Published in AJSE, Vol:19, Issue: 01
Received on 16th November 2019
Revised on 14th January 2020
Accepted on 30th January 2020

AIUB JOURNAL OF SCIENCE AND ENGINEERING
ISSN: 1608 – 3679 (print) 2520 – 4890 (Online)

Performance Analysis of 16-Channel Hybrid WDM-CSRZ-DQPSK PON for Different Transmission Speeds and Distances

Irin Sultana Bristy, Mohammad Nasir Uddin

Abstract*—Sixteen channel wavelength-division-multiplexed passive optical network (WDM-PON) based on one Mach-Zehnder modulator and carrier suppressed return to zero differential quadrature phase-shift keying (CSRZ-DQPSK) transmitter is designed and evaluated for various bit rates (20 Gbps to 80 Gbps). The effect of changes in transmission distance with increased bit rate is also discussed and hence quality factors and bit error rates are analyzed to evaluate their performances. The relation between transmission distance, quality factor (Q factor) and bit error rate (BER) have been focused to determine the optimized result.

***Keywords*—Mach-Zehnder modulator, dual-drive (DD) Mach-Zehnder modulation, carrier suppressed return to zero differential quadrature phase-shift keying, wavelength-division-multiplexing, passive optical network, bit error rate, quality factor.**

I. INTRODUCTION

As the number of users is being increased, high speed with longer transmission range and better signal quality is essential for today’s communication system. The majority of communication sectors are focusing on higher bandwidth to meet their user demand [1]. Transmission speed and security is also another two important requirements for this upgrading system. Optical fiber network satisfies this combined necessity better than the traditional copper-based access network by providing faster-transmitted information with security. Time-division multiplexing (TDM) is a mostly known optical fiber network system that is reliable for a lesser number of users. But in case of increased number of user wave division multiplexing (WDM) based passive optical network (PON) shows better performance with bandwidth expansion. WDM-PON provides higher bandwidth compared to standard PON and this operation is usually done in single wavelength mode [2]. In WDM system, each wavelength is assigned for individual users where MUX or DEMUX is used as node splitter. This is why power-splitting loss doesn’t occur in WDM-PON configuration [3, 4]. Low power-splitting loss enables this scheme to transmit signals for a long-distance that is more than 20 km. So, the use of PON in a telecommunication system is credibly increased due to its comparatively cost-saving property and high security to provide fiber to the home (FTTH) [5]. As a result, the WDM-PON will become a ground-breaking and accessible broadband network technology to provide high bandwidth to the user [6].

The convergence of access networks is also an important parameter to minimize the framing cost in case of high data rate in PON technology. This is why a converged network with WDM-PON and WiMAX system is designed and evaluated in which the data are modulated with multi-band technique through Single Mach-Zehnder modulation [7].

Another important feature grabs concentration while designing a PON system is good channel spacing. Several integrated optical interferometers in WDM applications have been investigated to propose increased channel spacing [8]-[11]. Here, they proposed a four-channel optical waveguide multiplexer or demultiplexer having a channel spacing of 5 GHz for frequency division multiplexer (FDM) based transmission system. Generally in WDM system, Mach-Zenhder modulators are used for upgrading network systems due to its asymmetrical Mach-Zehnder interferometer having two arms with different lengths which enable wide-ranging channel spacing.

The Mach-Zehnder modulation scheme is also used for controlling the amplitude of an optical wave from a laser source. A single-stage dual-drive Mach-Zehnder modulator for radio over frequency (RoF) architecture is suggested for a low-cost external modulation scheme [12]. Single dual-drive Mach-Zehnder modulation scheme is analyzed and suggested for less complexity and better performance which is also cost-effective [13]. In this paper, they evaluated the performance of conventional 3 MZM based CSRZ-DQPSK transmitter system as well as non-conventional 2 MZM and Single dual-drive MZM using the same transmission scheme. Low cost with less complexity is the concerned factors here for single-channel 20 Gbps scheme and

Irin Sultana Bristy
Student, EEE
American International University-Bangladesh (AIUB)
Dhaka, Bangladesh
E-mail: irinsultanabristy1313@gmail.com

Mohammad Nasir Uddin
Associate Professor & Head of EEE Dept. (Graduate Program),
Faculty of Engineering
American International University-Bangladesh (AIUB)
Dhaka, Bangladesh
E-mail: drnasir@aiub.edu

considering the low-cost arrangement, Single dual-drive MZM is suggested. For improving dispersion tolerance, mono-stage MZM is also demonstrated for CSRZ generation [14].

