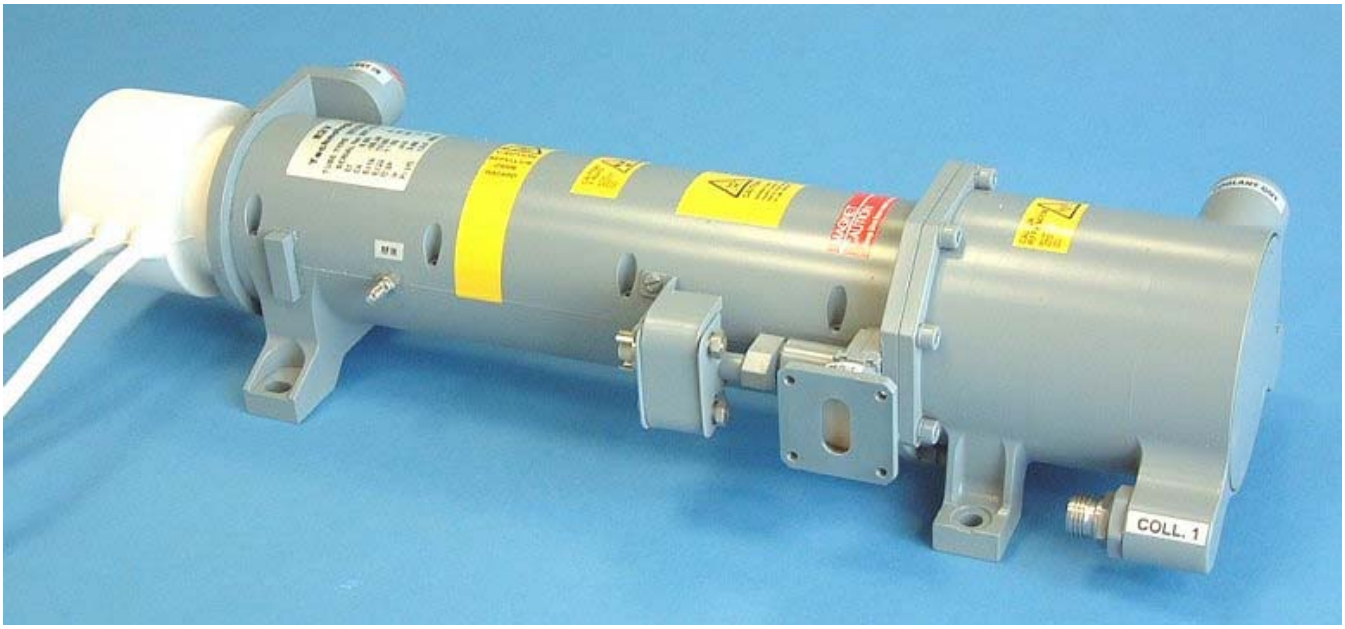
e2v technologies

N10570A
X-Band Pulsed Travelling Wave Tube



ABRIDGED DATA

Pulsed power amplifier travelling wave tube, coupled-cavity type, with integral periodic permanent magnet focusing. The tube is of rugged construction, designed for an airborne environment and weighs less than 8 kg. It is shadow-grid modulated and is capable of producing a mean output power of 1650 W when cooled with silicate ester based fluid. The tube has a dual stage depressed collector to enhance efficiency.

Frequency	9.4 – 10.0	GHz
Output power (peak)	20	kW min
Input power	31	dBm max
Duty cycle	0.0825	
Efficiency	0.32	

GENERAL

Electrical

Cathode	indirectly heated	
Heater voltage (see notes 1 and 2)	10.5	V
Heater current	3.0	A
Cathode pre-heating time (see note 3)	3.0	minutes
Ion pump voltage (see notes 4, 5 and 6)	3.0	kV

Mechanical

Overall dimensions	see outline
RF connections:	
input	SMA female
output	UG-39/U with 4 holes M4 x 0.7
Mounting position	any
Net weight	8 kg (17.6 pounds) max

Cooling

The tube uses Coolanol 25 R or equivalent.

Flow rate at 20 °C inlet temperature	15	l./min
Pressure drop at 15 l./min	1.0	bar

Environmental

The tube is designed to meet MIL-E-5400, class 2.

Magnetic Fields

No magnetic materials or energised magnets may be placed within 75 mm (3 inches) of any part of the tube. The compass safe distance for a 1° deflection is 1.5 m (59 inches) and for a $^1/_8$° deflection 3 m (118 inches).

