENVIRONMENTAL TESTS

The isolator withstands the following environmental tests of MIL-STD-202C

Moisture resistance, method 106B
Temperature cycling, method 102A, condition D
Thermal shock, method 107B, condition A
Vibration, method 201A
Shock, method 202B

# WAVEGUIDE ISOLATOR

Frequency 8.5 to 9.6 GHz

**DIMENSIONS** (in mm)

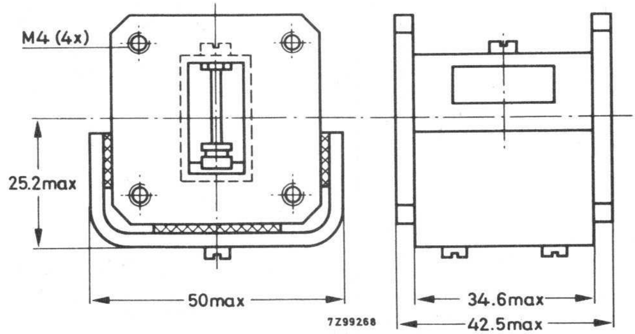



Fig.1

**ELECTRICAL DATA** (see also Fig.2)

| | |
|---|---|
| Frequency range | 8.5 to 9.6 GHz |
| Isolation | > 20 dB |
| Insertion loss | < 1 dB |
| V.S.W.R. | < 1.15 |
| Maximum power | 10 W |
| Temperature range | -10 to +70 °C<br>For other temperatures please inquire |

**MECHANICAL DATA**

| | |
|---|---|
| Material of waveguide and flange | brass |
| Mating flange type | 154 IEC-UBR 100 |
| Finish of flanges | nickel plated |
| Colour | black |
| Weight | 300 g |

Typical performance as a function of frequency at an operating temperature of 20 °C.

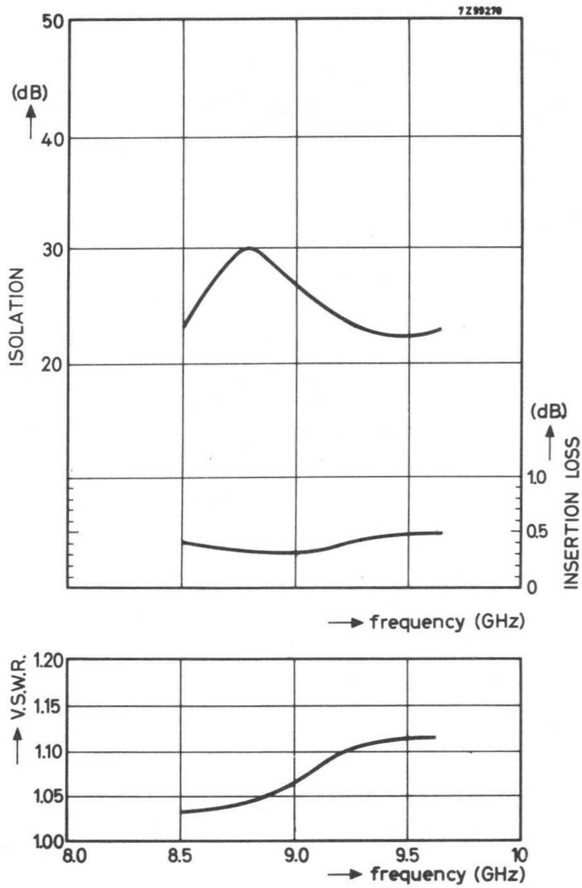



Fig.2

## ENVIRONMENTAL TESTS

The isolator withstands the following environmental tests of MIL-STD-202C

Moisture resistance, method 106B
Temperature cycling, method 102A, condition D
Thermal shock, method 107B, condition A
Vibration, method 201A
Shock, method 202B

# WAVEGUIDE ISOLATOR

Frequency 7.125 to 7.750 GHz

**DIMENSIONS** (in mm)

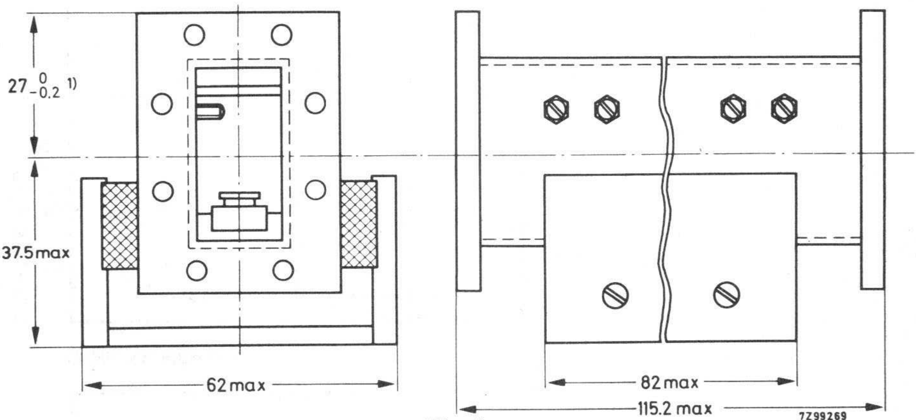



Fig. 1

**ELECTRICAL DATA** (See also Fig. 2)

| | |
|---|---|
| Frequency range | 7.125 to 7.750 GHz |
| Isolation | > 30 dB |
| Insertion loss | < 0.3 dB |
| V.S.W.R. | < 1.05 |
| Maximum power | 20 W |
| Temperature range | -10 to +70 °C<br>For other temperatures please inquire |

**MECHANICAL DATA**

| | |
|---|---|
| Material of waveguide and flange | brass |
| Mating flange type | 154 IEC-UER 70 [1]) |
| Finish of flanges | gold plated |
| Colour of waveguide | grey |
| magnets | black |
| magnet yoke | nickel |
| Weight | 1450 g |

[1]) The flange of this isolator is a standard flange except for the dimension indicated with [1]) (2 mm shorter)

Typical performance as a function of frequency at an operating temperature of 20 °C.

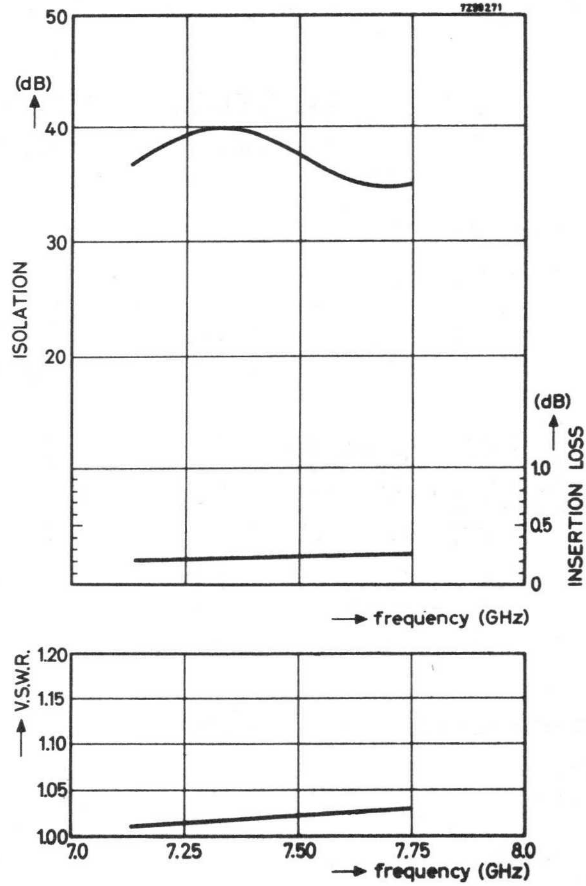



Fig. 2

# ISOLATOR

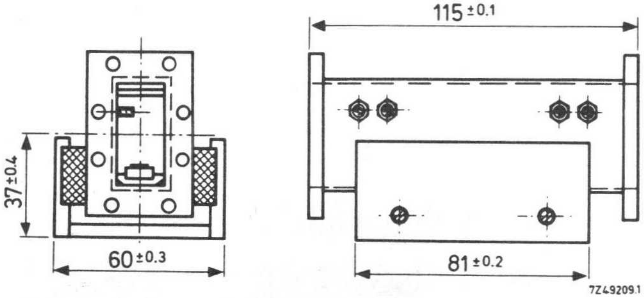
RZ 25233-16

ELECTRICAL DATA

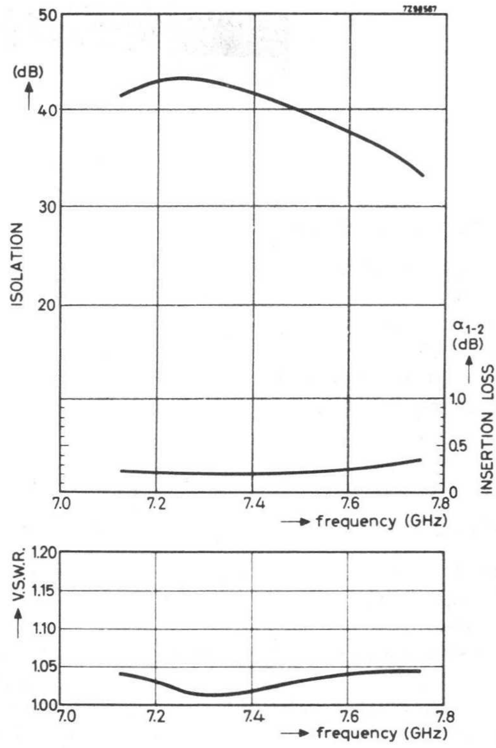
| | |
|---|---|
| Frequency range | 7.125-7.750 GHz |
| Isolation | > 30 dB |
| Insertion loss | < 0.3 dB |
| V.S.W.R. | < 1.05 |
| Nominal power (c.w.) | 20 W |
| Temperature range | -10 to +70 °C<br>For other temperature ranges please inquire |

MECHANICAL DATA

| | |
|---|---|
| Material | brass |
| Waveguide type | R70 (I.E.C.) |
| Flange type | UER70 (I.E.C.); other flanges to order |
| Finish of waveguide and flanges | goldplated upon silverplated<br>outside enamelled grey |
| of magnet system | nickel standard mat |
| Weight | 1450 g |




Dimensions in mm




Typical performance as a function of frequency at a working temperature of 20 °C.

# COAXIAL ISOLATOR

Frequency 740 to 810 MHz

**DIMENSIONS** (in mm)

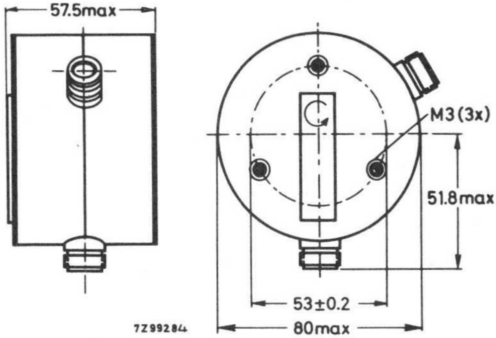



Fig. 1

**ELECTRICAL DATA**

| | |
|---|---|
| Frequency range | 740 to 810 MHz |
| Isolation | > 22 dB |
| Insertion loss | < 0.3 dB |
| V.S.W.R. | < 1.2 |
| Maximum power | 100 W |
| Maximum permissible reflected power | 2 W |
| Temperature range | −10 to +70 °C<br>For other temperature ranges please inquire |

**MECHANICAL DATA**

| | |
|---|---|
| Connector type | N female 50 Ω |
| Finish of connector | silver plated |
| Colour of housing | silver |
| top and bottom face | black |
| Weight | 1200 g |

# COAXIAL ISOLATOR

Frequency 890 to 970 MHz

**DIMENSIONS** (in mm)

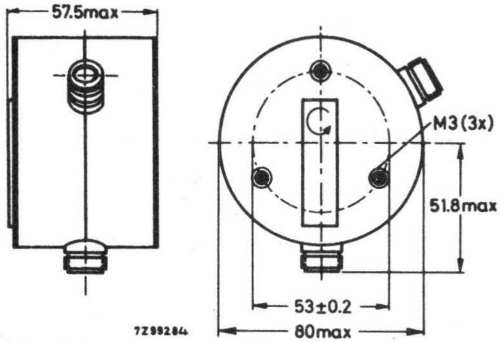



Fig.1

**ELECTRICAL DATA** (see also Fig.2)

| | |
|---|---|
| Frequency range | 890 to 970 MHz |
| Isolation | > 22 dB |
| Insertion loss | < 0.3 dB |
| V.S.W.R. | < 1.2 |
| Maximum power | 100 W |
| Maximum permissible reflected power | 2 W |
| Temperature range | −10 to +70 $^{o}$C<br>For other temperature ranges please inquire |

**MECHANICAL DATA**

| | |
|---|---|
| Connector type | N female 50 Ω |
| Finish of connector | silver plated |
| Colour of housing | silver coloured |
| top and bottom face | black |
| Weight | 1200 g |

Typical performance as a function of frequency at an operating temperature of 20 °C

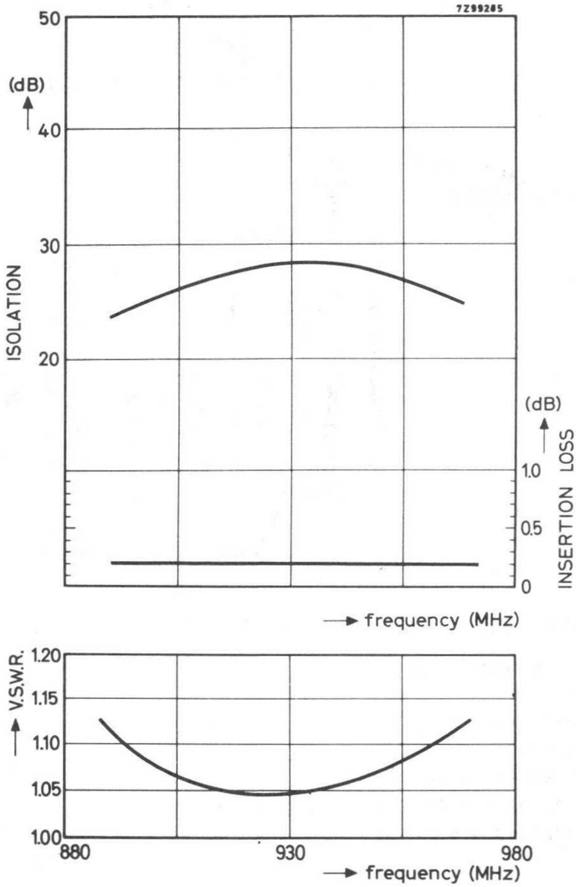



Fig.2

# COAXIAL ISOLATOR

Frequencie 2.96 to 3.22 GHz

**DIMENSIONS** (in mm)

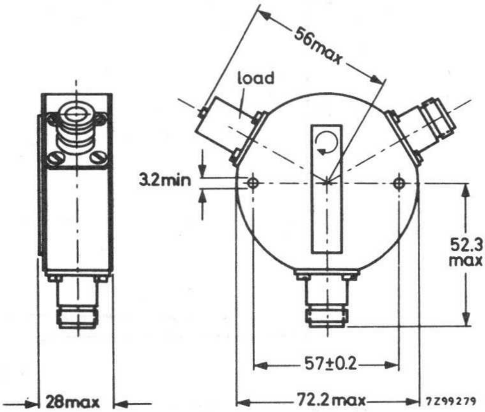



Fig.1

**ELECTRICAL DATA** (see also Fig.2)

| | |
|---|---|
| Frequency range | 2.96 to 3.22 GHz |
| Isolation | > 20 dB |
| Insertion loss | < 0.3 dB |
| V.S.W.R. | < 1.2 |
| Maximum power | 100 W |
| Maximum permissible reflected power | 2 W |
| Temperature range | −10 to +70 °C<br>For other temperature ranges please inquire |

**MECHANICAL DATA**

| | |
|---|---|
| Connector type | N female 50 Ω |
| Finish of connector | silver plated |
| Colour of housing | silver |
| top and bottom face | black |
| Weight | 550 g |

Typical performance as a function of frequency at an operating temperature of 20 °C.

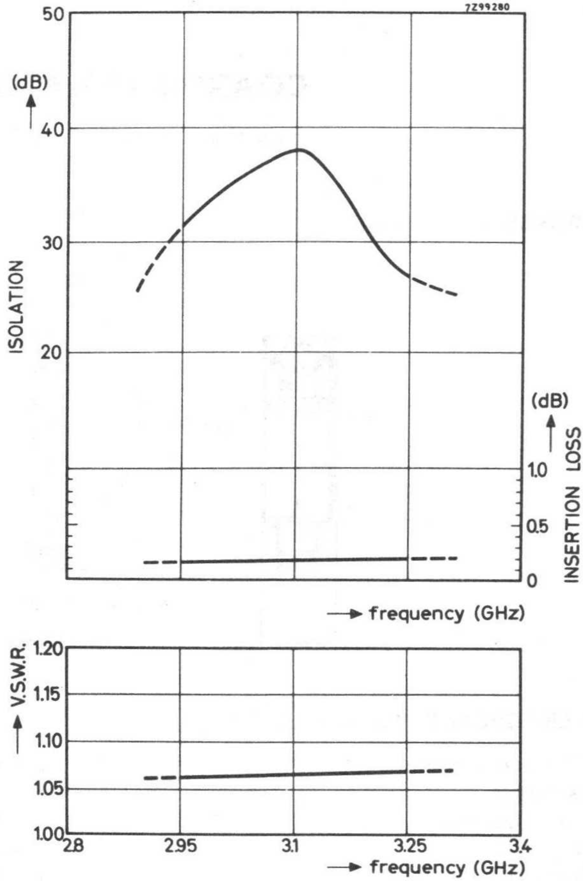



Fig.2

# COAXIAL ISOLATOR

Frequency 3.56 to 3.90 GHz

**DIMENSIONS** (in mm)

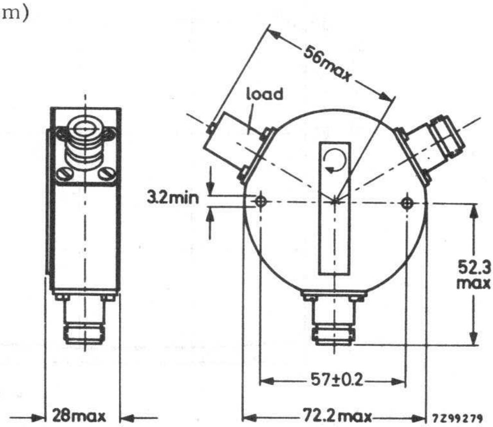



Fig.1

**ELECTRICAL DATA** (see also Fig.2)

| | |
|---|---|
| Frequeny range | 3.56 to 3.90 GHz |
| Isolation | > 20 dB |
| Insertion loss | < 0.3 dB |
| V.S.W.R. | < 1.2 |
| Maximum power | 100 W |
| Maximum permissible reflected power | 2 W |
| Temperature range | -10 to +70 °C<br>For other temperature ranges please inquire |

**MECHANICAL DATA**

| | |
|---|---|
| Connector type | N female 50 Ω |
| Finish of connector | silver plated |
| Colour of housing | silver |
| top and bottom face | black |
| Weight | 550 g |

Typical performance as a function of frequency at an operating temperature of 20 °C.

