DESIGN LOW NOISE AMPLIFIER WITH ULTRAWIDEBAND FREQUENCY

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BORANG PENGESAHAN STATUS LAPORAN
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Tajuk Projek	:	DESIGN LOW NOISE AMPLIFIER WITH ULTRAWIDEBAND FREQUENCY 1GHz-5GHz
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For the most beloved and supporting parents,

AHMAD KHIDIR BIN MUIN
DALILAH BINTI MUHD SAID

Special dedicated to my beloved parents, umi and ayah, beloved siblings, grandmother, grandfather and also to others who encouraged me throughout my journey of education to the special one, who inspired me.

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ABSTRACT

In the new era of communication technology, Ultra Wideband is a communication method used in wireless networking to achieve high bandwidth connections with low power utilization. In the receiver part of Ultra Wideband systems, there is one special type of the electronic amplifier used in communication systems which amplifies very weak signals captured by antenna. This part of receiver called low noise amplifier which is located of the front-end of receiver. Without LNA the systems will produce a very weak signal and have a noise. Federal Communication Commission (FCC) has licensing on the use of UWB frequency which the frequency allocations ranging from 3.1 GHz to 10.6 GHz. The objective of this project final year is to design a LNA using frequency 1 GHz to 5 GHz. The noise figures that to achieve are less than 1.5 dB and gain is larger than 12 dB. Technique that has been used in this project is feedback method. This UWB frequency due to its benefits that are transmits information using very low power, short impulses thinly spreading over a wide bandwidth, high data rate and less multipath fading.

ABSTRAK

Dalam era teknologi komunikasi, '*Ultrawideband*' adalah satu kaedah kemunikasi yang digunakan dalam rangkaian wayarles untuk mencapai sambungan jalur lebar dengan penggunaan kuasa yang rendah. Pada bahagian penerima system jalur 'ultrawideband' terdapat satu jenis khas penguat elektronik yang digunakan dalam system komunikasi yang menguatkan isyarat yang lemah dimana ia di diterima pada bahagian antenna. Ini sebahagiannya dipanggil penguat bunyi yang rendah dimana terletak akhir dihadapan penerima. Tanapa penguat lemah ini, ia akan menghasilkan isyarat yang lemah dan hingar. Suruhanjaya Komunikasi Persekutuan(FCC) telah memberi perlesenan ke atas penggunaan frekuensi '*Ultrawideband'* yang terdiri daripada 3.1GHz ke 10.6GHz. Objektif projek ini adalah merekabentuk penguat lemah dengan menggunakan frekuensi 1GHz hingga 5GHz. Teknik yang digunakan dalam projek ini adalah teknik suap-balik. Angka hingar yang hendak diterima adalah kurang daripada 1.5 dB dan gandaan adalah lebih besrar dari 12 dB. Frekuensi *ultrawideband*" ini memberikan kesan baik dimana ia menghantar informasi menguunakan kuasa yang rendah, impuls yang pendek dan boleh merebak pada jalur lebar dengan lebih luas dan kadar data yang tinggi,

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LIST OF ABBREVIATIONS

ADS	-	Advance Design System
CMOS	-	Complementary-Symmetry Metal–Oxide–Semiconductor
FCC	-	Federal Communication Commission
GPS	-	Global Positioning Systems
LNA	-	Low Noise Amplifier
LAN	-	Local Area Network
PHEMT	-	Pseudo orphic High Electron Mobility Transistors
RF	-	Radio Frequency
SS	-	Spread Spectrum
UWB	-	Ultra Wideband
VLF	-	Very Low Frequency
WLAN	-	Wireless Local Area Network

LIST OF SYMBOLS

Symbols	Definition
C	Capacitor
dB	Decibel
f	Frequency
g	Element Values
G	Giga
H	Height
Hz	Hertz
I	Current
K	Rollet‟s Stability Factor
Km	Kilometer
L	Inductance
M	Meter
mA	Miliampere
mm	Milimeter
mW	Miliwatt
π	Pi
P	Power
R	Resistance
S	Scattering
V	Voltage
ω	Angulare Frequency

APPENDIX

CHAPTER 1

INTRODUCTION

1.1 Project Background

Wireless communication is among technology's biggest contributions to mankind. Wireless communication involves the transmission of information over a distance without using of wires, cables or any other forms of electrical conductors. The transmitted distance can be anywhere between a few meters (for example, a television's remote control), it can transmitted distance anywhere with a thousands of kilometers (for example, radio communication). Actually, Ultra Wideband (UWB) wireless communications is a different approach and offers wireless communications compared to conventional narrow band systems. Global interest in the technology is huge. Some estimates predict the UWB market will be larger than the existing wireless LAN and Bluetooth markets.

