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Performance Analysis Of Optical System Using Fbg With Different Modulators, Pulse Generators And Low Pass Filters

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Abstract:

Fiber optic communication is the process of representing the digital ones and zeroes as pulses of light. The message is transmitted from transmitter to receiver connected by an optical fiber, which acts as a channel. Fiber optics offer exceptionally low loss, longer distance between repeaters, high data carrying capacity and less cross talk. However one of the major problems it faces during its propagation is dispersion which causes overlapping of pulses leading to inter Symbol interference (ISI). This project uses two different types of modulators called Mcah-Zehnder modulator and LiNb Mach-Zehnder modulator for analysis and Fiber Bragg Grating (FBG) as dispersion compensation techniques. Two different types of mostly used pulse generators called NRZ pulse generator and Gaussian pulse generator are used to analyse the performance of the system. At the receiver part different type of low pass filters are used to find out the best suitable filter for a distance of 50km optical fiber communication with the help of single mode optical fiber. The comparison of different models has been done from parameters like Q-factor, Bit error rate, Eye clouser.

Keywords ***—Dispersion, Fiber Bragg Grating, Dispersion compensation , Grating Length ,Q- factor, Min BER, Power Levels, Eye Height,Amplifier gain, Optisystem 14.0.***

I. INTRODUCTION

Fiber optic communication is a method of transmitting information from one place to another by sending pulses of light through optical fiber. Like other Communication systems optical communication system also faces problems like dispersion, attenuation and non-linear effects that lead to deterioration in its performance. Among them dispersion affects the most and it is tough to overcome as compared to others[1].Thus,it is important to work upon an effective dispersion compensation technique that leads to performance enhancement of the optical system. It has an important role in optical communication system especially when designing optical amplifiers and filters. The modulation of the refractive index can be achieved by exposing the core of the fiber to ultra-violet radiation. This produces change in the refractive index of the core. FBG reflects particular wavelengths of light and transmits all others due to 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.

II. DISPERSION

The phenomenon of wave where its phase velocity is dependent on its frequency is known as dispersion. It is one of the factor due to which degradation occurs in the overall performance of optical fiber. Two types of mode are used in optical fibre single mode and multimode. Single mode optical fibre is optical fibre that is designed for the transmission of a single ray as a carrier and is used for long-distance signal transmission. When a pulse travel through single mode then broadening of pulse is observed, which is one of the example of dispersion. Rainbow is also one of the example. Dispersion limits the bandwidth of the fiber because the broadening optical pulse limits the rate that pulses can follow one another on the fiber and still be distinguishable at the receiver side. Single mode fibre optic does suffer from the chromatic dispersion although it is present in multimode but it is negligible. Chromatic dispersion means that the different colours or wavelengths travel at different speeds within the same mode. Chromatic dispersion is the result of material dispersion, waveguide dispersion, or profile dispersion. Several techniques can be used to compensate the accumulated dispersion in the fiber like dispersion compensating fiber or fiber bragg grating. There are three main compensation scheme i.e. pre, post and symmetrical compensation scheme. The dispersion is proportional to the length of the fiber. If length increases the width becomes bulk and the magnitude is reduced.

III. FIBER BRAGG GRATING

The fundamental principle behind the operation of an FBG is Fresnel reflection,where light travels in between media's of different refractive indices and thus may reflect and refract at the interface[7].

There are six common structures for FBGs:

1. Uniform positive-only index change,
2. Gaussian apodized,
3. Raised-cosine apodized,
4. Chirped [10]
5. Discrete phase shift, and
6. Superstructure[11]

A.Chirped Fiber Bragg Gratings

Chirped fiber grating is used to compensate for dispersion. The idea of dispersion compensation using chirped fiber gratings was firstly proposed by Qulette and later demonstrated experimentally by Williams et.al. A fiber Bragg grating is a reflective device composed of an optical fibre which is having modulation of its core refractive index over a certain length. The grating reflects light propagating through the fiber when its wavelength corresponds to the modulation periodicity. y. In a chirped FBG, the periodicity of the induced index modulation varies along the grating's length. The different wavelengths are reflected by different portions of the grating because grating period varies along the axis and accordingly are delayed by different amounts of time. The net effect is a compression of the input pulse that can be adjust to compensate for the chromatic dispersion accumulated along the fiber link. The maximum reflectivity is obtained at the wavelength providing the Bragg condition

