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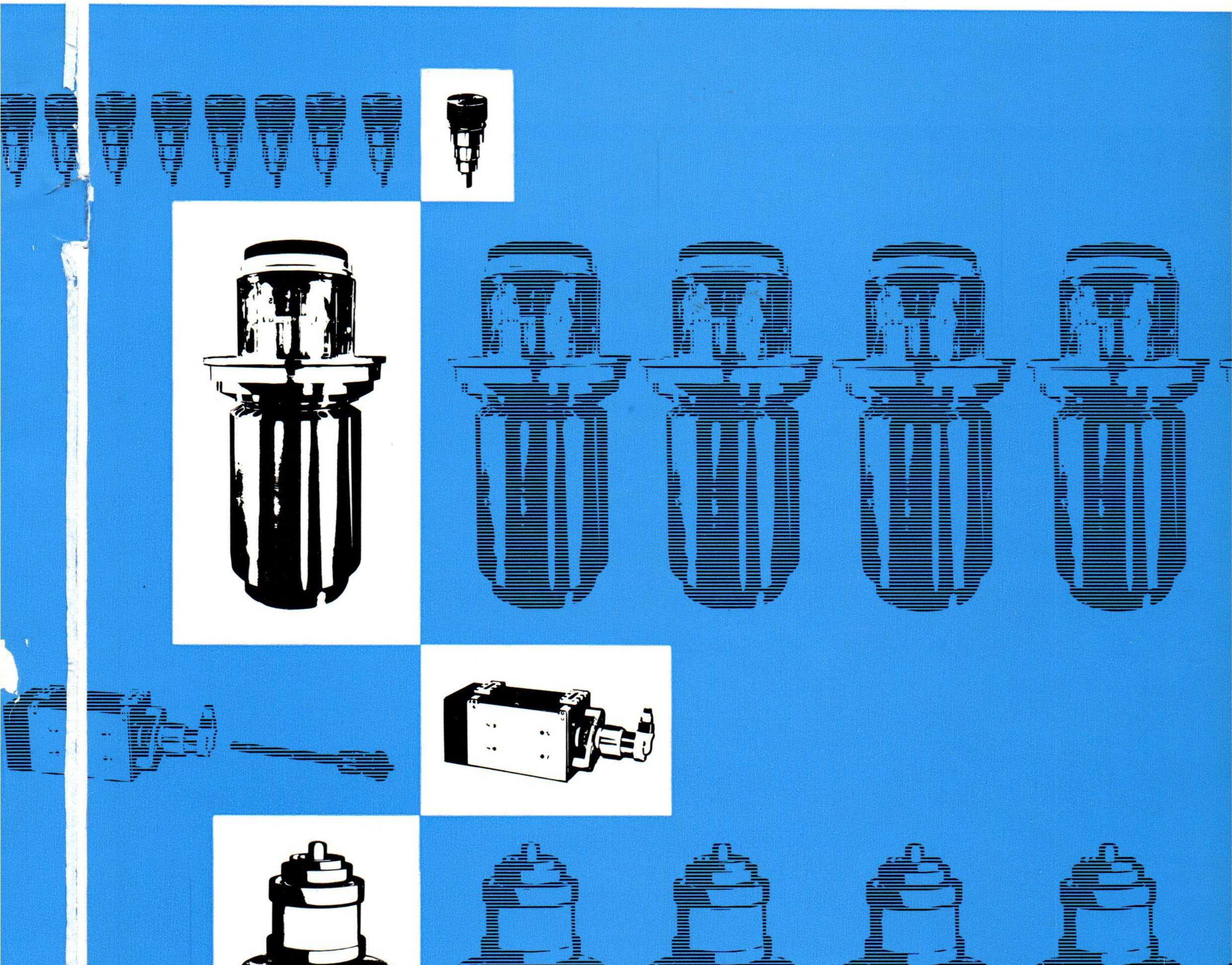


Power and Special Purpose Tubes

Symbols for Electrodes

c	Collector
dl	Delay line
g	Grid, focusing electrode, accelerating electrode
h	Helix
i.C. (int con)	Internal connection
k	Cathode
p	Plate

Several grids, focusing and accelerating electrodes are numbered 1, 2, 3... according to their relative position from the cathode, the lowest number being closest to the cathode.

Symbols for Voltages

E_b	dc plate or collector voltage
e_b	Plate pulse voltage
E_{bb}	dc plate or collector supply voltage
E_c	dc grid voltage, dc focusing voltage, dc accelerating voltage
e_c	Grid pulse voltage
E_{cc}	dc grid, focusing or accelerating supply voltage
E_{dl}	dc delay line voltage
E_f	Heater voltage
E_g	rms value of ac component of grid voltage
e_g	Peak grid voltage
E_h	dc helix voltage
E_{hk}	Heater - cathode voltage
E_{ip}	dc ion pump voltage
E_p	rms value of ac component of plate voltage with respect to cathode
e_p	Peak plate voltage

LIST OF ABBREVIATIONS AND SYMBOLS MICROWAVE TUBES

Symbols for Currents

I_b	dc plate or collector current
I_{bo}	Zero signal dc plate current
i_b	Plate pulse current
I_c	dc grid current
	dc focusing current
	dc accelerating current
i_c	Grid pulse current
I_{dl}	Delay line current
I_f	Heater current
I_g	rms value of ac component of grid current
i_g	Peak grid current
I_h	Helix current
i_h	Peak helix current
I_{ip}	dc ion pump current
I_k	dc cathode current
i_k	Peak cathode current
I_p	rms value of ac component of plate current
i_p	Peak plate current

Symbols for Power Values

P_d	Average drive power
p_d	Peak or pulse drive power
P_{dl}	Delay line power dissipation
$P_{d\,syn}$	Synchron drive power
P_g	Power dissipation of grid, focusing or accelerating electrode
P_h	Helix power dissipation
P_i	Power input (plate)
P_o	Average power output
p_o	Peak power output
$P_{o\,syn}$	Synchron power output
P_p	Plate or collector power dissipation
P_{sat}	Saturation power

Symbols for Capacitances

C_{in}	Input capacitance
C_{mn}	Capacitance between the electrodes m and n
$C_{mn/p}$	Capacitance of electrodes m and n with respect to electrode p
C_{out}	Output capacitance

Symbols for Resistances

R_b	dc resistance of external plate or collector circuit (bypassed)
R_g	Resistance in series with grid
R_k	Resistance in series with cathode
R_p	Resistance in series with plate

Other Symbols

Du	The product of time of pulse and pulse repetition rate (Duty cycle)
F	Frequency
G	Gain
IM2	2 tone intermodulation ratio
IM3	3 tone intermodulation ratio
NF	Noise factor
P	Pressure drop
P_{rr}	Pulse recurrence rate
S	Transconductance
T	Temperature
T_A	Ambient temperature
T_E	Envelope temperature
t_k	Cathode - conditioning time, preheating time
T_P	Collector or plate temperature
t_p	Pulse duration
T_M	Magnet system temperature
T_{surf}	Surface temperature
V	Air flow rate
VSWR	Voltage standing wave ratio
α	Cold attenuation
μ	Amplification factor

LIST OF ABBREVIATIONS AND SYMBOLS MICROWAVE TUBES

Dimensions

A	Amperes (may be either ac rms or dc)
a	Amperes (peak value)
A_{ac}	ac amperes (rms)
ac	Alternating current
Adc	dc amperes
^{o}C	Degrees centigrade
cm	Centimeter
cps (Hz)	Cycles per second
CW	Continuous wave
db	Decibels
dc	Direct current
Gc (GHz)	Gigacycles (kilomegacycles)
kc (kHz)	Kilocycles
kv	Peak kilovolts
kVdc	dc kilovolts
kW	kilowatts
kw	Peak kilowatts
if	Intermediate frequency
m	Meter or one - thousandth
m^3/h	Cubic meter per hour
mA	ac (rms) or dc milliamperes
ma	Peak milliamperes
mAac	ac milliamperes (rms)
mAdc	dc milliamperes
Mc (MHz)	Megacycles
Meg	Megohms
min	Minutes
mm	Millimeter
ms	Milliseconds
rf	Radio frequency
rms	Root mean square
V	Volts (may be either ac rms or dc)
v	Volts, peak value
W	Watts
w	Peak watts
μAac	ac microamperes (rms)
μAdc	dc microamperes
μf	Microfarads
μs	Microseconds
μμf	Micromicrofarads

POWER TRAVELING WAVE TUBE

$F = 1.7$ to 2.3 Gc

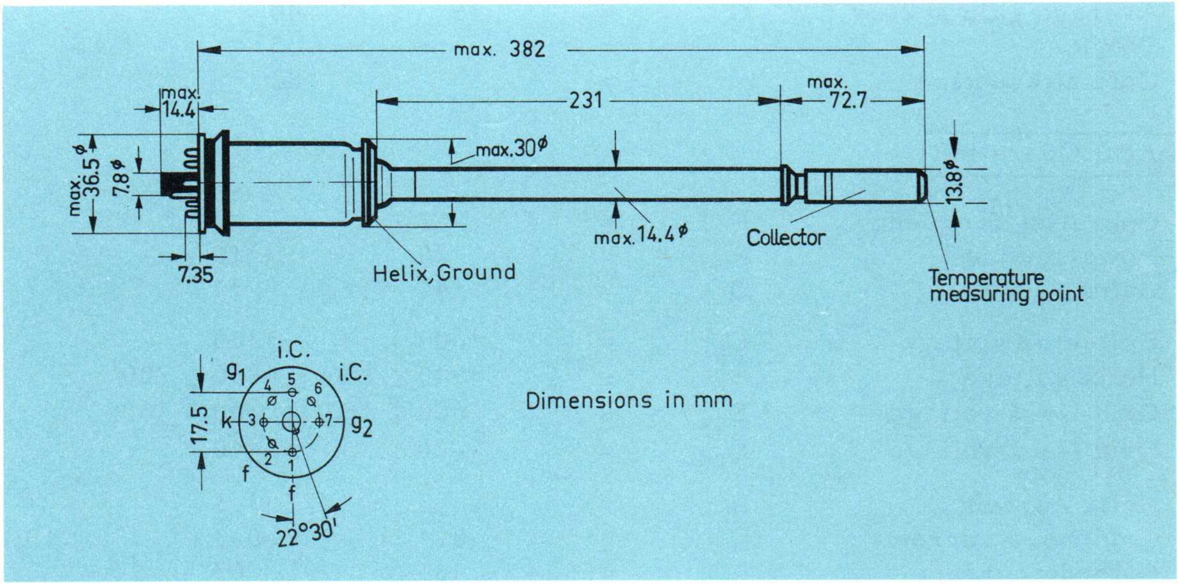
RW 2

SIEMENS

S&H Sach-Nr.
Q00041-X3251

Design and Application

Power traveling wave tube especially designed for broadband radio relay systems with an average power output of 20 W and an average small-signal gain of 40 db.
The magnet system including the tube and the connections is provided with rf shielding.
The tube is a periodic permanent magnet focused traveling wave tube and is a plug-in match in its associated magnet system MRW 2. The magnet system has a particularly small leakage field. The tube is designed to operate with depressed collector.
The magnet system may be delivered by choice with a conduction cooler (MRW 2a) or with a convection cooler (MRW2b). The rf-power is coupled in and out by way of waveguides.
The rf input and output ports are designed for connection to coaxial cable.



Tube base	: special type, included in magnet system
Weight of tube	: approx. 200 gm net (7 ozs)
Weight of magnet system	: approx. 12 kg (27 lbs)
Dimensions of magnet system	: approx. 100 x 130 x 384 mm without tube socket (4 x 5 1/8 x 15 ins)
Dimensions of the tube packing	: 170 x 170 x 560 mm (6 5/8 x 6 5/8 x 22 ins)
rf connector	: optional 50 Ω, N connector 3/7 or coax. 7/16 60 Ω, coax. 3.5/9.5 or coax. 7/16
Mounting position	: any (see cooling)

Heating

Heater voltage	E_f	=	6.3	Vac (1)
Heater current	I_f	≈	0.8	Aac
Preheating time	t_k	≧	2	min (2)

indirect by ac, parallel supply
Metal capillary dispenser cathode

Characteristics

(f = 2.0 Gc, I_k = 85 mA)

			min.	nom.	max.	
Peak saturation power	P_{sat}	=	27	35		W
Small signal gain	G	=	40	44		db
Average gain at 20 W CW	G	=	36	40		db
VSWR		=		1.35	1.85	(3)
Cold attenuation	α	=		80		db

Typical Operation

Operating frequency	F	=	2	2	Gc
Power output	P_o	=	20	10	W
Gain	G	=	40	37	db
Collector voltage	E_b	=	1600	1300	Vdc (4)
Helix voltage	E_h	≈	1900 ± 200	1850 ± 200	Vdc (5)
Grid No.2 voltage	E_{c2}	≈	600 ± 150	600 ± 150	Vdc (5)
Grid No.1 voltage	E_{c1}	=	-20	-40	Vdc (4, 6)
Helix current	I_h	=	3	1.5	mAdc
Grid No.2 current	I_{c2}	≦	0.1	0.1	mAdc
Cathode current	I_k	=	85	65	mAdc (4)
Noise factor	NF	≈	21		db
AM/PM conversion		≈	3.8		°/db (7)

All voltages are referred to the cathode

(1) If the maximum variation of the heater voltage exceeds the absolute limits of ± 2 % the operating performance of the tube will be impaired and its life shortened.
(2) Once the tube has been operated at full voltages and currents, the preheating time for subsequent operation may be reduced to ≧ 45 sec.
(3) At input and output of cold tube in the frequency range 1.7 to 2.3 Gc
(4) Setting values
(5) The spreads quoted are intended for use when designing the power supply.
(6) It is advisable to obtain E_{c1} by means of a cathode resistor.
(7) AM/PM conversion is the phase shift of the rf output signal when changing the input by 1 db.

Maximum Ratings (absolute values)

Collector supply voltage	E_{bb}	max	1900	Vdc
Collector voltage	E_{bb}	max	1800	Vdc
Collector dissipation	P_p	max	150	W
Helix voltage	E_h	max	2300	Vdc
Helix voltage	E_h	min	1600	Vdc
Helix current	I_h	max	7	mAdc
Peak helix current	i_h	max	10	ma (1)
Grid No. 2 voltage	E_{c2}	max	900	Vdc
Grid No. 2 dissipation	P_{c2}	max	0.2	W
Grid No. 1 voltage	$-E_{c1}$	max	100	Vdc
Grid No. 1 voltage	$+E_{c1}$	max	0	Vdc
Cathode current	I_k	max	100	mAdc
Load VSWR		max	2.0	
Collector temperature	T	max	270	°C (2)
Magnet system temperature	T	max	100	°C (3)
Ambient temperature	TA	min	-20	°C
Ambient temperature	TA	max	55	°C (4)

(1) During starting and due to power supply surges

(2) Without rf-signal, the temperature of the collector may rise for three days maximum up to 300 °C

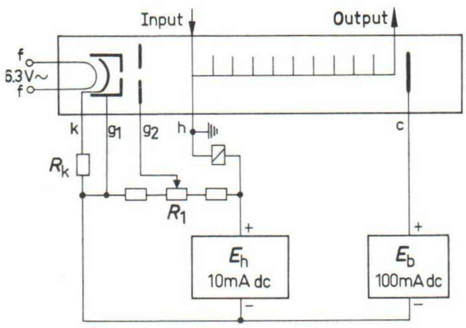
(3) Measured at the output waveguide flange. It may be necessary to remove the lacquer from the measuring point.

(4) See "cooling", page 4

Operating Instructions

The traveling wave tube RW 2 is operated in conjunction with a magnet system MRW 2. The advantages of the periodic permanent magnetic focusing of the RW 2 are the particularly small dimensions of the magnet system and an extremely low leakage field. The sensitivity to temperature changes is low.

The magnet system should only be mounted by way of the fixing holes provided for this purpose. With operation in radio link systems, directional couplers should be connected to the tube input and output to avoid distoriton due to multiple reflexions. The rf waveguide to the magnet system should be flexible to prevent any mechanical stress on the input and output ports of the magnet system.
All voltages applied to the tube are referred to the cathode.
The voltage drop in the heater supply leads must be taken into account.
The voltage must be set such that it is exactly 6.3 V at the socket. When using the standard cable of 1.1 m length supplied with the connector socket the total voltage drop is 0.1 V.
The Grid No. 1 voltage can be obtained from a cathode resistor R_k. The Grid No. 2 voltage must be variable within the range quoted. It is tapped from a voltage divider R_1, the total resistance of which must not exceed 2.5 Meg. Stability and residual hum voltage (helix voltage) depend upon the equipment requirements.
The collector voltage need not be stabilized, but it must not fall more than 50 Vdc below the indicated operating value.
A protective relay must be inserted in the helix supply circuit to disconnect the helix and Grid No. 2 voltage, when the maximum permissible helix current is exceeded.
When using an independent voltage source for Grid No. 2, the voltage must be automatically switched off immediately if the helix voltage fails.
This may be achieved by interlocking the protection circuits.
When the collector voltage fails, the helix voltage and Grid No. 2 voltage must be disconnected either by the overload relay in the helix circuit or by a voltage interlocking system.



Cooling

To dissipate the heat from the collector the magnet system may either be provided with conduction cooling (MRW 2a) or convection cooling (MRW 2b).

Conduction Cooling

The heat dissipated by the collector is conducted to two Cu-plates, mounted on two opposite sides of the magnet system. The heat (max. 55 W per plate) must be conducted from these plates. The temperature of the plate must not exceed 115 °C in this case. The plates are insulated from the collector and can be earthed.

Convection Cooling

When using the air-cooled version with the tube operating under the 20 W conditions detailed on page 2, an air stream with a flow rate of approx. 100 liters/min is required to cool the collector. At reduced ratings the tube can be operated at a maximum collector dissipation of 65 W in an ambient of up to 40 °C without forced cooling, provided the tube is horizontal and a natural circulation of air through the cooler assembly can be guaranteed.

Starting

For safe handling of the equipment, the magnet system must be properly grounded. For this purpose a solder tag is provided near the output port, see page 6.

1. Connect of supply leads. (initial starting)
   The collector voltage is connected by means of an e.h.t. cable to the solder tag under the coverplate of the cooling system (see page 6). The helix connection is soldered to the tag near the output port (see page 6).
   The other voltages are applied to the tube via the supply cable. The individual leads are color-coded as follows:

Heater	f.f	:	brown, brown-yellow	
Cathode	k	:	yellow	
Grid No. 1	g_1	:	green, red	*)
Grid No. 2	g_2	:	blue	
Earth		:	black	

*) connect green and red lead together!

2. Unscrew the retaining nut.
3. Insert the tube in magnet system, push on tube socket and screw on nut until stop is reached (avoid tilting the socket).
4. Apply heater voltage and preheat tube.
5. Apply air cooling.
6. Apply collector voltage
7. Switch-on helix and Grid No. 2 voltages simultaneously (the time difference between applying the voltages to both electrodes must not exceed 0.2 sec). Make sure that full voltages are applied immediately and not increased gradually to full value.
8. Adjust cathode current by varying Grid No. 2 voltage.
9. Adjust helix current to minimum with the aid of radial field correction (pair of rings at input end of magnet system) and axial field correction (additional single ring at input end of magnet system).
10. Apply rf input signal and readjust helix voltage for optimum gain at specified power output.
11. Repeat field correction according to point 8.

For interruption in operation up to 10 sec duration the tube may be switched on without preheating.

Switching off

The operating voltages can be switched off either simultaneously or in the reverse order to that in which they were applied.

Ordering Numbers for Traveling Wave Tube RW 2 and Associated Elements

Form and direction of the connector socket

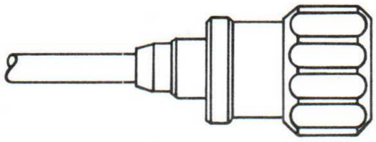


fig.1

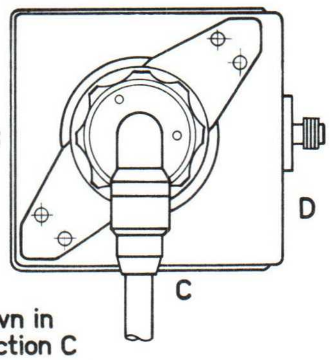


fig.2

The various arrangements of the cooler assembly and collector connection

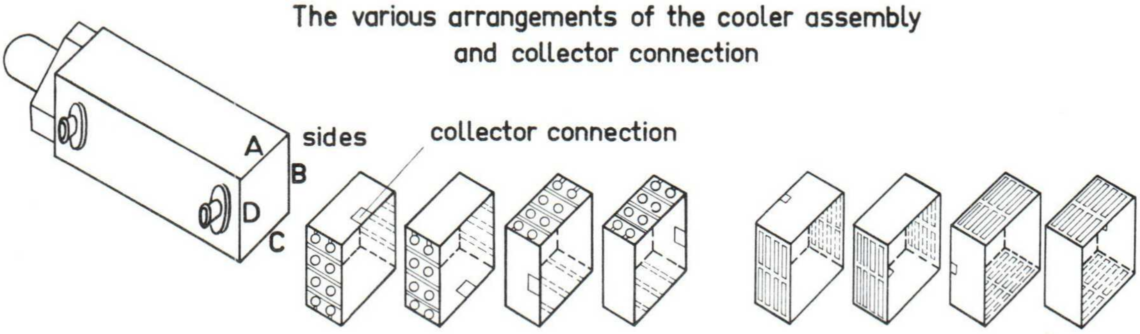


fig. 3a 3b 3c 3d 3e 3f 3g 3h

Ordering Numbers for Traveling Wave Tube RW 2 and Associated Elements

Ordering numbers for traveling wave tube RW 2 and RW-connector sockets

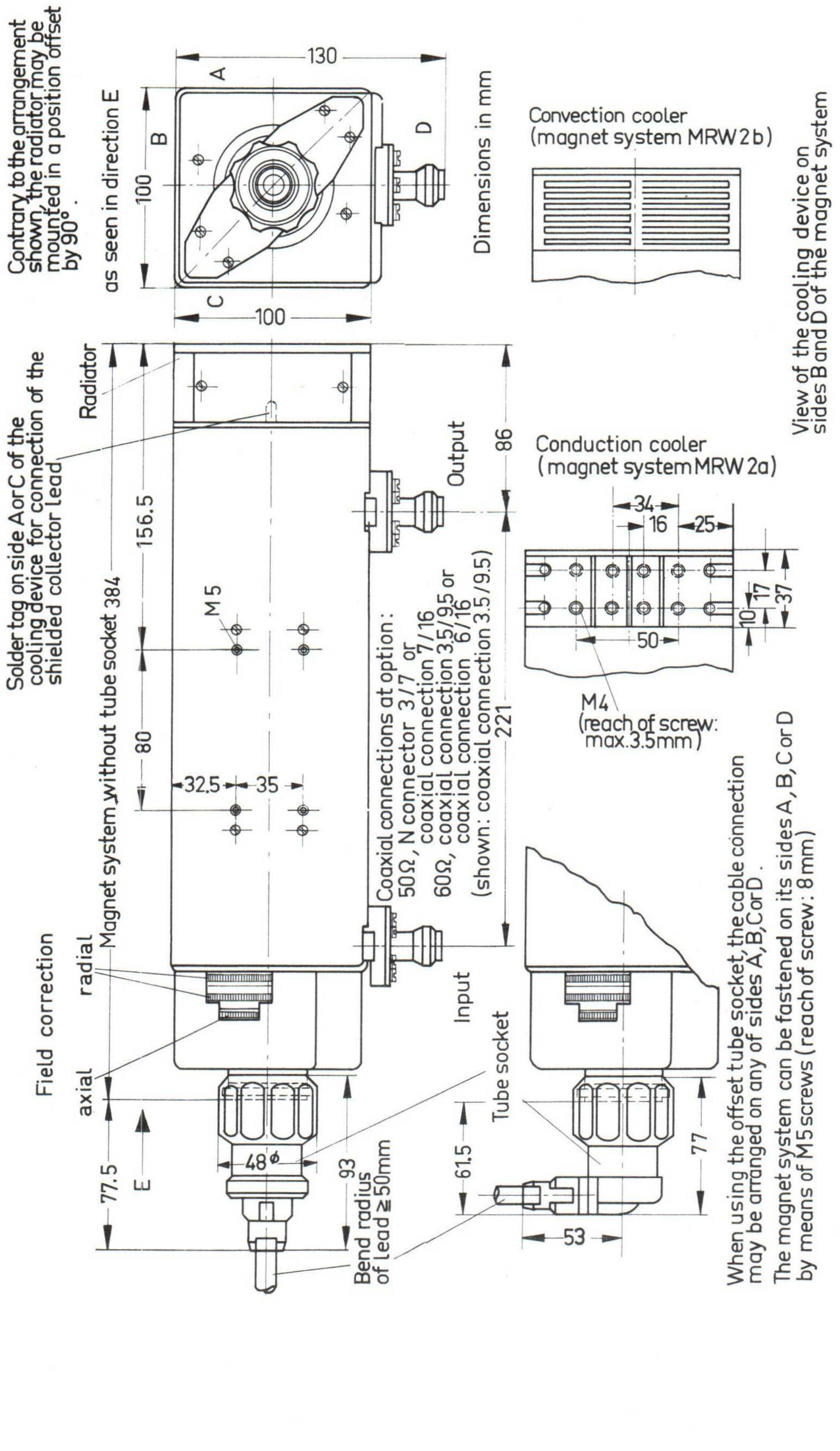
Designation	Design		Ordering numbers	Fig.
Traveling wave tube RW 2			Q00041-X3251	
RW-connector socket	axial	standard	Q00081-X2321	1
RW-connector socket	bend in direction A	cable	Q00081-X2322	2
RW-connector socket	bend in direction B	length	Q00081-X2323	2
RW-connector socket	bend in direction C	1.2 m (1)	Q00081-X2324	2
RW-connector socket	bend in direction D		Q00081-X2325	2
RW-connector socket	axial	cable	Q00081-X2315	1
RW-connector socket	bend in direction A	length	Q00081-X2316	2
RW-connector socket	bend in direction B	as	Q00081-X2317	2
RW-connector socket	bend in direction C	required (2)	Q00081-X2318	2
RW-connector socket	bend in direction D		Q00081-X2319	2

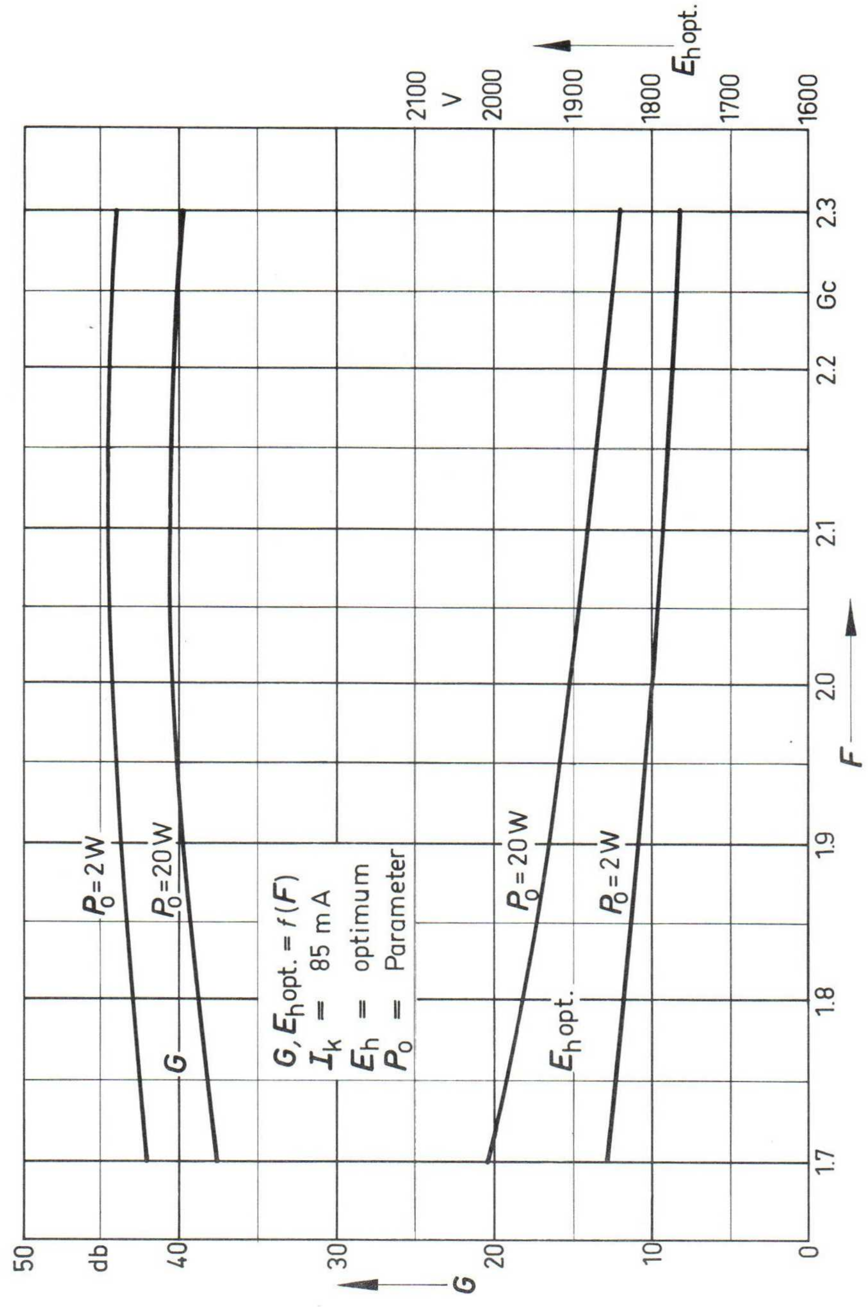
(1) 0.1 m of this length as free leads.
(2) When ordering please specify total length of cable and length of free leads.

Ordering numbers for magnet systems MRW 2

	Design			Ordering numbers Q00043-X....				
Designation	Cooling	Cooling in direct.	Collect. connect. at side	Coaxial connections 3.5/9.5	3/7 (1)	7/16	6/16	Fig.
Magn. syst. MRW 2a11	Conduction	B-D	A	2401	2411	2421	2431	3a
Magn. syst. MRW 2a12		B-D	C	2405	2415	2425	2435	3b
Magn. syst. MRW 2a21		A-C	D	2402	2411	2421	2431	3c
Magn. syst. MRW 2a22		A-C	B	2406	2416	2426	2436	3d
Magn. syst. MRW 2b11	Convection	B-D	A	2403	2413	2423	2433	3e
Magn. syst. MRW 2b12		B-D	C	2407	2417	2427	2437	3f
Magn. syst. MRW 2b21		A-C	D	2404	2414	2424	2434	3g
Magn. syst. MRW 2b22		A-C	B	2408	2418	2428	2438	3h

(1) N-connector


Contrary to the arrangement shown, the radiator may be mounted in a position offset by 90°.
as seen in direction E
A
B
C
D
130
100
100
Dimensions in mm
Convection cooler (magnet system MRW 2b)
View of the cooling device on sides B and D of the magnet system
Solder tag on side A or C of the cooling device for connection of the shielded collector lead
Radiator
Output
Magnet system without tube socket 384
156.5
80
M5
32,5
35
86
221
Coaxial connections at option: 50Ω, N connector 3/7 or coaxial connection 7/16
60Ω, coaxial connection 3.5/9.5 or coaxial connection 6/16
(shown: coaxial connection 3.5/9.5)
Conduction cooler (magnet system MRW 2a)
34
16
25
50
10
17
37
M4 (reach of screw: max.3.5mm)
Field correction
radial
axial
Input
Tube socket
77.5
E
48 ⌀
93
61.5
77
53
Bend radius of lead ≥50mm
When using the offset tube socket, the cable connection may be arranged on any of sides A, B, C or D.
The magnet system can be fastened on its sides A, B, C or D by means of M5 screws (reach of screw: 8 mm)


G, E_h opt. = f (F)
I_k = 85 mA
E_h = optimum
P_o = Parameter
P_o = 2 W
P_o = 20 W
G
E_h opt.
F
Gc
G
db
V
1.7
1.8
1.9
2.0
2.1
2.2
2.3
0
10
20
30
40
50
1600
1700
1800
1900
2000
2100

Characteristics

$G = f\,(P_o)$

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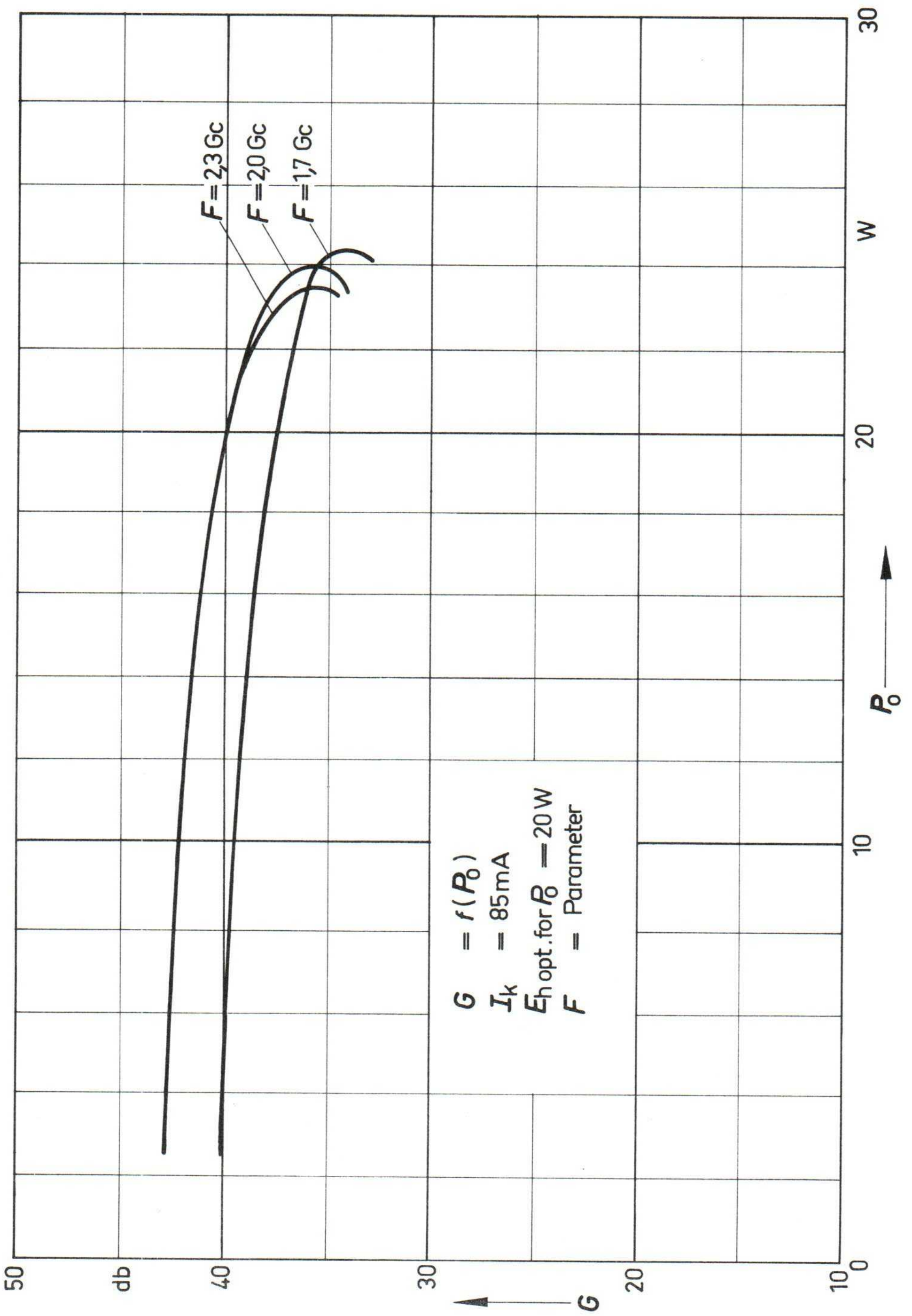
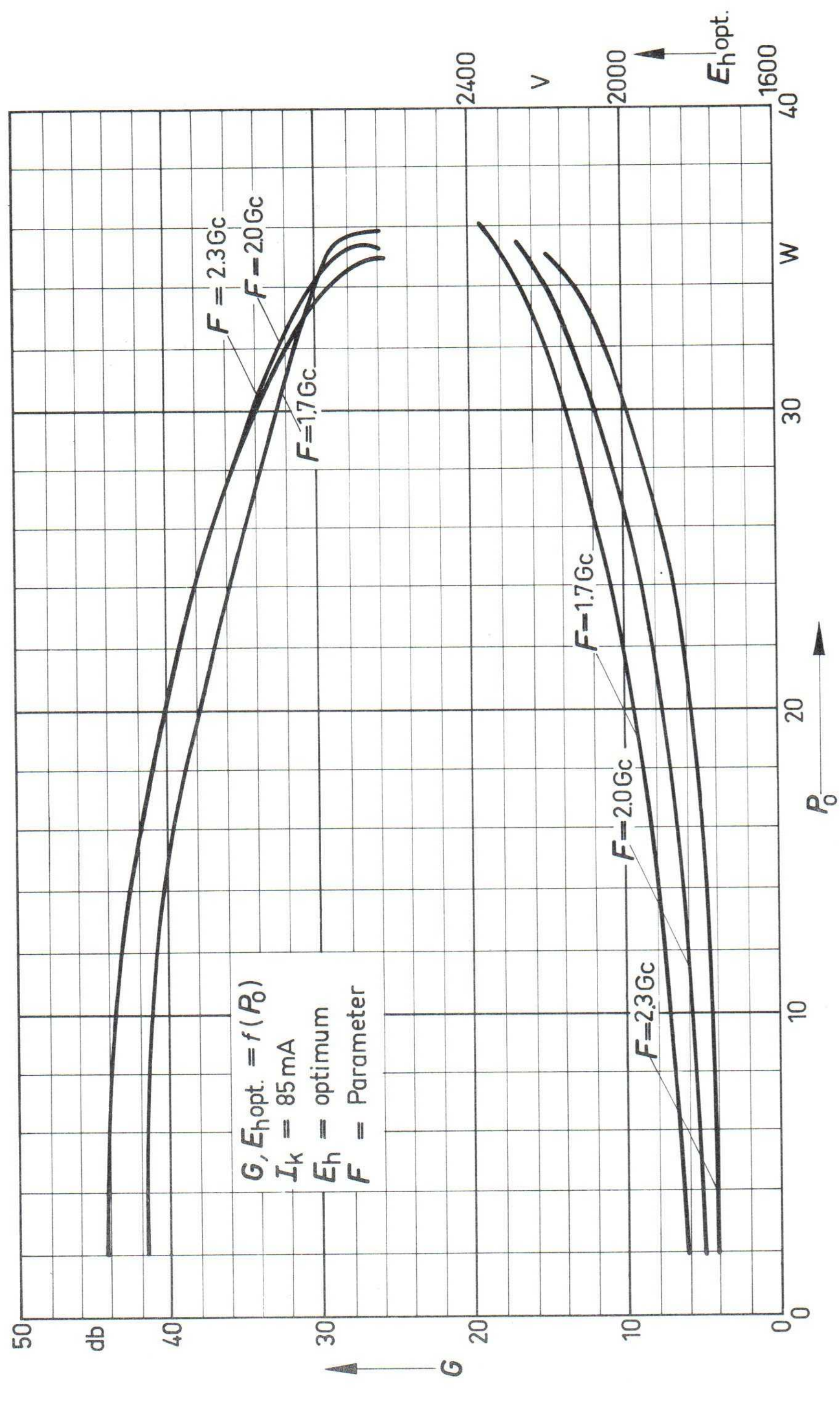


