A

Seminar Report

On

MOSFET

Submitted in partial fulfillment of the requirement for the award of degree of ECE

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Acknowledgement

I would like to thank respected Mr…….. and Mr. ……..for giving me such a wonderful opportunity to expand my knowledge for my own branch and giving me guidelines to present a seminar report. It helped me a lot to realize of what we study for.

Secondly, I would like to thank my parents who patiently helped me as i went through my work and helped to modify and eliminate some of the irrelevant or un-necessary stuffs.

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Last but clearly not the least, I would thank The Almighty for giving me strength to complete my report on time.

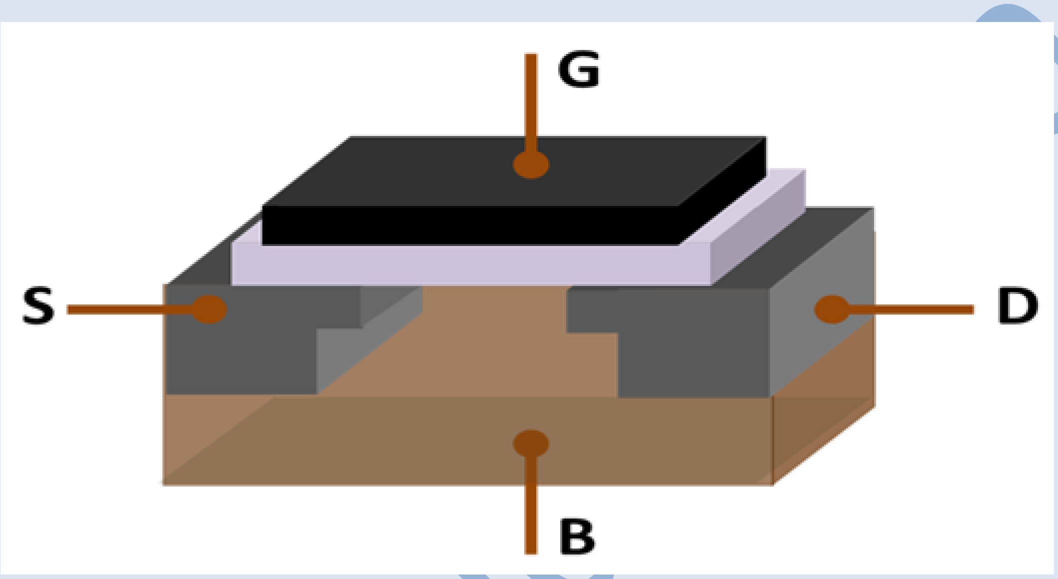
Preface

I have made this report file on the topic **MOSFET**; I have tried my best to elucidate all the relevant detail to the topic to be included in the report. While in the beginning I have tried to give a general view about this topic.

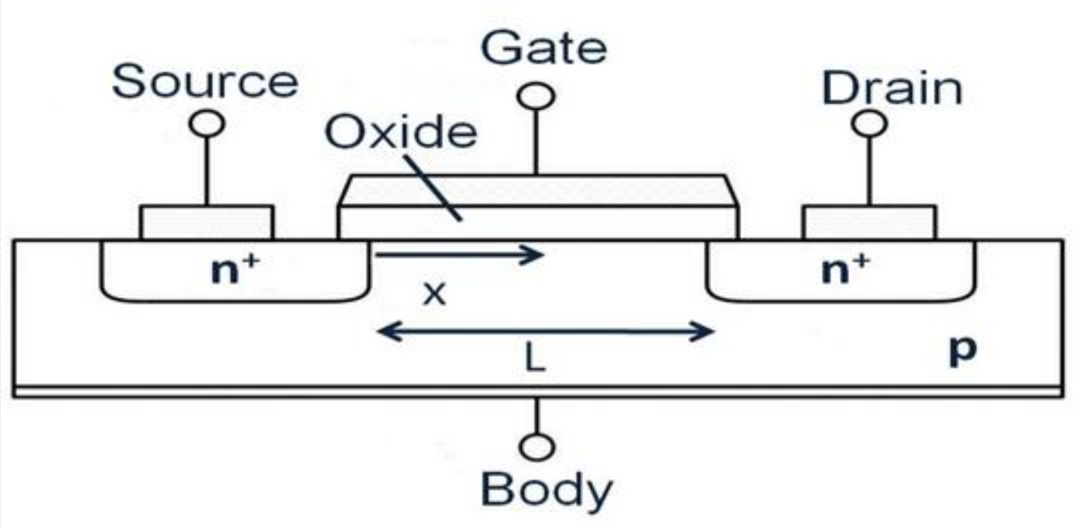
My efforts and wholehearted co-corporation of each and everyone has ended on a successful note. I express my sincere gratitude to …………..who assisting me throughout the preparation of this topic. I thank him for providing me the reinforcement, confidence and most importantly the track for the topic whenever I needed it.

