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Optical Signal Processing Based on Optical Delay Line Filter for Different Optical Transmission Network Applications

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Abstract— *This paper has deeply investigated the optical signal processing of optical delay line filter for high speed optical transmission network applications. We have developed their model to include user defined bit sequence generator length of 128 which is provided to the amplitude modulator instead of electro-optical modulator at a data rate of 10 to 40 Gb/s. Rectangular optical filter at line transmission is employed with low pass Chebyshev filter instead of low pass Bessel filter in their model. Maximum quality factor and minimum bit error rates are the major interesting performance parameters in our comparison for different network applications in optiwave simulation version 13.*

Index Terms— Optical delay line filter, Network applications, Optical signal processing, and finite impulse response.

I. INTRODUCTION

Processing of microwave signals in the optical domain has been a topic of interest for many years [1-3]. The key advantage of using photonics techniques is the high speed, which overcomes the inherent bottleneck caused by the limited sampling rate of currently available digital electronics. In addition, a photonic microwave signal processor provides other advantages such as large tunability and reconfigurability, low loss, light weight, and immunity to electromagnetic interference [4]. Among the many processor configurations, the one with a finite impulse response (FIR) is the most popular configuration thanks to the simplicity and implementability in the optical domain, which has been pursued intensively in the past few years. In a FIR filter, the input signal is time delayed, weighted, and then summed as the output.

To avoid optical interference a photonic microwave FIR filter is usually designed to operate in the incoherent regime, which leads to all-positive coefficients or special designs have to be incorporated to generate negative or complex coefficients. It is known that a FIR filter with all positive coefficients can provide very limited functionalities [5]. In practice, it is often desired that the filter has a bandpass response with flat top and sharp transition bands. To do so, negative or complex coefficients are required. In addition, for advanced microwave signal processing, a FIR filter with a sophisticated phase response, such as a quadratic phase response [6], is usually required, which leads to the requirement for negative or complex coefficients. As a result, techniques to generate negative and complex tap coefficients in a photonic microwave FIR filter are highly desirable [7].

Photonic processors for microwave signal-processing functions are attractive because of their very high time bandwidth product capabilities [8, 9]. Such processors can remove the bottlenecks caused by limited sampling speeds in conventional electrical signal processors. In addition, they have excellent isolation, immunity to electromagnetic interference (EMI), and remove the limitations of optoelectronic (O/E) and electro-optic (E/O) conversions for processing high speed signals that are already in the optical domain. Photonic processors also have the ability of attaining extremely high resolution and selectivity at microwave frequencies [10, 11].

II. BASIC SIMULATION SETUP

The optical transmission system consists of transmitter, fiber transmission channel, dispersion compensator and a receiver. A single span of continuous wave (CW) Laser source operating at a frequency of 193.1 THz (1550 nm) is taken into analysis. A non return to zero (NRZ) wave form is generated by user defined bit Sequence generator length of 128 is provided to the Amplitude Modulator at a data rate of 10 and 40 Gb/s as shown in Fig. 1.

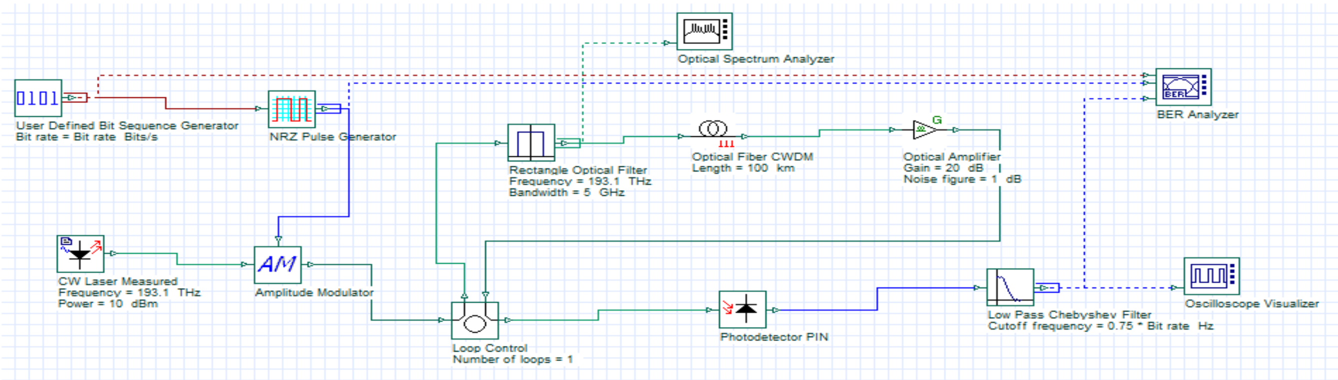

Fig. 1. Optical Delay Line Filter Architecture.

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An optical fiber transmission channel comprising of 120 km of single mode fiber compensated by 24 km optical fiber and loss is overcome by an amplifier with a Gain of 20 dB is considered. The receiver consists of a PIN photodiode and a low pass Chebyshev filter with a cut-off frequency of 75% of the data rate. BER Analyzer is used to analyze the performance measure of the link in terms of minimum BER, maximum Q factor and an eye opening penalty (EOP).The fiber optic link is simulated in Optisystem simulation environment and the link parameters are obtained.

III. Performance Analysis

Optical delay line filters are deeply investigated Based on the simulation parameters of optiwave simulation version 13, and the series of figures from (2-19), the following facts are assured:

i) Figs. (2, 3) show the comparison between our proposed model and previous model with respect to maximum Q factor and minimum bit error rate at long haul network applications. It is observed that our proposed model has presented higher Q factor over 100 km fiber transmission in comparison with previous model. Bit error rate can be controlled with 50-80 km and 170-200 km in our proposed model.

ii) As shown in Figs. (4-15) have presented maximum Q factor and minimum bit error rate through BER analyzer simulation for different transmission network applications with proposed modified model. It is theoretically found that the dramatic effects of high transmission distance on maximum quality factor.

iii) Figs. (16-19) show the relation between signal amplitude and time for different proposed filter bandwidth using oscilloscope visualizer.