RöK 3506E / 1.11.65

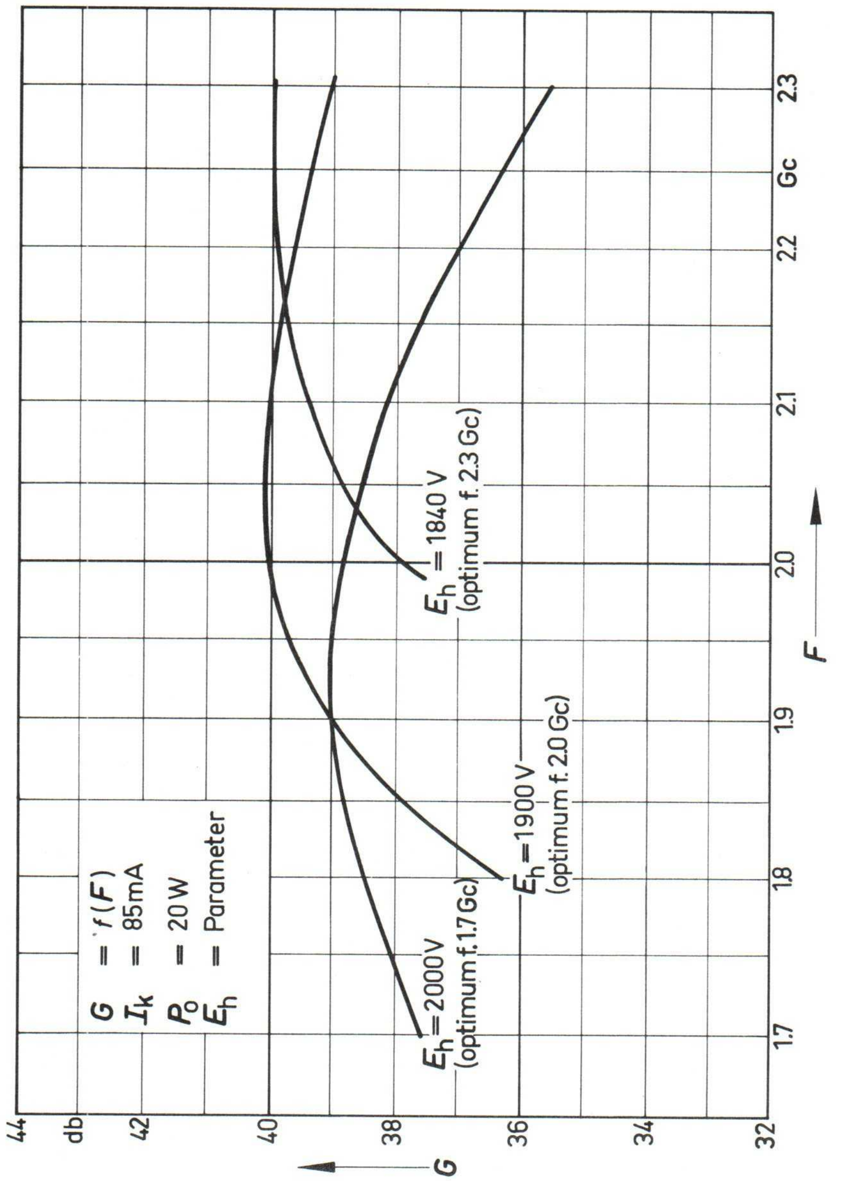
Characteristics

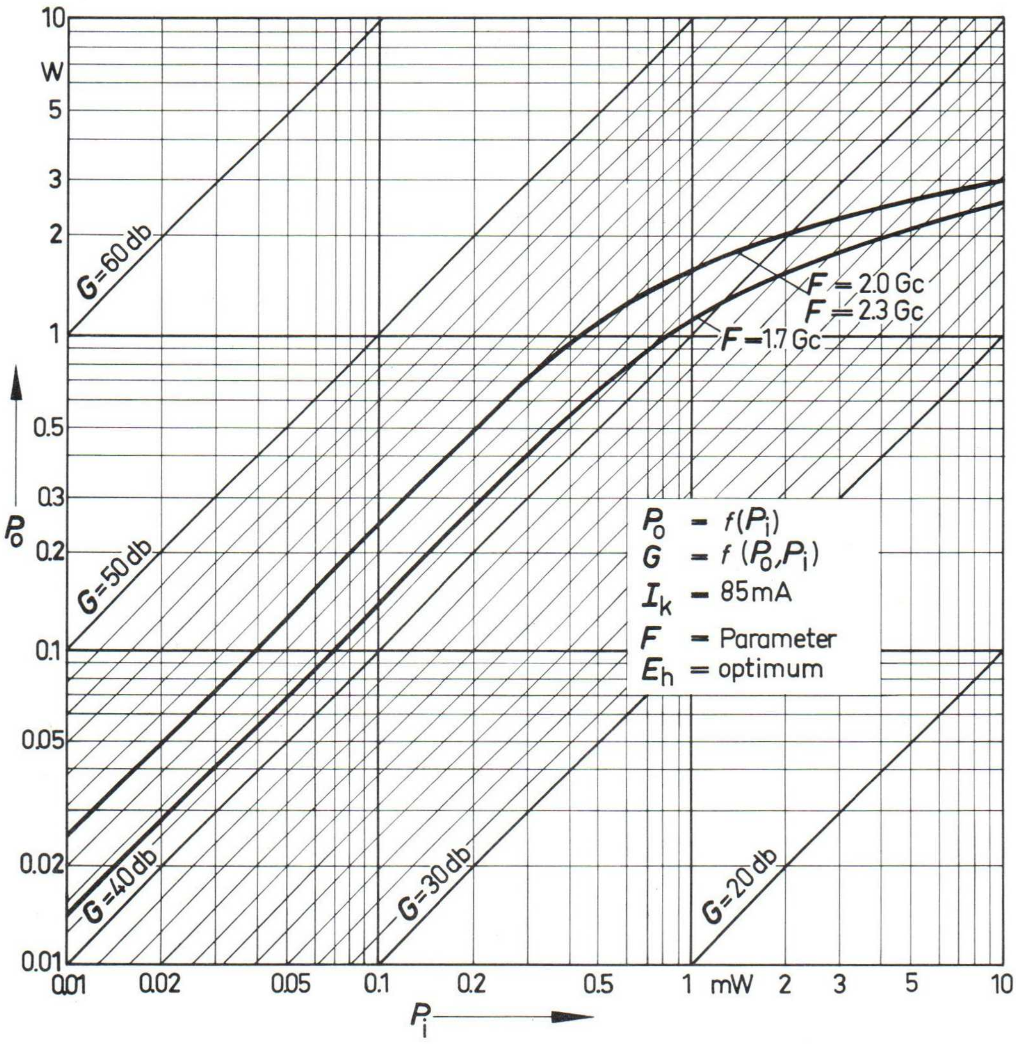
$G, E_{h\ opt} = f(P_o)$



Characteristics

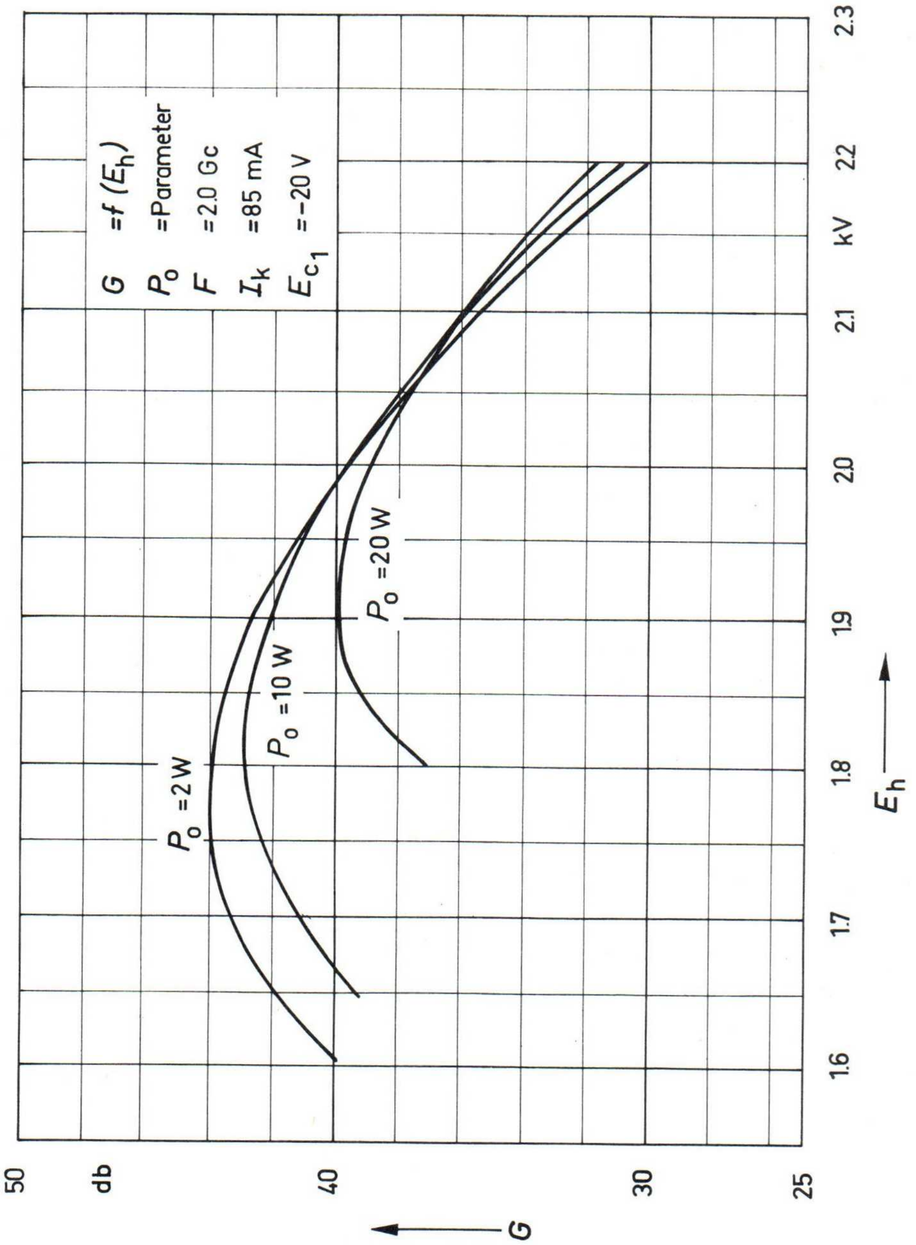
$G = f(F)$

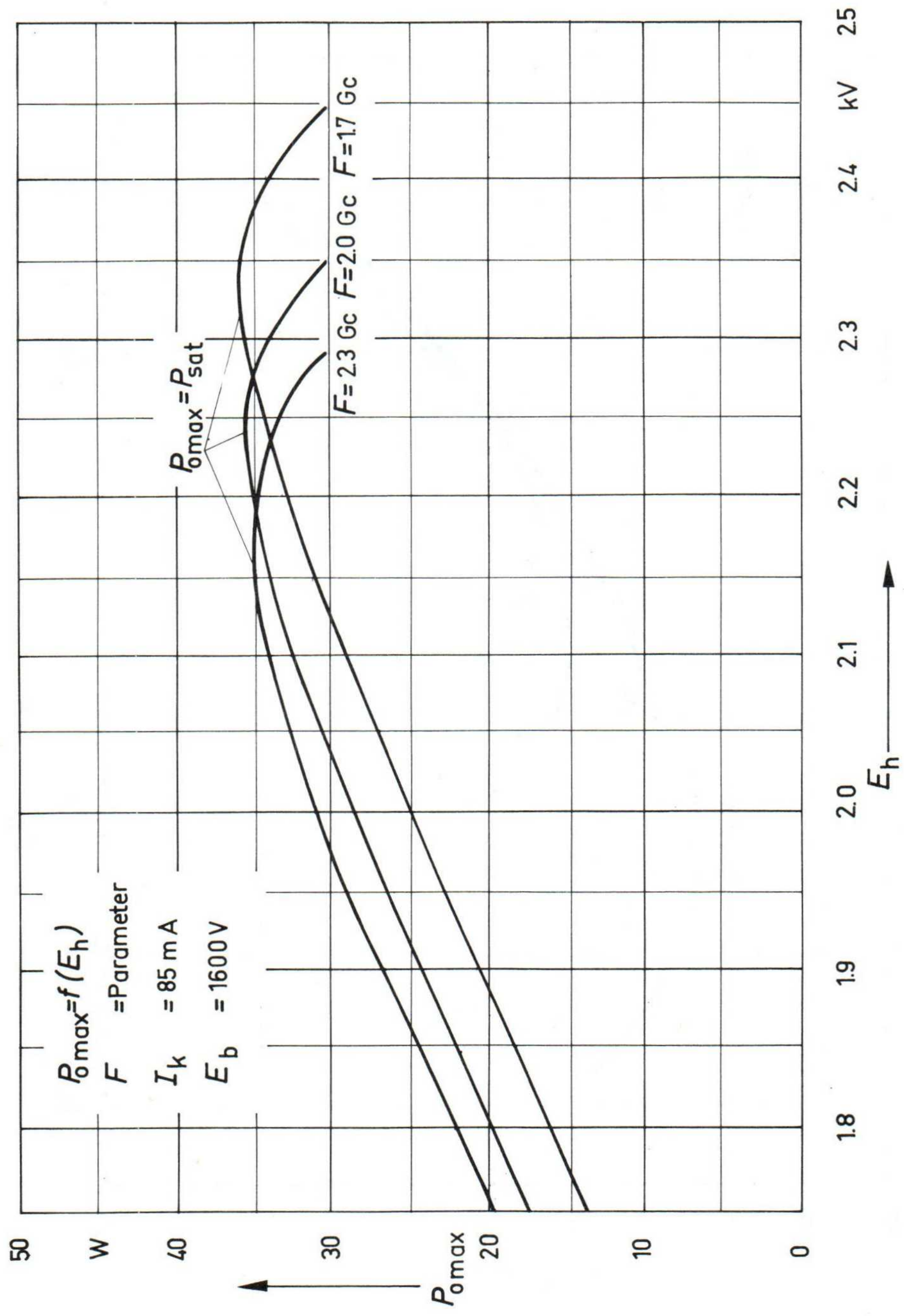


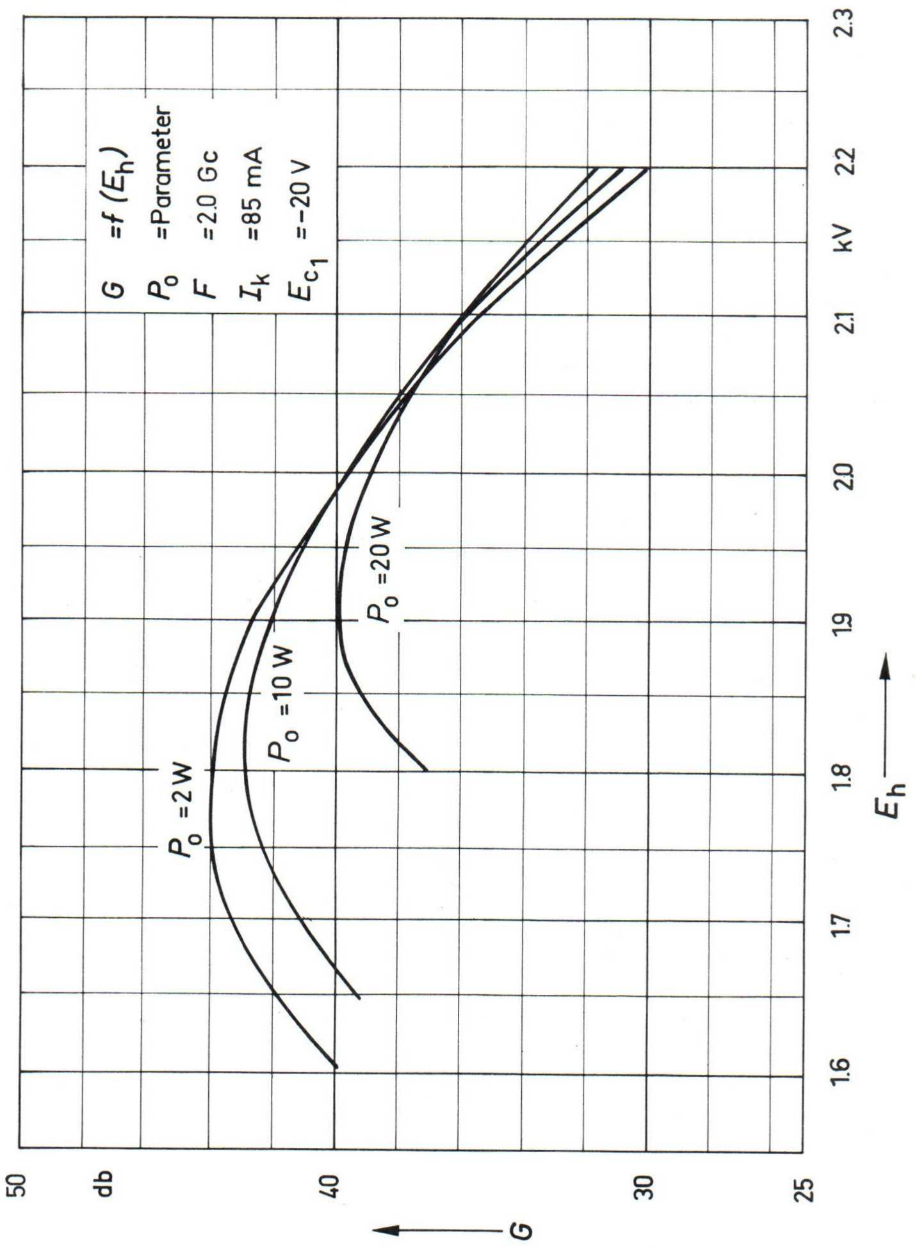

10
W
5
3
2
1
0.5
0.3
0.2
0.1
0.05
0.02
0.01
Po
0.01
0.02
0.05
0.1
0.2
0.5
1 mW
2
3
5
10
Pi
G=60 db
G=50 db
G=40 db
G=30 db
G=20 db
F = 2.0 Gc
F = 2.3 Gc
F = 1.7 Gc
Po = f(Pi)
G = f (Po,Pi)
Ik = 85 mA
F = Parameter
Eh = optimum

Characteristics

$G = f(E_h)$




$P_{o\,max} = f\,(E_h)$
F =Parameter
I_k = 85 mA
E_b = 1600 V
$P_{o\,max} = P_{sat}$
F = 2.3 Gc
F = 2.0 Gc
F = 1.7 Gc
$P_{o\,max}$
W
0
10
20
30
40
50
E_h
kV
1.8
1.9
2.0
2.1
2.2
2.3
2.4
2.5



G =f (E_h)
P_o =Parameter
F =2.0 Gc
I_k =85 mA
E_c1 =−20 V
P_o =2 W
P_o =10 W
P_o =20 W
50
db
40
30
25
G
1.6
1.7
1.8
1.9
2.0
2.1
kV
2.2
2.3
E_h

Characteristics

$P_{o\,max} = f\,(E_h)$

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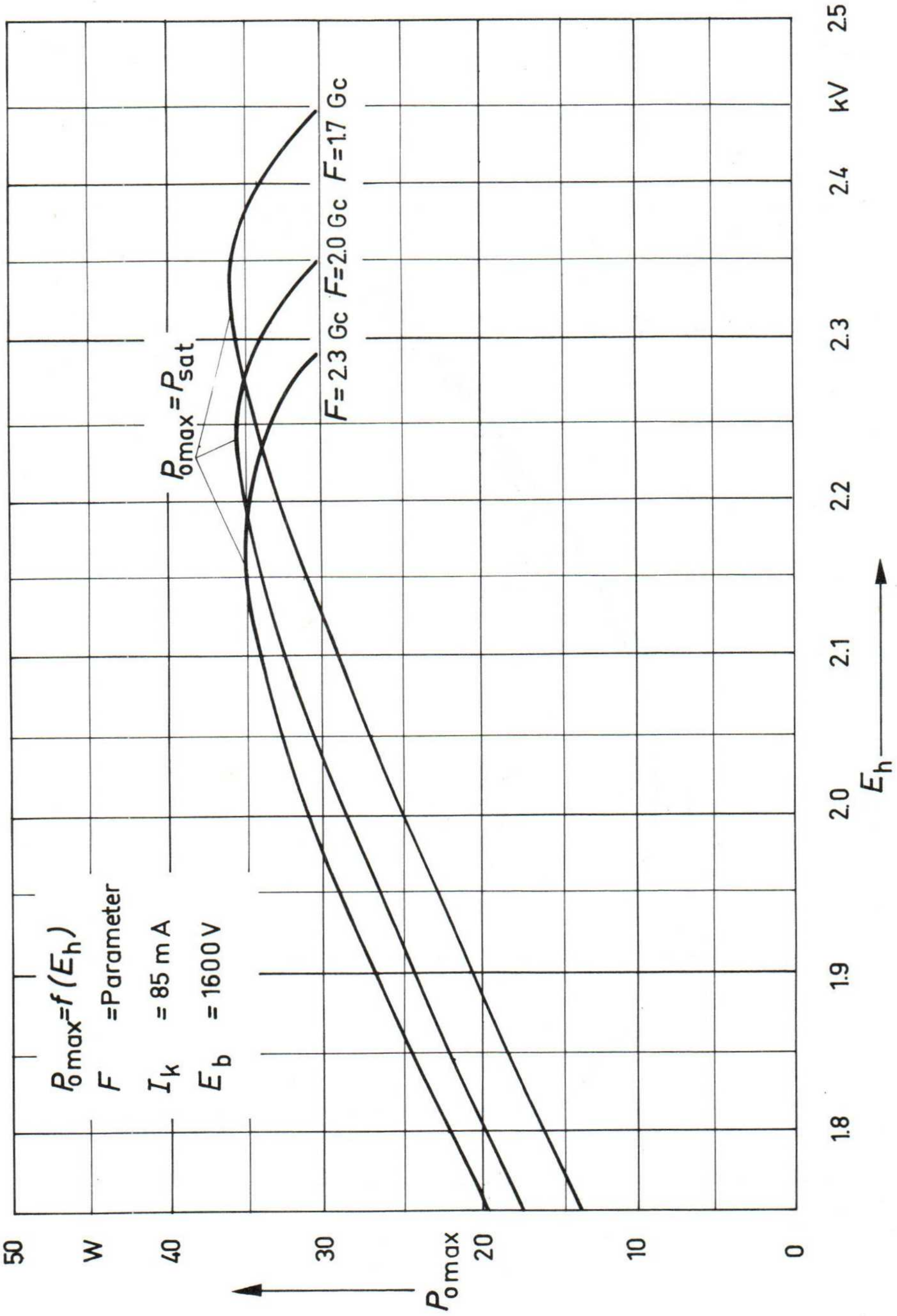
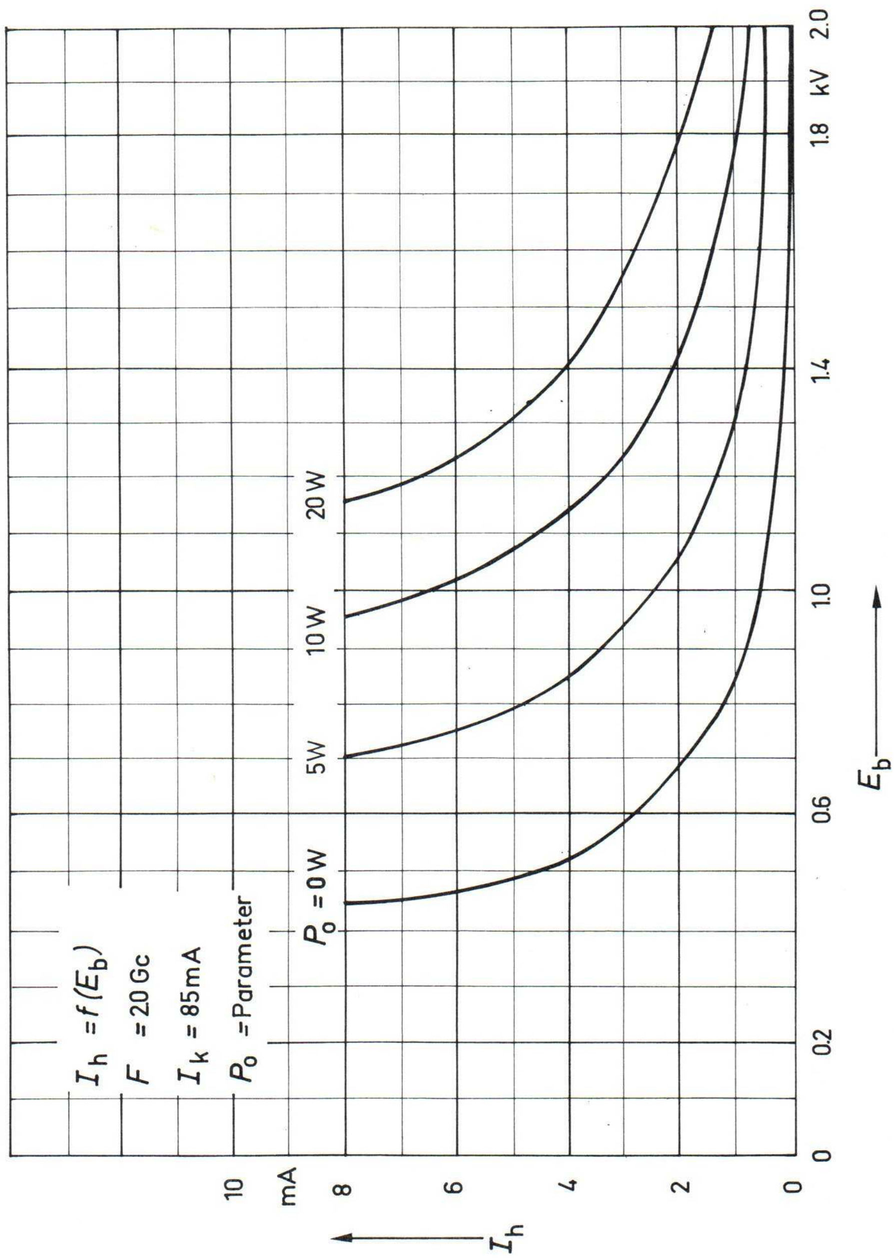


RöK 3506 E / 1.2.67


$I_h = f(E_b)$
$F = 20$ Gc
$I_k = 85$ mA
P_o = Parameter
$P_o = 0$ W
5W
10 W
20 W
0
2
4
6
8
mA
10
I_h
0
0.2
0.6
1.0
1.4
1.8 kV 2.0
E_b

Characteristics

$I_h = f(E_b)$

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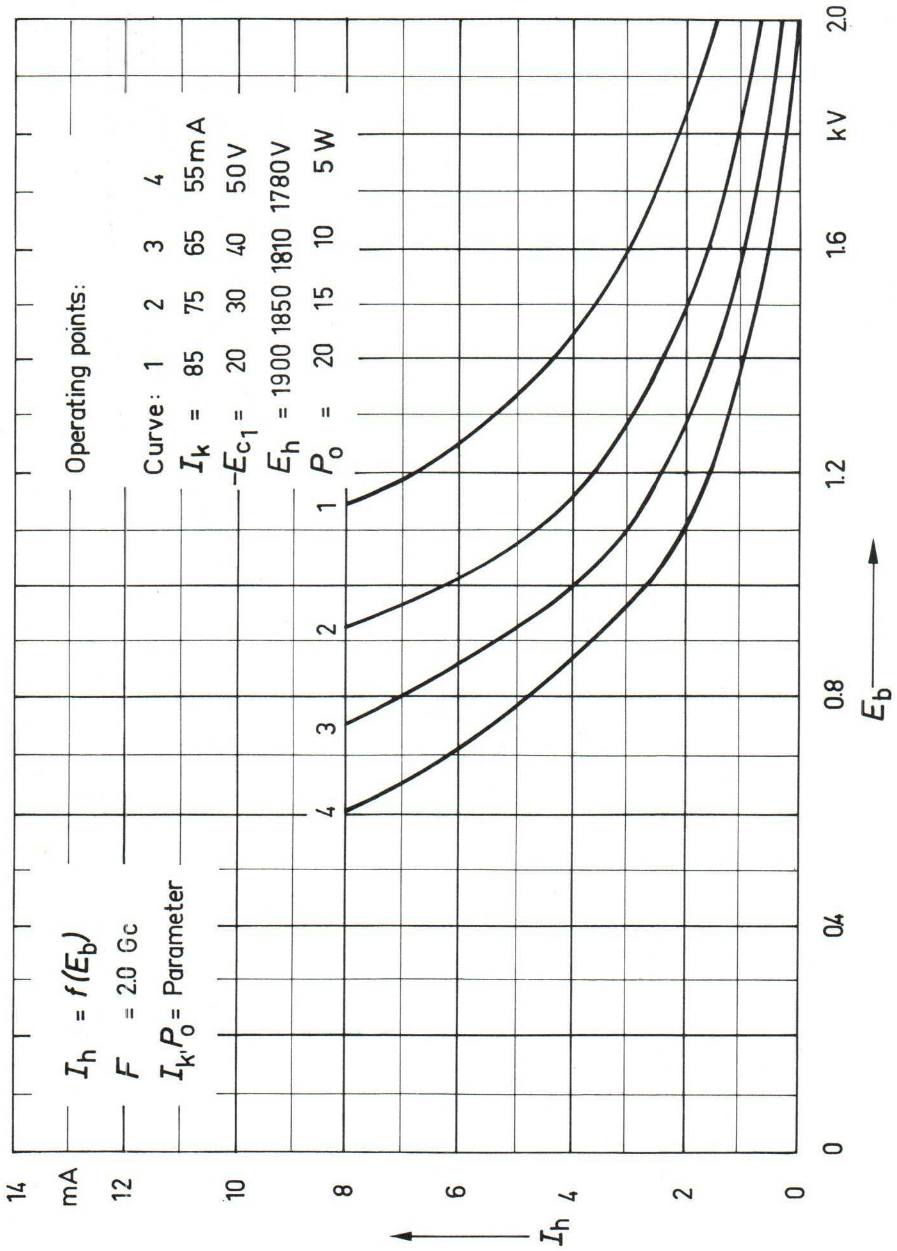
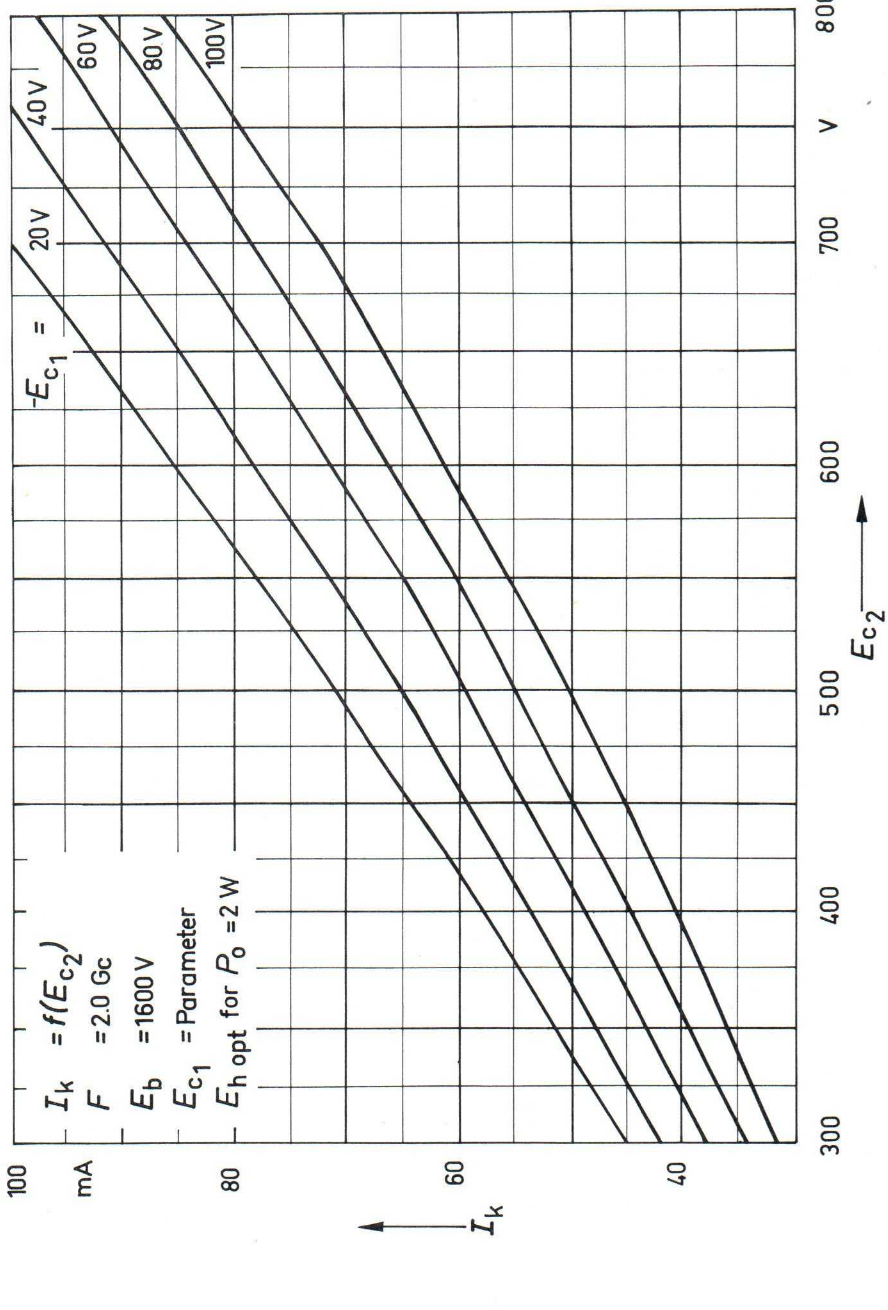
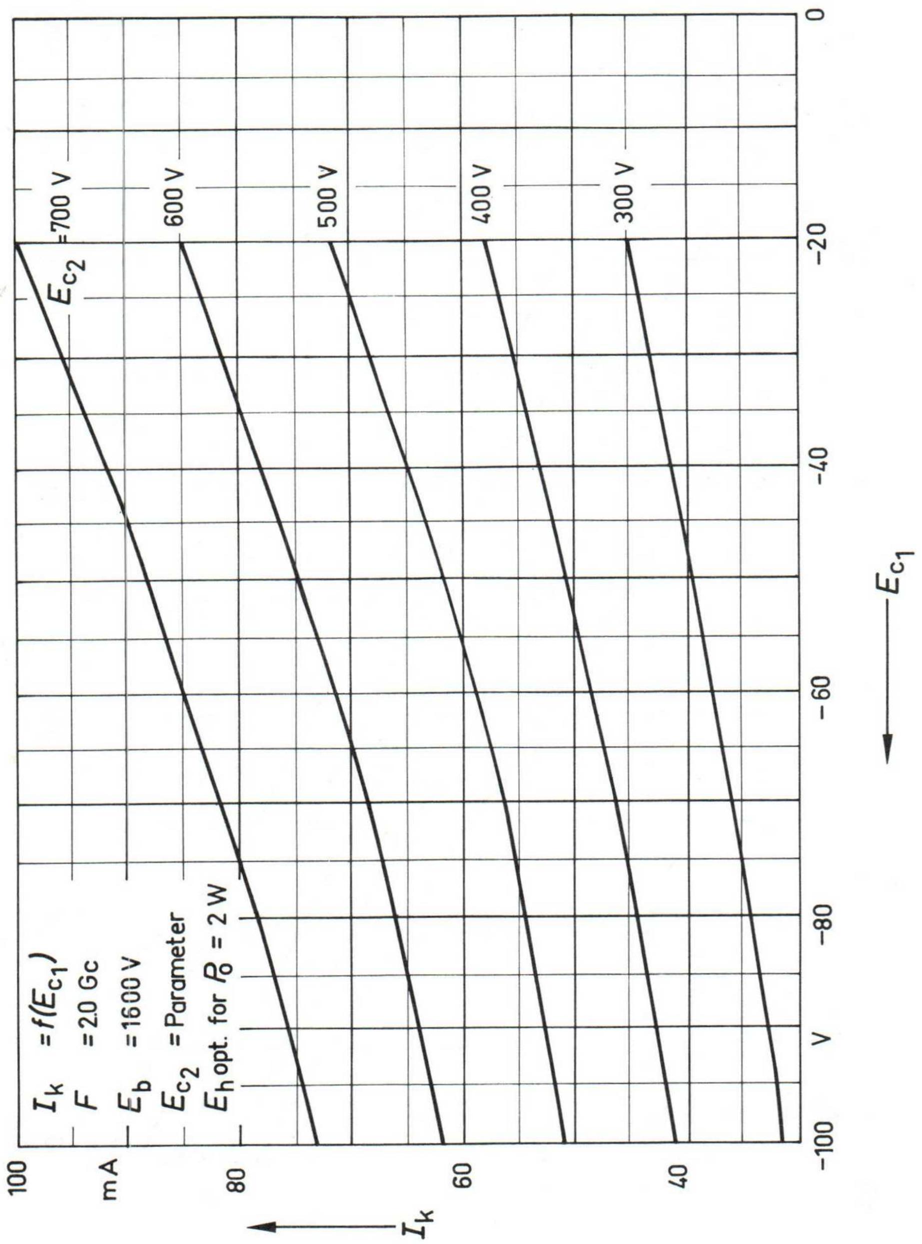
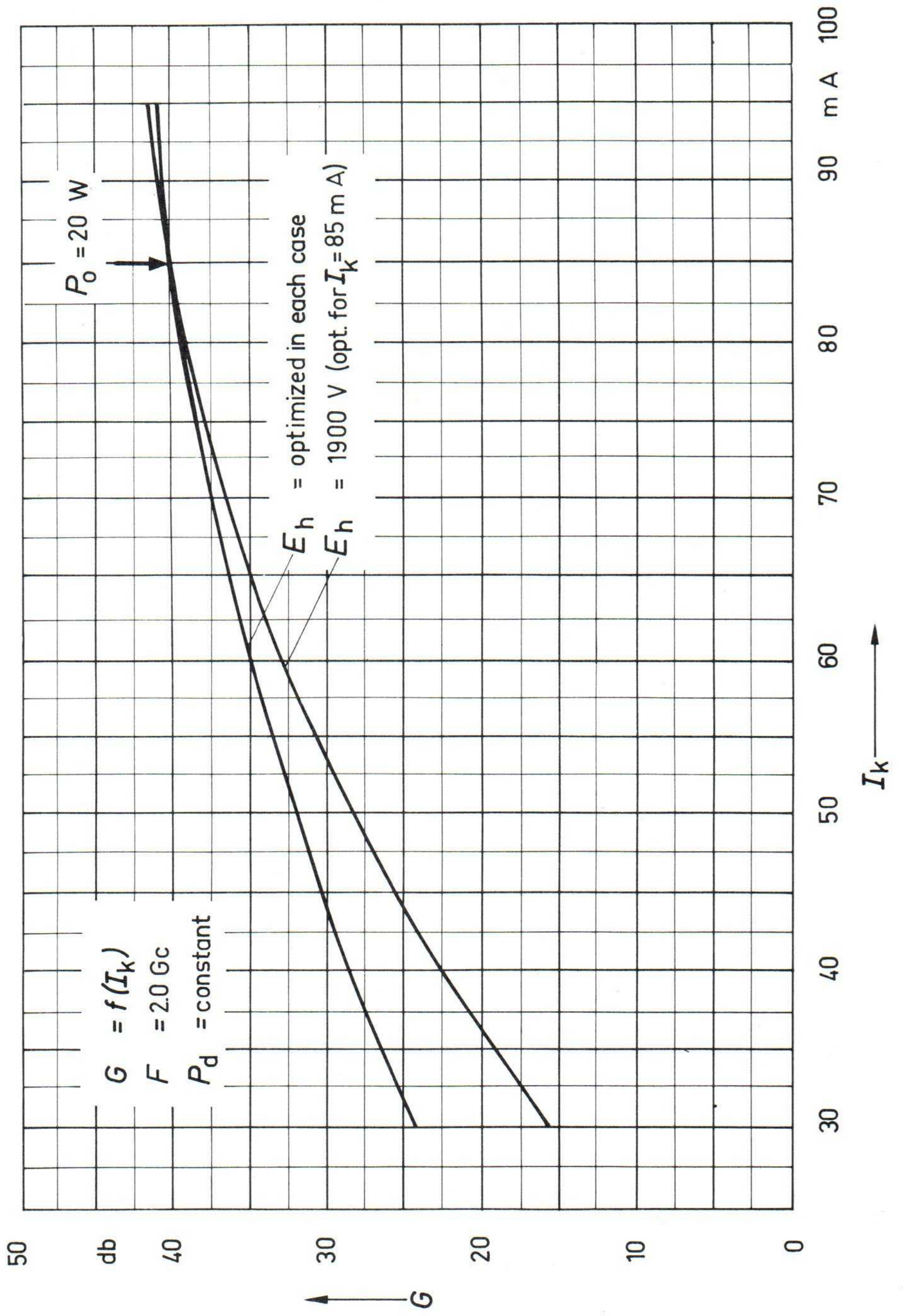



I_k = $f(E_{c_2})$
F = 2.0 Gc
E_b = 1600 V
E_{c_1} = Parameter
E_h opt for P_o = 2 W
$-E_{c_1}$ =
20 V
40 V
60 V
80 V
100 V
100
mA
80
60
40
I_k
300
400
500
600
700
V
800
E_{c_2}

Characteristics

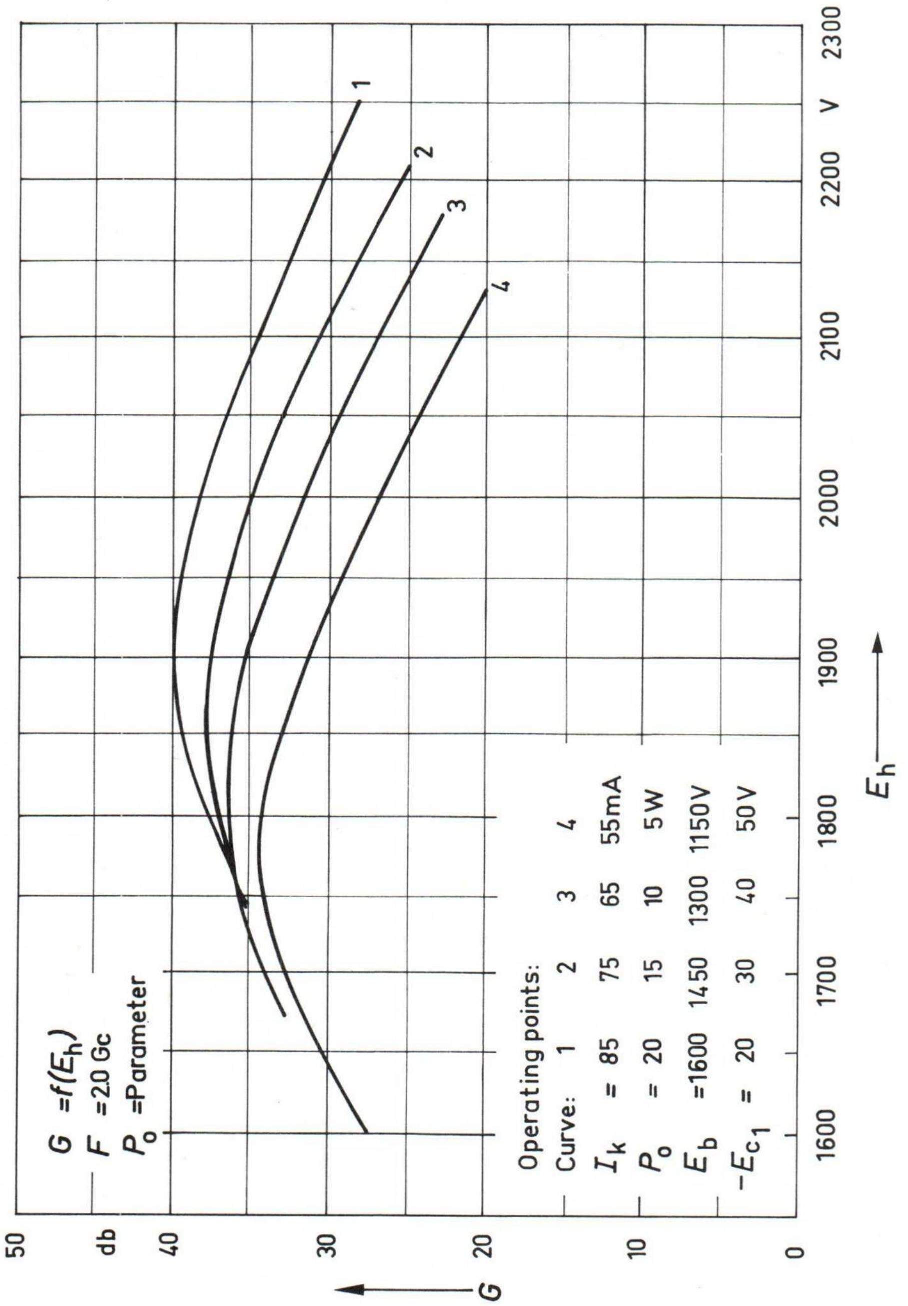
$I_k = f(E_{c1})$

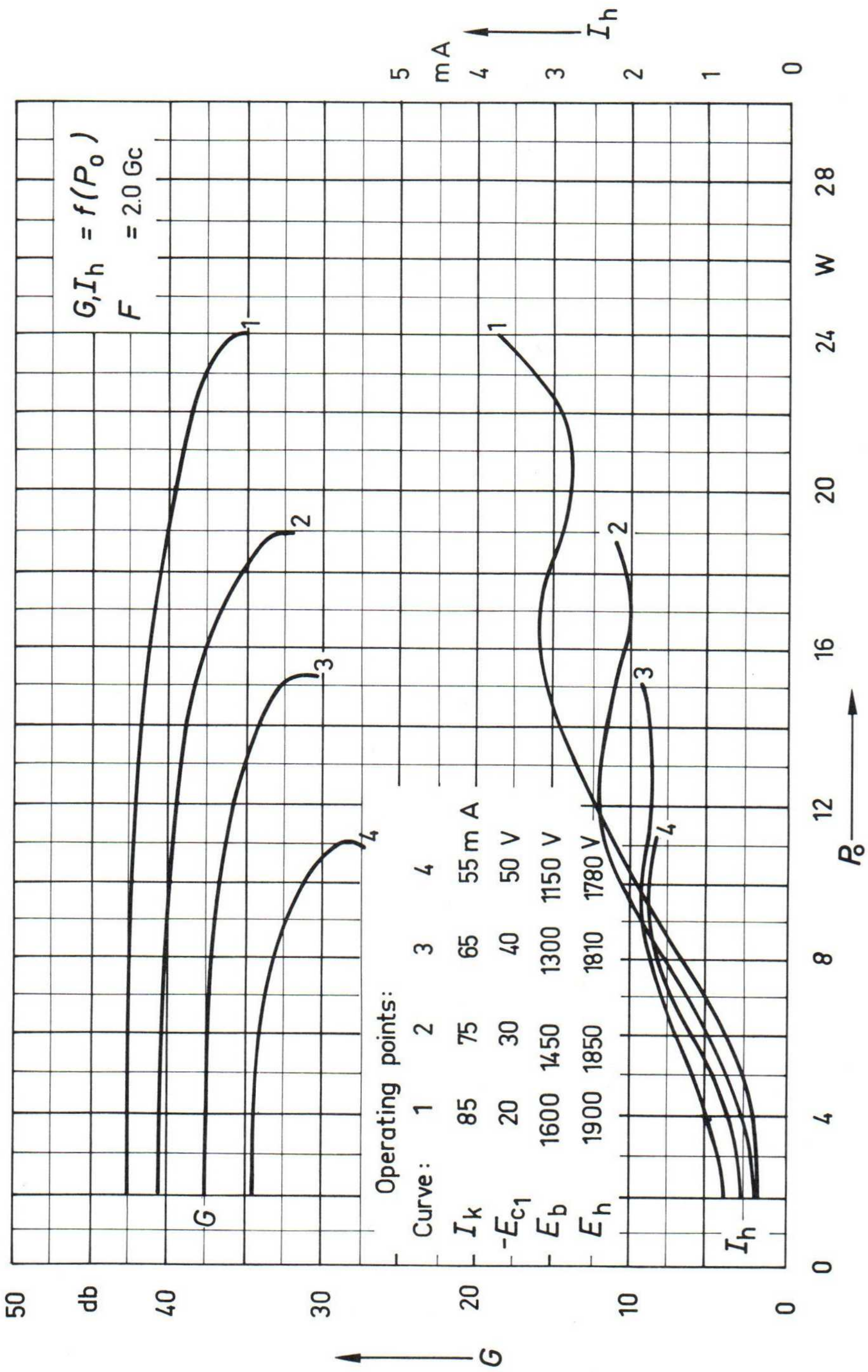



$G = f(I_k)$
F = 2.0 Gc
P_d = constant
P_o = 20 W
E_h = optimized in each case
E_h = 1900 V (opt. for I_k = 85 mA)
G
db
0
10
20
30
40
50
I_k
mA
30
40
50
60
70
80
90
100

Characteristics

$G = f(E_h)$




$G, I_h = f(P_o)$
$F = 2.0$ Gc
Operating points:
Curve: 1 2 3 4
I_k 85 75 65 55 mA
$-E_{c1}$ 20 30 40 50 V
E_b 1600 1450 1300 1150 V
E_h 1900 1850 1810 1780 V
G
I_h
db
mA
W
P_o
1
2
3
4
0 10 20 30 40 50
0 1 2 3 4 5
0 4 8 12 16 20 24 28

Characteristics

$G = f(P_o)$

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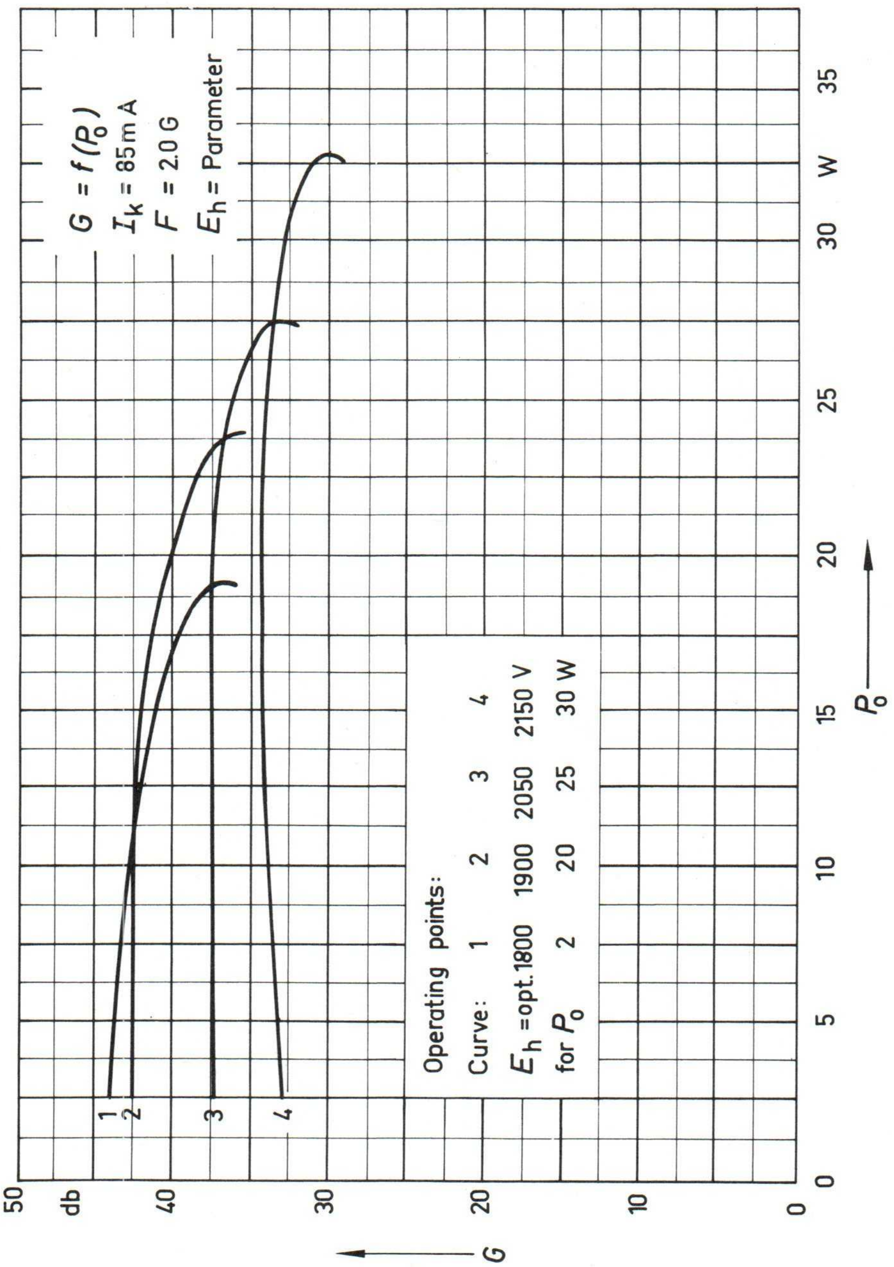
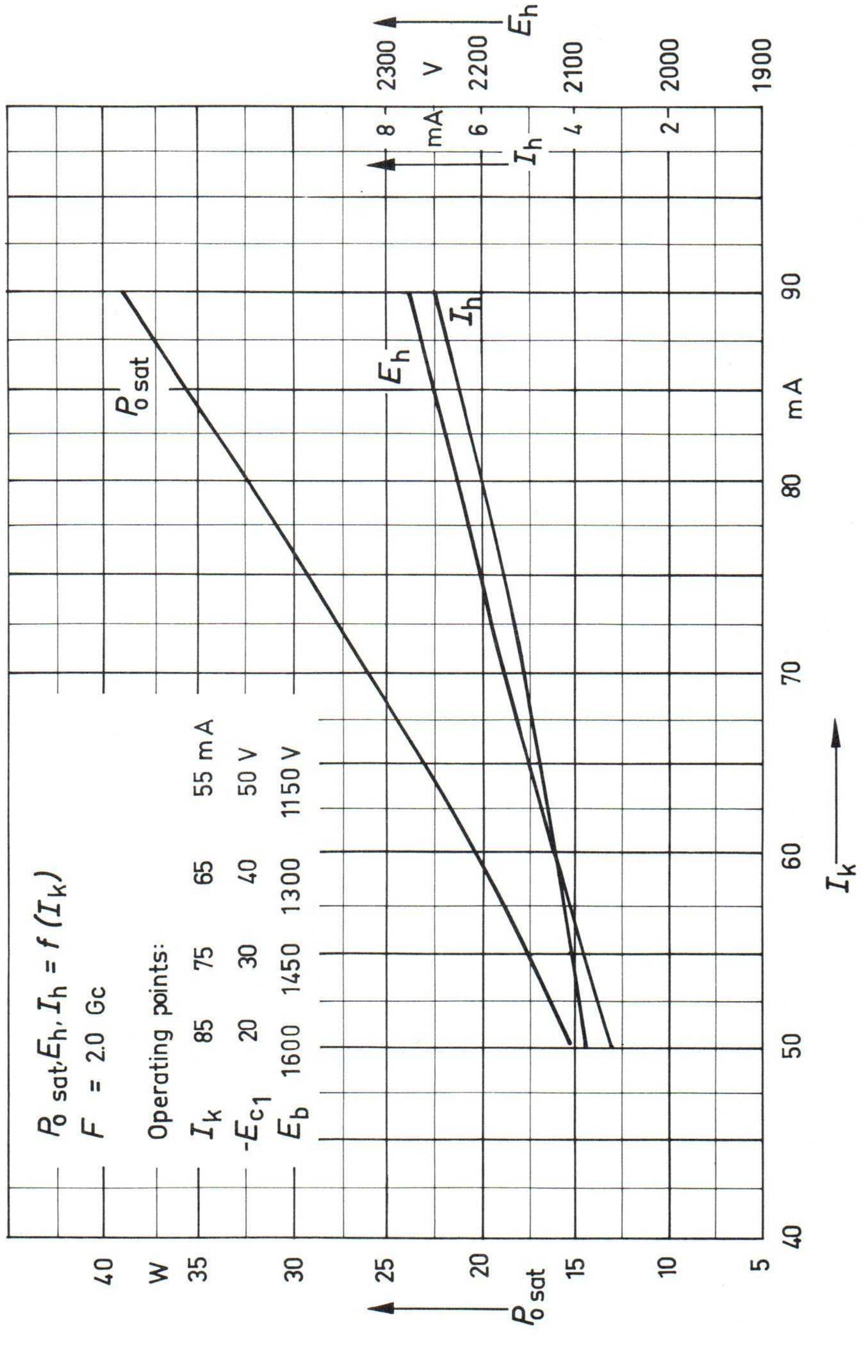
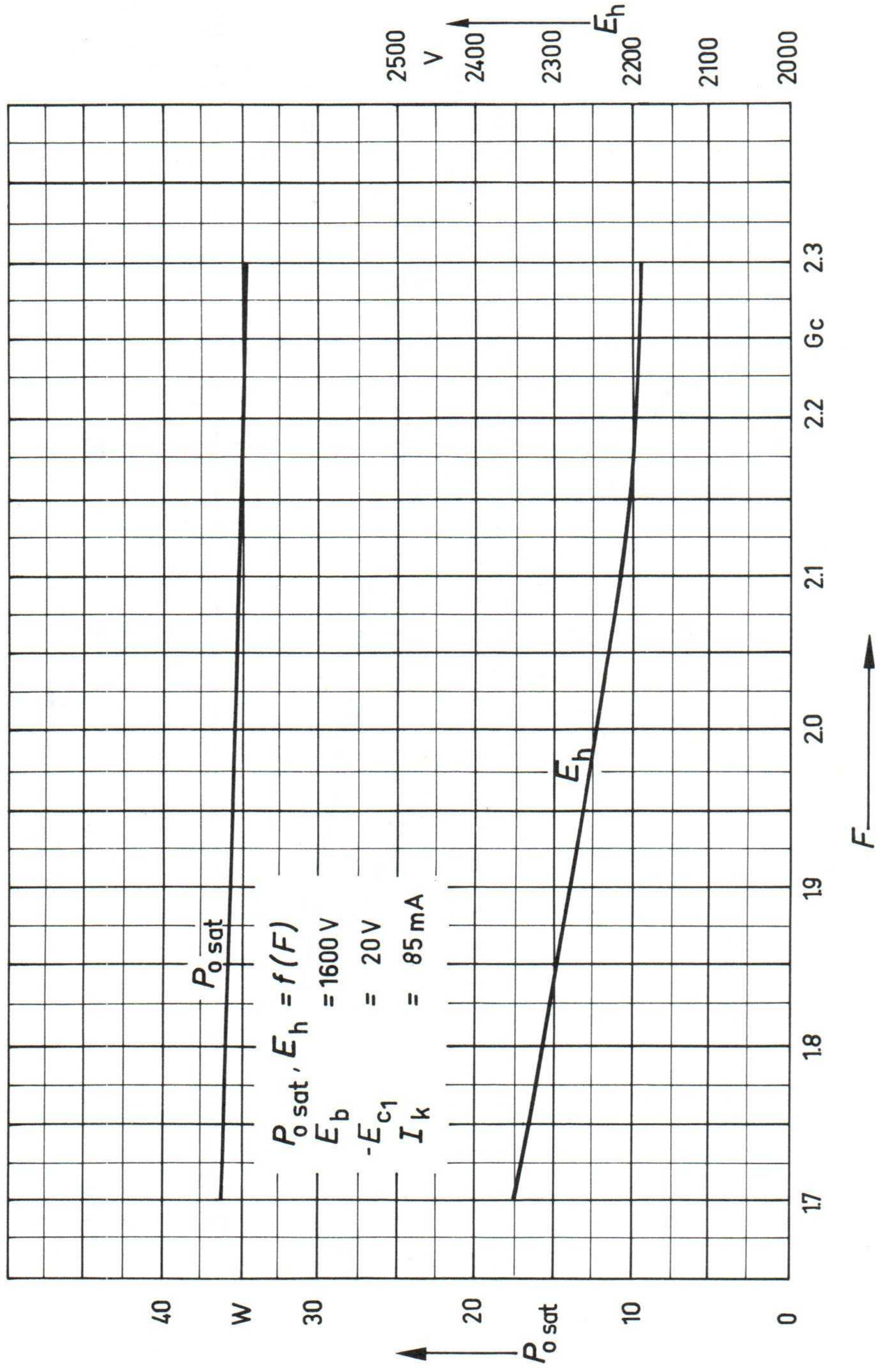
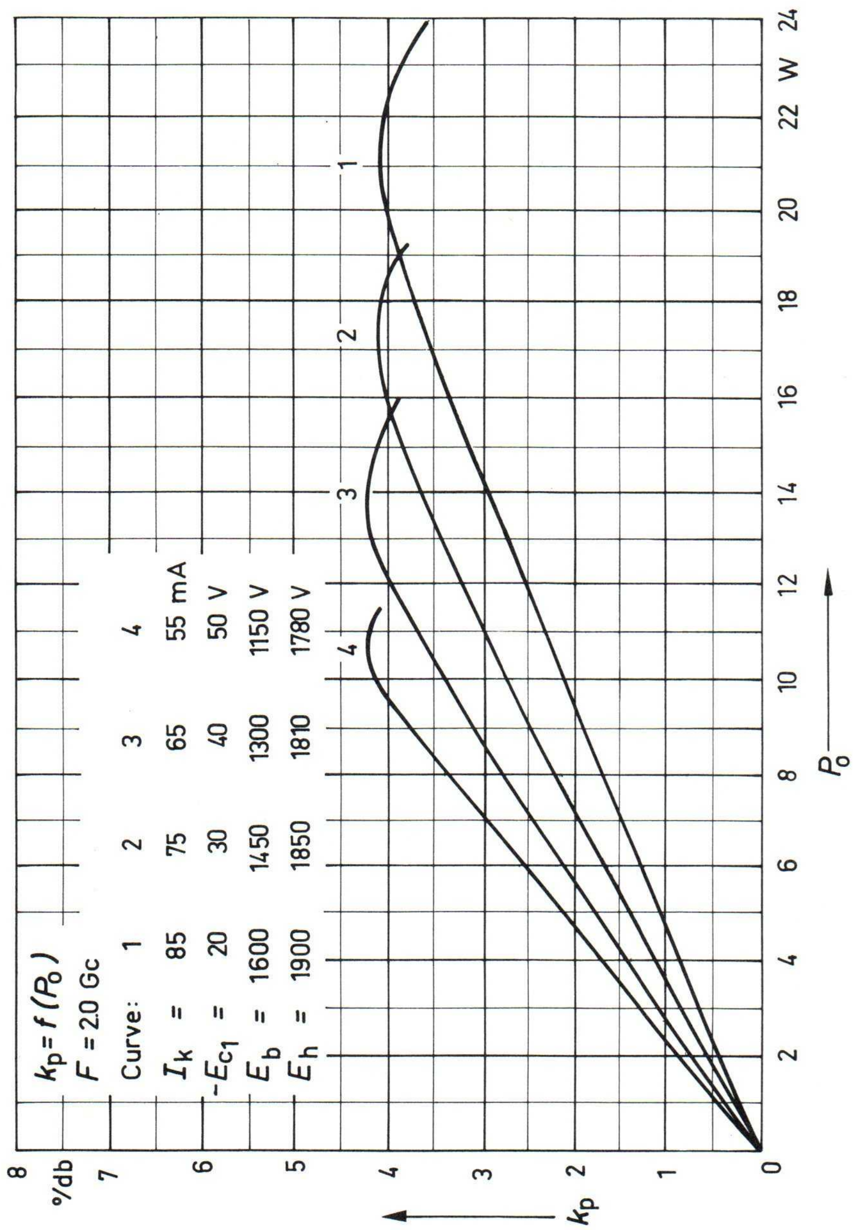


