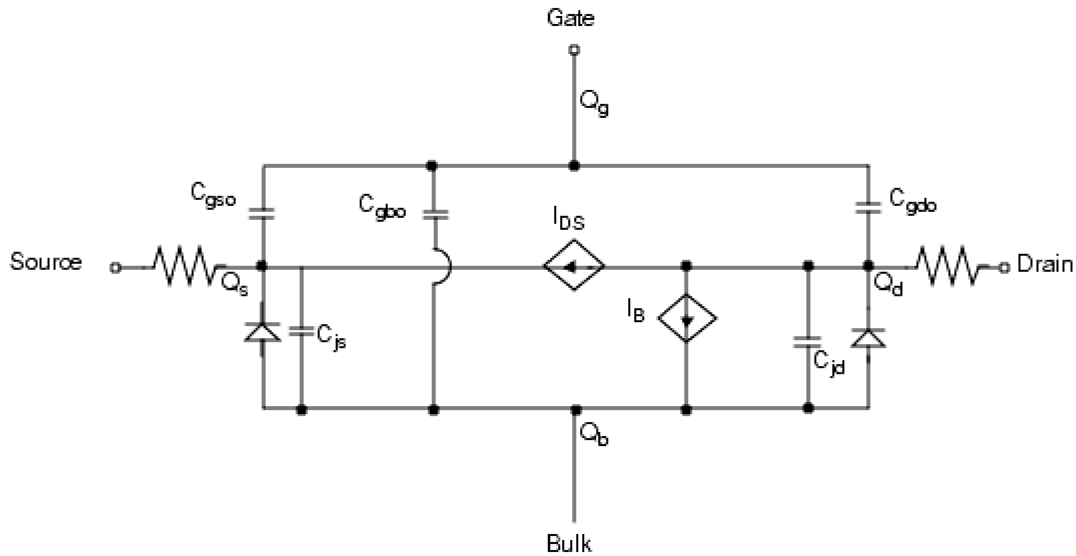
The following text is an excerpt from the Cadence documentation of Spectre for the 6.012 Microelectronics courses in Fall 05.

MOS Level-1 Model (mos1)



Channel Width and Length

$$W_{scaled} = w*scale + xw*scalem$$

$$W_{eff} = \begin{cases} w*scale + xw*scalem - 2wd*scalem & \text{(Level 1-3)} \\ w*scale + xw*scalem - dw*scalem & \text{(BSIM 1-2)} \end{cases}$$

$$L_{eff} = \begin{cases} l*scale + xl*scalem - 2ld*scalem & \text{(Level 1-3)} \\ l*scale + xl*scalem - dl*scalem & \text{(BSIM 1-2)} \end{cases}$$

Threshold Voltage

$$V_{TH} = vto + gamma(\sqrt{phi - V_{BS}} - \sqrt{phi})$$

Drain Saturation Voltage

$$V_{DSAT} = V_{GS} - V_{TH} \equiv V_{GST}$$

Drain Current for the Subthreshold Region

Note: These equations apply when V_{GS}-$V_{ON} \leq 0$.

You cannot use the subthreshold current equations without nfs.

$$V_{ON} = \begin{cases} V_{TH} + nV_t & \text{if } nfs \text{ is specified} \\ V_{TH} & \text{otherwise} \end{cases}$$

where

$$n = 1 + \frac{C_{FS} + C_D}{C_{ox}}$$

$$C_{FS} = q \times (nfs)$$

$$C_D = \frac{gamma\ C_{ox}}{2\sqrt{phi - V_{BS}}}$$

$$I_{DS} = I_{DS,ON} e^{(V_{GS} - V_{ON})/nV}$$

where $I_{DS,ON}$ is the drain current evaluated at $V_{GS} = V_{ON}$.

Drain Current for the Triode Region

Note: These equations apply when $V_{GS}V_{ON}$ and $V_{DS} \leq V_{DSAT}$.

$$I_{DS} = \beta\left(V_{GST} - \frac{1}{2}V_{DS}\right)V_{DS}(1 + lambda * V_{DS})$$

where

$$\beta = \frac{kp * W_{eff}}{L_{eff}}$$

Drain Current for the Saturation Region

Note: This equation applies when $V_{GS}V_{ON}$ and $V_{DS}V_{DSAT}$.

$$I_{DS} = \frac{\beta V_{GST}^2}{2}(1 + lambda * V_{DS})$$

Because the standard SPICE Level-1 model does not include any of the short-channel phenomena, such as mobility modulation and velocity-saturation effects, the uses for this model are limited. To retain high computational efficiency and improve accuracy, the Spectre® circuit simulator incorporates two parameters, theta and vmax, into the Level-1 model. The meanings of theta and vmax are the same as those in the Level-3 model. The modified Level-1 model is like a simplified Level-3 model. Spectre uses the modified Level-1 model if theta or vmax (or both) is specified. The drain current equations for the modified Level-1 model are shown in the following section.

Drain Saturation Voltage (Modified Level-1 Model)

$$V_{DSAT} = \frac{V_{GST}}{\sqrt{K}}$$

where

$$K = \frac{1 + V_c + \sqrt{1 + 2V_c}}{2}$$

$$V_c = \frac{V_{GST} uo}{vmax * L_{eff}}$$

Drain Current for the Triode Region (Modified Level-1 Model)

$$I_{DS} = \frac{\beta(V_{GST} - \frac{1}{2}V_{DS})V_{DS}[1 + lambda * V_{DS}]}{(1 + theta * V_{GST})(1 + V_{DS}/(E_c L_{eff}))}$$

where

$$E_c = \frac{vmax}{uo}$$

Drain Current for the Saturation Region (Modified Level-1 Model)

$$I_{DS} = \frac{\beta(V_{GST} - \frac{1}{2}V_{DSAT})V_{DSAT}[1 + lambda * V_{DS}]}{(1 + theta * V_{GST})(1 + V_{DSAT}/E_c L_{eff})}$$