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RESEARCH ARTICLE

Performance Evaluation of EPON Link at 1550 and 1350 nm using NRZ and RZ Modulation Technique

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Abstract

The research work has evaluated the performance of the proposed link in terms of Q- Factor and BER at wavelength of 1550 nm and 1350 nm at transmission distance of 30 km. The comparison has also been drawn among the proposed EPON link with NRZ and RZ modulation scheme. *In this work, simulative investigation to evaluate the performance of EPON transmission links using NRZ and RZ modulation schemes at high transmission rate is reported. Further, the results have been reported by compensating the degradations introduced by fiber dispersion using DC fiber for the proposed EPON transmission links and a comparison is presented for evaluating the performance of such systems with NRZ and RZ modulation technique. Our result shows that the NRZ performs better than RZ modulation scheme as the later severely suffered with fading problems due to fiber dispersion. In case of NRZ modulation technique, an improvement in BER ratio and total power received is achieved in comparison to RZ modulation technique.*

Keyword: - EPON, NRZ, RZ, BER

1. INTRODUCTION

In current years, the telecommunication backbone network has been upgraded from time to time while more fibers are laid and devices of larger capacities attended into utilize. But have you been conscious that access network, the copper line remains the leading choice. The tremendous upsurge in Internet services has found the shortage of the access network's capacity. The access network that's called “last mile” still remains the bottleneck between high-speed LANs and the high-capacity backbone network. Probably the most widely deployed “broadband” solutions today are DSL and CM networks. Although they're improvements in comparison to 56 kbps dial-up lines, they're still struggling to supply enough bandwidth for emerging services such as for example like video-on-demand (VOD), interactive gaming, or two-way video conferencing. A brand new sort of access technology is essential for the time with following features: inexpensive, simple, upgradeable, and to manage to provide bundled voice, data and video services. EPON, which merges the low-cost Ethernet technology and low-cost optic network architecture, is the higher representative of the future-oriented next generation access network technologies. As early as in November 2000, about 200 experts from 80 companies formed a study band of IEEE and this group was chartered with extending existing Ethernet technology into subscriber access area. Then in September 2001, this study group is officially named as Ethernet in the First Mile (EFM) study group and is focused on instituting EPON standards underneath the architecture of the IEEE 802.3 protocol. In June 2004, the IEEE 802.3ah standard is approved by IEEE Standard Board and then officially released. EPON is on the basis of the Ethernet standard, unlike other PON technologies, which are on the basis of the ATM standard. Allowing you utilize economies-of-scale of Ethernet, and provides simple, easy-to-manage connectivity to Ethernet-based, IP equipment, both at the client premises and at the central office. Much like other Gigabit Ethernet media, it's well-suited to transport packetized traffic, that will be dominant at the access layer, in addition to time-sensitive voice and video traffic and thus has 2N optical transceivers. Curb-switched Ethernet uses one trunk fiber and thus saves fiber and space in the Central Office (CO). However it uses 2N+2optical transceivers and needs electric power in .EPON also uses just one trunk fiber and thus minimizes fibers and space in the CO, and also only uses N+1optical transceivers. It takes no electric power in the field. The drop throughput may be around the line rate on the trunk link. EPON can support downstream broadcast such as for example video. The IEEE 802.3ah EPON specification defines Multi-Point Control Protocol (MPCP), Point-to-Point Emulation (P2PE), and two 1490/1310 nm PMDs for 10and 20 km, required to construct an EPON system. Typical EPON-based systems may include extra features above the IEEE 802.3ah standard, including security, authentication and dynamic bandwidth allocation.

1.2 ARCHITECTURE OF ETHERNET PASSIVE OPTICAL NETWORKS

A typical EPON system is composed of OLT, ONU, and ODN (see Figure 1).

