

B.1.4 Drain Saturation Voltage

For $R_{ds} > 0$ or $\lambda \neq 1$:

$$V_{dsat} = \frac{-b - \sqrt{b^2 - 4ac}}{2a}$$

$$a = A_{bulk}^2 W_{eff} V_{sat} C_{ox} R_{DS} + \left(\frac{1}{\lambda} - 1\right) A_{bulk}$$

$$b = -\left((V_{gsteff} + 2V_t) \left(\frac{2}{\lambda} - 1\right) + A_{bulk} E_{sat} L_{eff} + 3A_{bulk} (V_{gsteff} + 2V_t) W_{eff} V_{sat} C_{ox} R_{DS} \right)$$

$$c = (V_{gsteff} + 2V_t) E_{sat} L_{eff} + 2(V_{gsteff} + 2V_t)^2 W_{eff} V_{sat} C_{ox} R_{DS}$$

$$\lambda = A_1 V_{gsteff} + A_2$$

For $R_{ds} = 0$ and $\lambda = 1$:

$$V_{dsat} = \frac{E_{sat} L_{eff} (V_{gsteff} + 2V_t)}{A_{bulk} E_{sat} L_{eff} + (V_{gsteff} + 2V_t)}$$

$$A_{bulk} = \left(1 + \frac{K_{lox}}{2\sqrt{\Phi_s - V_{bs eff}}} \left(\frac{A_0 L_{eff}}{L_{eff} + 2\sqrt{X_J X_{dep}}} \left(1 - A_{gs} V_{gsteff} \left(\frac{L_{eff}}{L_{eff} + 2\sqrt{X_J X_{dep}}} \right)^2 \right) + \frac{B_0}{W_{eff}' + B_1} \right) \right) \cdot \frac{1}{1 + Keta V_{bs eff}}$$