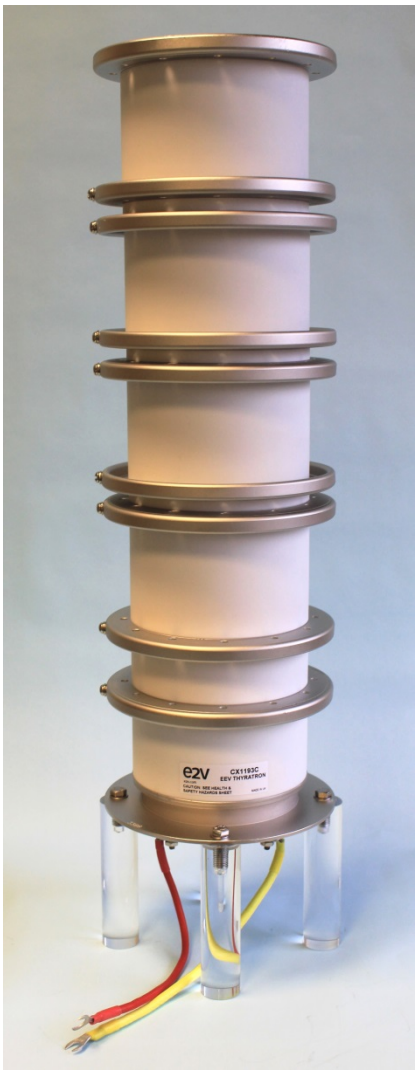
CX1193C

Deuterium Filled Four Gap Ceramic Thyratron

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



ABRIDGED DATA

Deuterium-filled four-gap thyratron with ceramic envelope, featuring high peak current, high rate of rise of current, low jitter and drift.
The two trigger grids enable a high current grid 1 pre-pulse to be used, which enables sub-nanosecond jitter to be achieved.
A reservoir normally operated from a separate heater supply is incorporated. The reservoir heater voltage can be adjusted to a value consistent with anode voltage hold-off in order to achieve the fastest rate of rise of current possible from the tube in the circuit.

Modulator Service

Peak anode voltage (see note 1)	-	130 kV max
Peak forward anode current	-	10 kA max
Average anode current	-	4.0 A max

Crowbar Service

Peak anode voltage (see note 1)	-	100 kV max
Peak forward anode current	-	40 kA max
Conducted charge	-	18 C max

GENERAL DATA

Electrical

Cathode (connected internally to one end of heater)	-	Oxide coated	
Cathode heater voltage	-	6.3	+ 0.3 V - 0.0 V
Cathode heater current	-		40 A
Reservoir heater voltage (see note 1)	-		5.0 V
Reservoir heater current	-		10 A
Tube heating time (minimum)	-		15 min

Mechanical

Seated height	-	479 mm (18.858 inches) max
Clearance required below mounting flange	-	60 mm (2.362 inches) min
Overall diameter (excluding connections)	-	152.4 mm (6.000 inches) max
Net weight	-	10.8 kg (23.8 pounds) max
Mounting position (see note 2)	-	Any
Tube connections	-	See outline

e2v technologies (uk) limited, Waterhouse Lane, Chelmsford, Essex CM1 2QU United Kingdom Holding Company: e2v technologies plc
Telephone: +44 (0)1245 493493 Facsimile: +44 (0)1245 492492
Contact e2v by e-mail: enquiries@e2v.com or visit www.e2v.com for global sales and operations centres.

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Cooling

The tube must be cooled by total liquid immersion, for example in force circulated transformer oil (see e2v technologies Technical Reprint No. 108 'The cooling of oil-filled electrical equipment, with special reference to high power line-type pulse generators' by G. Scoles). Care must be taken to ensure that air is not trapped inside the tube end cover.

MAXIMUM AND MINIMUM RATINGS

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

Anode (Pulse Modulator Service)		**Min**	**Typ**	**Max**	
Peak forward anode voltage	.	-	-	130	kV
Peak inverse anode voltage (see note 3)	.	-	-	130	kV
Peak forward anode current	.	-	-	10	kA
Average anode current	.	-	-	4.0	A
Pulse duration	.	-	2.0	-	µs
Rate of rise of anode current (see note 4)	.	-	>100	-	kA/µs
Pulse repetition rate (see note 5)	.	-	100	-	pps

Anode (Single-Shot or Crowbar Service)		**Min**	**Typ**	**Max**	
DC forward anode voltage	.	-	-	100	kV
Peak forward anode current	.	-	-	40	kA
Total conducted charge: Capacitor discharge Crowbar service (see note 6)	. .	 -	 -	 0.4	 C
		-	-	18	C
Repetition rate	.	1 pulse per 10 s			

