High-Power Travelling Wave Tube

F = 7.9 to 8.4 GHz

Design and Application

High-power travelling wave tube for multi-carrier operation in the frequency band 7.9 to 8.4 GHz with a minimum saturation power of 8 kW. In single-carrier operation the tube gives a CW output power of 8 kW at a minimum gain of 34 db over the complete frequency band 7.9 to 8.4 GHz; in two-carrier operation the minimum third order intermodulation product is -18 db at a CW output power of 1.25 kW per carrier.

The tube YH 1047 is a solenoid-focused travelling wave tube and is designed to operate with depressed or non-depressed collector.

The tube is field-replaceable and can be easily inserted in the focusing system.

The input and output ports are designed for connection to waveguides. The collector, delay line and solenoid are water-cooled.

Weight of tube	: approx. 20 kg/44 lbs
Weight of solenoid	: approx. 100 kg/220 lbs
Length of tube	: approx. 910 mm/35.8"
Outer diameter of the solenoid	: approx. 230 mm/9.1"
Waveguide	: RG-51/U
Flange	: UG-51/U
Mounting position	: vertical, collector upwards

Heating

Heater voltage	Ef	11 ± 1	V	1)2)
Preheating voltage	Ef'	0.85 · Ef	V	
Heater current	If	max 6	A	
Preheating time	tk	min 5	min	

indirect by dc, metal capillary dispenser cathode.

Characteristics

Frequency range	F	7.9 to 8.4	GHz	5)
Gain slope	ΔG/ΔF	max 0.1	db/MHz	5)
Bandwidth	B	500	MHz	
Saturation power	Psat	min 8	kW	
Gain (Po = 8 kW)	G	min 34	db	
Tube VSWR		1.5		3)
Cold attenuation	α	80	db	

Typical Operation

5 kW CW Single Carrier Operation

Operating frequency	F	8.3	GHz	
Output power	Po	5	kW	
Gain	G	36	db	
Collector voltage	Eb	13.5	kVdc	
Delay line voltage	Edl	18.5	kVdc	1)
Modulating anode voltage	Ec2	9.5	kVdc	1)
Grid No.1 voltage	Ec1	-200	Vdc	1)
Cathode current	Ik	3.0	Adc	1)
Delay line current	Idl	80	mAdc	
Modulating anode current	Ic2	1.5	mAdc	
AM/PM conversion	kp	4.5	°/db	
Coil Current	Isol	20	Adc	1)4)

1) to 5) see page 4
6) see "Operating Instructions", page 4

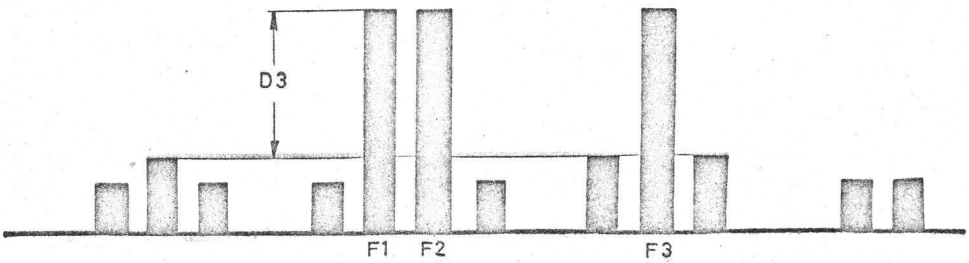
Multi-Carrier Operation with two Carriers each of 1250 W spaced 5 MHz apart in the frequency range 7.9 to 8.4 GHz 5)

		min	nom	max		
Gain	G	37			db	
Third order intermodulation products	D3	-18			db	
Collector voltage	Eb		13.5		kVdc	
Delay line voltage	Edl		18		kVdc	1)
Modulating anode voltage	Ec2		10		kVdc	1)
Grid No.1 voltage	Ec1		-200		Vdc	1)
Delay line current	Idl		40		mAdc	
Modulating anode current	Ig2			2	mAdc	
Cathode current	Ik		2.8		Adc	1)

Multi-Carrier Operation with 2 to 6 Carriers of Equal Output power

The approximate values of the average output power per carrier are shown in the following table for specified values of the third order intermodulation product as function of the number of carriers:

