DESIGN FABRICATION AND CHARACTERIZATION OF FRONT-END TRANSMITTER FOR 5 GHZ WLAN APPLICATIONS

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ABSTRACT

Design Fabrication and Characterization of Front-End Transmitter for 5 GHz WLAN Applications

The general objective of the report is to deliver plan of 5 GHz radio frequency front-end utilizing Advanced Design System software and afterward assemble an operational model. Utilizing the model to decide whether RF circuits at 5 GHz can be effectively created utilizing disseminated parts on an overlay substrate.

The plan procedure for the front-end comprises of two phases. In first phase the dispersed parts are composed and recreated, and in the second phase all segments converted into a Printed Circuit Board. This Printed Circuit Board will then be fabricated and collected. Estimations on radio frequency front-end and elements are made utilizing a system analyzer, keeping in mind the end goal to quantify the S-parameters.

CERTIFICATE OF CORRECTNESS AND APPROVAL

It is hereby confirmed that data in this report "**Design Fabrication and Characterization of Front-End Transmitter for 5 GHz WLAN Applications**" completed by 1) Capt. Umar Farooq 2) Capt. Mansoor Akhtar 3) Capt. Nadeem Akhtar 4) Capt. Shehzore Ameer under the course of Assoc. Prof. Dr. Farooq Ahmed Bhatti in completion of our degree of Bachelor in Telecommunication Engineering is correct as well as approved. Percentage of plagiarism turns out to be ____________ when checked on Turnitin available on LMS.

Approved By

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DECLARATION

We thus proclaim that no substance and type of work introduced in this postulation has been submitted in help of another honor of capability or degree either in this organization or anyplace else.

DEDICATION

This proposition is devoted in thanks toward ALLAH ALMIGHTY our Creator who has blessed us with wisdom, knowledge and understanding then to our parents for their direction and their endless support. Then to our Faculty for their guidance and supervision. Without their help and supervision this project would not have been made possible.

ACKNOWLEDGEMENT

The accomplishment of this project would not have been possible without the contribution of different people the names of which cannot be reckoned with. Their assistances are sincerely respected and thankfully recognized. We would like to thank following:

To Allah Almighty who is the most Powerful and Merciful and everything is in His obedience.

Assoc. Prof. Dr. Farooq Ahmed Bhatti for his support and guidance during the entire project.

To all relatives, friends.

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ABBREVIATIONS

ADS	Advanced Design System. Simulation tool
EM	Electromagnetic
LNA	Low Noise Amplifier
NF	Noise Figure
PA	Power Amplifier
PCB	Printed Circuit Board
RF	Radio Frequency
RX	Receiver
SMD	Surfaced Mounted Device
TX	Transmitter
WLAN	Wireless Local Area Network
Z0	Characteristic line impedance
ZL	Load impedance
$\lambda/2$	Half wavelength
Tx	Transmission
Eq	Equation
LO	Local Oscillator
CW	Continuous Wave

CHAPTER 1

1. INTRODUCTION

With the recent rapid advance in wireless communication, various applications are being appeared such as cordless, cellular, paging, data over voice, and the wireless local networking. Due to the prerequisite of wireless multimedia service and the rapid growth of communication signal processing method, the high rate 6~54Mbps WLAN standard was made in July 1999.

In this project, we are presenting the 5GHz band RF Front End transmitter which will be designed and tested in the wireless channel. Before implementing the transmitter on the printed circuit board, the characteristics of transmitter are simulated using commercial software.

1.1 PROJECT OVERVIEW

We have selected **"Front-End Transmitter for 5 GHz WLAN Applications"** as our project. Project envisages on the design, fabrication and characterization of transmitter front-end for 5 GHz WLAN applications. This front-end form an essential part of the transmitting systems.

1.2 PROBLEM STATEMENT

With the recent rapid advance in wireless communication, various applications are being appeared such as cordless, cellular, paging, data over voice, and the wireless local networking. Owing to the prerequisite of wireless multimedia service and the rapid growth of communication signal processing method, the high rate 6~54Mbps WLAN standard was made in July 1999. So, we need to have a system that can support the required data rate.

1.3 APPROACH

1. Design a simple transmitter front-end
2. Characterize the transmitter front-end
3. Enhance the output power by using HPA
4. Increasing the gain by using appropriate ICs
5. Optimizing the results using optimization techniques on ADS

1.4 OBJECTIVES

In this project, we are going to simulate process for RF front-end transmitter using ADS. And the results are optimized using the optimization techniques on ADS.

1.5 ORGANIZATION

Document starts with the abstract which describes the main details of our project **Design Fabrication and Characterization of Front-End Transmitter for 5 GHz WLAN Applications**, tracked by the overview section which states the problematic statement, method, possibility, objectives and limitations. The literature appraisal segment defines several resources delivered online and in different books previously. The proposal and progress part demonstrate the diagrams which depicts the nitty gritty plan, its components, and the simulated results.

CHAPTER 2

RF THEORY

The part is proposed to illustrate some fundamental comprehension of radio frequency hypothesis and plan

2.1 GENERAL RF THEORY

Managing AC and DC circuits of low frequency, customary Kirchhoff's voltage as well as current laws are utilized for examination devices. Heading into higher working frequencies laws of Kirchhoff's can never be implemented without losing correctness. Examining a lower frequency circuit, an electrode between two components dependably expect to have a similar potential in any case. With regards to frequencies around 500 MHz the past supposition may never be accurate. The explanation behind this is the wavelength of the signal turns out to be small to the point that current as well as voltage will spread as waves.

