Optimization of the performance parameters of the Giga passive optical networks for high transmission data rates with various modulation schemes

Article *in* Journal of Optical Communications · December 2022

DOI: 10.1515/joc-2022-0245

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https://doi.org/10.1515/joc-2022-0245
Received September 18, 2022; accepted November 26, 2022; published online December 15, 2022

Abstract: This article has demonstrated the performance parameters optimization of the Giga passive optical networks (PONs) can enhanced with high transmission data rates with various modulation schemes. These modulation schemes are Mach–Zehnder modulator (MZM), electro-absorption modulator (EAM), amplitude modulator (AM), dual drive MZM measured (DDMZMM), electroabsorption modulator measured (EAMM), and LiNb MZM. The network reach can be extended to 30 km with 20 Gb/s. Maxi Q and mini bit error rate can be measured at both PIN and APD receivers. The study has emphasized AM modulation scheme is the best candidate modulation scheme for upgrading the network performance efficiency. LiNb MZM is the worst modulation scheme for the estimation of PONs performance. Optical power signals after fiber optic channel based different modulation schemes are clarified. EAM modulation scheme is the best technique for upgrading optical power signal through the network reach.

Keywords: DDMZM; EAM; MZM; performance optimization; PON.

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1 Introduction

They have studied the Ethernet passive light network simulation system by using Optimism simulation software version 3.6 [1–12]. They have used this program to build Ethernet light passive network with the performance parameters evaluation [13–20]. They have evaluated the light passive network performance based on the employment of 1580 and 1625 nm wavelength instead of 1310 and 1490 nm [21–30]. They have used light line terminal with light network unit for the build of the system architecture based on single mode fiber with various fiber lengths [31–40]. Their results clarified the enhancement of the light Ethernet network performance parameters though the increase the total number of subscribers that are connected to the light Ethernet network [41–45]. They have employed the transmission distance incremental that is reduced in the light output power received at the receiver site and therefore reduces BER [46–50]. Optical system networking have been clarified the attractive techniques and methods to high rate increase in light Ethernet optical path networking [51–59]. High Giga bit bandwidths are employed for Internet/multimedia applications. The higher transmission reach that achieved the interconnection delays are increased. By the employment of digital optical fibers, consistent signal is employed over the transmission path length [60–70].

Their studies have calculated the budget of the fiber loss to be sure that enough light signals have reached the light receiver in order to achieve adequate system network performance [71–75]. Their studies are employed to calculate the fiber pulse dispersion and then to calculate the fiber bandwidth [76–85]. Passive light network system can be used to transmit signals at the proper high speed data rates transmission through ling reach [86–93]. The performance parameters of a digital light transmission system can be estimated by the date rate transmission distance product at the Tx–Rx spacing [94–106]. There are many performance parameters that is influenced by this passive light ether met network system, the required input signal light power in the receiver site are employed to get the BER, and the total fiber system attenuation and fiber bandwidth through passive light Ethernet network system [107–128].

This study has clarified the network reach that can be extended to 30 km with 20 Gb/s. Maximum Q and mini bit error rate can be tested at both PIN and APD receivers. The study has emphasized AM modulation scheme is the best candidate modulation scheme for upgrading the network performance efficiency. LiNb MZM is the worst modulation scheme for the estimation of PONs performance. Optical power signals after fiber optic channel based different modulation schemes are clarified. EAM modulation scheme is the best technique for upgrading optical power signal through the network reach.

2 Simulation network model

Figure 1(a) shows the schematic view of passive optical network description. Figure 1(b) clarify the passive optical network simulation description. The digital stream of bits generates serial of bits (one's and zero's) and these stream of bits are encoded with NRZ modulation code. CW Laser generates the light signal which is used as a carrier to modulate the digital signal formats. The combined data bits and the light signal code are modulated. These modulation schemes are MZM, EAM, AM, DDMZMM, EAMM and LiNb MZM. Maximum Q and mini bit error rate can be tested at both PIN and APD receivers. The study has emphasized AM modulation scheme is the best candidate modulation scheme for upgrading the network performance efficiency. LiNb MZM is the worst modulation scheme for the estimation of PONs performance. The modulated signals are attenuated through the optical attenuator. The attenuated signal though the optical fiber channel and then amplified through Raman amplifiers and EDFA amplifiers. The optical splitters are splitting through PIN and APD receiver and the retiming, reshaped and reconfigured signal through 3R regenerator. The light power is measured and Q and BER are measured through the measurement device.

3 Network system results with discussions

We have clarified the performance parameters optimization of the Giga passive optical networks (GPONs) can enhanced with high transmission data rates with various modulation schemes. These modulation schemes are MZM, EAM, AM, DDMZMM, EAMM and LiNb MZM. The network reach can be extended to 30 km with 20 Gb/s. Maximum Q and mini bit error rate can be analyzed at both PIN and APD receivers. The study has emphasized AM modulation scheme is the best candidate modulation scheme for upgrading the network performance efficiency. LiNb MZM is the worst modulation scheme for the estimation of PONs performance. Optical power signals after fiber optic channel based different modulation schemes are clarified. EAM modulation scheme is the best technique for upgrading optical power signal through the network reach. Figure 2 has presented the Q factor with time based MZM in the presence of PIN receiver. Q value is 10.9832 while BER is 2.04×10^{-28}, eye eight is 0.045, threshold value is 0.0128 and decision inst. is 0.703.

Figure 3 has clarified the Q factor with time based MZM in the presence of APD receiver. Q value is 10.9385 while BER is 2.29×10^{-28}, eye eight is 0.1322, threshold value is 0.356 and decision inst. is 0.703.

Figure 4 has clarified Q with time based EAM in the presence of PIN receiver. Q value is 10.6232 while BER is 1.13×10^{-26}, eye eight is 0.0417, threshold value is 0.01289 and decision inst. is 0.703.

Figure 5 has clarified Q with time based EAM in the presence of APD receiver. Q value is 10.34 while BER is 2.06×10^{-25}, eye eight is 0.1220, threshold value is 0.062 and decision inst. is 0.703.

Figure 6 shows Q with time based AM in the presence of PIN receiver. Q value is 14.1062 while BER is 1.15×10^{-45}, eye eight is 0.0465, threshold value is 0.0116 and decision inst. is 0.71875.

Figure 7 illustrates Q with time based AM in the presence of APD receiver. Q value is 13.6178 while BER is 1.33×10^{-42}, eye eight is 0.138711, threshold value is 0.0312 and decision inst. is 0.71875.

Figure 8 clarifies the Q with time based DDMZMM in the presence of PIN receiver. Q value is 10.3397 while BER is 1.67×10^{-25}, eye eight is 0.0599, threshold value is 0.01612 and decision inst. is 0.71875.

Figure 9 illustrates Q with time based DDMZMM in the presence of APD receiver. Q value is 10.6154 while BER is 9.965×10^{-27}, eye eight is 0.1819, threshold value is 0.06846 and decision inst. is 0.359375. Figure 10 shows Q with time based EAMM in the presence of PIN receiver. Q value is