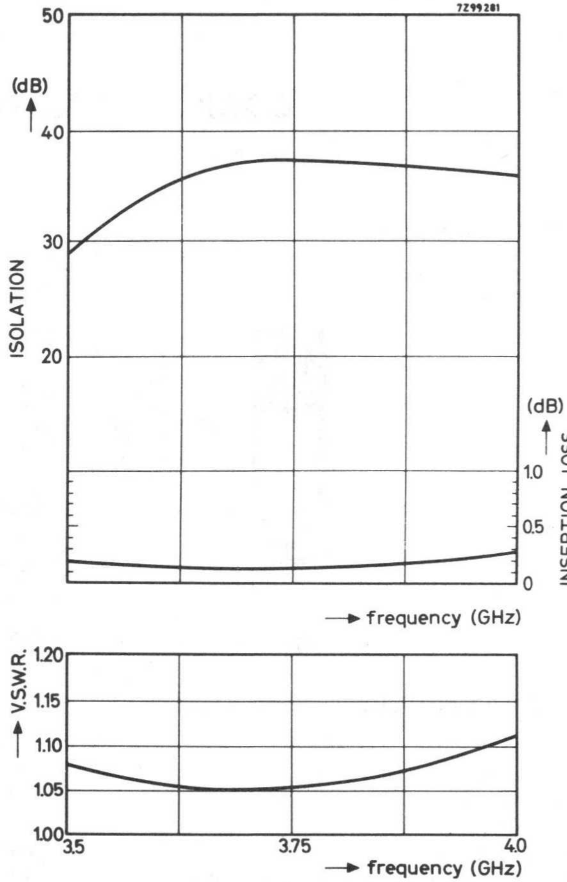


Fig.2

# COAXIAL ISOLATOR

Frequency 1.48 to 1.95 GHz

**DIMENSIONS** (in mm)

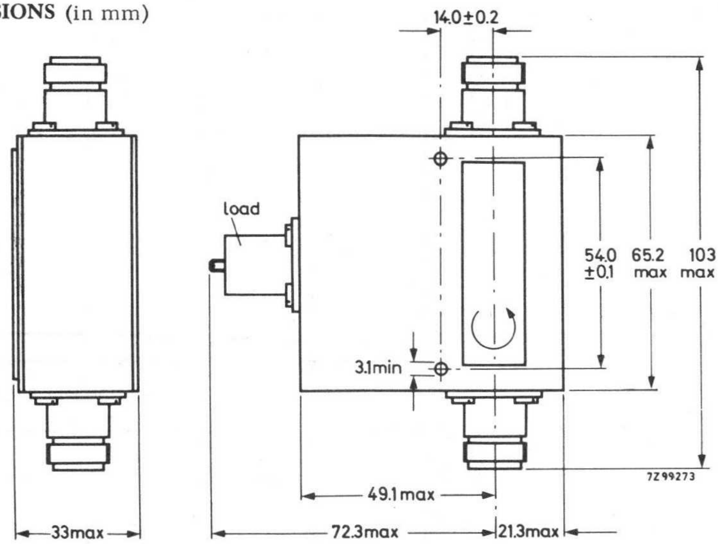



Fig.1

**ELECTRICAL DATA** (see also Fig.2)

| | |
|---|---|
| Frequency range | 1.48 to 1.95 GHz |
| Isolation | > 20 dB |
| Insertion loss | < 0.3 dB |
| V.S.W.R. | < 1.2 |
| Maximum power | 50 W |
| Maximum permissible reflected power | 2 W |
| Temperature range | −10 to +70 °C<br>For other temperature ranges please inquire. |

**MECHANICAL DATA**

| | |
|---|---|
| Connector type | N female 50 Ω |
| Finish of connector | silver plated |
| Colour of housing | grey |
| top and bottom face | black |
| Weight | 500 g |

Typical performance as a function of frequency at an operating temperature of 20 °C.

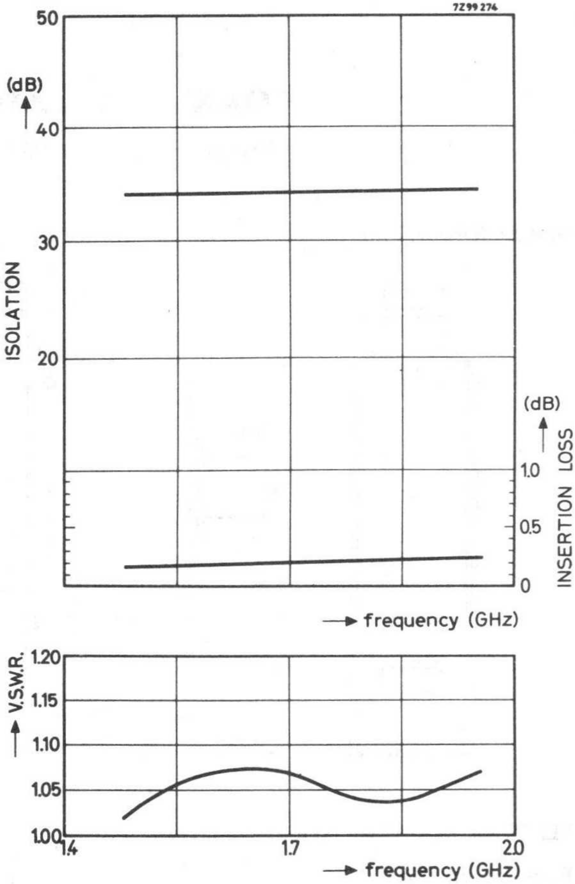
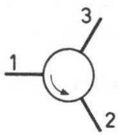



Fig. 2

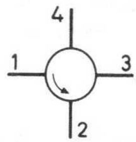
INTRODUCTION

A circulator is a passive non-reciprocal device with three or more ports. It contains a core of ferrite material in which energy introduced into one port is transferred to an adjacent port, the other ports being isolated.

Although circulators can be made with any number of ports, the most commonly used are 3 ports and 4 ports, the symbols of which are given in Fig.1 and 2.




symbols




3 port circulator
Fig.1

4 port circulator
Fig.2

Energy entering into port 1 emerges from port 2, energy entering into port 2 emerges from port 3, and so on in cyclic order. In this direction of circulation an ideal circulator would have no losses, but in practical constructions there are some losses.

In an ideal circulator no energy would flow in the direction opposite to the circulation direction. Again in practice this isolation is in the order of 20 to 30 dB, in very narrow bands even higher.

The non-reciprocal behaviour of circulators is the result of gyromagnetic effects in the ferrite when this is biased with a magnetic field.

APPLICATION

The main application of circulators is duplexing of systems for simultaneous transmission and reception in low and medium power telecommunication equipment as illustrated in Fig.3 and 4.

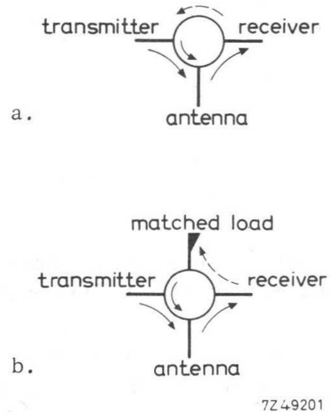



Fig.3
Duplexing of one receiver and one transmitter

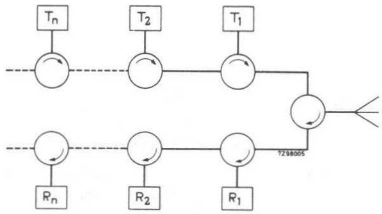



Fig.4
Duplexing of a number of transmitters and receivers

R = receiver; T = transmitter

The reasons that both 3 port and 4 port circulators are used are:

a. a 3 port circulator usually has a wider bandwidth than a 4 port circulator,
b. a 4 port circulator (of which the fourth port is provided with a matched load, see Fig.3b), however, does not require a very accurately matched receiver so that a much simpler filter can be used on the receiver input.

A 3 port circulator can also be used as an isolator by putting a matched load on one port, Fig.5. Particularly at lower frequencies the characteristics of a circulator as to decoupling of functions are superior to those of an isolator. Decoupling can be increased by cascading circulators, see Fig.6. The decoupling is directly proportional to the number of circulators; so is the insertion loss.

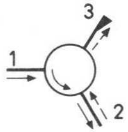



fig.5

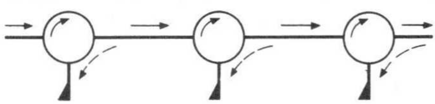
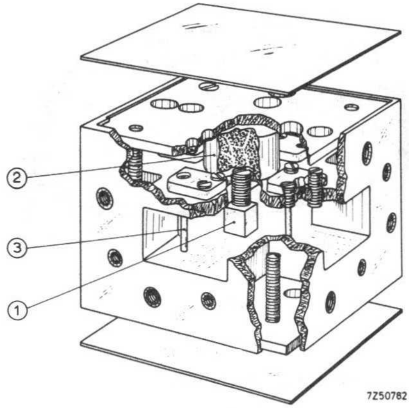


fig.6

CONSTRUCTION

As for the construction of the circulators two types may be distinguished, the waveguide circulators and the coaxial circulators. Both are junction types.

Waveguide circulators



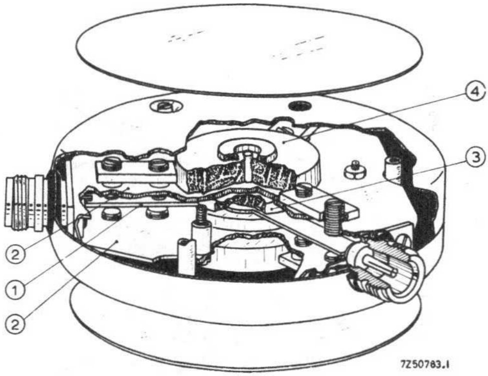

Construction of a waveguide circulator
Fig.7

In this type three or four waveguides intersect each other at 120° or 90° angles. In Fig.7 a 4-port waveguide circulator of the junction type is shown. Exactly in the centre of the intersection a piece of ferrite (1) is located between two magnets (2).

In the waveguide some posts (3) are placed which are required to achieve a good match.

## Coaxial circulators

In Fig.8 a coaxial circulator of the junction type is shown. Three copper strips (1) intersect at an angle of 120° in the centre of the circulator, thus forming a Y-arrangement [1]). These strips are mounted between two earth plates (2), in this way forming a matched high frequency conductor. In the exact centre of the circulator two ferrite discs (3) and magnets (4) are mounted.




Construction of a coaxial circulator
Fig.8

## Mounting

Mounting of a coaxial circulator can be done by removing the three screws in the cover plates. The screw size is 3 x 10 mm metric. The circulator can then be placed directly against a metal support and be secured by the three screws.

## TERMS AND DEFINITIONS

Frequency range is the range within which the circulator meets the guaranteed specification.
Outside this range the electrical properties deteriorate rapidly. The circulator will not be damaged, however, if erroneously subjected to frequencies outside the range.

Isolation is the ratio, expressed in dB, of the energy entering into a port to the energy scattered into the adjacent port on the side opposite to normal circulation. It is measured with a matched source and all other ports correctly terminated.
The isolation $\alpha_{1-3}$, i.e. the isolation between ports 1 and 3, is equal to $\alpha_{3-2}$ and $\alpha_{2-1}$. (See Fig.1).

---

[1]) A T-arrangement can be made on request.

Insertion loss is the attenuation resulting from the insertion of a circulator into a transmission system, expressed in dB, of the power delivered to a matched load before insertion of the circulator, to the power delivered to that load after insertion of the circulator.

Voltage standing wave ratio (VSWR) is the ratio of the maximum to the minimum voltages along the line. It is measured with all other ports terminated with a matched load.
The coaxial circulators are designed with a characteristic impedance of 50 ohms.

Typical data. These data are derived by taking the mean measured values of several production runs of the component.

Maximum power is the largest power that a circulator can handle when one port is terminated with a mismatch of VSWR = 2, whilst the next port is matched with VSWR $\leq$ 1.2. This power value should under no circumstances be exceeded.

Temperature range is the ambient temperature range within which the circulators will function to specification.
(When necessary special temperature compensation is built in.)

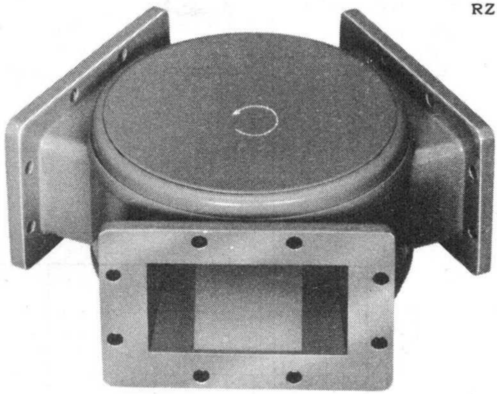
CAUTION

a. The circulators have rather strong internal magnetic fields which are carefully adjusted for optimal operation,

b. They are not to be subjected to strong external magnetic fields.

# CIRCULATOR

RZ 21604-1

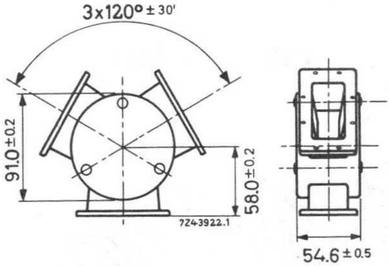


ELECTRICAL DATA

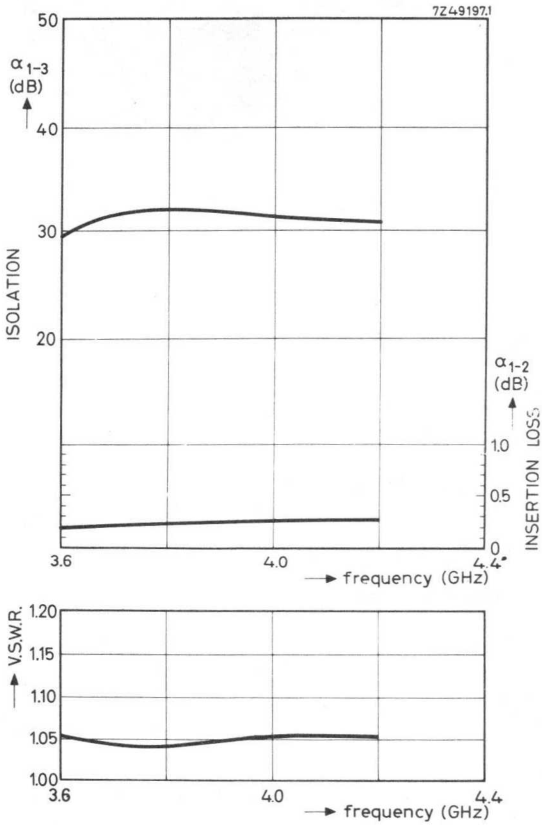
| | |
|---|---|
| Frequency range | 3.6-4.2 GHz |
| Isolation $\alpha_{1-3}$ | > 25 dB |
| Insertion loss $\alpha_{1-2}$ | < 0.4 dB |
| V.S.W.R. | < 1.12 |
| Nominal power (c.w.) | 100 W |
| Temperature range | +10 to +60 °C<br>For other temperature ranges please inquire |

MECHANICAL DATA

| | |
|---|---|
| Construction | waveguide 3 port |
| Material | aluminium |
| Flange type | UER 40 (I.E.C.) |
| Finish | iridium flashed,<br>covers enamelled grey |




Dimensions in mm.




Typical performance as a function of frequency at a working temperature of 20 °C.