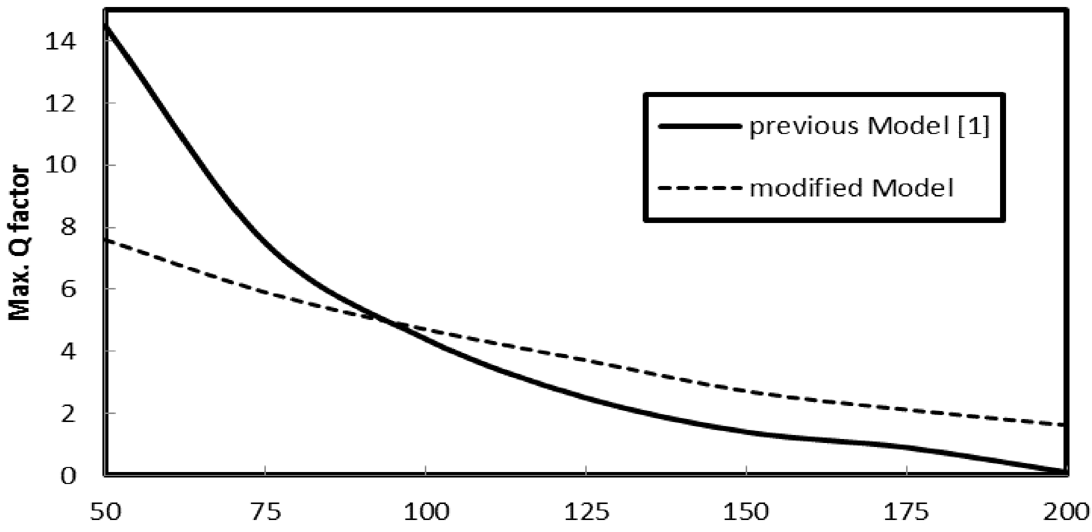

Fig. 2. Relation between maximum Q factor and length at long haul network applications.

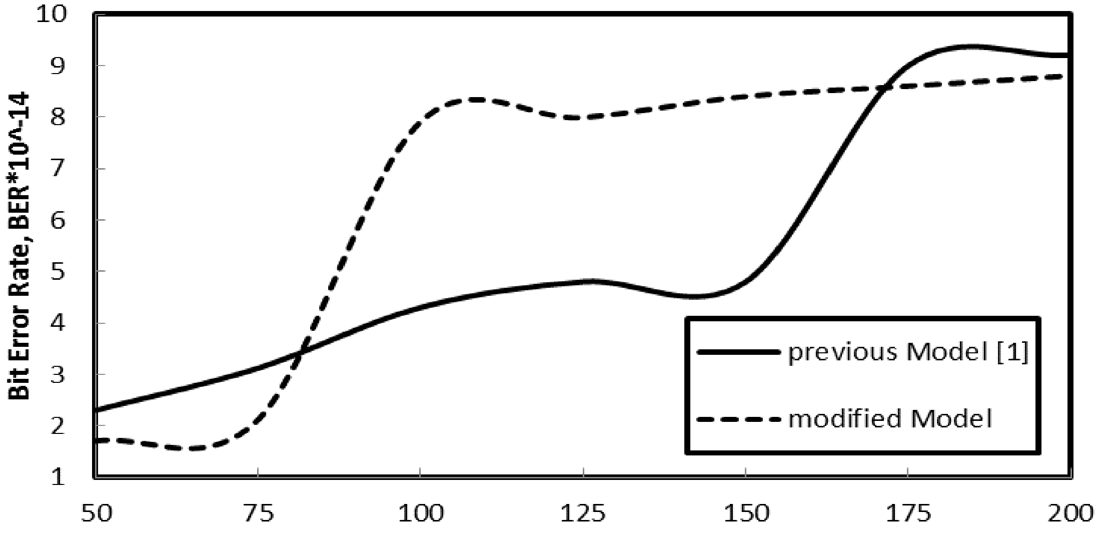

Fig. 3. Relation between minimum bit error rate and length at long haul network applications.

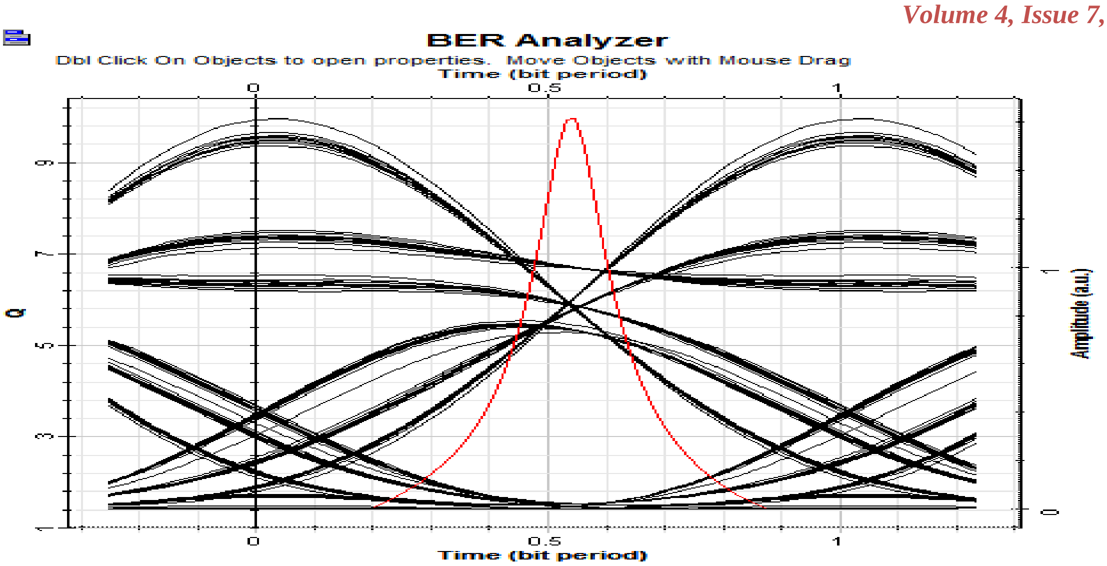

Fig. 4. Relation between amplitude and time with L=1 Km (Q. Factor).

