MICROWAVE TUBES

Summary Data

6320/2138 E Ed. 7

STC Components

Introduction

The Electron Tube Unit of STC Components offers a comprehensive range of devices for the UHF and microwave frequency bands. Since we achieved the world's first public operating travelling wave tube demonstration in 1948 and the first travelling wave tube to be installed in a microwave radio link in 1952 we have been one of the world's major microwave tube manufacturers. Our current range includes production electron tubes covering the range 470MHz to 18GHz and lists devices for both commercial and military uses.

The production and development facility at Paignton also offers a wide range of associated solid state power supply units. These are available for most STC Components' travelling wave tubes including all the latest metal/ceramic packaged types for line of sight radio links and ground satellite communications transmitters. Military limiter and medium power devices are offered in the packaged amplifier form.

The complete device range listed in this catalogue comprises:

a) Travelling Wave Tubes
b) Associated power supplies
c) Travelling Wave Tube Amplifiers
d) A pulsed amplifier klystron
e) A coaxial triode
f) Waveguide Thermocouples

The travelling wave tube/twt amplifier list includes devices for the following applications:

1. Medium power tubes, primarily for use in line of sight radio links but also adaptable for laboratory applications.
2. Limiter amplifiers for use in radar or ECM receivers.
3. Medium power amplifiers for use in radar or ECM applications.
4. High power CW tubes for UHF TV transposers.
5. Medium power tubes and amplifiers for use in ground satellite transmitters.
6. Low noise tubes, primarily for use in radar or ECM receivers.
7. High power pulsed tubes for UHF radar transmitters.

Electron Tube Unit has development devices in the following categories and enquiries are invited:

1. Helix type travelling wave tubes in the 26 to 40GHz frequency range with associated power supplies. These will be suitable for military and commercial applications requiring a few tens of watts output power.
2. Wide band helix type travelling wave tubes having power outputs up to 150 watts CW suitable for military applications at frequencies up to 18GHz, together with associated power supplies.
3. Helix type travelling wave tubes having power outputs up to 300 watts CW suitable for commercial applications at frequencies up to 14GHz, together with associated power supplies.

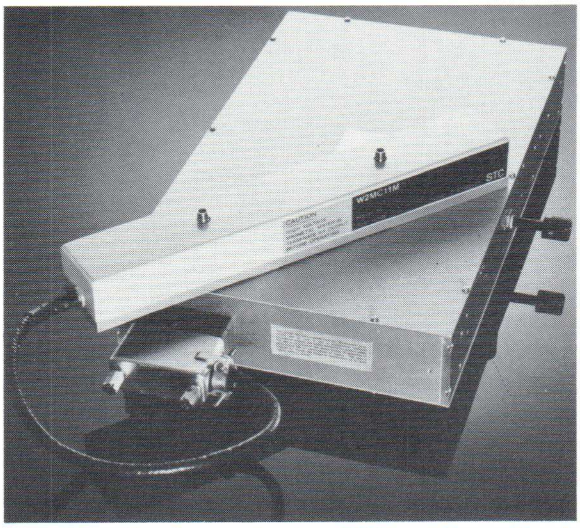
STC Components has a policy of continuous improvement and reserves the right to make changes to this product range without notice.

Development Samples

Development devices are supplied from our development or preproduction programme and as such are not qualification approved products nor totally evaluated for product safety. No condition warranty or representation regarding quality suitability performance life or continuation of supply is given or implied and the Guarantee in clauses 6a and 6h of our standard conditions is not applicable. The right is reserved to change the design or specification or cease supply without notice.

Travelling-wave Amplifier Tubes

Communication Types



Ground Satellite Communications TWT and Power Supply

Type	Alternative codes	Frequency range min. (GHz)	Frequency range max. (GHz)	Gain Nom. (dB)	Gain at P_{out} (W)	Noise factor at wkg. output (dB)	Efficiency (η)	Typical operation AM-PM conv. (°/dB)	V_{col} (kV)	V_{hel} (kV)	I_{col} (mA)	I_k (mA)	Focus Mount Codes or r.f. Connector Type	Status
LINE OF SIGHT RADIO TWTs														
a) Packaged Types														
W3MC/3A		10,7	11,7	43	10	25		2	2,4	4,3	36		WG17	Q
W3MC/3F	PO11042	10,7	11,7	43	10	25		2	2,4	4.3	36		WG17	Q
*W3MC/11A	PO11049	10,7	11,7	42,5	10	25	27	2,2	1,2/ 0,625†	3,30		38	Type SMA	Q
*W3MC/12D		10,7	11,7	40,4‡	22	26	39	3,0	1,3/ 0,65†	3,38‡		49	Type SMA	D
*W3MC14D		10,7	11,7	37,4‡	11	25	28	3,0	1,3/ 0,65†	3,38‡		38	Type SMA	D
*W3MC/15C		10,7 12,2	11,7 12,7	38,2‡ 37,3‡	10 8	25 25	29 23	3,0	1,2/ 0,6†	2,94‡		36	Type SMA	Q
*W3MC16R		10,7 12,2	11,7 13,25	40,4‡ 40 ‡	22 20	25 25	39 35	3,0 4,0	1,3/ 0,65†	3,38‡ 3,30		49 51	Type SMA	D
*W3MC20D		10,7	11,7	46	2§	24,5	–	0,8	1,7/ 0,85	4,2		90	Type SMA	D
*W3MC21E		12,75	13,25	40	10	25	25	3,0	1,2/ 0,6†	3,23‡		39	Type SMA	D
*W4MC11S		7,7	8,5	38,6‡	11	25	30	2,5	1,1/ 0,55†	2,5 ‡		41	Type N	D
*W4MC12C		7,1	8,5	38,2‡	10	25	30	2,5	1,2/ 0,6†	2,94‡		33	Type SMA	D
*W4MC13F		7,2	7,9	38,2‡	10	25	30	3,0	1,2/ 0,6†	2,90‡		33	Type SMA	D
W5MC/1A	PO11047	5,925	6,425	38	10	25	22	2,2	1,3	3,35	31		Type SMA	Q
W5MC/2A	PO11047	6,425	7,110	37,5	10	25	22	2,2	1,3	3,30	32		Type SMA	Q
*W5MC/11C		5,925	7,125	38,2‡	10	24	27	2,5	1,2/ 0,6†	2,94‡		38	Type SMA	Q
*W5MC13B		6,425	7,110	39	22	26	37	3,0	1,3/ 0,65†	3,05		56	Type SMA	D
*W5MC15D		5,8	6,425	39,6‡	11	25	24	3,0	1,05	2,5 ‡		39	Type N	Q
*W5MC16B		5,925	6,425	38,6‡	11	24	31	3,0	1,2/ 0,6†	2,5 ‡		37	Type SMA	D
*W5MC17D		5,925	7,125	38,2‡	10	24	26	3,0	1,2/ 0,6†	2,5 ‡		39	Type SMA	D
*W5MC18M		5,925	6,425	38,8‡	15	24	33	2,5	1,23/ 0,615†	3,0 ‡		47	Type SMA	D

