IGCT Thyristors

Modern devices with high dynamic turn-on and turn-off parameters

Voltage range

up to 4500 V

Current range

up to 1600 A

Operating frequency

up to 1000 Hz

Control

optical

IGCT Thyristors

IGCT (Insulated Gate Commutated Thyristor) is in principle a turn-off thyristor (GTO) with high dynamic parameters in turn-on and turn-off mode. Turn-off process speed is above all a factor by which GTO and IGCT devices differ from each other.

The IGCT device is composed of two elementary parts, GCT thyristor structure which is placed in a disk case similarly to the GTO device and a gate unit to which the disk case with GCT is attached as tight as possible. Therefrom comes the English name of this new sort of device that stems from the fact that the gate unit is literally integrated with the GCT thyristor. It is so because the rate of rise of gate turn-off current must be extremely high for the due function of GCT and therefore self-inductance (spurious inductance) of gate unit including lead must be minimized.

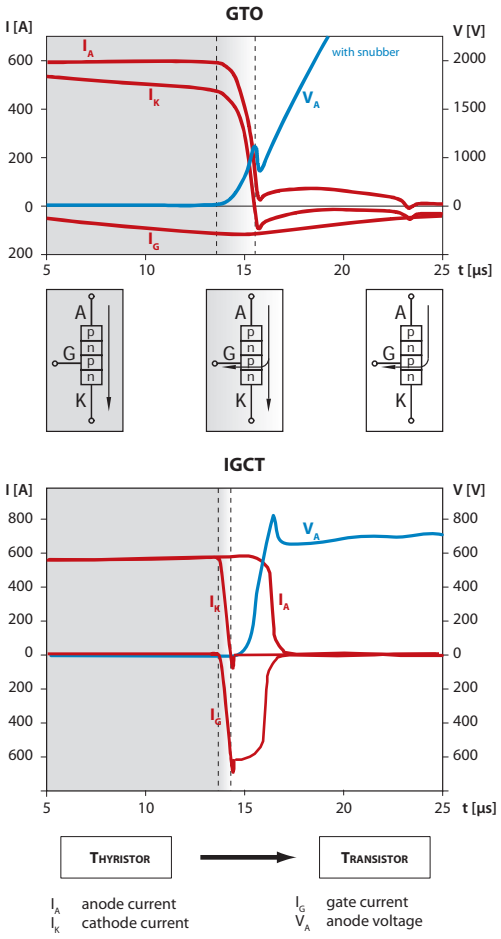

Fig. 1 Comparison of voltage and current waveforms at GTO and IGCT structure turn-off

Comparison of GTO, IGCT and IGBT

The IGCT device unites in itself the main advantages of thyristors (low on-state voltage drop, low on-state power losses) with the advantages of transistors or more precisely of IGBT devices (a convenient way of snubberless turn-off). The difference of voltage and current waveforms at GTO and IGCT structure turn-off comes through in figure 1.

The advantages of GCT compared to GTO at turn-off:

- high dv_D/dt
- minimum demands on snubbers
- essential turn-off losses reduction
- significant turn-off time reduction

In the past IGBT devices were mainly applied for the construction of semiconductor converters. At presence are more and more used IGCT thyristors that have in certain aspects much better properties. Disadvantage of IGBT is low surge current capability. This device needs to detect starting failure operation and ensure its proper turn-off within 10 µs. Otherwise the device will be destroyed. Thyristor architecture (including GCT) has high surge current capability. Eventual failure states, where thyristor current rises above permissible values, can be solved by a fittingly selected control which will switch all IGCT thyristors on and the whole converter will be disconnected from incoming supply by over-current protection (high speed-switch, fast fuse). Safety turn-off can be done in time thousand times longer than in case of IGBT.

IGCT Thyristors

Converters with IGCT devices, that are constructed particularly for higher power, are in comparision to converters with IGBT devices better especially for these reasons:

- Their construction is considerably simplier, more robust and therefore more reliable.
- They have lower on-state voltage drop and therefore lower losses in turn-on state, even considering losses in antiparallel diodes. It can be estimated that the total energy loss in traction voltage inverter with IGCT devices will decrease on the average to 80% up to 90% of the value that it would have in a inverter with IGBT devices.
- They have high values of surge on-state current. This fact enables to protect the whole inverter with IGCT devices by an ordinary fast so-called semiconductor fuse.
- IGCT devices can work without turn-off snubbers. Using these snubbers the turn-off ability increases.

Company Polovodiče, a.s. provides diodes and gate units power supplies for IGCT conterter designing. In IGCT converters is necessary to use diodes with special recovery properties.

References

IGCT thyristors produced by Polovodiče, a.s. are used in pulse converters type 6070 and in inverters of type 6051. Both converters are mainly intended for traction purposes. They are used in trolleybuses produced by the company Škoda since 2002. IGCT thyristors also are the main component part of modernized suburban unit drives series 560, operated by the railway company ČD (czech railways).

Basic characteristics of controllable power semiconductor components intended for converters with voltage higher than 400 V

Kind of device	Advantages	Deficiencies	Application fields
Thyristors (SCR)	Minimum on-state losses. Maximum overload capacity. High reliability. Relatively easy possibility of parallel and series connection.	Necessity of turn-off circuits. Low working frequency.	DC drives. High power supply sources. Induction heating sources. Static compensators.
GTO	Controlled turn-off ability. Relatively high overload capacity. Series connection possibility. Working frequency of hundreds of Hz.	Higher on-state losses. High control power.	High power drives. Static compensators. Continuous supply sources. Induction heating sources.
IGCT	Controlled turn-off ability. Relatively high overload capacity. Low on-state losses. Working frequency of kHz. Series connection possibility. High cyclic resistance.		High power drives. Supply inverter sources for DC transmissions. Big frequency converters.
IGBT	Controlled turn-off ability. Minimum working frequency up to 10 kHz. Very low control power.	Very high on-state losses. Relatively low cyclic resistance.	Choppers. Continuous supply sources. Statical compensators and active filters. Switching sources.

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Doc. No. NOU 0805119