MOS Transition Frequency

Emmanuel Jesus R. Estallo
Electrical and Electronics Engineering Institute
University of the Philippines - Diliman
Quezon City, Philippines
emmanuel.estallo@eee.upd.edu.ph

I. NMOS Transition Frequency

A. Increasing the number of fingers

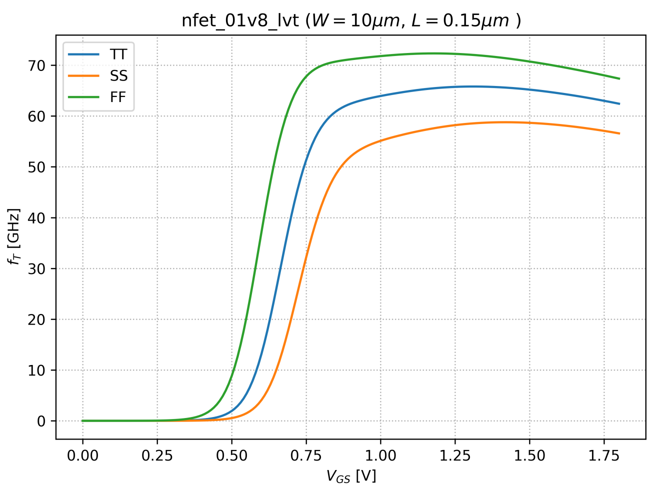

Fig. 1. NMOS f_t Plot ($nf = 1$)

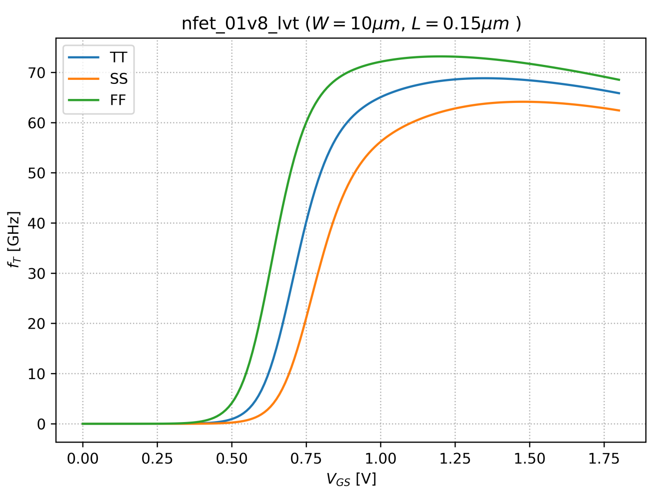

Fig. 2. NMOS f_t Plot ($nf = 10$)

As we can see from figures 1 and 2, the effect of varying nf depends on the region of operation. For the NMOS, increasing nf decreases f_t for $V_{GS} \leq 1.0V$. That is, for the weak and moderate inversion regions. For the square-law and velocity saturation regions, increasing nf also increases f_t.

B. Increasing the length

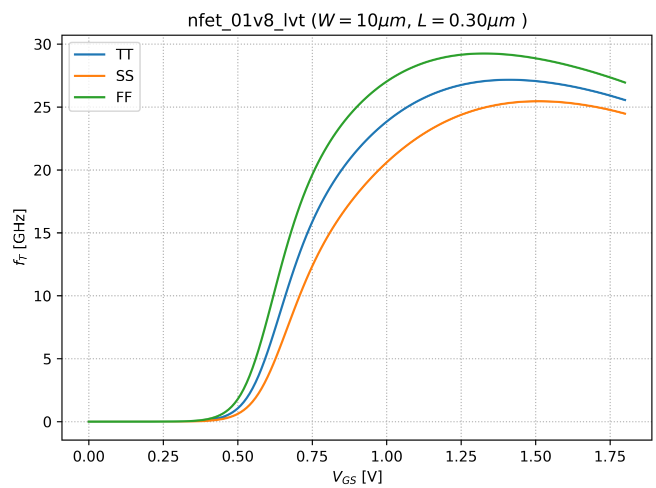

Fig. 3. NMOS f_t Plot ($nf = 1$)

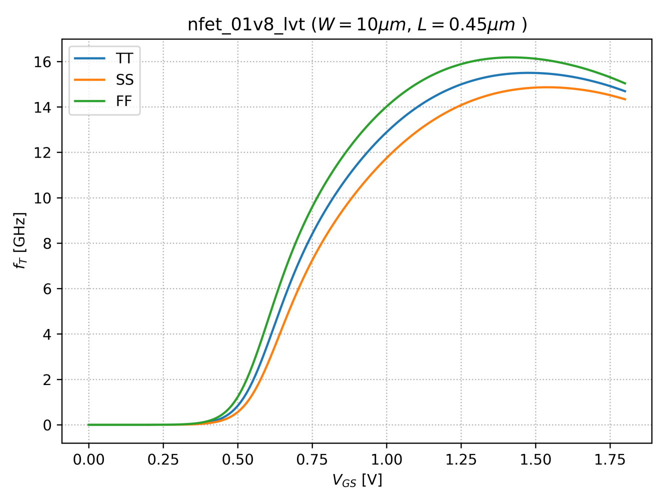

Fig. 4. NMOS f_t Plot ($nf = 1$)

Increasing the length decreases the f_t. We know that:

$$f_t = \frac{g_m}{2\pi C_{gg}}$$

Since g_m decreases with increasing L, the f_t decreases as well. The effect of process variations are also less — we can see that f_t is more "clustered" around the tt corner for higher values of L.