Introduction

The MOSFET (Metal Oxide Semiconductor Field Effect Transistor) transistor is a semiconductor device which is widely used for switching and amplifying electronic signals in the electronic devices. The MOSFET is a core of integrated circuit and it can be designed and fabricated in a single chip because of these very small sizes. The MOSFET is a four terminal device with source(S), gate (G), drain (D) and body (B) terminals. The body of the MOSFET is frequently connected to the source terminal so making it a three terminal device like field effect transistor. The MOSFET is very far the most common transistor and can be used in both analog and digital circuits.



The MOSFET works by electronically varying the width of a channel along which charge carriers flow (electrons or holes). The charge carriers enter the channel at source and exit via the drain. The width of the channel is controlled by the voltage on an electrode is called gate which is located between source and drain. It is insulated from the channel near an extremely thin layer of metal oxide. The MOS capacity present in the device is the main part



The MOSFET can be function in two ways

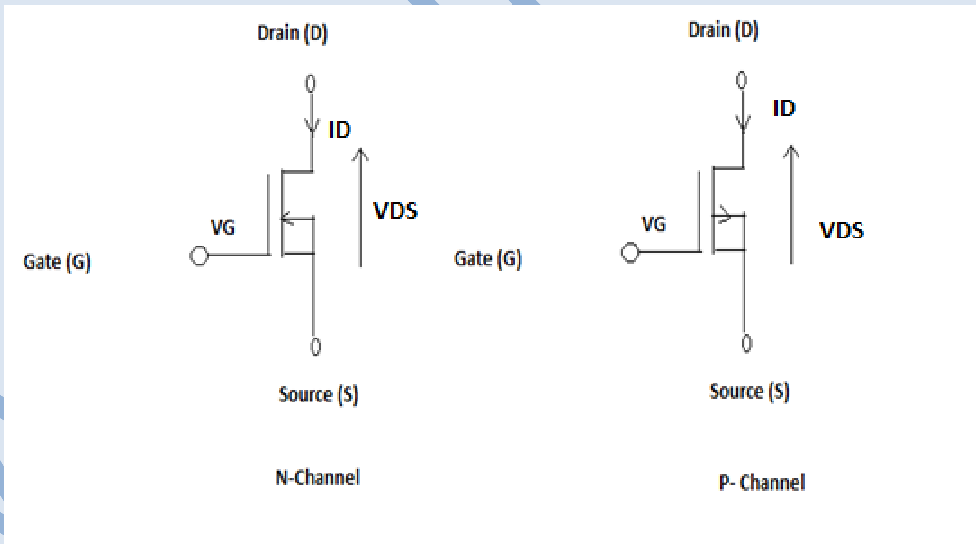
Deflection Mode

Enhancement Mode

Deflection Mode:

