

**SIMULATOR DEVELOPMENT FOR PEAK TO AVERAGE POWER RATIO
OF OFDM SYSTEM**



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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POWER RATIO OF OFDM SYSTEM

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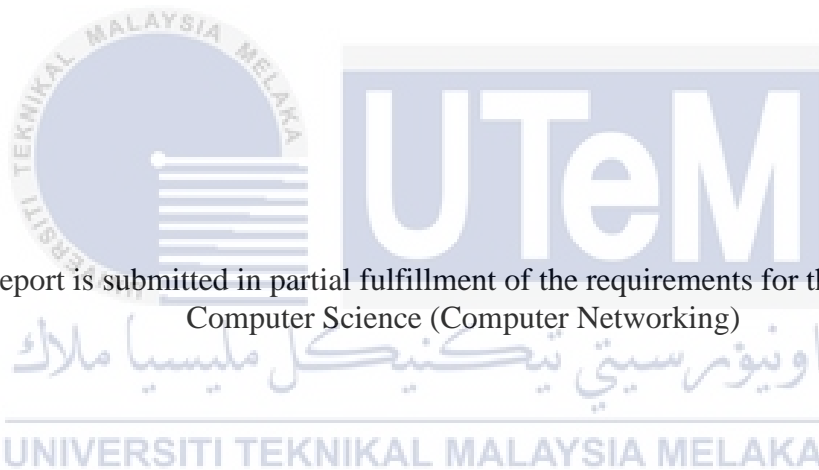
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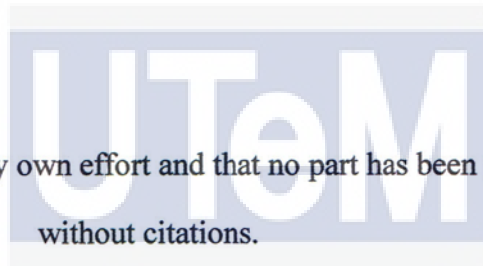


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I hereby declare that this project report entitled

SIMULATOR DEVELOPMENT FOR PEAK TO AVERAGE POWER RATIO OF OFDM SYSTEM




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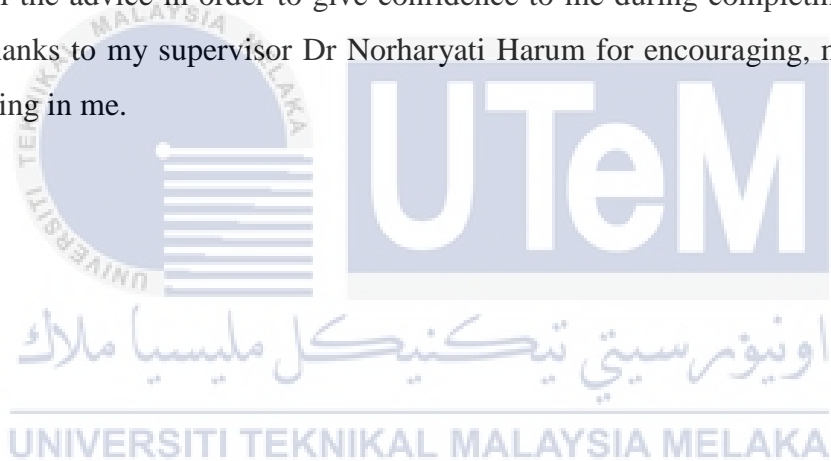
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DEDICATION

This thesis is dedicated to my beloved parents Jasmi Bin Talib and Rozaini Binti Osman. Thank you for your greatest support that you gave during my hardest time and all the advice in order to give confidence to me during completing this project, and thanks to my supervisor Dr Norharyati Harum for encouraging, motivating and believing in me.



