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Wide-Band, Linear Low Noise Amplifier Design

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1　Introduction

As the CMOS technology getting more advanced in terms of scaling down the transistor channel length, its speed (i.e. f_T) is improving accordingly making the design of wide-band LNA without the usage of inductors is possible by using the negative shunt-shunt feedback (SSFB), but unfortunately the advanced CMOS transistor will suffer from a poor achievable linearity performance and especially IIP3 [2]. In this paper we present a technique to improve the linearity of the SSFB LNA by suppressing the 2nd order harmonic distortion (OHD) in the FB loop by the usage of a parallel positive FB which will lead to an improvement of the obtained IIP3.

2　Circuit implementation and results

By reducing the 2nd order harmonic distortion (OHD) that is produced by M3 in fig.1 (a) a reduction in the 3rd OHD at the output V_{out} that is generated from " squaring " (due to M1 transconductance first derivative) the combination between V_{in} and the 2nd OHD come from M3 . To do so a positive feedback M4 (fig.1 (b)) is used in parallel with negative one (M3) where the net 2nd OHD current at node X toward V_{in} will be the difference between the 2nd OHD current of M3 and M4, to reduce the noise in the positive feedback loop the channel of M4 is sized with its longest length (0.5 μm). To avoid oscillation M3 transconductance should be larger enough than M4 one. To examine the validity of the proposed technique, two LNAs were designed and fabricated by using TSMC 0.18 μm CMOS technology with standard V_{th}. The expected input third-order intercept point (IIP3) estimated from single-tone measurement for both LNAs as shown in Fig.3. An average IIP3 improvement of +8 dB is expected. Minimum noise figure of 2.8 dB was achieved at 2 GHz in the proposed circuit. 3 dB down bandwidth is about 3.7 GHz. Each of the fabricated LNAs consumes a current of 7.8 mA from 1.8 V power supply and occupies 0.007 mm^2.

3　Conclusion

An efficient linearization technique for the SSFB topology was presented, an enhancement of +8dBm of IIP3 can be obtained while maintaining other RF parameters unchanged besides consuming the same power.

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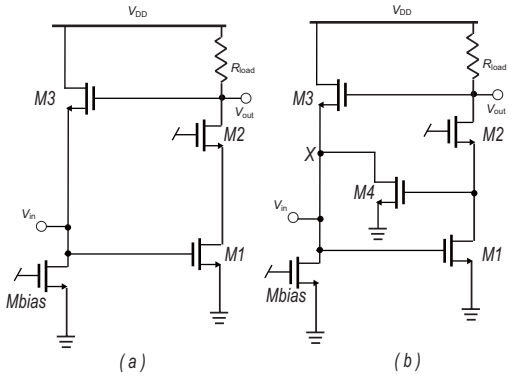

Fig. 1　(a). Conventional SSFB LNA [1] (b). SSFB LNA with parallel positive FB for linearization.

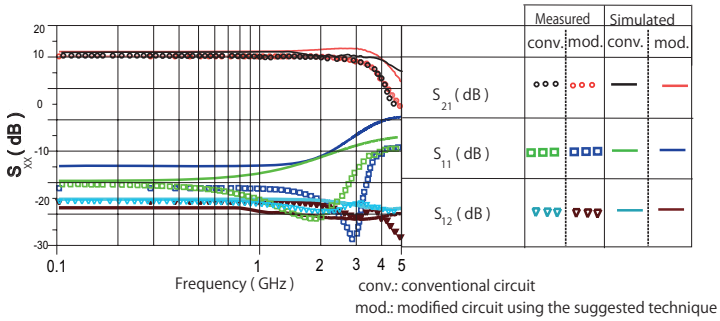

Fig. 2　S-parameters measurenents

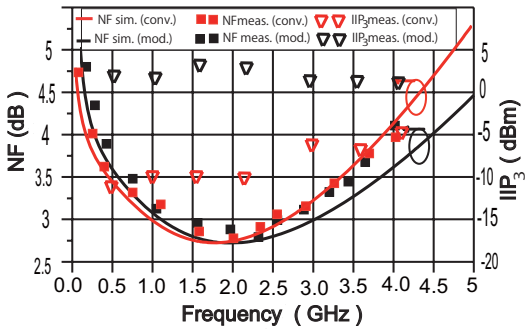

Fig. 3　NF and IIP3

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