# HX3020

## Deuterium-Filled High Energy Switch

## INTRODUCTION

The HX3020 is a high energy switch designed for circuits where there is a large conducted charge per pulse at high peak current. The switch incorporates a thermionic cathode and a titanium-based reservoir/getter system to maintain internal deuterium pressure throughout life. These features provide low anode delay time and jitter combined with ease of triggering and a large dynamic range of anode voltage.
The HX3020 is designed to provide high reliability against pre-fires at the rated anode voltage, has a high tolerance against circuit fault conditions and contains no mercury.


## MAXIMUM RATINGS (see note 1)

The peak current/coulomb rating applied will determine the shot lifetime of the HX3020. The ratings below are based on factory tests where a critically-damped current waveform with a FWHM pulse width of 270 µs was used.

| | | |
|---|---|---|
| Peak forward voltage | - | 30 kV |
| Peak forward current/charge (recommended maximum for normal operation) | - | 125 kA/35 C |
| Expected life at 125 kA/35 C | - | 20,000 shots |
| Peak forward current/charge (recommended maximum fault rating) | - | 250 kA/70 C |
| Expected life at 250 kA/70 C | - | 1500 shots |

## CHARACTERISTICS

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

## GENERAL

### Electrical

| | | |
|---|---|---|
| Cathode heater voltage | - | 6.0 ± 0.2 V |
| Cathode heater current | - | 26 A max |
| Reservoir heater voltage | - | 6.0 ± 0.2 V |
| Reservoir heater current | - | 10 A max |



e2v technologies (uk) limited, Waterhouse Lane, Chelmsford, Essex CM1 2QU United Kingdom  Holding Company: e2v technologies plc
Telephone: +44 (0)1245 493493  Facsimile: +44 (0)1245 492492
Contact e2v by e-mail: enquiries@e2v.com or visit www.e2v.com for global sales and operations centres.



A1A-HX3020 Version 6, April 2016
122571

Template: DF764388A-11

## Mechanical

| | | |
|---|---|---|
| Seated height | - | 470 mm (18.504 inches) max |
| Clearance required below mounting flange | - | None |
| Overall diameter (mounting flange) | - | 230 mm (9.055 inches) nom |
| Net weight | - | 23.6 kg (52 pounds) approx. |
| Mounting position and method | - | See note 6 |
| **Circuit connections** | - | See Fig. 1 |

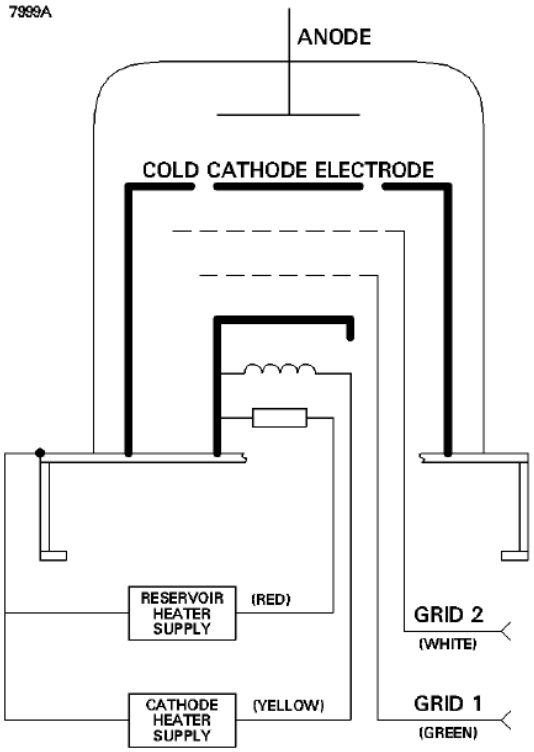



**Fig. 1: HX3020 Schematic**
The return connection for the cathode heater and reservoir supplies is the mounting flange.

## Cooling and Dissipation

The HX3020 is intended for single-shot or low repetition rate applications. Therefore most of the power 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 liquid cooled applications, natural convection currents induced by the dissipated heater power will provide adequate cooling.
The HX3020 has a voltage drop of approximately 100 V at 125 kA and thus the approximate energy dissipated in joules per pulse is 100 x C, where C is the conducted charge in coulombs.

## Environmental

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

# TRIGGERING

The HX3020 incorporates two trigger electrodes and there are two alternative methods recommended for triggering. Fig. 2a shows the simplest method, where the applied pulse is shared between grid 1 and grid 2 with suitable series grid resistors. Fig. 2b shows an alternative method whereby a DC priming current, derived from a simple DC power supply, is applied to grid 1. The trigger pulse is applied to grid 2.