For index to symbols * † ‡ § please see opposite page.

Travelling-wave Amplifier Tubes

Communication Types—*continued*

CV6247

Type	Alternative codes	Frequency range min. (GHz)	Frequency range max. (GHz)	Gain Nom. (dB)	Gain at P_{out} (W)	Noise factor at wkg. output (dB)	Efficiency (η)	AM-PM conv. (°/dB)	Typical operation V_{col} (kV)	V_{hel} (kV)	I_{col} (mA)	I_k (mA)	Focus Mount Codes or r.f. Connector Type	Status
LINE OF SIGHT RADIO TWTs—*continued*														
a) Packaged Types														
*W5MC19C		5,925	6,425	45	5§	24,5	–	0,8	1800/ 1000†	3,47‡		100	Type SMA	D
W7MC/2R		3,6	4,2	40	10	22		1,8	1350	2,4		38	Type SMA	Q
*W7MC13B		3,7	4,2	38,6‡	11	24	29	3,0	1200/ 600†	2,5 ‡		40	Type SMA	D
b) Field Replaceable Types														
W3/2GR		10,7	13,2	44	5	30	–	2	2,2	3,4	30		WM109CR	Q
W3/2GC		10,7	11,7	40	10	30	–	2,5	2,2	3,5	30		WM109C	Q
W3/5G		10,7	11,7	43	10	25	–	1,8	2,4	4,35	36		WM114	Q
W4/2G	W4/2GC	7,0	8,5	41	7	28	–	1,5	2,0	3,3	40		WM108C, WM108CA	Q
W5/1G		5.85	7,1	40	5	26	–	–	2,0	3,1	40		495-LVA-105	Q
W5/2G	CV6163	5,85	7,2	41	10	28	–	2,4	2,1	3,4	50		WM107AB, WM107AD	Q
W5/2GD		5,85	6,4	42	7	28	–	1,8	2,1	3,4	50		WM107DA	Q
W5/2GF		6,6	7,9	36	7	28	–	1,8	2,1	3,3	50		WM107DF	Q
W5/4GC		5,85	7,2	39	10	24,5	–	1,8	2,1	3,4	50		WM112C	Q
W5/4GF	PO11043	5,85	7,9	40	10	24,5	–	2,0	2,1	3,3	50		WM112F	Q
W7/3G W7/3GY	CV5293	3,6	4,2	40	5	–	–	–	3,05	3,0	40		28-LTU-407C 28-LTU-503A	Q Q
W7/4G	CV6162	3,6	4,2	39	7	27	–	–	2,0	3,0	40		495-LVA-101 A or B	Q
W7/5GA		3,6	4,2	43	20	–	–	–	1,8	2,6	80		WM110AZ	Q
W7/5GC		3,7	5,0	40	10	–	–	–	1,7	2,55	65		WM110C	Q
W7/6GC		3,7 4,4	4,2 5,0	41 41	10 10	27 27	– –	2,0 2,0	1,9 1,9	2,7 2,65	65 65		WM111CB WM111CA	Q Q
W7/6GA	PO11041	3,7	4,2	42,5	20	27	–	1,3	1,9	2,68	80		WM111A	Q
W7/6GZ		3,6	4,2	43	20	27	–	1,3	1,9	2,68	80		WM111Z	Q

For index to symbols * † ‡ § please see below.

Communication Types

Type	Alternative codes	Frequency range min. (GHz)	Frequency range max. (GHz)	Gain Nom. (dB)	Gain at P_{out} (W)	Noise factor at wkg. output (dB)	Efficiency (η)	AM-PM conv. (°/dB)	Typical operation V_{col} (kV)	V_{hel} (kV)	I_{col} (mA)	I_k (mA)	Focus Mount Codes or r.f. Connector Type	Status
GROUND SATELLITE COMMUNICATIONS (Packaged TWTs)														
*W2MC11M		14,0	14,5	43 40	2 20	27	–	1,0	1400/ 700†	3,9‡		60	Type SMA	Q
*W4MC14A		7,9	8,4	37	10	24,5	26	3,0	1200/ 600†	2,6‡		35	Type SMA	D
*W5MC14M		5,925	6,425	45	2	24	–	0,5	1200/ 600†	2,4 ‡		54	Type SMA	D
*W5MC20M		5,925	6,425	42	40	25	40	4,0	1700/ 850†	3,85‡		85	Type SMA	D
WIDE BAND TRAVELLING WAVE TUBES (Packaged TWTs)														
*W3MW1B		7,9	10,7	40	10	27	–	–	1200/ 600†	2,9 ‡		40	Type SMA	D
*W5MW1M		4,0	8,0	41	10	25	25	–	1200/ 600†	2,4 ‡		40	Type SMA	D

