SNS COLLEGE OF ENGINEERING

Coimbatore-35
An Autonomous Institution

Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai

DEPARTMENT OF MECHATRONICS

19MO504 – INDUSTRIAL ELECTRONCIS
III YEAR V SEM

UNIT 1 – PHASE CONTROLLED CONVERTERS

TOPIC – Triggering and Commutation Techniques of SCR

Ms.B.SAJITHA., M.E.,(Ph.D.,)
ASSISTANT PROFESSOR,
DEPARTMENT OF EEE,
SNSCE, Coimbatore.

TRIGGERING METHODS

- THYRISTOR TURNING ON IS ALSO KNOWN AS **TRIGGERING**.

- WITH ANODE POSITIVE WITH RESPECT TO CATHODE, A THYRISTOR CAN BE TURNED ON BY ANY ONE OF THE FOLLOWING TECHNIQUES :
  - FORWARD VOLTAGE TRIGGERING
  - GATE TRIGGERING
  - DV/DT TRIGGERING
  - TEMPERATURE TRIGGERING
  - LIGHT TRIGGERING

Forward Voltage Triggering

- When breakover voltage (VBO) across a thyristor is exceeded than the rated maximum voltage of the device, thyristor turns ON.
- At the breakover voltage the value of the thyristor anode current is called the latching current (IL) .
- Breakover voltage triggering is not normally used as a triggering method, and most circuit designs attempt to avoid its occurrence.
- When a thyristor is triggered by exceeding VBO, the fall time of the forward voltage is quite low (about 1/20th of the time taken when the thyristor is gate-triggered).
- However, a thyristor switches faster with VBO turn-ON than with gate turn-ON, so permitted di/dt for breakover voltage turn-on is lower.

dv/dt triggering

- With forward voltage across anode & cathode of a thyristor, two outer junctions (A & C) are forward biased but the inner junction (J2) is reverse biased.
- The reversed biased junction J2 behaves like a capacitor because of the space-charge present there.
- As p-n junction has capacitance, so larger the junction area the larger the capacitance.
- If a voltage ramp is applied across the anode-to-cathode, a current will flow in the device to charge the device capacitance according to the relation:
- If the charging current becomes large enough, density of moving current carriers in the device induces switch-on.

$$i_c = C.\frac{dv}{dt}$$

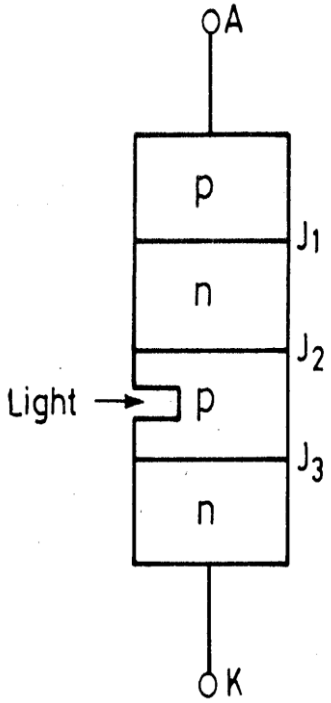
- This method of triggering is not desirable because high charging current (Ic) may damage the thyristor.

Temperature Triggering

- During forward blocking, most of the applied voltage appears across reverse biased junction J2.
- This voltage across junction J2 associated with leakage current may raise the temperature of this junction.
- With increase in temperature, leakage current through junction J2 further increases.
- This cumulative process may turn on the SCR at some high temperature.
- High temperature triggering may cause Thermal runaway and is generally avoided.

Light Triggering

- In this method light particles (photons) are made to strike the reverse biased junction, which causes an increase in the number of electron hole pairs and triggering of the thyristor.
- For light-triggered SCRs, a slot (niche) is made in the inner p-layer.
- When it is irradiated, free charge carriers are generated just like when gate signal is applied b/w gate and cathode.
- Pulse light of appropriate wavelength is guided by optical fibers for irradiation.
- If the intensity of this light thrown on the recess exceeds a certain value, forward-biased SCR is turned on. Such a thyristor is known as light-activated SCR (LASCR).
- Light-triggered thyristors is mostly used in high-voltage direct current (HVDC) transmission systems.



Thyristor Gate Control Methods

- An easy method to switch ON a SCR into conduction is to apply a proper positive signal to the gate.
- This signal should be applied when the thyristor is forward biased and should be removed after the device has been switched ON.
- Thyristor turn ON time should be in range of 1-4 micro seconds, while turn-OFF time must be between 8-50 micro seconds.
- Thyristor gate signal can be of three varieties.
  - **D.C Gate signal**
  - **A.C Gate Signal**
  - **Pulse**

Thyristor Gate Control Methods

D.C Gate signal: Application of a d.c gate signal causes the flow of gate current which triggers the SCR.

- Disadvantage is that the gate signal has to be continuously applied, resulting in power loss.
- Gate control circuit is also not isolated from the main power circuit.

A.C Gate Signal: In this method a phase - shifted a.c voltage derived from the mains supplies the gate signal.

- Instant of firing can be controlled by phase angle control of the gate signal.

Pulse: Here the SCR is triggered by the application of a positive pulse of correct magnitude.

- For Thyristors it is important to switched ON at proper instants in a certain sequence.
- This can be done by train of the high frequency pulses at proper instants through a logic circuit.
- A pulse transformer is used for circuit isolation.
- Here, the gate looses are very low because the drive is discontinuous.

Thyristor Commutation Classification

Commutation can be classified as

- Natural commutation
- Forced commutation

Thyristor Commutation

- Commutation: Process of turning off a conducting thyristor
  - Current Commutation
  - Voltage Commutation

- A thyristor can be turned ON by applying a positive voltage of about a volt or a current of a few tens of milliamps at the gate-cathode terminals.

- But SCR cannot be turned OFF via the gate terminal.

- It will turn-off only after the anode current is negated either naturally or using forced commutation techniques.

- These methods of turn-off do not refer to those cases where the anode current is gradually reduced below Holding Current level manually or through a slow process.

- Once the SCR is turned ON, it remains ON even after removal of the gate signal, as long as a minimum current, the Holding Current (IH), is maintained in the main or rectifier circuit.

Assessment

Q1. What is the purpose of a commutation circuit in SCR?

- A) To turn on the SCR
- B) To turn off the SCR
- C) To amplify the signal
- D) To reduce power loss

Answer: B) To turn off the SCR

Q2. In a forced commutation circuit, the SCR is turned off by:

- A) Removing the gate signal
- B) Applying a reverse voltage across the SCR
- C) Reducing the load current
- D) Cooling the SCR

Answer: B) Applying a reverse voltage across the SCR

Q3. A driver circuit in power electronics is primarily used for:

- A) Increasing the voltage
- B) Providing sufficient current to the gate terminal
- C) Reducing the load current
- D) Protecting the device from overvoltage

Answer: B) Providing sufficient current to the gate terminal

References

1. http://www.digimat.in/nptel/courses/video/108101126/L89.html