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ABSTRACT

OFDM or Orthogonal Frequency Division Multiplexing is a system that used to encode the digital data on multiple carrier frequency. OFDM is one of the popular systems that used in many digital communication systems such as DSL internet access, wireless network and 4G mobile communications. Although OFDM has many advantages such as high bit rate and high efficiency of spectral it still has disadvantage which is the form of the high Peak-to-Average Power Ratio (PAPR) that occur during signal transmission. If the PAPR is high OFDM system require high intensity amplifier and it will cause the complexity at transmitter that lead to the increasing in cost of transmitter. This project focuses on studying the PAPR of the OFDM system and developing the simulator that can reduce the PAPR values in order to increase the signal strength. The simulator will be developed by using the MatLAB software and the simulation results will be collected and analyzed. The contribution from this project is that the PAPR of OFDM will be studied and the analysis will documented. This project is progressed based on the methodology model which is waterfall model. There are 5 phases in this methodology which are planning, literature review, design, analysis and testing, and implementation.

ABSTRAK

OFDM atau *Orthogonal Frequency Division Multiplexing* adalah satu system yang menggunakan is mengekod data digital pada pelbagai *carrier frequency*. OFDM adalah salah satu sistem yang digunakan oleh pelbagai jenis system komunikasi digital seperti *DSL internet access*, rangkaian tanpa wayar dan komunikasi mudah alih 4G. Walaupun OFDM mempunyai banyak manfaat seperti tinggi *bit rate* and tinggi kecekapan spectrum, ia masih mempunyai kekurangan iaitu nilai PAPR yang tinggi yang berlaku ketika penghantaran signal. Sekiranya nilai PAPR tinggi, sistem OFDM memerlukan *amplifier* yang berkuasa tinggi dan akan berlakunya kerumitan pada *transmitter* yang menyebabkan kepada pertambahan pada kos *transmitter*. Projek ini tertuju kepada kajian ke atas nilai PAPR untuk sistem OFDM dan pembinaan simulator yang boleh mengurangkan nilai PAPR supaya kekuatan signal bertambah. Simulator akan dibina menggunakan menggunakan perisian MatLAB dan keputusan daripada simulator akan dikumpulkan serta akan dinilai. Sumbangan project ini ialah nilai PAPR untuk sistem OFDM dapat dikaji dan semua analisa dapat didokumenkan. Projek ini dilaksanakan berdasarkan model metodologi iaitu *waterfall model*. Terdapat 5 fasa dalam metodologi ini iaitu *planning, literature review, design, analysis and testing, and implementation*.

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CHAPTER I

INTRODUCTION

1.1 Introduction



Orthogonal frequency division multiplexing (OFDM) has been used in wireless technology because of the effectiveness of its performance especially LTE technology. OFDM gives many benefits after the implementation of it but during the implementation of OFDM certain factors cause the problem to occur. The major factor is peak to average power ratio of OFDM system. The title of this project is Simulator Development for Peak to Average Power Ratio (PAPR) of OFDM system. This project will be focused in developing the PAPR simulator that will be used to generate the value of PAPR in OFDM system. PAPR is one of the important values that affect the performance of OFDM. The simulator will be inputted with different value in order to determine which result is the best for the OFDM system. The development of the simulator in this project will be completed by using the MatLAB software. There will be one simulator which is for Quadrature phase-shift keying (QPSK). In this project, the code for simulator will be designed and implemented until it can be used. After the simulators are developed, the simulation to produce PAPR value will be done and all the results will be compared and analyzed.

1.2 Problem Statement

Recently, OFDM is one of the technologies that commonly use in wireless transmission. Although it highly recommended technology to be used there still a problem which is high peak to average power ratio that occur during the signal transition. The high PAPR in OFDM system require high intensity amplifier and it will cause the complexity at transmitter that lead to the increasing in cost of transmitter. If the high intensity amplifier do not use in the OFDM implementation it will cause the poor OFDM performance. Table 1.1 shows the problem statement of this project.

Table 1.1: Summary of Problem Statement

PS	Problem Statement
PS ₁	High Peak to Average Power Ratio (PAPR) can cause the degradation of OFDM performance.

