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Comparative Analysis In Between Transmission System with or Without FBG in Optical Fiber System

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Abstract *– In optical communication system to compensate dispersion Fiber Bragg grating (FBG) is one of the applicable and important components. Here we are calculating best amount of parameters by simulating the model and then observe the effect of this component in data receiver. To tackle the non linear effects of transmission system Fiber Bragg grating has been employed with optisystem software very length. The analysis based on the chromatic dispersion. An analysis of optical System with FBG and without FBG length of 60 to 80km. We are design without FBG length of 60km which is generate ber 10-9 and Provide best dispersions and with FBG its very up to 80km and achieve best output of the system. We used FBG length 27mm chirp parameter 0.0007. Propagated light in a FBG core which satisfies the Bragg conditions is resonated by grating structure and reflected. The distance between gratings specify the reflected wavelength, so that, reflected light in Bragg wavelength is removed from transmission spectra.*

Keywords*: (DCF) Dispersion Compensating Fiber,(OPC)Optical Phase Conjugator,(FBG)Fiber Bragg Grating.*

I. Introduction

Now a day's communication is major research section. We are work to transmit data in high distance without any noise so we are design different type of system. Optical fiber transmission systems are designed, analyzed and simulated to get long length of fiber. The performance of optical fiber on optical signals is characterized by chromatic dispersion, background loss, polarization mode dispersion (PMD) and nonlinearity. Through an optical fiber, transmit information from one place to another by transmitting light pulses; this method is called fiber-optic communication. Electromagnetic carrier wave is modulated to carry information. In the 1970s first developed, fiber-optic communication systems have transform the telecommunications industry and have played a important role in the advent of the Information Age. A preferable solution is that we can use Dispersion compensating fibers and they can provide broadband dispersion compensation. But there are several drawbacks of using dispersion compensating fiber, such as high nonlinearity and high insertion loss.

We are design two system one is with fbg and another fbg to check the which is best system which is provide best output and cover long distance so finally achieve we work withot fbg only 60 km and after it does not provide proper dispersion and with fbg is give best dispersion in 60 to 80 km. FBG is a type of common single mode fiber that is like a grating. The Bragg conditions satisfied propagated light, in a FBG core is resonated by grating structure and reflected wave. The gratings distance specifies the reflected wavelength, so that, from transmission spectra reflected light is removed in Bragg wavelength. 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 creating a periodic variation in 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. The first in-fiber Bragg grating was demonstrated by Ken Hill in 1978.Initially, the gratings were fabricated using a visible laser propagating along the fiber core. In 1989, Gerald Meltz and colleagues demonstrated the much more flexible transverse holographic inscription technique where the laser illumination came from the side of the fiber.

This instrument performs some operations like reflection and filtering with high efficiency and low loses. Some variations are created in period of gratings (as result variations along the grating in a chirp FBG. There is a delay occurred in wavelength with different time intervals, along the axis the period of grating changes, different wavelengths are reflected by different

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parts of grating. In a communication link chromatic dispersion can be compensated and compression in incident pulse occurred finally. Most important reason to use chirp FBGs than all other suggested types, are cost efficiency and low internal lose nonlinear effects (Isa and Ahmet, 2005).

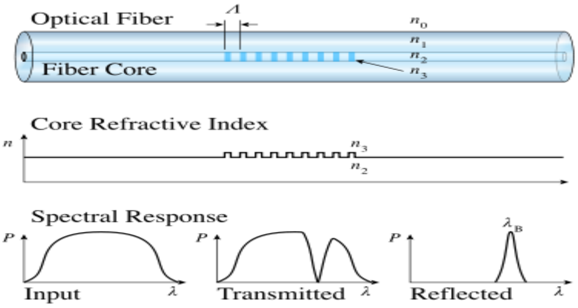

Fig. 1 FBG

II. Theory

As Shown in Figure 1, FBG is there is a enclosement of alternative modulation of refractive index which acts like a wavelength selective mirror. FBGs were firstly percept as a result of strong argon ion laser radiation to a fiber with germanium dope. Afterwards, there so many methods were employed in order to map grating in optical fiber in which comprehensive types of pulsed and continuous lasers were used in visible and ultraviolet region (Raman, 1999; Othonos and Kyriacos, 1999; Marcuse, 1994). As a result according to Bragg wavelength, gratings selectively reflect the propagated light in fiber which is given as follow:

