

# Ber Calculation Using Matlab Simulation For Ofdm Transmission

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**Abstract**—Orthogonal frequency division multiplex (OFDM) modulation is being used more and more in telecommunication, wired and wireless. DVB and DAB already use this modulation technique and ADSL is based on it. The advantages of this modulation are the reason for its increasing usage. OFDM can be implemented easily, it is Spectrally efficient and can provide high data rates with sufficient robustness to channel imperfections.

The purpose of this paper is to use a Matlab simulation of OFDM to see how the Bit Error Ratio (BER) of a transmission varies when Signal to Noise Ratio (S/N Ratio) and Multipropagation effects are changed on transmission channel.

**Index Terms**— BER, FFT, ISI, OFDM, S/N

## I. INTRODUCTION

In an OFDM [4] scheme a large number of sub-channels or sub-carriers are used to transmit digital data. Each sub-channel is orthogonal to every other. They are closely spaced and narrow band. The separation of the sub-channels is as minimal as possible to obtain high spectral efficiency. OFDM is being used because of its capability to handle with multipath interference at the receiver.

These two are the main effects of multipropagation [3]. Frequency selective fading and Inter Symbolic Interference (ISI) [5]. In OFDM the large number of narrow band sub-carriers provides sufficiently "flat" channels. Therefore the fading can be handled by simple

equalizing techniques for each channel. Furthermore the large amount of carriers can provide same data rates of a single carrier modulation at a lower symbol rate.

The symbol rate of each channel can be dropped to a point that makes each symbol longer than the channel's impulse response. This eliminates ISI.

The two main drawbacks of OFDM are the large dynamic range of the signals being transmitted and the sensitivity to frequency errors.

Using a Matlab simulation we can implement an OFDM transmission. Using the simulation we can easily change the values of S/N ratio [2] and change the multipropagation effects on the transmission. Then we can analyze the results of each transmission and see how the BER [1] is changed.

## II. OFDM SIMULATION

### A. The Matlab source code

The Matlab code used in this paper was developed by Alan C. Brooks and Stephan Hoelzer [8]. This implementation is used to transmit a computer file in binary data form modulated by OFDM and 16- QAM modulation. A scheme of every part of the implementation can be seen in Fig 1. As it can be seen in the figure channel imperfections are modeled in this implementation. In the end of the transmission, when the receiver receives the data, a comparison of the transmitted and the received messages is done in order to calculate the Bit Error Ratio (BER).

This paper does not explain in detail the simulation code. It uses it to create results and see the behavior of OFDM under different channel properties. Nevertheless some of the main variables of the code are described, because the choice of them has a critical effect on the results.

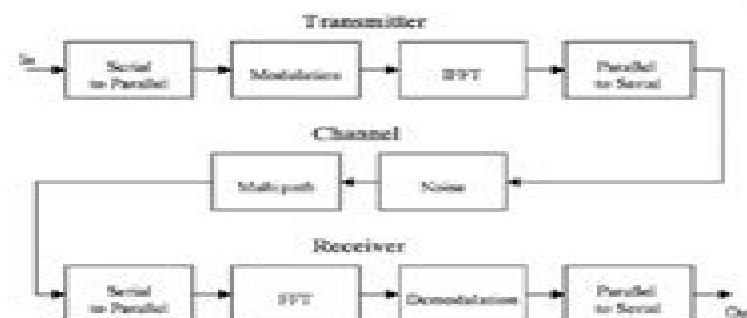


Figure 1. Matlab Flow Chart

### B. General Options in the Simulation

The general options of each transmission are in the `setup.m` file of the simulation. Two of the most important variables are analyzed.

