

# HY-11

## Hydrogen Filled Triode Thyatron



### Description

The HY-11 is a hydrogen-filled, triode thyatron. The hydrogen gas fill facilitates reliable operation at a lower to moderate voltage and very high pulse repetition rates when compared to similar deuterium filled thyatrons. High pulse currents are achievable using only free or forced air convection cooling. The tube may be mounted by its mounting flange in any position.

### Specifications

#### Absolute Ratings

(Maximums) (Nonsimultaneous)

|  |                          |
|--|--------------------------|
| ep <sub>y</sub> , Peak Forward Anode Voltage (Notes 1, 2 & 3).....     | 18 kv                    |
| ib, Peak Forward Anode Current (Notes 4, 5 & 6).....                   | 500 A                    |
| ib <sub>x</sub> , Peak Reverse Anode Current (Note 7).....             | .1 ib                    |
| ep <sub>x</sub> , Peak Reverse Anode Voltage (Note 8).....             | 15 kv                    |
| ep <sub>y</sub> Min., Minimum Anode Supply Voltage.....                | 1 kv DC                  |
| t <sub>p</sub> , Anode Current Pulse Duration (Note 5).....            | 10 μsec.                 |
| I <sub>b</sub> , Average Anode Current.....                            | 0.5 A <sub>dc</sub>      |
| I <sub>p</sub> , RMS Average Current (Note 9).....                     | .8 A <sub>ac</sub>       |
| P <sub>b</sub> , Anode Dissipation Factor (V x A x pps) (Note 10)..... | 10x10 <sup>9</sup>       |
| t <sub>r</sub> , Maximum Anode Current Rise Rate.....                  | 1X10 <sup>11</sup> a/sec |

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### A Typical Operating Condition (Note 11)

|  |                          |
|--|--------------------------|
| epy, Peak Forward Anode Voltage .....            | 10 kv                    |
| ib, Peak Forward Anode Current .....             | 100 a                    |
| tp, Anode Current Pulse Duration .....           | 1.1 $\mu$ sec.           |
| Prr, Pulse Repetition Rate .....                 | 4.5 kHz                  |
| Ib, Average Anode Current .....                  | 0.5 Adc                  |
| Ip, RMS Average Current .....                    | 7 Aac                    |
| Pb, Anode Dissipation Factor (V x A x pps) ..... | 4.5x10 <sup>9</sup>      |
| tr, Maximum Anode Current Rise Rate .....        | 1x10 <sup>10</sup> a/sec |

### General Electrical Data

|   |              |
|---|--------------|
| Ef, Cathode Heater Voltage (Vac) .....                      | 6.3 $\pm$ 5% |
| If, Cathode Heater Current                                  |              |
| nom. @ Ef = 6.3Vac, (Aac) .....                             | 6.8          |
| max. @ Ef = 6.3Vac, (Aac) .....                             | 7.5          |
| Er, Reservoir Heater Voltage, Nominal (Vac) (Note 12) ..... | 6.3          |
| Ir, Reservoir Heater Current                                |              |
| nom. @ Er = 6.3Vac, (Aac) .....                             | 2.8          |
| max. @ Er = 6.3Vac, (Aac) .....                             | 4            |
| tk, Tube Warm-Up Time (Minimum Minutes) .....               | 3            |

### Triggering Requirements (Control Grid)

|  | MIN. | TYP. | MAX. |
|--|------|------|------|
| egy, Peak Open Circuit Trigger Voltage (Forward) (V) ..... | 200  | 500  | 50   |
| Zg, Driver Circuit Output Impedance (Ohms) .....           | ---  | 100  | 500  |
| Driver Pulse Rise Time (ns) .....                          | ---  | 100  | 150  |
| Driver Pulse Width ( $\mu$ s) .....                        | 1    | 2    | ---  |
| Peak Reverse Grid Voltage (V) .....                        | ---  | ---  | 200  |
| Bias Voltage (Negative) (V) .....                          | ---  | ---  | 200  |