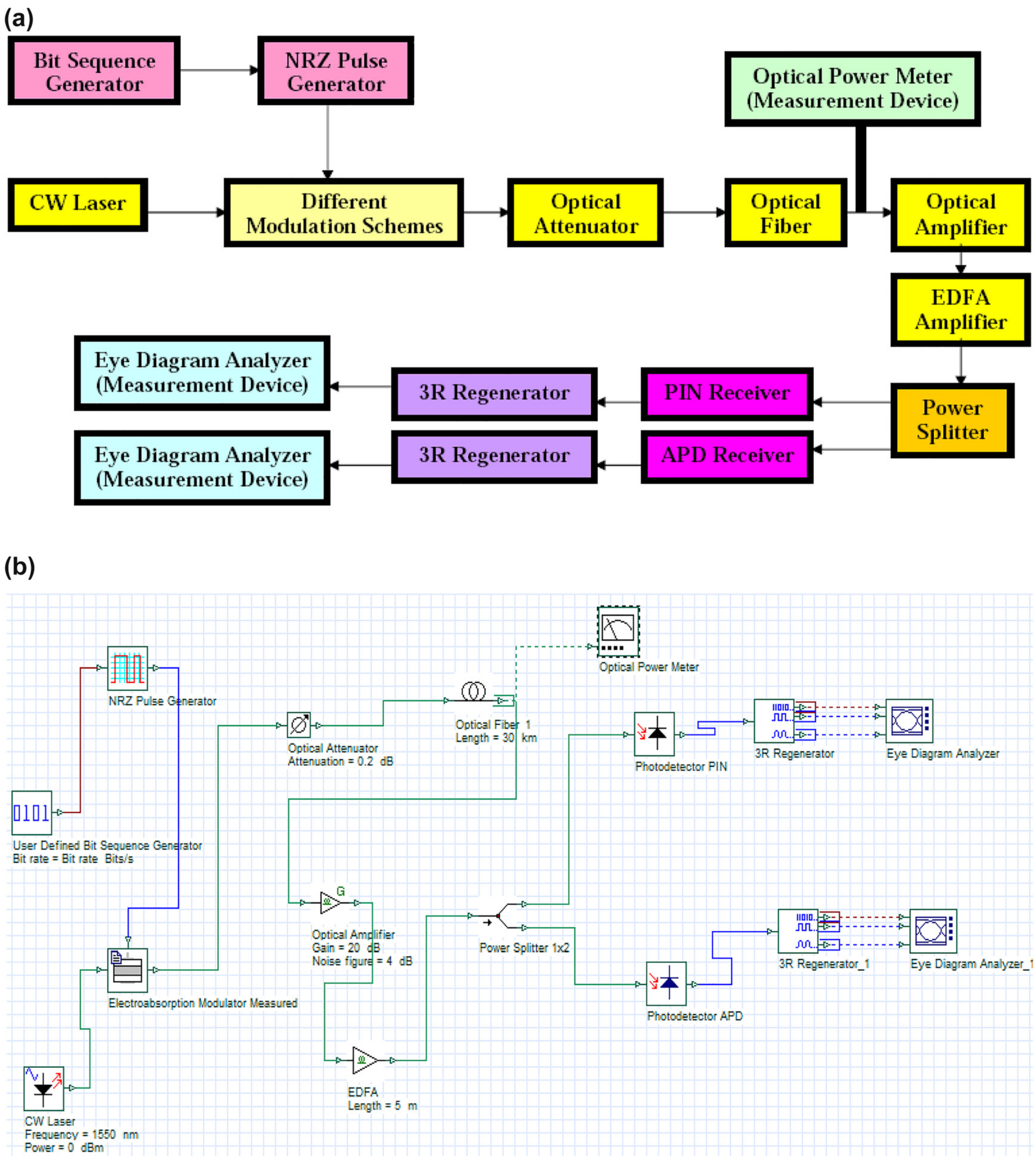

Figure 1: (a) Proposed passive optical network description. (b) Proposed passive optical network description.

11.634 while BER is 1.14×10^{-31}, eye eight is 0.043, threshold value is 0.009 and decision inst. is 0.703125. Figure 11 shows Q with time based EAMM in the presence of APD receiver. Q value is 11.2779 while BER is 7.06×10^{-30}, eye eight is 0.1305, threshold value is 0.02902 and decision inst. is 0.703125. Figure 12 reports Q with time based LiNb MZM in the presence of PIN receiver. Q value is 7.543 while BER is 2.144×10^{-14}, eye eight is 0.0285, threshold value is 0.0144259 and decision inst. is 0.59375.

Figure 13 illustrates Q with time based LiNb MZM in the presence of APD receiver. Q value is 7.419 while BER is 5.4798×10^{-14}, eye eight is 0.08396, threshold value is 0.04238 and decision inst. is 0.59375. Figure 14 reports the light power signal after fiber optic channel based LiNb MZM modulation scheme. The power is –13.606 dBm which is equivalent 43.589 µW. Figure 15 shows the light power signal after fiber optic channel based AM modulation scheme. The power is –8.638 dBm which is equivalent 136.808 µW. Figure 16

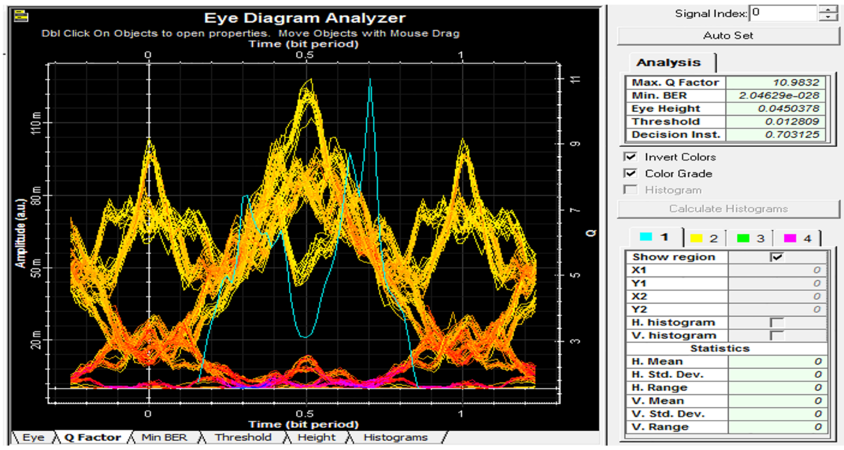

Figure 2: *Q* factor variations with time based MZM in the presence of PIN receiver.

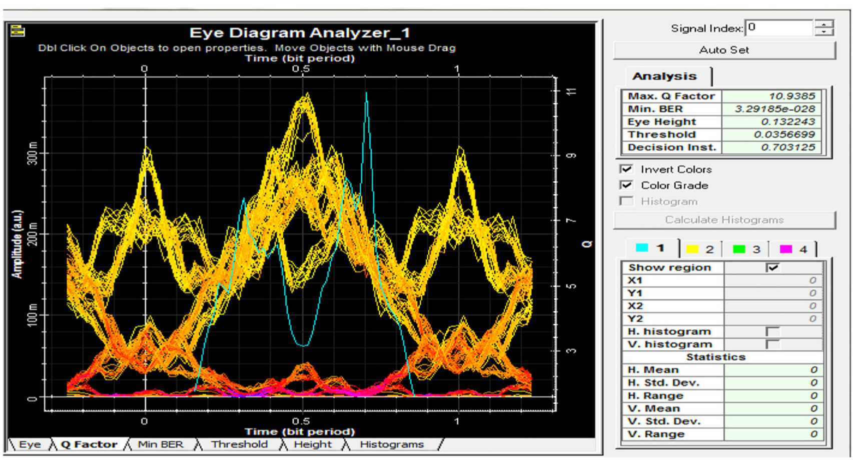

Figure 3: *Q* factor variations with time based MZM in the presence of APD receiver.

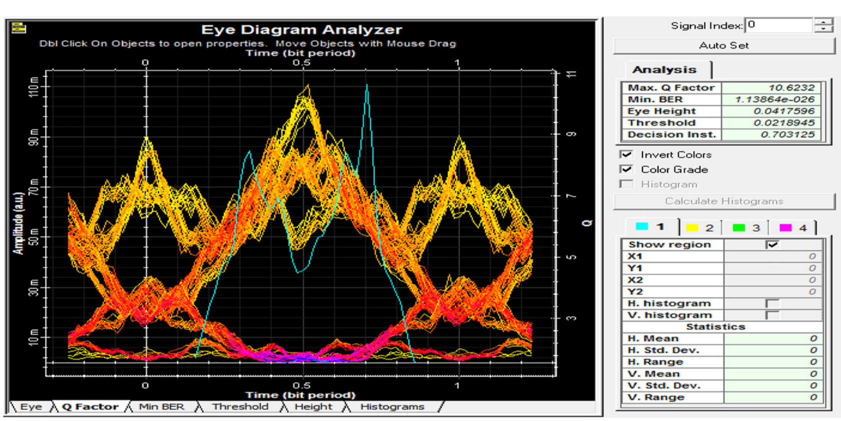

Figure 4: *Q* with time based EAM in the presence of PIN receiver.

