IMPACT OF ATTENUATION COEFFICIENT ON DCF COMPENSATED OPTICAL COMMUNICATION SYSTEM

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Abstract - Today, Optical communication system has reached such a level where it has virtually become the backbone in the field of communication. Its performance is deteriorated by the dispersion since dispersion increases the value of BER and reduces the system's bandwidth. However, dispersion compensation fiber (DCF) is used to reduce the effect of dispersion in optical communication system. In this paper, the impact of attenuation coefficient (α) is analysed to order to estimate the performance of DCF compensated optical communication system at different values of α (0.1, 0.2,1,3 and 5 dBm/km). The range of DCF lengths taken for analysis is from 1-5 km. The performance of the system is estimated using eye diagrams, Q factor, output power and noise power with varying attenuation coefficient at different DCF length

Index Terms - Attenuation, Attenuation coefficient, DCF Dispersion, Optical Communication System.

I. INTRODUCTION

Data transmission from one point to another in any communication system is done using electromagnetic waves. Fiber optic communication uses optical fiber to transmit the data, which has enhanced the level of global communication. The basic building blocks of the communication system are optical transmitter (source), communication channel (optical fiber) and optical receiver (destination). The main function of channel is to transmit the signal from source to destination keeping the information free from any kind of distortion [1-3]. High speed and high efficiency are the need of time thus optical fiber networks need to explore all the performance determining parameters in detail to fulfil the demands. Attenuation is one of the important parameter to study. As it gives the information of reduce light intensity within the fiber. The performance of the fiber is calculated in terms of amount of output power to the fiber and output power observed from the fiber which also includes α that is attenuation coefficient, involving all contributions to attenuation and is expressed in dBm/km. The system designing should be such that it should take into account all the possible problems or difficulties faced by communication system world-wide and try to discover the possible solutions after analyzing different parameters. For efficient and economic use of fiber optics, understanding of mechanisms of attenuation and strategies for their minimal effect on the system is important [4].

In this paper, the effect of attenuation coefficient is analysed on optical fiber communication system at different DCF lengths in accordance to factors like Q factor, output power and noise power.

II. DISPERSION COMPENSATION FIBER (DCF)

Dispersion compensation fiber is one of the best and suitable way to remove dispersion (Fig.1) from the optical communication system so that analysis of other factors like attenuation coefficient can be done without any hindrance. DCF uses different techniques to remove dispersion that are pre compensation, post compensation and systematic compensation. DCF fulfils the high bandwidth requirement of the user, making it popular in the field of optical communication. DCF helps to remove dispersion from the system hence it becomes easy to perform other operations on the system for better signal quality and high performance. It is one of the best techniques to remove non linearities from the system. In this era of high technology where communication has reached at high level of its advancement, optical communication system with the help of DCF is serving the world with its enormous services [6].



Fig.1 Concept of DCF [6]

III. SYSTEM DESCRIPTION

Fig.2 shows the optical communication system that is proposed and designed for simulation purpose. The

software used for understanding the effect of Attenuation coefficient is Optisystem.

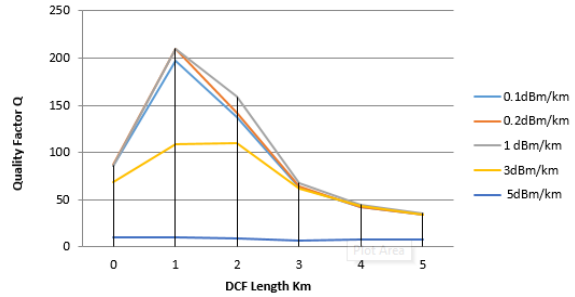


Fig. 3 DCF length versus Quality factor at different values of α.

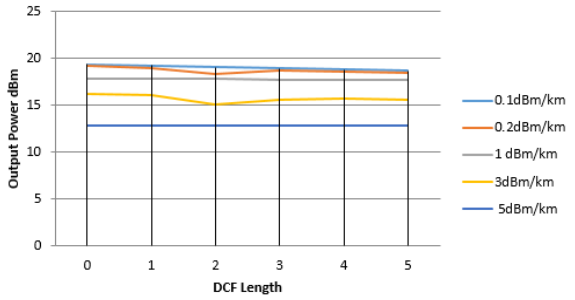


Fig . 4 DCF length versus output power at different values of α.

