PHILIPS

Data handbook

PHILIPS Electronic components and materials

Electron tubes

Part 2 October 1974

Microwave products

ELECTRON TUBES

Part 2 **October 1974**

General section

Communication magnetrons

Magnetrons for micro-wave heating

Klystrons, high power

Klystrons, medium and low power

Travelling-wave tubes

Diodes

Triodes

T-R Switches

Microwave semiconductor devices

Isolators-circulators

Index at the back

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CARACAS

DATA HANDBOOK SYSTEM

Our Data Handbook System is a comprehensive source of information on electronic components, subassemblies and materials; it is made up of three series of handbooks each comprising several parts.

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

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

Where ratings or specifications differ from those published in the preceding edition they are pointed out by arrows. Where application information is given it is advisory and does not form part of the product specification.

If you need confirmation that the published data about any of our products are the latest available, please contact our representative. He is at your service and will be glad to answer your inquiries.

ELECTRON TUBES (BLUE SERIES)

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

Part 1a Transmitting tubes for communications and Tubes for r.f. heating Types PB2/500 ÷ TBW15/125 — **April 1973**

Part 1b Transmitting tubes for communication — **August 1974**
Tubes for r.f. heating
Amplifier circuit assemblies

Part 2 Microwave products — **October 1974**

Communication magnetrons
Magnetrons for micro-wave heating
Klystrons
Traveling-wave tubes
Diodes
Triodes
T-R Switches
Microwave Semiconductor devices
Isolators Circulators

Part 3 Special Quality tubes; — **March 1972**
Miscellaneous devices

Part 4 Receiving tubes — **September 1973**

Part 5a Cathode-ray tubes — **November 1973**

Part 5b Camera tubes; Image intensifier tubes — **December 1973**

Part 6 Products for nuclear technology — **January 1974**
Photodiodes

Photomultiplier tubes
Channel electron multipliers
Geiger-Mueller tubes
Neutron tubes
Photo diodes

Part 7 Gas-filled tubes — **February 1974**

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 T.V. Picture tubes — **May 1974**

SEMICONDUCTORS AND INTEGRATED CIRCUITS (RED SERIES)

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

Part 1a Rectifier diodes and thyristors — **June 1974**

Rectifier diodes
Voltage regulator diodes
Transient suppressor diodes
Thyristors, diacs, triacs
Rectifier stacks

Part 1b Diodes — **July 1974**

Small signal germanium diodes
Small signal silicon diodes
Special diodes
Voltage regulator diodes
Voltage reference diodes
Tuner diodes

Part 2 Low frequency transistors — **July 1974**

Part 3 High frequency and switching transistors — **October 1974**

Part 4a Special semiconductors — **March 1973**

Transmitting transistors
Microwave devices
Field effect transistors
Dual transistors
Microminiature devices for thick- and thin-film circuits

Part 4b Devices for opto-electronics — **March 1973**

Photosensitive diodes and transistors
Light emitting diodes
Infra-red sensitive devices
Photocouplers
Photoconductive devices

Part 5 Linear integrated circuits — **July 1973**

Part 6 Digital integrated circuits — **April 1974**

DTL (FC family)
CML (GX family)
MOS (FD family)
MOS (FE family)

COMPONENTS AND MATERIALS (GREEN SERIES)

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

Part 1 Functional units, Input/output devices, Electro-mechanical components, Peripheral devices — **June 1974**

High noise immunity logic FZ/30-Series
Circuit blocks 40-Series and CSA70
Counter modules 50-Series
Norbits 60-Series, 61-Series
Circuit blocks 90-Series
Input/output devices
Electro-mechanical components
Peripheral devices

Part 2a Resistors — **September 1974**

Fixed resistors
Variable resistors
Voltage dependent resistors (VDR)
Light dependent resistors (LDR)
Negative temperature coefficient thermistors (NTC)
Positive temperature coefficient thermistors (PTC)
Test switches

Part 2 Resistors, Capacitors — **April 1973**

Electrolytic capacitors
Paper capacitors and film capacitors
Ceramic capacitors
Variable capacitors
Fixed resistors
Variable resistors
Non-linear resistors (VDR, LDR, NTC, PTC)

Part 3 Radio, Audio, Television — **June 1973**

FM tuners
Loudspeakers
Television tuners, aerial input assemblies
Components for black and white TV
Components for colour television
Deflection assemblies for camera tubes

Part 4a Soft ferrites — **October 1973**

Ferrites for radio, audio and television
Small coils
Ferroxcube potcores and square cores
Ferroxcube transformer cores

Part 4b Piezoelectric ceramics, Permanent magnet materials — **October 1973**

Part 5 Ferrite core memory products — **January 1974**

Ferroxcube memory cores
Matrix planes and stacks
Core memory systems

Part 6 Electric motors and accessories — **March 1974**

Small synchronous motors
Stepper motors
Miniature direct current motors

Part 7 Circuit blocks — **September 1971**

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

General section

List of symbols

Definitions

Waveguides

Flanges

Rating system

Some devices are labelled

Maintenance type

Obsolescent type

or

Obsolete type

Maintenance type	-	Available for equipment maintenance No longer recommended for equipment production.
Obsolescent type	-	Available until present stocks are exhausted.
Obsolete type	-	No longer available.

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_{f_p}, 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_{i_a}
Peak input power	W_{i_p}
Output power	W_o
Peak output power	W_{o_p}
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	Δf_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
Rate of rise of voltage	$\frac{dVa}{dT}$, $\frac{\Delta V}{\Delta T_{rv}}$
Voltage standing wave ratio	VSWR
Reflection coefficient	α
Duty factor	δ
Efficiency	η
Wavelength	λ
Amplification factor	μ

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.

Δf_p — The pulling figure Δf_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).

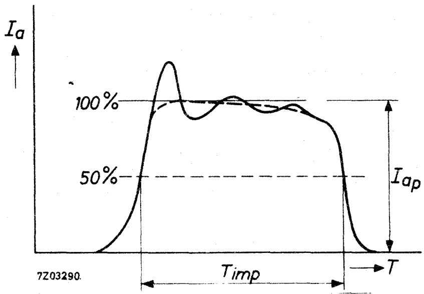


Fig. 1.
current pulse

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.

VSWR — 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)

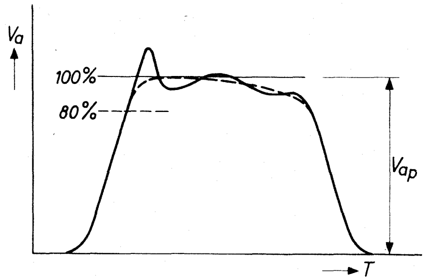


Fig. 2.
voltage pulse

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.

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

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

RECTANGULAR WAVEGUIDE DATA AND DESIGNATIONS

FREQUENCY RANGE TE_{10} - mode 153 IEC* GHz	WAVEGUIDE DESIGNATION						WAVEGUIDE Inner cross-section 153 IEC*			WAVEGUIDE Outer cross-section 153 IEC*			ATTENUATION in dB/m for copper waveguide 153 IEC*			Theoretical C. W. power rating** lowest to highest frequency MW
	153 IEC*	BRITISH STAND.	RETMA	JAN RG- /U brass	JAN RG- /U alum.	BAND PREFIX	Width mm	Height mm	Tolerance on width and height ±	Width mm	Height mm	Tolerance on width and height ±	Frequency GHz	Theoretical value	Maximum value	
1.14 — 1.73	R 14	WG 6	WR 650	69	103	L	165.10	82.55	0.33	169.16	86.61	0.20	1.36	0.00522	0.007	12.0 — 17.0
1.45 — 2.20	R 18	WG 7	WR 510	—	—	D	129.54	64.77	0.26	133.60	68.83	0.20	1.74	0.00749	0.010	7.5 — 11.0
1.72 — 2.61	R 22	WG 8	WR 430	104	105	—	109.22	54.61	0.22	113.28	58.67	0.20	2.06	0.00970	0.013	5.2 — 7.5
2.17 — 3.30	R 26	WG 9A	WR 340	112	113	—	86.36	43.18	0.17	90.42	47.24	0.17	2.61	0.0138	0.018	3.4 — 4.8
2.60 — 3.95	R 32	WG 10	WR 284	48	75	S	72.14	34.04	0.14	76.20	38.10	0.14	3.12	0.0189	0.025	2.2 — 3.2
3.22 — 4.90	R 40	WG 11A	WR 229	—	—	A	58.17	29.083	0.12	61.42	32.33	0.12	3.87	0.0249	0.032	1.6 — 2.2
3.94 — 5.99	R 48	WG 12	WR 187	49	95	G	47.55	22.149	0.095	50.80	25.40	0.095	4.73	0.0355	0.046	0.94 — 1.32
4.64 — 7.05	R 58	WG 13	WR 159	—	—	C	40.39	20.193	0.081	43.64	23.44	0.081	5.57	0.0431	0.056	0.79 — 1.0
5.38 — 8.17	R 70	WG 14	WR 137	50	106	J	34.85	15.799	0.070	38.10	19.05	0.070	6.46	0.0576	0.075	0.56 — 0.71
6.57 — 9.99	R 84	WG 15	WR 112	51	68	H	28.499	12.624	0.057	31.75	15.88	0.057	7.89	0.0794	0.103	0.35 — 0.46
7.00 — 11.00	—	—	WR 102	—	320	T	25.90	12.95	0.125	29.16	16.21	0.125	—	—	—	0.33 — 0.43
8.2 — 12.5	R 100	WG 16	WR 90	52	67	X	22.860	10.160	0.046	25.40	12.70	0.05	9.84	0.110	0.143	0.20 — 0.29
9.84 — 15.0	R 120	WG 17	WR 75	—	—	M	19.050	9.525	0.038	21.59	12.06	0.05	11.8	0.133	—	0.17 — 0.23
11.9 — 18.0	R 140	WG 18	WR 62	91	—	P	15.799	7.899	0.031	17.83	9.93	0.05	14.2	0.176	—	0.12 — 0.16
14.5 — 22.0	R 180	WG 19	WR 51	—	—	—	12.954	6.477	0.026	14.99	8.51	0.05	17.4	0.238	—	0.080 — 0.107
17.6 — 26.7	R 220	WG 20	WR 42	53	121	—	10.668	4.318	0.021	12.70	6.35	0.05	21.1	0.370	—	0.043 — 0.058
21.7 — 33.0	R 260	WG 21	WR 34	—	—	—	8.636	4.318	0.020	10.67	6.35	0.05	26.1	0.435	—	0.034 — 0.048
26.4 — 40.0	R 320	WG 22	WR 28	—	—	—	7.112	3.556	0.020	9.14	5.59	0.05	31.6	0.583	—	0.022 — 0.031
32.9 — 50.1	R 400	WG 23	WR 22	—	—	—	5.690	2.845	0.020	7.72	4.88	0.05	39.5	0.815	—	0.014 — 0.020
39.2 — 59.6	R 500	WG 24	WR 19	—	—	—	4.775	2.388	0.020	6.81	4.42	0.05	47.1	1.060	—	0.011 — 0.015
49.8 — 75.8	R 620	WG 25	WR 15	—	—	—	3.759	1.880	0.020	5.79	3.91	0.05	59.9	1.52	—	0.0063 — 0.0090
60.5 — 91.9	R 740	WG 26	WR 12	—	—	—	3.099	1.549	0.020	5.13	3.58	0.05	72.6	2.03	—	0.0042 — 0.0060
73.8 — 112.0	R 900	WG 27	WR 10	—	—	—	2.540	1.270	0.020	4.57	3.30	0.05	88.6	2.74	—	0.0030 — 0.0041
92.2 — 140.0	R 1200	WG 28	WR 8	—	—	—	2.032	1.016	0.020	4.06	3.05	0.05	111.0	3.82	—	0.0018 — 0.0026
114.0 — 173.0	R 1400	WG 29	WR 7	—	—	—	1.651	0.826	—	—	—	—	136.3	5.21	—	0.0012 — 0.0017

* IEC Recommendations are obtainable from :
Central Office of the International Electrotechnical Commission
1, rue de Varembé
GENEVA, Switzerland

** based on breakdown of air of 15,000 volts per cm (safety factor of approx. 2 at sea level)

FLANGE DESIGNATIONS

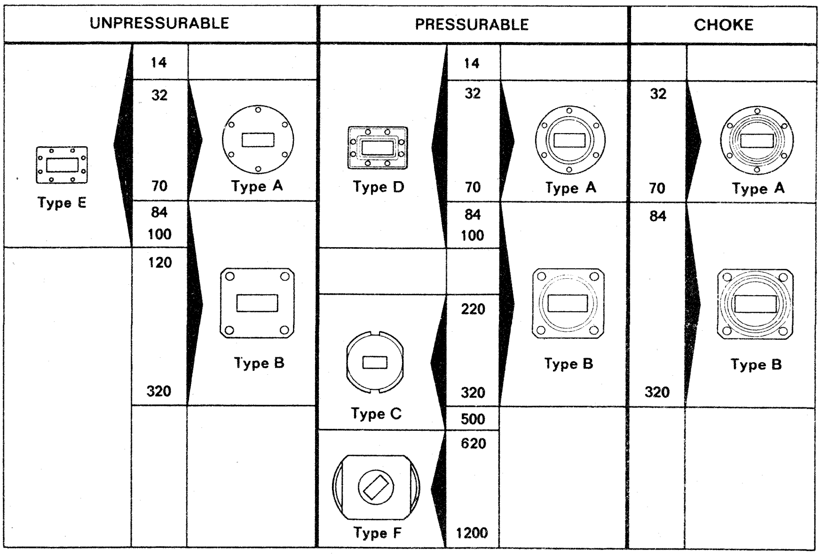
FOR WAVEGUIDE 153 IEC*	FLANGE DESIGNATION					
	PLAIN FLANGE			CHOKE FLANGE		
	154 IEC	JAN UG /U Brass	JAN UG /U Aluminium	154 IEC	JAN UG /U Brass	JAN UG /U Aluminium
R 14	PDR 14	417A	418A			
R 18	PDR 18					
R 22	PDR 22	435A	437A			
R 26	PDR 26	553	554			
R 32	UER 32 PDR 32 PAR 32 UAR 32	53	584	CAR 32	54A	585A
R 40	UER 40 PDR 40					
R 48	PAR 48 PDR 48 UAR 48 UER 48	149A	407	CAR 48	148C	406B
R 58	PAR 58 PDR 58 UAR 58 UER 58			CAR 58		
R 70	PAR 70 PDR 70 UAR 70 UER 70	344	441	CAR 70	343B	440B
R 84	PBR 84 PDR 84 UBR 84 UER 84	51	138	CBR 84	52B	137B
R 100	PBR 100 PDR 100 UBR 100 UER 100	39	135	CBR 100	40B	136B
R 120						
R 140	PBR 140 UBR 140	419		CBR 140	541A	
R 180						
R 220	PBR 220 UBR 220 PCR 220	595	597	CBR 220	596A	598A
R 260	PCR 260					
R 320	PBR 320 PCR 320 UBR 320	599		CBR 320	600A	
R 400	PCR 400	383				
R 500	PCR 500 PAR 500					
R 620	PCR 620 PFR 620	385				
R 740	PCR 740 PFR 740	387				
R 900	PCR 900 PFR 900					
R 1200	PCR1200 PFR 1200					

IEC

Waveguide flanges covered by IEC recommendation shall be indicated by a reference number comprising the following information:

a. the number of the present IEC publication.
b. the letters "IEC"
c. a dash.
d. a letter relating to the basic construction of the flange
   - P = pressurable
   - C = choke, pressurizable
   - U = unpressurizable

e. a letter for the type according to the drawing. Flanges with the same letter and of the same waveguide size can be mated.
f. the letter and number of the waveguide for which the flange is designed.



* IEC Recommendations are obtainable from :

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1, rue de Varembé
GENEVA, Switzerland

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

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-

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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 characteristics 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 bombardment(back heating). Before the application of the h.t. 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. 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 Waiting time (also known as h.t. delay time or warming-up time)

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

3.4 Heater starting current or peak heater starting current (surge current)

With some tubes it is required to limit the (peak) value of the heater current 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 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.

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 (γ) 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 (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.

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

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
Peak heater starting current	I_{f_p}	max.	12	A
Cold heater resistance	R_{f_o}	>	0.6	Ω
Waiting time	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:

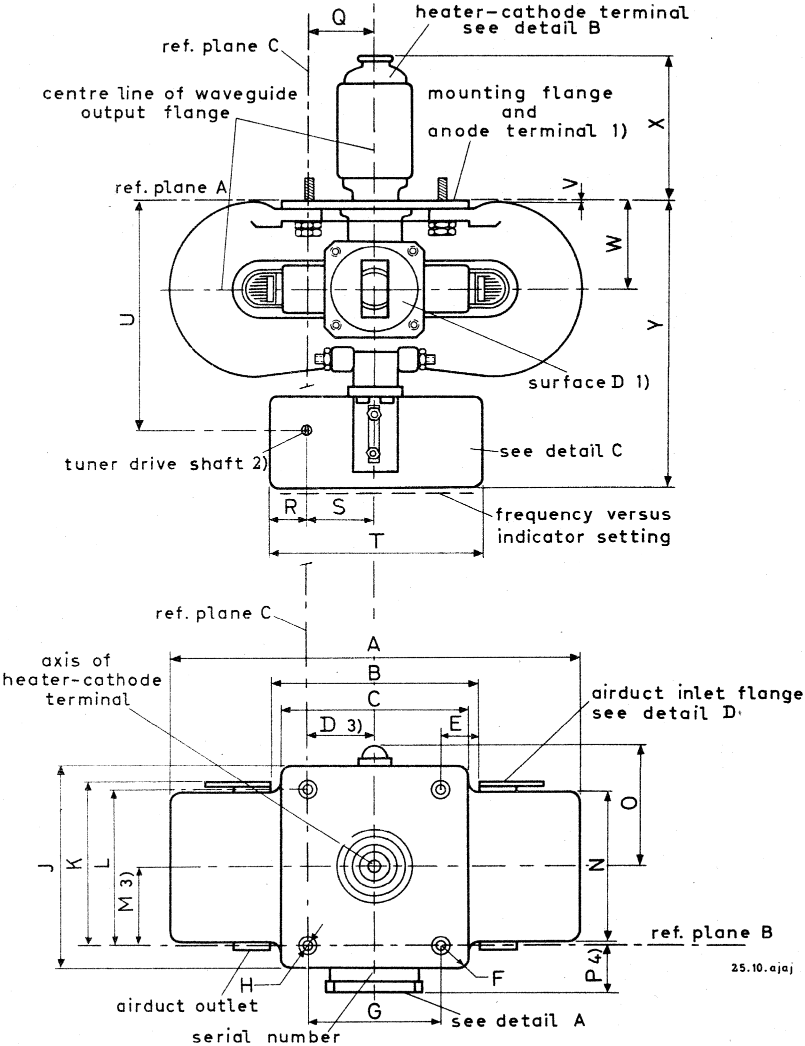
$$V_f = 13.75\ (1 - \frac{W_i}{450})\ \text{V}$$ (see page 11)

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

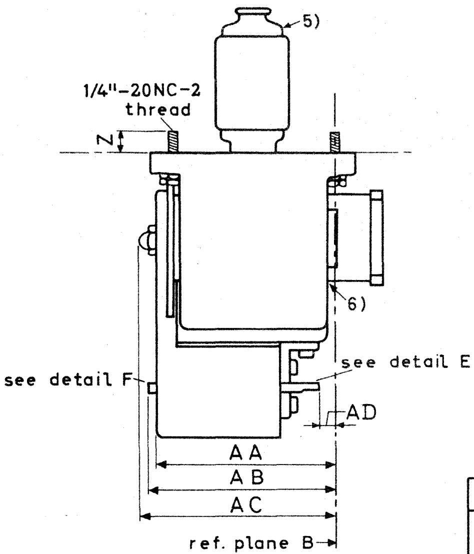
Frequency	f	8.5 to 9.6	GHz
Pulling figure (VSWR = 1.5)	Δf_p	< 13.5	MHz
Peak anode voltage at I_{ap} = 27.5 A	V_{ap}	20 to 23	kV
Capacitance anode to cathode	C_{ak}	9 to 13	pF

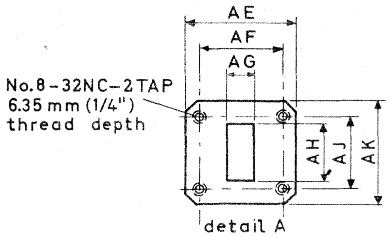
MECHANICAL DATA



For notes see page 5

MECHANICAL DATA (continued)



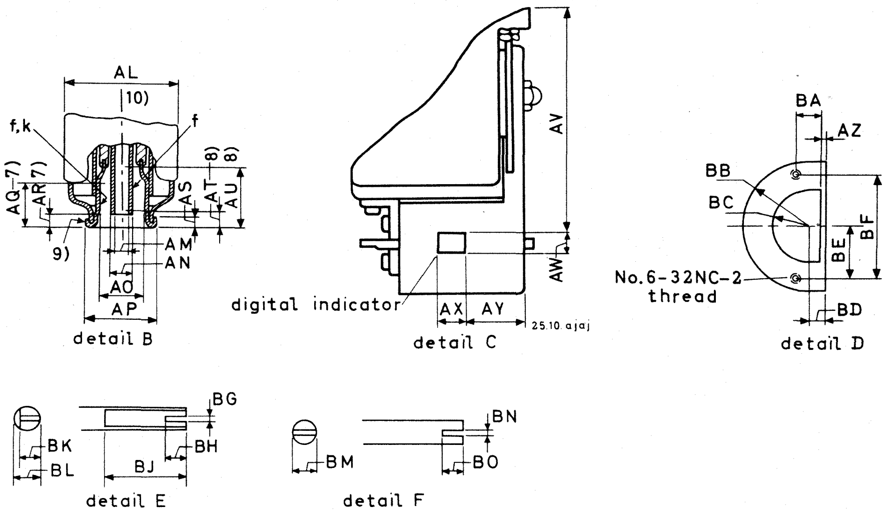


The millimeter dimensions have been derived from inches.

	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

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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	δ	max.	0.0011	
Heater starting voltage	V_{fo}	max.	15	V
Peak heater starting current	I_{f_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_{ip}	max.	630	kW
Rate of rise of anode voltage [1]				
for pulse duration $\leqq$ 1.5 μs	$\frac{\Delta V_a}{\Delta T_{rv}}$	min.	70	kV/μs
		max.	225	kV/μs
for pulse duration > 1.5 μs	$\frac{\Delta V_a}{\Delta T_{rv}}$	min.	70	kV/μs
		max.	200	kV/μs
Voltage standing wave ratio	VSWR	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	δ	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 load giving a VSWR 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 calculating 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).

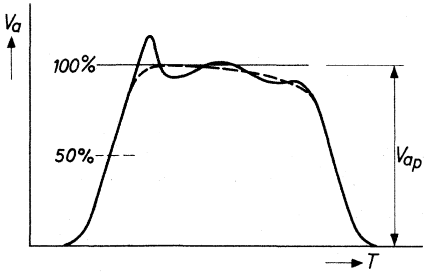


Fig.1

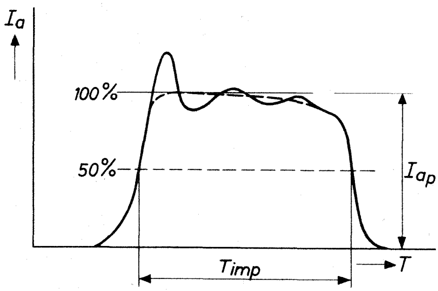


Fig.2

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.

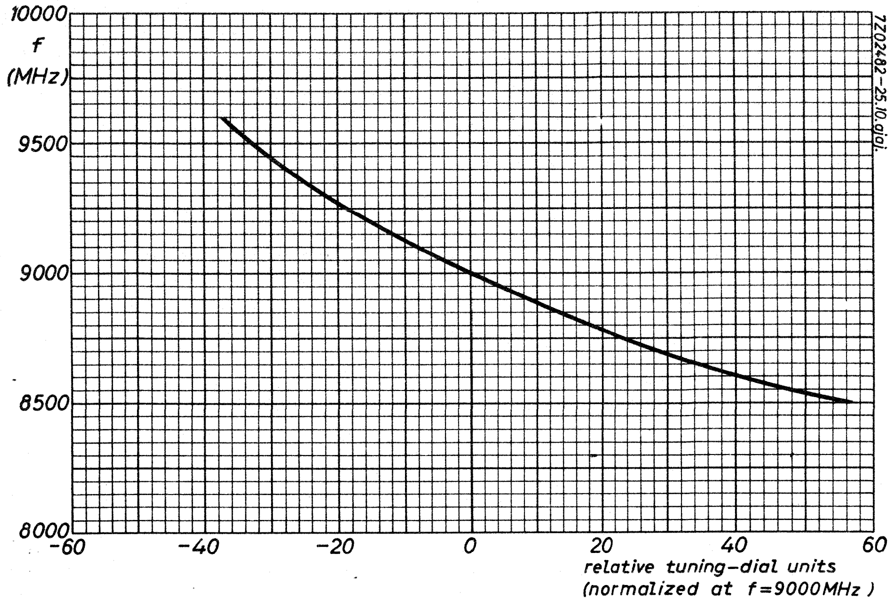
A dust-cover is placed on the output flange, to keep its opening closed until the tube is mounted into the equipment. Before putting the magnetron into operation, the user should make sure that the output waveguide and the recessed cathode terminal are entirely clean and free from dust and moisture.

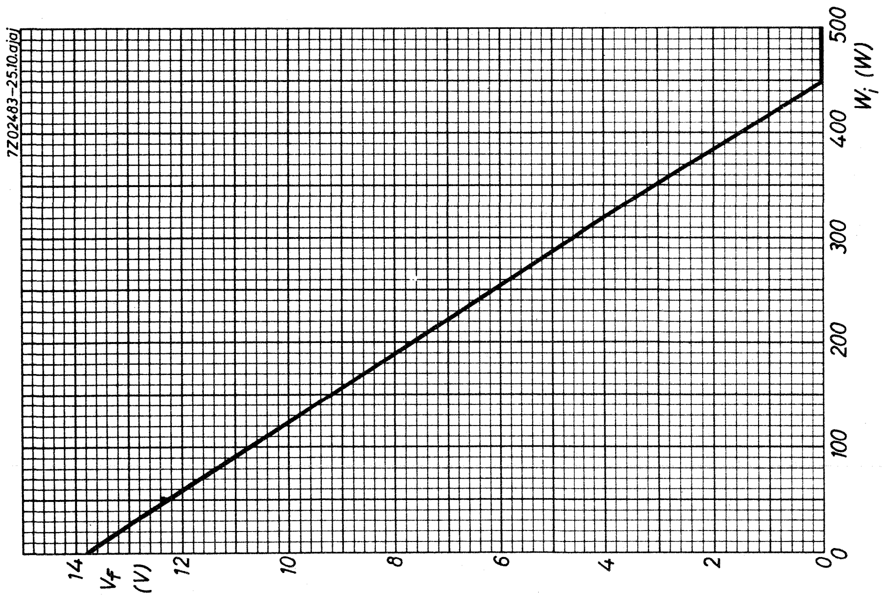
The magnetron should be mounted by means of its mounting flange; it should be secured to the chassis by means of the four captive screws (thread 1/4"-20NC-2). Special attention has been given to the flatness of the mounting flange so that, if necessary, a pressure seal can be made for the input assembly. 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

Packaged magnetron intended for pulsed service at a fixed frequency. Designed for very short pulse operation and particularly suited for use in high-definition short-range radar systems.

The YJ1020 incorporates a dispenser type of cathode to ensure 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.

QUICK REFERENCE DATA			
Frequency, fixed within the band	f	32,7 to 33,4	GHz
Peak output power	W_{op}	25	kW
Construction		packaged	

CATHODE : dispenser type

HEATING : indirect by a.c. (30 to 1650 Hz) or d.c.
In case of d.c. the terminal f, k must have positive polarity.

Heater voltage, starting	V_{fo}		4,5	V ± 10%
Heater current at V_f = 4,5 V	I_f		3,6	A ± 0,7 A
Heater current, peak starting	I_{fp}	max.	8	A
Cold heater resistance	R_{f_o}	>	0,16	Ω
Waiting time	T_w	min.	3	min

The heater voltage must be reduced immediately after the application of the anode input power in accordance with the graph on page 7.

TYPICAL CHARACTERISTICS

Stable range: peak anode current	I_{ap}		6 to 16	A
Anode voltage, peak at I_{ap} = 10,5 A	V_{ap}		11,5 to 13,5	kV
Frequency temperature coefficient	$\frac{\Delta f}{\Delta t_a}$	<	−1	MHz/°C
Pulling figure (VSWR = 1,5)	Δf_p		40	MHz
Pushing figure	$\frac{\Delta f}{\Delta I_a}$	<	4	MHz/A
Distance of voltage standing wave minimum [1]	d		0,05 to 0,25	λg
		=	0,58 to 3,15	mm
Capacitance, anode to cathode	C_{ak}		7	pF

LIMITING VALUES (Absolute max. rating system)

Pulse duration [2]	T_{imp}	max.	0,05	µs
Duty factor	δ	max.	0,0003	
Anode current, peak [2]	I_{ap}	max.	16	A
		min.	6	A
Input power, mean	W_{ia}	max.	60	W
Rate of rise of anode voltage [2]	$\frac{dV_a}{dT}$	max.	400	kV/µs
		min.	200	kV/µs
Voltage standing wave ratio	VSWR	max.	1,5	
Anode temperature [3]	t_a	max.	150	°C
Cathode and heater terminal temperature	t	max.	150	°C
Pressure, input and output	p	max.	30	N/cm^2 abs [4]
		min.	6	N/cm^2 abs

[1] The distance of the VSW 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 pulse definitions page 4.

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

[4] 1 N/cm^2 = 75 mm Hg.

OPERATING CHARACTERISTICS

Heater voltage, running	V_f	4,2	V
Pulse duration 2)	T_{imp}	0,04 x)	μs
Pulse repetition rate	f_{imp}	2500	p.p.s.
Duty factor	δ	0,0001	
Anode voltage, peak 2)	V_{ap}	11,5 to 13,5	kV
Rate of rise of anode voltage 2)	$\frac{dV_a}{dT}$	300	kV/μs
Anode current, mean, pre-oscillation current included	I_a	1,6	mA
Anode current, peak 2)	I_{ap}	10,5	A
Output power, mean	W_o	2,5	W
peak	W_{op}	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 cathode and heater terminals below 150 °C.

PRESSURE

The magnetron need not be pressurized when operating at atmospheric pressure.
To prevent arcing the pressure must exceed 6 N/cm^2 (Absolute limit).

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.

2) See page 2

CIRCUIT NOTES

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

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 load giving a VSWR 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 supplied 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 mean anode current. The occurrence of this diode current can be avoided by preventing the anode voltage becoming positive with respect to the cathode during the intervals between the pulses.

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 calculating 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).

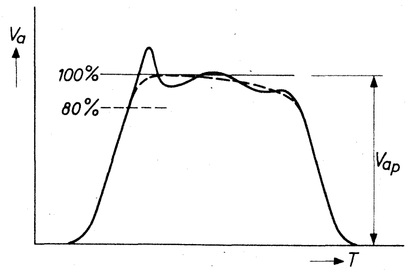


Fig. 1

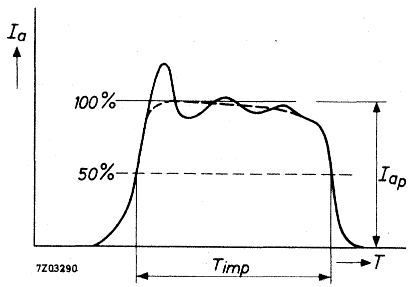


Fig. 2

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 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. If the tubes cannot be stored at normal temperature 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.

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

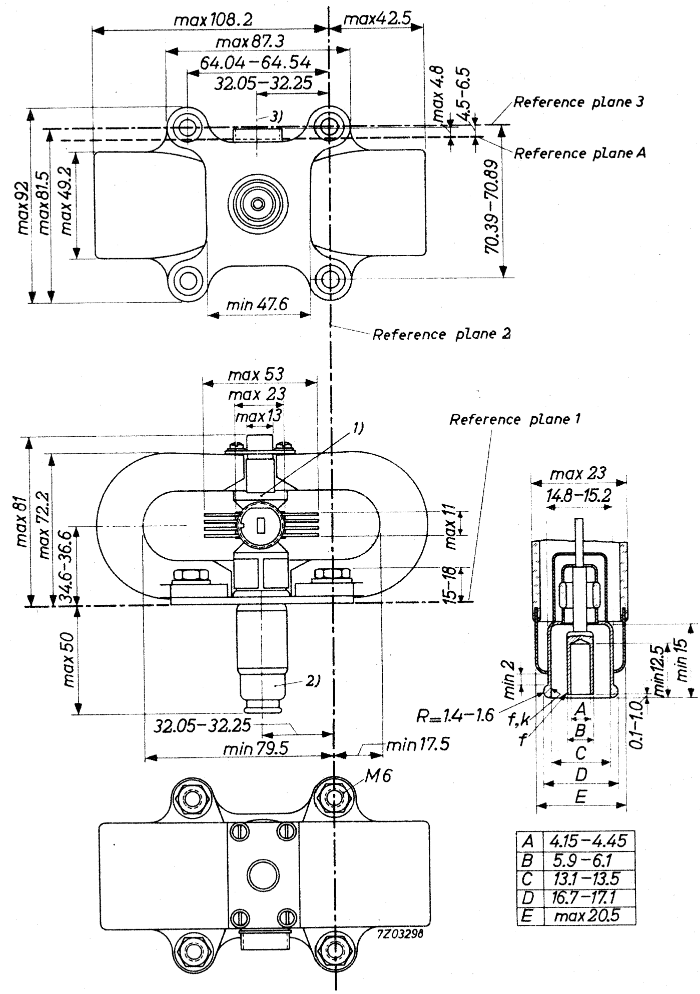
Mounting position	: any
Net mass	: 1,9 kg
Waveguide output system	: 153 IEC – R320 = RG – 96/U
Waveguide coupling system	: Z8 300 16

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

Cathode connector	: Jettron 91 – 010 or equivalent

The mounting flange and the waveguide output system are designed to permit the use of pressure seals. See also under "Limiting Values".

Dimensions in mm

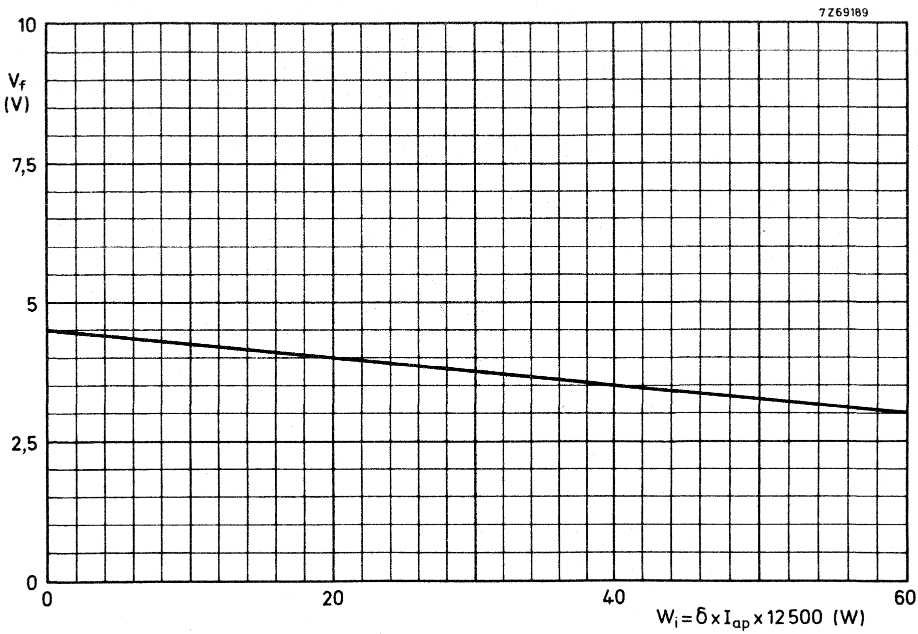


A	4.15−4.45
B	5.9−6.1
C	13.1−13.5
D	16.7−17.1
E	max 20.5

1) Inscription of serial number.

2) The axis of the common cathode-heater terminal is within a radius 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.


7Z69189
10
V_f
(V)
7,5
5
2,5
0
0
20
40
60
$W_i = \delta \times I_{ap} \times 12500$ (W)

PULSED MAGNETRON

Packaged magnetron intended for pulsed service at a fixed frequency. Designed for very short pulse operation and particularly suited for use in high-definition short-range radar systems.

The YJ1021 incorporates a dispenser type of cathode to ensure 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.

QUICK REFERENCE DATA			
Frequency, fixed within the band	f	32,7 to 33,4	GHz
Peak output power	W_{op}	30	kW
Construction		packaged	

CATHODE : dispenser type

HEATING : indirect by a.c. (30 to 1650 Hz) or d.c.
In case of d.c. the terminal f, k must have positive polarity.

Heater voltage, starting	V_{fo}		4,5	V ± 10%
Heater current at V_f = 4,5 V	I_f		3,6	A ± 0,7 A
Heater current, peak starting	I_{fp}	max.	8	A
Cold heater resistance	R_{fo}	>	0,16	Ω
Waiting time	T_w	min.	3	min

The heater voltage must be reduced immediately after the application of the anode input power in accordance with the graph on page 7.

TYPICAL CHARACTERISTICS

Stable range: peak anode current	I_{ap}		6 to 16	A
Anode voltage, peak at I_{ap} = 12,5 A	V_{ap}		11,5 to 13,5	kV
Frequency temperature coefficient	$\frac{\Delta f}{\Delta t_a}$	<	−1	MHz/°C
Pulling figure (VSWR = 1,5)	Δf_p		40	MHz
Pushing figure	$\frac{\Delta f}{\Delta I_a}$	<	4	MHz/A
Distance of voltage standing wave minimum [1]	d		0,05 to 0,25	λg
		=	0,58 to 3,15	mm
Capacitance, anode to cathode	C_{ak}		7	pF

LIMITING VALUES (Absolute max. rating system)

Pulse duration [2]	T_{imp}	max.	0,2	µs
Duty factor	δ	max.	0,0003	
Anode current, peak [2]	I_{ap}	max.	16	A
		min.	6	A
Input power, mean	W_{ia}	max.	60	W
Rate of rise of anode voltage for pulse duration = 0,1 µs [2]	$\frac{dV_a}{dT}$	max.	300	kV/µs
		min.	200	kV/µs
Voltage standing wave ratio	VSWR	max.	1,5	
Anode temperature [3]	t_a	max.	150	°C
Cathode and heater terminal temperature	t	max.	150	°C
Pressure, input and output	p	max.	30	N/cm² abs [4]
		min.	6	N/cm² abs

[1] The distance of the VSW 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 pulse definitions page 4.

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

[4] 1 N/cm^2 = 75 mm Hg.

[5] Diode current suppressed by a suppressor voltage of about +300 V on the cathode with respect to the anode.

OPERATING CHARACTERISTICS

Heater voltage, running	V_f	4,0	3,8	V
Pulse duration 2)	T_{imp}	0,04	0,1	µs
Pulse repetition rate	f_{imp}	2500	2000	p.p.s.
Duty factor	δ	0,0001	0,0002	
Anode voltage, peak 2)	V_{ap}	11,5 to 13,5	11,5 to 13,5	kV
Rate of rise of anode voltage 2)	$\frac{dV_a}{dT}$	400	250	kV/µs
Anode current, mean	I_a	1,6	2,5	mA 5)
peak 2)	I_{ap}	16	12,5	A
Output power, mean	W_o	2,5	6	W
peak	W_{op}	25	30	kW

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 cathode and heater terminals below 150 °C.

PRESSURE

The magnetron need not be pressurized when operating at atmospheric pressure.
To prevent arcing the pressure must exceed 6 N/cm^2 (Absolute limit).

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.

Notes see page 2.

CIRCUIT NOTES

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

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 load giving a VSWR 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 supplied 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 mean anode current. The occurrence of this diode current can be avoided by preventing the anode voltage becoming positive with respect to the cathode during the intervals between the pulses.

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 calculating 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).

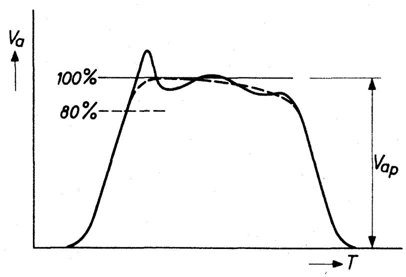


Fig. 1.

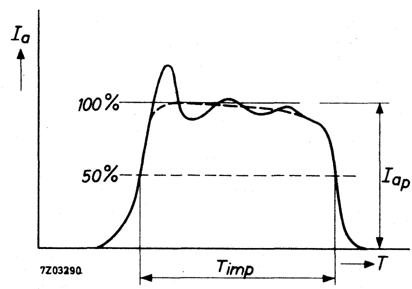


Fig. 2.

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 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. If the tubes connot be stored at normal temperature 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.

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 mass : 1,9 kg

Waveguide output system : 153 IEC – R320 = RG – 96/U

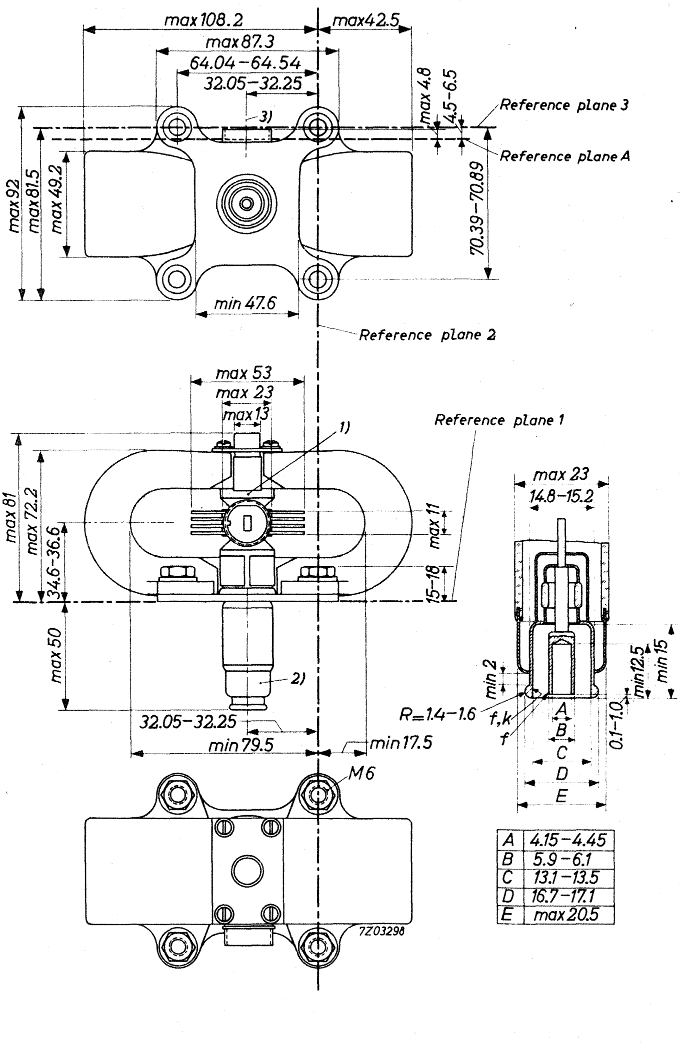
Waveguide coupling system : Z8 300 16

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

Cathode connector : Jettron 91 – 010 or equivalent

The mounting flange and the waveguide output system are designed to permit the use of pressure seals. See also under "Limiting Values".

Dimensions in mm

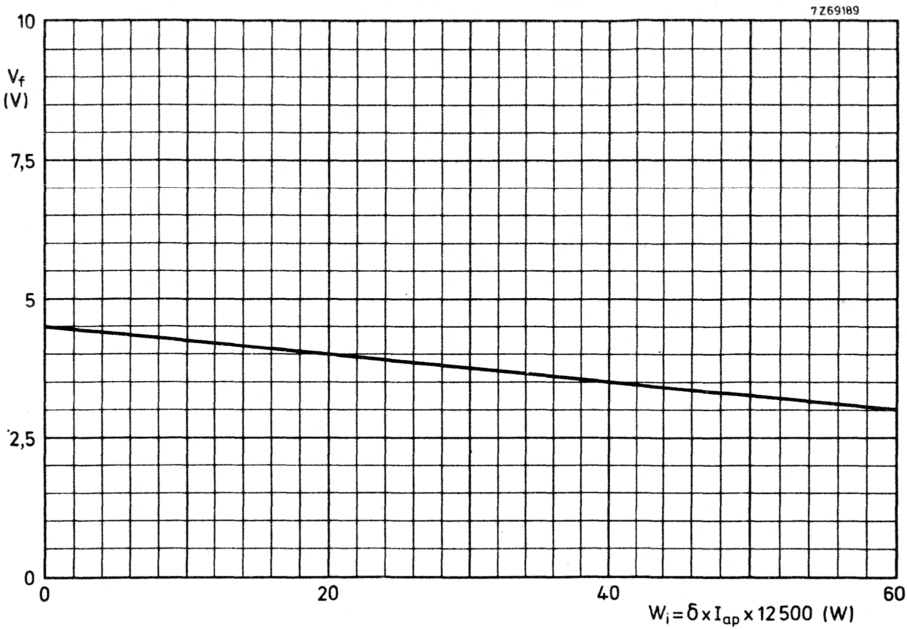


A	4.15−4.45
B	5.9−6.1
C	13.1−13.5
D	16.7−17.1
E	max 20.5

1) Inscription of serial number.

2) The axis of the common cathode-heater terminal is within a radius 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.


7Z69189
10
V_f
(V)
7,5
5
2,5
0
0
20
40
60
$W_i = \delta \times I_{ap} \times 12\,500$ (W)

PULSED MAGNETRON

Packaged magnetron for pulsed service at a fixed frequency.

The YJ1023 incorporates a dispenser type of cathode to ensure 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.

QUICK REFERENCE DATA			
Frequency, fixed within the band	f	34,512 to 35,208	GHz
Peak output power	W_{op}	20	kW
Construction		packaged	

CATHODE : dispenser type

HEATING : Indirect by a.c. (30 to 1650 Hz) or d.c.
In case of d.c. the terminal f, k must have positive polarity.

Heater voltage, starting	V_{fo}		4,5	V ± 10%
Heater current at V_f = 4,5 V	I_f		3,6	A ± 0,7 A
Heater current, peak starting	I_{fp}	max.	8	A
Cold heater resistance	R_{fo}	>	0,16	Ω
Waiting time	T_w	min.	3	min.

At an anode input power of more than 21 W the heater voltage must be reduced immediately after the application of anode input power in accordance with the graph on page 7.

TYPICAL CHARACTERISTICS

Stable range: peak anode current	I_{ap}		6 to 12	A
Anode voltage, peak, at I_{ap} = 9 A	V_{ap}		12 to 14	kV
Frequency temperature coefficient	$\frac{\Delta f}{\Delta t_a}$	<	−1	MHz/°C
Pulling figure (VSWR = 1,5)	Δf_p		40	MHz
Pushing figure	$\frac{\Delta f}{\Delta I_a}$	<	4	MHz/A
Distance of voltage standing wave minimum [1]	d		0,25 to 0,40	λg
		=	2,6 to 4,4	mm
Capacitance, anode to cathode	C_{ak}		6	pF

LIMITING VALUES (Absolute max. rating system)

Pulse duration [2]	T_{imp}	max.	0,2	µs
Pulse repetition rate	f_{imp}	max.	7200	p.p.s.
Duty factor	δ	max.	0,0015	
Anode current, peak [2]	I_{ap}	max.	12	A
		min.	6	A
mean	I_a	max.	6	mA
		min.	3	mA
Input power, peak	W_{iap}	max.	150	kW
mean	W_{ia}	max.	75	W
Rate of rise of anode voltage at T_{imp} = 0,1 µs [2]	$\frac{dV_a}{dT}$		60 to 200	kV/µs
Voltage standing wave ratio	VSWR	max.	1,5	
Anode temperature [3]	t_a	max.	150	°C
Cathode and heater terminal temperature	t	max.	150	°C
Pressure, input and output	p	max.	30	N/cm^2 abs [4]
		min.	6	N/cm^2 abs [4]

[1] The distance of the VSW minimum outside the tube is between 0,25 and 0,4 λg (2,6 and 4,4 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 matched load.

[2] See pulse definitions page 4.

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

[4] 1 N/cm^2 = 75 mm Hg.

OPERATING CHARACTERISTICS

Heater voltage, running	V_f	3	V
Pulse duration 2)	T_{imp}	0,14	µs
Pulse repetition rate	f_{imp}	3600	p.p.s.
Duty factor	δ	0,0005	
Anode voltage, peak 2)	V_{ap}	12 to 14	kV
Rate of rise of anode voltage	$\frac{dV_a}{dT}$	100	kV/µs
Anode current, mean	I_a	4,5	mA
peak 2)	I_{ap}	9	A
Output power, mean	W_o	10	W
peak	W_{op}	20	kW

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 cathode and heater terminals below 150 °C.

To safeguard the magnetron against overheating, provision is made for mounting a thermoswitch, e.g. type 3BTL6 (Texas Instruments Inc.). This switch should become operative at a temperature of 140 °C at its mounting plate.

PRESSURE

The magnetron need not be pressurized when operating at atmospheric pressure. To prevent arcing, the pressure must exceed 6 N/cm^2 (Absolute limit).

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.

Notes see page 2.

CIRCUIT NOTES

a) To prevent heater burn-out the negative high-voltage pulse must be applied to the common heater/cathode terminal f, k.

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 load giving a VSWR 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 supplied 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 mean anode current. The occurrence of this diode current can be avoided by preventing the anode voltage becoming positive with respect to the cathode during the intervals between the pulses.

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 calculating the rate of rise of anode voltage the 100% value must be taken as 13 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).

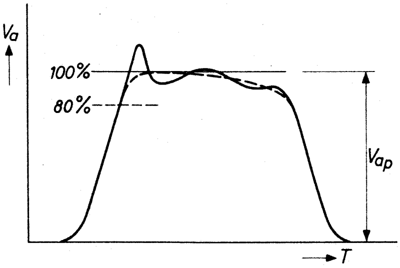


Fig. 1.

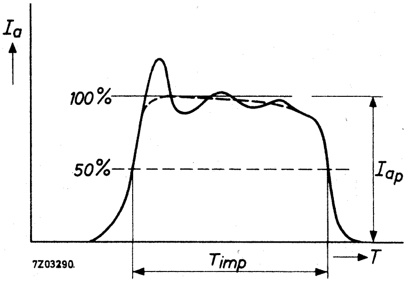


Fig. 2.

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 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. If the tubes cannot be stored at normal temperature 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.

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 mass : 1,9 kg

Waveguide output system : 153IEC – R320 = RG-96/U

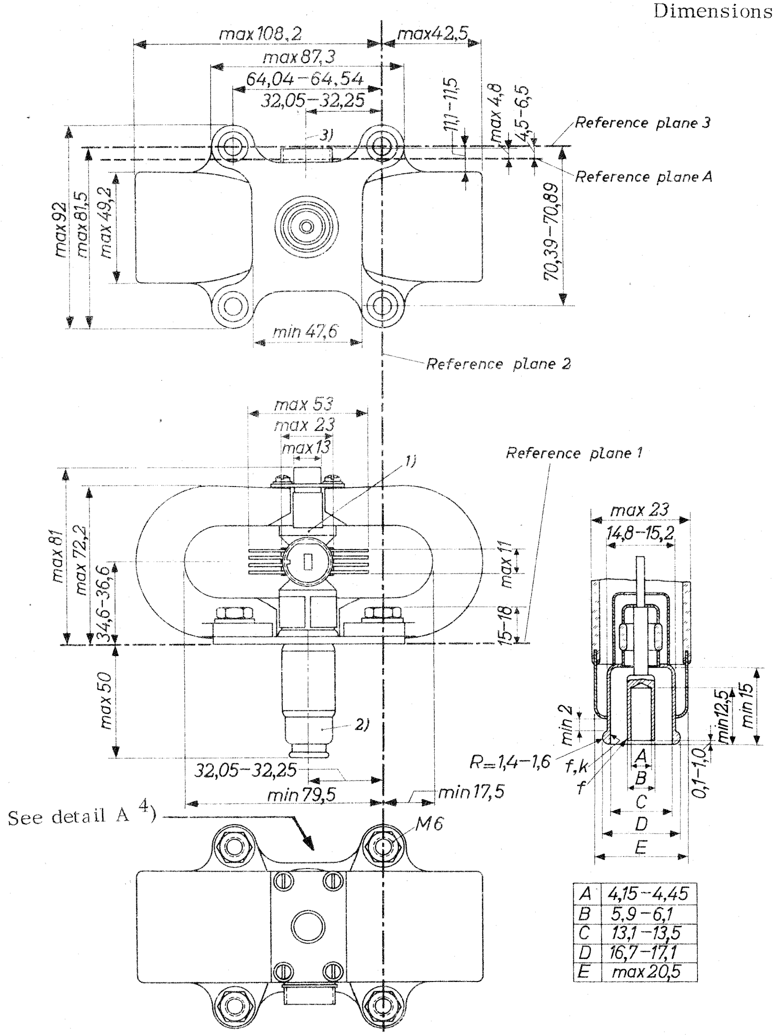
Waveguide coupling system : Z8 300 16

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

Cathode connector : Jettron 91 – 010 or equivalent

The mounting flange and the waveguide output system are designed to permit the use of pressure seals. See also under "Limiting Values".

Dimensions in mm



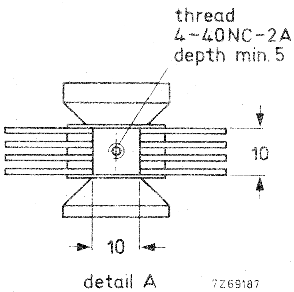
A	4,15–4,45
B	5,9–6,1
C	13,1–13,5
D	16,7–17,1
E	max 20,5

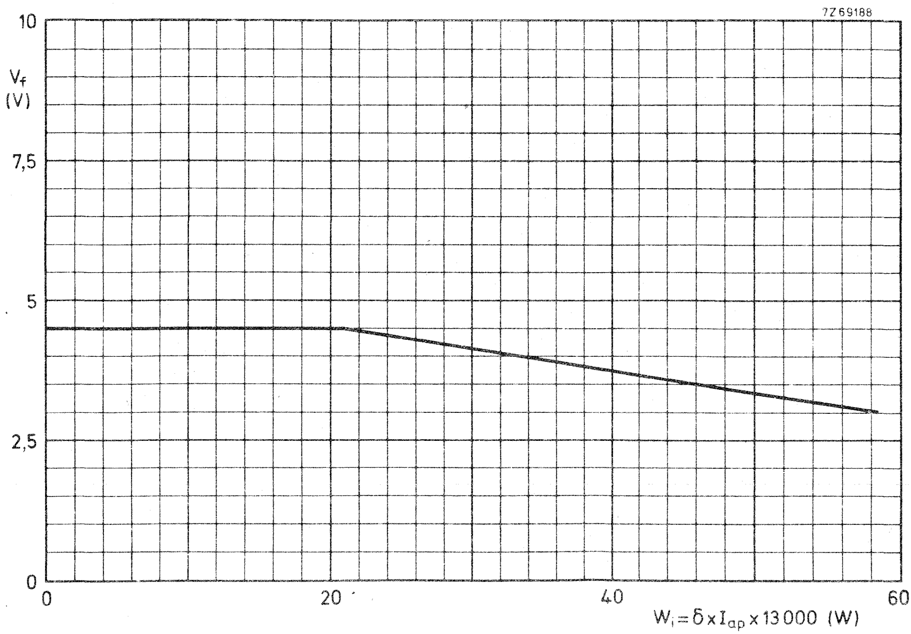
1) Inscription of serial number.

2) The axis of the common heater-cathode 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 heater-cathode terminal is max. 0,125 mm.

3) Centre of waveguide.

4) Plate for mounting a thermoswitch, see detail A.


thread
4-40NC-2A
depth min. 5
10
10
detail A
7Z69187


7Z69188
10
V_f
(V)
7,5
5
2,5
0
0
20
40
60
$W_i = \delta \times I_{ap} \times 13\,000$ (W)

PULSED MAGNETRON

Frequency agile 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. The magnetron type YJ1181 provides in addition to frequency agile operation the possibility to select any fixed frequency within its band (e.g. for MTI).

QUICK REFERENCE DATA

Type	Nominal centre frequency (GHz)	$\Delta f_{min.}$ * (GHz)	$\Delta f_{max.}$ * (GHz)	Agile frequency excursion (MHz)	Peak output power (kW)
YJ1180 , YJ1181	9,050	8,925 - 9,175	8,7 - 9,5	450	200
YJ1180L, YJ1181L	8,850	8,725 - 8,975	8,5 - 9,3		
YJ1180H, YJ1181H	9,150	9,025 - 9,275	8,8 - 9,6		
Construction	packaged				

*) $\Delta f_{min.}$ is the frequency band that is at least covered by any individual magnetron of the same type.

$\Delta f_{max.}$ represents the outer limits for possible oscillation frequencies for any individual magnetron of the same type.

HEATING: indirect by a.c. (30 to 1650 Hz) 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		3,15	A ± 0,35 A
Peak heater starting current	I_{f_p}	max.	12	A
Cold heater resistance	R_{f_o}	>	0,8	Ω
Waiting time	T_w	min.	150	s

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

$$V_f = 14,8\ (1 - \frac{I_a}{41,5})\ \text{V}$$ (see also page 9)

where I_a (in mA) = duty factor x peak anode current.
When $I_a \leq 3$ mA the heater voltage must be 13,75 V.

TYPICAL CHARACTERISTICS

Peak anode voltage at I_{ap} = 26,5 A	V_{ap}	21	to	24	kV	
Pulling figure	Δf_p		<	15	MHz	
Pushing figure	$\frac{\Delta f}{\Delta I_a}$		<	0,5	MHz/A	
Passive -oscillation frequency difference	Δf	9	to	16	MHz	1)
Frequency temperature coefficient	$\frac{\Delta f}{\Delta t_a}$		<	-0,5	MHz/°C	
Capacitance; anode to cathode	C_{ak}		<	20	pF	

MECHANICAL DATA

Net weight : approx. 7 kg

Mounting position : any

Support : mounting flange

The waveguide output has been designed for coupling to standard rectangular waveguide 153 IEC-R 84.

Waveguide output flange: couples to 154 IEC-CBR 84 flange.

Tuner speed : 4500 revolutions/minute

One revolution of the tuner shaft corresponds to 16 full tuning cycles. One cycle consists of a quasi-sinusoidal excursion through the entire tuning range and return.

THERMOSWITCH, mounted on tube, see outline drawing

Contact	S.P.S.T. normally closed
Opening temperature	110 to 122 °C
Closing temperature	approx. 100 °C
Contact ratings 220 V a.c., 1,5 A; 220 V d.c., 0,4 A	non-inductive load
Leads	black, 2

1) The passive-oscillation frequency difference will not vary more than 4 MHz for each individual tube over its frequency band.

LIMITING VALUES (Absolute max. rating system)

Pulse duration [1]	T_{imp}	max.	1,60	μs
		min.	0,13	μs
Duty factor	δ	max.	0,0011	
Heater voltage	V_f	max.	15	V
Peak heater starting current	I_{f_p}	max.	12	A
Anode current, peak [1]	I_{a_p}	max.	27,5	A
		min.	15,0	A
Anode voltage, peak [1]	V_{a_p}	max.	24	kV
Anode input power, mean	W_{i_a}	max.	660	W
peak	$W_{i_{ap}}$	max.	660	kW
Rate of rise of anode voltage for pulse duration ≤ 0,15 μs	$\frac{dV_a}{dT}$	max.	205	kV/μs
		min.	60	kV/μs
for pulse duration > 0,15 μs	$\frac{dV_a}{dT}$	max.	180	kV/μs
		min.	60	kV/μs
Voltage standing wave ratio	VSWR	max.	1,5	
Anode temperature at measuring point (see outline drawing)	t_a	max.	160	°C
Cathode and heater terminal temperature at measuring point (see outline drawing)	t	max.	165	°C
Input pressurization [2]	p	max.	30	N/cm^2abs
		min.	8	N/cm^2abs
Output pressurization [2]	p	max.	30	N/cm^2abs
		min.	10	N/cm^2abs

[1] See " Pulse characteristics and definitions"

[2] $1 N/cm^2 \approx 75$ mm Hg

OPERATING CHARACTERISTICS

Pulse duration [1]	T_{imp}	0,15	1,0	1,5	μs
Pulse repetition rate	f_{imp}	2200	1000	670	p.p.s.
Duty factor	δ	0,00033	0,001	0,001	
Peak anode voltage [1]	V_{ap}	22,5	22,5	22,5	kV
Rate of rise of voltage [1]	$\frac{dV_a}{dT}$	180	150	150	kV/μs
Peak anode current [1]	I_{ap}	26,5	26,5	26,5	A
Heater voltage, running	V_f	11,7	5,3	5,3	V
Output power, mean	W_o	66	200	200	W
peak	W_{op}	200	200	200	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 120 °C under any condition of operation. If necessary, the heater/cathode terminal should also be cooled to keep its temperature below 165 °C. An air flow of approximately 0,85 m^3/min is normally sufficient.

PRESSURE

The mounting flange and the output waveguide flange are designed to permit the use of pressure seals. The minimum pressure to prevent cumulative electrical breakdown in the output coupling shall be 10 N/cm^2abs . See also under "Limiting values"

LIFE

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

[1] See " Pulse characteristics and definitions"

STARTING A NEW MAGNETRON

When a magnetron is taken into operation for the first time some sparking and instability may occur. It is recommended to start the magnetron in the following way:

1. Apply heater voltage (13,75 V) for at least 150 s.
2. Raise the anode current gradually, preferably starting at the shortest available pulse duration, until one half of the normal operating output power is obtained. Operate the magnetron at this power level at the lowest tunable frequency.
   Take care that the heater voltage is reduced in accordance with the heater voltage cut-back schedule.
3. 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.
4. Repeat the procedure 1, 2, and 3 with the magnetron operating in the frequency agile mode.

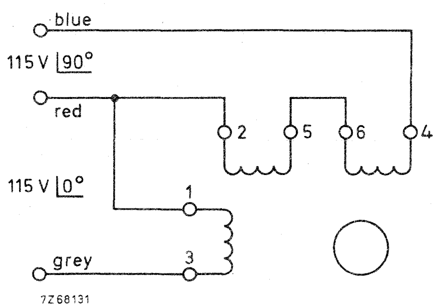
After this running-in schedule the magnetron can be put into use at the normal operating conditions.

AGEING OF MAGNETRON

It is recommended that magnetrons kept in store are re-aged every 12 to 24 months. Recommended ageing procedure available on request.

TUNING MECHANISM

The tuning is achieved by rotating a tuner inside the vacuum part of the magnetron. This tuner is magnetically coupled to the tuner motor and rotates with the same speed as the motor. The magnetron is tuned over one complete cycle when the motor shaft is rotated 1/16 rev. (22,5 ^{o}). The tuner can rotate in both clockwise and counter-clockwise directions depending on the electrical connection of the tuner motor. See below for information on the connection of the tuner motor.
It is advised to run the tuning motor normally only during oscillation conditions.



Two-phase, 400 Hz supply
90 ^{o} shift between phases
Phase voltage 115 V
Input power 9 W/phase

FREQUENCY LOCK (YJ1181 only)

The YJ1181 is provided with a tuner lock added to the motor, so that it can be used for frequency agile or fixed frequency operation.
Agile tuning is only achieved when the motor rotates clockwise. Fixed frequency operation is obtained by reversing the direction of rotation of the motor axis. In this direction a built-in mechanical device is actuated that locks the motor shaft. This lock keeps the tuner in a defined angular position, corresponding to a predetermined frequency. This angular position can be adjusted by means of a shaft protruding from the motor housing (see outline drawing).

CIRCUIT NOTES

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

b. The magnetron is used in combination with an F.T.L.O. (fast-tuned local oscillator) including a circulator which provides load isolation at the same time. The distance between circulator and magnetron should be as short as possible.
Under no circumstances should the magnetron be operated with a load giving a VSWR 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 supplied 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 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 mean anode current.

The occurrence of this diode current can be avoided by preventing the anode voltage becoming positive with respect to the cathode during the intervals between the pulses.

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 calculating the rate of rise of anode voltage the 100% value must be taken as 22,5 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).

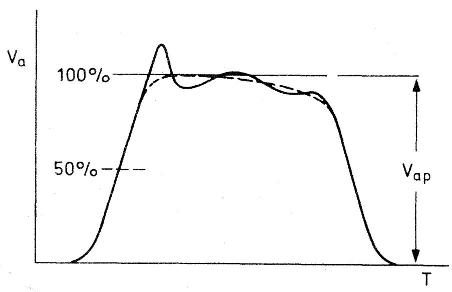


Fig.1

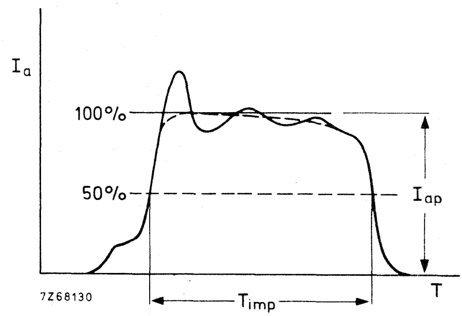


Fig.2

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 in) 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 they must be stored in protective packing.

When handling and mounting the magnetron, a minimum distance of 5 cm (2 in) 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.

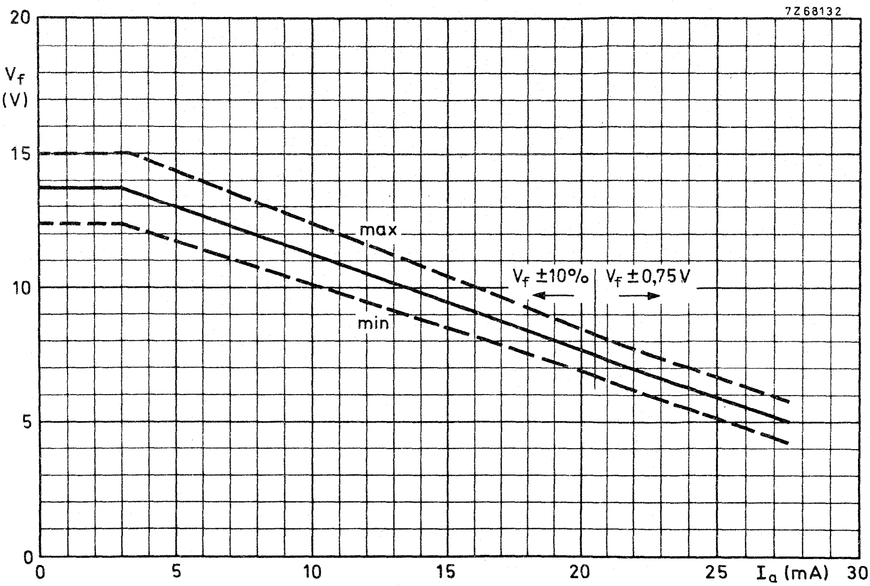
A dust-cover is placed on the output flange, to keep its opening closed until the tube is mounted into the equipment. Before putting the magnetron into operation, the user should make sure that the output waveguide and the recessed cathode terminal are entirely clean and free from dust and moisture.

The magnetron should be mounted by means of its mounting flange; it should be secured to the chassis by means of four bolts (thread 1/4"-2ONC-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 nostrain is exerted on the output system when the mounting bolts are tightened and when the output system is being coupled to the waveguide in the equipment.

To fasten the magnetron output flange to the 153 IEC-R 84 waveguide, a choke flange 154 IEC-CBR 84 should be used. The latter flange must be modified by reaming the four mounting holes with a 4, 3 mm drill. It can then be fastened to the magnetron output flange by means of four M4 bolts. 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 the air inlet flange by means of non-magnetic bolts and nuts.

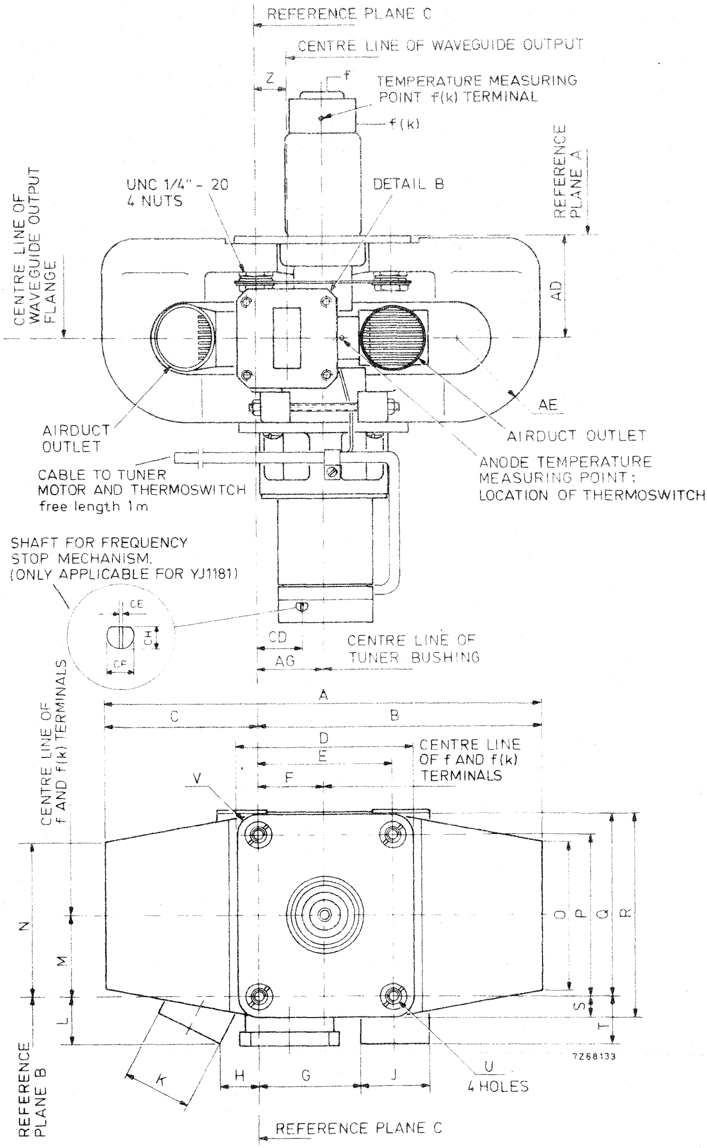
A connector with flexible supply leads should be used for the connection of heater and heater/cathode terminals.



Heater voltage reduction curve

Ref.	Dimensions in mm			Remarks
	min.	nom.	max.	
A			213,5	
B			138,5	
C			75	
D			88,1	
E	63,25	63,50	63,75	
F	30,55	31,75	32,95	
G		47,5		
H		18,5		
J		ϕ32		
K		ϕ32		
L		22,5		
M	36,9	38,1	39,3	
N			75	
O			73	
P	75,95	76,2	76,45	
Q			86,9	
R			98,4	
S			10,7	
T		22,5		
U		ϕ7,15		
V		R 10,3		
Z	13,55	14,75	15,95	
AD	45,9	47,1	48,3	
AE		R 40		
AG	29,75	31,75	33,75	
CD	12,5	14,5	16,5	Only applicable for YJ1181
CE	1,0	1,0	1,1	Only applicable for YJ1181
CF	4,75	4,77	4,79	Only applicable for YJ1181
CH	3,8	4,0	4,2	Only applicable for YJ1181

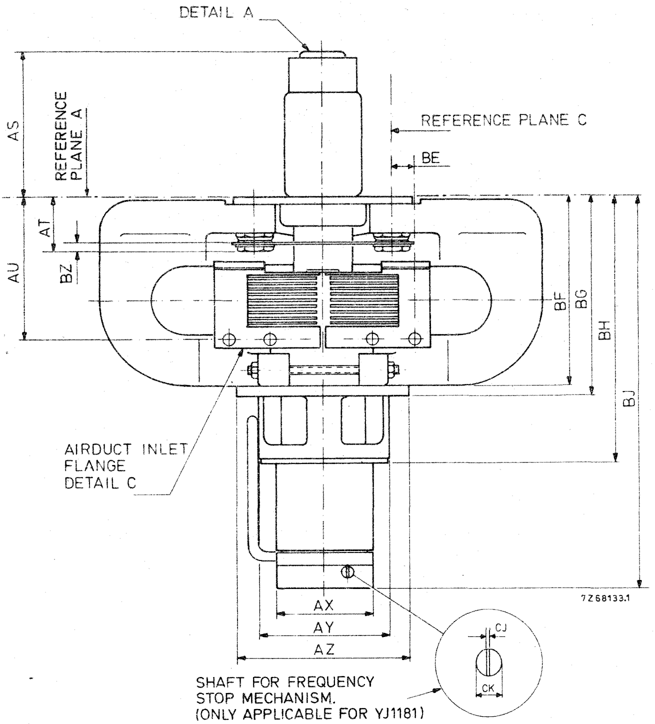
MECHANICAL DATA



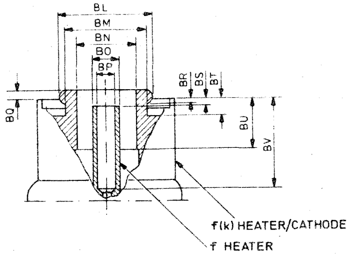
Front and top view

Ref.	Dimensions in mm			Remarks
	min.	nom.	max.	
W		46,5		
X	37,3	37,4	37,5	
Y		12,6		
AA		46,5		
AB	34,2	34,3	34,4	
AC		28,5		
AF		R 29,5		
AH	34,5	36,0	37,5	
AJ		1		
AK		1,6		
AL		4		
AS	65,10		69,85	
AT		25		
AU	61,1	64,1	67,1	
AV		24		
AW		70		
AX			ϕ 44,5	
AY			ϕ 64	
AZ			ϕ 82	
BA		100		
BB	85,5	87,0	88,5	
BC	65,5	67,0	68,5	
BD	18,5	20	21,5	
BE	8,75	11,75	14,75	
BF			90	
BG			96	
BH			127	
BJ			185	
BK		4		
BL	ϕ 20,95	ϕ 21,10	ϕ 21,25	
BM		ϕ 19		
BN	ϕ 13,55	ϕ 13,70	ϕ 13,85	
BO	ϕ 5,95	ϕ 6,35	ϕ 6,75	
BP	ϕ 4,18	ϕ 4,30	ϕ 4,42	
BQ	0			
BR	2,95	3,20	3,45	
BS	3,15	3,95	4,75	
BT		6,35		
BU	13,1			
BV	19			
BX	ϕ 6,0	ϕ 6,0	ϕ 6,5	
BY				The holes have M4 screw thread
BZ		5		
CJ	1,0	1,0	1,1	Only applicable for YJ 1181
CK	ϕ 4,75	ϕ 4,77	ϕ 4,79	Only applicable for YJ 1181

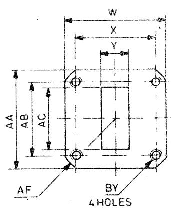
MECHANICAL DATA



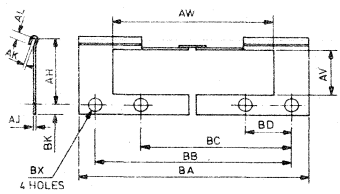
Side view



DETAIL A



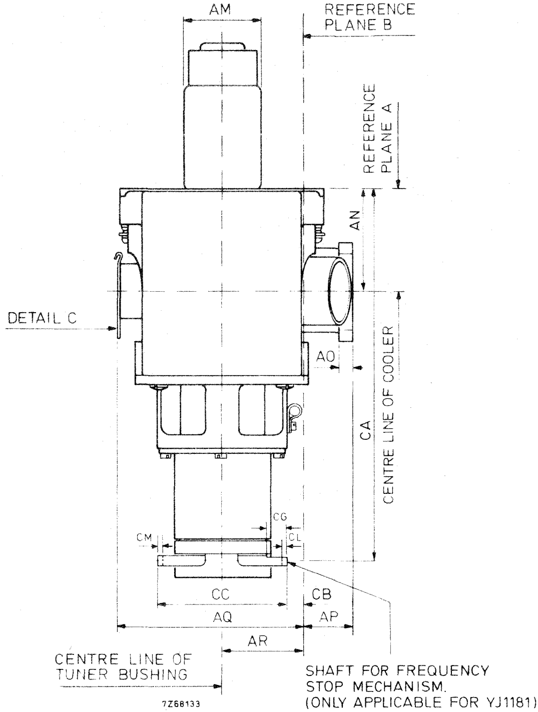
DETAIL B



DETAIL C

Ref.	Dimensions in mm			Remarks
	min.	nom.	max.	
AM			ϕ 38, 1	
AN	44, 1	47, 1	50, 1	
AO		6, 5		
AP	22, 2	23, 0	23, 8	
AQ	82, 5	85, 5	88, 5	
AR	36, 1	38, 1	40, 1	
CA	170, 0	173, 5	177, 0	Only applicable for YJ 1181
CB	6, 35	7, 85	9, 35	Only applicable for YJ 1181
CC	59, 35	60, 35	61, 35	Only applicable for YJ 1181
CG	15, 4	15, 9	16, 4	Only applicable for YJ 1181
CL	3, 1	3, 9	4, 7	Only applicable for YJ 1181
CM	3, 1	3, 9	4, 7	Only applicable for YJ 1181

MECHANICAL DATA



Rear view

PULSED MAGNETRON

Frequency agile 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. The magnetron type YJ1321 provides in addition to frequency agile operation the possibility to select any fixed frequency within its band (e.g. for MTI).

QUICK REFERENCE DATA			
Frequency		Ku-band	
Nominal centre frequency	f	16,5	GHz
Agile frequency excursion		670	MHz
Peak output power	W_{o_p}	65	kW
Construction		packaged	

HEATING : indirect by a.c. (30 to 1000 Hz) or d.c.

Heater voltage, starting and stand-by	V_{f_o}		12,6	V ± 10%
Heater current at V_f = 12,6 V	I_f		1,0	A ± 0,1 A
Peak heater starting current	I_{f_p}	max.	5	A
Cold heater resistance	R_{f_o}	>	2,2	Ω
Waiting time	T_w	min.	120	s

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

$$V_f = 12,6\,(1 - \frac{I_a}{10})\ \mathrm{V}$$ (see also page 9)

where I_a (in mA) = duty factor x peak anode current.
When $I_a > 10$ mA the heater voltage must be 0 V.

Data based on pre-production tubes.

TYPICAL CHARACTERISTICS

Peak anode voltage at I_{ap} = 15 A	V_{ap}		14,5 to 16,5	kV
Pulling figure	Δf_p	<	22	MHz
Pushing figure	$\frac{\Delta f}{\Delta I_a}$	<	1	MHz/A
Passive-oscillation frequency difference	Δf		22 to 37	MHz [1])
Capacitance, anode to cathode	C_{ak}	<	10	pF

MECHANICAL DATA

Net weight : approx. 3,2 kg

Mounting position : any

Support : mounting flange

The waveguide output has been designed for coupling to standard rectangular waveguide 153 IEC-R 140.

Waveguide output flange: couples to 154 IEC-CBR 140 flange.

Tuner speed : 4500 revolutions/minute
One revolution of the tuner shaft corresponds to 16 full tuning cycles. One cycle consists of a quasi-sinusoidal excursion through the entire tuning range and return.

THERMOSWITCH , mounted on tube, see outline drawing

Contact	S.P.S.T. normally closed
Opening temperature	110 to 122^o
Closing temperature	approx. 100^o
Contact ratings 220 V a.c., 1,5 A; 220 V d.c., 0,4 A	non-inductive load
Leads	black, 2

[1]) The passive-oscillation frequency difference will not vary more than 7 MHz for each individual tube over its frequency band.

LIMITING VALUES (Absolute max. rating system)

Pulse duration [1]	T_{imp}	max.	1,0	µs
		min.	0,1	µs
Duty factor	δ	max.	0,0011	
Heater voltage	V_f	max.	14	V
Peak heater starting current	I_{fp}	max.	5	A
Anode current, peak [1]	I_{ap}	max.	17	A
		min.	10	A
Anode voltage, peak [1]	V_{ap}	max.	16,5	kV
Anode input power, mean	W_{i_a}	max.	250	W
peak	$W_{i_{ap}}$	max.	280	kW
Rate of rise of anode voltage for pulse duration ≤ 0,15 µs	$\frac{dV_a}{dT}$	max.	150	kV/µs
		min.	40	kV/µs
for pulse duration > 0,15 µs	$\frac{dV_a}{dT}$	max.	130	kV/µs
		min.	40	kV/µs
Voltage standing wave ratio	VSWR	max.	1,5	
Anode temperature at measuring point (see outline drawing)	t_a	max.	160	°C
Input pressurization [2]	p	max.	30	N/m²abs
		min.	8	N/m²abs
Output pressurization	p	max.	30	N/m²abs
		min.	10	N/m²abs

[1] See "Pulse characteristics and definitions".
[2] 1 N/cm² = 75 mm Hg.

OPERATING CHARACTERISTICS

Pulse duration [1]	T_{imp}	0,1	1,0	μs
Pulse repetition rate	f_{imp}	3300	1000	p.p.s.
Duty factor	δ	0,00033	0,001	
Peak anode voltage [1]	V_{a_p}	15,5	15,5	kV
Rate of rise of voltage [1]	$\frac{dV_a}{dT}$	143	126	kV/μs
Peak anode current [1]	I_{a_p}	15	15	A
Heater voltage, running	V_f	6,3	0	V
Output power, mean	W_o	22	65	W
peak	W_{o_p}	65	65	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 on the anode block to keep the temperature of the anode block below 120 °C under any condition of operation. An air flow of approximately 0,85 m^3/min is normally sufficient.

PRESSURE

The mounting flange and the output waveguide flange are designed to permit the use of pressure seals. The minimum pressure to prevent cumulative electrical breakdown in the output coupling shall be 10 N/cm^2abs. See also under "Limiting values".

LIFE

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

STARTING A NEW MAGNETRON

When a magnetron is taken into operation for the first time some sparking and instability may occur. It is recommended to start the magnetron in the following way:

1. Apply heater voltage (12,6 V) for at least 120 s.
2. Raise the anode current gradually, preferably starting at the shortest available pulse duration, until one half of the normal operating output power is obtained. Operate the magnetron at this power level at the lowest tunable frequency. Take care that the heater voltage is reduced in accordance with the heater voltage cut-back schedule.

---

[1]) See "Pulse characteristics and definitions".

STARTING A NEW MAGNETRON (continued)

3. 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.

4. Repeat the procedure 1, 2, and 3 with the magnetron operating in the frequency agile mode.

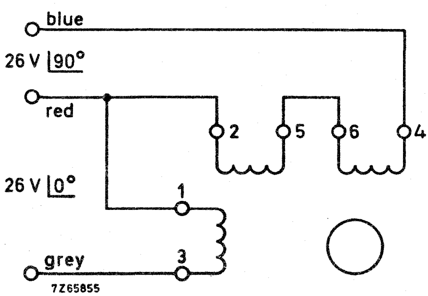
After this running-in schedule the magnetron can be put into use at the normal operating conditions.

AGEING OF MAGNETRON

It is recommended that magnetrons kept in store are re-aged every 12 to 24 months. Recommended ageing procedure available on request.

TUNING MECHANISM

The tuning is achieved by rotating a tuner inside the vacuum part of the magnetron. This tuner is magnetically coupled to the tuner motor and rotates with the same speed as the motor. The magnetron is tuned over one complete cycle when the motor shaft is rotated 1/16 rev. (22,5°). The tuner can rotate in both clockwise and counter-clockwise directions depending on the electrical connection of the tuner motor. See below for information on the connection of the tuner motor.
It is advised to run the tuner motor normally only during oscillation conditions.



Two-phase, 400 Hz supply
90° shift between phases

Phase voltage	26	V
Input power	6	W/phase

Motors for other voltages can be supplied on request.

FREQUENCY LOCK (YJ1321 only)

The YJ1321 is provided with a tuner lock added to the motor, so that it can be used for frequency agile or fixed frequency operation.
Agile tuning is only achieved when the motor rotates clockwise. Fixed frequency operation is obtained by reversing the direction of rotation of the motor axis. In this direction a built-in mechanical device is actuated that locks the motor shaft. This lock keeps the tuner in a defined angular position, corresponding to a predetermined frequency. This angular position can be adjusted by means of a shaft protruding from the motor housing (see outline drawing).

CIRCUIT NOTES

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

b. The magnetron is used in combination with an F.T.L.O. (fast-tuned local oscillator) including a circulator which provides load isolation at the same time. The distance between circulator and magnetron should be as short as possible.
Under no circumstances should the magnetron be operated with a load giving a VSWR 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 supplied 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 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 mean anode current.

The occurrence of this diode current can be avoided by preventing the anode voltage becoming positive with respect to the cathode during the intervals between the pulses.

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 calculating the rate of rise of anode voltage the 100% value must be taken as 15, 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).

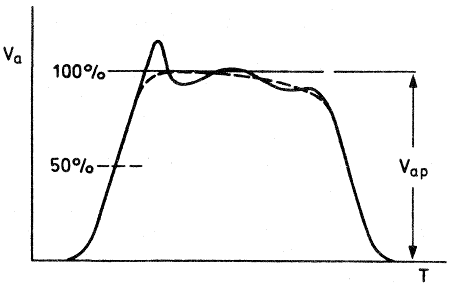


Fig. 1

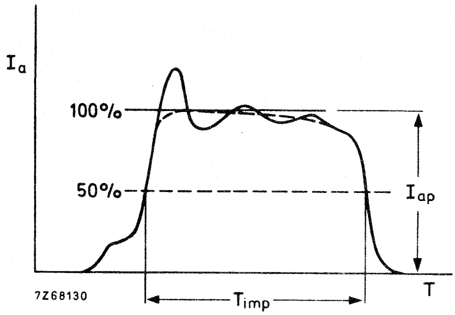


Fig. 2

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 be handled carefully. 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 in) 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 to 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 they must be stored in protective packing.

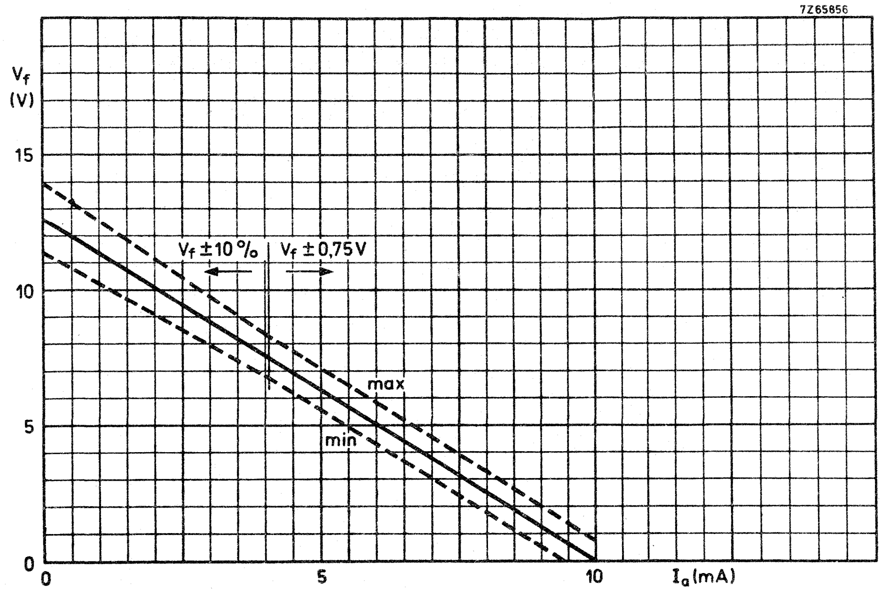
When handling and mounting the magnetron, a minimum distance of 5 cm (2 in) between the magnet and any piece of magnetic material should be maintained to avoid mechanical shocks to the magnetron. For this reason it is required to use non-magnetic tools during installation, such as non-magnetic stainless 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 is 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 four bolts (thread M6). 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 bolts are tightened and when the output system is being coupled to the waveguide in the equipment.

To fasten the magnetron output flange to the 153 IEC-R 140 waveguide, a choke flange 154 IEC-CBR 140 should be used. The latter flange must be modified by reaming the four mounting holes with a 4,3 mm drill. It can then be fastened to the magnetron output flange by means of four M4 bolts. This connection should be such that a reliable contact is established in order to avoid arcing and other bad contact effects.

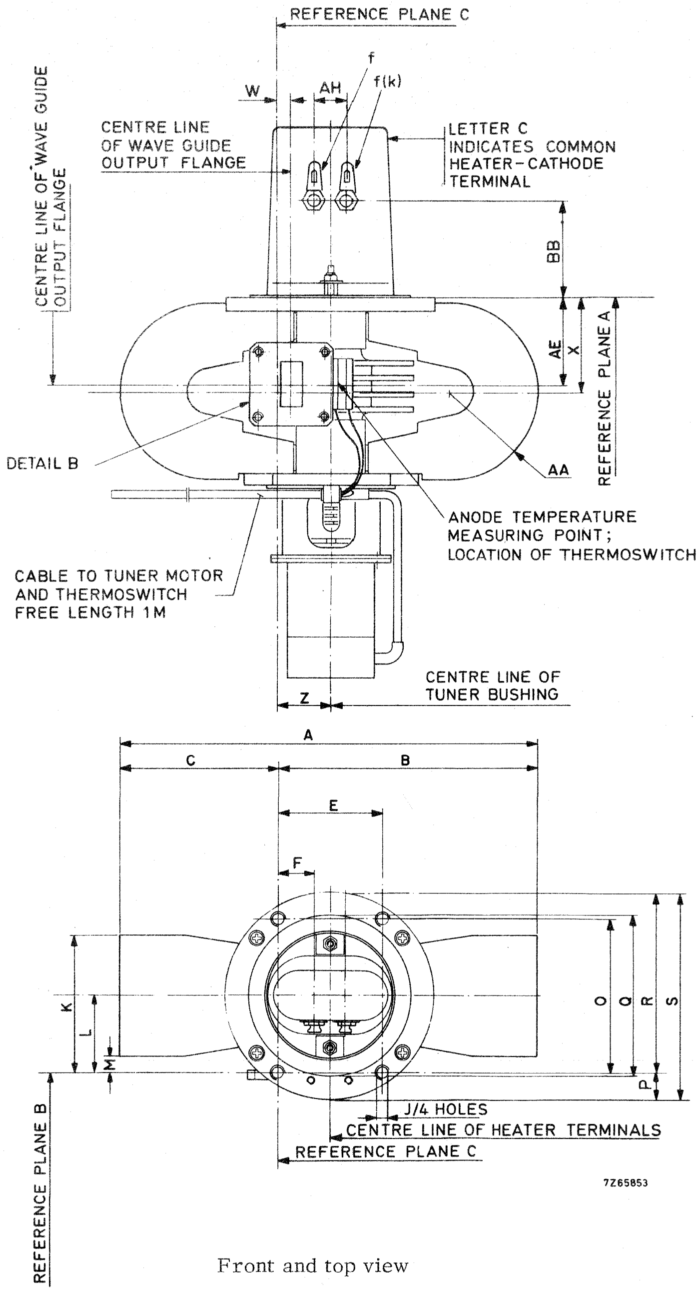
A connector with flexible supply leads should be used for the connection of heater and heater/cathode terminals.



