COMPARISION OF STATIC CHARACTERISTICS OF IGBT AND MOSFET

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Abstract—The current driven IGBT has characteristics of high gain factor as comparison to the voltage driven MOSFET. The characteristics of the IGBT dominates the application of MOSFET but only with a disadvantage of Thermal breakthrough of IGBT decreases the output stability and harmonics introduced in the signal. In this paper the comparision of IGBT characteristics is carried out with the output characteristics experimentaly so as to optimize the standered Output levels for applications.

Keywords—Dynamic Characteristics, Static Characteristics

I. INTRODUCTION

The metal–oxide–semiconductor field-effect transistor (MOSFET, MOS-FET, or MOSFET) is a type of transistor used for amplifying or switching electronic signals. The main advantage of a MOSFET over a regular transistor is that it requires very little current to turn on (less than 1mA), while delivering a much higher current to a load (10 to 50A or more).

An insulated-gate bipolar transistor (IGBT) is a three-terminal power semiconductor device primarily used as an electronic switch which, as it was developed, came to combine high efficiency and fast switching. It switches electric power in many modern appliances: variable-frequency drives (VFDs), electric cars, trains, variable speed refrigerators, lamp ballasts, air-conditioners and even stereo systems with switching amplifiers. Since it is designed to turn on and off rapidly, amplifiers that use it often synthesize complex waveforms with pulse-width modulation and low-pass filters. In switching applications modern devices feature pulse repetition rates well into the ultrasonic range—frequencies which are at least ten times the highest audio frequency handled by the device when used as an analog audio amplifier\cite{1}

II. STATIC & DYNAMIC CHARACTERISTICS OF MEASUREMENT SYSTEM

The performance characteristics of an instrument are mainly divided into two Categories:

i) Static characteristics

ii) Dynamic characteristics

Static characteristics: The set of criteria defined for the instruments, which are used to measure the quantities which are slowly varying with time or mostly constant, i.e., do not vary with time, is called ‘static characteristics’.

Dynamic characteristics: The set of criteria defined for the instruments, which are changes rapidly with time, is called ‘dynamic characteristics’.

We conducted the experiment to verify the Static characteristics of MOSFET and IGBT. The results of the both are plotted using MATLAB\cite{2}.

III. MOSFET CHARACTERISTIC

MOSFET V-I CHARACTERISTIC

For VGS < VT, ID = 0

As VDS increases at a fixed VGS, ID increases in the triode region due to the increased lateral field, but at a decreasing rate since the inversion layer density is decreasing • Once pinch off is reached, further VDS increases only increase ID due to the formation of the high field region • The device starts in triode, and moves into saturation at higher VDS.
MOSFET ID-VGS Characteristics

As ID is increased at fixed VDS, no current flows until the inversion layer is established • For VGS slightly above threshold, the device is in saturation since there is little inversion layer density (the drain end is pinched off) • As VGS increases, a point is reached where the drain end is no longer pinched off, and the device is in the triode region • A larger VDS value postpones the point of transition to triode [3].

IV. INSULATED GATE BIPOLAR TRANSISTOR (IGBT)

OUTPUT CHARACTERISTICS

The plot for forward output characteristics of an NPT-IGBT is shown in Figure 5. It has a family of curves, each of which corresponds to a different gate-to-emitter voltage (VGE). The collector current (IC) is measured as a function of collector-emitter voltage (VCE) with the gate-emitter voltage (VGE) constant.
The transfer characteristic is defined as the variation of ICE with VGE values at different temperatures, namely, 25o C, 125o C, and -40o C. A typical transfer characteristic is shown in Figure 6. The gradient of transfer characteristic at a given temperature is a measure of the transconductance (gfs) of the device at that temperature[4]. A large gfs is desirable to obtain a high current handling capability with low gate drive voltage. The channel and gate structures dictate the gfs value. Both gfs and RDS(on) (onresistance of IGBT) are controlled by the channel length which is determined by the difference in diffusion depths of the P base and N+ emitter. The point of intersection of the tangent to the transfer characteristic determines the threshold voltage (VGE(th)) of the device[5].

![Fig 4.Drain characteristics](image)

**V. EXPERIMENTAL PROCEDURE FOR MOSFET**

**ID-VDS CHARACTERISTICS:**

1. VGS has to be kept constant.
2. Need to vary the VDS and ID current has to be noted down.
3. Results can be plotted using MATLAB.

**TO OBTAIN THE ID-VGS CHARACTERISTICS**

1. VDS has to be kept constant.
2. Need to vary the VGS and ID current has to be noted down.
3. Results can be plotted using MATLAB.

**RESULTS:**

Results were plotted using MATLAB simulator

i) For IGBT
Plot of ID-VGS characteristics for VDS =10V and VDS=15v
Fig 6. ID Vs VGS characteristics of MOSFET

ii) For IGBT
Plot of ID-VDS characteristics for VGS =5.1V and VDS=5.2v

Fig 7. ID Vs VDS characteristics of MOSFET

iii) For MOSFET
Plot of ID-VDS characteristics for VGS =3.5V and VDS=3.7v

Fig 8. ID Vs VGS characteristics of IGBT
iv) For MOSFET Plot of ID-VDS characteristics for VDS =10V and VDS=15v

![Graphs of ID-VDS characteristics for IGBT](image)

Fig 9. ID Vs VDS characteristics of IGBT

VI. CONCLUSION

Experimental simulations obtained from the MALTAB are differed from the actual implementation due to the hardware set up.

REFERENCES