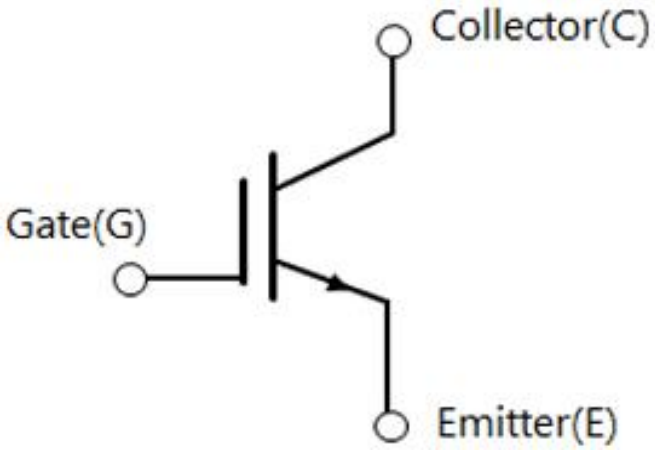
IGBT

What is an IGBT?



IGBT stands for insulated-gate bipolar transistor. It is a power transistor that takes the best part of a conventional bipolar junction transistor and a field effect transistor, the high input impedance and high switching speeds of a MOSFET with low saturation voltage of a bipolar transistor, and combines them together to produce another type of transistor switching device that is capable of handling large collector-emitter currents with virtually zero gate current drive.

An IGBT is a semiconductor device that consist of three

terminals, the collector that where the main current enters the IGBT, the emitter that where the main current exits the LGBT and the gate that is the control terminal where a voltage is applied to turn the device on or off.

Key Parameters

- **Collector-Emitter Voltage:** This parameter determines the maximum voltage the IGBT can block without breaking down**.**
- **Gate-Emitter Voltage**: Exceeding this voltage can damage the gate oxide layer, leading to device failure.
- **Collector Current**: This determines the maximum current the device can handle under normal operating conditions.
- **Gate Charge**: Affects the switching speed and efficiency. Lower gate charge allows faster switching and reduced power loss during switching.
- **Total Power Dissipation:** This parameter is critical for thermal management and determining the need for cooling solutions.

Operation Regions of IGBT

The function of an IGBT can be classified into different regions depending on the voltage applied at its terminals. The three main operation regions are:

- **Cut-off Region (V_GE < V_th) :** In this region, the gate-to-emitter voltage (V_GE) is lower than the threshold voltage (V_th), and the IGBT is in the off state. The device does not conduct, and there is minimal current flow between the collector and emitter. The IGBT behaves like an open switch in this region.
- **Active (linear) Region (V_GE > V_th, V_CE > 0) :** In the active region, the gate-to-emitter voltage (V_GE) exceeds the threshold voltage (V_th), and the collector-to-emitter voltage (V_CE) is significant. The IGBT is partially on, and the current flow through the collector is controlled by the gate voltage. The device operates in a linear manner, with the IGBT acting like a voltage-controlled current source.
- **Saturation Region (V_GE > V_th, V_CE ≈ Low):** In the saturation region, the gate-to-emitter voltage (V_GE) remains above the threshold voltage (V_th), and the collector-to-emitter voltage (V_CE) is minimal. The IGBT is fully on, allowing maximum current flow between the collector and emitter with minimal voltage drop across the device. The IGBT acts like a closed switch in this

region. This region is often used for power switching applications.