# WAVEGUIDE 3-PORT CIRCULATOR

Frequency 3.6 to 4.2 GHz

**DIMENSIONS** (in mm)

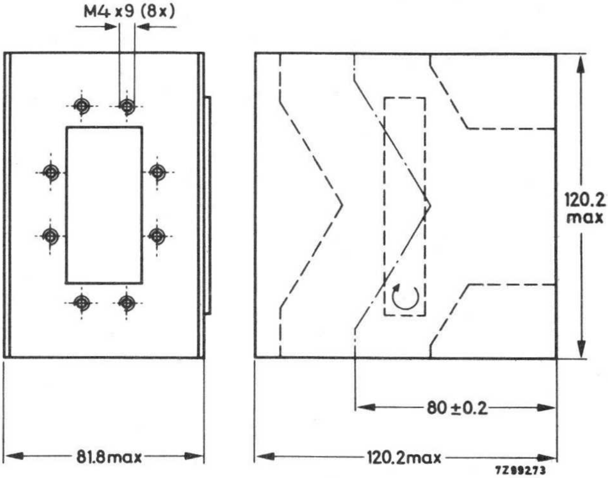



Fig.1

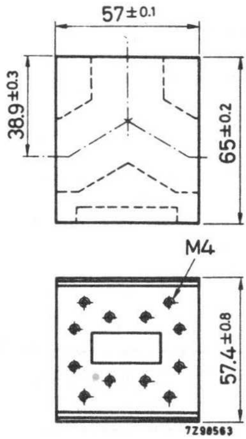
**ELECTRICAL DATA**

| | |
|---|---|
| Frequency range | 3.6 to 4.2 GHz |
| Isolation $\alpha_{1-3}$ | > 28 dB |
| Insertion loss $\alpha_{1-2}$ | < 0.3 dB |
| V.S.W.R. | < 1.1 |
| Maximum power | 50 W |
| Temperature range | 0 to +70 $^{o}$C<br>For other temperature ranges please inquire |

**MECHANICAL DATA**

| | |
|---|---|
| Material of waveguide and flanges | aluminium |
| Mating flange type | 154 IEC-UER 40 |
| Finish of flanges | alodine |
| Colour of top and bottom face | grey |
| Weight | 2900 g |

# CIRCULATOR



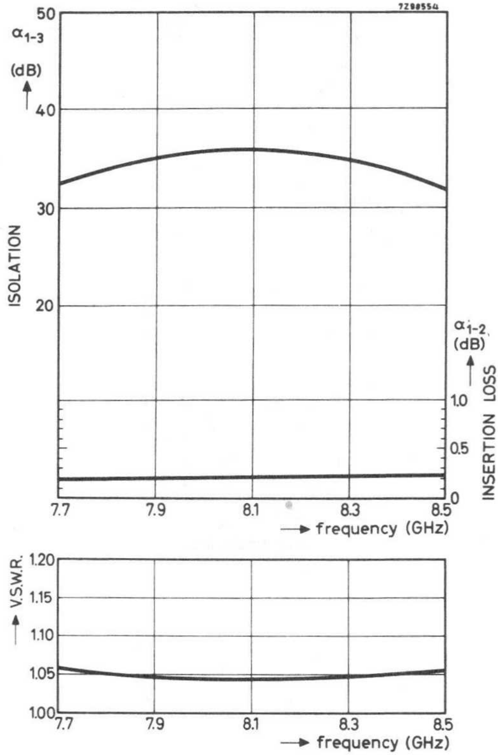

Dimensions in mm

ELECTRICAL DATA

| | |
|---|---|
| Frequency range | 7.7-8.5 GHz |
| Isolation $\alpha_{1-3}$ | > 25 dB |
| Insertion loss $\alpha_{1-2}$ | < 0.3 dB |
| V.S.W.R. | < 1.1 |
| Nominal power (c.w.) | 50 W |
| Temperature range | +10 to +40 $^{o}$C<br>For other temperature ranges please inquire |

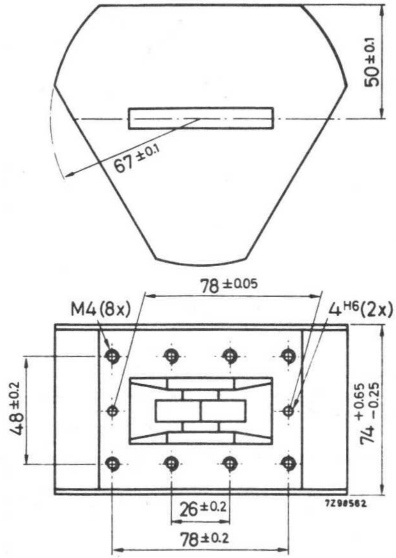
MECHANICAL DATA

| | |
|---|---|
| Construction | waveguide 3 port |
| Material | brass |
| Flange type | UER84/UBR84 (I.E.C.) |
| Finish | goldplated upon silverplated<br>outside enamelled grey |




Typical performance as a function of frequency at a working temperature of 20 °C.

# CIRCULATOR




Dimensions in mm

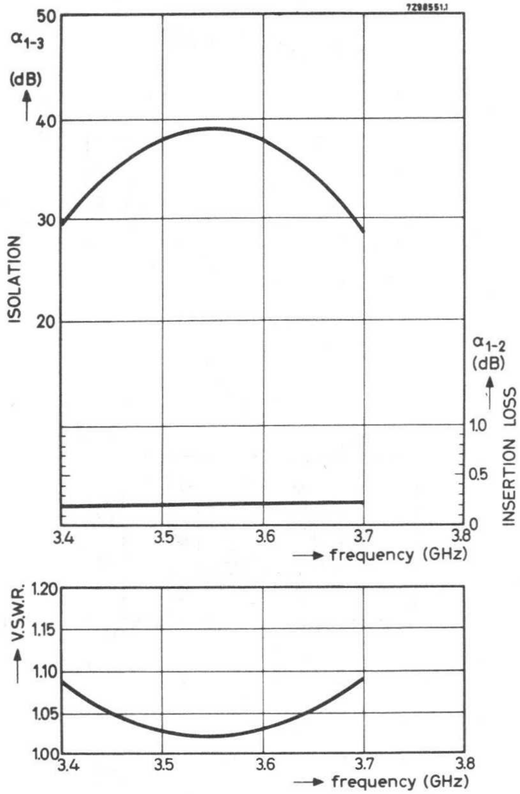
ELECTRICAL DATA

| | |
|---|---|
| Frequency range | 3.4-3.7 GHz |
| Isolation $\alpha_{1-3}$ | > 25 dB |
| Insertion loss $\alpha_{1-2}$ | < 0.3 dB |
| V.S.W.R. | < 1.1 |
| Nominal power (c.w.) | 50 W |
| Temperature range | +5 to +45 °C<br>For other temperature ranges please inquire |

MECHANICAL DATA

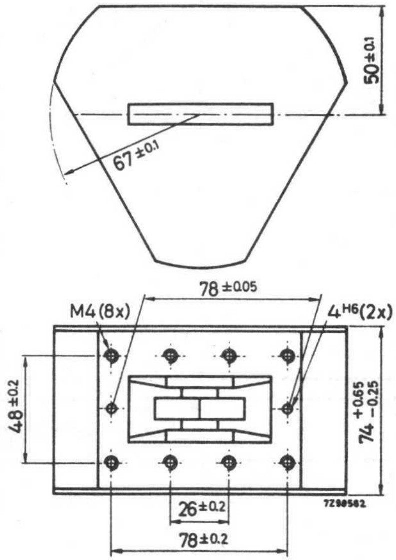
| | |
|---|---|
| Construction | waveguide 3 port |
| Material | aluminium |
| Flange type | C.C.T.U. No.6 *) |
| Finish | alodine<br>outside enamelled grey |

*) UER40 available on request




Typical performance as a function of frequency at a working temperature of 20 °C.

# CIRCULATOR




Dimensions in mm

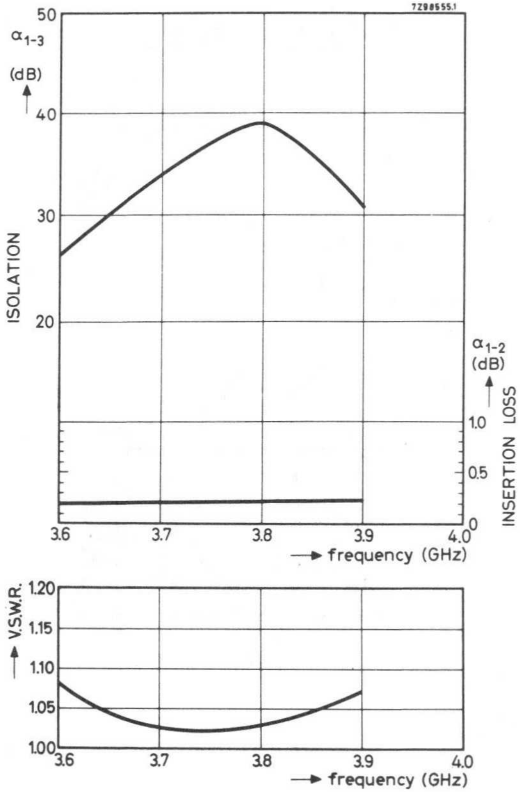
ELECTRICAL DATA

| | |
|---|---|
| Frequency range | 3.6-3.9 GHz |
| Isolation $\alpha_{1-3}$ | > 25 dB |
| Insertion loss $\alpha_{1-2}$ | < 0.3 dB |
| V.S.W.R. | < 1.1 |
| Nominal power (c.w.) | 50 W |
| Temperature range | +5 to +45 °C<br>For other temperature ranges please inquire |

MECHANICAL DATA

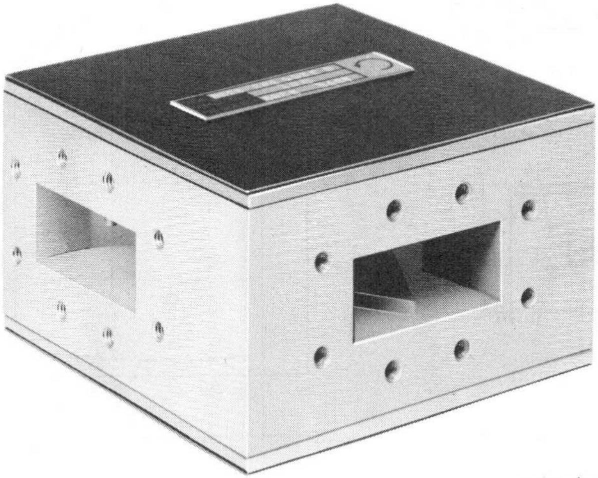
| | |
|---|---|
| Construction | waveguide 3 port |
| Material | aluminium |
| Flange type | C.C.T.U. No.6 *) |
| Finish | alodine,<br>outside enamelled grey |

*) UER40 available on request




Typical performance as a function of frequency at a working temperature of 20 °C.

# CIRCULATOR



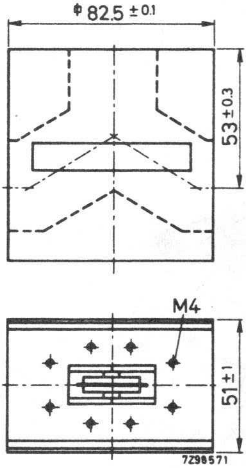
RZ 25233-2

ELECTRICAL DATA

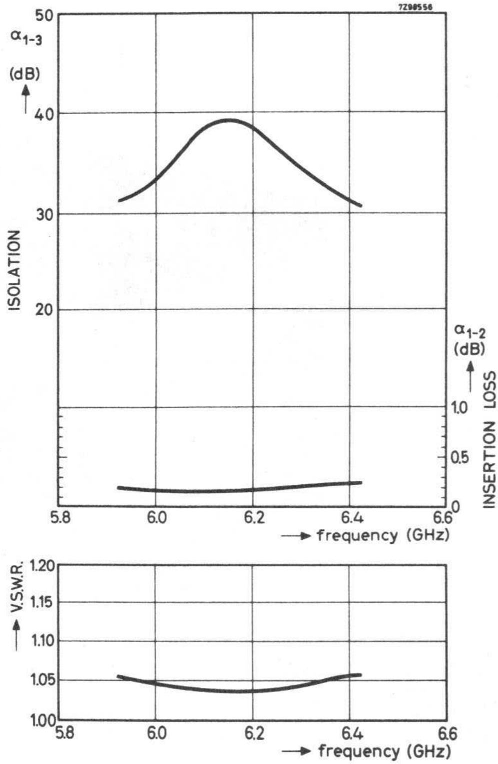
| | |
|---|---|
| Frequency range | 5.925-6.425 GHz |
| Isolation $\alpha_{1-3}$ | > 25 dB |
| Insertion loss $\alpha_{1-2}$ | < 0.3 dB |
| V.S.W.R. | < 1.12 |
| Nominal power (c.w.) | 100 W |
| Temperature range | +10 to +40 °C<br>For other temperature ranges please inquire |

MECHANICAL DATA

| | |
|---|---|
| Construction | waveguide 3 port |
| Material | aluminium |
| Flange type | UER70 (I.E.C.) |
| Finish | alodine,<br>covers black |
| Weight | 950 g |




Dimensions in mm




Typical performance as a function of frequency at a working temperature of 20 °C.

# WAVEGUIDE 3-PORT CIRCULATOR

Frequency 6.425 to 7.125 GHz

**DIMENSIONS** (in mm)

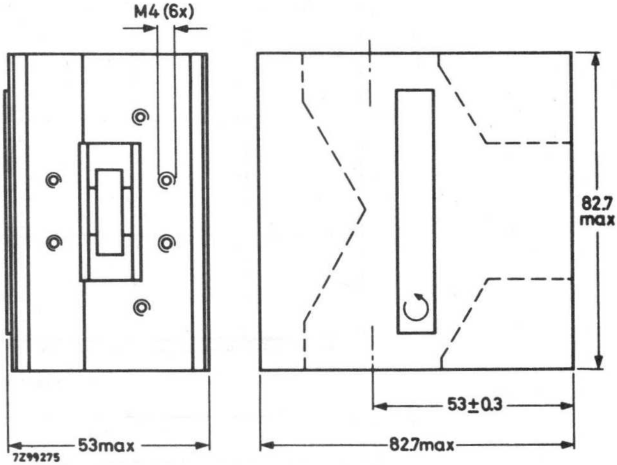



Fig.1

**ELECTRICAL DATA** (see also Fig.2)

| | |
|---|---|
| Frequency range | 6.425 to 7.125 GHz |
| Isolation $\alpha_{1-3}$ | > 30 dB |
| Insertion loss $\alpha_{1-2}$ | < 0.15 dB |
| V.S.W.R. | < 1.07 |
| Maximum power | 100 W |
| Temperature range | -10 to +70 $^{o}$C<br>For other temperature ranges please inquire |

**MECHANICAL DATA**

| | |
|---|---|
| Material of waveguide and flanges | aluminium |
| Mating flange type | 154 IEC-UER 70 |
| Finish of flanges | alodine |
| Colour of top and bottom face | black |
| Weight | 950 g |

Typical performance as a function of frequency at an operating temperature of 20 °C

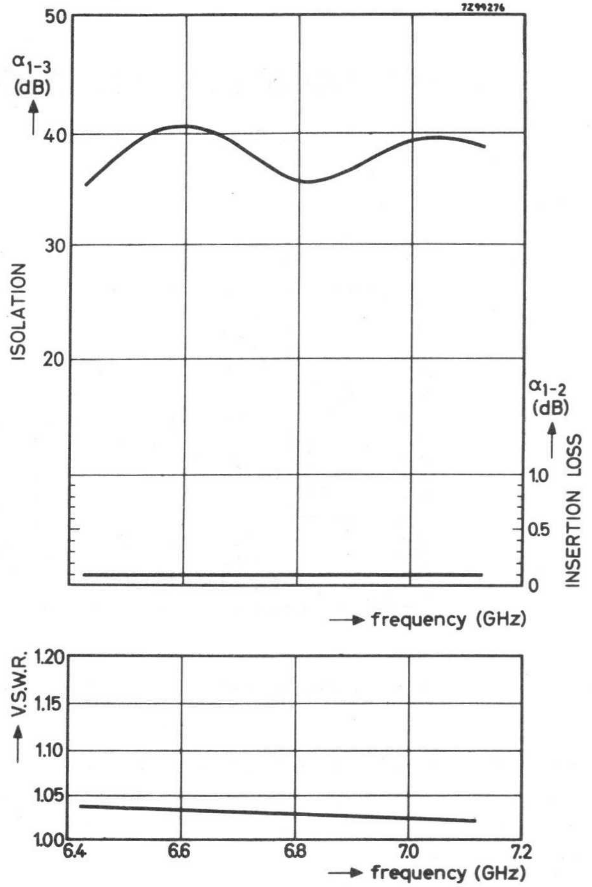



Fig.2

# WAVEGUIDE 3-PORT CIRCULATOR

Frequency 7.125 to 7.750 GHz

**DIMENSIONS** (in mm)

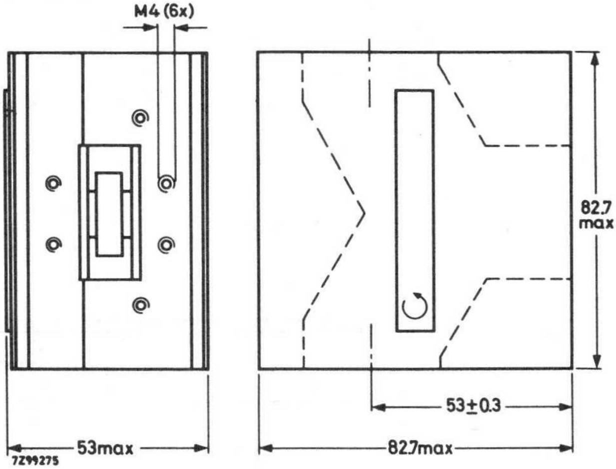



Fig.1

**ELECTRICAL DATA** (see also Fig.2)

| | |
|---|---|
| Frequency range | 7.125 to 7.750 GHz |
| Isolation $\alpha_{1-3}$ | > 30 dB |
| Insertion loss $\alpha_{1-2}$ | < 0.2 dB |
| V.S.W.R. | < 1.06 |
| Maximum power | 100 W |
| Temperature range | −10 to +70 °C<br>For other temperature ranges please inquire |

**MECHANICAL DATA**

| | |
|---|---|
| Material of waveguide and flanges | aluminium |
| Mating flange type | 154 IEC-UER 70 |
| Finish of flanges | alodine |
| Colour of top and bottom face | black |
| Weight | 950 g |

Typical performance as a function of frequency at an operating temperature of 20 °C.

