CX1528
Air Cooled, Deuterium-Filled, Metal/Ceramic Thyratron

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

ABRIDGED DATA

Deuterium-filled thyratron with metal/ceramic envelope, suitable for switching high peak and average power.

A reservoir normally operated from a separate heater supply is incorporated. In order to achieve the fastest rate of rise of current possible from the tube in the circuit, the reservoir heater voltage can be adjusted within the specified limits to obtain the maximum thyratron gas pressure consistent with the required voltage hold-off.

Peak forward anode voltage	35	kV max
Peak anode current	5	kA max
Average anode current	5.0	A max

GENERAL DATA

Electrical

Cathode	barium aluminate impregnated tungsten	
Cathode heater voltage (see note 1)	6.3 ± 0.3	V
Cathode heater current	37.5	A
Reservoir heater voltage (see notes 1 and 2)	$6.3 \begin{smallmatrix} +0.7 \\ -0.3 \end{smallmatrix}$	V
Reservoir heater current	7.0	A
Tube heating time (minimum)	10.0	min

Mechanical

Seated height	230 mm (9.055 inches) max
Clearance required below mounting flange	80 mm (3.150 inches) min
Overall diameter (excluding connections)	122 mm (4.803 inches) max
Net weight	3.6 kg (8 pounds) approx
Mounting position	see note 3
Tube connections	see outline

Cooling

The tube must be cooled by forced-air directed mainly onto the base and the metal/ceramic envelope should be maintained below the maximum rated temperature. A fan of output between 2.83 and 7.08 m^3/min (100 and 250 ft^3/min) (depending on the mechanical layout) will be necessary to keep the tube operating temperatures below the limits specified below. e2v technologies cooling modules, types MA2235A and MA2235B, are suitable for the purpose.

In addition to 275 W of heater power, the tube dissipates from 100 watts per ampere average anode current, rising to 300 W/A or greater at the highest rate of rise and fall of anode current.

The cathode end of the tube must be cooled whenever heater voltages are applied.

Envelope temperature:

anode, gradient grid, grid 1 and grid 2	200	°C max
cathode flange and end cover	120	°C max

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PULSE MODULATOR SERVICE MAXIMUM AND MINIMUM RATINGS

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

Anode

	Min	Max	
Peak forward anode voltage (see note 4)	–	35	kV
Peak inverse anode voltage		see note 5	
Peak forward anode current	–	5	kA
Average anode current	–	5	A
Rate of rise of anode current		see notes 6 and 7	

Triggering

For maximum life and minimum grid spike these thyratrons should be triggered with a pre-pulse on grid 1.

Grid 2

	Min	Max	
Unloaded grid 2 drive pulse voltage (see note 8)	600	2000	V
Grid 2 pulse duration	0.5	-	μs
Rate of rise of grid 2 pulse (see notes 7 and 9)	10	-	kV/μs
Grid 2 pulse delay (see note 10)	0.5	3.0	μs
Peak inverse grid 2 voltage	–	450	V
Loaded grid 2 bias voltage (see note 11)	−100	−300	V
Impedance of grid 2 drive circuit (see note 12)	50	200	Ω

Grid 1 – Pulsed

	Min	Max	
Unloaded grid 1 drive pulse voltage	600	2000	V
Grid 1 pulse duration	2.0	-	μs
Rate of rise of grid 1 pulse	1.0	-	kV/μs
Peak inverse grid 1 voltage	–	450	V
Loaded grid 1 bias voltage		see note 13	
Peak grid 1 drive current (see note 14)	10.0	40.0	A

Grid 1 – DC Primed

	Min	Max	
DC grid 1 unloaded priming voltage	75	150	V
DC grid 1 priming current	0.25	1.0	A

Cathode

	Min	Max	
Heater voltage	6.3 ± 0.3		V
Heating time	10	-	min

Reservoir

	Min	Max	
Heater voltage	$6.3^{+0.7}_{-0.3}$		V
Heating time	10	-	min

Environmental

	Min	Max	
Ambient temperature	0	+40	°C

CHARACTERISTICS

	Min	Typical	Max	
Critical DC anode voltage for conduction	–	0.5	2.0	kV
Anode delay time	–	200	250	ns
Anode delay time drift (see note 15)	–	15	25	ns
Time jitter (see note 16)	–	1.0	5.0	ns
Recovery time (see note 17)	–	20	-	μs
Cathode heater current (at 6.3 V)	30	37.5	45	A
Reservoir heater current (at 6.3 V)	6.0	7.0	8.0	A

NOTES

1. It is recommended that the cathode heater and the reservoir heater are supplied from independent power supplies. **The common connection for these two supplies is the yellow sleeved lead, not the cathode flange.**

   N.B. The tube will suffer irreversible damage if the cathode flange is connected as the common point.

