MOSFET Report

Metal-Oxide-Semiconductor Field-Effect Transistor (mosfet transistor) is a three terminal semiconductor electronic device the Gate, Drain and Source.

The gate is used to control the current, the source is used to introduce current, and the drain is used to output current.

The function of the mosfet is to control the current, and by adjusting the gate voltage, the current between the source and drain can be controlled, and there are two types of the mosfet the p-channel mosfet and the N-channel mosfet, in an n-channel MOSFET, a positive gate voltage allows current to flow from drain to source, while in a p-channel MOSFET, a negative gate voltage allows current to flow

Also there are four classifications for the mosfet the P-channel enhancement, P-channel depletion, N-channel enhancement, and N-channel depletion

. **Depletion Mode:** The transistor requires the Gate-Source voltage to switch the device off. The depletion-mode mosfet is equivalent to a “Normally Closed” switch.

. **Enhancement Mode:** The transistor requires a Gate-Source voltage to switch the device on. The enhancement mode mosfet is equivalent to a “Normally Open” switch.

The key parameters:

The threshold voltage

The minimum gate –to-source voltage (Vgs)that is needed to create a conducting path between the source and drain terminals

Drain-Source Voltage (VDS)

VDS represents MOSFET absolute maximum voltage between Drain and Source. In operations, voltage stress of Drain-Source should not exceed maximum rated value

Gate-Source Voltage (VGS)

VGS represents operating driver voltage between Gate and Source. In operations, voltage stress of Gate-Source should not exceed maximum rated value.

Total Power Dissipation

PD represents the capability of maximum power dissipation that a MOSFET can handle. Moreover, capability of power dissipation varies by different temperature conditions

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IGBT Report

An insulated gate bipolar transistor (IGBT) is a three-terminal (collector, emitter, gate) power semiconductor device primarily forming an electronic switch.

It was developed to combine high efficiency with fast switching. It consists of four alternating layers PNPN that are controlled by a metal oxide semiconductor (MOS) gate structure.

The structure of an IGBT is similar to a Power MOSFET but its operation resembles a power BJT. It is because a bipolar current flows through electrons and holes. Power MOSFETs only drive unipolar current in the device. But the physical construction of IGBT is similar to an n-channel Power MOSFET with the addition of an injection layer, it combines the advantages of MOSFETs and BJTs for use in power supply and motor control circuits.

The parameters

Collector-emitter voltage (VCE)

The VCE represents a collector-emitter voltage drop in the ON state, and is used to calculate the power dissipation loss of the IGBT.

DC collector current (IC)

refers to the current flowing through the collector terminal of an IGBT. It is the primary current that determines the device's power-handling capability and influences the overall performance of the IGBT-based circuit

Gate-emitter voltage (VGE)

The voltage required at the gate terminal of an IGBT to turn it ON and establish a conducting channel between the collector and emitter terminals

Thermal resistance (RthJC)

It represents the thermal impedance between the semiconductor junction and the external case of the device.

regions of operation

Cutoff Region

The IGBT is off, and no current flows between the collector and emitter. The device behaves like an open switch.

Active Region

The IGBT is fully turned on, allowing current to flow between the collector and emitter. This region is used for switching applications, where the IGBT acts like a closed switch.

Note: I got those regions from chatGPT because I didn't find those regions well by searching

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High Side vs. Low Side Switching

In systems employing high-side switching, the switch is inserted between the positive power line and the load. Low-side switching, by contrast, connects the load to ground.

High-side switching is the preferred switching technique in situations where short circuits to ground are likelier to occur than short circuits to the positive power line. Think for instance of cars or machines where most of the structure or body is connected to ground. In such cases it is safer to disconnect the load from the battery than from ground. Also, in humid environments, this usually results in less connector corrosion as the load carries no voltage in the off state.

So in cases where a (heavy) load only has to be switched on or off, high-side switching is the preferred method. When the power to a load must be controlled through (relatively) high-speed PWM, for instance in a lighting or heating system, low-side switching is recommended. And then there are half H-bridges that require both a high-side and a low-side switch and PWM Therefore, as always, before settling on any technique, make sure that it is a valid choice for your particular application.

