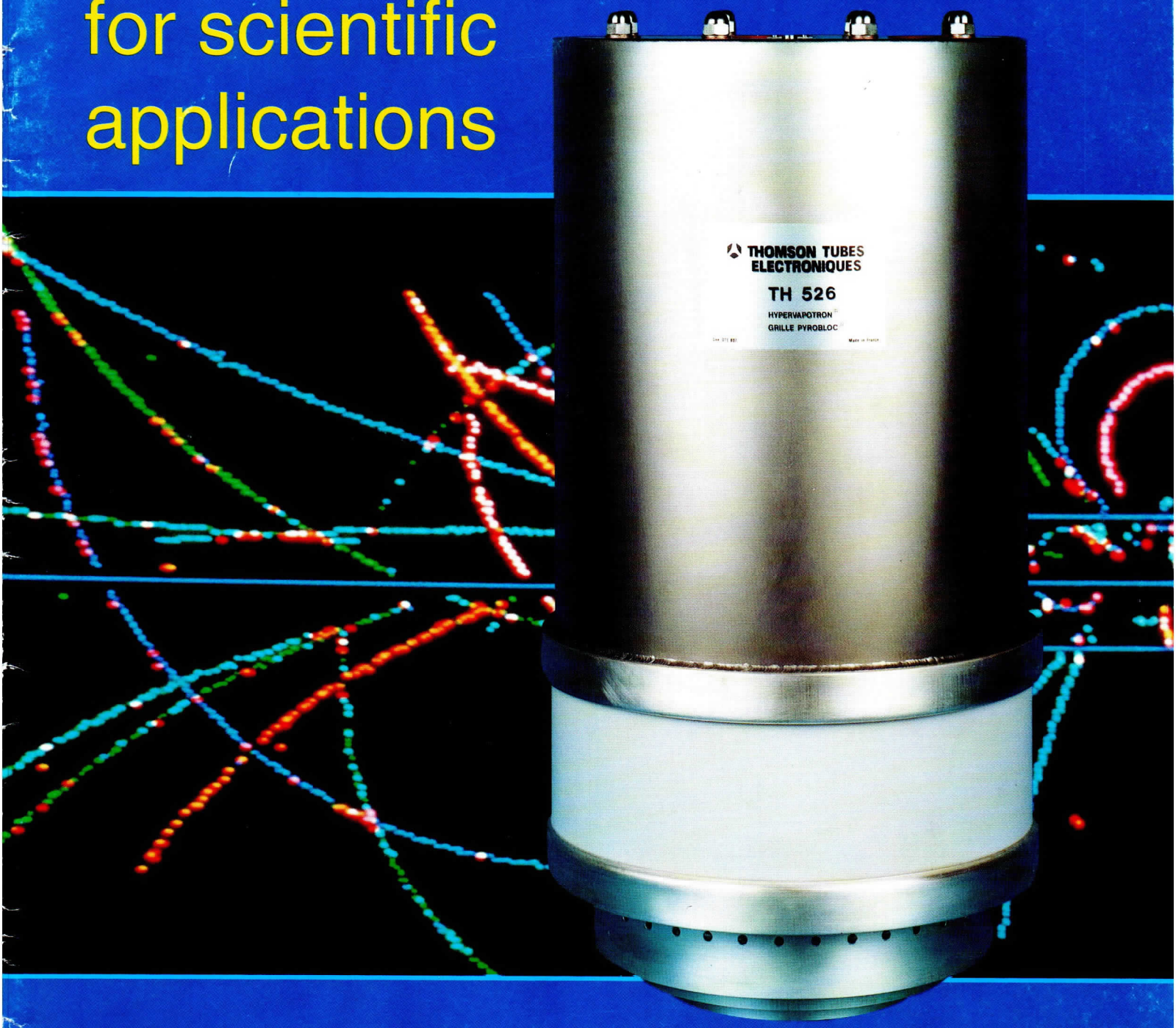
TTE 178

Power grid tubes for scientific applications



THOMSON TUBES ELECTRONIQUES

Power grid tubes for scientific applications

Power-grid tubes the high power solution

High power is required in an increasing number of scientific projects. For these high-power requirements at relatively low frequencies, power-grid tubes offer a well adapted and adaptable solution. Triodes and tetrodes may be used as high-power RF sources in applications such as particle accelerators or plasma heating at the ion-cyclotron resonance frequency. They may also be used as regulators or HV switches in HV modulators.