MAXIMUM AND MINIMUM RATINGS
(Absolute values) (See note 4)

	Min	Max	
Heater voltage	9.0	11.0	V
Heater surge current (see note 7)	–	5.0	A
Cathode pre-heating time	3.0	30	minutes
Collector 1 voltage	13	16	kV
Collector 1 current (peak)	–	2.5	A
Collector 2 voltage	8.0	11	kV
Collector 2 current (peak)	–	5.0	A
Cathode voltage (see note 1)	−24	−26.3	kV
Cathode current (peak)	–	5.4	A
Body current (peak)	–	0.9	A
Grid bias voltage (negative)	380	420	V
Peak forward grid voltage (see note 1)	215	380	V
Grid current (peak)	–	50	mA
Ion pump voltage (see note 5)	2.7	3.5	kV
Ion pump current (see note 6)	–	1.0	mA
RF drive power (peak) (see notes 1 and 8)	–	34	dBm
Duty cycle (see note 9)	–	0.0825	
Pulse duration	0.3	100	µs
Input and output VSWR		see note 10	

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TYPICAL OPERATION

Heater voltage	10.5	V
Cathode voltage	−25	kV
Collector 1 voltage	14	kV
Collector 2 voltage	9.0	kV
Grid bias voltage	−400	V
Grid pulse voltage	300	V
Grid cut-off voltage (see note 11)	−100	V
Cathode current (peak)	4.0	A
Body current (peak)	0.6	A
Grid current (peak)	15	mA
RF input power	30	dBm
RF output power (peak)	20	kW
RF duty cycle	8.25	%

NOTES

1. Each tube is marked with recommended values of heater voltage, cathode voltage, peak forward grid voltage and RF drive power.
2. The heater voltage may be DC, or AC up to 15 kHz, square or sine wave. It must be stabilised to the marked value ±2%, unless a frequency above 60 Hz is used, in which case the heater power must be maintained at the value given by the voltage and current shown on the test sheet. Stabilisation to ±5% for short periods (up to 30 minutes) will not affect tube life significantly. If a DC heater supply is used, the common heater-cathode terminal must be positive.
3. If the heater is operated for more than 30 minutes, it is essential to draw beam current before switch-off.
4. Cathode and ion pump voltages are with respect to the body structure. Other voltages are with respect to the cathode.
5. The ion pump voltage must be applied whenever the tube is operating.
6. The ion pump should be operated from a 3 kV DC power supply capable of delivering 100 μA continuously. During switch-on, the ion pump may draw 1 mA surge current and under this condition the voltage may fall to 1.5 kV. An interlock should be provided to prevent application of cathode and grid pulse voltages if the ion pump current exceeds 10 μA.
7. Defined as the maximum rms value of heater current during warm-up. The cold impedance of the heater is approximately 0.33 Ω.
8. The tube may be driven with a CW signal which must not exceed the marked value by more than 3 dB.
9. When operating at 0.0825 duty cycle, the peak forward grid voltage must not vary more than ±5 V from the optimum value, and the cathode voltage must not vary more than ±500 V from the marked value, except that no damage will result if the cathode voltage is varied ±2 kV for a maximum period of 0.1 s. The grid drive pulse must be removed if the cathode voltage falls below 95% of the marked value.
10. The tube will be damaged if it is operated with open-circuit or short circuit conditions at either the input or output RF connectors.
11. Measured at 1 mA cathode current with normal cathode and collector voltages.

SWITCH-ON PROCEDURE

The following sequence is to be used unless otherwise agreed with e2v technologies.

a) Apply 3 kV to ion pump.
b) Establish the specified coolant flow.
c) Apply the marked value of heater voltage and allow a cathode warm-up period of at least 3 and not more than 30 minutes (if this period exceeds 20 minutes it is essential to draw current before switching off).
d) Apply negative grid bias voltage.
e) Apply simultaneously the collector voltages and the marked value of cathode voltage.
f) Apply the marked value of grid pulse drive.
g) Apply RF input power.

Warning: Cathode voltage must not be applied unless the negative grid bias is established. Grid pulse drive must not be applied unless the collector and cathode voltages are established.

SWITCH-OFF PROCEDURE

The tube is switched off by reversing the switch-on procedure. Note that negative grid bias must be maintained until the cathode is at body voltage; a discharging contactor may be used to ensure rapid discharging of the power supply capacitors during switch-off.

LONG-TERM STORAGE

The vacuum in the tube should be maintained during storage by operating the ion pump and heater at least once per year. The ion pump voltage only is applied first, and when the ion pump current is less than 5 μA heater voltage is applied, and operated until the ion pump current is again less than 5 μA. The maximum ion pump current must be limited to 200 μA by heater voltage control.

