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Analyzing Integrated Fiber-To-The-Home And Radio-Over-Fiber System

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Abstract:

FTTH and ROF are two promising techniques for future multi-service access network facilitating the transmission of both radio frequency and baseband signals on a single wavelength over a single fiber using mach-zehnder modulator. Signals suffer from a performance fading problem caused by fiber dispersion however can be removed by dispersion shifting fiber. The power penalties of both baseband and radio frequency are less than 0.2 dB after transmission over 50 km SMF, revealing the feasibility of the integrated FTTH and ROF system.

Our work on the RoF based FTTH system has brought in the advantages of optical fiber for carrying the radio signals facilitating the FTTH system possible. We have focused on the design and performance analysis of the system making use of the OptiSystem software.

Index Terms- Fiber-to-the-home (FTTH), Radio-over-fiber (ROF), Single mode fiber (SMF).

Introduction:

Broadband telecommunication system and high speed data rate demand of wireless and wired line are new services which are being offered in different packages using standard networks for several applications. FTTH and ROF are two promising candidates for wireless and wire line access network. Single shared infrastructure comprises of integration of two distributed networks that is the wireless and wire line access networks. Both RF and BB signals transmit on a single wavelength over a single fiber using one external modulator with acceptable performance. Simultaneous modulation and transmission of RF and BB signal has been demonstrated [1]-[4]. Signals suffer from performance fading problem by fiber dispersion [1]-[2]. Therefore, a dispersion-shifting fiber is used to compensate for the fiber dispersion, which is considered as one of the most powerful approaches to overcome this limitation and has been investigated intensively during the past few years. One of the best ways is to enable FTTH and ROF systems to share a single optical fiber network. ROF systems have been widely investigated due to advantages of optical fiber such as low loss, large bandwidth, and transparent characteristics for radio signal transmission. Hence, a simple and cost-effective modulation and transmission of the independent BB and RF signals without periodical performance fading due to fiber dispersion are required.

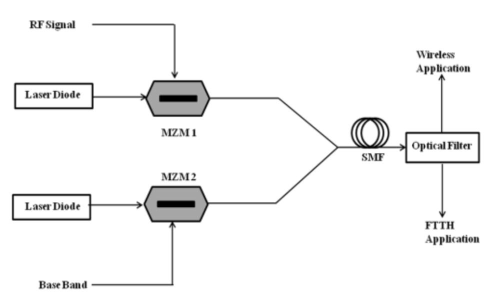

Fig.1

In this paper, simultaneous modulation and transmission of a 1.5-Gb/s ON-OFF-keying BB signal and 622-Mb/s ON-OFF-keying RF signal has been

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analyzed using one external integrated modulator. An external modulator is the key to electrical-to-optical conversion over a wide range. In the proposed system, RF signal does not suffer from performance fading problem. The power penalties of both RF and BB signals are less than 0.2 dB after transmission over 50 km SMF. This technique has potential for future FTTH access networks combined with wireless access supported by an ROF wireless feeder.

Simulation schematic:

Designed system has been simulated using simulation software Optisystem-11. Figure 2 shows the simulation schematic drawn in optiSystem-11 window using various in-built blocks provided by the software. Optisystem-11 is an advanced optical communication system simulation package designed for professional engineering. It can be used to design optical communication systems and simulate them to determine their performance given various component parameters. Optisystem-11 is designed to combine the greatest accuracy and modeling power with ease of use on both window and UNIX platforms. It includes the most advanced component models and simulation algorithms, validated and used for research documented in numerous peer-reviewed professional publications, to guarantee the highest possible accuracy and real world result. Simulation results that are produced by optisystem 9.0 include signal waveform plots and eye diagrams at any point within the system, and bit error rate (BER) plots. Other simulation results are also available including signal spectra, frequency chirp, power, dispersion map and more.

