PHILIPS

Data handbook

PHILIPS Electronic components and materials

Electron tubes

Part 2a November 1977

Microwave tubes

ELECTRON TUBES

Part 2a November 1977

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.

SEMICONDUCTORS AND INTEGRATED CIRCUITS (RED SERIES)

Part 1a	**March 1976**	**SC1a 03-76**	**Rectifier diodes, thyristors, triacs** Rectifier diodes, voltage regulator diodes (> 1,5 W), transient suppressor diodes, rectifier stacks, thyristors, triacs
Part 1b	**May 1977**	**SC1b 05-77**	**Diodes** Small signal germanium diodes, small signal silicon diodes, special diodes, voltage regulator diodes (< 1,5 W), voltage reference diodes, tuner diodes
Part 2	**November 1977**	**SC2 11-77**	**Low-frequency and dual transistors**
Part 3	**April 1976**	**SC3 04-76**	**High-frequency and switching transistors**
Part 4a	**June 1976**	**SC4a 06-76**	**Special semiconductors** Transmitting transistors, field-effect transistors, dual transistors, microminiature devices for thick and thin-film circuits
Part 4b	**July 1976**	**SC4b 07-76**	**Devices for optoelectronics** Photosensitive diodes and transistors, light emitting diodes, displays, photocouplers, infrared sensitive devices, photoconductive devices
Part 5a	**November 1976**	**SC5a 11-76**	**Professional analogue integrated circuits**
Part 5b	**March 1977**	**SC5b 03-77**	**Consumer integrated circuits** Radio-audio, television
Part 6	**October 1977**	**SC6 10-77**	**Digital integrated circuits** LOCMOS HE4000B family
Signetics integrated circuits 1976			Logic, Memories, Interface, Analogue, Microprocessor, Milrel

ELECTRON TUBES (BLUE SERIES)

Part 1a	December 1975	ET1a 12-75	**Transmitting tubes for communication, tubes for r.f. heating** Types PE05/25 to TBW15/25
Part 1b	August 1977	ET1b 08-77	**Transmitting tubes for communication, tubes for r.f. heating, amplifier circuit assemblies**
Part 2	May 1976	ET2 05-76	**Microwave products** (This book is valid until Part 2b becomes available.)
Part 2a	November 1977	ET2a 11-77	**Microwave tubes** Communication magnetrons, magnetrons for microwave heating, klystrons, travelling-wave tubes, diodes, triodes T-R switches
Part 3	January 1975	ET3 01-75	**Special Quality tubes, miscellaneous devices**
Part 4	March 1975	ET4 03-75	**Receiving tubes**
Part 5a	August 1976	ET5a 08-76	**Cathode-ray tubes** Instrument tubes, monitor and display tubes, C.R. tubes for special applications
Part 5b	May 1975	ET5b 05-75	**Camera tubes, image intensifier tubes**
Part 6	January 1977	ET6 01-77	**Products for nuclear technology** Channel electron multipliers, neutron tubes, Geiger-Müller tubes
Part 7a	March 1977	ET7a 03-77	**Gas-filled tubes** Thyratrons, industrial rectifying tubes, ignitrons, high-voltage rectifying tubes
Part 7b	March 1977	ET7b 03-77	**Gas-filled tubes** Segment indicator tubes, indicator tubes, switching diodes, dry reed contact units
Part 8	May 1977	ET8 05-77	**TV picture tubes**
Part 9	June 1976	ET9 06-76	**Photomultiplier tubes; phototubes**

COMPONENTS AND MATERIALS (GREEN SERIES)

Part 1	June 1977	CM1 06-77	**Assemblies for industrial use** High noise immunity logic FZ/30-series, counter modules 50-series, NORbits 60-series, 61-series, circuit blocks 90-series, circuit block CSA70(L), PLC modules, input/output devices, hybrid circuits, peripheral devices, ferrite core memory products
Part 2a	October 1977	CM2a 10-77	**Resistors** 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 2b	April 1976	CM2b 04-76	**Capacitors** Electrolytic and solid capacitors, paper capacitors and film capacitors, ceramic capacitors, variable capacitors
Part 3	January 1977	CM3 01-77	**Radio, audio, television** FM tuners, loudspeakers, television tuners and aerial input assemblies, components for black and white television, components for colour television
Part 4a	October 1976	CM4a 10-76	**Soft ferrites** Ferrites for radio, audio and television, beads and chokes, Ferroxcube potcores and square cores, Ferroxcube transformer cores
Part 4b	December 1976	CM4b 12-76	**Piezoelectric ceramics, permanent magnet materials**
Part 5	July 1975	CM5 07-75	**Ferrite core memory products** Ferroxcube memory cores, matrix planes and stacks, core memory systems
Part 6	April 1977	CM6 04-77	**Electric motors and accessories** Small synchronous motors, stepper motors, miniature direct current motors
Part 7	September 1971	CM7 09-71	**Circuit blocks** Circuit blocks 100 kHz-series, circuit blocks 1-series, circuit blocks 10-series, circuit blocks for ferrite core memory drive
Part 8	February 1977	CM8 02-77	**Variable mains transformers**
Part 9	March 1976	CM9 03-76	**Piezoelectric quartz devices**
Part 10	November 1975	CM10 11-75	**Connectors**

General section

List of symbols

Definitions

Waveguides

Flanges

Rating system

Some devices are labelled

Maintenance type

Obsolescent type

Maintenance type - Available for equipment maintenance
No longer recommended for equipment production.

Obsolescent type - Available until present stocks are exhausted.

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_{a_o}
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_{ia}
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
Transconductance	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
Cathode preheating time, also called waiting time; the minimum period of time during which the heater or filament voltage should be applied before the application of electrode 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).

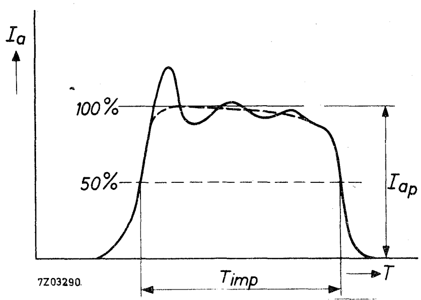


Fig. 1.
current pulse

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)

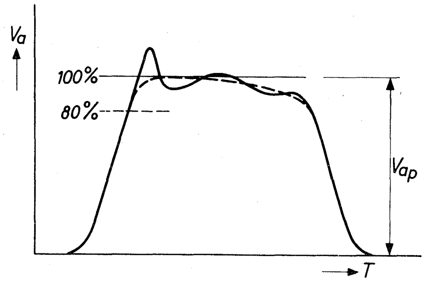


Fig. 2.
voltage pulse

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.

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

RECTANGULAR WAVEGUIDE DATA AND DESIGNATIONS

FREQUENCY RANGE TE_{10} - mode 153 IEC* GHz	WAVEGUIDE DESIGNATION			JAN RG- /U			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	brass	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)

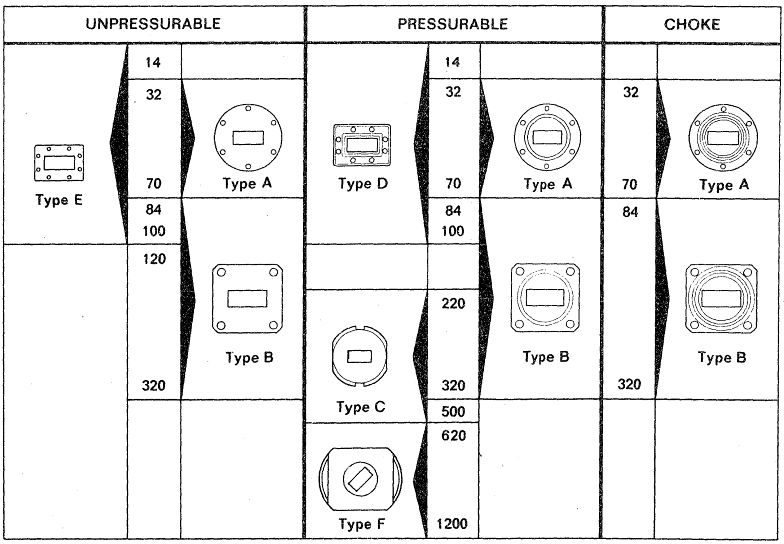
FLANGE DESIGNATIONS

FOR WAVEGUIDE 153 IEC*	FLANGE DESIGNATION: PLAIN FLANGE 154 - IEC	PLAIN FLANGE JAN UG /U Brass	PLAIN FLANGE JAN UG /U Aluminium	CHOKE FLANGE 154 IEC	CHOKE FLANGE JAN UG /U Brass	CHOKE FLANGE 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 :
Central Office of the
International Electrotechnical Commission
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.

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.

7Z2 9010

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 de-mineralised 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

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_{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} = 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).

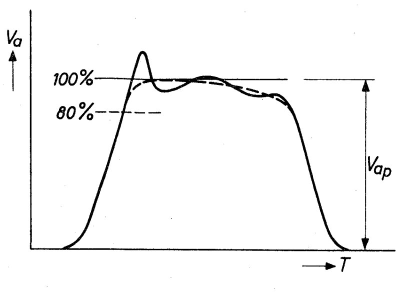


Fig. 1

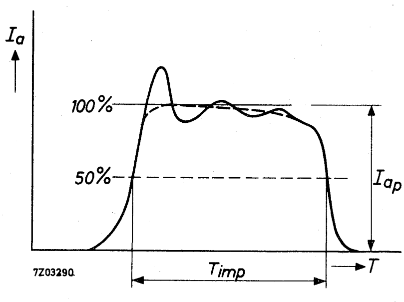


Fig. 2

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

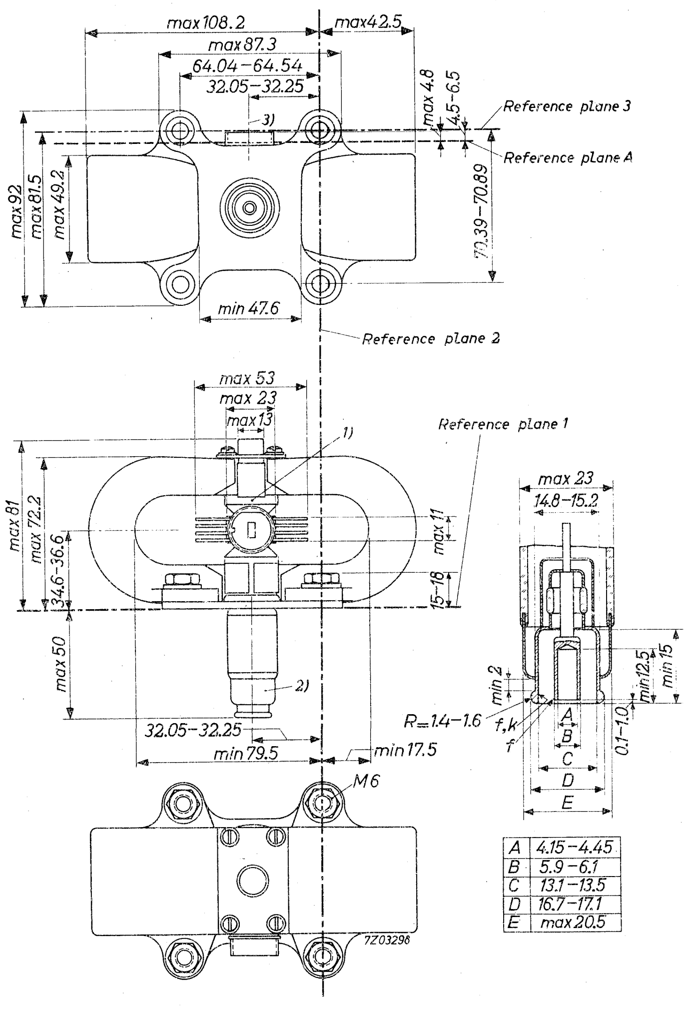
Mounting position	: any
Net mass	: 1,9 kg
Waveguide output system	: 153 IEC – R320 = RG – 96/U
Waveguide coupling system	: Z8 300 16

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

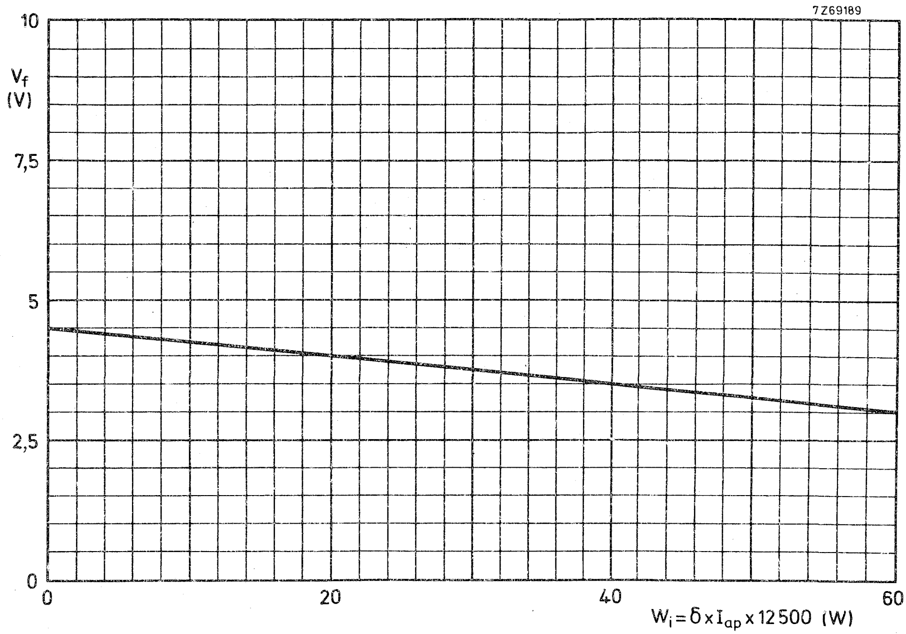


A	4.15–4.45
B	5.9–6.1
C	13.1–13.5
D	16.7–17.1
E	max 20.5

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/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.

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).

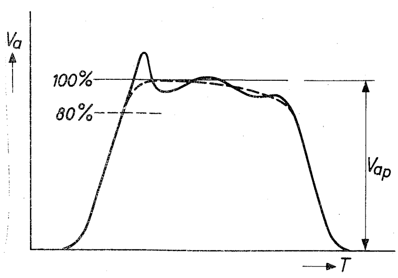


Fig. 1.

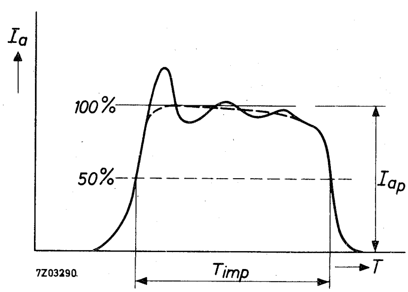


Fig. 2.

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

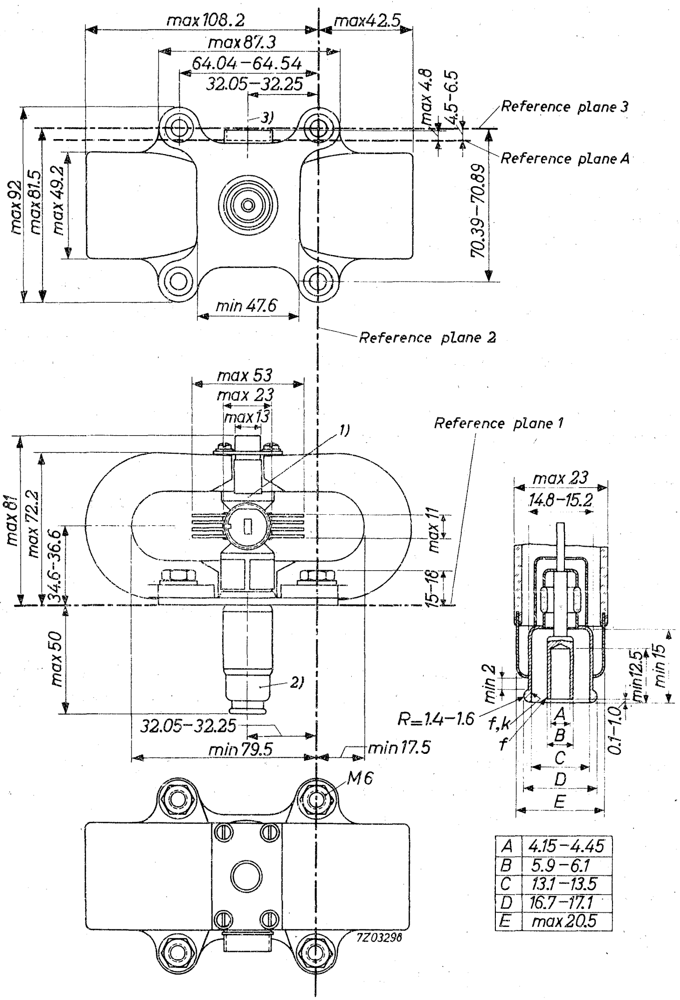
Mounting position	: any
Net mass	: 1,9 kg
Waveguide output system	: 153 IEC – R320 = RG – 96/U
Waveguide coupling system	: Z8 300 16

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

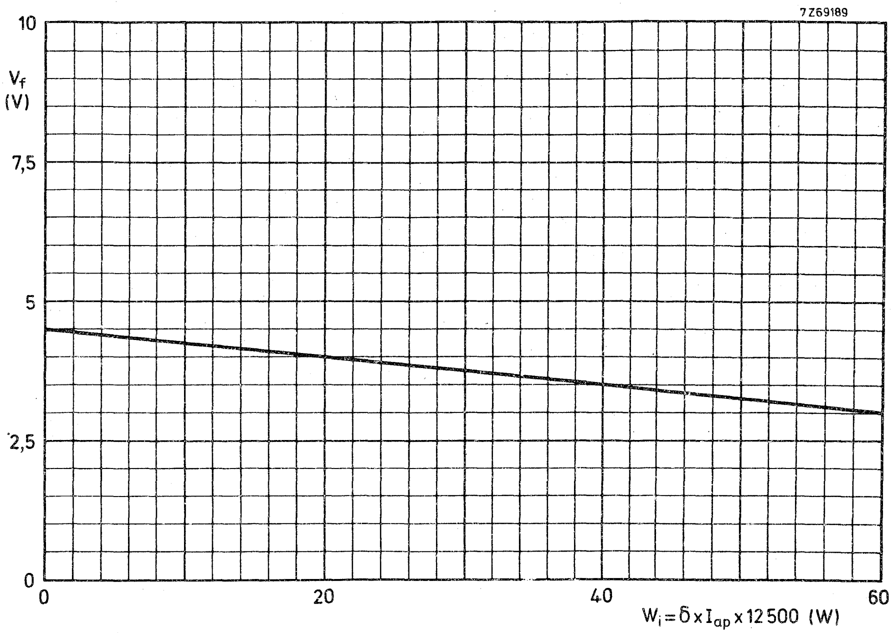


A	4.15−4.45
B	5.9−6.1
C	13.1−13.5
D	16.7−17.1
E	max 20.5

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 35,200	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.
If d.c. is used 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).

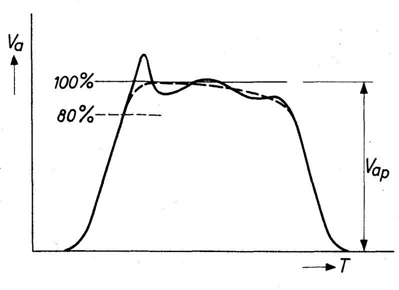


Fig. 1.

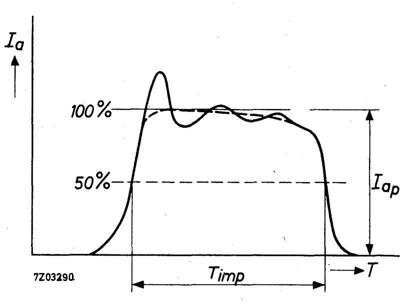


Fig. 2.

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

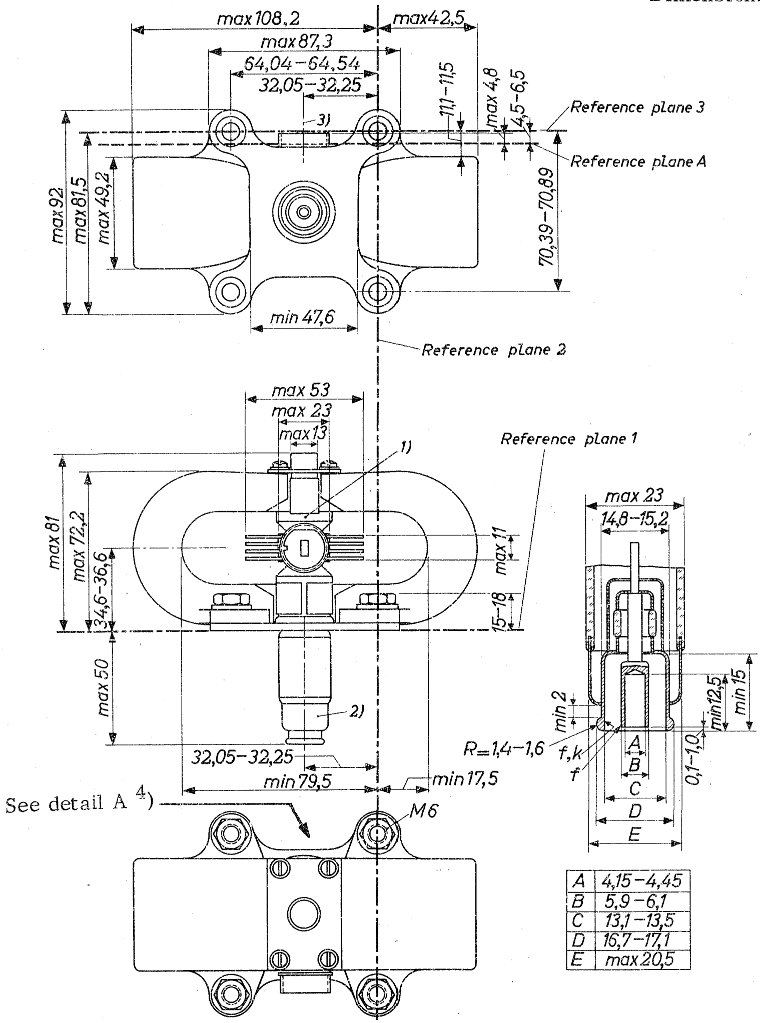
Mounting position	: any
Net mass	: 1,9 kg
Waveguide output system	: 153IEC – R320 = RG-96/U
Waveguide coupling system	: Z8 300 16

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



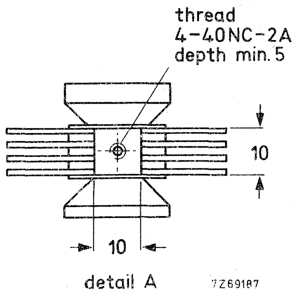
A	4,15−4,45
B	5,9−6,1
C	13,1−13,5
D	16,7−17,1
E	max 20,5

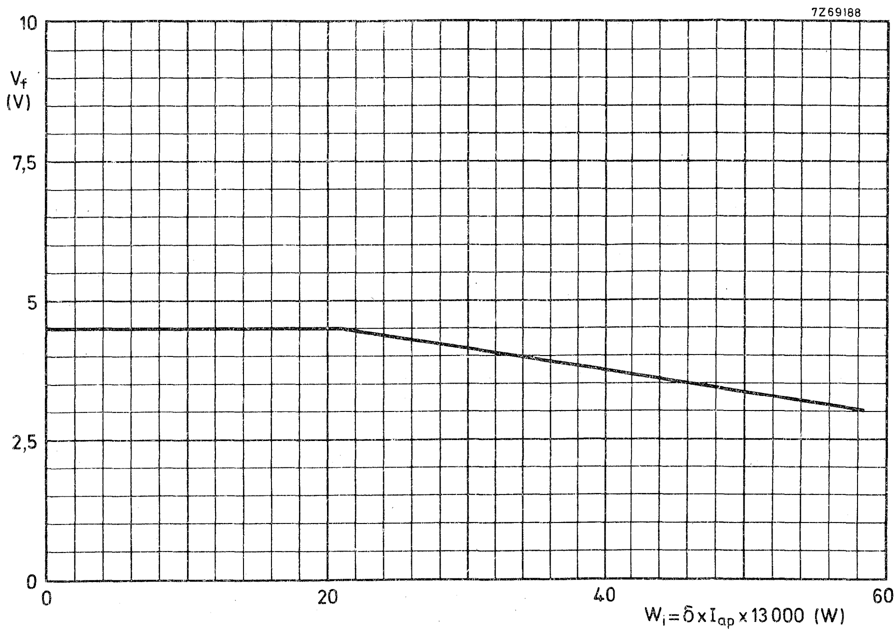
1) Inscription of serial number.

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:

$$V_f = 14,8\left(1 - \frac{I_a}{41,5}\right)\ \mathrm{V}$$ (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/^{o}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 ^{o}C
Closing temperature	approx. 100 ^{o}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_{fp}	max.	12	A
Anode current, peak [1]	I_{ap}	max.	27,5	A
		min.	15,0	A
Anode voltage, peak [1]	V_{ap}	max.	24	kV
Anode input power, mean	W_{ia}	max.	660	W
peak	W_{iap}	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.

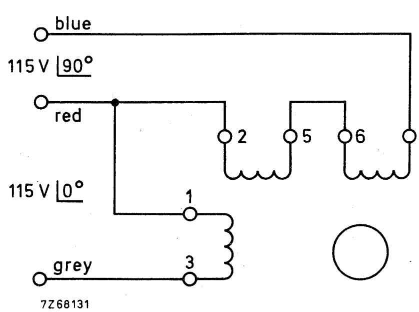
AGEING OF MAGNETRON

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 $^{\circ}$). 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 $^{\circ}$ 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).

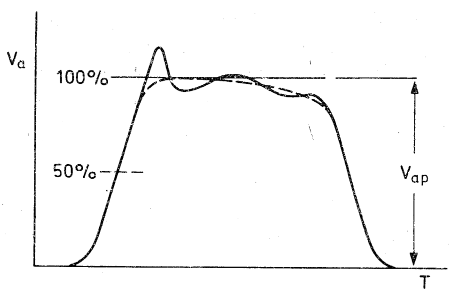


Fig. 1

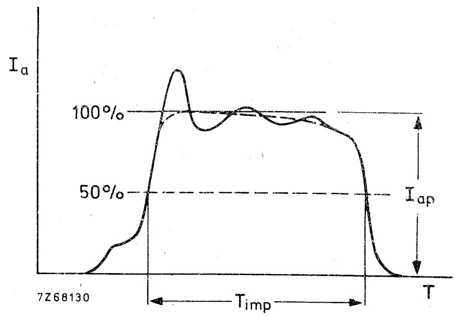


Fig. 2

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.

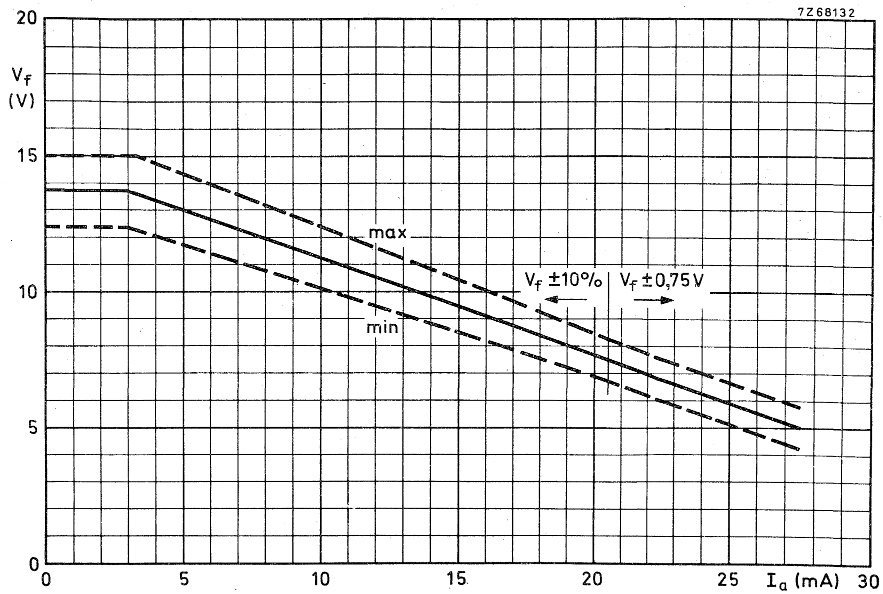
A dust-cover is placed on the output flange, to keep its opening closed until the tube is mounted into the equipment. Before putting the magnetron into operation, the user should make sure that the output waveguide and the recessed cathode terminal are entirely clean and free from dust and moisture.

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.

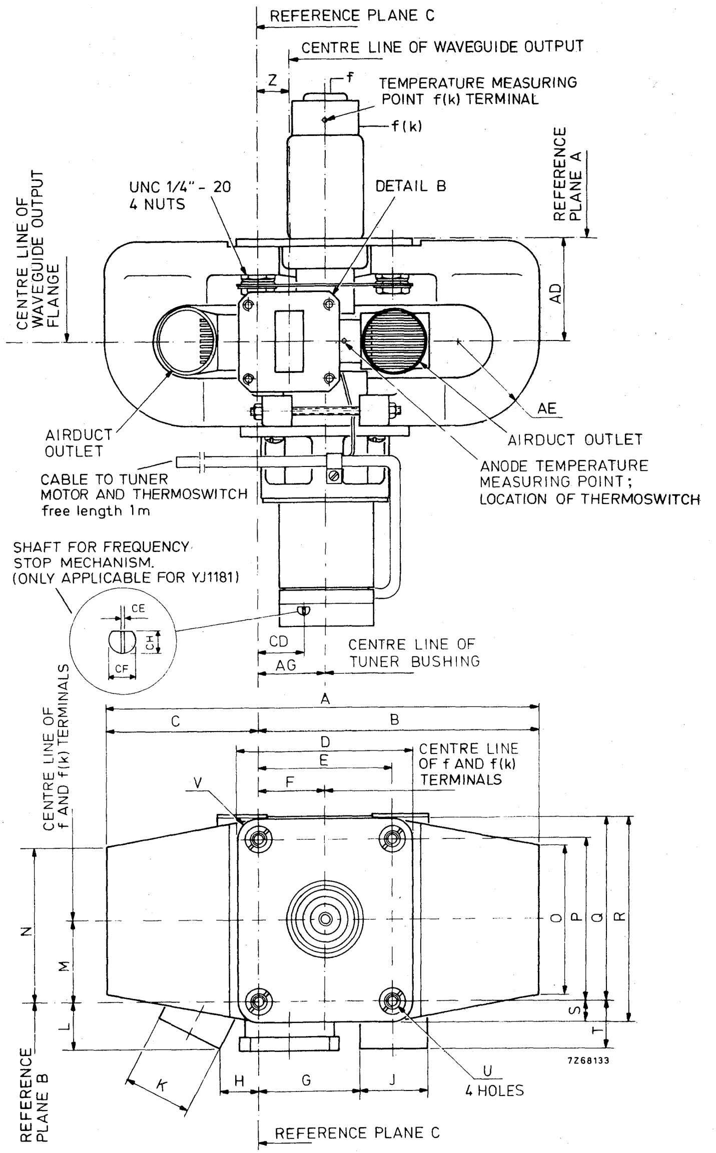
A connector with flexible supply leads should be used for the connection of heater and heater/cathode terminals.



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

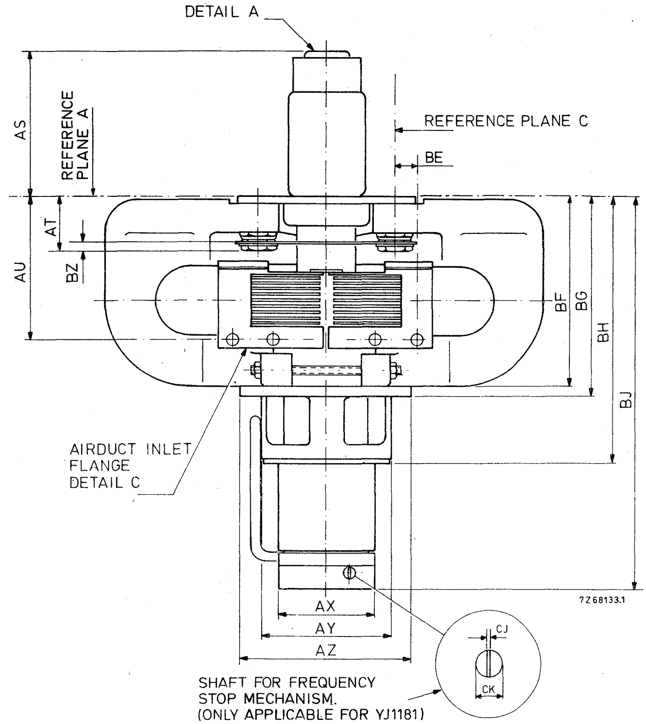
MECHANICAL DATA



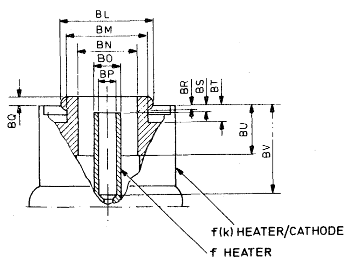
Front and top view

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

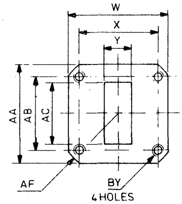
MECHANICAL DATA



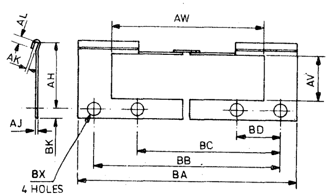
Side view



DETAIL A



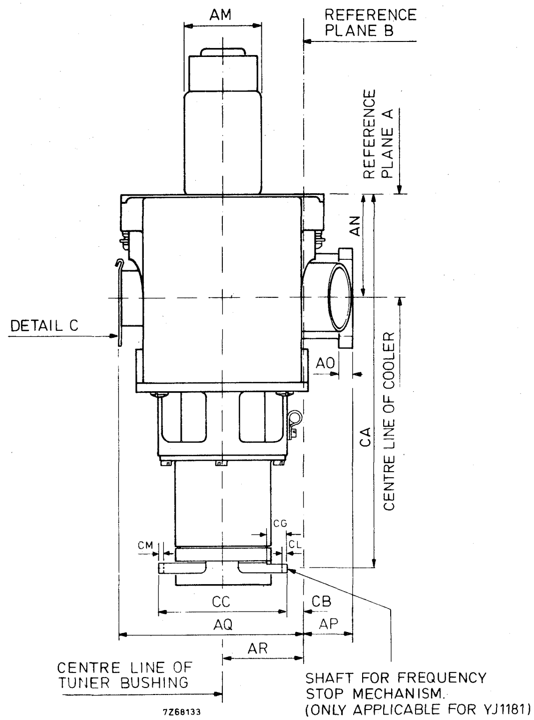
DETAIL B



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:

$$V_f = 12,6\,(1 - \frac{I_a}{10})\ \text{V}$$ (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. .

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. min.	1,0 0,1	μs 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. min.	17 10	A 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. min.	150 40	kV/μs kV/μs
for pulse duration > 0,15 μs	$\frac{dV_a}{dT}$	max. min.	130 40	kV/μs 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. min.	30 8	N/m^2abs N/m^2abs
Output pressurization	p	max. min.	30 10	N/m^2abs N/m^2abs

[1]) See "Pulse characteristics and definitions".
[2]) 1 N/cm^2 = 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.

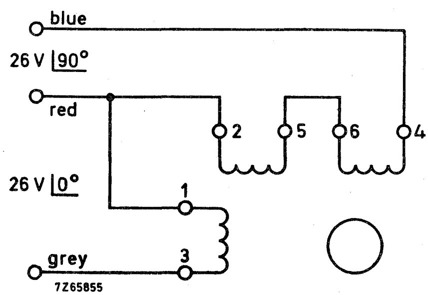
After this running-in schedule the magnetron can be put into use at the normal operating conditions.

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 ^{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 tuner motor normally only during oscillation conditions.



Two-phase, 400 Hz supply
90^{o} 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).

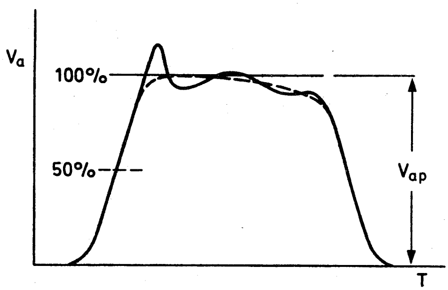


Fig. 1

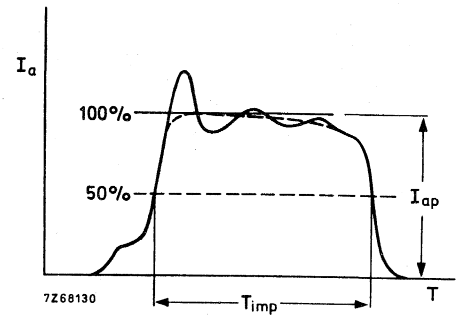


Fig. 2

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.

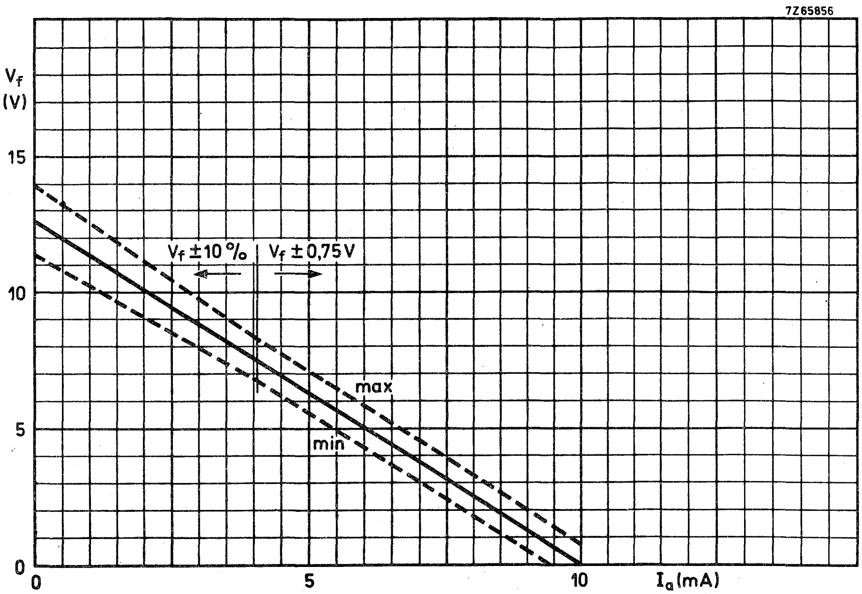
When handling and mounting the magnetron, a minimum distance of 5 cm (2 in) between the magnet and any piece of magnetic material should be maintained to avoid mechanical shocks to the magnetron. For this reason it is required to use non-magnetic tools during installation, such as non-magnetic stainless 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.

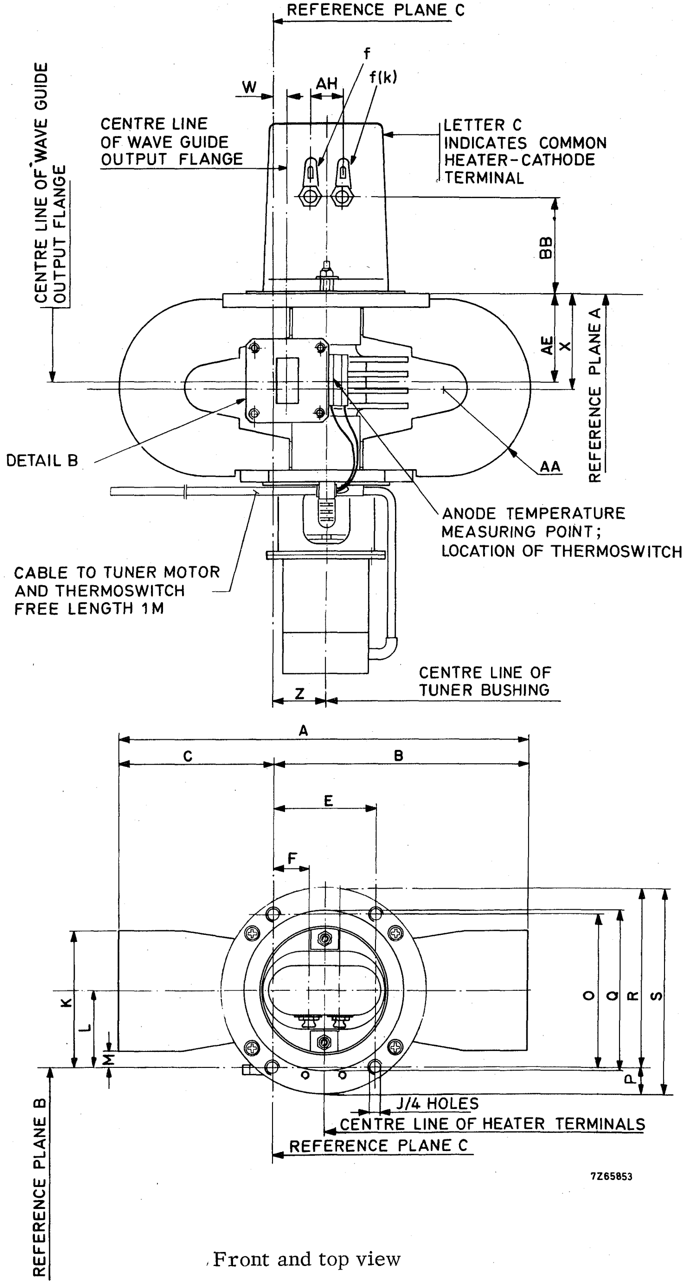
A connector with flexible supply leads should be used for the connection of heater and heater/cathode terminals.



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	

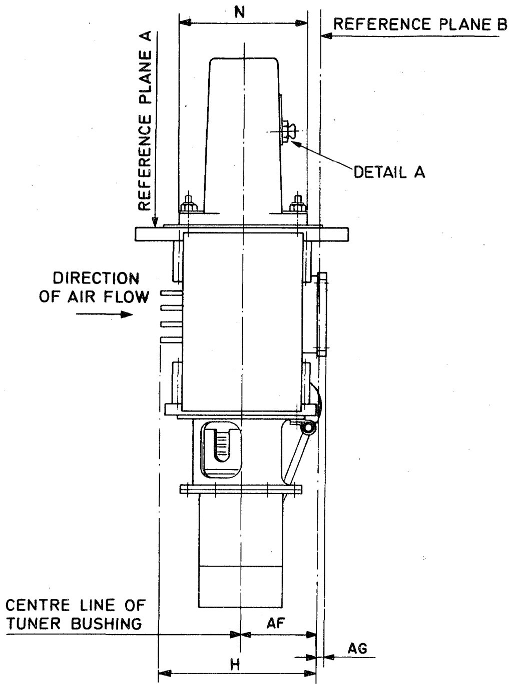
MECHANICAL DATA



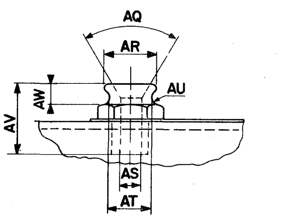
Front and top view

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	

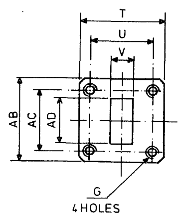
MECHANICAL DATA



Side view



DETAIL A
(FLYING LEADS ALSO AVAILABLE)

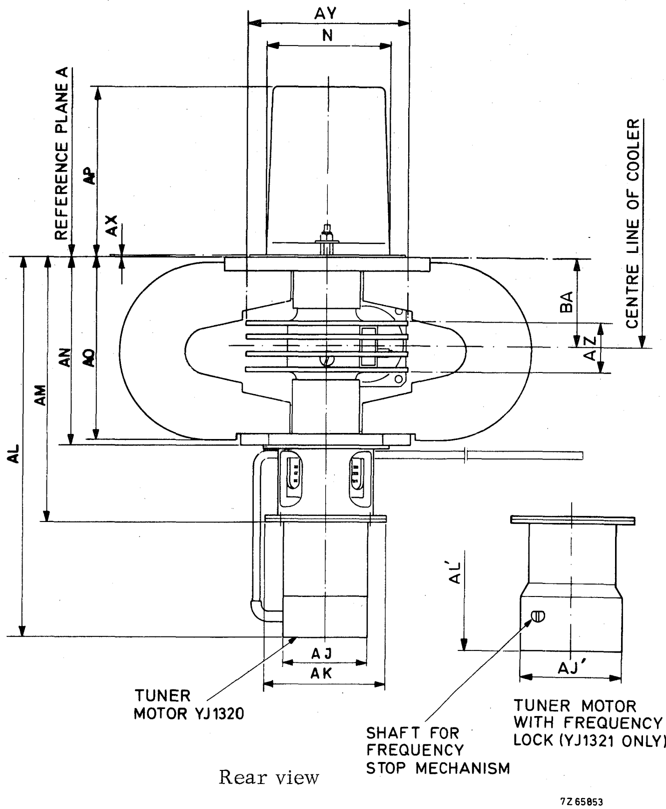


DETAIL B

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

Forced air-cooled unpackaged tunable magnetron for pulsed service.

QUICK REFERENCE DATA			
Frequency, tunable within the band	f	2,700 to 2,900	GHz
Peak output power	W_{op}	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:

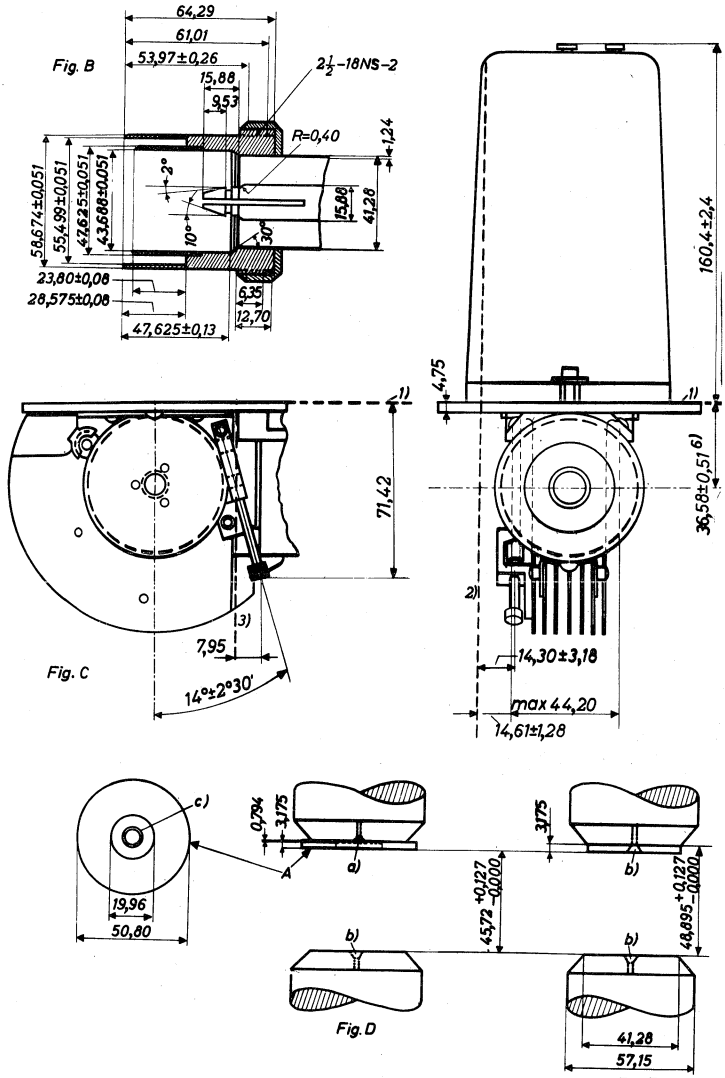
W_{i_a} (W)	V_f (V)
< 400	16
400 to 600	15
600 to 800	13
800 to 1000	10,5
1000 to 1200	8

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

MECHANICAL DATA

Dimensions in mm

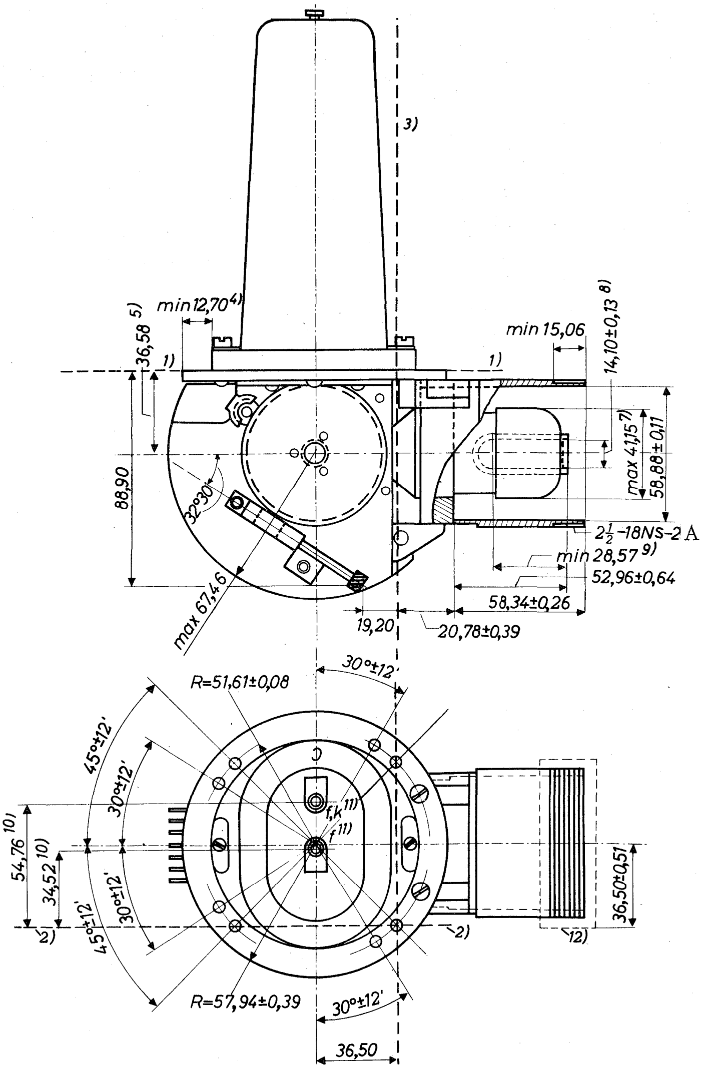
Net weight 2, 3 kg



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.

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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)

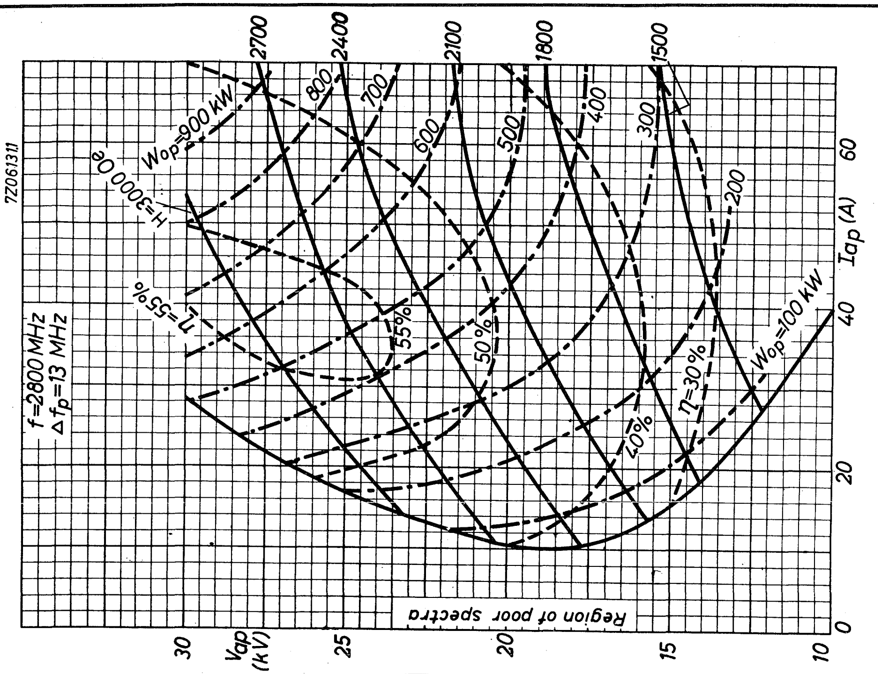
Pulse duration	T_{imp}	max.	2,5	μs
Duty factor	δ	max.	0,001	
Peak anode current	I_{ap}	max.	70	A
Mean anode input power	W_{ia}	max.	1200	W
Peak anode input power	W_{iap}	max.	2100	kW
Peak anode voltage	V_{ap}	max.	32	kV
Rate of rise of anode voltage	dVa/dT	max. min.	150 75	kV/μs [1] kV/μs [1]
Voltage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

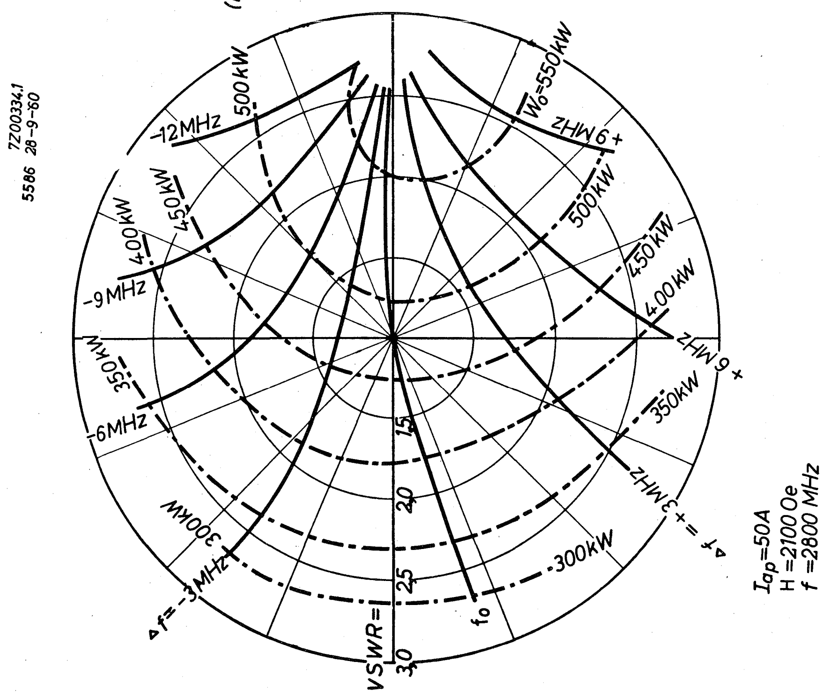
OPERATING CHARACTERISTICS

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
Region of poor spectra
Vap (kV)
30
25
20
15
10
Iap (A)
0
20
40
60


7Z00334.1
28-9-60
5586
500kW
-12MHz
450kW
400kW
-9MHz
350kW
-6MHz
300kW
Δf=-3MHz
Wo=550kW
+9MHz
500kW
450kW
400kW
+6MHz
350kW
Δf=+3MHz
300kW
f0
VSWR=
15
20
25
30
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	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
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 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.	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 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	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).

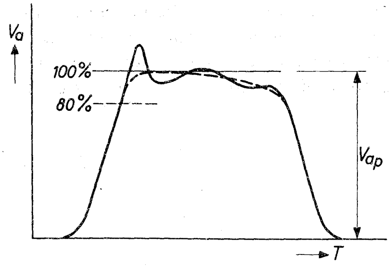


Fig. 1.

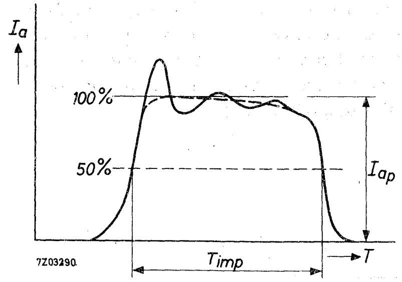


Fig. 2.

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

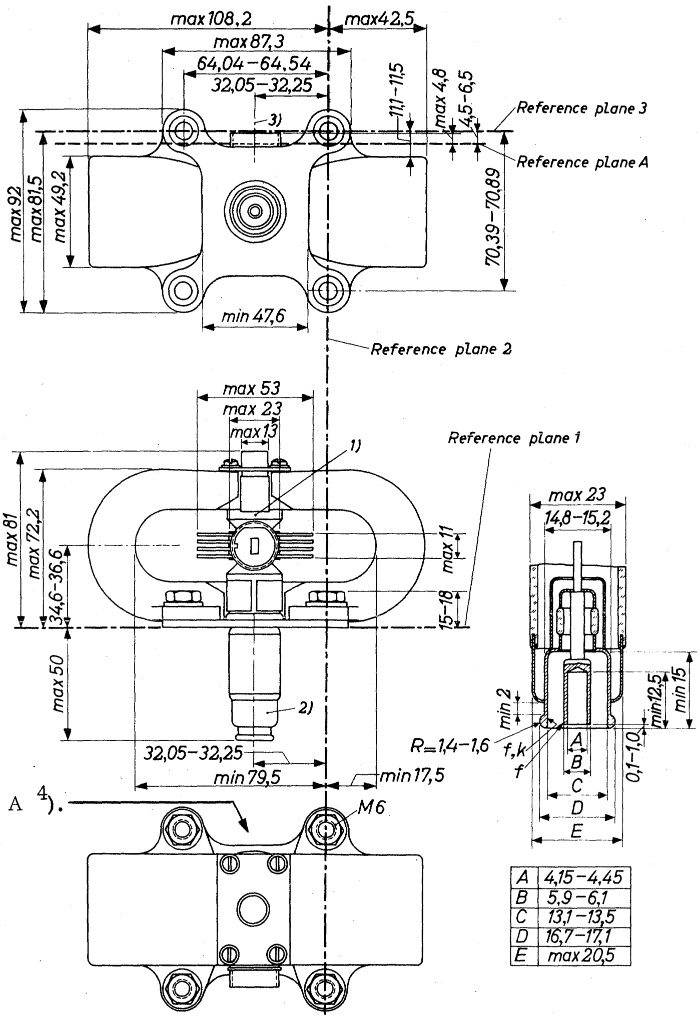
Waveguide coupling system : Z8 300 16

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].

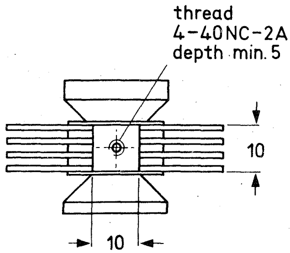
A	4,15–4,45
B	5,9–6,1
C	13,1–13,5
D	16,7–17,1
E	max 20,5

1) Inscription of serial number.

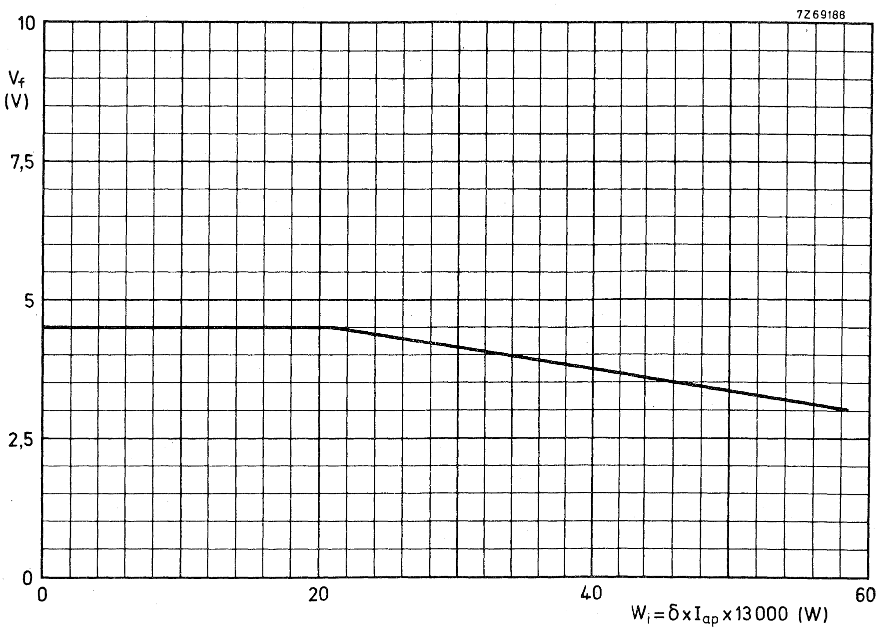
2) The axis of the common heater-cathode terminal is within a radius of 1,5 mm from the centre of the mounting plate. The eccentricity of the axis of the inner cylinder of the heater terminal with respect to the axis of the inner cylinder of the common heater-cathode terminal is max. 0,125 mm.

3) Centre of waveguide.

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



detail A 7Z69187



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	9405 to 9505	200	250
55030	9345 to 9405		
55031/02	9260 to 9345		
55031/01	9168 to 9260		
55032/02	9085 to 9168		
55032/01	9003 to 9085		
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

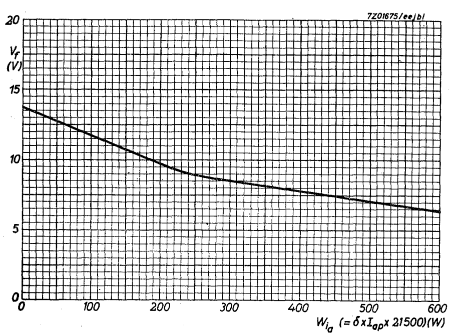
Peak anode voltage	V_{a_p}	20 to 23	kV
Pulling figure (VSWR = 1.5)	Δf_p	13	MHz
		< 17,5	MHz
Pushing figure	$\frac{\Delta f}{\Delta I_{a_p}}$	< 0,25	MHz/A
Temperature coefficient	$\frac{\Delta f}{\Delta t}$	< -0,25	MHz/°C
Anode to cathode capacitance	C_{ak}	14	pF

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/cm²
			45	lbs/sq in abs.

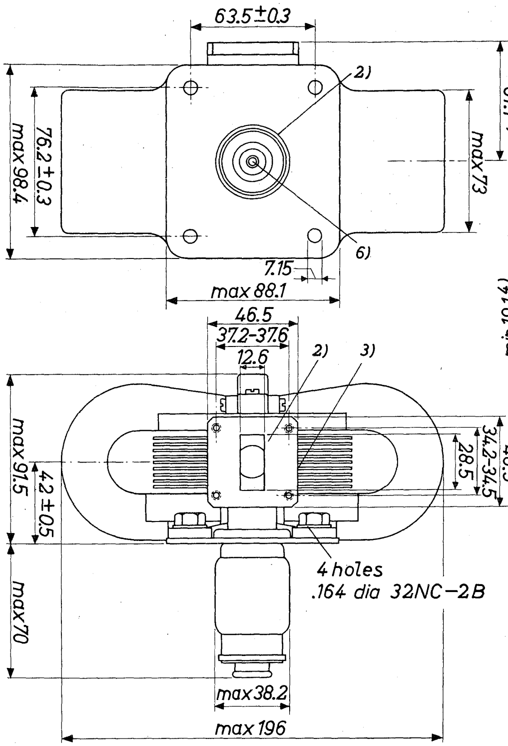
Operation at pressures lower than 60 cm Hg may result in arc-over across the heater-cathode stem with consequent damage to the magnetron. The output assembly must always be pressurized. When the magnetron is not working into a matched load, the pressure on th the output window must be higher than 1 kg/cm^2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

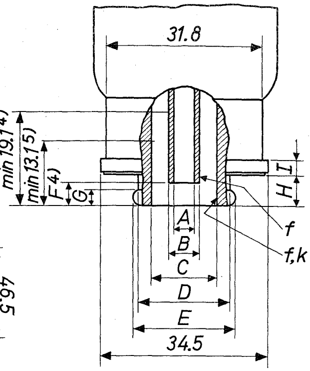


MECHANICAL DATA

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.

[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).

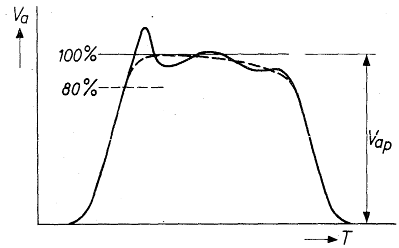


Fig. 1

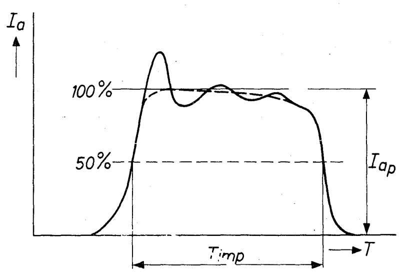


Fig.2

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 microwave heating

Available for equipment maintenance. No longer recommended for equipment production.

Abridged data

CONTINUOUS-WAVE MAGNETRON

Continuous-wave water-cooled packaged magnetron intended for microwave heating applications.

QUICK REFERENCE DATA

Frequency, fixed with the band	f	2,425 to 2,475 GHz
Output power	W_o	2,0 to 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. See also page 5.

Heater voltage, starting	V_f		5 V $^{+5\%}_{-10\%}$
Heater voltage, stand-by	V_f		4,8 V $^{+5\%}_{-10\%}$
Heater current at V_f = 5 V	I_f	≈ <</br>	35 A 38 A
Heater current, peak starting	I_{fp}	max	100 A
Cold heater resistance	R_{fo}	≈	20 mΩ
Waiting time (time before application of high voltage at V_f = 5 V	T_w	min	120 s

TYPICAL CHARACTERISTICS measured under matched load conditions (VSWR ⩽ 1,05) and a d.c. power supply

Frequency, fixed within the band	f	2,425 to 2,475 MHz
Anode voltage at I_a = 750 mA	V_a	4,45 to 4,85 kV

LIMITING VALUES AND OPERATING CHARACTERISTICS

Anode voltage obtained from a single-phase full-wave, or three-phase half-wave, rectifier without smoothing filter.

A. OPERATION WITH W_o = 2 kW

LIMITING VALUES (Absolute maximum rating system)

Anode current, mean	I_a	max min	0,8 A 0,1 A
Anode current, peak	I_{ap}	max	2,1 A
Voltage standing wave ratio at 0,37 λ < d < 0,44 λ	VSWR	max	4
remaining region	VSWR	max	5

TYPICAL OPERATION (into a matched load)

Heater voltage, running	V_f		2	V
Anode current, mean	I_a		0,75	A
Anode current, peak	I_a		2	A
Anode voltage (measured with d.c.)	V_a		4,75	kV
Output power	W_o		2	kW
		>	1,85	kW
Efficiency	η		55	%

B. OPERATION WITH W_o = 2,5 kW

A fixed reflection element with a VSWR of 1,5 and a phase position of 0,41 λ should be inserted between magnetron and load.

LIMITING VALUES (Absolute maximum rating system)

Anode current	I_a	max	0,9	A
		min	1,1	A
Anode current, peak	I_{ap}	max	2,1	A
Voltage standing wave ratio at 0,37 λ < d < 0,44 λ	VSWR	max	2,5	
remaining region	VSWR	max	4	

TYPICAL OPERATION (into a matched load) *

Heater voltage, running	V_f		1,5	V
Anode current, mean	I_a		0,85	A
Anode current, peak	I_{ap}		2	A
Anode voltage (measured with d.c.)	V_a		4,8	kV
Output power	W_o		2,5	kW
		>	2,3	kW
Efficiency	η	≈	60	%

C. OPERATION WITH W_o = 2,5 kW FOR MICROWAVE OVENS

The average VSWR should be 3 at d = 0,41 λ.

LIMITING VALUES (Absolute maximum rating system)

Anode current, mean	I_a	max	0,85	A
		min	0,1	A
Anode current, peak	I_{ap}	max	2,1	A
Voltage standing wave ratio at 0,3 λ < d < 0,5 λ	VSWR	max	4	
intermittent (T = max 0,02 s and max 20% of the time)	VSWR	max	10	**
remaining region	VSWR	max	4	

* With respect to reference plane B of fixed reflection element.

** The average reflected power for any one-second period must not exceed the reflected power equivalent to a VSWR of 4. When operating under these conditions, the tube should not be permitted to mode.

TYPICAL OPERATION

Heater voltage, running	V_f		1,8 V
Anode current, mean	I_a		0,8 A
Anode current, peak	I_{ap}		2 A
Anode voltage	V_a		4,95 kV
Voltage standing wave ratio at $0,3\,\lambda < d < 0,5\,\lambda$	VSWR		3
Output power	W_o		2,5 kW
		>	2,3 kW
Efficiency	η	≈	60 %

COOLING

Anode block	water
Required quantity of water	see cooling curve
Cathode radiator, via air duct	low-velocity air flow $> 0,2\ m^3/min$

TEMPERATURE LIMITS (Absolute maximum rating system)

Anode temperature at reference point for temperature measurement	t_a	max	125 °C
Cathode radiator temperature	t	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 ° at the mounting plate.