The binary data from bit generator should be encoded into electrical signal or optical waveform signal. In the case of external modulation, nonreturn to zero (NRZ) format provides the most straight-forward data generation method among all formats. Two NRZ are used in this proposed scheme to provide less complexity and large dispersion tolerance. For OCDMA (Optical code division multiple access) in FTTH network, NRZ format shows better performance with BER 1×10^{-14} than RZ (Return to zero) [15]. For long-haul and high-speed data-rate NRZ is recommended for its low BER and high Q factor [16].

Differential quadrature phase-shift keying (DQPSK) is used for a more compact spectrum as two-bit information is carried by a single optical symbol. DQPSK also provides better tolerance towards chromatic dispersion [17]. This scenario happens because a single optical symbol carries two-bit information and all the information is precoded in differential optical phases such as 0, $\frac{\pi}{2}$, π and $\frac{3\pi}{2}$.

From the literature review, it is clear that increasing channel capacity of WDM and a simple MZM system for wide channel spacing, are the concerned factors for better transmission quality with band-efficiency. In this paper, signals with sixteen channels are performed in WDM-MZM transmission system with CSRZ-DQPSK format for different bit rates and various transmission distances where quality factor (Q factor) and bit error rate (BER) are the focused parameters for measuring received signal quality and comparing performance. Using a data stream consist of 16 channels enables satisfying band efficiency for the increased user. Single dual-drive MZM also provides cost-saving and less-complex scheme for external modulation in a long haul.

II. METHODOLOGY

A. *Single Dual-Drive Mach-Zehnder Modulation*

The operation of a single dual-drive Mach-Zehnder modulator is discussed and investigated for good channel spacing. Fig. 1 shows the basic structure of a dual-drive MZM. The dual-drive MZM consists of two-phase modulators that can be operated independently. Assuming steady-state operation, the two arms of a dual-drive MZM have independent drive voltage E_I and E_Q. Input electric field is E_i. So the output electric field is:

$$E_O = \frac{E_{in}}{2}\left[exp\left(j\pi\,\frac{E_I}{V_\pi}\right) + exp\left(j\pi\,\frac{E_Q}{V_\pi}\right)\right] \tag{1}$$

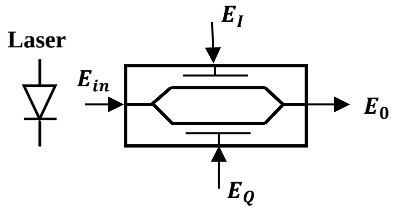

Fig. 1: Basic structure of a dual-drive MZM

V_π is the voltage to provide a phase shift of each phase modulator. The MZM is operated as a phase modulator if E_I=E_Q. Any quadrature signal can be generated by choosing both of the voltages properly. The relationship (1) between input and output electric field can be rewritten in the normalized form of:

$$E_O = \frac{r_{max}}{2}\left(e^{j\phi_1} - e^{j\phi_2}\right) \tag{2}$$

Where phase $\phi_1 = \frac{\pi E_I}{V_\pi}$ and phase $\phi_2 = \frac{\pi E_Q}{V_\pi + \pi}$. The output electric field E_O is the difference of two vectors in the circle which have a radius of $\frac{r_{max}}{2}$. The MZM of (2) is normally biased at the minimum transmission point or the null point. The amplitude of the maximum output electric field is r_{max} when E_I =E_Q or ϕ_1 and ϕ_2 are antipodal phase.

