

# Novel Codes Family for Modified Spectral-Amplitude-Coding OCDMA Systems and Performance Analysis

Mohammad Noshad, *Student Member, IEEE*, and Kambiz Jamshidi

**Abstract**—In this paper a novel family of codes for modified spectral-amplitude-coding optical code division multiple access (SAC-OCDMA) is introduced. The proposed codes exist for more number of processing gains comparing to the previously reported codes. In the network using these codes, the number of users can be extended without any essential changes in the previous transmitters. In this study, we propose a construction method for these codes and compare their performance with previously reported codes.

**Index Terms**—Optical Code Division Multiple Access (OCDMA), Spectral amplitude coding, Ideal cross-correlation codes, Multi-User Interference (MUI)

## I. INTRODUCTION

MULTI-USER interference (MUI) is the main performance degrading impairment in optical code division multiple access (OCDMA) systems. So most efforts in this area have concentrated on decreasing the bit error rate (BER) due to the MUI and consequently to increase the number of active users. In a spectrally amplitude coding OCDMA (SAC-OCDMA) system, the effect of MUI is reduced by utilizing codes with fixed in phase cross-correlation [1]. In this scheme a spectral encoding has been applied on the output of a broadband source. Some receivers have been proposed for the spectral amplitude OCDMA systems, but in all of them the system performance is degraded because of incoherency of the received light fields. Indeed in these systems the main limit on the system performance is imposed by the phase induced intensity noise (PIIN) originated from the incoherency of the light sources. The incoherent light fields that were mixed and incident upon a photodiode, causes a phase noise which lead to an intensity noise. In the square-law detection the phase of the received signal in different frequencies is not considered and therefore beating occurs among each spectral component through the square-law detection. The effect of the interference between incoherent sources on the SAC systems performance degradation is indicated in [2].

Another problem of the SAC-OCDMA systems is the limitation on the existing codes. The codes introduced for

SAC-OCDMA exist for only some special integer numbers. Hence in SAC systems the trends are toward two main aims: 1) Providing codes which exist for a wide integer numbers and 2) Reducing the PIIN. A code with length  $F$ , weight  $w$  and in-phase cross-correlation  $\lambda$  is denoted by  $(F, w, \lambda)$ . In spectral amplitude codes the code-length is equal to the number of the frequency bins. When  $\lambda = 1$ , we say the code has ideal in-phase cross correlation.

In this manuscript we present a novel family of codes for modified SAC-OCDMA systems, which gives more flexibility in the selecting of the code length. These codes can be extended in length while their weight is constant and so for increasing the number of users there is no necessity to change all of the transmitter and receiver structures. In addition the construction of these codes is easy comparing to the previous codes. A simple method based on basic mathematics for designing of the codes, is offered in this paper and the structure of two-weight codes is presented using this technique. Furthermore in this paper the exact values of the mean and variance of the decision variable is calculated using combinations and then utilizing the Gaussian approximation the performance analysis of these codes is attained with good approximation. Performance of the proposed codes has been analyzed and compared with that of previously reported codes.

The rest of the paper is organized as follows. Section II is concerned on the principles of spectral amplitude OCDMA systems. In section III the code construction is studied and the structure of two-weight codes is derived. In section IV we analyze the performance of the proposed codes. In section V we give some numerical results and compare them with the simulation outcomes and finally, conclusions are drawn in section V.

## II. PRINCIPLES OF THE SPECTRAL AMPLITUDE CODING

The spectral amplitude codes are the codes which spread in the wavelength domain as shown in Fig.1. Each code-word is



Fig.1. Scheme of spectral amplitude coding

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# Comprehensive Performance Analysis Of Dw Code Family For Sac Ocdma

**Rima Matem**



## **Comprehensive Performance Analysis Of Dw Code Family For Sac Ocdma:**

Comprehensive Performance Analysis of DW Code Family for SAC-OCDMA Muthana Kydir, 2014-11-25 The performance of a realistic optical code division Multiple Access OCDMA network have been evaluated with PIN and APD receivers also evaluated with NRZ and RZ transmitters This compassion has been carried out including realistic system parameters as chromatic dispersion Multiple Access Interference MAI receiver noises dark current short noise and receiver thermal noise and photodiode bandwidth We analyze the error probability of the network taking into account these parameters The data formats used to modulate the carrier light wave in modern optical communication system is vital to achieving good system performance The RZ improvements have been studied in several publications for a limited set of parameters such as fiber length duty cycle The earlier generations of OCDMA which was based on direct conversion from electrical to optical domain was complicated and impractical However the advent of Optical Spectral Amplitude Coding OSAC Scheme with simpler approach has revived the viability of this technology Modified Double Weight MDW and Enhanced Double Weight EDW are the two codes proposed to overcome the limitations of existing codes at a reduced cost *Development of Novel OCDMA Codes for FTTH Network*, 2013 The aim of this research is to develop a new family of codes for the spectral amplitude coding SAC Optical Code Division Multiple Access OCDMA which can be superior to the performance of SAC OCDMA systems

*Development of New Two Dimensional ZCC/MD Spectral/spatial Code for OCDMA System* Rima Matem, 2019 The scope of this study is considered with improving the capability of 2D code by using spectral spatial methods to enhance performance and suppress the influence of the MAI effect in the incoherent SAC OCDMA system The scheme used is based on a spectral and spatial encoding decoding process Each user will be allocated a hybrid signature code where the optical pulses will be first encoded in the spectral domain using the ZCC code scheme and later the MD code will be encoded in the spatial domain The serious issues to be addressed when designing the code in the OCDMA system with satisfactory performance are that the correlation properties and the number of users can be supported Hence to demonstrate the potential of this approach and its suitability for application the mathematical derivation is investigated Some parameters are simulated such as SNR and BER under the effects of the number of active users the effective power and receivers noises The simulation analysis is included to validate the theoretical findings using the software version 7.0

## **2-D Extended EDW : the New Scheme of Two Dimensional Wavelength-time Coding for Optical Code Division Multiple Access System**

Nurolhuda Mohd Noor, 2016 In OCDMA system designing a successful code for isolating the users is one of the main issues that has to be tackled due to its importance to mitigate the deleterious effect of MAI The research presented in this thesis focuses on the code design of incoherent 2 D spectral temporal SAC OCDMA system namely 2 D Extended EDW code Fig 1.1 illustrates the scope of the research it is shown that the research will be focus on the family of Spectral Amplitude Coding SAC codes and used wavelength time or spectral temporal technique to perform 2 D coding in OCDMA system

Performance Analysis and Comparison of Walsh-Hadamard and Related Orthogonal Codes Used in CDMA Rong Jin, 2004

**Performance Analysis of Code Divisionmultiple Access Systems with Spread Spectrum Phase Modulation**

**Using MODSIM** J. K. Potts, S. Shepherd, Brian G. West, European Space Agency, Marconi Research Laboratories, 1976

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