Heater voltage reduction curve

Ref.	Dimensions in mm			Remarks
	min.	nom.	max.	
A			180	
B			112	
C			68	
E	43, 8	44, 0	44, 2	
F	15, 0	15, 6	16, 3	
J				The holes have M6 screwthread
K			59, 5	
L	31, 4	32, 0	32, 6	
M	4			
O	63, 8	64, 0	64, 2	
P			13, 5	
Q	66, 5	66, 7	66, 9	
R			78	
S			ϕ 91	
W	2, 3	3, 2	4, 0	
X		37, 2		
Z	20	22	24	
AA		R34		
AE	34, 4	35, 5	36, 6	
AH	12, 45	12, 70	12, 95	
BB	40, 6	42, 6	44, 6	

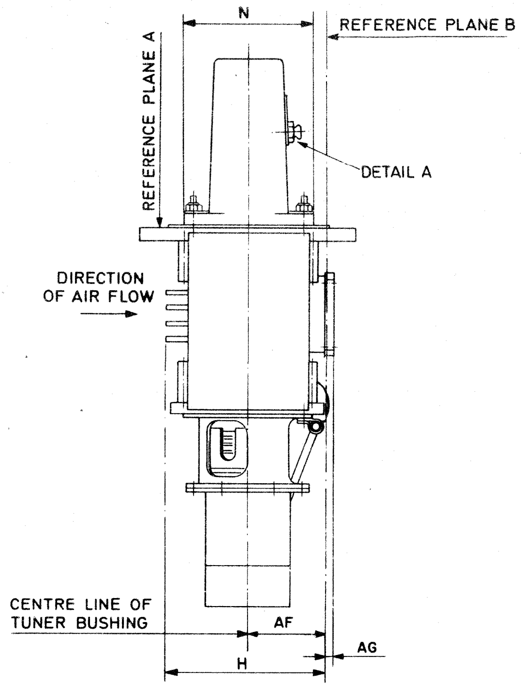
MECHANICAL DATA



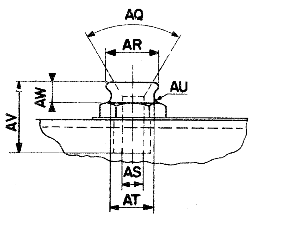
Front and top view

Ref.	Dimensions in mm			Remarks
	min.	nom.	max.	
G				The holes have M4 screwthread
H			70	
N			ϕ 55	
T		33, 3		
U	24, 2	24, 3	24, 4	
V		7, 9		
AB		33, 3		
AC	25, 2	25, 3	25, 4	
AD		15, 8		
AF	30	32	34	
AG	2, 7	3, 4	4, 1	
AQ		60^{o}		
AR	7, 06	7, 14	7, 21	
AS	4, 16	4, 29	4, 42	
AT	5, 82	5, 94	6, 06	
AU		R1		
AV		17, 5		
AW	2, 64	2, 76	2, 88	

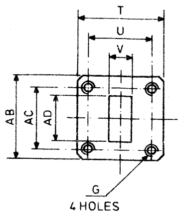
MECHANICAL DATA



Side view



DETAIL A
(FLYING LEADS ALSO AVAILABLE)

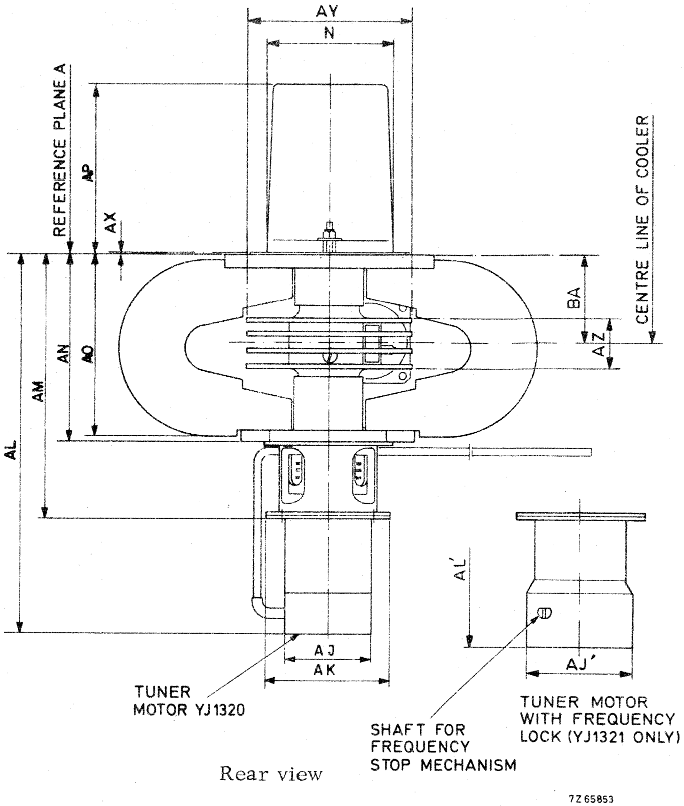


DETAIL B

7Z65853

Ref.	Dimensions in mm			Remarks
	min.	nom.	max.	
AJ			ϕ38	YJ1320 only
AJ'			ϕ 44,5	YJ1321 only
AK			ϕ55	
AL			162	YJ1320 only
AL'			167	YJ1321 only
AM			115	
AN		74,5		
AO			73,5	
AP	70	71,5	73	
AX	0,6	0,8	1,0	
AY		70		
AZ		19		
BA		35,5		
N			ϕ 55	

MECHANICAL DATA



Rear view

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

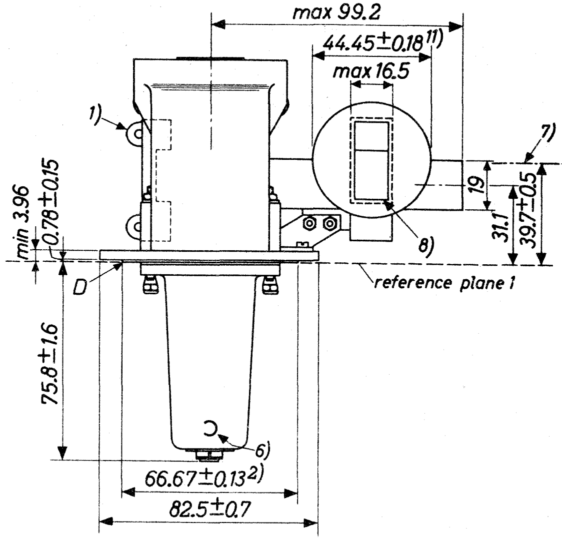
Peak anode voltage at I_{a_p} = 14 A	V_{a_p}	=	13 to 15.5	kV
Increase of peak anode voltage at a frequency variation from 8500 to 9600 MHz with I_{a_p} constant	ΔV_{a_p}	=	0.9	kV
Dynamic impedance	R_i	=	150	Ω
Pulling figure at V.S.W.R. = 1.5	Δf_p	<	18	MHz
Negative temperature coefficient	$-\frac{\Delta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

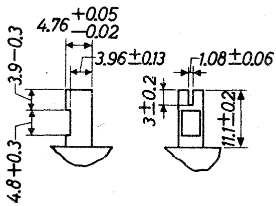
[1]) Measured with

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

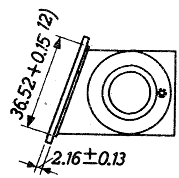
MECHANICAL DATA Dimensions in mm

Net weight: 2.3 kg

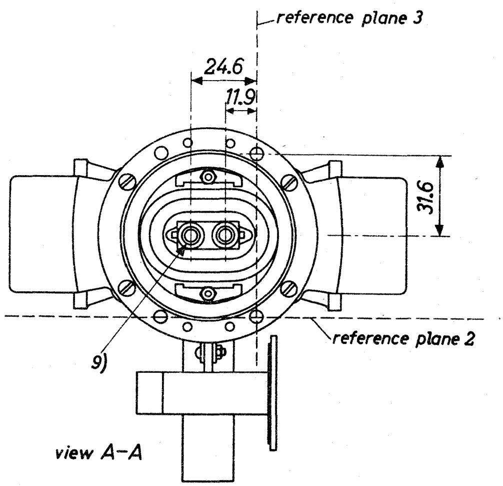




Worm shaft ends

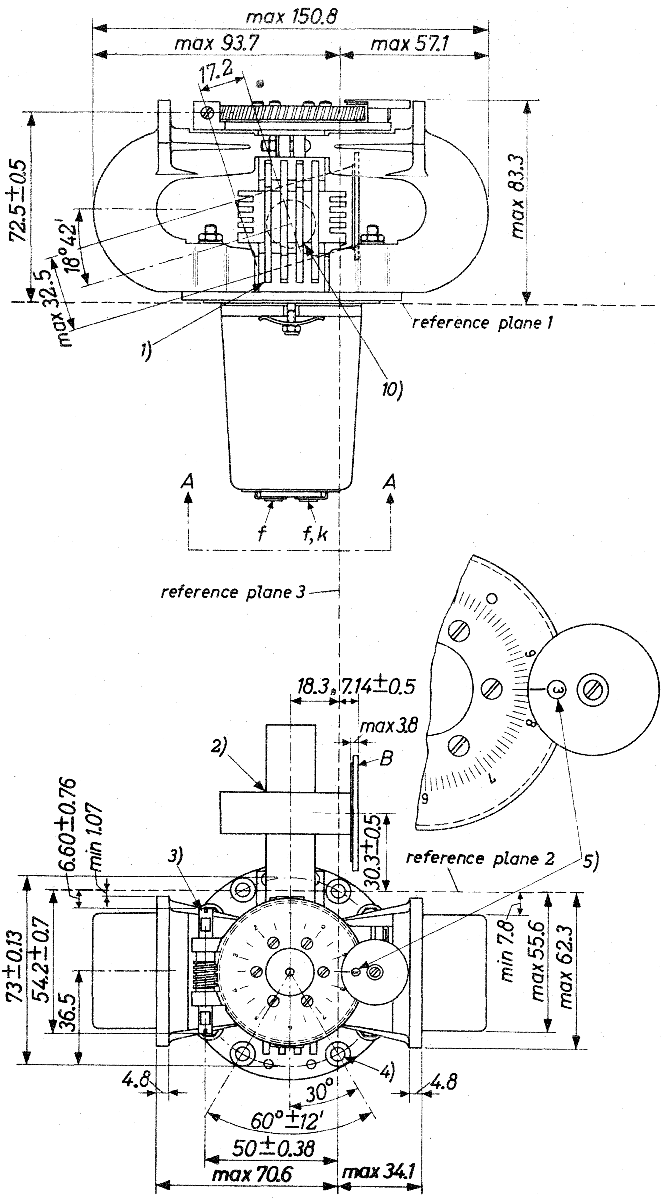


Magnetron output



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.

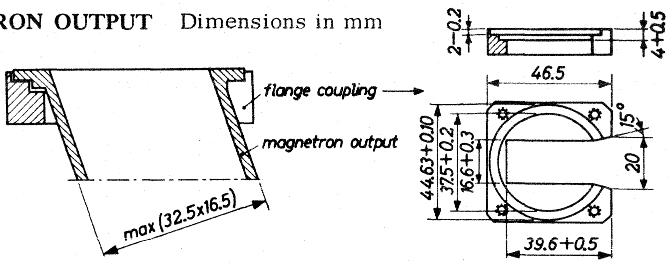
9) Banana pin jack, 15 mm long, diameter 4.29 ± 0.13 mm.

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. min.	9650 8450	MHz MHz
Voltage standing wave ratio	V.S.W.R.	max.	1.5	
Duty factor	δ	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	δ	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.

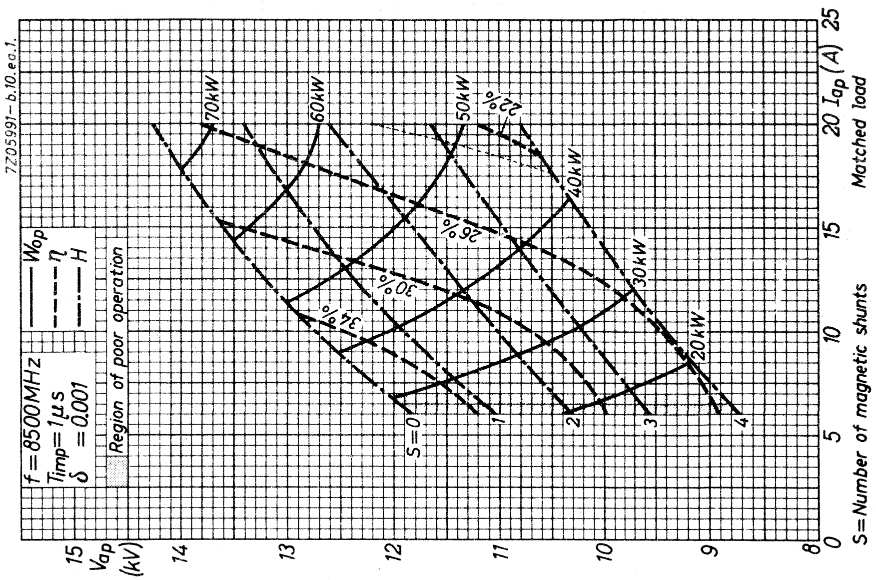
STORAGE, HANDLING AND MOUNTING

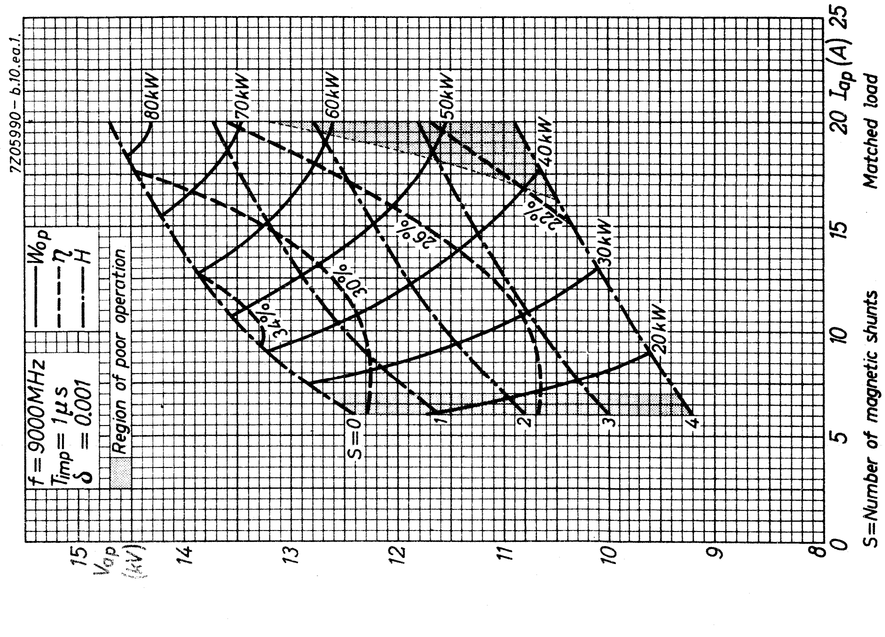
In storage sufficient distance should be maintained between the magnetrons to prevent decrease of field strength of the magnetron magnet due to the interaction with adjacent magnets. A minimum distance of 15 cm (6 inches) should be maintained between tubes. Magnetic materials should be kept away from 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.

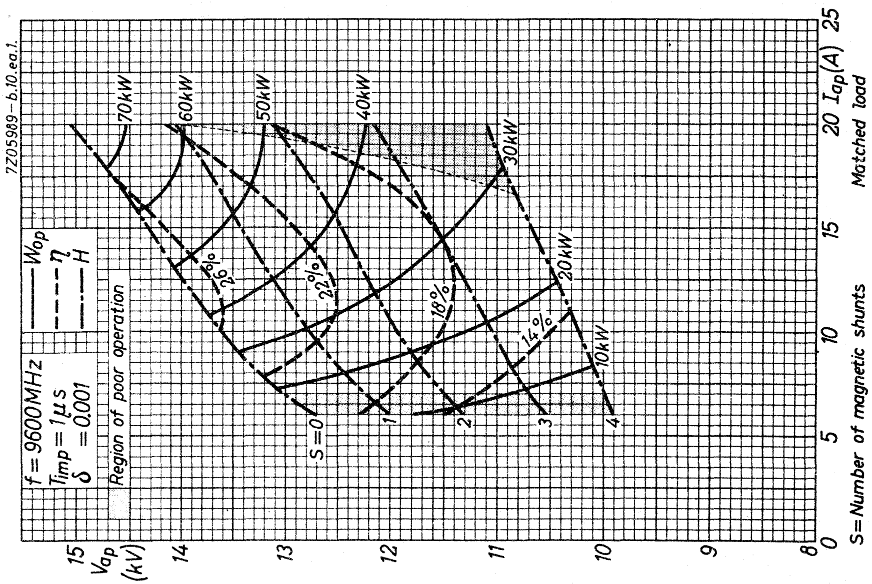
DIAGRAMS

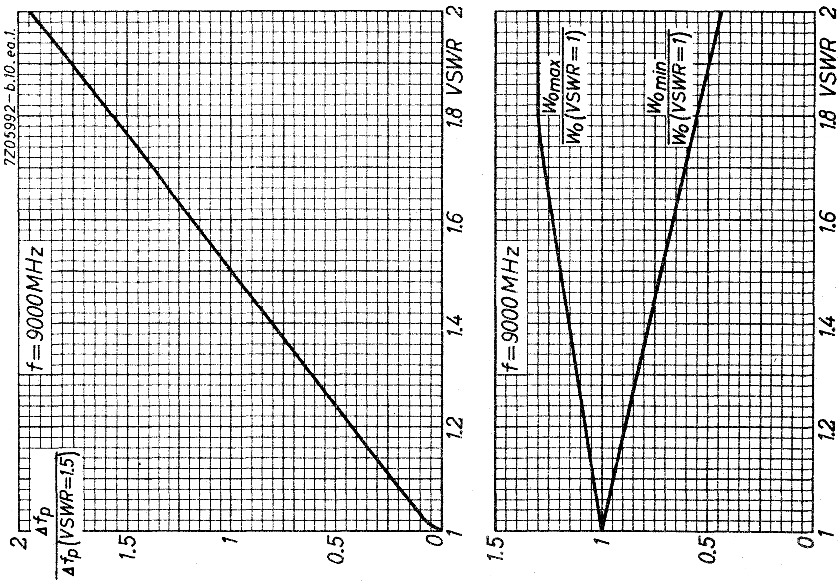
Average performance charts at a frequency of 8500, 9000 and 9600 MHz are given on page 9 and 10 respectively. The magnetron is operated into a matched load. These charts show contours of magnetic field strength (indicated by the number of magnetic shunts S), peak output power and efficiency as functions 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.

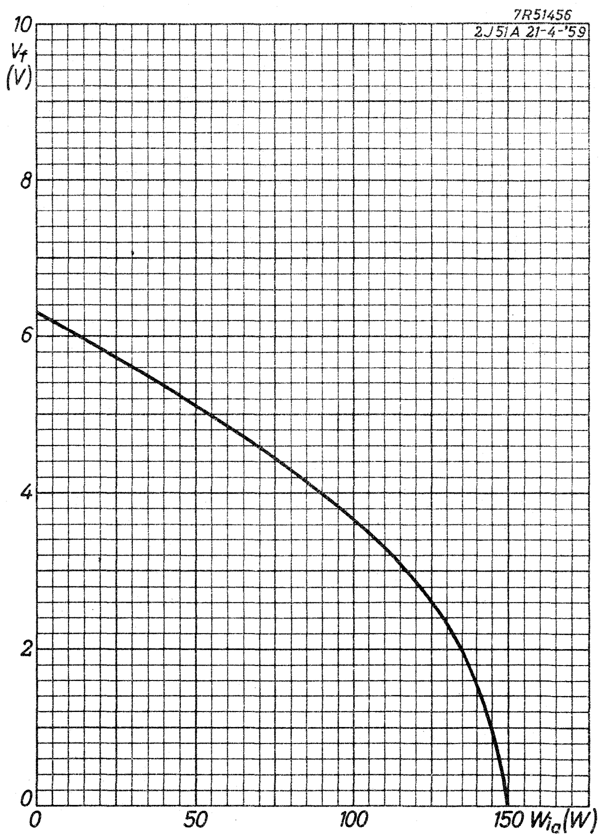
$W_{o\,max}$ = output power at phase adjusted for maximum power
$W_{o\,min}$ = output power at phase adjusted for minimum power


7Z05991-b.10.ea.1.
f = 8500MHz
Timp = 1 µs
δ = 0.001
Region of poor operation
Wop
η
H
Vap (kV)
Iap (A)
Matched load
S = Number of magnetic shunts
70kW
60kW
50kW
40kW
30kW
20kW
22%
26%
30%
34%
S=0
1
2
3
4
15
14
13
12
11
10
9
8
0
5
10
15
20
25


7Z05990-b.10.ea.1.
f = 9000MHz
Timp = 1 µs
δ = 0.001
Region of poor operation
Wop
η
H
Vap (kV)
Iap (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
15
14
13
12
11
10
9
8
0
5
10
15
20
25


7Z05989-b.10.ea.1.
f = 9600MHz
T_{imp} = 1µs
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)
I_{ap}(A) Matched load
S = Number of magnetic shunts


7Z05992-b.10.ea.1.
f=9000MHz
$\frac{\Delta f_p}{\Delta f_p (VSWR=1.5)}$
VSWR
f=9000MHz
$\frac{W_{o max}}{W_o (VSWR=1)}$
$\frac{W_{o min}}{W_o (VSWR=1)}$


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	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:

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

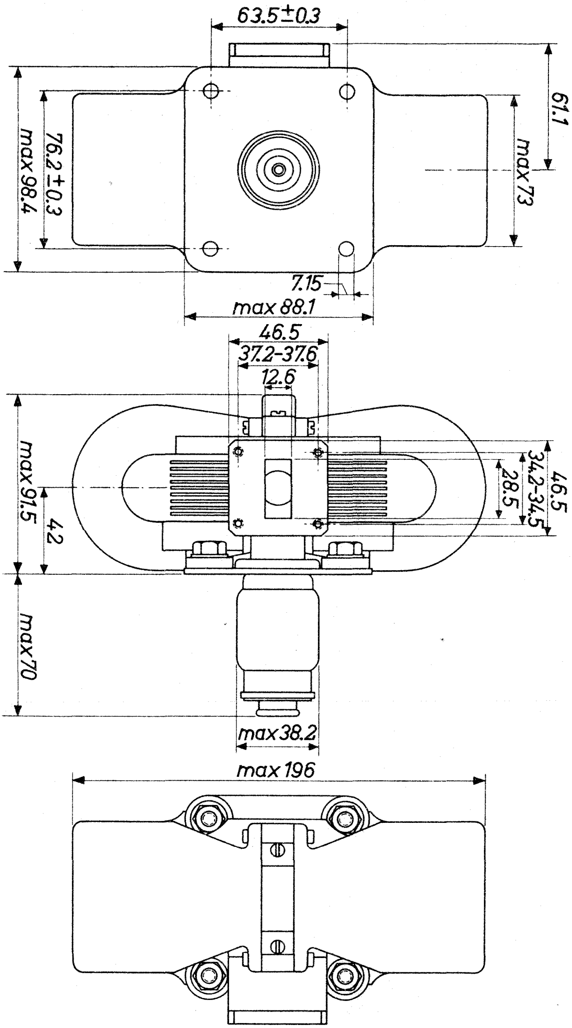
The heater current must never exceed a peak value of 15 A at any time during the initial energising schedule.

TYPICAL CHARACTERISTICS

Peak anode voltage	V_{a_p}	< 23	kV
Pulling figure	Δf_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		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 unpackaged tunable magnetron for pulsed service.

QUICK REFERENCE DATA		
Frequency, tunable within the band	f	1220 to 1350 MHz
Peak output power	W_{o_p}	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	Δf_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)

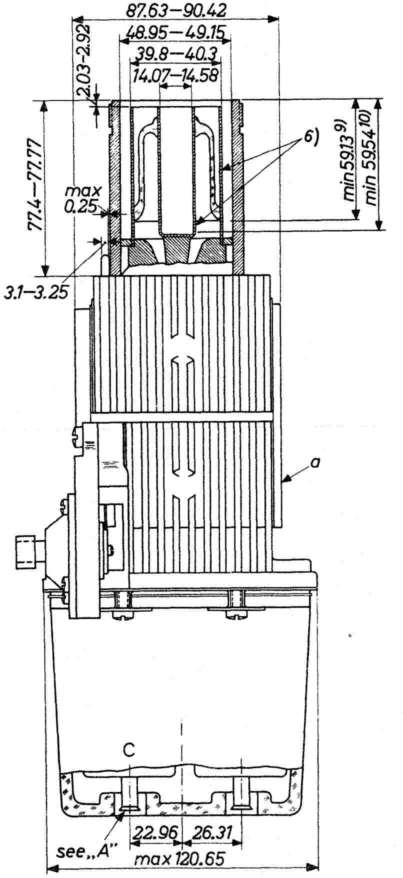
The magnetron output has been designed for coupling to a standard coaxial transmission line with an outer diameter of 1 5/8".

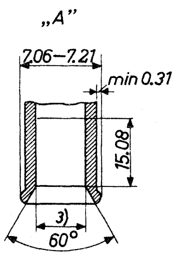
COOLING

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

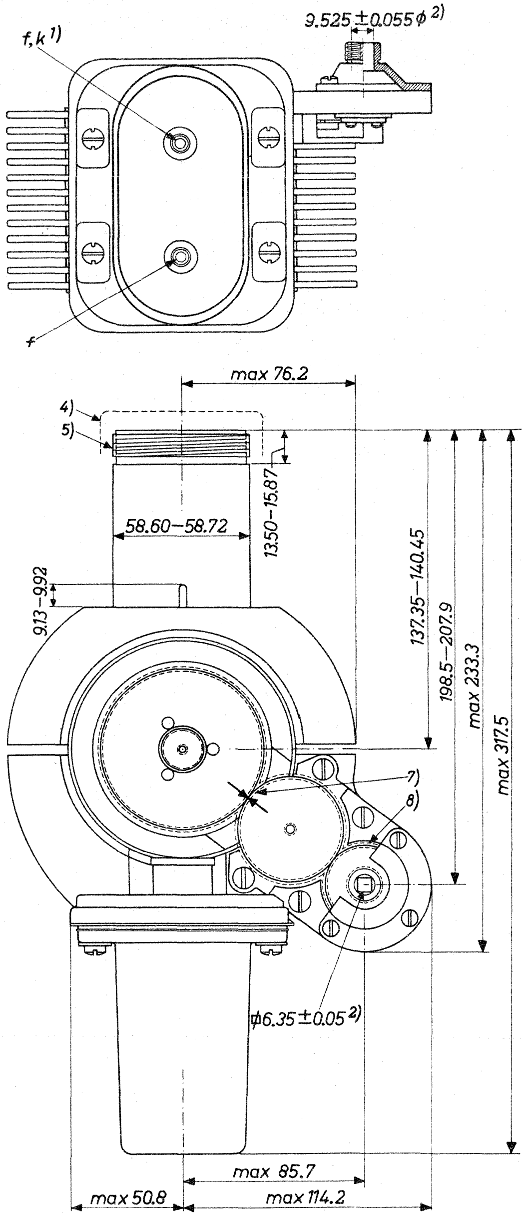
To prevent electrical breakdown of the coaxial transmission line which can result in permanent damage to the magnetron, it is essential to pressurize this line for peak output powers greater than 400 kW. (max. 3.2 atm)





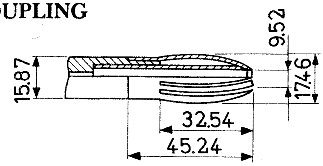
For footnotes see page 5.

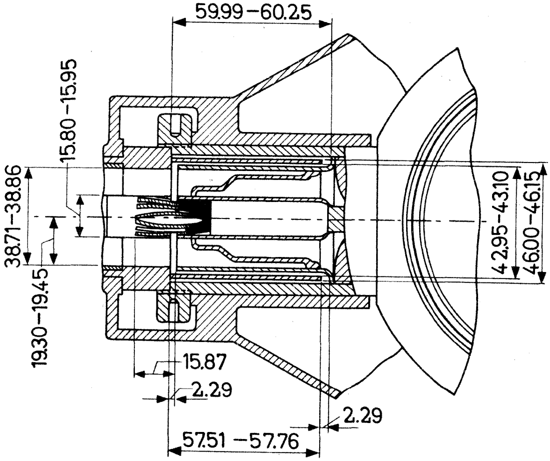
MECHANICAL DATA (continued) Dimensions in mm



RECOMMENDED COUPLING

Dimensions in mm



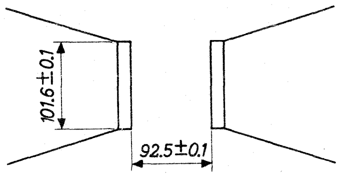


The dimensioned cylindrical surfaces shall be concentric within 0.076 mm

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.

---

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	δ	=	max.	0.0025	
Pulse repetition rate	f_{imp}	=	max.	1000	Hz
Pulse duration	T_{imp}	=		1 to 6	μs
Voltage rise time					
at T_{imp} = 1 μs	T_{rv}	=	min.	0.3	μs
at T_{imp} = 4 μs	T_{rv}	=	min.	0.5	μs
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	μs
Pulse repetition rate	f_{imp}	=	1000	Hz
Duty factor	δ	=	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 current 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)

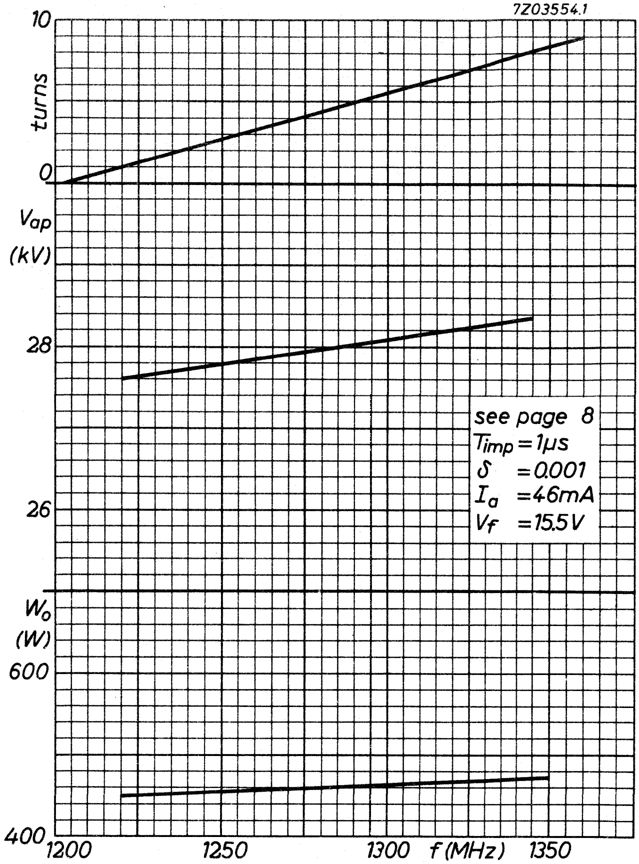
4. As soon as the magnetron operates stably, gradually raise the anode current until the normal operating conditions are reached. If sparking occurs stop raising anode current until the magnetron operates stably again. Care should be taken that the maximum ratings are not exceeded.

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
V_{ap}
(kV)
28
26
see page 8
T_{imp} = 1μs
δ = 0.001
I_a = 46mA
V_f = 15.5V
W_o
(W)
600
400
1200
1250
1300
f (MHz)
1350

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 in coaxial output transmission line and a separate magnet having an air gap of 1,8 in and a magnetic field strength of 216 A/mm (2700 Oe).

HEATING : indirect

Heater starting voltage	V_{f_o}		16	V ± 10%
Heater current at V_f = 16 V	I_f		2,8 to 3,4	A
Peak heater starting current	I_{f_p}	max.	12	A
Waiting time	T_w	min.	2	min

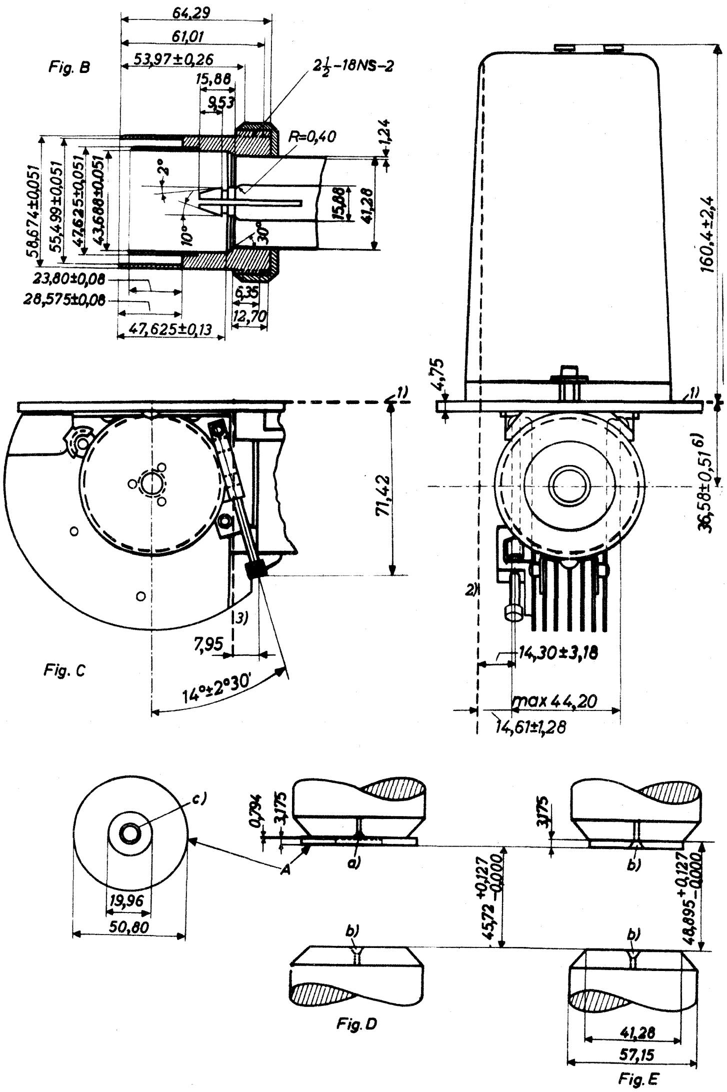
During high-voltage operation the heater voltage must be reduced according to the following schedule:

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

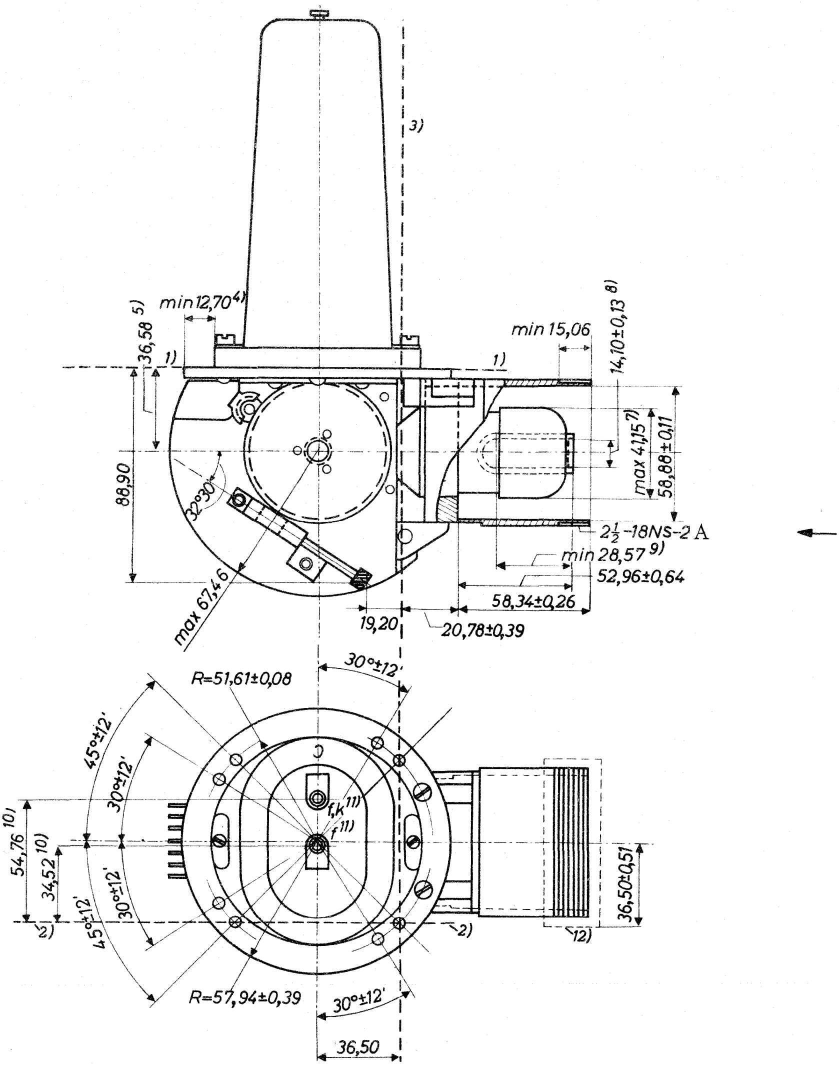
Net weight 2,3 kg



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.

The cathode side (non-tuner side) of the magnetron anode should be adjacent to the north pole of the magnet.

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 max. rating system)

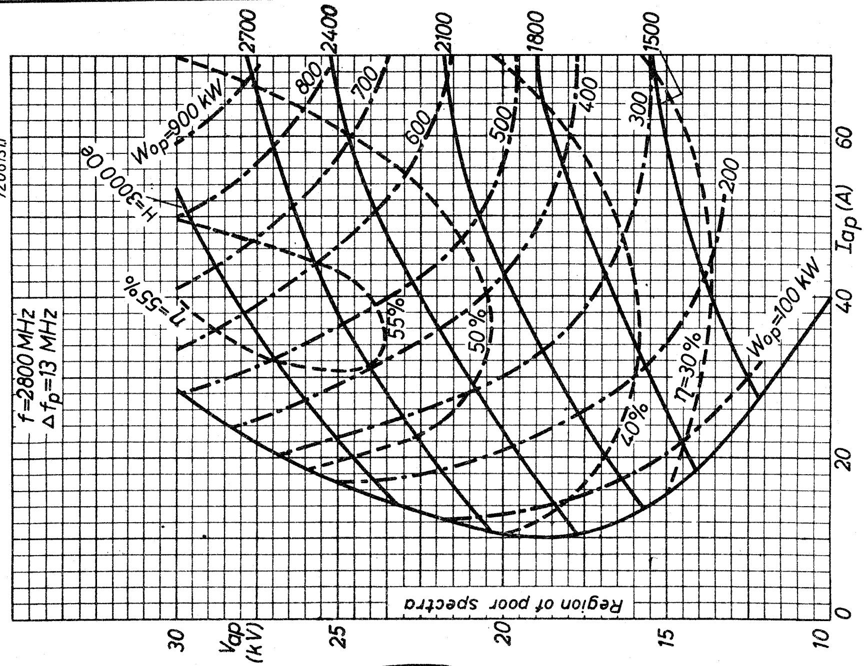
Pulse duration	T_{imp}	max.	2,5	μs
Duty factor	δ	max.	0,001	
Peak anode current	I_{ap}	max.	70	A
Mean anode input power	W_{ia}	max.	1200	W
Peak anode input power	W_{iap}	max.	2100	kW
Peak anode voltage	V_{ap}	max.	32	kV
Rate of rise of anode voltage	dVa/dT	max. min.	150 75	kV/μs [1] kV/μs [1]
Voltage standing wave ratio	VSWR	max.	1,5	
Anode temperature	t_a	max.	100	°C

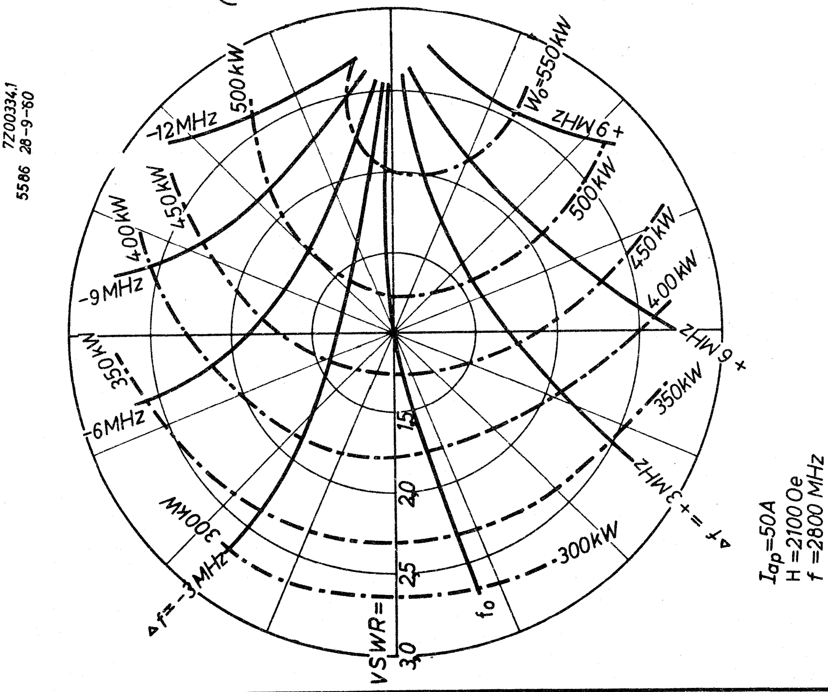
OPERATING CHARACTERISTICS

Frequency	f		2,7 to 2,9	GHz
Peak anode current	I_{ap}		70	A
Mean anode current	I_a		35	mA
Peak anode voltage	V_{ap}		27 to 30	kV
Rate of rise of anode voltage	dVa/dT		140	kV/μs [1]
Pulse duration	T_{imp}		1	μs
Duty factor	δ		0,0005	
Magnetic field strength	H		216 (2700	A/mm Oe)
Mean output power	W_o		400	W
Peak output power	W_{op}		800	kW
Bandwidth	B	<	2,5	MHz
Pulling figure	Δf_p	<	15	MHz

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

[1]) 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.


7Z06131.1
f=2800 MHz
Δfp=13 MHz
2700
2400
2100
1800
1500
800
700
600
500
400
300
200
Wop=900 kW
H=3000 Oe
η=55%
55%
50%
40%
η=30%
Wop=100 kW
Iap (A)
0
20
40
60
Vap (kV)
30
25
20
15
10
Region of poor spectra


7Z00334.1
5586 28-9-60
Wo=550kW
500 kW
450kW
400kW
350kW
300kW
500kW
450kW
400kW
350kW
300kW
-12MHz
-9MHz
-6MHz
Δf=-3MHz
+9MHz
+6MHz
Δf=+3MHz
f0
VSWR=
1.5
2.0
2.5
3.0
Iap=50A
H=2100 Oe
f=2800 MHz

PULSED MAGNETRON

Packaged magnetron for pulsed service at a fixed frequency.
Designed for very short pulse operation and particularly suited for high-definition short-range radar systems.

The 7093 incorporates a dispenser type of cathode to ensure 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.

QUICK REFERENCE DATA			
Frequency, fixed within the band	f	34,512 to 35,208	GHz
Peak output power	W_{op}	30	kW
Construction		packaged	

CATHODE : dispenser type

HEATING : indirect by a.c. (30 to 1650 Hz) or d.c.
In case of d.c. the terminal f, k must have positive polarity.

Heater voltage, starting	V_{fo}		4,5	V ± 10%
Heater current at V_f = 4,5 V	I_f		3,6	A ± 0,7 A
Heater current , peak starting	I_{fp}	max.	8	A
Cold heater resistance	R_{fo}	>	0,16	Ω
Waiting time	T_w	min.	3	min.

At an anode input power of more than 21 W the heater voltage must be reduced immediately after the application of anode input power in accordance with the graph on page 7.

TYPICAL CHARACTERISTICS

Stable range: peak anode current	I_{ap}		6 to 16	A
Anode voltage, peak at I_{ap} = 12,5 A	V_{ap}		12 to 14	kV
Frequency temperature coefficient	$\frac{\Delta f}{\Delta t_a}$	<	-1	MHz/°C
Pulling figure (VSWR = 1,5)	Δf_p		35	MHz
Pushing figure	$\frac{\Delta f}{\Delta I_a}$	<	4	MHz/A
Distance of voltage standing wave minimum [1]	d		0,25 to 0,40 = 2,6 to 4,4	λg mm
Capacitance, anode to cathode	C_{ak}		6	pF

LIMITING VALUES (Absolute max. rating system)

Pulse duration [2]	T_{imp}	max.	0,2	µs
Duty factor	δ	max.	0,0003	
Anode current, peak [2]	I_{ap}	max. min.	16 6	A A
Input power, mean	W_{ia}	max.	60	W
Rate of rise of anode voltage at T_{imp} = 0,1 µs [2]	$\frac{dV_a}{dT}$		200 to 300	kV/µs
Voltage standing wave ratio	VSWR	max.	1,5	
Anode temperature [3]	t_a	max.	150	°C
Cathode and heater terminal temperature	t	max.	150	°C
Pressure, input and output	p	max. min.	30 6	N/cm² abs [4] N/cm² abs [4]

[1] The distance of the VSW minimum outside the tube is between 0,25 and 0,4 λg (2,6 and 4,4 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 pulse definitions page 4.

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

[4] 1 N/cm² = 75 mm Hg.

[5] Diode current suppressed by a suppressor voltage of about + 300 V on the cathode with respect to the anode.

OPERATING CHARACTERISTICS

Heater voltage, running	V_f	4,0	4,5	V
Pulse duration 2)	T_{imp}	0,1	0,04	μs
Pulse repetition rate	f_{imp}	2000	2500	p.p.s.
Duty factor	δ	0,0002	0,0001	
Anode voltage, peak 2)	V_{ap}	12 to 14	12 to 14	kV
Rate of rise of anode voltage 2)	$\frac{dV_a}{dT}$	250	400	kV/μs
Anode current, mean	I_a	2,5	1,6	mA 5)
, peak 2)	I_{ap}	12,5	16	A
Output power, mean	W_o	6	2,5	W
, peak	W_{op}	30	25	kW

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 cathode and heater terminals below 150 °C.

To safeguard the magnetron against overheating, provision is made for mounting a thermoswitch, e.g. type 3BTL6 (Texas Instruments Inc.). This switch should become operative at a temperature of 140 °C at its mounting plate.

PRESSURE

The magnetron need not be pressurized when operating at atmosheric pressure. To prevent arcing, the pressure must exceed 6 N/cm^2 (Absolute limit).

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.

Notes see page 2.

CIRCUIT NOTES

a) To prevent heater burn-out the negative high-voltage pulse must be applied to the common heater/cathode terminal f, k.

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 load giving a VSWR 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 supplied 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 mean anode current. The occurrence of this diode current can be avoided by preventing the anode voltage becoming positive with respect to the cathode during the intervals between the pulses.

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 calculating the rate of rise of anode voltage the 100% value must be taken as 13 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).

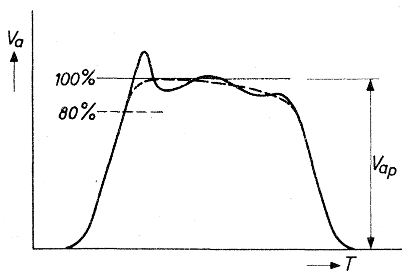


Fig. 1.

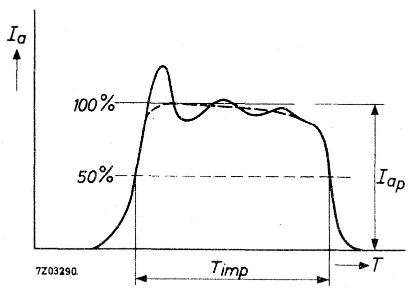


Fig. 2.

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 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. If the tubes cannot be stored at normal temperature 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.

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 mass : 1,9 kg

Waveguide output system : 153 IEC – R320 = RG – 96/U

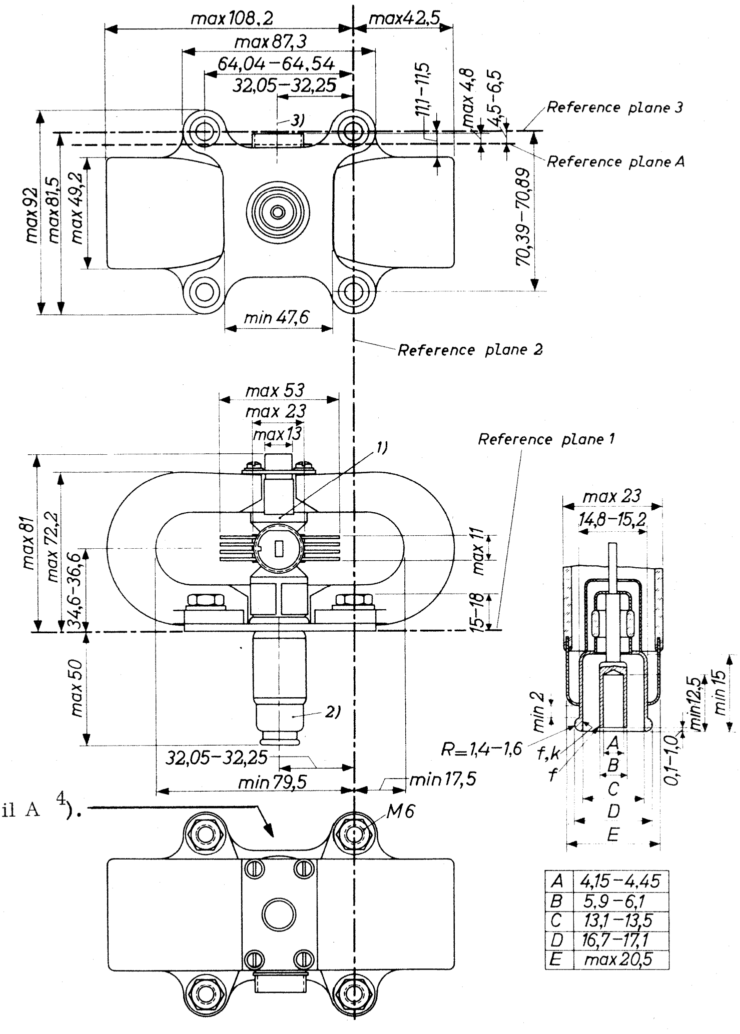
Waveguide coupling system : Z8 300 16

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

Cathode connector : Jettron 91-010 or equivalent

The mounting flange and the waveguide output system are designed to permit the use of pressure seals. See also under "Limiting Values".

Dimensions in mm



See detail A 4).

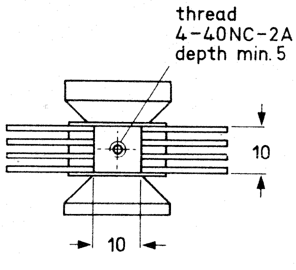
A	4,15−4,45
B	5,9−6,1
C	13,1−13,5
D	16,7−17,1
E	max 20,5

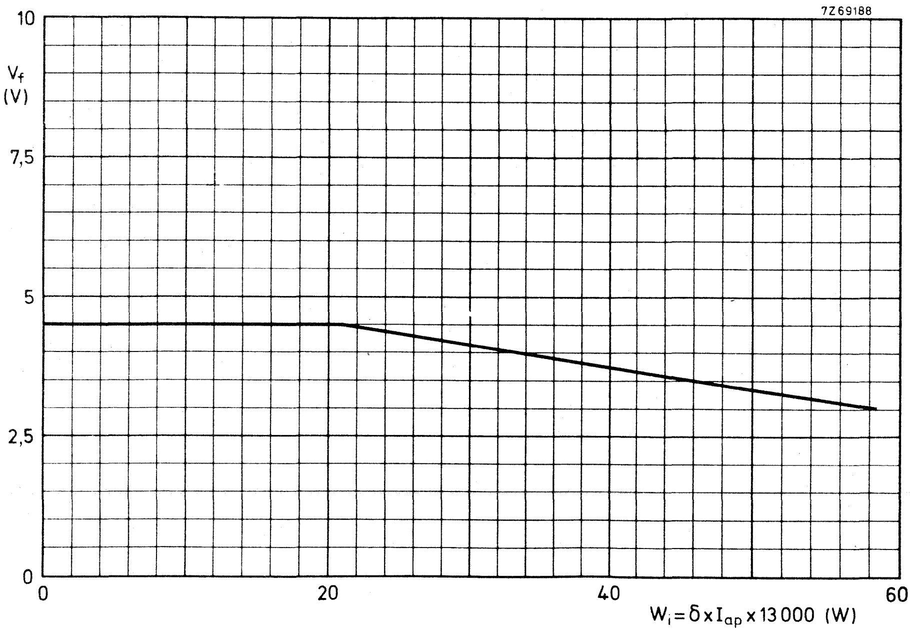
1) Inscription of serial number.

2) The axis of the common heater-cathode 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 heater-cathode terminal is max. 0,125 mm.

3) Centre of waveguide.

4) Plate for mounting a thermoswitch, see detail A, page 7.


thread
4-40NC-2A
depth min. 5
10
10
detail A
7Z69187


7Z69188
10
V_f
(V)
7,5
5
2,5
0
0
20
40
60
$W_i = \delta \times I_{ap} \times 13\,000$ (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 to 0, 1 μs.

QUICK REFERENCE DATA			
Type	Frequency band (MHz)	Peak output power (kW)	
		T_{imp} = 0.1 μs	T_{imp} = 1 μs
55029 55030 55031/02 55031/01 55032/02 55032/01	9405 to 9505 9345 to 9405 9260 to 9345 9168 to 9260 9085 to 9168 9003 to 9085	200	250
construction		packaged	

HEATING : indirect

Heater voltage, starting	V_f	13, 75	V $^{+10\ \%}_{-\ 5\ \%}$
Heater current at V_f = 13, 75 V	I_f	3, 00 to 3, 75	A
Peak heater starting current	I_{f_p}	max. 15	A
Cold heater resistance	R_{f_o}	> 0, 6	Ω
Waiting time	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 2.

TYPICAL CHARACTERISTICS

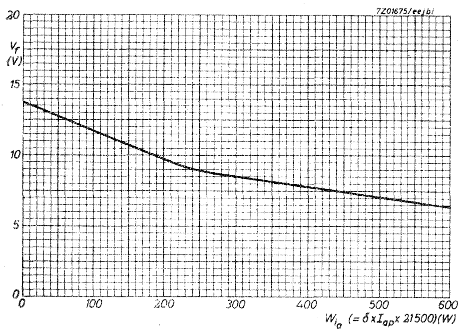
Peak anode voltage	V_{a_p}	20 to 23	kV
Pulling figure (VSWR = 1.5)	Δf_p	13	MHz
		< 17, 5	MHz
Pushing figure	$\frac{\Delta f}{\Delta I_{a_p}}$	< 0, 25	MHz/A
Temperature coefficient	$\frac{\Delta f}{\Delta t}$	< -0, 25	MHz/°C
Anode to cathode capacitance	C_{ak}	14	pF

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 whichever.

Pulse duration	T_{imp}	max.	1	μs
Duty factor	δ	max.	0,001	
Heater starting voltage	V_f	max.	15	V
Peak heater starting current	I_{f_p}	max.	15	A
Peak anode current	I_{a_p}	max.	27,5	A
Mean input power	W_{i_a}	max.	635	W
Peak input power	$W_{i_{a_p}}$	max.	635	kW
Rate of rise of anode voltage for T_{imp} = 1 μs	dV_a/dT	max.	110	kV/μs
		min.	70	kV/μs
for T_{imp} = 0,25 μs	dV_a/dT	max.	160	kV/μs
		min.	120	kV/μs
for T_{imp} = 0,1 μs	dV_a/dT	max.	220	kV/μs
		min.	160	kV/μs
Voltage standing wave ratio	VSWR	max.	1,5	
Anode temperature at measuring point	t_a	max.	150	°C
Cathode/heater terminal temperature	t	max.	165	°C
Pressurization of input and output assemblies	p	max.	3,1	kg/cm^2
			45	lbs/sq in abs.

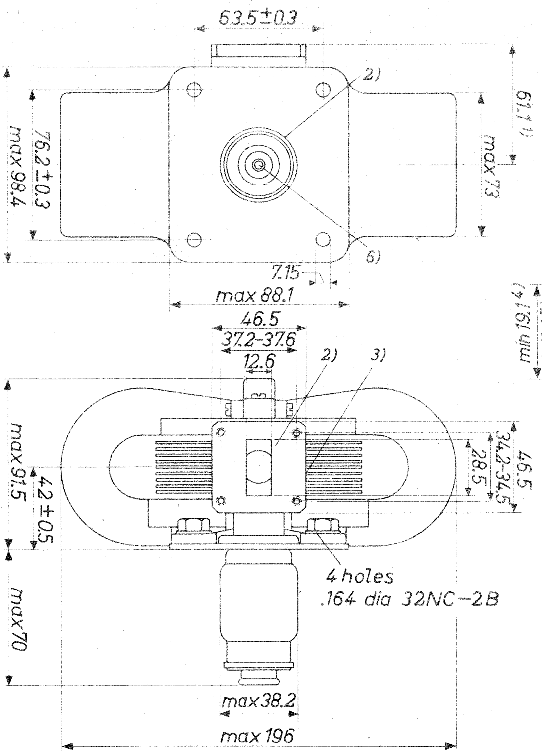
Operation at pressures lower than 60 cm Hg may result in arc-over across the heater-cathode stem with consequent damage to the magnetron. The output assembly must always be pressurized. When the magnetron is not working into a matched load, the pressure on th the output window must be higher than 1 kg/cm^2 (15 lbs/sq.in).

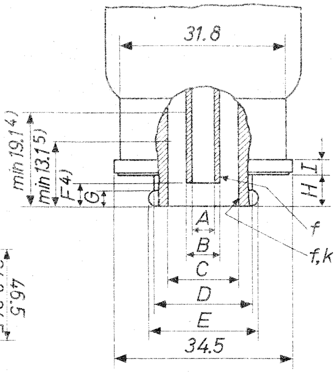


MECHANICAL DATA

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	δ	0.0002	0.0005	0.001	
Heater voltage [1]	V_f	12	9	6.5	V
Peak anode voltage	V_{ap}	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_{ap}	22.5	24	27.5	A
Average output power	W_o	41	110	250	W
Peak output power	W_{op}	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.

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[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).

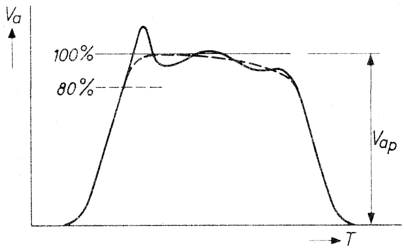


Fig. 1

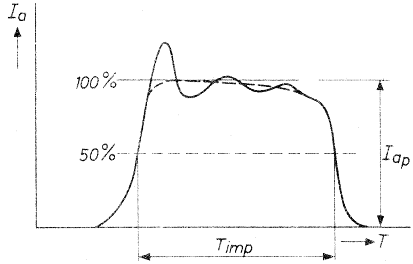


Fig.2

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.

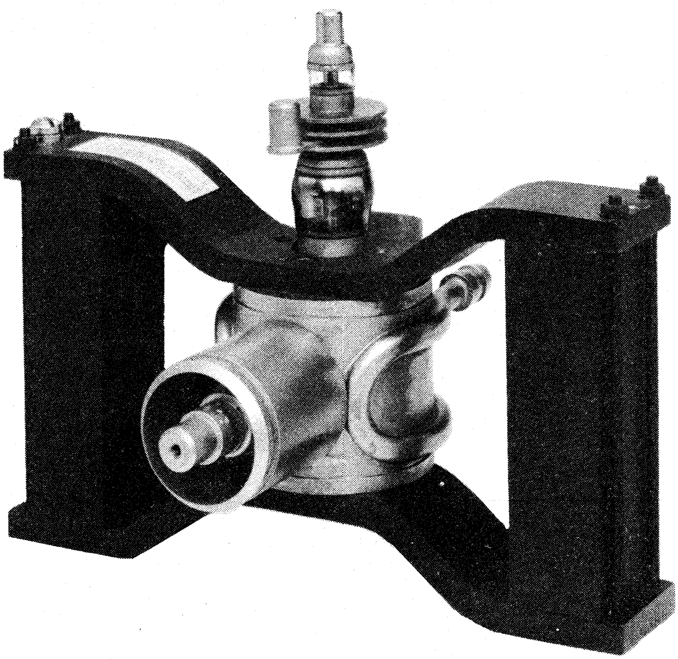
Magnetrons
for micro-wave heating

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	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 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 λ < d < 0.44λ	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	η	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	η	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_{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]	
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_{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	η	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.

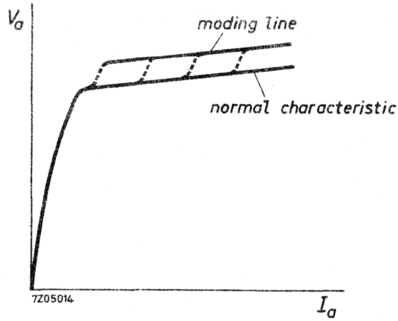
OPERATIONAL CHECKS

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.

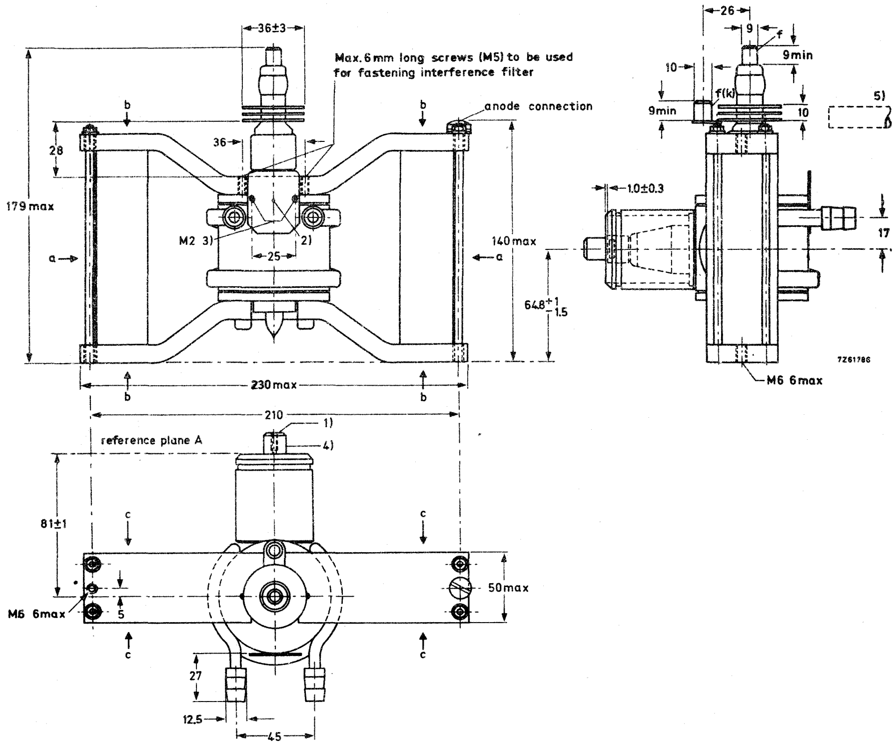


X–Y display of magnetron characteristic (unfiltered supply)

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.

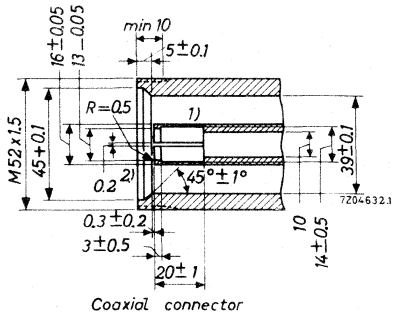
5) Non-metallic circular air duct, inner diameter 13 mm.

OUTPUT COUPLING

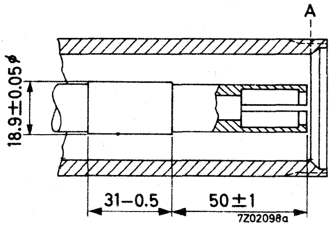
The tube may be coupled by suitable means to a coaxial line or waveguide, either directly or through a fixed reflection elements.

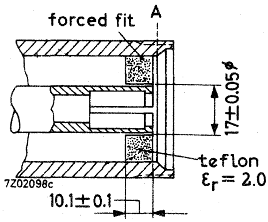
16/39 Coaxial line [3]) (characteristic impedance 53.4 Ω)

(See operating notes) Dimensions in mm



Fixed reflection elements [3]) V.S.W.R. approx. 1.5, d approx. 0.41 λ (examples). (See operating notes).





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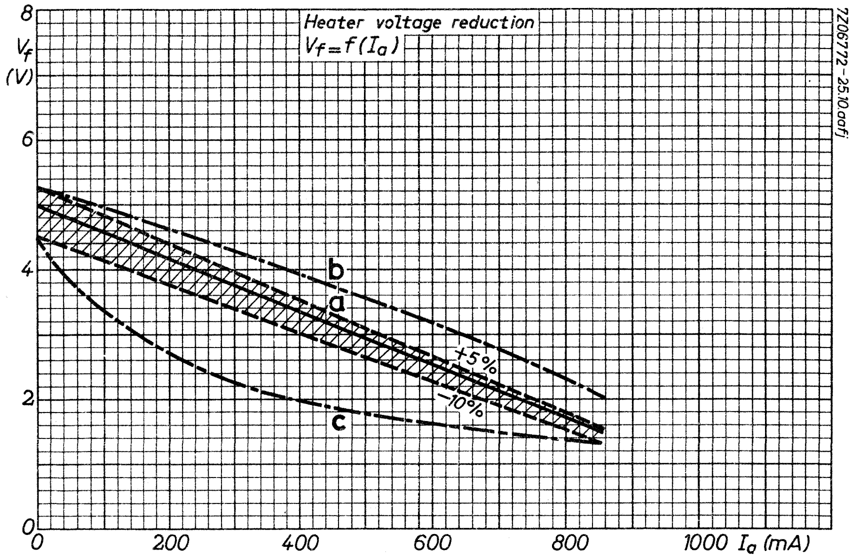
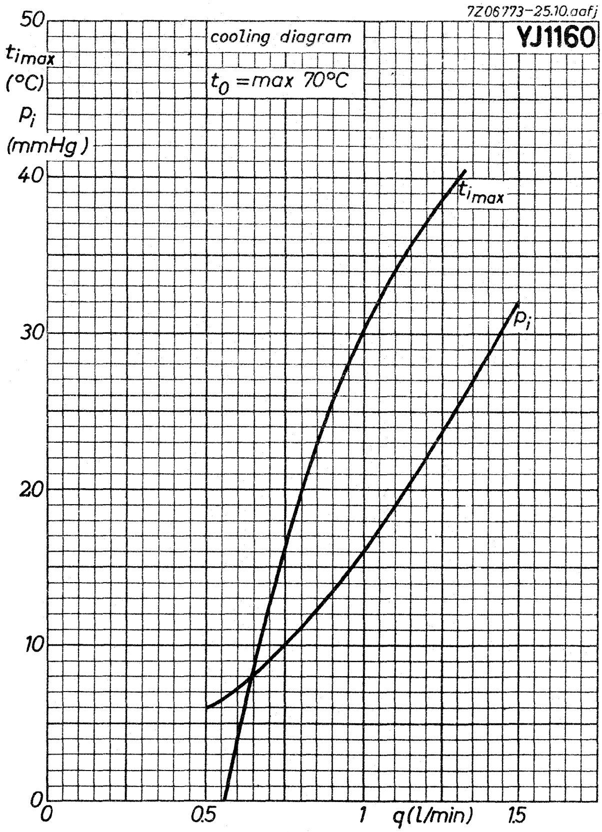
1) The inner conductor must be movable to accept the tolerances of the tube.

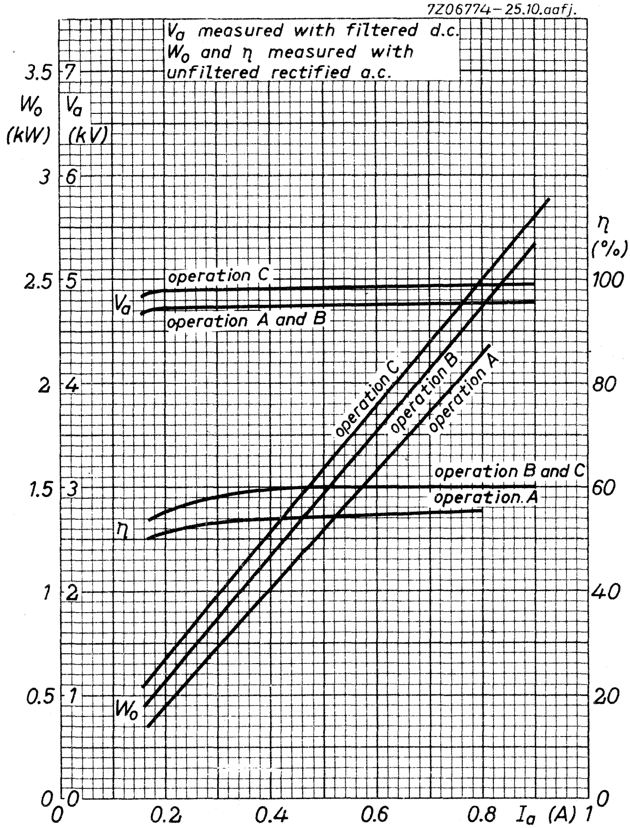
2) 6 Slots 0.2 mm; the wall segments should be deburred and be pressed together after slotting.

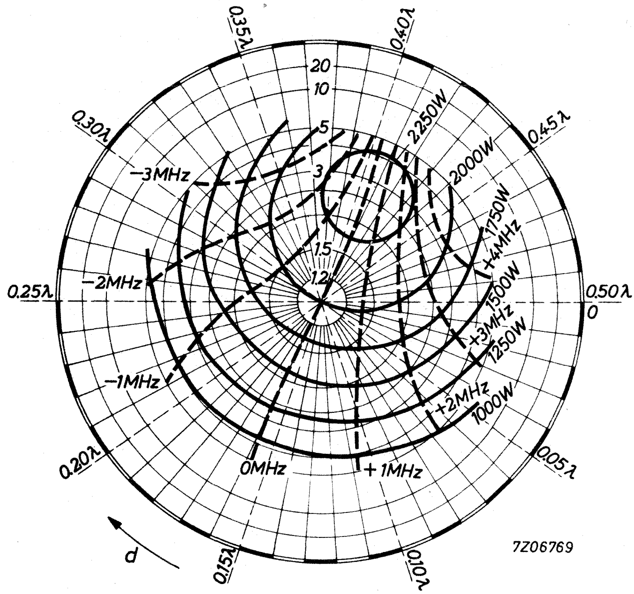
3) Not supplied by tube manufacturer.


Heater voltage reduction
$V_f = f(I_a)$
V_f (V)
8
6
4
2
0
0
200
400
600
800
1000 I_a (mA)
b
a
c
+5%
-10%
7Z06772-25.10.aaf


7Z06773-25.10.aafj
YJ1160
cooling diagram
t_0 = max 70°C
t_{imax} (°C)
p_i (mmHg)
50
40
30
20
10
0
0
0.5
1
1.5
q (l/min)
t_{imax}
p_i

Performance chart

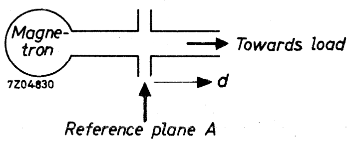


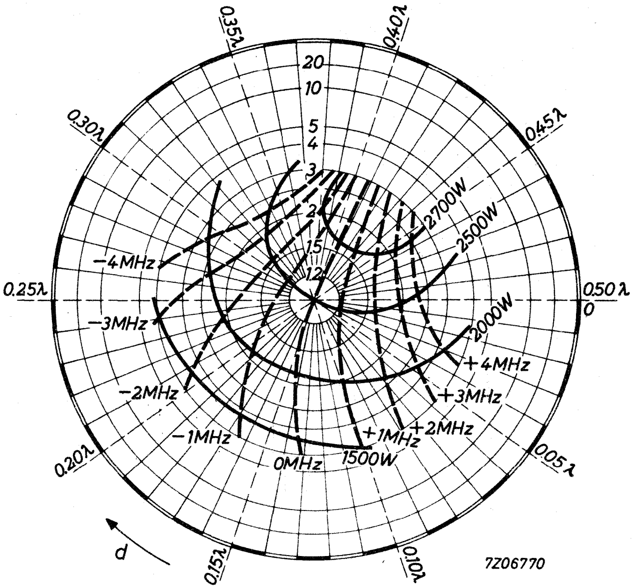


Load diagram Operation A
Mean anode current 0.75A
Peak anode current 2A

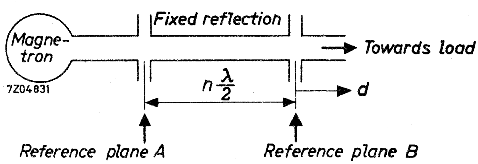
d=distance of standing wave minimum from reference plane A towards load

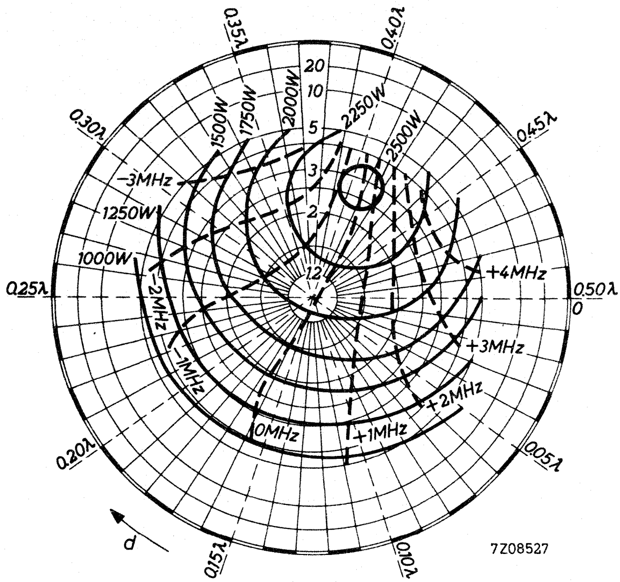
Temperature at reference point 85°C





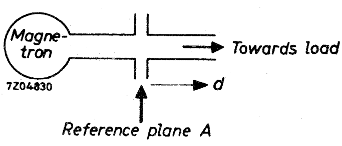
Load diagram Operation B
Mean anode current 0.85A
Peak anode current 2A
Fixed reflection VSWR = 1.5 d = 0.41λ
d = distance of standing wave minimum from reference plane B towards load
Temperature at reference point 85°C





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	

CATHODE: Dispenser type

HEATING: Indirect by A.C. (50 to 60 Hz) or D.C.

Heater voltage, starting	V_{fo}		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 page14. 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_{ap}	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_{ap}	2.0	A
Anode voltage [2]	V_a	4.75	kV
Output power	W_o	2.0	kW [3]
Efficiency	η	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	η	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_{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	η	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	^oC
Cathode radiator temperature		max. 180	^oC

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 ^oC to 110 ^oC 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_o, 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 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 ^{o}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.

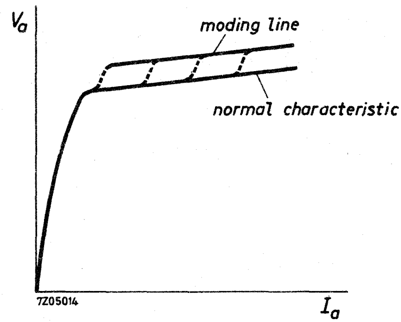
OPERATIONAL CHECKS

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.

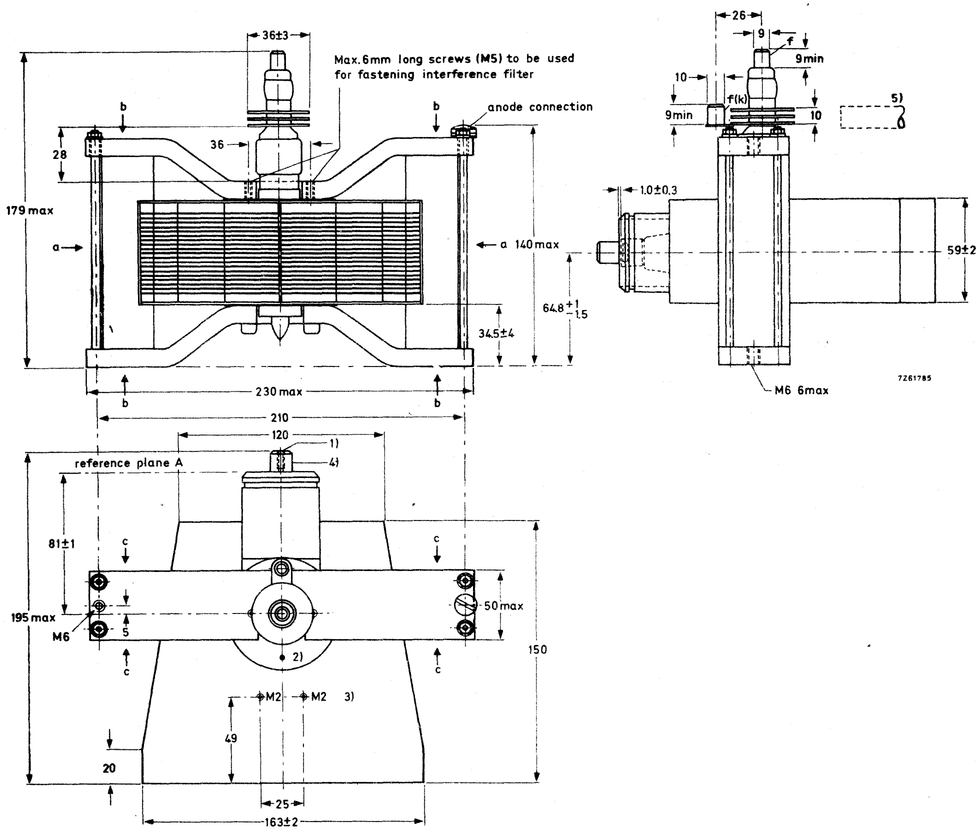


X–Y display of magnetron characteristic (unfiltered supply)

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.

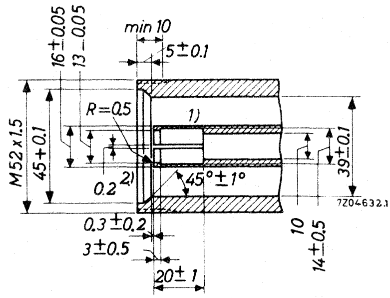
4) Excentricity of inner conductor with respect to the outer conductor max. 0.4 mm.

5) Non-metallic circular air duct, inner diameter 13 mm.

OUTPUT COUPLING

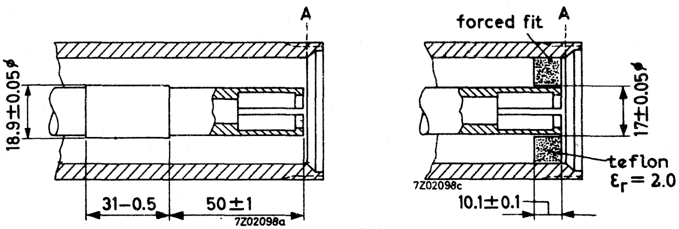
The tube may be coupled by suitable means to a coaxial line or waveguide, either directly or through a fixed reflection element.

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).



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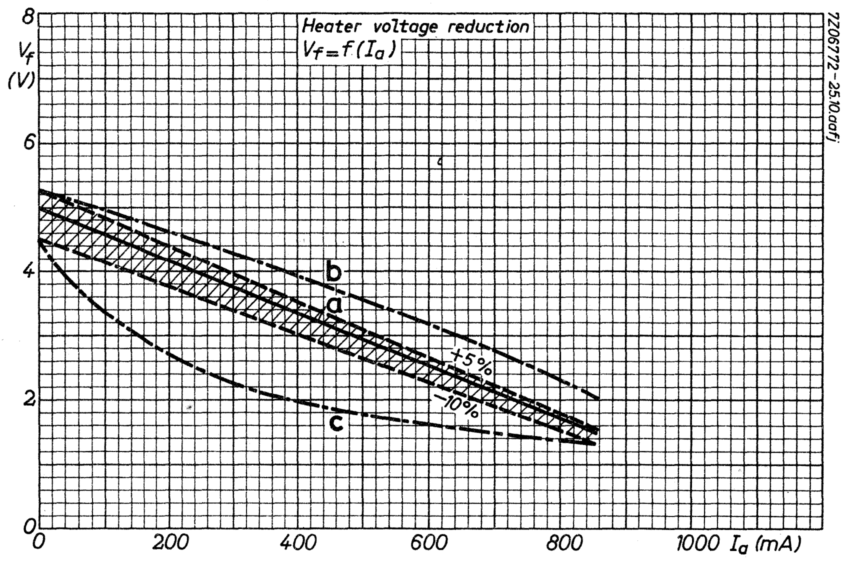
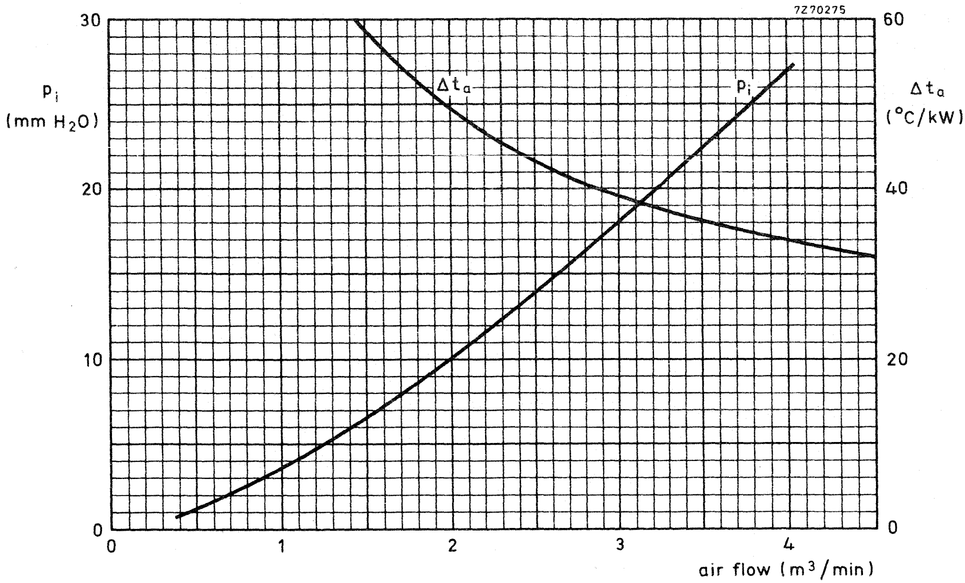
1) The inner conductor must be movable to accept the tolerances of the tube.

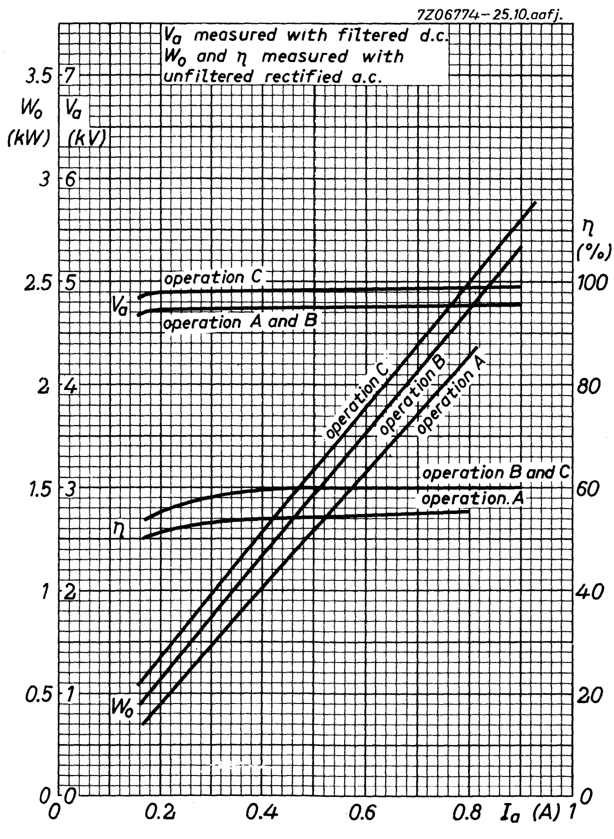
2) 6 Slots 0.2 mm; the wall segments should be deburred and be pressed together after slotting.

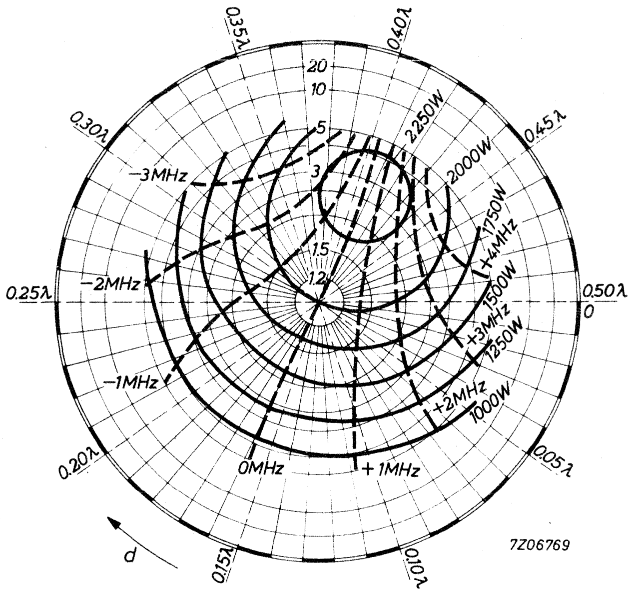
3) Not supplied by tube manufacturer.


Heater voltage reduction
$V_f = f(I_a)$
7Z06772-25.10.aafj
V_f
(V)
8
6
4
2
0
0
200
400
600
800
1000 I_a (mA)
b
a
c
+5%
-10%


7Z70275
30
20
10
0
60
40
20
0
p_i
(mm H_2O)
Δt_a
(°C/kW)
Δt_a
p_i
0
1
2
3
4
air flow (m^3/min)

Performance chart

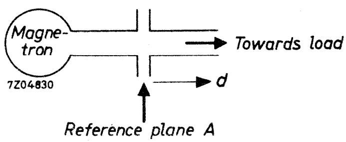


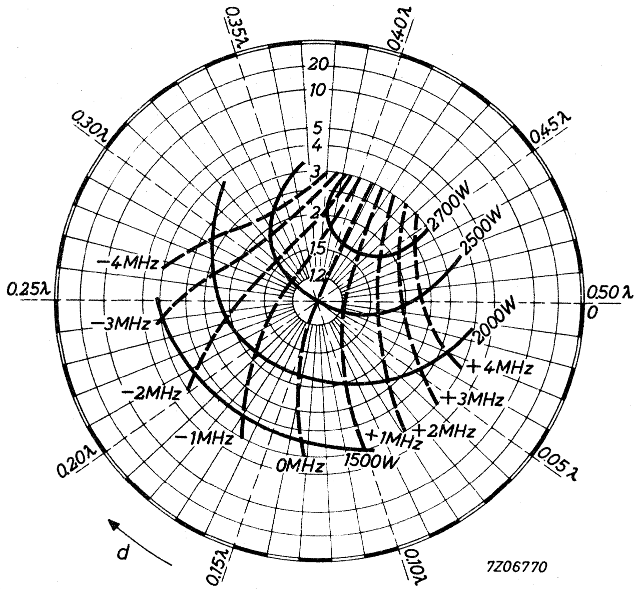


Load diagram Operation A
Mean anode current 0.75A
Peak anode current 2A

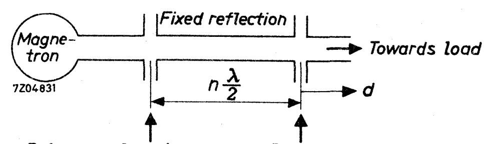
d = distance of standing wave minimum from reference plane A towards load

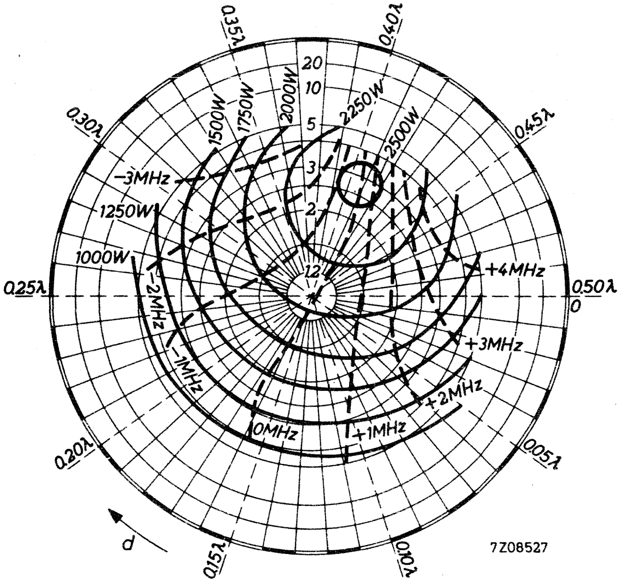
Temperature at reference point 95 °C





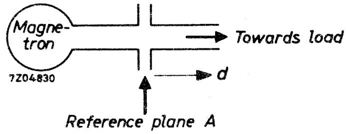
Load diagram Operation B
Mean anode current 0.85A
Peak anode current 2A
Fixed reflection VSWR = 1.5 d = 0.41λ
d = distance of standing wave minimum from reference plane B towards load
Temperature at reference point 95°C





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

QUICK REFERENCE DATA		
Frequency, fixed within the band	f	2,350 to 2,400 GHz
Output power	W_o	2,0 or 2,5 kW
Construction		packaged

The YJ1164 is equivalent to the YJ1160, except for the frequency band, being 2,350 to 2,400 GHz.

CONTINUOUS-WAVE MAGNETRON

Water-cooled continuous-wave magnetron with integral magnet intended for industrial microwave heating applications. The metal-ceramic tube features a quick heating cathode and a high efficiency.
Under typical operating conditions it can deliver an output power of 6 kW.

QUICK REFERENCE DATA			
Frequency, fixed within the band	f	2, 430 to 2, 470	GHz
Output power	W_o	6	kW
Construction	packaged, metal ceramic		
Cathode	quick heating		

TYPICAL OPERATION

Conditions

Filament voltage, starting	V_f	5, 5	V
Waiting time	T_W	45	s
Filament voltage, operating	V_f	1, 0	V
Anode supply	non-smoothed three-phase full-wave rect.		
Anode current, peak	I_{ap}	1, 5	A
mean [1])	I_a	1, 25	A
Load impedance			
Voltage standing wave ratio	VSWR	1, 5	
Phase, with respect to reference plane	d	0, 42 λ in direction of load	
Cooling	See pertinent paragraph		

Performance

Filament current at V_f = 1, 0 V	I_f	5	A
Anode voltage, mean [1])	V_a	7, 3	kV
Output power	W_o	6	kW
	W_o	> 5, 4	kW
Efficiency	η	65	%

For other load impedance and anode current conditions see pages 12 and 13 and "Design and operating notes".

1) Measured with a moving coil instrument.

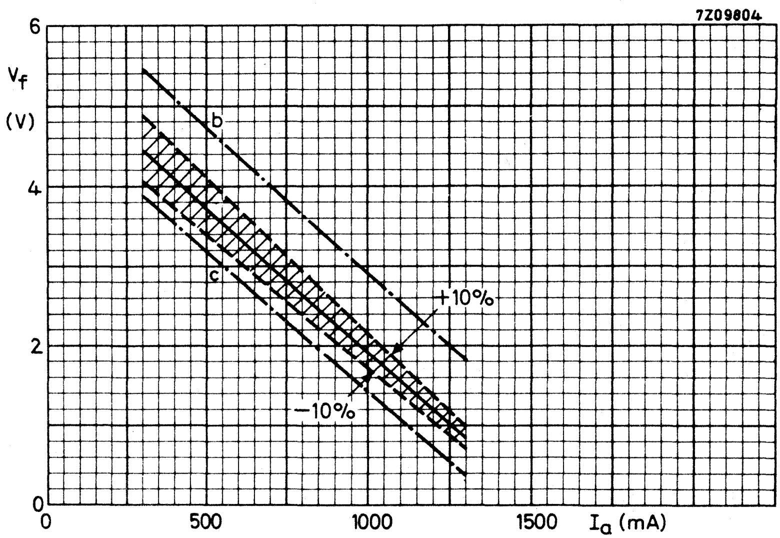
CATHODE : Thoriated tungsten

HEATING : direct by a.c. (50 Hz or 60 Hz) or d.c.

In case of d.c. the filament terminal (f) must have positive polarity.

Filament voltage, starting and stand-by	V_f	5,5	V ± 10%
operating at $I_{a\ mean}$ = 1,25 A	V_f	1,0	V ± 10%
Filament current at V_f = 5,5 V, I_a = 0	I_f	46 < 50	A A
at V_f = 1,0 V, $I_{a\ mean}$ = 1,25 A	I_f	5	A
Filament starting current, peak	I_{f_p} max.	120	A
Cold filament resistance	R_{f_o}	15	mΩ
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 to the operating value.
If it is intended to design the equipment for a variable output power, either continuously adjustable or stepwise, the filament voltage must be reduced as a function of the anode current (see graph below). The reduced filament voltage may be set to a value within the area bordered by the lines b and c, but for longest life it should be within the hatched area. In no circumstances should the filament voltage reach a value outside the limits given by the lines b and c.



Filament voltage reduction curve.

TYPICAL CHARACTERISTICS measured under matched load conditions (VSWR ≤ 1,05) and non-smoothed rectified three-phase full-wave supply.

Frequency, fixed within the band	f		2,430 to 2,470	GHz
Anode voltage, mean [1]	V_a		7,2	kV
Anode current, mean [1]	I_a		1,25	A
Output power	W_o		5,5	kW

LIMITING VALUES (Absolute max. rating system)

Filament voltage, starting	V_f	max.	6,05	V
		min.	4,95	V
operating (I_a mean = 1,25 A)	V_f	max.	2,00	V
see also under "Heating"		min.	0,50	V
Filament starting current, peak	I_{f_p}	max.	120	A
Waiting time	T_w	min.	30	s
Anode current, mean [1]	I_a	max.	1,3	A
		min.	0,3	A
peak	I_{ap}	max.	1,7	A
Anode input power	W_{ia}	max.	9,6	kW
Temperature at reference point, closed cooling circuit	t_a	max.	85	°C
open cooling circuit	t_a	max.	70	°C
Temperature of filament terminals	t	max.	180	°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	VSWR	max.	2,5	

1) Measured with a moving coil instrument.

COOLING

Anode block	water
Minimum required quantity of water and pressure drop	see cooling curves
Filament structure	airflow; see temperature limits under "Limiting values"
R.F. output system	airflow of min. 0,1 m^3/min at room temperature

With only the filament voltage applied some water and air cooling is required to keep the temperature below the limiting values.

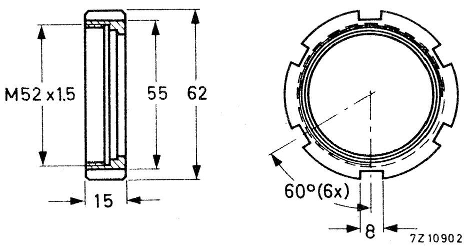
To safeguard the magnetron against overheating if the anode cooling fails, provision is made for mounting a thermoswitch. This switch should operate at a mounting disc temperature of 70 °C for an open and 85 °C for a closed water cooling circuit.

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.

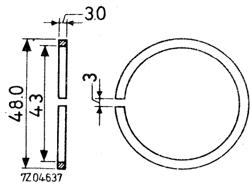
ACCESSORIES

Cap nut for output coupling	type 55312
Spring ring	type 55313
Soft copper washer, supplied with tube	type 55328
Cap nut	type TE1051b
Hose nipple	type TE1051c

Dimensions in mm



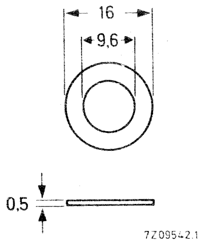
Cap nut type 55312



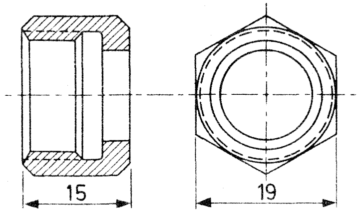
Spring ring type 55313

ACCESSORIES (continued)

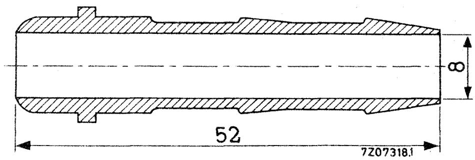
Dimensions in mm



Washer type 55328



Cap nut type TE1051b (thread 3/8" gas)



9 mm Hose nipple type TE1051c

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 electrical and mechanical parameters will vary around the nominal values.

Anode supply

The magnetron should be operated from a non-smoothed rectified three-phase full-wave supply unit. This unit should be so designed that no limiting value for the mean and peak anode currents is exceeded, wahtever 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 anode is earthed and the cathode will be at high negative potential with respect to the anode.
The transformer should be so designed that the filament voltage and the peak filament starting current limits are not exceeded.

Integral filament and filament/cathode connectors

The magnetron should not be operated without its connectors.
For stress relieve of the terminals, the connector leads should be flexible.

If temporary removal of the connectors cannot be avoided, ensure that they are refitted exactly in their original positions.

Load impedance

Optimum output power and life are 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, 42 λ from the reference plane for electrical measurements (see outline drawing) in the direction of the load.

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 disc around the cathode structure. (See also under "Mounting").

Tube cleanness

The ceramic parts of the cathode and output structure of the tube must be kept clean during operation.
The cooling air should be ducted and filtered to prevent deposits forming on the insulation.

STORAGE, HANDLING AND MOUNTING

Storage and handling

The original pack should be used for transporting and storing the tube.
Shipment of the tube mounted in the equipment is only permitted if specifically authorized by the 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 13 cm is maintained between the tubes. As the thoriated tungsten filament is sensitive to shocks and vibration, care should be taken when handling unpacked tubes that undue shocks and vibrations 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 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 precision instruments nearby.

Mounting

When magnetic materials are present in two or more planes, their minimum distance from the magnet shall be 13 cm in all directions.

All tools (screw-drivers, 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 circuit of the magnetic flux.

The output coupling of the tube should not be used as the only means of mounting.
The simplest way of mounting the magnetron in position is to replace the two original M6x8 screws (through the bottom cover) by screws which are long enough to hold both the bottom cover of the magnetron and the mounting plate of the equipment.
The power supply lead to the anode should be connected to the anode terminal (see outline drawing) or to one of the mounting screws.

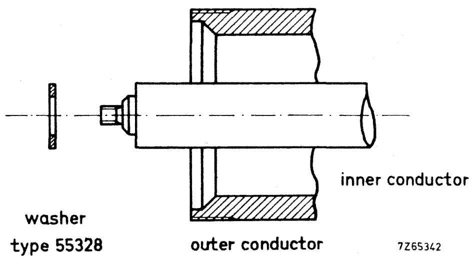
The mounting disc for the filter box is provided with 6 holes to receive M3x6 screws.

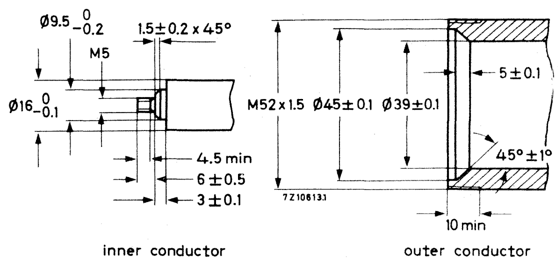
Operational checks

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 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. With the non-smoothed rectified three-phase full-wave power supply the V_a/I_a characteristic should be a fairly straight line. The appearance of a second line or parts thereof distinctly above the first line indicates "moding" (undesired modes of oscillation) that can rapidly damage 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.