$$\lambda B = 2n\Lambda \qquad (1)$$

In the equation (1), n and Λ are refractive index of core and grating period in fiber, respectively. A uniform grating can be shown as sinusoidal modulation of fiber core refractive index (Martin, 2004):

$$n(z) = ncore + \delta n\,[1 + \cos(\,2\pi z/\Lambda + \varphi(z)\,)] \qquad (2)$$

In which ncore is the core refractive index when it is not radiated and δn is amplitude of induced refractive index variations.

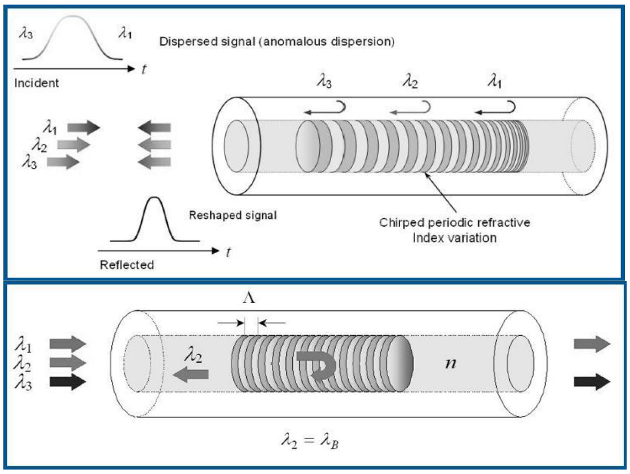

Fig.2 Principle of operation of a FBG

The fundamental principle behind the operation of a FBG is reflection. Where light traveling between media of different refractive indices may both reflect and refract at the interface.

The refractive index will typically alternate over a defined length. The reflected wavelength (λ_B), called the Bragg wavelength, is defined by the relationship,

$$\lambda_B = 2n_e\Lambda \qquad (3)$$

where n_e is the effective refractive index of the grating in the fiber core and Λ is the grating period. The effective refractive index quantifies the velocity of propagating light as compared to its velocity in vacuum. n_eDepends not only on the wavelength but also (for multimode waveguides) on the mode in which the light propagates. For this reason, it is also called modal index.

The wavelength spacing between the first minima (nulls, see Fig. 2), or the bandwidth ($\Delta\lambda$), is (in the strong grating limit) given by,

$$\Delta\lambda = \left[\frac{2\delta n_0 \eta}{\pi}\right]\lambda_B \qquad (4)$$

where δn_0 is the variation in the refractive index ($n_3 - n_2$), and η is the fraction of power in the core. Note that this approximation does not apply to weak gratings where the grating length, L_g, is not large compared to $\lambda_B \setminus \delta n_0$.

The peak reflection ($P_B(\lambda_B)$) is approximately given by,

$$P_B(\lambda_B) \approx \tanh^2\left[\frac{N\eta(V)\delta n_0}{n}\right] \qquad (5)$$

where N is the number of periodic variations. The full equation for the reflected power ($P_B(\lambda)$), is given by,

$$P_B(\lambda) = \frac{\sinh^2\left[\eta(V)\delta n_0\sqrt{1-\Gamma^2}\frac{N\Lambda}{\lambda}\right]}{\cosh^2\left[\eta(V)\delta n_0\sqrt{1-\Gamma^2}\frac{N\Lambda}{\lambda}\right]-\Gamma^2} \qquad (6)$$

where,

$$\Gamma(\lambda) = \frac{1}{\eta(V)\delta n_0}\left[\frac{\lambda}{\lambda_B}-1\right] \qquad (7)$$