B. *DQPSK Precoder*

The dual-drive MZM requires a reduced number of signal levels and so this kind of transmitter scheme is suitable for generating differential quadrature phase-shift keying (DQPSK) signals for higher spectral efficiency transmission. In any transmitter scheme, a precoder is compulsory with the purpose of avoiding recursive decoding in the receiver end as well as minimizing error propagation to decrease hardware complexity.

U_i and V_i are the input signals in the DQPSK precoder that come from the PRBS which have different bit rates each time. I_i and Q_i are the DQPSK coding output and they are described as:

$$I_i = \overline{(Q_{i-1} \oplus I_{i-1})\,(U_i \oplus I_{i-1})} + (Q_{i-1} \oplus I_{i-1})\,(\overline{V_i \oplus I_{i-1}}) \tag{3}$$

$$Q_i = \overline{(Q_{i-1} \oplus I_{i-1})\,(V_i \oplus I_{i-1})} + (Q_{i-1} \oplus I_{i-1})\,(\overline{U_i \oplus I_{i-1}}) \tag{4}$$

The Mach-Zehnder modulator generates in-phase data with a phase-shift of 0 and 180°. The value of I and Q can be marked as (00, 01, 10, 11) and the logic operation of the precoder is shown in TABLE I. E_{in} is the incident light beam from CW laser source. E_I and E_Q are the spitted parts of the input signal with 90° phase shift. These two microwave signals are indicating I-phase and Q-phase of the precoder.

TABLE I. Phase-shift corresponding to Bit Pairs

Bit sequence	Phase (θ)	I_i	Q_i
00	45°	$\overline{I_i}$	$\overline{Q_i}$
01	135°	$\overline{I_i}$	Q_i
10	315°	I_i	$\overline{Q_i}$
11	225°	I_i	Q_i

C. *Single Dual-drive (DD) Mach-Zehnder Modulation Based Transmitter Scheme*

A π phase-shift between the two modulating signals is needed in case of carrier suppressed with a double sideband where for single-sideband this phase-shift is π /2 and ±π /2. This scenario happens in a transmission scheme with two MZM. Sine generator is eliminated because of the mono-stage MZM based transmission system.

A bit generator provides signals at a speed of different bit rates which is precoded later by 4-DPSK precoder to get I and Q signal components. The NRZ pulse generator creates a sequence of non-return to zero pulses coded by the PRBS. NRZ is not self-clocking so supplementary techniques should be used to avoid bit slip. Synchronization in NRZ is controlled through a square wave signal known as bit clock. The block diagram of the Single Mach-Zehnder modulation based transmitter is shown in Fig. 2.

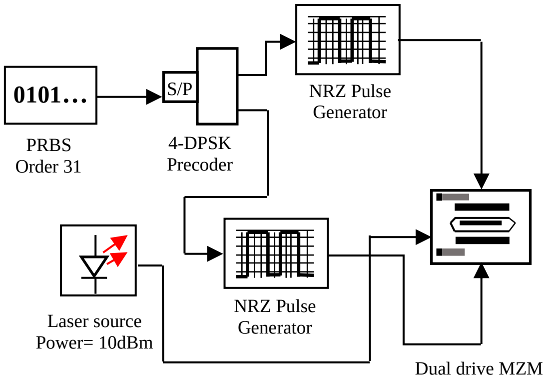

Fig. 2: Block diagram of Single DD Mach-Zehnder modulation based transmitter

D. *Noncoherent Receiver Scheme*

A demultiplexer is used at the very beginning of the receiver unit to reform every signal. The signal with 1-bit delay and 45° phase shift is converted to electrical signal from optical one by PIN and 3R (re-time, re-amplifier, re-shaping) regenerator. Electric subtractor is used to receive both the converted components and send them for re-shaping. At the end of the scheme, eye diagram analyzer and BER analyzer are used to evaluate performance. A block diagram of a receiver for downstream signals in the optical network unit is shown in Fig. 3.

