



**Faculty of Electronic and Computer Engineering**

**RF RECEIVER DESIGN USING THE DIRECT CONVERSION  
APPROACH AT 5.8 GHz BAND BASED ON IEEE 802.11a  
STANDARD**

**Asreen Anuar bin Abd Aziz**

**Master of Science in Electronic Engineering**

**2014**

**RF RECEIVER DESIGN USING THE DIRECT CONVERSION APPROACH AT  
5.8 GHz BAND BASED ON IEEE 802.11a STANDARD**

**ASREEN ANUAR BIN ABD. AZIZ**

**A thesis submitted  
in fulfillment of the requirements for the degree of Master of Science  
in Electronic Engineering**

**Faculty of Electronic and Computer Engineering**

**UNIVERSITI TEKNIKAL MALAYSIA MELAKA**

**2014**

## DECLARATION

I declare that this thesis entitled “RF Receiver Design Using The Direct Conversion Approach at 5.8 GHz Based On IEEE 802.11a Standard” is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : .....

Name : Asreen Anuar Bin Abd Aziz

Date : 08 September 2014

## **APPROVAL**

I hereby declare that I have read this thesis and in my opinion this thesis is sufficient in terms of scope and quality for the award of Master of Science in Electronic Engineering.

Signature : .....

Supervisor Name : Prof. Madya Dr. Abdul Rani Bin Othman

Date : .....

## **DEDICATION**

To my beloved mother and father,

Pn. Wan Jah Binti Haji Mat Zain and En. Abd Aziz Bin Haji Saamah

To my brother and sisters,

Azrul Afenddy, Azlen Suryaniey and Aznen Anizam

To my lovely wife and daughter,

Rashidah Rashed and Atiyah Zahra'

To my mother and father-in-law

Muslipah and Rashid

To all my family members

To my supervisors and lecturers

Then last but not least to all my friends.

## ABSTRACT

This thesis presents the development and analysis of a radio frequency (RF) front-end direct conversion receiver at 5.725 – 5.825 GHz where IEEE 802.11a standard is used as performance test. The RF receiver is designed based on the commercialized products (off-the-shelf) where it focuses on the system design tradeoff, rather than circuit design tradeoff. The RF receiver has been designed with the selected architecture where it is consist of low noise amplifier (LNA), radio frequency amplifier (RFA), power divider and two bandpass filters. The modeled RF receiver has been analyzed by using Advanced Design System (ADS) 2005A software for system characteristic and performance test. From the simulation, minimum sensitivity is -91 dBm at data rate 6 Mbps and -74 dBm at data rate 54 Mbps where it is comply with the IEEE 802.11a standard. The RF receiver prototype has been measured and this system produces has gain of 39 dB which is higher than the reviewed of 37.5 dB. The noise figure of this work is measured at 1.30 dB, which is better than the reviewed work at 4.6 dB. The nonlinearity characteristic such as power at 1dB compression point (P1dB) and third order intercept point (IP3) is observed. From the measurement, the RF receiver will drop 1 dB when input power ( $P_{in}$ ) is injected above -27 dBm then it caused output power ( $P_{out}$ ) start saturated. The third output intercept point (OIP3) and third input intercept point (IIP3) is at around 15 dBm and -24.50 dBm respectively. The RF receiver system characteristic such as sensitivity meet the standard requirement of IEEE 802.11a standard for wireless local area network (WLAN) bridge system.