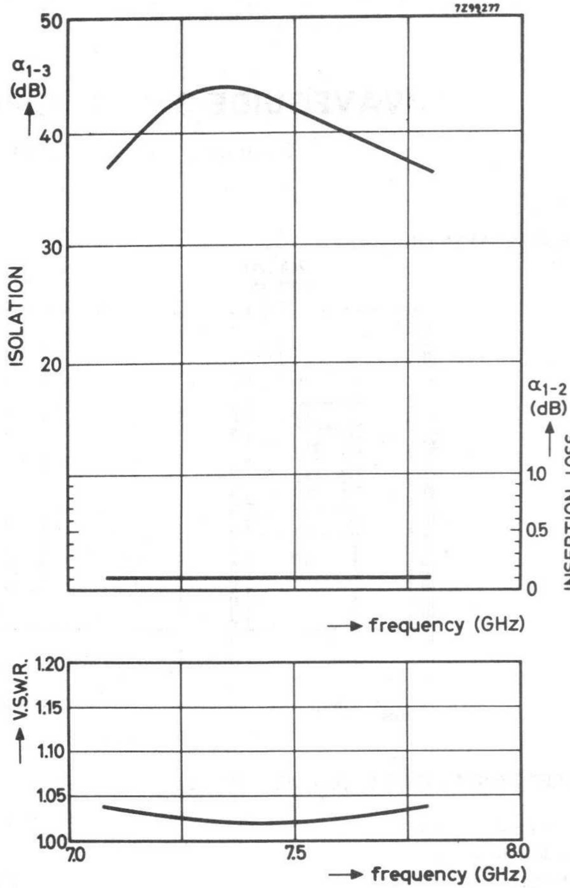



Fig. 2

# WAVEGUIDE 3-PORT CIRCULATOR

Frequency 5.925 to 6.425 GHz

**DIMENSIONS** (in mm)

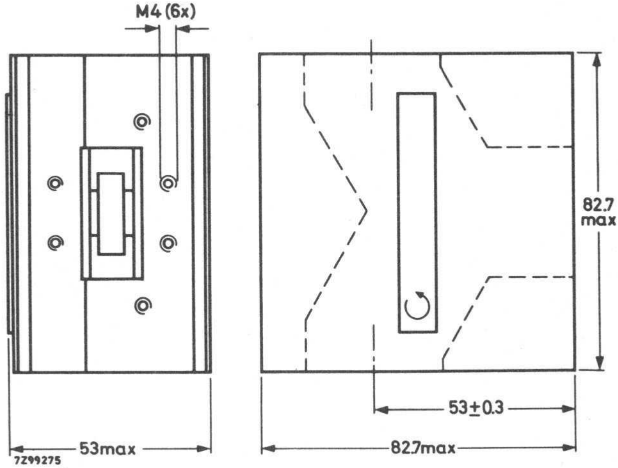



Fig.1

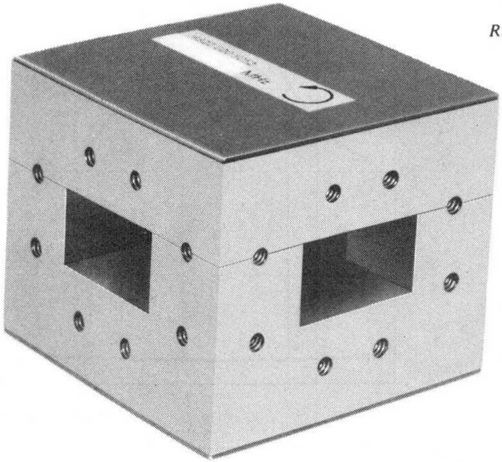
**ELECTRICAL DATA**

| | |
|---|---|
| Frequency range | 5.925 to 6.425 GHz |
| Isolation $\alpha_{1-3}$ | > 30 dB |
| Insertion loss $\alpha_{1-2}$ | < 0.2 dB |
| V.S.W.R. | < 1.06 |
| Maximum power | 100 W |
| Temperature range | $-10\,^{o}C$ to $+70\,^{o}C$<br>For other temperature ranges please inquire |

**MECHANICAL DATA**

| | |
|---|---|
| Material of waveguide and flanges | Aluminium |
| Mating flange type | 154 IEC-UER 70 |
| Finish of flanges | alodine |
| Colour of top and bottom face | black |
| Weight | approx 950 g |

# CIRCULATOR



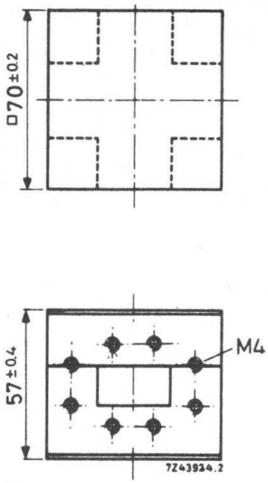
RZ 21478-1.1

ELECTRICAL DATA

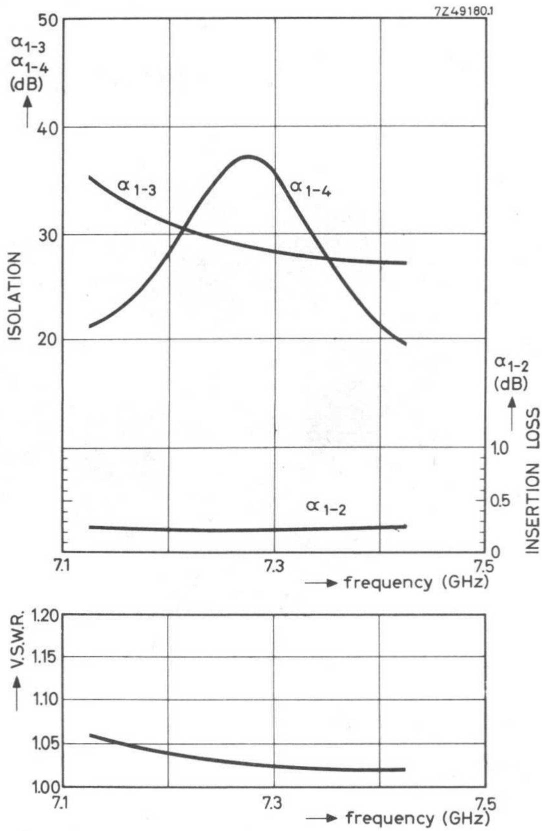
| | |
|---|---|
| Frequency range | 7.125-7.425 GHz |
| Isolation $\alpha_{1-3}$ | > 25 dB |
| $\alpha_{1-4}$ | > 18 dB |
| Insertion loss $\alpha_{1-2}$ | < 0.3 dB |
| V.S.W.R. | < 1.1 |
| Nominal power (c.w.) | 100 W |
| Temperature range | +10 to +60 °C<br>For other temperature ranges please inquire |

MECHANICAL DATA

| | |
|---|---|
| Construction | waveguide 4 port |
| Material | brass |
| Flange type | UER70 (I.E.C.) |
| Finish | goldplated upon silverplated,<br>covers black |
| Weight | 920 g |



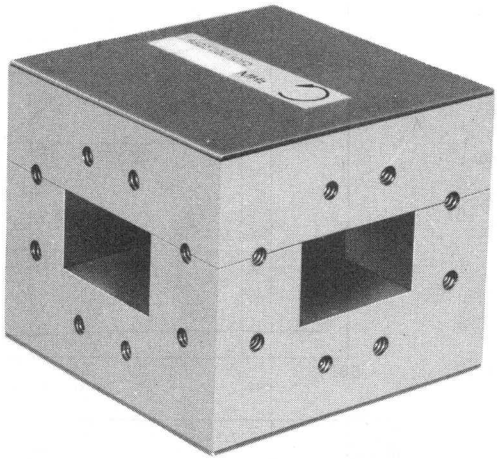

Dimensions in mm.




Typical performance as a function of frequency at a working temperature of 20 °C.

# CIRCULATOR

*RZ 21478-1.1*

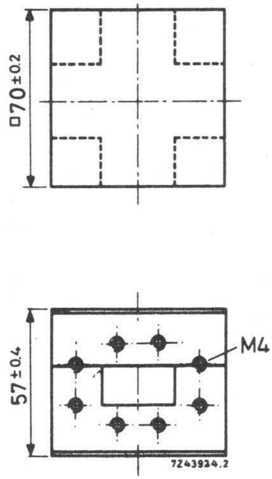


ELECTRICAL DATA

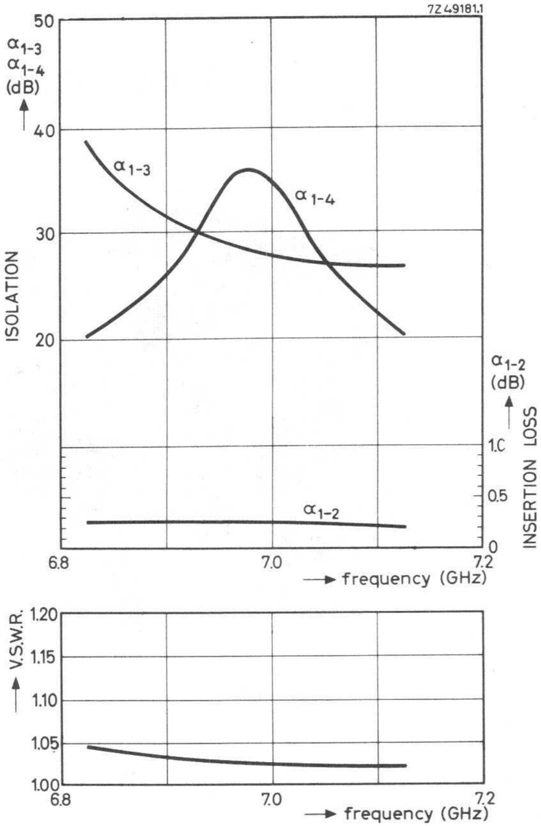
| | |
|---|---|
| Frequency range | 6.825-7.125 GHz |
| Isolation $\alpha_{1-3}$ | > 25 dB |
| $\alpha_{1-4}$ | > 18 dB |
| Insertion loss $\alpha_{1-2}$ | < 0.4 |
| V.S.W.R. | < 1.08 |
| Nominal power (c.w.) | 100 W |
| Temperature range | +10 to +60 °C |
| | For other temperature ranges please inquire |

MECHANICAL DATA

| | |
|---|---|
| Construction | waveguide 4 port |
| Material | brass |
| Flange type | UER 70 (I.E.C.) |
| Finish | goldplated upon silverplated, covers black |
| Weight | 920 g |



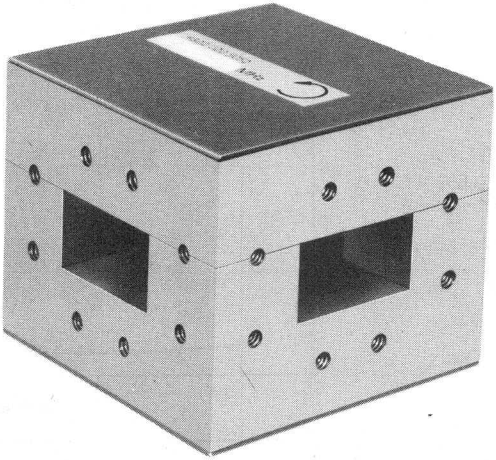

Dimensions in mm.




Typical performance as a function of frequency at a working temperature of 20 °C.

# CIRCULATOR

*RZ 21478-1.1*

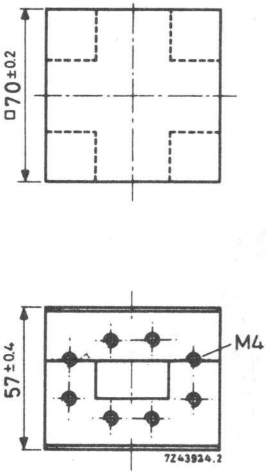


ELECTRICAL DATA

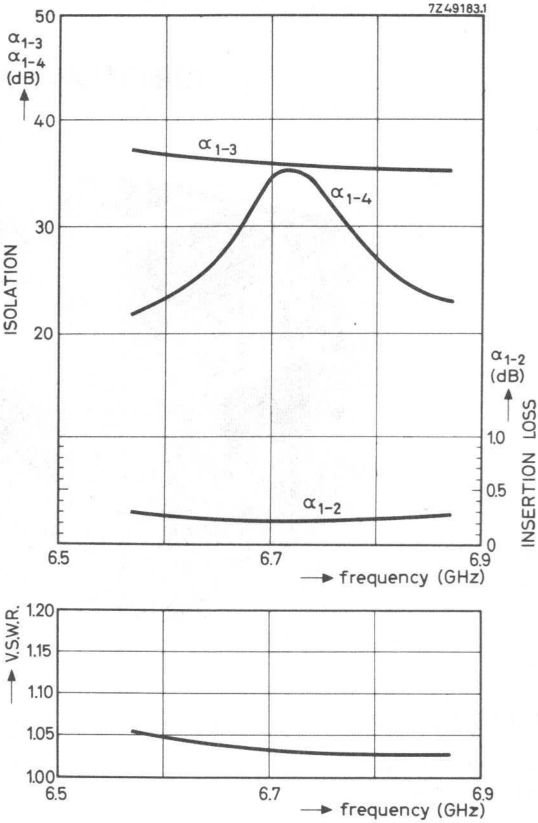
| | |
|---|---|
| Frequency range | 6.575-6.875 GHz |
| Isolation $\alpha_1$-3 | > 25 dB |
| $\alpha_1$-4 | > 20 dB |
| Insertion loss $\alpha_1$-2 | < 0.4 dB |
| V.S.W.R. | < 1.1 |
| Nominal power (c.w.) | 100 W |
| Temperature range | +10 to +60 °C<br>For other temperature ranges please inquire |

MECHANICAL DATA

| | |
|---|---|
| Construction | waveguide 4 port |
| Material | brass |
| Flange type | UER 70 (I.E.C.) |
| Finish | goldplated upon silverplated,<br>covers black |
| Weight | 920 g |



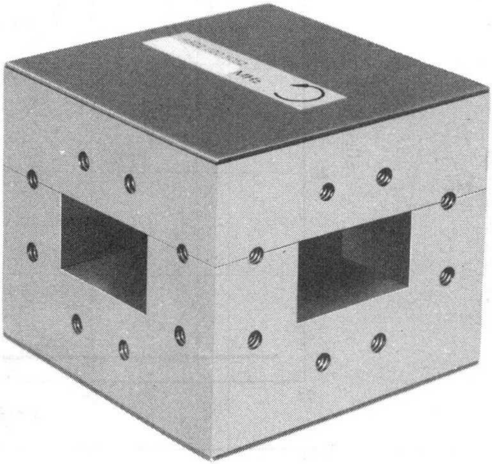

Dimensions in mm.




Typical performance as a function of frequency at a working temperature of 20 °C.

# CIRCULATOR

RZ 21478-1.1

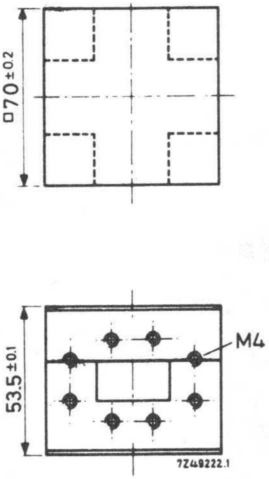


ELECTRICAL DATA

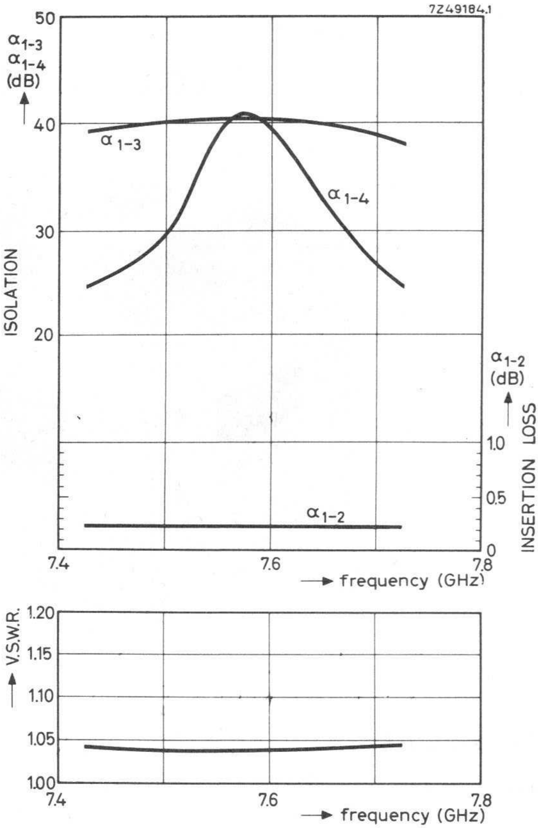
| | |
|---|---|
| Frequency range | 7.425-7.725 GHz |
| Isolation $\alpha_{1-3}$ | > 30 dB |
| $\alpha_{1-4}$ | > 20 dB |
| Insertion loss $\alpha_{1-2}$ | < 0.4 dB |
| V.S.W.R. | < 1.1 |
| Nominal power (c.w.) | 100 W |
| Temperature range | +10 to +60 °C<br>For other temperature ranges please inquire |

MECHANICAL DATA

| | |
|---|---|
| Construction | waveguide 4 port |
| Material | brass |
| Flange type | UER 70 (I.E.C.) |
| Finish | goldplated upon silverplated,<br>covers black |
| Weight | 920 g |



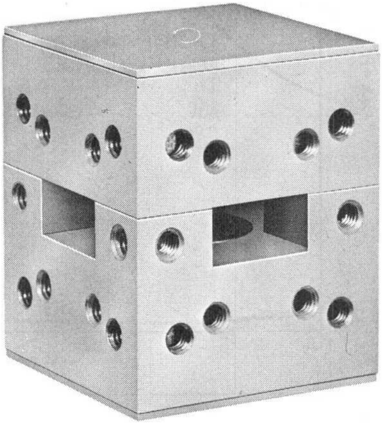

Dimensions in mm.




