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Enhanced performance analysis of 10 Gbit/s optical OFDM-RoF transmission links

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ABSTRACT

In this paper, we have presented analysis of 10 Gbit/s optical OFDM-RoF transmissions links with distance of 50 km and reported the improved performance by usage of a square root module (SQRT).

1. Introduction

Radio over fiber (RoF) is a hybrid system having both fiber optic link and free-space radio path. In such RoF systems microwave data signals are modulated onto an optical carrier at a central station and then transported to remote sites or base station using optical fiber [1]. The base-stations then transmit the RF signals over small areas using microwave antennas. Such a system is important in number of applications including mobile, satellite communications, wireless local area networks, mobile broadband service etc. [2]. OFDM is used extensively in broadband wired and wireless communication systems [3–5]. In OFDM, the received signal at any time depends on multiple transmitted symbols. In this case the equalization rises rapidly [6]. Combined RoF technology with optical OFDM system cannot only reduce multipath fading of wireless signals but also improves signal quality. Moreover, the systems have seamless coverage, increased channel capacity, transmission rate and simplify digital signal processing by means of adding more base stations [7]. Therefore, Optical OFDM system can be regarded as a specific deployment scheme of OFDM-RoF system. By this system, we can also improve the system flexibility and provide a very large coverage area without increasing the cost and complexity of the system. Radio over fiber transmission performance of OFDM signals for dual-band of 2.4/5 GHz wireless LAN systems with very low-data rate have been evaluated [8,9]. An experimental demonstration of OFDM-RoF system for transmitting 1 Gbps OFDM signal on 40 GHz millimeter-wave carriers over 80 km SSM fiber is proposed and achieved less than 0.5 dB power penalty at BER of 10^{-6} without dispersion compensation [10]. We have proposed to use a square root transfer function module similar as reported in [11,12]. The square root module (SQRT) transfer function module has been placed after the photodiode which compensates its square law characteristic for improving the performance of linear equalizer [13]. In this paper we propose the simulative OFDM-RoF transmitter and receiver with optical fiber reported in Section 2. The simulation results have been discussed in Section 3. The conclusion of our simulative results is presented in Section 4.

2. System description

In our proposed optical OFDM-RoF transmission links (Fig. 1), 10 Gbit/s QAM data is generated and then modulated into OFDM by means of OFDM modulator using 512 subcarriers and FFT size of 1024. These are then IQ modulated at an intermediate frequency of 7.5 GHz. Then OFDM analog signal is mixed with RF signal of 17.5 GHz through clock. This Intermediate signal modulates directly the light of a continuous wave (CW) through Mach–Zehnder modulator (MZM). The light is then transmitted on single mode fiber. The attenuation of the fiber is 0.2 dB/km.

After propagation the signal is converted optical to electrical through PIN photodiode. The electrical and optical sample spectra along the system are presented in Figs. 2 and 3.

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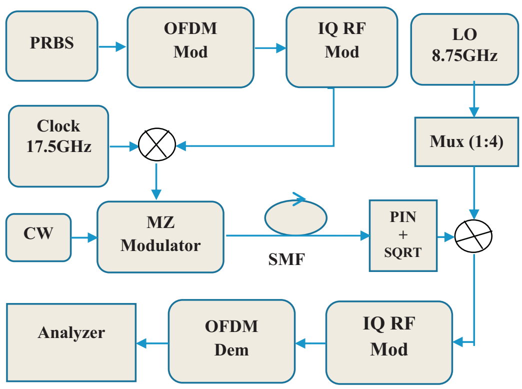
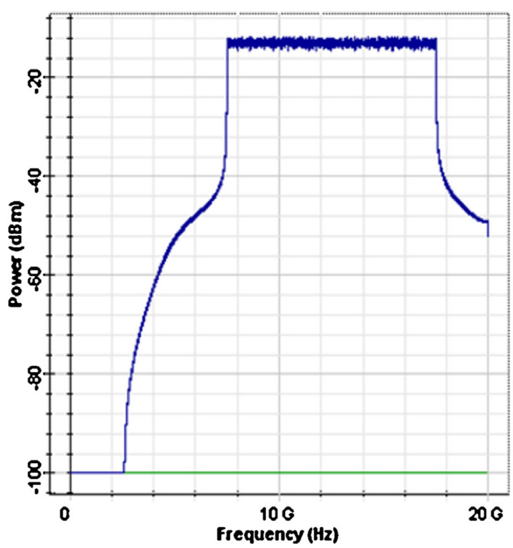
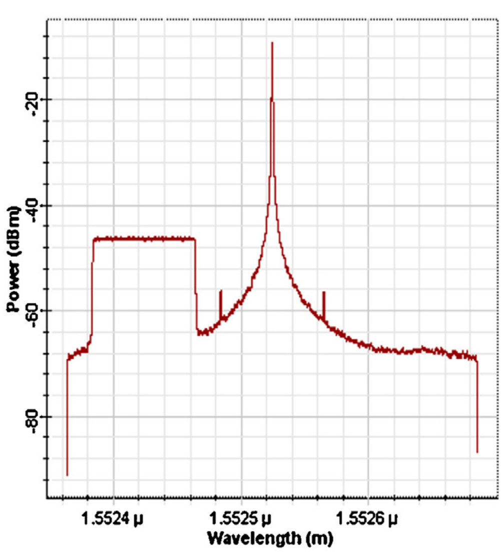


