TELEDYNE

Teledyne e2v

CX1671A/2
Hollow Anode, Three-Gap Ceramic Thyratron

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

ABRIDGED DATA

Hollow anode, deuterium-filled, three-gap, high voltage thyratron with ceramic envelope, featuring high peak current, high rate of rise of current and low jitter. This tube has been developed specifically for use in low inductance circuits where voltage/current reversal occurs.
The hollow anode structure enables the tube to cope with inverse voltage and current without consequent reduction in its high voltage hold-off capability due to electrode damage.

A reservoir operating 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 forward anode voltage	-	105 kV max
Peak anode current	-	3.0 kA max
Peak reverse current	-	3.0 kA max
Average anode current	-	1.0 A max
Rate of rise of current	-	>150 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	-		22.5 A
Reservoir heater voltage (see note 1)			5.0 V
Reservoir heater current			7.0 A
Tube heating time (minimum)	-		15. min
Inter-electrode capacitances (approx):			
Anode to gradient grid 2	-		15 to 20 pF
Gradient grid 2 to gradient grid 1	-		15 to 20 pF
gradient grid 1 to grid 2	-		15 to 20 pF

Mechanical

Seated height	-	342.9mm (13.500 inches) max
Clearance required below mounting flange	-	38.1 mm (1.500 inches) min
Overall diameter Mounting flange		111.1mm (4.375 inches) nom
Net weight	-	4.0 kg (8¾ pounds) approx.
Mounting position (see note 4)	-	any
Tube connections	-	See outline

Cooling

Cooling	-	oil or coolant immersion

Cooling by oil or coolant immersion is necessary for satisfactory tube operation. Further information is contained in the relevant section of the Preamble

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 may be exceeded.

	Min	Typ	Max	
Anode (Pulse Modulator Service)				
Peak forward anode voltage (see note 2)	-	-	105	kV
Peak inverse anode voltage (see note 3)	-	-	90	kV
Peak forward anode current	-	3.0	-	kA
Peak reverse anode current	-	-	3.0	kA
Average anode current	-	-	1.0	A
Rate of rise of anode current (see notes 5 and 6)	-	10	-	kA/µs
Pulse repetition rate (see note 7)	-	400	-	pps

Anode (Single-Shot or Crowbar Service, see note 8)

		Min	Max	
DC forward anode voltage	.	-	80	kV
Peak anode current	.	-	10	kA
Total conducted charge:	.			
capacitor discharge	.	-	0.1	C
crowbar service (see note 9)	.	-	4.0	C
Repetition frequency	.		1 pulse per 10 s max	

Grid 2

Unloaded grid 2 drive pulse voltage (see note 10)		500	2000	V
Grid 2 pulse duration		0.5	-	µs
Rate of rise of grid 2 pulse (see note 6)		10	-	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	500	Ω

Grid 1 – Pulsed

Unloaded grid 1 drive pulse voltage (see note 10)	.	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
Loaded grid 1 bias voltage	.		See note 11	
Peak grid 1 drive current	.	0.3	1.0	A

Grid 1 – DC Primed (see note 8)

DC grid 1 unloaded priming voltage.		75	150	V
DC grid 1 priming current	.	75	150	mA

Cathode

		Min	Max	
Heater voltage	.	6.3	+0.5 -0.0	V
Heating time	.	15	-	min

Reservoir

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

Environmental

Ambient temperature	.	-50	+90	°C
Altitude	.	-	3	Km
		-	10000	ft

CHARACTERISTICS

Anode	Min	Typ	Max	
Critical DC anode voltage for conduction (see note 12).	-	0.5	7.0	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
Recovery time	.	See note 6		
Cathode heater current (at 6.3V)	20	22.5	25	A
Reservoir heater current(at 5.0 V)	6	7	8	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 anode current, the reservoir voltage should be set to the highest value compatible with maintenance of anode hold-off voltage. The reservoir voltage should be stabilised to +0.05V.

2. 105kV is the maximum level at which the thyratron should be operated. For pulse modulator service, a maximum peak forward anode voltage of 85kV is recommended. Voltage hold off reliability may be improved by the use of command charge techniques to minimise the voltage hold off period for the thyratron. A 1 hour DC hold-off test at 60kV is carried out during manufacture.

3. Due to the bidirectional switching capability of the tube, the presence of any reverse voltages will result in reverse current.