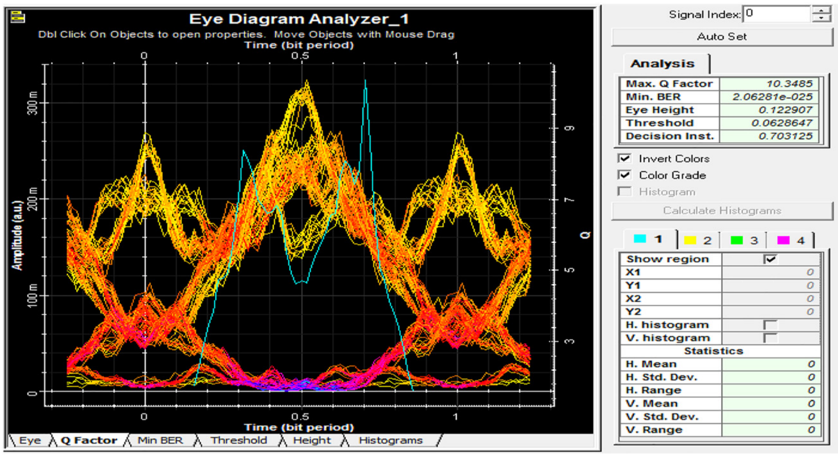

Figure 5: *Q* with time based EAM in the presence of APD receiver.

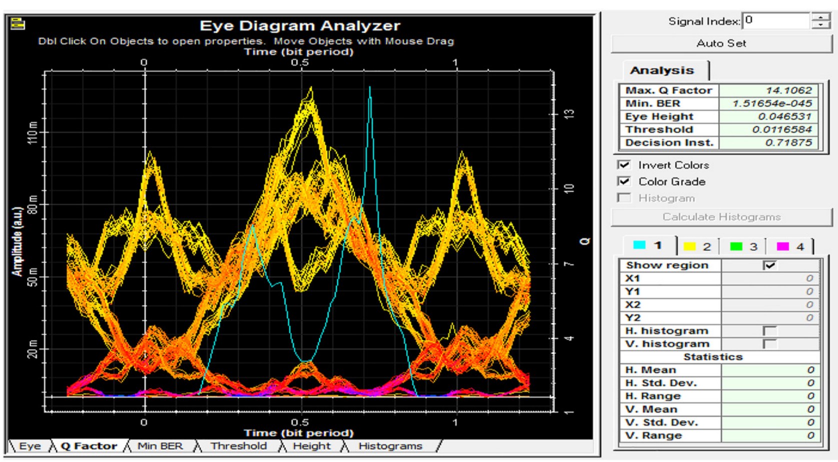

Figure 6: *Q* with time based AM in the presence of PIN receiver.

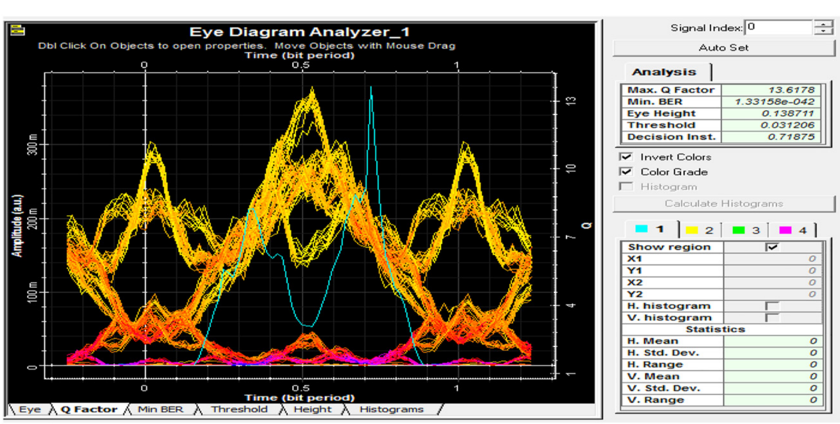

Figure 7: *Q* factor variations with time based AM in the presence of APD receiver.

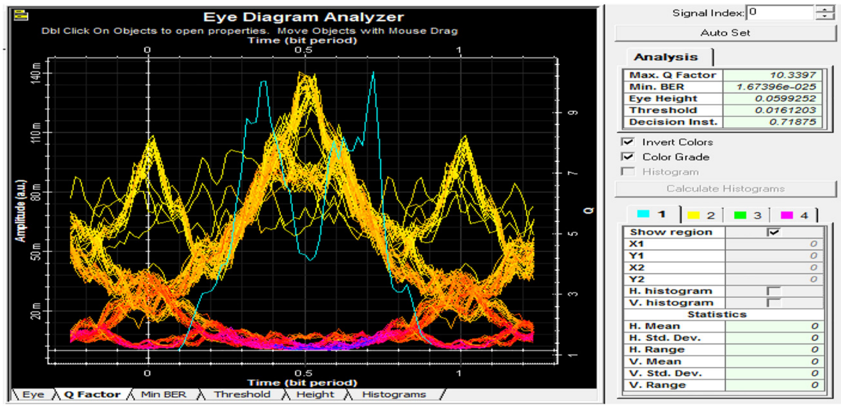

Figure 8: *Q* factor variations with time based DDMZMM in the presence of PIN receiver.

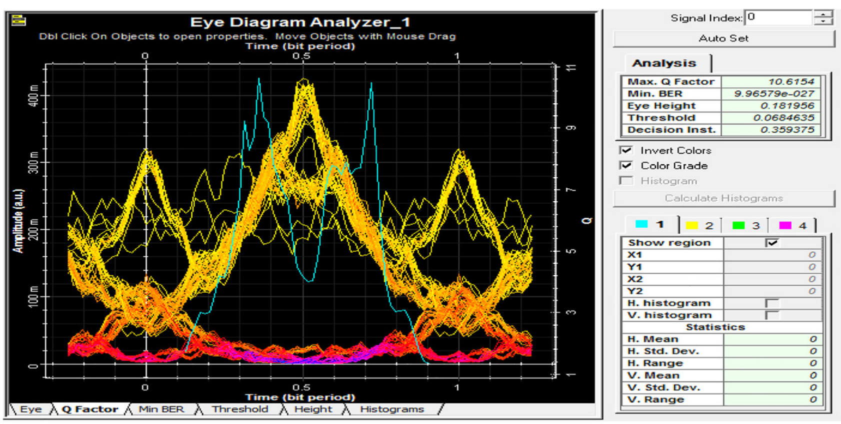

Figure 9: *Q* factor variations with time based DDMZMM in the presence of APD receiver.

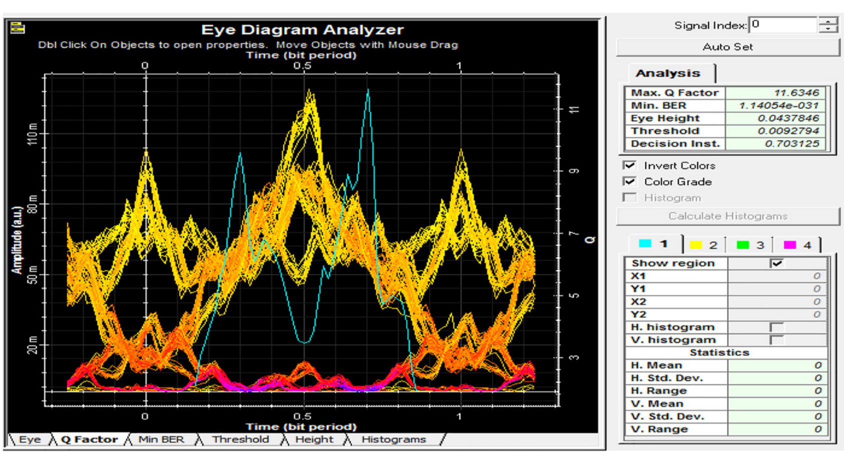

Figure 10: *Q* factor variations with time based EAMM in the presence of PIN receiver.

clarifies the light power signal after fiber optic channel based MZM modulation scheme. The power is –8.640 dBm which is equivalent 136.775 µW. Figure 17 illustrates the light power signal after fiber optic channel based EAM modulation scheme. The power is –8.678 dBm which is equivalent 141.962 µW.

Figure 18 shows the light power signal after fiber optic channel based DDMZMM modulation scheme. The power is –10.490 dBm which is equivalent 89.327 µW. Figure 19 shows the light power signal after fiber optic channel based EAMM modulation scheme. The power is –8.625 dBm which is equivalent 137.525 µW.

