5.6 POWER MOSFET

Power MOSFET is a type of MOSFET which is specially meant to handle high levels of power. These exhibit high switching speed and can work much better in comparison with other normal MOSFETs in the case of low voltage levels. However its operating principle is similar to that of any other general MOSFET.

Power MOSFETs which are most widely used are n-channel Enhancement-mode or p-channel Enhancement-mode or n-channel Depletion-mode in nature.

Further, there are a wide variety of power MOSFET structures like Vertical Diffused MOS (VDMOS) or Double-Diffused MOS or DMOS, UMOS or Trench-MOS, VMOS, etc. An n-substrate VDMOS made of n-substrate and an n- epitaxial layer into which p and n+ regions are embedded into using double diffusion process.

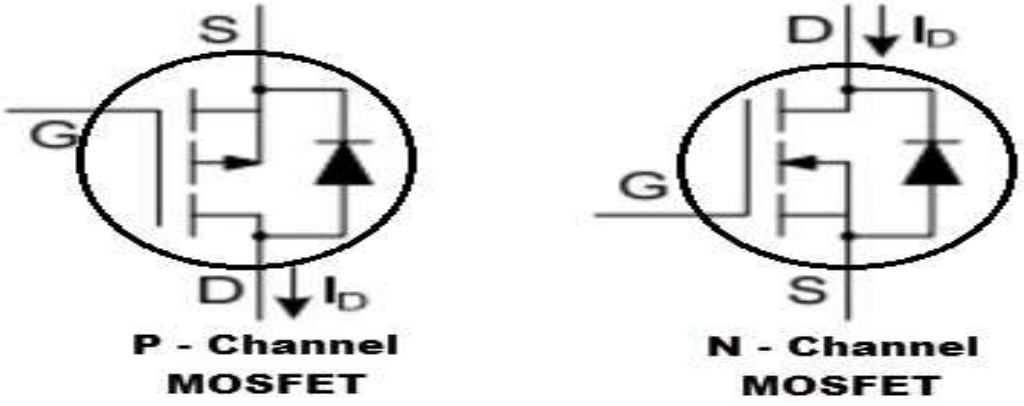

Fig:5.6.1 Symbol of Power MOSFET P and N Channel

Here the channel is formed in a p-type region when the gate-to-source voltage is made positive. Most importantly, here, the Source (S) terminal is placed over the Drain (D) terminal forming a vertical structure. As a result, in VDMOS the current flows beneath the gate area vertically between the source and the drain terminals through numerous n+ sources conducting in-parallel. As a result, the resistance offered by the device during its ON state RDS(ON) is much lower than that in the case of normal MOSFETs which enable them to handle high currents. This resistance of the device is seen to double as the current increments by about 6%. On the other hand RDS(ON) is highly influenced by the junction temperature TJ and is seen to be positive in nature.

Similar to this we can even have a p-substrate power MOSFET provided we replace n-type materials with p-type and then reverse the polarities of the voltages applied.

However they exhibit a much higher RDS(ON) in comparison with n-substrate devices as they employ holes as their majority charge carriers instead of electrons. Nevertheless, these are preferred to be used as buck converters.

