DETAIL SPECIFICATION OF TH 2104C

This specification is to be used jointly with the general specification NF C95 (French equivalent of MIL-E-1), for all the parts thereof that are applicable.

The meaning of the symbols appears in paragraph 1.3.3.2 of the general specification.

The symbol * (when used) indicates that the actual value or text will be specified in a later issue of this specification.

The symbol vn refers to the nominal operating value of a parameter.

At the end of this specification, one will be given the correspondence between symbols of the NF C95-201 (French) and MIL-E-1 specification.

As usual in English documentation :

- A decimal point is used to separate the fractional part of any number from the integer one (instead of a comma in the NF C95 general specification).

- The voltage standing wave ratio is referred to as VSWR (instead of ROS in the NF C95 general specification).

Voltages, unless otherwise specified, are referenced to cathode potential.

DESCRIPTION :

Klystron amplifier

- 5 integral cavities
- Solenoid focusing TH 20277 A
- Water cooled
- Frequency of operation : 1300 MHz
- 4 to 5 MW, 100 kW, 2 ms pulse duration

WEIGHT : 240 kg approximately

MOUNTING POSITION : vertical, cathode down

PROTECTION AGAINST X-RAYS PRODUCED BY KLYSTRON : required **TH 20514**

DIMENSIONS AND CONNECTIONS : see drawing

COOLING REQUIREMENTS : body and collector : water

PACKING : According to norm GAM-EMB1 (French document equivalent of MIL-E-75)

ACCESSORIES : See list.
- The accessories of the list are not supplied with the klystron, but those specifically indicated as built-in into the klystron.

ABSOLURE RATINGS (see NF C95-201 - art. 1.3.2) : (Note 1)

Parameter	Vf	Ipdf	tk	Vpi	Ipi	Ppi	Vkcr	Pscr	Ps
Unit	V	A	mn	kV	mA	W	kV	MW	kW
Maximum	29	50	-	5.5	0.1	50	132	5.5	120
Minimum	-	-	15	4.5	-	-	-	-	-
Note	2-3	4	-	-	17	-	-	-	-

Parameter	tpV	tpRF	Vki	Pcolcr	Pcol	Pecr	Pemoy	Load VSWR	Pct
Unit	ms	ms	kV	MW	kW	kW	W	-	kW
Maximum	2.3	2.1	33	14	300	0.5	25	1.5:1	25
Minimum	-	-	-	-	-	-	-	-	-
Note	5-20	20	23	-	-	6	-	-	8

Parameter	Isol	Water flow		Water temperature	Window pressurization	Water pressure
		Collector	Body			
Unit	A	dm^3/mn	dm^3/mn	°C	bar (with dry air)	bar relative
Maximum	70	-	-	35	3	6.5
Minimum	vn - 7.5%	240		-	2.5	-
Note	7	18	18	9 - 10	11	-

GENERAL TEST CONDITIONS

- Preheating : Vf = vn (Note 2) tk = 15 mn
- TH 2104C klystron must be used with TH 20277A focusing solenoid and its countercoil : Isol = vn (Note 7)
- fo = 1300 MHz ± 1 MHz
- VSWR of water load ≤ 1.2:1 (measurement at low RF level)
- The output waveguide is filled with Freon 12 or SF6 at an absolute pressure of 1.5 bar
- Vpi = 5 kV ± 0.5 KV
- Body cooling water flow : J = 8.5 dm^3/mn (Note 18)
- Collector cooling water flow : J = 250 dm^3/mn (Note 18)
- Device for measuring the average power dissipated on the body REGLINDEX-DOP with 10°C full scale by BRION-LEROUX Cie, or equivalent.
- Operating mode (Note 12) : Pscr = 4 MW - Ps = 100 kW - tpRF = 500 µs $^{+\ 30\mu s}_{-\ 20\ \mu s}$ (Note 13)