## ABSTRAK

*Tesis ini melaporkan satu pembangunan dan analisis sebuah penerima frekuensi radio (RF) penukaran terus bahagian hadapan pada frekuensi 5.725 – 5.825 GHz di mana piawaian IEEE802.11a telah digunakan sebagai ujian prestasi. Penerima RF ini direkabentuk berdasarkan kepada produk komersial (daripada pasaran) di mana ia menumpukan pada pertukaran rekabentuk sistem, berbanding pertukaran rekabentuk litar. Penerima RF ini telah direkabentuk dengan seni bina yang terpilih di mana ia mengandungi satu penguat hingar rendah (LNA), satu penguat frekuensi radio (RFA), satu pembahagi kuasa dan dua penapis lulus jalur. Penerima RF ini telah dianalisis dengan menggunakan perisian Advanced Design System (ADS) 2005A untuk ciri-ciri sistem dan ujian prestasi. Daripada simulasi, sensitiviti minima adalah -91 dBm pada kadaran data 6 Mbps dan -74 dBm pada kadaran data 54 Mbps di mana ianya mematuhi piawaian IEEE802.11a. Prototaip penerima RF ini telah diukur dan sistem ini telah menghasilkan gandaan sebanyak 39 dB yang mana lebih tinggi berbanding dengan 37.5 dB nilai yang dikaji. Angka hingar bagi penyelidikan ini diukur pada 1.30 dB, yang mana ianya lebih baik berbanding dengan nilai 4.6 dB kerja yang dikaji. Sifat-sifat ketidaksejajaran seperti kuasa pada titik mampatan 1 dB ( $P_{1dB}$ ) dan titik pintasan tertib ketiga ( $IP_3$ ) diperhatikan. Daripada pengukuran, penerima RF akan jatuh 1 dB apabila kuasa masukan ( $P_{in}$ ) dibekal lebih daripada -27 dBm kemudian ia menyebabkan kuasa keluaran ( $P_{out}$ ) mula menjadi tepu. Keluaran titik pintasan tertib ketiga ( $OIP_3$ ) dan masukan titik pintasan tertib ketiga ( $IIP_3$ ) adalah masing-masing pada lingkungan 15 dBm dan -24.50 dBm. Ciri-ciri sistem penerima RF seperti sensitiviti mencapai piawaian keperluan IEEE802.11a untuk sistem perhubungan rangkaian tanpa wayar kawasan setempat (WLAN).*

## ACKNOWLEDGEMENT

First and foremost, I would like to take this opportunity to thank to my supervisor, Associate Professor Dr. Abdul Rani Bin Othman from the Faculty of Electronic and Computer Engineering Universiti Teknikal Malaysia Melaka (UTeM) for his constant support, motivation and encouragement throughout my research especially in completing this thesis. With his assist, we successful obtained RF front-end receiver which is designed and fabricated from Man & Tel, Korea.

I would also like to thank to my former supervisor Engr. Imran Bin Mohd Ibrahim from the Faculty of Electronics and Computer Engineering for his guidance and advice, my co-supervisor Mr. Noor Azwan Bin Shairi from the Faculty of Electronic and Computer Engineering for his a lots of support in thesis arrangement especially in technical part and also give motivation and inspiration to me. Special thanks also Minister of Science and Technology of Malaysia (MOSTI) and UTeM short term grant funding for the financial support throughout this project.

Particularly, I would like to thank Department of Telecommunication, Faculty of Electronic and Computer Engineering for providing postgraduate laboratory with complete facilities to easier my research works. Also thanks to technicians and and security guard for allowing me to use this lab wheather on the day and the night side to complete this research. I would like to thank to my friends and lecturers where always together in postgraduate laboratory that I unable to mention their name in supporting me in this research. Again, I want to thank to my co-supervisor Mr. Noor Azwan Bin Shairi for introducing and assisting me in measurement of the RF receiver prototype at Telekom Malaysia Research and Developement (TM R&D).

Also thanks to all family members especially my beloved mother, father, my lovely wife and daughter where I know they never stop praying for me so that I become success. Thank you all!!!