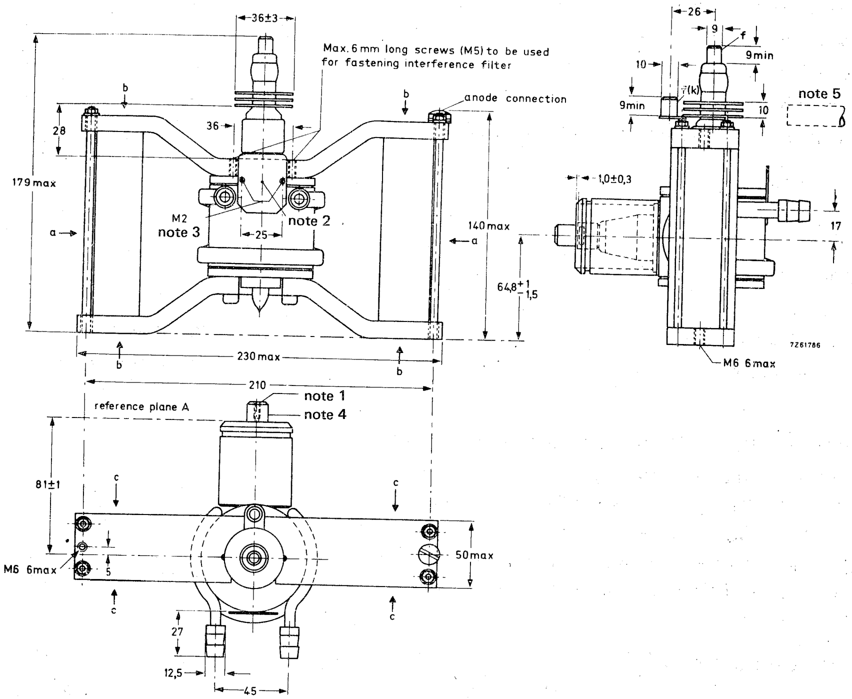
MECHANICAL DATA Dimensions in mm

Net mass: ≈ 4,7 kg

Mounting position: any

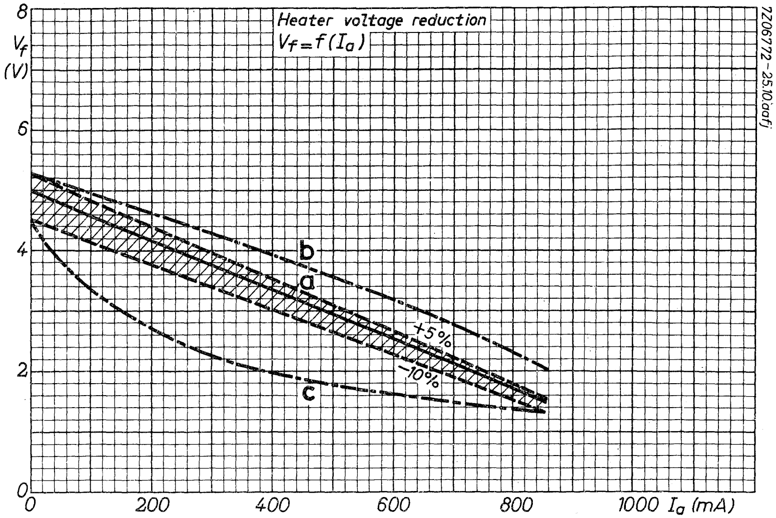
ACCESSORIES

Cap nut	type	55312
Spring ring	type	55313
Heater connector	type	40634
Heater/cathode connector	type	40649



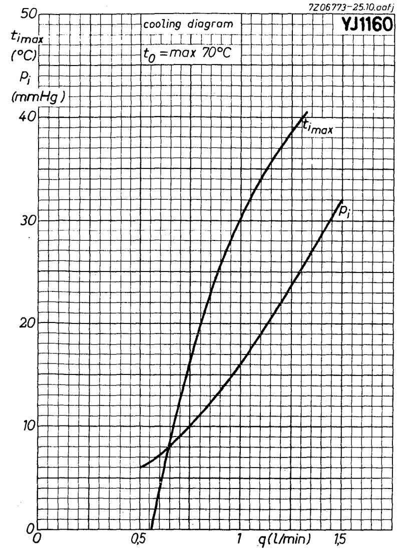
Notes

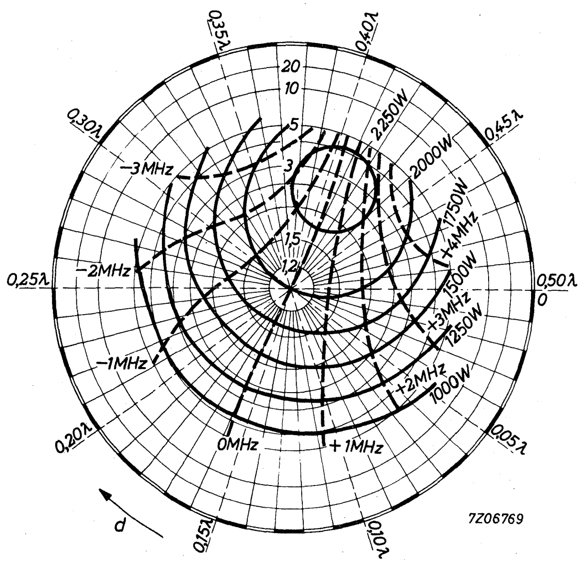
1. Axial hole for short antenna: M4, depth 9 mm minimum.
2. Reference point for temperature measurements.
3. Mounting holes for thermoswitch.
4. Eccentricity of inner conductor with respect to the outer conductor max 0,4 mm.
5. Non-metallic air duct, inner diameter 13 mm.



Immediately after applying the anode voltage the heater voltage must be reduced as a function of the anode current according to the diagram above. 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 the equipment has been designed 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 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 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.



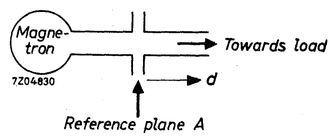


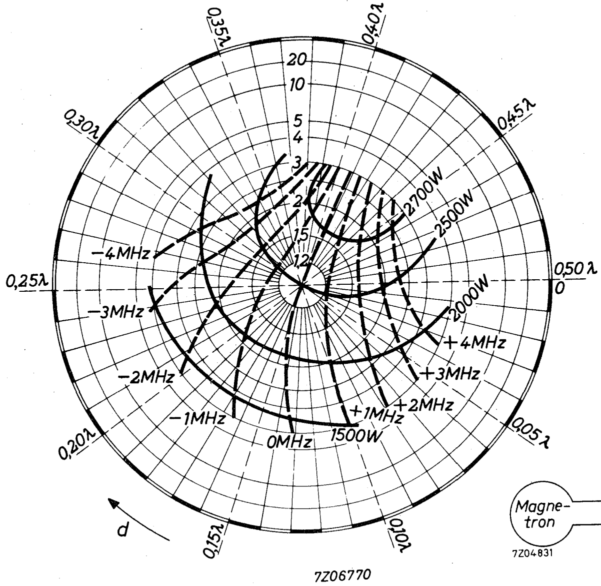
Load diagram Operation A

Mean anode current 0,75 A
Peak anode current 2 A

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

Temperature at reference point 85 °C



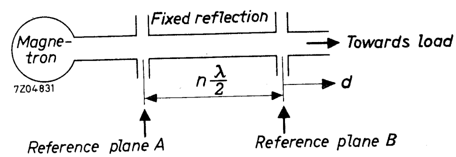


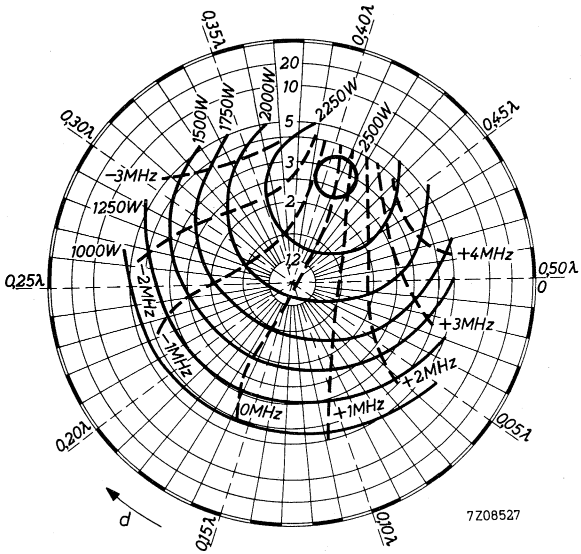
Load diagram Operation B

Mean anode current 0,85 A
Peak anode current 2 A
Fixed reflection VSWR = 1,5
d = 0,41 λ

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

Temperature at reference point 85 °C



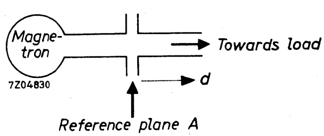


Load diagram Operation C

Mean anode current 0,8 A
Peak anode current 2 A

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

Temperature at reference point 85 °C



Available for equipment maintenance. No longer recommended for equipment production.
Abridged data

CONTINUOUS-WAVE MAGNETRON

Continuous-wave air-cooled packaged magnetron intended for microwave heating applications.

QUICK REFERENCE DATA

Frequency, fixed within the band	f	2,425 to 2,475 GHz
Output power	W_o	2,0 or 2,5 kW
Construction	packaged	
Anode supply	unfiltered single-phase full-wave, or three-phase half-wave rectified	

CATHODE

HEATING

TYPICAL CHARACTERISTICS

LIMITING VALUES AND OPERATING CONDITIONS

TEMPERATURE LIMITS

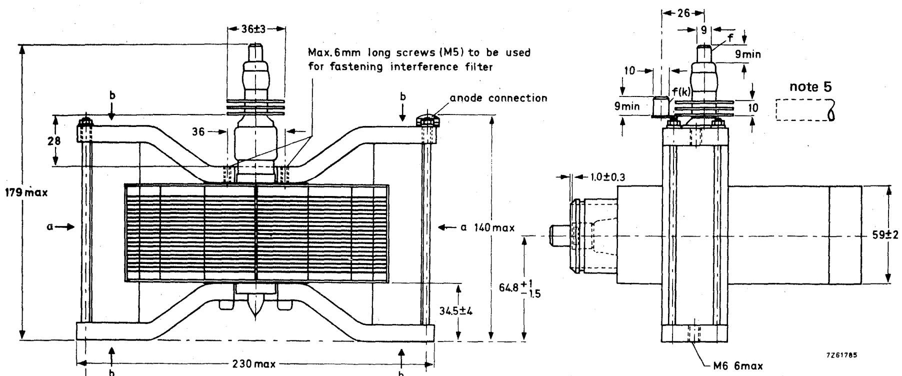
See YJ1160

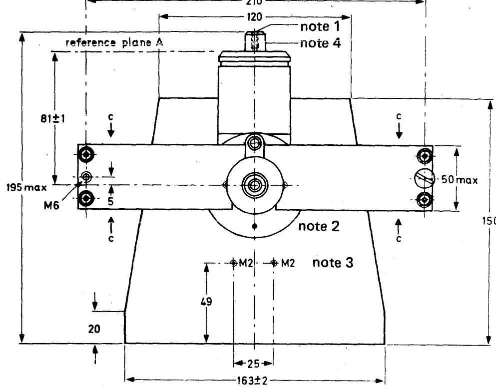
COOLING

Anode block	forced air
Required quantity of air	see cooling curve
Cathode radiator, via air duct	low-velocity air flow (> 0,2 m^3/min)

MECHANICAL DATA

Dimensions in mm





1. Axial hole for short antenna: M4, depth ⩾ 9 mm.
2. Reference point for temperature measurements.
3. Mounting holes for thermoswitch.
4. Eccentricity of inner conductor with respect to the outer conductor max 0,4 mm.
5. Non-metallic air duct, inner diameter 13 mm.

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

Packaged, water-cooled continuous-wave magnetron with integral R.F. filter, intended for industrial microwave heating applications. The tube features a quick-heating cathode, high efficiency, and has a typical 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		
Cooling	water and air		
R.F. filter	integral		

Blue Binder, Tab 9

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	three-phase full-wave rect.		
Anode current, mean	I_a	1,25	A
peak	I_{ap}	1,5	A
Load impedance			
Voltage standing wave ratio	VSWR	1,5	
Phase, in direction of load, with respect to reference plane	d	0,42	λ
Cooling	see pertinent paragraph		

Performance

Filament current at V_f= 1,0V	I_f	5	A
Anode voltage, mean	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 11 and 12 and "Design and operating notes".

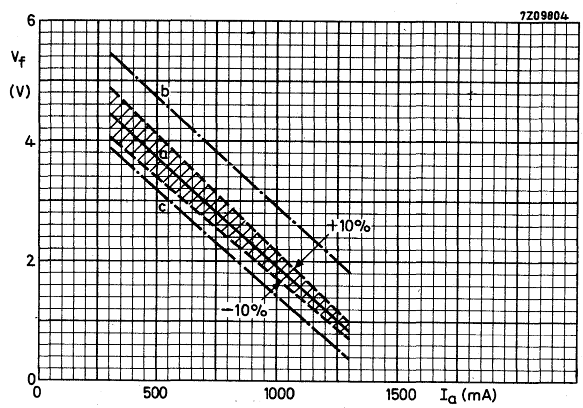
CATHODE : thoriated tungsten

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

With 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		44 48	A A
at V_f = 1,0 V; I_a mean = 1,25 A	I_f		5	A
Filament starting current, peak	I_{fp}	max.	150	A
Cold filament resistance	R_{fo}		17	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 stepped, 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 three-phase full-wave rectified supply. (See "Design and operating notes".)

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

LIMITING VALUES (Absolute max. rating system)

Anode current, mean	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
Cooling water outlet temperature, closed cooling circuit	t_o	max.	75	°C
open cooling circuit	t_o	max.	65	°C
Voltage standing wave ratio	VSWR	max.	2,5	

COOLING

Anode block	water			
Minimum required rate of flow and pressure drop	see curves page 10			
R.F. filter box	air			
Required rate of flow at room temperature	q	min.	60	ℓ/min.
Pressure drop	see curve page 10			
R.F. output system	air			
Required rate of flow at room temperature	q	min.	100	ℓ/min.

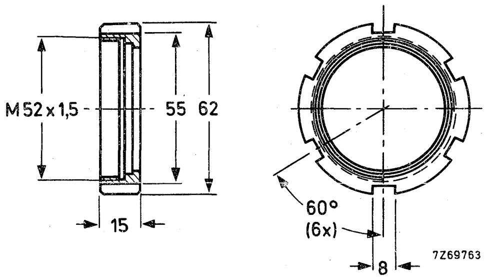
With only the filament voltage applied some water and air cooling is required.

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

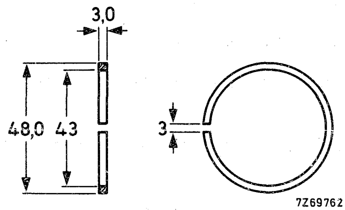
The R.F. output system of the magnetron is provided with air inlet and outlet holes for the application of at least 100 ℓ/min of cooling air to the ceramic part inside the outer conductor. For an example of a cooling device around the output system see "Output coupling". All inlet holes must be used for entrance of air to obtain the required uniform cooling.
The cooling air must be filtered to be free from dust, water and oil.

ACCESSORIES

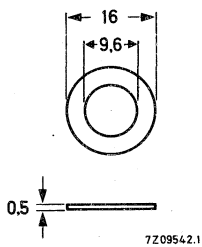
Cap nut for output coupling	type 55312	
Spring ring	type 55313	
Soft copper washer, supplied with tube	type 55328	
Cap nut	type TE1051b	
Hose nipple	type TE1051c	
→ Recommended isolator	2722 163 02004	Dimensions in mm



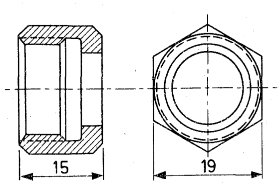
Cap nut type 55312



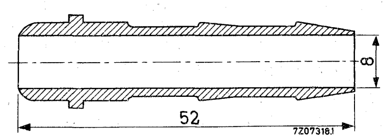
Spring ring type 55313



Washer type 55328



Cap nut type TE1051b (thread 3/8 in 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 may be operated from a three-phase full-wave rectified supply unit. This unit should be so designed that no limiting value for the mean and peak anode currents is exceeded, whatever the operating conditions. The use of a current regulating and limiting device is recommended.

Filament supply

The secondary of the filament transformer must be well insulated from the primary since in normal magnetron operation the 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.

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.
When using the coaxial-to-R26 waveguide transition shown on page 8 this condition is automatically reached, provided antenna type B is used. Antenna type A, together with the above transition, gives a VSWR of about 1 (matched). Detailed construction drawings available on request.

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 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 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

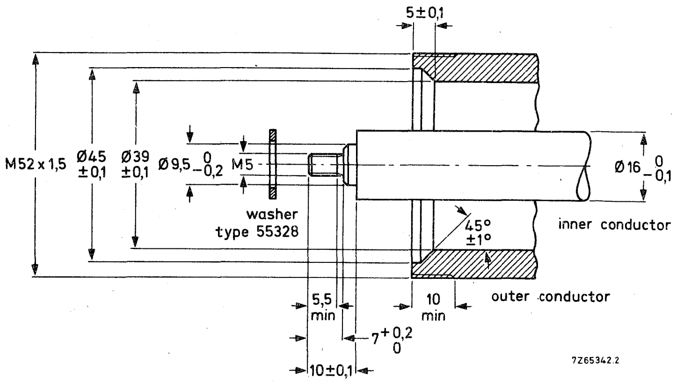
When magnetic materials are present in two or more planes, their minimum distance from the magnet shall be 13 cm in all directions.

All tools (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 circuit of the magnetic flux.

To prevent mechanical stresses and torques, the output coupling should not be used as the only means of mounting; an additional flexible support of the tube is necessary.

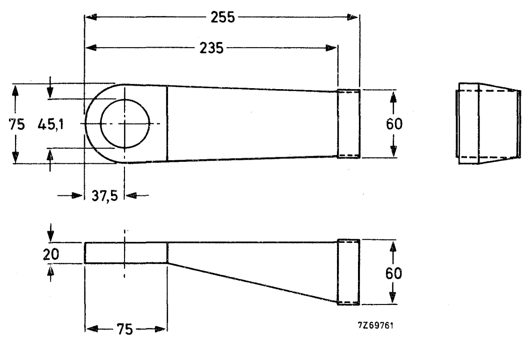
OUTPUT COUPLING

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



Example of a cooling device for output system (not supplied by the manufacturer)

Material: non-magnetic



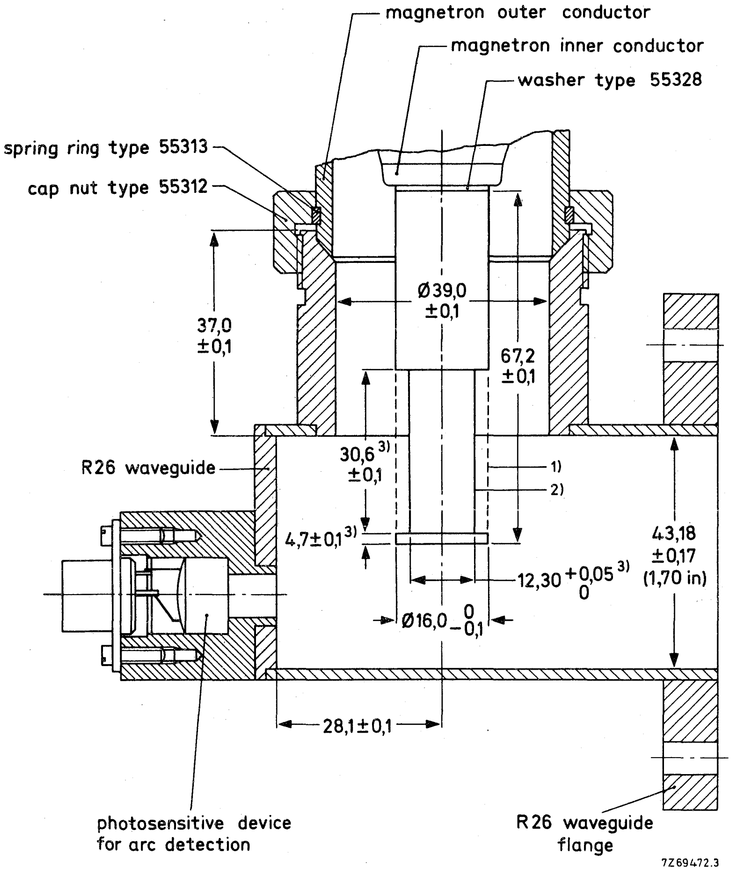
Pressure drop at 100 ℓ/min:
- about 600 Pa (≈ 60 mm H_2O) with air outlet via outlet holes;
- about 300 Pa (≈ 30 mm H_2O) if air can also escape towards the load through coaxial line.

---

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. A firm contact between antenna and inner conductor of tube must be assured.
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 a coaxial to an R26 waveguide transition is shown below.



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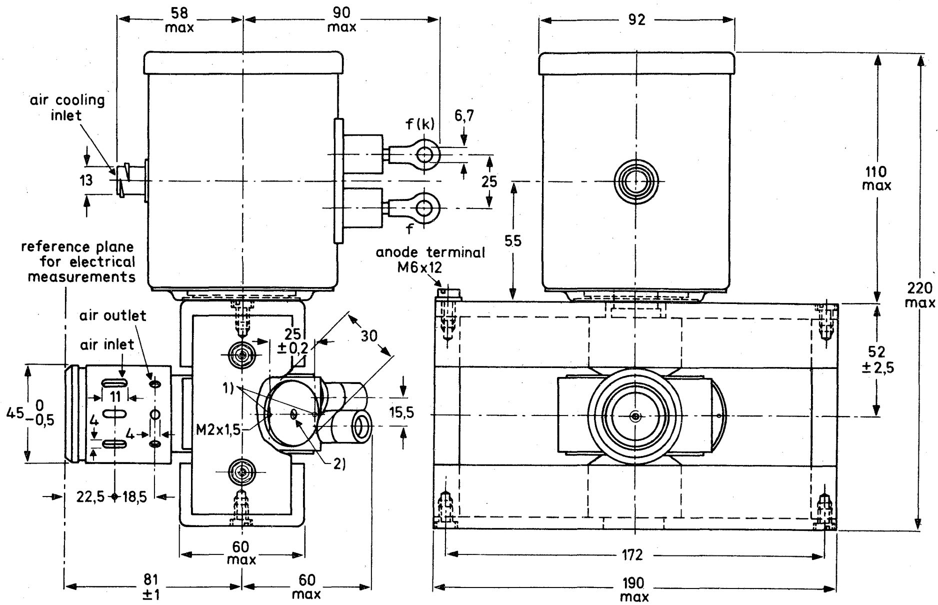
1) Antenna type A (cylindrical) for matched load.

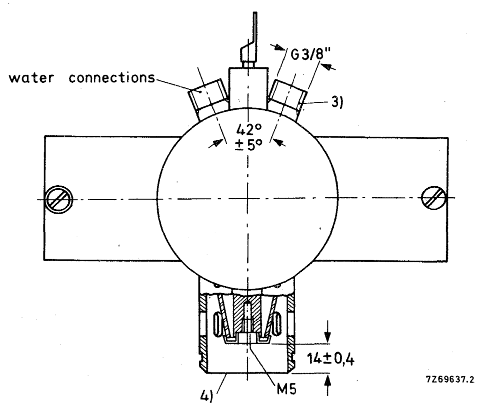
2) Antenna type B. VSWR ≈1,5 in direction of sink for matched waveguide load.

3) These dimensions for antenna type B only.

MECHANICAL DATA

Dimensions in mm





Mounting position: any

Net mass : approx. 4,7 kg

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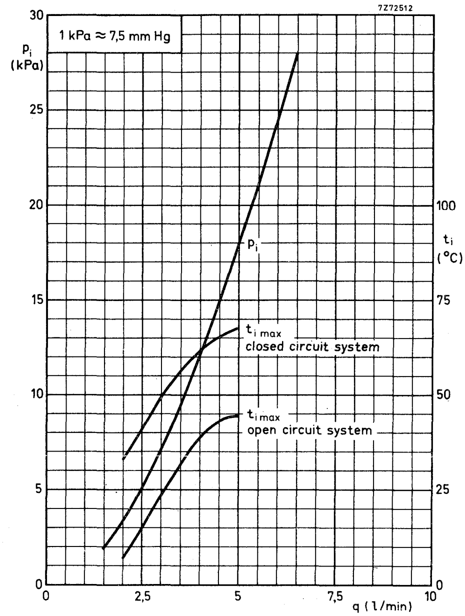
1) Two M2 screws for mounting a thermoswitch are supplied with the magnetron.

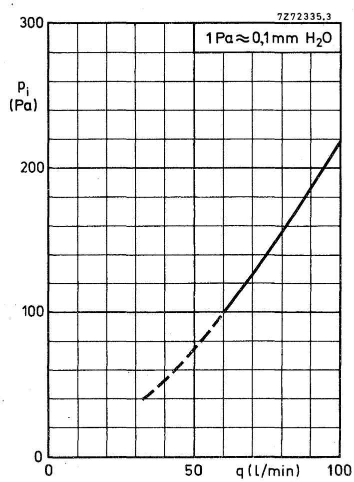
2) Plate for mounting a thermoswitch; temperature reference point.

3) To be connected to hose nipple type TE 1051c (DIN 44415) for 9 mm hose with cap nut type TE 1051b (CR3/8 in DIN 8542 Ms).

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

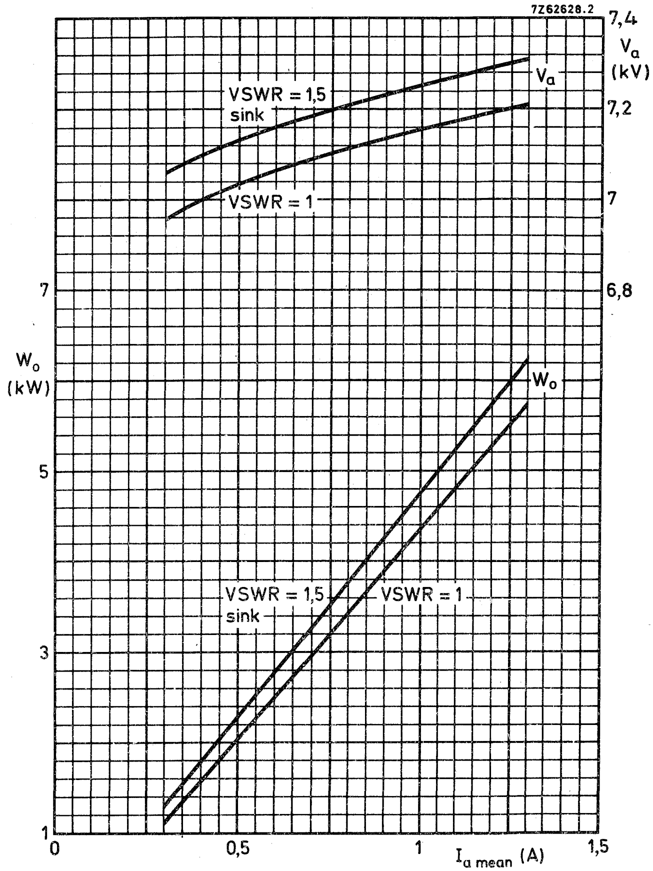


Minimum required quantity of water q, and pressure drop p_i as a function of water inlet temperature t_i. Water supplied via hose nipple TE1051c.
When additional information is required please contact the manufacturer.

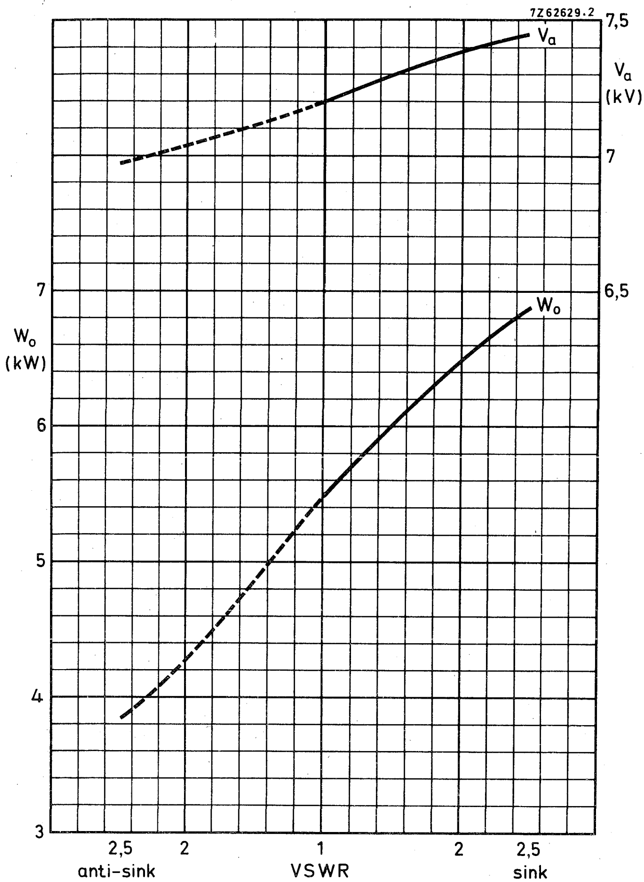


Pressure drop as a function of airflow through filter box.

1 kPa ≈ 7, 5 mm Hg.

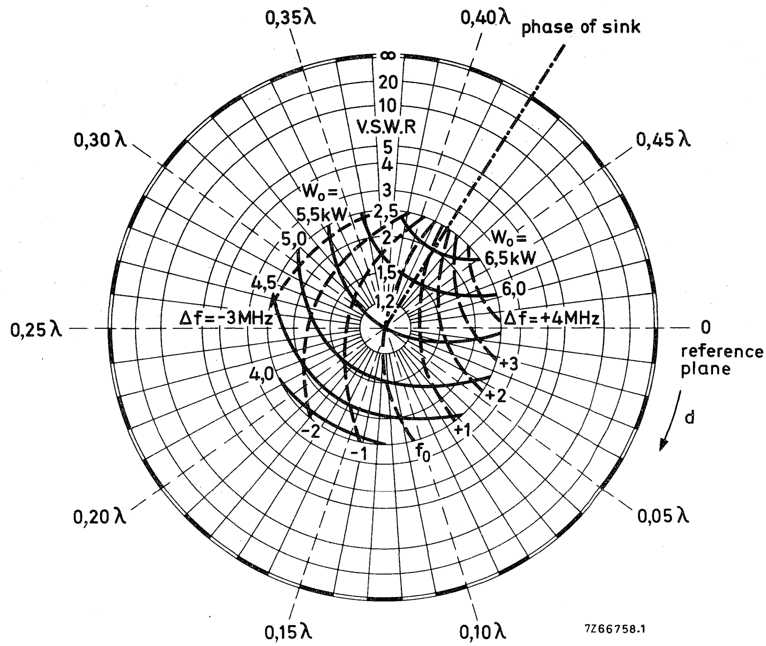


Output power and anode voltage as a function of anode current.



$V_f = 1,0$ V
I_a mean = 1, 25 A

Output power and anode voltage as a function of load impedance.



Load diagram

Anode supply	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

Packaged, water-cooled continuous-wave magnetron with integral r.f. filter, intended for industrial microwave heating applications. The tube features a quick-heating cathode, high efficiency, and has a typical output power of 6 kW.

QUICK REFERENCE DATA

Frequency, fixed within the band	f	2,350 to 2,400 GHz
Output power	W_o	6 kW
Construction		packaged, metal-ceramic
Cathode		quick-heating
Cooling		water and air
R.F. filter		integral

The YJ1194 is equivalent to the YJ1193, except for the frequency band, being 2,350 to 2,400 GHz.

Recommended isolator 2722 163 02024

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_{fp}	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_{ap}	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	100	Pa *

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.

Mass

Net mass	approx.	2,4	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

*) 1 Pa ≈ 0,1 mm H_2O.

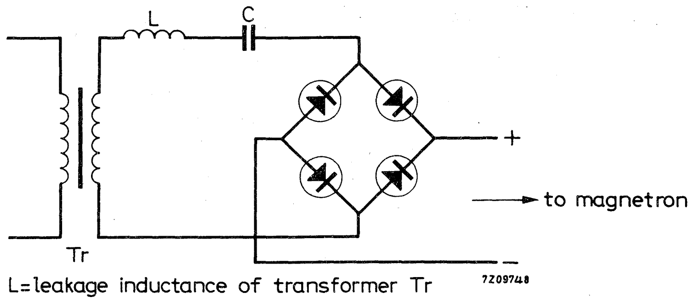
DESIGN AND OPERATING NOTES

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

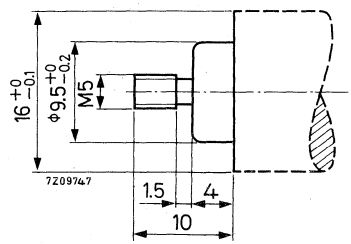
The magnetron has a high filament current and losses in filament voltage caused by bad connections, will result in poor operation. Therefore, it is important to ensure that the filament and filament/cathode connectors make good electrical and thermal contact with their respective terminals.
The connectors,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

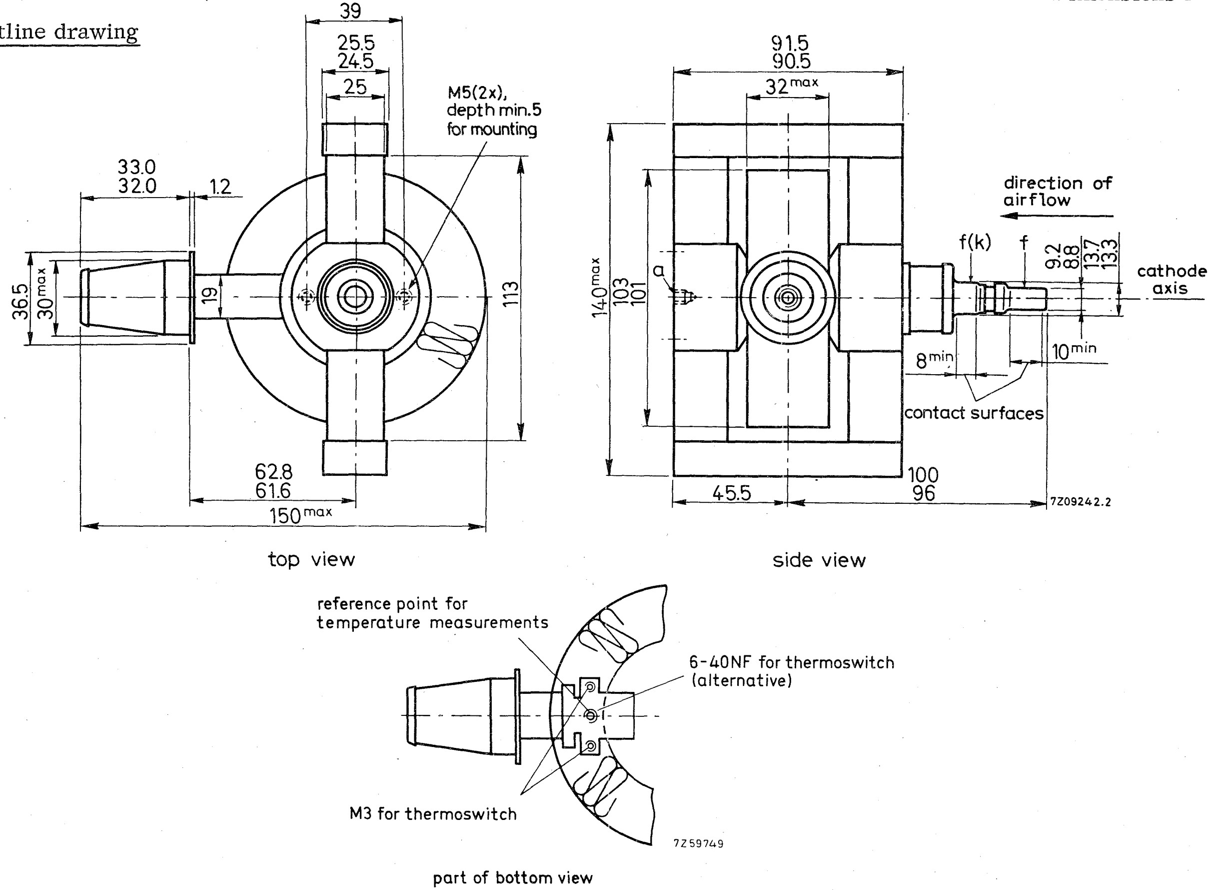
When magnetic materials are present in two or more planes, the minimum distance from the magnet shall be 13 cm in all directions.

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)

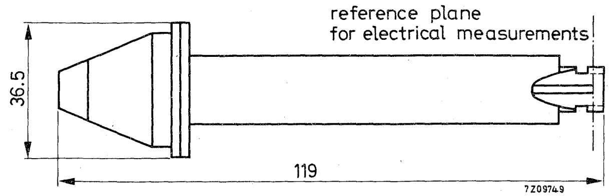
Outline drawing

Dimensions in mm

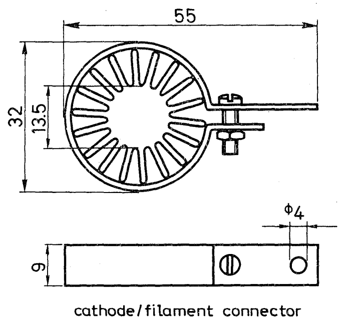


ACCESSORIES

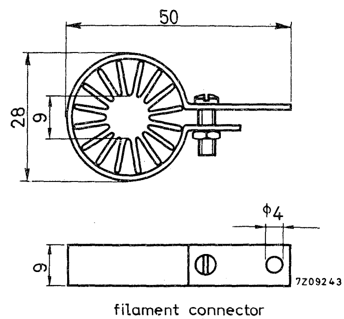
Dimensions in mm



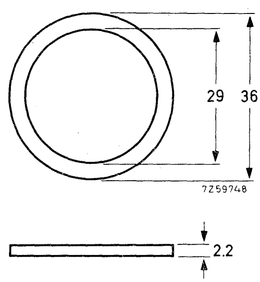
Measuring probe 55336



Filament/cathode connector 55324

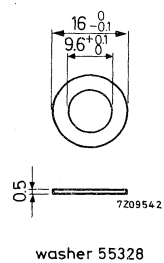


Filament connector 55323



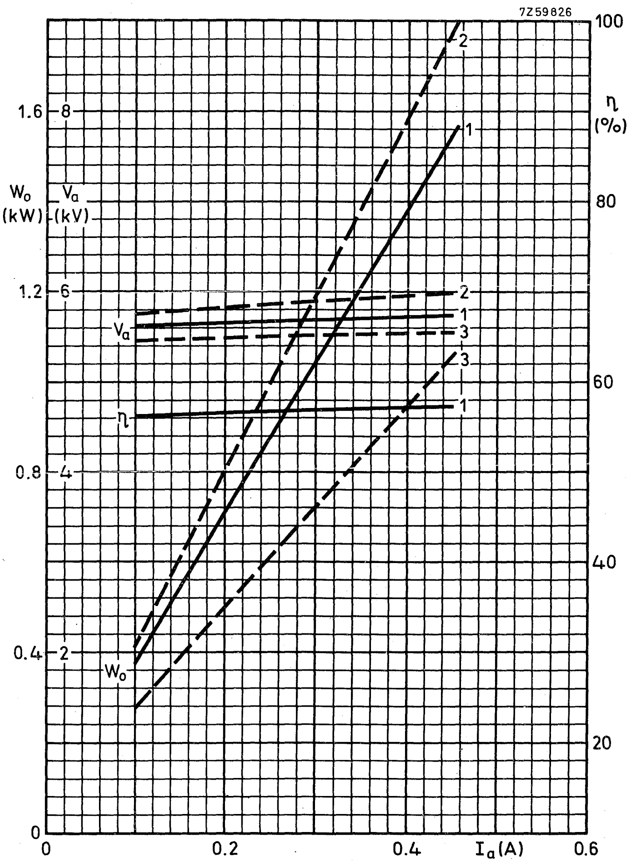
Material : monel mesh

R. F. gasket 55341

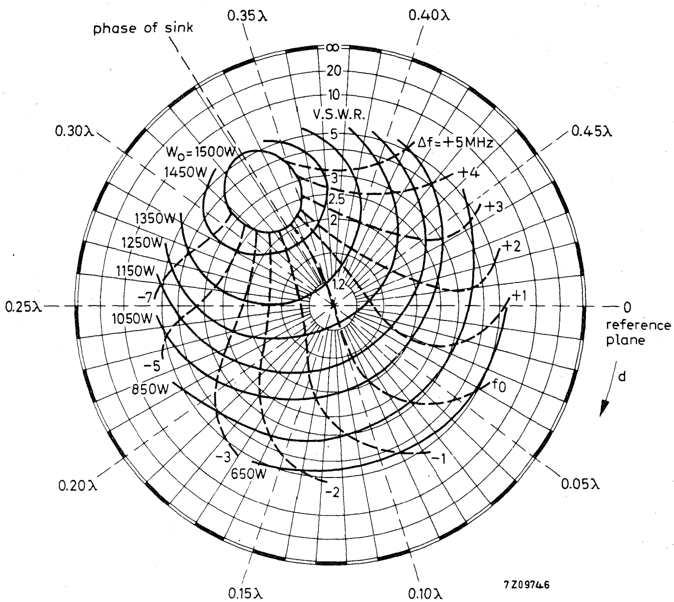


Material : soft copper

Washer 55328



1) with V.S.W.R. ≤ 1.05
2) with V.S.W.R. = 3 in sink region
3) with V.S.W.R. = 3 in anti sink region



Load diagram

Mean anode current 380 mA
Frequency f_0 2.450 GHz
Constant air cooling
d = distance of voltage standing wave minimum from the reference plane for electrical measurements (measuring probe 55336) towards load

CONTINUOUS-WAVE MAGNETRON

Integral-magnet, forced-air cooled continuous-wave magnetron with integral R.F. filter intended for microwave heating applications. The tube features a quick heating cathode, high efficiency, and has a typical output power of 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		
R.F. filter	integral		

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		
Anode current, mean	I_a		680	mA
peak	I_{ap}		1100	mA
Load impedance, measured with probe 55345				
Voltage standing wave ratio	VSWR		2,5	
Phase, in direction of load, with respect to reference plane	d		0,14	λ
Cooling; rate of flow	q	min.	2,5	m^3/min [1]
		see also pertinent paragraph		

Performance

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

[1]) Based on a cooling air inlet temperature t_i = max. 50 °C

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 = 680 mA	V_f		3,5	V± 10%
Filament current at V_f = 5,0 V, I_a = 0	I_f		41	A
			< 45	A
at V_f = 3,5 V, I_a = 680 mA	I_f		27	A
Filament current, peak starting	I_{fp}	max.	150	A
Cold filament resistance	Rf_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_{ap}	5,5	kV
Anode current, mean	I_a	700	mA
Output power	W_o	2,2	kW

LIMITING VALUES (Absolute max. rating system)

Anode current, mean	I_a	max.	750	mA
peak	I_{ap}	max.	1250	mA
Anode voltage	V_a	max.	10	kV [1])
Temperature of mounting bracket at central contact point of thermoswitch (see also under "Cooling")	t	max.	140	°C
Voltage standing wave ratio, measured with probe 55345	VSWR	max.	5	
during max. 0,02 s and max. 20% of the time	VSWR	max.	10	

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.

[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.

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.
Direction of air flow: see outline drawing.

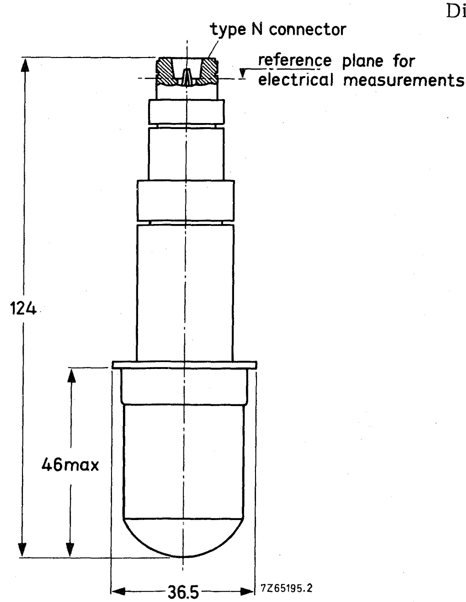
With only the filament voltage applied some air cooling is required to keep the temperature below the limiting value.

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.
Switching-off temperature 135±5 °C.

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

Dimensions in mm

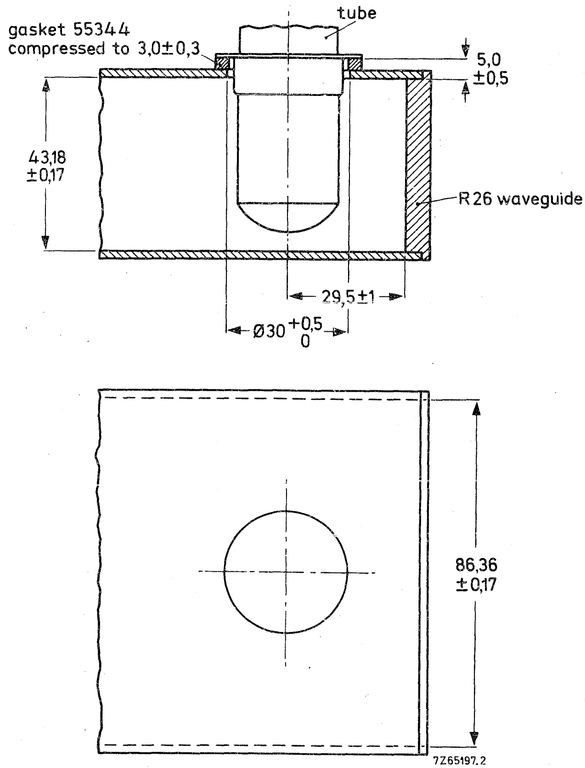


Fig. 1 Launching section

DESIGN AND OPERATING NOTES

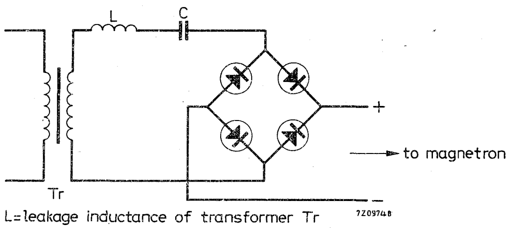
General

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_{f_0}, f, W_0 etc.) will vary around the nominal values.

Anode supply

The magnetron may be operated from an L-C stabilized power supply.
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.

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.

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 deposits forming on the insulation.

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 tubes. 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 tube. 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).

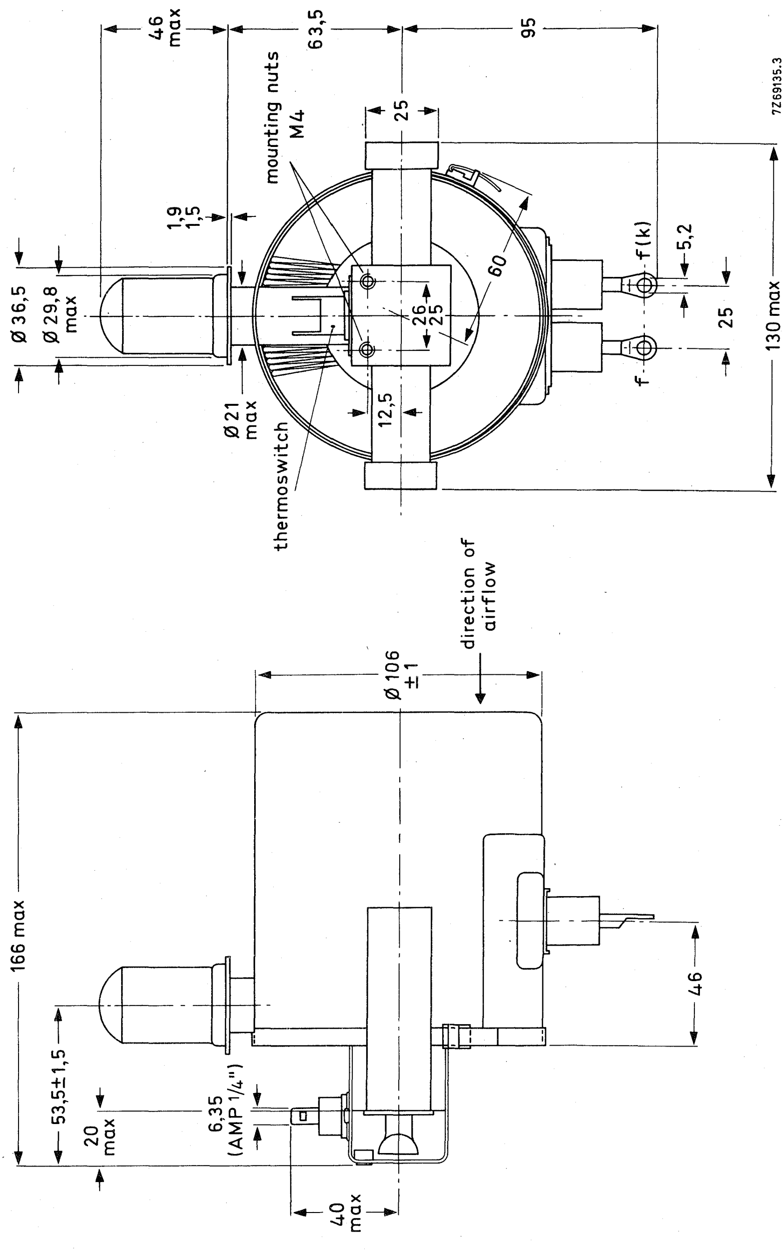
The output coupling should not be used as the only means of mounting and be kept free from undue stress.

The minimum distance between the magnetron and magnetized materials shall be 13 cm.
The minimum 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.

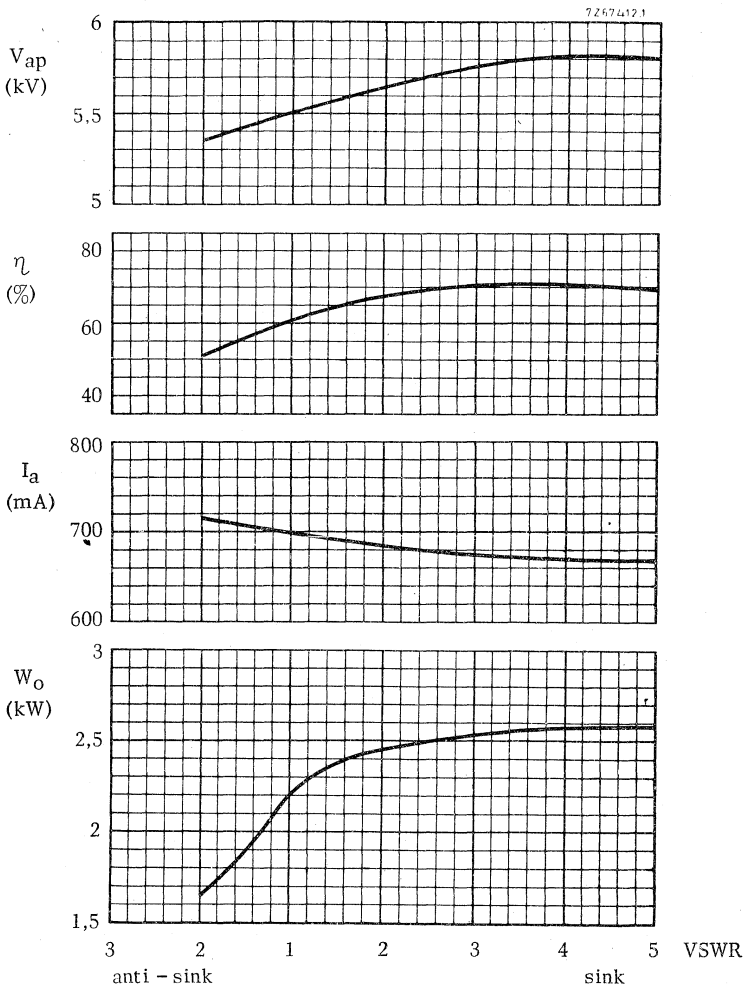
All tools (screwdrivers, wrenches etc.) used close to or in contact with the magnetron must be of non-magnetic material to avoid unwanted attraction and possible mechanical damage to ceramic parts as well as short circuit of the magnetic flux.

MECHANICAL DATA Dimensions in mm



Mounting position : any

Net mass : approx. 2 kg


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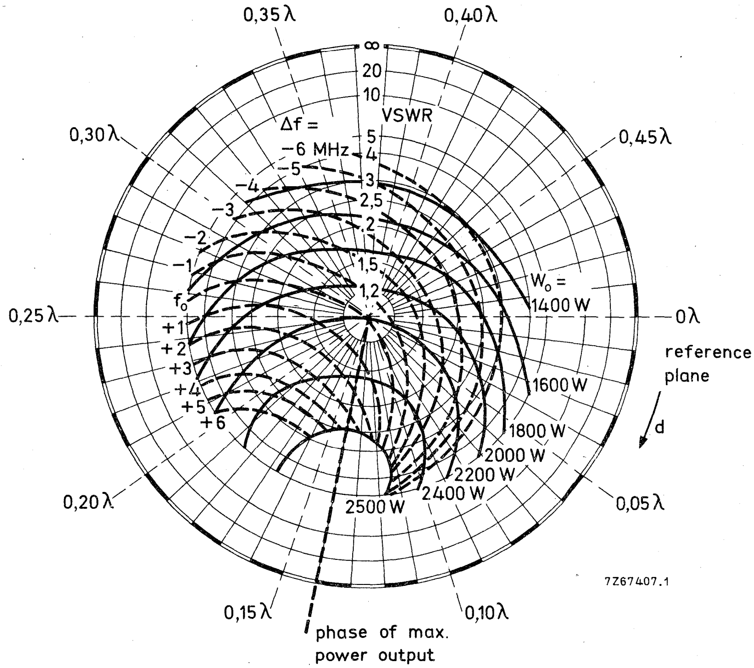
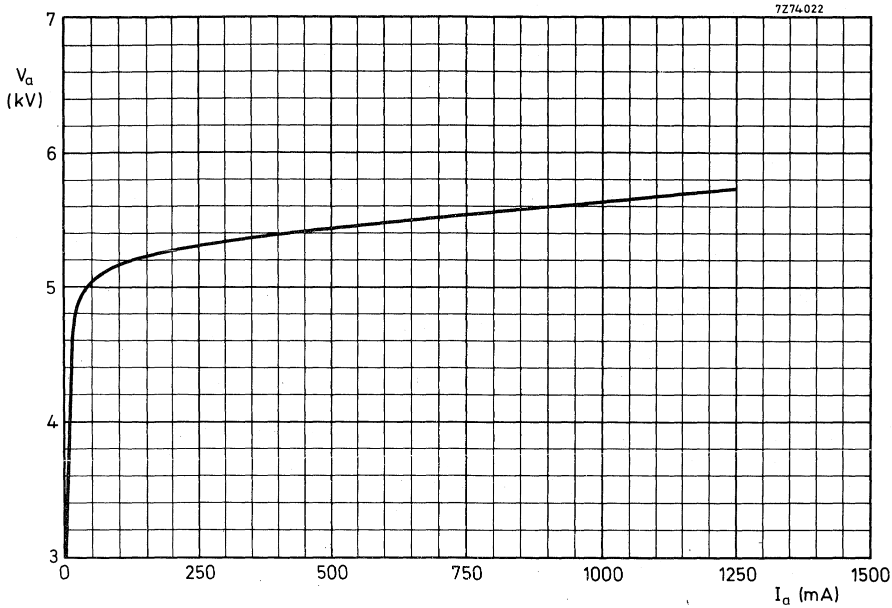
5
VSWR
anti - sink
sink

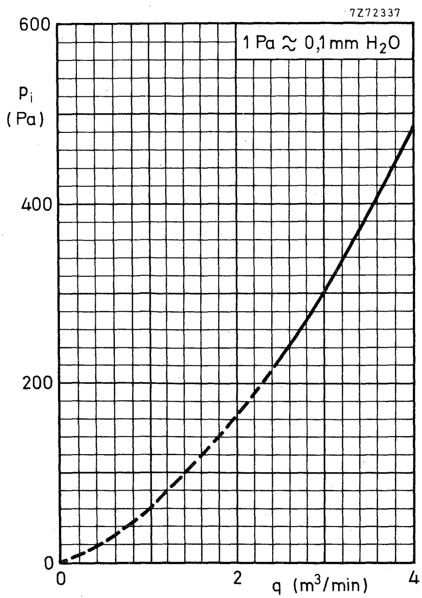


Load diagram

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



Dynamic characteristic; anode voltage as a function of anode current at VSWR = 2,5 in direction of sink



Pressure drop as a function of rate of flow (air)

CONTINUOUS-WAVE MAGNETRON

Integral-magnet, water cooled continuous-wave magnetron with integral R.F. filter, intended for industrial microwave applications. The tube features a quick heating cathode, high efficiency, and has a typical output power of 3 kW.

QUICK REFERENCE DATA			
Frequency, fixed within the band	f	2,425 to 2,475	GHz
Output power	W_o	3	kW
Construction	packaged, metal-ceramic		
Cathode	quick heating		
R.F. filter	integral		

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		10	s
Filament voltage, operating	V_f		2,5	V
Anode supply	three-phase, full-wave rectified			
Anode current, mean	I_a		800	mA
peak	I_{ap}	<	1100	mA
Load impedance measured with probe 55345				
Voltage standing wave ratio	VSWR		2,5	
Phase, in direction of load, with respect to reference plane	d		0,14	
Cooling of anode block	water, see Fig. 7			
Cooling of filter box	air, q = 60 l/min, see Fig. 6 Inlet temperature t_i = max. 50 °C See also pertinent paragraph			

Performance

Filament current at V_f = 2,5 V	I_f		20	A
Anode voltage, peak	V_{ap}		6	kV
Output power	W_o		3,2	kW
	W_o	>	2,9	kW
Efficiency			70	%

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 $I_{a\ mean}$ = 800 mA	V_f		2,5	V± 10%
Filament current at V_f = 5,0 V, I_a = 0	I_f		41	A
		<	45	A
at V_f = 2,5 V, I_a = 800 mA	I_f		20	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.	8	s

Immediately after applying the anode voltage the filament voltage must be reduced to the operating value. See Fig. 5

TYPICAL CHARACTERISTICS measured under matched load conditions (VSWR ≤ 1,05) and three-phase full-wave rectified supply (See "Design and operating notes")

Frequency, fixed within the band	f	2,425 to 2,475	GHz
Anode voltage, peak	V_{a_p}	5,8	kV
Anode current, mean	I_a	800	mA
Output power	W_o	2,8	kW

LIMITING VALUES (Absolute max. rating system)

Anode current, mean	I_a	max.	850	mA
peak	I_{a_p}	max.	1100	mA
Anode voltage	V_a	max.	10	kV [1])
Cooling water outlet temperature, open cooling circuit	t_o	max.	65	°C
closed cooling circuit	t_o	max.	75	°C
Temperature of mounting bracket at central contact point of thermoswitch (see also under "Cooling")	t	max.	120	°C
Voltage standing wave ratio, measured with probe 55345	VSWR	max.	5	
during max. 0,02 s and max. 20% of the time	VSWR	max.	10	

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.

[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.

COOLING

Anode block	water

For pressure drop as a function of rate of flow see Fig. 7

Filter box	air

For pressure drop as a function of rate of flow see Fig. 6

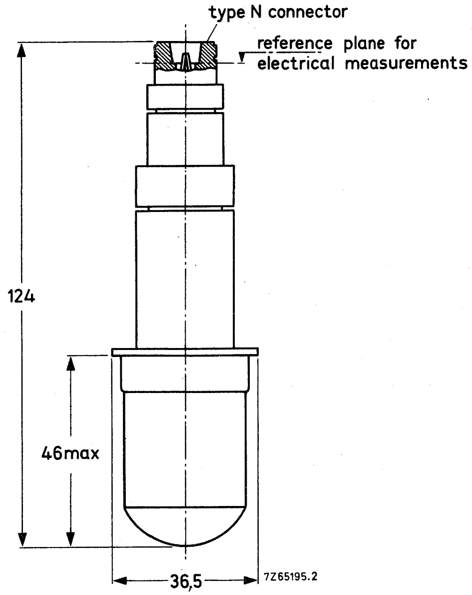
With only the filament voltage applied the air cooling and some water cooling is required.

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.
Switching-off temperature 115 ± 5 ^{o}C.

ACCESSORIES

Thermoswitch; mounted on tube	type	55364
R.F. gasket, supplied with tube	type	55344
Measuring probe (for measurements only)	type	55345
Recommended isolator	2722 163 02004	

Dimensions in mm



Measuring probe 55345

MECHANICAL DATA

Dimensions in mm

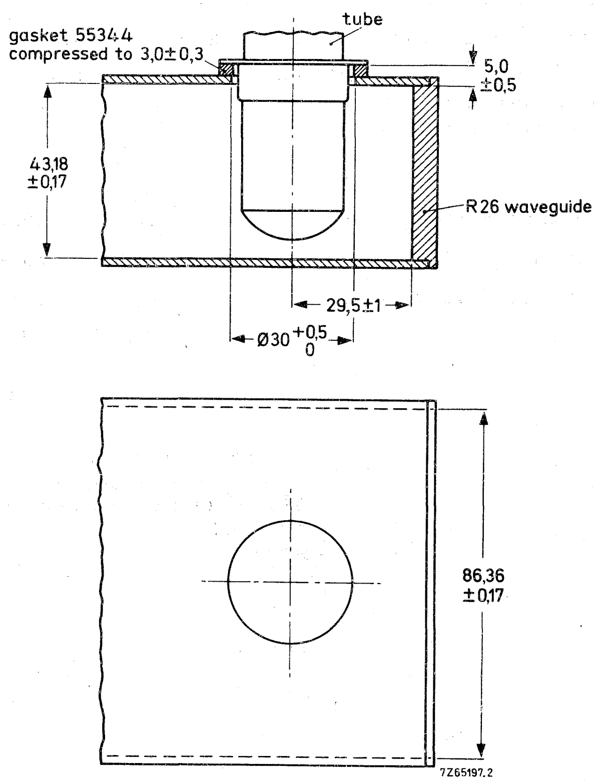


Fig. 1 Launching section

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 specification given in this data 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.

Anode supply

The magnetron may be operated from a non-smoothed three-phase full-wave rectified supply unit. This unit should be so designed that no limiting value for the mean and peak anode current is exceeded, whatever the operating conditions. The use of a current limiting device is recommended.

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 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.

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.
The 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.

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 deposits forming on the insulation.

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 tubes. 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 tube. 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.

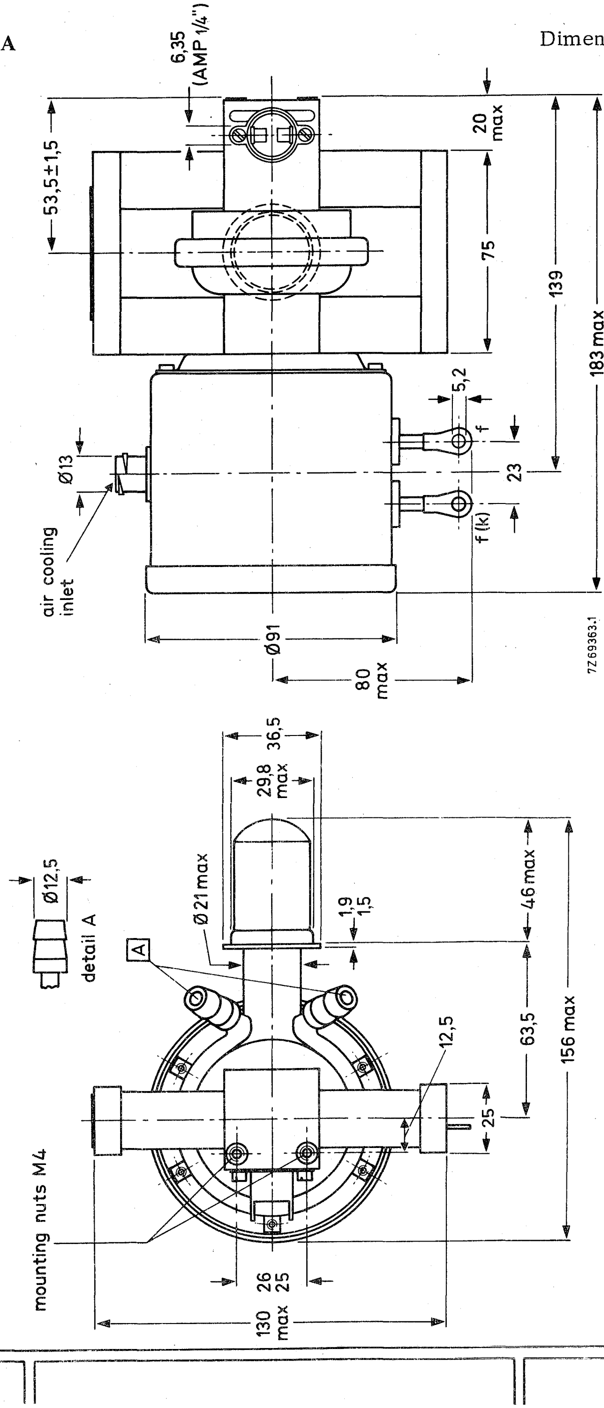
The minimum distance between the magnetron and magnetized materials shall be 13 cm.
The minimum distance between the magnetron and other ferromagnetic materials shall be 3 cm.

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.

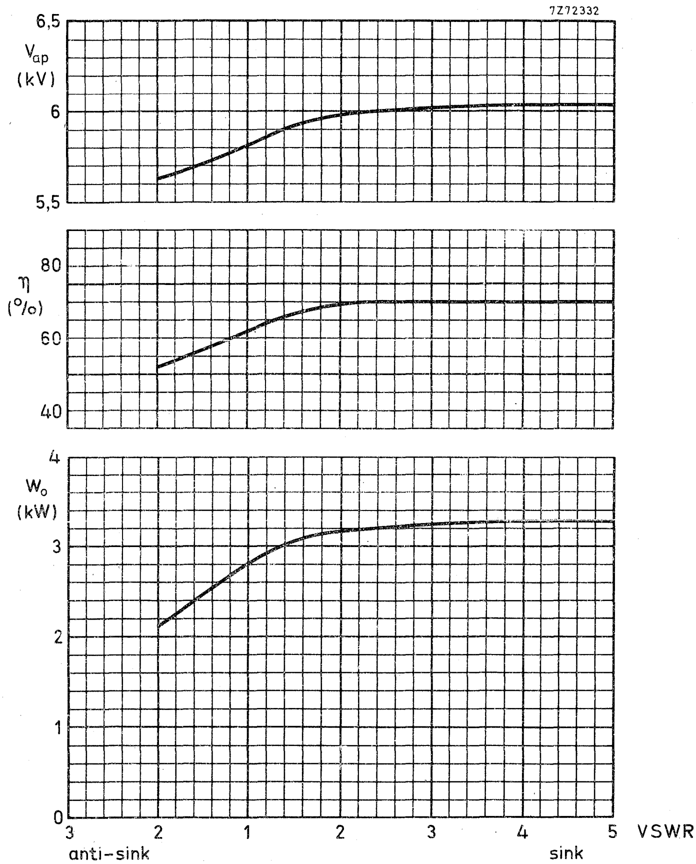
MECHANICAL DATA

Dimensions in mm



Mounting position : any

Net mass : approx. 1, 8 kg



I_a = 800 mA

Fig. 2

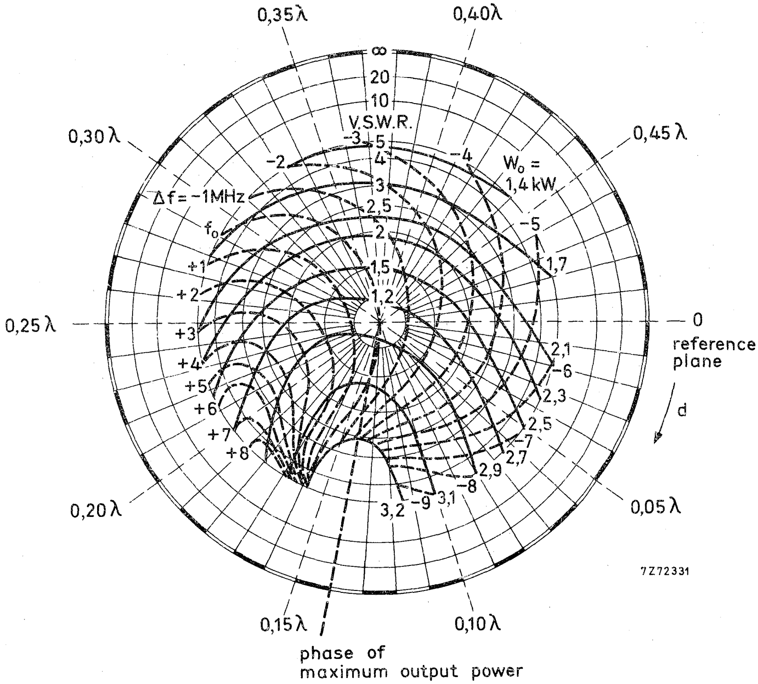


Fig. 3

Load diagram

Measured with a three-phase full-wave rectified power supply
Frequency f_0 = 2, 450 GHz
Anode current, mean I_a = 800 mA
Anode current, peak I_{a_p} = 1000 mA at matched load
Constant cooling
d = Distance of voltage standing wave minimum from the reference plane for electrical measurements (measuring probe 55345) towards load

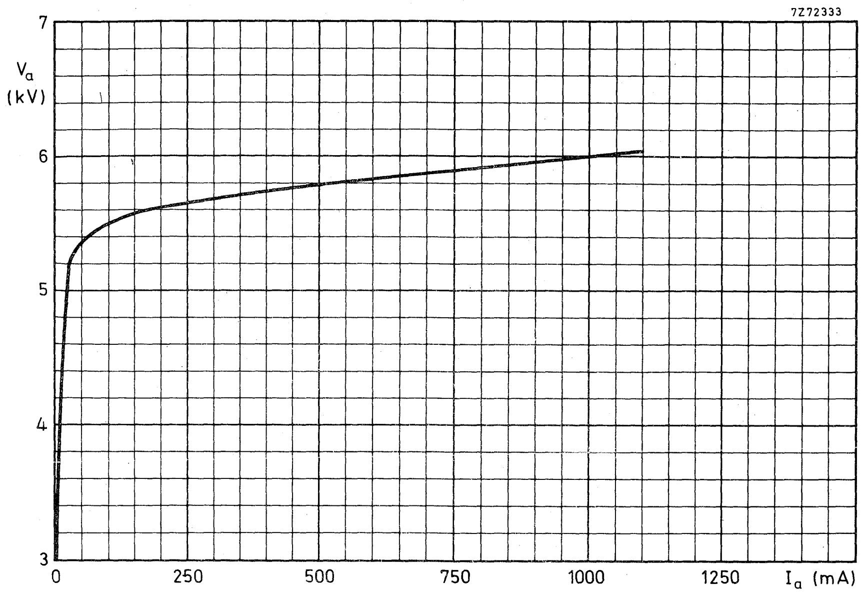


Fig. 4

Dynamic characteristic: anode voltage as a function of anode current at VSWR = 2, 5 in direction of sink

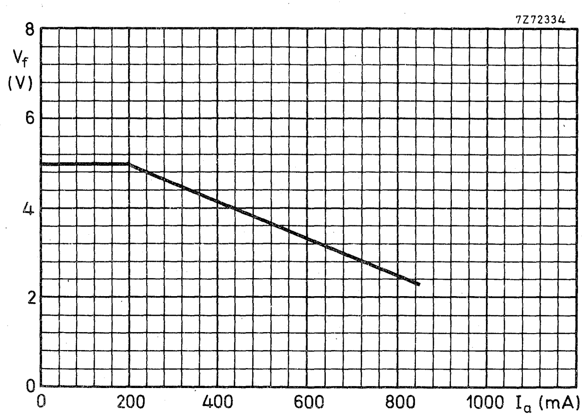


Fig. 5

Filament voltage reduction curve

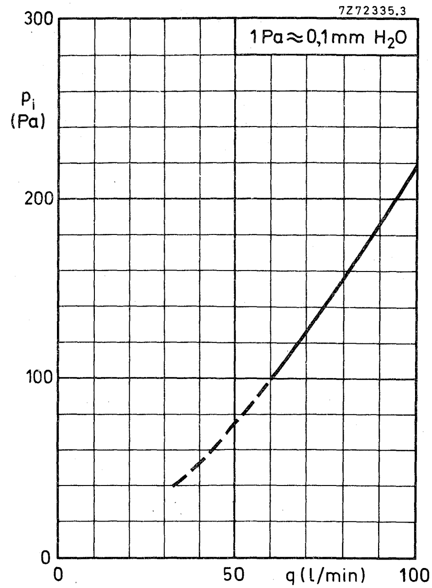


Fig. 6
Pressure drop
as a function of rate of flow (air)

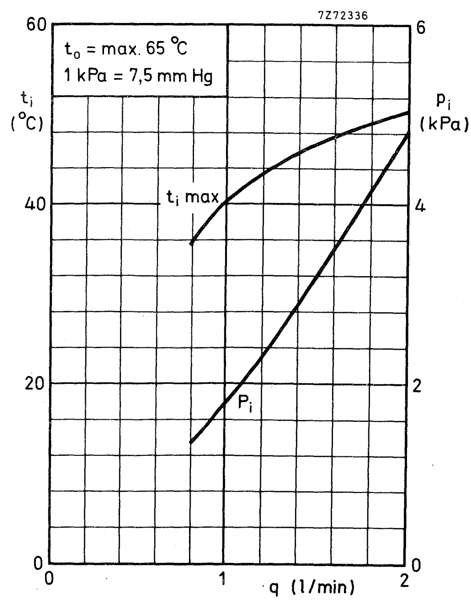


Fig. 7
Pressure drop and max. inlet temperature
as a function of rate of flow (water)

CONTINUOUS-WAVE MAGNETRON

Integral-magnet, water-cooled, continuous-wave magnetron with integral R.F. filter, intended for industrial microwave applications. The tube features a quick-heating cathode, high efficiency, and has a typical output power of 3 kW.