Rather than utilizing Kirchhoff's laws we must manage EM waves and issues like phase, velocity Vp and skin depth become significant. Spread constant and phase largely rely upon the medium encompassing the electrode and they will decide the wave length for a particular frequency. Since the encompassing standard is a vital outline constraint, picking a decent substrate is one of the primary plan ventures in radio frequency plan. Skin impact is a result that likewise happens because of the electromagnetic wave nature and this impact powers most of the vitality to low near the electrode's surface. Infiltration of the signal into the electrode is estimated in depth of skin. Effective cross-sectional area is decreased when the energy is focused on the conductor's surface. In this way, misfortune because of higher obstruction will happen. The change in the impact on resistance will be little when copper thickness is changed at high frequencies and the resistance will be greatly affected by changing the length as well as width.

2.1.1 TRANSMISSION LINES

In circuits of radio frequency outline tx lines are utilized because of the great conduct at higher frequencies. Tx lines are just conductors with an identified separation. Cases of tx lines are microstrip, two wire and coaxial lines. Inside these lines current as well as voltage spread as waves and subsequently phase differ over its length. Separating a tx line in little (point of confinement imperceptibly little) sections, Kirchhoff's laws can in any case be connected.

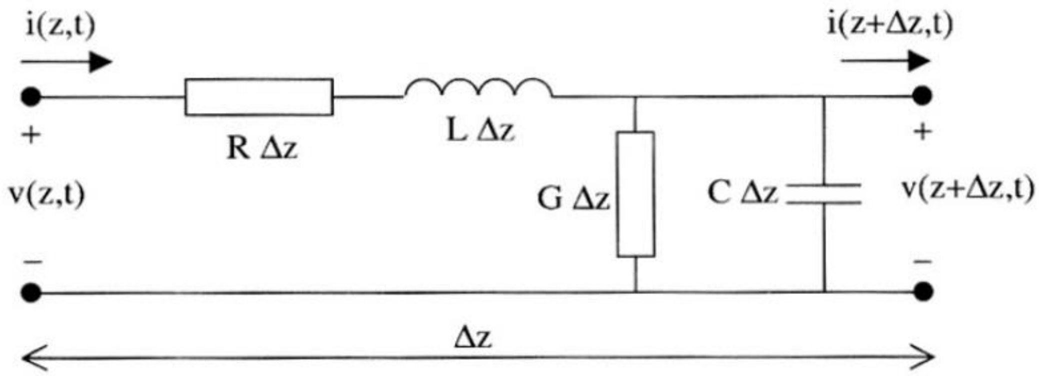

Figure 2.1: Lumped element tx line model

In schematically depiction of the microscopic tx line:

R = Resistance

L = Inductance

G = Conductance

C = Capacitance

Laws of Kirchhoff's would be able to be connected to circuit of lumped component in figure 2.1, giving the eqs as under:

$$v(z,t) - R\Delta z i(z,t) - L\Delta z \frac{\partial i(z,t)}{\partial t} - v(z+\Delta z,t) = 0 \qquad (2.1a)$$

$$i(z,t) - G\Delta z v(z+\Delta z,t) - C\Delta z \frac{\partial v(z+\Delta z,t)}{\partial t} - i(z+\Delta z,t) = 0 \qquad (2.1b)$$

Dividing eq 2.1(a) and 2.1(b) by Δz and changing the parameters as Δz → 0, eqs as under will be given:

$$\frac{\partial v(z,t)}{\partial z} = -Ri(z,t) - L\frac{\partial i(z,t)}{\partial t} \qquad (2.2a)$$

$$\frac{\partial i(z,t)}{\partial z} = -Gv(z,t) - C\frac{\partial v(z,t)}{\partial t} \qquad (2.2b)$$

With the help of steady-state of sinusoidal condition spreading in z-direction can be detected, and eqs 2.2(a) and 2.2(b) are simplified as under:

$$\frac{\partial v(z,t)}{\partial z} = -Ri(z,t) - L\frac{\partial i(z,t)}{\partial t} \qquad (2.3a)$$

$$\frac{\partial i(z,t)}{\partial z} = -Gv(z,t) - C\frac{\partial v(z,t)}{\partial t} \qquad (2.3b)$$

Wave eqs for V(z) & I(z) are initiated through comprehending eqs 2.3(a) & 2.3(b):

$$\frac{d^2V(z)}{dz^2} - \gamma^2 V(z) = 0 \qquad (2.4a)$$

$$\frac{d^2I(z)}{dz^2} - \gamma^2 I(z) = 0 \qquad (2.4b)$$

Solution for equation 2.4a & 2.4b can be found and written as:

$$V(z) = {V_0}^+ e^{-j\gamma z} + {V_0}^- e^{j\gamma z} \qquad (2.5a)$$

$$I(z) = {I_0}^+ e^{-j\gamma z} + {I_0}^- e^{j\gamma z} \qquad (2.5b)$$

The term $e^{-\gamma jz}$ signifies wave spread in z^+-direction, and $e^{\gamma jz}$ denote spreading in the z^--direction. By merging eqs 2.3 & 2.4, we will get the following eq:

$$I(z) = \frac{\gamma}{R + jwL} V(z) \quad (2.6)$$

Which gives the characteristics impedance:

$$Z_0 = \frac{V(z)}{I(z)} = \sqrt{\frac{R + jwL}{G + jwC}} \quad (2.7)$$

Z_0 isn't a component of time, length and waveform. It is an element of the model parameters just and may along these lines effectively be altered by modifying the conductor measurements and separation to the ground plane. Due to the neglection of the conductive and resistive terms Z_0 will be composed as:

$Z_0 = \sqrt{L}/C$, where Z_0 is a constant. (2.8)

2.1.2 LOSSLESS TRANSMISSION LINE

The eq 2.8 shows lossless electrode and the proportion amongst current and voltage is consistent. Ending the tx line shown in figure 2.2 with load impedance ZL ≠ Z0 will change the proportion. If a frequency wave has the frame V0+ $e^{j\beta z}$ is produced from a source.