1.3 Project Question

For this project, few questions have been constructed based on the problem statement of the project. In order to complete the project all questions must be answered and solved. The following Table 1.2 shows the summary of project questions.

Table 1.2: Summary of Project Question

PS	PQ	Project Question
PS ₁	PQ ₁	How do we know it is a PAPR of OFDM system?
	PQ ₂	How to reduce the PAPR value in OFDM system?
	PQ ₃	What is the PAPR value of QPSK in OFDM system?

1.4 Project Objective

Based on the project questions, this project must meet these 3 main objectives. This project involves the better understanding of the PAPR and how it can affect OFDM system. In order to achieve good understanding in PAPR of OFDM system, the basic structure of the OFDM system and PAPR will be studied. After the first objective is completed, the simulator for Peak to Average Power Ratio of OFDM system will be developed using the MatLAB software. When the development of simulator is finished, the simulation will be executed in order to generate and analyze the PAPR value of OFDM system. Table 1.3 shows the summary of project objectives.

Table 1.3: Summary of Project Objective

PS	PQ	PO	Project Objective
PS ₁	PQ ₁	PO ₁	To study the Peak to Average Power Ratio of the OFDM system.
	PQ ₂	PO ₂	To develop the simulator for PAPR of OFDM system.
	PQ ₃	PO ₃	To generate and analyze the PAPR value of OFDM system.

1.5 Project Scope

The scope of this project is stated as the following list:

- a) This project will focus on the PAPR of OFDM system.
- b) This project will focus on the developing a simulator to produce PAPR of OFDM by using the MatLab software.
- c) This project will focus on the results of the simulation that will be analyzed to find the best result.

1.6 Project Contribution

The improvement in current technology makes the OFDM is one of the important wireless technologies used in data transmission but because of the hitch occur during transmission, the solution for this problem will be produced. The simulator for the peak to average power ration of OFDM will be developed to produce the PAPR value that suitable for the OFDM.

Table 1.4: Summary of Project Contribution

PS	PQ	PO	PC	Project Contribution
PS ₁	PQ ₁	PO ₁	PC ₁	Proposed a simulator that can be use for PAPR of OFDM.
	PQ ₂	PO ₂		
	PQ ₃	PO ₃	PC ₂	Documentation all the analysis of the project.

1.7 Thesis Organization

Chapter 1: Introduction

This chapter will focus on the introduction of the project which includes the project background, problem statement, question arise, objectives, scope of the project, project contribution and thesis organization.

Chapter 2: Literature review

This chapter will include the proposed solution and analysis of the previous work that related to this project. All the explanation of the previous project will be supported by the journal and other reading materials.

Chapter 3: Project Methodology

This chapter will explain the methodology of the project which are the phases of the activities that will done during this project.

Chapter 4: Design

This chapter will focus on the designing the structure of the simulator for OFDM system in order to produce PAPR value.

Chapter 5: Implementation

This chapter will focus on the simulator development. The coding will be done on the MatLAB software based. All simulator code will be arranged according to the simulator design.

Chapter 6: Testing and Analysis

This chapter will focus on executing the simulator in order to generate the PAPR value based on one type of modulation which is QPSK. Then, the value will be analyzed.

Chapter 7: Conclusion

This chapter consists of project summarization, project contribution and project limitation. All the steps done in will be explained briefly. The suggestion for simulator improvement also include in this chapter.


1.8 Conclusion

As the conclusion, at the end of the project, the simulator for the PAPR of OFDM system will be developed and the simulation can be done in order to produce the analysis for this project. The continuation of project will be based on this chapter. The next chapter will focus on the literature review which will cover the model approach and the previous details of project about peak to average ratio of OFDM system.

