e2v technologies

N10503
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 mobile military applications, and weighs less than 12 kg. It is shadow-grid modulated and a typical duty cycle is 0.01 with forced-air cooling.

Frequency range	8.6 to 9.5	GHz
Output power (peak)	25	kW
Minimum gain	46	dB

GENERAL

Electrical

Cathode	indirectly heated	
Heater voltage (see notes 1 and 2)	10.5	V
Heater current	3.4	A
Cathode pre-heating time	5.0	minutes
Ion pump voltage	3.0	kV

Mechanical

Overall dimensions	see outline	
RF connections	NATO S.N. 5985-99-083-0052 (UG-39/U)	
Mounting position	any	
Net weight	11.8	kg max

Cooling

Maximum cooling air temperature	+65	+30	°C
Minimum flow rate at sea level	135	80	ft^3/min
Maximum back pressure	6.5	2.7	in. w.g.

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 of any part of the tube.

MAXIMUM AND MINIMUM RATINGS
(Absolute values) (See note 3)

	Min	Max	
Heater voltage	10	11.5	V
Heater surge current (see note 4)	–	7.0	A
Cathode pre-heating time (see note 5)	5.0	–	min
Collector current (peak)	–	7.0	A
Cathode voltage	−23	−26	kV
Cathode current (peak)	–	7.0	A
Body current (peak)	–	2.5	A
Ion pump voltage (see note 6)	2.7	3.3	kV
Ion pump current (see note 7)	–	1.0	mA
RF drive power (see notes 1 and 8)	–	0.5	W
Duty cycle (see note 9)	–	0.01	
Pulse duration	0.25	5.0	µs
Frequency range	8.5	9.6	GHz
Input and output VSWR (see note 10):			
8.5 to 9.6 GHz	–	1.5:1	
8.2 to 10.2 GHz	–	1.65:1	
8.1 to 10.3 GHz	–	2.0:1	
Ambient temperature:			
storage	−60	+85	°C
operating	−40	+65	°C
Collector temperature (see note 11)	–	175	°C

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TYPICAL OPERATION

Cathode voltage	−25	kV
Grid pulse voltage	380	V
Grid cut-off voltage (see note 12)	−190	V
Cathode current (peak)	6.0	A
Body current (peak)	1.0	A
Grid current (peak)	7.0	mA
RF output power	28	kW
RF input power	0.3	W
Grid capacitance	65	pF

NOTES

1. Each tube is marked with the recommended values of heater voltage, cathode voltage, peak grid pulse voltage and RF drive power.
2. The heater voltage may be DC or AC up to 25 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. Cathode and ion pump voltages are with respect to the tube body, which is earthed. Other voltages are with respect to cathode. The collector is operated at earth potential.
4. Defined as the maximum peak value of heater current during warm-up. The cold impedance of the heater is approximately 0.33 Ω.
5. The pre-heating time can be reduced to 3 minutes by applying 115% of the marked heater voltage, reducing to the marked value after 3 minutes.
6. The ion pump voltage must be applied whenever the tube is operating.
7. 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 remove the cathode and grid pulse voltages if the ion pump current exceeds 20 μA.
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 0.01 duty cycle, the grid pulse voltage must not vary more than ±30 V, or the cathode voltage more than ±1 kV from the marked values, except that no damage will result if the cathode voltage is varied ±2 kV for a maximum of 0.1 s.
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. A thread insert, M3 x 5 mm deep, it is provided at the collector end close to the air outlet. The temperature at this point must not exceed 175 °C.
12. Measured at 5 mA cathode current duty cycle less than 0.0005.

SWITCH-ON PROCEDURE

The following switch-on procedure is to be used unless otherwise agreed with e2v technologies.

a) Apply 3 kV to the ion pump.
b) Establish the specified cooling air flow.
c) Apply the marked value of heater voltage and allow a cathode warm-up period of 5 minutes.
d) Apply negative grid bias voltage
e) Apply the marked value of cathode voltage.
f) Apply the marked value of grid pulse drive.

RF input power may be applied to the tube before cathode voltage.

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 a 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 5 μA. The maximum ion pump current must be limited to 200 μA by heater voltage control.

