

## INTRODUCTION

The HX3002 is a gas discharge switch capable of conducting high peak currents with a large conducted charge per pulse. It is suitable for use in applications such as the discharge of capacitor banks into various loads, or as a crowbar switch for various protection purposes.

The switch is deuterium filled and incorporates a thermionic cathode and deuterium reservoir within the ceramic/metal envelope. It is easily triggered, has a large dynamic range of operating voltages and contains no mercury.

## MAXIMUM RATINGS (see note 1)

Peak forward anode voltage	-	38 kV
Peak current:		
Pulse width >25 $\mu$ s	-	25 kA
Pulse width <25 $\mu$ s	-	30 kA
Conducted charge per pulse (capacitor discharge)	-	40 C

## CHARACTERISTICS

Minimum anode takeover voltage (see note 2)	-	1 kV
Minimum anode current (see note 2)	-	1 kA
Anode delay time (see note 3)	-	1 $\mu$ s max
Jitter (peak – peak) (see note 3)	-	10 ns
Anode voltage fall-time (see note 3)	-	100 ns
Warm-up time (see note 5)	-	10 mins
Rate of rise of current	-	See note 4

## GENERAL

### Electrical

Cathode heater voltage	-	5.0 $\pm$ 0.2 V
Cathode heater current	-	11 A max
Reservoir heater voltage (see note 5)	-	4.0 to 6.0 V
Reservoir heater current	-	6 A max



### Mechanical

Seated height	-	260 mm (10.236 inches)
Clearance required below mounting flange	-	31.75 mm (1.250 inches)
Overall diameter	-	111.13 mm (4.375 inches)
Net weight	-	5.7 kg (12.6 pounds) approx.
Mounting position (see note 6)	-	Any

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## Cooling

The HX3002 is intended for single-shot or very low repetition rate applications. Therefore most of the power to be dissipated comes from the cathode and reservoir heaters. It is suitable for both air and liquid cooled environments, and in either case there are no demanding cooling requirements. For air-cooled applications, it is sufficient to ensure that the ambient air is not allowed to stagnate around the envelope, for example, by directing air from a small fan, typically 0.28 to 0.57 m<sup>3</sup>/min (10 to 20 ft<sup>3</sup>/min). For liquid-cooled applications, natural convection currents induced by the dissipated heater power will provide adequate cooling.

## Environmental

Ambient temperature range	-	+10 to +40 °C
Altitude	-	3,000 m 10,000 ft

## TRIGGERING

The HX3002 incorporates two trigger electrodes and there are two alternative methods recommended for triggering. Figs. 1a and 1b show the simplest method, where the applied pulse is shared between grid 1 and grid 2 with suitable series grid resistors. Fig. 1c shows an alternative method whereby a DC priming current, derived from a simple DC power supply, is applied to grid 1 and a trigger pulse with a standing negative bias is applied to grid 2. (When DC priming is used on grid 1, a negative bias voltage must be applied to grid 2).

The second method of triggering may be preferred for crowbar applications, because the voltage Vg1, measured directly between the mounting flange and grid 1, may be used to provide a fail-safe, ready-to-fire interlock. If Vg1 is between +10 and +30 V DC, the HX3002 will fire when triggered. If Vg1 is outside these limits, for example due to insufficient warm-up time or a fault in the heater supplies, the HX3002 will fail to fire.

### Minimum Grid 2 Trigger Pulse Requirements (see note 7)

		Min	Max	
Unloaded voltage	-	500	2000	V
Loaded pulse current	-	10	50	A
Pulse duration (FWHM)	-	1	2	µs
Unloaded rate of rise of voltage (see note 8)	-	2	50	kV/µs
Negative bias	-	-100	-150	V