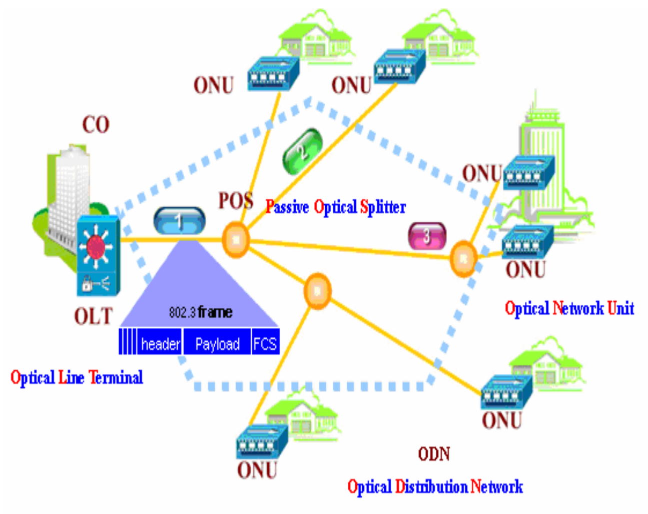

Figure 1 EPON Network Architecture

The OLT (Optical Line Terminal) resides in the Central Office (CO) and connects the optical network to the metropolitan-area network or wide-area network, also referred to as the backbone or long-haul network. OLT is both a transition or router and a multi-service platform which supplies EPON-oriented optical interfaces. Form network assembling and access functions, OLT may also perform bandwidth assignments, network security and management configurations based on the customers' different QoS / SLA requirements.

The ONU (Optical Network Unit) is found either at the end-user location or at the curb and provides optical interfaces which are attached to the OLT and service interfaces at users' side such as for example voice, data and video. The ODN（Optical Distributed Network）is a visual distribution network and is principally consists of more than one passive optical splitters which connect the OLT and ONU. Its function is always to split downstream signal in one fiber into several fibers and combine optical upstream signals from multiple fibers into one. Optical splitter is just a simple device which needs no power and can work within an all-weather environment. The conventional splitters have a splitting ratio of 2, 4, 8, 16 or 32and link to each other. The longest distance the ODN could cover is 20Km.

ADVANTAGES OF EPONS

EPONs are simpler, most efficient and less expensive than alternate multiservice access solutions. Its key benefits are

(1). HIGHER BANDWIDTH

EPONs provide the highest bandwidth to customer of any other PON system. Its other benefits of having higher bandwidth are

a. More subscribers per PON.
b. More bandwidth per subscriber.
c. Higher split counts.
d. Video capabilities.
e. Better QOS.

(2). LOW COST

EPONs provide the following cost reduction opportunities :

a. Eliminate complex and expensive ATM and SONET elements and dramatically simplify network architecture.
b. Long-lived passive optical components reduce outside plant maintenance.
c. Standard Ethernet interfaces eliminate the need for additional DSL or cable modems.
d. No electronics in outside plant reduces need for costly powering and right-of-way space.

(3). MORE REVENUE

a. EPONs can support a complete bundle of data, voice and video services which allows carriers to boost revenues by exploiting the broad range and flexibility of service offering available.
b. Revenue opportunities from EPONs include:
c. Support for legacy TDM, ATM and SONET services.
d. Delivery of new gigabit Ethernet, fast Ethernet, IP multicast, and dedicated wavelength services.
e. Provisioning of bandwidth in scalable 64kbps increments up to 1 gbps
f. Tailoring of services to customer needs with guaranteed SLAs.
g. Quick response to customer needs with flexible provisioning and rapid service reconfiguration.

