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Comparison the Performance Evaluation of Xgpon-Rof System with Wdm and Scm for Different Modulation Schemes

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ABSTRACT

At the present time and as a result to the recent developed technology demand for higher data rate and capacity has been increased. For the wireless networks, the combination of radio over fiber (RoF) with (XGPON) Gigabit-capable PON techniques produce a high data rate at lower cost. Thus, this paper illustrates that the performance of RoF-XGPON optical link has been analyzed for multi-channel through combining two multiplexing techniques, such as; Subcarrier Multiplexing (SCM) and Wavelength Division Multiplexing (WDM). The proposed system utilizes WDM-xGPON and SCM-XGPON architecture combined with RoF technology with 10 Gpbs data rate and (2.4, 5.8, 10 and 15) GHz radio frequency (RF), when change the optical fiber length between (10 to 80) km. The network performance is compared with various digital quadrate amplitude modulation schemes, like ; 4 - QAM, 16 - QAM and 64 - QAM for various input power (-2, 2, and 6) dB. The performance analysis is based on the optical spectrum of transmitted and received signals for 4-channel, constellation diagram, eye diagram, bit error rate (BER), power received, and quality factor. The result explain that the WDM-XGPON-Rof performs better than SCM-XGPON-Rof for different modulation schemes. The bit error rate for WDM-XGPON less than the SCM-XGPON while the power received recorded to the WDM-XGPON greater than SCM-XGPON and the quality factor for SCM-XGPON less than the WDM-XGPON. Therefore The simulation results show that the WDM-XGPON-RoF gives better performance from SCM-XGPON-RoF. The software optisystem version 15 has been used to simulate this system

1. Introduction

RoF is one of the most important applications in fiber optic system. In RoF, light is set to a radio frequency and transmitted over fiber optics for easy wireless access . Technically, RoF is a hybrid system that combines wireless and optical in one system leading to high capacity, high data rate, transparent and mobile solutions [1]. RoF networks allow customers to retain their traffic while also providing them with the necessary bandwidth

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for current and future connections [2]. Passive Optical Network (PON) A network with multiple optical fibers and a variety of broadband services [3]. PON remove all active components between the client and the server. This is done by introducing passive optical components to route traffic over the network. The passive optical network acts as a transmission device between OLT and various ONT through optical subdivisions, which removes multiplex or multiplex signals by destination and origin. Therefore, the network has three devices: OLT, ONT and splitter, and each has its own function on the passive optical network which is necessary. XGPON is a variant of PON technology which can support higher data rate (10 Gbps) using a point to multipoint access mechanism. A XGPON system is a point-to-multipoint network architecture deploying optical access lines between a carrier's central office and customer sites [4]. The major advantage of using XGPON standard that is its more speed as compared too other PON standards. It is observed that XGPON bandwidth 10 Gbits/s for individually subscriber. The RoF system is integrating wireless and fiber based technology. The main objective of the RoF system is to distribute broadband signals to distributed base stations for wireless access using an optical access network[12]. The PON combination with RoF technology provides a high capacity solution and high data rate[10]. Waveform Division Multiplexing (WDM) The basic concept of WDM technology is to combine multi-channel optical with different wavelengths that come from different optical sources to a single fiber through multiple transmitters used on the sender side as well as multiplexer removal tools on the side of the receiver to split WDM channels[11]. However, WDM is an effective method that can be used in the fiber optic feeder network to increase the capacity of RoF systems, increase the usable fiber bandwidth and increase the number of base stations supported by the central office [5,6]. Subcarrier Multiplexing (SCM) technology is one of the multicast technologies that can be used in the optical system to increase bandwidth efficiency. SCM is more sensitive to noise effects, limiting data rates and maximum sub-carrier frequencies[8,9]. Optical sub-carrier multiplexing (OSM) is a system in which more than one signal is transmitted in the radio frequency field and then transmitted through the use of a single wavelength[7]. In this paper, we analyze and compare between RoF-XGPON-WDM and RoF-XGPON-SCM system regarding parameters such as transmission distance, eye diagram, power, Q factor and BER. It shows the RoF-XGPON-WDM is more energy efficient and transmits data at long distance with low losses and best BER as compared to the RoF –XGPON-SCM. the systems performance is analyzed on the basis of variation of factors such as quality factor , eye diagram and minimum BER using 15 optisystem.