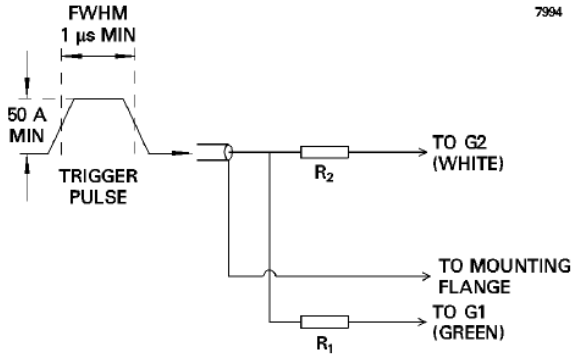



**Fig. 2a: Trigger Connections for Pulse Shared between Grid 1 and Grid 2**
$R_2$ is selected to provide at least the minimum specified trigger pulse current. $R_1 = 10R_2$.
Vitreous enamelled wirewound resistors are recommended.

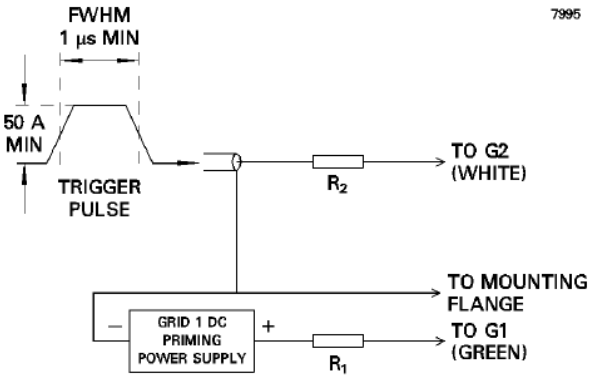



**Fig. 2b: Trigger Connections for DC Priming of Grid 1, with Pulse Applied to Grid 2**
$R_2$ is selected to provide at least the minimum specified trigger pulse current.
$R_1$ is selected to provide a DC priming current within the specified limits. $R_1$ must have a power rating that equals or exceeds the power delivered by the grid 1 DC priming power supply.
Vitreous enamelled wirewound resistors are recommended.

**Minimum Trigger Pulse Requirements (see note 7)**

| | | |
|---|---|---|
| Unloaded pulse voltage | - | 1000 V |
| Loaded pulse current | - | 50 A |
| Pulse duration (FWHM) | - | 1 µs |
| Unloaded rate of rise of voltage (see note 8) | - | 2 kV/µs |

| Grid 1 DC Priming Requirements (see note 9 and Fig. 2b) | Min | | Max | |
|---|---|---|---|---|
| Unloaded voltage | - | 120 | - | V |
| Loaded current | - | 40 | 60 | mA |

## NOTES

1. During conduction, the HX3020 generates an internal magnetic field that prevents plasma constriction at peak currents up to 130 kA; this minimises electrode erosion. At peak currents in excess of 130 kA, electrode erosion progressively increases and thus the attainable shot life at the rated peak fault current of 250 kA is much lower than it is at 125 kA.

2. The HX3020 is intended for use in circuits where the peak current and charge transfer are high and there is a minimum recommended circuit current rating of 5 kA/5 C. Below these levels, smaller switches are recommended (e.g. the HX3002). Provided that the circuit delivers >5 kA/5 C at 2 kV, the HX3020 will trigger reliably down to this voltage.

3. The figures quoted refer to conditions where the HX3020 is triggered with the minimum specified trigger pulse. Lower anode delay times and jitters can be attained with higher grid current.

4. For most applications, the rate of rise of current is determined by the external circuit.

5. After a period of storage/non-operation of greater than one month, an initial warm-up time of 30 minutes is recommended, reverting to 10 minutes thereafter.

6. The HX3020 must be installed by the mounting flange, with the anode uppermost. The tube is shipped with a carriage assembly which can be attached to the tube to make handling easier. This should be attached to the tube as shown in the carriage assembly diagram on page 5. The carriage assembly must be removed before the tube is operated. The tube must not be lifted using the anode connection.

7. The HX3020 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 HX3020. 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 Fig. 2b).