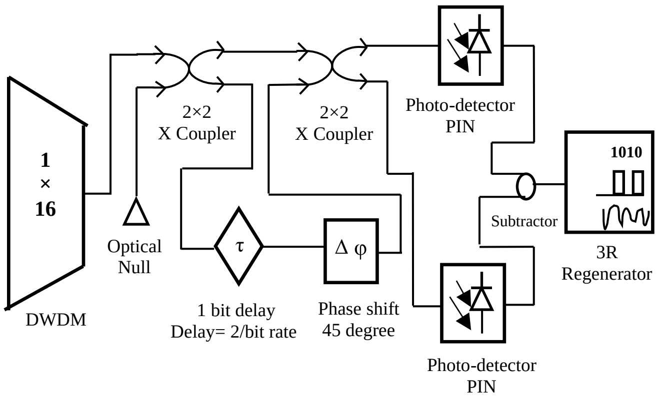

Fig. 3: Block diagram of the receiver unit

III. SIMULATION

All the simulation parameters are shown in TABLE II below. A continuous wave (CW) laser array having sixteen different output ports is used to provide signals to the modulator units. Laser array has equally spread wavelength ranges from 1565 nm to 1541 nm.

There are sixteen units of modulators in the transmitter unit which provide all the encoded and modulated signals to the 16×1 wavelength-division-multiplexer. Dispersion compensating fiber (DCF) is placed followed by single-mode fiber (SMF) to compensate the loss due to spreading light waves while propagating. For the optimized result, EDFAs (erbium-doped fiber amplifier) are used to compensate the attenuation loss of fiber. EDFA amplifies the optical signal directly without requiring its conversion to the electric domain. Traveling through single-mode fiber optic, these signals are reformed separately by 1×16 WDMUX and sent to the coupler of the corresponding receiver unit. PIN detector converts optical input to electrical output. Low Pass Bessel filter is used which passes the low-frequency signal and discard high-frequency carrier signal. The output from the receiver unit goes to the 3R regenerator followed by the eye diagram analyzer.

TABLE II. Simulation Parameters

Sl. No.	Parameters	Values
1.	Laser linewidth	0.1 MHz
2.	PRBS bit rate	20 Gbps, 40 Gbps, and 80 Gbps
3.	PRBS order	31
4.	Optical power	10 dBm
5.	Fiber distance	10 km, 50 km, 100 km, 150 km and 200 km.
6.	Fiber attenuation	0.2 dBm/km
7.	Operation wavelength	1550 nm
8.	Fiber dispersion	0.2 ps/nm/km
9.	Dark current	10 nA
10.	Cutoff frequency	0.8×bit rate (GHz)
11.	Photodiode responsivity	0.8 A/W

IV. RESULT AND DISCUSSION

The entire scheme of the 16×1 WDM based passive optical network has been analyzed for different bit rates and various distances. The measurement components like eye diagram visualizer, BER analyzer are used for measuring Q factor and Bit error rate. Three different simulation setups for three different bit rates have been used for analyzing and evaluating performance. The operating wavelength of the SMF is fixed at 1550 nm as the central wavelength of all the channels is 1550 nm. The modulation bandwidth of PIN is 2 GHz.

Wavelengths usually vary from 800 nm to 1600 nm, but so far the most commonly used wavelengths in fiber optics are 850 nm, 1300 nm, and 1550 nm. For these wavelengths, the attenuation of the fiber is less compared to other wavelengths. But the widespread used wavelength for long haul communication is 1550 nm due to the absorption characteristics of the glass materials used in fiber. Besides, for short wavelengths, Rayleigh scattering starts increasing. Wavelength series for this simulation setup ranges from 1541 nm to 1565 nm. As the operating wavelength of SMF is 1550 nm, so wavelength series is chosen in the way that the central wavelength can be operated as best while traveling through this fiber. High frequency or low wavelength upsurges the line resistance that leads to decrease signal quality. In the entire data stream, it is observed that the best performing channel is operating at 1550 nm wavelength and the worst-performing channel is operating at 1541 nm wavelength.

