"Performance Analysis of Different Dispersion Compensation Techniques in Fiber Optics Communication System"

Dissertation-II

Submitted in partial fulfilment of the

Requirement for the award of the degree

of

Master of technology

in

Electronics and Communication Engineering

By

SorabhBathla

Regd. No.-11512256

Under the esteemed Guidance

Of

Mr.Munish Singh

Assistant Professor

School of Electrical and Electronics Engineering

Lovely Professional University

Jalandhar

May2017

TOPIC APPROVAL PERFORMA

School of Electronics and Electrical Engineering

Program : P175::M.Tech. (Electronics and Communication Engineering) [Full Time]

COURSE CODE : ECE521 **REGULAR/BACKLOG :** Regular **GROUP NUMBER :** EEERGD0221

Supervisor Name : Munish Singh **UID :** 17486 **Designation :** Assistant Professor

Qualification : ________________________ **Research Experience :** ________________________

SR.NO.	NAME OF STUDENT	REGISTRATION NO	BATCH	SECTION	CONTACT NUMBER
1	SorabhBathla	11512256	2015	E1514	7508309588

SPECIALIZATION AREA : Wireless Communication **Supervisor Signature:** ___________________

PROPOSED TOPIC : Investigation on WDM and Dispersion in Optical Netwoks

Qualitative Assessment of Proposed Topic by PAC		
Sr.No.	**Parameter**	**Rating (out of 10)**
1	Project Novelty: Potential of the project to create new knowledge	7.50
2	Project Feasibility: Project can be timely carried out in-house with low-cost and available resources in the University by the students.	6.50
3	Project Academic Inputs: Project topic is relevant and makes extensive use of academic inputs in UG program and serves as a culminating effort for core study area of the degree program.	8.00
4	Project Supervision: Project supervisor's is technically competent to guide students, resolve any issues, and impart necessary skills.	7.00
5	Social Applicability: Project work intends to solve a practical problem.	7.00
6	Future Scope: Project has potential to become basis of future research work, publication or patent.	6.50

PAC Committee Members		
PAC Member 1 Name: Rajeev Kumar Patial	UID: 12301	Recommended (Y/N): Yes
PAC Member 2 Name: Lavish Kansal	UID: 15911	Recommended (Y/N): Yes
PAC Member 3 Name: Dr.Gursharanjeet Singh	UID: 13586	Recommended (Y/N): NA
DAA Nominee Name: Amanjot Singh	UID: 15848	Recommended (Y/N): NA

Final Topic Approved by PAC: **Investigation on WDM and Dispersion in Optical Netwoks**

Overall Remarks: Approved

PAC CHAIRPERSON Name: 11106::Dr.GauravSethi **Approval Date:** 05 Oct 2016

DECLARATION

I, Sorabh Bathla, student of Master of Technology under Department of Electronics and Communication Engineering of Lovely Professional University, Punjab, hereby declare that all the information furnished in this pre-dissertation report titled **"Performance Analysis of Different Dispersion Compensation Techniques in Fiber Optics Communication System."** is based on my own intensive research and is genuine. This pre-dissertation, to the best of my knowledge, does not contain any work which is not done by me.

Date:

Sorabh Bathla
Registration No.11512256

CERTIFICATE

This is to certify that the Dissertation-II titled "**Performance Analysis of Different Dispersion Compensation Techniques in Fiber Optics Communication System**". That is being submitted by "**SorabhBathla**" in partial fulfillment of the requirements for the award of Master of Technology, is a record of bonafide work done under my guidance. The content of this report, in full or in parts, have neither taken from any other source nor have been submitted to any other Institute or university forward of any degree or diploma and the same is certified.

Mr.Munish Singh

Supervisor
Assistant Professor
(Lovely Professional University)

Objective of the Thesis is satisfactory/unsatisfactory

Examiner I **Examiner II**

Acknowledgement

I would like to offer my profoundest gratitude to my Organisation **“Lovely Professional University”** for giving me opportunity to use their resource and work in such a challenging environment. I am grateful to the individuals whom contributed their valuable time towards my thesis.

I wish to express my sincere and heart full gratitude to my guide “**Mr.Munish Singh**“Assistantprofessor, who guides me to take up this thesis in sync with globaltrends in scientific approach.

I owe my heartiest thanks to my parents & all those guidepost who really acted as lightening pillars to enlighten my way throughout this project that has led to successful and satisfactory completion of my Dissertation-II.

Last but not least, I would like to thank God for the strength that keeps me standing and for the hope that keeps me believing that this report would be possible. I would also thank the staff members of the department of Electronics and Communication engineering who have been very patient and co-operative with us.

SorabhBathla

Reg. No. 11512256

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

Sr. No.	Abb.	Full Form
1.	CD	Chromatic Dispersion
2.	ROF	Radio over Fiber
3.	RF	Radio Frequency
4.	IF	Intermediate Frequency
5.	RS	Remote Station
6.	GIPOF	Graded Index Polymer Optical Fiber
7.	BS	Base Station
8.	MT	Mobile Transciever
9.	OCS	Optical Carrier Suppression
10.	FBG	Fiber Bragg Grating
11.	PA	Power Amplifier
12.	LNA	Low Noise Amplifier
13.	FTTA	Fiber to the Antenna
14.	WDM	Wavelength Division Multiplexing
15.	SMF	Single Mode Fiber
16.	DCF	Dispersion Compensating Fiber

ABSTRACT

Dispersion is a term which defines that the pulse or signals gets scattered or distorted due to the inconsistency in the frequency of the signals and modes of the light pulse. This can affect the signal's quality to an extent hence they can lead to error in the network. In single-mode fiber optic WDM, the performance of the system is affected by CD i.e. Chromatic Dispersion. The reason behind the occurrence of CD is that the signals that are multiplexed are of different colors and each color have different wavelength. CD is also known as GVD i.e. Group Velocity Division. It also leads to the occurrence of ISI i.e. Inter Symbol Interference. Various research works has been conducted for the purpose of dispersion compensation. In this a new method for dispersion compensation has been developed. The method is developed by combining the DCB grating along with advance band pass filters. Traditionally RZ and RSBG modulation techniques were adopted for the modulation but in proposed work MDRZ i.e. Modified Duobinary Return to Zero, NRZ modulation is adopted to achieve the better results along with various bit rates. The simulation is performed in Optisystem where length has been varying from 200 to 209 Kms and Power has been varying from 5 to 14 dBm. Each model has been compared with individual model and concludes the efficiency of the outperform model in terms of threshold, BER, Q-factor and Eye height.

CHAPTER 1

INTRODUCTION

1.1 Fiber Optical Communication

Fiber Optical communication refers to a technology whereby mild is modulated through a radio signal and transmitted over an optical fiber link to facilitate Wi-Fi get right of entry to, inclusive of 3G and Wi-Fi simultaneous from the equal antenna. In other phrases, radio alerts are carried over fiber-optic cable. as a result, a unmarried antenna can get hold of any and all radio alerts (3G, Wi-Fi, mobile, and so on..) carried over a single-fiber cable to a primary location in which system then converts the indicators; that is opposed to the traditional way where every protocol kind (3G, Wi-Fi, cell) requires separate device on the place of the antenna. Radio transmission over fiber is used for a couple of functions, along with in cable television (CATV) networks and in satellite base stations, the term ROF is usually applied whilst this is executed for wireless get entry to.

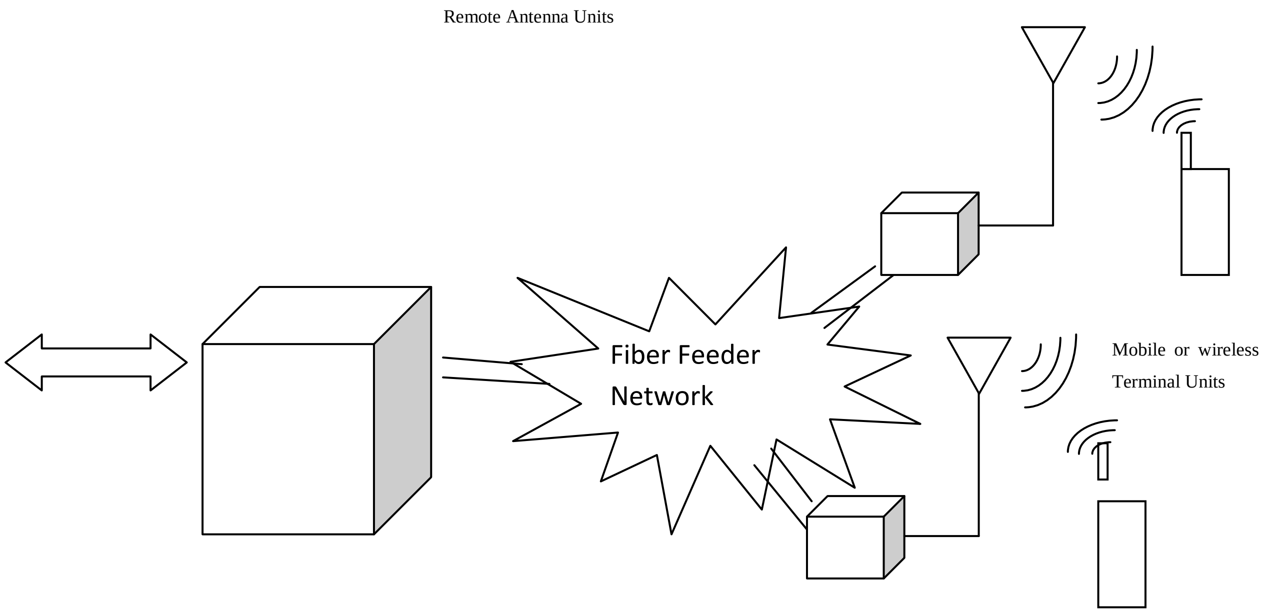

Figure 1.1 Concept of Radio over Fiber System.

In ROF structures, Wi-Fi alerts are transported in optical shape among a vital station and a hard and fast of base stations earlier than being radiated via the air. every base station is tailored to speak over a radio link with at the least one user's mobile station placed inside the radio variety of stated base station. The advantage is that the equipment for Wi-Fi, 3G and other protocols can be centralized in one region, with far off antennas attached through fiber optic serving all protocols. It substantially reduces the gadget and maintenance value of the community.

ROF transmission systems are usually categorized into two principal categories (RF-over-fiber IF-over-fiber) relying at the frequency range of the radio signal to be transported.

a) In RF-over-fiber structure, a facts-wearing RF (radio frequency) signal with a high frequency is imposed on a light wave signal earlier than being transported over the optical hyperlink. Consequently, wireless signals are optically dispensed to base stations at once at excessive frequencies and transformed from the optical to electric domain at the base stations earlier than being amplified and radiated by using an antenna. As a end result, no frequency up–down conversion is needed at the various base stations, thereby ensuing in easy and alternatively value-powerful implementation is enabled at the bottom stations.

b) In IF-over-fiber structure, an IF (intermediate frequency) radio signal with a lower frequency is used for modulating mild earlier than being transported over the optical link. Consequently, before radiation through the air, the signal should be up-converted to RF at the base station.

Numbers of simulation equipment can be used to layout ROF structures. Popular commercial equipment were advanced with the aid of Opti-wave systems Inc. and VPI photonics.

1.2 Advantages of ROF

1.2.1 Low Attenuation

It's miles a well-known fact that indicators transmitted on optical fiber attenuate tons less than via different media, especially when as compared to wireless medium. With the aid of the use of optical fiber, the sign will journey similarly, lowering the want of repeaters.

1.2.2 Low Complexity

ROF makes use of the idea of a remote station (RS). This station handiest consists of an optical-to-electrical (O/E) (and an non-compulsory frequency up or down converter), amplifiers, and the antenna. This means that the useful resource control and signal technology circuitry of the base station may be moved to a centralized location and shared among several far flung stations, thus simplifying the structure.

1.2.3 Lower Cost

Easier shape of far off base station approach lower price of infrastructure, decrease power intake by using gadgets and less complicated maintenance all contributed to decreasing the overall set up and upkeep cost. Similarly discount can also be made with the aid of use of low-value graded index polymer optical fiber (GIPOF).

1.3 Limitation of ROF Technology

Radio over fiber is a system which converts the light form signals into analogous signals. While this modulation the noise and distortion to the signals can also occur in an ROF system. The occurrence of noise and distortion in the signals can lead to Noisy figures and Dynamic Range NF. Dynamic range has a vital role in ROF system like GSM .the working of dynamic range is to control the fluctuations in the power that occur when the power is supplied to Base Station from MUs.

1.4 Architecture of ROF

Micro-cells and Pico-cells concepts are the pioneering approach in mobile and assorted network systems. Indeed, 4G networks (Release 12 LTE advanced) have considered these new aspects in order to boost system capacity and improve hotspot. Assuming medium range cell coverage for ROF systems at millimeter band due to high frequency and important atmospheric absorption, we can budge to Pico-cells and micro-cells in enclosed and al fresco environments respectively.

The ROF system is composed of Central Office (CO), a PON network, a base Station (BS) and a mobile transceiver (MT) as depicted in Figure.

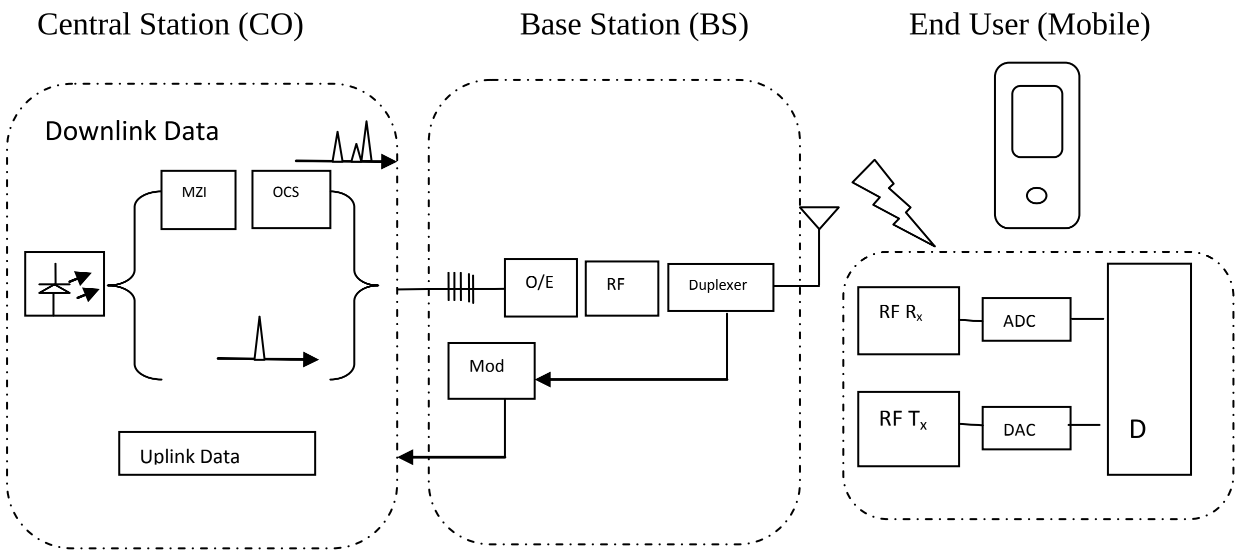

Figure 1.2 Architecture of ROF

At Central Office (CO), an optical carrier is generated at 1550 nm then divided into two parts using an optical splitter. The first part of the optical signal is modulated by 16 QAM signal with 5.28 Gbps data rate. The optical modulated carrier undergoes a second Mach-Zehndermodulator using Optical Carrier Suppression (OCS) technique in order to generate millimeter wave at 60GHz. The second part is combined with the modulated signal and the resulting signal is transmitted over 20Km fiber link [3].

1.4.1 Base station architecture

Arriving to Base Station, the optical signal is transmitted over fiber Bragg Grating (FBG), the millimeter wave is converted into RF signal using a photo detector. The resulting RF signal at 60GHz is amplified by a Power Amplifier (PA) in order to reach the maximum transmit power of *10* dBm.The received data from Mobile User modulates the optical carrier reflected through fiber Bragg Grating (FBG) and acting as an optical source for the uplink. The resulting modulated optical wave is transmitted over fiber link to CO where it is converted to electrical signal then down converted to baseband.

1.4.2 Mobile transceiver architecture

We assume a 60GHz direct-conversion transceiver using quadrature oscillators presenting low phase noise. The direct conversion architecture is widely used for 60 GHz providing minimum complexity and better image rejection [4].

The topology of the transmitter and receiver is symmetrical and consists of a local oscillator at 60 GHz, I/Q mixers, an amplification stage and a pass band filter for the transmitter block. The receiver is composed of a band selection filter, an amplification stage using Low Noise Amplifier (LNA), Quadrature mixers and local oscillator allowing to directly down-convert RF channels to baseband. Figure represents the block diagram of the transceiver.

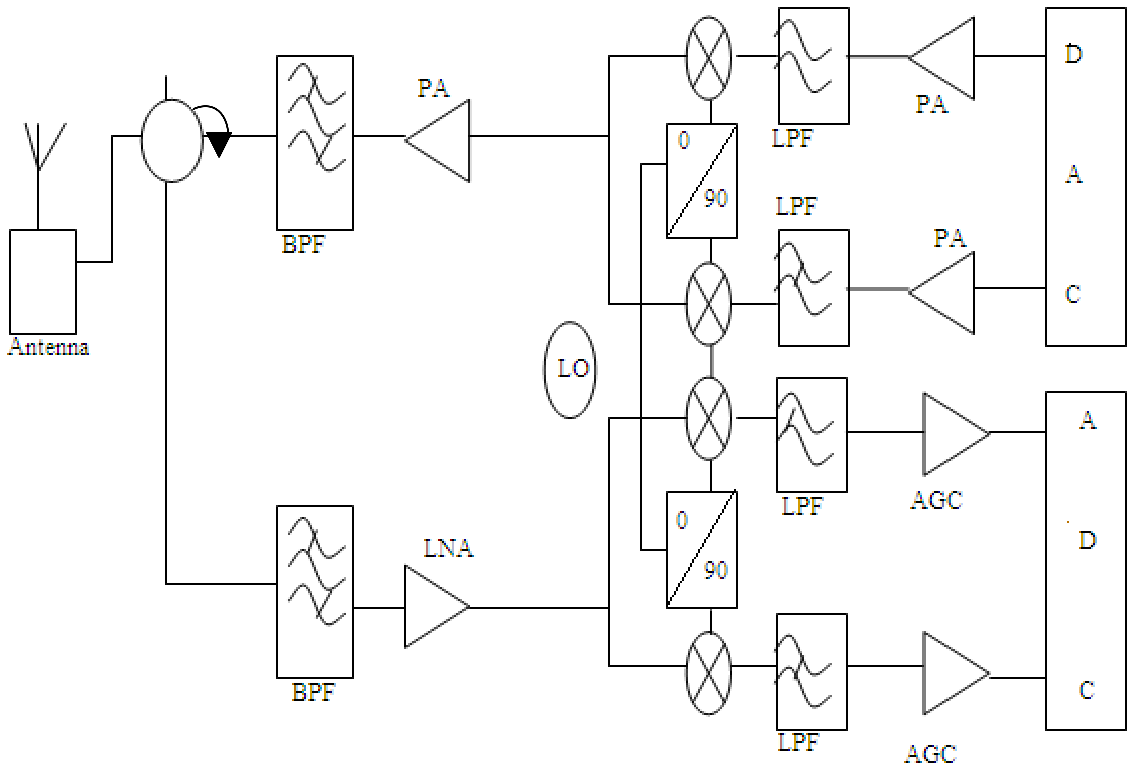

Figure1.3 Mobile Front End Transceiver.