2. System Design

The main goal of this paper is to investigate the intergration of RoF with XGPON. The system design as shown in **Fig. 1.** includes four main parts which are transmitter, fiber channel, Splitter and receiver. Used as a source of data with 10 Gbps of data rate the Pseudo-Random Bit Sequence Generator (PRBS). The QAM sequence generator utilized as QAM modulator for the data rate. Band-pass filter (BPF) utilized at both transmitter and receiver to get the detecated spectrum. The Mach-Zehnder Modulator (MZM) used as optical modulator which modulate the radio signal over light signal that generated by Continuous Wave laser (with 1500 nm of wavelength). The Splitter 1x32 device splits evenly the signal input power to 32 output ports. At the receiver side, after photodetection by Positive-Intrinsic-Negative (PIN), Filter the signal and amplify it to regenerate the required signal. The signal then fed into bit error rate (BER) analyzer and the spectrum for data analysis.

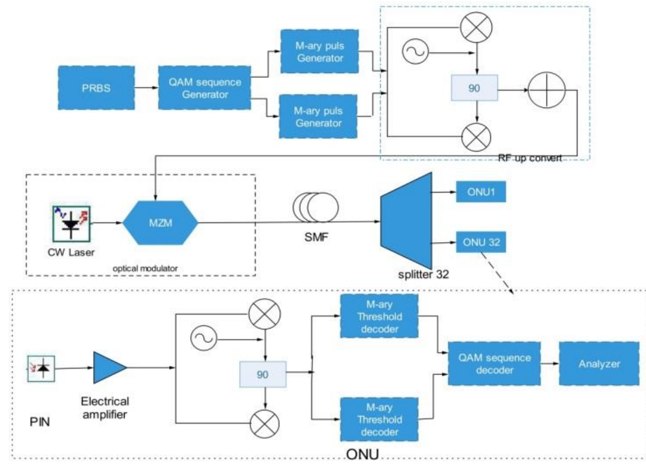
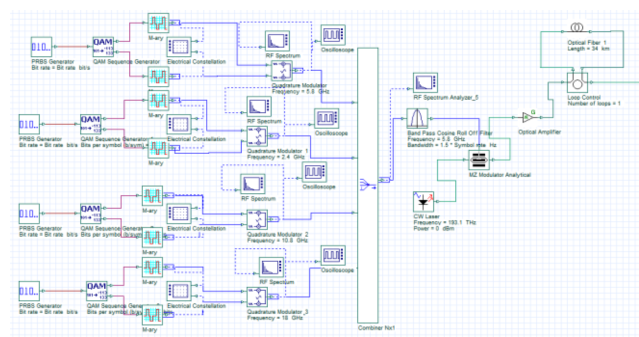
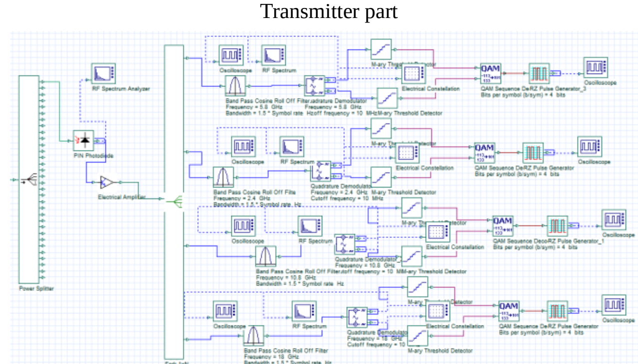


Figure 1. RoF-XGPON system design

However, 4-RF channels (2.4 GHz, 5.8 GHz, 10 GHz and 15 GHz) are simulated through used (4-QAM,16-QAM and 64-QAM) modulation techniques. The proposed simulation setup model for the SCM-XGPON-RoF system is shown in **Fig. 2.**



