

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

ABRIDGED DATA

Hollow anode, deuterium-filled three-gap thyratrons with metal/ceramic envelope, featuring high peak current, high rate of rise of current, low jitter and >50% voltage/current reversal.

They have been developed specifically for high voltage, high peak power applications. Two different modes of operation are possible. They can be operated as three-gap thyratrons for general pulse modulator service at up to 80 kV. Alternatively they can be operated as two-gap thyratrons at up to 45 kV for applications with high inverse current, such as occurs, for example, in excimer laser circuits. Operation in the two-gap mode provides extended life time over traditional two-gap hollow anode thyratrons.

The patented hollow anode structure enables the tubes to cope with inverse voltage and current without consequent reduction in its high voltage hold off capability due to electrode damage.

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.

The CX1925X, which must be used in conjunction with Teledyne e2v resistor box MA942A, permits a larger variation in internal deuterium pressure than the CX1925. Resistor box settings and/or reservoir heater voltage can be adjusted within the specified limits to obtain the maximum thyatron gas pressure consistent with the required voltage hold-off.



Three-gap Operation

Peak forward anode voltage	-	80 kV max
Peak forward anode current	-	15 kA max
Peak reverse anode current	-	10 kA max
Average anode current	-	5.0 A max
Rate of rise of current	-	>100 kA/μs
Jitter	-	1.0 ns
Pulse repetition rate	-	2000 pps max

Two-gap Operation

Peak forward anode voltage	-	45 kV max
Peak forward anode current	-	15 kA max
Peak reverse anode current	-	10 kA max
Average anode current	-	2.0 A max
Rate of rise of current	-	>300 kA/μs
Jitter	-	1.0 ns
Pulse repetition rate	-	1000 pps max

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126447

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	+ 0.7 V - 0.3 V
Reservoir heater current	-	7.0 A	
Tube heating time (minimum)	-	10.0 min	

Mechanical

Seated height	-	263 mm max	
Clearance required below mounting flange	-	80 mm min	
Overall diameter (excluding connections)	-	122 mm max	
Net weight	-	4.2 kg approx.	
Mounting position	-	See note 3	
Tube connections	-	See outline	

Cooling

The tube must be cooled by total liquid immersion, for example in force-circulated transformer oil (see Teledyne e2v 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.

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

MAXIMUM AND MINIMUM RATINGS

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

Two-gap operation requires anode/gradient grid connections which are different from those required for three-gap operation. It is important that the correct schematic diagram is followed.

Anode (Three-gap operation)	Min	Max	
Peak forward anode voltage (see note 4)	-	80	kV
Peak inverse anode voltage	See note 5		
Peak forward anode current	-	15	kA
Average anode current	-	5	A
Rate of rise of anode current	See notes 6 and 7		

Anode (Two-gap operation)	Min	Max	
Peak forward anode voltage	-	45	kV
Peak inverse anode voltage	See note 5		
Peak forward anode current	-	15	kA
Average anode current	-	2	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)	1000	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	-100	-200	V
Impedance of grid 2 drive circuit (see note 11)	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 12		
Peak grid 1 drive current (see note 13)	10.0	25.0	A

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

Reservoir	Min	Max
Heater voltage	6.3 + 0.7 6.3 - 0.3	V
Heating time	10	- min

Environmental	Min	Max
Ambient temperature	0	+70 °C

CHARACTERISTICS

	Min	Typ	Max	
Critical DC anode voltage for conduction	-	0.5	2.0	kV
Anode delay time	-	200	250	ns
Anode delay drift time (see note 14)	-	15	25	ns
Time jitter (see note 15)	-	1.0	5.0	ns
Recovery time (see note 16)	-	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

- 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 Figs. 1 and 2. In order to meet the jitter specification, it may be necessary in some circumstances that the cathode heater be supplied from a DC source.