OUTPUT COUPLING

The output system of the magnetron must be coupled via a 16/39 coaxial line transition (characteristic impedance 53,4 Ω see drawing below) [1] [2] to the load system.

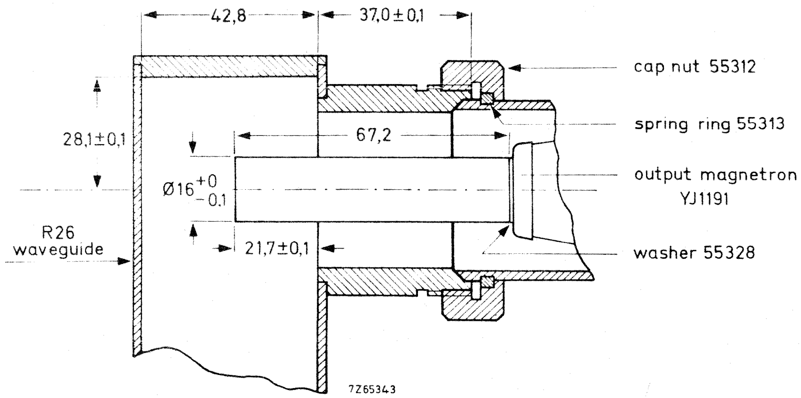




1) The inner conductor should be able to accept the tolerances of the magnetron output system (see outline drawing) and thermal expansion.

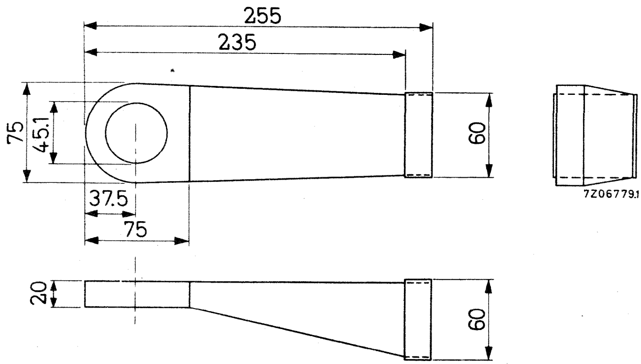
2) The soft copper washer type 55328 shall be used between the inner conductor and the magnetron output system.
When screwing the inner conductor into the magnetron output system the maximum permissible torque is 1,5 Nm (15 kgcm).

An example of the coupling of the tube via this coaxial line transition to an R26 waveguide is shown below:



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 via outlet holes

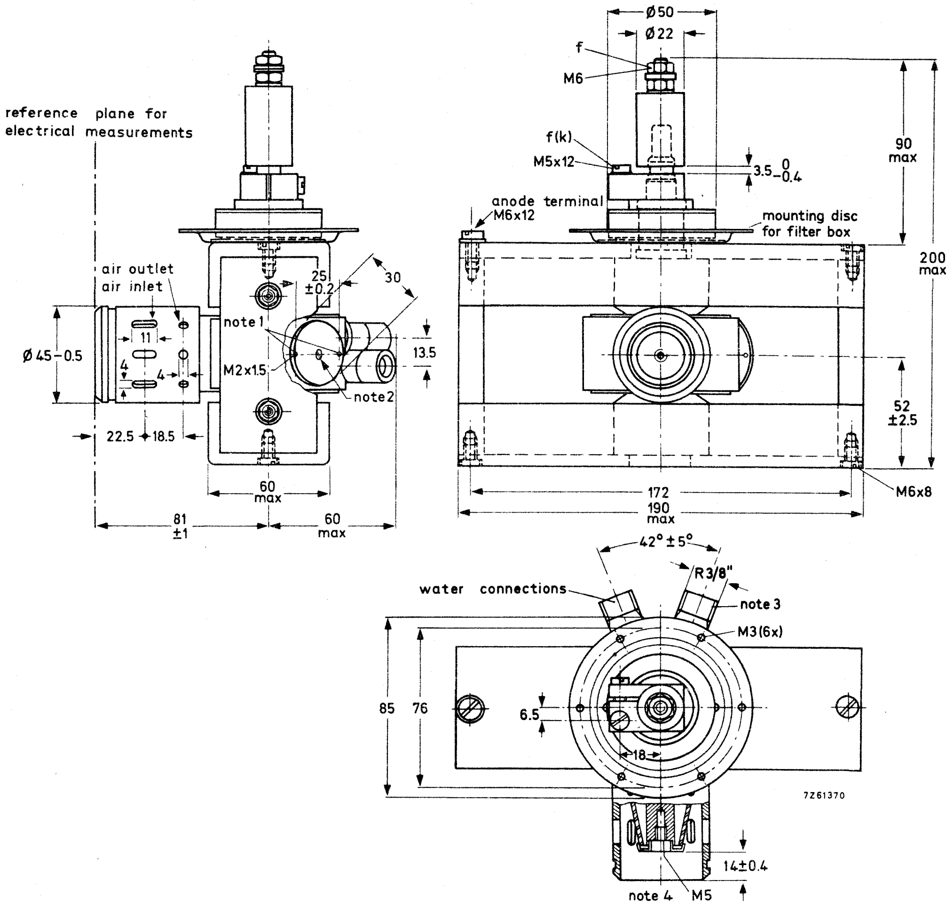
About 30 mm H_2O if air can also escape towards the load through coaxial line.

3) Not supplied by the manufacturer.

MECHANICAL DATA Dimensions in mm

→ Mounting position: any

Weight : approx. 4 kg

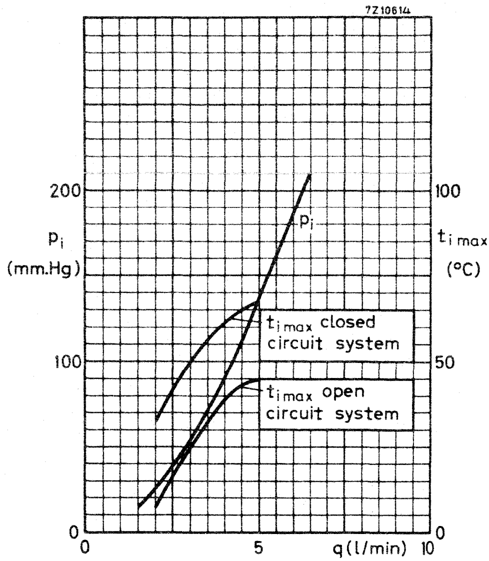


1) Two M2 screws for mounting a thermoswitch are supplied with the magnetron.

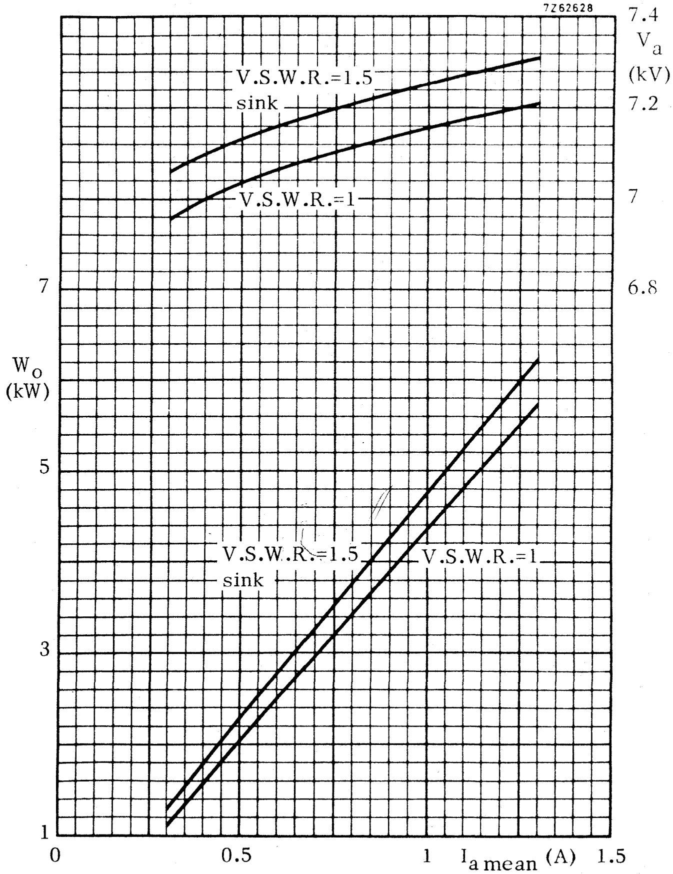
2) Plate for mounting a thermoswitch; temperature reference point.

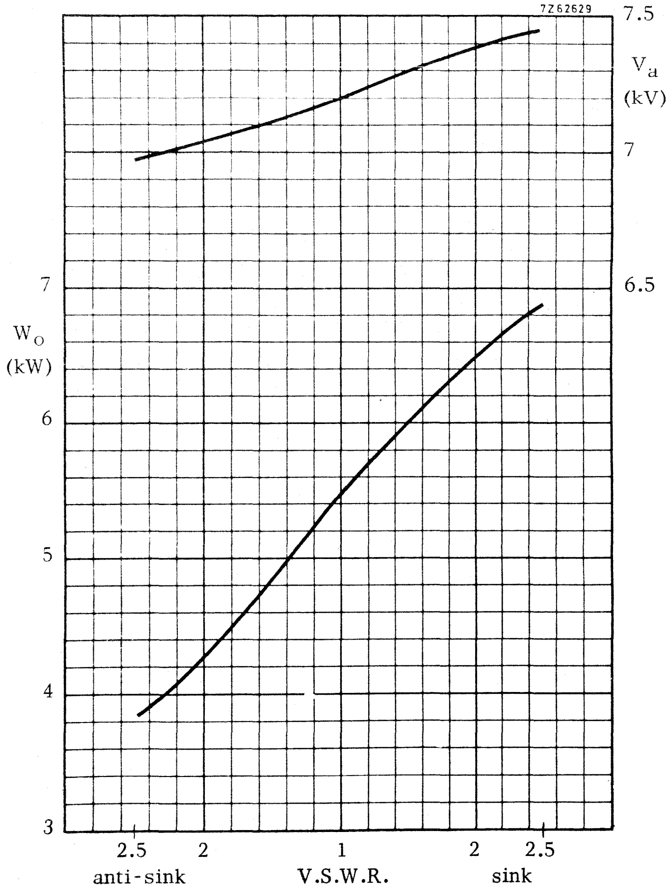
3) To be connected to hose nipple type TE1051c (DIN 44415) for 9 mm hose with cap nut type TE1051b (CR3/8 in DIN 8542 Ms).

4) Eccentricity of inner conductor with respect to outer conductor max. 0,4 mm.

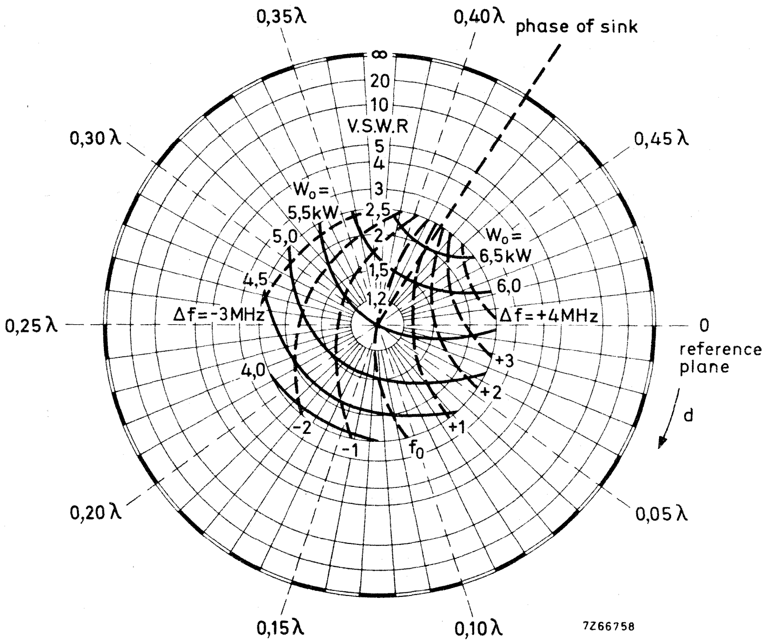


Minimum required quantity of water q, and pressure drop p_i as a function of water inlet temperature t_i . Water supplied via hose nipple TE1051c.
When additional information is required please contact the manufacturer.


7Z62628
7.4
V_a
(kV)
7.2
7
6.8
V.S.W.R.=1.5
sink
V.S.W.R.=1
7
W_o
(kW)
5
3
1
V.S.W.R.=1.5
sink
V.S.W.R.=1
0
0.5
1
$I_{a\,mean}$ (A)
1.5



V_f = 1,0 V
$I_{a_{mean}}$ = 1250 mA



Load diagram

Anode supply	non-smoothed three-phase full-wave rectified
Filament voltage	1 V
Anode current, mean	1, 25 A
Anode current, peak	1, 5 A
Constant cooling	

d = distance of standing wave minimum from reference plane towards load

CONTINUOUS-WAVE MAGNETRON

QUICK REFERENCE DATA		
Frequency, fixed within the band	f	2,350 to 2,400 GHz
Output power	W_o	6 kW
Construction		packaged

The YJ1192 is equivalent to the YJ1191, except for the frequency band, being 2,350 to 2,400 GHz.

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				

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	°C
Temperature at any other point on the tube	t	max.	200	°C

1) Measured under matched load conditions. (V.S.W.R. ≤ 1.05)
2) Measured with a moving coil instrument.
3) Measured on a filtered anode voltage supply (I_{ap} ≤ 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 — any

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

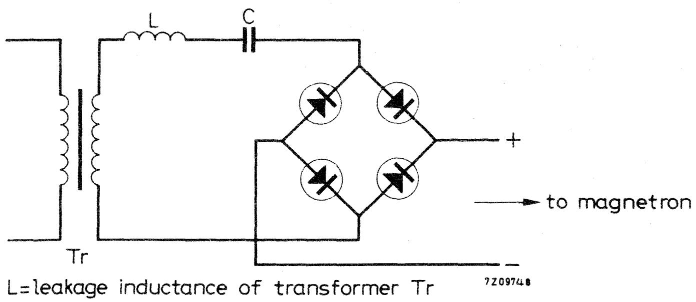
DESIGN AND OPERATING NOTES

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

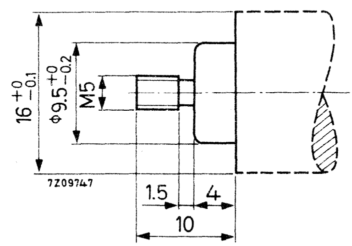
The magnetron has a high filament current and losses in filament voltage caused by bad connections, will result in poor operation. Therefore, it is important to ensure that the filament and filament/cathode connectors make good electrical and thermal contact with their respective terminals.
The connectors, 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

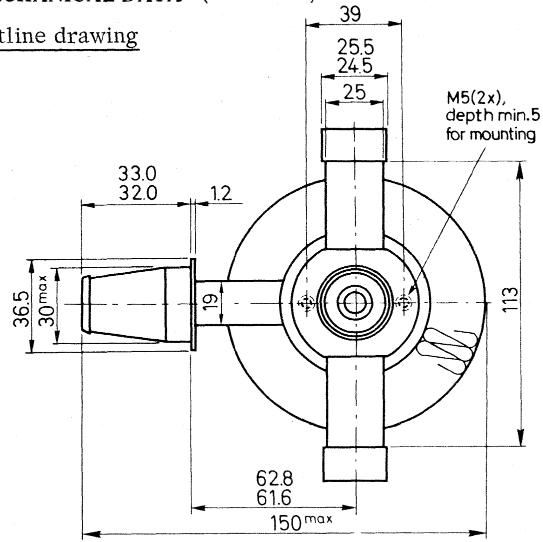
When magnetic materials are present in two or more planes, the minimum distance from the magnet shall be 13 cm in all directions.

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).

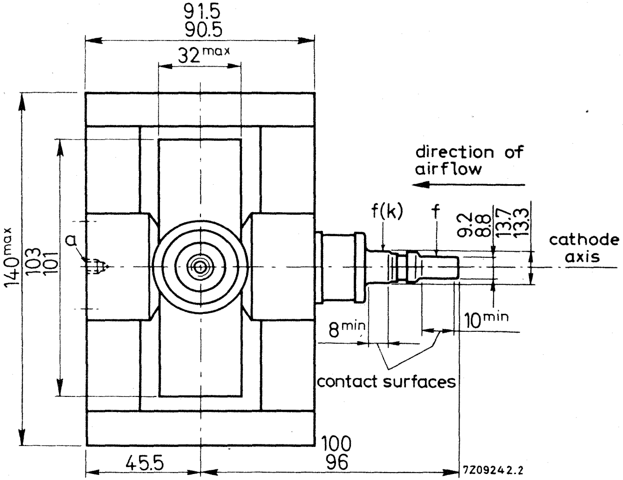
MECHANICAL DATA (continued)

Dimensions in mm

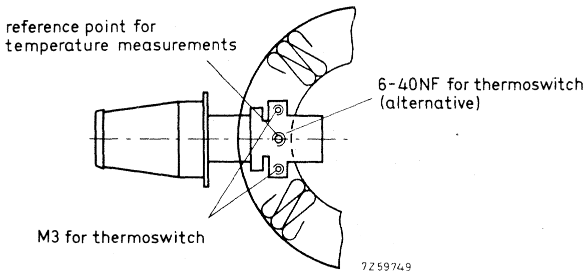
Outline drawing



top view



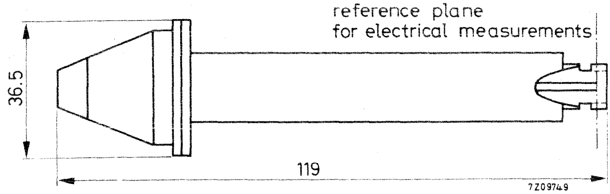
side view



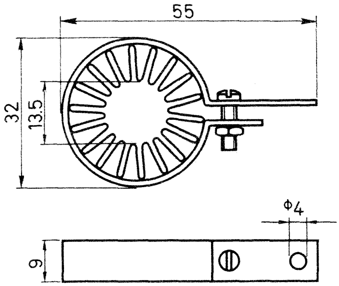
part of bottom view

ACCESSORIES

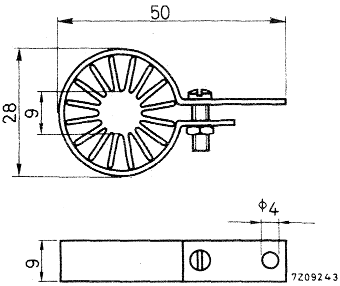
Dimensions in mm



Measuring probe 55336



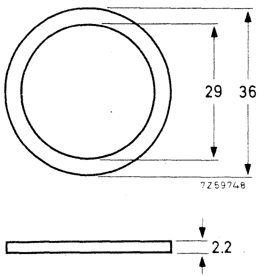
cathode/filament connector

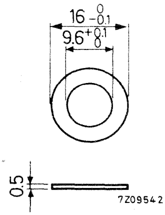


filament connector

Filament/cathode connector 55324

Filament connector 55323





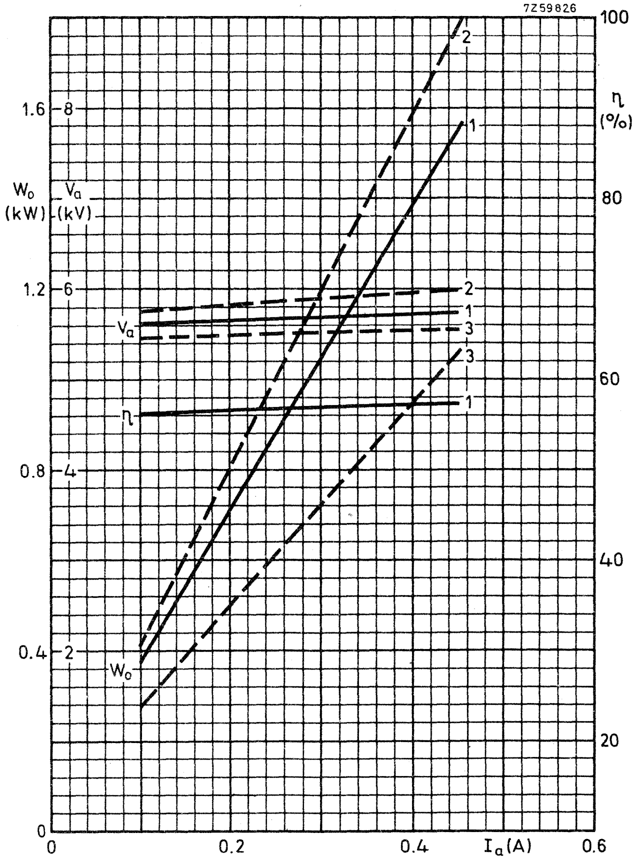
washer 55328

Material : monel mesh

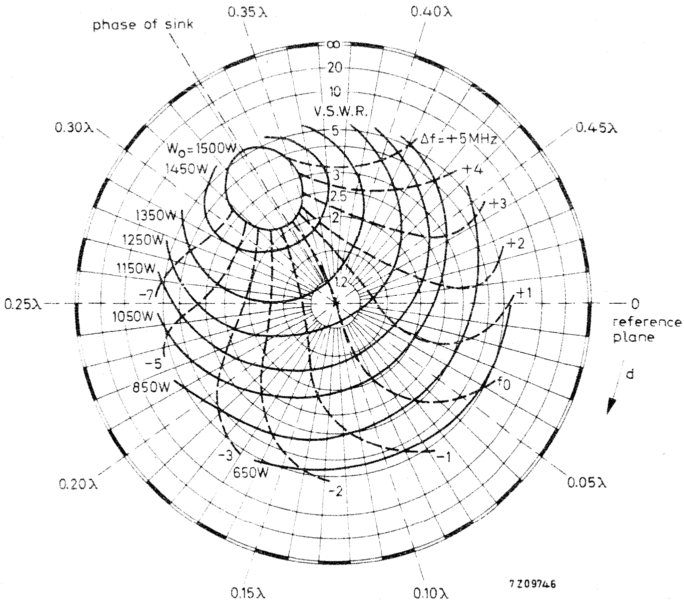
R. F. gasket 55341

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

Integral-magnet, forced-air cooled continuous-wave magnetron intended for microwave heating applications. The tube features a quick heating cathode, a high efficiency and, with an L-C stabilized power supply, the output is 2,5 kW.

QUICK REFERENCE DATA			
Frequency, fixed within the band	f	2,425 to 2,475	GHz
Output power	W_o	2,5	kW
Construction	packaged, metal-ceramic		
Cathode	quick heating		

TYPICAL OPERATION with the tube coupled to an R26 waveguide according to Fig.1.

Conditions

Filament voltage, starting	V_f	5,0	V
Waiting time	T_w	7	s
Filament voltage, operating	V_f	3,5	V
Anode supply		L-C stabilized	1)
Load impedance, measured with probe 55345			
Voltage standing wave ratio	VSWR	2,5	
Phase, in direction of load, with respect to reference plane	d	0,13 λ	
Cooling; rate of flow	q	min. 2,5	m^3/min 2)
		see also pertinent paragraph	

Performance

Filament current at V_f = 3,5 V	I_f	27	A
Anode voltage, peak	V_{a_p}	5,7	kV
Anode current, mean	I_a	680	mA
Output power	W_o	2,5	kW
	W_o	min. 2,25	kW
Efficiency	η	69	%

For other load impedance and anode current conditions see page 8 and "Design and operating notes"

1) See "Design and operating notes".
2) Based on a cooling air inlet temperature t_i = max. 40 °C

Data based on pre-production tubes.

CATHODE : Thoriated tungsten

HEATING : direct by a.c. (50 Hz or 60 Hz) or d.c.

In case of d.c. the terminal f(k) must have positive polarity.

Filament voltage, starting and stand-by	V_f		5,0	V ± 10%
operating at $I_{a\,mean}$ = 700 mA	V_f		3,5	V ± 10%
Filament current at V_f = 5,0 V, I_a = 0	I_f		43	A
			< 46	A
at V_f = 3,5 V, I_a = 700 mA	I_f		27	A
Filament current, peak starting	I_{f_p}	max.	150	A
Cold filament resistance	R_{f_o}		13	mΩ
Waiting time (time before application of high voltage)	T_w	min.	6	s

TYPICAL CHARACTERISTICS measured under matched load conditions (VSWR ≤ 1,05) and L-C stabilized power supply. (See "Design and operating notes").

Frequency, fixed within the band	f	2,425 to 2,475	GHz
Anode voltage, peak	V_{a_p}	5,5	kV
Anode current, mean	I_a	700	mA
Output power	W_o	2,2	kW

LIMITING VALUES (Absolute max. rating system)

Filament voltage, starting	V_f	max.	5,5	V
		min.	4,5	V
operating ($I_{a\,mean}$ = 700 mA)	V_f	max.	3,85	V
		min.	3,15	V
Filament current, peak starting	I_{f_p}	max.	150	A
Waiting time	T_w	min.	6	s
Anode current, mean	I_a	max.	750	mA
		min.	200	mA
peak at $I_{a\,mean}$ = 750 mA	I_{a_p}	max.	1250	mA
Anode voltage	V_a	max.	10	kV [1]
Temperature at any point on the tube	t	max.	170	°C
Voltage standing wave ratio, measured with probe 55345,				
continuous	VSWR	max.	5	
during max, 0,02 s and max. 20% of the time [2]	VSWR	max.	10	

[1]) It is recommended that a suitable spark gap be connected between the filament/cathode terminal and the anode (earth) to prevent the max. anode voltage being exceeded.

[2]) This means: Any period of time up to 0,02 s during which the VSWR is between 5 and 10 must be followed by a period four times as long during which the VSWR is ≤ 5. When operating under these conditions the magnetron should not be permitted to mode.

COOLING

Anode block and filament structure — forced air

For pressure drop as a function of rate of flow see page 10

The cooling air must be so ducted that it is uniformly distributed.

All leakage must be avoided. Direction of airflow: see outline drawing.

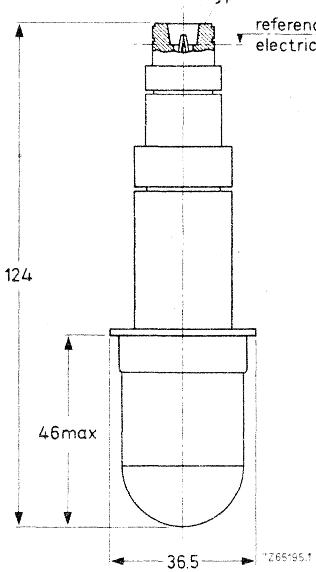
With only the filament voltage applied some air cooling is required to keep the temperature below the limiting value.

The magnetron is provided with a normally closed thermoswitch to protect the tube against overheating. The thermoswitch is rated 250 V a.c., 10 A.

ACCESSORIES

Thermoswitch; mounted on tube	type 55347
R.F. gasket; supplied with tube	type 55344
Measuring probe (for measurements only)	type 55345

Dimensions in mm



Measuring probe 55345

MECHANICAL DATA

Mounting position : any

Net weight : approx. 1,8 kg

MECHANICAL DATA

Dimensions in mm

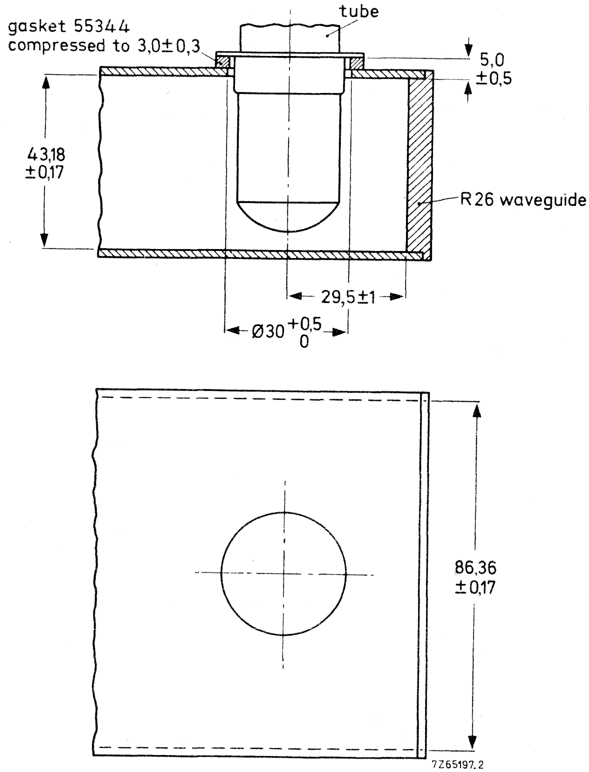


Fig. 1 Launching section

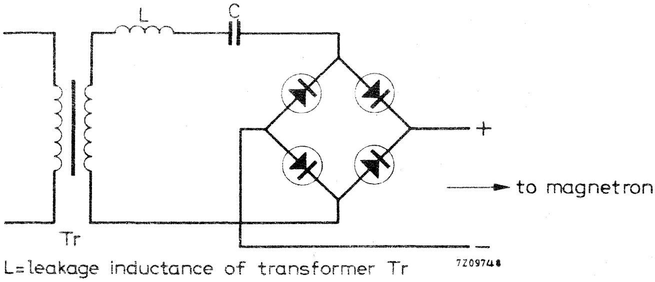
DESIGN AND OPERATING NOTES

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, R_{fo}, f, W_o etc.) will vary around the nominal values.

Anode supply

The magnetron should be operated from an L-C stabilized anode supply unit. The circuit should be so designed that for a nominal magnetron at matched load : V_{ap} = 5,5 kV, $I_{a\ mean}$ = 700 mA, I_{ap} = 1100 mA. Detailed information on power supply design available on request.



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 during normal magnetron operation the anode is earthed and the cathode will be at a high negative potential with respect to the anode.
The transformer should be so designed that the filament voltage and peak filament starting current limits are not exceeded.

Filament and filament/cathode connections

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 leads make good electrical and thermal contact with the tube terminals.

To relieve these terminals from undue stress, the leads should be flexible.

Load impedance, measured with measuring probe

The probe 55345 simulates the R.F. output system of the magnetron ; it may be coupled to an R26 waveguide to replace the magnetron ; in all cases the type 55344 gasket should be used. The termination of the probe matches a standard N-type connector.
This measuring probe enables the designer of microwave heating equipment to determine the value of the load impedance (VSWR and phase of reflection), using standard cold measuring techniques, and to arrive at the correct coupling for the magnetron.

Shielding

Where required, R.F. radiation from the filament terminals may be reduced by external filtering and/or shielding.

Tube cleanness

The ceramic parts of the input and output structure of the tube must be kept clean during installation and operation.
The cooling air should be filtered to prevent deposists forming on the insulation during operation.

STORAGE, HANDLING AND MOUNTING

Storage and handling

The original pack should be used for transporting the tube.
Shipment of the tube mounted in the equipment is permitted if specifically authorized by the manufacturer.
When the tubes have to be unpacked, e.g. at an assembling line or for measurement purposes, care should be taken that a minimum distance of 13 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.

As high intensity magnetic fields associated with transformers and other magnetic equipment can demagnetize the magnets, they should not be present.

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 precision instruments nearby.

Mounting

The magnetron should be mounted with two M4 bolts fitting the nuts on the mounting bracket (see outline drawing).

The output coupling should not be used as the only means of mounting and be kept free from undue stress.

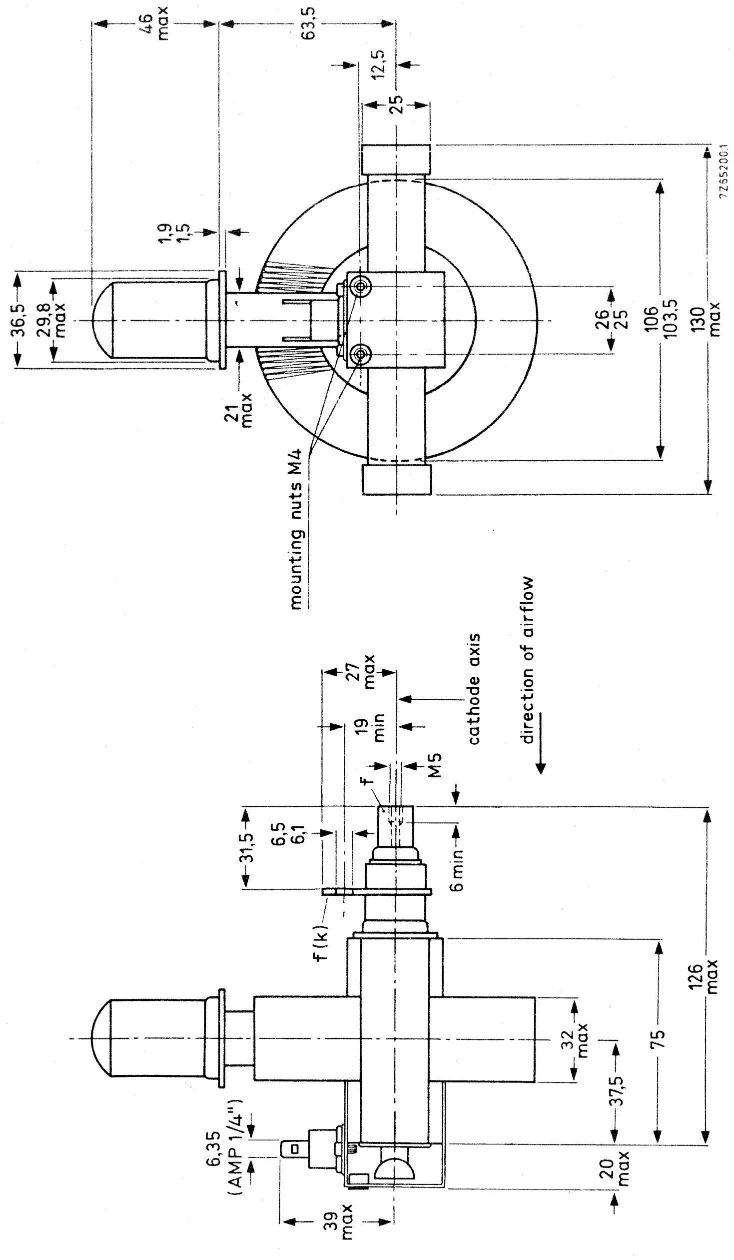
The min. distance between the magnetron and magnetized materials shall be 13 cm. The min. distance between the magnetron and other ferromagnetic materials shall be 3 cm.

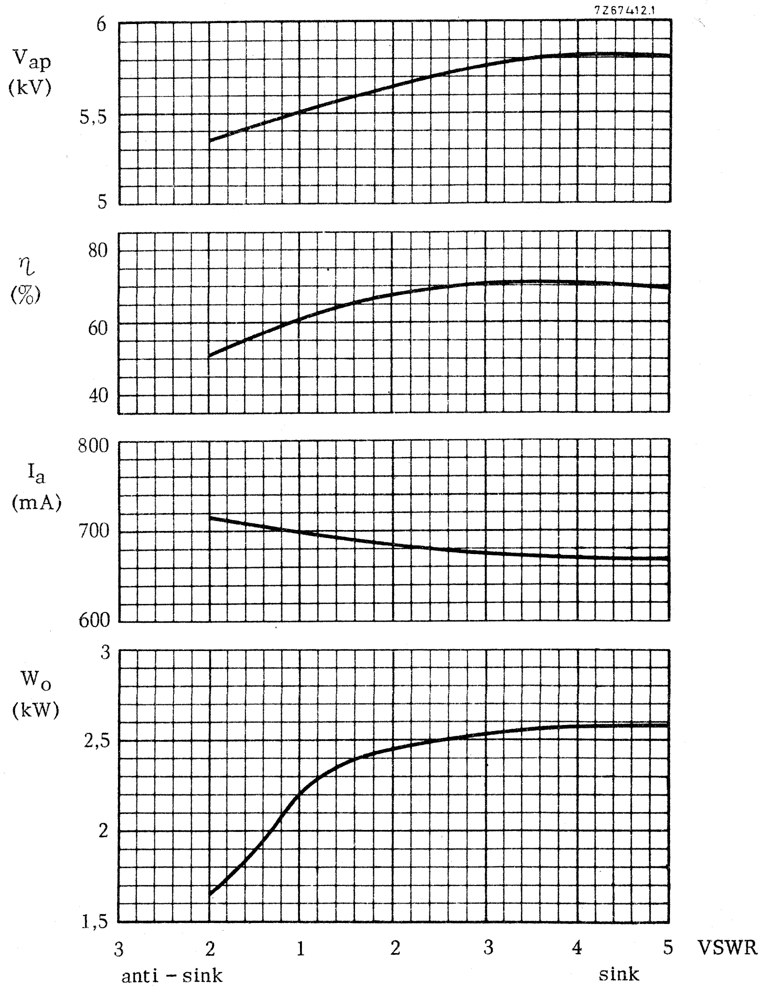
The gasket 55344 is essential to ensure good R.F. contact between the output of the magnetron and the waveguide to which it is connected.

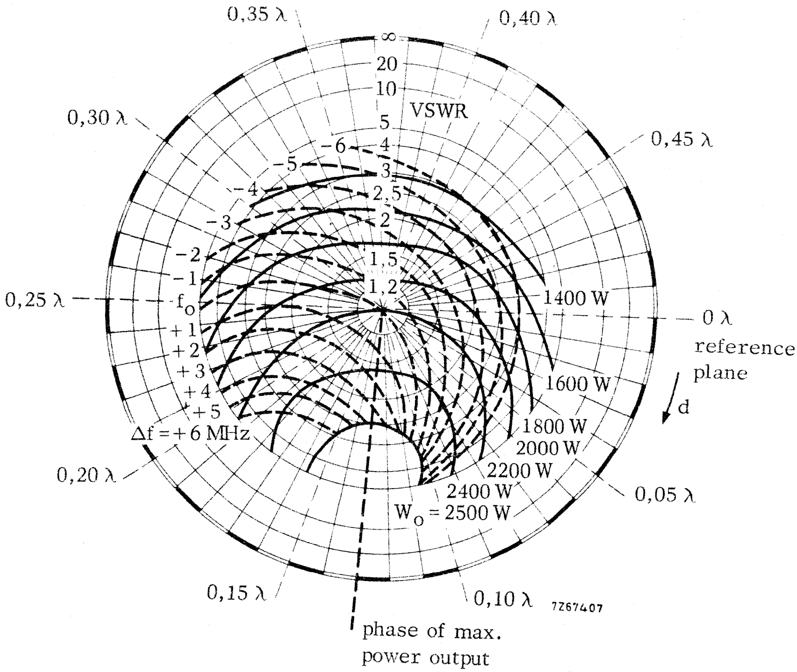
All tools (screwdrivers, wrenches etc.) used close to or in contact with the magnetron must be of non-magnetic material to avoid unwanted attraction and possible mechanical damage to ceramic parts as well as short circuit of the magnetic flux.

The magnetron earth connection can be made via the mounting nuts (see outline drawing).

MECHANICAL DATA Dimensions in mm

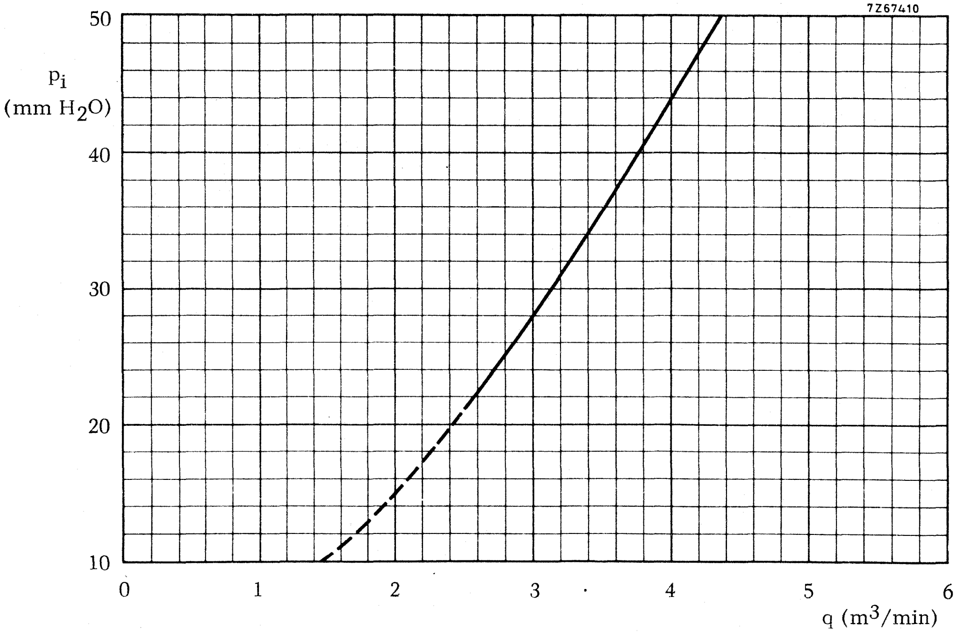



7Z67412.1
Vap
(kV)
6
5,5
5
η
(%)
80
60
40
Ia
(mA)
800
700
600
Wo
(kW)
3
2,5
2
1,5
3
2
1
2
3
4
5
VSWR
anti – sink
sink



Load diagram

Measured with an L-C stabilized power supply
Mean anode current I_a = 700 mA at matched load
Frequency f_o = 2,450 GHz
Constant air cooling q = 2,5 m^3/min
d = Distance of voltage standing wave minimum from the reference plane for electrical measurements (measuring probe 55345) towards load


7Z67410
p_i
(mm H_2O)
50
40
30
20
10
0
1
2
3
4
5
6
q (m^3/min)

CONTINUOUS-WAVE MAGNETRON

Integral-magnet, forced-air cooled continuous-wave magnetron intended for microwave heating applications. The tube features a quick heating cathode, a high efficiency and , with an L-C stabilized power supply, the output is 1,5 kW.

QUICK REFERENCE DATA			
Frequency fixed within the band	f	2,425 to 2,475	GHz
Output power	W_o	1,55	kW
Construction	packaged, metal-ceramic		
Cathode	quick heating		

TYPICAL OPERATION with the tube coupled to an R26 waveguide according to Fig.1.

Conditions

Filament voltage, starting	V_f		5,0	V	
Waiting time	T_w		7	s	
Filament voltage, operating	V_f		3,5	V	
Anode supply			L-C stabilized		1)
Load impedance, measured with probe 55345					
Voltage standing wave ratio	VSWR		2,5		
Phase, in direction of load, with respect to reference plane	d		0,13 λ		
Cooling; rate of flow	q	min.	2	m^3/min	2)
		see also pertinent paragraph			

Performance

Filament current at V_f = 3,5 V	I_f		18	A
Anode voltage, peak	V_{a_p}		6	kV
Anode current, mean	I_a		370	mA
Output power	W_o		1,55	kW
	W_o	min.	1,4	kW
Efficiency	η		70	%

For other load impedance and anode current conditions see page 8 and "Design and operating notes".

1) See "Design and operating notes"
2) Based on a cooling air inlet temperature t_i = max. 50 °C.
Data based on pre-production tubes.

CATHODE : Thoriated tungsten

HEATING : direct by a.c. (50 Hz or 60 Hz) or d.c.

In case of d.c. the terminal f(k) must have positive polarity.

Filament voltage, starting and stand-by	V_f		5,0	V ± 10%
operating at $I_{a\,mean}$ = 370 mA	V_f		3,5	V ± 10%
Filament current at V_f = 5,0 V, I_a = 0	I_f		26	A
			< 29	A
at V_f = 3,5 V, I_a = 370 mA	I_f		18	A
Filament current, peak starting	I_{f_p}	max.	100	A
Cold filament resistance	R_{f_o}		20	mΩ
Waiting time (time before application of high voltage)	T_w	min.	6	s

TYPICAL CHARACTERISTICS measured under matched load conditions (VSWR ≤ 1,05) and L-C stabilized power supply. (See "Design and operating notes")

Frequency, fixed within the band	f	2,425 to 2,475	GHz
Anode voltage, peak	V_{a_p}	5,9	kV
Anode current, mean	I_a	370	mA
Output power	W_o	1,35	kW

LIMITING VALUES (Absolute max. rating system)

Filament voltage, starting	V_f	max.	5,5	V
		min.	4,5	V
operating ($I_{a\,mean}$ = 370 mA)	V_f	max.	3,85	V
		min.	3,15	V
Filament current, peak starting	I_{f_p}	max.	100	A
Waiting time	T_w	min.	6	s
Anode current, mean	I_a	max.	400	mA
		min.	100	mA
peak at $I_{a\,mean}$ = 400 mA	I_{a_p}	max.	700	mA
Anode voltage	V_a	max.	10	kV [1]
Temperature at any point on the tube	t	max.	170	°C
Voltage standing wave ratio, measured with probe 55345				
continuous	VSWR	max.	5,5	
during max. 0,02 s and max. 20 % of the time [2]	VSWR	max.	10	

[1] It is recommended that a suitable spark gap be connected between the filament/cathode terminal and the anode (earth) to prevent the max. anode voltage being exceeded.

[2] This means: Any period of time up to 0,02 s during which the VSWR is between 5,5 and 10 must be followed by a period four times as long during which the VSWR is ≤ 5,5. When operating under these conditions the magnetron should not be permitted to mode.

COOLING

Anode block and filament structure — forced air

For pressure drop as a function of rate of flow see page

The cooling air must be so ducted that it is uniformly distributed.
All leakage must be avoided. Direction of airflow: see outline drawing.

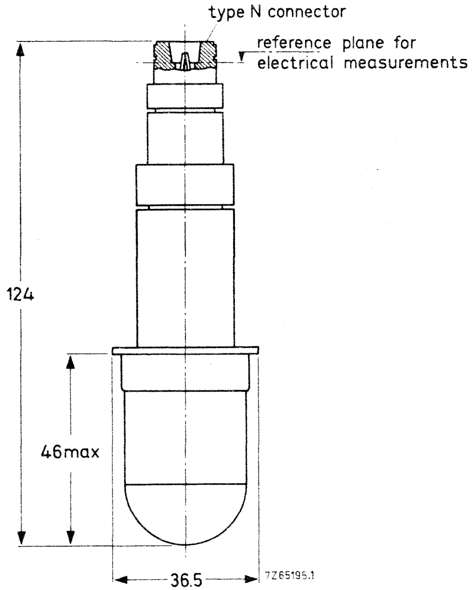
With only the filament voltage applied some air cooling is required to keep the temperature below the limiting value.

The magnetron is provided with a normally closed thermoswitch to protect the tube against overheating. The thermoswitch is rated 250 V a.c., 10 A.

ACCESSORIES

Thermoswitch, mounted on tube	type	55347
R.F. gasket; supplied with tube	type	55344
Measuring probe (for measurements only)	type	55345

Dimensions in mm



Measuring probe 55345

MECHANICAL DATA

Mounting position : any

Net weight : approx. 1,8 kg

MECHANICAL DATA Dimensions in mm

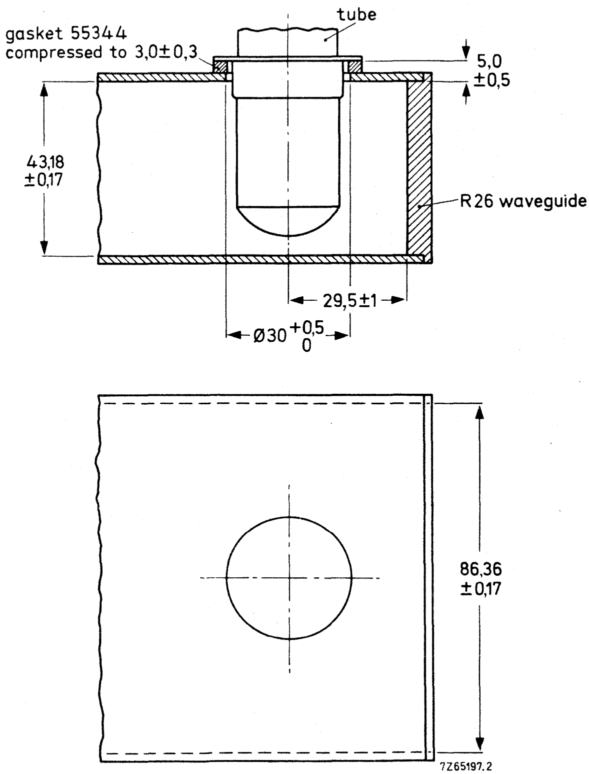


Fig. 1 Launching section

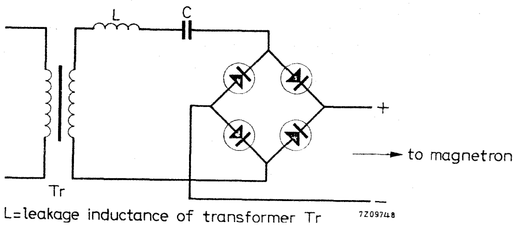
DESIGN AND OPERATING NOTES

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, R_{fo}, f, W_o etc.) will vary around the nominal values.

Anode supply

The magnetron should be operated from an L-C stabilized anode supply unit. The circuit should be so designed that for a nominal magnetron at matched load: V_{a_p} = 5,9 kV, I_a mean = 370 mA, I_{a_p} = 600 mA. Detailed information on power supply design available on request.



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 during normal magnetron operation the anode is earthed and the cathode will be at a high negative potential with respect to the anode.
The transformer should be so designed that the filament voltage and peak filament starting current limits are not exceeded.

Filament and filament/cathode connections

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 leads make good electrical and thermal contact with the tube terminals.

To relieve these terminals from undue stress, the leads should be flexible.

Load impedance, measured with measuring probe

The probe 55345 simulates the R.F. output system of the magnetron; it may be coupled to an R26 waveguide to replace the magnetron; in all cases the type 55344 gasket should be used. The termination of the probe matches a standard N-type connector.
This measuring probe enables the designer of the microwave heating equipment to determine the value of the load impedance (VSWR and phase of reflection), using standard cold measuring techniques, and to arrive at the correct coupling for the magnetron.

Shielding

Where required, R.F. radiation from the filament terminals may be reduced by external filtering and/or shielding.

Tube cleanness

The ceramic parts of the input and output structure of the tube must be kept clean during installation and operation.
The cooling air should be filtered to prevent deposists forming on the insulation during operation.

STORAGE, HANDLING AND MOUNTING

Storage and handling

The original pack should be used for transporting the tube.
Shipment of the tube mounted in the equipment is permitted if specifically authorized by the manufacturer.
When the tubes have to be unpacked, e.g. at an assembling line or for measurement purposes, care should be taken that a minimum distance of 13 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.

As high intensity magnetic fields associated with transformers and other magnetic equipment can demagnetize the magnets, they should not be present.

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 precision instruments nearby.

Mounting

The magnetron should be mounted with two M4 bolts fitting the nuts on the mounting bracket (see outline drawing).

The output coupling should not be used as the only means of mounting and be kept free from undue stress.

The min. distance between the magnetron and magnetized materials shall be 13 cm. The min. distance between the magnetron and other ferromagnetic materials shall be 3 cm.

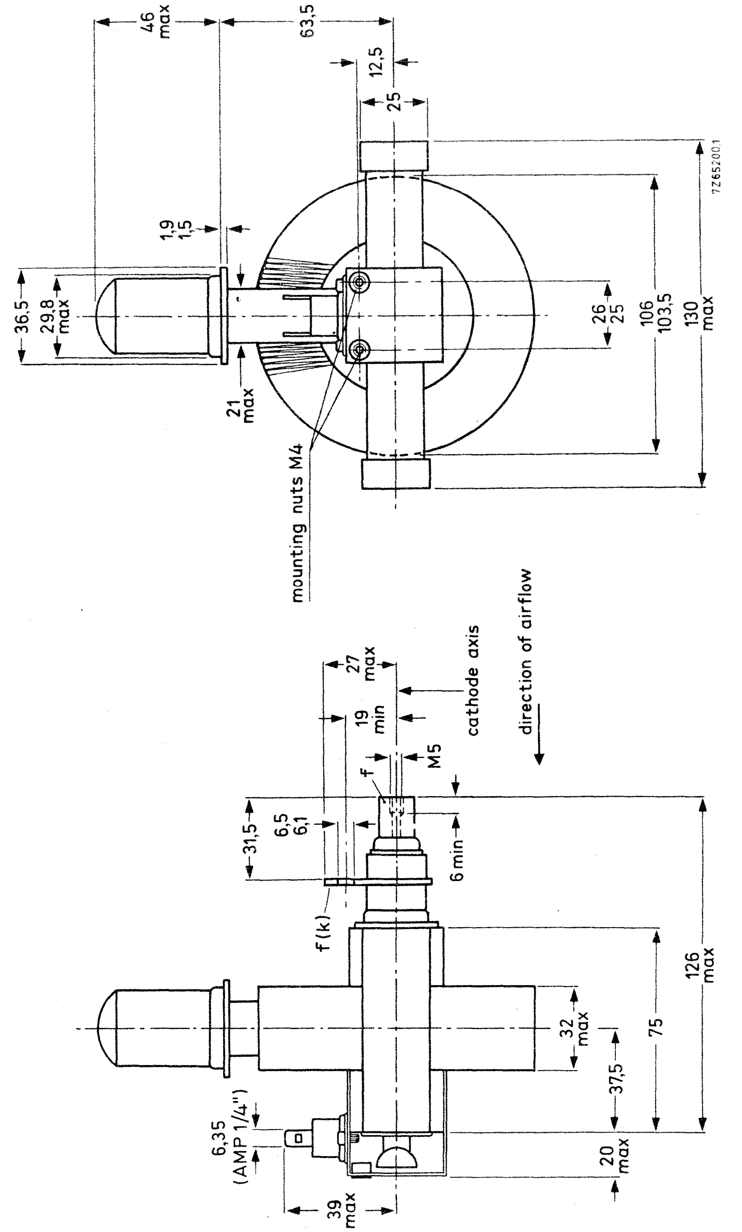
The gasket 55344 is essential to ensure good R.F. contact between the output of the magnetron and the waveguide to which it is connected.

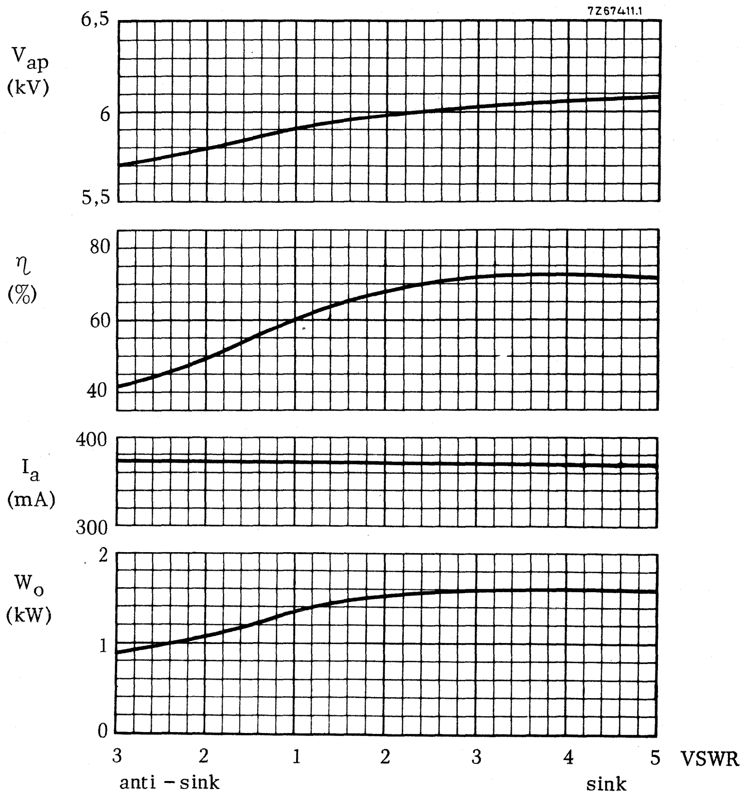
All tools (screwdrivers, wrenches etc.) used close to or in contact with the magnetron must be of non-magnetic material to avoid unwanted attraction and possible mechanical damage to ceramic parts as well as short circuit of the magnetic flux.

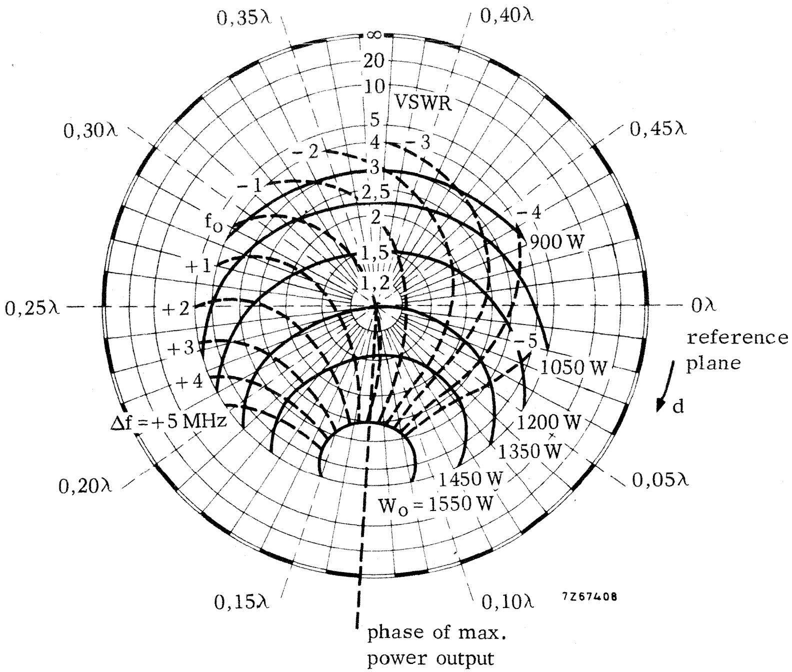
The magnetron earth connection can be made via the mounting nuts (see outline drawing).

MECHANICAL DATA

Dimensions in mm

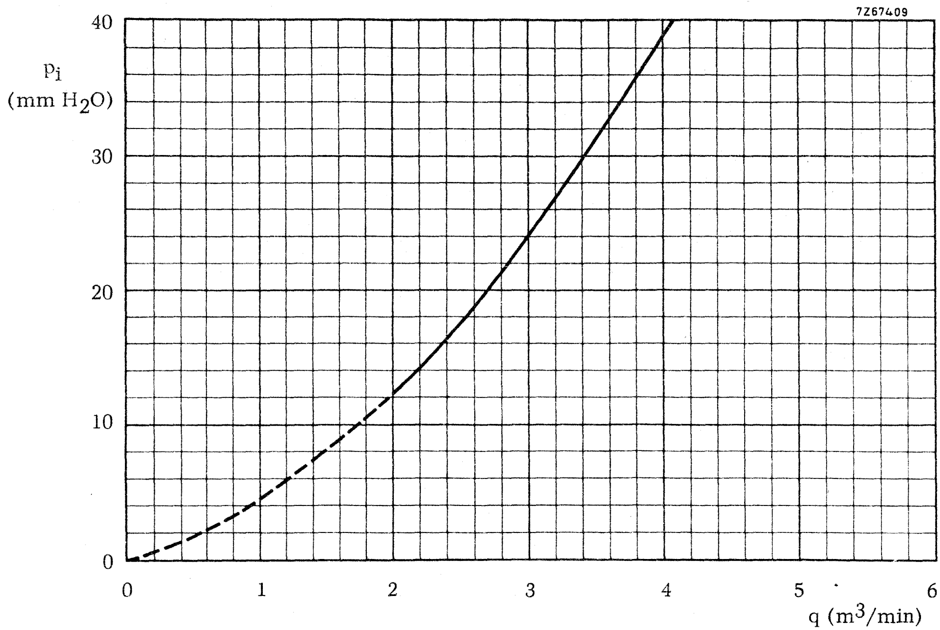



7Z67411.1
6,5
Vap
(kV)
6
5,5
80
η
(%)
60
40
400
Ia
(mA)
300
2
Wo
(kW)
1
0
3 2 1 2 3 4 5 VSWR
anti - sink
sink



Load diagram

Measured with an L-C stabilized power supply
Mean anode current I_a = 370 mA at matched load
Frequency f_o = 2, 450 GHz
Constant air cooling q = 2 m^3/min
d = Distance of voltage standing wave minimum from the reference plane for electrical measurements (measuring probe 55345) towards load


7Z67409
p_i
(mm H_2O)
40
30
20
10
0
0
1
2
3
4
5
6
q (m^3/min)

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	Rf_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

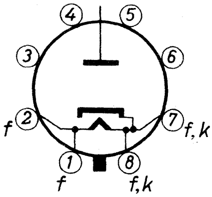
Frequency, fixed within the band	f	2.425 to 2.475	GHz
Anode voltage at $I_{a_{mean}}$ = 200 mA [1]	V_a	1.65 $^{+0.05}_{-0.10}$	kV [2][3]

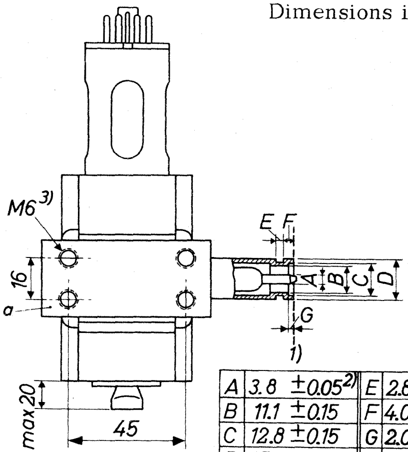
[1]) Measured with moving coil instrument
[2]) Anode voltage measured with D.C.
[3]) Measured at matched load (V.S.W.R. < 1.05)

MECHANICAL DATA

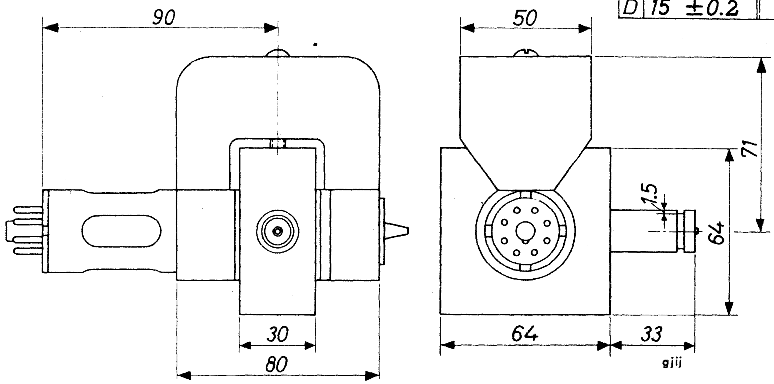
Dimensions in mm

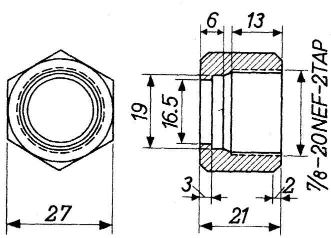
Outline drawing





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

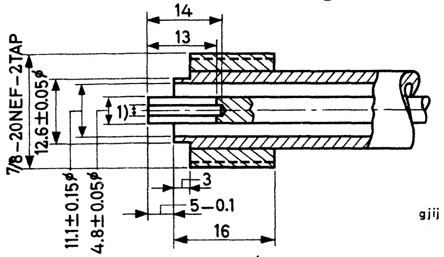
Socket 2422 501 03001

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

OUTPUT COUPLING

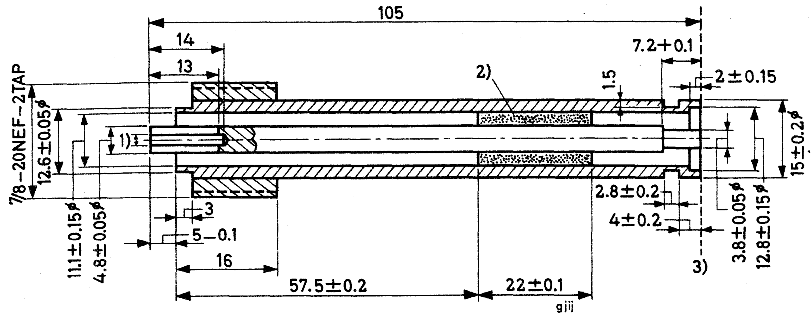
4.8/11.1 coaxial line (50.3 Ω) 4)

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



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1) Hole 3.85 + 0.05 mm with 2 slots. The wall segments should be pressed together after slotting.

2) Teflon, ε_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

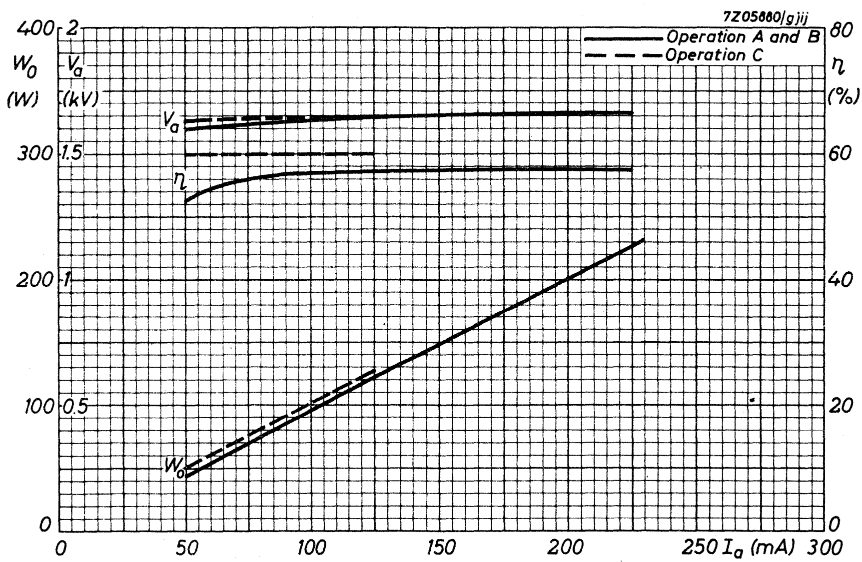
The original packing should be used for transporting and storing the tube.

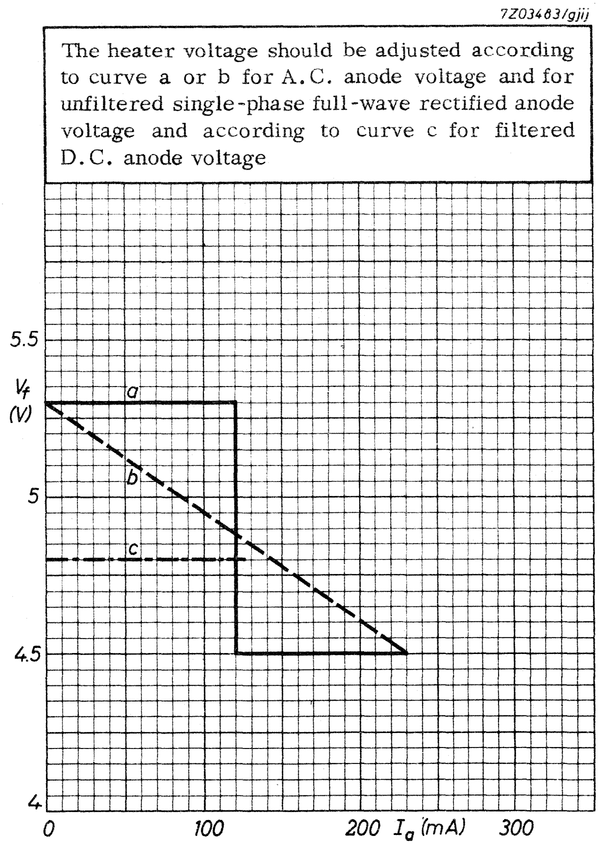
The strong magnetic field necessary for the operation of the tube must not be weakened permanently. Therefore the tube should never be placed directly on any piece of ferromagnetic material (steel shelfs etc.). The best protection for the tube is its original packing. When the tubes have to be unpacked, 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.

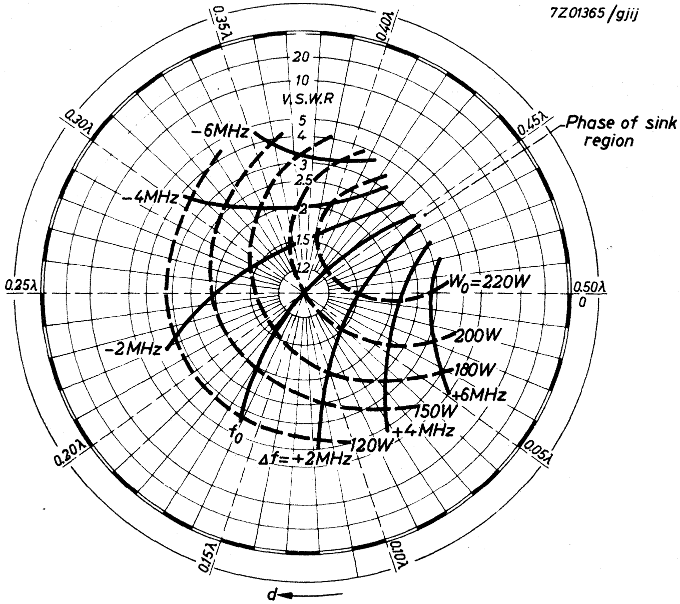
Watches and sensitive measuring instruments may be influenced and damaged by exposure to the magnetic field.

MOUNTING

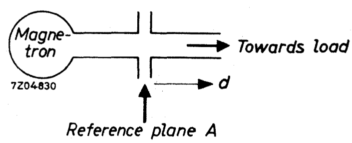
All tools (screwdrivers, wrenches etc.) used close to or in contact with the magnetron should be made of non-magnetic material (e.g. beryllium copper, or brass) to avoid unwanted attraction and possible mechanical damage to glass parts as well as short-circuiting of the magnetic flux.


7Z05880/gjij
Operation A and B
Operation C
400
300
200
100
0
W_0
(W)
2
1.5
1
0.5
V_a
(kV)
80
60
40
20
0
η
(%)
0
50
100
150
200
250
300
I_a (mA)
V_a
η
W_o


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
5.5
V_f
(V)
a
b
5
c
4.5
4
0
100
200
I_a (mA)
300



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

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

7Z2 9001

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 (≈ 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 ± 3%.

POWER SUPPLY FOR FOCUSING COILS

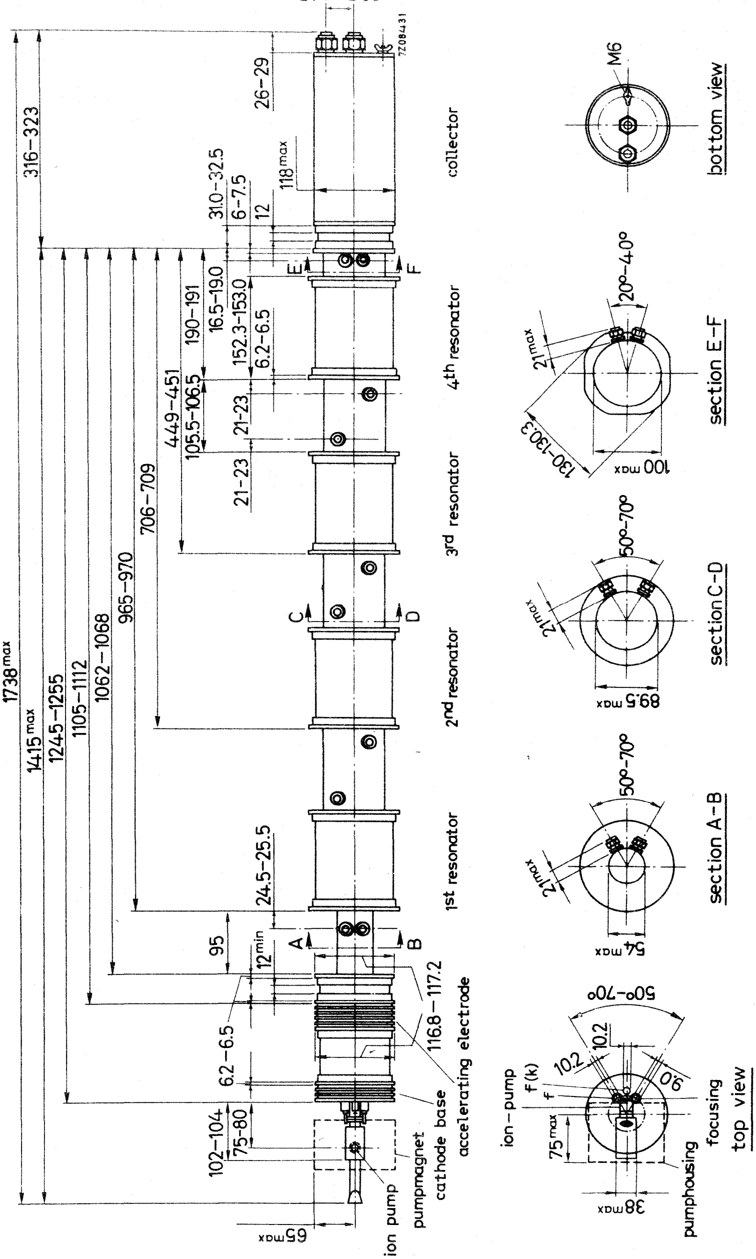
Focusing coil	V	35 to 50 V
	I	1.0 to 1.5 A
Focusing coils for drift tubes (connected in series)	V	250 to 500 V
	I	1.8 to 2.8 A

COOLING

Cathode base	low velocity air flow
Accelerating electrode	low velocity air flow
Drift tubes	water or glycol solution (30%) q = 2 l/min, t_i = max. 60 °C
Output resonator	forced air q = 2 m^3/min at t_i = 20 °C
Collector	water or glycol solution (30%) See cooling curves

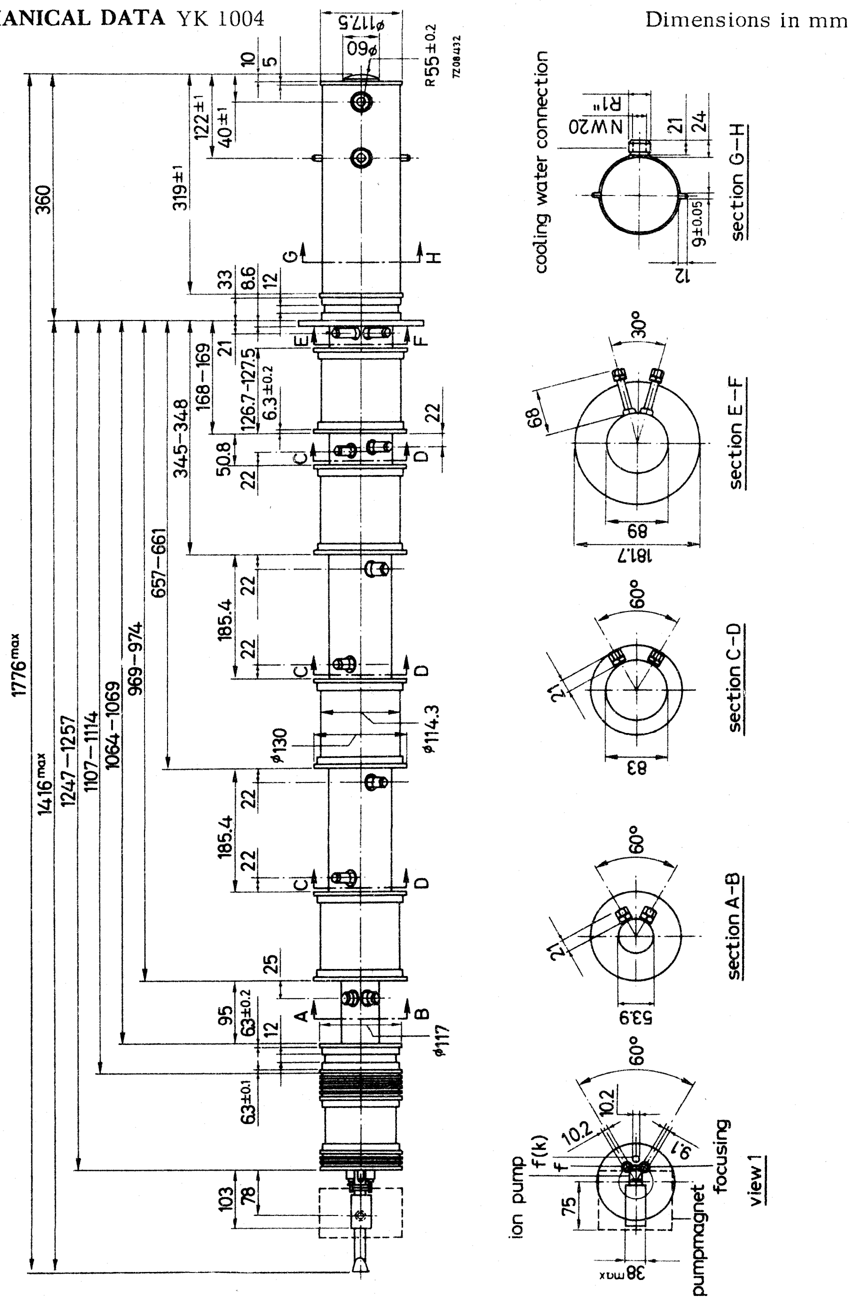
MECHANICAL DATA YK 1000

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.

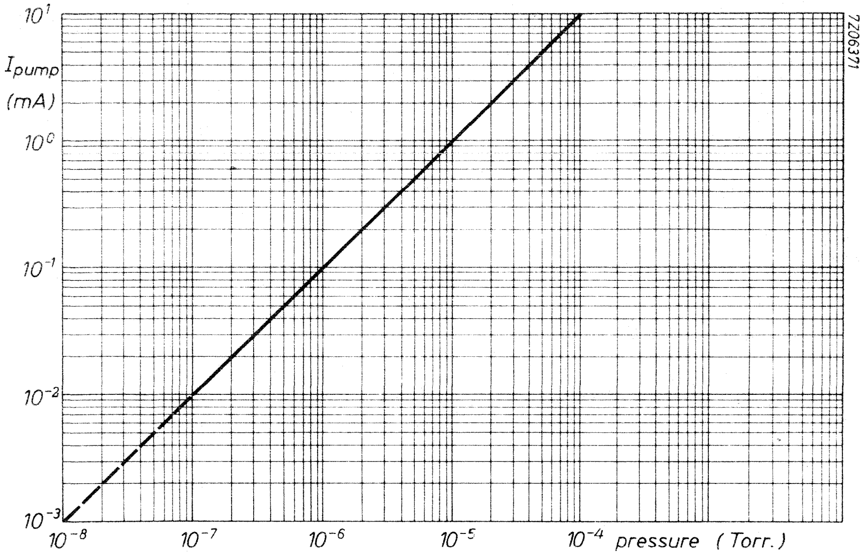
Cathode voltage	$-V_k$	max.	20	kV
Cathode voltage at zero current	$-V_{k_o}$	max.	21	kV
Cathode current	I_k	max.	2.1	A
Total drift tube current	I	max.	100	mA
Focusing electrode to cathode voltage	$-V_{foc/k}$	max.	500	V
Pump voltage (cathode reference)	$V_{pump/k}$	max.	4	kV
Pump current	I_{pump}	max.	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

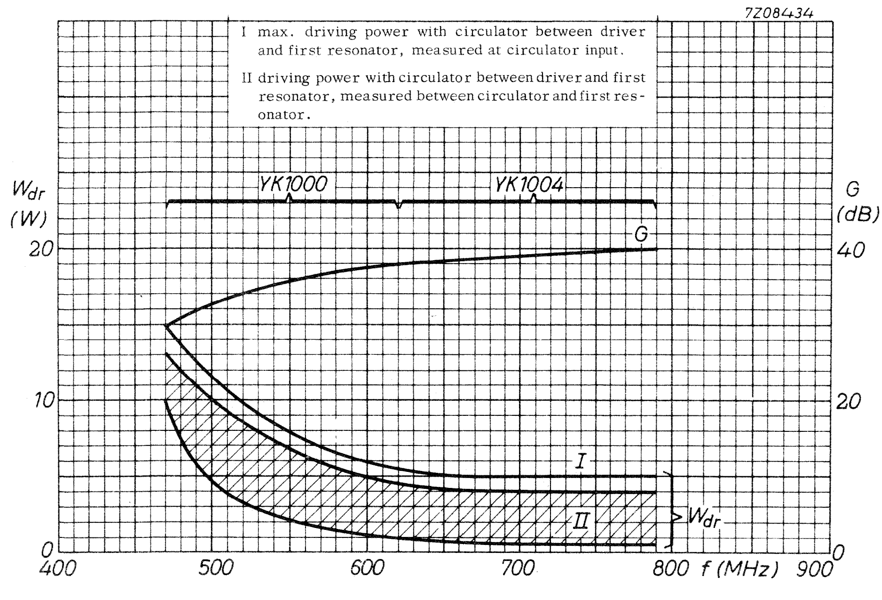
OPERATING CONDITIONS

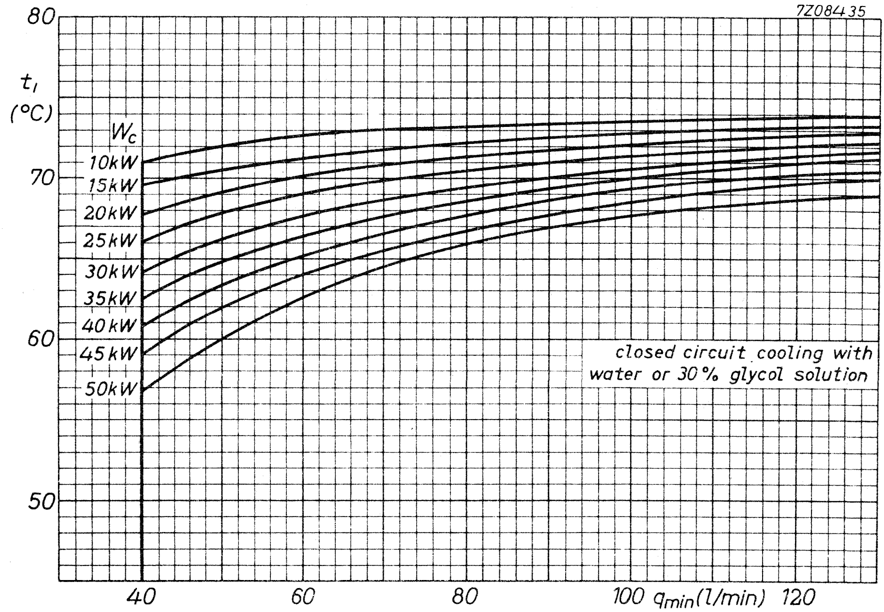
As a 10 kW T.V. picture amplifier in the band 470 MHz to 790 MHz according to the C.C.I.R. system with negative modulation. Unless otherwise mentioned all voltages are specified with respect to ground.

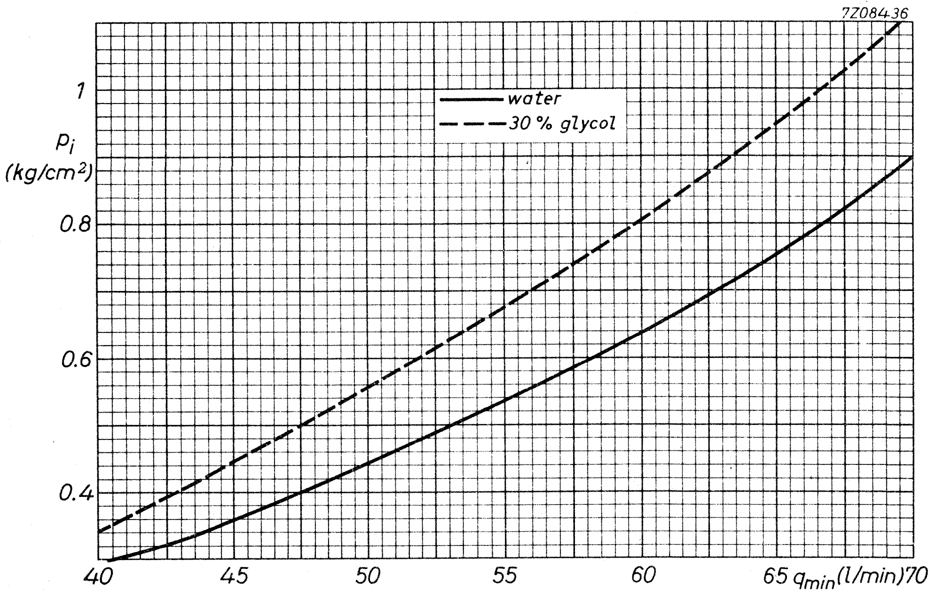
Cathode voltage	V_k	19.0	18.0	kV
Focusing electrode to cathode voltage	$V_{foc/k} \approx$	- 250	- 200	V
Cathode current	I_k	2.05	2.0	A
Drift tube current, static 1)	I ≈	40	40	mA
dynamic 2)	I ≈	50	50	mA
Driving power, sync		See curve		
Output power, sync	W_o	11	11	kW
Power gain	G ≈	30	30	dB

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)
20
10
0
40
20
0
I
II
W_{dr}
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)
	01071 (590 MHz to 720 MHz)
	01081 (710 MHz to 860 MHz)
	01101 (608 MHz to 790 MHz)

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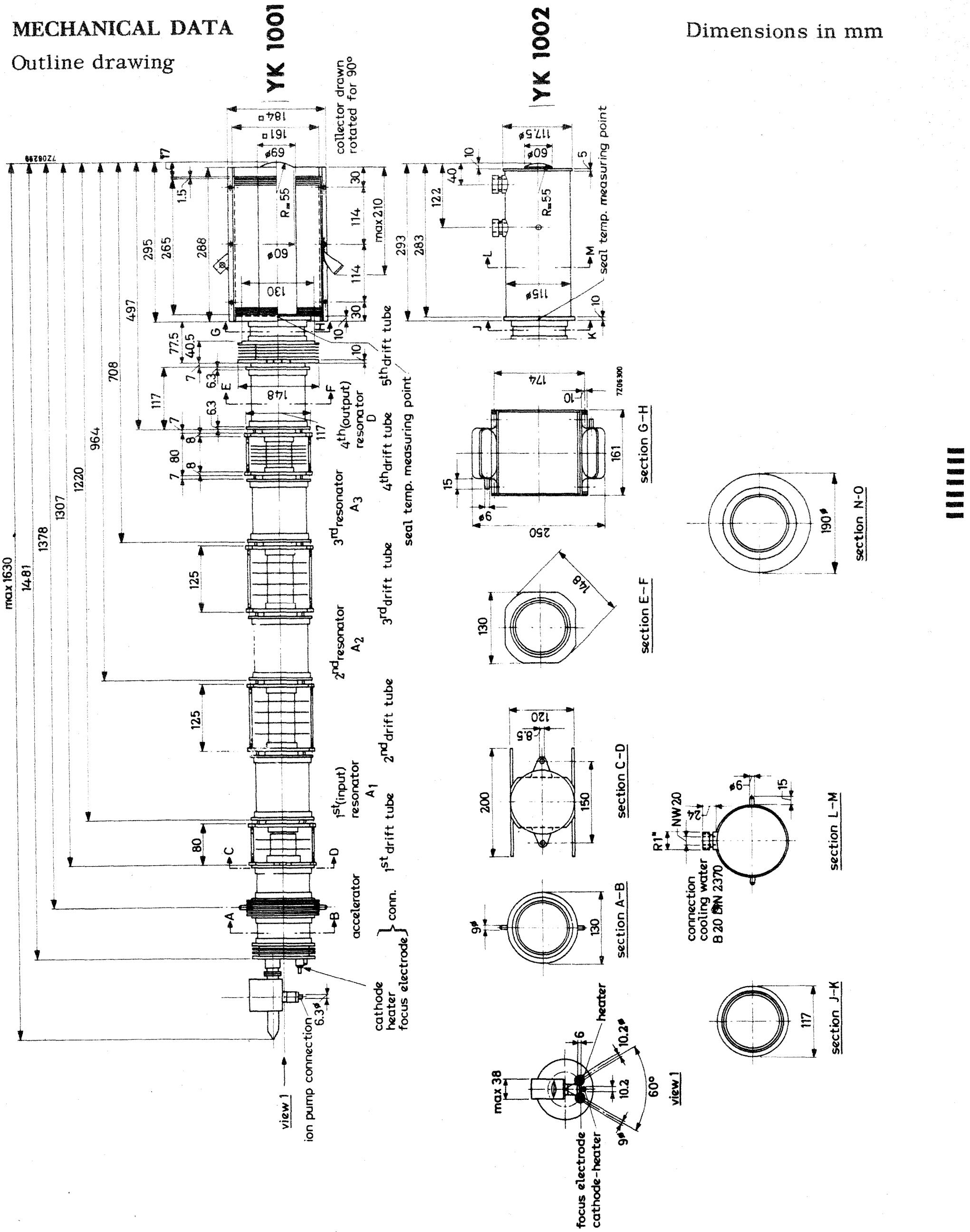
[1] In case of operation with a collector voltage less than -2kV these plates should be fitted along the collector in order to keep the collector temperatures below the max. values. See "Instructions for operation and maintenance".

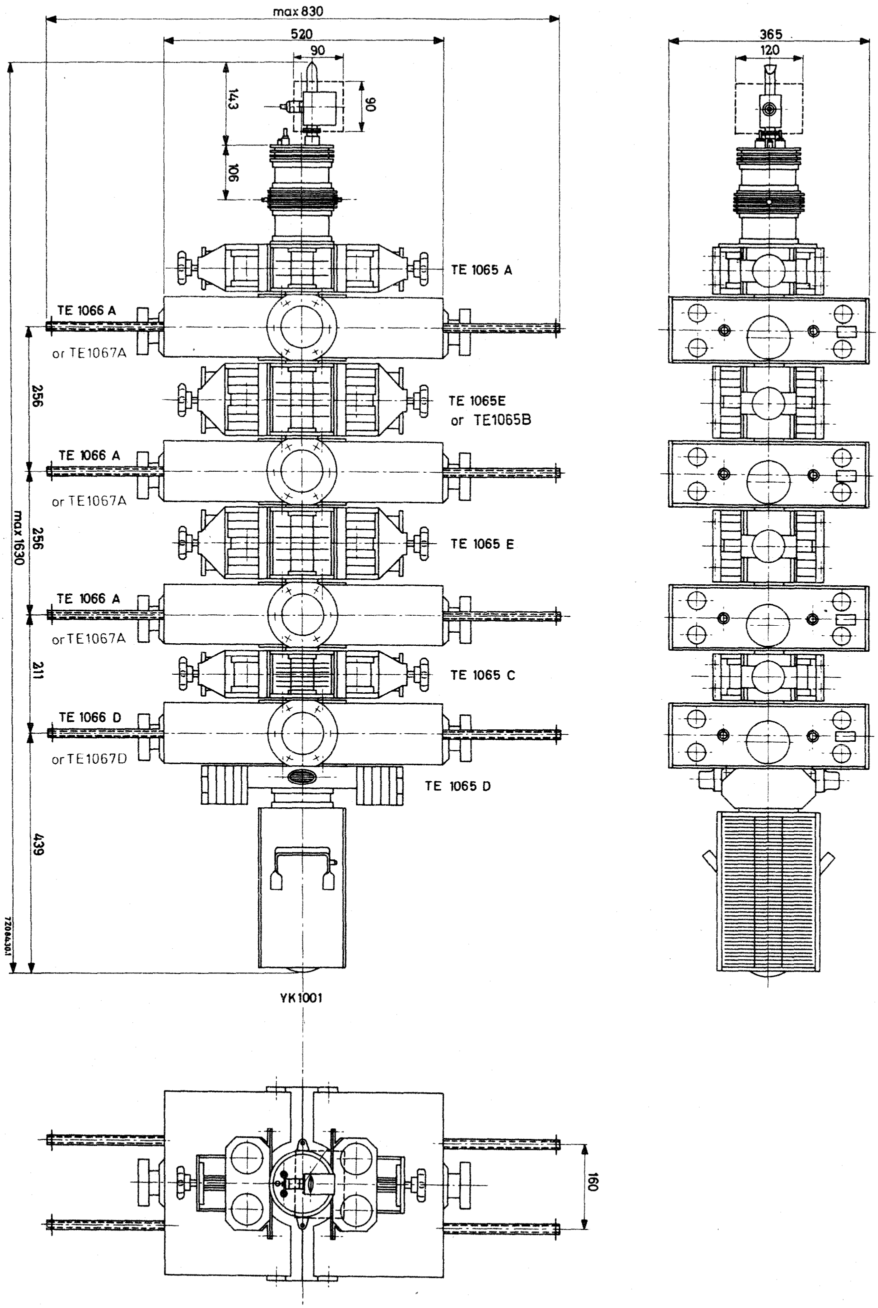
[2] If the klystron is used under T.V. transposer conditions replace 2xB by 2xE.

MECHANICAL DATA

Outline drawing

Dimensions in mm




max 830
520
90
143
90
106
365
120
TE 1065 A
TE 1066 A
or TE1067A
256
TE 1065E
or TE1065B
TE 1066 A
or TE1067A
max 1630
256
TE 1065 E
TE 1066 A
or TE1067A
211
TE 1065 C
TE 1066 D
or TE1067D
TE 1065 D
439
7Z084301
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

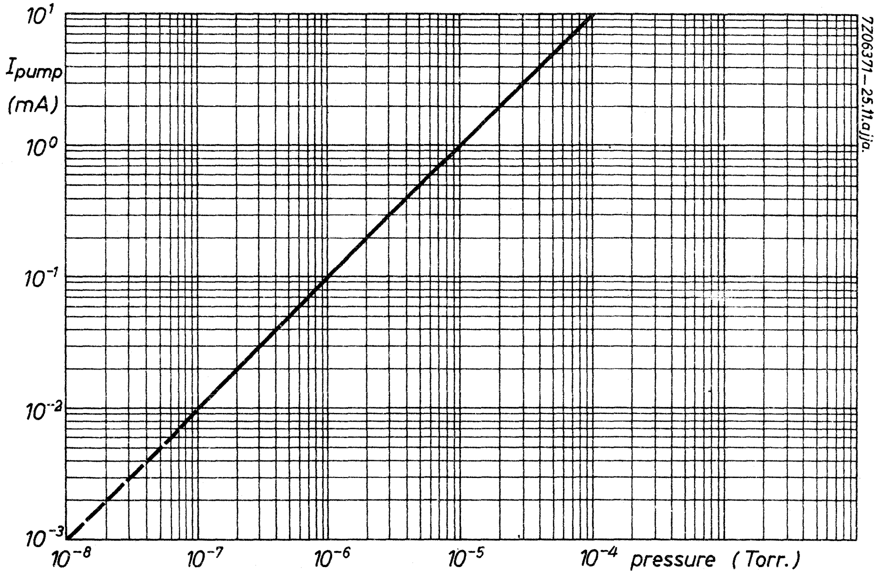
Notes see page 7

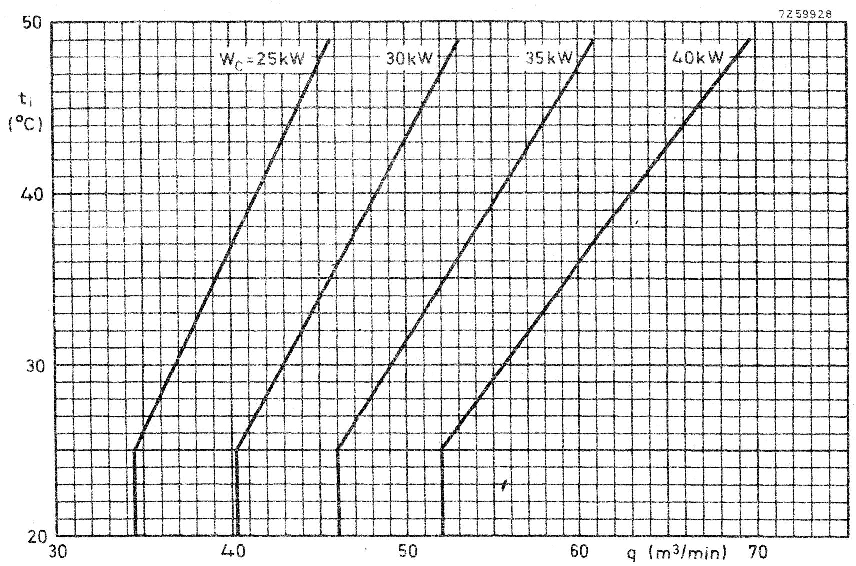
Notes to page 6

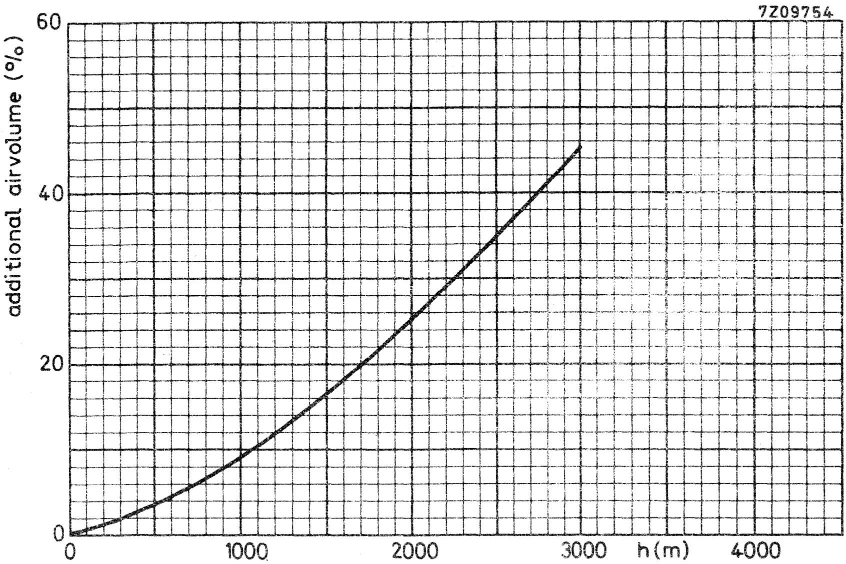
1) Fluctuations of the beam voltage up to $\pm$ 3% will not damage the tube; to meet the signal-transfer quality requirements the nominal beam voltage should not vary more than $\pm$ 1%.
2) With the appropriate focusing magnets TE1065, cavities TE1066 and a circulator between the driver and input cavity 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.

