CX2610

Two-Gap, Deuterium Filled, Ceramic Thyratron

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

ABRIDGED DATA

Deuterium filled, double-gap, high voltage thyratron with ceramic envelope, featuring high peak current, high rate of rise of current, low jitter and drift. The tube can switch high peak currents with short pulse durations at very high rates of rise of current, and is also suitable for general pulse modulator service at longer pulse durations.
A reservoir 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.

Peak forward anode voltage	-	55 kV max
Peak forward anode current	-	10 kA max
Average anode current	-	2.0 A max
Rate of rise of anode current	-	100 kA/µs

GENERAL DATA

Electrical

Cathode (connected internally to one end of heater)	-	Oxide coated	
Cathode heater voltage	-	6.3	+ 0.5 V - 0.0 V
Cathode heater current	-		24.0 A
Reservoir heater voltage (nominal, see note 1)	-		5.0 V
Reservoir heater current (at 5.0 V)	-		7.0 A
Tube heating time (minimum)	-		10 min

Mechanical

Seated height	-	182.28 mm (7.176 inches) nom
Clearance required below mounting flange	-	50.8 mm (2.000 inches) min
Overall diameter (mounting flange)	-	111.1 mm (4.375 inches) nom
Net weight	-	2.2 kg (4.75 pounds) approx.
Mounting position (see note 2)	-	Any
Tube connections	-	See outline

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A1A-CX2610 Version 4, February 2017
122571

Template: DF764388A-11

Cooling

For all applications, either forced-air cooling or total liquid immersion cooling is needed. For forced-air cooling, it is recommended that air be directed at the cathode flange as indicated in Fig. 1. For applications in air which combine high peak current with high rate of rise of current near to the maximum average current rating, it may also be necessary to cool the anode as indicated in Fig. 1.

Maximum temperature of envelope - 150 °C

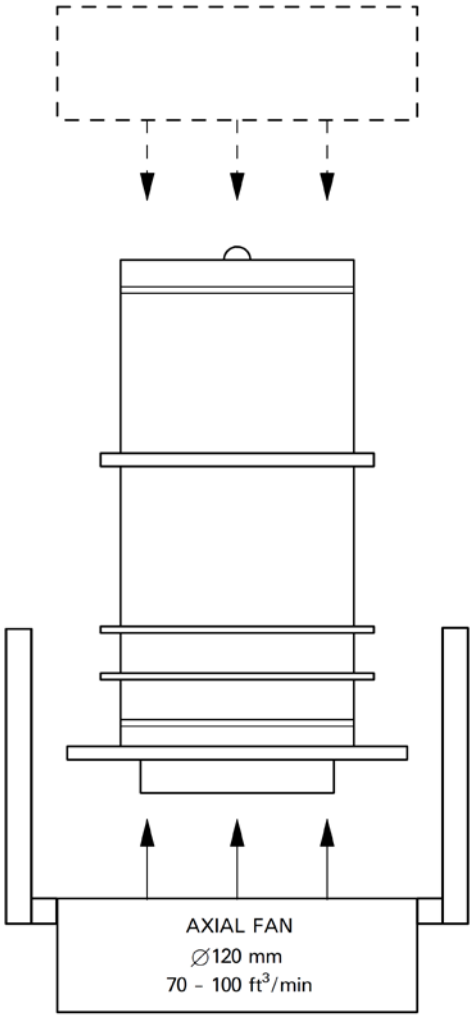


Fig. 1 Recommended Cooling Arrangement

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**	**Typ**	**Max**	
Peak forward anode voltage	.	-	-	55	kV
Peak reverse anode voltage	.		See note 3		
Peak forward anode current	.	-	3.0	10	kA
Average anode current	.	-	-	2.0	A
Pulse duration	.	-	2.0	-	µs
Rate of rise of anode current (see notes 1 and 4)	.	-	100	-	kA/µs
Repetition rate (see note 4)	.	-	10	-	Hz

Anode (Single shot or Fault Conditions, see note 5)		**Min**	**Typ**	**Max**	
DC forward anode voltage	.	-	-	40	kV
Peak anode current	.	-	-	10	kA
Total conducted charge:					
Capacitor discharge	.	-	-	0.1	C
Fault conditions (see note 6)		-	-	4.0	C
Repetition rate	.		1 pulse per 10 s max		

Triggering

The CX2610 has two trigger grids, designated grid 1 and grid 2 (see outline drawing). For maximum lifetime, it is recommended that the CX2610 be triggered with two independent pulses to grids 1 and 2 as indicated in the schematic diagram on page 4.

