SIEMENS

HIGH POWER TRAVELING-WAVE TUBE

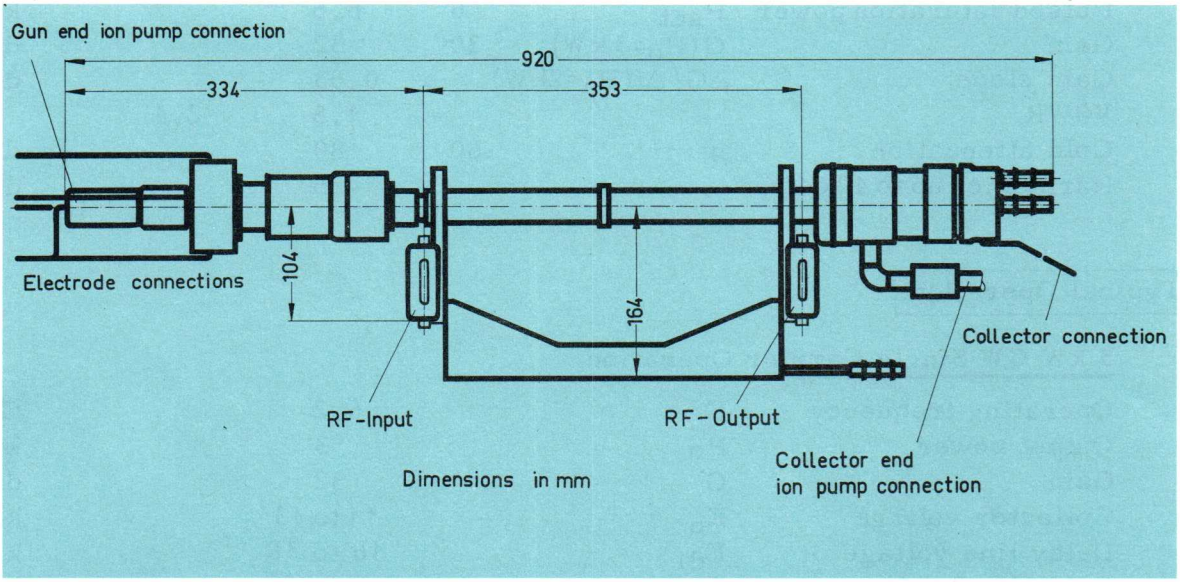
F = 5.925 to 6.425 GHz

YH 1041

Order No.
Q42-X4653

Design and Application

High-power traveling wave tube for multi-carrier operation in the frequency band 5.925 to 6.425 GHz with a pulse saturation power of 6 kW. In single-carrier operation the tube gives a CW output power of 3 kW at a minimum gain of 29 dB; in two-carrier operation the third order intermodulation product is -22 dB at an average CW output power of 0.5 kW per carrier.
The YH 1041 is a PPM focused traveling wave tube and is designed to operate with depressed collector.
The tube is easily replaceable in the magnet system MYH 1041.
Waveguide rf input and output ports are used. The collector and delay line are water-cooled.



Length of tube	: approx. 920 mm/(36")
Dimensions of magnet system with tube	: approx. 1036 mm x 230 mm x 380 mm (41"x9"x15")
Weight of magnet system	: approx. 60 kp/(132 lbs)
Weight of tube	: approx. 9,5 kp (21 lbs)
Waveguide *)	: F 70, DIN 47302
Flange	: UGF 70, DIN 47303

*) Available accessory: Waveguide transition YHZ 9505, F 70 to WR 137, 34.8 mm x 15.8 mm with flange UG 344/U

Heating

Heater voltage	E_f	6.5		Vac 1, 2)
Preheating voltage	E_f'	$0.85 \cdot E_f$		Vac
Heater current	I_f	2.5		Aac
Preheating time	t_k	min. 5		min