PROTECTIVE CIRCUITS

The tube can be permanently damaged by excessive current caused by power supply faults, operating errors, internal or waveguide arcs and the following protective circuits are recommended.

i) The modulator power supply should include a crowbar circuit, activated by an increase in cathode current of 10% or an increase in body current of 20% above nominal values. The crowbar should reduce the cathode voltage to zero within 10 μs.
ii) A spark gap should be connected directly between the grid and cathode of the tube, to break down within 1 μs at 1 kV. Connections to the spark gap should be as short as possible.
iii) In the event of an arc, the modulator should limit the current drawn to 100 times the nominal peak value and 20 times the nominal average value until the power supply is completely de-energised.

HEALTH AND SAFETY HAZARDS

This tube is safe to handle and operate provided that the relevant precautions stated herein are observed. e2v technologies does not accept responsibility for damage or injury resulting from the use of this tube. Equipment manufacturers, users and service personnel must ensure that adequate precautions are taken. Appropriate warning labels and notices must be provided on equipment incorporating this tube and in associated operating manuals.

High Voltage

Equipment must be designed so that operators cannot come into contact with high voltage circuits. Tube enclosures should have fail-safe interlocked switches to disconnect the primary power supply and discharge all high voltage capacitors before allowing access.

RF Radiation

Personnel must not be exposed to excessive RF radiation. All RF connectors must be correctly fitted before operation, so that no leakage of RF energy can occur, and the RF output must be correctly terminated.