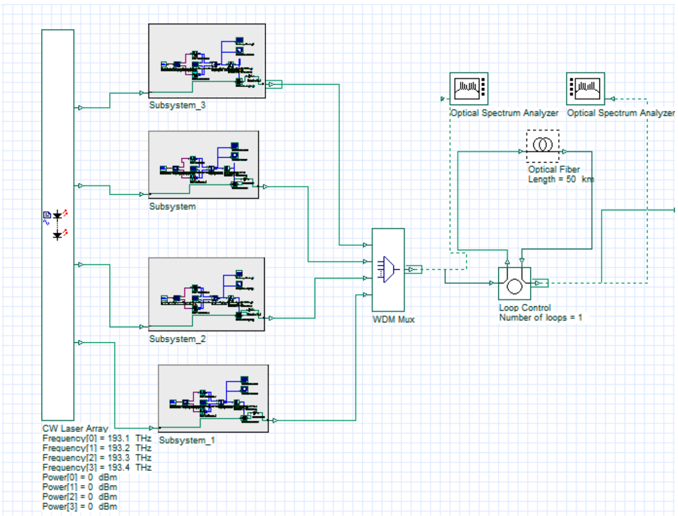
Transmitter part



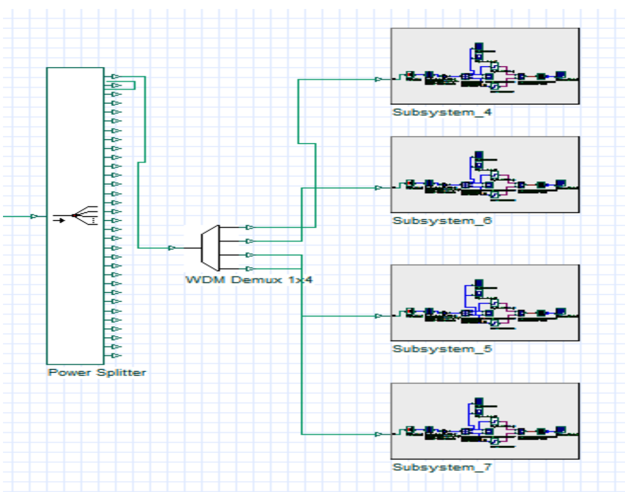
Receiver part

Figure 2. simulation setup model for the SCM-XGPON-RoF system

channels with different wavelengths coming from different optical sources into a single fiber using multiplexers at the transmitter end and demultiplexers in the receiver to split WDM channels, which are simulates through use different modulation techniques. The proposed simulation setup for the WDM – XGPON-RoF model shown in **Fig. 3.**



Transmitter part for WDM-XGPON



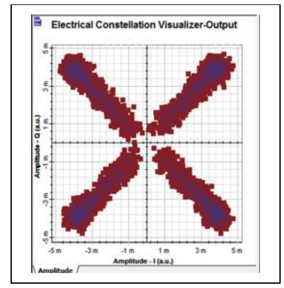
Receiver part for WDM-XGPON

Figure 3. simulation setup model for the WDM-XGPON-RoF system

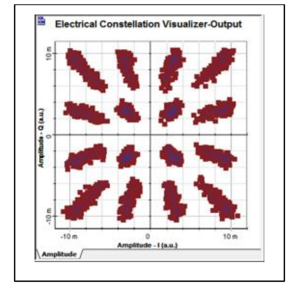
3. Result and Discussion

The performance of the proposed system depended on many factor like eye diagram, BER, quality factor, power and constellation diagram. To compare the performance of SCM-XGPON-RoF system with WDM-XGPON-RoF. The relation between max. Q factor and BER.

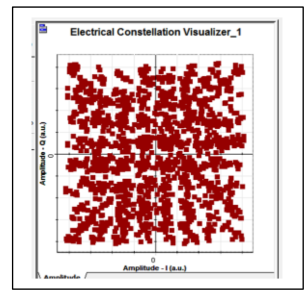
Figs. 4 and 5 shows received constellation diagram for the SCM-XGPON and WDM-XGPON, respectively, after 50 km. The distortion in the signal at the receiver is increased in SCM-XGPON system greater than WDM-XGPON.