### Triggering Characteristics

|   | MIN. | TYP. | MAX. |
|---|------|------|------|
| Anode Delay Time (nS) (Notes 13 & 14) ..... | ---  | ---  | 500  |
| Anode Delay Time Drift (nS) (Note 14) ..... | ---  | ---  | 100  |
| Time Jitter (nS) (Note 14) .....            | ---  | ---  | 5    |

### Notes

1. The dwell time at the peak anode voltage should be minimized in order to minimize pre-firing. For operation at the rated epy, the dwell time must not exceed 1 millisecond.
2. After thyatron anode current stops flowing and before voltage is reapplied to the anode, the anode voltage must stay between 0 and -500 volts for at least 20  $\mu$ s to allow the gas to deionize.
3. This tube may be operated in air at up to 20 kv. Some of the more important derating factors that determine the safe operating voltage in air are the cleanliness of the tube's ceramic insulators, the rate of rise of anode voltage, the dwell time at the operating peak anode voltage, the pulse repetition rate, and ambient pressure, temperature, humidity and contaminant level. This tube may also be operated while immersed in an insulating gas or liquid.
4. The peak current capability of 1600 a applies to, short pulse (tp<0.3  $\mu$ s) duration applications.

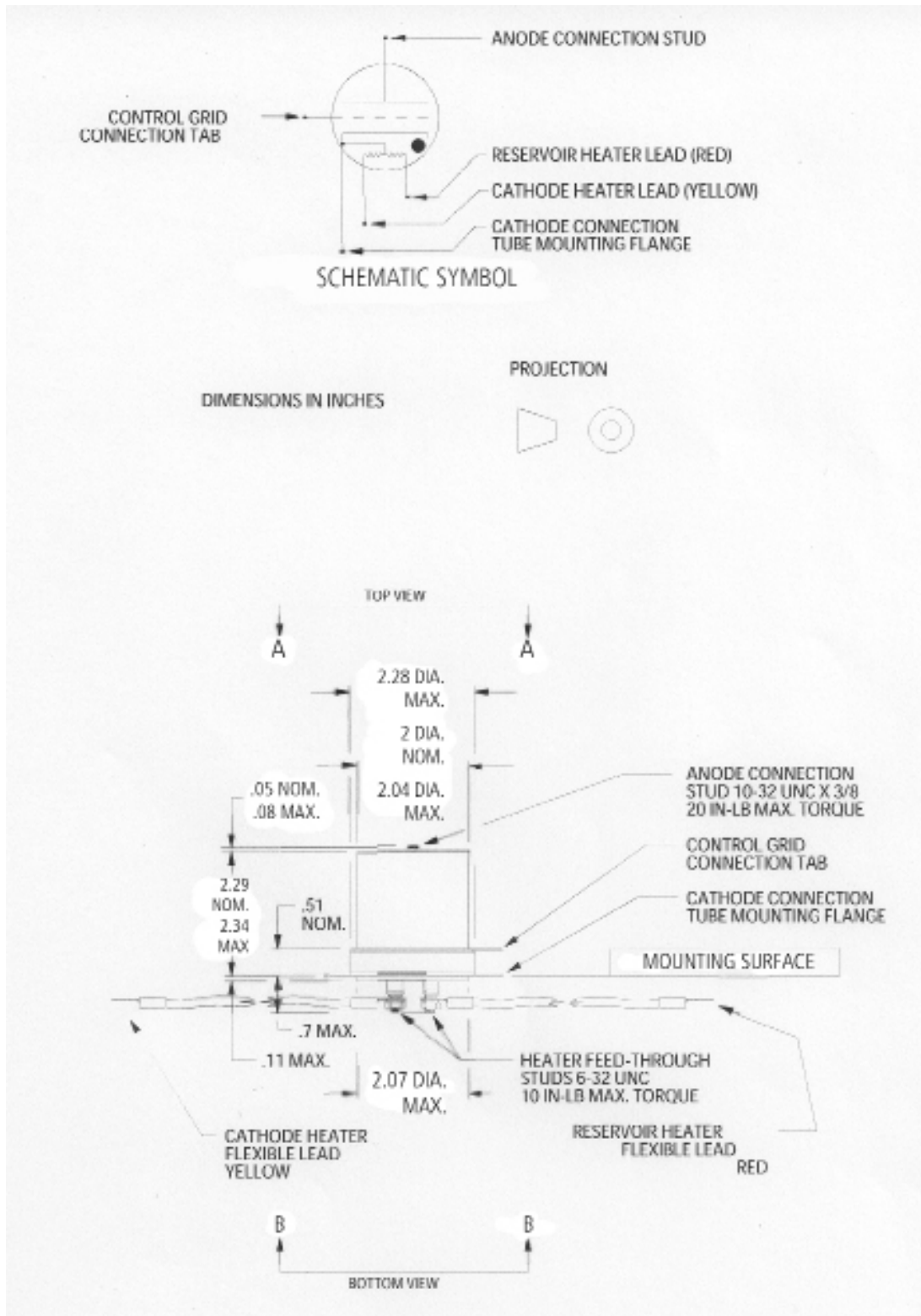
**Notes (cont.)**

5. The pulse width is measured on the discharge current waveform at the half peak current level.
6. For anode current pulse widths greater than 0.3 microseconds but less than 10 microseconds, a useful formula for estimating the allowable peak current is  $i_b = i_{b0} (3/t_p)^{1/2}$  amps, where  $t_p$  is the pulse width in microseconds, and  $i_{b0}$ , the peak current rating at  $t_p = 3$  microseconds, is 500 amps for this tube.
7. This tube is not designed to conduct current in the reverse direction. The tube will have a tendency to cut-off conduction in the reverse direction but may not be able to stop reverse conduction if the reverse voltage across the thyatron is high enough. In the case where there is conduction in the reverse direction, the absolute value of the reverse peak current must be limited to no more than 10% of the peak value of the previous positive half cycle of the thyatron current waveform.
8. The reverse anode voltage shown applies for a previously non-conducting tube. Exclusive only of a spike not longer than 25 nanoseconds, the peak reverse anode voltage must not exceed 500 v during the first 50 microseconds after conduction.