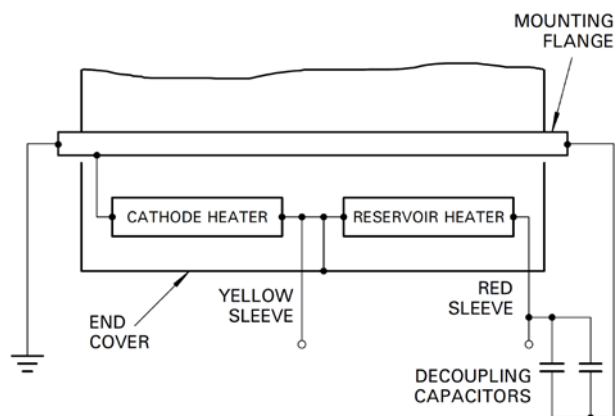


Fig. 1 CX1925 base connections

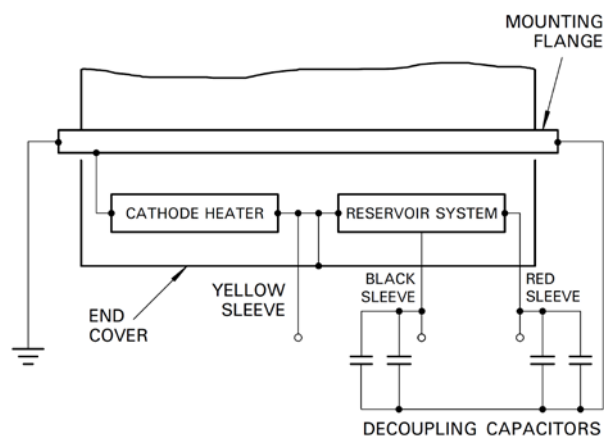


Fig. 2 CX1925X base connections

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 at switch-on, when the cathode heater impedance is minimal. This situation can be avoided by ensuring that the two supplies are in antiphase. 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. CX1925X gas pressure may be altered using Teledyne e2v resistor box type MA942A. The CX1925X **must** be used in conjunction with the MA942A. The resistor box must be connected between the gas pressure control lead (black sleeve) and the cathode heater lead (yellow sleeve). Gas pressure may be increased by increasing the resistor box settings from their initial recommended values which accompany each delivered CX1925X. The gas pressure may be increased to a value consistent with the required forward hold-off voltage. Additional variations in gas pressure can be achieved 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 60 kV and there must be no overshoot.
5. Due to the bidirectional switching capability of the tube, the presence of any reverse voltages following the forward current pulse will result in reverse current.
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 well in excess of 100 kA/ μ s.
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 μ s of the top of the grid 1 pulse must overlap the corresponding first 0.25 μ s of the top of the delayed grid 2 pulse.
11. During both the drive pulse period and during recovery when the current flow is reversed.
12. DC negative bias voltages must not be applied to grid 1.
13. 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.
14. Measured between the second minute after the application of HT and 30 minutes later.
15. 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/ μ s.
16. The amount of time available for thyatron 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 thyatron in a conducting state.

HEALTH AND SAFETY HAZARDS

Teledyne e2v 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 equipment 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 door open.

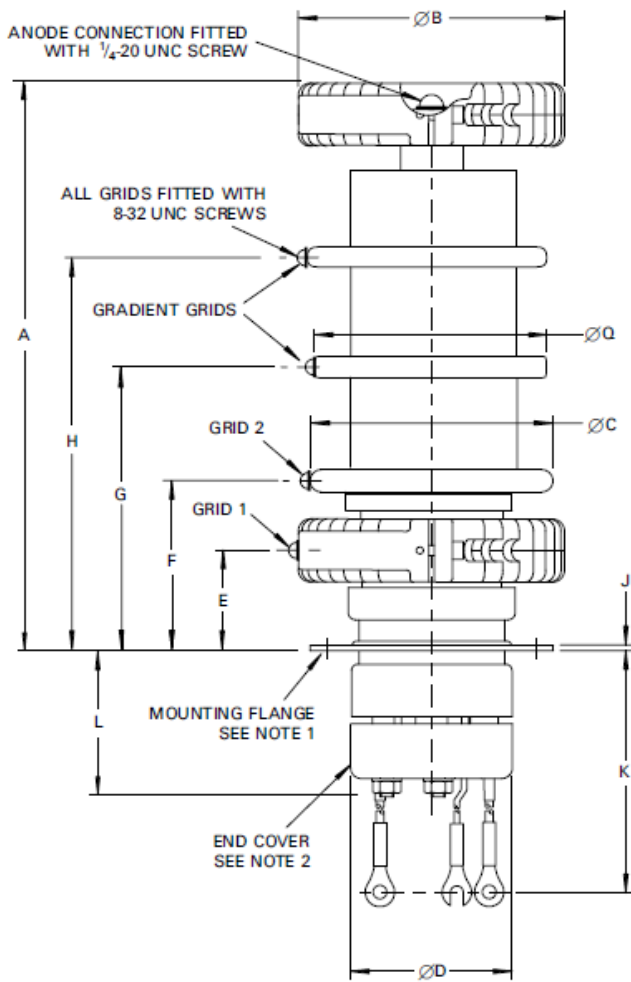


X-Ray Radiation

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 thyatron 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 OF CX1925