---

## TABLE OF CONTENTS

	PAGE
DECLARATION	
APPROVAL	
DEDICATION	
ABSTRACT	i
ABSTRAK	ii
ACKNOWLEDGEMENT	iii
TABLE OF CONTENTS	iv
LIST OF TABLES	vi
LIST OF FIGURES	viii
LIST OF APPENDICES	x
LIST OF ABBREVIATIONS	xi
LIST OF PUBLICATIONS	xiv
CHAPTER	
1. INTRODUCTION	1
1.0 Introduction	1
1.1 Objectives	2
1.2 Problem Statement	2
1.3 Research Scopes	4
2. RADIO FREQUENCY FRONT-END RECEIVER	7
2.1 Objective	7
2.2 Radio Frequency Receiver Architecture	8
2.3 Super Heterodyne and Direct Conversion Receiver	8
2.4 Heterodyne Receiver Versus Direct Conversion Receiver	9
2.5 Direct Conversion RF Front-End Receiver Design	15
2.6 Heterodyne Versus Direct Conversion Receiver	21
3. RF RECEIVER SYSTEM	22
3.1 Introduction	22
3.2 RF Receiver System Consideration	22
3.2.1 Sources of Noise	23
3.2.2 Noise Figure	24
3.2.3 Gain Compression and 1 dB Compression Point	28
3.2.4 Dynamic Range	29
3.2.5 Intermodulation Distortion and Third Order Intercept Point (IP3)	31
3.3 RF Receiver Specification	38
3.3.1 IEEE 802.11a Standard	39
3.4 Summary	43
4. RF RECEIVER DESIGN	44
4.1 Introduction	44
4.2 RF Receiver Block Diagram	44
4.3 Characteristics of RF Components	46
4.3.1 Low Noise Amplifier	46
4.3.2 RF Amplifier	47
4.3.3 Power Divider	49
4.3.4 Filter	50

4.4	RF Receiver Budget and Analysis	52
4.4.1	Receiver Gain	52
4.4.2	Receiver P1 dB and IP3	55
4.4.3	Receiver Noise Figure	59
4.5	Summary	60
<b>5.</b>	<b>SIMULATION AND MEASUREMENT SETUP</b>	<b>61</b>
5.1	Introduction	61
5.2	Simulation and Measurement Process	61
5.3	RF Receiver Modeling	64
5.4	Simulation Setup Under ADS RF and Analog Simulator	65
5.4.1	Gain, Output Power and Noise Figure of Every Stage	65
5.4.2	Gain Compression	67
5.4.3	Third Order Intercept Point	69
5.5	Simulation Setup Under ADS Ptolemy Simulator	71
5.5.1	Sensitivity	71
5.6	Measurement Setup	74
5.6.1	Measurement of S-Parameter for RF Component	74
5.6.2	RF Receiver Measurement	76
5.6.2.1	Measurement of Gain, Output Power and Gain Compression	76
5.6.2.2	Measurement of Third Order Intercept Point	77
5.7	Summary	77
<b>6.</b>	<b>RESULT AND DISCUSSION</b>	<b>79</b>
6.1	Introduction	79
6.2	Simulation Result of the RF Receiver Characteristics	79
6.2.1	Gain and Noise Figure of Every Stage	80
6.2.2	The System 1dB Compression Point	81
6.2.3	Third Order Intercept Point (IP3)	84
6.2.4	Sensitivity	87
6.3	Measurement Result of RF Subcomponent	93
6.3.1	Low Noise Amplifier (LNA)	92
6.3.2	RF Amplifier	95
6.3.3	Power Divider	97
6.3.4	Bandpass Filter	98
6.4	Measurement Result of RF Receiver	99
6.4.1	Gain and Noise Figure	99
6.4.2	System 1 dB Compression Point	102
6.4.3	The Third Order Intercept Point	104
6.5	Summary	108
<b>7.</b>	<b>CONCLUSION</b>	<b>109</b>
7.1	Summary	109
7.2	Suggestion of Future Work	110
	<b>REFERENCES</b>	<b>111</b>
	<b>APPENDICES</b>	<b>116</b>