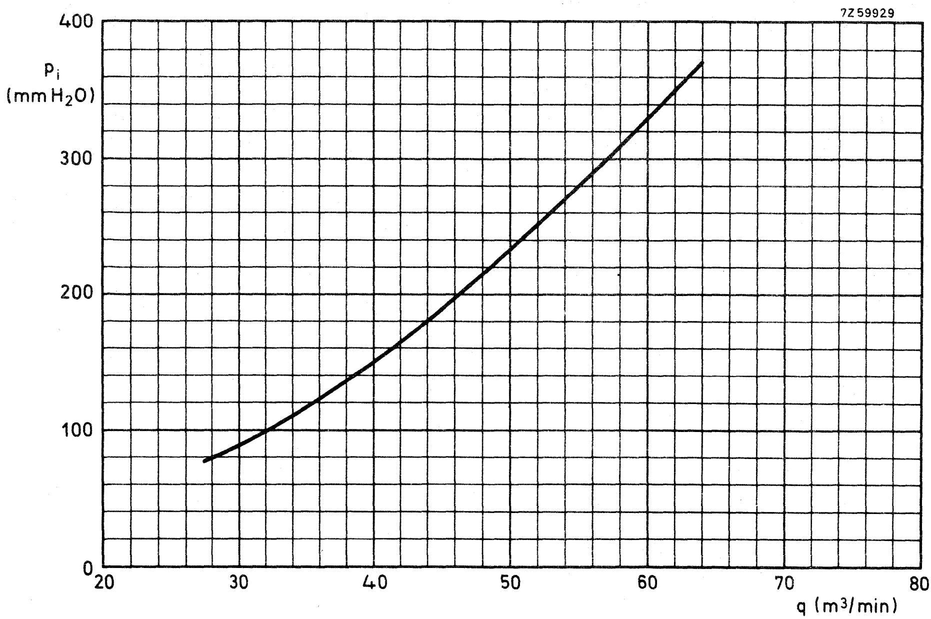
Weight

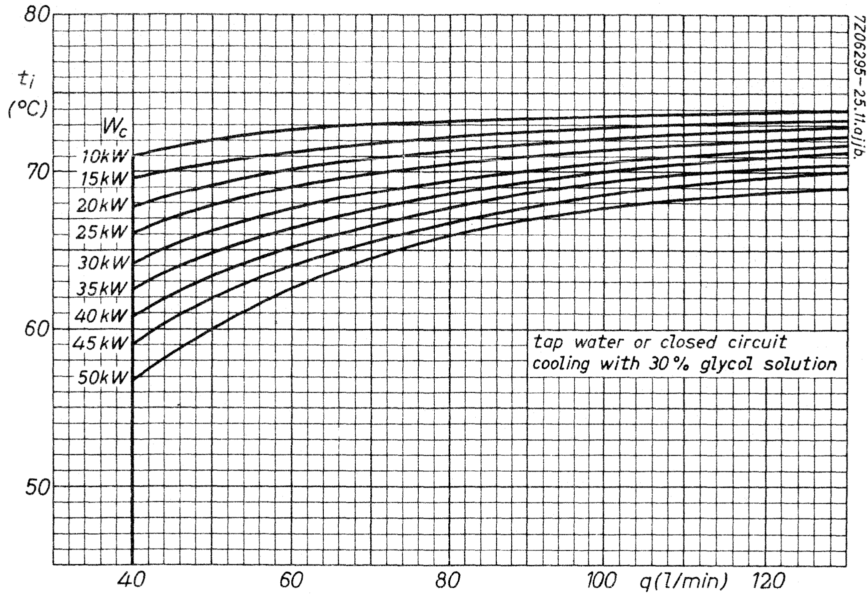
Net weight	YK1001	approx.	55 kg
	YK1002	approx.	45 kg
Total weight of accessories		approx.	125 kg

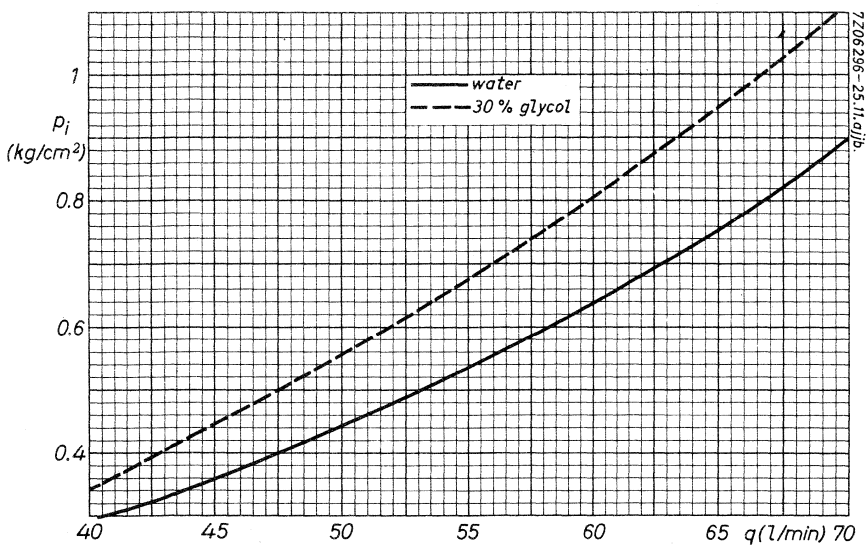

10^{1}
I_{pump}
(mA)
10^{0}
10^{-1}
10^{-2}
10^{-3}
10^{-8}
10^{-7}
10^{-6}
10^{-5}
10^{-4}
pressure (Torr.)
7Z06371–25.11.a.jjo.


7Z59928
W_C = 25kW
30kW
35kW
40kW
t_i (°C)
50
40
30
20
30
40
50
60
q (m³/min)
70


7Z09754
additional airvolume (%)
60
40
20
0
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
$q\ (m^3/min)$


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
40
60
80
100
q(l/min)
120
7Z06295-25.11.ajb.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p_i
(kg/cm²)
0.8
0.6
0.4
water
30 % glycol
40
45
50
55
60
65
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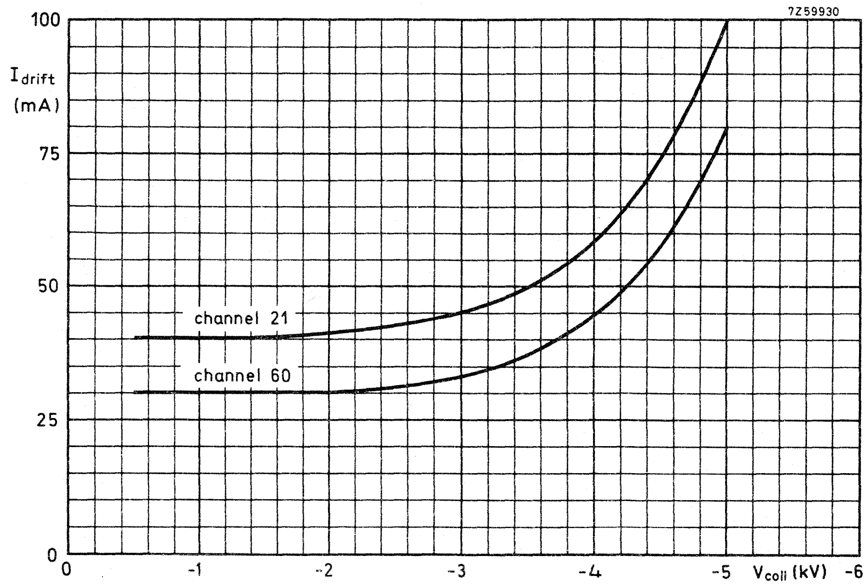
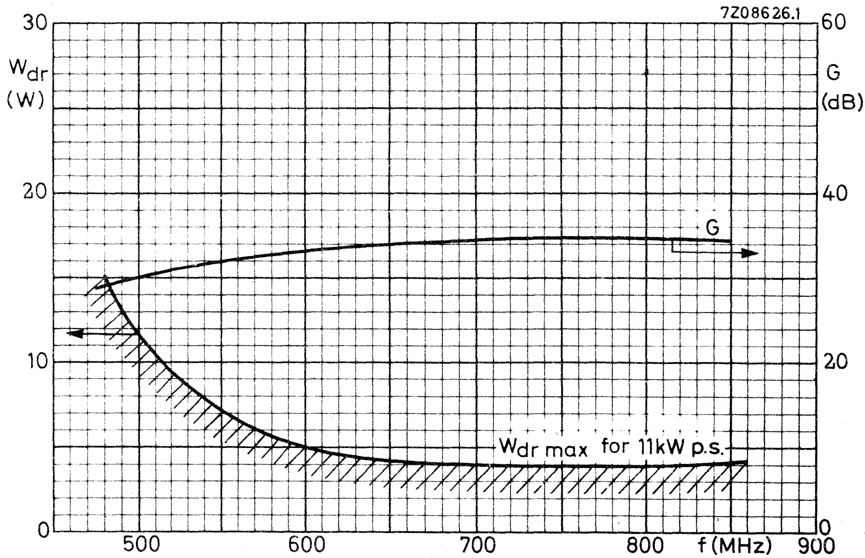
70
7Z06296-25.11.ajb.


7Z59930
100
I_{drift}
(mA)
75
50
channel 21
channel 60
25
0
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)

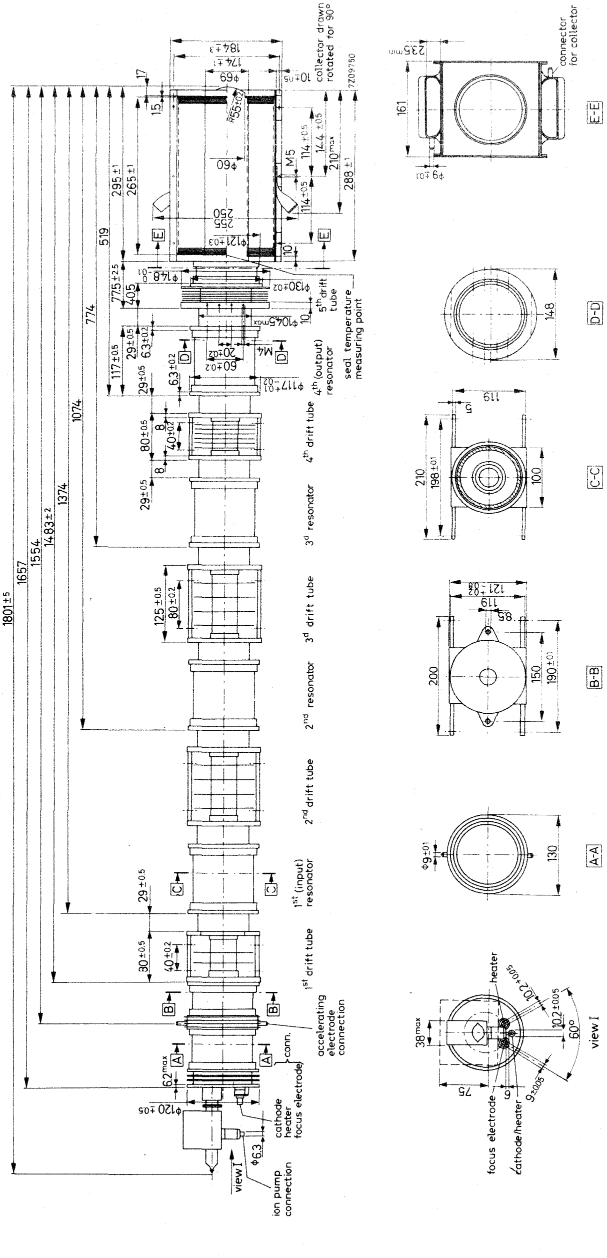
WEIGHT

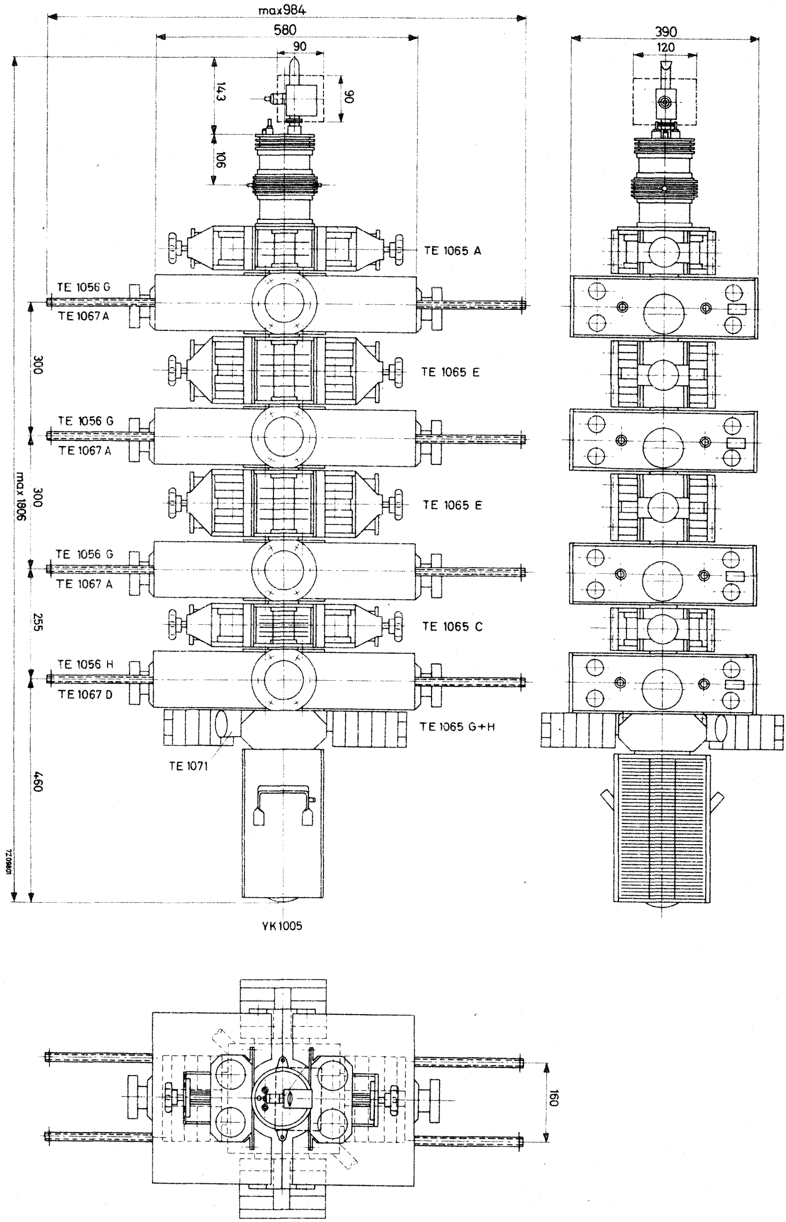
Net weight YK1005	approx. 60 kg
Accessories, total	approx. 130 kg

MECHANICAL DATA

Dimensions in mm

Outline drawing




max984
580
90
143
90
106
390
120
TE 1065 A
TE 1056 G
TE 1067 A
300
TE 1065 E
TE 1056 G
TE 1067 A
max 1806
300
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 ± 3% will not damage the tube; to obtain a good signal-transfer quality the nominal beam voltage should not vary more than ±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 Ω 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.

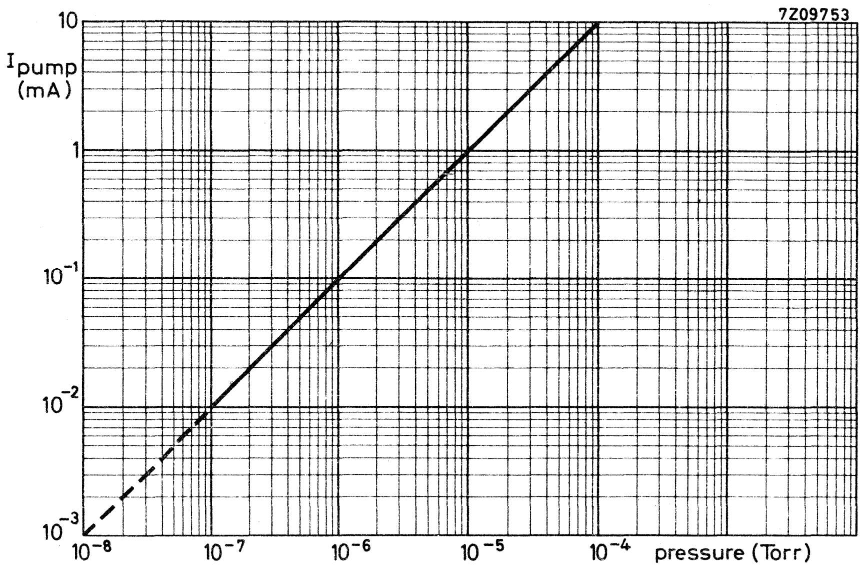
10) Measured with a sawtooth voltage with amplitude between 17% and 75% of the peak sync value, on which is superimposed a 4.43 MHz sine wave with a 10% peak-to-peak value.

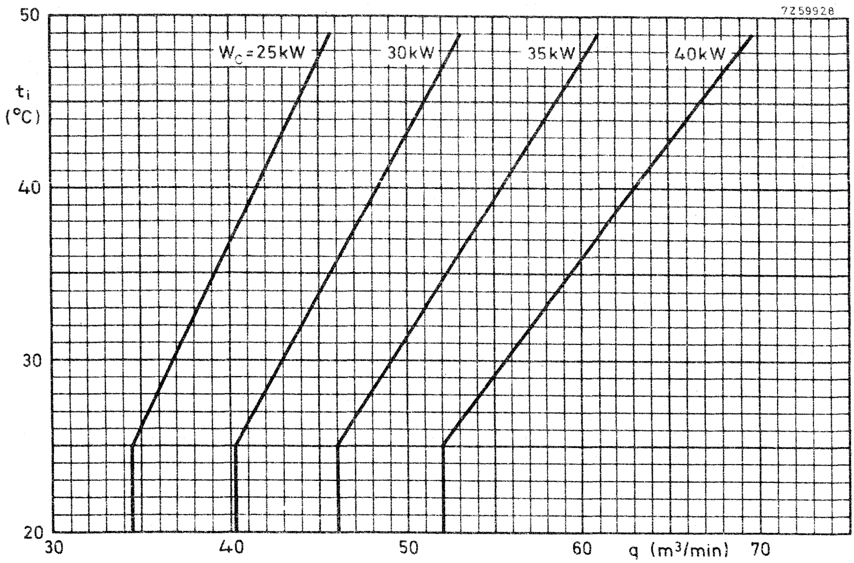
11) A picture/sync ratio of 75/25 for the outgoing signal of the klystron requires a ratio of max. 55/45 for the incoming signal.

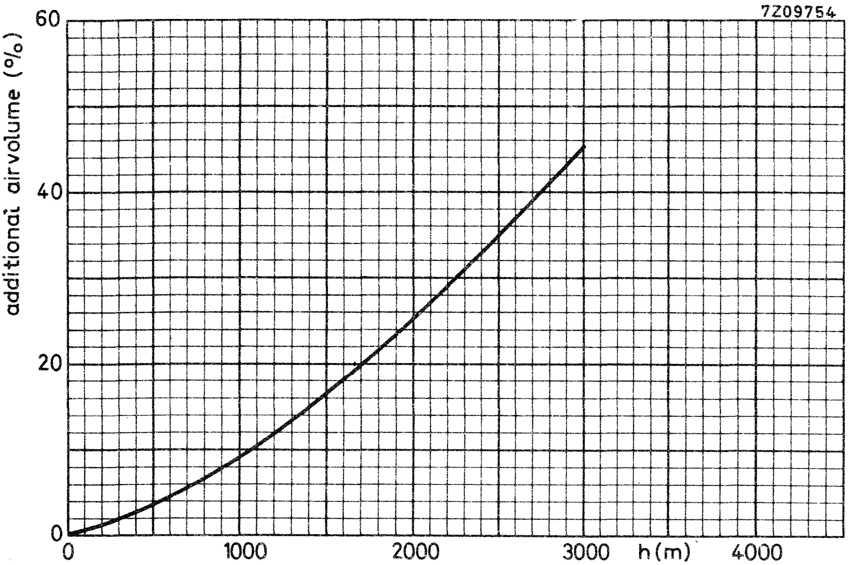
12) Measured with modulation 10 to 75%, without compensation, VSB filter between driver and klystron.

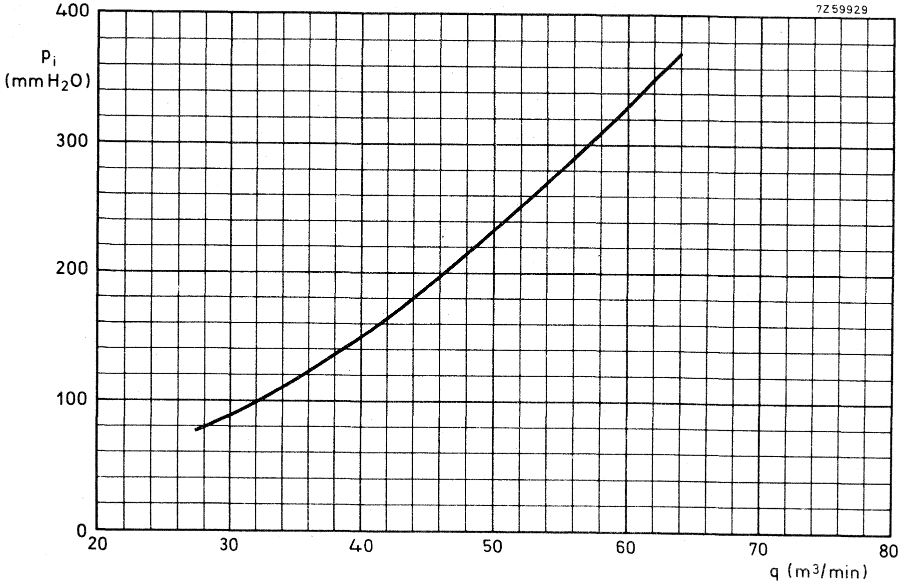
13) Produced by the klystron itself; excluded hum from power supplies.

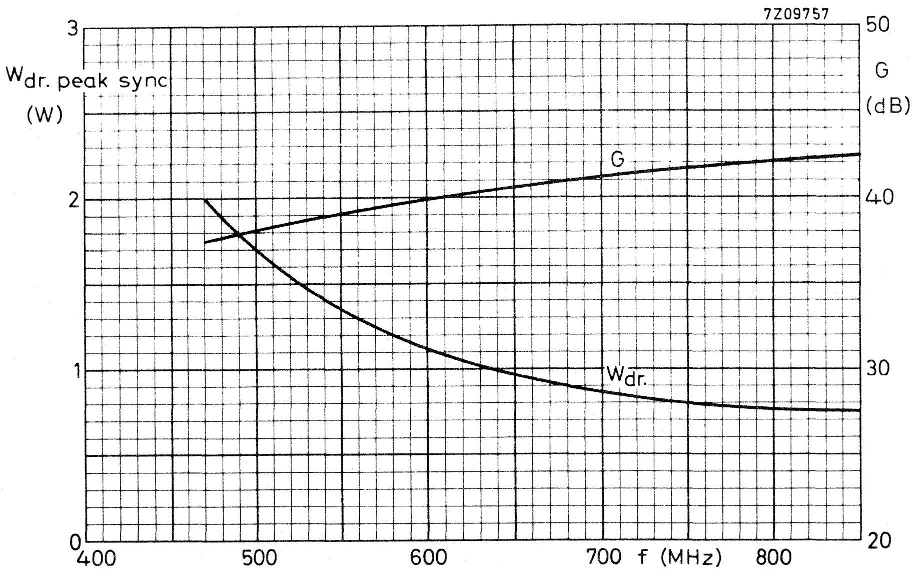
14) The power supply should be adjustable from-100 V to-700 V and be pre-loaded with min. 10 mA at-700 V.


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 airvolume (%)
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
400
500
600
700
f (MHz)
800
50
G
(dB)
40
30
20
G
$W_{dr.}$

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	ρ	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

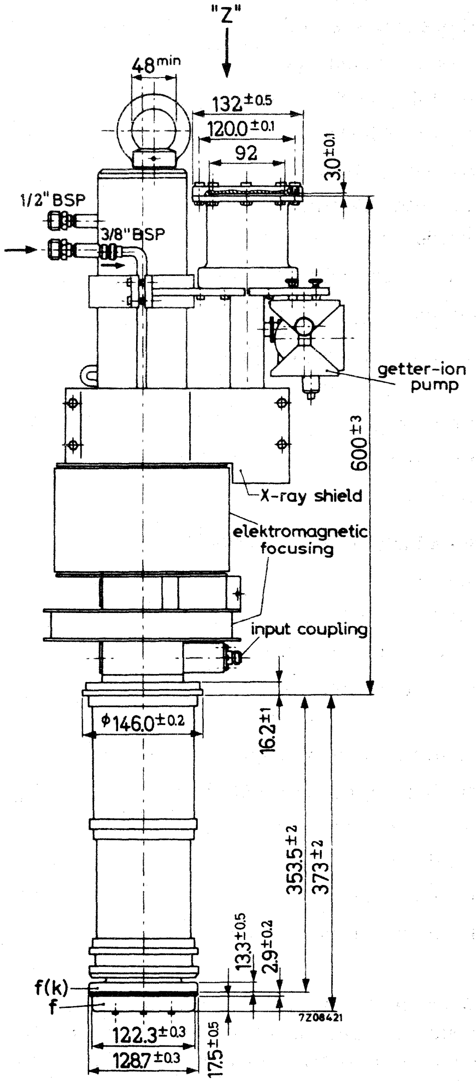
Weight

Net weight approx. 110 kg

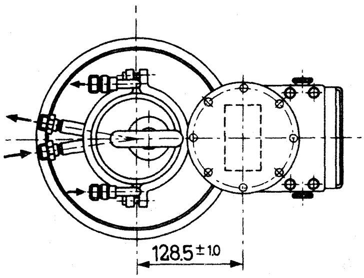
[1] Data for operation at p.r.r. higher than 50 p.p.s. on request.

MECHANICAL DATA

Dimensions in mm



view "Z"



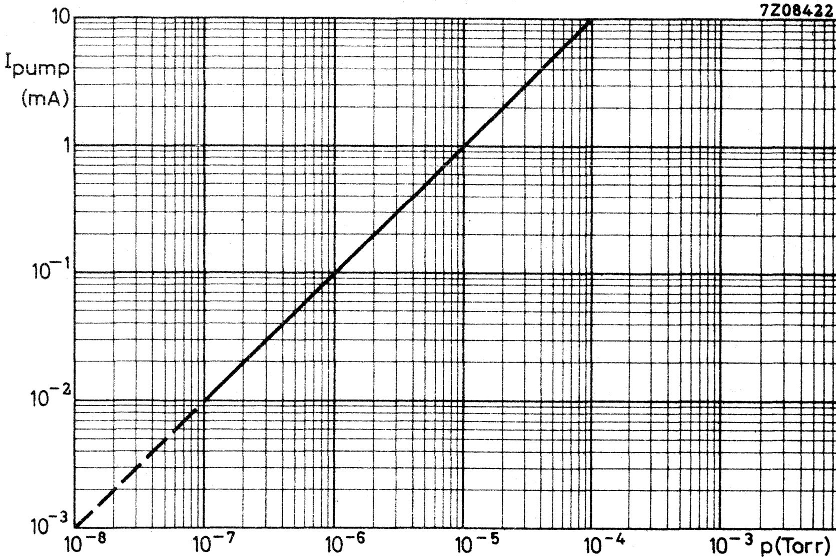
LIMITING VALUES (Absolute max. rating system) for pulsed operation.
All voltages are specified with respect to ground.

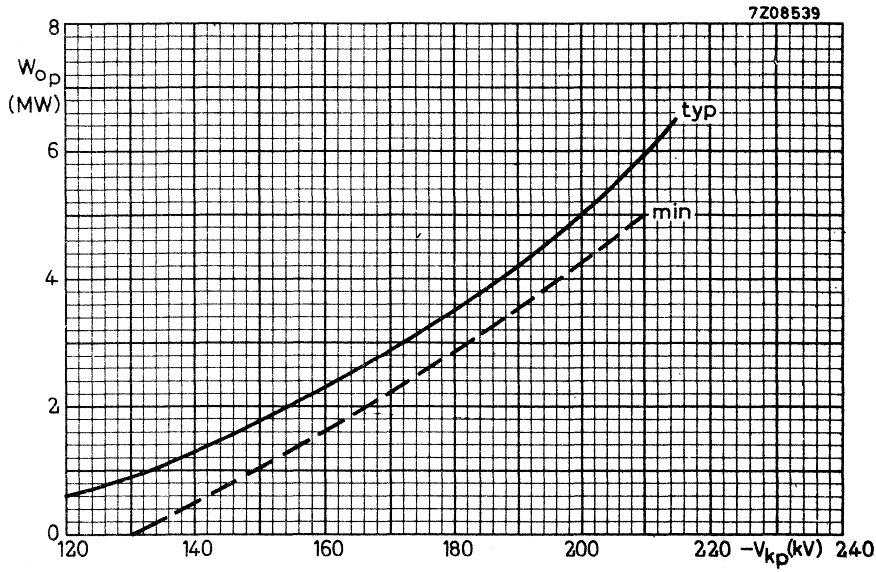
Cathode voltage, peak	$-V_{kp}$	max.	220	kV
Cathode current, peak	I_{kp}	max.	120	A
Beam input power, peak	W_i	max.	25	MW
R.F. input power, peak	W_{dr}	max.	10	kW
R.F. output power, peak	W_{op}	max.	8	MW
Pulse repetition rate	p.r.r.	max.	600	p.p.s.
Pulse duration	T_{imp}	max.	3	μs
Voltage standing wave 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	^oC

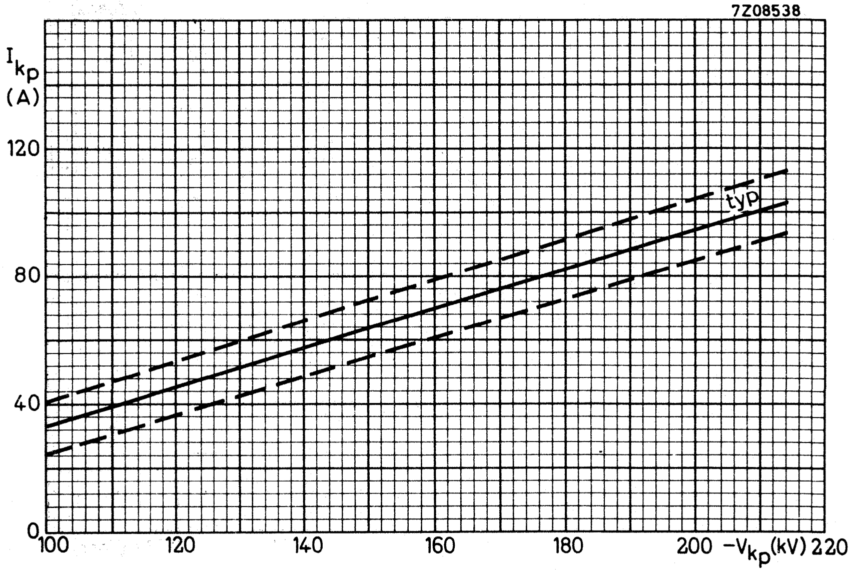
OPERATING CONDITIONS 1)

Frequency	f	2998	MHz
Heater current	If	2)	
Cathode voltage, peak 3)	V_{kp}	- 210	kV
Cathode current, peak	I_{kp}	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_{op}	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
10
I_{pump}
(mA)
1
10^{-1}
10^{-2}
10^{-3}
10^{-8}
10^{-7}
10^{-6}
10^{-5}
10^{-4}
10^{-3} p(Torr)


7Z08539
8
W_{op}
(MW)
6
4
2
0
typ
min
120
140
160
180
200
220 $-V_{kp}$(kV) 240


7Z08538
I_{kp} (A)
120
80
40
0
100
120
140
160
180
200
$-V_{kp}$(kV)
220
typ

U.H.F. POWER KLYSTRON

U.H.F. T V power klystron in metal-ceramic construction, with four external resonant cavities, integral permanent magnets, and incorporated getter-ion pump.
The klystron is intended to be used with depressed collector voltage in 10 kW and 20 kW vision transmitters, in sound transmitters or in high-power transposers in the frequency range 470 to 860 MHz.

QUICK REFERENCE DATA

Frequency range	470	to	860	MHz
Output power, peak sync			25	kW
Gain			≥ 40	dB
Cooling	forced air			

HEATING : indirect by d.c.

Cathode	dispenser type			
Heater voltage [1]	V_f		8	V
Heater current	I_f		≈ 32 (≤ 36)	A

The heater current should never exceed a peak value of 65 A.

Cold heater resistance	R_{f_o}		≈ 28	mΩ
Waiting time				
a. Heater voltage 8 V	T_w	min.	180	s
b. Flash heating 9 V		note 2		
c. Stand-by 5,5 V	T_w	min.	0	s [3]

FOCUSING

The integral temperature-compensated coaxial permanent magnets are pre-adjusted by the tube manufacturer.

[1] During operation the heater voltage should not fluctuate more than ± 3 %.

[2] Detailed information for flash-heating (120s/9V) on request.

[3] Valid after a waiting time of at least 8 min (on V_f=5,5 V); as soon as the beam voltage is switched on, the heater voltage must be increased to 8 V.

Data based on pre-production tubes.

COOLING

Cathode socket and accelerating electrode	low velocity airflow	1)
Drift tube 3	low velocity airflow	1)
Drift tube 4	forced air, 1 m^3/min, p_i = 80 mm H_2O	
Drift tube 5	forced air, 2 m^3/min, p_i = 80 mm H_2O	
Cavity 3	forced air, 1 m^3/min, p_i = 80 mm H_2O	
Output cavity (4)	forced air, 1 m^3/min, p_i = 80 mm H_2O	
Collector (60 kW dissipation)	forced air, min. 55 m^3/min, p_i = 170 mm H_2O 2)	

Cooling data, using the trolley TE1081

Cathode socket, drift tubes, and cavities	forced air, approx. 5 m^3/min, p_i = 80 mm H_2O
Collector (60 kW dissipation)	forced air, min. 55 m^3/min, p_i = 210 mm H_2O 2)

LIMITING VALUES (Absolute max. rating system)

Heater voltage	max.	8.5	V
Cathode to body voltage	max.	-28	kV
Accelerator to body voltage	max.	-28	kV
	min.	0	kV
Collector to body voltage	max.	-5	kV
	min.	-0,5	kV
Focusing electrode to cathode voltage	max.	-600	V
	min.	-100	V
Cathode current	max.	4	A
Accelerator electrode current	max.	1,5	mA
Drift tube current, static	max.	60	mA
dynamic 3)	max.	200	mA
Collector dissipation	max.	65	kW
Series resistor in accelerator electrode circuit	min.	10	kΩ
Pump voltage, no load condition	max.	5	kV
	min.	3	kV
Pump current	max.	15	mA
VSWR of load at operating frequency	max.	1,5	
Temperature of focusing magnets	max.	65	°C
Inlet temperature of cooling air	max.	45	°C

Notes see page 3

GETTER-ION PUMP SUPPLY

Pump voltage, no load condition	4	kV
Internal resistance	300	kΩ

If it is between 3 kV and 5 kV, the collector to body voltage may be used as the pump supply voltage. In this case the pump anode must be connected to body (earth) via a 300 kΩ series resistor.

MOUNTING
Mounting position: vertical with collector down.

WEIGHT
Net weight YK1151 : approx. 100 kg

1) 0,5 m^3/min with reference to an area of 100 cm^2.

2) See also cooling curves.

3) A drift tube current cut-out should be provided to protect the klystron. The cut-out should have an automatic action which depends on the drive level.

ACCESSORIES (standard)

Frequency range (MHz) Channel Stub Circulator	470 to 638 21 to 41 TE1089 see note [1]	638 to 790 42 to 60 TE1089 2722 162 01561	790 to 860 61 to 68 TE1089 2722 162 03261
Cavity 1 Input coupling device	TE1077A TE1083	TE1078A TE1084	TE1078A TE1084
Cavity 2 Load coupling device	TE1077A TE1085	TE1078A TE1086	TE1078A TE1086
Cavity 3 Load coupling device Adaptor flange	TE1077A TE1085 -	TE1078A TE1086 -	TE1078D TE1086 TE1090
Cavity 4 Cutput coupling device	TE1077D TE1091A	TE1078D TE1092A	TE1078D TE1092A
Trolley Air duct for cavities Air duct for drift tube 3 Air duct for drift tube 4 Air duct for drift tube 5	TE1081 - TE1117 TE1118 TE1119	TE1081 TE1115 TE1117 TE1118 TE1119	TE1081 TE1116 TE1117 TE1118 TE1119
Magnet for ion pump	TE1053A	TE1053A	TE1053A
Connectors Heater Heater/cathode Focusing electrode Accelerating electrode Collector Ion pump Earth	 40649 40649 40634 40634 40649 40634 40649	 40649 40649 40634 40634 40649 40634 40649	 40649 40649 40634 40634 40649 40634 40649

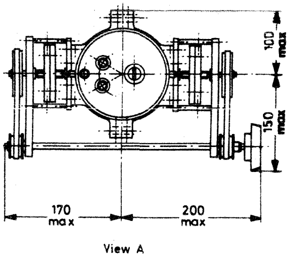
Special parts

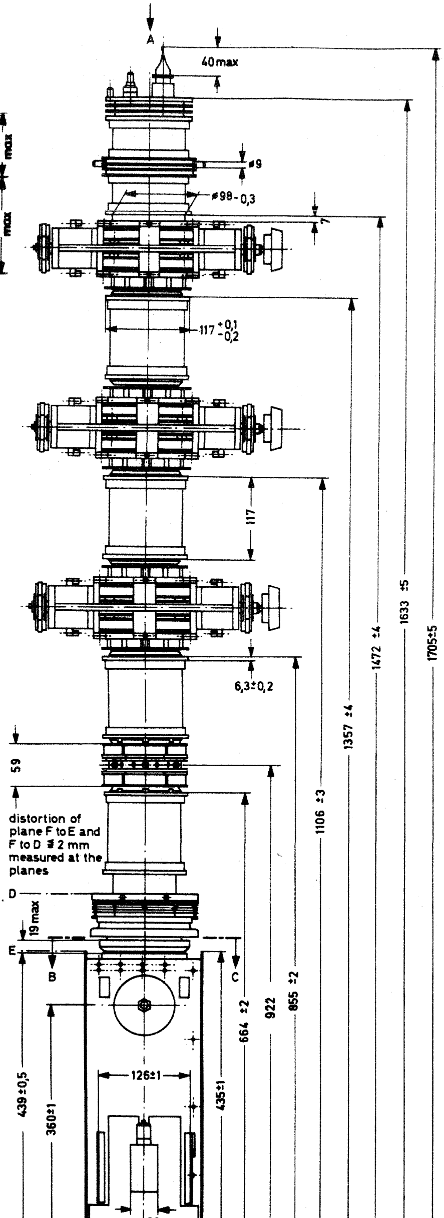
Load coupling unit mating TE1077D (instead of TE1091A)	TE1087
Load coupling unit mating TE1078D (instead of TE1092A)	TE1088
Plug connection mating TE1091A	TE1091B
Plug connection mating TE1092A	TE1092B
Tube extractor	TE1113

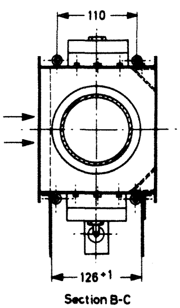
[1]) For frequency range 470 to 604 MHz (channel 21 to 37): 2722 162 01551
For frequency range 604 to 638 MHz (channel 38 to 41): 2722 162 01561

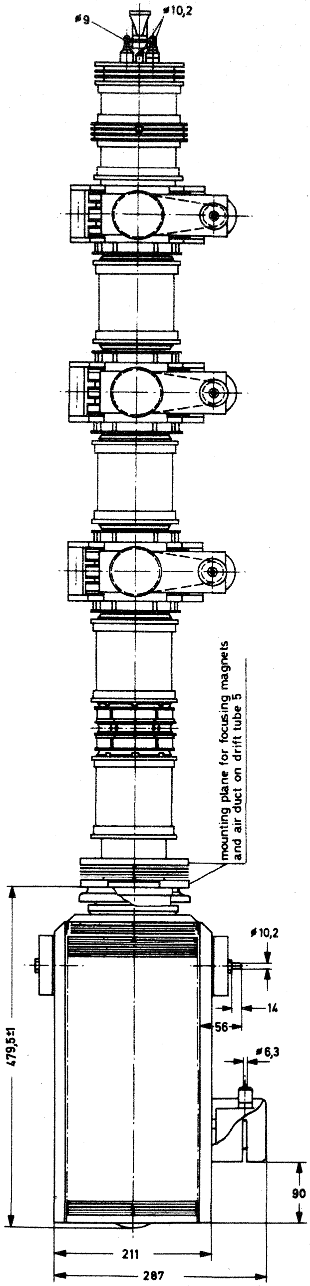
MECHANICAL DATA

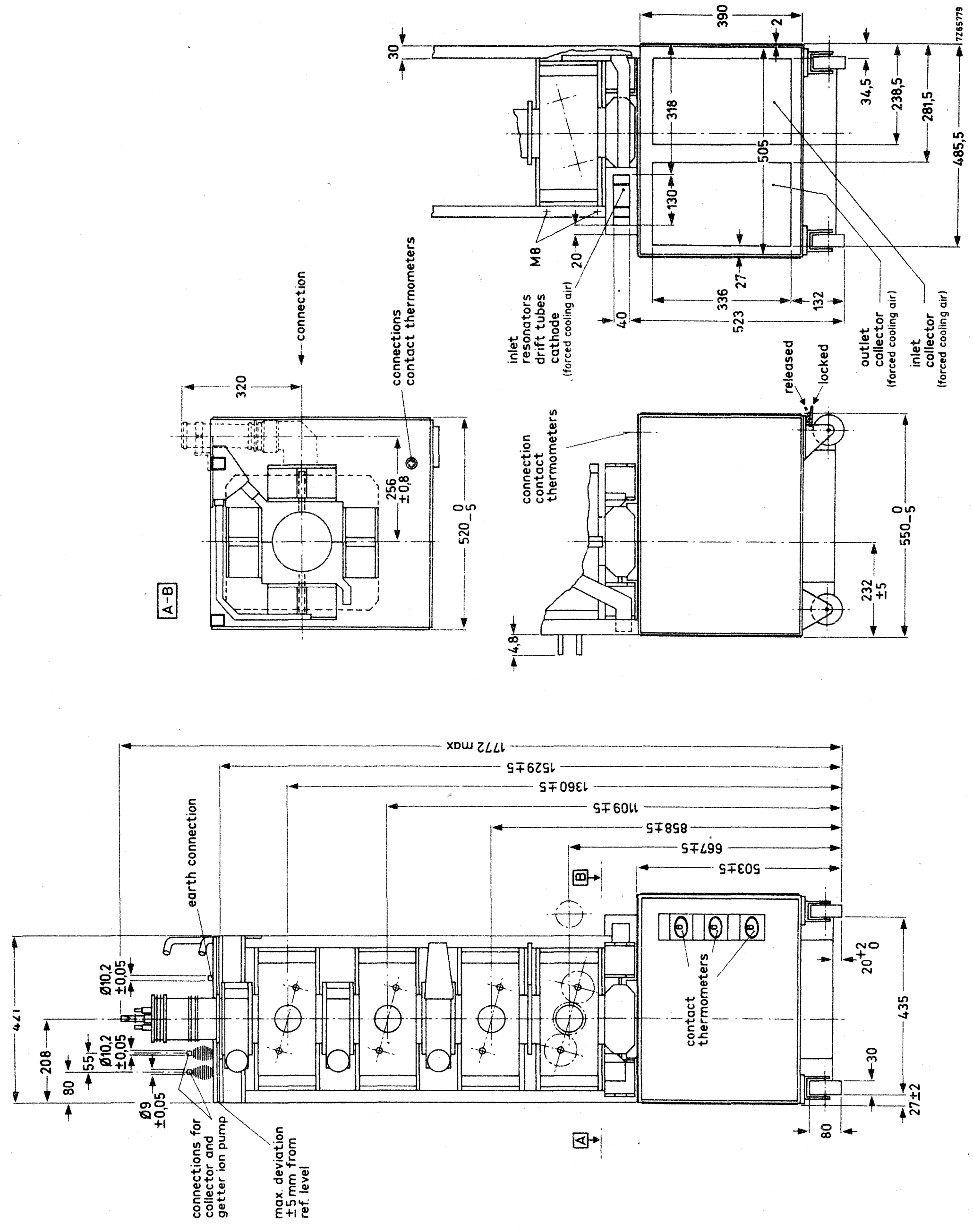
Dimensions in mm










connection
connections contact thermometers
320
256 ±0,8
520 0 -5
A-B
inlet resonators drift tubes cathode (forced cooling air)
M8
20
40
523
336
27
132
130
318
505
390
2
30
34,5
238,5
281,5
485,5
outlet collector (forced cooling air)
inlet collector (forced cooling air)
released
locked
connection contact thermometers
550 0 -5
232 ±5
4,8
7Z65779
earth connection
Ø10,2 ±0,05
Ø9 ±0,05
421
208
80
55
connections for collector and getter ion pump
max. deviation ±5 mm from ref. level
1772 max
1529±5
1360±5
1109±5
858±5
667±5
503±5
B
A
contact thermometers
435
30
27±2
80

TYPICAL OPERATION [1] (With stated accessories)

A. As a 20 kW vision transmitter, in accordance with the C.C.I.R.-G standard

Operating conditions

Frequency range	470 to 638		638 to 790	790 to 860	MHz
Channel	21 to 41		42 to 60	61 to 68	
Cathode to collector voltage	-16,5	-20,0	-20,0	-20,0	kV [2]
Cathode current	3,6	3,0	3,0	3,1	A
Collector to body voltage	-4,0	-4,0	-4,0	-4,5	kV
Body current (black level)	100	70	70	70	mA
Accelerating electrode to body voltage	0	≈ -6	≈ -6	≈ -6	kV
D.C. input power	59	60	60	62	kW
Focusing electrode to cathode voltage	-100 to -600		-100 to -600	-100 to -600	V [3]

Performance [4]

	min.	typ.	max.	
Output power, peak sync	22			kW
Driving power, peak sync				
in channels 21 to 41			2,5	W
in channels 42 to 68			1,7	W
Sync compression			40/25	[5]
V.S.B. suppression	23	25		dB [6]
Noise, with reference to black level	-48	> -50		dB [7]
Low frequency linearity	0,75	0,8		[8]
Differential gain	0,75	0,85		[9]
Differential phase		+10/-3	+15/-5	deg [9][10]
Variation in response characteristic as a function of power level				
in the double sideband region		0,25	0,5	dB [11]
in the single sideband region		0,4	0,6	dB [12]
Ripple of response characteristic (white level 10/20)			0,3	dB
Max. output power		25		kW [13]
Efficiency		42		%

Notes see page 10

TYPICAL OPERATION 1) (With stated accessories)

B. As a 10 kW vision transmitter, in accordance with the C.C.I.R.-G standard

Operating conditions

Frequency range	470 to 638		638 to 790	790 to 860	MHz
Channel	21 to 41		42 to 60	61 to 68	
Cathode to collector voltage	-13,5	-16,0	-16,0	-16,0	kV 2)
Cathode current	2,4	2,1	2,1	2,2	A
Collector to body voltage	-4,0	-4,0	-4,0	-4,5	kV
Body current (black level)	70	50	50	50	mA
Accelerating electrode to body voltage	≈ -2,0	≈ -5,5	≈ -5,5	≈ -6,0	kV
D.C. input power	33,0	33,5	33,5	35,0	kW
Focusing electrode to cathode voltage	-100 to -600		-100 to -600	-100 to -600	V 3)

Performance 4)

	min.	typ.	max.	
Output power, peak sync	11			kW
Driving power, peak sync				
in channels 21 to 41			2,5	W
in channels 42 to 68			1,7	W
Sync compression			40/25	5)
V.S.B. compression	23	25		dB 6)
Noise, with reference to black level	-48	> -50		dB 7)
Low frequency linearity	0,75	0,80		8)
Differential gain	0,75	0,85		9)
Differential phase		+10/-3	+15/-5	deg 9)10)
Variation of response characteristic as a function of power level				
in the double sideband region		0,25	0,50	dB 11)
in the single sideband region		0,4	0,6	dB 12)
Ripple of response characteristic (white level 10/20)			0,3	dB
Max. output power		12,5		kW 13)
Efficiency		38		%

Notes see page 10

TYPICAL OPERATION [1]) (With stated accessories)

C. As a sound transmitter, in accordance with the C.C.I.R. -G standard.

For operation in combination with a 22 kW vision stage

Frequency range	470 to 638				638 to 790		790 to 860		MHz
Channels	21 to 41				42 to 60		61 to 68		
Cathode to collector voltage	-16,5		-20,0		-20,0		-20,0		kV
Collector to body voltage	-4,0		-4,0		-4,0		-4,5		kV
Focusing electrode to cathode voltage	-100 to -600				-100 to -600				V
Driving power	≤ 0,5				≤ 0,5				W
Accelerating electrode to body voltage	-12,5	-14,5	-16,5	-18,5	-16,5	-18,5	-17,0	-19,0	kV
Cathode current	0,9	0,6	0,8	0,5	0,8	0,5	0,8	0,5	A [14])
Output power	4,4	2,2	4,4	2,2	4,4	2,2	4,4	2,2	kW

For operation in combination with an 11 kW vision stage

Frequency range	470 to 638				638 to 790		790 to 860		MHz
Channels	21 to 41				42 to 60		61 to 68		
Cathode to collector voltage	-13,5		-16,0		-16,0		-16,0		kV
Collector to body voltage	-4,0		-4,0		-4,0		-4,5		kV
Focusing electrode to cathode voltage	-100 to -600				-100 to -600				V
Driving power	≤ 0,5				≤ 0,5				W
Accelerating electrode to body voltage	-11,5	-13,0	-14,5	-16,0	-14,5	-16,0	-15,0	-16,5	kV
Cathode current	0,6	0,4	0,5	0,3	0,5	0,3	0,5	0,3	A [14])
Output power	2,2	1,1	2,2	1,1	2,2	1,1	2,2	1,1	kW

Notes see page 10

NOTES TO "TYPICAL OPERATION"

1) In case of failure the beam voltage must be switched-off and made to drop below 5 % of its nominal value within 500 ms after occurrence of this failure.

2) Fluctuations up to ± 3 % will not damage the tube ; to obtain a good signal transfer quality the beam voltage should not vary more than ±1 %.

3) To be adjusted for the stated cathode current.

4) The signal transfer quality is measured at matched load (VSWR ≤ 1, 05).

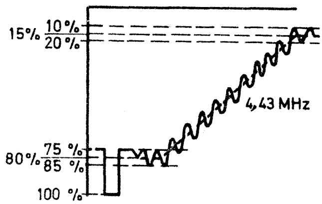
5) Calculated from $(1 - V_{black}/V_{sync})_{in} / (1 - V_{black}/V_{sync})_{out}$

6) Measured with 10 to 75 % modulation without compensation ; V.S.B. filter between driving stage and klystron.

7) Produced by the klystron itself ; without hum from power supplies.

8) Measured with a staircase signal of 10 to 75 % of the peak sync value.

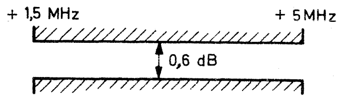
9) Measured with a sawtooth voltage with an amplitude between 15 and 80 % of the peak sync value on which is superimposed a 4, 43 MHz sine wave with a 10 % peak to peak value.



10) Phase difference to burst signal.

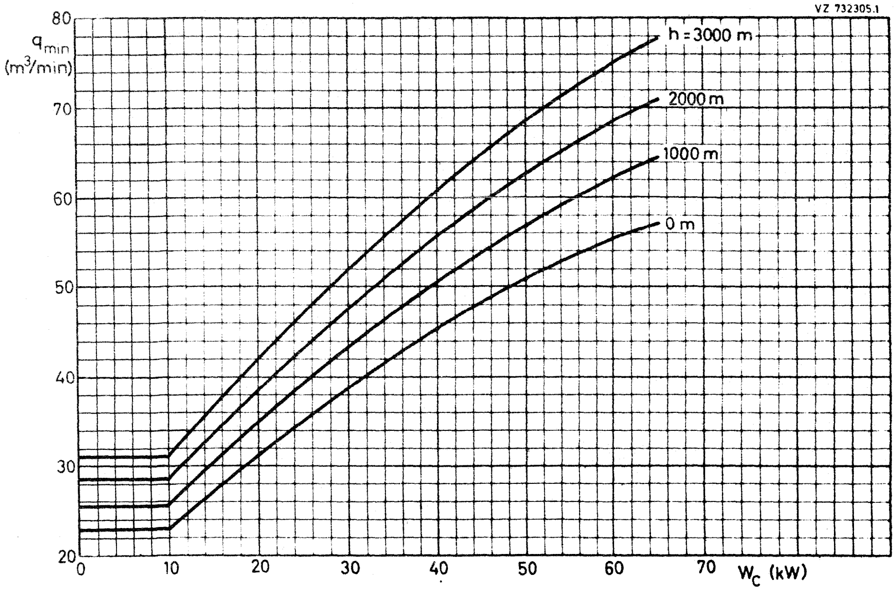
11) With respect to ± 0, 5 MHz around the carrier frequency.

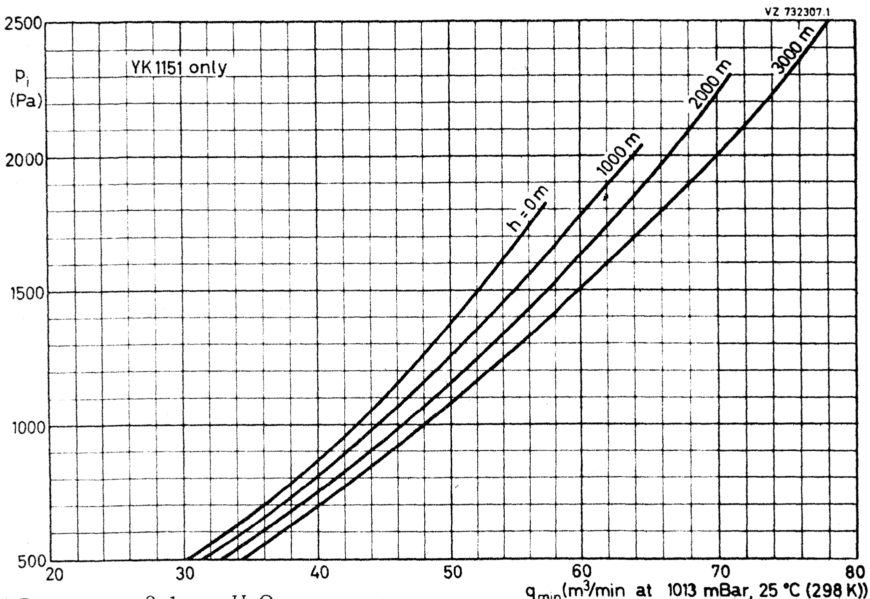
12) With respect to indicated tolerance range



13) With increased driving power under the given operating conditions, without guaranty for signal transfer quality.

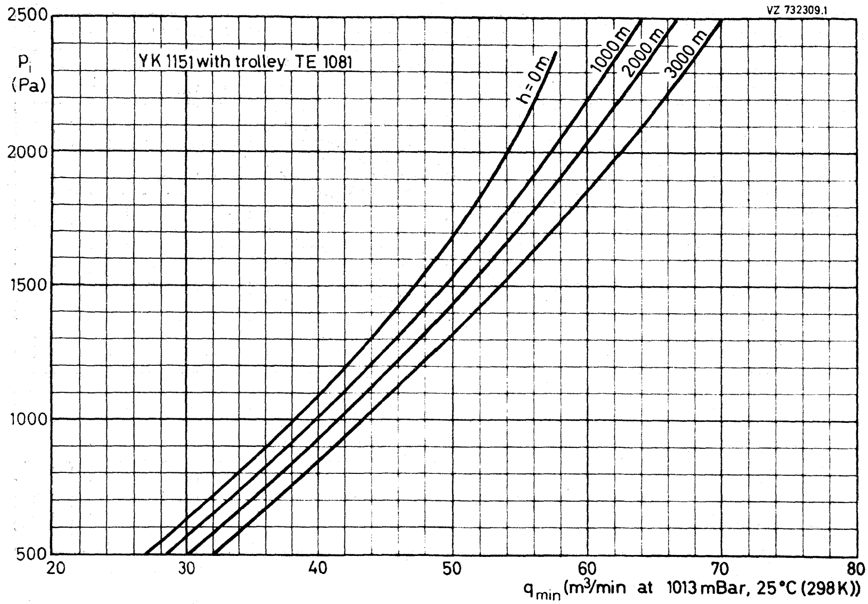
14) Cathode current adjusted by accelerating electrode voltage (coarse) , and focusing electrode voltage (fine).





1 Pa = approx. 0,1 mm H_2O

The above curves apply to air inlet temperatures up to 45 °C.



1 Pa = approx. 0, 1 mm H_2O

The above curves apply to air inlet temperatures up to 45 °C.

Klystrons, medium and low 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.

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]

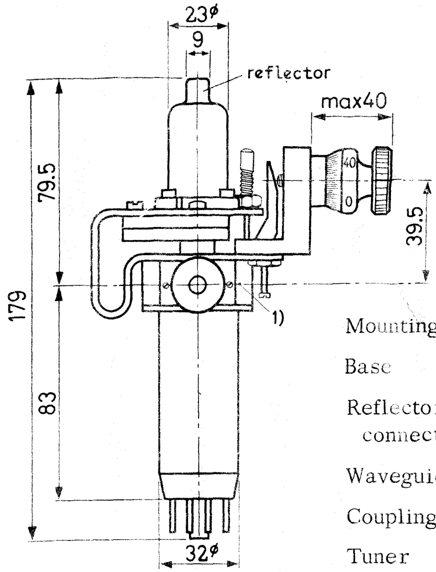
TYPICAL CHARACTERISTICS

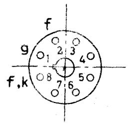
Mechanical tuning range	f	=	67 to 74	GHz
Mechanical tuning rate, average over range		=	3.5 GHz	per turn

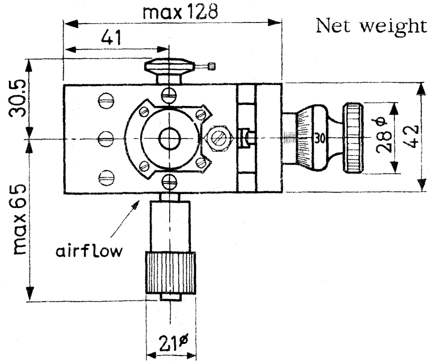
All voltages are given with respect to the cathode

[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 ø

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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	Δf	=	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.

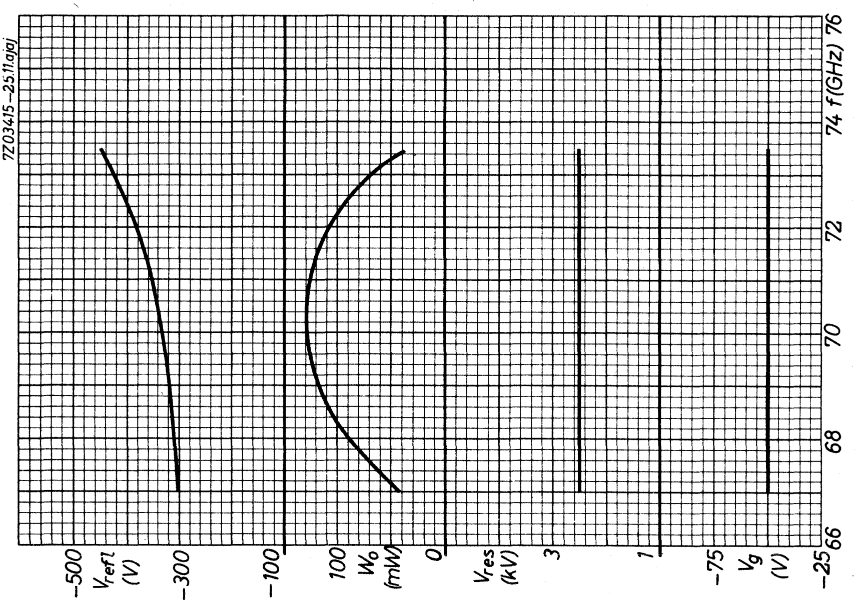
Before applying any voltage be sure that the reflector is connected and the series impedance between reflector and cathode does not exceed 75 kΩ.
The reflector voltage must never be allowed to become positive with respect to the cathode. In doubtful cases a diode should be applied between the reflector and cathode to prevent the reflector from becoming positive.
Further the reflector voltage must be applied prior to the resonator voltage.

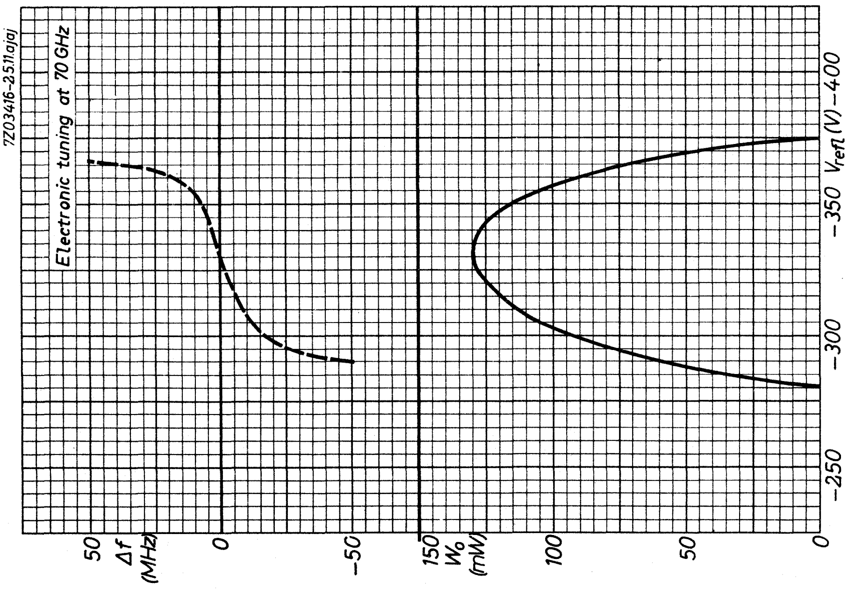
The internal impedance of the grid supply should not exceed 10 kΩ.

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
f (GHz)
66
68
70
72
74
76
-500
V_{refl} (V)
-300
-100
100
W_o (mW)
0
V_{res} (kV)
3
1
-75
V_g (V)
-25


7Z03416-25.11.ajaj
Electronic tuning at 70 GHz
V_{refl} (V)
-250
-300
-350
-400
50
Δf (MHz)
0
-50
150
W_o (mW)
100
50
0

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	

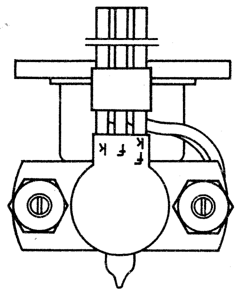
LIMITING VALUES (Absolute limits)

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

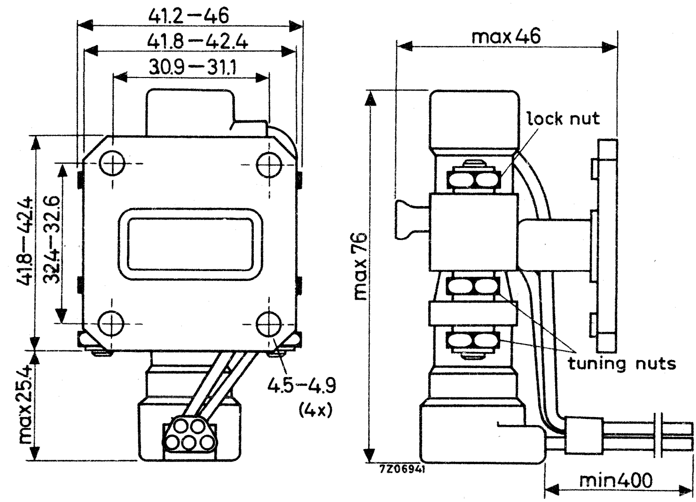


Warning

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 (WR90)

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

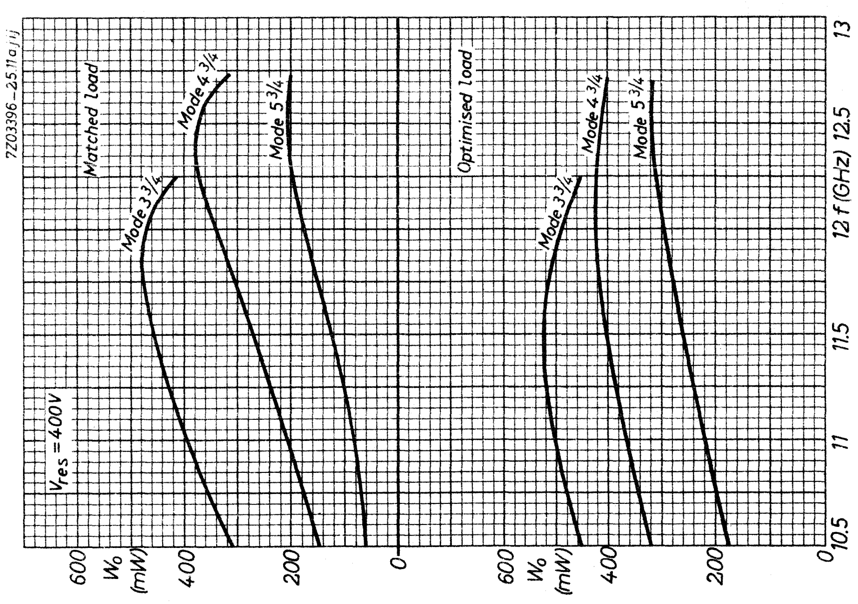
TYPICAL CHARACTERISTICS

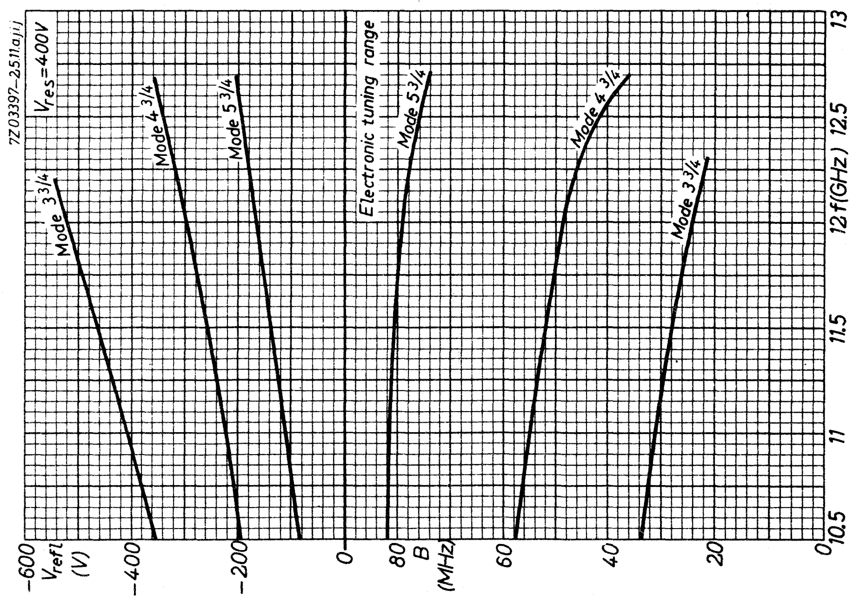
Mechanical tuning range	f	=	10.5 to 12.2	GHz
Electronic tuning range between half-power points at any point in the mechanical tuning range at V_{res} = 400 V	Δf	>	30	MHz
Reflector modulation sensitivity at f = 10.5 to 12.2 GHz	$\frac{\Delta f}{\Delta V_{refl}}$	=	0.8 to 2.0	MHz per V
Power output at 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	Δf	=	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	Δf	= 1 <	3	MHz
0 to 30 km altitude	Δf	= 2 <	10	MHz
Frequency modulation under vibration of 5 g applied to the flange (50 to 5000 Hz in three planes)	Δf	<	4	MHz

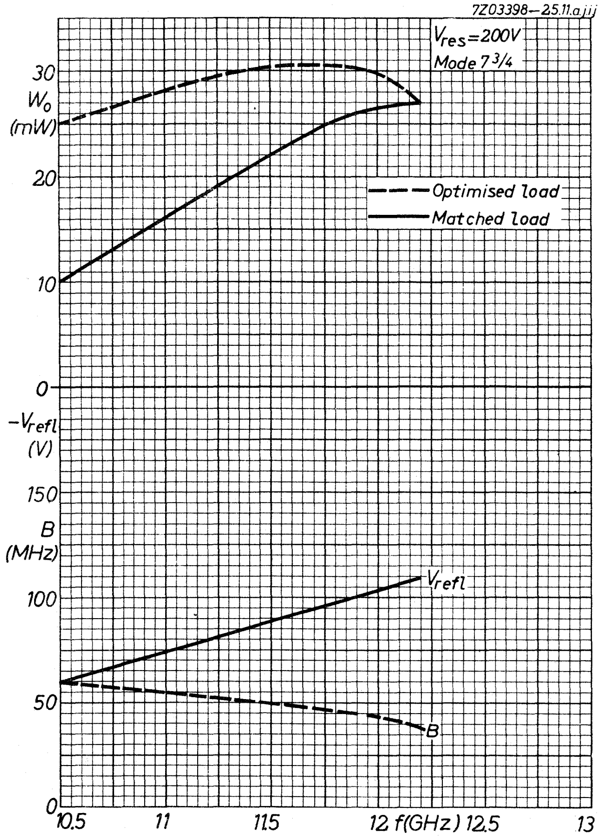
OPERATING CHARACTERISTICS

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		Δf	=	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		Δf	=	60	50	38	MHz


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)
f (GHz)
10.5
11
11.5
12
12.5
13
600
400
200
0


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)
B (MHz)
f (GHz)
10.5
11
11.5
12
12.5
13
−600
−400
−200
0
80
60
40
20
0



7Z03398—25.11.ajij
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 light weight reflex klystron with integral cavity and wave-guide 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	Δf		> 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	Δf	=	0.5	MHz
Temperature coefficient in the range t_{amb} = −10 to +40 °C	$\frac{\Delta f}{\Delta t}$		< 0.25	MHz per °C

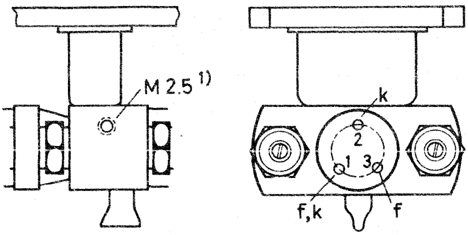
OPERATING CHARACTERISTICS

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		Δf	=	58	52	47	MHz
Reflector modulation coefficient		$\frac{\Delta f}{\Delta V_{refl}}$	=	1.0	1.0	1.0	MHz /V

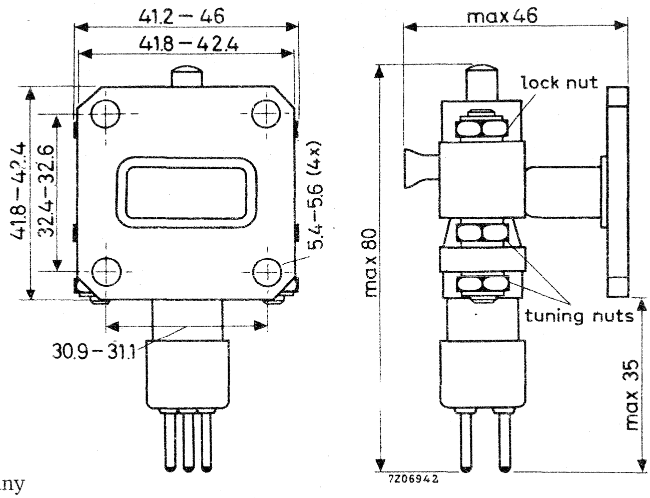
Frequency		f	=	10.5	11.5	12.2	GHz
Resonator voltage		V_{res}	=	200	200	200	V
Resonator current		I_{res}	=	23	23	23	mA
Reflector voltage		V_{refl}	=	−60	−90	−110	V
Output power	matched load	W_o	=	10	22	27	mW
	optimised load	W_o	=	25	30	27	mW
Electronic tuning range between half-power points		Δf	=	60	50	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

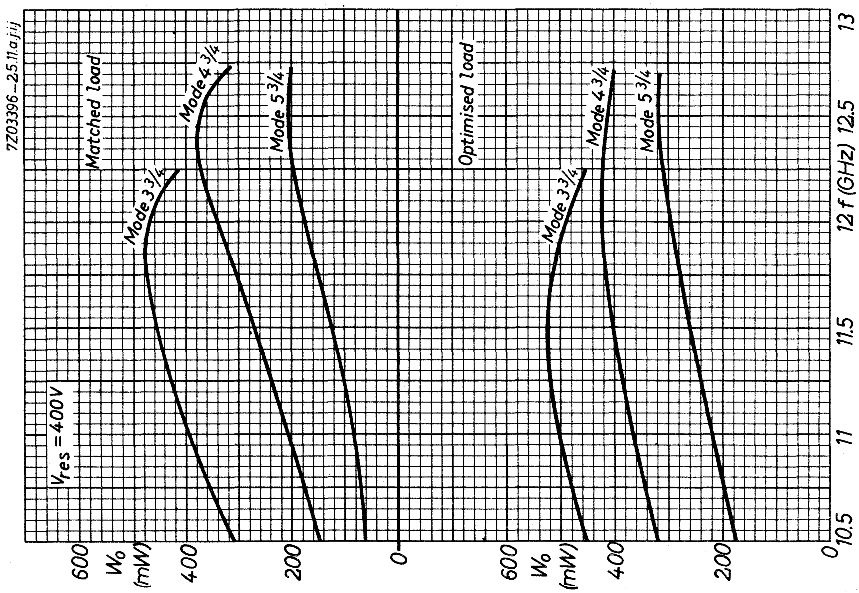
Loosen both tuning nuts at socket side. Turn both nuts in centre in small steps to the left or to the right until required frequency is obtained.
Then fix lower nuts again.
Do not touch lock nut at reflector side.

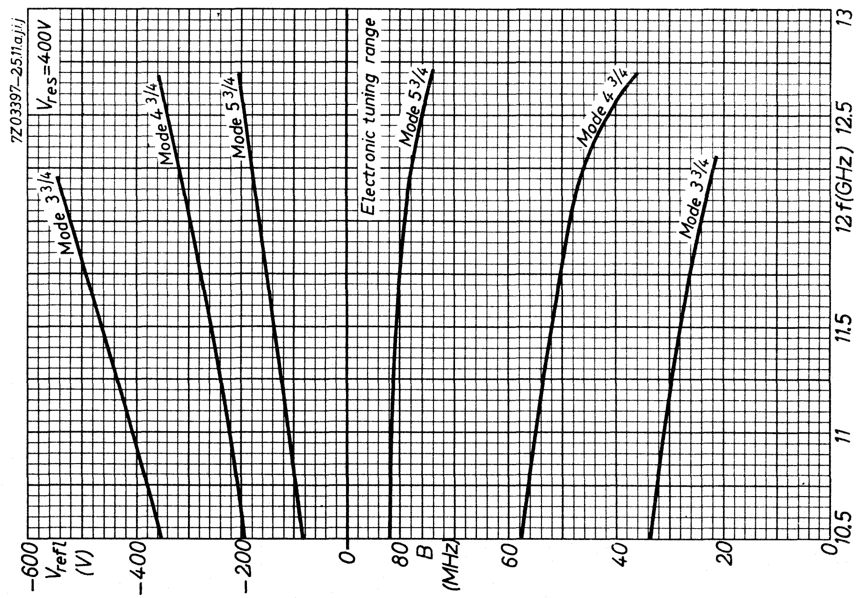
WARNING

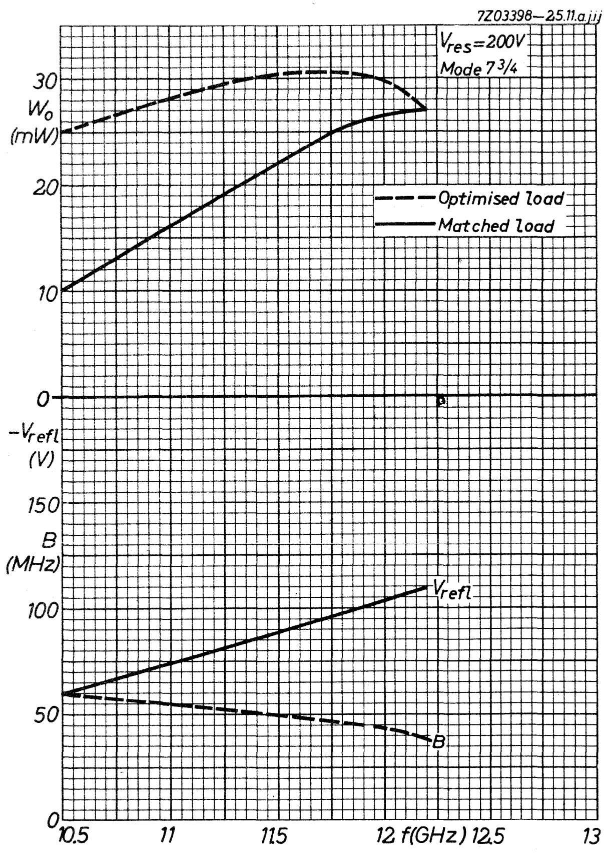
Do not apply the heater voltage to the cathode pin as this will result in the destruction of the tube.

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
Mode 3 3/4
Mode 4 3/4
Mode 5 3/4
V_{res} = 400V
W_o (mW)
f (GHz)
0
200
400
600
10.5
11
11.5
12
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)
B (MHz)
f (GHz)
-600
-400
-200
0
80
60
40
20
10.5
11
11.5
12
12.5
13


7Z03398—25.11.a.j.i.j
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

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)

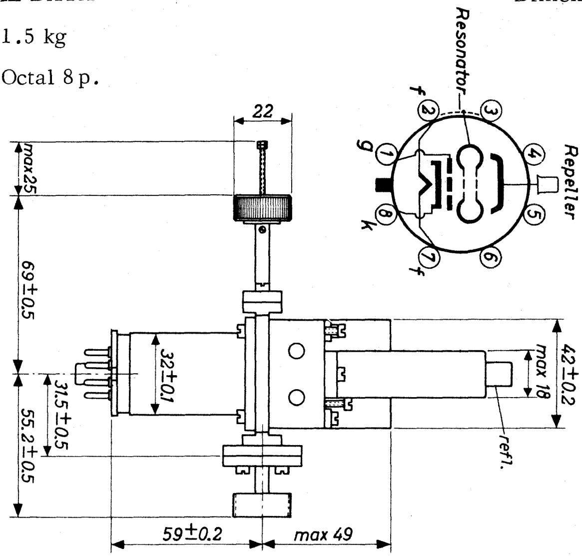
Heater voltage	V_f	=	6.3	V $^{+10\%}_{-2\%}$
Resonator voltage	V_{res}	=	max. 2500	V
Resonator current	I_{res}	=	max. 18	mA
Resonator dissipation	W_{res}	=	max. 45	W
Negative grid voltage	$-V_g$	=	0 to 100	V
Internal impedance of grid bias supply	Z_i	=	max. 1000	Ω
Negative reflector voltage	$-V_{refl}$	=	50 to 600	V
Body temperature	t	=	max. 80	°C

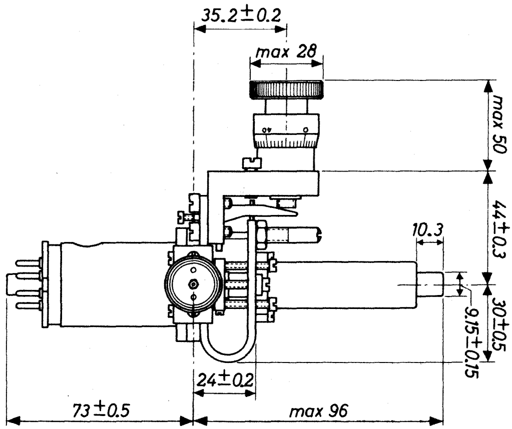
MECHANICAL DATA

Dimensions in mm

Net weight: 1.5 kg

Base : Octal 8 p.





Mounting position: arbitrary

Output waveguide RG-96/U

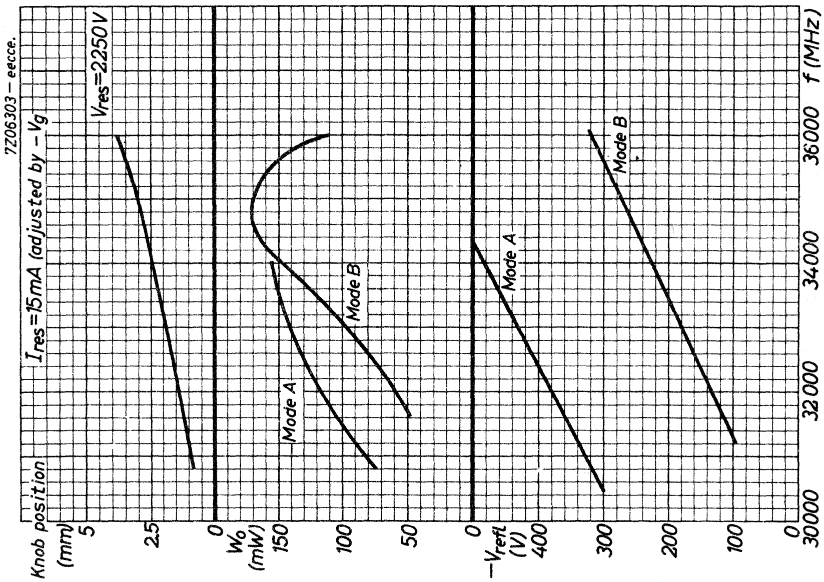
Waveguide coupling system Z830016 (American reference drawing AS-2092)
The parts Z830017 and Z830019 of this coupling system are an integral part of the tube.

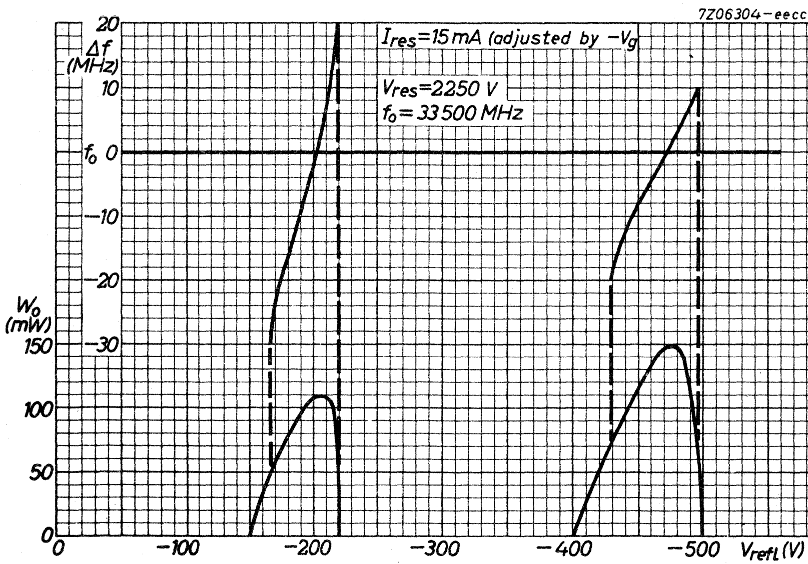
OPERATING CHARACTERISTICS

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	Δf	=	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}=15mA (adjusted by $-V_g$)
V_{res}=2250V
Knob position (mm)
5
2.5
0
W_o (mW)
150
100
50
0
Mode A
Mode B
$-V_{refl}$ (V)
400
300
200
100
0
Mode A
Mode B
f (MHz)
30000
32000
34000
36000


7Z06304–eecce.
I_{res}=15 mA (adjusted by $-V_g$)
V_{res}=2250 V
f_o= 33500 MHz
Δf (MHz)
20
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 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.

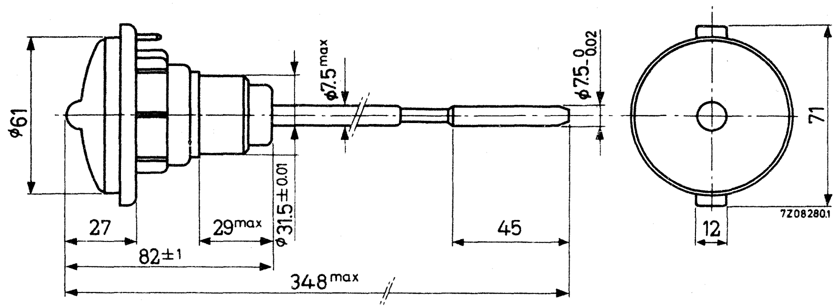
MECHANICAL DATA (continued)

Accessories

Mount type P6L-11, convection cooled, with IEC R70 waveguide input and output (34.84 x 15.80 mm^2)

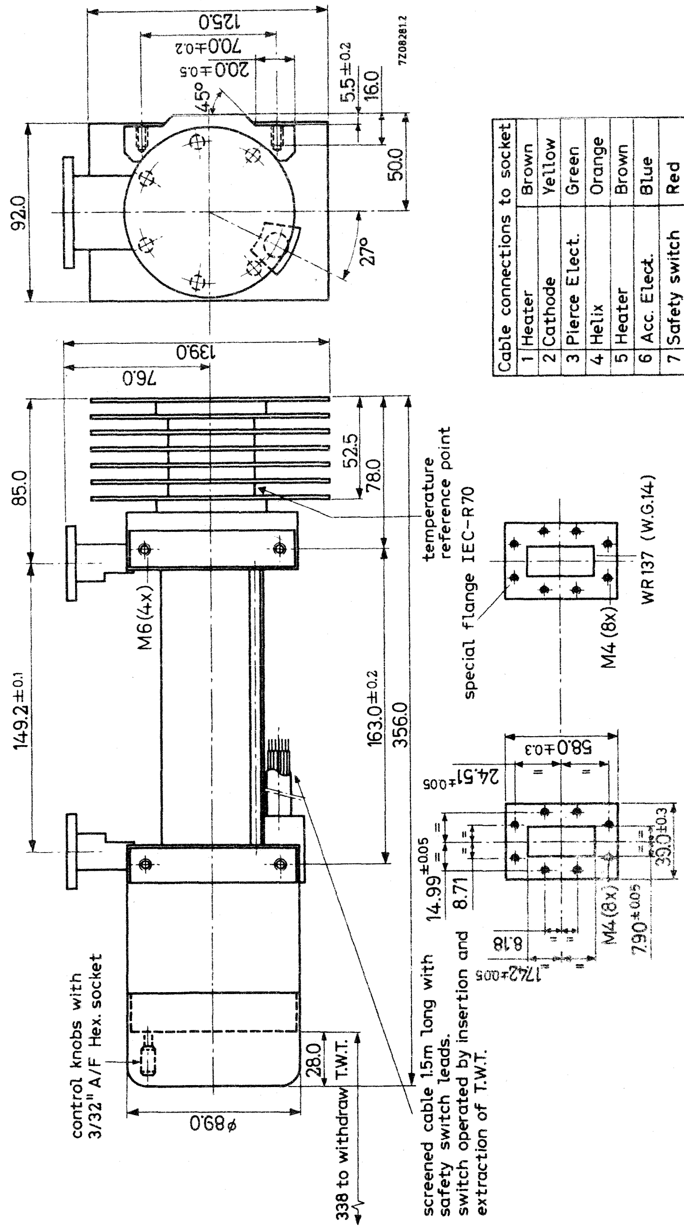
Dimensions and connections

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. min.	2.2 1.8	kV kV
Helix voltage	V_x	max.	4.0	kV
Accelerator voltage	V_{acc}	max.	3.0	kV
Pierce electrode voltage	$-V_{g_1}$	max. min.	250 0	V 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

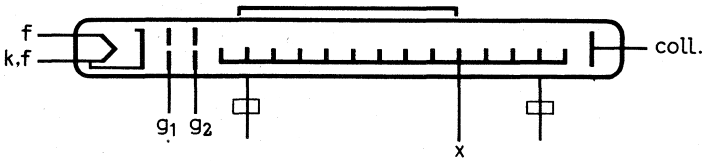
For shorter waiting time when the tube already has been in operation see "Application of voltages".

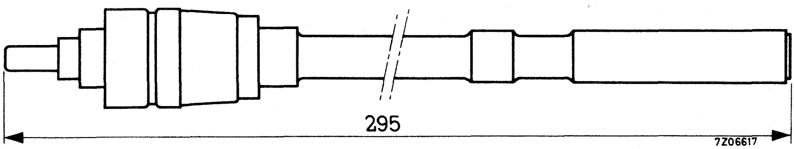
COOLING: Natural cooling
by convection with mount 55329 or
by conduction with mount 55332

MECHANICAL DATA Dimensions in mm

Mounting position : Any. See "Design and operating notes" under "Cooling"

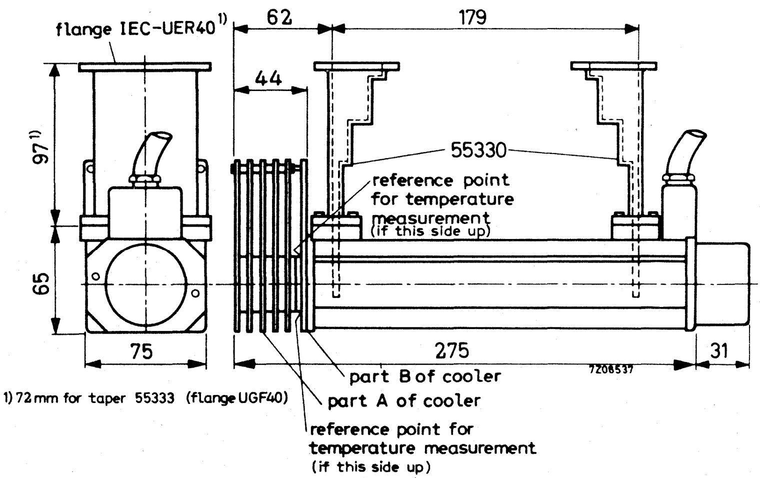
Weight of tube	approx.	60	g
Weight of mount	approx.	4.5	kg





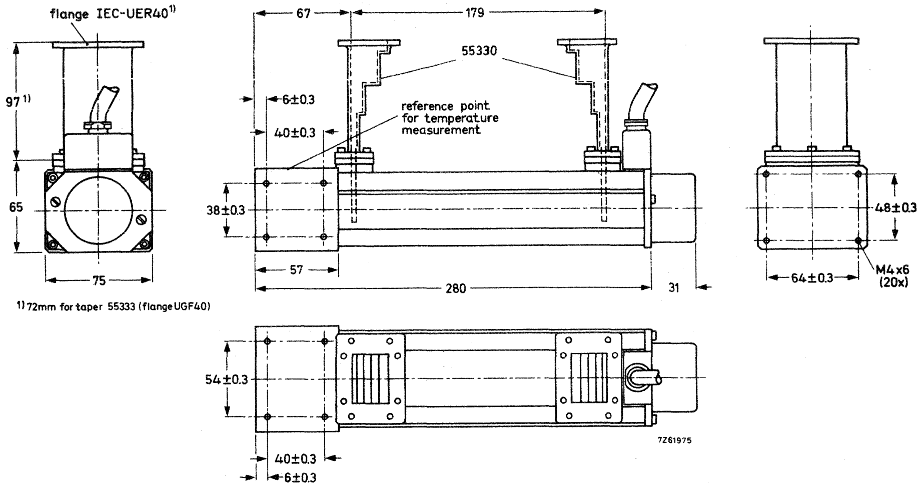
ACCESSORIES (to be ordered separately)

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



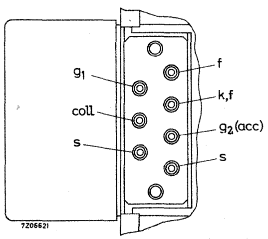
Mount 55332 with conduction (heatsink) cooling and waveguide tapers 55330

Connections

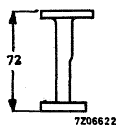
The mount is provided with flying leads, marked with colours

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 <u>Mount type 55329</u>

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 <u>Mount type 55332</u>

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 <u>Magnetic shielding</u>

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.

<u>Warning</u>

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.

