IGBT

Insulated Gate Bipolar Transistor

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Insulated- gate bipolar transistor

Combination of MOSFET and Power BJT

BJT: low conduction losses (especially at larger blocking voltages),

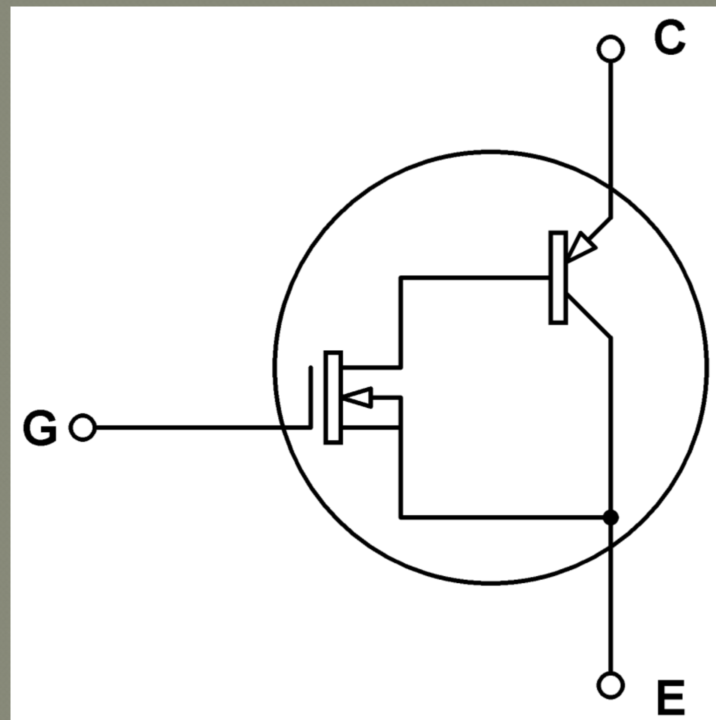
longer switching times, current- driven

MOSFET : faster switching speed, easy to drive (voltage- driven),

larger conduction losses (especially for higher blocking

IGBT

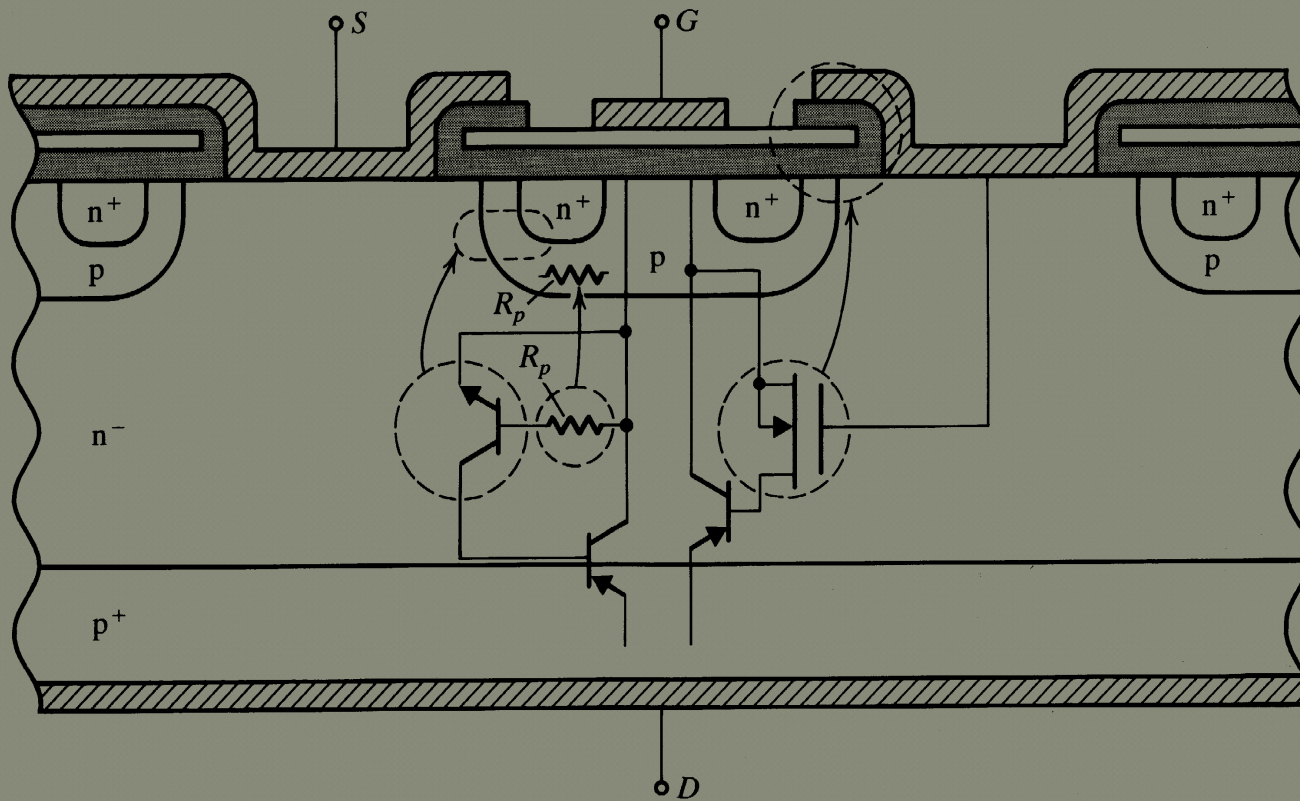
IGBT is an integrated connection of MOSFET and BJT as shown Below.