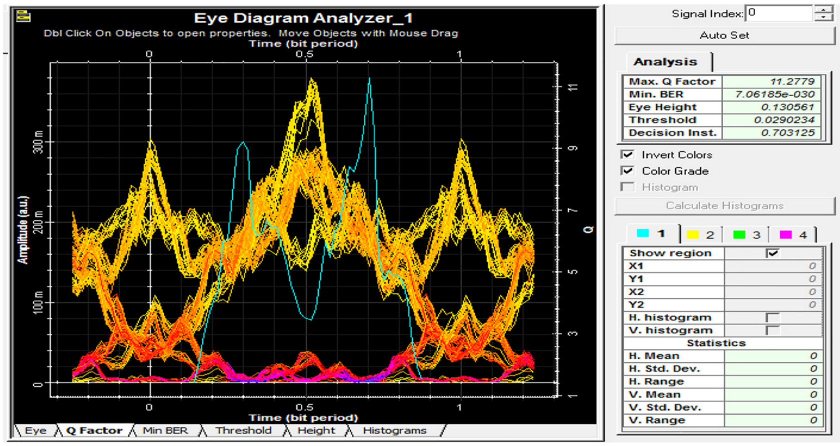

Figure 11: *Q* factor variations with time based EAMM in the presence of APD receiver.

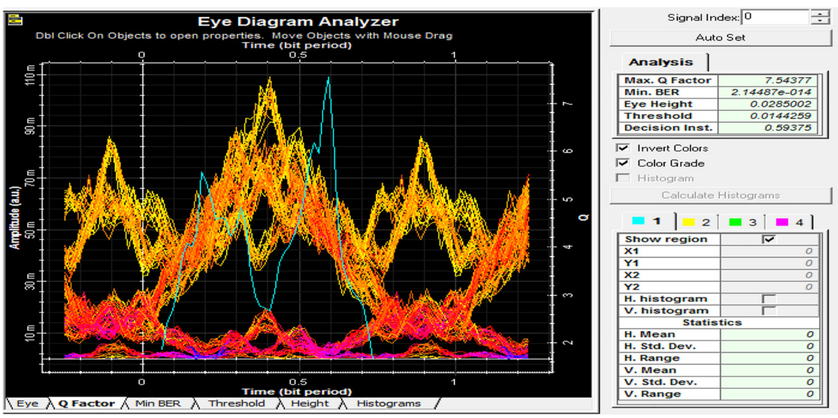

Figure 12: *Q* factor variations with time based LiNb MZM in the presence of PIN receiver.

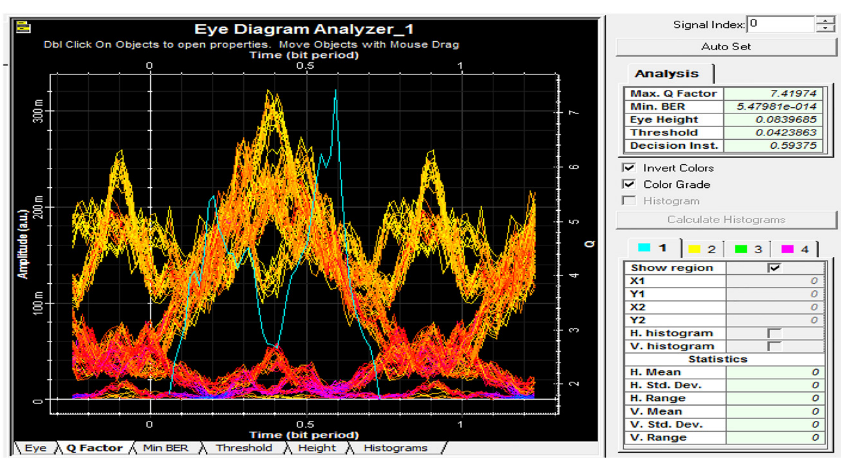

Figure 13: *Q* factor variations with time based LiNb MZM in the presence of APD receiver.

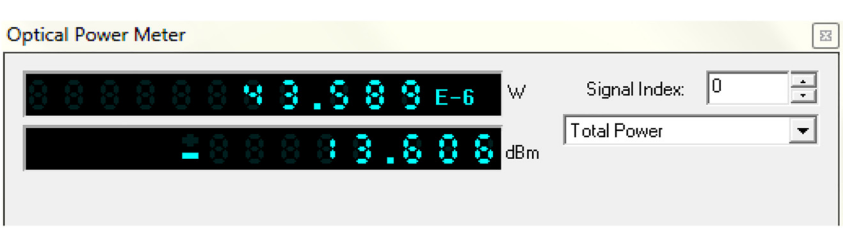

Figure 14: Optical power signal after fiber optic channel based LiNb MZM modulation scheme.

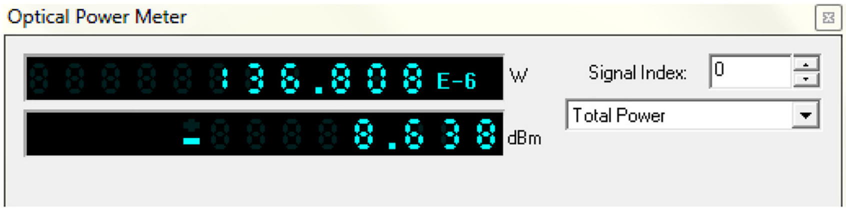

Figure 15: Optical power signal after fiber optic channel based AM modulation scheme.

Figure 16: Optical power signal after fiber optic channel based MZM modulation scheme.

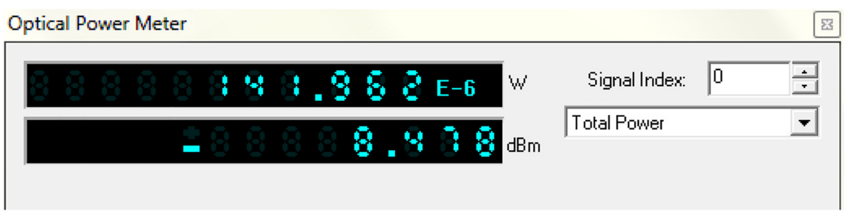

Figure 17: Optical power signal after fiber optic channel based EAM modulation scheme.

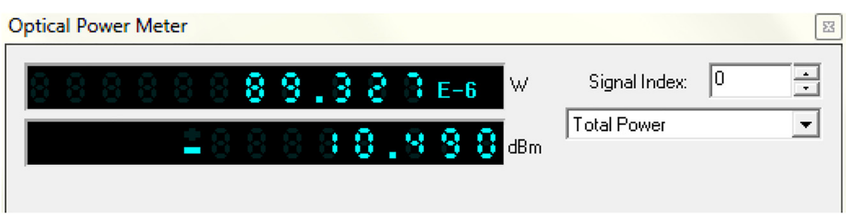

Figure 18: Optical power signal after fiber optic channel based DDMZMM modulation scheme.

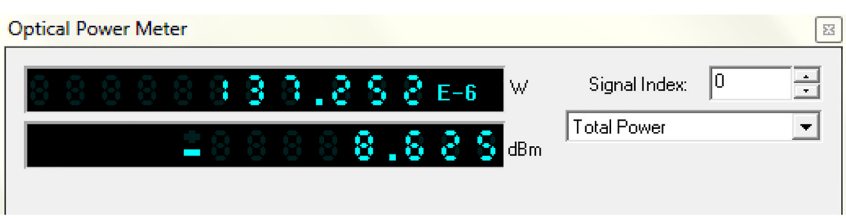

Figure 19: Optical power signal after fiber optic channel based EAMM modulation scheme..

4 Conclusions

We have studied the optimization of the performance parameters of the Giga-bit PONs for the high transmission data rates with various modulation schemes. Q factor and BER values estimation are clarified based MZM, EAM, AM, DDMZMM, EAMM and LiNb MZM in the presence of both PIN and APD receivers. Max Q factor is 14.1, 13.61 and BER is 1.51×10^{-45}, 1.33×10^{-42} with AM modulation scheme for PIN, APD receivers respectively. While the Max Q factor is 7.54, 7.41 and BER is 2.14×10^{-14}, 5.47×10^{-14} with the LiNb MZM modulation scheme for PIN, APD receivers respectively. Thus the best modulation scheme is AM modulation scheme while the worst modulation scheme is LiNb MZM for the network distance up to 30 km and 20 Gb/s. The best candidate for upgrading the optical power signal through the network is EAM modulation technique, where the power is achieved a value of 141.962 μW through the fiber channel.