II.1. Chirped fiber Bragg gratings

The refractive index profile of the grating may be modified to add other features, such as a linear variation in the grating period, called a chirp. The reflected wavelength changes with the grating period, broadening the reflected spectrum. A grating possessing a chirp has the property of adding dispersion—namely; different wavelengths reflected from the grating will be subject to different delays. This property has been used in the development of phased-array antenna systems and polarization mode dispersion compensation, as well. Grating period and refractive index modulation depth can be controlled to create Chirped FBG with the length of the FBG by using advanced fabrication technique and production facilities. The process of chirped FBG for dispersion compensation was firstly introduced by Quellete and later was demonstrated by Williams et.al. Chirped FBG can be demonstrated as an in-filter broadband reflective optical fiber. Therefore there is a delay occurred to the shorter wavelength, related to longer wavelengths. The entire wavelength in the light pulse should be comes out at the same time so that chirped grating can be designed to equalized or nullified the dispersion in the optical pulse. As shown in Figure 3, different wavelengths are reflected from different parts of grating when a signal enters into chirp. Thus, grating produced a delay related to wavelength of signal. This feature is used for dispersion compensating in communication links.

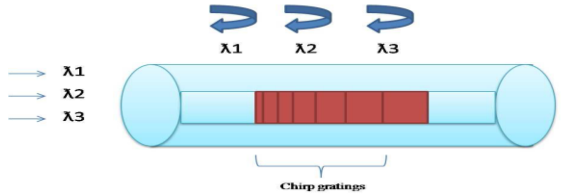

Fig. 3: Chirped fiber Bragg gratings

III. Methodology

1. Simulation Tool (Optisystem simulator)
2. without FBG
3. with FBG.

III.1. Optisystem simulator

Optisystem is software for the testing, optimization and design of any type of optical link in the physical layer of the broad spectrum of optical networks, to local area networks (LANs) and metropolitan area networks (MANs) from long haul systems. Optisystem is complete optical communication system simulation package. In fiber optic communication systems system level simulator is based on the realistic modeling of it, a truly hierarchical definition of components and new simulation environment and systems.

OptiSystem is an optical communication system simulation package for the design, testing, and optimization of virtually any type of optical link in the physical layer of a broad spectrum of optical networks, from analog video broadcasting systems to intercontinental backbones. A system level simulator based on the realistic modeling of fiber-optic communication systems, OptiSystem possesses a powerful simulation environment and a truly hierarchical definition of components and systems. Its capabilities can be easily expanded with the addition of user components and seamless interfaces to a range of widely used tools. OptiSystem is compatible with Optiwave's OptiAmplifier and OptiBPM design tools.

OptiSystem is an innovative, rapidly evolving, and powerful software design tool that enables users to plan, test, and simulate almost every type of optical link in the transmission layer of a broad spectrum of optical networks from LAN, SAN, MAN to ultra-long-haul. It offers transmission layer optical communication system design and planning from component to system level, and visually presents analysis and scenarios. Its integration with other Optiwave products and design tools of industry leading electronic design automation software all contribute to OptiSystem speeding your product to market and reducing the payback period.

III.2. GRATING FABRICATION

Five sets of dispersion compensating gratings (DCG's) were realized at four ITU channels: 1549.32, 1552.52, 1555.75, and 1558.98 nm. The two central wavelengths were fabricated at BT Laboratories while the others at Alcatel. The DCG's were designed to compensate fiber dispersion around 1200 ps/nm corresponding to about 80 km of standard telecom fiber.