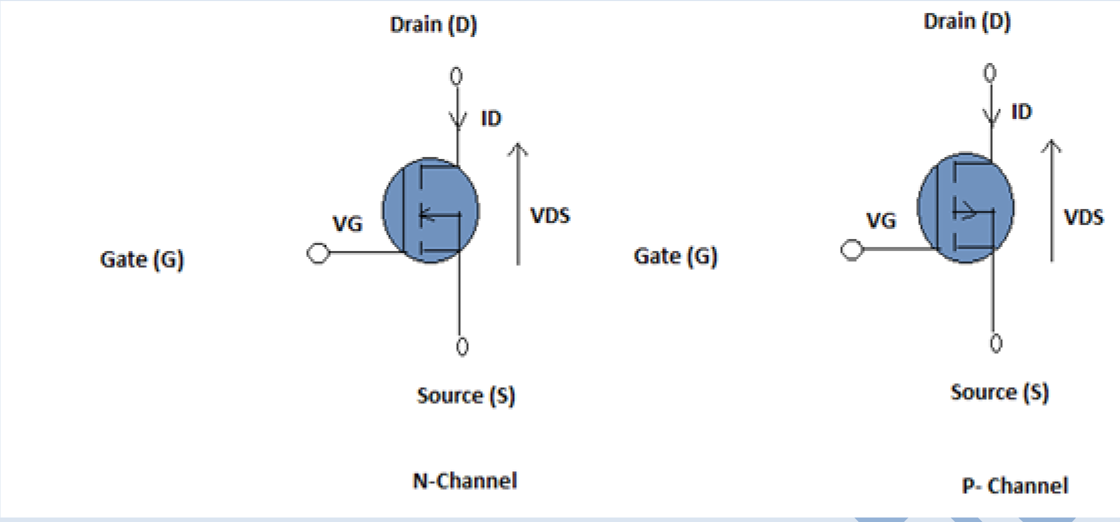
When there is no voltage on the gate, the channel shows its maximum conductance. As the voltage on the gate is either positive or negative, the channel conductivity decreases.

For example



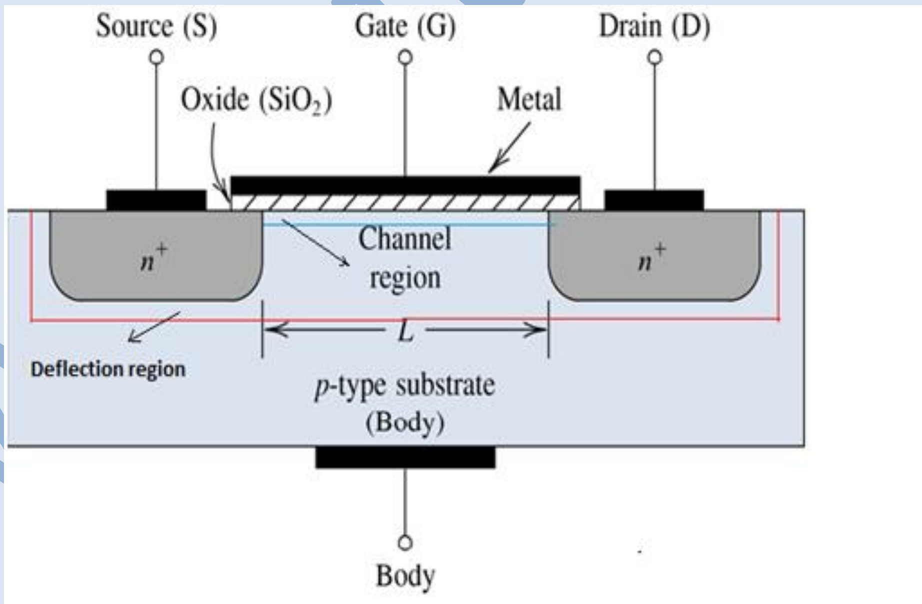
Enhancement mode:

When there is no voltage on the gate the device does not conduct. More is the voltage on the gate, the better the device can conduct.



