N CHANNEL MOSFET

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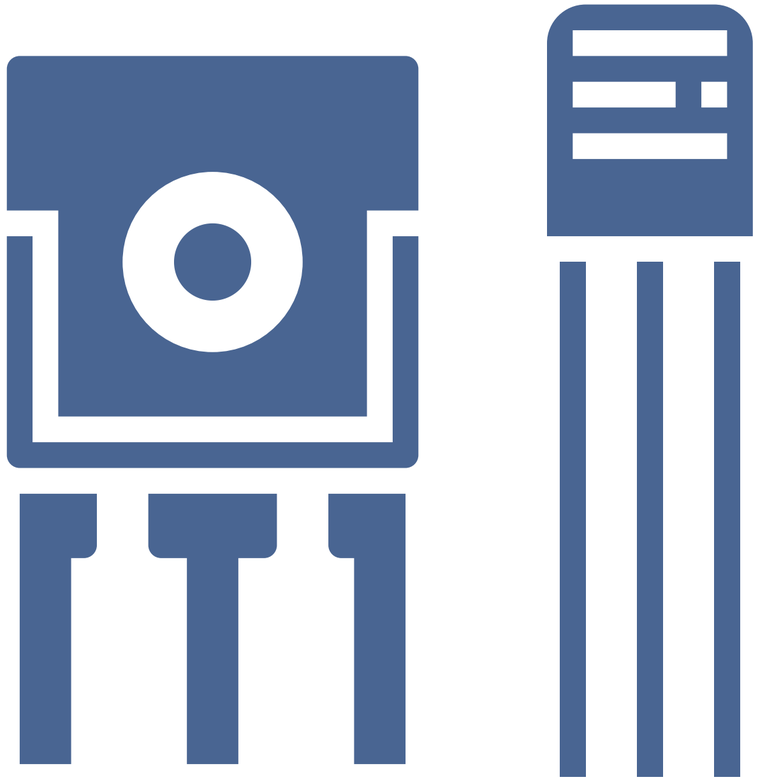
Contents

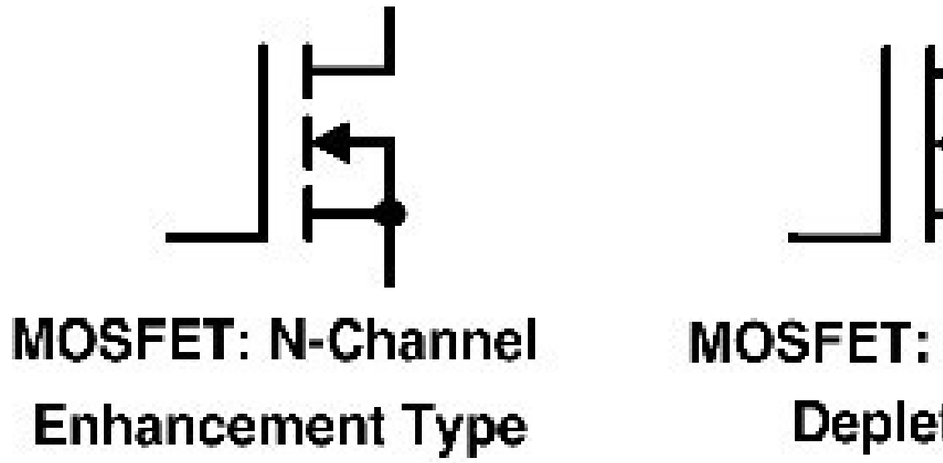


Introduction

- The MOSFET (Metal Oxide Semiconductor Field Effect Transistor) transistor is a semiconductor device that is widely used for switching purposes and for the amplification of electronic signals in electronic devices.
- A MOSFET is either a core or integrated circuit where it is designed and fabricated in a single chip because the device is available in very small sizes.
- MOSFET is further classified as **p-type and n-type**.
- These p-types and n-type MOSFETs are further classified as **enhancement and depletion-based MOSFETs**.
- MOSFETs consist of **three terminals** which are referred to as the **source, drain, and gate.** The functionality of the MOSFETs is dependent on these terminals.

