E2V Technologies
CX1168B
Two-Gap, Double-Ended Ceramic Thyratron

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

ABRIDGED DATA

Deuterium-filled, two-gap, 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 operating from separate heater supplies are incorporated. The tube is electrically symmetrical, with identical cathode and grid assemblies at both ends; the flange electrode which is positive when the tube is triggered is referred to as the anode.

Peak forward anode voltage	70	kV max
Peak anode current	3.0	kA max
Average anode current	3.0	A max

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)	21.5	A
Reservoir heater voltage (each end) (see note 1)	5.0	V
Reservoir heater current (each end)	7.0	A
Tube heating time (minimum)	15	min
Inter-electrode capacitances, gradient grid to grid 2 (each end)	15 to 20	pF approx

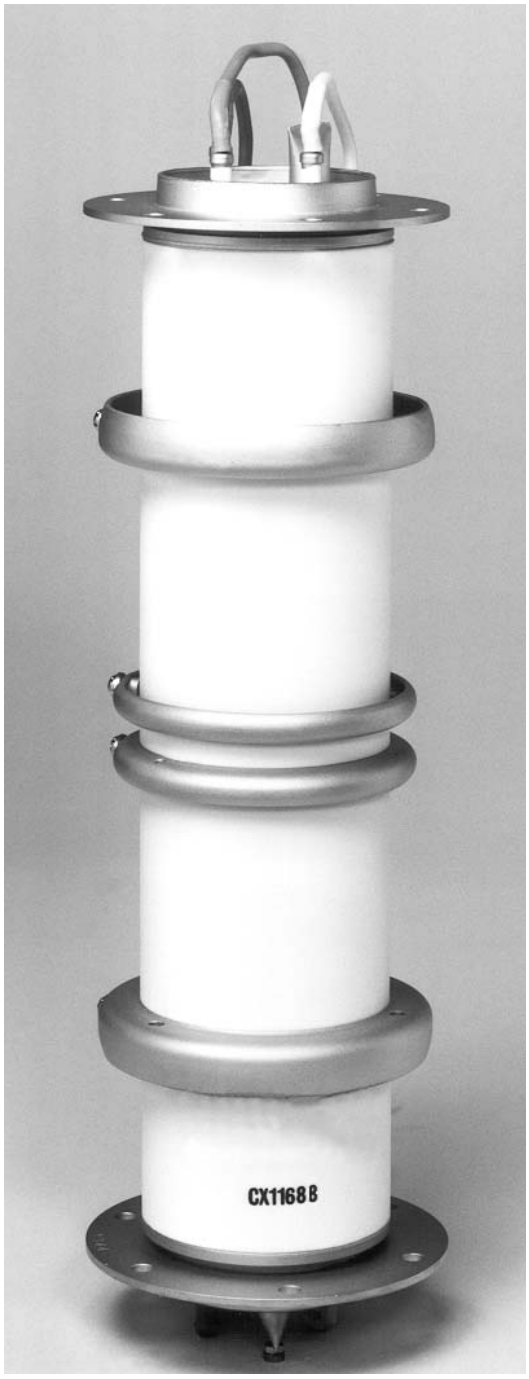
Mechanical

Seated height (flange to flange)	313.5 mm (12.344 inches) max
Clearance required below flanges	38.1 mm (1.500 inches) min
Overall diameter (mounting flange)	111.1 mm (4.375 inches) nom
Net weight	3.5 kg (7.7 pounds) approx
Mounting position (see note 2)	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 the bases, and the metal/ceramic envelope should be maintained below the maximum rated temperature. An air flow of at least 2.83 m^3/min (100 ft^3/min) at each end, depending on the mechanical layout, will be necessary to keep the tube operating temperatures under the limits specified below.



In addition to 400 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.

Both ends 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 necessarily be used simultaneously, and no individual rating must be exceeded.