RöK 3506 E/1.2.67


$P_{o\,sat}, E_h, I_h = f(I_k)$
F = 2.0 Gc
Operating points:
I_k 85 75 65 55 mA
$-E_{c1}$ 20 30 40 50 V
E_b 1600 1450 1300 1150 V
$P_{o\,sat}$
E_h
I_h
W
V
mA
I_k


$P_{o\,sat}$, E_h = f (F)
E_b = 1600 V
$-E_{c1}$ = 20 V
I_k = 85 mA
$P_{o\,sat}$
E_h
2500
V
2400
2300
2200
2100
2000
40
W
30
20
10
0
1.7
1.8
1.9
2.0
2.1
2.2
Gc
2.3
F


kp = f (Po)
F = 2.0 Gc
Curve: 1 2 3 4
Ik = 85 75 65 55 mA
-Ec1 = 20 30 40 50 V
Eb = 1600 1450 1300 1150 V
Eh = 1900 1850 1810 1780 V
%/db
kp
Po
W

Characteristics

$K_p, c = f(E_h)$

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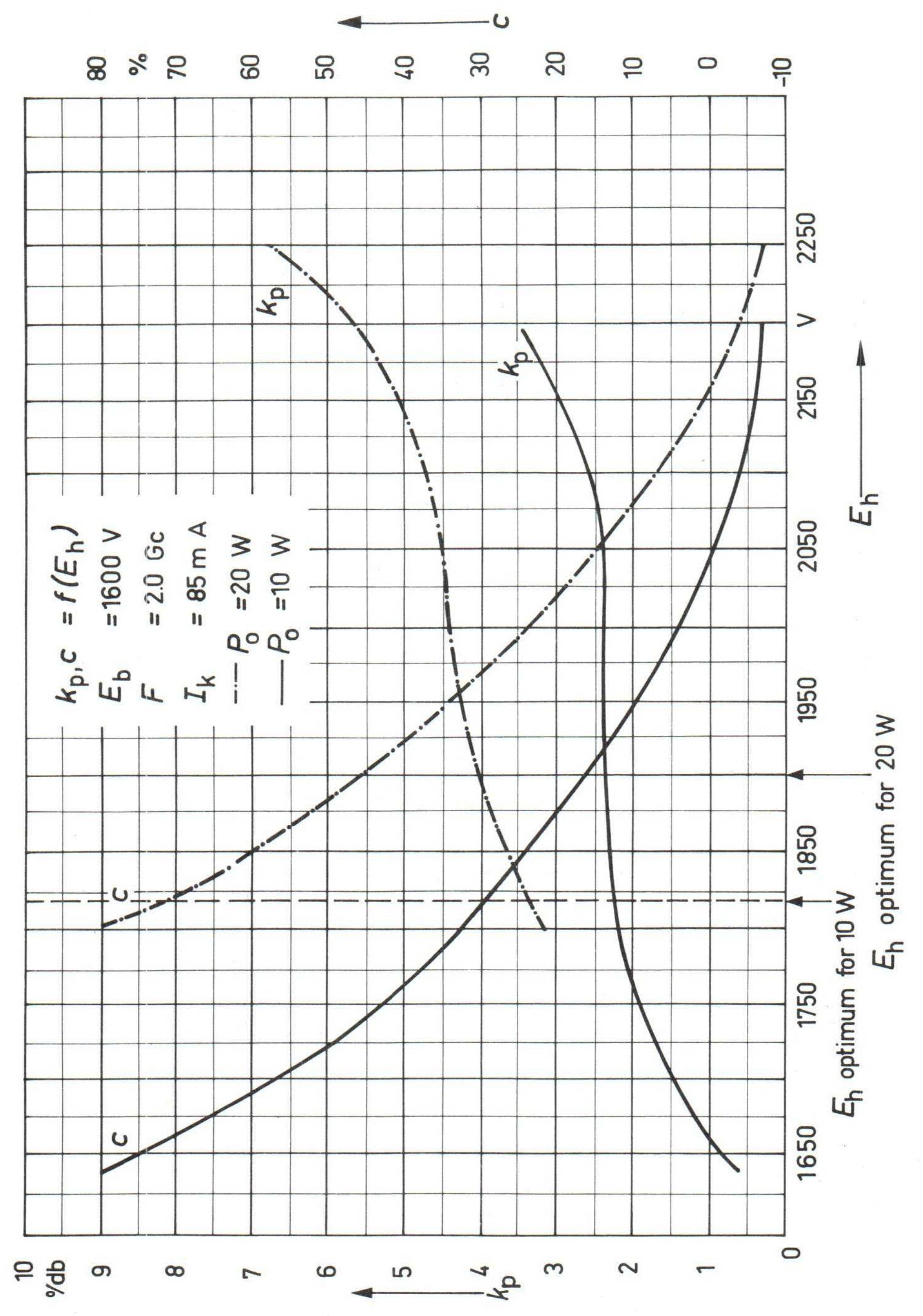
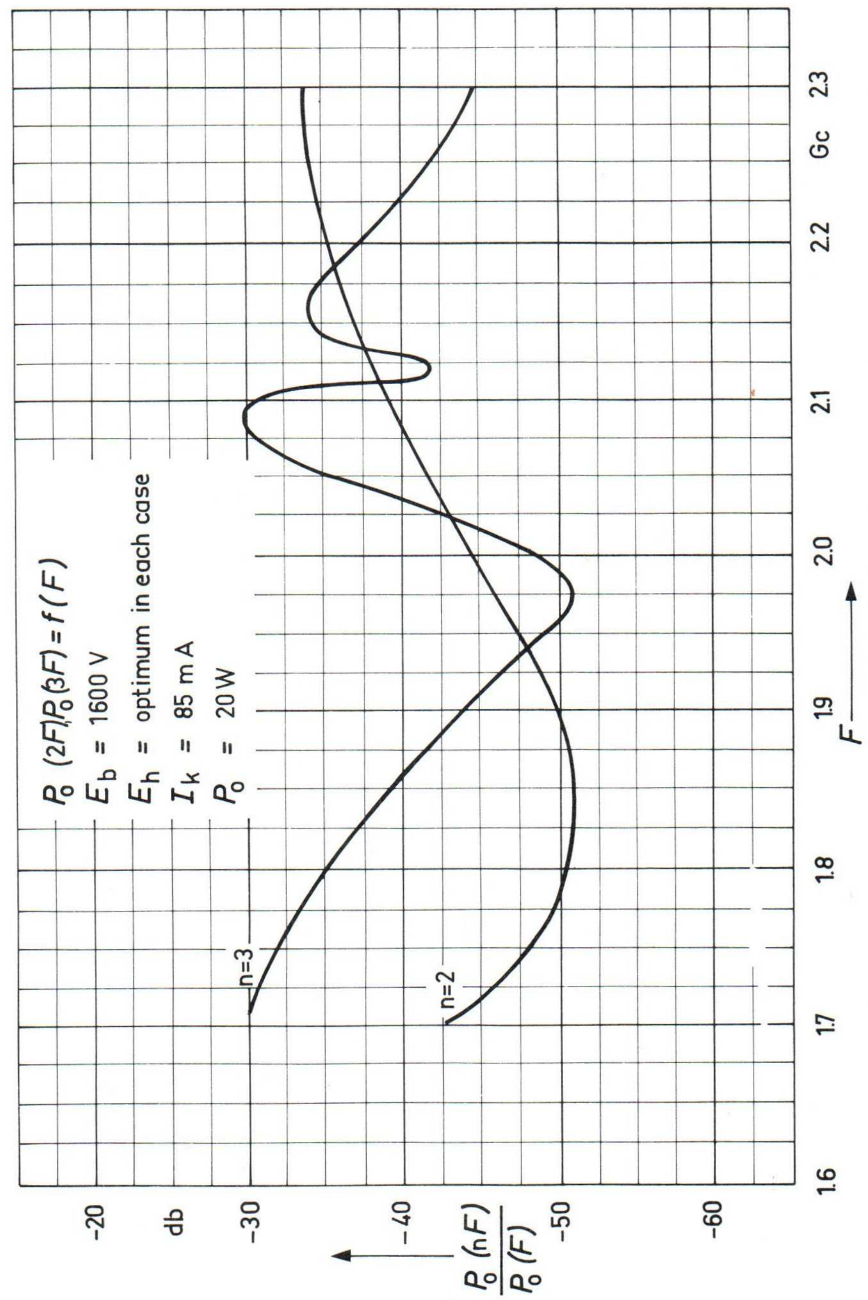


RöK 3506 E / 1.2.67

Characteristics

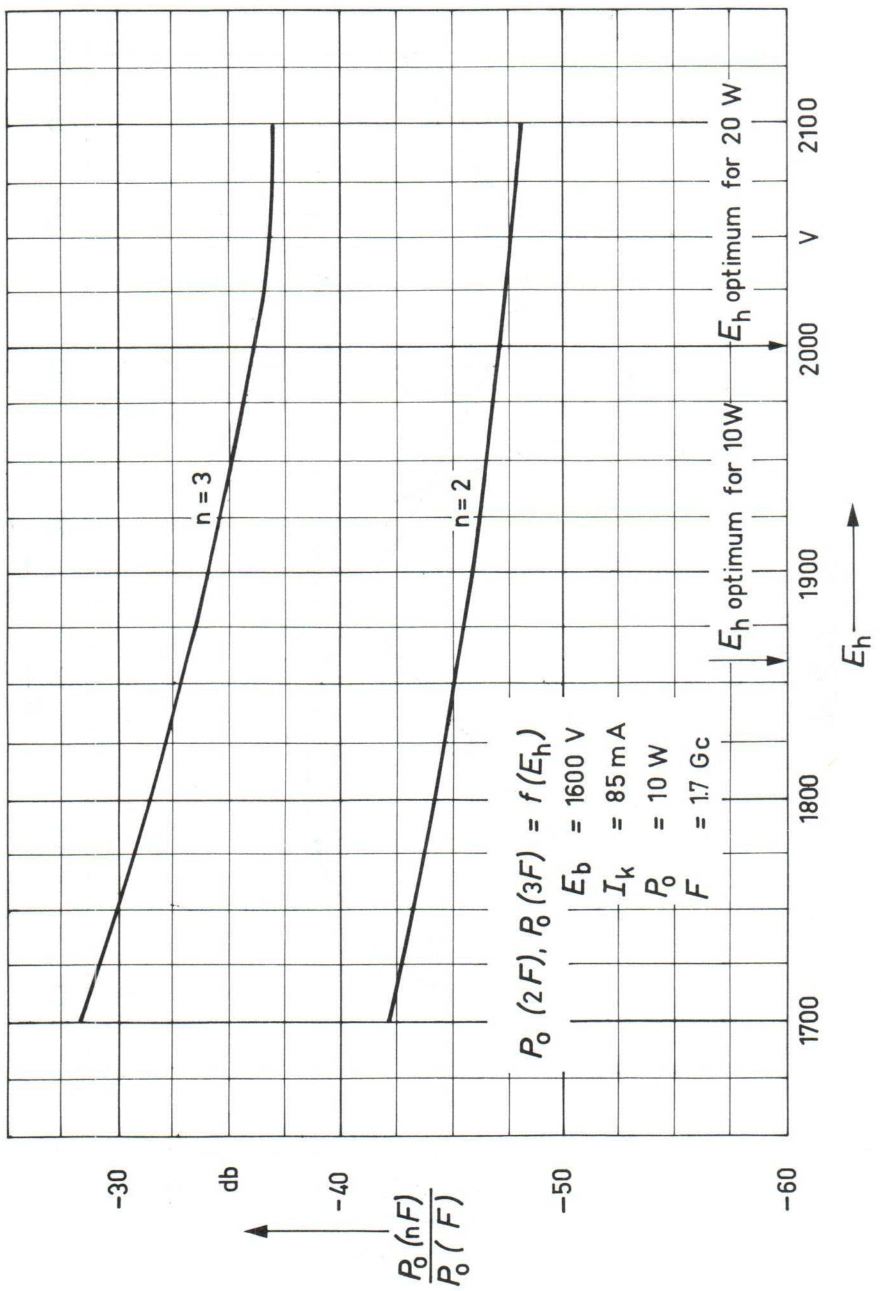
$$\frac{P_o\,(nF)}{P_o\,(F)} = f\,(F)$$



Characteristics

$$\frac{P_o\ (nF)}{P_o\ (F)} = f\ (E_h)$$

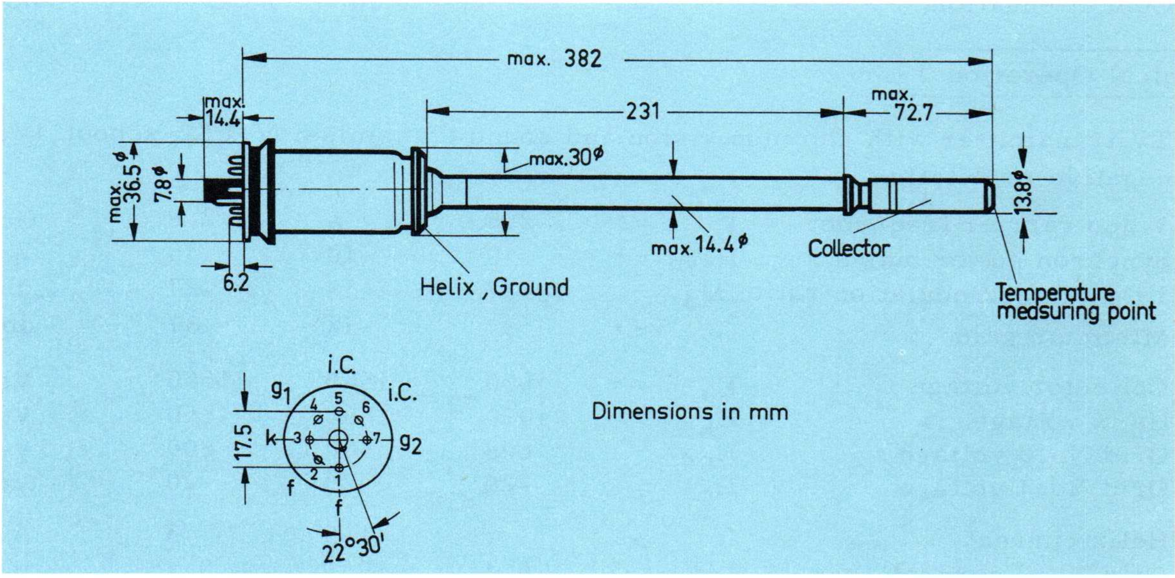
SIEMENS



S&H Sach-Nr.
Q00041-X3256

Design and Application

Power traveling wave tube for a frequency range from 2.4 to 2.8 Gc with an average saturation power output of 32 W and an average small-signal gain of 42 db. The tube is particularly suitable for use in tv transmission networks (school tv) and in broadband-telecommunication systems.
The tube is a periodic permanent magnet focused traveling wave tube and is a plug-in match in its associated magnet system. The magnet system has a particularly small leakage field. The tube is designed to operate with depressed collector.
Cooling may be effected by conduction or convection.
The rf input and output ports are designed for connection to coaxial cable.
The magnet system including the tube and the connections is provided with rf shielding.



Weight of magnet system	: approx. 12.5 kg (28 lbs)
Weight of tube	: approx. 200 gm net (7 ozs)
Dimensions of magnet system	: 100 x 130 x 384 mm without tube socket (4 x 5 1/8 x 15 ins)
Dimensions of the tube packing	: 170 x 170 x 560 mm (6 5/8 x 6 5/8 x 22 ins)
rf connector	: optional 50 Ω, N connector 3/7 or coaxial connection 7/16; 60 Ω, coaxial connection 3.5/9.5 or coaxial connection 6/16
Mounting position	: any (see cooling)

Heating

Heater voltage	E_f	=	6.3	Vac (1)
Heater current	I_f	≈	0.8	A ac
Preheating time	t_k	≧	2	min (2)

indirect by a.c., parallel supply
Metal capillary dispenser cathode

Characteristics

(f = 2.6 Gc, I_k = 85 mA)

			min.	nom.	max.	
Saturation power	P_{sat}	=	27	32		W
Small signal gain	G	=	39	42		db
Gain at 20 W CW	G	=	36	40		db
VSWR		=		1.35	1.85	(3)
Cold attenuation	α	=		80		db

Typical Operation I

TV transmitter with common vision and sound transmission (USA school tv), negative modulation

Video carrier frequency	F	=	2.6	2.6	2.6	Gc
Synchron power output	P_{syn}	=	10	10	16	W
3 tone intermodulation ratio	IM_3	=	-27	-30	-27	db (4)(5)
Minimum gain	G	=	37	38	37	db
Collector voltage	E_b	=	1600	1500	1500	Vdc
Helix voltage	E_h	=	1850	1850	1850	Vdc (6)
Grid No. 2 voltage	E_{c2}	=	600	600	600	Vdc
Grid No. 1 voltage	E_{c1}	=	-20	-20	-20	Vdc
Helix current	I_h	≈	1	1.5	3	mAdc (7)
Grid No. 2 current	I_{c2}	≦	0.1	0.1	0.1	mAdc
Cathode current	I_k	=	85	90	90	mAdc
Sync pulse compression		≦	30	20	30	%

(1) If the maximum variation of the heater voltage exceeds the absolute limits of ± 2 % the operating performance of the tube will be impaired and its life shortened.

(2) Once the tube has been operated at full voltages and currents, the preheating time for subsequent operation may be reduced to ≧ 45 sec.

(3) At input and output of cold tube in the frequency range 2.4 to 2.8 Gc

(4) These figures are valid for a difference in level between picture carrier (during sync pulses) and sound carrier of 10 db

(5) See page 3

(6) Helix voltage for optimal small signal gain + 100 V

(7) For black level CW output power approx. 50 % of the synchron output power

(5) The distortion of a tv signal produced by non-linear effects can be determined by passing a simulated tv signal consisting of unmodulated picture carrier F_v, sound carrier F_s and sideband F_{sb} through the traveling wave tube. The non-linear effects in the amplifier produce spurious frequencies within the tv channel and one of these, F_{sp} has a particularly large amplitude compared with any others within the channel and is therefore of concern. If the amplitudes of the 3 input frequencies are selected as indicated in fig. 1, the amplitude ratio between the frequencies F_{sb} and F_v corresponds to the white-to-black amplitude range of a tv signal. The frequency response of the television receiver used has been taken into account here, namely that the picture carrier is reduced by 6 db to the Nyquist flank.
A measure of the intermodulation products of interest is expressed by the difference in power output, in decibels, at the side-band frequency F_{sb} and the spurious frequency F_{sp}. This difference in level is given in the operating data as the 3 tone intermodulation ratio IM_3 and is referred to the sync power level at which the tube is operating. In fig. 1 and fig. 2 the sync power level is assumed to be 0 db.
Virtually the same information on intermodulation products produced by non-linear effects in the amplifier may also be obtained by using the 2 tone method. In this case the tube is driven by 2 unmodulated carriers of equal amplitude having frequencies F_1 and F_2, as shown in fig. 2. Of interest are the spurious frequencies $2\,F_1 - F_2$ and $2\,F_2 - F_1$ at the output, which are third order intermodulation products. The ratio, in decibels, of the power output at one of the spurious frequencies to the power output at one of the input frequencies gives the 2 tone intermodulation ratio IM_2, and is once again a typical measure of amplifier performance. This ratio is generally referred to the sync power level, which is 6 db above the input signals as shown in fig. 2.
A relationship between the 3 tone and 2 tone intermodulation ratios can be found mathematically and is also verifiable by experiment. This relationship depends on the difference in level between picture carrier (during sync pulses) and to sound carrier. If the difference is 7 db, as standardized in Europe, to a close approximation the formula $IM_3 = IM_2 + 3$ db is valid. It must be taken into account, that both IM_2 and IM_3 are negative values. If this difference is 10 db, the 2 tone and 3 tone intermodulation ratios are identical.

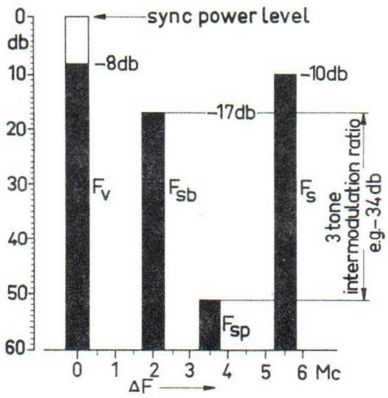


fig.1

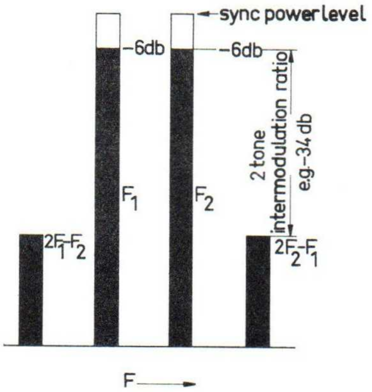


fig.2

Typical Operation II

Operating frequency	F	=	2.6	Gc
Power output	P_o	=	20	W (1)
Gain	G	≈	40	db
Collector voltage	E_b	=	1600	Vdc (2)
Helix voltage	E_h	≈	1800	Vdc
Grid No. 2 voltage	E_{c2}	≈	600	Vdc
Grid No. 1 voltage	E_{c1}	=	-20	Vdc (2,3)
Helix current	I_h	≈	3	mAdc
Grid No. 2 current	I_{c2}	≤	0.1	mAdc
Cathode current	I_k	=	85	mAdc (2)
Noise factor	NF	≈	25	db
AM/PM-conversion		≈	5	°/db (4)

Maximum Ratings (absolute values)

Collector supply voltage	E_{bb}	max	1900	Vdc
Collector voltage	E_b	max	1800	Vdc
Collector dissipation	P_p	max	150	W
Helix voltage	E_h	max	2200	Vdc
Helix voltage	E_h	min	1600	Vdc
Helix current	I_h	max	7	mAdc (5)
Helix dissipation	P_h	max	12	W
Grid No. 2 voltage	E_{c2}	max	900	Vdc
Grid No. 2 dissipation	P_{c2}	max	0.2	W
Grid No. 1 voltage	E_{c1}	min	-100	Vdc
Grid No. 1 voltage	E_{c1}	max	0	Vdc
Load VSWR		max	2	
Cathode current	I_k	max	100	mAdc
Collector temperature	T	max	270	°C (6)
Magnet system temperature	T	max	100	°C (7)
Ambient temperature	T_A	min	-20	°C
Ambient temperature	T_A	max	55	°C (8)

(1) The tube is designed to operate at reduced cathode current in applications requiring lower output. In such cases the manufacturer should be consulted.

(2) Setting value

(3) It is advisable to obtain the Grid No. 1 voltage by means of the cathode resistor.

(4) AM/PM-conversion is the rate of change of (1) the phase of the rf output voltage relative to the phase of the rf input voltage with respect to (2) the rf driving power at a constant value of rf output power. This is expressed in degrees per decibel.

(5) The helix current may rise momentarily to 10 mAdc due to power supply surges and during starting.

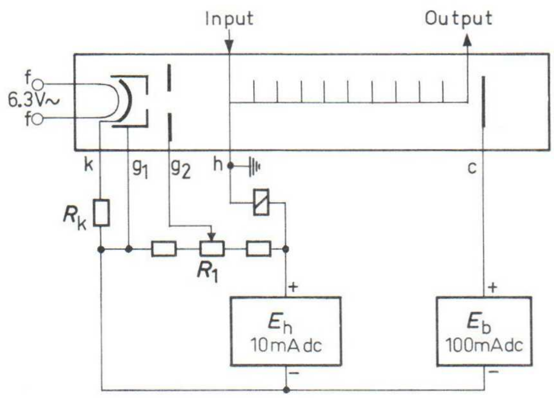
(6) Without rf signal, the temperature of the collector may rise for a short time (max. 3 days) up to 300 °C.

(7) Measured at the coax output. It may be necessary to remove the lacquer from the measuring point.

(8) See cooling, page 5.

Operating Instructions

The traveling wave tube RW 21 is operated in conjunction with a magnet system MRW 21. The advantages of the periodic permanent magnetic focusing of the RW 21 are the particularly small dimensions of the magnet system and an extremely small leakage field. The magnet system should only be mounted by way of the fixing holes provided for this purpose. The rf co-axial leads to the magnet system should be flexible to prevent any mechanical stress on the coax input and output of the magnet system.
All voltages applied to the tube are referred to the cathode. The voltage drop in the heater supply leads must be taken into account. The voltage must be set exactly 6.3 V at the socket. The total voltage drop in the normal connecting cable supplied (length 1.1 m) is 0.1 V.
The Grid No. 1 voltage can be obtained from the cathode resistor R_k.
The Grid No. 2 voltage must be variable between 500 ... 800 Vdc.
The Grid No. 2 voltage is tapped from a voltage divider R_1, the total resistance of which must not exceed 2.5 Meg.
The helix voltage must be variable between 1600 and 2000 Vdc. Stability and residual hum voltage depend upon the equipment requirements.
It is not necessary to stabilize the collector voltage but precautions must be taken to ensure that the maximum ratings, particular the admissible collector dissipation, are not exceeded.
When using a separate voltage source for Grid 2 precautions must be taken to ensure that this voltage is automatically switched off when the helix voltage fails. When collector voltage fails, the helix voltage and Grid 2 voltage must be automatically switched off (by means of a protection relay).



Cooling

To dissipate the heat from the collector the magnet system may either be provided with conduction cooling (MRW 21 a) or convection cooling (MRW 21 b)

Conduction cooling

The heat at the collector is conducted to two Cu-plates, mounted on two opposite sides of the magnet system. The heat (max. ca. 70 W per plate) must be conducted from these plates. The temperature of the plate must not exceed 115 °C in this case. The plates are insulated from the collector and can be earthed.

Conduction cooling

An air flow of approx. 100 l/min is required when the tube is operated according to the data on page 2. At reduced ratings the tube may be operated without additional cooling at an ambient temperature of 40 °C up to a collector dissipation of max. 65 W.
In this case the tube has to be mounted in horizontal position and a natural vertical air circulation is provided throught the radiator.

Starting

For safe handling of the equipment, the magnet system must be properly grounded.
The following describes the starting sequence:

1) Connection of dc-leads.
   The collector voltage is connected by means of a high voltage cable to the solder tag under the coverplate of the cooling system. (see page 8)
   The helix connection is soldered to the tag near the coax-output. (see page 8)
   The other voltages are applied to the tube via the supply cable.
   The individual leads are color-coded as follows:

Heater	f, f	:	brown, brown- yellow
Cathode	k	:	yellow
Grid No. 1	g_1	:	green, red *)
Grid No. 2	g_2	:	blue
Earth			black

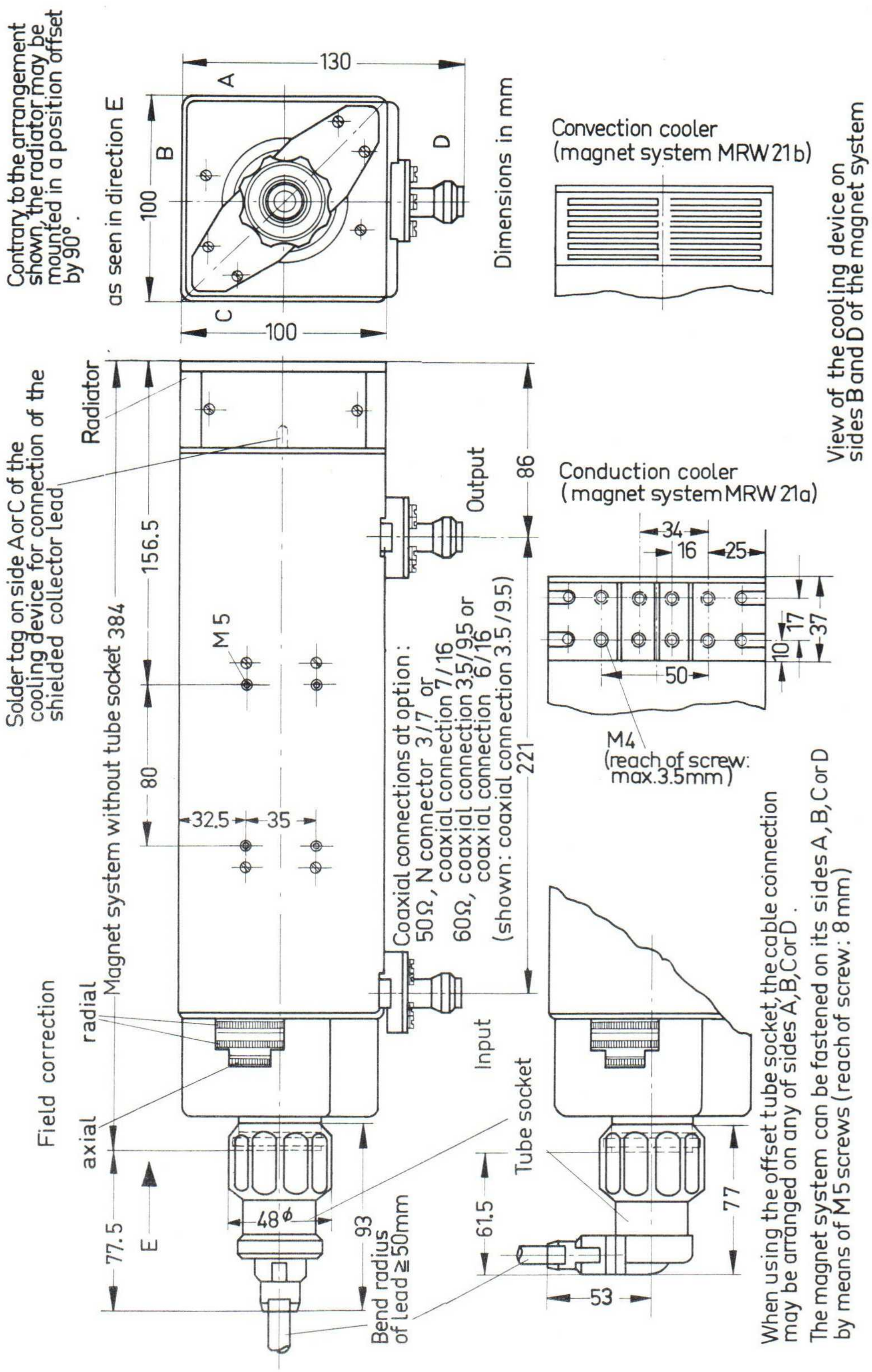
   *) connect green and red lead together

2) Unscrew the retaining nut and remove the connector socket.
3) Insert the tube in magnet system, push on tube socket and screw on nut until stop is reached. (avoid tilting the socket)
4) Apply heater voltage and preheat tube for at least 2 min.
5) Switch-on air cooling
6) Apply collector voltage
7) Switch-on helix and Grid No. 2 voltages simultaneously.
   The full voltages should be applied immediately and not increased gradually to full value.
8) Adjust cathode current by varying Grid No. 2 voltage
9) Adjust helix current to minimum with the aid of radial field correction (pair of rings at input end of magnet system) and axial field correction (additional at input end of magnet system).
10) Apply rf input signal and readjust helix voltage for optimum gain at specified power output.
11) Repeat field correction according to point 9

For interruption of operating up to 10 sec duration the tube may be switched on without preheating.

Switching off

The operating voltages can be switched off either simultaneously or in the reverse order to that in which they were applied.


Contrary to the arrangement shown, the radiator may be mounted in a position offset by 90°.
as seen in direction E
130
A
B
100
C
100
D
Dimensions in mm
Convection cooler (magnet system MRW 21b)
View of the cooling device on sides B and D of the magnet system
Solder tag on side A or C of the cooling device for connection of the shielded collector lead
Radiator
Output
86
156.5
Magnet system without tube socket 384
M5
80
32.5
35
Coaxial connections at option:
50 Ω, N connector 3/7 or coaxial connection 7/16
60 Ω, coaxial connection 3.5/9.5 or coaxial connection 6/16
(shown: coaxial connection 3.5/9.5)
221
Conduction cooler (magnet system MRW 21a)
34
16
25
50
10
17
37
M4 (reach of screw: max. 3.5mm)
Field correction
radial
axial
Input
Tube socket
77.5
E
48 ⌀
93
Bend radius of lead ≧50mm
61.5
53
77
When using the offset tube socket, the cable connection may be arranged on any of sides A, B, C or D.
The magnet system can be fastened on its sides A, B, C or D by means of M5 screws (reach of screw: 8mm)

Ordering Numbers for Traveling Wave-Tube RW 21 and Associated Elements

SIEMENS

Ordering numbers for traveling wave tube RW 21 and RW-connector sockets

Designation	Design		Ordering numbers	Fig.
Traveling wave tube RW 21			Q00041-X3256	
RW-connector socket	axial	standard cable length 1.2 m (1)	Q00081-X2321	1
RW-connector socket	bend in direction A		Q00081-X2322	2
RW-connector socket	bend in direction B		Q00081-X2323	2
RW-connector socket	bend in direction C		Q00081-X2324	2
RW-connector socket	bend in direction D		Q00081-X2325	2
RW-connector socket	axial	cable length as required(2)	Q00081-X2315	1
RW-connector socket	bend in direction A		Q00081-X2316	2
RW-connector socket	bend in direction B		Q00081-X2317	2
RW-connector socket	bend in direction C		Q00081-X2318	2
RW-connector socket	bend in direction D		Q00081-X2319	2

(1) 0.1 m of this length as free leads.
(2) When ordering please specify total length of cable and length of free leads.

Ordering numbers for magnet systems MRW 21

Designation	Design			Ordering numbers Q00043-X....				Fig.
	Cooling	Cooling in direct.	Collect. connect. at side	Coaxial connections				
				3.5/9.5	3/7 1)	7/16	6/16	
Magn.syst. MRW 21a11	Con-duction	B-D	A	2442	2451	2461	2471	3a
Magn.syst. MRW 21a12		B-D	C	2445	2455	2465	2475	3b
Magn.syst. MRW 21a21		A-C	D	2442	2452	2462	2472	3c
Magn.syst. MRW 21a22		A-C	B	2446	2456	2466	2476	3d
Magn.syst. MRW 21b11	Con-vection	B-D	A	2443	2453	2463	2473	3e
Magn.syst. MRW 21b12		B-D	C	2447	2457	2467	2477	3f
Magn.syst. MRW 21b21		A-C	D	2444	2454	2464	2474	3g
Magn.syst. MRW 21b22		A-C	B	2448	2458	2468	2478	3h

(1) N-connector

Form and direction of the connector socket

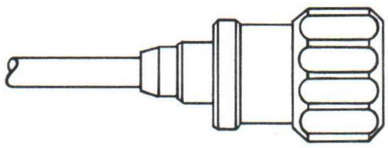


fig.1

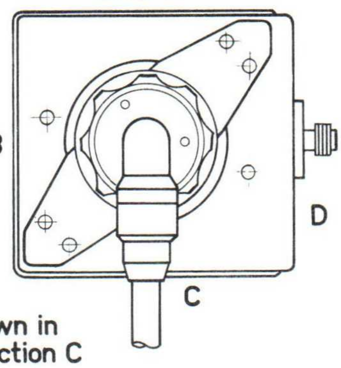


fig.2

The various arrangements of the cooler assembly and collector connection

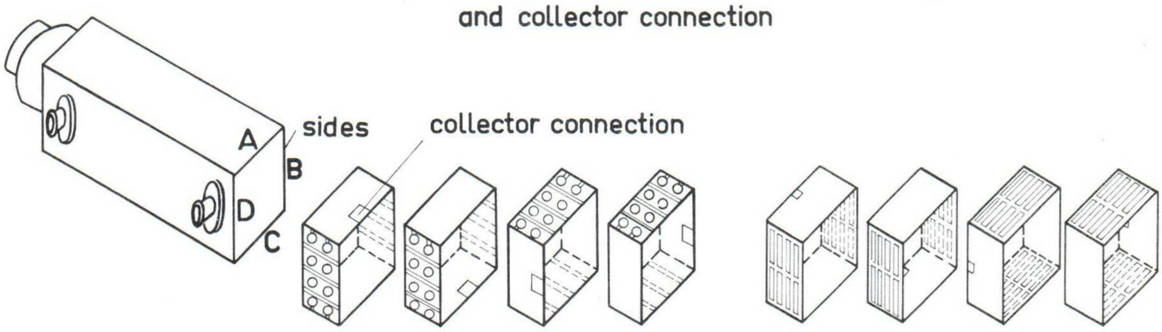
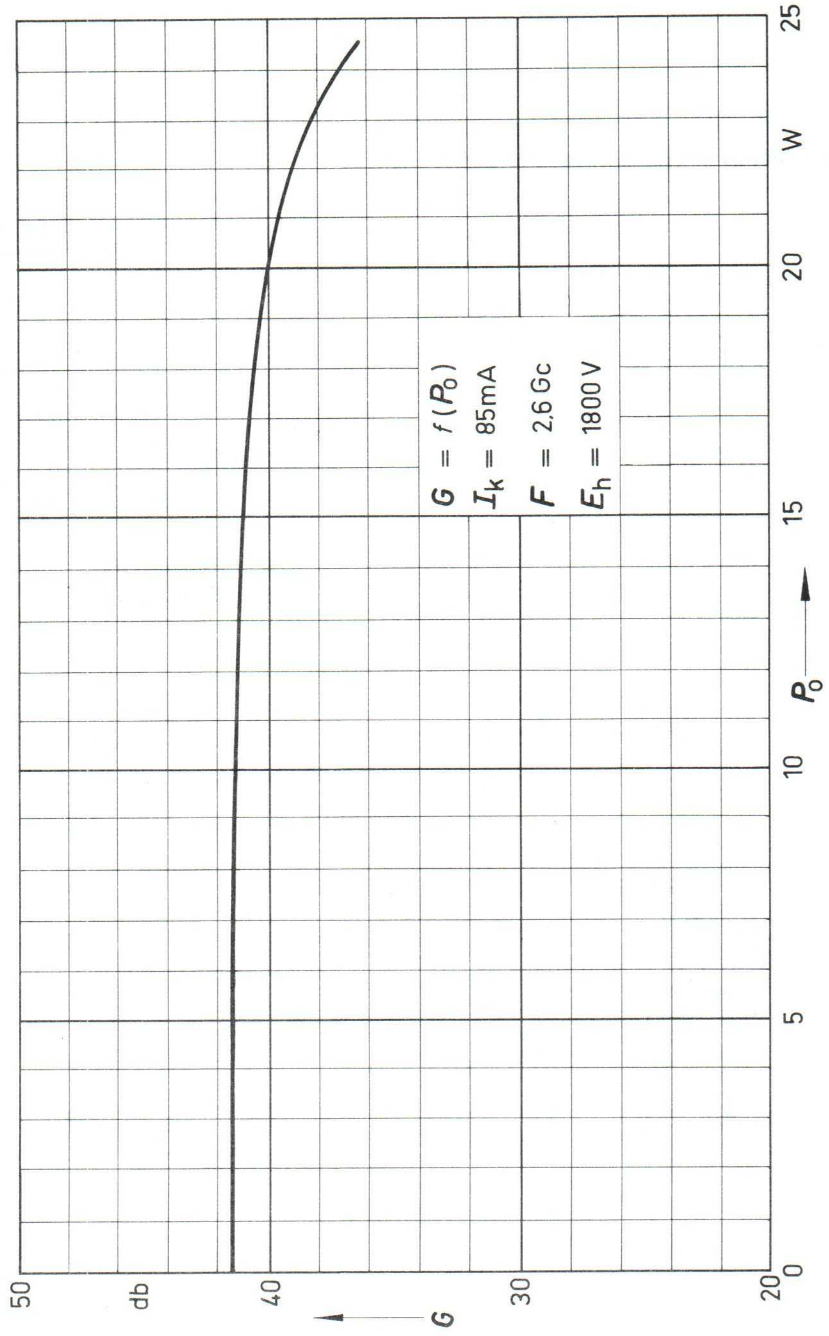
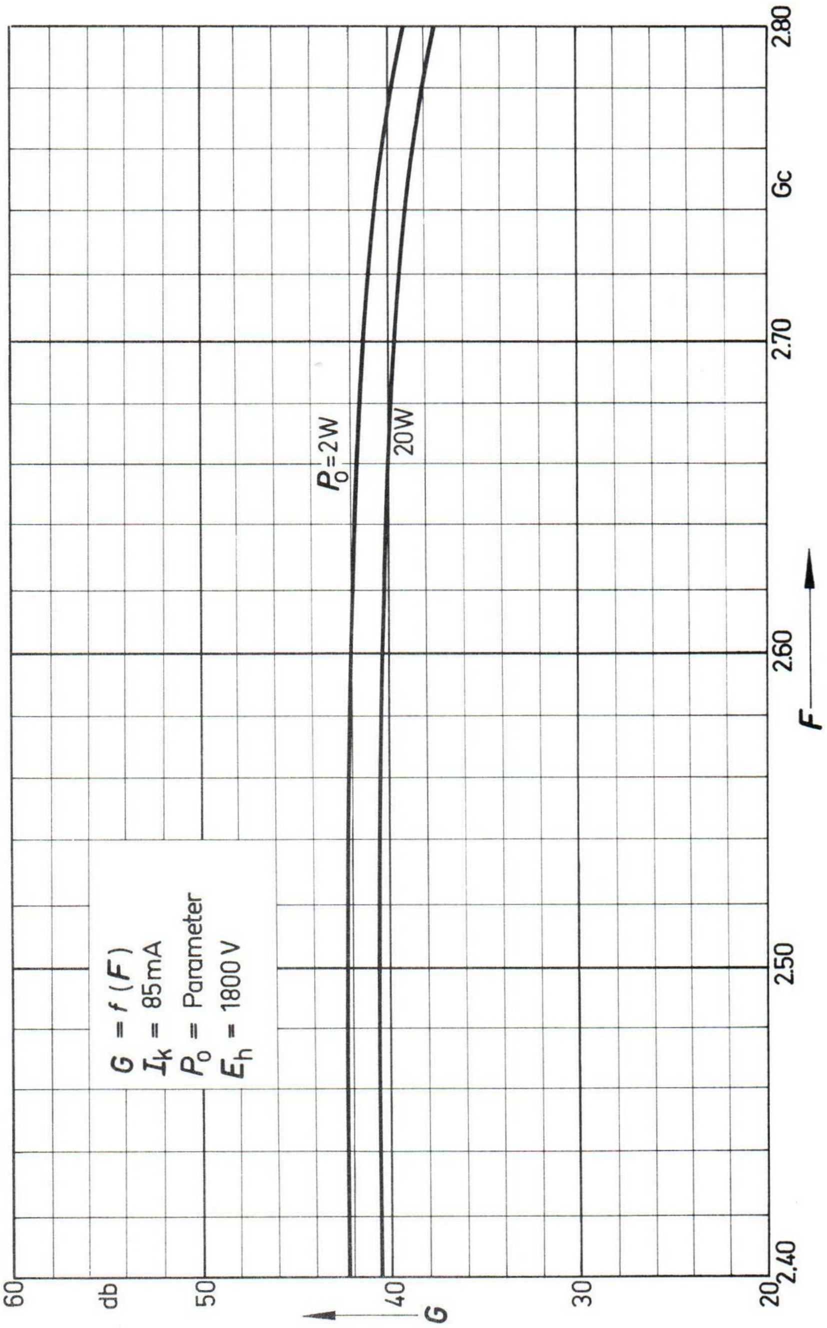


fig. 3a 3b 3c 3d 3e 3f 3g 3h

Characteristics

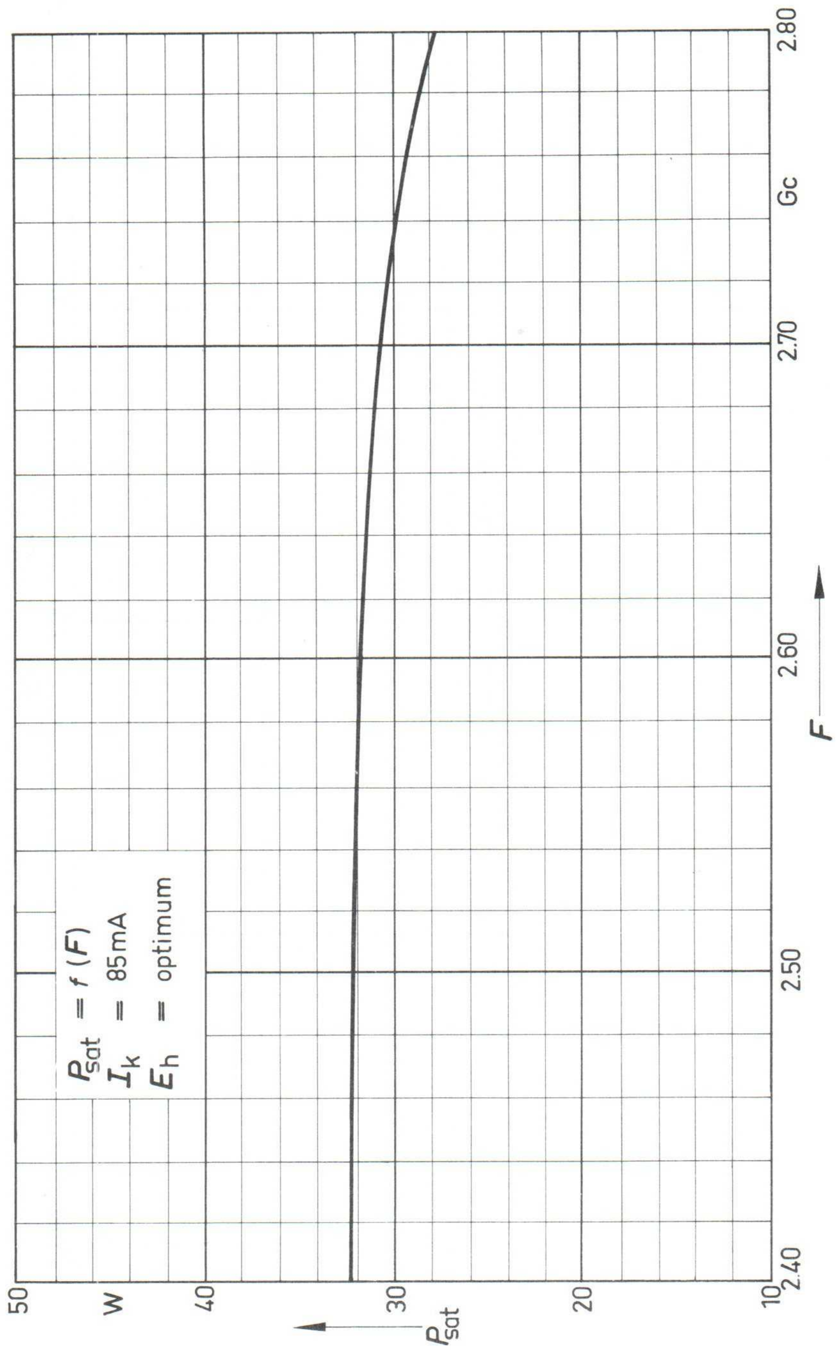
$G = f(P_o)$



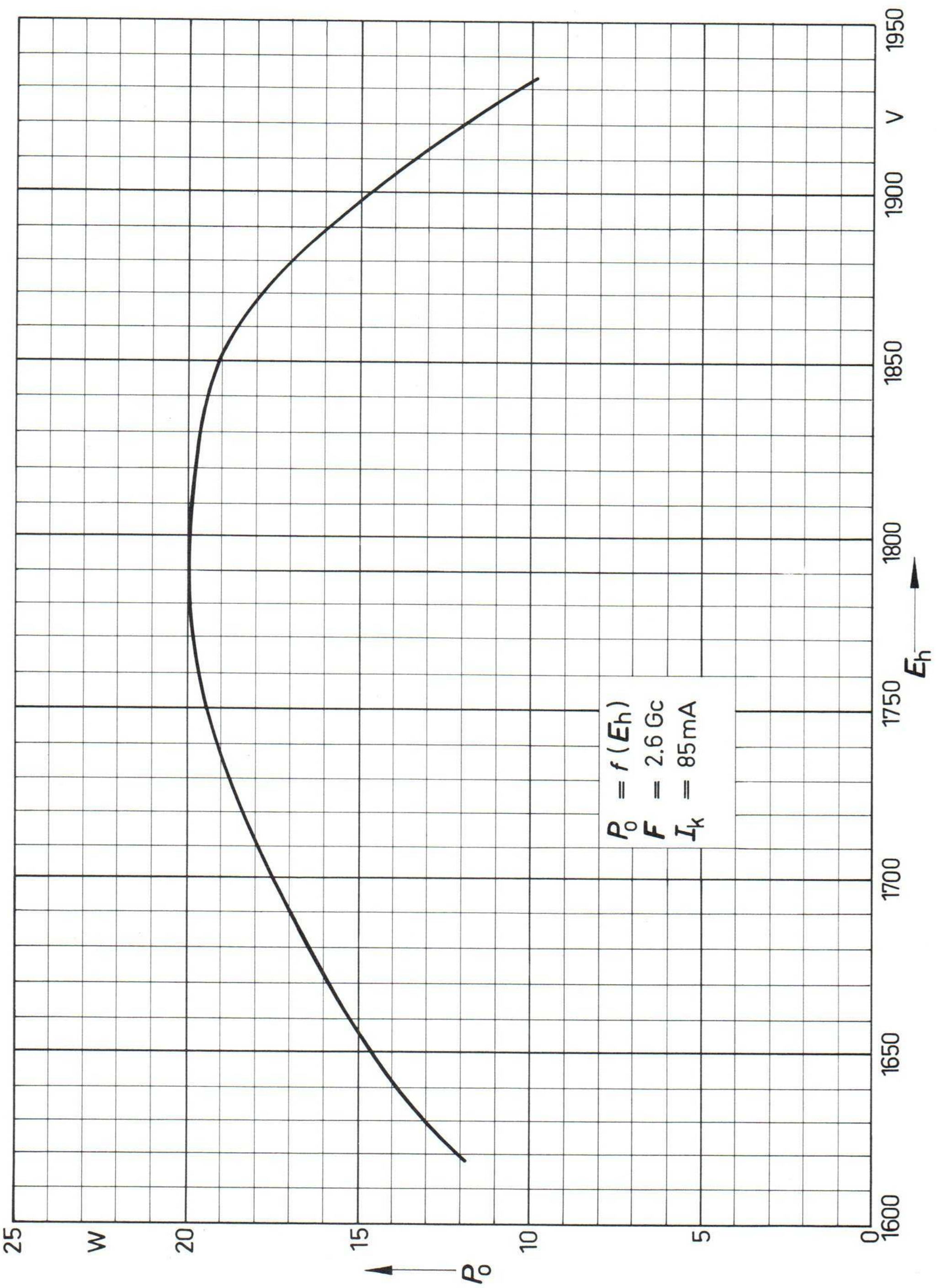

G = f (F)
I_k = 85 mA
P_o = Parameter
E_h = 1800 V
P_o = 2W
20W
60
db
50
40
30
20
G
2.40
2.50
2.60
2.70
2.80
Gc
F

