

### **Efficient Multiple Access Technique for Future Generation Wireless Systems**

#### A Thesis

Submitted in partial fulfillment for the requirements for the degree of Doctor of Philosophy in Communications Engineering (Electronics and Communications Engineering)

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#### **Statement**

This dissertation is submitted as a partial fulfillment of the degree of Doctor of Philosophy in Electrical Engineering (Electronics and Communications Engineering), Faculty of Engineering, Ain Shams University.

The author carried out the work included in this thesis and no part of it has been submitted for a degree or a qualification at any other scientific entity.

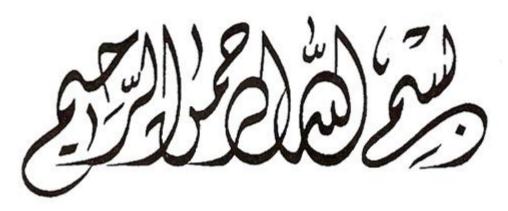
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" يرفع الله الذين امنوا منكم والذين أوتوا العلم درجات والله بما تعملون خبير "

صدق الله العظيم

الآية (١١) سورة المجادلة

### Acknowledgements

First and foremost, I would like to thank **ALLAH**, the Almighty for the great help during my whole life.

In memorial of *Professor Adel El-Henawy*, may ALLAH have mercy with him, I would like to thank him for his continuous encouragement and support during the period he worked with me before his death.

I would like to express my honest thanks and appreciation to my supervisors: *Professor Abdelhalim Zekry, Professor Salah Elagooz* and *Professor Fathi Abdelsamie* for their valuable guidance, support and suggestions. Their encouragement helped me overcome the difficulties I have encountered throughout my research. It has been a pleasure working under their supervision and will be a valuable memory in my life.

I would also like to thank my family for their constant love and support. I would not be the person I am without their influence and back up. My true love goes to my *father and mother*.

I am also especially grateful to *my wife* and my daughters *Rolan* and *Rovan* for their kindness, support, and encouragement, which provided the necessary enthusiasm to accomplish this thesis. This thesis is a dedication for their love.

#### **List of Publications**

- 1. **M. A. Abd El-Hamed**, Abdelhalim Zekry, Salah S. Elagooz and Fathi E. Abd El-Samie "Blind Selective Mapping for Single-Carrier Frequency Division Multiple Access System" Digital Signal Processing, 75 (2018) 25–37, 2018, Elsevier. (**IF=2.33**).
- M. A. Abd El-Hamed, Abdelhalim Zekry, Salah S. Elagooz, and Fathi E. Abd El-Samie, "Impact of Power Amplifier non-linearity on Blind Selective Mapping for SC-FDMA System" Japan-Africa Conference on Electronics, Communications and Computers (JAC-ECC 2017), Hilton Alexandria Green Plaza, Alexandria, Egypt 18-20 Dec. 2017.
- 3. **M. A. Abd El-Hamed**, Abdelhalim Zekry, Salah S. Elagooz and Fathi E. Abd El-Samie "All Pass Filter Approach for Single-Carrier Frequency Division Multiple Access System" International Journal of Communication Systems, Wiley. (**Revision**).

#### **Abstract**

Next generation of wireless mobile communication system will allow the provision of advanced multimedia services with ubiquitous access thanks to the higher data rates offered. However, it is necessary for the transmission technologies to be able to cope with problems deriving from high data rate transmission over wireless channels.

Hitherto, Orthogonal Frequency Division Multiplexing has been the most widely used multiplexing technique due to its robustness against frequency selective fading channels that highly encounter in mobile transmission. However, it suffers from High Peak-to-Average Power Ratio which may be particularly troublesome in uplink transmission because of the costly high power amplifiers that are needed in the user terminals.

Single Carrier-Frequency Division Multiple Access has become an alternative technique to the Orthogonal Frequency Division Multiple Access due to its low Peak-to-Average Power Ratio. It was chosen as the uplink multiple access scheme in the 3<sup>rd</sup> Generation Partnership Project Long Term Evolution. However, Single Carrier-Frequency Division Multiple Access still suffer from high Peak-to-Average Power Ratio in the uplink transmission which results in reducing power efficiency of the system. As a result there is a need to reduce the Peak-to-Average Power Ratio of the Single Carrier-Frequency Division Multiple Access system.

In this thesis many theoretical foundations of Single Carrier-Frequency Division Multiple Access have been introduced. The performance of the Single *ABSTRACT* ix

Carrier-Frequency Division Multiple Access system has been studied and enhanced by applying two proposed techniques for reducing the Peak-to-Average Power Ratio namely Blind-Selective Mapping and All Pass Filters schemes. Different factors and parameters are taken into consideration and many comparisons have been made to clarify the obtained results. Results show that the proposed Blind-Selective Mapping Single Carrier-Frequency Division Multiple Access scheme provides better performance compared with the traditional Single Carrier-Frequency Division Multiple access scheme. Also, in comparing the performances of the two proposed Peak-to-Average Power Ratio reduction schemes, results shows that the All Pass Filters Single Carrier-Frequency Division Multiple Access provides better performance in terms of the Peak-to-Average Power Ratio. Many other results are given in the thesis.

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#### List of Abbreviations

1G First Generation

2G Second Generation

3G Third Generation

3D Three Dimensional

3GPP Third Generation Partnership Project

4G Fourth Generation

5G Fifth Generation

A/D Analog-to-Digital

ACE Active Constellation Extension

AMPS Advance Mobile Phone Service

AM/AM Amplitude/Amplitude

AM/PM Amplitude/Phase

APFs ALL Pass Filters

APFs-SC-FDMA SC-FDMA system based on APFs

ASE Active Set Extension

AWGN Additive White Gaussian Noise

BER Bit Error Rate

BS Base Station

B-SLM Blind Selective Mapping

B-SLM-SC-FDMA Blind Selective Mapping scheme for SC-FDMA

B-SLM-SC-IFDMA SC-IFDMA based on B-SLM

B-SLM-SC-LFDMA SC-LFDMA based on B-SLM

CCDF Complementary Cumulative Distribution Function

CCRR Computational Complexity Reduction Ratio

CDMA Code Division Multiple Access

CFOs Carrier Frequency Offsets

CL Clipping Level
CP Cyclic Prefix

CR Clipping Ratio

C-SLM Conventional Selected Mapping

C-SLM-SC-LFDMA SC-LFDMA based on C-SLM

D/A Digital-to-Analog

DFDMA Distributed Frequency Division Multiple Access

DVB Digital Video Broadcasting

dB Decibel

FDE Frequency Domain Equalization

EDGE Enhanced Data Rates for GSM Evolution

FFT Fast Fourier Transform

FBMC Filter Bank Multicarrier

FDMA Frequency Division Multiple Access

GA Genetic Algorithm

GFDM Generalized Frequency Division Multiplexing

GPRS General Packet Radio Service

GSM Global System for Mobile

HD High Definition

HPA High Power Amplifier

HSPA High Speed Packet Access

IP Internet Protocol

I/Q In-phase/Quadrature-phase

IAI Inter-Antenna Interference

IBI Inter-Block Interference

IBO Input Back-Off