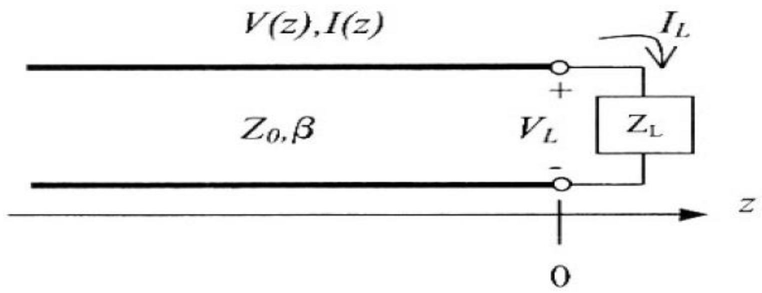

Figure 2.2: Tx line terminated with a load impedance Z_L

The aggregate V or I on the Tx line is equivalent to the reflected waves and the entirety of occurrence, so eq 2.9.

$$V(z) = V_0^{+} e^{-j\beta z} + V_0^{-} e^{j\beta z} \quad (2.9a)$$

$$I(z) = I_0^{+} e^{-j\beta z} + I_0^{-} e^{j\beta z} \quad (2.9b)$$

Where

$$\frac{V_0^{+}}{I_0^{+}} = Z_0 = \frac{-V_0^{-}}{I_0^{-}} \quad (2.10)$$

At z = 0 voltage and current ratio is given by:

$$Z_L = \frac{V(z)}{I(z)} = \frac{V_0^{+} + V_0^{-}}{V_0^{+} - V_0^{-}} Z_0 \quad (2.11)$$

Voltage amplitude ratio between incident and reflected wave is referred to as the Voltage Reflection Coefficient Γ and is given by:

$$\Gamma = \frac{V_0^{-}}{V_0^{+}} = \frac{Z_L - Z_0}{Z_L + Z_0} \quad (2.12)$$

There is no reflected wave if $\Gamma = 0$. This can be obtained if the load impedance Z_L and characteristic impedance Z_0 are equivalent to each other, see eq 2.12. In this case the load impedance Z_L and line are matched since there no incident wave is reflected.

2.1.3 S-PARAMETERS

S-parameter have a very important role in radio frequency related to technical and measurement documentation. This significance is since traditional system characterizations like opener short-circuit measurements cannot be done because it is completed during an application of low frequency. Techniques for measuring systems of low frequency typically attempt to determine the whole I or V. These ways are difficult to achieve utilizing these ways at higher frequency, so by utilizing S-parameters, defined as normalized power wave's ratio and can easily be measured.

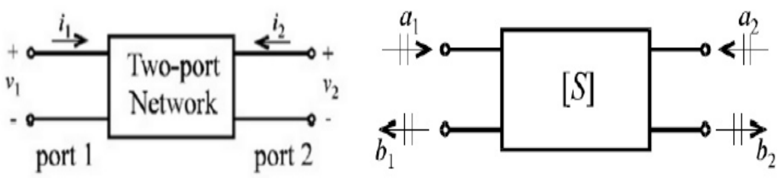

Figure 2.3: Two port network

Figure 2.3 shows two different two port representations, the left one shows the definition for voltage and current and the right one shows the normalized incident power wave an and normalized reflected power wave bn. The normalized power waves are defined as follows:

$$a_1 = \frac{V_1 + Z_0 I_1}{2\sqrt{Z_0}} = \frac{voltage\ wave\ incident\ on\ port\ 1}{\sqrt{Z_0}} \tag{2.13}$$

$$a_2 = \frac{V_2 + Z_0 I_2}{2\sqrt{Z_0}} = \frac{voltage\ wave\ incident\ on\ port\ 2}{\sqrt{Z_0}} \tag{2.14}$$

$$b_1 = \frac{V_1 + Z_0 I_1}{2\sqrt{Z_0}} = \frac{voltage\ wave\ incident\ on\ port\ 1}{\sqrt{Z_0}} \tag{2.15}$$

$$b_2 = \frac{V_2 + Z_0 I_2}{2\sqrt{Z_0}} = \frac{voltage\ wave\ incident\ on\ port\ 2}{\sqrt{Z_0}} \tag{2.16}$$

Where two-port network characteristic impedance is Z_0. S-parameters are obtained by measuring the phase and magnitude of the transmitted, incident and reflected voltage waves. Based upon terminating port, a two-port network S parameter can be obtained differently.

$$S_{11} = \frac{b_1}{a_1} \qquad S_{21} = \frac{b_2}{a_1} \qquad S_{22} = \frac{b_2}{a_2} \qquad S_{12} = \frac{b_1}{a_2} \tag{2.17}$$

If $a_1 = 0$ and $a_2 = 0$ then none of the power waves are reverted neither to port 1 nor port 2. This can be done only when Tx lines terminate into their Z_0.

2.2 DISTRIBUTED COMPONENTS

Radio frequency circuits design can be produced utilizing lumped components of capacitors and inductors or by utilizing distributed components, such as Tx lines. Both methods have their merits and demerits. Lumped components are small and small area is utilized for the implementation of radio frequency component. Wavelength of low frequencies are longer as compared to high frequencies. The size becomes too large to be implemented for a distributed radio frequency-component in a real beneficial application. However, in modern era high frequencies are utilized by more applications, which resolves the issue of larger size. Another demerit is that for distributed components, good substrates are expensive. By utilizing distributed elements, the benefit is that some of the parameters like width and length can change to some extent but desired function of the component remains same. This work aims at distributed elements for implementation of the front-end radio module at 5GHz.

An important and known term related to distributed elements is the $\lambda/4$ wavelength. By utilizing Smith chart, the input impedance doesn't change with any additional length of Tx line, at a matched impedance condition.