Working Principle of MOSFET:

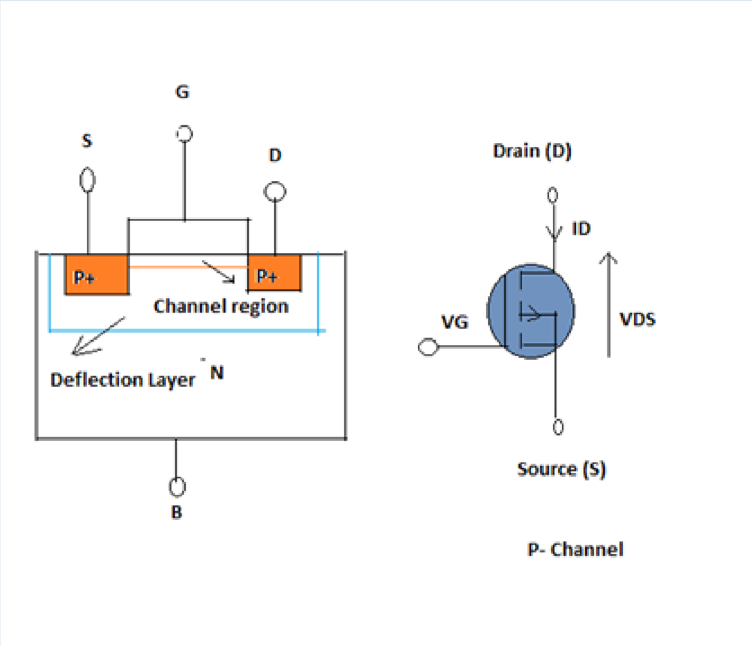
The aim of the MOSTFET is to be able to control the voltage and current flow between the source and drain. It works almost as a switch. The working of MOSFET depends upon the MOS capacitor. The MOS capacitor is the main part of MOSFET. The semiconductor surface at the below oxide layer which is located between source and drain terminal. It can be inverted from p-type to n-type by applying a positive or negative gate voltages respectively. When we apply the positive gate voltage the holes present under the oxide layer with a repulsive force and holes are pushed downward with the substrate. The deflection region populated by the bound negative charges which are associated with the acceptor atoms. The electrons reach channel is formed. The positive voltage also attracts electrons from the n+ source and drain regions into the channel. Now, if a voltage is applied between the drain and source, the current flows freely between the source and drain and the gate voltage controls the electrons in the channel. Instead of positive voltage if we apply negative voltage , a hole channel will be formed under the oxide layer.



MOSFET Block Diagram

P-Channel MOSFET:

The P- Channel MOSFET has a P- Channel region between source and drain. It is a four terminal device such as gate, drain, source, body. The drain and source are heavily doped p+ region and the body or substrate is n-type. The flow of current is positively charged holes. When we apply the negative gate voltage, the electrons present under the oxide layer with are pushed downward into the substrate with a repulsive force. The deflection region populated by the bound positive charges which are associated with the donor atoms. The negative gate voltage also attracts holes from p+ source and drain region into the channel region.

