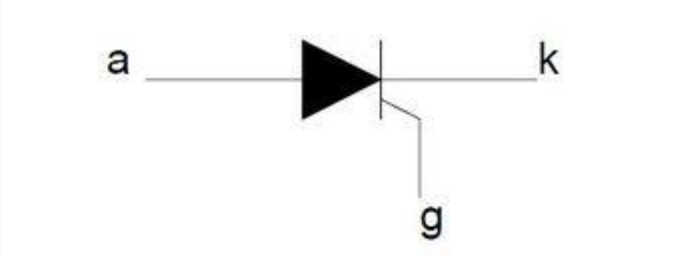
Thyristor - Basic Concepts

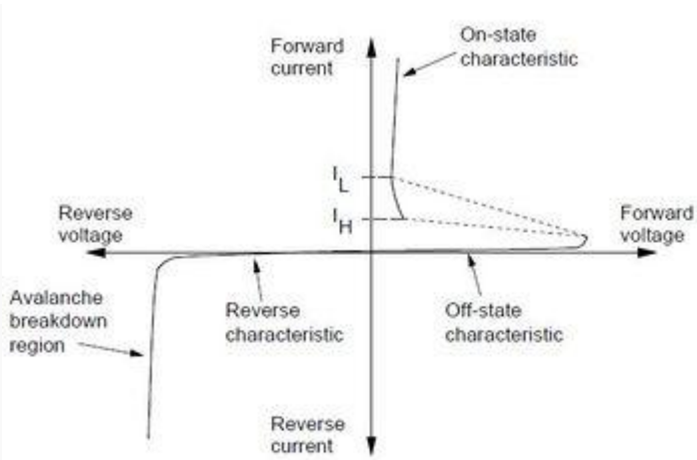
Introduction



Thyristor

A thyristor is a controlled rectifier where the unidirectional current flow from anode (a) to cathode (k) is initiated by a small signal current from gate (g) to cathode.

Turn-On



Thyristor U-I characteristic

A thyristor is turned on by making its gate positive with respect to its cathode, thereby causing current flow into the gate. When the gate voltage reaches the threshold voltage V_{GT} and the resulting current reaches the threshold current I_{GT}, within a very short time known as the gate-controlled turn-on time, t_{gt}, the load current can flow from 'a' to 'k'. If the gate current consists of a very narrow pulse, say less than 1μs, its peak level will have to increase for progressively narrower pulse widths to guarantee triggering. When the load current reaches the thyristor's latching current I_L, load current flow will be maintained even after removal of the gate current. As long as adequate load current continues to flow, the thyristor will continue to conduct without the gate current. It is said to be latched ON. Note that the V_{GT}, I_{GT} and I_L specifications given in data are at 25 °C. These parameters will increase at lower temperatures, so the drive circuit must provide adequate voltage and current amplitude and duration for the lowest expected operating temperature.

Rule 1. To turn a thyristor (or triac) ON, a gate current ≥ I_{GT} must be applied until the load current is ≥ I_L. This condition must be met at the lowest expected operating temperature

Sensitive gate thyristors such as the BT150 can be prone to turn-on by anode to cathode leakage current at high temperatures. If the junction temperature Tj is increased above Tj max, a point will be reached where the leakage current will be high enough to trigger the thyristor's sensitive gate. It will then have lost its ability to remain in the blocking state and conduction will commence without the application of an external gate current. This method of spurious turn-on can beavoided by using one or more of the following solutions:

- 1. Ensure that the temperature does not exceed Tj max.
- 2. Use a thyristor with a less sensitive gate such as the BT151, or reduce the existing thyristor's sensitivity by including a gate-to-cathode resistor of 1kΩ or less.
- 3. If it is not possible to use a less sensitive thyristor due to circuit requirements, apply a small degree of reverse biasing to the gate during the 'off' periods. This has the effect of increasing I_L. During negative gate current flow, particular attention should be paid to minimising the gate power dissipation.

Turn-off (commutation)

SCR Thyristor 6500V/1500A

Phase control thyristors

In order to turn the thyristor off, the load current must be reduced below its holding current I_H for sufficient time to allow all the mobile charge carriers to vacate the junction. This is achieved by "forced commutation" in DC circuits or at the end of the conducting half cycle in AC circuits. (Forced commutation is when the load circuit causes the load current to reduce to zero to allow the thyristor to turn off.) At this point, the thyristor will have returned to its fully blocking state. If the load current is not maintained below IH for long enough, the thyristor will not have returned to the fully blocking state by the time the anode-to-cathode voltage rises again. It might then return to the conducting state without an externally-applied gate current. Note that I_H is also specified at room temperature and,like I_L, it reduces at higher temperatures.The circuit must therefore allow sufficient time for the load current to fall below I_H at the maximum expected operating temperature for successful commutation.

Rule 2. To turn off (commutate) a thyristor (or triac), the load current must be $< I_H$ for sufficient time to allow a return to the blocking state. This condition must be met at the highest expected operating temperature.

Source:

http://www.openelectrical.org/wiki/index.php?title=Thyristor