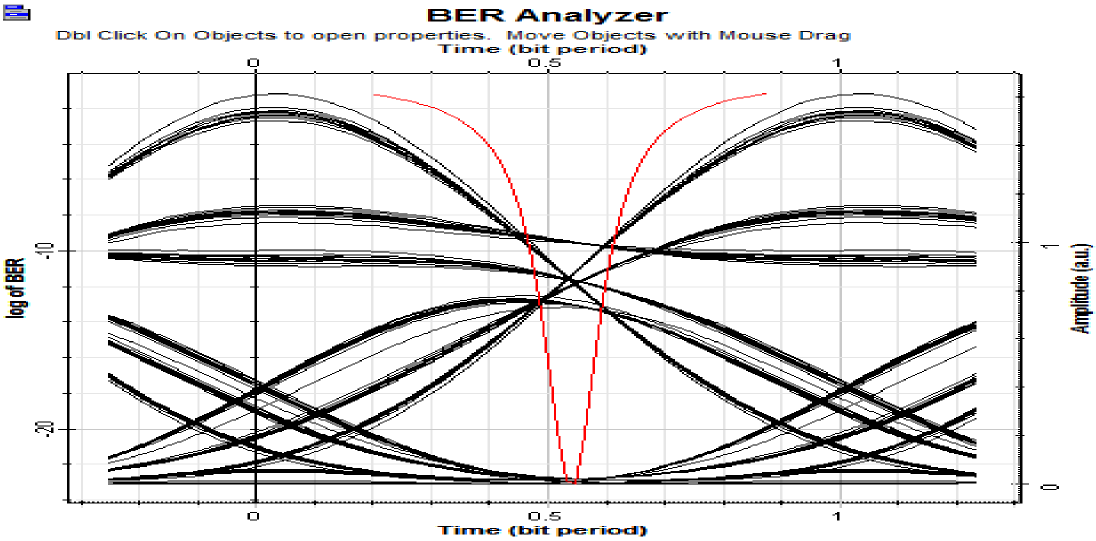

Fig. 5. Relation between amplitude and time with L=1 Km (Min BER).

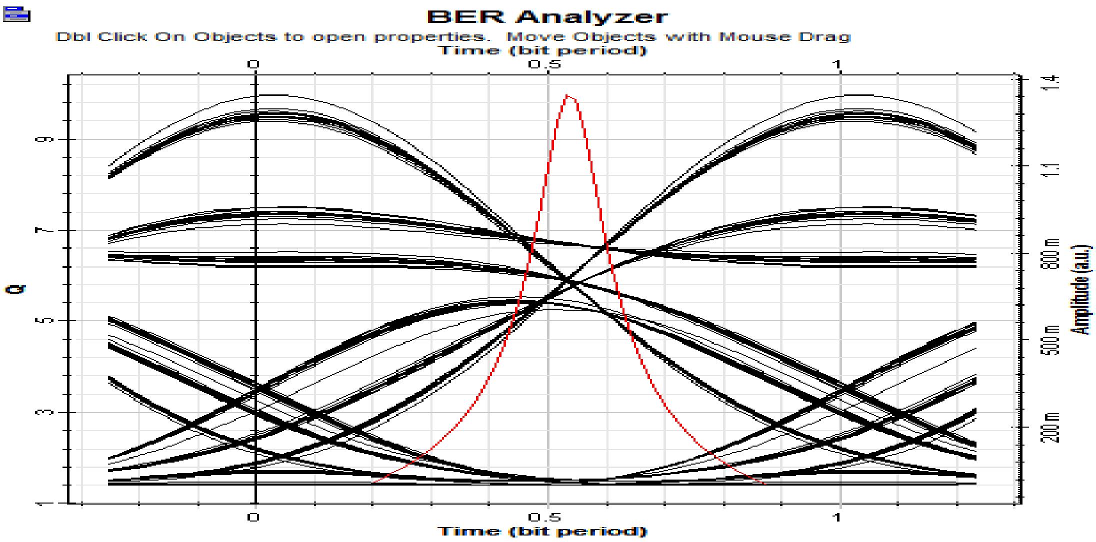

Fig. 6. Relation between amplitude and time with L=5 Km (Q. Factor).

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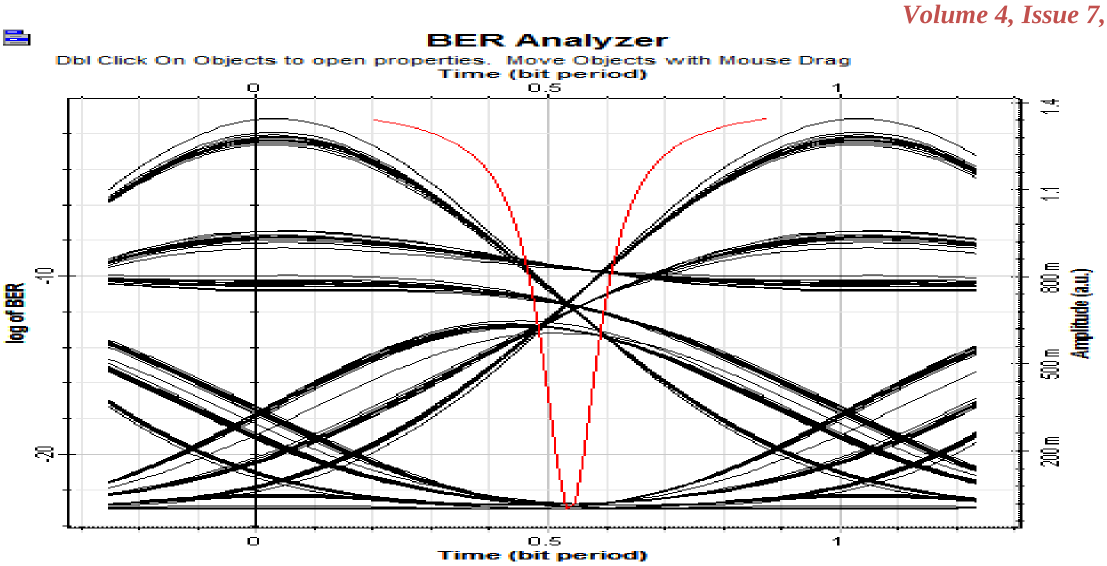

Fig. 7. Relation between amplitude and time with L=5 Km (Min BER).