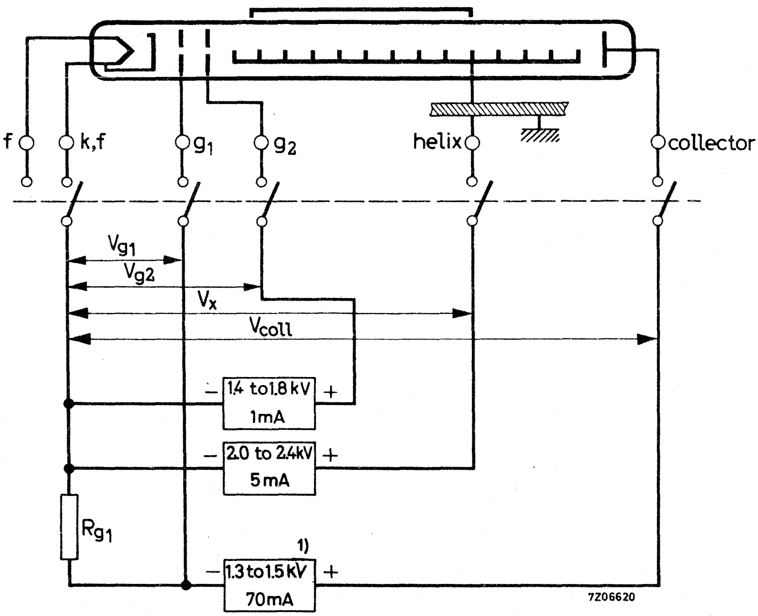
4. SAFETY

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.

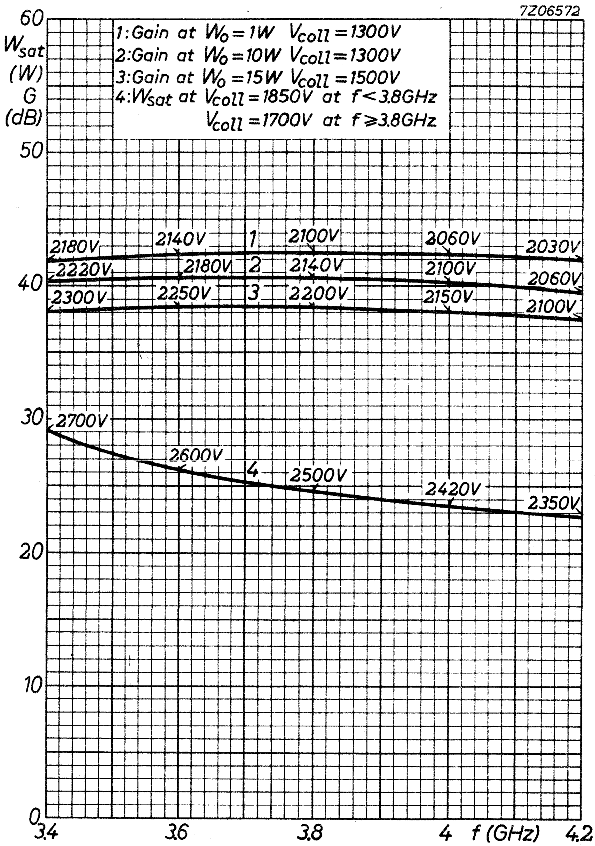
9 ENVIRONMENTAL CONDITIONS

Ambient temperature

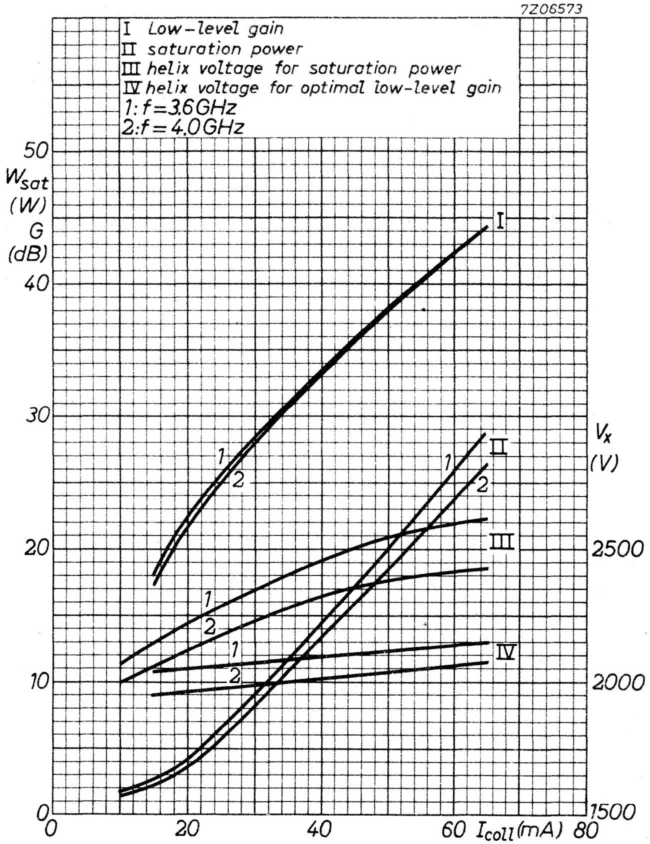
storage	t_{amb}	min.	-60	^{o}C
		max.	+65	^{o}C
operation	t_{amb}	min.	-30	^{o}C
		max.	+65	^{o}C
Relative humidity			0 to 95	%

The tube and mount resist fungus attack.

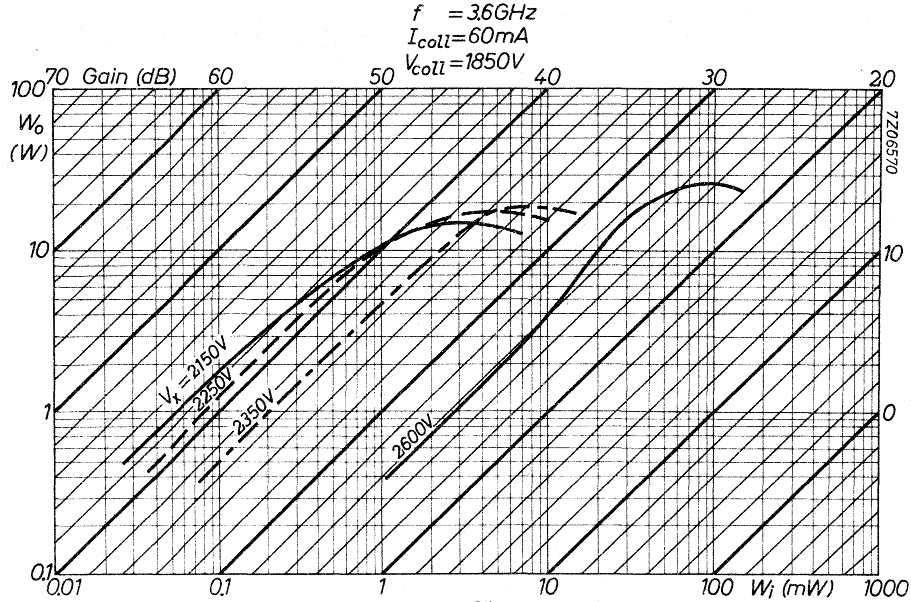
For changes in gain and helix current over the specified temperature range see curves on page 19



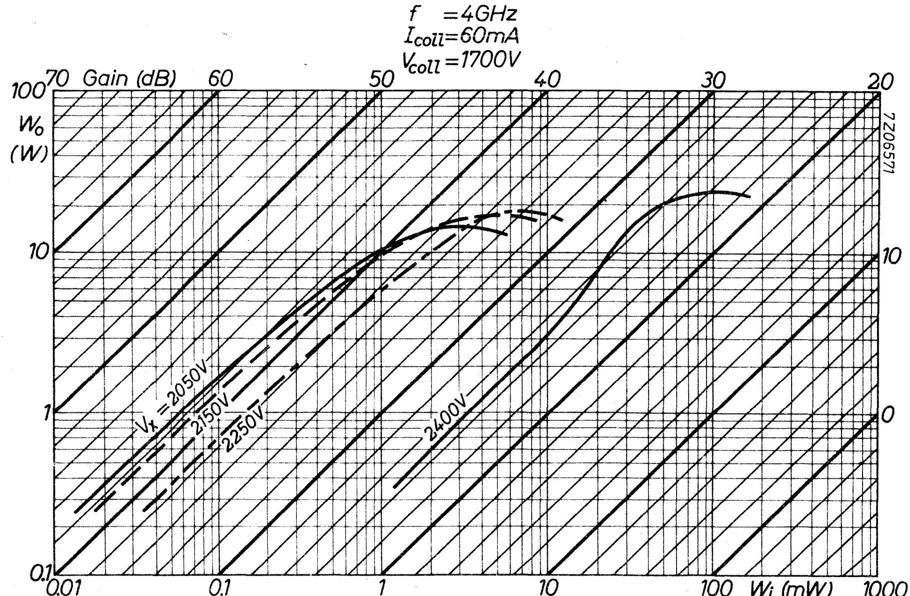
Gain and saturation power = f(frequency)



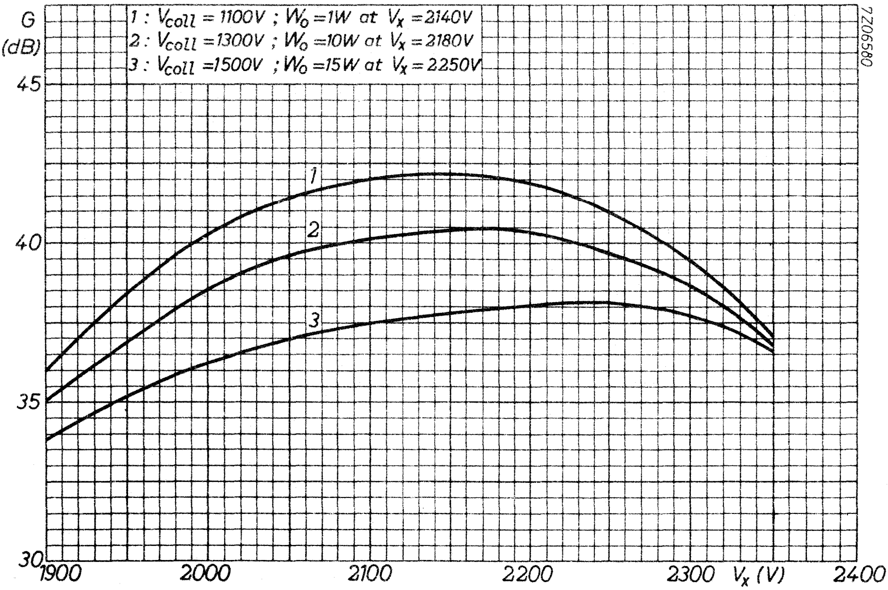
Gain and saturation power = f(collector current)



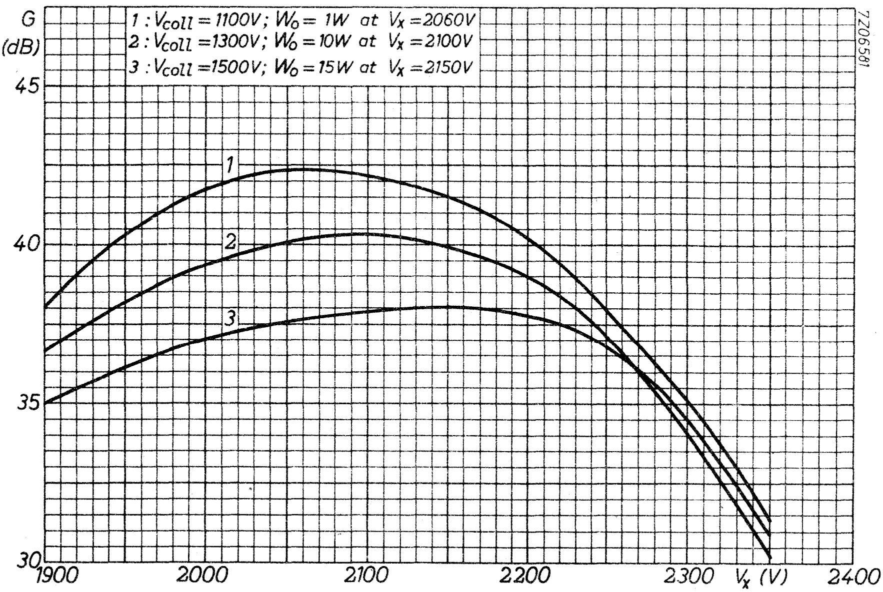
output power = f(input power)



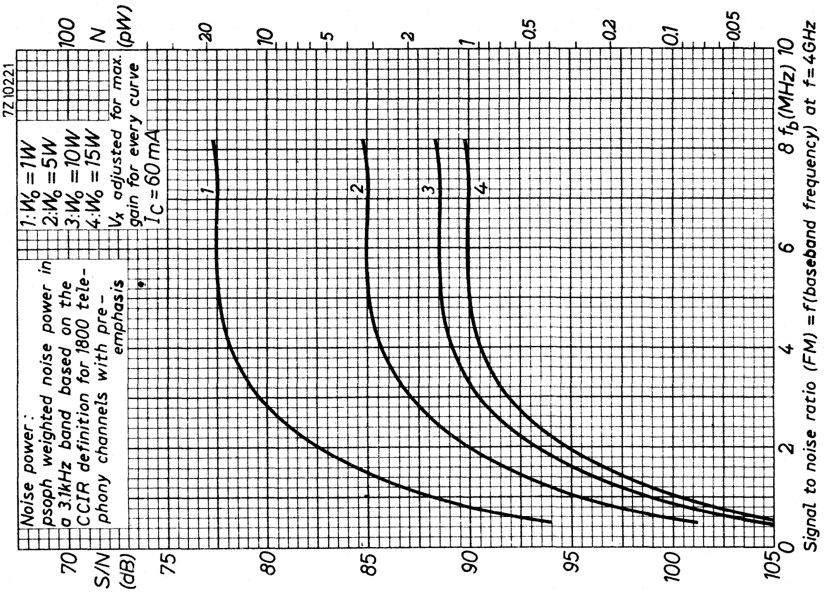
output power = f(input power)

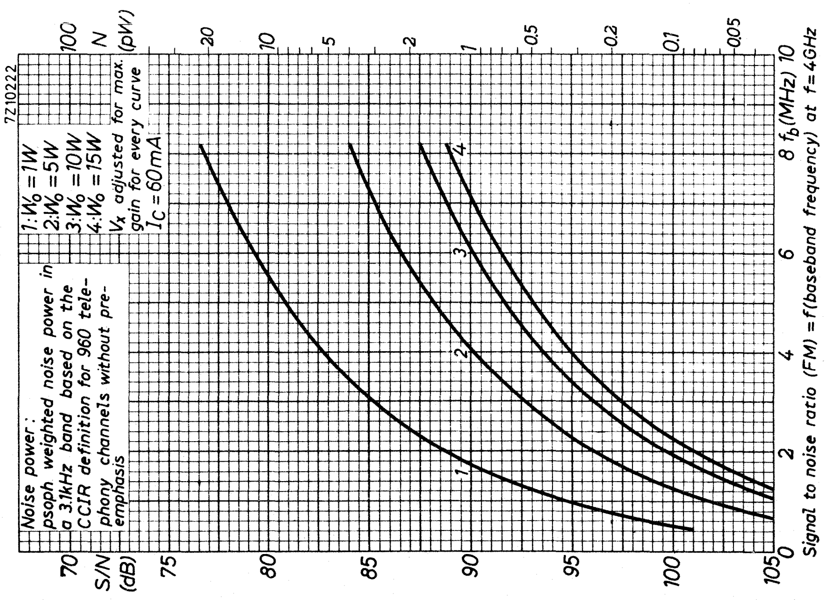


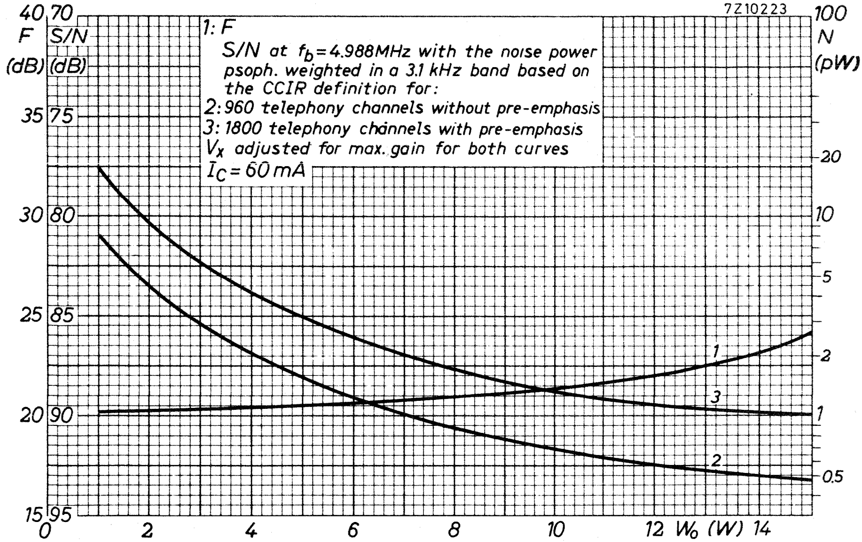
Gain = f(helix voltage) f = 3.6GHz



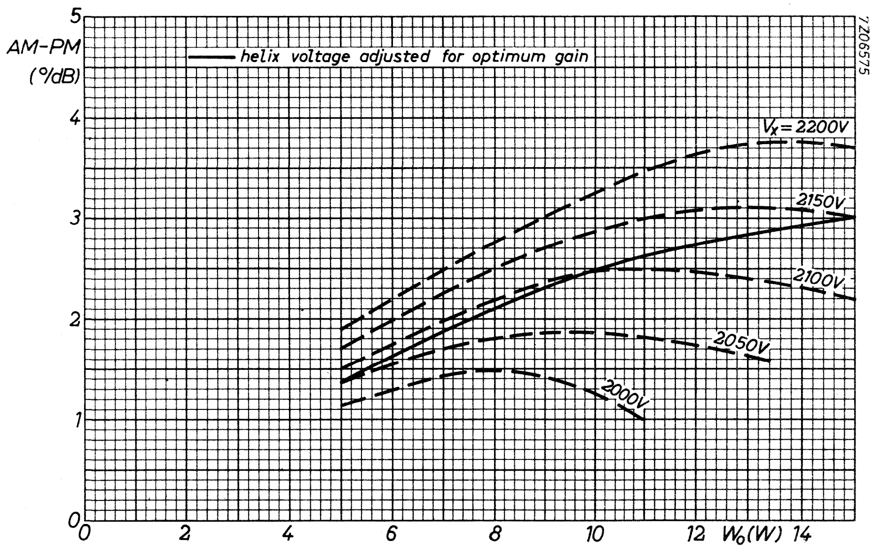
Gain = f(helix voltage) f = 4GHz


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 = 60 mA
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
10
f_b (MHz)
1
2
3
4
Signal to noise ratio (FM) = f(baseband frequency) at f = 4GHz

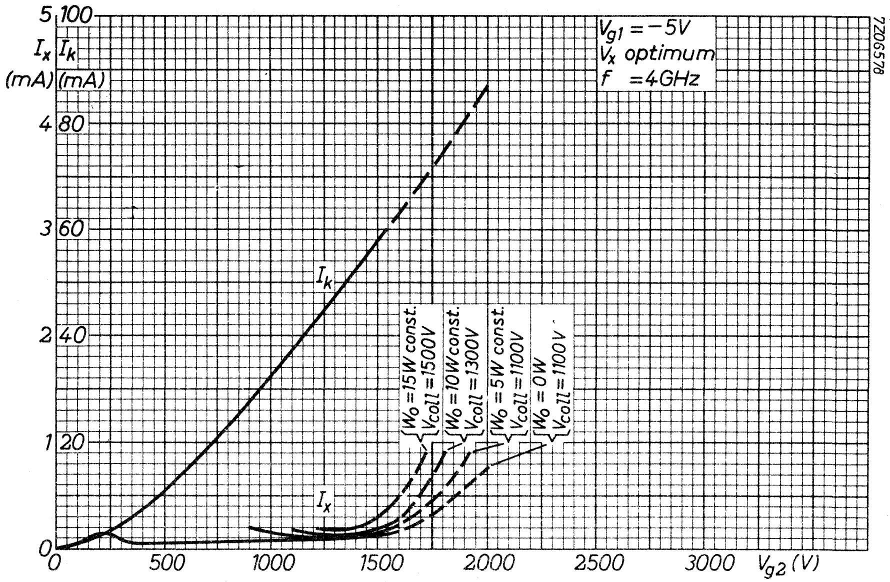

7Z10222
Noise power:
psoph weighted noise power in a 3.1kHz band based on the CCIR definition for 960 telephony channels without pre-emphasis
1: W_o = 1W
2: W_o = 5W
3: W_o = 10W
4: W_o = 15W
V_x adjusted for max. gain for every curve
I_C = 60 mA
S/N (dB)
70
75
80
85
90
95
100
105
N (pW)
100
20
10
5
2
1
0.5
0.2
0.1
0.05
0
2
4
6
8
10
f_b (MHz)
1
2
3
4
Signal to noise ratio (FM) = f(baseband frequency) at f = 4GHz



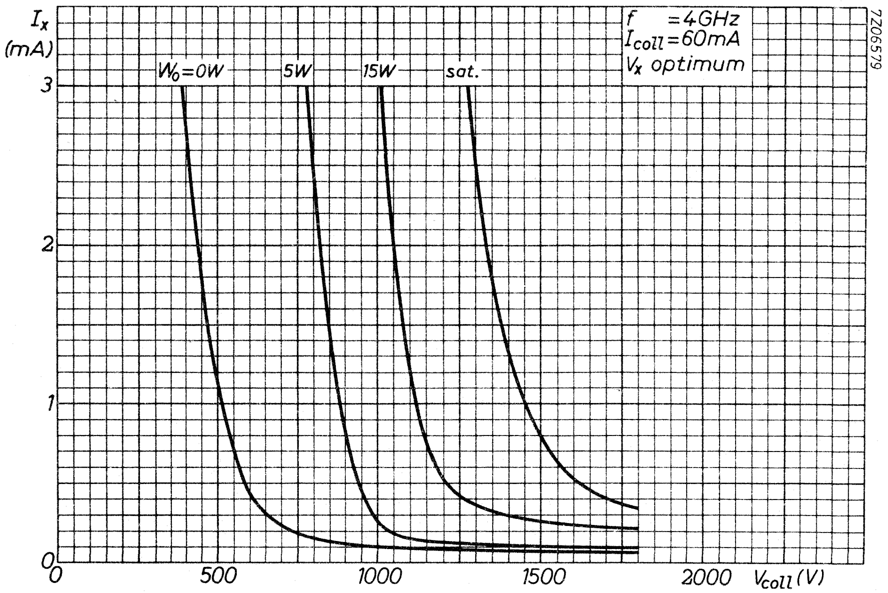
Thermal noise (FM) = f(output power) at f = 4 GHz



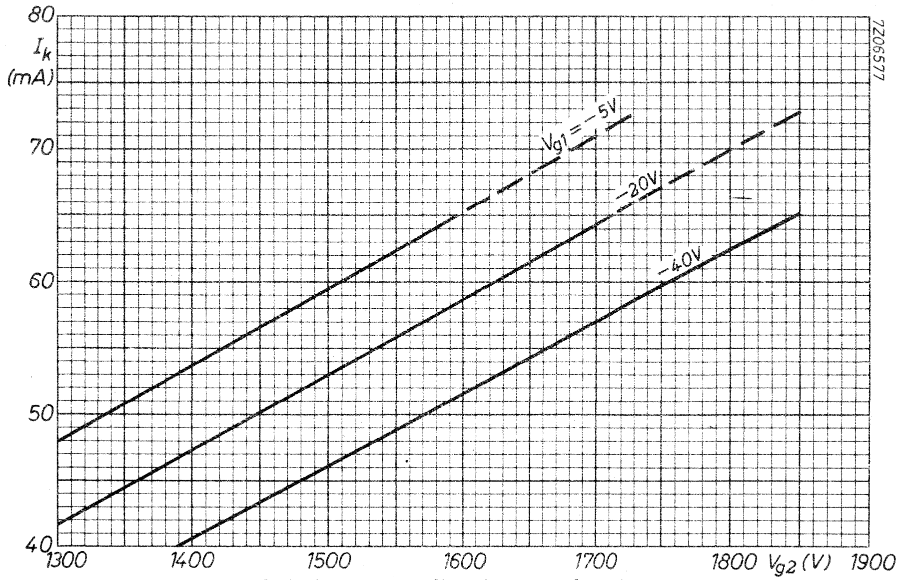
AM to PM conversion = f(output power) at f = 4 GHz



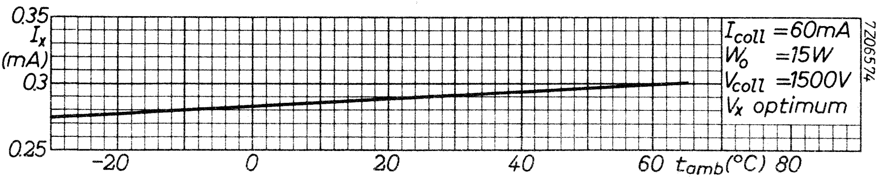
Cathode current and helix current = f(accelerator voltage)

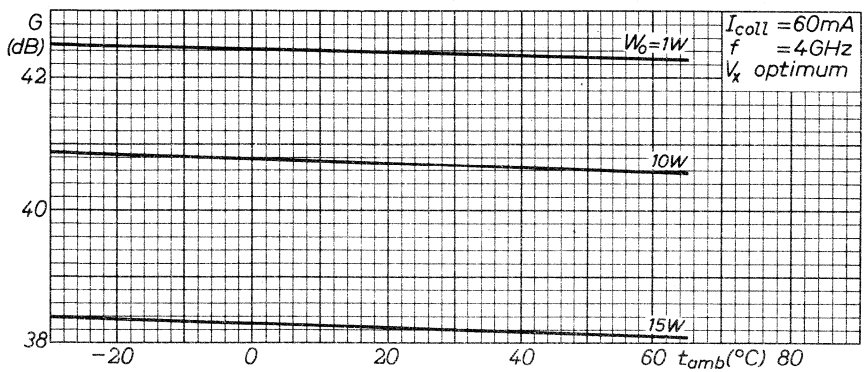


Helix current = f(collector voltage)



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

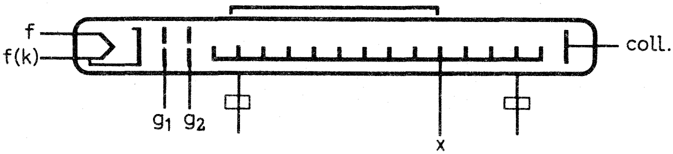
For shorter waiting time when the tube already has been in operation see "Application of voltages".

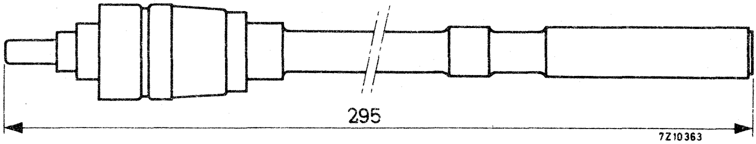
COOLING : By conduction. See also page 9.

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





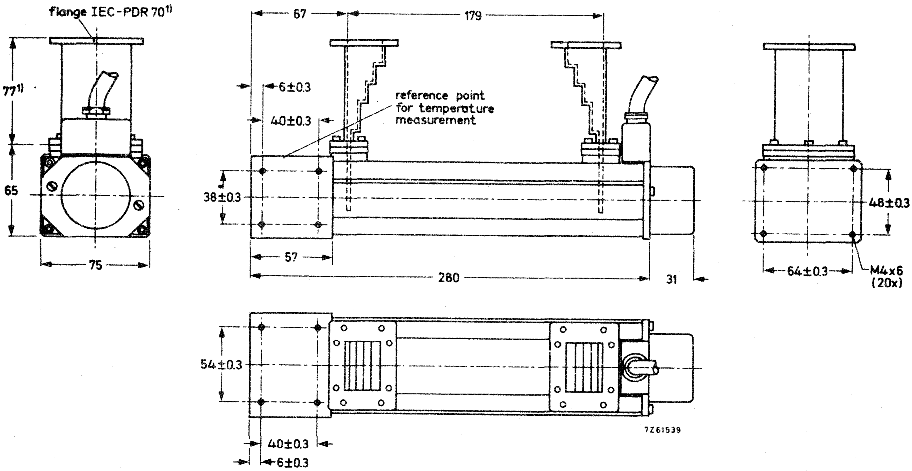
ACCESSORIES (to be ordered separately)

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



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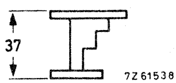
1) Flange IEC-UER-84

Waveguide taper 55342

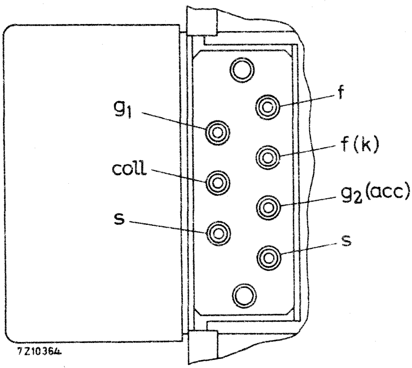


Connections

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	^{o}/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 ^{o}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	^{o}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

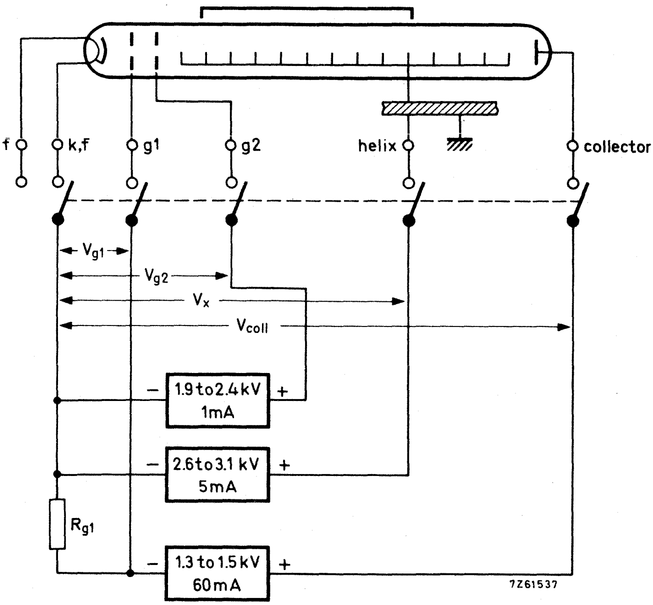
An example of a supply circuit for 5, 10 and 15 W operation is given in the figure.

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 °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 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.

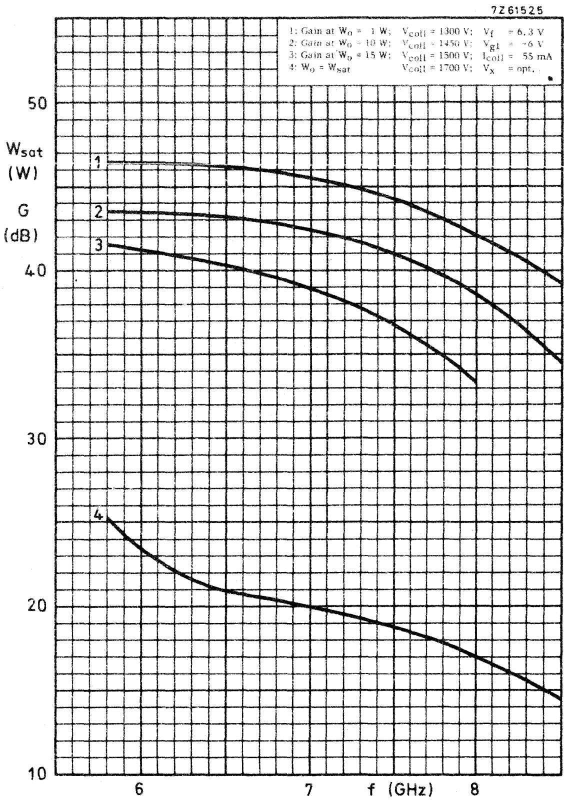
8. ENVIRONMENTAL CONDITIONS

Ambient temperature

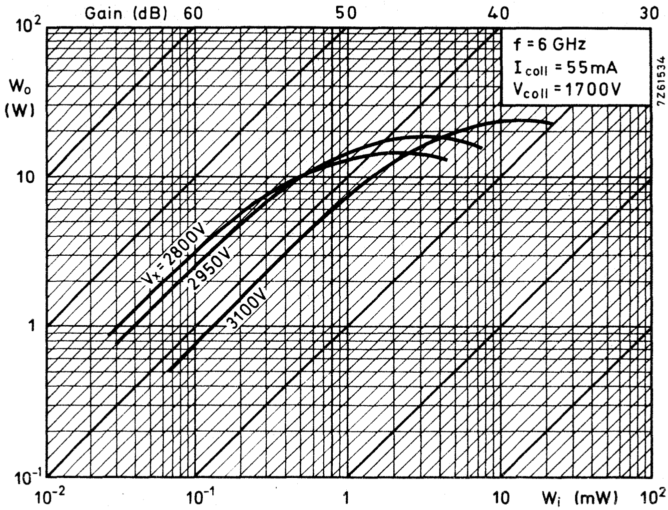
storage	t_{amb}	min.	−60	°C
		max.	+65	°C
operation	t_{amb}	min.	−30	°C
		max.	+65	°C

Relative humidity 0 to 95 %

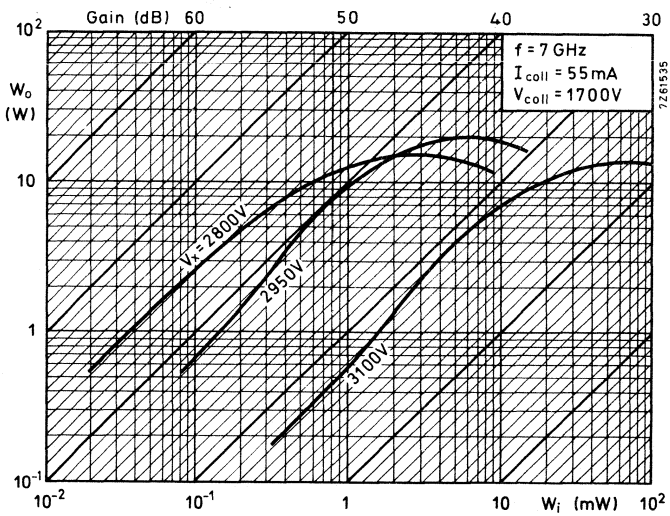
The tube and mount resist fungus attack.



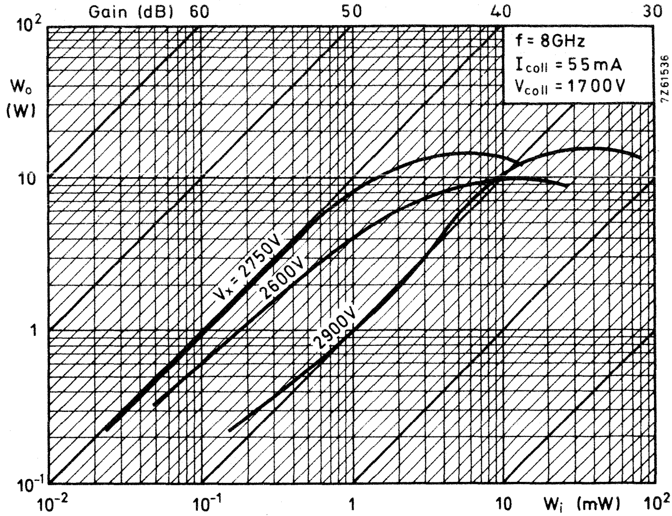
Gain and saturation power = f (frequency)



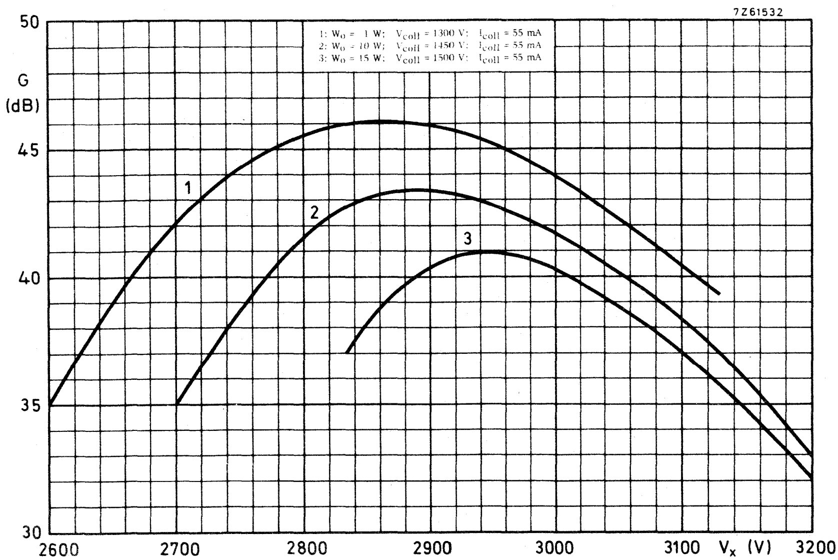
Output power = f (input power)



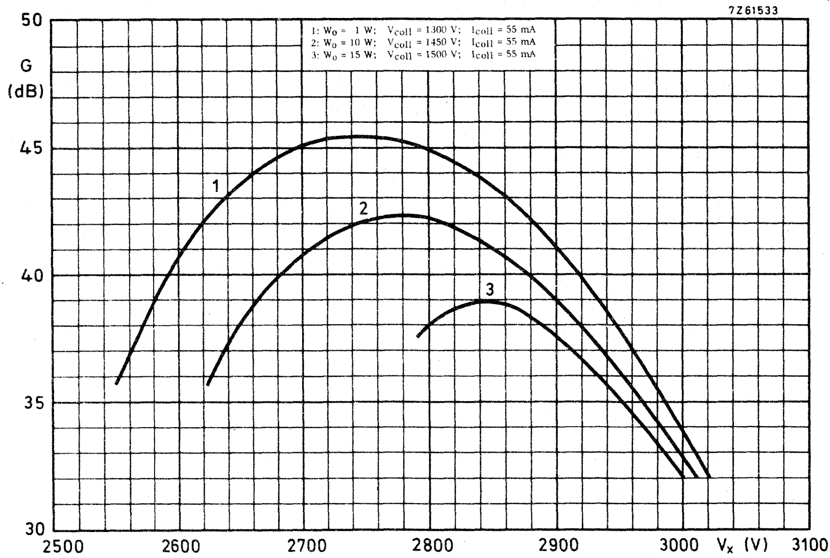
Output power = f (input power)



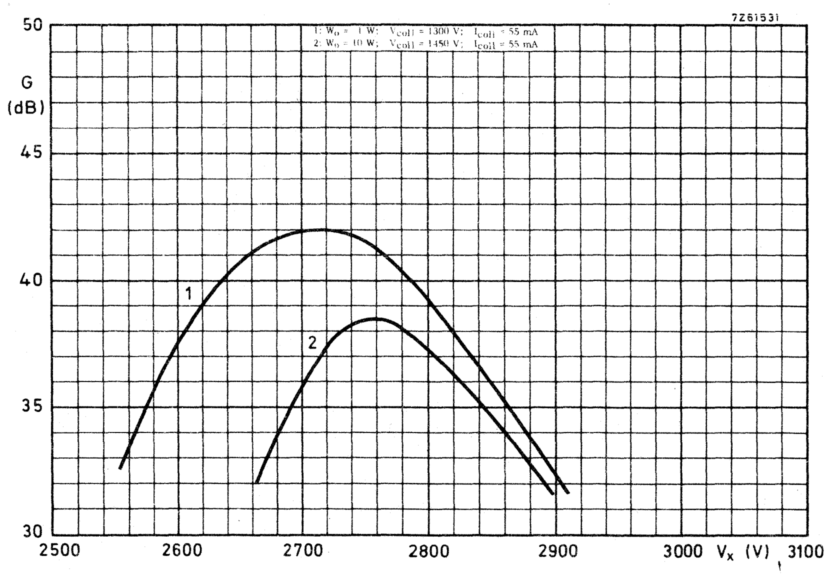
Output power = f (input power)



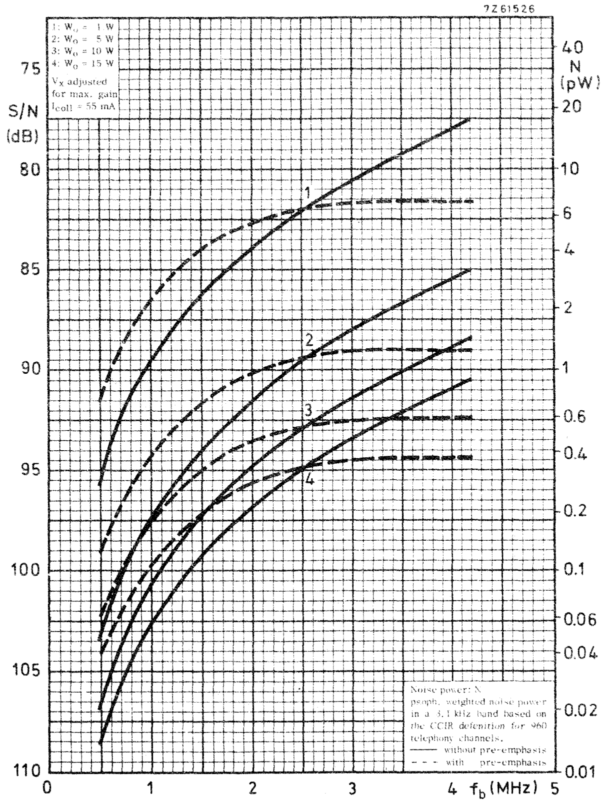
Gain = f (helix voltage) f = 6 GHz



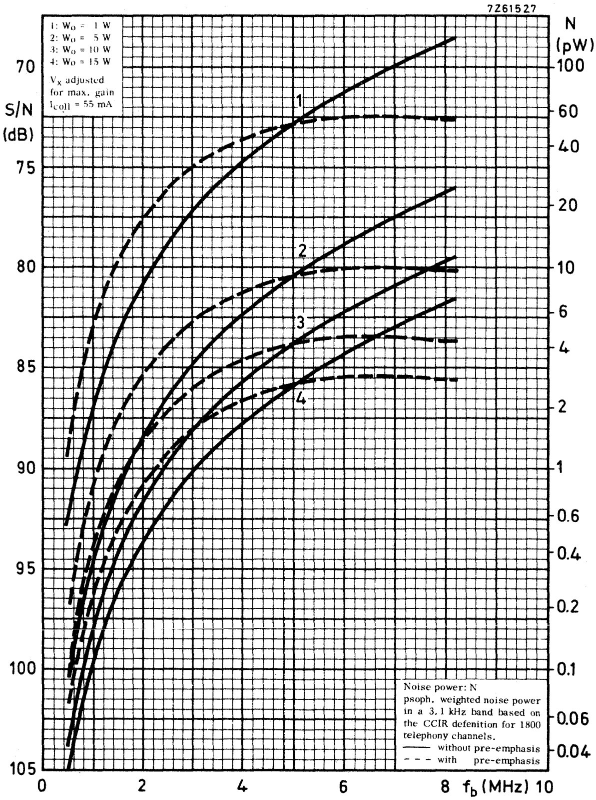
Gain = f (helix voltage)   f = 7 GHz



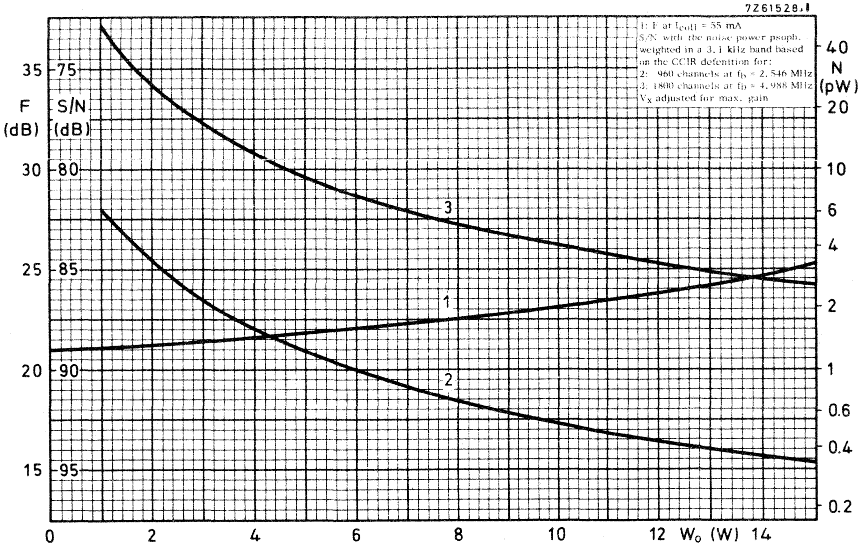
Gain = f (helix voltage)   f = 8 GHz



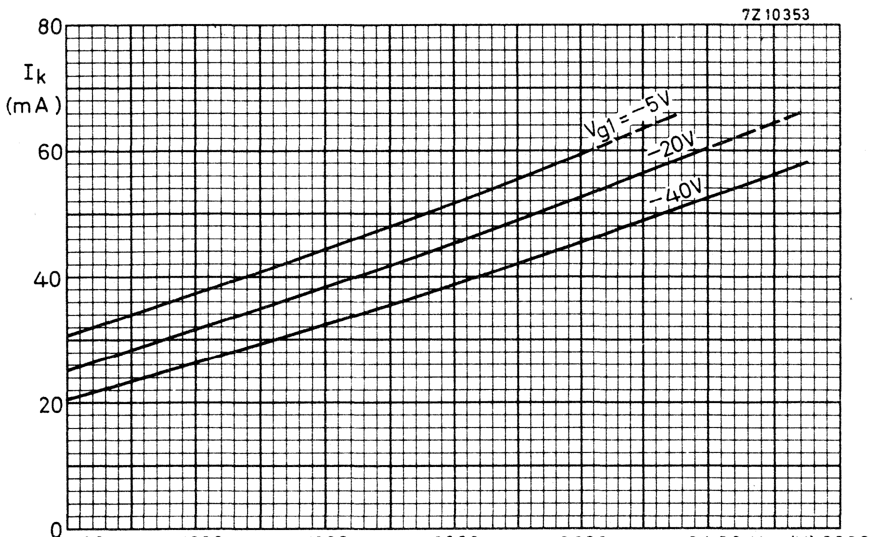
Signal to noise ratio (FM) = f (baseband freq.) at f = 6 GHz



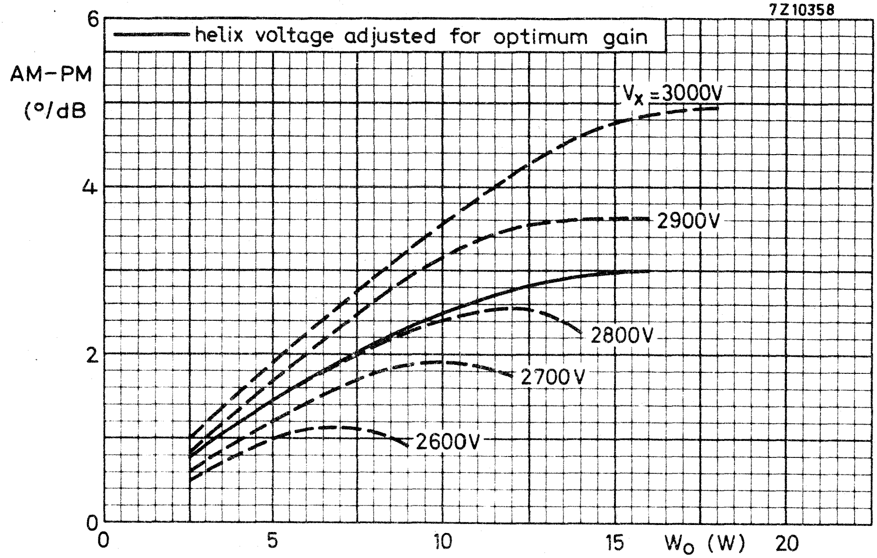
Signal to noise ratio (FM) = f (baseband freq.) at f = 6 GHz



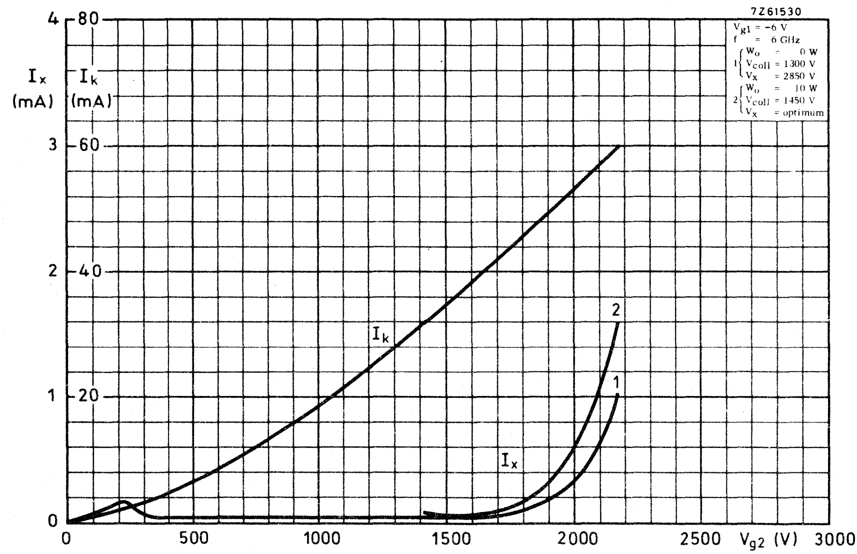
Thermal noise (FM) = f (output power) at f = 6 GHz



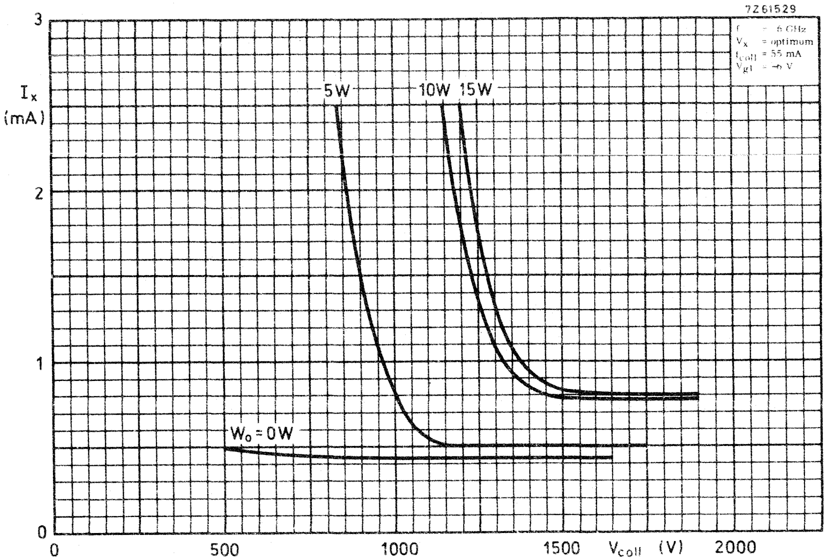
Cathode current = f (accelerator voltage)



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

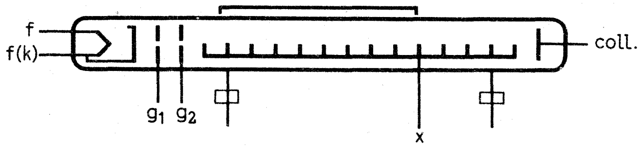
For shorter waiting time when the tube already has been in operation see "Application of voltages".

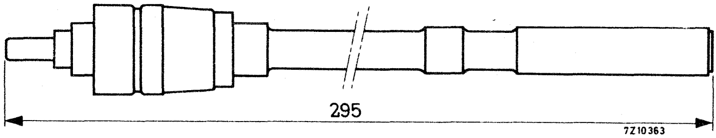
COOLING : By conduction. See also page 9.

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

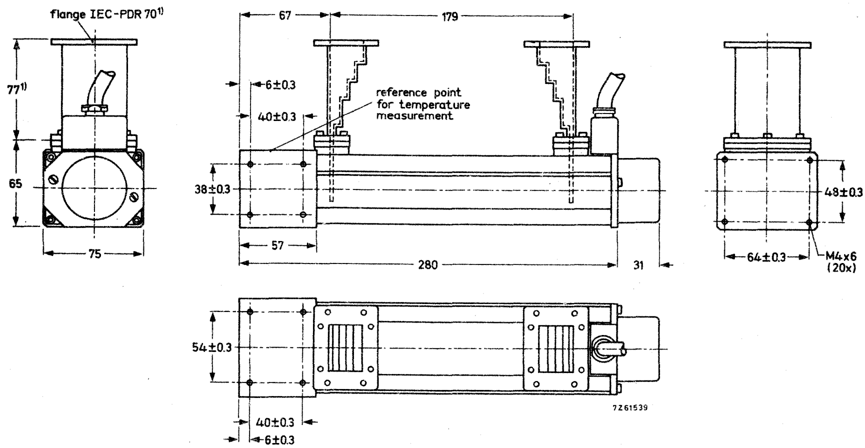


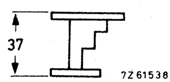


ACCESSORIES (to be ordered separately)

→ PPM mount for conduction cooling	type	55361
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 falnge mating IEC-UER84	type	55342

Mount with conduction (heatsink) cooling and waveguide tapers type 55338





Flange IEC-UER84

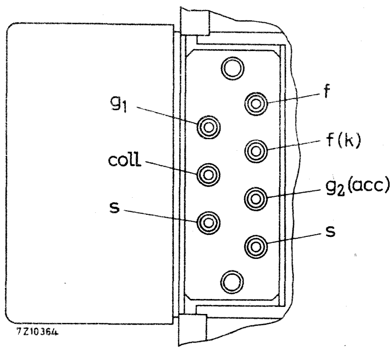
1) Waveguide taper 55342

Connections

The mount is provided with a cable with colour marked leads:

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_{g1}		−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_{g2}	approx.	2050	2000	2000	V
Accelerator current	I_{g2}		<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	°/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_{g1}		−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_{g2}	approx.	2050	2000	2000	V
Accelerator current	I_{g2}		<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	°/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	°/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 °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

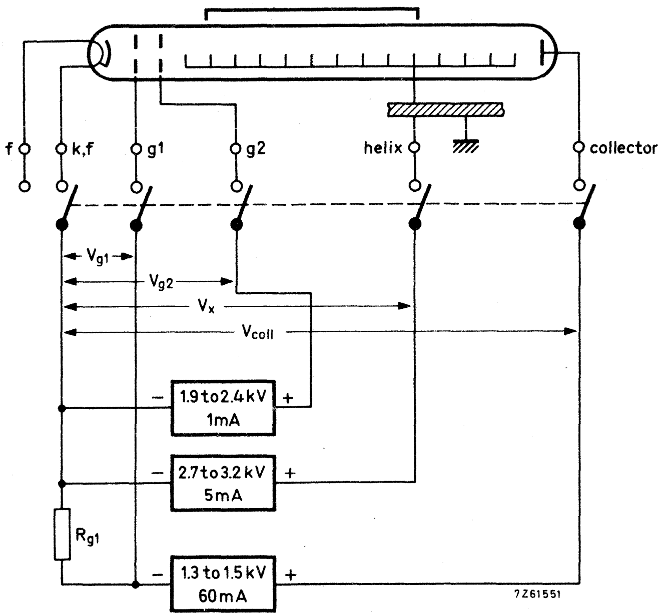
An example of a supply circuit for 5, 10 and 15 W operation is given in the figure.

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	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.

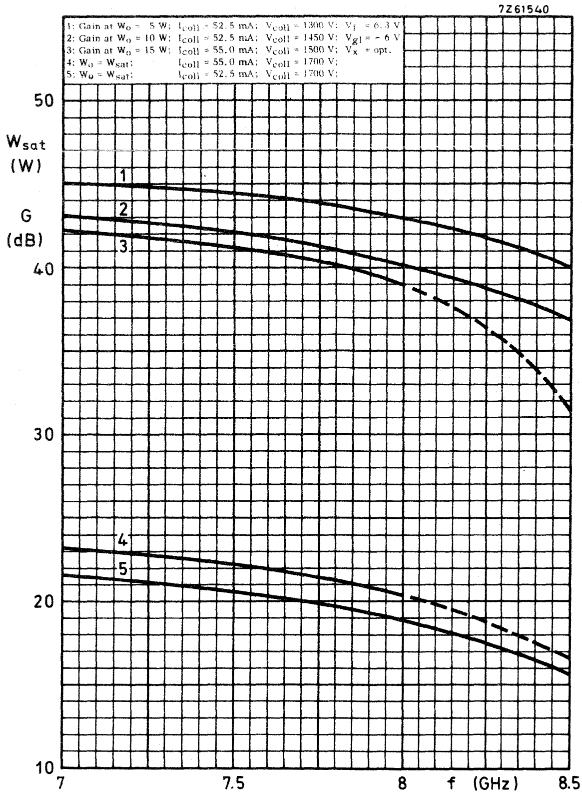
It may be noted that the difference between the voltage reflection coefficients of the hot and the cold (i.e. with respectively without electron beam) tube is less than 0.2 for the input as well as the output side, measured at an output power level of 5 W or more.

8. ENVIRONMENTAL CONDITIONS

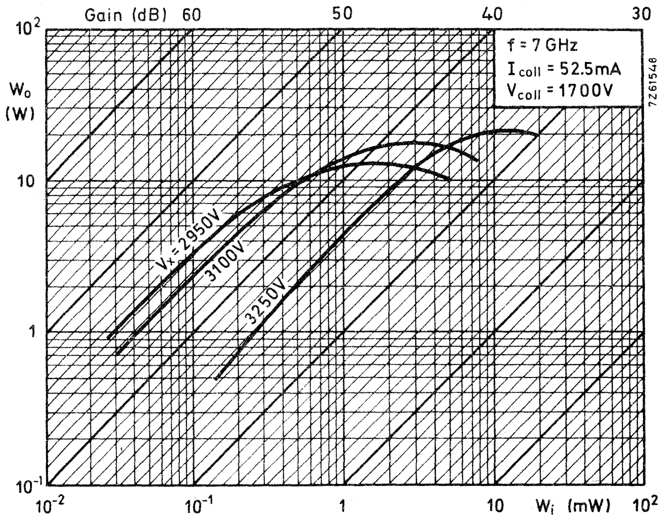
Ambient temperature,

storage	t_{amb}	min.	−60	°C
		max.	+65	°C
operation	t_{amb}	min.	−30	°C
		max.	+65	°C
Relative humidity			0 to 95	%

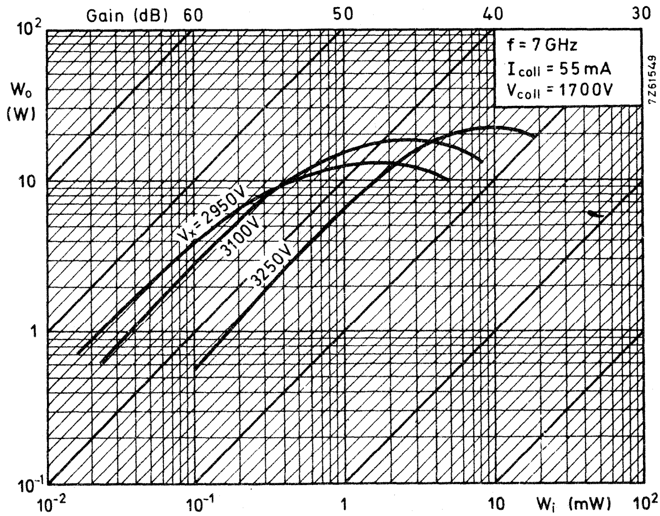
The tube and mount resist fungus attack.



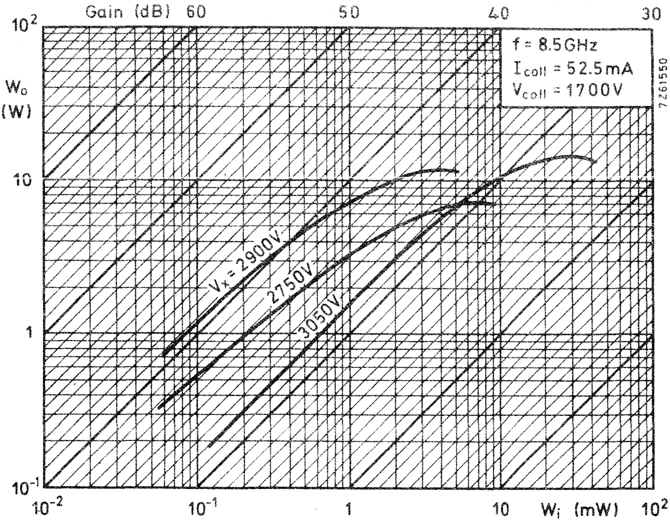
Gain and saturation power = f (frequency)



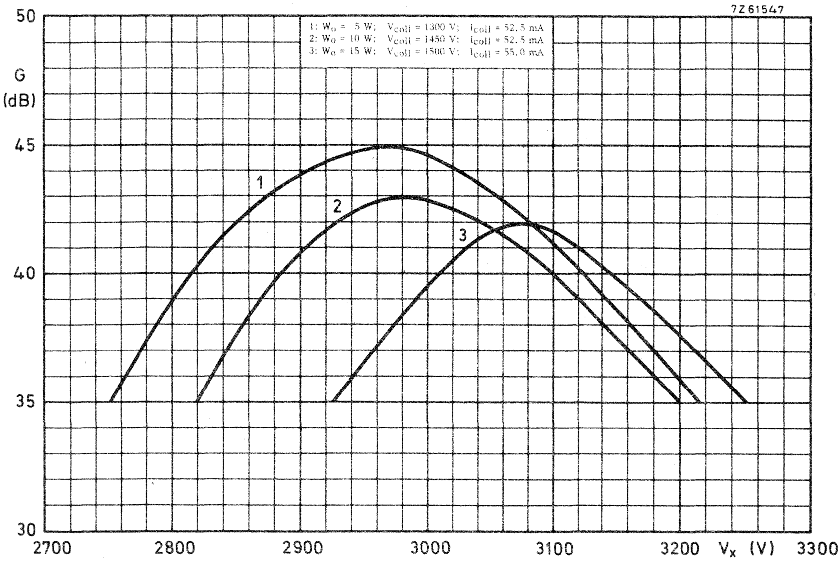
Output power = f (input power)



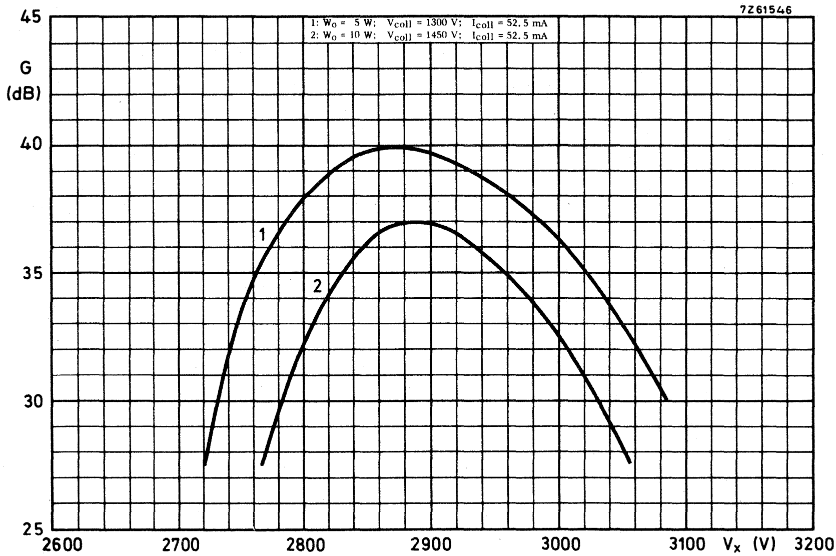
Output power = f (input power)



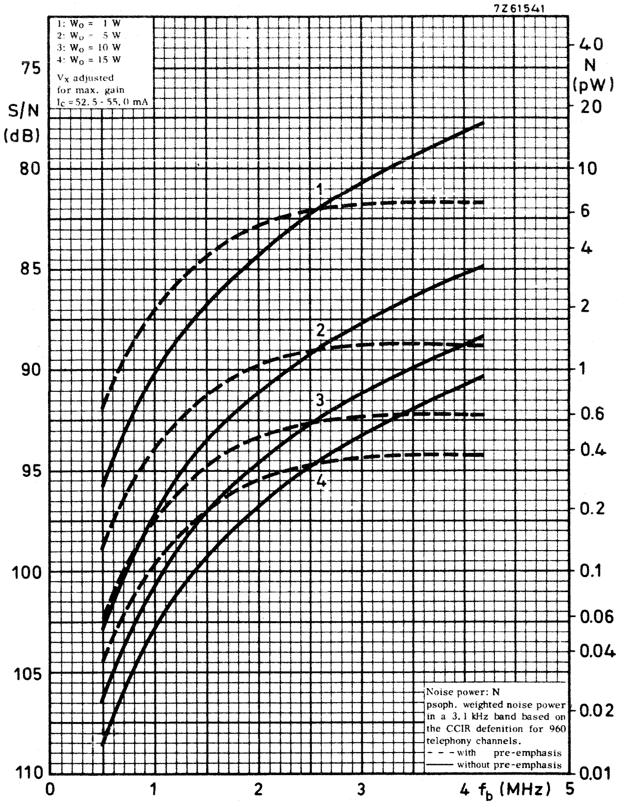
Output power = f (input power)



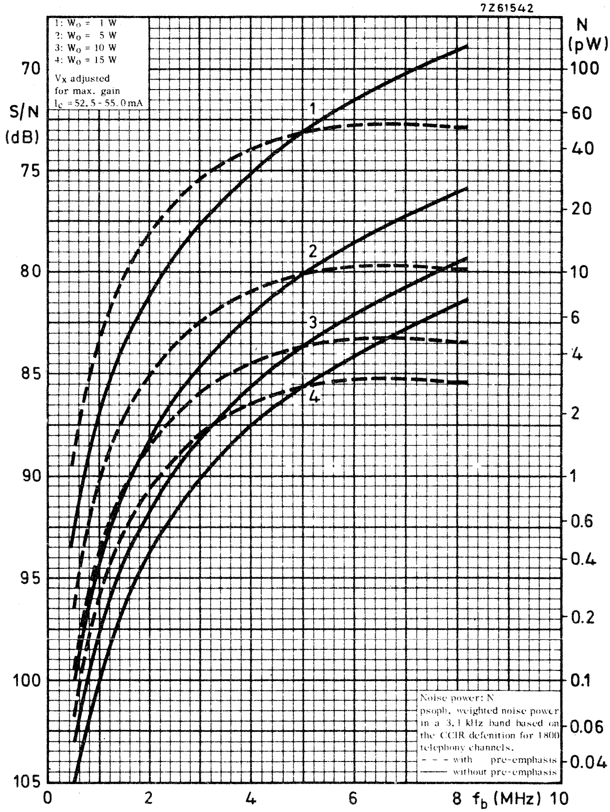
Gain = f (helix voltage); f = 7.0 GHz



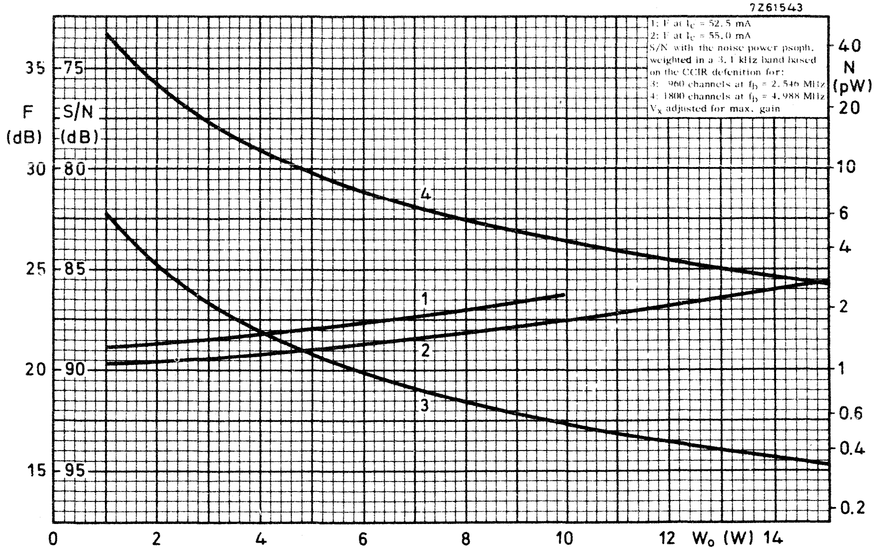
Gain = f (helix voltage); f = 8.5 GHz



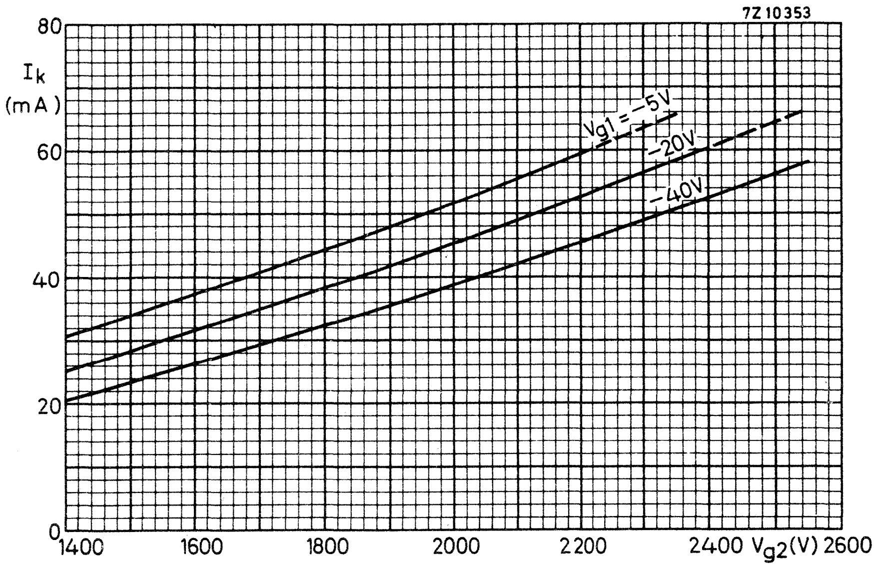
Signal to noise ratio (FM) = f (baseband freq.) at f = 7 GHz



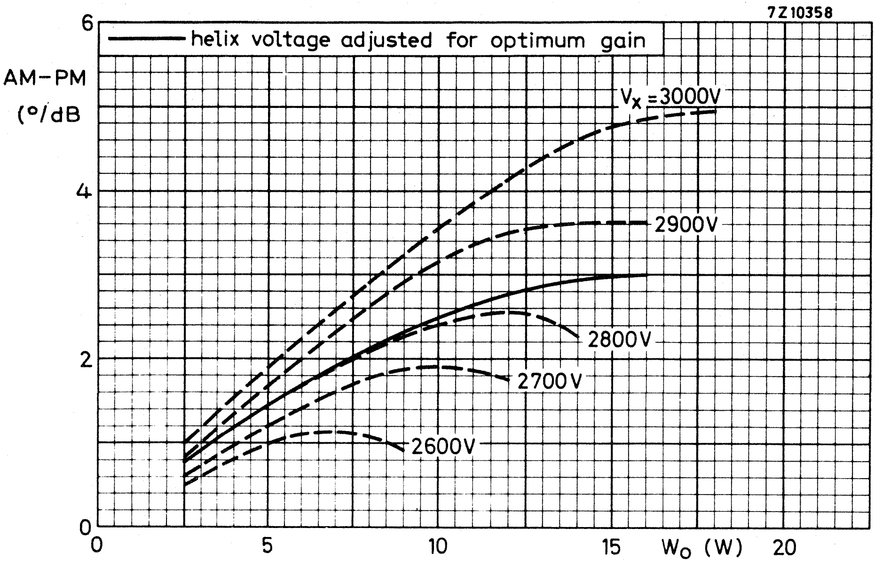
Signal to noise ratio (FM) = f (baseband freq.) at f = 7 GHz



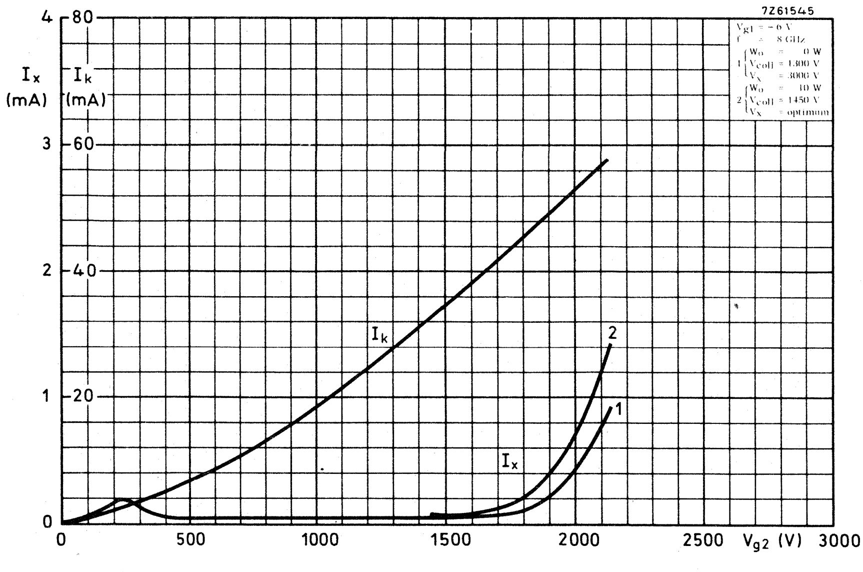
Thermal noise (FM) = f (output power) at 7 GHz



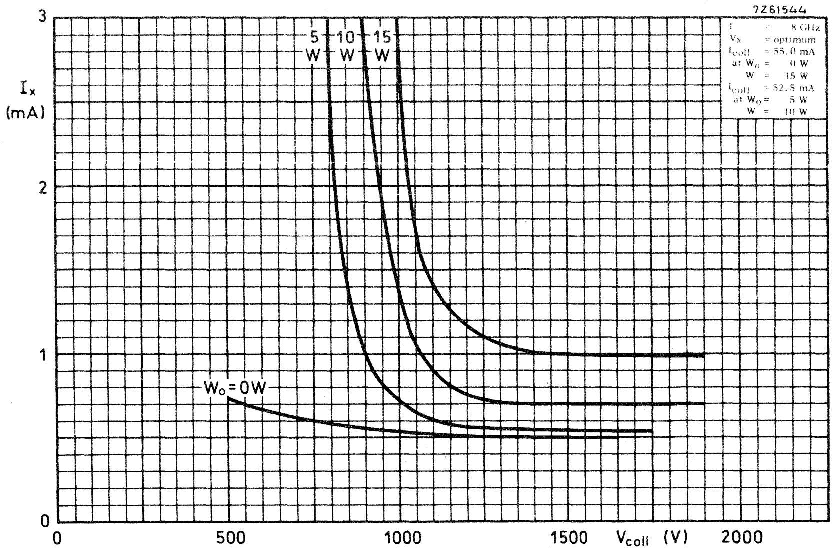
Cathode current = f (accelerator voltage)



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

The YH1210 is a metal-ceramic, forced-air cooled high power T.W.T. for use in TV transposers in the UHF bands IV and V (470-860 MHz). As a linear amplifier in the final stage it provides, with the phase correction unit, a vision power of more than 220 W peak sync under common vision and sound conditions. The gain is approximately 30 dB and the 3 tone intermodulation products are better than −54 dB. The tube is used in a permanent magnet focusing mount and under typical operating conditions the input power consumption is approximately 3 kW.

QUICK REFERENCE DATA

Frequency		470 to 860 MHz
Output power, peak sync (CCIR system G)	1)	220 W
Gain	1)	approx. 30 dB
Intermodulation product (ref. peak sync.)	1)	−54 dB
Interchangeability		plug-in focus
		plug-in match
Construction		unpackaged
tube		metal-ceramic
mount		permanent magnet
input and output connector		50 Ω, type N
Cooling		forced air

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		6.5	V ± 2%
Heater current at V_f = 6.5 V	I_f	approx.	3.2	A
Waiting time (Heating time before application of high voltage)	T_w	min.	5	min

The heater starting current should never exceed a peak value of 8A when an A.C. voltage, or 6 A when a D.C. voltage is applied.

1) With phase compensation unit type 55382

Data based on pre-production tubes.

COOLING : Forced air

Airflow (at sea level and for inlet temperatures up to 45 °C)	q min. 3.5 m^3/min
	p_i 50 mmH_2O
For other altitudes	see page 7

MECHANICAL DATA

Mounting position:	any
Weight of tube	approx. 3.5 kg
Weight of mount	approx. 53 kg
Outline drawing of tube	see page 3
Outline drawing of mount	see page 4

ACCESSORIES

Permanent magnet mount	type 55380
Base connector with 5 core cable (2 m)	type 55381
Phase compensation unit for 19 in rack	type 55382

Connections

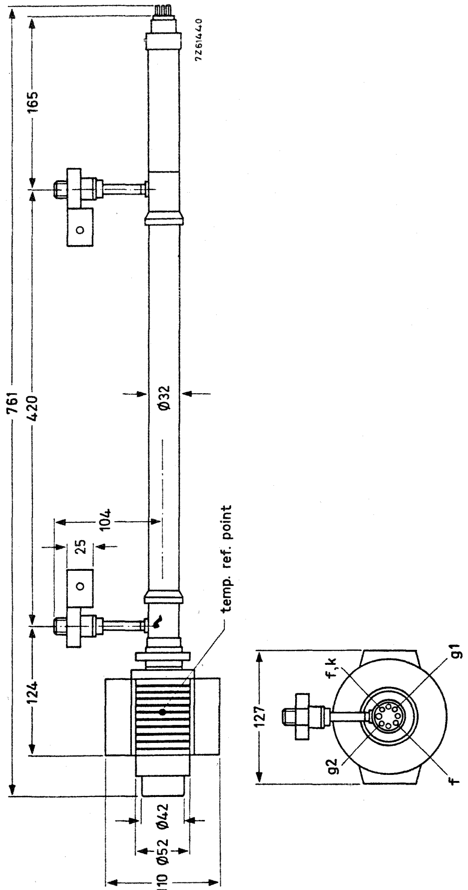
The leads of the 5 core cable are marked by colours:

Heater	brown
Heater(cathode)	brown-yellow
Cathode	yellow
Focusing electrode	green
Accelerator electrode	blue
Earth, via mount	black

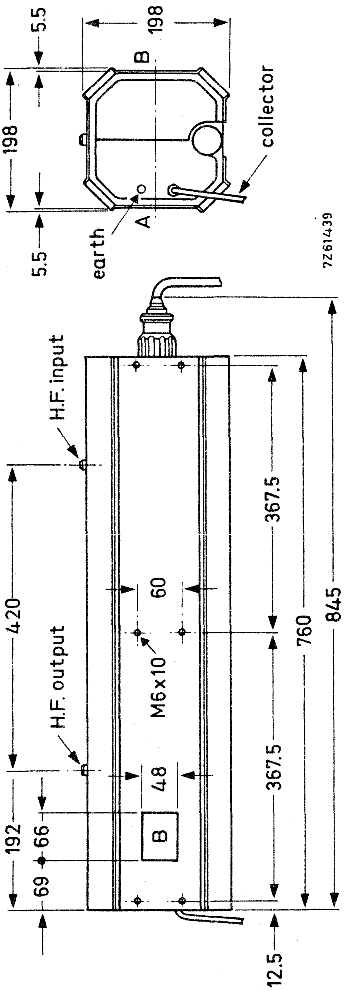
The helix is internally connected to the tube body, which in turn is connected to the mount. The mount is earthed.

The collector is electrically isolated from the tube body and is connected to its power supply via the flying lead.

Dimensions of tube (in mm)



Dimensions of mount (in mm)



U.H.F. LINEAR AMPLIFIER FOR TELEVISION TRANSPOSER SERVICE WITH COMMON VISION AND SOUND TRANSMISSION

TYPICAL OPERATION, vision and sound combined, (according to CCIR system G), with the use of the phase compensation unit 55382
Voltages are specified with respect to cathode.

Operating conditions

Frequency of vision carrier	f	550	615	780	MHz
Helix voltage	V_x	3650	3500	3300	V
Collector voltage	V_{coll}	3650	3500	3300	V
Focusing electrode voltage	V_{g1}	−100	−100	−100	V
Accelerator voltage 4)	V_{g2} approx.	560	610	680	V
Cathode current	I_k	850	850	850	mA
Helix current	I_x	10	10	10	mA

Typical performance

Output power, peak sync	$W_{o\,p.s.}$	220	220	220	W
Output power, sound	$W_{o\,sound}$	44	44	44	W
Gain 1)	G	30	31	32	dB
Intermodulation product (ref. peak sync.) 2)		−54	−54	−54	dB
Low frequency linearity 3)		≥ 95	≥ 95	≥ 95	%
Differential gain 3)		≥ 95	≥ 95	≥ 95	%
Differential phase of colour subcarrier		≤ 3	≤ 3	≤ 3	°

1) These figures incorporate a loss of approx. 3 dB in the phase compensation unit.

2) The intermodulation products of the input test signals are −70 dB with respect to peak sync. These signals are set at f_v=-8 dB, f_s = −7 dB and f_{sb} = −17 dB with respect to peak sync level. Vision/sound ratio 5 : 1.

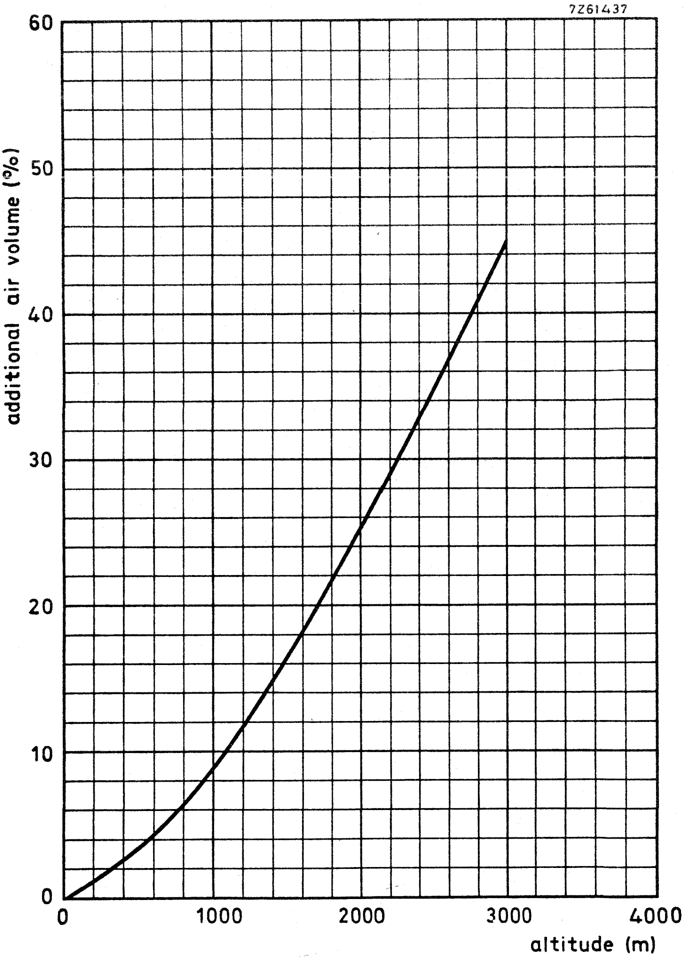
3) These figures are measured with vision signal as well as with combined vision-sound signals.

4) To be adjusted for indicated cathode current.

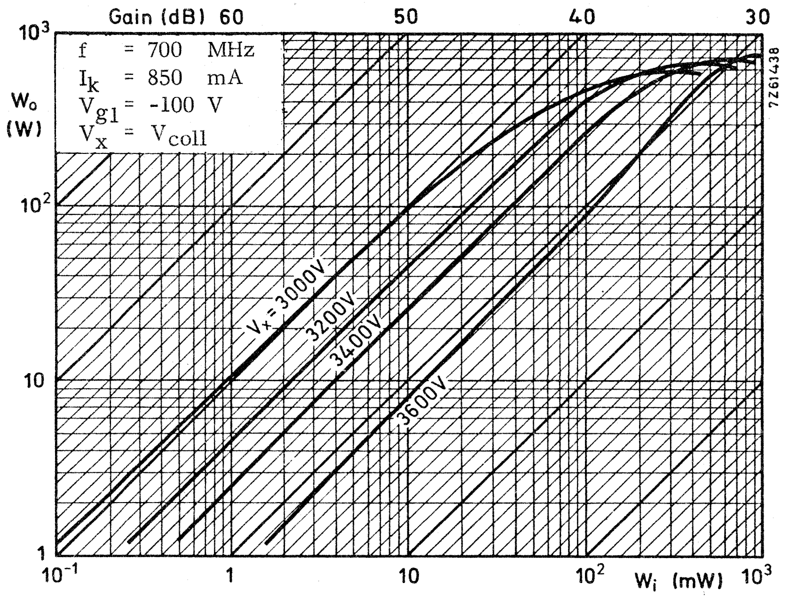
LIMITING VALUES (Absolute max. rating system)
(Voltages are specified with respect to cathode, unless otherwise stated).

Helix voltage	V_x	max.	4200	V
Collector to helix voltage	V_{coll-x}	max.	500	V
Accelerator voltage	V_{g2}	max.	1000	V
Focusing electrode voltage, negative	$-V_{g1}$	min.	0	V
		max.	200	V
Cathode current	I_k	max.	1.0	A
Helix current	I_x	max.	20	mA
Accelerator current	I_{g2}	max.	3	mA
Collector dissipation	W_{coll}	max.	4.0	kW
Power reflected from load	W_{refl}	max.	20	W
Temperature of cooler at reference point [1]	t_{coll}	max.	200	°C
Temperature, ambient	t_{amb}	max.	+50	°C
		min.	−20	°C
storage, for tube and mount	t_{stg}	min.	−40	°C
Altitude	h	max.	3000	m

[1]) Reference point at rim of centre cooling fin at outlet side.



Additional cooling air volume as a function of altitude.


Gain (dB) 60
50
40
30
10^3
W_o (W)
f = 700 MHz
I_k = 850 mA
V_{g1} = -100 V
V_x = V_{coll}
7Z61438
10^2
10
1
V_x = 3000V
3200V
3400V
3600V
10^{-1}
1
10
10^2
W_i (mW)
10^3

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

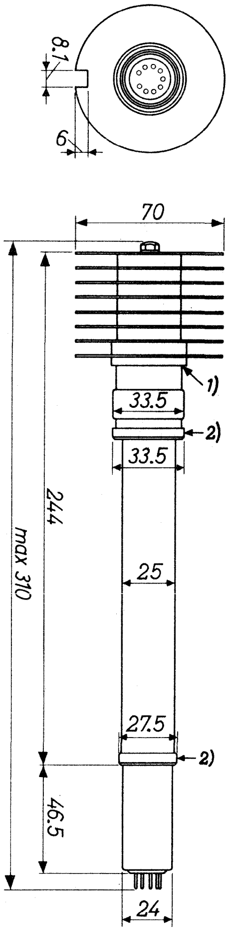
MECHANICAL DATA

Dimensions in mm

Net weight 0.5 kg

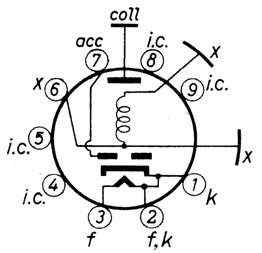
Net weight of mount 30 kg

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

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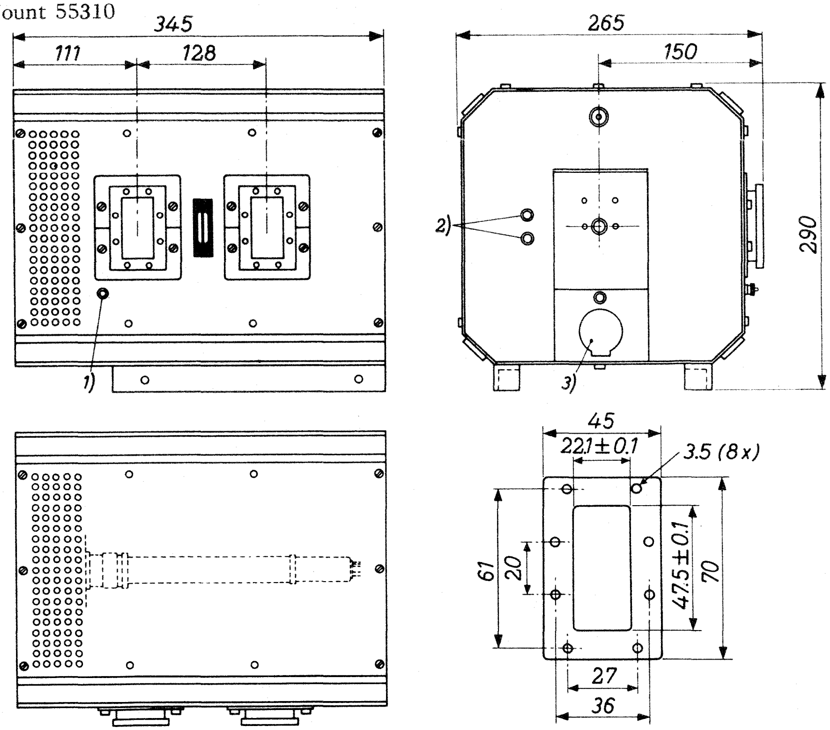
1) Reference point for collector temperature measurement

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

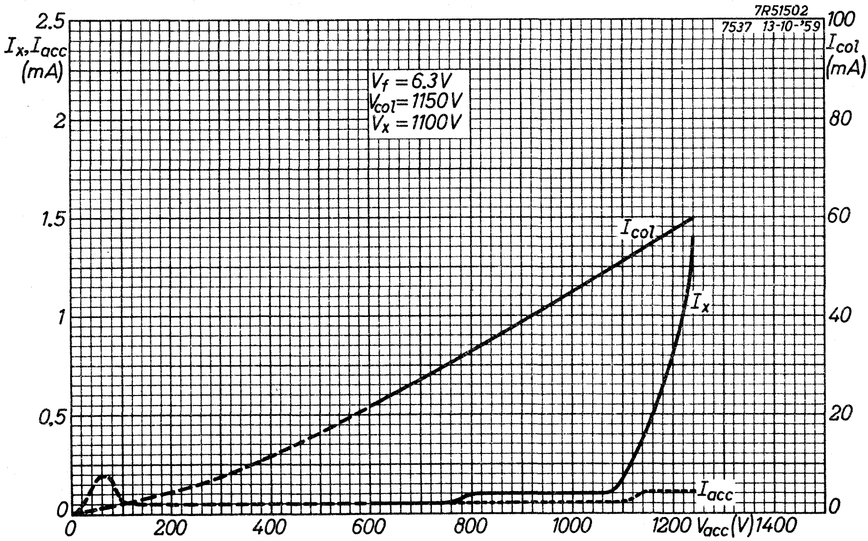
The procedure described under 2.2 can be followed without any risk of disturbing the properties of the tube. It should be noted, however, that normally about 5 minutes cathode heating time is required to obtain completely stable operation of the tube.

3. Switching off procedure

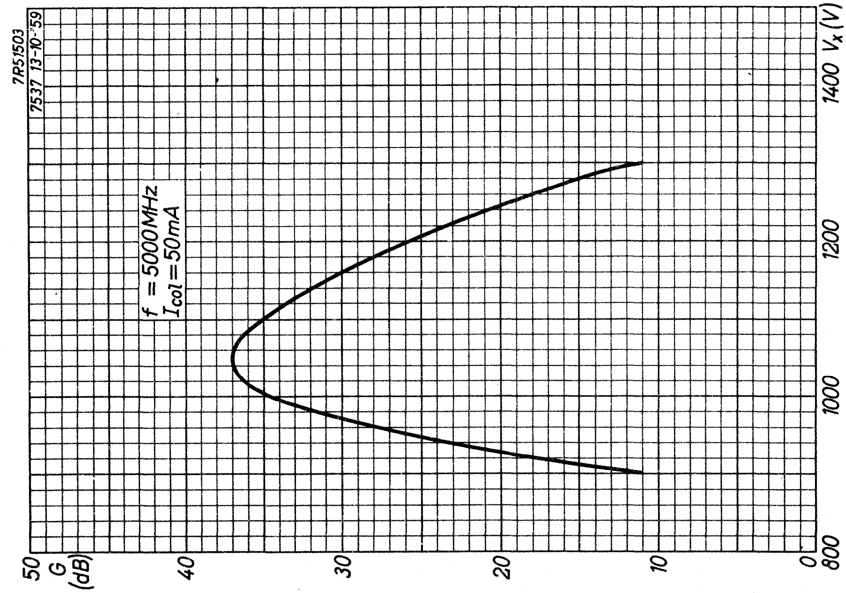
3.1 a. Switch off all voltages simultaneously.
b. Remove plug, open the door and pull out the tube.

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.

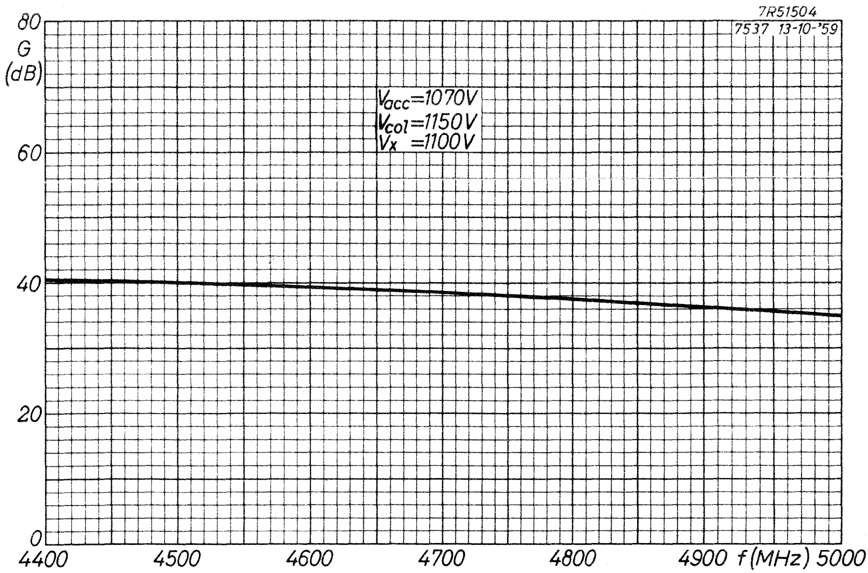
The methods 3.1 and 3.2 are optional.