PULSE MODULATOR SERVICE
(See note 3)

	Min	Max	
Anode			
Peak forward or inverse anode voltage (see note 4)	–	70	kV
Peak anode current	–	3.0	kA
Peak anode current (pulse repetition rate limited to 60 pps max)	–	4.0	kA
Average anode current	–	3.0	A
Rate of rise of anode current (see notes 5 and 6)	–	10.0	kA/μs

SINGLE-SHOT OR CROWBAR SERVICE
(See note 7)

DC forward anode voltage	–	60	kV
Peak anode current	–	±15	kA
Conducted charge:			
capacitor discharge	–	0.2	C
crowbar service (see note 8)	–	6	C
Repetition frequency	1 pulse per 10s max		

Grid 2 (Cathode end)

Unloaded grid 2 drive pulse voltage (see note 9)	200	1000	V
Grid 2 pulse duration	1.0	–	μs
Rate of rise of grid 2 pulse (see note 6)	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	−200	V
Forward impedance of grid 2 drive circuit	50	1000	Ω

Grid 1 – DC Primed (Anode or both ends) (See note 10)

DC grid 1 unloaded priming voltage	75	150	V
DC grid 1 priming current	25	50	mA

Grid 1 – Pulsed (Cathode end) (See note 11)

Peak grid 1 drive current	0.3	1.0	A
Unloaded grid 1 drive pulse voltage (see note 7)	300	1000	V
Grid 1 pulse duration	2.0	–	μs
Rate of rise of grid 1 pulse (see note 6)	1.0	–	kV/μs
Peak inverse grid 1 voltage	–	450	V

Cathodes

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

Reservoirs

Heater voltage (see note 1)	3.5	6.5	V
Heating time	15	–	min

Environmental

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

CHARACTERISTICS

	Min	Typical	Max	
Critical DC anode voltage for conduction (see note 12)	–	3.0	5.0	kV
Anode delay time (see notes 12 and 13)	–	0.1	0.25	μs
Anode delay time drift (see notes 12 and 14)	–	15	50	ns
Time jitter (see note 12)	–	1.0	5.0	ns
Cathode heater current (at 6.3 V)	18	21.5	25	A
Reservoir heater current (at 5.0 V)	6.0	7.0	9.0	A

NOTES

1. 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 reservoirs must be operated at the same heater voltage.
2. The tube must be mounted by one of the cathode flanges, with flexible connections to all other electrodes.
3. Triggered charging techniques are recommended because the tube has a relatively long recovery time (100 – 200 μs).
4. 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 60 kV and there must be no overshoot.
5. 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.
6. This rate of rise refers to that part of the leading edge of the pulse between 25% and 75% of the pulse amplitude.
7. 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.
8. In crowbar service, most of the amp-seconds are often in the power supply follow-on rather than the storage capacitor discharge.
9. 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.
10. When DC priming is used on grid 1 at the cathode end, 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.
11. Pre-pulsing of grid 1 at the cathode (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.
12. Typical figures are obtained on test using conditions of minimum grid drive. Improved performance can be expected by increasing grid drive.
13. 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.
14. 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