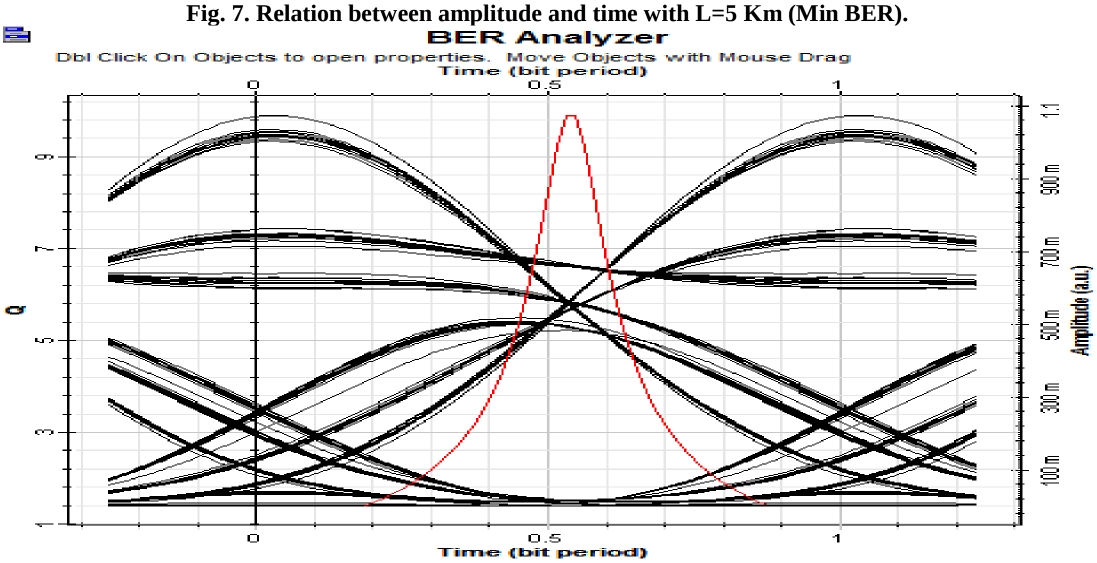

Fig. 8. Relation between amplitude and time with L=10 Km (Q. Factor).

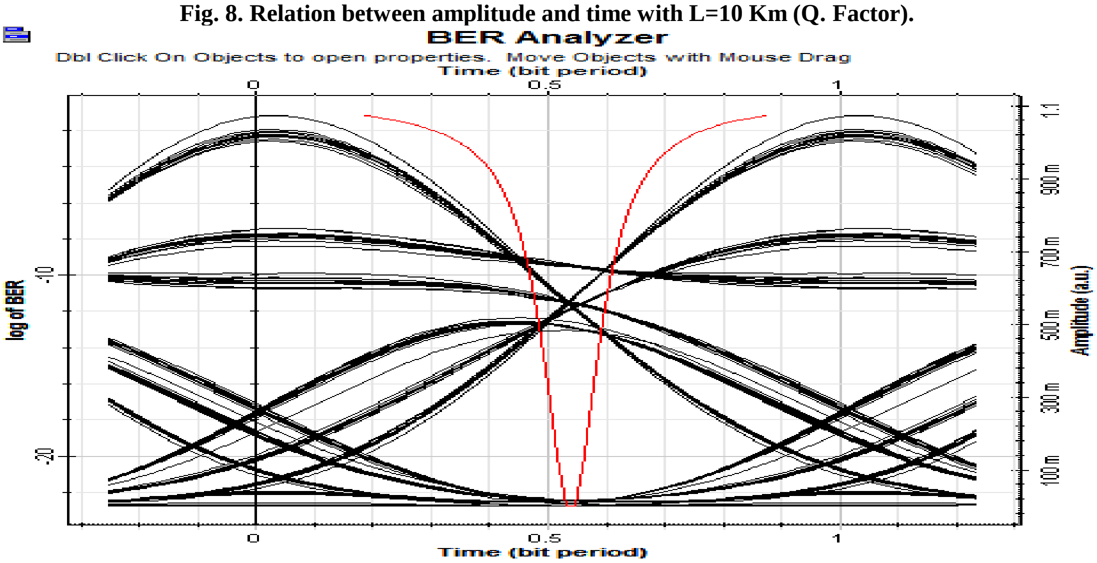

Fig. 9. Relation between amplitude and time with L=10Km (Min BER).

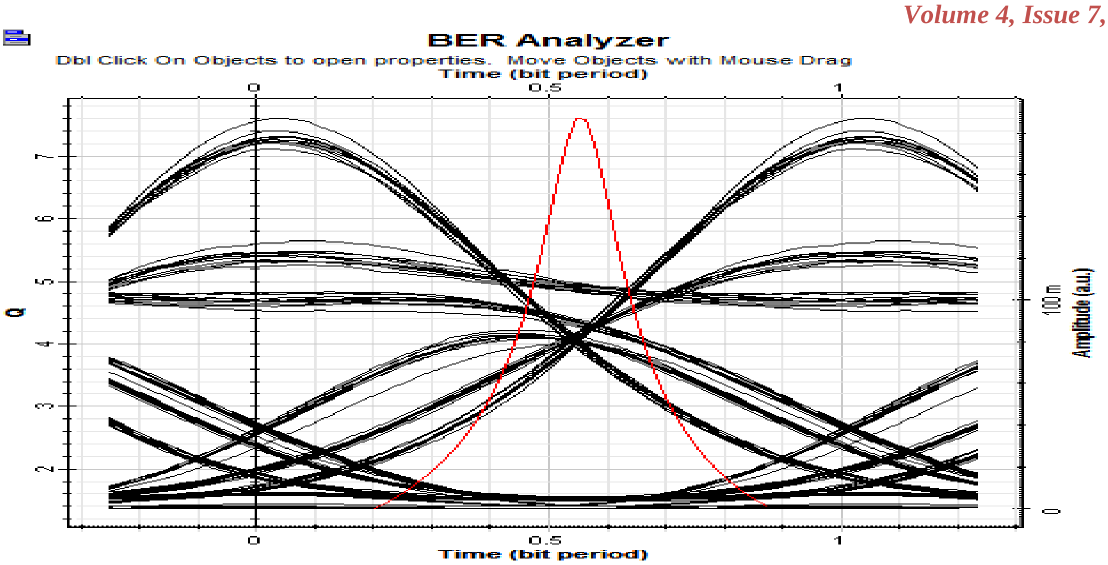

Fig. 10. Relation between amplitude and time with L=50 Km (Q. Factor).