Grid 1 (Current driven)		**Min**	**Typ**	**Max**	
Unloaded grid 1 voltage (see note 7)	.	300	500	2000	V
Loaded grid 1 current	.	8	12	20	A
Grid 1 pulse duration	.	1	2	5	µs
Peak inverse grid 1 voltage	.	-	-	-450	V
Rate of rise of grid 1 pulse	.	0.5	1	5	kV/µs

Grid 2 (Voltage driven)		Min	Typ	Max	
Unloaded grid 2 voltage (see note 7)	.	500	1000	2000	V
Grid 2 pulse duration	.	0.5	1.0	2.0	µs
Rate of rise of grid 2 pulse (see notes 8 and 9)	.	4	10	-	kV/µs
Loaded grid 2 bias voltage (see note 5)	.	-50	-100	-150	V
Forward impedance of grid 2 drive circuit (see note 10)	.	50	100	200	Ω
Grid 2 timing delay (see schematic)	.	0.5	1.0	5.0	µs

Heaters		Min	Typ	Max	
Cathode heater voltage	.	6.3	6.6	6.8	V
Reservoir heater voltage (see note 1)	.	4.5	5.0	6.5	V
Tube heating time	.	10	-	-	min

Environmental		Min	Typ	Max	
Ambient temperature	.	-50	-	+90	°C
Altitude	.	- -	- -	3 10000	km ft

CHARACTERISTICS

		Min	Typ	Max	
Critical DC anode voltage for conduction (see note 11)	.	-	1.0	2.0	kV
Anode delay time (see notes 11 and 12)	.	-	0.15	0.25	µs
Anode delay time drift (see notes 11 and 13)	.	-	20	50	ns
Time jitter (see note 11)	.	-	2.0	5.0	ns
Cathode heater current (at 6.3 V)	.	20.0	24.0	27.0	A
Reservoir heater current (at 5.0 V)	.	6.0	7.0	8.0	A

NOTES

1. The reservoir heater must be supplied from a variable supply independent of the cathode heater supply. The recommended reservoir voltage for operation at 40 kV DC anode voltage is stamped on the tube.
   The higher the reservoir voltage, the faster the thyratron will switch, but the anode voltage hold-off will be increased.
   The optimum reservoir voltage is the maximum which is consistent with forward anode voltage hold-off under the user's circuit conditions, provided this does not exceed 6.5 V.

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

3. The peak inverse voltage, including spike, must not exceed 5 kV for the first 25 µs after the anode pulse.

4. Triggered charging techniques are recommended to achieve the maximum gas pressure, reliability and life. Thyratron recovery problems are also eliminated. 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.

5. A negative bias must be applied to grid 2 to ensure reliable anode voltage hold-off. A higher grid 1 current pulse will require a larger grid 2 negative bias to prevent the tube firing from the grid 1 pulse.

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.

8. This rate of rise refers to that part of the leading edge of the pulse between 25% and 75% of the pulse amplitude.

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. During the drive pulse period and during recovery when the current flow is reversed.

11. Typical figures are obtained on test using conditions of minimum grid 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 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.