1.5 Future-Proof

Fiber optics are designed to address gigabits/second speeds which means they may be capable of manage speeds supplied by future generations of networks for future years. RoF generation is also protocol and bit-fee obvious, hence, can be hired to use any present day and future technology. New ROF techniques that guide MIMO-enabled Wi-Fi offerings, considerably 4G/5G mobile and 802.11 WLAN requirements, have additionally been proposed.

The most famous use for RF over fiber is for cable TV structures. it is not possible to run RF indicators over copper cable to greater than few hundred toes. content vendors may additionally delivery their whole CATV channel lineup over a unmarried-fiber optic cable, because this way they can transport the signal for masses of km. it really works like this: an electrical RF signal generally within the variety of fifty four–870 MHz is transformed to modulated light using RF 1310 nm or 1550 nm laser optics. The mild travels over single-mode fiber to the fiber optic RF receiver wherein is transformed again to electrical RF. electric RF is without delay connected to a television or set-top box. 1550 nm is more popular as it has fewer losses in the fiber and with the aid of the use of fiber-optic amplifier known as EDFA it's miles feasible to extend the transport distance. 1310 nm is dropping approximately zero.35 dB/KM of optical signal, 1550 nm is losing simplest 0.25 dB/km. Optical finances between transmitter and receiver varies, depending on the transmitter energy and receiver sensitivity.

1.6 Applications of ROF

1.6.1 Get Entry to Dead Zones

Important software of ROF is its use to provide wireless insurance within the vicinity in which wireless backhaul link is not feasible. these zones can be regions inside a shape including a tunnel, areas behind buildings, Mountainous locations or secluded areas which include jungles.

1.6.2 FTTA (Fiber to the antenna)

Via using an optical connection immediately to the antenna, the equipment dealer can gain several advantages like low line losses, immunity to lightning moves/electric powered discharges and decreased complexity of base station through attaching lightweight optical-to-electric (O/E) converter at once to antenna.

It is observed that in today's era the use of network and communication application is increased. This makes this field as the more interesting field for the researchers to work upon it. With the enhancement in the field of networks the numbers of users are also increased. The performance of the applications which are related to the network or internet depends upon the bandwidth of the network. To make the system more effective and efficient the availability and consumption of bandwidth is very important factor. To increase the bandwidth of the network, various solutions are provided by the researchers. WDM (Wavelength Division Multiplexed) is one of these solutions. The WDM network supports massive bandwidth range and also provides the better data transmission range. In WDM network, the data is multiplexed to the transmission lines. It provides the facility to transfer the multiple wavelength at a given period of time or simultaneously. The WDM uses the concept of Fiber optic network which supports the massive bandwidth and data transmission range.

Hence there is need to fulfill the requirement regarding the better data transmission rate and vast bandwidth. To fulfill this need the concept of WDM along with fiber optic network is designed. The key feature of optical fiber network is that it provides large range of data transmission and gigantic bandwidth for data transferring. Due to its features the use of WDM along with optic fiber is increased day by day. Hence there is a lot of work to do in order to increase the performance of the optic fiber network. Therefore there is a requirement to find out the parameters or factor that affects the quality of the fiber optic network. Loss and dispersion are the factors that leave an impact on the performance of optic fiber network by degrading its performance.

1.7 The Effect of Dispersion

Dispersion is a term which defines that the pulse or signals gets scattered or distorted due to the inconsistency in the frequency of the signals and modes of the light pulse. This can affect the signal's quality to an extent hence they can lead to error in the network. In single-mode fiber optic the performance of the system is affected by CD i.e. Chromatic Dispersion. The reason behind the occurrence of CD is that the signals that are multiplexed are of different colors and each color have different wavelength.

Polarization is another dispersion which affects the quality of the signals. The reason behind the occurrence of the polarization dispersion is that even though the single mode fiber can prolong for one transverse mode. The mode carries two various polarizations. The distortion in fiber can leads to the alteration in the propagation velocity for both of the polarizations. This process is known as birefringence. It is defined as follows:

$$B_m = \frac{|B_x - B_y|}{k_0} = n_x - n_y \qquad (1)$$

Here B_m defines the term birefringence;

n_x , $n_y$defines the refractive of two orthogonal polarizations.

For the given value ofB_m, the phase difference is formed after light wave transmission of L km is as:

$$\phi = k_0 B_m L = \frac{2\pi}{\lambda}(N_x - N_y)L = (\beta_x - \beta_y)L \qquad (2)$$

Here the used term B_m plays an important role. if the corresponding value of B_m is constant i.e. does not vary over the process of light wave transmission, then the difference between its slow and fast axis will periodically repeated. The power exchange is periodically and it is known as polarization beat length:

$$L_B = \frac{2\pi}{|\beta_x - \beta_y|} = \frac{\lambda}{B_m} \quad (3)$$

1.8 Types of Dispersion

There are three types of conversions basically defined as follows:

1. Intermodal Dispersion
2. Intramodal Dispersion
3. Polarization Dispersion

1.8.1 Intermodal Dispersion

Intermodal dispersion mostly occurs in multimode fibers. The reason behind the occurrence of intermodal dispersion is that when the beam of light passing from multimode fiber then the light gets dispersed and travels through various propagation angles. Hence this is known as critical mode similarly if the beam of light travels equal to the fiber it is known as fundamental mode.

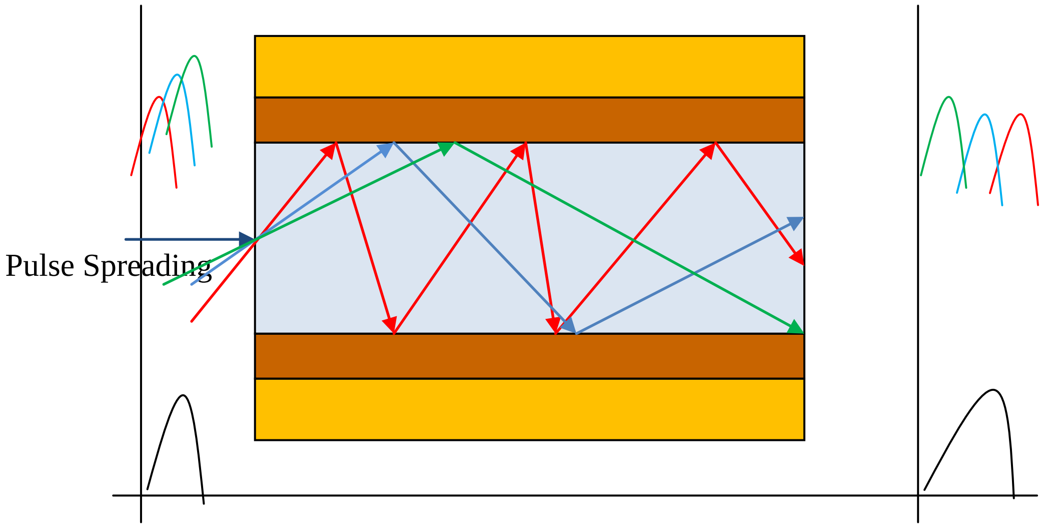

Figure 1.4 Intermodal Dispersion in Multimode Fiber

Above figure describes this concept. The figure shows the beam of light travelling parallel to the fiber and also shows the beam that travels through various propagations. The bream which travels through various propagations reaches to the output at different times. Hence it leads to the scattered output and finally dispersion occurs to the signals at receiver or output end.

1.8.2 Polarization Mode Dispersion

Polarization mode dispersion is another type of dispersion that can occur in fiber optic network of WDM. The following figure describes the concept of polarization mode of dispersion. The polarization mode dispersion takes place when two linear polarized waves takes place in fiber optic cable and these waves or signals mutually propagates at perpendicular plane as following figure shows. But the perpendicular planes are not same because of asymmetry in fiber cable, splicing process, refractive index and this cause polarization dispersion.

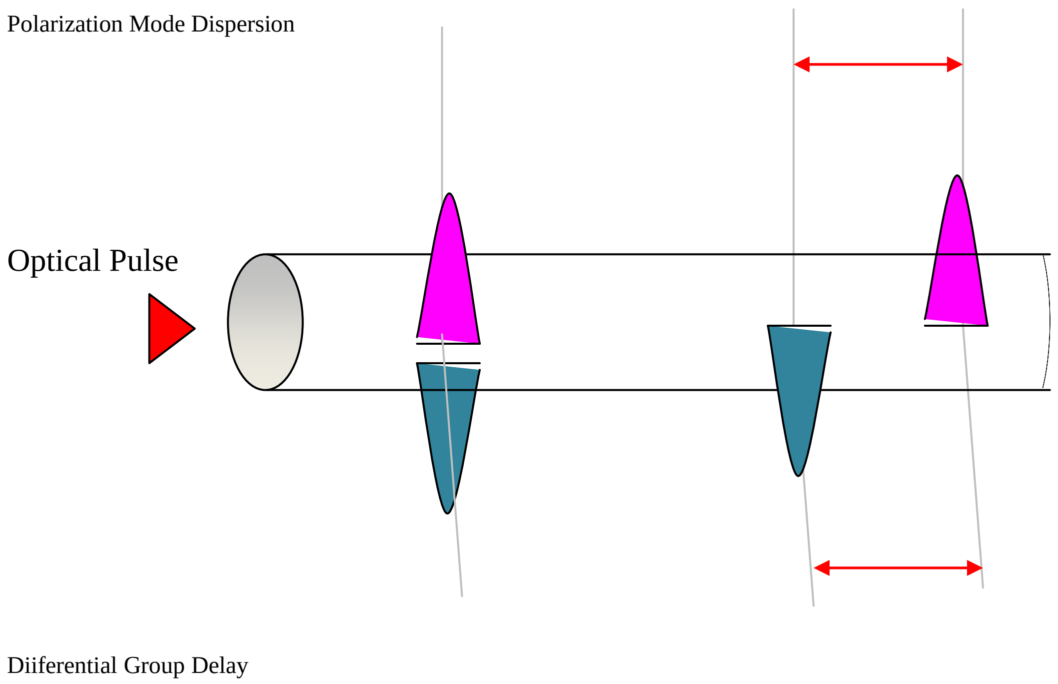

Figure 1.5 Polarization Mode Dispersion.

1.8.3 Intramodal Dispersion

It is a dispersion which can occur in single mode fiber optic network and multimode fiber network as well. Whereas the intermodal dispersion takes place in multimode fiber network only. The intramodal dispersion leads to the scattering of the signals. The signals are scattered because the signals that carries the information contains multiple wavelength. This process gives rise to group velocity dispersion.

The difference between intermodal dispersion and intramodal dispersion is that the intermodal dispersion can take place in SMF i.e. Single Mode Fiber only whereas the intramodal dispersion can occur in SMF and Multimode fiber also. The other difference is that the intermodal dispersion occurs when the signals passes from multimode fiber along with the various propagation angles. Whereas the reason of intramodal dispersion is that the signals passes from fiber optic carries multiple wavelength and it leads to the occurrence of group velocity dispersion.

1.9 TECHNIQUES

There are many techniques that can be used for dispersion compensation in WDM. Following techniques are one of those techniques.

1. FBG(Fiber Bragg Grating)
2. DCF(Dispersion Compensating Fiber)

1.9.1 FBG (Fiber Bragg Grating)

FBG is a technique used for dispersion compensation in Wavelength Division Multiplexing. It is a distributed Bragg reflector. [2]Bragg reflector reflects a specific pulse or wavelength. After reflection of the light or wavelength is transferred to all other channels. The FBG can be used as an optical filter which blocks the certain wavelength. The refractive index varies with respect to the propagating medium. The working of FBG relies on the principle of Fresnel reflection[5]. The principle of Fresnel reflection describes that the beam of light that is passing through the media cab reflect or refract at the interface. The value of the refractive index will vary over a specific length. At the time of refraction an amount of light is reflected back. These reflected light signals are grouped into a single large reflection corresponding to a particular wavelength. This particular wavelength indicates the value of grating period equal to the half of the input light wavelength. This situation or point leads to the Bragg condition on the wavelength and the wavelength will be considered as Bragg wavelength. The equation used for Bragg wavelength is as follows[2]:

$$\lambda_B \equiv 2\bar{n} \qquad (4)$$

The value of Bragg wavelength will change according to the grating length. Hence at the point where the Bragg condition is satisfied the frequency component is reflected over that point. The equation for grating dispersion is as follows

$$D_g = \frac{2\bar{n}}{C(\Delta\lambda)} \qquad (5)$$

In equation (5), $\bar{n}$ is used for defining the average mode index $\Delta\lambda$, indicates grating bandwidth; C stands for light velocity.Basically, there are two configurations of FBG as follows:

1. Pre compensation
2. Post compensation

1.9.1.1 Pre-Compensation

It defines when the FBG is placed at the starting of optical link and before amplifier. Following figure describes the concept of pre compensation.

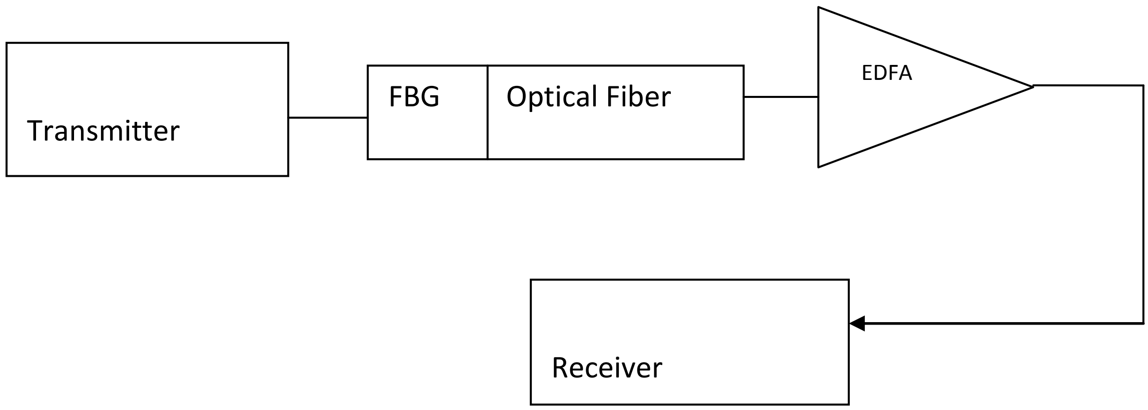

Figure 1.6 Pre Compensation in FBG [2

1.9.1.2 Post Compensation: It defines the situation when FBG s placed at the end of optical link. Following figure describes the post compensation.

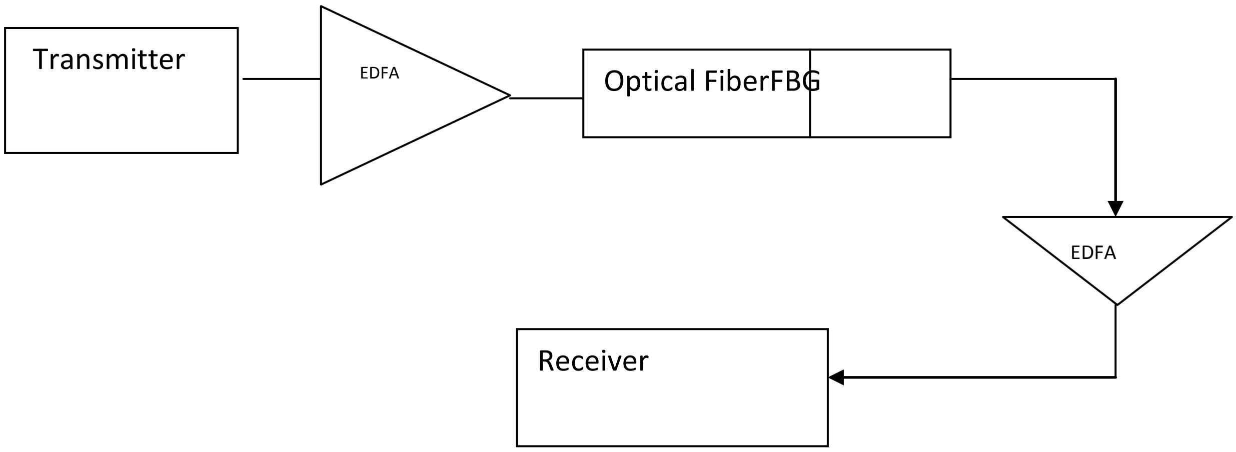

Figure 1.7 Post Compensation in FBG.

1.9.2 DCF (Dispersion Compensating Fiber)

DCF is a dispersion Compensating Fiber. It is used as a technique for updating the installed links which are created by using single mode fiber. DCF supports the negative dispersion value ranging from -70 to -90 ps/nm/km[6]. It can also used for compensating the positive dispersion of transmission fiber. The performance of WDM is decreased because of group velocity dispersion in the network. The smaller size of the DCF is suitable for mostly cases. Because it supports the low insertion loss value, low polarization mode dispersion value, low optical nonlinearity and high or large value of CD (Chromatic Dispersion) coefficient. The value of net dispersion is should zero when there is a negative DCF after a positive SMF. The equation is as follows[1]:

$$D_{SMF} \times L_{SMF} = -D_{DCF} \times L_{DCF} (6)$$

In equation (6), the variable D defines the dispersion and the variable L defines the Length of each fiber. DCF supports three configurations as follows:

1. Pre compensation
2. Post compensation
3. Mix compensation

1.9.2.1 Pre Compensation

Itrefers when the DCF of dispersion is placed before standard fiber so that the positive dispersion of standard fiber can be compensated.

