INTERNATIONAL INSTITUTE OF INFORMATION TECHNOLOGY
INNOVATION & LEADERSHIP

Protection Circuits

Need of Protection

- A thyristor may be subjected to
  - High di/dt
  - High dv/dt
  - Over voltages
  - Over currents

di/dt protection

- Thyristor is a gate controlled device & turned on by gate pulse
- When Thyristor turns on, there is a transition of the charge carriers all the way through its junction
- Local hot spot: Due to large rate of rise of anode current (di/dt) than the spreading of charge carriers, localized heat generation will take place. This is called as Local hot spot.
- Typical *di /dt* limit value:20-500 A/μ sec.

dv/dt protection

- In the forward blocking state of the Thyristor, junction J1 & junction J3 are forward biased & only junction J2 is reverse biased.
- Junction J2 work as a capacitor with constant capacitance, Cj (junction capacitance).
- If dva/dt increases, leakage current through the J2 junction increases.

dv/dt protection

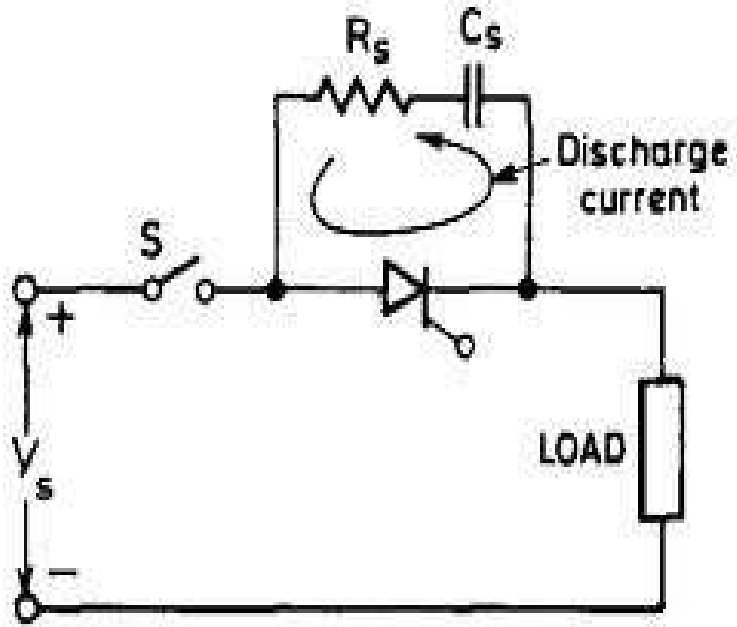
- Due to this leakage current, the devise will be turned On in absence of Gate pulse; this is dv/dt triggering.

- Typical values of *dv/dt* : 20-500 V/μsec.

- The use of the snubber circuit which can be connetced in parallel with the Thyristor, can prevent this false turn-on by *dv/dt change*.

Snubber Circuit

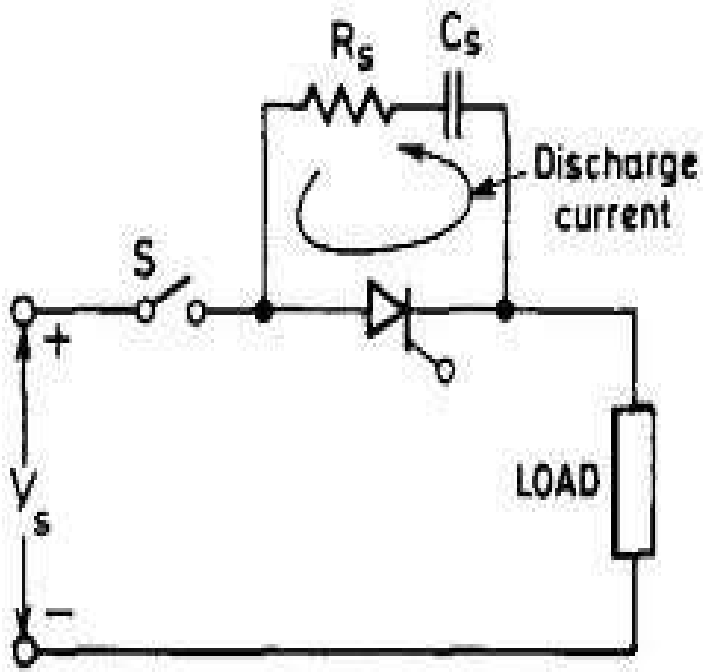
- It consists of a capacitor connected in series with a resistor which is applied parallel with the thyristor.
- When S is closed then voltage V_s is applied across the device as well as C_s suddenly.



Snubber circuit across SCR.

