AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING
Electronics and Communications Engineering Department

Timing and frequency offset correction of received OFDM symbols in advanced communication systems.

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STATEMENT

This dissertation is submitted to Ain Shams University for the degree of Master of Science in Electrical Engineering (Electronics and Communications Engineering).

The work included in this thesis was carried out by the author at the Electronics and Communications Engineering Department, Faculty of Engineering, Ain Shams University, Cairo, Egypt.

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ABSTRACT

Marriam Abou Baker Mohammed

Timing and frequency offset correction of received OFDM symbols in advanced communication systems.

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This thesis presents a study of how to correct timing and frequency offset of orthogonal division multiplexing (OFDM). OFDM is considered the most common digital modulation technique in advanced communication systems such as ADSL, WLAN and Wi- MAX. OFDM systems have a great immunity against multipath fading, noise and any delayed channels.

Timing errors during transmission complicates the process of determining the start of the received OFDM symbol. In addition to some sort of phase rotation according to Fourier transform which translates the time delay into phase shift. Beside timing errors due to transmission, OFDM symbols may suffers from carrier frequency offsets due to multipath fading. Some old methods are used to solve the problem of synchronization such as 'data aided'.

This method uses predetermined training symbols which reduce the efficiency of transmitted channels due to the reduction of the part of band width dedicated for data transmission. A new method for synchronization depends on the cyclic prefix (CP) which is the process of copying the last L part of transmitted OFDM symbols to the beginning of OFDM symbol. CP represents a percentage of OFDM symbol. The effect of different percentages of CP in the synchronization process is tested.

MATLAB SIMULINK and HDL code generation is used for OFDM system simulation and HDL code generation.

Key words: OFDM (Orthogonal frequency division multiplexing) – CP (Cyclic prefix)- Timing errors –MTLAB-MATLAB HDL coder-timing synchronization.

Tables of contents

Tables of contents ……………………………………………………......... v

List of abbreviations……………………………………………….. x

List of symbols ……………………………………………………. xii

List of figures ……………………………………………………........ xiii

List of tables ……………………………………………………….... xvii

Introduction ……………………………………………………….. 1

Chapter 1 ……………………………………………………….... 4

Basics of multicarrier transmission……………………….......... 4

Introduction…………………………………………….……….. 4

1.1 OFDM technique in IEEE standards (Institute of Electrical and Electronics Engineers)…………………………………….. 8

1.2 OFDM and IEEE802.11a……………………………………….. 9

1.3 OFDM and IEEE 802.16a……………………………………….. 10

IEEE 802.16c 2002………………………………………………... 10

1.2.4 IEEE 802.16 2004……………………………………………. 11

1.3 Frequency Division Multiplexing (FDM) versus Orthogonal frequency Division Multiplexing (OFDM)…………………... 12

1.4 OFDM Basics……………………………………………………. 16

1.4.1 The cyclic prefix……………………………………………... 18

1.4.2 The main advantages and disadvantages of cyclic prefix……………………………………………………… 21

1.5 Circular Convolution and frequency domain………………. 23

1.6 Implementation of multicarrier modulation in OFDM systems……………………………………………………… 25

Chapter2…………………………………………………………… 27

OFDM System analysis and design…………………………….. 27

2.1 Introduction……………………………………….…….……. 27

2.2 OFDM Symbols…………………………………………… 27

2.3 OFDM System…………………………….………….…… 28

2.4 OFDM System in details…………………………………… 30

2.4.1Signal Mapper Operation……………………………… 30

2.4.2 Coding……………………………………………….. 31

2.4.3 Pilot Subcarriers………………………………………. 31

2.4.4 Frequency to time domain converter (IFFT)…………. 33

2.4.5 Cyclic Extension and Shaping…………………………. 33

2.4.6 Transmission Channels………………………………… 34

2.5 Optimum Signal to Noise Ratio (SNR) in presence
of Timing Errors…………………………….…………………... 34

2.6 Time Dispersion Estimation For Adaptive OFDM Systems… 36

2.7 Methods for OFDM Synchronization…………..………. 37

2.7.1 OFDM Synchronization Based on Devoting
Specific Training Symbols……………………………….. .. 38

2.7.2 Synchronization Frame Structure ………..…………… .. 41

2.7.2.a Rough Timing Recovery Method …..……………… .. 43

2.7.2.b Steps of Rough Timing Recovery Method………… .. 44

2.7.2.c Advantages of Using Frame Synchronization Method. .. 45

2.7.3 Synchronization Techniques in the Continuous Mode
Burst Packet Mode Transmission Systems…………………… … 46

2.7.3.a Coarse Symbol Timing in Continuous
Transmission Mode…………………………………………… 47

2.7.3.b Fine Symbol Timing in Continuous
Transmission Mode……………………………………………. 47

2.7.4 Symbol Timing Synchronization in Burst Packet Mode… 47

2.8 Frequency Offset Estimation………………………………… 48

2.8.1 Frequency Offset Estimation Using Specific
Training Symbols…………………………………………………… 49

2.8.2 Frequency Offset Estimation in Continuous Mode and
Burst Packet Mode…………………………………………………. 50

2.8.2.a Integer Carrier Frequency Offset………………………. 51

2.8.2.b Coarse Decimal Carrier Frequency Offset…………….. 52

2.8.2.c Fine Decimal Fine Frequency Offset…………………... 52

2.8.2.d Carrier Frequency Offset Control Mode………………. 53

2.8.2.e Carrier Frequency Offset in Burst Packet
Transmission Mode………………………………………………. 53