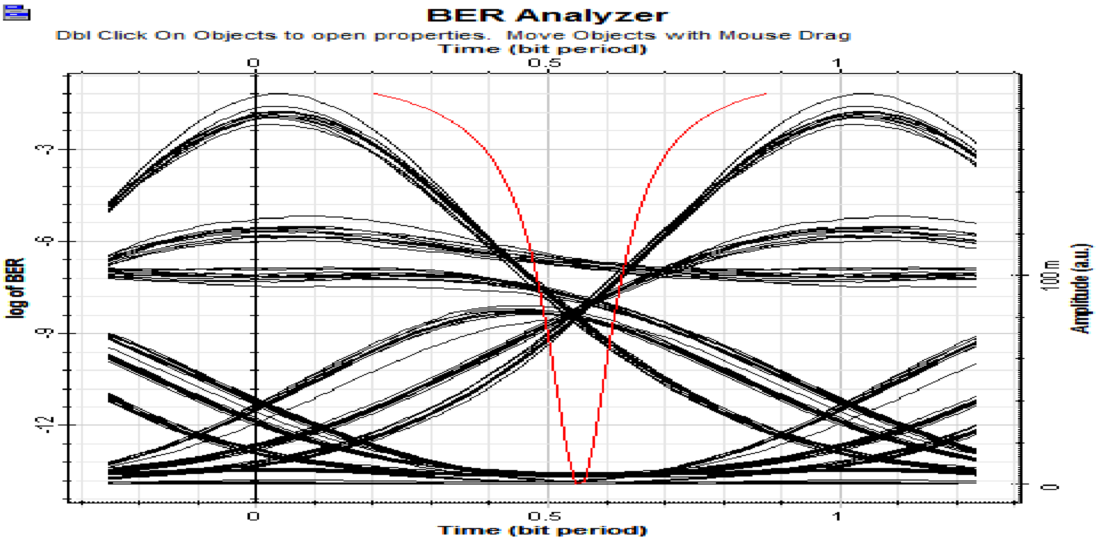

Fig. 11. Relation between amplitude and time with L=50 Km (Min BER).

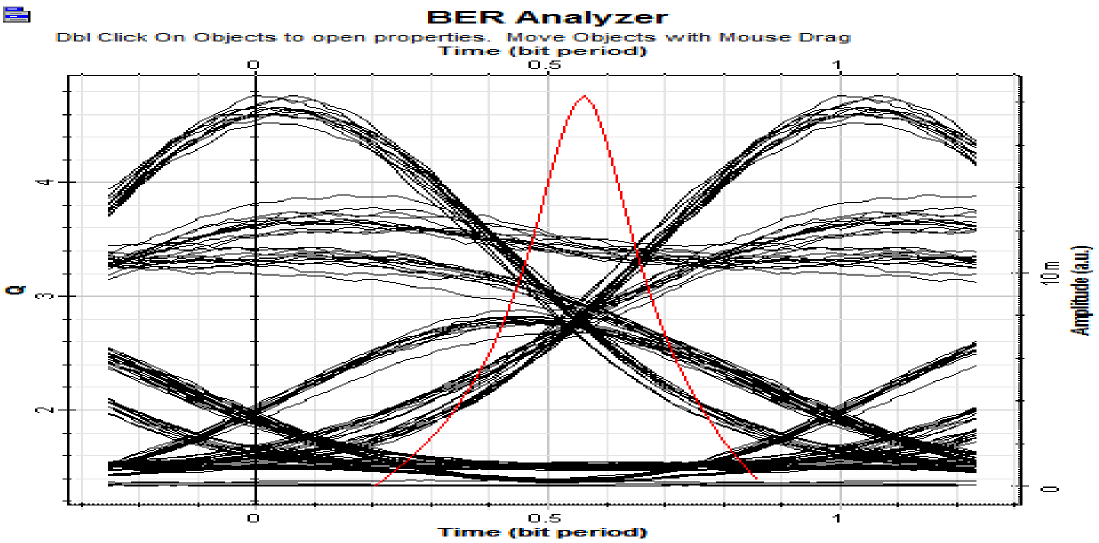

Fig. 12. Relation between amplitude and time with L=100 Km (Q. Factor).

