3.7 Substrate Current

The substrate current in BSIM3v3.2.1 is modeled by

$$I_{sub} = \frac{\alpha_0 + \alpha_1 \cdot L_{eff}}{L_{eff}} (V_{ds} - V_{dseff}) \exp\left(- \frac{\beta_0}{V_{ds} - V_{dseff}} \right) \frac{I_{ds0}}{1 + \frac{R_{ds} I_{ds0}}{V_{dseff}}} \left(1 + \frac{V_{ds} - V_{dseff}}{V_A} \right) \tag{3.7.1}$$

where parameters α_0 and β_0 are impact ionization coefficients; parameter α_1 improves the I_{sub} scalability.

3.8 A Note on V_{bs}

All V_{bs} terms have been substituted with a V_{bseff} expression as shown in Eq. (3.8.1). This is done in order to set an upper bound for the body bias value during simulations. Unreasonable values can occur if this expression is not introduced.

$$V_{bseff} = V_{bc} + 0.5[V_{bs} - V_{bc} - \delta_1 + \sqrt{(V_{bs} - V_{bc} - \delta_1)^2 - 4\delta_1 V_{bc}}\ ] \tag{3.8.1}$$

where δ_1=0.001V.

Parameter V_{bc} is the maximum allowable V_{bs} value and is obtained based on the condition of $dV_{th}/dV_{bs} = 0$ for the V_{th} expression of 2.1.4.