IGBT (Insulated Gate Bipolar Transistor)

Introduction

The insulated gate bipolar transistor (IGBT) was developed to combine high efficiency with fast switching. It combines high input impedance of a MOSFET with the low saturation voltage of bipolar junction transistor (BJT). Since it is designed to turn on and off rapidly it is widely used in electronics applications requiring efficient switching and high voltage operation.

Key Parameters

- Collector-Emitter Voltage (V_{CE}): It describes the threshold voltage between the collector and the emitter, that keeps the IGBT in its off state. If this value is exceeded, the IGBT will act as a closed switch.
- Collector Current (I_C): The maximum current that can go through the collector when the IGBT is in its on state.
- Gate Threshold Voltage ($V_{GE_{th}}$): The minimum voltage needed between the gate and the emitter in order to turn the IGBT on.
- On-State Voltage ($V_{CE_{sat}}$): The voltage between the collector and the emitter when the IGBT is in saturation and fully conducting.

Operating Regions

1. Cutoff Region: The IGBT is in this region when the gate-emitter voltage (V_{GE}) is below the threshold value. No current flows between the collector and the emitter, and the IGBT is in its off state.
2. Active Region: The IGBT enters this region when the gate-emitter voltage (V_{GE}) exceeds the threshold value. Then, the IGBT enters it on state, and acts like voltage-controlled current source.
3. Saturation Region: The IGBT is fully on in this region, and acts like a closed switch. In this region, the collector-emitter voltage (V_{CE}) is minimal, and most of the applied voltage appears across the load.