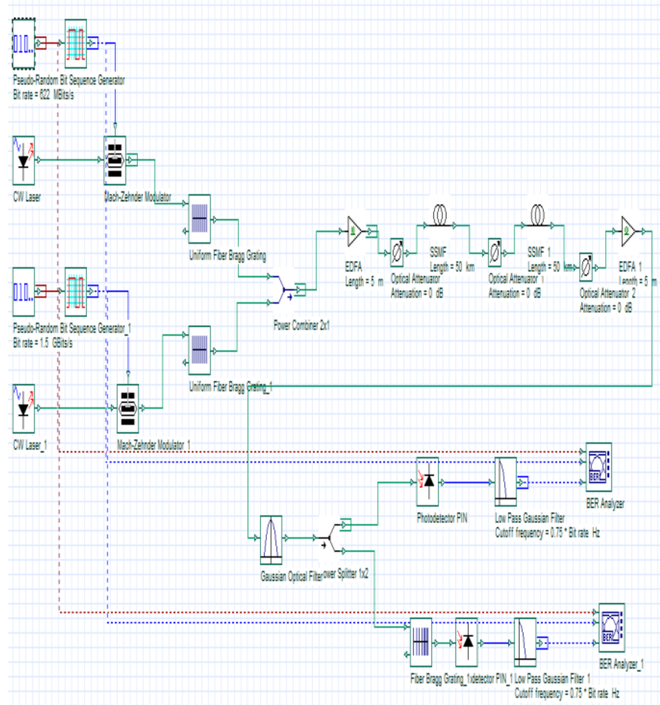

Fig.2 Experimental setup for RF and BB signal generation and transmission

Experimental Setup

Fig.2 shows the experimental setup for signal generation and transmission using mach-zehnder modulator (MZM). The continuous wave laser is generated lasing wavelength 1554.94 nm is injected into a polarization controller (PC) and then fed into a single-drive x-cut MZM with a half-wave voltage of 5.5 V. The RF signal is a 622Mbps pseudorandom bit sequence with NRZ pulse generator injected into the MZM (a). And the BB signal is 1.5Gbps NRZ pseudorandom bit sequence injected into the MZM (b). MZM modulate signal with a peak-to-peak voltage of 12.7 V. The MZM output of BB and RF signal combine in optical combiner. The optical signal are amplified by an erbium-doped fiber amplifier (EDFA) to compensate for the loss of the modulator, yielding power of 0dBm before transmission over 50km single mode fiber (SMF) and again transmission over 50-km with 0dB attenuation. Next 50km fiber is attached for distance increases, because

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100km SMF cannot be used. So two 50-km SMF are to be used with repeaters. Following transmission over 50km SMF, the optical signals are preamplified by EDFA and then filtered by optical filter with a bandwidth 0.4nm. At the remote node, the fiber grating with a 3-dB bandwidth of 4GHz is used to separate these two signals, and each signal is sent to the corresponding application.

Experimental Result:

The measured and simulated BER curves for FTTH and ROF applications as a function of the received optical power level for free running, free running refers to directly transmitted. To optimize the RF signal performance and the signal for driving MZ-a decreases form 0.6 to 0.1 and no BB signal are sent to MZ-b biased at a minimum transmission point. RF signal take 0.6, 0.5, 0.43and0.1, and BB signal is fixed.

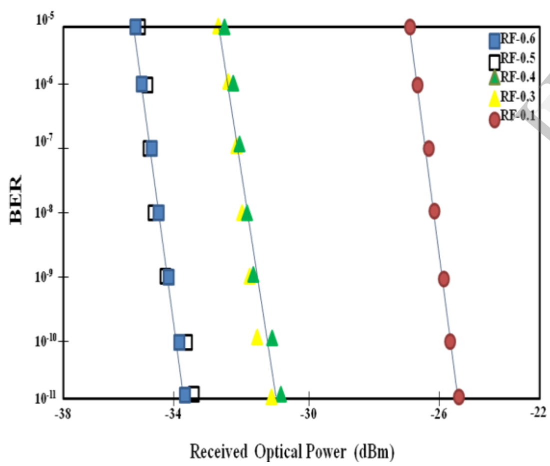

Fig.3 BER curves of RF signals from 0.6 to 0.1

Fig 3 shows the variation of the receiver sensitivity of the RF with different signal. The RF receiver sensitivity initially improves and then declines as the signals decreases from 0.6 to 0.1. As the RF signal decreases then MZM nonlinearity decreases. Hence RF sensitivity will improve.

To optimize the BB signals for driving MZ-b decreases from 1 to 0.18 and RF is fixed at a signal which exhibits the best sensitivity. The bias point of MZ-b is adjusted to maximize the extinction ratio of the BB signal, as the signal varies from 1 to 0.18. As the BB signal decreases same sensitivity of the RF and BB signals can be achieved. Under optimal conditions for driving MZ-a and MZ-b.

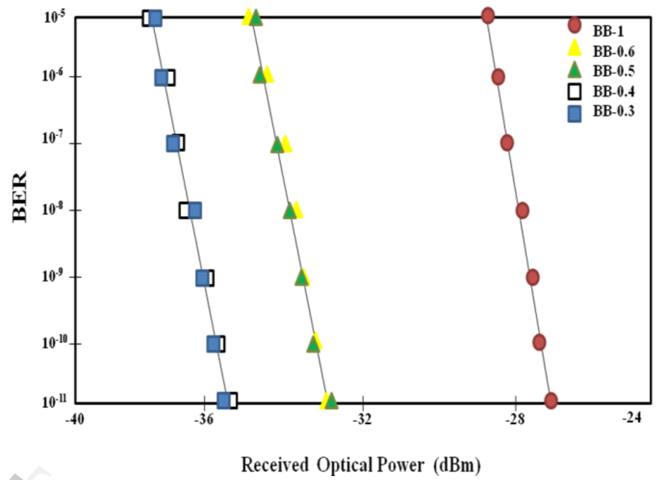

Fig4. BER curves of BB and RF signals from 1 to 0.18 with fixed RF.

