DESIGN AND ANALYSIS OF LOW NOISE AMPLIFIER USING CADENCE

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BORANG PENGESAHAN STATUS LAPORAN

PROJEK SARJANA MUDA II

Tajuk Projek : **DESIGN AND ANALYSIS OF LOW NOISE AMPPLIFIER USING CADENCE**

Sesi Pengajian :

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DECLARATION

This declaration is to clarify that all of the submitted contents of this project are original in its figure, excluding those, which have been admitted specifically in the references. All the work process involves is from my own idea and creativity. All contents of this project have been submitted as a part of partial fulfilment of Bachelor of Electronic Engineering in Computer Engineering.

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June 2014

"I hereby declare that I have read this report and in my opinion this report "Design and Analysis of Low Noise Amplifier using CADENCE" is sufficient in terms of the scope and quality for the bachelor of Electronic Engineering (COMPUTER)."

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Special Dedicated

To my beloved family members for their true love, prayers and encouragement. Then to my supervisor that guide and give moral support to me and to all my friends for your support throughout my educational journey.

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ABSTRAK

Kertas ini membentangkan Bunyi Rendah Amplifier yang juga dikenali sebagai LNA untuk setiap aplikasi dalam sistem komunikasi tanpa wayar. LNA adalah penguat elektronik yang digunakan untuk menguatkan isyarat yang sangat lemah yang mungkin diterima oleh antenna. LNA adalah bahagian yang sangat penting dalam penerima RF kerana apabila menggunakan bunyi LNA boleh dikurangkan dengan keuntungan oleh penguat apabila bunyi penguat diterima terus daripada isyarat yang diterima. Penguat bunyi yang rendah telah direka untuk mendapatkan prestasi yang lebih baik dengan mengikuti kehendak dalam era baru ini terdiri daripada kenaikan yang tinggi , angka bunyi yang rendah, penggunaan kuasa lebih rendah , kawasan cip kecil , kos rendah dan input yang baik dan output yang sepadan. Di samping itu , kerja-kerja ini merupakan satu skema LNA terdiri daripada tiga peringkat yang menggunakan penguat pintu biasa , parit penguat biasa dan induktor aktif. Pintu biasa dan longkang biasa digunakn untuk peringkat masukan dan keluaran dalam setiap LNA. Ia juga digunakan untuk keluaran yang sangat baik dan keluaran yang sangat sepadan dan mempunyai potensi untuk mendapatkan penggunaan kuasa yang lebih rendah dan untuk mengurangkan saiz cip dalam reka bentuk susun atur. LNA mencapai keputusan yang terbaik dengan kenaikan simulasi 14.7dB, penggunaan kuasa yang amat rendah dari 0.8mW, angka hingar 7dB dan luas kawasan cip yang kecil 0.26mm ². Reka bentuk ini dilaksanakan dengan menggunakan perisian CADENCE dengan teknologi terbaru 0.13µm.

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ABSTRACT

This paper presents a Low Noise Amplifier also known as LNA for any application in wireless communication system. LNA is an electronic amplifier used to amplify a possible very weak signal that captured by antenna. LNA is a very important part in RF receiver because when using a LNA, noises can reduce the gain by the amplifier when the noise of the amplifier is received directly from received signal. The low noise amplifier have designed to get the better performance by following the requirement in this new era consists of high gain, low noise figure, lower power consumption, small chip area, low cost and good input and output matching. Besides that, this work represents an LNA schematic consists of three stages which is common gate amplifier, common drain amplifier and active inductor. Common gate and common drain is used for input and output stages in every LNA. It is also used for excellent input and output matching and has a potential to get a lower noise. While, for active inductor, is used to obtain the lower power consumption and to reduce the chip size in layout design. LNA achieved the best performance with a simulated gain of 14.7dB, extremely lower power consumption of 0.8mW, noise figure of 7dB and small chip area of 0.26mm². The design is implemented by using the CADENCE software with the latest technology of 0.13µm.

