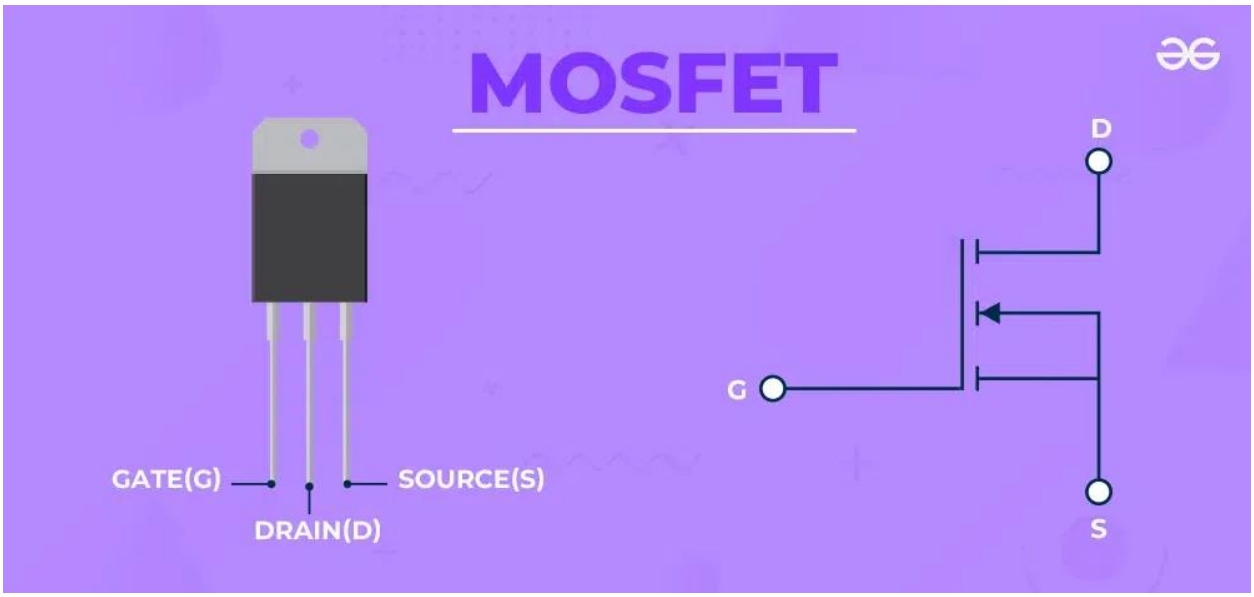
MOSFET Report

What is MOSFET?



MOSFET stands for metal oxide semiconductor field-effect transistor, and it is a field effect transistor where the voltage determines the conductivity of the device. It is a commonly used electronic component that is widely used in digital and electronic circuits.

It is used for switching or amplifying signals. The ability to change conductivity with the amount of applied voltage can be used for amplifying or switching electronic circuits.

The MOSFET consists of three main parts: the gate, the source and the drain. The gate is used to control the current, the source is used to introduce the current, the drain is used to output the current.

MOSFET Key Parameters:

1. Drain-Source Voltage (VDS) – This is the maximum voltage that can be applied across the drain and source terminals of the MOSFET without causing breakdown.

2. Drain Current (ID) – This is the maximum current that the MOSFET can handle without exceeding its thermal limits or causing damage.

3. On-State Resistance (RDS(on)) – This is the resistance of the MOSFET when it is fully turned on. Lower values of RDS (on) lead to less power dissipation and lower conduction losses.

4. Gate Threshold Voltage (VGS(th)) – This is the voltage required to turn on the MOSFET. It is important to choose a MOSFET with a VGS(th) that is compatible with your drive circuit.

5. Gate Charge (QG) – This is the total amount of charge required to fully turn on the MOSFET. MOSFETs with higher

gate charge require more drive current and may be slower to switch.

