Probabilistically Shaped PAM-8 for Few Mode IM/DD Links with a Training Sequence Aided CMA

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Introduction

In recent years, data traffic has exploded due to the rise of cloud services and high definition (HD) Video. Pulse amplitude modulation has received a lot of attention with a simple and low-cost scheme for short-reach application. On the other hand, compared with the traditional single-mode fiber, the space division multiplexing (SDM) technology has greatly increased the capacity limit.

In this paper, we experimentally investigate the performance of uniform and probabilistically shaped PAM-8 signals over 10-km 6-mode gradient index fiber. A training sequence aided constant modulus algorithm (TA-CMA) is proposed to equalize the signal impairments from the FMF channel. The experimental results indicate that the proposed TA-CMA can achieve a ~1dB receiver power gain at 7% overhead FEC threshold (3.8×10-3).

Principle

Typical constant modulus algorithm (CMA) is a common blind equalization algorithm, which is effective for constant modulus modulation. The signal points of non-modulus mode signals are not on the same ring, so different moduli are needed to equalize the signals on different rings. There are several cost functions given by radius-directed (RD) method in CMA algorithm for signals with multiple moduli. In this paper, the TA-CMA is proposed to overcome the dynamic characteristics and mode coupling in the few-mode links, which can improve the accuracy of error convergence. Fig. 1. illustrates the schematic of TA-CMA.

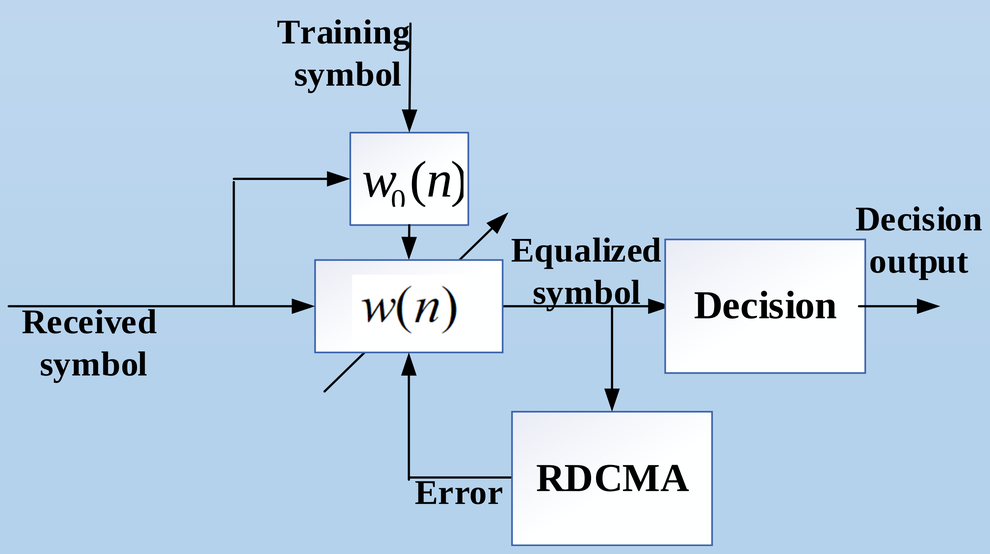

Fig. 1. the schematic of the training sequence aided constant modulus algorithm

Results and Discussions

From Fig. 2, it can be seen that the sensitivity of the receiver in two modes is improved at 7% HD-FEC overhead. After a transmission of 10km, the BER of the uniform PAM8 signal is reduced to 1.0×10-2 while received power is 6dBm. The performance of uniform PAM-8 is higher than FEC threshold within the range of received power we measured while that of PS-PAM-8 was lower than FEC threshold at 2dBm.Considering training, PS and 7% HD-FEC overhead, the net bit rate of PS-PAM-8 is 43.5Gbit/s.