A. *Analysis of Q Factor*

Fig. 4 shows the signal quality for different distances corresponding to their bit rate. In the case of 20 Gbps bit rate, Q factor varies between 33 and 3.2 for transmitting 10 km to 300 km respectively. Channel quality and parameters are not significantly favorable all-time. So, if the worst channel is considered (Fig. 4 (b)), this range becomes 30.5 to 2.6 for the previously mentioned distances. When this transmission scheme has a bit rate of 40 Gbps, quality factors of all the channels in the data stream vary 20 to 23 for 10 km traveling distance and 1.9 to 2.5 for 300 km routing distance. Similarly, the best performing channel with 80 Gbps scheme shows quality factor 18 for 10 km and 1.5 for 300 km. Worst performing channel has obtained this parameter value as 14 and .05 correspondingly. Additional distance results in high signal distortion which plays vital role in lowering quality factor below its acceptable commercial value. Data of all the bit rate traveling 300 km has collected for the analysis purpose. Not all the scheme performs well for all the bit rate. Signals having Q factor less than 6 are not accepted for commercial communication systems.

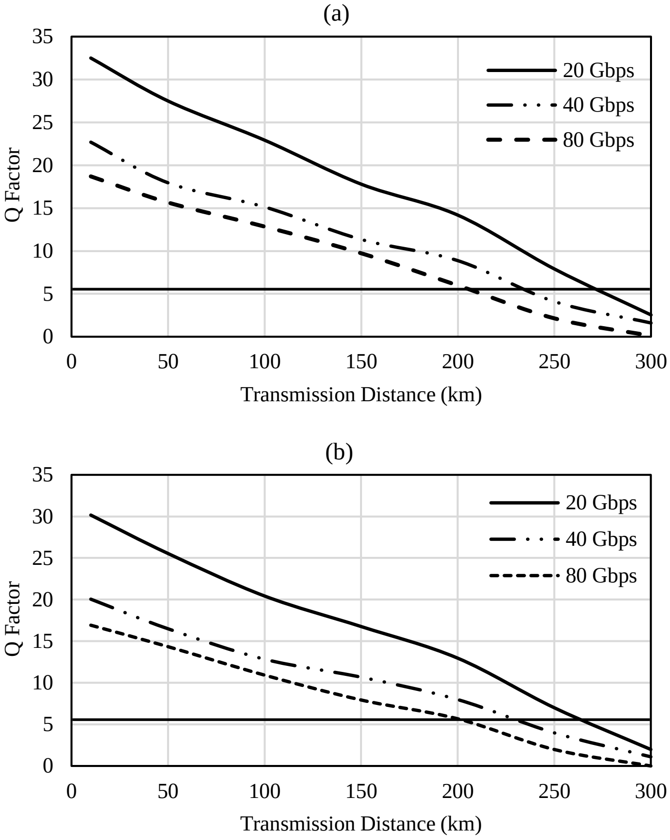

Fig. 4: Graphical representation of quality factor vs. distance for various speeds: (a) best channel (b) worst channel

It is also observed that performance differences are less acute with the increased bit rate. Fig. 4 (a) shows, for the increased 20 Gbps speed quality factor becomes around 23 from 33 for 10 km distance at 40 Gbps bit rate. Again for increased 40 Gbps speed, the quality factor becomes 18 for 80 Gbps compared to 23 for 40 Gbps speed at the same 10 km distance. The same scenario is observed in Fig. 4 (b) for the channel which has the highest channel-gap from the central wavelength.

It is informed previously that the best performing channel (Fig. 4 (a)) for each bit rate is working at 1550 nm wavelength as the SMS is designed to be operated on that wavelength. In contrast, the worst-performing channel is operating at 1541 nm wavelength (Fig. 4(b)). As the wavelengths start to shift far more and more from the center wavelength, the carried information or energy is started to face more distortion and noise. The gain of optical amplifier (EDFA) is not perpetually constant in the entire wavelength series. When other wavelengths are started to become split from the operating wavelength, the fiber becomes more affected by insertion loss, dispersion loss, intrinsic attenuation and losses due to scattering. So the outputs of these channels at the receiver end are not as satisfying as the central one.