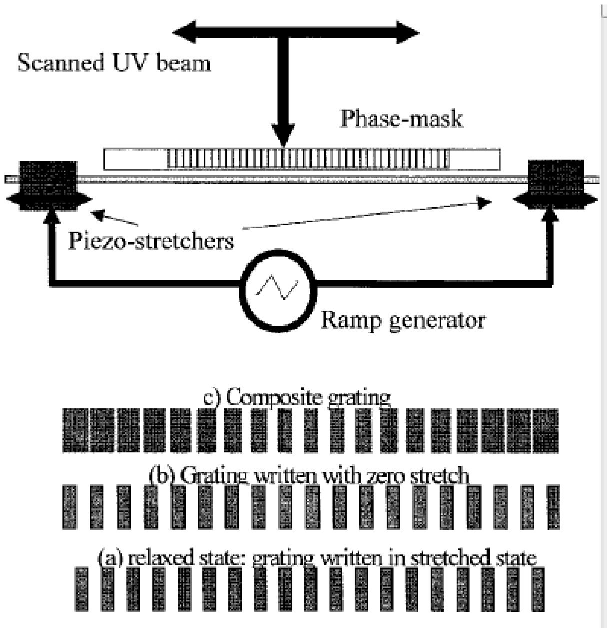

Figure 4 Schematic of the symmetric stretch scheme for writing apodized gratings. (a), (b) Two gratings combined to generate (c) the composite grating. The experimental arrangement is shown immediately above the composite grating.

III.3. Transmission system Use FBG

The transmission system model includes a user defined bit sequence generator, return-zero (RZ), a continuous wave (CW) laser with frequency 193.1 and output power 1MW and an AM modulator. The modulation of signal done with a return-zero user defined sequence in AM modulator. The output of system1 is fed into optical fiber whose length is 80km, dispersion is 16.75ps/km/nm, dispersion slope is 0.050pm/nm2/km, and attenuation index is 0.20km. Now to get a better result or to achieve a better signal the dispersed wave goes into the chirp fiber Bragg grating. The parameters involved in chirp

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FBG are frequency, effective refractive index, length of grating, apodization function, tanh parameter, chirp function. Linear parameter and their values are 193.1THz, 1.45, 6, Tanh, 5, linear and 0.0001 respectively. The amplification of signal done through EDFA amplifier which has a gain amount of 6dB. The receiver side consists of a photo detector (PIN) and eye diagram analyzer.

IV. Result

We design transmission system to achieve best output of optical system each system has best result. We design firstly without FBG system is can provide communication only 60km without dispersion and then we use FBG and very length of optical fiber and we achieve length 80km no more losses. Simulation of transmission system is done by using Chirped Fiber Bragg grating for compensation of dispersion. 10 Gbps data is transmitted for long distance of 70 km. The behavior of the system is defined by Q-factor and bit error rate (BER).By the proposed system the length is increased from 10 km to 70 km along with the increase in the q-factor from 20.0024 to 20.8985 and BER is reduced from 2.61793e-089 to 1.65689e-097.