4. The tube must be mounted by means of its mounting flange.

5. In single-shot or burst mode, this parameter can exceed 150kA/ms. 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. Command charging techniques are recommended because this thyratron has a long recovery time (100 – 600 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.

8. When DC priming is used on grid 1, a negative bias of 100 to 200 V must be applied to grid 2 to ensure anode voltage hold-off. Also 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. Grid 1 DC priming is recommended for crowbar service.

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

10. Measured with respect to cathode. When grid 1 is pulse driven, the last 0.25 ms of the top of the grid 1 pulse must overlap the corresponding first 0.25 ms of the top of the delayed grid 2 pulse.

11. DC negative bias voltages must not be applied to grid 1. When grid 1 is pulse driven, the potential of grid 1 may vary between -10 and +5 V with respect to cathode potential during the period between the completion of recovery and the commencement of the succeeding grid pulse.

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

Teledyne e2v hydrogen thyratrons are safe to handle and operate, provided that the relevant precautions stated herein are observed. Teledyne e2v 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 Teledyne e2v devices and in operating manuals.

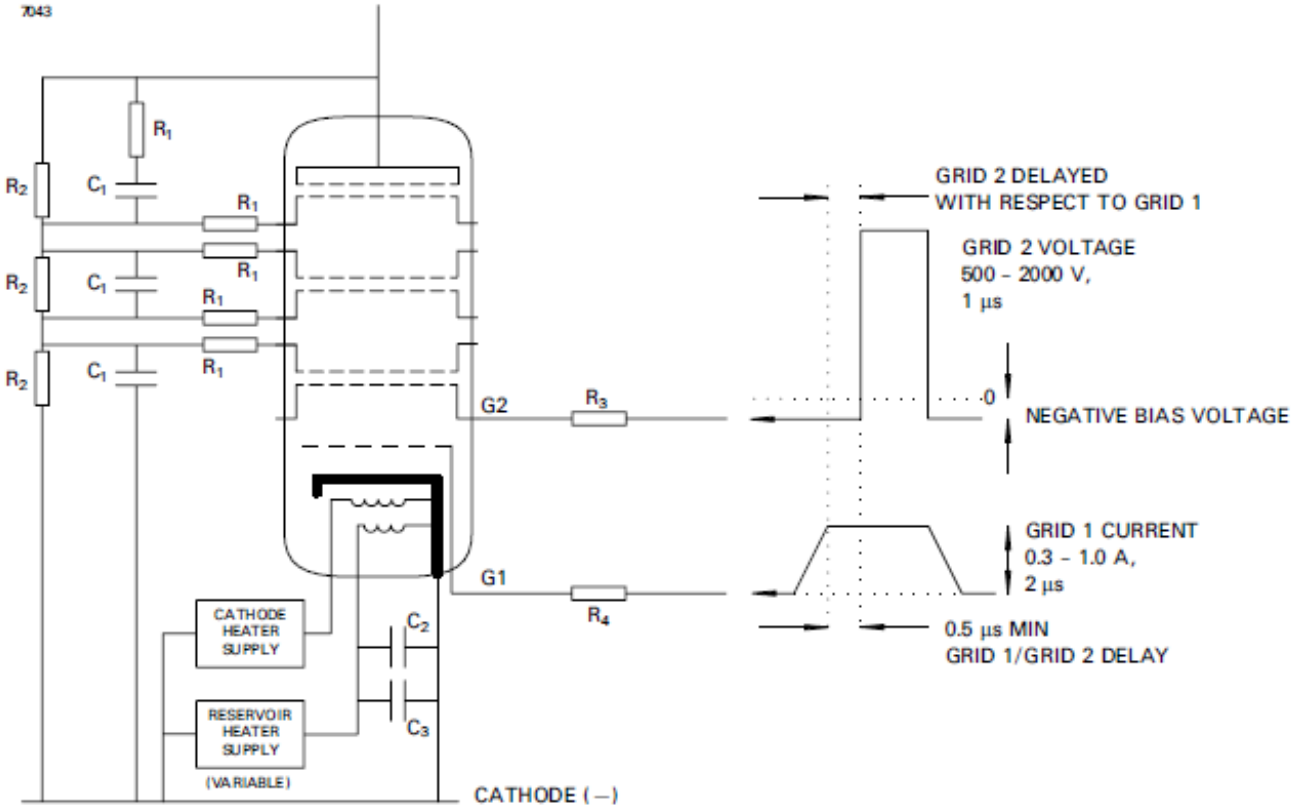
High Voltage

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 (Modulator Service)



RECOMMENDED GRADIENT 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 series resistor. 12 W vitreous enamelled wirewound is recommended, of an impedance to match the grid 1 drive pulse circuit and set the grid 1 current.