Thomson Tubes Electroniques produces a wide range of RF power-grid tubes covering most requirements in scientific applications. The company has also developped a number of accessories and RF circuits, as well as complete amplifier systems, to simplify tube use and optimize operation. For energy switching, Thomson also designs and manufactures triggered spark gaps and hydrogen thyratrons.

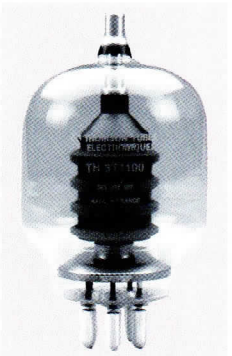
The company pioneered the technologies that made very high power tubes possible : pyrolytic-graphite grids for excellent operating stability and Hypervapotron™ anode cooling for high-capacity heat dissipation. The company continues in its search for optimal solutions to the changing requirements of scientific research.

The variety of scientific needs means that your application may not be included in the categories presented here. If you are unable to find the right solution to your particular specification in this products guide, please do not hesitate to contact us. Many requirements not covered by the tubes listed in this document may be satisfied by tubes designed for other applications under different conditions. Very specific requirements not covered by existing products can also be studied by Thomson Tubes Electroniques upon request.

Many factors are at play in tube operation, and these can considerably influence tube performances and lifetimes. Thomson Tubes Electroniques will assist you in selecting the correct tube and circuit or defining the most suitable operating point. You should fill in as much information on your need as possible using the guide on page 20.

TH 556

TH 352



TH 3T 1100

Reference	Maximum ratings (1)			
	F	Po	Va	Wa
	MHz	kW	kV	kW
TH 3T 1100	60	2.5	5	0.8
TH 3T 2100B	50	3.5	5	1
TH 3T 5100	50	11	6	2
TH 350A	120	30	13	15
TH 750A	120	30	13	20
TH 351	50	50	13	17
TH 751	50	50	13	20
TH 352	50	80	13	25
TH 752	50	80	13	30
TH 553	30	160	15	100
TH 533	30	220	16	200
TH 554A	30	290	18	200
TH 531	30	350	18	200
TH 534	30	510	19	250
TH 556	30	850	18	600

Triodes for RF oscillators

(2)	Anode cooling	Heater power supply (3)		Typical operating examples (2)					
Wg		Vf	If	F	Po	Va	Ia	Vg	Ig
kW		V	A	MHz	kW	kV	A	V	A
0.05	air	7.5	18	30	2.4	5	0.6	-500	0.1
0.1	air	7.5	30	30	2.7	5	0.7	-350	0.16
0.2	air	7.5	55	30	6.2	6	1.35	-660	0.15
0.5	air	7.5	150	40	30	10	4	-720	0.6
0.5	water	7.5	150	40	30	10	4	-720	0.6
0.65	air	7.5	180	40	50	11	6	-800	1.2
0.65	water	7.5	180	40	50	11	6	-800	1.2
1	air	12.6	180	40	80	11	9	-800	1.5
1	water	12.6	180	40	80	11	9	-800	1.5
3	Hypervapotron	15	180	10	156	14	13	-800	3.5
3	Hypervapotron	18	200	10	220	14	20	-800	4.5
3	Hypervapotron	18	280	10	290	13.5	29	-800	6.6
3.5	Hypervapotron	16	440	10	350	14	32	-800	8
7	Hypervapotron	22	400	10	510	15	46	-750	9
8	Hypervapotron	23	550	10	850	17.5	62	-850	12.5

TH 318

see back cover for notes

Reference	Maximum ratings (1)			
	F	Po (peak)	Va	Wa
	MHz	kW	kV	kW
TH 318	1500	40	6.2*	0.7
TH 596	500	150	18*	40
TH 591	500	190	18*	60
TH 170R	200	2500	40	10
TH 116	225	5000	42	80

* Pulsed anode voltage

RF triodes for short and medium pulse amplifiers (≤ 1 sec)

