3.3.2 Extrinsic Case (R_{ds} > 0)

The current expression when $R_{ds} > 0$ can be obtained based on Eq. (2.5.9) and Eq. (3.3.4). The expression for linear drain current from subthreshold to strong inversion is:

$$I_{ds} = \frac{I_{dso}}{1 + \frac{R_{ds} I_{dso}}{V_{ds}}} \tag{3.3.5}$$

3.4 Unified V_{dsat} Expression

3.4.1 Intrinsic case (R_{ds}=0)

To get an expression for the electric field as a function of *y* along the channel, we integrate Eq. (3.3.1) from 0 to an arbitrary point *y*. The result is as follows

$$E_y = \frac{I_{dso}}{\sqrt{(WQ_{chs0}\mu_{eff} - \frac{I_{dso}}{E_{sat}})^2 - \frac{2 I_{ds0} W Q_{chs0} \mu_{eff}\, y}{V_b}}} \tag{3.4.1}$$

If we assume that drift velocity saturates when *Ey=Esat*, we get the following expression for I_{dsat}

$$I_{dsat} = \frac{W \mu_{eff} Q_{chs0} E_{sat} L V_b}{2L(E_{sat} L + V_b)} \tag{3.4.2}$$