C_1 = 300 to 500 pF capacitors with a voltage rating equal to the peak forward voltage. These capacitors may be needed to divide the voltage correctly across each gap when charging times are less than 5 ms approx.

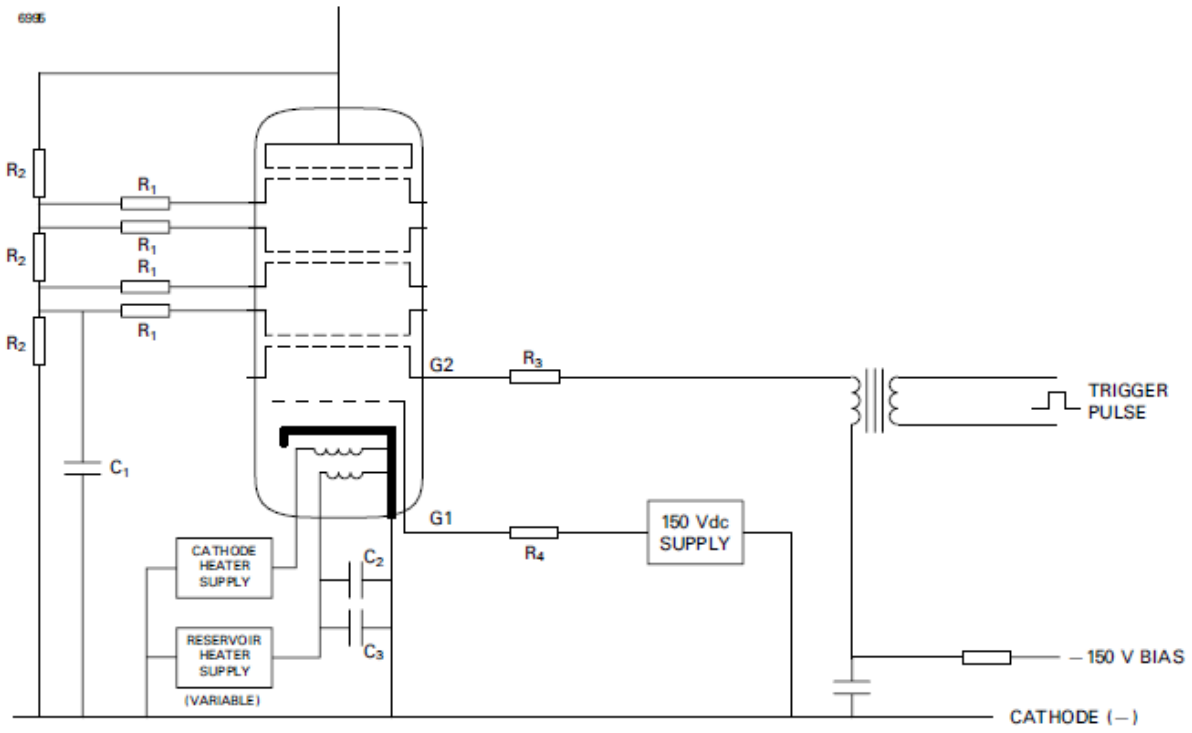
C_2, C_3 = Reservoir protection capacitors with a voltage rating ≥500 V;

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

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

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 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 voltage.