2.9Frequency Offset in General………………………………. 53

Chapter 3……………………………………………………….... 56

OFDM System Implementation and Results……………………… 56

3.1 Introduction…………………………………………………….. 56

3.2 Building OFDM Transmitter………………………………… 58

3.3 Building ODFM Receiver…………………………………… 61

3.4 Results of Simulation……………………………………….... 64

3.4.1Constellation Diagram of QPSK Modulator……………… 65

3.4.2 Correct Removing of Cyclic Prefix……………………… 66

3.4.3 The Transmitted OFDM Signals………………………… 68

3.5 The Effect of Delayed Channel on
The received OFDM Symbols………………………………… … 69

3.6 The Effect of Frequency Offsets on
the Received OFDM Symbols …………………………………… 72

3.7 The Effect of Different Cyclic Prefix Length on

The Correlation Results…………………………………………….. 77
3.8 The VHDL Code of OFDM Transceiver………………….. . 80
3.9 The VHDL Code for QPSK Demodulator………………… . 85
3.9.1 HDL Code for QPSK demodulator…………………….. . 85
3.9.2 HDL Code for QPSK Modulator……………………… 87
3.9.3 OFDM System Package…... 88
3.9.4 OFDM System (Transceiver)……………………………. 88
Chapter 4…………………………………………………………… 95
Conclusion and Future work ……………………………. 95
Appendix A………………………………………………………… 97
Basic Mathematics Used in OFDM System………………... 97
A.1 Introduction…………………………………………………….. 97
A.2 Fourier Transforms and its inverse……………………….. 97
A.2.1 Fourier Transforms Properties Under
Different Cases of f(t)……………………………………………… 100
A.2.2 Fourier Transform is Complex if f(t) is Real in General.. 100
A.2.3 Fourier Transform is Real and Even if f(t) is Even……. 100
A.2.4 Fourier Transform is Imaginary and Odd if f(t) is Odd... 101
A.2.5 Fourier Transform is Complex if f(t) is Imaginary…….. 101
A.2.6 Fourier Transform is Imaginary and
Even if f(t) is Imaginary and Even…………………………….. 102
A.2.7 Fourier Transform is Real and Odd if f(t) is
Imaginary and Odd…………………………………………….. 103
A.3 General Properties of Fourier Transform………………… 103
A.3.1 Linearity……………………………………………….. 103
A.3.2 Symmetry………………………………………………. 104
A.3.3 Time Scaling…………………………………………… 104

A.3.4 Time Shifting…………………………………………… 105
A.3.5 Frequency shifting……………………………………… 105
A.4 QPSK Modulation…………………………………………. 105
A.5 Cross Correlation Function………………………………..… 111
A.6 Signal Parameter Estimation……………………………… 112
A.7 The Likelihood function………………………………….. 113
A.8 Maximum Likelihood Carrier Phase Estimation…………. 114
References…………………………………………………….. 115

List of Abbreviations

WBMSC	Wireless Broad Band Multimedia Communication System
Mbps	Mega Bits Per Second
ISI	Inter Symbol Interference
OFDM	Orthogonal Frequency Division Multiplexing
FDM	Frequency Division Multiplexing
IEEE	Institute of Electrical and Electronics Engineering
WLAN	Wireless Local Area Network
MBWA	Mobile Broadband Wireless Access
GHZ	Giga hertz
ADSL	Asymmetric Digital Subcarrier Line
DAB	Digital Audio Broadcasting
MAC	Media Access Control
PHY	Physical layer
PLCP	Physical Layer Convergence Protocol
PSDU	Payload
BPSK	Binary Phase Shift Keying
WMAN	Wireless Metropolitan Area Network
BWA	Broadband Wireless Access
MIMO	Multiple Input Multiple Output
QoS	Quality of Service
LOS	Line of Site
NLOS	Non Line Of Site
QPSK	Quadrature Phase Shift Keying
QAM	Quadrature Amplitude Modulation
FFT	Fast Fourier Transform
IFFT	Inverse Fast Fourier Transform

CP	Cyclic Prefix
RF	Radio Frequency
TDMA	Time Division Multiple Access
FDMA	Frequency Division Multiple Access
CDMA	Code Division Multiple Access
OFDMA	Orthogonal Frequency Division Multiple Access
DFT	Discrete Fourier Transform
BER	Bit Error Rate
ICI	Inter Carrier Interference
ZP	Zero Prefix
WiMAX	Worldwide Interoperability for Microwave Access
SNR	Signal to Noise Ratio
CIR	Channel Impulse Response
PN	Pseudo Number
DAB	Digital Audio Broadcasting
DVB-T	Digital Video Broadcasting
MLE	Maximum Likelihood Estimation
AWGN	Additive White Gaussian Noise
DA	Data Aided
NDA	Non Data Aided
CFO	Carrier Frequency Offset
HDL	Hardware Description Language
FPGA	Field Programmable Gate Array
RS	Reed Solomon

List of symbols

Ts	Sampling time
t	Channel delay spread
L	Number of lower rate sub-streams
Bc	Coherent bandwidth
Tb	Original bit rate
B	Bandwidth of single carrier transmission
Tg	Guard band time interval
h	Channel impulse response
σ^2	Noise power
N	Total number of points processed by DFT or IDFT
n	Sample index of carrier
k	Number of cycles of N points
R	High data rate stream
τ	Timing offset
Tm	Maximum channel delay spread
Ng	Number of samples in guard interval
rm	The received OFDM signal
C(n)	Cross correlation values
D	The amount of delay through transmission
P(n)	The received signal energy
M(n)	Timing metric
δf	Carrier frequency offset
Δf	Frequency spacing
f(t)	Signal in time domain
F(f)	Signal in frequency domain
fs	Sampling frequency
θ	Phase shift