Characteristics

$P_{sat} = f\ (F)$



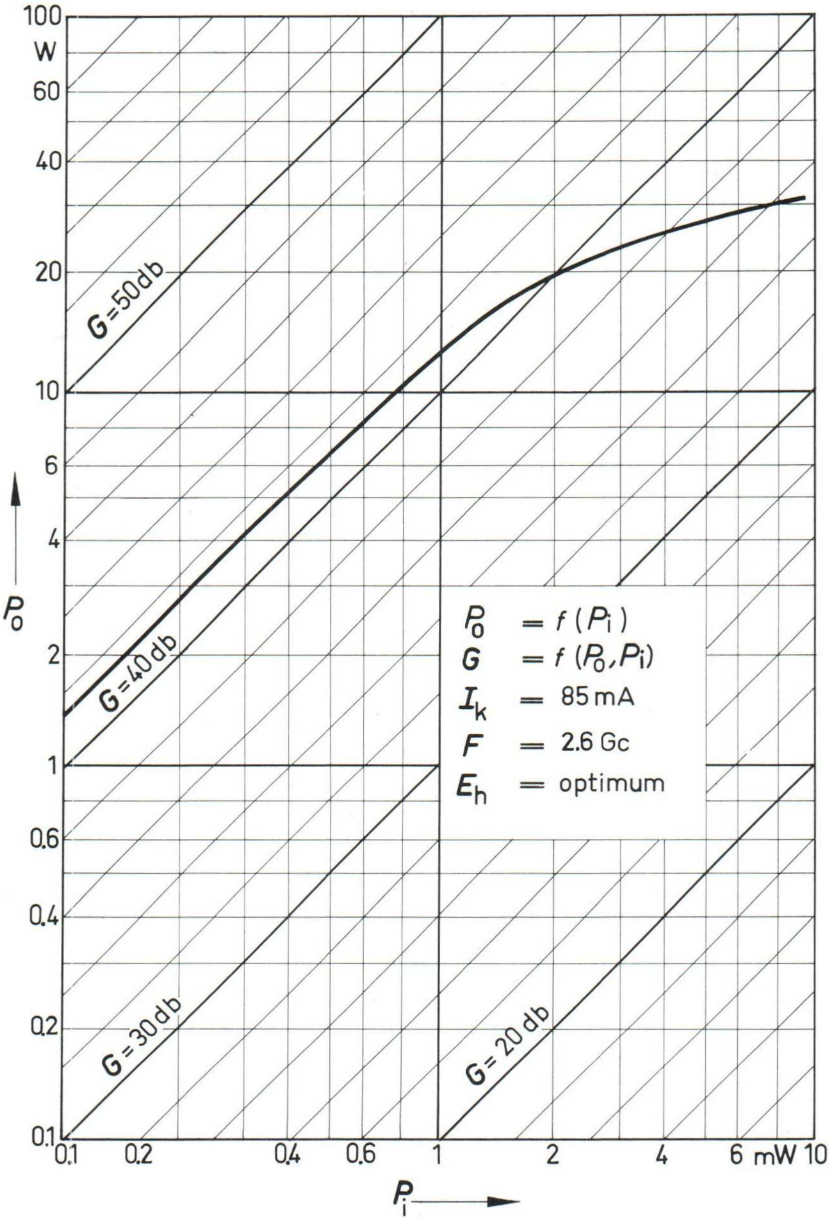
RöK 3515 E / 1.11.65


$P_o = f(E_h)$
$F = 2.6$ Gc
$I_k = 85$ mA
P_o
W
25
20
15
10
5
0
E_h
V
1600
1650
1700
1750
1800
1850
1900
1950

Characteristics

$P_o = f(P_i)$

SIEMENS



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WERNERWERK FÜR BAUELEMENTE
Printed in Germany

RöK 3515E / 1.11.65

SIEMENS

POWER TRAVELING WAVE TUBE

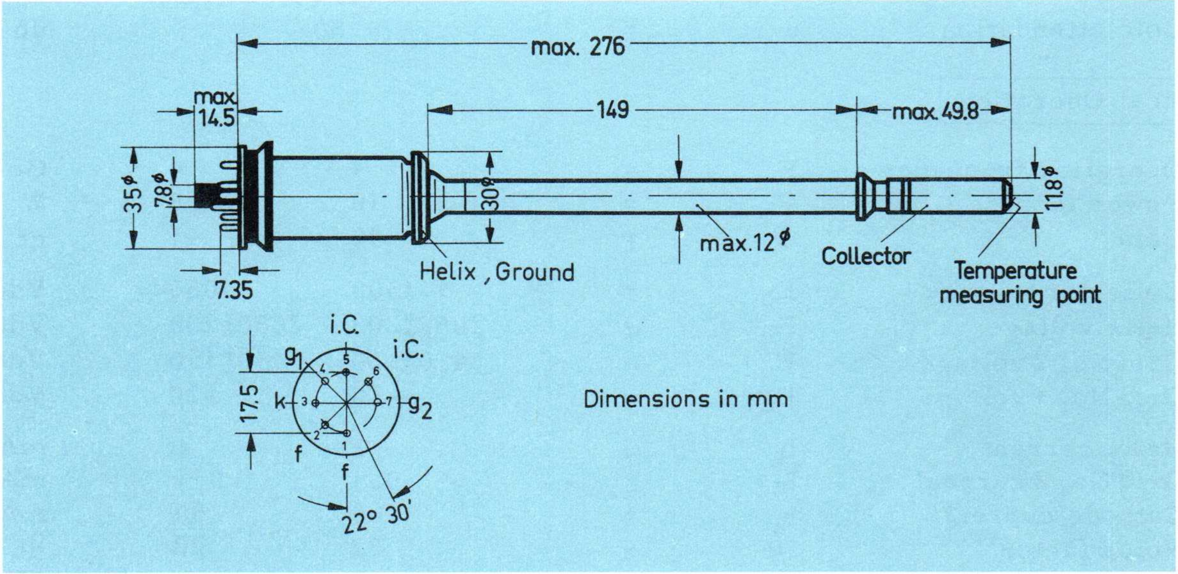
F = 3.6 to 4.3 Gc

RW 4

S&H-Sach-Nr.
Q00041-X3253

Design and Application

Power traveling wave tube especially designed for broadband radio relay systems with an average power output of 10 watts and an average gain of 40 db. The magnet system including the tube and the connections is provided with rf shielding. The RW4 is a periodic permanent magnet focused traveling wave tube and is a plug-in match in its associated magnet system MRW4. The magnet system has a particularly small leakage field. It is designed to operate with depressed collector.
The magnet system may be delivered by choice with a conduction cooler (MRW4a) or with a convection cooler (MRW4b).
The rf power is coupled in and out by way of waveguides.



Tube base:	special type
Weight of tube:	approx. 100 gm net
Weight of magnet system:	approx. 10 kg (22.05 lbs)
Dimensions of magnet system:	100 x 120 x 275 mm (without tube socket) 4" x 4 3/4" x 11"
Waveguide:	F 40, DIN 47302, 58.17 x 7 mm, 2.29" x 0.28"
Flange:	UGF 40, DIN 47303
Mounting position:	any (see cooling)
Dimensions of packing:	170 x 170 x 460 mm, 6.7"x6.7"x18.1"

Heating

Heater voltage	E_f	=	6.3	Vac (1)
Heater current	I_f	≈	0.8	Aac
Preheating time	t_k	≧	2	min (2)

indirect by ac, parallel supply
Metal capillary dispenser cathode

Characteristics

(F = 4.0 Gc, I_k = 60 mA)

			min	nom	max	
Pulse saturation power	P_{sat}	=	16	22		W
Low signal gain	G	=	38	42		db
Gain	$G(P_o=10W)$	=	36	40		db
VSWR		=		1.2	1.5	(3)
Cold attenuation	α	=		80		db

Typical Operation

Operating frequency	F	=	4	4	Gc
Power output	P_o	=	10	5	W
Gain	G	=	40	41	db
Collector voltage	E_b	=	1300	1050	Vdc (5)
Helix voltage	E_h	≈	2050±200	2050±200	Vdc (8)
Grid No. 2 voltage	E_{c2}	≈	450±150	450±150	Vdc (8)
Grid No. 1 voltage	E_{c1}	=	-20	-20	Vdc (5,6)
Helix current	I_h	≈	2	1	mAdc
Grid No. 2 current	I_{c2}	≦	0.1	0.1	mAdc
Cathode current	I_k	=	60	60	mAdc (5)
Noise factor	NF	≈	22	22	db
AM/PM conversion	k_p	≈	3		°/db (7)

All voltages are referred to the cathode

(1) If the maximum variation of the heater voltage exceeds the absolute limits of ± 2 % the operating performance of the tube will be impaired and its life shortened.
(2) Once the tube has been operated at full voltages and currents, the preheating time for subsequent operation may be reduced to ≧ 45 sec.
(3) At input and output of cold tube in the frequency range 3.6...4.3 Gc.
(4) For tube operation at lower power output levels than 10 W it is also possible to reduce the cathode current by adjusting the grid voltages.
(5) Setting values
(6) It is advisable to obtain E_{c1} by means of a cathode resistor.
(7) AM/PM conversion is the phase shift of the RF output signal when changing the input by 1 db.
(8) The spreads quoted are intended for use when designing the power supply.

Maximum Ratings

(absolute values)

Collector supply voltage	E_{bb}	max	1600	Vdc
Collector voltage	E_b	max	1500	Vdc
Collector dissipation	P_p	max	85	W
Helix voltage	E_h	max	2300	Vdc
Helix voltage	E_h	min	1800	Vdc
Helix current	I_h	max	6	mAdc
Peak helix current	i_h	max	8	ma (1)
Grid No. 2 voltage	E_{c2}	max	600	Vdc
Grid No. 2 dissipation	P_{c2}	max	0.2	W
Grid No. 1 voltage	$-E_{c1}$	max	100	Vdc
Grid No. 1 voltage	$+E_{c1}$	max	0	Vdc
Cathode current	I_k	max	70	mAdc
Load VSWR		max	2	
Collector temperature	T	max	270	°C (2)
Magnet system temperature	T	max	100	°C (3)
Ambient temperature	TA	min	-20	°C
Ambient temperature	TA	max	55	°C (4)

(1) During starting and due to power supply surges.

(2) Without rf signal, the temperature of the collector may rise for three days maximum up to 300 °C.

(3) Measured at the output waveguide flange. It may be necessary to remove the lacquer from the measuring point.

(4) See "cooling", page 4

Operating Instructions

The traveling wave tube RW 4 is operated in conjunction with its associated magnet system MRW 4. The advantages of the periodic permanent magnetic focusing of the RW 4 are the particularly small dimensions of the magnet system and an extremely low leakage field. The sensitivity to temperature changes is low.

The magnet system should only be mounted by way of the fixing holes provided for this purpose. With operation in radio link systems, directional couplers should be connected to the tube input and output to avoid distortion due to multiple reflexions. The rf waveguide to the magnet system should be flexible to prevent any mechanical stress on the input and output ports of the magnet system.

All voltages applied to the tube are referred to the cathode.

The voltage drop in the heater supply leads must be taken into account.

The voltage must be set such that it is exactly 6.3 V at the socket. When using the standard cable of 1.1 m length supplied with the connector socket the total voltage drop is 0.1 V.

The Grid No. 1 voltage can be obtained from a cathode resistor R_k. The Grid No. 2 voltage must be variable within the range quoted. It is tapped from a voltage divider R_1, the total resistance of which must not exceed 2.5 Meg.

Stability and residual hum voltage (helix voltage) depend upon the equipment requirements.

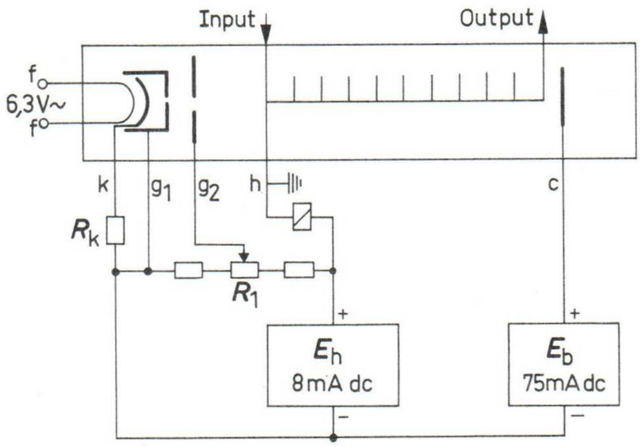
The collector voltage need not be stabilized, but it must not fall more than 50 Vdc below the indicated operating value.

A protective relay must be inserted in the helix supply circuit to disconnect the helix and Grid No. 2 voltage, when the maximum permissible helix current is exceeded.

When using an independent voltage source for Grid No. 2, the voltage must be automatically switched off immediately if the helix voltage fails.

This may be achieved by interlocking the protection circuits.

When the collector voltage fails, the helix voltage and Grid No. 2 voltage must be disconnected either by the overload relay in the helix circuit or by a voltage interlocking system.



Cooling

To dissipate the heat from the collector the magnet system may either be provided with conduction cooling (MRW 4a) or convection cooling (MRW 4b).

Conduction Cooling

The heat dissipated by the collector is conducted to two Cu-plates, mounted on two opposite sides of the magnet system. The heat (max. 40 W per plate) must be conducted from these plates. The temperature of the plate must not exceed 115 °C in this case. The plates are insulated from the collector and can be earthed.

Convection Cooling

At ambient temperatures up to +55 °C the forced air cooling can be achieved by using a chimney provided the magnet system is mounted horizontally and air circulates naturally in a vertical direction through the radiator on the magnet system. This chimney should have a cross section of 50 x 100 mm and a height of 800 mm. If the magnet system is mounted other than horizontally, additional cooling by a weak forced air stream is necessary. In this case, the deciding factor is the admissible collector temperature which should not exceed the absolute maximum limit of 270 °C.

Starting

For safe handling of the equipment, the magnet system must be properly grounded. For this purpose a solder tag is provided near the output port, see page 6.

1. Connect of supply leads. (initial starting).
   The collector voltage is connected by means of an e.h.t. cable to the solder tag under the coverplate of the cooling system (see page 6). The helix connection is soldered to the tag near the output port (see page 6).
   The other voltages are applied to the tube via the supply cable. The individual leads are color-coded as follows:

Heater	f,f	:	brown, brown-yellow
Cathode	k	:	yellow
Grid No. 1	g_1	:	green, red *)
Grid No. 2	g_2	:	blue
Earth		:	black

*) connect green and red lead together!

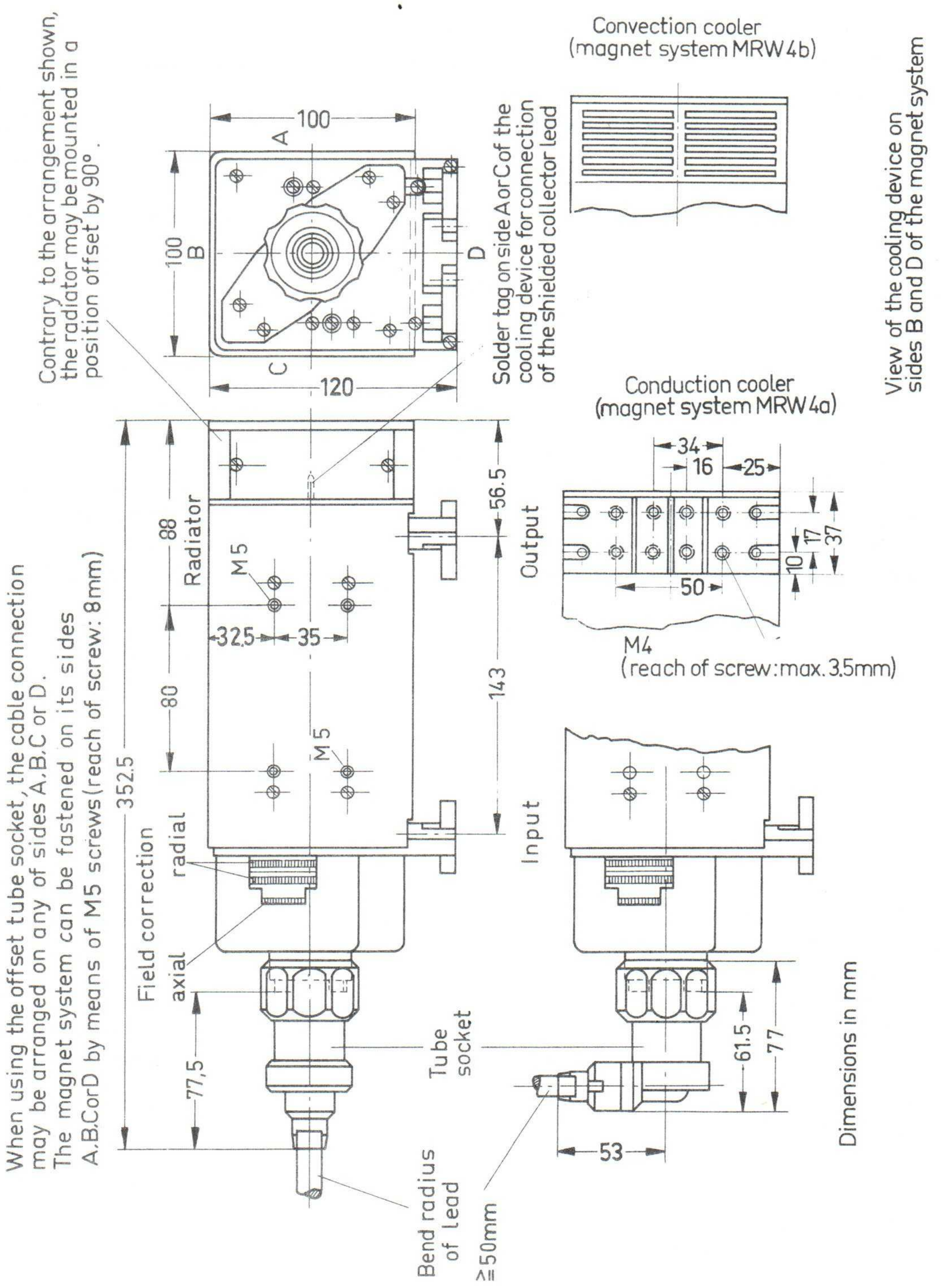
2. Unscrew the retaining nut.
3. Insert the tube in magnet system, push on tube socket and screw on nut until stop is reached (avoid tilting the socket).
4. Apply heater voltage and preheat tube.
5. Apply collector voltage.
6. Switch-on helix and Grid No. 2 voltages simultaneously (the time difference between applying the voltages to both electrodes must not exceed 0.2 sec). Make sure that full voltages are applied immediately and not increased gradually to full value.
7. Adjust cathode current by varying Grid No. 2 voltage.
8. Adjust helix current to minimum with the aid of radial field correction (pair of rings at input end of magnet system) and axial field correction (additional single ring at input end of magnet system).
9. Apply rf input signal and readjust helix voltage for optimum gain at specified power output.
10. Repeat field correction according to point 8.

For interruption in operation up to 10 sec duration the tube may be switched on without preheating.

Switching off

The operating voltages can be switched off either simultaneously or in the reverse order to that in which they were applied.

Magnet System MRW 4



The various arrangements of the cooler assembly and collector connection

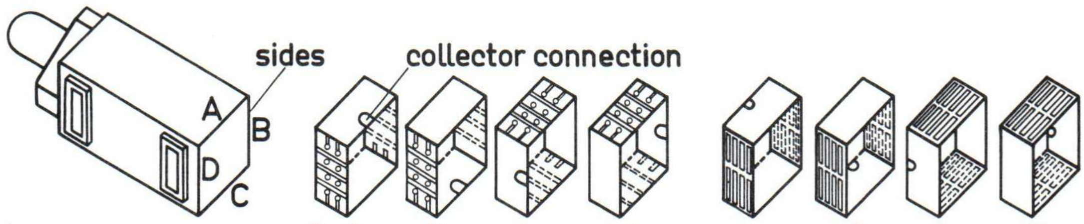


fig.1a 1b 1c 1d 1e 1f 1g 1h

Form and direction of the connector socket

fig.2

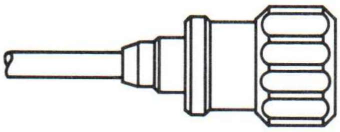
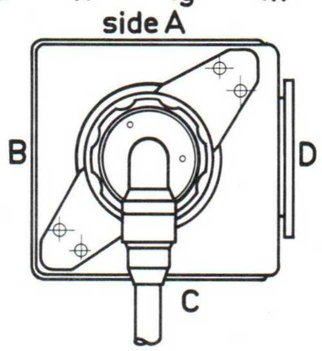


fig.3 shown in direction C



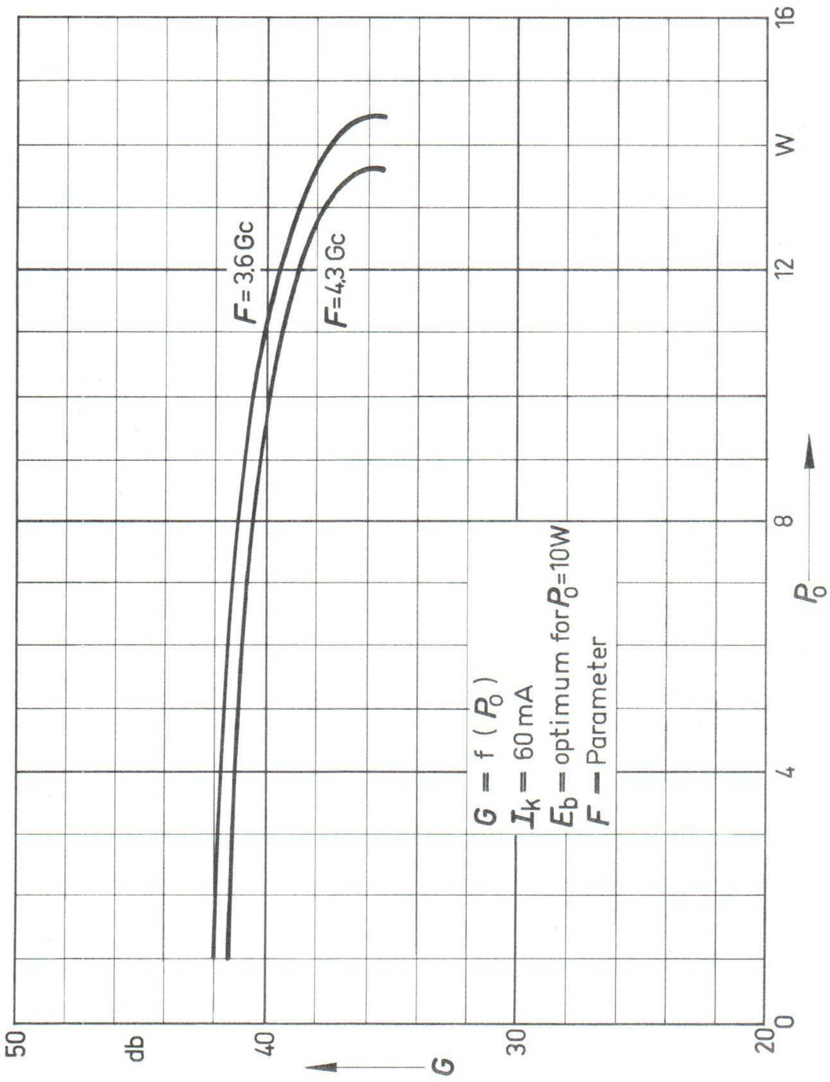
Ordering numbers for traveling wave tube RW 4 and associated elements

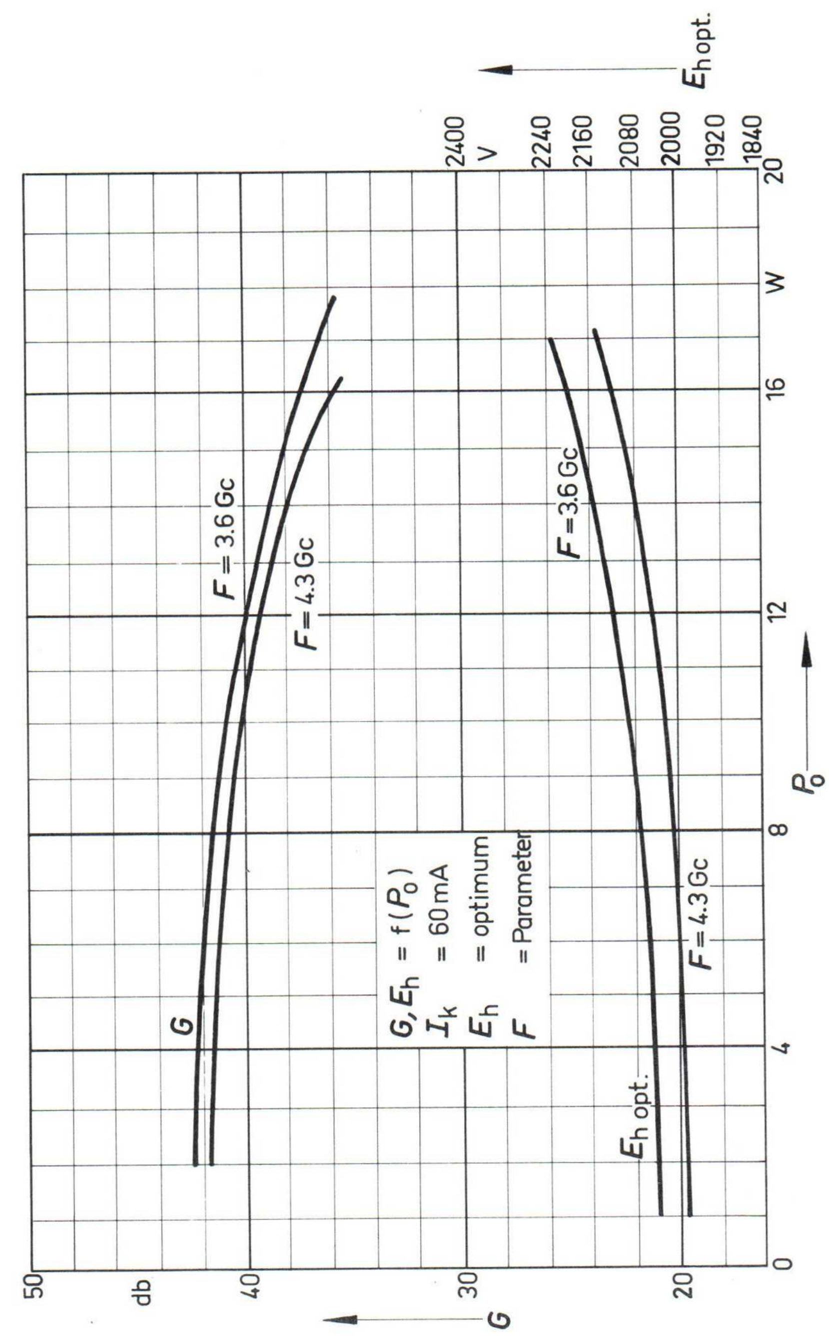
Designation	Design			Ordering numbers	fig.
	Cooling	Cooling in direct.	Collector connection at side		
Traveling wave tube RW 4				Q00041-X3253	
Magn.syst.MRW 4 a 11	Conduction	B-D	A	Q00043-X2321	1a
Magn.syst.MRW 4 a 12	Conduction	B-D	C	Q00043-X2325	1b
Magn.syst.MRW 4 a 21	Conduction	A-C	D	Q00043-X2322	1c
Magn.syst.MRW 4 a 22	Conduction	A-C	B	Q00043-X2326	1d
Magn.syst.MRW 4 b 11	Convection	B-D	A	Q00043-X2323	1e
Magn.syst.MRW 4 b 12	Convection	B-D	C	Q00043-X2327	1f
Magn.syst.MRW 4 b 21	Convection	A-C	D	Q00043-X2324	1g
Magn.syst.MRW 4 b 22	Convection	A-C	B	Q00043-X2328	1h
RW-connector socket	axial			Q00081-X2321	2
RW-connector socket	bend in direction A		standard cable length 1.2 m (1)	Q00081-X2322	3
RW-connector socket	bend in direction B		standard cable length 1.2 m (1)	Q00081-X2323	3
RW-connector socket	bend in direction C		standard cable length 1.2 m (1)	Q00081-X2324	3
RW-connector socket	bend in direction D		standard cable length 1.2 m (1)	Q00081-X2325	3
RW-connector socket	axial			Q00081-X2315	2
RW-connector socket	bend in direction A		cable length as required (2)	Q00081-X2316	3
RW-connector socket	bend in direction B		cable length as required (2)	Q00081-X2317	3
RW-connector socket	bend in direction C		cable length as required (2)	Q00081-X2318	3
RW-connector socket	bend in direction D		cable length as required (2)	Q00081-X2319	3

(1) 0.1 m of this length as free leads
(2) when ordering please specify total length of cable and length of free leads

Characteristics

$G = f(P_o)$

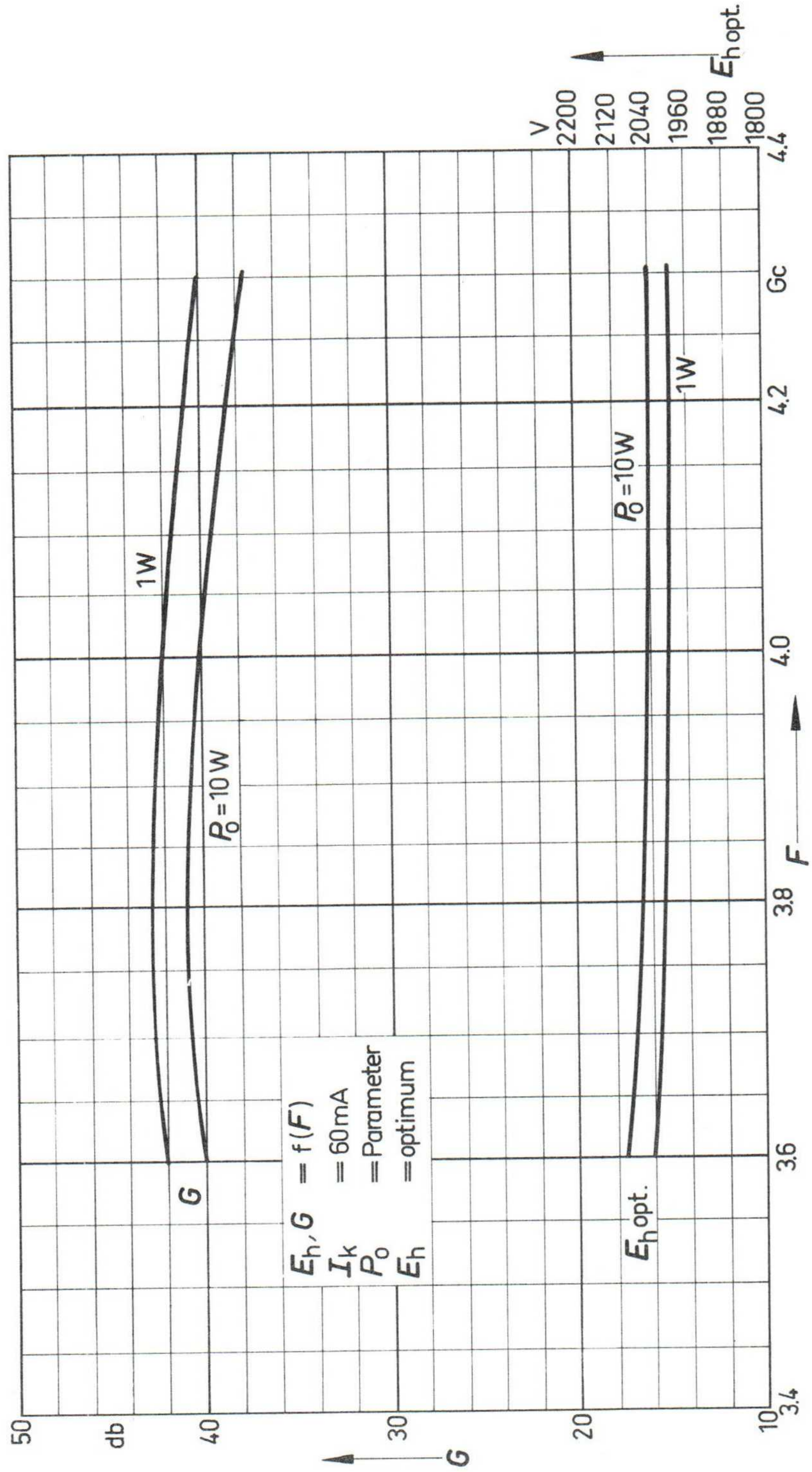




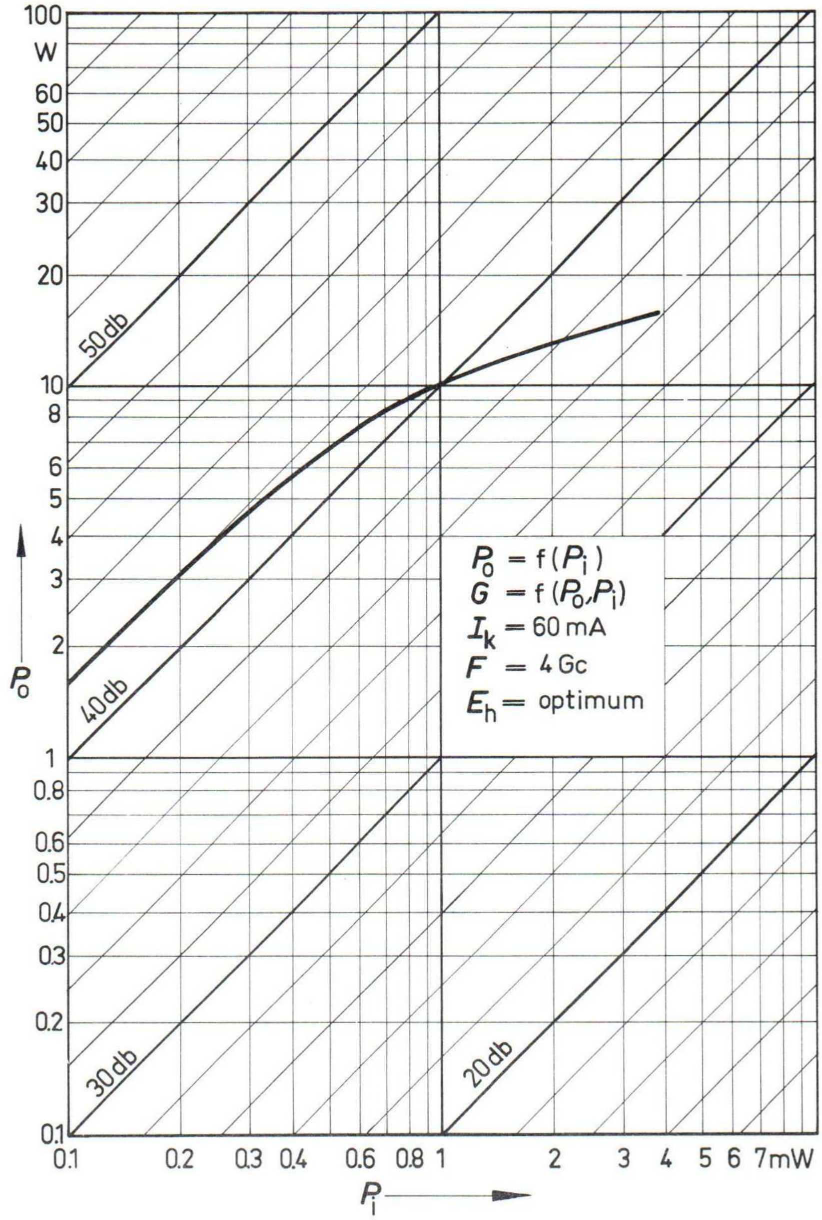
$E_{h\ opt.}$
2400
V
2240
2160
2080
2000
1920
1840
$F = 3.6$ Gc
$F = 4.3$ Gc
$F = 3.6$ Gc
$F = 4.3$ Gc
G
$E_{h\ opt.}$
$G, E_h = f(P_o)$
$I_k = 60$ mA
E_h = optimum
F = Parameter
50
db
40
30
20
G
0
4
8
12
16
W
20
P_o

Characteristics

$G, E_{h\,opt} = f\,(F)$



RöK 3510E / 1.10.65


100
W
60
50
40
30
20
10
8
6
5
4
3
2
1
0.8
0.6
0.5
0.4
0.3
0.2
0.1
P_o
0.1
0.2
0.3
0.4
0.6
0.8
1
2
3
4
5
6
7mW
P_i
50db
40db
30db
20db
P_o = f (P_i)
G = f (P_o,P_i)
I_k = 60 mA
F = 4 Gc
E_h = optimum

POWER TRAVELING WAVE TUBE

f = 3.6 to 4.2 Gc

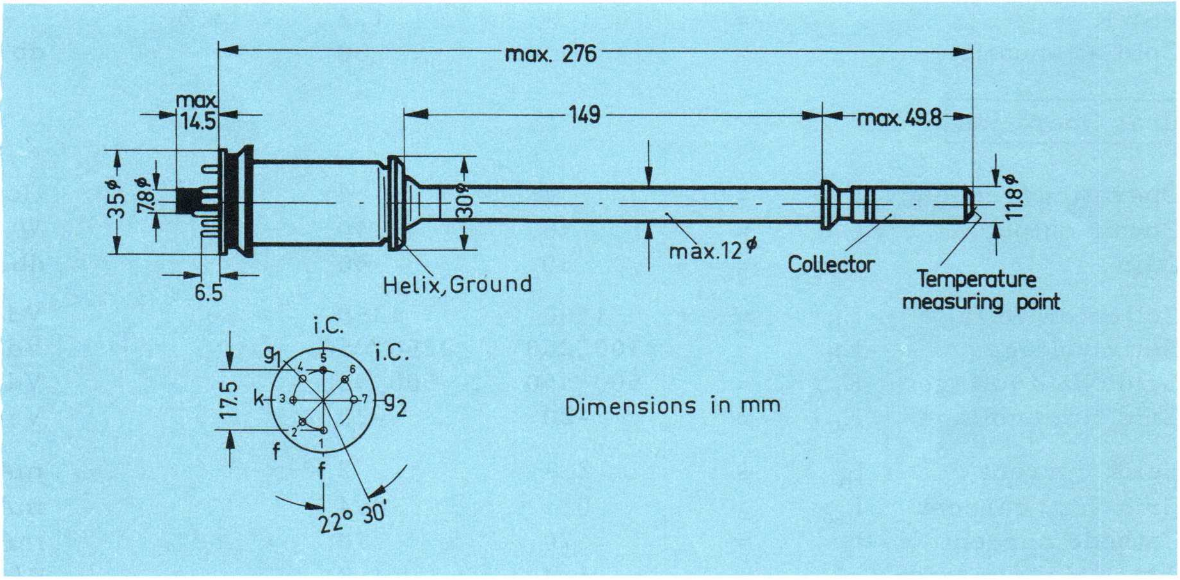
SIEMENS

RW 42

S&H-Sach-Nr.
Q00041-X3261

Design and Application

Power traveling wave tube especially designed for broadband radio relay systems with an average power output of 16 watts and an average gain of 39 db The magnet system including the tube and the connections is provided with rf shielding. The RW 42 is a periodic permanent magnet focused traveling wave tube and is a plug-in match in its associated magnet system MRW 4. The magnet system has a particularly small leakage field. It is designed to operate with depressed collector.
The magnet system may be delivered by choice with a conduction cooler (MRW 4 a) or with a convection cooler (MRW 4 b). The rf power is coupled in and out by way of waveguides.



Tube base:	special type
Weight of tube:	approx. 100 gm net
Weight of magnet system:	approx. 10 kg (22.05 lbs)
Dimensions of magnet system:	100 x 120 x 275 mm (without tube socket) 4" x 4 3/4" x 11"
Waveguide:	F 40, DIN 47302, 58.17 x 7 mm, 2.29" x 0,28"
Flange:	UGF 40, DIN 47303
Mounting position:	any (see cooling)
Dimensions of packing:	170 x 170 x 460 mm, 6.7" x 6.7" x 18.1"

ATTENTION please!
The Tube RW 42 must be used in connection with the amplifier MRW 42

Heating

Heater voltage	E_f	=	6.3	Vac (1)
Heater current	I_f	≈	0.8	Aac
Cathode heating time	t_k	≧	2	min (2)

indirect by ac, parallel supply
Metal capillary dispenser cathode

Characteristics

(f = 4.0 Gc, I_k = 70 mAdc)

			min	nom	max	
Pulse saturation power	P_{sat}	=		30		W
Average gain (P_o=16 W)	G	=	36	39		db
Small-signal gain	G	=	38	41		db
VSWR		=		1.2	1.5	(3)
Cold attenuation	α	=		80		db

Typical Operation

Operating frequency	F	=	4	4	Gc
Power output	P_o	=	16	10	W (4)
Gain	G	=	39	40	db
Collector voltage	E_b	=	1500	1350	Vdc (5)
Helix voltage	E_h	=	2300±250	2250±250	Vdc (7)
Grid No. 2 voltage	E_{c2}	=	500±150	500±150	Vdc (7)
Grid No. 1 voltage	E_{c1}	=	-20	-20	Vdc (5, 6)
Helix current	I_h	≈	2,5	2	mAdc
Grid No. 2 current	I_{c2}	≦	0.1	0.1	mAdc
Cathode current	I_k	=	70	70	mAdc (5)
AM/PM conversion		≈	3.4	1.8	°/db
Noise factor	NF	≈		20	db

All voltages are referred to the cathode

(1) If the maximum variation of the heater voltage exceeds the absolute limits of ± 2 %, the operating performance of the tube will be impaired and its life shortened.
(2) Once the tube has been operated at full voltages and currents, the preheating time for subsequent operation may be reduced to ≧ 45 sec.
(3) At input and output of cold tube in the frequency range of 3.6 to 4.2 Gc.
(4) For the tube operation at lower power output levels than 16 W it is also possible to reduce the cathode current by adjusting the grid voltages. Please consult the tube manufacturer for further details.
(5) Setting values
(6) It is advisable to obtain E_{c1} by means of cathode resistor.
(7) The spreads quoted are intended for use when designing the power supply.

Maximum Ratings (absolute values)

Collector supply voltage	E_{bb}	max	1800	Vdc
Collector voltage	E_b	max	1600	Vdc
Collector dissipation	P_p	max	110	W
Helix voltage	E_h	max	2500	Vdc
Helix voltage	E_h	min	1800	Vdc
Helix current	I_h	max	5	mAdc
Peak helix current	i_h	max	8	madc (1)
Grid No. 2 voltage	E_{c2}	max	700	Vdc
Grid No. 2 dissipation	P_{c2}	max	0.2	W
Grid No. 1 voltage	$-E_{c1}$	max	100	Vdc
Grid No. 1 voltage	$+E_{c1}$	max	0	Vdc
Cathode current	I_k	max	75	mAdc
Load VSWR		max	2	
Collector temperature	T	max	270	°C (2)
Magnet system temperature	T	max	100	°C (3)
Ambient temperature	TA	min	-20	°C
Ambient temperature	TA	max	55	°C (4)

(1) During starting and due to power supply surges.
(2) Without rf signal, the temperature of the collector may rise for three days maximum up to 300 °C.
(3) Measured at the output waveguide flange. It may be necessary to remove the lacquer from the measuring point.
(4) See "cooling", page 4

Operating Instructions

The traveling wave tube RW 42 is operated in conjunction with its associated magnet system MRW4. The advantages of the periodic permanent magnetic focusing of the RW 42 are the particularly small dimensions of the magnet system and an extremely low leakage field. The sensitivity to temperature changes is low.

The magnet system should only be mounted by way of the fixing holes provided for this purpose. With operation in radio link systems, directional couplers should be connected to the tube input and output to avoid distortion due to multiple reflexions. The rf waveguide to the magnet system should be flexible to prevent any mechanical stress on the input and output ports of the magnet system.

All voltages applied to the tube are referred to the cathode.

The voltage drop in the heater supply leads must be taken into account. The voltage must be set such that it is exactly 6.3 V at the socket. When using the standard cable of 1.1 m length supplied with the connector socket the total voltage drop is 0.1 V.

The Grid No. 1 voltage can be obtained from a cathode resistor R_k. The Grid No. 2 voltage must be variable within the a/m range. It is tapped from a voltage divider R_1, the total resistance of which must not exceed 2.5 Meg.

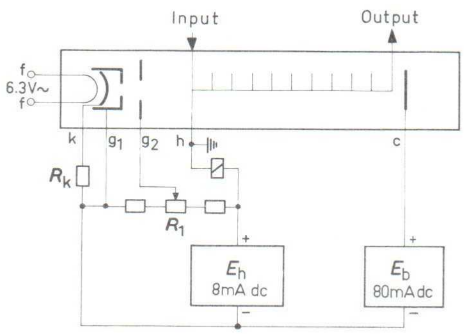
Stability and residual hum of the helix voltage depend upon the equipment requirements.

