Hybrid NRZ/RZ line coding scheme based hybrid FSO/FO dual channel communication systems

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ABSTRACT

This study simulates the hybrid non return to zero (NRZ)/return to zero (RZ) line coding scheme based hybrid free space optics (FSO)/fiber optics (FO) dual channel communication systems. The max Q factor/Min BER are simulated after APD based both erbium doped fiber amplifiers (EDFAs) and wide band traveling wave semiconductor optical amplifiers (WBTWSOAs) with 50 km fiber channel and 4 km FSO channel. Max SPAL/min noise SPAL, max signal power amplitude/min noise signal power with spectral frequency, and the total electrical power are demonstrated and clarified in this proposed study. This work emphasized that the fiber channel is reached up to 100 km reach and FSO channel can be also extended to 4 km reach with 40 Gbps.

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1. INTRODUCTION

In communication systems, the input electrical signals which carry the information to be transmitted are first converted into optical signals by modulating the optical source output through one of two mechanisms; by varying the drive current of source or by varying the light intensity at the optical source output [1-12]. The optical fiber has low attenuation coefficient and large angle of light acceptance cone [13-22]. The optical signal is propagating via the optical fiber within optical wavelengths range through several ray paths [23-30]. This will cause a distortion of the propagating optical signal. The propagated optical signals suffer from attenuation and distortion. This distortion leads to spreading and deforming of the optical pulses [31-43]. The spreading causes the adjacent optical pulses to be overlapped leading to inter symbol interference (ISI) [44-58].

2. SIMULATION MODEL

Figure 1 shows the simulation model based hybrid NRZ/RZ line coding scheme-based hybrid FSO/FO dual channel communication systems. Every data sources are used to generate the stream sequence of bits. The fork unit distributes the data signals between NRZ and RZ encoded signals. Then the hybrid encoded signals are combined through the combiner unit. The continuous wave laser is responsible for generating the light signal with 1550 nm and 10 mW. Electro optic MZM modulators employed to modulate the two input signals from the encoders and light sources.

Through the two fork units and power combiner units the modulated signals are passed through the FSO channel with a length of 4 km in the presence of 0.2 dB/km loss. The modulated signals are injected from the two FSO communication channel to the power combiner. The power combiner is directed the signal to the fork unit. Where the fork unit is responsible for distribute the signals to the two optical fiber communication channels. The fiber communication channel has a reach of 50 km. These signals can be directed to erbium doped fiber amplifiers in direction and in another direction the signal is forward to WBTWSOAs. The signal strength based pump laser into the two used optical amplifiers in the system. The light modulated signals are directed from the dual fiber channel to APD photo-detectors. The light receivers convert the modulated signal into the electronic form. The filters remove the higher order frequencies and its harmonics.

3R regenerators are used to retime/reshape/regenerate the signal in order to be processed. Power amplitude is tested with the receiver by oscilloscope visulaizer. The eye diagram analyzers measure the Q value and min BER. The total electrical power through the receiver is tested by the electrical power meter visulaizers. RFSA measures the relation between the power against the spectral wavelength or frequency domain.

