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DISPERSION COMPENSATION IN OPTICAL FIBER COMMUNICATION USING FIBER BRAGG GRATING TECHNIQUE –A OUTLINE

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Abstract: In the present day of communication optical fiber has emerged as a productive and viable mode for communication. Dispersion in optical fiber communication is primary drawback which has an impact on the implementation of optical fiber. For compensation of dispersion there are diverse methods. Some applications rely on Fiber optics due to its small size, less loss and small interferences from surroundings. For compensation of dispersion there are different techniques one such technique is Fiber Bragg Grating (FBG). In the propound work we used FBG technique for lossless data transmission more than 500 kilometers. Optisystem 16 Simulator is used as a simulation tool and several parameters are simulated for appropriate results. Cosimulation is done using MATLAB tool.

Keywords*: *Compensation of Dispersion, Optical fiber, FBG, Optisytem Simulator.

I. INTRODUCTION

The weight, size, bandwidth and budget of metal conductors led scientists and engineers to analyze other means of data handling. From several alternatives, one best alternative for data handling is optical fiber. Fiber optics is one of the prominent ways for communication of data because of its various advantages like small size, less weight, immunity to interference, high transmission capacity and long distance transmission. Optical fibers are widely used in telecommunication and transmission of light by it is very much accurate and efficient. But there are various losses in optical fiber which will degrade the quality of optical fiber they are absorption, scattering, dispersion and bending of light. The main factor that degrades the function of optical fiber is Dispersion. The optical pulse widens on account of dispersion when they move along single mode fiber and reduces speed of data transfer thus interference is caused and limits received optical power. In order to overcome this drawback main component used is FBG. FBG is a dispersed Bragg reflector which is built on tiny segment of fiber and transfers all other wavelength and clogs a particular wavelength of light. Applications of FBGs are Optical communication system, Optical sensors for its easy fabrication, wavelength selectivity and compacity. Most prominent is Germanium-doped silica fiber which is used to make fiber Bragg gratings. At the simulation end firstly simulating the communication system model and various simulation setting parameters like fiber cable length (mm), FBG length (mm), input power (dBm) is given at cable side and other parameters are observed like noise figure (dB,) Q-factor, gain(dB), output power (dBm) towards receiving end. All results are obtained by using eye diagrams for analyzing the results we require the OPTISYSTEM 16.0 Simulator.

II. THE DISPERSION CONCEPT OF FIBER BRAGG GRATING

A. Working Principle of FBG

Dr. Kenneth O hill illustrated the concepts of FBG and its applications. Manufacturing of FBGs are done by carving periodic or aperiodic variation in the certain type of optical fiber's core by UV laser. There are two methods involved in this they are interference and masking. Usually germanium doped silicon fiber is used. Germanium based fiber is photosensitive in nature. By the exposure to UV source the core refractive index changes because of this property. It works on principle of Fresnel reflection. FBG is a kind of Bragg reflector which reflects certain frequency and transmits all other and it acts like dielectric mirror. The wavelength which is reflected is Bragg wavelength given as $\lambda_B=2n_e\Lambda$.

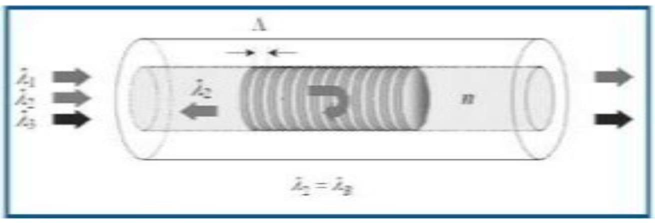

Fig 1 Working Principle of FBG

III. REVIEW OF LITERATURE & RESULTS

A. Mohammadi et al, 2011 their works illustrates about dispersion compensation using the dispersion compensating fibers. The study included the implementation of Chirped FBGs as dispersion balancer for communication through optical fibers. Using Chirped Bragg grating simulation of communication model is done by increasing the chirp parameters, power is increased which is observed at the receiver [1].