QUICK REFERENCE DATA			
Frequency, fixed within the band	f	2,350 to 2,400	GHz
Output power	W_o	3	kW
Construction	packaged, metal-ceramic		
Cathode	quick heating		
R.F. filter	integral		

The YJ1443 is equivalent to the YJ1442, except for the frequency band, being 2,350 to 2,400 GHz, and the measuring probe, having type no. 55373.

Recommended isolator 2722 163 02024 ←

CONTINUOUS-WAVE MAGNETRON

Integral-magnet, forced -air cooled continuous-wave magnetron with integral R.F. filter intended for microwave heating applications. The tube features a quick-heating cathode, high efficiency, and has a typical output power of 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		
R.F. filter	integral		

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 (see "Design and operating notes")		L-C stabilized		
Anode current, mean	I_a		370	mA
peak	I_{a_p}		600	mA
Load impedance, measured with probe 55345				
Voltage standing wave ratio	VSWR		2,5	
Phase, in direction of load, with respect to reference plane	d		0,14	λ
Cooling; rate of flow	q	min.	2	m^3/min [1])
		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
Output power	W_o		1,55	kW
	W_o	min.	1,4	kW
Efficiency	η		70	%

[1]) Based on a cooling air inlet temperature t_i = max. 50 °C.

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_{fp}	max.	100	A
Cold filament resistance	R_{fo}		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_{ap}	5,9	kV
Anode current, mean	I_a	370	mA
Output power	W_o	1,35	kW

LIMITING VALUES (Absolute max. rating system)

Anode current, mean	I_a	max.	400	mA	
peak	I_{ap}	max.	900	mA	
Anode voltage	V_a	max.	10	kV	1)
Temperature of mounting bracket at central contact point of thermoswitch (see also under "Cooling")	t	max.	140	°C	
Voltage standing wave ratio, measured with probe 55345.	VSWR	max.	5,5		
during max. 0,02 s and max. 20% of the time	VSWR	max.	10		

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.

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.

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.

Direction of airflow: see outline drawing.

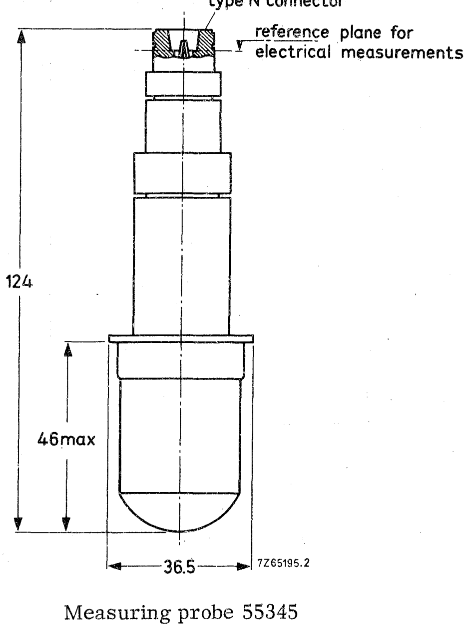
With only the filament voltage applied some air cooling is required to keep the temperature below the limiting value.

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.
Switching-off temperature 135±5 °C.

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

Dimensions in mm

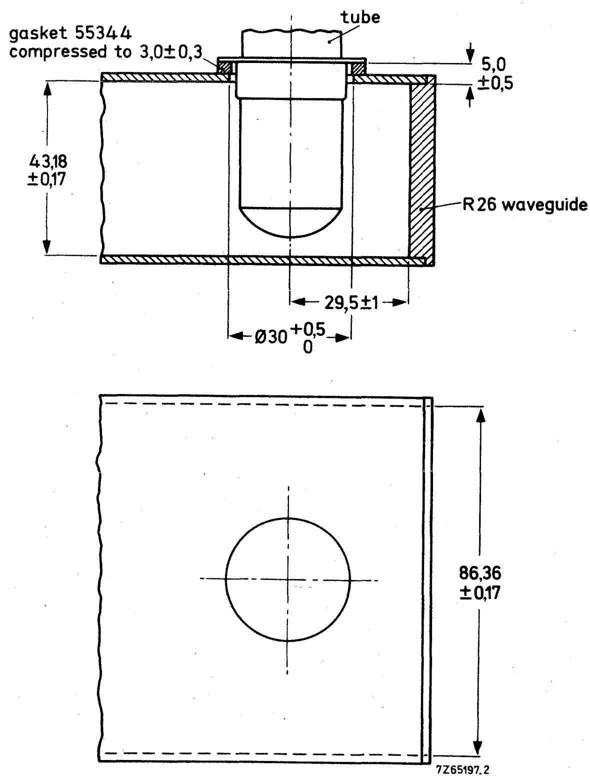


Fig. 1 Launching section

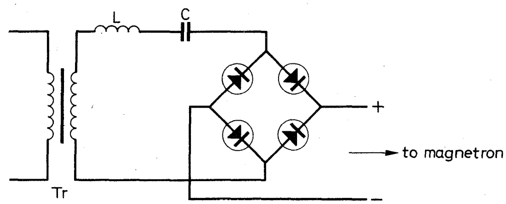
DESIGN AND OPERATING NOTES

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, Rf_o, f, W_o etc.) will vary around the nominal values.

Anode supply

The magnetron may be operated from an L-C stabilized anode supply unit. 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 high negative potential with respect to the anode.
The transformer should be so designed that the filament voltage and filament peak 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 contact with the tube terminals.

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.
The 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.

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 deposits 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 tubes. 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 tube. 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 magnetron earth connection can be made via these nuts.

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

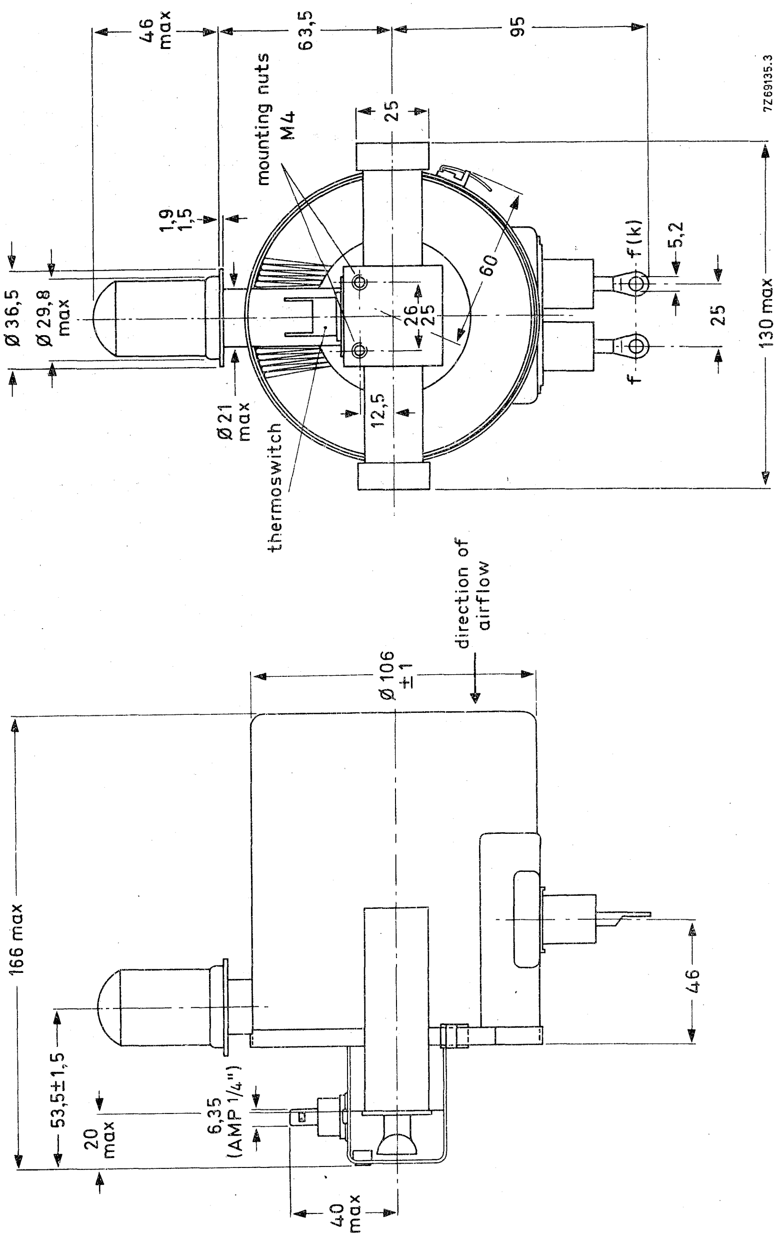
The min. distance between the magnetron and magnetized materials shall be 13 cm. The min. distance between the magnetron and other ferromagnetic materials shall be 3 cm.

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.

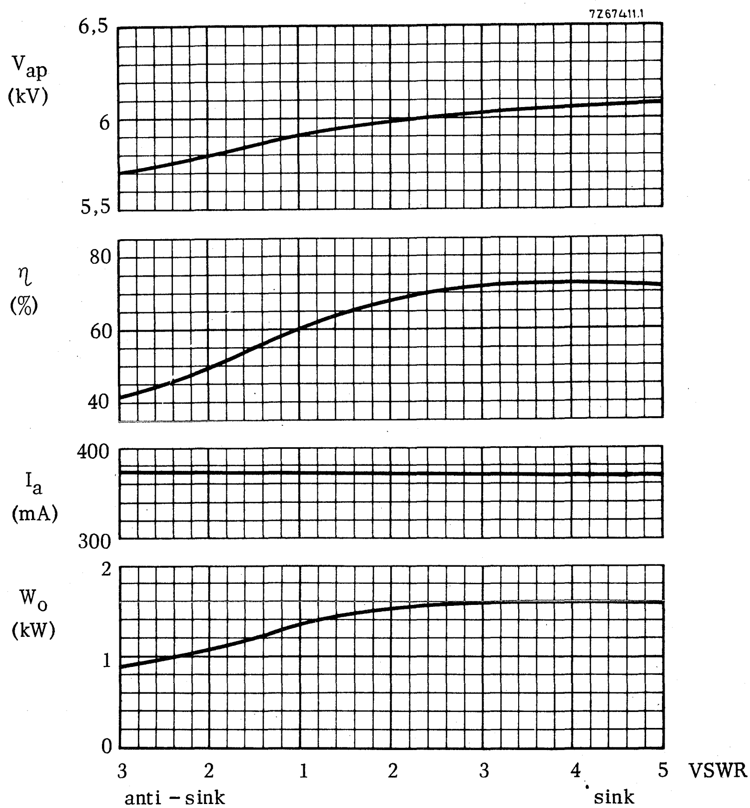
All tools (screwdrivers, wrenches etc.) used close to or in contact with the magnetron must be of non-magnetic material to avoid unwanted attraction and possible mechanical damage to ceramic parts as well as short circuit of the magnetic flux.

MECHANICAL DATA

Dimensions in mm



Mounting position : any
Net mass : approx. 2 kg


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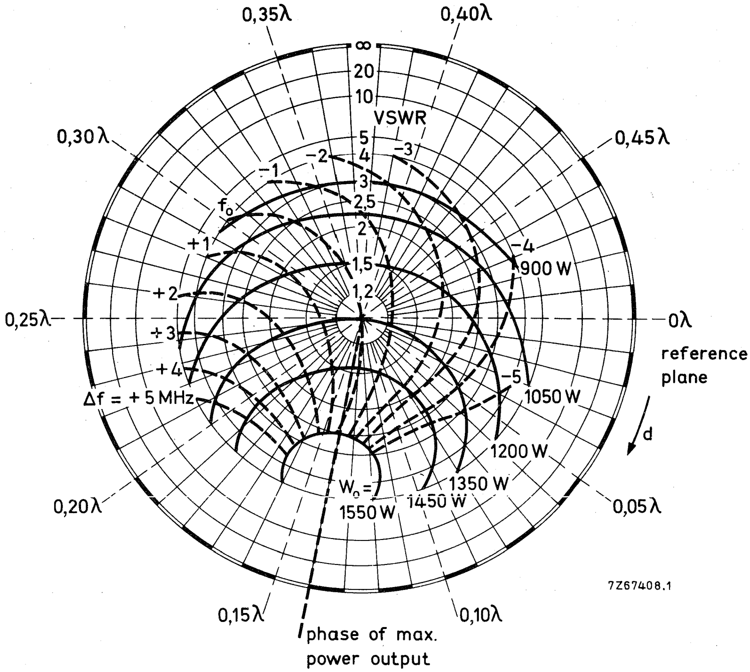
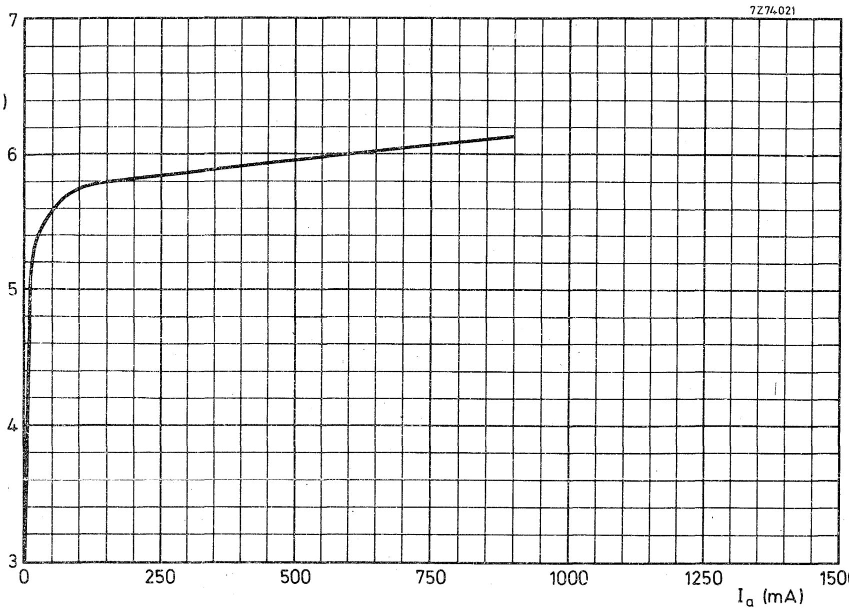
VSWR
anti – sink
sink

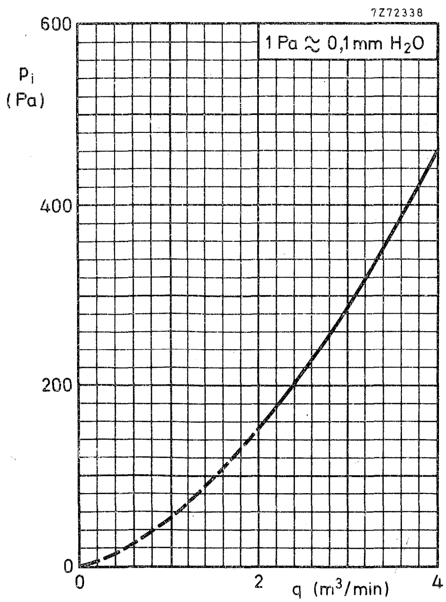


Load diagram

Measured with an L-C stabilized power supply
Mean anode current I_a = 370 mA at matched load
Frequency f_0 = 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



Dynamic characteristic; anode voltage as a function of anode current at VSWR = 2,5 in direction of sink



Pressure drop as a function of rate of flow (air)

CONTINUOUS-WAVE MAGNETRON

Packaged, metal-ceramic, forced-air cooled, continuous-wave magnetron with integral R.F. cathode filter. The tube is primarily intended for use in domestic microwave ovens and features cold-start operation and high efficiency.
Under typical operating conditions the output power is 1100 W.
This light-weight tube may be mounted in any position.

QUICK REFERENCE DATA

Frequency, matched load	f	2,450	GHz
Output power	W_o	1100	W
Construction	packaged, metal-ceramic		
Cathode	thoriated tungsten, cold start, quick heating		
R.F. cathode filter	integral		

TYPICAL OPERATION

Conditions

Filament voltage	V_f		3,2	V
Anode supply (see "Design and operating notes")	L-C stabilized half-wave doubler			
Anode current, mean	I_a		380	mA
peak	I_{ap}	≈	1250	mA
Cooling; rate of flow	q		1	m^3/min

Performance (at matched load; for other load conditions see page 7.)

Filament current	I_f		14,5	A
Anode voltage, peak	V_{ap}		4	kV
Frequency	f		2,450	GHz
Output power	W_o		1100	W
	W_o	>	950	W
Efficiency	η		72	%

Data based on pre-production tubes.

HEATING

Thoriated tungsten, cold start, quick-heating cathode

Filament voltage	V_f	3,2	V ±10%
Filament current at V_f = 3,2 V, I_a = 0	I_f	15,5	A
Cold filament resistance	R_{fo}	30	mΩ
Pre-heating time (waiting time)	T_w	0	

GENERAL DATA

Electrical

Frequency, fixed within the band	f 2,435 to	2,465	GHz
Phase of sink, measured with probe type 55371	d	0,11	λ

Mechanical

Mounting position	any		
Mass	≈	1	kg

LIMITING VALUES (Absolute max. rating system)

Filament voltage	V_f	max.	3,2	V +10%
		min.	3,2	V −10%
Anode current, mean	I_a	max.	420	mA
peak		see note 1		
Anode voltage	V_a	max.	12	kV 2)
Cooling; rate of flow	q	min.	1	m^3/min
	see also pertinent paragraph			
Temperature at reference point (see outline drawing)	t	max.	180	°C
Voltage standing wave ratio, measured with probe type number 55371	VSWR	max.	4	
during max. 0,02 s and max. 20% of the time	VSWR	max.	10	

Any period of time up to 0,02 s during which the VSWR is between 4 and 10 must be followed by a period four times as long during which the VSWR is ≤ 4.

1) Under no circumstances should the magnetron be permitted to mode. Amongst other conditions, the moding stability of a magnetron depends on the R.F. loading conditions such as VSWR, phase of reflection, and coupling section. It also depends on peak anode current, mean anode current, and current waveform. For a magnetron operating from an L-C stabilized half-wave doubler anode supply, the peak to mean anode current ratio is approximately 3 to 3,5.

2) For "cold-start" operation it is recommended that, for the anode voltage, a rectifier be used with a reverse breakdown voltage of 10 to 12 kV and having an avalanche energy rating of ≥ 2 J.

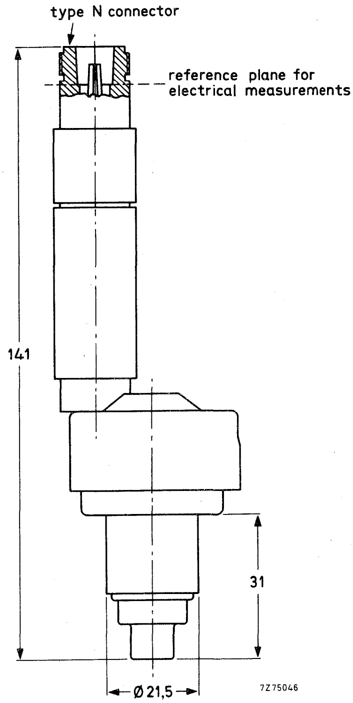
COOLING

Anode block	forced air		
Required quantity of air, based on an air inlet temperature of 50 °C max. under typical operating conditions	q min.	1	m^3/min
Pressure drop as a function of rate of flow	see page 8		
Direction of air flow through radiator	arbitrary		

To protect the magnetron against overheating it is recommended that a thermoswitch be mounted in the position shown on the outline drawing. Thermoswitch switching-off temperature 100 °C.

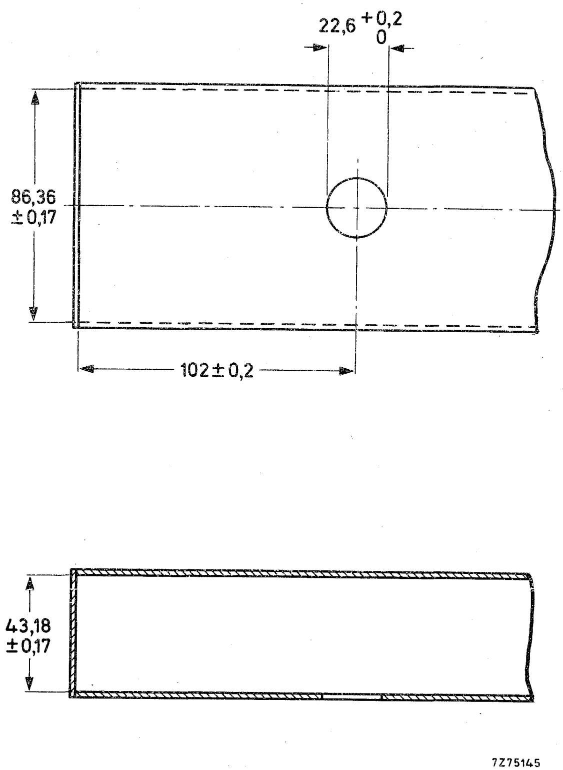
ACCESSORIES

R.F. gasket; supplied with tube	type	55372
Measuring probe for oven design measurements	type	55371
Mounting bracket	cat. no.	4322 041 03832



Measuring probe type 55371

Dimensions in mm



Coupling section for YJ1500 into a waveguide R26 (used for measurements)

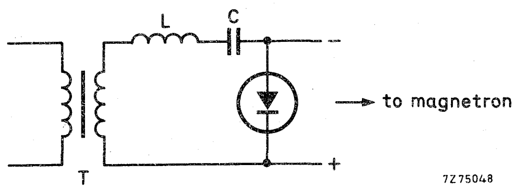
DESIGN AND OPERATING NOTES

General

Whenever operation of the magnetron at conditions substantially different from those indicated under "Typical operation" is considered the tube supplier should be consulted.

Anode supply

The magnetron may be operated from an L-C stabilized half-wave doubler anode supply unit. Information on power supply design is available on request.



L = leakage inductance of transformer T

Basic circuit of an L-C stabilized half-wave doubler anode supply unit.

Filament supply

Simultaneous application of filament and anode voltage is permitted ("cold start").
The filament winding of the transformer must be well insulated from the primary winding since the anode is earthed and the cathode is at a high negative potential with respect to the anode and the primary winding.
When "variable power control" is used, please contact the tube supplier.

Load impedance, measured with measuring probe

The measuring probe type 55371 enables the designer of the microwave oven 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.
For the cold measurements the probe, with gasket type 55372, is coupled to the coupling section instead of the magnetron.
The termination of the probe matches a standard N-type connector.
Assistance in the design of the H.F. part of the oven, including the magnetron coupling method, may be given by the tube manufacturer.

Tube cleanness

The ceramic parts of the input and output structure of the tube must be kept clean and dry during installation and operation.

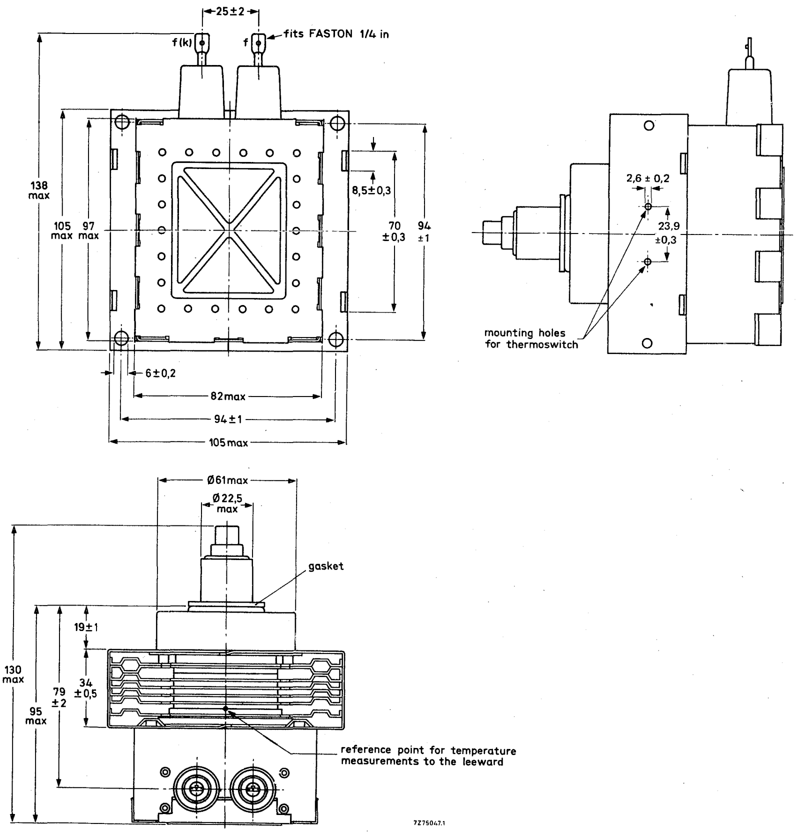
Mounting

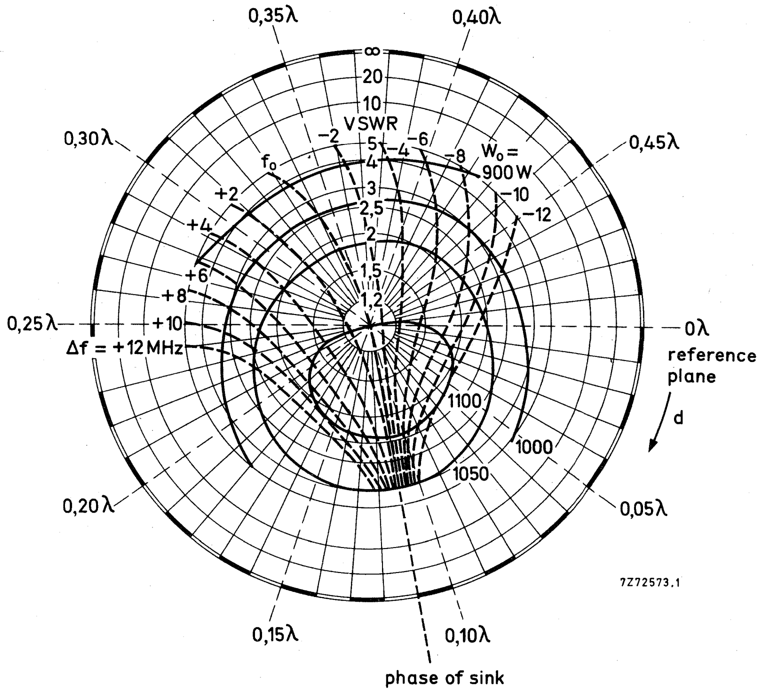
The magnetron should be mounted on a non-ferromagnetic coupling section by means of 4 screws through the holes in the air duct or by 4 mounting brackets catalogue number 4322 041 03832 which can be hooked into the slits in the air duct side-walls.
To ensure good R.F. contact between the magnetron and the coupling section the use of gasket type 55372 is essential.

MECHANICAL DATA Dimensions in mm

Mounting position : any

Net mass : approx. 1 kg





Load diagram

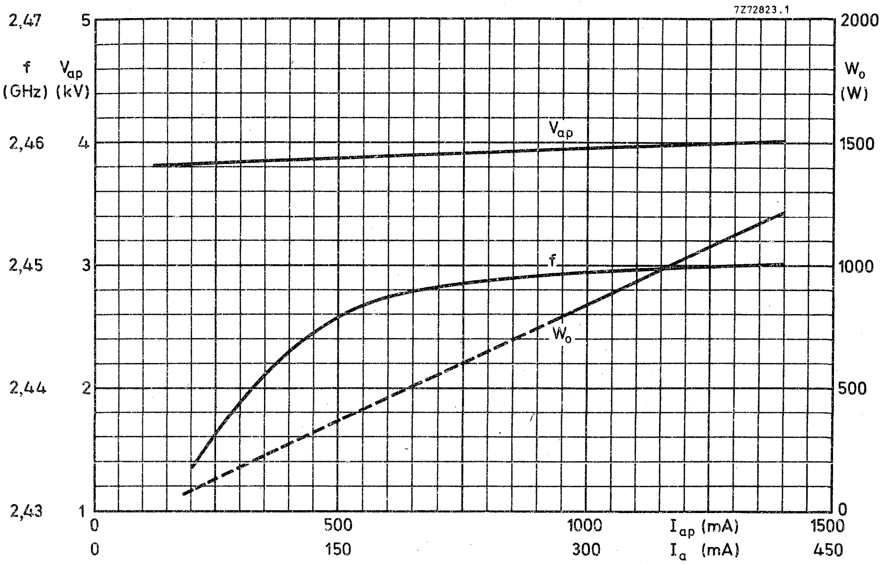
Measured with an L-C stabilized half-wave doubler anode supply

Mean anode current I_a = 380 mA at matched load

Frequency f_O = 2, 450 GHz

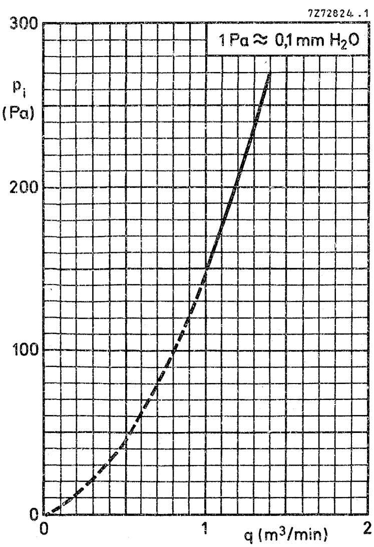
Constant air cooling q = 1 m^3/min

d = Distance of voltage standing wave minimum from the reference plane for electrical measurements (measuring probe type 55371) towards load



Peak anode voltage, V_{ap}, as a function of peak anode current, I_{ap}.
Frequency, f, as a function of peak anode current, I_{ap}.
Output power, W_o, as a function of mean anode current, I_a, measured with an L-C stabilized half-wave doubler supply with $\frac{I_{ap}}{I_a} = \frac{10}{3}$.

Load: matched.



Pressure drop, p_i, across radiator as a function of air flow, q.

CONTINUOUS-WAVE MAGNETRON

Integral-magnet, air-cooled or heatsink-cooled continuous-wave magnetron intended for diathermy and other low-power 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	
Cathode		nickel matrix type	

CATHODE : nickel matrix type

HEATING : indirect by a.c. 50 Hz to 60 Hz, or d.c.

		Operation A, B, and D	Operation C	
Heater voltage, starting and stand-by	V_f	5,3	4,8	V ±10%
Heater current at starting voltage	I_f	3,5	3,3	A
Heater current, peak starting	I_{f_p}	max. 8,5		A
Cold heater resistance	R_{f_o}	0,2		Ω
Waiting time	T_w	min. 180	min. 240	s

Immediately after applying the anode voltage the heater voltage must be reduced as a function of the anode current:

Operation A or B	according to curve a or curve b	see page 10
Operation C	no reduction (curve b)	
Operation D	according to curve b	

On these values a tolerance of ± 10% is allowed.

TYPICAL CHARACTERISTICS measured under matched load conditions (VSWR < 1,05) and d.c. anode voltage.

Frequency, fixed within the band	f	2,425 to 2,475	GHz
Anode voltage, d.c.	V_a	1,55 to 1,70	kV
Anode current	I_a	200	mA

COOLING

a) Low velocity air flow with a rate of flow of 0,4 to 0,5 m^3/min .
Direction of air flow, see outline drawing.
The air flow need not be ducted.

or

b) Heatsink. The tube does not require any extra cooling provided it is effectively mounted on a heat-conducting non-magnetic plate. A vertical position of this plate facilitates the heat transfer.

MECHANICAL DATA

Net mass : approx. 2,4 kg

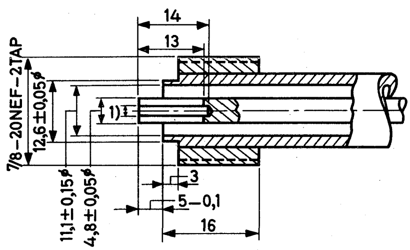
Mounting position : any

Base : octal
The socket for this base should not be rigidly mounted, it should have flexible leads and be allowed to move freely.

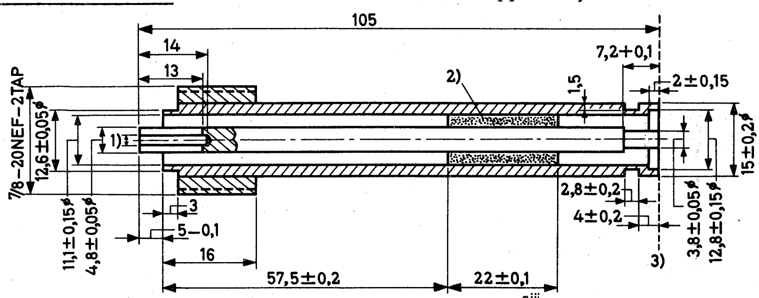
OUTPUT COUPLING

4,8/11,1 coaxial line (50,3 Ω); not supplied by the tube manufacturer.

The inner conductor should be sufficiently flexible to accept the eccentricity of the inner conductor of the magnetron output.



Fixed reflection element, VSWR ≈ 2, d ≈ 0,45λ ; not supplied by the tube manufacturer.



1) Hole 3,85+0,05 mm with 2 slots. The segments should be pressed together after slotting.
2) Teflon $\epsilon_r = 2,0$; driving fit.
3) Reference plane B.

TYPICAL OPERATION AND LIMITING VALUES

Operation A: A.C. anode supply

LIMITING VALUES (Absolute max. rating system)

Heater voltage, starting and stand-by	V_f	max.	5,83	V
		min.	4,77	V
operating	V_f	max.	4,95	V
		min.	4,05	V
Waiting time	T_w	min.	180	s
Anode current, mean	I_a	max.	230	mA
peak	I_{ap}	max.	1,4	A
Temperature, anode	t_a	max.	125	°C
cathode seal	t	max.	210	°C
Voltage standing wave ratio	VSWR	max.	2	

TYPICAL OPERATION

Conditions

Heater voltage, starting	V_f	5,3	V
Waiting time	T_w	180	s
Heater voltage, operating	V_f	4,5	V
Anode supply		a.c.	
Load		matched	

Performance

Anode voltage, measured with d.c.	V_a	1,65	kV
Anode current, mean	I_a	200	mA
peak	I_{ap}	1,3	A
Output power	W_o	200	W

Operation B : Unfiltered single-phase full-wave rect. anode supply

LIMITING VALUES (Absolute max. rating system)

Heater voltage, starting and stand-by	V_f	max.	5,83	V
		min.	4,77	V
operating	V_f	max.	4,95	V
		min.	4,05	V
Waiting time	T_w	min.	180	s
Anode current, mean	I_a	max.	230	mA
peak	I_{a_p}	max.	1,4	A
Temperature, anode	t_a	max.	125	^oC
cathode seal	t	max.	210	^oC
Voltage standing wave ratio	VSWR	max.	2	

TYPICAL OPERATION

Conditions

Heater voltage, starting	V_f	5,3	V
Waiting time	T_w	180	s
Heater voltage, operating	V_f	4,5	V
Anode supply	unfiltered single-phase full-wave rectified a.c.		
Load	matched		

Performance

Anode voltage, measured with d.c.	V_a	1,65	kV
Anode current, mean	I_a	200	mA
peak	I_{a_p}	0,7	A
Output power	W_o	200	W

Operation C : 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	VSWR		2	
Phase, **in direction of sink** (See under "Output coupling")	d		0,45	λ

LIMITING VALUES (Absolute max. rating system)

Heater voltage, starting, stand-by, and operating	V_f	max.	5,28	V
		min.	4,32	V
Waiting time	T_w	min.	240	s
Anode current	I_a	max.	125	mA
Temperature, anode	t_a	max.	125	°C
cathode seal	t	max.	210	°C
Voltage standing wave ratio	VSWR	max.	3	[1]

TYPICAL OPERATION

Conditions

Heater voltage, starting	V_f	4,8	V
Waiting time	T_w	240	s
Heater voltage, operating	V_f	4,8	V
Anode supply		d.c.	
Load		matched	

Performance

Anode voltage, d.c.	V_a	1,65	kV
Anode current	I_a	100	mA
Output power	W_o	100	W

[1]) With respect to reference plane B of fixed reflection element.

Operation D : Pulsed anode supply

LIMITING VALUES (Absolute max. rating system)

Heater voltage, starting and stand-by	V_f	max.	5,83	V
		min.	4,77	V
operating	see curve b, page 10			
Waiting time	T_w	min.	180	s
Anode current, mean	I_a	max.	230	mA
peak	I_{ap}	max.	1,4	A
Rate of rise of anode current	$\frac{dI_a}{dt}$	max.	50	mA/µs
Temperature, anode	t_a	max.	125	°C
cathode seal	t	max.	210	°C
Voltage standing wave ratio	VSWR	max.	2	

TYPICAL OPERATION

Conditions

Heater voltage, starting	V_f	5,3	V
Waiting time	T_w	180	s
Heater voltage, operating	see curve b, page 10		
Anode supply		pulsed	
Load		matched	

Performance

Anode voltage	V_a	1,7	kV
Anode current, mean	I_a	0 to 200	mA
peak	I_{ap}	1,3	A
Output power, mean	W_o	0 to 200	W
peak	W_{op}	1,4	kW

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_{f_0}, f, W_o) will vary around the nominal values.

Anode supply

The magnetron may be operated from an a.c. supply, from an unfiltered single-phase full-wave rectified a.c. supply, from a d.c. supply, or from a pulsed supply.
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 secondary of the heater transformer must be well insulated from the primary since during 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 heater voltage and peak heater starting current limits are not exceeded.

Stand-by operation

To avoid the time consuming warm-up period when frequent switching of the tube is intended, the heater should be switched back to the stand-by condition after each oscillation period. The tube then remains ready for instantaneous operation.

Stability of operating mode

Oscillation stability may be affected by:
1) excessive microwave power reflection from the load,
2) excessive anode current,
3) over or underheating of the cathode,
4) changes in magnetic field.
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 operating conditions under all load conditions within the limiting values.

Shielding

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

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 10 cm is maintained between magnets.

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 four bolts fitting the threaded holes in the mounting bracket (see outline drawing).

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

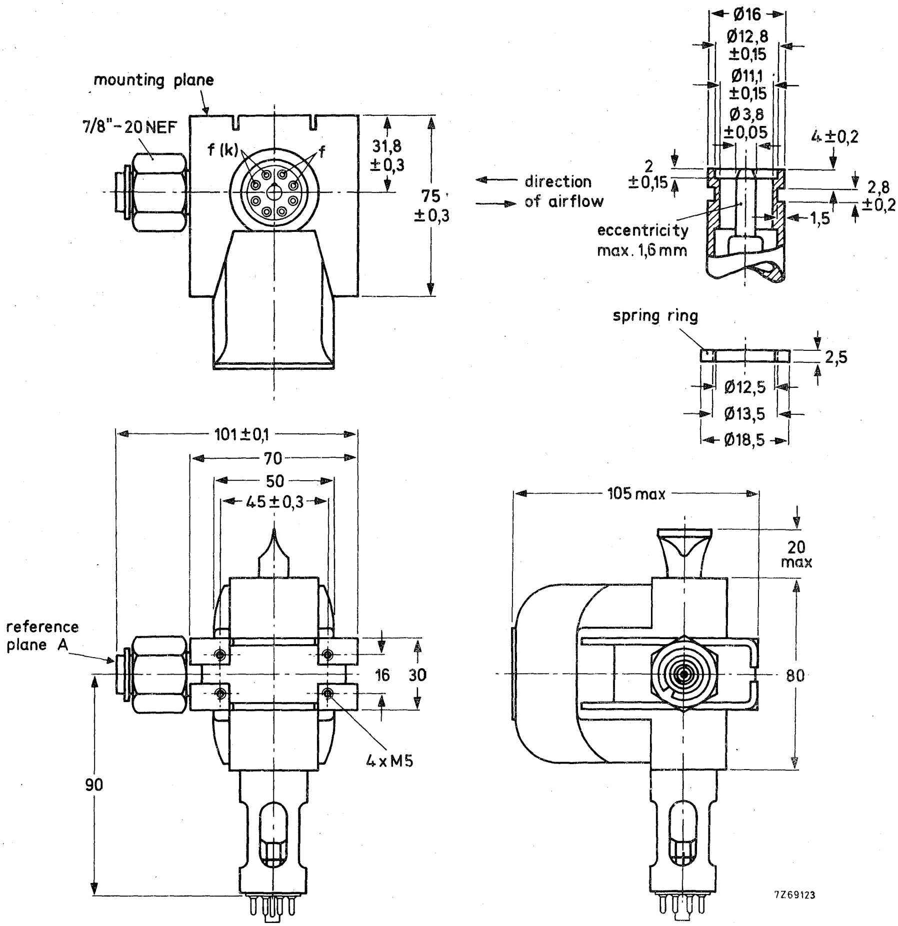
The minimum distance between the magnetron and magnetized materials shall be 10 cm.
The minimum distance between the magnetron and other ferromagnetic materials shall be 5 cm.

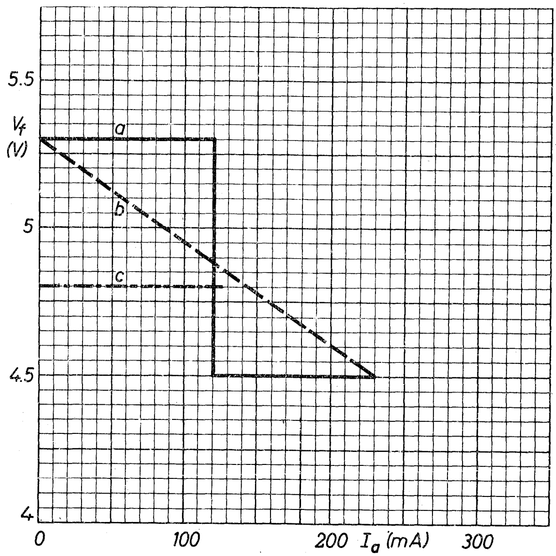
All tools (screwdrivers, wrenches etc.) used close to or in contact with the magnetron must be of non-magnetic material to avoid unwanted attraction and possible mechanical damage to tube parts as well as short circuit of the magnetic flux.

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

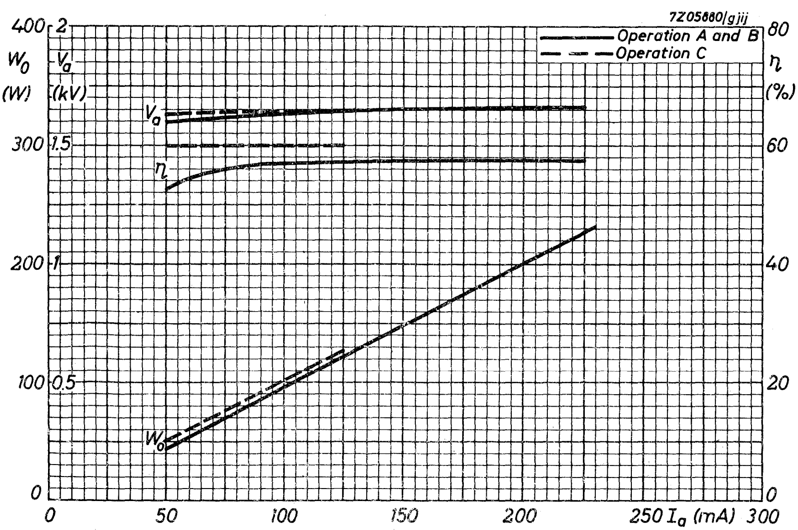
MECHANICAL DATA

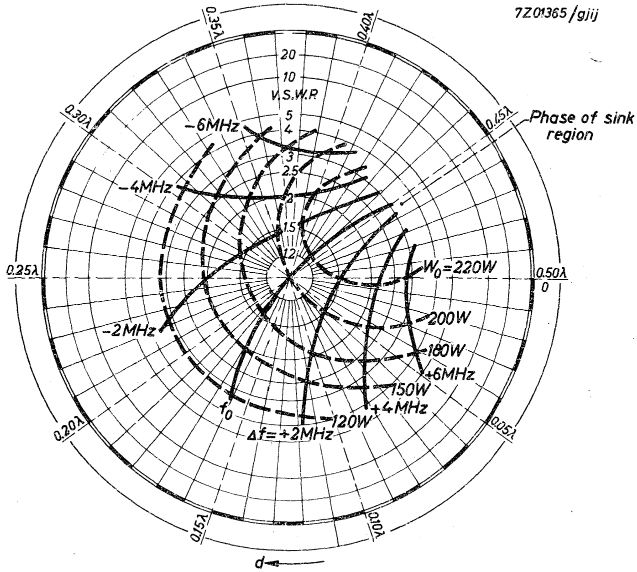
Dimensions in mm



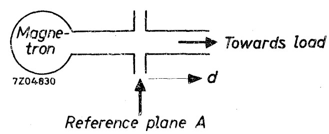


Heater voltage reduction curves





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

of the klystron. If necessary, the ceramic insulators and windows must be carefully cleaned, as dirt may damage the klystron on account of local over-heating. 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.

4.3. Switching on the heater current

If the data sheet does not contain special data concerning the heater current during switch-on, the tube may be switched on at full heater voltage.
If maximum values are stated for the heater current during switch-on, they relate to the absolute maximum instantaneous value under unfavourable conditions. In the case of A.C. supply this value will occur if the tube is switched on at the maximum amplitude of the highest mains voltage. It is possible to calculate the maximum current during switch-on if the cold resistance and the relationship between the heater current and the heater voltage are known. In practice a heater transformer more or less acting as a leakage transformer is mostly used for limiting the starting current, or a choke coil or resistor is connected in series with the primary of the heater transformer. This choke coil or resistor can be short-circuited by a relay whose action is delayed by about 15 seconds. By means of a calibrated oscilloscope it can be checked whether the starting current remains within the permissible limits; the supply lead may, if necessary, be used as precision resistance.

5. COOLING

5.1. Forced-air cooling

It is essential that the faces of tubes that are to be cooled by an air-blast should be hit as evenly as possible by the air stream, so as to prevent large differences in temperature which may give rise to mechanical stresses. In many cases (in particular with the large types of tubes) an additional air stream must be directed to the metal-to-glass or metal-to-ceramic seals. The cooling air is usually supplied from a fan via an insulating duct. This air should be filtered, so that all impurities and moisture are removed; in addition to this the radiator must be cleaned at regular intervals. The data concerning the cooling can be found in the data sheets. The cooling must be switched on together with the heating. After the klystron has been switched off cooling air must be supplied for some time; this period depends on the size of the tube and the load. If the cooling of whatever part of the tube is interrupted or if the quantity of cooling air is too small, the collector voltage and the heating must be switched off automatically.

5.2. Water-cooling

With water-cooled klystrons the cooling equipment is rigidly attached to the tube. If the equipment should be live, the cooling water must be supplied through insulating pipes, of sufficient lenght.
The water-cooling and air-cooling for other parts of the tube must be switched on together with the heating. The cooling-water circuit must be arranged so that the water always enters at the bottom, no matter how the tube is mounted. If the pumps should be out of operation, the water jacket(s) of the tube must always be full. In that case after-cooling may in general be done away with.
In many cases the metal-to-glass or metal-to-ceramic seals require additional cooling by a low velocity air flow. If the cooling water supply or additional

air-cooling should fail, the collector voltage and heating must immediately be switched off. Further cooling data can be found in the data sheets.
The specific resistance of the cooling water must be min. 20 kΩ-cm, the temporary hardness must be max. 6 German degrees of hardness. On principle destilledwater shouldbe used in the circulation cooler; to reduce the corrosive effect of the distilled water about 700 mg of 24-% dyamide hydrate and 700 mg sodium silicate must be added per litre. The pH-value should range from 7 to 9.
If frost is to be expected, a suitable anti-freezing mixture should be added.

6. STORAGE

Klystrons may only be stored in their original packing and according to the instructions, so as to avoid damage. For fitting the tubes must be removed from the packing and directly inserted into the support. In all cases the "Instructions for operation and maintenance" must be adhered to.
In the case of prolonged storage the vacuum of high-power klystrons should be checked at intervals of about three months and improved if necessary, both being possible with the aid of the built-in getter ion pump and a suitable power supply / test unit. During this operation the heater supply should preferably be turned on slowly.

U.H.F. POWER KLYSTRON

Power amplifier klystron in metal-ceramic construction designed for four external resonant cavities, magnetic beam focusing, continuous operating getter ion pump. The tubes are intended for use as U.H.F. power amplifier in T.V. transmitters.

QUICK REFERENCE DATA			
Frequency	YK 1000	400 to 620	MHz
	YK 1004	610 to 790	MHz
Power output		11	kW
Power gain		30	dB
Cooling	water and air.		

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

Cathode			dispenser type	
Heater voltage	V_f		7.5 to 8	V 1)
Heater current	I_f		32 ($\leq$ 36)	A

The heater current should never exceed a peak value of 80 A when applying a A.C. heater voltage or 65 A when applying a D.C. heater voltage.

Cold heater resistance	R_{f_o}		28	mΩ
Heating time before application of high voltage (waiting time)	T_w	unit	180	s

GETTER ION PUMP POWER SUPPLY

Pump voltage, unloaded (cathode reference)	V_{pump}		3.9	kV
loaded ($\approx$ 3 mA)	V_{pump}		3.0	kV
Internal resistance	R_i	approx.	300	kΩ
Pump current as a function of pressure	I_{pump}	See page 7		

1) During operation the applied heater voltage should not fluctuate more than $\pm$ 3%.

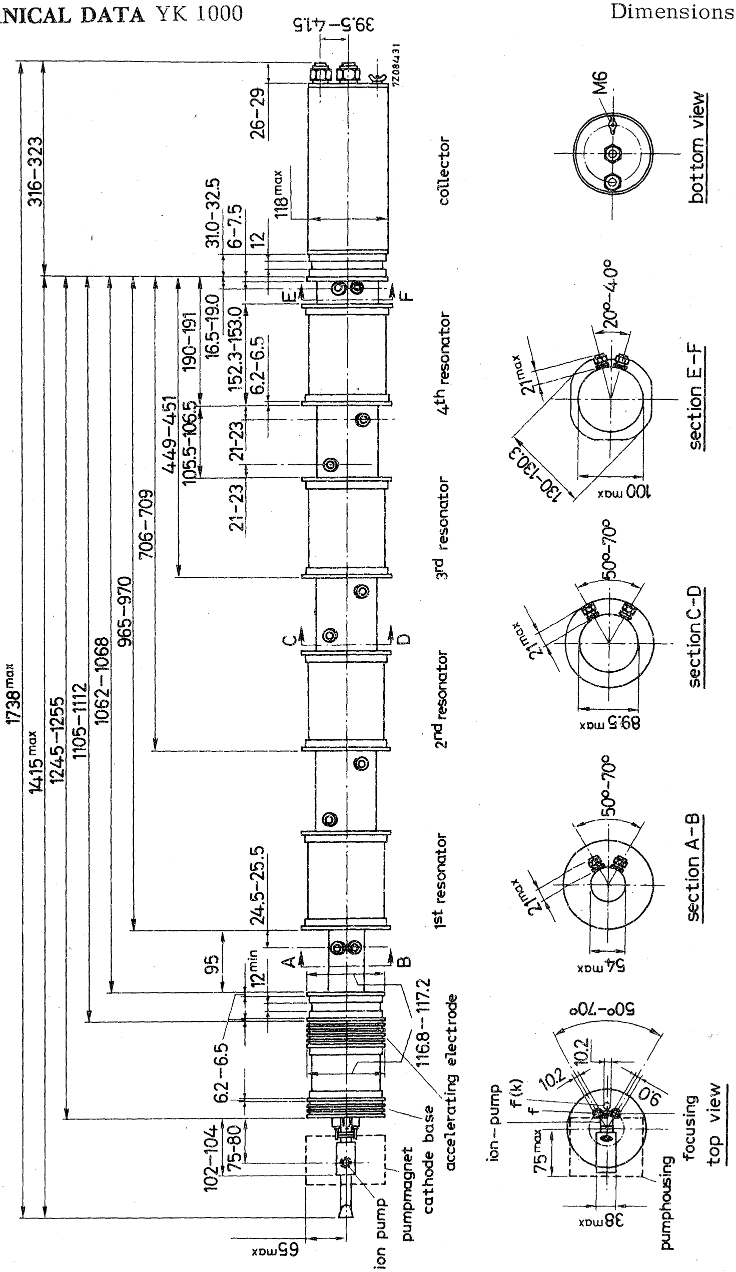
POWER SUPPLY FOR FOCUSING COILS

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

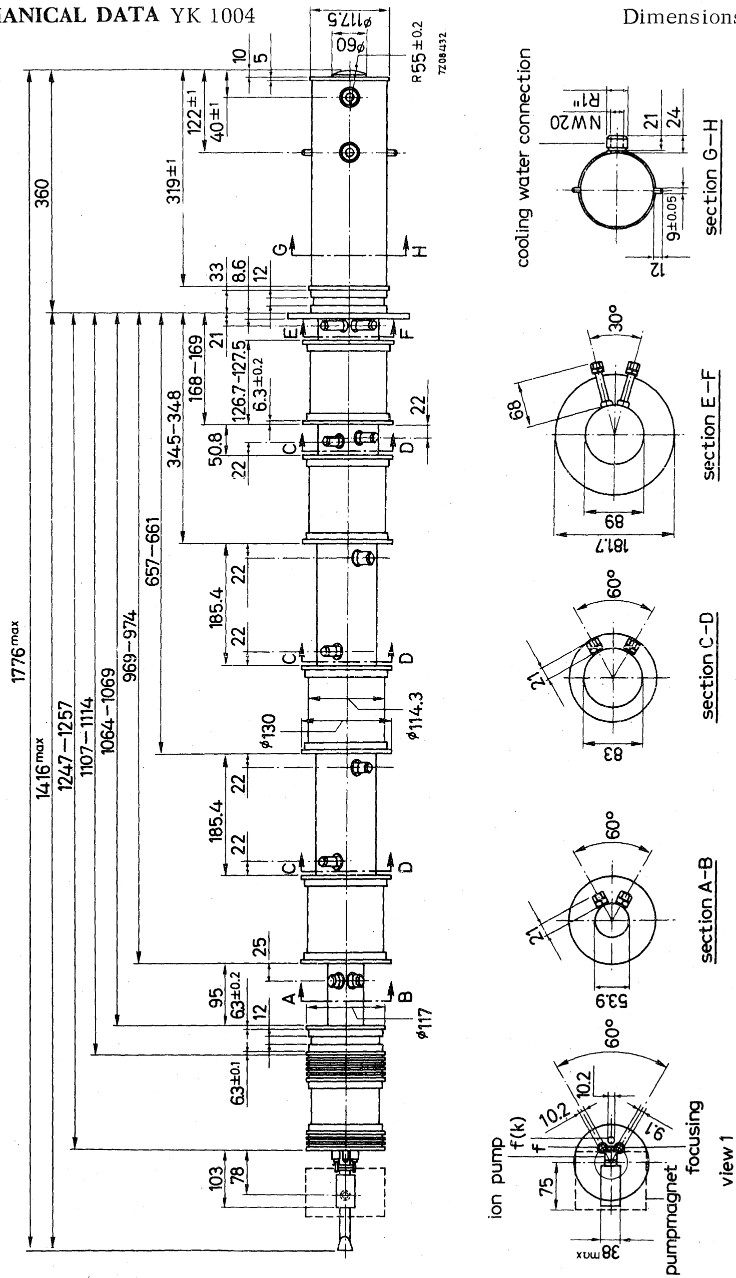
COOLING

Cathode base	low velocity air flow
Accelerating electrode	low velocity air flow
Drift tubes	water or glycol solution (30%) 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.

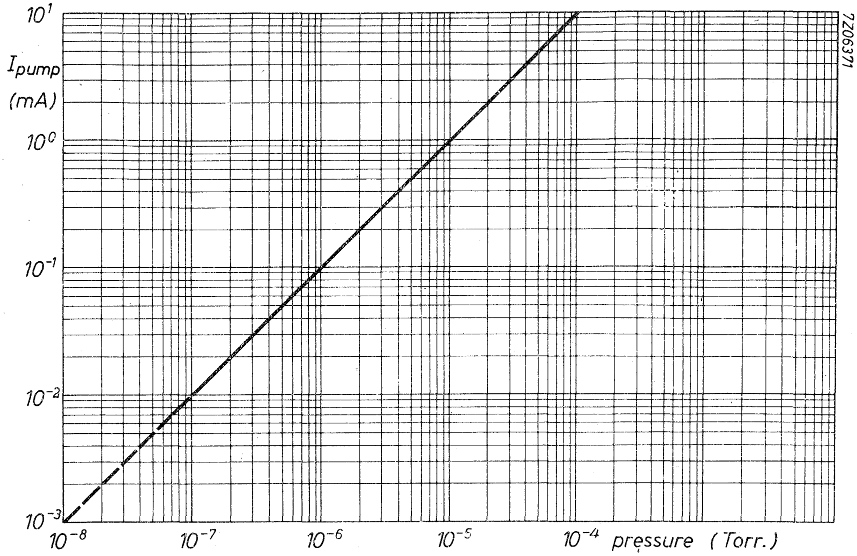
Cathode voltage	$-V_k$	max.	20	kV
Cathode voltage at zero current	$-V_{k_o}$	max.	21	kV
Cathode current	I_k	max.	2.1	A
Total drift tube current	I	max.	100	mA
Focusing electrode to cathode voltage	$-V_{foc/k}$	max.	500	V
Pump voltage (cathode reference)	$V_{pump/k}$	max.	4	kV
Pump current	I_{pump}	max.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

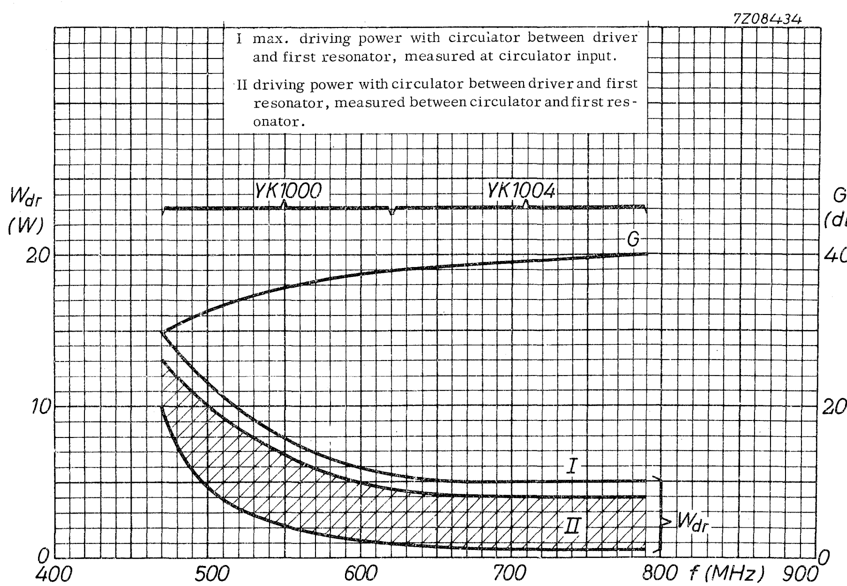
OPERATING CONDITIONS

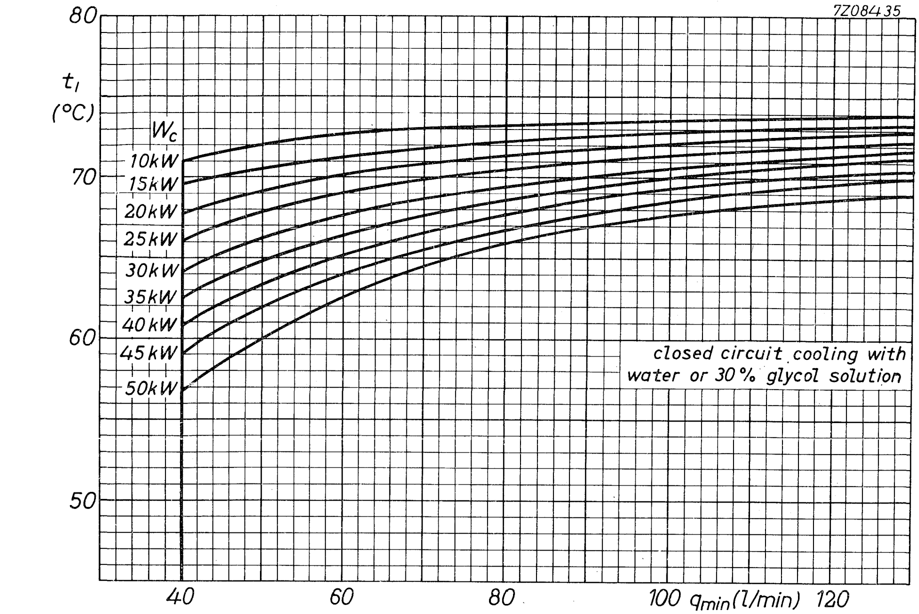
As a 10 kW T.V. picture amplifier in the band 470 MHz to 790 MHz according to the C.C.I.R. system with negative modulation. Unless otherwise mentioned all voltages are specified with respect to ground.

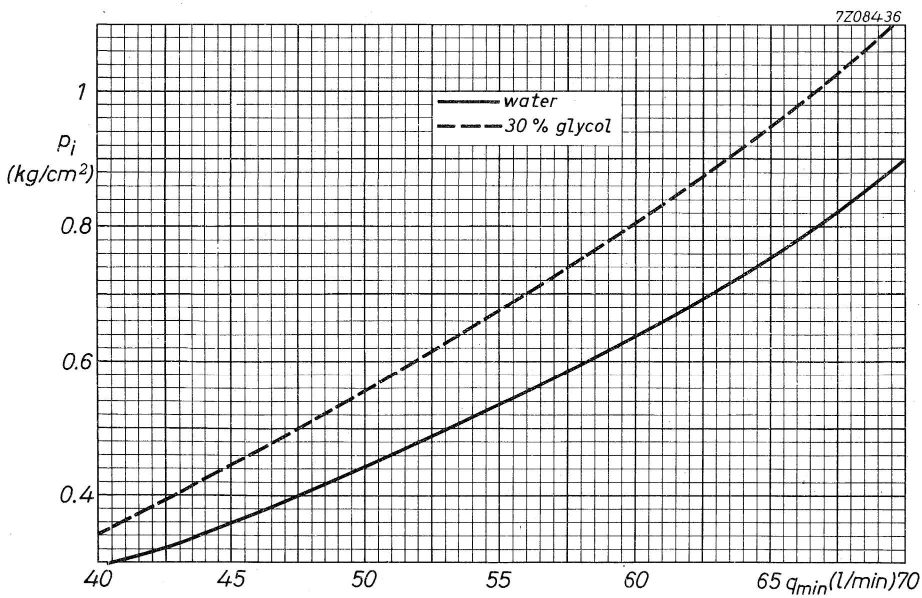
Cathode voltage	V_k	19.0	18.0	kV
Focusing electrode to cathode voltage	$V_{foc/k} \approx$	-250	-200	V
Cathode current	I_k	2.05	2.0	A
Drift tube current, static 1)	$I \approx$	40	40	mA
dynamic 2)	$I \approx$	50	50	mA
Driving power, sync		See curve		
Output power, sync	W_o	11	11	kW
Power gain	$G \approx$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

[1]) For optimum operating conditions the electron beam should be focused for minimum drift tube current.


7Z06371
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.)


7Z08434
I max. driving power with circulator between driver and first resonator, measured at circulator input.
II driving power with circulator between driver and first resonator, measured between circulator and first resonator.
YK1000
YK1004
W_{dr}
(W)
G
(dB)
G
I
II
W_{dr}
20
10
0
40
20
0
400
500
600
700
800
f (MHz)
900


7Z08435
80
t_l
(°C)
W_c
10kW
70
15kW
20kW
25kW
30kW
35kW
40kW
60
45kW
50kW
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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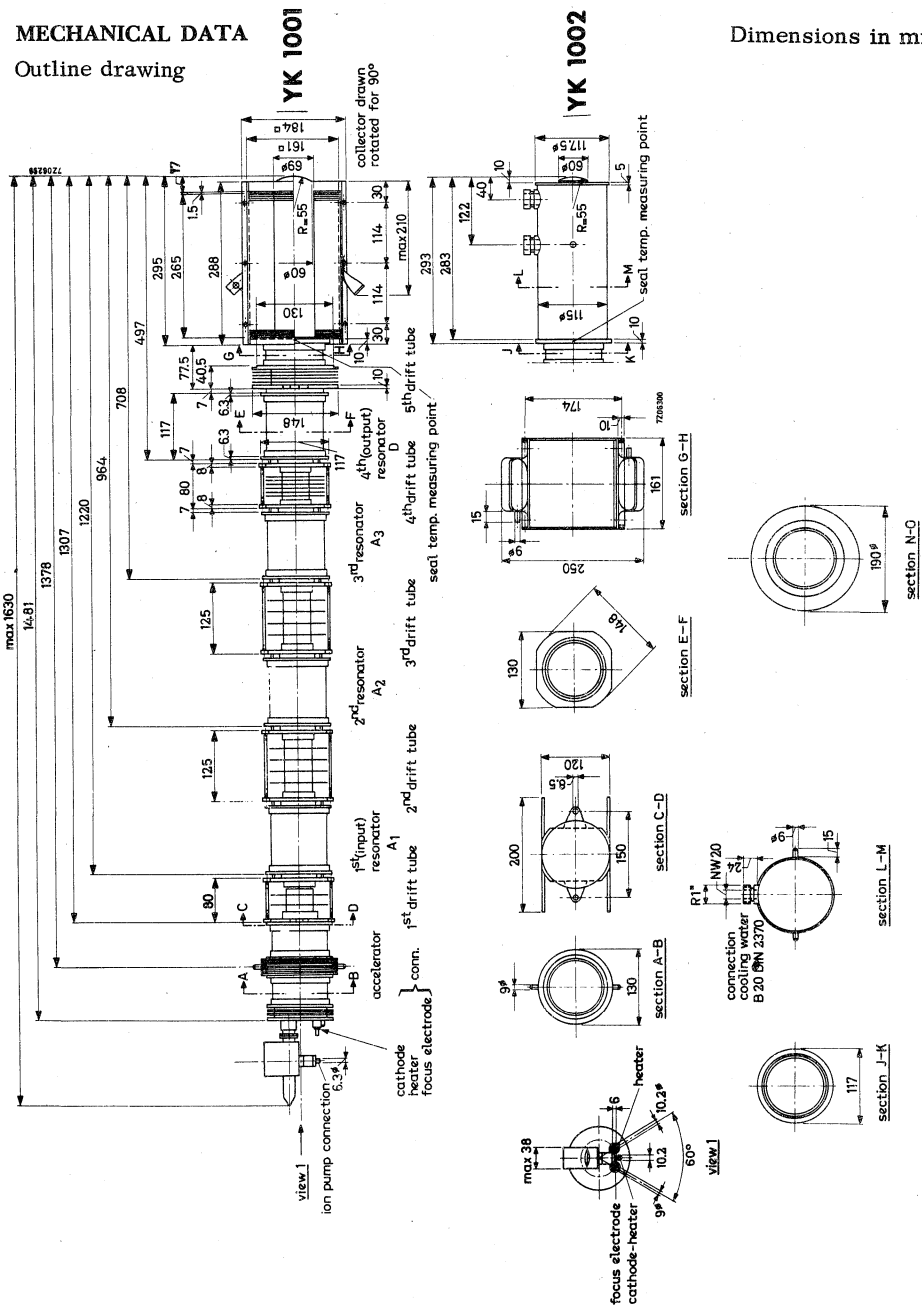
[1] In case of operation with a collector voltage less than -2kV these plates should be fitted along the collector in order to keep the collector temperatures below the max. values. See "Instructions for operation and maintenance".