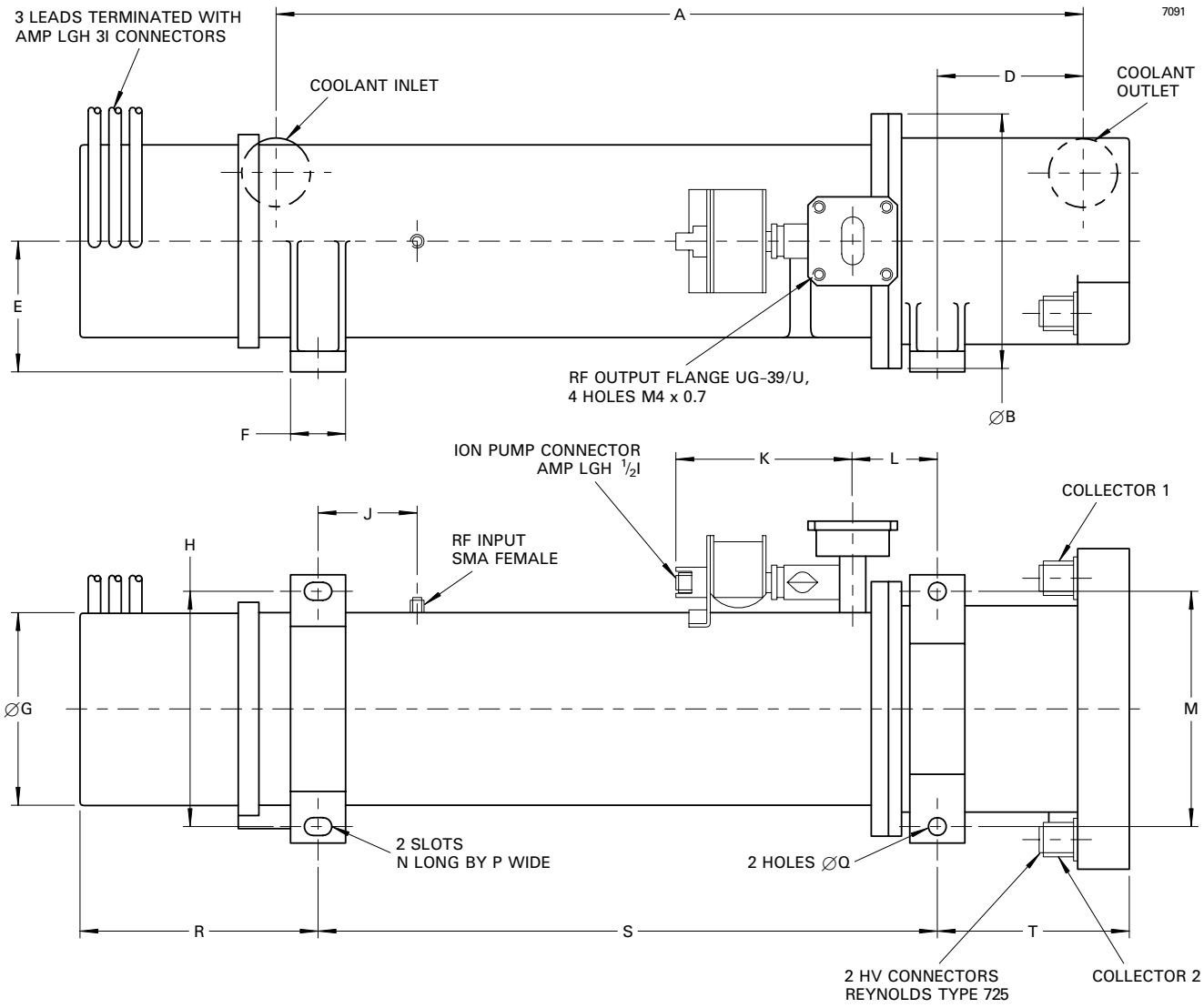
X-Ray Radiation

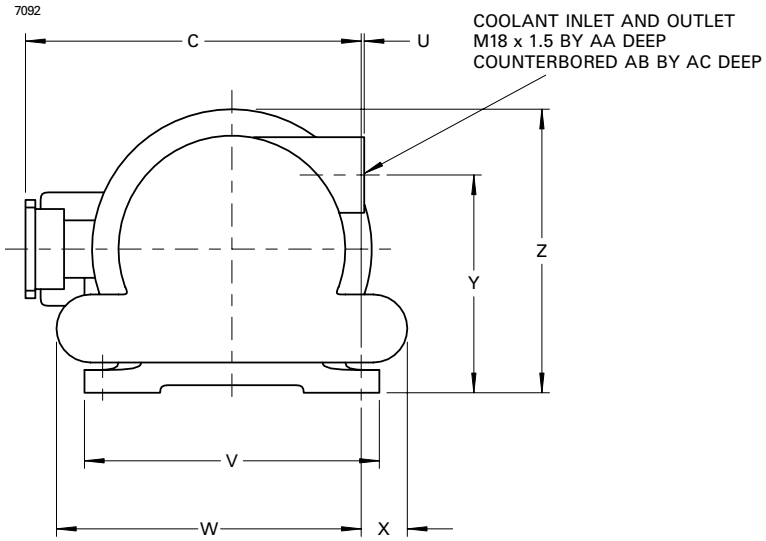
The operating voltage of this tube results in the emission of X-rays. The maximum penetrating ability of the X-rays may correspond to a voltage approximately twice the applied voltage. Shielding is required.

Beryllium Oxide Ceramics

This tube contains beryllium oxide ceramic parts, which are not accessible unless the metal casing of the tube is damaged or removed. ***Beryllium oxide dust or fumes are highly toxic if inhaled, or if particles enter a cut or abrasion.*** Consult e2v technologies regarding the disposal of damaged or life-expired tubes.

OUTLINE (All dimensions without limits are nominal)





Ref	Millimetres	Inches
A	366.5 ± 4.0	14.429 ± 0.157
B	118.0	4.646
C	137.0 ± 1.0	5.394 ± 0.039
D	71.5 ± 2.0	2.815 ± 0.079
E	60.0	2.362
F	25.0 max	0.984 max
G	86.0	3.386
H	110.0 ± 0.5	4.331 ± 0.020
J	55.0	2.165
K	92.5 ± 2.5	3.642 ± 0.098
L	40.0 ± 1.0	1.575 ± 0.039
M	110.0 ± 0.5	4.331 ± 0.020
N	12.0	0.472
P	8.5	0.335
Q	8.5 min	0.335 min
R	111.0 max	4.370 max
S	289.00 ± 1.25	11.378 ± 0.049
T	87.85 max	3.459 max
U	0.5	0.020
V	125.0 max	4.921 max
W	130.0 max	5.118 max
X	20.0 max	0.787 max
Y	90.0 max	3.543 max
Z	119.0 max	4.685 max
AA	11.0 min	0.433 min
AB	23.55 ± 0.05	0.927 ± 0.002
AC	1.20 max	0.047 max
	1.05 min	0.041 min

Inch dimensions have been derived from millimetres.

Lead Connections

Lead	Sleeve colour	Element	Length (mm)
1	Brown	Heater	520 $^{+\ 15}_{-\ 5}$
2	Yellow	Heater, cathode	430 $^{+\ 15}_{-\ 5}$
3	Green	Grid	520 $^{+15}_{-\ 5}$