### Grid 1 DC Priming Requirements (see note 9 and Fig. 1b)

		Min	Max	
Unloaded voltage	-	120	-	V
Loaded current	-	50	75	mA

## NOTES

1. It is important that the maximum peak forward current rating is not exceeded under normal circumstances. The HX3002 will tolerate higher peak currents than specified but only on an isolated event basis. Operating above the peak current rating will result in plasma constriction within the device, causing enhanced electrode erosion. Repeated operation under these circumstances will shorten the useful operating lifetime. Plasma constriction times are quite long, and therefore higher, but safe, peak currents can be specified for shorter pulses. The HX3002 has been tested, and operates well, with a half-sine 30 kA, 15 µs pulse with 15 kA reverse current.  
For power supply crowbar applications, the HX3002 has a much higher coulomb rating than 40 C, because much of the total conducted charge is as a result of the follow-on current from the HV power supply, and is thus at relatively low peak currents. The overall pulse shape for crowbar applications is thus a short pulse of several kilo-amps, followed by a longer duration 'tail' of up to a few hundred amps.
2. The minimum anode takeover voltage is the applied anode voltage below which the HX3002 may fail to start to conduct when triggered with the minimum specified trigger pulse.  
Also, in order for the initial plasma discharge to transfer to a copper arc for full conduction, the circuit must provide more than 1 kA.
3. The figures quoted refer to conditions where the HX3002 is triggered with the minimum specified trigger pulse.
4. For most applications, the rate of rise of current is determined by the external circuit.
5. The recommended reservoir voltage is indicated on the tube envelope and should be strictly observed. It is strongly recommended that the reservoir power supply is variable between 4.0 and 6.0 V.
6. The HX3002 must be installed by the mounting flange, but may be mounted in any orientation.
7. The HX3002 is triggered by the current delivered by the trigger circuit rather than the applied trigger voltage. Therefore it is important that the trigger circuit delivers at least the minimum specified pulse current.

8. The term 'unloaded' refers to conditions where the cathode and reservoir heaters are cold and thus where no trigger current will be drawn by the HX3002. Conversely, the term 'loaded' refers to conditions where both the cathode and reservoir heaters have been switched on for at least the minimum stated warm-up time.
9. The magnitude of the grid 1 DC priming current is determined by the series grid resistor (see Figs. 1a and 1b). If grid 1 DC priming is used, then grid 2 negative bias is necessary.

 **High Voltage**

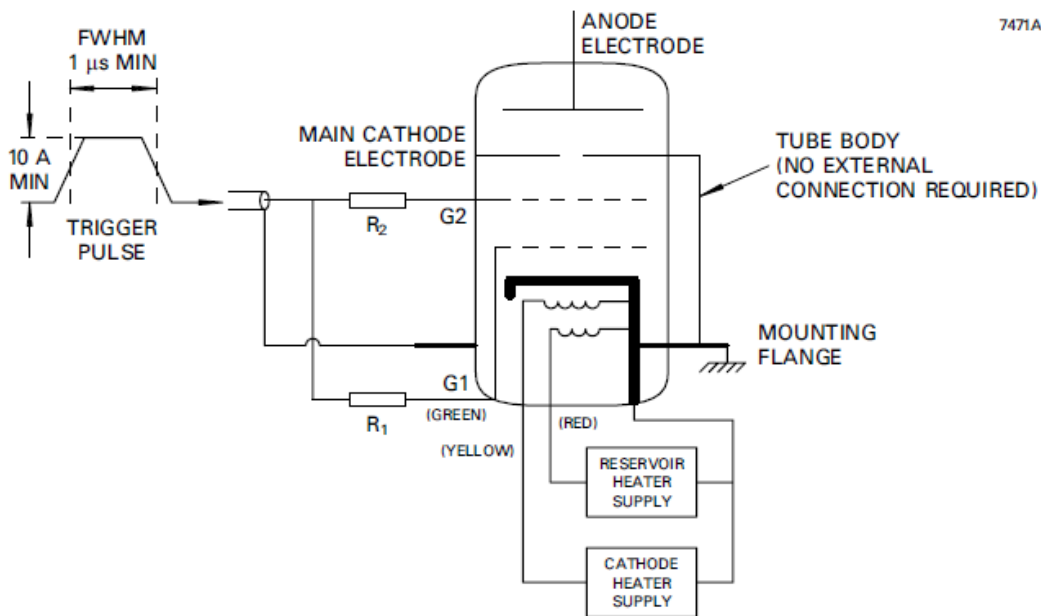
Equipment must be designed so that personnel cannot come into contact with high voltage circuits. All high voltage circuits and terminals must be enclosed and fail-safe interlock switches must be fitted to disconnect the primary power supply and discharge all high voltage capacitors and other stored charges before allowing access. Interlock switches must not be bypassed to allow operation with access door open.