2. Related Work

Marilet De Andrade et al. [1] Long-Reach Passive Optical Network (LR-PON) using hybrid TDM/WDM techniques was one of the candidates for the future optical access that could solve the expected increase in terms of traffic demand and area coverage. One of its advantages was the possibility to share the capacity of any wavelength among more than one user, through TDM/WDM hybrid multiplexing. However, it was still an open issue which transmission technology (DWDM transmitters, colorless transmitters, coherent detection, direct detection) could more effectively satisfy the requirements and characteristics of the future long-reach access network. Tanny Liem et al. [2] Ethernet Passive Optical Network (EPON) was chosen for servicing diverse applications with higher bandwidth and Quality-of-Service (QoS), starting from Fiber-To-The-Home (FTTH), FTTB (business/building)and FTTO (office). Typically, a single OLT could provide services to both residential and business customers on the same Optical Line Terminal (OLT) port; thus, any failures in the system would cause a great loss for both network operators and customers. Aihan Yin et al. [3] Ten gigabit Ethernet passive optical network (10G EPON),which is viewed by many as an attractive solution to deliver very high-speed broadband access, is widely deployed in some data transmission areas with confusing security issues such as eavesdrop and masquerade caused by its point-to-multi-point topology. To solve the security problems, a new authentication scheme based on NSS signature algorithm using Hash is proposed. Vishal Sharma et al. [4] For bottleneck problem of the broadband access networks, Ethernet-PON comes out as a striking and promising solution. Even though, EPON nodes necessitate a cost-effective up-gradation, WDM based topology proved to be a vigilant up-grading approach that deals with the deployment of multiple wave-lengths in the upstream/downstream directions. Partha Bhaumik et al. [5] In an increasingly content – centric world where users consume large amounts of multimedia content , video delivery platforms over packet networks , such as Internet Protocol Television (IPTV) , were gaining rapid popularity . At the same time ,to serve the ever-increasing bandwidth demand from users ,access networks ,traditionally the bottle neck for high-bandwidth applications , were also undergoing rapid evolution .Forecasting how streaming IPTV over a network would perform was challenging as the data rate of a video stream varies with scene ,time , frame rate ,and encoding .Never the less ,it was important to evaluate the performance of an access network for IPTV traffic to ensure good Quality of Service (QoS) for users. Aihan Yin et al. [6] with the development of access network, 10G EPON had gained more and more attention. As its topology structure was point-to-multi-point and the downstream data was broadcasted, it would suffer from eaves-dropping and masquerading attack. To eliminate these safety threats, this paper proposed an integrated security scheme including a bilateral authentication method and an encryption algorithm combined with one-way hash function. Abhishek Dixit et al. [7] energy efficiency and green communication shave become well-established themes for next-generation communications systems, with specific regard to reducing carbon footprint, lowering environmental impact, and minimizing operational expenditures. Apart from conforming to the required societal green agenda, there were also many practical and financial advantages to creating solutions that exhibit such benefits . Hui-Tang Lin et al. [8] Ethernet Passive Optical Networks (EPONs) was regarded as an important technology for current access networks. However, EPONs perform poorly in differentiated service environments, and may therefore fail to meet the Quality of Service (QoS) demands of emerging triple-play services (i.e. Voice over IP, video and BE traffic). Accordingly, the present study proposes a novel Dynamic Bandwidth Allocation (DBA) scheme, designated as Frame- Oriented Interleaved Polling with Adaptive Cycle Time (FIPACT), to improve the differentiated QoS capability of EPON networks. Maurizio Casoni et al. [9] In this paper the end– to– end TCP performance of a hybrid network composed of multiple Ethernet Passive Optical Networks (EPONs) in the access segment connected to the same edge node of a core network was evaluated . Three possible core network paradigms were considered: Optical Circuit Switching (OCS), Optical Burst Switching (OBS) and Optical Packet Switching (OPS) . Dung Pham Van et al. [10] In this paper, a sleep-aware dynamic bandwidth allocation (SDBA) algorithm and the supporting protocol werer proposed for maximizing energy efficiency while satisfying the end-user QoS constraints on downstream (DS) and upstream (US) transmissions in 10G- EPONs. The SDBA maximizes the Optical Network Unit (ONU) polling cycle to increase the time for which each ONU sleeps outside the allocated timeslot. The polling cycle, however, was computed by considering QoS constraints (i.e., frame delay and loss rate) of all the transmissions given their finite data buffers to provide the users with the requested QoS. Anu Mercian et al. [11] A wide array of dynamic bandwidth allocation (DBA)mechanisms had been proposed for improving bandwidth utilization and reducing idle times and packet delays in passive optical networks (PONs). Baljeet Kaur et al. [12] Performance of four channel WDM RoF-EPON link based on OVSB transmission using SOA was enhanced by compensating dispersion and FWM with DCF and FBG by 10.95% for equal channel spacing and further improvement had been shown up to 23.61% by using unequal spacing for the same transmission link. The performance enhancement by using DCF and FBG was ascertained by evaluating Q factor and eye opening. Baljeet Kaur et al. [13] A system was presented which uses optical SSB transmission on WDM RoF–EPON link to compensate dispersion and FWM with DCF and FBG. Yang Qin et al. [14] Ethernet Passive Optical Network (EPON) was viewed by many as an attractive solution to the first mile problem. With the rapidly increasing number of user application, the capacity of current EPON had quickly become insufficient and upgrading its architecture with the wavelength division multiplexing (WDM) technology had become a natural choice. On the other hand, with more and more multimedia applications emerging in the network, providing good quality of service (QoS) to various classes of traffic was a challenge. Dapeng Wu et al. [15] To improve the utilization of bandwidth in EPON (Ethernet Passive Optical Network), a novel dynamic bandwidth allocation algorithm was proposed. Logically, all ONUs were divided into two different zones logically.

