A
Seminar report
On

Thryistors

Submitted in partial fulfillment of the requirement for the award of degree
of Electronics and Communications

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Introduction

Large semiconductor diode can be considered as a predecessor to thyristors. The advent of thyristors started the field new power electronics. P-N-P-N switch concept's introduction in the year of 1956 was one among initial advancement. This switch concept was published by J.L. Moll and others in Bell laboratories. Very fast, engineers recognized its importance to control and power conversion. After this recognition, within a time period of nine months announced a commercial silicon control rectifier and year of an announcement was 1957. The initial commercial silicon rectifier had a blocking voltage of 300V and had 25A of continuous current carrying capacity. Silicon controlled rectifiers is another name for thyristors. Many other machines in a huge number which has similar features like a thyristor have been developed. Few examples of such devices are mentioned below:

- Inverter grade fast thyristor
- Silicon controlled switch (SCS)
- Light-activated silicon controlled switch (LASCR)
- Asymmetrical thyristor (ASCR)
- Reverse conducting thyristor (RCT)
- Diac
- Triac
- Gate turn off thyristor (GTO)

If we observe thyristor from an operational point of view and from a constructional point of view then it has following features:

- It is a four layer device
- It has three terminals
- It is also a minority carrier semi-controlled machine

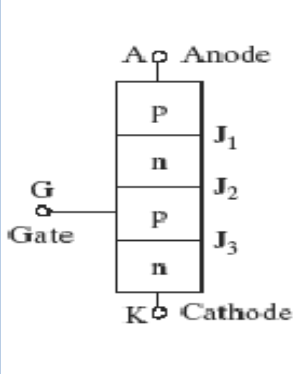
The thyristor can be operated with a current signal but it is difficult to turn off device without interrupting main current. It has feature of conducting current in only one direction and blocking voltage in both directions. Because of internal latch-up technique, it gives very low forward voltage drop. If we compare thyristors with BJT then thyristors have longer switching times.

Background on Thyristors

- **They name Thyristor comes from two similar device names 'Thyratron' and 'Transistor'**
- **Thyristors are useful due to their ability to handle large current in power applications and fast switching**
- **The most common thyristor is the SCR which stands for "Silicon Controlled Rectifier"**

Characteristics of thyristors

- **When the anode is at a positive potential V_{AK} with respect to the cathode with no voltage applied at the gate, junctions J_1 and J_3 are forward biased, while junction J_2 is reverse biased. As J_2 is reverse biased, no conduction takes place.**

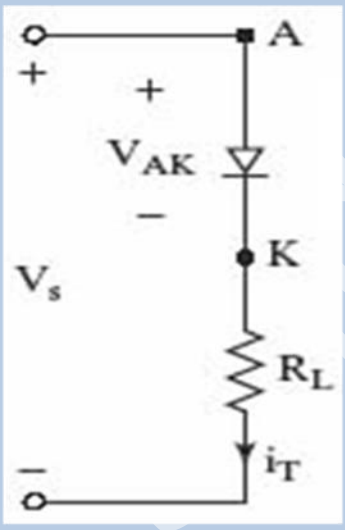


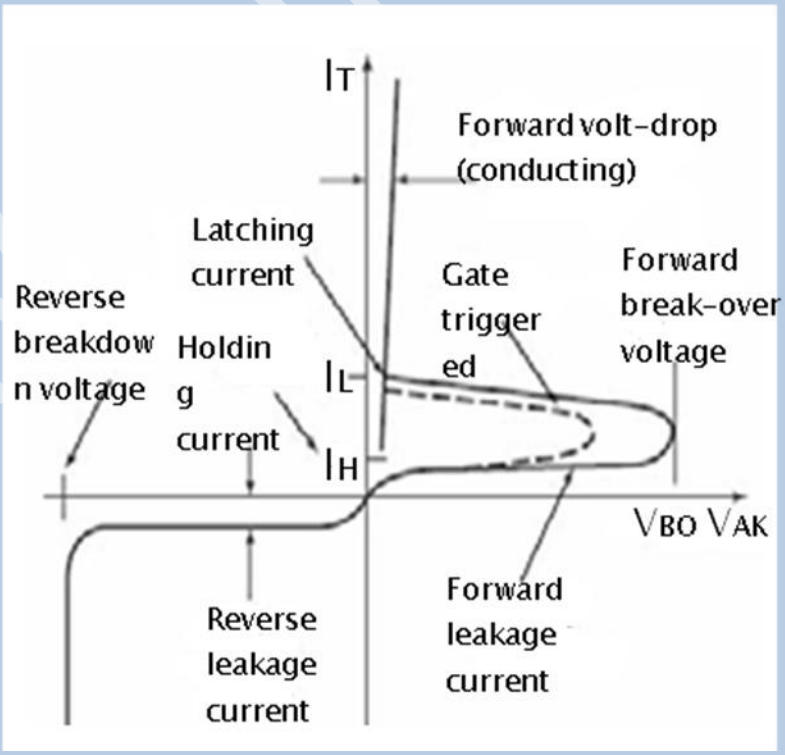
- **Now if V_{AK} is increased beyond the breakdown voltage V_{BO} of the thyristor, avalanche breakdown of J_2 takes place and the thyristor starts conducting.**

- **If a positive potential V_G is applied at the gate terminal with respect to the cathode, the breakdown of the junction J_2 occurs at a lower value of V_{AK}. By selecting an appropriate value of V_G, the thyristor can be switched into the on state suddenly.**

