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Comparative Analysis of CMOS Mixers in 45NM VLSI Technology

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Abstract

Frequency translation in a system is performed by a non-linear device known as a mixer. A substantial discussion has been provided for several CMOS circuit configurations which are currently used to realize a frequency mixing operation with more emphasis on their working and operation as a mixer. Three topologies, single balanced mixer, double balanced mixer and double balanced dual gate mixer are presented here using 45nm VLSI technology. The mixer is designed in Cadence Virtuoso tool version 6.4.1. The three topologies are compared on the bases of average DC power consumption and port-to-port isolation. In the context of better frequency translation, 45nm CMOS technology provides better switching performance, less power consumption and higher density as compare to other CMOS technologies.

***Keywords:*Frequency translation, average Dc power consumption, port-to-port isolation, switching performance, higher density.**

1. Introduction

A mixer is an important building block of a radio transceiver whose function is to translate signal frequency to a higher or lower spectrum generally by the multiplication of two signals. Depending on the type of application, the input to a mixer is either Intermediate Frequency (IF) signal or Radio Frequency (RF)signal multiplied by a reference Local Oscillator(LO) signal.. The output frequency may be sum or may be difference of the two frequencies. One signal is wanted and other is unwanted and can be easily reduced by filtering [3].

$$RF = A\cos(RF)\,t$$

$$LO = B\cos(LO)\,t$$

$$IF = \frac{1}{2}\{A\cos(RF)t + B\cos(LO)t\}$$

2. Single Balanced Mixer

Mixers based on the multiplication of two signals exhibit superior performance as they ideally generate only the desired mixing products. Both the RF and LO signals are applied at different ports [2]. The schematic of single balanced mixer is given in figure 1.

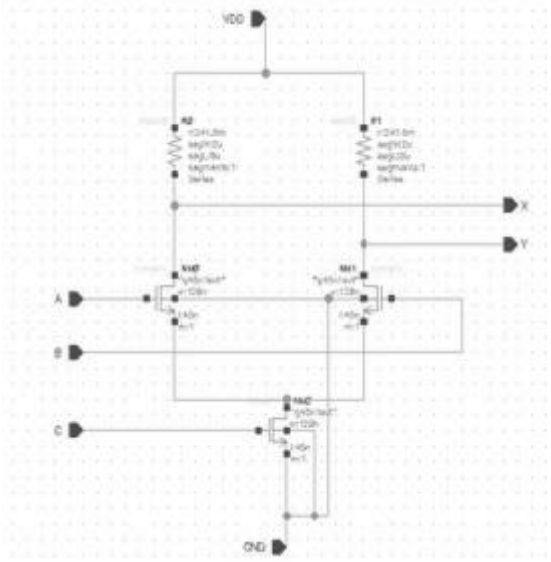

Figure 1 Schematic of Single Balanced Mixer

The incoming RF voltage signal is first convened into a current signal and then multiplied in Current domain. The FETs NM0and NM2 are biased a little above their threshold level which results in alternatively switching of NM0and NM2 on and offthe LO. Consequently, one LO transistor is always on, while other LO transistor is ideally off keeping the RF transistor in saturation. Therefore, the LO signal can be considered as a square wave consisting of oddharmonics of the LO frequency. Port A, B, C

represents LO_P, LO_N and RF respectively. Port X and Y represent IF_P and IF_N respectively.

2.1 Transient Response of Single Balanced Mixer

The transient response of SBM is shown in figure 2.

Figure 2 Transient response of Single Balanced Mixer

3. Double Balanced Gilbert Mixer

Two single-balanced mixers can be combined to form a double-balanced mixer. Both RF and LO inputs of the mixer are now differential. The active double-balanced current switch mixer is also termed as Gilbert cell mixer as show in Figure 3.

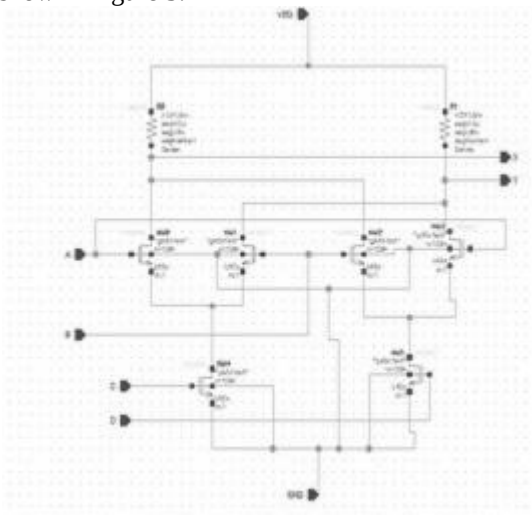

Figure 3 Schematic of Double Balanced Gilbert Mixer

The LO drive should be large enough to make the differential pair act like current-steering switches. The two single-balanced mixers are connected in anti-paralle1 as far as LO signal is concerned but in parallel for RF signal, therefore, the LO terms are cancelled at the output port [4].

