MOSFET

The MOSFET is an abbreviation of Metal Oxide Semiconductor Field Effect Transistor. In MOSFET, the gate is insulated from the channel by using SiO_2 layer. The input impedance of MOSFET is high, because the gate current is extremely small. It is also called as Insulated Gate FET (IGFET).

There are two types of MOSFET.

They are,
1. Enhancement MOSFET (E-MOSFET).
2. Depletion MOSFET (DE-MOSFET).

Enhancement MOSFET (E-MOSFET)

The enhancement MOSFET works only in enhancement mode. It does not conduct when gate to source voltage (VGS) is equal to zero, therefore it is called as 'normally OFF MOSFET'. It is widely used in digital circuits. There are two types of enhancement MOSFET. They are

1. N-channel E-MOSFET
2. P-channel E-MOSFET

Depletion MOSFET (DE-MOSFET)

The depletion MOSFET can be operated in either depletion mode or enhancement mode. Therefore, it is called as DE-MOSFET. There are two types of depletion MOSFET. They are,

1. N channel depletion MOSFET
2. P-channel depletion MOSFET

Application for MOSFET

1. MOSFET is widely used for switching and amplifying the signals.
2. It is used in FM radio and TV receivers (for mixer operation).
3. It is used in computer memories.
4. It is used as auto intensity control of street lights.

Table 6.3 Comparison of JFET and MOSFET

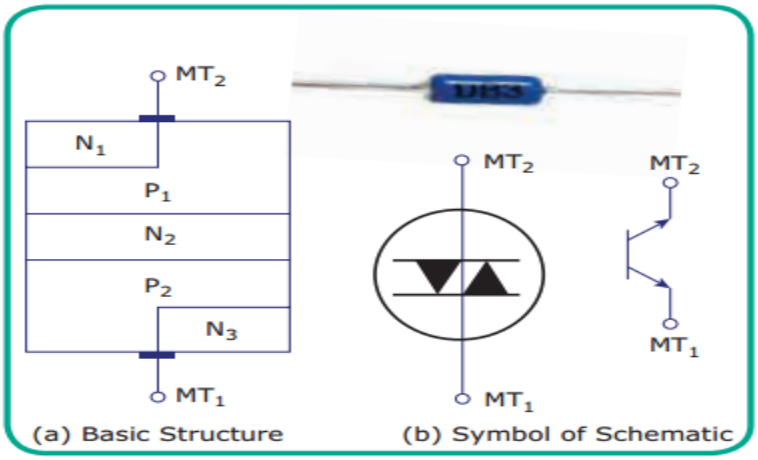
S.No	JFET	MOSFET
1.	JFET stands for Junction Field Effect Transistor	MOSFET stands for Metal Oxide Semiconductor Field Effect Transistor
2.	It can be operated only in the depletion mode	It can be operated either depletion or in enhancement mode
3.	It has high input impedance (10^8 Ω)	It has very high input impedance (from 10^{10} Ω to 10^{15} Ω)
4.	It is difficult to fabricate	It is easier to fabricate
5.	Gate current (Ig) is high	Gate current (Ig) is low
6.	It is mainly used in low noise application	It is widely used in VLSI circuits

DIAC

The DIAC is a bidirectional semiconductor switching device. It can be switched 'ON' using both polarities. DIAC is a short version of DIODE Alternating Current. It is widely used as a triggering device of a Triac, especially, for AC switches, dimmer application and starter circuits in fluorescent lamps.

Construction:

Figure shows the structure and symbol of DIAC. The DIAC is a two terminal device, namely MT_1, MT_2. It is a combination of parallel semiconductor layers ($P_1N_1P_2N_2$,$P_2N_1P_1N_3$) connected in anti-parallel. The DIAC can be configured to conduct in both the directions. The structure of DIAC is similar to transistor, but no terminal attached to the base layer.