Third order intermodulation products below the level of any carrier D3 (db)	Average output power per carrier (W)				
	Number of carriers				
	2	3	4	5	6
-14	1425	775	660	610	550
-16	1320	660	550	525	490
-18	1100	550	465	440	415
-20	935	440	385	375	355
-22	765	360	305	285	270



Notes see page 4

Maximum Ratings (absolute values)

Collector voltage	Eb	max	20	kVdc	
Collector voltage	Eb	min	12.5	kVdc	6)
Collector dissipation	Pp	max	55	kW	
Delay line voltage	Edl	max	20	kVdc	
Delay line current (without rf)	Idl	max	50	mAdc	7)
Delay line current (with rf)	Idl	max	120	mAdc	
Modulating anode voltage	Ec2	max	12	kVdc	
Modulating anode dissipation	Pc2	max	50	W	
Grid No.1 voltage neg.	-Ec1	min	50	Vdc	
Grid No.1 voltage neg.	-Ec1	max	2.5	kVdc	
Load VSWR		max	1.3		
Cathode current	Ik	max	3.3	Adc	
CW power output	Po CW	max	8.5	kW	

Operating Instructions

The traveling wave tube YH1047 can be operated only in conjunction with its focusing system.

All voltages applied to the tube are referred to the cathode. Details on the power supply - e.g. electrical data, current and voltages monitoring etc. - are provided in a special power supply specification for the YH 1047.

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1) The exact setting value will be indicated for each individual tube.
2) If the maximum variation of the heater voltage exceeds the absolute limits of $\pm$ 1 % of the setting value, the operating performance and life will be impaired. Stand-by operation with 0.85 Ef' 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 be operated immediately at full rf power.
3) At input and output of cold tube in the frequency range 7.9 to 8.4 GHz.
4) Both coils are operated from a single power supply.
5) Circulators must be provided at the input and output of the tube. The VSWR of the circulators must be $\leq$ 1.15 in the frequency band 7.9 to 8.4 GHz and $\leq$ 1.5 in the frequency band 7 to 9 GHz.
6) For low output power levels, the collector voltage can be reduced as fast as the delay line current does not exceed 60mA.
7) At Eb = 12.5 kV.

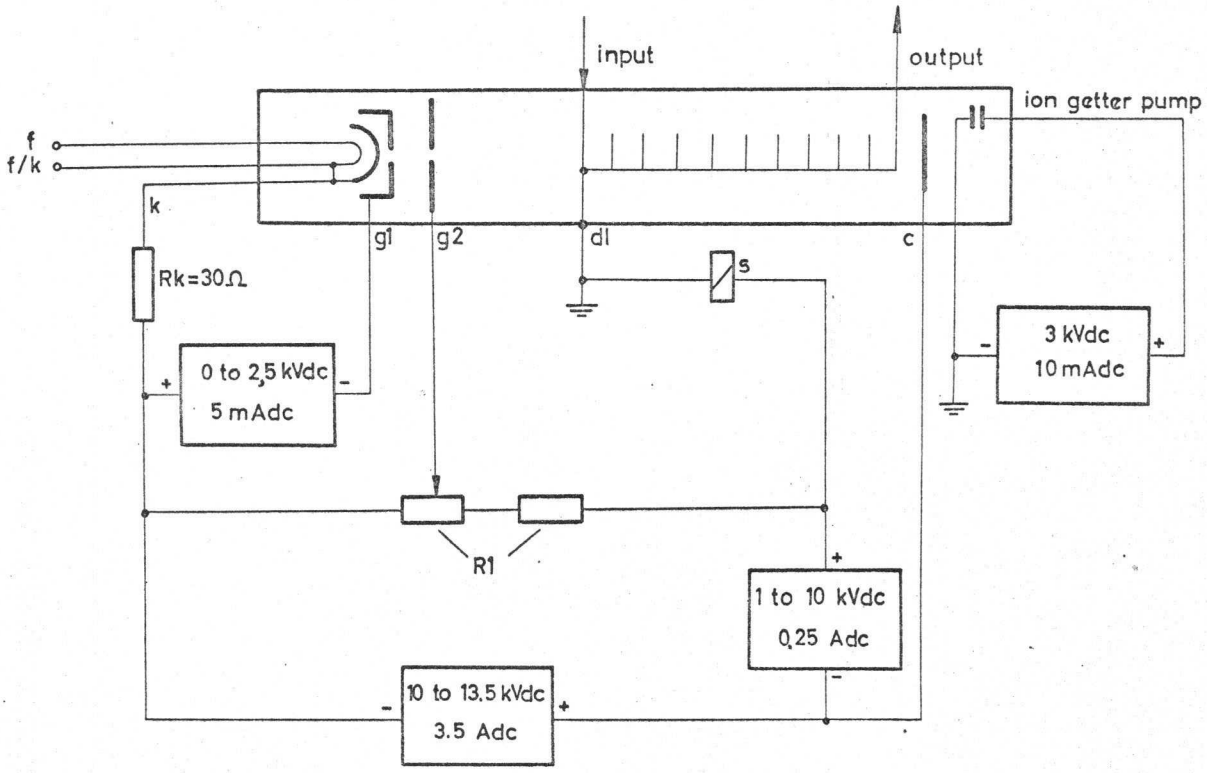
The following circuit diagram shows one of the possible power supply arrangements. The delay line lead must incorporate a protective devise (s), which disconnects the operating voltage, if the permissible maximum value of the delay line current of 120 mAdc is exceeded. The protective device must operate such that the delay line voltage is removed from the tube itself within 15 ms.