2)	Anode cooling	Heater power supply (3)		Typical operating examples (2)						
Wg		Vf	If	F	Po	Va	Ia	Vg	tp	Duty
kW		V	A	MHz	kW	kV	A	V	msec	%
0.003	air	6.3	5.5	975	30	6	8.5	-150	0.2	1
0.35	Hypervapotron	7.5	110	425	100	13	12	-120	4	15
0.35	Hypervapotron	10	190	425	190	18	20	-260	4	15
1.5	Hypervapotron	15	380	200	2300	37	130	-650	1	0.02
1.5	Hypervapotron	20	500	200	4800	40	210	-400	0.3	0.1
				200	2200	30	151	-400	0.7	3

TH 116

TH 525

TH 563

TH 382

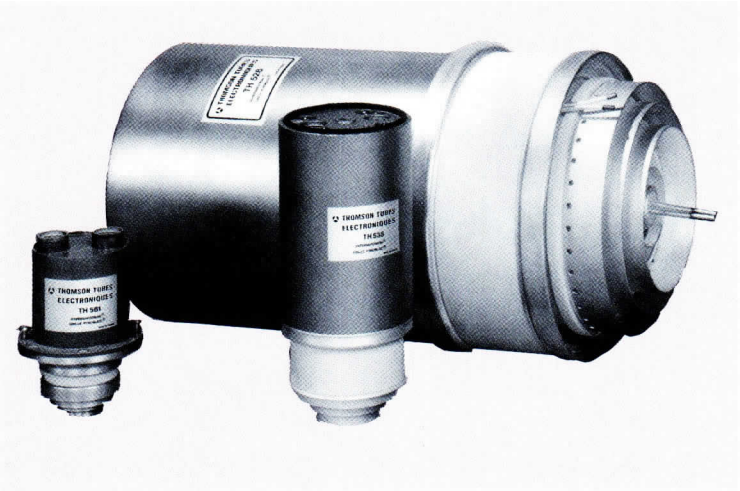
see back cover for notes

Reference	Maximum ratings (1			
	F	Po(peak)	Va	Wa
	MHz	kW	kV	kW
TH 347	1000	8	5	4.5
TH 298	500	9	5	5
TH 593	1000	15	6	10
TH 382	1000	30	7	12.5
TH 343	200	35	9	18
TH 561	500	35	8	20
TH 582	1000	35	7.5	25
TH 563	1000	60	9	40
TH 571A	500	70	8	50
TH 563A	800	100	11	35
TH 571B	500	150	15	50
TH 391	450	200	18	12
TH 535	200	300	20	100
TH 530	200	400	30*	100
TH 681	250	450	22	250
TH 555A	110	1000	30*	250
TH 573	110	1600	30*	300
TH 519	140	1600	30*	700
TH 518	110	2500	30*	1000
TH 526	170	3000	30	1200
TH 525	100	3500	30	1500
TH 539	30	4000	30	1000

* Pulsed anode voltage

RF tetrodes for short and medium pulse amplifiers (≤ 1 sec)

