CX1171BC
Three-Gap, Double-Ended Ceramic Thyratron

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

ABRIDGED DATA

Deuterium-filled, three-gap, double-ended high voltage thyratron with ceramic/metal envelope, featuring low jitter, firing time and drift. The design of the control grids permits a high level of pre-triggering which allows the thyratron to switch high peak currents at very high rates of rise of current. The tube is also suitable 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	100	kV max
Peak anode current	3.0	kA max
Average anode current	2.0	A max
Rate of rise of current	>150	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)	22.5	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 (each gap)	15 to 20	pF approx

Mechanical

Seated height (flange to flange)	410.54 mm (16.175 inches) max
Clearance required below flanges	38.1 mm (1.500 inches) min
Overall diameter (mounting flange)	111.13 mm (4.375 inches) nom
Net weight	4.7 kg (10.3 pounds) approx
Mounting position (see note 2)	any
Tube connections	see outline

Cooling

Cooling	liquid or forced-air
Liquid	oil or coolant immersion
Forced-air	see below

Cooling by oil or coolant immersion is necessary above about 60 kV 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
(Absolute values)

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

Anode (Pulse Modulator Conditions)

	Min	Typical	Max	
Peak forward or inverse anode voltage	-	-	100	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
Rate of rise of anode current (see notes 3 and 4)	-	10	-	kA/μs
Pulse repetition rate (see note 5)	-	100	-	pps

Anode (Single-Shot or Fault Conditions)

	Min	Max	
DC forward anode voltage	-	80	kV
Peak anode current	-	10	kA
Total conducted charge:			
capacitor discharge	-	0.1	C
fault conditions (see note 6)	-	4.0	C
Repetition frequency	1 pulse per 10 s max		

Grid 2 (Cathode End)

	Min	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 note 4)	20	-	kV/μs
Grid 1 - grid 2 pulse delay	0.5	3.0	μs
Peak inverse grid 2 voltage	-	450	V
Loaded grid 2 bias voltage (see note 8)	−50	−180	V
Forward impedance of grid 2 drive circuit	50	500	Ω

Grid 2 (Anode End)

Connected directly to the anode flange (see schematic).

Grid 1 (Cathode End)

	Min	Max	
Peak grid 1 drive current	25	80	A
Unloaded grid 1 drive pulse voltage (see note 7)	300	2000	V
Grid 1 pulse duration	1.0	-	μs
Rate of rise of grid 1 pulse	500	-	V/μs
Peak inverse grid 1 voltage	-	450	V

Grid 1 (Anode End)

DC primed with 100 mA (±20%) from a 150 V (±20%) source.

Grid 0 (Cathode End) (See note 9)

Connected directly to the cathode flange, pulsed with 10% of grid 1 pulse or DC primed with 100 mA (±20%) from a 150 V (±20%) source.

Cathode (Both Ends)

	Min	Max	
Heater voltage	6.3	6.8	V
Heating time	15	-	min

Reservoir (Both Ends)

	Min	Max	
Heater voltage (see note 1)	4.5	6.5	V
Heating time	15	-	min

Environmental

	Min	Max	
Ambient temperature	−50	+90	°C
Altitude	-	3	km
	-	10 000	ft

CHARACTERISTICS

	Min	Typical	Max	
Critical DC anode voltage for conduction (see note 10)	-	5.0	7.0	kV
Anode delay time (see notes 10 and 11)	-	0.1	0.25	μs
Anode delay time drift (see notes 10 and 12)	-	15	50	ns
Time jitter (see note 10)	-	1.0	5.0	ns
Cathode heater current (at 6.3 V)	20	22.5	25	A
Reservoir heater current (at 5.0 V)	6.0	7.0	8.0	A