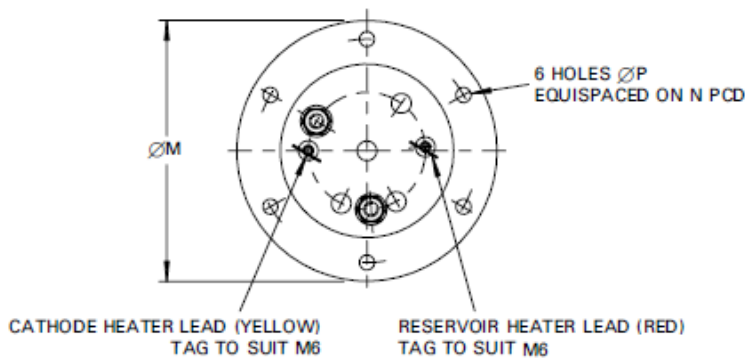
Ref	Millimetres	Inches
A	263.0	10.354
B	122.0 max	4.803 max
C	111.0	4.370
D	75.0 max	2.953 max
E	46.0	1.811
F	78.0	3.071
G	125.2	4.929
H	172.4	6.787
J	2.5	0.098
K	381.00 ± 6.35	15.00 ± 0.250
L	70.0 max	2.756 max
M	111.13	4.375
N	95.25 max	3.750 max
P	6.5	0.256
Q	105.0	4.134

Inch dimensions have been derived from millimetres

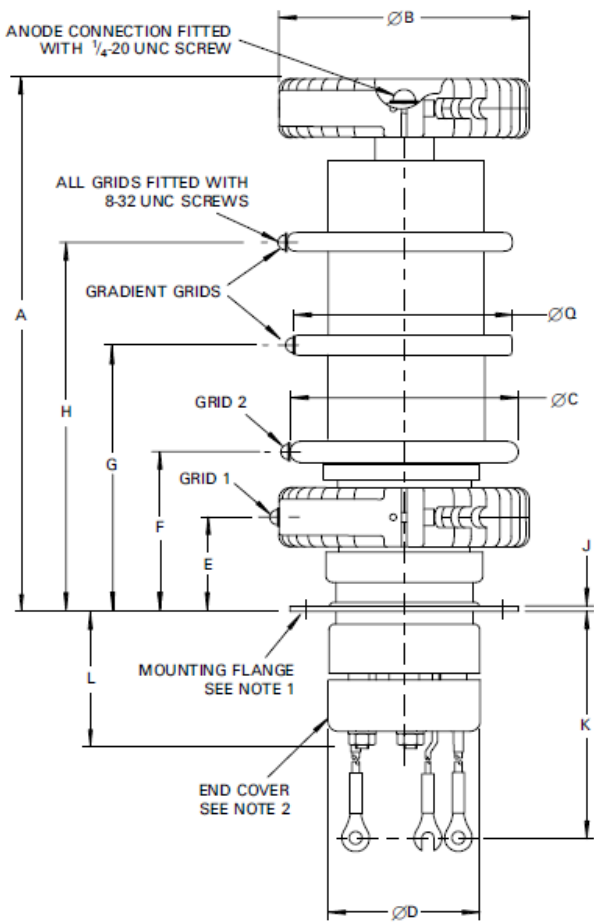
Outline Notes

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



OUTLINE OF CX1925X



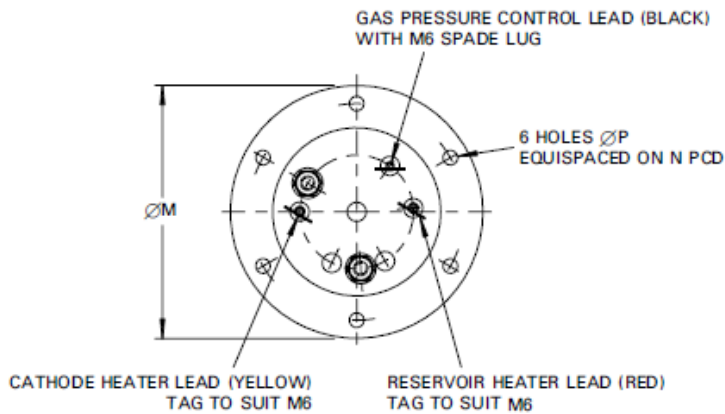
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H	172.4	6.787
J	2.5	0.098
K	381.00 ± 6.35	15.00 ± 0.250
L	70.0 max	2.756 max
M	111.13	4.375
N	95.25 max	3.750 max
P	6.5	0.256
Q	105.0	4.134