Reference	Test Condition	Symbol	Limits		Unit
			min	max	
	QUALIFICATION TESTS :				
	Harmonic power (Note 19)	-	-	-20	dBc
	Spurious power at other than harmonics total	-	-	-70	dBc
	Phase sensitivity to beam voltage (Note 22)	-	-	*	°/%
	Phase drift as function of inlet cooling water temperature change (Note 22)	-	-	-	°/°C
	Resonant frequency drift as a function of inlet cooling temperature change (Note 22)	-	-	*	kHz/°C
	Amplitude modulation from heater if powered with 50 Hz (Note 22)	-	-	*	dB
	Amplitude drift as function of inlet cooling water temperature change (Note 22)	-	-	*	%/°C
	Phase modulation from heater if powered with 50 Hz (Note 22)	-	-	*	°
	Phase shift with RF drive power change from -10dB below saturation (Note 22)	-	-	*	°/dB
	In the focusing magnet current interval ± 2% : (Note 22)				
	- output RF phase variation	-	-	*	°
	- output RF amplitude variation	-	-	*	dB
	Transfer curves (Note 21)	-	-	-	-

Reference	Test Condition	Symbol	Limits min	Limits max	Unit
	ACCEPTANCE TESTS :				
A.B.1.1	Visual inspection,				
A.B.2.1	Dimensions : see drawing				
A.C.4.2	Heater voltage (Note 14)	Vf	20	28	V
A.C.4.1	Heater current (Note 15)	If	17	28	A
	Operating mode :				
	Peak beam voltage	Vkcr	-	128	kV
	Peak cathode current	Ikcr	-	95	A
	Beam perveance	K	1.75	2.15	$\mu A/V^{3/2}$
	Peak drive power (Note 6)	Pecr	-	200	W
	Focusing coil current (Note 7)	Isol	-	68	A
	Efficiency (Note 16)	η	40	-	%
	Average body power (Note 8)	Pct	-	15	kW
	Bandwidth : (-1 dB)	Δf	8	-	MHz
	Ion pump current (Note 17)	Ipi	-	20	µA
	Cooling circuits tests :				
	. Window and body circuit flow = 8.5 dm^3/mn (Note 18)	Δp	-	5	bar
	. Collector circuit flow = 250 dm^3/mn (Note 18)	Δp	-	1.5	bar
	END OF LIFE CONDITION :				
	Peak output power	Pscr	3.4	-	MW
	Vkcr = 128 kV Vf $\leq$ 28 V (Note 3) Pct $\leq$ 15 kW Pecr, Isol optimized				

NOTES CONCERNING OPERATION AND TESTS

NOTE 1 - These limits should never be exceeded in either continuous or intermittent operation for any change of voltage or environmental conditions.

Two or more ABSOLUTE RATINGS must not be reached simultaneously.

NOTE 2 - In normal operation, the heater voltage should be held to the specified value indicated by the manufacturer on the test sheet "vn". If not the tube might be damaged beyond repair.

NOTE 3 - During the life of the klystron and depending on the evolution of its cathode, the manufacturer may request the used to adjust the filament voltage to a value different of the specified value in order to optimize tube operation.

NOTE 4 - The filament surge current (rms) after switching on the filament voltage should not exceed the specified value.

NOTE 5 - Voltage pulse duration measured at 75% amplitude.

NOTE 6 - The drive power for tube saturation must not be exceeded by more than 3 dB and must be less than the maximum value specified.

NOTE 7 - The klystron must be operated in a model TH 20277A electromagnet. This electromagnet consists of a main coil, three correction coils and two countercoils. By means of a terminal block and movable connection strips, the profile of the magnetic field can be optimized at the point of injection of the electron beam.

For each klystron, the Tube's Test Report indicates the connections to be made on the TH 20277A terminal block and the optimum value "vn" of the coil current, Isol, for each of the different levels of peak RF power.

The klystron can be irremediably damaged if the beam voltage is applied before the electromagnet current has been adjusted to the value given in the Test Report, or to a value compatible with the ABSOLUTE RATINGS, set by the current Isol.

Isol must be adjusted to within ± 2% of the value given in the Test Report for the operating mode used (see Note 8). The beam voltage can then be raised from zero to the value indicated for this mode, without any danger for the tube, whether or not RF drive is applied. On the other hand, it may be dangerous for the klystron to exceed the indicated beam voltage value without increasing Isol accordingly (see the Operating Instructions, UTH*).

NOTE 8 - The device used for body power control has a 5 to 10 seconds time constant to high voltage switch-off. In order to prevent tube damage it is necessary to preset the focusing coil current to better than ± 2% of the value specified in the test data sheet for the chosen mode of operation.