Typical performance as a function of frequency at a working temperature of 20 °C.

# CIRCULATOR

RZ 21478-3

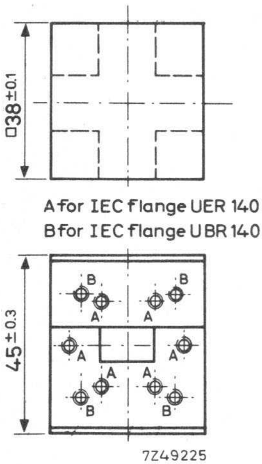


## ELECTRICAL DATA

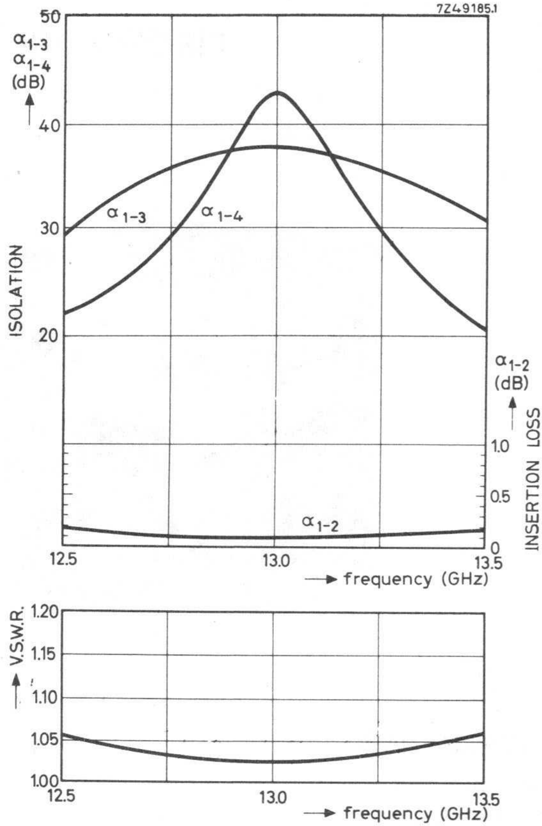
| | |
|---|---|
| Frequency range | 12.5 - 13.5 GHz |
| Isolation $\alpha_{1-3}$ | > 25 dB |
| $\alpha_{1-4}$ | > 20 dB |
| Insertion loss $\alpha_{1-2}$ | < 0.3 dB |
| V.S.W.R. | < 1.1 |
| Nominal power (c.w.) | 25 W |
| Temperature range | +10 to +60 °C<br>For other temperature ranges please inquire |

## MECHANICAL DATA

| | |
|---|---|
| Construction | waveguide 4 port |
| Material | brass |
| Flange type | UER140 and UBR140 (I.E.C.) |
| Finish | goldplated upon silverplated<br>outside enamelled grey |
| Weight | 320 g |

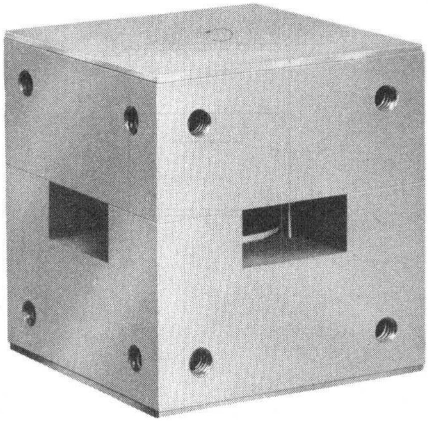



Dimensions in mm.




Typical performance as a function of frequency at a working temperature of 20 °C.

# CIRCULATOR

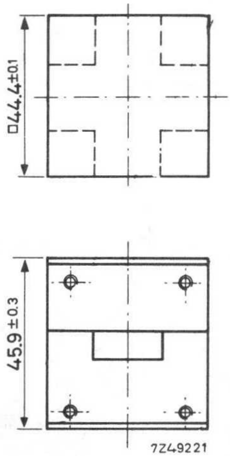


## ELECTRICAL DATA

| | |
|---|---|
| Frequency range | 10.7-11.7 GHz |
| Isolation $\alpha_{1-3}$ | > 30 dB |
| $\alpha_{1-4}$ | > 18 dB |
| Insertion loss $\alpha_{1-2}$ | < 0.3 dB |
| V.S.W.R. | < 1.1 |
| Nominal power (c.w.) | 25 W |
| Temperature range | +10 to +60 °C<br>For other temperature ranges please inquire |

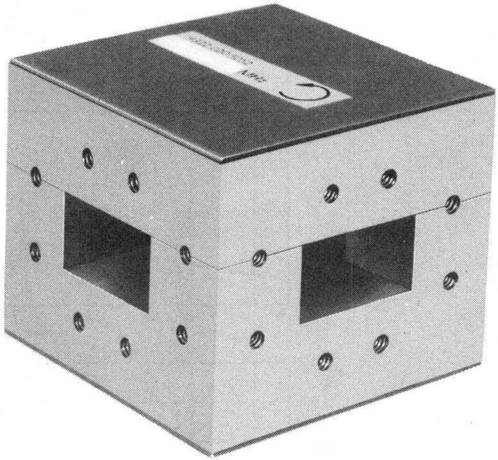
## MECHANICAL DATA

| | |
|---|---|
| Construction | waveguide 4 port |
| Material | brass |
| Flange type | UBR 100 (I.E.C.) |
| Finish | goldplated upon silverplated<br>outside enamelled grey |
| Weight | 390 g |




Dimensions in mm.

# CIRCULATOR



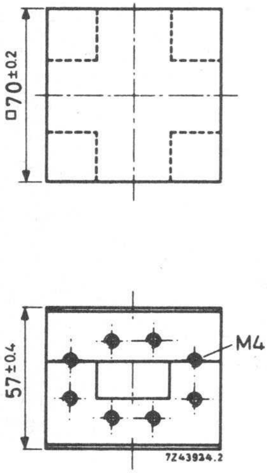
RZ 21478-1.1

ELECTRICAL DATA

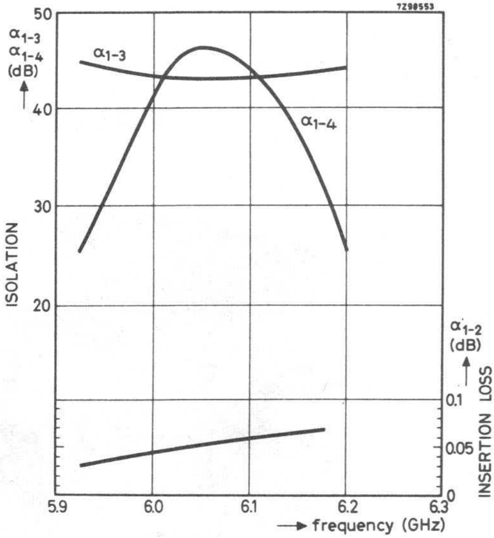
| | |
|---|---|
| Frequency range | 5.925-6.175 GHz |
| Isolation $\alpha_{1-3}$ | > 33 dB |
| $\alpha_{1-4}$ | > 20 dB |
| Insertion loss $\alpha_{1-2}$ | < 0.1 dB |
| V.S.W.R. | < 1.05 |
| Nominal power (c.w.) | 150 W |
| Temperature range | +10 to +60 °C<br>For other temperature ranges please inquire |

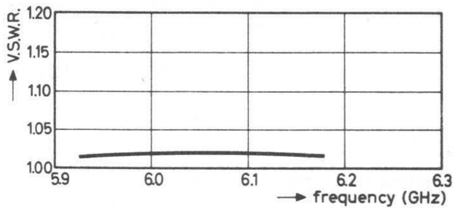
MECHANICAL DATA

| | |
|---|---|
| Construction | waveguide 4 port |
| Material | brass |
| Flange type | UER 70 (I.E.C.) |
| Finish | goldplated upon silverplated,<br>covers black |
| Weight | 920 g |



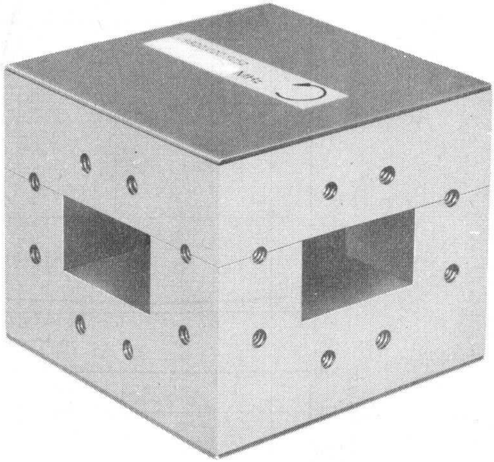

Dimensions in mm




Typical performance as a function of frequency at a working temperature of 20 °C.

# CIRCULATOR



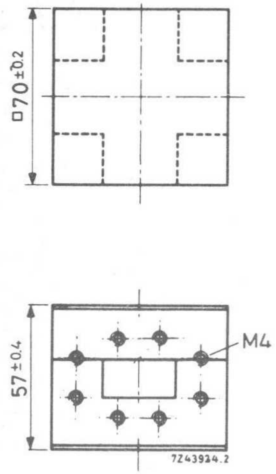
RZ 21478-1.1

ELECTRICAL DATA

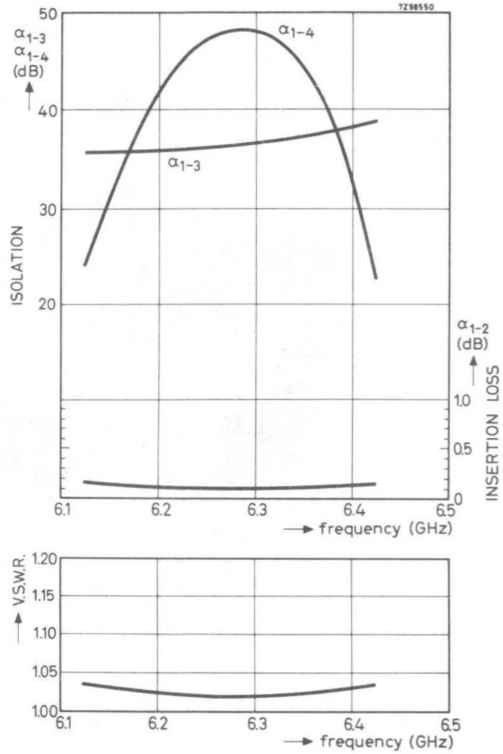
| | |
|---|---|
| Frequency range | 6.125-6.425 GHz |
| Isolation $\alpha_{1-3}$ | > 30 dB |
| $\alpha_{1-4}$ | > 20 dB |
| Insertion loss $\alpha_{1-2}$ | < 0.1 dB |
| V.S.W.R. | < 1.06 |
| Nominal power (c.w.) | 150 W |
| Temperature range | +10 to +60 °C<br>For other temperature ranges please inquire |

MECHANICAL DATA

| | |
|---|---|
| Construction | waveguide 4 port |
| Material | brass |
| Flange type | UER 70 (I.E.C.) |
| Finish | goldplated upon silverplated,<br>covers black |
| Weight | 920 g |




Dimensions in mm




Typical performance as a function of frequency at a working temperature of 20 °C.

# CIRCULATOR

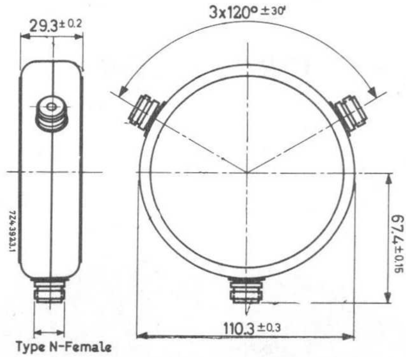
RZ 21478-9

ELECTRICAL DATA

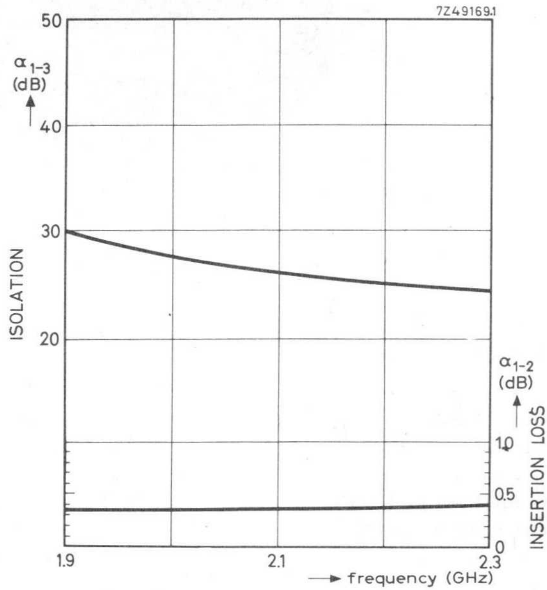
| | |
|---|---|
| Frequency range | 1.9-2.3 GHz |
| Isolation $\alpha_{1-3}$ | > 20 dB |
| Insertion loss $\alpha_{1-2}$ | < 0.75 dB |
| V.S.W.R. | < 1.15 |
| Nominal power (c.w.) | 50 W |
| Temperature range | -10 to +80 °C<br>For other temperature ranges please inquire |

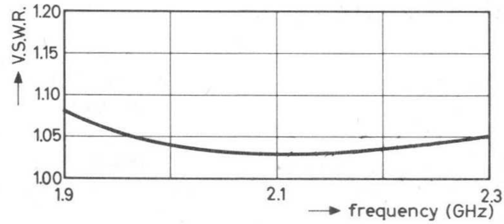
MECHANICAL DATA

| | |
|---|---|
| Construction | coaxial 3 port |
| Terminations | type N-female |
| Finish | connectors silverplated,<br>body outside enamelled grey |
| Weight | 600 g |




Dimensions in mm

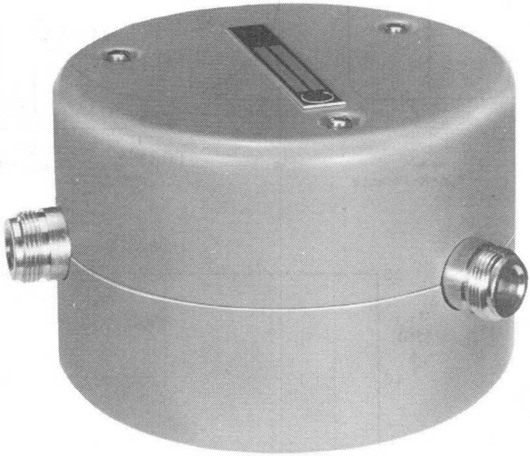



Typical performance as a function of frequency at a working temperature of 20 °C.

# CIRCULATOR

RZ 21478-8

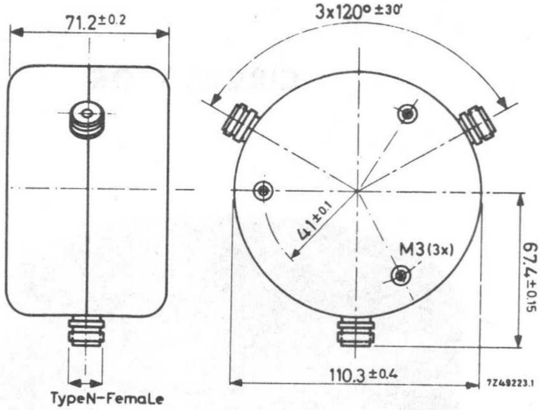


ELECTRICAL DATA

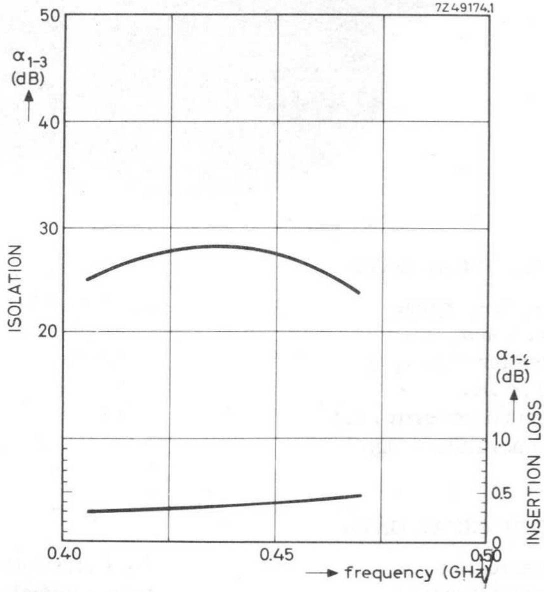
| | |
|---|---|
| Frequency range | 0.406-0.470 GHz |
| Isolation $\alpha_{1-3}$ | > 20 dB |
| Insertion loss $\alpha_{1-2}$ | < 0.6 dB |
| V.S.W.R. | < 1.2 |
| Nominal power (c.w.) | 100 W |
| Temperature range | -10 to +80 °C<br>For other temperature ranges please inquire |

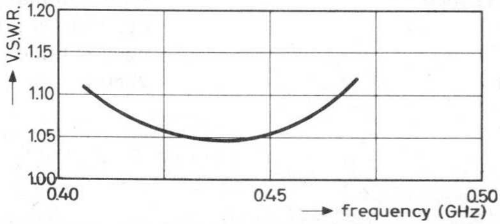
MECHANICAL DATA

| | |
|---|---|
| Construction | coaxial 3 port |
| Terminations | type N-female |
| Finish | connectors silverplated,<br>body outside enamelled grey |
| Weight | 2080 g |




Dimensions in mm

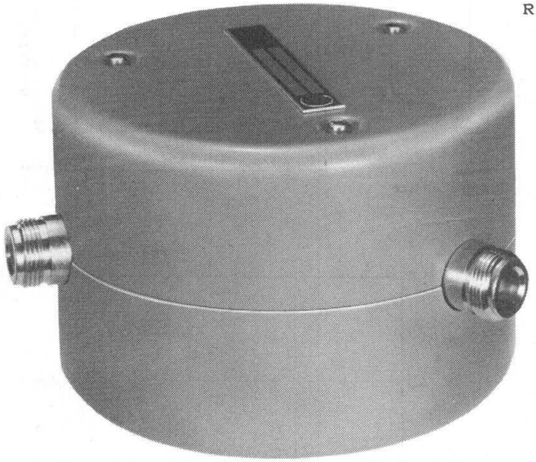



Typical performance as a function of frequency at a working temperature of 20 °C.