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ABBREVIATIONS

LNA	-	Low Noise Amplifier
RF Transceiver	-	Radio Frequency Receiver and Transmitter
RFID	-	Radio Frequency Identification
CC	-	Common Collector
CB	-	Common Base
CE	-	Common Emitter

LIST OF APPENDICES

CHAPTER I

INTRODUCTION

Nowadays, the wireless communication system field is a system that is very important in our daily lives for example GPS, Wi-Fi, Bluetooth, RFID systems, satellite communications and many more. Therefore, an LNA is a key component that significant in the RF transceiver where the RF transceiver controls the efficiency of the whole system in communication. In this new era, user demand increase in term of the requirement for better performance such as high gain, low noise figure, lower power consumption, lesser weight, lower cost and smaller chip area.

1.1 Amplifier Theory

There are three basic amplifier configurations for bipolar transistors:

1. The common-emitter (CE) amplifier
    i. Has the affordable voltage gain, input and output impedance.
    ii. It has from limited bandwidth.
2. The common-base (CB) amplifier
    i. Affordable output impedance and voltage gain as well as high bandwidth
    ii. This input impedance tends to be fairly low (approximately 25 Ω at 1 mA.)
3. The common-collector (CC) amplifier

i. Has high bandwidth and sufficient input impedance
ii. Has a voltage gain of approximately 1

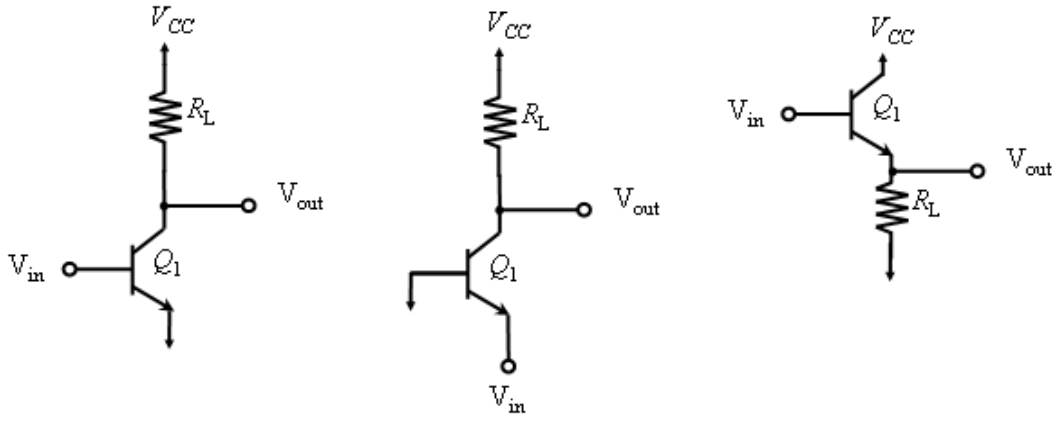

Figure 1.1 Common emitter, common base and common collector [1]

1.2 Low Noise Amplifier

Low noise amplifier is also known as LNA, a special type of electronic that widely used in wireless communication system. A LNA can be found in RF transmitter and receiver for the basic building block in communication system. Hereby, LNA is the most important part of the receiver because it is placed at the front of the receiver and act as an amplifier to amplify the received signals in order to works as an electronic amplifier. In order to get the level that required for LNA to amplify the received signals of additional noise, the radio receiver should have an amplifier, a mixer and a filter.

Furthermore, the main function of LNA is to amplify a very low signal. This amplify method is with no additional noise is to maintain the required signal to noise ratio at very low power level and for higher signal levels. The receiver, named as receiver sensitivity, can be received by LNA when the amplification provides the first level of the requirement. By using this LNA, noise can be reduced by manipulating the gain. The amplifier also can reduce the noise only if the noise of the amplifier is injected directly into the received signal.

Figure 1.2 shows that the basic of RF receiver block diagram. It is commonly used to modulate and demodulate the transmission of RF signal. The function of the transmitter is to carrying the signal meanwhile the RF receivers receives the signal From time to time, the consumer's demands, by following the requirement of LNA in term of low noise, high gain, low cost, smaller size and good input and output matching, have been rises together with the technologies. In this proposed project, the LNA design will be created in order to fulfil these requirements. Figure 1.2 below shows the block diagram of RF receiver.