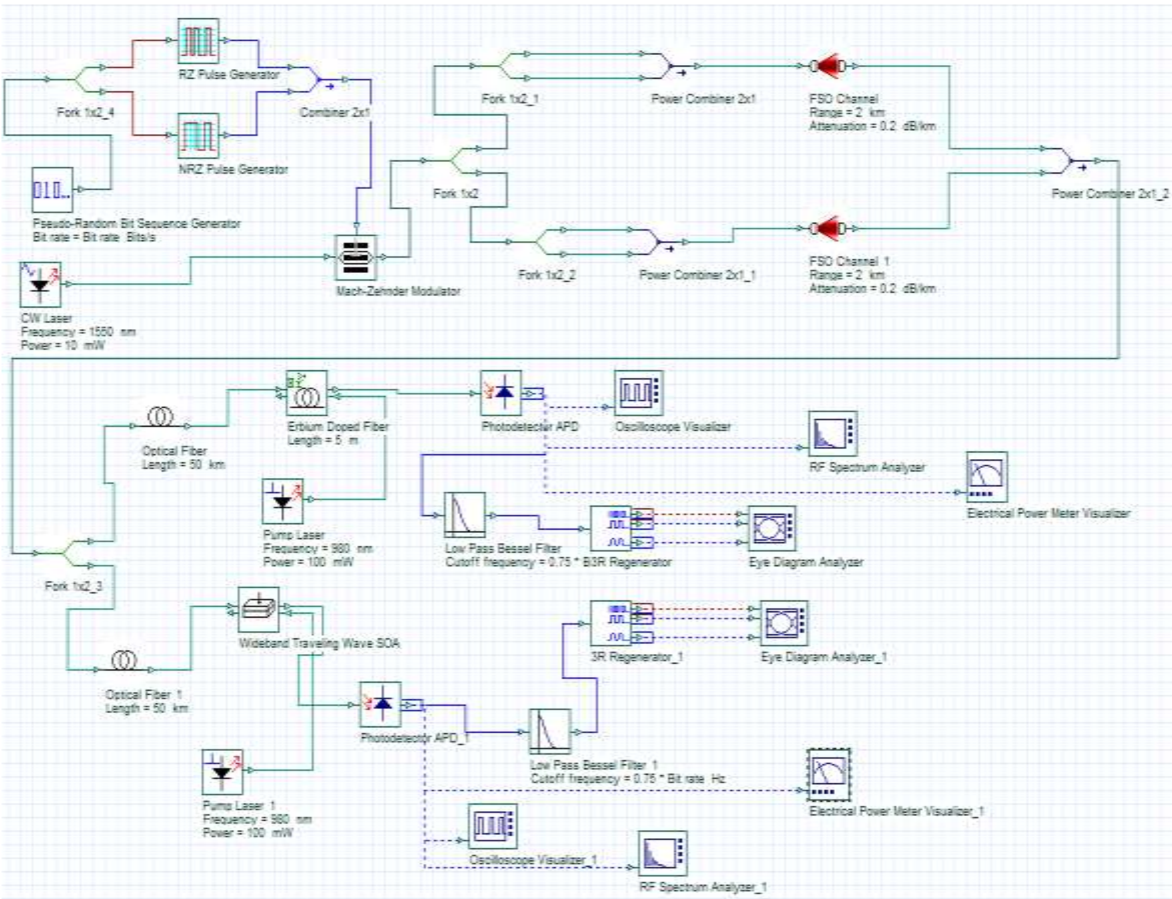

Figure 1. Simulation work

3. DISCUSSIONS

The Q factor/BER after APD receiver based both erbium doped fiber, WBTWSOAs with dual channel of 50 km fiber channel and 4 km FSO channel have been simulted. Also, the max SPAL (SPAL) and min noise SPAL are clarified with time/spectral wavelength variations after APD receiver-based erbium doped fiber amplifiers with 50 km fiber channel and 4 km FSO channel. Total electrical power (TEP) is demonstrated after APD receiver based both optical amplifiers with both dual communication channels with the parameters in Table 1.

Table 1. Variables for the proposed article

Parameters	Values/Units
CW Laser	
Frequency	1550 nm
Power	10 mW
linewidth	10 MHz
FSO Channel	
Range	2 km
Attenuation	0.2 dB/km [Clear Weather]
Tx. diameter	5 cm
Rx. diameter	20 cm
Tx./Rx. Loss	0.1 dB
Optical Fiber Channel	
Wavelength	1550 nm
Range	50 km
EDFA amplifier	
Length	5 m
Numerical aperture	0.24
Core radius	2.2 µm
WBTWSOA amplifier	
Injection current	130 mA
Coupling loss	3 dB
Active length	600 µm
Height=Width	0.4 µm
APD receiver	
Gain	10
Responsitivity	0.9 A/W