## LIST OF TABLES

TABLE	TITLE	PAGE
2.1 (a)	The Advantages and Disadvantages of Heterodyne Receiver	13
2.1 (b)	The Advantages and Disadvantages of Direct Conversion Receiver	14
2.2	Development of Direct Conversion RF Front-End Receiver	20
3.1	Specification Description with References Number	38
3.2	IEEE 802.11a Standard Specification	41
3.3	IEEE 802.11a Data Rate versus Minimum Sensitivity and Adjacent Channel Rejection	43
4.1	LNA Parameters for RF Receiver Design	47
4.2	RF Amplifier Parameters for RF Receiver Design	48
4.3	Wilkinson Power Divider Parameters for RF Receiver Design	50
4.4	Filters Parameter for RF Receiver System	52
4.5	The Gain Budget of RF Receiver System	54
4.6	The P1 dB and IP3 Budget of RF Receiver System	56
4.7	The System Noise Figure Budget for RF Receiver System	59
6.1	Gain and Noise Figure at Every Stage of RF Receiver Chain	79
6.2	The Sensitivity Estimation Based on Figure 6.6	89
6.3	The RF Receiver's SNR Estimation	90
6.4	The RF Receiver's Dynamic Range Estimation	91
6.5	The Summary of LNA Measurement Result Based on Figure 6.7	93
6.6	The Summary of RF Amplifier Measurement Result Based on Figure 6.8	95

6.7	Parameter Measurement of Power Divider	96
6.8	Parameter Measurement of Bandpass Filter	97
6.9	Summary of Gain and Noise Figure of RF Receiver Based on Figure 6.9 and Figure 6.10	100
6.10	Comparison of Gain and Noise Figure between Measured, Simulated and Calculated Results	100
6.11	System 1dB Compression Point Measurement at 5.745 GHz and 5.805 GHz Center Frequency	101
6.12	Summary of the Third Order Intercept Point Measurement at Center Frequency of 5.745 GHz Based on Figure 6.11	104
6.13	Summary of the Third Order Intercept Point Measurement at Center Frequency of 5.745 GHz Based on Figure 6.12	106

## LIST OF FIGURES

FIGURE	TITLE	PAGE
1.1	Direct-Conversion Receiver Configuration for WLAN System	4
1.2	RF Receiver Design and Verification Process	6
2.1 (a)	Typical Heterodyne Receiver	8
2.1 (b)	Typical Direct Conversion Receiver	9
3.1	Two Port Network With $G$ and Added Noise Power $N_n$	25
3.2	Cascaded Components for RF System	26
3.3	Level of The Ideal and Practical Two-Port $P_{out}$ Versus $V_{in}$	28
3.4	Practical Dynamic Range of The RF Receiver System	30
3.5	Two-Port Network Intermodulation Product and Their Relative Frequency	32
3.6	Third-Order Intercept Point in a Two-Port Network	33
3.7	Fundamental $P_o$ and IM3 Products $P_d$ Output Power Versus Frequency	35
3.8	Cascaded Receiver Networks	36
3.9	IEEE 802.11a Operating Channel Frequencies	39
3.10	Adjacent Channel Specified by IEEE 802.11a Standard	42
4.1	The Proposed RF Receiver Architecture for Point to Point Communication	45
4.2	Type of Power Divider	49
4.3	The Characteristic of Band Pass Filter	51
4.4	Cascaded RF Receiver System	53
5.1	Simulation Process	62