(2)		Anode cooling	Heater power supply (3)		Typical operating examples (2)							
Wg2	Wg1		Vf	If	F	Po	Va	Ia	Vg2	Vg1	tp	Duty
kW	kW		V	A	MHz	kW	kV	A	V	V	msec	%
0.025	0.005	air	6	34	500	4.5	5	0.5	475	-60	0.02	0.1
0.060	0.040	air	6	50	200	6	4.5	2	500	-100	1	30
0.075	0.025	Hypervapotron	6	65	400	10	5	3.2	600	-60	0.1	1.5
0.12	0.05	air	4.2	125	500	20	5	5.1	600	-120	0.01	30
0.30	0.10	air	7.6	125	108	30	9	4.8	500	-90	100	20
0.25	0.1	Hypervapotron	7	140	450	30	7	7	700	-150	0.05	1
0.12	0.05	Hypervapotron	4.2	150	500	25	6	6.4	700	-80	1	60
0.2	0.08	Hypervapotron	5.2	210	770	55	9	10.5	800	-120	4	20
0.4	0.15	Hypervapotron	8	180	200	60	7.5	13	800	-130	0.12	12
0.2	0.08	Hypervapotron	5.2	210	500	80	11	11	800	-110	0.25	25
0.4	0.15	Hypervapotron	8	180	400	100	13.5	10	750	-250	1	30
					179	120	14	7.2	800	-150	1	25
0.3	0.1	air	8	180	425	200	17	20	800	-200	0.25	2.5
1.2	0.5	Hypervapotron	10	200	200	300	18	23.4	1200	-200	1	0.5
0.6	0.3	Hypervapotron	10	200	200	300	25	17	1200	-450	1	15
3	1.5	Hypervapotron	10	325	225	270	13.5	29	1300	-330	1	4
4	1.5	Hypervapotron	15	320	12	500	17	38	1300	-600	100	0.1
5	2	Hypervapotron	15	490	12	1000	20	70	1500	-500	100	0.1
6	2	Hypervapotron	15	500	130	700	14.5	72	1500	-400	100	30
8	3	Hypervapotron	23	500	90	1500	22	100	1500	-400	100	0.1
12	4	Hypervapotron	17	950	155	2500	28	138	1600	-400	0.3	3
					70	1200	16	111	1650	-320	10	30
12	4.5	Hypervapotron	20	950	60	3000	28	150	1500	-400	0.3	3
16	6	Hypervapotron	30	900	13	4000	25	223	1800	-420	2	10



TH 561 TH 535 TH 526

see back cover for notes

Reference	Maximum ratings (1)			
	F	Po(peak)	Va	Wa
	MHz	kW	kV	kW
TH 347	1000	6	5	4.5
TH 593	1000	10	6	10
TH 382	1000	15	6.5	12.5
TH 561	300	20	8	20
TH 582	1000	25	7.5	25
TH 563	1000	45	9	40
TH 571B	400	90	15	50
TH 120	30	120	20	45
TH 535	200	120	20	100
TH 781	200	300	22	250
TH 519	140	850	25	700
TH 518	110	1400	25	1000
TH 526	130	2200	30	1200
TH 525	80	2500	30	1500

RF tetrodes for long pulse amplifiers (>1 sec)

(2)		Anode cooling	Heater power supply (3)		Typical operating examples (2)							
Wg2 kW	Wg1 kW		Vf V	If A	F MHz	Po kW	Va kV	Ia A	Vg2 V	Vg1 V	tp sec	Duty %
0.025	0.005	air	6	34	500	4	4	1.7	400	-50	2	10
0.075	0.025	Hypervapotron	6	65	500	8	5	2.5	700	-70	5	20
0.12	0.05	air	4.2	125	500	10	6	2.5	600	-110	2	1
0.25	0.10	Hypervapotron	7	140	200	15	6.5	3.5	600	-140	2	10
0.12	0.05	Hypervapotron	4.2	150	500	15	6	4	800	-120	2	20
0.2	0.08	Hypervapotron	5.2	210	500	45	8.5	7.8	800	-130	5	40
0.4	0.15	Hypervapotron	8	180	200	70	12	7.7	800	-120	2	10
0.6	0.3	water	10	200	27	80	16	6.4	700	-450	2	10
1.2	0.5	Hypervapotron	10	200	120	80	9	14.7	800	-110	30	12.5
4	1.5	Hypervapotron	10	325	150	150	14	16	1000	-280	30	20
6	2	Hypervapotron	15	500	55	700	16	65	1500	-450	20	1.5
8	3	Hypervapotron	23	500	60	1320	22.5	95	1500	-500	10	10
12	4	Hypervapotron	17	950	120	1000	18	85	1600	-270	30	12.5
					80	2000	23	121	1650	-400	30	12.5
12	4.5	Hypervapotron	20	950	55	2000	23.7	121	1700	-450	20	3

TH 781

TH 120

TH 571B

see back cover for notes

Reference	Maximum	
	F	Po
	MHz	kW
TH 347	900	3
TH 298	300	5
TH 593	900	7
TH 382	900	10
TH 541	200	12
TH 561	300	15
TH 582	900	20
TH 343	200	25
TH 563	900	35
TH 571A	300	40
TH 571B	400	80
TH 120	30	100
TH 535	200	100
TH 581	110	300
TH 681	200	300
TH 781	200	300
TH 555A	110	400
TH 573	110	700
TH 519	140	850
TH 518	110	1100
TH 526	130	1700
TH 525	70	1800
TH 539	30	2500