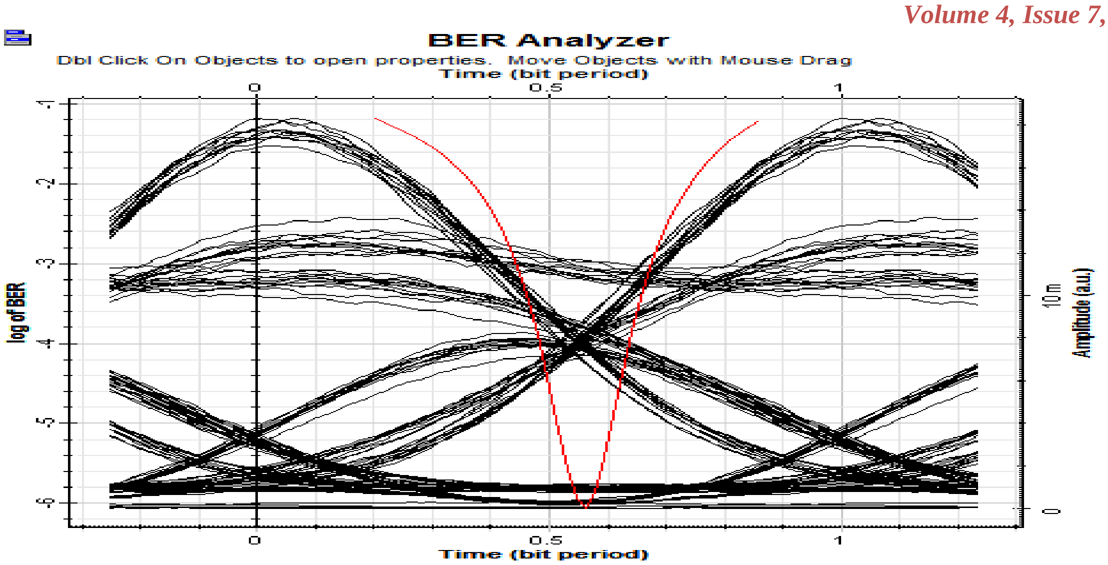

Fig. 13. Relation between amplitude and time with L=100 Km (Min BER).

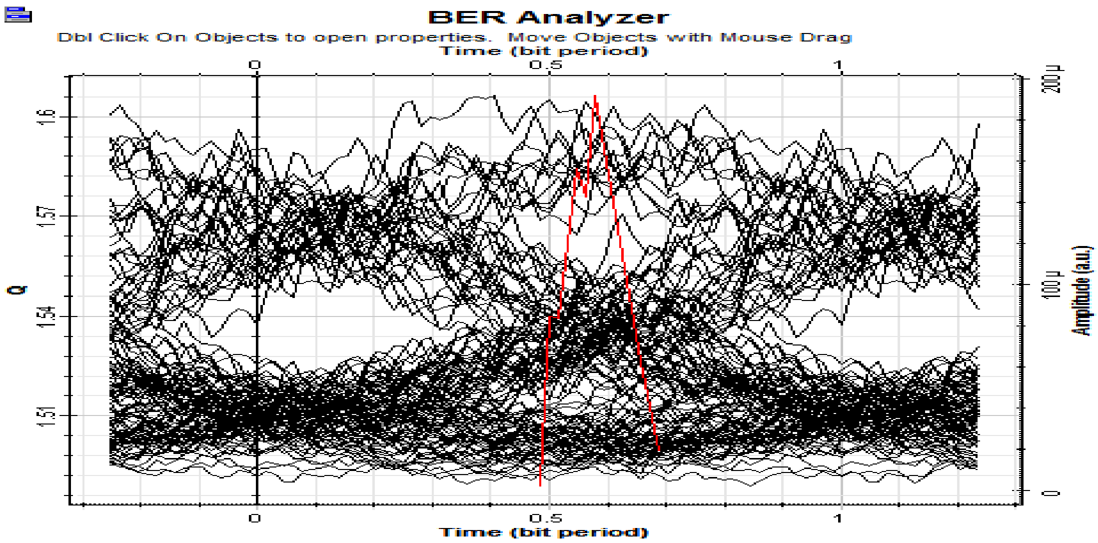

Fig. 14. Relation between amplitude and time with L=200 Km (Q. Factor).

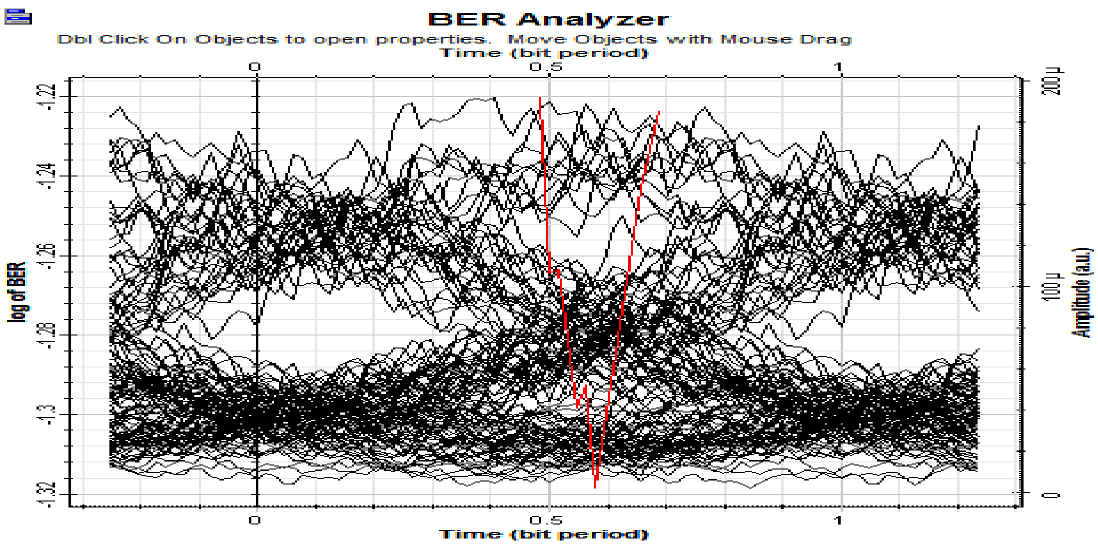

Fig. 15. Relation between amplitude and time with L=200 Km (Min BER).

