

Different soliton pulse order effects on the fiber communication systems performance evaluation

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ABSTRACT

The study outlined the soliton pulse order effects on the performance efficiency of the optical transceiver systems. The power after fiber is reported for various Soliton pulse order. Max optical signal power (SP) and min optical noise power (NP) are clarified versus time after optical fiber for various soliton pulse order. As well as the max electrical power amplitude against time period is demonstrated after electrical filter for various soliton pulse order. It is reported that the optical transceiver performance efficiency can be upgraded with the first soliton order pulse. The soliton technique is used for high speed communication transmission systems. Soliton technique is used to compensate the dispersion and balanced with nonlinear effects. The soliton order effects is then discussed to choose the suitable soliton order for high speed system performance efficiency. The soliton techniques can be used also for extended ultra high transmission distance with high data rates.

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1. INTRODUCTION

The most problem in optical communication systems is the increase need for high bit rates and max fiber reach with high transmission quality [1]-[6]. The increase capacity in optical fibers lines that are already used, there are many techniques for this purpose. The increase in transmitted channels number by using ultra dense wavelength division multiplexing schemes [7]-[15]. So it is possible to use one optical fiber line to carry maximum transmitted channels up to 100 channels and each channel acts optical wavelength different from each other [16]-[24].

There is a development in optical fiber lines that reach to the stage to establish optical networks [25]-[29]. These optical networks that include all optical components. These networks can be classified into passive or active linear or nonlinear optical networks. The suitable transmission distance in passive optical networks is between 10 to 20 km between sender and receiver. The suitable transmission distance in active optical networks is 80 to 90 km. linear/nonlinear passive optical communication networks can be modified its distance by using all optical amplifiers [30]-[35].

Fiber Bragg grating (FBG) employed with dispersion compensation over different transmission distances for NRZ at 20 Gb/s [36]-[39]. It was revealed that the signal quality slightly changed over longer transmission distance when using FBG [12]-[20]. So, FBG is preferred especially for longer fiber lengths.

The effects of applying different input power levels on the system performance in case of using FBG as a dispersion compensator have been studied in detail [40]-[43]. It was found that as the power level increases, the fiber nonlinearity effects are also increasing. Wavelength division multiplexing (WDM) system has been modeled using cascaded fiber Bragg grating. The system performance has been analyzed for two cases; with using the cascaded FBG and without using the cascaded FBG. A significant improvement in system performance has been achieved when using cascaded FBG [44]-[55].

The Soliton pulse order effects on the performance efficiency of the optical transceiver systems is studied and simulated. The power after fiber is reported for various Soliton pulse order. Max optical signal power and min optical noise power are clarified versus time after optical fiber for various Soliton pulse order. As well as the max electrical power amplitude against time period is demonstrated after electrical filter for various Soliton pulse order. It is reported that the optical transceiver performance efficiency can be upgraded with the first soliton order pulse. FBG device compensates dispersion in the fiber line and the dispersion can be controlled.

2. RESEARCH METHOD

Figure 1 has outlined the Soliton pulse order effects on the optical transceiver systems. The data source generator generates stream of bits sequence. The sequence of bits is reconfigured through the Gaussian pulse generators. Soliton pulses with various orders can be generated with the gaussian pulse generator. The laser rate equations are responsible for the generation of 1550 nm wavelength and a power of 10 dBm. LiNb mach zehnder modulators are responsible for modulated the electro-optic signal. The sig. is injected into 300 km distance. Sig. is degraded with the cable and attenuations due to the losses. The signal can be processed through the butterworth optical filter. The losses in the signal can be treated through 5 m length EDFA and Raman amplifiers. The optical signal can be converted to electrical signal and can be treated from the ripples through PIN Photodetector and low pass butterworth electrical filter respectively. 3R regenerator can be retimed/reshaped the signal again.

