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An all-optical feedback loop based frequency encoded data-storing unit by EDFA

Baishali Sarkar
B.N. Mahavidyalaya, Itachuna, Hooghly, West Bengal, India

Sourangshu Mukhopadhyay
The University of Burdwan, Burdwan, West Bengal, India

ABSTRACT: Erbium Doped Fiber Amplifier (EDFA) is an established and potential optical device which can amplify an optical weak probe signal strongly by the use of a suitable pump beam. This fiber has the main advantage of amplifying as well as modulating an optical signal. There are reported many optical switching operations and systems where EDFA has been used massively. Here a new concept is proposed by the current authors of using an optical feedback loop with the use of an EDFA, for the development of an all-optical and frequency encoded 1 bit latch and n bit memory system. The advantage of the whole system is that it is all-optical in nature and thus it gives superfast operation speed.

1 INTRODUCTION

Nonlinear materials are very much established for the development of several optical switches. Different all optical switching based logic operations, optical modulations, demodulations etc. are proposed by the use of such materials (Esmaeilian *et al.*, 2011, Chakraborty, *et al.*, 2009, Pal, *et al.*, 2009, Bonk, *et al.*, 2012, Johnson, *et al.*, 2010, Kusalajeerung, *et al.*, 2011). Again the nonlinearity of Erbium doped optical fiber is also a promising optical system not only for amplifying an optical signal, but also for switching and modulation purposes (Desurvire, *et al.*, 1987, Chakraborty, *et al.*, 2011, Mahad, *et al.*, 2009). EDFA is an optical fiber doped with erbium, which acts as an amplifier. If a high power pump beam (wavelength of 980 nm or 1480 nm) is mixed with a signal beam (in the wavelength region 1530–1570 nm) and passed through the erbium-doped silica fiber, then after a certain distance the pump power is abruptly dropped and the small power of the signal beam is enhanced strongly (Yariv, 1991, Ghatak, *et al.*, 1999, Desurvire, 1990, Desurvire, 1994). In our proposal we report a process of developing a frequency encoded 1 bit all optical memory unit (latch) by the use of the above property of EDFA. The EDFA was earlier used in optical latch (Chakraborty, *et al.*, 2011). There the role of EDFA was only for amplifying an optical signal. Here in this proposed scheme EDFA is used as an optical switch.

2 FREQUENCY ENCODING PRINCIPLE

In optical data processing and parallel computation several encoding/decoding techniques are seen to be used. For example intensity encoding, polarization encoding, phase encoding and frequency encoding (Garai, *et al.*, 2010, Garai, *et al.*, 2009, Garai, *et al.*, 2010, Ghosh, *et al.*, 2011). These encoding techniques uses certain reference level of a signal to indicate the logic state '1' and '0' for Boolean representation of data. Except the frequency encoding principle all other types of encoding changes the reference level of '1' and '0' during transmission and operation of data. In case of intensity encoding (for example) the value of intensity representing the '1' logic state may be dropped down to the '0' state because of absorption/attenuation of data in the medium during transmission. So the bit error problem may come. On the other hand frequency encoding/decoding has the reliability in encoding of bit, as generally frequency of a signal are not changed in the medium during operation/transmission. That is why a faithful and reliable optical operation can be achieved by frequency encoding process. Here if a particular frequency of light is considered as '1', the frequency of another light is considered as '0' logic state. Several frequency encoded optical logic operations are proposed by scientists and technologists.

3 EDFA AS AN OPTICAL SWITCH

Erbium doped fiber amplifier can be used very successfully for developing an optical switch. Its amplifying character, which is described below can be used for optical switching purpose. If a pump beam of wavelength $\lambda_p = 980$ nm and pump power $P_p = 7$ mw is jointly applied with a probe signal