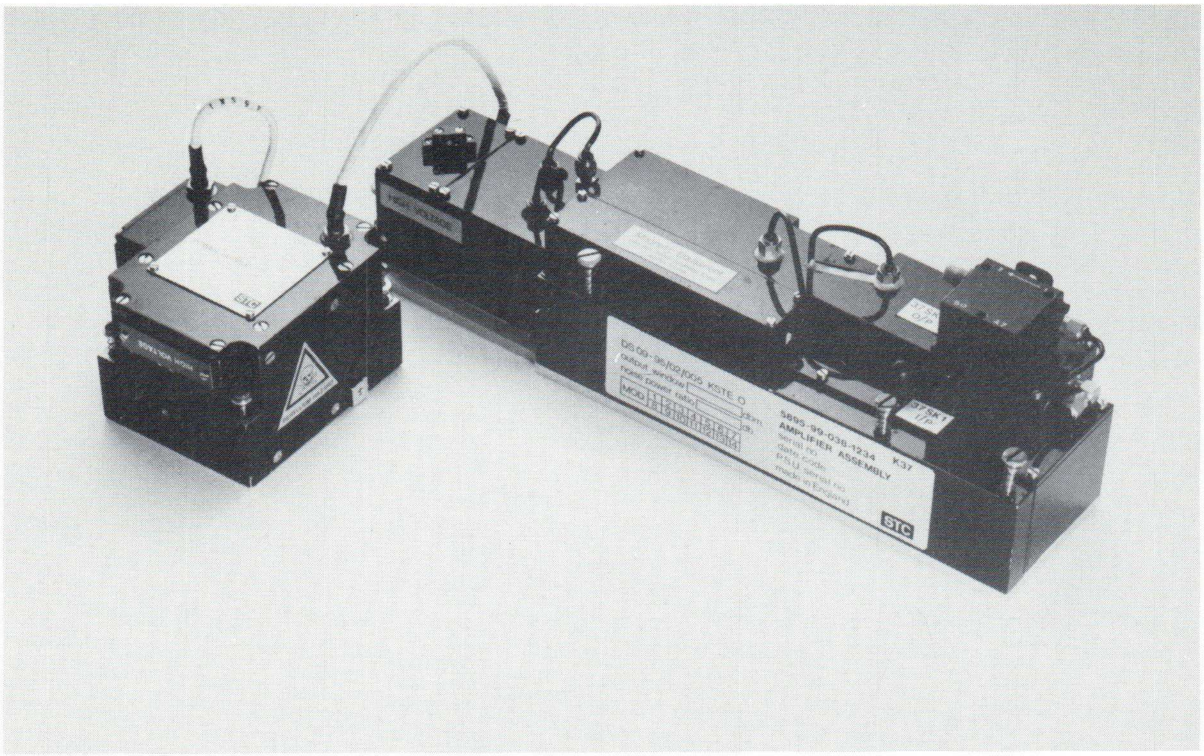
* Recommended for new equipment   † Two stage collectors   ‡ Fixed values   § Per tone (Two tone operation) 3rd Order Intercept point 50 dBm

Efficiency is defined as $\frac{Prf}{Pcol + Phel + Phtr} \times 100\%$

Status D – Development
Q – Qualified commercial product

Travelling-wave Amplifier Tubes

Low-power Military Tubes



Limiter Amplifier

Type	Alternative Codes	Frequency range min. (GHz)	Frequency range max. (GHz)	P_{out} (dBm)	Noise factor, small signal (dB)	Gain low-level (dB)	V_{col} (V)	V_{hel} (V)	I_{col} (μA)	Focus (Note 1)	Focus mount	Description (Note 2)	Status
*W6MT/2A	5960-99-038-0197	4	7,5	+8 to +16	9,5	31 to 35	(H.T. + 450/0/ −625V d.c.)			SFPM	Packaged	T	Q
*W3MQ/5A	5960-99-038-1722	9,1	9,85	+ 15	6,7	24	1200	950	700	SFPM	Packaged	N	Q
*W3MT/4A	5960-99-038-0135	7,5	12	+ 9 to + 17,5	9,5	30 to 36	(H.T. + 1200/0/ −25V d.c.)			SFPM	Packaged	T	Q
*W2MT/1A	5960-99-038-0691	12	18	+ 10 to + 18,5	11	30 to 36	(H.T. +1400/0/ −25V d.c.)			SFPM	Packaged	T	Q
*W2MT/3A	5960-99-038-0722	12	18	+ 7 to + 15	11	29,5 to 34,5	(H.T. + 1400/0/ −25V d.c.)			SFPM	Packaged	T	Q
W9/2E	CV6090	2,5	4,1	+ 4,8 to + 10,8	7,5	38 to 50	600	400	400	Sol	495-LVA-005B	S	Q
W9/3E	CV6127	2,5	4,1	−12 to −4	<18	11 to 20	300	200	125	Sol	495-LVA-007E	LS	Q
W10/3E	CV6120	2,7	3,3	+ 4,8	6,8	20 to 25	700	450	400	Sol	495-LVA-003A	S	Q

* Recommended for new equipment

Note 1. Focusing method: SFPM = Straight field permanent magnet; Sol = Solenoid Electro-magnet

