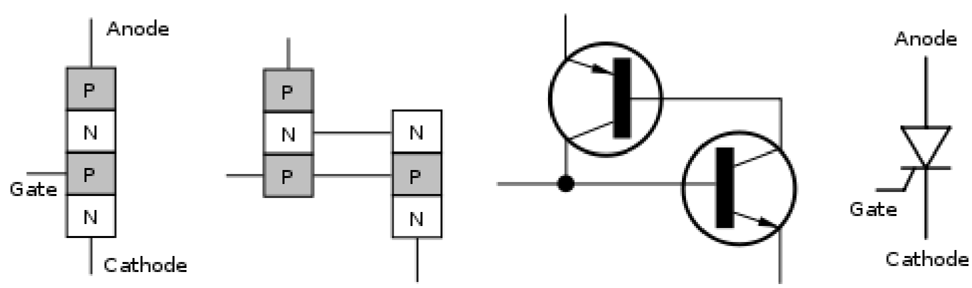
SCR

A silicon-controlled rectifier (or semiconductor-controlled rectifier) is a four-layer solid state device that controls current. The name "silicon controlled rectifier" or SCR is General Electric's trade name for a type of thyristor.

Construction of SCR

An SCR consists of four layers of alternating P and N type semiconductor materials. Silicon is used as the intrinsic semiconductor, to which the proper dopants are added. The junctions are either diffused or alloyed. The planar construction is used for low power SCRs (and all the junctions are diffused). The mesa type construction is used for high power SCRs. In this case, junction J2 is obtained by the diffusion method and then the outer two layers are alloyed to it, since the PNPN pellet is required to handle large currents. It is properly braced with tungsten or molybdenum plates to provide greater mechanical strength. One of these plates is hard soldered to a copper stud, which is threaded for attachment of heat sink. The doping of PNPN will depend on the application of SCR, since its characteristics are similar to those of the thyratron. Today, the term thyristor applies to the larger family of multilayer devices that exhibit bistable state-change behaviour, that is, switching either ON or OFF.

The operation of a SCR and other thyristors can be understood in terms of a pair of tightly coupled bipolar junction transistors, arranged to cause the self-latching action:



Modes of operation

In the normal "off" state, the device restricts current to the leakage current. When the gate-to-cathode voltage exceeds a certain threshold, the device turns "on" and conducts current.

The device will remain in the "on" state even after gate current is removed so long as current through the device remains above the holding current. Once current falls below the holding current for an appropriate period of time, the device will switch "off". If the gate is pulsed and the current through the device is below the holding current, the device will remain in the "off" state.

If the applied voltage increases rapidly enough, capacitive coupling may induce enough charge into the gate to trigger the device into the "on" state; this is referred to as "dv/dt triggering." This is usually prevented by limiting the rate of voltage rise across the device, perhaps by using a snubber. "dv/dt triggering" may not switch the SCR into full conduction rapidly and the partially-triggered SCR may dissipate more power than is usual, possibly harming the device.

SCRs can also be triggered by increasing the forward voltage beyond their rated breakdown voltage (also called as break over voltage), but again, this does not rapidly switch the entire device into conduction and so may be harmful so this mode of operation is also usually avoided. Also, the actual breakdown voltage may be substantially higher than the rated breakdown voltage, so the exact trigger point will vary from device to device. This device is generally used in switching applications.

Reverse Bias

SCR are available with or without reverse blocking capability. Reverse blocking capability adds to the forward voltage drop because of the need to have a long, low doped P1 region. Usually, the reverse blocking voltage rating and forward blocking voltage rating are the same. The typical application for reverse blocking SCR is in current source inverters.

SCR incapable of blocking reverse voltage are known as asymmetrical SCR, abbreviated ASCR. They typically have a reverse breakdown rating in the 10's of volts. ASCR are used where either a reverse conducting diode is applied in parallel (for example, in voltage source inverters) or where reverse voltage would never occur (for example, in switching power supplies or DC traction choppers)