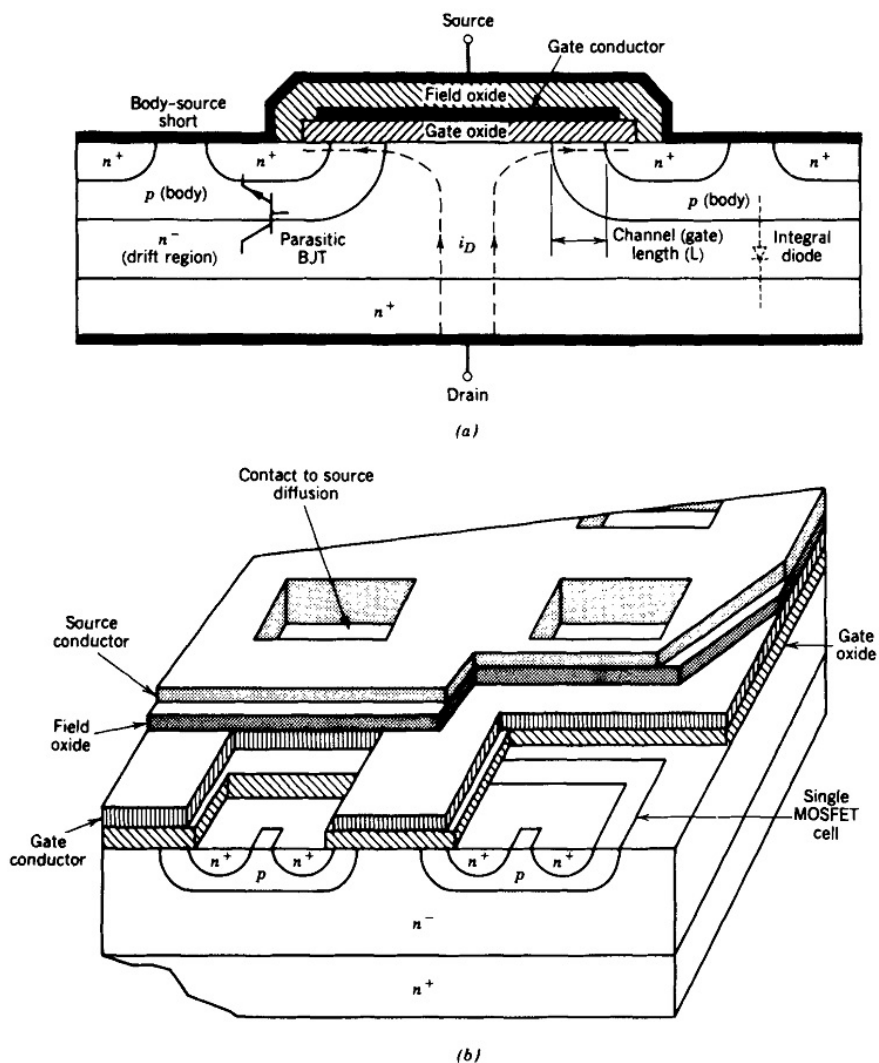
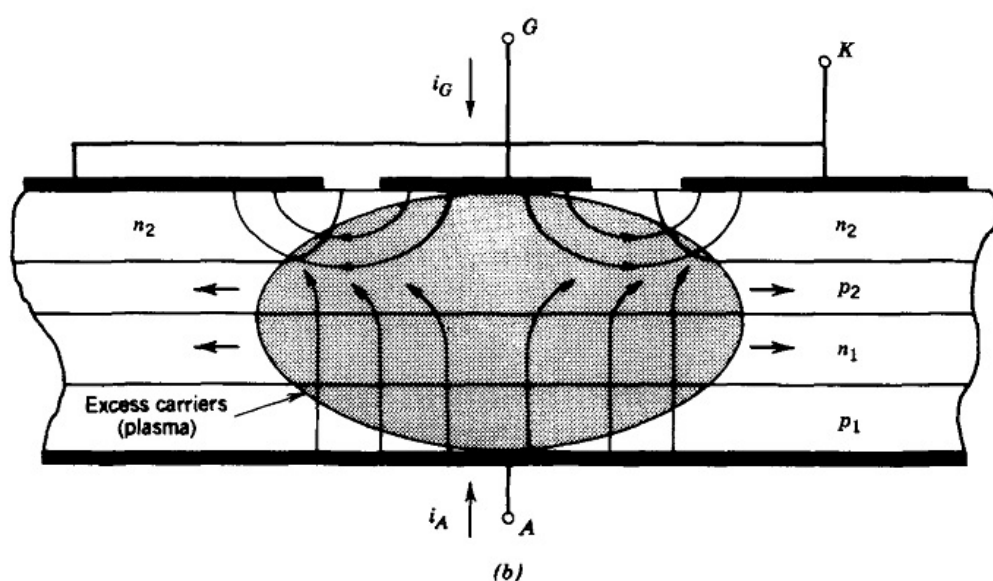