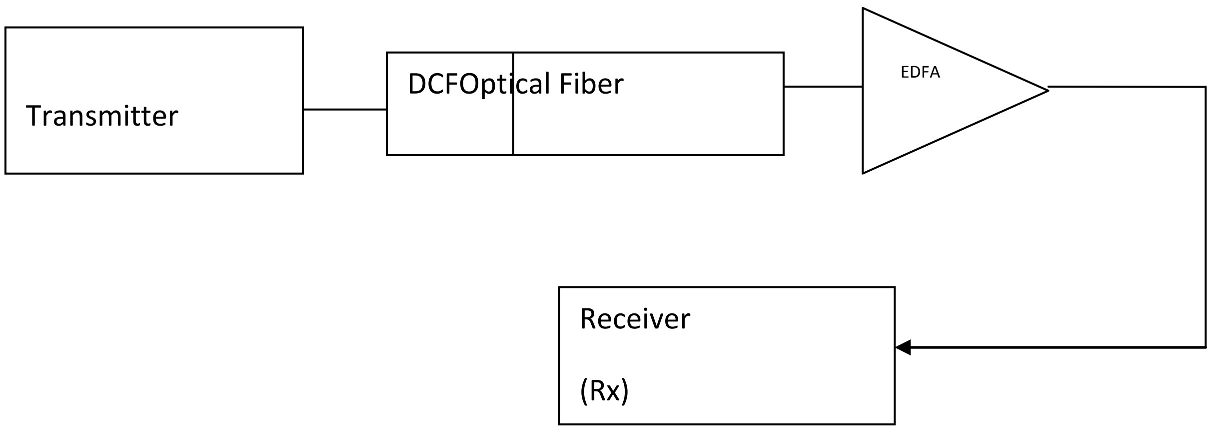

Figure 1.8 Pre Compensation in DCF [1]

1.9.2.2Post Compensation

Itrefers when the DCF of dispersion is placed after standard fiber so that the positive dispersion of standard fiber can be compensated

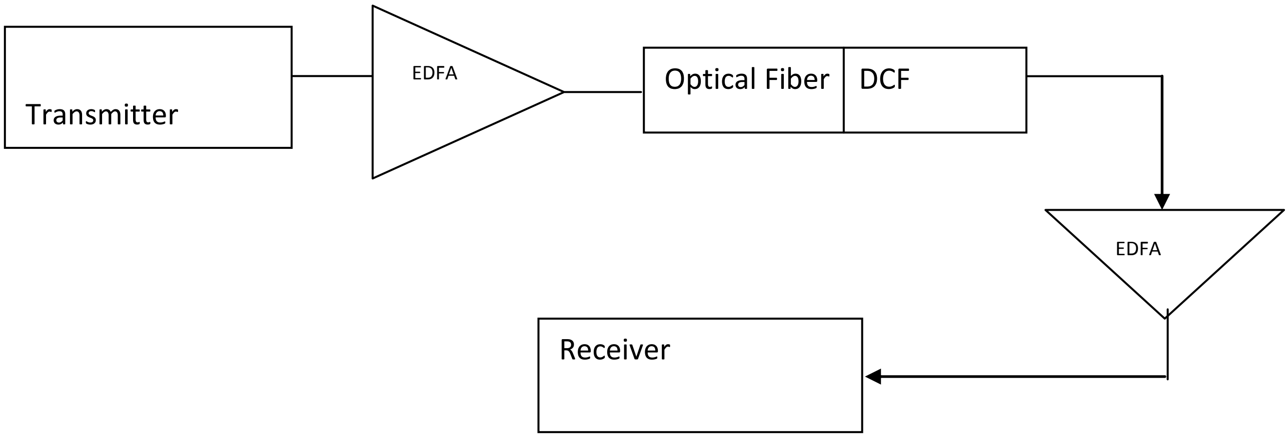

Figure 1.9 Post Compensation in DCF[1]

1.9.2.3 Mix Compensation

It referswhen the DCF of dispersion is placed before and after standard fiber so that the positive dispersion of standard fiber can be compensated.

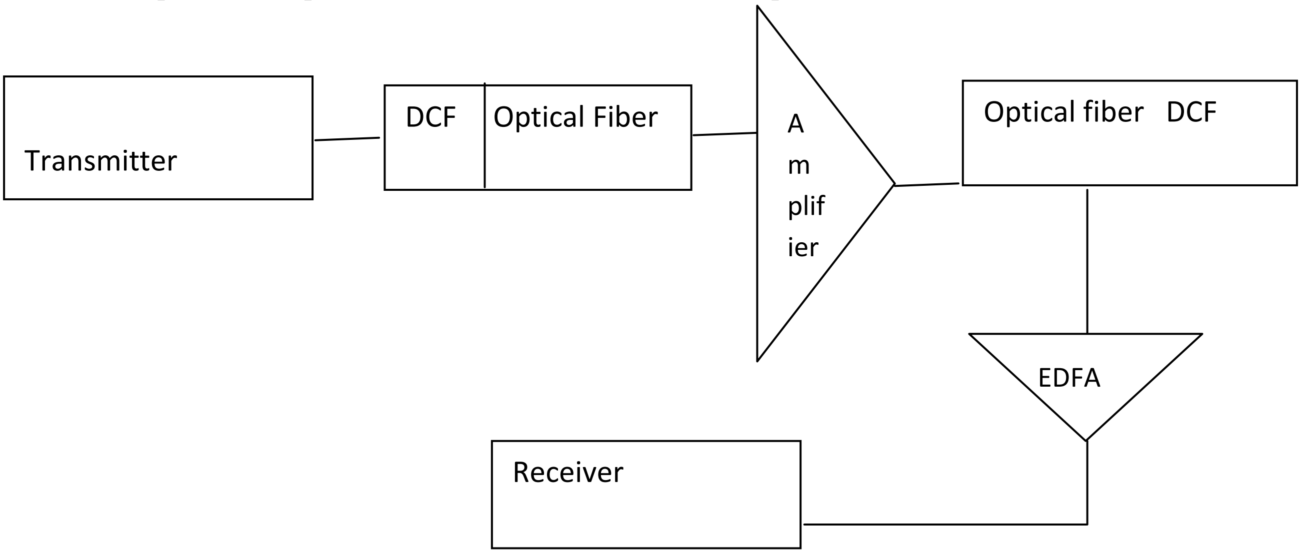

Figure 1.10 Mix Compensation in DCF[1]

Table 1 Comparison Table of DCF and FBG Compensation [2]

S.No	**Compensation Techniques**	**Q-Factor**	**Bit Error Rate (BER)**
1.	Pre Compensation using DCF	12.8	2.077e-38
2.	Post Compensation Using DCF	15.5	6.192e-055
3.	Mix Compensation using DCF	15.9	1.263e-057
4.	Pre Compensation using FBG	16.0	2.328e-058
5.	Post Compensation using FBG	16.3	2.478e-060

The table above shows the comparison between compensation techniques of FBG and DCF with respect to two parameters i.e. Q-Factor and BER (Bit Error Rate). In case of DCF compensation technique the Q-factor of mix compensation is better than the pre and post compensation whereas in case of FBG the Q-factor of post compensation is high as compare to pre compensation. And the BER ofmix compensation using DCF is quite less as compare to other techniques.

CHAPTER 2

LITERATURE REVIEW

ShubhamVerma, et al., "Design of full duplex radio over fiber (Fi-Wi) link through FBG", (2015) ,The use of network communication is increased day by day which left various negative impact on it. There are many lacking points in traditional network communication systems such as lower bandwidth, lower transmission data rate, lower coverage of area by network etc. These various shortcomings are overcome by introducing fiber optic communication system. Fiber communication system provides wider bandwidth, higher data transmission rate and large area coverage by the network, greater capacity, flexibility of the network etc. the proposed work is a combination of ROF with FBG along with DPSK and CPFSK. The results are calculated in the form of various parameters such as BER and Q factor. The results proves the efficiency of proposed work

A.M. Zin, et al., "An overview of radio-over-fiber Networks Technology", (2010), mobile and wireless networks are in trend now days. The requirement of wireless network is increased in order to overcome the various points such as to reduce the cell size so that large number of users can accommodated to it, to implement the microwave/millimeter waves so that the congestion in lower frequency bands can be removed. In order to create a reliable and efficient network the consisted bases station should be cost effective. The development of a cost-effective Base Station (BSs) is a key to be success in the market. Radio-over-fiber (ROF) technology is a promising solution for this requirement. So the optical fiber is used for removing theses discrepancies because it has various properties such as it facilitates the users with wider bandwidth, high rate of data transmission, loss less medium of data transmission, Optical fibers are attractive for ROF systems due to the following characteristics: very high bandwidth, low loss, immune to EMI, light weight, small cross section, low cost, and high flexibility. This lightens the various milestones in this technology.

Vagheshe Antony, et al., " Performance Improvement and Cost Reduction Techniques for Radio over Fiber Communications", IEEE, (2015) this is an overview to the various cost reduction methods or technologies used for ROF. These ROF techniques are candidate technology for future 5G generation of wireless networking systems. This provides a brief introduction or description about various terms which are related to ROF. The architecture of

ROF is explained by the author along with various techniques of ROF which are quite beneficial for enhancing the all over performance of a ROF communication system. The main focus of the work is to reduce the installation cost of the communication system.

Ting Su, et al., "Bidirectional multiband radio over fiber system based on polarization multiplexing and wavelength reuse", IEEE (2015), the proposed work is based on phase shift induced polarization modulation to intensity modulation combined with Mach-Zehnder modulator (MZM). The objective of this paper is to spawn multi-band signals. The results of proposed work matches the level of radio frequency, microwave and mm- waves signals.

Sara Rebhi, et al., "Perform evaluation of radio over fiber System at 60HGz for outdoor and indoor environment", IEEE, (2014), the need of high data transmission rates and wider bandwidth has been increased day to day with the increasing number of users. Fiber Optic along with radio frequency is invent as solution of this need of users. In this work the proposed work is simulated by considering a network which starts from central office to end user via various base stations. The analysis of the network is done on the basis of various measurements such as propagation environment of the whole system. The propagation models used are Rayleigh and Rician propagation model. The simulation is performed on both indoor and outdoor networks along with high data rates.

Jincy john, et al., "Design and simulation of a radio over fiber system and its performance analysis", IEEE,(2012), Fiber Optical communication has various plus points such as it supports data transmission in optic waves along with wider bandwidth. The WiFi with fiber optic cable provide real time multimedia facility to the users. The proposed work is simulated using Optisystem 10 and RF wireless systems pooled with optical fiber link model. The results of proposed work are shown in the form of parameters such as BER and Q-factor. The simulation is performed in MATLAB.

FabriceMfuamba, et al., "Adaptive performance improvement of fiber Bragg grating in radio over fiber", Scientific research, (2016), ROF is a transmission system which is a combination of radio frequency and fiber optic system. This combination facilitates the end user with a higher range of data transmission along with lower cost incurred on components to install the network. The Fiber optic is recent field for researchers for research work. The use FBG (Fiber Brag Grating) comes into existence from last few years. The FBG is used for compensation of dispersion in communication which highly boost the performance of the network.

Lin cheng, et al., " Coordinated Multipoint Transmissions in Millimeter-Wave Radio-over-Fiber Systems", IEEE, (2015), In this paper author explains that radio over fiber technology is a combination of two techniques wireless and fiber optic networks. It is an preferable and important technology used to access broadband in case of wireless networking systems applications of ROF system is last mile solutions, existing radio coverage and capacity etc. The proposed technique is the combination of various coding paradigms by using large number of useful parameters. The results of proposed work lead to the high performance with respect to numerically point in radio over fiber communication system. The results are calculated on the basis of following parameters such as transmission of data with respect to bit rates and product per channel on the basis of single mode fiber. The various coding techniques used in proposed work are Return to Zero (RZ), NRZ i.e. Non return to Zero etc. the work improvement is proved by calculating BER and PSNR of the proposed technique and then compared by traditional optical communication system.

Anthony Ng'oma, et al., "Radio-over-Fiber Technologies for Multi-Gb/s Wireless Applications", (2013),the proposed work is based on multi-Gb/s wireless distribution at mm-wave frequency. Various signal processing techniques are used in this work. The results after simulations prove ultra high capacity data transmission at greater than 50 Gb/s.

Junwenzhang, et al., " Full-Duplex Quasi-Gapless Carrier-Aggregation using FBMC in Centralized Radio-over-Fiber Heterogeneous Networks", IEEE,(2016), In this work the proposed work is done for implementing the full duplex asynchronous quasi-gapless for MMW-ROF-RAT i.e. Milli Meter Wave Radio Over Frequency Radio Access Technology. The one word used for this is FBMC i.e. Filter Bank Multicarrier. The work is implemented by considering the 5G heterogeneous Mobile Data network. In this the 14 banded FBMC signals are agglomerated with single carrier guard band in 60-GHz downlink system. The same work is also implemented for uplink networks. The performance of FBMC with OFDM system is analyzed. The results prove that the proposed FBMC is suitable for LTE system. The comparison of FBMC is done with OFDM systems n the basis of various parameters such as spectral efficiency with EVM and hence it is proved that the FBMC has better spectral efficiency.

Pooja, et al., " Advantages and Limitation of Radio over Fiber System ", In this paper author explains that radio over fiber technology is a combination of two techniques wireless and fiber optic networks. It is an preferable and important technology used to access broadband in case of wireless networking systems applications of ROF system is last mile solutions, existing radio coverage and capacity etc. In this paper pros and cons of ROF system is explained by author. Various techniques which are used to transfer the Radio signals by using fiber is also define in this. Idea behind the usage of radio over frequency technology is also given by the author.

Naresh Kumar, et al., "A Review Paper On Radio Over Fibre Technology"(2011),In this paper author defines that radio over fiber is a technology which is used to control the traffic over the wireless communication networking system. It is a technique which is created by using two techniques collectively. The techniques which are used for creating ROF are fiber optic and wireless. Hence it transfers the data in the form of light by using fiber optic cables as a medium of transmission. In this advantage along with disadvantages of the radio over fiber system is explained. Author also represents some techniques which are used in ROF for data transmission. Some applications of radio over fiber technology is also described like ROF is used in backhaul etc.

D.Wake, et al., "Radio over Fiber Systems for Mobile Applications"(2005) In this author reperesents a scenario of ROF in which low cost optoelectronic components are used for distributing data over various antennas. Whereas in ROF systems complex and costly equipments are used to transfer the data over the wireless network. In this various design issue regarding ROF system is discussed along with another parameters like bandwidth supported by the channel, modulation frequency of the channel and sub carriers in OFDM. Hence it is proved that noise introduced in the signals does not effects much more on range of the signals in wireless network. From the cost point of view ROF is best technology to be used as compare t5o other technologies. It also best in performance parameters as others are not that much better.

Ali Hussein Radhi, et al., " Performance Analysis of Radio over Fiber System with Ook Based Dwdm for Fiber to Home Network", (2015) ,In this paper author describes that to reducing the Bit Error rate of lowest power penality in case of ROF system is quite a major problem. In this paper performance of WFDM system which poses the 5 GbpsOOk signals and 5 base station in 6 km area is evaluated. In this paper it is shown by the author that the proposed technique has less BER and is much efficient as compare to other techniques. The value received of BER in proposed technique is negotiable in case of multimedia and real time application.

A**. J. Cooper, et al., "Fiber/Radio for the provision of cordless/mobile telephony services in the access,"**A four channel CT2 fibre/radio system has been demonstrated over single-mode fibre using subcarrier multiplexing techniques. A spurious free electrical dynamic range of 51 dB was achieved which is sufficient for a mobile range of approximately 100 m. The use of subcarrier multiplexing simplifies the design of the radio transceiver and allows complex processing equipment to be located at the local exchange

SreeneshShashidharan ,et al., "Design and Simulation of Radio Over Fiber System and its Performance Analysis using RZ coding (**2015**)"A Radio Over Fiber has the special characteristic feature of having both a fiber optic link and a free space radio path. Fiber based wireless (Fi-Wi) access facilitates high-capacity multimedia services in a real-time basis. The simulation model developed using Optisystem 10 have integrated systems for both RF wireless and optical fiber whereby, the ROF network model consists of a central station, a remote access unit and an optical fiber link model that uses the commercially available parameters. We also investigates the variations in Q-factor, BER and eye opening with respect to the wavelength, bit rate and fiber length using the simulation software.

Harpreetkaur, et al., "Comparison of NRZ and RZ data modulation formats in SAC-OCDMA system under introduced clock timing jitter of laser diode "(2013), This paper presents the implementation of optical fiber in SAC-OCDMA system along with different modulation schemes or formats. The use of optical fiber has been increased from last few decades since it has various advantages of use such as small in size, flexible in nature, wider bandwidth, high data transfer rates etc. The fiber optic used in this work are corning submarine, corning LEAF, corning TITAN and Alcatel 6900. The implementation of these fiber optics are compared with the implementation of various coding techniques such as NNRZ and RZ formats. The results shows that the NRZ has better performance as compare to other techniques. The performance of the whole system is measured in BER. The performance or BER of corning marine is better than other fiber optics hence it is advised that this can be used in near future for better performance of the network.

Arya Mohan, et al., "Full Duplex Transmission in ROF System using WDM and OADM Technology " (2015), Radio over Fiber (ROF) is a technology where light is modulated with radio frequency signals and transmitted over the optical fiber to facilitate wireless access and transmission. The convergence of wired and wireless networks is a promising solution for the increasing demand of transmission capacity and flexibility, as well as offering economic advantages due to its broad bandwidth and low attenuation characteristics. The full duplex transmission of ROF is accomplished by means of Wavelength Division Multiplexing (WDM) and Optical Add Drop Multiplexer (OADM), where WDM enables transmission of different signals through a single mode fiber over large distance and OADM permits transmission of both down-link and uplink data via the same single-mode fiber. In addition, the performance analysis of ROF system employing various line coding techniques has also been done. The simulation is done using a commercial optical system simulator named OptiSystem 12.0 by Optiwave.

Osama A, et al., "High Transmission Capacity Performance of Radio Over Fiber System for Short and Long Distances " (2013), Inthis paper evaluates the various parameters that directly effects the performance of the optical transmission system. The evaluation has been done in order to investigate the transportation of the signals over short range with multimode graded index and over a long range data transmission with single mode silica dropped fiber optic cable. It is evaluated that the transmission capacity of the optical fiber system is due to wider bandwidth and lower attenuation energy for both large or distance transmission in network. The performance of proposed work is analyzed parametrically as well as numerically and hence proved that the it has better efficiencies and reliable as compare to traditional. The observed results shows that the transmission bit rates in single mode silica and multimode graded index fiber are better than the traditional ones. The whole system was implemented by considering the CWDM, DWDM and MTDM techniques.

Shuvodip Das, et al., " Modeling and Performance Analysis of ROF System for Home Area Network with Different Line Coding Schemes Using Optisystem" , **(2014),** Optical communication has various plus points such as it supports data transmission in optic waves along with wider bandwidth ROF is a transmission system which is a combination of radio frequency and fiber optic system. This combination facilitates the end user with a higher range of data transmission along with lower cost incurred on components to install the network. It is an preferable and important technology used to access broadband in case of wireless networking systems applications of RoF system is last mile solutions, existing radio coverage and capacity etc. It is an preferable and important technology used to access broadband in case of wireless networking systems applications of RoF system is last mile solutions, existing radio coverage and capacity etc. The techniques which are used for creating ROF are fiber optic and wireless. Hence it transfers the data in the form of light by using fiber optic cables as a medium of transmission In this various design issue regarding ROF system is discussed along with another parameters like bandwidth supported by the channel, modulation frequency of the channel and sub carriers in OFDM. The simulation is done by considering the Optisystem 12 and the performance is measured in the form of various parameters such as Q-Factor, BER, eye height and threshold of bit rate and fiber length of various line coding methods.

Virendrakumar, et al., "Design and Performance Analysis of Optical Transmission System"(2014), Fiber Optical communication refers to a technology whereby mild is modulated through a radio signal and transmitted over an optical fiber link to facilitate Wi-Fi get right of entry to, inclusive of 3G and Wi-Fi simultaneous from the equal antenna. In this work the author focuses on long term long Haul optical transmission system with respect to both chromatic dispersion and non linearity. Loop control is also preferred by this work as it is a vital component and as simple and it also enhances the length of optical fiber. For amplifying the signals EDFA is used. The aim of this work is to measure and analyze the performance of the optical system by using two various modulation schemes i.e. NRZ and RZ. The purpose behind using the NRZ modulation is to shun the occurrence of ISI on an optical carrier wave. As each and every modulation scheme has some pros and cons over each other therefore the performance of both modulation schemes are analyzed. The results and performance is calculated on various parameters such as Q-Factor, BER, eye diagram, average input power in order to found advantages and disadvantages of RZ modulation scheme.

AbdEl–Naser A. Mohamed, et al., " Transmission Characteristics of Radio over Fiber (ROF) Millimeter Wave Systems in Local Area Optical Communication Networks"

(2011), The paper proposed a new technique for ROF which allows the transmission of radio frequency signals by using optical fiber cable. The optical fiber is used because it has various positive points such as it is a loss less data transmission medium, light weight, provide larger bandwidth for data transmission, small size, economically cheap, flexible and easy to maintain. The proposed work use the MTDM i.e. Maximum Time Division Multiplexing technique to enhance the performance of ROF system and it is collaborated with multi bit rates with the help of various transmission techniques such as Soliton and MTDM etc. the proposed work is implemented by using the 4 link space division multiplexing and multi channels dense wavelength division multiplexing.

