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POWER FET STRUCTURES (DMOS AND VMOS) AND APPLICATIONS

Abstract

Power MOSFETS are designed to handle significant power levels. It's main advantages are its high commutation speed and good efficiency at low voltage levels. Power MOSFETS have a vertical structure rather than a planar structure.

Outline

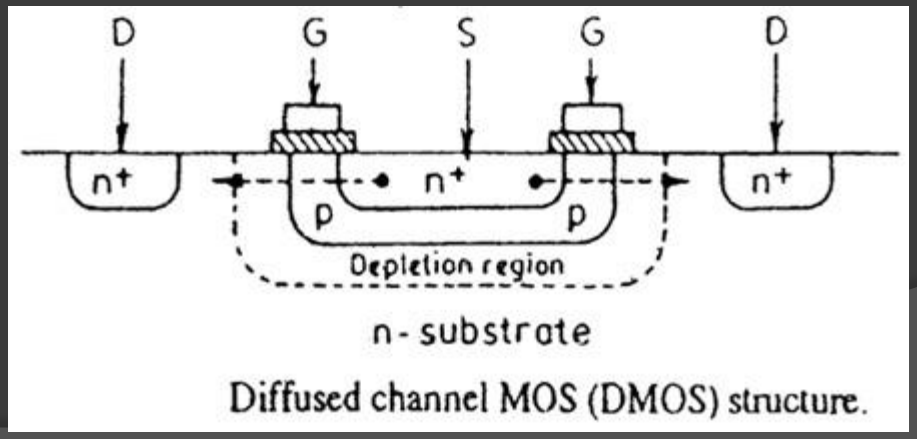
- DMOS
  - What is a DMOS?
  - DMOS Structure
  - DMOS Applications
- VMOS
  - What is a VMOS?
  - VMOS Structure
  - VMOS Applications

DMOS what is it?

- Double-diffused MOSFET (DMOS)
- A power MOSFET in which the source and channel regions are formed using a double diffusion process
- Used in switching applications with high voltage and high frequencies

DMOS Structure

- p-substrate region and the n+ source contact are diffused through a common window defined by edge of gate
- p-base region is diffused deeper than the n+ source
- Result: difference in the lateral diffusion distance between p-base and the source defines the surface channel length



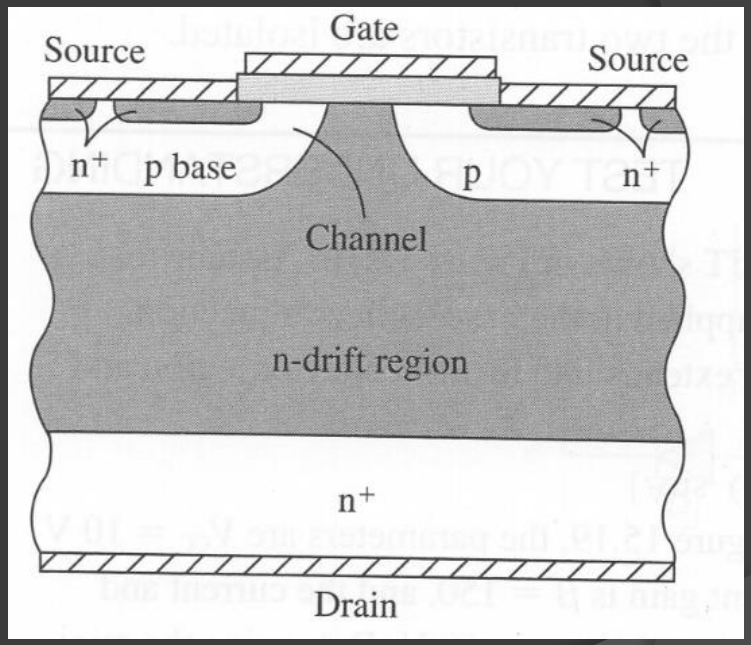
Diffused channel MOS (DMOS) structure.

http://www.circuitstoday.com/wp-content/uploads/2010/07/DMOS-Structure.jpg

DMOS Structure

- Electrons enter the source terminal and flow laterally through the inversion layer under the gate to the n-drift region.
- Once here the electrons flow vertically through the n-drift region to the drain terminal.
- Conventional current direction is from the drain to the source.