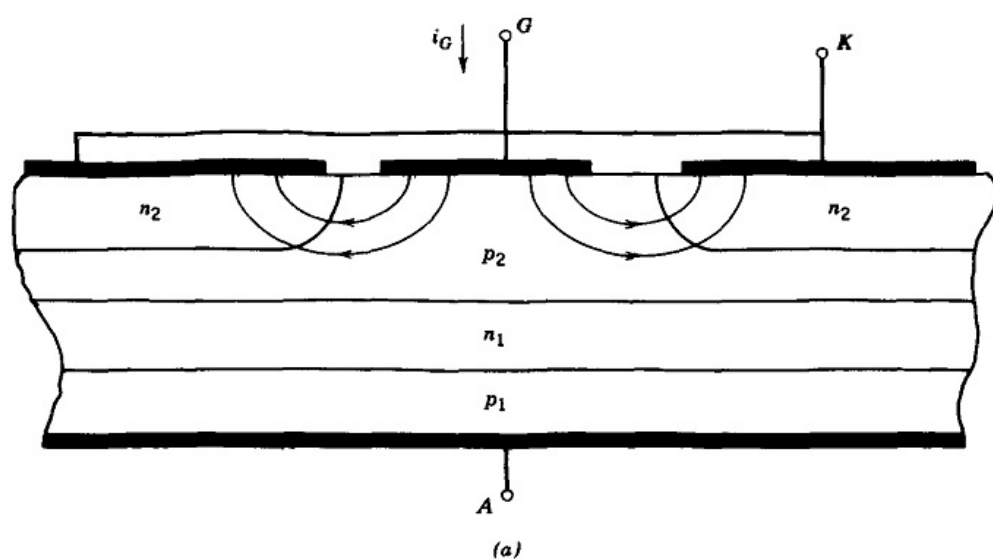
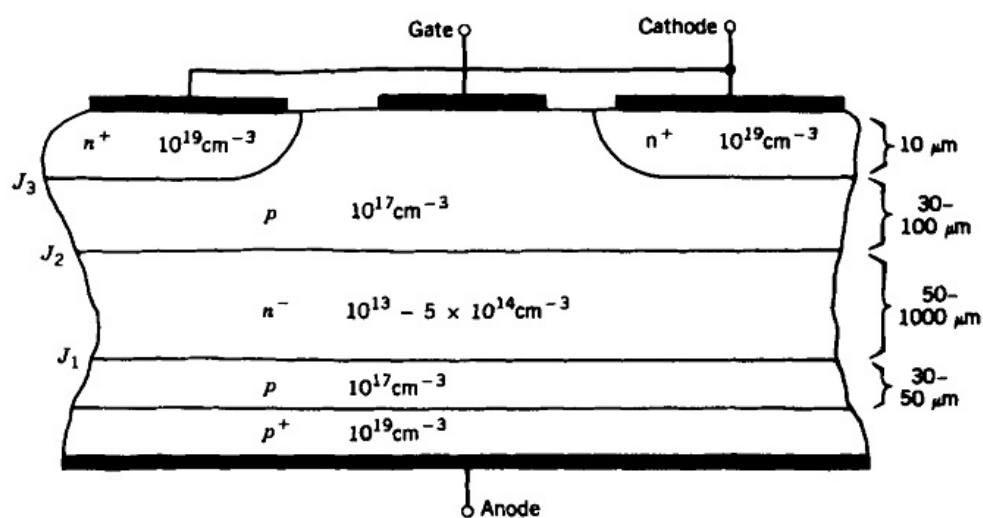


