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Thyristor and their applications

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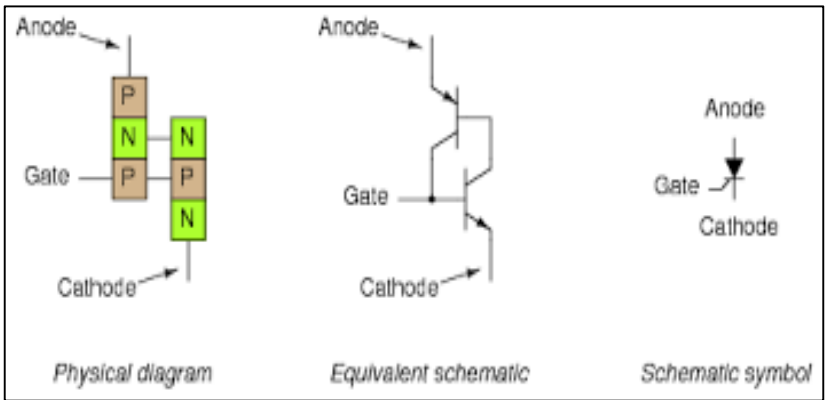
Abstract
This chapter is basically depend on basic information about SCR (Silicon Controlled Rectifier) it's characteristics. How SCR is different from diode and methods of turn on of scr. Its application in converter, inverter and chopper circuit.

Keywords: SCR, GTO, RCT, Triggering, Circuit fusing rating

Introduction
Bell Laboratories were the first to fabricate a silicon-based semiconductor device called thyristor. Its first prototype was introduced by GEe (USA) in 1957. This company did a great deal of pioneering work about the utility of thyristors in industrial applications. Semiconductor devices, with their characteristics identical with there characteristics identical with that of thyristor, are triac, diac, silicon-controlled switch, programmable unijunction transistor (PUT), GTO, RCT etc. This whole family of semiconductor devices is given the name thyristor can be stated as

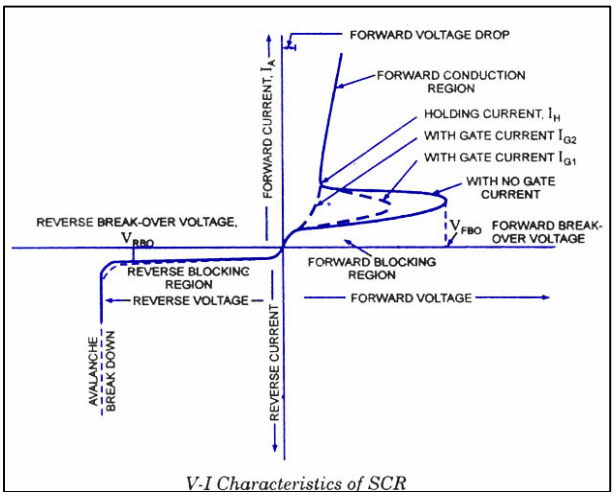
(1) It constitutes three or more *p-n* junctions.
(2) It has two stable states. An ON-state and an OFF-state and can change its state from one to another.

Silicon controlled rectifier
A silicon controlled rectifier is a semiconductor device that acts as a true electronic switch. It can change alternating current into direct current and at the same time can control the amount of power fed to the load. Thus *SCR* combines the features of a rectifier and a transistor.



Constructional details: When a *pn* junction is added to a junction transistor, the resulting three *pn* junction device is called a silicon controlled rectifier. Fig. shows its construction. It is clear that it is essentially an ordinary rectifier (*pn*) and a junction transistor (*npn*) combined in one unit to form *pnpn device*. Three terminals are taken; one from the outer *p-type* material called *anode A*, second from the outer *n*-type material called *cathode K* and the third from the base of transistor section and is called *gate G*. In the normal operating conditions of *SCR*, anode is held at high positive potential *w.r.t.* cathode and gate at small positive potential *w.r.t.* cathode. Fig also shows the symbol of *SCR*.

VI characteristics of SCR



V-I Characteristics of SCR

Important Terms

The following terms are much used in the study of *SCR*:
(i) Breakover voltage **(ii)** Peak reverse voltage
(iii) Holding current **(iv)** Forward current rating
(v) Circuit fusing rating

(i) Breakover voltage: *It is the minimum forward voltage, gate being open, at which SCR starts conducting heavily i.e. turned on.* Thus, if the breakover voltage of an *SCR* is 200 V, it means that it can block a forward voltage (*i.e. SCR* remains open) as long as the supply voltage is less than 200 V. If the supply voltage is more than this value, then *SCR* will be turned on. In practice, the *SCR* is operated with supply voltage less than breakover voltage and it is then turned on by means of a small voltage applied to the gate.Commercially available *SCRs* have breakover voltages from about 50 V to 500 V.

(ii) Peak reverse voltage (*PRV*): *It is the maximum reverse voltage* (*cathode positive w.r.t. anode*) *that can be applied to an SCR without conducting in the reverse direction*. Peak reverse voltage (*PRV*) is an important consideration while connecting an *SCR* in an a.c. circuit. During the negative half of a.c. supply, reverse voltage is applied across *SCR*. If *PRV* is exceeded, there may be avalanche breakdown and the *SCR* will be damaged if the external circuit does not limit the current. Commercially available *SCRs* have *PRV* ratings upto 2.5 kV.