6. Switching Speed – This is the amount of time required for the MOSFET to transition from fully off to fully on or vice versa. MOSFETs with faster switching speeds may have higher switching losses but can allow for higher switching frequencies.

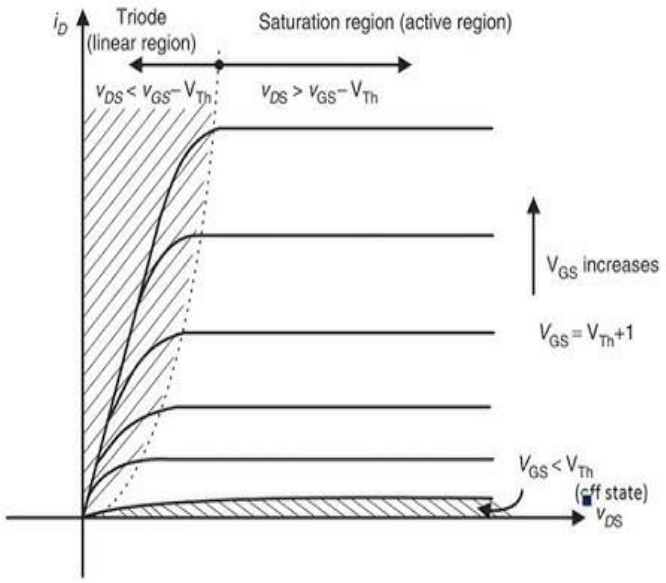
7. Thermal Resistance (RθJA) – This is the resistance from the MOSFET junction to the ambient air. It is important to choose a MOSFET with a low RθJA to minimize heat dissipation.

8. Package Type – MOSFETs come in a variety of package types, including through-hole and surface-mount options. It is important to choose a package type that is compatible with your PCB and assembly processes.

Operation Regions of MOSFET

The function of a MOSFET can be classified into different regions depending on the voltage applied at its terminal. The three main operations regions are:

- **Cut-off Region (VGS < Vt):** In this area, the gate-to-source voltage (VGS) is lower than the threshold voltage (Vt) and the MOSFET is in the off state. The channel is not conducting and the current from the drain to the source is very small. MOSFET is an open switch in this region.
- **Triode Region (VGS > Vt, VDS < VGS – Vt):** In the triode region the gate-to-source voltage (VGS) exceeds the threshold voltage (Vt), and the drain-to-source voltage (VDS) is also significant but less than the difference between VGS and Vt. In this region, the MOSFET behaves as a variable resistor. Both VGS and VDS control the drain current (ID) and the MOSFET is not fully on.
- **Saturation Region (VGS > Vt, VDS ≥ VGS – Vt):** In the saturation region, both VGS and VDS voltages are significant. The MOSFET is completely on, and there is a linear relationship between ID and VDS.The MOSFET acts as an voltage-controlled current source in this region. The saturation is the region of interest for many applications like amplifiers and digital logic circuits.



Guidelines on selecting the right MOSFET for different applications

- **Power Supplies:** For power supply applications, low RDS(on) and high VDS ratings are crucial. Ensure the MOSFET can handle the input voltage and current requirements of the power supply. Consider using synchronous rectification with N-channel MOSFETs for higher efficiency.
- **Motor Drivers:** In motor control applications, both the maximum drain current and switching speed are important. Choose MOSFETs with low $R_{DS(on)}$ to minimize conduction losses and high current capability to handle motor startup and stall currents.

- **Audio Amplifiers:** Audio amplifiers require MOSFETs with low distortion and good linearity. Look for MOSFETs with low total harmonic distortion (THD) and good thermal stability to ensure high audio quality.
- **LED Drivers:** For LED driver applications, choose MOSFETs with low RDS(on) and high switching speed to maintain efficiency. Ensure the MOSFET can handle the current requirements of the LED array.
- **DC-DC Converters:** DC-DC converters benefit from MOSFETs with low RDS(on), low gate charge, and fast switching speeds. These characteristics help improve efficiency and reduce heat generation in the converter.