Inch dimensions have been derived from millimetres

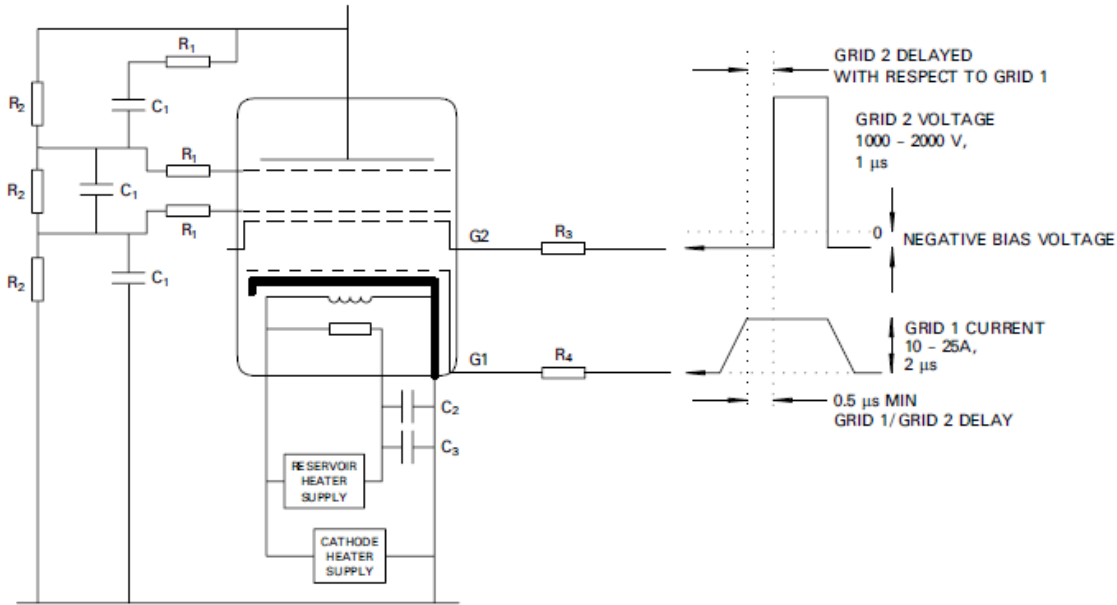
Outline Notes

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.

