A silicon-controlled rectifier (or semiconductor-controlled rectifier) is a four-layer solid state device that controls current.

**Figure 13.1:** SCR Construction and schematic symbol.

**SCR Triggering**
When \( I_G = 0 \) the device is in the off state.

When a positive pulse is applied to the gate both transistors turn on. The anode must be more positive than the cathode.

\( I_{B2} \) turns on \( Q_2 \) providing a path for \( I_{B1} \) into the \( Q_2 \) collector.

The collector current of \( Q_1 \) provides additional base current for \( Q_2 \). \( Q_2 \) stays in conduction after the trigger pulse is removed, and sustains the saturation conduction of \( Q_1 \) by providing a path for \( I_{B1} \); in turn \( Q_1 \) sustains the saturated conduction of \( Q_2 \) by providing \( I_{B2} \).

The devices latches once it is triggered on. In this condition the very low resistance between the anode and the cathode can be approximated by a closed switch.

To turn off the SCR the anode current must drop below the value of the holding current.
SCR Characteristics

- $V_{BR(F)}$ Forward Breakover Voltage
- $I_H$ Holding Current
- $I_{GT}$ Gate Trigger Current
- $I_{F(avg)}$ Average Forward Current
- Forward Conduction Region
- Forward Blocking Region
- Reverse Breakdown Voltage
- Circuit Fusing
\[ I_{\text{max}} = \frac{I^2 t (\text{rated})}{I_s^2} \]  

(13.1)

Where

\[ I_{\text{max}} = \]

\[ I^2 t = \]

\[ I_s^2 = \]

- Critical Rise

\[ \Delta V = \frac{dv}{dt} \Delta t \]  

(13.2)

Where

\[ \Delta V = \]

\[ \frac{dv}{dt} = \]

\[ \Delta t = \]

**Preventing False Triggering**

- Usually caused by one of two conditions
  
  - 
  
  -
Noise at the gate signal

- Two methods to reduce
  - 
  -

Noise in $V_{AK}$

- 

SCR Application

- The SCR Crowbar see page 845
- The SCR phase shifter see page 845

Failure modes

- As well as the usual failure modes due to exceeding voltage, current or power ratings, thyristors have their own particular modes of failure, including:
  
  - **Turn on $di/dt$** — in which the rate of rise of on-state current after triggering is higher than can be supported by the spreading speed of the active conduction area (SCRs & triacs).

  - **Forced commutation** — in which the transient peak reverse recovery current causes such a high voltage drop in the sub-cathode region that it exceeds the reverse breakdown voltage of the gate cathode diode junction (SCRs only).

Discrete Photodetectors

Light Emitters

Light Detectors
Two characteristics are used to describe light.

Wavelength

Light Intensity

The photodiode is a diode whose ___________________ conduction is _________________________.

Define opaque

What is light current?
What is dark current?

What is wavelength of peak spectral response?

What is sensitivity?

What is spectral response?

The phototransistor is ______________________________________________________________
What is optocoupling?

The Photo-Darlington is ________________________________

What is an optoisolator?

What is an optointerrupter?