2.3 LOW NOISE AND POWER AMPLIFIERS

Radio frequency circuits design utilizing amplifiers significantly differs from the traditionally utilized design methodology for low frequency. Considerations as current and voltage waves, matched networks to minimize the VSWR and undesirable fluctuations must be considering at high frequencies. Therefore, circuit stability must be ensured while designing a radio frequency amplifier circuit. Noise and gain circles can be drawn on the Smith Chart to determine circuit properties.

2.3.1 STABILITY

S-parameters for amplifier at desired range of frequencies are required to stabilize an amplifier. These S-parameters will be utilized to draw stability circles on the Smith chart, to determine whether or not the amplifier is stable in desired region.

The Rolett factor can also be utilized to study the stability of an amplifier. This is beneficial for viewing larger frequency spectrum.

$$k = \frac{1 - |S_{11}|^2 - |S_{22}|^2 + |\Delta|^2}{2|S_{12}||S_{21}|} > 1 \qquad (2.18)$$

Where

$$|\Delta| = |S_{11}S_{22} - S_{12}S_{21}| \qquad (2.19)$$

In order to design a stable amplifier circuit, which implies that at the selected frequency the amplifier remains stable in the entire Smith Chart domain and must satisfy following conditions.

$$|S_{11}| < 1 \ \& \ |S_{22}| < 1 \qquad (2.20)$$

Also

$$|\Delta| < 1 \ \& \ k > 1 \qquad (2.21)$$

A stabilizing network is required to stabilize the radio frequency amplifier in case of instability. A way to stabilize radio frequency amplifier is to insert shunt or series resistor can also be utilized to stabilize the radio frequency amplifier either at output or input port, but most preferred to port at the output because resistor produces undesired noise.

2.3.2 GAIN

Gain of radio frequency amplifier circuit is obtained by a technique utilizing constant operating gain circles and represent the gain in the Smith Chart. The first step for measuring the maximum gain of amplifier the following expression will be utilized.

$$G_T = \frac{power\ delivered\ to\ the\ load}{available\ power\ from\ source} = \frac{(1-\ |\Gamma_L|^2)|S_{21}|}{(1-\ |\Gamma_{IN}|^2)|1 - S_{22}\Gamma_L|^2}$$

When value of gain obtained is maximum other values of gain can be selected and plotted on Smith Chart, and beneficial when considering noise. This is accomplished by selecting values lesser than the G_T, and then the eqs utilized to calculate radius and center of the constant gain circle will be given by:

$$Center\ \ d_{go} = \frac{go\ (S_{22} - \Delta S_{11}{}^*)}{1 + go\ (|S_{22}|^2 -\ |\Delta|^2)} \tag{2.22}$$

$$Radius\ \ r_{go} = \frac{\sqrt{1 - 2kgo|S_{11}S_{21}| + go^2|S_{12}S_{21}|^2}}{|1 + go\left(S_{22}{}^2 -\ |\Delta|^2\right)|} \tag{2.23}$$

Where k (Rolett factor) and g0 is given by:

$$go = \frac{G}{|S_{21}|^2}\ \ where\ G = 10^{(Desired\ gain\ in\ dB)/10} \tag{2.24}$$

Utilizing these circles, a suitable load reflection coefficient Γ_L can be selected and the source reflection coefficient Γ_S can be found as follow:

$$\Gamma_S = \left(\frac{S_{11} - \Delta\Gamma_L}{1 - S_{22}\Gamma_L}\right)^* \quad (2.25)$$

Thus, to design a matching network these reflection coefficients can be utilized.

2.3.3 NOISE

Low Noise Amplifier circuit design is a concession between gain, NF & stability, one cannot get the maximum value of gain. For designing a Low Noise Amplifier circuit efficiently, depiction for NF from the Smith Chart is utilized. Thus, one can analyse stability, gain and NF properties at the same time.

Three key parameters utilized in order to carry out analysis of NF of an RADIO FREQUENCY amplifier.

- NF minimum, based upon the operating frequency and condition of the device.
- Equivalent noise resistance Rn
- Optimum reflection coefficient Γ_{opt}

Given these parameters, at any given source reflection point Γ_S in the Smith Chart the NF can be determined as:

$$F = F_{min} + \frac{4R_n}{Z_0}\frac{|\Gamma_S - \Gamma_{opt}|^2}{(1 - |\Gamma_S|^2)|1 + \Gamma_{opt}|^2} \quad (2.26)$$

Since Γs and Γ_L depend on each other (see eq 2.25) the following eqs can be obtained:

$$Center\ d_{gs} = \frac{(1 - S_{22}d_{go})(S_{11} - \Delta d_{go}) - r_{go}{}^2\Delta^* S_{22}}{|1 - S_{22}d_{go}|^2 - r_{go}{}^2|S_{22}|^2} \quad (2.27)$$

CHAPTER 3

DESIGN PROCESS

3.1 DESIGN OVERVIEW

The principle of the radio front-end is to act as interface between a transceiver and antennas. once the signal is received, it'll filter, amplify and during this case, balance the signal before down conversion. whereas transmission it'll filter and amplify the signal once up conversion. The design of RF transmitter is shown in figure 3.1.