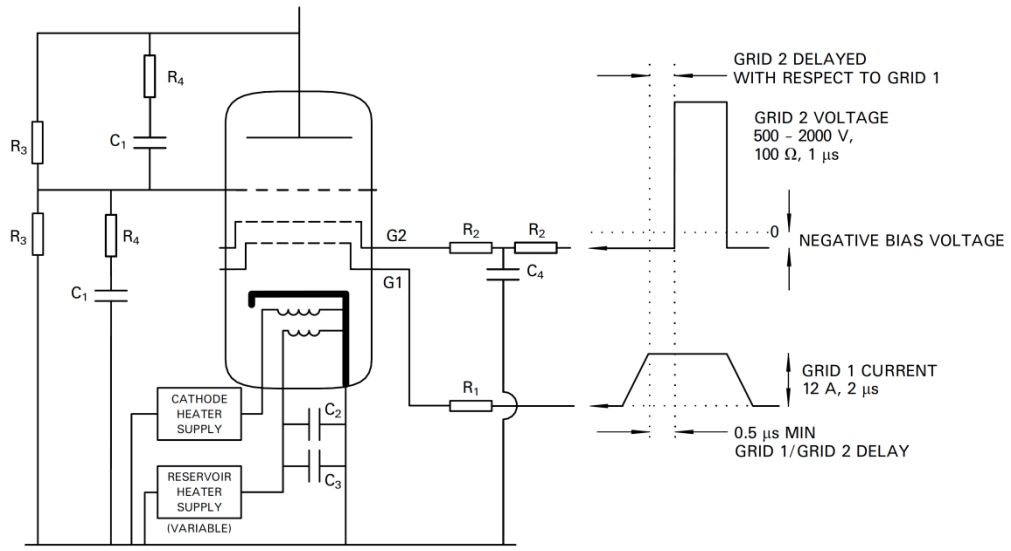
High Voltage

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



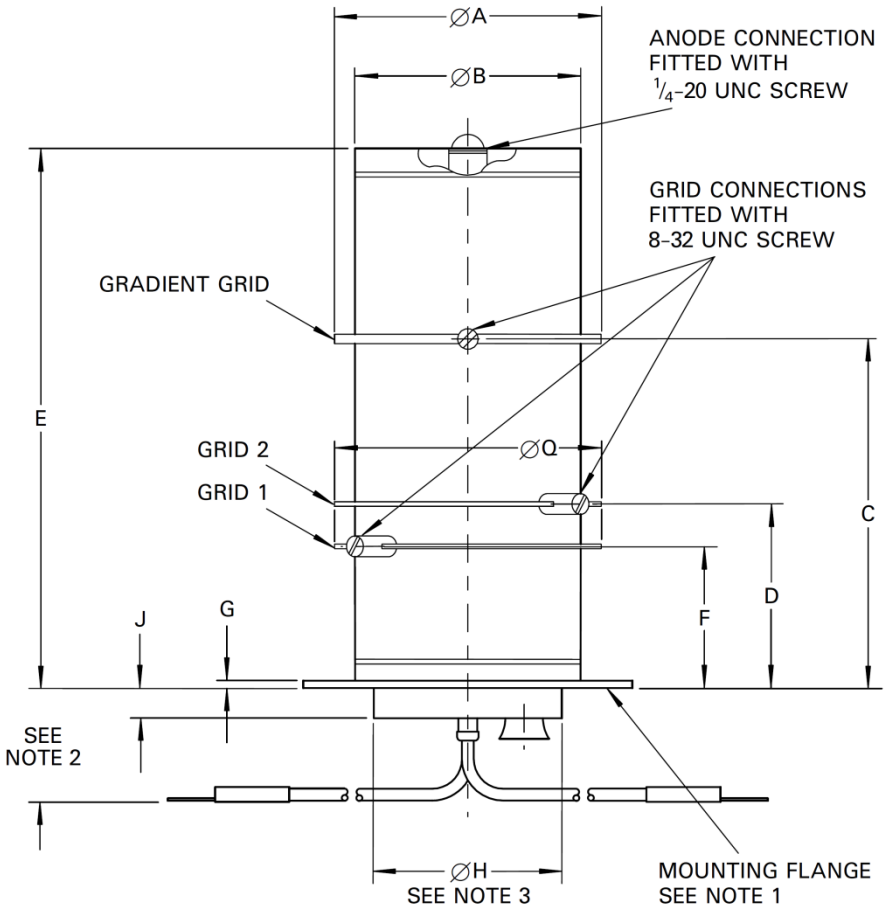
RECOMMENDED GRID, CATHODE AND RESERVOIR HEATER CONNECTIONS

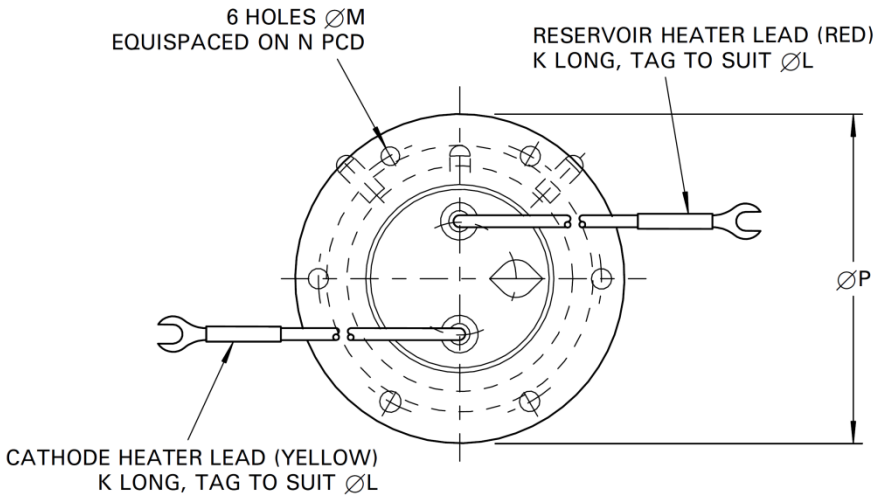
R_1	=	Grid 1 series resistor. 12 W vitreous enamelled wirewound is recommended, of an impedance to match the grid drive pulse circuit and set the grid 1 current.
R_2	=	Grid 2 series resistors. 12 W vitreous enamelled wirewound are recommended, of an impedance to match the grid 2 drive pulse circuit.
R_3	=	5 to 25 MΩ high voltage resistors with a power rating consistent with the forward anode voltage.
R_4	=	470 Ω 12 W vitreous enamelled wirewound resistors.
C_1	=	300 to 500 pF capacitors with a voltage rating equal to the peak forward voltage. These capacitors (with R4) may be needed to divide the voltage correctly across each gap when charging time is less than 5 ms approx.
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).
C_4	=	Approx. 500 pF ceramic disc capacitor rated >10 kV to suppress grid spike.

Components R_1, R_2, C_3 and C_4 should be mounted as close to the tube as possible.

OUTLINE

(All dimensions without limits are nominal)





Ref	Millimetres	Inches
A	90.0	3.543
B	77.80 max	3.063 max
C	117.82	4.639
D	62.06	2.443
E	182.28	7.176
F	47.76	1.880
G	2.5	0.098
H	69.85 max	2.750 max
J	12.7 max	0.500 max
K	190.5 min	7.500 min
L	6.35	0.250
M	6.5	0.256
N	95.25	3.750
P	111.13	4.375
Q	92.5	3.642

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 50.8 mm (2.000 inches) must be allowed below the mounting flange.
3. The recommended mounting hole is 73.03 mm (2.875 inches) diameter.