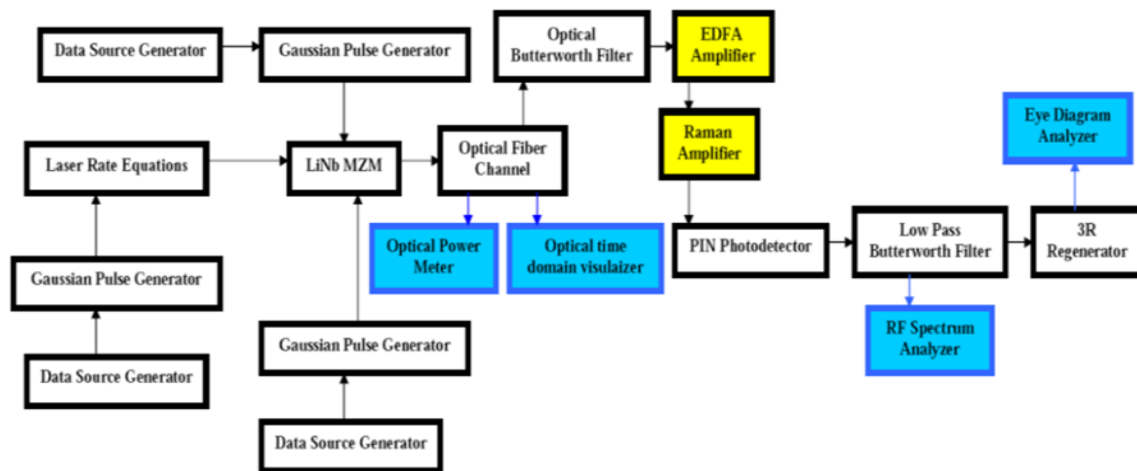


Figure 1. Proposed simulation model description

Max Q, min BER are tested by BER analyzer. The nonlinear pulse propagation in optical fiber can be estimated by [4],

$$n(I) = n_0 + n_2 I \quad (1)$$

with linear index (n_0), I is the optical intensity, and nonlinear index (n_2). The chirped hyper-secant Soliton pulse can be modeled by [4],

$$u(\xi, \tau) = N_s \text{Sech}(p\tau) \exp[iK\xi - iq \ln(\text{Cosh}(p\tau))] \quad (2)$$

where the parameters ξ , τ , and u are estimated by [4]:

$$\xi = \frac{z|\beta_2|}{T_0^2} \tag{3}$$

$$\tau = \frac{T}{T_0} \tag{4}$$

$$u = \sqrt{\frac{\gamma T_0^2}{|\beta_2|}} \tag{5}$$

with β_2 is the propagation constant, T_0 is the bit period, and z is Soliton propagation distance.

3. RESULTS AND DISCUSSION

The Soliton pulse order effects with the engagement between EDFA/Raman amplifiers on the performance efficiency of the transceiver systems have been simulated. We have demonstrated the total optical power after optical fiber for various soliton order pulse. The max optical SP and optical NP with time after optical fiber for various soliton order pulse are reported. As well as the max electrical power amplitude versus periodic time after electrical filter for the first soliton order pulse is clarified. The clarified results depend on the items in Table 1.

Table 1. List of items in this proposed work [3], [5], [9]

Parameters	Values/Units
Laser rate equation source	
Wavelength	1550 nm
Power	10 dBm
Drive current	38 mA
Mod. Peak current	28 mA
Line width	10 MHz
LiNb MZM modulator	
Insertion loss	5 dB
Extinction ratio	20 dB
Optical link	
Length	3000 km
Wavelength	1550 nm
Loss	0.14 dB/km
EDFA/Raman Amplifiers	
EDFA Length	5 m
Core radius	2.2 μ m
PIN Photodetector	
Responsitivity	1 A/W
Gain	5 dB

Figure 2(a) clarifies the total optical power after optical fiber for the first soliton order pulse. The total optical power is 83.366 μ W (10.79 dBm) with the first soliton order pulse. Figure 2(b) demonstrates the total optical power after optical fiber for the second soliton order pulse. The total optical power is 45.64 μ W (13.406 dBm) with the second soliton order pulse. Figure 2(c) illustrates the total optical power after optical fiber for the third soliton order pulse. The total optical power is 39.429 μ W (14.401 dBm) with the third soliton order pulse. With the first soliton order pulse the total optical power can be enhanced than other high Soliton pulse order.

