A Review of CMOS Low Noise Amplifier for UWB System

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***Abstract*—A number of CMOS low noise amplifier (LNA) design for ultra-wideband (UWB) application had been produced with a various topology and techniques from year 2004 to 2016. The performance of LNA such as frequency bandwidth, noise figure, input and output matching and gain depend with the choice of the topology and technique used. Among the techniques introduced are current reuse, common source, resistive feedback, common gate, Chebyshev filter, distributed amplifier, folded cascade and negative feedback. This paper presents the collection of review about design of low noise amplifier used for UWB application in term of topology circuit. Thus, the problem and limitation of the CMOS LNA for UWB application are reviewed. Furthermore, recent developments of CMOS LNAs are examined and a comparison of the performance criteria of various topologies is presented.**

***Index Terms*—Low Noise Amplifier (LNA); Ultra-Wideband (UWB); Radio Frequency (RF).**

I. INTRODUCTION

Ultra-wideband (UWB) is a very promising technology with its features for major advances in wireless communications, networking, radar and imaging system. UWB transceiver is a combination of transmitter and receiver that will be used to transmit and receive the data signal processing. In UWB transmitter and receiver, the component involved are power amplifier [1]- [2], mixer [3], low noise amplifier (LNA) [4]-[6], and oscillator. UWB transmission system offers ability to transmit the data for short-range communications, security system and measurement applications. The advantages of this technology including low-power transmission, its stability for multi-path fading and it require low power. In 2002, Federal Communication Commission (FCC) had defined UWB as any signal having bandwidth of greater than 500 MHz or a fractional bandwidth larger than 20% at all times of transmission where the frequency allocated is from 3.1 GHz to 10.6 GHz.

LNA is the "front end" of the receiver that function to get and amplify a very low power, low voltage signal which also containing unwanted signal that received from antenna, at the range of certain bandwidth. LNA are commonly located very close to receiver to reduce the loss. In fact, the LNA is an important block in wireless communication receiver that widely used in UWB technology. The key parameters of LNA are wide input and output matching, flat gain, low power consumption, good linearity and low noise figure. The most important requirement for LNA is to have tolerable gain to minimize the noise that will be produced by another block after LNA. However, if the gain is extremely high, it will cause a large interference signal that is exceeding the limit can be handled by mixer's linearity. Generally, UWB application, minimum gain of LNA is above 10 dB. Meanwhile, the best noise figure (NF) for LNA is lower than 3dB because of unavoidable losses of RF filter remain little noise budget for other active block [4]. Therefore, the LNA design must be a good design to minimize the contribution of noise and higher gain as possible.

II. DEVELOPMENT OF LNA FOR UWB

Development of LNA in UWB using CMOS technology had been introduced since 2004 [4] with the introduction of LNA with cascode feedback. Since then, there are various designs and improvement to produce better LNA used in UWB. Table 1 shows the development of low noise amplifier for UWB system. The design is fully based on CMOS technology. In this table, the proposed design cover frequency from 3.1-10.6 GHz, 3-5 GHz, 3-7 GHz etc., depending on the application of the design.

III. LOW NOISE AMPLIFIER FOR ULTRA-WIDEBAND DESIGN TECHNIQUES

The first research on LNA for UWB had been conducted 2 years after FCC released the frequency for UWB by [4]. In their design, they using cascode feedback technique to reduce the high frequency roll-off of the input devices due to the Miller effect [4]. Since then, a lot of researches on LNA for UWB system had been done. The most topology used are current reuse topology, some of the research used filter known as Chebyshev filter, feedback circuit and single-ended cascode topology.

A. Single-ended Cascode Topology

The single ended cascode topology involved only one stage of differential LNA. This topology adopted to reduce the needed of using multiple stage or transmission line based matching technique that will lead to space consuming. Most of the single stage in LNA use common source (CS). The reason is common gate (CG) has lower noise values than CS and make it more suitable to be used for optical and microwave broad-band communication applications. However, common drain (CD) is rarely use in LNA design but widely used for the low thermal-resistance, oscillator and low-distortion variable-gain amplifier [25].

Figure 1 shows the schematic of LNA with common source and common drain topologies [18]. The proposed design used single stage differential LNA using matching technique at the output circuit to avoid the degrading effect of the low-quality factor, Q. This design adopted using 0.13 µm CMOS technology. The common source configuration then will