Figure 2 clarifies the max Q, min BER for EDFAs with 50 km fiber channel and 4 km FSO channel. The Q factor/bit error rate are 9.52, 8.09x10^{-22} respectively. Figure 3 demonstrates the max Q, min BER for WBTWSOAs with 50 km fiber and 4 km FSO (dual channel). The Q/ bit error rate are 6.36, 9.72x10^{-11} respectively. The system with dual communication channel can be upgraded with EDFAs in compared to WBTWSOAs. Figure 4 shows the max SPAL, min noise SPAL versus time after receiver-based erbium doped Fiber Amplifiers with 50 km fiber channel and 4 km FSO channel. Where the peak power, min noise power (MNP) are 191.6 mV, -5.82 mV respectively.

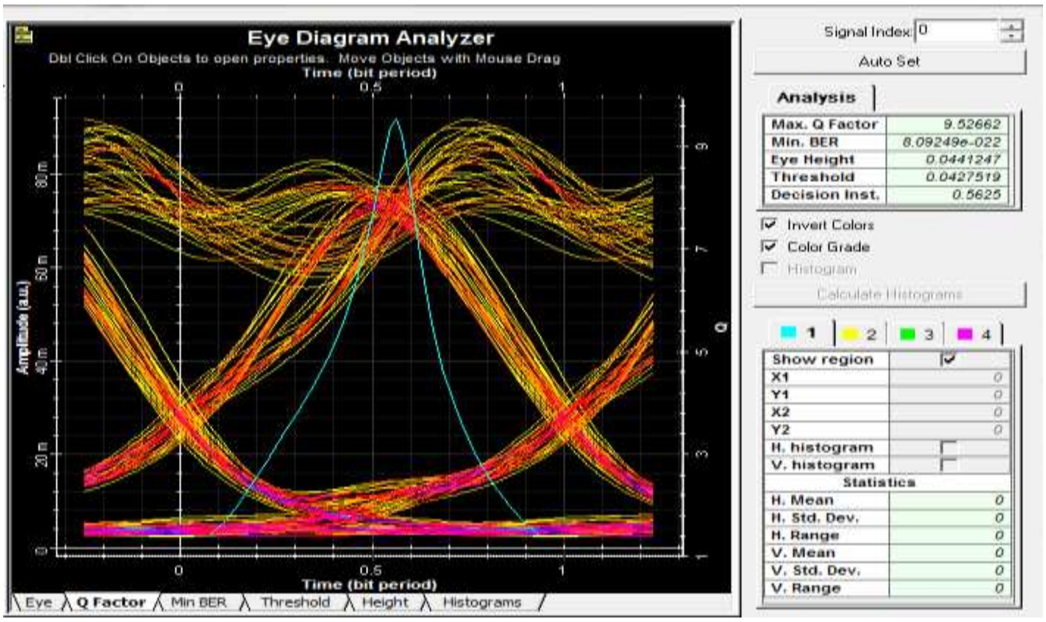

Figure 2. Max Q/Min BER after APD receiver-based erbium doped fiber amplifiers with 50 km fiber channel and 4 km FSO channel