With the klystron operating, adjust the solenoid current for the best trade-off between efficiency, gain, stability and power dissipated on the body. Body power must remain close to the value given on data sheet.

Body power trip-off level must be adjusted to a value of 20% to 30% above value corresponding to optimum operating conditions, as described above, without exceeding maximum values defined in this specification.

If should be remembered that an adjustment of solenoid current resulting in a reduction of the body power is in favor of a longer tube life.

NOTE 9 - Inlet water temperature.

NOTE 10 - Water quality :
- dry residue : < 5 cg/dm3
- Ph : 6.5 to 7.5
- (Ca + Mg) dissolved : < 2 cg/dm3

NOTE 11 - The output waveguide must be filled with gas at an absolute pressure of :
- 2.5 to 3.0 bar if gas is dry air (normal value 2.75 bar)
- 1.05 to 1.5 bar, if gas is Freon 12 or SF6 (normal value 1.25 bar)

NOTE 12 - The peak beam voltage, Vkcr, the peak drive power, Pecr, and the focusing (solenoid) current are optimized for the operating mode, to obtain the best possible compromise between gain, efficiency and dissipated body power.

NOTE 13 - The RF pulse duration of the driver can be longer than tpV, but in this cas it must be centered on the voltage pulse duration tpV.

NOTE 14 - Voltage indicated in the Test Report should be within the specified limits.

NOTE 15 - With Vf equal to the value indicated in the Test Report, the filament current should be within specified limits after allowing 15 minutes warm-up time.

NOTE 16 - a) Efficiency is defined as the ratio :

$$\eta = \frac{Pscr\ (kW)}{Vkcr\ (kV)\ x\ Ikcr\ (A)}$$

If an accurate measurement of Vctcr and Ikcr is impossible on the test equipment, use the efficiency formula defined by e.

b) Peak RF output power is calculated by multiplying the average output power by 1/D (D : duty factor).

c) Duty factor is calculated by the following formula :
D = tpRF x fr
Where : tpRF is the detected RF power pulse duration measured at -3 dB
fr is the repetition frequency

d) Average power dissipated on the water cooled dummy load is given by the expression Ps (kW) = ΔT (°C) x J (l/mn) x $\frac{4.18}{60}$
Where - ΔT is the water temperature increase
- J is the water flow

e) $\eta = \frac{Pscr}{(Pcolcr + Pctcr)_o}$

In this case :

$(Pcolcr + Pctcr)_0 = \frac{Pctmoy + Pcolmoy}{tpV\ x\ (Hz)}$ *with* $Pecr = 0$

NOTE 17 - A safety device must swtitch-off :

- the high voltage when the ion pump current exceeds 20 µA
- and filament voltage when the ion pump current exceeds 0.1 mA.

NOTE 18 - Conversion : 1 CFM = 28.32 dm3/mn
1 gallon/mn 3.8 dm^3/mn

NOTE 19 - Harmonic power at each harmonic frequency with a load VSWR of less than 1.20:1 on the fundamental and load VSWR of less than 1.50:1 on the considered harmonic.

NOTE 20 - Because of the test facilities, the tube can only be tested at the factory with tpV and RF pulses of 500 % µs +30 µs
- 20 µs
After conditioning of the tube with RF pulses of 2 ms on customer test facilities, tests will be performed according to site Acceptance Test Procedure.