3. Proposed Technique

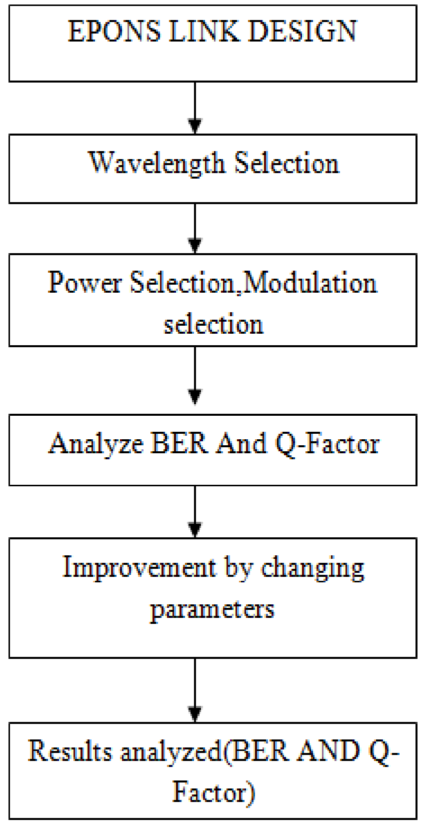

Fig. 2 Flow chart of proposed Technique

4. Result Analysis NRZ

Non-return to zero encoding is used in slow speed synchronous and asynchronous transmission interfaces. With NRZ, a logic 1 bit is sent as a high value and a logic 0 bit is sent as a low value. The reciever may lose synchronization when using NRZ to encode a synchronous link which may have long runs of consecutive bits with the same value.

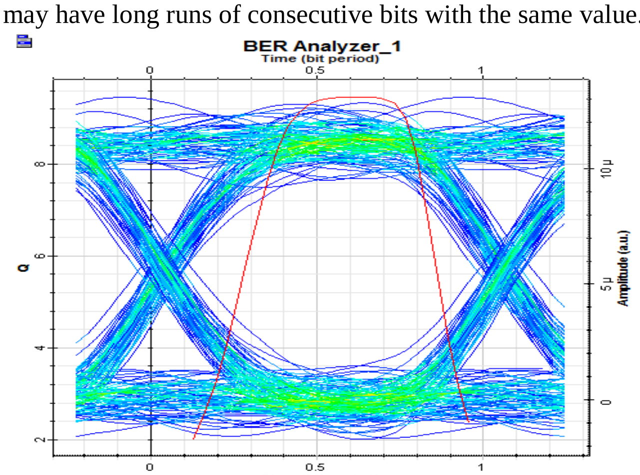

Fig 3. Eye diagram of downstream

In the above Fig 3, it represents the NRZ eye diagram in downstream. In this figure x-axis represents the time (bit period) and y-axis represents the Q- factor.

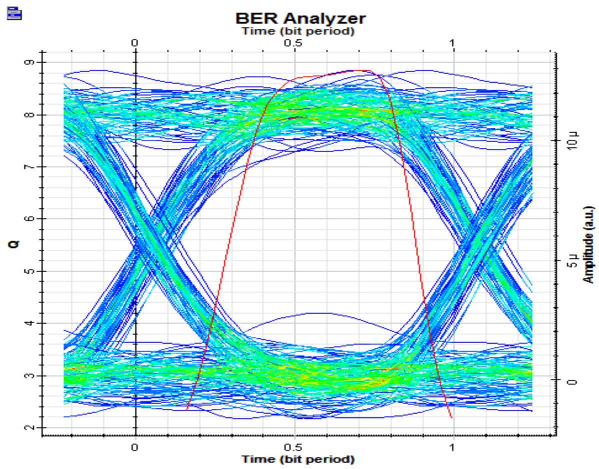

Fig 4. Eye Diagram of Upstream

The above Fig 4 represents the NRZ eye diagram in Upstream.