Cross-section of DMOS



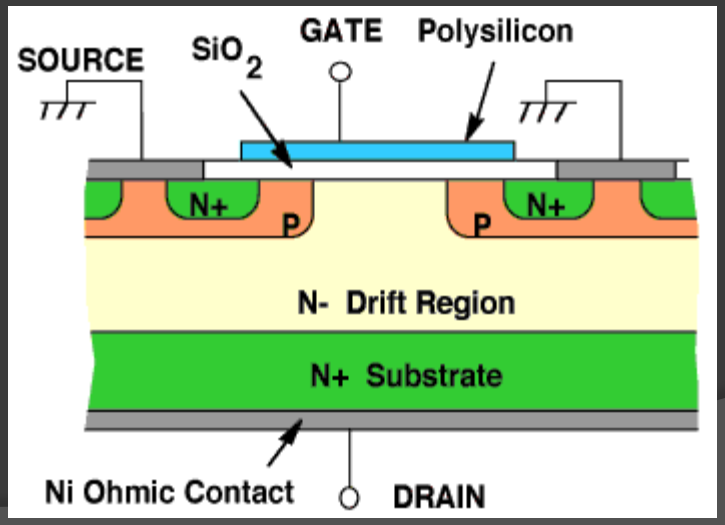
Semiconductor Physics and Devices textbook by Donald A. Neamen

DMOS Structure

- DMOS similar to BJT
- Important characteristic are the breakdown voltage and the on-resistance
- A lightly doped drift region between the drain contact and the channel region helps ensure a very high breakdown voltage

DMOS Structure

- The n-drift region must be moderately doped so that the drain breakdown voltage is large
- The thickness of the n-drift region should be as thin as possible in order to minimize drain resistance



Applications of DMOS

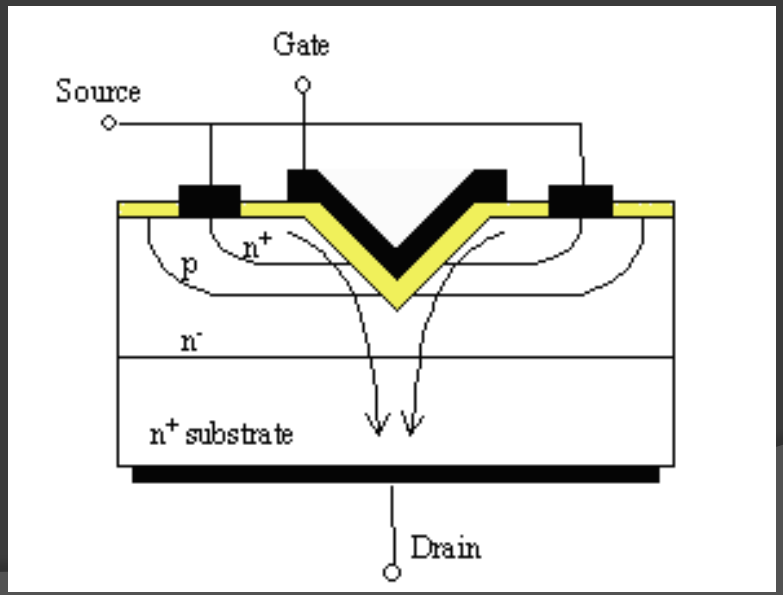
- Automotive Control Applications
- Power supplies
- Inkjet print heads

VMOS what is it?