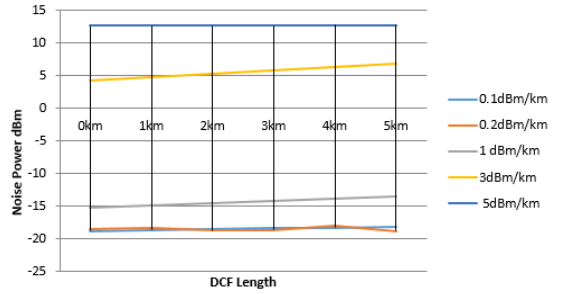


Fig. 5 DCF length versus noise power at different values of α

Table I. Parameter used in the simulation

Parameters	SMF	DCF
Reference wavelength	1550nm	1550nm
Length	10km	Variable
Attenuation coefficient	Variable	Variable
Dispersion	17.5ps/(nm.km)	-80ps/(nm.km)
Dispersion slope	0.08ps/nm^2/km	0.08ps/nm^2/km
Differential group delay	3ps/km	3ps/km

There are three parts of the setup: transmitter, channel and receiver. The transmitter section, comprises of a laser whose frequency is defined 193.1 THz and its power is at 20dbm. The Pseudo Random Binary Sequence (PRBS) generates data based on different operating modes, NRZ coded signal is generated from a Non-Return to Zero (NRZ) and after wards, the signal is digitally modulated by the user data using Mach-Zehnder (MZ) modulator. The signal from the transmitter output is then transmittedinto the channel that contains DCF, optical fiber and FBG [8]. At the receiver, photodiode converts the output from channel to electrical signal. Thereafter, signal is passed into low pass filter (LPF) followed by 3R regenerator and eye diagram analyser [9-10] and the signal is recovered. Simulation parameters [1][5] used in the system are given in Table I.

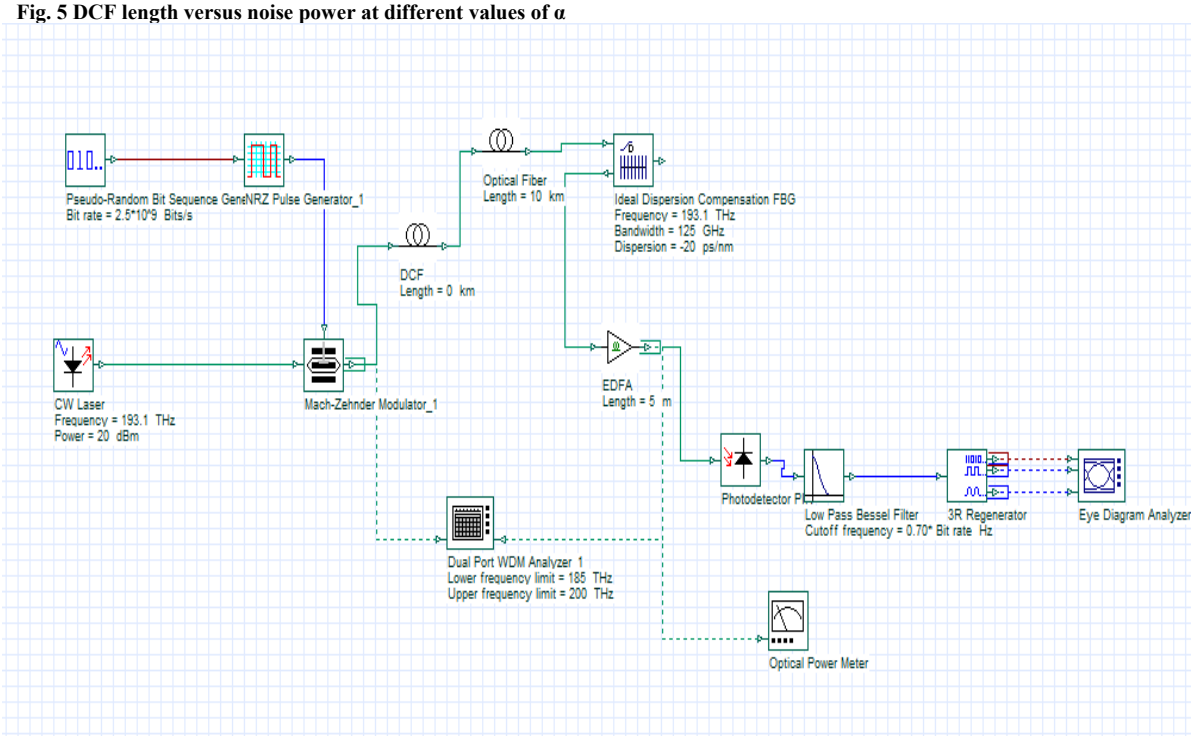


Fig. 2 Simulation setup for understanding the effect of α on the system.