The max optical SP and min optical NP versus time after optical fiber for the first soliton order pulse outlined in Figure 3(a). The optical power is 0.000312 W and min NP is -1.486×10^{-5} W with the first Soliton pulse order. The max optical SP and min optical NP versus time after optical fiber for the second soliton order pulse are clarified in Figure 3(b). The peak SP is 0.00024299 W and min NP is -1.1571×10^{-5} W with the second Soliton pulse order. The max optical SP and min optical NP versus time after optical fiber for the third soliton order pulse are demonstrated in Figure 3(c). Optical power is 0.00020829 W and min NP is -9.9184×10^{-6} W with the third soliton pulse order. The max optical SP can be upgraded and min optical NP can be reduced by using the first soliton order pulse.

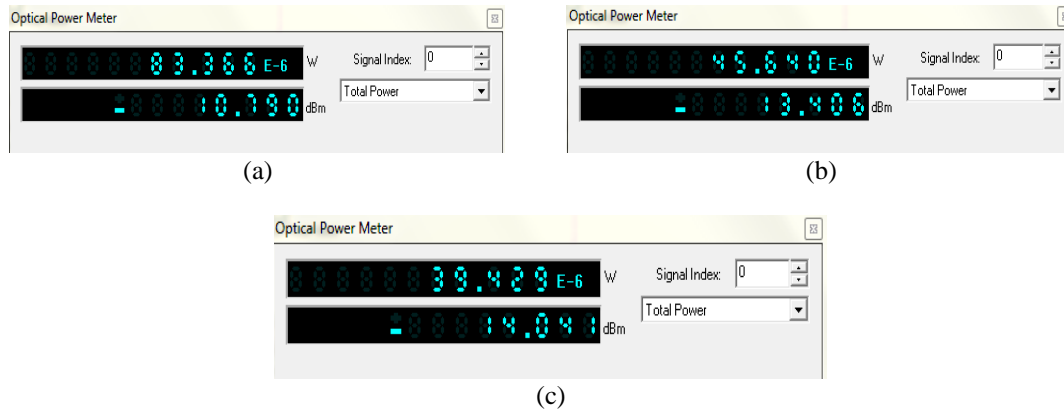


Figure 2. These figures are; (a) total power after fiber for the first soliton order pulse; (b) total power after fiber for the second soliton order pulse; (c) total power after fiber for the third soliton order pulse

