1^{st} high side vs low side switch

1-High side switch is placed in the upper circuit with respect to an external load in power supply side (the switch between the source and the load)

2-low side switch is placed in the lower circuit in ground side

Why and when we choose one over the other

In a circuit where various loads are connected to a single power supply voltage such as in vehicle where the battery voltage is fixed and body connected to ground, the output can easily become grounded, making a high side switch better in detecting abnormal conditions such as ground faults.

In circuits which loads are placed at various power supply voltages the low side switches are ideal for it, the low side switches operates by applying an input voltage to the gate and connecting the mosfet source to the ground.

2^{nd} MOSFET parameters

1-VDS (BR) Drain-source break down voltage

If the application exceeds this voltage value it might resultnin the destruction of a mosfet

We should choose mosfets with VDS sufficiently hogher than the voltage we will be using.

2-VGS(TH) gate-source threshold voltage

Its required to turn on mosfet

This signals allows the drain current to start flowing through the mosfet

When we apply this gate voltage signal it should be at least more than the threshold voltage

Onle then the mosfet will turn on.

3-ID continuous drain current

It's the max continuous current which a mosfet can curry when the mosfet is turned on

When the junction temperature of the mosfet increases the current handling capacity of the mosfet decreases exponentialy.

4-RDS(on) It’s the resistance between drain and source

It’s the key parameter in calculating conduction loses and eventually ris in junction temperature of the mosfet,

This RDS(on) increases if VDS increases, that means if we take a different mosfet with higher VDS its RDS will definitely will be higher,

The mosfet is a positive temperature coefficient device so if the junction temperature of a mosfet increase the RDS will increase

5-IDss drain leackage current

This is also a drain to source current so when VGs is on that means the mosfet is turned off

Even if we don’t give any gate voltage signal to the mosfet still this fellow allows some small amount of current to flow, We can call it a leakage current

And this leakage current should be as small as possible

6-IDm peak drain current

It’s the maximum drain current which can flow through the mosfet for only 10ms or less

Drain current capacity changes with change in pulse timing and VDs, if the pulse duration is more this peak drain current increases

Mosfet 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 RDS(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.

3rd IGBT (insulated gate bipolar transistor)

Its a voltage-controlled power electronic switching device that combines the best characteristics of both BJTs and MOSFETs.

Key Parameters of IGBTs:

1-Collector-Emitter Voltage (V_CE)

The maximum voltage that can be applied between the collector and emitter without causing breakdown.

2-Gate-Emitter Voltage (V_GE)

The voltage required between the gate and emitter to turn the IGBT on or off. Typically, it ranges from 10V to 20V.

3-Collector Current (I_C)

The maximum current that the IGBT can handle when it is fully on.

4-Collector-Emitter Saturation Voltage (V_CE(sat))

The voltage drop across the collector-emitter when the IGBT is in the on-state and conducting its rated current.

5-Gate Charge (Q_G)

The total charge required to turn the IGBT on. It impacts the switching speed and gate drive requirements.

6-Turn-On Time (t_on) and Turn-Off Time (t_off)

The time it takes for the IGBT to switch from off to on (t_on) and from on to off (t_off). These times affect the switching losses.

7-Power Dissipation (P_D)

The amount of power the IGBT dissipates in the form of heat during operation. It is crucial for thermal management.

8-Thermal Resistance (R_thJC and R_thJA)

R_thJC: Thermal resistance from junction to case.

R_thJA: Thermal resistance from junction to ambient. Lower values indicate better heat dissipation.

9-Short-Circuit Withstand Time (t_sc)

The maximum time the IGBT can withstand a short-circuit condition before it is damaged.

10-Safe Operating Area (SOA)

A graphical representation of the voltage and current conditions over which the IGBT can safely operate without damage.

11-Input Capacitance (C_ies)

The capacitance between the gate and emitter when the collector is shorted to the emitter. It affects the switching characteristics of the IGBT.

12-Output Capacitance (C_o)

The capacitance between the collector and emitter when the gate is shorted to the emitter.

13. Reverse Recovery Time (t_rr)

The time required for the IGBT to stop conducting after it switches off, particularly in applications where it is connected to a diode.

14-Gate-Emitter Threshold Voltage (V_GE(th))*:

The minimum gate-emitter voltage needed to start turning on the IGBT.

These parameters help in selecting the right IGBT for specific applications, ensuring that the device can handle the required voltage, current, and thermal conditions while maintaining efficient operation.

Task 2

Npn overvoltage protection