Author contributions: All the authors have accepted responsibility for the entire content of this submitted manuscript and approved submission.

Research funding: None declared.
Conflict of interest statement: The authors declare no conflicts of interest regarding this article.

References

1. Ramezani Z, Orouji AA. A new DG nanoscale TFET based on MOSFETs by using source gate electrode: 2D simulation and an analytical potential model. J Korean Phys Soc 2017;71:215–21.
2. Anvarifard MK, Ramezani Z, Amiri IS. High ability of a reliable novel TFET-based device in detection of biomolecule specifies—a comprehensive analysis on sensing performance. IEEE Sensor J 2020; 21:6880–7.
3. Ramezani Z, Orouji AA. Dual metal gate tunneling field effect transistors based on MOSFETs: a 2-D analytical approach. Superlattices Microstruct 2018;113:41–56.
4. Tahhan SR, Atieh A, Hasan M, Hall T. Characterization and experimental verification of actively mode-locked erbium doped fiber laser utilizing ring cavity. TM – Tech Mess 2020;87:535–41.
5. Tahhan SR, Abass AK, Ali MH, Characteristics of chirped fiber Bragg grating dispersion compensator utilizing two apodization profiles. J Commun 2018;13:108–13.
6. Tahhan SR, Ghazai AJ, Alwan IM, Ali MH. Investigation of the characteristics of high-resistivity silica based hybrid porous core photonic crystal fiber for terahertz wave guidance. Digest J Nanomater Biostruct 2019;14:831–41.
7. Singh M, Malhotra J, Mani Rajan MS, Dhasarathan V, Aly MH. Performance evaluation of 6.4 Tbps dual polarization quadrature phase shift keying Nyquist-WDM superchannel FSO transmission link: impact of weather conditions. Alex Eng J 2020;59: 977–86.
8. Dhasarathan V, Singh M, Malhotra J. Development of high-speed FSO transmission link for the implementation of 5G and Internet of Things. Wireless Network 2019;26:2403–12.
9. Al-Khaffaf DAJ, Alsahlany AM. 60 GHz millimetre wave/10 gbps transmission for super broadband wi-fi network. J Commun 2019;14: 261–6.
10. Al-Khaffaf DAJ, Al-Hamiri MG. Performance evaluation of campus network involving VLAN and broadband multimedia wireless networks using OPNET modeler. TELKOMNIKA (Telecommun, Comput, Electron Control) 2021;19:1490–7.
11. Alsahlany AM, Al-Khafaf DAJ. An efficient improvement of frame aggregation mechanisms for VHT at MAC and PHY layers in IEEE802.11ac using MIMO channel. J Theor Appl Inf Technol 2018;96: 6817–27.
12. Rashed ANZ. High Reliability optical interconnections for short range applications in high speed optical communication systems. J Opt Laser Technol 2013;48:302–8.
13. Rashed ANZ. High performance photonic devices for multiplexing/ demultiplexing applications in multi band operating regions. J Comput Theor Nanosci 2012;9:522–31.
14. Chakkravarthy SP, Arthi V, Karthikumar S, Rashed ANZ, Yupapin P, Amiri IS. Ultra high transmission capacity based on optical first order soliton propagation systems. Results Phys 2019;12:512–3.
15. Rashed ANZ, Metwae'e MA. Operation performance characteristics of vertical cavity surface emitting lasers (VCSELs) under high thermal neutrons irradiated fields. J Russ Laser Res 2013;34:1–8.
16. Rashed ANZ. Optical fiber communication cables systems performance under harmful gamma irradiation and thermal environment effects. IET Commun 2013;7:448–55.
17. Rashed ANZ, El-halawany MME. Transmission characteristics evaluation under bad weather conditions in optical wireless links with different optical transmission windows. Wireless Pers Commun 2013; 71:1577–95.
18. Rashed ANZ, Sharshar H. Performance evaluation of short range underwater optical wireless communications for different ocean water types. Wireless Pers Commun J 2013;72:693–708.
19. Rashed ANZ. Performance signature and optical signal processing of high speed electro-optic modulators. Opt Commun 2013;294:49–58.
20. Rashed ANZ, Metwae'e M. Maximization of repeater spacing in ultra wide-wavelength-division multiplexing optical communication systems based on multi pumped laser diodes. J Russ Laser Res 2013; 34:255–61.
21. Rashed ANZ. High efficiency wireless optical links in high transmission speed wireless optical communication networks. Int J Commun Syst 2014;27:3416–27.
22. Rashed ANZ, Saad AEl-FA. Different electro-optical modulators for high transmission-data rates and signal-quality enhancement. J Russ Laser Res 2013;34:336–45.
23. Rashed ANZ. High efficiency laser power transmission with all optical amplification for high transmission capacity submarine cables. J Russ Laser Res 2013;34:603–13.
24. Rashed ANZ. Submarine fiber cable network systems cost planning considerations with achieved high transmission capacity and signal quality enhancement. Opt Commun 2014;311:44–54.
25. Rashed ANZ, Mohamed AE-NA, Metawe'e MA. New trends of transmission capacity evaluation of submarine fiber cable systems with different ultra-high multiplexing, amplification and propagation techniques. Arabian J Sci Eng 2014;39:945–56.
26. Rashed ANZ. Optical network management and its performance evaluation for both future cost planning and triple play solutions. Wireless Pers Commun J 2014;75:2005–20.
27. Rashed ANZ, Daher MG, Hasane Ahammad SK, Montalbo FJP. Sorathiya V, Asaduzzaman S, et al. Non return to zero line coding with suppressed carrier in FSO transceiver systems under light rain conditions. J Opt Commun 2022;1–15. https://doi.org/10.1515/joc-2022-0039 [Epub ahead of print].
28. Rashed ANZ, Mohammed A-EA, Dardeer OMA. Performance evaluation of a WDM/OCDM based hybrid optical switch utilizing efficient resource allocation. Chin Opt Lett 2014;12:050602.
29. Rashed ANZ. Optical wireless communication systems operation performance efficiency evaluation in the presence of different fog density levels and noise impact. Wireless Pers Commun J 2015;81: 427–44.
30. Amiri IS, Rashed ANZ, Yupapin P. High-speed light sources in high-speed optical passive local area communication networks. J Opt Commun 2019;1–14. https://doi.org/10.1515/joc-2019-0070 [Epub ahead of print].
31. Rashed ANZ, Tabbour MSF, Natarajan K. Performance enhancement of overall LEO/MEO intersatellite optical wireless communication systems. Int J Satell Commun Netw 2019;38:31–40.
32. Amiri IS, Rashed ANZ, Mohammed AEA, El-Din ES, Yupapin P. Spatial continuous wave laser and spatiotemporal VCSEL for high-speed long haul optical wireless communication channels. J Opt Commun 2019; 1–19. https://doi.org/10.1515/joc-2019-0061 [Epub ahead of print].
33. Amiri IS, Rashed ANZ, Yupapin P. Average power model of optical Raman amplifiers based on frequency spacing and amplifier section

