Design of a Gilbert Cell Multiplier

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Abstract

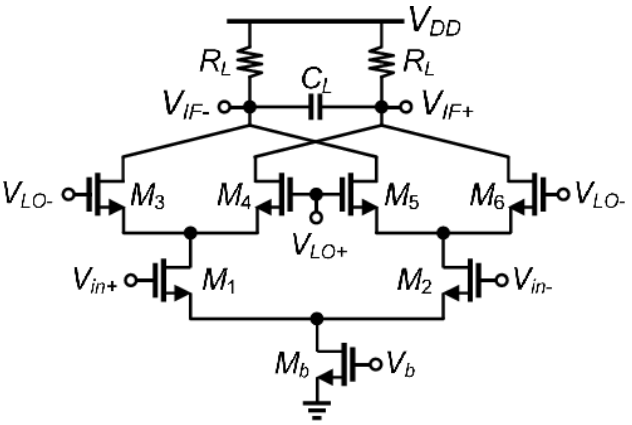
A Gilbert Cell is designed and implemented using CMOS logic with the help of Synopsys iPDK and Synopsys Custom design Platform. The Gilbert cell is a cross-coupled differential amplifier. It is a type of RF mixer circuit which is widely used in a range of applications. It is a double balanced mixer in which the symmetrical topology is used to remove the unwanted RF(Radio frequency) and LO(local Oscillator) output signals from the IF(Intermediate frequency) signal by cancellation for required applications. Though it requires a higher number of components, Gilbert cell is widely used due to its performance benefits.

Reference Circuit Details

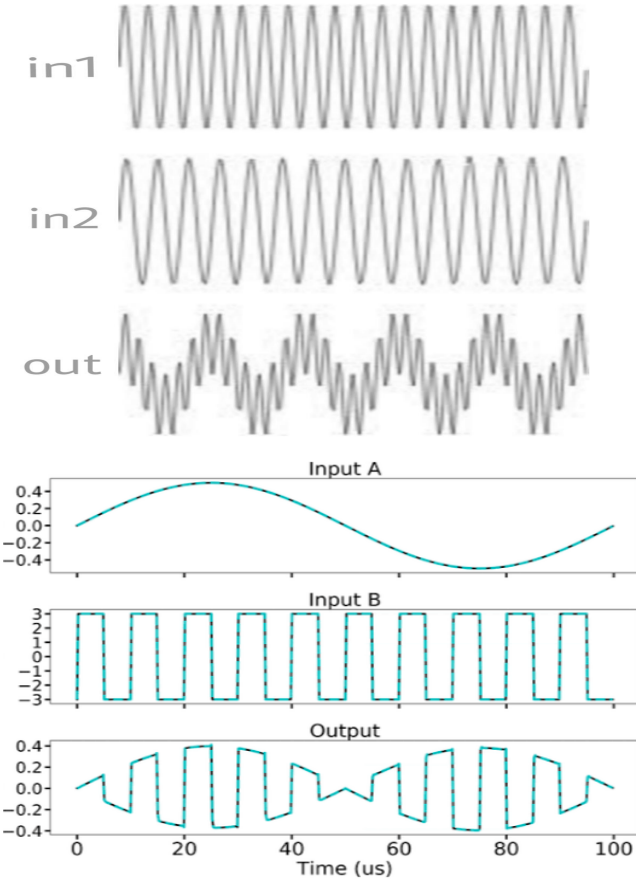
Gilbert Cell is an analog multiplier or mixer circuit that takes in two signals as input and produces their analog product as output. It can be viewed as a circuit whose gain can be electrically controlled. It is a popular choice for IC design since it can be built only using transistors without a need for components like inductors which are harder to fabricate. The popular applications of Gilbert cell include Variable gain amplifier, Four quadrant analog multiplier, Automatic gain control circuits, phase detector and frequency mixer. It can be used in modulation processes like AM, SSB and DSB.

The main component of a Gilbert cell is a differential amplifier pair which is built using four transistors. The first input signal of the mixer is provided to this circuit. The differential pair needs to be supplied with two dependent current sources. The gain of the differential pair depends on these tail current values. A Third differential amplifier circuit is used to act as the current source for the differential pair. The operation of the third diff-amplifier depends on the input voltage level provided by the second input signal of the mixer. This entire setup is referred to as the Gilbert Cell or Gilbert mixer circuit. The output of the system is the analog product of two input signals scaled by a constant factor.

Reference Circuit Design



Reference Waveforms



Reference Papers

[1] Pouya Solati, Mohammad Yavari, A wideband high linearity low noise CMOS active mixer, Springer Science media.