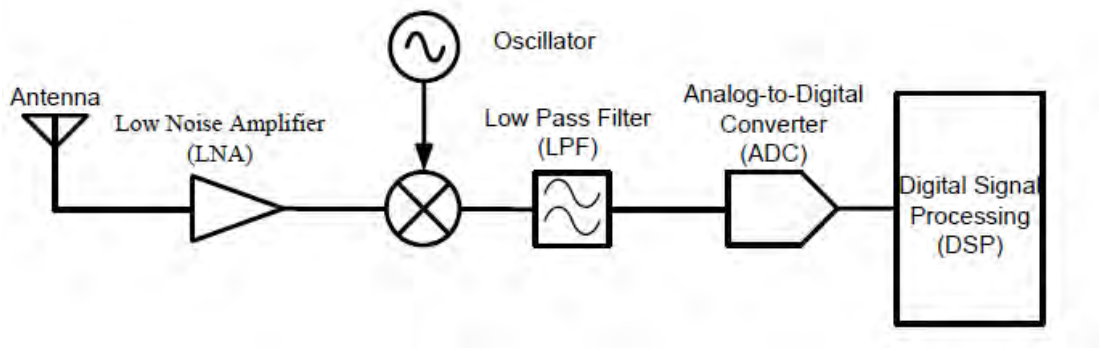

Figure 1.2 Basic RF receiver block diagram[2]

1.3 Problem Statement

A low noise amplifier has been designed to presents a considerable challenge because of its simultaneous requirement. Therefore, LNA requires a design that has enhance the parameters listed below:

1. High gain
2. Low noise figure
3. Lower power consumption
4. Good input and output matching
5. Cost
6. Size

1.4 Objectives

The project aims to achieve the following objectives:

1. To design a low noise amplifier by using the CADENCE software with latest technology (0.13um).
2. To simulate and analyse the performance of the proposed design.

1.5 Project Scope

The proposed project is limited to the following scopes:

1. To design a low noise amplifier with the latest technologies and to analyse the circuit to achieve the requirements.
2. To draw the layout by using the CADENCE software.

1.6 Project Significant

The project brings some benefits such as:

1. To reduce the power consumption, the cost and the size of the latest technology (0.13μm).
2. Can be used in any communication system in this new era.

1.7 Thesis Organization

This thesis comprises five chapters: Introduction, Literature Review, Project Methodology, Result and Discussion, and Conclusion and Future Work. The introduction of the project has been given in this chapter, where it is specifically explains the background of the project for further understanding of the thesis. Chapter 2, the Literature review, reviews the theory on amplifier topologies, low noise amplifier and several other topics that related to the project. Chapter 3 discusses the methodology of the overall project which is divided into two stages

which is PSM I and PSM II. PSM I covers on the literature review and LNA research. Whereas in PSM II continues with the designing the schematic circuit and the layout by using the CADENCE software. Experimental results and discussions were explained in further details in Chapter 4. Finally, the thesis ends up with Chapter 5, which concludes the overall project followed by a number of recommendations for future work and research.

CHAPTER II

LITERATURE REVIEW

This chapter provides an overview of relevant literatures as well as the basic theoretical concept of LNA topologies and the target specification including the gain, the power consumption, and the noise figure. Then, this chapter proceeds with the comparison of several of low noise amplifier designs followed by the proposed circuit. The significant complexity of the comparison is selecting the appropriate circuit for this project. At the end of the chapter, a summary is provided.

2.1 Low Noise Amplifier Topologies

Low noise amplifier is the first stage in the RF receiver and it is very important part in RF receivers. Hereby, low noise amplifier should be matched with the antenna characteristic. The characteristic of antenna is excellent input and output matching and to generate high gain.

To optimize the low noise amplifier design, the suitable topology should be selected for low power and low voltage. For shunt series feedback common source topology, it is difficult to get the very low power consumption in order to match the requirement such as the gain, small noise figure and good input and output matching. Furthermore, for common gate topology, the gain was less than 10dB with a very low power consumption.