Power supply for the solenoid

Coil : I_{sol} = 15 to 21 Adc; U_{sol} max. 220 Vdc

Current stability ± 1 %

In the event of a fault in the solenoid power supply the tube must be switched off within 15 ms.



Ion Getter Pump

For the ion getter pump a power supply is necessary delivering a dc voltage of 3 kV and dc current of 10 mA. The pump must not be inoperative for more than four months.

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Target Specification

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YH 1047

Cooling

To dissipate the heat developed, the collector, the delay line and the solenoid must be cooled with distilled and deionized water or with a 60/40 water/Glycol mixture. The cooling circuit flow rates are as follows.

Water cooling

Collector:	Water flow min. 45 ltr/min (1.6 cubic ft/min)	1)
	Water flow min. 33 ltr/min (1.2 cubic ft/min)	2)
	Pressure drop approx. 4.5 atm (67.5 psi)	1)3)
	Pressure drop approx. 2.5 atm (37.5 psi)	2)3)
	Maximum temperatures	
	at inlet 65 °C	
	at outlet 85 °C	
Delay line:	Water flow approx. 8 ltr/min (0.28 cubic ft/min)	
	Pressure drop approx. 1.5 atm (22.5 psi)	
Solenoid:	Water flow approx. 6 ltr/min (0.21 cubic ft/min)	
	Pressure drop approx. 0.6 atm (9 psi)	

60/40 Water/Glycol cooling

Collector:	Coolant flow min. 60 ltr/min (2.1 cubic ft/min)	1)4)
	Coolant flow min. 45 ltr/min (1.6 cubic ft/min)	2)
	Pressure drop approx. 7 atm (105 psi)	1)3)
	Pressure drop approx. 7 atm (105 psi)	2)3)
	Maximum temperatures	
	at inlet 65 °C	
	at outlet 85 °C	
Delay line:	Coolant flow approx. 12 ltr/min (0.42 cubic ft/min)	
	Pressure drop approx. 3.5 atm (52.5 psi)	
Solenoid:	Coolant flow approx. 8 ltr/min (0.28 cubic ft/min)	
	Pressure drop approx. 1.5 atm (22.5 psi)	

The maximum static pressure of the coolant in each cooling circuit must not exceed 13.5 atü (200 psig).

1) Collector dissipation 55 kW (with non-depressed collector)
2) Collector dissipation 35 kW (with depressed collector)
3) At a minimum water temperature at inlet of 45 °C.
4) For this conditions remove valve at outlet. Minimum pressure at outlet 1.5 atm.

Starting

The tube can be quickly mounted in the focusing system. The focusing system and the tube must be properly earthed. The leads to the electrodes are color-coded as follows:

Heater	f	: brown	
Heater/Cathode	f/k	: brown-yellow	
Cathode	k	: yellow	1)
Grid No. 1	g1	: green	
Modulating anode	g2	: blue	
Collector	c	: red	

The lead for the delay line is connected to the grounding terminals of the focusing system and the tube. 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 is operated according to this procedure subsequent switch-on to full rf power need only be preceded by normal preheating.