RF tetrodes for CW amplifiers

ratings (1) (2)				Anode cooling	Heater power supply(3)		Typical operating examples (2)					
Va	Wa	Wg2	Wg1		Vf	If	F	Po	Va	Ia	Vg2	Vg1
kV	kW	kW	kW		V	A	MHz	kW	kV	A	V	V
5	4.5	0.025	0.005	air	6	34	500	2	4	0.8	500	-60
5	5	0.06	0.04	air	6	50	179	3	5	0.8	400	-80
6	10	0.075	0.025	Hypervapotron	6	65	360	2.3	3	1.8	500	-70
6.5	12.5	0.12	0.05	air	4.2	125	500	6	5	2	600	-120
8	15	0.15	0.05	Hypervapotron	6.5	85	108	10	7	2	400	-120
8	20	0.25	0.10	Hypervapotron	7	140	110	12	7.5	2.3	500	-110
7.5	25	0.12	0.05	Hypervapotron	4.2	150	500	10	6	3.3	600	-110
9	18	0.3	0.1	air	7.6	125	108	25	8.5	4.2	600	-125
9	40	0.2	0.08	Hypervapotron	5.2	210	500	30	8	5.9	800	-130
8	50	0.4	0.15	Hypervapotron	8	180	178	40	6.5	10.2	800	-125
15	50	0.4	0.15	Hypervapotron	8	180	345	60	10.5	7.7	650	-270
20	45	0.6	0.3	water	10	200	2	73	12	8	700	-350
20	100	1.2	0.5	Hypervapotron	10	200	63	100	10	14.2	800	-110
22	150	2	0.8	Hypervapotron	10	280	63	250	16	23	1250	-350
20	250	3	1.5	Hypervapotron	10	325	110	200	16.3	16	1000	-320
20	250	4	1.5	Hypervapotron	10	325	30	280	15	23	1500	-700
							200	200	11	28	1250	-350
22	250	4	1.5	Hypervapotron	15	320	30	400	16	37	1000	-250
25	300	5	2	Hypervapotron	15	490	30	700	18	56	1250	-350
25	700	6	2	Hypervapotron	15	500	100	450	13	46.5	1000	-300
25	1000	8	3	Hypervapotron	23	500	30	1100	18	88	1250	-350
30	1200	12	4	Hypervapotron	17	950	100	1300	14	143	1400	-250
30	1500	12	4.5	Hypervapotron	20	950	50	1500	18	120	1500	-250
30	1000	16	6	Hypervapotron	30	900	1.5	2500	23	131	1250	-600

TH 558

TH 5188

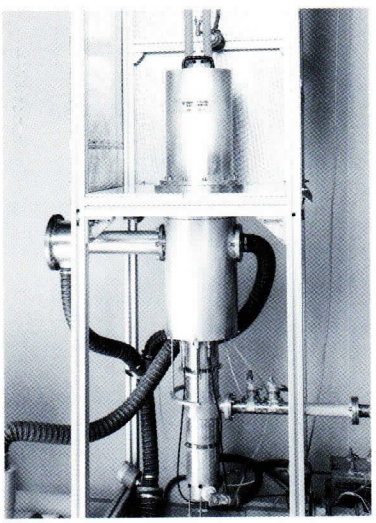
see back cover for notes

Reference	Maximum ratings (1) (4)				
	V1a kV	I2k A	Wa kW	Wg2 kW	Wg1 kW
Triode					
TH 146B	45	400	45		1.8
Tetrodes					
TH 573	35	300	300	5	2
TH 558	35	450	500	8	3
TH 530	50	100	100	0.6	0.3
TH 5187B	75	120	1	0.35	0.1
TH 5184	85	5	1	0.075	0.025
TH 5186	100	5	1.5	0.075	0.025
TH 5188W	120	10	10	0.2	0.075
TH 5188	120	10	10	0.2	0.075
TH 5189	120	15	15	0.4	0.075