 **X-Ray Radiation**

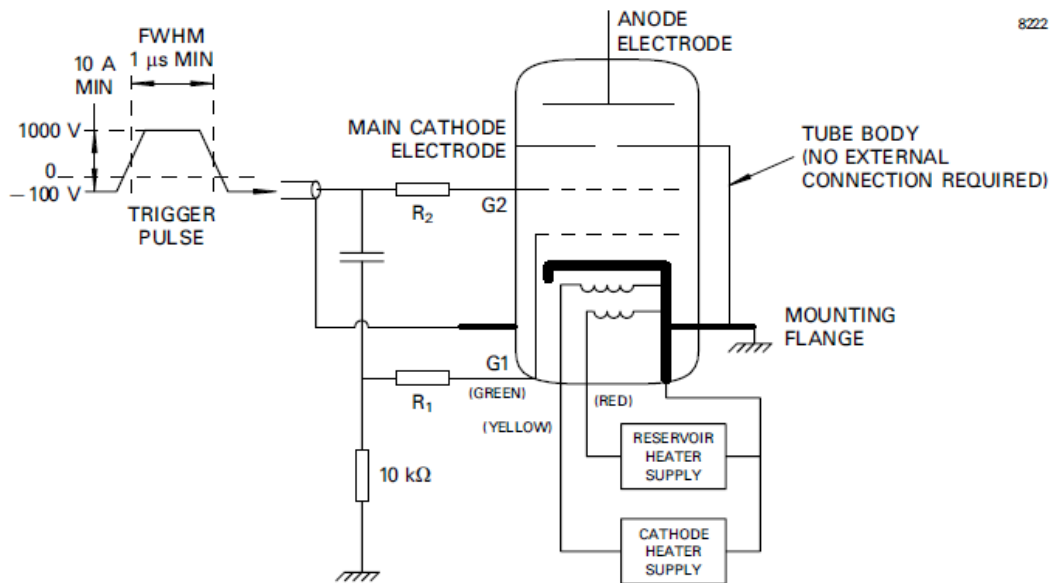
All high voltage devices produce X-rays during operation and may require shielding. The X-ray radiation from hydrogen thyratrons is usually reduced to a safe level by enclosing the equipment or shielding the switch with at least 1.6 mm (1/16 inch) thick steel panels. Users and equipment manufacturers must check the radiation level under their maximum operating conditions.

**HEALTH AND SAFETY HAZARDS**

e2v technologies gas discharge switches 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.



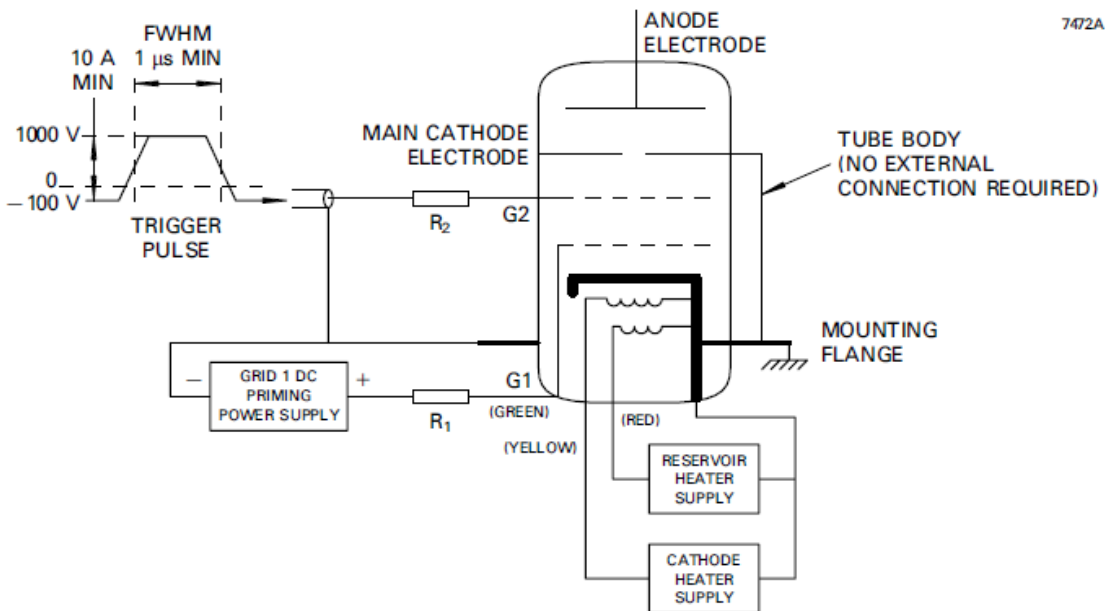
**Fig. 1a. Circuit and Trigger Connections for Pulse Shared between Grid 1 and Grid 2**  
 $R_2$  is selected to provide at least the minimum specified trigger pulse current.  $R_1 = 10R_2$ . Vitreous enamelled wirewound resistors are recommended.



