E2V Technologies
CX1154B
Double-Ended Ceramic Thyratron

The data to be read in conjunction with the Hydrogen Thyratron Preamble.

ABRIDGED DATA

Deuterium-filled, double ended high voltage thyratron with ceramic/metal envelope, featuring low jitter, firing time and drift. Suitable for switching high power and for switching long pulses.

Reservoirs are incorporated, operating from separate heater supplies. The tube is electrically symmetrical, with identical cathode and grid assemblies at both ends. The flange electrode which is positive when the tube is tested is referred to as the anode and the flange electrode which is negative has the tube serial number stamped on it.

Peak forward anode voltage	35	kV max
Peak anode current (see Ratings)	±3.0	kA max
Average anode current	2.0	A max
Typical pulse repetition rate	100	pps
Typical rate of rise of anode current (see note 1)	10	kA/μs

GENERAL DATA

Electrical

Cathodes (connected internally to one end of associated heater)	oxide coated	
Cathode heater voltage (each end)	6.3 $^{+\ 0.5}_{-\ 0.0}$	V
Cathode heater current (each end)	23.0	A
Reservoir heater voltage (each end) (see note 2)	5.0	V
Reservoir heater current (each end)	7.0	A
Tube heating time (minimum)	15	min
Inter-electrode capacitances, 'anode' to grid 2	15 to 20	pF approx

Mechanical

Seated height (flange to flange)	251.6 mm (9.906 inches) nom
Clearance required below flanges	38.1 mm (1.500 inches) min
Overall diameter (mounting flange)	111.1 mm (4.375 inches) nom
Net weight	2.5 kg (5.5 pounds) approx
Mounting position (see note 3)	any
Tube connections	see outline

Cooling liquid or forced-air

Liquid	oil or coolant immersion
Forced-air	see below

Cooling by oil or coolant immersion is preferred in view of the high voltages present. Further information is contained in the relevant section of the Preamble.

The tube may be cooled by forced-air directed mainly onto both anode and cathode bases, and the metal/ceramic envelope should be maintained below the maximum rated temperature.

Air flows of at least 2.83 m^3/min (100 ft^3/min), depending on the mechanical layout, will be necessary to keep the tube operating temperatures under the limits specified below.

In addition to 420 W of heater power, the tube dissipates from 100 W per ampere average anode current, rising to 300 W/A at the highest rates of rise and fall of anode current.

The cathode end of the tube must be cooled whenever heater voltages are applied, since the cathode flange will reach a temperature of 120 °C above ambient in the absence of cooling.

Envelope temperature:

ceramic, anode and grids	150	°C max
cathode flange and base	120	°C max

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MAXIMUM AND MINIMUM RATINGS

These ratings cannot be used simultaneously, and no individual rating must be exceeded.

PULSE MODULATOR SERVICE
(See note 4)

	Min	Max	
Anode			
Peak forward or inverse anode voltage (see note 5)	–	35	kV
Peak anode current	–	±3.0	kA
Peak anode current (pulse repetition rate limited to 60 pps max)	–	±4.0	kA
Average anode current	–	2.0	A

SINGLE-SHOT OR CROWBAR SERVICE
(See Note 6)

DC forward anode voltage	–	30	kV
Peak anode current	–	±15	kA
Conducted charge:			
capacitor discharge	–	0.2	C
crowbar service (see note 7)	–	6	C
Repetition frequency	1 pulse per 10s max		

Grid 2 (Cathode end)

Unloaded grid 2 drive pulse voltage (see note 8)	400	2000	V
Grid 2 pulse duration	1.0	–	µs
Rate of rise of grid 2 pulse (see note 9)	1.0	–	kV/µs
Grid 2 pulse delay	0.5	3.0	µs
Peak inverse grid 2 voltage	–	450	V
Loaded grid 2 bias voltage	−50	−180	V
Forward impedance of grid 2 drive circuit	50	500	Ω

Grid 1 – DC Primed (Anode or both ends)
(See note 6)

DC grid 1 unloaded priming voltage	75	150	V
DC grid 1 priming current	75	150	mA

Grid 1 – Pulsed (Cathode end)
(See notes 6, 10 and 11)