Table II Different values of Quality factor

DCF length	α 0.1dBm / km	α 0.2dBm / km	α 1dBm / km	α 3dBm / km	α 5dBm / km
0	86	87	86	69	10
1	197	210	210	109	9.9
2	138	142	159	110	9.4
3	63	64	68	62	6.65
4	42.6	42.95	45	43	8.04
5	34	34	36	34	7.63

Table III Different values of output power

DCF length	α 0.1dBm / km	α 0.2dBm / km	α 1dBm / km	α 3dBm / km	α 5dBm / km
0	19.32	19.2	17.81	16.12	12.84
1	19.17	18.89	17.78	16	12.83
2	19.02	18.29	17.75	15	12.82
3	18.89	18.65	17.72	15.57	12.81
4	18.77	18.55	17.69	15.63	12.8
5	18.65	18.46	17.66	15.5	12.79

Table IV Different values of Noise Power

DCF length	α 0.1dBm / km	α 0.2dBm / km	α 1dBm / km	α 3dBm / km	α 5dBm / km
0	-18.82	-18.57	-15.23	4.21	12.57
1	-18.7	-18.44	-14.97	4.74	12.59
2	-18.57	-18.77	-14.61	5.26	12.6
3	-18.44	-18.65	-14.28	5.76	12.62
4	-18.29	-17.95	-13.95	6.24	12.63
5	-18.14	-18.81	-13.6	6.71	12.64

IV. RESULTS AND DISCUSSION

To check the effect of Attenuation coefficient on the system, simulation is done with DCF length 0-5 km. Fig.3 shows the graph between DCF length and Q factor with α values 0.1, 0, 2, 1, 3 and 5 dBm/km. It is clear from the graph that value of Q factor is highest at α value 0.2 and 1dBm/km that is 210 at DCF length of 1 km and the graph shows decreasing trend when further DCF length is increased. Table II shows exact values of Q factor at different lengths of DCF and α.
Fig.4 compares DCF and output power and it is seen that power is highest at α value 0.1dBm/km that is 19.32dBm. DCF length here is 0 km, all values range between 12 and 19 for all DCF lengths but value of output power decreases with increase in value of attenuation coefficient, accurate values of output power can be seen in Table III.

Fig.5 shows graph between DCF and Noise power and its clear that lowest value is received at α value 0.1dBm/km, -18.82 and the values tend to increase when DCF length and value of α increases.

Fig.6 shows the eye diagrams with DCF length 0 km and value of attenuation coefficient (0.1, 0.2, 1, 3 and 5 dBm/km. Similarly, Fig. 7, 8, 9, 10, 11 show eye diagrams with DCF length 1 to 5 km and respective values of α. In general terms at low value of α, better results are seen and results degrade at high values.