PROTECTIVE CIRCUITS

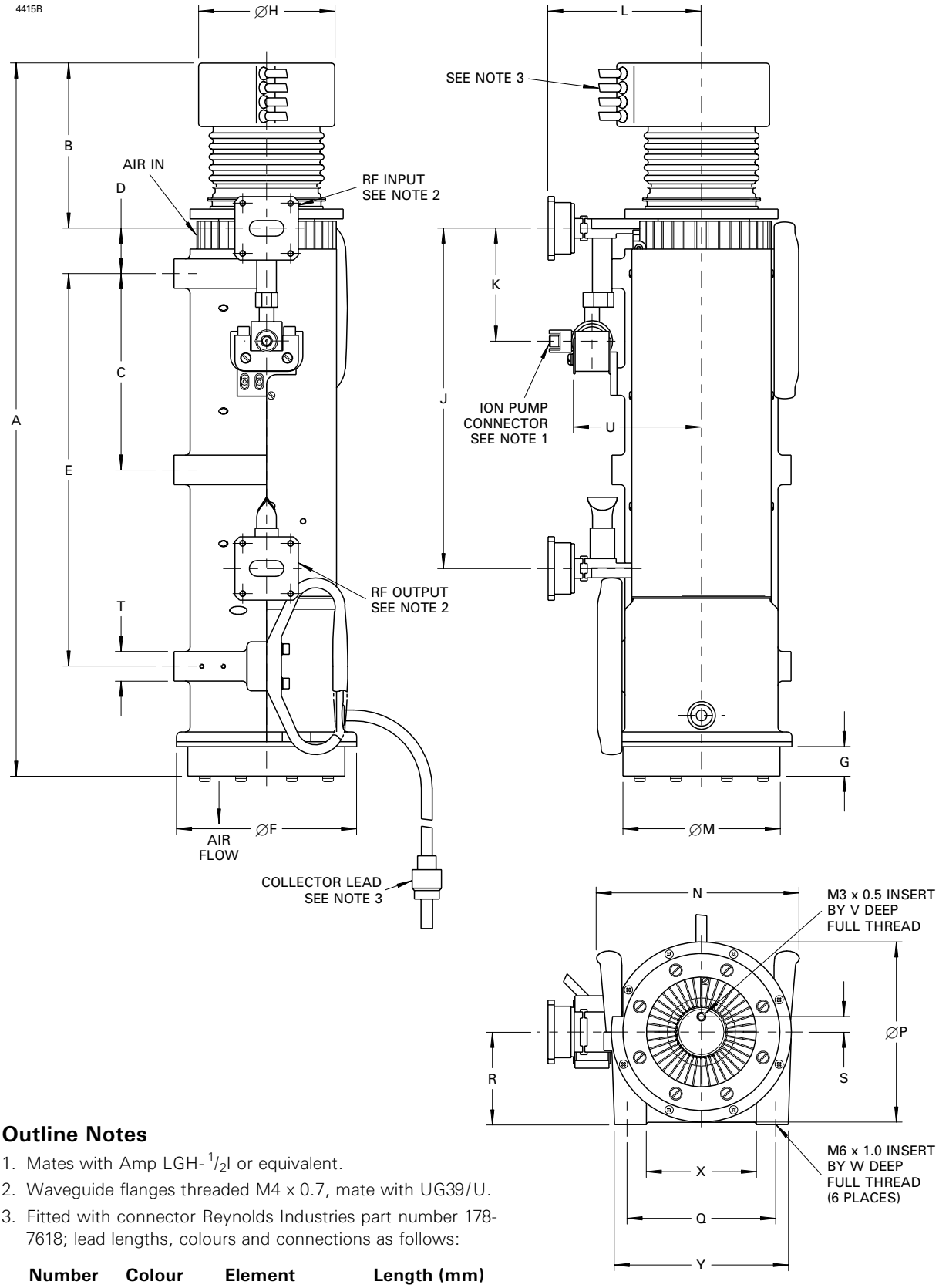
The tube can be permanently damaged by excessive current caused by power supply faults, operating errors, internal or waveguide arcs and the following protective circuits are recommended.

i) The modulator power supply should include a crowbar circuit, activated by a body current exceeding 2 A. The response time should be less than 1.5 μs and the cathode voltage should be reduced to less than 5 kV within 12 μs. If no crowbar is used, the energy which can be discharged between cathode and body must be limited to 50 J.

ii) A spark gap should be connected directly between the grid and cathode of the tube, to break down within 1 μs at 1.5 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.

OUTLINE (Dimensions on page 4)



Outline Notes

1. Mates with Amp LGH-$^{1}/_{2}$I or equivalent.
2. Waveguide flanges threaded M4 x 0.7, mate with UG39/U.
3. Fitted with connector Reynolds Industries part number 178-7618; lead lengths, colours and connections as follows:

Number	Colour	Element	Length (mm)
1	Brown	Heater	240 ± 10
2	Yellow	Heater, cathode	215 ± 10
3	Yellow	Heater, cathode	185 ± 10
4	Green	Grid	200 ± 10
5	Red	Collector	300 ± 10

Outline Dimensions

Ref	Millimetres
A	466.1 ± 6.4
B	109.2 ± 3.1
C	127.0 ± 0.4
D	28.5 ± 3.1
E	254.0 ± 0.8
F	117.4 max
G	19.1 ±0.8
H	90.4 max
J	216.0 ± 8.0
K	73.2 ± 3.1
L	99.8 ± 3.1
M	101.6 ± 0.4
N	152.4 max
P	120.7 max
Q	96.0 ± 0.4
R	60.0 ± 1.5
S	9.5 ± 0.5
T	31.8 max
U	105.0 max
V	5.0 min
W	10.0 min
X	71.0 ± 0.8
Y	110.5 ± 2.0

HEALTH AND SAFETY HAZARDS

e2v technologies electronic devices are 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 electronic devices it produces. Equipment manufacturers and users must ensure that adequate precautions are taken. Appropriate warning labels and notices must be provided on equipments incorporating e2v technologies devices and in operating manuals.

High Voltage

Equipment must be designed so that personnel cannot come into contact with high voltage circuits. All high voltage circuits and terminals must be enclosed and fail-safe interlock switches must be fitted to disconnect the primary power supply and discharge all high voltage capacitors and other stored charges before allowing access. Interlock switches must not be bypassed to allow operation with access doors open.

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 assembly contains beryllium oxide ceramic parts, which are not accessible unless the metal casing of a 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.