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Experimental Demonstration of a 2×20G Baud MDM Transmission over 20km

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Introduction

With the popularity of internet services, it is necessary to increase the capacity of fiber optical transmission. To overcome the limit of standard single mode fiber (SSMF), Space-division multiplexed (SDM) transmission based on multi-core (MCF) or multi-mode fiber (MMF) is one of the most population solutions nowadays. The capacity of SDM transmission can be promoted by times with the increase of the cores and the spatial modes.

Experiment Setup

Figure 1 shows the experimental setup. At the transmitter, the light is emitted from an external cavity (ECL) at 1550nm with 100 kHz linewidth. The electronic signal generated from an arbitrary waveform generator with 65GSa/s was modulated by the 40GHz Mach–Zehnder modulator (MZM) to achieve electrical/optical conversion. Then the erbium-doped fiber amplifier (EDFA) is used to provide the power gain into the 1×6 optical coupler. The delay line is used to Resolve the correlation between modes.

Afterwards, the signals are coupled into the six-mode spatial-multiplexer (MUX). The transmission link consists of 2 unrepeated spans of 10km FMF and then we used a demultiplexer (DEMUX) to spilt the signals. The EDFA and a variable optical attenuator is used for adjusting the launched signal power into the 50GHz photodetector. Then a digital phosphor oscilloscope (Tektronix DPO72004C) with 100GSa/s and 20GHz bandwidth were used to receive the signal. We then processed the digitized signal offline using MATLAB.

The offline DSP is performed at receiver which includes low pass filter, time recovery, cascaded modulus algorithm (CMA), decision-directed least mean square (DD-LMS) algorithm and the BER calculation.

Modes	***LP01***	***LP11a***	***LP11b***	***LP21a***	***LP21b***	***LP02***
MUX1	1.44	1.48	1.6	2	3.05	5.19
MUX2	1.25	0.9	0.92	1.88	1.89	4.37

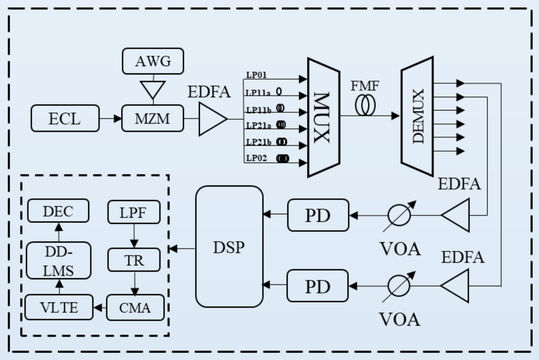

Fig. 1. Experiment Setup for the 2×20G baud/s PAM4 system.

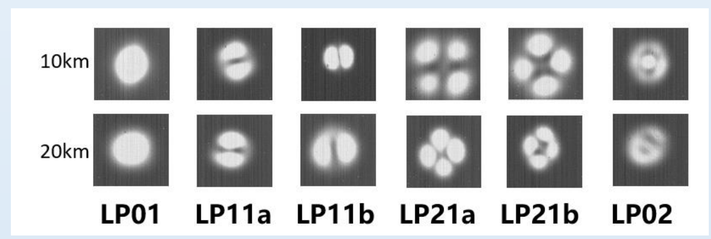

Fig. 2. The beam intensity distribution map after 10km and 20km.

Results and Discussions

Figure 3 shows the measured bit error rate (BER) curves versus received power in the 10 km 20G baud/s PAM4 system. It is worth noting that, BER decreases as the received optical power increases after 10km transmission. With the order of mode increases, the transmission performance will also decrease. For degenerate modes, the transmission performance shows a similar trend. Figure 4(a) demonstrated the measured BER curves versus Symbol Rate from 2GBaud to 20GBaud. Figure 4(b) demonstrated the relationship of transmission performance and distance. With the transmission distance increases, the crosstalk between degenerate modes will also increase, which will lead to the quality of the received signal deteriorate.

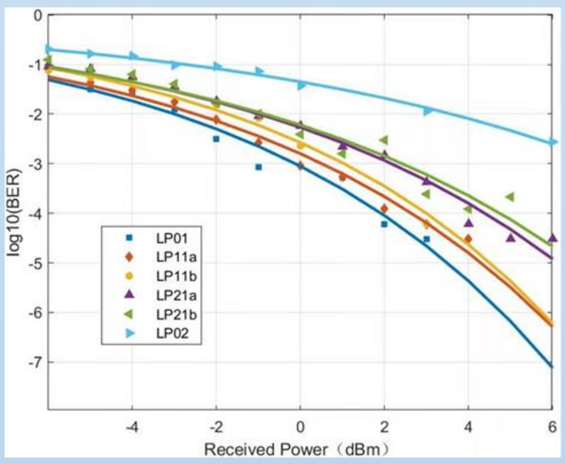

Fig. 3. Measured BER curves versus received power
in the 10 km 20G baud/s PAM4 system.

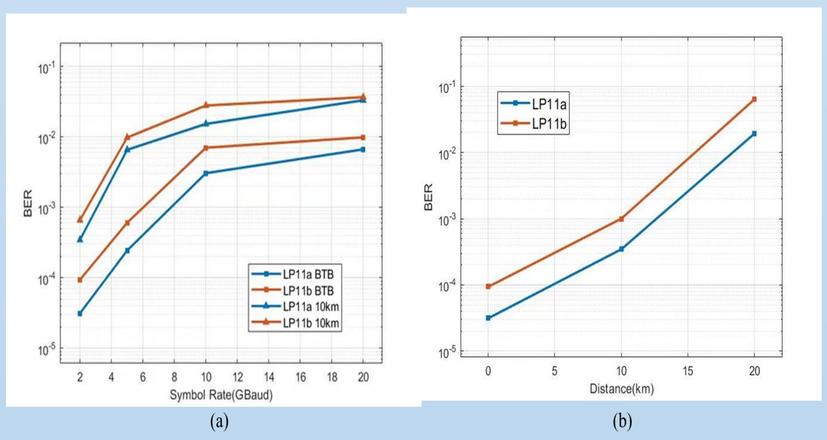

Figure 4. Results of 2×20G baud/s PAM4 system (a) Measured BER curves versus Symbol Rate. (b)Measured BER curves versus distance.

Conclusion

In this paper, we experimentally demonstrate a 2×20G Baud PAM4 Transmission over 20km.The joint algorithm is proposed which is composed of CMA and DDLMS. The result shows that the BER can be reduced to 1.0×10-3 with the joint composed of CMA and DDLMS while received power is 0dB. We also discussed the effect of symbol rate and transmission distance on the performance.

Acknowledgements

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