5.2 RZ

RZ (return-to-zero) refers to a form of digital data transmission in which the binary low and high states, represented by numerals 0 and 1, are transmitted by voltage pulses having certain characteristics. The signal state is determined by the voltage during the first half of each data binary digit . The signal returns to a resting state (called zero) during the second half of each bit.

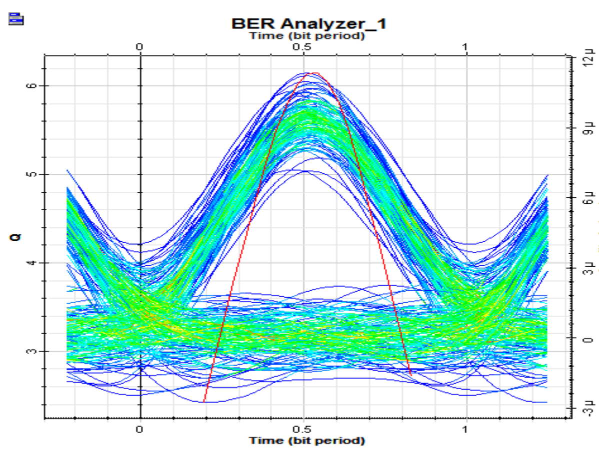

Fig 5. Eye diagram in downstream

In the above Fig 5, it represents the RZ Eye Diagram in downstream.

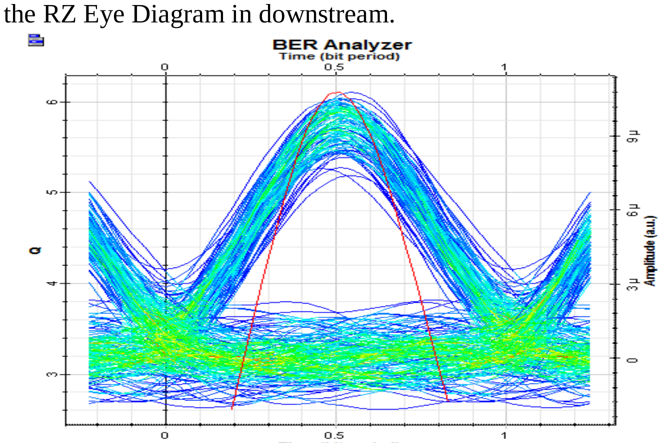

Fig 6. Eye Diagram of Upstream

The Fig 6, shows the RZ eye diagram in upstream.

Comparison between NRZ and RZ

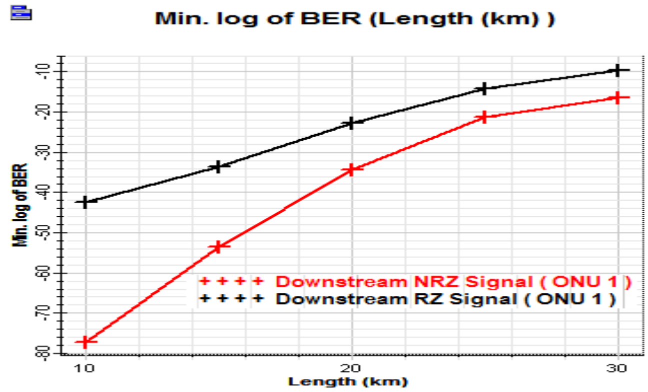

Fig 7. BER

The above Fig 7, shows the comparative analysis of Bit Error Rate (BER) between NRZ and RZ in downstream. In this figure the red line represents the NRZ Signal in downstream and black line represents the RZ signal in downstream. X-axis represents the Length in KM and Y-axis represents the Min. log of BER.