5.2	Measurement Process	63
5.3	Simulation Setup for System Gain, Noise Figure and Output Power of Every Stage	65
5.4	Gain Compression Point Setup	67
5.5	Data Display Window of Gain Compression	68
5.6	The Simulation Setup for Third Order Intercept Point	69
5.7	Data Display Result of Third-Order Intercept Point	70
5.8	Simulation Setup for RF Receiver's Sensitivity	72
5.9	Data Display Window of RF Receiver Minimum Sensitivity	73
5.10	Test Configuration for Two Ports S-Parameter Measurement	75
5.11	Test Configuration for Three Ports S-Parameter Measurement	75
6.1	Gain Compression Point for RF Receiver at 5.745 GHz	81
6.2	Gain Compression Point for RF Receiver at 5.805 GHz	82
6.3	The IMD Level of RF Receiver at Center Frequency of 5.745 GHz	83
6.4	The IMD Level of RF Receiver at Center Frequency of 5.805 GHz	84
6.5	Sensitivity Result at Different System Noise Figure	87
6.6	The RF Receiver's Minimum Input Level (Sensitivity) at All Data Rates	88
6.7	Gain and Noise Figure Measurement of LNA at Upper 5 GHz UNII Frequency	92
6.8	Gain and Noise Figure Measurement of RF Amplifier at Upper 5 GHz UNII Frequency	94
6.9	Gain and NF Measurement of RF Receiver at 5.745 GHz Center Frequency	99
6.10	Gain and NF Measurement of RF Receiver at 5.805 GHz Center Frequency	99
6.11	The Third Order Intercept Point Measurement at Center Frequency of 5.745 GHz	103
6.12	The Third Order Intercept Point Measurement at Center Frequency of 5.805 GHz	105

## **LIST OF APPENDICES**

<b>APPENDIX</b>	<b>TITLE</b>	<b>PAGE</b>
A	LNA Design Specificaion	116
B	Parameter Survey at The Market	117
C	RF Amplifier Design Specification	118
D	Power Divider Design Specification	119
E	Specification Sheet of Band Pass Filter	120
F	Simulation Result for Gain, Output Power and Noise Figure	121
G	Configuration of RF Receiver Measurement	123

## **LIST OF ABBREVIATIONS**

ACR	Adjacent Channel Rejection
ADS	Advanced Design System
ASP	Analog Signal Processing
BFP	Bandpass Filter
BiCMOS	Bipolar Complementary Metal Oxide Semiconductor
Balun	Balance Unbalance
CIMD	Carrier To Intermodulation Distortion
CMOS	Complementary Metal-Oxide Semiconductor
CWTS	China Wireless Telecommunication Standardization Group
DC	Direct Current
DCR	Direct Conversion Receiver
DECT	Digital European Telecommunication
DR	Dynamic Range
DSP	Digital Signal Processing
DUT	Device Under Test
EVM	Error Vector Magnitude
FCC	Federal Communications Commission
FET	Field Effect Transistor



$G$	Gain Factor
GaAs	Gallium Arsenide
GHz	Giga Hertz
GSM	Global System for Mobile Communications
HDTV	High Definition Television
HEMT	High Electron Mobility Transistor
IEEE	Institute of Electrical and Electronics Engineers
IF	Intermediate Frequency
IIP <sub>3</sub>	Third Input Intercept Point
IL	Insertion Loss
IM3	Third Order Intermodulation
IMD	Intermodulation Distortion
IP3	Third Intercept Point
I/Q	In Phase/Quadrature
IR	Image Rejection
ISM	Industrial, Scientific and Medical
LC	Inductor Capacitor Network
LPF	Low Pass Filter
LNA	Low Noise Amplifier
LO	Local Oscillator
MAN	Metropolitan Area Network
Mbps	Mega Bit Per Second
MDS	Minimum Detectable Signal
MMIC	Monolithic Microwave Integrated Circuit
NF	Noise Figure

