# Silicon Controlled Rectifier

**Electronic Devices Lab : Experiment 10**

Department of Electrical Engineering
Indian Institute of Technology, Bombay
October 4, 2022.

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# Background Information

- Thyristors (sometimes termed SCRs, meaning silicon-controlled rectifiers) are one of the oldest types of solid-state power devices.
- They have very high power-handling capability.
- They have a unique four-layer construction and are latching switches that can be turned on by the control terminal (gate) but cannot be turned off by the gate.
- SCRs are employed in DC transmission line applications, Inverters, Rectifiers, etc.

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# Background Information (continued)

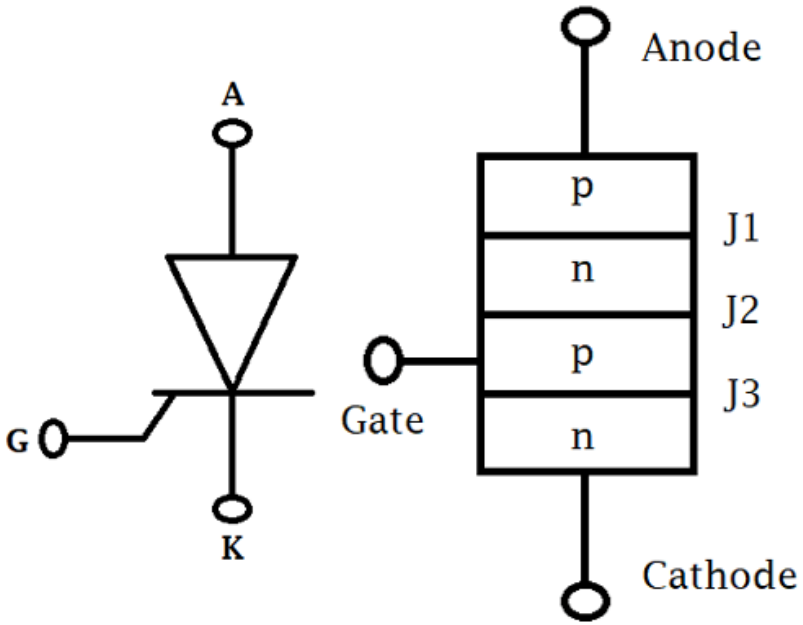


Figure: scr schematic

# Blocking State of SCR

- In the reverse-blocking state, the anode is biased negative with respect to the cathode. Junctions j1 and j3 indicated in Fig. are reverse biased and j2 is forward biased. Junction j1 must support the reverse voltage because j3 has a low breakdown voltage as a consequence of the heavy doping on both sides of the junction.
- In the forward-blocking state, the junctions j1 and j3 are forward biased and j2 is reverse biased. The doping densities in each of the layers are such that the n1 layer(between j1 and j2) is where the depletion region of the reverse-biased j2 junction appears, and thus this region again determines the blocking voltage capability, this time for the forward blocking state.

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# Two-transistor Analogy of SCR