S. pachnicke , et al., "Fiber Optical Transmission Systems", (2013), this study provides a review to the use of ROF in WDM communication system. WDM is wavelength Division Multiplexing communication system which uses the concept of fiber optic for data transmission. The points or properties which are covered under this study are layout of WDM system along with its characteristics and components such as transmitter, receiver, optical amplifiers etc. various properties of various components are also described briefly in this work. This paper can be helpful to various researchers to have an view over ROF in WDM topic.

Mohamed, et al. , "High Transmission Performance of Radio Over Fiber Systems over Traditional Optical Fiber Communication Systems Using Different Coding Formats for Long Haul Applications", **(2013**), **R**OF is a Radio over fiber communication system which is in use now days. It has various recompense such as wider bandwidth which supports the high capacity of transmission, flexibility of the network, Low attenuation, economically cheap to install etc. In this work the ROF system is compared with traditional optical communication system. The proposed technique is the combination of various coding paradigms by using large number of useful parameters. The results of proposed work lead to the high performance with respect to numerically point in radio over fiber communication system. The results are calculated on the basis of following parameters such as transmission of data with respect to bit rates and product per channel on the basis of single mode fiber. The various coding techniques used in proposed work are Return to Zero (RZ), NRZ i.e. Non return to Zero etc. the work improvement is proved by calculating BER and PSNR of the proposed technique and then compared by traditional optical communication system.

Xiaoqiong qi et al. , "Fiber Dispersion and Nonlinearity Influences on Transmissions of AM and FM Data Modulation Signals in Radio-Over-Fiber System" (2010), The transmission characteristics of Amplitude Modulation and Frequency Modulation in Radio over Fiber transmission system is revised numerically in this work. The dispersion leaves an impact on micro modulation scheme by effecting signals with double side band, single side band and optical carrier Suppression. The various effects of dispersion on signals is briefly introduced and distinguished in this work. The problem of power fluctuation on both side i.e. base station and end user is also calculated and analyzed by this work. The proposed work is implemented by using Simulation in MATLAB. The observed results prove that the power fluctuation or other power related problems can be reduced to a greater extent by using modulation depth in AM.

CHAPTER 3

PROBLEM FORMULATION AND PROPOSED WORK

3.1Problem Formulation

As we know the use of fiber optic cables has been increased with the enhancement in the technology and the users of fiber optic communication is also increased to a greater extent. As the use of this technology is increased it leads confinement to various problems in communication. The main problem that rises in this is chromatic dispersion. Dispersion is a term which defines that the pulse or signals gets scattered or distorted due to the inconsistency in the frequency of the signals and modes of the light pulse. This can affect the signal's quality to an extent hence they can lead to error in the network. In single-mode fiber optic system the performance of the system is affected by CD i.e. Chromatic Dispersion. The reason behind the occurrence of CD is that the signals that are multiplexed are of different colors and each color have different wavelength. To overcome this problem dispersion compensation is used. Dispersion compensation is a term which is referred to remove the effect of Chromatic dispersion on the signals by using various compensation techniques. Hence there is a need to develop such a dispersion compensation system or method which reduces or vanishes the effect of chromatic dispersion on various signals while communication.

3.2Proposed Work

There are various techniques available which can remove the effect of chromatic dispersion on the optical signals. The use of optical signals with radio frequency is one of the options for dispersion compensation. In proposed work grating equalization technique is used along with various dispersion compensation components. In order to compensate the effect of chromatic dispersion optical filters are used. DCB grating is used in proposed work and it includes IDCG, FBG, GOF. All of these are compensation components. For implement the proposed work SMF for 40Gbps data rate is considered. The results are calculated in the form of various parameters such as BER, Q-factor in different input power levels.

3.3Objectives of the Study

The main objectives for the proposed work are:

- To replace the traditional modulation format RZ (Return-to-Zero) with the advanced modulation format MRDZ for better and proficient results in chromatic dispersion.
- To analyze the different filter with for comparison and acquire the best out of them.
- To change the input Coding scheme to enhance the system performance.
- To update model with replacing the existing RZ modulation technique by advanced coding techniques scheme.
- To design and implement the existing system for analyzing the present work.

CHAPTER 4

RESULT METHODOLOGY

The methodology of the proposed model 1 and proposed model 2 are mentioned below where RZ modulation has been replaced with the MDRZ in the proposed model. In the first proposed model, GOF filter has used whereas in the proposed model 2 BOF has used in order to compensate the effect of chromatic dispersion. The implementation of the proposed model 1 and 2 are:

4.1 Proposed Model 1

1. Initially, MDRZ pulse generator generates the information which has combined with the Laser and then forwarded to the modulator.
2. Modulator sends the information to the DCB using fiber which has further consists of three dispersion compensation components i.e. FBG, IDCG and GOF which is used to reduce the group delay.
3. Further, the Low pass filter is used to reduce the effect of chromatic dispersion by removing the noise.
4. Lastly, analyze the effect of input power on BER through BER analyzer.

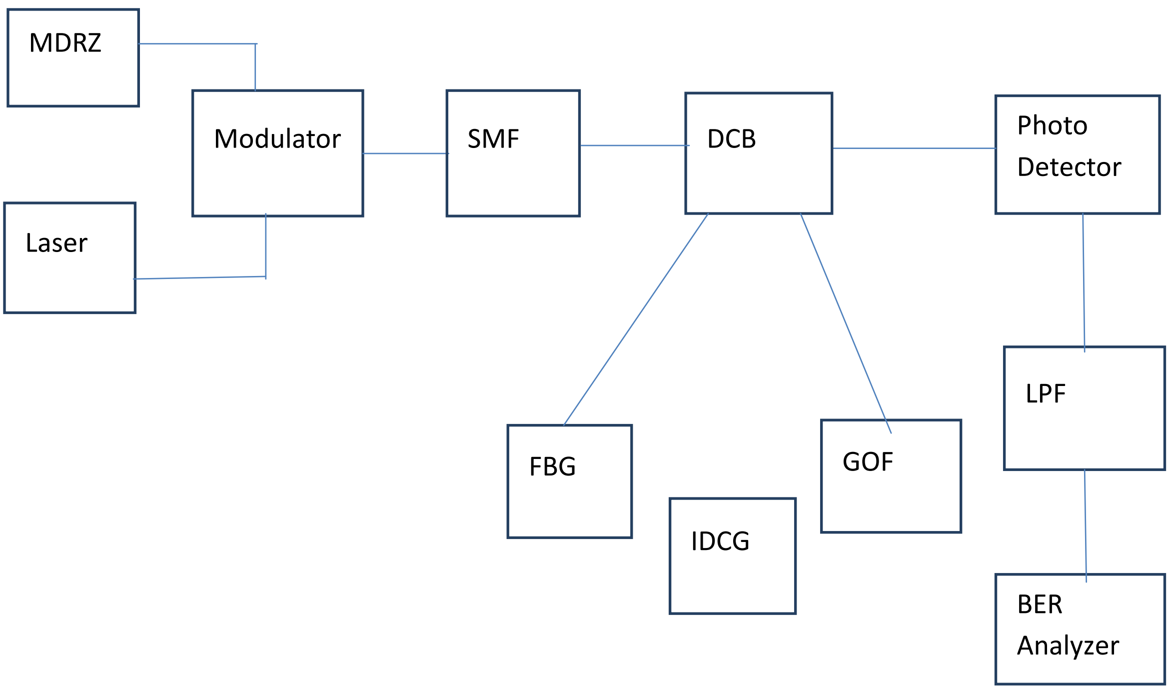

Figure 4.1 Proposed Model 1.

4.2 Proposed Model 2

The proposed model 2 has a replacement of GOF with BOF filter in order to reduce the effect of chromatic dispersion. Experimental analysis has performed for both models in an attempt to acquire the effective and efficient results. The rest proposed model 2 works same as proposed model 1.

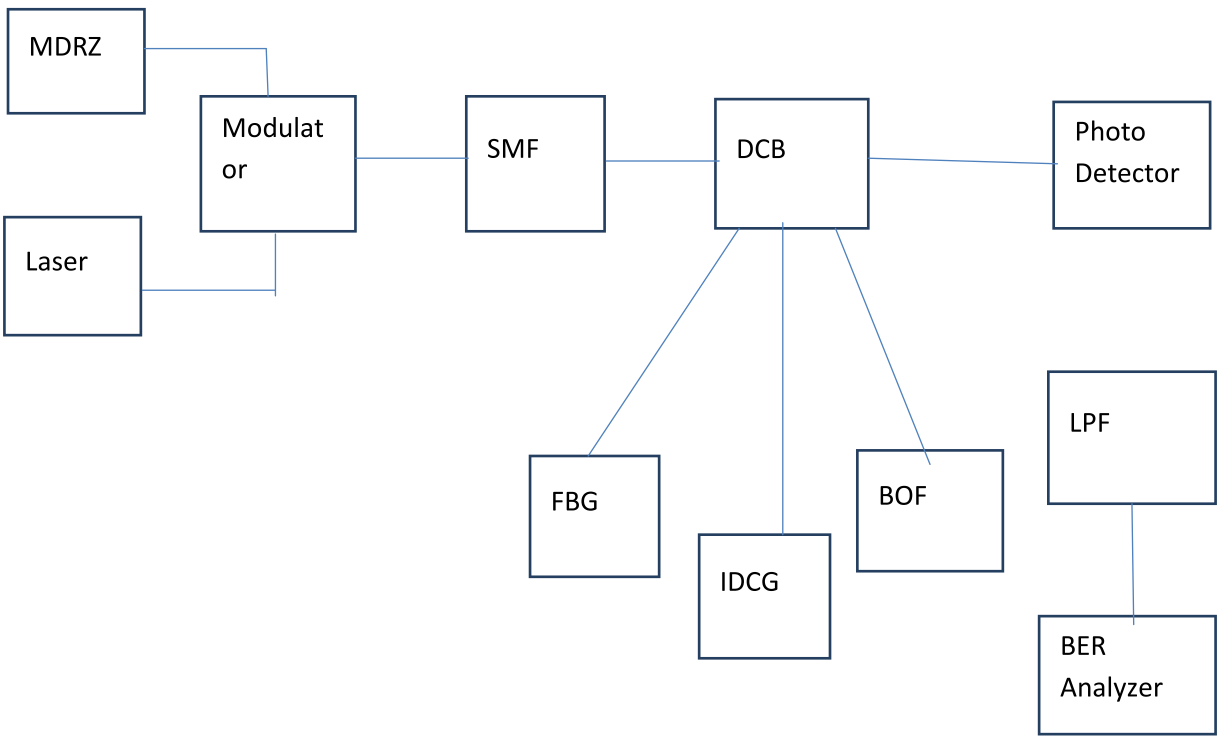

Figure 4.2 Proposed Model 2.

CHAPTER 5

RESULT AND DISCUSSION

In this chapter of the thesis, the results which have acquired after performing paper and proposed model are acquired. The simulation analysis has done under different parameters such as BER, eye height, threshold and Q-factor with the variations of Power and Distance i.e. length.

Figure 5.1 represents the Q-factor of the proposed model with GOF i.e. Gaussian Optical filter where optical fiber length remains constant i.e. 200 and power has been varying from 5 to 14 dBm. Q-factor with the increase in power has also been increasing which is effective for the system.

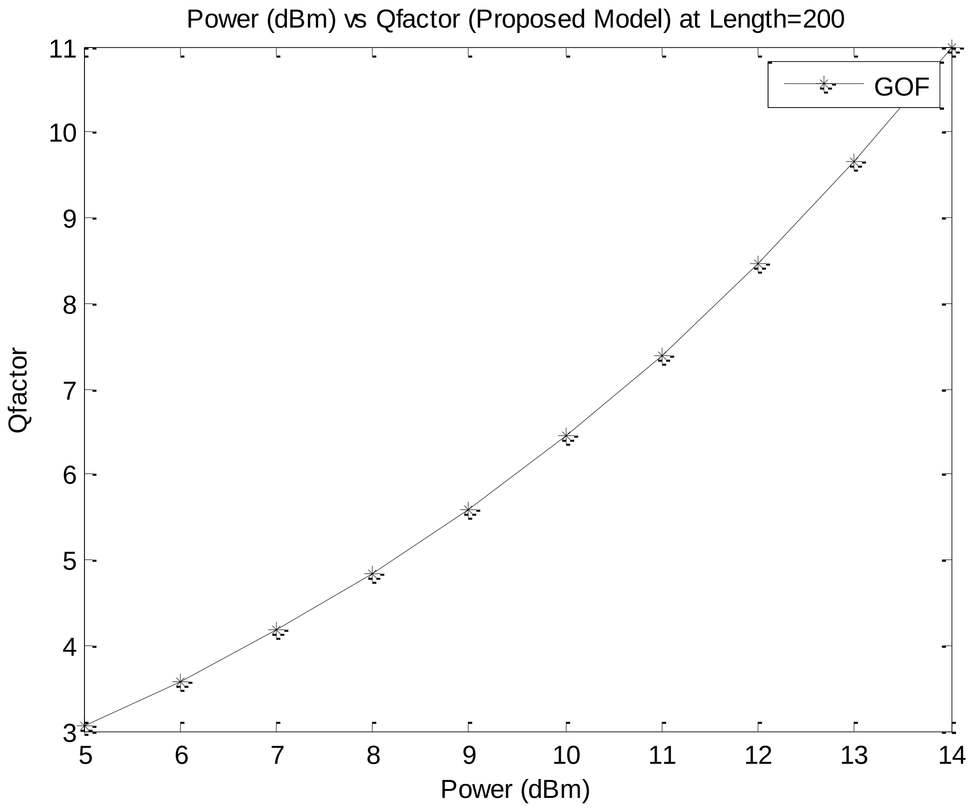

Figure 5.1 Power Versus Q-factor of the Proposed Model with GOF.

Figure 5.2 shows the power vs. BER of the proposed model with GOF where power has been varying from 5 to 14 dBm and length remains constant.

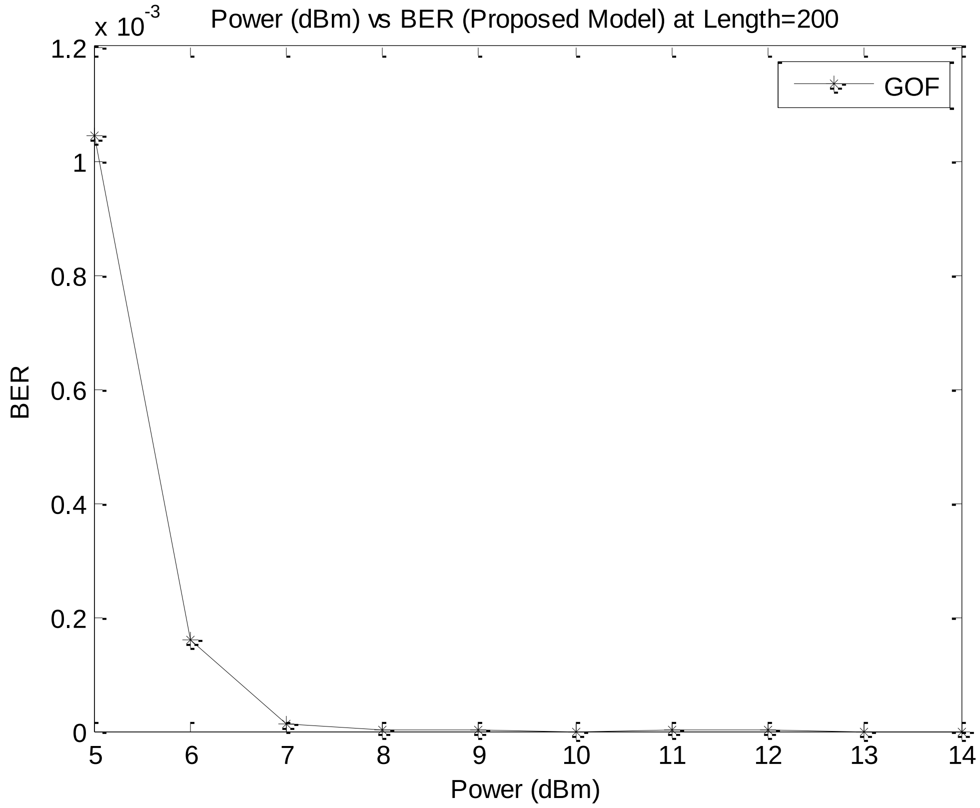

Figure 5.2 Power versus BER of the proposed model with GOF.

Below figure 5.3 and 5.4 shows the analysis of the parameter eye height and threshold versus power with proposed GOF respectively which shows that the length of the optical power which is constant at 200 and power has been varying from 5 to 14 dbm.

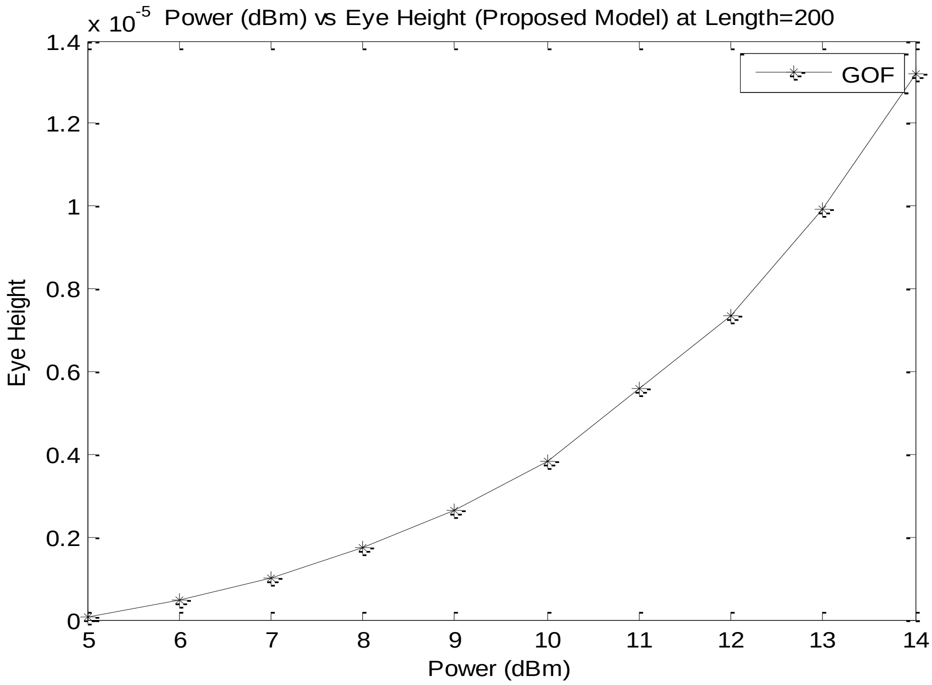

Figure 5.3 Power vs. Eye Height of the Proposed Model at Constant Optical Length i.e. 200KM.