N-Channel MOSFET

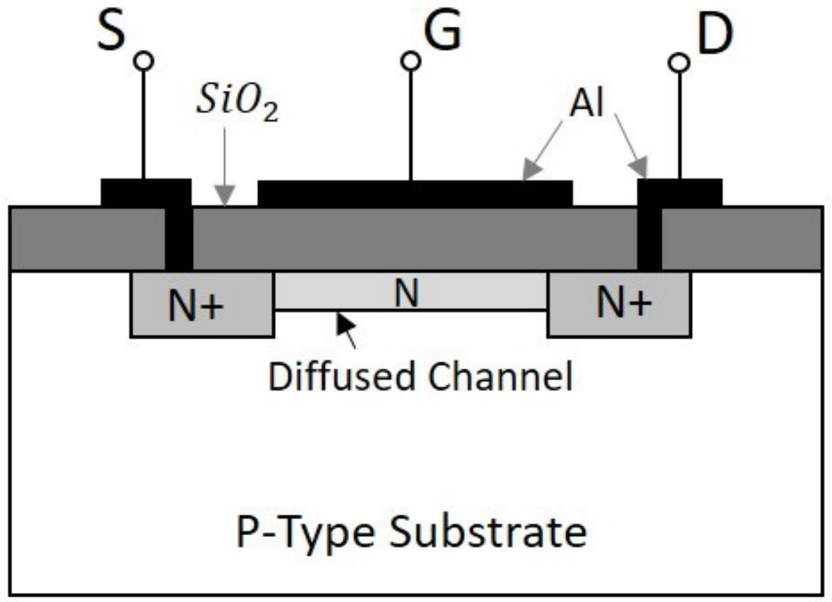
- The MOSFET formed in which the conduction is due to the channel of majority charge carriers called **electrons**. When this MOSFET is activated as ON this condition results in the maximum amount of the current flow through the device. This type of MOSFET is defined as **N-channel MOSFET.**
- These n-channel MOSFETs are further classified as
    1. N-Channel with Enhancement MOSFET and
    2. N-Channel with Depletion MOSFET



Symbols for N-channel Depletion and Enhancement Types

Construction of N- Channel MOSFET

- Let us consider an N-channel MOSFET to understand its working. A lightly doped P-type substrate is taken into which two heavily doped N-type regions are diffused, which act as source and drain. Between these two N+ regions, there occurs diffusion to form an N channel, connecting drain and source.
- A thin layer of Silicon dioxide (SiO2) is grown over the entire surface and holes are made to draw ohmic contacts for drain and source terminals. A conducting layer of aluminium is laid over the entire channel, upon this SiO2 layer from source to drain which constitutes the gate. The SiO2 substrate is connected to the common or ground terminals.
- Because of its construction, the MOSFET has a very less chip area than BJT, which is 5% of the occupancy when compared to bipolar junction transistor.
- This device can be operated in modes. They are **depletion and enhancement modes.**

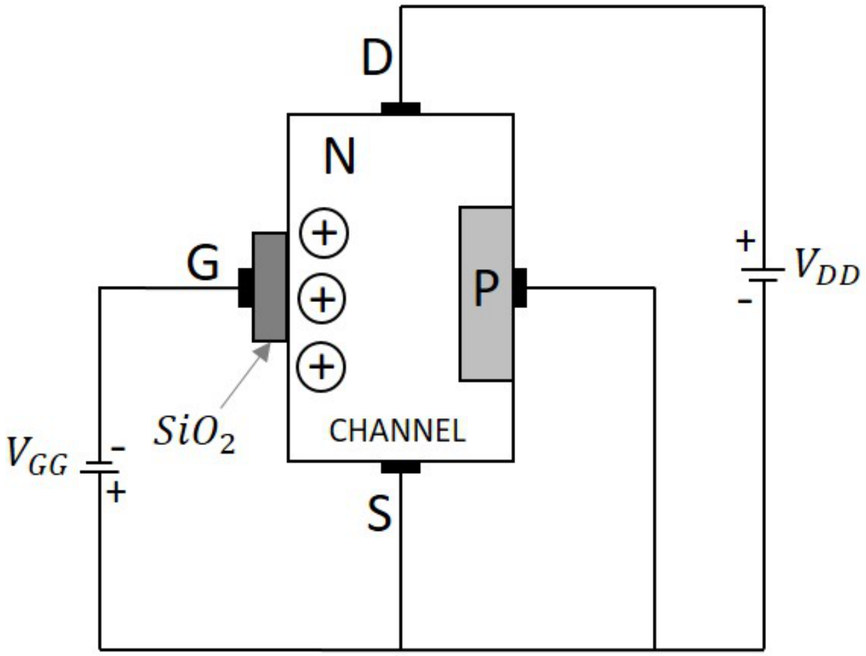


Structure of N-channel MOSFET

N-Channel MOSFET with Depletion Mode

In depletion mode, the gate terminal should be at negative potential while the drain is at a positive potential, as shown in the following figure.

- When no voltage is applied between gate and source, some current flows due to the voltage between drain and source. Let some negative voltage is applied at VGG. Then the minority carriers i.e. holes, get attracted and settle near the SiO2 layer. But the majority of carriers, i.e., electrons get repelled.
- With some amount of negative potential at VGG, a certain amount of drain current ID flows from source to drain. When this negative potential is further increased, the electrons get depleted and the current ID decreases.
- The channel nearer to the drain gets more depleted than at the source and the current flow decreases due to this effect.
- Hence it is called depletion mode MOSFET.

