Low-power radio design for the IoT
Exercise 9 (20.05.2021)

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Problem 1 Dual Gate Mixer

Consider the dual-gate mixer shown in Fig. 1. Assume when M_1 is on, it has an on-resistance of R_{on1}. Also, assume abrupt edges and a 50% duty cycle for the LO, also $G_{ds1} = G_{ds2} = 0$ and the connection between bulk and source.

- Compute the voltage conversion gain of the circuit. Assume M_2 does not enter the linear region and denote its transconductance by g_{m2}.
- If R_{on1} is very small, determine the IP_2 of the circuit. Assume M_2 has an overdrive of $V_{GS0} - V_{TH}$ in the absence of signals (when it is on).

Problem 2 Active mixer with load mismatch

Consider the active mixer shown in Fig. 2, where LO has abrupt edges and a 50% duty cycle. Also, assume $G_{ds1} = G_{ds2} = 0$ and the connection between bulk and source. The load resistors exhibit mismatch, but the circuit is otherwise symmetric. Assume M_1 carries a bias current of $I_{\rm ss}$.

- Determine the output offset voltage.
- Determine the $\rm IP_2$ of the circuit in terms of the overdrive and bias current of M_1.

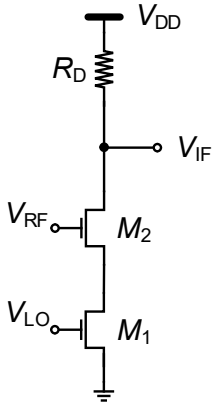

Figure 1: Dual-gate mixer

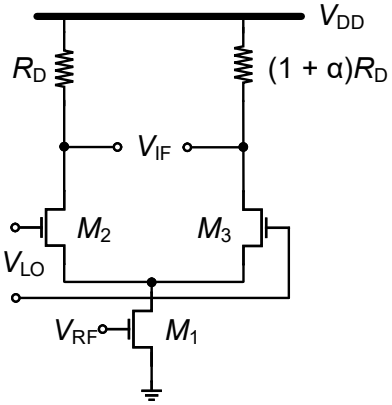

Figure 2: Active mixer with load mismatch