Research Paper

ANALYSIS OF WORKING OF LNA IN UWB RANGE

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ABSTRACT

An ultra-wideband (UWB) noise-canceling low-noise amplifier (LNA) has been proposed in this paper. By using Chebyshev filter, the effective bandwidth of noise canceling is extended. This LNA has been fabricated in a 0.18μm CMOS process. The measured noise figure is calculated over 3.1–10.6-GHz along with good gain and noise figure, good linearity is also required for the LNA to operate properly. The 1-dB compression point and IIP3 point are the characteristics measuring the linearity of the RF components. The objective is to get -10 dB of 1-dB compression point.

Keywords: Chebeshev filter, CMOS, LNA, UWB.
**Introduction**

The demand for high-speed wireless communication systems is growing during the last few years. With a frequency spectrum allocated from 3.1 to 10.6-GHz, ultra-wideband (UWB) is emerging as a very attractive solution for short-distance and high data rate wireless communications. Two possible approaches have been proposed to implement an UWB system. One uses the multi-band OFDM modulation, while the other transmits short pulses with position or polarity modulation. Although the standard has not been completed, a front-end wideband low noise amplifier is indispensable regardless of the receiver architecture. The amplifier must meet several stringent requirements. Those include broadband input matching to minimize return loss, sufficient gain to suppress the noise of a mixer, low noise figure (NF) to enhance receiver sensitivity, low power consumption to increase battery life, and small die area to reduce the cost. There are several existing solutions for high frequency wideband amplifiers in CMOS technology.

Distributed amplifiers can bring the gain-bandwidth-product (GBW) to a value close to device $f_T$, but consume large power and area [1]. Amplifiers employing shunt-shunt feedback are well-known for their wideband matching capability, but require high power consumption to obtain reasonable noise figure [2]. A multi-section LC ladder matching network has been proposed to achieve wideband matching, low noise figure, and low power consumption simultaneously [3]. However, the rapid growth of noise figure at high frequencies decreases the receiver sensitivity when operating at upper bands. Besides, the loss of inductors in the matching network contributes substantial noise, and this makes it difficult to realize them in a small area. In this work, the concept of noise canceling is re-exploited [4]. By using inductive series and shunt peaking techniques and the design methodology described in this paper, broadband noise canceling effectively lowers the noise figure over the target band under reasonable power consumption and small die area.

**CIRCUIT DISCRIPTION**
The proposed schematic is shown in Figure 1. A Chebyshev filter is used to achieve resonance in the reactive part of the input impedance over the whole frequency range of 3 to 10 GHz. Typically the Chebyshev filter consists of two capacitors and two inductors. The Chebyshev filter works as a passband filter if the sizes of L1, C1, L2 and C2 are selected correctly.

The proposed solution expands the basic inductively degenerated common source amplifier by inserting an input multi section reactive network, so that the overall reactance can be resonated over a wider bandwidth. This input matching network is shown in the Figure 1, by a dotted square. A capacitor (C3) is placed to add flexibility to the design. Different values of C3, would give different matching conditions. The cascade connection of M1 and M2 improves the input output reverse isolation and the frequency response of the amplifiers.

Object detection and tracking is an important challenging task within the area in Computer Vision that try to detect, recognize and track objects over a sequence of images called video. It helps to understand, describe object behavior instead of monitoring computer by human operators. It aims to locating moving objects in a video file or surveillance camera. Object tracking is the process of locating an object or multiple objects using a single camera, multiple cameras or given video file. Invention of high quality of the imaging sensor, quality of the image and resolution of the image are improved, and the exponential increment in computation power is required to be created of new good algorithm and its application using object tracking. In Object Detection and Tracking we have to detect the target object and track that object in consecutive frames of a video file. Object tracking fundamentally entails estimating the location of a particular region in successive frames in a video sequence. Properly detecting objects can be a particularly challenging task, especially since objects can have rather complicated structures and may change in shape, size, location and orientation over subsequent video frames. Various algorithms and schemes have been introduced in the few decades, that can track objects in a particular video sequence, and each algorithm has their own advantages and drawbacks. Any object tracking algorithm will contain errors which will eventually cause a drift from the object of interest. The better algorithms should be able to minimize this drift such that the tracker is accurate over the time frame of the application. In object tracking the important challenge that has to consider while the operating a video
tracker are when the background is appear which is similar to interested object or another object which are present in the scene. This phenomena is known as clutter. The other challenges except from cluttering may difficulty to detect interested object by the appearance of the that object itself in the frame plane due to factors which are described as follows:

The input network impedance is equal to \( \frac{R_s}{W(s)} \) where \( W(s) \) is the Chebyshev filter transfer function given by:

\[
W(s) = \frac{wL_1}{1} + \frac{1}{wC_1} + wL_2
\]

(1) Note that \( W(s) \) is approximately unity in the in-band and tends to zero at out-of-band. The impedance looking into the amplifier is therefore equal to \( R_s \) in the in-band, and it is very high out-of-band. At high frequency the MOS transistor acts as a current amplifier because of the channel length modulation effect. The current gain is given by \( \beta(s) = \frac{g_m}{sC_t} \) [6]. The current flowing into M1 is \( \frac{\text{Vin}W(s)}{R} \), and therefore the output current is \( \frac{\text{Vin}W(s)}{sC_tR} \). The load of the LNA is a shunt peaking transistor used as a resistor.

The overall gain is:

\[
\frac{V_{out}}{V_{in}} = \frac{\{G_mW(s)\}\{R_L(1+sL/R_L)\}}{\{sC_tR\}\{1+sR_LC_{out} + sC_{out}\}}
\]

(2)

where, \( R_L \) is the load resistance, \( L \) is the load inductance, and \( C_{out} \) is the total capacitance between the drain of M2 and ground. That means \( C_{out} = C_{db2} + C_{gd2} \), where \( C_{db2} \) is the drain and bulk capacitance of transistor M2. Equation (2) shows that the voltage gain roll is compensated by L because it is directly connected to the drain of transistor M2. Moreover, it shows that \( C_{out} \) introduces a spurious resonance with L, which must be kept out of the band. Simulation helps in choosing the final values of these components: \( L_3=1 \) nH and \( C_3=100 \) pF. The value of M2, which is in cascode connection to M1, is chosen to be as small as possible in order to reduce the parasitic capacitance. A very large value of \( R_2 \) (higher than 200\( \Omega \))

Figure 1: Proposed circuit diagram.

CIRCUIT ANALYSIS

Gain analysis

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could result in reduction of the headroom. Keeping all these criteria in mind, the value chosen for RL and L are 90 Ω and 2 nH, respectively.

Figure 2: Voltage gain in dB

Figure 3: Power Gain

Figure 4: Noise factor

References

[1] A Wideband Low Power Low-Noise Amplifier in CMOS Technology