stage optimization. J Opt Commun 2019;1–18. https://doi.org/10.1515/joc-2019-0081 [Epub ahead of print].
34. Amiri IS, Houssien FMAM, Rashed ANZ, Mohammed AE-NA. Temperature effects on characteristics and performance of near-infrared wide bandwidth for different avalanche photodiodes structures. Results Phys 2019;14:102–10.
35. Amiri IS, Rashed ANZ. Simulative study of simple ring resonator-based brewster plate for power system operation stability. Indonesian J Electr Eng Comput Sci 2019;16:1070–6.
36. Amiri IS, Rashed ANZ. Different photonic crystal fibers configurations with the key solutions for the optimization of data rates transmission. J Opt Commun 2019;1–17. https://doi.org/10.1515/joc-2019-0100 [Epub ahead of print].
37. Amiri IS, Rashed ANZ, Ramya KC, Vinoth Kumar K, Maheswar R. The physical parameters of EDFA and SOA optical amplifiers and bit sequence variations based optical pulse generators impact on the performance of soliton transmission systems. J Opt Commun 2019; 1–22. https://doi.org/10.1515/joc-2019-0156 [Epub ahead of print].
38. Amiri IS, Houssien FMAM, Rashed ANZ, Mohammed AE-NA. Optical networks performance optimization based on hybrid configurations of optical fiber amplifiers and optical receivers. J Opt Commun 2019; 1–19. https://doi.org/10.1515/joc-2019-0153 [Epub ahead of print].
39. Amiri IS, Rashed ANZ, Sarker K, Paul BK, Ahmed K. Chirped large mode area photonic crystal modal fibers and its resonance modes based on finite element technique. J Opt Commun 2019;1–14. https://doi.org/10.1515/joc-2019-0146 [Epub ahead of print].
40. Amiri IS, Houssien FMAM, Rashed ANZ, Mohammed AE-NA. Comparative simulation of thermal noise effects for photodetectors on performance of long-haul DWDM optical networks. J Opt Commun 2019;1–17. https://doi.org/10.1515/joc-2019-0152 [Epub ahead of print].
41. Amiri IS, Rashed ANZ, Mohammed AE-NA, Aboelazm MB. Single wide band traveling wave semiconductor optical amplifiers for all optical bidirectional wavelength conversion. J Opt Commun 2019;1–16. https://doi.org/10.1515/joc-2019-0168 [Epub ahead of print].
42. Amiri IS, Rashed ANZ, Mohammed AE-NA, Fawzy Zaky W. Influence of loading, regeneration and recalling elements processes on the system behavior of all optical data bus line system random access memory. J Opt Commun 2019;1–18. https://doi.org/10.1515/joc-2019-0163 [Epub ahead of print].
43. Malathy S, Vinoth Kumar K, Rashed ANZ, Vigneswaran D, Eeldien ES. Upgrading superior operation performance efficiency of submarine transceiver optical communication systems toward multi tera bit per second. Comput Commun J 2019;146:192–200.
44. Amiri IS, Rashed ANZ. Numerical investigation of V shaped three elements resonator for optical closed loop system. Indonesian J Electr Eng Comput Sci 2019;16:1392–7.
45. Rashed ANZ, Tabbour MSF. The engagement of hybrid dispersion compensation schemes performance signature for ultra wide bandwidth and ultra long haul optical transmission systems. Wireless Pers Commun J 2019;109:2399–410.
46. Rashed ANZ, Tabbour MSF, El-Meadawy S, Anwar T, Sarlan A, Yupapin P, Amiri IS. The effect of using different materials on erbium-doped fiber amplifiers for indoor applications. Results Phys 2019;15: 103–10.
47. Amiri IS, Rashed ANZ. Power enhancement of the U-shape cavity microring resonator through gap and material characterizations. J Opt Commun 2019;1–18. https://doi.org/10.1515/joc-2019-0108 [Epub ahead of print].
48. Amiri IS, Kuppusamy PG, Rashed ANZ, Jayarajan P, Thiyagupriyadharsan MR, Yupapin P. The Engagement of hybrid ultra high space division multiplexing with maximum time division multiplexing techniques for high-speed single-mode fiber cable systems. J Opt Commun 2019;1–16. https://doi.org/10.1515/joc-2019-0205 [Epub ahead of print].
49. Amiri IS, Rashed ANZ, Jahan S, Paul BK, Ahmed K. Polar polarization mode and average radical flux intensity measurements based on all optical spatial communication systems. J Opt Commun 2019;1–20. https://doi.org/10.1515/joc-2019-0159 [Epub ahead of print].
50. Sivaranjani S, Sampathkumar A, Rashed ANZ, Sundararajan TVP, Amiri IS. Performance evaluation of bidirectional wavelength division multiple access broadband optical passive elastic networks operation efficiency. J Opt Commun 2019;1–20. https://doi.org/10.1515/joc-2019-0175 [Epub ahead of print].
51. Amiri IS, Rashed ANZ, Yupapin P. High-speed transmission circuits signaling in optical communication systems. J Opt Commun 2019; 1–13. https://doi.org/10.1515/joc-2019-0197 [Epub ahead of print].
52. Amiri IS, Rashed ANZ, Jahan S, Paul BK, Ahmed K, Yupapin P. Technical specifications of the submarine fiber optic channel bandwidth/capacity in optical fiber transmission systems. J Opt Commun 2019; 1–15. https://doi.org/10.1515/joc-2019-0226 [Epub ahead of print].
53. Amiri IS, Rashed ANZ. Signal processing criteria based on electro-optic filters for fiber optic access transceiver systems. J Opt Commun 2019; 1–16. https://doi.org/10.1515/joc-2019-0116 [Epub ahead of print].
54. Amiri IS, Rashed ANZ, Yupapin P. Pump laser automatic signal control for erbium-doped fiber amplifier gain, noise figure, and output spectral power. J Opt Commun 2019;1–18. https://doi.org/10.1515/joc-2019-0203 [Epub ahead of print].
55. Amiri IS, Rashed ANZ, Parvez AHMS, Paul BK, Ahmed K. Performance enhancement of fiber optic and optical wireless communication channels by using forward error correction codes. J Opt Commun 2019;1–18. https://doi.org/10.1515/joc-2019-0191 [Epub ahead of print].
56. Amiri IS, Rashed ANZ, Yupapin P. Z Shaped like resonator with crystal in the presence of flat mirror based standing wave ratio for optical antenna systems. Indonesian J Electr Eng Comput Sci 2020;17: 1405–9.
57. Amiri IS, Rashed ANZ, Yupapin P. Influence of device to device interconnection elements on the system behavior and stability. Indonesian J Electr Eng Comput Sci 2020;18:843–7.
58. Eid MMA, Amiri IS, Rashed ANZ, Yupapin P. Dental lasers applications in visible wavelength operational band. Indonesian J Electr Eng Comput Sci 2020;18:890–5.
59. Amiri IS, Rashed ANZ, Yupapin P. Comparative simulation study of multi stage hybrid all optical fiber amplifiers in optical communications. J Opt Commun 2020;1–16. https://doi.org/10.1515/joc-2019-0132 [Epub ahead of print].
60. Amiri IS, Rashed ANZ, Kader HMA, Al-Awamry AA, Abd El-Aziz IA, Yupapin P, et al. Optical communication transmission systems improvement based on chromatic and polarization mode dispersion compensation simulation management. Optik J 2020;207:163–72.
61. Samanta D, Sivaram M, Rashed ANZ, Boopathi CS, Amiri IS, Yupapin P. Distributed feedback laser (DFB) for signal power amplitude level improvement in long spectral band. J Opt Commun 2020;1–19. https://doi.org/10.1515/joc-2019-0252 [Epub ahead of print].
62. Amiri IS, Rashed ANZ, Yupapin P. Analytical model analysis of reflection/transmission characteristics of long-period fiber Bragg grating (LPFBG) by using coupled mode theory. J Opt Commun 2020; 1–18. https://doi.org/10.1515/joc-2019-0187 [Epub ahead of print].