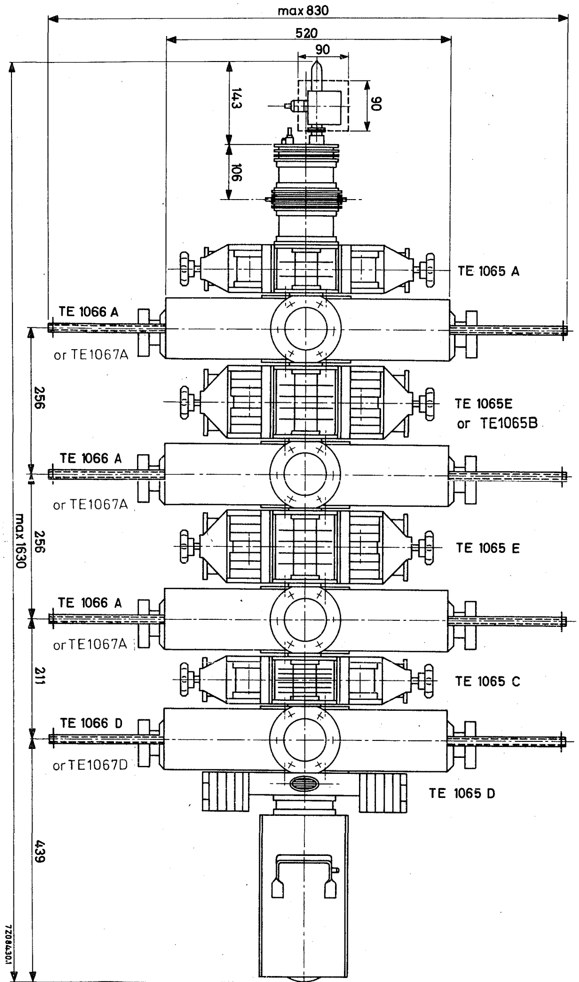
[2] If the klystron is used under T.V. transposer conditions replace 2xB by 2xE.

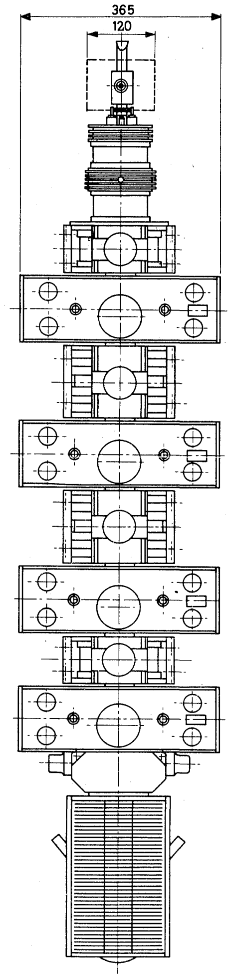
MECHANICAL DATA

Outline drawing

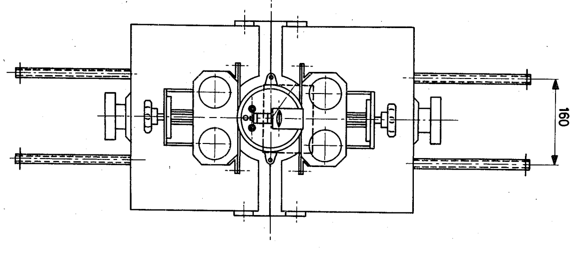
Dimensions in mm




max 830
520
90
14.3
90
106
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


365
120

YK1001


160

LIMITING VALUES AND OPERATING CONDITIONS

Unless otherwise mentioned all voltages are specified with respect to ground.

LIMITING VALUES (Absolute max. rating system)

Heater voltage	max.	8.5	V
Cathode voltage	max.	-22	kV
Cathode voltage at zero current	max.	-25	kV
Accelerating electrode voltage at zero current	max.	-25	kV
Collector voltage	max.	-7	kV
	min.	-0.5	kV
Focusing electrode to cathode voltage	max.	-700	V
	min.	-100	V
Series resistance in accelerating electrode circuit	max.	20	kΩ
	min.	10	kΩ
Cathode current	max.	2.3	A
Drift tube current [1]	max.	150	mA
Beam power	max.	42	kW
Collector dissipation	max.	40	kW
Voltage standing wave ratio	max.	1.5	
Pump voltage	max.	4.5	kV
Pump current	max.	15	mA
Temperature of			
cathode base and accelerating electrode	max.	125	°C
drift tubes 1, 2 and 3	max.	80	°C
drift tubes 4 and 5	max.	150	°C
resonant cavity D	max.	125	°C
collector seal YK1001	max.	200	°C
collector body YK1001 [2]	max.	300	°C
outlet cooling water YK1002	max.	75	°C

1) The limiting values for various operating conditions are given on page 12

2) For safeguarding this temperature limit it is recommended to measure the air outlet temperature at least at two places, viz. one at 5 cm and one at 15 cm from the upper collector plate and at a distance of 5cm from the cooling fins. See also "Instructions for operation and maintenance".

OPERATING CONDITIONS

During operation the applied voltages should not fluctuate more than ± 3%. 1)

A. As 5 kW and 10 kW vision amplifier in the band 470 MHz to 860 MHz in accordance with the C.C.I.R. system with negative modulation. 2)3)
Bandwidth (-1 dB): 6 MHz

Output power, peak sync		5.5	5.5	11	11	kW
Driving power, peak sync 4)5)6)		8	8	10	10	W
Power gain 4)		30	30	30	30	dB
Cathode to collector voltage 7)		-16.0	-11.5	-18	-13.5	kV
Collector voltage 8)		-0.5	-5	-0.5	-5	kV
Accelerating electrode voltage 9)		0	0	0	0	kV
Focusing electrode to cathode voltage 16)	≈	-400	-400	-400	-400	V
Cathode current		1.6	1.6	1.9	1.9	A
Drift tube current, static 10)		25	30	25	30	mA
black level 11)	≈	40	80	40	100	mA
Differential gain 12)	≈	80	80	80	80	%
Sync compression 13)	≤	45/25	45/25	45/25	45/25	
V.S.B. suppression 14)	≤	-20	-20	-20	-20	dB
Noise with ref. to black level 15)	≤	-46	-46	-46	-46	dB

Tuning of cavities with respect to carrier frequency

Cavity A1	approx.	+ 3	MHz
Cavity A2	approx.	-0.5	MHz
Cavity A3	approx.	+4.5	MHz
Cavity D	approx.	0	MHz

External cavity loading at black level for 11 kW sync power output

Cavity A1	max.	5	W
Cavity A2	max.	100	W
Cavity A3	max.	200	W

B. As 1 kW, 2 kW and 4 kW TV sound amplifier in the band 470 to 860 MHz 2)3)

Output power		1.1	1.1	2.2	2.2	4.4	4.4	kW
Driving power 4)5)	≤	0.5	0.5	0.5	0.5	0.5	0.5	W
Cathode to coll. voltage 7)		-18	-13.5	-18	-13.5	-18	-13.5	kV
Collector voltage		-0.5	-5	-0.5	-5	-0.5	-5	kV
Acc. electr. voltage		-9	-9	-7.5	-7.5	-5.5	-5.5	kV
Foc. electr. to cath. voltage	≈	-400	-400	-400	-400	-400	-400	V
Cathode current		0.5	0.5	0.7	0.7	1.0	1.0	A
Drift tube current dyn 10)	≈	40	50	40	50	50	70	mA

Notes see page 7

Notes to page 6

1) Fluctuations of the beam voltage up to ± 3% will not damage the tube; to meet the signal-transfer quality requirements the nominal beam voltage should not vary more than ± 1%.

2) With the appropriate focusing magnets TE1065, cavities TE1066 and a circulator between the driver and input cavity A1.

3) In case of a failure all electrode voltages for the klystron except the pump and heater voltages should be switched off, and reduced to less than 5% of the nominal value within 500 ms after the failure has occurred.

4) Dependent on operating frequency, see page 12

5) The driving power Wdr is measured between the circulator and the first cavity at a 50 ohm resistance and represents the sum of the forward and the reflected power in the first cavity.

6) A pre-correction is to be introduced in the pre-stage to compensate for the level dependency of the bandpass curve caused by non-linearities of the klystron, see "Instructions for operation and maintenance".

7) At frequencies above 790 MHz a higher beam power is required to meet the nominal output requirement. Operating data on request.

8) In case of operation with a collector voltage less than - 2kV the temperature-compensating plates TE1073 should be fitted along the collector. See "Instructions for operation and maintenance".

9) It is recommended to obtain this voltage from a voltage divider between cathode and ground, which should carry a quiescent current of minimum 3 mA.

10) To be focused for minimum drift tube current.

11) At black level to be focused for minimum drift tube current.
If necessary to obtain the required signal transfer quality, a deviation of max. 10% from this minimum current is permitted. The lim. value, see page 12, may, however, not be exceeded.

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

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

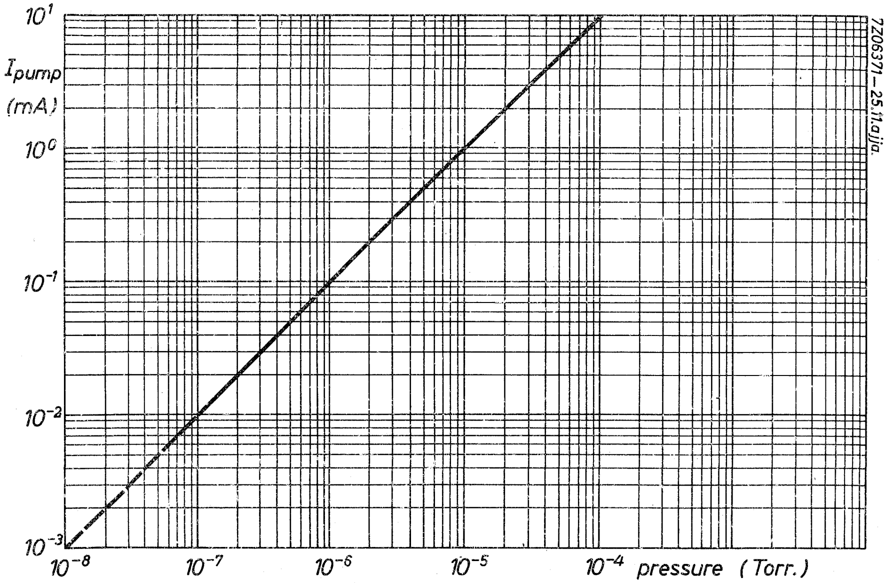
14) Measured with 10 to 70% modulation, without compensation. V.S.B. filter between driver and klystron.

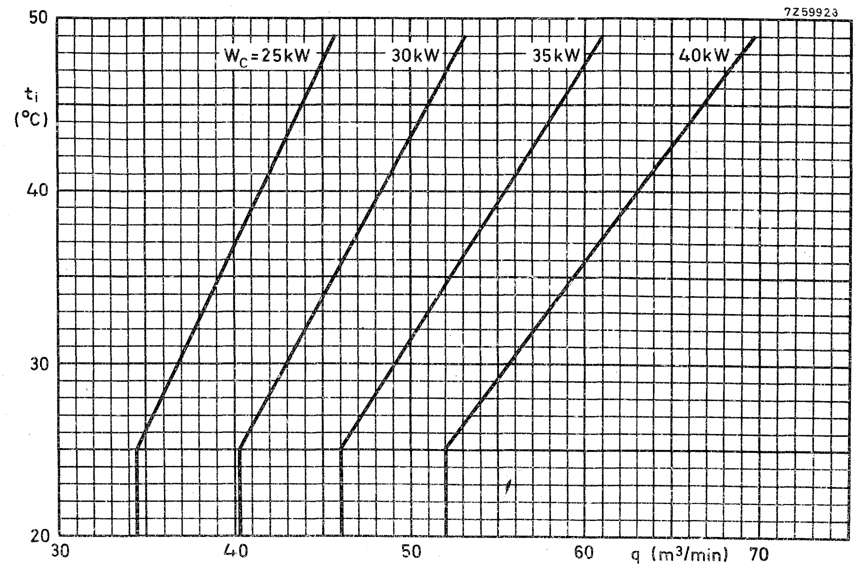
15) Produced by the klystron itself, without hum from power supplies.

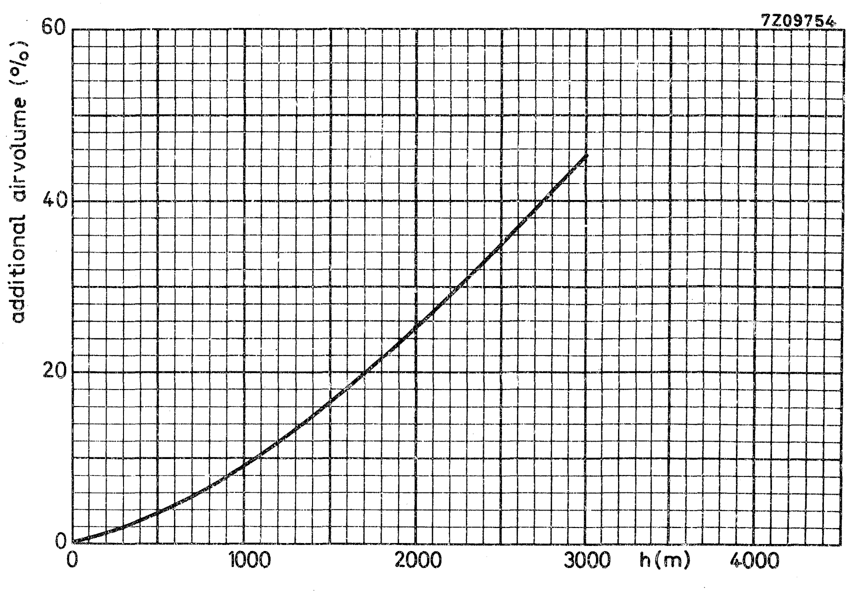
16) The power supply should be adjustable from −100 V to −700 V and be preloaded with min. 10 mA at −700 V.

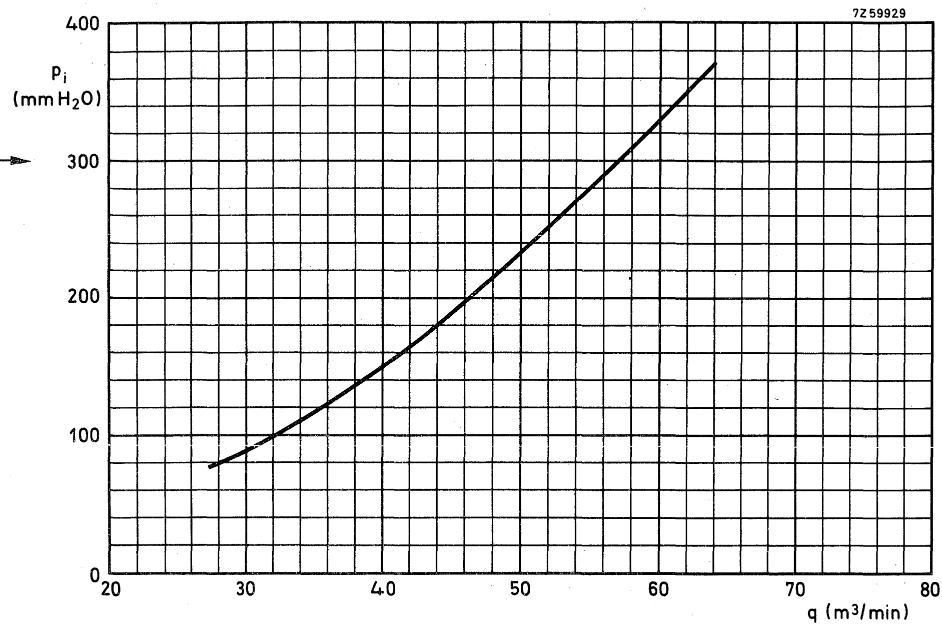
Weight

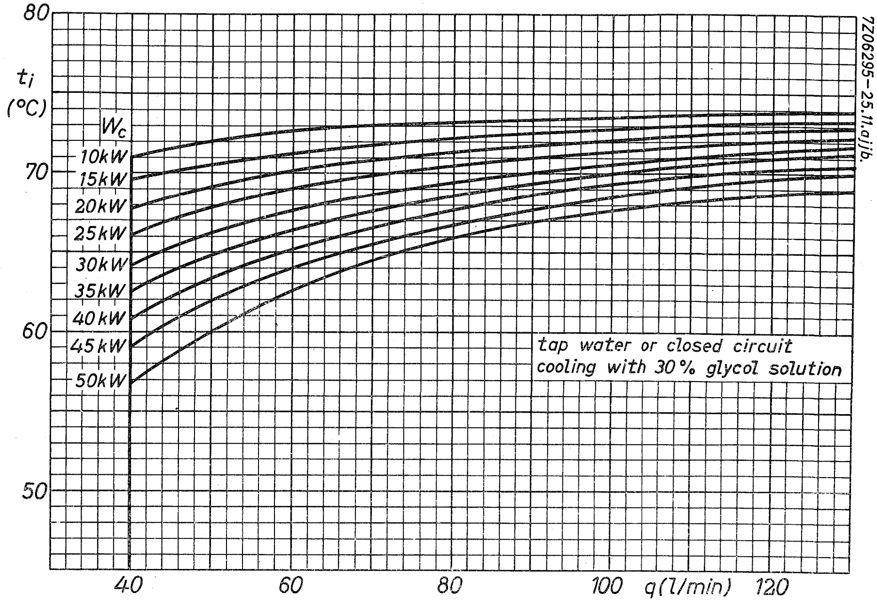
Net weight	YK1001	approx.	55	kg
	YK1002	approx.	45	kg
Total weight of accessories		approx.	125	kg

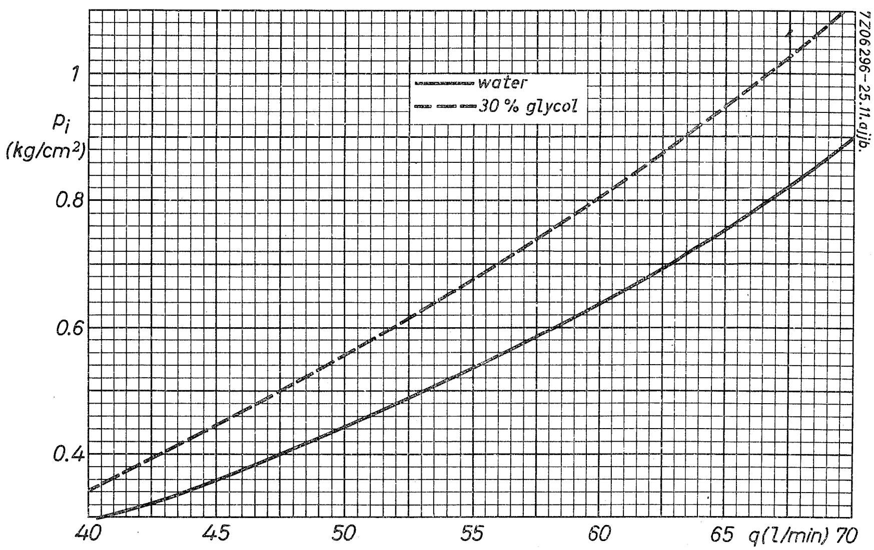

10^1
I_{pump}
(mA)
10^0
10^{-1}
10^{-2}
10^{-3}
10^{-8}
10^{-7}
10^{-6}
10^{-5}
10^{-4}
pressure (Torr.)
7Z06371–25.11.ajja.


7Z59923
W_c=25kW
30kW
35kW
40kW
t_i (°C)
50
40
30
20
30
40
50
60
70
q (m³/min)


7Z09754
additional airvolume (%)
60
40
20
0
0
1000
2000
3000
4000
h(m)


7Z59929
400
p_i
(mm H_2O)
300
200
100
0
20
30
40
50
60
70
80
q (m^3/min)


80
t_i
(°C)
W_c
10kW
15kW
20kW
25kW
30kW
35kW
40kW
45kW
50kW
70
60
50
40
60
80
100
q(l/min)
120
tap water or closed circuit cooling with 30 % glycol solution
7Z06295-25.11.ajib.


1
p_i
(kg/cm²)
0.8
0.6
0.4
40
45
50
55
60
65
q(l/min)
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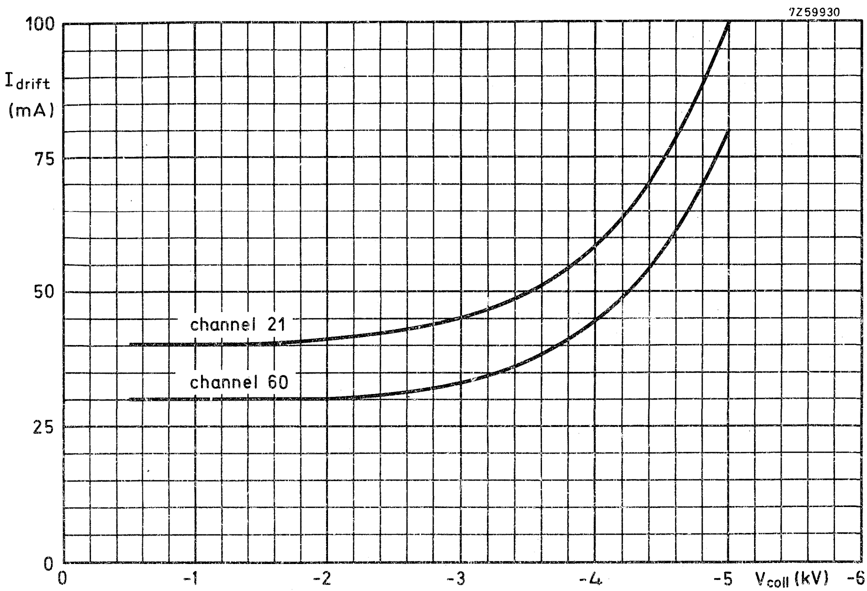
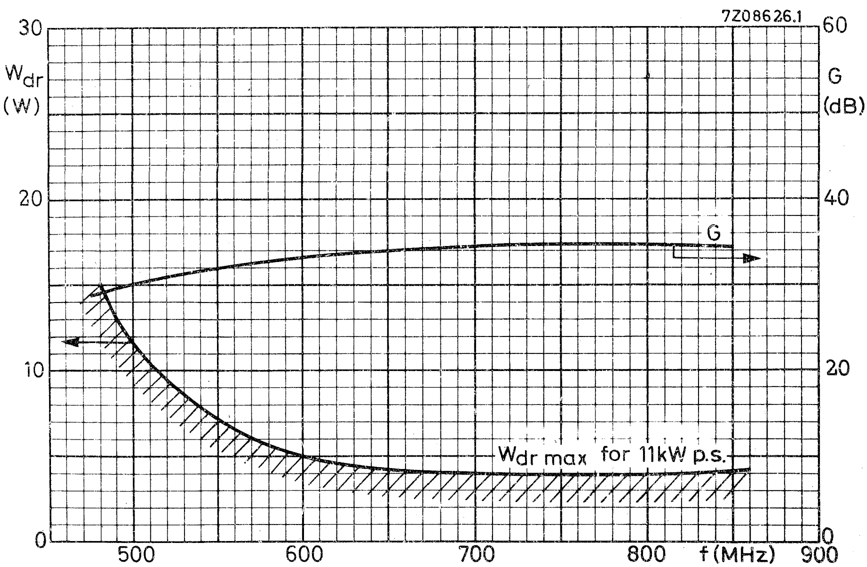
water
30 % glycol
7Z06296-25.11.ajib.


7Z59930
100
I drift
(mA)
75
50
channel 21
channel 60
25
0
0
-1
-2
-3
-4
-5
Vcoll (kV)
-6


7Z08626.1
30
Wdr
(W)
20
10
0
60
G
(dB)
40
20
0
G
Wdr 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)

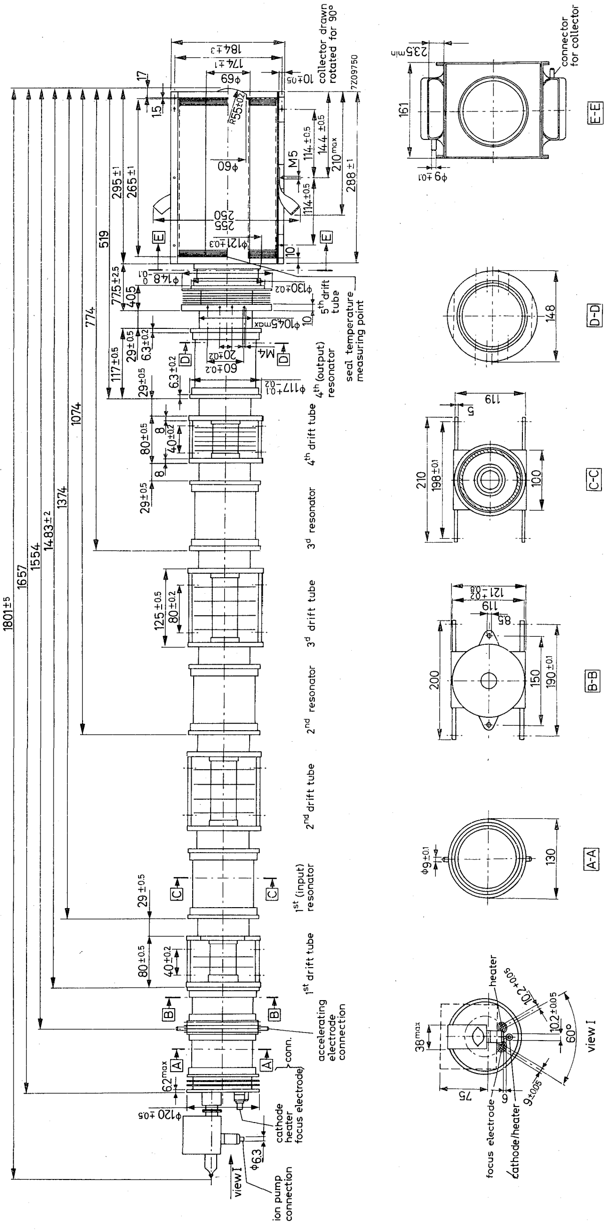
WEIGHT

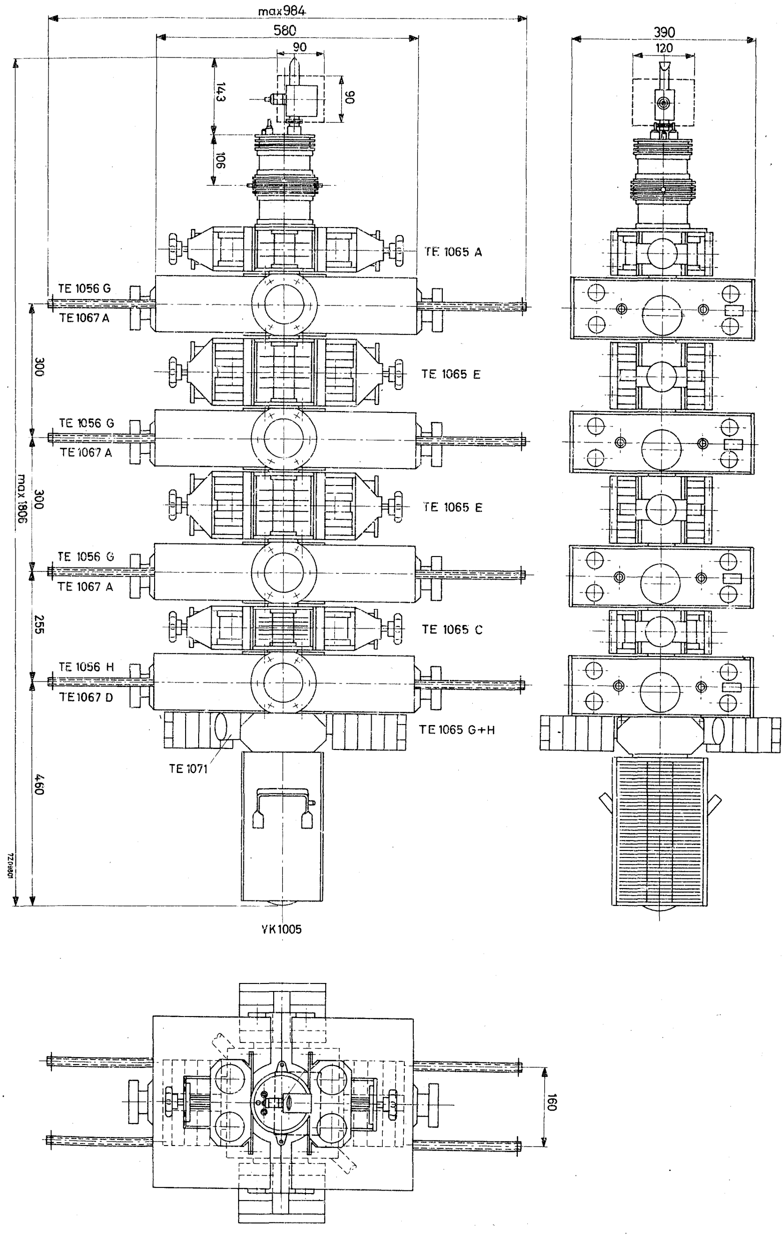
Net weight YK1005	approx. 60 kg
Accessories, total	approx. 130 kg

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
300
max 1806
TE 1065 E
TE 1056 G
TE 1067 A
255
TE 1065 C
TE 1056 H
TE 1067 D
TE 1065 G+H
TE 1071
460
7Z09601
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.

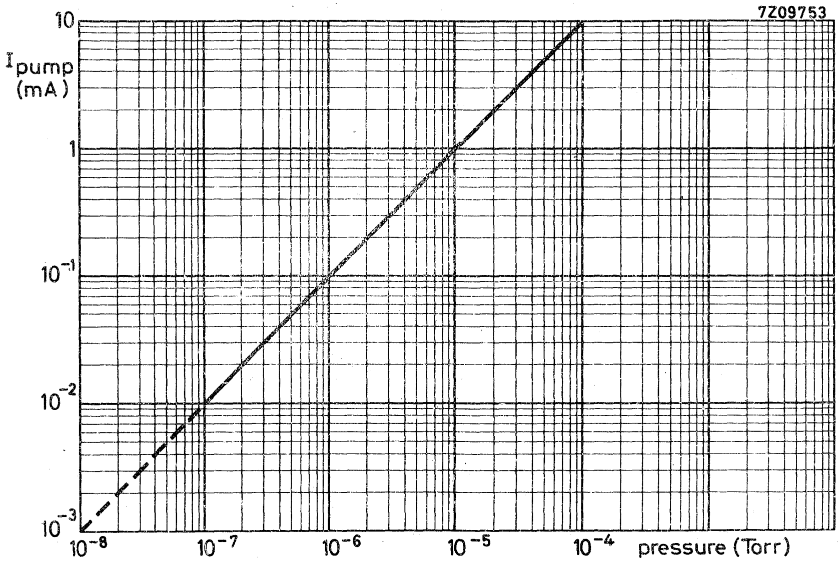
10) Measured with a sawtooth voltage with amplitude between 17% and 75% of the peak sync value, on which is superimposed a 4.43 MHz sine wave with a 10% peak-to-peak value.

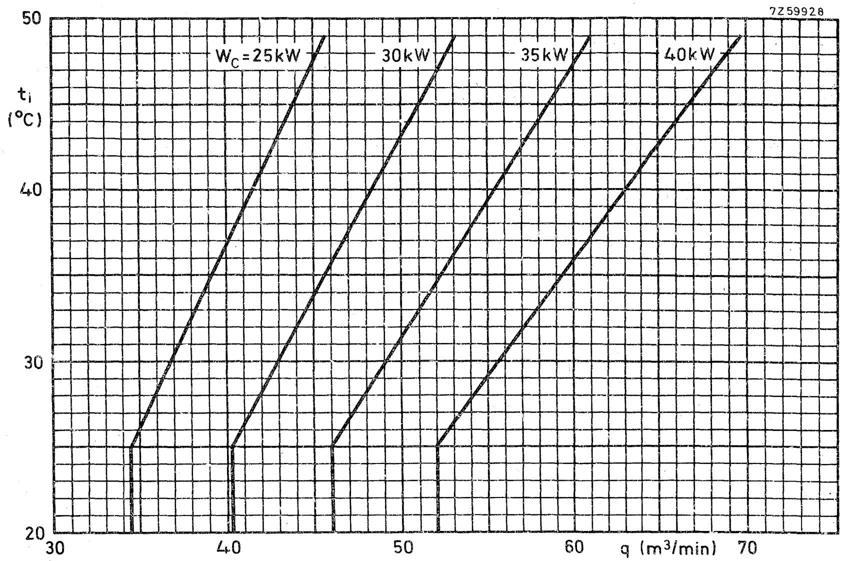
11) A picture/sync ratio of 75/25 for the outgoing signal of the klystron requires a ratio of max. 55/45 for the incoming signal.

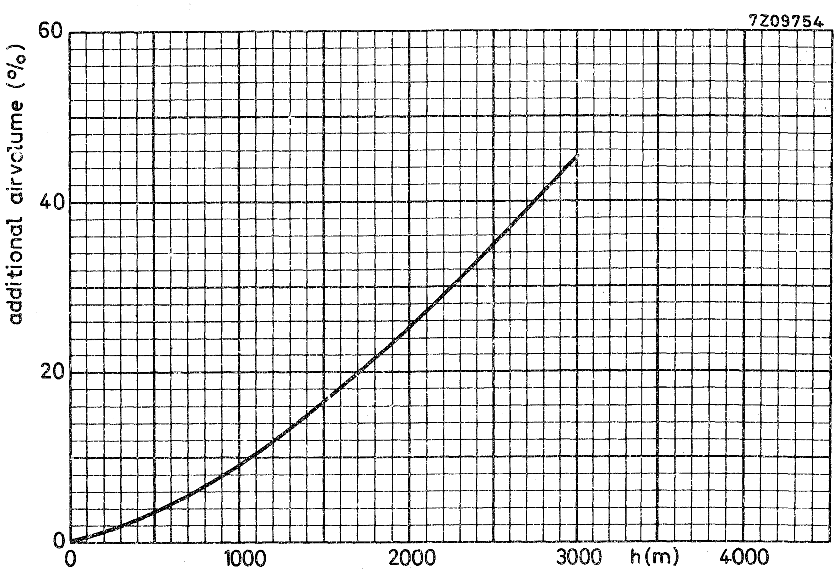
12) Measured with modulation 10 to 75%, without compensation, VSB filter between driver and klystron.

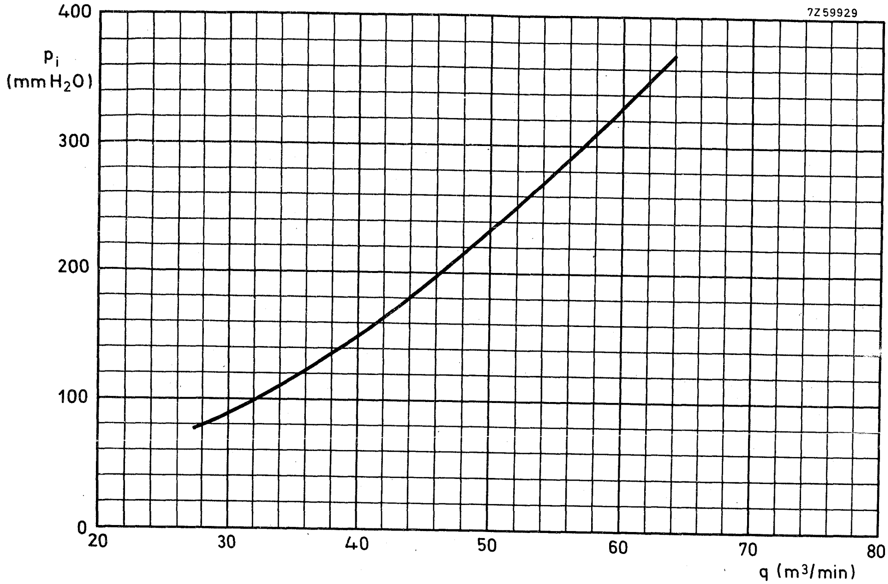
13) Produced by the klystron itself; excluded hum from power supplies.

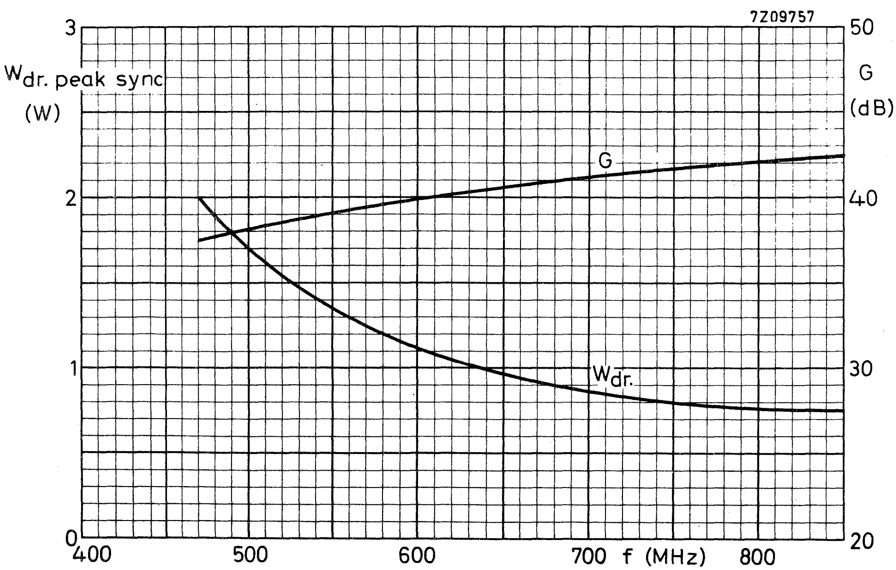
14) The power supply should be adjustable from -100 V to -700 V and be pre-loaded with min. 10 mA at -700 V.


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
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)


7Z09757
3
$W_{dr.\ peak\ sync}$
(W)
2
1
0
50
G
(dB)
40
30
20
G
$W_{dr.}$
400
500
600
700
f (MHz)
800

PULSED POWER KLYSTRON

Fixed frequency pulsed power klystron in metal-ceramic construction for the range 2998 ± 5 MHz, with 3 internal cavities, electromagnetic focusing, continuously operating getter-ion pump, coaxial input connector and S-band output wave guide, water cooled, intended as amplifier in linear accelerators and similar applications.

QUICK REFERENCE DATA			
Frequency [1]	f	2998 ± 5	MHz
Peak power output	W_{o_p}	6	MW
Power gain	G	30	dB
Focusing		electromagnetic	
Focusing coils and cavities		integral	
Cooling		water	
R.F. input connector		coax type N [2]	
R.F. output flange		on request	

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

Cathode : oxide coated

Heater voltage	V_f	3 to 4.6	V	
Heater current	I_f	70 to 82	A	3)

The heater current should never exceed a peak value of 150 A when applying an A.C. heater voltage or 100 A when applying a D.C. heater voltage.

Cold heater resistance	R_{f_o}	6	mΩ
Heating time before application of high voltage (waiting time)	T_w	min. 45	min.

GETTER-ION PUMP POWER SUPPLY

Pump voltage, unloaded	V_{pump}	4	kV
Internal resistance	R_i	approx. 300	kΩ
Pump current as a function of pressure	I_{pump}	See page A	

1) The klystron is factory tuned to 2998 MHz but can be delivered for any frequency within the range 2993 MHz to 3003 MHz. Other frequencies on request
2) Other types on request
3) The correct heater current is marked on each tube

COOLING (valid for a pulse repetition rate up to 50 p.p.s.) [1)]

Drift tubes and focusing coils	q	min.	4	l/min.
	p	max.	3.5	kg/cm^2
Collector	q	min.	7	l/min.
	p	max.	3.5	kg/cm^2
Specific resistance of cooling water	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

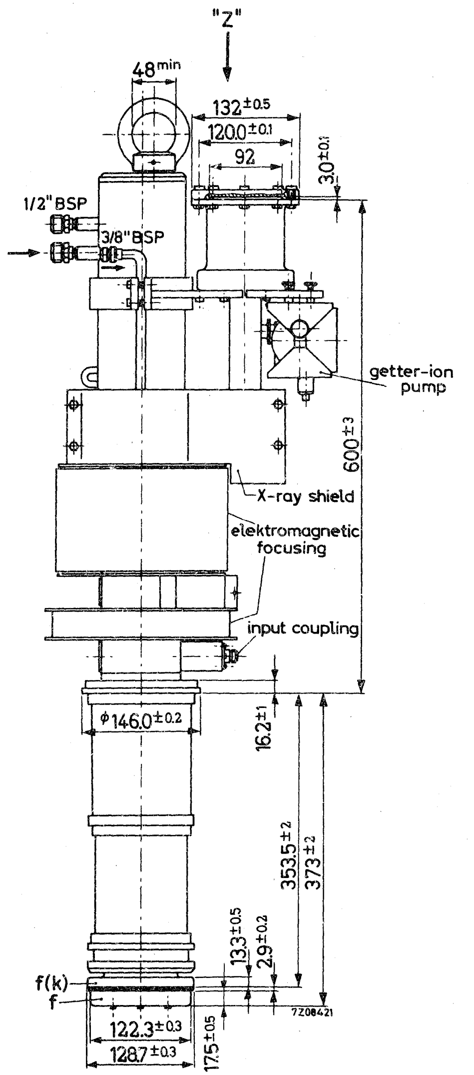
Weight

Net weight approx. 110 kg

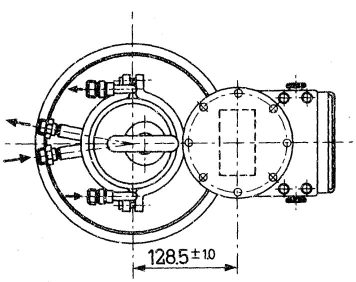
[1)] Data for operation at p.r.r. higher than 50 p.p.s. on request.

MECHANICAL DATA

Dimensions in mm



view "Z"



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

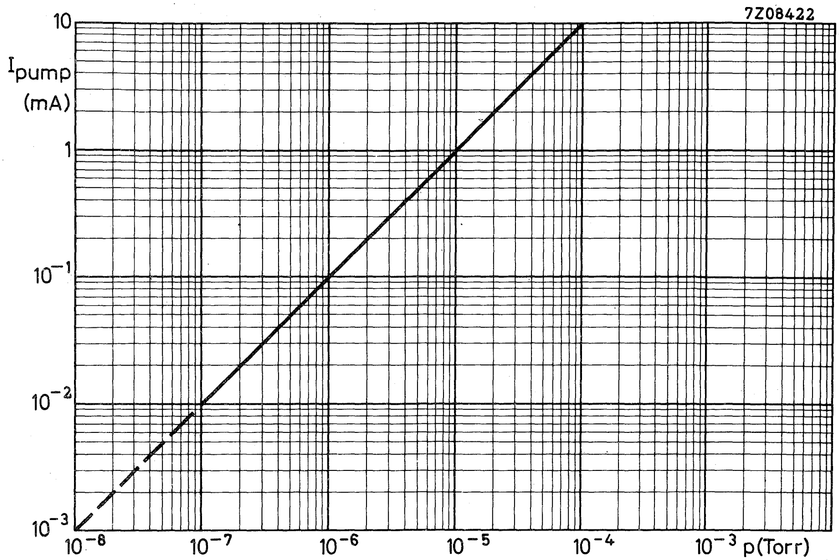
Cathode voltage, peak	$-V_{kp}$	max.	220	kV
Cathode current, peak	I_{kp}	max.	120	A
Beam input power, peak	W_i	max.	25	MW
R.F. input power, peak	W_{dr}	max.	10	kW
R.F. output power, peak	W_{op}	max.	8	MW
Pulse repetition rate	p.r.r.	max.	600	p.p.s.
Pulse duration	T_{imp}	max.	3	μs
Voltage standing wave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

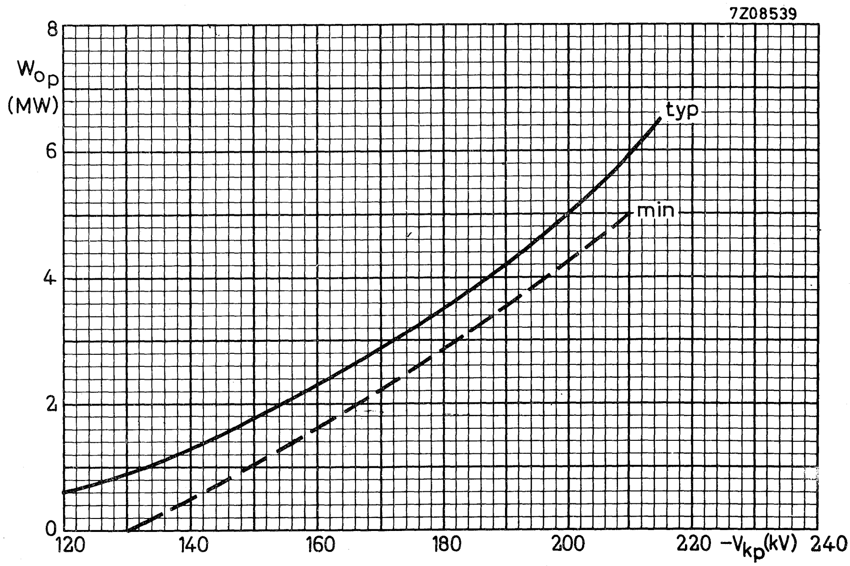
OPERATING CONDITIONS 1)

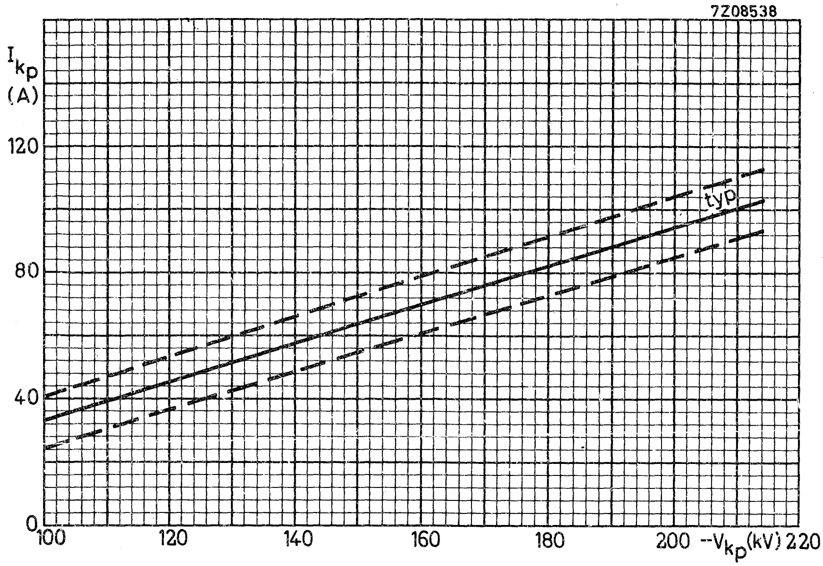
Frequency	f	2998	MHz
Heater current	If	2)	
Cathode voltage, peak 3)	V_{kp}	- 210	kV
Cathode current, peak	I_{kp}	100	A
mean	I_k	10	mA
Focusing magnet voltage	V_{magn}	40	V
Focusing magnet current 4)	I_{magn}	29	A
Pulse repetition rate 5)	p.r.r.	50	p.p.s.
Pulse duration	T_{imp}	2.2	μs
R.F. input power	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.

7Z2 9046


7Z08422
10
Ipump
(mA)
1
10⁻¹
10⁻²
10⁻³
10⁻⁸
10⁻⁷
10⁻⁶
10⁻⁵
10⁻⁴
10⁻³ p(Torr)


7Z08539
8
Wop
(MW)
6
4
2
0
typ
min
120
140
160
180
200
220 −Vkp(kV) 240


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

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.

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

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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 Output 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	40649	40649	40649
Heater/cathode	40649	40649	40649
Focusing electrode	40634	40634	40634
Accelerating electrode	40634	40634	40634
Collector	40649	40649	40649
Ion pump	40634	40634	40634
Earth	40649	40649	40649

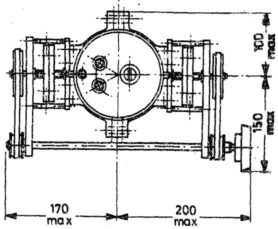
Special parts

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

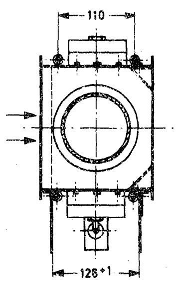
[1]) For frequency range 470 to 604 MHz (channel 21 to 37) : 2722 162 01551
For frequency range 604 to 638 MHz (channel 38 to 41) : 2722 162 01561

MECHANICAL DATA

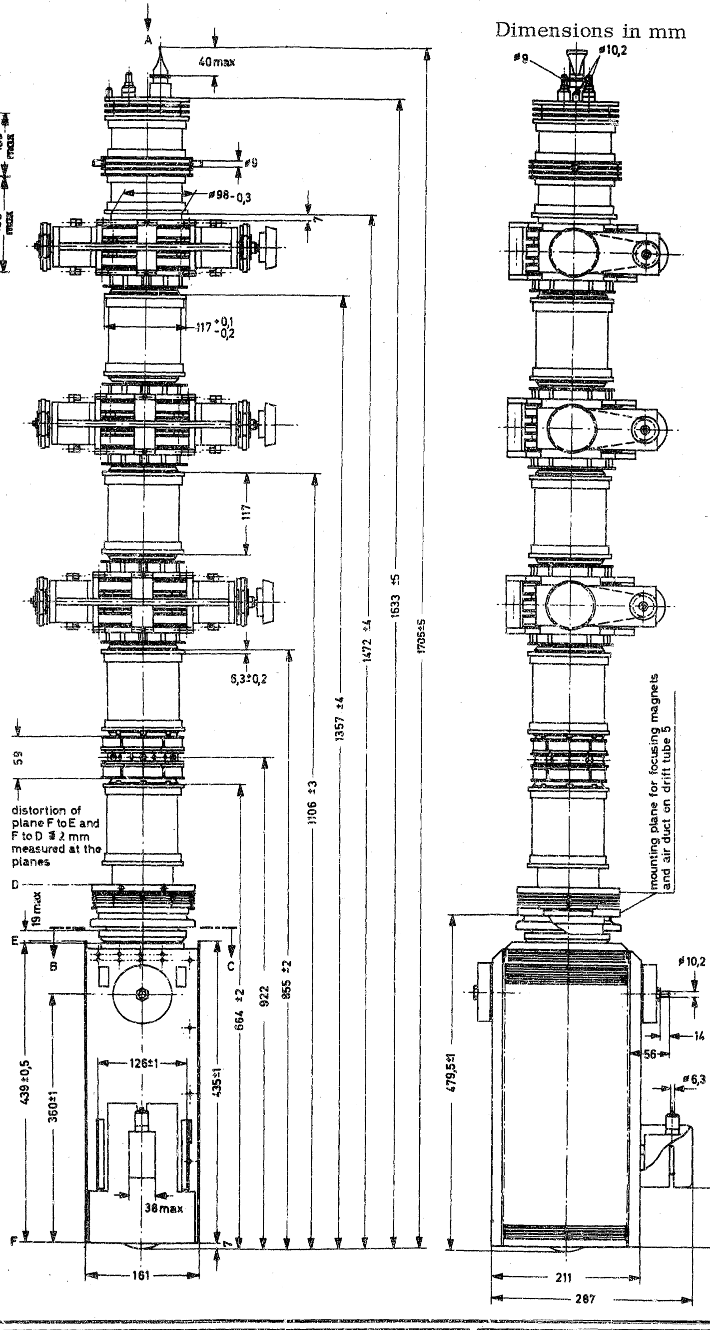
Dimensions in mm

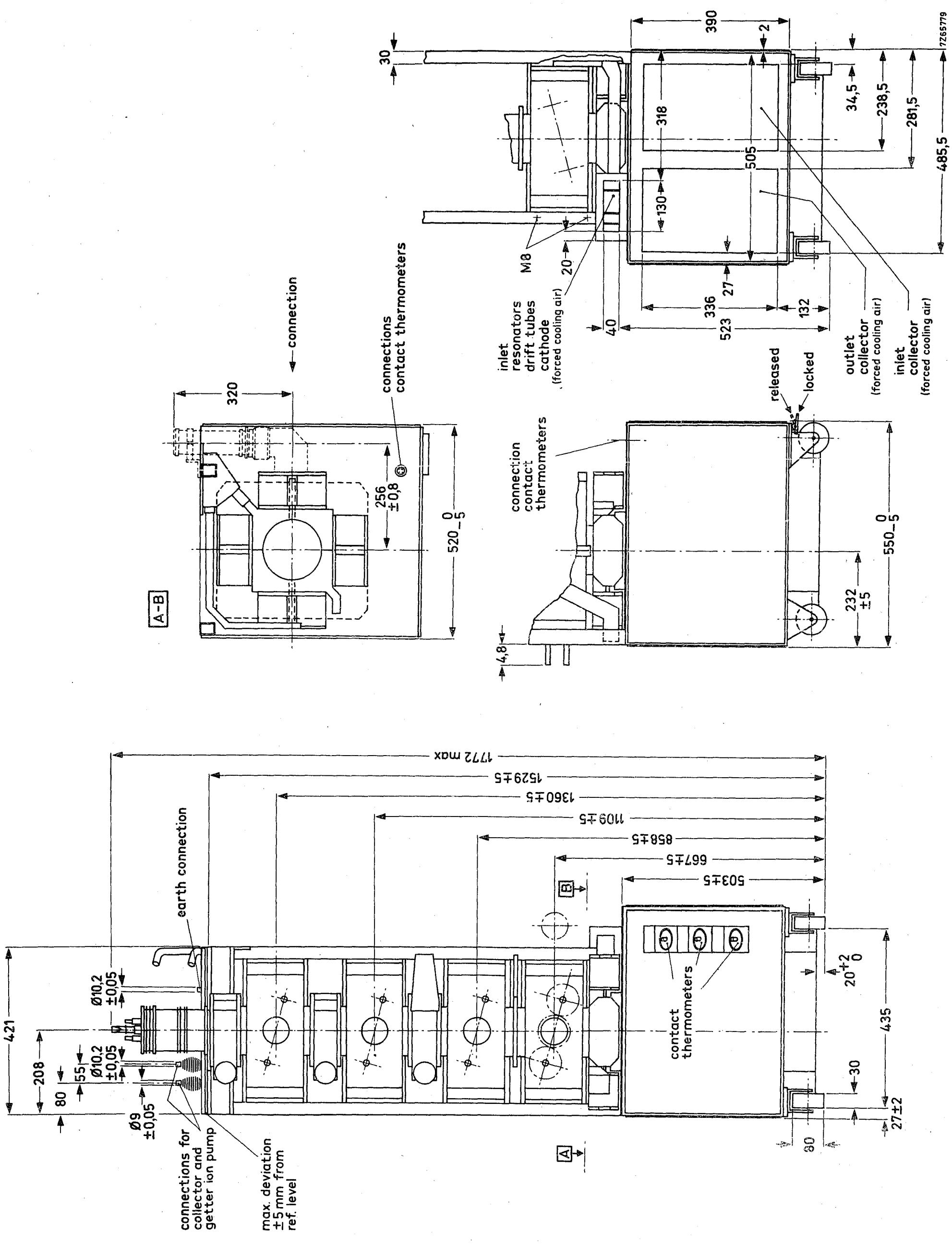


View A



Section B-C




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

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]

Output power, peak sync	22			kW
	min.	typ.	max.	
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).

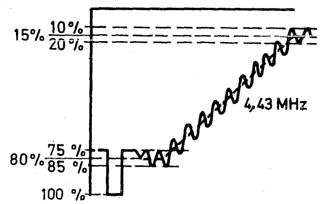
5) Calculated from $(1-V_{black}/V_{sync})_{in} / (1-V_{black}/V_{sync})_{out}$

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.

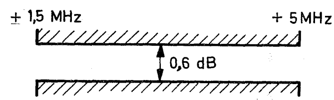
9) Measured with a sawtooth voltage with an amplitude between 15 and 80 % of the peak sync value on which is superimposed a 4,43 MHz sine wave with a 10 % peak to peak value.



10) Phase difference to burst signal.

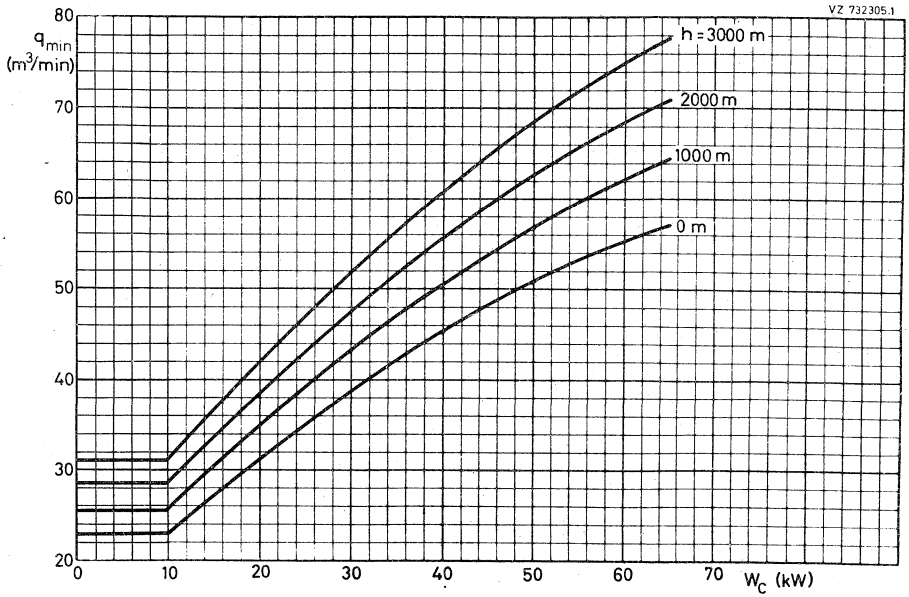
11) With respect to ± 0,5 MHz around the carrier frequency.

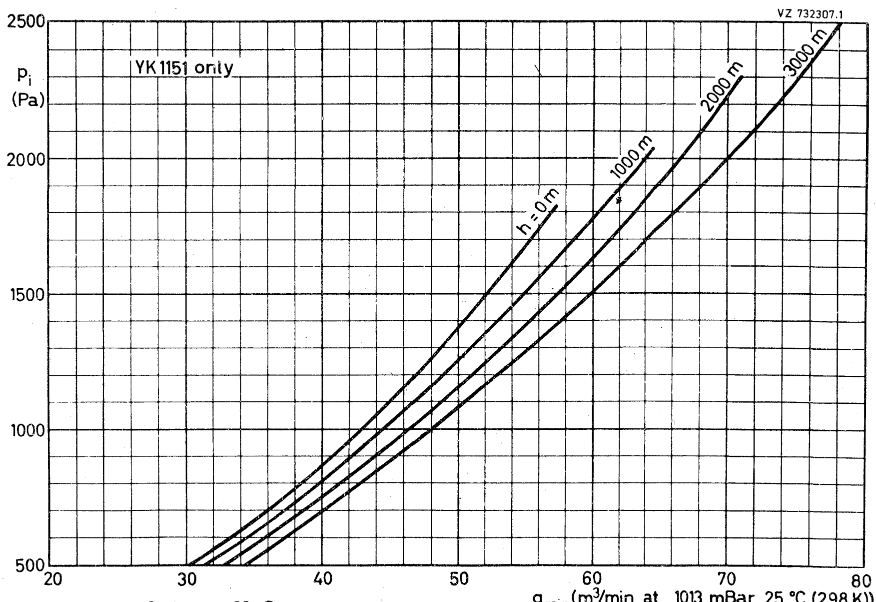
12) With respect to indicated tolerance range



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

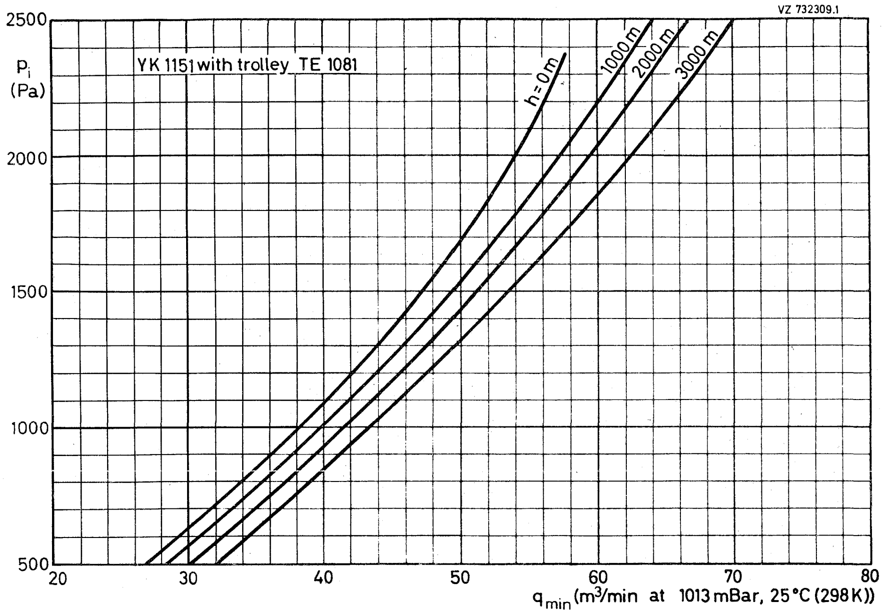
14) Cathode current adjusted by accelerating electrode voltage (coarse), and focusing electrode voltage (fine).





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.

U.H.F. POWER KLYSTRON

Vapour-cooled U.H.F. TV power klystrons of metal-ceramic construction, with four external resonant cavities, and electromagnetic focusing.
The klystrons are intended to be used in 40 kW vision transmitters, and in sound transmitters.

QUICK REFERENCE DATA			
Frequency range			
YK1190		470 to 610	MHz
YK1191		590 to 720	MHz
Output power, peak sync		45	kW
Gain	≈	44	dB
Cooling	vapour		

HEATING: indirect by d.c.

Cathode		dispenser type		
Heater voltage [1]	V_f		8,5	V
Heater current	I_f		24,5 (< 27)	A

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

Cold heater resistance	R_{fo}	≈	30	mΩ
Waiting time				
a. Heater voltage 8,5 V	T_w	min.	300	s
b. After stand-by at V_f = 6 V [2]	T_w	min.	0	s

FOCUSING: electromagnetic

Resistance of focusing coils			
cold (20 °C)		7,5 to 9,5	Ω
operating at an ambient temperature of 20 °C	≤	11	Ω

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

[2] The beam current may be switched-on after a "stand-by" period of minimum 10 min at V_f = 6 V. The heater voltage must be increased to its nominal value simulteneously. Stand-by conditions are restricted to continuous periods of 2 weeks at a time. They must be separate by approximately equal periods of normal operation or of rest.

BEAM CONTROL

The accelerator voltage allows the adjustment of the beam current between 0% and 100%.

GETTER ION PUMP POWER SUPPLY [1]

Ion pump supply voltage, unloaded (cathode reference)	3 to 4	kV
Internal resistance	300	kΩ

COOLING

Cathode socket and accelerator electrode	air; q ≈ 0,15 m^3/min, t_i max. 40 °C
Collector	vapour volume of water [2] converted to steam: 27 cm^3/min per kW collector dissipation resulting in 43 ℓ/min steam per kW collector dissipation
Drift tubes	water; rate of flow to drift tubes and collector connected in series q = 9 ℓ/min, t_i max. 80 °C, p_i = 200 kPa (≈ 2 at)
Cavities 3 and 4	forced air; q = 1,5 m^3/min, p_i = 250 Pa (≈ 25 mm H_2O), t_i max. 45 °C

MOUNTING

Mounting position: vertical with collector up.

To remove the tube from the magnet assembly a total free height of 3,5 m is required.

MASS

Net mass YK1190, YK1191	approx. 80 kg
Cavities	approx. 45 kg
Magnet assembly with coils and boiler	approx. 850 kg

WARNING

The ceramic part of the output cavity is made of beryllium oxide the dust of which is toxic. For the disposal of tubes observe government regulations.

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[1]) To ensure that during storage the tube is ready for immediate operation the getter ion pump should be operated at least every 6 months, every 3 months being recommended. For details see "Klystron instruction book".

[2]) To avoid corrosion of the cooling water circuit de-ionized water should be used. A water de-ionizer should be built in the water circuit, alternatively the cooling water should be de-ionized by adding:
700 mg 24% hydrazine hydrate and
700 mg sodium silicate per litre.
The pH should be 7 to 9; the resistivity > 100 Ω.m.

ACCESSORIES See note 1 page 6.

A. Supplied with each tube	YK1190	YK1191
1 set of sealing rings	TE1147	TE1147
B. Required for each tube		
Damping ring against collector interference (fitted on the tube)	TE1111	TE1132
Protecting ring for accelerator (fitted on the tube)	TE1141	TE1141
Cathode cooling ring (fitted on the tube)	TE1142	TE1142
Extension pipes for drift tubes	6 x TE1133A 2 x TE1133B	6 x TE1133A 2 x TE1133B
Interconnecting pipes for cooling water of drift tubes t_1 to t_2	TE1134A	TE1135A
t_2 to t_3	TE1134B	TE1135B
t_3 to t_4	TE1134C	TE1135C
t_4 to t_5	TE1134D	TE1135D
Flexible tubes for cooling water supply from dolly to tube	TE1145A	TE1145A
from tube to boiler	TE1145B	TE1145B
C. Required in addition to B when a different tube type is replaced by the YK1190 or YK1191		
Magnet insert	TE1138	TE1138
Water shield	TE1139	TE1139
Spark gap	TE1140	TE1140
Heater/cathode supply cable (red)	TE1146A	TE1146A
Heater supply cable (blue)	TE1146B	TE1146B
Accelerator supply cable (yellow)	TE1146C	TE1146C
D. Required in addition to B and C for first equipment only		
Cavities	3 x TE1121A 1 x TE1121D	3 x TE1098A 1 x TE1098D
Input coupler	TE1122A	TE1102A
Load coupler for cavities 2 and 3	2 x TE1122	2 x TE1102
Output coupler for cavity 4	TE1123	TE1105
Arc detector	TE1107	TE1107
Magnet assembly with coils	TE1108	TE1108
Boiler	TE1110	TE1110
Tool set	TE1137	TE1137
Recommended circulator	2722 162 01551	2722 162 01561

For detailed information contact the tube supplier.

LIMITING VALUES (Absolute max. rating system)

Heater voltage	max.	9,5	V
Cathode to body voltage	max.	-23	kV
	min.	0	V
Cathode to body voltage, cold	max.	-27	kV
Cathode current	max.	7	A
Drift tube current	max.	150	mA
Accelerator to body (earth) voltage	never negative		
Accelerator current	max.	6	mA
Collector dissipation	max.	150	kW
VSWR of load	max.	1,5	
Envelope temperature	max.	175	°C

OPERATING CONDITIONS

A. As 4 kW/2 kW sound transmitter, in accordance with CCIR standard G

Conditions	gain tuned operation		efficiency tuned operation		
Cathode to body voltage	-22	-22	-20,5	-20,5	kV
Accelerator to body voltage 2)	-16	-15	-14	-13	kV
Cathode current	0,95	1,15	1	1,25	A
Focusing coil current	9	9	9	9	A
Driving power 3)	1,5	1,5	1,5	1,5	W
Bandwidth (-1 dB)	1	1	1	1	MHz
Performance					
Output power	2,25	4,5	2,25	4,5	kW

Notes see page 6.

B. As a 40 kW vision transmitter, in accordance with CCIR standard G

Conditions		gain tuned operation		efficiency tuned operation		
Cathode to body voltage		−22		−20,5		kV
Cathode current	4)	6,3		5,7		A
Drift tube current						
no drive		15		15		mA
drive for $W_{o\ sync}$ = 45 kW at black level		30		40		mA
Focusing coil current		10,5		10,5		A
		channel 21	channel 38	channel 21	channel 38	
Driving power, peak sync 3) YK1190		2	1,5	10	7	W
		channel 37	channel 51	channel 37	channel 51	
YK1191		1,5	1	7	5	W
Bandwidth (−1 dB)	5)	8		8		MHz
Performance						
Output power		45		45		kW
Differential gain (black to white)	6)	80		75		%
Differential phase (black to white)	6)	6		7		deg
Linearity (10-step staircase)		70		65		%
Efficiency		32		38,5		%
Saturation output power		55		50		kW
Saturation efficiency		40		43		%
A.M. noise		−60		−60		dB

Notes see page 6.