OFDM	Orthogonal Frequency Division Multiplexing
OIP <sub>3</sub>	Third Output Intercept Point
PDA	Personal Digital Assistant
PER	Packet Error Rate
PSDU	Physical Sublayer Service Data Units
PWD	Power Divider
QAM	Quadrature Amplitude Modulation
QPSK	Quadrature Phase Shift Keying
RC	Resistor Capacitor Network
RF	Radio Frequency
RFA	Radio Frequency Amplifier
RFIC	Radio Frequency Integrated Circuit
RR <sub>30</sub>	Order Rejection Ratio
SDR	Software Defined Radio
SiGe	Silicon Germanium
SNR	Signal To Noise Ratio
TD-SCDMA	Time Division – Synchronous Code Division Multiple Access
TOI	Third Order Intercept Point
TRF	Tuned Radio Frequency
U-NII	Unlicensed National Information Infrastructure
VCO	Voltage Control Oscillator
VNA	Vector Network Analyzer
WiBro	Wireless Broadband
WiMAX	Worldwide Interoperability for Microwave Access
WLAN	Wireless Local Area Network



## LIST OF PUBLICATIONS

1. Othman A.R, **Abd Aziz A.**, Pongot K., Shairi A., Mohd Nor M.N, “ *Design and Sensitivity Analysis of Direct Conversion RF Receiver for IEEE 802.11a WLAN System at 5.8 GHz Frequency*”, 2012 IEEE Student Conference on Research and Development SCORED 2012, Parkroyal Resort Hotel, Penang, Malaysia on 5 – 6 December 2012.
2. **A. A. Abd Aziz**, N. A. Shairi, I. M. Ibrahim, A. R. Othman, “*Direct Conversion RF Receiver Design and Sensitivity Analysis for WLAN Point to Point Communication at 5.8 GHz Band*” in Proceeding of 2009 IEEE International Conference on Antennas, Propagation and Systems (INAS 2009).
3. **A. A. Abd Aziz**, N. A. Shairi, I. M. Ibrahim, A. R. Othman, “*Design and Analyses of Direct Conversion RF Receiver for WLAN System Based On IEEE802.11a Standard*” in Malaysia Technical Universities Conference on Engineering and Technology (MUCEET 2009).
4. M. A. Othman, A. S. Jaafar, **A. A. Abd Aziz**, “*Simulation of a Broadband Amplifier for Broadband Applications*” in Seminar Pencapaian Penyelidikan UTeM (REACH 2008).
5. Othman, A.R.; Halim, M.H.C.; Aziz, M.Z.A.A.; Sahingan, S.A.; Selamat, M.F.; Aziz, **A. A. Abd Aziz**; *5-6GHz Front End Low Noise Amplifier* in 6th National Conference on Telecommunication Technologies 2008 and 2008 2nd Malaysia Conference on Photonics. NCTT-MCP 2008.

6. Othman, A.R, Halim, M.H.C.; Aziz, M.Z.A.A.; .Sahingan, S.A.; Selamat, M.F.; **Aziz, A.A.A.**; *Low Noise Amplifier for front end transceiver at 5.8 GHz* in International Conference on Electronic Design, 2008. ICED 2008.
7. **A. A. Abd Aziz**, A. R. Othman, I. M. Ibrahim, “*Simulation of Cascading LNA and RF Amplifier for Front-End Direct Conversion Receiver at 5.8 GHz*” In Asia Pacific Conference On Applied Electromagnetics Proceeding (APACE 2007).
8. Othman, A.R.; Ibrahim, I.M.; Samingan, M.; **Aziz, A.A.A** ; Selamat, M.; Halim, H.C.; Single stage RF amplifier at 5.8GHz ISM band with IEEE 802.11a standard in Asia-Pacific Conference on Applied Electromagnetics Proceeding (APACE 2007).
9. Othman, A.R.; Ibrahim, I.M.; Selamat, M.; Samingan, M.; **Aziz, A.A.A**; Halim, H.C.; 5.75 GHz microstrip bandpass filter for ISM band in Asia-Pacific Conference on Applied Electromagnetics Proceeding (APACE 2007).