Fig. 1. Simulation setup of a high speed OFDM-RoF transmission links.

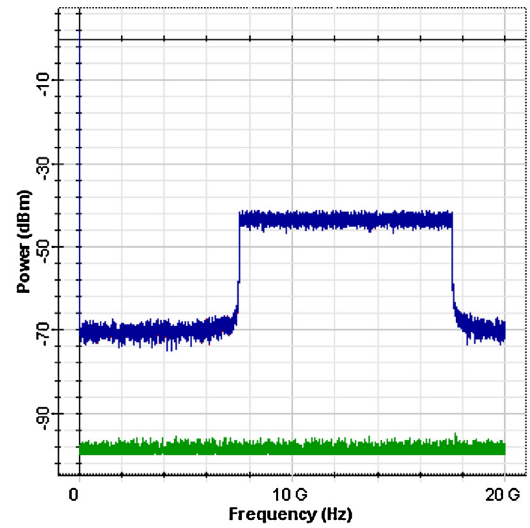


(a)

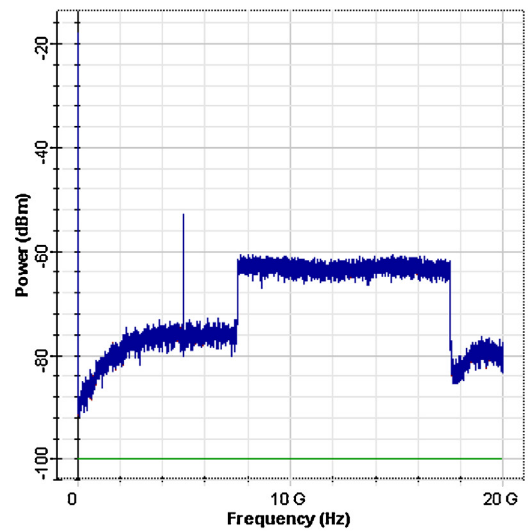


(b)

Fig. 2. Electrical and optical spectrum of (a) OFDM-RF mixed signal and (b) OFDM-RoF using SSB modulation scheme.



(a)



(b)

Fig. 3. Electrical spectrum of OFDM-RoF transmission links with (a) OSSB modulated data after optical span of 0 km and (b) OSSB modulated data after optical span of 50 km.

The electrical spectrum of OFDM analog signal after mixing with RF signal of 17.5 GHz is depicted in Fig. 2(a) while the optical spectrum optical single side band (OSSB) treated with OFDM-RoF after MZM is depicted in Fig. 2(b). The Electrical spectrum of OFDM-RoF transmission links with OSSB modulated data after optical span of 0 km is depicted in Fig. 3(a) while after optical span of 50 km is depicted in Fig. 3(b).

3. Results and discussion

For the sake of reference performance and better understanding of the benefits of the proposed scheme, we have started by characterizing the system without the SQRT module and then considering the SQRT module.

3.1. Case I: analysis of SSB-OFDM-RoF transmission link

The parameters used in this case are transmission length is set to 50 km, transmitter power − 4 dBm, attenuation = 0.2 dB/km, dispersion = 16.75 ps/nm/km.