## 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.

### High Voltage

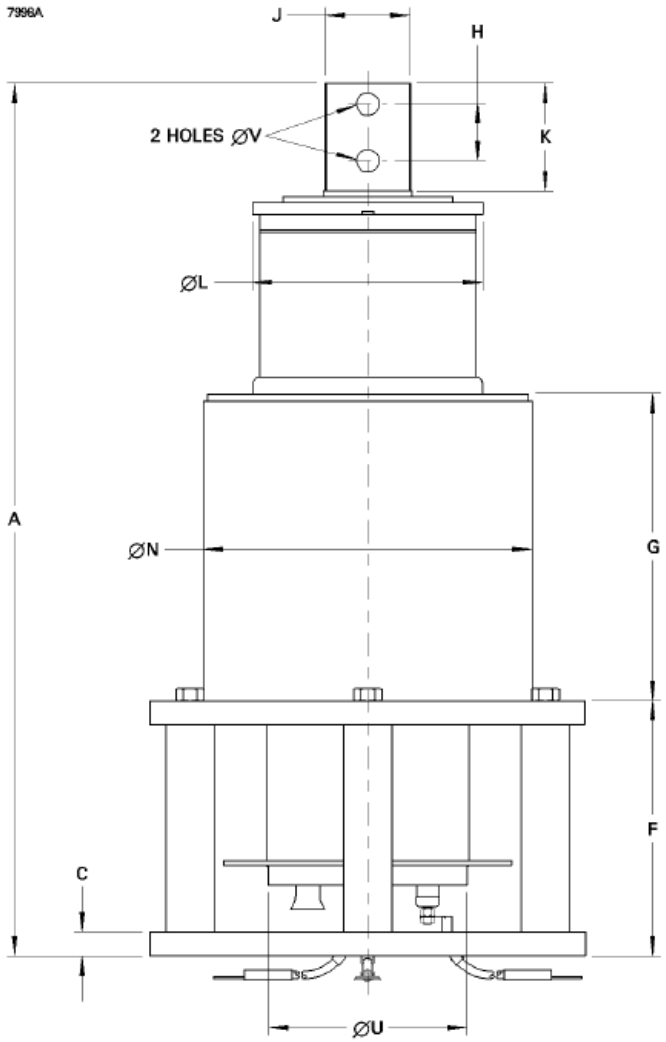
Equipment must be designed so that personnel cannot come into contact with high voltage circuits. All high voltage circuits and terminals must be enclosed and fail-safe interlock switches must be fitted to disconnect the primary power supply and discharge all high voltage capacitors and other stored 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.

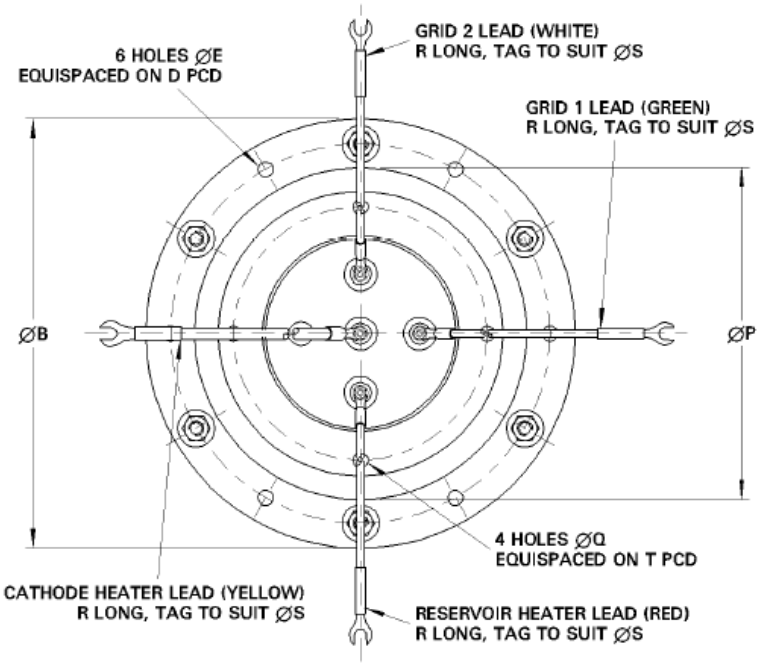
# OUTLINE

## (All dimensions without limits are nominal)




| Ref | Millimetres | Inches |
|---|---|---|
| A | 470.0 max | 18.504 max |
| B | 230.0 | 9.055 |
| C | 12.5 | 0.492 |
| D | 203.2 | 8.000 |
| E | 8.2 | 0.323 |
| F | 136.0 | 5.354 |
| G | 163.0 | 6.417 |
| H | 30.0 | 1.181 |
| J | 44.0 | 1.732 |
| K | 57.0 | 2.244 |
| L | 122.0 | 4.803 |
| N | 174.0 | 6.850 |
| P | 177.8 | 7.000 |
| Q | 6.5 | 0.256 |
| R | 254.0 min | 10.000 min |
| S | 6.35 | 0.250 |
| T | 135.74 ± 0.25 | 5.344 ± 0.10 |
| U | 106.35 max | 4.187 max |
| V | 12.0 | 0.472 |

Inch dimensions have been derived from millimetres



## CARRIAGE ASSEMBLY DIAGRAM