Metal dispenser cathode

Characteristics

($F = 6.2$ GHz, $I_k = 1.5$ Adc)

		min	nom	max	
Pulsed saturation power	P_{sat}	6	6.5		kW
Gain	$G(P_o=3\,kW)$	30	32		dB
Gain slope	$\Delta G/\Delta f(P_o=2kW)$		0.03		dB/MHz
VSWR			1.5	2.1	3)
Cold attenuation	a	60	80		dB
Harmonics up to 40 GHz			-25		dB 4)

Typical Operation

3 kW CW Single Carrier Operation

Operating frequency	F	6.2	GHz
Output power	P_o	3	kW
Gain	G	32	dB
Collector voltage	E_b	11 to 13	kVdc
Delay line voltage	E_{d1}	16 to 18	kVdc 1)
Grid No. 2 voltage	E_{c2}	2.5 to 4	kVdc 1)
Grid No. 1 voltage	E_{c1}	-80 to -400	Vdc 1)
Cathode current	I_k	1.5	Adc
Delay line current	I_{d1}	<150	mAdc
Grid No. 2 current	I_{c2}	< 2	mAdc
AM/PM conversion	k_p	4.5	°/dB

1) The exact setting value will be indicated for each tube.

2) If the maximum variation of the heater voltage exceeds the absolute limits of ± 2 % of the setting value, the operating performance and life will be impaired. Stand-by operation with 85 % of the nominal heater voltage, other electrode voltages not applied to the tube. By increasing the heater voltage to its nominal value, and switching on the 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 GHz.

4) Level of all harmonics below the fundamental in the frequency range 5.925 to 6.425 GHz.

Multi-carrier operation with two carriers each of 500 W spaced 5 MHz apart.

		min	nom	
Gain	G (F = 5.925 GHz)	34	36	dB
	G (F = 6.32 GHz)	31	32	dB
	G (F = 6.425 GHz)	29	30	dB
Third order intermodulation products	D3 (F = 5.925 GHz)	-24	-25	dB
	D3 (F = 6.32 GHz)	-22	-23	dB
	D3 (F = 6.425 GHz)	-21	-22	dB

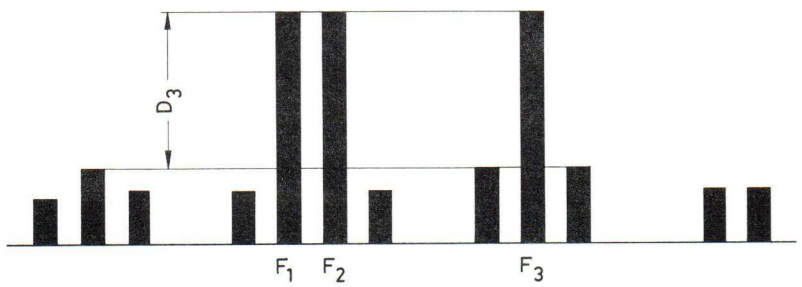
Collector voltage	E_b	10.5 to 13	kVdc
Delay line voltage	E_{d1}	16 to 18	kVdc 1)
Grid No. 2 voltage	E_{c2}	2.4 to 4	kVdc 1)
Grid No. 1 voltage	E_{c1}	-80 to 400	Vdc 1)
Delay line current	I_{d1}	< 150	mAdc
Grid No. 2 current	I_{g2}	< 2	mAdc
Cathode current	I_k	1.5	Adc

Multi-carrier operation with 2 to 6 carriers of equal output power

The average output power per carrier is shown in the following table for some values of the third order intermodulation products as function of the number of carriers, measured at the top end of the band between 6.4 and 6.425 GHz. At the lower end of the band the intermodulation products are 3 to 4 dB better (see above data).

Third order intermodulation products below the level of any one carrier D3 (dB)	Average output power per carrier (W)				
	Number of carriers				
	2	3	4	5	6
-14	1100	550	500		
-16	900	450	400	390	
-18	750	370	330	320	310
-20	600	300	270	260	250
-22	500	250	210	200	190
-24	380	190	170	160	155
-26	300	150	135	130	125

1) The exact setting value will be indicated for each tube.