$$\lambda B = 2n_{eff}\,\Lambda$$

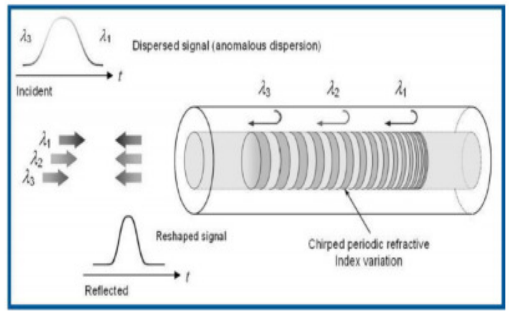

Fig 1 FBG compensate for dispersion by reflecting different wavelengths at different locations along the grating lengths

IV. SIMULATIONS SETUP

In this paper, simulations have been performed using NRZ modulation formats at different transmission power levels and different SMF lengths and grating length . Various simulations parameters utilized in this analysis work are given in Table no.1.

A.COMPONENTS

1) ***MODULATORS***

Here we have used MZ modulator and Linb modulator to get better result.Modulation is done using a MachZehnder modulator which has two inputs (optical signal and electrical signal) and one output (optical).

2)***PULSE GENERATOR***

NRZ and gaussain pulse generator has been used to find out the best suitable result for this communication.

3)***LOW PASS FILTERS***

The following types of low pass filters are used in different simulation and the outputs are compared with one another.

