Design of a Fiber Bragg Grating for Decoding DPSK Signals

L.A. Vazquez-Zuniga, P. Petropoulos and D.J. Richardson

Optoelectronics Research Centre, University of Southampton, United Kingdom.
Email:lavz@orc.soton.ac.uk, pp@orc.soton.ac.uk.

ABSTRACT

We present the design of a Fiber Bragg Grating (FBG) to demodulate signals of a Differential Phase Shift Keying (DPSK) modulation format at a bit rate of 10 Gb/s.

1. INTRODUCTION

DPSK is a modulation format in which the information is carried in optical phase changes between bits. DPSK exhibits several advantages in long haul telecommunication systems over other conventional modulation formats, such as a higher sensitivity at the receiver. However one of its main disadvantages relates to its complex receiver structure, which includes delay interferometers and balanced-photoreceivers [1]. In this work, a FBG is designed as a means of decoding DPSK signals, potentially offering significant advantages, such as compactness, ready fiber integration, and low-cost fabrication.

2. FBG DESIGN

The design of the device is based on the technique of pulse shaping with FBGs operating in the weak grating limit [2]. In this operating regime, the impulse response *h(t)* of a FBG is given by the inverse Fourier transform of its frequency response *H(ω),* which is also related to the complex form of the refractive index modulation profile of the grating.

$$h(t) = \int_{-\infty}^{+\infty} H(\omega) e^{-jwt} \, d\omega. \qquad (1)$$

In order to perform decoding of DPSK signals, an FBG will act as a device which compares the optical phases between two consecutive bits. For this, the impulse response of the grating, *h(t),* will be formed by two pulses of 100ps width having a π phase difference between them. The reflected optical response in the frequency domain *Y(ω)* (the demodulated signal) to a pulse of a finite time duration *X(ω),* in this case the DPSK signal is given as the product of the incident signal *X(ω)* with the impulse response of the grating *H(ω)* [2]*:*

$$Y(\omega) = H(\omega) X(\omega) \qquad (2)$$

3. NUMERICAL SIMULATIONS

Our simulations were carried out in Matlab. A sequence of NRZ bits at a bit rate of 10 Gb/s were encoded in the DPSK format. The DPSK signal spectrum *X(ω),* was multiplied by a hypothetical FBG impulse response *H(ω),* modeled following the specifications mentioned in the previous section. This process was iterated by modifying the output *Y(ω)* to result in a more suitable signal in terms of intersymbol interference and spectral bandwidth. The improved signal, together with *X(ω),* were used to determine an apodization profile for the grating (Fig.1a). Fig.1b shows the simulation of a 7-bit DPSK sequence decoded using this FBG.

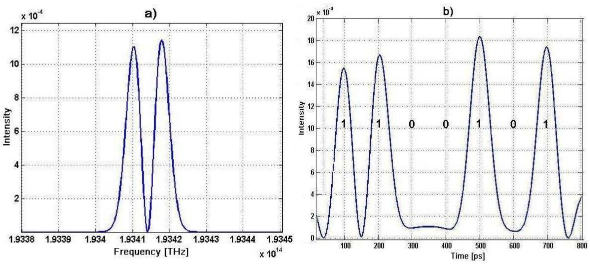

Fig. 1: a) FBG Reflectivity *H(ω)* and b) Signal obtained at the output of the fiber Bragg grating . Original signal: 1100101, DPSK *X(ω)* 0π000ππ0.

4. CONCLUSION

The design of a FBG for decoding DPSK signals was presented. The demodulation is done by comparing the phases of two consecutive bits inside the FBG structure. An FBG with a suitable impulse response has been designed, and our simulations show a correct demodulation of the DPSK signal. Issues associated with the design and performance of the FBG will be discussed during the presentation of the paper.

ACKNOWLEDGEMENTS

The work of L.A. Vazquez-Zuniga is sponsored by CONACyT.

REFERENCES

[1] A.H. Gnauk et al., JLT, vol. 23, No. 1, 2005.
[2] P.Petropoulos et.al, JLT, Vol. 19, No. 5, 2001.