The comparison of the CMOS Double-Balanced Mixer for WLAN applications

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Abstract

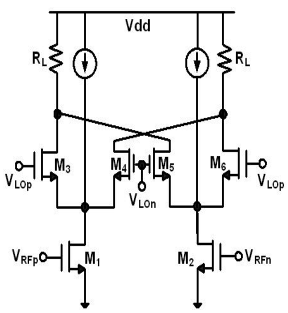
In this paper, we present the comparison of the CMOS Double-Balanced Mixer for WLAN applications using the tail current source and not using it at the same current. The mixers are derived from the Gilbert cell mixer and have been simulated by using TSMC 0.18㎛ RF CMOS technology.

I. Introduction

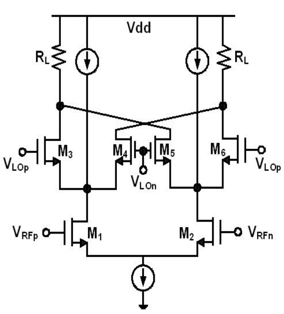
Since several years the research in the possibilities of CMOS technologies for RF applications has been greatly growing. The trend towards deep sub-micron technologies has resulted in the development of CMOS technologies for the design of RF circuits. Besides, CMOS integrated technologies for wireless applications over the GHz frequency range are receiving much attention due to their potential for low cost and the prospect of system on a chip[1].

Mixer is a critical block in a communication systems that perform frequency translation. As a part of RF circuits, its performances such as linearity, conversion gain and noise figure directly influence the RF system. In this study, We propose the comparison of the CMOS Double-Balanced Mixer for WLAN applications using tail current source and not using it at the same current. The designed mixers are based on the Gilbert cell mixer. A Gilbert cell mixer has a better LO-IF and LO-RF isolation but needs more power consumption and has higher noise figure. It can also reduce the even order harmonics of the RF and LO signals[2].

II. The comparison of the Mixer



(a) Common source grounded



(b) Tail current source

Figure 1. Simplified schematic of the designed Mixer

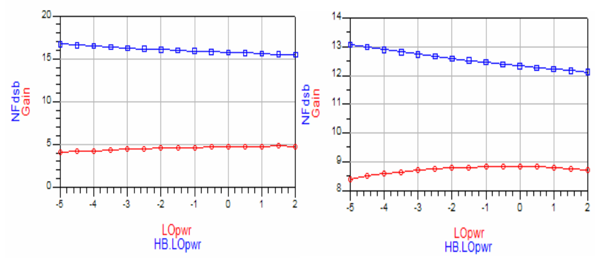
Figure 1. shows schematics of the proposed CMOS Mixer for WLAN applications. The designed mixers are based on the Gilbert cell mixer. Current bleeding technique is also applied to them. Current bleeding technique allows control of the dc currents for switching transistors (between $M_{3,5}$ and $M_{4,6}$) separately from that of the transconductance stage (M_1, M_2). It can provide a higher conversion gain through the higher load resistor because part of the transconductance stage current is being steered from the switching transistors. Furthermore, with bleeding, either the switching transistors could be operated at a lower gate-source voltage or smaller size transistors could be used. However, the major drawback of current bleeding is addition of noise signals due to the presence of the bleeding circuit[3]. The difference of the Figure 1. (a) and (b) is existence and nonexistence of the tail current source. A differential pair with a constant tail current source(b) exhibits higher-order nonlinearity than grounded sources(a). Tail current biasing source can also decrease the voltage headroom

requirements of the remaining stacked MOSFETs. However, if the sources are grounded, a much higher IIP_3 is obtained and the output contains no third-order intermodulation products[4].

In this study we compared the CMOS Double-Balanced Mixer for WLAN applications using the tail biasing current source and not using it at the same current.

Ⅲ. Simulation Results

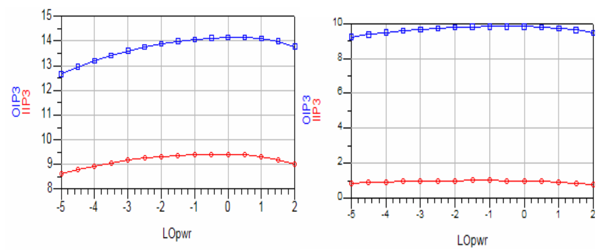
CMOS Double-balanced mixer was designed in a TSMC 0.18㎛ RF CMOS technology and simulated using Agilent Technology's ADS tool. The rf input frequency of the mixer 5.755 GHz, LO is 5.75 GHz, IF is at 5 MHz. The rf input power level is -30㏈m and supply voltage is 1.8V. The simulation was performed at the same current (5mA).



(a) Common source grounded (b) Tail current source

Figure 2. Conversion gain and Noise figure

As can be seen from Figure 2.(a) and (b), conversion gain and double side band(DSB) noise figure were swepted from -5㏈m to 2 ㏈m. Output termination is a 1 kΩ resistive load.



(a) Common source grounded (b) Tail current source

Figure 3. IIP_3 and OIP_3

A two-tone IIP_3 (Input-referred third-order intercept point) and OIP_3 (Output-referred third-order intercept point) simulations were performed on the mixer and results are shown in Figure 3. The two tones were applied with equal power levels at 5.775 GHz and 5.776 GHz. The power consumption is 9 ㎽.

Table 1. Simulation results of the designed Mixer

	Common source grounded	Tail current source
Technology	TSMC 0.18㎛ RF CMOS	
Power consumption	9 ㎽	
RF frequency	5.755 GHz	
LO frequency	5.75 GHz	
IF frequency	5 MHz	
LO power	0 dBm	
Conversion gain	4.74 dB	8.83 dB
(DSB) Noise figure	15.76 dB	12.33 dB
IIP3	9.41 dBm	0.99 dBm
Output resistive load	1 kΩ	

Table 1. clearly shows simulation results of the designed mixers. As can be seen from Table 1, IIP_3 is definitely different with them.

Ⅳ. Conclusion

In this work, CMOS Double-Balanced Mixer for WLAN applications using the tail current source and not using it at the same current were compared. We know that the existence and nonexistence of the tail current source affect lineality, conversion gain and noise figure.

Acknowledgment

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