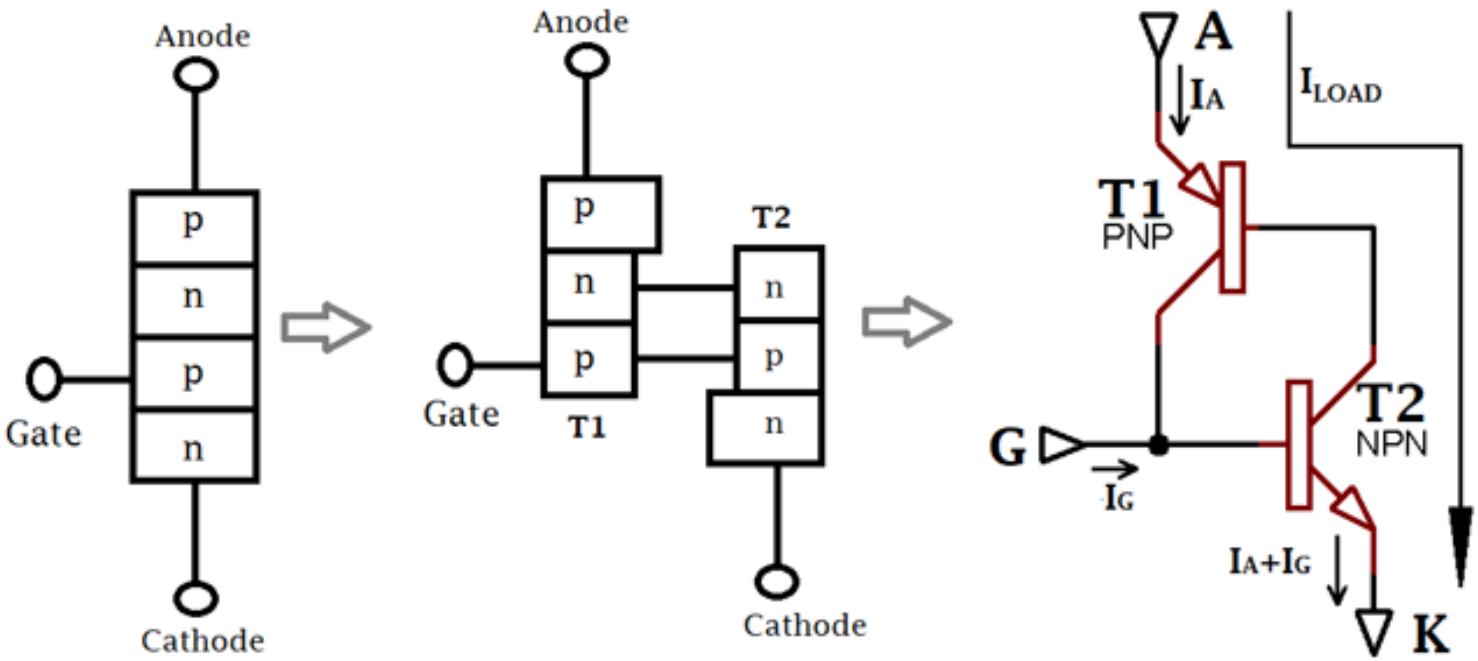


Figure: two-transistor equivalent circuit of a thyristor

# Forward Conducting State

- Here, the equivalent circuit of two transistor shows that the base of PNP transistor T1 is fed by collector current of NPN transistor T2 and collector current of transistor T1 feeds base of transistor T2.
- Hence, conduction of both the transistor depends on each other. So, until one of the base of any transistor get base current it will not conduct even if the voltage is present at anode and cathode.
- This regenerative action carries the thyristor into the on state. The large current flow between the anode and cathode.

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# Latching and Holding current

- **Latching current** The minimum anode current required to maintain the ON condition even after removal of the gate current is the latching current.
- **Holding current** The minimum anode current below which the SCR will go to forward blocking state is the holding current.

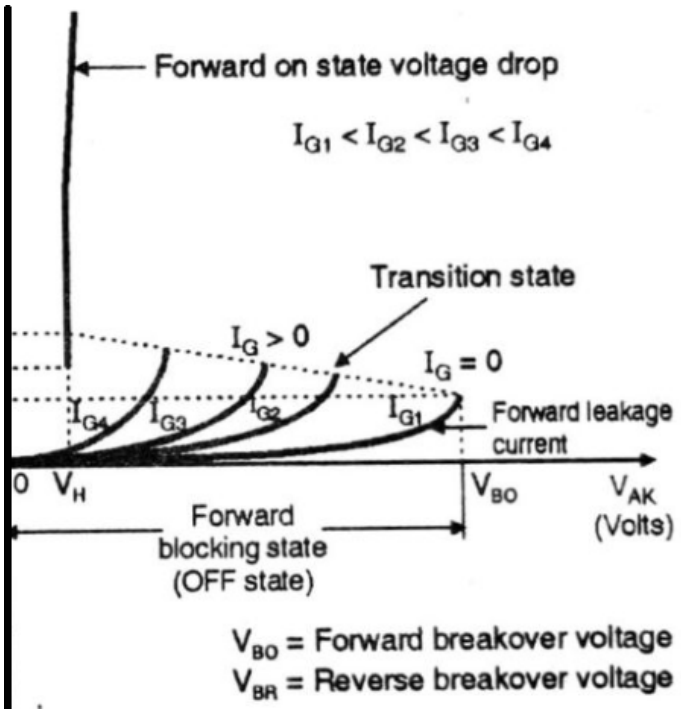


Figure: SCR I-V Characteristics

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# Aim of the experiment

In this experiment, the following tasks are to be done:

1. To obtain the I-V characteristics of SCR.
2. To vary the gate currents and plot the I-V characteristics for different gate currents.
3. To control the phase angle of a sinusoidal signal using SCR

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# Components Necessary

The following components are needed in order to perform the experiment.

- 1 SCR
- Resistors : $1k\Omega$, $10k\Omega$
- Potentiometer : $1k\Omega$
- fixed power supplies, multi-meters
- Breadboard and connecting wires
- capacitor : $1\mu F$
- 1 diode : 1N914

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# Package Dimensions

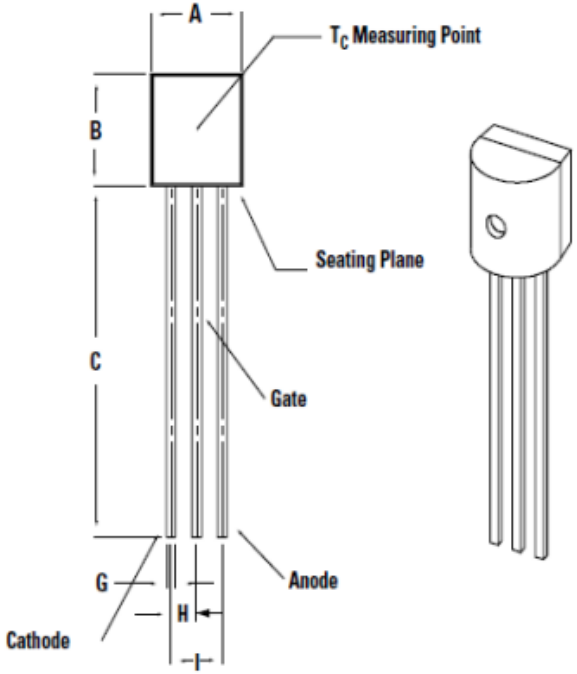


Figure: SCR Pins

# Circuit for measuring I-V characteristics

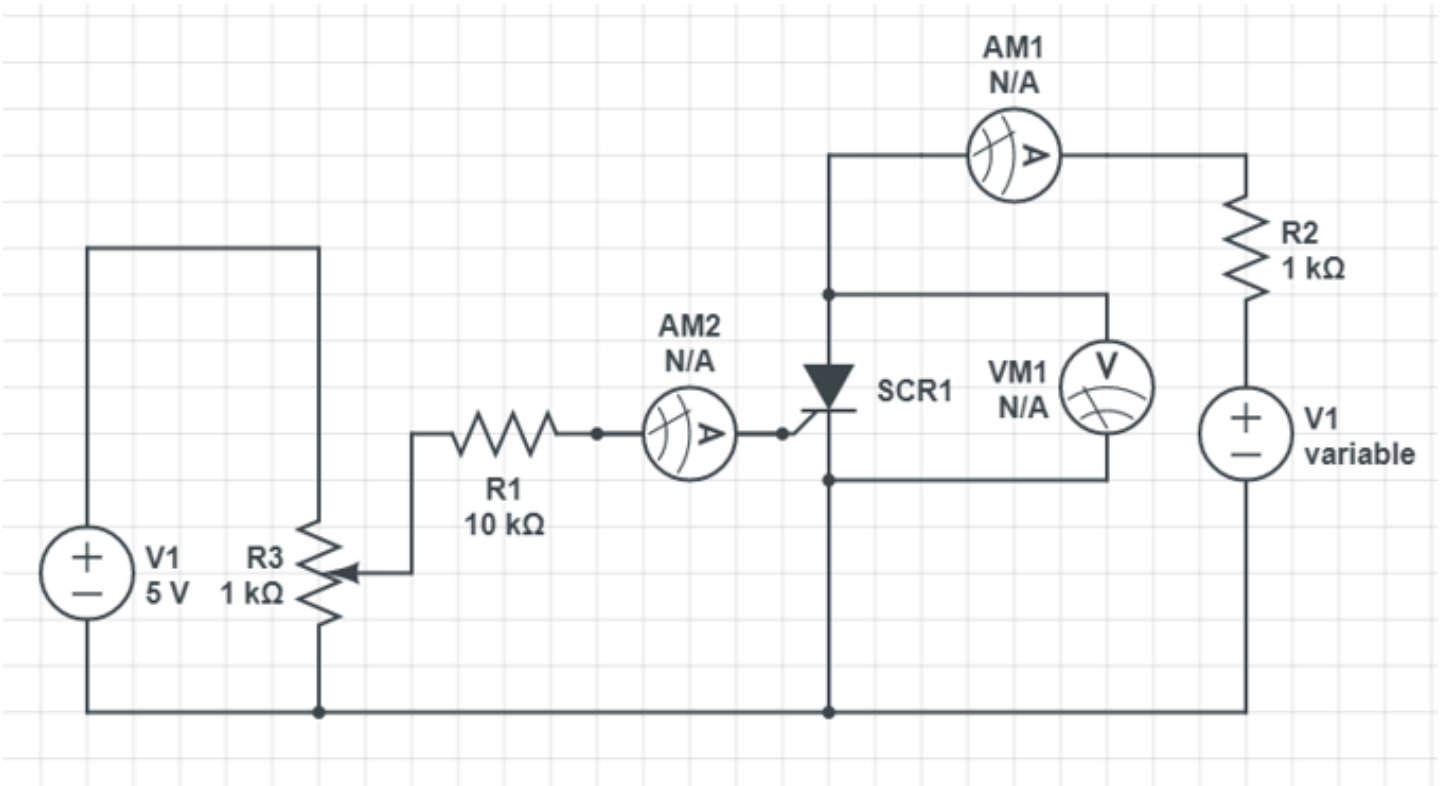


Figure: circuit for SCR I-V characteristics

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# Plotting the IV characteristics

- Connect the circuit shown in the above figure.
- With the gate current equal to zero, increase the anode voltage to the maximum value. Observe that the SCR would not turn on. This state of the SCR is called the forward blocking mode(explained above).
- Now fix the anode to cathode voltage to $10V$ and increase the gate current to $1\mu A$.
- After making the gate current constant at $1\mu A$, observe the sudden drop in the voltage across the SCR. This would imply that the SCR has come into the forward conduction mode (meaning close switch, with some turn on voltage drop)
- Now increase the anode-cathode voltage from $10V$ up to $20V$ (in steps of $0.5V$) and note down the current readings.
- repeat the same procedure for different values of gate current (say $4\mu A$,$7\mu A$ and $10\mu A$)

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# Plotting the IV characteristics

| $V_{supply}$ | $V_{ak}$ | $I_{ak}$ |
|---|---|---|
| 1 | | |
| 2 | | |
| | | |
| 10 | | |
| 10.5 | | |
| 11 | | |
| | | |

- The gate current should be given only after making the supply $10V$.
- Till $V_{supply} = 10V$, the current in the circuit (anode-cathode current) would be very less.
- When $V_{supply}$ exceeds $10V$, once the gate current is given, the SCR will turn on.
- Repeat the same procedure for different gate currents ($4\mu A$,$7\mu A$ and $10\mu A$)

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# SCR Application : Phase Control

