

POWER CONTROLLER DEVICES

POWER DIODES TYPES

Power diodes can be classified as

- General purpose diodes.
- High speed (fast recovery) diodes.
- Schottky diode.

General Purpose Diodes

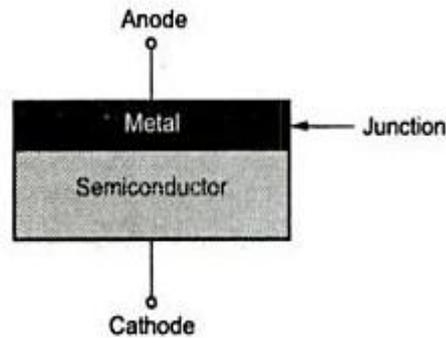
The diodes have high reverse recovery time of about 25 microseconds (μsec). They are used in low speed (frequency) applications. e.g., line commutated converters, diode rectifiers and converters for a low input frequency upto 1 KHz. Diode ratings cover a very wide range with current ratings less than 1 A to several thousand amps (2000 A) and with voltage ratings from 50 V to 5 KV. These diodes are generally manufactured by diffusion process. Alloyed type rectifier diodes are used in welding power supplies. They are most cost effective and rugged and their ratings can go upto 300A and 1KV.

Fast Recovery Diodes

The diodes have low recovery time, generally less than 5 μs . The major field of applications is in electrical power conversion i.e., in free-wheeling ac-dc and dc-ac converter circuits. Their current ratings is from less than 1 A to hundreds of amperes with voltage ratings from 50 V to about 3 KV. Use of fast recovery diodes are preferable for free-wheeling in SCR circuits because of low recovery loss, lower junction temperature and reduced di/dt . For high voltage ratings greater than 400 V they are manufactured by diffusion process and the recovery time is controlled by platinum or gold diffusion. For less than 400 V rating epitaxial diodes provide faster switching speeds than diffused diodes. Epitaxial diodes have a very narrow base width resulting in a fast recovery time of about 50 ns.

Schottky Diodes

A Schottky diode has metal (aluminium) and semi-conductor junction. A layer of metal is deposited on a thin epitaxial layer of the n-type silicon. In Schottky diode there is a larger barrier for electron flow from metal to semi-conductor. Figure shows the schotty diode.



When Schottky diode is forward biased free electrons on n-side gain enough energy to flow into the metal causing forward current. Since the metal does not have any holes there is no charge storage, decreasing the recovery time. Therefore a Schottky diode can switch-off faster than an ordinary p-n junction diode. A Schottky diode has a relatively low forward voltage drop and reverse recovery losses. The leakage current is higher than a p-n junction diode. The maximum allowable voltage is about 100 V. Current ratings vary from about 1 to 300 A. They are mostly used in low voltage and high current dc power supplies. The operating frequency may be as high 100-300 kHz as the device is suitable for high frequency application.

Comparison Between Different Types Of Diodes

General Purpose Diodes	Fast Recovery Diodes	Schottky Diodes
Upto 5000V & 3500A	Upto 3000V and 1000A	Upto 100V and 300A
Reverse recovery time – High	Reverse recovery time – Low	Reverse recovery time – Extremely low.
$t_{rr} \approx 25\mu s$	$t_{rr} = 0.1\mu s$ to $5\mu s$	$t_{rr} =$ a few nanoseconds
Turn off time - High	Turn off time - Low	Turn off time – Extremely low
Switching frequency – Low	Switching frequency – High	Switching frequency – Very high.
$V_F = 0.7V$ to $1.2V$	$V_F = 0.8V$ to $1.5V$	$V_F \approx 0.4V$ to $0.6V$

B. Thyristors

Silicon Controlled Rectifiers (SCR):

The SCR has 3- terminals namely:

Anode (A), Cathode (k) and Gate(G).

Internally it is having 4-layers p-n-p-n as shown in figure (b).

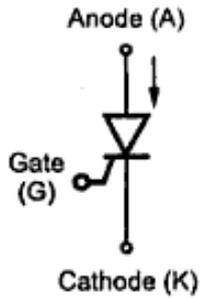


Fig.1.2 (a). Symbol

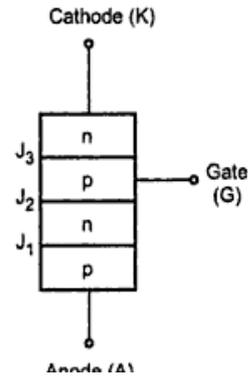


Fig.1.2 (b). Structure of SCR

The word thyristor is coined from thyatron and transistor. It was invented in the year 1957 at Bell Labs.

The Thyristors can be subdivided into different types

- Forced-commutated Thyristors (Inverter grade Thyristors)
- Line-commutated Thyristors (converter-grade Thyristors)
- Gate-turn off Thyristors (GTO).
- Reverse conducting Thyristors (RCT's).
- Static Induction Thyristors (SITH).
- Gate assisted turn-off Thyristors (GATT).
- Light activated silicon controlled rectifier (LASCR) or Photo SCR's.
- MOS-Controlled Thyristors (MCT's).

C. POWER TRANSISTORS

Transistors which have high voltage and high current rating are called power transistors. Power transistors used as switching elements, are operated in saturation region resulting in a low - on state voltage drop. Switching speed of transistors is much higher than the thyristors. And they are extensively used in dc-dc and dc-ac converters with inverse parallel connected diodes to provide bi-directional current flow. However, voltage and current ratings of power transistor are much lower than the thyristors. Transistors are used in low to medium power applications. Transistors are current controlled device and to keep it in the conducting state, a continuous base current is required.

Power transistors are classified as follows

- Bi-Polar Junction Transistors (BJTs)
- Metal-Oxide Semi-Conductor Field Effect Transistors (MOSFETs)
- Insulated Gate Bi-Polar Transistors (IGBTs)
- Static Induction Transistors (SITs)