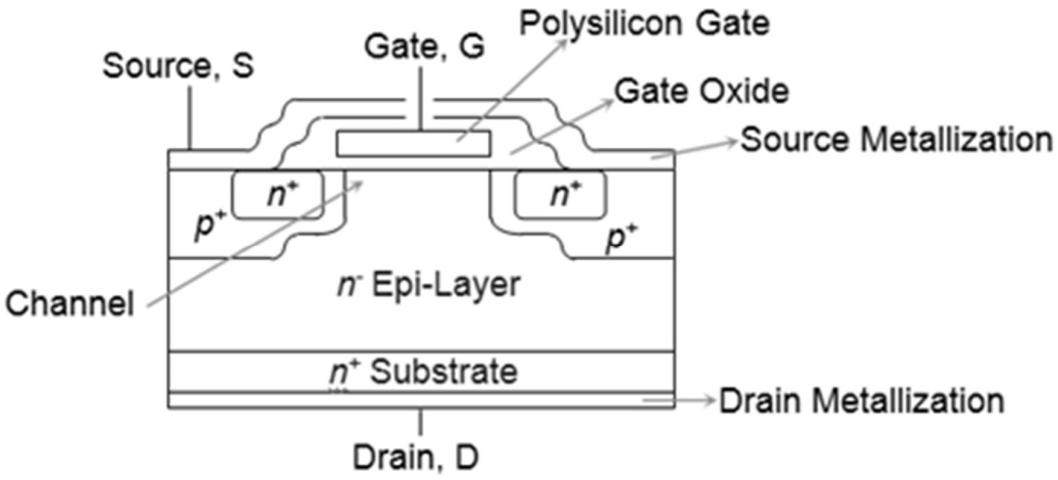

Fig:5.6.2 Construction of N Substrate Power MOSFET

Although the structures of the normal MOSFETs and the power MOSFETs are seen to be different, the basic principle behind their working remains unaltered. That is, in both of them the formation of conduction channel is the same which is nothing but the suitable bias applied at the gate terminal resulting in an inversion layer. As a result, the nature of transfer characteristics and the output characteristics exhibited by either of them are almost identical to each other.

Further, it is to be noted that in the case of power MOSFETs which are based on vertical structure, the doping and the thickness of the epitaxial layer decide the voltage rating while the channel width decides its current rating. This is the reason because of which they can sustain high blocking voltage and high current, making them suitable for low power switching applications. However even lateral-structure based MOSFETs exist which behaves better in comparison with vertical-structure based designs especially in saturated operating region, enabling their use in high-end audio amplifiers. Another advantage of power MOSFET is the fact that they can be paralleled as their forward voltage drop increases with an increase in the temperature which in turn assures equal current distribution amongst all of its components.

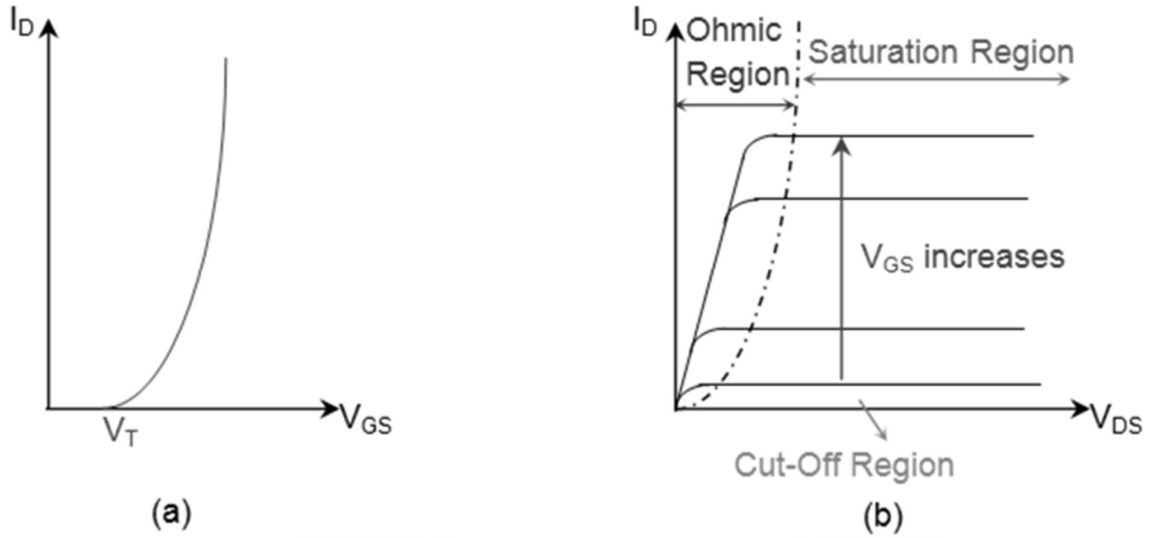

Fig:5.6.3 Power MOSFET (a) Transfer Characteristics (b) Output Characteristics

Applications of Power MOSFET

- DC to DC converters
- Low voltage motor controllers
- These are widely used in the low voltage switches which are less than the 200V