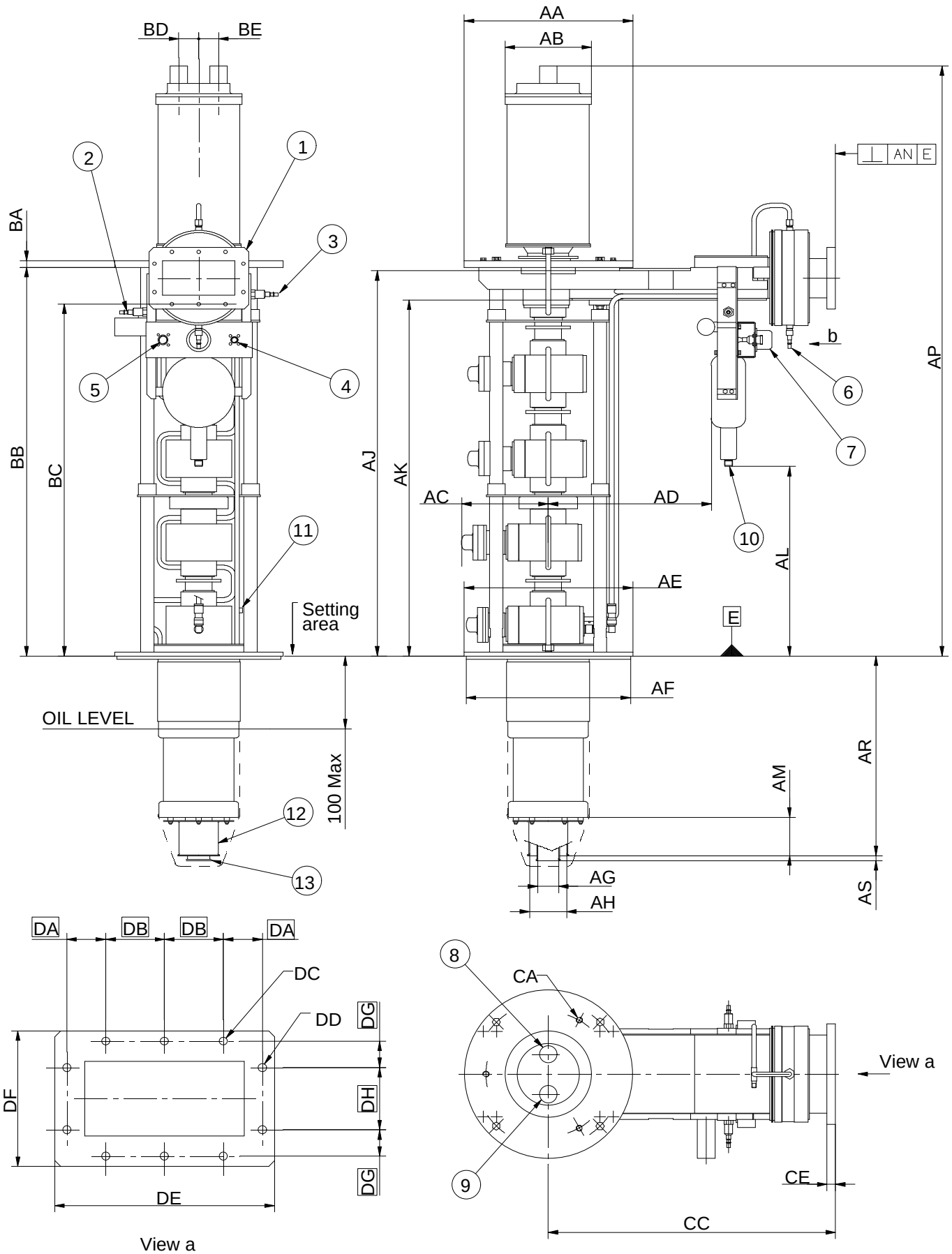
NOTE 21 - There shall be no discontinuous changes in the RF power output, when the RF drive is changed to procedure output power from zero to full power at any time during the RF pulse.
(VSWR ≤ 1.20:1 at any phase angle)

NOTE 22 - Objective values have been defined. The guaranteed values will be defined after the qualification of the first tube.

NOTE 23 - Vki = backwind reverse voltage.

