Simplified T Model with Body Effect

Figure 1 shows the MOSFET T model with a Thévenin source in series with the gate and the body connected to signal ground. We wish to solve for the equivalent circuit in which the sources i_{sg} and i_{sb} are replaced by a single source which connects from the drain node to ground having the value $i'_d = i'_s$. We call this the simplified T model. The first step is to look up into the branch labeled i'_s and form a Thévenin equivalent circuit. With $i'_s = 0$, we can use voltage division to write

$$v_{s(oc)} = v_{tg}\frac{r_{sb}}{r_s + r_{sb}} = v_{tg}\frac{r_s/\chi}{r_s + r_s/\chi} = \frac{v_{tg}}{1+\chi} \tag{1}$$

With $v_{tg} = 0$, the resistance r'_s seen looking up into the branch labeled i'_s is

$$r'_s = r_s \| r_{sb} = \frac{r_s}{1+\chi} = \frac{1}{(1+\chi)\, g_m} \tag{2}$$

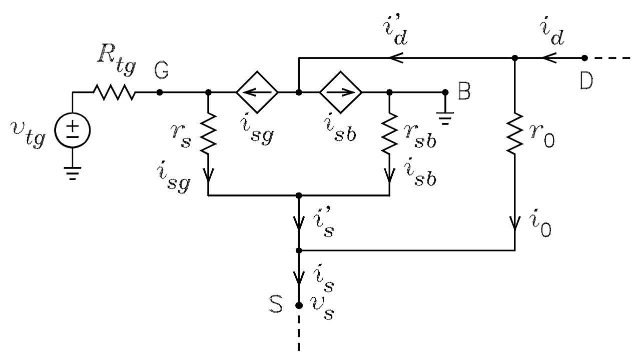

Figure 1: T model with Thévenin source connected to the gate and the body connected to signal ground.

The simplified T model is shown in Fig.2. Compared to the corresponding circuit for the BJT, the MOSFET circuit replaces v_{tb} with $v_{tg}/(1+\chi)$ and r'_e with $r'_s = r_s/(1+\chi)$. Because the gate current is zero, set $\alpha = 1$ and $\beta = \infty$ in converting any BJT formulas to corresponding MOSFET formulas. The simplified T model is derived with the assumption that the body lead connects to signal ground. In the case that the body lead connects to the source lead, it follows from Fig. 1 that $i_{sb} = 0$. Connecting the body to the source is equivalent to setting $\chi = 0$ in the MOSFET equations.

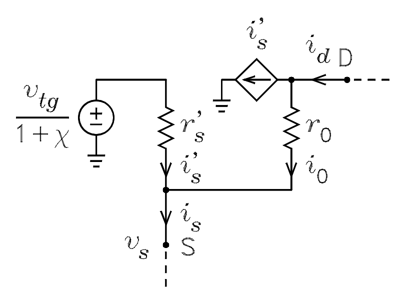

Figure 2: Simplified T model.