Low-power radio design for the IoT
Exercise 10 (05.05.2022)

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Problem 1 Dual Gate Mixer

Consider the dual-gate mixer shown in Fig. 1. Assume that the dc voltage applied at the gate of M2 is such that transistor M2 is biased in strong inversion and saturation and M1 is biased in the linear region when V_{LO} is high and that its on-resistance is R_{on1}. Also, assume that the LO signal has abrupt edges and a 50% duty cycle. You can also neglect the output conductances of transistors M1 and M2 ($G_{ds1} = G_{ds2} = 0$) and the source and drain access resistances.

- Compute the voltage conversion gain of the circuit. Assume M2 remains in saturation and denote its transconductance by G_{m2}.
- If R_{on1} is very small, determine the IP_2 of the circuit. Assume M2 has an overdrive of $V_{G0} - V_{T0}$ 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 the LO signal has abrupt edges and a 50% duty cycle. As above you can neglect the output conductances ($G_{ds1} = G_{ds2} = 0$) and the source and drain access resistance. The load resistors exhibit mismatch, but the circuit is otherwise symmetric. Assume M1 carries a bias current I_b.

- Determine the output offset voltage.
- Determine the IP_2 of the circuit in terms of the overdrive and bias current of M1.

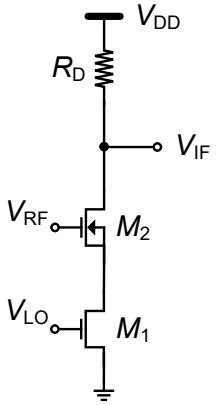

Figure 1: Dual-gate mixer

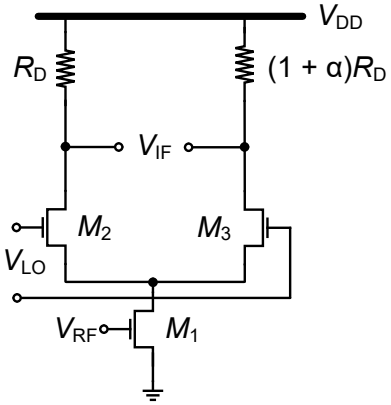

Figure 2: Active mixer with load mismatch