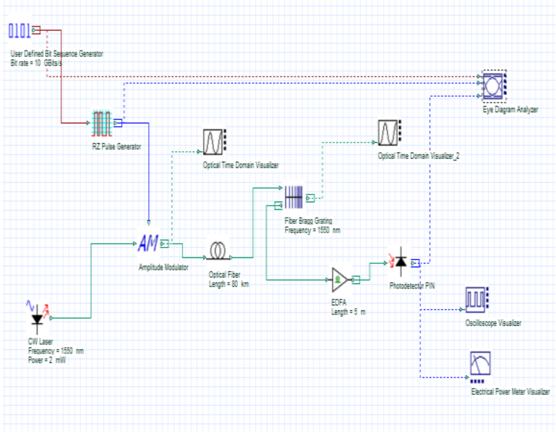

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Fig. 5: use of FBG

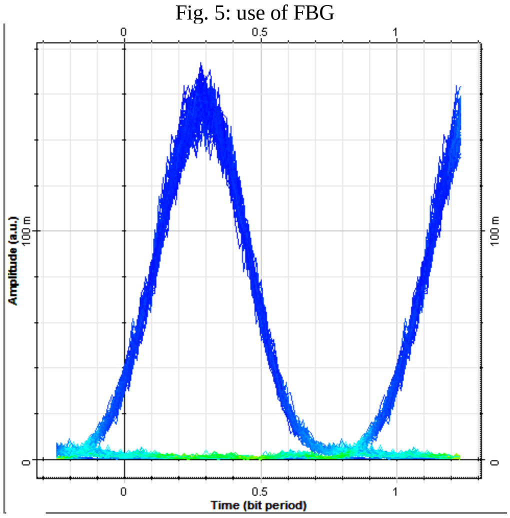

Fig.6 Eye Analyzer of fiber length is 70km

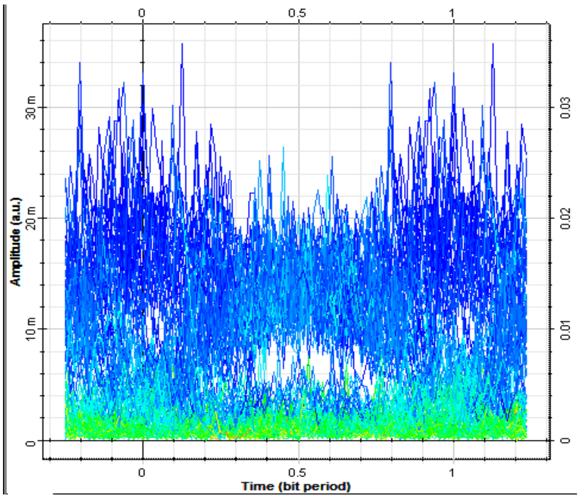

Fig.7 Eye Analyzer of fiber length is 70km without FBG

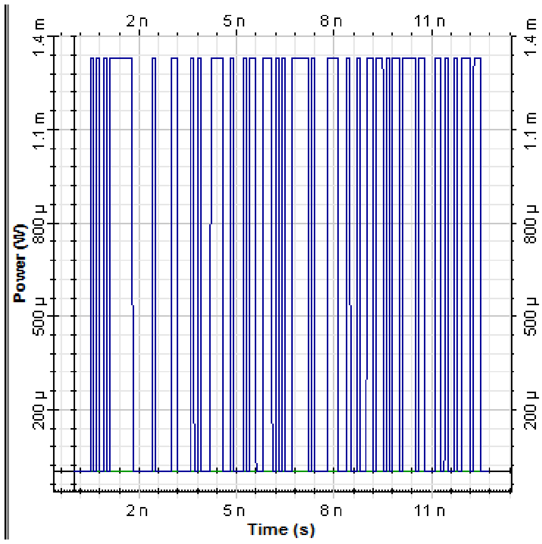

Fig. 8 Optical time domain Visualizer fiber length is 70 km without FBG

Table 1 Result table

	Parameter	Base paper	Proposed
With FBG	Fiber length		70km
	Q-factor		20.8985
	BER	1.4213e-12	1.65689e-097
	Eye height		0.132136
Without FBG	Fiber length		70km
	Q-factor		2.95937
	BER	1.0288e-10	0.00137786
	Eye height		-0.000160779

In this result table shows the different parameter values of proposed model. The proposed system is with FBG and Without FBG.

V. Conclusion

Above Design in information transmission communication system is simulated. To get better result chromatic dispersion should be compensated in optical fiber. We increase the length of fiber to transmit the signal to long length with less dispersion. The length we gained is 70 km which is better for the system than the other.

Second Design we employed a chirp FBG to simulate and compensate the dispersion in a communication system in information transmission. Whenever we increase the length of grating the extension of pulse will be decreased because of that the signal will be cover more length without or less dispersion. So the quality of signal will be same at the receiver as the transmitter. The efficiency will be high and the cost will be low by using chirp fiber Bragg grating.

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