NOTES

1) Correct operation of the tube can be guaranteed only if a set of accessories, approved by the tube manufacturer, is used.
The tube may generate X-rays. Adequate shielding is obtained by using the accessories listed.

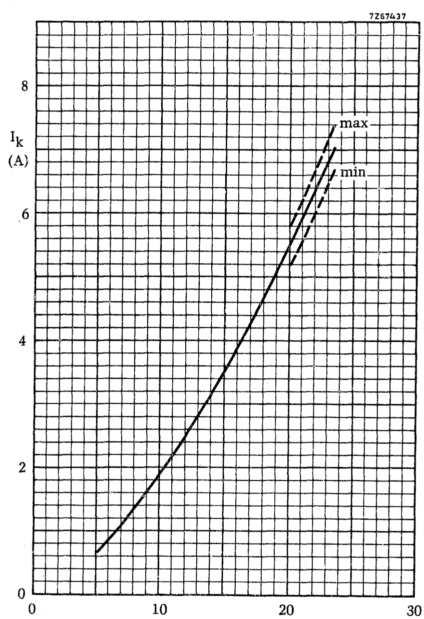
2) The voltage divider for the adjustment of the cathode current should be designed for an accelerator current of max. 1,5 mA.

3) Defined as the power into a matched load representing the first cavity.

4) If the accelerator is connected to the body via a 10 kΩ resistor, the current remains within ± 5% of the values given in the graph below.

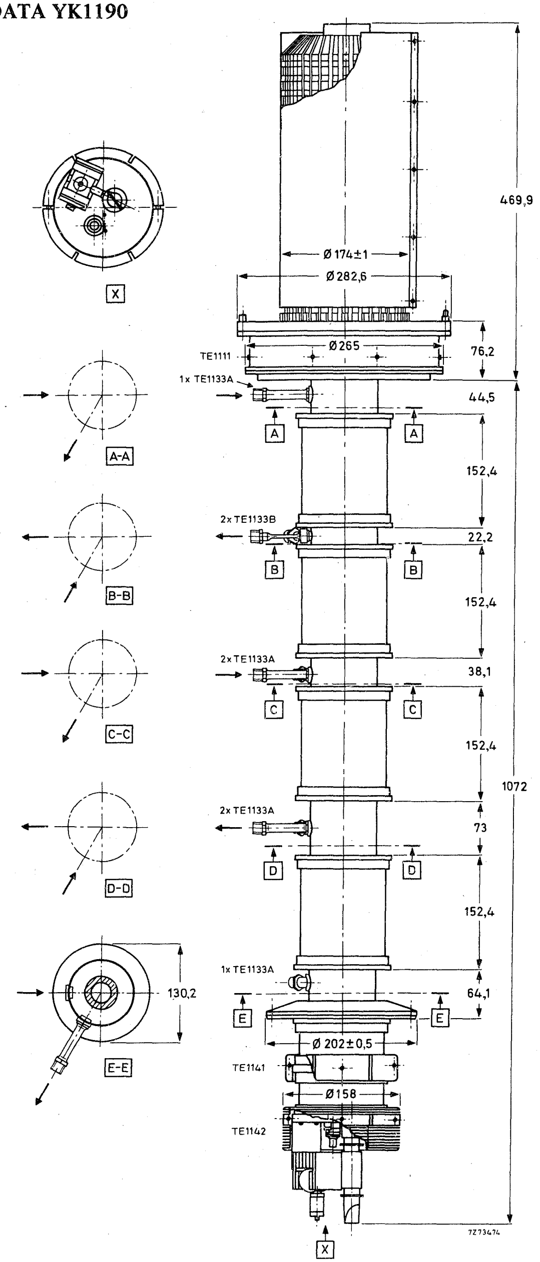
5) Varying the input level between black and white at any sideband frequency within this band will not cause a variation of the peak sync output power exceeding 0,5 dB.

6) Measured with a sawtooth signal of line frequency, running from 12,5% to 75% of the peak sync value, with a 4,43 MHz sine-wave super imposed having a 10% peak-to-peak value.



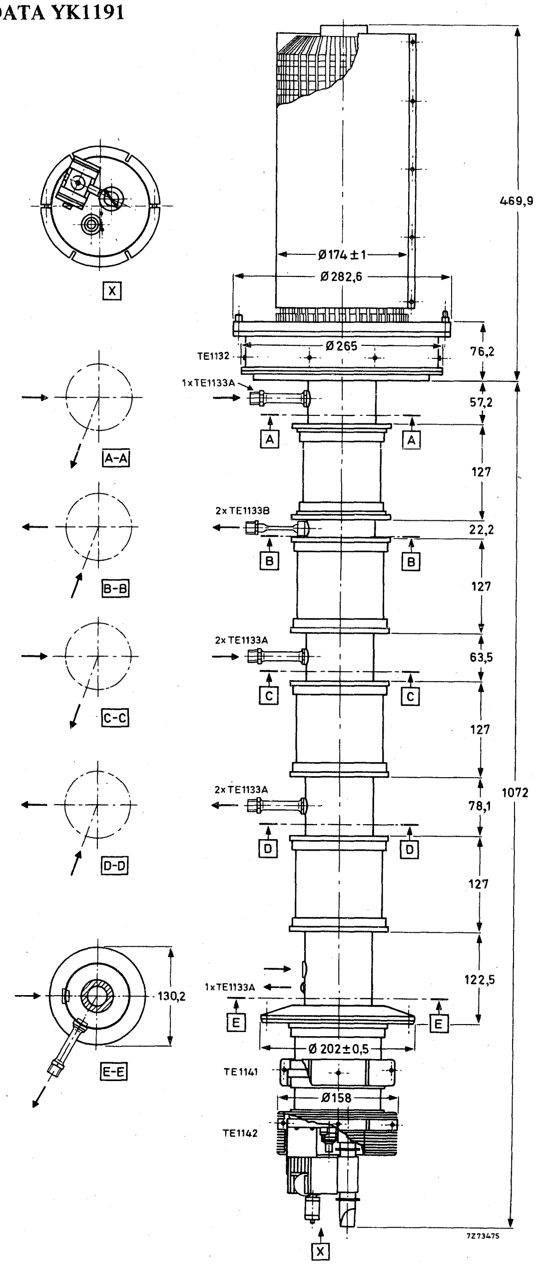
MECHANICAL DATA YK1190

Dimensions in mm



MECHANICAL DATA YK1191

Dimensions in mm



U.H.F. POWER KLYSTRON

Forced-air cooled power amplifier klystron in metal-ceramic construction for the frequency band of 11,8 to 12,2 GHz. The tube has internal resonant cavities, beam focusing by means of permanent magnets, and an integral getter-ion pump. The YK1210 is intended to be used in vision and sound transmitters, and transposers. It may be operated with or without depressed collector voltage.

QUICK REFERENCE DATA

Frequency range	11,8 to 12,2 GHz
Output power as vision transmitter	1,15 kW
Gain	50 dB
Cooling	forced air

HEATING: indirect by d.c.

Cathode	dispenser type			
Heater voltage	V_f		5 to 6	V
Heater current	I_f		4 (≤ 5)	A
Heater peak starting current	I_{fp}	max	8	A
Cold heater resistance	R_{fo}	≈	20	mΩ
Waiting time	T_w	min	120	s

COOLING

Cathode socket and accelerating electrode	low-velocity air flow 0,5 m^3/min, 100 cm^2
Body	forced air, ≈ 0,5 m^3/min p_i ≤ 1000 Pa (100 mm H_2O)
Collector	forced air, ≈ 6 m^3/min p_i ≤ 1000 Pa (100 mm H_2O)

GETTER-ION PUMP SUPPLY

Pump voltage, no-load condition	3 kV
Internal resistance of supply	300 kΩ

MOUNTING

Vertical

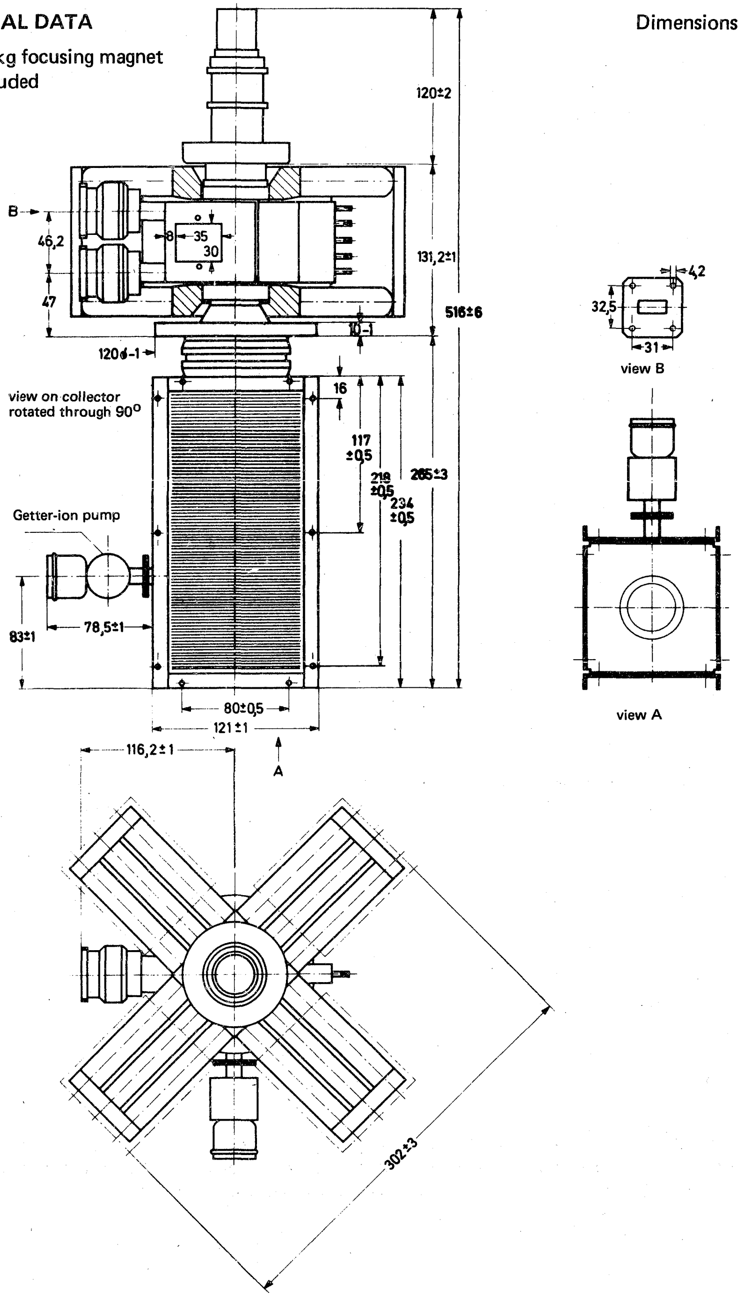
Forces on klystron terminals max 10 N. Bending moment max 10 Nm.

To maintain correct focusing, the magnetic system should not be closer than 150 mm to external ferromagnetic materials, and no closer than 300 mm to external magnets.

MECHANICAL DATA

Dimensions in mm

Mass: ≈ 30 kg focusing magnet included



LIMITING VALUES (Absolute maximum rating system)

Collector to cathode voltage	max	15 kV
Body to collector voltage	max	4 kV
Body to accelerator voltage	max	15 kV
Accelerator to cathode voltage	max min	10 kV 7,5 kV
Cathode current	max	650 mA
Collector dissipation	max	7,5 kW
Drift tube current, static, set value	max	10 mA
As vision transmitter at $W_{o\,sync}$ = 1 kW		
dynamic, without depressed collector voltage	max	30 mA
dynamic, with depressed collector voltage	max	60 mA
as transposer at $W_{o\,sync}$ = 210 W		
dynamic, without depressed collector voltage	max	20 mA
dynamic, with depressed collector voltage		
current cut-out region		20 to 50 mA
measuring range	max	60 mA
Getter-ion pump voltage	max min	4 kV 2,5 kV
Pump current	max	15 mA
Internal resistance of the pump supply	min	300 kΩ
Accelerator current	max	−0,2 to +2 mA
Series resistor in accelerator circuit	min	10 kΩ
Temperature of focusing magnets	max	55 °C
Inlet temperature of cooling air	max min	45 °C 5 °C

TYPICAL OPERATION

Frequency range	11,8 to 12,2		GHz
Bandwidth (–1 dB)	⩾ 12		MHz
Power gain	50 (⩾ 49)		dB
	without depressed collector voltage	with depressed collector voltage	
As vision transmitter			
Collector to cathode voltage	10,5	8,5	kV
Body to collector voltage	0	2	kV
Cathode current	0,4	0,4	A
Output power, sync	1,15	1,15	kW
As sound transmitter			
Collector to cathode voltage	10,5	8,5	kV
Body to collector voltage	0	2	kV
Cathode current	0,4	0,4	A
Output power	1,05	1,05	kW
As transposer (W_o nom 100 W)			
Collector to cathode voltage	10,5	8,0	kV
Body to collector voltage	0	2,5	kV
Cathode current	0,4	0,4	A
Output power, sync	105	105	W
Intermodulation products	⩾ –57	⩾ –57	dB
As transposer (W_o nom 200 W)			
Collector to cathode voltage	12	9	kV
Body to collector voltage	0	3	kV
Cathode current	0,5	0,5	A
Output power, sync	210	210	W
Intermodulation products	⩾ –57	⩾ –57	dB

GENERAL NOTES ON POWER SUPPLY DESIGN

	range*	internal resistance	hum
Heater voltage	4,5 to 6,5 V (max 5 A)	The heater current should not exceed a value of 8 A when switching on the supply	Corresponding to non-smoothed three-phase bridge rectifier
Body to collector voltage	0/2,0/2,5/3,0 kV 100 mA continuous 200 mA peak	< 600 Ω	< 0,1%
Collector to cathode voltage**	8,0/8,5/9,5 kV with depressed collector voltage 10,5/11,5 kV without depressed collector voltage	< 600 Ω	< 0,1%
Body to accelerator voltage	Via potentiometer. Total resistance ≈ 5 MΩ and series resistor 10 kΩ (suitable for 15 kV) between accelerator electrode and tap.		

* Maximum allowable deviation from nominal or set values:
a) ±2% during adjustment, if the published performance is to be attained.
b) ±1% fluctuation of the set values during operation to maintain the performance.

** It is recommended that additional taps be made ≈ 500 V above and below the indicated values.

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

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.

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.

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	

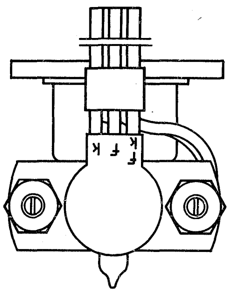
LIMITING VALUES (Absolute limits)

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

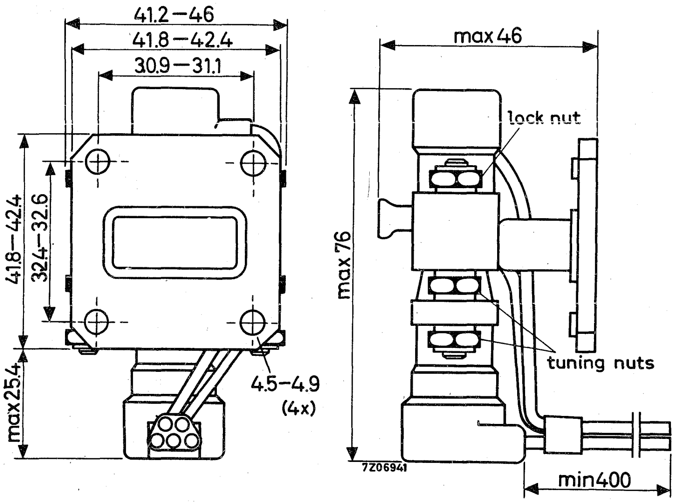
Dimensions in mm



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

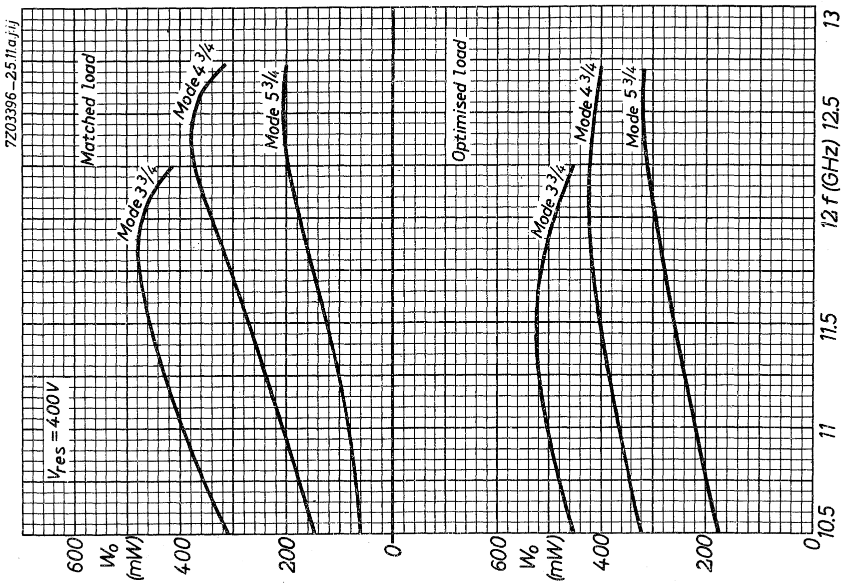
TYPICAL CHARACTERISTICS

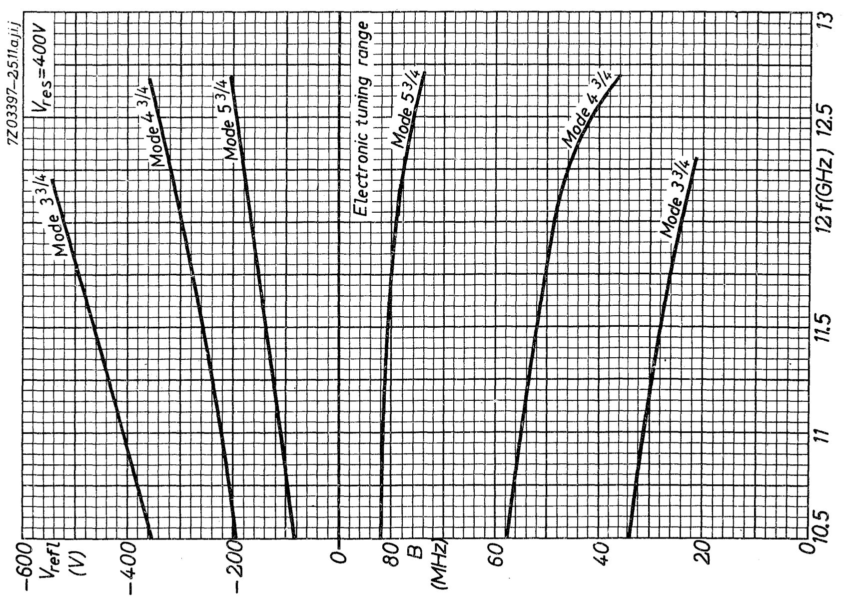
Mechanical tuning range	f	=	10.5 to 12.2	GHz
Electronic tuning range between half-power points at any point in the mechanical tuning range at V_{res} = 400 V	Δf	>	30	MHz
Reflector modulation sensitivity at f = 10.5 to 12.2 GHz	$\frac{\Delta f}{\Delta V_{refl}}$	=	0.8 to 2.0	MHz per V
Power output at 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

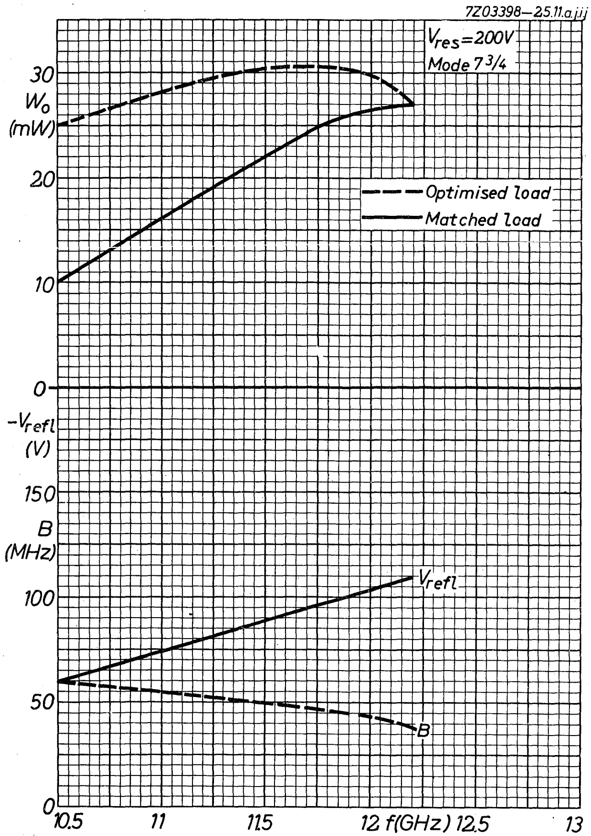
OPERATING CHARACTERISTICS

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} = 400 V
Mode 3 3/4
Mode 4 3/4
Mode 5 3/4
W_o (mW)
600
400
200
0
f (GHz)
10.5
11
11.5
12
12.5
13


7Z03397-25.11.a.j.i.j
V_{res} = 400 V
Electronic tuning range
Mode 3 3/4
Mode 4 3/4
Mode 5 3/4
V_{refl} (V)
-600
-400
-200
0
B (MHz)
80
60
40
20
0
f (GHz)
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

Mechanically tunable light weight reflex klystron with integral cavity and waveguide output

QUICK REFERENCE DATA		
Frequency, tunable within the band	f	10.5 to 12.2 GHz
Power output	W_o	400 mW
Construction		waveguide output

HEATING: indirect

Heater voltage	V_f	=	6.3	V	±10 %
Heater current at V_f = 6.3 V	I_f	=	1.2	A	
Cathode heating time	T_w	=	min. 15	s	

LIMITING VALUES (Absolute limits)

Resonator voltage	V_{res}	=	max. 450	V
Resonator current	I_{res}	=	max. 70	mA
Negative reflector voltage	$-V_{refl}$	=	20 to 1000	V
Body temperature	t	=	max. 200	°C [1]

TYPICAL CHARACTERISTICS

Mechanical tuning range	f	=	10.5 to 12.2	GHz
Electronic tuning range between half-power points at any point in the mechanical tuning range at V_{res} = 400 V	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 ^{o}C	$\frac{\Delta f}{\Delta t}$		< 0.25	MHz per ^{o}C

OPERATING CHARACTERISTICS

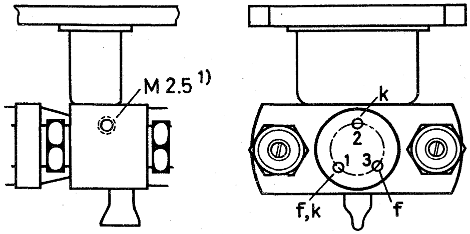
Frequency		f	=	10.5	11.5	12.2	GHz
Resonator voltage		V_{res}	=	400	400	400	V
Resonator current		I_{res}	=	65	65	65	mA
Reflector voltage		V_{refl}	=	−190	−260	−315	V
Output power	matched load	W_o	=	150	270	370	mW
	optimised load	W_o	=	320	400	420	mW
Electronic tuning range between half-power points		Δf	=	58	52	47	MHz
Reflector modulation coefficient		$\frac{\Delta f}{\Delta V_{refl}}$	=	1.0	1.0	1.0	MHz /V

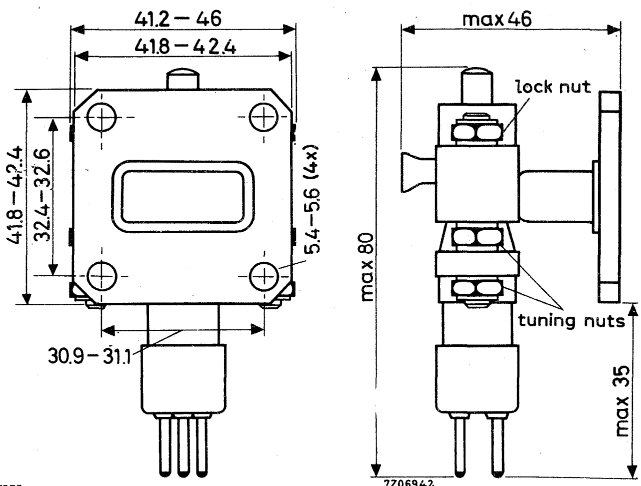
Frequency		f	=	10.5	11.5	12.2	GHz
Resonator voltage		V_{res}	=	200	200	200	V
Resonator current		I_{res}	=	23	23	23	mA
Reflector voltage		V_{refl}	=	−60	−90	−110	V
Output power	matched load	W_o	=	10	22	27	mW
	optimised load	W_o	=	25	30	27	mW
Electronic tuning range between half-power points		Δf	=	60	50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

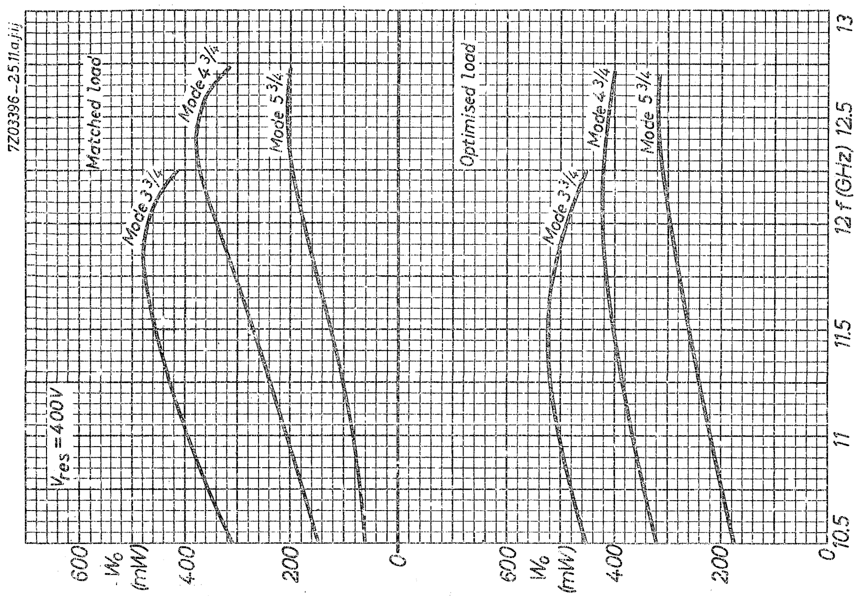
Loosen both tuning nuts at socket side. Turn both nuts in centre in small steps to the left or to the right until required frequency is obtained.
Then fix lower nuts again.
Do not touch lock nut at reflector side.

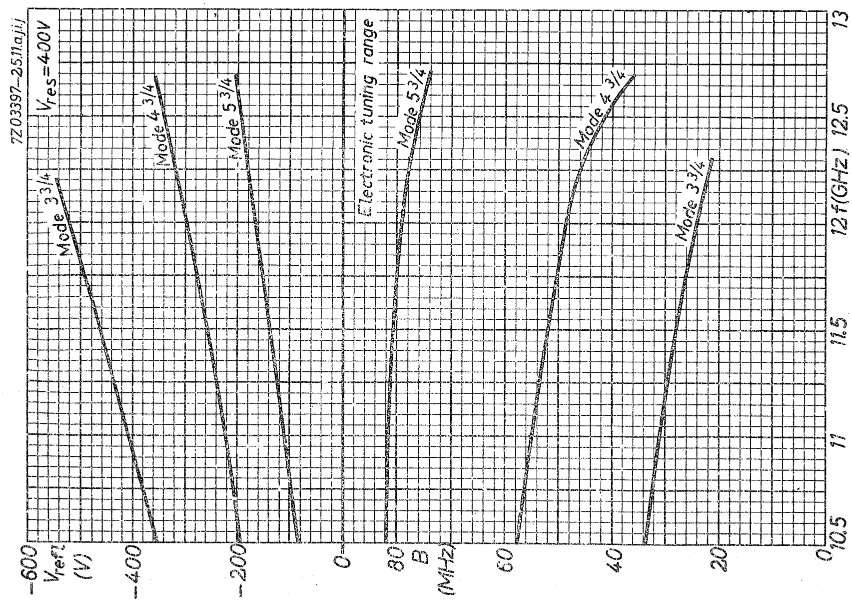
WARNING

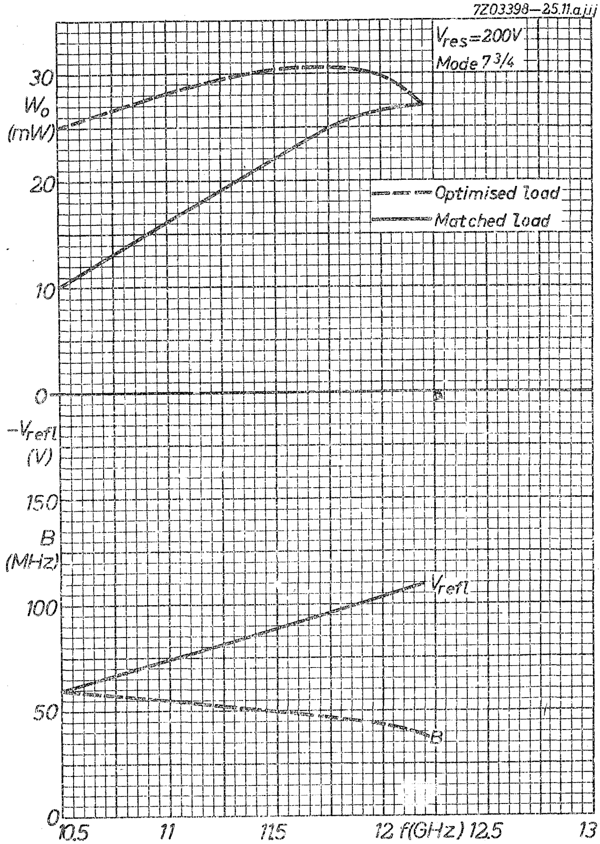
Do not apply the heater voltage to the cathode pin as this will result in the destruction of the tube.

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
V_{res} = 400V
Mode 3 3/4
Mode 4 3/4
Mode 5 3/4
Mode 3 3/4
Mode 4 3/4
Mode 5 3/4
600
W_o
(mW)
400
200
0
600
W_o
(mW)
400
200
0
10.5
11
11.5
12 f (GHz) 12.5
13


7Z03397-25.11.a.j.i.j
V_{res} = 400V
Mode 3 3/4
Mode 4 3/4
Mode 5 3/4
Electronic tuning range
Mode 5 3/4
Mode 4 3/4
Mode 3 3/4
-600
V_{refl}
(V)
-400
-200
0
80
B
(MHz)
60
40
20
0
10.5
11
11.5
12 f (GHz) 12.5
13


7Z03398—25.11.a.i.i.i
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

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	$W_{o_{sat}}$	25 W
Gain	G	38 dB
Construction , tube		unpackaged
mount		periodic permanent magnet

CATHODE : Dispenser type

HEATING : Indirect by a.c. or d.c.

Heater voltage	V_f		6,3	V ±2%
Heater current	I_f		0,85 to 1,05	A
Cathode preheating time (waiting time)	T_w	min.	2	min
for a new tube	T_w	min.	5	min

When operated on d.c. the heater must be negative with respect to cathode.

TEMPERATURE LIMITS AND COOLING

Absolute max. temperature at reference point on mount cooler	t	max.	140	°C

Ambient temperature range

			min.	max.	
Operation to full specification	1)	t_{amb}	−10	+65	°C
Operation without damage to tube		t_{amb}	−20	+65	°C
Storage	2)	t_{amb}	−60	+85	°C

Notes see page 7.

Cooling

Tube installed in convection-cooled mount **type P6L11**

horizontally mounted	natural
vertically mounted	natural assisted by convection duct or low velocity air flow

A conduction-cooled mount is available.

MECHANICAL DATA

Dimensions in mm

Mounting position : Any (but see "Cooling"). The barrel of the mount must be protected from strong magnetic fields such as from isolators, and should be several centimetres from steel plates.

Mass

Net mass of tube : 0, 15 kg

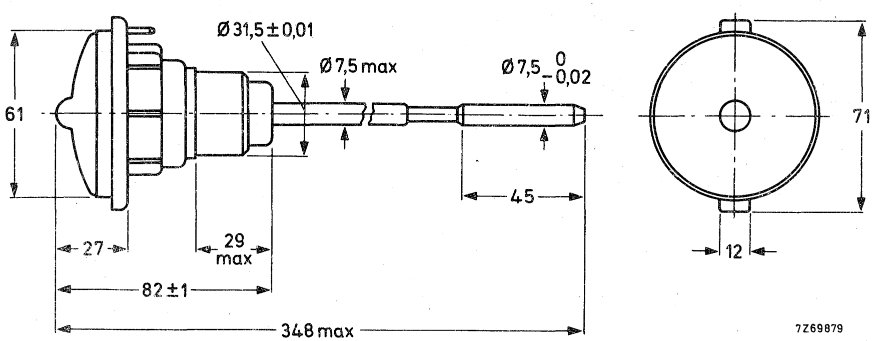
Net mass of mount : 4, 9 kg

Accessories

Mount, convection-cooled, with 153 IEC-R70 waveguide input and output (34, 85 mm x 15, 799 mm) type P6L11

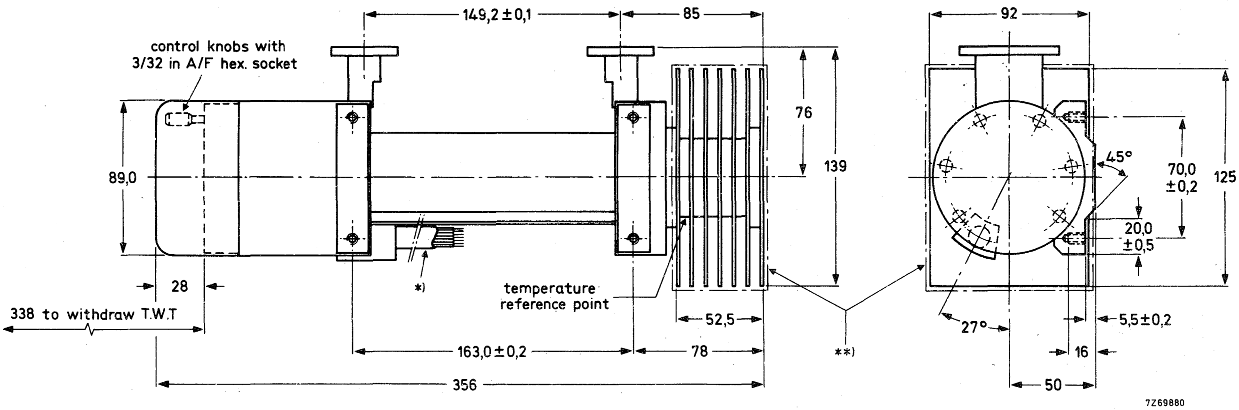
Dimensions

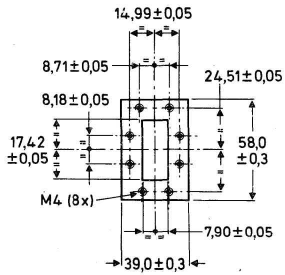
Tube



Note tube is fragile. It should be inserted carefully into the mount and then pushed home axially. Rotation is also necessary to negotiate the withdrawal check lugs.

Dimensions of mount P6L11





special flange IEC-R70

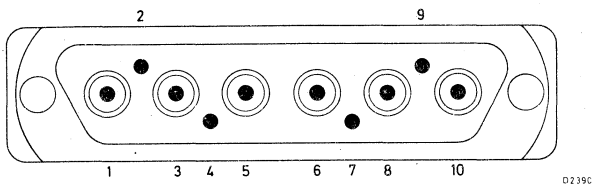
* Screened cable 590 mm long with safety switch leads and Amphenol plug 17-801.
Safety switch is operated by insertion and extraction of T.W.T.

** When mount is installed there must be a minimum clearance of 3 mm around the cooler.

Note that the equipment should be designed so that the maximum misalignment moment at R.F. connectors is 19,6 Nm. The cooling fins are movable and require a minimum clearance of 3 mm. The mount should be handled with special care during installation to avoid damage to the cooling fins.

Plug connections to mount

Amphenol plug 17-801



1 helix	6 cathode
2 collector (earth)	7 safety circuit
3 grid no. 2 (accelerator electrode)	8 heater
4 -	9 safety circuit
5 grid no. 1 (focusing electrode)	10 heater

DESIGN RANGES FOR POWER SUPPLY

Voltages are specified with respect to cathode

Normal operation

		min.	max.	
Grid no. 1 voltage 3)	V_{g1}	-20	0	V
Grid no. 1 current	I_{g1}		100	μA
Grid no. 2 voltage	V_{g2}	1,9	2,7	kV 4) 5)
Grid no. 2 current	I_{g2}	-250	+250	μA
Helix voltage	V_x	3,2	3,8	kV
Helix current	I_x		1,5	mA 5) 6)
Collector voltage	V_{coll}	1,9	2,1	kV 7)
Collector current	I_{coll}		50	mA

Notes see page 7.

TYPICAL OPERATION as a power amplifier with the collector earthed and tube focused in a mount type P6L11. Tubes are fully interchangeable in mounts and tube replacement is a simple operation.
Voltages are specified with respect to cathode

Conditions

Frequency	f	6	GHz
Heater voltage	V_f	6,3	V
Grid no. 1 voltage	V_{g1}	-15	V
Helix voltage	V_x	3,4	kV
Collector voltage (earth)	V_{coll}	2	kV
Collector current	I_{coll}	45	mA

Performance

Gain	G	38	dB
Output power	W_o	15	W
Noise factor **(including gas noise)**	F	28	dB
Hot input match	VSWR	1,2	
Hot output match	VSWR	1,4	
Grid no. 1 current	I_{g1}	1	μA
Grid no. 2 current	I_{g2}	5	μA
Helix current	I_x	0,5	mA
Grid no. 2 voltage	V_{g2}	2,2	kV

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

Grid no. 1 voltage	$-V_{g1}$	max. min.	250 0	V V
Grid no. 2 voltage	V_{g2}	max.	3	kV
Helix voltage	V_x	max.	4	kV
Helix current	I_x	max.	1,3	mA [6])
Collector voltage	V_{coll}	max. min.	2,2 1,9	kV kV
Collector current	I_{coll}	max.	50	mA
Collector dissipation	W_{coll}	max.	100	W
R.F. input power	W_i	max.	250	mW [8])

Notes see page 7.

TEST CONDITIONS AND LIMITS

Tube focused in mount P6L11

Conditions

Heater voltage	V_f	6, 3	V
Grid no. 1 voltage	V_{g1}	-15	V
Grid no. 2 voltage	V_{g2}	see notes 6 and 9	
Helix voltage	V_x	see note 10	
Collector voltage	V_{coll}	1, 9	kV
Collector current range *	I_{coll}	40 to 50	mA
Output power	W_o	15	W
Frequency range	f	5, 925 to 6, 425	GHz 11)

Limits and characteristics

		min.	max.	
Gain at W_o = 15 W	G	37	40	dB
Noise factor ** at W_o = 15 W	F		30	dB
Saturation output power	$W_{o\ sat}$	23		W 12)
Hot input match	VSWR		1, 5	13)
Hot output match	VSWR		2	13)
Grid no. 2 voltage	V_{g2}	1, 9	2, 7	kV
Helix voltage	V_x	3, 2	3, 8	kV
Grid no. 1 current	I_{g1}		100	μA
Grid no. 2 current	I_{g2}		250	μA
Helix current	I_x		1, 3	mA 6)
A.M./P.M. conversion** at W_o = 15 W			2	°/dB 14)
Attenuation		see note 15		

Notes see page 7.

* Specified on data sheet enclosed with tube.

** Design test only.

NOTES

1) The magnetic circuit is fully temperature-compensated in this range, and the operation of the tube will not change as the temperature is varied.

2) If the temperature of the mount is lowered below -60 °C the magnets will suffer an **irreversible change.**

3) V_{g1} is normally fixed at -15 V.

4) For adjustment of focus it is also necessary for the grid no. 2 voltage to be variable in the range 0 to 1,9 kV without stabilization. As an alternative the negative voltage on grid no. 1 may be increased within certain limits to reduce the collector current (see "Limiting Values").

5) The power supply should be designed so that any automatic switching allows the correct cathode preheating time (which may be reduced or eliminated for momentary breaks of 5 s), followed by establishment of all electrode voltages except V_{g2}.
The V_{g2} may then be applied.
All supplies should usually be stabilized to within ±2% except where otherwise stated.
A protective device to reduce V_{g2} should operate if the helix current exceeds its limiting value (but see note 6).

6) During the focusing operation the helix current may (transiently) be allowed to reach 2 mA. It may be useful to set the focusing screws on a new mount 1,5 turns back from fully home before commencing the switch-on operation.

7) The collector voltage is usually fixed at 2 kV. This supply need not be stabilized provided that it remains in the range 1,9 to 2,1 kV when the tube is operating.

8) The output power reflected back into the tube by the load (for example the **output isolator) should also not exceed this limit.**

9) V_{g2} should be adjusted to give the specified collector current while cyclically adjusting focusing screws for minimum helix current.

10) V_x should be **adjusted** to give the maximum gain at the specified output power. Focusing should then be re-optimized.

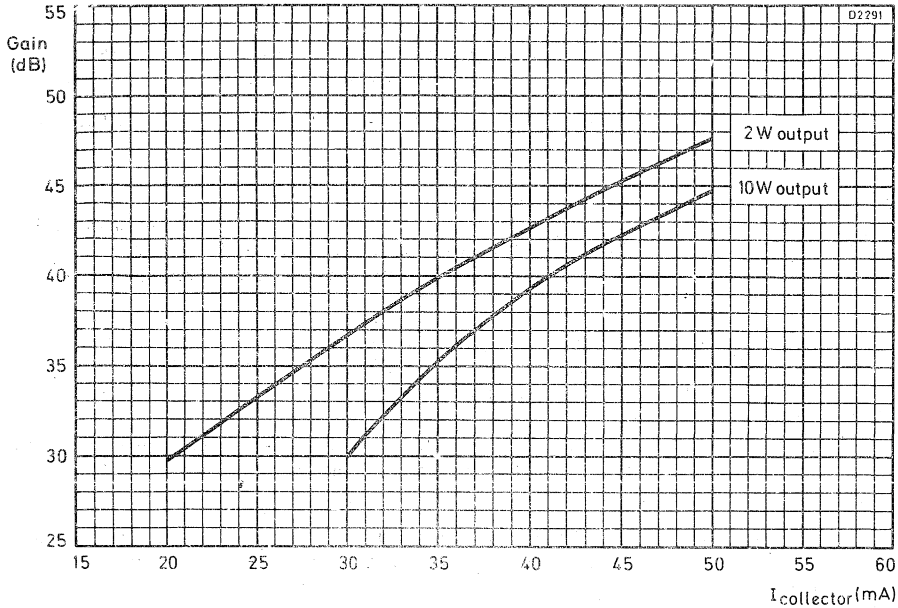
11) The tube is tested at the centre and the extremes of the frequency range.

12) Measured pulsed at a duty ratio of 1 : 2. If necessary the helix voltage is readjusted to give maximum output power as the input power is increased and the focus re-optimized.

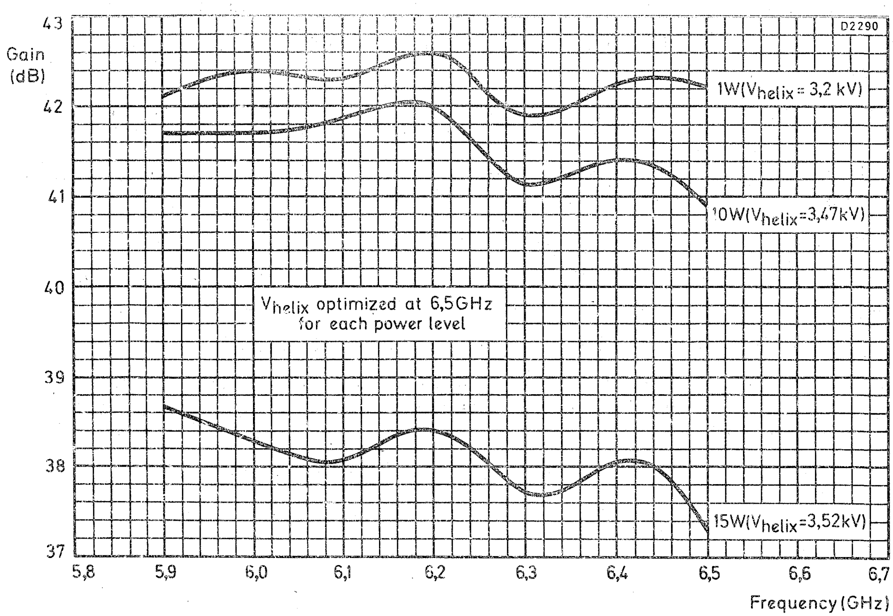
13) This is obtained without adjustment at each frequency ("plug-in" match).

14) The value given for A.M. to P.M. conversion is that obtained under the stated conditions. Improved values may be obtained with other settings of helix voltage and input power.

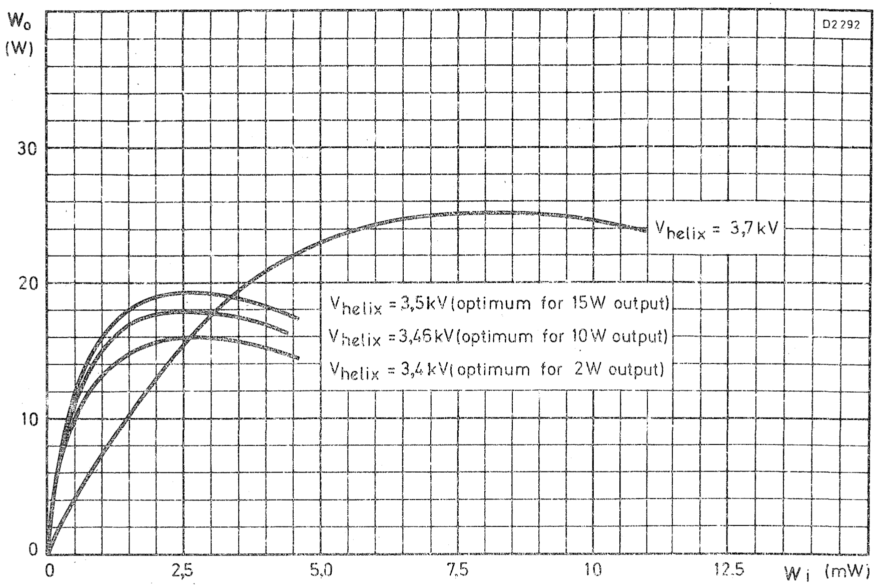
15) With electrode voltages not applied minimum attenuation is 60 dB.



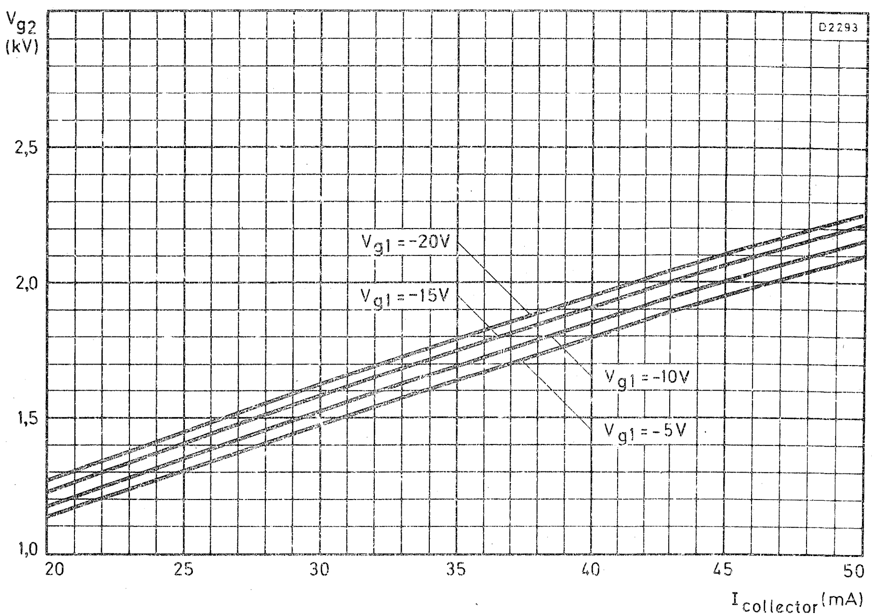
Gain as a function of collector current at 6,2 GHz



Gain as a function of frequency (power as parameter)



Output power as function of input power (helix voltage as parameter) at 6, 2 GHz



Grid no. 2 voltage as a function of collector current

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

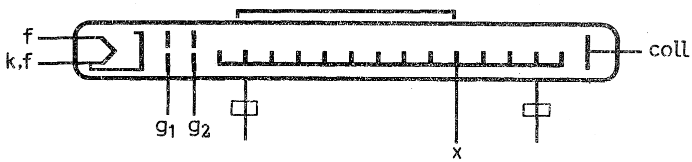
For shorter waiting time when the tube already has been in operation see "Application of voltages".

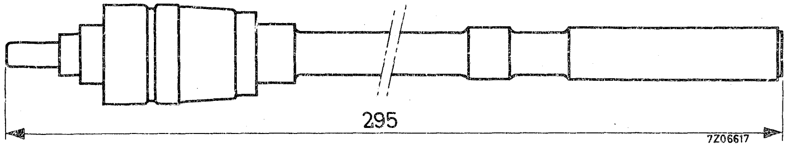
COOLING: Natural cooling
by convection with mount 55329 or
by conduction with mount 55332

MECHANICAL DATA Dimensions in mm

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

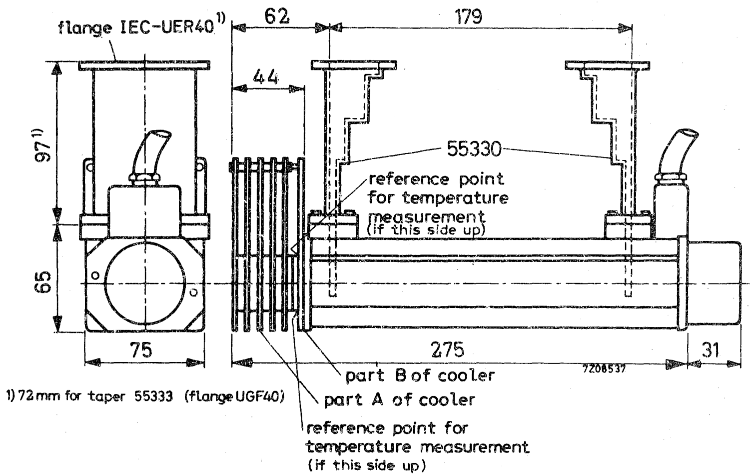
Weight of tube	approx.	60	g
Weight of mount	approx.	4.5	kg





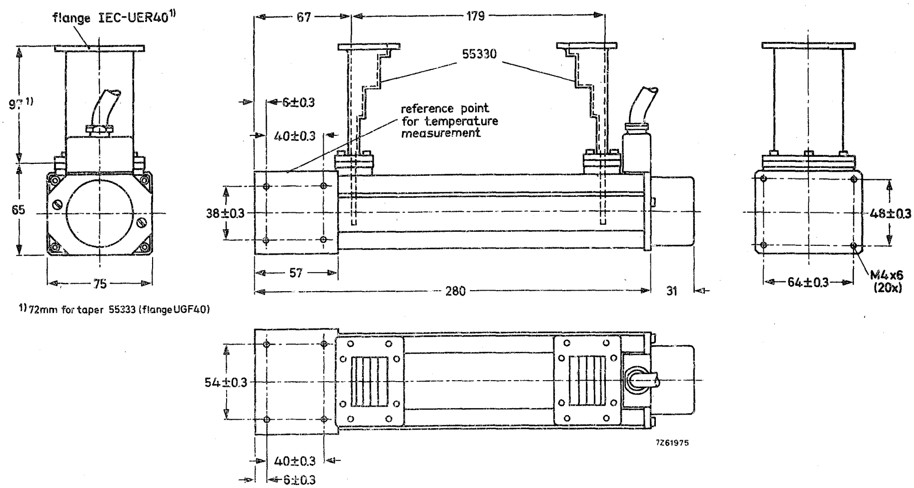
ACCESSORIES (to be ordered separately)

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



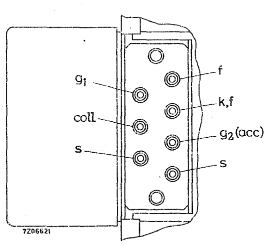
Mount 55332 with conduction (heatsink) cooling and waveguide tapers 55330

Connections

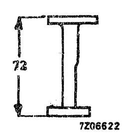
The mount is provided with flying leads, marked with colours

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	^{o}/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}	$I_{coll} x V_{coll} - W_o$ = max.	90	W
Power reflected from load		max.	2	W [1])
Cooler temperature at reference point				
mount type 55329	t	max.	140	°C
mount type 55332	t	max.	150	°C

[1]) To avoid overheating of the helix.

DESIGN AND OPERATING NOTES

1. GENERAL DESIGN CONSIDERATIONS

Equipment design should be oriented around the tube specifications given in these data sheets and not around one particular tube since due to normal production variations the design parameters will vary around the nominal values given.

2. INSTALLATION OF THE MOUNT

Two main methods may be discerned:

a) Fixing the mount relative to the microwave circuit by only connecting the waveguide tapers to the input and output sides of the circuit.

b) Employing a) and establishing additional support by fastening the mount to the rack with two clamps 55331. In this case it is recommended to use a short piece of flexible waveguide at input and output side to prevent excessive strain on the mount via the tapers, unless very careful alignment of the waveguide components can be assured.

Possible forces on the waveguides must not produce a moment greater than 2 mkg at the flanges.

2.1 Mount type 55329

The cooler of the mount consists of the parts A and B (see drawing). Part A is slightly movable and should be handled with special care. The mount should be installed in such a way, that is is not resting on the parts A or B of the cooler, and that part A always remains freely movable. When a tube is in the mount, no forces should be exerted on part A, since they would be directly transferred to the collector.

2.2 Mount type 55332

This mount has no movable parts. If clamps are used (method b) the slightly larger dimensions of the cooler with regard to the main part of the mount must be considered.

2.3 Magnetic shielding

The periodic permanent magnet mount is completely shielded. This implies that no additional measures need be taken to prevent the magnetic properties of the mount from being affected by external magnetic fields. The mount will not influence surrounding equipment which is susceptible to stray magnetic fields.
Several mounts may be placed side by side without disturbance of the focusing qualities. Isolators may be installed quite near to the mount.

Warning

If any part of the shielding is removed, the magnetic properties of the mount may be disturbed irreversibly.

3. INSTALLATION OF THE TUBE

Unlock the mount cap (see outline drawing) by turning it slightly counter-clockwise. The cap can then easily be removed, and the tube inserted by carefully pushing it in. Finally put the cap on the mount again, and lock by turning it clockwise.
The above instructions are also a guide for taking the tube out of the mount.

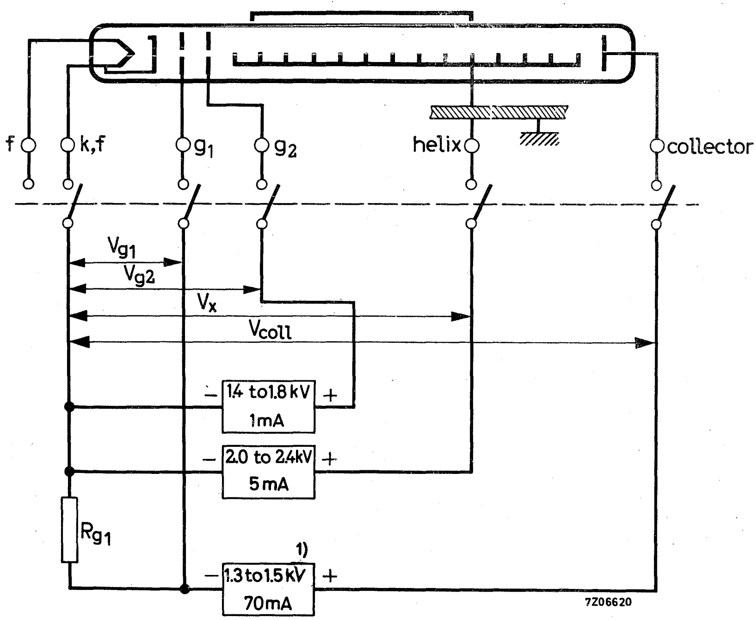
4. SAFETY

The supply voltages are fed to the tube via the mount cap. When the cap is unlocked all voltages are removed from the tube.
The two violet leads can be incorporated into an additional safety circuit which switches the voltages off at the power supply if the cap is unlocked. Thus the voltages can also be removed from the mount.

The mount should always be earthed.

5. POWER SUPPLY

The design of the power supply depends on whether 5, 10 or/and 15 W operation is desired. An example of a supply circuit for 10 and 15 W operation is given in the figure.



1) For 5 W operation a minimum of 1.1 kV is required.

The design of the power supply should be so that

V_{g_2} can be varied between 1.4 and 1.8 kV, V_x can be varied between 2.0 and 2.4 kV. V_{g_1} is −5 V at I_{coll} = 60 mA.

The collector voltage must be 1.1 kV, 1.3 kV, or 1.5 kV at I_{coll} = 60 mA for a desired output of 5 W, 10 W, or 15 W respectively.

For measurements of saturation output power the collector voltage should be 1.7 kV (between 3.8 and 4.2 GHz) and 1.85 kV (between 3.4 and 3.8 GHz)

The helix voltage may then reach 2.7 kV.

6. COOLING

Tube and mount need no artificial means of cooling. The natural cooling of the collector has been made possible by depression of the collector potential with respect to the helix and by ensuring adequate heat transfer from the collector to the environment.

6.1 Mount 55329

Under typical operating conditions and at an ambient temperature of not more than 65 °C, the cooler temperature at the reference point (see drawing) is well below the limit, provided the tube is mounted horizontally, and free air circulation is possible.

Under less favourable conditions a slight additional cooling by a low-velocity air flow may be required. Checking the temperature at the reference point then is strongly advised.

6.2 Mount 55332

Under typical operating conditions and at an ambient temperature of not more than 65 °C, the cooler temperature at the reference point (see drawing) is well below the limit, provided an aluminium heatsink of 300 mm x 300 mm x 6 mm is mounted on one of the cooler surfaces. The heatsink should be fixed with its centre contacting the cooler and in a vertical position. The mount itself may have any position in the equipment.
This is only an example and other heatsink configurations may be employed. It will then be necessary to check the temperatures reached at the reference point under extreme conditions e.g. 65 °C ambient temperature.

7 APPLICATION OF VOLTAGES

7.1 Switching-on procedure for new tubes

7.1.1 Apply the heater voltage for the specified waiting time.

7.1.2 Apply the rated voltages to the collector, to the helix, to the accelerator and to the focusing electrode in case of a separate supply simultaneously (see Remarks).

7.1.3 Adjust the accelerator voltage to obtain a collector current of 60 mA.

7.1.4 Apply the R.F. input signal, adjust the level to obtain the required output power while simultaneously adjusting the helix voltage for optimum gain.

7.2 Readjustment during life

During life the collector current may decrease.
A readjustment of the accelerator voltage to obtain I_{coll} = 60 mA will then be necessary.

7.3 Switching-off procedure

All voltages may be switched off simultaneously (see Remarks).

7.4 Switching-on procedure after interruption of voltage

7.4.1 Interruption of less than 40 s:
All voltages may be switched on simultaneously.

7.4.2 Interruption of more than 40 s but less than 1 week:
Apply the heater voltage for min. 40 s, then apply all other voltages simultaneously.

7.4.3 Interruption of more than 1 week:
Apply the heater voltage for the specified waiting time of 2 min.
Apply all other voltages simultaneously.

Remarks

If the voltages cannot be switched simultaneously the possibility exists that all the cathode current is flowing to the accelerator or the helix. This condition may never last for more than 10 ms, otherwise it will cause permanent damage to the tube. This may be avoided by switching the accelerator voltage on after the other electrode voltages, or off before the other electrode voltages.

8 INPUT AND OUTPUT CIRCUIT AND GROUP DELAY

In order to avoid phase distortions due to long-line effect, the insertion of an isolator between tube and antenna, and between tube and pre-stage is strongly recommended. The isolators should be positioned as close to the tube as possible.
If isolators with a V.S.W.R. of less than 1.05 are used at a short distance from the tube, the reflections result in a variation of group delay of less than 0.2 nanoseconds over a band of 20 MHz.

It may be noted that the difference between the voltage reflection coefficients of the hot and cold (i.e. without beam) tube is less than 0.2 for the input as well as the output side.

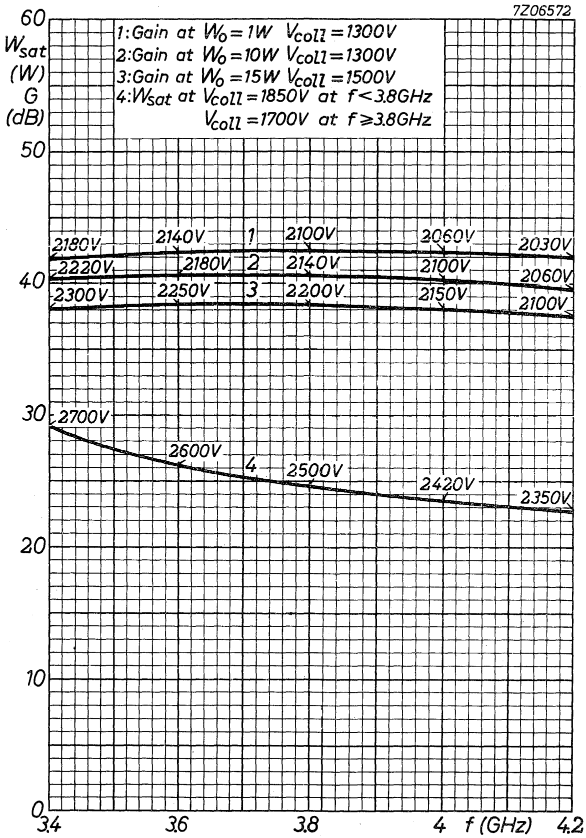
9 ENVIRONMENTAL CONDITIONS

Ambient temperature

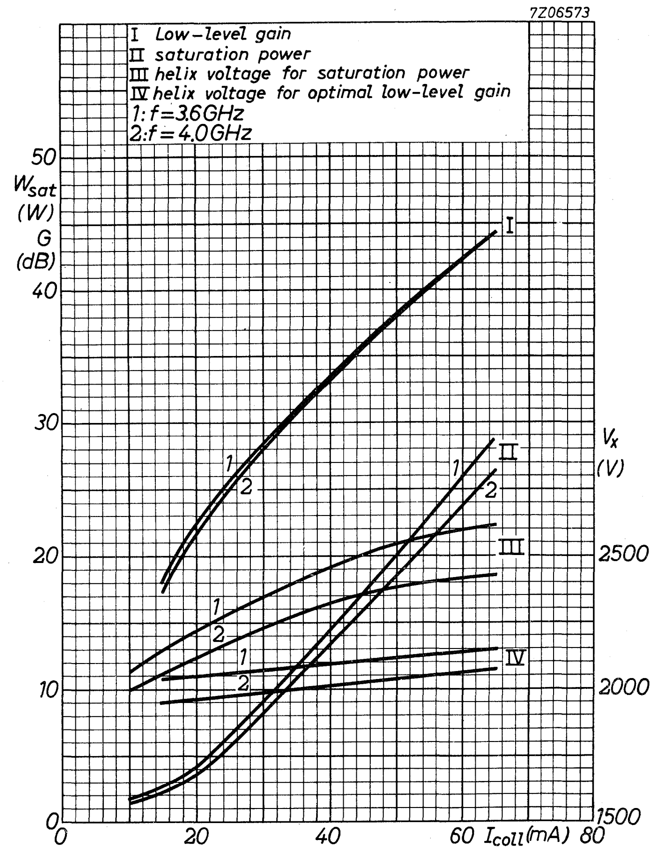
storage	t_{amb}	min.	-60	°C
		max.	+65	°C
operation	t_{amb}	min.	-30	°C
		max.	+65	°C
Relative humidity			0 to 95	%

The tube and mount resist fungus attack.