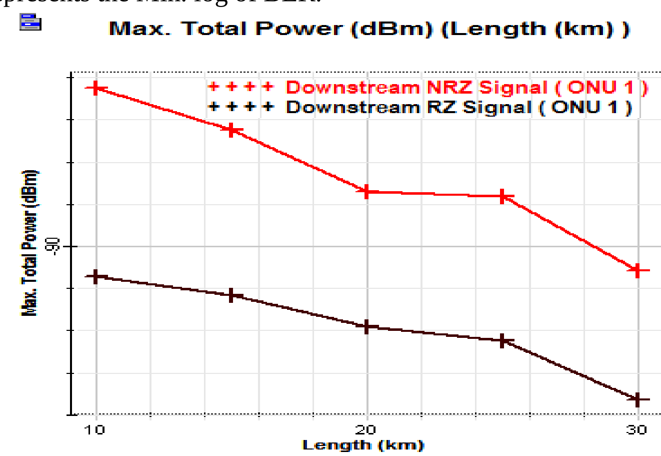

Fig 8. Power

The above Fig 8., shows the comparative analysis of Max. Total Power between NRZ and RZ in downstream. In this figure the red line represents the NRZ Signal in downstream and black line represents the RZ signal in downstream. X-axis represents the Length in KM and Y-axis represents the Maximum Total Power in dBm.

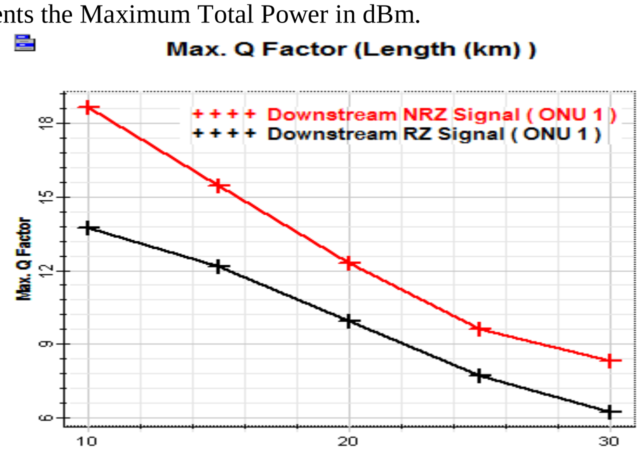

Fig 9. Q- Factor

The above Fig 9., shows the comparative analysis of Q- Factor between NRZ and RZ in downstream. In this figure the red line represents the NRZ Signal in downstream and black line represents the RZ signal in downstream. X-axis represents the Length in KM and Y-axis represents the Max. Q- Factor.

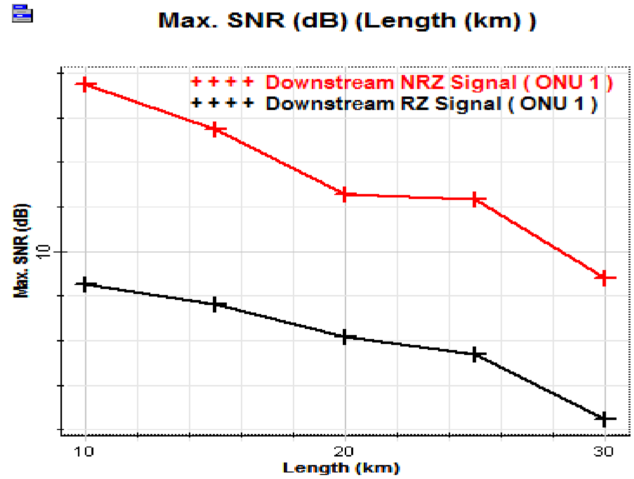

Fig 10. SNR

The above Fig 10., shows the comparative analysis of SNR between NRZ and RZ in downstream. In this figure the red line represents the NRZ Signal in downstream and black line represents the RZ signal in downstream. X-axis represents the Length in KM and Y-axis represents the Max. SNR in dB.