B. Shariful Islam et al, 2014 their works describes about the experiment carried by the use of FBG for reducing third order and group velocity dispersion. Depending on positions of FBG four arrangements are done they are pre and post compensation, mid and bi compensations. At receiver end bit error rate and Q factor are compared between standard single mode fiber (SSMF) and non-zero dispersion shifted fibers (NZDSF). By using Bi-end configurations it gave a more desirable performance for SSMF and using mid configuration it gave more preferable performance for NZDSF [2].

C. Valts Dilendorfs et al, 2016 author states about the two various types of dispersion compensators like FBGs and Dispersion compensator fiber (DCF) were seen in single channel and multiple channels. This work tells about which compensators are best suited for one and more than one channels in Wavelength Division Multiplexing optical system. Using FBG & DCF pre and post compensation of the fiber is done. DCF is not preferred much because it gives short optical line lengths as compared to FBG [3].

D. Tianjiao Xie et al, 2014 their work tells about the chromatic dispersion analysis at various lengths (50km, 100km and 200km) for single mode fiber and it also tells that chromatic dispersion increases with widening of pulse and increase with distance of the fiber. The survey is made based on the results procured by Optisystem simulator. The various signal performances are examined at SMF (Single mode fiber) with different power levels of input by utilizing eye diagram, BER analyzer and also maximum quality factor [4].

E. Fabrice Mfuamba Kabonzo et al, 2015 they presented that the combination of radio above fiber technology along with orthogonal frequency division multiplexing which resulted in excessive data rates and components with reduced cost. This paper deals with OFDM through wavelength division multiplexing with the assistance of FBG as dispersion compensator over optical fiber. Simulation software used is VPI transmission Maker. In each transmitter, quadrature modulation signals around four are generated at the frequency range of 18Gbps data and it is modulated with continuous wave before transmission over single mode fiber (SMF) by using Mech Zehnder Modulator. By this method performance is improved along with data rate and cost constraints. The development of hyperbolic tangent for FBG as dispersion compensator is done [5].

F. Naqib Muhammed Faiyaz et al, 2014 develops hyperbolic transfer profile in FBG as dispersion balancer. By the developed profile, can compensate for chromatic dispersion up to 2237ps/nm at 1550 nm. The length of the FBG was 140km used for single mode fiber. FBG based model replaces old DCF (Dispersion compensating fiber) based dispersion compensation because FBG is better when compared to DCF since it has many advantages as compared to DCF [6].

G. Natalia M. Litchinitser et al, 1997 their work emphasize about the FBGs effects on reflective and transmissive modes and its numerical examination is done. Firstly the reactivity of chirped, index modulation, reflective gratings with respect to the grating chirp parameter, grating length is investigated. They gave less reactivity to the parameters. Here they introduced the grating based dispersion compensation [7].

H. N. Md. Yusoff et al, 1997 their work shows how the signal is transmitted through chirped Fiber Bragg grating. The power obtained for pre, post compensations are -0.19dbm and -0.7dbm .The signal quality are dissimilar with BER rate of 2.65e-07 and 4.95e-07 procured for post and pre compensation. Author concludes that for inline compensation it gives high BER when comparison is made with pre and post configurations [8].

I. S. S. Azmiri Khan et al, 2010 authors put forward a scientific model which tells about the apodized FBGs for chromatic dispersion balance. By choosing correct apodization strength factor the dispersion can be minimized. In this work the apodization factor is 0.7-0.8 for chirped hyperbolic tangent apodised FBG and it compensated dispersion of about 400ps [9].

J. Md. Jahidul Islam et al, 2012 author presents those recent technologies in the domain of optical fiber. FBGs play an important role for dispersion compensation with high performance and efficiency. Performance of optical fiber is analyzed for the length of about 200km the dispersion is approximate of about 75.5ps/nm/km and for 150km they succeeded in compensating dispersion about 33.8ps/nm/km. In this work it obtained good performance till 300km and for more than 500Km it was not that satisfactory so future study was carried on to resolve this issue for more fiber length [10].