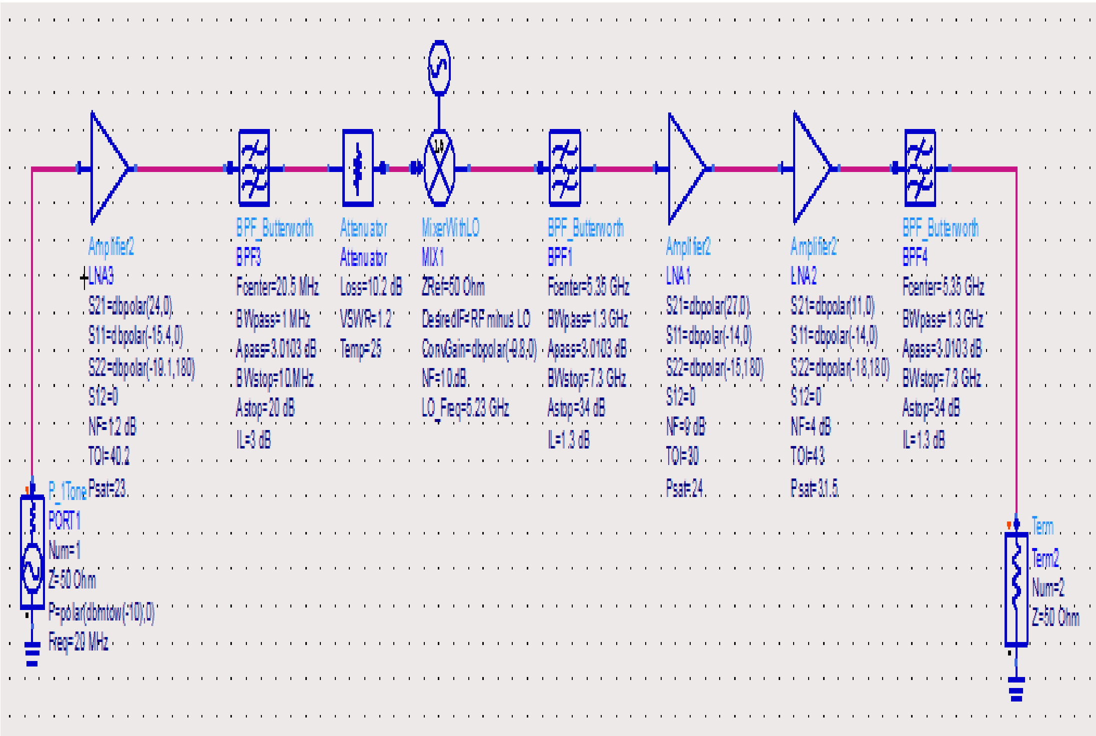

Figure 3.1: Design of the RF Transmitter

3.2 DESIGN SPECIFICATIONS

Table 3.1: Design Specifications

PARAMETER	REQUIREMENT
FREQUENCY	5.15 – 5.35 GHz
CHANNEL BANDWITH	16.6 MHz
MAXIMUM OUTPUT POWER	200Mw
OPERATING VOLTAGE	5V

The design specifications of the front-end transmitter are given in Table 3.1.

3.3 COMPONENTS

3.3.1 AMPLIFIER

An amplifier is an electronic equipment which will increase the ability of a signal. This electronic equipment uses power from an influence provide to extend the amplitude of a signal. The number of amplification provided by an electronic equipment is measured by its gain: the magnitude relation of output voltage, current, or power to input. An electronic equipment may be a circuit that incorporates a power gain bigger than one.

A low noise amplifier (LNA) enhances a low-control motion without altogether corrupting its SNR. An intensifier expands the intensity of both the clamor and the flag at its information. LNAs limits the extra commotion. Planners exchange offs between impedance coordinating, picking the speaker innovation, (for example, low-noise segments) and choosing low-commotion biasing conditions to limit noise.

The function of using this amplifier is to make the noise minimum and amplify the signal only. It also reduces the noise figure. It is nonlinear device and it generates harmonics. In this system we are using PHA-13LN IC of minicircuits which is a low noise amplifier with a frequency of 1 MHz to 1 GHz. The data sheet of this IC can be found in the reference [6] given at the end. The results after this stage have been shown in Table 3.2.

Table 3.2: Results of Low Noise Amplifier

Noise Figure Reflection	1.2 dB
Output Gain	20.656 dB
Output Power	10.656 dBm
Input Frequency	20 MHz

3.3.2 Band Pass Filter

A pass band filter is the part which licenses frequency inside an unequivocal assortment and discards frequencies past that arrangement. An impeccable band pass station must have a level passband and would thoroughly discard all frequencies outside the passband.

In genuine, no bandpass filter is ideal. The filter does not discard all frequencies adjacent to the favored repeat go absolutely; particularly, there is a domain basically outside the proposed passband where frequencies are discarded, yet not discarded.

As sounds has been delivered in the past stage so this band pass channel is utilized to get the scope of favored frequency. Passband begins from - 3dBm and stopband begins from - 10dBm. The Bandwidth at half-control focuses is estimated as (pick up - 3 dB, √2/2, or around 0.707 with respect to top) on a graph demonstrating frequency versus exchange work for a band-pass channel.

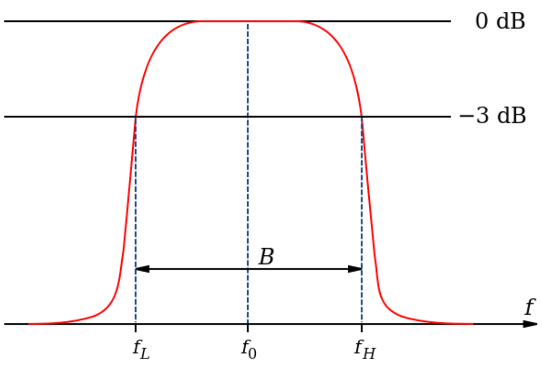

Figure 3.2: Bandpass Filter Half Power Points

The center frequency of this filter is 20.5 MHz with a pass bandwidth of 1 MHz and stop bandwidth of 10 MHz. The insertion loss at this phase will be 2 dB. The time when all signal has been passed through the Bandpass Filter we will get the results as shown in Table 3.3. The IC of bandpass filter which has been used at this stage is SXBP-20R5 of minicircuits with a frequency of 20 MHz to 21 MHz. The data sheet of this IC can be found in the reference [7] given at the end.