One of the main characteristics of every simulation model of OFDM is the size of the fast Fourier transformation (FFT) used to generate the signal. In the

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at International Conference on Communication Circuits and Systems IC3S 2020 held at KIIT Bhubaneswar India from 16 18 October 2020 It brings together new works from academicians scientists industry professionals scholars and students together to exchange research outcomes and open up new horizons in the areas of signal processing communications and devices Advances in Computing and Network Communications Sabu M. Thampi,Erol Gelenbe,Mohammed

Atiquzzaman,Vipin Chaudhary,Kuan-Ching Li,2021-04-20 This book constitutes the thoroughly refereed post conference proceedings of the 4th International Conference on Computing and Network Communications CoCoNet 20 October 14 17 2020 Chennai India The papers presented were carefully reviewed and selected from several initial submissions The papers are organized in topical sections on Signal Image and Speech Processing Wireless and Mobile Communication Internet of Things Cloud and Edge Computing Distributed Systems Machine Intelligence Data Analytics Cybersecurity Artificial Intelligence and Cognitive Computing and Circuits and Systems The book is directed to the researchers and scientists engaged in various fields of computing and network communication domains **Applications of MATLAB in Science and Engineering** Tadeusz Michalowski,2011-09-09 The book consists of 24 chapters illustrating a wide range of areas where

MATLAB tools are applied These areas include mathematics physics chemistry and chemical engineering mechanical engineering biological molecular biology and medical sciences communication and control systems digital signal image and video processing system modeling and simulation Many interesting problems have been included throughout the book and its contents will be beneficial for students and professionals in wide areas of interest Index to IEEE Publications Institute of Electrical and Electronics Engineers,1998 Issues for 1973 cover the entire IEEE technical literature **Interference Mitigation for Multi-band OFDM Using Diversity Combining and Erasure Based Methods** Eric Paul Reinbold,2005

Mobile Lightweight Wireless Systems Javier Del Ser,Eduard Axel Jorswieck,Joaquin Miguez,Marja Matinmikko,Daniel P Palomar,Sancho Salcedo Sanz,Sergio Gil-Lopez,2012-04-23 This book constitutes the thoroughly refereed post conference proceedings of the Third International ICST Conference Mobile Lightweight Wireless Systems MOBILIGHT 2011 held in Bilbao Spain on May 9 10 2011 In numbers MOBILIGHT 2011 was organized as a 2 day single track event with 18 technical presentations and 3 specialized workshops focused on opportunistic sensing and processing in mobile wireless sensor and cellular networks MOBISENSE multimode wireless access networks MOWAN and strategic network planning applied to market regulation NETSTRAT totaling to 34 papers presented during the conference and included in the proceedings

**Digital Design of Signal Processing Systems** Shoab Ahmed Khan,2011-07-28 Digital Design of Signal Processing Systems discusses a spectrum of architectures and methods for effective implementation of algorithms in hardware HW Encompassing all facets of the subject this book includes conversion of algorithms from floating point to fixed point format parallel architectures for basic computational blocks Verilog Hardware Description Language HDL SystemVerilog and coding guidelines for synthesis The book also covers system level design of Multi Processor System on Chip MPSoC a consideration

of different design methodologies including Network on Chip NoC and Kahn Process Network KPN based connectivity among processing elements A special emphasis is placed on implementing streaming applications like a digital communication system in HW Several novel architectures for implementing commonly used algorithms in signal processing are also revealed With a comprehensive coverage of topics the book provides an appropriate mix of examples to illustrate the design methodology Key Features A practical guide to designing efficient digital systems covering the complete spectrum of digital design from a digital signal processing perspective Provides a full account of HW building blocks and their architectures while also elaborating effective use of embedded computational resources such as multipliers adders and memories in FPGAs Covers a system level architecture using NoC and KPN for streaming applications giving examples of structuring MATLAB code and its easy mapping in HW for these applications Explains state machine based and Micro Program architectures with comprehensive case studies for mapping complex applications The techniques and examples discussed in this book are used in the award winning products from the Center for Advanced Research in Engineering CARE Software Defined Radio 10 Gigabit VoIP monitoring system and Digital Surveillance equipment has respectively won APICTA Asia Pacific Information and Communication Alliance awards in 2010 for their unique and effective designs

