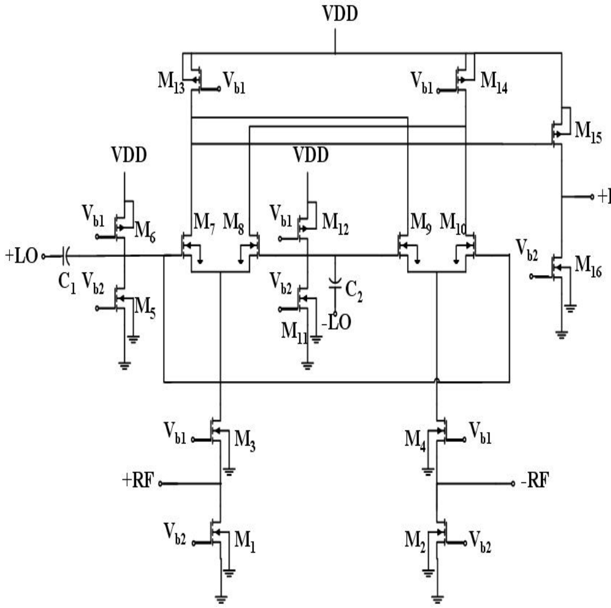

Fig. 2 Circuit schematic of the doubly balanced Gilbert-cell mixer, consisting of a Gilbert-cell core, tow common gate input stage, and a simple buffer.

B. *Parallel Transistor In Input Transconductance Stage*

Refer to MGTR (Multiple Gate Transistor Method) [1] architecture shown in Fig. 3. This method not used passive component and has been better linearity. The transistors M_4 and M_5 are applied in input transconductance stage, using M_3- M_4, and M_5-M_6 produced differential signal to offset interference signal and to increase linearity in Fig 4. The $C_1$and C_2 is added for impedance transformation and to get a better isolation.

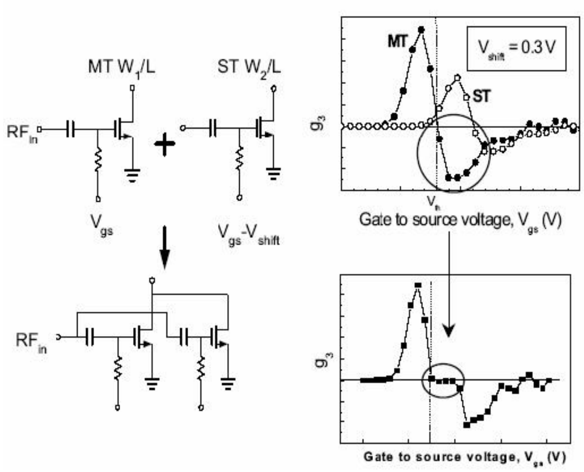

Fig. 3 MGTR CIRCUIT

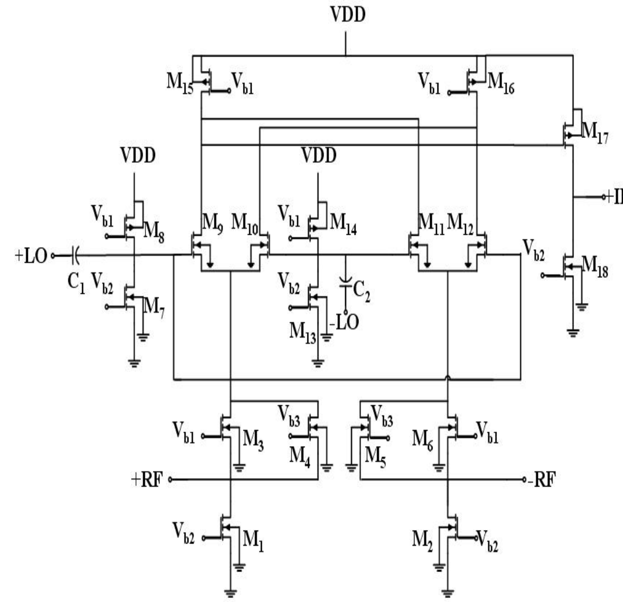

Fig. 4 Schematic of the proposed mixer

III. SIMULATION RESULTS

The proposed low power highly linear direct conversion mixer were designed in standard TSMC 0.18-um CMOS technology. The simulation tool of ADS (advanced design system) is applied in these designs. The mixer operated in 2.4GHz frequency bands. As can be seen Fig 3, the MGTR (Multiple Gate Transistor Method) [1] architecture proposed in Fig 4, can provide good linearity compared to traditional common-gate mixer in Fig. 2 much higher IIP3 13dBm and achieved low power in table l. The comparisons of performance are listed in table 2. Compare with previous publishes [3-6] the overall performances appear very good.