Basic Structure and Symbol of DIAC

Application of DIAC

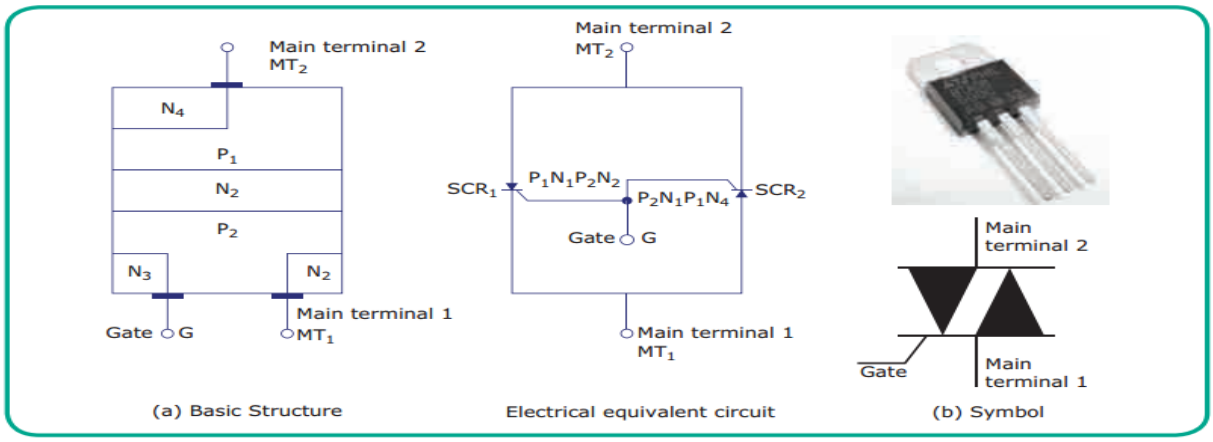
1. Used as Triggering device in TRIAC Power Control System.
2. Used in Lamp Dimmer Circuit
3. Used in Heater Control Circuit.
4. Used in Motor Speed Control.

TRIAC

TRIAC is a three terminal semiconductor switching device. They are MT_1, MT_2 and gate. Here, the gate terminal is used to control the ACin a load. TRIAC is a short version of TRIODE AC switch. The flow of current in TRIAC is bi-directional that means current can flow in both directions.

Construction:

The structure and symbol of TRIAC is shown in the Figure . It comprises of two SCRs connected in the anti-parallel direction. It acts as a switch for both the directions. From the diagram we can understand that the $MT_1$and gate terminals are close to each other. The gate provides control over conduction in either direction.



TRIAC

Application of TRIAC

1. It can be used as a static switch to turn AC power ON and OFF.
2. It is used for motor speed control.
3. It is used for illumination control.
4. It is used for heater control.
5. It is used for phase control

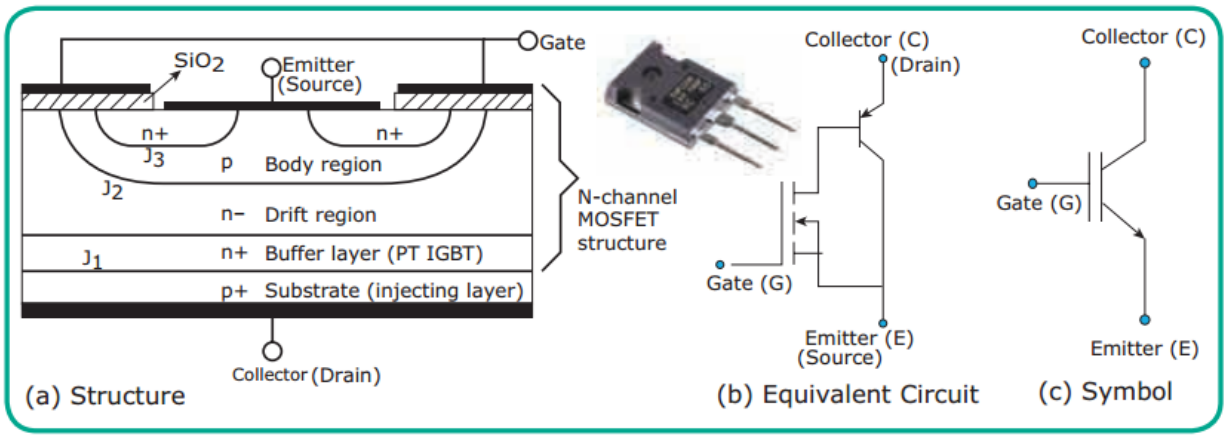
INSULATED GATE BIPOLAR TRANSISTOR (IGBT)

IGBT is a three terminal semiconductor device with huge bipolar current carrying capability. So, this device is designed to make use of the benefits of both BJT and MOSFET devices in the form of monolithic.