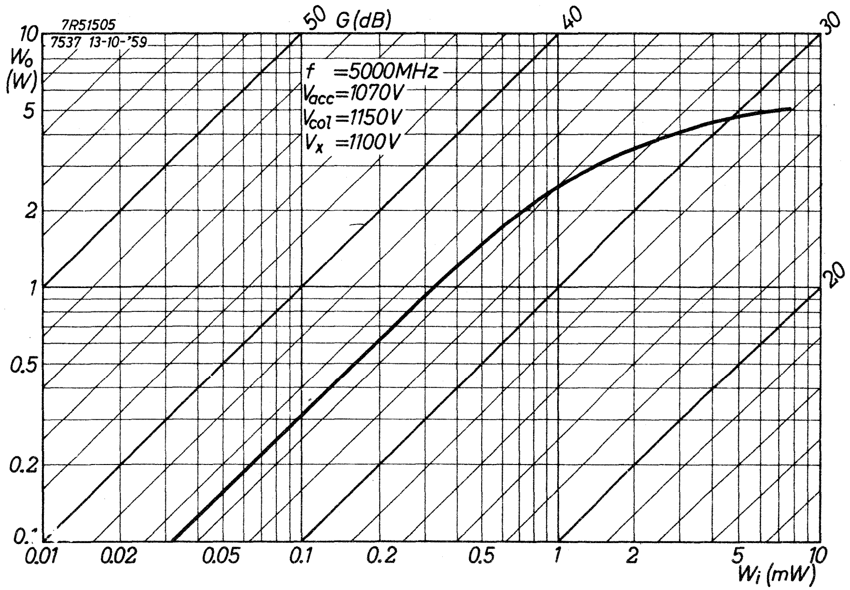


7R51502
7537 13-10-'59
2.5
I_x, I_{acc}
(mA)
2
1.5
1
0.5
0
100
I_{col}
(mA)
80
60
40
20
0
V_f = 6.3V
V_{col} = 1150V
V_x = 1100V
I_{col}
I_x
I_{acc}
0
200
400
600
800
1000
1200
V_{acc}(V)
1400



7R51503
7537 13-10-'59
f = 5000MHz
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)
V_{acc}=1070V
V_{col}=1150V
V_x =1100V
60
40
20
0
4400
4500
4600
4700
4800
4900
f (MHz)
5000


7R51505
7537 13-10-'59
10
W_o
(W)
5
2
1
0.5
0.2
0.1
50
G (dB)
40
30
20
f =5000MHz
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)

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

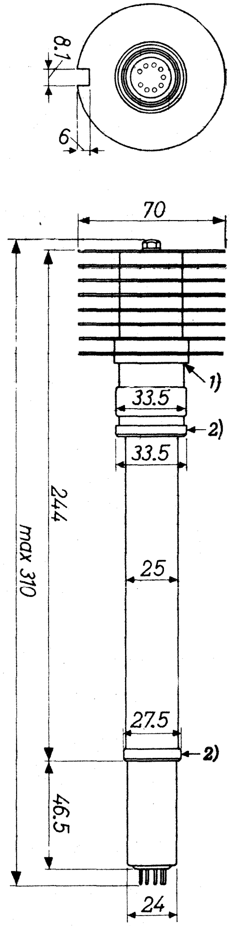
MECHANICAL DATA

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)

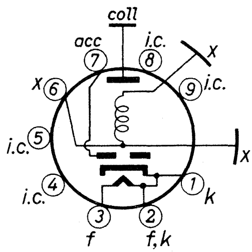
3

4 Collector (coll)

5 Accelerator (acc)

6 Heater (f)

7 Heater and cathode (f, k)



Tube base (Noval)

Mounting position: arbitrary

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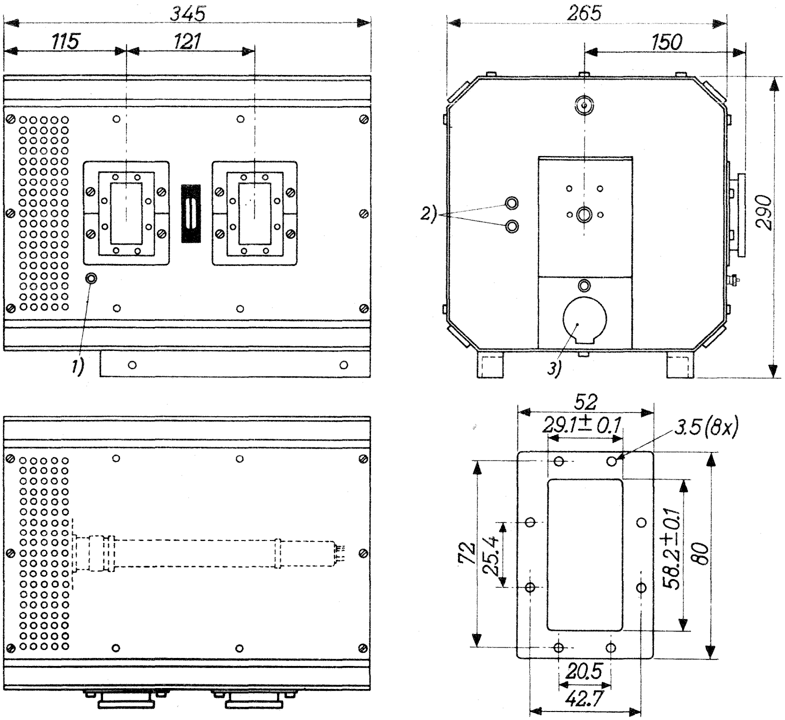
1) Reference point for collector temperature measurement

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 $t_{amb} < 55\ ^oC$ no forced air cooling is required to keep the collector temperature below the maximum permissible value of 175 ^oC, 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

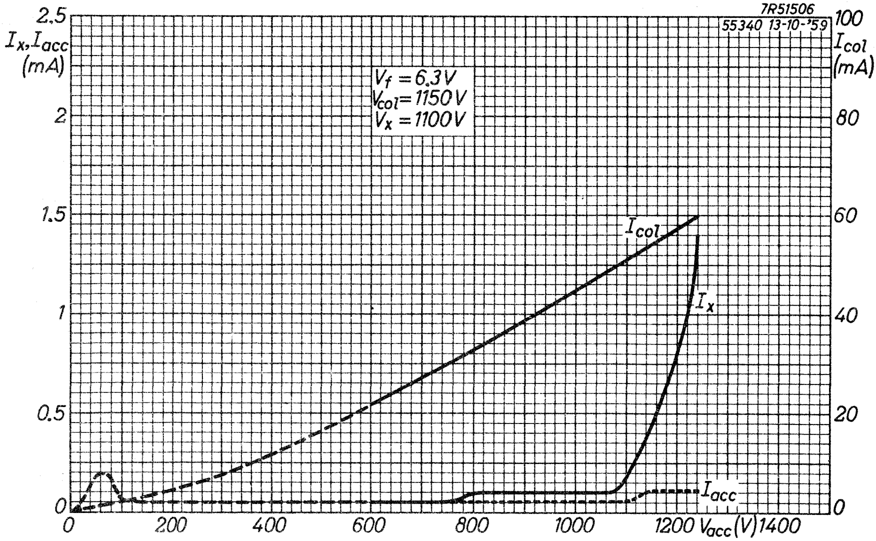
The procedure described under 2.2 can be followed without any risk of disturbing the properties of the tube. It should be noted, however, that normally about 5 minutes cathode heating time is required to obtain completely stable operation of the tube.

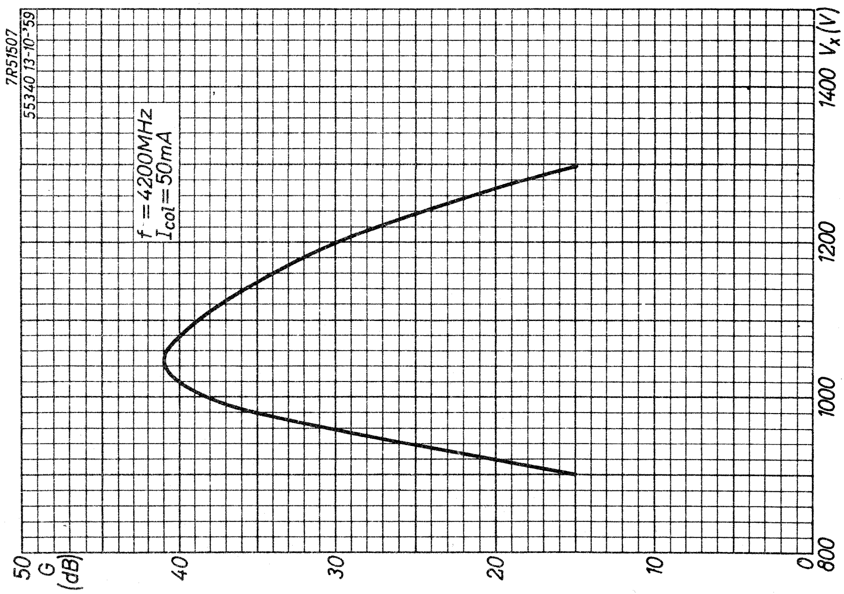
3. Switching off procedure

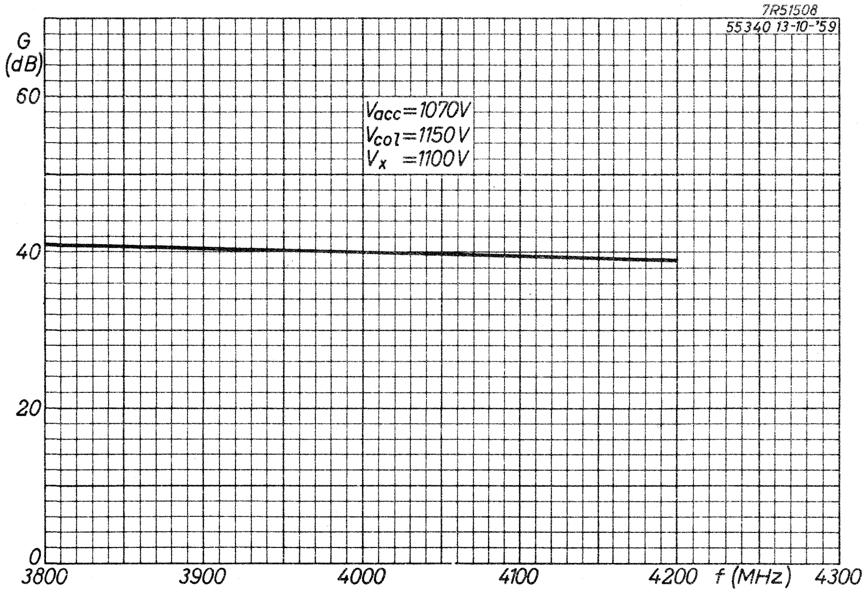
3.1 a. Switch off all voltages simultaneously.
    b. Remove plug, open the door and pull out the tube.

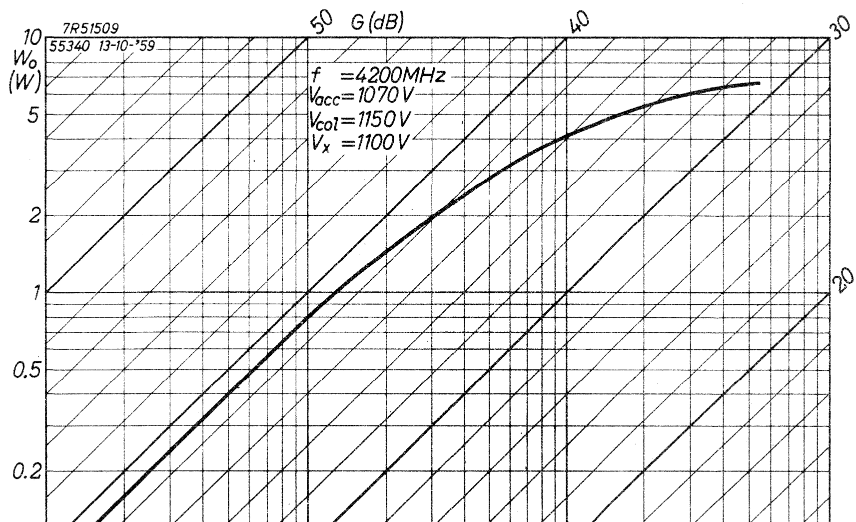
3.2 a. Bring accelerator voltage to helix potential.
    b. Switch off the cathode voltage.
    c. Switch off the accelerator, collector and heater voltages.
    d. Remove plug, open the door and pull out the tube.

The methods 3.1 and 3.2 are optional.


7R51506
55340 13-10-'59
2.5
2
1.5
1
0.5
0
I_x, I_{acc} (mA)
100
80
60
40
20
0
I_{col} (mA)
V_f = 6.3 V
V_{col} = 1150 V
V_x = 1100 V
I_{col}
I_x
I_{acc}
0
200
400
600
800
1000
1200
1400
V_{acc} (V)


7R51507
55340 13-10-'59
f = 4200 MHz
I_{col} = 50 mA
800
1000
1200
1400
V_x (V)
50
40
30
20
10
0
G (dB)


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
W_o (W)
10
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

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

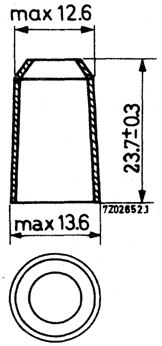
$V_{d\,inv_p}$ (f > 100 MHz) = max. $\frac{100}{f}$ x 1000 V [1])

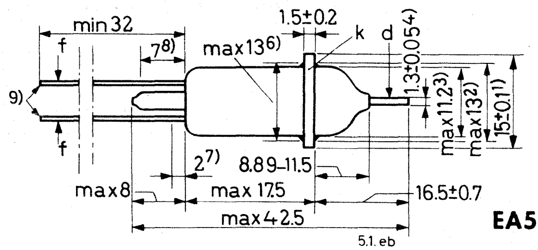
Cathode current (heater voltage from 5.6 to 7.0 V)	I_k	=	max.	0.3	mA
Peak cathode current (heater voltage from 5.6 to 7.0 V)	I_{k_p}	=	max.	5	mA [2])
Voltage between heater and cathode	V_{kf}	=	max.	50	V
External resistance between heater and cathode	R_{kf}	=	max.	20	kΩ
Heater voltage	V_f	=	max.	7.0	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

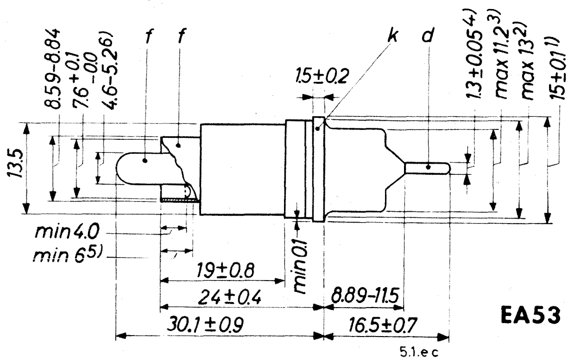




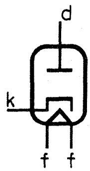
EA52

Protective cap for EA52

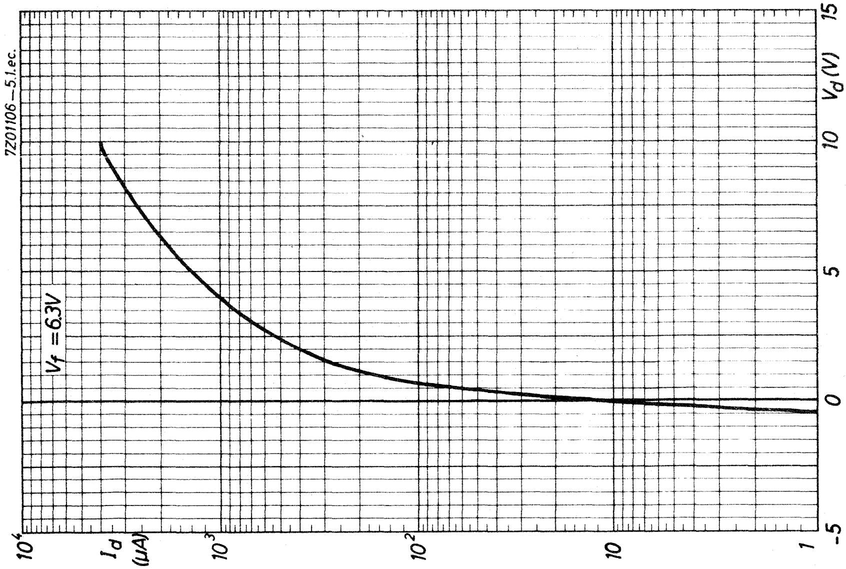
For protection during transport the EA52 is fitted with a plastic cap which should preferably be removed when the tube is mounted into position. If the cap is not removed, make sure that its temperature does never exceed 100 °C.

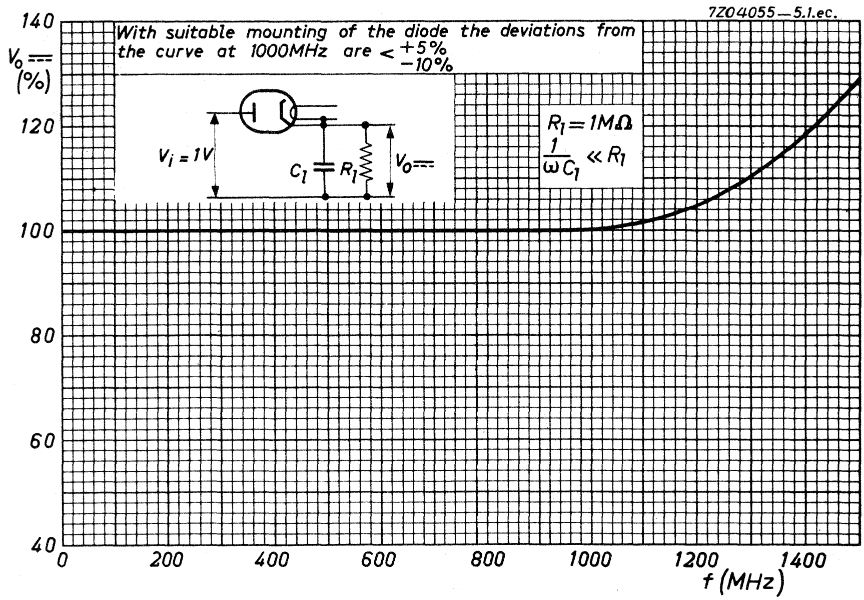


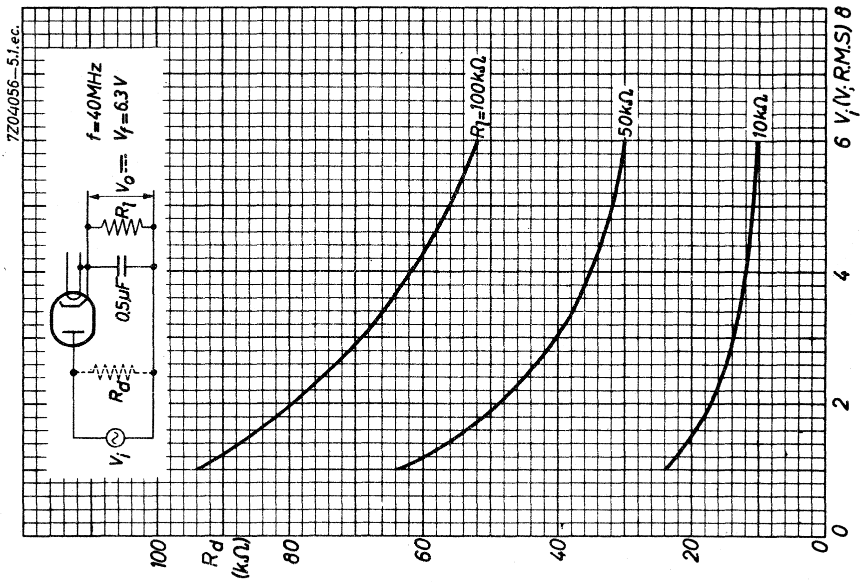
EA53

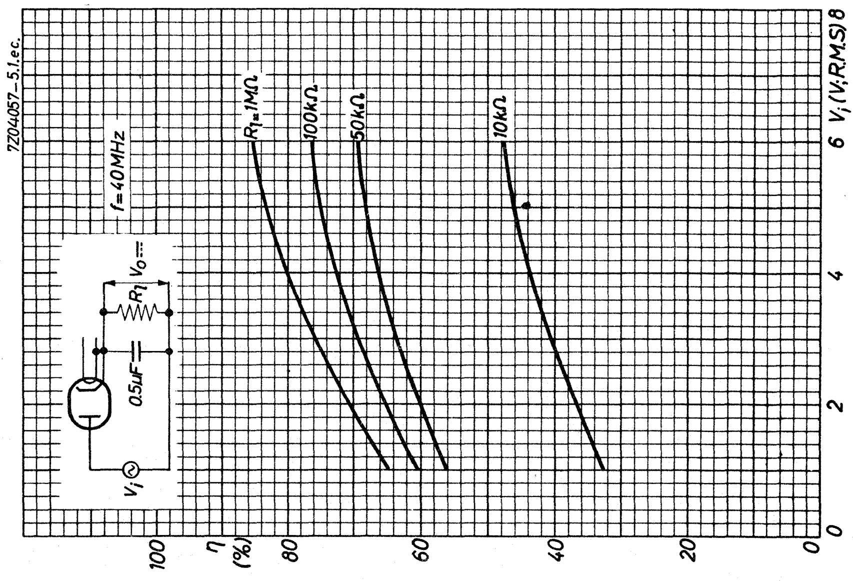


[1)] In order to avoid strain, the connection to the cathode disc should be sufficiently flexible.
[2)] Maximum diameter of the glass seal.
[3)] Eccentricity with respect to the cathode disc max. 0.35 mm.
[4)] Eccentricity with respect to the cathode disc max. 0.25 mm.
[5)] This dimension defines the 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_i = 1V
C_1
R_1
V_0
R_1 = 1MΩ
$\frac{1}{\omega C_1} \ll R_1$
V_0 (%)
140
120
100
80
60
40
0
200
400
600
800
1000
1200
1400
f (MHz)


7Z04056—5.1.ec.
f=40MHz
Vf=6.3V
Vo=
Rl
0.5μF
Rd
Vi
Rl=100kΩ
50kΩ
10kΩ
Rd
(kΩ)
100
80
60
40
20
0
Vi (V; R.M.S)
0
2
4
6
8


7Z04057—5.1.ec.
f=40MHz
Vo=
Rl
0.5μF
Vi
Rl=1MΩ
100kΩ
50kΩ
10kΩ
η
(%)
100
80
60
40
20
0
Vi (V; R.M.S)
0
2
4
6
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

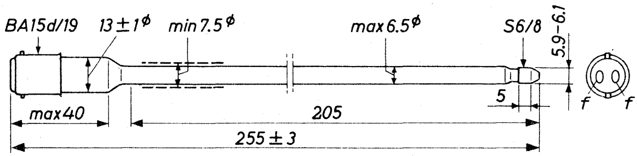
REMARKS

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

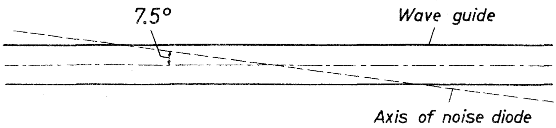
[1]) Change in noise level over 200 hours of operation is negligible.
[2]) For recommended ignition circuit see page 2.

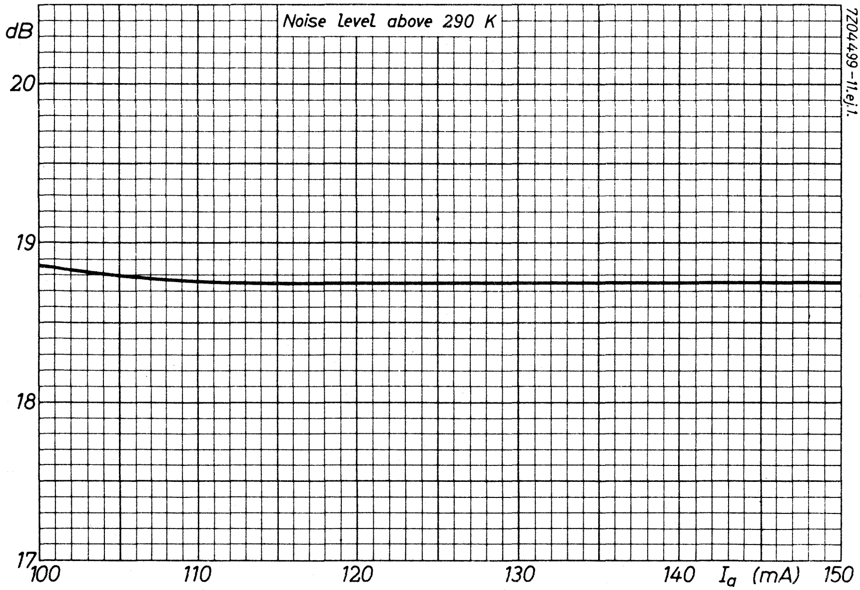
MECHANICAL DATA

Dimensions in mm



MOUNTING POSITION: Cathode at receiver side





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

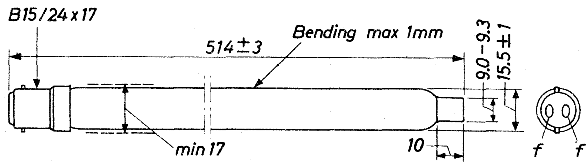
REMARKS

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

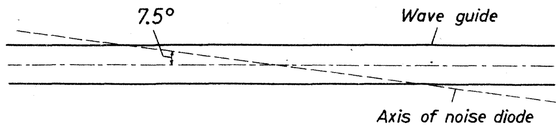
[1]) Change in noise level over 200 hours of operation is negligible.
[2]) For recommended ignition circuit see page 2.

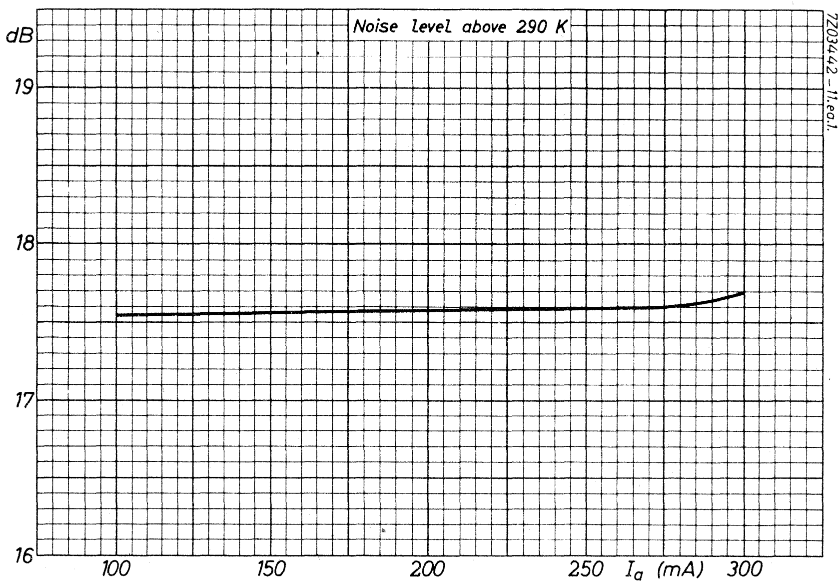
MECHANICAL DATA

Dimensions in mm
Small top cap



MOUNTING POSITION: Cathode at receiver side





OBSOLESCENT TYPE

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	$V_{a_{inv_p}}$	= 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

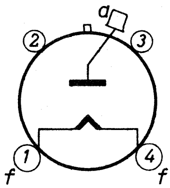
Heater voltage	V_f	=	5.5	V
Peak forward anode voltage	V_{a_p}	=	10	kV
Peak anode current	I_{a_p}	>	2	A

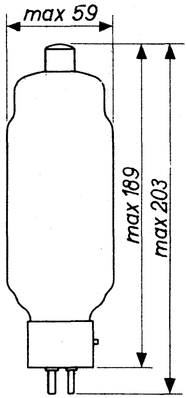
MECHANICAL DATA Dimensions in mm

Net weight: 90 g

Base: Medium 4p. with bayonet

Cap : Medium





Mounting position: vertical with base down

ACCESSORIES

Anode clip 40619

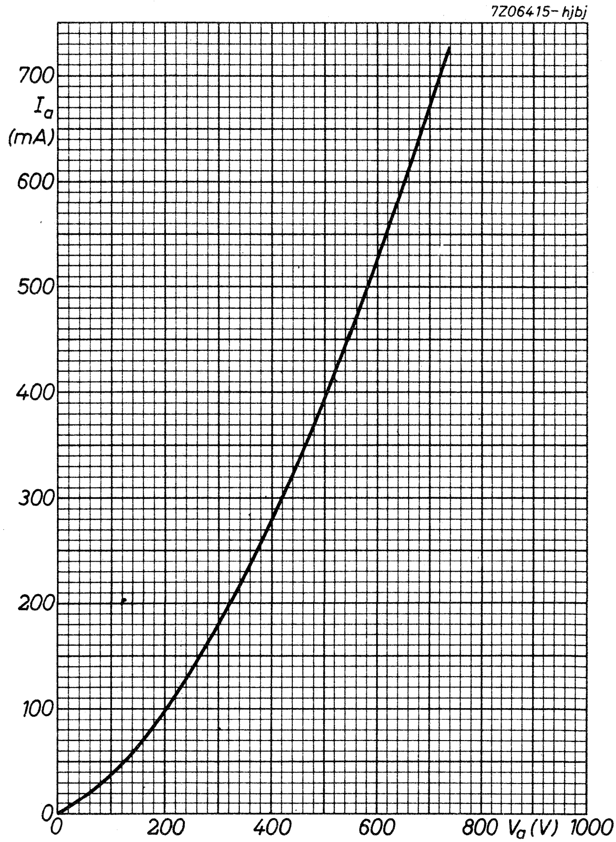
At voltages above 2 kV the socket must be insulated from the chassis.

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 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		μ	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

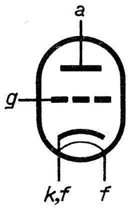
Anode to all other elements except grid	C_a	=	0.03	pF
Grid to all other elements except anode	C_g	=	1.8	pF
Anode to grid	C_{ag}	<	1.3	pF

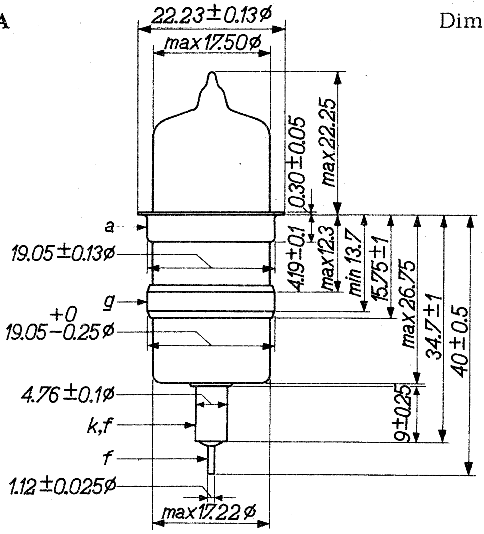
TYPICAL CHARACTERISTICS

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	μ	=	30	

MECHANICAL DATA

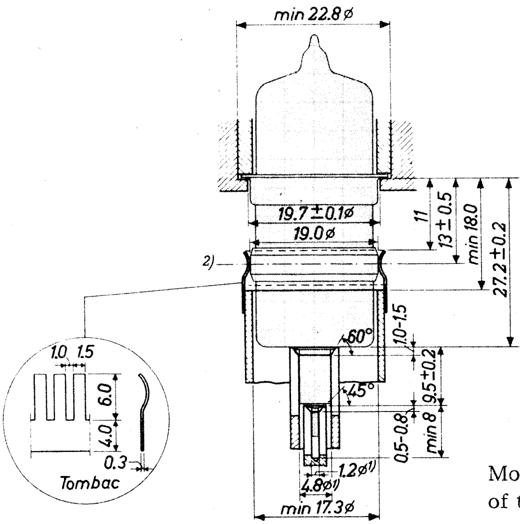
Dimensions in mm





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

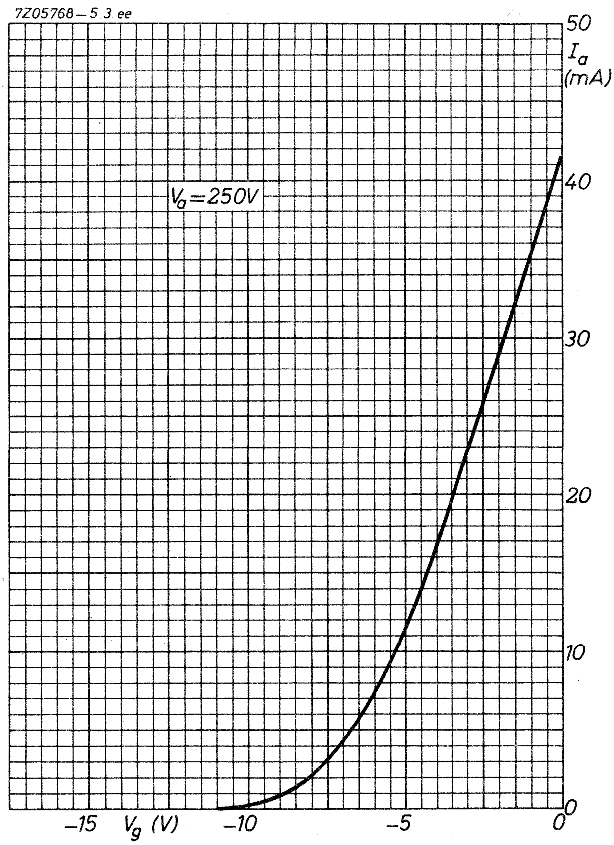


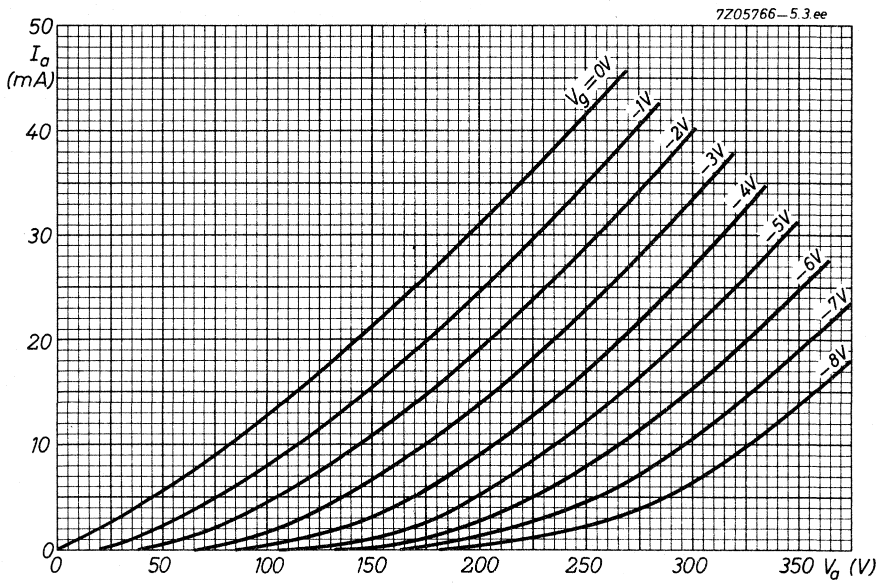
Mounting of the tube

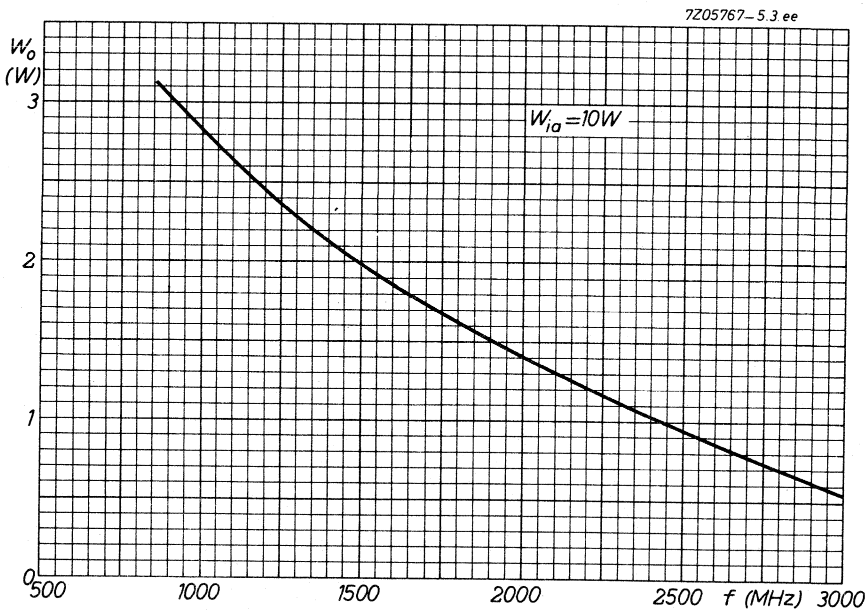
1) In order to make good contact these sockets should be slotted.
2) Line of contact.

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	°C




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	μ	=	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)

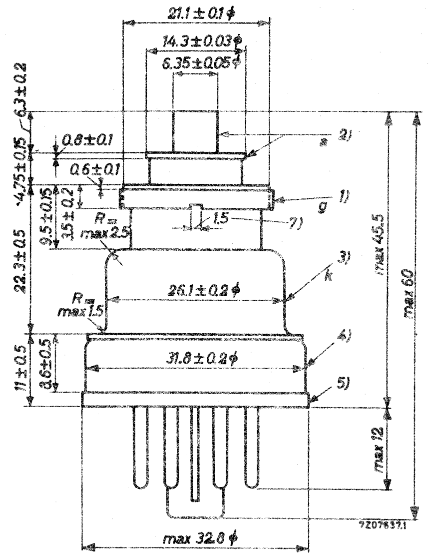
Anode to grid	C_{ag}	=	1.4	pF [1])
Anode to cathode	C_{ak}	=	0.035	pF
Grid to cathode	C_{gk}	=	3.0	pF [2])

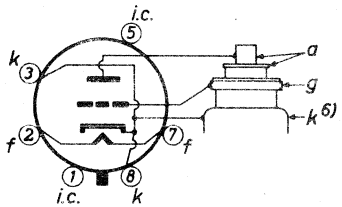
[1]) Measured with a shield of 1 mm thickness and with a hole of 15 mm diameter

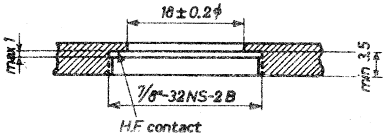
[2]) Measured with a shield of 1 mm thickness and with a hole of 23 mm diameter

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 <2.5	2.8	V
Mutual conductance	S	=	21	> 15	18	mA/V
Amplification factor	μ	=	43	> 33 < 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.

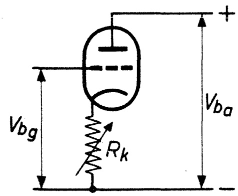
6) H.F. and D.C. connections of the cathode. Pins 3 and 8 are connected internally to this terminal.

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

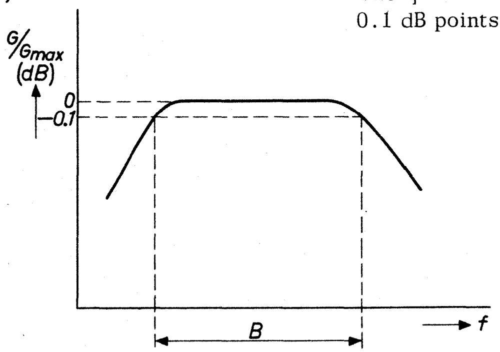
Frequency	f	=	4		4		GHz
Anode supply voltage	V_{ba}	=	200		200		V
Anode current	I_a	=	60		30		mA
Grid supply voltage	V_{bg}	=	+20		+20		V
Cathode resistor	R_k	=	[1]		[1]		
Bandwidth	B	=	50 [2]		50 [2]		MHz
Output power { G = 8 dB, V_f = 6.3 V	W_o	=	1.8	>1.5	–		W
Output power { G = 6 dB, V_f = 6.3 V	W_o	=	–		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)

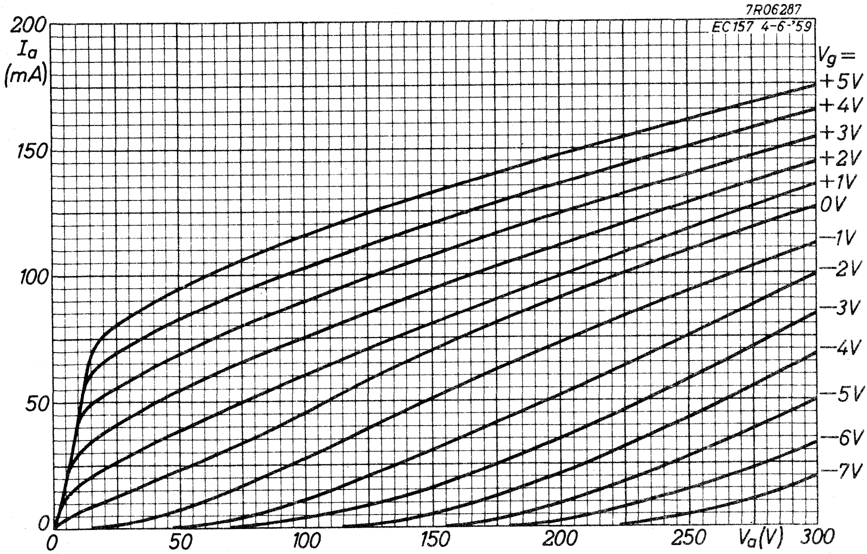
Anode voltage in cold condition		V_{a_o}	=	max.	500	V
Anode voltage		V_a	=	max.	300	V
Anode dissipation		W_a	=	max.	12.5	W
Negative grid voltage		$-V_g$	=	max.	50	V
Peak negative grid voltage		$-V_{gp}$	=	max.	100	V
Positive grid voltage		$+V_g$	=	max.	5	V
Peak positive grid voltage		$+V_{gp}$	=	max.	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

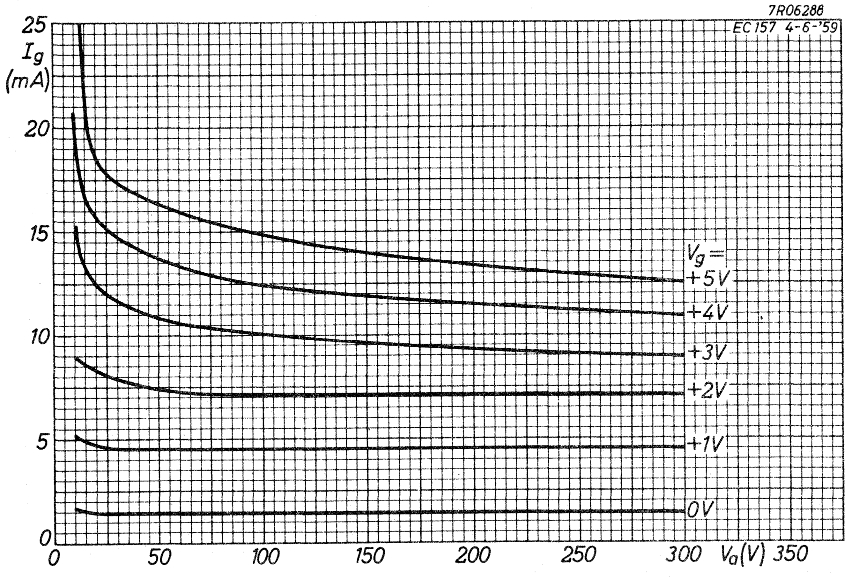
[1] In grounded grid circuits at a frequency of 4 GHz.

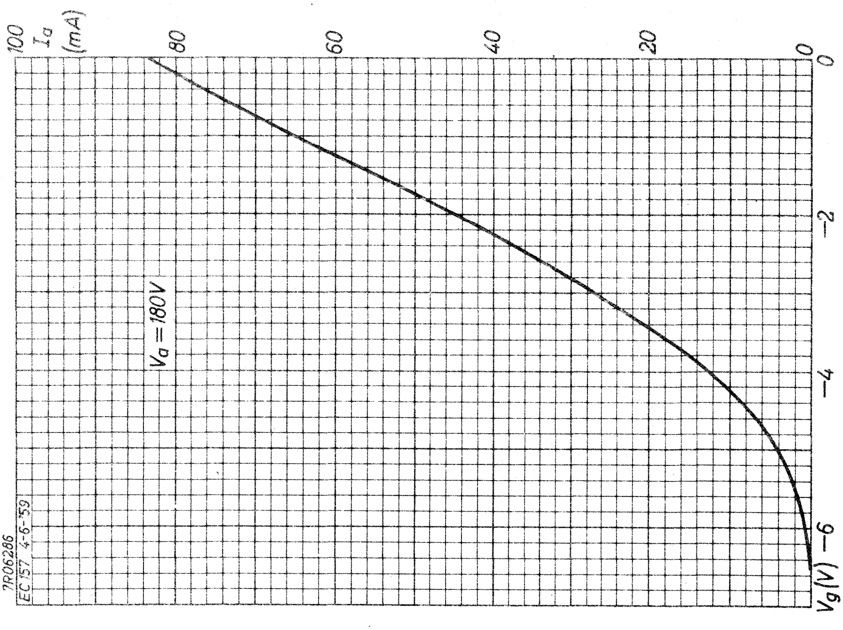
[2] This value may be multiplied by the D.C. inverse feedback factor for the cathode current to a maximum of 25 kΩ.

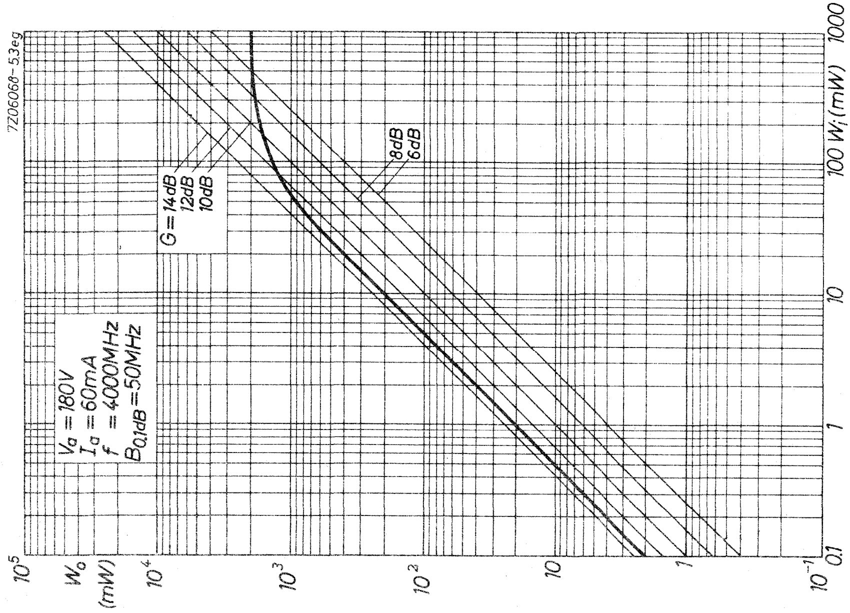
[3] A low-velocity air flow may be required.

[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


100
Ia
(mA)
80
60
40
20
0
0
-2
-4
-6
Vg(V)
Va = 180V
7R06286
EC157 4-6-'59


7206068-53eg
Va = 180V
Ia = 60mA
f = 4000MHz
B0,1dB = 50MHz
G = 14dB
12dB
10dB
8dB
6dB
Wo
(mW)
10^5
10^4
10^3
10^2
10
1
10^-1
0.1
1
10
100 Wi (mW)
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	μ	=	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])

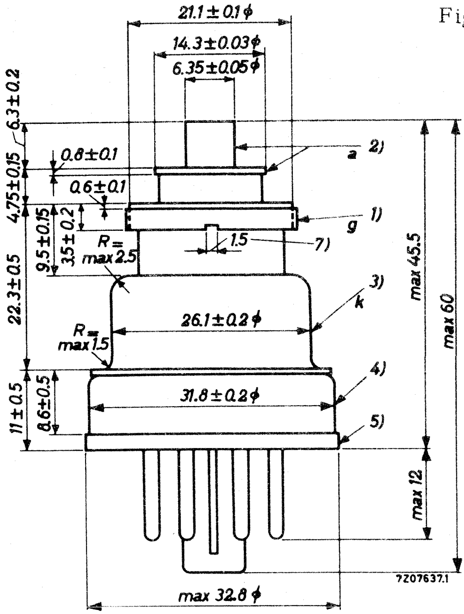
[1]) Measured with a shield of 1 mm thickness and with a hole of 15 mm diameter

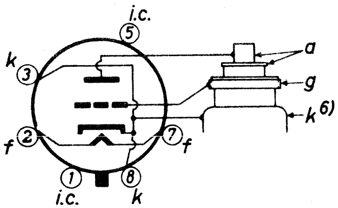
[2]) Measured with a shield of 1 mm thickness and with a hole of 23 mm diameter

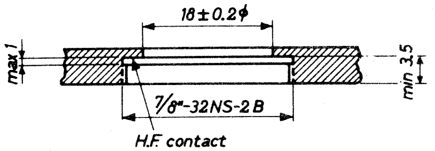
MECHANICAL DATA

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 < +1.5	−3.5	V
Mutual conductance	S	=	28	> 18	22	mA/V
Amplification factor	μ	=	30	> 20 < 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.

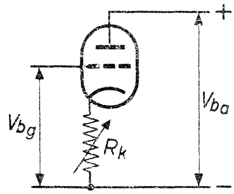
[6]) H.F. and D.C. connections of the cathode. Pins 3 and 8 are connected internally to this terminal.

[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

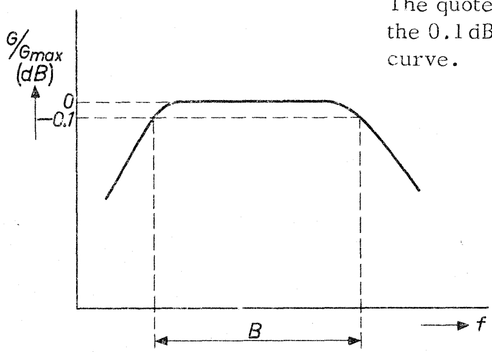
Frequency	f	=	4		GHz
Anode supply voltage	V_{ba}	=	200		V
Grid supply voltage	V_{bg}	=	+20		V
Anode current	I_a	=	140		mA
Cathode resistor	R_k	=	1)		
Bandwidth	B	=	50	2)	MHz
Output power (G = 6 dB)	W_o	=	5.3	>4.5	W
Low level gain (W_{dr} = 10 mW)	G	=	11.5	>9.5	dB

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)

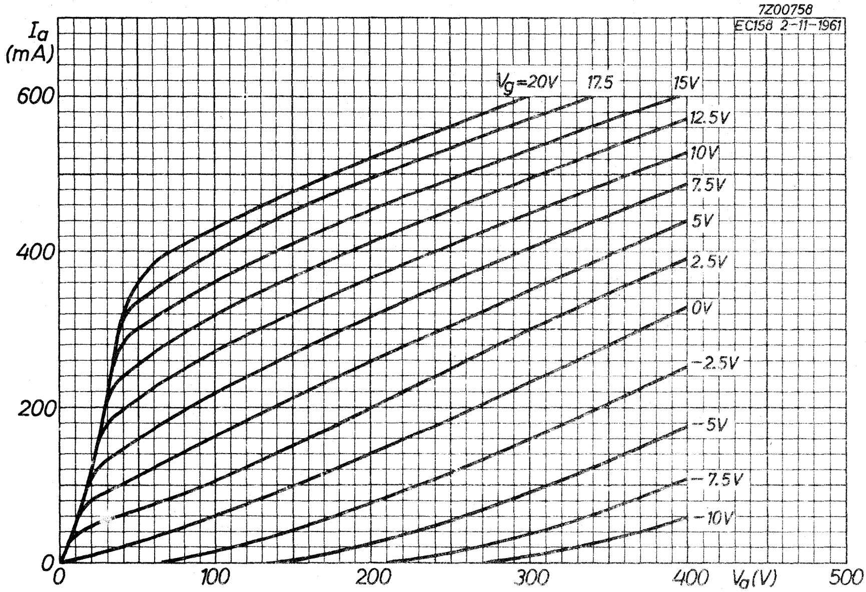
Anode voltage in cold condition		V_{a_o}	= max.	500	V
Anode voltage		V_a	= max.	300	V
Anode dissipation		W_a	= max.	30	W [1]
Negative grid voltage		$-V_g$	= max.	50	V
Peak negative grid voltage		$-V_{g_p}$	= max.	100	V
Positive grid voltage		$+V_g$	= max.	10	V
Peak positive grid voltage		$+V_{g_p}$	= 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

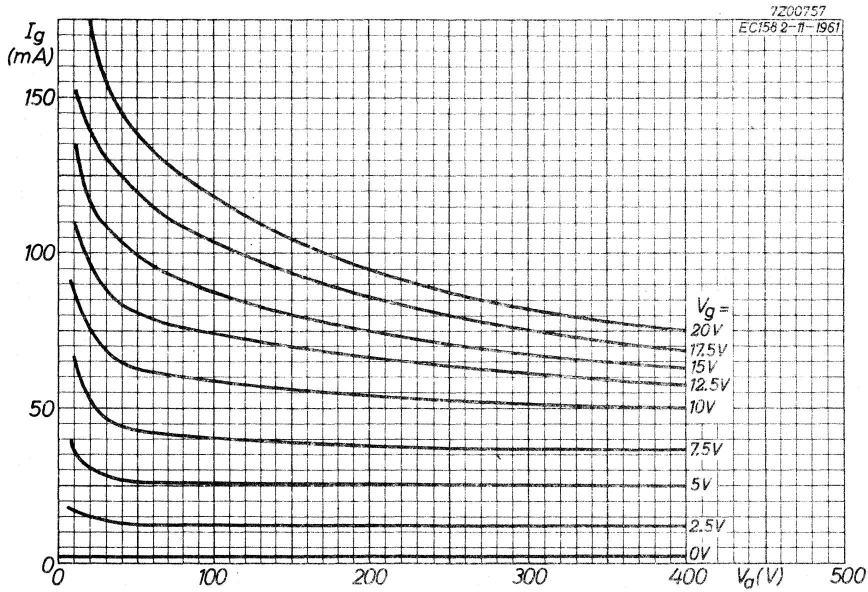
[1]) Special attention must be paid to the cooling.

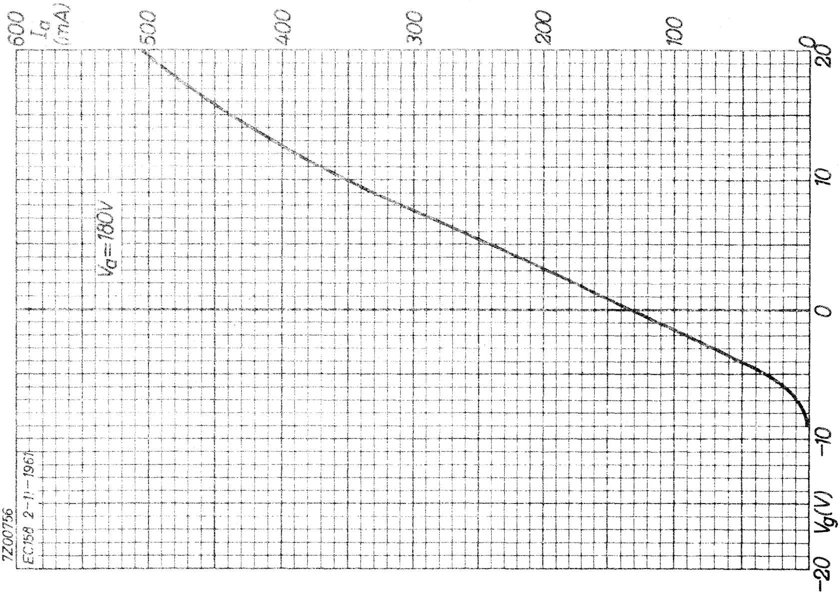
[2]) In grounded grid circuits at a frequency of 4 GHz.

[3]) This value may be multiplied by the D.C. inverse feedback factor for the cathode current to a maximum of 25 kΩ.

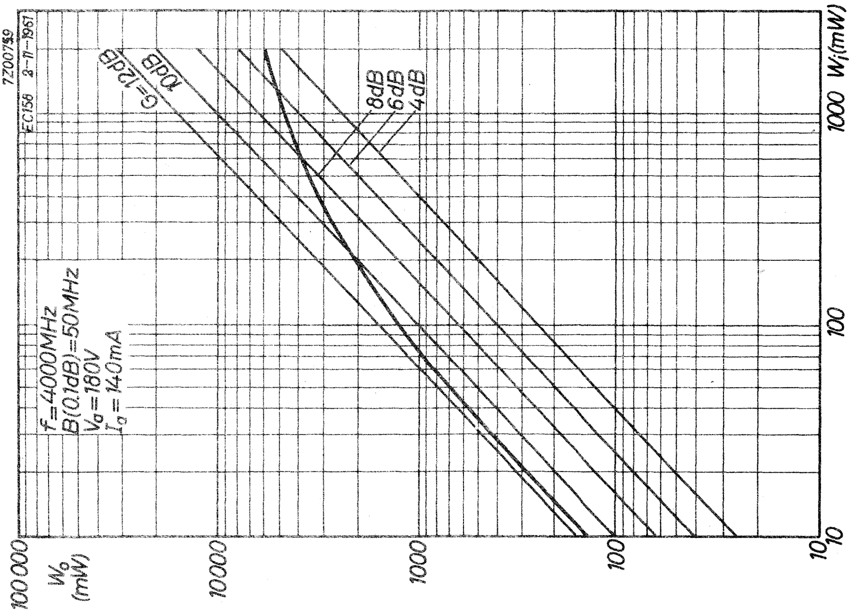
[4]) To be measured with a temperature sensitive paint e.g. Tempilaq.


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



Ia (mA)
600
500
400
300
200
100
0
Va=180V
Vg(V)
-20
-10
0
10
20
7Z00756
EC158 2-11-1961



Wo (mW)
100000
10000
1000
100
10
Wi (mW)
10
100
1000
f=4000MHz
B(0.1dB)=50MHz
Va=180V
Ia=140mA
G=12dB
10dB
8dB
6dB
4dB
7Z00759
EC158 2-11-1961

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	μ	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	μ		60		

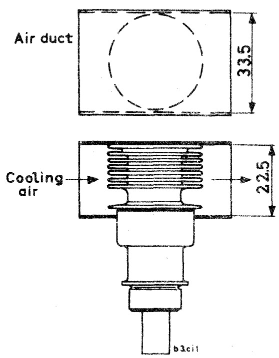
---

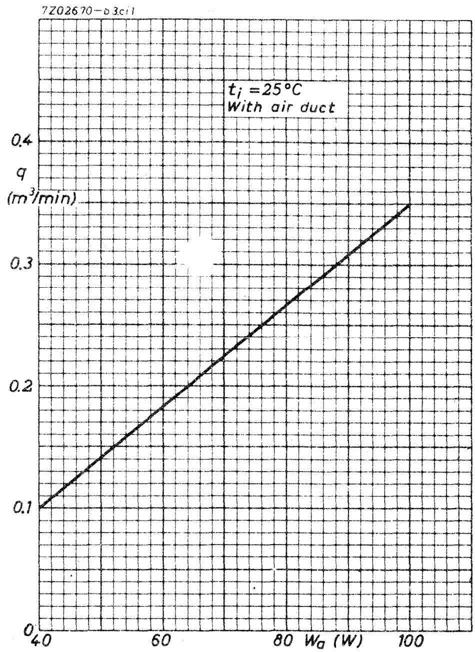
1) The heater voltage should be reduced to a value depending on the cathode current and frequency. See curve page 5. The maximum fluctuation should not exceed ±5%.

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.



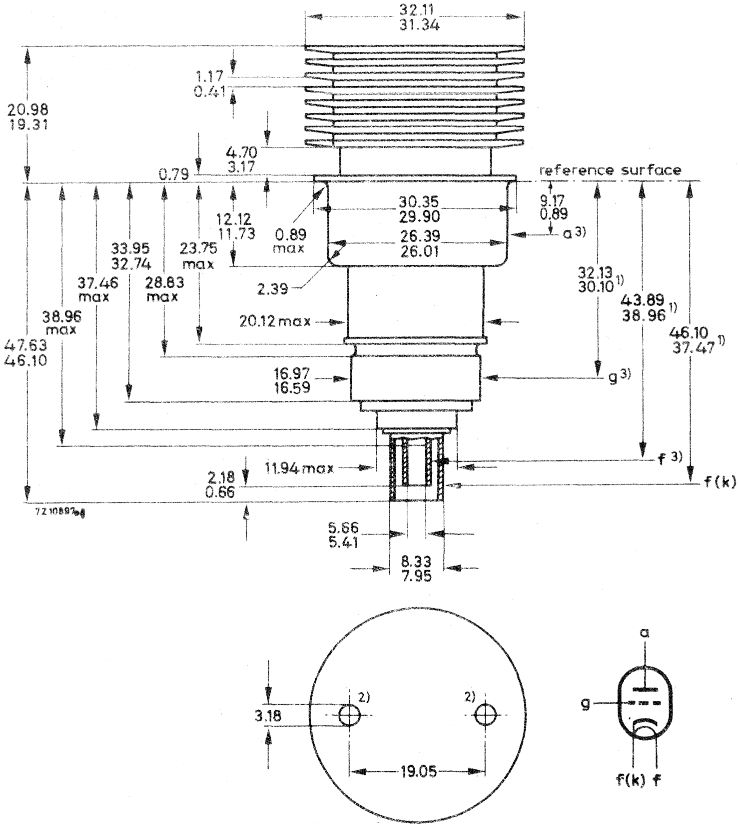


LIFE EXPECTANCY

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

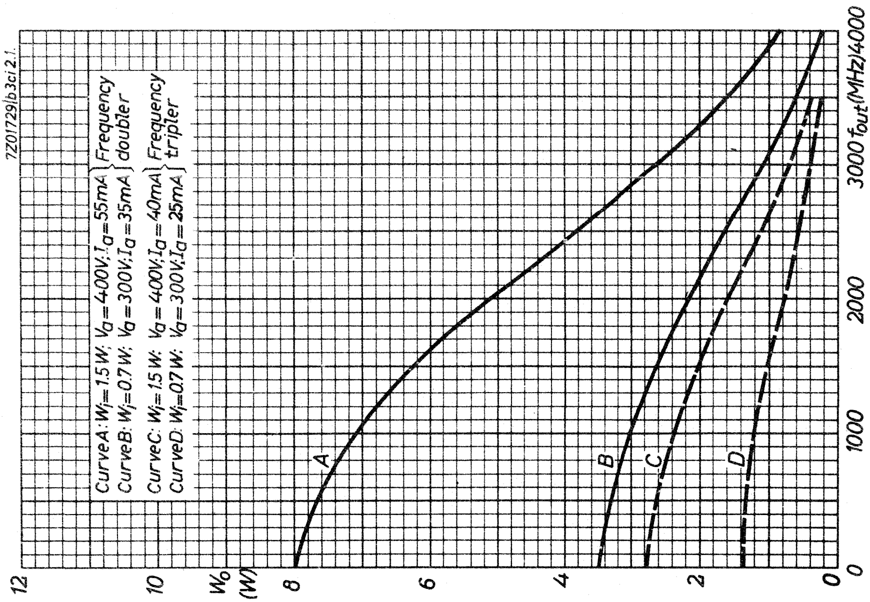
LIMITING VALUES (Absolute max. rating system)

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

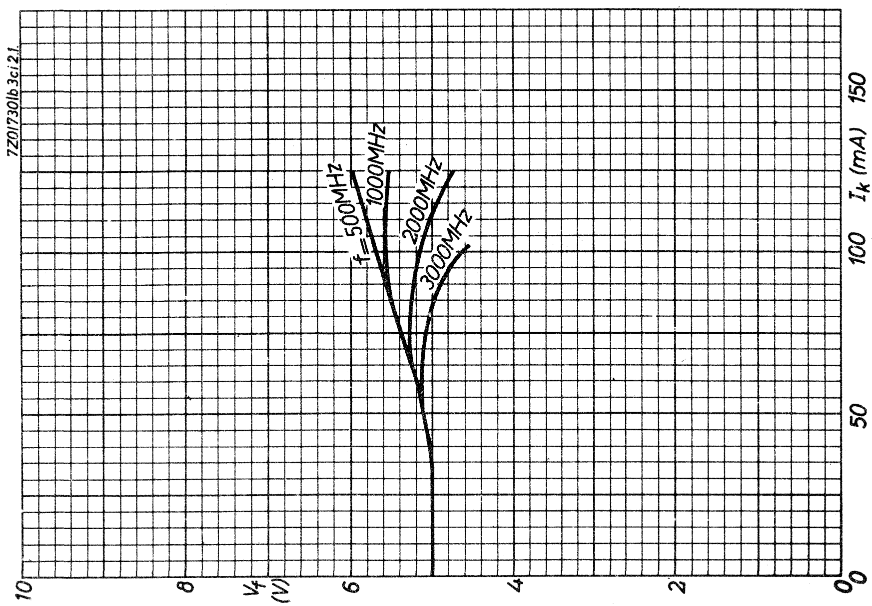
OPERATING CHARACTERISTICS

C.W. Oscillator

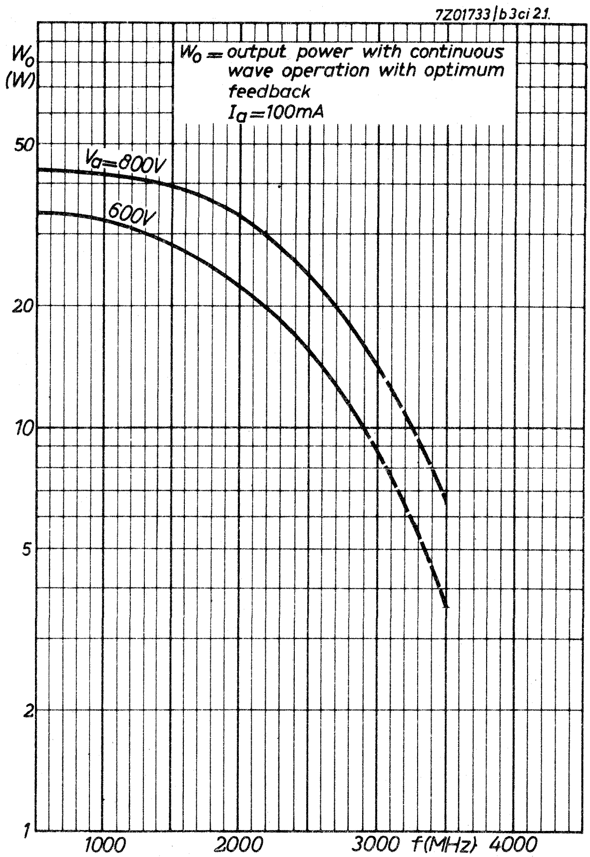
Frequency	f	500	2500	MHz
Heater voltage	V_f	5.8	4.8	V
Anode voltage	V_a	600	600	V
Anode current	I_a	80	100	mA
Grid current	I_g	25	6	mA
Output power	W_o	26	16	W



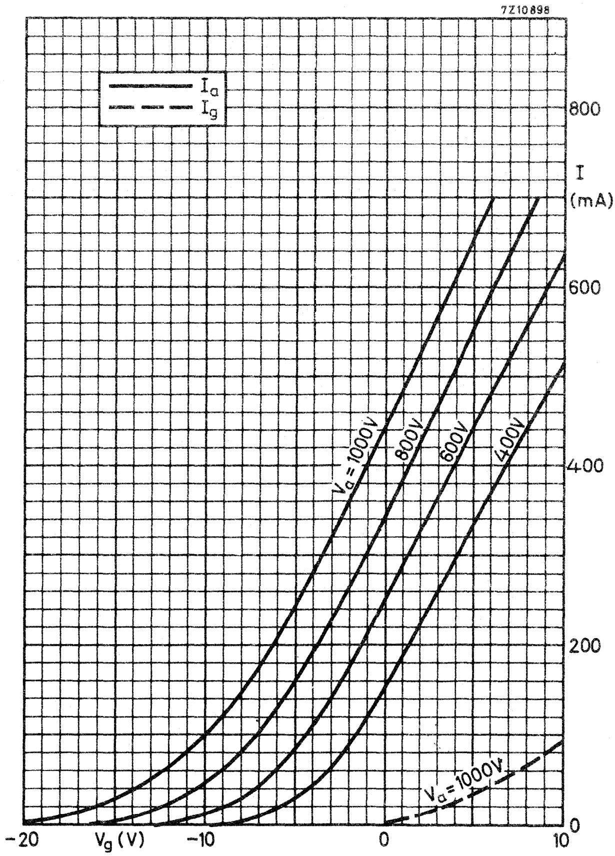
7Z01729 lb 3ci 2.1
Curve A: Wi = 1.5 W; Va = 400 V; Ia = 55 mA } Frequency doubler
Curve B: Wi = 0.7 W; Va = 300 V; Ia = 35 mA
Curve C: Wi = 1.5 W; Va = 400 V; Ia = 40 mA } Frequency tripler
Curve D: Wi = 0.7 W; Va = 300 V; Ia = 25 mA
A
B
C
D
Wo (W)
fout (MHz)
0
1000
2000
3000
4000
0
2
4
6
8
10
12

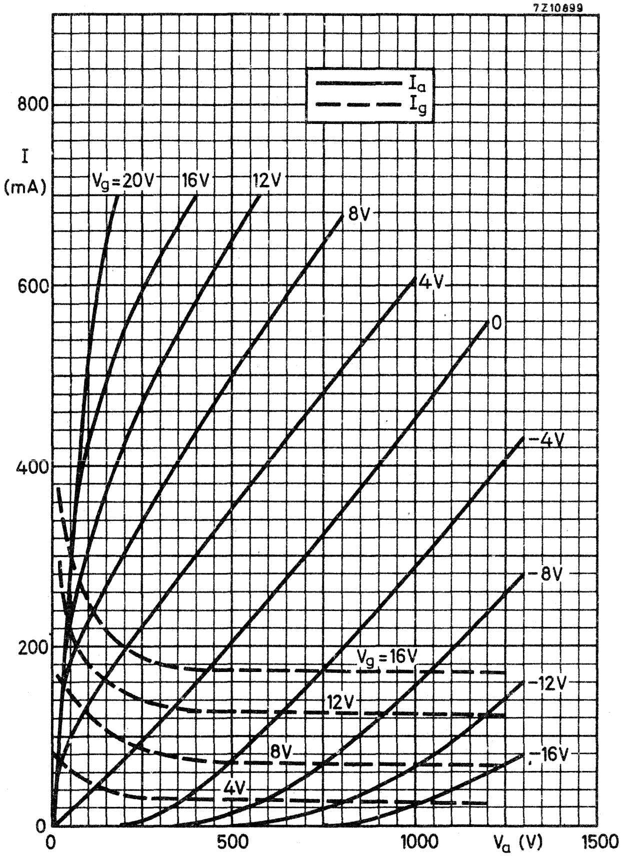


7Z01730 lb 3ci 2.1
f = 500MHz
1000MHz
2000MHz
3000MHz
Ik (mA)
Vf (V)
0
50
100
150
0
2
4
6
8
10



7Z01733 | b3ci 2.1.
W0 (W)
W0 = output power with continuous wave operation with optimum feedback
Ia=100mA
Va=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
Ia
Ig
800
600
400
200
0
I
(mA)
Vg = 20V
16V
12V
8V
4V
0
−4V
−8V
−12V
−16V
Vg = 16V
12V
8V
4V
0
500
1000
Va (V)
1500

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	μ	=	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.

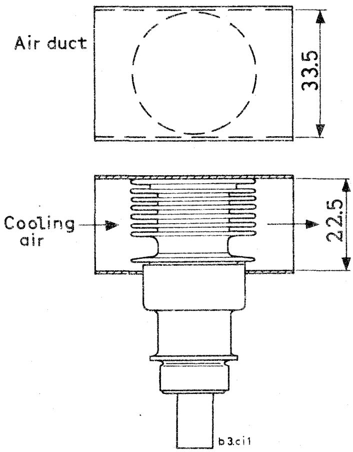
CAPACITANCES

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

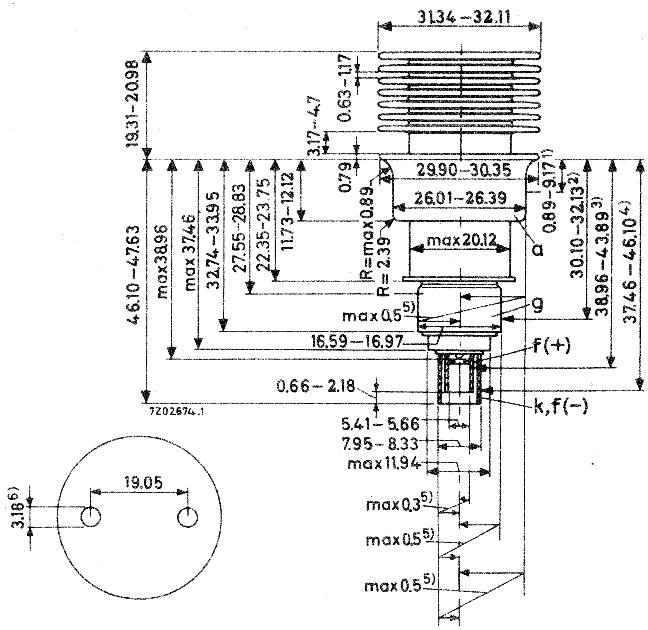
For maximum anode dissipation and assuming the use of an air duct of the dimensions indicated, an air flow of approx. 350 l/min is required for cooling the radiator in case of an inlet temperature of 25 °C. If necessary, the other surfaces should be cooled as well with a low-velocity air flow. As the 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	$-V_{gp}$	=	max. 400	V
Peak positive grid voltage	$+V_{gp}$	=	max. 30	V
Grid dissipation	W_g	=	max. 2	W
Grid current	I_g	=	max. 50	mA
Cathode current	I_k	=	max. 125	mA
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	μ	=	100			

OPERATING CHARACTERISTICS

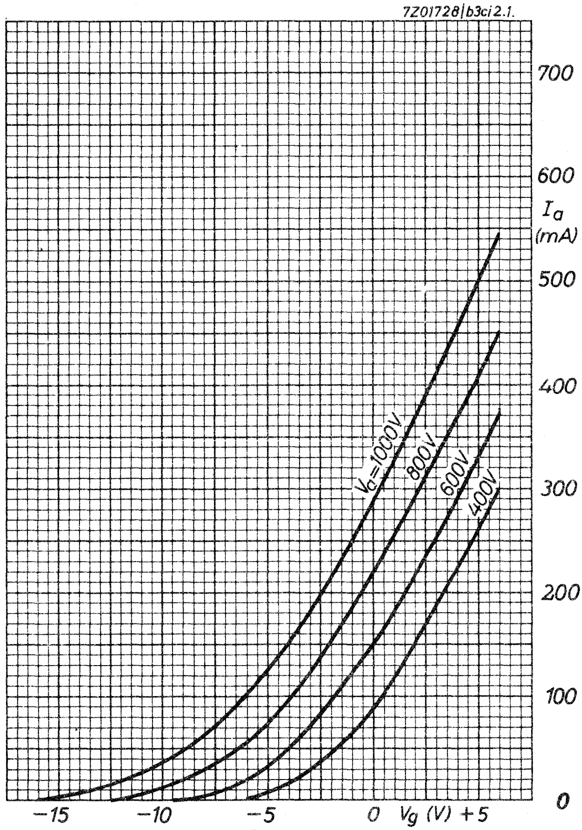
C.W. oscillator

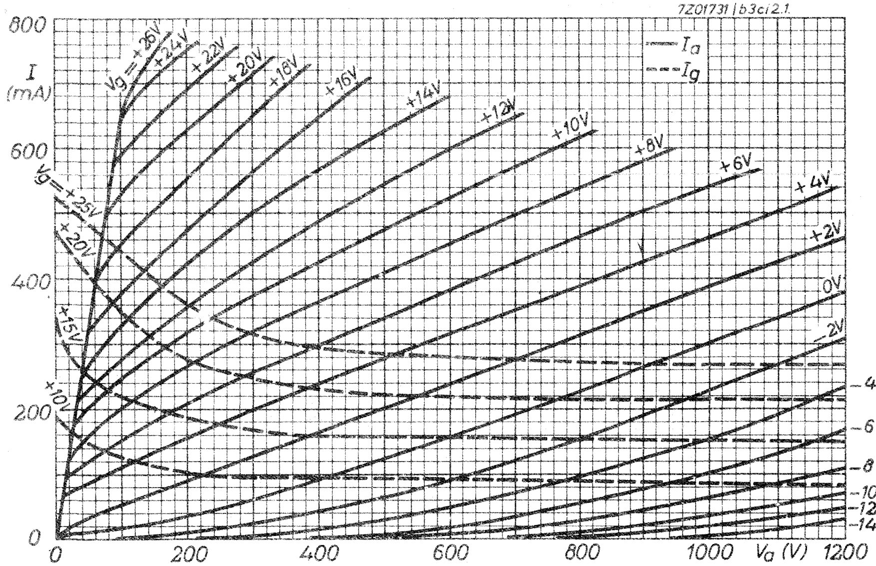
Frequency	f	=	2500	2500	MHz
Heater voltage	V_f	=	4.5	4.5	V
Anode voltage	V_a	=	600	800	V
Anode current	I_a	=	100	100	mA
Grid current	I_g	=	10	8	mA
Output power	W_o	=	16	24	W

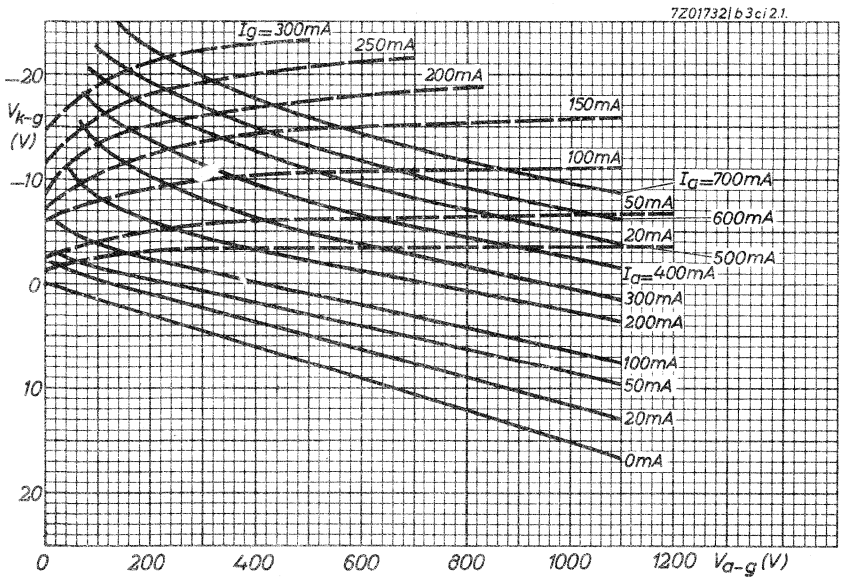
Frequency doubler

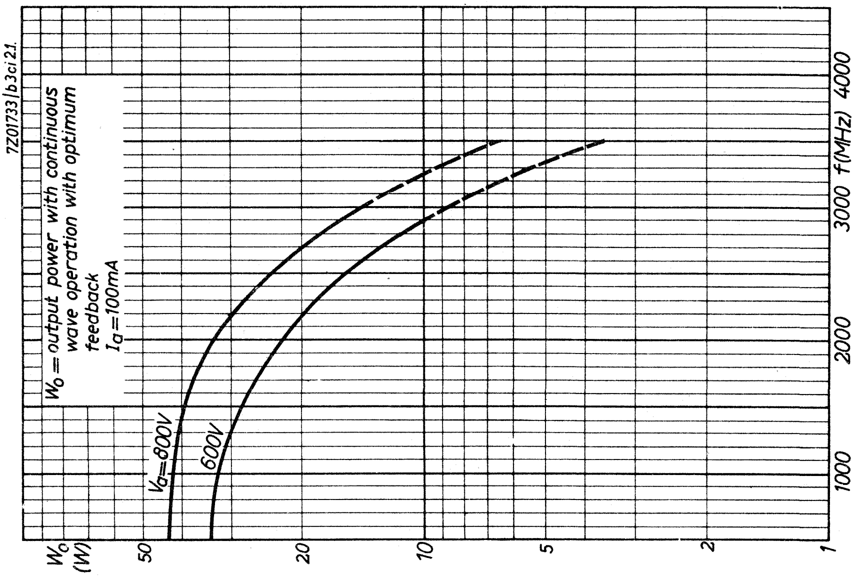
Frequency	f	=	1000/2000	MHz
Heater voltage	V_f	=	5.6	V
Anode voltage	V_a	=	400	V
Grid voltage	V_g	=	−15	V
Anode current	I_a	=	55	mA
Grid input power	W_{ig}	=	1.5	W
Output power	W_o	=	5.2	W

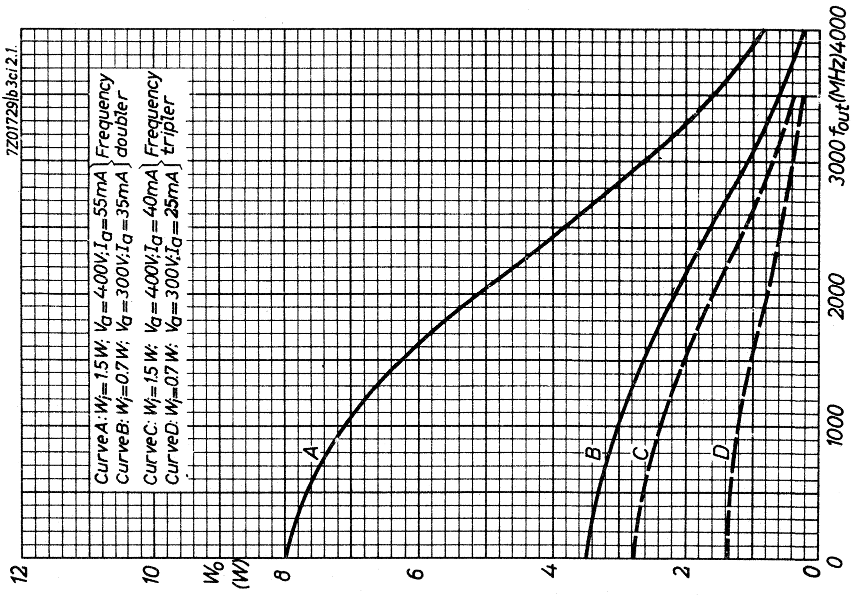
The life of the tube depends on the load and particularly on the tube temperature and the anode voltage. It is therefore recommended that the tube output required be attained with the lowest possible anode voltage, and that the tube temperature be kept as low as possible by adequate cooling.

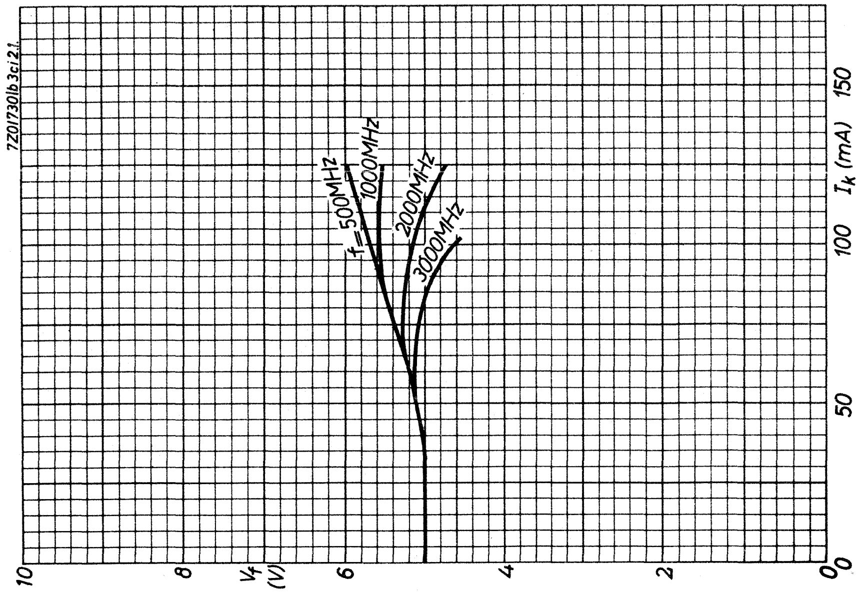

7Z01728|b3ci 2.1.
700
600
I_a (mA)
500
400
300
200
100
0
V_a=1000V
800V
600V
400V
−15
−10
−5
0
V_g (V)
+5

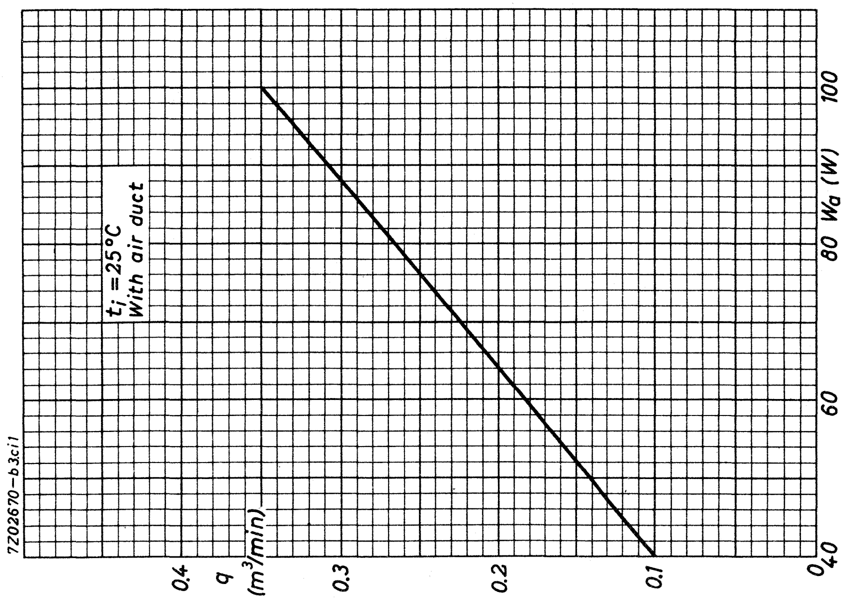

7Z01731 | b3ci 2.1.
I (mA)
Ia
Ig
Vg = +26V
+24V
+22V
+20V
+18V
+16V
+14V
+12V
+10V
+8V
+6V
+4V
+2V
0V
−2V
−4V
−6V
−8V
−10V
−12V
−14V
Vg = +25V
+20V
+15V
+10V
Va (V)
0
200
400
600
800
1000
1200


7Z01732 | b3ci 2.1.
Ig = 300mA
250mA
200mA
150mA
100mA
50mA
20mA
Ia = 700mA
600mA
500mA
Ia = 400mA
300mA
200mA
100mA
50mA
20mA
0mA
Vk-g (V)
−20
−10
0
10
20
Va-g (V)
0
200
400
600
800
1000
1200


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
I_k (mA)
150
100
50
0
V_f (V)
10
8
6
4
2
0


t_i = 25°C
With air duct
7Z02670-b3ci1
Wa (W)
100
80
60
40
q (m³/min)
0.4
0.3
0.2
0.1
0

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	μ	=	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

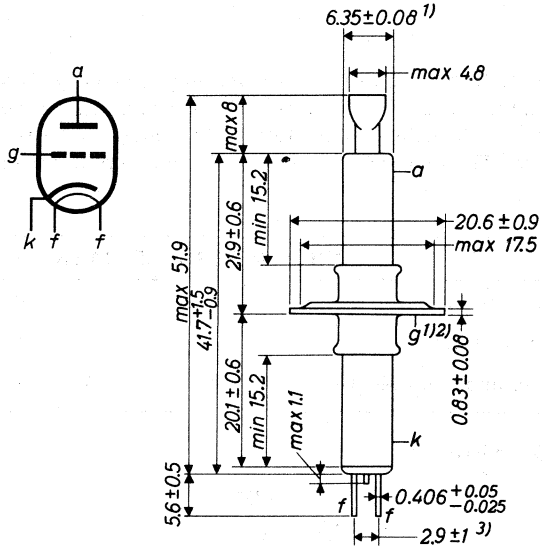
CAPACITANCES

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	μ	=	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_{ia}	= 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)

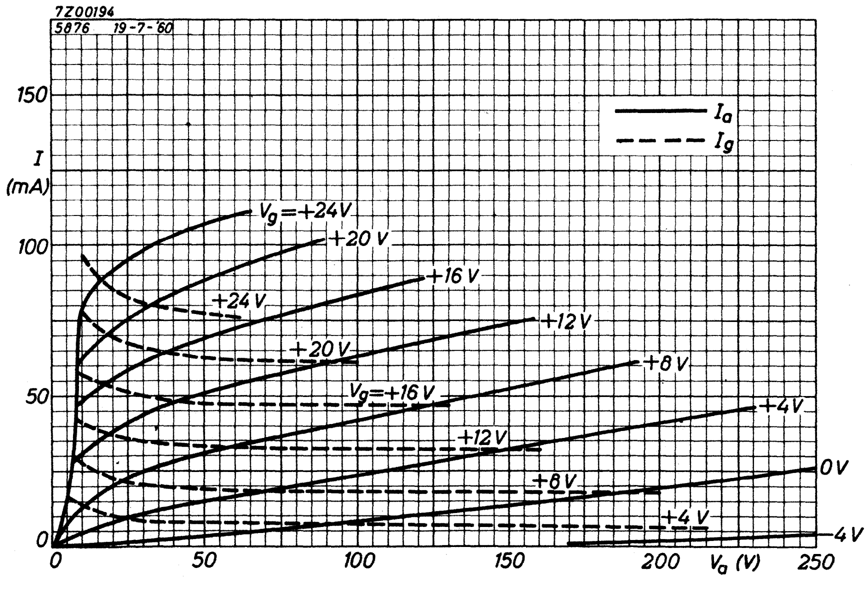
Anode voltage	V_a	= max.	330	V
Anode current	I_a	= max.	22	mA
Anode input power	W_{i_a}	= max.	7.5	W
Anode dissipation	W_a	= max.	6.25	W [1]
Negative grid voltage	$-V_g$	= max.	100	V
Grid current	I_g	= max.	8	mA
Grid circuit resistance	R_g	= max.	0.1	MΩ
Heater to cathode voltage	V_{kf}	= max.	90	V
Anode 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
I
(mA)
100
50
0
0
50
100
150
200
V_a (V)
250
I_a
I_g
V_g=+24V
+20 V
+16 V
+12 V
+8 V
+4 V
0 V
-4 V
+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		μ	=	27	
Mutual conductance		S	=	6	mA/V
Maximum anode dissipation,	CCS	W_a	= max.	7	W
class C telegraphy	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

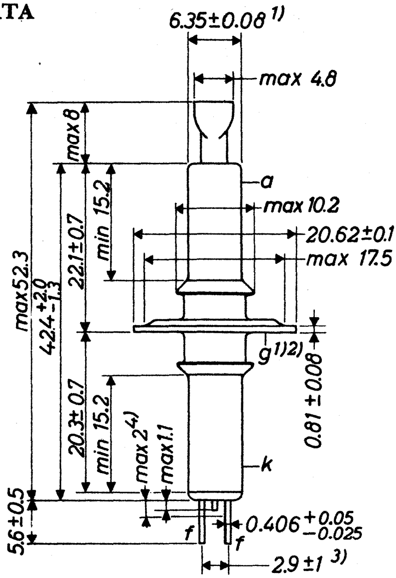
TYPICAL CHARACTERISTICS

Anode voltage	V_a	=	200	V
Anode current	I_a	=	25	mA
Mutual conductance	S	=	6	mA/V
Amplification factor	μ	=	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	$-V_{gp}$	= max.	150	V
Peak anode current	I_{ap}	= max.	3	A
Peak rectified grid current	I_{gp}	= 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_{gp}	=	-110	V
Grid resistor	R_g	=	100	Ω
Peak anode current	I_{ap}	=	3	A
Peak rectified grid current	I_{gp}	=	1.1	A
Anode current	I_a	=	3	mA
Grid current	I_g	=	1.1	mA
Peak output power	W_{op}	=	1200	W [4]
Pulse duration	T_{imp}	=	1	μs
Pulse repetition frequency	f_{imp}	=	1000	Hz
Duty factor	δ	=	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

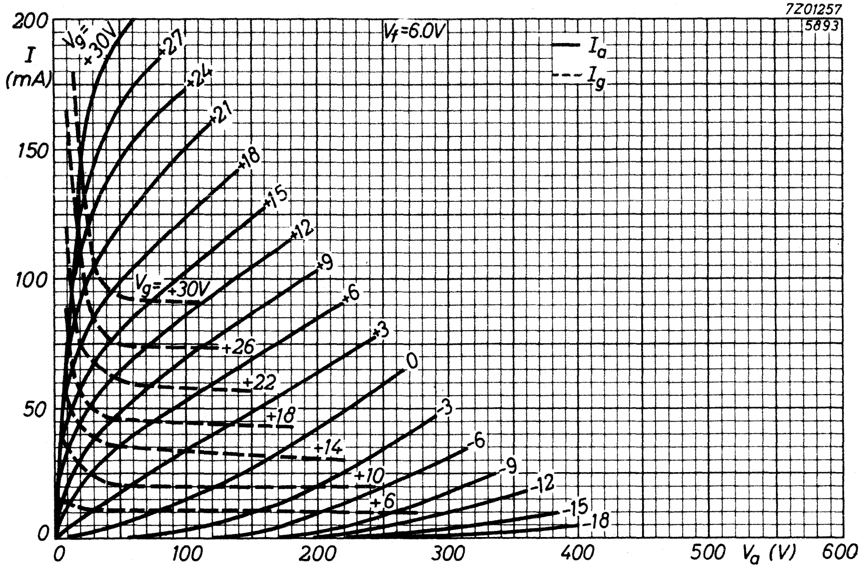
			CCS	ICAS	
Anode voltage	V_a	= max.	260	320	V
Negative grid voltage	$-V_g$	= max.	100	100	V
Anode current	I_a	= max.	33	33	mA
Grid current	I_g	= max.	12	12	mA
Anode input power	W_{i_a}	= max.	8.5	10.5	W
Anode dissipation	W_a	= max.	6	7.5	W [1])
Grid circuit resistance	R_g	= max.	0.1	0.1	MΩ
Cathode to heater voltage	V_{kf}	= max.	90	90	V
	$-V_{kf}$	= max.	90	90	V

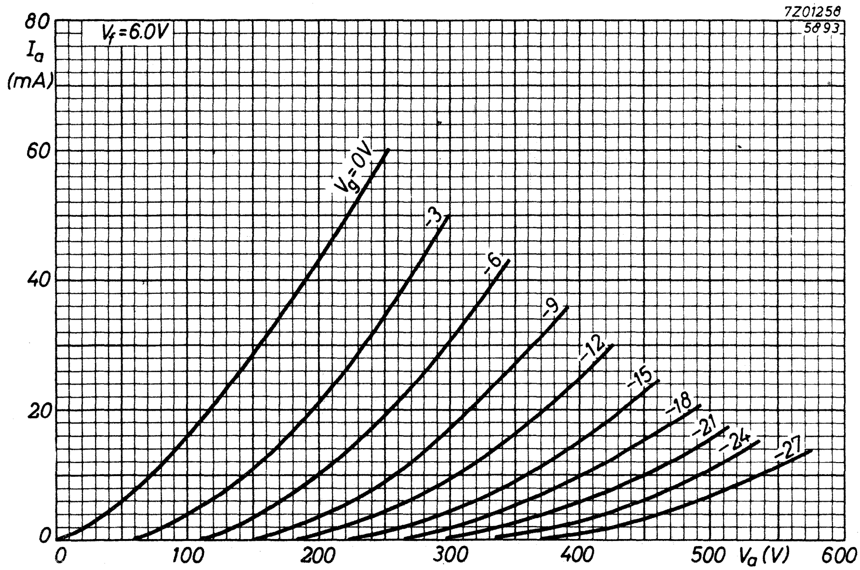
OPERATING CONDITIONS as frequency doubler up to 1000 MHz in grounded grid circuit

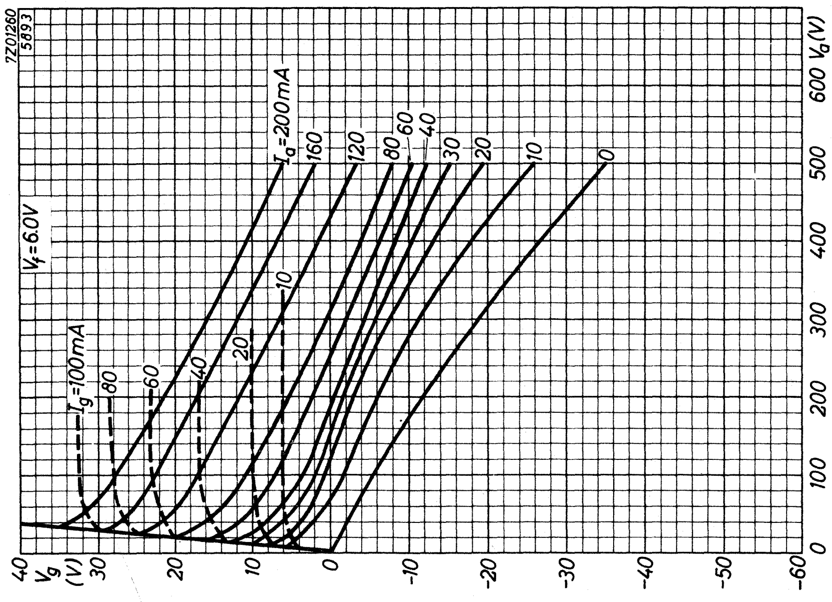
			CCS	ICAS	
Anode voltage	V_a	=	250	300	V
Grid voltage	V_g	=	-40	-50	V [2])
Anode current	I_a	=	33	33	mA
Grid current	I_g	=	7	8	mA
Driver output power	W_{dr}	=	3.2	3.5	W
Output power	W_o	=	2.75	3.0	W

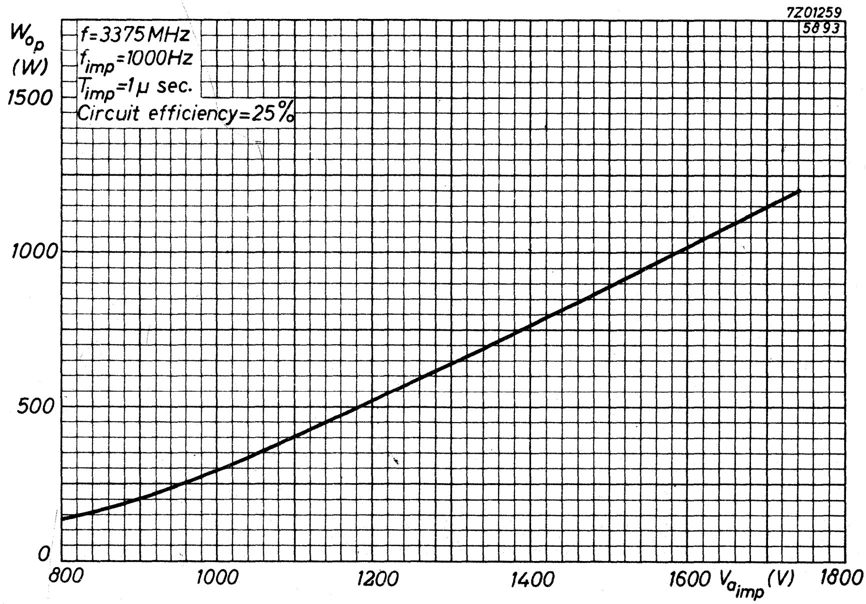
[1]) In applications where the anode dissipation exceeds 2.5 watts, it is important that a large area of contact be provided between the anode cylinder and the connector in order to provide adequate heat conduction.