Modulator and regulator triodes / tetrodes

Anode cooling	Heater power supply (3)		Typical operating examples (4)							
	Vf	If	V1a	Po	V2a	I2k	Vg2	Vg1	tp	Duty
	V	A	kV	MW	kV	A	V	V	msec	%
forced oil	13	500	40	9.6	8	300	-	-1500	0.012	1.2
Hypervapotron	15	490	30	8.25	2.5	300	2000	-1200	0.3	5
Hypervapotron	23	500	30	13.75	2.5	500	2000	-1200	0.3	5
Hypervapotron	10	200	45	2.0	5	50	700	-550	1	25
air	12.6	100	70	4.4	7	70	1500	-1450	0.001	0.1
oil	7.5	17	80	0.15	4	2	500	-550	200	10
oil	7.5	17	90	0.215	4	2.5	500	-700	200	10
water	7.5	35	100	0.48	4	5	1000	-1000	200	50
oil	7.5	35	100	0.48	4	5	1000	-1000	200	50
forced oil	7.5	35	100	0.72	4	7.5	1500	-1000	200	50

RF circuits



TH 18781

Thomson Tubes Electroniques designs and manufactures RF circuits tailored to customer specifications.
Please consult us for further information. The examples given here are only a sample of the wide range of circuits available. Information on our other standard circuits may be obtained from the company.

Circuit reference	Frequency range MHz
TH 18554A	13.56
TH 18525	35 - 80 (+ 120)
TH 18546	88 - 108
TH 18626	144 - 160
TH 18781	195 - 225
TH 18527C	170 - 230
TH 18528D	350 - 370
TH 18665F	314 - 450
TH 18550S	460 - 800

Amplifiers

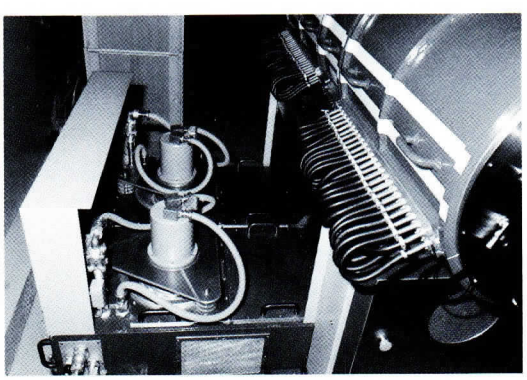


Photo courtesy CEA

TH 10120

Thomson Tubes Electroniques designs and manufactures complete amplifiers to requested specifications. The examples given here are a few of our previously developed amplifiers.

Reference	Tubes
TH 10565	2 x TH 565
	2 x TH 541
TH 10120	2 x TH 120
TH 10573	1 x TH 573
	1 x TH 741
TH 10526	1 x TH 526
	1 x TH 535
	1 x TH 561
TH 10626	1 x TH 526
TH 10571	1 x TH 571B
	1 x TH 593
TH 10347	1 x TH 347

Tube reference	Peak RF output power
	kW
TH 554B	250 (CW)
TH 526	2000
TH 535	300
TH 526	2500
TH 781	450
TH 571B	120
TH 571B	120
TH 393	6 (CW)
TH 563A	100

Circuits	Frequency range	Power peak / average	Pulse length	Duty rate
	MHz	kW		
-	0.17	1800 / 1800	-	CW
-	0.5 - 4.6	2 x 50 / 2 x 50	-	CW
-	13.56	500 / 500	-	CW
TH 18525	35 - 80	2000 / 250	30 s	0.125
TH 18535	or	or		
TH 18561	120	1400 / 175		
TH 18626	144 - 160	2500 / 75	0.3 ms	3 %
TH 18528D	350 - 360	60 / 60	-	CW
TH 18565C				
TH 18363	500	5 / 0.0005	10 µs	0.01 %

Triggered spark gaps

TH 9084

Thomson Tubes Electroniques may also develop spark gaps to match particular specifications.
Triggering circuits also are available.
Please consult us for further information.