IGBT has several applications in power electronics, particularly, PWM, UPS, SMPS and other power circuits. It increases the efficiency, dynamic performance and reduces the level of the audible noise. IGBT are also named as bipolar MOS transistor and conductivity modulated field effect transistor (COMFET).

Construction:

Figure 6.23 shows the structure, equivalent circuit and symbol of an IGBT. It is similar to the structure of MOSFET and the main difference is the presence of p+ layer that is added to the drain side. This p+ layer is also called injecting layer. The next layer is n+ layer also called as buffer layer. There is a p-n junction J_1 between the injecting layer and the buffer layer. There are two more p-n junctions J_2 and J_3 as shown in Figure. The junction J_1 blocks reverse voltage. The junction J_2 blocks forward voltage when IGBT is off.



Insulated Gate Bipolar Transistor

Working Principle:

When a positive voltage is applied between the gate and source, the power MOSFET turns 'ON' and acts as a low resistance between the base and collector of the PNP transistor, thereby the IGBT is turned 'ON'. When there is no gate to source voltage the MOSFET is turned off and hence the PNP transistor is also off because no longer base current is supplied. Thus, the IGBT acts as a switch.

Application of IGBT

1. The IGBT is used in medium to high power application like SMPS, traction motor control etc.

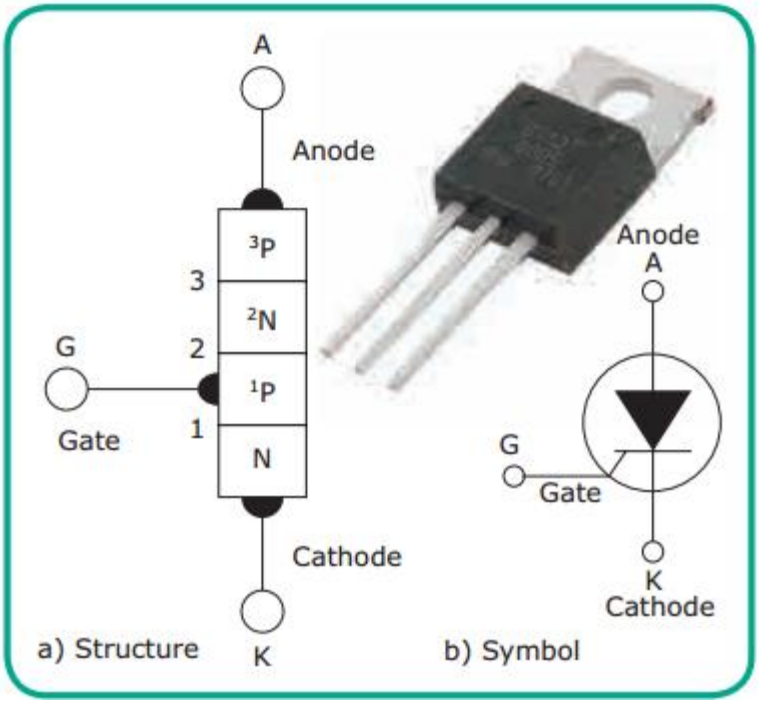
2. Large IGBT modules consist of many devices in parallel have the capability to control current in hundreds of amperes with blocking voltage of 6500 V.

SILICON CONTROLLED RECTIFIER (SCR)

SCR is a three terminal and three junction semiconductor device acts as true electronic switch. It is a unidirectional device. It converts AC to DC and controls the amount of power fed to the load. It contains the features of a rectifier and transistor. SCR is widely used device in the Thyristor family, so it is commonly called as Thyristor.

Construction:

SCR consists of four semiconductor layers forming a PNPNstructure as shown in the Figure. There are three junctions namely J_1, J_2, J_3. SCR have three leads, they are anode (A), cathode (K) and gate (G). The end P-layer acts as anode, the end N-layer acts as cathode and the P-layer nearer to cathode acts as gate.



SCR Structure and Symbol

Working Principle:

In the normal operating conditions of SCR, the anode (A) is always kept at high positive potential with respect to cathode (K), and gate (G) is at small positive potential with respect to cathode. A load resistor (R_L) is connected in series with Anode (A). The working of SCR can be studied under the following two conditions.

Application of SCR

1. The SCR is used in the circuit of AC voltage stabilizer.
2. It can be used as switch.
3. It is used in inverters.
4. It is used with AC power control with solid relay.

5. It is used to control motor speed.

6. It is used in light dimmer control circuits.