CHAPTER II

LITERATURE REVIEW

2.1 Introduction



In this chapter, the discussion will focus on the literature review on Simulator Development for Peak to Average Power Ratio of the OFDM System and other related project that is similar to the technique that shall be used in this project. On the literature review, the three objectives will be covered for better understanding of the PAPR architecture. The main component in OFDM will be discussed such as base station, relay station, its advantages and disadvantages in order to increase knowledge in this field. In this chapter, the technique that will be used in this project will be proposed. Figure 2.1 shows the summary of Chapter 2.

Based on Figure 2.1, the summarization for Chapter 2 is shown one by one. Chapter 2 documentation is starting from the introduction which explaining what kinds of contents include in this chapter. Then, the chapter continues with related work. Related work will consists of domain of the project and the keywords used in the project. After the keywords explanations, the 3 project related journals will be reviewed thoroughly and after that the solution will be proposed.

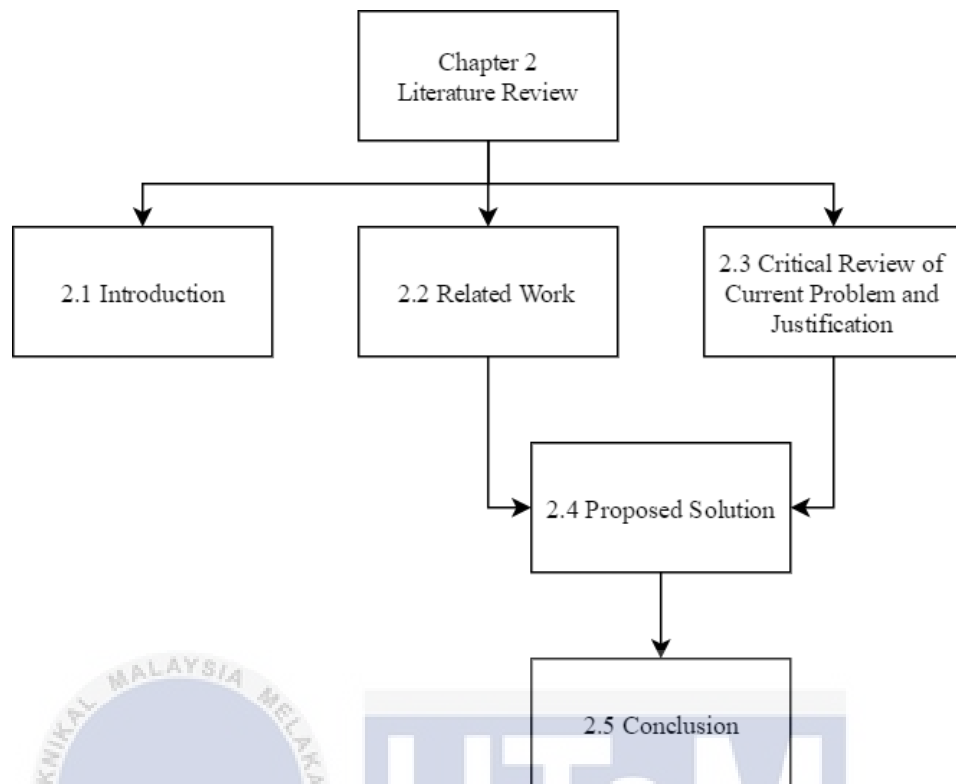


Figure 2.1: Chapter 2 Summary

2.2 Related Work

2.2.1 Domain

The main domain for this project is OFDM or Orthogonal Frequency Division Multiplexing. OFDM is a wireless technology that commonly used in order to transmit data because of its high speed of data transmission. Although OFDM has more advantage than other wireless technologies it still has major drawback which it can cause the degradation of performance. The cause for the OFDM problem is PAPR or peak to average power ratio. In this chapter, an overview of peak to average power ratio and some other concepts that related to the PAPR of OFDM will be explained.

