

IGBT

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IGBT stands for Insulated Gate Bipolar Transistor.

IGBT is semiconductor device that has a three terminal. The three terminals of the IGBT are: emitter (E), collector (C) and gate (G) as shown in figure (1).

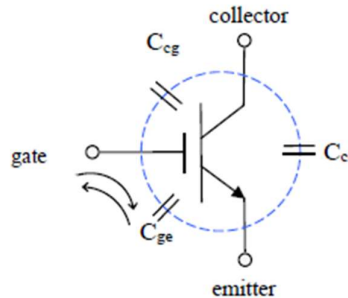


Figure 1: IGBT Symbol

It is used in electronic circuits as switch or amplifier of signals.

1. Characteristics of IGBT.

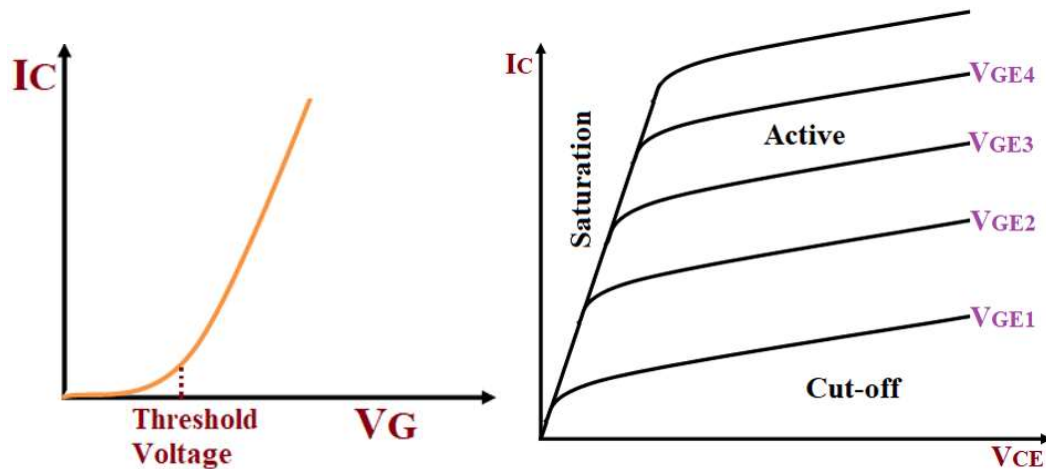


Figure 2: IGBT Characteristics Left- transfer characteristics Right- collector characteristics

The IGBT has the combined characteristics of BJT (high-power) and MOSFET (high-speed converting and voltage-driven). The control signal is applied to the gate terminal of the IGBT.

The IGBT shares the collector characteristics of a BJT, with the same saturation cut-off and active regions. It shares the transfer characteristics of a MOSFET and the control method, which is voltage control (V_{GE}).

IGBT can only be used for low frequencies (kHz).

It has low forward voltage drop.

2. IGBT Driver.

Due to presence of capacitance in gate terminal, additional circuit is needed to charge and discharge input capacitor to switch on and off IGBT. So, IGBT driver is a component which rapidly charges and discharges IGBT gate according to control signals, and make it switch on and off normally.

IGBT emitter or IGBT collector their potentials change periodically in applications. So, Gate drivers function as providing short-circuit protection and drive correct potential difference.

IGBT driver is also used to amplify the control signals.

3. Key Parameters

I. Absolute Maximum Ratings

(All at an ambient temperature of 25 °C unless otherwise specified)

- VCE: Maximum allowable voltage between collector and emitter when the IGBT is turned off. Exceeding the voltage will cause an avalanche breakdown of the IGBT and damage it beyond repair
- VGE: Maximum allowable voltage between the gate and emitter. As VGE increases, the faster it turns on and the more VGE decreases, the faster it turns off. If the VGE is greater than the positive or negative limits, the IGBT will break due to oxide breakdown and dielectric rupture.
- IC: Maximum continuous collector current. The continuous collector current determines the amount of heat dissipated in the IGBT. The higher the current that passes through the IGBT, the more the heat is dissipated. If the current is too high, the temperature will reach the point where the IGBT will be damaged. It is also important to know that the maximum continuous current decreases as switching frequency increases as seen in figure 3:

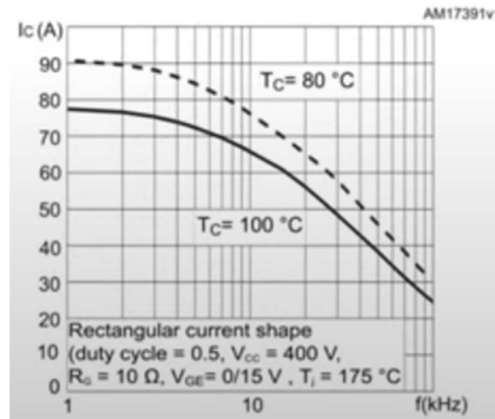


Figure 3: Collector current against switching frequency for an IGBT

- Peak Collector Current: also called the pulse collector current it is much higher when compared to continuous collector current maximum due to the heat dissipating in an instant will not raise the temperature as much as continuous release of heat.

II. Safe Operating Area

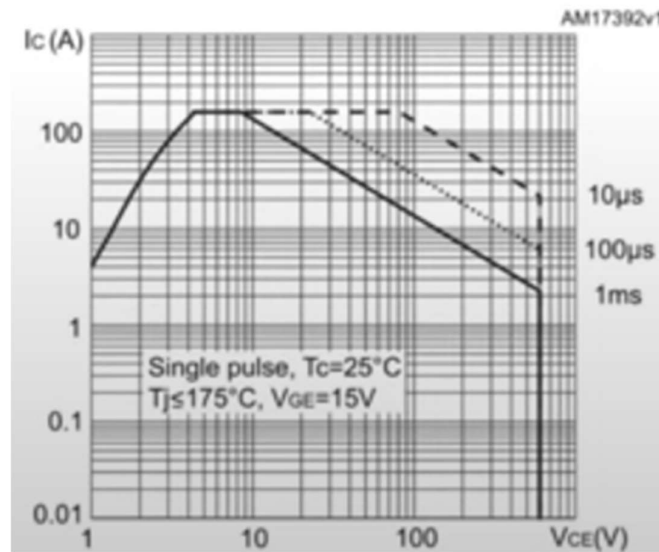


Figure 4: Safe Operating Area of an IGBT

4. References

- <https://components101.com/articles/what-is-igbt-working-operation-symbol-and-types>
- <https://www.electronics-tutorials.ws/power/insulated-gate-bipolar-transistor.html>
- How to select an IGBT? IGBT selection | How to find a right IGBT? By Foolish Engineer:
<https://www.youtube.com/watch?v=XWh0Mr35hVU>