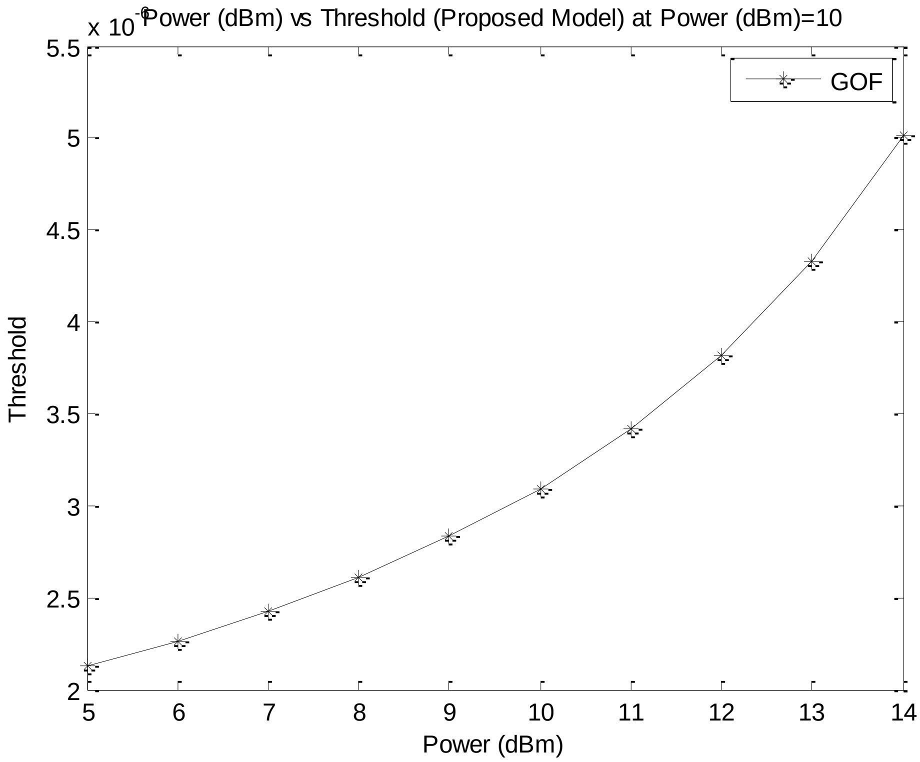

Figure 5.4 Power vs. Threshold of the Proposed Model with GOF at Power 10 dBm

Figure 5.5 represents the Q-factor of the proposed model with GOF i.e. Gaussian Optical filter that shows that with the increase in distance Q-factor has been decreasing but the initial value of the Q'factor was efficient i.e. 7.5. Power has been constant i.e. 10 dBm where length has been changing or having variations.

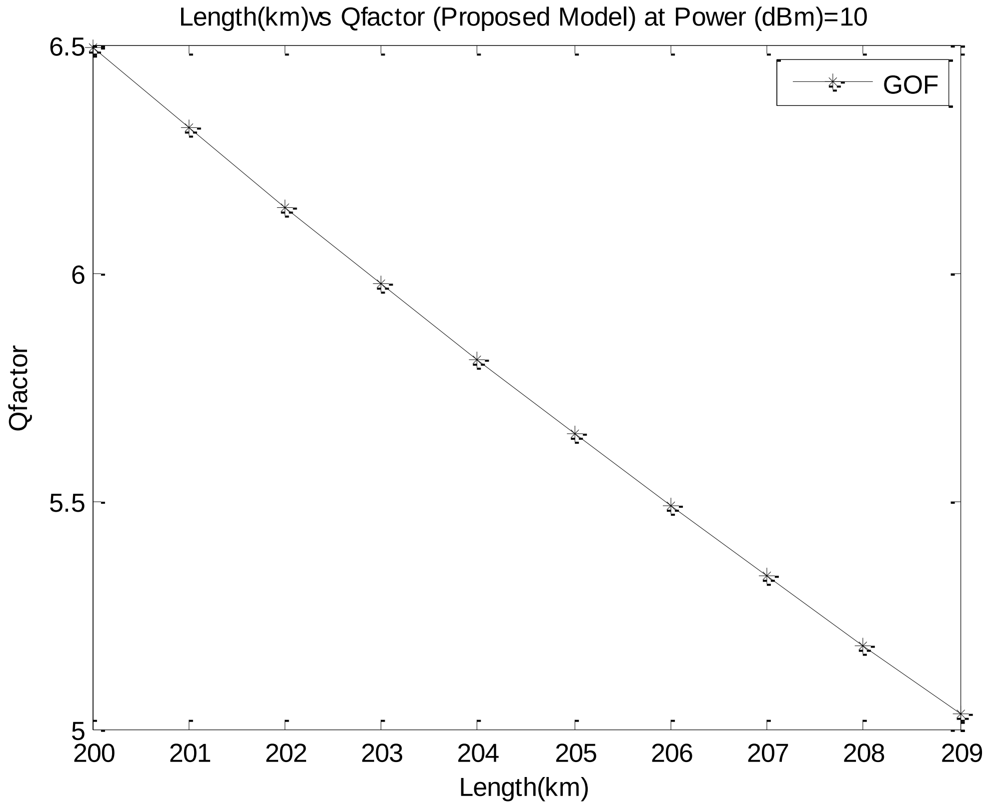

Figure 5.5 Q-factor parameter with respect to Length at Constant Power of 10 dBm.

Figure 5.6 shows the proposed model in terms of BER with respect to length at a constant power of 10 dBm. BER of the proposed model with GOF has been decreasing which is excellent for the system. At initial stage of the proposed model, the value of the BER is decreased but with the variations in the distance, BER has been increasing. Therefore, with the high distance, there is a possibility of little change in BER parameter.

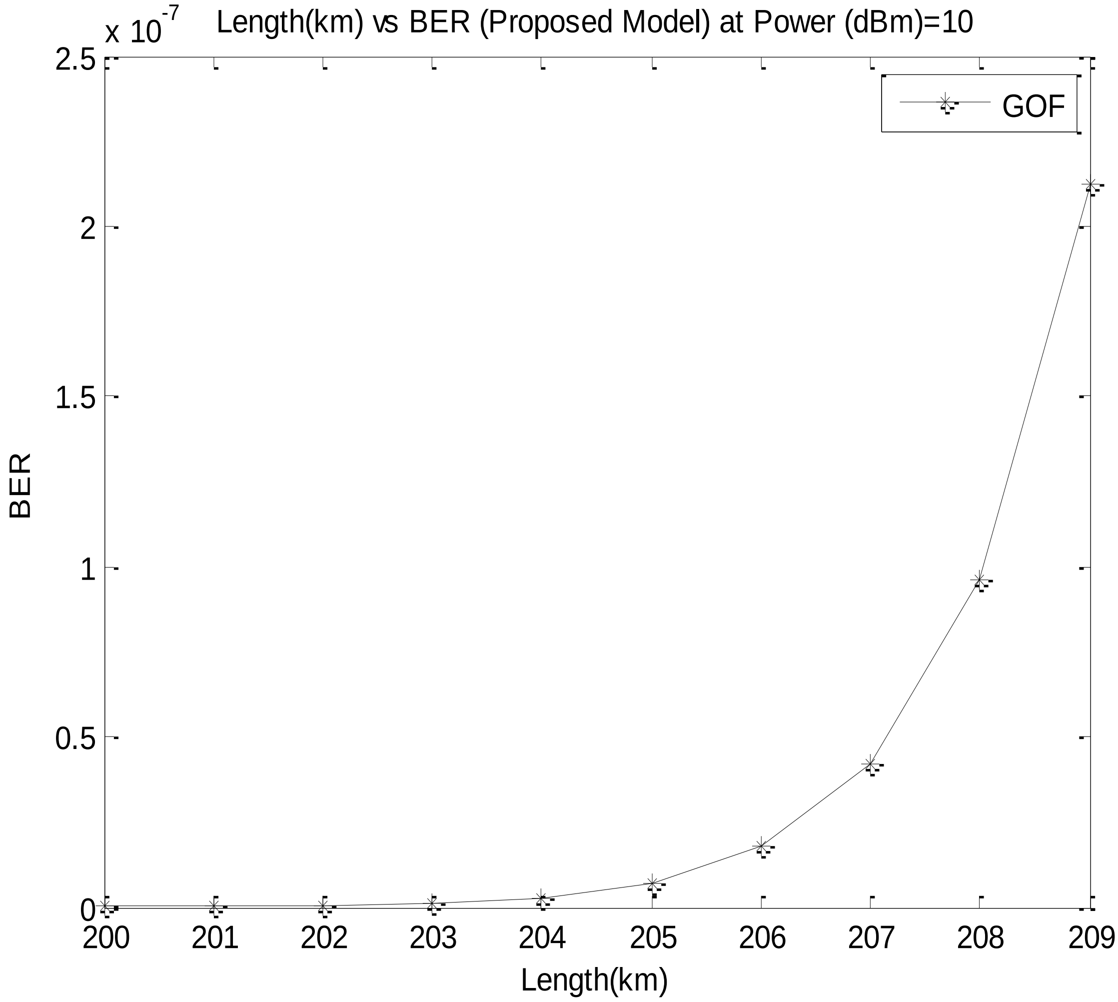

Figure 5.6 BER parameter with respect to Length at constant power of 10 dBm

Figure 5.7 shows the eye height of the proposed model with GOF whose value has been decreasing with the number of variations in the length or distance. Below figure has been analyzed at 10 dBm constant power. Decrement in the height of the eye has shown the efficiency of the proposed model.

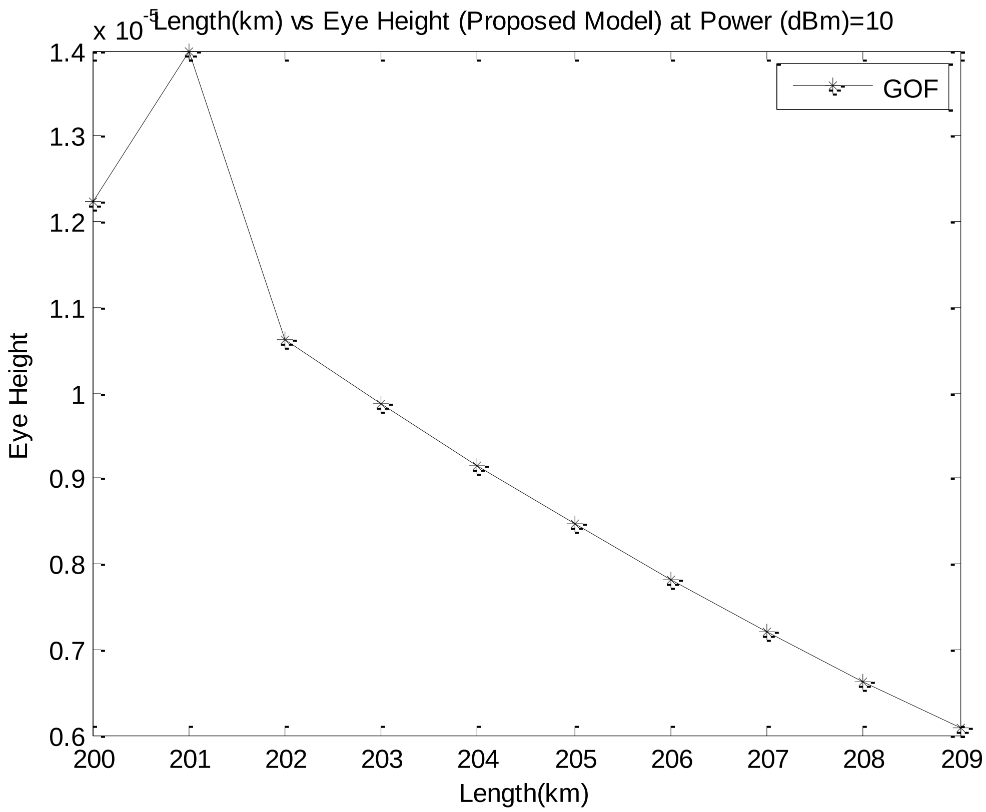

Figure 5.7 Eye Height of the proposed model with respect to Length at constant power of 10 dBm

Figure 5.8 describes the threshold parameter of the proposed model in terms of length and power where length parameter has been varied and power remains constant at 10dbm. Initially the value of the threshold lies nearer to the 9.8, with the variations in the length, threshold has also been decreasing.

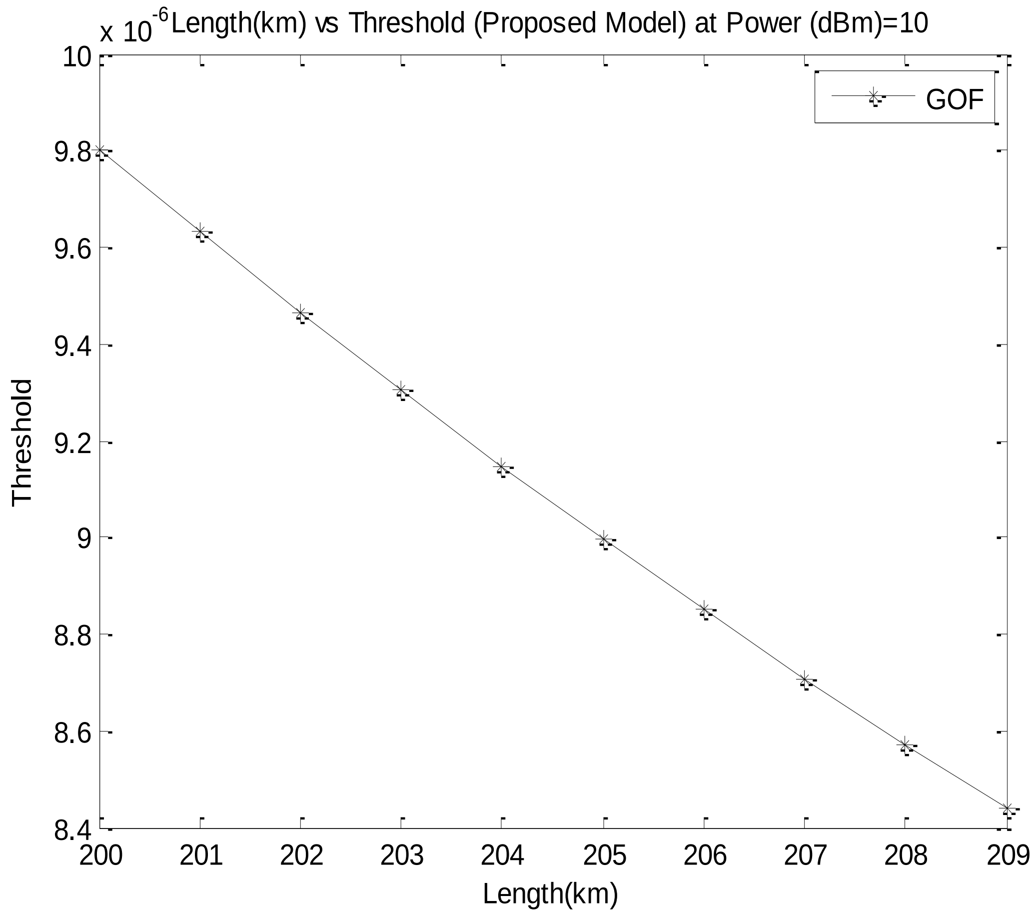

Figure 5.8 Threshold of proposed model with respect to Length at constant power of 10 dBm

Figure 5.9 represents the proposed model with BOF i.e. Bessel Optical Filter where Optical fiber length remains constant i.e. 200kms and power has been varied from 5 to 14 dBm. Q-factor of the proposed model has been increased with the increase in power that shows the effectiveness of the system with BOF.

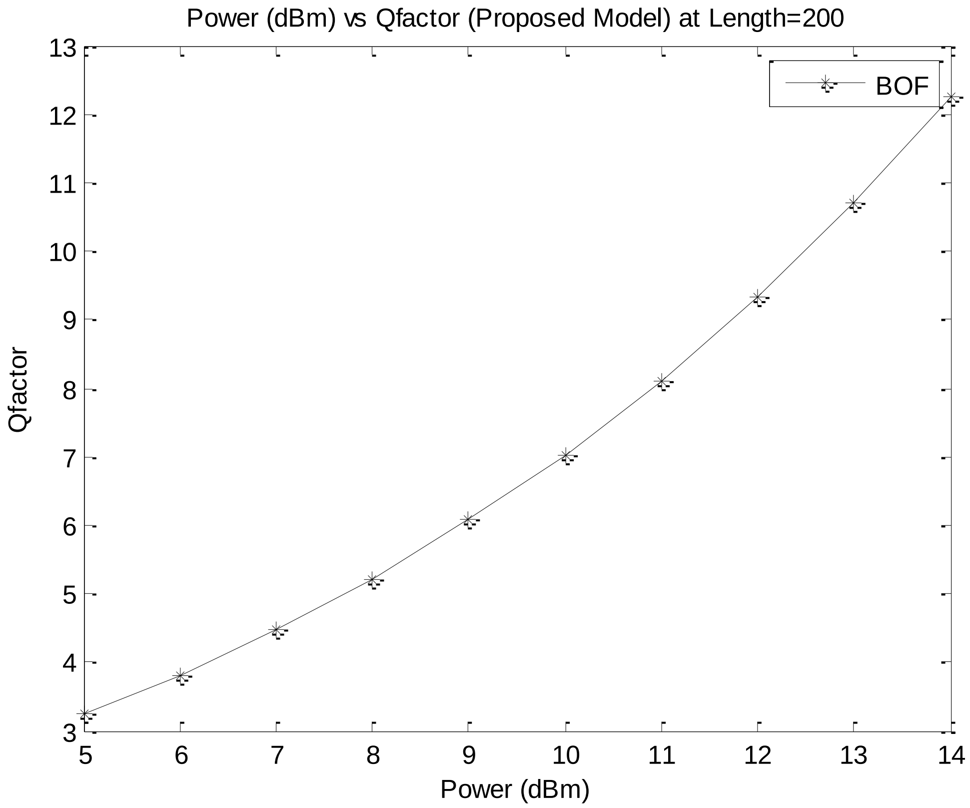

Figure 5.9 Q-factor of the proposed model with respect to Power and at constant optical fiber length i.e. 200 KM.

BER of the proposed model has shown in the below figure where length of the optical fiber is fixed and power has changed from 5 to 14. With the increment in the power, BER has also decreased which is quite effective for the proposed model. Initially BER was high, but with the increment in power, it has been decreasing.

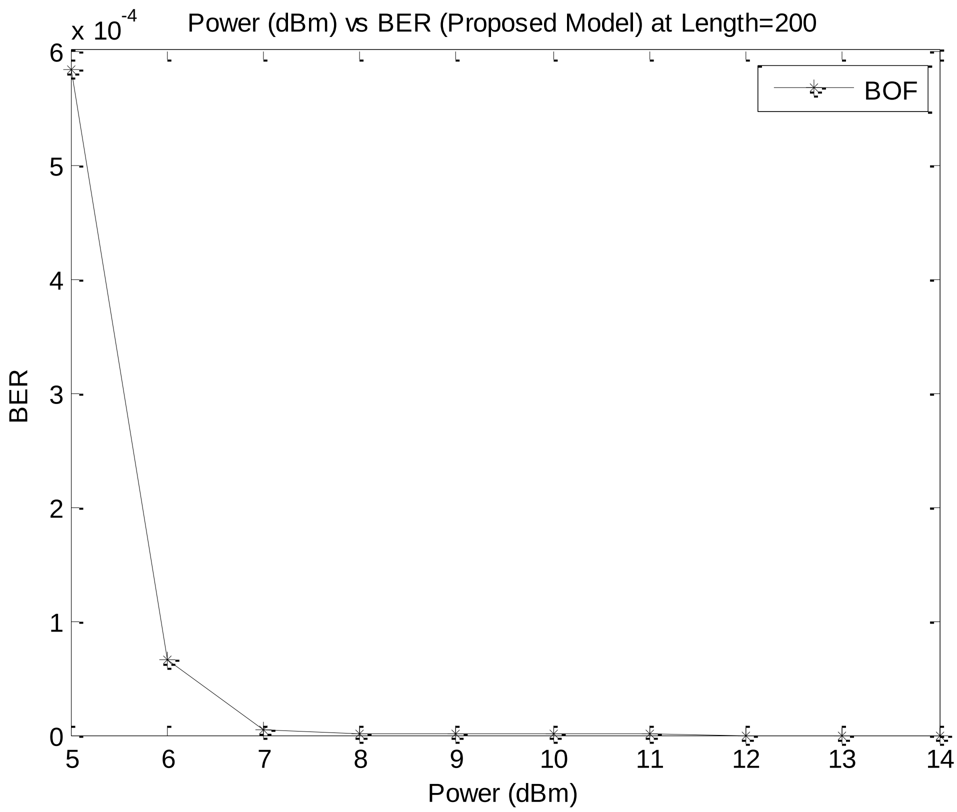

Figure 5.10 BER of the proposed model with respect to Power and at constant optical fiber length i.e. 200 KM

Figure 5.11 shows the eye height of the proposed model with BOF where with the increase in power, height of the eye has also been increasing. Length of the optical fiber remains constant i.e. 200 and power has been varied accordingly for the simulation analysis.

