1.8 Study of IGCT

The Integrated Gate-Commutated Thyristor (IGCT) operates on the principle thatthyristors are ideal conduction devices whereas transistors are ideal turn-off devices. The IGCT therefore converts a thyristor structure to a transistor structure prior to turn- off by fast commutation of the cathode current and keeps it biased off with a 20 V source. This results in a device which dynamically and statically blocks like an IGBT (open-base pnp transistor producing the same turn-off losses) but conducts like a thyristor i.e. with about half the on-state voltage due to the greater plasma density produced by the two emitters. (pnp & npn transistors)

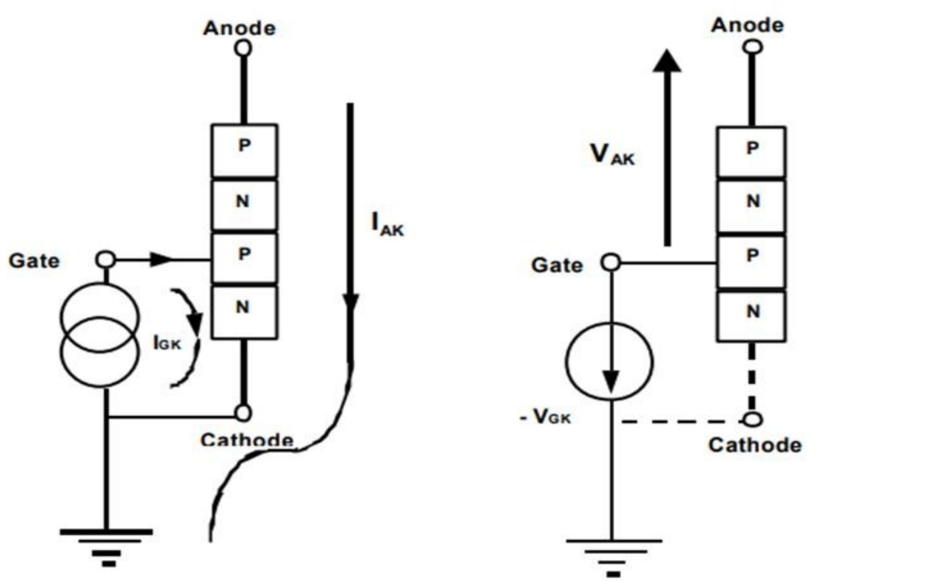

Fig 1.8.1 Symbol of IGCT

[Source: "Power Electronics" by P.S.Bimbra, Khanna Publishers Page: 27]

IGCT is the new member in the power semiconductor family (1997). It was introduced by ABB. It is a special type of GTO thyristor. Similar to GTO, it is a fully controllable power switch. ie, It can be turned-On and turned-Off by applying a gate signal. It has lower conduction losses as compared to GTO thyristors. It withstands higher rates of voltage rise(dv/dt). So snubber circuits are not required for most of the applications.

STATIC AND SWITCHING CHARACTERISTICS OF IGCT

The structure of IGCT is very similar to a GTO thyristor.

In an IGCT, the gate turn-off current is greater than the anode current. This results in shorterturn-off times.The main difference compared with a GTO and thyristor is a reduction in cell size, combined with a much more substantial gate connection, resulting in a much lower inductance in the gate drive circuit and drive circuit connection.The very high gate currents and the fast di/dt rise of the gate current means that regular wires cannot be used to connect the gate drive to the IGCT.

TURN-ON

In the turn-on mode, GCT behaves exactly like a thyristor (or a GTO). This operation principle can be understood by considering the equivalent two-transistor model. The p+n− p and n+ p n− regions represent PNP and NPN transistors respectively. The anode of the GCT is connected to p+ region, which is the emitter of the PNP transistor. The collector of the PNP is connected to the gate of the NPN transistor and vice-versa, because of n− region neighboring the p region. The cathode of the GCT is connected to the n+ region, which is the emitter of the NPN transistor. This two-transistor model has two stable states, ON and OFF, which are determined by the gate control. When a current is supplied to the gate to turn on the GCT, the gate current flows to the cathode.

This turns on the NPN transistor and its collector current will now flow from the anode through the J1junction. The J1junction is the emitter of the PNP transistor; therefore,the collector current of the PNP is then the base current of the NPN.

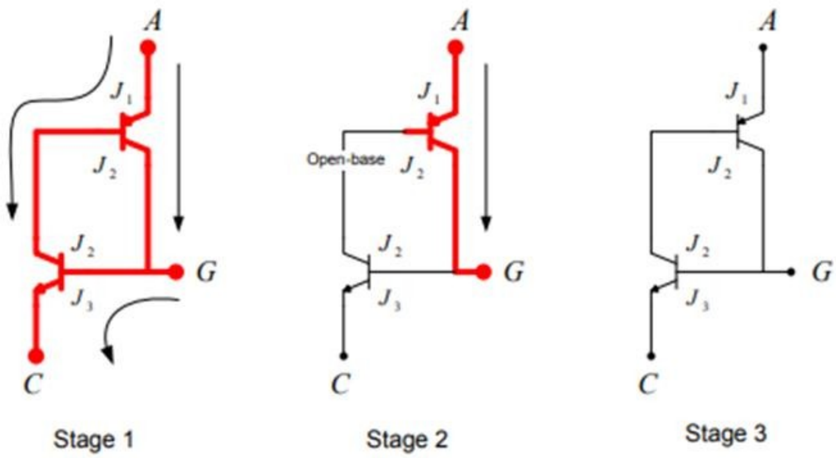

Fig 1.8.2 Turn on stages of IGCT

[Source: "Power Electronics" by P.S.Bimbra, Khanna Publishers Page: 28]

The two transistorsare connected in positive feedback allowing for a self-sustaining state called latch-up. This state is reached because the large current flowing between the anode and cathode is able to inject enough carriers into the base regions to keep the transistors saturated without the need of continuous gate current flow. Typical turn-on time for a GCT is about ≈ 10µs.

TYPES OF IGCT

These devices are available either with or without reverse blocking capability.IGCTs capable of blocking reverse voltage are known as symmetrical IGCTs. The typical application of symmetrical IGCTs is in Current Source Inverters (CSI).IGCTs incapable of blocking reverse voltage are known as asymmetrical IGCTs. They typically have a reverse breakdown rating in tens of volts or less. Such IGCTs are used where either a reverse conducting diode is applied in parallel or where reverse voltage would never occur. Asymmetrical IGCT can be fabricated with a reverse-conducting diode in the same package. These are known as reverse conducting (RC) IGCTs.

APPLICATIONS

The main applications of IGCT are in variable frequency inverters, drivers and traction. Multiple IGCTs can be connected in series or in parallel for higher power applications. The device has been applied in power system inter-tie installations (100MVA) and medium-power (up to 5MW) industrial drives.