Table 3.3: Results of Bandpass Filter

Output Gain	17.826 dB
Output Power	7.826 dBm
Output Noise Figure Reflection	1.215 dB

3.3.3 Attenuator

As the name involve RF attenuators decrease the level of the flag, i.e. they weaken the flag. This lessening might be essential to watch a circuit organize from getting a signal level that is too high. An attenuator might be utilized to supply an exact impedance coordinate as most settled attenuator propose a impedance, or attenuators might be utilized as a part of a decent variety of territories where flag levels should be controlled. This attenuator is used for the protection of the mixer which is attached ahead of it. Mixer is non-linear device and it has diodes which will be burnt due to high power so that is why the attenuator has been used to protect the mixer. Table 3.4 shows the results which have been obtained by integrating all the components behind this stage as show in figure 3.1. In the system at this stage we are using LAT-10 IC of minicircuits which is an attenuator of wideband with a frequency of DC to 2500 MHz. The data sheet of this IC can be found in the reference [8] given at the end. The results after this stage have been shown in Table 3.2.

Table 3.4: Results of Attenuator

Output Gain	7.626 dB
Output Power	2.338 dBm
Output Noise Figure Reflection	1.717 dB

3.3.4 Mixer

A mixer has 3-port electronic circuit. 2 ports are “input” and the other port is an “output” port1. The ideal mixer combines 2 input signals such that the required frequency is the sum or divergence frequency of the inputs.

$$f_{out} = f_{in1} +/- f_{in2}$$

It has the LO port, the RF port, and the IF port. The Local oscillator usually works with a sine CW signal or a square signal. It varies with application and mixer. Theoretically Local Oscillator proceed as the “gateway” of mixer can be measured “ON” when the Local Oscillator voltage is “OFF” than the LO is a voltage. The Local Oscillator port is typically used as an input.

In this system we are using SIM-U742MH IC of minicircuits which is a mixer IC with a frequency of 0.1 MHz to 7400 MHz. The data sheet of this IC can be found in the reference [9] given at the end. Up conversion of a signal has been depicted with the help of a diagram as shown in Figure 3.3.

The input frequency is 20 MHz and the frequency of local oscillator is 5.23 GHz. So, the output of the mixer will be:

Cos(20 MHz) x Cos(5.23 GHz)

0.5 cos (5.23 GHz – 20 MHz) + 0.5 cos(5.23 GHz + 20 MHz)

0.5 cos (5.21 GHz) + 0.5 cos(5.25 GHz)

We will use the signal of 5.25 GHz because it is the center frequency of the wlan band of 5.15 GHz to 5.35 GHz band. Mixer is used for mixing of different frequency and it give us the loss as well, so the output power, gain and noise reflection after this stage has been shown in Table 3.5.

Table 3.5: Results of Mixer

Output Gain	-2.236 dB
Output Power	-12.236 dBm
Output Noise Figure Reflection	6.728 dB
Output Frequency	5.25 GHz

3.3.5 Band Pass Filter(a)

This **pass band filter** is to allow frequencies in given range and remove frequencies beyond that series. Center frequency of this filter is 5.25 GHz with a pass bandwidth of 1.3 GHz and stop bandwidth of 7.3 GHz. The insertion loss at this stage will be 1.3 dB. The Bandpass Filter has been used again in the circuit because now the frequency has been up converted to 5 GHz. So, table 3.6 shows the results in a tabulated form after this bandpass filter. In this system we have used BFCW-542 IC of minicircuits which is a band pass filter with a frequency of 4700 to 6000 MHz. The data sheet of this IC can be found in the reference [10] given at the end.

Table 3.6: Results of Bandpass Filter (a)

Output Gain	-3.617 dB
Output Power	-13.617 dBm
Output Noise Figure Reflection	7.233 dB

3.3.6 Driver Amplifier

They are generally used to direct grequency through a circuit or to control different factors, for example, different parts, a few gadgets in the circuit. An enhancer can likewise be viewed as a driver for control speaker, amplifiers, or a voltage controller that keeps a joined segment working inside a wide scope of info voltages.

This amplifier will be device driver amplifier. It is necessary for driving of power amplifier. This amplifier has been used to excite the signal for the input to the power amplifier. After this stage we will get output power, gain and noise reflection as shown in Table 3.7. At this stage we have used HMC-633 IC of Analog Devices which is a driver amplifier with a gain of 29 dB. The data sheet of this IC can be found in the reference [11] given at the end.

Table 3.7: Results of Driver Amplifier

Output Gain	22.884 dB
Output Power	12.884 dBm
Output Noise Figure Reflection	13.111 dB

3.3.7 Power Amplifier

The transmitter– collectors are utilized for voice and information correspondence as well as for climate detecting. This power amplifier will increase the output power of our transmitter to a level that it can be sent at desired location. Table 3.8 shows the results of our project when the signal has been amplified to a desired level. In this system we are using HMC-637A IC of Analog Devices which is a power amplifier with a frequency of 1 MHz to 1 GHz. The data sheet of this IC can be found in the reference [12] given at the end.

Table 3.8: Results of Power Amplifier

Output Gain	33.919 dB
Output Power	23.919 dBm
Output Noise Figure Reflection	13.112 dB

3.3.8 Band Pass Filter(b)

This **pass band filter** has been used at this stage to have the desired band of frequencies. As in the previous stage we have used an amplifier so harmonics may been produced, so in order to get the desired frequency we need this pass band filter. Table 3.9 shows our final values of the output power, gain and noise reflection. At this stage we have used BFCW-542 IC of minicircuits which is a band pass filter with a frequency of 4.7 GHz to 6 GHz. The data sheet of this IC can be found in the reference [10] given at the end.