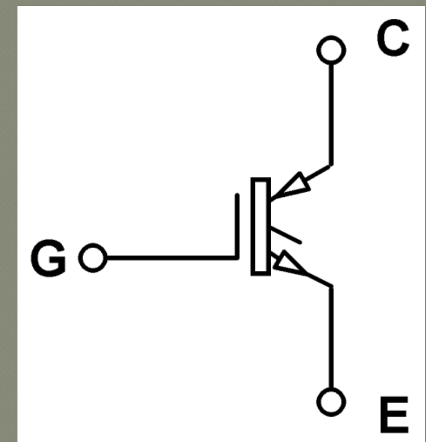


IGBT

- The driving is simple like Power MOS.
- Low forward drop per unit area of BJT.
- Much smaller area results compared to same power MOSFET.
- The two transistors are of opposite polarity (n-channel and PNP), the gate is driven with respect to collector of BJT, therefore, the collector of BJT is designated as Emitter of IGBT and Emitter of BJT as collector of IGBT.

Structure and Symbol of IGBT





Structure of IGBT

- The structure of IGBT is very much like vertical MOSFET, except that the substrate is heavily doped p-type rather than n-type.
- Integration of two devices rather than discrete connection has an advantage: when the IGBT is on, the BJT is also on conductivity modulating the drift region and greatly reducing the drain resistance of MOSFET.
- If the two devices are connected discretely, the FET un-modulated resistive drop would result in a higher collector-base drop resulting higher V_{CE} for the Bipolar Transistor.

Structure of IGBT

- One disadvantage of integration is that the structure forces the BJT with wide base.
- Another disadvantage is that the BJT has PNP configuration rather than superior NPN transistor.
- A further problem of integration of the two devices eliminates access to the base terminal of the BJT, preventing the use of negative base current to improve turn-off.

