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**A MULTI-CARRIER CDMA MOBILE COMMUNICATIONS
SYSTEM EMPLOYING PRE-RAKE AND DIVERSITY**

By

B18330

Fatma Abd El-Karim Kamel Newagy

**A Thesis Submitted to the
Faculty of Engineering at Cairo University
in Partial Fulfillment of the
Requirements For the Degree of
MASTER OF SCIENCE
in
ELECTRONICS AND COMMUNICATIONS**

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GIZA, EGYPT

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Dr. Hebatallah M. Mourad

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Approved by the
Examining Committee:

Prof. Dr. Emad K. Al-Hussaini

Main advisor

E.K. Al-Hussaini

Dr. Hebat-allah M. Mourad

Advisor

Hebat-Allah Mourad

Prof. Dr. Salwa H. El-Ramly

Member

Salwa El-Ramly

Prof. Dr. Magdi Fekry

Member

[Signature]

**FACULTY OF ENGINEERING, CAIRO UNIVERSITY
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Abstract

In this thesis a combination of orthogonal frequency division multiplexing (OFDM) and code division multiple access (CDMA) has been proposed for application in a mobile personal communications system. This is called Multi-carrier (MC) CDMA system. It combines a high spectral efficiency with an immunity to channel dispersion. Furthermore, instead of building a rake receiver in the mobile unit (MU), the base station (BS) can pre-rake the signal before transmission in the downlink using the channel impulse response estimated from the uplink. The mobile unit uses a conventional receiver and still achieves approximately the same performance as in the case of the rake receiver. For further improvements, dual transmitter diversity is employed to combat fading. Theoretical and simulation results are obtained for the system under consideration. Depicted results show appreciable improvements when compared with those previously considered in the literature.

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Symbols & Abbreviations

Symbols

$a_k(t)$	The Pseudo noise (PN) code for user k .
$\beta_{k,\ell}$	The channel gain for path ℓ and user k .
$\beta_{k,m,\ell}$	The channel gain for path ℓ and subcarrier m and user k .
$b_k(t)$	The data stream for user k .
$b_{i,m}$	The input data at time instant i and subcarrier m .
$C_{k,l}(m)$	The discrete aperiodic cross-correlation function between users k, l .
$h_k(t)$	The complex low-pass impulse response of the channel for user k .
$h_{k,m}(t)$	The complex low-pass impulse response of the channel for user k and subcarrier m .
K	The total number of users.
L	The number of channel paths.
M	The number of subcarriers in multi-carrier systems.
N	The spreading factor of spread spectrum systems.
$n(t)$	Zero mean additive white gaussian noise (AWGN) with two sided power spectral density $N_0/2$.
P	The transmitted power.
$r_k(t)$	The received signal at user k .
$r_{k,m}(t)$	The received signal at user k and subcarrier m .
$r^{th}(t)$	The received signal from the transmitted j^{th} antenna.
$S_k(t)$	The down-link transmitted signal for user k .
$S_{k,m}(t)$	The down-link transmitted signal for user k and subcarrier m .
T	The data bit duration.
T_s	The data symbol duration.
T_c	The pseudo noise (PN) code chip duration.
T_{CP}	The length of cyclic prefix.
T_o	The OFDM symbol duration.

U_k	The normalizing factor that keeps the instantaneous transmitted power constant regardless of the number of channel paths.
$\gamma_{k,\ell}$	The channel phase for user k and channel path ℓ .
$\gamma_{k,m,\ell}$	The channel phase for user k and channel path ℓ and subcarrier m .
ω_m	The orthogonal frequency of subcarrier m .
Y_i	The SNR for one branch from the transmit antenna i .

Abbreviations

ADSL	Asymmetric Digital Subcarrier Lines.
AWGN	Additive White Gaussian Noise.
BER	Bit Error Rate.
BPSK	Binary Phase Shift Keying.
BS	Base Station.
CDMA	Code Division Multiple Access.
CP	Cyclic Prefix.
DAB	Digital Audio Broadcasting.
DFT	Discrete Fourier Transform.
DS-SS	Direct Sequence Spread Spectrum.
DVB	Digital Video Broadcasting.
ETSI	European Telecommunications Standards Institute.
FDM	Frequency Division Multiplexing.
FFT	Fast Fourier Transform.
HDSL	High-bit-rate Digital Subcarrier Lines.
HDTV	High-definition Television.
ICI	Inter Carrier Interference.
IFFT	Inverse Fast Fourier Transform.
ISI	Intersymbol Interference.
LAN	Local Area Network.
MAI	Multiple Access Interference.
MC-CDMA	Multi-carrier CDMA.