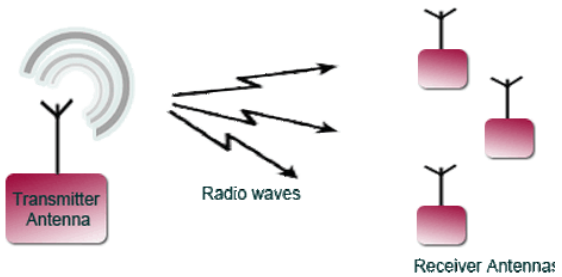

Figure 1.0 : Wireless Communication

Ultra-wideband (UWB) technology offers a solution for the bandwidth, cost, power consumption, and physical size requirements of next-generation consumer electronic devices. With the consistent high data rates across multiple devices and PCs within the digital home and office which enables wireless connectivity for UWB. This emerging technology provides the high bandwidth that multiple digital video and audio streams require throughout the home. With the support of industry workgroups, such as the wireless universal serial bus (USB) workgroup and technology leader's example Intel technology there are offers to make a high speed WPAN which can connect the devices throughout the home.

At the receiver there are have an LNA design presents a considerable challenge because of its simultaneous requirement for high gain, low noise figure, good input and output matching and unconditional stability at the lowest possible current draw from the amplifier. UWB communication poses big challenges for low noise amplifier (LNA) design.

The design of LNA 1GHz until 5GHz is using BFP640 SiGe HBTr. Due to the designs that have chosen because designs for use in low cost commercial. It has high gain, high linearity and low noise performance and so on, so that it can satisfy our requirement perfectly in awide band range., Others the design will perform in FR3 board which have a fully intergrated for low noise amplifier for UWB.

The HBT device was chosen because of its higher maximum available gain (MAG) and the ease to obtain an unconditional stability over a wide bandwidth owing to its. lower impedance.[20]

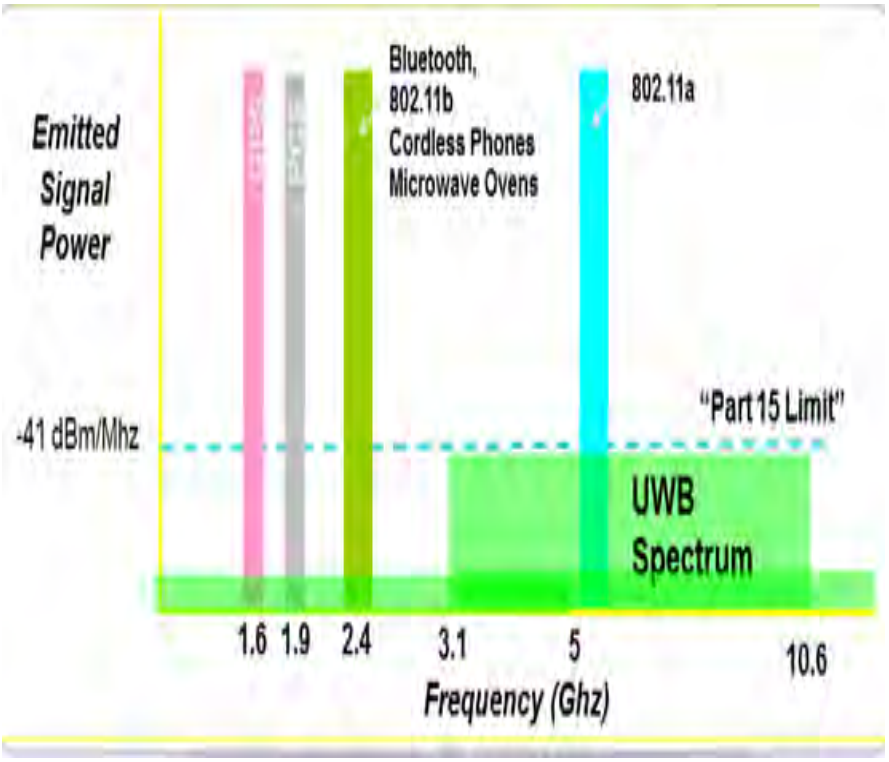

Figure 1.1 : UWB Spectrum

1.2 Problem Statement

LNA function in today's communication system provides first level of amplification of the signal received at the receiver. The smallest possible signal that can be received by the receiver defines as receiver's sensitivity.

The LNA function plays an undisputed importance in the receiver design. Its main function is to amplify extremely low signals without adding noise. thus preserving required signal to noise ratio of the system at extremely low power levels.

1.3 Objective

The problems occur when amplifying the signal where the transmitted noise also being amplified. To avoid from this noise happen, the LNA is designed so that

the signal is transmitted without contributing too much noise. The objective of this research is to perform circuit design, including circuit analysis such as simulation and measurement at 1GHz until 4 GHz frequency. This low noise amplifier will produce noise figure less than 1.5dB and also high gain above 12dB. The method used in obtaining the gain and noise figure is a feedback method,. The results of gain and noise figure from the three methods will choose the best result.