   The cathode heater supply must be connected between the cathode flange and the cathode heater lead (yellow sleeve), the reservoir heater supply must be connected between the cathode heater lead (yellow sleeve) and the reservoir heater lead (red sleeve), see Fig. 1. In order to meet the jitter specification, it may be necessary in some circumstances that the cathode heater be supplied from a DC source.

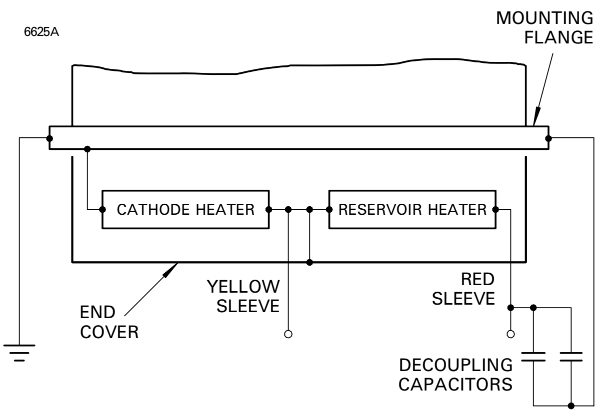


Fig. 1 Base connections

Care should be taken to ensure that excessive voltages are not applied to the reservoir heater circuit from the cathode heater supply because of high impedance cathode heater connections. For example, in the worst case, an open circuit heater lead will impress almost double voltage on the reservoir heater, especially on switch-on, when the cathode heater impedance is minimal.

This situation can be avoided by ensuring that the two supplies are in anti-phase. The reservoir heater circuit must be decoupled with suitable capacitors, for example, a 1 μF capacitor in parallel with a low inductance 1000 pF capacitor.

The heater supply systems should be connected directly between the cathode flange and the heater leads. This avoids the possibility of injecting voltages into the cathode and reservoir heaters. At high rates of rise of anode current, the cathode potential may rise significantly at the beginning of the pulse, depending on the cathode lead inductance, which must be minimised at all times.

If a single transformer is used to supply both the cathode heater and the reservoir heater, then the reservoir heater lead (red sleeve) must be connected to the mounting flange.

2. The gas pressure may be increased to a value consistent with the required forward hold-off voltage by altering the reservoir heater supply voltage within the specified range.
3. The tube must be fitted using its mounting flange, with flexible connections to all other electrodes. The preferred orientation is with the tube axis vertical and anode uppermost; mounting the tube with its axis horizontal is permissible. It is **not** recommended that the tube is mounted with its axis vertical and cathode uppermost.
4. The maximum permissible peak forward voltage for instantaneous starting is 30 kV and there must be no overshoot.
5. 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.
6. The ultimate value which can be attained depends to a large extent upon the external circuit. The rate of rise of current can be in excess of 100 kA/μs.
7. This rate of rise refers to that part of the leading edge of the pulse between 10% and 90% of the pulse amplitude.
8. Measured with respect to cathode.
9. 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.
10. 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.
11. Negative bias of 100 to 200 V must be applied to grid 2 to ensure anode voltage hold-off.
12. During both the drive pulse period and during recovery when the current flow is reversed.
13. DC negative bias voltages must not be applied to grid 1.
14. The optimum grid 1 pulse current is the maximum value which can be applied without causing the tube to switch before the grid 2 pulse is applied. This value is variable depending on gas pressure, maximum forward anode voltage, grid 2 negative bias voltage, peak current and repetition rate.
15. Measured between the second minute after the application of HT and 30 minutes later.
16. A time jitter of less than 1 ns can be obtained if the cathode heater voltage is supplied from a DC source, by adopting double-pulsing, and by applying a grid 2 pulse with a rate of rise of voltage (unloaded) in excess of 20 kV/μs.
17. 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.

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

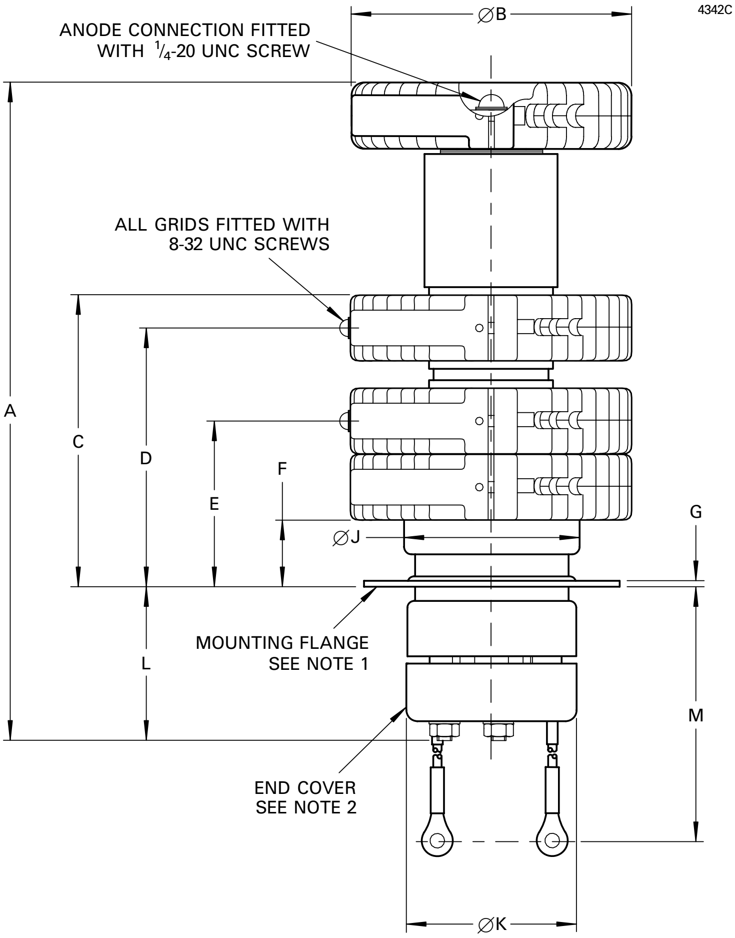
Equipment must be designed so that personnel cannot come into contact with high voltage circuits. All high voltage circuits and terminals must be enclosed and fail-safe interlock switches must be fitted to disconnect the primary power supply and discharge all high voltage capacitors and other stored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