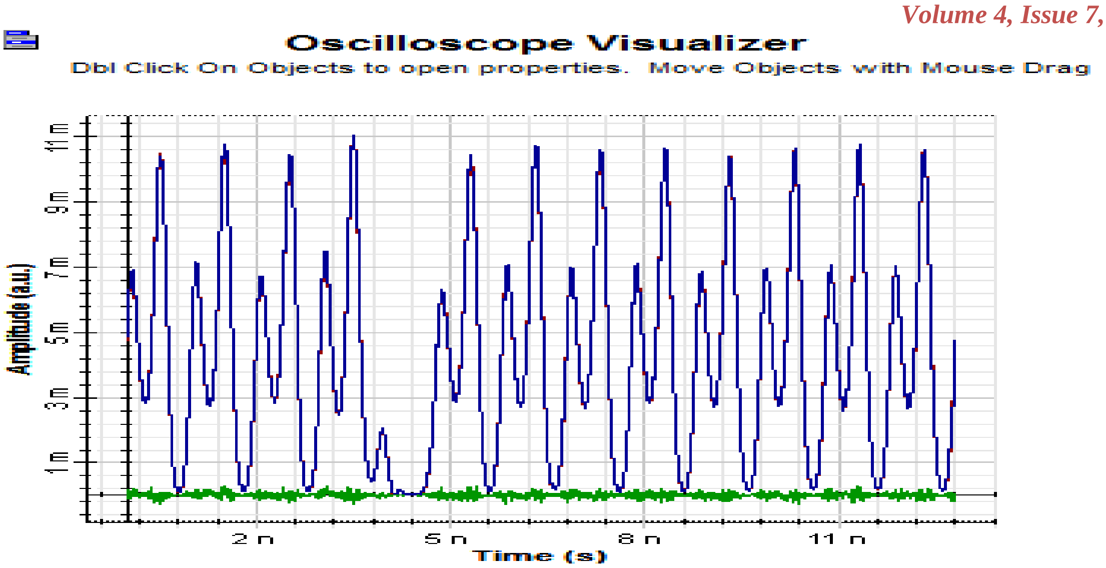

Fig. 16. Relation between amplitude and time with B.W=5 MHZ.

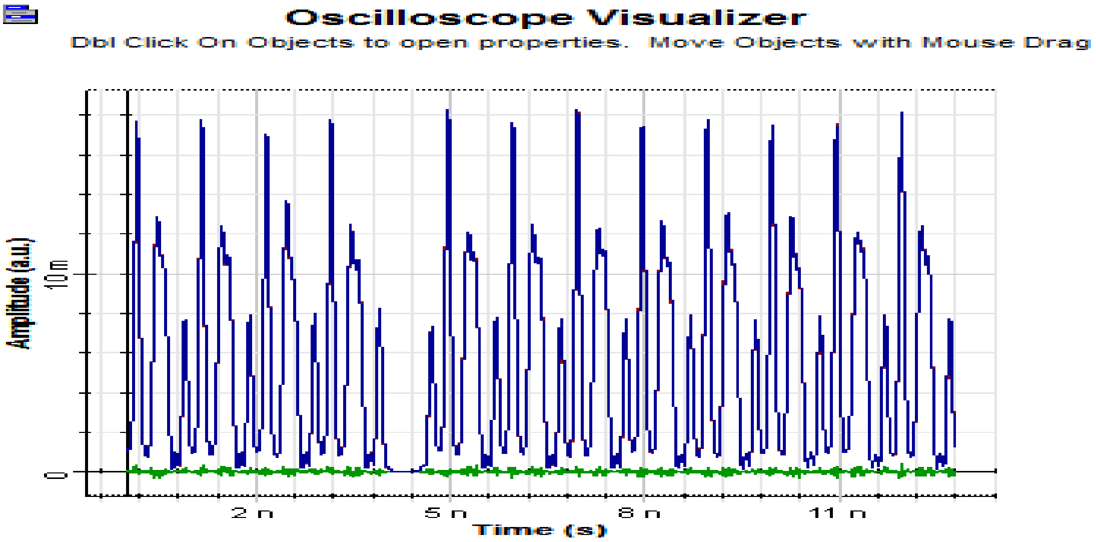

Fig. 17. Relation between amplitude and time with B.W=10 MHZ.

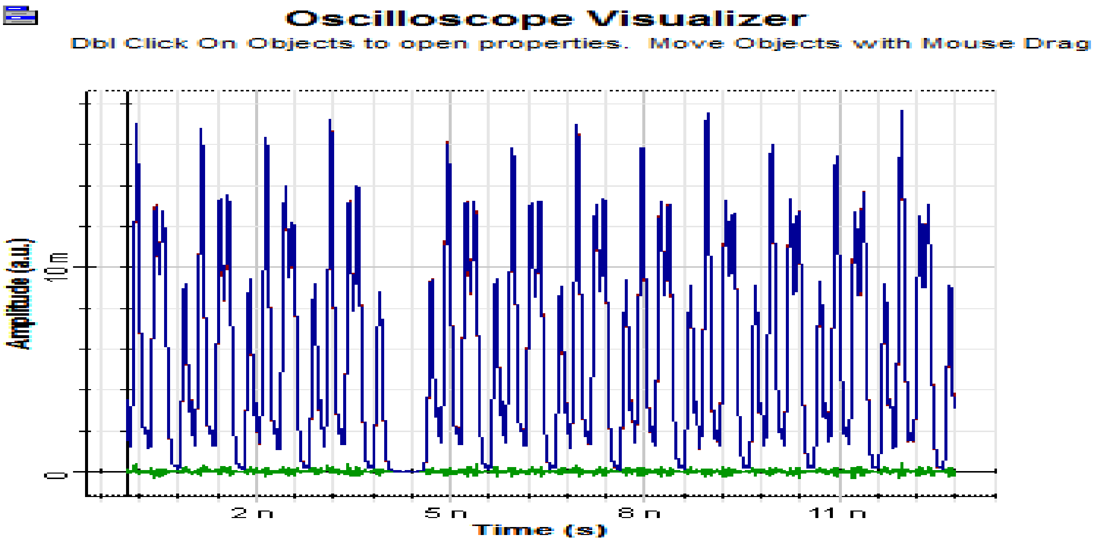

Fig. 18. Relation between amplitude and time with B.W=15 MHZ.