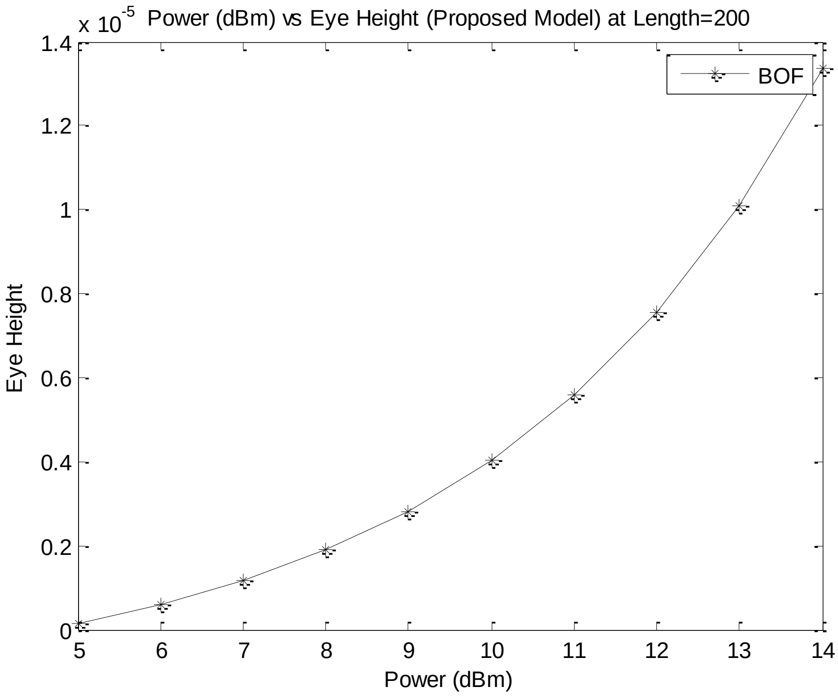

Figure 5.11 Eye Height of the proposed model with respect to Power and at constant optical fiber length i.e. 200 KM.

Figure 5.12 below shows the threshold parameter of the proposed model with BOF on the basis of power and length.

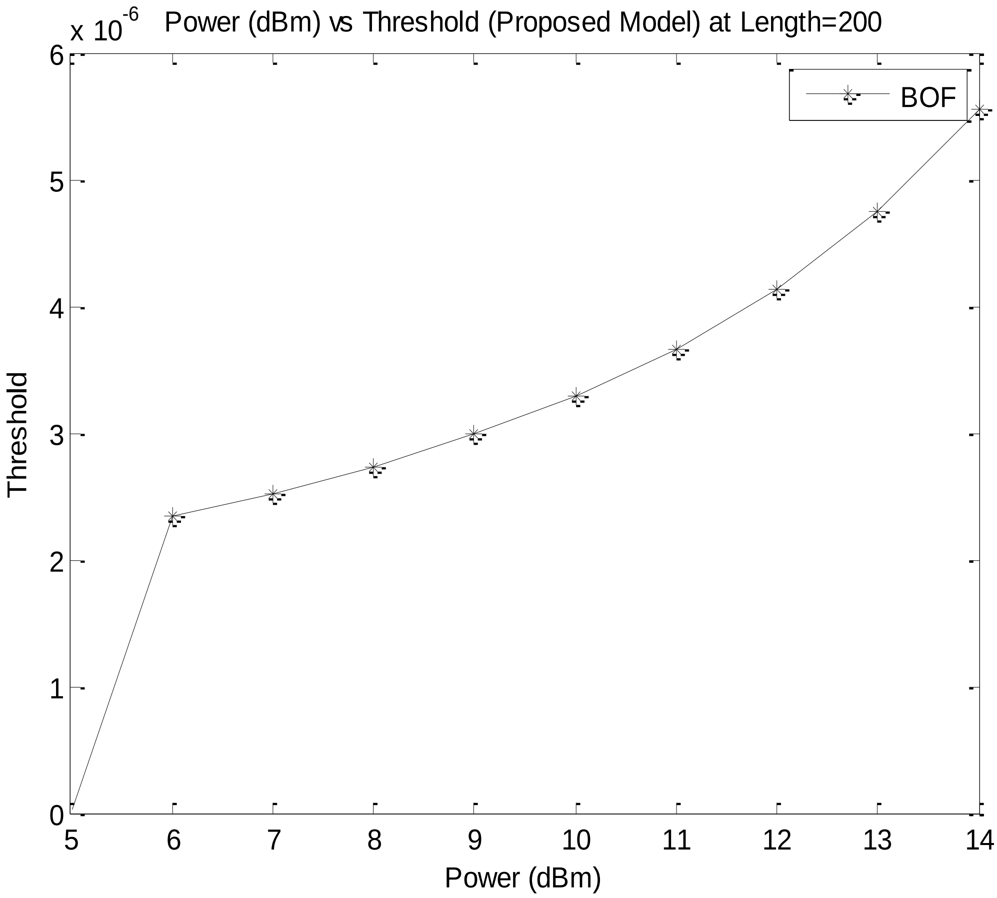

Figure 5.12 Threshold of the proposed model with respect to constant length and varying power.

Below simulated graph shows the BER, eye height, threshold and Q-factor parameter of the proposed model with GOF with respect to the length of the optical fiber where power remains constant at 10 dBm and length has been varying from 200 to 209 kms.

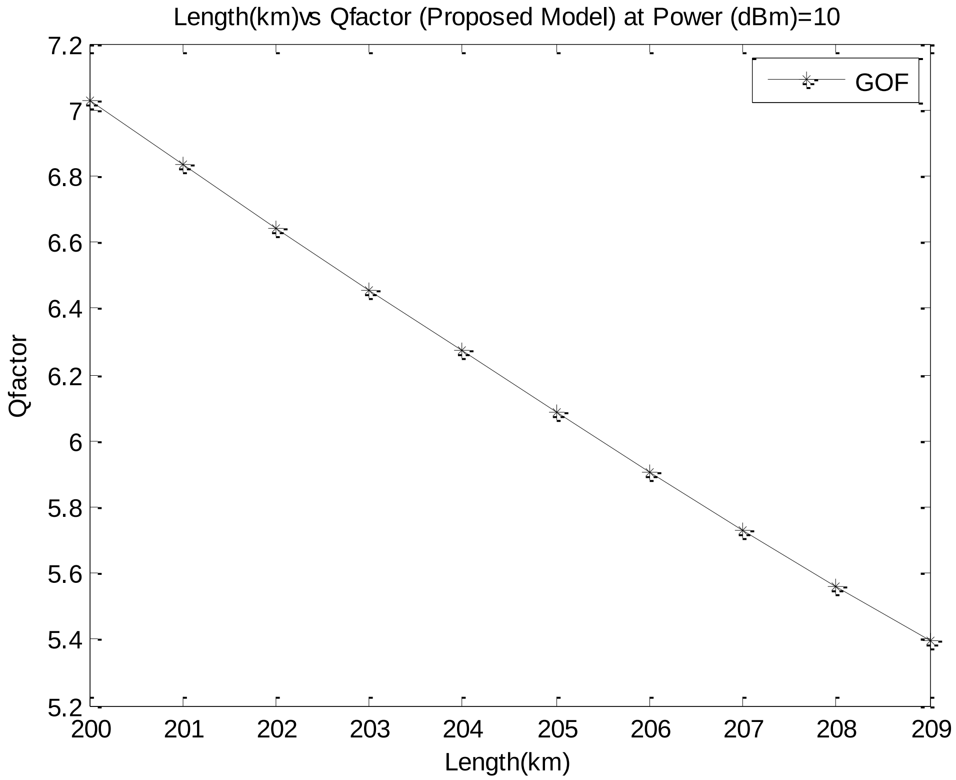

Figure 5.13 Q-factor vs. Length of the proposed model with GOF at constant power.

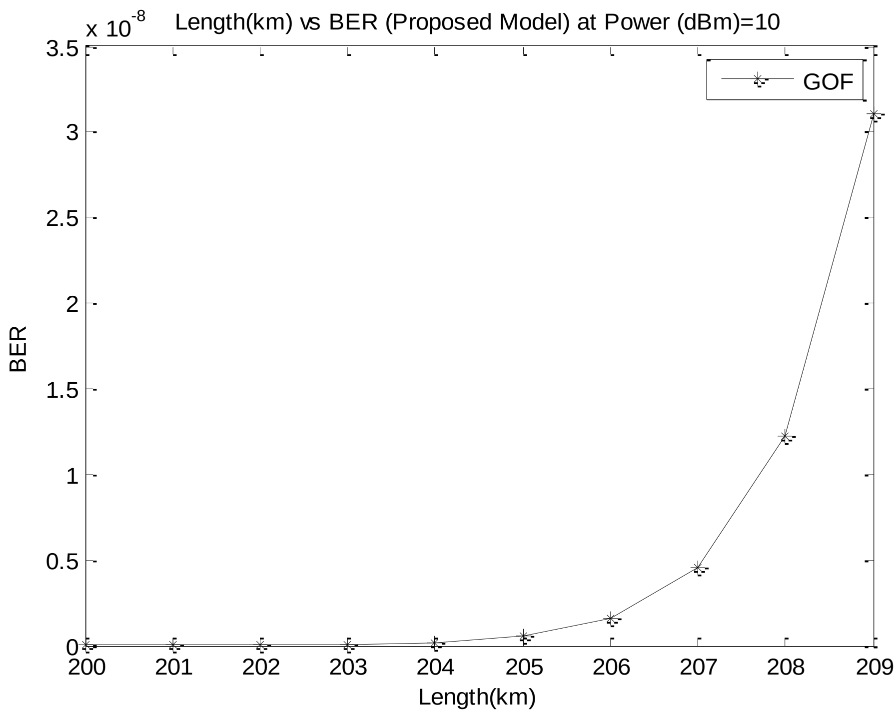

Figure 5.14 BER vs. Length of the proposed model with GOF at constant power.

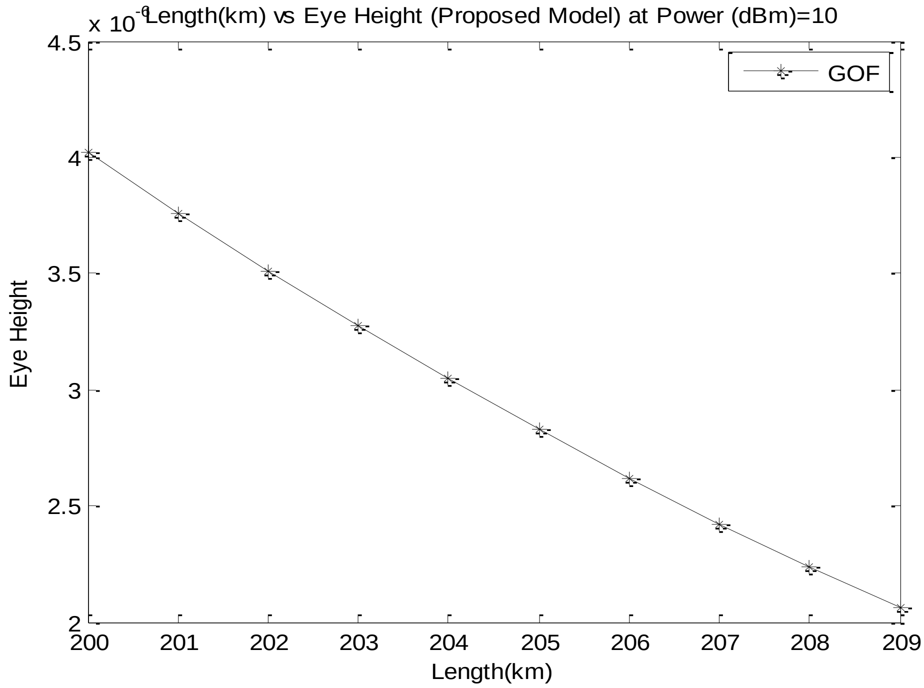

Figure 5.15 Eye Height vs. Length of the proposed model with GOF at constant power.

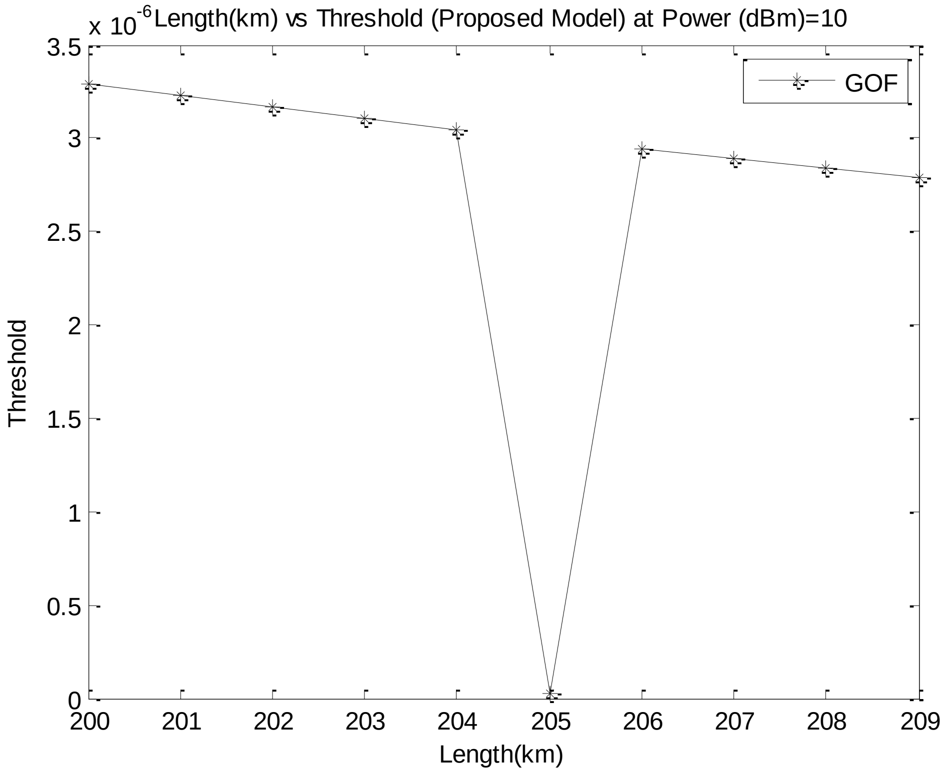

Figure 5.16 Threshold vs. Length of the proposed model with GOF at constant power.

In the paper, four parameters have been taken such as Q-factor, BER, threshold and Eye height with respect to power and length. For the simulation purpose, length of the optical fiber has been constant i.e. 200 kms and power has been varying from 5 to 14 dBm. The results has acquired after performing simulation with GOF has shown below.

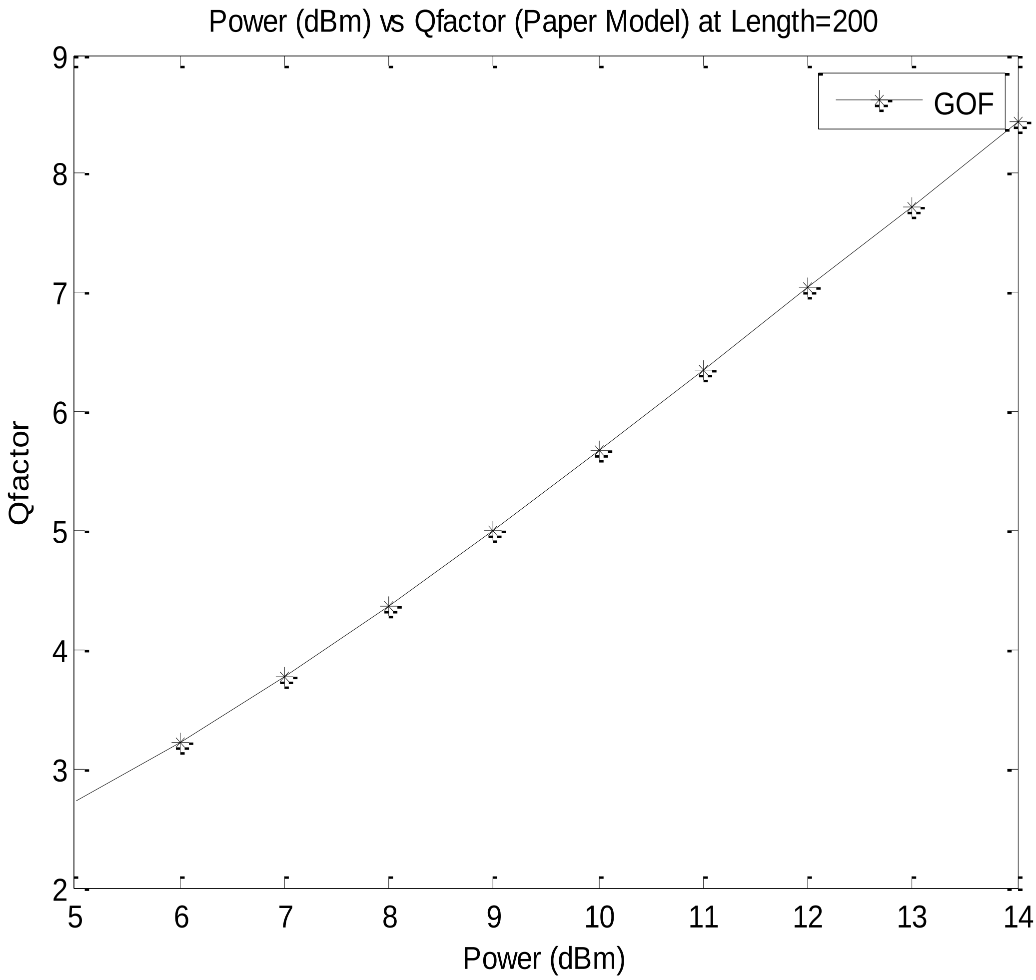

Figure 5.17 Q-factor vs. Power of the paper model with GOF at constant length.