a.4-OAM SCM-XGPON

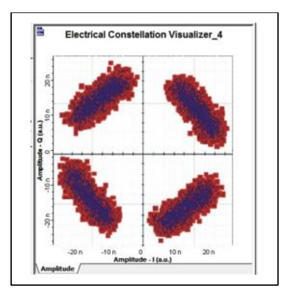


b.16-OAM SCM-XGPON

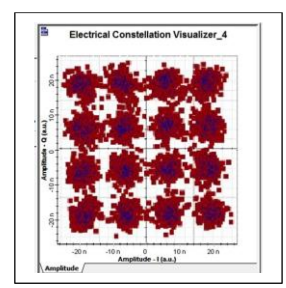


c.64-QAM SCM-XGPON

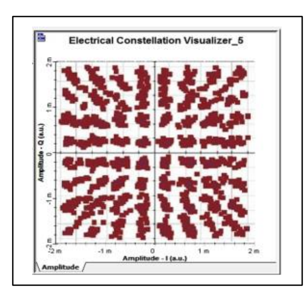
Figure (4) constellation diagram for the SCM-XGPON-RoF system model for different modulation scheme



a.4-OAM WDM-XGPON



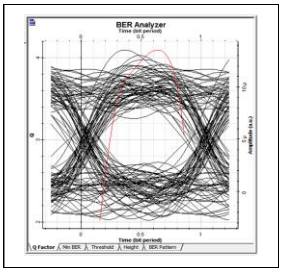
b.16-OAM WDM-XGPON



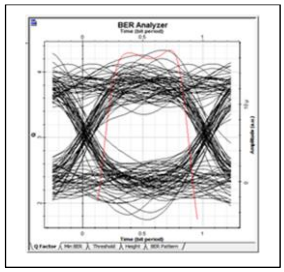
c.64-QAM WDM-XGPON

Figure (5) constellation diagram for the WDM-XGPON-RoF system model for different modulation scheme

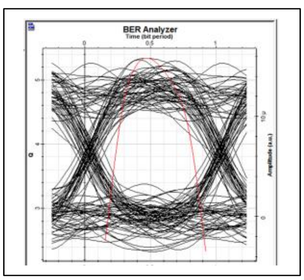
Figs. 6 and 7 shows the eye diagram for the SCM-XGPON and WDM-XGPON after 50km. The shown the signal quality high speed digital transmission. The eye diagram for WDM-XGPON clear and open is better than SCM-XGPON.



a.4-QAM SCM-XGPON

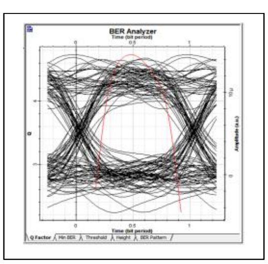


b.16-QAM SCM-XGPON

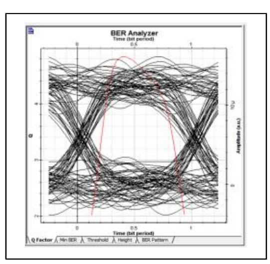


c.64-QAM SCM-XGPON

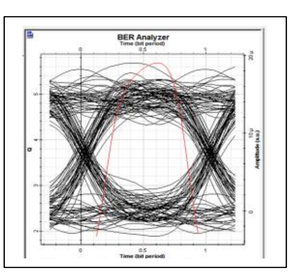
Figure (6) eye diagram for the SCM-XGPON-RoF system model for different modulation scheme



a.4-QAM WDM-XGPON



b.16-QAM WDM-XGPON



c.64-QAM WDM-XGPON

Figure (7) eye diagram for the WDM-XGPON-RoF system model for different modulation scheme

Figs. 8 and 9. shows the opposite of BER with the length of optical fiber length. The distance from 10 km to 80 km. The BER increase when the fiber length is increase. The system WDM-XGPON obtained a good results because the BER less than SCM-XGPON. The 64-QAM for WDM at 49 km the bit error rate less than 10-9 [10] acceptable level while the BER for 64-QAM for SCM less than 10-9 at 46 km.