# CIRCULATOR

RZ 21478-8

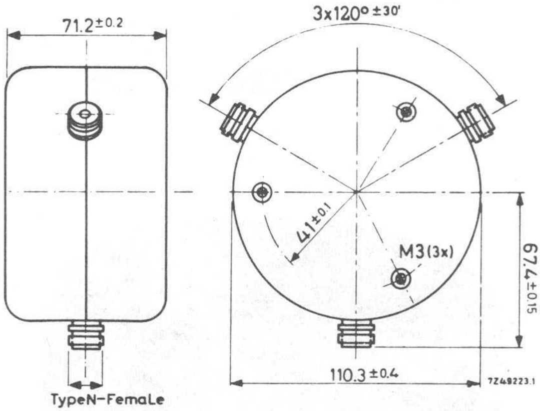


## ELECTRICAL DATA

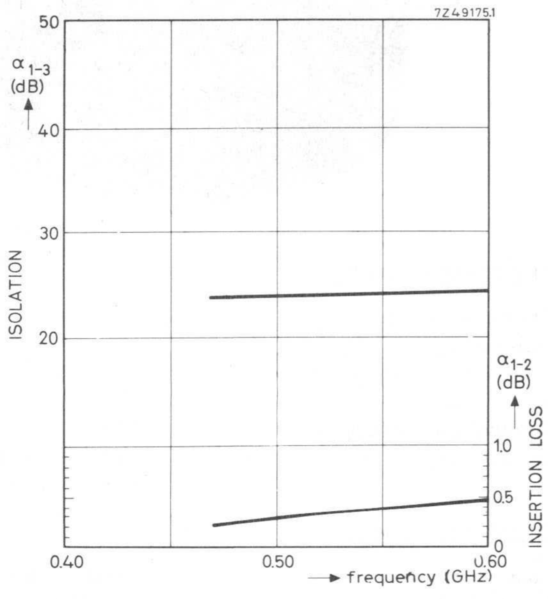
| | |
|---|---|
| Frequency range | 0.47-0.60 GHz |
| Isolation $\alpha_{1-3}$ | > 20 dB |
| Insertion loss $\alpha_{1-2}$ | < 0.6 dB |
| V.S.W.R. | < 1.2 |
| Nominal power (c.w.) | 100 W |
| Temperature range | -10 to +80 $^{o}$C<br>For other temperature ranges please inquire |

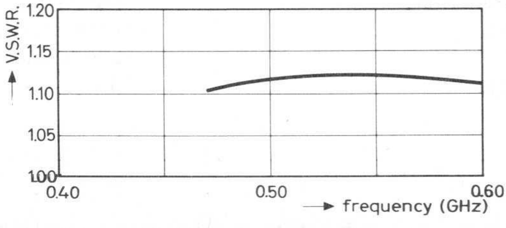
## MECHANICAL DATA

| | |
|---|---|
| Construction | coaxial 3 port |
| Terminations | type N-female |
| Finish | connectors silverplated,<br>body outside enamelled grey |
| Weight | 2080 g |




Dimensions in mm

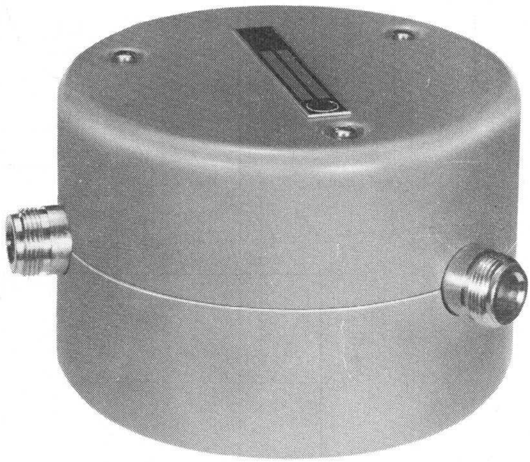



Typical performance as a function of frequency at a working temperature of 20 °C.

# CIRCULATOR

RZ 21478-8

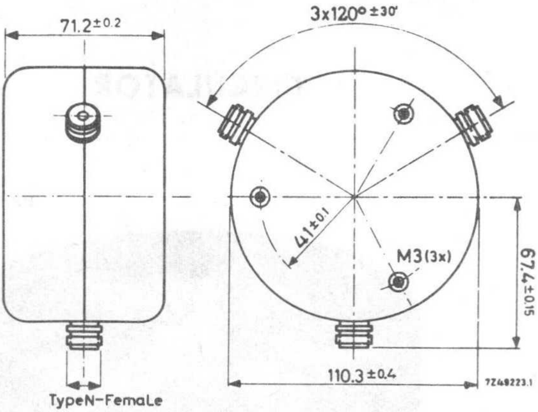


ELECTRICAL DATA

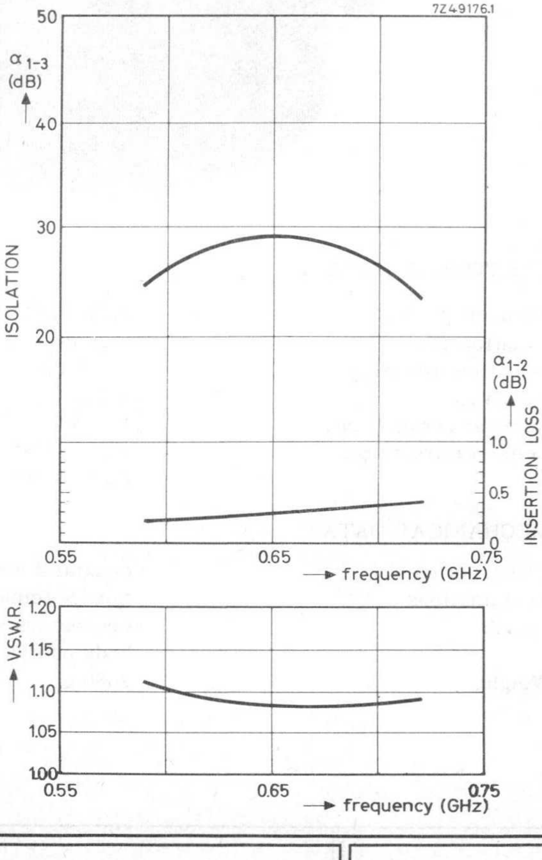
| | |
|---|---|
| Frequency range | 0.59-0.72 GHz |
| Isolation $\alpha_{1-3}$ | > 20 dB |
| Insertion loss $\alpha_{1-2}$ | < 0.6 dB |
| V.S.W.R. | < 1.2 |
| Nominal power (c.w.) | 100 W |
| Temperature range | -10 to +80 °C |
| | For other temperature ranges please inquire |

MECHANICAL DATA

| | |
|---|---|
| Construction | coaxial 3 port |
| Terminations | type N-female |
| Finish | connectors silverplated, body outside enamelled grey |
| Weight | 2080 g |



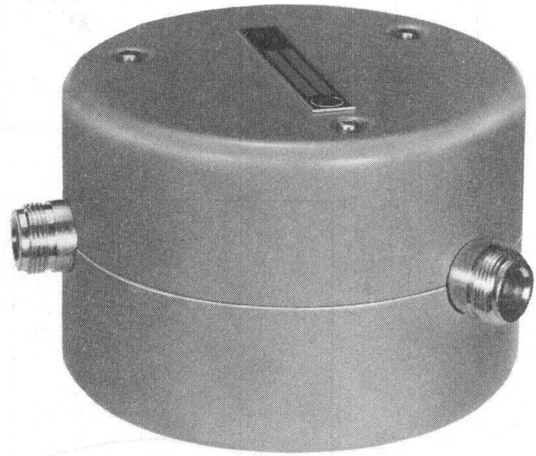

Dimensions in mm




Typical performance as a function of frequency at a working temperature of 20 °C.

# CIRCULATOR

RZ 21478-8

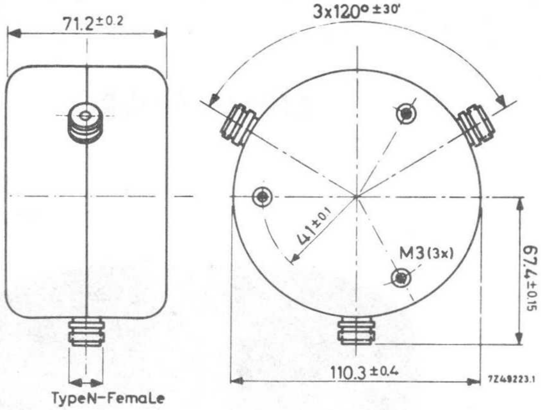


ELECTRICAL DATA

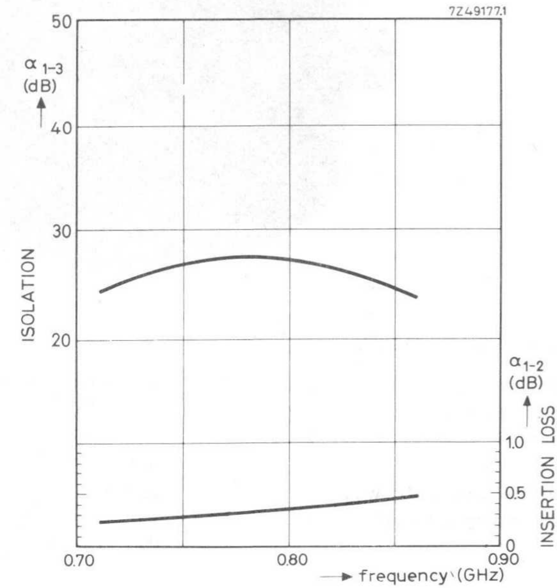
| | |
|---|---|
| Frequency range | 0.71-0.86 GHz |
| Isolation $\alpha_{1-3}$ | > 20 dB |
| Insertion loss $\alpha_{1-2}$ | < 0.6 dB |
| V.S.W.R. | < 1.2 |
| Nominal power (c.w.) | 100 W |
| Temperature range | -10 to +80 $^{o}$C<br>For other temperature ranges please inquire |

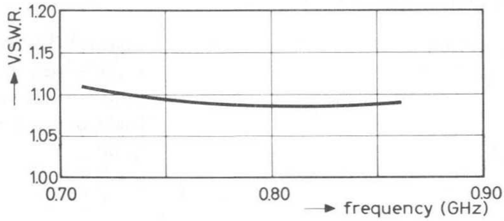
MECHANICAL DATA

| | |
|---|---|
| Construction | coaxial 3 port |
| Terminations | type N-female |
| Finish | connectors silverplated,<br>body outside enamelled grey |
| Weight | 2080 g |




Dimensions in mm

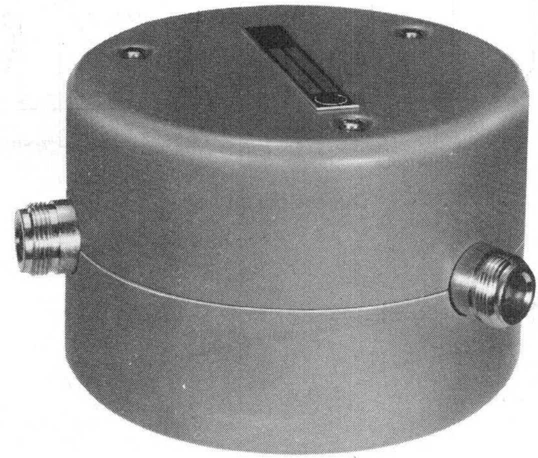



Typical performance as a function of frequency at a working temperature of 20 °C.

# CIRCULATOR

RZ 21478-8

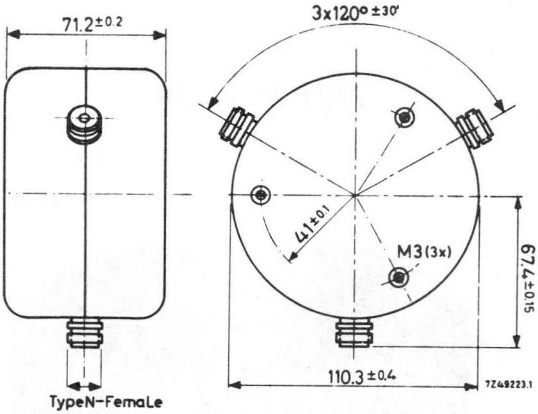


ELECTRICAL DATA

| | |
|---|---|
| Frequency range | 0.45-0.55 GHz |
| Isolation $\alpha_{1-3}$ | > 20 dB |
| Insertion loss $\alpha_{1-2}$ | < 0.6 dB |
| V.S.W.R. | < 1.2 |
| Nominal power (c.w.) | 100 W |
| Temperature range | −10 to +80 °C<br>For other temperature ranges please inquire |

MECHANICAL DATA

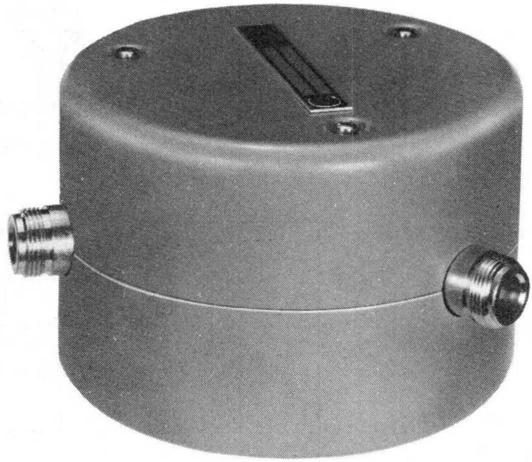
| | |
|---|---|
| Construction | coaxial 3 port |
| Terminations | type N-female |
| Finish | connectors silverplated,<br>body outside enamelled grey |
| Weight | 2080 g |




Dimensions in mm

# CIRCULATOR

RZ 21478-8

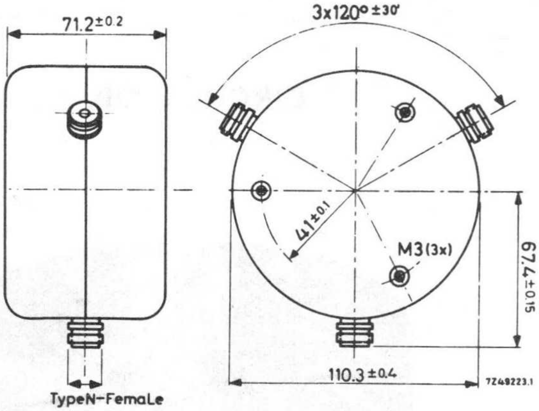


## ELECTRICAL DATA

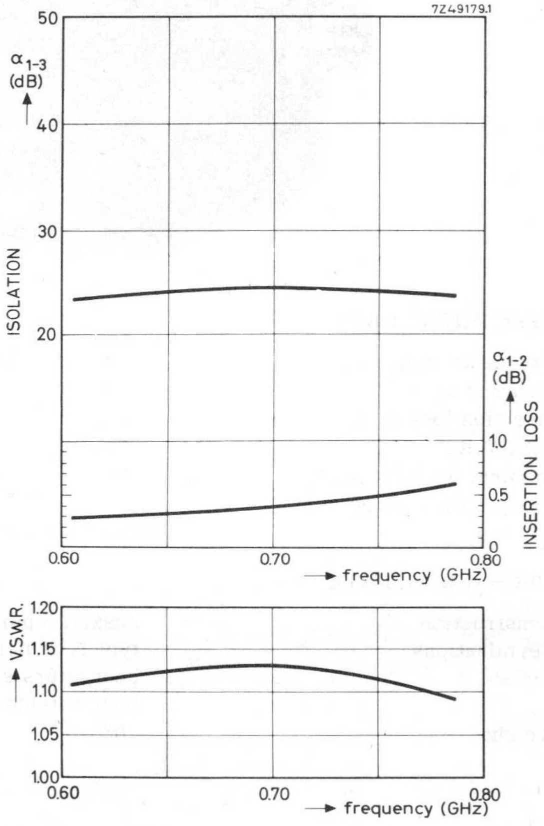
| | |
|---|---|
| Frequency range | 0.608-0.783 GHz |
| Isolation $\alpha_{1-3}$ | > 20 dB |
| Insertion loss $\alpha_{1-2}$ | < 0.75 dB |
| V.S.W.R. | < 1.2 |
| Nominal power (c.w.) | 100 W |
| Temperature range | -10 to +80 °C |
| | For other temperature ranges please inquire |

## MECHANICAL DATA

| | |
|---|---|
| Construction | coaxial 3 port |
| Terminations | type N-female |
| Finish | connectors silverplated |
| | body outside enamelled grey |
| Weight | 2080 g |

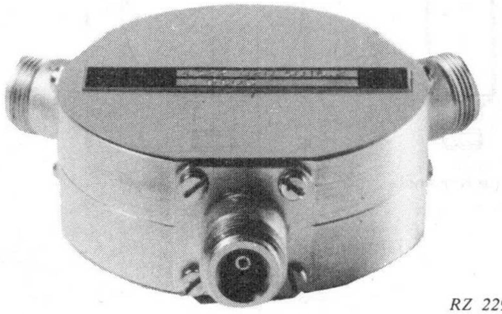



Dimensions in mm




Typical performance as a function of frequency at a working temperature of 20 °C.