see back cover for notes

Reference	Maximum ratings (5) (6)		
	V kV	A kA	E J
TH 9062	5	5	25
TH 9051	5	50	400
TH 9052	10	50	400
TH 9057	19	50	400
TH 9084	32	50	1000
TH 9058	40	50	400
TH 9085	37	50	1000

Thyratrons

TH 5027

see back cover for notes

Reference	Number of electrodes	Envelope material
TH 5023	3	ceramic
TH 5071		
F 5008A		
F 5024		
TH 5041	4	glass
TH 5059		
TH 5027		ceramic

Typical operating examples (6) (7)

V kV	A kA	E J	Life shots
2	3	3	10^3
4	25	100	10^4
8	25	100	10^4
15	25	100	10^4
16	7	300	10^6
32	25	100	10^4
20	10	800	10^6

Filling gas	Forward voltage kV	Peak current A	Average current A	Power factor ($x10^9$)
hydrogen	8	90	0.1	2.7
	12	350	0.2	4
	16	150	0.45	7
	25	500	0.5	9.5
	25	1000	1.25	9
deuterium	35	1000	1.25	14
	40	5000	5	70

Selection of a tube/ circuit assembly and optimal operating point

When selecting a power-grid tube and its RF circuit, certain parameters must be taken into consideration.Thomson Tubes Electroniques uses its intimate knowledge of power-grid tube operation to assist you in this choice.

As much information as possible concerning the relevant items in the following list should be submitted to us. We will then recommend the correct tube/circuit assembly and the most suitable operating point.

- Your application
- Definition of your request :
  - Feasibility
  - Budgetary quote
  - Detailed offer

  for
  - Tube alone
  - Tube + circuit
  - Complete amplifier system (specify full requirements)
- Number of units required
- Time schedule (may or may not allow for some development)
- Frequency(ies), or frequency range to be covered continuously
- Instantaneous bandwidth
- Output power per unit : peak and average, or CW ; is a multi-tube solution possible ?
- Pulse length and duty factor
- Load mismatch : VSWR (module and phase)
- Any electrical or mechanical constraints, or preferences, such as :
  - electrical/mechanical compatibility with existing tube/circuit/psu (replacement or upgrading),
  - dimensional or handling restraints,
  - preferred type of cooling,
  - pulsed anode voltage : acceptable or not (mainly for short pulse/low duty applications),
  - motor driven cavity tuning,
  - major importance of efficiency, gain, bandwidth, linearity, etc.,
  - other relevant factors.

NOTES

1 - Maximum ratings : these are influenced by all other operating parameters, and are often not compatible. Please consult Thomson Tubes Electroniques for your particular application. No two maximum ratings should ever be reached simultaneously.

2 -

F	:	Frequency
Po	:	RF output power
Va	:	Anode voltage
Ia	:	Anode current
Wa	:	Average anode dissipation
Vg2	:	Screen-grid voltage
Wg2	:	Average screen-grid dissipation
Vg, Vg1	:	Control-grid voltage
Ig	:	Control-grid current
Wg, Wg1	:	Average control-grid dissipation
Vf	:	Filament heater voltage
If	:	Filament heating current
T_p	:	Pulse length
Duty	:	Duty rate

3 - Heating : The operating heater voltage depends on the specific operating conditions. Users should forward these conditions to Thomson Tubes Electroniques who will in turn recommend the optimal heating parameters. The operating heater voltage has to be regulated to within $\pm$ 2 %.

4 -

V1a	:	Anode voltage, tube non conducting
V2a	:	Voltage drop during conduction
I2k	:	Cathode current
Wa	:	Average anode dissipation
Wg2	:	Average screen-grid dissipation
Wg1	:	Average control-grid dissipation
Vg2	:	Screen-grid voltage
Vg1	:	Control-grid voltage
Vf	:	Filament heater voltage
If	:	Filament heating current
Po	:	Useful output power
T_p	:	Conducting time
Duty	:	Conducting duty rate

5 - No more than one maximum rating may be applied at any time.

6 -

V	:	Anode voltage
A	:	Switched peak current
E	:	Switched energy
Life	:	Expected life (number of shots) when operated under the conditions given in the example

7 - When the tube is operated at higher levels, its life will be shortened.

NOTES

(See Over)

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