Liste des accessoires - *Accessories list* -

DESCRIPTION	F : fourni O : optionnel *S : supplied* *O : optional*	Référence *P / N*	Remarques *Remarks*	Quantité *Quantity*
1 Focalisateur : *Electromagnet :* - basse impédance / *low impedance* - haute impédance / *high impedance*	TH 20277A			1
2 Contre bobine *Countercoil*	-			
3 Aimant pompe ionique *Ion pump magnet*	-			
4 Connecteur F/K *F/K connector*	TV 19201			1
5 Connecteur entrée RF *RF input connector*	TH 20174		equiv. UG 21 D/U	1
6 Connecteur pompe ionique *Ion pump connector*	TH 20175		equiv. UG 59 D/U	1
7 Connecteur sonde thermométrique *Thermal probe connector*	TH 20488			1
8 Bride de raccordement RF *Mating RF output flange*	-			
9 Joint bride de sortie RF *RFoutput gasket*	TH 20148			1
10 Recombineur *Recombiner*	-			
11 Raccords d'eau collecteur *Collector water-circuit fittings*	TH 20350			2
12 Raccords d'eau corps / fenêtre *Body / window water-circuit fittings*	TH 20204			2
13 Raccord vidange *Drain fitting*	TH 20066			1
14 Bouilleur collecteur *Collector boiler*	-			
15 Chemise d'eau collecteur *Collector water jacket*	-			
16 Hydrocondenseur *Water condenser*	-			
17 Soupape *Valve*	-			
18 Système de levage *Lifting device*	TH 20340			1
19 Blindage plomb *X-ray shielding*	TH 20514			1
20 Alimentation pompe ionique I*on pump power supply*	TH 20231			1
21 Transition - Taper *Output taper*	-			
22 Chariot support *Support cart*	V69			1
23 Caisse d'emballage *Packing crate*	V69			1
24 Divers *Miscellaneous item*	-			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DIMENSIONS IN MM

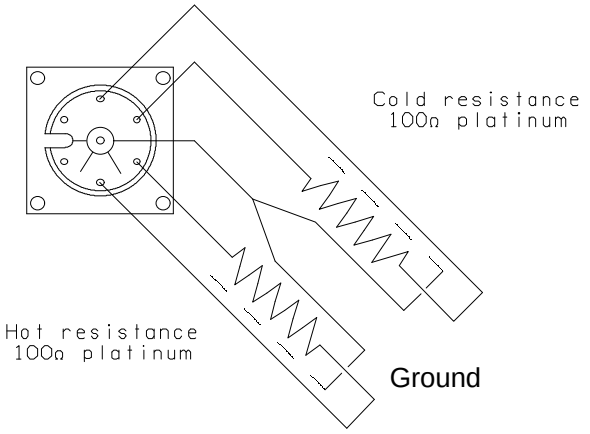
ITEM	-	MIN	MAX	OBSERVATIONS
AA	DIA	379.2	380.1	-
AB	DIA	-	280	-
AC	-	-	190	-
AD	-	355	-	-
AE	DIA	379	380.1	-
AF	DIA	369.4	370.2	-
AG	DIA	46.5	47.5	on 20 mm length (Heater connection)
AH	DIA	83	84	on 30 mm length (Cathode heater)
AJ	-	-	868.5	-
AK	-	795	-	-
AL	-	400	-	-
AM	-	84.5	87.5	-
AN	-	-	1.7	-
AP	-	-	1600	-
AR	-	433	442	-
AS	-	8	13	-
-	-	-	-	-
BA	-	14.5	15.5	-
BB	-	868.8	871.2	-
BC	-	781.31	791.31	-
BD	-	82.5	83.5	-
BE	-	56.5	57.5	-
-	-	-	-	-
CA	DIA	-	-	3 holes M14 at 120° / DIA 310
CC	-	637	650	-
CE	-	13	20	-
-	-	-	-	-
DA	-	39.7		-
DB	-	60.3		-
DC	DIA	8.4	8.6	6 holes ⌖ Ø 0.4 Ⓜ
DD	DIA	8.25	8.35	4 holes ⌖ Ø 0.25 Ⓜ
DE	-	219.5	-	-
DF	-	137.3	-	-
DG	-	26.96		-
DH	-	63.46		-

Waveguide
WR 650

CONNECTIONS,ACCESSORIES AND MISCELLANEOUS

ITEM	FUNCTION	OBSERVATIONS
1	Output flange	Waveguide WR 650
2	Drain connector	Staubli connector mates with TH 20066
3	Water outlet (Body - Window)	Staubli connector mates with TH 20204
4	RF input	UG 22 D/U mates with UG 21 D/U
5	Thermometric resistances socket	SOCAPEX socket mates with FFD 17 P Plug
6	Water inlet (Body - Window)	Staubli connector mates with TH 20204
7	Shock detector	OMNIG calibrated 15 g
8	Water outlet	Connector mates with TH 20350
9	Water inlet	Connector mates with TH 20350
10	Ion pump input	UG 61 D/U mates with UG 59 D/U
11	Body water circuit drain	
12	Filament cathode connector	Mates with TV 19201
13	Filament connector	Mates with TV 19201

View along b



Socket SOCAPEX EM 17 P