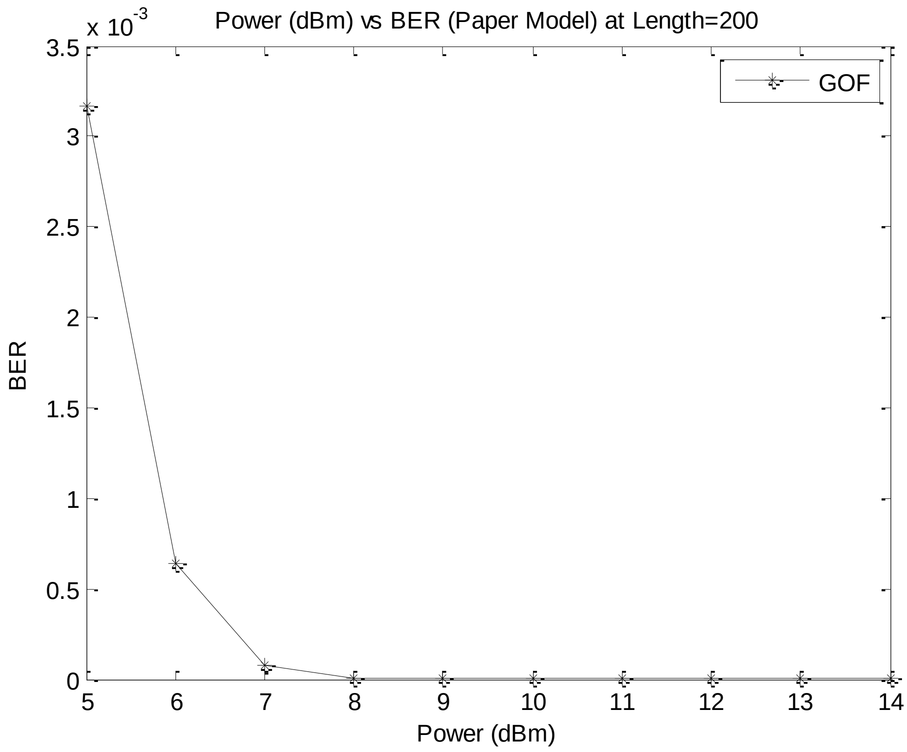

Figure 5.18 BER vs. Power of the paper model with GOF at constant length.

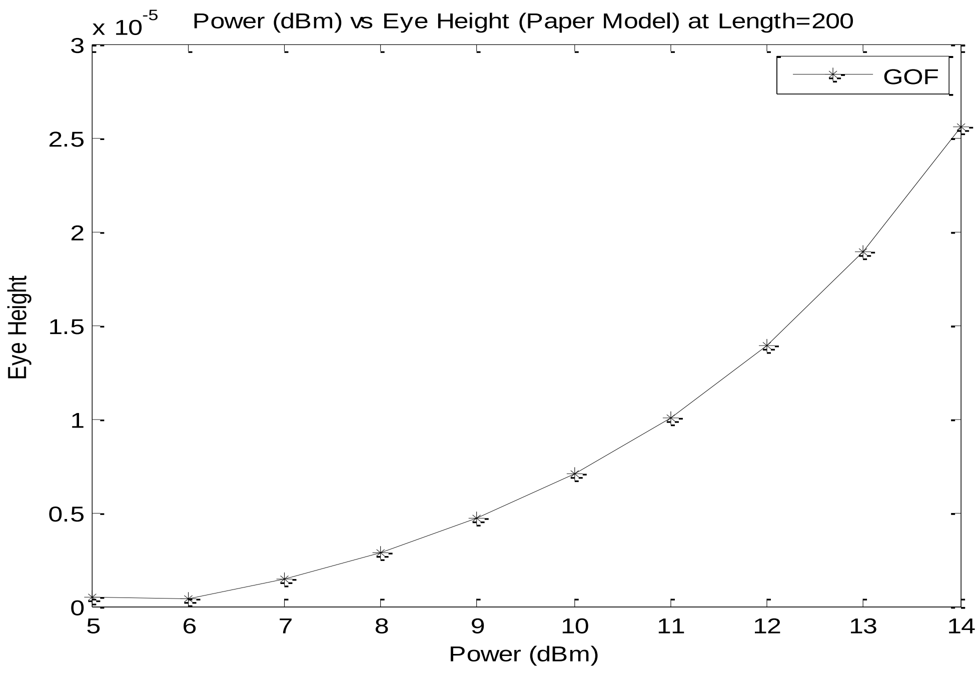

Figure 5.19 Eye Height vs. Power of the paper model with GOF at constant power.

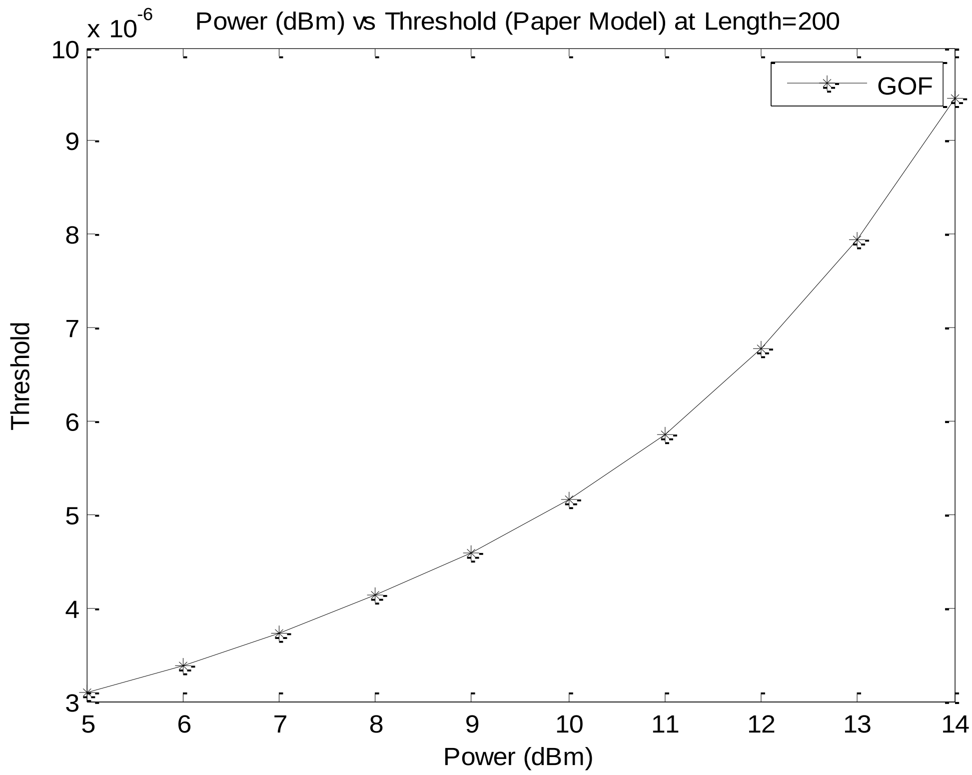

Figure 5.20 Threshold vs. Power of the paper model with GOF at constant length.

Previously length was constant, now for the further simulation power has constant i.e. 10 dbm and length has been varying from 200 to 209 kms i.e. with 1 km distance. As the paper model was simulated with constant length, similarly now it will be simulated for constant power using four parameters such as Q-factor, BER, Eye height and Threshold.

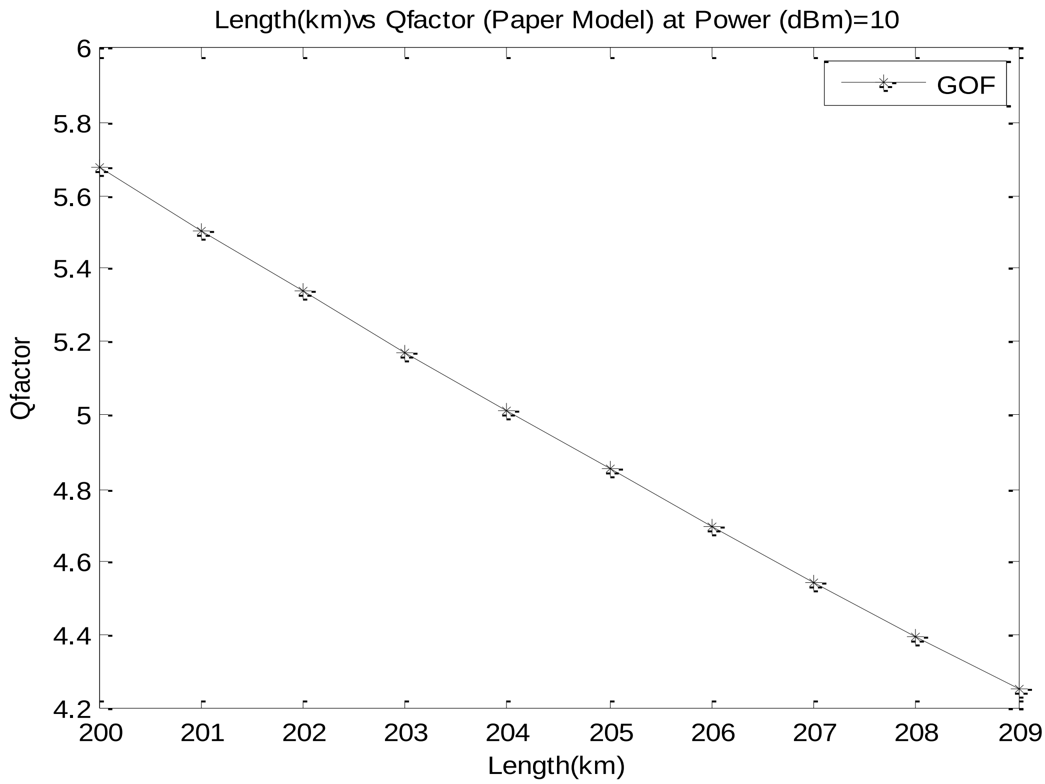

Figure 5.21 Q-factor vs. Length of the paper model with GOF at constant power.

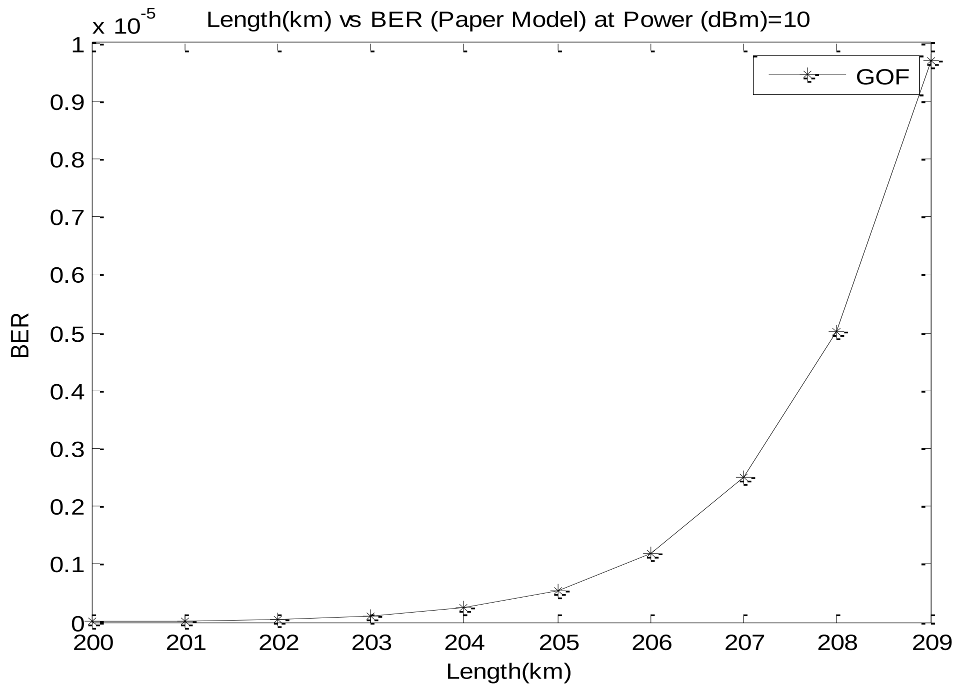

Figure 5.22 BER vs. Length of the paper model with GOF at constant power.

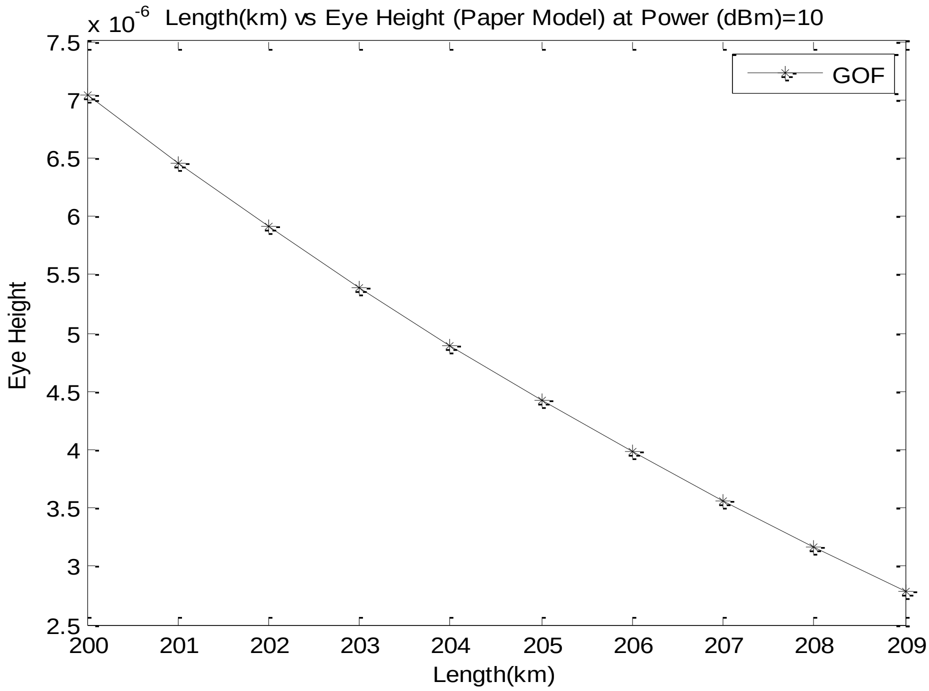

Figure 5.23 Eye Height vs. Length of the paper model with GOF at constant power.

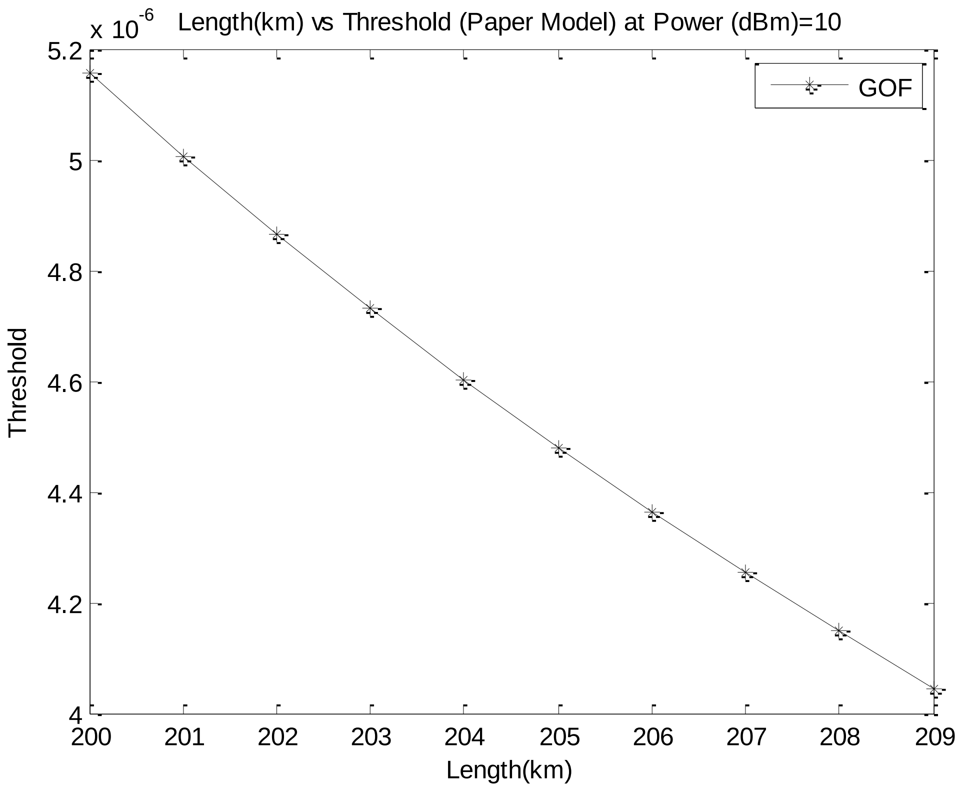

Figure 5.24 BER vs. Length of the proposed model with GOF at constant power.

5.1 Comparison between Paper model, Proposed Model 1 and Proposed Model 2

The simulation analysis has performed with paper model, proposed model 1 and proposed model 2 on the basis of different parameters such as Q-factor, BER, Threshold and Eye height. The results acquired from these parameters has shown below where power taken as a constant parameter for four different cases and then length parameter taken as a constant for four parameters mentioned above. The Proposed model 1 has evaluated through GOF and proposed model 2 has evaluated through BOF by replacing RZ modulation format of the paper model.

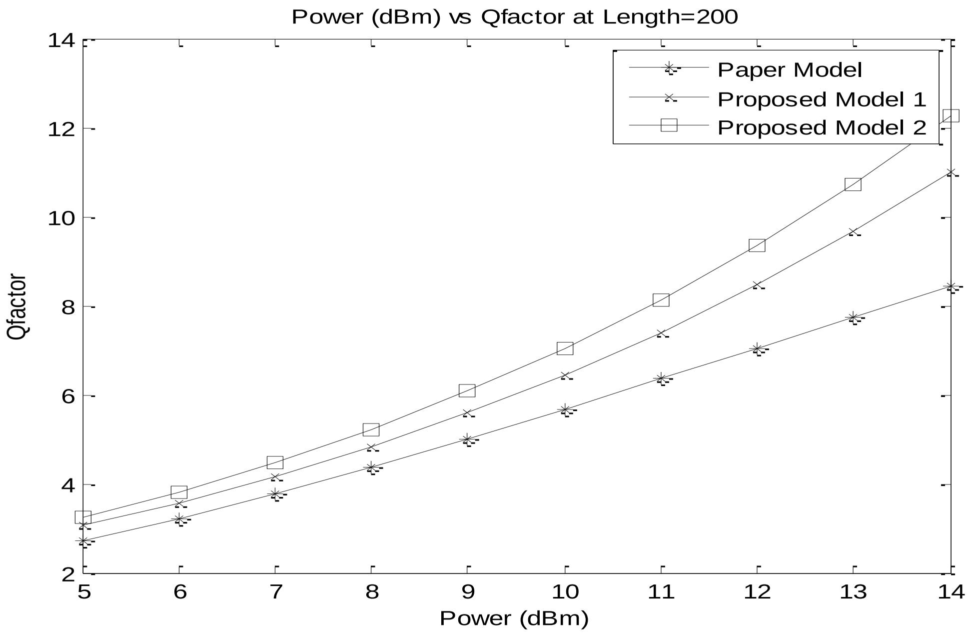

Figure 5.25 Comparison graph of paper, proposed model 1 and proposed model 2 in terms of Power vs. Q-factor at Length 200KM.