1.cosinerolloff filter
2.Raised cosine filter
3.Bessels filter
4.Gaussian Filter

B. DESIGN

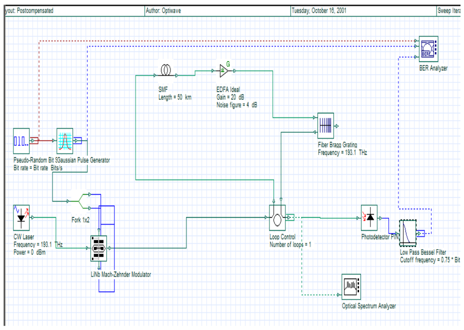

Fig 2 Linb Gaussian modulation

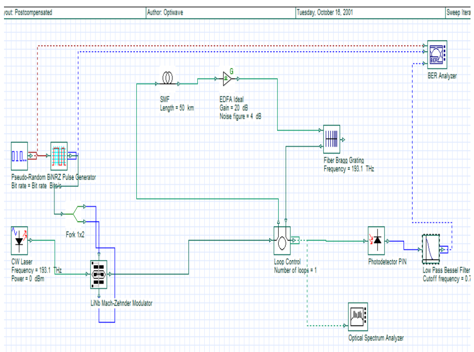

Fig 3 Linb NRZ modulation

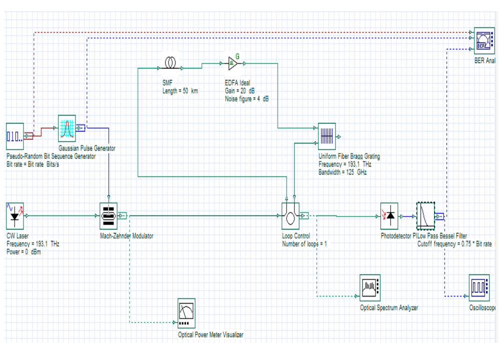

Fig 4 **Gaussian MZ modulator**

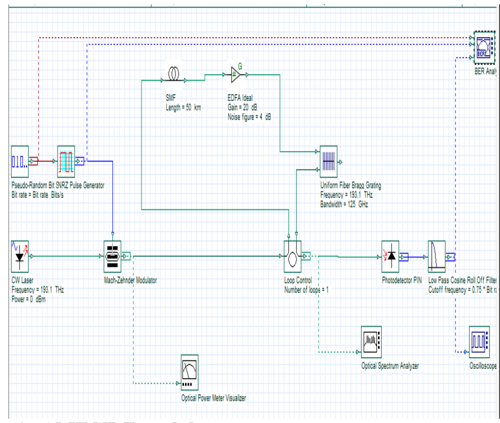

Fig 5 **MZ NRZ modulator**

C. RESULTS

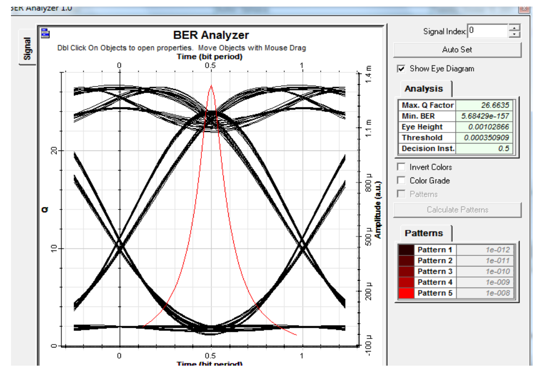

Fig 6Eye diagram of Gaussian pulse fbg cosine roll off filter

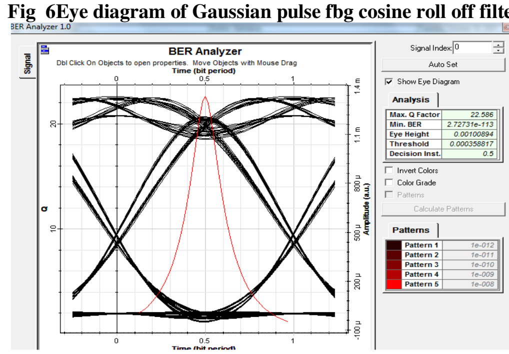

Fig 7 Eye diagram of Gaussian pulse fbg raised cosine filter

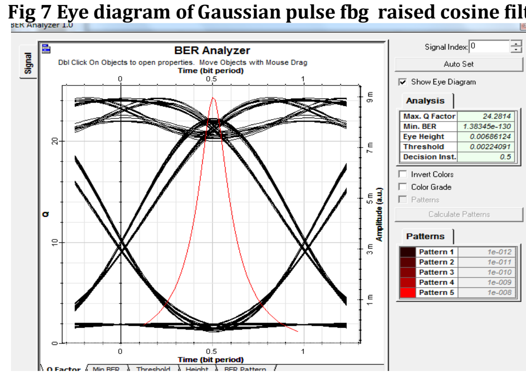

Fig 8 Eye diagram of Gaussian pulse uniform cosine roll off filter

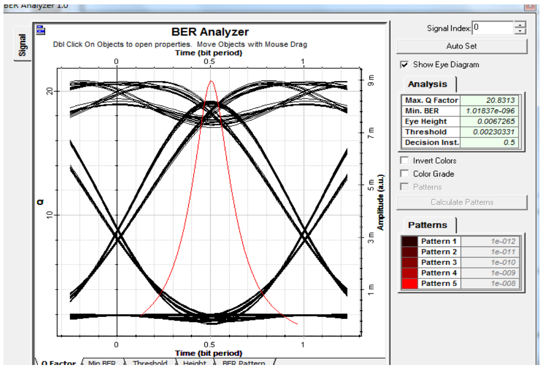

Fig 9 Eye diagram of Gaussian pulse uniform fbg raised cosine filter

TABLE 1

Grating length(mm)	Q-factor	Min BER	Eye height
1	26.6635	5.68429-157	0.00102866
2	22.586	2.72731e-113	0.00100894
3	14.2814	1.38345e-130	0.00686124
4	20.8313	1.01837e-096	0.0067265
5	18.4597	2.16625e-076	0.0488406
6	18.4298	3.6982e-	0.00620966
7	19.6754	1.73239e-086	0.000930555
8	18.3067	3.63635e-075	0.000914591
9	17.8357	1.86349e-071	0.000894191
10	17.2599	4.64439e-067	0.00610429

V. CONCLUSION

from above analysis we can conclude that between the MZ modulator and LiNb MZ modulator, The MZ modulator gives best output. Between the Uniform FBG and Chriped FBG, Chriped FBG gives best output. Among all filters the cosine roll off filter gives the best output. And as a pulse generator Gaussian pulse generator gives the best output.

Hence here we can conclude that a system with MZ modulator, Chriped FBG, Cosine roll fiter, Gaussian pulse generator gives the best results for 50 km optical fiber communication, which is shown in the table with highest value. .

From all above cases two cases are found which cannot be used for signal transmission for this system as this combination give Q-factor value less than 7, which can cause signal distortion at the receiver side.

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