9.  $I_p$  is the true root mean square (RMS) current. For relatively rectangular shaped current pulses without a reverse current, the RMS anode current may be approximated as the square root of the product of the peak current and the average current.
10. Forced air or liquid immersion cooling should always be used in any situation where cooling by natural convection is insufficient to keep the temperature of the tube's envelope below 200°C. Typically, a room temperature air flow of 50 to 150 cfm directed into the anode cup will be sufficient. When the tube is cooled by immersion in a force-circulated liquid coolant, the anode dissipation factor may be tripled provided that the envelope temperature does not exceed 200°C.
11. Typical, simultaneous operating conditions other than the example shown in this data sheet might also be acceptable. The conditions shown herein produce a discharge current waveform of the peak forward anode current shown and no current reversal. The pulse width is measured at the half peak current level. The RMS current is approximated using the relationship shown in note 9. The average current is the product of the stored charge (in the pfn being switched by the thyatron) and the pulse repetition rate.
12. The optimum reservoir heater voltage is that which provides the best overall compromise among anode heating, anode voltage holdoff and holdoff recovery, anode current rise rate, and the tube's overall triggering characteristics. For most applications, the optimum reservoir heater voltage lies between 90% and 110% of the nominal value. Operation at voltages below 90% of nominal can result in permanent damage from anode overheating; operation at high reservoir heater voltages degrades anode holdoff and holdoff recovery, and can permanently damage the reservoir itself.
13. The anode delay time is measured from the 25% point on the rise of the unloaded grid voltage pulse to the 10% point on the rise of the anode current pulse.
14. Delay time, delay time drift and time jitter may be simultaneously minimized by applying the maximum grid drive voltage ( $e_{gy}$ ) at a high rate of rise of voltage from a source of low impedance ( $Z_g$ ).
15. All data and specifications are subject to change without notice.
16. Data sheet origination date is shown on the last page. This data sheet becomes obsolete when more recent revisions are published.