[2]) Obtained from grid resistor.


7Z01257
5893
V_f=6.0V
I_a
I_g
I (mA)
V_g=+30V
+27
+24
+21
+18
+15
+12
+9
+6
+3
0
-3
-6
-9
-12
-15
-18
V_g=+30V
+26
+22
+18
+14
+10
+6
200
150
100
50
0
0
100
200
300
400
500
V_a (V)
600


7Z01258
5893
V_f=6.0V
I_a (mA)
V_g=0V
-3
-6
-9
-12
-15
-18
-21
-24
-27
80
60
40
20
0
0
100
200
300
400
500
V_a (V)
600


7Z01260
5893
V_f=6.0V
I_a=200mA
160
120
80
60
40
30
20
10
0
I_g=100mA
80
60
40
20
10
V_g (V)
V_a(V)
0
100
200
300
400
500
600
40
30
20
10
0
-10
-20
-30
-40
-50
-60


7Z01259
5893
W_{o_p} (W)
f=3375 MHz
f_{imp}=1000Hz
T_{imp}=1 μ sec.
Circuit efficiency=25%
1500
1000
500
0
800
1000
1200
1400
1600
1800
$V_{a_{imp}}$ (V)

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		μ	=	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

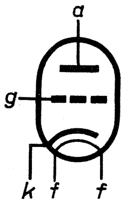
Anode voltage	V_a	=	200	V
Anode current	I_a	=	27	mA
Amplification factor	μ	=	27	
Mutual conductance	S	=	7	mA/V

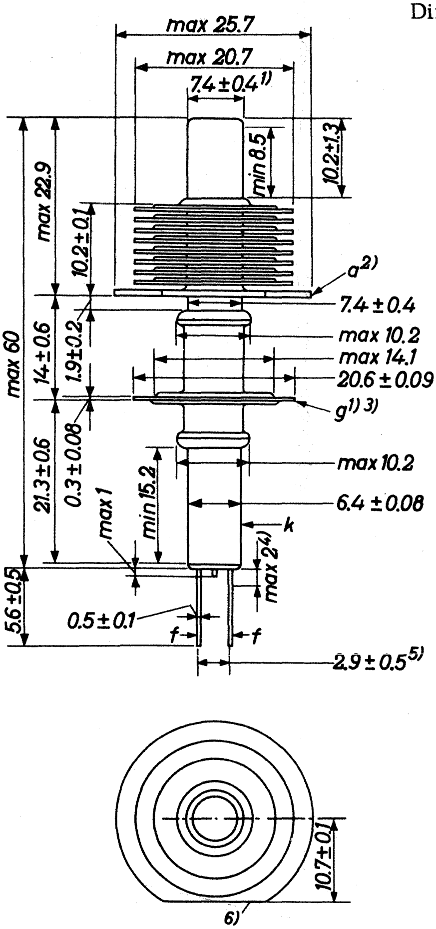
[1]) Flat plate shield 31.75mm diameter located parallel to the plane of the grid flange and midway between the grid flange and the anode terminal fin of the radiator. The shield is tied to the cathode.

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.

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_ℓ	=	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_ℓ	=	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

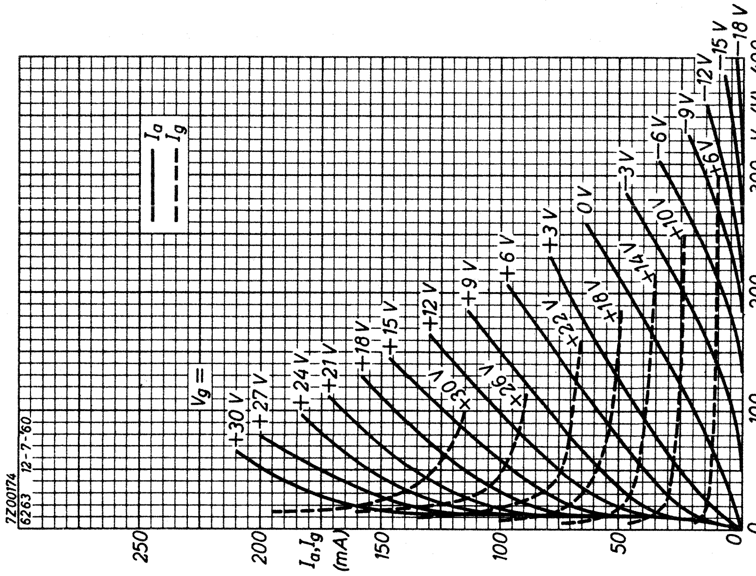
OPERATING CHARACTERISTICS in grounded grid circuit

			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_ℓ	=	6.7	8	W [2][3]

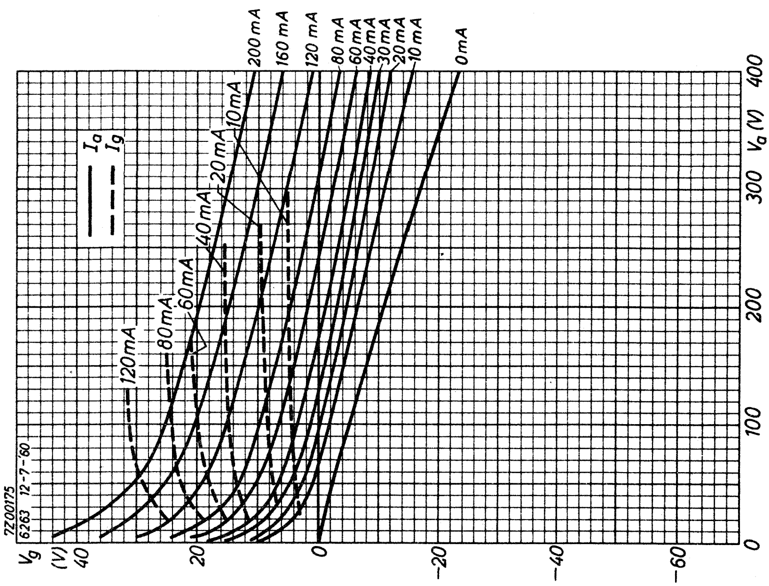
[1] From a grid resistor or from a suitable combination of grid resistor and fixed supply or grid resistor and cathode resistor.

[2] Measured in a circuit having an efficiency of about 75%.

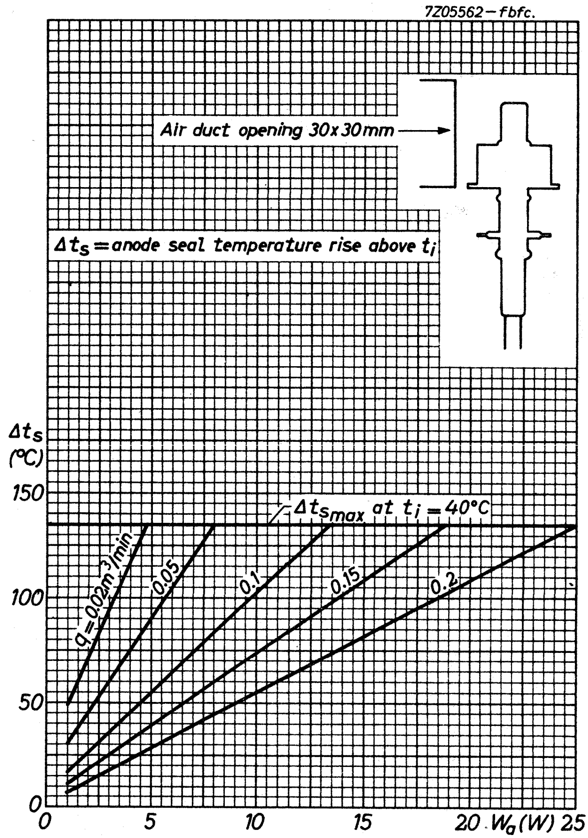
[3] Power transferred from driving stage included.



I_a
I_g
$V_g =$
+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 (mA)
V_a (V)
0
50
100
150
200
250
0
100
200
300
400
7Z00174
6263
12-7-'60



I_a
I_g
200 mA
160 mA
120 mA
80 mA
60 mA
40 mA
30 mA
20 mA
10 mA
0 mA
120mA
80mA
60mA
40mA
20mA
10mA
V_g (V)
40
20
0
−20
−40
−60
V_a (V)
0
100
200
300
400
7Z00175
6263
12-7-'60


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		μ	=	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

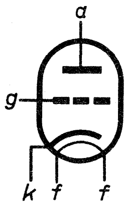
Anode voltage	V_a	=	200	V
Anode current	I_a	=	18.5	mA
Amplification factor	μ	=	40	
Mutual conductance	S	=	6.8	mA/V

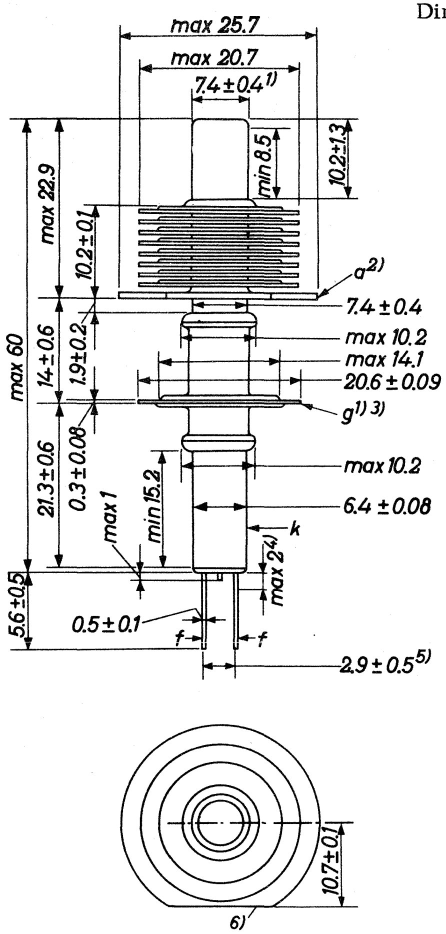
[1]) Flat plate shield 31.75 mm diameter located parallel to the plane of the grid flange and midway between the grid flange and the anode terminal fin of the radiator. The shield is tied to the cathode.

MECHANICAL DATA

Dimensions in mm

Net weight: 24 g





Mounting position: arbitrary

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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.

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_ℓ	=	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_ℓ	=	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)

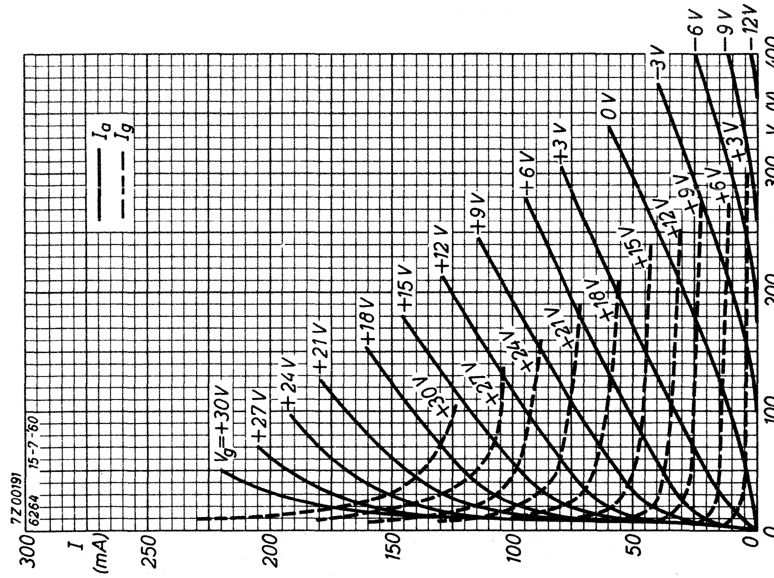
			CCS	ICAS	
Anode voltage	V_a	=	max. 300	max. 350	V
Anode current	I_a	=	max. 33	max. 45	mA
Anode input power	W_{i_a}	=	max. 9.9	max. 15.8	W
Anode dissipation	W_a	=	max. 6	max. 9.5	W
Negative grid voltage	$-V_g$	=	max. 125	max. 140	V
Grid current	I_g	=	max. 15	max. 15	mA
Grid circuit resistance	R_g	=	max. 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

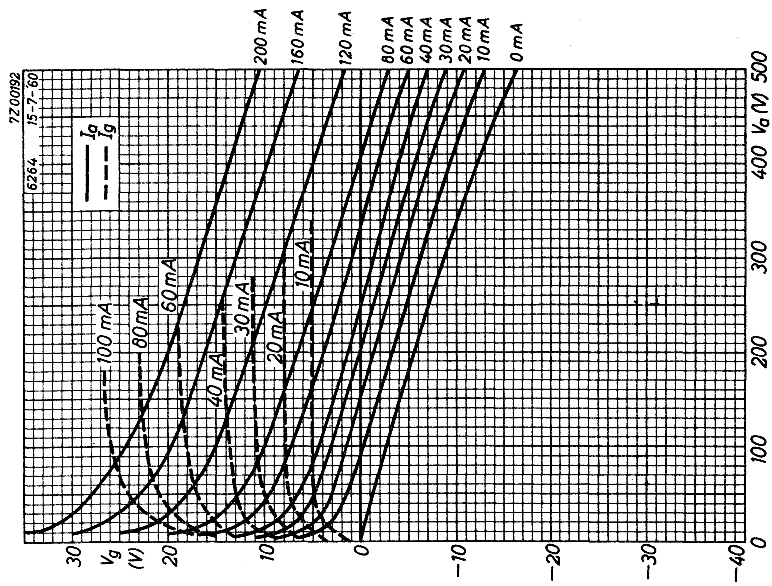
OPERATING CHARACTERISTICS in grounded grid circuit

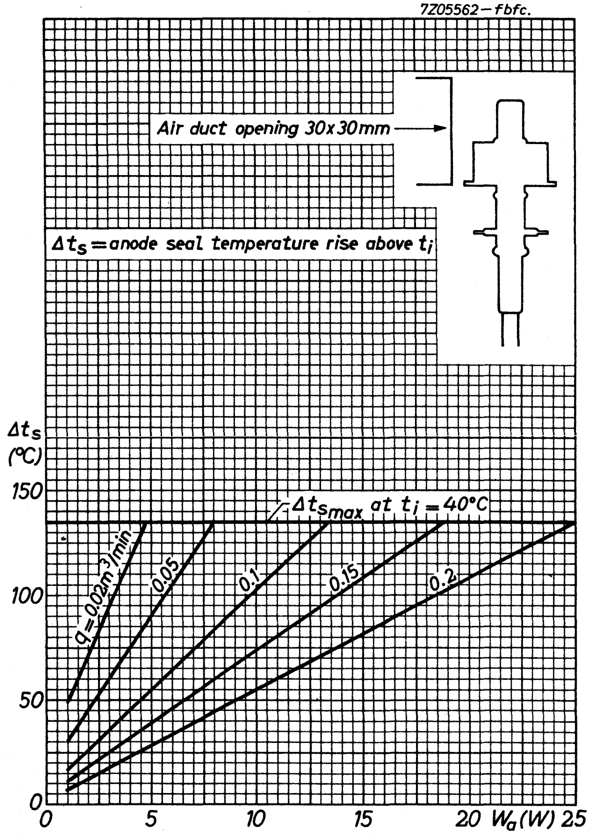
			CCS	ICAS	
Frequency	f	=	170/510	170/510	MHz
Anode voltage	V_a	=	300	350	V
Anode current	I_a	=	26	36.5	mA
Grid voltage	V_g	=	-110	-122	V [1])
Grid current	I_g	=	4.1	5.8	mA
Driving power	W_{dr}	=	2.75	4.5	W
Output power in the load	W_ℓ	=	2.1	3.4	W [2])

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
I
(mA)
300
250
200
150
100
50
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	μ	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

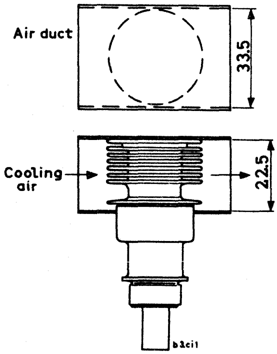
Anode voltage	V_a	600	V
Cathode resistor	R_k	30	Ω
Anode current	I_a	60 to 95	mA
Transconductance	S	20 to 30	mA/V
Amplification factor	μ	100	

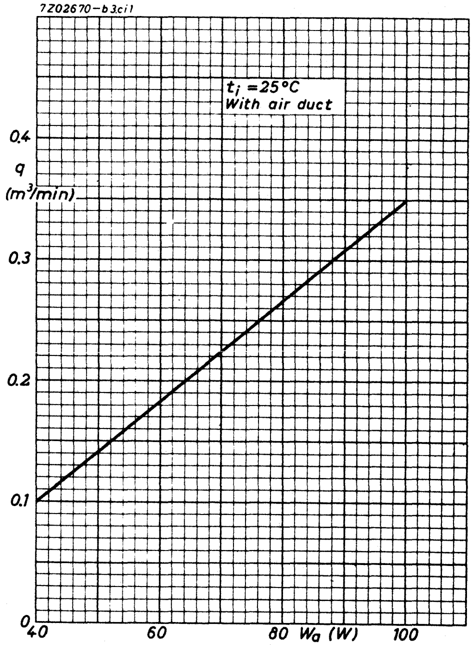
1) The heater voltage should be reduced to a value depending on the cathode current and frequency. See curve on page 6. The maximum fluctuation should not exceed ± 5%.

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.



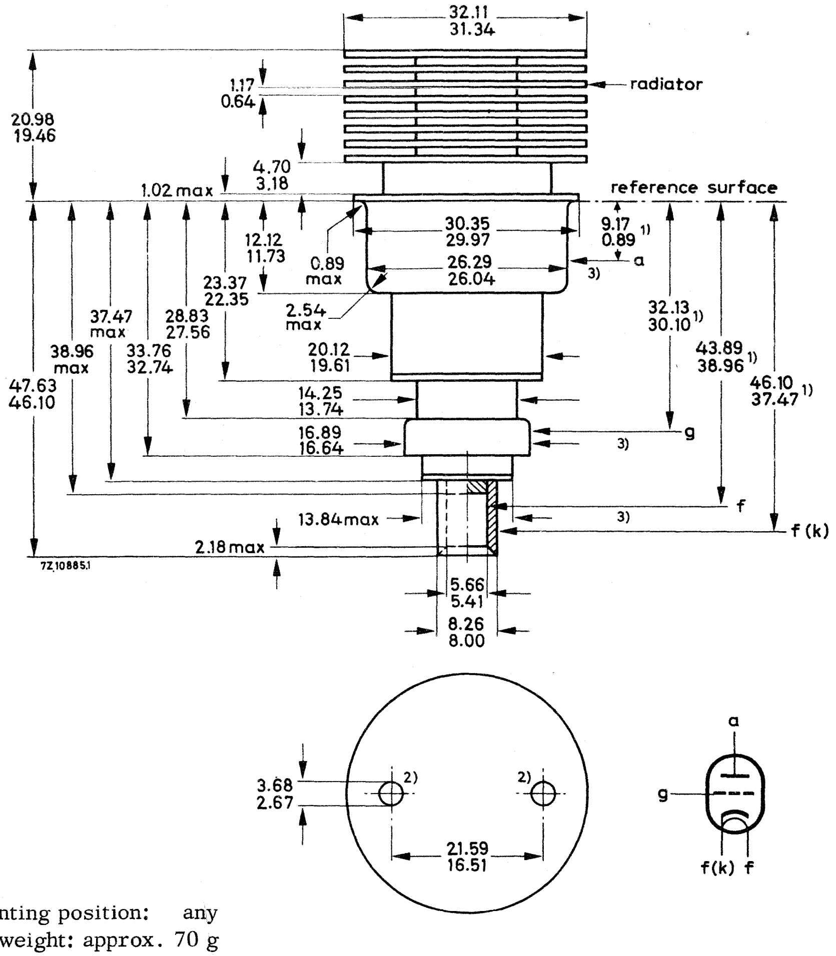


LIFE EXPECTANCY

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

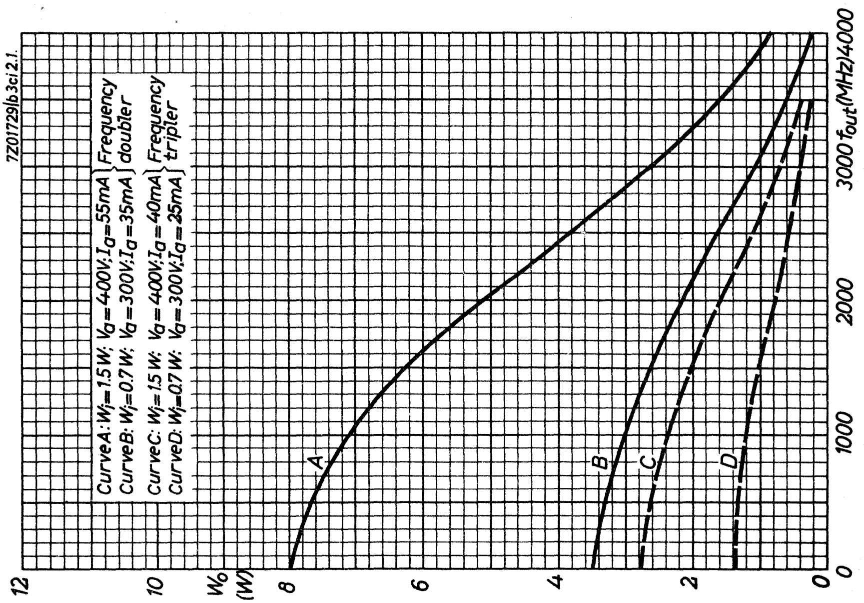
ANODE PULSED OSCILLATOR

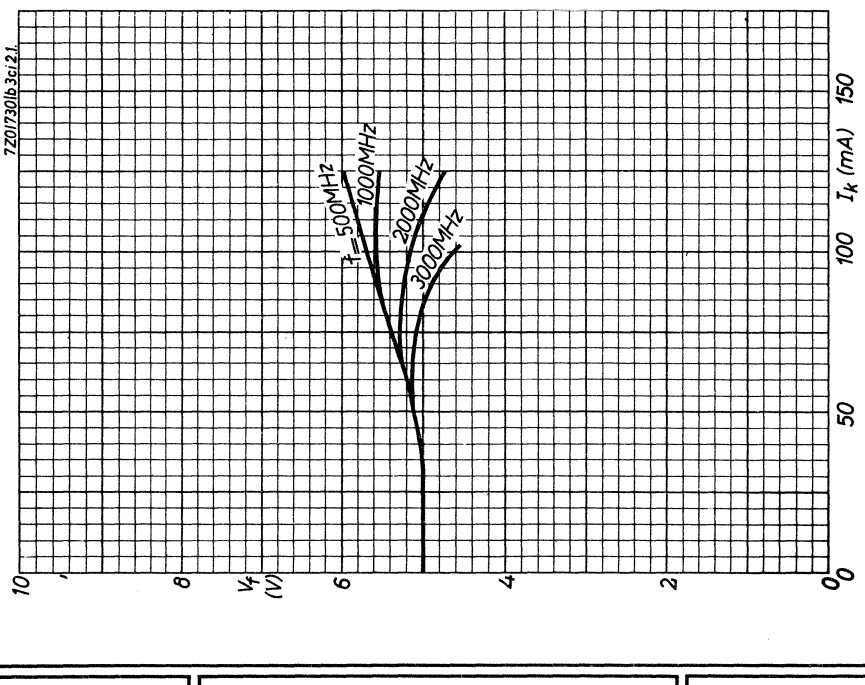
LIMITING VALUES (Absolute max. rating system)

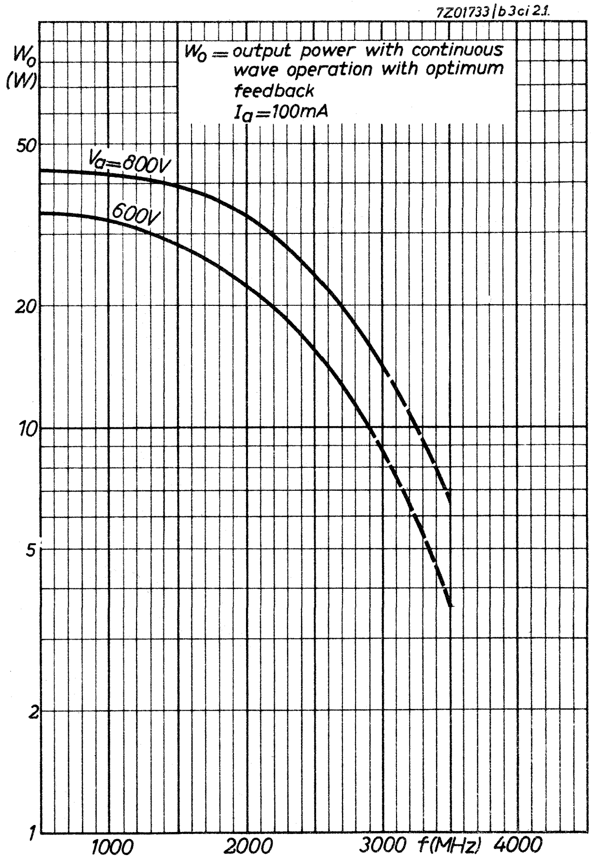
Frequency	f	max.	3000	MHz
Pulse duration	T_{imp}	max.	3	μs
Duty cycle	δ	max.	0.0025	
Anode voltage, peak	V_{ap}	max.	3500	V
Anode current, peak	I_{ap}	max.	3	A
Anode dissipation	W_a	max.	27	W
Grid voltage, negative	$-V_g$	max.	150	V
negative peak	$-V_{gp}$	max.	750	V
positive peak	V_{gp}	max.	250	V
Grid voltage, peak	I_{gp}	max.	1.8	A
Grid dissipation	W_g	max.	2	W
Envelope temperature	t_{env}	max.	300	°C
Altitude	h	max.	20	km

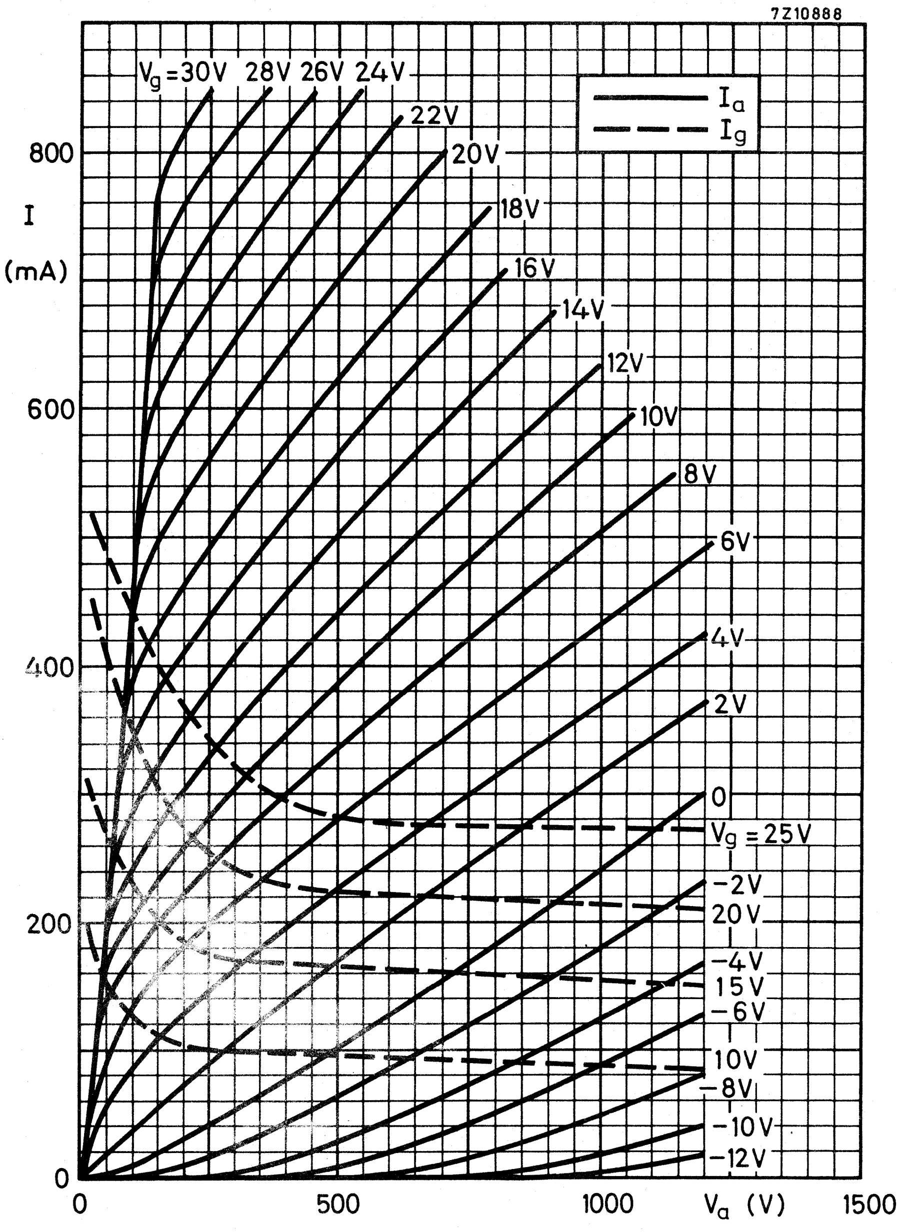
OPERATING CHARACTERISTICS

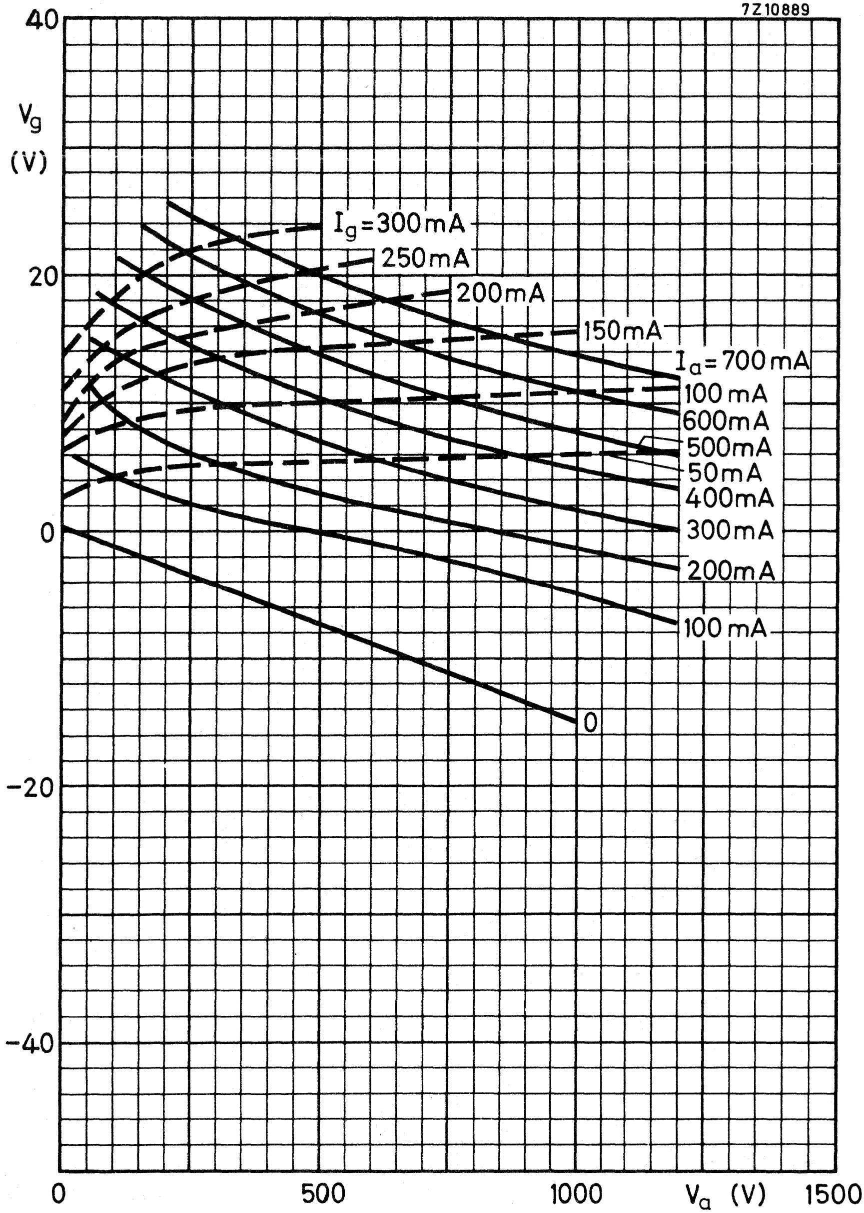
Frequency	f	3000	MHz
Pulse duration	T_{imp}	3	μs
Duty cycle	δ	0.0025	
Heater voltage	V_f	5.8	V
Anode voltage, peak	V_{ap}	3500	V
Anode current	I_a	7.5	mA
Grid current	I_g	4.5	mA
Output power, peak	W_{op}	2	kW

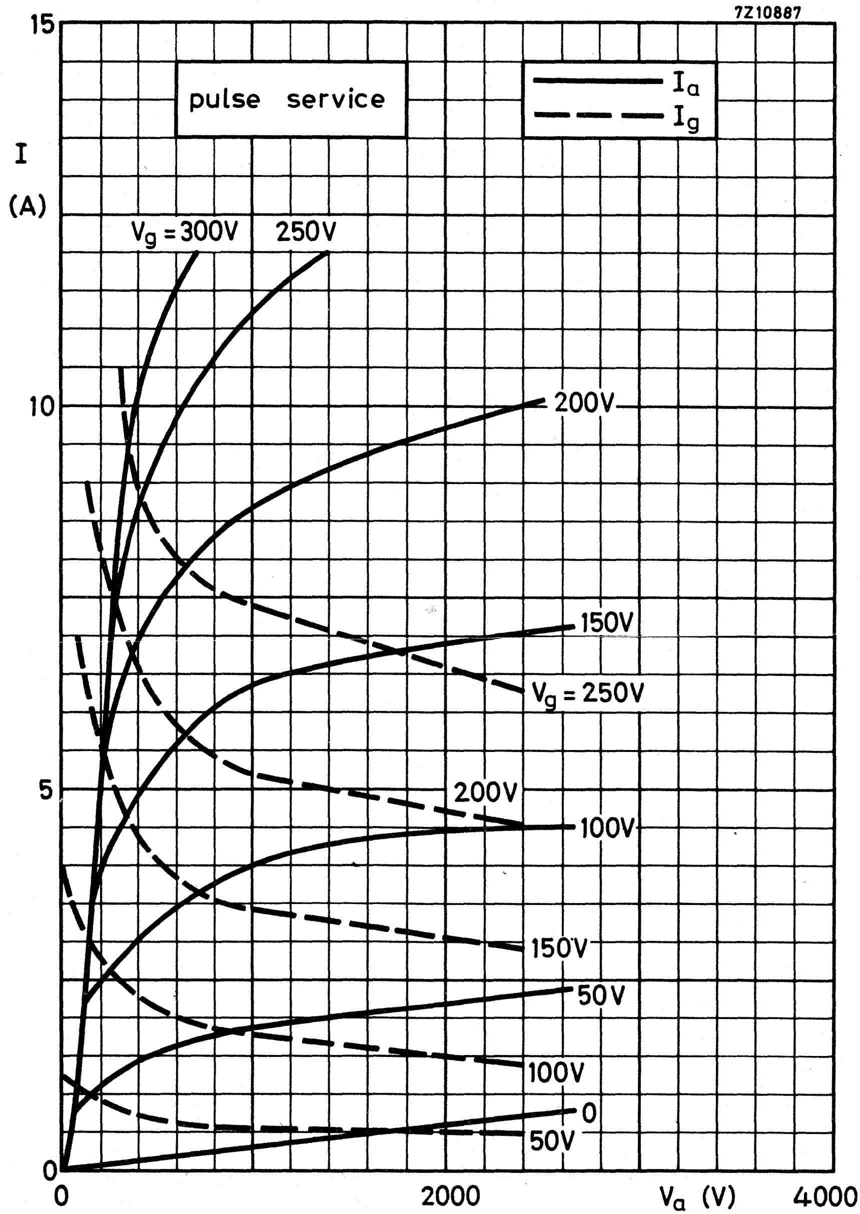

7Z01729/b3ci2.1.
Curve A: Wi=1.5 W; Va=400V; Ia=55mA
Curve B: Wi=0.7 W; Va=300V; Ia=35mA
Frequency doubler
Curve C: Wi=1.5 W; Va=400V; Ia=40mA
Curve D: Wi=0.7 W; Va=300V; Ia=25mA
Frequency tripler
A
B
C
D
Wo (W)
0
2
4
6
8
10
12
fout (MHz)
0
1000
2000
3000
4000


7Z01730/b3ci2.1.
f=500MHz
1000MHz
2000MHz
3000MHz
Vf (V)
0
2
4
6
8
10
Ik (mA)
0
50
100
150

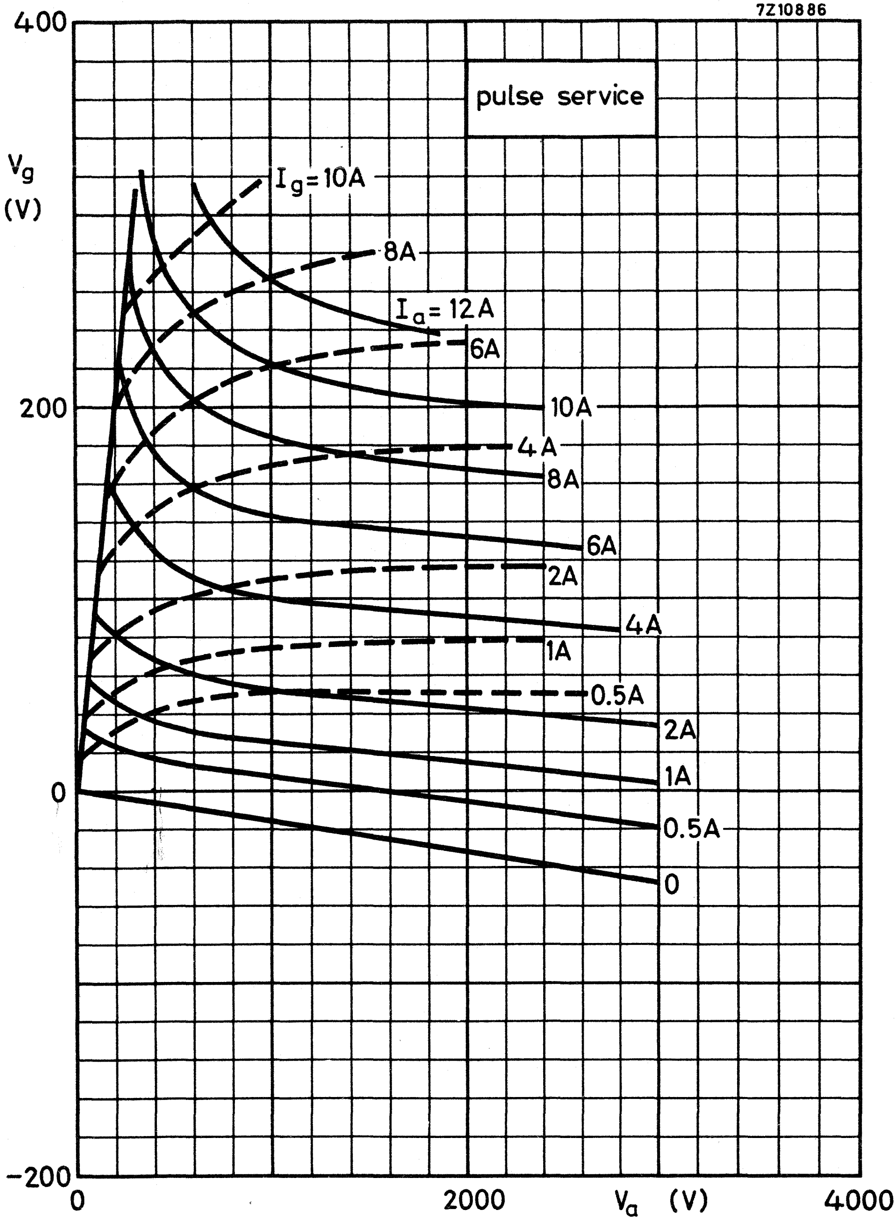

7Z01733 | b3ci 2.1.
Wo = output power with continuous wave operation with optimum feedback
Ia = 100mA
Wo (W)
Va=800V
600V
50
20
10
5
2
1
1000
2000
3000
f(MHz)
4000


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
1500
V_a (V)



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
V_g (V)
400
200
0
−200
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

For further data refer to data EC157

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

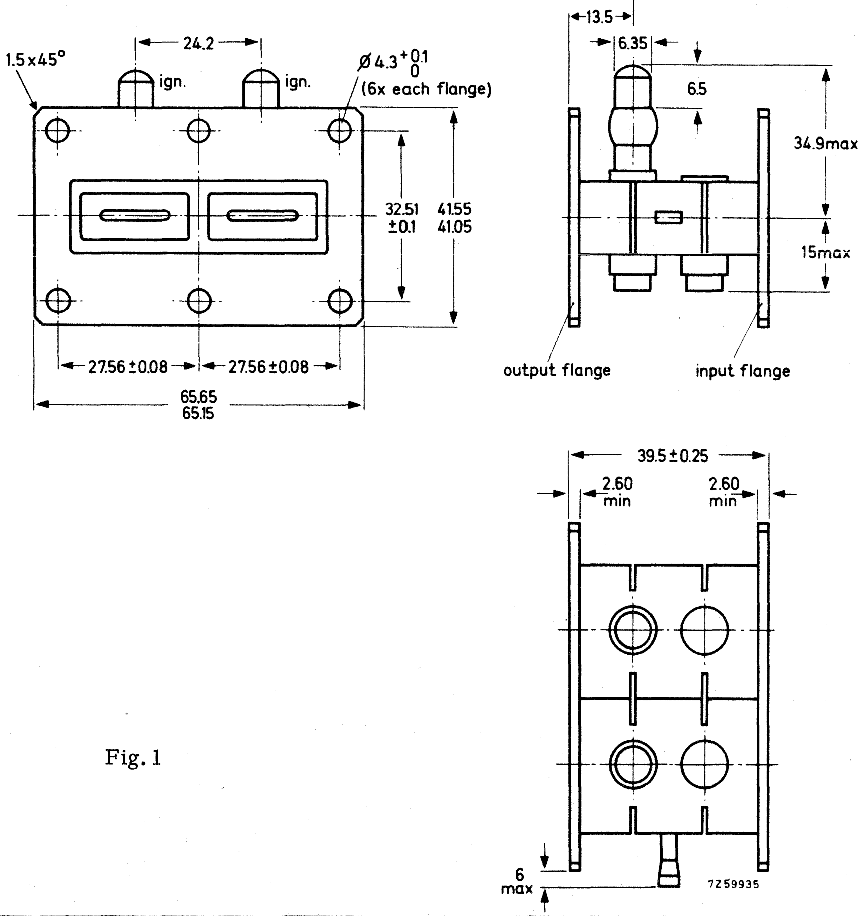


Fig. 1

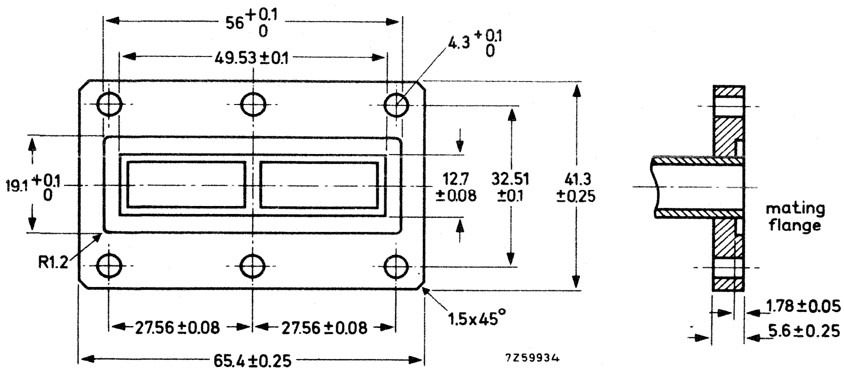


Fig. 2 Gasket assembly

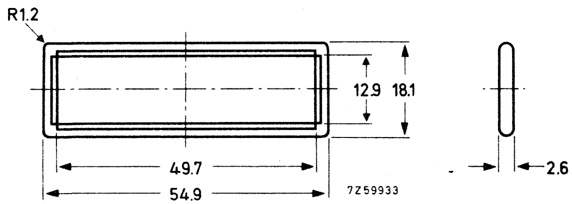


Fig. 3 Gasket

Microwave semiconductor devices

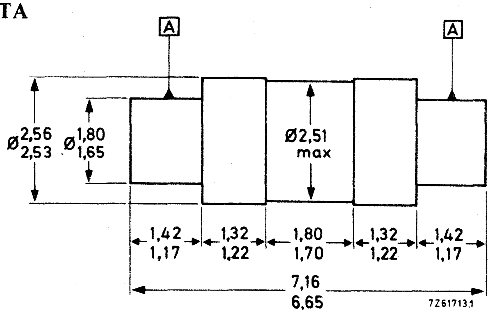
MICROWAVE MIXER DIODES

Subminiature germanium point-contact mixer diodes primarily intended for low noise mixer applications at X-band.

QUICK REFERENCE DATA					
Frequency range		f		1.0 to 18	GHz
Noise figure	AAY39	F	typ.	6.0	dB
	AAY39A	F	typ.	7.0	dB

MECHANICAL DATA

Dimensions in mm



A = concentricity tolerance = ± 0.15

The cathode indicates the electrode which becomes positive in an a.c. rectifier circuit.
The cathode is marked red

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Burn-out				
D.C. spike		max.	0.1	erg
R.F. spike		max.	0.05	erg
Pulse peak power (t_p = 0.5 µs)		max.	0.5	W
Temperatures				
Storage temperature	T_{stg}		−55 to +100	°C
Operating ambient temperature	T_{amb}		−55 to +100	°C

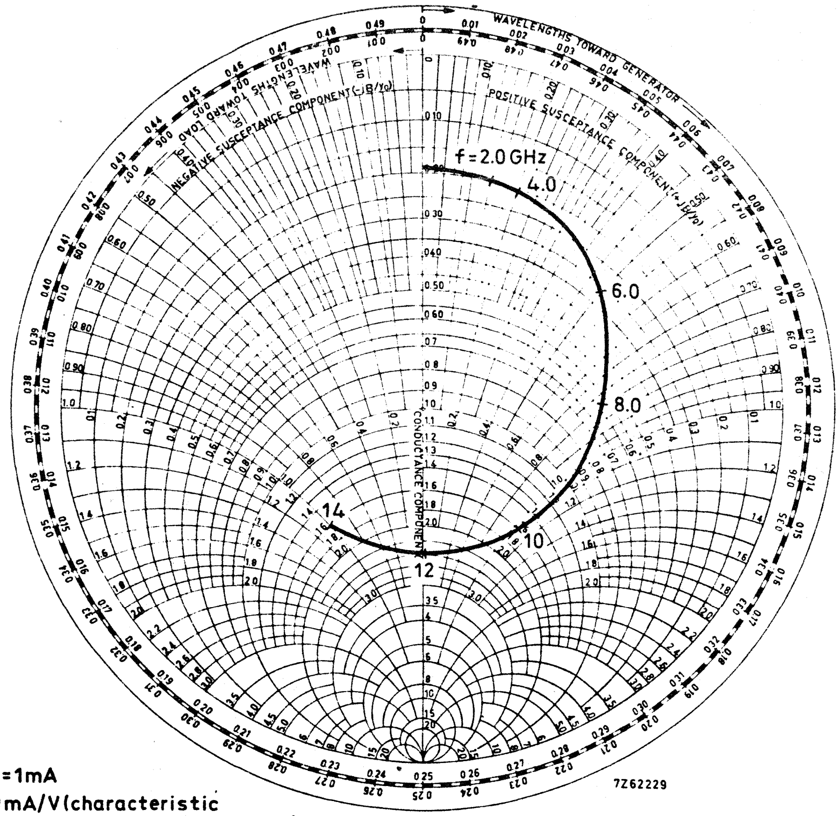
CHARACTERISTICS T_{amb} = 25 °C

Reverse current at V_R = 0.5 V		I_R	typ.	3.0	µA
Forward current at V_F = 0.5 V		I_F	typ.	5.0	mA
Overall noise figure [1]	AAY39	F	typ.	6.0	dB
				5.5 to 6.5	dB
	AAY39A	F	typ.	7.0	dB
			<	7.5	dB
Conversion loss	AAY39		typ.	4.2	dB
	AAY39A		typ.	5.0	dB
Noise temperature ratio					
i.f. = 45 MHz	AAY39		typ.	1.1 : 1	
	AAY39A		typ.	1.2 : 1	
Voltage standing wave ratio		V.S.W.R.	<	1.43 : 1	
Intermediate frequency impedance		Z_{if}		250 to 450	Ω
Operating frequency range		f		1.0 to 18	GHz

NOTE

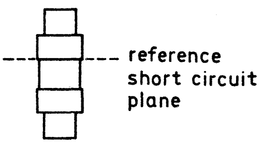
Optimum performance is obtained when the oscillator drive is adjusted to give a diode rectified current of 1.0 mA and the load resistance is restricted to max. 100 Ω

[1]) Measured at 9.375 GHz, 1.0 mA diode rectified current, R_L = 15 Ω, this value includes i.f. noise of 1.5 dB.



7Z62229

$I_{F(AV)}$ = 1mA
y_o = 20mA/V (characteristic admittance)



7Z62230

APPLICATION INFORMATION

1. Mixer performance

Measured overall noise figure

f = 16.5 GHz; F_{if} = 1.5 dB; i.f. = 45 MHz	F	typ.	7.0	dB
f = 3.0 GHz; F_{if} = 1.5 dB; i.f. = 45 MHz	F	typ.	5.5	dB
f = 9.5 GHz; i.f. = 3.0 kHz	F	typ.	29	dB

2. Signal/Flicker noise ratio at 9.5 GHz

measured at 2.0 kHz from carrier in a 70 Hz bandwidth			131	dB

3. Detector performance

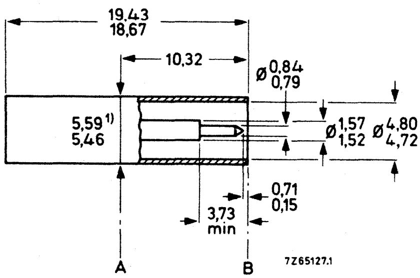
Tangential sensitivity f = 9.375 GHz; B = 1.0 MHz; I_F = 50 μA		typ.	−52	dBm
Video impedance; I_F = 50 μA	Z_{iv}	typ.	800	Ω

MICROWAVE MIXER DIODES

The AAY51 and AAY51R as well as the AAY52 and AAY52R (for terminal identification see mechanical data on this page) form a pair of normal and reverse polarity mixer diodes for use in balanced mixer circuits at J-band (Ku-band). The diodes give a good impedance match over the whole band. These types are packaged in the standard coaxial outline for the frequency, similar to 1N78 types.
The encapsulation is hermetically sealed.

QUICK REFERENCE DATA					
Frequency range		f		12 to 18	GHz
Noise figure	AAY51; AAY51R	F	typ.	7.0	dB
	AAY52; AAY52R	F	typ.	8.0	dB

MECHANICAL DATA Dimensions in mm



Body diameter values are guaranteed only from A to B

The body is cadmium plated in order to be compatible with an aluminium holder.

TERMINAL IDENTIFICATION

AAY51 } AAY52	Pin	cathode
	Body (red)	anode
AAY51R } AAY52R	Pin	anode
	Body (blue)	cathode

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC134)

Burn-out

Multiple d.c. spike		max.	0.1	erg

Temperatures

Storage temperature	T_{stg}	−55 to +100	°C
Ambient temperature	T_{amb}	−55 to +100	°C

CHARACTERISTICS T_{amb} = 25 °C

Reverse current at V_R = 0.5 V		I_R	typ.	3.0	μA
Forward current at V_F = 0.5 V		I_F	typ.	9.0	mA
Overall noise figure [1]					
	AAY51; AAY51R	F	typ.	7.0	dB
			<	7.5	dB
	AAY52; AAY52R	F	typ.	8.0	dB
			<	8.5	dB
Conversion loss	AAY51; AAY51R		typ.	5.2	dB
Noise temperature ratio; i.f. = 45 MHz					
	AAY51; AAY51R			1.1 : 1	
Voltage standing wave ratio; i.f. = 45 MHz					
Measured at 13.5 GHz		V.S.W.R.	<	1.5 : 1	
Measured in band 13 - 18 GHz		V.S.W.R.	<	2.5 : 1	
Intermediate frequency impedance		Z_{if}	typ.	270	Ω
			220 to	320	Ω
Operating frequency range		f	12 to	18	GHz

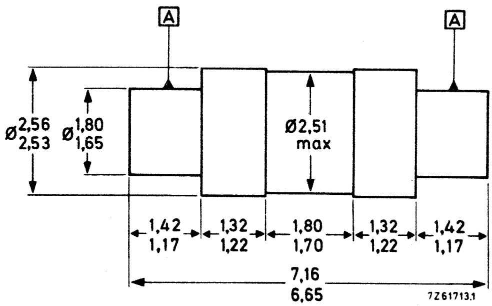
[1]) Measured at 13.5 GHz in JAN201 holder, this value includes i.f. noise of 1.5 dB.

MICROWAVE MIXER DIODE

Subminiature germanium point-contact mixer diode for use at Q-band (Ka-band)

QUICK REFERENCE DATA			
Frequency range		26 to 40	GHz
Noise figure	typ.	8.5	dB

MECHANICAL DATA Dimensions in mm



A = concentricity tolerance = ±0,15

The cathode is marked red
The cathode indicates the electrode which becomes positive in an a.c. rectifier circuit.

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Burn-out			
R.F. spike		max.	0.03 erg
Pulse peak power (t_p = 0.2 μs)		max.	0.5 W
Temperatures			
Storage temperature	T_{stg}		−55 to +100 °C
Operating ambient temperature	T_{amb}		−55 to +100 °C

CHARACTERISTICS T_{amb} = 25 °C

Reverse current at V_R = 0.5 V	I_R	typ.	2.0 μA
Forward current at V_F = 0.5 V	I_F	typ.	2.0 mA
Overall noise figure [1]	F	typ. <	8.5 dB 10 dB
Conversion loss		typ.	5.5 dB
Noise temperature ratio; i.f. = 45 MHz			1.6 : 1
Voltage standing wave ratio [2]	V.S.W.R.	typ. <	1.4 : 1 1.8 : 1
Intermediate frequency impedance	Z_{if}	typ.	1000 Ω 700 to 1400 Ω
Operating frequency range			26 to 40 GHz

MATCHED PAIRS

The diodes can be supplied in matched pairs under the typenumber 2-AAY59M.
The diodes are matched to ±10% on rectified current and within 150 Ω i.f. impedance

[1]) Measured at 34.86 GHz, 0.5 mA diode rectified current, this value includes i.f. noise of 1.5 dB

[2]) With respect to standard test holder

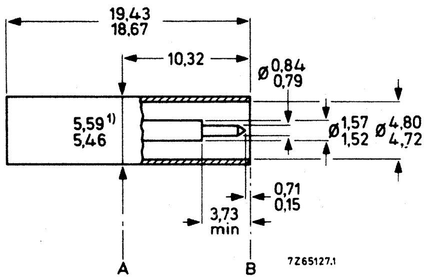
MICROWAVE DETECTOR DIODES

Germanium bonded backward diodes primarily intended for low level detector applications at J-band (Ku-band). The AEY29 and AEY29R are packaged in the standard coaxial outline for this frequency band, similar to 1N78 types.
The encapsulation is hermetically sealed.

QUICK REFERENCE DATA			
Frequency range	f	12 to 18	GHz
Zero bias tangential sensitivity at J-band	typ.	−43	dBm

MECHANICAL DATA

Dimensions in mm



Body diameter values are guaranteed only from A to B

TERMINAL IDENTIFICATION

AEY29	Pin	cathode
	Body (red)	anode
AEY29R	Pin	anode
	Body (green)	cathode

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC134)

Temperatures

Storage temperature	T_{stg}	−55 to +100	°C
Ambient temperature	T_{amb}	−55 to +100	°C

CHARACTERISTICS

T_{amb} = 25 °C

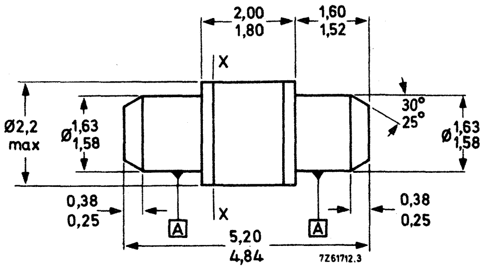
Reverse current at V_R = 0.3 V	I_R	typ.	100	µA
Forward current at V_F = 0.3 V	I_F	typ.	12	mA
Tangential sensitivity				
measured at 16.5 GHz, zero bias, video bandwidth 1.0 MHz (in JAN201 holder)		typ.	−43	dBm
Figure of merit				
measured at 16.5 GHz, M is taken as the product of current sensitivity, expressed in µA/µW and the root of video impedance in Ω (in JAN201 holder)	M	>	50	
Video impedance				
zero bias, V_i < 1.0 mV (d.c. or a.c. r.m.s.)	Z_{iv}	typ.	300	Ω
Voltage standing wave ratio				
w.r.t. JAN201 holder, measured at f = 16.5 GHz, zero bias and c.w. input power < 1.0 µW	V.S.W.R.	<	5 : 1	

MICROWAVE DETECTOR DIODES

Subminiature germanium bonded backward diodes primarily intended for broad band low level detector applications at X-band.

QUICK REFERENCE DATA				
Frequency range			1 to 18	GHz
Zero bias tangential sensitivity at X-band	AEY31 :	typ.	−53	dBm
	AEY31A:	typ.	−50	dBm

MECHANICAL DATA Dimensions in mm



A = concentricity tolerance = ± 0.15

The cathode is marked red.
The cathode indicates the electrode which becomes positive in an a.c. rectifier circuit.

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC134)

Temperatures

Storage temperature	T_{stg}	-55 to +150	^oC
Operating ambient temperature	T_{amb}	-55 to +150	^oC

CHARACTERISTICS $T_{amb} = 25\,^oC$

Reverse current at V_R = 0.3 V		I_R	typ.	100	µA
Forward current at V_F = 0.3 V		I_F	typ.	12	mA
Tangential sensitivity					
measured at 9.375 GHz, zero bias, video bandwidth 1.0 MHz	AEY31		typ.	-53	dBm
	AEY31A		typ.	-50	dBm
Figure of merit					
measured at 9.375 GHz, M is taken as the product of current sensitivity expressed in µA/µW, and the root of video impedance in Ω	AEY31	M	>	120	
	AEY31A	M	>	50	
Video impedance					
Zero bias, V_i < 1.0 mV (d.c. or a.c. r.m.s.)		Z_{iv}	typ.	300	Ω
Voltage standing wave ratio					
w.r.t. 50 Ω, measured at f = 9.375 GHz, zero bias and c.w. input power < 1.0µW. The nominal rectifier admittance at a reference plane X-X taken at the end faces of the ceramic insulator (see drawing page 1) = $\frac{1-j}{25}$ A/V		V.S.W.R.	<	5 : 1	

APPLICATION INFORMATION

1. Detector performance

Tangential sensitivity f = 1.0 to 18 GHz; B = 1.0 MHz	AEY31 :	typ.	−53	dBm
	AEY31A:	typ.	−50	dBm
Voltage standing wave ratio f = 1.0 to 18 GHz; Z_o = 50 Ω	V.S.W.R.	<	5 : 1	

2. Mixer performance i.f. = 45 MHz

Measured overall noise figure f = 9.375 GHz; F_{if} = 1.5 dB $P_{L.O.}$ = 200 μW; I_o = 1.0 mA	F_o	typ.	9.0	dB
f = 16.5 GHz; F_{if} = 1.5 dB $P_{L.O.}$ = 200 μW; I_o = 1.0 mA	F_o	typ.	9.5	dB
Intermediate frequency impedance I_o = 1.0 mA	Z_{if}	typ.	130	Ω
Voltage standing wave ratio f = 1 to 18 GHz; Z_o = 50 Ω I_o = 1.0 mA	V.S.W.R.	<	2.5 : 1	

3. Doppler mixer performance

Measured overall noise figure f = 9.375 GHz; i.f. = 3 kHz F_{if} = 2.0 dB	F_o	typ.	18	dB

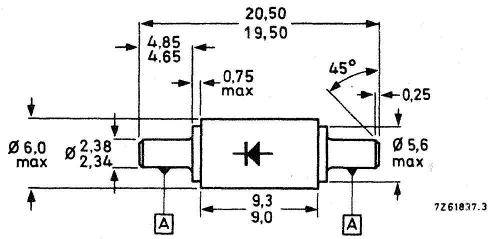
MICROWAVE DETECTOR DIODE

Silicon Schottky barrier diode in DO-23 (1N23) outline intended for use in doppler radar systems and intruder alarms where low 1/f noise and high detector sensitivity is required.

QUICK REFERENCE DATA				
Current sensitivity at X-band		typ.	1.0	μA/μW
1/f noise at 1 kHz	F	typ.	10	dB

MECHANICAL DATA Dimensions in mm

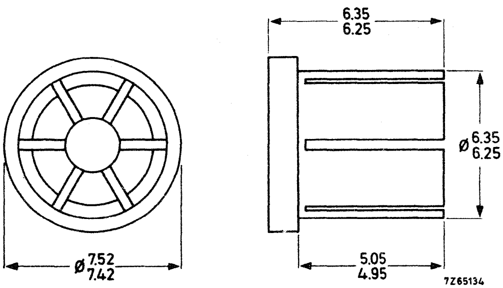
DO-23



A = concentricity tolerance = ± 0,20

Accessory 56321 Dimensions in mm

Converts the BAV46 to DO-22 outline

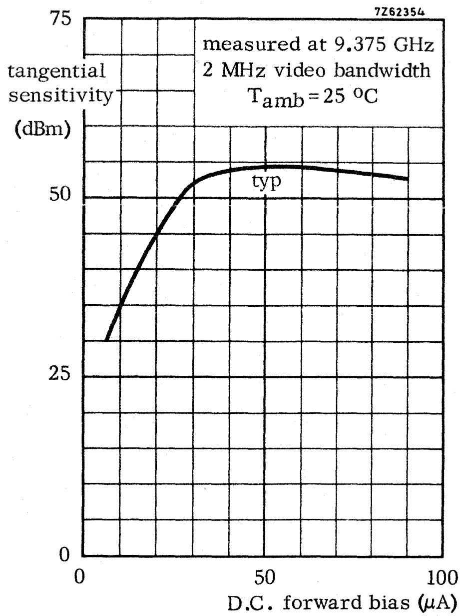


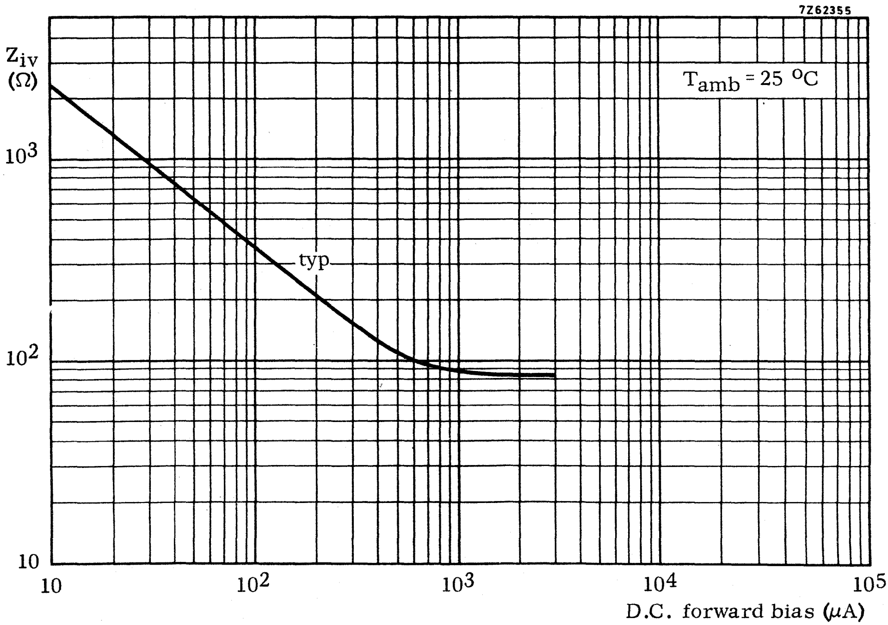
RATINGS Limiting values in accordance with the Absolute Maximum System (IEC134)

Burn-out				
Multiple R.F. spike		max.	20	nJ
		max.	0.2	erg
Pulse power (peak value)				
$f = 9.375$ GHz; $t_p = 0.5\ \mu s$		max.	1.0	W
Temperatures				
Storage temperature	T_{stg}		−55 to +150	°C
Ambient temperature	T_{amb}		−55 to +150	°C

CHARACTERISTICS $T_{amb} = 25\ °C$

Current sensitivity at f = 9.375 GHz				
D.C. forward bias = 30 μA Local oscillator drive = 1 μW Socket: JAN106 holder		> typ.	0.8 1.0	μA μA
Tangential sensitivity				
Video bandwidth = 2 MHz		typ.	52	dBm
1/f noise figure				
$f_{if} = 1$ kHz; B = 50 Hz D.C. forward bias = 30 μA	F	typ. <	10 15	dB dB
Voltage standing wave ratio at f = 9.375 GHz				
D.C. forward bias = 30 μA Local oscillator drive = 1 μW $R_L = 15\ \Omega$; JAN106 holder	V.S.W.R.	typ. <	3 : 1 5 : 1	
Video impedance				
D.C. forward bias = 30 μA	Z_{iv}	typ.	850	Ω


7Z62354
measured at 9.375 GHz
2 MHz video bandwidth
Tamb = 25 °C
tangential sensitivity (dBm)
75
50
25
0
typ
0
50
100
D.C. forward bias (μA)


7Z62355
Ziv (Ω)
Tamb = 25 °C
10³
10²
10
typ
10
10²
10³
10⁴
10⁵
D.C. forward bias (μA)

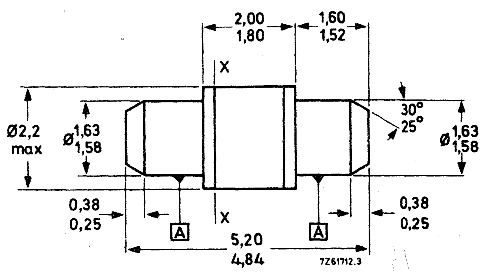
MICROWAVE MIXER DIODES

A series of sub-miniature reversible outline Schottky barrier mixer diodes. The planar technology employed imparts a high degree of reliability and reproducability.
The metal ceramic case is hermetically sealed.

QUICK REFERENCE DATA					
Noise figure at X-band	BAV96A	F	<	7,5	dB
	BAV96B	F	<	7,0	dB
	BAV96C	F	<	6,5	dB
	BAV96D	F	<	6,0	dB

MECHANICAL DATA

Dimensions in mm



A = concentricity tolerance = ± 0,15

The cathode is marked red.
The cathode indicates the electrode which becomes positive in an a.c. rectifier circuit.

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC134)

Burn-out 1)		max.	0,18	erg
Temperatures				
Storage temperature	T_{stg}	−55 to +150		°C
Ambient temperature	T_{amb}	−55 to +150		°C

CHARACTERISTICS T_{amb} = 25 °C

Noise figure at f = 9,375 GHz 2)	BAV96A	F	<	7,5	dB
	BAV96B	F	<	7,0	dB
	BAV96C	F	<	6,5	dB
	BAV96D	F	<	6,0	dB
Voltage standing wave ratio 3)		V.S.W.R.	typ.	1,33	
			<	1,43	
Intermediate frequency impedance 4)		Z_{if}	200 to	400	Ω
Local oscillator power 2)		P_{lo}	typ.	0,8	mW
			<	1,5	mW

MATCHED PAIRS

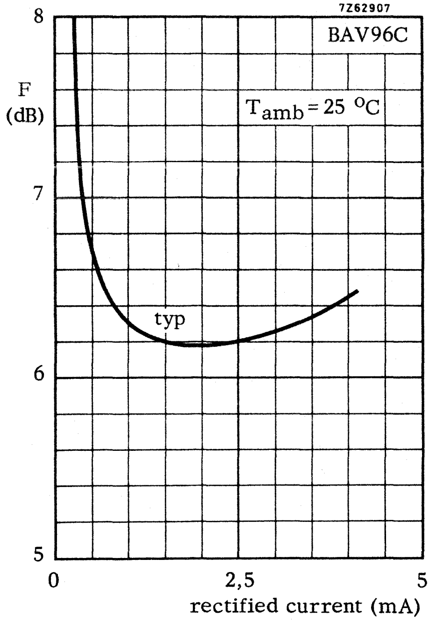
Matched pairs may be supplied. Matching is normally: Rectified current ±10%; Intermediate frequency impedance ±25 Ω.
Type numbering follows the pattern 2-BAV96AM etc.

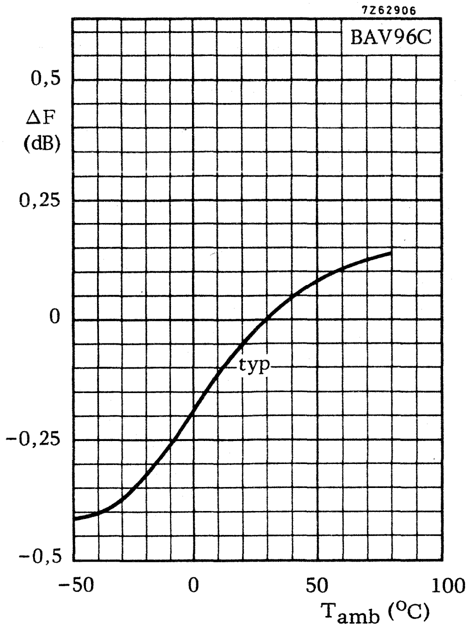
1) Burn-out is defined as the r.f. pulse energy necessary to cause 1 dB degradation in noise figure when the diode is subjected to 2 x 10^8 pulses of 2 ns width.

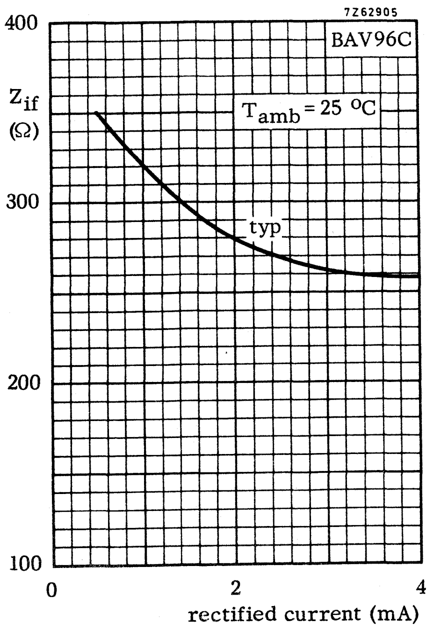
2) Measured at 9,375 GHz ±0,1 GHz and includes i.f. amplifier contribution of 1,5 dB; i.f. amplifier 45 MHz, d.c. return for diode less than 15 Ω. Rectified current 1 mA. Test method BS9321/1406.

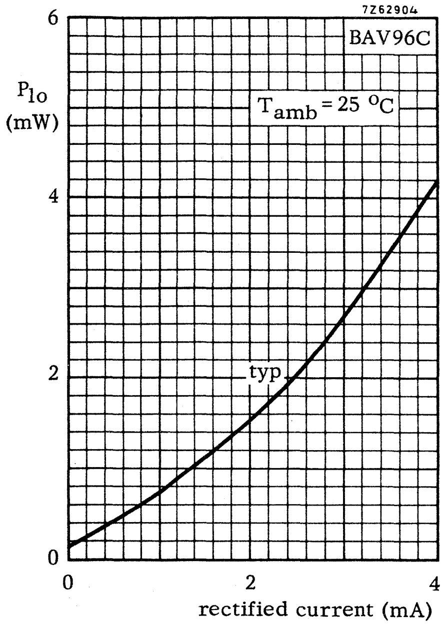
3) Measured in a reduced height waveguide mount under the same test conditions as note 2. Test method BS9321/1409.

4) Test method BS9321/1405. Same test conditions as note 3).


7Z62907
BAV96C
F
(dB)
T_{amb} = 25 °C
typ
8
7
6
5
0
2,5
5
rectified current (mA)


7Z62906
BAV96C
ΔF
(dB)
typ
0,5
0,25
0
−0,25
−0,5
−50
0
50
100
T_{amb} (°C)


7Z62905
BAV96C
Z_{if}
(Ω)
T_{amb} = 25 °C
typ
400
300
200
100
0
2
4
rectified current (mA)


7Z62904
BAV96C
P_{lo}
(mW)
T_{amb} = 25 °C
typ
6
4
2
0
0
2
4
rectified current (mA)

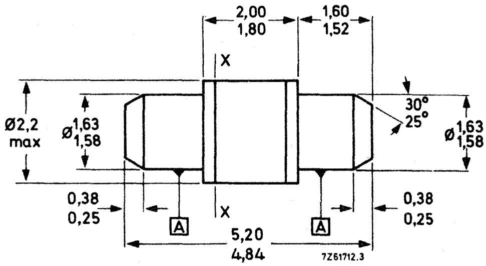
MICROWAVE DETECTOR DIODE

A silicon Schottky barrier diode especially designed to give high sensitivity when used as a microwave detector over the frequency range 1 to 18 GHz. The diode exhibits low 1/f noise making it suitable for use in doppler radar systems as well as detector applications. The BAV97 is supplied in a subminiature reversible encapsulation equally suited to wave-guide, coaxial and strip line circuits.

QUICK REFERENCE DATA				
Tangential sensitivity		typ.	54	dBm
1/f noise at 1 kHz	F	typ.	10	dB

MECHANICAL DATA

Dimensions in mm



A = concentricity tolerance = ± 0,15

The cathode is marked red.
The cathode indicates the electrode which becomes positive in an a.c. rectifier circuit.

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC134)

Peak R.F. power 1)		max.	0,75	W
Temperatures				
Storage temperature	T_{stg}		−55 to +150	°C
Junction temperature	T_j		−55 to +150	°C

CHARACTERISTICS

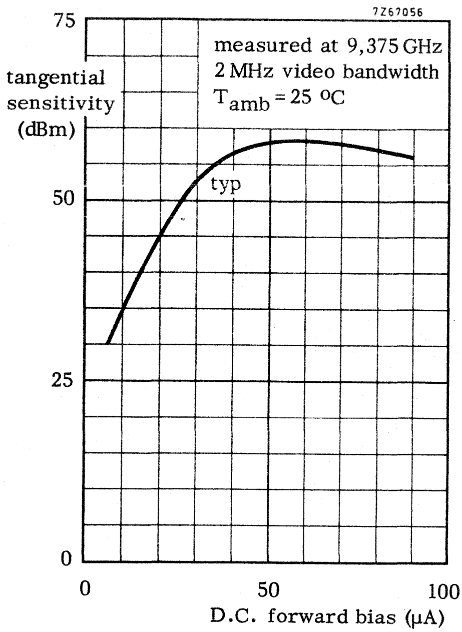
Tangential sensitivity 2)		>	52	−dBm
		typ.	54	−dBm
1/f noise figure 3)	F	typ.	10	dB
		<	15	dB
Video impedance 4)	Z_{iv}	typ.	500	Ω

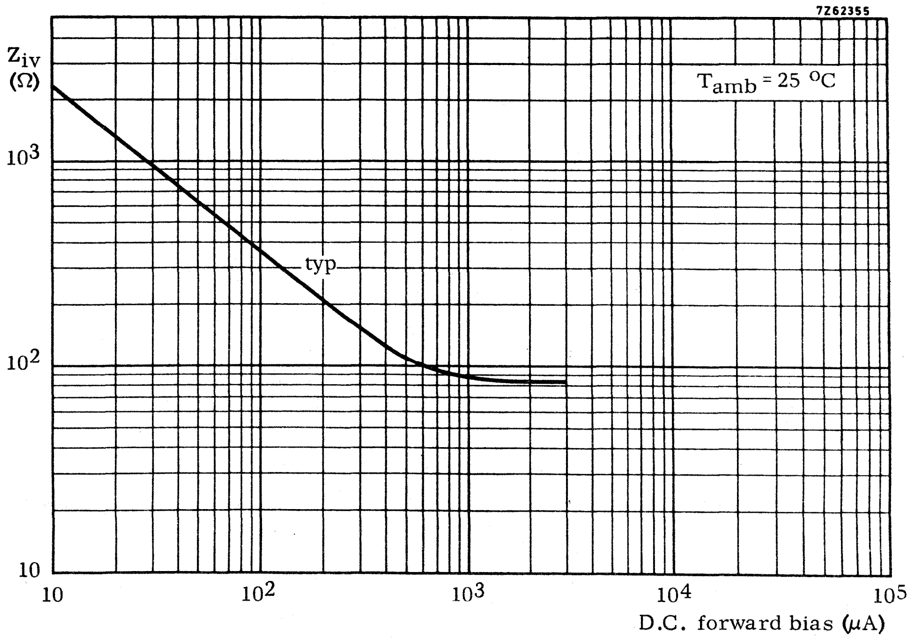
1) Measured at 9,375 GHz with 0,5 μs pulse width and pulse repetition frequency of 2 kHz. Rating defined as the power level which will give no greater than 5 dB deterioration in tangential sensitivity.

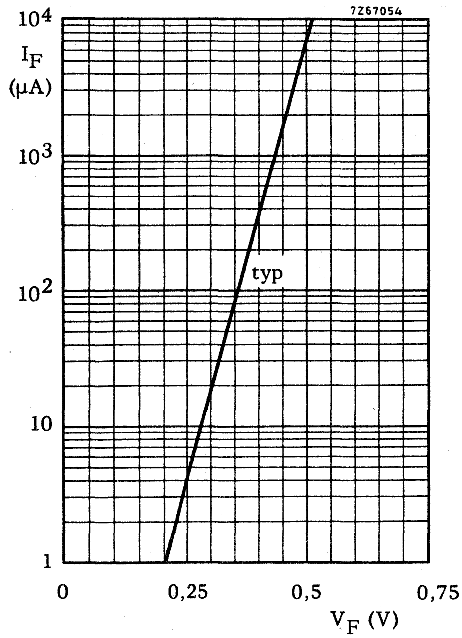
2) Measured with 0 - 2 MHz video bandwidth and 50 μA forward bias. Microwave test frequency 9,375 GHz. There will be a 2 dB improvement in sensitivity with a video bandwidth 1 kHz - 2 MHz.

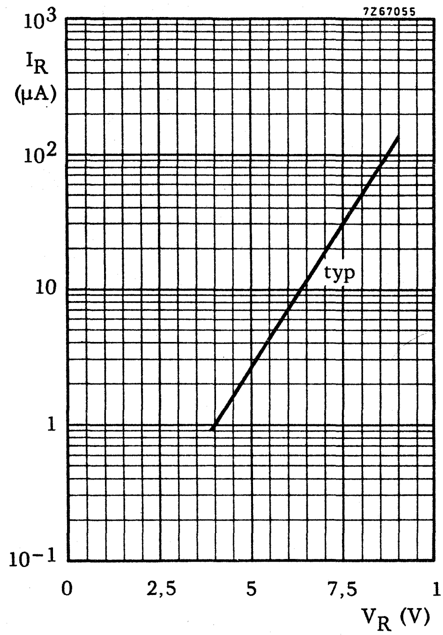
3) Measured at 30 μA forward bias and a frequency of 1 kHz with a bandwidth of 250 Hz. The 1/f noise is unchanged up to 150 μA bias.

4) Measured with forward bias of 50 μA.


7Z67056
75
50
25
0
tangential
sensitivity
(dBm)
measured at 9,375 GHz
2 MHz video bandwidth
T_{amb} = 25 °C
typ
0
50
100
D.C. forward bias (μA)


7Z62355
Z_{iv}
(Ω)
10^3
10^2
10
T_{amb} = 25 °C
typ
10
10^2
10^3
10^4
10^5
D.C. forward bias (μA)


7Z67054
10^4
I_F (μA)
10^3
10^2
10
1
typ
0
0,25
0,5
0,75
V_F (V)


7Z67055
10^3
I_R (μA)
10^2
10
1
10^{-1}
typ
0
2,5
5
7,5
1
V_R (V)

MICROWAVE MIXER DIODES

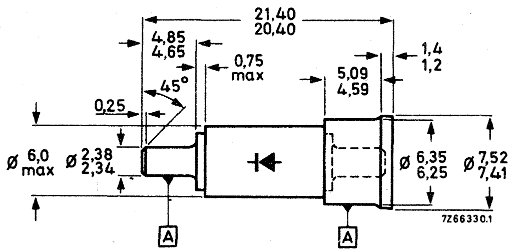
Silicon Schottky barrier mixer diodes in a DO-22 envelope. The diodes are equivalent to 1N23 and 1N415 series.

QUICK REFERENCE DATA					
Noise figure in X-band	BAW95D	F	<	8.2	dB
	BAW95E	F	<	7.5	dB
	BAW95F	F	<	7.0	dB
	BAW95G	F	<	6.5	dB

MECHANICAL DATA

Dimensions in mm

DO-22



A = concentricity tolerance = ± 0,20

Symbol indicates polarity

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC134)

Total power dissipation (peak value)				
$f = 9.375$ GHz; $t_p = 0.5$ µs	P_{tot}	max.	1.0	W
Burn-out				
Multiple r.f. spike; $\Delta F = 1$ dB		max.	20	nJ
		max.	0.2	erg
Temperatures				
Storage temperature	T_{stg}		−55 to +150	°C
Ambient temperature	T_{amb}		−55 to +150	°C

CHARACTERISTICS $T_{amb} = 25$ °C

Overall noise figure at $f = 9.375$ GHz

$I_{F(AV)} = 1$ mA; $R_L = 15\,\Omega$

F includes $F_{if} = 1.5$ dB with 45 MHz i.f.

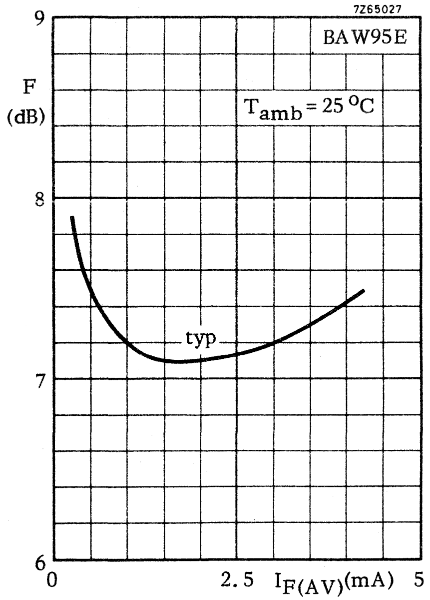
BAW95D	F	typ.	7.8	dB
		<	8.2	dB
BAW95E	F	typ.	7.2	dB
		<	7.5	dB
BAW95F	F	typ.	6.8	dB
		<	7.0	dB
BAW95G	F	typ.	6.3	dB
		<	6.5	dB

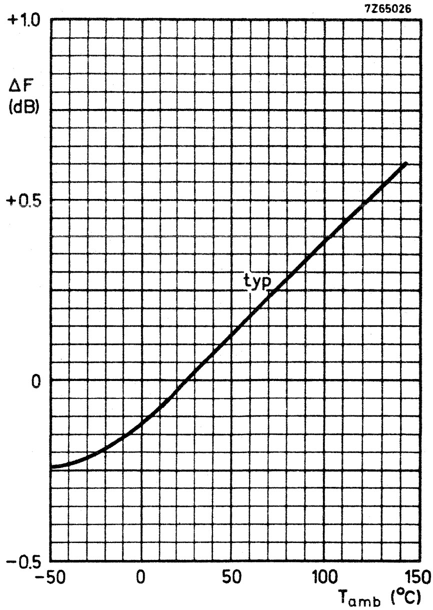
Voltage standing wave ratio at $f = 9.375$ GHz

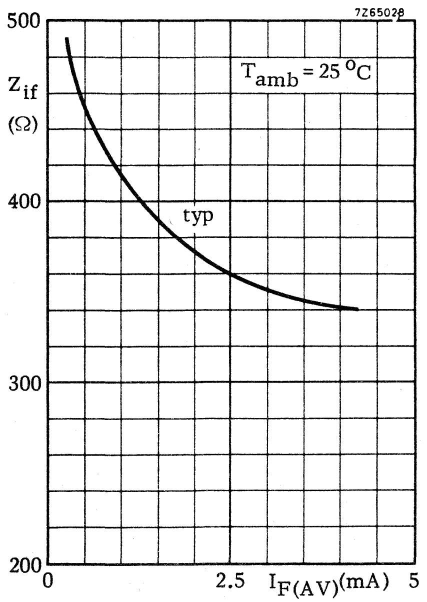
$I_{F(AV)} = 1$ mA; $R_L = 15\,\Omega$; socket: JAN-106	V.S.W.R.	<	1.3	

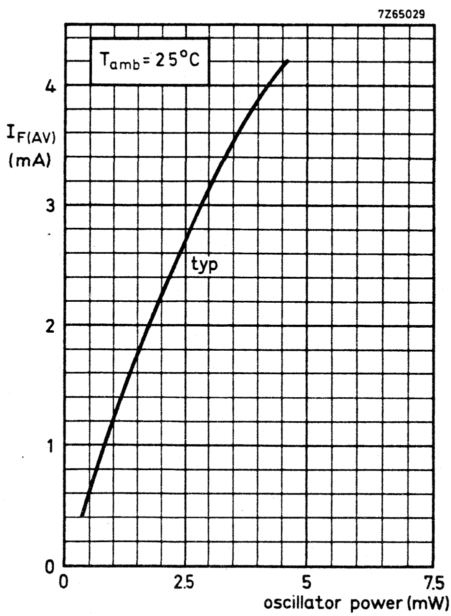
Intermediate frequency impedance at $f = 9.375$ GHz

$I_{F(AV)} = 1$ mA; $R_L = 15\,\Omega$ with 45 MHz i.f.	Z_{if}	typ.	415	Ω
			250 to 500	Ω


7Z65027
BAW95E
F
(dB)
T_{amb} = 25 °C
typ
9
8
7
6
0
2.5
5
$I_{F(AV)}$ (mA)


7Z65026
ΔF
(dB)
typ
+1.0
+0.5
0
−0.5
−50
0
50
100
150
T_{amb} (°C)


7Z65028
Z_{if}
(Ω)
T_{amb} = 25 °C
typ
500
400
300
200
0
2.5
5
$I_{F(AV)}$ (mA)


7Z65029
T_{amb} = 25 °C
$I_{F(AV)}$
(mA)
typ
4
3
2
1
0
0
2.5
5
7.5
oscillator power (mW)

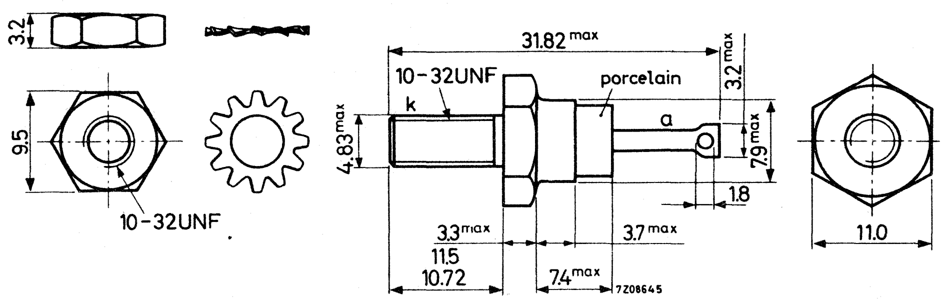
SILICON PLANAR EPITAXIAL VARACTOR DIODE

Varactor diode with a very low series resistance, in a low inductance, hermetically sealed, welded ceramic-metal DO-4 envelope.
The BAY96 is a high efficiency frequency multiplier designed for use in the v.h.f. and u.h.f. regions.
With the reverse voltage rating of 120 V, it can handle an input power up to 40 W.

QUICK REFERENCE DATA				
Continuous reverse voltage	V_R	max.	120	V
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	20	W
Junction temperature	T_j	max.	175	°C
Total capacitance at f = 1 MHz				
V_R = 6 V	C_d		28 to 39	pF
Diode series resistance at f = 400 MHz				
V_R = 6 V	r_D	max.	1.2	Ω
Cut-off frequency $\frac{1}{2\pi r_D C_d}$ at V_R = 120 V	f_{co}	typ.	25	GHz

MECHANICAL DATA Dimensions in mm

DO-4



Diameter of hole in heatsink: max. 5.2 mm
Accessories available: 56295 (56262A)

Torque on nut: min. 8 cm kg
max. 17 cm kg

RATINGS (Limiting values) [1])

Voltage

Continuous reverse voltage	V_R	max.	120	V

Power dissipation

Total power dissipation up to T_{mb} = 25 ^oC	P_{tot}	max.	20	W

Temperatures

Storage temperature	T_{stg}	-65 to +175		^oC
Junction temperature	T_j	max.	175	^oC

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	7.5	$^oC/W$

CHARACTERISTICS

Total capacitance at f = 1 MHz				
V_R = 6 V	C_d	28 to	39	pF
Diode series resistance at f = 400 MHz				
V_R = 6 V	r_D	typ.	0.9	Ω
		<	1.2	Ω
Cut-off frequency $\frac{1}{2\pi r_D C_d}$ at V_R = 120 V	f_{co}	typ.	25	GHz

APPLICATION INFORMATION

Frequency tripler 150 to 450 MHz

The tripler circuit at page 3 consists of a parallel connection of the varactor, the input and output circuits, and the idler circuits. This shunt configuration has two outstanding advantages for high power harmonic generation.

1. The varactor can be grounded on one side, thus utilizing the chassis as a heatsink.
2. The varactor, being a low impedance device, operates best in a circuit that requires a low impedance coupling element between input and output circuits.

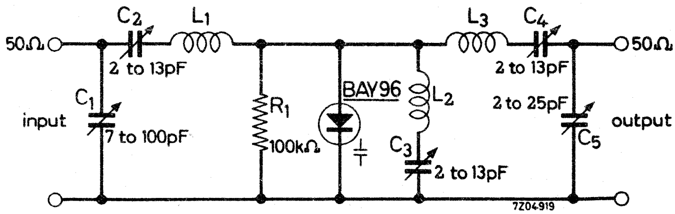
The function of the input and output networks is to provide impedance matching, and at the same time eliminate undesired r.f. current components, minimizing losses. A single tuned circuit is insufficient for the reduction of spurious response and therefore, a suitable output filter should follow the multiplier.

