

Research Migration Project

<https://esim.fossee.in/research-migration-project>



The Research Migration Project is an initiative of FOSSEE, IIT Bombay that promotes the use of eSim for reproducing published research circuits originally implemented using proprietary simulation tools. The objective is to migrate these validated designs to eSim to build an open source resource database.

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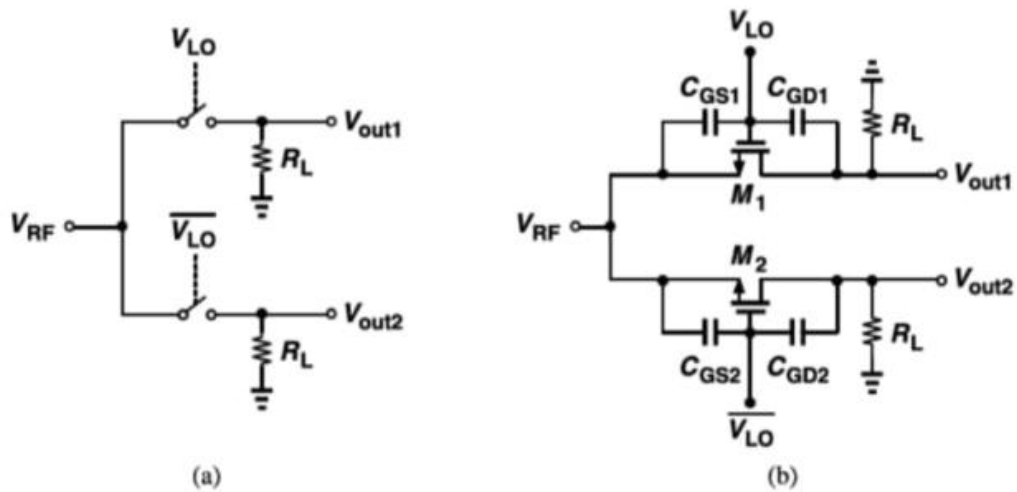
Title of the circuit: Design and Simulation of Single-Balanced and Double-Balanced Passive MOSFET Mixers

Theory/Description: Efficient frequency translation is critical in RF receiver front-ends. This project explores passive commutation mixers utilizing NMOS transistors operating in the linear region as voltage-controlled switches. A single-balanced passive mixer uses two NMOS switches driven by differential Local Oscillator (LO) phases to commutate an RF input, which inherently suffers from LO-to-IF feedthrough. A double-balanced passive mixer expands this into a four-transistor commutation quad. By applying balanced LO waveforms and balanced RF inputs, the opposing LO feedthroughs at each output node perfectly cancel each other out, yielding superior isolation.

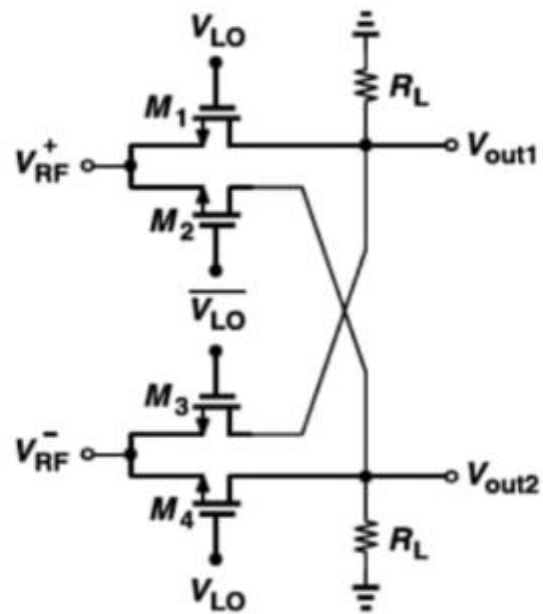
Reason to reproduce with eSim: To migrate fundamental textbook RF commutation circuits into eSim's open-source database. This project validates Ngspice's capability to accurately simulate passive frequency mixing, commutating switch behaviour, and LO feedthrough cancellation using generic discrete MOS components without relying on proprietary foundry PDKs

Expected Outcome/Outputs: The successful frequency translation of an RF signal. The single-balanced mixer simulation will output a mixed signal containing noticeable LO-IF leakage. The double-balanced mixer simulation will demonstrate complete feedthrough cancellation, outputting a clean Double-Sideband Suppressed-Carrier (DSB-SC) signal.

Circuit Diagram(s):



SINGLE BALANCED PASSIVE MIXER



DOUBLE- BALANCED PASSIVE MIXER

Block Diagram (s): NIL -Directly implementing transistor-level schematics

Expected Results (Input, Output waveforms and/or Multimeter readings):

Inputs: A low-frequency differential AC sine wave (RF Input) and a high-frequency differential pulse/square wave (LO Input).

Outputs: Transient voltage waveforms across the differential load resistors showing the mathematical multiplication of the RF and LO frequencies (DSB-SC envelope).

Research Paper/Journal/etc.:

Title: RF Microelectronics (2nd Edition) - Chapter 6: Mixers

Author: Behzad Razavi

Page No.: 348 – 349

Link: <https://scholar.google.com/scholar?q=RF+Microelectronics+Behzad+Razavi>

Source/Reference(s): Razavi, B. (2011). *RF Microelectronics* (2nd ed.). Prentice Hall.