**Figure 20-9** Voltage and current waveforms for a power diode driven by currents with a specified rate of rise during turn-on and a specified rate of fall during turn-off.



**Figure 22-1** (a) Vertical cross-section and (b) perspective view of an  $n$ -channel power MOSFET. A complete MOSFET is composed of many thousands of cells connected in parallel to achieve large gain and low on-state resistance. Some of the layers in the perspective view have been cut away to enhance the clarity of the drawing.

Tristör



**Figure 23-8** Initial growth and lateral spread of the excess carriers in a thyristor at turn-on illustrating the need to limit  $di_F/dt$ : (a) injection of minority carriers into the  $p_2$  base region by the gate current during the turn-on delay time that initiates the regenerative switching action; (b) initial turned-on areas of the thyristor in the vicinity of the gate electrode shortly after the turn-on delay time. The further lateral expansion of this area is also shown.

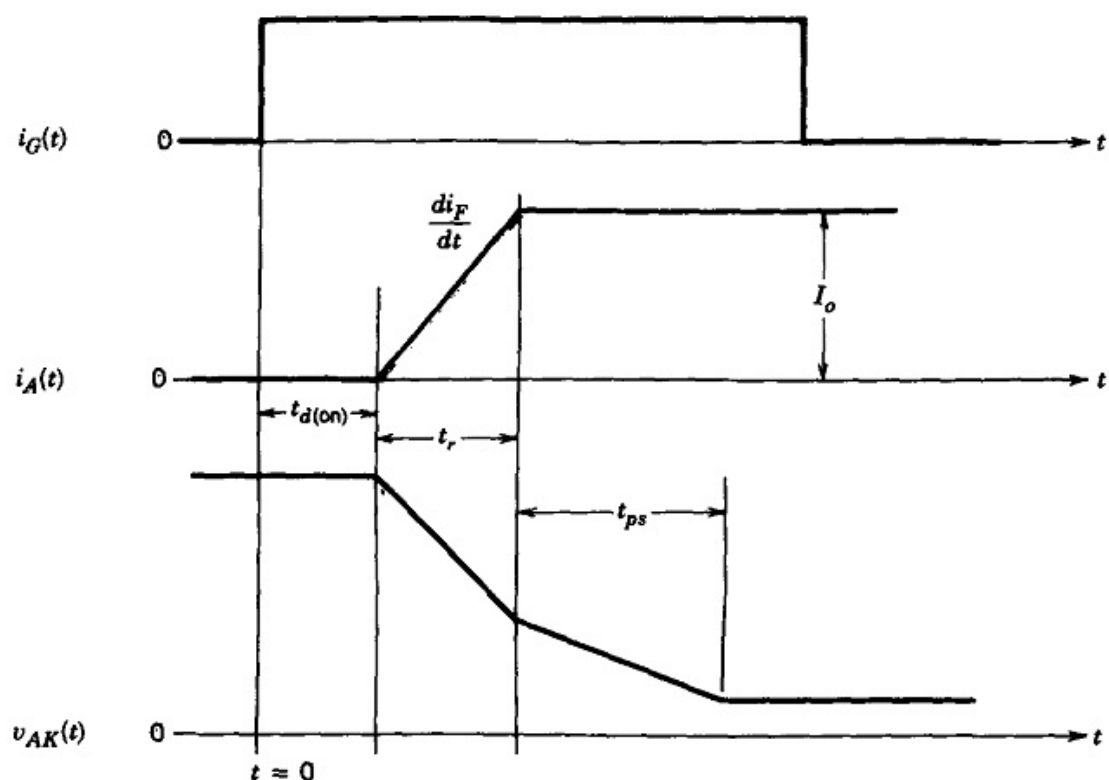


Figure 23-7 Thyristor voltage and current waveforms during turn-on.

