APPENDIX A

MOSFET MODEL IN STRONG INVERSION

The basic equation [22] that describes the drain current of the MOS transistor as a function of terminal voltages is

$$I_D = \left(\frac{W}{L}\right)\{f(V_G, V_S) - f(V_G, V_D)\} \tag{A.1}$$

where W is the channel width, L is the channel length and the V_G, V_S, and V_D are gate, source, and drain voltages referred to the substrate, as illustrated in Fig. A.1.

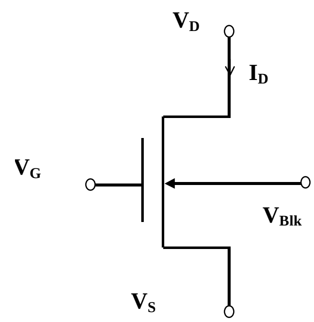

Fig. A.1. NMOS transistor.

In this work, the NMOS transistors in the current divider operate with gate potential equal to V_{DD}. So, they operate in strong inversion. In strong inversion

$$f(V_G, V_{S(D)}) = \frac{\mu n C'_{ox}}{2}\{V_p(V_G) - V_{S(D)}\}^2 \tag{A.2}$$

where V_P (V_G) is the pinch-off voltage of the MOS transistor, n is the slope factor, μ is the carrier mobility and C'_{OX} is the oxide capacitor per unit area. V_P depends on the gate voltage [30] and can be approximated as

$$V_p = \frac{V_G - V_{TO}}{n} \tag{A.3}$$

The slope factor (n) depends slightly on the gate voltage.

(A.1) can be written as:

$$I_D = (I_F - I_R) = I_S(i_f - i_r) \tag{A.4}$$

where

$$I_S = I_{SQ}\left(\frac{W}{L}\right) \qquad\qquad I_{SQ} = \mu n C'_{ox}\frac{\phi_t^2}{2}$$

and

$$i_{f(r)} = \frac{I_{F(R)}}{I_S}$$

where I_{SQ} is the normalization current for a square transistor, $I_{F(R)}$ is the forward (reverse) saturation current, Is is the normalization current, $i_{f(r)}$ is forward (reverse) normalized current [66], and ϕ_t is the thermal voltage.

The switch conductance can be expressed as

$$g_{DS} = \frac{\partial I_D}{\partial V_D}\Big|_{V_S = V_B} = \mu n C'_{ox}\frac{W}{L}(V_P - V_B) \tag{A.5}$$

For more details about the MOS transistor modeling and symbols, we refer the reader to reference [67-chpt. 2].