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PERFORMANCE EVOLUTION OF OPTICAL LINK USING DISPERSION COMPENSATION FIBER & FBG

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ABSTRACT

Major challenge faced by today's telecommunication network is the increasing demand of data rates and better quality signal at longer distance. Communication, which in the past was confined to narrowband voice signals, now demands a high quality visual, audio, and data context. To mitigate this challenge, the only solution is to use optical fiber communication. But even in optical fiber for longer distance communication major problem is the intrusion of nonlinear effects, attenuation, dispersion and scattering. To enhance overall communication link performance and reduce dispersion, different compensation technologies are proposed. In this paper, dispersion compensation scheme is studied. The two techniques which are widely used for dispersion compensations are Dispersion Compensating Fiber (DCF) and Fiber Bragg Grating (FBG) are studied here. The performance is measured in terms of BER, Q-factor and eye diagram.

Keywords: Dispersion, DCF, FBG, Optical, Optisystem, RZ

I. INTRODUCTION

The optical communication link consists of main three sections: transmission, optical channel and receiver section. The signal gets distorted mainly in optical channel. In optical channel there is an intrusion of attenuation, dispersion, scattering and nonlinear effects. Non linear effects can be reduced using different modulation schemes. But to reduce dispersion there are two different dispersion compensating techniques are available: dispersion compensating fiber (DCF) and Fiber Bragg Grating (FBG). The DCF introduces a negative dispersion coefficient. FBG are very attractive components because as well as being passive, linear and compact, retain strong dispersion in both reflection and transmission. In the transmission section, the gratings are placed in the line with the fiber. It will help to achieve the maximum compression ratio. This paper will give an emphasis on the study of dispersion. The rest of the paper is organized as follows; in section II the Dispersion compensating Fiber (DCF) is discussed and in section III a description of Fiber Bragg Grating (FBG) is given. Section IV shows the simulation design of communication system using DCF and FBG using RZ schemes. Section V includes simulation results and comparison and section VI concludes the paper.

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II. DISPERSION COMPENSATING FIBER (DCF)

The DCF introduces a negative dispersion coefficient. The fiber's dispersion can be manipulated by varying the refractive index profile and the relative index value. Very high negative dispersion is achieved by methods like depressed cladding or decreasing the core radius.[1]The length of the optical Single Mode Fiber (SMF) is differed and in agreement with it the length of Dispersion Compensating Fiber (DCF) is additionally changed individually as indicated by the equation,

$$D_{SMF} \text{ X } L_{SMF} + D_{DCF} \text{ X } L_{DCF} = 0_{[2]}$$

Where, D_{SMF} = Dispersion Coefficient of Single Mode Fiber

L_{SMF} = Length of Single Mode Fiber

D_{DCF} = Dispersion Coefficient of Dispersion

L_{DCF} = Length of Dispersion Compensating Fiber

III. FIBER BRAGG GRATING (FBG)

A fiber Bragg grating (FBG) is a type of distributed Bragg reflector constructed in a short segment of optical fiber that reflects particular wavelengths of light and transmits all others. This is achieved by adding a periodic variation to the refractive index of the fiber core, which generates a wavelength specific dielectric mirror. A fiber Bragg grating can therefore be used as an inline optical filter to block certain wavelengths, or as a wavelength-specific reflector. Fiber Bragg Gratings are made by laterally exposing the core of a single-mode fiber to a periodic pattern of intense ultraviolet light.

IV. SIMULATION SET-UP

The optical link is stimulated using Optisystem 13.0 simulation software. In this paper, two dispersion compensating techniques are compared. The optical link consists of three section : transmitter, optical channel and receiver. The transmitter section consists of Psuedo Random Bit Sequence (PRBS) generator followed by RZ pulse generator. The CW laser is used as an optical source having 5dBm power operating at 193.1THz frequency followed by Mach Zehnder modulator. The optical link is made using SMF and dispersion is compensated using DCF or FBG. An amplifier is used to amplify the optical signal in optical channel. TABLE I shows the fiber parameters for simulation. In the receiver section, PIN Photodiode is used followed by a Bessel filter at particular frequency, which is followed by a BER analyzer to get results of the Q- factor, BER and eye diagrams.

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Table I: Simulation Parameters

Parameters	Value
Bit Rate	10 Gbps
Transmission Distance	10 km & 50km
Input Power	5dbm
Frequency	193.1THz
Dispersion Co-efficient of SMF	17 ps/nm/km
Dispersion Co-efficient of DCF	-85 ps/nm/km

V. RESULTS

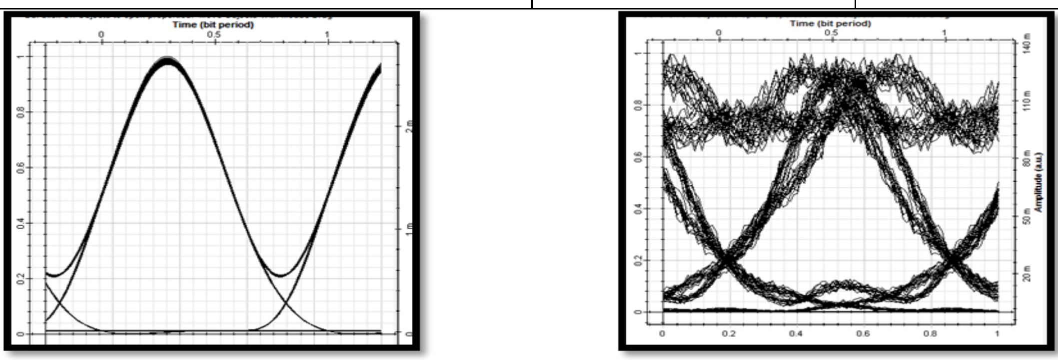
To measure the performance of the optical link, factors like Q-factor, BER and Eye Diagram is taken into consideration. TABLE II shows the readings of Q-factor and BER at 5dBm input power for optical link without compensator and with both compensation.

Table II: Q-factor and BER at 10 km distance

Configuration	Q-factor	BER
Dispersion Compensating Fiber	277.282	0
Fiber Bragg Grating	47.49	0

Table III: Q-factor and BER at 50 km distance

Configuration	Q-factor	BER
Dispersion Compensating Fiber	142.57	0
Fiber Bragg Grating	7.731	5.13E-15



(a) (b)

Figure 1: Eye Diagram @50 km (a)DCF (b)FBG

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VI CONCLUSION

Dispersion is the major problem for a longer distance optical communication system. To compensate dispersion compensating techniques are examined here. The techniques are simulated in optisystem simulation software. The link is operated at 10 Gbps data rate to two valued of distance i.e 10 km and 50 km. From the result it can be concluded that dispersion can be compensated are using DCF and FBG. As the distance increases, the value of Q-factor decreases. By comparing the results it is found that DCF shows better output compared to FBG.

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