Table 3.9: Results of Bandpass Filter (b)

Output Gain	32.619 dB
Output Power	22.619 dBm
Output Noise Figure Reflection	13.112 dB

CHAPTER 4

4.1 SIMULATED RESULTS

ADS has been used for the simulation and optimization of the results. The output power, gain and noise reflection of the complete system are 22.619 dBm, 32.619 dB, and 13.112 dB respectively. Figure 4.1, 4.2 and 4.3 have been used for the graphical depiction of output power, gain and noise reflection of the complete system respectively.

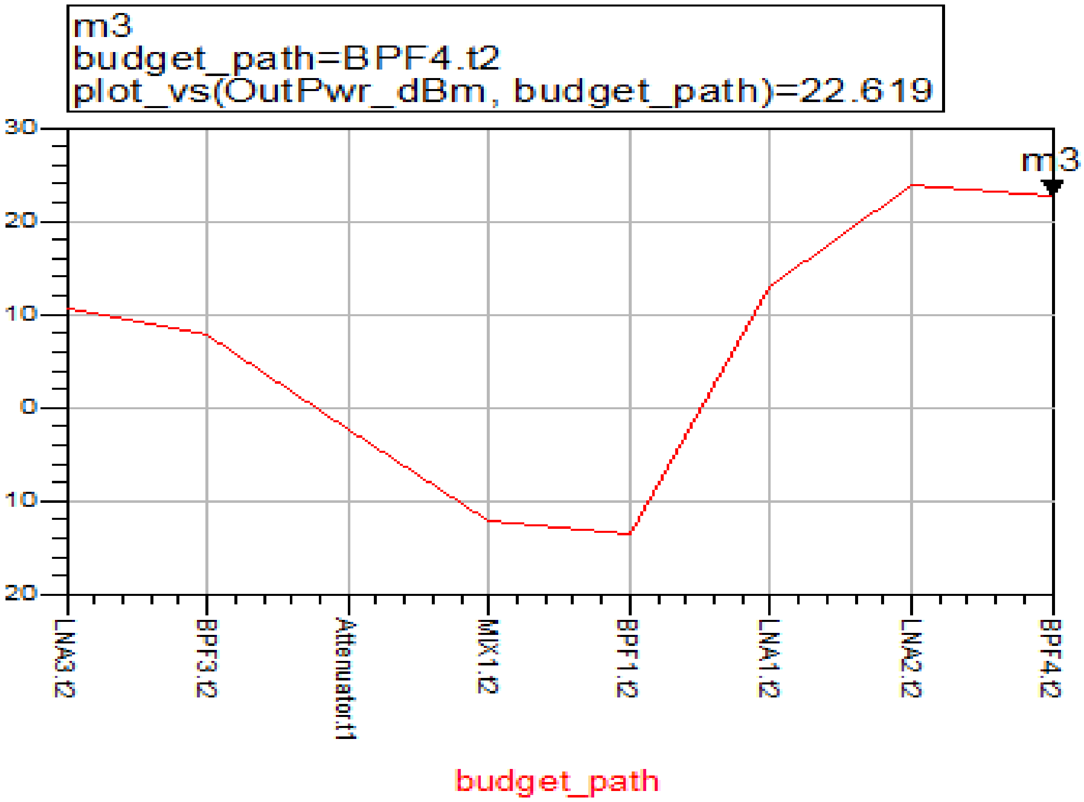

Figure 4.1: Graph of Output Power Vs Budget Path

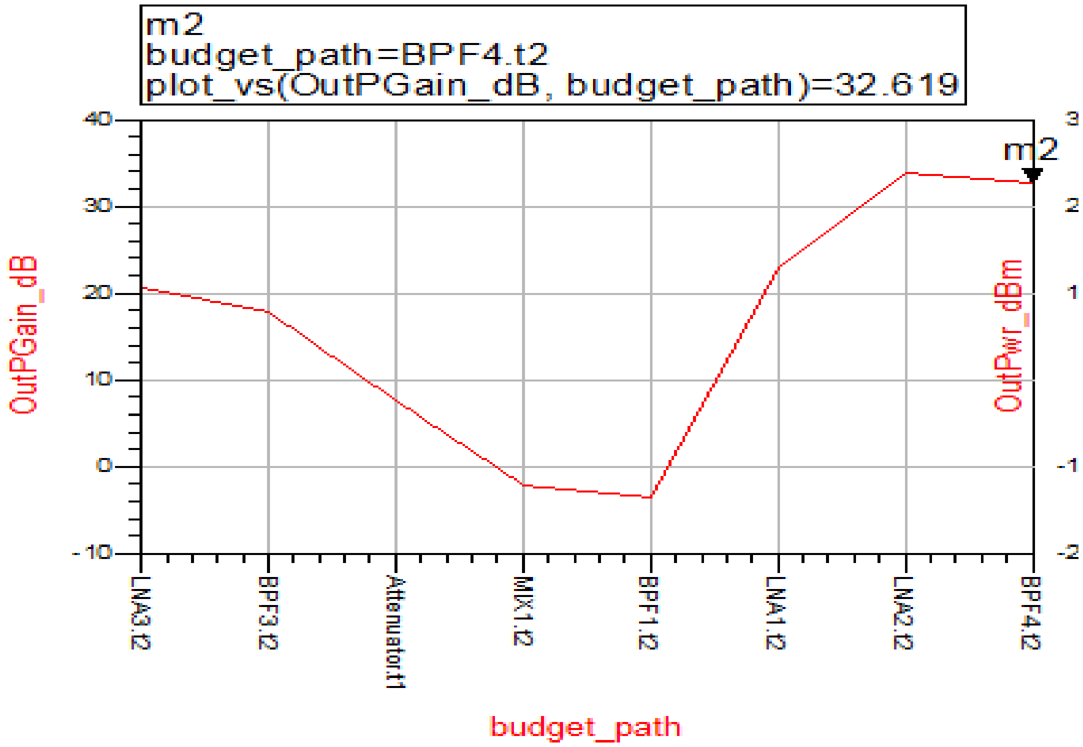

Figure 4.2: Graph of Gain Vs Budget Path

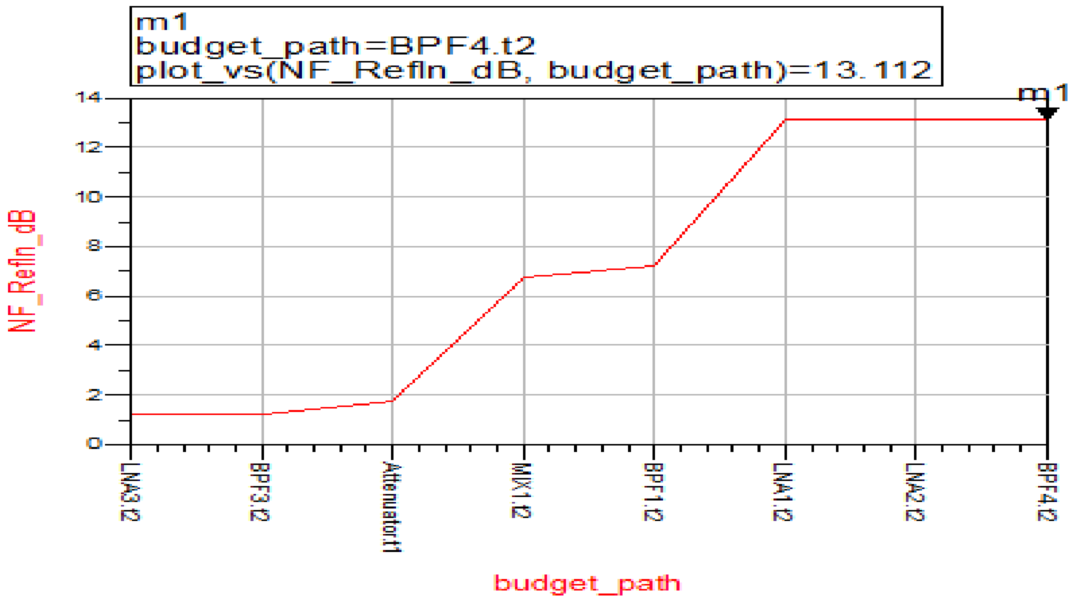

Figure 4.3: Graph of Noise Reflection Vs Budget Path

CHAPTER 5

5.1 CONCLUSION