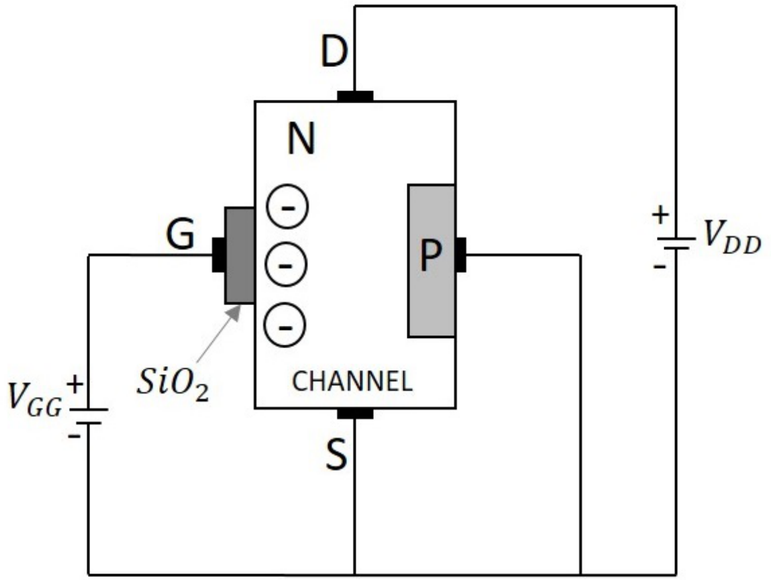


Working of MOSFET in depletion mode

N-Channel MOSFET with Enhancement Mode

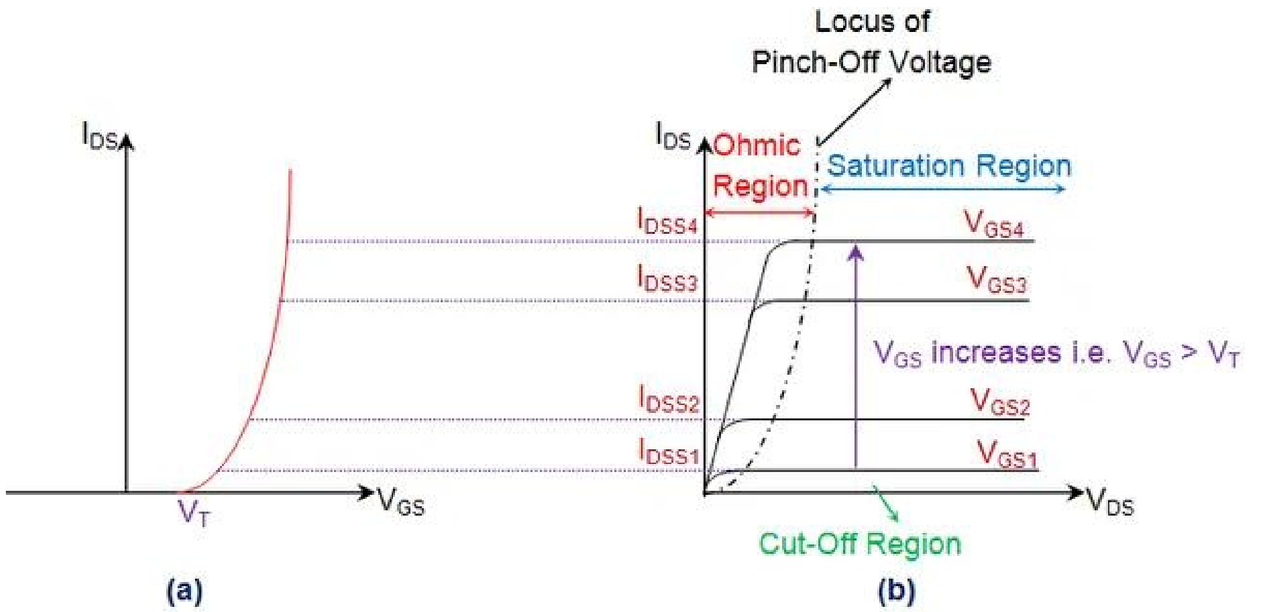
The same MOSFET can be worked in **enhancement mode,** if we can change the polarities of the voltage VGG. So, let us consider the MOSFET with gate-source voltage **VGG being positive** as shown in the following figure.

- When no voltage is applied between gate and source, some current flows due to the voltage between drain and source. Let some positive voltage is applied at VGG. Then the minority carriers i.e. holes, get repelled and the majority carriers i.e. electrons get attracted to the SiO2 layer.
- With some amount of positive potential at VGG, a certain amount of drain current ID flows from source to drain. When this positive potential is further increased, the current ID increases due to the flow of electrons from the source and these are pushed further due to the voltage applied at VGG. The current flow gets enhanced due to the increase in electron flow better than in depletion mode.
- Hence this mode is termed as Enhanced Mode MOSFET.



Working of MOSFET in Enhancement mode

N-Channel MOSFET Characteristics



n-Channel Enhancement type MOSFET (a) Transfer Characteristics (b) Output Characteristics

- The current through the device will be zero until the VGS exceeds the value of threshold voltage VT.
- This state represents the cut-off region of MOSFET's operation.
- As VGS increases, even the saturation current flowing through the device also increases.
- VT is seen to increase with an increase in VGS.

thank you!