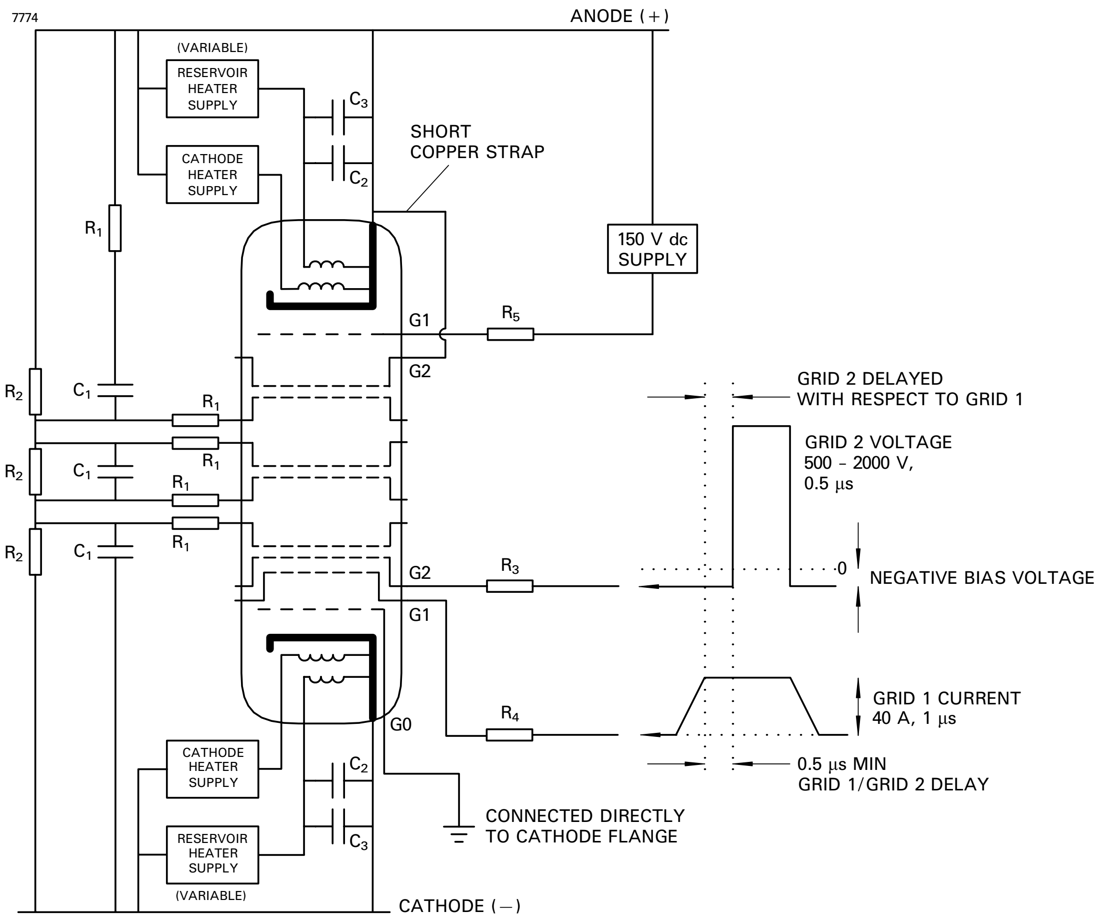
NOTES

1. The reservoir heater must be decoupled with a suitable capacitor to avoid damage by spike voltages. The recommended reservoir heater voltage is stamped on individual tube envelopes. For maximum rate of rise of current, this voltage should be set to the highest level compatible with maintenance of anode voltage hold-off. The reservoir voltage should be stabilised to ±0.05 V.
2. The tube must be mounted by one of the flanges, with flexible connections to all other electrodes.
3. For single-shot, very low frequency and burst mode applications this parameter can exceed 150 kA/μs. The ultimate value which can be attained depends to a large extent upon the external circuit.
4. This rate of rise refers to that part of the leading edge of the pulse between 25% and 75% of the pulse amplitude.
5. Triggered charging techniques are recommended because this thyratron has a long recovery time (100 - 200 μs) due to the gradient grid drift space. 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. Under fault conditions, 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. 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.
8. A negative bias must be applied to grid 2 at the cathode to ensure reliable anode voltage hold-off. The higher grid 1 at the cathode is pulsed, the larger the grid 2 negative bias must be to prevent the tube firing on the grid 1 pulse.
9. For modulator applications, the grid 0 lead is normally connected directly to the cathode flange and not used. Alternatively, grid 0 may be DC primed and the grid 0 current and/or voltage used as a 'thyratron ready to fire' interlock.

10. Typical figures are obtained on test using conditions of minimum grid drive. Improved performance can be expected by increasing grid drive.
11. 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.
12. The drift in delay time over a period from 10 seconds to 10 minutes after reaching full voltage.

SCHEMATIC DIAGRAM

Recommended grid, cathode and reservoir heater connections



R_1 = 470 Ω 12 W vitreous enamelled wirewound resistors.

R_2 = 5 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, of an impedance to set the grid 1 drive pulse current.

R_5 = Grid 1 series resistor to set the DC current. 12 W vitreous enamelled wirewound is recommended.

C_1 = 500 pF capacitors with a voltage rating equal to the peak forward voltage. These capacitors may be needed to share the anode voltage equally between the high voltage gaps when the charging time is less than approx. 5 ms.