[1]) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

APPLICATION INFORMATION (continued)

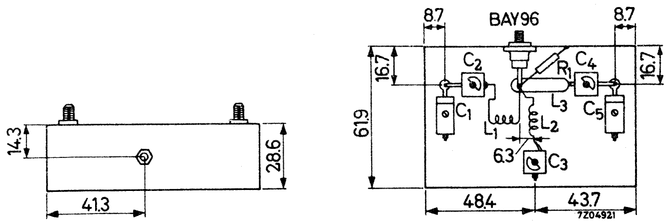
140 to 450 MHz tripler circuit

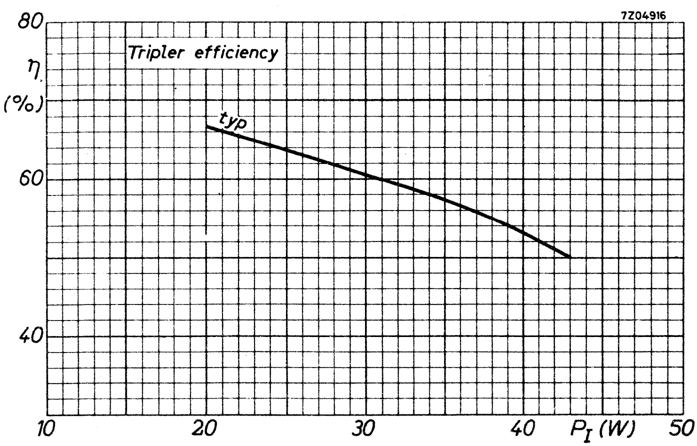
Efficiency at P_I = 25 W	η	>	60	%
		typ.	64	%

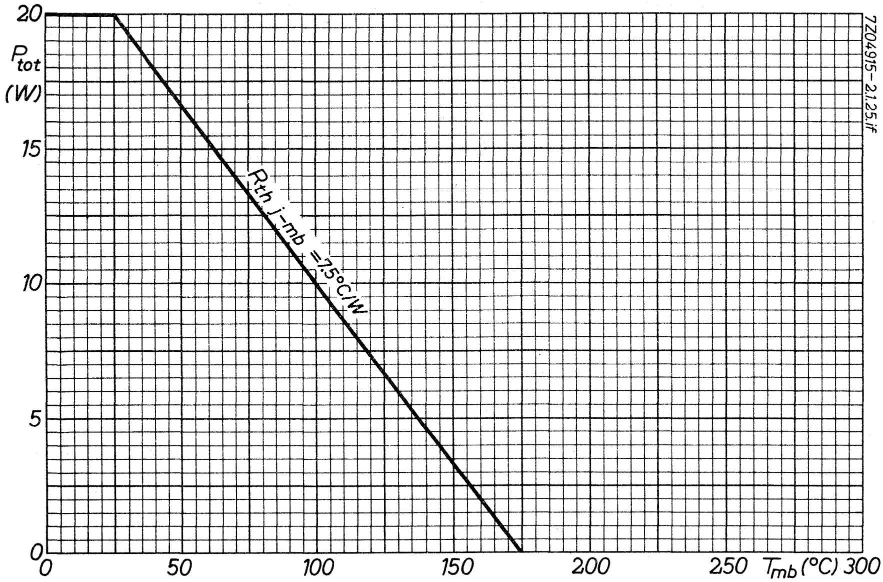


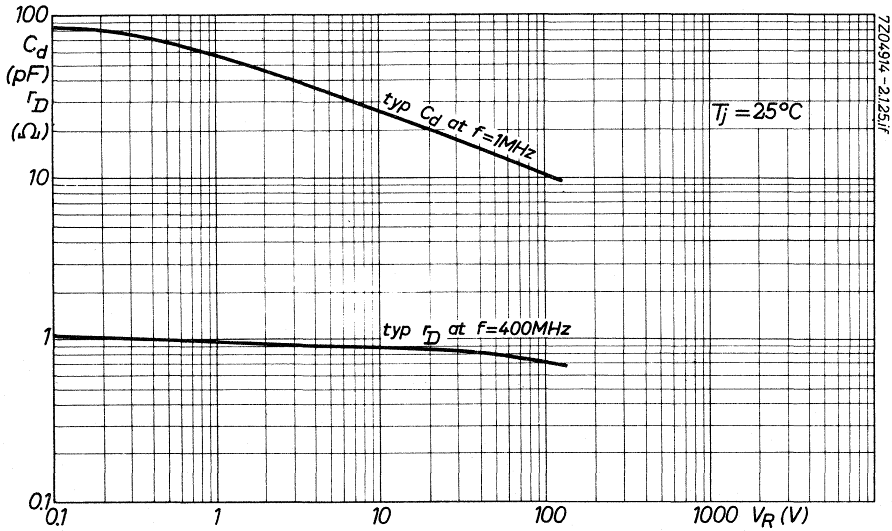
L_1 = 6.5 turns; d = 1.3 mm. Length of coil: 14.3 mm, inner diameter: 7.5 mm.
L_2 = 2 turns; d = 2 mm. Length of coil: 7.9 mm, inner diameter: 6.7 mm.
L_3 = copper strip, cross section 6.3 x 0.5 mm^2, length: 25.4 mm, height above chassis: 14.3 mm.

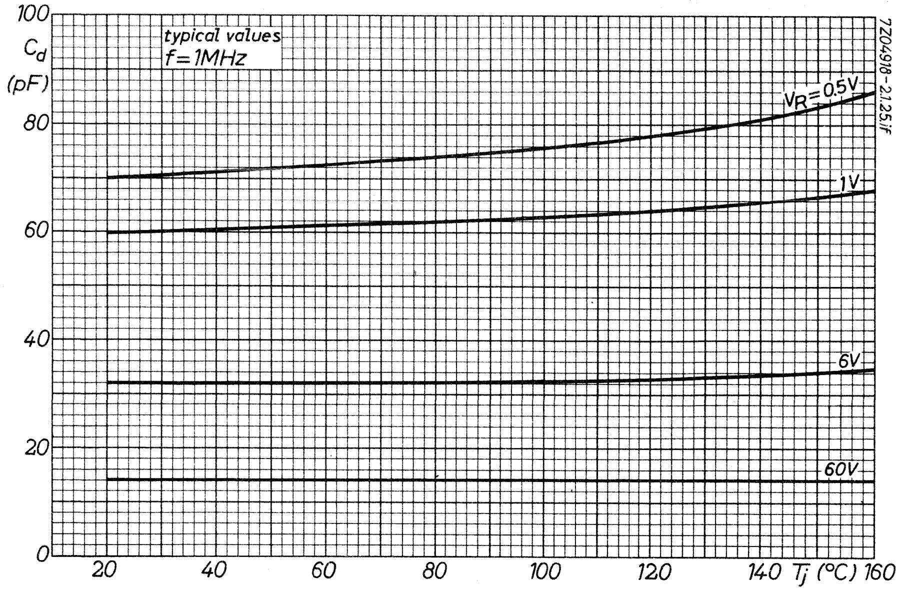
Component lay-out of tripler circuit: Dimensions in mm

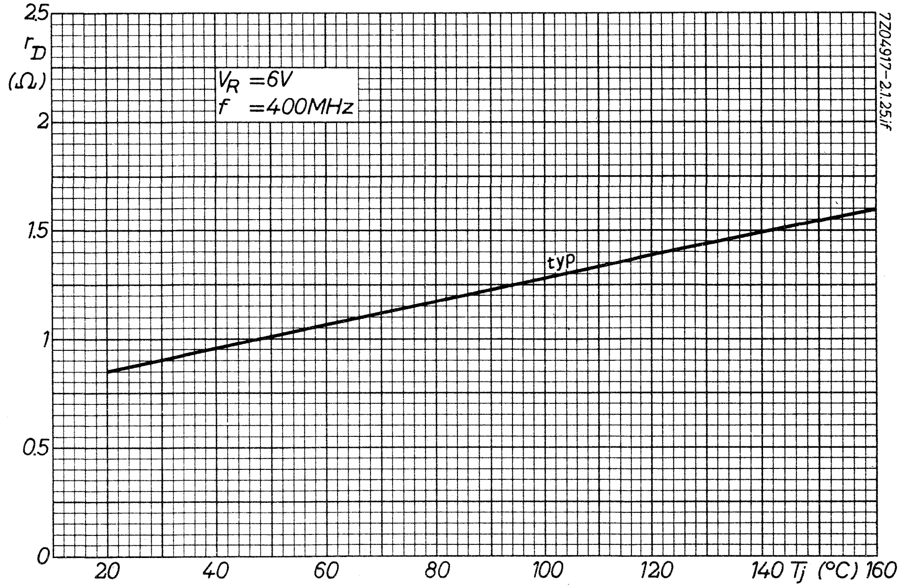





20
P_{tot}
(W)
15
10
5
0
0
50
100
150
200
250
T_{mb} (°C)
300
$R_{th\ j\text{-}mb} = 7.5\ °C/W$
7Z04915 - 2.1.25.if


100
C_d
(pF)
r_D
(Ω)
10
1
0.1
0.1
1
10
100
1000
V_R (V)
typ C_d at f=1MHz
typ r_D at f=400MHz
$T_j = 25°C$
7Z04914 - 2.1.25.if


100
C_d
(pF)
80
60
40
20
0
typical values
f = 1MHz
V_R = 0.5V
1V
6V
60V
7Z04918-2.1.25.if
20
40
60
80
100
120
140 T_j (°C) 160


2.5
r_D
(Ω)
2
1.5
1
0.5
0
V_R = 6V
f = 400MHz
typ
7Z04917-2.1.25.if
20
40
60
80
100
120
140 T_j (°C) 160

X-BAND COAXIAL MIXERS

Miniature, thin film microstrip balanced mixers using bonded non-replaceable Schottky barrier diodes. The mixers are suitable for radar and communications receivers rarticularly where size and weight are critical.

QUICK REFERENCE DATA		
Frequency range		
CL7330	9 to 10	GHz
CL7331	10,7 to 11,7	GHz
CL7332	11,7 to 12,7	GHz
Noise figure	7	dB
Input connectors	O.S.M.204	

Unless otherwise stated, data is applicable to all types.

CHARACTERISTICS at t_{amb} = 25 °C

Characteristics apply to the whole 1 GHz frequency range of each mixer.

Centre frequency		
CL7330	9,5	GHz
CL7331	11,2	GHz
CL7332	12,2	GHz

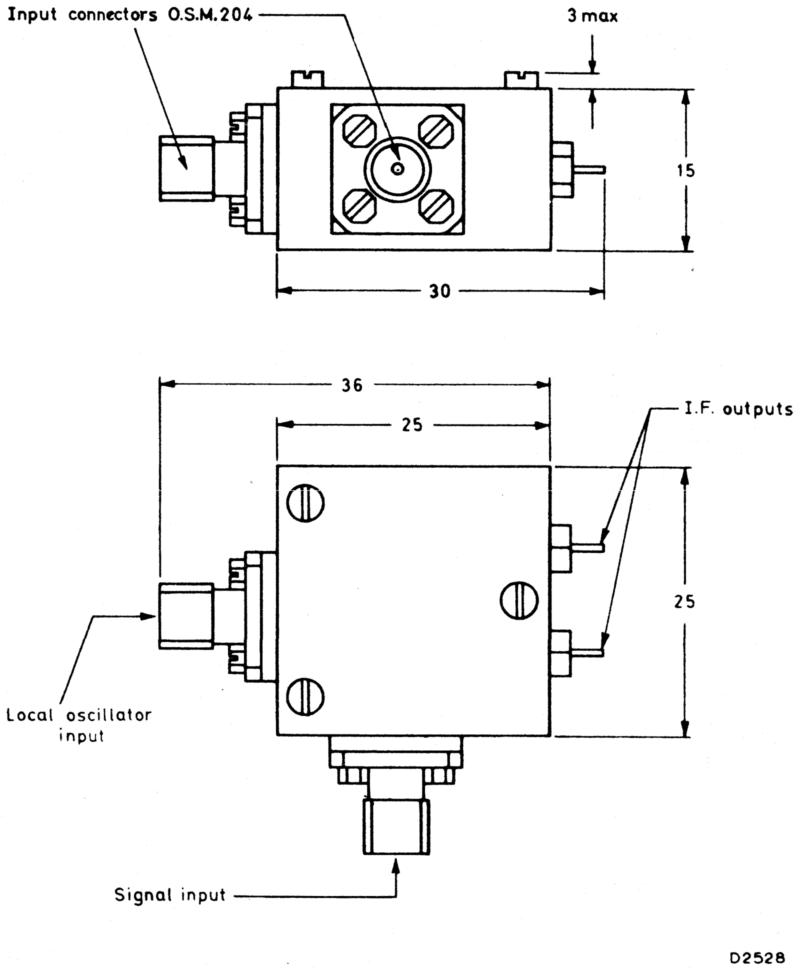
	Notes	min.	typ.	max.	
Bandwidth		± 500			MHz
Isolation	1)	15	20		dB
Voltage standing wave ratio	1), 2)		2	3	
Noise figure	1), 3)		7,0	7,5	dB
Out of balance	4)		0,5	1,5	dB
I.F. impedance	1)		135		Ω
Output capacitance			4		pF
Local oscillator power	1)		2.0	2,5	mW
Input impedance			50		Ω

Notes see page 3

MECHANICAL DATA

Dimensions in mm

Weight : approx. 32 g



NOTES

1) The local oscillator power level is adjusted to give 1,5 mA rectified current on the most efficient diode, that is, i.f. output terminal indicating the higher current of the two.

2) Characteristics applicable to both signal and local oscillator inputs.

3) The noise figure is the overall value including a 1,5 dB i.f. amplifier noise figure at 45 MHz.

4) The power level is adjusted to give 1,5 mA rectified current from the most efficient diode. If this level is W_1, the power is increased to W_2 to give 1,5 mA rectified current from the other diode. Out of balance is defined as $10 \log_{10} \frac{W_1}{W_2}$ dB.

X-BAND GUNN OSCILLATOR

Electronically tuned oscillator intended for use as a local oscillator in marine radars employing a single balanced mixer and no a.f.c. system.

QUICK REFERENCE DATA				
Centre frequency	f		9,4	GHz
Mechanical tuning range	Δf	min.	± 100	MHz
Electronic tuning range	Δf	min.	40	MHz
Output power	W_o		8	mW
Supply voltage	V_G		-7,5	V
Ouput coupling	plain flange WG16/WR90			

TYPICAL OPERATING CONDITIONS

Supply voltage	1)	V_G	-7,5	V
Supply current		I_G	150	mA
Tuning voltage	2)	V_T	0 to -10	V
Tuning current		I_T	10	μA
Output power		W_o	8	mW

CHARACTERISTICS at 25 °C

			min.	typ.	max.	
Centre frequency		f		9.4		GHz
Mechanical tuning range		Δf	± 100	± 150		MHz
Electronic tuning range		Δf	40	60		MHz
Electronic tuning sensitivity	3)	$\Delta f/\Delta V_T$		10		MHz/V
Output power	4)	W_o	5	8		mW
Frequency deviation over temperature range					± 15	MHz
Pushing figure		$\Delta f/\Delta V_G$		15		MHz/V
Pulling figure	5)	Δf_p		± 10		MHz

Notes see page 2
Data based on pre-production devices

LIMITING VALUES (Absolute max. rating system)

Supply voltage	$-V_G$	max.	8	V
Supply current	I_G	max.	200	mA
Tuning voltage	$-V_T$	max.	12	V
Tuning current	I_T	max.	100	μA

TEMPERATURE LIMITS

Ambient temperature	t_{amb}	max.	+70	°C
		min.	-30	°C

NOTES

[1]) The active element will be damaged if the supply voltage is reversed. Care should be taken to avoid transients as far as possible.

[2]) The voltage supply should have a source impedance of less than 1 kΩ.

[3]) Output power measured under all conditions of tuning and temperature.

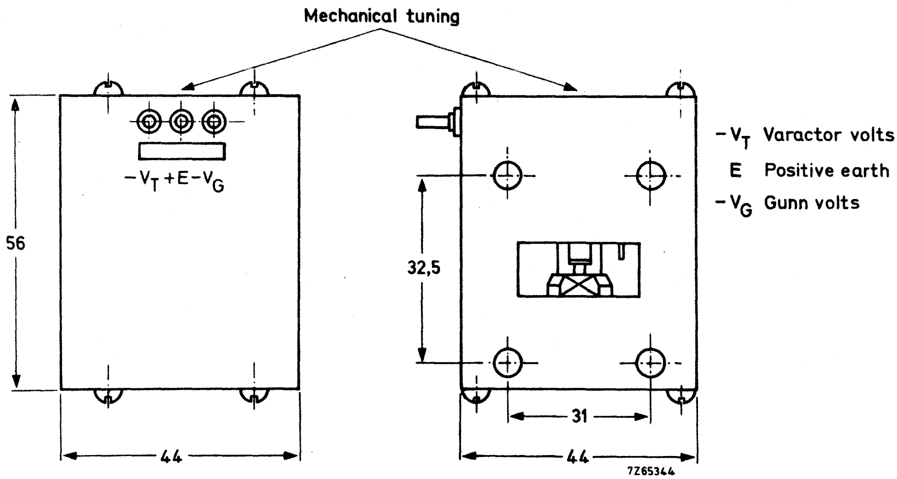
[4]) The electronic tuning characteristic is essentially non-linear, giving greatest slope at low tuning voltages. The figure quoted is the typical figure for chord slope between 0 and 3 V tuning voltage.

[5]) Load VSWR 1,5 maximum. The sign depending upon the phase of mismatch.

MECHANICAL DATA

Dimensions in mm

Net weight: approx. 250 g



X-BAND GUNN OSCILLATOR

Fixed frequency Gunn oscillator for operation in the 10,7 GHz band.
Applications include all forms of miniature radar systems.

QUICK REFERENCE DATA			
Centre frequency	f	10,69	GHz
Output power	W_o	8	mW
Supply voltage	V_G	7	V
Output coupling	plain flange WG16/WR90		

TYPICAL OPERATING CONDITIONS [1] [2]

Supply voltage	V_G	7	V
Supply current	I_G	140	mA
Output power	W_o	8	mW

CHARACTERISTICS at 25 °C

		min.	typ.	max.	
Centre frequency	f		10,69		GHz
Output power	W_o	5	8		mW
Frequency (fixed)	f	10,675	10,690	10,700	GHz
Temperature coefficient of frequency	$\Delta f/\Delta t$		-0,25	-0,40	MHz/degC
Pushing figure	$\Delta f/\Delta V_G$		1,5		MHz/V

LIMITING VALUES (Absolute max. rating system)

Supply voltage	V_G	max.	8	V
Supply current, running	I_G	max.	200	mA
starting	I_G	max.	250	mA
Voltage standing wave ratio	VSWR	max.	1,5	

Notes see page 2

Data based on pre-production devices.

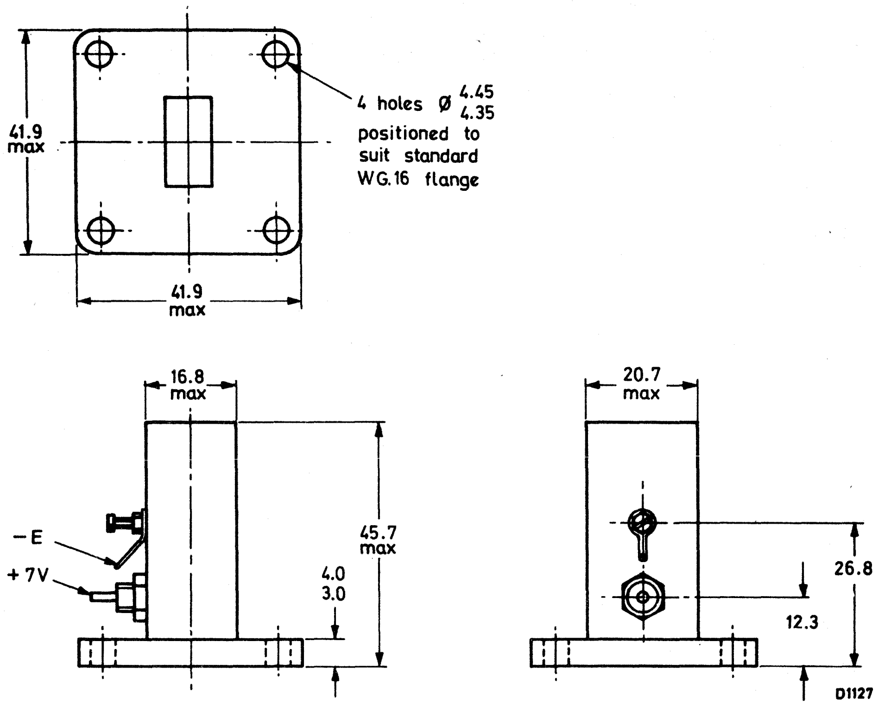
TEMPERATURE LIMITS

Ambient temperature	max.	+40	°C
	min.	0	°C

MECHANICAL DATA

Dimensions in mm

Net weight: approx. 35 g



NOTES

1) The active element will be damaged if the supply voltage is reversed. Care should be taken to avoid transients in excess of 8 V. A voltage regulator diode to shunt the power supply is recommended for this purpose.

2) A 10 nF capacitor between the $+V_G$ terminal and earth (E) is recommended to suppress any tendency to low frequency oscillations in the supply leads.

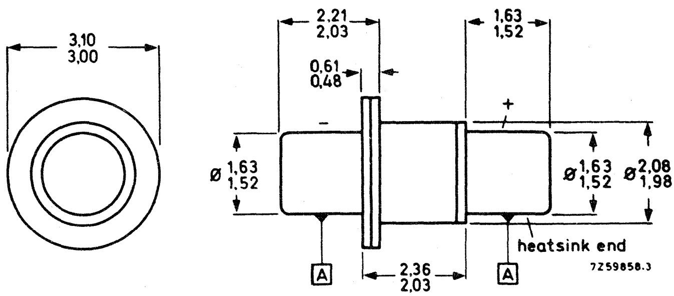
GUNN EFFECT DIODES

Gallium arsenide Gunn effect diodes for c.w. oscillators at to X-band frequencies. The devices are mounted in a small double ended ceramic-metal case with hermetic seal suitable for mounting in various types of cavity.

The main types CXY11A to C will oscillate throughout X-band, the actual frequency depending on the cavity used. The sub-types 8.5, 10.5 and 11.5 are only specified in a 1 GHz band centred on 8.5, 10.5 and 11.5 GHz respectively (see table 1 on page 2)

QUICK REFERENCE DATA					
Operating voltage		V	typ.	7	V
Total power dissipation up to T_{pin} = 35 °C		P_{tot}	max.	1.0	W
Operating frequency			X-band		
Output power at f = 9.5 GHz	CXY11A	P_o	>	5	mW
	CXY11B	P_o	>	10	mW
	CXY11C	P_o	>	15	mW

MECHANICAL DATA Dimensions in mm



A = concentricity tolerance = ±0,13
Type marking on the container
The heat should be transferred via the flangeless pin

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltage [1]	V	max.	7.0	V
Total power dissipation up to T_{pin} = 35 °C	P_{tot}	max.	1.0	W
Storage temperature	T_{stg}	max.	175	°C

CHARACTERISTICS T_{pin} = 35 °C

Current at V = 7.0 V	I	typ.	140	mA
Operating frequency [2]	f		8.0 to 12	GHz
Output power [3]				
CXY11A	P_o	>	5	mW
		typ.	8	mW
CXY11B	P_o	>	10	mW
		typ.	12	mW
CXY11C	P_o	>	15	mW
		typ.	20	mW

[1]) Bias must always be applied in such a way that the flanged end of the device is negative. Reversing polarity or exceeding maximum rating may cause permanent damage. Care should be taken not to exceed voltage transients of 8 V.

[2]) The frequency is governed by the choise of cavity to which the device is coupled. For frequency coverage see table 1.

[3]) P_o is measured in a coaxial cavity at the test frequency given in table 1.

Table 1.	Test frequency and frequency coverage in GHz			
	8.5 8 to 9	9.5 8 to 12	10.5 10 to 11	11.5 11 to 12
P_o > 5 mW, typ. 8 mW	$CXY11A_{8.5}$	CXY11A	$CXY11A_{10.5}$	$CXY11A_{11.5}$
P_o > 10 mW, typ. 12 mW	$CXY11B_{8.5}$	CXY11B	$CXY11B_{10.5}$	$CXY11B_{11.5}$
P_o > 15 mW, typ. 20 mW	$CXY11C_{8.5}$	CXY11C	$CXY11C_{10.5}$	$CXY11C_{11.5}$

SILICON VARACTOR DIODES

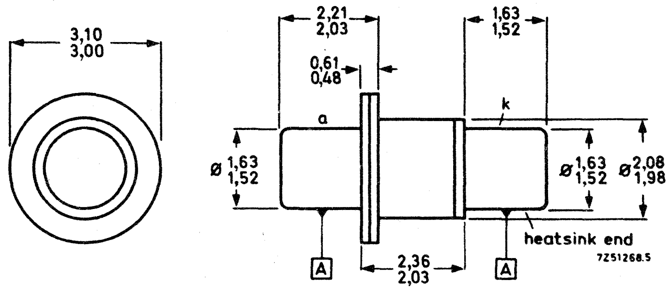
Silicon planar epitaxial varactor diodes exhibiting step recovery characteristics, especially suitable for use in frequency multiplier circuits up to S-band output frequency.

QUICK REFERENCE DATA				
Ouput power (doubler 1.0 to 2.0 GHz) at P_i = 12 W	P_o	>	6.0	W
Resistive cut-off frequency at V_R = 6 V	f_c	typ.	100	GHz
Diode capacitance at V_R = 6 V	C_d	typ.	6.0	pF

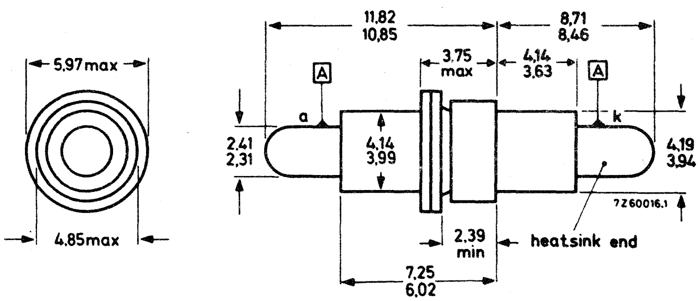
MECHANICAL DATA

Dimensions in mm

1N5152



1N5153



A = concentricity tolerance = ±0,13
Type marking on container
The heat should be transferred via the cathode pin

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Reverse voltage	V_R	max.	75	V
Total power dissipation up to T_{pin} = 70 °C	P_{tot}	max.	5	W
Storage temperature	T_{stg}		−55 to +175	°C
Junction temperature	T_j	max.	175	°C

THERMAL RESISTANCE

From junction to pin	$R_{th\ j\text{-}pin}$	=	20	°C/W

CHARACTERISTICS at T_{amb} = 25 °C

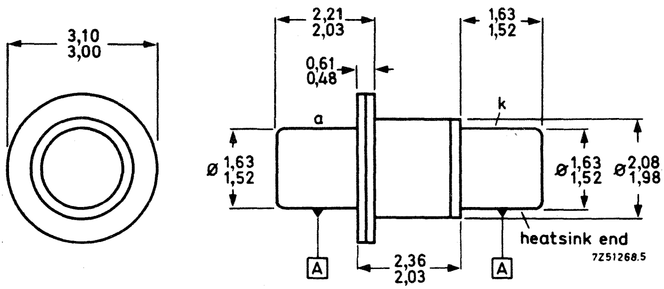
Reverse breakdown voltage I_R = 10 μA	$V_{(BR)R}$	>	75	V
Forward voltage I_F = 10 mA	V_F	<	1.0	V
Reverse current at V_R = 60 V	I_R	typ. <	1.0 1.0	nA μA
Resistive cut-off frequency at V_R = 6 V; f = 2.0 GHz	f_c	> typ.	55 100	GHz GHz
Diode capacitance at V_R = 6 V; f = 1 MHz	C_d	5.0 to	7.5	pF
Overall efficiency in doubler circuit P_i = 12 W; f_i = 1.0 GHz	η	> typ.	50 60	% %

SILICON VARACTOR DIODE

Silicon planar epitaxial varactor diode exhibiting step recovery characteristics; especially suitable for use in frequency multiplier circuits up to C-band output frequency.

QUICK REFERENCE DATA				
Output power (tripler 2.0 to 6.0 GHz) at P_i = 5 W	P_o	>	2.0	W
Resistive cut-off frequency at V_R = 6 V	f_c	typ.	120	GHz
Diode capacitance at V_R = 6 V	C_d	typ.	2.0	pF

MECHANICAL DATA Dimensions in mm



A = concentricity tolerance = ±0,13
Type marking on container
The heat should be transferred via the cathode pin

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Reverse voltage	V_R	max.	35	V
Total power dissipation up to T_{pin} = 70 °C	P_{tot}	max.	3	W
Storage temperature	T_{stg}		−55 to +175	°C
Junction temperature	T_j	max.	175	°C

THERMAL RESISTANCE

From junction to pin	$R_{th\ j\text{-}pin}$	=	35	°C/W

CHARACTERISTICS at T_{amb} = 25 °C

Reverse breakdown voltage I_R = 10 μA	$V_{(BR)R}$	>	35	V
Forward voltage I_F = 10 mA	V_F	<	1.0	V
Reverse current at V_R = 26 V	I_R	typ.	1.0	nA
		<	1.0	μA
Resistive cut-off frequency at V_R = 6 V; f = 2.0 GHz	f_c	>	100	GHz
		typ.	120	GHz
Diode capacitance at V_R = 6 V; f = 1 MHz	C_d	1.0 to	3.0	pF
Overall efficiency in tripler circuit P_i = 5 W; f_i = 2.0 GHz	η	>	40	%

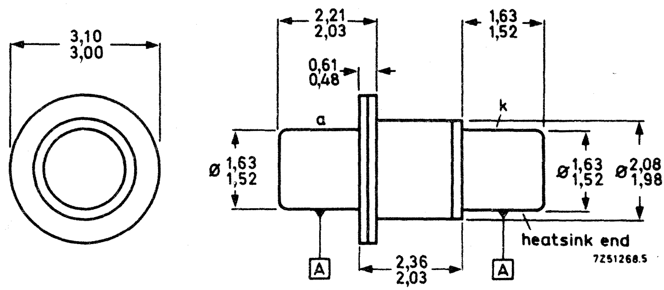
SILICON VARACTOR DIODE

Silicon planar epitaxial varactor diode exhibiting step recovery characteristics, especially suitable for use in frequency multiplier circuits up to X-band output frequency.

QUICK REFERENCE DATA				
Output power (doubler 5.0 to 10 GHz) at P_i = 2.6 W	P_o	>	1.0	W
Resistive cut-off frequency at V_R = 6 V	f_c	typ.	200	GHz
Diode capacitance at V_R = 6 V	C_d	typ.	0.8	pF

MECHANICAL DATA

Dimensions in mm



A = concentricity tolerance = ±0,13
Type marking on container
The heat should be transferred via the cathode pin

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Reverse voltage	V_R	max.	20	V
Total power dissipation up to T_{pin} = 70 °C	P_{tot}	max.	2.5	W
Storage temperature	T_{stg}		−55 to +175	°C
Junction temperature	T_j	max.	175	°C

THERMAL RESISTANCE

From junction to pin	$R_{th\ j\text{-}pin}$	=	38.5	°C/W

CHARACTERISTICS at T_{amb} = 25 °C

Reverse breakdown voltage I_R = 10 μA	$V_{(BR)R}$	>	20	V
Forward voltage I_F = 10 mA	V_F	<	1.0	V
Reverse current at V_R = 16 V	I_R	<	0.1	μA
Resistive cut-off frequency at V_R = 6 V; f = 8 GHz	f_c	> typ.	180 200	GHz GHz
Diode capacitance at V_R = 6 V; f = 1 MHz	C_d	0.6 to	1.0	pF
Overall efficiency in doubler circuit P_i = 2.6 W; f_i = 5.0 GHz	η	>	38	%

Isolators-circulators

SURVEY

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INTRODUCTION

Isolators

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.

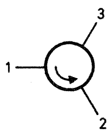
For the coaxial isolators in this section, which are coaxial 3-port circulators with a matched load on one port, see section "Circulators, introduction".

Additional information see also product book "Isolators and Circulators".

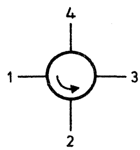
Circulators

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.



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

Isolators

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 V.S.W.R. 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.

Circulators

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.

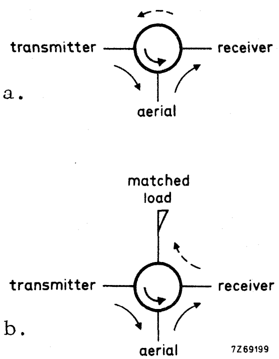


Fig.3 Duplexing of one receiver and one transmitter.

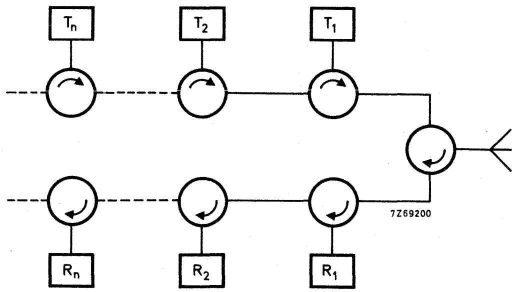


Fig.4 Duplexing of a number of transmitters and receivers

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.

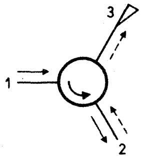


Fig. 5

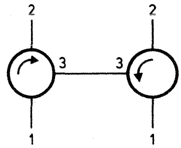


Fig. 6a H-configuration

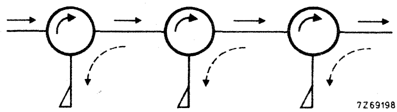
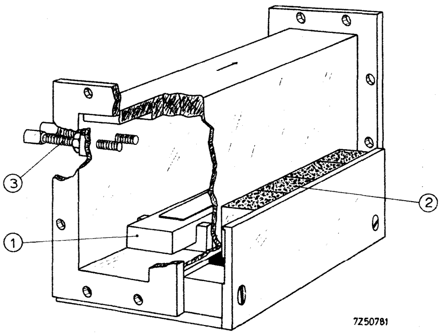


Fig. 6b π-configuration

CONSTRUCTION

Waveguide isolators

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

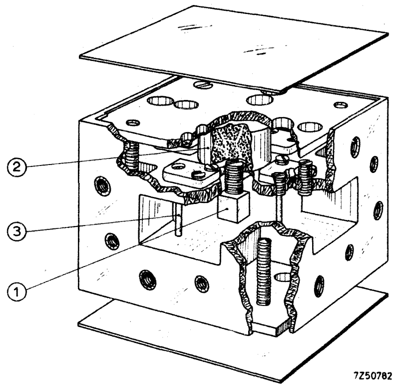
The screws (3) protruding into the waveguide are used to match the isolator for minimum voltage standing wave ratio.

Coaxial isolators

For construction and mounting see section "coaxial circulators".

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



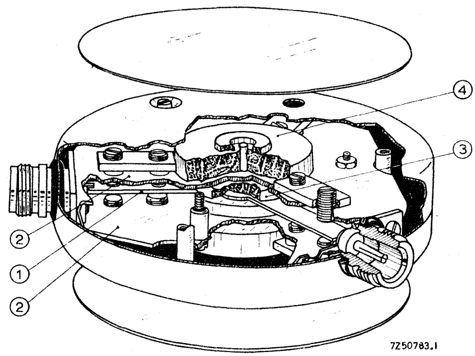
Construction of a waveguide circulator
Fig. 7

In this type three or four waveguides intersect each other at 120° of 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

[1]) A T-arrangement can be made on request.

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 isolator/circulator meets the guaranteed specification.
Outside of this range the electrical properties deteriorate rapidly. The circulators will not be damaged, however, if erroneously subjected to frequencies outside the range.

Isolation isolator: 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.
circulator: 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 α_{1-3}, i.e., the isolation between ports 1 and 3, is equal to α_{3-2} and α_{2-1} (see Fig. 1).

Insertion loss is the attenuation which results from including an isolator/circulator in the transmission system. It is given as a ratio, expressed in dB, which compares the situation before and after the insertion of the isolator/circulator, i.e., the power delivered to a matched load is compared with the power delivered to the same load after the insertion of an isolator/circulator (which has the isolated port terminated with a matched load).

Voltage standing wave ratio (V.S.W.R.) is the ratio of the maximum to the minimum voltages along a lossless line.
For the circulators it is measured with all other ports terminated by a matched load. The coaxial circulators are designed with a characteristic impedance of 50 ohms.

Maximum power isolator: maximum power is the largest power that may be passed through the isolator in forward direction into a load with a V.S.W.R. of 2.
circulator: maximum power is the largest power that a circulator can handle at sea level when one port is terminated with a mismatch of V.S.W.R. ≤ 1,2.
The maximum power value for isolators/circulators should under no circumstances be exceeded.
For coaxial circulators the maximum power is the maximum continuous-wave power unless a maximum peak power is separately stated. These power levels should not be exceeded.

The peak power is the maximum peak sync power as defined by the CCIR signal standard. This value is given for isolators/circulators in the VHF and UHF television frequencies. If this value is exceeded the isolator/circulator can be damaged by arcing in the internal transmission structure of the isolator/circulator.

Values are valid for one signal passage only.

Since the sound power, P_s, passes throught the circulator twice in a signal-combining circulator, the average power, when $P_s = 0,2\ P_{sync}$, is given by $P \approx 1,17\ P_{sync}$.

Under worst-case conditions, the peak power produced for the same signal is given by

$$P_M = (\sqrt{P_{sync}} + 2\sqrt{P_s}) = P_{sync}\ (1+2\sqrt{0,2})^2 = 3,6\ P_{sync}$$

Temperature range is the ambient temperature range within which the isolators/circulators function to specification.
(When necessary special temperature compensation is built in for the circulators).
Outside the temperature range the circulator still functions but the electrical behaviour may be far outside the guaranteed specifications. However, no permanent damage can be expected unless a large temperature rise is caused by excessive power handling.
The storage temperature of the isolators may be from −40 to + 125 °C.

CONNECTORS

Unless otherwise specified, the isolators/circulators have the following connectors:
- type N-female, 50 Ω. Finish of connectors nickel plate.
- type SMA (MIL-C-39012/60). Finish of connectors gold plate.
- type HF 7/16 (acc. to DIN 47223). Finish of connectors silver plate.
- type EIA 7/8. Finish of connectors silver plate.

CAUTION

1. The isolators/circulators have internal magnetic fields which are carefully adjusted for optimal operation.
2. They are not to be subjected to strong external magnetic fields.

QUALITY GUARANTEE

Subject to the Conditions of Guarantee the Manufacturer guarantees the isolators/circulators supplied to the purchaser to meet the specifications as published in the Manufacturer's Data Handbook and to be free from defects in material and workmanship.
Under this guarantee the Manufacturer will within one year after shipment to the original purchaser repair or replace at the Manufacturer's option, free of charge, any isolator/circulator proved by the Manufacturer's inspection to be thus defective.

STANDARD TEST SPECIFICATIONS

Initial and temperature measurements

These measurements have been carried out at a temperature of ±25 °C, and with extreme temperatures of +70 °C and −10 °C, with a power level not exceeding 10 mW.

Tropical test

This test has been carried out completely in accordance with IEC test D: Accelerated damp heat. Temperature 55 °C+2 °C and the R.H. 95-100% for a period of 16 hours, then a period of 8 hours with a temperature of +25 °C and the R.H. 80-100% to complete the 24 hours cycle. This test without interruption for 6 cycles.

Vibration test

This test has been carried out completely in accordane with MIL-STD 202D, method 201A; frequency range 10-55 Hz vice-versa; 3 x 2 hours in respectively X - Y and Z direction with a total excursion of 1,5 mm.

Thermal shock test

This test has been carried out completely in accordance with MIL-STD 202D, method 107C under condition A; 5 cycles with extreme temperatures of −55 °C and + 85 °C. Duration of one cycle 1 hour.

Mechanical shock test

This test has been carried out in accordance with MIL-STD 202D, method 213A under condition G; peak value 100 g, duration 6 ms, and with extreme peak values up to 800 g ± 1 ms for each device, referring to the results of the drop test.

RF power test

The device have been tested in accordance with the definition of maximum power in the data handbook namely with V.S.W.R. = 2. The ambient temperature of 25 °C was increased to 70 °C and the duration of the test was 1 hour for each device.

Final measurements

After completion of above tests final measurements were carried out at a temperature of +25 °C and with a power level not exceeding 10 mW.
The results of these tests should be within the guaranteed values.

Dimensions and visual appearance

This has been checked in accordance with the published data.

Remark:

On request, different and/or additional tests can carried out.

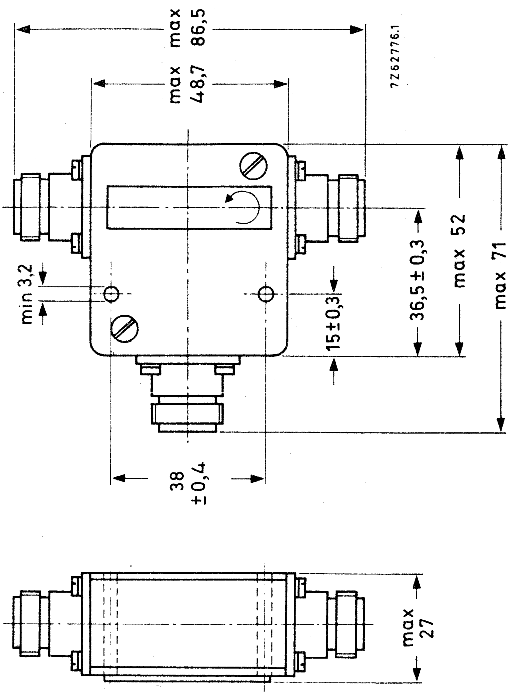
100 W UHF TV BANDS IV-V COAXIAL CIRCULATOR SERIES

frequency range	isolation (dB)		insertion loss (dB)		V.S.W.R.		max. power (W)		temperature range	connector type	weight approx.	suffix in cat. number
(MHz)	guaranteed	typ.	guaranteed	typ.	guaranteed	typ.	c.w.	peak sync.	(°C)	*)	(g)	2722 162
400-470	≥ 20	25	≤ 0,5	–	≤ 1,25	1,15	100	–	−10 to +60	N-female	400	03411
470-600	≥ 20	25	≤ 0,5	0,35	≤ 1,25	1,15	100	200	−10 to +60	N-female	400	01551
600-800	≥ 20	25	≤ 0,5	0,35	≤ 1,25	1,15	100	200	−10 to +60	N-female	400	01561
790-1000	> 20	25	< 0,5	0,3	< 1,25	1,14	100	170	−10 to +60	N-female	400	03261

Note: Combinations, to form 4-port versions (π or H configurations), can be made to special order.

*) On request, these circulators can be made available with different connector types.
On request, isolator versions of these circulators are available.

DIMENSIONS (mm)



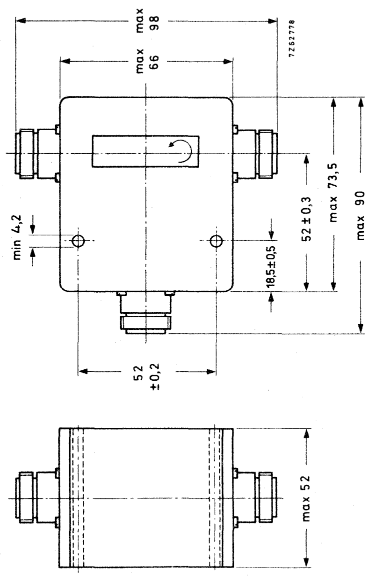
2722 162 03411
01551
01561
03261

300 W UHF TV COAXIAL CIRCULATOR SERIES

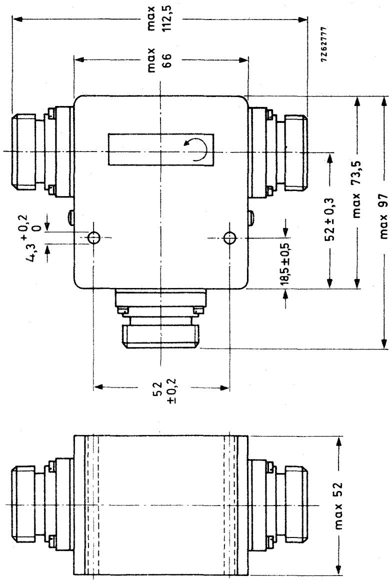
frequency range (MHz)	isolation (dB) guaranteed	isolation (dB) typ.	insertion loss (dB) guaranteed	insertion loss (dB) typ.	V.S.W.R. guaranteed	V.S.W.R. typ.	max. power (W) c.w.	max. power (W) peak sync.	temperature range (°C)	connector type *)	weight approx. (g)	suffix in cat. number 2722 162
400-470	≥ 20	25	≤ 0,35	0,20	≤ 1,25	1,15	300	500	−10 to +60	N-female	1200	01571
400-470	≥ 20	25	≤ 0,35	0,20	≤ 1,25	1,15	300	500	−10 to +60	HF 7/16	1200	01621
470-600	≥ 20	25	≤ 0,35	0,20	≤ 1,25	1,15	300	500	−10 to +60	N-female	1200	01581
470-600	≥ 20	25	≤ 0,35	0,20	≤ 1,25	1,15	300	500	−10 to +60	HF 7/16	1200	01631
590-720	≥ 20	25	≤ 0,35	0,20	≤ 1,25	1,15	300	500	−10 to +60	N-female	1200	01591
590-720	≥ 20	25	≤ 0,35	0,20	≤ 1,25	1,15	300	500	−10 to +60	HF 7/16	1200	01641
600-800	≥ 20	25	≤ 0,35	0,20	≤ 1,25	1,15	300	500	−10 to +60	N-female	1200	01601
600-800	≥ 20	25	≤ 0,35	0,20	≤ 1,25	1,15	300	500	−10 to +60	HF 7/16	1200	01651
710-860	≥ 20	25	≤ 0,35	0,20	≤ 1,25	1,15	300	500	−10 to +60	N-female	1200	01611
710-860	≥ 20	25	≤ 0,35	0,20	≤ 1,25	1,15	300	500	−10 to +60	HF 7/16	1200	01661

*) On request, these circulators can be made available with different connector types
On request, isolator versions of these circulators are available.

DIMENSIONS (mm)



2722 162 01571
01581
01591
01601
01611



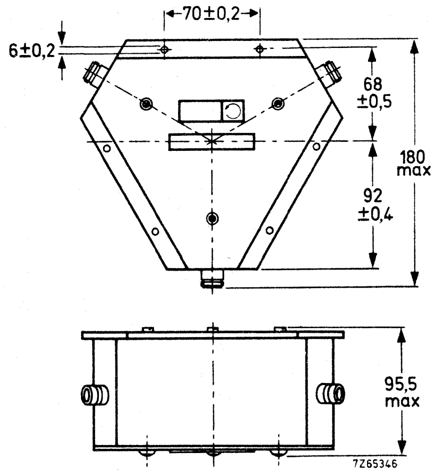
2722 162 01621
01631
01641
01651
01661

500 W/1 kW VHF TV COAXIAL CIRCULATOR SERIES

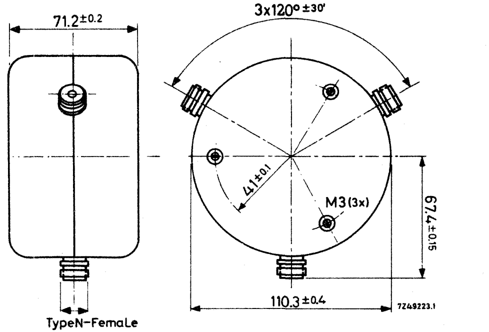
frequency range (MHz)	isolation (dB) guaranteed	isolation (dB) typ.	insertion loss (dB) guaranteed	insertion loss (dB) typ.	V.S.W.R. guaranteed	V.S.W.R. typ.	max. power (W) c.w.	max. power (W) peak sync.	temperature range (°C)	connector type	weight approx. (g)	suffix in cat. number 2722 162
160-178	≥ 20	24	≤ 0,35	0,3	≤ 1,25	1,15	500	850	−10 to +60	N-female	2100	01871
160-178	≥ 20	24	≤ 0,35	0,3	≤ 1,25	1,15	1000	1800	−10 to +40*)	HF 7/16	2150	01901
173-204	≥ 20	24	≤ 0,35	0,3	≤ 1,25	1,15	500	850	−10 to +60	N-female	2100	01861
173-204	≥ 20	24	≤ 0,35	0,3	≤ 1,25	1,15	1000	1800	−10 to +40*)	HF 7/16	2150	01891
200-230	≥ 20	24	≤ 0,35	0,3	≤ 1,25	1,15	500	850	−10 to +60	N-female	2100	01851
200-230	≥ 20	24	≤ 0,35	0,3	≤ 1,25	1,15	1000	1800	−10 to +40*)	HF 7/16	2150	01881
225-270	≥ 20	24	≤ 0,35	0,3	≤ 1,25	1,15	500	850	−10 to +60	N-female	2100	03171
225-270	≥ 20	24	≤ 0,35	0,3	≤ 1,25	1,15	1000	1800	−10 to +40*)	HF 7/16	2150	03181
Maintenance types												
150-160	> 20	22	< 0,3	0,25	< 1,25	1,1	1000	1700	+10 to +70	N-female	6400	01361
160-190	> 20	22	< 0,35	0,25	< 1,25	1,1	1000	1700	+10 to +60	N-female	6400	01371
170-200	> 20	22	< 0,35	0,25	< 1,25	1,1	1000	1700	+10 to +60	N-female	6400	01341
190-220	> 20	22	< 0,35	0,25	< 1,25	1,1	1000	1700	+10 to +60	N-female	6400	01381
195-230	> 20	22	< 0,35	0,25	< 1,25	1,1	1000	1700	+10 to +60	N-female	6400	01351

*) With air cooling (filtered) at a pressure of 25 mm water column and max. 40 °C intake temperature, the permissible connector temperature is +55 °C.

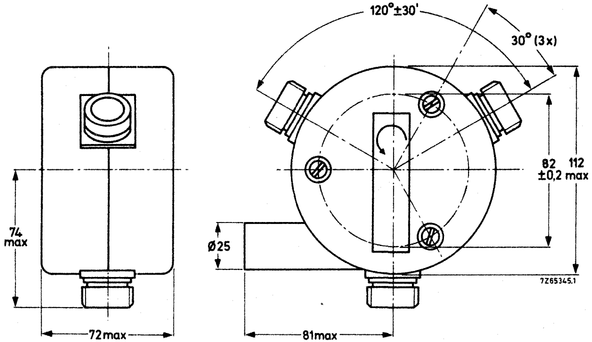
DIMENSIONS (mm)



2722 162 01341
01351
01361
01371
01381



2722 162 01851
01861
01871
01881



2722 162 01881
01891
01901
03181

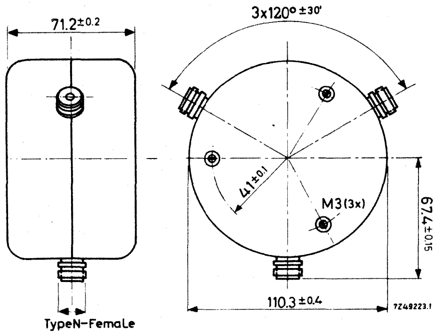
500 W/2 kW UHF TV BANDS IV-V COAXIAL CIRCULATOR SERIES

frequency range	isolation (dB)		insertion loss (dB)		V.S.W.R.		max. power (W)		temperature range	connector type	weight approx.	suffix in cat. number
(MHz)	guaranteed	typ.	guaranteed	typ.	guaranteed	typ.	c.w.	c.w.+ peak sync.	(°C)		(g)	2722 162
470-600	> 22	24	< 0,35	0,25	< 1,2	1,15	500	900	-10 to +70	N-female**)	2080	01121
470-600	> 20	24	< 0,35	0,17	< 1,25	1,12	2000	2000	-10 to +40*)	HF 7/16	2000	01261
590-720	> 22	24	< 0,35	0,25	< 1,2	1,15	500	900	-10 to +70	N-female**)	2080	01131
590-720	> 22	27	< 0,35	0,15	< 1,2	1,1	2000	2000	-10 to +40*)	HF 7/16	2000	01281
600-800	> 20	24	< 0,35	0,17	< 1,25	1,13	2000	2000	-10 to +40*)	HF 7/16	2000	01331
710-860	> 22	24	< 0,35	0,25	< 1,2	1,15	500	900	-10 to +70	N-female**)	2080	01141
710-860	> 22	26	< 0,35	0,16	< 1,2	1,15	2000	2000	-10 to +40*)	HF 7/16	2000	01271

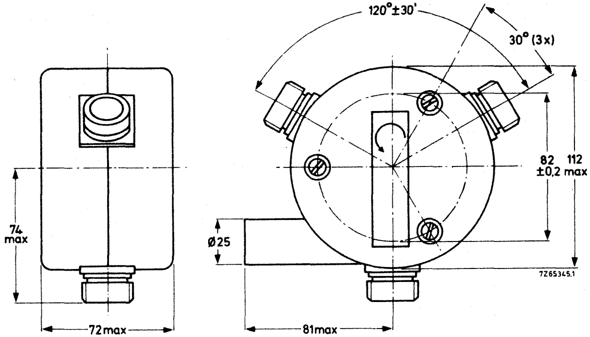
*) With air cooling (filtered) at a pressure of 25 mm water column and max. 40 °C intake temperature, the permissible connector temperature is +60 °C.

**) Also available with connector HF 7/16 (to DIN 47223), EIA 7/8, and EIA 1 5/8.

DIMENSIONS (mm)



2722 162 01121
01131
01141



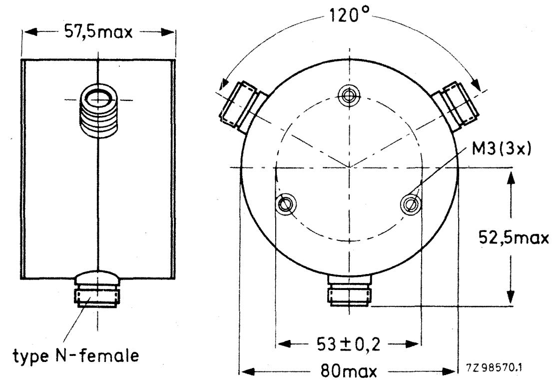
2722 162 01261
01271
01281
01331

100 W UHF TV COAXIAL CIRCULATOR SERIES (maintenance types)

frequency range (MHz)	isolation (dB)		insertion loss (dB)		V.S.W.R.		max. power (W)	temperature range (°C)	connector type	weight approx. (g)	catalogue number
	guaranteed	typ.	guaranteed	typ.	guaranteed	typ.					
370-402	> 20	22	< 0,3	0,20	< 1,2	1,15	100	−10 to +70	N-female	1200	2722 162 01221
406-470	> 20	22	< 0,4	0,20	< 1,2	1,15	100	+10 to +70	N-female	1200	01151
445-485	> 22	23	< 0,3	0,20	< 1,2	1,15	100	−10 to +70	N-female	1200	01231
470-600	> 20	22	< 0,35	0,20	< 1,25	1,15	100	+10 to +70	N-female	1200	01161
590-720	> 22	23	< 0,35	0,20	< 1,2	1,15	100	+10 to +70	N-female	1200	01171
710-860	> 22	23	< 0,35	0,20	< 1,2	1,15	100	+10 to +70	N-female	1200	01181
710-860	> 22	23	< 0,35	0,20	< 1,2	1,15	100	+10 to +70	N-female	1200	01241
740-810	> 22	23	< 0,3	0,20	< 1,2	1,15	100*)	−10 to +70	N-female	1200	02001
890-970	> 22	23	< 0,3	0,20	< 1,2	1,15	100*)	−10 to +70	N-female	1200	02011

*) maximum permissible reflected power 2 W.

DIMENSIONS (mm)



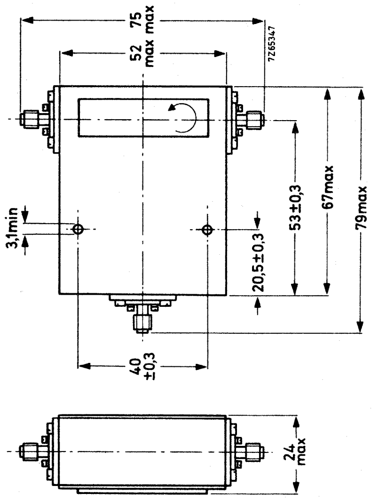
2722 162 01151	2722 162 01221
01161	01231
01171	01241
01181	02001
	02011

OCTAVE BANDWIDTH CIRCULATOR/ISOLATOR SERIES

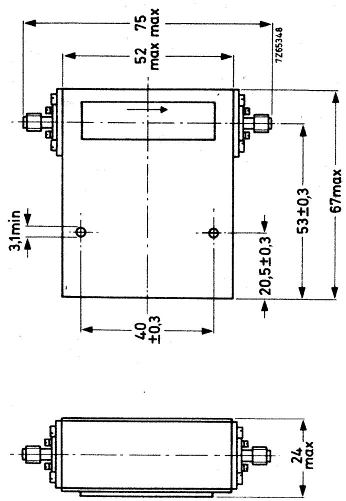
frequency range (GHz)	isolation (dB)		insertion loss (dB)		V.S.W.R.		max. power (W)		temperature range (°C)	connector type	weight approx. (g)	suffix in cat. number 2722 162
	guaranteed	typ.	guaranteed	typ.	guaranteed	typ.	forward	reverse				
2-4	> 20	24	< 0,5	0,35	< 1,25	1,15	50	50	−10 to +70	N-female	300	01491
2-4	> 20	24	< 0,5	0,35	< 1,25	1,15	50	50	−10 to +70	SMA	300	01501
2-4	> 20	24	< 0,5	0,35	< 1,25	1,1	50	5	−10 to +70	N-female	300	02091
2-4	> 20	24	< 0,5	0,35	< 1,25	1,1	50	5	−10 to +70	SMA	300	02101
3-6	> 20	27	< 0,5	0,3	< 1,25	1,1	20	20	−10 to +70	SMA	120	01511
3-6	> 20	27	< 0,5	0,3	< 1,25	1,1	20	5	−10 to +70	SMA	120	02071
4-8	≥ 20	23	≤ 0,5	0,3	≤ 1,25	1,15	10	10	−10 to +70	SMA	100	01811
4-8	≥ 20	27	≤ 0,5	0,3	≤ 1,25	1,15	10	10	−10 to +70	SMA	100	02111
7-12,7	≥ 20	23	≤ 0,6	0,4	≤ 1,25	1,15	10	10	−10 to +70	SMA	60	01821
7-12,7	> 20	25	≤ 0,6	0,35	≤ 1,25	1,12	10	2	−10 to +70	SMA	100	02121
12-18	≥ 20	22	≤ 0,5	0,35	≤ 1,30	1,2	5	5	−10 to +70	SMA	20	03301
12-18	≥ 20	22	≤ 0,5	0,35	≤ 1,25	1,2	5	1	−10 to +70	SMA	20	02221

Note: Combinations, to form 4-port versions (π or H configurations), can be made to special order.

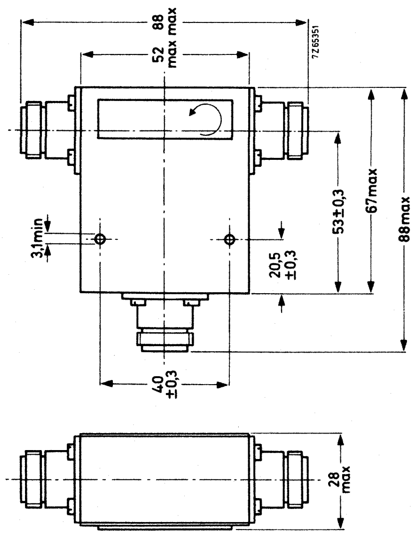
DIMENSIONS (mm)



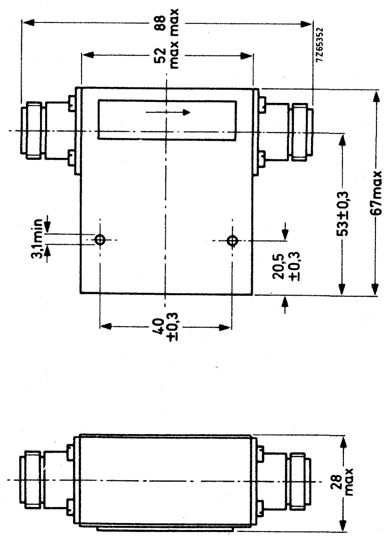
2722 162 01501



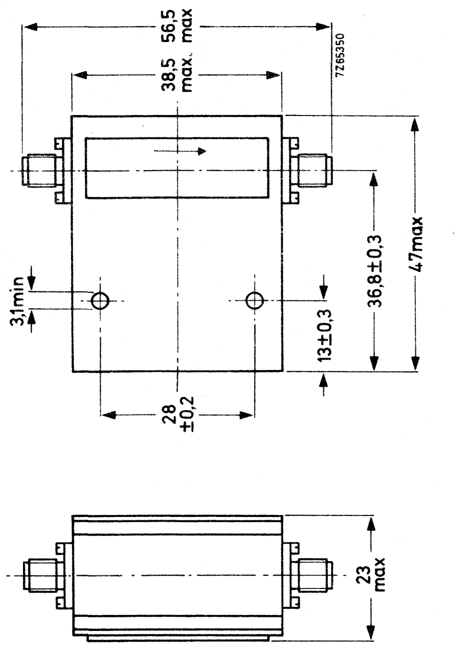
2722 162 02101



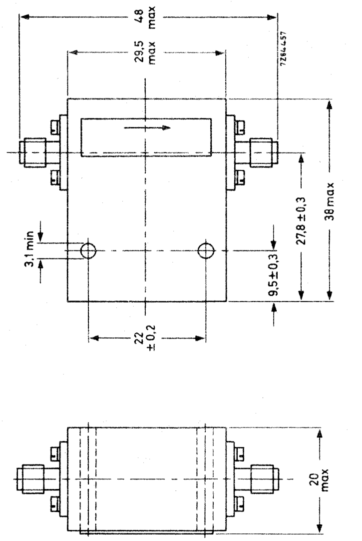
2722 162 01491



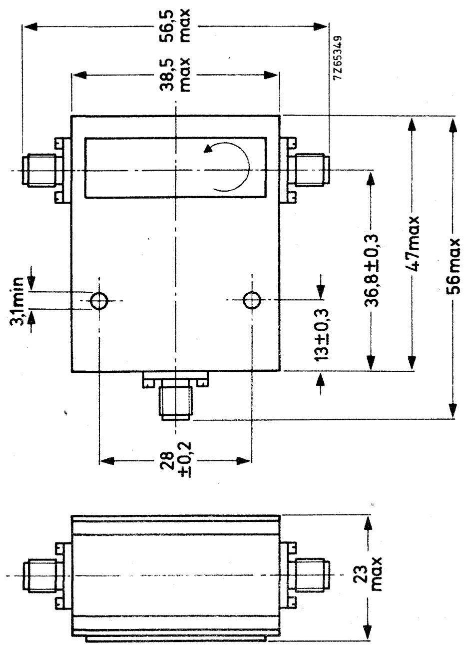
2722 162 02091



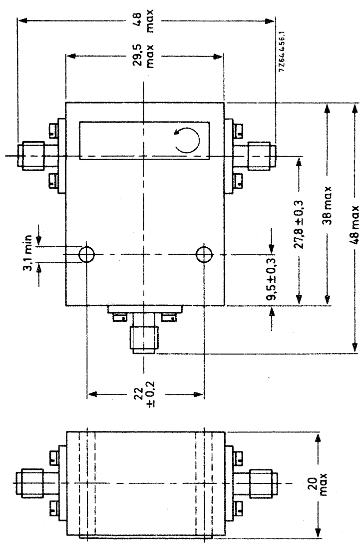
2722 162 02071



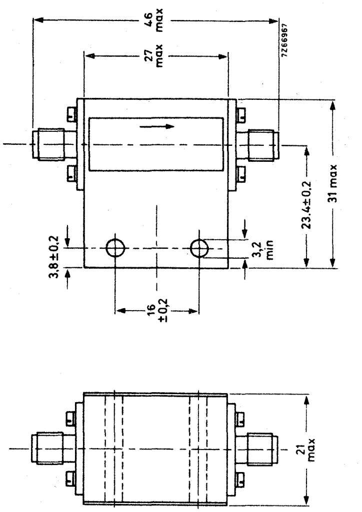
2722 162 02111



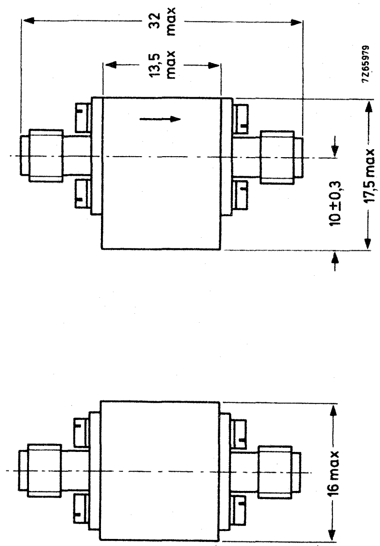
2722 162 01511



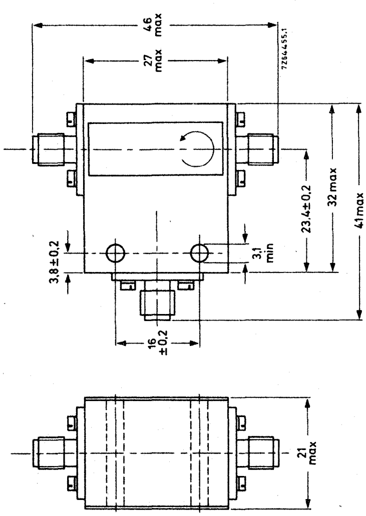
2722 162 01811



2722 162 02121



2722 162 02221



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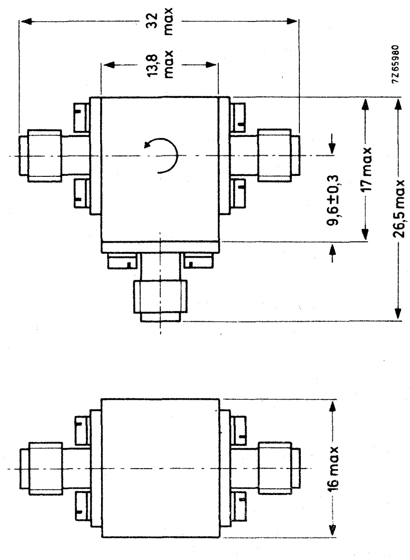


2722 162 03301

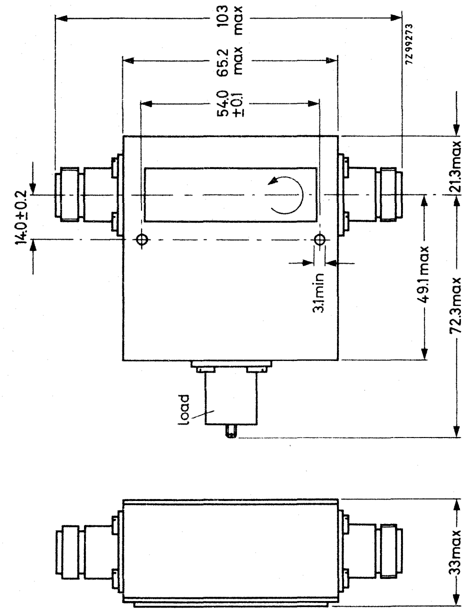
STANDARD BANDS COAXIAL CIRCULATOR/ISOLATOR SERIES (3-port versions)

frequency range (GHz)	isolation (dB)		insertion loss (dB)		V.S.W.R.		max. power (W)		temperature range (°C)	connector type	weight approx. (g)	suffix in cat. number 2722 162
	guaranteed	typ.	guaranteed	typ.	guaranteed	typ.	forward	reverse				
0,225-0,27	> 18	21	< 0,35	0,2	< 1,35	1,25	150	-	0 to +70	N-female	725	01931
0,27 -0,33	> 18	21	< 0,35	0,2	< 1,35	1,25	150	-	0 to +70	N-female	725	01941
0,33 -0,40	> 18	21	< 0,35	0,3	< 1,35	1,25	150	-	0 to +70	N-female	725	01951
0,79 -1	> 20	25	< 0,5	0,3	< 1,25	1,14	100	-	−10 to +60	N-female	400	03261
1,48 -1,95	> 20	28	< 0,3	0,3	< 1,2	1,08	50	2	−10 to +70	N-female	500	02041
1,7 -1,9	≥ 25	27	≤ 0,25	0,2	≤ 1,12	1,10	20	-	0 to +50	N-female [2])	400	03271
1,7 -2,3	> 20	28	< 0,3	0,2	< 1,25	1,10	50	2	−10 to +70	N-female	500	02051 [1])
1,9 -2,1	≥ 25	27	≤ 0,25	0,2	≤ 1,12	1,10	20	-	0 to +50	N-female [2])	400	03281
2,1 -2,3	≥ 25	27	≤ 0,25	0,2	≤ 1,12	1,10	20	-	0 to +50	N-female [2])	400	03291
3,8 -4,2	≥ 25	27	≤ 0,25	0,2	≤ 1,12	1,10	10	-	−10 to +70	SMA	110	03431
4,4 -5	≥ 25	27	≤ 0,25	0,2	≤ 1,12	1,10	10	-	−10 to +70	SMA	110	03441
7,9 -10,4	≥ 20	22	≤ 0,4	0,35	≤ 1,25	1,23	5	1	−10 to +70	SMA	30	02231

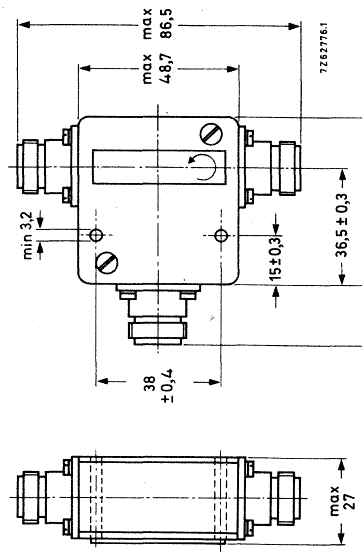
[1]) Maintenance type

[2]) 2 male, 1 female

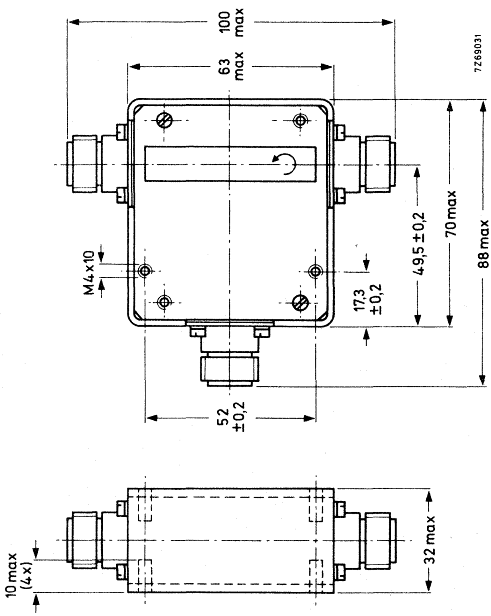
DIMENSIONS (mm)



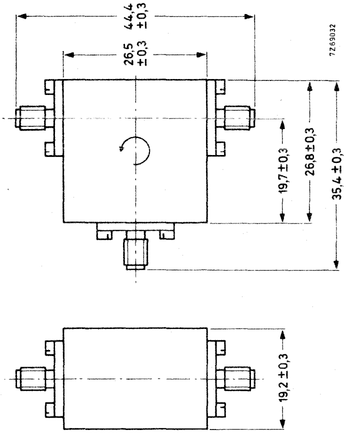
2722 162 02041



2722 162 03261
03271
03281
03291



2722 162 01931
01941
01951



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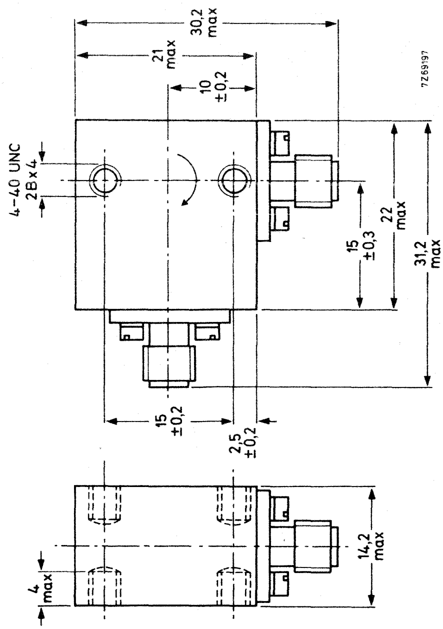

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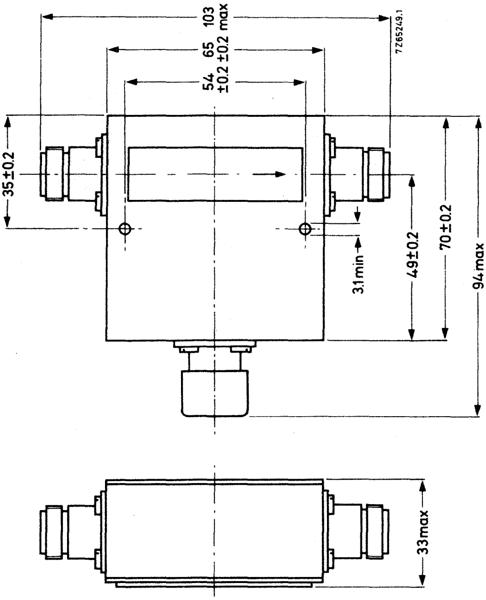


2722 162 02051

STANDARD BANDS COAXIAL CIRCULATOR SERIES (4-port versions)

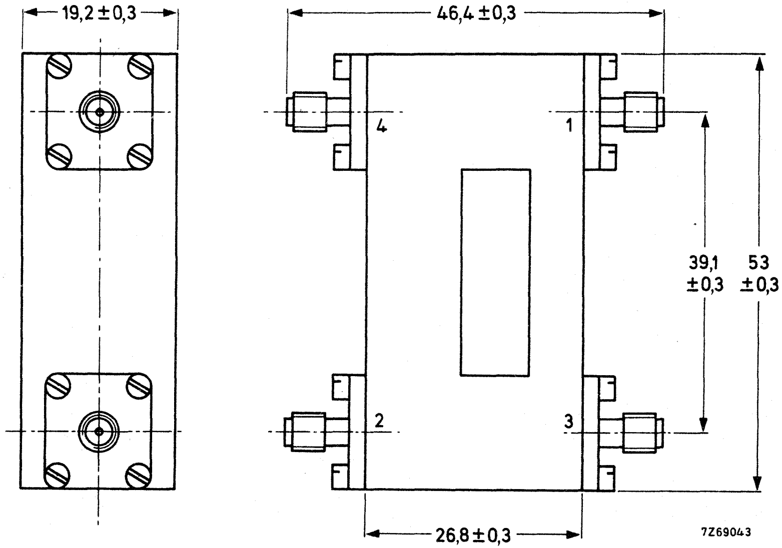
freq. range	isolation (dB)				insertion loss (dB)				V.S.W.R.		max. (c.w.) power	temperature range	connector type	suffix in cat. number
	guaranteed		typical		guaranteed		typical		guaranteed	typ.				
(GHz)	α1-4 α3-2	α2-1 α4-2	α1-4 α3-2	α2-1 α4-3	α4-1 α2-3	α1-2 α3-4	α4-1 α2-3	α1-2 α3-4			(W)	(°C)		2722 162
3,8-4,2	≥ 25	≥ 50	27	52	≤ 0,25	≤ 0,5	0,2	0,4	≤ 1,12	1,1	10	−10 to +70	SMA	04031
4,4-5	≥ 25	≥ 50	27	52	≤ 0,25	≤ 0,5	0,2	0,4	≤ 1,12	1,1	10	−10 to +70	SMA	04041

Weight of circulators : 220 g approx.

DIMENSIONS (mm)

2722 162 04031

04041



WAVEGUIDE CIRCULATOR SERIES (3-port versions)

frequency range (GHz)	isolation (dB)		insertion loss (dB)		V.S.W.R.		max. power (W)	temperature range (°C)	flange type (IEC) *)	weight approx. (g)	catalogue number
	guaranteed	typ.	guaranteed	typ.	guaranteed	typ.					
3,4 -3,8	≥ 28	35	≤ 0,4	0,15	≤ 1,08	1,04	50	0 to +50	UER40	1500	2722 161 02261
3,8 -4,2	≥ 28	35	≤ 0,2	0,15	≤ 1,08	1,04	50	0 to +50	UER40	1500	02231
5,925-6,425	> 30	35	< 0,2	0,15	< 1,06	1,04	100	-10 to +70	UER70	950	02101
6,425-7,125	> 30	33	< 0,15	0,13	< 1,07	1,04	100	-10 to +70	UER70	950	02081
7,125-7,750	> 30	33	< 0,2	0,13	< 1,06	1,04	100	-10 to +70	UER70	950	02091
7,7 -8,5	> 25	32	< 0,5	0,2	< 1,1	1,05	50	+10 to +40	UER84	825	02191
7,7 -8,5	≥ 25	28	≤ 0,5	0,3	≤ 1,1	1,08	50	+10 to +40	UER84	825	02281
7,9 -8,4	≥ 30	33	≤ 0,3	0,15	≤ 1,06	1,04	50	+10 to +40	UER84	825	02271

Note: On request, 3-port versions can be coupled to form n-ports.

*) Material of flanges: aluminium. Finish of flanges: alodine.

WAVEGUIDE CIRCULATOR SERIES (4-port versions)

frequency range (GHz)	isolation (dB)		insertion loss (dB)		V.S.W.R.		nominal power (c.w.) (W)	temperature range (^oC)	flange type (IEC) *)	weight approx. (g)	suffix in cat. number 2722 161
	α1-3	α1-4	guaranteed	typ.	α1-3	α1-4					
5,925-6,175	> 33	> 20	< 0,1	0,10	< 1,05	< 1,04	150	+ 10 to + 60	UER 70	920	03081
6,125-6,425	> 30	> 20	< 0,1	1,10	< 1,06	< 1,06	150	+ 10 to + 60	UER 70	920	03091
6,575-6,875	> 25	> 20	< 0,4	0,35	< 1,10	< 1,10	100	+ 10 to + 60	UER 70	920	03031
6,825-7,125	> 25	> 18	< 0,4	0,35	< 1,08	< 1,08	100	+ 10 to + 60	UER 70	920	03011
7,125-7,425	> 25	> 18	< 0,3	0,25	< 1,10	< 1,10	100	+ 10 to + 60	UER 70	920	03001
7,425-7,725	> 30	> 20	< 0,4	0,35	< 1,10	< 1,10	100	+ 10 to + 60	UER 70	920	03041
10,7 -11,7	> 30	> 18	< 0,3	0,25	< 1,10	< 1,10	25	+ 10 to + 60	UBR 100	390	03061
12,5 -13,5	> 25	> 20	< 0,3	0,25	< 1,10	< 1,10	25	+ 10 to + 60	UER 140/ UBR 140	320	03051

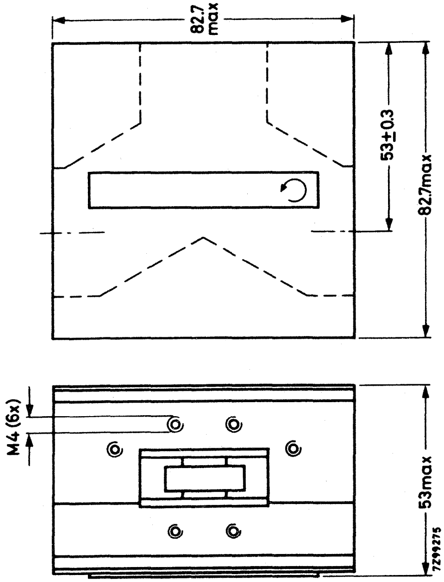
ISOLATOR (terminated circulator)

frequency range (GHz)	isolation (dB)		insertion loss (dB)		V.S.W.R.		max. c.w. power forward/ reverse (W)	cooling water temp. (^oC) (water pressure 6 atm. abs)		flange type (IEC) * *)	HF monitoring terminal	weight approx. (g)	suffix in cat. number 2722 163
	guaranteed	typ.	guaranteed	typ.	guaranteed	typ.		inlet	outlet				
2,425-2,475	> 20	30	< 0,30	0,15	> 1,10	1,05	6500	40	50	PDR26	N-female	5000	02001

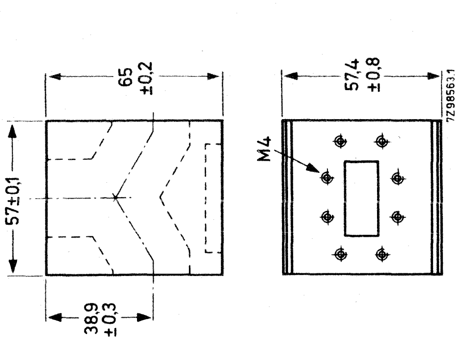
*) Material of flange: brass; Finish of flange: gold plate on silver plate.
* *) Finish of flange/housing: alodine.

DIMENSIONS (mm)

3-PORT VERSIONS



2722 161 02081
02091
02101



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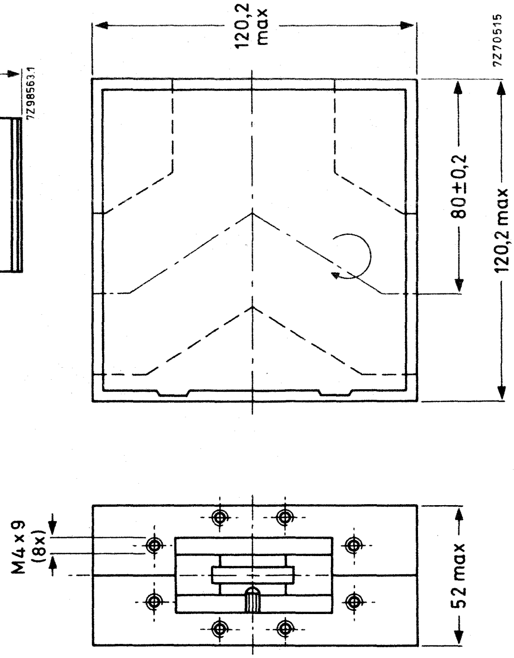
02271
02281



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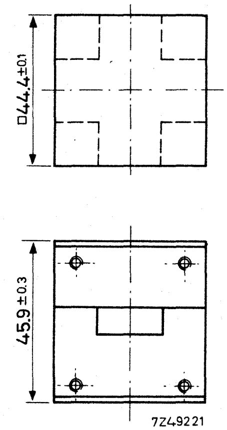
02261

4-PORT VERSIONS



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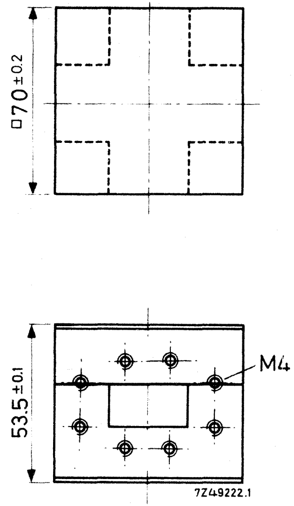

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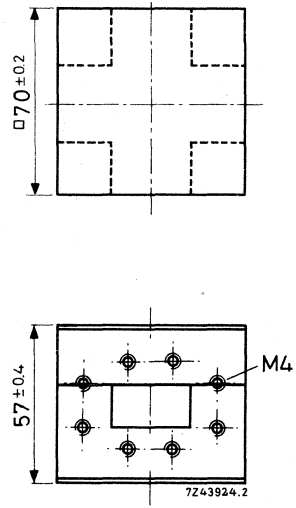
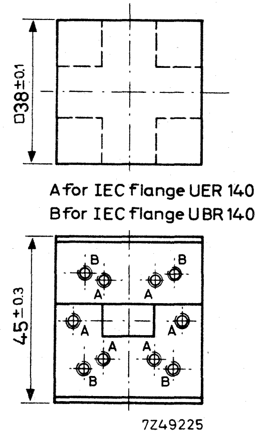


2722 161 03001
03011
03031
03081
03091



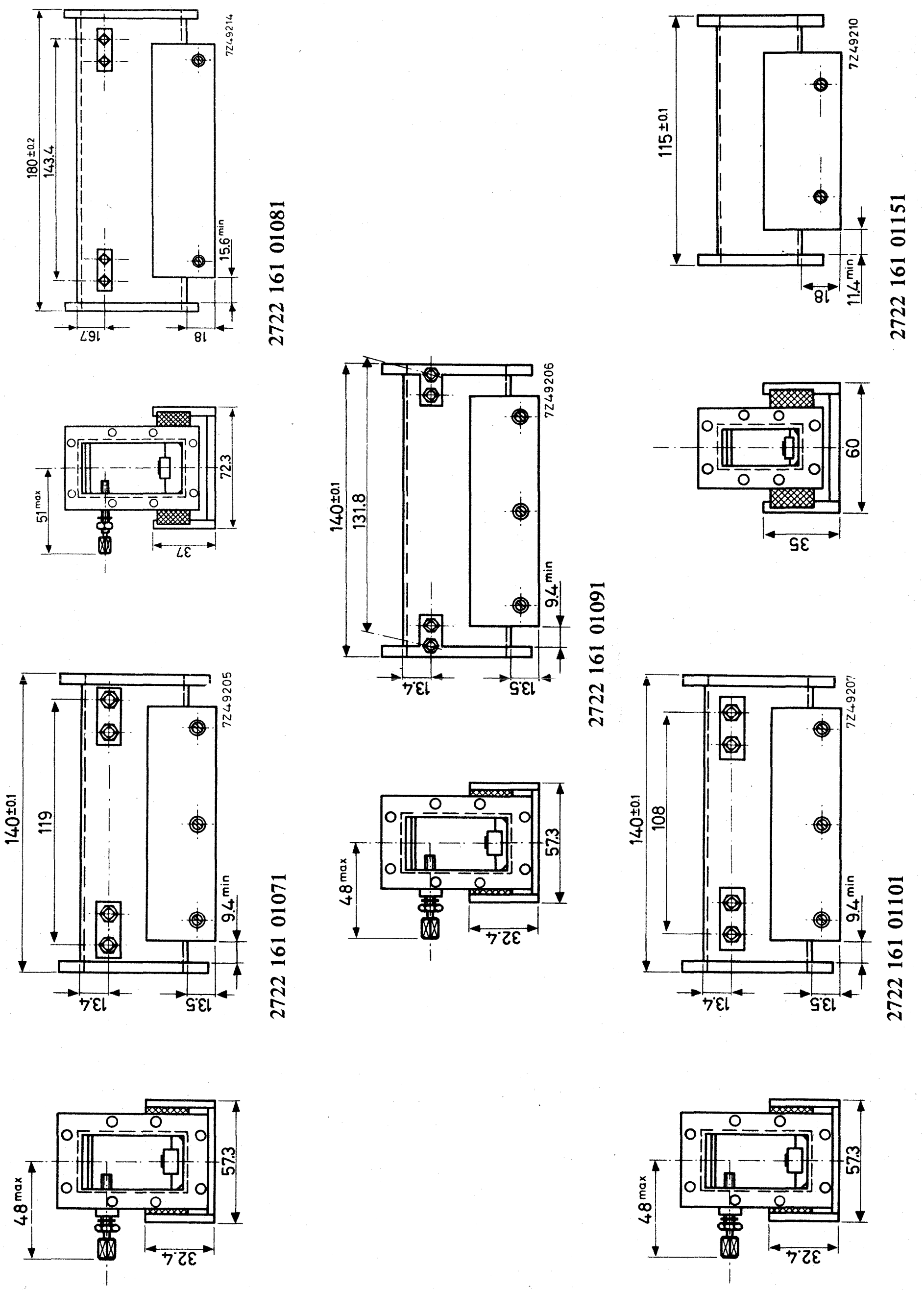
2722 161 03051

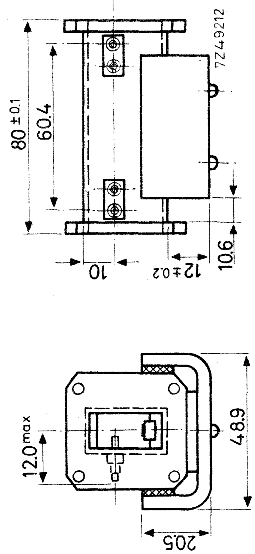
WAVEGUIDE ISOLATOR SERIES

frequency range (GHz)	isolation (dB)	insertion loss (dB)	V.S.W.R.	power (c.w.) (W)	temperature range (°C)	waveguide type (IEC)	flange type (IEC) *)	weight approx. (g)	catalogue number
3,8 -4,2	> 30	< 0,8	< 1,05	10	+ 10 to + 40	R48	UER48	1700	2722 161 01071
3,8 -4,2	> 30	< 0,5	< 1,05	10	+ 10 to + 80	R40	UER40	2450	01081
4,2 -4,6	> 30	< 0,5	< 1,05	10	+ 10 to + 40	R48	UER48	1680	01091
4,6 -5,0	> 30	< 0,8	< 1,05	10	+ 10 to + 40	R48	UER48	1680	01101
5,925-6,425	> 30	< 0,3	< 1,05	20	− 10 to + 70	R70	UER70	1450	01191
6,425-7,150	> 30	< 0,3	< 1,05	20	− 10 to + 70	R70	UER70	1450	01251
6,825-7,425	> 30	< 0,3	< 1,05	20	− 10 to + 70	R70	UER70	1450	01231
7,125-7,750	> 30	< 0,3	< 1,05	20	− 10 to + 70	R70	UER70	1450	01291
7,250-7,750	> 30	< 0,3	< 1,05	20	− 10 to + 70	R70	UER70	1450	01241
7,4 -8,025	> 30	< 0,5	< 1,05	10	− 10 to + 70	R70	UER70	1450	01151
7,7 -8,5	> 30	< 0,5	< 1,05	10	+ 10 to + 70	R84	UBR84	1260	01161
8,5 -9,6	> 30	< 0,5	< 1,05	10	− 10 to + 70	R100	UBR100	420	01211
8,5 -9,6	> 15	< 0,6	< 1,15	1	+ 10 to + 70	R100	UBR100	400	01221
8,5 -9,6	> 55	< 1,2	< 1,2	10	− 10 to + 70	R100	154-UER100**)	600	01261
8,5 -9,6	> 20	< 1	< 1,15	10	− 10 to + 70	R100	154-UBR100**)	300	01271
10,7 -11,7	> 30	< 0,8	< 1,05	5	+ 10 to + 70	R100	UBR100	430	01171
12,5 -13,5	> 30	< 0,5	< 1,05	10	+ 10 to + 70	R140	UBR100	220	01181

*) Other flanges to order. Finish of waveguide and flanges: gold plate on silver plate.
**) Finish of flanges nickel plate.

DIMENSIONS (mm)





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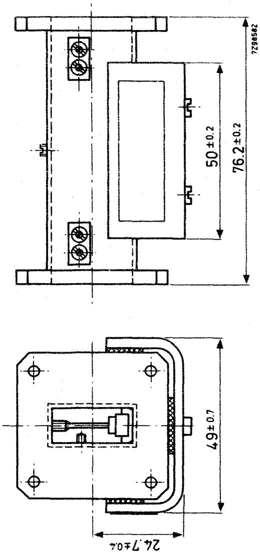

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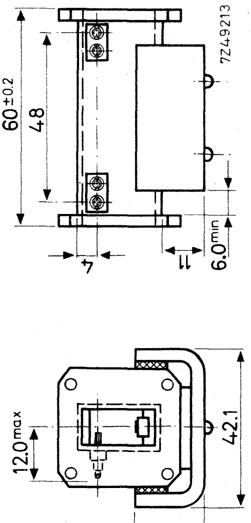

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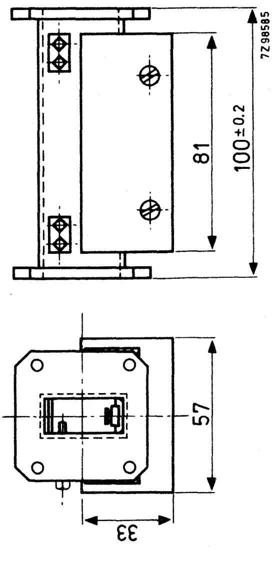

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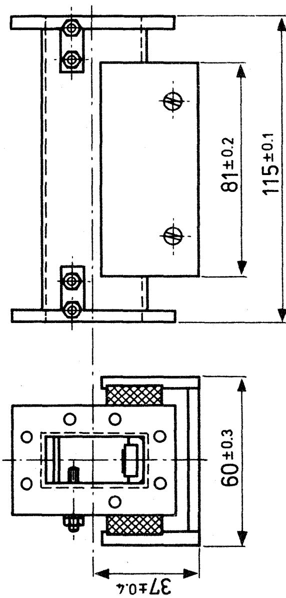

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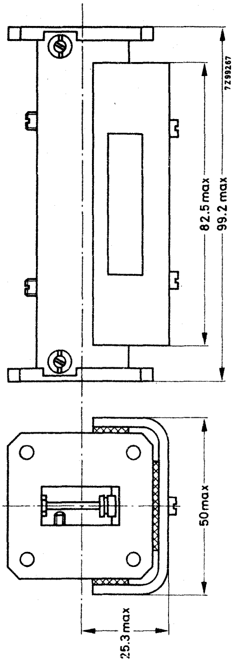

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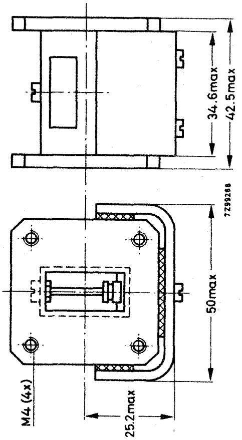

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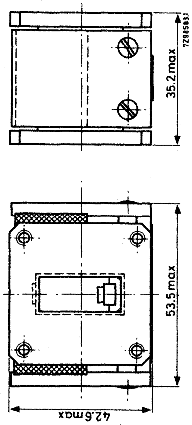

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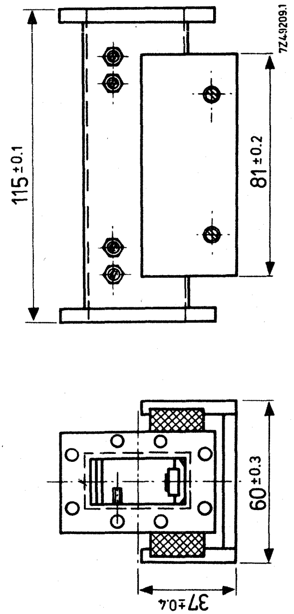

2722 161 01231
01241
01291

INDEX OF TYPENUMBERS

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AAY51	SD	CXY11A	SD	YJ1192	MH
AAY51R	SD	CXY11B	SD	YJ1280	MH
AAY52	SD	CXY11C	SD	YJ1300	CM
AAY52R	SD	EA52	D	YJ1320	CM
AAY59	SD	EA53	D	YJ1321	CM
AEY29	SD	EC55	T	YJ1440	MH
AEY29R	SD	EC157	T	YJ1480	MH
AEY31	SD	EC158	T	YK1000	PK
AEY31A	SD	K50A	D	YK1001	PK
BAV46	SD	K51A	D	YK1002	PK
BAV96A	SD	LB6 25	TWT	YK1004	PK
BAV96B	SD	YD1050	T	YK1005	PK
BAV96C	SD	YH1090	TWT	YK1010	K
BAV96D	SD	YH1172	TWT	YK1090	K
BAV97	SD	YH1210	TWT	YK1091	K
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CL7330	SD	YJ1162	MH	1N5157	SD
CL7331	SD	YJ1164	MH	2C39BA	T
CL7332	SD	YJ1180	CM	2J51A	CM

CM = Communication magnetrons
D = Diodes
ISC = Isolators, circulators
K = Klystrons, medium and low power
MH = Magnetrons for microwave heating
PK = Klystrons, high power
SD = Microwave semiconductor devices
T = Triodes
T-RS = T-R switches
TWT = Travelling-wave tubes

Type No.	Section	Type No.	Section	Type No.	Section
4J50	CM				
5J26	CM				
5586	CM				
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5876A	T				
5893	T				
6263	T				
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55340	TWT				
56032	T RS				
2722 161 ..... to 2722 162	ISC				

CM = Communication magnetrons
D = Diodes
ISC = Isolators, circulators
K = Klystrons, medium and low power
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PK = Klystrons, high power
SD = Microwave semiconductor devices
T = Triodes
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General section

Communication magnetrons

Magnetrons for micro-wave heating

Klystrons, high power

Klystrons, medium and low power

Travelling-wave tubes

Diodes

Triodes

T-R Switches

Microwave semiconductor devices

Isolators-circulators

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