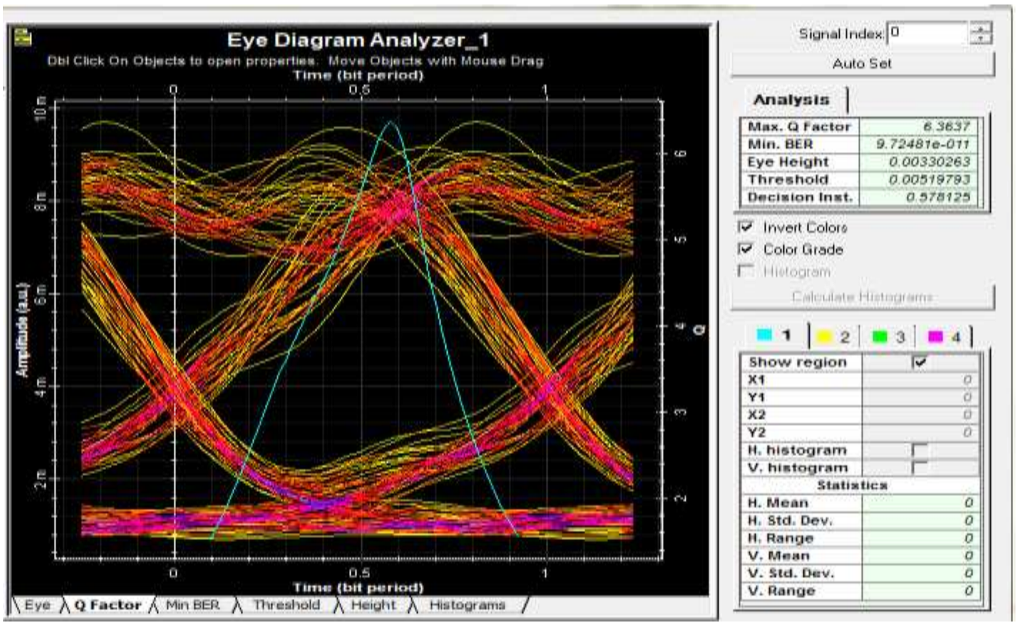

Figure 3. Max Q/Min BER based WBTWSOAs with 50 km fiber and 4 km FSO channel

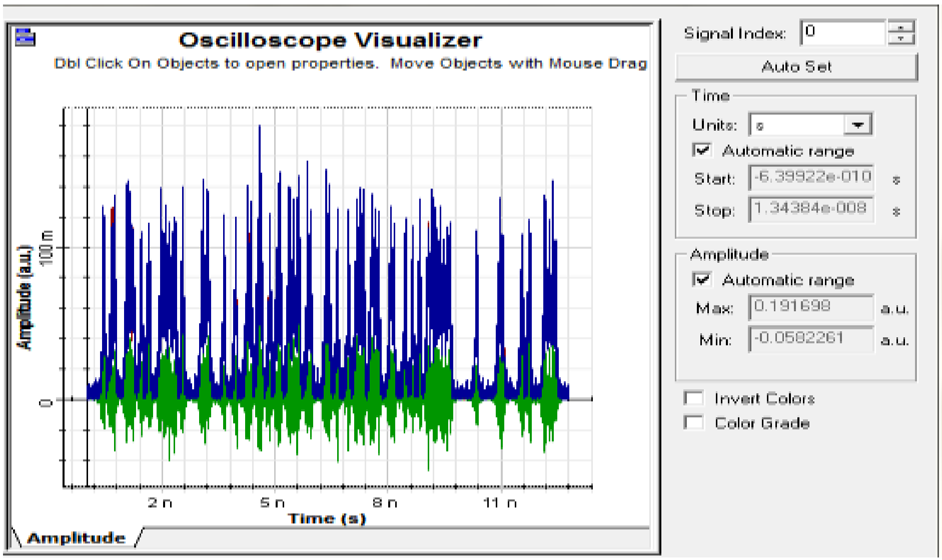

Figure 4. Max SPAL/min noise SPAL versus time after APD receiver-based erbium doped fiber amplifiers with 50 km fiber channel and 4 km FSO channel

Figure 5 illustrtes the max SPAL, min noise SPAL versus time for WBTWSOAs with 50 km fiber and 4 km FSO channel. The peak power, MNP are 31.23 mV, -8.53 mV respectively. The study indicated that the peak power, MNP can be upgraded with the presence of EDFAs in compared to WBTWSOAs. Figure 6 illustrates the peak power amplitude, MNP with spectral frequency after APD receiver-based erbium doped Fiber Amplifiers with 50 km fiber channel and 4 km FSO channel. Where the peak power, MNP are 6.0677 dBm, -105.051 dBm respectively.