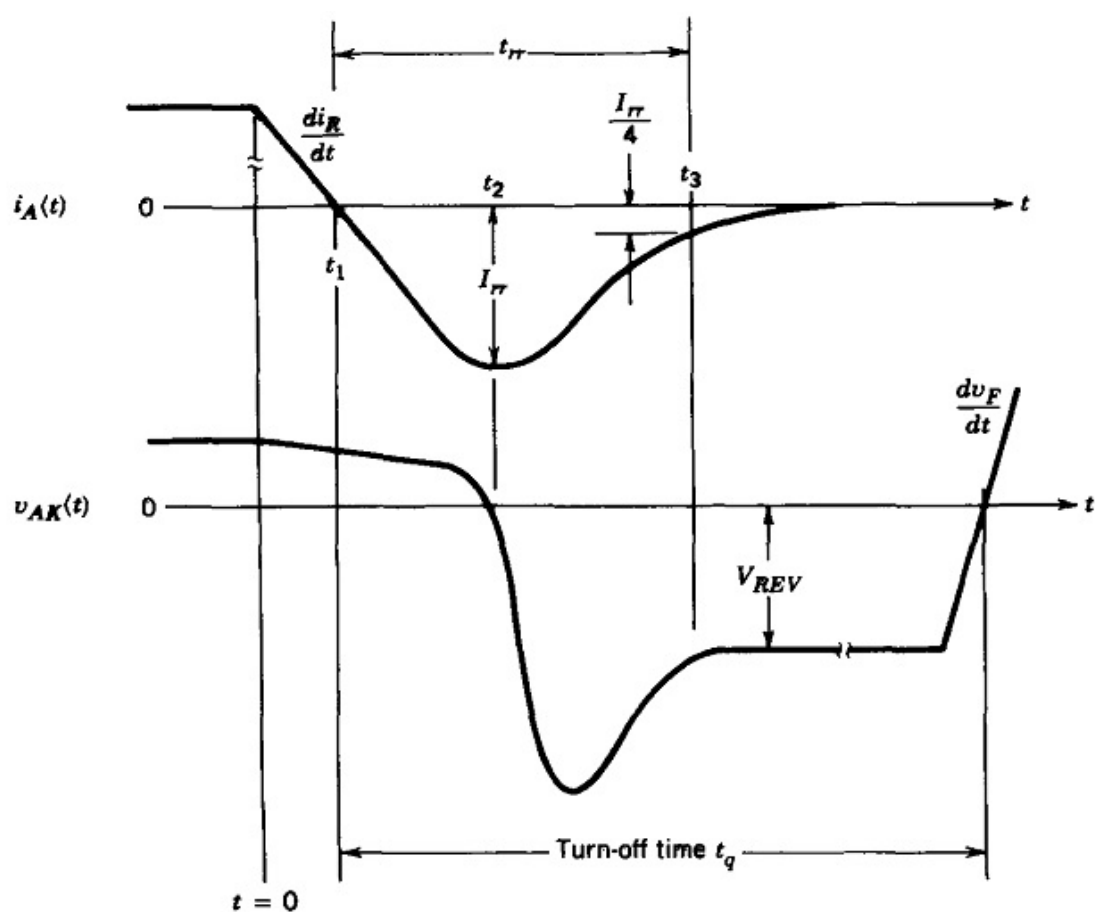


Figure 23-10 Thyristor voltage and current waveforms during turn-off. A reapplied forward-blocking voltage must not be impressed on the thyristor until a specified time period, the recovery time  $t_q$ , has elapsed. The rate of rise of the reapplied forward voltage  $dv_F/dt$  must be kept below a specified value.