Unloaded grid 1 drive pulse voltage (see note 8)	300	1000	V
Grid 1 pulse duration	2.0	–	µs
Rate of rise of grid 1 pulse (see note 9)	1.0	–	kV/µs
Peak inverse grid 1 voltage	–	450	V
Peak grid 1 drive current	0.3	2.0	A

Cathodes

Heater voltage	6.3	+ 0.5 / − 0.0	V
Heating time	15	–	min

Reservoirs

Heater voltage (see note 2)	4.5	6.5	V
Heating time	15	–	min

Environmental

Ambient temperature	−50	+90	°C
Altitude	–	3	km
	–	10 000	ft

CHARACTERISTICS

	Min	Typical	Max	
Critical DC anode voltage for conduction (see note 11)	–	0.3	0.5	kV
Anode delay time (see notes 11 and 12)	–	0.1	0.25	µs
Anode delay time drift (see notes 11 and 13)	–	15	50	ns
Time jitter (see note 11)	–	1.0	5.0	ns
Cathode heater current (at 6.3 V)	20	23	26	A
Reservoir heater current (at 5.0 V)	6.0	7.0	9.0	A

NOTES

1. For single-shot or burst mode applications this parameter can exceed 100 kA/µs. The ultimate value which can be attained depends to a large extent upon the external circuit.
2. The reservoir heaters must be decoupled with suitable capacitors to avoid damage by spike voltages. The recommended reservoir heater voltage is stamped on individual tube envelopes and both anode and cathode reservoirs must be operated at the same voltage. The recommended reservoir heater voltage is set for thyratron operation at the maximum DC hold-off voltage under crowbar conditions. For operation at lower anode voltages or under modulator conditions the reservoir heater voltages at both ends of the tube should be increased to a value consistent with anode voltage hold-off. Maximum reservoir heater voltage (i.e. maximum gas pressure in the tube) is one prerequisite for maximum thyratron life.
3. The tube must be mounted by one of the cathode flanges, with flexible connections to all other electrodes.
4. Triggered charging techniques are recommended because the tube conducts both positive and negative current.
5. This is the maximum hold off voltage in either direction before the tube is triggered. The maximum permissible peak forward voltage for instantaneous starting is 35 kV and there must be no overshoot.
6. At the cathode end, when DC priming is used on grid 1, a negative bias of 100 to 180 V must be applied to grid 2 to ensure anode voltage hold-off. DC priming of grid 1 at both ends is recommended for crowbar service.
7. In crowbar service, most of the amp-seconds are often in the power supply follow-on rather than the storage capacitor discharge.
8. Measured with respect to the associated cathode. The tube is triggered by pulsing the grid 2 at the negative end, while the grid 2 at the anode (positive) end is connected to its associated cathode and carries most of the forward anode current. When grid 1 is pulse driven, the last 0.25 µs of the top of the grid 1 pulse must overlap the corresponding first 0.25 µs of the top of the delayed grid 2 pulse.
9. This rate of rise refers to that part of the leading edge of the pulse between 25% and 75% of the pulse amplitude.
10. Pre-pulsing of grid 1 at the negative end is recommended for modulator and high rate of rise of current applications. The grid 1 at the anode (positive) end will normally be DC primed.

11. Typical figures are obtained on test using conditions of minimum grid 2 drive. Improved performance can be expected by increasing grid drive.
12. The time interval between the instant at which the rising unloaded grid 2 pulse reaches 25% of its pulse amplitude and the instant when anode conduction takes place.
13. The drift in delay time over a period from 10 seconds to 10 minutes after reaching full voltage.