Grid 2 – Voltage driven		**Min**	**Typ**	**Max**	
Unloaded grid 2 drive pulse voltage (see note 7)	.	500	-	2000	V
Grid 2 pulse duration	.	0.5	-	-	µs
Rate of rise of grid 2 pulse (see notes 4 and 8)	.	10	20	-	kV/µs
Grid 2 pulse delay (see note 9)	.	0.5	-	3.0	µs
Peak inverse grid 2 voltage	.	-	-	450	V
Loaded grid 2 bias voltage (see note 10)	.	-100	-	-180	V
Forward impedance of grid 2 drive circuit	.	50	-	500	Ω

Grid 1 – Pulse Current Driven (see note 11)		**Min**	**Typ**	**Max**	
Peak grid 1 drive current	.	30	100	150	A
Unloaded grid 1 drive pulse voltage (see note 7)	.	300	-	2000	V
Grid 1 pulse duration	.	1.0	-	-	µs
Peak inverse grid 1 voltage	.	-	-	450	V
Loaded grid 1 bias voltage	.	See note 12			

Grid 1 – DC Primed for Crowbar Applications (see note 11)		**Min**	**Typ**	**Max**	
DC grid 1 unloaded priming voltage	.	75	-	150	V
DC grid 1 priming current	.	200	-	300	mA

Heaters		**Min**	**Typ**	**Max**	
Cathode heater voltage	.	6.3	6.3	6.6	V
Reservoir heater voltage	.	4.5	5.0	6.5	V
Tube heating time	.	15	-	-	min

Environmental (Operational)		**Min**	**Typ**	**Max**	
Ambient temperature	.	0	-	+40	°C
Altitude	.	- -	- -	3 10,000	km ft

CHARACTERISTICS

		Min	Typ	Max	
Critical DC anode voltage for conduction (see note 13)	.	-	7.0	10.0	kV
Anode delay time (see notes 13 and 14)	.	-	200	300	ns
Anode delay time drift (see notes 13 and 15)	.	-	15	50	ns
Time jitter (see note 13)	.	-	1.0	5.0	ns
Recovery time	.		See note 5		
Cathode heater current (at 6.3 V)	.	35	40	45	A
Reservoir heater current (at 5.0 V)	.	8.0	10	12	A

NOTES

1. The reservoir heater supply must be obtained either from the cathode heater supply or if a separate supply is used it must be decoupled with suitable capacitors (for example a 1 µF capacitor in parallel with a low inductance 1000 pF capacitor) to avoid damage to the reservoir. The recommended reservoir heater voltage for each individual tube is stamped on the tube envelope; for maximum rate of rise of current, the reservoir heater voltage should be set to the highest level compatible with the tube hold-off voltage being maintained.
   Permanent damage may result if the tube is operated below the minimum recommended reservoir voltage.

2. The tube must be fitted using its mounting flange.

3. The peak inverse voltage including spike must not exceed 10 kV for the first 25 µs after the anode pulse. Amplitude and rate of rise of inverse voltage contribute greatly to tube dissipation and electrode damage; if these are not minimised in the circuit, tube life will be shortened considerably. The aim should be for an inverse voltage of 3 – 5 kV peak with a rise time of 0.5 µs.

4. This rate of rise refers to that part of the leading edge of the pulse between 10% and 90% of the pulse amplitude. For maximum rate of rise of anode current applications, grid 1 pre-pulsing must be used and the maximum value obtainable will depend on the external circuit parameters.

5. This thyratron has a long recovery time because of the gradient grid drift space. The amount of time available for thyratron recovery must be maximised by circuit design, and reliable operation may necessitate the use of command charging techniques. The amount of time required for recovery is affected by gas pressure, peak current, pulse duration and load mismatch which keeps the thyratron in a conducting state.

6. In crowbar service most of the coulombs are often in the power supply follow-on current rather than the storage capacitor discharge.

7. Measured with respect to cathode.

8. A lower rate of rise may be used, but this may result in the anode delay time, delay time drift and jitter exceeding the limits quoted.

9. At least the first 0.25 µs of the top of the grid 1 pulse must precede the delayed grid 2 pulse.

10. The higher grid 1 is pulsed, the larger must the grid 2 negative bias be to prevent the tube firing on the grid 1 pulse.

11. For maximum thyratron life in fast pulse applications, grid 1 should be pulse driven. In crowbar applications, grid 1 can be primed with a DC current to minimise triggering time from detection of fault.

12. DC negative bias voltages must not be applied to grid 0 or grid 1. When grids 0 and 1 are pulse driven, their potentials may vary between −10 V and +5 V with respect to cathode potential during the period between the completion of recovery and the commencement of the succeeding grid pulse.