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

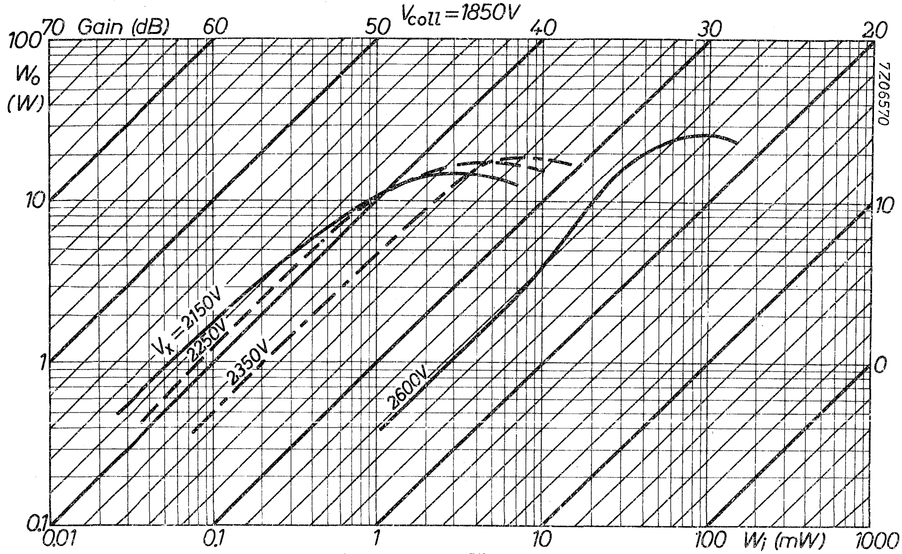


Gain and saturation power = f(frequency)



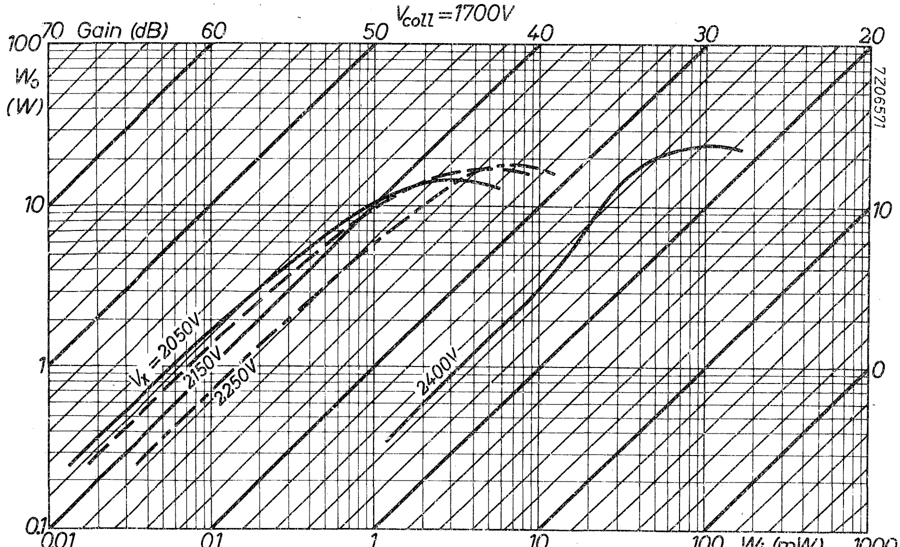
Gain and saturation power = f(collector current)

f = 3.6GHz
I_{coll}=60mA
V_{coll}=1850V

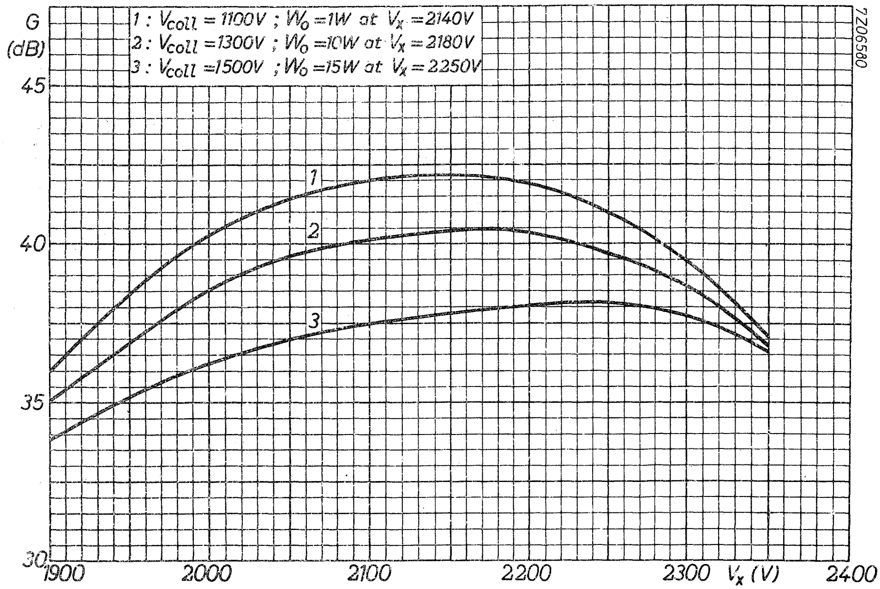


output power = f(input power)

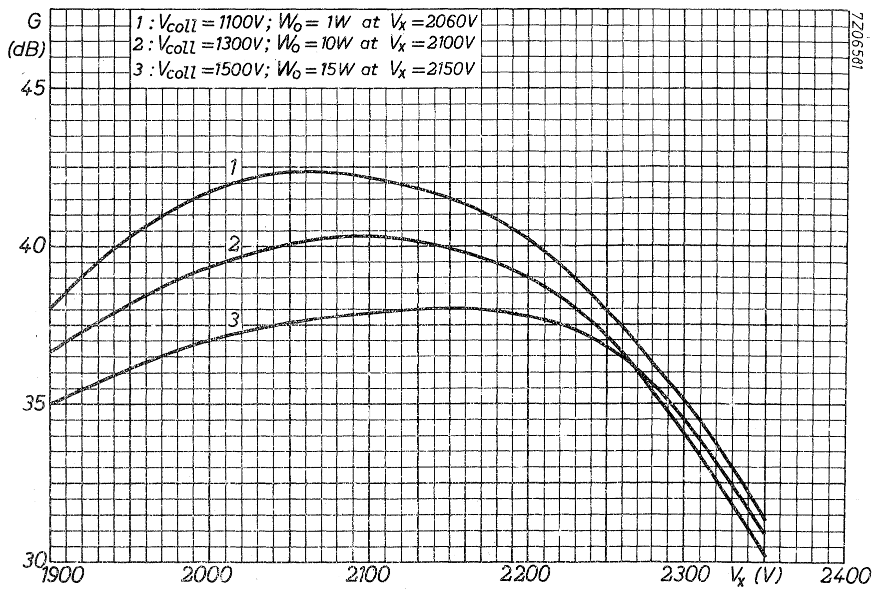
f = 4GHz
I_{coll}=60mA
V_{coll}=1700V



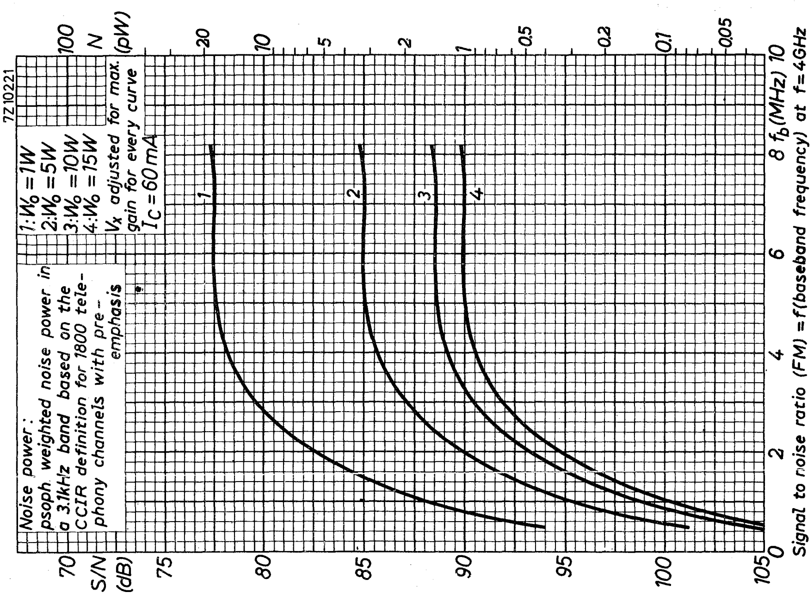
output power = f(input power)

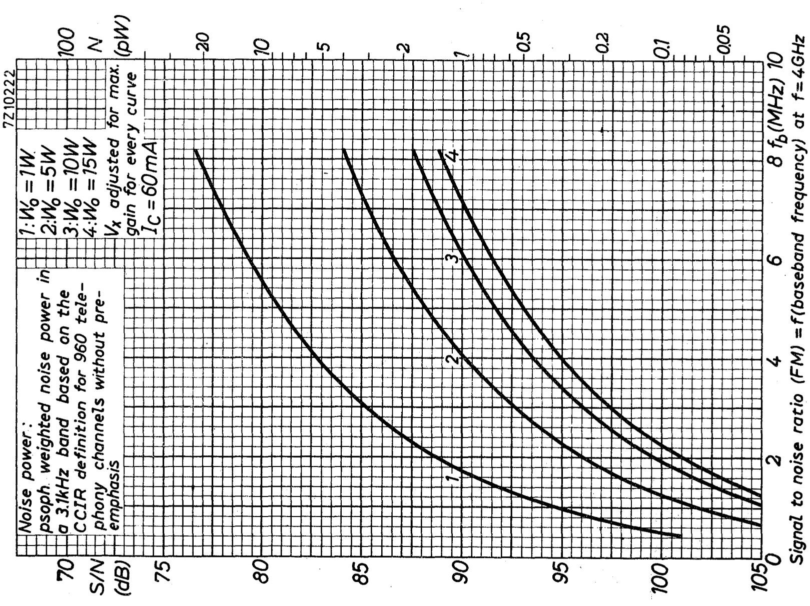


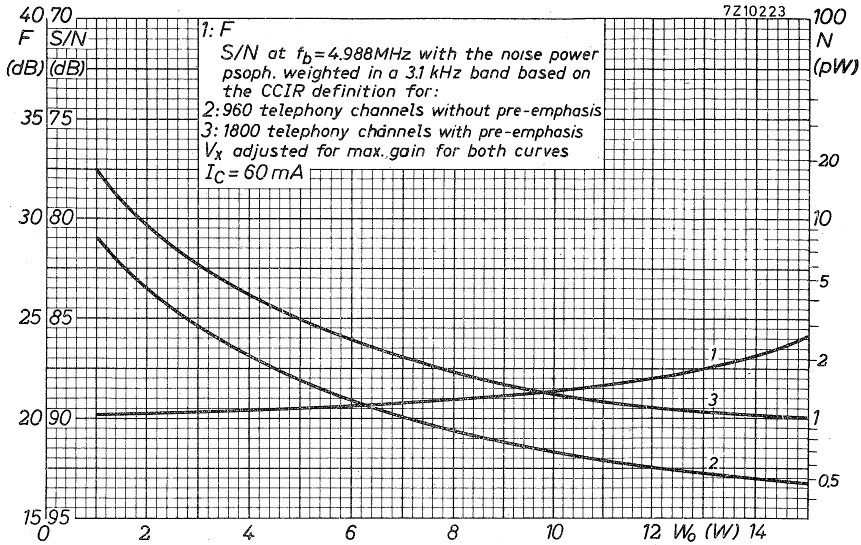
Gain = f(helix voltage) f = 3.6GHz



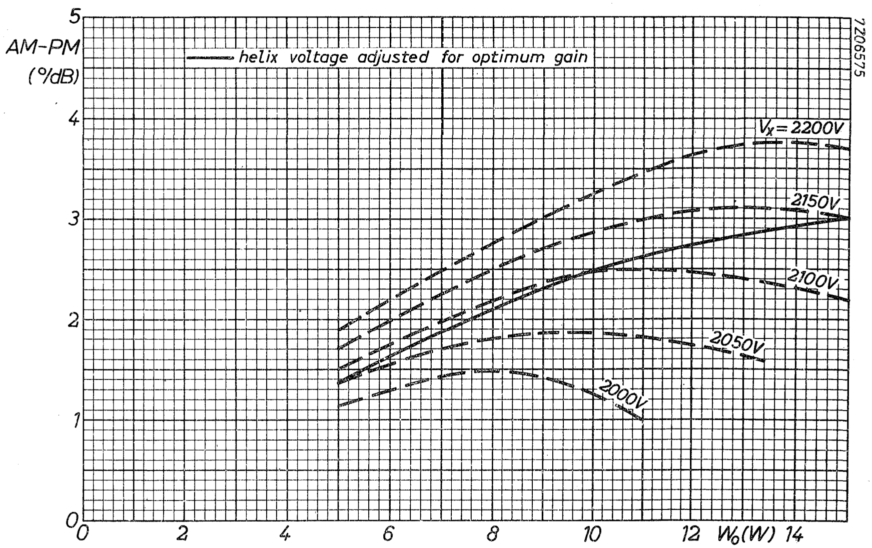
Gain = f(helix voltage) f = 4GHz


7Z10221
Noise power:
psoph. weighted noise power in a 3.1kHz band based on the CCIR definition for 1800 telephony channels with pre-emphasis
1: Wo = 1W
2: Wo = 5W
3: Wo = 10W
4: Wo = 15W
Vx adjusted for max. gain for every curve
IC = 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
1 2 3 4
0 2 4 6 8 fb(MHz) 10
Signal to noise ratio (FM) = f(baseband frequency) at f=4GHz

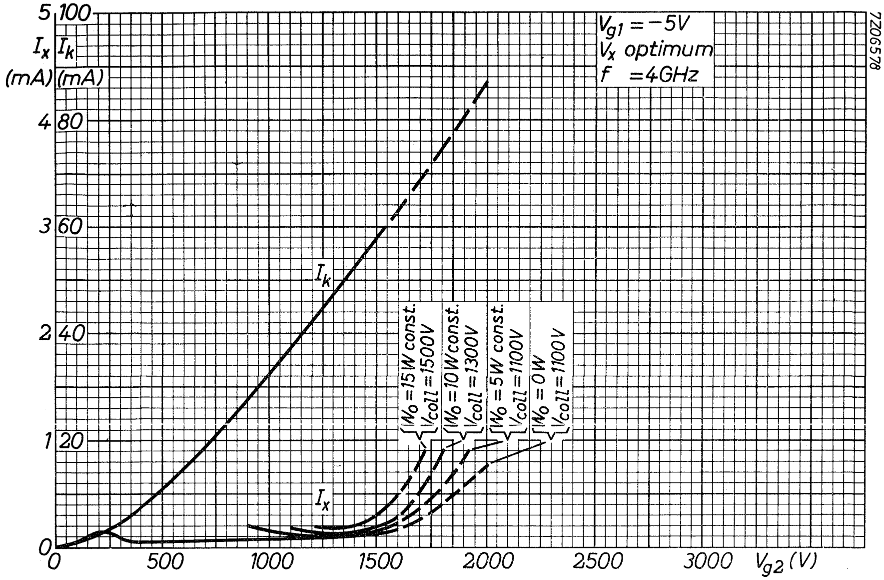

7Z10222
Noise power:
psoph. weighted noise power in a 3.1kHz band based on the CCIR definition for 960 telephony channels without pre-emphasis
1: Wo = 1W
2: Wo = 5W
3: Wo = 10W
4: Wo = 15W
Vx adjusted for max. gain for every curve
IC = 60 mA
S/N (dB)
70 75 80 85 90 95 100 105
N (pW)
100 20 10 5 2 1 0.5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



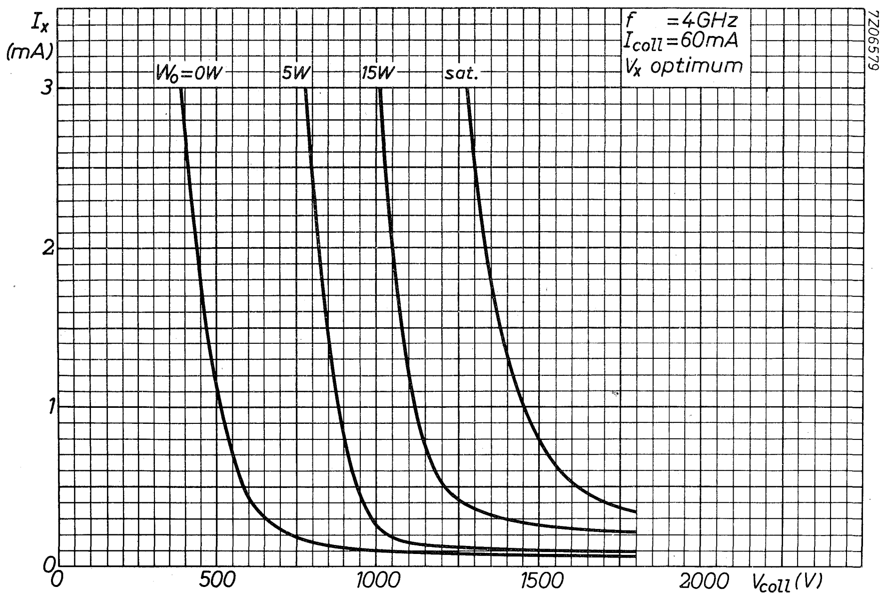
Thermal noise (FM) = f(output power) at f = 4 GHz



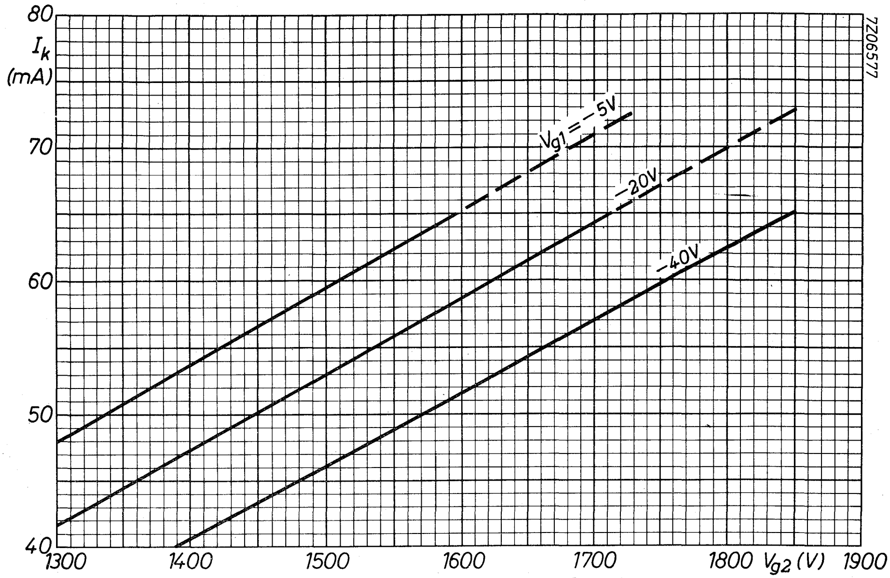
AM to PM conversion = f(output power) at f = 4 GHz



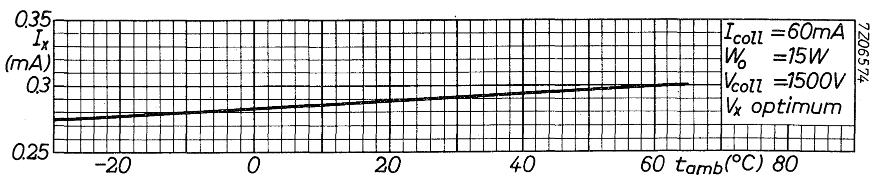
Cathode current and helix current = f(accelerator voltage)

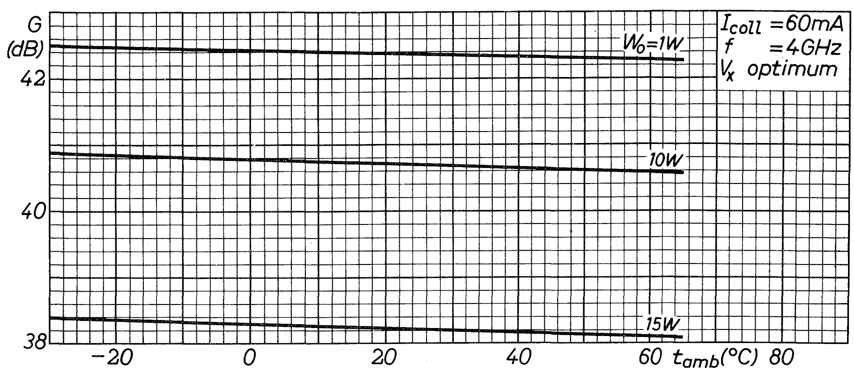


Helix current = f(collector voltage)



Cathode current = f(accelerator voltage)





Helix current and gain = f(ambient temperature)

TRAVELLING-WAVE TUBE

Travelling-wave tube with a periodic permanent magnet mount designed for wide-band microwave link applications.

QUICK REFERENCE DATA		
Frequency	5.8 to 8.5	GHz
Saturation output power at midband	20	W
Low-level gain at midband	45	dB
Interchangeability	plug-in focus, plug-in match	
Construction	unpackaged	
tube	glass-metal envelope, metal-ceramic base	
mount	periodic permanent magnet	
Cooling	conduction	

CATHODE : Dispenser type

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

When operated on D.C. the cathode must be connected to the positive side of the heater power supply.

Heater voltage	V_f		6.3	V ± 2%
Heater current at V_f = 6.3 V	I_f	approx.	1	A
Waiting time (Heating time before application of high voltage)	T_W	min.	2	min

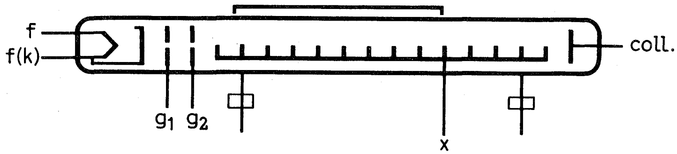
For shorter waiting time when the tube already has been in operation see "Application of voltages".

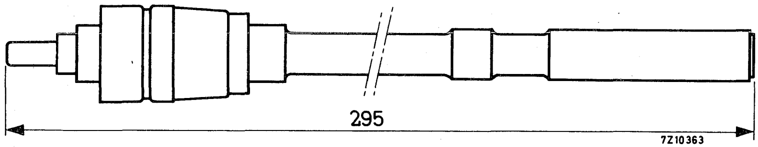
COOLING : By conduction. See also page 9.

MECHANICAL DATA Dimensions in mm

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

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

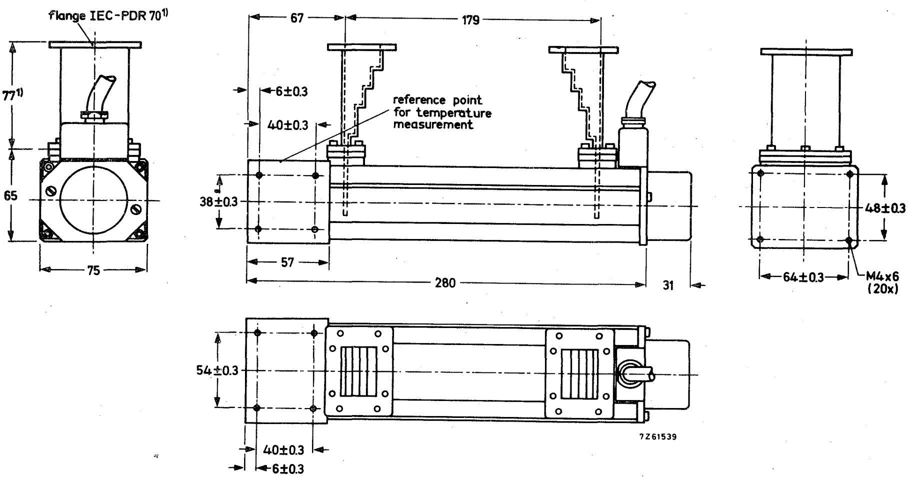




ACCESSORIES (to be ordered separately)

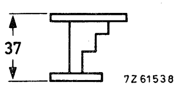
PPM mount for conduction cooling	type 55337
Waveguide taper (two required) to waveguide IEC-R70 (34.85 x 15.80 mm^2) with flange mating IEC-PDR70	type 55338
Waveguide taper (two required) to waveguide IEC-R84 (28.50 x 12.62 mm^2) with flange mating IEC-UER84	type 55342

Mount with conduction (heatsink) cooling and waveguide tapers 55338



1) Flange IEC-UER-84

Waveguide taper 55342

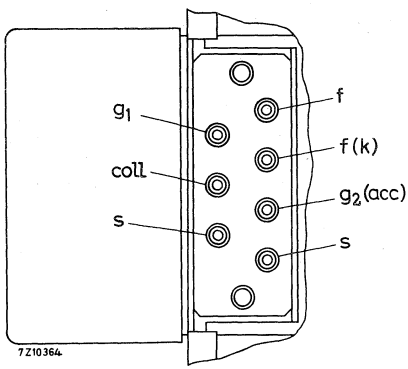


Connections

The mount is provided with flying leads, marked by colours

Heater/cathode	yellow
Heater	brown
Focusing electrode	green
Accelerator	blue
Helix	to be earthed via mount
Collector	red
Safety circuit (closed or opened, when putting on respectively off the mount cap)	two violet leads

Connections in cable housing



GENERAL CHARACTERISTICS

Frequency range	f	5.8 to 8.5	GHz	
Saturation output power (CW)	W_{sat}	20	W	1)
Low-level gain	G	45	dB	2)
Gain at W_o = 15 W	G	39	dB	3)
Thermal noise factor at W_o = 15 W	F	25	dB	4)
AM to PM conversion at W_o = 15 W	k_p	3	^{o}/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 ^oC $I_{coll} \times V_{coll} - W_o$	W_{coll}	max.	90	W
Power reflected from load		max.	2	W 1)
Cooler temperature at reference point	t	max.	150	^oC

1) To avoid overheating of the helix.
2) To be adjusted for indicated collector current.

DESIGN AND OPERATING NOTES

1. INSTALLATION OF THE MOUNT

Two main methods may be discerned:

a) Fixing the mount relative to the microwave circuit by only connecting the waveguide tapers to the input and output sides of the circuit.

b) Employing a) and establishing additional support by fastening the mount to the rack with clamps. In this case it is recommended to use a short piece of flexible waveguide at the input and output sides to prevent excessive strain on the mount via the tapers, unless very careful alignment of the waveguides can be assured.

Possible forces on the waveguides must not produce a moment greater than 2 mkg at the flanges.

1.1 Mount

The mount has no movable parts. If clamps are used (method b) the slightly larger dimensions of the cooler as compared to the main part of the mount must be considered.

1.2 Magnetic shielding

The periodic permanent magnet is completely shielded. This implies that no additional measures need be taken to prevent the magnetic properties of the mount from being affected by external magnetic fields. The mount will not influence surrounding equipment which is susceptible to stray magnetic fields. Several mounts may be placed side by side without disturbing the focusing qualities. Isolators may be installed quite near to the mount.

Warning

If any part of the shielding is removed, the magnetic properties of the mount may be disturbed irreversibly.

2. INSTALLATION OF THE TUBE

Unlock the mount cap (see outline drawing) by turning it slightly counterclockwise. The cap can then easily be removed, and the tube inserted by carefully pushing it in.
Finally put the cap on the mount again, and lock by turning it clockwise.
These instructions also apply (in the reverse order) for taking the tube out of the mount.

3. SAFETY

The supply voltages are fed to the tube via the mount cap. When the cap is unlocked all voltages are removed from the tube. The two violet leads can be incorporated into an additional safety circuit which switches the voltages off at the power supply if the cap is unlocked. Thus the voltages can also be removed from the mount.

The mount should always be earthed.

4. POWER SUPPLY

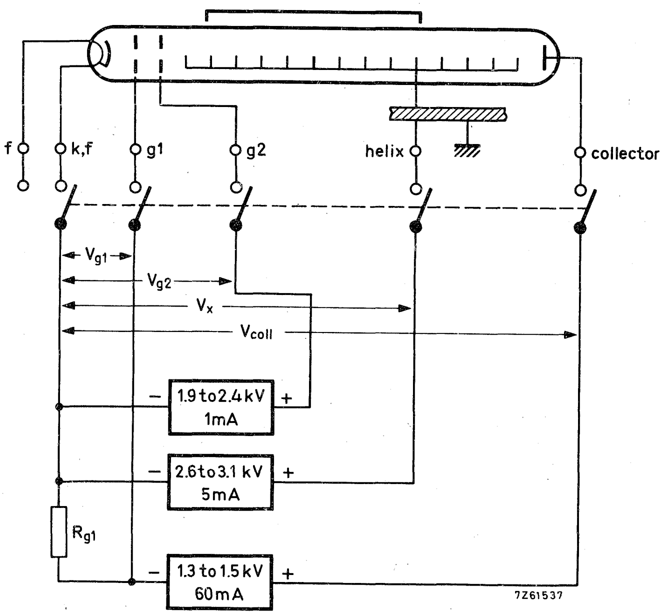
An example of a supply circuit for 5, 10 and 15 W operation is given in the figure.

Design ranges for the power supply
(electrode voltages with respect to cathode)

	Min.	Max.	
Accelerator voltage	1900	2400	V
Accelerator current		0.3	mA
Helix voltage	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.

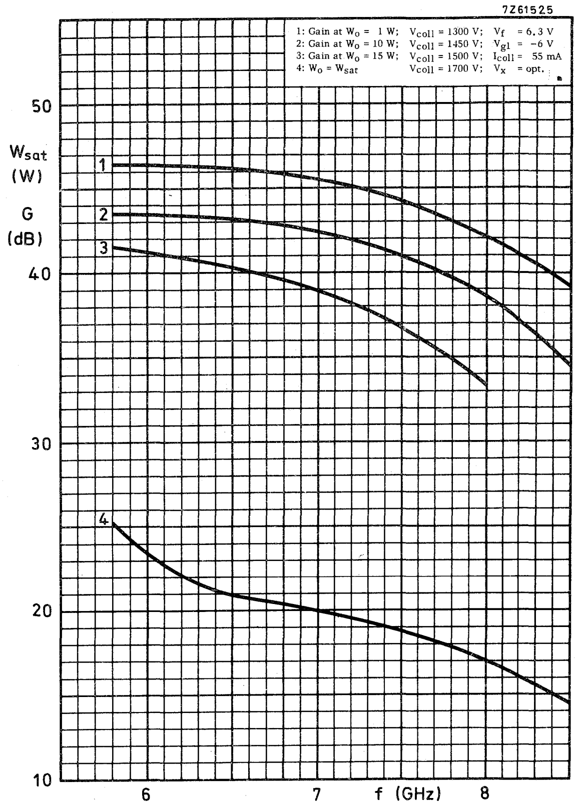
8. ENVIRONMENTAL CONDITIONS

Ambient temperature

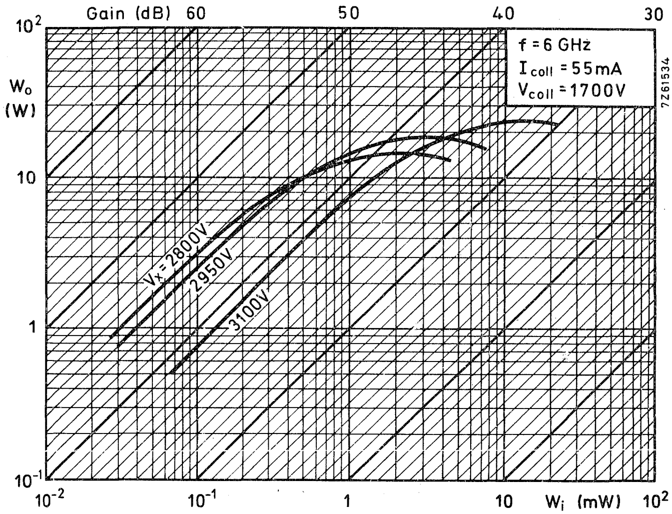
storage	t_{amb}	min.	-60	^{o}C
		max.	+65	^{o}C
operation	t_{amb}	min.	-30	^{o}C
		max.	+65	^{o}C

Relative humidity 0 to 95 %

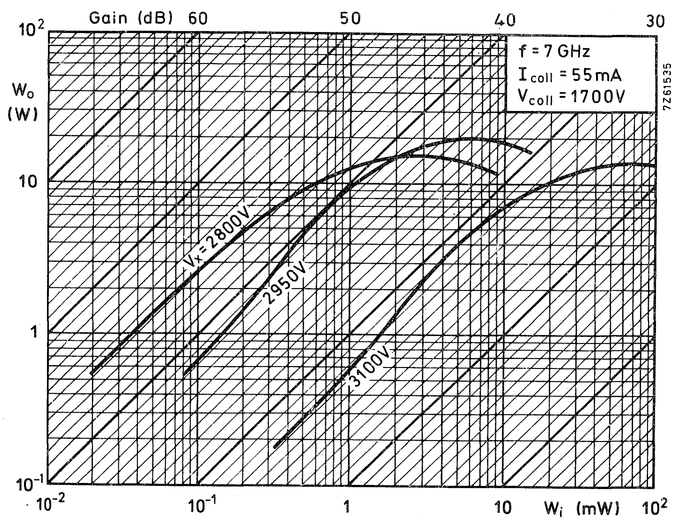
The tube and mount resist fungus attack.



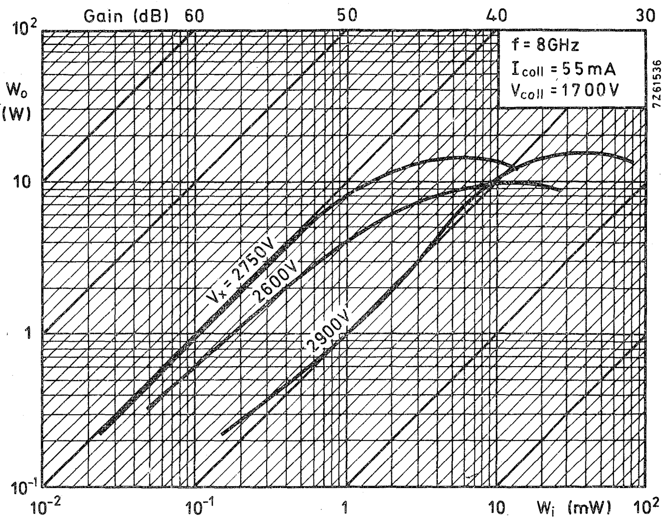
Gain and saturation power = f (frequency)



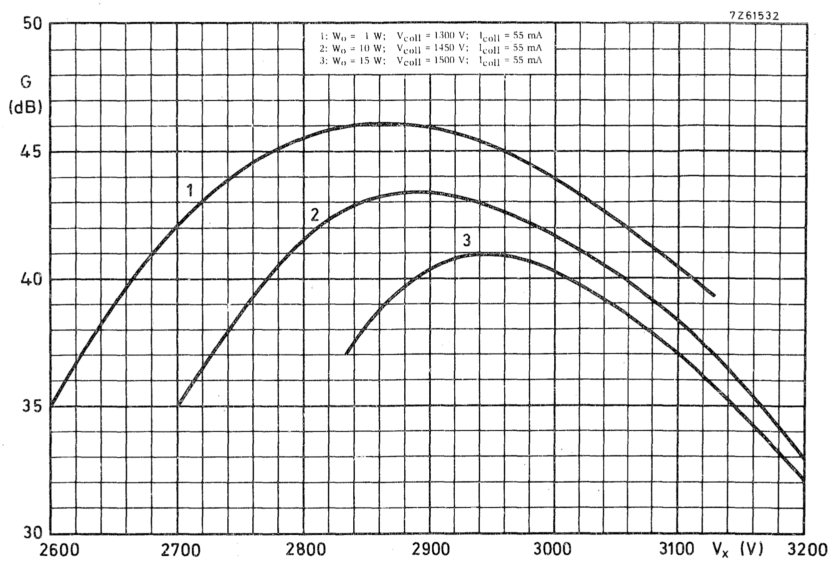
Output power = f (input power)



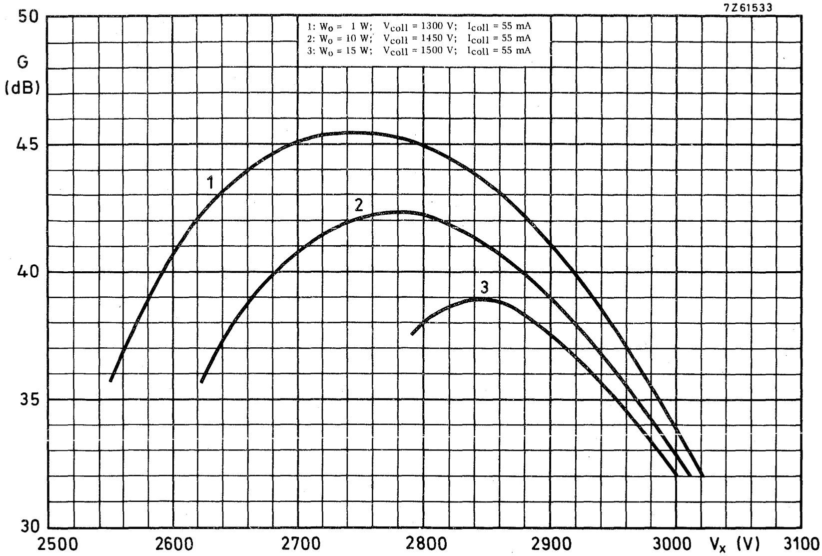
Output power = f (input power)



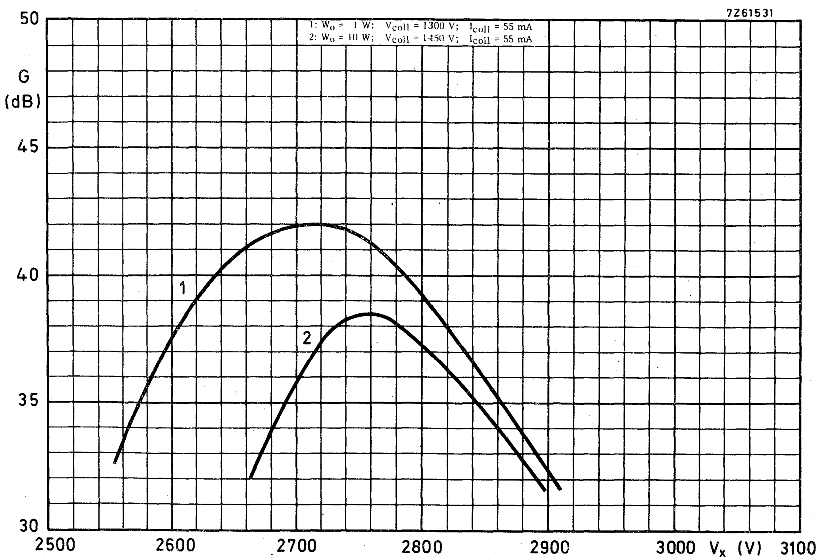
Output power = f (input power)



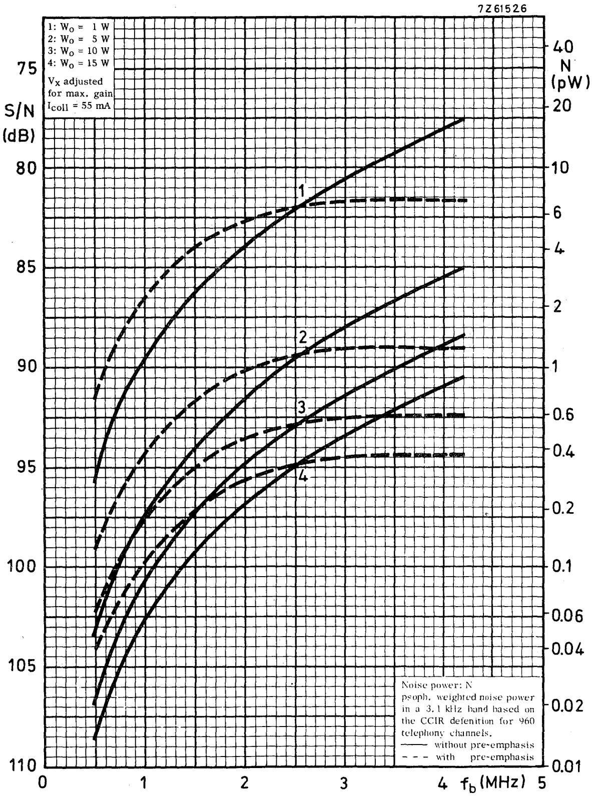
Gain = f (helix voltage) f = 6 GHz



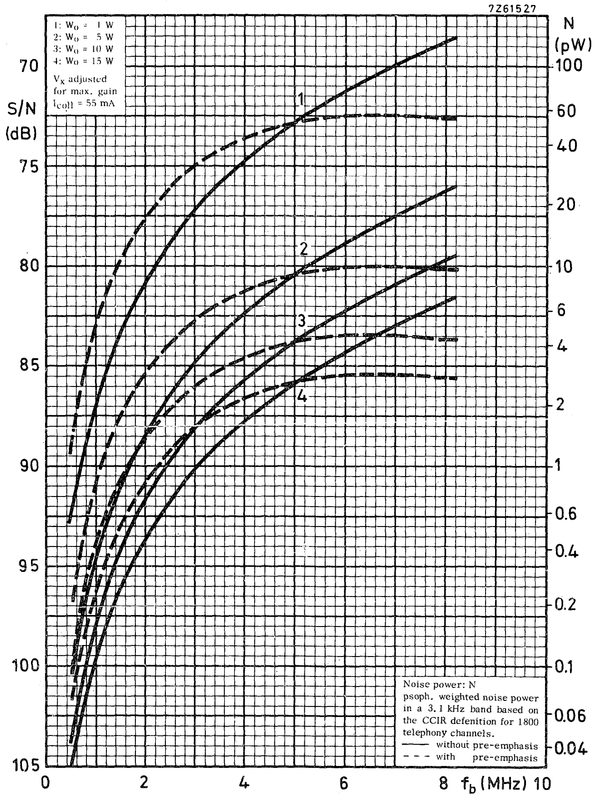
Gain = f (helix voltage) f = 7 GHz



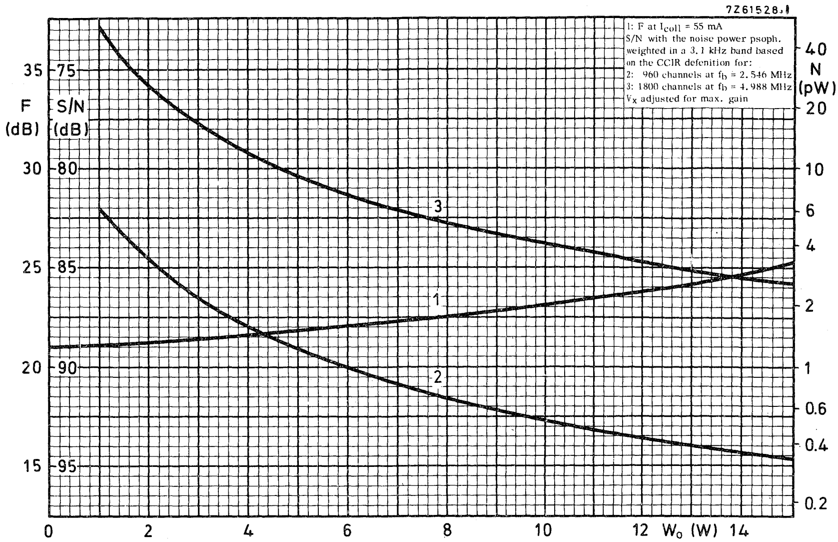
Gain = f (helix voltage) f = 8 GHz



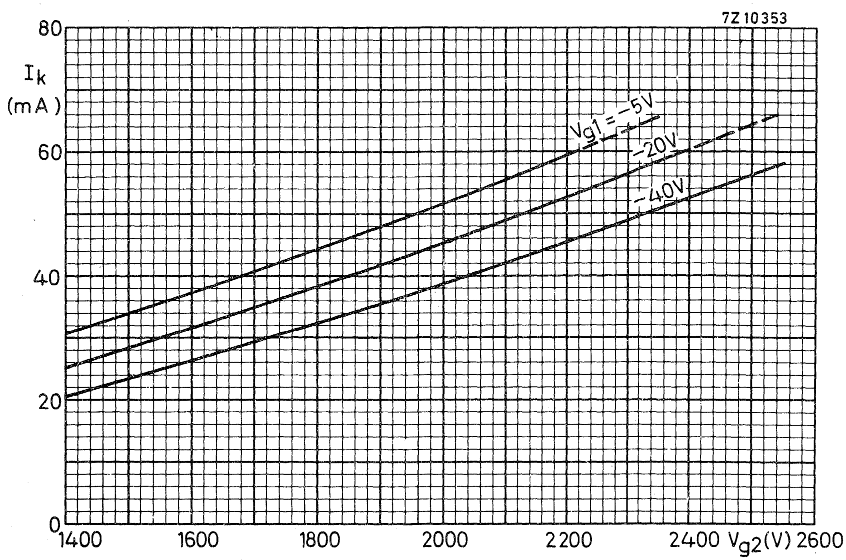
Signal to noise ratio (FM) = f (baseband freq.) at f = 6 GHz



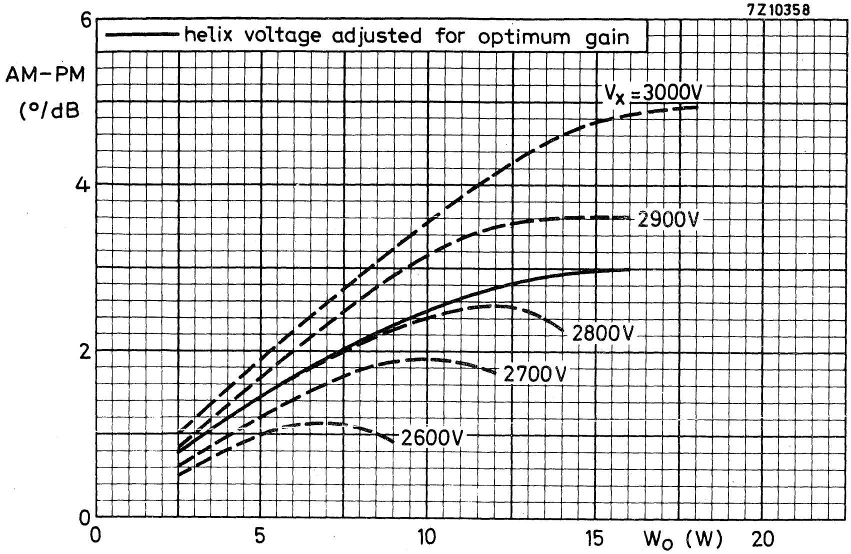
Signal to noise ratio (FM) = f (baseband freq.) at f = 6 GHz



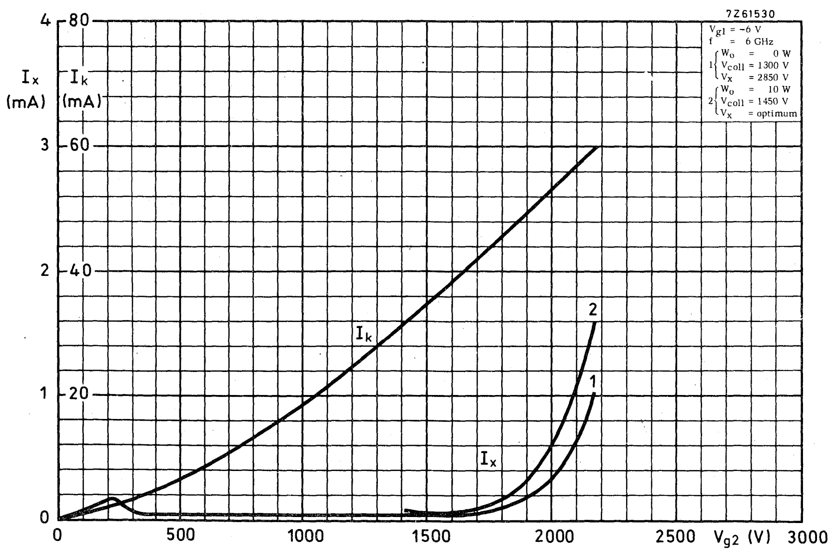
Thermal noise (FM) = f (output power) at f = 6 GHz



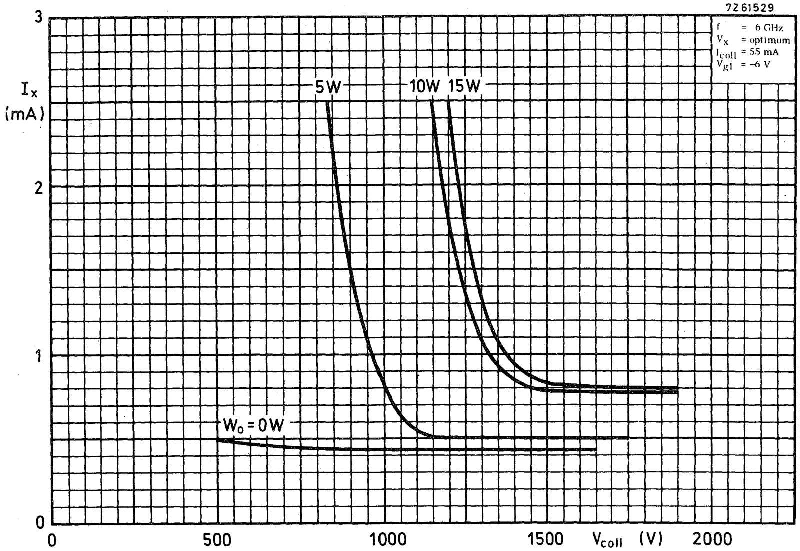
Cathode current = f (accelerator voltage)



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

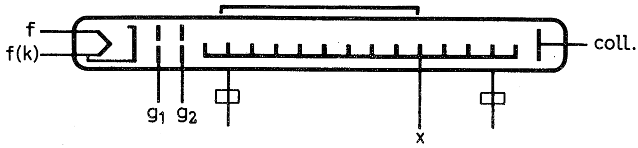
For shorter waiting time when the tube already has been in operation see "Application of voltages".

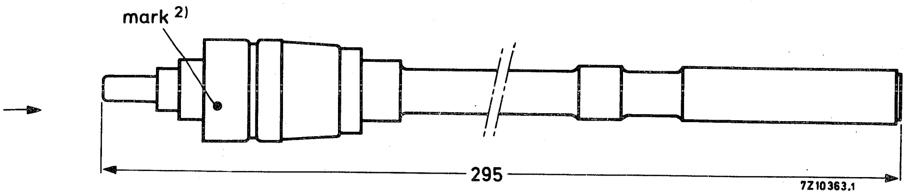
COOLING : By conduction. See also page 9.

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

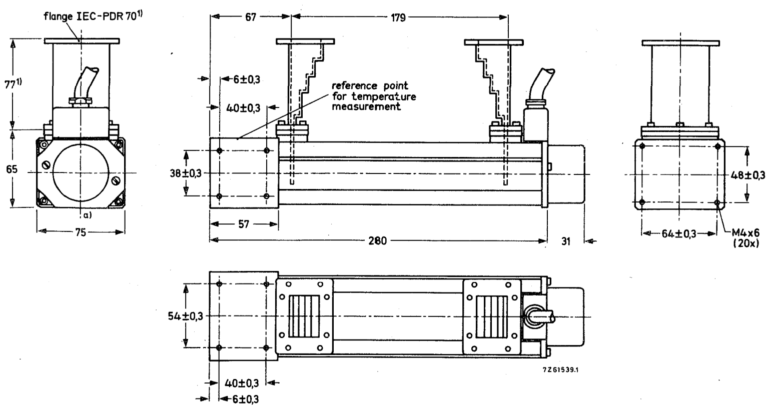


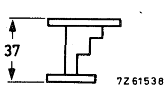


ACCESSORIES (to be ordered separately)

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 **flange** mating IEC-UER84	type	55342

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





Flange IEC-UER84

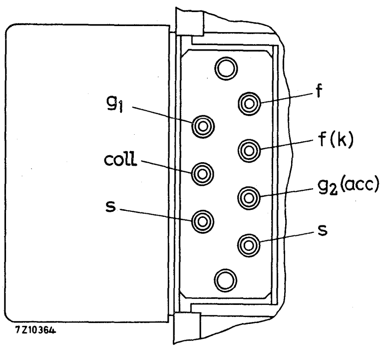
Notes see page 3.

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 or taking off the mount cap)	two violet leads

Connections in cable housing



[1]) Waveguide taper 55342.

[2]) The tube is provided with a mark on the accelerator terminal. For optimum performance the tube must be inserted with this mark in line with the centre line a) of the cable housing on the mount.

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	^{o}/dB

LIMITING VALUES (Absolute maximum rating system)

(Voltages are specified with respect to the cathode unless otherwise specified)

Focusing electrode voltage	$-V_{g1}$	min.	0	V
		max.	50	V
Accelerator voltage	V_{g2}	max.	2700	V
Helix voltage	V_x	max.	3300	V
Collector to helix voltage	V_{coll-x}	max.	2500	V
Cathode current	I_k	max.	58	mA
Accelerator current	I_{g2}	max.	0.3	mA
Helix current	I_x	max.	3	mA
R.F. input level	W_i	max.	100	mW
Collector dissipation at t_{amb} = 65 ^oC $I_{coll} \times V_{coll} - W_o$	W_{coll}	max.	90	W
Power reflected from load		max.	2	W [1]
Cooler temperature at reference point	t	max.	150	^oC

1) To avoid overheating of the helix.
2) To be adjusted for indicated collector current.

DESIGN AND OPERATING NOTES

1. INSTALLATION OF THE MOUNT

Two main methods may be discerned:

a) Fixing the mount relative to the microwave circuit by only connecting the waveguide tapers to the input and output sides of the circuit.

b) Employing a) and establishing additional support by fastening the mount to the rack with clamps. In this case it is recommended to use a short piece of flexible waveguide at the input and output sides to prevent excessive strain on the mount via the tapers, unless very careful alignment of the waveguides can be assured.

Possible forces on the waveguides must not produce a moment greater than 2 mkg at the flanges.

1.1 Mount

The mount has no movable parts. If clamps are used (method b) the slightly larger dimensions of the cooler as compared to the main part of the mount must be considered.

1.2 Magnetic shielding

The periodic permanent magnet is completely shielded. This implies that no additional measures need be taken to prevent the magnetic properties of the mount from being affected by external magnetic fields. The mount will not influence surrounding equipment which is susceptible to stray magnetic fields. Several mounts may be placed side by side without disturbing the focusing qualities. Isolators may be installed quite near to the mount.

Warning

If any part of the shielding is removed, the magnetic properties of the mount may be disturbed irreversibly.

2 INSTALLATION OF THE TUBE

Unlock the mount cap (see outline drawing) by turning it slightly counter-clockwise. The cap can then easily be removed, and the tube inserted by carefully pushing it in. See also note 2, page 3.
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

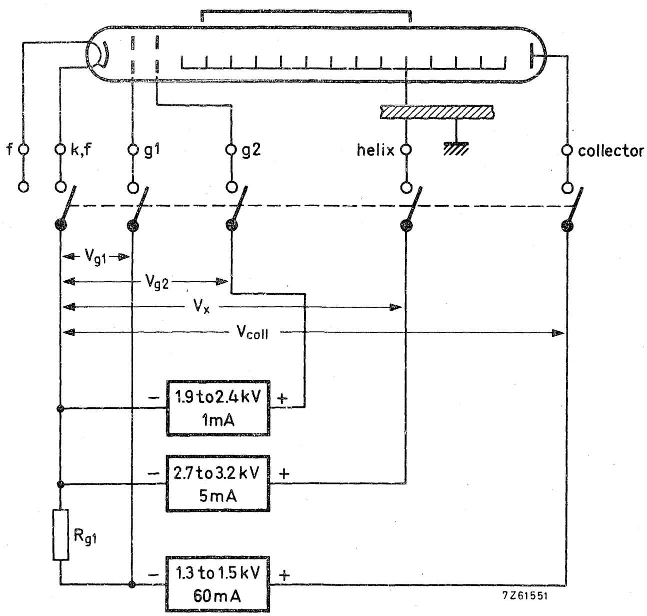
An example of a supply circuit for 5, 10 and 15 W operation is given in the figure.

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.

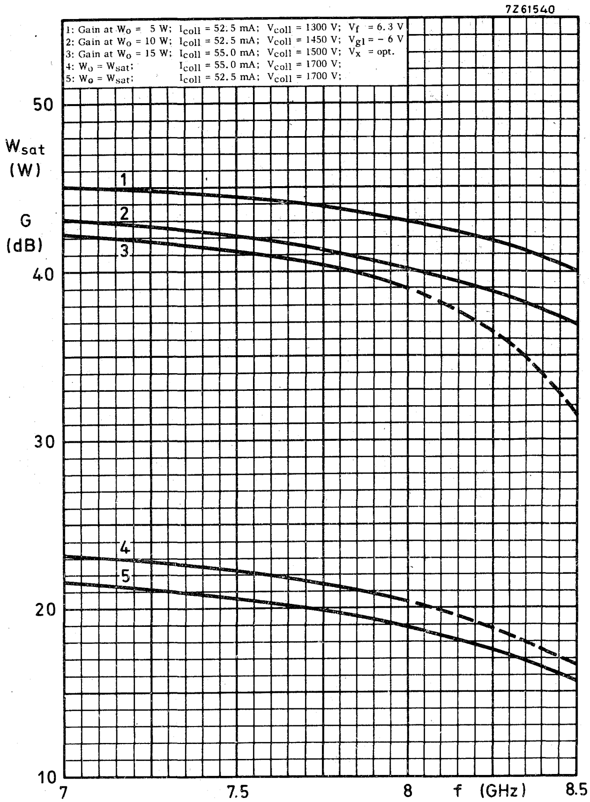
It may be noted that the difference between the voltage reflection coefficients of the hot and the cold (i.e. with respectively without electron beam) tube is less than 0.2 for the input as well as the output side, measured at an output power level of 5 W or more.

8. ENVIRONMENTAL CONDITIONS

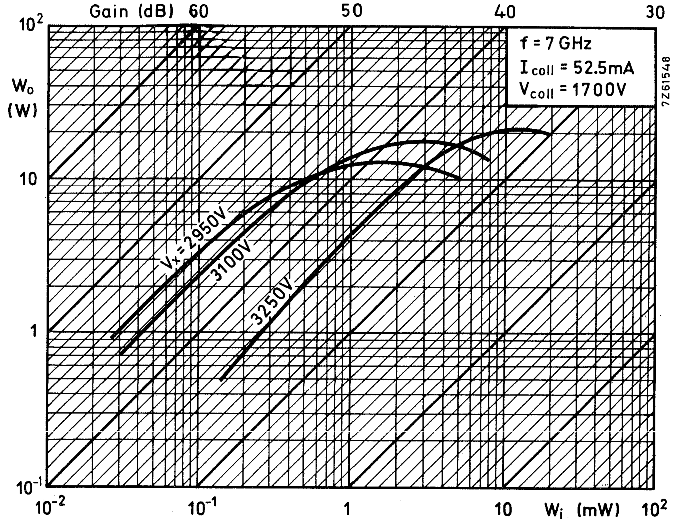
Ambient temperature,

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

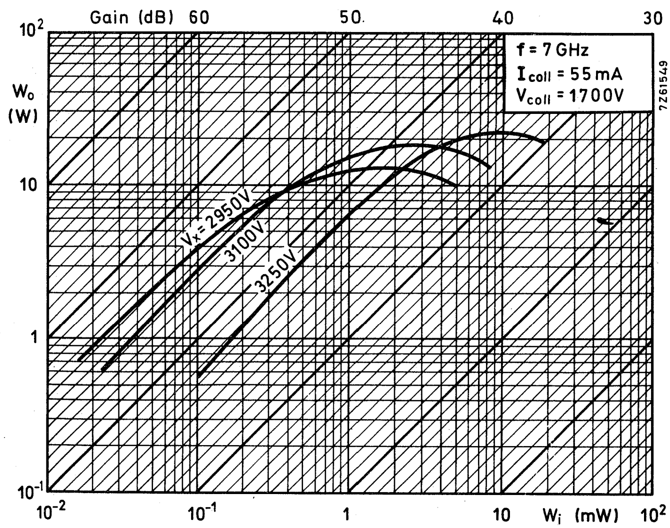
The tube and mount resist fungus attack.



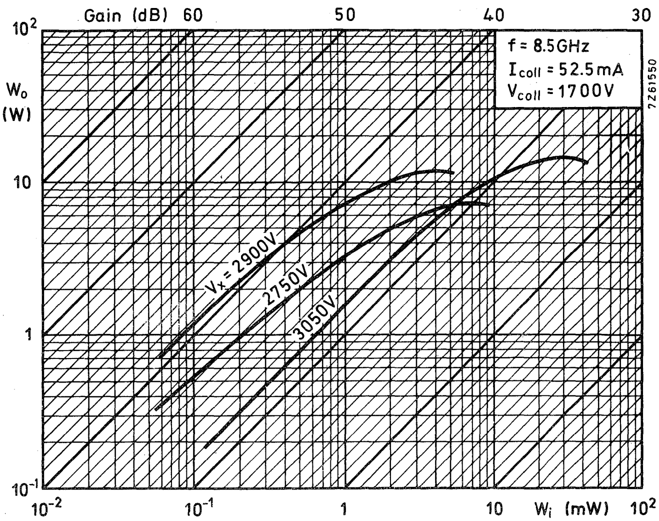
Gain and saturation power = f (frequency)



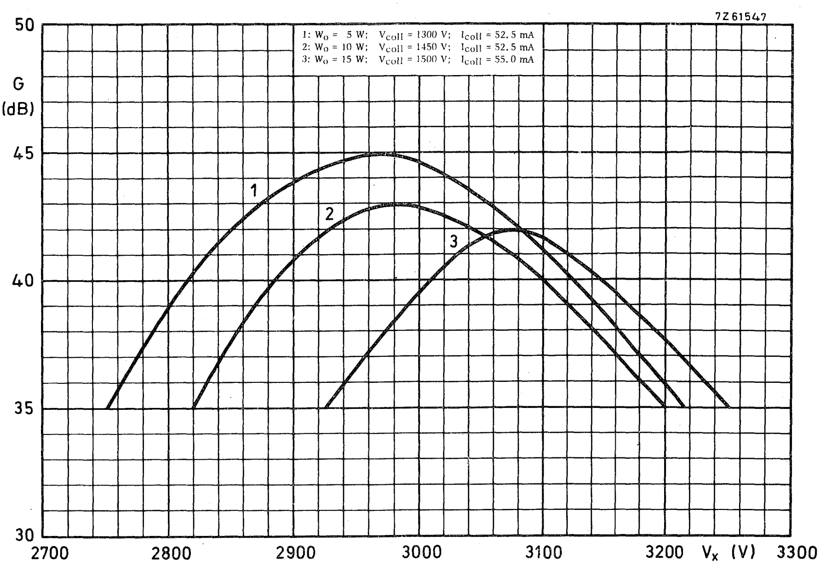
Output power = f (input power)



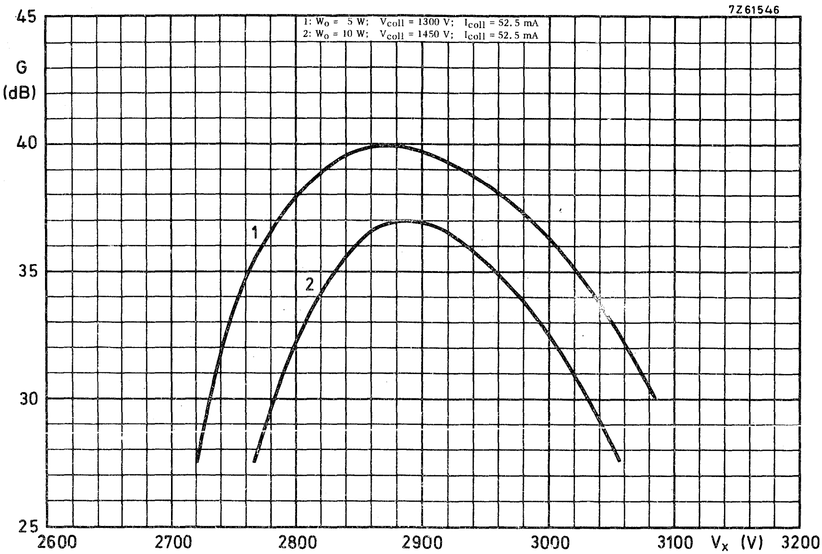
Output power = f (input power)



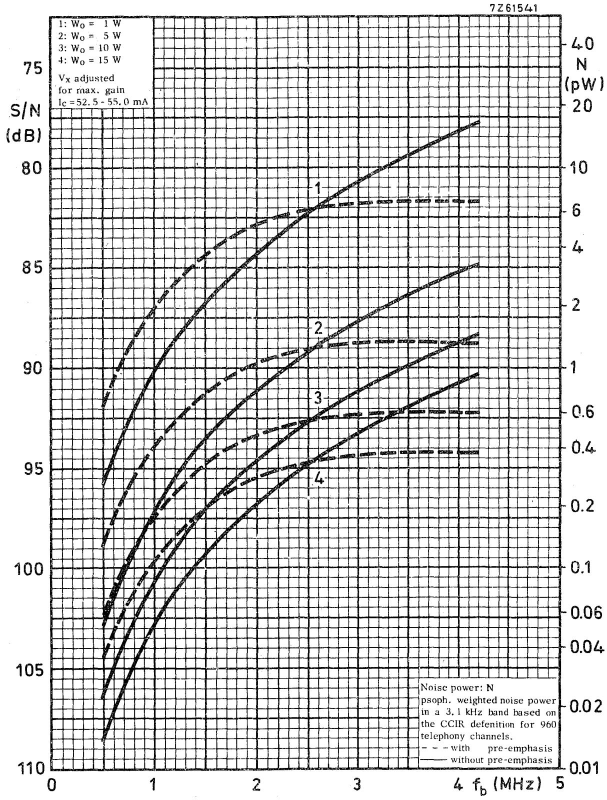
Output power = f (input power)



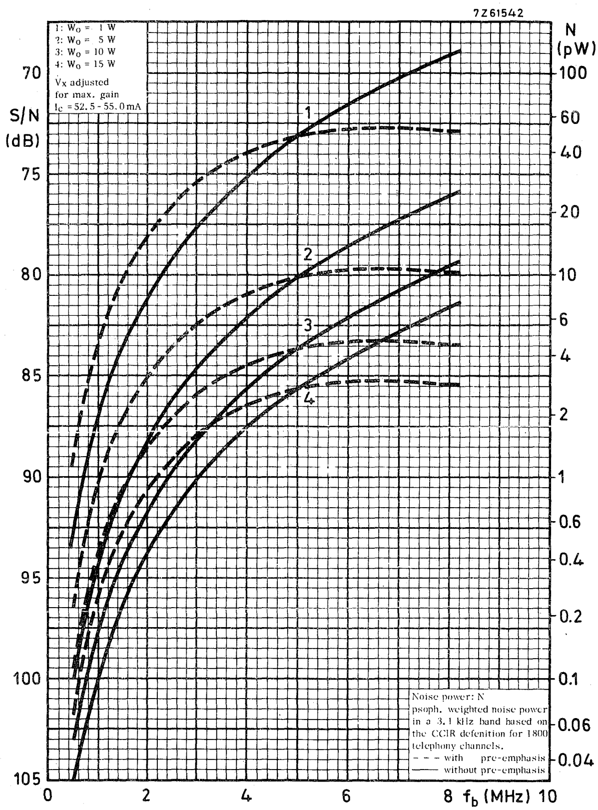
Gain = f (helix voltage); f = 7.0 GHz



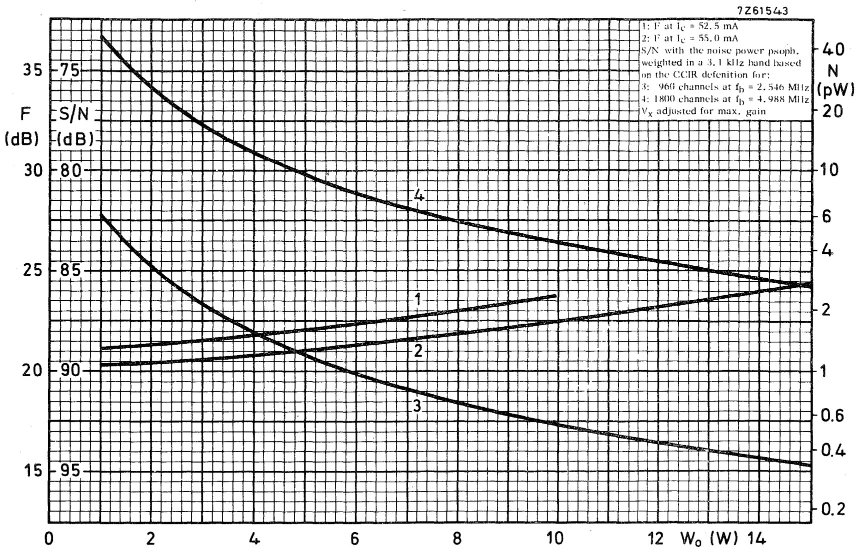
Gain = f (helix voltage); f = 8.5 GHz



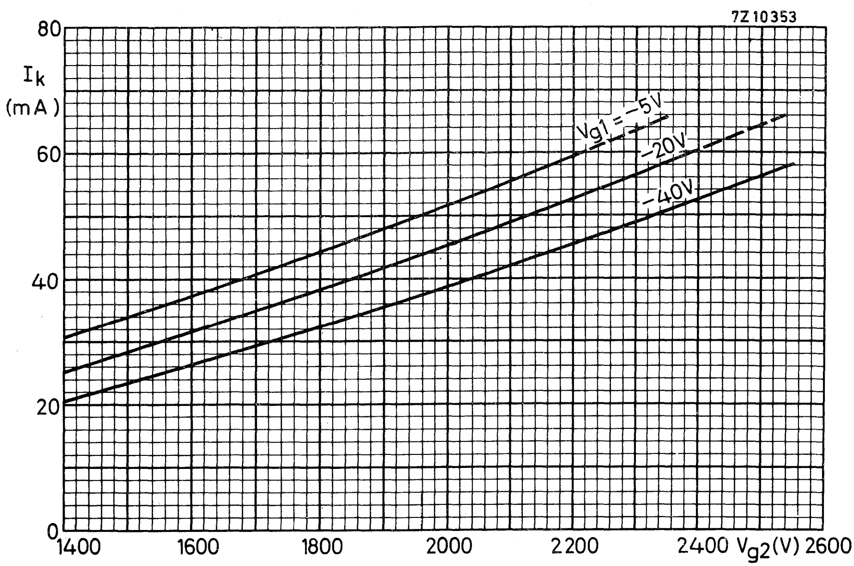
Signal to noise ratio (FM) = f (baseband freq.) at f = 7 GHz



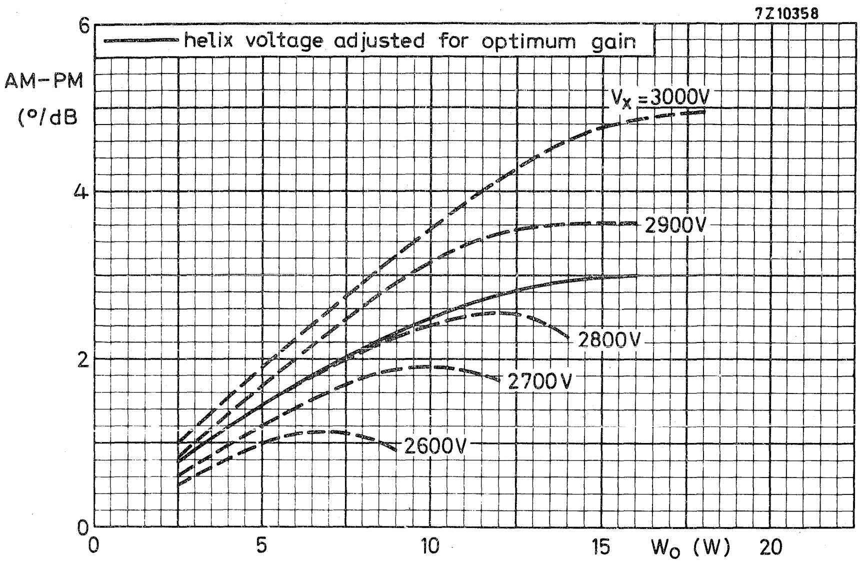
Signal to noise ratio (FM) = f (baseband freq.) at f = 7 GHz



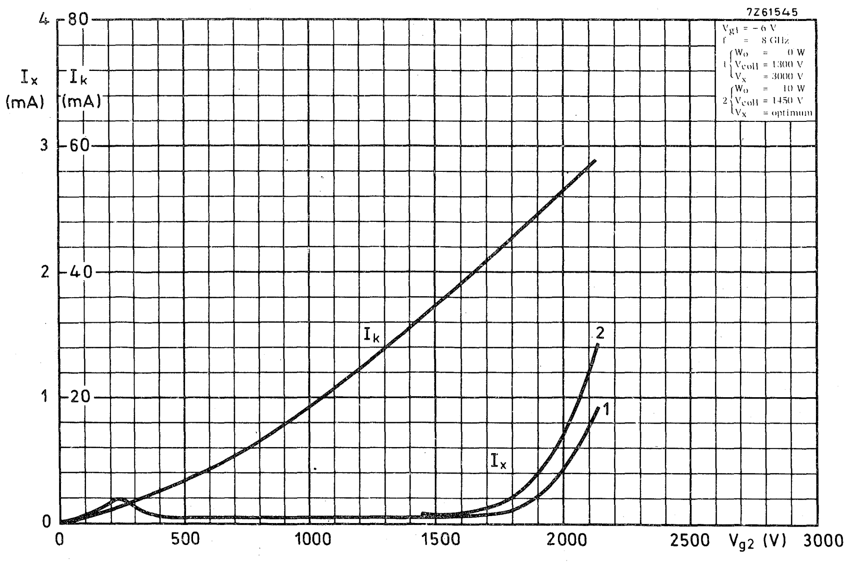
Thermal noise (FM) = f (output power) at 7 GHz



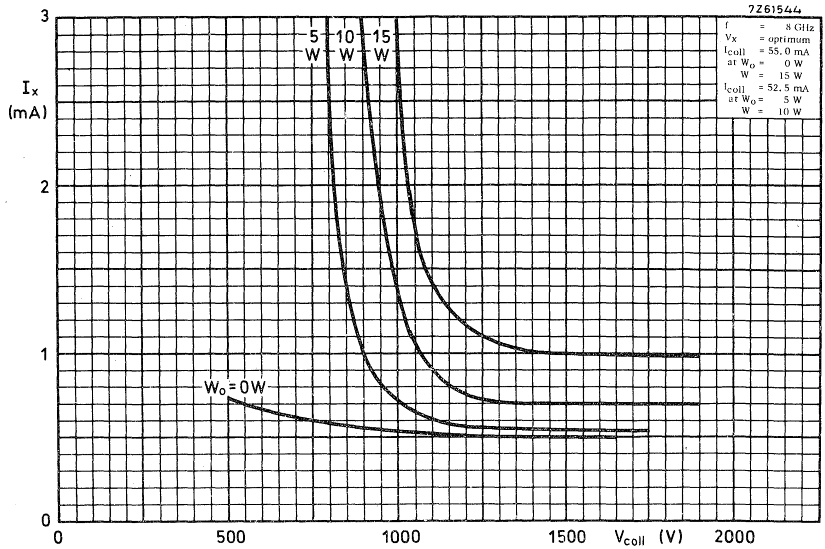
Cathode current = f (accelerator voltage)



AM to PM conversion = f (output power) at f = 7 GHz



Cathode current and helix current = f (accelerator voltage)



Helix current = f (collector voltage)

TRAVELLING WAVE TUBE

QUICK REFERENCE DATA				
Frequency	f	=	4.4 to 5.0	GHz
Low level gain at 5.0 GHz	G	>	36	dB
Saturated output power	W_o	>	6	W
Construction	unpackaged with uniform field permanent magnet focusing			

DESCRIPTION

The wave propagating structure is of the helical type. The separate mount for the tube with r.f. conductors for coupling to the input and output waveguides contains a permanent magnet of the uniform field type, which is completely shielded by means of the surrounding box.
The tube is designed for plug-in match in the waveguide circuit. This gives the advantage that, after changing tubes, no tuning will be necessary, nor will the voltages on the tube have to be reestablished, apart from the starting procedure. Only a slight adjustment of the tube in the magnetic field will be required.