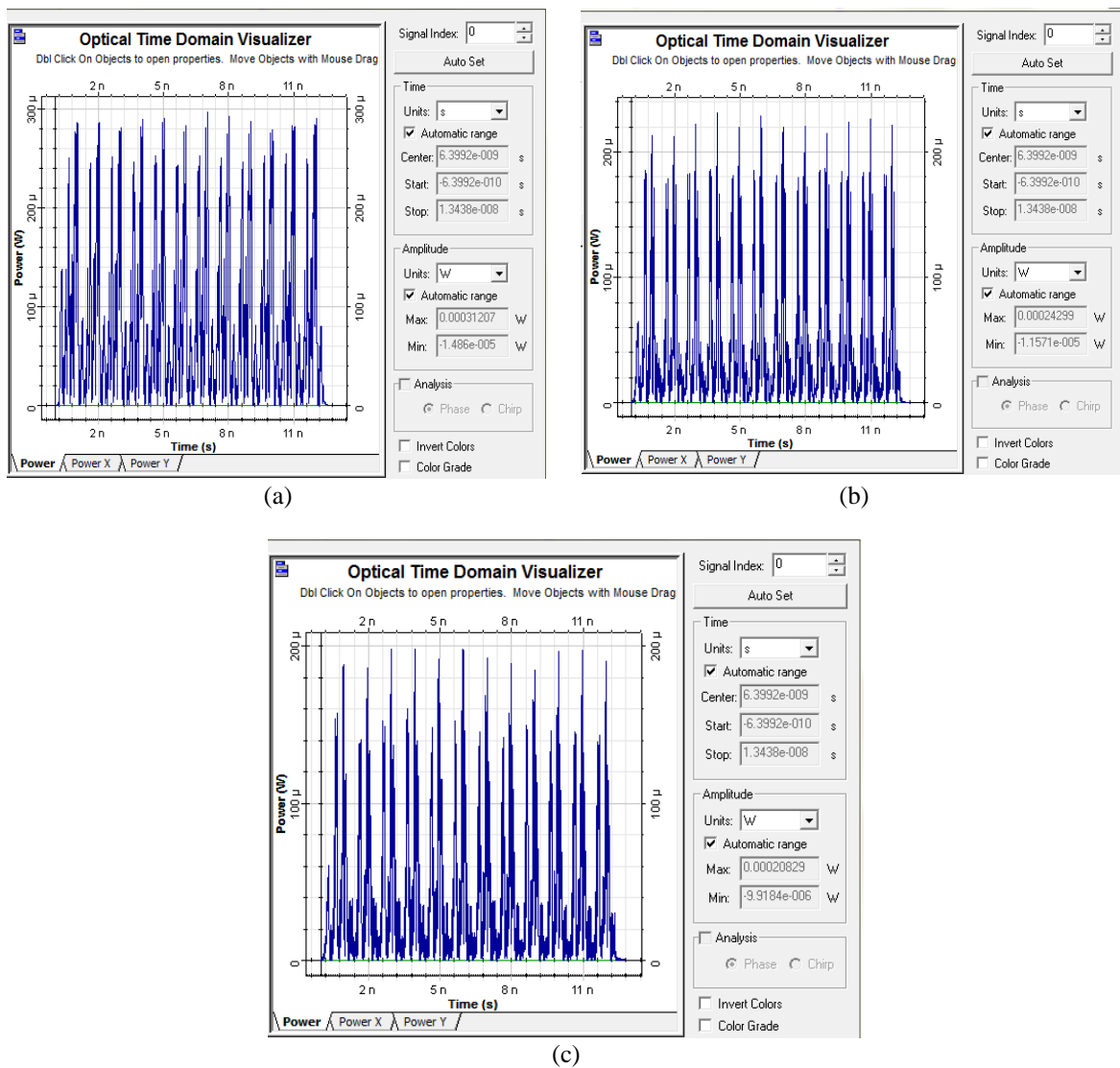


Figure 3. These figures are; (a) Max optical signal and min optical NPs versus time after optical fiber for the first soliton order pulse, (b) Max optical signal and min optical NPs versus time after optical fiber for the second soliton order pulse; (c) Max optical signal and min optical NPs versus time after optical fiber for the third soliton order pulse

The max electrical SP and min electrical NP against frequency after electrical filter for the first soliton order pulse are clarified in Figure 4(a). Electrical power is 0.656534 dBm and min electrical SP is -104.793 dBm with the first soliton order pulse. The max electrical SP and min electrical NP against frequency after electrical filter for the second soliton order pulse are reported in Figure 4(b). The peak SP is -0.881793 dBm and min electrical SP is -104.72 dBm with the second soliton order pulse. The max electrical SP and min electrical NP against frequency after electrical filter for the third soliton order pulse are outlined in Figure 4(c). Electrical power is -1.57224 dBm and min electrical SP is -104.687 dBm with the third soliton order pulse. The max electrical SP can be upgraded and the min electrical NP can be reduced in the presence of first soliton order pulse. The max electrical power amplitude versus time after electrical filter for the first soliton order pulse is shown in Figure 5(a). The Q is 9.1376 and BER is 3×10^{-20} with the first Soliton pulse order. The max electrical power amplitude versus time after electrical filter for the second soliton order pulse is indicated in Figure 5(b). The Q is 7.30714 and BER is 1.27335×10^{-13} with the second soliton pulse order. The max electrical power amplitude versus time after electrical filter for the third soliton order pulse is reported in Figure 5(c). The Q is 5.87183 and BER is 1.9×10^{-9} with the third soliton pulse order. The Q factor can be enhanced and BER can be reduced by using the first soliton order pulse.