K. Abdallah Ikhlef et al, 2012 depicts the simulation and modeling of FBG to analyze maximum reflectivity, minimum side lobes, Grating length is the main parameter which tells about the performance of the FBG. Two factors are analyzed, one is the FBG reflectance increments as its increase in grating length and another is with increase in the reflectivity of 99.99% and the grating length of 10mm it maintained the same reflectivity for longer length [11].

L. Nazmi A.Mohammed et al, 2014 in their paper experiment is made for single channel system with precise rate along with instrument for analyzing compensation of dispersion techniques. The DCF is good compensator but it's costly so in order to overcome that linearly chirped tanh FBG is used and its price is moderate with good performance [12].

M. Yosef Taher Aladadi et al, 2016 author describes about optimized apodization profile which is modeled for CDC (chromatic dispersion compensator) and its evaluated using 2µm transmission window. The linear region and delay slope has improved with good performance and group delay ripple is totally suppressed. The outcome of CDC is good for two CFBG (Chirped FBG) with diverse specifications rather than with same specifications [13].

N. Aasif Bashir Dar et al, 2017 in their work different chromatic dispersion compensating techniques are analyzed. Each technique has advantages and disadvantages. DCF is commercialized technique and Optical phase conjugation is a good approach for dispersion compensation but it is sensitized to phase modulation schemes. Out of all this FBGs provide better performance because of its compact life, low insertion losses. FBG is characterized based on group delay response, reflection spectrum analysis of chirp factor is 0.0001, tanh apodization coefficient is 4 and Ac modulation is 0.0001 which gives best performance [14].

O. Sharma et al, 2018 in their work by using IDCFBG (Ideal dispersion compensation fiber Bragg grating) of diverse configurations with bit rate 100 GB/s and fiber length of 120km its performance is analyzed. The result of this is observed by Q factor, eye diagrams and BER for various configurations. From the experiments they conclude that FBG reduced dispersion compensation. The post compensation reduced dispersion with good BER and quality factors as compared to pre compensation and mixed IDCFBG simulation models [15].

P. Mansee Sharma et al, 2018 their works tells to develop FBG as a dispersion equalizer. The overall efficiency is obtained by analyzing eye diagram and Q factor at a bit rate of 40Gbps.The wavelength was 1554nm and optimized input power was 20dbm, Length of FBG is 2.2mm, FBG effective index is 1.42.Q factor achieved was efficient with a value of 99.05 and noise figure of 15.50, dispersion was reduced with increase in eye height of 0.5774[16].

Q. Peng Xia et al, 2019 in this paper using Optisystem software the simulation of dispersion compensation is done. The performance of NRZ (Non return to Zero) generator and Mach Zender Modulator is improved by using FBG technique. In this work three methods are analyzed one is post, symmetric and pre compensation methods. With respect to fiber input power for several compensation methods transmission performance is dissimilar and simulated using optisystem software [17].

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R. Gnanam Gnanagurunathan et al, 2006 their work recommends that FBG compensator beat the performance as compared to DCF for all applications like long haul link, short haul link, and modulation scheme analysis and traffic load variation on WDM systems with four channels. The suitable choice for chromatic dispersion compensation is FBG and it improves long term network growth. FBG has smaller dimensions and less insertion loss. The author examined that when the traffic load exceeded from 2.5 to 40GB/s the performance of DCF declined more when compared to FBG. The FBG was able to undergo any modulation scheme like RZ and NRZ with acceptable performance [18].

IV. CONCLUSION

According to the reviewed work of different authors it is examined that FBG is feasible for dispersion compensation it may be long haul or short haul link with its diverse benefits as comparable with other dispersion compensators in optical fiber. The performance is evaluated with simulated model results. By the simulation the better results for FBG are obtained in the case of internal loss, nonlinear effects etc.

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