HEATING: indirect; dispenser type cathode

Heater voltage	V_f	=	6.3	V
Heater current	I_f	=	800	mA
Waiting time	T_w	=	min. 5	min

GENERAL CHARACTERISTICS

Magnetic field strength	H	=	600	Oe
Cold transmission loss (f = 4.4 to 5.0 GHz)		>	55	dB
Saturated output power (I_{coll} = 50 mA)	W_o	>	6	W
Frequency	f	=	5.0	GHz
Helix voltage	V_x	=	optimal	
Collector current	I_{coll}	=	50	mA
Output power	W_o	=	100	mW
Low level gain	G	>	36	dB

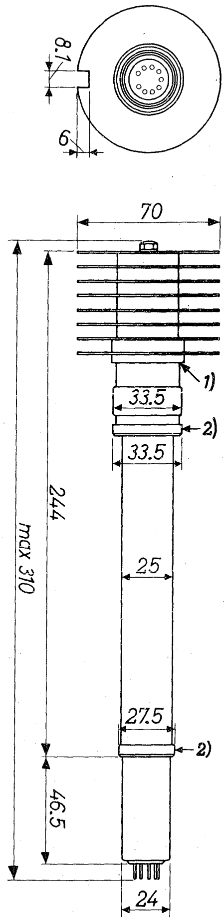
MECHANICAL DATA

Dimensions in mm

Net weight 0.5 kg

Net weight of mount 30 kg

Input and output
waveguides RG-49/U



Connections of the plug of the mount

1, 2 } Helix (x)

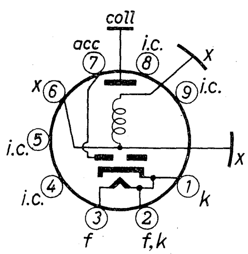
3 -

4 Collector (coll)

5 Accelerator (acc)

6 Heater (f)

7 Heater and cathode (f, k)



Tube base (Noval)

Mounting position: arbitrary

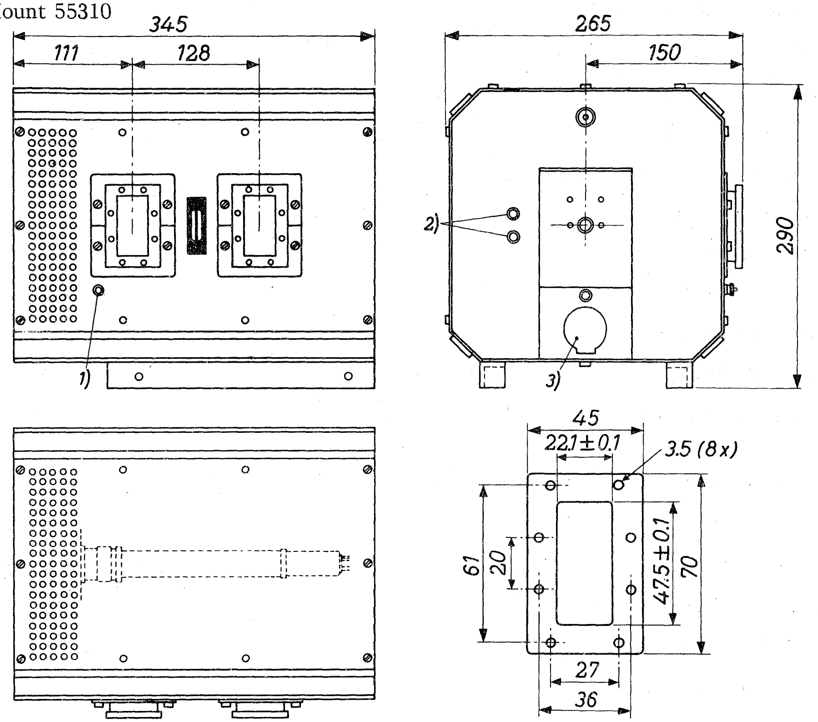
---

1) Reference point for collector temperature measurement

2) Contact rings

MECHANICAL DATA (continued) Dimensions in mm

Mount 55310



ATTENTION

Do not apply voltages to the tube when the door is open
Do not remove any part of the shielding box, nor introduce ferro-magnetic materials into the mount.

NOTE

A socket wrench for the alignment screws is fixed near the fastener on the door.

---

1) Earth connection

2) Alignment screws

3) Connector to power supply

LIMITING VALUES (Absolute limits)

Voltages with respect to cathode

Heater voltage	V_f	=	6.3 V ± 2%		
Cathode current	I_k	=	max.	55	mA
Accelerator voltage	V_{acc}	=	max.	1500	V
Accelerator to helix voltage	V_{acc-x}	=	max.	500	V
Accelerator current	I_{acc}	=	max.	0.35	mA
Helix voltage	V_x	=	max.	1500	V [1])
Helix current	I_x	=	max.	4	mA
Collector voltage	V_{coll}	=	max.	1500	V
Collector dissipation	W_{coll}	=	max.	70	W
Collector temperature	t_{coll}	=	max.	175	°C [2])

OPERATING CHARACTERISTICS as power amplifier

Voltages with respect to helix

Frequency	f	=	4.4 to 5.0	GHz
Cathode voltage	V_k	=	-1100	V
Accelerator voltage	V_{acc}	=	-30	V
Accelerator current	I_{acc}	<	0.35	mA
Helix current	I_x	<	3	mA
Collector voltage	V_{coll}	=	+50	V
Collector current	I_{coll}	=	47 to 53	mA
Power gain at f = 5.0 GHz				
at W_o = 100 mW	G	>	34	dB
at W_o = 2.5 W	G	>	32	dB
Voltage standing wave ratio	VSWR	<	1.5	[3])
Noise figure	F	<	30	dB

---

[1]) The helix is galvanically connected to the mount.

[2]) For reference point of the collector temperature see note [1]) page 2.

[3]) For input and output. Measured cold, i.e. with beam switched off.
For further particulars see paragraph "Transmission line".

Cooling

The tube is convection cooled by natural air circulation. Under normal operating conditions and at $t_{amb} < 55\ ^{o}C$ no forced air cooling is required to keep the collector temperature below the maximum permissible value of 175 ^{o}C, provided the tube is mounted horizontally and no obstructions are offered for the air circulation through the ventilation holes in the mount. For less favourable conditions a slight additional air flow will be necessary.

Shielding

Nowhere along the box surface a magnetic field strength of 2000 Oe close to the shielding plates extended over a cross sectional area of 30 cm^2 and directed perpendicular to the box surface, causes a change, worth mentioning, in the focus quality. Several mounts may be placed on top of or next to each other, without mutual disturbance of focusing qualities.
The stray field of the mount, measured at a distance of 1 cm from the box, is in general less than 10 Oe. On a few spots, e.g. near the ventilation holes and the alignment screws this value is exceeded with max. 20 Oe, but then the 10 Oe value is still reached within a distance of 4 cm from the box.

Transmission line

To obtain the full benefit of the broadband characteristics of the tube, the insertion of an isolator between the tube and the prestage and between the tube and the antenna is strongly recommended. The isolators should be positioned as close as possible to the tube. By these provisions phase distortion by long line effects is avoided.
The difference between the reflection coefficients at input and output sides of the cold tube (i.e. without beam) and the warm tube is less than 0.2.
Provided an isolator with a VSWR of less than 1.05 is placed at a short distance (10 to 20 cm) at either side of the tube, the reflections result in a variation of group delay of less than 0.1 mμsec over a band of 20 MHz.

Operating instructions

The mount is provided with an alignment device for the proper positioning of the tube with respect to the magnetic field in the mount.
For alignment screws see drawing of the mount.
As the helix current depends on the position of the tube with respect to the magnetic field, special attention must be given to the proper alignment of the tube during the steps c and d of the starting procedure given below. To prevent tube damage it is essential to observe the 4 mA maximum limit on the helix current.

1. Starting procedure

1.1 Remove the plug, loosen the fastener and open the door.

1.2 Insert the tube into the mount as shown in the drawing of the mount (take care, the tube is subject to magnetic forces). When the tube is blocked by some parts of the mount, a small correction in the position of the tube will be sufficient to avoid the obstacles.

1.3 Close the door, lock the fastener and put on the plug.

1.4 Switch on the supply voltages in the following sequence (the voltages mentioned below are with respect to the helix, which is normally at ground potential):
   a. Apply the rated heater voltage for at least 5 minutes.
   b. Apply +50 V to the collector and −30 V to the accelerator. These voltages may be applied simultaneously.
   c. Apply the cathode voltage gradually, adjusting the alignment of the tube in order not to exceed 4 mA helix current.
   d. Apply the H.F. signal to the input of the tube and adjust the alignment of the tube until the helix current reaches a minimum.

2. Switching procedure after interruption of voltages

2.1 Interruption less than 1 second. All voltages can be applied simultaneously. The output will reach 95% of the stable end value within 0.2 sec after the application of the voltages.

2.2 Interruption 1 sec or more. The voltages must be applied in the following sequence:
   a. Apply the rated heater voltage for at least 40 seconds.
   b. Apply +50 V to the collector and −30 V to the accelerator. These voltages may be applied simultaneously.
   c. Apply the rated cathode voltage. Voltages mentioned under b) and c) can be applied simultaneously.

   The H.F. voltage can be applied at any time.
   The output will reach 95% of the stable end value within 60 sec after the application of the heater voltage.

Remark

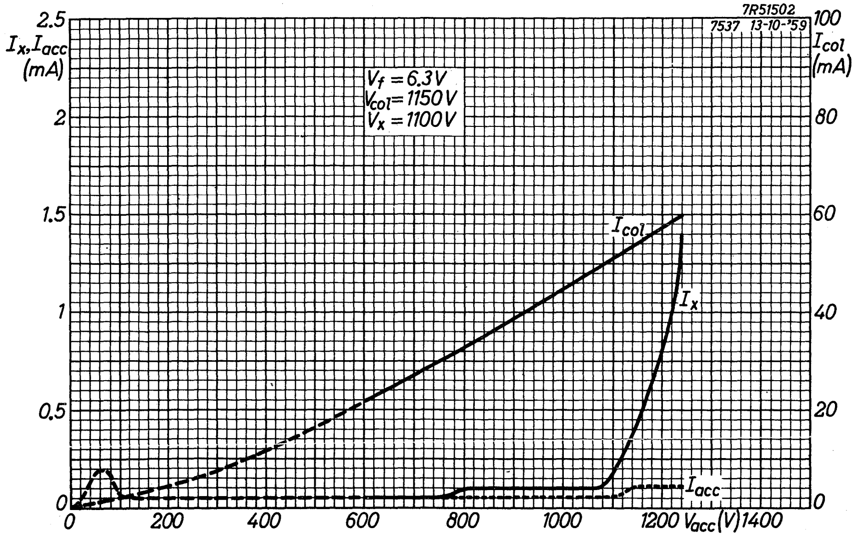
The procedure described under 2.2 can be followed without any risk of disturbing the properties of the tube. It should be noted, however, that normally about 5 minutes cathode heating time is required to obtain completely stable operation of the tube.

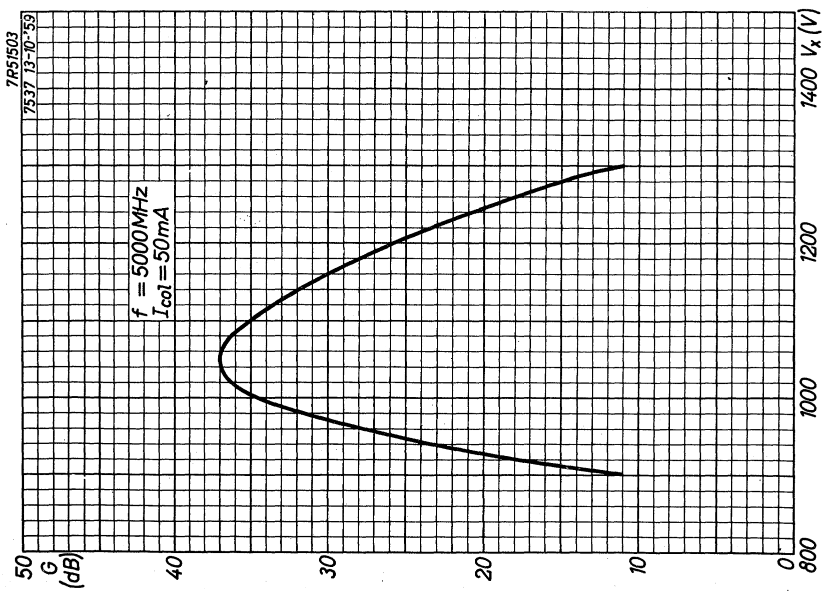
3. Switching off procedure

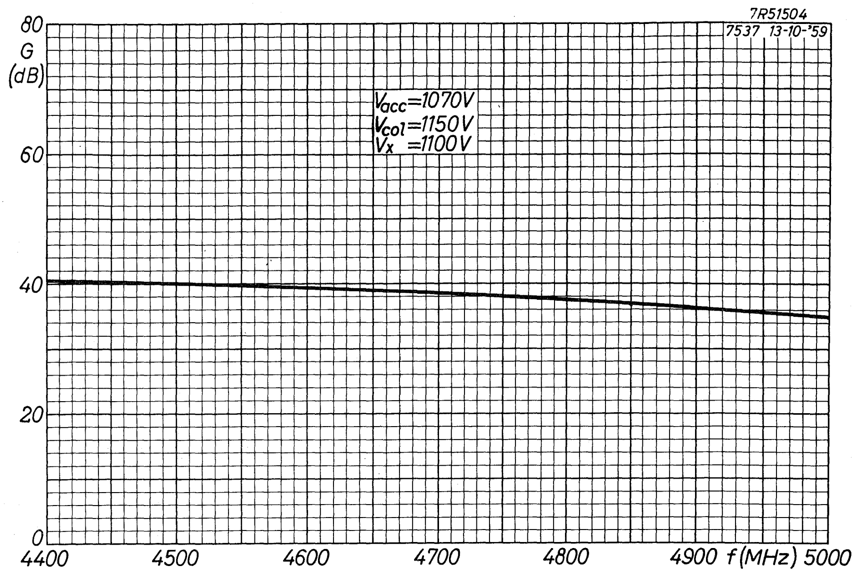
3.1 a. Switch off all voltages simultaneously.
b. Remove plug, open the door and pull out the tube.

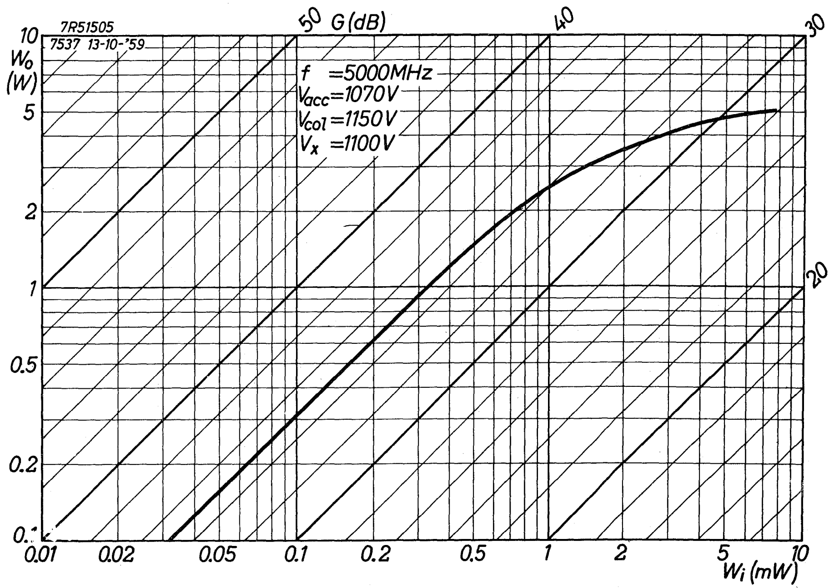
3.2 a. Bring accelerator voltage to helix potential.
b. Switch off the cathode voltage.
c. Switch off the accelerator, collector and heater voltages.
d. Remove plug, open the door and pull out the tube.

The methods 3.1 and 3.2 are optional.


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
$V_f = 6.3 V$
$V_{col} = 1150 V$
$V_x = 1100 V$
I_{col}
I_x
I_{acc}
0
200
400
600
800
1000
1200
V_{acc} (V)
1400


7R51503
7537 13-10-'59
$f = 5000 MHz$
$I_{col} = 50 mA$
1400 V_x (V)
1200
1000
800
50
G (dB)
40
30
20
10
0


7R51504
7537 13-10-'59
80
G
(dB)
60
40
20
0
V_{acc}=1070V
V_{col}=1150V
V_x =1100V
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 } Helix (x)
2 }

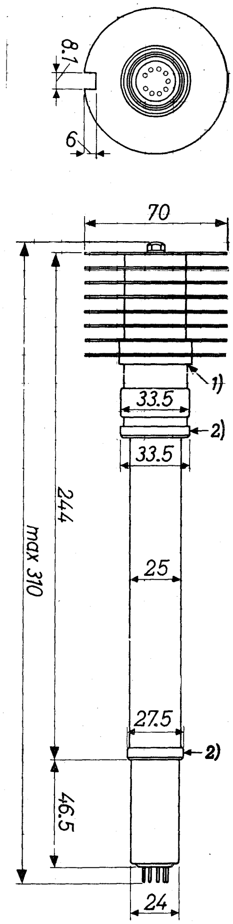
3

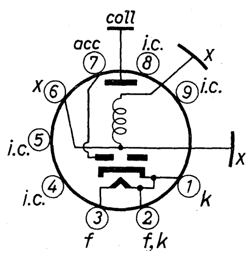
4 Collector (coll)

5 Accelerator (acc)

6 Heater (f)

7 Heater and cathode (f, k)





Tube base (Noval)

Mounting position: arbitrary

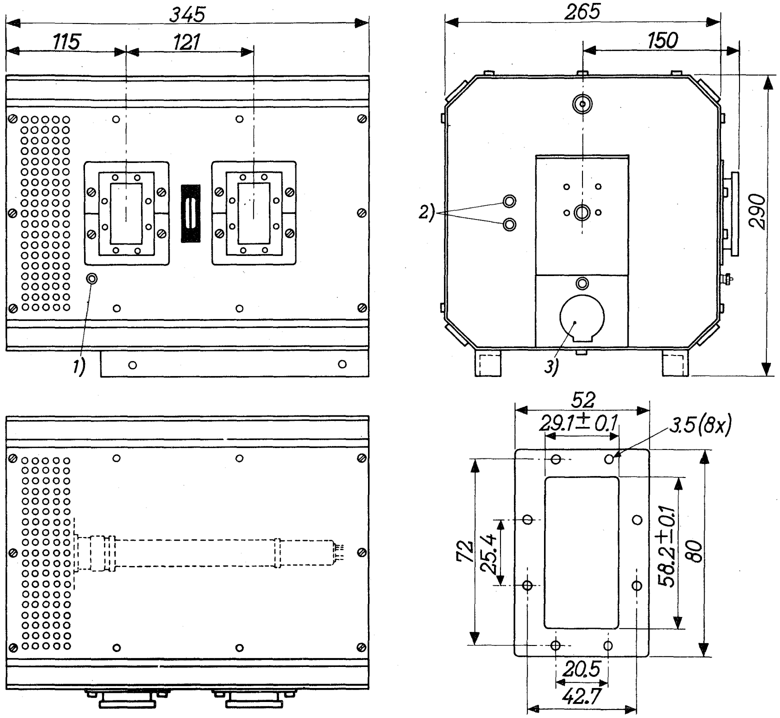
---

1) Reference point for collector temperature measurement

2) Contact rings

MECHANICAL DATA (continued) Dimensions in mm

Mount 55309



ATTENTION

Do not apply voltages to the tube when the door is open
Do not remove any part of the shielding box, nor introduce ferro-magnetic materials into the mount.

NOTE

A socket wrench for the alignment screws is fixed near the fastener on the door.

---

1) Earth connection

2) Alignment screws

3) Connector to power supply

LIMITING VALUES (Absolute limits)

Voltages with respect to cathode

Heater voltage	V_f	=	6.3 V ± 2%	
Cathode current	I_k	=	max. 55	mA
Accelerator voltage	V_{acc}	=	max. 1500	V
Accelerator to helix voltage	V_{acc-x}	=	max. 500	V
Accelerator current	I_{acc}	=	max. 0.35	mA
Helix voltage	V_x	=	max. 1500	V [1])
Helix current	I_x	=	max. 4	mA
Collector voltage	V_{coll}	=	max. 1500	V
Collector dissipation	W_{coll}	=	max. 70	W
Collector temperature	t_{coll}	=	max. 175	°C [2])

OPERATING CHARACTERISTICS as power amplifier

Voltages with respect to helix

Frequency	f	=	3.8 to 4.2	GHz
Cathode voltage	V_k	=	-1100	V
Accelerator voltage	V_{acc}	=	-30	V
Accelerator current	I_{acc}	<	0.35	mA
Helix current	I_x	<	3	mA
Collector voltage	V_{coll}	=	+50	V
Collector current	I_{coll}	=	47 to 53	mA
Power gain at f = 4.2 GHz				
at W_o = 100 mW	G	>	37	dB
at W_o = 3.0 W	G	>	35	dB
Voltage standing wave ratio	VSWR	<	1.5	[3])
Noise figure	F	<	30	dB

---

[1]) The helix is galvanically connected to the mount.

[2]) For reference point of the collector temperature see note [1]) page 2.

[3]) For input and output. Measured cold, i.e. with beam switched off. For further particulars see paragraph "Transmission line".

Cooling

The tube is convection cooled by natural air circulation. Under normal operating conditions and at $t_{amb} < 55\ ^{o}C$ no forced air cooling is required to keep the collector temperature below the maximum permissible value of 175 °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

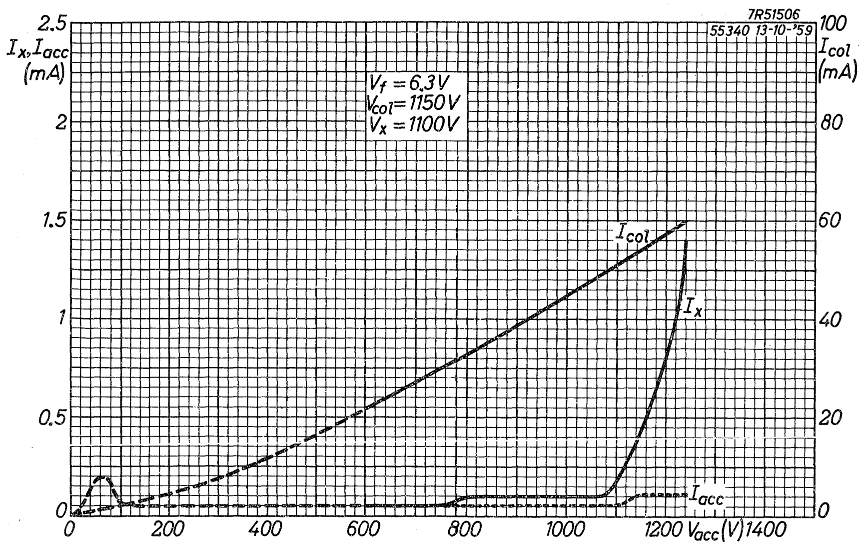
The procedure described under 2.2 can be followed without any risk of disturbing the properties of the tube. It should be noted, however, that normally about 5 minutes cathode heating time is required to obtain completely stable operation of the tube.

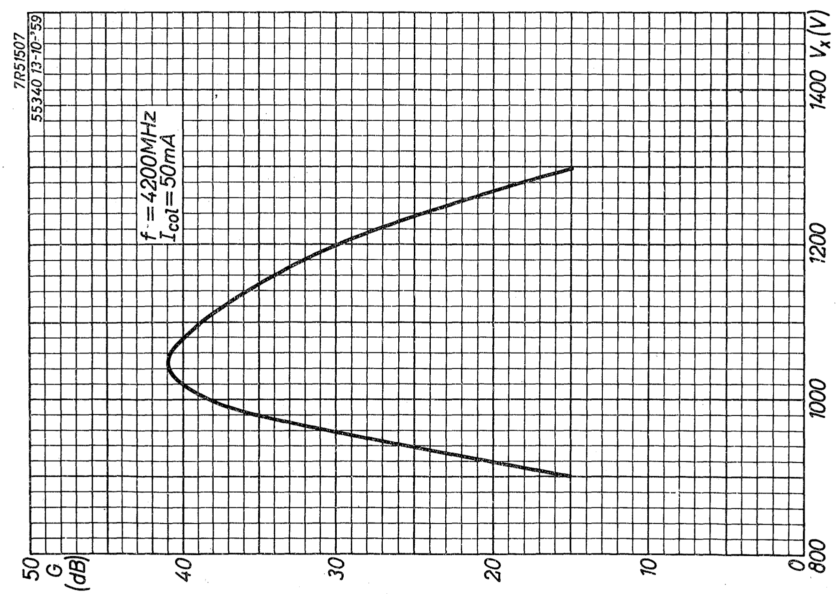
3. Switching off procedure

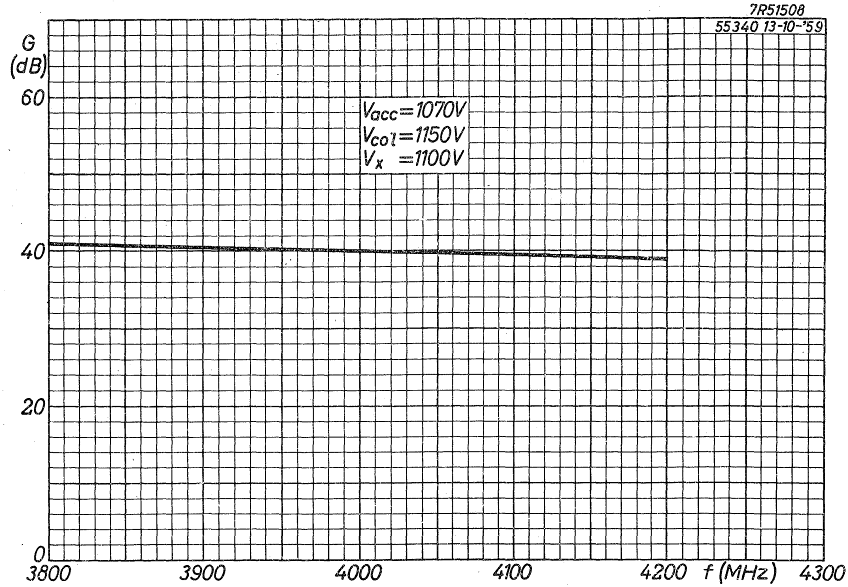
3.1 a. Switch off all voltages simultaneously.
b. Remove plug, open the door and pull out the tube.

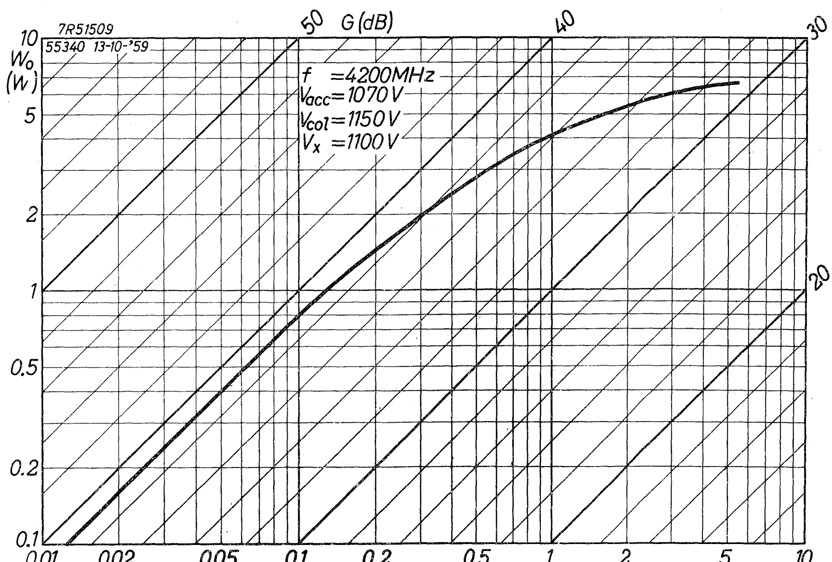
3.2 a. Bring accelerator voltage to helix potential.
b. Switch off the cathode voltage.
c. Switch off the accelerator, collector and heater voltages.
d. Remove plug, open the door and pull out the tube.

The methods 3.1 and 3.2 are optional.


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


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


7R51508
55340 13-10-'59
G
(dB)
60
40
20
0
V_{acc}=1070V
V_{col}=1150V
V_x =1100V
3800
3900
4000
4100
4200
f (MHz)
4300


7R51509
55340 13-10-'59
10
W_o
(W)
5
2
1
0.5
0.2
0.1
50
G (dB)
40
30
20
f =4200MHz
V_{acc}=1070V
V_{col}=1150V
V_x =1100V
0.01
0.02
0.05
0.1
0.2
0.5
1
2
5
10
W_i (mW)

Diodes

MEASURING DIODE

QUICK REFERENCE DATA				
Frequency	f		1000	MHz
Peak inverse voltage	$V_{d\,inv_p}$	max.	1000	V

HEATING : indirect by A.C. or D.C.; series or parallel supply

Heater voltage	V_f	=	6.3	V
Heater current	I_f	=	300	mA

CAPACITANCE Between anode and cathode C_d < 0.5 pF

TYPICAL CHARACTERISTICS

Heater voltage	V_f	=	6.3	V
Diode current	I_d	=	0.5	mA
Diode voltage	V_d	<	3	V

LIMITING VALUES (Absolute limits)

Peak inverse voltage

at frequencies lower than 100 MHz

$V_{d\,inv_p}$ (f < 100 MHz) = max. 1000 V

at frequencies higher than 100 MHz

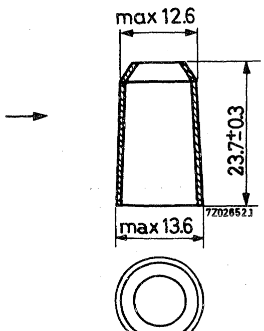
$V_{d\,inv_p}$ (f > 100 MHz) = max. $\frac{100}{f}$ x 1000 V [1]

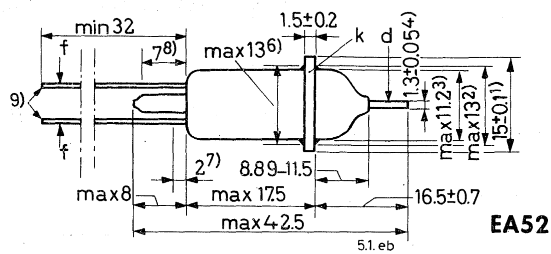
Cathode current (heater voltage from 5.6 to 7.0 V)	I_k	=	max.	0.3	mA
Peak cathode current (heater voltage from 5.6 to 7.0 V)	I_{k_p}	=	max.	5	mA [2]
Voltage between heater and cathode	V_{kf}	=	max.	50	V
External resistance between heater and cathode	R_{kf}	=	max.	20	kΩ
Heater voltage	V_f	=	max.	7.0	V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

[1]) f in MHz

[2]) For frequencies lower than 100 Hz I_{k_p} = max. 0.3 + 0.047f mA (f in Hz)

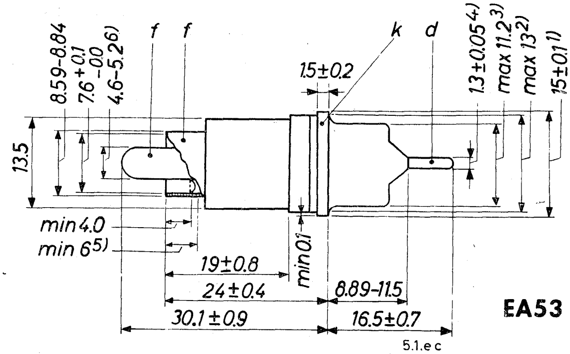
Dimensions in mm

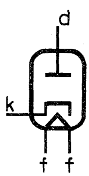




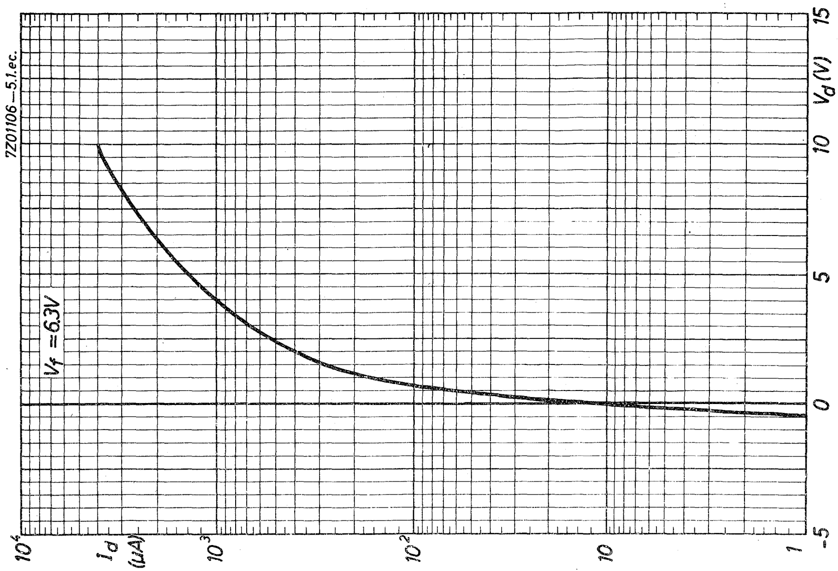
Protective cap for EA52

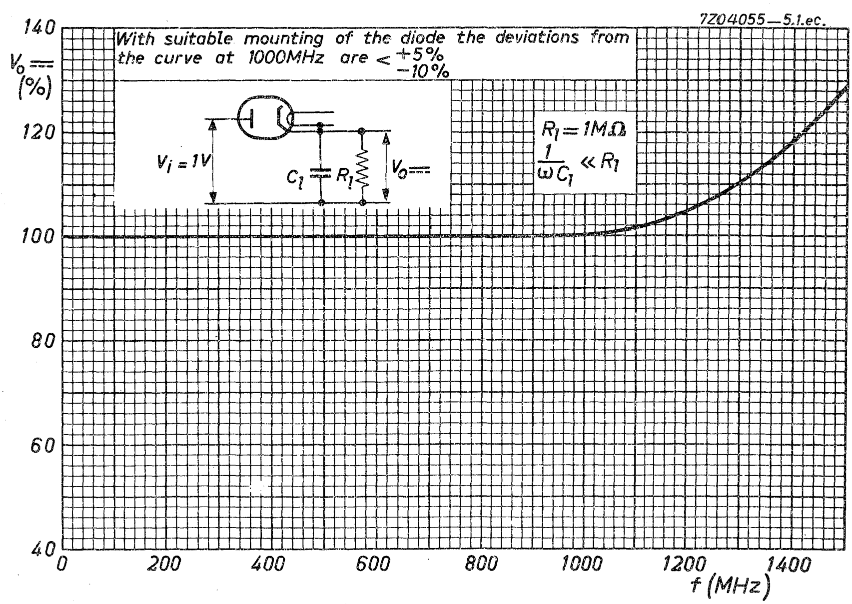
For protection during transport the EA52 is fitted with a plastic cap which should preferably be removed when the tube is mounted into position. If the cap is not removed, make sure that its temperature does never exceed 100 °C.

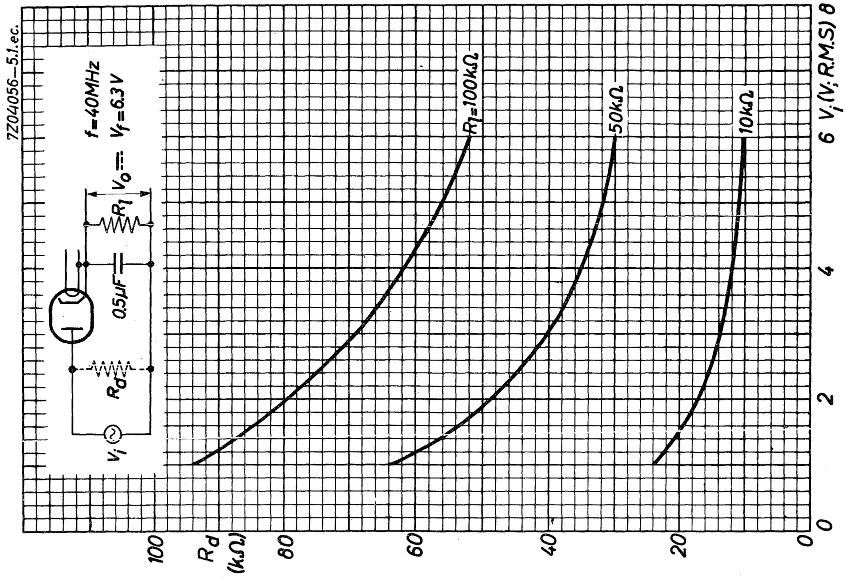


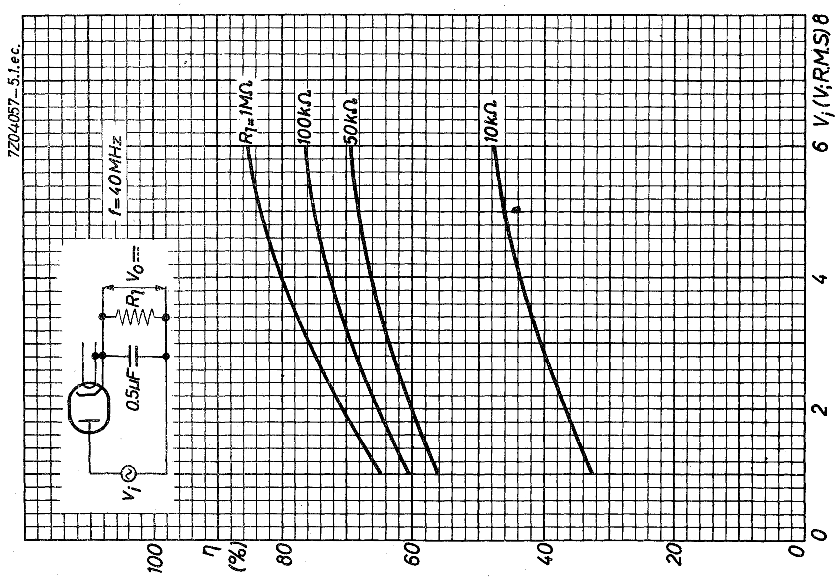


1) In order to avoid strain, the connection to the cathode disc should be sufficiently flexible.
2) Maximum diameter of the glass seal.
3) Eccentricity with respect to the cathode disc max. 0.35 mm.
4) Eccentricity with respect to the cathode disc max. 0.25 mm.
5) This dimension defines the length of the cylindrical section.
6) The max. dimension includes the eccentricity.
7) This part of the leads should not be bent.
8) This part of the leads should not be soldered.
9) Gold plated leads, 0.4 mm diameter.


7Z01106—5.1.ec.
V_f = 6.3V
V_d (V)
15
10
5
0
−5
10^4
I_d (μA)
10^3
10^2
10
1


7Z04055—5.1.ec.
With suitable mounting of the diode the deviations from the curve at 1000MHz are < +5% −10%
V_o (%)
V_i = 1V
C_1
R_1
V_o
R_1 = 1MΩ
$\frac{1}{\omega C_1} \ll R_1$
140
120
100
80
60
40
0
200
400
600
800
1000
1200
1400
f (MHz)


7Z04056–5.1.ec.
f=40MHz
V_o ⎓
V_f=6.3V
R_l
0.5μF
R_d
V_i
R_l=100kΩ
50kΩ
10kΩ
R_d (kΩ)
100
80
60
40
20
0
0
2
4
6
8
V_i (V_i R.M.S)


7Z04057–5.1.ec.
f=40MHz
V_o ⎓
R_l
0.5μF
V_i
R_l=1MΩ
100kΩ
50kΩ
10kΩ
η (%)
100
80
60
40
20
0
0
2
4
6
8
V_i (V_i R.M.S)

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

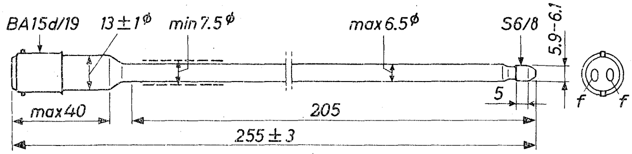
REMARKS

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

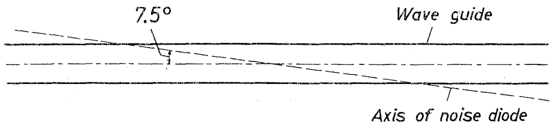
[1]) Change in noise level over 200 hours of operation is negligible.
[2]) For recommended ignition circuit see page 2.

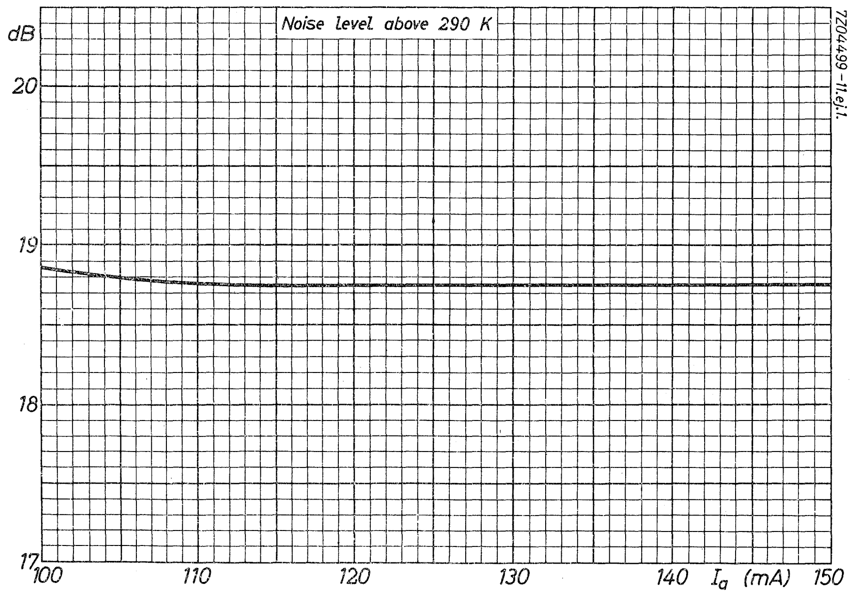
MECHANICAL DATA

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

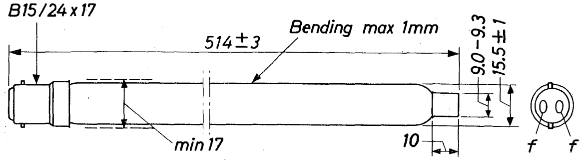
REMARKS

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

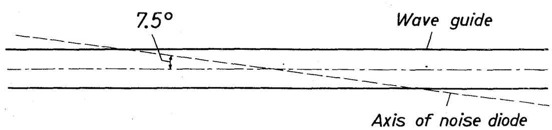
[1] Change in noise level over 200 hours of operation is negligible.
[2] For recommended ignition circuit see page 2.

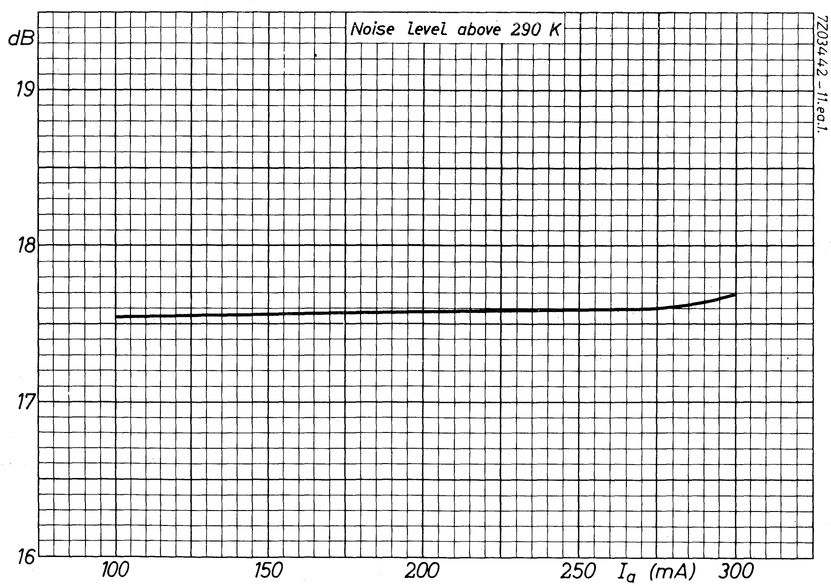
MECHANICAL DATA

Dimensions in mm
Small top cap



MOUNTING POSITION: Cathode at receiver side





Available for equipment maintenance. No longer recommended for equipment production.

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_{ap} = 10 kV	I_{ap}	>	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; thoriated tungsten filament

Filament voltage	V_f		5	V ± 5%
Filament current	I_f	min	6	A ± 0,5 A
Waiting time	T_w	min	5	s

CAPACITANCE

Anode to filament	C_{af}	1,4	pF

TYPICAL CHARACTERISTICS

Tube voltage drop at I_a = 100 mA	V_a	200	V

OPERATING CHARACTERISTICS as surge limiter

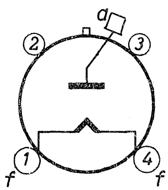
Heater voltage	V_f		5,5	V
Peak forward anode voltage	V_{ap}		10	kV
Peak anode current	I_{ap}	>	2	A

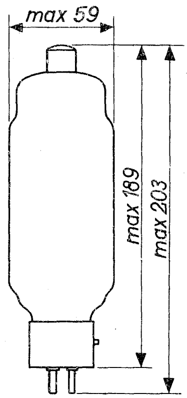
MECHANICAL DATA Dimensions in mm

Net weight: 90 g

Base: Medium 4p. with bayonet

Cap : Medium





Mounting position: vertical with base down

ACCESSORIES

Anode clip 40619

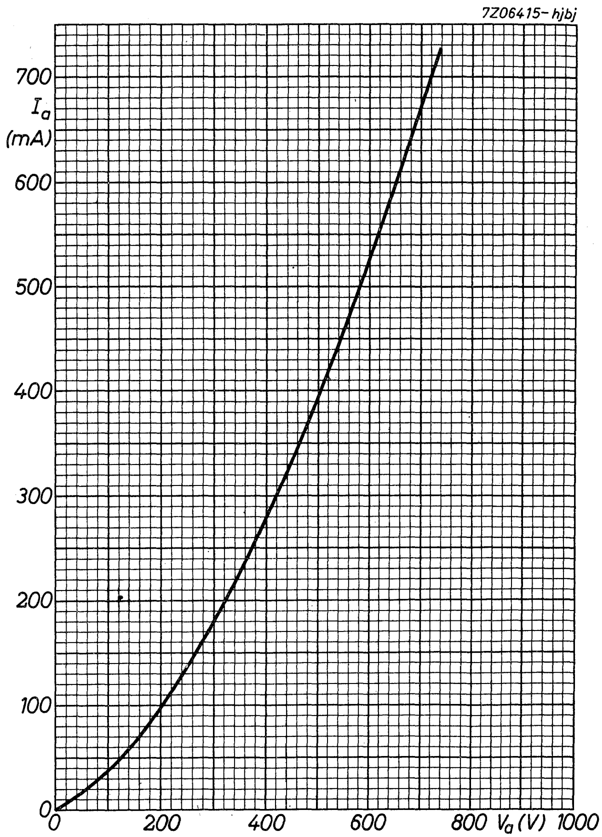
At voltages above 2 kV the socket must be insulated from the chassis.

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

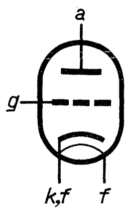
Anode to all other elements except grid	C_a	=	0.03	pF
Grid to all other elements except anode	C_g	=	1.8	pF
Anode to grid	C_{ag}	<	1.3	pF

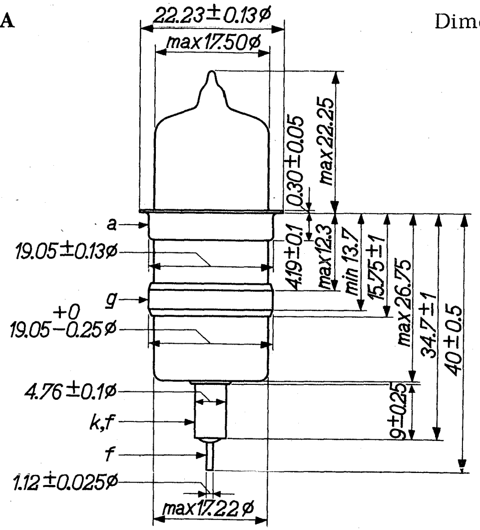
TYPICAL CHARACTERISTICS

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

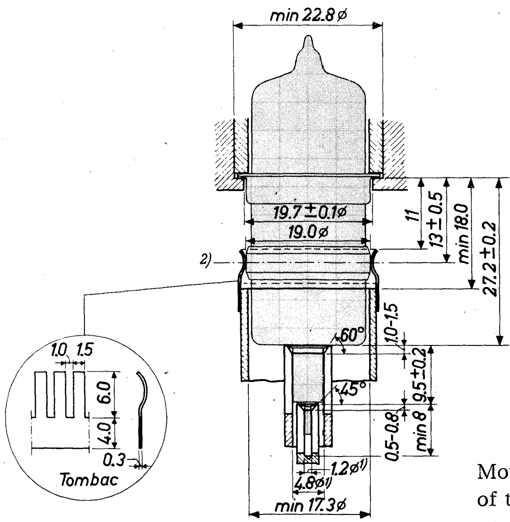




Eccentricity

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

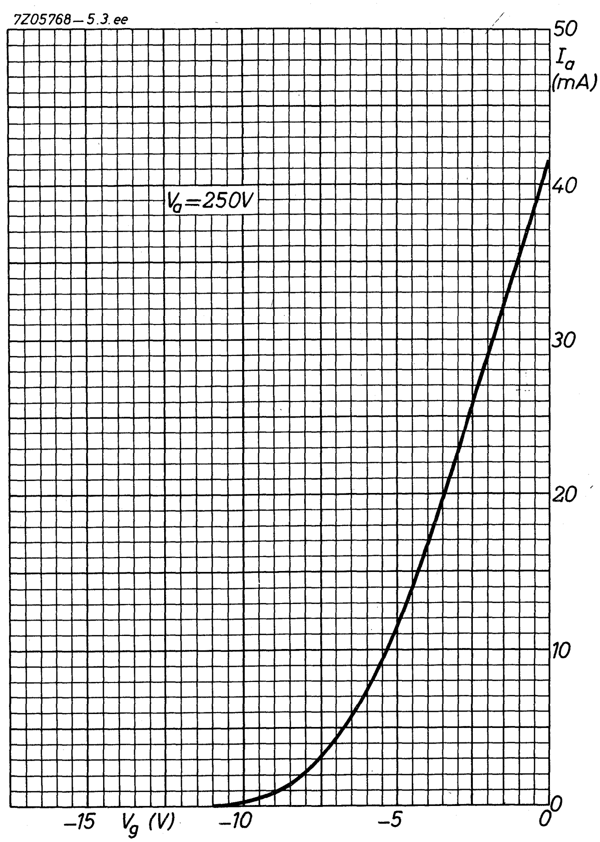


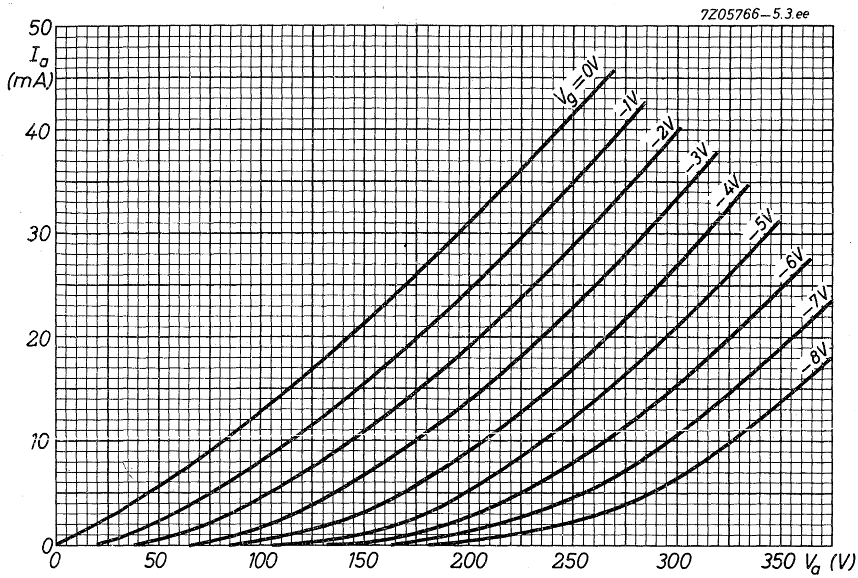
Mounting of the tube

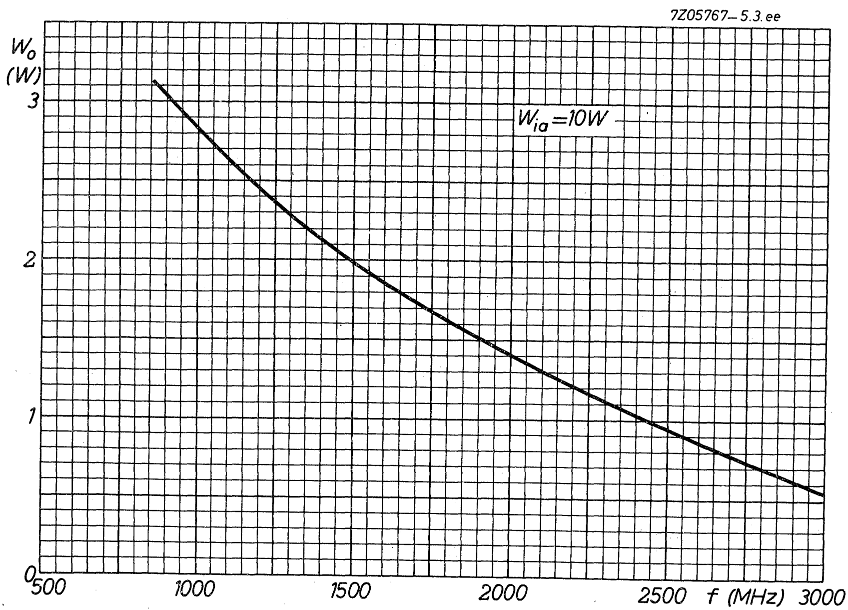
1) In order to make good contact these sockets should be slotted.
2) Line of contact.

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	^oC




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

Available for equipment maintenance. No longer recommended for equipment production.
Abridged data

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 = 4 MHz, G = 8 dB	W_o	1,8	W
Low-level gain at f = 4 GHz, B = 50 MHz	G	13	dB
Transconductance	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 simultaneously and no preheating will be necessary.

CAPACITANCES (V_f = 6,3 V; I_k = 0)

Anode to grid	C_{ag}	1,4	pF*
Anode to cathode	C_{ak}	35	fF
Grid to cathode	C_{gk}	3	pF**

TYPICAL CHARACTERISTICS

Anode voltage	V_a	180		180	V
Anode current	I_a	60		30	mA
Grid voltage	$-V_g$	1,25	>0 $<2,5$	2,8	V
Transconductance	S	21	>15	18	mA/V
Amplification factor	μ	43	>33 <52	43	

* Measured with a shield 1 mm thick with a hole of 15 mm diameter.
** Measured with a shield 1 mm thick with a hole of 23 mm diameter.

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		*		*	
Bandwidth (−0,1 dB)	B		50		50	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

LIMITING VALUES (Absolute maximum rating system)

Anode voltage (cold condition)	V_{ao}	max	500	V
Anode voltage	V_a	max	300	V
Anode dissipation	W_a	max	12,5	W
Grid voltage				
negative	$-V_g$	max	50	W
negative peak	$-V_{g\,p}$	max	100	V
positive	V_g	max	5	V
positive peak	$V_{g\,p}$	max	20	V
Driving power	W_{dr}	max	1	W**
Grid dissipation	W_g	max	200	mW
Grid current	I_g	max	10	mA
Grid circuit resistance	R_g	max	3	kΩ †
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

* Cathode resistor (max 500 Ω for Ia = 60 mA or max 1000 Ω for Ia = 30 mA) to be adjusted for the desired anode current.

** In grounded-grid circuits at a frequency of 4 GHz.

† This value may be multiplied by the d.c. inverse feedback factor for the cathode current to a maximum of 25 kΩ.

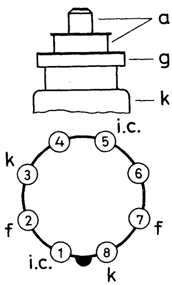
Heater voltage	V_f		6,3	V ± 2%
Seal temperature				
anode	t_a	max	150	°C* †
grid	t_g	max	100	°C* †
cathode	t_k	max	100	°C* †
Mounting torque		max	2,5	Nm
			(25	kgcm)
		min	2	Nm
			(20	kgcm)

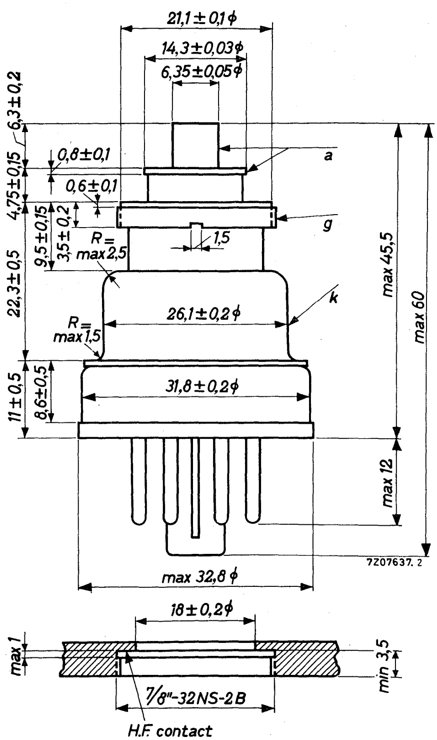
MECHANICAL DATA

Dimensions in mm

Base: octal

Mounting position: any





Shock and vibration

The tube can withstand vibrations of 2,5 g (peak), 25 Hz in all directions and shocks of 25 g (peak), 10 ms in all directions. These test conditions should not be interpreted as continuous operating conditions.

* A low-velocity air flow may be required.
† To be measured with a temperature sensitive paint e.g. Tempilaq.

Available for equipment maintenance. No longer recommended for equipment production.

Abridged data

DISC SEAL TRIODE

Disc seal triode for use as power amplifer, 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
Transconductance	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 simultaneously and no preheating will be necessary.

CAPACITANCES (V_f = 6,3 V, I_k = 0)

Anode to grid	C_{ag}	1,7 pF*
Anode to cathode	C_{ak}	36 pF
Grid to cathode	C_{gk}	3,5 pF**

TYPICAL CHARACTERISTICS

Anode voltage	V_a	180		180 V
Anode current	I_a	140		60 mA
Grid voltage	V_g	0	> −2 < +1,5	−3,5 V
Transconductance	S	28	> 18	22 mA/V
Amplification factor	μ	30	> 20 < 40	30

* Measured with a shield 1 mm thick with a hole of 15 mm diameter.

** Measured with a shield 1 mm thick with a hole of 23 mm diameter.

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		*	
Bandwidth (−0,1 dB)	B		50	MHz
Output power (G = 6 dB)	W_0	5,3	>4,5	W
Low-level gain (W_{dr} = 10 mW)	G	11,5	>9,5	dB

LIMITING VALUES (Absolute maximum rating system)

Anode voltage (cold condition)	V_{ao}	max	500	V
Anode voltage	V_a	max	300	V
Anode dissipation	W_a	max	30	W
Grid voltage				
negative	$-V_g$	max	50	V
negative peak	$-V_{g\,p}$	max	100	V
positive	V_g	max	10	V
positive peak	$V_{g\,p}$	max	30	V**
Driving power	W_{dr}	max	2	W †
Grid dissipation	W_g	max	350	mW
Grid current	I_g	max	25	mA
Grid circuit resistance	R_g	max	3	kΩ ††
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	max	6,3	V ± 2%
Seal temperatures				
anode	t_a	max	150	°C *▲
grid	t_g	max	100	°C *▲
cathode	t_k	max	100	°C *▲
Mounting torque		max	2,5	Nm
			(25	kgcm)
		min	2	Nm
			(20	kgcm)

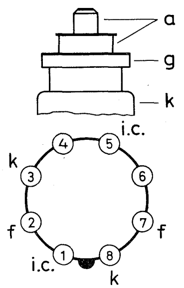
* Cathode resistor (max 200 Ω) to be adjusted for the desired anode current.
** Special attention must be paid to the cooling.
† In grounded-grid circuits at a frequency of 4 GHz.
†† This value may be multiplied by the d.c. inverse feedback factor for the cathode current to a maximum of 25 kΩ.
▲ To be measured with a temperature sensitive paint e.g. Tempilaq.

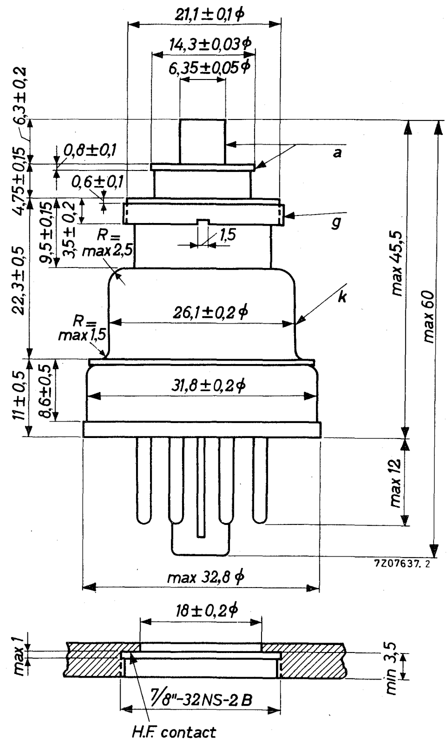
MECHANICAL DATA

Dimensions in mm

Base: octal

Mounting position: any





Shock and vibration

The tube can withstand vibrations of 2,5 g (peak), 25 Hz, in all directions and shocks of 25 g (peak), 10 ms in all directions. These test conditions should not be interpreted as continuous operating conditions.

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

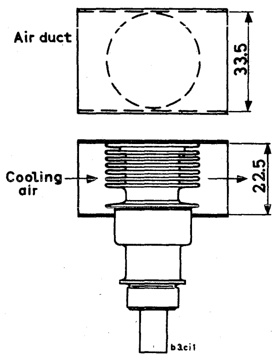
TYPICAL CHARACTERISTICS

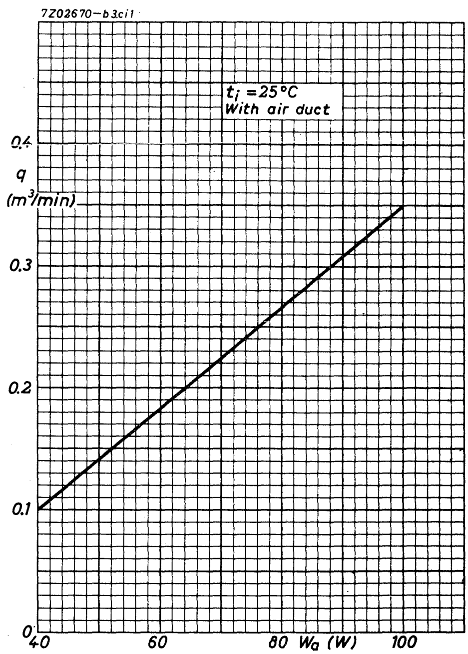
		min.	nom.	max.	
Anode voltage	V_a		500		V
Cathode resistor	R_k		30		Ω
Anode current	I_a	83	100	125	mA
Transconductance	S	22	27	32	mA/V
Amplification factor	μ		60		

[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%.

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 1/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.



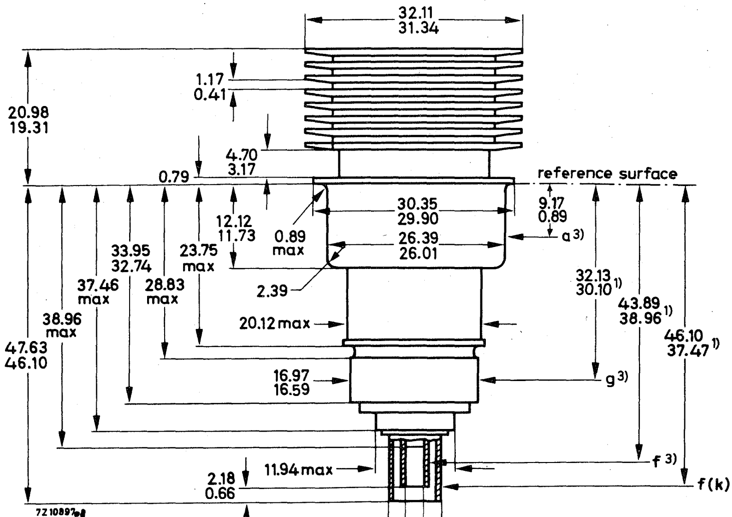


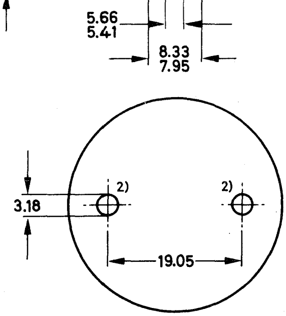
LIFE EXPECTANCY

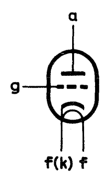
The life of the tube depends on the operating conditions and particularly on the tube temperature and the anode voltage. It is therefore recommended that the tube output required be attained with the lowest possible anode voltage, and that the tube temperature be kept as low as possible by adequate cooling.