The collector voltage need not to be stabilized, but it must not fall more than 50 Vdc below the indicated operating value.

A protective relay must be inserted in the helix supply circuit to disconnect the helix and Grid No. 2 voltage, when the maximum permissible helix current is exceeded.

When using an independent voltage source for Grid No. 2, the voltage must be automatically switched off immediately if the helix voltage fails. This may be achieved by interlocking the protection circuits.

When the collector voltage fails, the helix voltage and Grid No. 2 voltage must be disconnected either by the overload relay in the helix circuit or by a voltage interlocking system.



Cooling

To dissipate the heat from the collector the magnet system may either be provided with conduction cooling (MRW4a) or convection cooling (MRW 4 b).

Conduction Cooling

The heat dissipated by the collector is conducted to two Cu-plates, mounted on two opposite sides of the magnet system. The heat (max. 55 W per plate) must be conducted from these plates. The temperature of the plate must not exceed 115 °C in this case. The plates are insulated from the collector and can be earthed.

Convection Cooling

An additional cooling by low air-flow is required, when using the convection-cooled system. In this case it is important that the maximum admissible collector temperature of 270 °C (absolute limit) is not exceeded.

Starting

For safe handling of the equipment, the magnet system must be properly grounded. For this purpose a solder tag is provided near the output port, see page 6.

1. Connect of supply leads. (Initial starting)
   The collector voltage is connected by means of an e.h.t. cable to the solder tag under the coverplate of the cooling system (see page 6). The helix connection is soldered to the tag near the output port (see page 6).
   The other voltages are applied to the tube via the supply cable. The individual leads are color-coded as follows:

Heater	f,f	: brown, brown-yellow
Cathode	k	: yellow
Grid No. 1	g_1	: green, red *)
Grid No. 2	g_2	: blue
Earth		: black

   *) connect green and red lead together !
2. Unscrew the retaining nut.
3. Insert the tube in magnet system push on tube socket and screw on nut until stop is reached (avoid tilting the socket).
4. Apply heater voltage and preheat tube.
5. Apply collector voltage.
6. Switch-on helix and Grid No. 2 voltages simultaneously (the time difference between applying the voltages to both electrodes must not exceed 0.2 sec). Make sure that full voltages are applied immediately and not increased gradually to full value.
7. Adjust cathode current by varying Grid No. 2 voltage.
8. Adjust helix current to minimum with the aid of radial field correction (pair of rings at input end of magnet system) and axial field correction (additional single ring at input end of magnet system).
9. Apply rf input signal and readjust helix voltage for optimum gain at specified power output.
10. Repeat field correction according to point 8.

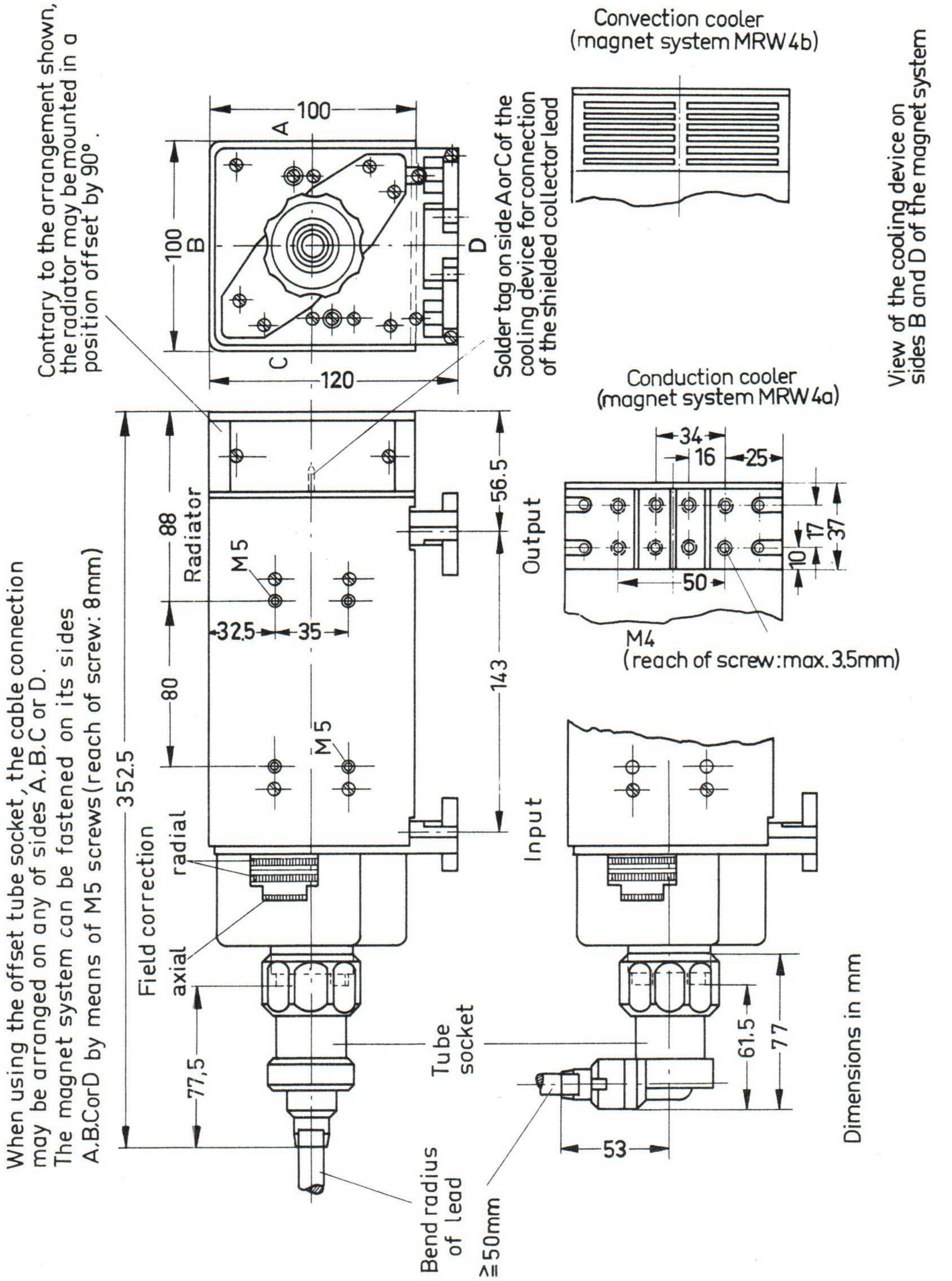
For interruption in operation up to 10 sec duration the tube may be switched on without preheating.

Switching off

The operating voltages can be switched off either simultaneously or in the reverse order to that in which they were applied.

Magnet System MRW 42

SIEMENS



The various arrangements of the cooler assembly and collector connection

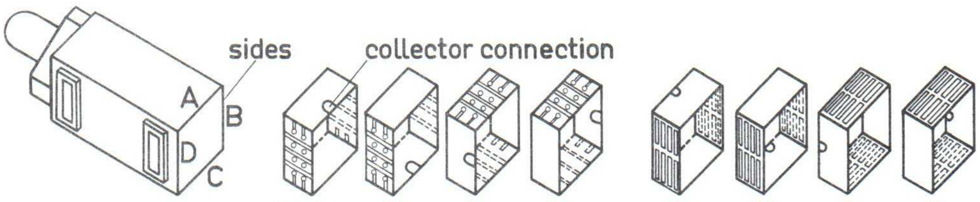


fig.1a 1b 1c 1d 1e 1f 1g 1h

Form and direction of the connector socket

fig.2

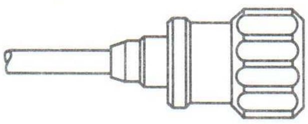
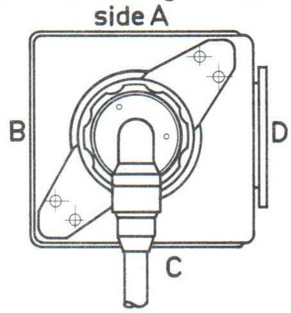


fig.3 shown in direction C



Ordering numbers for traveling wave tube RW 42 and associated elements

designation	Design			Ordering numbers	fig.
	Cooling	Cooling in direct.	Collector connection at side		
Traveling wave tube RW 42				Q00041-X3261	
Magn.syst.MRW 4 a11	Conduction	B-D	A	Q00043-X2321	1a
Magn.syst.MRW 4 a12	Conduction	B-D	C	Q00043-X2325	1b
Magn.syst.MRW 4 a21	Conduction	A-C	D	Q00043-X2322	1c
Magn.syst.MRW 4 a22	Conduction	A-C	B	Q00043-X2326	1d
Magn.syst.MRW 4 b11	Convection	B-D	A	Q00043-X2323	1e
Magn.syst.MRW 4 b12	Convection	B-D	C	Q00043-X2327	1f
Magn.syst.MRW 4 b21	Convection	A-C	D	Q00043-X2324	1g
Magn.syst.MRW 4 b22	Convection	A-C	B	Q00043-X2328	1h
RW-connector socket	axial			Q00081-X2321	2
RW-connector socket	bend in direction A		standard cable length 1.2 m (1)	Q00081-X2322	3
RW-connector socket	bend in direction B		standard cable length 1.2 m (1)	Q00081-X2323	3
RW-connector socket	bend in direction C		standard cable length 1.2 m (1)	Q00081-X2324	3
RW-connector socket	bend in direction D		standard cable length 1.2 m (1)	Q00081-X2325	3
RW-connector socket	axial			Q00081-X2315	2
RW-connector socket	bend in direction A		cable length as required (2)	Q00081-X2316	3
RW-connector socket	bend in direction B		cable length as required (2)	Q00081-X2317	3
RW-connector socket	bend in direction C		cable length as required (2)	Q00081-X2318	3
RW-connector socket	bend in direction D		cable length as required (2)	Q00081-X2319	3

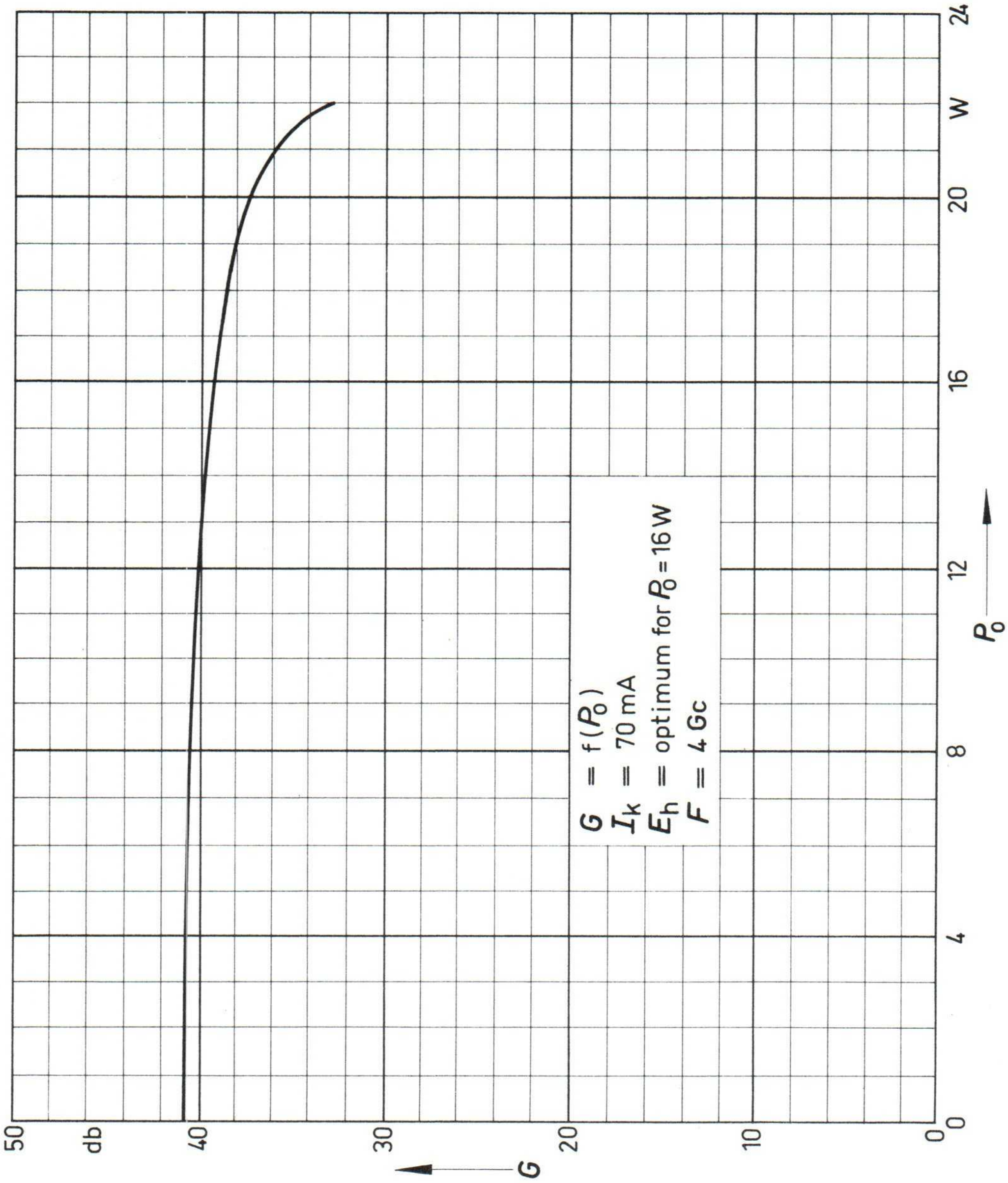
(1) 0.1 mm of this length as free leads

(2) When ordering please specify total length of cable and length of free leads

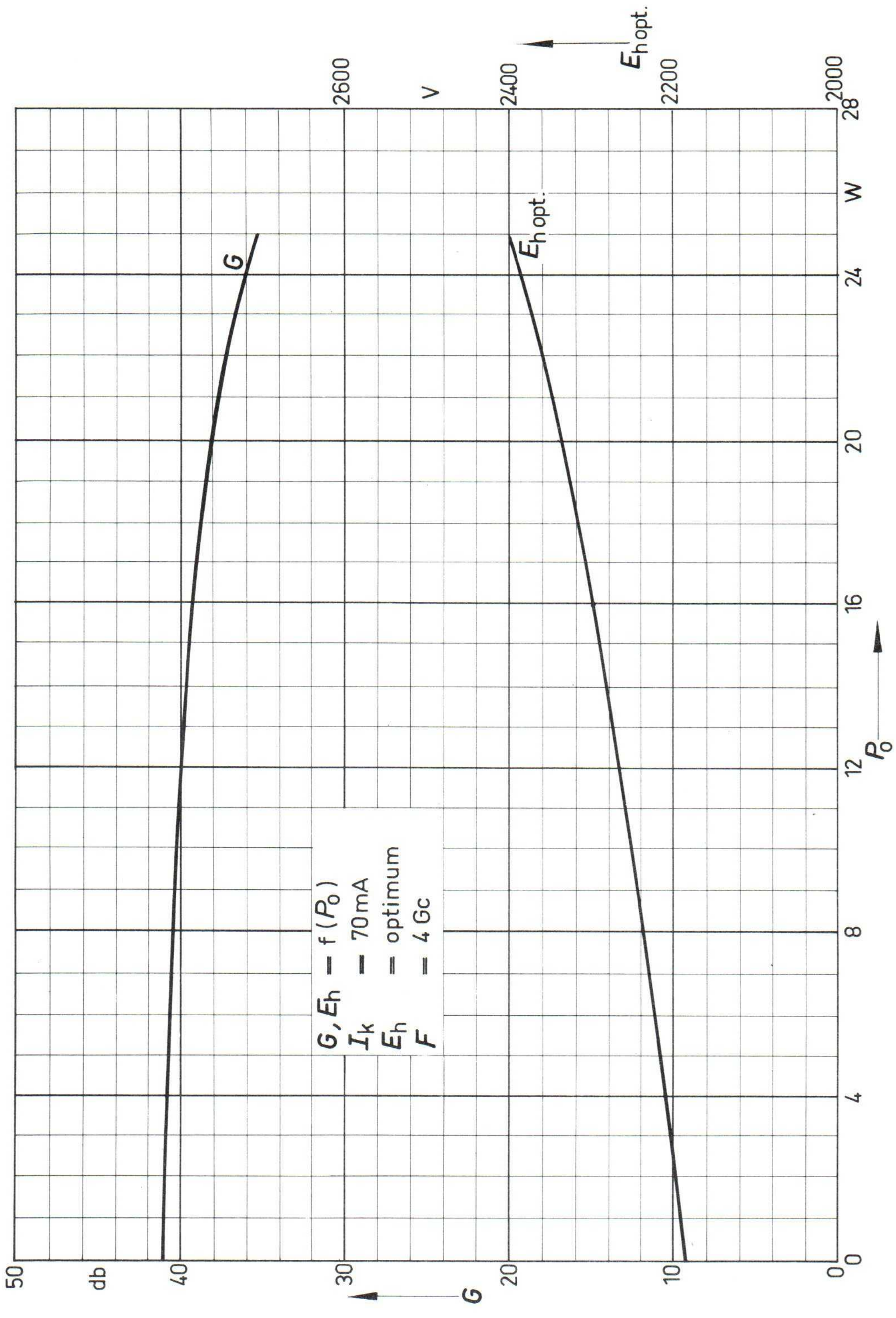
Characteristics

$G = f(P_o)$

SIEMENS



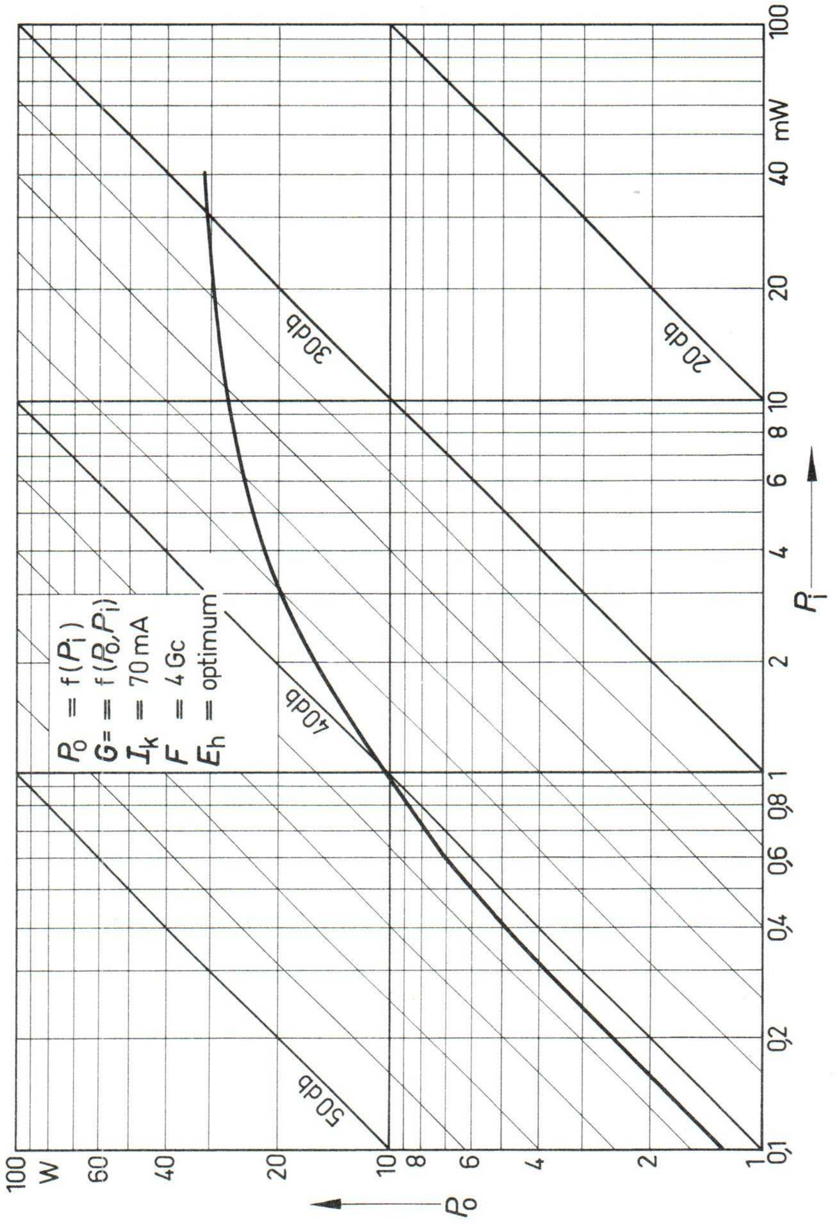
RöK 3516 E / 1.10.65

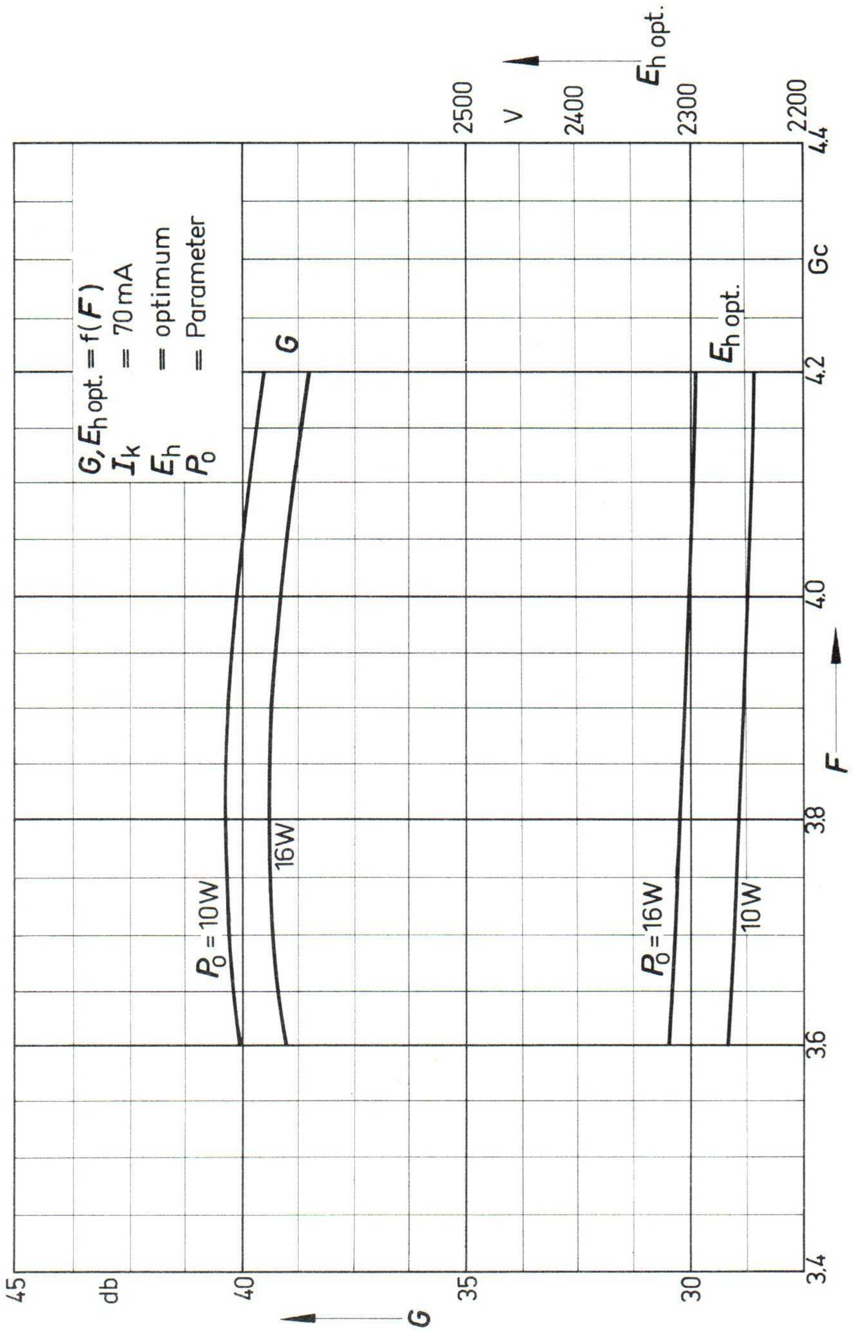

G
$E_{h\,opt.}$
$G, E_h = f(P_o)$
$I_k = 70\,mA$
E_h = optimum
$F = 4\,Gc$
2600
V
2400
2200
2000
$E_{h\,opt.}$
50
db
40
30
20
10
0
G
0
4
8
12
16
20
24
28
W
P_o

Characteristics

$P_o = f(P_i)$

SIEMENS



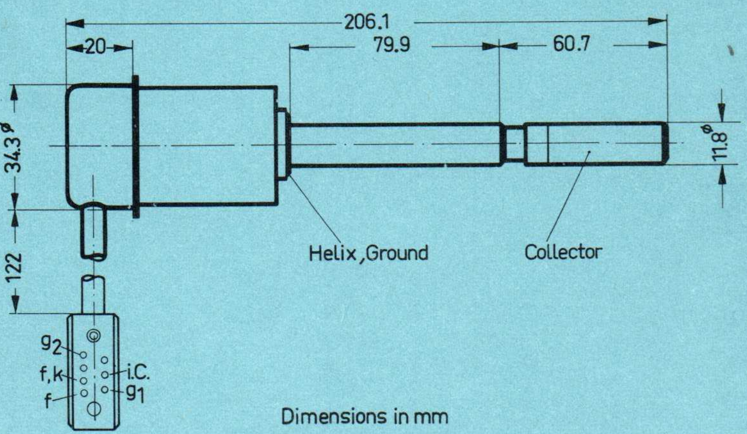

G, E_h opt. = f(F)
I_k = 70 mA
E_h = optimum
P_o = Parameter
G
E_h opt.
P_o = 10W
16W
P_o = 16W
10W
45
db
40
35
30
G
2500
V
2400
2300
2200
E_h opt.
3.4
3.6
3.8
4.0
4.2
4.4
F
Gc

S&H-Sach-Nr.
Q00041-X3258

Design and Application

Traveling wave tube for wideband radio relay systems, with an average output power of 4 W and an average gain of 38 db.

The tube is a permanent magnet focused traveling wave tube and is a plug-in match in its associated magnet system MRW 70. Cooling may be effected by natural air circulation. The rf input and output ports are designed for connection with waveguide. The magnet system including the tube and the connections is provided with rf shielding.



Weight of tube	: approx. 180 g (5 1/2 ozs)
Weight of magnet system	: approx. 9.2 kg (20.3 lbs)
Dimensions of the magnet system	: 136 x 128 x 230 mm (5 1/2 x 5 x 9 ins)
Waveguide	: F 70; DIN 47302; 34,85 x 5 mm
Flange	: UGF 70, DIN 47303
Mounting position	: any (see page 4 "cooling")

Heating

Heater voltage	E_f	=	6.3	V	(1)
Heater current	I_f	≈	0.5	A	
Preheating time	t_k	≧	2	min	

indirect ac or dc, parallel supply
Cathode: oxide

Characteristics

(F = 7.5 Gc, $I_k \approx$ 33 mA)

			min	nom	max		
Pulse saturation power	P_{sat}	=		7		W	
Gain at 4 W CW	G	=	34	38		db	
VSWR		=			1.65		(2)
Cold attenuation	α	=		80		db	

Typical Operation

Operating frequency	F	=	7.5	Gc	
Output power	P_o	=	4	W	
Gain	G	=	38	db	
Collector voltage	E_b	≈	1600	Vdc	
Helix voltage	E_h	≈	1600	Vdc	
Grid No. 2 voltage	E_{c2}	≈	470	Vdc	
Cathode resistor	R_k	=	1100	kohms	(3)
Helix current	I_h	≈	2	mAdc	
Grid No. 2 current	I_{c2}	≦	0.1	mAdc	
Cathode current	I_k	≈	33	mAdc	

(1) If the maximum variation of the heater voltage exceeds the absolute limits of +2 and -4 % the operating performance of the tube will be impaired and its life shortened.

(2) At input and output of cold tube in the frequency range of 7.1 to 7.8 Gc.

(3) Grid No. 1 voltage ≈ -35 V

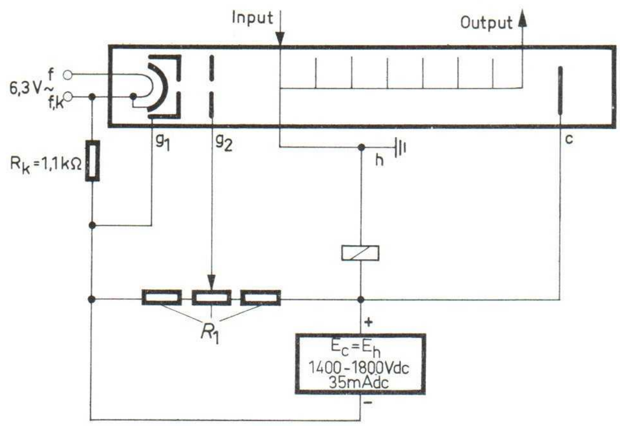
Maximum Ratings (absolute values)

Collector voltage	E_b	max	1800	Vdc
Collector dissipation	P_p	max	60	W
Helix voltage	E_h	max	1800	Vdc
Helix current	I_h	max	4	mAdc
Peak helix current	ih	max	6	mAdc (1)
Grid No. 2 voltage	E_{c2}	max	600	Vdc
Grid No. 1 voltage neg.	$-E_{c1}$	max	100	Vdc
Grid No. 1 voltage pos.	$+E_{c1}$	max	0	Vdc
Cathode current	I_k	max	35	mAdc
Collector temperature	T	max	270	°C (2)
Ambient temperature	TA	min	-20	°C
Ambient temperature	TA	max	+55	°C

Operating Instructions

The traveling wave tube RW 70 is operated in conjunction with its associated magnet system MRW 70. The advantages of the permanent magnetic focusing of the RW 70 are the particularly small dimensions of the magnet system and an extremely low leakage field. The sensitivity to temperature changes is low. The magnet system is magnetically virtually neutral.
The magnet system should only be mounted by way of the fixing holes provided for this purpose. With operation in radio link systems, directional couplers should be connected to the tube input and output to avoid distortion due to multiple reflexions. The rf waveguide to the magnet system should be flexible to prevent any mechanical stress on the input and output ports of the magnet system.
All voltages applied to the tube are referred to the cathode.
The Grid No. 1 voltage is obtained from a cathode resistor R_k. The Grid No. 2 voltage must be variable within the range from 370 to 570 V. It is tapped from a voltage divider R_1, the total resistance of which must not exceed 1 Meg.
The helix voltage E_h which is less or equal to the collector voltage E_b must be variable between 1400 and 1800 V (admissible voltage drop across the protection relay 20 V). A protection relay must be incorporated in the helix voltage supply lead which automatically switches off the helix and Grid No. 2 voltages (E_h and E_{c2}) if the maximum admissible value of helix current is exceeded.
When using an independent voltage source for Grid No. 2, the voltage must be automatically switched off immediately if the helix voltage ≈ collector voltage fails. This may be achieved by interlocking the protection circuits.
Heater and cathode are at approx. 1800 V with respect to earth, and the transformer insulation must therefore be designed to withstand this potential difference.

(1) For short periods during run up and mains surges.
(2) Without rf signal, the temperature of the collector may rise for three days maximum up to 300 °C.



Cooling

The tube can be operated without additional cooling when mounted horizontally with the rf connector above or below, and natural air circulation in a vertical direction through the radiator is assured. If the magnet system is mounted in any other position, forced air cooling with a weak air stream is necessary.

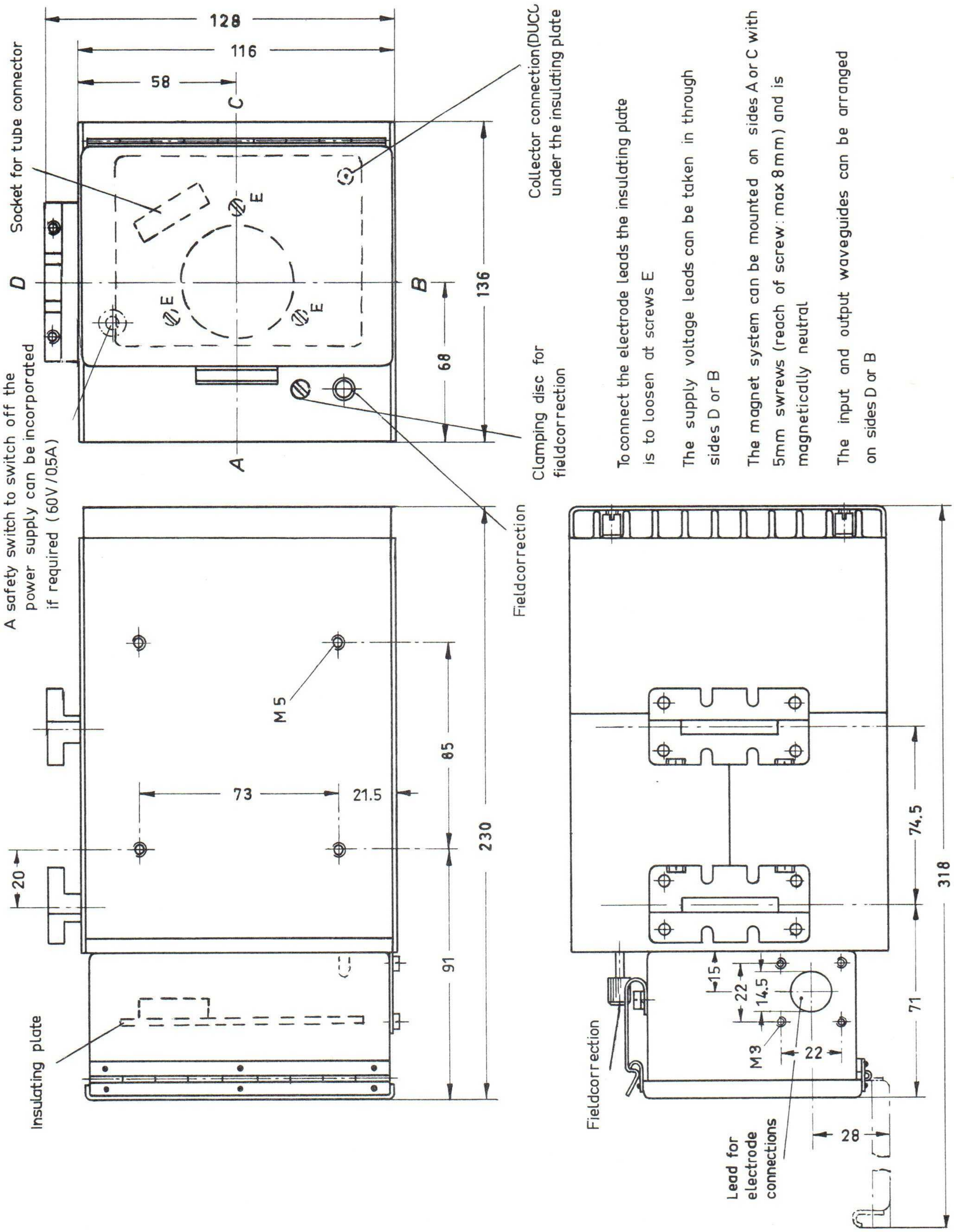
Starting

For safe handling of the equipment, the magnet system must be properly grounded.

1. Connect of supply leads (initial starting)
   The helix voltage lead is connected to the earth terminal on the magnet system. All other supply leads are connected to the appropriate pin of the connector socket or the collector terminal (see page 5) (or to the safety switch as required).
2. Insert the tube into the magnet system and connect-up the socket.
3. Apply heater voltage and preheat tube for at least 2 minutes.
4. Switch on the power supply for the collector (E_b), helix (E_h) and grid No.2 (E_{c2}) voltages. All voltages must either be supplied simultaneously at their full value, or when run up, in the same voltage ratio as valid for normal operation.
5. Adjust grid No.2 voltage for minimum helix current.
6. Loosen the clamping disc and adjust the helix current for minimum with the aid of the field correction, then tighten the clamping disc again.
7. Apply rf input signal and readjust helix voltage for optimum gain at specified power output.
8. Repeat field correction according to point 6.

Switching off

The operating voltages should be switched off simultaneously.



To connect the electrode leads the insulating plate is to loosen at screws E

The supply voltage leads can be taken in through sides D or B

The magnet system can be mounted on sides A or C with 5mm swrews (reach of screw: max 8 mm) and is magnetically neutral

The input and output waveguides can be arranged on sides D or B

POWER TRAVELING WAVE TUBE

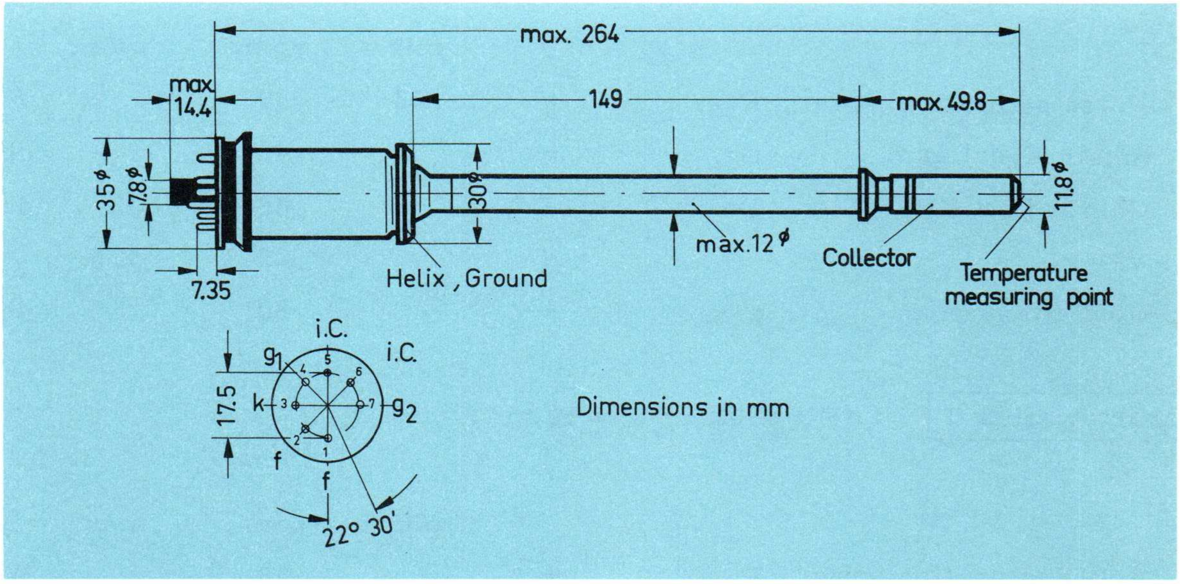
F = 5.8 to 8.5 Gc

RW 80

S&H-Sach-Nr.
Q00041-X3255

Design and Application

Power traveling wave tube with an average power output of 15 W up to 7 Gc respectively with an average power output of 10 W up to 8.5 Gc for use in radio relay systems.
The RW 80 is a periodic permanent magnet focused traveling wave tube and is a plug-in match in its associated magnet system MRW 80. The magnet system has a particularly small leakage field. The tube is designed to operate with depressed collector. The magnet system including the tube and the connections is provided with rf shielding.
The magnet system may be delivered by choice with a conduction cooler (MRW 80a) or with a convection cooler (MRW 80b). The rf power is coupled in and out by way of waveguides.



Tube base	: special type	(1)
Weight of magnet system	: approx. 9.5 kg (21 lbs)	
Weight of tube	: approx. 110 gm net (3.9 ozs)	
Dimensions of magnet system	: 100x112x264 mm without tube socket (3.9x4.4x10.4 ins)	
Dimensions of tube packing	: 175x175x475 mm (6.9x6.9x18.7 ins)	
Waveguide	: F 70, DIN 47302, 34.85x5 mm	
Flange	: UGF 70, DIN 47303	
Mounting positon	: any (see "cooling")	

(1) The connector socket including cable can be supplied in axial form or with 90° bend to the axis, as desired (see page 8).

Heating

Heater voltage	E_f	=	6.3	Vac (1)
Heater current	I_f	≈	0.8	Aac
Preheating time	t_k	≥	2	min (2)

indirect by ac, parallel supply
Metal capillary dispenser cathode

Characteristics I (F = 6.0 Gc, I_k = 50 mA)

			min	nom	max		
Pulse saturation power	P_{sat}	=	22	30		W	
Small signal gain	G	=	38	42		db	
Gain at 15 W CW	G	=	36	40		db	
VSWR		=		1.25	1.5		(3)
Cold attenuation	α	=		80		db	

Characteristics II (F = 8.0 Gc, I_k = 50 mA)

			min	nom	max	
Pulse saturation power	P_{sat}	=		18		W
Small signal gain	G	=	35	39		db
Gain at 10 W CW	G	=	33	37		db
Cold attenuation	α	=		80		db

(1) If the maximum variation of the heater voltage exceeds the absolute limits of ± 2 % the operating performance of the tube will be impaired and its life shortened.
(2) Once the tube has been operated at full voltages and currents, the preheating time for subsequent operation may be reduced to ≥ 45 sec.
(3) At input and output of cold tube in the frequency range of 5.8 to 8.5 Gc

Typical Operation (F = 6.0 Gc)

Power output	P_o	=	15	10	5	W
Gain	G	=	40	41	41,5	db
Collector voltage	E_b	=	1500	1300	1200	Vdc (1)
Helix voltage	E_h	=	2900±250	2900±250	2900±250	Vdc (2)
Grid No. 2 voltage	E_{c2}	=	550±120	550±120	550±120	Vdc (2)
Grid No. 1 voltage	$-E_{c1}$	=	40	40	40	Vdc (1,3)
Cathode current	I_k	=	50	50	50	mAdc (1,4)
Helix current	I_h	≈	1.5	1	1	mAdc (1)
Grid No. 2 current	I_{c2}	≦	0.1	0.1	0.1	mAdc
Noise factor	NF	≈	22	22	22	db
AM/PM conversion		≈	5	3	1.5	°/db (5)

Typical Operation (F = 6.0 Gc)

Power output	P_o	=	10	5	2	W
Gain	G	=	38	35	32	db
Collector voltage	E_b	=	1350	1200	1200	V dc (1)
Helix voltage	E_h	=	2900±250	2900±250	2850±250	V dc (2)
Grid No. 2 voltage	E_{c2}	=	550±120	550±120	500±120	V dc (2)
Grid No. 1 voltage	$-E_{c1}$	=	55	80	90	Vdc (1,3)
Cathode current	I_k	=	45	40	35	mA (1)
Helix current	I_h	≈	1.2	1.0	1.0	mA
Grid No. 2 current	I_{c2}	≦	0.1	0.1	0.1	mA
Noise factor	NF	≈	22	22	22	db
AM/PM conversion		≈	3,7	2.5	1.2	°/db (5)

Typical Operation (F = 7.0 Gc)

Power output	P_o	=	15	10	5	W
Gain	G	=	39.5	40.5	41	db
Collector voltage	E_b	=	1450	1300	1200	Vdc (1)
Helix voltage	E_h	=	2850±250	2850±250	2850±250	Vdc (2)
Grid No. 2 voltage	E_{c2}	=	550±120	550±120	550±120	Vdc (2)
Grid No. 1 voltage	$-E_{c1}$	=	40	40	40	Vdc (1,3)
Cathode current	I_k	=	50	50	50	mAdc (1,4)
Helix current	I_h	≈	1.5	1	1	mAdc
Grid No. 2 current	I_{c2}	≦	0.1	0.1	0.1	mAdc
Noise factor	NF	≈	22	22	22	db

Footnotes see page 4

Typical Operation (F = 8.4 Gc)

Power output	P_o	=	10	5	W
Gain	G	=	37.5	38	db
Collector voltage	E_b	=	1300	1200	Vdc (1)
Helix voltage	E_h	=	2800±250	2800±250	Vdc (2)
Grid No. 2 voltage	E_{c2}	=	550±120	550±120	Vdc (2)
Grid No. 1 voltage	$-E_{c1}$	=	40	40	Vdc (1, 3)
Cathode current	I_k	=	50	50	mAdc (1, 4)
Helix current	I_h	≈	1.5	1	mAdc
Grid No. 2 current	I_{c2}	≦	0.1	0.1	mAdc
Noise factor	NF	≈	22	22	db

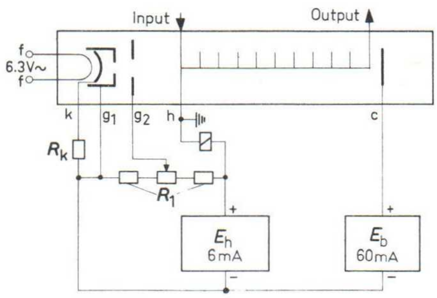
Maximum Ratings (absolute values)

Collector supply voltage	E_{bb}	max	1700	Vdc	
Collector voltage	E_b	max	1600	Vdc	
Collector dissipation	P_p	max	80	W	
Helix voltage	E_h	max	3200	Vdc	
Helix voltage	E_h	min	2400	Vdc	
Helix current	I_h	max	3.5	mAdc	(6)
Peak helix current	i_h	max	5	ma	(6)
Grid No. 2 voltage	E_{c2}	max	700	Vdc	
Grid No. 2 dissipation	P_{c2}	max	0.2	W	
Grid No. 1 voltage neg.	$-E_{c1}$	max	100	Vdc	
Grid No. 1 voltage pos.	$+E_{c1}$	max	0	Vdc	
Load VSWR		max	2.0		
Cathode current	I_k	max	55	mAdc	
Collector temperature	T	max	270	°C	(7)
Magnet system temperature	T	max	100	°C	(8)
Ambient temperature	TA	max	55	°C	(9)
Ambient temperature	TA	min	-20	°C	

(1) Setting values
(2) The spreads quoted are intended for use when designing the power supply.
(3) It is advisable to obtain E_{c1} voltage by means of a cathode resistor.
(4) A variation of 7 mA cathode current in the range 48 to 55 mA produces a change in gain of approximately 0.5 db.
(5) AM/PM conversion is the phase shift of the rf output signal when changing the input by 1 db.
(6) During starting and due to power supply surges
(7) Without rf-signal, the temperature of the collector may rise for three days maximum up to 300 °C.
(8) Measured at the waveguide (rf-output). It may be necessary to remove the lacquer from the measuring point.
(9) See "cooling"

Operating Instructions

The traveling wave tube RW 80 is operated in conjunction with a magnet system MRW 80. The advantages of the periodic permanent magnetic focusing of the RW 80 are the particularly small dimensions of the magnet system and an extremely low leakage field. The sensitivity to temperature changes is low.
The magnet system should only be mounted by way of the fixing holes provided for this purpose. With operation in radio link systems, directional couplers should be connected to the tube input and output to avoid distortion due to multiple reflexions. The rf waveguide to the magnet system should be flexible to prevent any mechanical stress on the input and output ports of the magnet system.
All voltages applied to the tube are referred to the cathode.
The voltage drop in the heater supply leads must be taken into account.
The voltage must be set such that it is exactly 6.3 V at the socket. When using the standard cable of 1.1 m length supplied with the connector socket the total voltage drop is 0.1 V.
The Grid No.1 voltage can be obtained from a cathode resistor R_k. The Grid No.2 voltage must be variable within the range quoted. It is tapped from a voltage divider R_1, the total resistance of which must not exceed 2.5 Meg.
Stability and residual hum voltage (helix voltage) depend upon the equipment requirements.
The collector voltage need not be stabilized, but it must not fall more than 50 Vdc below the indicated operating value.
A protective relay must be inserted in the helix supply circuit to disconnect the helix and Grid No.2 voltage, when the maximum permissible helix current is exceeded.
When using an independent voltage source for Grid No.2, the voltage must be automatically switched off immediately if the helix voltage fails.
This may be achieved by interlocking the protection circuits.
When the collector voltage fails, the helix voltage and Grid No.2 voltage must be disconnected either by the overload relay in the helix circuit or by a voltage interlocking system.



Cooling

To dissipate the heat from the collector the magnet system may either be provided with conduction cooling (MRW 80 a) or convection cooling (MRW 80 b).

Conduction Cooling

The heat dissipated by the collector is conducted to two Cu-plates, mounted on two opposite sides of the magnet system. The heat (max 40 W per plate) must be conducted from these plates. The temperature of the plate must not exceed 115 °C in this case. The plates are insulated from the collector and can be earthed.

Convection Cooling

If the tube is operated with a collector dissipation of less than 65 W and an ambient temperature of less than 40 °C no additional cooling is necessary provided that the tube is mounted in horizontal position with a natural vertical air circulation through the radiator. At higher collector dissipation up to 75 W a chimney with a cross section of 50 x 100 mm and a height of 800 mm will be sufficient, if cooling by a slight forced air flow (appr. 10 l/min) shall not be used. In any other case forced air cooling is necessary not to exceed the absolute limit of collector temperature of 270 °C.

Starting

For safe handling of the equipment, the magnet system must be properly grounded. (A solder tag is provided near the output port, see page 8).

1. Connection of dc-leads (initial starting):
   The collector voltage is connected by means of a high voltage cable to the solder tag under the coverplate of the cooling system (see page 8). The helix connection is soldered to the tag near the output port (see page 8). The other voltages are applied to the tube via the supply cable.
   The individual leads are color-coded as follows:

Heater	f, f	: brown, brown-yellow	
Cathode	k	: yellow	
Grid No. 1	g_1	: green, red	*)
Grid No. 2	g_2	: blue	
Earth		: black	

*) connect green and red lead together!