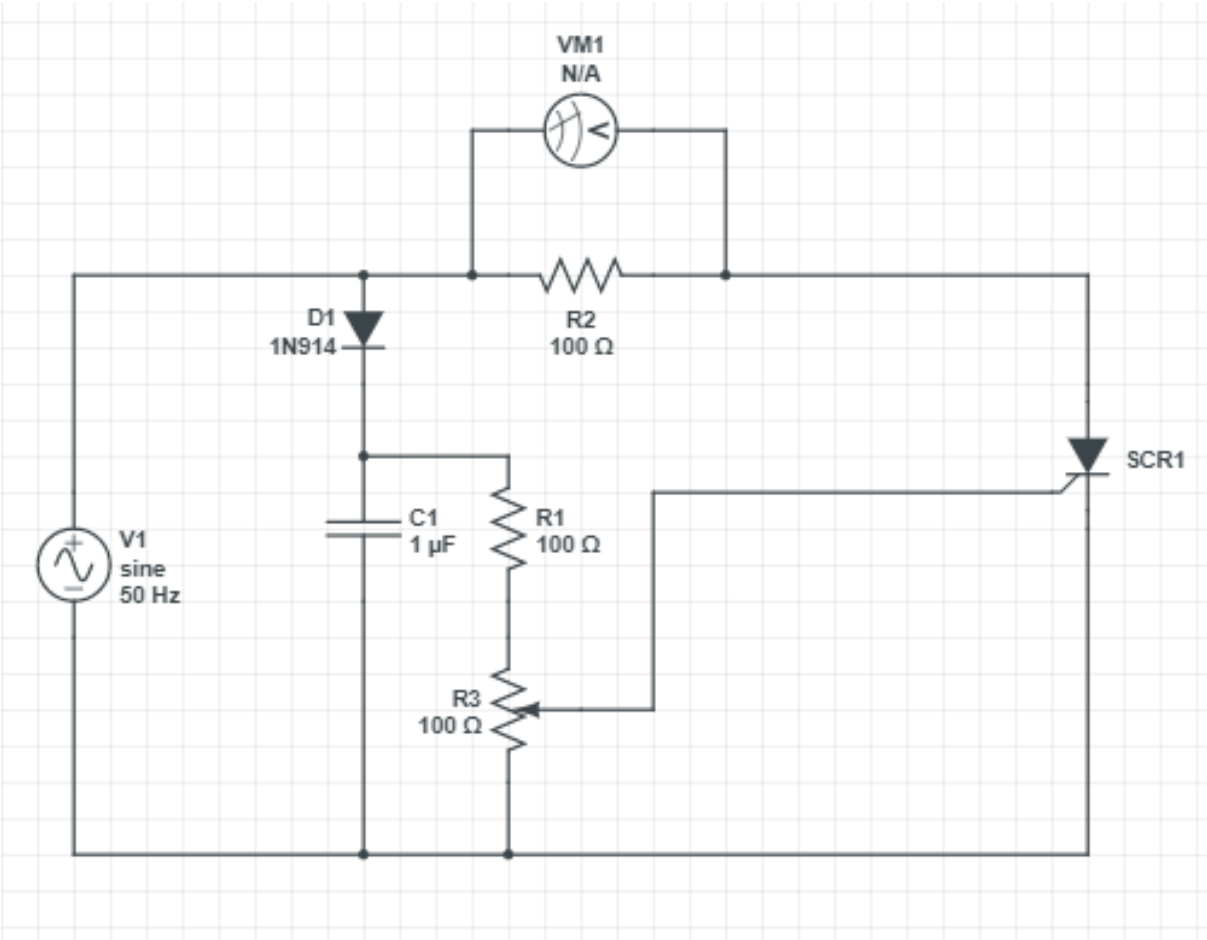


Figure: Phase control using SCR

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# Application continued

- Connect the circuit shown above.
- The circuit above shows the resistance triggering of SCR, where it is employed to drive the load from the input AC supply. Resistance and diode combination circuit acts as gate control circuitry to switch the SCR in the desired condition.
- Since the applied voltage is positive, the SCR is forward biased and does not conduct until its gate current is more than minimum gate current of the SCR.
- The SCR remains ON until the anode current is equal to the holding current of the SCR. And it will switch OFF when the voltage applied is zero. So the load current is zero as the SCR acts as an open switch.
- Observe that the output (on the oscilloscope) would be controlled by the potentiometer. When the pot is varied, the voltage across the resistance $R_2$ changes, which in turn changes the voltage at the gate. The maximum value up to which the phase can be controlled is 90 degrees.

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