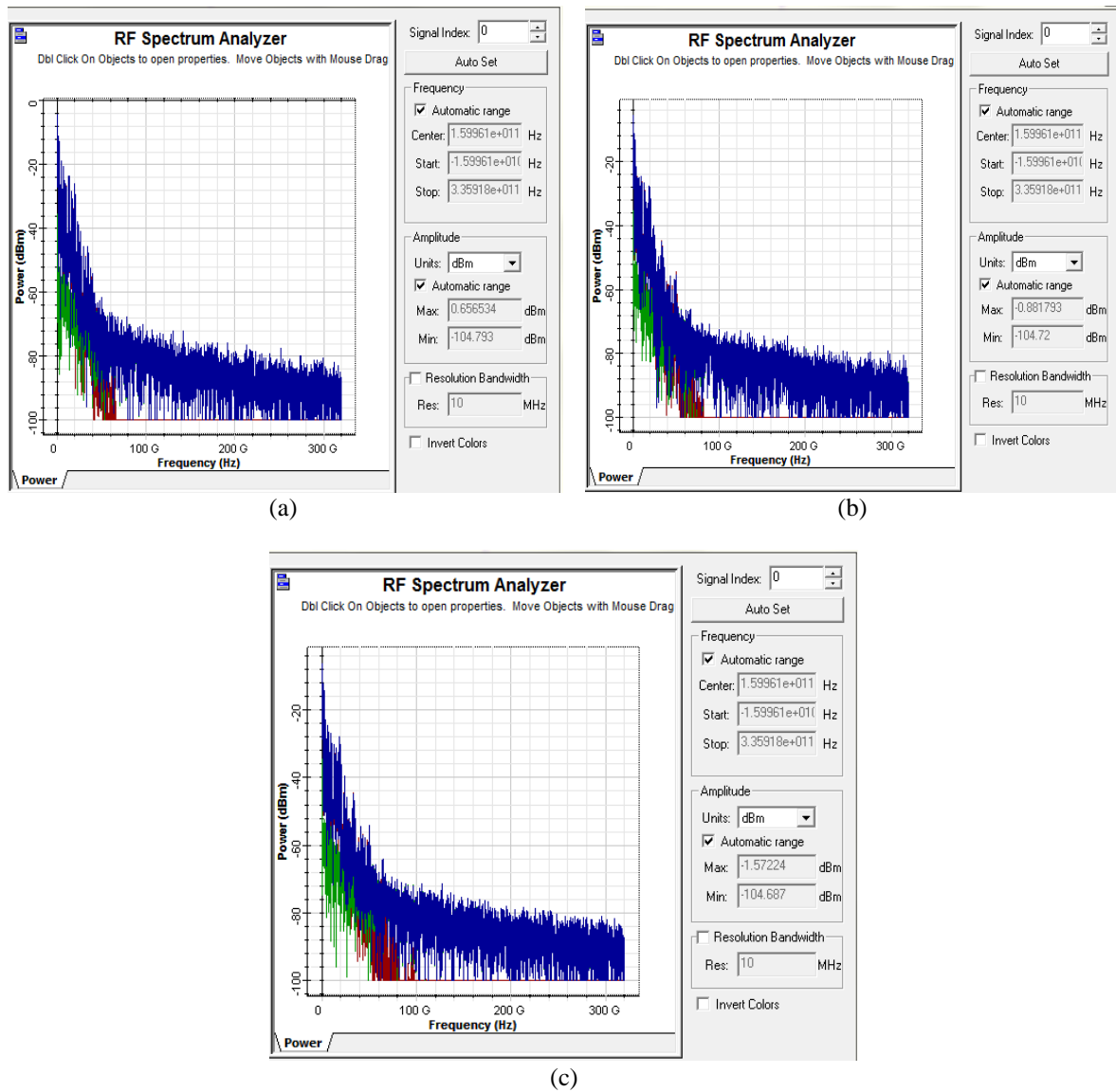


Figure 4. These figures are; (a) Max electrical SP and min electrical NP against frequency after electrical filter for the first soliton order pulse; (b) Max electrical SP and min electrical NP against frequency after electrical filter for the second soliton order pulse; (c) Max electrical SP and min electrical NP against frequency after electrical filter for the third soliton order pulse