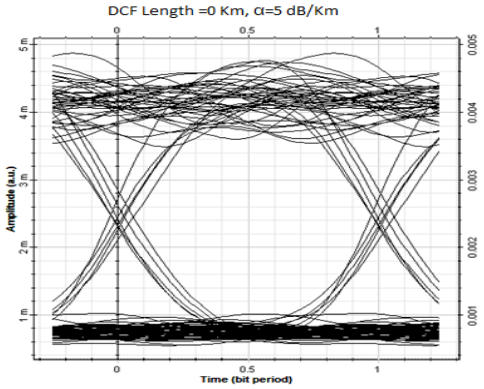


Fig.6 Eye diagram at DCF length 0 KM

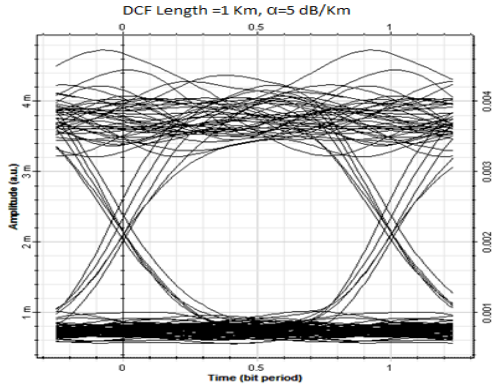


Fig.7 Eye Diagram at DCF length 1 KM

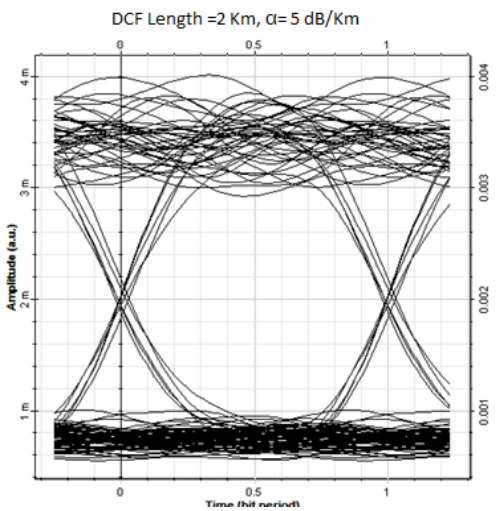


Fig.8 Eye Diagram at DCF Length 2 KM

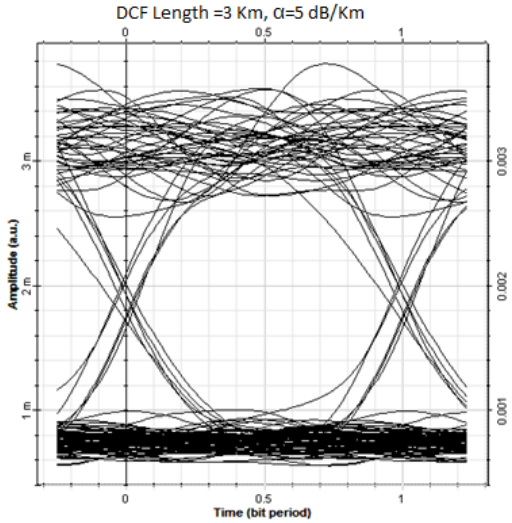


Fig.9 Eye diagram at DCF length 3 KM

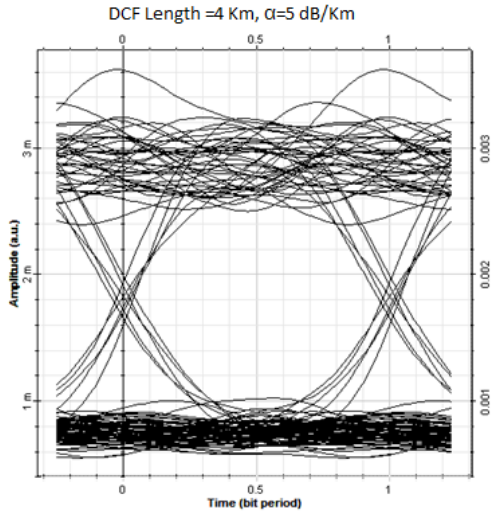


Fig.10 Eye Diagram at DCF length 4 KM

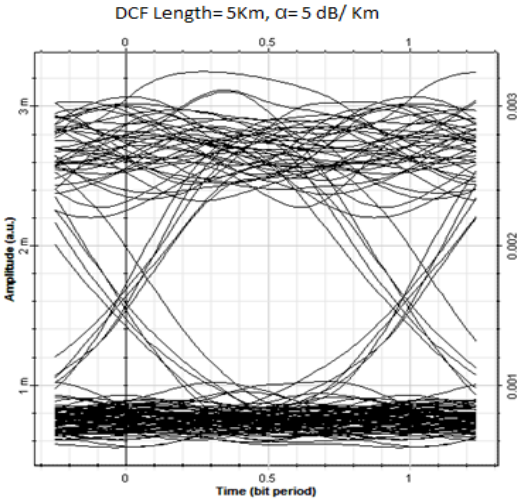


Fig.11 Eye Diagram at DCF length 5 KM

CONCLUSION

In this paper, the designing and analysis of an DCF compensated optical communication system is carried out. Investigation of the system is done using different values of DCF (0 to 5 Km) and attenuation coefficient (α) having values 0.1, 0.2, 1, 3 and 5 dBm/km. It is observed from analysis that better results are received at low value of α and at less distance of DCF, as the value of attenuation coefficient increases and DCF length increases, the results deplete. The value of Q factor is highest (210) at 0.2 dBm/km and DCF length 0 km. For output power, maximum value is 19.32dBm with α 0.1dBm/km and DCF length 0 km, also for noise power the lowest value is received (-18.82) with α 0.1dBm/km and DCF length 0 km.

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