	COMMON-GATE INPUT TRANSCONDUCTOR STAGE	PARALLEL TRANSISTOR IN INPUT TRANSCONDUCTANCE STAGE
Process	0.18um	
Supply Voltage	1.8V	
RF Frequency	2.4GHz	
LO Frequency	2.3GHz	
IF Frequency	100MHz	
Conversion Gain	11.41(dB)	11.08(dB)
IIP3	8.40(dBm)	13.64(dBm)
Input Return Loss	-29.07(dB)	-28.52(dB)
RF-IF Isolation	-52.91(dB)	-52.77(dB)
LO-IF Isolation	-50.88(dB)	-50.87(dB)
LO-RF Isolation	-25.60(dB)	-25.25(dB)
Noise Figure	14.54(dB)	14.46(dB)
Power	3.96mW	3.99mW

Table 1 Performance of Mixer

	This work	[3]	[4]	[5]	[6]
Process	0.18um	0.18um	0.18um	0.18um	0.18um
RF Frequency	2.4GHz	2.4GHz	2.4GHz	2.4GHz	2.4GHz
Conversion Gain	11.08(dB)	19(dB)	9(dB)	15.7(dB)	4(dB)
IIP3	13.64(dBm)	-12.5(dBm)	0.5(dBm)	1(dBm)	8.5(dBm)
Input Return Loss	-28.52(dB)	-	<-10(dB)	-	-
RF-IF Isolation	-52.77(dB)	<-20(dB)	<-12(dB)	-	-
LO-IF Isolation	-50.87(dB)	<-20(dB)	<-12(dB)	-	-
LO-RF Isolation	-25.25(dB)	<-20(dB)	<-12(dB)	-	-
Noise Figure	14(dB)	-	10.32(dB)	12.9(dB)	-
Supply Voltage	1.8V	1.8V	1.8V	1.8V	1.2V
Power	3.99mW	-	28.8mW	16.2mW	6mW

Table 2 Comparisons of mixer performance

In the Fig.5 and 6 display the conversion gain of the direct-conversion mixer of common-gate and the proposed mixer for 2.4GHz frequency band. The conversion gain can achieve 11.41dB and 11.08dB respectively.

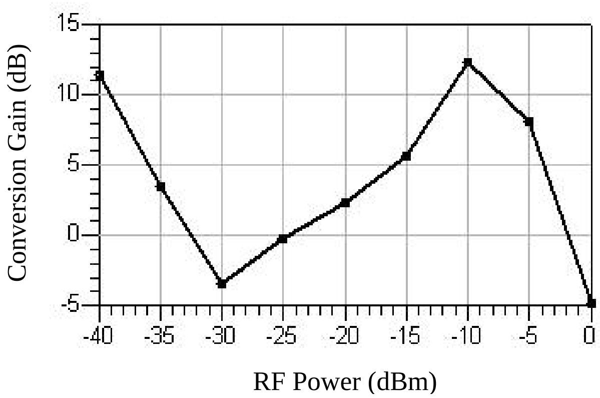

Fig. 5 Conversion gain of Common–Gate input transconductance stage.

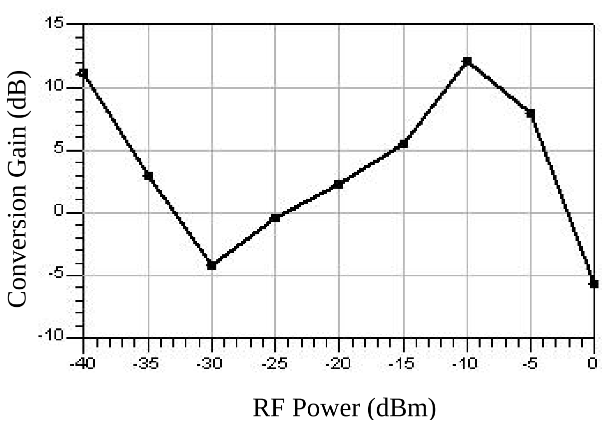

Fig. 6 The Conversion gain of proposed mixer

In Figure 7and 8, the IIP3 is measured by two tone, 2.405GHz and 2.395GHz, after testing output power and inter-modulation distortion (IM3) power, we can calculate the IIP3 by :

$$\boldsymbol{IIP3=Pin+}\frac{\Delta P}{2} \quad (1)$$

As can be seen from Fig 7-Fig 8, the proposed mixer in Fig 4, the linearity is improved. The IIP3 can achieve 13.64dBm.