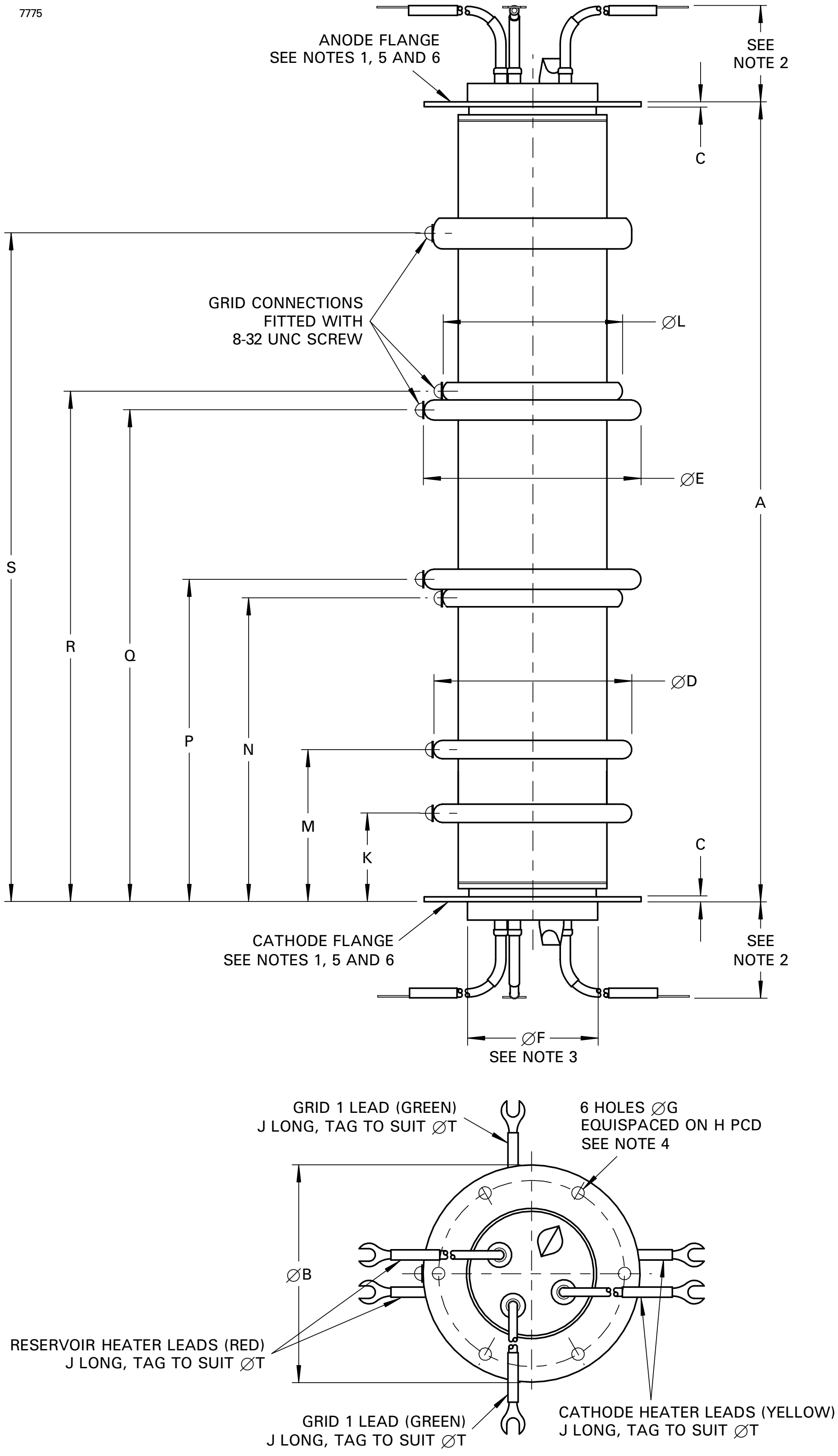
C_2, C_3 = Reservoir protection capacitors with a voltage rating $\geqslant$500 V;

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

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

Components R_1, R_3, R_4, R_5, 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	408.30 ± 2.54	16.075 ± 0.100
B	111.13	4.375
C	2.50 ± 0.25	0.098 ± 0.010
D	101.6 ± 1.6	4.000 ± 0.063
E	111.13 ± 1.60	4.375 ± 0.063
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	44.3	1.744
L	92.08 ± 1.60	3.625 ± 0.063
M	76.9	3.027
N	154.4	6.078
P	164.1	6.461
Q	251.5	9.902
R	261.2	10.283
S	341.9	13.461
T	6.35	0.250

Inch dimensions have been derived from millimetres.

Outline Notes

1. The mounting flange is the connection for the local cathode, cathode heater return and reservoir heater return.
2. A minimum clearance of 38 mm (1.500 inches) must be allowed below the mounting flange.
3. The recommended mounting hole is 73 mm (2.850 inches) diameter.
4. The holes in one flange are within $\pm \, ^1/_2{}^\circ$ of the holes in the other flange when measured from the bottom axis of the flange.
5. The cathode and anode ceramics are clearly marked; the cathode flange is marked with the unique tube serial number.
6. The tube will load into a cylindrical gauge 120 mm diameter x 410 mm long without distortion. The gauge wall is concentric and orthogonal to the anode and cathode flange mounting holes.

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.