- Named after V-shaped gate region
- Vertical MOSFET with high current handling capability as well as high blocking voltage
- Consists of a double diffused n^+/p layer, which is cut by a V-shaped groove
- Metalized area over the V-groove controls the current flow in the P region

Structure of VMOS

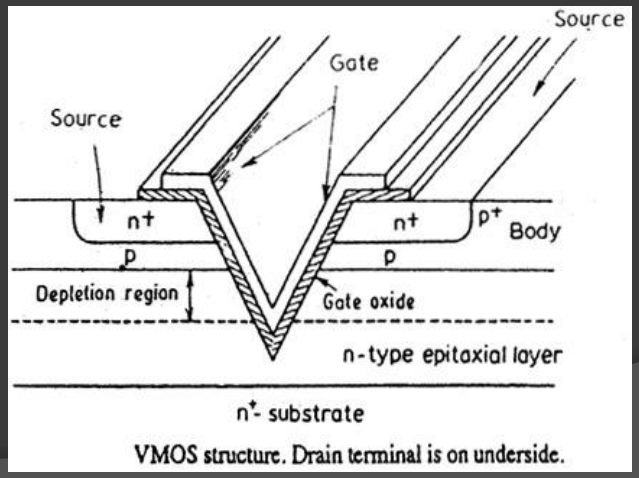
- V-groove cuts through the double diffused layer creating two vertical MOSFETs
- Short gate length, which is determined by thickness of p-type layer
- Vertical structure allows for use of low-doped drain region which results in a high blocking voltage



http://ecee.colorado.edu/~bart/book/book/chapter7/ch7_8.htm#7_8_2

Structure of VMOS

- V shape allows device to deliver higher amount of current from source to the drain
- Shape of the depletion region creates a wider channel
- The V-shaped gate increases the cross-sectional area of source-to-drain path

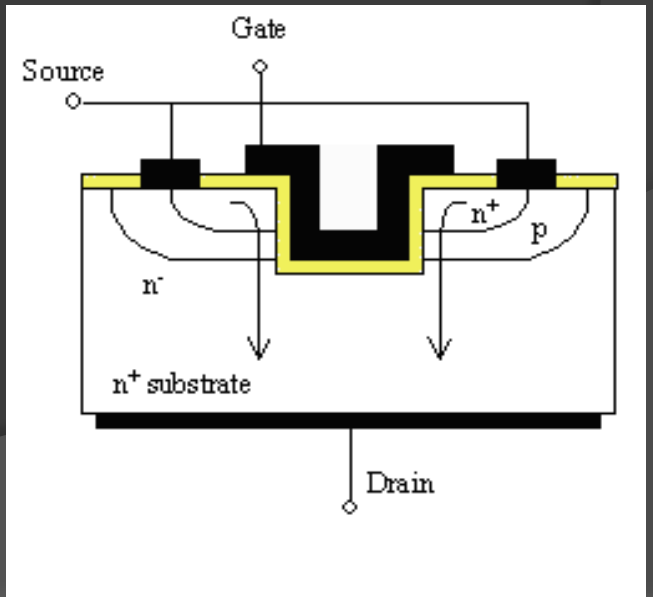


VMOS structure. Drain terminal is on underside.

Structure of VMOS

- Main drawback of VMOS:
  - Structure is more complicated than traditional FETs, making it more expensive.

- UMOS
  - More cross-sectional surface area



Application of VMOS

- Hi-fi audio power amplifiers
- Broadband high frequency amplifiers
- Switching power amplifiers

Summary

- Power MOSETS have a vertical structure of both the DMOS and VMOS
- Used in a variety of applications that desire increased switching speeds and a variety of voltage levels
- Doping and channel lengths contribute to the characteristic of each of these MOSFETs

References

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Five Key Points

- Main advantages are high commutation speed and good efficiency at low voltages
- Power MOSFETS have a vertical structure rather than planar
- DMOS uses double diffusion process
- V-shaped gate in VMOS increases cross-sectional area of the source-to-drain path
- Most important characteristics are the breakdown voltage and the on-resistance