Working of Snubber Circuit

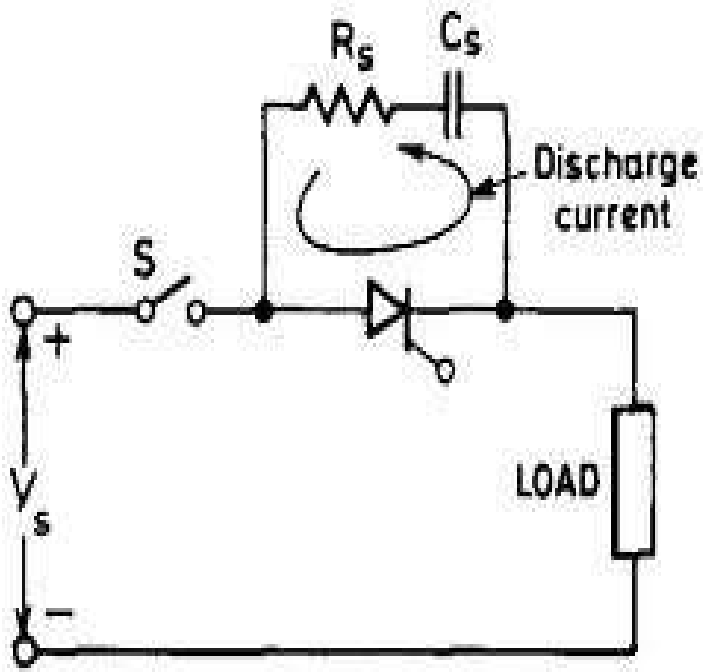
- At first Snubber circuit behaves like a short circuit. Therefore voltage across the device is zero.
- Gradually voltage across C_s builds up at a slow rate. So *dv/dt* across the thyristor will stay in allowable range.



Snubber circuit across SCR.

Working of Snubber Circuit

- Discharging current can be limited with the help of a resistance (R_s) connected in series with the capacitor (C_s) to keep the value of current and rate of change of current in a safe limit.



Snubber circuit across SCR.

Over Voltage Protection

Types of Overvoltage :

- Internal Over voltages
  - During commutation of thyristor (power devices).
- External Over voltages
  - Due to interruption of current in inductive circuits.
  - dv / dt
  - Due to Lightning stroke on source feeders.

Over Voltage Protection

Overvoltage Protection Circuits :

1. Snubber Circuit
   - For the protection of dv/d t rating.
   - Design of snubber circuit.

2. Using Comparators
   - To cut-off either supply voltage or load.

Over Current Protection

Overcurrent Causes :

1. Overcurrent due to faults
2. Overcurrent due to short circuit
3. Overcurrent due to surge current
4. Overcurrent due to rise in junction temperature

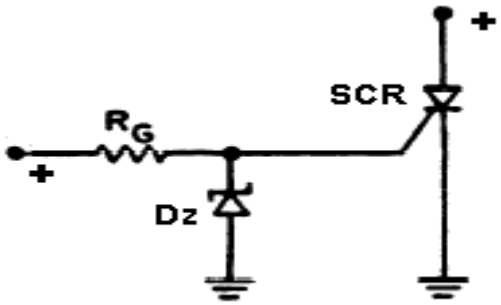
Over Current Protection

Over current Protection Circuits :

1. Using Semiconductor Fuse
2. di/dt protection
   - By designing a proper reactor in series with device
3. Using electronic Crowbar protection circuit
4. Using Current Transformer and Comparators
   - To cut-off either supply voltage or load.

Gate Protection

- Like thyristor, Gate circuit should also be protected from over voltages and over currents. Over voltages in the gate circuit can cause false triggering and over current can cause high junction temperature.
- Protection against over-voltages is achieved by connecting a zener diode across the gate circuit.
- A resistor is connected in series with the gate to provide protection against over-currents.
- A capacitor and a resistor are also connected across the gate to cathode to bypass the noise signals



Cooling & Heat Sinks

- Losses during working of power devices:
  - i) On-state loss
  - ii) Switching loss (during turn on & turn off)
  - iii) Losses due to leakage current
  - iv) Gate drive loss
- A large amount of heat is generated due to these losses
- To maintain the devise temperature in a particular range, cooling must be used to transfer this heat from device to atmosphere.

Cooling & Heat Sinks

- A **heat sink** is a passive heat exchanger that cools a device by dissipating heat into the surrounding medium like air / water / etc.

- Heat sinks are used with high-power semiconductor devices where the heat dissipation ability of the basic device is insufficient to moderate its temp.

- A heat sink is designed to maximize its surface area in contact with the cooling medium surrounding it.

THANK YOU!!

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