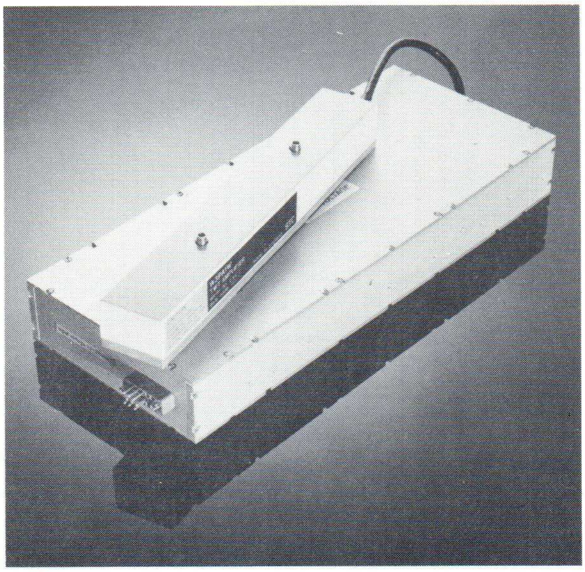
Note 2. Description: T = Packaged low-noise gain-track tube; integral power distribution network; N = Packaged low-noise amplifier with wide dynamic range; S = Low noise amplifier tube. Separate focus mount.; LS = Limiter tube. Separate focus mount.

MISCELLANEOUS TYPES (Packaged TWTs)

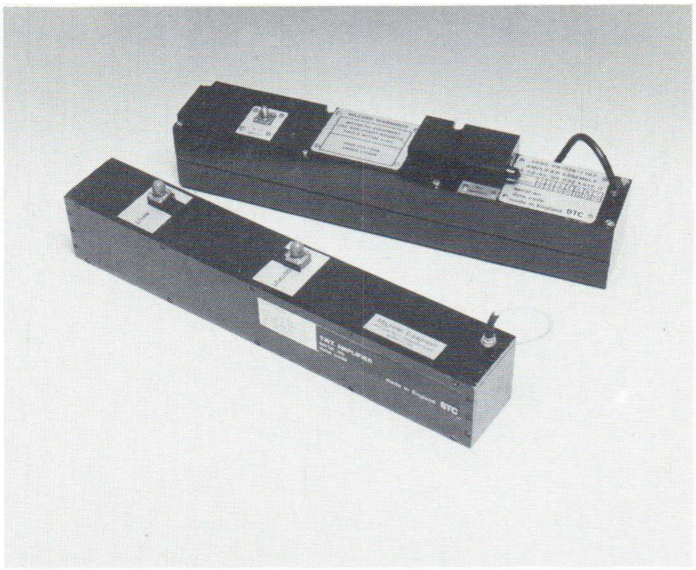
Type	Alternative codes	Frequency range min. (GHz)	Frequency range max. (GHz)	Gain Nom. (dB)	Gain at P_{out} (W)	Noise factor at wkg. output (dB)	Efficiency (η)	AM-PM conv. (°/dB)	Typical operation V_{col} (kV)	Typical operation V_{hel} (kV)	Typical operation I_{col} (mA)	Typical operation I_k (mA)	Focus Mount Codes or r.f. Connector Type	Status
W6MM11P		5,03	5.09	38	25	25	34	4,0	1700/850	2,7		65	Type SMA	D

Travelling-wave Tube Amplifiers

Military TWT Amplifiers



W3PA1W



W5PA1M & W2PA1M

Type	Alternative Codes	Frequency range min. (GHz)	Frequency range max. (GHz)	Wkg. P_{out} (W)	S.S. Gain (dB)	N.F. (dB)	V_{in} (V)	Primary Power P_{in} (W)	f_{in} (Hz)	R.F. Connectors	Description	Status
*W2PA2W		14	nom	20	45	27	28	110	DC	Type SMA	M	Q
*W2PA1M	5895-99-038-7168	8	18	1,6	G + NF = 51dB		115,1ϕ	45	400	Type SMA	M	Q
*W3PA1W		9,6	10,25	25	45	26	28	110	DC	Type SMA	M	Q
*W3PL3D	5895-99-038-2141	7	17†	0.02	55	13,5	115,3ϕ	40	400	Type SMA	L	Q
*W4PL2D	5895-99-038-1234	5	12†	0,02	55	12,5	115,3ϕ	40	400	Type SMA	L	Q
*W5PA1M	5895-99-038-7167	4	8	0,8	G + NF = 43dB		115,1ϕ	25	400	Type SMA	M	Q