HEALTH AND SAFETY HAZARDS

E2V Technologies hydrogen thyratrons 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

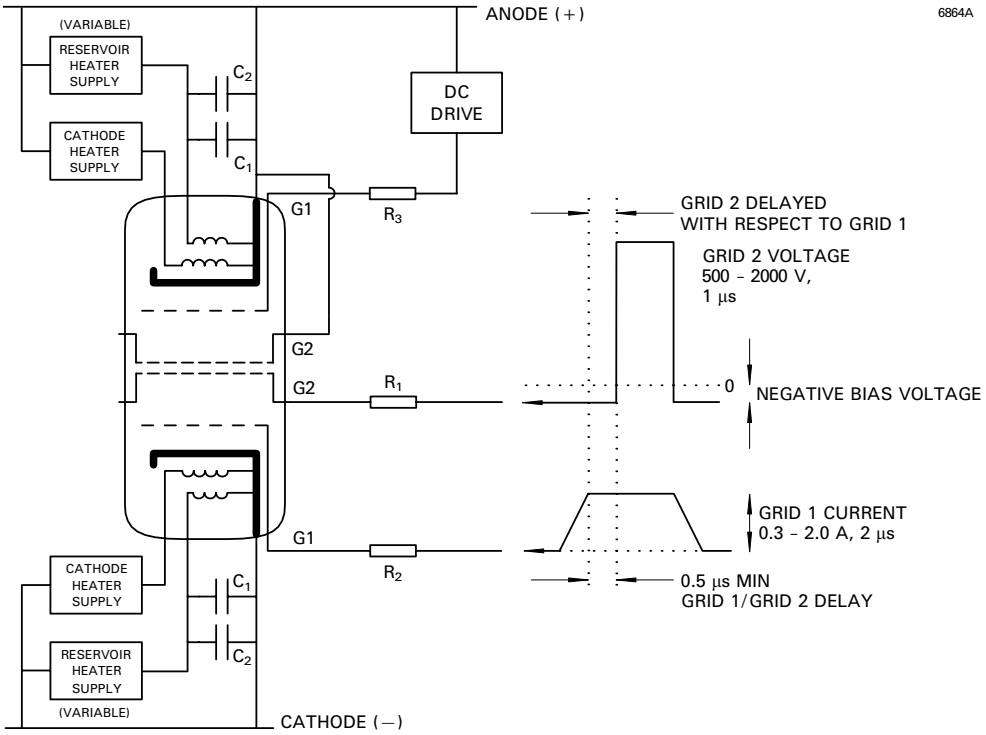
Equipment must be designed so that personnel cannot come into contact with high voltage circuits. All high voltage circuits and terminals must be enclosed and fail-safe interlock switches must be fitted to disconnect the primary power supply and discharge all high voltage capacitors and other stored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

X-Ray Radiation

All high voltage devices produce X-rays during operation and may require shielding. The X-ray radiation from hydrogen thyratrons is usually reduced to a safe level by enclosing the equipment or shielding the thyratron with at least 1.6 mm ($^1/_{16}$ inch) thick steel panels.

Users and equipment manufacturers must check the radiation level under their maximum operating conditions.

SCHEMATIC DIAGRAM



RECOMMENDED GRID, CATHODE AND RESERVOIR HEATER CONNECTIONS

R_1 = Grid 2 series resistor. 12 W vitreous enamelled wirewound is recommended, of an impedance to match the grid 2 drive pulse circuit.

R_2 = Grid 1 resistor. 12 W vitreous enamelled wirewound is recommended, of a total impedance to match the grid 1 drive pulse circuit.

R_3 = Grid 1 resistor. 12 W vitreous enamelled wirewound is recommended to set the grid 1 current.

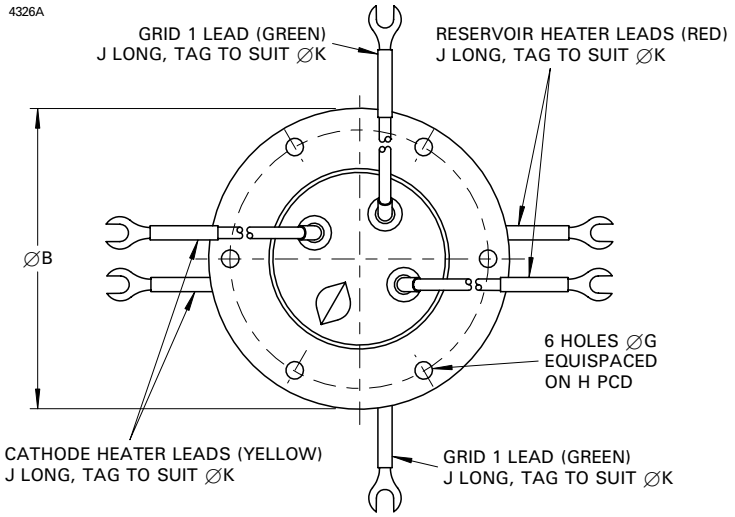
C_1, C_2 = Reservoir protection capacitors with a voltage rating $\geqslant$500 V;

C_1 = 1000 pF low inductance (e.g. ceramic),

C_2 = 1 µF (e.g. polycarbonate or polypropylene).

