Chapter 3

Multiband Multi-Standard LNA with CPW Transmission Line Inductor

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ABSTRACT

LNA is one very essential bloc in the RF receiver. Due to the growth of the standard evolution, this component must handle several frequency bands with the best performances. This chapter presents a wide band LNA design for IEEE802.16 standard with the CMOS 0.35µm technology. In this LNA, we use a CPW transmission line to design the inductive degeneration inductor of 0.38nH. This circuit has a $S_{21}$ of 12dB, a noise figure less than 3dB and an input/output reflexion coefficient less than -10dB between 2 and 6GHz. The CPW line presents a characteristic impedance of 120Ω, an inductance of 0.38nH, a capacitance of few fF and a resistance less than 2Ω on the desired frequency band.

INTRODUCTION

Traditional wireless communication systems are designed for only one standard. However, the demand for wireless services convergence, in which users can access different standards with the same wireless device, is driving the multi-bands multi-standards transceivers development. Thus, future RF front-ends need to operate over a multiple frequency bands with the best performances such as low cost, least size and with low power.

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Different receiver architectures exist in the literature and the objective of any designer is to find the best full receiver integration solution for multi-standards applications. One of the multi-band receiver components is the low noise amplifier LNA which has to be able to operate over multi-bands frequencies with the same specifications especially in term of gain, noise, matching and linearity. In the integrated circuit of the RF systems, passives elements are widely used especially in the impedance matching between the different blocs of the receiver such as between antenna-LNA or between LNA-mixer. These passives can be lumped (spiral inductor) or distributed (transmission line) and in both cases they have an important role.

This chapter treats the design of a multi-bands LNA for the WiMAX receiver with the use of a coplanar wave guide CPW transmission line inductor. In the second section we will present the different receivers architectures and the choice of the best one for WiMAX applications. In the third section we will present the different multi-bands LNA structures in the literature, followed by the proposed wide band LNA circuit design. Next, transmission lines types are described and a comparison between them is done to choose the best and performed one which is the CPW line for the design of a low value inductor. Finally, simulation results are presented.

RECEIVER ARCHITECTURE

In the receiver path, the main role of the RF part is the transposition of the modulated signal, which was received by the antenna, to the base band. The difference between one receiver and other in RF systems is presented in the disposition and in the number of blocs. (Super)Heterodyne, homodyne zero IF and low IF are the three existing receivers architectures. Each one has its advantages and its drawbacks.

Heterodyne Receiver

The super heterodyne architecture [L. Lévy, http://perso.club-internet.fr/dspt/LEVY.htm], Figure 1, provides the best and superior selectivity and sensitivity with the use of two down conversion steps of the desired RF signal. The first down conversion of the signal is around a fixed intermediate frequency (IF) and the second down conversion to the base band is centered on the central frequency of the desired channel. These two steps are realized with two local oscillators.

However, an undesired image signal will be created after the first mixing which has to be attenuated with an image reject filter and this last constitutes the major drawback of this architecture. RF and IF filters integrations are very difficult because the inductors have high quality factors. Moreover, this receiver requires an impedance matching between every two blocs, presents higher power consumption and it isn’t adaptable for multiband applications.

Homodyne Receiver (Zero IF)

In the previous receiver, the frequency down conversion is done in two steps. To resolve the image reject problem, the homodyne receiver (Colebraok, http://www.thevalvepage.com/radtech/synchro/synchro.htm), Figure 2, or zero IF receiver doesn’t need an IF frequency and therefore there is a direct conversion to the base band. There is no image problem and therefore no need of a reject filter neither a necessity
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