II. PMOS Transition Frequency

A. Increasing the number of fingers

We now consider the behavior of PMOS when nf is increased. As we can see from figures 5, 6, unlike the NMOS, at least for this PDK, increasing nf decreases f_t on all regions of operation.

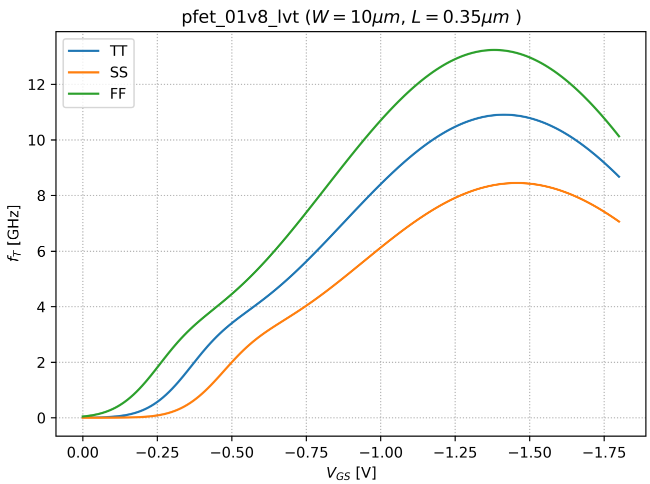

Fig. 5. PMOS f_t Plot ($nf = 1$)

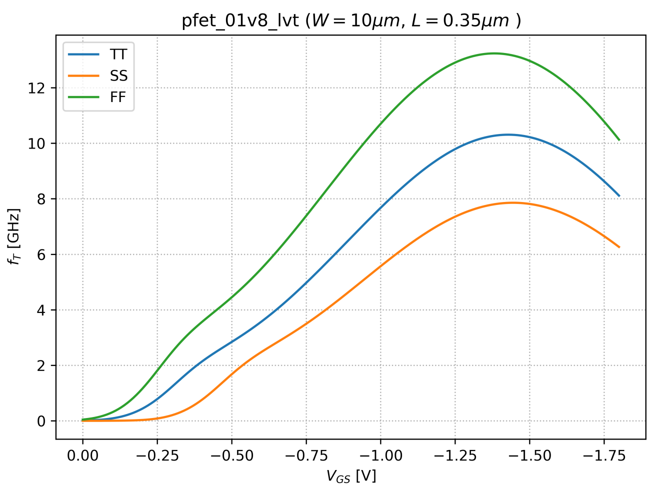

Fig. 6. PMOS f_t Plot ($nf = 10$)

B. Increasing the length

Similar to the NMOS, increasing the length also decreases f_t of the PMOS. If the lengths of the PMOS and NMOS are the same, the NMOS has the higher f_t, as we can see from figures 4 and 7.

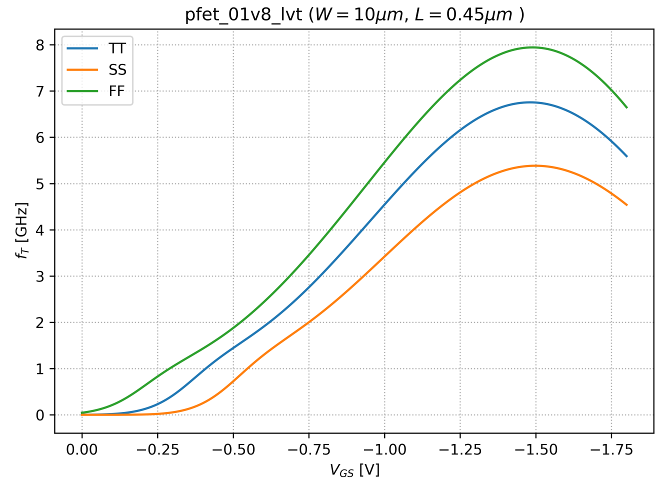

Fig. 7. PMOS f_t Plot ($nf = 1$)

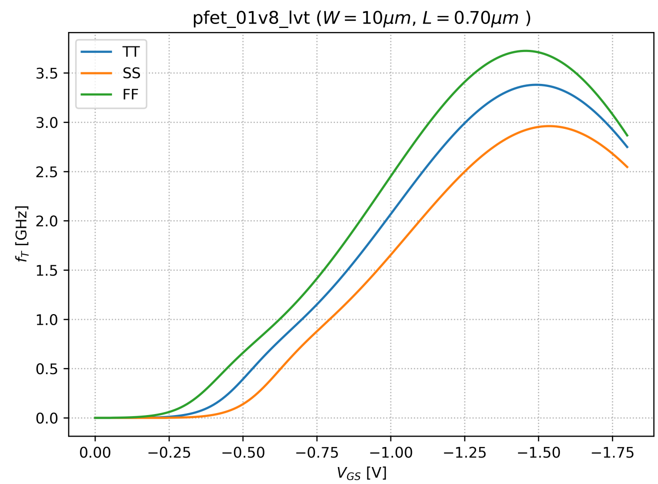

Fig. 8. PMOS f_t Plot ($nf = 1$)

Similar to the NMOS, increasing the length also reduces the effects of process variations. f_t gets more clustered arount the tt corner when we increase L.

III. Comments and Discussions

Initially, I thought that increasing nf increases the f_t all the time since the parasitics are reduced when we increase nf. However, it turns out that it was not the case. Since nf has an effect on g_m as well, f_t will only increase when there is less reduction on g_m than C_{gg}.

As expected, increasing L reduces the effects of process variations for both the PMOS and NMOS. However, f_t is also reduced greatly. Increasing L also increases the required $|V_{GS}|$ to reach the higher regions of operation. The ff corner does not change much even if nf is varied, unlike the ss and tt corners.