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

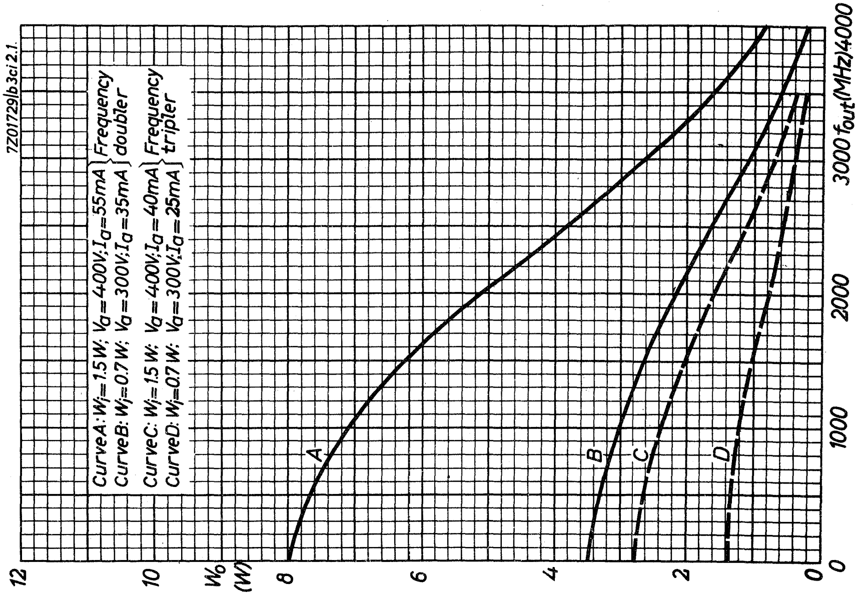
LIMITING VALUES (Absolute max. rating system)

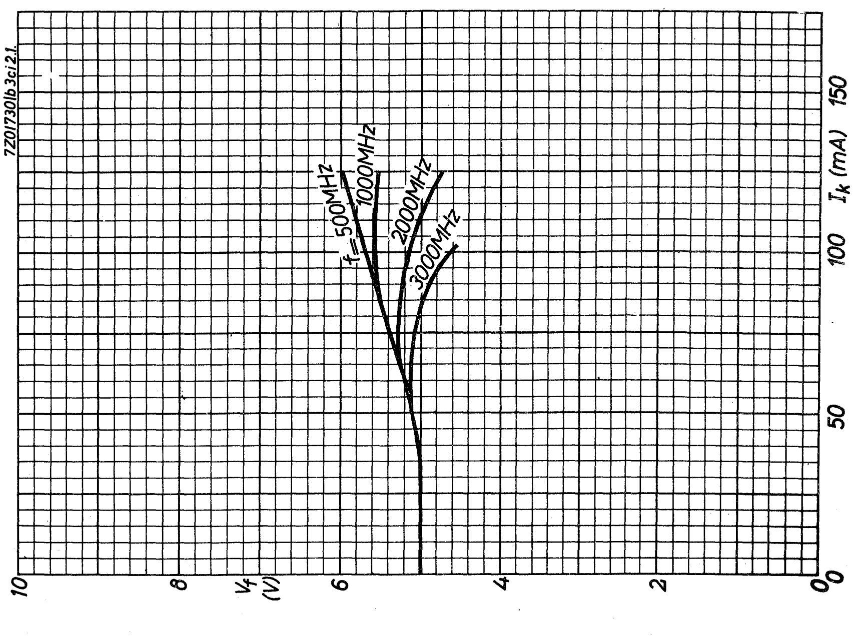
Frequency	f	up to	2500	MHz
Anode voltage (unmodulated)	V_a	max.	1000	V
Anode voltage (100% modulated)	V_a	max.	800	V
Anode dissipation	W_a	max.	100	W
Grid voltage negative	$-V_g$	max.	150	V
negative peak	$-V_{gp}$	max.	400	V
positive peak	V_{gp}	max.	25	V
Grid current	I_g	max.	50	mA
Grid dissipation	W_g	max.	2	W
Cathode current	I_k	max.	125	mA
Envelope temperature	t_{env}	max.	250	°C

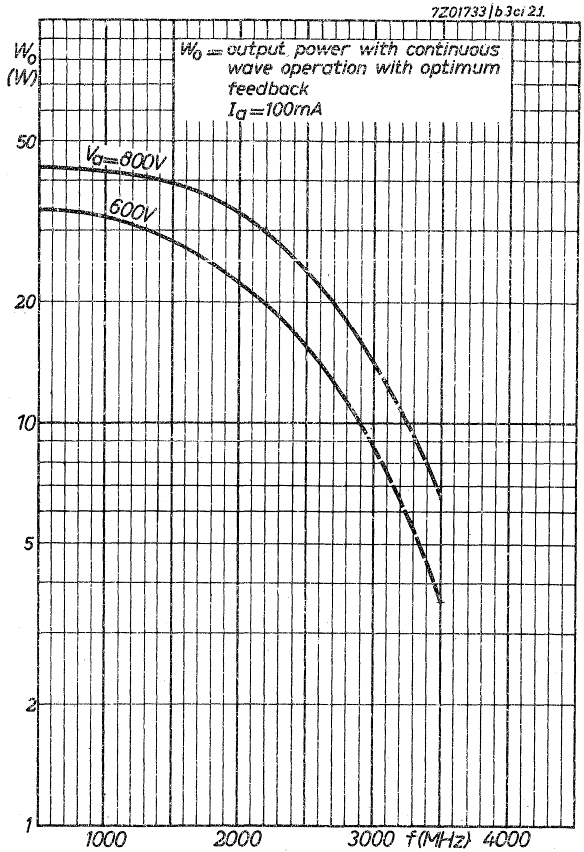
OPERATING CHARACTERISTICS

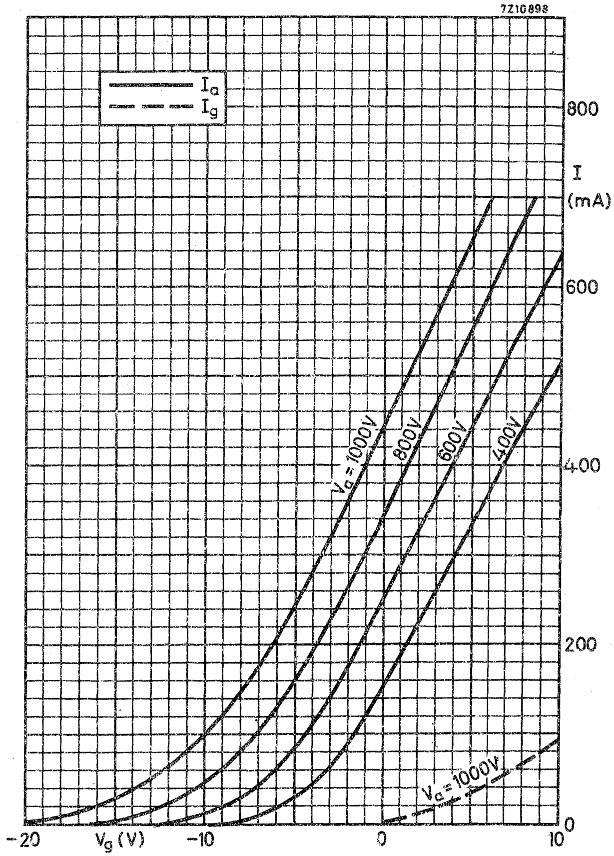
C.W. Oscillator

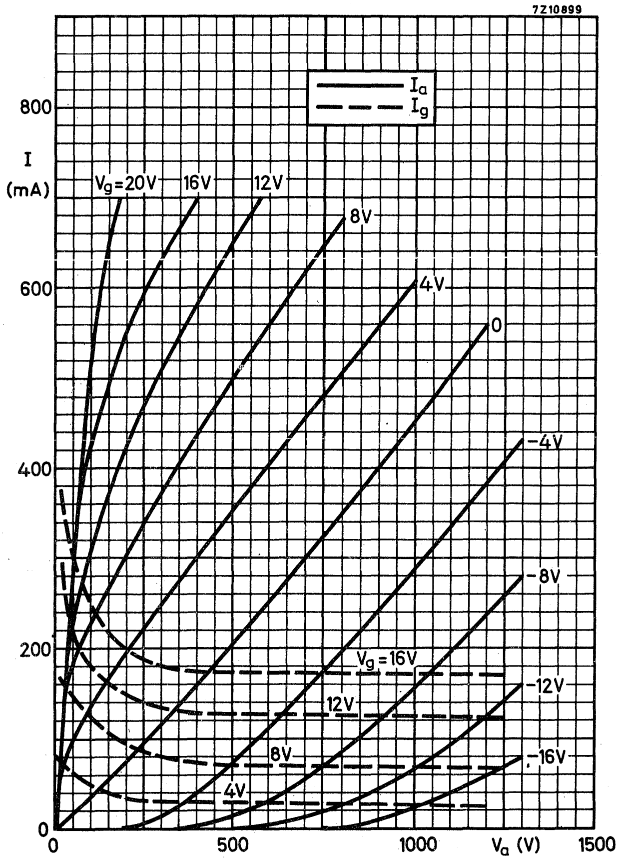
Frequency	f	500	2500	MHz
Heater voltage	V_f	5.8	4.8	V
Anode voltage	V_a	600	600	V
Anode current	I_a	80	100	mA
Grid current	I_g	25	6	mA
Output power	W_o	26	16	W


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


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


7Z01733 | b 3ci 2.1.
W_o (W)
W_o = output power with continuous wave operation with optimum feedback
I_a=100mA
V_a=800V
600V
50
20
10
5
2
1
1000
2000
3000
f(MHz)
4000


7Z10898
I_a
I_g
800
I
(mA)
600
400
200
0
V_a = 1000V
800V
600V
400V
V_a = 1000V
−20
V_g (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 power triode of metal-ceramic construction intended for use as oscillator, and linear broadband amplifier in TV transposer service.

QUICK REFERENCE DATA

Output power at f = 700 MHz (oscillator)	W_o	30	W
Transconductance	S	30	mA/V
Amplification factor	μ	75	
Construction	metal-ceramic		

HEATING: Indirect by a.c. or d.c.; parallel supply

Heater voltage	V_f		6	V*
Heater current	I_f	0,9 to 1,05		A
Waiting time	T_w	min	1	min

CAPACITANCES

Anode to cathode	C_{ak}	<	0,05	pF
Anode to grid	C_{ag}		2,2	pF
Grid to cathode	C_{gk}		8	pF

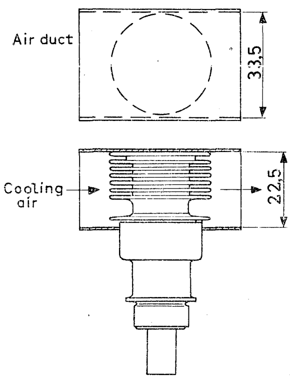
TYPICAL CHARACTERISTICS

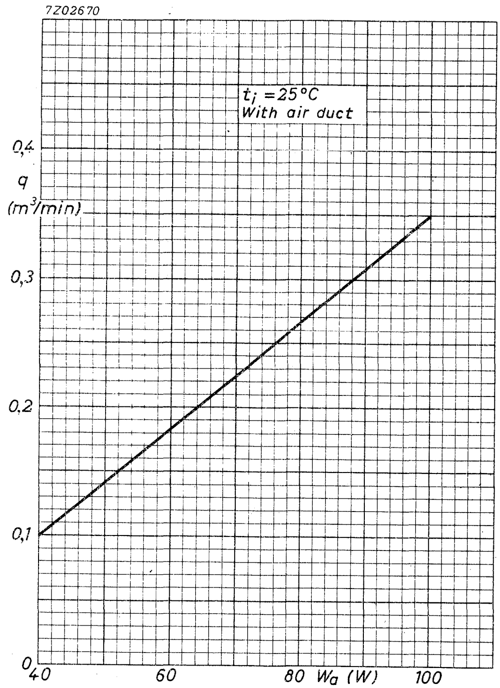
Anode voltage	V_a	500	V
Cathode resistor	R_k	30	Ω
Anode current	I_a	100	mA
Transconductance	S	30	mA/V
Amplification factor	μ	75	

* The heater voltage should be reduced to a value dependent on the cathode current and frequency. The maximum fluctuation should not exceed ± 5%.

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.



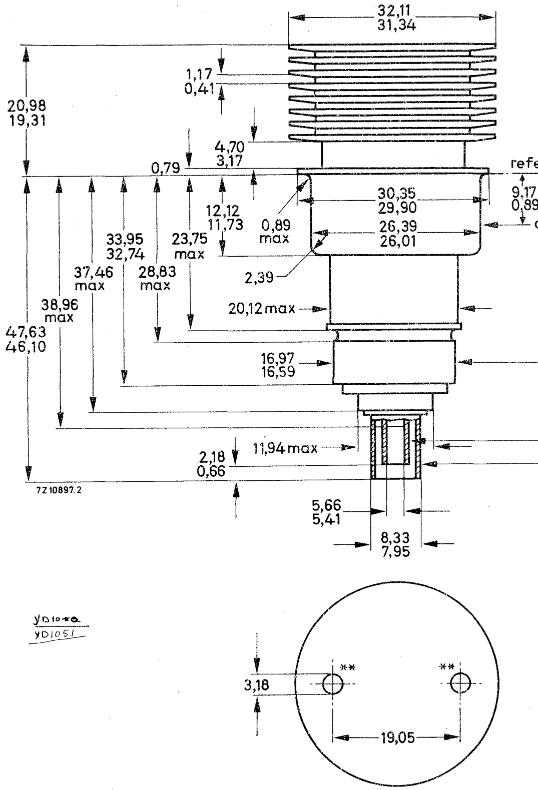


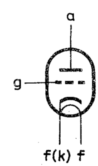
LIFE EXPECTANCY

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





Mounting position: any

Net mass: approx. 70 g

* Electrode contact areas.

** Holes for tube extractor in top fin only.

† 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 maximum rating system)

Frequency	f	up to	2500	MHz
Anode voltage	V_a	max	1000	V
Anode dissipation	W_a	max	100	W
Grid voltage, negative	$-V_g$	max	150	V
Grid voltage, negative peak	$-V_{gp}$	max	400	V
Grid voltage, positive peak	V_{gp}	max	40	V
Grid current	I_g	max	50	mA
Grid dissipation	W_g	max	2	W
Cathode current	I_k	max	190	mA
Envelope temperature	t_{env}	max	250	°C

OPERATING CHARACTERISTICS

C.W. OSCILLATOR

Frequency	f	700	MHz
Heater voltage	V_f	5,6	V
Anode voltage	V_a	850	V
Grid voltage	V_g	−20	V
Anode current	I_a	100	mA
Grid current	I_g	10	mA
Output power	W_o	30	W

LINEAR AMPLIFIER

Frequency	f	710	MHz
Heater voltage	V_f	5,7	V
Bandwidth (−1 dB)	B	8	MHz
Anode voltage	V_a	850	V
Grid voltage	V_g	−10	V
Grid current	I_g	0	mA
Anode current, no signal	I_a	80	mA
Anode current	I_a	100	mA
Output power (white)	W_o	17	W
Power gain	G	15	dB

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
Transconductance	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 s or C.W. operation with V_a = max. 300 V and I_k = max. 30 mA, preheating is not necessary.

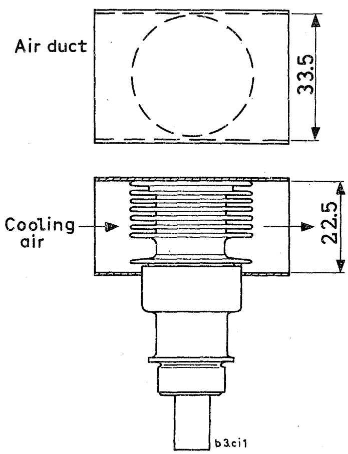
CAPACITANCES

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

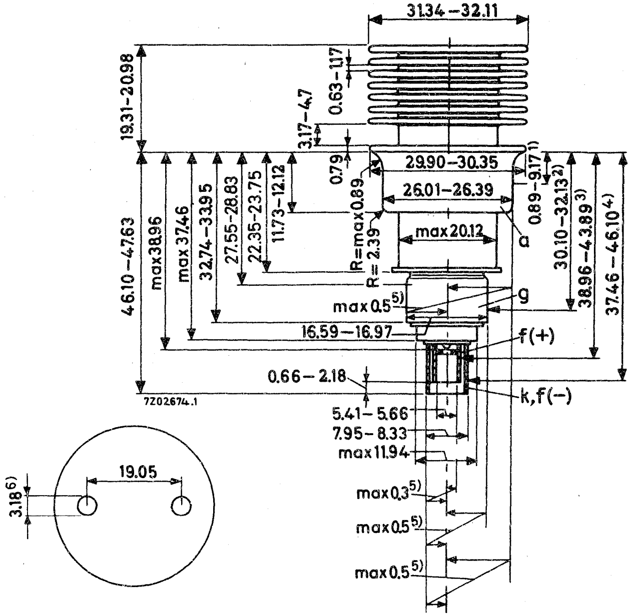
For maximum anode dissipation and assuming the use of an air duct of the dimensions indicated, an air flow of approx. 350 l/min is required for cooling the radiator in case of an inlet temperature of 25 °C. If necessary, the other surfaces should be cooled as well with a low-velocity air flow. As the 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	°C

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

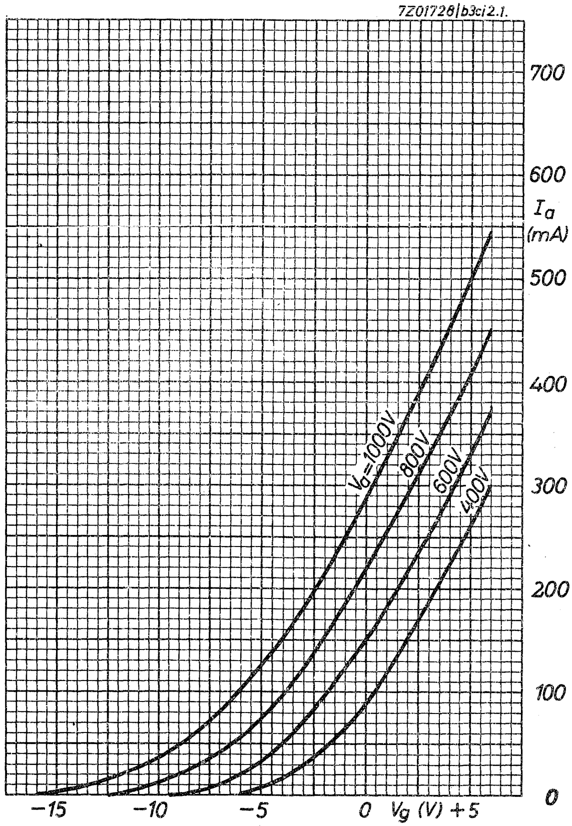
C.W. oscillator

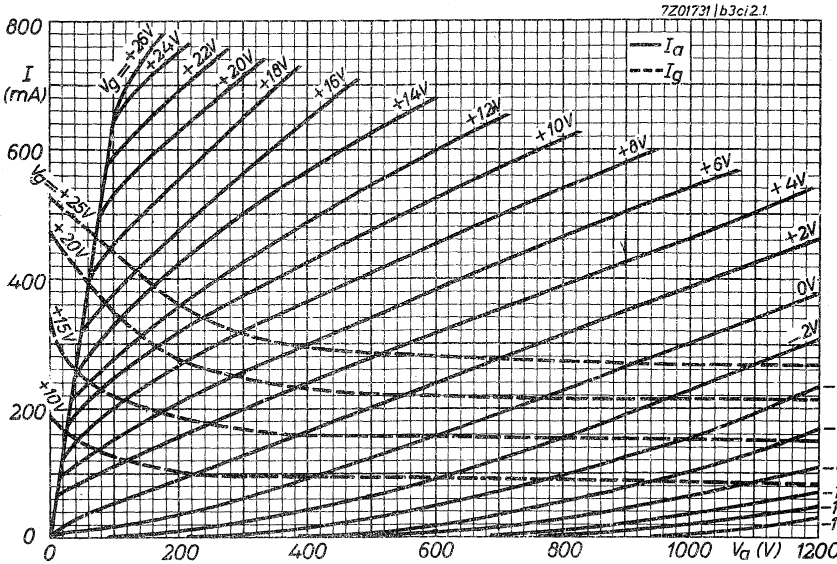
Frequency	f	=	2500	2500	MHz
Heater voltage	V_f	=	4.5	4.5	V
Anode voltage	V_a	=	600	800	V
Anode current	I_a	=	100	100	mA
Grid current	I_g	=	10	8	mA
Output power	W_o	=	16	24	W

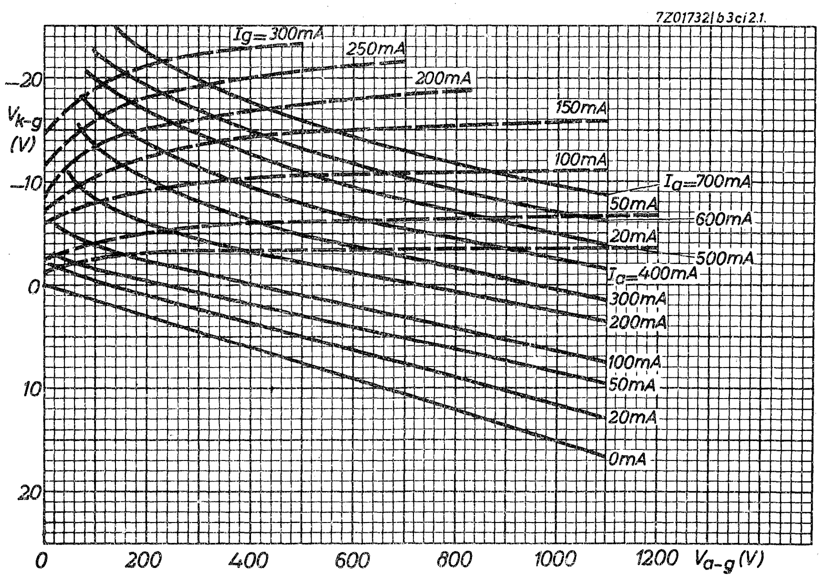
Frequency doubler

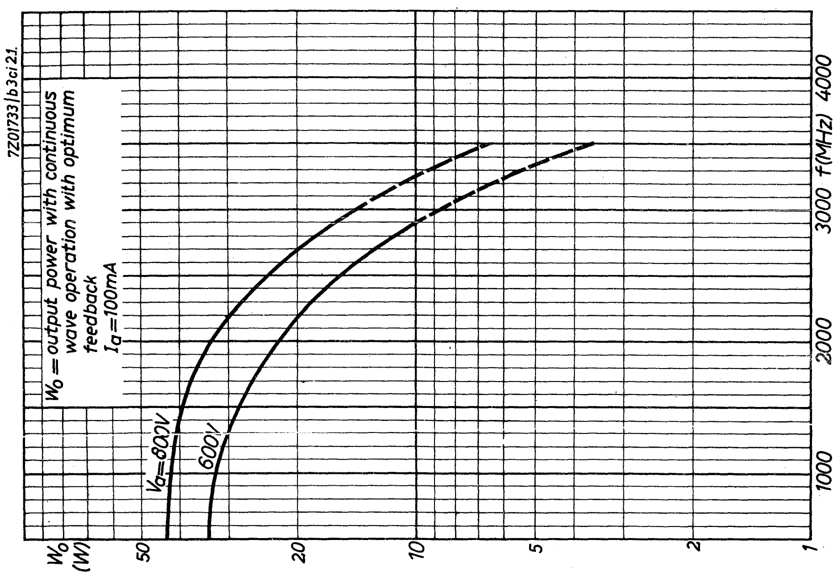
Frequency	f	=	1000/2000	MHz
Heater voltage	V_f	=	5.6	V
Anode voltage	V_a	=	400	V
Grid voltage	V_g	=	−15	V
Anode current	I_a	=	55	mA
Grid input power	W_{ig}	=	1.5	W
Output power	W_o	=	5.2	W

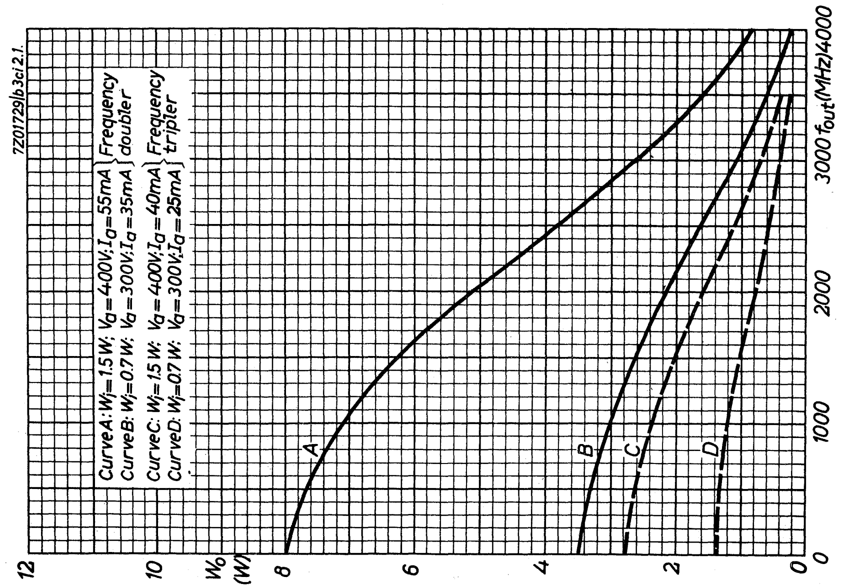
The life of the tube depends on the load and particularly on the tube temperature and the anode voltage. It is therefore recommended that the tube output required be attained with the lowest possible anode voltage, and that the tube temperature be kept as low as possible by adequate cooling.

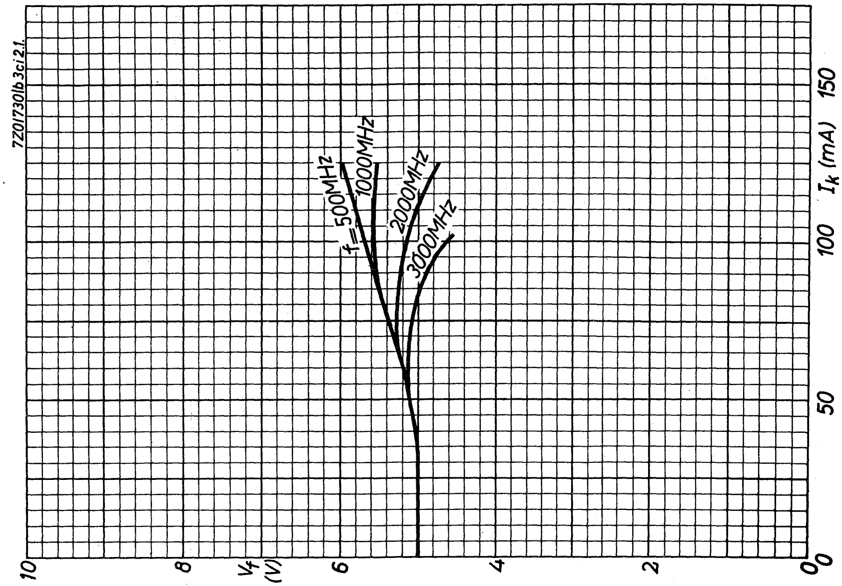

7Z01728/b3ci2.1.
700
600
I_a (mA)
500
400
300
200
100
0
V_a=1000V
800V
600V
400V
−15
−10
−5
0
V_g (V)
+5

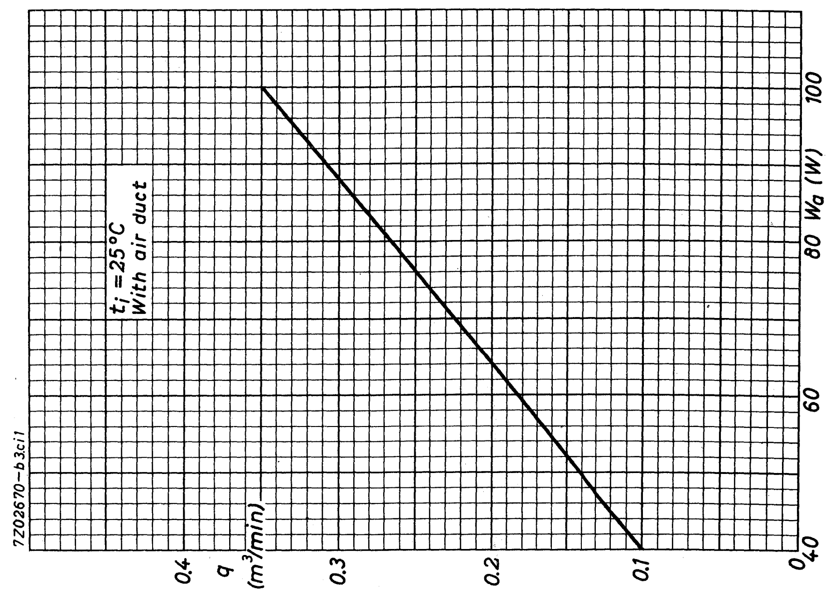

7Z01731 | b3ci 2.1.
800
600
400
200
0
I
(mA)
Ia
Ig
Vg = +26V
+24V
+22V
+20V
+18V
+16V
+14V
+12V
+10V
+8V
+6V
+4V
+2V
0V
-2V
-4V
-6V
-8V
-10V
-12V
-14V
Vg = +25V
+20V
+15V
+10V
0
200
400
600
800
1000
Va (V)
1200


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


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


7Z01729/b3ci 2.1.
Curve A: W_i=1.5 W; V_a=400V; I_a=55mA } Frequency doubler
Curve B: W_i=0.7 W; V_a=300V; I_a=35mA
Curve C: W_i=1.5 W; V_a=400V; I_a=40mA } Frequency tripler
Curve D: W_i=0.7 W; V_a=300V; I_a=25mA
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
V_f (V)
10
8
6
4
2
0
I_k (mA)
0
50
100
150


7Z02670-b3ci1
t_i = 25°C
With air duct
q (m^3/min)
0.4
0.3
0.2
0.1
0
W_a (W)
40
60
80
100

PENCIL TYPE UHF HIGH MU TRIODE

Pencil type UHF high-mu triode for use in grounded grid service as RF amplifier, IF amplifier or mixer in receivers operating at frequencies up to about 1000 MHz, as frequency multiplier up to about 1500 MHz and as oscillator up to 1700 MHz. The tube can be used at altitudes up to 20 km without pressurized chambers.

QUICK REFERENCE DATA				
Amplification factor	μ		56	
Transconductance	S		5,6	mA/V
Maximum anode dissipation	W_a	max.	5,25	W

HEATING: Indirect by a.c. or d.c.

Heater voltage	V_f		6,3	V
Heater current	I_f		135	mA

CAPACITANCES

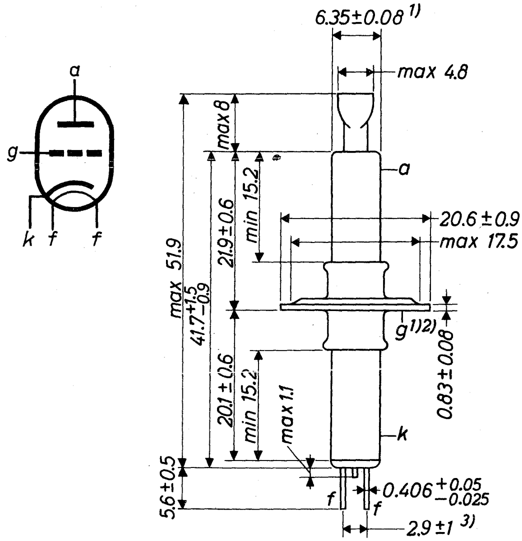
Anode to all except grid	C_a	<	0,035	pF
Grid to all except anode	C_g		2,5	pF
Anode to grid	C_{ag}		1,4	pF

TYPICAL CHARACTERISTICS

Anode voltage	V_a	250	V
Anode current	I_a	18	mA
Amplification factor	μ	56	
Transconductance	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

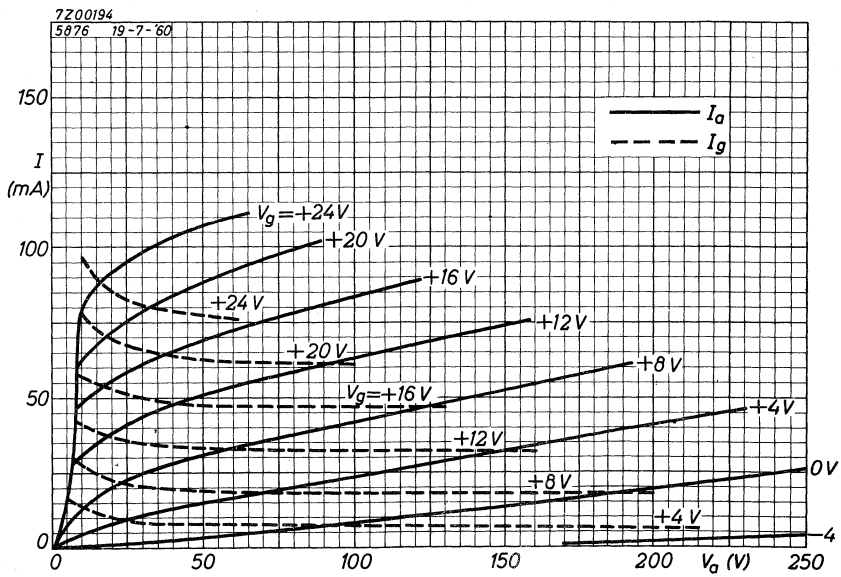
OPERATING CHARACTERISTICS

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
+4V
0V
-4V
+24 V
+20 V
V_g=+16 V
+12 V
+8 V
+4 V

PENCIL TYPE UHF HIGH MU TRIODE

The 5876A is the ruggedized version of the 5876

PENCIL TYPE UHF MEDIUM MU TRIODE

Pencil type UHF medium-mu triode for use in grounded grid service as anode pulsed oscillator up to 3300 MHz and altitudes up to 3 km, or as class A amplifier, RF amplifier, RF oscillator or frequency doubler up to 1000 MHz and altitudes up to 30 km.

QUICK REFERENCE DATA					
Amplification factor		μ		27	
Transconductance		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 a.c. or d.c.

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

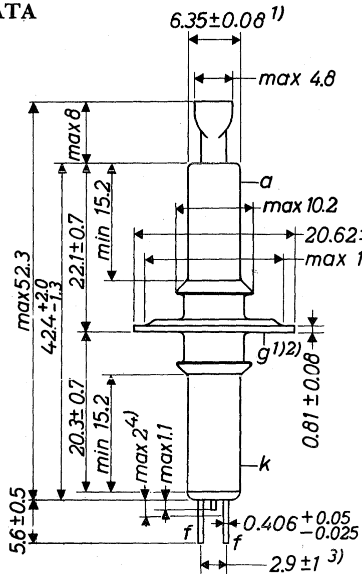
Anode voltage	V_a	200	V
Anode current	I_a	25	mA
Transconductance	S	6	mA/V
Amplification factor	μ	27	
Internal resistance	R_i	4500	Ω

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

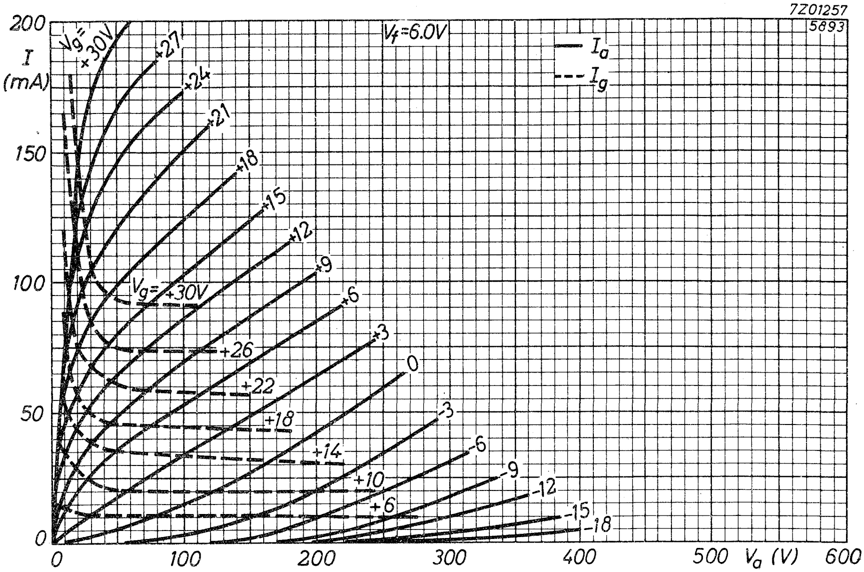
				CCS	ICAS	
Anode voltage	V_a	=	max.	260	320	V
Negative grid voltage	$-V_g$	=	max.	100	100	V
Anode current	I_a	=	max.	33	33	mA
Grid current	I_g	=	max.	12	12	mA
Anode input power	W_{ia}	=	max.	8.5	10.5	W
Anode dissipation	W_a	=	max.	6	7.5	W [1]
Grid circuit resistance	R_g	=	max.	0.1	0.1	MΩ
Cathode to heater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

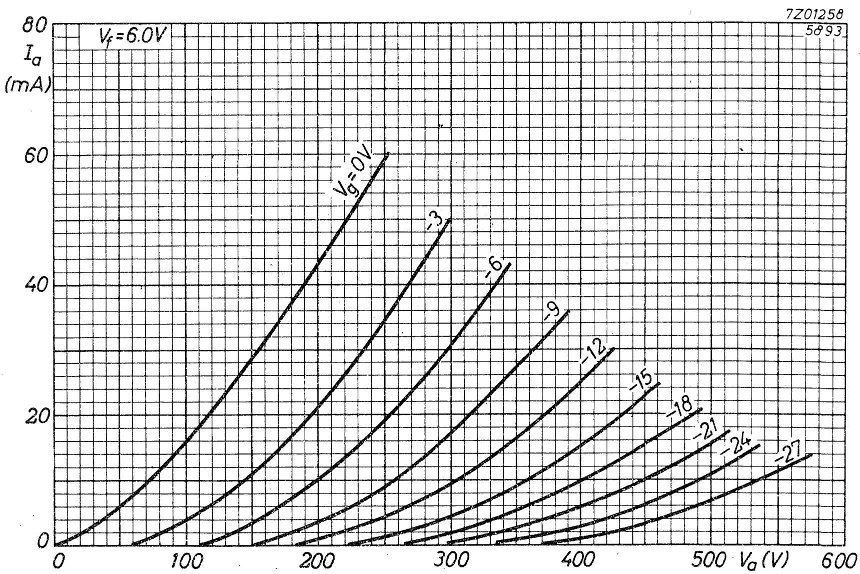
OPERATING CONDITIONS as frequency doubler up to 1000 MHz in grounded grid circuit

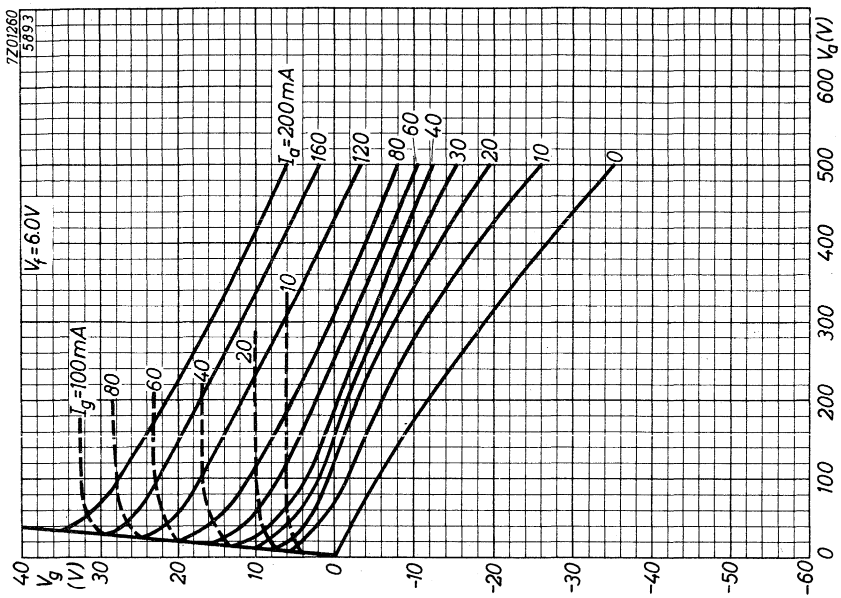
			CCS	ICAS	
Anode voltage	V_a	=	250	300	V
Grid voltage	V_g	=	−40	−50	V [2]
Anode current	I_a	=	33	33	mA
Grid current	I_g	=	7	8	mA
Driver output power	W_{dr}	=	3.2	3.5	W
Output power	W_o	=	2.75	3.0	W

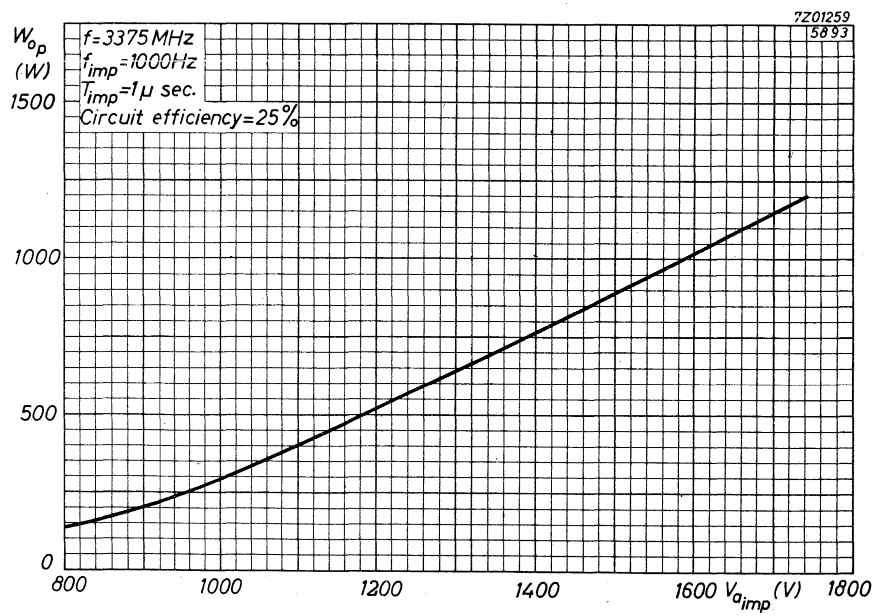
[1]) In applications where the anode dissipation exceeds 2.5 watts, it is important that a large area of contact be provided between the anode cylinder and the connector in order to provide adequate heat conduction.

[2]) Obtained from grid resistor.


7Z01257
5893
V_f=6.0V
I_a
I_g
I (mA)
200
150
100
50
0
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
0
100
200
300
400
500
V_a (V)
600


7Z01258
5893
V_f=6.0V
I_a (mA)
80
60
40
20
0
V_g=0V
-3
-6
-9
-12
-15
-18
-21
-24
-27
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
600 V_a(V)
500
400
300
200
100
0
40
V_g (V)
30
20
10
0
-10
-20
-30
-40
-50
-60


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

PENCIL TYPE UHF MEDIUM MU TRIODE

Pencil type UHF medium-mu triode with external anode radiator for use in grounded grid service as RF power amplifier and oscillator. The tube can be used at **altitudes** up to 20 km without pressurized chambers.

QUICK REFERENCE DATA					
Amplification factor		μ		27	
Transconductance		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

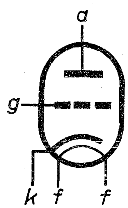
Anode voltage	V_a	200	V
Anode current	I_a	27	mA
Amplification factor	μ	27	
Transconductance	S	7	mA/V

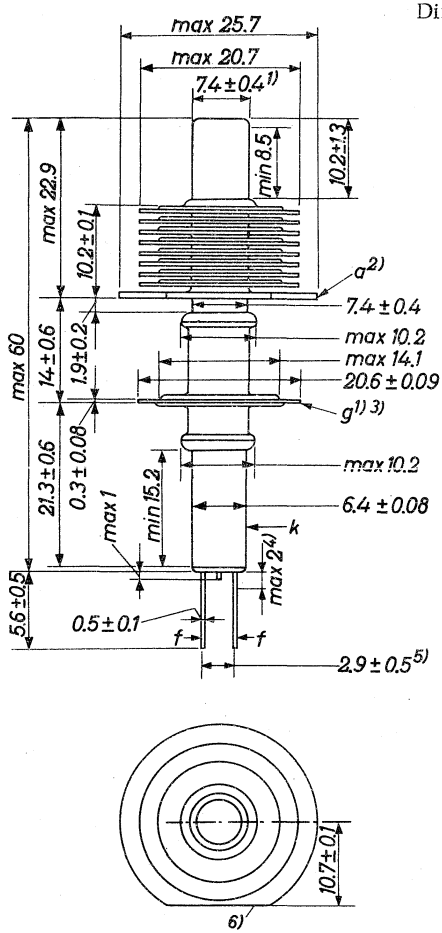
[1]) Flat plate shield 31,75 mm diameter located parallel to the plane of the grid flange and midway between the grid flange and the anode terminal fin of the radiator. The shield is tied to the cathode.

MECHANICAL DATA

Dimensions in mm

Net weight: 24 g





Mounting position: arbitrary

1) Maximum eccentricity of the axes of the radiator core cap and the grid terminal flange with respect to the axis of the cathode terminal is 0.38 mm.

2) The tilt of the anode terminal fin of the radiator with respect to the rotational axis of the cathode cylinder is determined by chucking the cathode terminal, rotating the tube and gauging the total travel distance of the anode terminal fin parallel to the axis at a point approximately 0.5 mm inward from the straight edge of the anode terminal fin for one complete rotation. The total travel distance will not exceed 0.9 mm.

COOLING

To keep the anode seal temperature below the maximum admissible value of 175 °C generally no forced air cooling will be required. Under conditions of free circulation of air an adequate cooling will be provided by means of the radiator in combination with a connector having adequate heat conduction capability. Under less favourable environmental conditions provision should be made to direct a blast of cooling air from a small blower through the radiator fins. The quantity of air should be sufficient to limit the anode seal temperature to 175 °C.
See also the cooling curves page 8.

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_{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	=	−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_{ia}	=	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

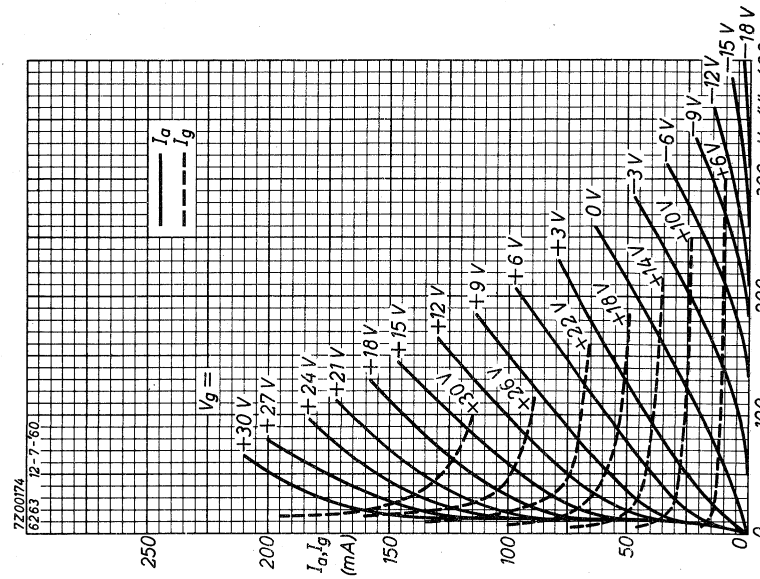
OPERATING CHARACTERISTICS in grounded grid circuit

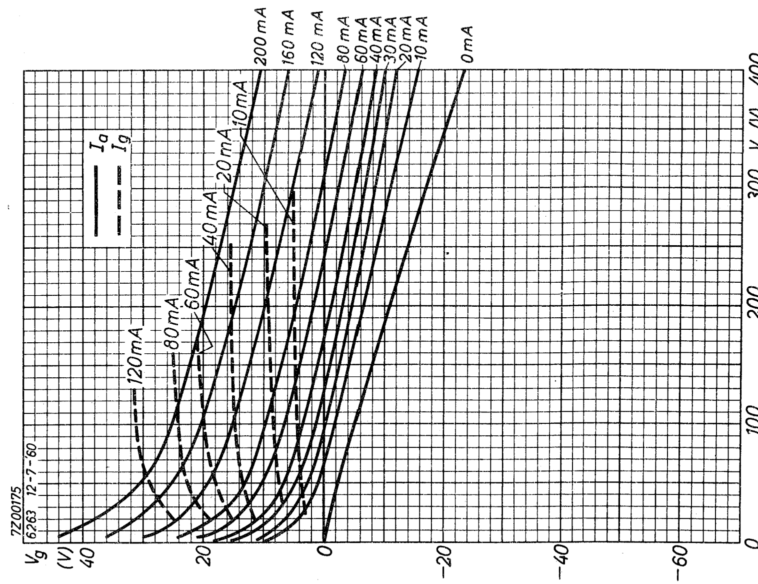
			CCS	ICAS	
Frequency	f	=	500	500	MHz
Anode voltage	V_a	=	275	320	V
Anode current	I_a	=	33	35	mA
Grid voltage	V_g	=	−42	−52	V [1]
Grid current	I_g	=	13	12	mA
Driving power	W_{dr}	=	2.0	2.4	W
Output power in the load	W_ℓ	=	6.7	8	W [2][3]

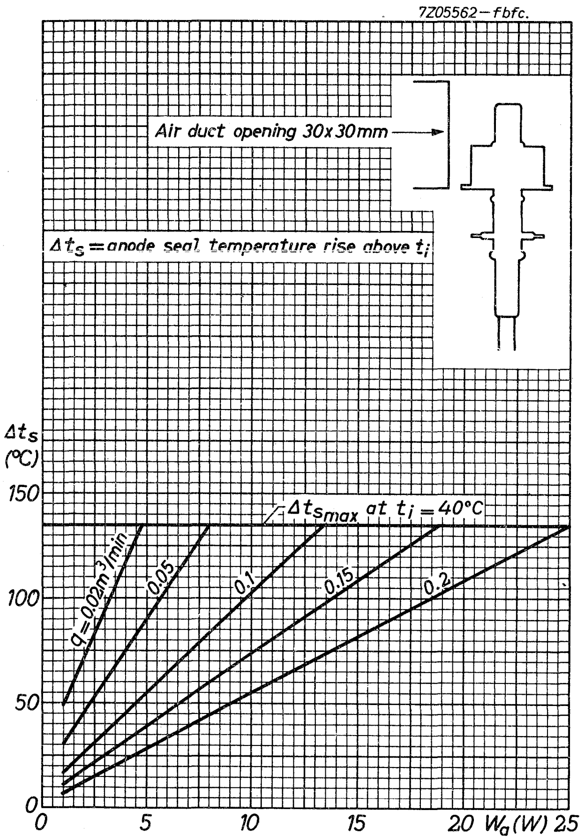
[1] From a grid resistor or from a suitable combination of grid resistor and fixed supply or grid resistor and cathode resistor.

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

[3] Power transferred from driving stage included.


7Z00174
6263 12-7-'60
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


7Z00175
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
120 mA
80 mA
60 mA
40 mA
20 mA
10 mA
V_g (V)
40
20
0
−20
−40
−60
V_a (V)
0
100
200
300
400


7Z05562—fbfc.
Air duct opening 30x30mm
Δts = anode seal temperature rise above ti
Δts
(°C)
150
100
50
0
Δtsmax at ti = 40°C
q = 0.02m³/min
0.05
0.1
0.15
0.2
0
5
10
15
20
Wa (W)
25

PENCIL TYPE UHF MEDIUM MU TRIODE

The 6263A is the ruggedized version of the 6263

PENCIL TYPE UHF MEDIUM MU TRIODE

Pencil type UHF medium-mu triode with external anode radiator for use in grounded grid service as frequency multiplier; also useful as RF power amplifier and oscillator. The tube can be used at altitudes up to 20 km without pressurized chambers.

QUICK REFERENCE DATA					
Amplification factor		μ		40	
Transconductance		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

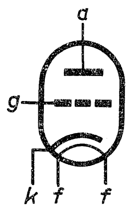
Anode voltage	V_a	200	V
Anode current	I_a	18,5	mA
Amplification factor	μ	40	
Transconductance	S	6,8	mA/V

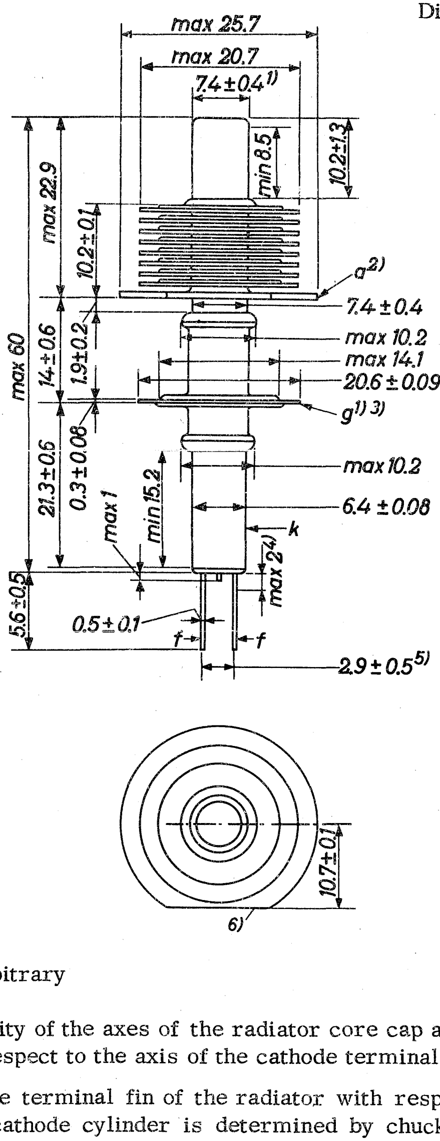
[1]) Flat plate shield 31,75 mm diameter located parallel to the plane of the grid flange and midway between the grid flange and the anode terminal fin of the radiator. The shield is tied to the cathode.

MECHANICAL DATA

Dimensions in mm

Net weight: 24 g





Mounting position: arbitrary

1) Maximum eccentricity of the axes of the radiator core cap and the grid terminal flange with respect to the axis of the cathode terminal is 0.38 mm.

2) The tilt of the anode terminal fin of the radiator with respect to the rotational axis of the cathode cylinder is determined by chucking the cathode terminal, rotating the tube and gauging the total travel distance of the anode terminal fin parallel to the axis at a point approximately 0.5 mm inward from the straight edge of the anode terminal fin for one complete rotation. The total travel distance will not exceed 0.9 mm.

COOLING

To keep the anode seal temperature below the maximum admissible value of 175 °C generally no forced air cooling will be required. Under conditions of free circulation of air an adequate cooling will be provided by means of the radiator in combination with a connector having adequate heat conduction capability. Under less favourable environmental conditions provision should be made to direct a blast of cooling air from a small blower through the radiator fins. The quantity of air should be sufficient to limit the anode seal temperature to 175 °C.
See also the cooling curves page 8.

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	^{o}C

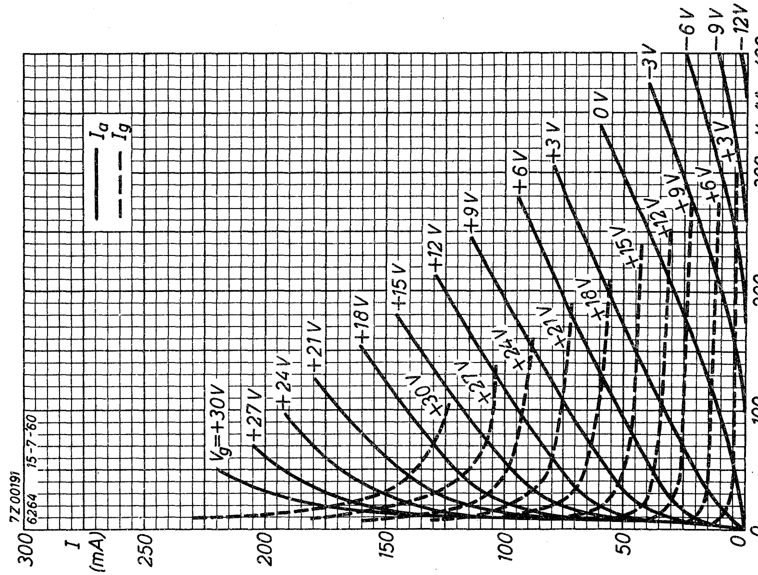
OPERATING CHARACTERISTICS in grounded grid circuit

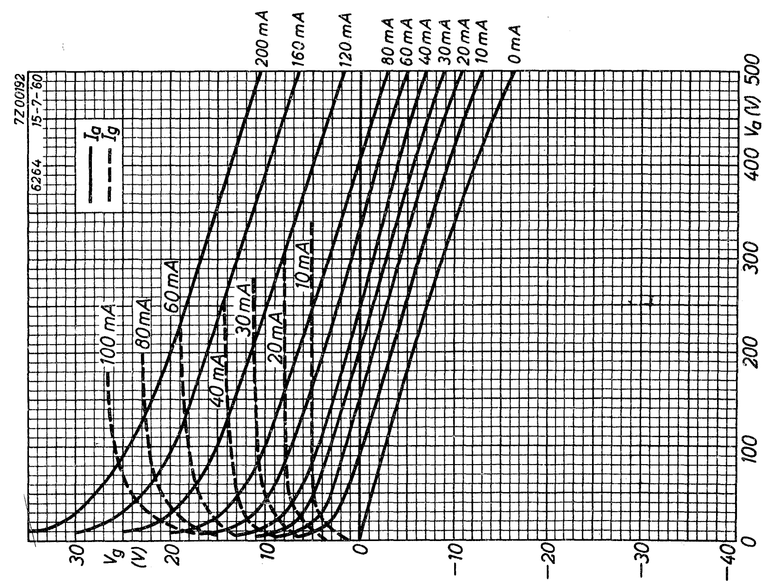
			CCS	ICAS	
Frequency	f	=	170/510	170/510	MHz
Anode voltage	V_a	=	300	350	V
Anode current	I_a	=	26	36.5	mA
Grid voltage	V_g	=	-110	-122	V [1])
Grid current	I_g	=	4.1	5.8	mA
Driving power	W_{dr}	=	2.75	4.5	W
Output power in the load	W_ℓ	=	2.1	3.4	W [2])

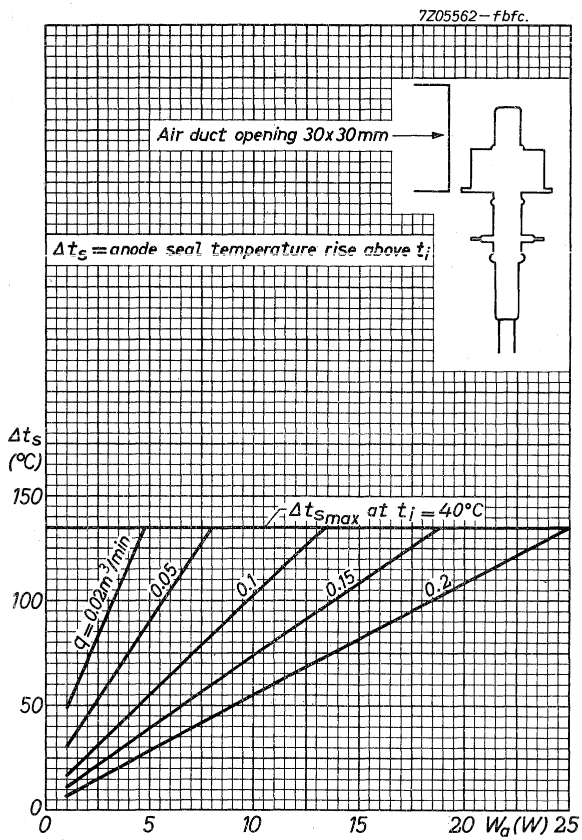
---

[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 (mA)
Va (V)
Ia
Ig
Vg=+30V
+27V
+24V
+21V
+18V
+15V
+12V
+9V
+6V
+3V
0V
−3V
−6V
−9V
−12V


7Z00192
6264
15-7-'60
Vg (V)
Va (V)
Ia
Ig
200 mA
160 mA
120 mA
80 mA
60 mA
40 mA
30 mA
20 mA
10 mA
0 mA
100 mA
80mA
60mA
40mA
30mA
20mA
10mA


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

Available for equipment maintenance. No longer recommended for equipment production.
Abridged data

DISC SEAL TRIODE

Air-cooled disc seal triode of metal-ceramic construction intended for use as oscillator, modulator, mixer, frequency multiplier or amplifier up to a frequency of 3000 MHz. Rugged construction.

QUICK REFERENCE DATA

Output power at 2,5 GHz	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	V
Heater current	I_f		0,9 to 1,05	A
Cathode heating time	T_h	min	1	min

CAPACITANCES

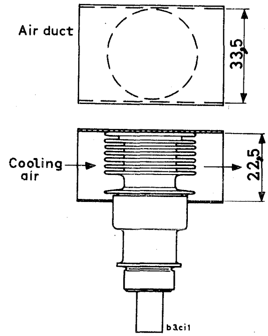
Anode to grid	C_{ag}		1,95 to 2,15	pF
Anode to cathode	C_{ak}	<	35	fF
Grid to cathode	C_{gk}		5,6 to 7,0	pF
Anode to cathode (Vf = 6 V, I_k = 0)	C_{ak}	<	45	fF
Grid to cathode (Vf = 6 V, I_k = 0)	C_{gk}		7,5	pF

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	

COOLING

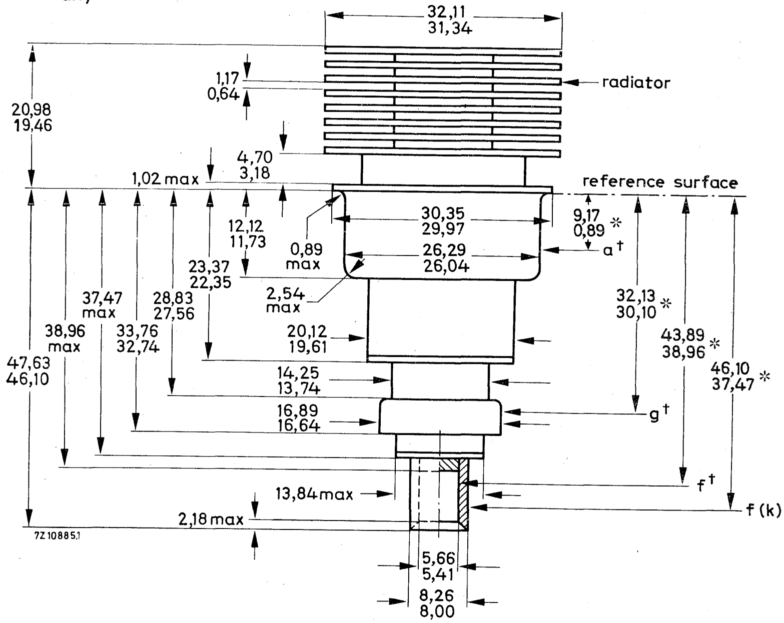
At maximum anode dissipation, the use of the indicated air duct and an air inlet temperature of 25 °C requires an air flow of approximately 350 l/min. If necessary, the other surface should be cooled with a low-velocity air flow.



MECHANICAL DATA

Net mass: ≈ 70 g

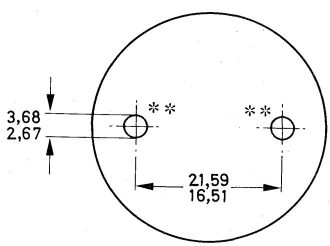
Mounting position: any

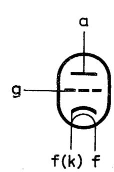


* Electrode contact area.

** Holes for tube extractor in top fins only.

† Eccentricity of contact surfaces.
Reference: cathode
Anode TIR max 0,5 mm
Grid TIR max 0,5 mm
Heater TIR max 0,3 mm





C.W. OSCILLATOR AND FREQUENCY DOUBLER

LIMITING VALUES (Absolute maximum 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	$-V_{g\,p}$	max	400	V
positive peak	V_g	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	^{o}C
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 maximum rating system)

Frequency	f	max	3000	MHz
Pulse duration	T_{imp}	max	3	μs
Duty factor	δ	max	0,0025	
Anode voltage, peak	$V_{a\,p}$	max	3500	V
Anode current, peak	$I_{a\,p}$	max	3	A
Anode dissipation	W_a	max	27	W
Grid voltage,				
negative	$-V_g$	max	150	V
negative peak	$-V_{g\,p}$	max	750	V
positive peak	$V_{g\,p}$	max	250	V
Grid current, peak	$I_{g\,p}$	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 factor	δ	0,0025	
Heater voltage	V_f	5,8	V
Anode voltage, peak	$V_{a\,p}$	3500	V
Anode current	I_a	7,5	mA
Grid current	I_g	4,5	mA
Output power, peak	$W_{o\,p}$	2	kW

Available for equipment maintenance. No longer recommended for equipment production.

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 1,5 Nm.

For further data refer to EC157

T-R Switches

Available for equipment maintenance. No longer recommended for equipment production.

DUAL T-R SWITCH

Broad-band gas-filled dual T-R switch covering the 8,490 to 9,580 GHz 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 maximum rating system) AND CHARACTERISTICS

Peak power	max	250	kW
	min	3	kW
Ignitor d.c. supply voltage	min	–600	V*
Ignitor current	max	200	μA
Ignitor voltage drop at an ignitor current of 100 μA	max	300	V
	min	170	V
Low-level characteristics			
Voltage standing wave ratio**			
at 8490 MHz	<	1,4	
at 9580 MHz	<	1,4	
at 8560 to 9490 MHz	<	1,2	
Duplexer loss †			
at 8490 MHz	<	1,1	dB
at 9580 MHz	<	1,1	dB
at 8560 to 9490 MHz	<	1,0	dB
High-level characteristics †			
Flat leakage power	<	15	mW
Spike leakage energy	<	15	nJ
		(0,15 erg)	
Arc loss	<	1	dB
Recovery time	<	7	μs

* The ignitor voltage shall be applied to each electrode via a suitable resistor giving 80 to 150 μA ignitor current.

** When measuring the v.s.w.r. the short-slot hybrids used shall have a v.s.w.r. of 1,1 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.

† 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

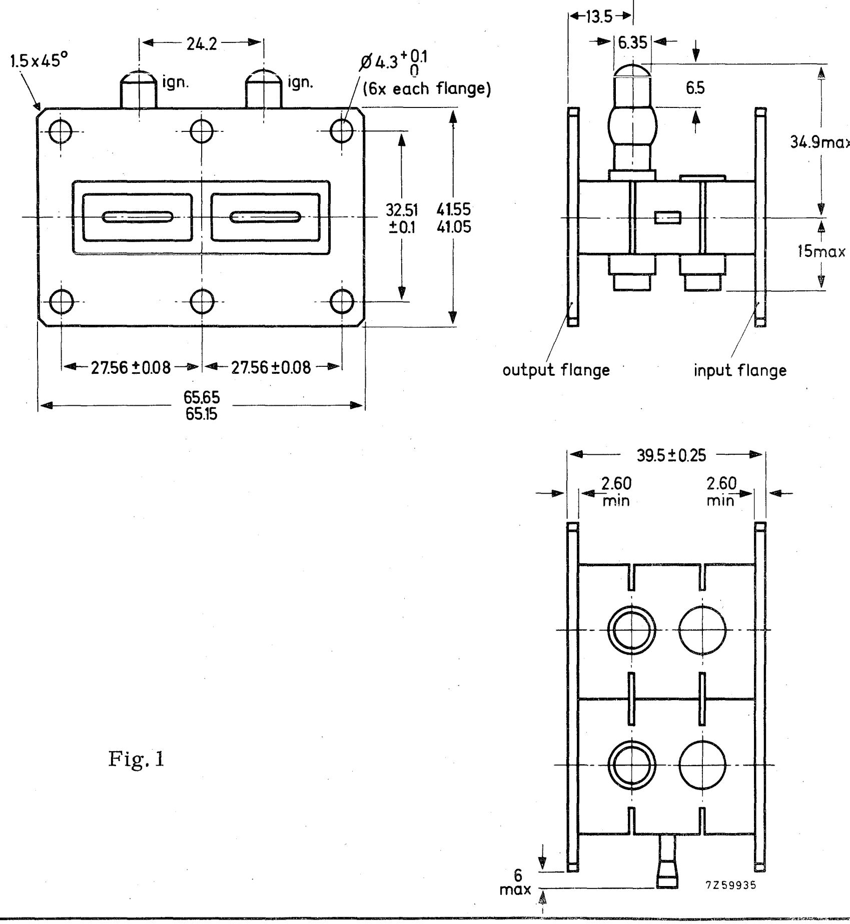


Fig. 1

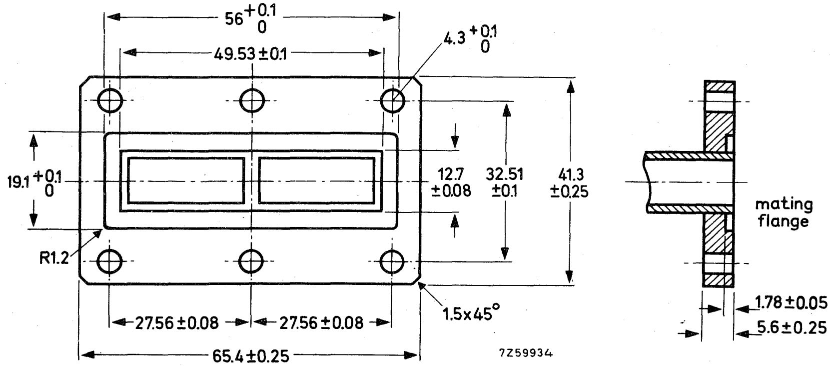


Fig. 2 Gasket assembly

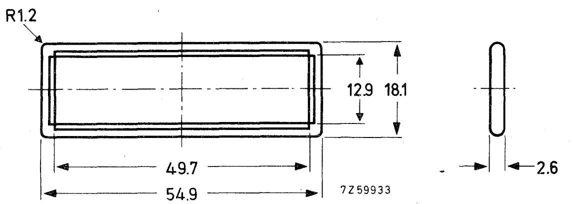


Fig. 3 Gasket

INDEX OF TYPE NUMBERS

type no.	section	type no.	section	type no.	section
EA52	D	YJ1441	MH	7093	CM
EA53	D	YJ1442	MH	7289	T
EC55	T	YJ1443	MH	7537	TWT
EC157	T	YJ1481	MH	8020	D
EC158	T	YJ1500	MH	8108	T
K50A	D	YK1000	KH	55029	CM
K51A	D	YK1001	KH	55030	CM
LB6-25	TWT	YK1002	KH	55031/01	CM
YD1050	T	YK1004	KH	55031/02	CM
YD1051	T	YK1005	KH	55032/01	CM
YH1090	TWT	YK1090	KM	55032/02	CM
YH1170	TWT	YK1091	KM	55340	TWT
YH1172	TWT	YK1110	KH	56032	TR
YJ1020	CM	YK1151	KH		
YJ1021	CM	YK1190	KH		
YJ1023	CM	YK1191	KH		
YJ1160	MH	YK1210	KH		
YJ1162	MH	2C39BA	T		
YJ1180	CM	5586	CM		
YJ1181	CM	5893	T		
YJ1193	MH	6263	T		
YJ1194	MH	6263A	T		
YJ1280	MH	6264	T		
YJ1320	CM	6264A	T		
YJ1321	CM	7090	MH		

CM = Communication magnetrons
D = Diodes
KH = Klystrons, high power
KM = Klystrons, medium and low power
MH = Magnetrons for microwave heating
T = Triodes
TR = T - R switches
TWT = Travelling-wave tubes

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