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

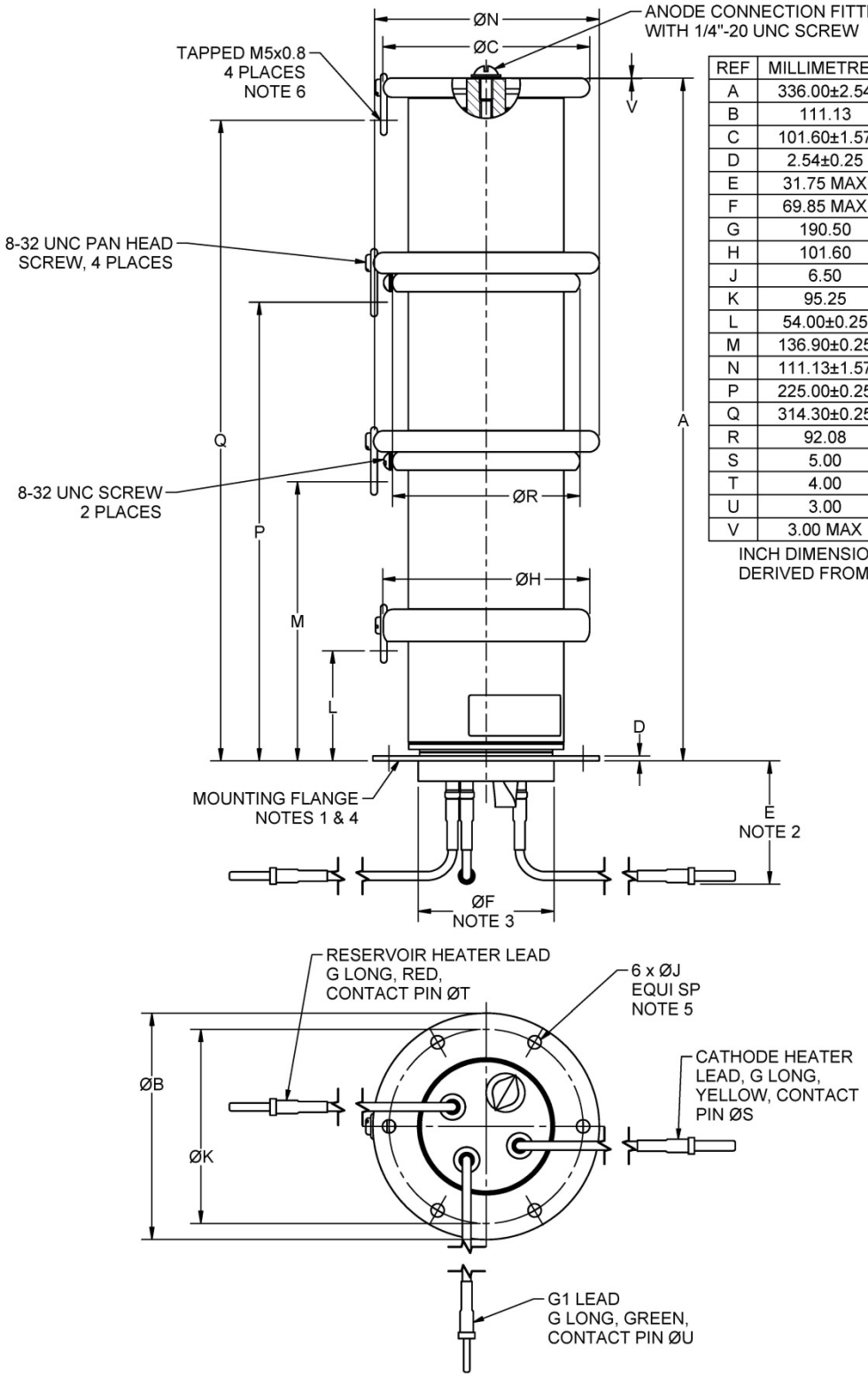
C_2 = 1000 pF low inductance (e.g. ceramic),

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	336.00±2.54	13.228±0.100
B	111.13	4.375
C	101.60±1.57	4.000±0.060
D	2.54±0.25	0.100±0.010
E	31.75 MAX	1.250 MAX
F	69.85 MAX	2.750 MAX
G	190.50	7.500
H	101.60	4.000
J	6.50	0.246
K	95.25	3.750
L	54.00±0.25	2.126±0.010
M	136.90±0.25	5.390±0.010
N	111.13±1.57	4.375±0.060
P	225.00±0.25	8.858±0.010
Q	314.30±0.25	12.374±0.010
R	92.08	3.625
S	5.00	0.197
T	4.00	0.157
U	3.00	0.118
V	3.00 MAX	0.118 MAX

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 38.1 mm (1.500 inches) must be allowed below the mounting flange.
3. The recommended mounting hole is 73.0 mm (2.875 inches) diameter.
4. Face of the anode stud to be paralelle to the bottom face of the flange within ±1°
5. Holes in flange & O/D of stress rings & O/D of anode stud to be concentric within 1.00[0.039].
6 Holes in tabs to be within ±½° of hole in flange measured from base axis ‘A’ – ‘A’ of flange