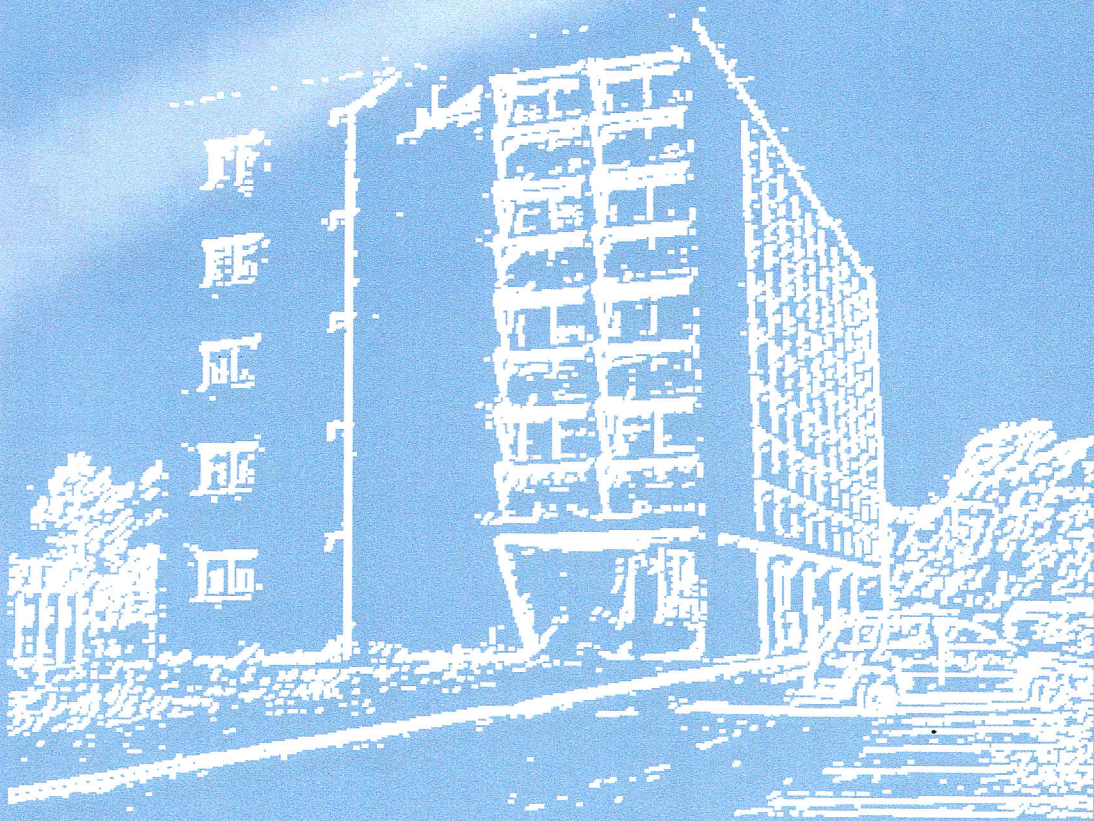# SEON 2006

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Characterization of a FBGs Based Coder/Decoder for an Optical Code Division Multiple Access System

L. Vesce, A. Teixeira, G. M. Tosi Beleffi, R. Nogueira, and P. André

Abstract—The authors present the study and characterization of a Fiber Bragg Gratings (FBGs) array that can be used to implement a simple 2D Optical Code Division Multiple Access (OCDMA) system. Time and wavelength code is generated directly by the positioning of the gratings inside. The complete FBGs characterization in terms of magnitude grating peaks, group delay and chromatic dispersion is needed and presented.

Index Terms—Fiber Bagg gratings, optical code division multiple access , optical fiber communication.

I. INTRODUCTION

THE growth of Internet use has lead to rapid deployment of Wavelength Division Multiplexed (WDM) transmission systems. However, to fully explore the available bandwidth of fibers new techniques need to be explored (e.g. reconfogurable code-generator for phase encoding applications in OCDMA systems based on a 40mm long uniform Bragg grating [1]).