B. *Highest Obtained Distance*

In the above figures, it is also observed a straight line is indicating the acceptable Q factor for signals in a communication network. The designed scheme gives optimized signal quality for more than 250 km when the PRBS has a bit rate of 20 Gbps. Data series that crosses or touches the straight line indicates low signal quality with various distortions. For 1550 nm wavelength and 40 Gbps speed, maximum distance is obtained which is approximately 230 km. Greater than this distance, signal started to lose quality with quality factor becoming less than 6. The same speed can travel 220 km transmission distance for 1541 nm wavelength having Q factor approximately 6.73. 80 Gbps transmission scheme can travel nearly 190 km and 180 km through the channel with 1550 nm and 1541 nm wavelength respectively. As bit rates and distances increase non-linear effect also increases which causes performance degradation in optical communication. These nonlinear effects include self-phase modulation (SPM), cross-phase modulation (CPM) stimulated Brillouin scattering (SBS), stimulated Raman scattering (SRS), etc.

TABLE III. Maximum obtained distance (Q Factor)

Bit rate	Highest obtained distance	Q factor
20 Gbps	260 km	6.00
40 Gbps	220 km	6.73
80 Gbps	180 km	6.12

The highest obtained distance with optimized signal quality according to the bit rate is summarized in TABLE III.

C. *Bit Error Rate*

A bit error rate (BER) of 10^{-11} is every so often considered as the minimum acceptable bit error rate for the communication network. The channel with 1541 nm wavelength has been considered for analysis purposes as this is the worst-performing channel among all. The accepted commercial value of log(BER) is started from -11 to below -11. As distance increases, the bit error rate is increased due to noise, interference, and distortion. BER is also increased for high-speed transmission scheme because of bit synchronization problems.

From Fig. 5, it is observed that all the values are below -11 up to 250 km. The bit error rate is highest for 80 Gbps speed at a distance of exactly 250 km which is approximately -11. For the same bit rate log(BER) becomes around -54 for 10 km transmission distance. Transmission system with 40 Gbps speed shows the value of BER from 10^{-63} to 10^{-9} for 10 km to 300 km respectively. Bit error rate is increased with the transmission speed as bit synchronization, interference and distortion increase for increased bit rate. The poorest performing channel with 20 Gbps scheme provides log(BER) from approximately -88 to -15 for 10 km to 300 km in that order. It can be noted that all the values are obtained without considering Forward Error Correction (FEC). The highest obtained distances for each bit rate considering the minimum BER are 310 km, 290 km and 250 km for 20 Gbps, 40 Gbps, and 80 Gbps respectively. But for these distances, Q factor degrades below 6 and so the maximum transmission distances of TABLE III are considered as the optimized distances for this scheme and for the corresponding bit rates.

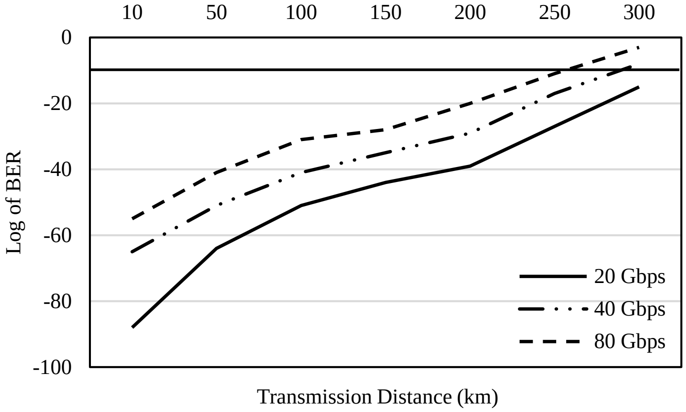

Fig. 5: Log of minimum BER vs. distance graph for different bit rates. The comparatively best channel is considered from 16 channels

V. CONCLUSION

Based on the obtained results from simulations, it is clear that the hybrid WDM-PON system based on mono-stage MZM and CSRZ-DQPSK provides standard signal quality that travels approximately 260 km for 20 Gbps speed. The highest speed for the above scheme is 80 Gbps which can transmit signal up to 180 km having Q factor 6.12. But if we consider the BER, 80 Gbps scheme is quite good for 250 km transmission distance though this distance is not considered because of the low Q factor. 20 Gbps scheme is comparatively most efficient for long-distance with the highest Q factor and lowest BER. But if the user demand is high-speed scheme then transmission distance should be sacrificed for good quality and secured information. In section IV, change in Q factor and BER according to the transmission distance and speed is presented by graphical representation so that depending on the user demand and band efficient property, the suitable and optimized set-up can be chosen.