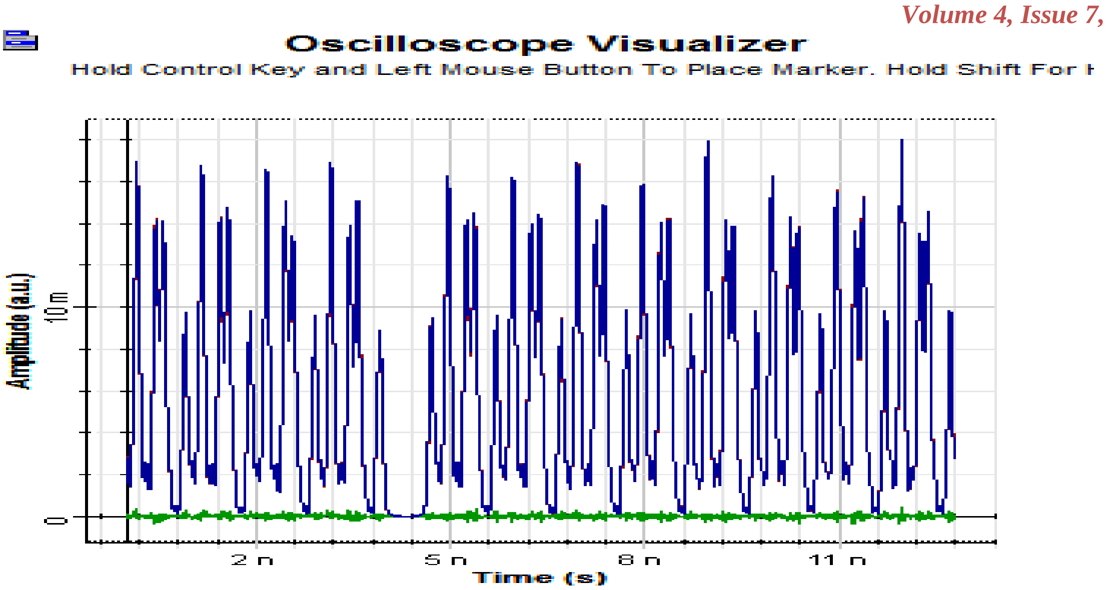

Fig. 19. Relation between amplitude and time with B.W=20 MHZ.

IV. CONCLUSIONS

In a summary, optical delay line filter are deeply investigated for different transmission network applications. Rectangular optical filter at line transmission is employed with low pass Chebyshev filter instead of low pass Bessel filter in their model. Our proposed model has presented high maximum quality factor over 100 km fiber transmission. It is observed that the effects of increasing filter bandwidth on the network transmission for long haul transmission applications. It is observed that our proposed model has presented higher quality factor in compared with their previous study as shown in Table 1 below for long haul network applications.

Table 1: Maximum Quality factor for previous and our proposed models.

Length (Km)	Previous Model	Modified Model
	Maximum Q Factor	
100	4.4	4.7
125	2.5	3.7
150	1.4	2.7
175	0.9	2.1
200	0.1	1.6

REFERENCES

[1] P. Pavithra, and M. Ganesh Madhan, "Dispersion Compensation using Delay Line Filter (DLF) with 2x2 Coupler," International Conference on Electronics and Communication Engineering, 28th April-2013, Bengaluru, ISBN: 978-93-83060-04-7.
[2] Y. Dai and J. Yao, "Nonuniformly Spaced Photonic Microwave Delay-Line Filters and Applications," IEEE Transactions on Microwave Theory and Techniques, Vol. 58, No. 11, pp. 3279-3289, Nov. 2010.
[3] J. Capmany, B. Ortega, and D. Pastor, "A tutorial on Microwave Photonic Filters," J. Lightw. Technol., Vol. 24, No. 1, pp. 201–229, Jan. 2006.
[4] R. A. Minasian, "Photonic Signal Processing of Microwave Signals," IEEE Trans. Microw. Theory Tech., Vol. 54, No. 2, pp. 832–846, Feb. 2006.
[5] J. Mora, M. V. Andres, J. L. Cruz, B. Ortega, J. Capmany, D. Pastor, and S. Sales, "Tunable All Optical Negative Multitap Microwave Filters Based on Uniform Fiber Bragg Gratings," Opt. Lett., Vol. 28, No. 15, pp. 1308–1310, Aug. 2003.
[6] J. Capmany, D. Pastor, A. Martinez, B. Ortega, and S. Sales, "Microwave Photonics Filters with Negative Coefficients Based on Phase Inversion in an Electro Optic Modulator," Opt. Lett., Vol. 28, No. 16, pp. 1415–1417, Aug. 2003.
[7] E. H. W. Chan and R. A. Minasian, "Novel All Optical RF Notch Filters with Equivalent Negative Tap Response," IEEE Photon. Technol. Lett., Vol. 16, No. 5, pp. 1370–1372, May 2004.
[8] Y. Dai and J. P. Yao, "Microwave Pulse Phase Encoding Using A photonic Microwave Delay Line Filter," Opt. Lett., Vol. 32, No. 24, pp. 3486–3488, Dec. 2007.
[9] N. You and R. A. Minasian, "Novel High- Optical Microwave Processor Using Hybrid Delay-Line Filters," IEEE Transactions on Microwave Theory and Techniques, Vol. 47, No. 7, pp. 1304-1308, July 1999.
[10] D. Le, T. Q. Tran and S. Kim, "Loss Effect Analysis in Optical Delay Lines Based on Two Coupled Resonators," Microwave and Optical Technology Letters, Vol. 56, No. 12, pp. 2986–2987, Dec. 2014.

[11] C. Wang and J. P. Yao, "Photonic Generation of Chirped Millimeter Wave Pulses Based on Nonlinear Frequency to Time Mapping in A nonlinearly Chirped Fiber Bragg Grating," IEEE Trans. Microw. Theory Tech., Vol. 56, No. 2, pp. 542–553, Feb. 2008.

Authors Profiles

Dr. Hamdy A. Sharshar was born in Menoufia State, Egypt country in 24 July, 1956. Received the B.Sc., M.Sc., and Ph.D. scientific degrees in the Electronics and Electrical Communications Engineering Department from Faculty of Electronic Engineering, Menoufia University in 1979, 1987, and 1993 respectively. Currently, his job carrier is Asscoc. Prof. Dr. in Electronics and Electrical Communications Engineering Department, Faculty of Electronic Engineering, Menoufia university, Menouf 32951, Egypt. His scientific master science thesis has focused on Electromagnetic scattering by plane and curved surfaces. As well as his scientific Ph. D. thesis has focused on Helical Antennas. His interesting research mainly focuses on wireless communication, radio over fiber communication systems, and optical network security and management. His areas of interest and experience in wireless optical access networks, analog communication systems, optical filters and Sensors, network management systems, multimedia data base, network security, encryption and optical access computing systems.

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