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**Fig. 1b. Circuit and Trigger Connections for Trigger Pulse with Negative Bias Shared between Grid 1 and Grid 2**

$R_2$  is selected to provide at least the minimum specified trigger pulse current.  $R_1 = 10R_2$ . Vitreous enamelled wirewound resistors are recommended.



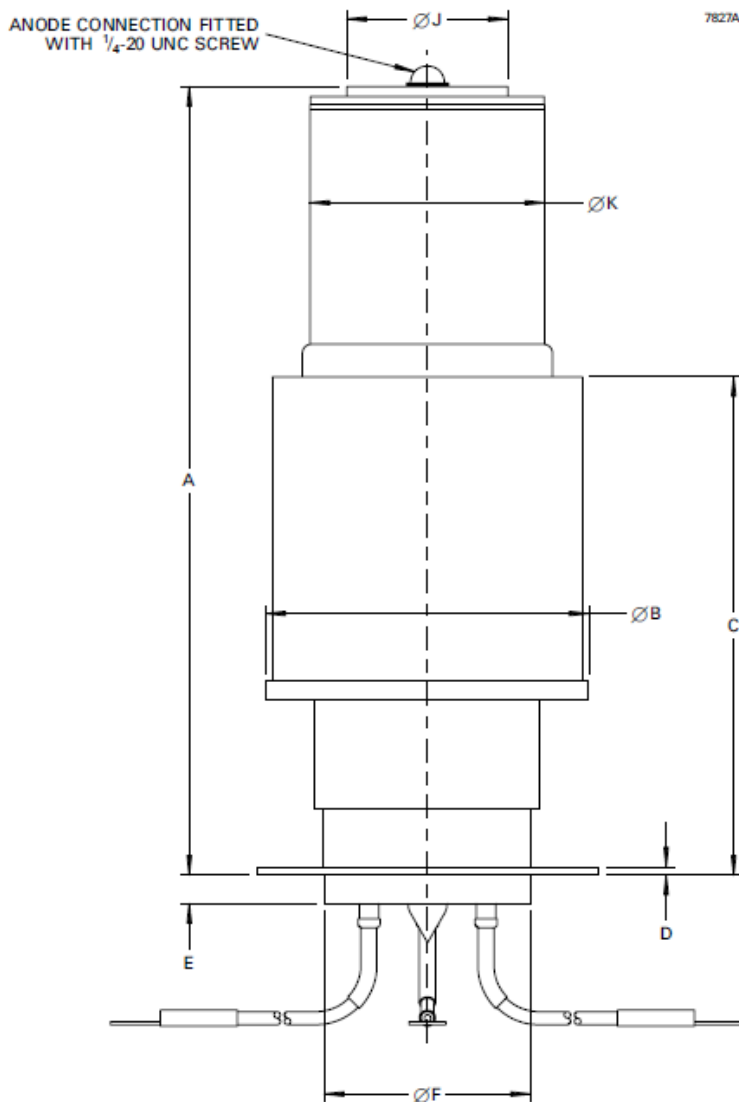
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**Fig. 1c. Circuit and Trigger Connections for DC Priming of Grid 1, with Pulse Applied to Grid 2**

$R_2$  is selected to provide at least the minimum specified trigger pulse current.  $R_1$  is selected to provide a DC priming current within the specified time.  $R_1$  must have a power rating that equals or exceeds the power delivered by the grid DC priming power supply. Vitreous enamelled wirewound resistors are recommended.

# OUTLINE

(All dimensions without limits are nominal)



Ref	Millimetres	Inches
A	260.0 max	10.236 max
B	105.0	4.134
C	164.0 max	6.457 max
D	2.54 ± 0.25	0.100 ± 0.010
E	12.7 max	0.500 max
F	68.25 max	2.687 max
G	254.0 min	10.000 min
H	6.5	0.256
J	52.4	2.063
K	78.0 max	3.071 max
L	111.13	4.375
M	95.25	3.750

Inch dimensions have been derived from millimetres

