A 1.5-V, 2.4GHz CMOS Low-Noise Amplifier

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Abstract: A 2.4GHz low noise amplifier has been designed in a standard CMOS 0.35 μm process. The transistor model is Bsim3 for 0.35 μm process. The amplifier provides a forward gain of 33dB with a noise figure only 0.92dB while drawing 17mw from a 1.5 V supply. Design simulation results are presented in this paper.

I. INTRODUCTION

As we know, the first stage of receiver is commonly a low-noise amplifier (LNA), whose main function is to provide enough gain to overcome the noise of subsequent stages (such as mixers), but not so much to cause the mixer overload. Secondly, an LNA should add as little noise as possible to minimize the impact on the overall noise performance. Thirdly, an LNA should accommodate large signals without distortion, i.e., provide good linearity. Frequently, an LNA also must provide specific impedance, such as 50 Ohms, to the input source and output load, which are particularly important. In addition, an LNA should provide low power consumption especially in portable systems.

The design of an LNA is full trade-offs between optimum gain, lowest noise figure, optimum input and output matching, high linearity and lower power consumption. While the literature is full of examples of LNA work in GaAs and bipolar technologies, there are few examples of CMOS design. However, CMOS provides the possibility of the integration of complete communication systems. Only recently have more and more people been involved in CMOS LNA designs, and have subsequently demonstrated the viability of CMOS LNA from 900MHz to 2.0GHz. [1][2][3].

II. CIRCUIT DESIGN

Following the circuit design given in [1][2], and with details presented in another conference [4], the complete circuit is shown in Figure 1. It was found that two-stage amplifier was required to achieve the desired gain, and

provided good isolation between the input and output. The first stage is a cascode amplifier form of M1 and M2. L_s and L_g are for input matching. L_d and C_d form a tank circuit to tune the LNA to 2.4GHz. M3 is output stage with matching network of L_o and C_o . M0, Rd and Rg form a bias circuit. M0 essentially is a current mirror with M1, while Rg prevents the bias circuit from shunt the RF input signal. Ci is used as a DC blocking capacitor. P1 and P2 are 50 Ohms source and load ports. On chip components include all transistors, inductors, capacitors and resistors.

Figure 1. Complete Circuit

III. SIMULATION RESULTS

The proposed circuit was simulated using Serenade 8.5. The transistor model is Bsim3v3 for TSMC 0.35 μm process. Figure 2 shows the forward gain of LNA. The amplifier provides a forward gain of 33dB at 2.4GHz. Noise Figure (NF) is obtained and shown in Figure 3. The simulated LNA achieves a noise figure of 0.9dB at 2.4GHz. The S11 and S22 parameters of LNA are illustrated in Figure 4. The simulated S11 and S22 are -23dB, -9dB respectively. The linearity of the LNA, which is normally evaluated by the output referred third-order intercept point (OIP3), is plotted in Figure 5. The simulated OIP3 is around 25dBm. Figure 6 show the response of input power versus output power, which indicates the 1dB compression point. The simulated 1dB compression point is -26dBm. The complete layout of

1011

IV. CONCLUSION

In this paper, we have demonstrated a low noise amplifier in a standard CMOS 0.35 μ m process, which can be the first amplifier in the receiver of a portable system. Based on the simulation results, we believe that CMOS is a suitable technology for wireless receiver design and will provide the integration of a complete communication system on a single chip in the future.

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