References

[1] K. Grobe and J. P. Elbers, “PON in Adolescene: From TDMA to WDM-PON”, IEEE Communications Magazine,” pp. 26-34, Jan. 2008.

[2] R. Keishna, M. Laxmi and N. Kumar, “ WDM PON: Emergence from TDMA to WDM for FTTx based Applications, Telecommunication Engineering Centre, Govt. of India, Jan. 2013.

[3] Z. Xu, Y. J. Wen, W. D. Zhong, M. Attygalle, X. Cheng, Y. Wang, T. H. Cheng and C. Lu, “WDM-PON Architectures With a Single Shared Interferometric Filter for Carrier-Reuse Upstream Transmission,” Journal of lightwave technology, vol. 25, no. 12, Dec. 2007.

[4] M. Choudhary and B. Kumar, “Analysis of Next Generation PON Architecture for Optical Broadband Access Networks,” IEEE Comm. Mag., 2006.

[5] J. J. Martínez, J. I. G. Gregorio, A. L. Lucia, A. V. Velasco, J. C. Aguado, and M. Á. L. Binué, “Novel WDM-PON Architecture Based on a Spectrally Efficient IM-FSK Scheme Using DMLs and RSOAsK,” Journal of lightwave technology, vol. 26, no. 3, Feb, 2008.

[6] A. E. N. A. Mohammed, A. N. Z. Rashed, G. E. S. M. E. Abyad and A. E. Fa. A. Saad, “High Transmission Bit Rate of A thermal Arrayed Waveguide Grating (AWG) Module in Passive Optical Networks,” International Journal of Computer Science and Information Security, vol. 1, no.1, May. 2009.

[7] Y. T. Hsueh, M. F. Huang, S. H. Fan and G. K. Chang, “A Novel Lightwave Centralized Bidirectional Hybrid Access Network: Seamless Integration of RoF With WDM-OFDM-PON,” IEEE photonics technology letters, vol. 23, no. 15, Aug. 2011.

[8] K. Inoue, N. Takato, H. Toba, and M. Kawachi, “A four-channel optical waveguide multi/dernultiplexer for 5-GHz spaced optical FDM,” J. Lightwave Technol., vol. 6, pp. 339-345, 1988.

[9] B. H. Verbeek, C. H. Henry, N. A. Olsson, K. J. Orlowsky, R. F. Kazarinov, and B. H. Johnson, “Integrated four-channel Mach-Zehnder multi/demultiplexer fabricated with phosphorous doped SiO_2, waveguides on Si,” J. Lightwave Technol., vol. 6, pp. 101 1 - 1015, 1988.

[10] R. G. Walker, J. Urquhart, I. Bennion, and A. C. Carter, “Guided wave 1.3/1.55 pm wavelength duplexers in lnGaAsP/InP,” In Proc. 5th European Conf. Integrated Opt. ECI0’89 (SPIE), vol. 1141, 1989, pp. 219-226.

[11] A. Yi-Yan, R. J. Den, M. Seto, and R. J. Hawkins, “GaAs/GaAlAs asymmetric Mach-Zehnder demultiplexer with reduced polarization dependence,” IEEE Photon. Technol. Lett., vol. 1, pp. 83-85, 1989.

[12] K. Yang, X. G. Huang, J. H. Zhu and W. J. Fang, “Transmission of 60 GHz wired/wireless based on full-duplex radio-over-fibre using dual-sextupling frequency,” IET Communications, vol. 6, pp. 2900-2906, 2012.

[13] R. CHITRAVELU, G. M. Muthu, “Performance evaluation of simple CSRZ-QDPSK transmitter configurations for 20-Gbps PON applications,” Turkish Journal Of Electrical Engineering & Computer Sciences, vol. 25, pp. 1263-1277.