* Recommended for new equipment

† Ratio max. to min. limits 1,8 : 1 in frequency range specified

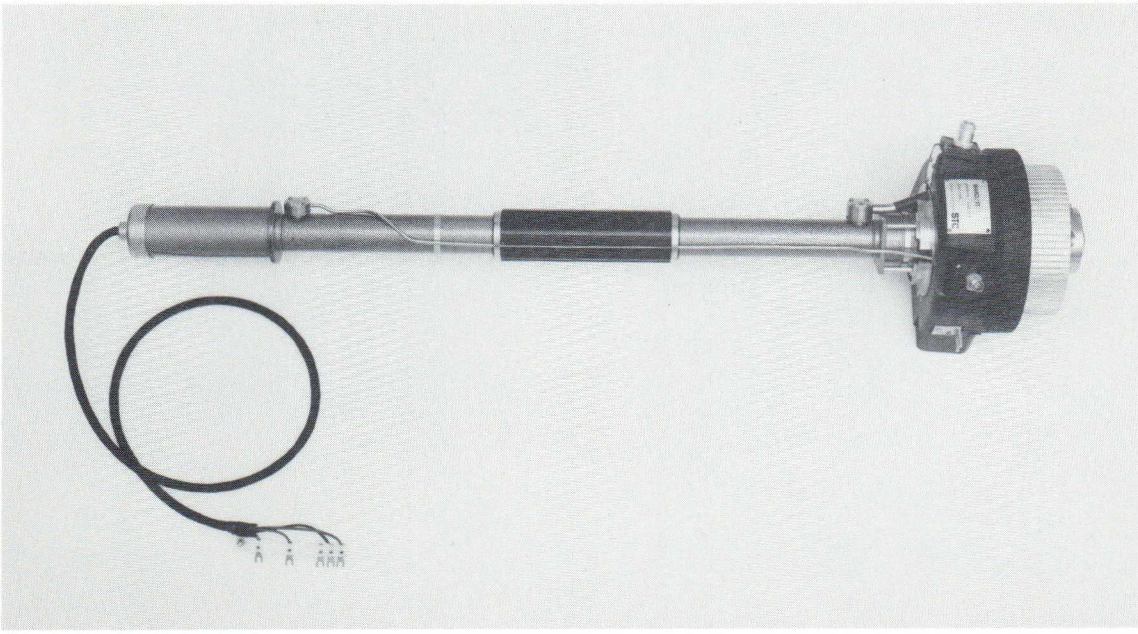
M = Medium Power Amplifiers L = Limiter Amplifiers

Commercial TWT Amplifier

Type	Frequency range min. (GHz)	Frequency range max. (GHz)	Sat. P_{out} (W)	Gain (dB)	N.F. (nom.) (dB)	V_{in} (V)	P_{in} (W)	f_{in} (Hz)	R.F. connectors	Height (mm)	Depth (mm)	Status
GROUND SATELLITE COMMUNICATIONS												
W4PC16E	7,9	8,4	30	39	25	24	136	dc.	Type SMA	310	190	D

U.H.F. Travelling-wave Amplifier Tubes

TV Transposer Tubes



W48D/1T

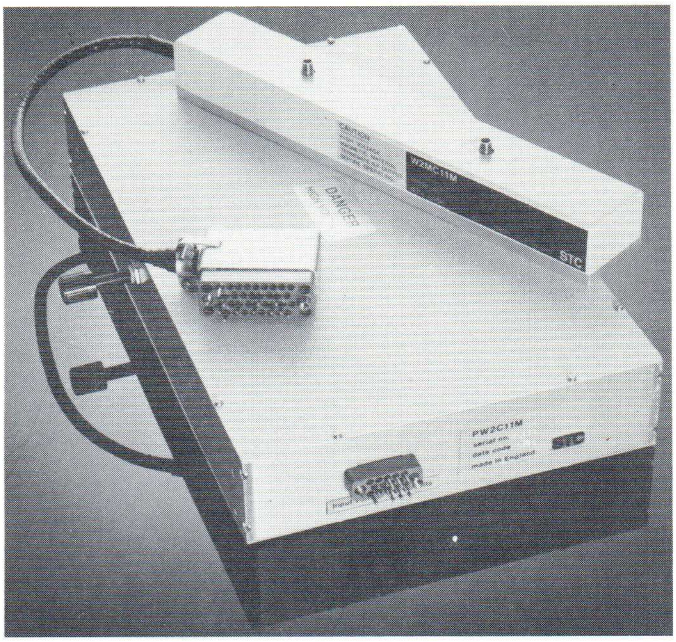
Type	Alternative code	Frequency range min. (MHz)	Frequency range max. (MHz)	Transposer service (TV) P_o pk. sync. (W)	Transposer service (TV) G (dB)	Typical operating conditions V_{col} (kV)	V_{hel} (kV)	I_k (A)	Sound service (TV) P_o (W)	Sound service (TV) G (dB)	V_{g2} (V)	V_h (V)	I_h (A)	$I_{mag.}$ (A)	$V_{mag.}$ (V)	Mount assembly STANTEL type	Status
W45B/5E	YH1020	470	860	53	35	2,9	3,1	0,75	–	–	700	6,3	2,8	–	–	WM455A	Q
						2,9	3,1	0,7	210	33	600	6,3	2,8	–	–	(MYH1020)	
W48D/1T		470	860	225	35	3,9	3,9	1,35	–	–	2000	11,5	4,5	8,0	85 max	WM481S	Q
				120	35	3,75	3,75	1,25	–	–	1900						

High Power Pulsed Tube

Type	Frequency range min. (GHz)	Frequency range max. (GHz)	P_{out} (nom.) (W)	Gain (nom.) (dB)	V_{hel} (kV)	V_{col} (kV)	I_k (mA)	Focus Mount	Status
W46D/2T	0,4	0,8	1,000 pk	30	3,8 (pulsed)	3,8 (pulsed)	1,600 pk	Solenoid WM461M	Q