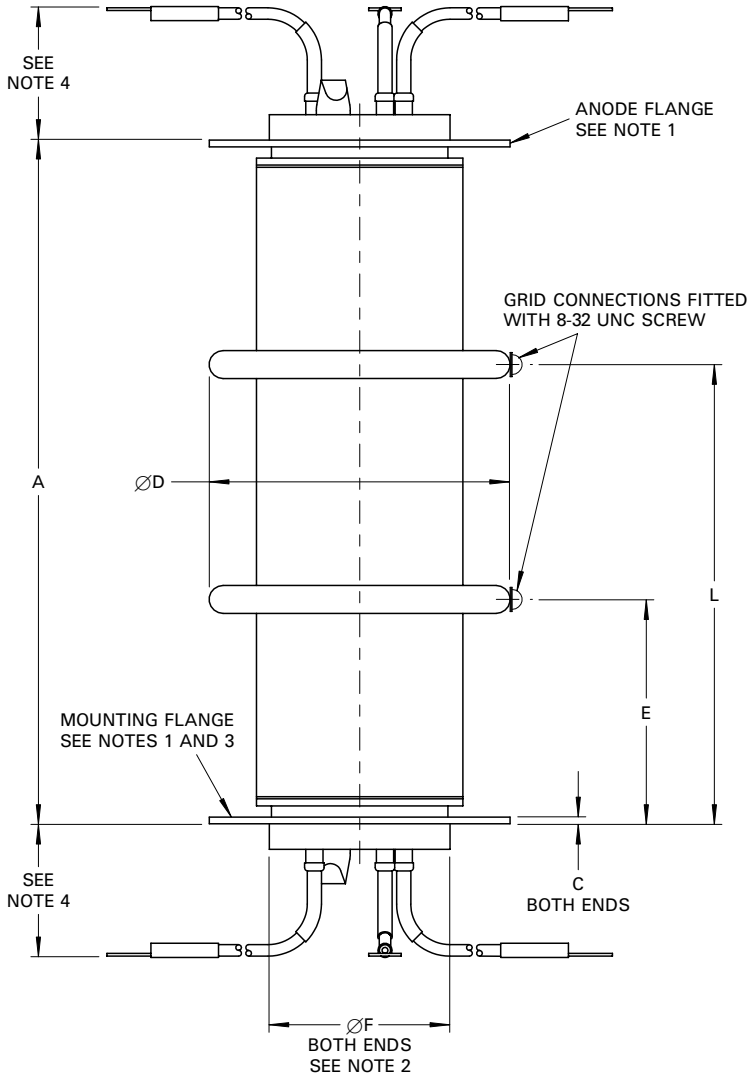
Components R_1, R_2, C_1 and C_2 should be mounted as close to the tube as possible.

OUTLINE
(All dimensions without limits are nominal)



Ref	Millimetres	Inches
A	251.61 ± 2.50	9.906 ± 0.098
B	111.13	4.375
C	2.50 ± 0.25	0.098 ± 0.010
D	111.13 ± 1.60	4.375 ± 0.063
E	82.4	3.244
F	69.85 max	2.750 max
G	6.5	0.256
H	95.25	3.750
J	152.4 min	6.000 min
K	6.35	0.250
L	169.2	6.661

Inch dimensions have been derived from millimetres.



Outline Notes

1. The two flanges will be parallel within 1.5 mm (0.059 inch).
2. The recommended mounting hole is 73.0 mm (2.875 inches) diameter.
3. The tube must be mounted by one flange only. The flanges are the connection for the local cathodes, cathode heater returns and reservoir heater returns.
4. A minimum clearance of 38.1 mm (1.500 inches) must be allowed below the mounting flange.