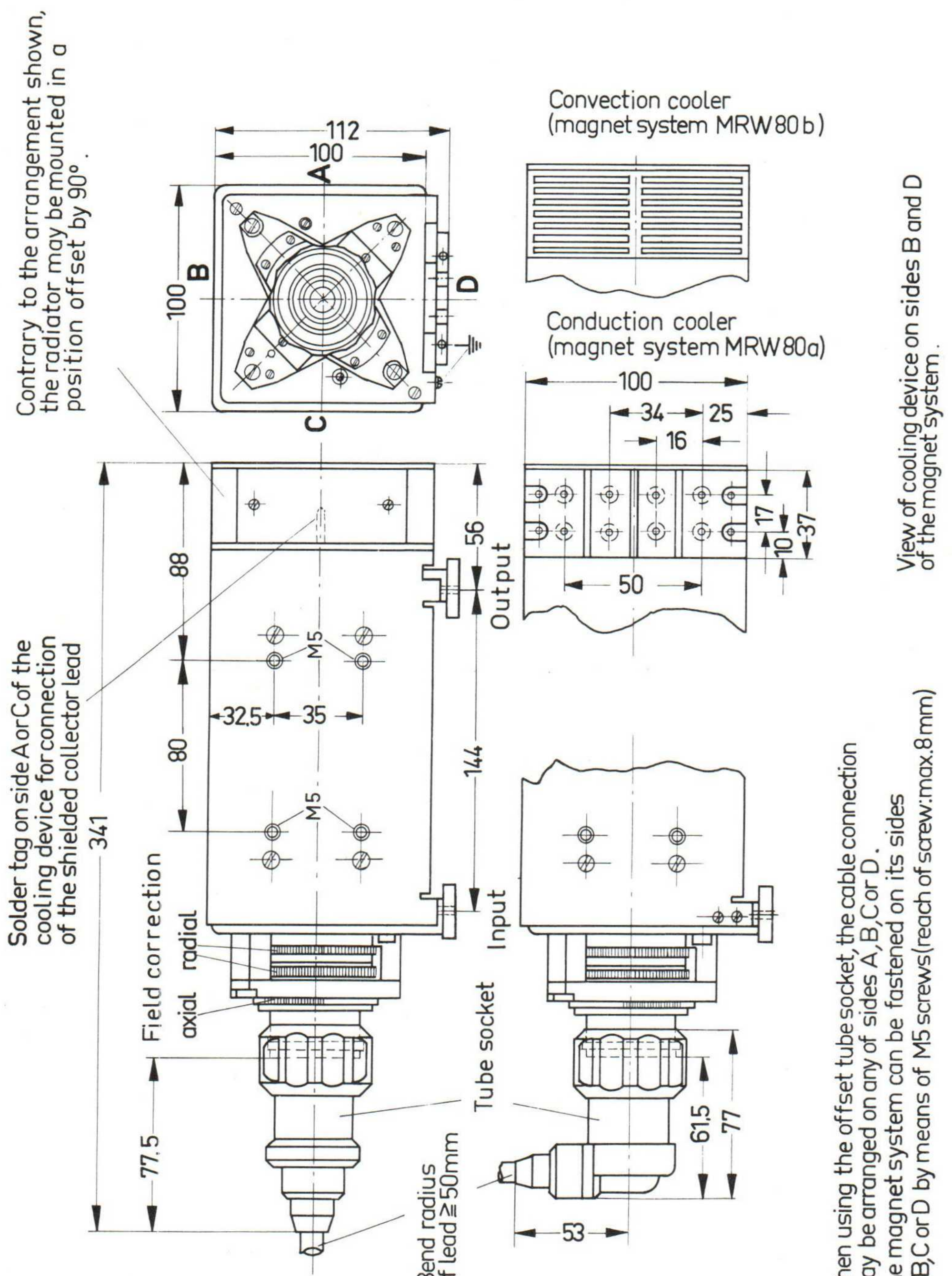
2. Unscrew the retaining nut
3. Insert the tube in magnet system, push on tube socket and screw on nut until stop is reached (avoid tilting the socket).

4. Apply heater voltage and preheat tube.
5. Apply collector voltage.
6. Switch on helix and Grid No. 2 voltages simultaneously (the time difference between applying the voltages to both electrodes must not exceed 0.2 sec.). Make sure that full voltages are applied immediately and not increased gradually to full value.
7. Adjust cathode current by varying Grid No. 2 voltage.
8. Adjust helix current to minimum with the aid of radial field correction (pair of rings at input end of magnet system) and axial field correction (additional ring at input end of magnet system).
9. Apply rf input signal and readjust helix voltage for optimum gain at specified power output.
10. Repeat field correction according to point 9. For interruption in operation up to 10 sec duration the tube may be switched on without preheating.

Switching off

The operating voltages can be switched off either simultaneously or in the reversed order to that in which they were applied.

Magnet System MRW 80



Dimensions in mm

The various arrangements of the cooler assembly and collector connection

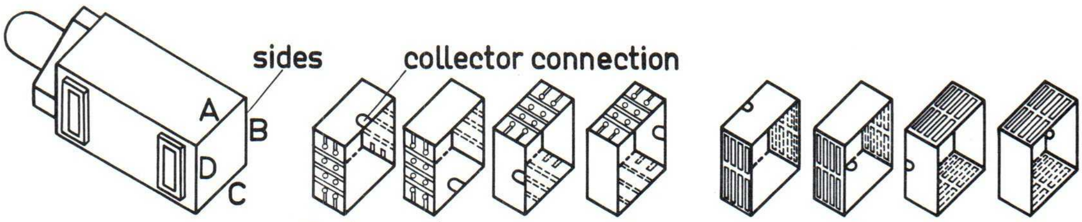


fig.1a 1b 1c 1d 1e 1f 1g 1h

Form and direction of the connector socket

fig.2

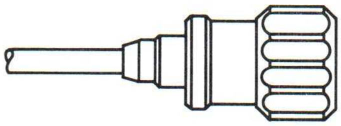
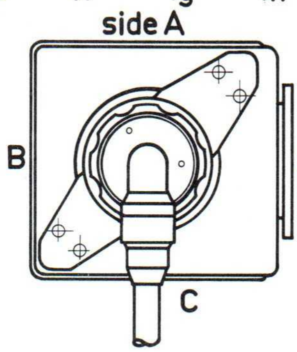


fig.3 shown in direction C



Ordering numbers for traveling wave tube RW 80 and associated elements

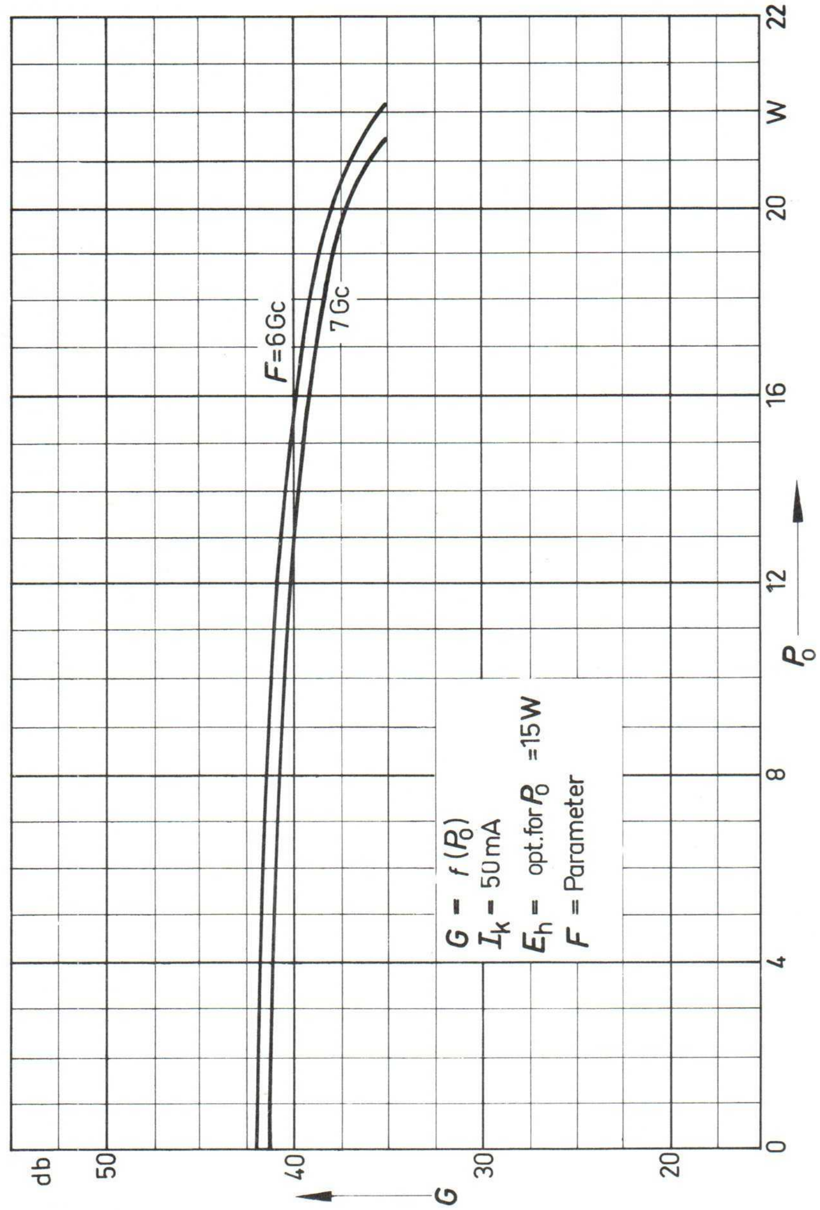
Designation	Design			Ordering numbers	Fig.
	Cooling	Cooling in direct.	Collect. connect. at side		
Traveling wave tube RW 80				Q00041-X3255	
Magn. syst. MRW 80a11	Conduction	B-D	A	Q00043-X2361	1a
Magn. syst. MRW 80a12		B-D	C	Q00043-X2365	1b
Magn. syst. MRW 80a21		A-C	D	Q00043-X2362	1c
Magn. syst. MRW 80a22		A-C	B	Q00043-X2366	1d
Magn. syst. MRW 80b11	Convection	B-D	A	Q00043-X2363	1e
Magn. syst. MRW 80b12		B-D	C	Q00043-X2367	1f
Magn. syst. MRW 80b21		A-C	D	Q00043-X2364	1g
Magn. syst. MRW 80b22		A-C	B	Q00043-X2368	1h
RW-connector socket	axial		standard cable length 1.2 m (1)	Q00081-X2321	2
RW-connector socket	bend in direction A			Q00081-X2322	3
RW-connector socket	bend in direction B			Q00081-X2323	3
RW-connector socket	bend in direction C			Q00081-X2324	3
RW-connector socket	bend in direction D			Q00081-X2325	3
RW-connector socket	axial		cable length as required (2)	Q00081-X2315	2
RW-connector socket	bend in direction A			Q00081-X2316	3
RW-connector socket	bend in direction B			Q00081-X2317	3
RW-connector socket	bend in direction C			Q00081-X2318	3
RW-connector socket	bend in direction D			Q00081-X2319	3

(1) 0.1 m of this length as free leads.
(2) When ordering please specify total length of cable and length of free leads.

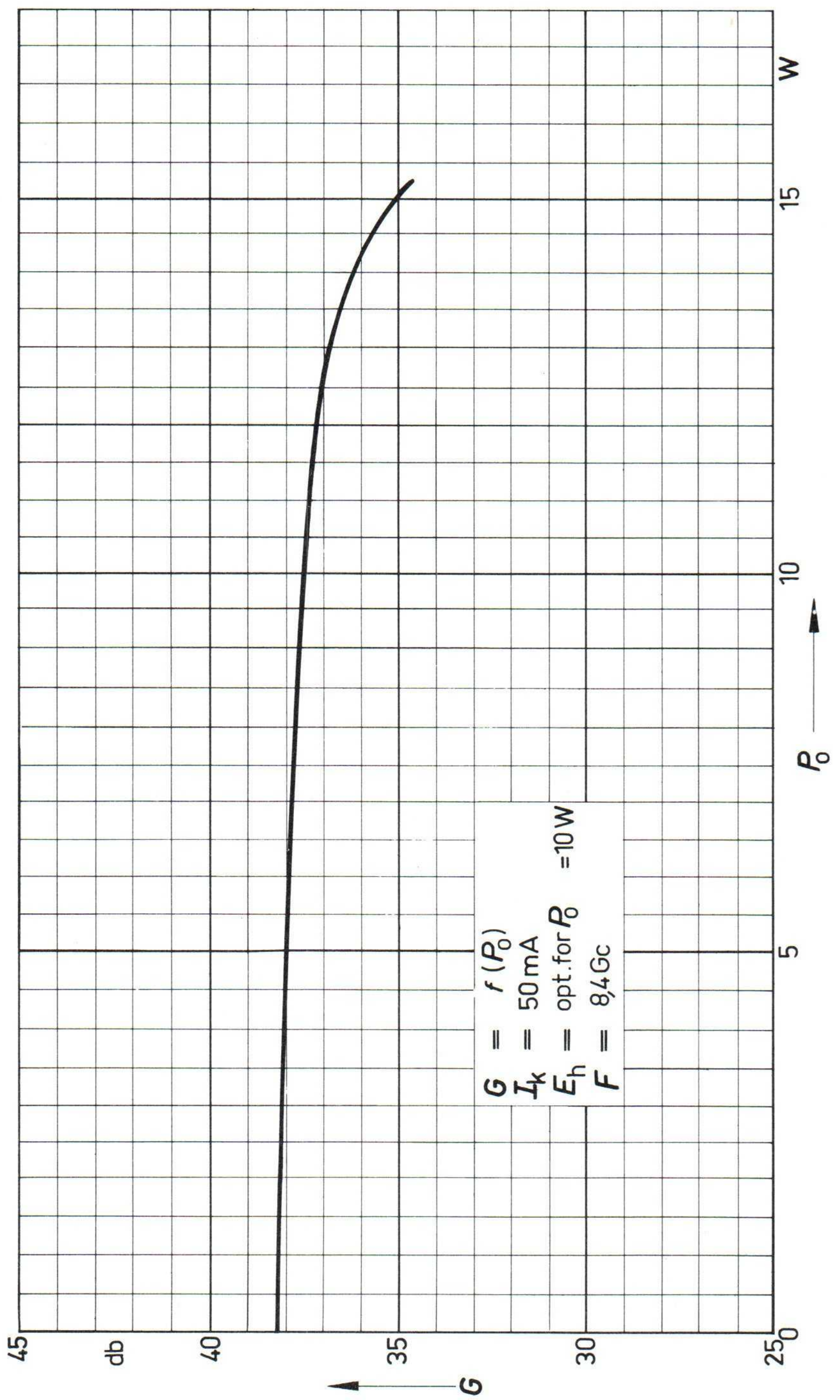
Characteristics

$G = f(P_o)$

SIEMENS

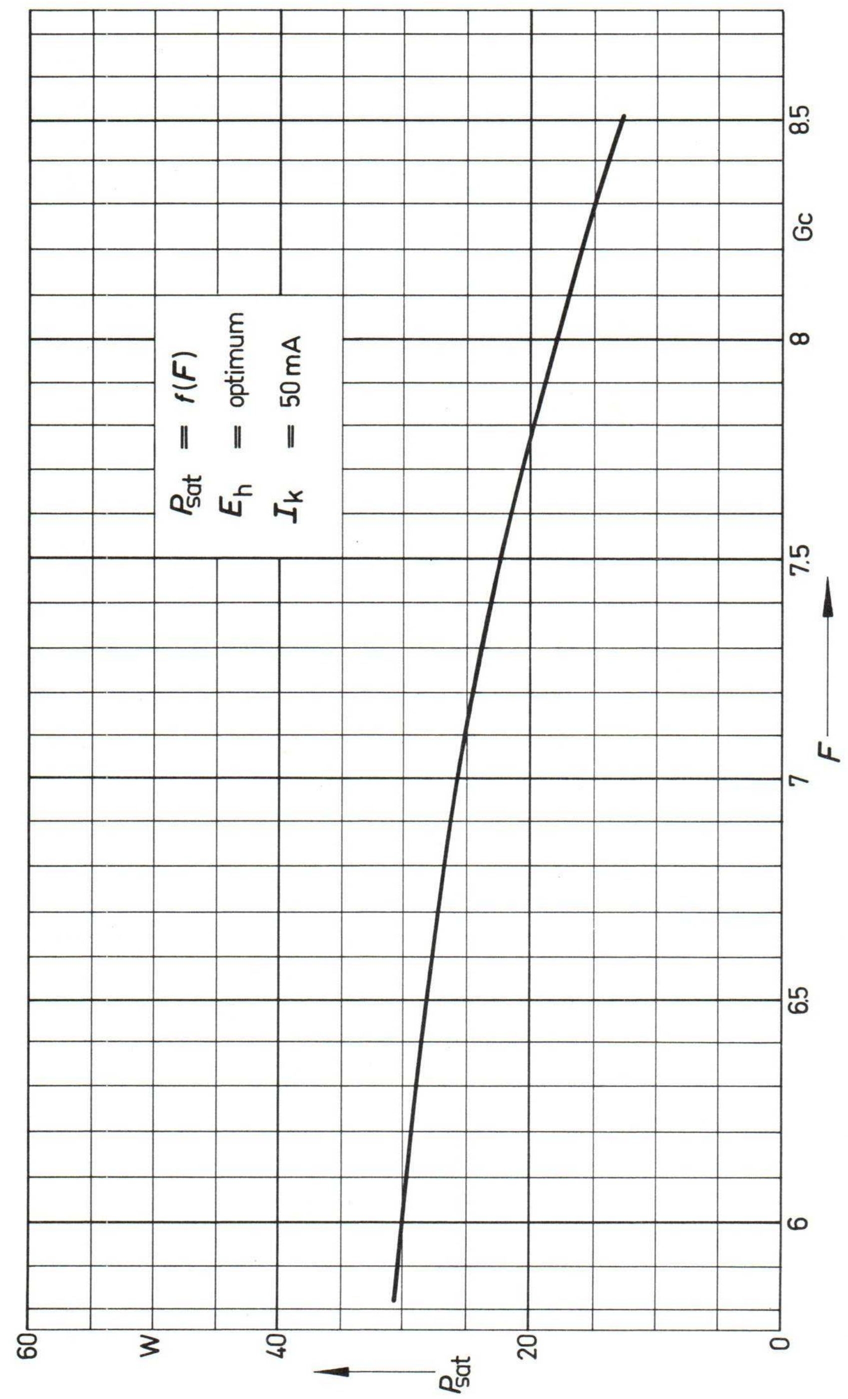


RöK 3518 E / 1.12.65


G = f (Po)
Ik = 50 mA
Eh = opt. for Po = 10 W
F = 8,4 Gc
G
db
45
40
35
30
25
Po
W
0
5
10
15

Characteristics

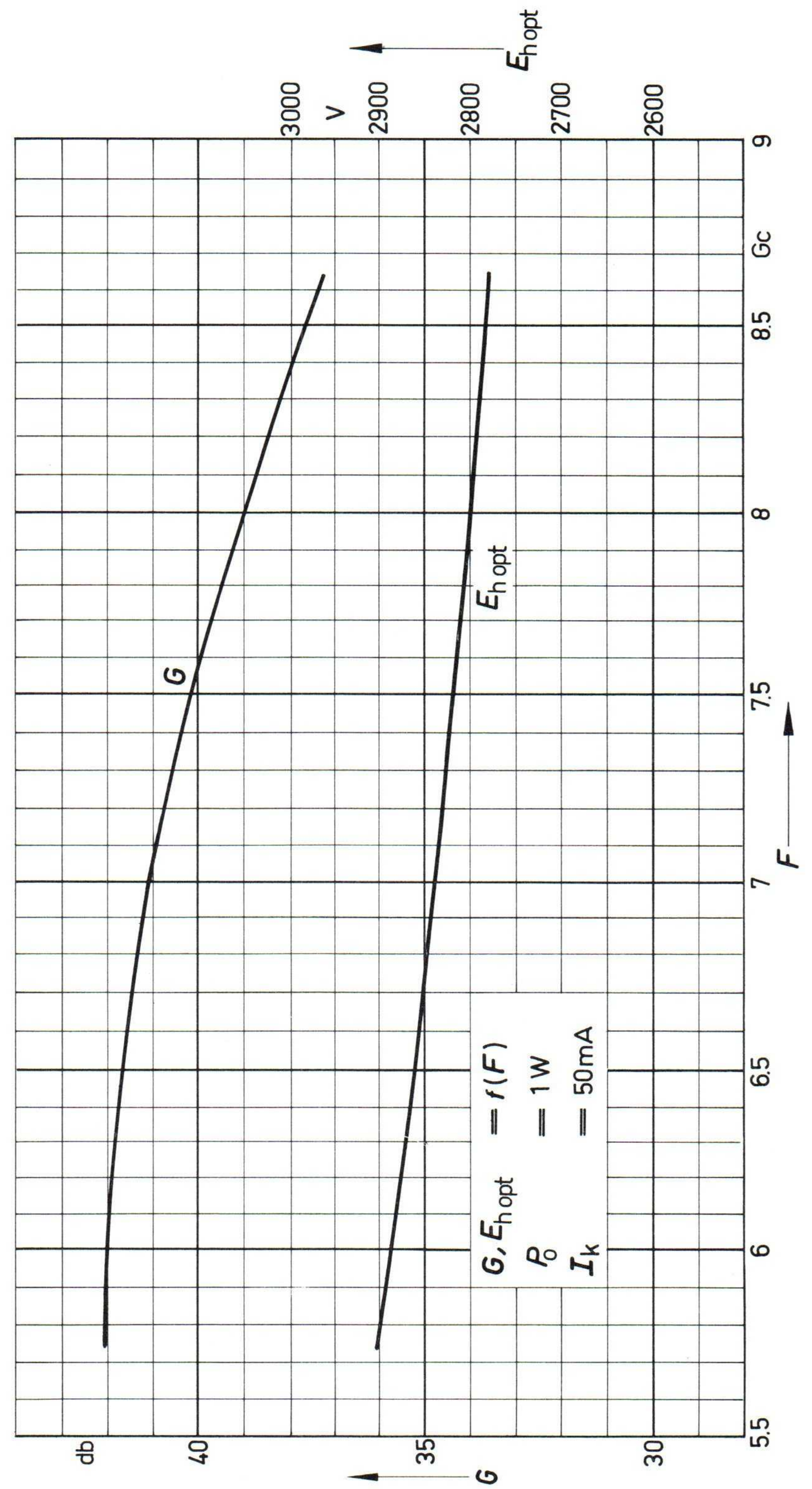
$P_{sat} = f\ (F)$



RöK 3518 E / 1.12.65

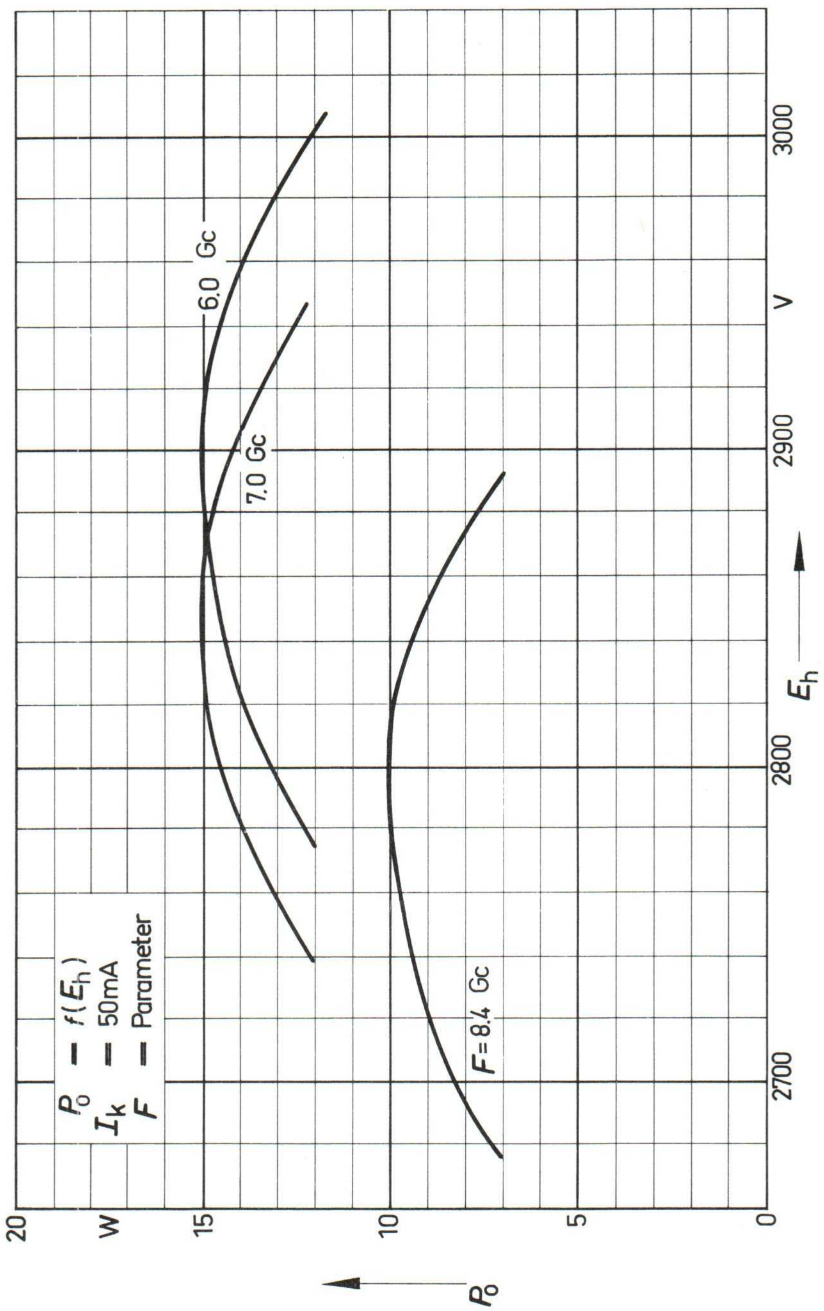
Characteristics

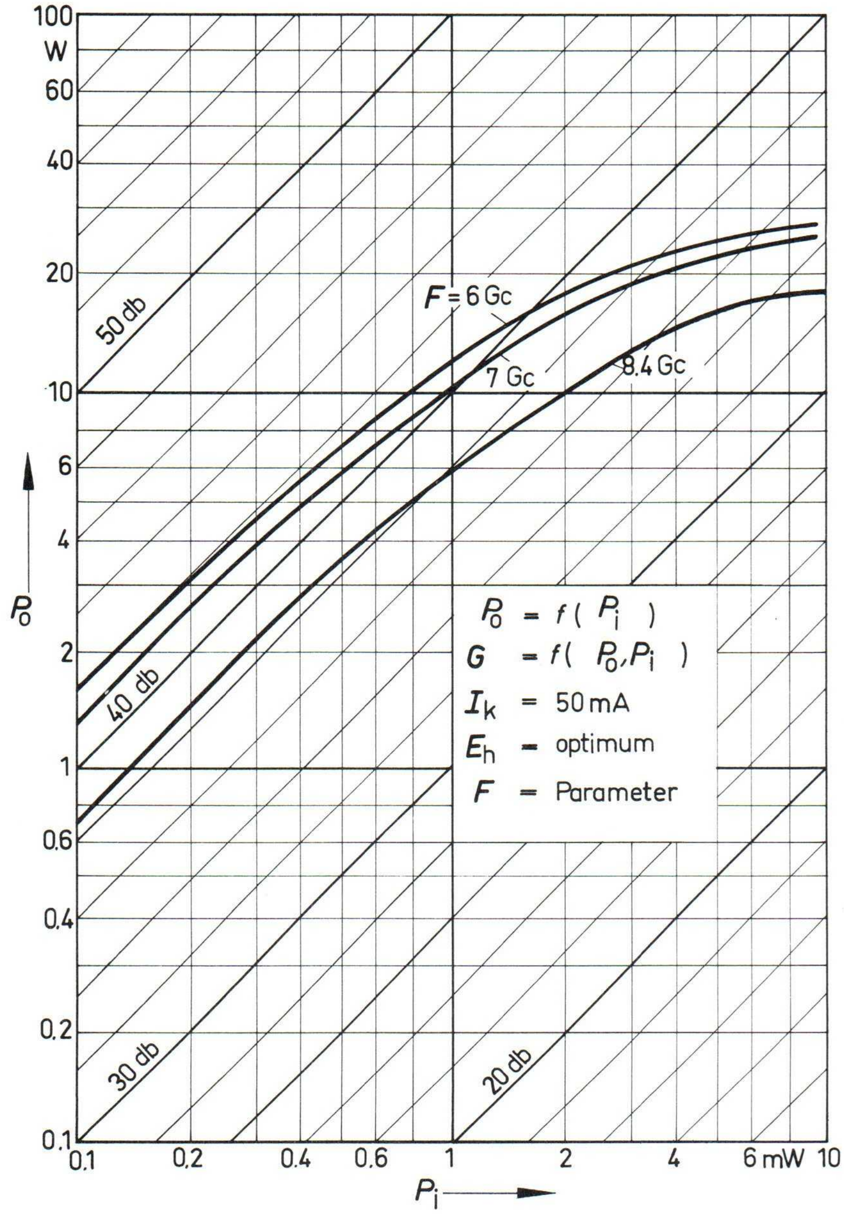
$G, E_{h\,opt} = f(F)$



Characteristics

$P_o = f(E_h)$




100
W
60
40
20
10
6
4
2
1
0.6
0.4
0.2
0.1
P_o
0.1
0.2
0.4
0.6
1
2
4
6 mW
10
P_i
50 db
40 db
30 db
20 db
F = 6 Gc
7 Gc
8.4 Gc
$P_o = f(P_i)$
$G = f(P_o, P_i)$
I_k = 50 mA
E_h = optimum
F = Parameter

SIEMENS

POWER TRAVELING WAVE TUBE

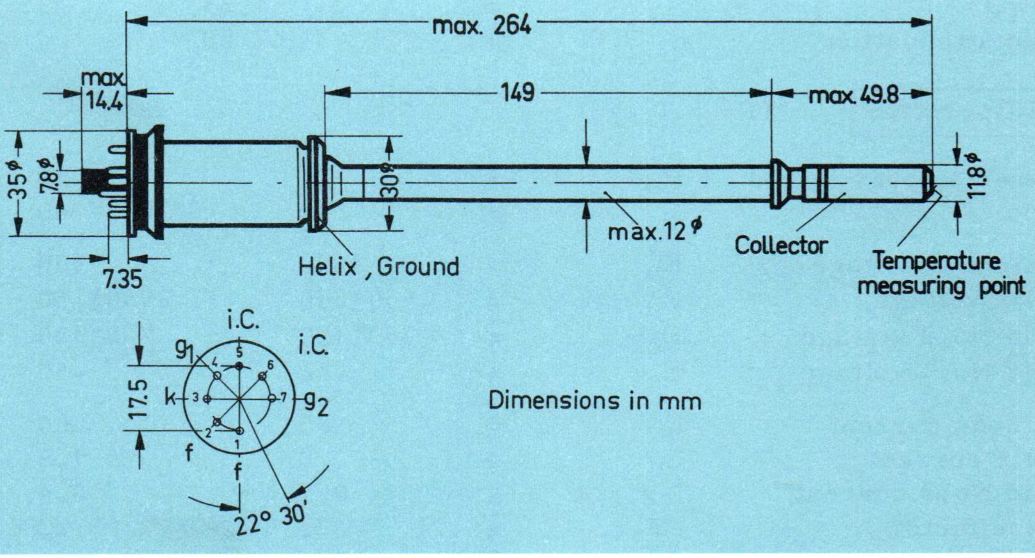
F = 5.8 to 8.5 Gc

RW 81

S&H-Sach-Nr.
Q00041-X3259

Design and Application

Power traveling wave tube with an average power output of 20 W up to 7 Gc respectively with an average power output of 15 W up to 8.5 Gc and an average gain of 39 db for use in radio relay systems.
The RW 81 is a periodic permanent magnet focused traveling wave tube and is a plug-in match in its associated magnet system MRW 80. The magnet system has a particularly small leakage field. The tube is designed to operate with depressed collector. The magnet system including the tube and the connections is provided with rf shielding.
The magnet system may be delivered by choice with a conduction cooler (MRW 80a) or with a convection cooler (MRW 80b). The rf power is coupled in and out by way of waveguides.



Tube base	: special type	(1)
Weight of magnet system	: approx. 9.5 kg (21 lbs)	
Weight of tube	: approx. 110 gm net (3.9 ozs)	
Dimensions of magnet system	: 100x112x264 mm without tube socket (3.9x4.4x10.4 ins)	
Dimensions of tube packing	: 175x175x475 mm (6.9x6.9x18.7 ins)	
Waveguide	: F 70, DIN 47302, 34.85x5 mm	
Flange	: UGF 70, DIN 47303	
Mounting position	: any (see "cooling")	

(1) The connector socket including cable can be supplied in axial form or with 90° bend to the axis, as desired (see page 8).

Heating

Heater voltage	E_f	=	6.3	Vac (1)
Heater current	I_f	≈	0.8	Aac
Preheating time	t_k	≥	2	min (2)

indirect by ac, parallel supply
Metal capillary dispenser cathode

Characteristics

(F = 6.0 Gc, I_k = 65 mA)

			min	nom	max	
Pulse saturation power	P_{sat}	=	27	35		W
Small signal gain	G	=	39	43		db
Gain at 20 W CW	G	=	37	41		db
VSWR		=		1.25	1.5	(3)
Cold attenuation	α	=		80		db

Typical Operation

(F = 6.0 Gc)

Power output	P_o	=	20	10	W
Gain	G	=	41	40	db
Collector voltage	E_b	=	1600	1300	V (4)
Helix voltage	E_h	=	2950±250	2950±250	V (5)
Grid No. 2 voltage	E_{c2}	=	750±150	700±150	V (5)
Grid No. 1 voltage	E_{c1}	=	-50	-50	V (4,6)
Cathode current	I_k	=	65	60	mA (4,7)
Helix current	I_h	≈	2	1.5	mA
Grid No. 2 current	I_{c2}	≦	0.1	0.1	mA
Noise factor	NF	≈	22	22	db
AM/PM conversion		≈	3.5	2	°/db (8)

(1) If the maximum variation of the heater voltage exceeds the absolute limits of ± 2 % the operating performance of the tube will be impaired and its life shortened.
(2) Once the tube has been operated at full voltages and currents, the preheating time for subsequent operation may be reduced to ≧ 45 sec.
(3) At input and output of cold tube in the frequency range 5.8 to 8.5 Gc
(4) Setting values
(5) The spreads quoted are intended for use when designing the power supply.
(6) It is advisable to obtain E_{c1} voltage by means of a cathode resistor.
(7) A variation of 1 mA cathode current in the range 58 to 65 mA produces a change in gain of approximately 0.5 db.
(8) AM/PM conversion is the phase shift of the rf output signal when changing the input by 1 db.

Typical Operation

(F = 8.0 Gc)

Power output	P_o	=	15	W
Gain	G	=	35	db
Collector voltage	E_b	=	1500	Vdc (1)
Helix voltage	E_h	=	2850 ± 250	Vdc (2)
Grid No. 2 voltage	E_{c2}	=	750 ± 150	Vdc (2)
Grid No. 1 voltage	E_{c1}	=	-50	Vdc (1, 3)
Cathode current	I_k	=	65	mAdc (1, 4)
Helix current	I_w	≈	2	mAdc
Grid No. 2 current	I_{c2}	≦	0.1	mAdc
Noise factor	NF	≈	22	db

Maximum Ratings

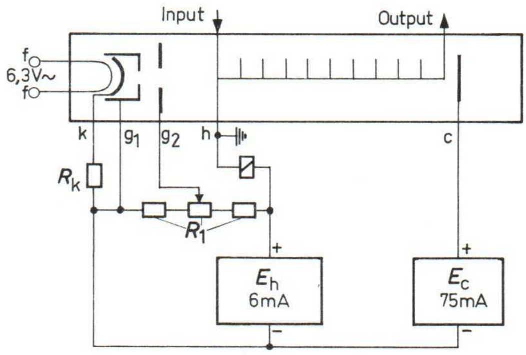
(absolute values)

Collector supply voltage	E_{bb}	max	1800	Vdc
Collector voltage	E_b	max	1700	Vdc
Collector dissipation	P_p	max	110	W
Helix voltage	E_h	max	3200	Vdc
Helix voltage	E_h	min	2400	Vdc
Helix current	I_w	max	3.5	mAdc
Peak helix current	i_w	max	6	madc (5)
Grid No. 2 voltage	E_{c2}	max	900	Vdc
Grid No. 2 dissipation	P_{c2}	max	0.2	W
Grid No. 1 voltage	$-E_{c1}$	max	100	Vdc
Grid No. 1 voltage	$+E_{c1}$	max	0	Vdc
Load VSWR		max	20	
Cathode current	I_k	max	70	mAdc
Collector temperature	T	max	270	°C (6)
Magnet system temperature	T	max	100	°C (7)
Ambient temperature	TA	min	-20	°C
Ambient temperature	TA	max	55	°C (8)

(1) Setting values
(2) The spreads quoted are intended for use when designing the power supply.
(3) It is advisable to obtain E_{c1} voltage by means of a cathode resistor.
(4) A variation of 1 mA cathode current in the range 58 to 65 mA produces a change in gain of approximately 0.5 db.
(5) During starting and due to power supply surges
(6) Without rf signal, the temperature of the collector may rise for three days maximum up to 300 °C.
(7) Measured at the waveguide (rf output). It may be necessary to remove the lacquer from the measuring point.
(8) See "cooling"

Operating Instructions

The traveling wave tube RW 81 is operated in conjunction with a magnet system MRW 80. The advantages of the periodic permanent magnetic focusing of the RW 81 are the particularly small dimensions of the magnet system and an extremely low leakage field. The sensitivity to temperature changes is low.
The magnet system should only be mounted by way of the fixing holes provided for this purpose. With operation in radio link systems, directional couplers should be connected to the tube input and output to avoid distortion due to multiple reflexions. The rf waveguide to the magnet system should be flexible to prevent any mechanical stress on the input and output ports of the magnet system.
All voltages applied to the tube are referred to the cathode.
The voltage drop in the heater supply leads must be taken into account.
The voltage must be set such that is is exactly 6.3 V at the socket. When using the standard cable of 1.1 m length supplied with the connector socket the total voltage drop is 0.1 V.
The Grid No.1 voltage can be obtained from a cathode resistor R_k. The Grid No.2 voltage must be variable within the range quoted. It is tapped from a voltage divider R_1, the total resistance of which must not exceed 2.5 Meg. Stability and residual hum voltage (helix voltage) depend upon the equipment requirements.
The collector voltage need not be stabilized, but it must not fall more than 50 Vdc below the indicated operating value.
A protective relay must be inserted in the helix supply circuit to disconnect the helix and Grid No.2 voltage, when the maximum permissible helix current is exceeded.
When using an independent voltage source for Grid No.2, the voltage must be automatically switched off immediately if the helix voltage fails.
This may be achieved by interlocking the protection circuits.
When the collector voltage fails, the helix voltage and Grid No.2 voltage must be disconnected either by the overload relay in the helix circuit or by a voltage interlocking system.



Cooling

To dissipate the heat from the collector the magnet system may either be provided with conduction cooling (MRW 80 a) or convection cooling (MRW 80 b).

Conduction Cooling

The heat dissipated by the collector is conducted to two Cu-plates, mounted on two opposite sides of the magnet system. The heat (max 40 W per plate) must be conducted from these plates. The temperature of the plate must not exceed 115 °C in this case. The plates are insulated from the collector and can be earthed.

Convection Cooling

If the tube is operated with a collector dissipation of less than 65 W and an ambient temperature of less than 40 °C no additional cooling is necessary provided that the tube is mounted in horizontal position with a natural vertical air circulation through the radiator. At higher collector dissipation up to 75 W a chimney with a cross section of 50 x 100 mm and a height of 800 mm will be sufficient, if cooling by a slight forced air flow (appr. 10 l/min) shall not be used. In any other case forced air cooling is necessary not to exceed the absolute limit of collector temperature of 270 °C.

Starting

For safe handling of the equipment, the magnet system must be properly grounded. (A solder tag is provided near the output port, see page 7).

1. Connection of dc-leads (initial starting):
   The collector voltage is connected by means of a high voltage cable to the solder tag under the coverplate of the cooling system (see page 7). The helix connection is soldered to the tag near the output port (see page 7). The other voltages are applied to the tube via the supply cable.
   The individual leads are color-coded as follows:

Heater	f,f	: brown, brown-yellow	
Cathode	k	: yellow	
Grid No. 1	g_1	: green, red	*)
Grid No. 2	g_2	: blue	
Earth		: black	

*) connect green and red lead together!

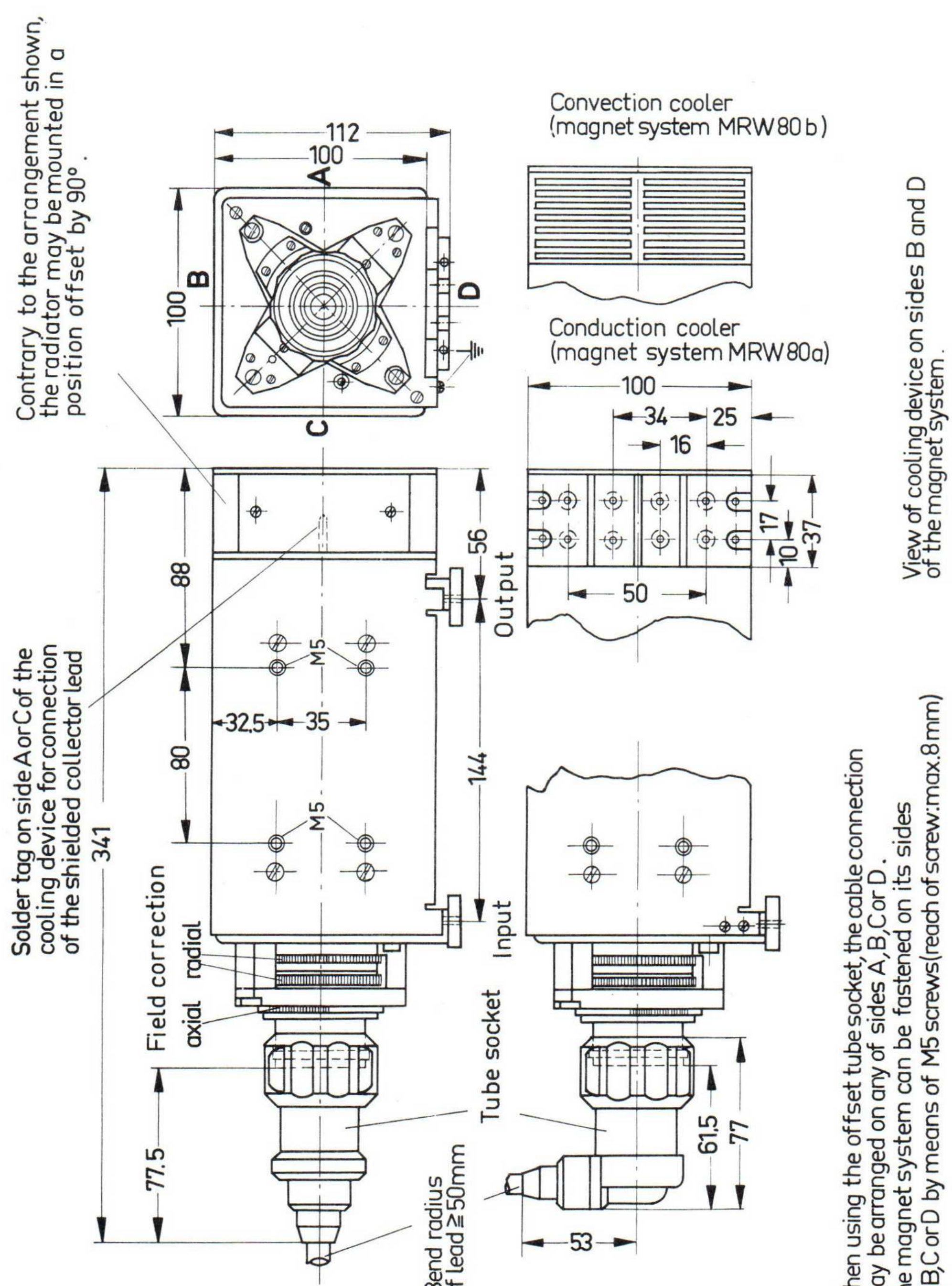
2. Unscrew the retaining nut

3. Insert the tube in magnet system, push on tube socket and screw on nut until stop is reached (avoid tilting the socket).

4. Apply heater voltage and preheat tube.
5. Apply collector voltage.
6. Switch on helix and Grid No. 2 voltages simultaneously (the time difference between applying the voltages to both electrodes must not exceed 0.2 sec.). Make sure that full voltages are applied immediately and not increased gradually to full value.
7. Adjust cathode current by varying Grid No. 2 voltage.
8. Adjust helix current to minimum with the aid of radial field correction (pair of rings at input end of magnet system) and axial field correction (additional ring at input end of magnet system).
9. Apply rf input signal and readjust helix voltage for optimum gain at specified power output.
10. Repeat field correction according to point 9. After interruption in operation up to 10 sec duration the tube may be switched on without preheating.

Switching off

The operating voltages can be switched off either simultaneously or in the reversed order to that in which they were applied.



