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Pre-distortion of Coherent Transmitter Components Using Feedback from Far End Receiver

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Introduction

Digital pre-distortion (DPD) has emerged as a powerful digital signal processing (DSP) technique to mitigate the linear and non-linear effects of high baud rate and higher order modulation formats coherent systems. We present a DPD technique, which relies on optical feedback signal from far end receiver and compensates for transmitter frequency response and I/Q skew.

Experimental Setup

The proposed DPD is based on the method published in [2], but we do not assume a B2B transmission. The RX is located at the far-end. Fig. 1 shows the link setup used in the experiments. DP 16-QAM/64QAM signals are sent over the link. At the RX, the signals are coherently demodulated using intradyne detection. After suitable RX DSP consisting of CD-compensation, clock recovery and carrier frequency offset compensation, the signals are fed back to the transmitter. In a real system, the feedback data can be sent over an established feedback channel. At the TX, the signals are first sent through a polarization de-multiplexing block and then to a DPD block where DPD is performed as explained in [2].

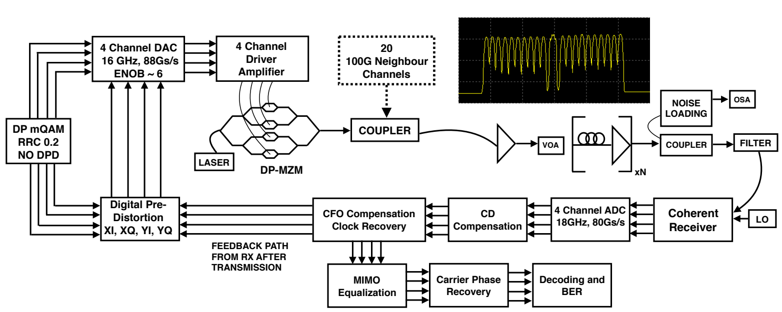

Fig. 1. DPD link setup

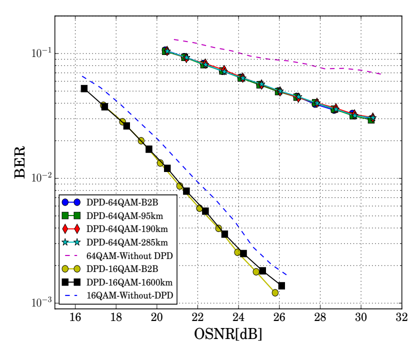

Fig.2 BER vs OSNR

Experimental Results

Fig. 2 shows the BER vs OSNR results for the proposed technique. Two cases for DP-16QAM/DP-64QAM over various link configurations are plotted. It is clear from the results that the performance of the transponder is independent of for which link configuration DPD was evaluated. In all the configurations, the calculated DPD coefficients deliver similar performance.

TX I/Q skew information can be measured from the calculated DPD coefficients.

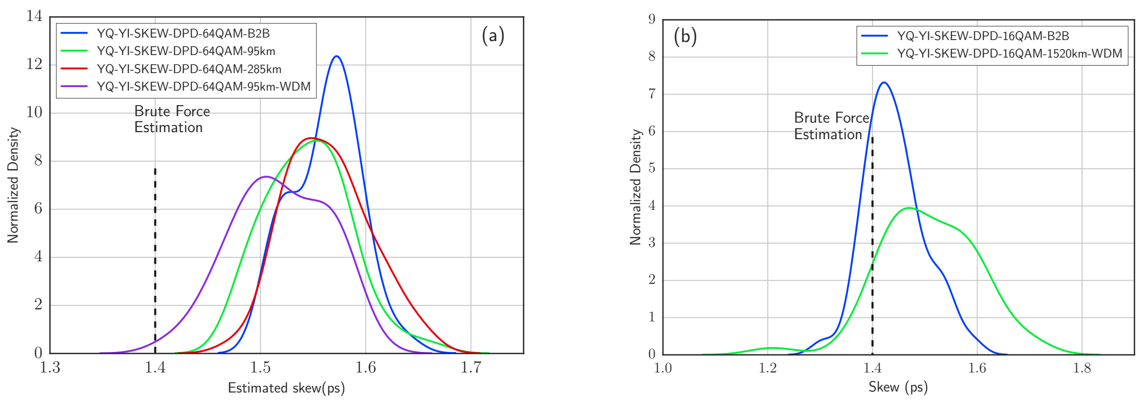

Fig. 3(a) Histogram of the TX I/Q skew estimates over various link distances for (a) DP-64QAM 400 Gb/s and (b) DP-16QAM 200 Gb/s.

To assess the accuracy of the estimation of the TX I/Q skew we performed 50 DPD runs under the same conditions listed above for DP-64QAM and DP-16QAM. TX I/Q skew information is calculated from the corresponding DPD coefficients. We computed the histogram with bin size of 0.01 ps of the estimated TX I/Q skew from data collected over the DPD runs for each scenario. The dashed line shows the result of a brute-force search, in which sweeping the I/Q skew and minimizing the BER found the optimum TX I/Q skew.

All the density estimate curves practically overlap .The mean skew value for all the cases, as estimated by the DPD algorithm, is between 1.5 ps and 1.6 ps. As expected, the standard deviation of 0.03 ps is smallest in the B2B case and increases to a value of 0.04 ps in case of DPD over fiber and WDM. The estimation of TX I/Q skew suffers the most in the case of DPD performed with DP-16QAM over 1520 km, as shown in Fig. 3b.

Conclusion

The proposed DPD scheme is capable of compensation of transmitter frequency response and I/Q skew without any prior measurements and can be dynamically implemented at time of system setup.

References

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[2] G. Khanna et.al, “A robust adaptive pre-distortion method for optical communication transmitters,” *IEEE Photon. Technol. Lett.*, vol. 28, no. 7, pp. 752–755, Apr. 1, 2015.