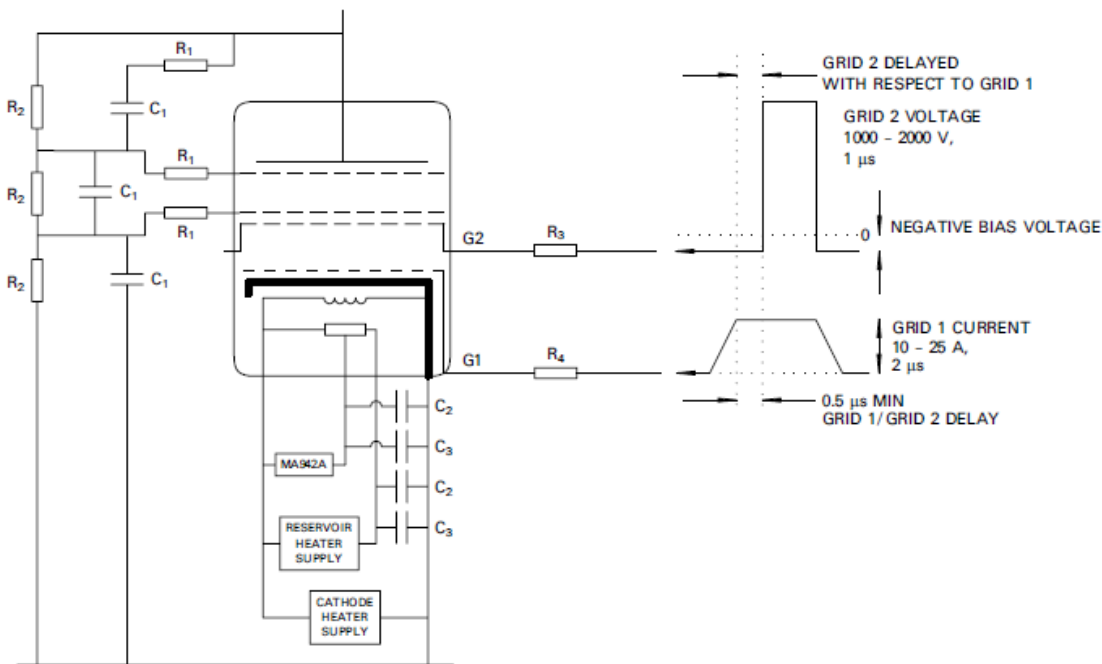
Detail of Mounting Flange



CX1925 SCHEMATIC DIAGRAM FOR THREE-GAP OPERATION



CX1925X SCHEMATIC DIAGRAM FOR THREE-GAP OPERATION



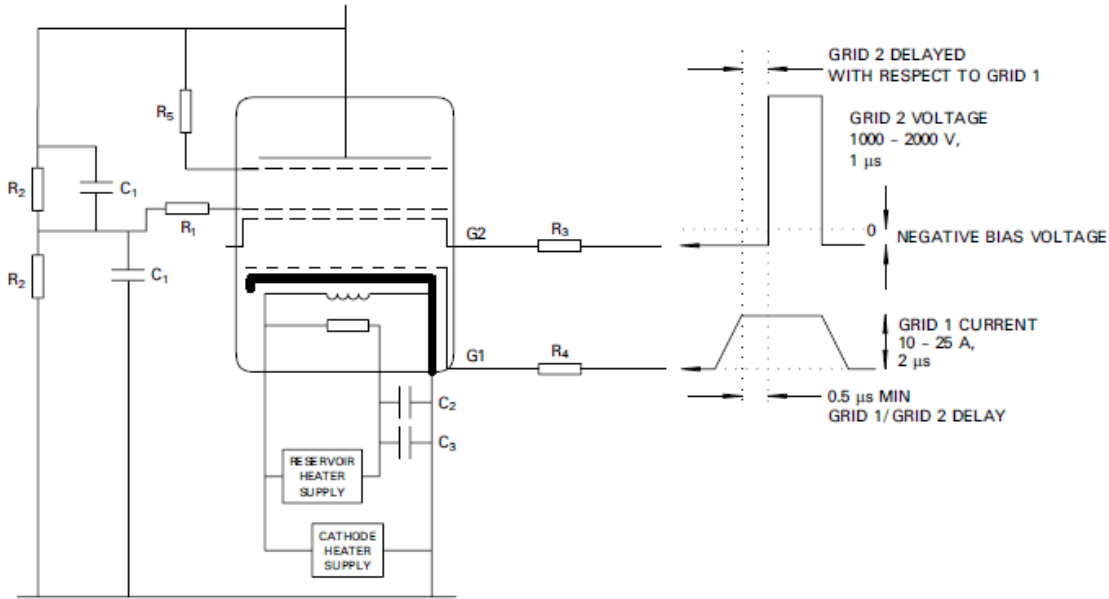
Recommended Values (both diagrams)

- R₁ = 470 Ω 2.5 W vitreous enamelled wirewound resistors.
- R₂ = 5 to 20 MΩ high voltage resistors with a power rating consistent with forward anode voltage.
- R₃ = Grid 2 series resistor. 12 W vitreous enamelled wirewound is recommended, of an impedance to match the grid 2 drive pulse circuit.
- R₄ = Grid 1 series resistor. 12 W vitreous enamelled wirewound is recommended, of a total impedance to match the grid 1 drive pulse circuit.