The objective of this project was to create an outline of a 5 GHz radio front-end utilizing ADS and utilize this plan to fabricate a model. In this paper, we presented the RF Front End transmitter that has been designed in accordance with the IEEE802.11 specification. The output power measured at the transmitter is 22.619 dBm.

The project was a difficult task for implementation as a whole, so for the ease and completion of the project, it has been divided into two distinct portions of simulation and fabrication. The design has been implemented on the software and simulation have been done on the ADS but due to high cost of the ICs the fabrication and test is left for other students who will carry forward this project. The Gerber files can be made by using the reference [13] at the end.

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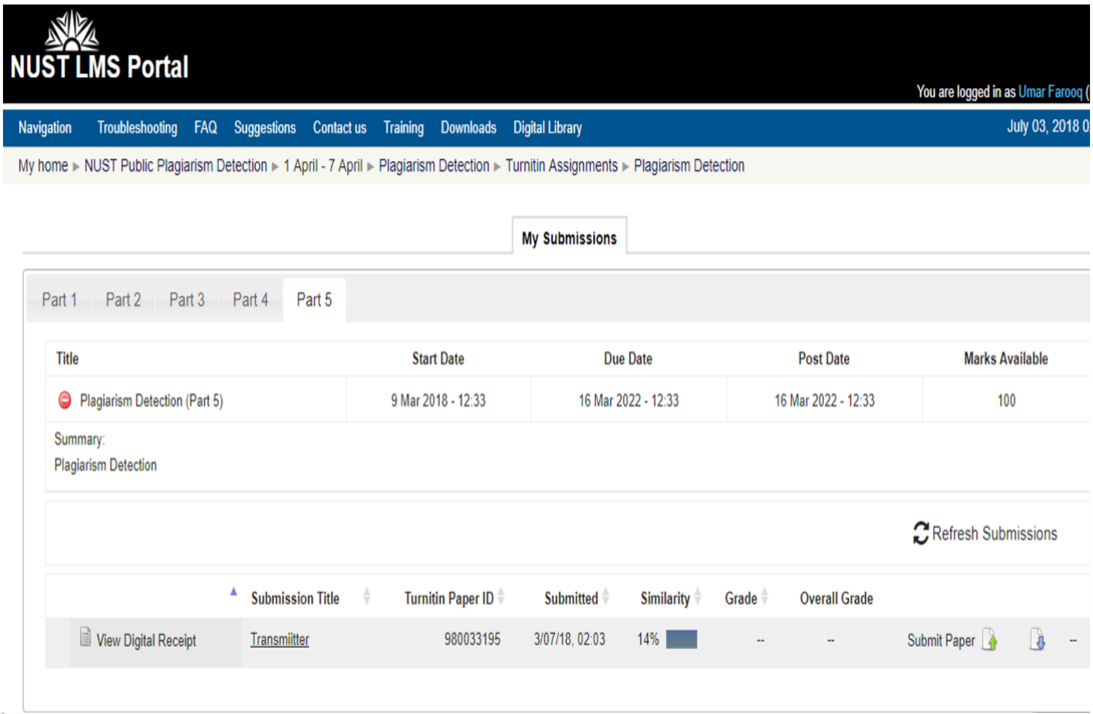

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