(iii) Holding current: *It is the maximum anode current, gate being open, at which SCR is turned off from ON conditions*.
As discussed earlier, when *SCR* is in the conducting state, it cannot be turned *OFF* even if gate voltage is removed. The only way to turn off or open the *SCR* is to reduce the supply voltage to almost zero at which point the internal transistor comes out of saturation and opens the *SCR*. The anode current under this condition is very small (a few mA) and is called *holding current*. Thus, if an *SCR* has a holding current of 5mA, it means that if anode current is made less than 5mA, then *SCR* will be turned off.

(iv) Forward current rating: *It is the maximum anode current that an SCR is capable of passing without destruction*.

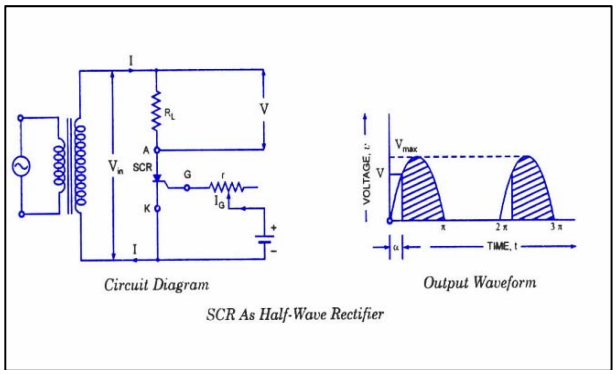
Every *SCR* has a safe value of forward current which it can conduct. If the value of current exceeds this value, the *SCR* may be destroyed due to intensive heating at the junctions. For example, if an *SCR* has a forward current rating of 40A, it means that the *SCR* can safely carry only 40 A. Any attempt to exceed this value will result in the destruction of the *SCR*. Commercially available *SCRs* have forward current ratings from about 30A to 100A.

(v) Circuit fusing (I2t) rating: *It is the product of square of forward surge current and the time of duration of the surge i.e.*, Circuit fusing rating = *I2t*
The circuit fusing rating indicates the maximum forward surge current capability of *SCR*. For example, consider an *SCR* having circuit fusing rating of 90 *A2s*. If this rating is exceeded in the *SCR* circuit, the device will be destroyed by excessive power dissipation.
Thyristor turn-on methods
1. forward-voltage triggering
2. gate triggering
3. *dv*/*dt* triggering
4. temperature triggering
5. light triggering

Application of thyristor

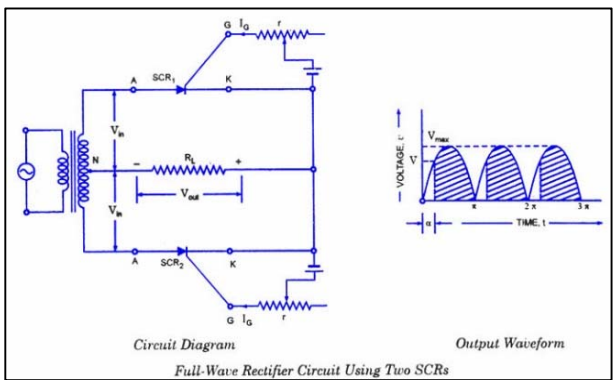
SCRs are mainly used in devices where the control of high power, possibly coupled with high voltage, is demanded. Their operation makes them suitable for use in medium- to high-voltage AC power control applications, such as lamp dimming, power regulators and motor control.
SCRs and similar devices are used for rectification of high-power AC in high-voltage direct-current power transmission. They are also used in the control of welding machines, mainly MTAW (metal tungsten arc welding) and GTAW (gas tungsten arc welding) processes similar.

(1) SCR single phase rectifire circuit



Circuit Diagram *Output Waveform*

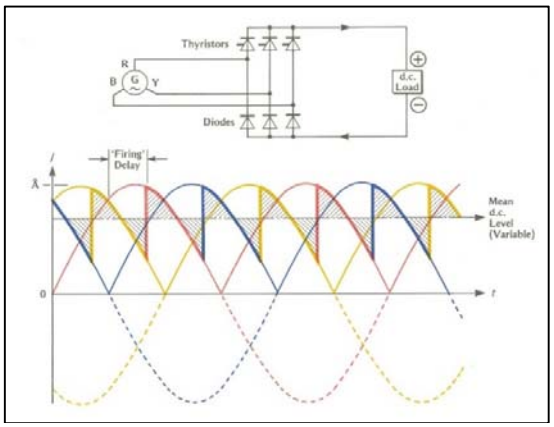
SCR As Half-Wave Rectifier



Circuit Diagram *Output Waveform*

Full-Wave Rectifier Circuit Using Two SCRs

(2) SCR 3 phase rectifier circuit



(3) SCR also used in inverter circuit to convert dc current into ac current

There are many method to convert dc current to ac current But those require more power sources and transformers so they are more bulky and require more cost so scr are very use full in conversion dc to ac current

(4) SCR also use in chopper circuit to convert dc current to dc current

So by using scr we can convert ac current to dc current or vice versa and we can also control output power using triggering angle so also use full in providing veriable voltage to armature of motor to control speed of motor

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