Maximum Ratings (absolute values)

Collector voltage	E_b	max	14	kVdc
Collector voltage	E_b (at P_o=3 kW)	min	11	kV
	(at ΣP_o=3 kW)	min	10.5	kV
	(at ΣP_o=1 kW)	min	7.5	kV
	(at ΣP_o=0.5 kW)	min	5.5	kV
Collector dissipation	P_p	max	24	kW
Delay line voltage	E_{d1}	max	18.5	kVdc
Delay line current (without rf)	I_{d1}	max	60	mAdc
Delay line current (with rf)	I_{d1}	max	160	mAdc
Grid No.2 voltage	E_{c2}	max	4.5	kVdc
Grid No. 2 dissipation	P_{c2}	max	9	W
Grid No. 2 voltage neg.	$-E_{c1}$	min	50	Vdc
Grid No. 1 voltage neg.	$-E_{c1}$	max	2.2	kVdc
Load VSWR		max	1.2	1)
Cathode current	I_k	max	1.7	Adc
CW power output	P_o CW	max	3.2	kW
Ambient temperature	T_A	min	-20	°C
Ambient temperature	T_A	max	60	°C

1) A circulator must be provided at the input and output of the tube. The VSWR of the output circulator must be better than 1.2.

Operating Instructions

The traveling wave tube YH 1041 can be operated only in conjunction with the magnet system MYH 1041. The periodic permanent focusing has a small leakage field; the magnet system has a low sensitivity to temperature changes.
When mounting the magnet system the distance between the magnet system and large ferromagnetic parts (e.g. mounting supports) should be 50 mm/2" and between the magnet system and small ferromagnetic parts (e.g. screws) 10 mm/0.5". The spacing between two magnet system should be at least 170 mm/6.5". In order to replace the tube, the magnet system can be swung open along its axis of symmetry.
All voltages applied to the tube are referred to the cathode. Details about the power supply - e.g. electrical data, current and voltage monitoring etc. - are given in a special power supply specification for YH 1041.

When designing the power supply the phase and amplitude pushing factors must be taken into account. These are:

1. Phase pushing factors

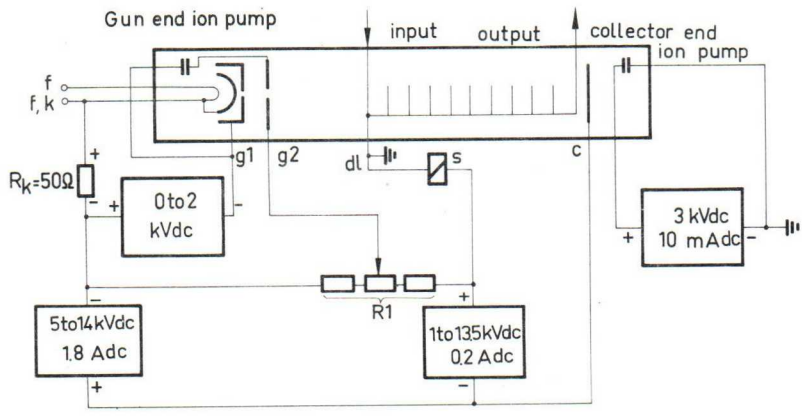
$$\frac{\Delta\phi}{\Delta E_{c1}}, \frac{\Delta\phi}{\Delta E_{c2}}, \frac{\Delta\phi}{\Delta E_{d1}} \qquad \text{about } 0.3\ ^{\circ}/V$$

2. Amplitude pushing factor

$$\frac{\Delta P_o}{\Delta E_{c1}} \approx 0.015\ db/V, \quad \frac{\Delta P_o}{\Delta E_{c2}} \approx 0.005\ db/V, \quad \frac{\Delta P_o}{\Delta E_{d1}} \approx 0.005\ db/V,$$

$$\frac{\Delta P_o}{\Delta E_b} \approx 0.02\ db/kV.$$

The following circuit diagram shows the recommended power supply arrangement. (1) The delay line lead must incorporate a protective device (s), which disconnects the operating voltages, if the permissible maximum value of the delay line current of 60 (without rf) or 160 mAdc (with rf) resp. is exceeded. The protection circuit must operate such thet the delay line voltage is removed from the tube itself within 15 ms.