Note: All electrode voltages are quoted relative to cathode

TWT Power Supply Units



Slimline Power Supply and Tube

19 inch Rack TWT Power Supply

Type	Alternative code	Associated TWT	V_{in} (V)	‡P_{in} (nom.) (W)	f_{in} (Hz)	Height (mm)	Depth (mm)	Width (mm)	Status
*PW2C11M		W2MC11M	21,8–28,2 or 42–56	96	d.c.	310	190	50	Q
*PW3C16R		W3MC/16R	43–56	80	d.c.	310	190	50	D
*PW3C20D		W3MC20D	21–28 or 42–56	120	d.c.	355	181	76	D
*PW3C21E		W3MC21E	43 to 56	60	d.c.	310	190	50	D
*PW3W1B		W3MW1B	21–28 or 42–56	–	d.c.	110	216	482	D
*PW4C13F		W4MC13F	21–28 or 42–56	58	d.c.	110	216	482	D
*PW4C14A		W4MC14A	21–33	55	d.c.	310	190	50	D
*PW5C11C		W4MC/12C W5MC/11C W3MC/15C	21–28 & 42–56	58	d.c.	110	216	482	Q
*PW5C13B		W5MC13B	20	90	d.c.	310	190	50	D
*PW5C14M		W5MC14M	21,8–28,2	58	d.c.	310	190	50	D
*PW5C16B		W5MC16B	20	58	d.c.	310	190	50	D
*PW5C17D		W5MC17D	21–28 or 42–56	65	d.c.	110	216	482	D
*PW5C18M		W5MC18M	21,8–28,2	80	d.c.	110	216	482	D
*PW5C19C		W5MC19C	21–28 or 42–56	150	d.c.	355	181	76	D
*PW5C20M		W5MC20M	21–28	150	d.c.	355	181	76	D
*PW6M11P		W6MM11P	42 to 56	120	d.c.	310	190	50	D
*PW7C13B		W7MC13B	20	50	d.c.	310	190	50	D
PW35A		W3/5G, W3MC series	240	360	50	267	308	482	D
PW51AH		W5MC series	21,8–28,2	170	d.c.	132	368	216	D
PW52F		W5/2GF	21,8–28,2	260	d.c.	167	400	196	Q
PW54D		W5/4G series	240	420	50	89	368	482	D
*P2W3Q5A	5840-99-527-3373	Two tubes type W3MQ/5A	115,1ϕ	100	400	205	313	374	Q

* Recommended for new equipment

‡ When operating associated twt under typical conditions

Pulsed Amplifier Klystron

Type	Alternative code	Frequency range min. (MHz)	Frequency range max. (MHz)	P_{out} peak (kW)	Gain (dB)	V_{beam} (kV)	I_{beam} (peak pulse) (A)	Duty cycle (%)	V_h (V)	Status
Z211/1G	CV5314	950	1213	7	34	15	2	3	12,6	Q

Ancillary Microwave Devices

S.H.F. Triode

		Maximum ratings				Typical operating conditions										
Type	Alternative code	P_a (W)	P_g (W)	V_a (kV)	I_k (mA)	f (MHz)	V_a (kV)	V_g (V)	I_a (mA)	I_g (mA)	V_h* (V)	P_{drive} (W)	P_{out} (W)	μ	g_m (mA/V)	Status
2C39A	CV2516	100	2	1	125	2500	0,9	−22	90	27	4,5	–	20	100	24	Q
						500	0,9	−40	90	30	6,0	6	45			

Note: Cooling is forced-air. Service is Class C unmodulated r.f. amplifier or oscillator

* The low frequency value is 6,3V which must be reduced at high frequencies as detailed in the data sheet.

Thermocouples (for use in waveguides)

Type	Frequency range min. (MHz)	Frequency range max. (MHz)	Output at cap	Resistance of couple nom. (Ω)	Safe I_h max. (mA)	I_h to produce in couple an open circuit e.m.f. of 15mV (mA)	Status
T2H/60JA	300	6000	+ve to disc	6	60	38	Q
T2H/60JB	300	6000	−ve to disc				

Product Safety

Safe operating conditions are the responsibility of the equipment designer and user.

Operation outside stated ratings may result in a safety hazard.

Microwave Tubes

1. **Material Content**

The vacuum envelope according to type and production date incorporates glass or high-alumina ceramic with associated copper and nickel alloy seals. Packaging and basing may involve plastic or RTV silicone rubber (LO1 26-7) insulating materials. Some tubes are fitted with PTFE covered connecting wires. Cathode coatings commonly contain Barium Oxide and Barium Getters are often used within a glass envelope. Accidental damage to tubes with glass envelopes will result in the normal hazards of broken glass aggravated by implosion effects.

2. **Physical Form**

The electrode structure, principally nickel alloy components, is mounted in a cylindrical glass or metal envelope. In the case of travelling-wave tubes the tube may be supplied together with its magnetic circuit and heat sink as a "packaged unit".

3. **Intrinsic Properties**

Non-operating
Inert, but precautions may be applicable appropriate to the presence of permanent magnets in packaged assemblies.

Operating
High voltages are required for correct operation and the supplies are potentially lethal. Equipment properly designed will ensure that personnel cannot come into contact with high voltage circuits. All high voltage circuits and terminals should be enclosed and fail-safe interlock switches should be fitted to disconnect the primary power supply and discharge all high voltage capacitors and stored charges in the electronic devices before allowing access. Interlock switches should not be bypassed to allow operation with access doors open. Equipment must be designed with enclosure interlocked and switched in accordance with the UK Factories Act 1961 (Dept of Employment)/1973 Memorandum on Electricity Regulations (SHW928) and the Health and Safety at Work Act 1974.
Exposure to the radio frequency power output should be avoided by ensuring that waveguide or co-axial circuits are correctly terminated. STANTEL tubes are designed to achieve when properly terminated an r.f. leakage below 10mW per square centimetre at 5cm from any surface of tube*. It is understood that this standard is likely to be incorporated in UK Defence Standard 59-60 Part 1 Annexe H (in preparation).
Additionally, with regard to discontinuous or intermittent exposure, the British Medical Research Council (1971) recommend that over the frequency range 30MHz to 30GHz a maximum energy density limit of 1mWh/cm^2 should apply in any six minute period.

4. **Fire Characteristics**

Primary
The key functional materials are not combustible.