1.4 Scope of Project

The scope of works for this final year is to design a Low Noise Amplifier for Ultra wideband application. Following is the scope of project;

a) Literature Review – At the beginning of this project will be research on the theory such as circuit theory.
b) Calculation – Analysis can be doing by calculation in term of stability, gain.
c) Simulation – Simulation is the procees that we have done for calculation part.
d) Fabrication – After running the simulation part, the circuit can be design The fabrication will be done using microstrip. The design will be fabricate the best technique

1.5 Thesis Outline

In this thesis outline there will be covered in four chapters. Chapter 1 is for Introduction. For this chapter, there are covers the background of the project, problem statement and scope of work in term of planning schedule.

For the Chapter 2, will be represent the theoretically part especially in basic of Ultra wideband, Ultra wideband works and other's. And for Chapter 2 will be discussing the theory of LNA and step of designing LNA. The methodologies will be cover in Chapter 3. Simulation results will be appearing when the project will be applied. Chapter 4 will covered the Results and the lastly dor the Chapter 5 will covered conclusion and future works.

CHAPTER 2

LITERATURE REVIEW

2.1 Ultra Wideband

In the technology of Ultra wideband for Radio Frequency which are using low energy to transmit binary data and extremely short duration impulses or bursts over a wide spectrum of frequencies. There are using over the distance from short to medium range 15 to 100 meters to deliver the data and also not involve a dedicated radio frequency. It's known as a carrier-free, impulse and base-band radio.

Ultra-Wideband (UWB) is a high data rate, low power short-range wireless technology that is generating a lot of interest in the research community and the industry, as a high-speed alternative to existing wireless technologies such as IEEE 802.11 WLAN, HomeRF, and Hiper LANs. The main advantage of UWB technology is low cost transceiver design. The major challenges in Ultra Wideband Communication Receivers are high speed, high dynamic range of ADC and Wideband Low Noise amplifier.[1] Ultra-Wideband (UWB) technology is loosely defined as any wireless transmission scheme that occupies a bandwidth of more than 25% of a center frequency, or more than 1.5GHz [2].

Ultra-Wideband Communications was first employed by Guglielmo Marconi in 1901 to transmit Morse code sequences across Atlantic Ocean using spark gap radio transmitters [3]. Approximately fifty years after Marconi, UWB technology

was applied to impulse radars in military applications and this technology was restricted to military from 1960s to 1990s. However, ultra-wideband is now ready for commercial applications because of recent advancements in microprocessors stemming from the rapid development of semiconductor technology. Therefore, it is more appropriate to consider UWB as a new name for a long-existing technology. [3]

2.2 Advantages and Limitation of the UWB

There are many advantages in this UWB technology. The advantages of the UWB system are offers a high data transmission especially. Other's than that the technology is the simple transceiver architecture. Ultra wideband also performs with the large channel capacity and high performance in multipath channels, and low signal-to-noise ratio and low power. UWB have been known as a power spectral density which also allows them to coexist the in term of cellular systems, wireless local area network (WLAN) and Global Positioning Systems (GPS). The FCC power spectral density emission limit for UWB emitters operating in the UWB band is -41.3dBm/MHz. The Federal Communications regulates interstate and international communications by radio, television, wire, satellite and cable in all 50 states, the District of Columbia and U.S. territories

2.3 Comparison Ultra wideband, IEEE 802.11a and Bluetooth

Wireless communication now days can give advantages to all of user. Actually the communication needs a range or a big area with the high speed limitation of the transmission of wireless. The comparison is following [4]:

Table 2.1 : Comparison between Bluetooth, IEEE 802.11a and UWB

Systems	Bluetooth	IEEE 802.11a	UWB
Operating range	10 meter	50 meters	10 meters
Peak Speed	1Mbps	54 Mbps	50 Mbps
Spatial Capacity	30,000 bit/sec/square-meter	83.000 bit/sec/square-meter	1,000,000 bit/sec/square-meter

2.4 Ultra Wideband Works

UWB differs substantially from conventional narrowband radio frequency (RF) and spread spectrum technologies (SS), such as Bluetooth Technology and 802.11a/b/g. A UWB transmitter works by sending billions of pulses across a very wide spectrum of frequency several GHz in bandwidth. The corresponding receiver then translates the pulses into data by listening for a familiar pulse sequence sent by the transmitter. UWB's combination of larger spectrum, lower power and pulsed data improves speed and reduces interference with other wireless spectra. In the United States, the Federal Communications Commission (FCC) has mandated that UWB radio transmissions can legally operate in the range from 3.1 GHz up to 10.6 GHz, at a limited transmit power of –41dBm/MHz. The result is dramatic short-range channel capacity and limited interference. [5]