

Physics of Semiconductor Devices

SECOND EDITION

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In Fig. 2 the basic device dimensions are the channel length L (also called the gate length), channel width Z , channel depth a , depletion-layer width h , and channel opening b . The voltage polarities shown are for an n -channel JFET. The polarities are inverted for a p -channel JFET. The source electrode is generally grounded, and the gate and drain voltages are measured with respect to the source. When $V_G = V_D = 0$, the device is in equilibrium and no current flows. For a given V_G (zero or negative values), the channel current increases as the drain voltage increases. Eventually, for sufficiently large V_D , the current will saturate at a value I_{Dsat} .

The basic current-voltage characteristics of a JFET are shown in Fig. 3, where the drain current is plotted against the drain voltage for various gate voltages. We can divide the characteristic into three regions: the linear region, where the drain voltage is small and I_D is proportional to V_D ; the saturation region, where the current remains essentially constant and is independent of V_D ; and the breakdown region, where the drain current increases rapidly with a slight increase of V_D . As the reverse gate bias increases, both the saturation current I_{Dsat} and the corresponding saturation voltage V_{Dsat} decrease. These decreases occur because of the reduced initial channel width, which results in larger initial resistance.

We shall now derive the current-voltage characteristics for long-channel FETs (i.e., channel length $L \gg$ channel depth a) based on the follow-

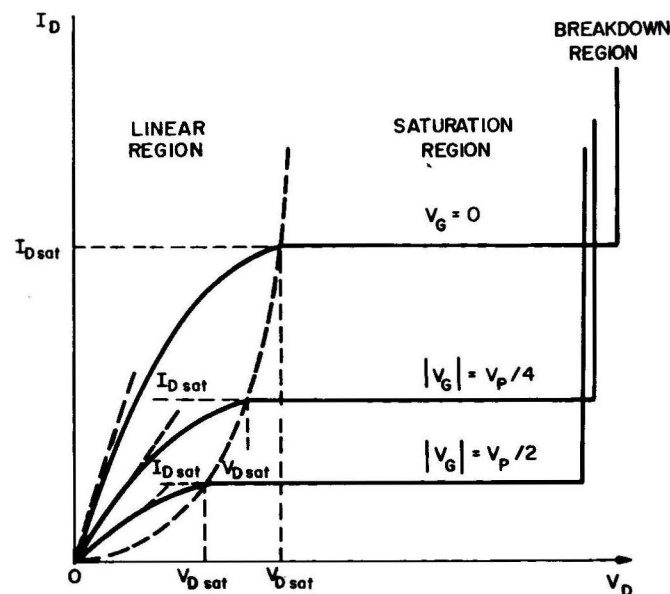


Fig. 3 Basic I - V characteristics of a JFET, which include the linear region, saturation region, and breakdown region. V_P is the pinch-off voltage. For a given voltage V_G , the current and voltage at the point where saturation occurs are designated by I_{Dsat} and V_{Dsat} , respectively.