63. Amiri IS, Rashed ANZ, Rahman Z, Paul BK, Ahmed K. Conventional/phase shift dual drive Mach–Zehnder modulation measured type based radio over fiber systems. J Opt Commun 2020;1–18. https://doi.org/10.1515/joc-2019-0312 [Epub ahead of print].
64. Alatwi AM, Rashed ANZ, El-Eraki AM, Amiri IS. Best candidate Routing algorithms integrated with minimum processing time and low blocking probability for modern parallel computing systems. Indonesian J Electr Eng Comput Sci 2020;19:847–854.
65. El-Hageen HM, Alatwi AM, Rashed ANZ. Silicon-germanium dioxide and aluminum indium gallium arsenide-based acoustic optic modulators. Open Eng J 2020;10:506–11.
66. El-Hageen HM, Alatwi AM, Rashed ANZ. RZ line coding scheme with direct laser modulation for upgrading optical transmission systems. Open Eng J 2020;10:546–51.
67. Alatwi AM, Rashed ANZ, El-Gammal EM. Wavelength division multiplexing techniques based on multi transceiver in low earth orbit intersatellite systems. J Opt Commun 2020;1–13. https://doi.org/10.1515/joc-2019-0171 [Epub ahead of print].
68. El-Hageen HM, Kuppusamy PG, Alatwi AM, Sivaram M, Yasar ZA, Rashed ANZ. Different modulation schemes for direct and external modulators based on various laser sources. J Opt Commun 2020;1–18. https://doi.org/10.1515/joc-2020-0029 [Epub ahead of print].
69. El-Hageen HM, Alatwi AM, Rashed ANZ. High-speed signal processing and wide band optical semiconductor amplifier in the optical communication systems. J Opt Commun 2020;1–20. https://doi.org/10.1515/joc-2020-0070 [Epub ahead of print].
70. El-Hageen HM, Alatwi AM, Rashed ANZ. Laser measured rate equations with various transmission coders for optimum of data transmission error rates. Indonesian J Electr Eng Comput Sci 2020;20:1406–1412.
71. Eid MMA, Ahasan Habib M, Shamim Anower M, Rashed ANZ. Highly sensitive nonlinear photonic crystal fiber based sensor for chemical sensing applications. Microsyst Technol J 2021;27:1007–14.
72. Eid MMA, Rashed ANZ, Shafkat A, Ahmed K. Fabry Perot laser properties with high pump lasers for upgrading fiber optic transceiver systems. J Opt Commun 2020;1–20. https://doi.org/10.1515/joc-2020-0146 [Epub ahead of print].
73. Eid MMA, Rashed ANZ, Hosen MS, Paul BK, Ahmed K. Spatial optical transceiver system–based key solution for high data rates in measured index multimode optical fibers for indoor applications. J Opt Commun 2020;1–15. https://doi.org/10.1515/joc-2020-0117 [Epub ahead of print].
74. Eid MMA, Rashed ANZ, El-Meadawy S, Ahmed K. Simulation study of signal gain optimization based on hybrid composition techniques for high speed optically dense multiplexed systems. J Opt Commun 2020;1–16. https://doi.org/10.1515/joc-2020-0150 [Epub ahead of print].
75. Alatwi AM, Rashed ANZ. Hybrid CPFSK/OQPSK modulation transmission techniques' performance efficiency with RZ line coding–based fiber systems in passive optical networks. Indonesian J Electr Eng Comput Sci 2021;21:263–70.
76. Alatwi AM, Rashed ANZ. An analytical method with numerical results to be used in the design of optical slab waveguides for optical communication system applications. Indonesian J Electr Eng Comput Sci 2021;21:278–86.
77. Alatwi AM, Rashed ANZ. Conventional doped silica/fluoride glass fibers for low loss and minimum dispersion effects. Indonesian J Electr Eng Comput Sci 2021;21:287–95.
78. El-Hageen HM, Alatwi AM, Rashed ANZ. Spatial optical transmitter based on on/off keying line coding modulation scheme for optimum performance of telecommunication systems. Indonesian J Electr Eng Comput Sci 2021;21:305–12.
79. Eid MMA, Rashed ANZ, Kurmendra. High speed optical switching gain based EDFA model with 30 Gb/s NRZ modulation code in optical systems. J Opt Commun 2020;1–19. https://doi.org/10.1515/joc-2020-0223 [Epub ahead of print].
80. Eid MMA, Rashed ANZ, Amiri IS. Fast speed switching response and high modulation signal processing bandwidth through $LiNbO_3$ electro-optic modulators. J Opt Commun 2020;1–18. https://doi.org/10.1515/joc-2020-0012 [Epub ahead of print].
81. Eid MMA, Houssien FMAM, Rashed ANZ, Mohammed AE-NA. Performance enhancement of transceiver system based inter satellite optical wireless channel (IS-OWC) for ultra long distances. J Opt Commun 2020;1–15. https://doi.org/10.1515/joc-2020-0216 [Epub ahead of print].
82. Eid MMA, Rashed ANZ, El-din ES. Simulation performance signature evolution of optical inter satellite links based booster EDFA and receiver preamplifiers. J Opt Commun 2020;1–17. https://doi.org/10.1515/joc-2020-0190 [Epub ahead of print].
83. Eid MMA, Rashed ANZ, El-gammal EM. Influence of dense wavelength division multiplexing (DWDM) technique on the low earth orbit intersatellite systems performance. J Opt Commun 2020;1–16. https://doi.org/10.1515/joc-2020-0188 [Epub ahead of print].
84. Eid MMA, Rashed ANZ, Al-Mamun Bulbul A, Podder E. Mono rectangular core photonic crystal fiber (MRC-PCF) for skin and blood cancer detection. Plasmonics J 2021;16:717–27.
85. Eid MMA, Seliem AS, Rashed ANZ, Mohammed AEl-NA, Ali MY, Abaza SS. High speed pulse generators with electro-optic modulators based on different bit sequence for the digital fiber optic communication links. Indonesian J Electri Eng Comput Sci 2021;21:957–67.
86. Eid MMA, Seliem AS, Rashed ANZ, Mohammed AEl-NA, Ali MY, Abaza SS. The key management of direct/external modulation semiconductor laser response systems for relative intensity noise control. Indonesian J Electr Eng Comput Sci 2021;21:968–77.
87. Eid MMA, Seliem AS, Rashed ANZ, Mohammed AEl-NA, Ali MY, Abaza SS. Duobinary modulation/predistortion techniques effects on high bit rate radio over fiber systems. Indonesian J Electr Eng Comput Sci 2021;21:978–86.
88. Alatwi AM, Rashed ANZ. A pulse amplitude modulation scheme based on in-line semiconductor optical amplifiers (SOAs) for optical soliton systems. Indonesian J Electr Eng Comput Sci 2021;21:1014–21.
89. Eid MMA, Rashed ANZ, El-Meadawy S, Habib MA. Best selected optical fibers with wavelength multiplexing techniques for minimum bit error rates. J Opt Commun 2020;1–18. https://doi.org/10.1515/joc-2020-0239 [Epub ahead of print].
90. Alatwi AM, Rashed ANZ, Abd El-Aziz IA. High speed modulated wavelength division optical fiber transmission systems performance signature. TELKOMNIKA (Telecommun, Comput, Electr Control) 2021;19:380–89.
91. Eid MMA, Rashed ANZ, El-gammal EM, Delwar TS, Ryu JY. The influence of electrical filters with sequence generators on optical ISL performance evolution with suitable data rates. J Opt Commun 2020;1–16. https://doi.org/10.1515/joc-2020-0257 [Epub ahead of print].
92. Alatwi AM, Rashed ANZ, Parvez AHMS, Paul BK, Ahmed K. Beam divergence and operating wavelength bands effects on free space optics communication channels in local access networks. J Opt Commun 2020;1–18. https://doi.org/10.1515/joc-2019-0276 [Epub ahead of print].
93. Shafkat A, Rashed ANZ, El-Hageen HM, Alatwi AM. The effects of adding different adhesive layers with a Microstructure fiber sensor