OUTLINE
(All dimensions without limits are nominal)



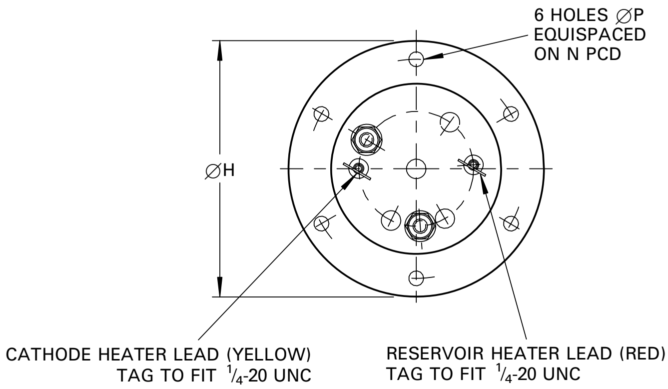
Ref	Millimetres	Inches
A	300.0 max	11.811 max
B	122.0 max	4.803 max
C	128.0	5.040
D	113.0	4.449
E	72.0	2.835
F	28.0	1.102
G	2.50	0.100
H	111.13	4.375
J	76.0	2.992
K	75.0 max	2.953 max
L	70.0 max	2.756 max
M	381.00 ± 6.35	15.000 ± 0.250
N	95.25	3.750
P	6.50	0.256

Inch dimensions have been derived from millimetres.

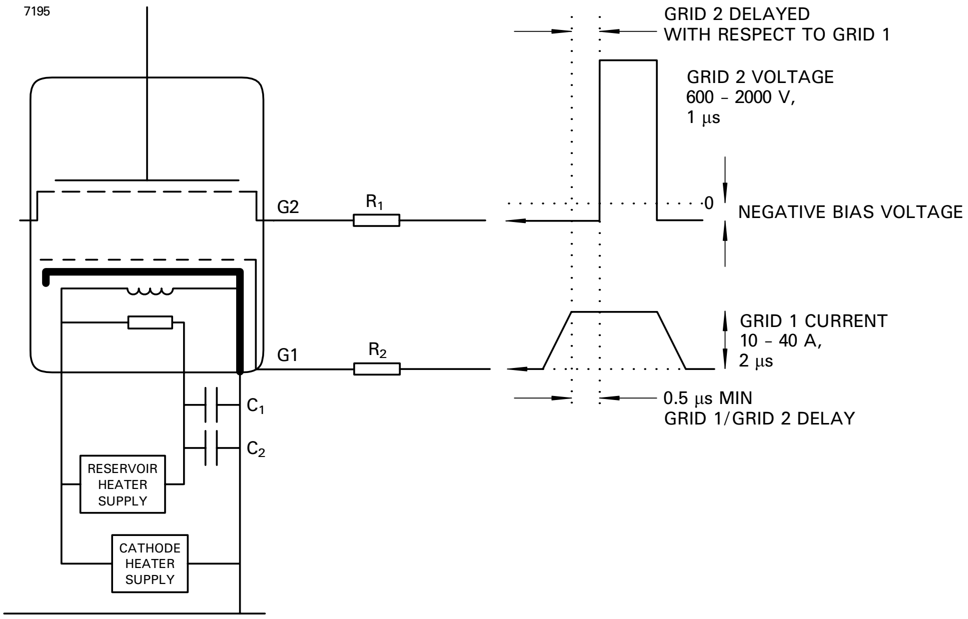
Outline Notes

1. The mounting flange is the connection for the cathode and cathode heater return.
2. The end cover is at heater potential and must not be grounded.

Detail of Mounting Flange



SCHEMATIC DIAGRAM



Recommended Values

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

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.