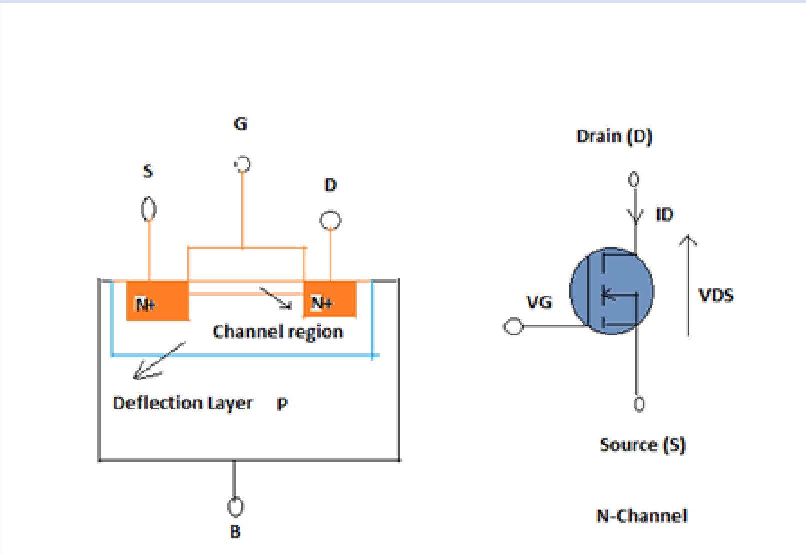


Enhanced mode

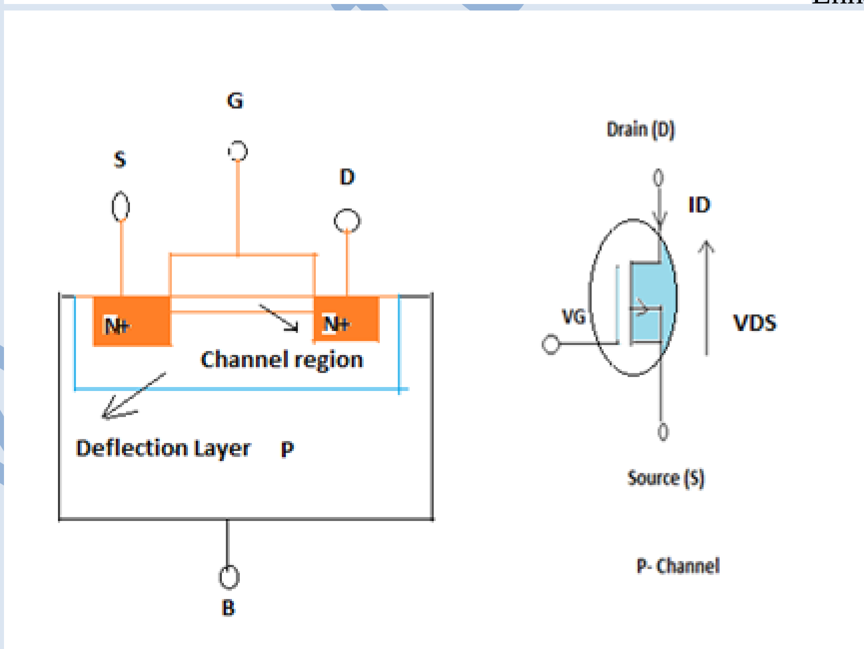
Deflection Mode

N- Channel MOSFET:

The N-Channel MOSFET has a N- channel region between source and drain It is a four terminal device such as gate, drain , source , body. This type of MOSFET the drain and source are heavily doped n+ region and the substrate or body is P- type. The current flows due to the negatively charged electrons. When we apply the positive gate voltage the holes present under the oxide layer pushed downward into the substrate with a repulsive force. The deflection region is populated by the bound negative charges which are associated with the acceptor atoms. The electrons reach channel is formed. The positive voltage also attracts electrons from the n+ source and drain regions into the channel. Now, if a voltage is applied between the drain and source the current flows freely between the source and drain and the gate voltage controls the electrons in the channel. Instead of positive voltage if we apply negative voltage a hole channel will be formed under the oxide layer.

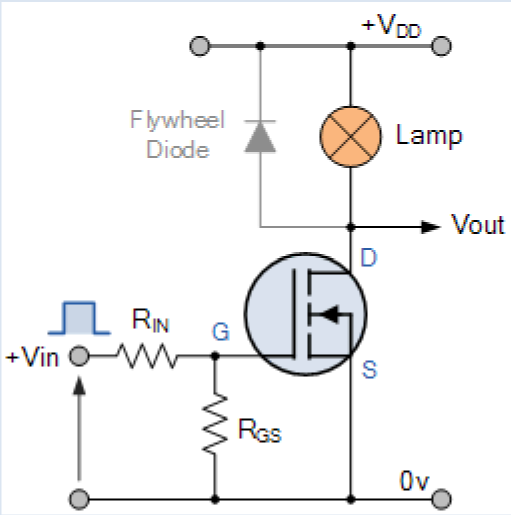


Enhanced mode



Deflection Mode

For Example Using the MOSFET as a Switch:



MOSFET SWITCH

In this circuit arrangement an enhanced mode and N-channel MOSFET is being used to switch a sample lamp ON and OFF. The positive gate voltage is applied to the base of the transistor and the lamp is ON (V_{GS} =+v) or at zero voltage level the device turns off (V_{GS}=0). If the resistive load of the lamp was to be replaced by an inductive load and connected to the relay or diode which is protect to the load. In the above circuit, it is a very simple circuit for switching a resistive load such as lamp or LED. But when using MOSFET to switch either inductive load or capacitive load protection is required to contain the MOSFET device. We are not giving the protection the MOSFET device is damage. For the MOSFET to operate as an analog switching device, it needs to be switched between its cutoff region where V_{GS} =0 and saturation region where V_{GS} =+v.

A Video Description of MOSFET as a Switch

MOSFET is also a transistor. We abbreviate it as Metal Oxide Silicon Field Effect Transistor. It will have P-channel and N-channel. It consists of a source, gate and drain. Here we connected a resistive load of 24Ω in series with an ammeter, and a voltage meter connected across the MOSFET. In the transistor the current flow in the gate is in positive direction and source goes to ground. In BJT's, the current flow is base-to-emitter circuit. But in MOSFET there is no current flow because there is a capacitor at the beginning of the gate, it just requires only voltage. We will know this by doing the simulation process with switching ON/OFF. When the switch is ON there is no current flow in the circuit, when we taken a resistance of 24Ω and 0.29 of ammeter voltage then we find negligible voltage drop across the source because there is +0.21V across MOSFET.

Resistance between drain and source is called RDS. Because of RDS, the voltage drop appears while current flow in circuit. RDS varies depending on the type of MOSFET (it could be 0.001, 0.005, and 0.05 depending on the voltage type).

Finally, we will conclude that, the transistor requires current whereas MOSFET require voltage. The driving requirement for the MOSFET is much better, much simpler as compared to a BJT.

Important MOSFET Parameters

Maximum Drain-Source Voltage, V_{DS}

V_{DS} is the maximum instantaneous operating voltage.

Continuous Drain Current, I_D

I_D is the maximum current the MOSFET can carry sometimes specified at a particular junction temperature.

Maximum Pulsed Drain Current, I_{DM}

I_{DM} is greater than ID and specified for a particular pulse width and duty cycle.

Maximum Gate-Source Voltage, V_{GS}

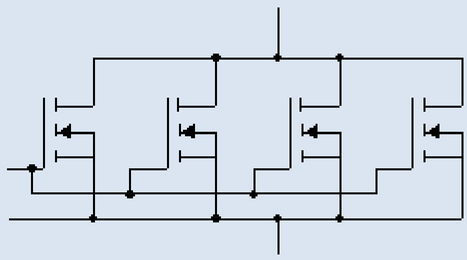
V_{GS} is the maximum voltage that can be applied between gate and source without damaging the gate insulation.

Gate Threshold Voltage, V_T , {V_{TH} , $V_{GS(th)}$ }

V_T is the minimum gate voltage at which the transistor will turn ON.

Parallel Connected MOSFETs

The parallel connection of MOSFETs allows higher load currents to be handled by sharing the current between the individual switches. Because MOSFETs have a positive temperature coefficient they can be paralled without the need for source resistors (BJTs need small emitter resistors that provide negative feedback). If one MOSFET starts to draw slightly more current than the others it heats up and its impedance increases which results in the current through it decreasing. Parallel MOSFETs should be mounted close together so that the gate drive impedances are the same and all transistors switch at the same time.



Advancements of the MOSFET

- The explosion of digital technologies has pushed the advancement of MOSFET technologies faster than any other Si transistor. This has happened due to the MOSFET being the prime building block of CMOS digital logic circuits.
- CMOS circuits are advantageous because they allow virtually no current to pass through and thus consume very little power.

Limitations of the MOSFET

- Overheating is very much a concern when considering today's integrated circuits contain millions of transistors in a relatively small space.
- Recently, the small size of MOSFETs has created operational problems as producing such tiny transistors is an enormous challenge,

REFERENCES

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