In order to increase the functionality of the future optical networks, research has moved its focus among many subjects, within them OCDMA. The latest is a spread spectrum technique that permits a large number users to share the same transmission bandwidth, having granted a unique address code [2].

Some peculiar features of the OCDMA are: improvement of system security, crosstalk performance, and allows asynchronous operations; flexible bandwidth management, and more network scalability.

Some approaches to provide OCDMA code tunability have been studied, e.g. implementations based on optical waveguide [3], [4] or on arrays of discrete fiber delay [5]. These approaches have the disadvantages of high fabrication complexity and cost.

In this work, a simple and off-the-shelf coder/decoder based on simple and well-known technology of the FBGs is presented and characterized.

This paper is organized as follows: in Section II (A.) the

L. Vesce, A. Teixeira, R. Nogueira, and P. André are with Instituto de Telecomunicacoes, University of Aveiro, Aveiro-Portugal (e-mail: vesce@av.it.pt, teixeira@ua.pt, rnogueira@av.it.pt, pandre@av.it.pt).

G. M. Tosi Beleffi is with ISCOM (Istituto Superiore delle Comunicazioni), Rome-Italy (e-mail: giorgio.tosibeleffi@comunicazioni.it).

working principle of OCDMA based on FBGs is presented; following (B.) is a description of the FBGs characterization results (gain/loss ratio, group delay and chromatic dispersion). In Section III the final considerations are presented.

II. APPROACH AND MEASUREMENTS

A. OCDMA based on FBGs

A FBG is a periodic or aperiodic perturbation of the effective absorption coefficient and/or the effective refractive index of an optical waveguide [6]. FBGs have low insertion losses and are compatible with existing optical fibers used in telecommunication networks. They allow low-cost manufacturing of very high quality wavelength-selective optical devices. Phase masks used to photo-imprint the gratings allow a manufacturing process relatively simple, flexible, low-cost and large-volume suitable.

The coder/decoder working principle is described. A set of wavelengths pulses at the input of an optical circulator, where, in the bidirectional arm, the FBGs array with the desired addressed wavelengths are placed [7]. At the output of the circulator there will appear a spread of the input pulses in time and wavelength according to the coder dimensioning. To realize the matched decoder, the FBGs bidirectionality feature is used, and the device whould be put in the reverse position. With this action the reverse time delays in the required wavelengths is obtained.

B. FBGs characterization
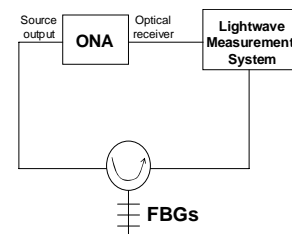
In Fig. 1 is presented the measurement set-up.

Fig. 1. OCDMA FBGs characterization set-up.

The ONA (Optical Network Analyser) source output is connected to an optical circulator that directs the light to the FBGs coders. At the output of the circulator, the FBGs reflected spectrum appears and enters the ONA input through

a lightwave measurement system.

In Fig. 2 is reported the code magnitude response. The three FBGs can be located by identifying the smaller insertion loss wavelengths: FBG1@1546.42nm, FBG2@1547.23nm, and FBG3@1549.50nm. The spacing can be calculated and are 0.81nm and 2.27nm, in an increasing wavelength observation. This corresponds approximately to a 1, 2, 4 code in the wavelength.
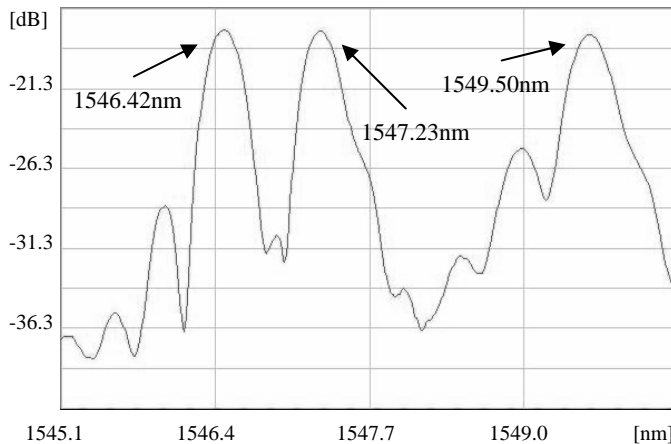