1) The cathode is internally connected to one side of the heater. It is advisable to connect 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 aditionally outside the tube, only the brown-yellow lead is to be connected to the yellow cathode lead.

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Target Specification

YH 1047

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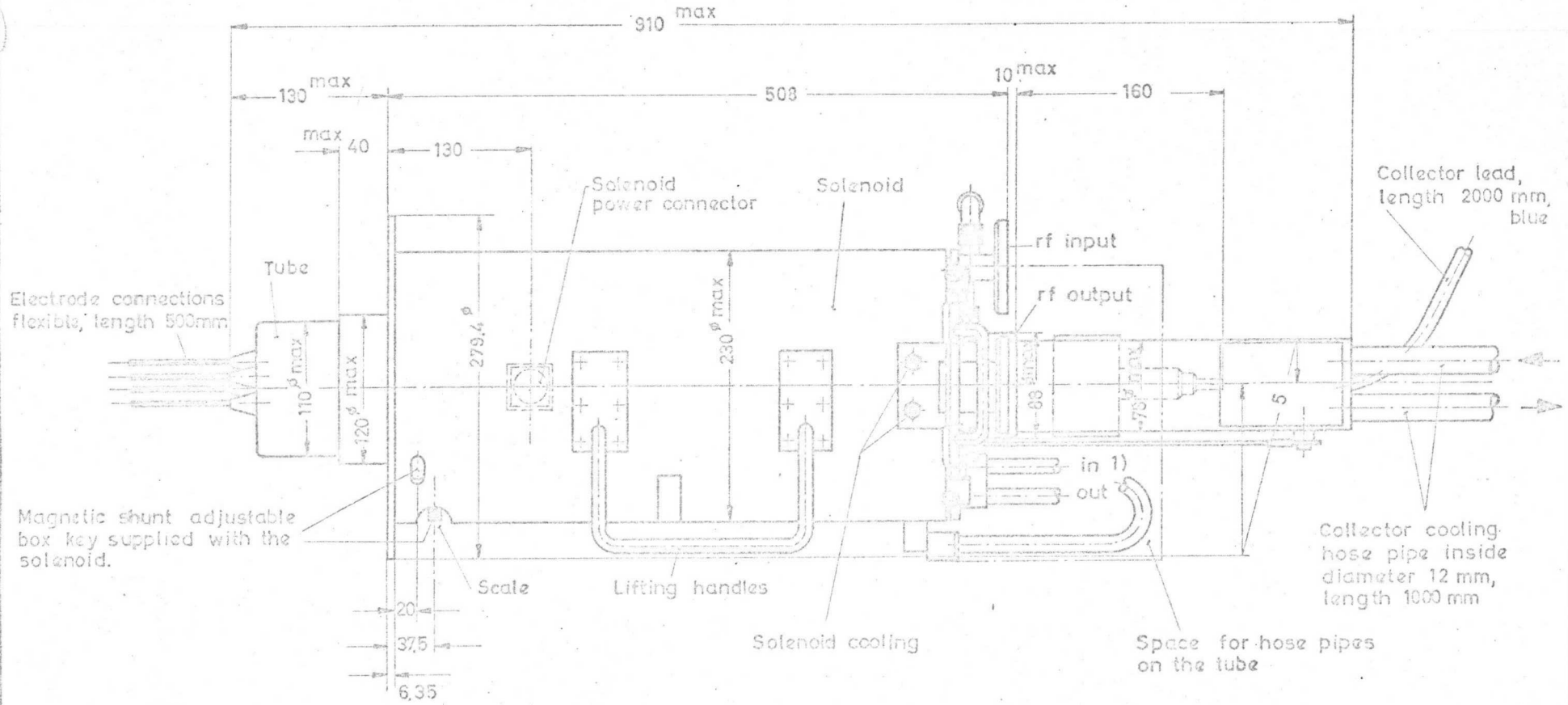

1) Colling: slow wave structure, window and output waveguide hose pipe inside diam. 10 mm, length 1000 mm

Dimensions in mm

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