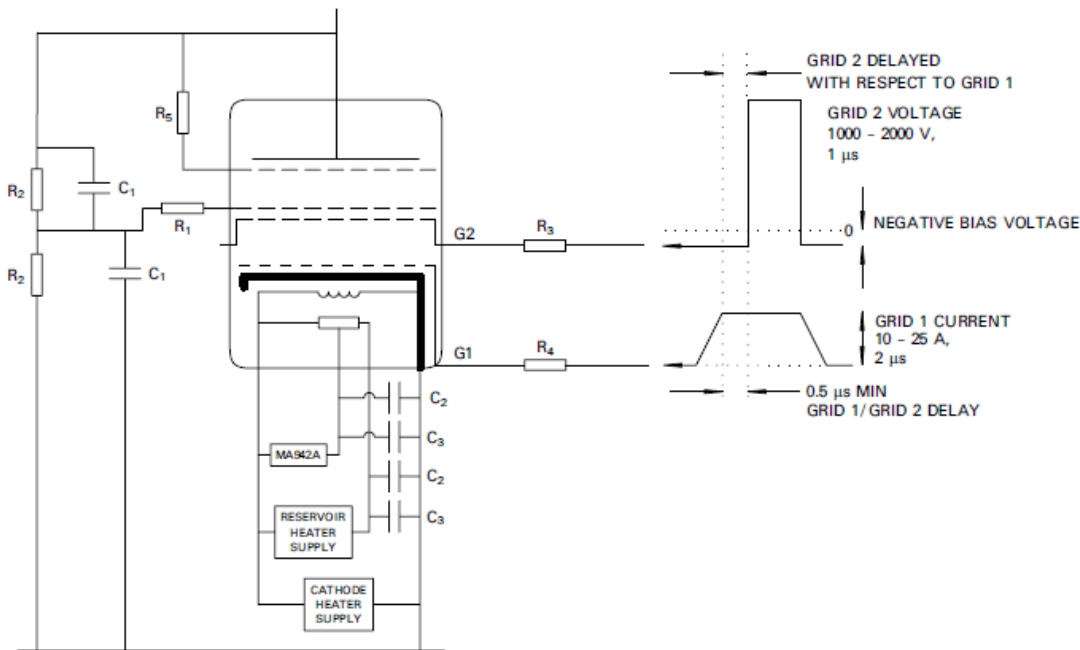
- C₁ = 500 pF capacitors with a voltage rating equal to the peak forward voltage (C₁ is needed to share the anode voltage equally between the high voltage gaps on fast charging rates. When the charging time is greater than approx. 5 ms, C₁ may be omitted).
- C₂, C₃: Reservoir protection capacitors with a voltage rating ≥ 500 V;
- C₂ = 1000 pF low inductance (e.g. ceramic),
- C₃ = 1 μF (e.g. polycarbonate or polypropylene).

Components R₃, R₄, C₂ and C₃ should be mounted as close to the tube as possible.

CX1925 SCHEMATIC DIAGRAM FOR TWO-GAP OPERATION



CX1925X SCHEMATIC DIAGRAM FOR TWO-GAP OPERATION



Recommended Values (both diagrams)

- R₁ = 470 Ω 2.5 W vitreous enamelled wirewound resistors.
- R₂ = 5 to 20 MΩ high voltage resistors with a power rating consistent with forward anode voltage.
- R₃ = Grid 2 series resistor. 12 W vitreous enamelled wirewound is recommended, of an impedance to match the grid 2 drive pulse circuit.
- R₄ = Grid 1 series resistor. 12 W vitreous enamelled wirewound is recommended, of a total impedance to match the grid 1 drive pulse circuit.
- R₅ = Anode resistor. 1 kΩ 12 W vitreous enamelled wirewound is recommended.

- C₁ = 500 pF capacitors with a voltage rating equal to the peak forward voltage (C₁ is needed to share the anode voltage equally between the high voltage gaps on fast charging rates. When the charging time is greater than approx. 5 ms, C₁ may be omitted).
- C₂, C₃: Reservoir protection capacitors with a voltage rating ≥ 500 V;
- C₂ = 1000 pF low inductance (e.g. ceramic),
- C₃ = 1 μF (e.g. polycarbonate or polypropylene).

Components R₃, R₄, C₂ and C₃ should be mounted as close to the tube as possible.

MA942A RESISTOR BOX

'X' type thyratrons have an additional lead on the base which enables the user to adjust the gas pressure inside the tube to a greater degree than is possible by changing the reservoir voltage. This allows the gas pressure to be optimised for a particular set of operating conditions, reducing the power dissipation in the thyratron to a minimum and maximising its switching speed. The maximum gas pressure allowable is dependent on the voltage hold off required; the higher the gas pressure, the more likely the thyratron is to break down spontaneously. Optimisation is achieved by increasing the gas pressure until the thyratron will no longer reliably hold off the required anode voltage, and then reducing it again only until the tube will operate reliably without spontaneous anode voltage breakdowns.