Structure of IGBT

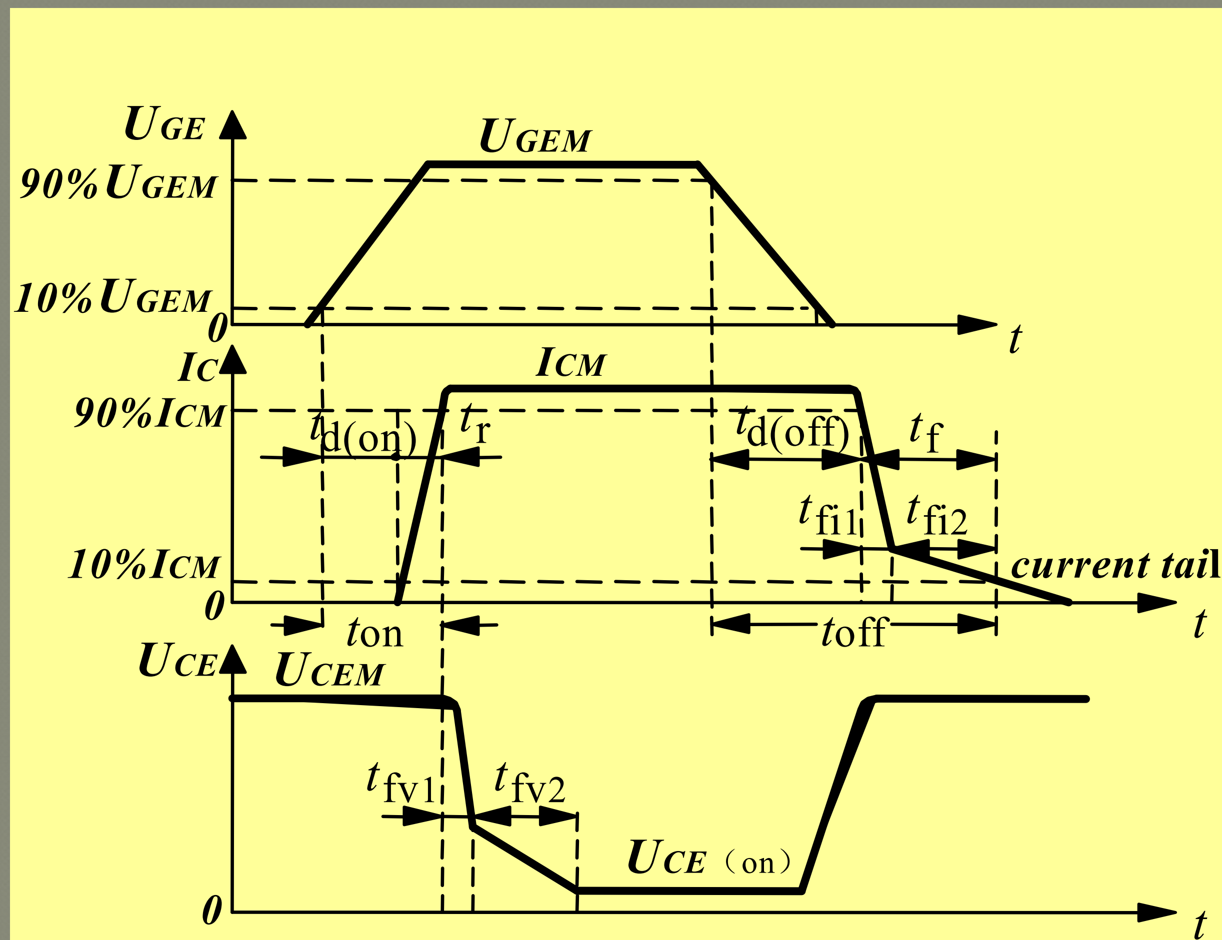
- Turn-off can be improved by reducing the transistor gain but at the expense of on-state drop.
- The integration of two devices produces a parasitic SCR as a regenerative connection of PNP and NPN transistors.
- Although the base of NPN transistor is shorted to emitter which should keep this transistor off, however, there is some resistance in this connection.

Structure of IGBT

- If during operation, the current through this region becomes high, the NPN transistor might be turned on, and SCR may latch.
- Once latched, nothing can be done to turn off the device.
- If the rate of rise of voltage at turn off is high enough, the capacitive charging current could trigger the SCR.
- Even with these problems IGBT has much to offer.
- This device is well suited to high voltage with moderate frequencies (1200 V upto 50KHz.)

IGBT

Switching characteristics



Commercial IGBTs

part number	Rated max voltage	Rated avg current	V_F(typical	t_f(typical)
Single-chip devices				
HGTG32N60E2	600V	32A	2.4V	0.62 μs
HGTG30N120D2	1200V	30A	3.2V	0.58 μs
multiple-chip power modules_				
CM400HA-12E	600V	400A	2.7V	0.3 μs
CM300HA-24E	1200V	300A	2.7V	0.3 μs

Thank you

For your attention