2.2.2 Domain Problem

When the transmission is using the OFDM technology, the performance will be decrease as the PAPR of OFDM that will be produced is higher (Paredes, n.d.). The high peak to average power ratio can reduce the signal strength. The value PAPR will be increase when the number of subcarriers used in the OFDM increase. There are few solutions that can be used in order to improve the performance of OFDM but some of the solutions will include the extra implementation cost for OFDM. PAPR also can be reduced by increase the Power Amplifier but it may cause the amplifier efficiency decrease.

2.2.3 Keyword

There are several terms that will be used in this project and shall serve the purpose as the keywords throughout the research of the project. The most important keyword for this project is uplink and downlink, OFDM, PAPR, relay station, subcarrier pairing, QPSK, and Rayleigh fading. The explanation of each keyword as following:

UPLINK AND DOWNLINK: The communication moving from the base station to the relay station and mobile station is called downlink. It means that the base station will be the transmitter which transmits data to the relay station. The relay station which acts as receiver and transmitter will receive the data from base station and send the data to the mobile station. Then, the mobile station will receive the data from the relay station. The communication from the mobile station to the relay station and base station is called uplink. The uplink happens when mobile station sends the data to the relay station and then relay station transmit the data to the base station. The mobile will act as the transmitter then send the data to relay station and the base station is a receiver. Figure 2.2 shows the communication flow for uplink and downlink.

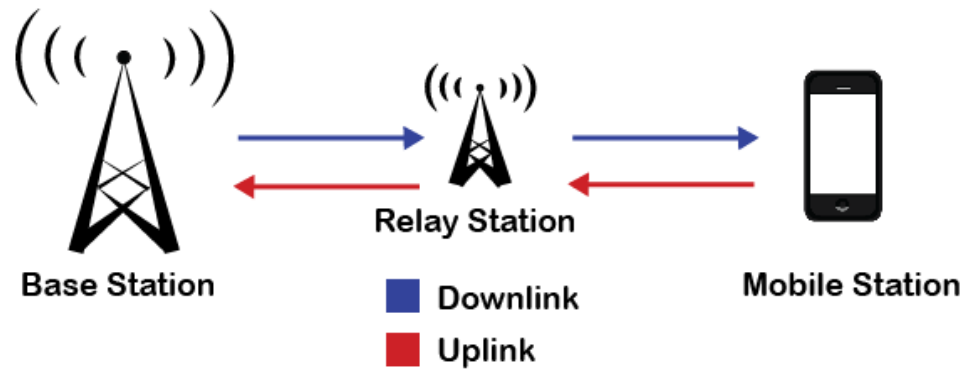


Figure 2.2: Uplink and Downlink

OFDM: Orthogonal frequency division multiplexing (OFDM) is an encoding method for digital data on multiple subcarrier frequencies. Each of these subcarriers carries a quantity of parallel data streams or channels and is modulated usually at a low symbol rate. Orthogonal is an adjective describing two things that do not dependent and interference to each other. OFDM is widely used for digital television and audio broadcasting but the most important is as broadband internet access and wireless networking.

This project will focus on OFDM in Long Term Evaluation (LTE). LTE is a standard high speed wireless communication using in mobile phones and data terminal based on GSM/EDGE and UMTS/HSPA technologies. The LTE uses the OFDM for the downlink which from the base station to the mobile station. The LTE specification provides downlink peak rates of 300 Mbit/s, uplink peak rates of 75 Mbit/s and QoS provisions permitting a transfer latency of less than 5 ms in the radio access network. LTE has the ability to manage fast-moving mobiles and supports multi-cast and broadcast streams.

OFDM is been a choice for LTE because it resilience to interference. OFDM has other advantages which is flexible to the inter-symbol and inter-frame interference. It comes from the low data rate on each of sub-channels. Besides, OFDM use the close-spaced overlapping sub-carriers that it makes efficient use of the available spectrum. Although OFDM has few advantages, it still has disadvantage which has high peak to average power ratio (Gangwar & Bhardwaj, 2012).