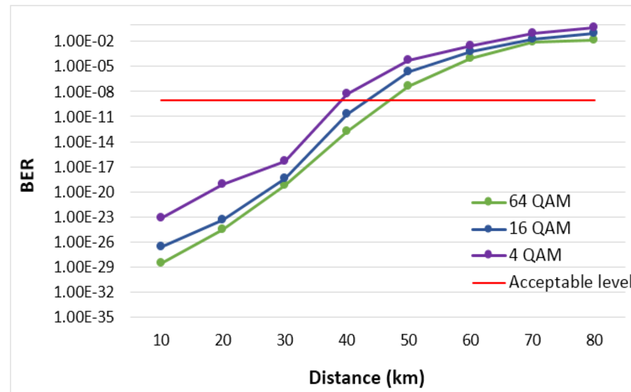


Figure (8) BER versus length of fiber for SCM-XGPON

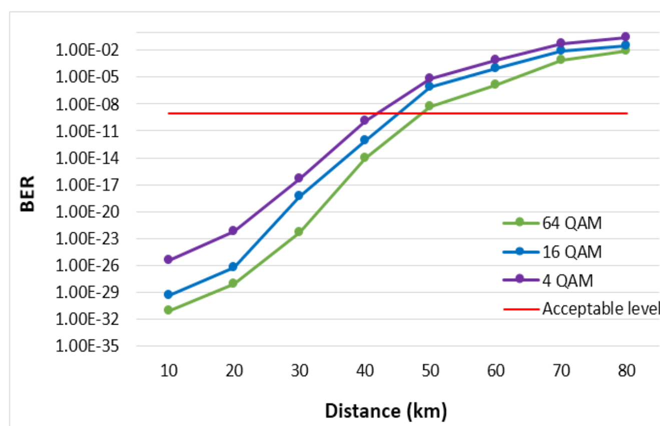


Figure (9) BER versus length of fiber for WDM-XGPON

This variation of power received with fiber has been for three types of modulation 4-QAM, 16-QAM and 64-QAM shows in **Figs. 10 and 11** for SCM-XGPON and WDM-XGPON respectively. The power received recorded in WDM-XGPON system high power than SCM-XGPON system. The 64-QAM modulation for SCM at 50 km record – 21.33dBm while the power received for WDM at 50 km is – 19.73dBm.

The BER versus the length fiber when the input power is different (-2dBm, 2dBm and 6 dBm) for SCM-XGPON and WDM-XGPON system shows in **Figs. 12 and 13** respectively. From the results, the BER increasing when the fiber distance been longer (from 10 km to 80 km). Results for BER of WDM best of SCM when input power is different (- 2dBm, 2dBm and 6 dBm). The 64-QAM modulation for SCM at 50 km when input power is 6 dBm the BER is 3.50×10-15 while for WDM at 50 km is 6.50 ×10-17.