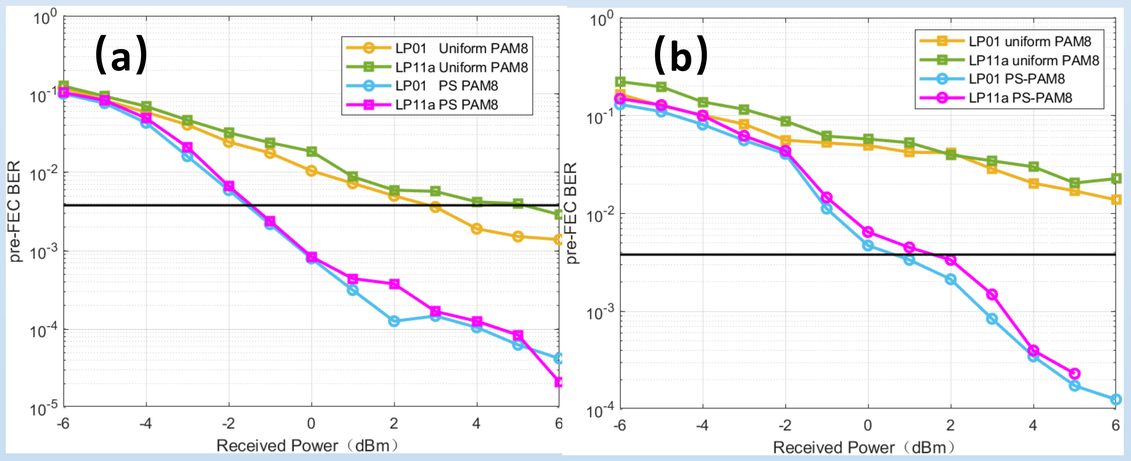

Fig. 2. Experimental results of PAM-8 with B2B (a) and after 10 km FMF transmission (b) for uniform and PS signal.

Fig. 3. shows the results of the experiment with or without TA-CMA in the B2B scenarios. The received power gain using TA-CMA is about 1dB for both two modes. As illustrated in Fig. 3(b), compared without TA-CMA when the received power is 3dBm, the signal amplitude with TA-CMA is more convergent.

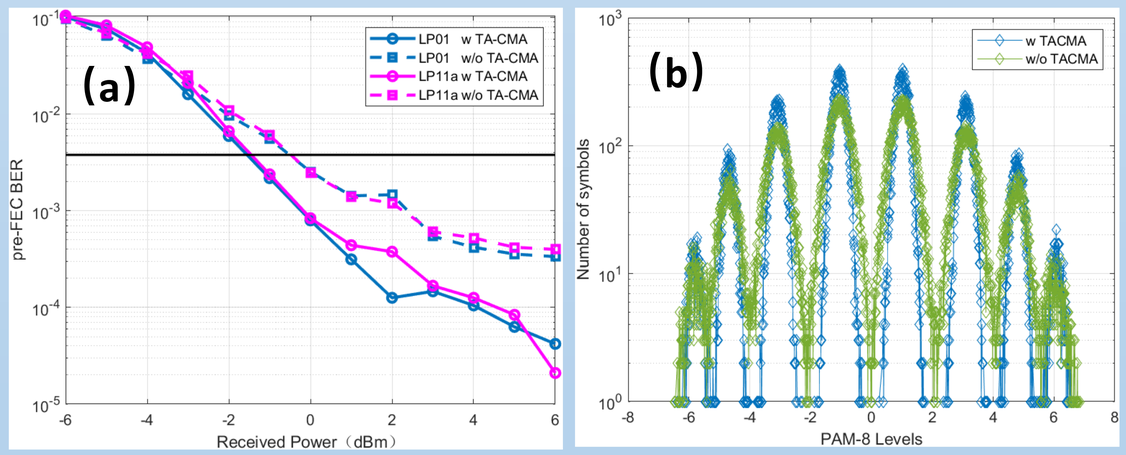

Fig. 3. (a)Experimental results of the experiment with or without TACMA in the B2B scenarios, (b)statistical graph of received signal with and without TA-CMA.

Conclusion

In this paper, the performance of 20GBaud uniform PAM-8 and PS-PAM-8 signals are experimentally demonstrated with pre-FEC BER performance over 10-km FMF (LP01/LP11a) based on a proposed training sequence aided CMA. The experimental results indicate that TA-CMA can achieve a ~1dB gain for receiver sensitivity at 7% overhead HD-FEC threshold, and the net bit rate of PSPAM-8 is 43.5Gbit/s.

Acknowledgements

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