The gas pressure of Teledyne e2v metal envelope thyratrons is normally set during manufacture to allow reliable operation at the maximum rated anode voltage, by resistors inside the base cap of the tube. In 'X' type tubes, these resistors are omitted and replaced by two parallel variable resistors mounted in the MA942A resistor box which is connected to the thyratron as shown in the schematic diagram. Increasing the value of this parallel combination will increase the pressure in the thyratron.

'X' type thyratrons are supplied with a recommended minimum combination of values. Do not use a lower combined value of resistors as this would result in the tube being operated with an unacceptably low gas pressure and may lead to tube damage and reduced tube life.

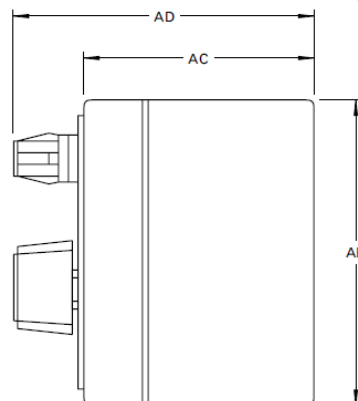
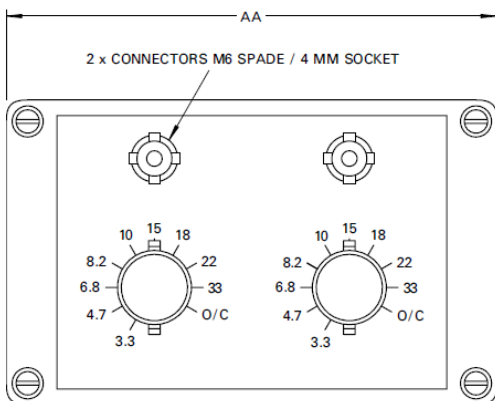
Ten resistor values can be selected by each rotary switch (3.0 Ω, 4.7 Ω, 6.8 Ω, 8.2 Ω, 10 Ω, 15 Ω, 18 Ω, 22 Ω, 33 Ω, O/C), giving the range of possible values shown in the table.

Paralleled Value (Ω)	Control Box Settings (Ω)		Paralleled Value (Ω)	Control Box Settings (Ω)	
1.65	3.3	3.3	5.19	6.8	22.0
1.94	3.3	4.7	5.30	8.2	15.0
2.22	3.3	6.8	5.63	8.2	18.0
2.35	4.7	4.7	5.64	6.8	33.0
2.35	3.3	8.2	5.97	8.2	22.0
2.48	3.3	10.0	6.00	10.0	15.0
2.70	3.3	15.0	6.43	10.0	18.0
2.78	4.7	6.8	6.57	8.2	33.0
2.79	3.3	18.0	see note	6.8	O/C
2.87	3.3	22.0	6.87	10.0	22.0
2.99	4.7	8.2	7.50	15.0	15.0
3.00	3.3	33.0	7.67	10.0	33.0
3.20	4.7	10.0	8.18	15.0	18.0
see note	3.3	O/C	see note	8.2	O/C
3.40	6.8	6.8	8.92	15.0	22.0
3.58	4.7	15.0	9.00	18.0	18.0
3.72	6.8	8.2	9.00	18.0	22.0
3.73	4.7	18.0	see note	10.0	O/C
3.87	4.7	22.0	10.31	15.0	33.0
4.05	6.8	10.0	11.0	22.0	22.0
4.10	8.2	8.2	11.65	18.0	33.0
4.11	4.7	33.0	13.2	22.0	33.0
4.51	8.2	10.0	15.0	15.0	O/C
4.68	6.8	15.0	16.5	33.0	33.0
see note	4.7	O/C	18.0	18.0	O/C
4.94	6.8	18.0	22.0	22.0	O/C
5.00	10.0	10.0	33.0	33.0	O/C
			O/C	O/C	O/C

Note: Do not set parallel resistors to these values, as this may cause the power rating of the resistor to be exceeded.

OUTLINE

(All dimensions without limits are nominal)



Ref	Millimetres	Inches
AA	125.0	4.921
AB	80.0	3.150
AC	57.0	2.244
AD	85.0 max	3.346 max

Inch dimensions have been derived from millimetres