Figure 7 clarifies the peak power amplitude/MNP with spectral frequency for WBTWSOAs with 50 km fiber and 4 km FSO channel. Where the peak power, MNP are -13.08 dBm, -104.139 dBm respectively. The study assured that the peak power, MNP with wavelength can be upgraded with the presence of EDFAs in compared to WBTWSOAs.

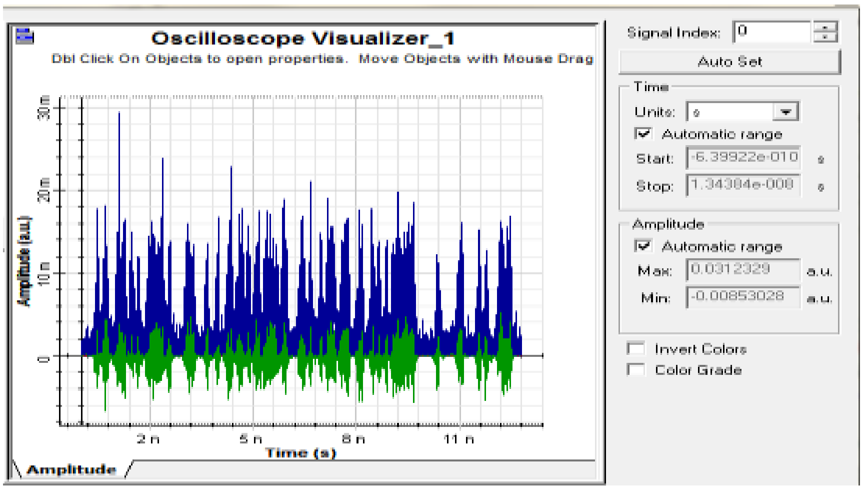

Figure 5. Max SPAL/min noise SPAL with time based WBTWSOAs with 50 km fiber and 4 km FSO channel

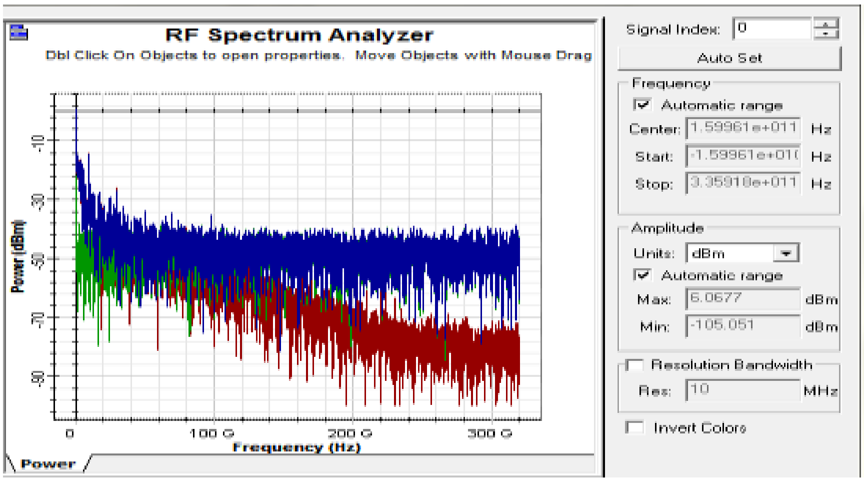

Figure 6. Max signal power amplitude/ MNP with frequency based erbium doped fiber amplifiers with 50 km fiber and 4 km FSO channel