*A Low-complexity Tentative Decision Interference Suppression Scheme for Multi-band OFDM* Meng Li, 2005

*Visible Light Communication* Suseela Vappangi, Vakamulla Venkata Mani, Mathini Sellathurai, 2021-08-10 The field of visible light communication VLC has diverse applications to the end user including streaming audio video high speed data browsing voice over internet and online gaming This comprehensive textbook discusses fundamental aspects research activities and modulation techniques in the field of VLC Visible Light Communication A Comprehensive Theory and Applications with MATLAB discusses topics including line of sight LOS propagation model non line of sight NLOS propagation model carrier less amplitude and phase modulation multiple input multiple output MIMO non linearities of optical sources orthogonal frequency division multiple access non orthogonal multiple access and single carrier frequency division multiple access in depth Primarily written for senior undergraduate and graduate students in the field of electronics and communication engineering for courses on optical wireless communication and VLC this book Provides up to date literature in the field of VLC Presents MATLAB codes and simulations to help readers understand simulations Discusses applications of VLC in enabling vehicle to vehicle V2V communication Covers topics including radio frequency RF based wireless communications and VLC Presents modulation formats along with the derivations of probability of error expressions pertaining to different variants of optical OFDM

**Intelligence Science and Big Data Engineering. Big Data and Machine Learning Techniques** Xiaofei He, Xinbo Gao, Yanning Zhang, Zhi-Hua Zhou, Zhi-Yong Liu, Baochuan Fu, Fuyuan Hu, Zhancheng Zhang, 2015-10-13 The two volume set LNCS 9242 9243 constitutes the proceedings of the 5th International Conference on Intelligence Science and Big Data Engineering IScIDE 2015 held in Suzhou China in June 2015 The total of 126 papers presented in the proceedings was

carefully reviewed and selected from 416 submissions They deal with big data neural networks image processing computer vision pattern recognition and graphics object detection dimensionality reduction and manifold learning unsupervised learning and clustering anomaly detection semi supervised learning

**The ... IEEE International Symposium on Personal, Indoor, and Mobile Radio Communications** IEEE International Symposium on Personal, Indoor, and Mobile Radio Communications,1995     *Electrical & Electronics Abstracts* ,1997     **Blind, Adaptive Equalization for Multicarrier Receivers** Richard K. Martin,2004     **Advances in Computing, Communication, Automation and Biomedical Technology** M. G. Sumithra ,Arulmurugan Ramu ,Chow Chee Onn,2020-12-30

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*Parallel Computing* Barbara Chapman,2010

From Multicores and GPUs to Petascale Parallel computing technologies have brought dramatic changes to mainstream computing the majority of todays PCs laptops and even notebooks incorporate multiprocessor chips with up to four processors Standard components are increasingly combined with GPUs Graphics Processing Unit originally designed for high speed graphics processing and FPGAs Free Programmable Gate Array to build parallel computers with a wide spectrum of high speed processing functions The scale of this powerful hardware is limited only by factors such as energy consumption and thermal control However in addition to

**Cognitive Radio Oriented Wireless Networks** Mark Weichold,Mounir Hamdi,Muhammad Zeeshan Shakir,Mohamed Abdallah,George K. Karagiannidis,Muhammad Ismail,2015-10-12

This book constitutes the thoroughly refereed post conference proceedings of the 10th International Conference on Cognitive Radio Oriented Wireless Networks CROWNCOM 2015 held in Doha Qatar in April 2015 The 66 revised full papers presented were carefully reviewed and selected from 110 submissions and cover the evolution of cognitive radio technology pertaining to 5G networks The papers are clustered to topics on dynamic spectrum access management networking protocols for CR modeling and theory HW architecture and implementations next generation of cognitive networks standards and business models and emerging applications for cognitive networks

**Proceedings of the Multi-Conference 2011** Himanshu B. Soni,Apurva Shah,2011-06-06

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