[14] D. S. Lee, M. S. Lee, Y. J. Wen and A. Nirmalathas, “Electrically band-limited CSRZ signal with simple generation and large dispersion tolerance for 40-Gb/s WDM transmission systems,” In IEEE Photonics Technology Letters, vol. 15, no. 7, pp. 987-989, Jul. 2003.

[15] M. Y. Aldouri, S. A. Aljunid, R. B. Ahmad and H. A. Fadhil, “Bit error rate (BER) performance of return-to-zero and non-return-to-zero data signals optical code division multiple access (OCDMA) system based on AND detection scheme in fiber-to-the-home (FTTH) networks,” Optica Applicata, vol. 41, no. 1, pp. 172-181, 2011.

[16] F. E. Seraji and M. S. Kiaee, “Eye-Diagram-Based Evaluation of RZ and NRZ Modulation Methods in a 10- Gb/s Single-Channel and a 160-Gb/s WDM Optical Networks,” International Journal of Optics and Applications, vol. 7, iss. 2, pp. 31-36, 2017.

[17] K. P. Ho and H. W. Cuei, "Generation of arbitrary quadrature signals using one dual-drive Modulator," In Journal of Lightwave Technology, vol. 23, no. 2, pp. 764-770, Feb. 2005. doi: 10.1109/JLT.2004.838855.

Irin Sultana Bristy has completed her Bachelor of Science (B.Sc.) in Electrical and Electronic Engineering from American International University-Bangladesh (AIUB) in 2016. Currently, she is working as Executive (Research and Content Development, Technology Division) in Light of Hope. Previously she was bearing responsibility as Assistant Engineer in Intraco Group from 2016 to 2018. As an active researcher, Irin Sultana has published several papers in the field of Automation and Optical Communication. Her research interest lies in Cancer Research, Biomedical Engineering, Optical Communication and Photonics.

Mohammad Nasir Uddin **Mohammad Nasir Uddin** received B.Sc. degree in Electrical and Electronic Engineering from Khulna University of Engineering and Technology, KUET in 2003 and M.Sc. Engineering in Computer Networks from Middlesex University, United Kingdom (UK) in 2006 and Ph.D. degree from Kyushu University, Japan in 2015. He became Certified Professional Engineer (PEng.) from IEB Bangladesh for his professional achievement during 2017. He started his teaching career as a Lecturer of Computer Science & Engineering Department of University of Development Alternative (UODA), Dhaka, Bangladesh on February 2004. On September 2006, he joined Department of Computing, The Business School of London, United Kingdom (UK) as a Lecturer. He was appointed as a Lecturer of Electrical and Electronic Engineering Department, Faculty of Engineering, American International University-Bangladesh (AIUB) on January 2009 and promoted to Assistant Professor during 2010. Currently he is serving as an Associate professor and Head of EEE dept. (Graduate Program). He received monbukagakusho scholarship from Japan Govt. to peruse his Ph.D. at Kyushu University, Opto-electronics (Hamamoto) Laboratory, Japan. He has received numerous awards including Merit Award during M.Sc. at Middlesex University, UK, 2013-IEEE Excellent student award from Japan, Deans Plaque for his outstanding research during Ph.D. His current research interest includes Active MMI Laser Diode, High-Speed Optical Communication, Wireless Communication, and Optical Sensor network. He has published one book, 33 pear reviewed journals and conference papers. He also served as Advisory committee member, organizing committee member, Track Chair, Track Co-Chair, Technical program committee member and reviewer for more than 30 conferences. Dr. Uddin is a senior member of the Institute of Electrical and Electronics Engineers (IEEE), a member of the Institute of Electronics, Information, and Communication Engineers (IEICE), Japan, LIFE FELLOW and PEng. of Institute of Engineers, Bangladesh (IEB) and life member of Bangladesh Electronic Society (BES). During 2016 he served as Vice-Chair of IEEE YP and during 2017 he served as Chair of Educational Activity of IEEE Bangladesh Section (Executive Committee member).