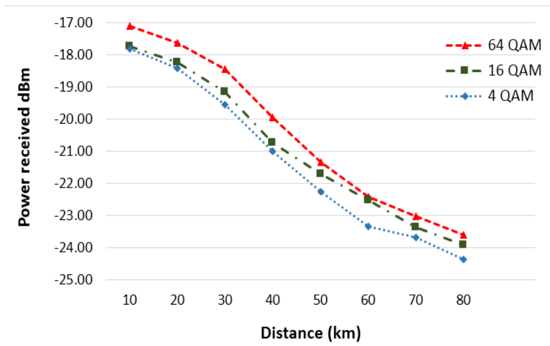


Figure 10. power received versus length of fiber for SCM-XGPON

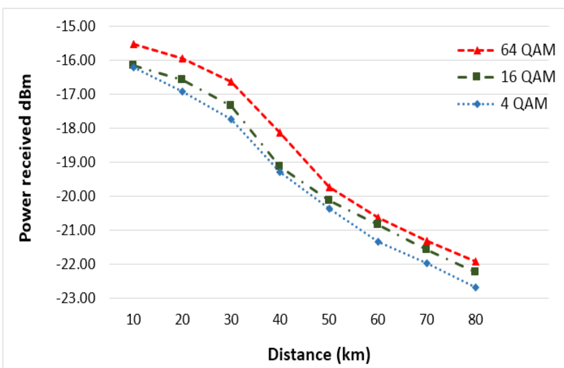


Figure 11. power received versus length of fiber for WDM-XGPON

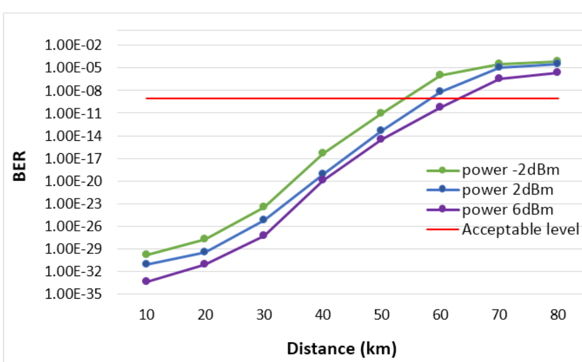


Figure 12. BER versus length of fiber for SCM-XGPON

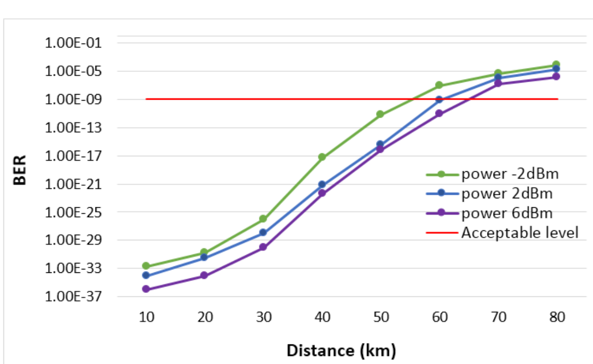


Figure 13. BER versus length of fiber for WDM-XGPON

The quality factor for SCM-XGPON system and WDM-XGPON system shows in **Figs. 14 and 15** respectively when the input power different (-2dBm, 2dBm and 6dBm). When increase the fiber the Quality factor decrease. The Quality factor for WDM greater than SCM. The 64-QAM modulation for SCM at 50 km when input power is 6 dBm the Q factor is 6.90 while for WDM is 8.10

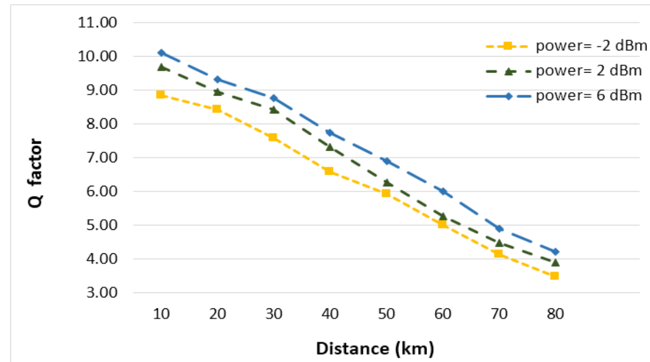


Figure 14. Quality factor versus length of fiber for SCM-XGPON

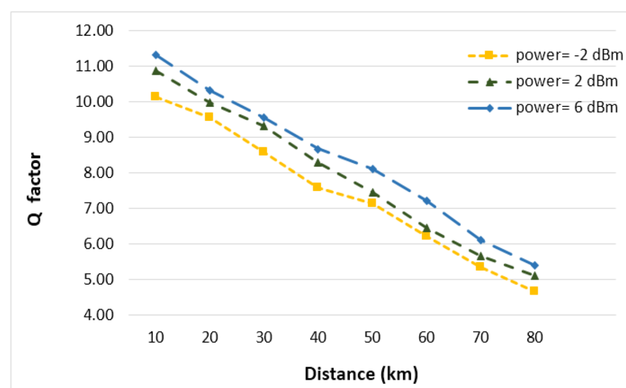


Figure 15. Quality factor versus length of fiber for WDM-XGPON

4. CONCLUSION

The XGPON combining it with the RoF system, which produces a system with very high efficient communication that uses the bandwidth effectively. Thus, the XGPON-ROF system possess better efficiency compared with the existing communication standards. In other words, combining between the XGPON and RoF will provides a robust communication by using the advantages of the optical fiber. In this paper, (WDM-XGPON) and (SCM-XGPON) were compared with (RoF) for constellation diagram, eye diagram, BER, power received, and Q-factor at different fiber length and at multi input power levels and use Three modulation schemes, such as; 4 - QAM, 16 - QAM and 64 - QAM. The eye diagram for WDM-XGPON open and clear is better than SCM-XGPON while power received for WDM-XGPON at 50km is -19.73 dBm when power received for SCM-XGPON -21.33 dBm at the same distanceThe results for BER when input power 6 dBm and modulation is 64-QAM at 50km the WDM-XGPON 6.50 ×10-17 and the SCM-XGPON 3.50 ×10-15.The simulation results show that the system WDM-XGPON gives the best results from SCM-XGPON. In addition, with the increased of data with decrease the quality. Furthermore, increase in constellation points are illustrated in the constellation output as well.

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