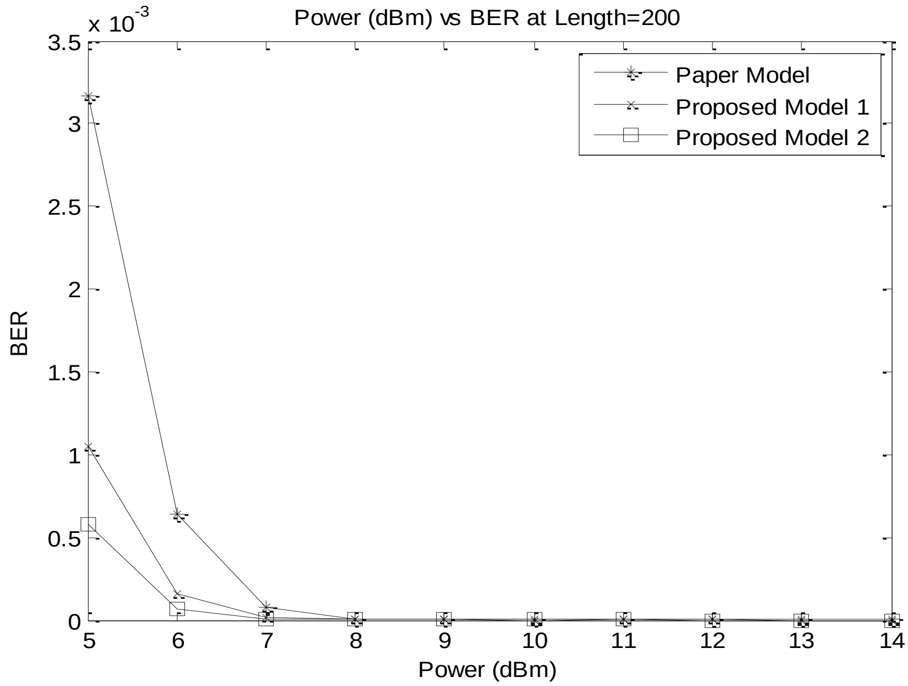

Figure 5.26 comparison graph of paper, proposed model 1 and proposed model 2 in terms of Power vs. BER at Length 200KM.

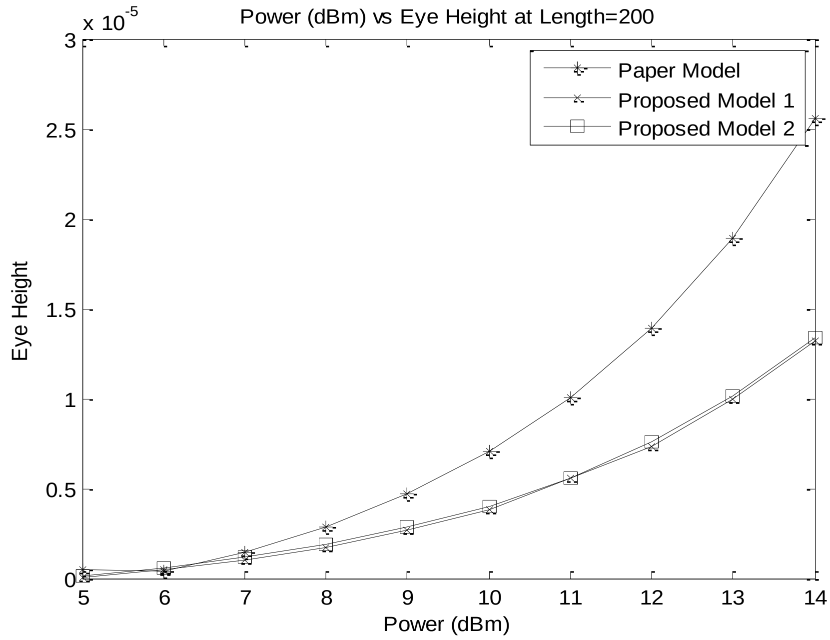

Figure 5.27 comparison graph of paper, proposed model 1 and proposed model 2 in terms of Power vs. Eye height at Length 200KM.

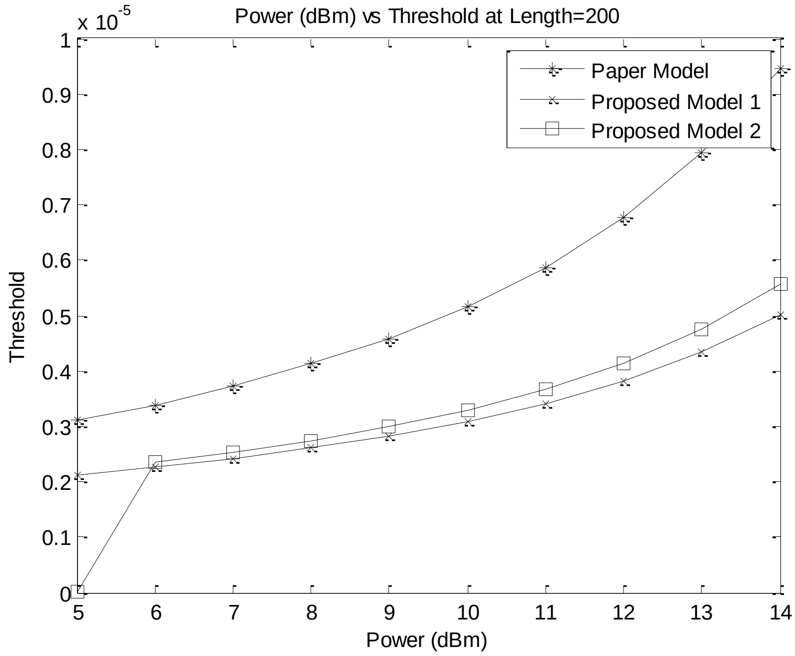

Figure 5.28 comparison graph of paper, proposed model 1 and proposed model 2 in terms of Power vs. Threshold at Length 200KM.

In the above simulated results, power has been varying. Now, in the below graphs, length has been changing and power remains constant in order to evaluate individual cases.

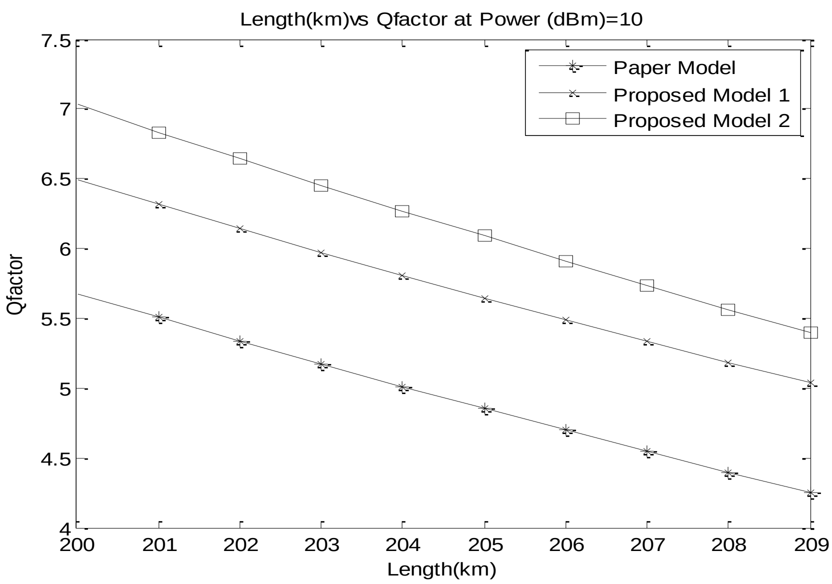

Figure 5.29 comparison graph of paper, proposed model 1 and proposed model 2 in terms of Length vs. Q'factor at Power 10

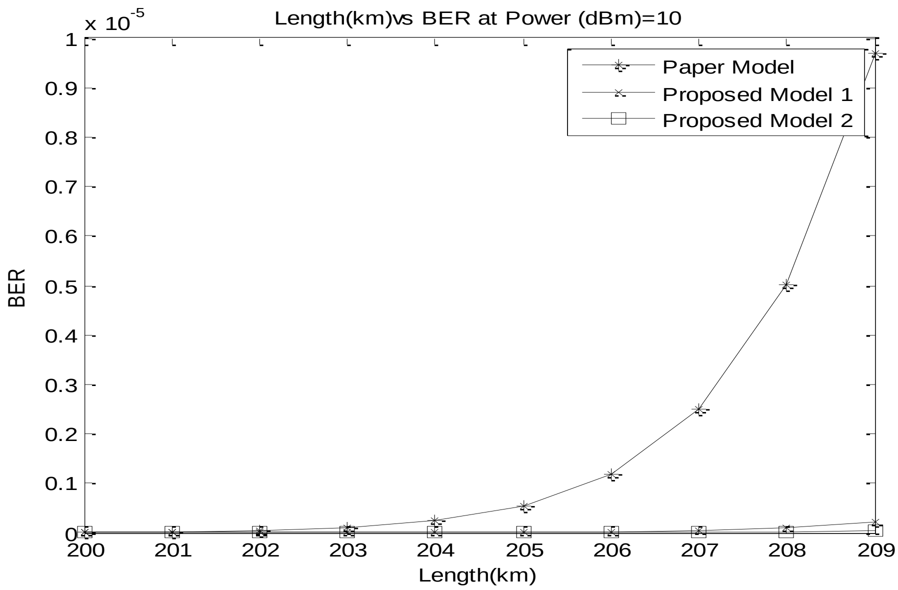

Figure 5.30 comparison graph of paper, proposed model 1 and proposed model 2 in terms of Length vs. BER at Power 10.

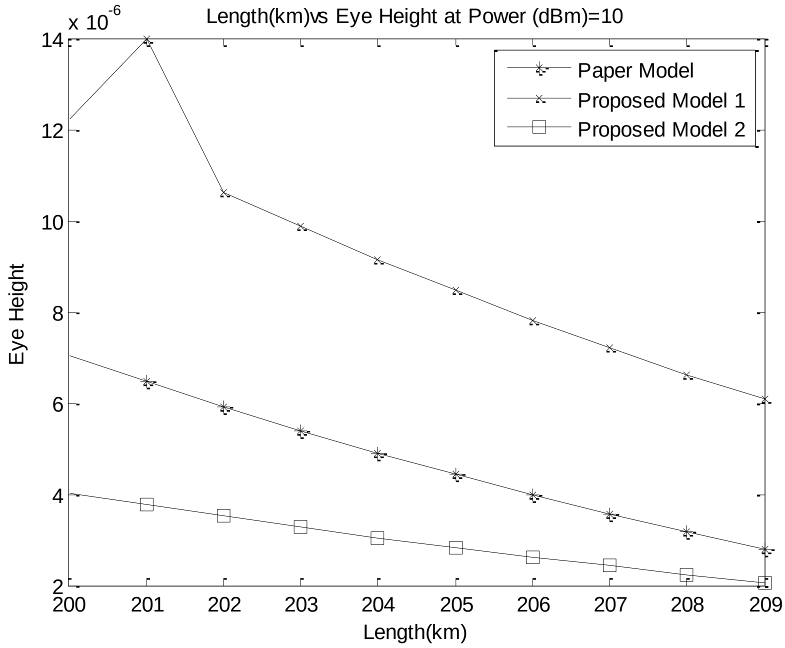

Figure 5.31 comparison graph of paper, proposed model 1 and proposed model 2 in terms of Length vs. Eye Height at Power 10.

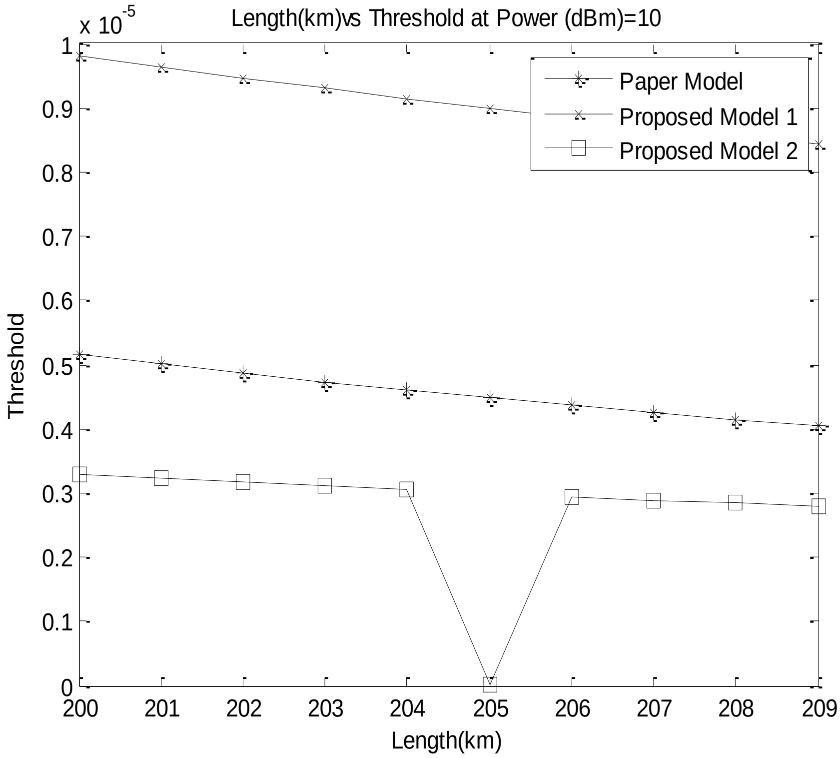

Figure 5.32 comparison graph of paper, proposed model 1 and proposed model 2 in terms of Power vs. Q-factor at Length 200KM.

5.2 Discussion

Figure 5.25, 5.26, 5.27 and 5.28 represents the variations in the power. Thus, these variations in the power affect the result of the paper, proposed model 1 and proposed model 2. Q-factor parameter initially was high in the proposed model 2 in comparison with other models and with the variations in the power it has been increasing. Thus, the result of the proposed model 2 is more efficient as with the increment in power, Q-factor is also increasing in other cases too but initially Q-factor of the proposed model 2 was better. Second parameter i.e. BER of the proposed model 2 is less i.e. 0.5 which is better in comparison with other models where BER was 1 in proposed model 1 and 3.2 in the paper model. Height of the eye of the proposed model 2 and proposed model 1 has slightly varying and lesser in comparison with paper model. Hence the proposed model 2 outperforms among other models.

CHAPTER 6

CONCLUSION AND FUTURE SCOPE

The simulation results have acquired through the MATLAB over different variations in the length and power. Different models are involved for the simulation such as paper mode, proposed model 1 and proposed model 2. Proposed Model has replaced the RZ modulation format and introduced the MDRZ modulation format. In this proposed model GOF and BOF filter has used to perform experimental analysis with parameters such as BER, Qfactor, Threshold and eye height. Proposed model 2 outperforms the proposed model 1 and paper model in terms of different parameters. High level of performance has achieved through proposed model 2 where individual parameter surpasses than another models parameter. In this work, with the increase of power and length, the value of BER and Q-factor has also increased in every model. However, in the proposed model 2, the initial of the BER and Q-factor is enhanced due to which it has considered the best model for reducing the effect of chromatic dispersion.

6.1 Future Work

- In future, different modulation formats can be used to enhance the effect of chromatic dispersion in the optical fiber system.
- We can use highly efficient amplifiers to strengthen the signal while transmitting through optical fiber cables.
- Material chosen should have optimum refractive index to support efficient transmission with minimum loss.

REFERENCES

[1] ShubahmVerma,et al., "*Design of full duplex radio over fiber (Fi-Wi) link through FBG*", IEEE, Pp 131-135, 2015

[2] A.M. Zin, et al., "*An overview of radio-over-fiber Networks Technology*", IEEE, Pp 1-3, 2010,

[3] Vagheshe Antony, et al., " *Performance Improvement and Cost Reduction Techniques For Radio Over Fiber Communications",* IEEE, Pp 1-45, 2015

[4] Ting Su,et al., "*Bidirectional multiband radio over fiber system based on polarization multiplexing and wavelength reuse*", IEEE vol 23(8), Pp 1-5, 2015

[5] Sara Rebhi, et al., *"Perform evaluation of radio over fiber System at 60HGz for outdoor and indoor environment",* IEEE, Pp 1-4, 2014

[6] Jincy john, et al., "*Design and simulation of a radio over fiber system and its performance analysis",* IEEE, Pp 636-640, 2012,

[7] FabriceMfuamba, et al., *"Adaptive performance improvement of fiber Bragg grating in radio over fiber",* Scientific research, vol 4, Pp 1-6, 2016

[8] Lin cheng, et al., *" Coordinated Multipoint Transmissions in Millimeter-Wave Radio-over-Fiber Systems"*, IEEE, Pp 1-8, 2015,

[9] Anthony Ng'oma, et al., *"Radio-over-Fiber Technologies for Multi-Gb/s Wireless Applications",* IEEE, Pp 1-3, 2013

[10] Junwenzhang, et al., "*Full-Duplex Quasi-Gapless Carrier-Aggregation using FBMC in Centralized Radio-over-Fiber Heterogeneous Networks*", IEEE, Pp 1-7, 2016,

[11] Pooja, et al., *" Advantages and Limitation of Radio over Fiber System "*,ijcsmc, Vol. 4, Issue. 5, May 2015, pg.506 – 511

[12] Naresh Kumar, et al., " *A Review Paper On Radio Over Fibre Technology*",ijaer, Vol.7 No.11,2012

[13] D.Wake, et al., *"Radio over Fiber Systems for Mobile Applications*"

[14] Ali Hussein Radhi,et al., " *Performance Analysis of Radio over Fiber System with Ook Based Dwdm for Fiber to Home Network*", IEEE, Volume 8, Issue 5, PP 26-29,2013

[15] A. J. Cooper, et al., "*Fiber/Radio for the provision of cordless/mobile telephony services in the access,"* Electronic Letter, vol. 26, pp. 2054–2056, Nov 1990

[16] SreeneshShashidharan, et al., *"Design and Simulation of Radio Over Fiber System and its Performance Analysis using RZ coding"* International Conference on Electrical, Electronics, Signals, Communication and Optimization (EESCO) , (2015),

[17] Harpreetkaur, et al., "*Comparison of NRZ and RZ data modulation formats in SAC-OCDMA system under introduced clock timing jitter of laser diode*", International Journal of Advanced Research in Computer and Communication Engineering Vol. 2, Issue 8, Pp 2942 – 2949, (2013),

[18] Arya Mohan, et al., *"Full Duplex Transmission in RoF System using WDM and OADM Technology*" IJERT Vol. 4 - Issue 01, (2015),

[19] Osama A *"High Transmission Capacity Performance of Radio Over Fiber System for Short and Long Distances "* , International Journal of Science, Engineering and Technology Research (IJSETR) Volume 2, Issue 12 , Pp 2099- 2106, (2013).

[20] Shuvodip Das , et al., " *Modeling and Performance Analysis of RoF System for Home Area Network with Different Line Coding Schemes Using Optisystem*", international journal of multidisciplinary sciences and engineering, vol. 5, no. 6,pp 1-8, (2014),

[21] Virendrakumar, et al., "*Design and Performance Analysis of Optical Transmission System"), IOSR Journal of Engineering (IOSRJEN)),* Vol. 04, Issue 05 ,PP 22-26, (2014).

[22] AbdEl–Naser A. Mohame*“ Transmission Characteristics of Radio over Fiber (ROF) Millimeter Wave Systems in Local Area Optical Communication Networks*”, Int. J. Advanced Networking and Applications, Volume: 02, Issue: 06, Pp 876-886, (2011).

[23] S. pachnicke, et al., ”*Fiber Optical Transmission Systems*” springer.”, (2012)

[24] Mohamed, et al., *“High Transmission Performance of Radio Over Fiber Systems over Traditional Optical Fiber Communication Systems Using Different Coding Formats for Long Haul Applications.”* Nonlinear Optics, Quantum Optics: Concepts in Modern Optics , Vol. 44 Issue 1, p41-63. 23p, (2012).

[25] Xiaoqiong qi, et al,. “*Fiber Dispersion and Nonlinearity Influences on Transmissions of AM and FM Data Modulation Signals in Radio-Over-Fiber System*” IEEE journal of quantum electronics Vol. 46, No. 8, Pp. 1170-1177, (2010).