Overcoming Chromatic Dispersion Effects in Radio over Fiber System Using Optical Vestigial Sideband plus Carrier Signal

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1. Introduction

Analog Radio over Fiber (A-RoF) technology is being studied to support mobile fronthauls in Beyond 5G networks. It is well known that the optical double-sideband (DSB) signal experiences signal fading caused by fiber dispersion in A-RoF transmission. The signal fading can be eliminated if an optical single-sideband plus carrier (OSSB+C) signal is used [1]. In this study, using optical vestigial sideband plus carrier (OVSB+C) signal, we experimentally study the requirement of optical side-band suppression to overcome the signal fading during the transmission.

2. Experimental Setup

Fig.1 shows the experimental setup. At the transmitter, a 93.75 kBaud/s 16-QAM signal was modulated onto a microwave carrier of 2 GHz in a software-defined radio (SDR). The SDR output was upconverted to 10 GHz by mixing with an 8 GHz output of a local oscillator (LO). The up-converted signal was coupled into two phase-shifters (PS) using a 90-degree hybrid coupler. The optical carrier from a distributed feedback laser diode was modulated by driving a dual-drive Mach Zehnder modulator (DDMZM) by the two outputs of PSs and an OVSB+C signal was generated [1]. The optical sideband-suppression ratio (OSSR) of the modulator output was controlled by adjusting the PSs. To study the effect of fiber dispersion, the modulated optical signal was dispersed using a variable dispersion compensator (VDC). The value of dispersion was set to 635 ps/nm to induce maximum signal fading in ODSB+C signal. The dispersed signal was received by a photodiode. CNR fluctuations at radio receivers were emulated by varying the received optical power (ROP) using a variable optical attenuator (OATT). The received RF signal was down-converted and sent to the SDR to evaluate the bit error rate (BER).

3. Results

Microwave-carrier frequency dependence of the OSSR is plotted in Fig. 2. First, we adjusted the PSs so as to achieve the maximum OSSR at 10 GHz. Then, we varied the LO frequency. The maximum OSSR of 29.6 dB at 10 GHz degrades when the frequency deviates from 10 GHz. These OSSR degradations are due to the collapsed phase relation between two driving signals. Despite the degradation, OSSR was maintained above 15 dB in the measured range. BER of the received signal is plotted against the ROP in Fig. 3. The BER improves with ROP due to increased CNR. The highest BER is noticed for the ODSB+C signal due to fading. When the OSSR is decreased from 20 dB to 10 dB, the required ROP to accomplish the BER of 10^{-5} increases only by 2 dB.

4. Conclusion

We experimentally studied the impact of fiber dispersion-induced signal fading on OVSB+C signals. Our results show that the fading can be almost totally overcome with OVSB+C signals. To accomplish the BER of 10^{-5} when OSSR > 10 dB, ROP penalty was 2 dB at maximum. We also investigated the microwave-carrier frequency dependence of OSSR. OSSR above 15-dB was achieved over a 10-GHz bandwidth in the studied system.

References

[1] G. H. Smith, et al., IEEE Trans. Microw. Theo. & Tech., vol. 45, no. 8, 1410-1415, (1997).

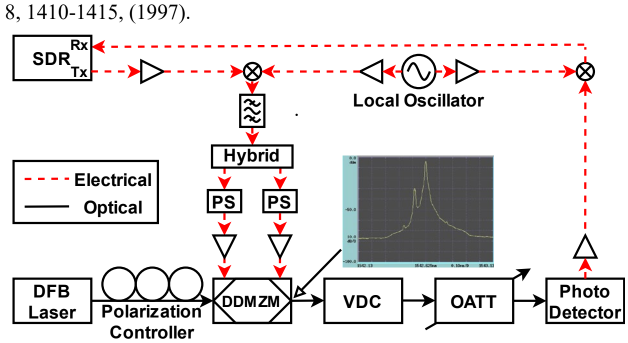

Fig. 1 Experimental setup.
(See text for abbreviations.)

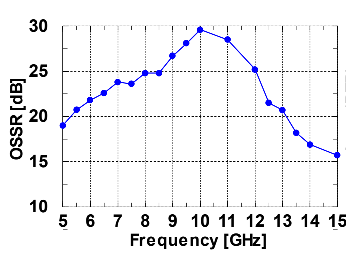

Fig. 2 Frequency dependence of OSSR

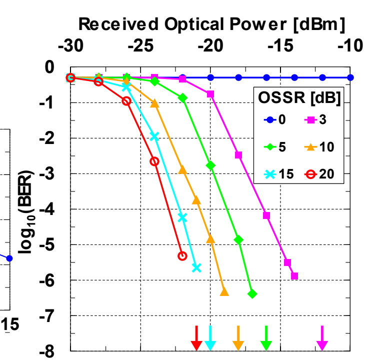

Fig. 3 ROP vs. BER.

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