The optical signals at an optical power of 0 dBm are transmitted over 25-km and 50-km SSMF. Fig. 5 plots the BER curves of the RF and BB signals. The power penalties of both signals at a BER of are less than 0.2 dB, as shown in Fig. 6.

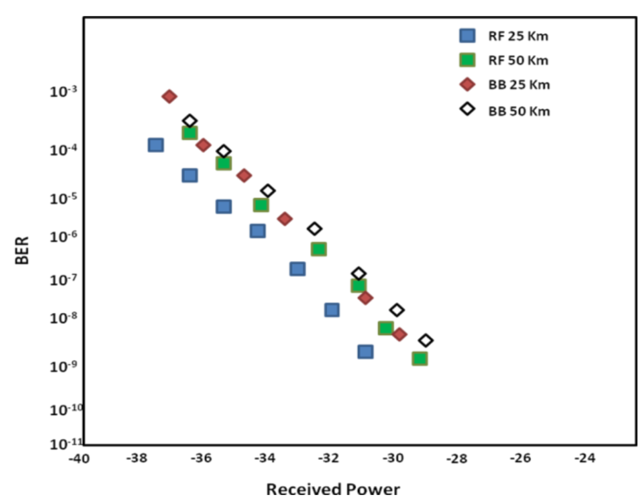

Fig.5 BER curves of both RF and BB signal following transmission over 25km and 50 km SMF.

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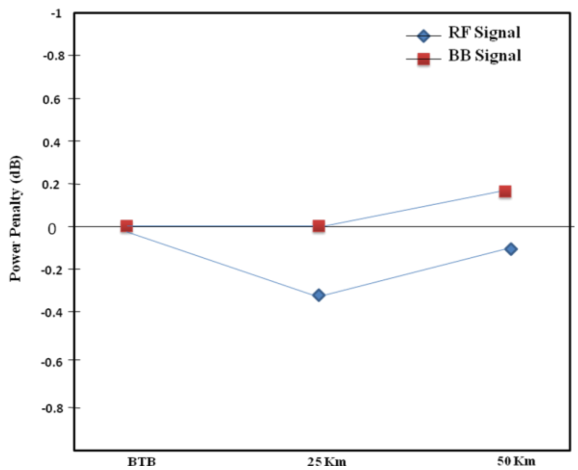

Fig.6 Power penalty of RF and BB signals following transmission over 25km and 50km.

Hence, this modulation overcomes the RF fading and has best receiver sensitivity.

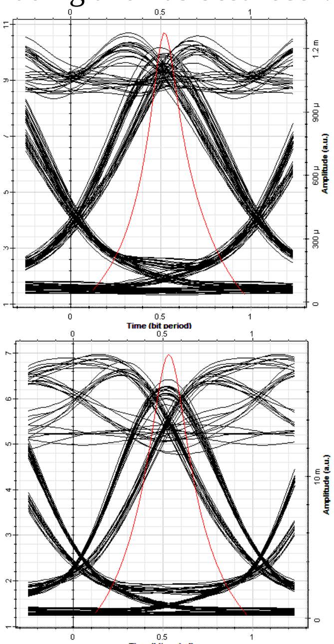

Fig 7(a) Received Eye diagram at 25km and 50km

Fig7 (a) show the Eye diagram, when RF signal is varied and BB signal is constant. This eye diagram show at 25km and 50km.

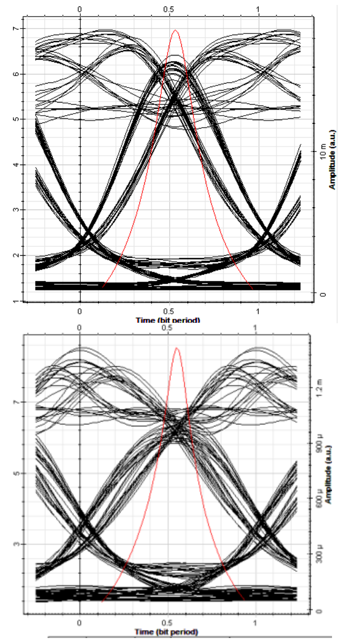

Fig 7(b) Received Eye Diagram at 25km and 50km

Fig7(b) eye diagram show at 25km and 50km, when BB signal is varied and RF signal is constant. This eye diagram gives a big opening which means that the intersymbol interference is low. Therefore, the interference between RF signal and BB signal is avoided.

Conclusion:

In this work, Fiber-to-the-home and Radio-over-fiber systems are facilitating the transmission of both radio frequency and baseband signals on a single wavelength over a single fiber using mach-zehnder modulator. Modulated signals suffer from a performance fading problem caused by fiber dispersion and it can be minimized by integrated dispersion shifting fiber. The power penalties of both baseband and radio frequency are less than 0.2 dB after transmission over 50km single mode fiber, revealing the feasibility of the system.

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