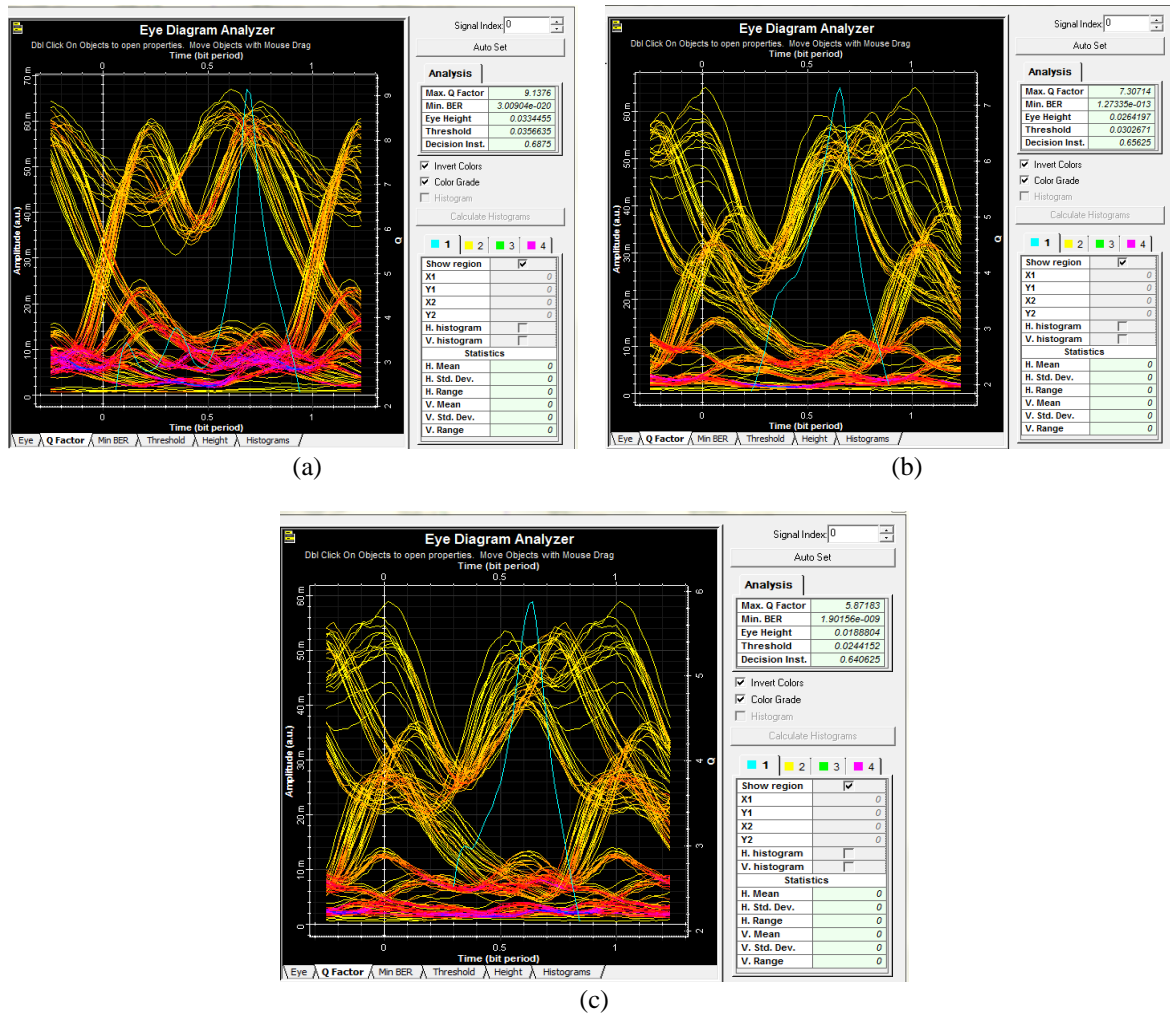


Figure 5. These figures are; (a) Max electrical power amplitude versus time after electrical filter for the first soliton order pulse; (b) Max electrical power amplitude versus time after electrical filter for the second soliton order pulse; (c) Max electrical power amplitude versus time after electrical filter for the third soliton order pulse

4. CONCLUSIONS

We have been simulated the Soliton pulse order variation effects on the performance efficiency of the transceiver communication systems. It is clarified that total optical power, max optical/electrical SPs and Q factor decrease linearly with the increase of the Soliton pulse order. It is outlined that the Q factor, max optical/electrical SPs and total optical power can be enhanced and min BER can be reduced by using the first soliton order pulse. Max Q factor can be enhanced with the choice of suitable propagation reach and amplification technique. The study emphasized that the important role of both EDFA/Raman amplifiers for strength the signal and upgrading Max Q values.

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