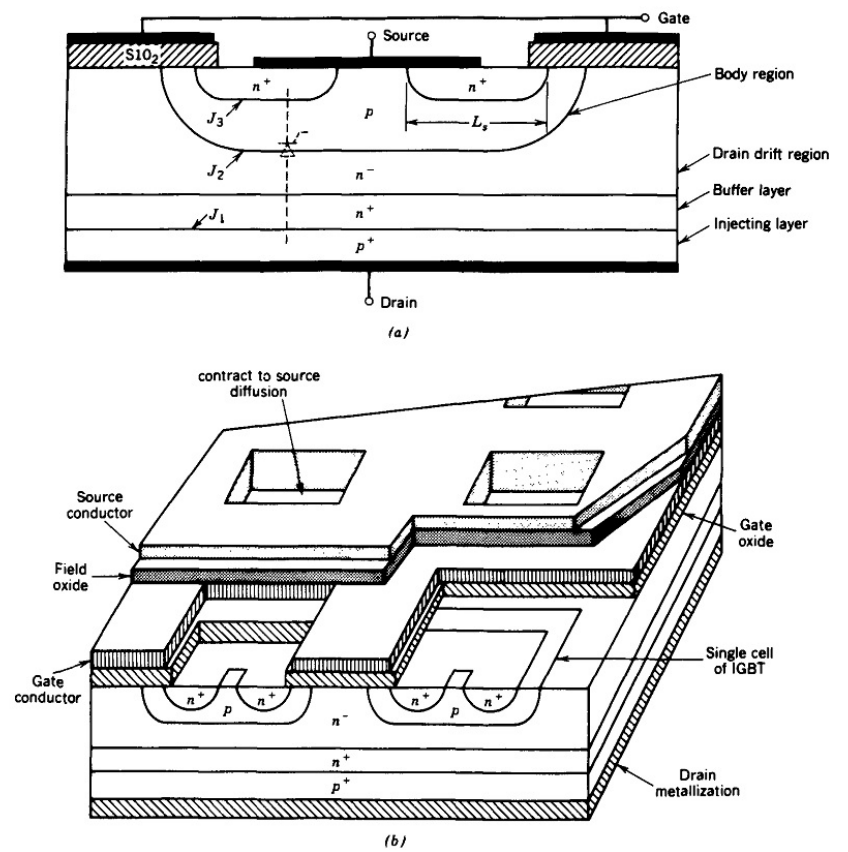


Figure 25-1 Vertical cross section and perspective view of an IGBT.

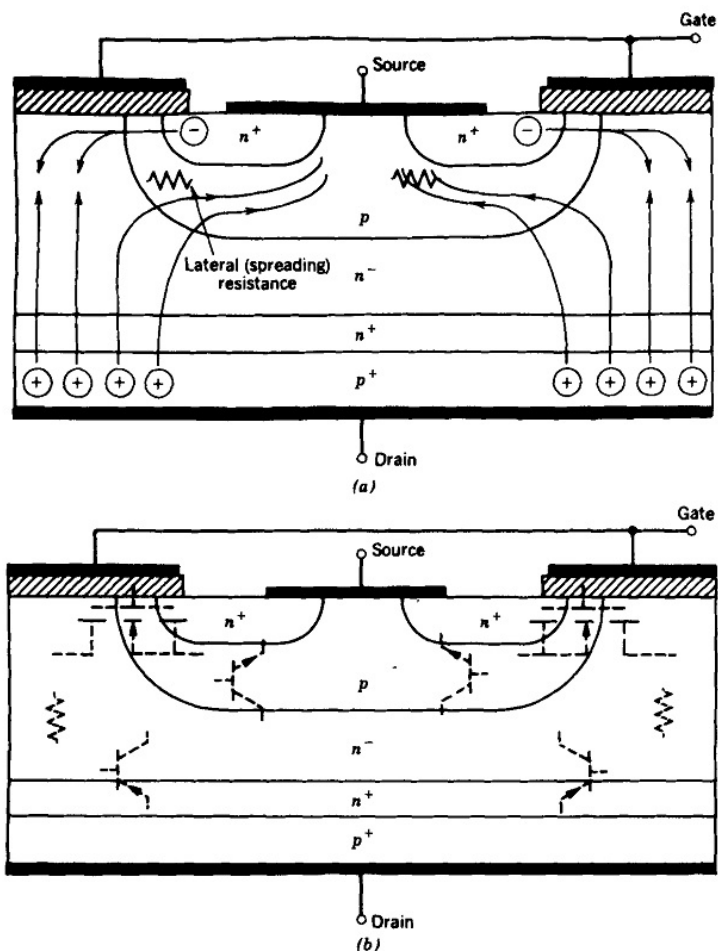


Figure 25-3 Vertical cross section of an IGBT showing (a) the on-state current flow paths and (b) the effective MOSFET and BJT operating portions of the structure.

**KAYNAK:**  
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