13. Typical figures are obtained on test using conditions of minimum grid drive. Improved performance can be expected by increasing grid drive.

14. 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.

15. The drift in delay time over a period from 10 seconds to 10 minutes after reaching full voltage.

HEALTH AND SAFETY HAZARDS

e2v technologies 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 equipment incorporating e2v technologies devices and in operating manuals.

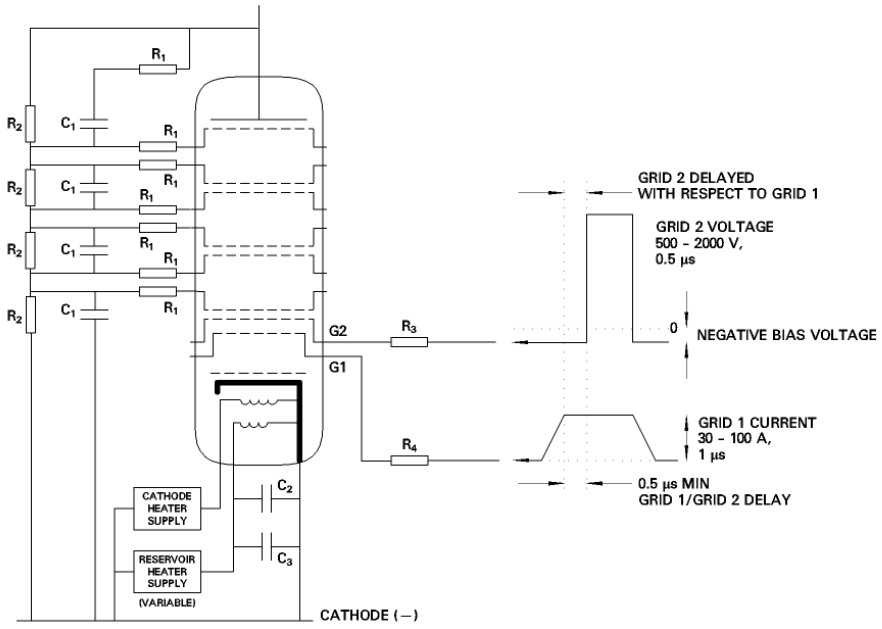
High Voltage

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 door 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.

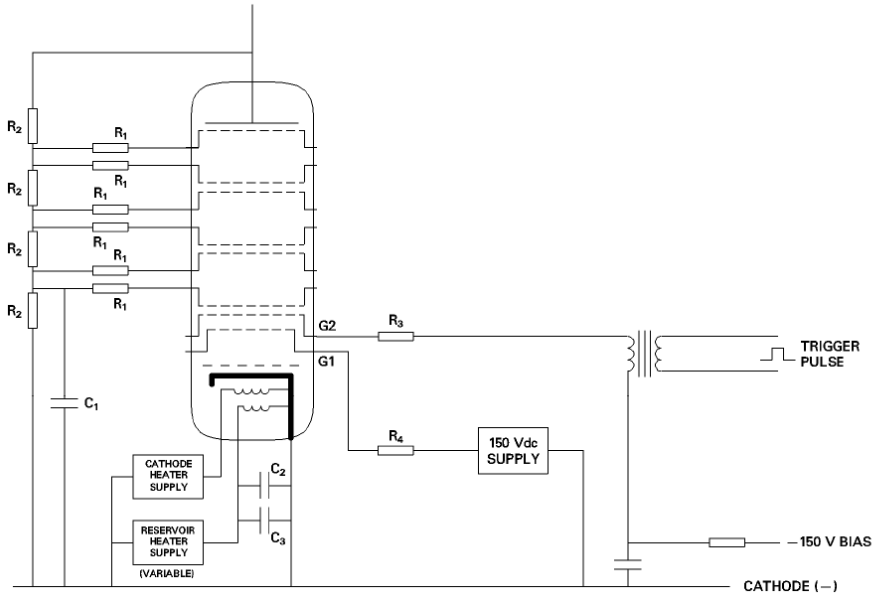
SCHEMATIC DIAGRAM (Modulator Service)



RECOMMENDED GRID, TRIGGER GRID, CATHODE AND RESERVOIR HEATER CONNECTIONS

R_1 = 470 Ω 2.5 W vitreous enamelled wirewound resistors.
R_2 = 5 to 20 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 resistor. 12 W vitreous enamelled wirewound is recommended, of an impedance to match the grid 1 drive pulse circuit.
C_1 = 500 pF capacitors with a voltage rating equal to the peak forward 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.