(1) In case of deviations from this arrangement the manufacturer should be consulted.

Ion Pumps

For the collector end ion pump, a power supply is necessary for 3 kVdc and 10 mAdc. The gun end ion pump is connected to grid No. 1. The electrode voltages must be automatically disconnected if a pressure of 10^{-6} Torr is exceeded (corresponding to a collector end ion pump current of 25 µAdc). During pauses in operation and tube storage the collector end ion pump must be kept in operation. During transport this pump can be inoperative for up to four months.

Cooling

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

Collector:	water flow	approx. 30 ltr/min (1.1 cubic ft/min)	(1)
	pressure	approx. 4 atm (60 Ψ)	
	temperature at inlet	max. 65 °C	
Delay line:	water flow	approx. 4 ltr/min (0.14 cubic ft/min)	
	pressure	approx. 4 atm (60 Ψ)	
	temperature at inlet	max. 65 °C	

In view of the voltage difference between collector and delay line, it must be ensured that the water supply lines are appropriately insulated. The tube must be protected in such a way that the supply voltages are removed from tube if there is a failure in the cooling system.

Starting

The tube can be quickly moutned in the magnet system, and is self-positioning. The magnet system must be properly earthed.

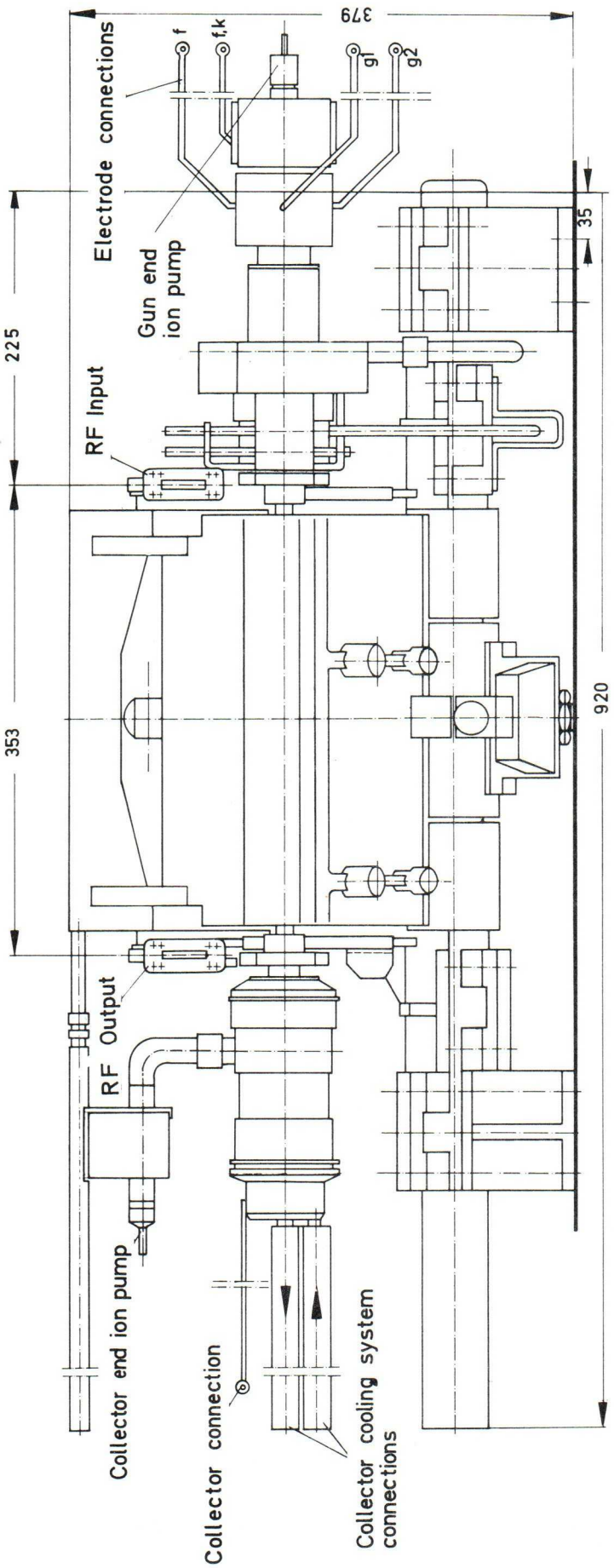
The leads to the electrodes are color-coded as follows:

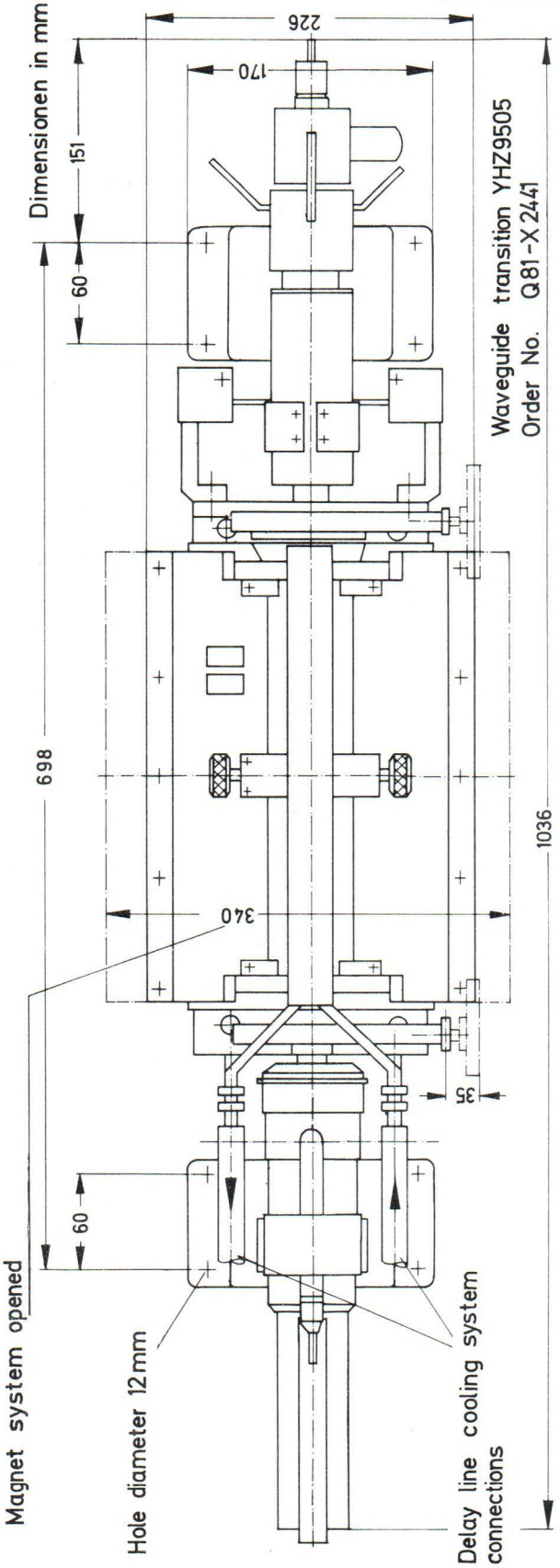
Heater	f	:	brown
Heater/Cathode	f/k	:	yellow
Grid No. 1	g_1	:	green
Grid No. 2	g_2	:	blue
Collector	c	:	red

The lead for the delay line is connected to the magnet system. Initial running up of the tube, in which the beam injection conditions are optimized, can be carried out by the end user according to the comprehensive instructions supplied with the tube. Once the tube has been fired up, the preheated tube may be run at full rf power immediately.

(1) Measured with open cooling circuit.

Order No.
Q43-X2396





Characteristics

Preheating time = f (duration of heating failure)

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