Switching Characteristic (IV)

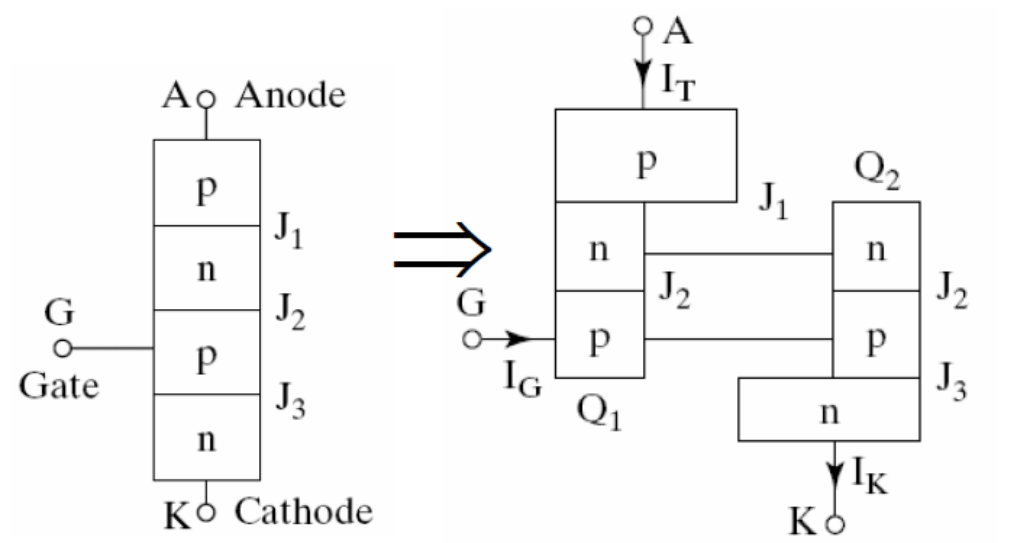
- **Forward breakdown voltage VBO**
  - **The voltage of avalanche breakdown**
- **Latching current IL**
  - **The minimum anode current required to maintain the thyristor in the on-state immediately after it is turned on and the gate signal has been removed**
- **Holding current IH**
  - **The minimum anode current to maintain the thyristor in the on-state**
- **IL > IH**





Different types of Thyristors

- **Silicon Controlled Rectifier (SCR).**
- **TRIAC.**
- **DIAC.**
- **Silicon Unilateral Switch (SUS) – has built in low voltage avalanche diode**



Applications

- **Mainly used where high currents and voltages are involved, and are often used to control alternating currents, where the change of polarity of the current causes the device to switch off automatically; referred to as Zero Cross operation.**
- **Thyristors can be used as the control elements for phase angle triggered controllers, also known as phase fired controllers.**

Conclusion

- **The main types of thyristors specified are the SCR, TRIAC, GTO, and MCT**
- **Operation modes for SCR include: Forward Active Conduction, Reverse Blocking, and Forward Blocking**
- **Characteristics of the SCR are dependent on large current and voltage**
- **Manufacturers strive for a good trade off between forward conducting voltage drop and switching time**
- **Applications are mainly centered around control of high current flow**

Constructional features of a thyristor

Circuit symbol of thyristor is shown below:

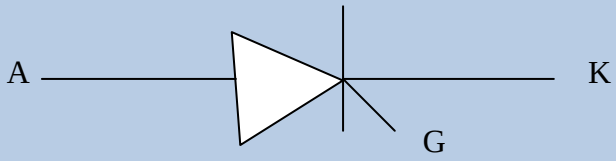


Fig1: circuit symbol of a thyristor

The schematic construction of a thyristor has lightly doped n^- layer which is sandwiched between p-type layers. These p-type layers have doing levels which are higher by two orders of magnitude. The p-layer which is in bottom has connections of gate terminal.

Steady-state characteristics of a thyristor:

Characteristics which come under steady-state characteristics are mentioned below:

- Static output i-v characteristics of a thyristor
- Thyristor gate characteristics

Thyristor ratings:

Few specifications of thyristor which are related to its steady-state characteristics are found in datasheet of a manufacturer and those are mentioned below:

- Voltage ratings
- Current ratings
- Gate specifications

1. **Voltage ratings:** Parameters related to voltage ratings are mentioned below:
    - Peak working forward OFF state voltage

- Peak repetitive off state forward voltage
- Peak non-repetitive off state forward voltage
- Peak working reverse voltage
- Peak repetitive reverse voltage
- Peak non-repetitive reverse voltage

2. **Current ratings:** Parameters which come under current ratings are mentioned below:
   - Maximum RMS current
   - Maximum surge current
   - Maximum squared current integral
   - Latching current
   - Holding current
   - Maximum forward voltage drop
   - Average power dissipation
3. **Gate specifications:** Parameters which are under gate specifications are:
   - Gate current to trigger
   - Gate voltage to trigger
   - Nontriggering gate voltage
   - Peak reverse gate voltage
   - Average gate power dissipation
   - Peak forward gate current

Switching characteristics:

Switching characteristics of a thyristor are:

- Turn on switching characteristics
- Turn off switching characteristics

1. **Turn on switching characteristics:** In this, transition time is known as thyristor turn of time. It is divided into three distinct intervals and they are:
   - Delay time
   - Rise time
   - Spread Time