based on surface plasmon resonance: a numerical study. Plasmonics J 2021;16:819–32.
94. Eid MMA, Rashed ANZ. Fiber optic propagation problems and signal bandwidth measurements under high temperature and high dopant germanium ratios. J Opt Commun 2020;1–17. https://doi.org/10.1515/joc-2020-0278 [Epub ahead of print].
95. Eid MMA, Rashed ANZ. Simulative and analytical methods of bidirectional EDFA amplifiers in optical communication links in the optimum case. J Opt Commun 2020;1–17. https://doi.org/10.1515/joc-2020-0193 [Epub ahead of print].
96. Eid MMA, Shehata E, Rashed ANZ. Cascaded stages of parametric optical fiber amplifiers with Raman fiber amplifiers for upgrading of telecommunication networks through optical wireless communication channel. J Opt Commun 2020;1–17. https://doi.org/10.1515/joc-2020-0279 [Epub ahead of print].
97. Eid MMA, Mohammed AEl-NA, Rashed ANZ. Simulative study on the cascaded stages of traveling wave semiconductor optical amplifiers based multiplexing schemes for fiber optic systems improvement. J Opt Commun 2020;1–18. https://doi.org/10.1515/joc-2020-0281 [Epub ahead of print].
98. Parvin T, Ahmed K, Alatwi AM, Rashed ANZ. Differential optical absorption spectroscopy based refractive index sensor for cancer cell detection. Opt Rev 2021;28:134–43.
99. Eid MMA, Said SM, Rashed ANZ. Gain/noise figure spectra of average power model Raman optical amplifiers in coarse wavelength multiplexed systems. J Opt Commun 2020;1–16. https://doi.org/10.1515/joc-2020-0289 [Epub ahead of print].
100. Eid MMA, Rashed ANZ, Ahammad MS, Paul BK, Ahmed K. The effects of Tx./Rx. pointing errors on the performance efficiency of local area optical wireless communication networks. J Opt Commun 2020;1–20. https://doi.org/10.1515/joc-2019-0256 [Epub ahead of print].
101. Eid MMA, Abd El-Hamid HS, Rashed ANZ. High-speed fiber system capacity with bidirectional Er-Yb CDFs based on differential phase shift keying (DPSK) modulation technique. J Opt Commun 2020;1–17. https://doi.org/10.1515/joc-2021-0001 [Epub ahead of print].
102. Eid MMA, Ibrahim A, Rashed ANZ. In line and post erbium-doped fiber amplifiers with ideal dispersion compensation fiber Bragg grating for upgrading optical access networks. J Opt Commun 2020;1–15. https://doi.org/10.1515/joc-2020-0306 [Epub ahead of print].
103. Eid MMA, Ahmed H, Rashed ANZ. Chirped Gaussian pulse propagation with various data rates transmission in the presence of group velocity dispersion (GVD). J Opt Commun 2020;1–13. https://doi.org/10.1515/joc-2020-0307 [Epub ahead of print].
104. Habib A, Rashed ANZ, El-Hageen HM, Alatwi AM. Extremely sensitive photonic crystal fiber–based cancer cell detector in the terahertz regime. Plasmonics 2021;16:1297–1306.
105. Shafkat A, Rashed ANZ, El-Hageen HM, Alatwi AM. Design and analysis of a single elliptical channel photonic crystal fiber sensor for potential malaria detection. J Sol-Gel Sci Technol 2021;98:202–11.
106. Eid MMA, Rashed ANZ. Fixed scattering section length with variable scattering section dispersion based optical fibers for polarization mode dispersion penalties. Indonesian J Electr Eng Comput Sci 2021; 21:1540–47.
107. Eid MMA, Seliem AS, Rashed ANZ, Mohammed AEl-NA, Ali MY, Abaza SS. High sensitivity sapphire FBG temperature sensors for the signal processing of data communications technology. Indonesian J Electr Eng Comput Sci 2021;21:1567–1574.
108. Eid MMA, Seliem AS, Rashed ANZ, Mohammed AEl-NA, Ali MY, Abaza SS. High modulated soliton power propagation interaction with optical fiber and optical wireless communication channels. Indonesian J Electr Eng Comput Sci 2021;21:1575–1583.
109. Eid MMA, Rashed ANZ, Delwar TS, Siddique A, Ryu JY. Linear/cubic measured pulse numerically with electrical jitter amplitude variations for the impact on fiber communication systems. J Opt Commun 2021; 1–17. https://doi.org/10.1515/joc-2020-0301 [Epub ahead of print].
110. Eid MMA, El-Meadawy S, Mohammed AEl-NA, Rashed ANZ. Wavelength division multiplexing developed with optimum length-based EDFA in the presence of dispersion-compensated fiber system. J Opt Commun 2021;1–16. https://doi.org/10.1515/joc-2020-0302 [Epub ahead of print].
111. Eid MMA. Sorathiya V, Lavadiya S, Habib MA, Helmy A, Rashed ANZ, Dispersion compensation FBG with optical quadrature phase shift keying (OQPSK) modulation scheme for high system capacity. J Opt Commun 2021;1–16. https://doi.org/10.1515/joc-2021-0022 [Epub ahead of print].
112. Eid MMA, Sorathiya V, Lavadiya S, Shehata E, Rashed ANZ. Free space and wired optics communication systems performance improvement for short-range applications with the signal power optimization. J Opt Commun 2021;1–14. https://doi.org/10.1515/joc-2020-0304 [Epub ahead of print].
113. Eid MMA, Rashed ANZ. Numerical simulation of long-period grating sensors (LPGS) transmission spectrum behavior under strain and temperature effects. Sensor Rev J 2021;41:192–9.
114. Eid MMA, Rashed ANZ. Basic FBG apodization functions effects on the filtered optical acoustic signal. Indonesian J Electr Eng Comput Sci 2021;22:287–96.
115. Eid MMA, El-Meadawy S, Mohammed AE-NA, Rashed ANZ. High data rates in optic fiber systems based on the gain optimization techniques. J Opt Commun 2021;1–16. https://doi.org/10.1515/joc-2021-0017 [Epub ahead of print].
116. Ahmed K, AlZain MA, Abdullah H, Luo Y, Vigneswaran D, Faragallah OS, et al. Highly sensitive twin resonance coupling refractive index sensor based on gold- and MgF_2-coated nano metal films. Biosensors 2021;11: 104–13.
117. Delwar TS, Siddique A, Biswal MR, Rashed ANZ, Jana A, Ryu JY. Novel multi-user MC-CSK modulation technique in visible light communication, Opt Quant Electron 2021;53:196–206.
118. Eid MMA, Habib MA, Anower MS, Rashed ANZ. Hollow core photonic crystal fiber (PCF)–based optical sensor for blood component detection in terahertz spectrum. Braz J Phys 2021;51:1017–25.
119. Eid MMA, Sorathiya V, Lavadiya S, Abd El-Hamid HS, Rashed ANZ. Wide band fiber systems and long transmission applications based on optimum optical fiber amplifiers lengths. J Opt Commun 2021;1–16. https://doi.org/10.1515/joc-2021-0020 [Epub ahead of print].
120. Zuhayer A, Abd-Elnaby MSHA, Eid MMA, Sorathiya V, Rashed ANZ. A Gold plated twin core D-formed photonic crystal fiber (PCF) for ultrahigh sensitive applications based on surface plasmon resonance (SPR) approach. Plasmonics J 2022;17:2089.
121. Daher MG, Jaroszewicz Z, Zyoud SH, Panda A, Ahammad SKH, Abd-Elnaby M, et al. Design of a novel detector based on photonic crystal nanostructure for ultra high performance detection of cells with diabetes. Opt Quant Electron 2022;54:1–15.
122. Smirani LK, Rashed ANZ, Ahammad SKH, Hossain MA, Daher MG, Fahmy E. Conventional/linear/Lorentzian material gain semiconductor optical amplifiers performance signature with four wave mixing (FWM) nonlinearity in optical fiber communication systems. J Opt Commun 2022;1–15. https://doi.org/10.1515/joc-2022-0147 [Epub ahead of print].

123. Smirani LK, Kumari M, Ahammad SKH, Hossain MA, MalekDaher G, Rashed ANZ, et al. Signal quality enhancement in multiplexed communication systems based on the simulation model of the optimum technical specifications of Raman fiber optical amplifiers. J Opt Commun 2022;1–17. https://doi.org/10.1515/joc-2022-0129 [Epub ahead of print].
124. Smirani LK, Ahammad SKH, Daher MG, Hossain MA, Rashed ANZ, Aabdelhamid HS. Optical transceiver communication systems performance evaluation based on nonlinear cross gain modulation effects. J Opt Commun 2022;1–16. https://doi.org/10.1515/joc-2022-0134 [Epub ahead of print].
125. Smirani LK, Abd El-Aziz IA, Ahammad SKH, Hossain MA, Daher MG, Rashed ANZ. Low loss flexibility and high efficiency of radio per fiber system for modern wireless communication system. J Opt Commun 2022;1–20. https://doi.org/10.1515/joc-2022-0145 [Epub ahead of print].
126. Sbeah ZA, Adhikari R, Sorathiya V, Chauhan D, Rashed ANZ, Chang SH, Dwivedi RP. GST-based plasmonic biosensor for hemoglobin and urine detection. Plasmonics J 2022;17:2391–404.
127. Daher MG, Trabelsi Y, Ahmed NM, Prajapati YK, Sorathiya V, Ahammad SH, et al. Detection of basal cancer cells using photodetector based on a novel surface plasmon resonance nanostructure employing perovskite layer with an ultra high sensitivity. Plasmonics J 2022;17:2365–73.
128. Talukder H, Hussayeen Khan Anik M, Ifaz Ahmad Isti M, Mahmud S, Talukder U, Biswas SK, et al. Double-layered side-polished ultra-highly sensitive photonic crystal fiber-based surface plasmonic refractive index sensor. Eur Phys J Plus 2022;137:1–15.