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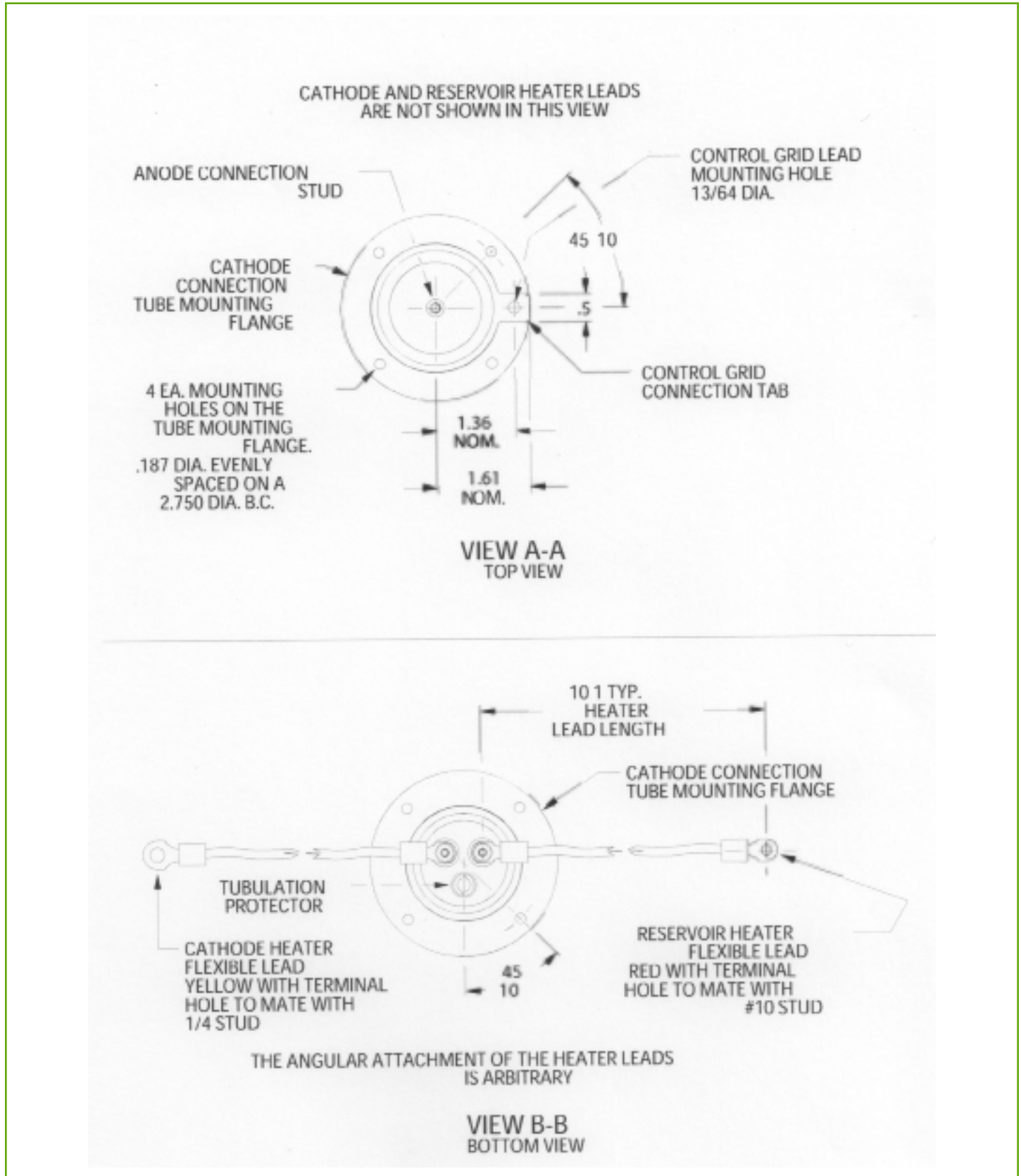
# Hydrogen Filled Triode Thyatron

FIGURE 1 Schematic



# Hydrogen Filled Triode Thyatron

FIGURE 2 Bottom-View Schematic



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