Fig. 2. Magnitude response of the coder with a resolution of 0.01nm.

In Fig. 3 the Group Delay (GD) is presented and will allow the determination of the time coding. The time code is therefore not following the same coding scheme of the wavelength: 1, 4, 2.
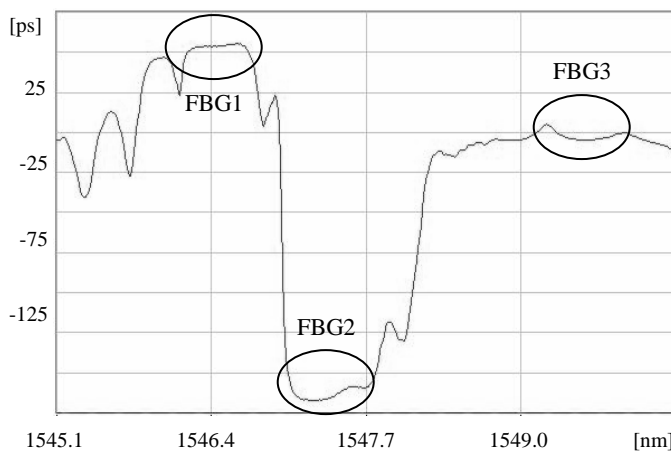

Fig. 3. Group delay of the coded gratings. The resolution is of 0.01nm.

We can calculate the respective position of the FBGs by using the time spacing between the gratings (Fig. 4).
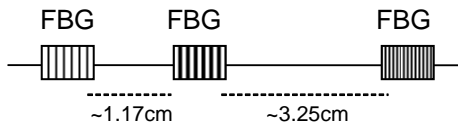

Fig. 4. FBGs location inside the fiber.

In order to asses the quality of the passbands of the engraved FBGs, the Chromatic Dispersion (CD) behaviour (Fig. 5) was also characterized. As it can be seen there is no significant dispersion difference between the three FBGs.
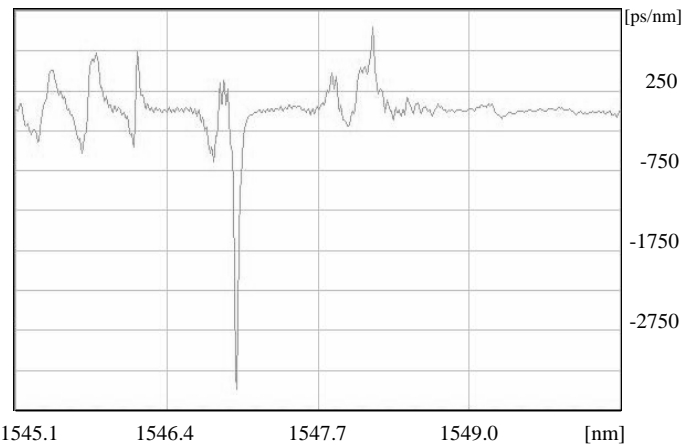

Fig. 5. Chromatic dispersion of the coded FBGs with a resolution of 0.01nm.

III. CONCLUSION

We have reported a complete characterization of a FBGs coder/decoder useful to realize spectral CDMA with programmable encoding. With a simple and right tuning of the FBGs we can change the wavelength code and so fully exploit the OCDMA flexible code provisioning system. By characterizing the coder magnitude, GD, and CD the placement of the FBGs could be determined.

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