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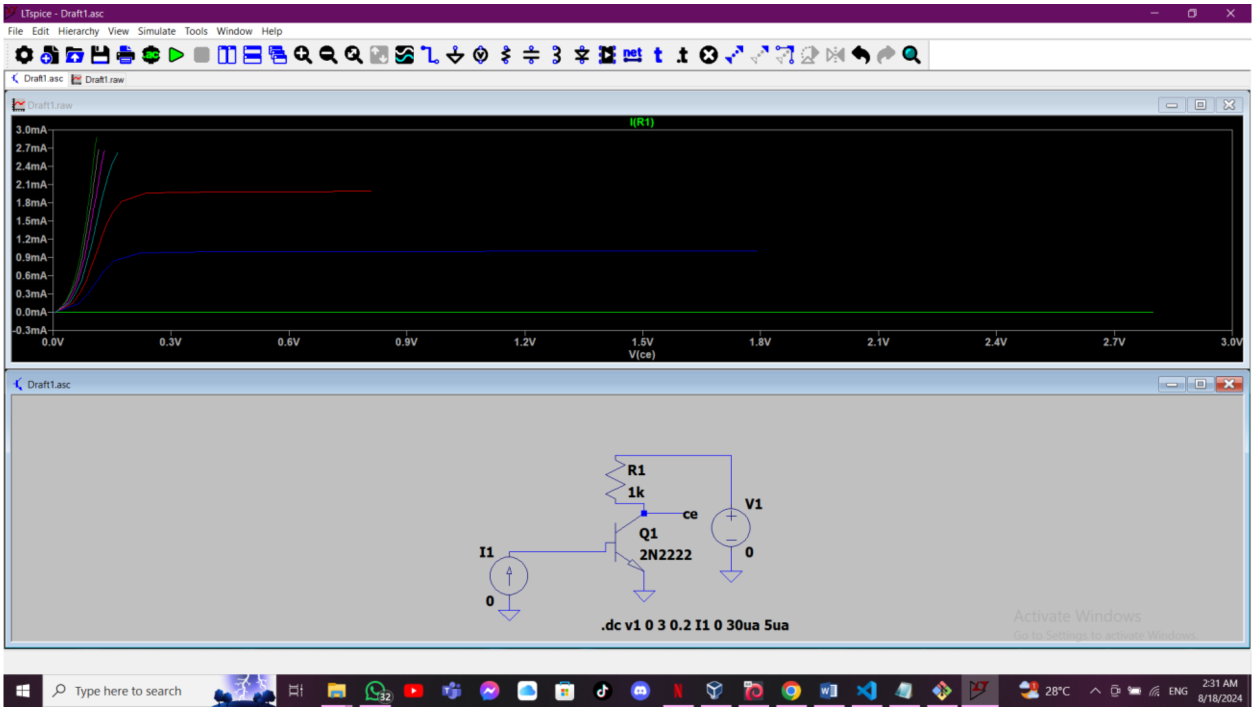
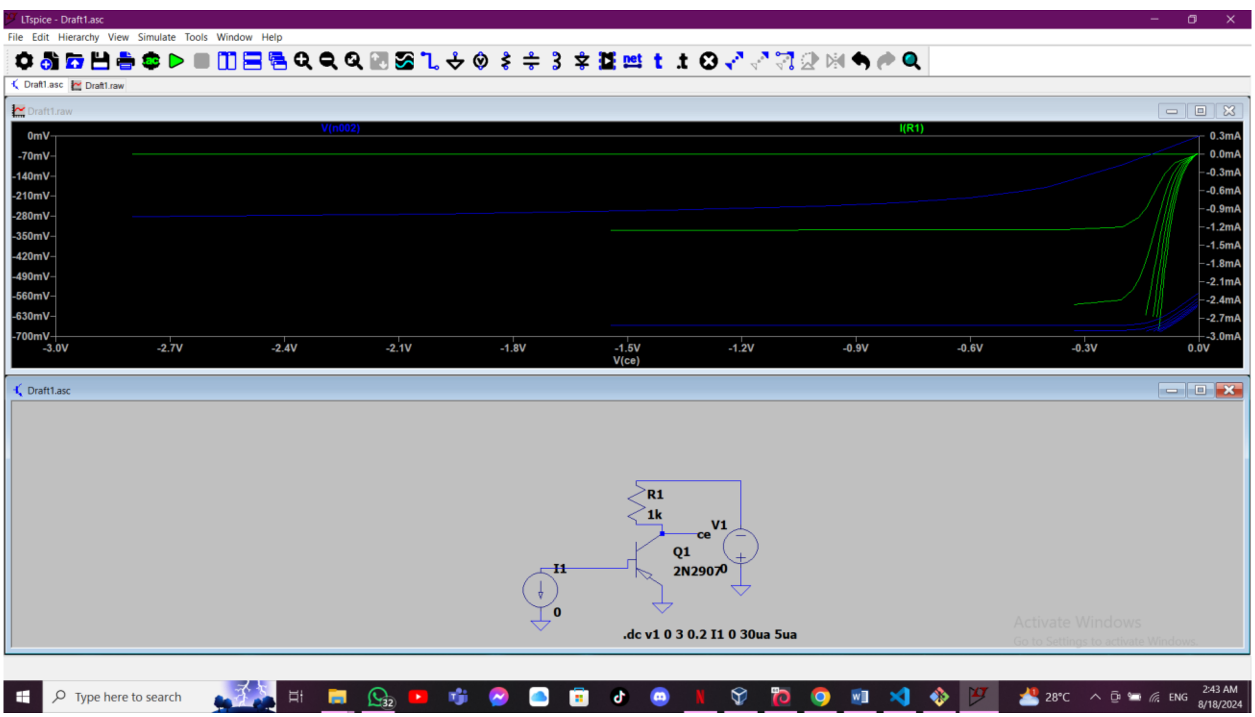
BJT Simulation



NPN simulation



. PNP simulation

In an NPN transistor, the current flows from the collector to the emitter, and it is controlled by a positive base-emitter voltage. The graph shows current increasing as the collector-emitter voltage (VCE) rises. In contrast, a PNP transistor's current flows from the emitter to the collector, controlled by a negative base-emitter voltage, so its graph shows current increasing as VCE becomes more negative. Essentially, NPN transistors are triggered by positive voltage, while PNP transistors are triggered by negative voltage.