Next, the noise must be added into the LNA because of the resistor thermal noise for the resistive termination common source topology. Besides, the specification for inductive degeneration common source topology in very low power consumption was satisfied but the isolation is not good enough to compare to the cascade inductor source degeneration topology. Still, it can get the similar low noise amplifier performance with very low power consumption. Lastly, for cascade inductor source degeneration topology, it provides higher gain with a low noise figure.[3]

Hence, there are several types of fundamental of topologies low noise amplifier to choose a common low noise amplifier for optimized the LNA design

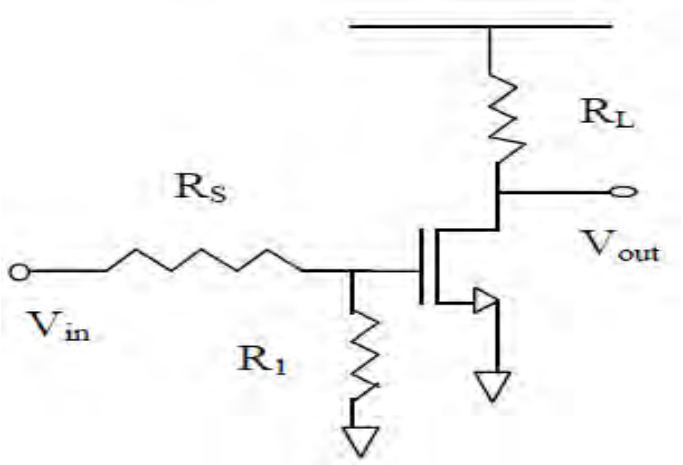

Figure 2.1 Resistive termination common source[3]

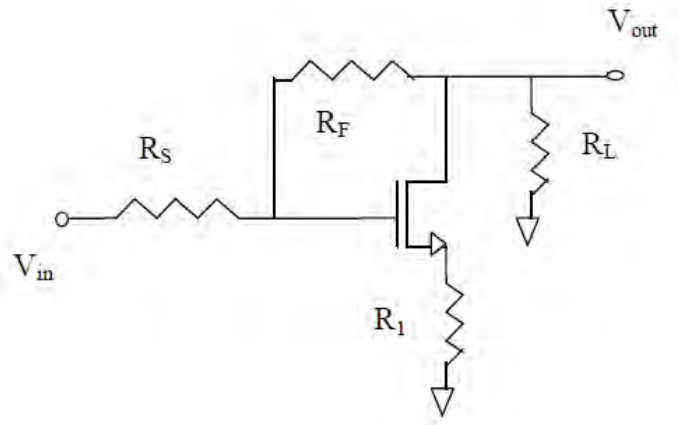

Figure 2.2 Shunt series feedback common source[3]

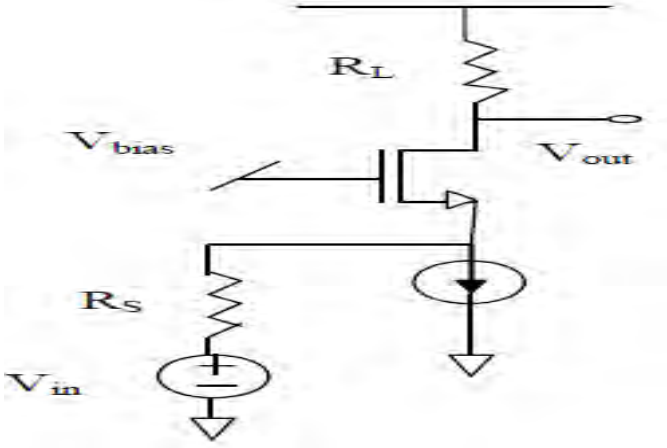

Figure 2.3 Common Gate[3]

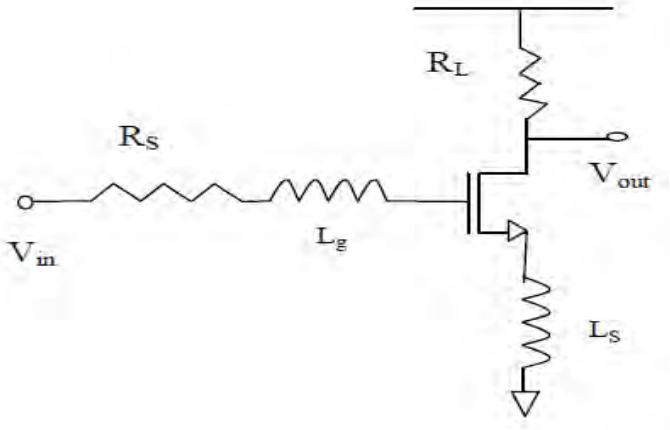

Figure 2.4 Inductive degeneration common source[3]