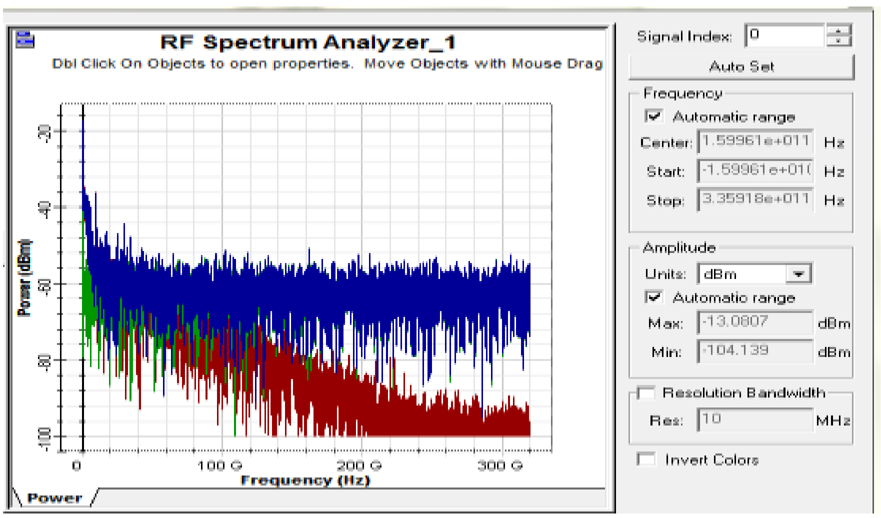

Figure 7. Max signal power amplitude/ MNP with frequency for WBTWSOAs with 50 km fiber and 4 km FSO channel

Figures 8 and 9 show the total electrical power after receiver with EDFAs, WBTWSOAs with dual channel of 50 km fiber channel and 4 km FSO channel. Figure 8 indicates TEP based erbium doped fiber amplifiers with 50 km fiber and 4 km FSO channel. Where the total electrical power is measured in 2.275 mW or in 3.569 dBm. Figure 9 demonstrated TEP based erbium doped fiber amplifiers with 50 km fiber channel and 4 km FSO channel. Where the total electrical power is measured in 0.026463 mW or in -15.773 dBm. So, the total electrical power after receiver is enhanced totally in the presence of EDFAs in compared to WBTWSOAs.

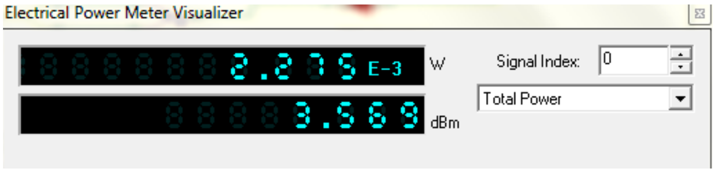

Figure 8. TEP after Rx. for erbium doped fiber amplifiers with 50 km fiber and 4 km FSO channel

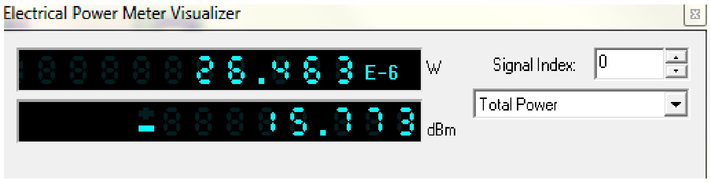

Figure 9. TEP after Rx. for WBTWSOAs with 50 km fiber and 4 km FSO channel

4. CONCLUSION

Hybrid NRZ/RZ line coding scheme-based hybrid dual channel of free space, optical fiber communication systems are simulated. The total electrical power after receiver is enhanced totally in the presence of EDFAs in compared to WBTWSOAs. The work emphasized that peak power, MNP with time duration, wavelength can be upgraded with the presence of EDFAs in compared to WBTWSOAs. The study assured that the Q factor/bit error rate with dual communication channel can be upgraded with EDFAs in compared to WBTWSOAs. So, it is recommended to use EDFAs in dual communication channel with a length of 5 m and numerical aperture of 0.24.

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