Secondary
PTFE wire covering and materials used in basing or packaging may burn and give rise to toxic fumes. Solenoid units should be protected by adequate current and thermal overload sensors.

5. **Handling**

The glass envelope types of tubes are particularly vulnerable to damage and care should be exercised when replacing in the associated circuit. Operating temperatures are high and circuit thermal inertia may also be high, requiring that adequate cooling time should be allowed after switch-off before tube handling is attempted. Some of these devices contain permanent magnets, care should be taken during handling.

6. **Storage**

Inert.

7. **Disposal**

Care needs to be taken with broken glass and Barium Oxide which is a toxic substance. Particular attention should be given to personal hygiene after handling broken tubes. Tubes with PTFE covered wires must NOT be disposed of where subsequent incineration may occur.

8. **Unsafe Use**

NORMAL RATINGS SHOULD NEVER BE EXCEEDED.
It is important that in the case of the twt, tubes are never operated without specific collector cooling. Trips should be fitted to safeguard against excessive helix current.
An interlock facility is fitted to the lid of the focus mounts for field replaceable twts, and should be correctly connected in the power supply circuit.
TUBE/FOCUS MAGNET ASSEMBLIES MUST NEVER BE OPERATED WITHOUT THE r.f. TERMINALS PROPERLY CONNECTED AND A MICROWAVE ENERGY ABSORBING LOAD ATTACHED TO THE OUTPUT TERMINAL. Failure to observe this precaution may result in hazard to the tube and the operating personnel. IN PARTICULAR, PERSONNEL MUST NOT LOOK INTO AN OPEN WAVEGUIDE OR COAXIAL TERMINATION OF AN ENERGISED DEVICE.

* The RF radiation limit quoted is that currently accepted for UK industry. There has been considerable debate on the matter and some countries prescribe lower limits – sometimes frequency-related.

Product Safety

Power Supplies

1. **Material Content**

These units contain printed circuit boards with semiconductor and other component assemblies. Transistors may have Beryllium Oxide heat sink assemblies. Units incorporating this material carry a Beryllia hazard label.
Under no circumstances must assemblies containing Beryllia ceramic be tampered with mechanically. In case accidental damage occurs, precautions appropriate to Beryllia hazard must be clearly understood by the personnel involved, and protective measures taken to avoid contact with skin or inhalation of dust. Some guidance can be obtained from UK DEF Standard 59-60 Part 1 Annexe E.
The wiring includes PTFE covered equipment wires. Capacitors may be of the Wet Electrolytic type.
In some power supply units a conformal coating of silicone rubber RTV3140 (LO1 29.1) is used.

2. **Physical Form**

The power supplies are normally provided with an aluminium or steel enclosing container. Occasionally transistors with Beryllium Oxide heat sinks are fixed external to the container. The containers are normally protected on the exterior by paint. Finned heat sinks may be attached to the exterior of the container. Some power supplies require the attachment of separate heat sinks before operation. An interlock facility may be provided in the power supply to prevent energising unless an output connector completing the interlock circuit is fitted, this should be correctly connected.

3. **Instrinsic Properties**

Non-operating
Normally safe when disconnected from primary power source. Seepage can occur from wet electrolytic capacitors in cases where handling damage has been inflicted or electrical overload or out-of-specification environmental conditions experienced at some time. Corrosion or short circuits may result.

Operating
These power supplies generate high voltages which are present internally and available at the output connector, these are potentially lethal.
Operation of power supplies with the covers removed exposes internal high voltage points and is dangerous. Covers should not be removed within one minute of disconnecting the primary power source to allow time for residual charges to bleed away.
Permanent damage may be caused by the connection of the incorrect primary power source. Component failure may cause local overheating.
Energising the power supply in conditions outside the relative humidity ratings, or when the power supply has been exposed to such conditions without a subsequent drying process being carried out may cause component damage or an unsafe condition.
External heat sinks may rise to high temperatures during operation.

4. **Fire Characteristics**

Primary
The key functional materials are not combustible.
Power supply units are fitted with protection circuits to minimise hazards resulting from overload or component failure but it is conceivable that unusual circumstances of failure, overload or damage could result in overheating sufficient to cause fire.

Secondary
Exterior paint will burn in an excessive heat environment. PTFE and Beryllium Oxide will give off toxic fumes when exposed to strong fire conditions.
Plastic materials may burn and give rise to toxic fumes.
In the event of the unit overheating or being operated outside the specified ratings, there is a risk that the electrolytic capacitors will vent and give off noxious fumes and/or fluids.

5. **Handling**

The units are sensibly robust but dropping or excessive vibration may lead to immediate damage or later component breakdown with consequent hazard.
The pack supplied by the manufacturer should always be used for transportation.

6. **Storage**

Normal care required for electronic equipment should be observed.
Storage outside the rated ambient conditions may lead to component failure and subsequent hazard.
The transport pack supplied by the manufacturer should be used for storage.

7. **Disposal**

Where power supplies contain Beryllium Oxide devices disposal should follow that recommended for the above substance.
Warning labels are attached to these units and individual semiconductors containing this substance are identified.
Since these units contain PTFE covered wires no disposal may be allowed which may involve incineration.

8. **Unsafe Use**

The units should be used within their maximum ratings with the correct connections used at the input and output sockets. Operation contrary to the above can result in damage and safety hazard.
Operation of power supplies with the covers removed exposes internal high voltage operating points and is dangerous.
Permanent damage may be caused by the connection of the incorrect primary power source. Component failure may cause local overheating.
Warning notices should be fitted to the equipment indicating as follows:

(a) Warning—High Voltage

and, where applicable,

(b) The following warning notice

BERYLLIUM OXIDE—HAZARD

This equipment includes a device containing beryllia, the dust of which is toxic.