# CIRCULATOR



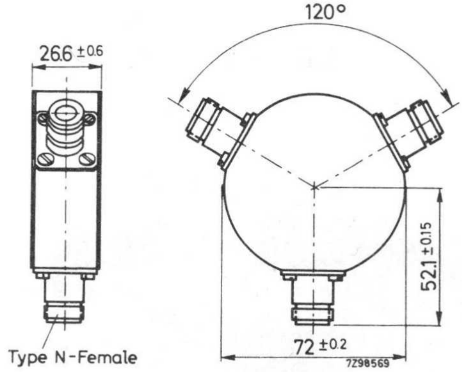
RZ 22967-1

## ELECTRICAL DATA

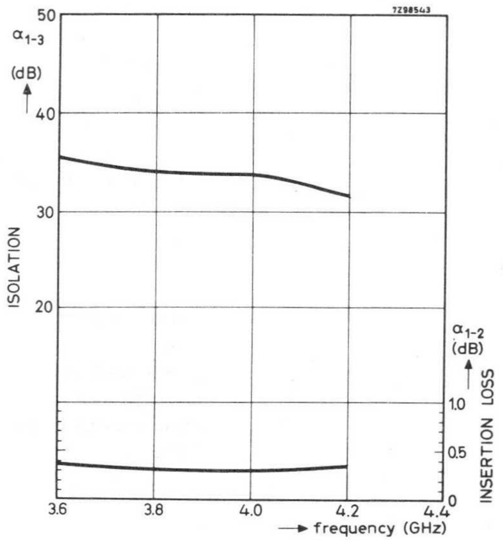
| | |
|---|---|
| Frequency range | 3.6-4.2 GHz |
| Isolation $\alpha_{1-3}$ | > 25 dB |
| Insertion loss $\alpha_{1-2}$ | < 0.5 dB |
| V.S.W.R. | < 1.15 |
| Nominal power (c.w.) | 50 W |
| Temperature range | +10 to +70 °C<br>For other temperature ranges please inquire |

## MECHANICAL DATA

| | |
|---|---|
| Construction | coaxial 3 port |
| Material | brass |
| Terminations | type N-female |
| Finish | silverplated,<br>top and bottom cover black |
| Weight | 550 g |

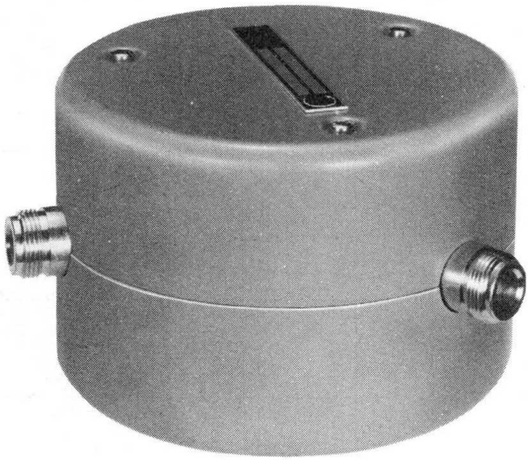



Dimensions in mm




Typical performance as a function of frequency at a working temperature of 20 °C

# CIRCULATOR



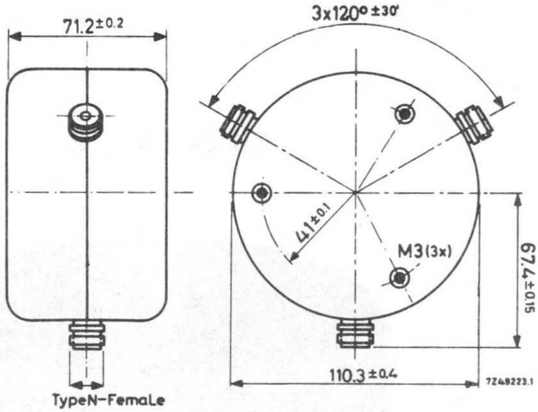
*RZ 21478-8*

ELECTRICAL DATA

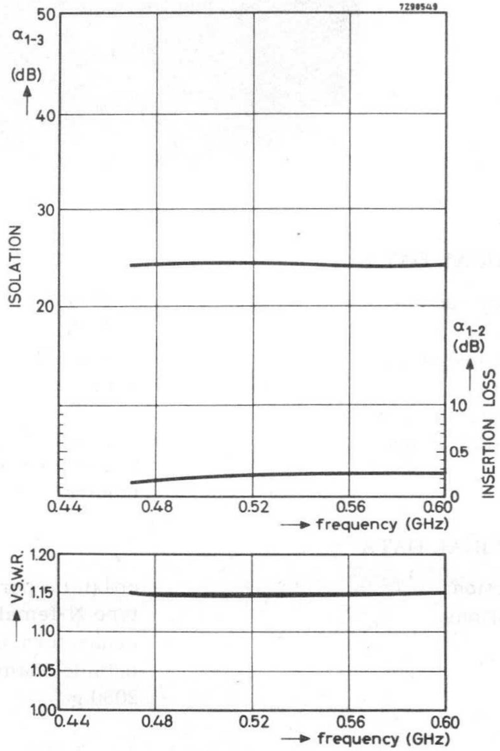
| | |
|---|---|
| Frequency range | 0.47-0.60 GHz |
| Isolation $\alpha_{1-3}$ | > 22 dB |
| Insertion loss $\alpha_{1-2}$ | < 0.35 dB |
| V.S.W.R. | < 1.2 |
| Nominal power (c.w.) | 500 W |
| Temperature range | -10 to +70 °C<br>For other temperature ranges please inquire |

MECHANICAL DATA

| | |
|---|---|
| Construction | coaxial 3 port |
| Terminations | type N-female |
| Finish | connectors silverplated,<br>outside enamelled grey |
| Weight | 2080 g |

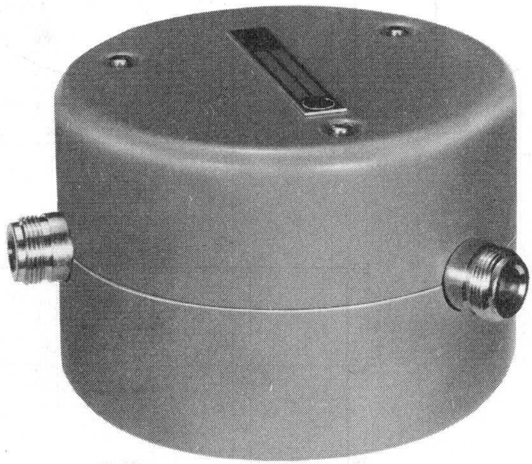



Dimensions in mm




Typical performance as a function of frequency at a working temperature of 20 °C.

# CIRCULATOR



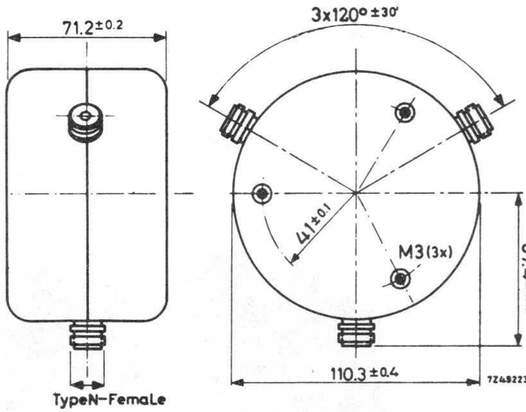
*RZ 21478-8*

ELECTRICAL DATA

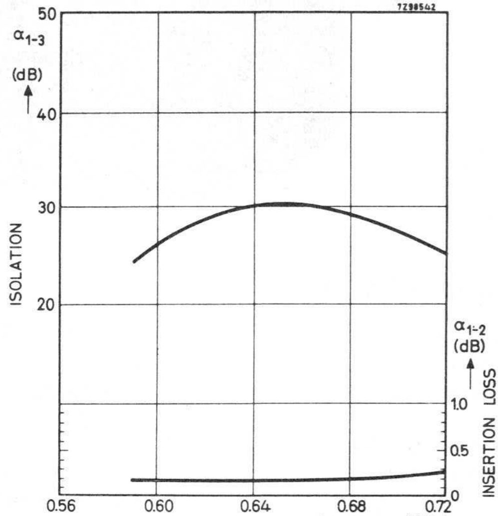
| | |
|---|---|
| Frequency range | 0.59-0.72 GHz |
| Isolation $\alpha_{1-3}$ | > 22 dB |
| Insertion loss $\alpha_{1-2}$ | < 0.35 dB |
| V.S.W.R. | < 1.2 |
| Nominal power (c.w.) | 500 W |
| Temperature range | −10 to +70 °C<br>For other temperature ranges please inquire |

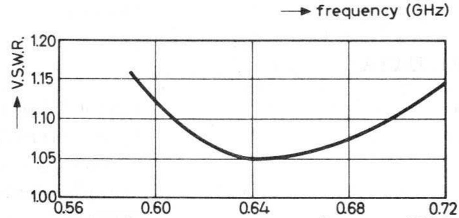
MECHANICAL DATA

| | |
|---|---|
| Construction | coaxial 3 port |
| Terminations | type N-female |
| Finish | connectors silverplated,<br>outside enamelled grey |
| Weight | 2080 g |



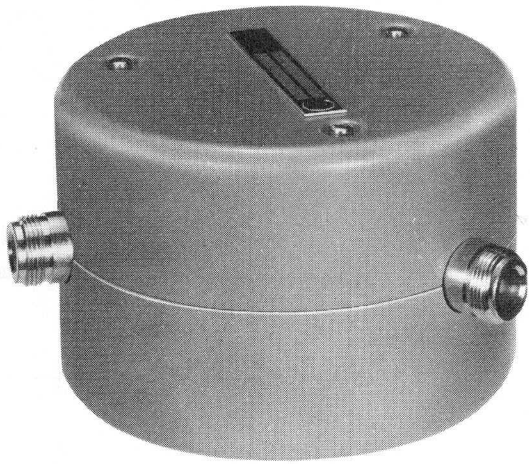

Dimensions in mm




Typical performance as a function of frequency at a working temperature of 20 °C.

# CIRCULATOR



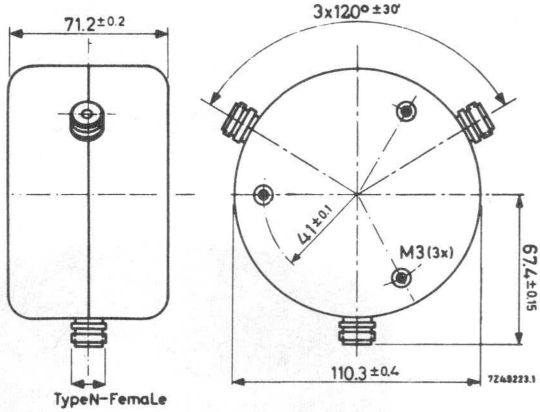
*RZ 21478-8*

ELECTRICAL DATA

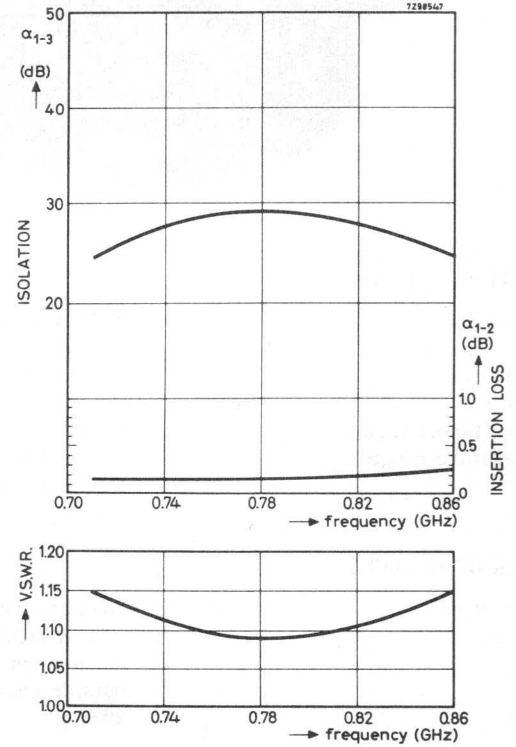
| | |
|---|---|
| Frequency range | 0.71-0.86 GHz |
| Isolation $\alpha_{1-3}$ | > 22 dB |
| Insertion loss $\alpha_{1-2}$ | < 0.35 dB |
| V.S.W.R. | < 1.2 |
| Nominal power (c.w.) | 500 W |
| Temperature range | -10 to +70 $^{o}$C<br>For other temperature ranges please inquire |

MECHANICAL DATA

| | |
|---|---|
| Construction | coaxial 3 port |
| Terminations | type N-female |
| Finish | connectors silverplated,<br>outside enamelled grey |
| Weight | 2080 g |

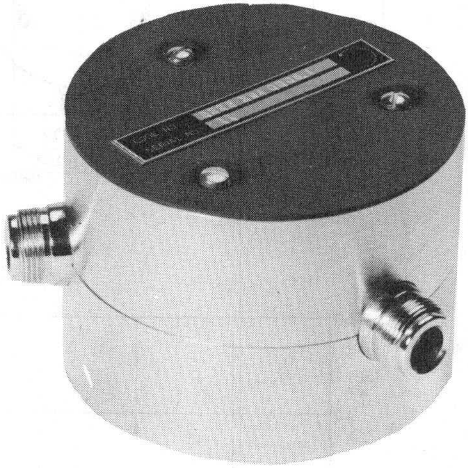



Dimensions in mm




Typical performance as a function of frequency at a working temperature of 20 °C.

# CIRCULATOR



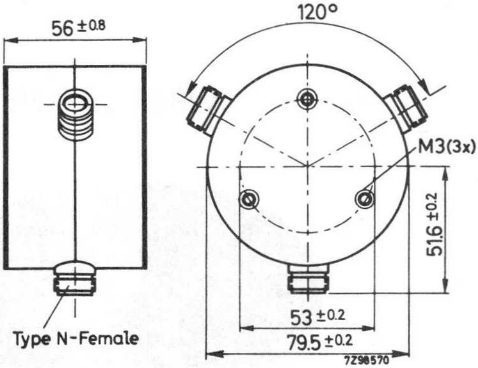
RZ 24733-1

ELECTRICAL DATA

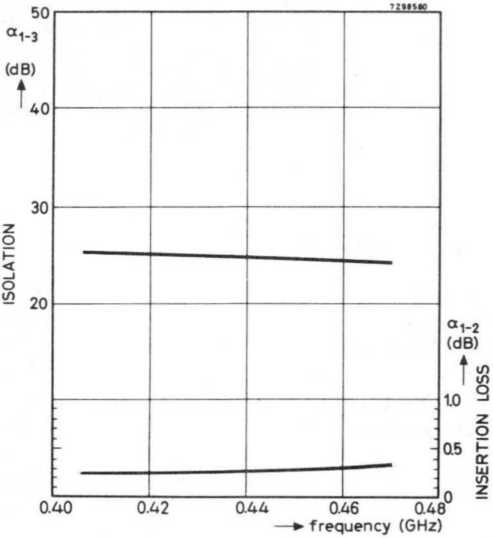
| | |
|---|---|
| Frequency range | 0.406-0.470 GHz |
| Isolation $\alpha_{1-3}$ | > 20 dB |
| Insertion loss $\alpha_{1-2}$ | < 0.40 dB |
| V.S.W.R. | < 1.2 |
| Nominal power (c.w.) | 100 W |
| Temperature range | +10 to +70 °C<br>For other temperature ranges please inquire |

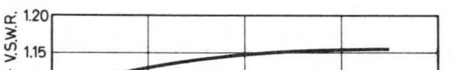
MECHANICAL DATA

| | |
|---|---|
| Construction | coaxial 3 port |
| Terminations | type N-female |
| Finish | silverplated<br>top and bottom cover black |
| Weight | 1200 g |



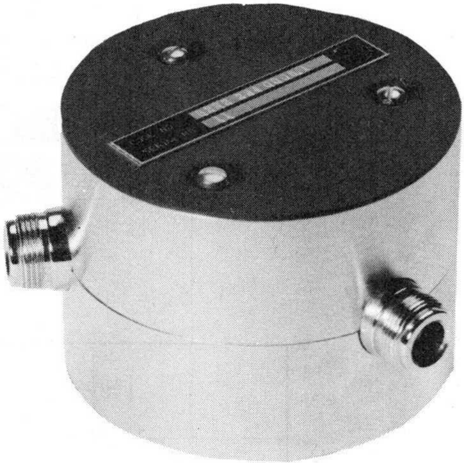

Dimensions in mm




Typical performance as a function of frequency at a working temperature of 20 °C.