Dimensions in mm

Ordering Numbers for Traveling Wave Tube RW 81 and Associated Elements

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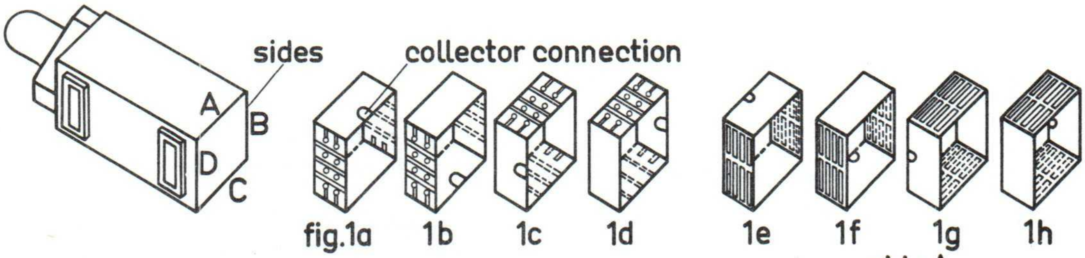
The various arrangements of the cooler assembly and collector connection



Form and direction of the connector socket

fig.2

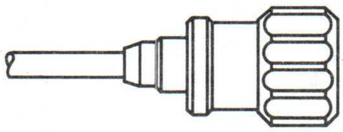
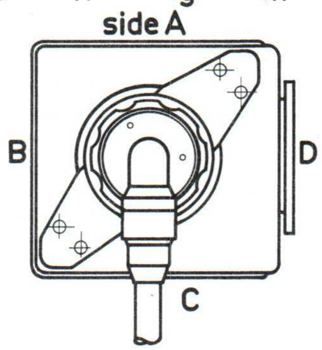


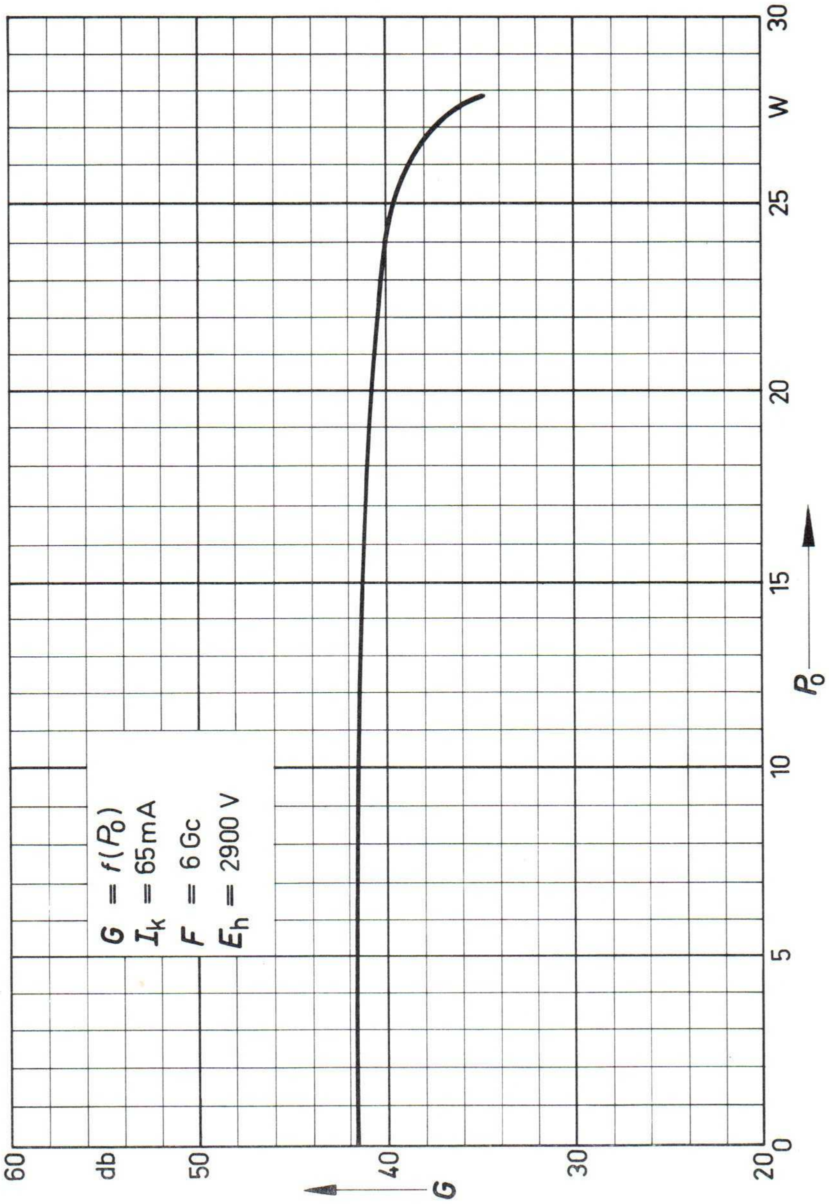
fig.3
shown in direction C



Ordering numbers for traveling wave tube RW 81 and associated elements

Designation	Design			Ordering numbers	Fig.
	Cooling	Cooling in direct.	Collector connection at side		
Traveling wave tube RW81				Q00041-X3259	
Magn. syst. MRW 80a11	Conduction	B-D	A	Q00043-X2361	1a
Magn. syst. MRW 80a12		B-D	C	Q00043-X2365	1b
Magn. syst. MRW 80a21		A-C	D	Q00043-X2362	1c
Magn. syst. MRW 80a22		A-C	B	Q00043-X2366	1d
Magn. syst. MRW 80b11	Convection	B-D	A	Q00043-X2363	1e
Magn. syst. MRW 80b12		B-D	C	Q00043-X2367	1f
Magn. syst. MRW 80b21		A-C	D	Q00043-X2364	1g
Magn. syst. MRW 80b22		A-C	B	Q00043-X2368	1h
RW-connector socket	axial			Q00081-X2321	2
RW-connector socket	bend in direction A		standard cable length 1.2 m (1)	Q00081-X2322	3
RW-connector socket	bend in direction B			Q00081-X2323	3
RW-connector socket	bend in direction C			Q00081-X2324	3
RW-connector socket	bend in direction D			Q00081-X2325	3
RW-connector socket	axial			Q00081-X2315	2
RW-connector socket	bend in direction A		cable length as required (2)	Q00081-X2316	3
RW-connector socket	bend in direction B			Q00081-X2317	3
RW-connector socket	bend in direction C			Q00081-X2318	3
RW-connector socket	bend in direction D			Q00081-X2319	3

(1) 0.1 m of this length as free leads
(2) When ordering please specify total length of cable and length of free leads


G = f(Po)
Ik = 65 mA
F = 6 Gc
Eh = 2900 V
Po
W
G
db
0
5
10
15
20
25
30
60
50
40
30
20

Characteristics

$P_o = f(P_i)$

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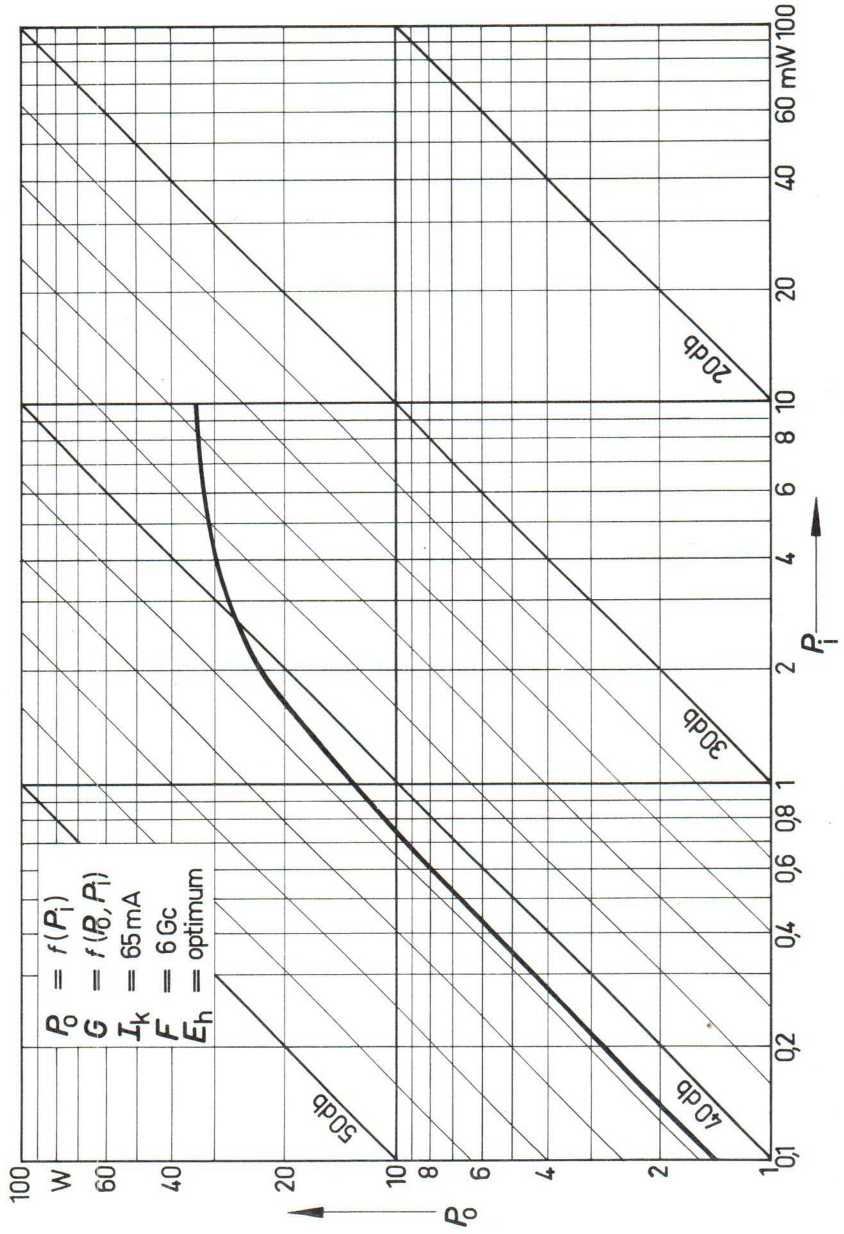


SIEMENS & HALSKE AKTIENGESELLSCHAFT

WERNERWERK FÜR BAUELEMENTE

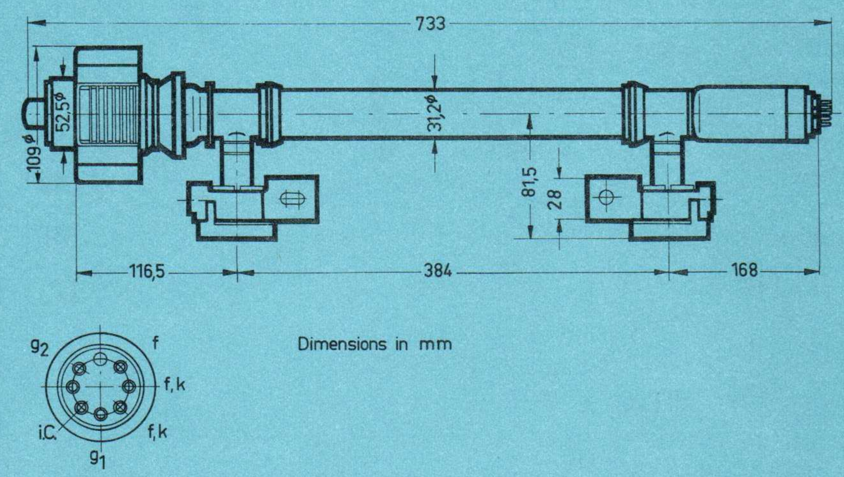
Printed in Germany

RöK 3519 E / 1.1.66

S&H-Sach-Nr.
Q00041-X4652

Design and Application

Forced air cooled high-power traveling wave tube for the frequency range from 470 to 960 Mc with an average pulse saturation power of 500 W and an average gain of 30 db.
The tube is intended for use in Band IV/V UHF TV transmitters and translators, FM sound transmitters and link amplifiers. It is focused by a permanent magnet, and is replaceable within this magnet system.
The tube is designed for use with coaxial input and output circuits.



Base	:	special type
Weight of tube	:	3 kg (6.6 lbs)
Weight of magnet system	:	40 kg (88 lbs)
Dimensions of magnet system	:	approx. 200 x 220 x 750 mm (8 x 8.5 x 29.5 ins)
rf connector	:	coaxial connection, 50 or 60 Ω (various standardized connections, see page 10)
Mounting position	:	any in stationed equipment

Heating

Heater voltage	E_f	=	6.3	Vac (1)
Heater current	I_f	≈	2.8	Aac

indirect by ac, parallel supply
Metal capillary dispenser cathode

Characteristics

(F= 700 Mc, I_k = 700 mA, E_h = 3100 V)

			min	nom	max	
Pulse saturation power	P_{sat}	=	450	550		W
Gain at 200 W CW	G	=	29	33		db
VSWR		=		1.35	1.85	(2)
Cold attenuation	α	=		80		db

(1) If the heater voltage variation exceeds the admissible 2 % of the setting value (absolute limits) the operational performance and life of the tube will be impaired.

(2) At tube input and output in the frequency range 470 to 960 Mc.

(3) Collector voltage always has to be 200 Vdc less than the helix voltage.

(4) During switch-on or as a result of mains surges.

(5) Measured at the outer edge of the last cooling fin on the side of air outlet.

(6) Measured at the magnet system near rf input and output (see page 9).

(7) It is recommended to set the grid No. 1 voltage by using a cathode resistor.

Maximum Ratings (absolute values)

Collector voltage	E_b	max	3100	Vdc	(3)
Collector voltage at zero collector current	E_{bo}	max	4000	Vdc	
Collector dissipation	P_p	max	2500	W	
Helix voltage	E_h	max	3300	Vdc	
Helix voltage at zero helix current	E_{ho}	max	4000	Vdc	
Helix current	I_h	max	30	mAdc	
Peak helix current	i_h	max	40	ma	(4)
Grid No. 2 voltage	E_{c2}	max	1000	Vdc	
Grid No. 1 voltage negative	$-E_{c1}$	max	200	Vdc	
Grid No. 1 voltage positive	$+E_{c1}$	max	0	Vdc	
Cathode current	I_k	max	750	mAdc	
Reflected CW power		max	20	W	
Collector temperature	T	max	200	°C	(5)
Magnet system temperature	T	max	55	°C	(6)
Ambient temperature	T_A	min	-20	°C	

Typical Operation

TV-band			IV	V	
Video carrier frequency	F_v	=	550	700	Mc
Synchron power output	P_{syn}	=	170	210	W
Gain	G	=	30	33	db
Collector voltage	E_b	=	3000	2900	Vdc
Helix voltage	E_h	=	3200	3100	Vdc
Grid No. 2 voltage	E_{c2}	≈	550	600	Vdc
Grid No. 1 voltage	$-E_{c1}$	=	100	100	Vdc (7)
Helix current	I_h	=	15	15	mAdc
Grid No. 2 current	I_{c2}	≦	±0.5	±0.5	mAdc
Cathode current	I_k	=	700	700	mAdc
Linearity (10 to 65 % peak amplitude)		≧	0.95	0.95	
Differential phase of the color sub-carrier		≦	3	3	degrees
Gain variation within the channel		≦	1	0.5	db

Footnotes on page 2

Maximum Ratings (absolute values)

Collector voltage	E_b	max	3100	Vdc	(1)
Collector voltage at zero collector current	E_{bo}	max	4000	Vdc	
Collector dissipation	P_p	max	2500	W	
Helix voltage	E_h	max	3300	Vdc	
Helix voltage at zero helix current	E_{ho}	max	4000	Vdc	
Helix current	I_h	max	20	mAdc	
Peak helix current	i_h	max	30	ma	(2)
Grid No. 2 voltage	E_{c2}	max	1000	Vdc	
Grid No. 1 voltage negative	$-E_{c1}$	max	200	Vdc	
Grid No. 1 voltage positive	$+E_{c1}$	max	0	Vdc	
Cathode current	I_k	max	800	mAdc	
Reflected CW power		max	20	W	
Collector temperature	T	max	200	°C	(3)
Magnet system temperature	T	max	55	°C	(4)
Ambient temperature	T_A	min	-20	°C	

Typical Operation

Video carrier frequency	f	=	700	Mc	
Synchron power output	P_{syn}	=	50	W	(5)
3 tone intermodulation ratio	IM_3	=	-34	db	(6, 7)
Gain	G	=	35	db	
Collector voltage	E_b	=	2900	Vdc	
Helix voltage	E_h	=	3100	Vdc	
Grid No. 2 voltage	E_{c2}	=	700	Vdc	
Grid No. 1 voltage	$-E_{c1}$	=	100	Vdc	(8)
Helix current	I_h	≈	8	mAdc	
Grid No. 2 current	I_{c2}	=	±0.5	mAdc	
Cathode current	I_k	=	750	mAdc	

(1) Collector voltage always has to be 200 Vdc less than the helix voltage.
(2) During switch-on or as a result of mains surges.
(3) Measured at the outer edge of the last cooling fin on the side of air outlet.
(4) Measured at the magnet system near rf-input and output (see page 9).
(5) A sync power output of more than 100 W can be obtained, if the linearity is subjectively judged only from the picture quality.
(6) See page 5
(7) These figures are valid for a difference in level between picture carrier (during sync pulses) and sound carrier of 7 db.
(8) It is recommended to set the grid No. 1 voltage by using a cathode resistor.

(6) The distortion of a tv signal produced by non-linear effects can be determined by passing a simulated tv signal consisting of unmodulated picture carrier F_v, sound carrier F_s and sideband F_{sb} through the traveling wave tube. The non-linear effects in the amplifier produce spurious frequencies within the tv channel and one of these, F_{sp} has a particularly large amplitude compared with any others within the channel and is therefore of concern. If the amplitudes of the 3 input frequencies are selected as indicated in fig. 1, the amplitude ratio between the frequencies F_{sb} and F_v corresponds to the white-to-black amplitude range of a tv signal. The frequency response of the television receiver used has been taken into account here, namely that the picture carrier is reduced by 6 db to the Nyquist flank.

A measure of the intermodulation products of interest is expressed by the difference in power output, in decibels, at the side-band frequency F_{sb} and the spurious frequency F_{sp}. This difference in level is given in the operating data as the 3 tone intermodulation ratio IM_3 and is referred to the sync power level at which the tube is operating. In fig. 1 and fig. 2 the sync power level is assumed to be 0 db.

Virtually the same information on intermodulation products produced by non-linear effects in the amplifier may also be obtained by using the 2 tone method. In this case the tube is driven by 2 unmodulated carriers of equal amplitude having frequencies F_1 and F_2, as shown in fig. 2. Of interest are the spurious frequencies $2\,F_1 - F_2$ and $2\,F_2 - F_1$ at the output, which are third order intermodulation products. The ratio, in decibels, of the power output at one of the spurious frequencies to the power output at one of the input frequencies gives the 2 tone intermodulation ratio IM_2, and is once again a typical measure of amplifier performance. This ratio is generally referred to the sync power level, which is 6 db above the input signals as shown in fig. 2.

A relationship between the 3 tone and 2 tone intermodulation ratios can be found mathematically and is also verifiable by experiment. This relationship depends on the difference in level between picture carrier (during sync pulses) and to sound carrier. If the difference is 7 db, as standardized in Europe, to a close approximation the formula $IM_3 = IM_2 + 3$ db is valid. It must be taken into account, that both IM_2 and IM_3 are negative values. If this difference is 10 db, the 2 tone and 3 tone intermodulation ratios are identical.

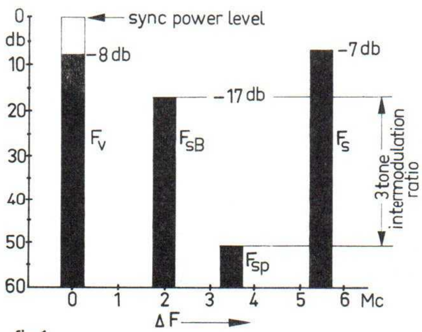


fig.1

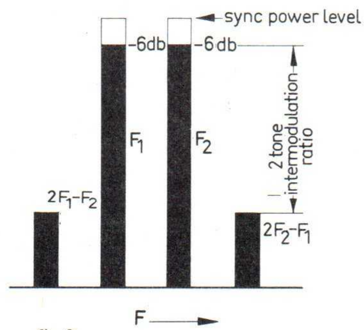
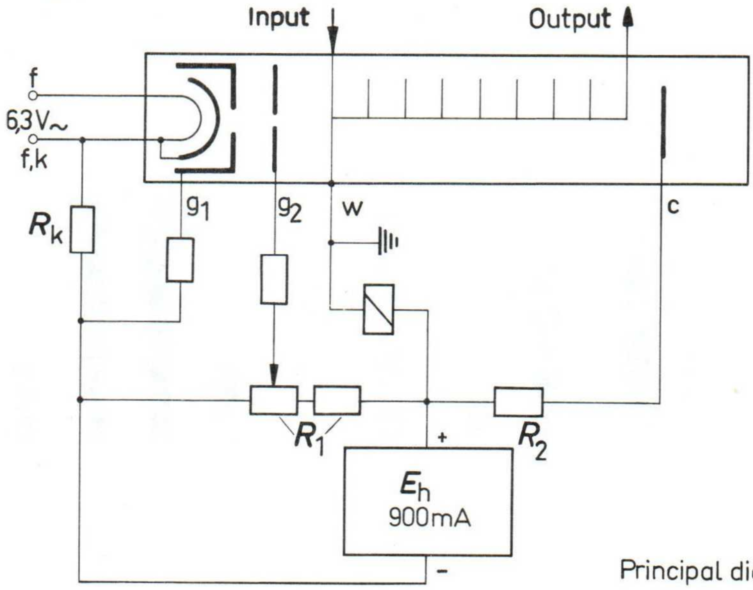


fig. 2

Operating Instructions

The traveling wave tube YH 1020 can only be operated in conjunction with its appropriate magnet system MYH 1020. This magnet has a low stray field and is practically insensitive to temperature. When mounting the magnet system the distance between the magnet system and large ferromagnetic parts (e.g. mounting supports) should be 60 mm (2.4") and between the magnet system and small ferromagnetic parts (e.g. screws) 30 mm (1.2"). Between two magnet systems the distance should amount to at least 90 mm (3.6"). The tube can be replaced by opening out the magnet system along its axis of symmetry.
All voltages applied to the tube are referred to the cathode.
The voltage drop in the cable should be considered when setting the heater voltage to the specified value. When using the socket and 1.1 meter length of cable supplied with the tube, the voltage drop in the cable is 0.25 V. The grid No. 1 voltage can be derived from the cathode resistor R_k. The supply voltages applied to grid No. 2 (E_{c2}), helix (E_h) and collector (E_b) are taken from a single power supply unit. (In case of deviations from this the manufacturer should be consulted.) The helix voltage should be variable between 2 700 and 3 300 Vdc, and the grid No. 2 voltage between 350 and 1,000 Vdc (see also footnote 1) on page 8).
The grid No. 2 voltage is derived from the potential divider R_1, the total resistance of which should not exceed 0.1 Meg. The collector voltage is lower than the helix voltage by an amount corresponding to the voltage drop across R_2 (see operating data pages 2 and 3).
A protection relay should be incorporated in the helix supply line which automatically cuts out the combined voltage supply if the helix value rises above the limiting values.
In order to protect grid No. 1 and grid No. 2 a series resistance of 10 kΩ must be incorporated in each supply line.
For protection of grid No. 1 and grid No. 2 one resistor each of 10 kΩ has to be mounted into the supply line.
The heater and cathode are at a potential of approximately 3000 Vdc with respect to earth and the insulation of the heater transformer must therefore be designed accordingly.



Principal diagram

Cooling

The collector must be cooled by an air flow of approx. 3000 l/min, pressure drop approx. 30 mm of water.
The air cooling system must be included in the protection circuit so that the power supply inclusive heater voltage is switched off if the air fails.
The decisive factor influencing the design of the cooling system is that the maximum admissible collector temperature of 200° C (absolute limit), as measured on the outer edge of the last cooling fin, must not be exceeded.

Installation

The magnet system must be properly earthed at the earthing point provided (see page 9).

Insertion of tube into magnet system (precise details are contained in the comprehensive assembly instructions).

1. Slide tube into field straightener and screw together. The field straightener is an integral part of the magnet system.
2. Place tube and field straightener in the opened out magnet system and fasten with screws.
3. Place focusing ring on the field straightener in the middle of the setting marks for field correction (see page 9).
4. Close magnet system.
5. Push socket onto tube base and screw retaining nut tight up to stop (connector socket should not be canted).
6. Fix the coaxial rf connectors to the tube input and output ports.

When mounting the magnet system and coaxial rf connectors and other connecting cables, any turning or bending moments on the tube input and output should be kept to a minimum.

Connection of supply voltage and switch-on sequence

1. Connect the individual leads (the first time the tube is placed in service): The collector voltage is applied to the tube through the high-voltage cable attached to the magnet system. The helix voltage lead is connected to the earthing plug socket on the earthing plug socket on the magnet system (see page 9).
   The remaining electrode voltages are applied to the tube via the supply cable screwed to the base of the tube. The individual leads in this cable are color-coded as follows:

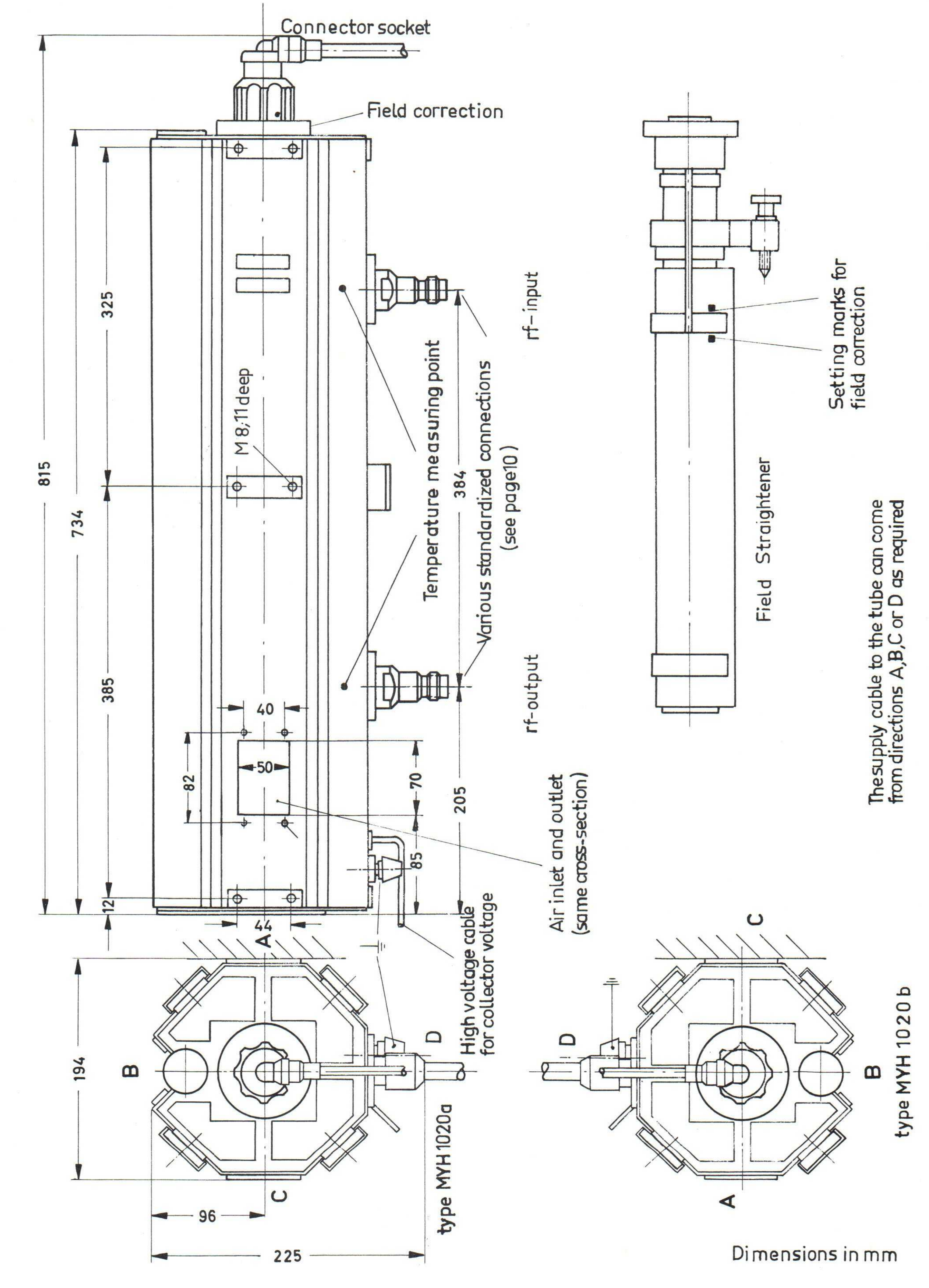
heater		: brown
heater/cathode	f/k	: brown-yellow (1)
cathode	k	: yellow (1)
grid No.1	g_1	: green
grid No.2	g_2	: blue
earth		: black

   The red lead must not be connected.

2. Switch-on air cooling (see also instructions under "cooling").
3. Switch-on all operating voltages, including heater voltage, simultaneously (see "Typical Operation" I resp. II and concerning characteristics). (2)
4. Adjust cathode current by varying grid No. 2 voltage.
5. Adjust helix current to minimum with the aid of axial field correction ring (large ring on the connector socket and of the magnet system).
6. Apply rf signal to input and repeat field correction as under 5.

(1) The cathode is internally connected to one side of the heater. It is advisible to connect to the cathode via the yellow lead in order to prevent hum troubles. The heater voltage is then applied separately through the brown and brown-yellow leads. If it is in fact decided to also connect heater and cathode additionally outside the tube, only the brown-yellow lead is to be connected to the yellow cathode lead.

(2) During the switch on phase the grid No. 2 voltage (E_{c2}) must be reduced automatically by at least 300 V. Suitable circuit proposals on request. At first operation or after longer non-operational periods (> 1 month) the tube should be run for approximately 10 minutes with E_{c2} = 0 V. On initial service and after very long non-operational periods, the starting period should be extended or repeated several times.

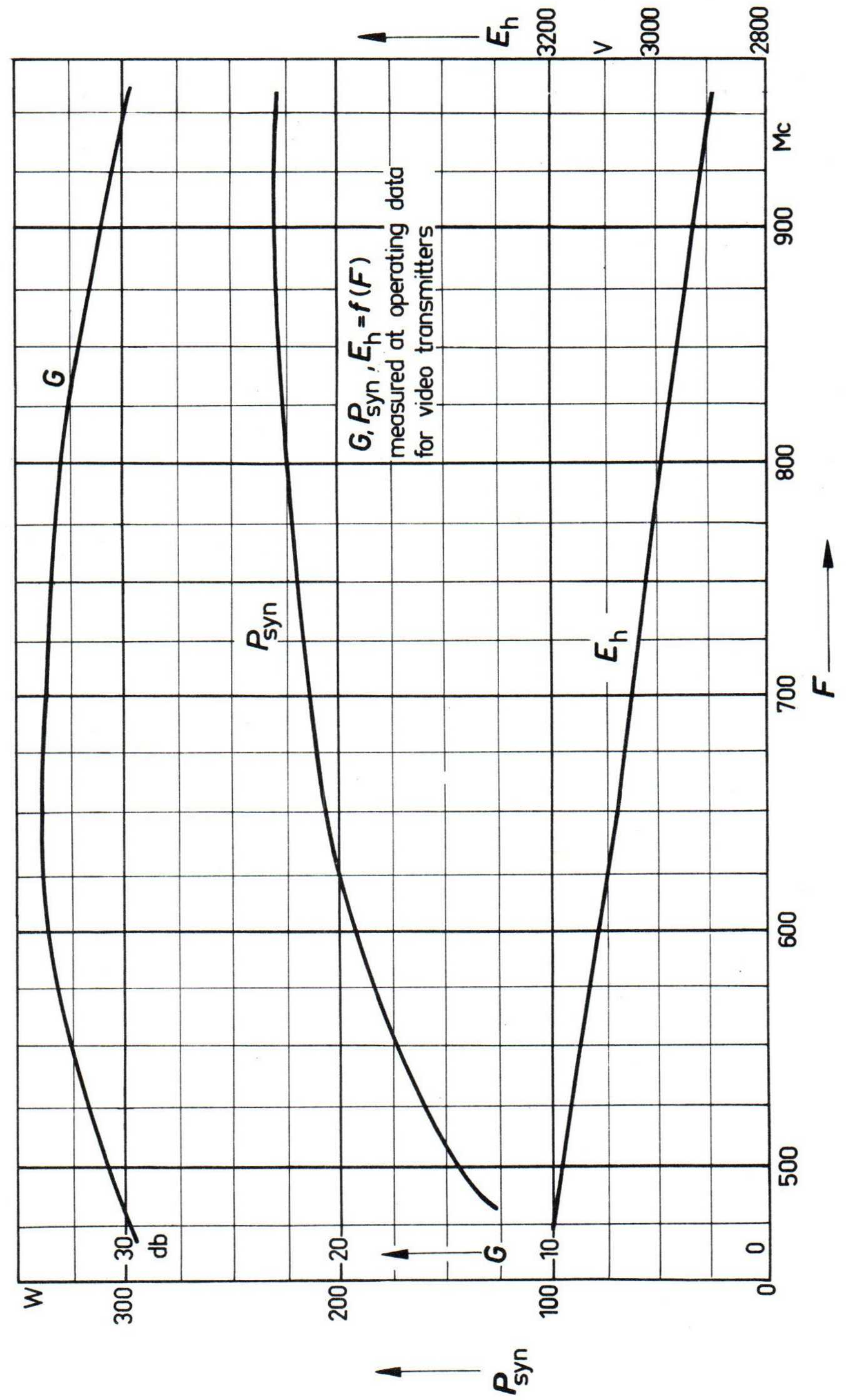


Connector socket
Field correction
M 8; 11 deep
Temperature measuring point
Various standardized connections
(see page 10)
rf-input
rf-output
Air inlet and outlet
(same cross-section)
High voltage cable
for collector voltage
815
734
325
385
384
205
12
40
50
82
70
85
44
194
96
225
A
B
C
D
type MYH 1020a
type MYH 1020 b
Field Straightener
Setting marks for
field correction
The supply cable to the tube can come
from directions A, B, C or D as required
Dimensions in mm

Ordering Numbers for Traveling Wave Tube YH 1020 and Associated Elements

Designation	Design		Ordering numbers	Fig.
Traveling wave tube YH 1020			Q00041-X4652	
Magn. syst. MYH 1020 a	Coax. connector (right)		Q00043-X2391	page 9
Magn. syst. MYH 1020 b	Coax. connector (left)		Q00043-X2392	page 9
Coax. connector	60Ω, 3.5/9.5		Q00081-X2401	
Coax. connector	60Ω, 6/16		Q00081-X2402	
Coax. connector	50Ω, 4.1/9.5		Q00081-X2403	
Coax. connector	50Ω, 7/16		Q00081-X2404	
Coax. connector	N-Connector		Q00081-X2405	
Coax. connector	C-Connector		Q00081-X2406	
Coax. connector	BNC-Connector		Q00081-X2407	
Coax. cable M6/16 L50	60Ω, 6/16; length 0.5 m		Q00081-X2311	
RW-connector socket	axial		Q00081-X2321	
RW-connector socket	bend in direction A	standard cable length 1.2 m (1)	Q00081-X2322	page 9
RW-connector socket	bend in direction B		Q00081-X2323	page 9
RW-connector socket	bend in direction C		Q00081-X2324	page 9
RW-connector socket	bend in direction D		Q00081-X2325	page 9
RW-connector socket	axial	cable length as required (2)	Q00081-X2315	
RW-connector socket	bend in direction A		Q00081-X2316	page 9
RW-connector socket	bend in direction B		Q00081-X2317	page 9
RW-connector socket	bend in direction C		Q00081-X2318	page 9
RW-connector socket	bend in direction D		Q00081-X2319	page 9

(1) 0.1 m of this length as free leads
(2) when ordering please specify total length of cable and length of free leads


G, Psyn, Eh = f (F)
measured at operating data
for video transmitters
G
Psyn
Eh
F
Mc
W
V
db
0
100
200
300
10
20
30
2800
3000
3200
500
600
700
800
900

Characteristics

P_{syn}, G, E_h, $= f\,(F)$

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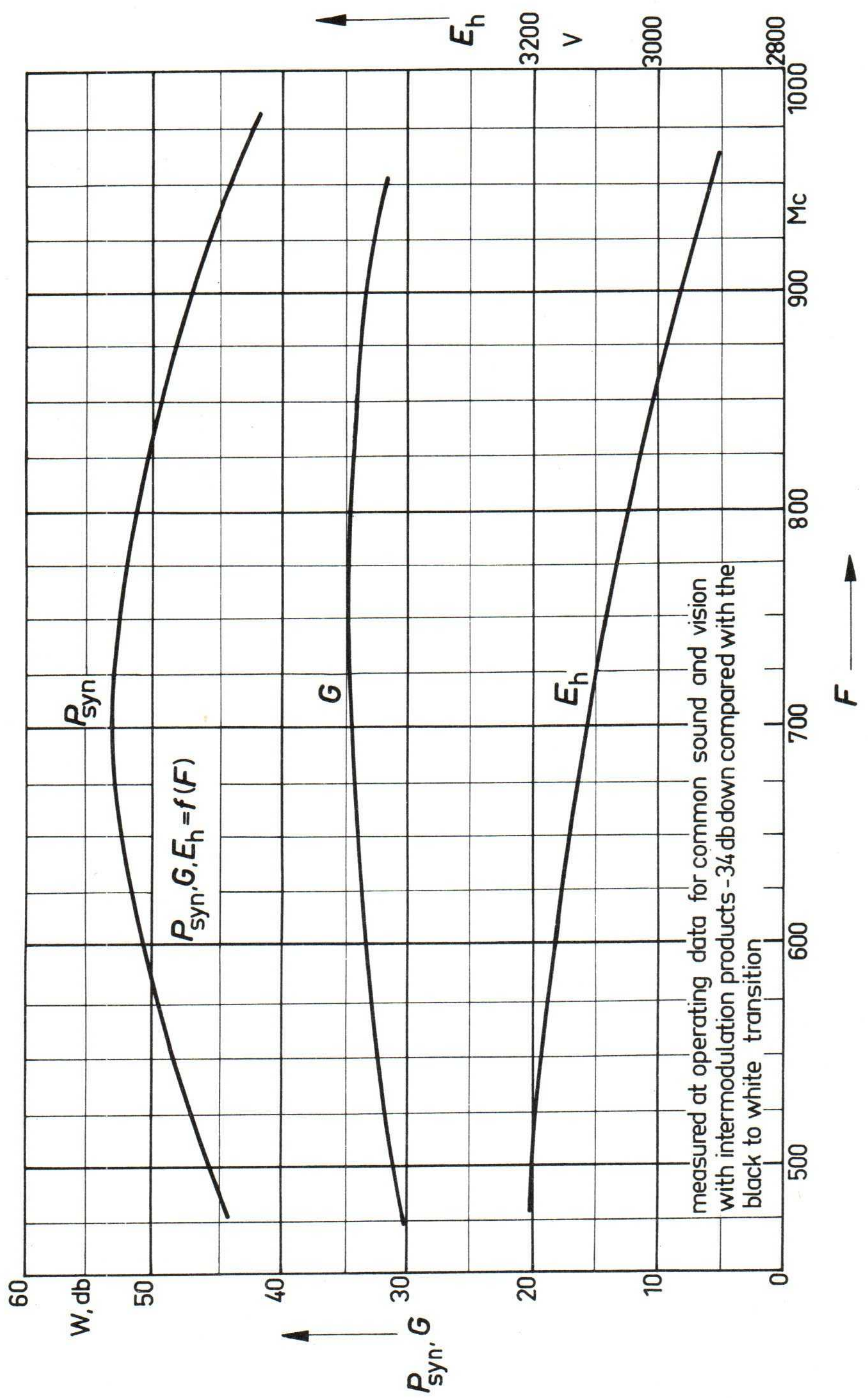

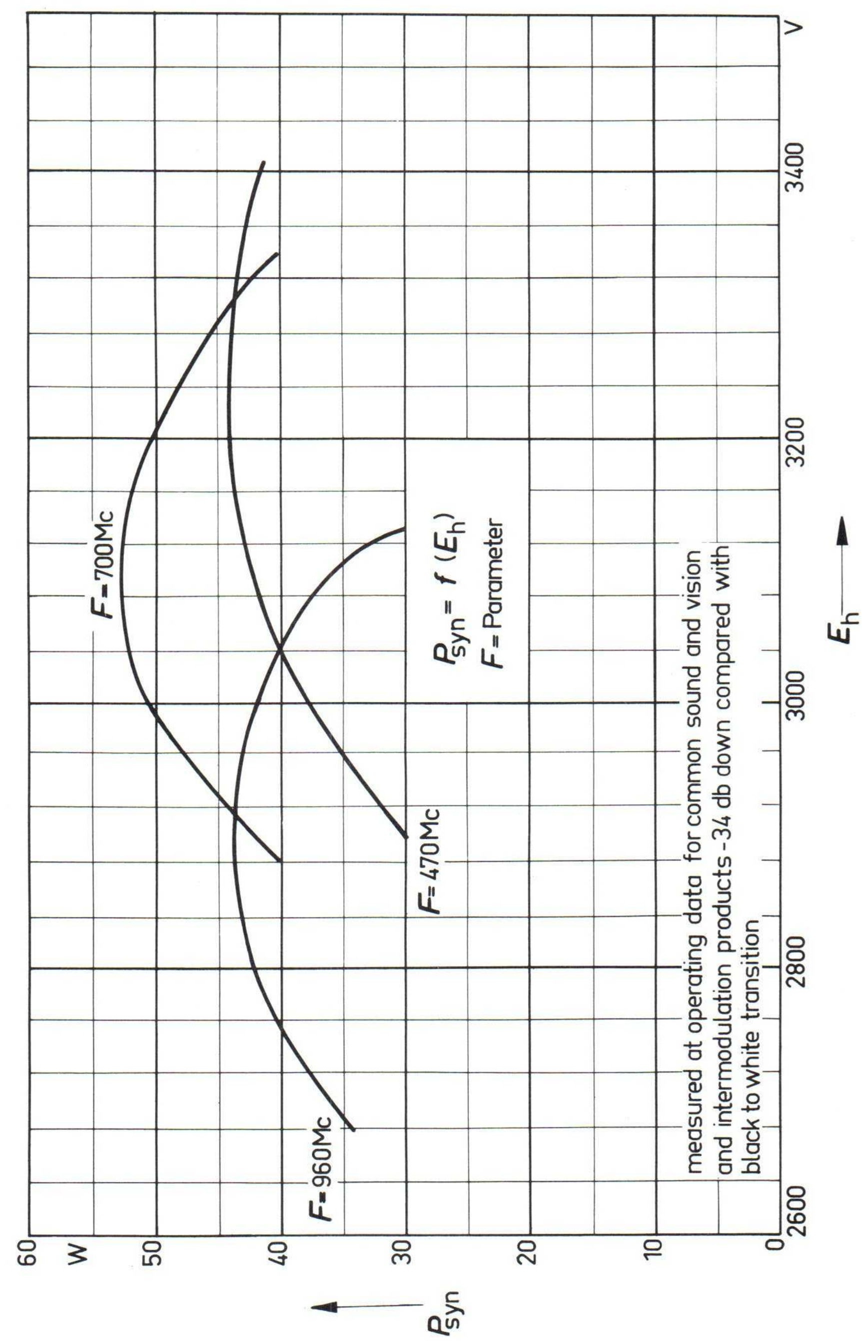
F = 700 Mc
F = 470 Mc
F = 960 Mc
$P_{syn} = f(E_h)$
F = Parameter
measured at operating data for common sound and vision and intermodulation products -34 db down compared with black to white transition
P_{syn}
W
60
50
40
30
20
10
0
E_h
V
2600
2800
3000
3200
3400

Characteristics

$G = f\,(E_h)$

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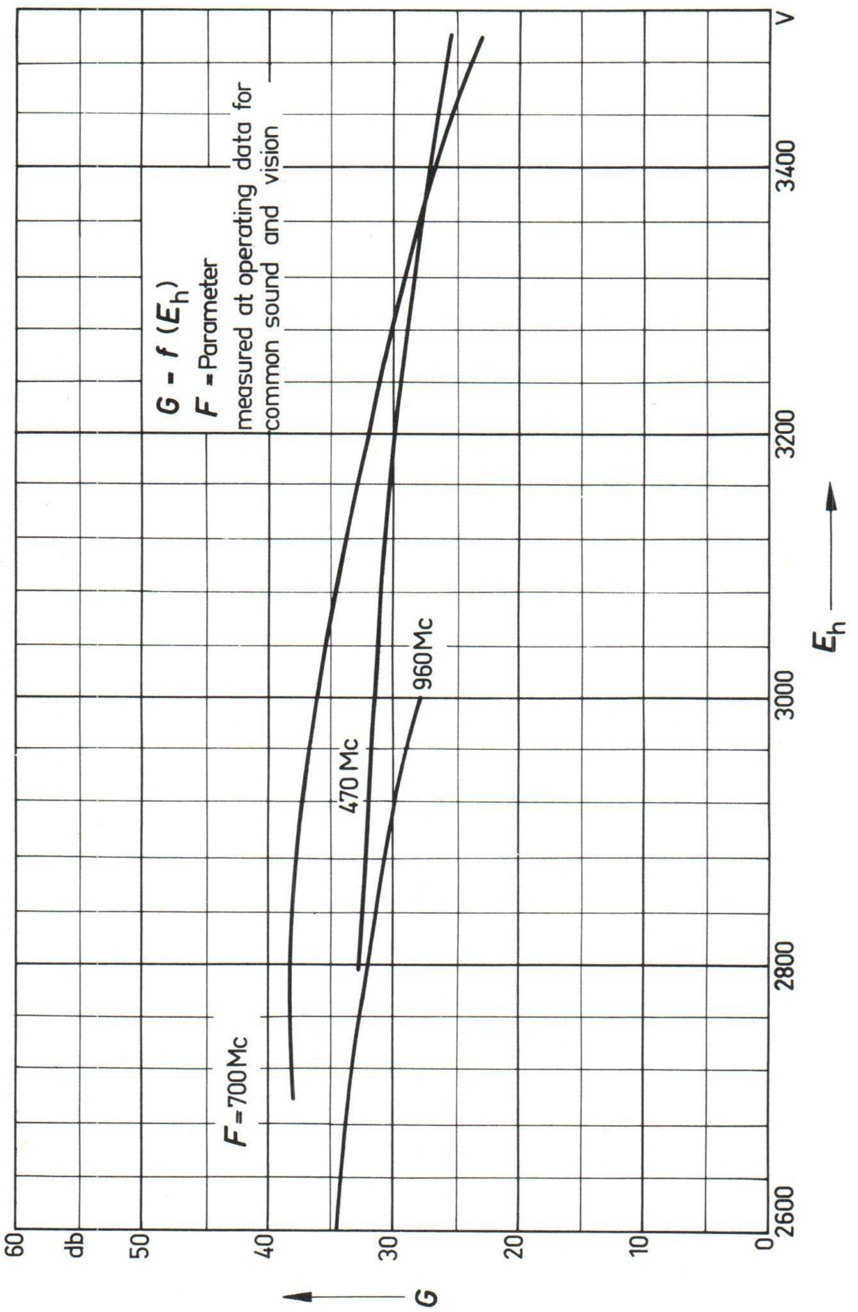


SIEMENS & HALSKE AKTIENGESELLSCHAFT
WERNERWERK FÜR BAUELEMENTE
Printed in Germany

RöK3509 E / 1.11.65

HIGH-POWER TRAVELING WAVE TUBE

F = 5.925 to 6.425 Gc

YH 1040

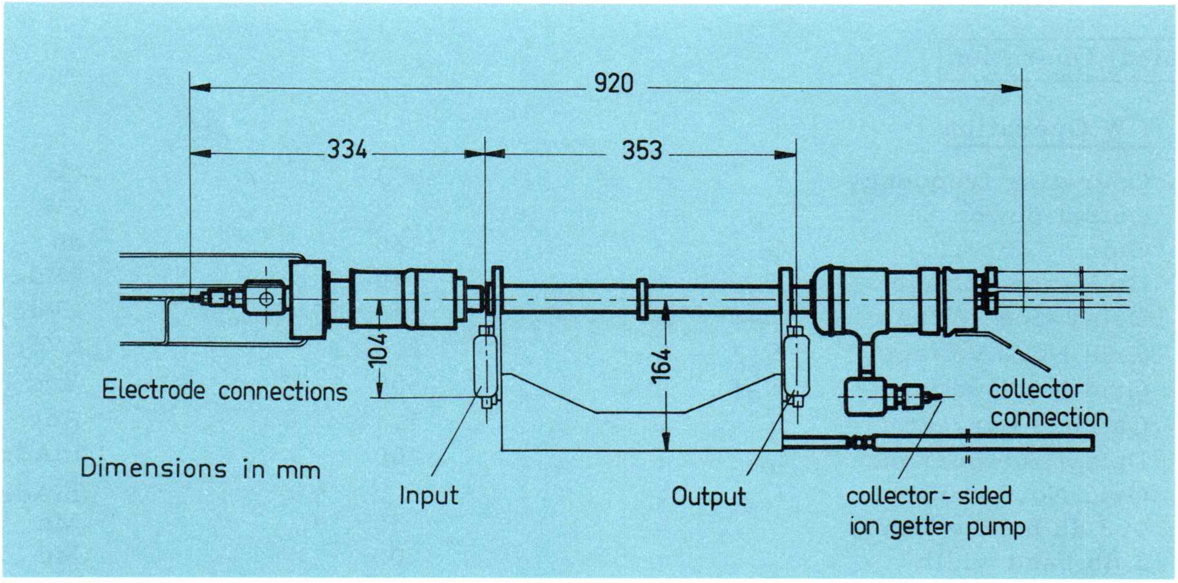
SIEMENS

S&H-Sach-Nr.
Q00041-X4654

Design and Application

Preliminary Data

High-power traveling wave tube for the frequency range from 5.925 to 6.425 Gc with a CW output power of 2 kilowatts and a gain of 30 db. The YH 1040 is a periodic permanent-magnet focused traveling wave tube and is designed to operate with depressed collector. Initial starting can be carried out be the customer according to the comprehensive instructions provided. After interruption of operation the preheated tube may be run at full power immediately. The tube is replaceable and can be mounted in the magnet system MYH 1040 within a short time.
The rf power is coupled in and out by way of waveguides. The collector and delay line are water-cooled.



Length of tube	: approx. 920 mm (36 ins)
Dimensions of magnet system	: approx. 920x220x335 mm (36x8.5x13 ins)
Weight of magnet system	: approx. 60 kg (132 lbs)
Weight of tube	: approx. 9.5 kg (21 lbs)
Waveguide	: F 70; DIN 47302, 34.85 x 15 mm
Flange	: UGF 70; DIN 47303

Heating

Heater voltage	E_f	=	6.5	Vac (1, 2)
Heater current	I_f	=	2.5	Aac
Preheating time	t_k	≧	5	min

indirect by ac, metal capillary dispenser cathode

Characteristics (F = 6.3 Gc, I_k = 1.1 Adc)

Pulse saturation power	P_{sat}	=	3	kW
Gain (P_o = 2 kW)	G	=	30	db
VSWR		≦	1.5	(3)
Cold attenuation	a	=	80	db

Typical Operation

CW Operation

Operating frequency	F	=	6.3	Gc
Output power	P_o	=	2	kW
Gain	G	=	30	db
Collector voltage	E_b	=	10	kVdc (4)
Delay line voltage	E_{d1}	≈	16	kVdc (1, 4)
Grid No. 2 voltage	E_{c2}	≈	2.6	kVdc (1)
Grid No. 1 voltage	E_{c1}	≈	-500	Vdc (1)
Cathode current	I_k	≈	1.1	Adc
Delay line current	I_{d1}	≈	100	mAdc
Grid No. 2 current	I_{c2}	≦	2	mAdc
0.2 db band width		=	30	Mc
3 db band width		=	500	Mc

(1) The exact setting value will be indicated for individual tubes.

(2) If the maximum variation of the heater voltage exceeds the absolute limits of ± 2 % the operating performance of the tube will be impaired and its life shortened. Stand-by operation is possible with E_f = 5.6 V, other electrode being switched off.
By increasing the heater voltage to its nominal value, and switching-on the remaining electrode voltages simultaneously, the tube can then be operated immediately at full rf power.

(3) At input and output of cold tube in the frequency-range 5.925 to 6.425 Gc.

(4) See Operating Instructions page 4.

Maximum Ratings (absolute values)

Collector voltage	E_b	max	15	kVdc (1)
Collector voltage	E_b	min	9	kVdc
Collector dissipation	P_p	max	16.5	kW
Delay line voltage	E_{d1}	max	17.5	kVdc
Delay line current (without rf)	I_{d1}	max	40	mAdc
Delay line current (with rf)	I_{d1}	max	150	mAdc
Grid No. 2 voltage	E_{c2}	max	3.5	kVdc
Grid No. 2 dissipation	P_{c2}	max	8	W
Grid No. 1 voltage neg.	$-E_{c1}$	min	50	Vdc
Grid No. 1 voltage neg.	$-E_{c1}$	max	2	kVdc
Load VSWR		max	1.5	
Cathode current	I_k	max	1.2	Adc
CW power output	P_o	max	2.2	kW
Ambient temperature	TA	min	-20	°C (2)
Ambient temperature	TA	min	60	°C (2)

(1) The collector voltage must be at least 1 kVdc lower than the delay line voltage

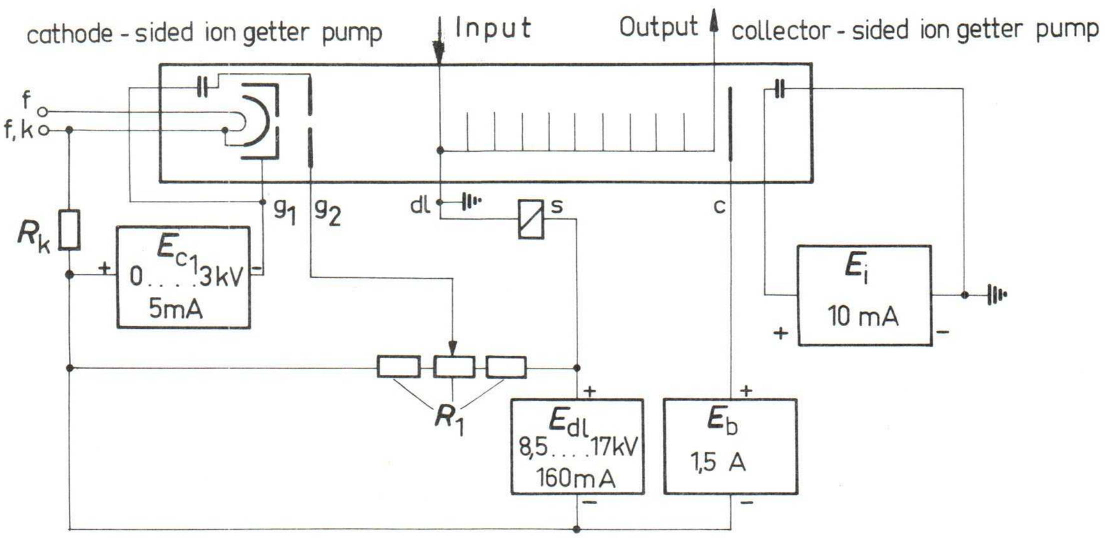
(2) For operation at lower or higher ambient temperatures please consult the tube manufacturer.