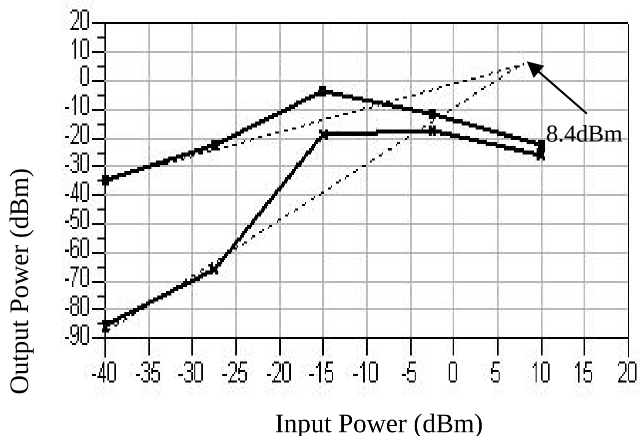

Fig. 7 IIP3 of the traditional common-gate mixer

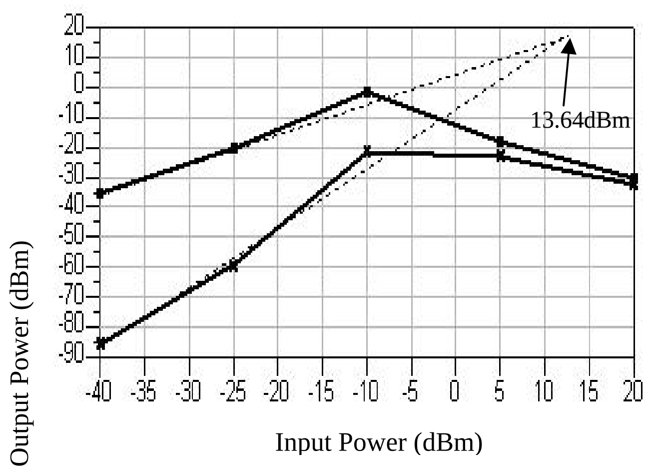

Fig. 8 IIP3 of the proposed mixer

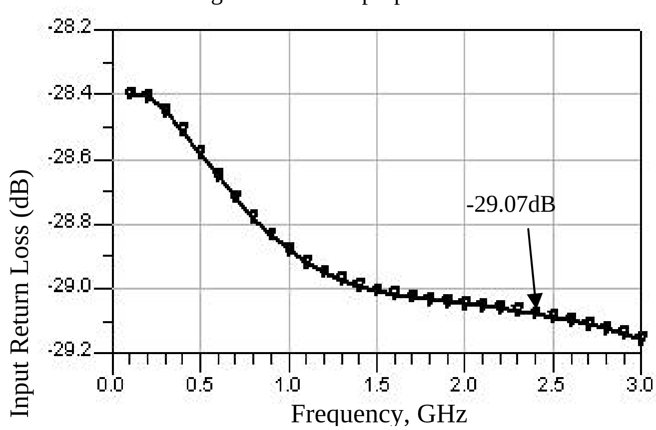

Fig. 9 Input return loss of the common-gate mixer

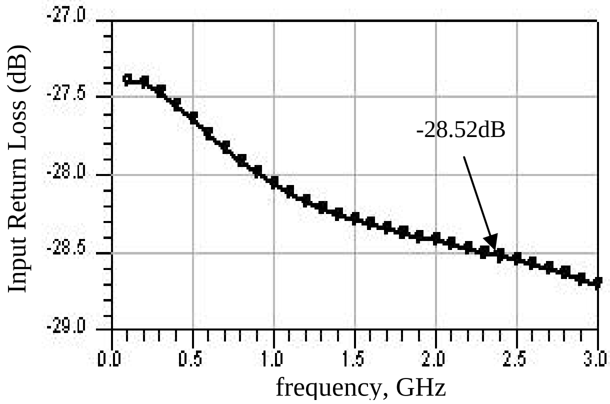

Fig. 10 Input return loss of the proposed mixer in 2.4GHz

Fig. 9-10. shows the return loss at RF port versus frequency.

IV. Conclusion

In this study, a low power highly linear direct conversion mixer with low power consumption is obtained. The mixer operated at 2.4GHz , which designed in 0.18um COMS process. In order to achieve impedance matching and to decrease passive components, common-gate is applied. Fig.8 Linearity is improved by referring to MGTR (Multiple Gate Transistor Method) [1] architecture, shows an excellent performance. In this direct conversion mixer, operating frequencies of 2.4GHz, it achieved a conversion gain is 11.08dB, IIP3 is 13.64dBm and the low power can be obtained. Furthermore, under 1.8V DC power supply the constant low power consumption is 3.99 mW.

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