Simulation of Modulation Depth Impact on Fiber Frequency Transfer

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Due to low loss characteristics of fibers, fiber-based frequency transfer techniques attract a lot of researchers. Frequency transfer requires the RF signal to be modulated to the optical carrier through a Mach-Zehnder modulator (MZM), and the RF signal is detected by a photodetector (PD). Increasing the power of optical signal incident on the PD can effectively improve the link gain. However, this approach will be limited by the power tolerance of the PD. In quadrature biasing modulation links, the optical carrier power does not contain any information but accounts for most of the total power[1]; therefore, increasing the modulation depth of the modulator is considered as a scheme to improve the frequency transfer metrics. Increasing the depth of modulation is thought to be a potential solution to enhance the performance of the instability of frequency transfer.

In this paper, we simulate the effect of different modulation depths on the frequency instability over a 640 km fiber link. Results show that the deeper the modulation depth is, the better the instability of the system is. When the modulation depth $m = 0.56$, the instability of the system is 4.3×10^{-14} @ $1s$, 7.8×10^{-17} @ $1000s$.

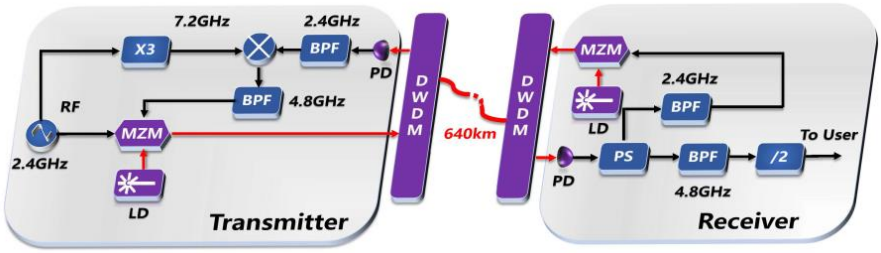

Fig. 1: The structure diagram of system. MZM: Mach-Zehnder modulator; PD: photodetector; LD: laser diode; BPF: bandpass filter; PS: power splitter.

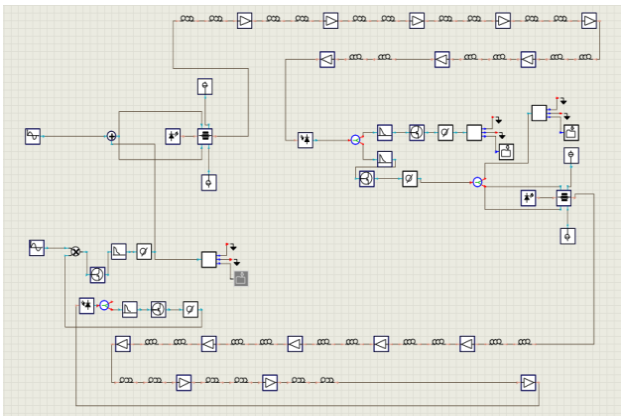

Fig. 2: The structure diagram of simulation system

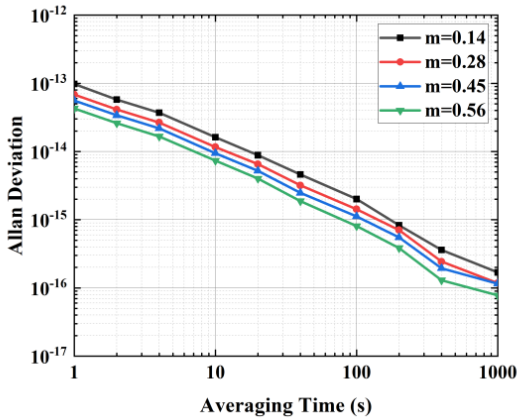

Fig. 3: Allan deviation at different modulation depth.

[1] Y. Fu, X. Zhang, B. Hraimel, T. Liu and D. Shen, "Mach-Zehnder: A Review of Bias Control Techniques for Mach-Zehnder Modulators in Photonic Analog Links," in *IEEE Microwave Magazine*, vol. 14, no. 7, pp. 102-107, Nov.-Dec. 2013, doi: 10.1109/MMM.2013.2280332.