## **CHAPTER 1**

### **INTRODUCTION**

#### **1.0 Introduction**

Wireless Local Area Network (WLAN) is seen as the technology that will enable the most convenient link between existing wired networks and portable computing. Communications equipments, such as laptop, computers and personal digital assistants (PDAs) at the office, hotel, company or campus level. Building company and campus wide data communications through the WLAN can reduce the need for wiring among several buildings (Qizheng Gu, 2005). In general, the application of the WLAN systems can be simply between two computers or between a computer and a wired network, all the way up to a complete network with many users and a great numbers of data paths.

The IEEE 802.11a standard defines a WLAN system based on the orthogonal frequency division multiplexing (OFDM) technology that splits an information signal across 52 separate subcarriers to provide a transmission of data rate up to 54 Mbps and throughput over 24.3 Mbps, and the operating frequency of the system is in license-free where it is called Unlicensed National Information Infrastructure (U-NII band) 5.15 to 5.35 GHz and 5.725 to 5.875 GHz bands. The high data rate WLANs like the 802.11a systems satisfy requirements of multimedia applications including streaming High Definition Television (HDTV) - quality video in the home, high-speed internet and file transfer.

## **1.1 Objectives**

The objective of the research project is to develop a system level design, simulation and measurement, including analysis and verification of a front-end direct conversion receiver at 5.725 – 5.825 GHz. The direct conversion receiver requires system level analysis and verification in terms of system characteristic and performance. Therefore, the IEEE 802.11a standard is used as performance test. This frequency range can provide higher bandwidth until 100 MHz. The front-end receiver should meet this standard requirement and should operate satisfactorily for WLAN Bridge system.

## **1.2 Problem Statement**

In designing and developing an RF receiver for WLAN communication system, the initial stage is determining what kind of architecture will be employed based on considerations of performance, cost, power consumption, and robust implementation. The selection of receiver architecture is playing the important role to achieve the desired performance. From the literature surveys, there are various type of receiver has been developed nowadays. That is direct conversion receiver, superheterodyne receiver, tuned radio receiver, low IF receiver and band-pass sampling radio (Gu, 2005). But the architectures mostly discussed are superheterodyne architecture and direct conversion architecture. At present most RF receivers in wireless communication systems are using superheterodyne architecture. This architecture has the best performance if compared with the others, and therefore it has been the most popular architecture since it invented in 1918. To obtain a great cost saving and to take advantage of multimode operation without increasing extra parts, the direct conversion or homodyne architecture has now become a very popular radio architecture for wireless communication systems (Chang *et. al.*, 2002a).

The performance of the RF receiver depends on the system design, circuit design, and working environment. The acceptable level of distortion or noise varies with the application (Chang *et. al.*, 2002b). Basically the system includes a couple of real RF components, such as amplifier, power divider, filters and local oscillator. Each of these components introduces different distortions such as thermal noise, phase noise, spurious frequencies and intermodulation distortion (Luzzatto *et. al.*, 2007). In a RF transceiver design, the distortions must be determined and reduced. This research work therefore aims to provide the best solution for the RF receiver design, so that, the best performance of WLAN Bridge system can be achieved. According to Razavi (1998a), the inefficient simulation technique in design tools is another challenge to RF designers in getting accurate simulation result.

This research work is to develop the RF front-end direct conversion receiver operating at 5.8 GHz band and be an alternative architecture compare to superheterodyne architecture. This band is allocated for the use of outdoor links (Razavi, 1998b). The system level analysis and verification are performed in terms of system characteristic and performance. The IEEE 802.11a standard is used for performance test such as sensitivity and adjacent channel rejection (ACR). Federal Communications Commission (FCC) approved IEEE 802.11a standard in September 1999 that uses the unlicensed 5 GHz U-NII bands. The IEEE 802.11a uses OFDM, a new coding scheme that provides a significantly higher data rates up to 54 Mbps. The required speeds defined in IEEE 802.11a are 6, 12 and 24 Mbps with optional speeds up to 54 Mbps. The communication distance for the system is at least 100 m.