DO NOT DISMANTLE OR TAMPER WITH COMPONENT PARTS.

Product Safety

UHF/SHF Thermocouples

1. **Material Content**

These devices are constructed of glass and metal and contain no toxic substances.

2. **Physical Form**

The bi-metal thermocouple element is housed in the glass end of the tube and a loop presenting a low impedance at high frequencies completed by a vacuum capacitor structure in the body of the glass tube.

A copper flange is provided for mounting the thermocouple in a hole in the wall of a waveguide so that the loop element couples to the r.f. power in the guide. Direct connection to the thermocouple are via flange (normally grounded) and the cap.

3. **Intrinsic Properties**

Non-operating

No hazard.

Operating

No hazard provided that the mounting in the waveguide is properly effected and the microwave radiation leakage does not exceed 10mW/square cm at 5 cm from the surface*. (It is understood that this standard is likely to be incorporated in UK Defence Standard 59-60 Part 1 Annexe H in preparation.) Only very low voltages (below 1 volt) are developed between the thermocouple connector cap and flange.

4. **Fire Hazard**

None.

5. **Handling**

Normal precautions associated with glass components.

6. **Storage**

Inert.

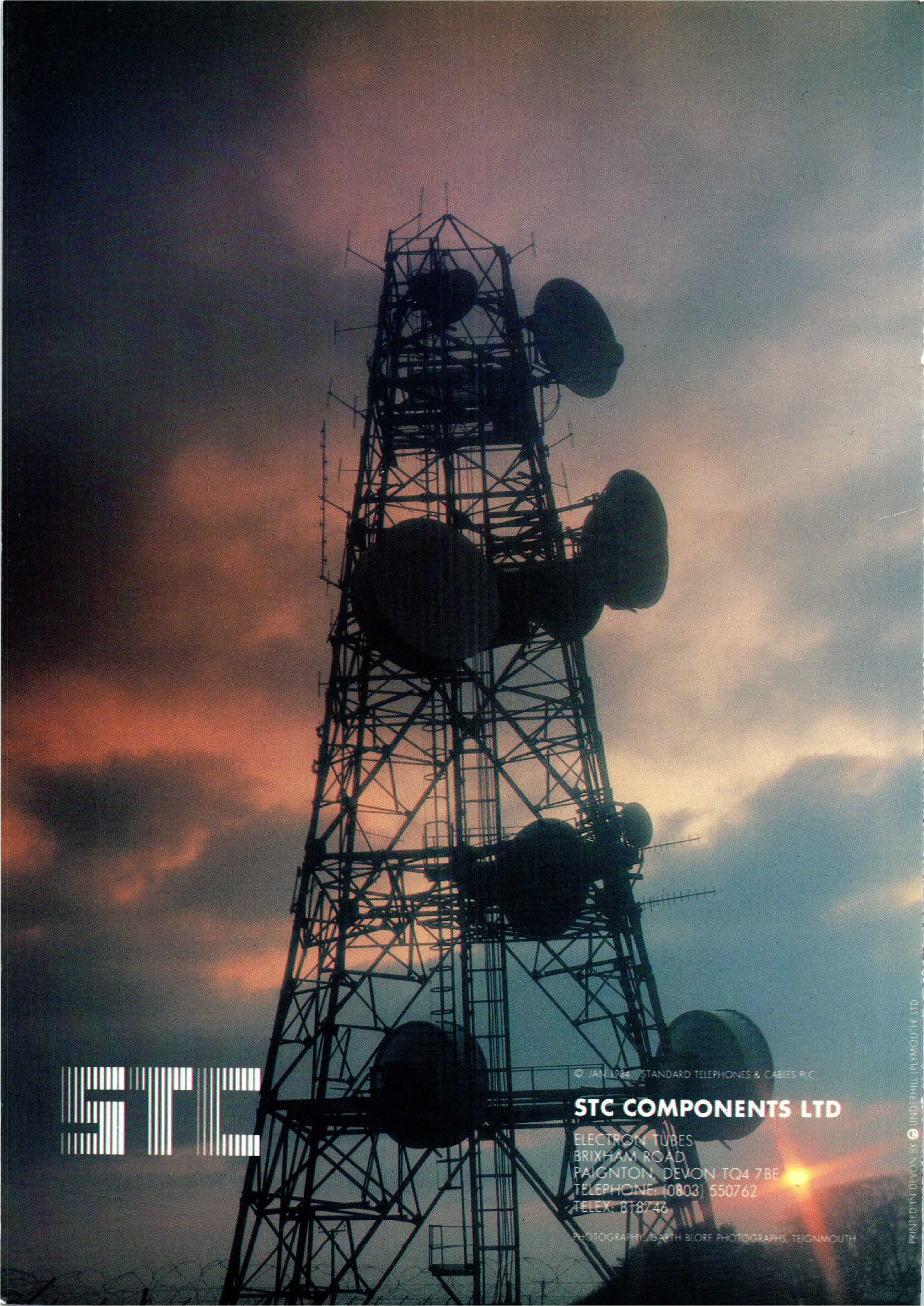
7. **Disposal**

No special precautions other than those associated with broken glass.

8. **Unsafe Handling**

The millivolt reading between flange and cap when the device is mounted in an energised waveguide is representative of the power only in the system in which the unit has been calibrated. In a different system, e.g. with change of propagation mode, the sample of radio energy intercepted by the thermocouple loop may be different and the calibration must be re-checked against a standard to avoid misleading readings.

* The RF radiation limit quoted is that currently accepted for UK industry. There has been considerable debate on the matter and some countries prescribe lower limits – sometimes frequency-related.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