# CIRCULATOR



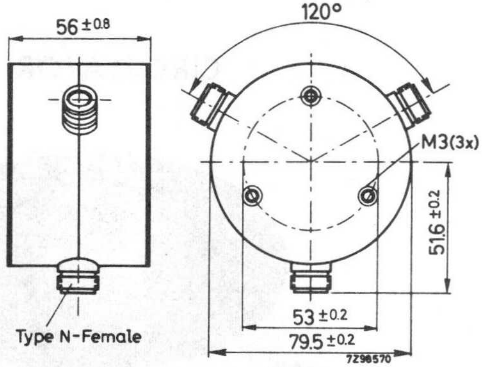
*RZ 24733-1*

ELECTRICAL DATA

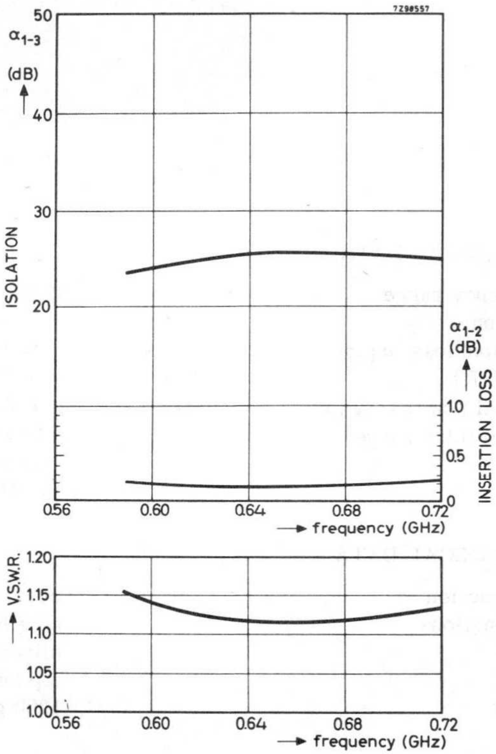
| | |
|---|---|
| Frequency range | 0.59-0.72 GHz |
| Isolation $\alpha_{1-3}$ | > 22 dB |
| Insertion loss $\alpha_{1-2}$ | < 0.35 dB |
| V.S.W.R. | < 1.2 |
| Nominal power (c.w.) | 100 W |
| Temperature range | +10 to +70 $^{o}$C<br>For other temperature ranges please inquire |

MECHANICAL DATA

| | |
|---|---|
| Construction | coaxial 3 port |
| Terminations | type N-female |
| Finish | silverplated<br>top and bottom cover black |
| Weight | 1200 g |

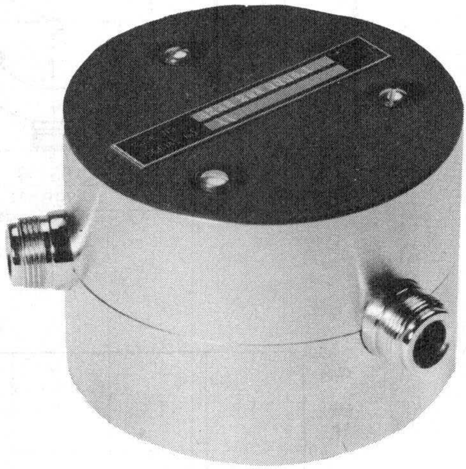



Dimensions in mm




Typical performance as a function of frequency at a working temperature of 20 °C.

# CIRCULATOR



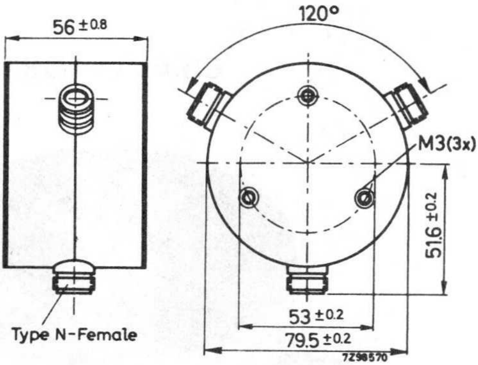
RZ 24733-1

ELECTRICAL DATA

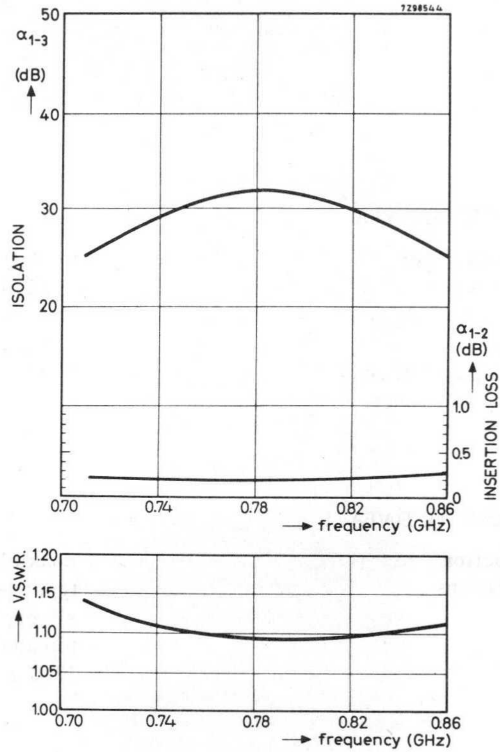
| | |
|---|---|
| Frequency range | 0.71-0.86 GHz |
| Isolation $\alpha_{1-3}$ | > 22 dB |
| Insertion loss $\alpha_{1-2}$ | < 0.35 dB |
| V.S.W.R. | < 1.2 |
| Nominal power (c.w.) | 100 W |
| Temperature range | +10 to +70 °C<br>For other temperature ranges please inquire |

MECHANICAL DATA

| | |
|---|---|
| Construction | coaxial 3 port |
| Terminations | type N-female |
| Finish | silverplated<br>top and bottom cover black |
| Weight | 1200 g |

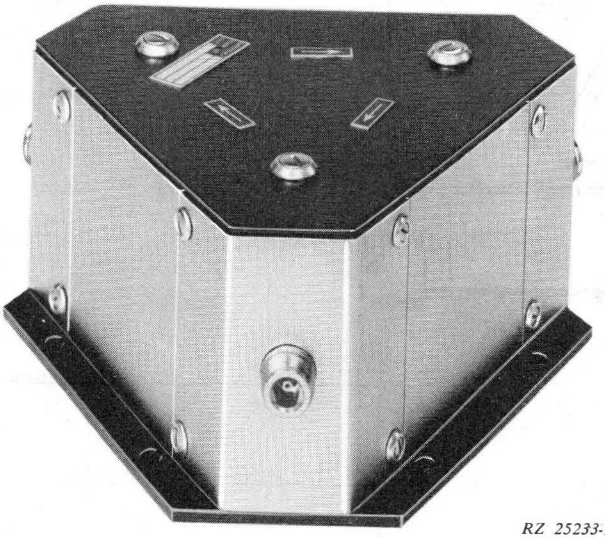



Dimensions in mm




Typical performance as a function of frequency at a working temperature of 20 °C.

# CIRCULATOR



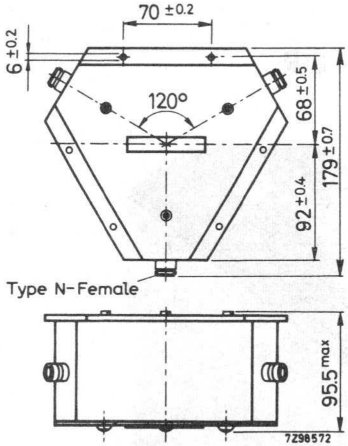
RZ 25233-1

ELECTRICAL DATA

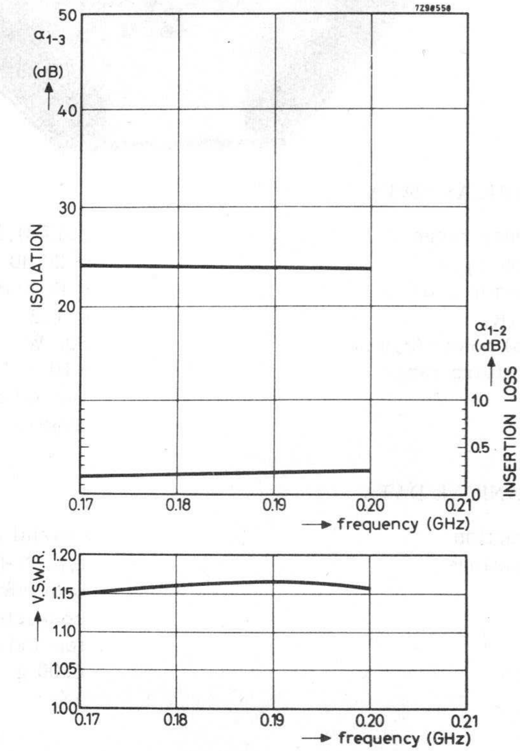
| | |
|---|---|
| Frequency range | 0.17-0.20 GHz |
| Isolation $\alpha_{1-3}$ | > 20 dB |
| Insertion loss $\alpha_{1-2}$ | < 0.40 dB |
| V.S.W.R. | < 1.2 |
| Nominal power (c.w.) | 500 W |
| Temperature range | +10 to +100 °C<br>For other temperature ranges please inquire |

MECHANICAL DATA

| | |
|---|---|
| Construction | coaxial 3 port |
| Terminations | type N-female |
| Finish | body nickelplated<br>connectors silverplated<br>top and bottom cover black |
| Weight | 6400 g |

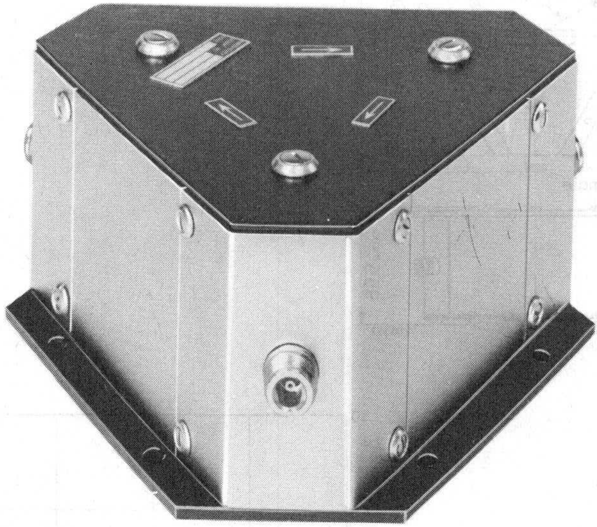



Dimensions in mm




Typical performance as a function of frequency at a working temperature of 20 °C.

# CIRCULATOR



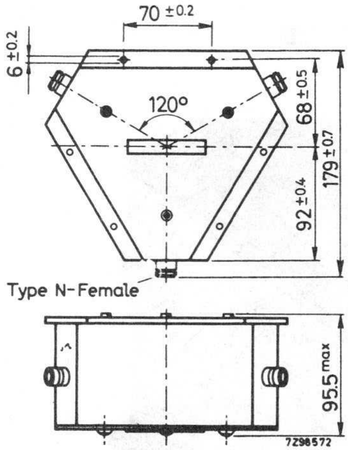
RZ 25233-1

ELECTRICAL DATA

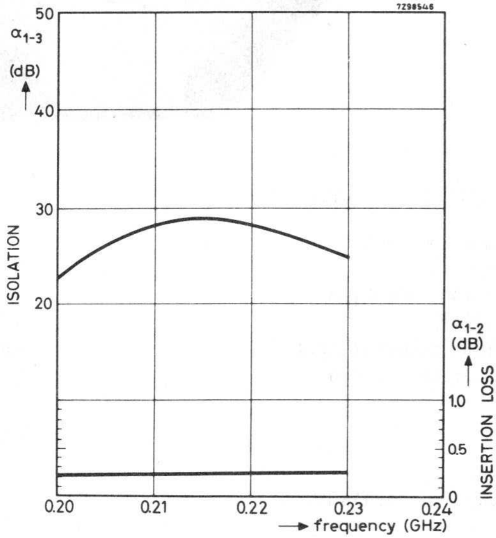
| | |
|---|---|
| Frequency range | 0.20-0.23 GHz |
| Isolation $\alpha_{1-3}$ | > 20 dB |
| Insertion loss $\alpha_{1-2}$ | < 0.40 dB |
| V.S.W.R. | < 1.2 |
| Nominal power (c.w.) | 500 W |
| Temperature range | +10 to +100 $^{o}$C<br>For other temperature ranges please inquire |

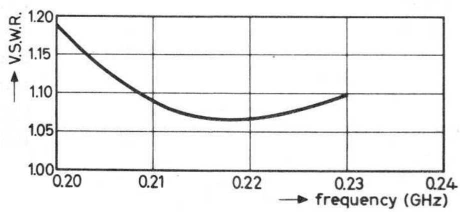
MECHANICAL DATA

| | |
|---|---|
| Construction | coaxial 3 port |
| Terminations | type N-female |
| Finish | body nickelplated<br>connectors silverplated<br>top and bottom cover black |
| Weight | 6400 g |




Dimensions in mm




Typical performance as a function of frequency at a working temperature of 20 °C.

# COAXIAL 3-PORT CIRCULATOR

Frequency 370 to 402 MHz

**DIMENSIONS** (in mm)

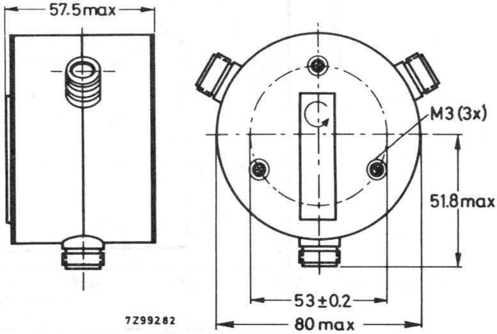



Fig. 1

**ELECTRICAL DATA**

| | |
|---|---|
| Frequency range | 370 to 402 MHz |
| Isolation $\alpha_{1-3}$ | > 20 dB |
| Insertion loss $\alpha_{1-2}$ | < 0.3 dB |
| V.S.W.R. | < 1.2 |
| Maximum power | 100 W |
| Temperature range | $-10$ to $+70\,^{\circ}C$. For other temperature ranges please inquire |

**MECHANICAL DATA**

| | |
|---|---|
| Connector type | N female 50 Ω |
| Finish of connector | silver plated |
| Colour of housing | silver |
| top and bottom face | black |
| Weight | 1200 g |

Typical performance as a function of frequency at an operating temperature of 20 °C

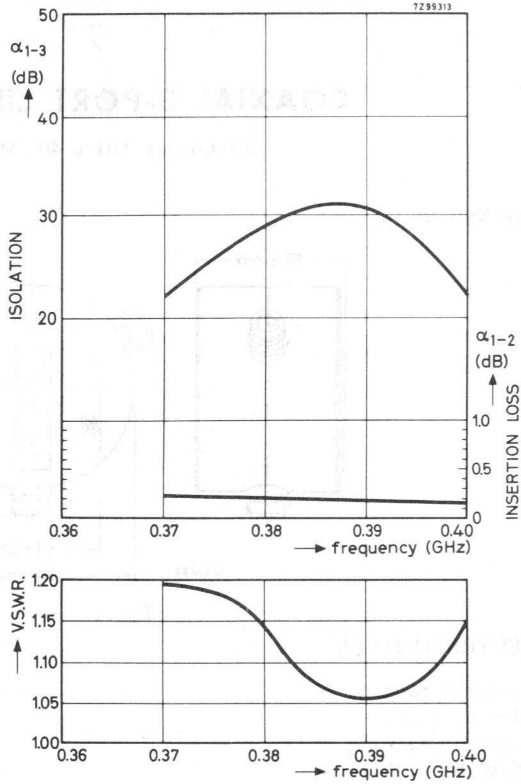



Fig. 2

# COAXIAL 3-PORT CIRCULATOR

Frequency 445 to 485 MHz

**DIMENSIONS** (in mm)

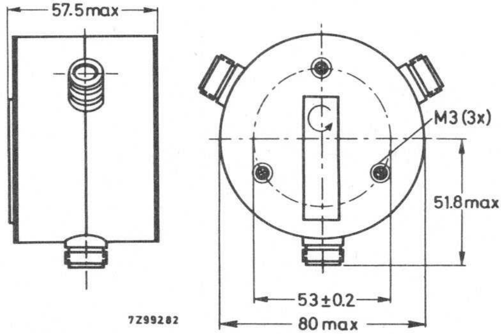



Fig.1

**ELECTRICAL DATA**

| | |
|---|---|
| Frequency range | 445 to 485 MHz |
| Isolation $\alpha_{1-3}$ | > 22 dB |
| Insertion loss $\alpha_{1-2}$ | < 0.3 dB |
| V.S.W.R. | < 1.2 |
| Maximum power | 100 W |
| Temperature range | −10 to +70 °C<br>For other temperature ranges please inquire |

**MECHANICAL DATA**

| | |
|---|---|
| Connector type | N female 50 Ω |
| Finish of connector | silver plated |
| Colour of housing | silver |
| top and bottom face | black |
| Weight | 1200 g |

# COAXIAL 3-PORT CIRCULATOR

Frequency 710 to 860 MHz

**DIMENSIONS** (in mm)

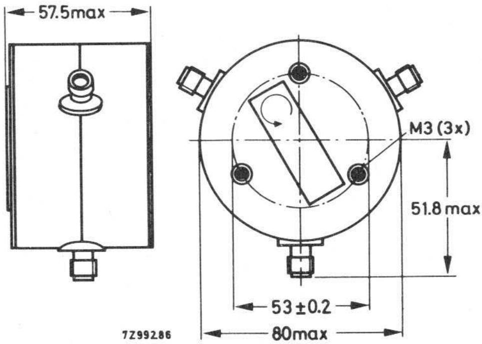



Fig. 1

## ELECTRICAL DATA

| | |
|---|---|
| Frequency range | 710 to 860 MHz |
| Isolation $\alpha_{1-3}$ | > 22 dB |
| Insertion loss $\alpha_{1-2}$ | < 0.35 dB |
| V.S.W.R. | < 1.2 |
| Maximum power | 100 W |
| Temperature range | +10 to +70 °C<br>For other temperature ranges please inquire |

## MECHANICAL DATA

| | |
|---|---|
| Connector type | TNC female 50 Ω |
| Finish of connector | silver plated |
| Colour of housing | silver |
| top and bottom face | black |
| Weight | 1200 g |

# INDEX OF TYPE NUMBERS



App = Appendix
CM = Communication magnetrons
D = Diodes
MH = Magnetrons for micro-wave heating
K = Klystrons
PK = Power klystrons
T = Triodes
T-RS = T-R Switches
TWT = Travelling-wave tubes

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