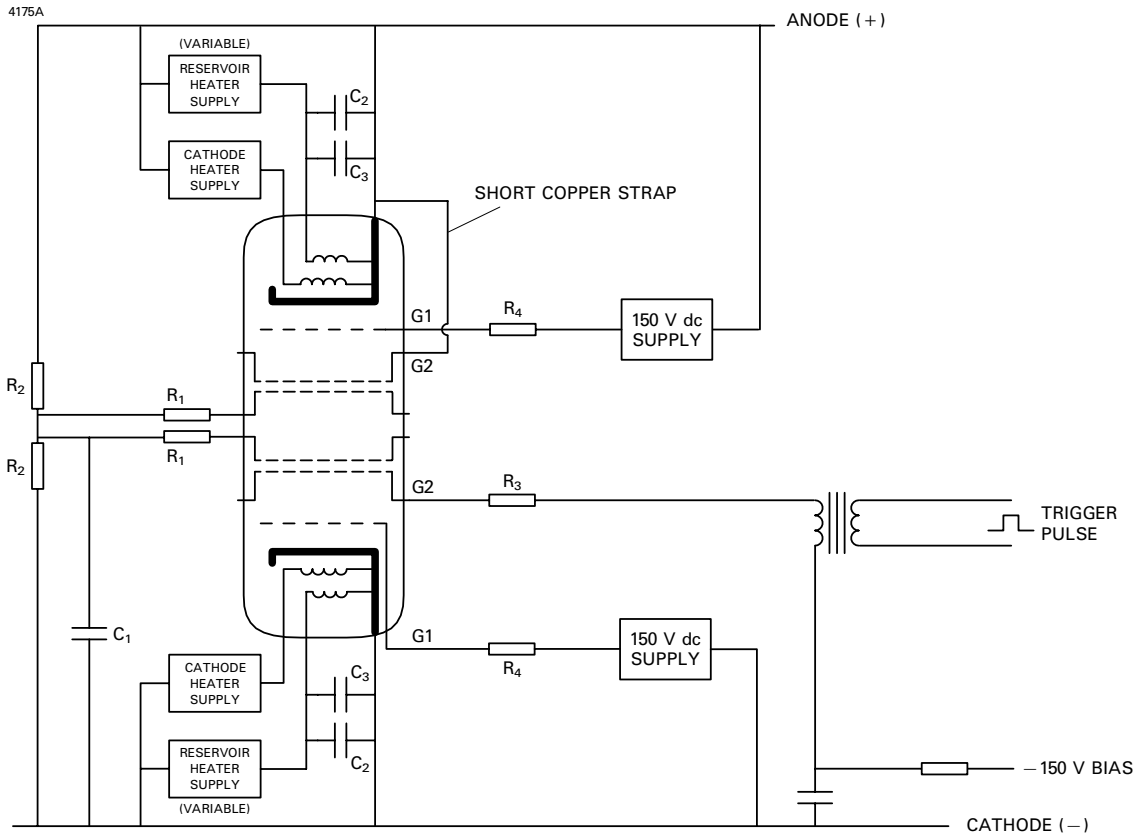
Equipment must be designed so that personnel cannot come into contact with high voltage circuits. All high voltage circuits and terminals must be enclosed and fail-safe interlock switches must be fitted to disconnect the primary power supply and discharge all high voltage capacitors and other stored 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



R_1 = 470 Ω 12 W vitreous enamelled wirewound resistors.

R_2 = 10 to 25 MΩ high voltage resistors with a power rating consistent with forward anode voltage.

R_3 = Grid 2 series resistor. 12 W vitreous enamelled wirewound is recommended, of an impedance to match the grid 2 drive pulse circuit.

R_4 = Grid 1 series resistor. 12 W vitreous enamelled wirewound is recommended.

C_1 = 500 to 1000 pF capacitor with a voltage rating equal to the peak forward anode voltage.

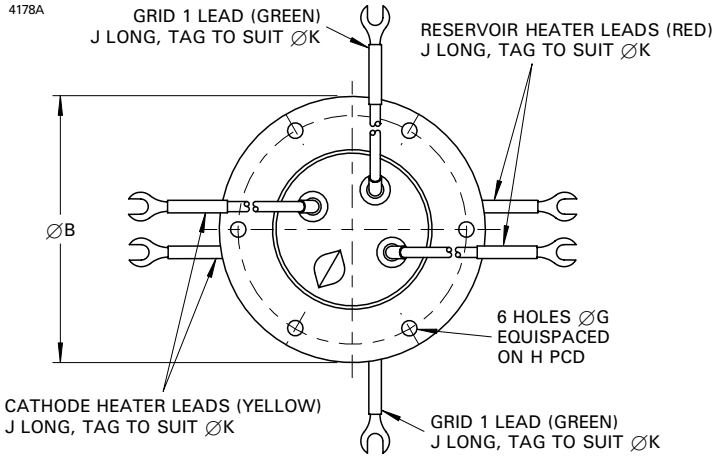
C_2, C_3 = Reservoir protection capacitors with a voltage rating ⩾500 V;