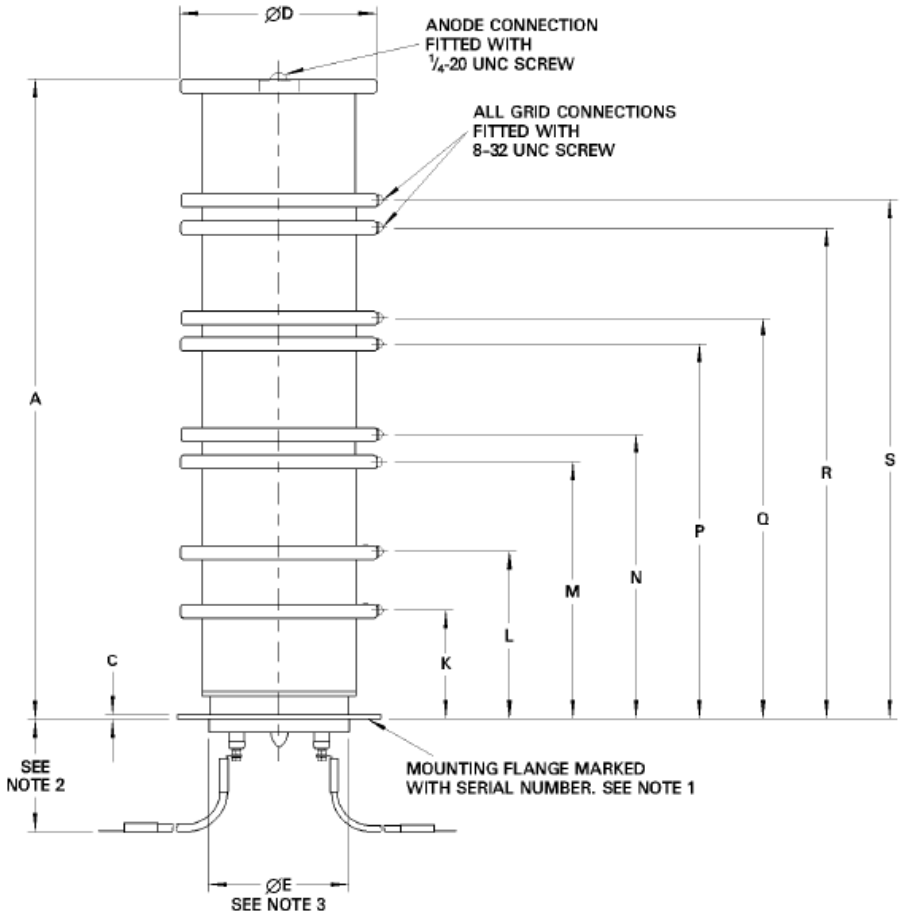
SCHEMATIC DIAGRAM (Crowbar Service)

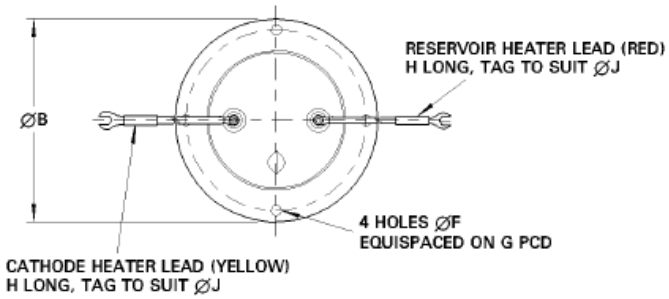


R_1 = 470 Ω 2.5 W vitreous enamelled wirewound resistors.
R_2 = 5 to 20 MΩ high voltage resistors with a power rating consistent with forward anode voltage.
R_3 - Grid 2 series resistor. 12 W vitreous enamelled wirewound is recommended, of an impedance to match the grid 2 drive pulse circuit.
R_4 - Grid 1 resistor. 12 W vitreous enamelled wirewound is recommended, of value to set the grid 1 current.
C_1 = 500 pF capacitors with a voltage rating equal to the peak forward 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	474.00 ± 5.08	18.661 ± 0.200
B	152.40 ± 0.25	6.000 ± 0.010
C	3.18	0.125
D	147.00 ± 1.57	5.787 ± 0.062
E	106.35 max	4.187
F	8.0	0.315
G	135.74 ± 0.25	5.344 ± 0.010
H	177.8 min	7.000 min
J	6.35	0.250
K	78.36	3.085
L	119.9	4.720
M	197.8	7.787
N	216.0	8.504
P	285.2	11.228
Q	303.7	11.957
R	372.9	14.681
S	391.4	15.409

Inch dimensions have been derived from millimetres.

Outline Notes

1. The mounting flange is the connection for the cathode, cathode heater return and reservoir heater return.
2. A minimum clearance of 57.15 mm (2.250 inches) must be allowed below the mounting flange.
3. The recommended mounting hole is 108 mm (4.250 inches) diameter.