3.1 Transient Response of Double Balanced Gilbert Mixer

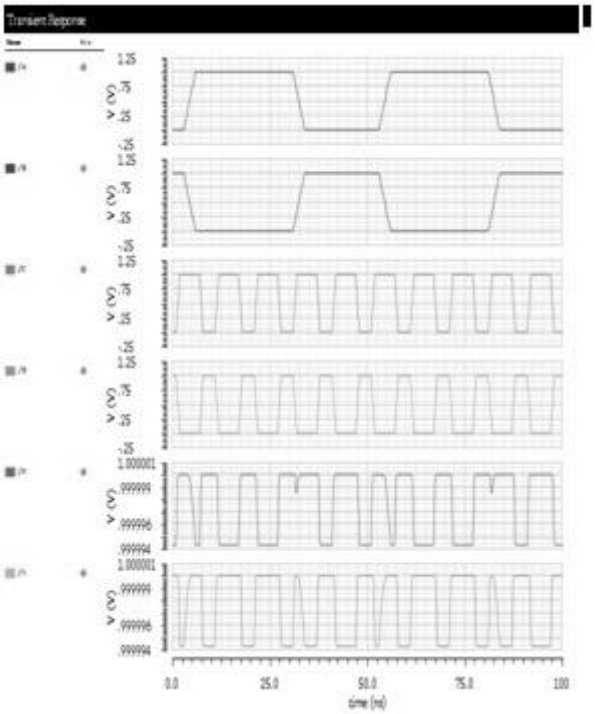

Figure 4 Transient Response of DBGM

4. Double Balanced Dual Gate Mixer

Dual gate mixers have one major advantage over single gate mixers that the RF and LO signals can be applied to the separate gates. The dual gate device is simply a cascode connection of two single gate FETs.In addition, this configuration is well suited to CMOS technology since the drain and source of the two cascoded devices can be shared reducing capacitance at the common junction [5]. The dual gate structure also has an added advantage of isolating LO and RF ports, allowing separate matching networks and providing inherent LO-RF isolation.The schematic of Double Balanced Dual Gate Mixer is shown in figure 4.

The disadvantages of dual gate mixer are the inevitable use of passive components for LO and IF rejection making it less useful in low frequency RFIC implementation, and reduction in conversion gain due to the possible addition

of a series resistance at the source of lower transistor, to evade instability that could exist due to the common-gate operation of LO transistor [1].

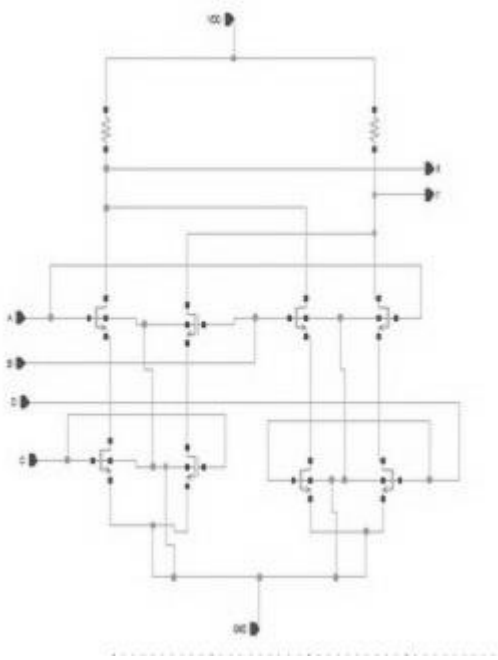

Figure 5 Schematic of Double Balanced Dual Gate Mixer

4.1 Transient Response of Double Balanced Dual Gate Mixer

Figure 6 Transient Response of DBDGM

5. RESULTS

The three mixer circuits are simulated using specterRF tool in Cadence Virtuoso 6.4.1. The three mixers are compared on the bases of average DC power consumption and port-to-port isolation. The average DC power consumption for single balanced mixer, double balanced Gilbert mixer and double balanced dual gate mixer are 9.08 µW, 20.15 µW and 20.13 µW respectively. The port-to-port isolation for the three is 15.89 dB, 27 dB and 29.52 dB respectively.

6. CONCLUSIONS

The three different topologies of Downconversion mixer has been designed in 45 nm CMOS process in Cadence virtuoso 6.4.1 tool. The single balanced mixer consumes least power among the three but worst port-to-port isolation performance. The port-to-port isolation is best in Double Balanced Dual Gate mixer. Based on the type of application one can choose any of the three topologies.

REFERENCES

[1] P. J. Sullivan, B. A. Xavier, W. H. Ku, "Double Balanced Dual-Gate CMOS mixer", *IEEE Journal of Solid-State Circuits*, vol. 34, NO. 6, June 1999, pp. 878-881.

[2] Bi Pham "A 1.9GHz Gilbert mixer in 0.18m CMOS for a cable tuner,"Department of Electronics Carleton University Ottawa, Canada.

[3] FerencMarki& Christopher Marki, "Mixer Basic Primer," Marki Microwave, 2010.

[4] P. J. Sullivan, B. A. Xavier, W. H. Ku, "Low Voltage Performance of a Microwave CMOS Gilbert CMOS Mixer", *IEEE Journal of Solid-State Circuits*, vol. 32, NO. 7, July 1997, pp. 1151-1155.

[5] P. J. Sullivan, B. A. Xavier, W. H. Ku, "Double Balanced Dual-Gate CMOS mixer", *IEEE Journal of Solid-State Circuits*, vol. 34, NO. 6, June 1999, pp. 878-881.