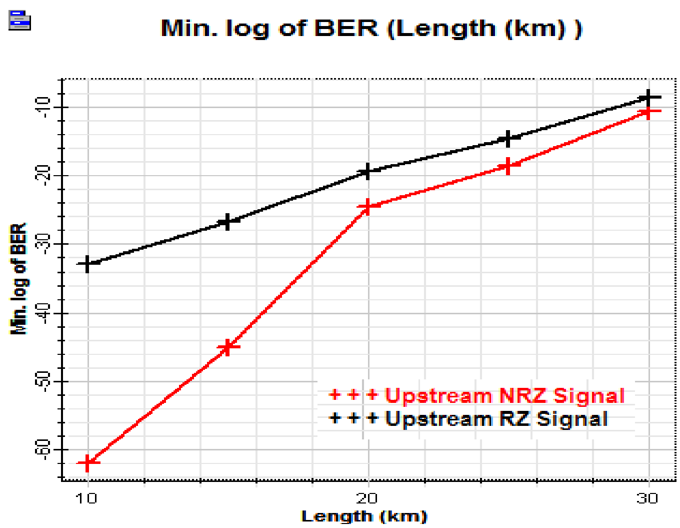

Fig 11. BER in Upstream

The above Fig 11., shows the comparative analysis of Bit Error Rate (BER) between NRZ and RZ in Upstream. In this figure the red line represents the NRZ Signal in upstream and black line represents the RZ signal in upstream. X-axis represents the Length in KM and Y-axis represents the Min. log of BER.

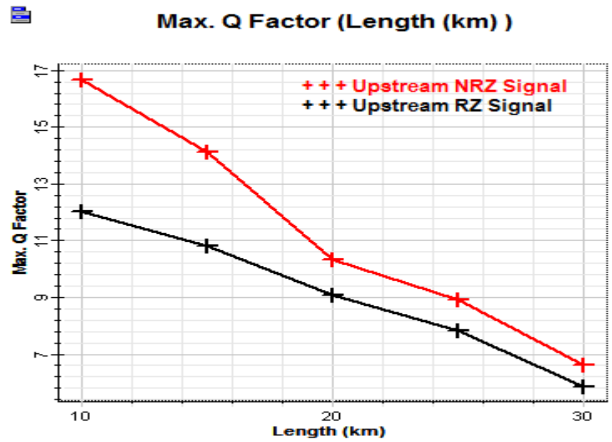

Fig 12. Q- Factor in Upstream

The above Fig 12., shows the comparative analysis of Q- Factor between NRZ and RZ in Upstream. In this figure the red line represents the NRZ Signal in Upstream and black line represents the RZ signal in upstream. X-axis represents the Length in KM and Y-axis represents the Max. Q- Factor.

5. Conclusion

In this system, there is chromatic dispersion in fiber which significantly limits the transmission distance. For a single mode laser, the symmetrical sidebands are created on the optical carrier. Due to fiber chromatic dispersion, a relative phase shift is added to these sidebands which depends on the wavelength, fiber distance and modulation frequency. Each sideband mixes with the optical carrier in the optical receiver. If the relative phase between these two components is 180◦, the components destructively interfere and the mm-wave electrical signal disappears. The detected signal power has been considered as reported. Therefore, it is important to compensate the fiber chromatic dispersion. The research work has evaluated the performance of the proposed link in terms of Q- Factor and BER at wavelength of 1550 nm and 1350 nm at transmission distance of 30 km. The comparison has also been drawn among the proposed EPON link with NRZ and RZ modulation scheme. In this work, simulative investigation to evaluate the performance of EPON transmission links using NRZ and RZ modulation schemes at high transmission rate is reported. Further, the results have been reported by compensating the degradations introduced by fiber dispersion using DC fiber for the proposed EPON transmission links and a comparison is presented for evaluating the performance of such systems with NRZ and RZ modulation technique. Our result shows that the NRZ performs better than RZ modulation scheme as the later severely suffered with fading problems due to fiber dispersion. In case of NRZ modulation technique, an improvement in BER ratio and total power received is achieved in comparison to RZ modulation technique. The comparisons have clearly shown the effectiveness of the proposed technique.

6. Future Work

This work has not considered only OSSB and ODSB modulation schemes , therefore in near future we will consider some more modulations techniques inorder to evaluate the effectiveness of the proposed technique further. Also limited number of quality parameters are considered therefore in near future some more quality parameters will be considered for better evaluation.

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