Operating Instructions

The traveling wave tube YH 1040 can be operated only in conjunction with a magnet system MYH 1040. The periodic permanent magnet focusing results in a small leakage field; the magnet system has a low sensitivity to temperature changes.
Ferromagnetic materials must be kept at a minimum distance from the magnet system as mounted in the equipment cabinet. Depending on size of material the following minimum distances apply

1. Small parts (screws) 10 mm (3/8 ins)
2. Larger parts (cabinet walls mounting brackets) 50 mm (2 ins)
3. Between two closed magnet systems 170 mm (6 3/4 ins)

In order to exchange the tube, the magnet can be swung open along the vertical axis.
All voltages applied to the tube are referred to the cathode.
To protect the tube, it is recommended that directional couplers be connected to the output.
If the tube shall operate with a collector voltage higher than 10 kVdc, the collector voltage must be adjustable in steps of ≦ 500 Vdc between 10 kVdc and the desired operating value for starting the tube.
The delay line voltage should be adjustable between 8.5 and 17 kVdc with an accuracy of ± 50 V.
The grid No. 2 voltage must be adjustable between 1.2 and 4 kVdc, to be picked off from the voltage divider R_1.
The grid No. 1 voltage can be generated by the cathode current across resitor $R_k \approx 100$ Ohms and an additional power supply adjustable between 0 and 3 kVdc.
The necessary stabilization of the delay line, grid No. 2 and grid No. 1 voltages and permissible hum depend on the requirements of each type of operation.
For communication transmissions to CCI specifications 0.1 ‰ must be met (this value refers to the peak value of the superimposed spurious voltages).
The heater and the cathode are at a potential of 17 kVdc with respect to ground. The heating transformer must therefore be dimensioned for this potential difference. The delay line lead must be provided with a protective device (S), which disconnects the operating voltages within 300 µs if the permissible maximum value of the delay line current is exceeded.



Ion Getter Pumps

For the collector-sided ion getter pump, a power supply is necessary delivering a dc voltage of 3 kVdc and a dc current of 10 mAdc. The cathode-sided ion getter pump is started by connecting the ion getter pump terminal with grid Nr. 1 terminal. The electrode voltages must be automatically disconnected if a pressure of 10^{-6} Torr is exceeded.
During pauses in operation and storage of the tube, the collector-sided ion getter pump must be kept in operation.

Cooling

To dissipate the heat developed, the collector and the delay line must be cooled by distilled water.
The cooling circuits must be dimensioned as follows:

Collector:	Water flow	≈ 25 ltr/min
	Pressure	≈ 3 atm
	Temperature at inlet	< 25 °C
	Temperature at outlet	< 35 °C
Delay line:	Water flow	≈ 2 ltr/min
	Pressure	≈ 3 atm
	Temperature at inlet	< 25 °C
	Temperature at outlet	< 35 °C

Appropriate measures have to be taken to prevent the formation of condensed water.
In view of the voltage difference between collector and delay line, it must be ensured that the water supply pipes are appropriately insulated.
The tube must be protected in such a way that the supply voltages are disconnected if there is a failure in the cooling system.

Starting

The tube is easily and quickly mounted into the magnet system, and centers itself automatically when laid into the magnet. The magnet system must be properly earthed.
The leads to the electrodes are color-coded as follows:

Heater	f	:	brown
Heater/cathode	f/k	:	yellow
Grid No. 1	g1	:	green
Grid No. 2	g2	:	blue
Collector	C	:	red

The lead for the delay line is connected to the magnet system.
The tube can be run up by the end user with the aid of the comprehensive instructions supplied.
After the tube has been run up for the first time, the preheated tube may be switched on immediately at full rf power.

Magnet System YH 1040

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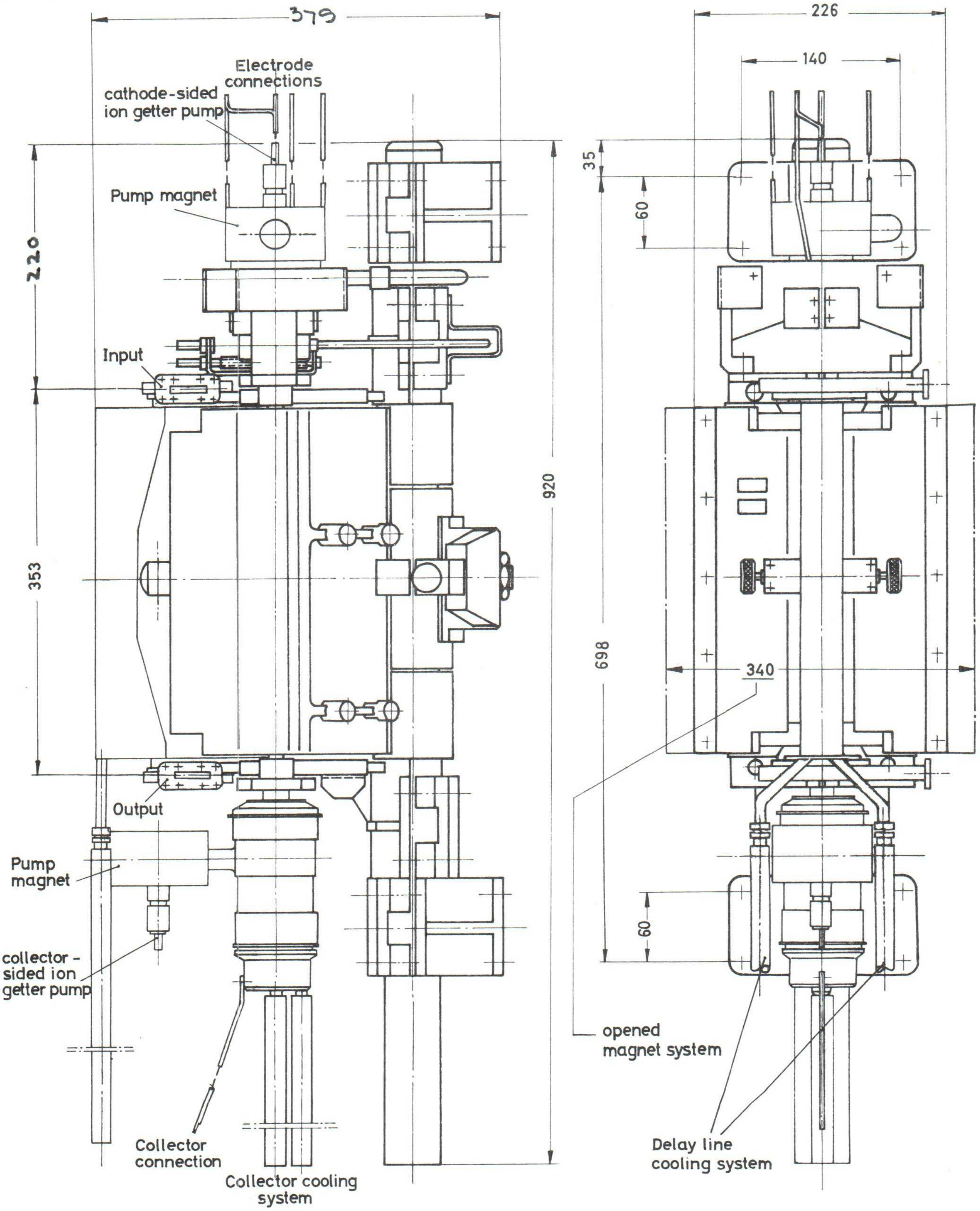
S&H-Sach-Nr.
Q00043-X2395



SIEMENS & HALSKE AKTIENGESELLSCHAFT

WERNERWERK FÜR BAUELEMENTE

Printed in Germany

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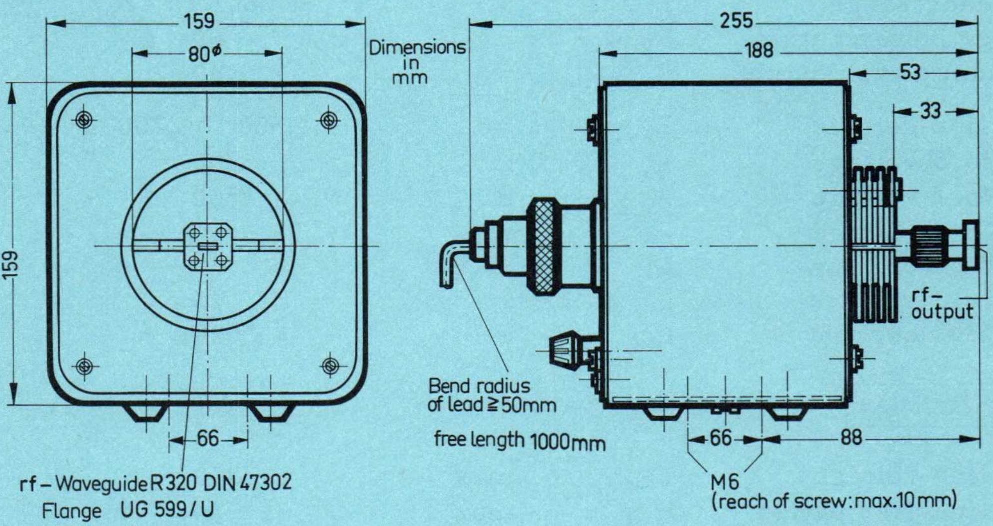
Design and Application

Backward-wave oscillator with an electronic tuning range of 26.5 to 42 Gc and an average power output of 60 mW and a minimum power output of 10 mW.
The oscillator is particularly suitable for measurements in the EHF range, for waveguide transmission systems, short-range EHF radar systems, and microwave spectroscopy.
Tube and magnet system form a single unit.



Weight of oscillator unit:	7.7 kg
Dimensions of packing:	190 x 190 x 390 mm

Heating

Heater voltage	E_f	=	6.3	Vac (1)
Heater current	I_f	≈	1	Aac
Cathode heating time	t_k	≥	2	min

indirect by ac, parallel supply
MK-dispenser cathode

Capacitances

Capacitance $C_{g1/k,g2,g3}$	=	6	µµf
Capacitance $C_{g2/k,g1,g3}$	=	5	µµf
Capacitance $C_{g3/k,g1,g2}$	=	4	µµf

Typical Operation

Frequency range	F	=	26.5 to 42	Gc
Average power output	$P_{o\ av}$	=	60	mW
Minimum power output	$P_{o\ min}$	=	10	mW
Delay line voltage	E_{dl}	=	500 to 2700	Vdc (2,3)
Grid No.3 voltage	E_{c3}	≈	200	Vdc (2)
Grid No.2 voltage	E_{c2}	≈	1500	Vdc (2)
Grid No.1 voltage	$-E_{c1}$	≈	60	Vdc (2)
Delay line current	I_{dl}	≈	13	mAdc
Grid No.3 current	I_{c3}	≈	3	mAdc
Grid No.2 current	I_{c2}	≈	0.4	mAdc

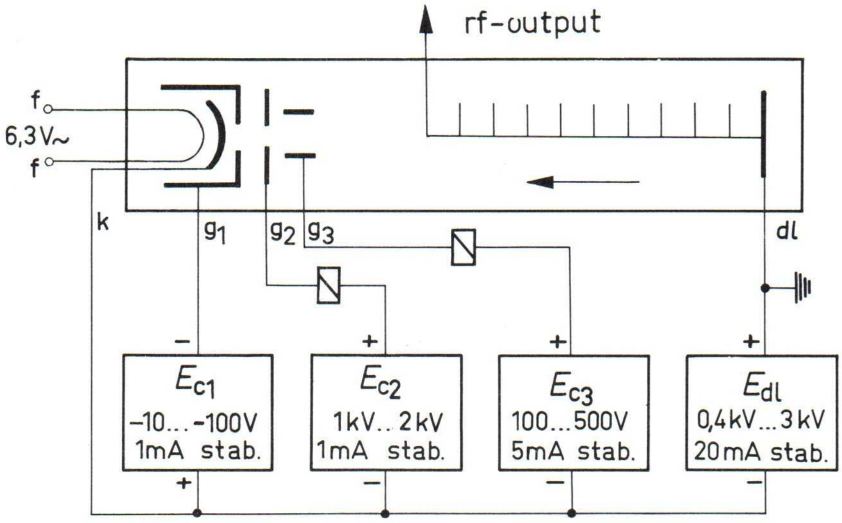
Maximum Ratings (absolute values)

Delay line voltage	E_{dl}	max	2800	Vdc
Delay line dissipation	P_{dl}	max	40	W
Grid No.3 voltage	E_{c3}	max	500	Vdc
Grid No.3 dissipation	P_{g3}	max	1.5	W
Grid No.2 voltage	E_{c2}	max	2000	Vdc
Grid No.2 dissipation	P_{g2}	max	1	W
Negative grid No.1 voltage	E_{c1}	max	10 to 400	Vdc
Cathode current	I_k	max	18	mAdc
Ambient temperature	T_A	min	-20	°C
Ambient temperature	T_A	max	55	°C

(1) With regard to the life of the tube the variation of the heater voltage may amount to ± 2 %. With respect to the requested frequency stability of the oscillator a much better stabilisation of the heater voltage will practically be necessary in any case.
(2) The exact setting value is shown on a curve delivered with each tube.
(3) Collector and delay line are electrically interconnected.

Operating Instructions

The tube and the permanent magnet required for guiding the beam form a single unit. The energy is coupled out through a rf waveguide R 320 DIN 47302 page 1 which is rigidly linked with the unit, and its associated flange UG-599/U.



Designations of the grids: g_1 = focusing electrode (Wehnelt)
g_2 = accelerating electrode
g_3 = focusing electrode

In the interest of good frequency stability, only regulated operating voltages, especially the delay line voltage and grid No.3 voltage should be used. The delay line voltage serves for setting the chosen operating frequency and must therefore be adjustable between 400 and 3000 Vdc. (See frequency range as function of collector and delay line voltage, K1). The other voltages should be adjustable within the limits indicated.

For protection of the tube, protective relays should be inserted in the grid No.2 and grid No.3 leads so that the grid No.3 and grid No.2 voltages are disconnected if the permissible grid dissipations are exceeded, or the power supplies for grids No.3 and No.2 should be protected in such a manner that they will be rapidly disconnected if any other operating voltage should fail or be disconnected.

A corresponding power supply (incl. collector connections) with an amplitude-modulation device RWON 11 and without an amplitude-modulation device RWON 111 can be supplied.

Modulation

Backward-wave oscillator RWO 40 may be operated with frequency modulation as well as with amplitude modulation by means of pulses or square waves. In the case of frequency modulation, the chosen modulation voltage is superimposed on the delay line voltage. The frequency swing can be adjusted by way of amplitude control. For keying the tube, a square-wave voltage of 250 volts peak-to-peak is applied between grid No. 1 and cathode, care having to be taken to ensure that the permissible limits of the grid No. 1 voltage (-10 to -400 volts) are not exceeded.

For modulation with square-wave pulses, it is practical to apply the bias required for continuous-wave operation to grid No. 1 and to modulate the tube by superimposing pulses of sufficient magnitude (250 volts peak-to-peak). In this case, normal operating voltages are applied to the other electrodes.

With square wave modulation the g_2, g_3 and delay line voltage supplies should have low source resistance, so as to ensure that as soon as the pulses are applied, the correct electrode voltages are also applied.

The devices required for the a/m modulations are contained already in the power supply RWON 11 available for RWO 40.

Cooling

For removing the heat, the radiator must be cooled with an air flow of about 150 l/min.
The cooling-air system must be protected in such a manner that the supply voltages are disconnected when the cooling system is cut out.

Starting

Color code of leads:

f	:	brown
f	:	brown-yellow
g_1	:	green
g_2	:	blue
g_3	:	red
dl	:	black
k	:	yellow

1. Switch on air cooling
2. Switch on heater voltage
3. Switch on grid No. 1 voltage to the operating value
4. Switch on delay line voltage (Edl) and grid No. 3 voltage (E_{c3})
5. Switch on grid No. 2 (E_{c2}) voltage to the value given on the attached card.

6. Adjust the tube to the required frequency by setting the delay line voltage as per the setting curve delivered with each tube.
7. Adjust grid No.3 voltage for optimum power.

Switching off

On no account switch the delay line voltage off first since the tube can be damaged.

1. Switch off grid No.2 voltage (E_{c2})
2. Switch off remaining supply voltages

After long breaks in operation (some weeks), it is recommended that the tube be operated at the following reduced voltages before switching on the full operating voltages for about 2 hours.

$E_{dl} \approx 1000$ Vdc $E_{c3} \approx 200$ Vdc $E_{c2} \approx 1000$ Vdc $E_{c1} \approx -70$ Vdc

Characteristics

$F = f(E_{dl})$

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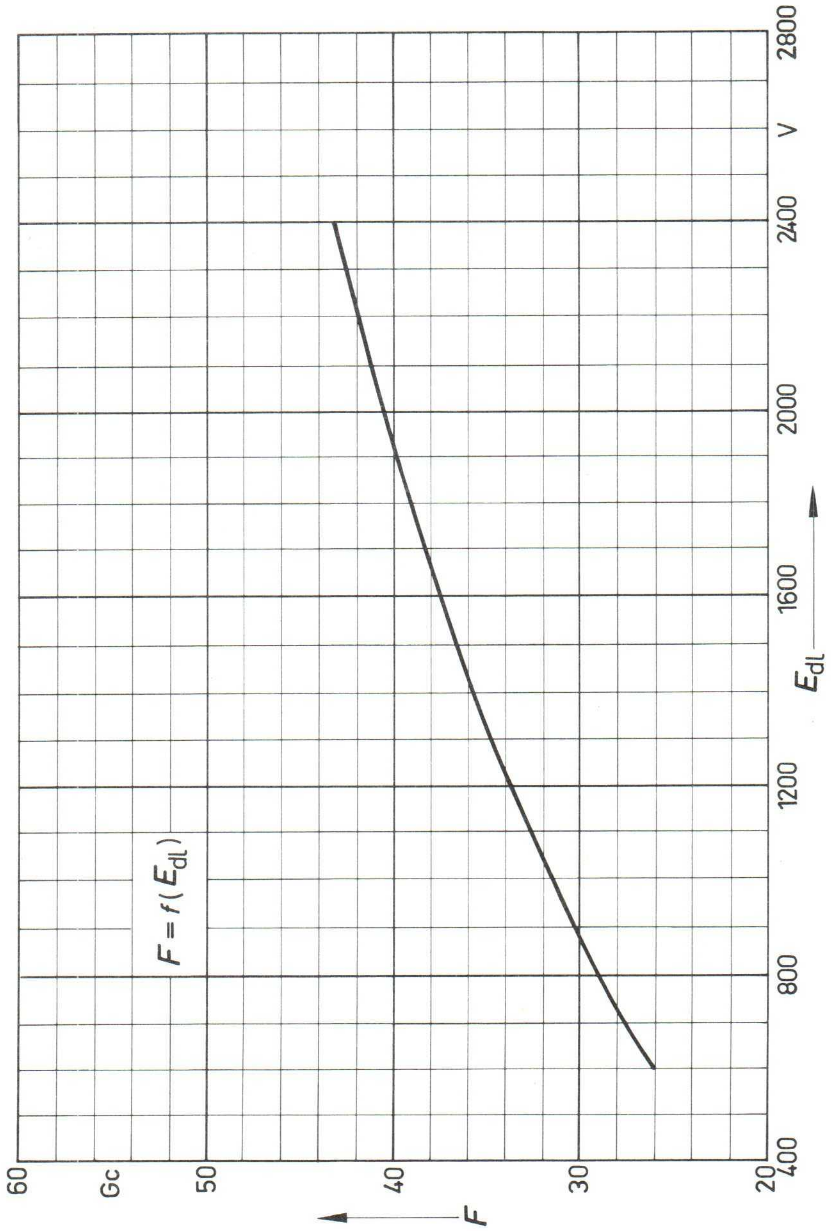


S I E M E N S & H A L S K E A K T I E N G E S E L L S C H A F T

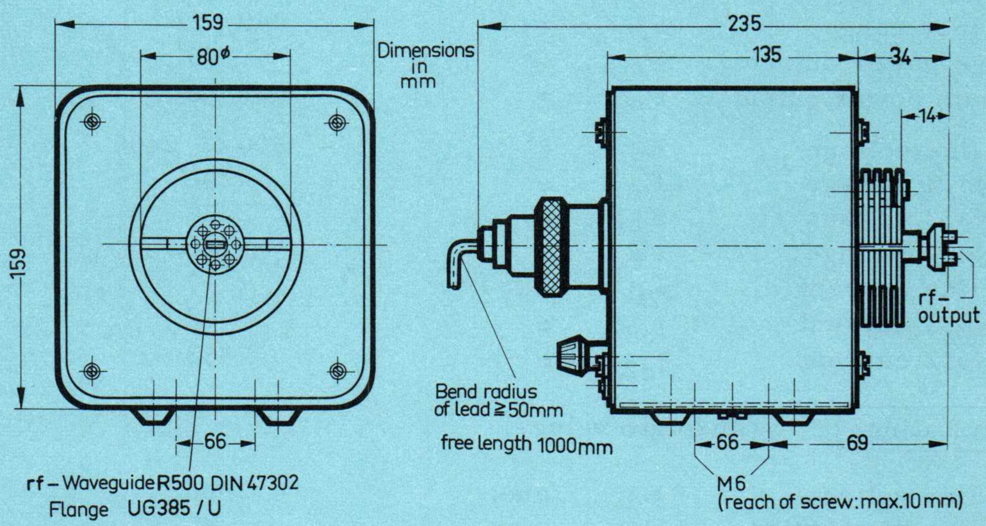
W E R N E R W E R K F Ü R B A U E L E M E N T E

Printed in Germany

S&H Sach-Nr.
Q00046-X3302

Design and Application

Backward-wave oscillator with an electronic tuning range of 40 to 61 Gc at an average power output of 20 mW and a minimum power output of 2 mW.
The oscillator is particularly suitable for measurements in the EHF range, for waveguide transmission systems, short-range EHF radar systems, and microwave spectroscopy.
Tube and magnet system form a single unit.



Weight of oscillator unit: 7.7 kg
Dimensions of packing: 190 x 190 x 390 mm

Heating

Heater voltage	E_f	=	6.3	Vac (1)
Heater current	I_f	≈	1	Adc
Cathode heating time	t_k	≧	2	min

indirect by ac, parallel supply
MK-dispenser cathode

Capacitances

Capacitance $C_{g1/k, g2, g3}$	=	6	μμf
Capacitance $C_{g2/k, g1, g3}$	=	5	μμf
Capacitance $C_{g3/k, g1, g2}$	=	4	μμf

Typical Operation

Frequency range	F	=	40 to 61	Gc
Average power output	$P_{o\ av}$	=	20	mW
Minimum power output	$P_{o\ min}$	=	2	mW
Delay line voltage	E_{dl}	=	500 to 2400	Vdc (2)
Grid No. 3 voltage	E_{c3}	≈	200	Vdc
Grid No. 2 voltage	E_{c2}	≈	2500	Vdc
Grid No. 1 voltage	$-E_{c1}$	≈	200	Vdc (3)
Delay line current	I_{dl}	≈	13	mAdc
Grid No. 3 current	I_{c3}	≈	2	mAdc
Grid No. 2 current	I_{c2}	≈	0.3	mAdc

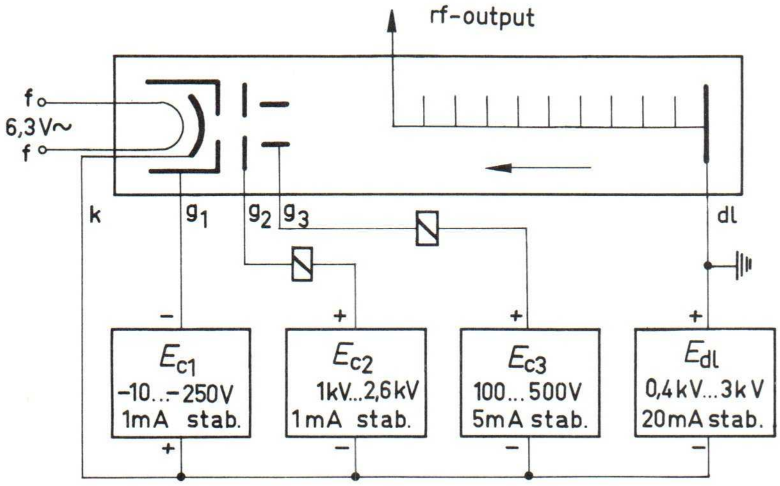
Maximum Ratings (absolute values)

Delay line voltage	E_{dl}	max	2800	Vdc
Delay line dissipation	P_{dl}	max	40	W
Grid No. 3 voltage	E_{c3}	max	500	Vdc
Grid No. 3 dissipation	P_{g3}	max	1.5	W
Grid No. 2 voltage	E_{c2}	max	2600	Vdc
Grid No. 2 dissipation	P_{g2}	max	1	W
Negative grid No. 1 voltage	E_{c1}	max	10 to 400	Vdc
Cathode current	I_k	max	18	mAdc
Ambient temperature	T_A	min	-20	°C
Ambient temperature	T_A	max	55	°C

(1) With regard to the life of the tube the variation of the heater voltage may amount to ± 2 %. With respect to the requested frequency stability of the oscillator a much better stabilisation of the heater voltage will practically be necessary in any case.
(2) The exact setting value is shown on a curve delivered with each tube.
(3) Collector and delay line are electrically interconnected.

Operating Instructions

The tube and the permanent magnet required for guiding the beam form a single unit. The energy is coupled out through an rf waveguide R 620 DIN 47302 which is rigidly linked with the unit, and its associated flange UG-385/U.



Designations of the grids: g_1 = focusing electrode (Wehnelt)
g_2 = acceleration electrode
g_3 = focusing electrode

In the interest of good frequency stability, only regulated operating voltages, especially the delay line voltage and grid No.3 voltage should be used. The delay line voltage serves for setting the chosen operating frequency and must therefore be adjustable between 500 and 2500 Vdc. (See frequency range as function of collector and delay line voltage, K1). The other voltages should be adjustable within the limits indicated.

For protection of the tube, protective relays should be inserted in the grid No.2 and grid No.3 lead so that the grid No.3 and grid No.2 voltages are disconnected if the permissible grid dissipations are exceeded, or the power supplies for grids No.3 and No.2 should be protected in such a manner that they will be rapidly disconnected if any other operating voltage should fail or be disconnected.

A corresponding power supply (incl. collector connections) with an amplitude-modulation device RWON 11 and without an amplitude-modulation device RWON 111 can be supplied.

Modulation

Backward-wave oscillator RWO 60 may be operated with frequency modulation as well as with amplitude modulation by means of pulses or square waves. In the case of frequency modulation, the chosen modulation voltage is superimposed on the delay line voltage. The frequency swing can be adjusted by way of amplitude control. For keying the tube, a square-wave voltage of 250 volts peak-to-peak is applied between grid No. 1 and cathode, care having to be taken to ensure that the permissible limits of the grid No. 1 voltage (-10 to -400 volts) are not exceeded.
For modulation with square-wave pulses, it is practical to apply the bias required for continuous-wave operation to grid No. 1 and to modulate the tube by superimposing pulses of sufficient magnitude (250 volts peak-to-peak). In this case, normal operating voltages are applied to the other electrodes.
With square wave modulation the g_2, g_3 and delay line voltage supplies should have low source resistance, so as to ensure that as soon as the pulses are applied, the correct electrode voltages are also applied.
The devices required for the a/m modulations are contained already in the power supply RWON 11 available for RWO 60.

Cooling

For removing the heat, the radiator must be cooled with an air flow of about 150 l/min.
The cooling-air system must be protected in such a manner that the supply voltages are disconnected when the cooling system is cut out.

Starting

Color code of leads:

f	: brown
fk	: brown-yellow
g_1	: green
g_2	: blue
g_3	: red
h	: black
k	: yellow

1. Switch on air cooling
2. Switch on heater voltage
3. Switch on grid No. 1 voltage to the operating value.
4. Switch on delay line voltage (E_{dl}) and grid No. 3 voltage (E_{c3})

5. Switch on grid No. 2 (E_{c2}) voltage to the values given on the attached card.
6. Adjust the tube to the required frequency by setting the delay line voltage as per setting curve delivered with each tube.
7. Adjust grid No. 3 voltage for optimum power.

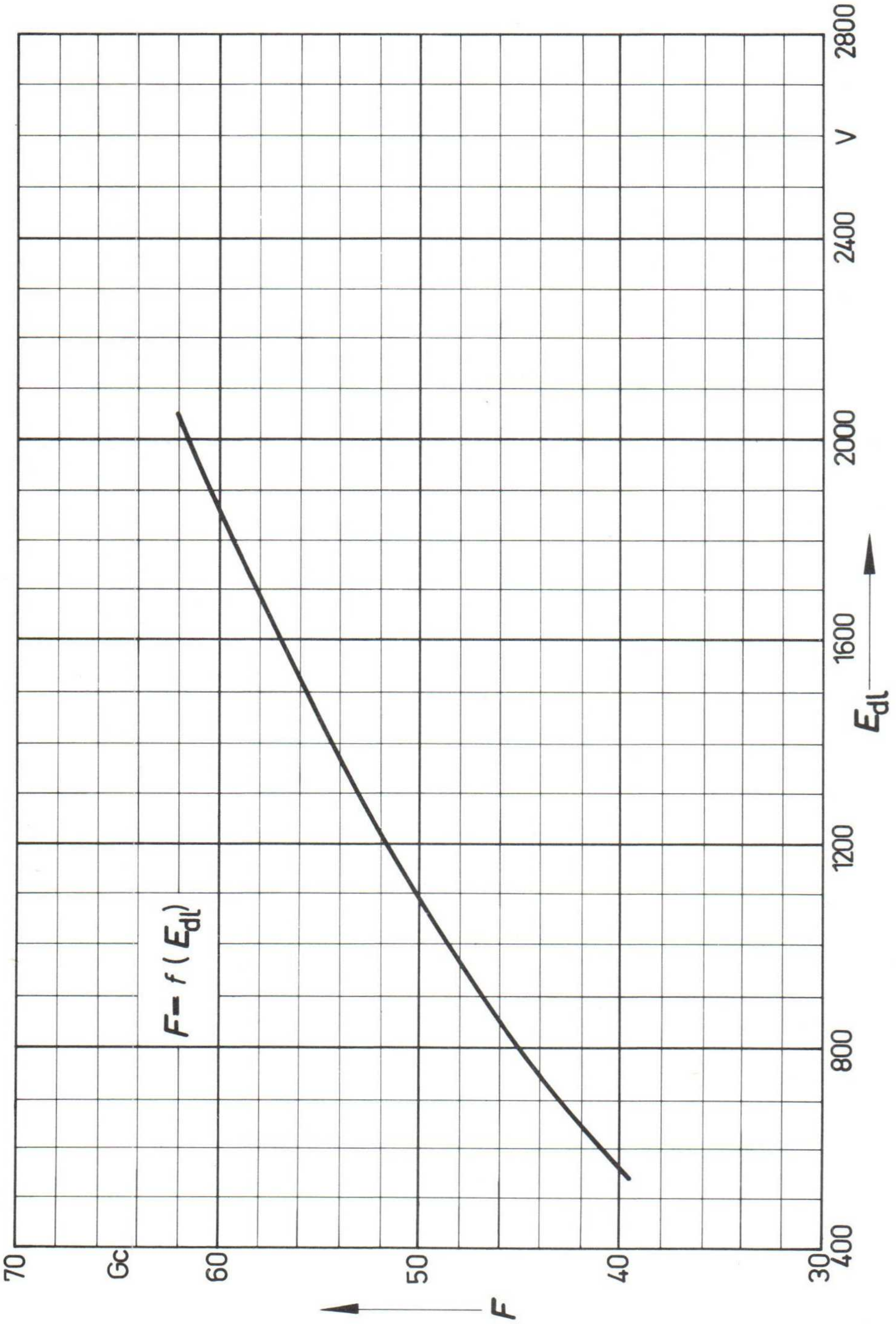
Switching off

On no account switch the delay line voltage off first since the tube can be damaged.

1. Switch off grid No. 2 voltage (E_{c2})
2. Switch off remaining supply voltages

After long breaks in operation (some weeks), it is recommended that the tube be operated at the following reduced voltages before switching on the full operating voltages for about 2 hours.

$E_{dl} \approx 1000$ Vdc $E_{c3} \approx 200$ Vdc $E_{c2} \approx 1000$ Vdc $E_{c1} \approx -70$ Vdc


$F = f(E_{dl})$
E_{dl}
V
2800
2400
2000
1600
1200
800
400
F
70
Gc
60
50
40
30

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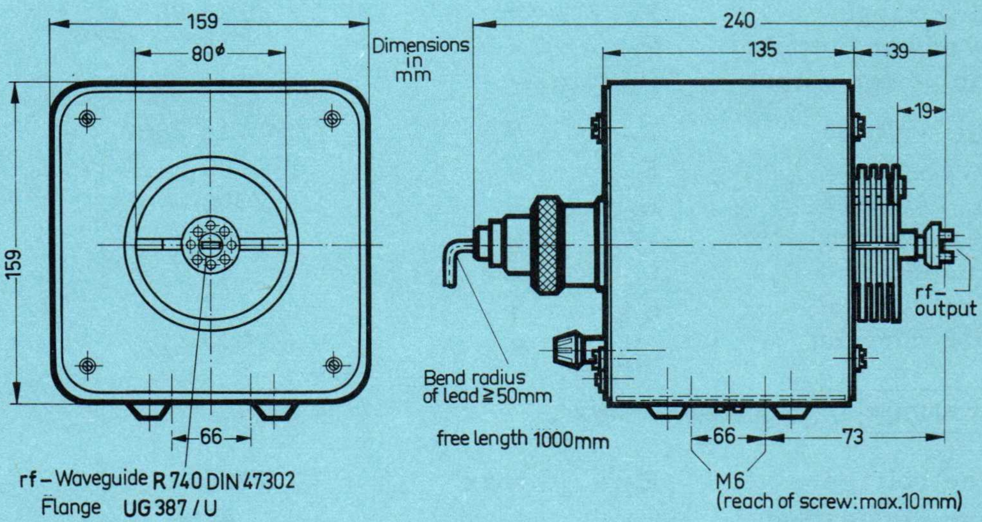
Design and Application

Backward-wave oscillator with an electronic tuning range of 60 to 90 Gc at an average power output of 5 mW and a minimum power output of 1 mW.
The oscillator is particularly suitable for measurements in the EHF range, for waveguide transmission systems, short-range EHF radar systems, and microwave spectroscopy.
Tube and magnet system form a single unit.



Weight of oscillator unit	:	7.7 kg
Dimensions of packing	:	190 x 190 x 390 mm

Heating

Heater voltage	E_f	=	6.3	V_{ac} (1)
Heater current	I_f	≈	1	Aac
Cathode heating time	t_k	≥	2	min

indirect by ac, parallel supply
MK-dispenser cathode

Capacitances

Capacitance $C_{g1/k,g2,g3}$	=	6	μμf
Capacitance $C_{g2/k,g1,g3}$	=	5	μμf
Capacitance $C_{g3/k,g1,g2}$	=	4	μμf

Typical Operation

Frequency range	F	=	60 to 90	Gc
Average power output	$P_{o\,av}$	=	5	mW
Minimum power output	$P_{o\,min}$	=	1	mW
Delay line voltage	E_{dl}	=	500 to 2500	Vdc (2,3)
Grid No.3 voltage	E_{c3}	≈	200	Vdc (2)
Grid No.2 voltage	E_{c2}	≈	2500	Vdc (2)
Grid No.1 voltage	$-E_{c1}$	≈	250	Vdc (2)
Delay line current	I_{dl}	≈	13	mAdc
Grid No.3 current	I_{c3}	≈	2	mAdc
Grid No.2 current	I_{c2}	≈	0.3	mAdc

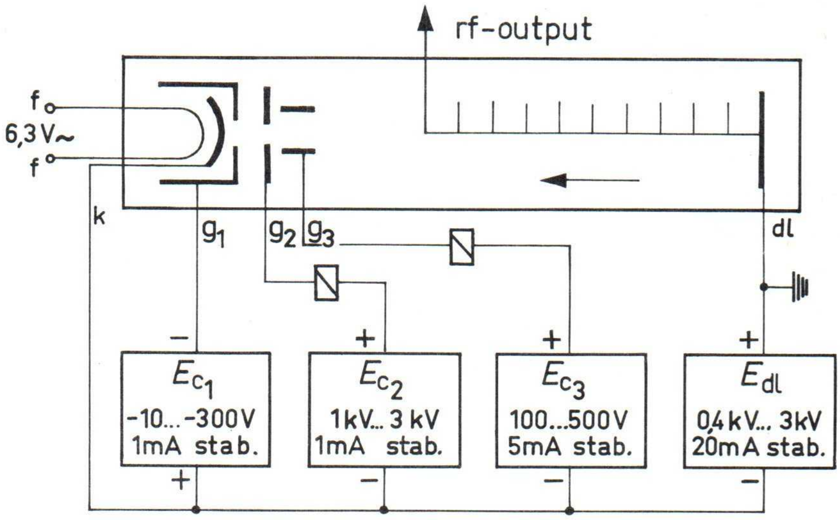
Maximum Ratings (absolute values)

Delay line voltage	E_{dl}	max	2800	Vdc
Delay line dissipation	P_{dl}	max	40	W
Grid No.3 voltage	E_{c3}	max	500	Vdc
Grid No.3 dissipation	P_{g3}	max	1.5	W
Grid No.2 voltage	E_{c2}	max	2600	Vdc
Grid No.2 dissipation	P_{g2}	max	1	W
Negative grid No.1 voltage	E_{c1}	max	10 to 400	Vdc
Cathode current	I_k	max	18	mAdc
Ambient temperature	T_A	min	-20	°C
Ambient temperature	T_A	max	55	°C

(1) With regard to the life of the tube the variation of the heater voltage may amount to ± 2 %. With respect to the requested frequency stability of the oscillator a much better stabilisation of the heater voltage will practically be necessary in any case.
(2) The exact setting value is shown on a curve delivered with each tube.
(3) Collector and delay line are electrically interconnected.

Operating Instructions

The tube and the permanent magnet required for guiding the beam form a single unit. The energy is coupled out through a rf waveguide R 740 DIN 47302 which is rigidly linked with the unit, and its associated flange UG-387/U.



Designation of the grids: g_1 = focusing electrode (Wehnelt)
g_2 = accelerating electrode
g_3 = focusing electrode

In the interest of good frequency stability, only regulated operating voltages esp. the delay line voltage and grid No. 3 voltage should be used. The delay line voltage serves for setting the chosen operating frequency and must therefore be adjustable between 500 and 2500 Vdc (see frequency range as function of collector and delay line voltage, K1). The other voltages should be adjustable within the limits indicated.

For protection of the tube, protective relay should be inserted in the grid No. 2 and grid No. 3 leads so that the grid No. 3 and grid No. 2 voltages are disconnected if the permissible grid dissipations are exceeded, or the power supplies for grids No. 3 and No. 2 should be protected in such a manner that they will be rapidly disconnected if any other operating voltage should fail or be disconnected.

A corresponding power supply (incl. collector connections) with an amplitude-modulation device RWON 11 and without an amplitude-modulation device RWON 111 can be supplied.

Modulation

Backward-wave oscillator RWO 80 may be operated with frequency modulation as well as with amplitude modulation by means of pulses or square waves. In the case of frequency modulation, the chosen modulation voltage is superimposed on the delay line voltage. The frequency swing can be adjusted by way of amplitude control. For keying the tube, a square-wave voltage of 250 volts peak-to-peak is applied between grid No. 1 and cathode, care having to be taken to ensure that the permissible limits of the grid No. 1 voltage (-10 to -400 volts) are not exceeded.

For modulation with square-wave pulses, it is practical to apply the bias required for continuous-wave operation to grid No. 1 and to modulate the tube by superimposing pulses of sufficient magnitude (250 volts peak-to-peak). In this case, normal operating voltages are applied to the other electrodes. With square wave modulation the g_2, g_3 and delay line voltage supplies should have low source resistance, so as to ensure that as soon as the pulses are applied, the correct electrode voltages are also applied.

The devices required for the a/m modulations are contained already in the power supply RWON 11 available for RWO 80.

Cooling

For removing the heat, the radiator must be cooled with an air flow of about 150 l/min.

The cooling-air system must be protected in such a manner that the supply voltages are disconnected when the cooling system is cut out.

Starting

The following switch-on procedure must be observed and the correct sequence definitely used:

Color code of leads:

f	: brown
f	: brown-yellow
g_1	: green
g_2	: blue
g_3	: red
dl	: black
k	: yellow

1. Switch on air cooling
2. Switch on heater voltage
3. Switch on grid No. 1 voltage to the operating value.
4. Switch on delay line voltage (E_{dl}) and grid No. 3 voltage (E_{c3}).

5. Switch on grid No. 2 (E_{c2}) voltage to the value given on the attached card.
6. Adjust tube to the required frequency by setting the delay line voltage as per the setting curve delivered with each tube.
7. Adjust grid No. 3 voltage for optimum power.

Switching off

On no account switch the delay line voltage off first since the tube can be damaged.

1. Switch off grid No. 2 voltage (E_{c2})
2. Switch off remaining supply voltages

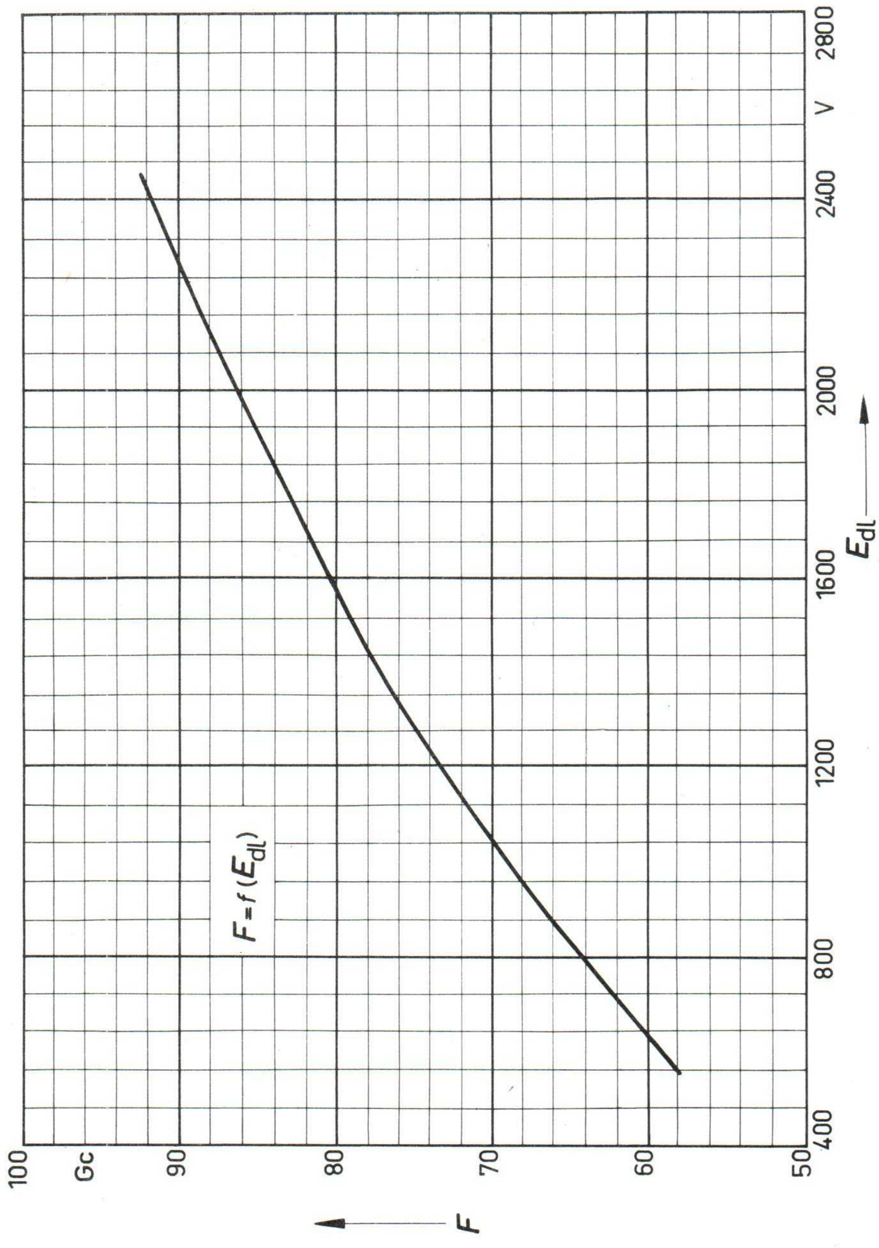
After long breaks in operation (some weeks), it is recommended that the tube be operated at the following reduced voltages before switching on the full operating voltages for about 2 hours.

$E_{dl} \approx 1000$ Vdc $E_{c3} \approx 200$ Vdc $E_{c2} \approx 1000$ Vdc $E_{c1} \approx -70$ Vdc

Characteristics

$F = f(E_{dl})$

SIEMENS



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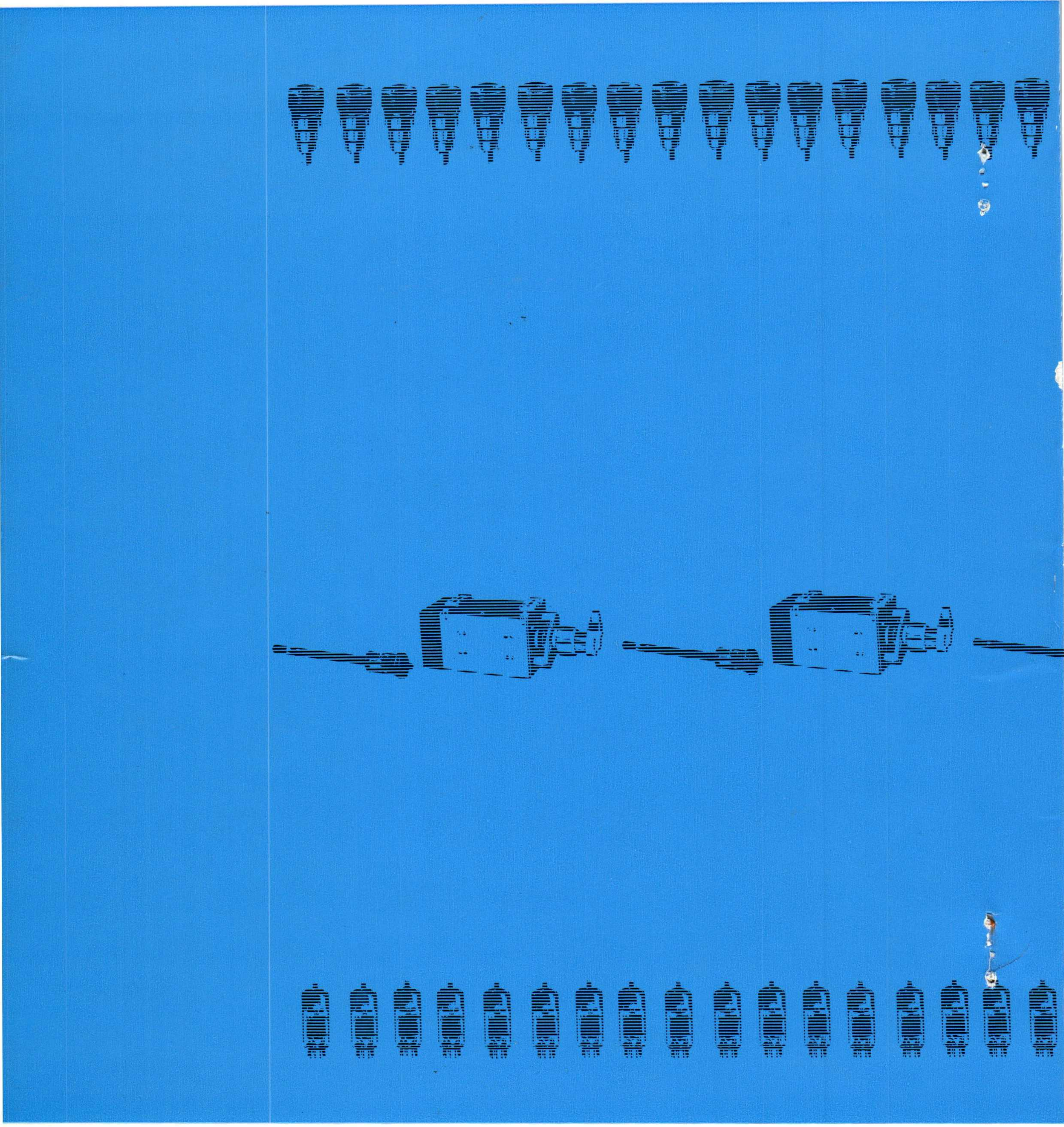

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