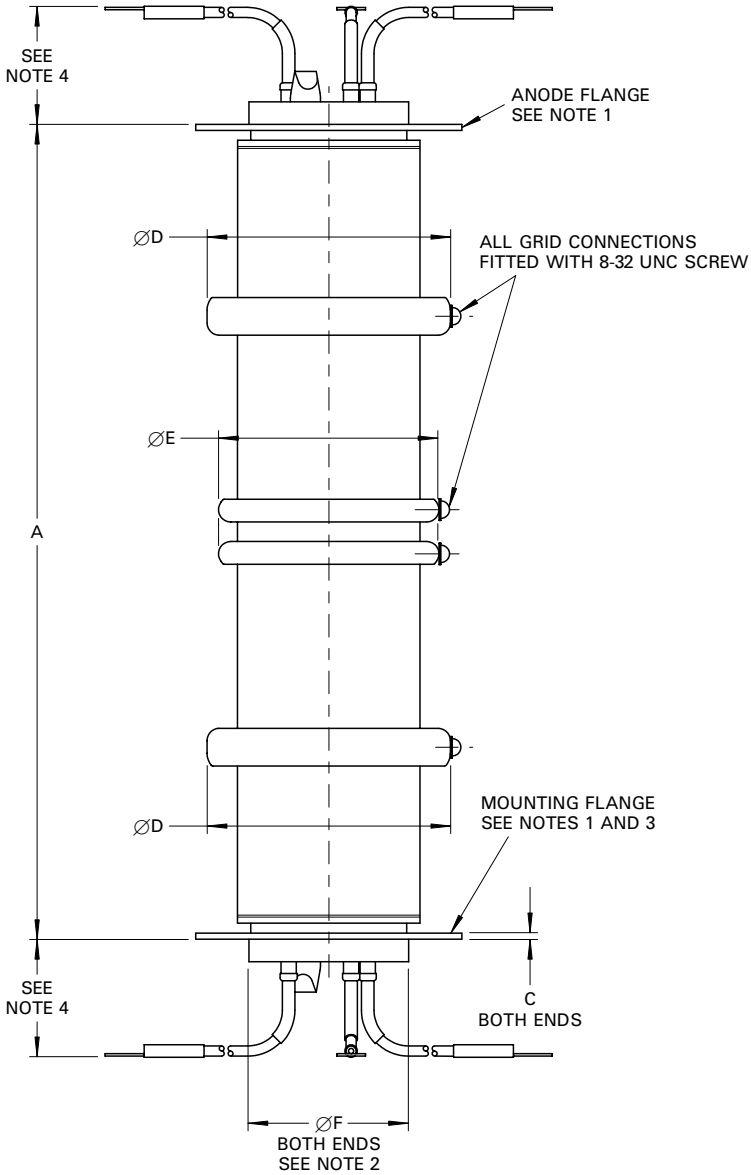
C_2 = 1000 pF low inductance (e.g. ceramic),

C_3 = 1 µF (e.g. polycarbonate or polypropylene).

Components R_3, R_4, C_2, and C_3 should be mounted as close to the tube as possible.

OUTLINE
(All dimensions without limits are nominal)





Ref	Millimetres	Inches
A	313.54 ± 2.54	12.344 ± 0.100
B	111.13	4.375
C	2.54	0.100
D	101.60 ± 1.57	4.000 ± 0.062
E	92.08 ± 1.57	3.625 ± 0.062
F	69.85 max	2.750 max
G	6.5	0.256
H	95.25	3.750
J	190.5 min	7.500 min
K	6.35	0.250

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 connections 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.

