100 Gbps DP-QPSK System with Digital Signal Processing

Manufacturer: Optiwave Simulation Tool: OptiSystem Sample Reference: 100 Gbps DP-QPSK System with DSP.osd

Abstract

The combination of polarization-multiplexing and quadrature phase-shift-keying (PM-QPSK or DP-QPSK) is emerging as one the most promising solutions to reach bit rate of 100 Gbps and higher. At the receiver end, the use of digital signal processing (DSP) results in significant deployment improvement over the traditional implementation. This demo shows a practical design example of a 100 Gbps DP-QPSK transmission system using coherent detection with digital signal processing for distortion compensation.

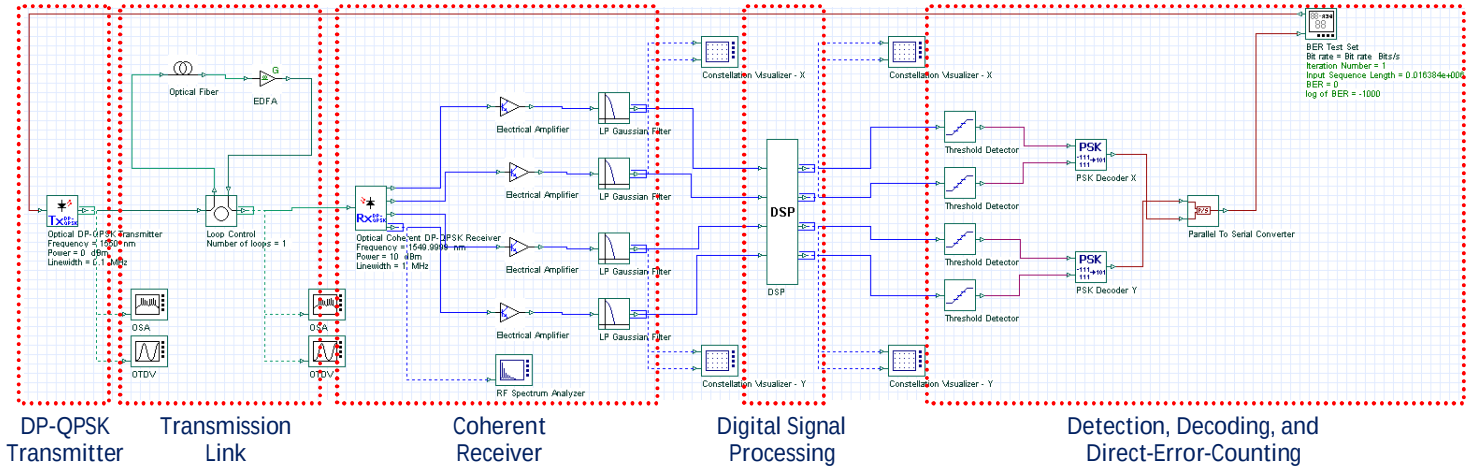

Fig. 1: 100 Gbps DP-QPSK system configuration

The above 100 Gbps DP-QPSK system can be divided into five main parts: DP-QPSK Transmitter, Transmission Link, Coherent Receiver, Digital Signal Processing, and Detection & Decoding (which is followed by direct-error-counting). The signal is generated by an optical DP-QPSK Transmitter, and is then propagated through the fiber loop where dispersion and polarization effects occur. It then passes through the Coherent Receiver and into the DSP for distortion compensation. The fiber dispersion is compensated using a simple transversal digital filter, and the adaptive polarization demultiplexing is realized by applying the constant-modulus algorithm (CMA). A modified Viterbi-and-Viterbi phase estimation algorithm (working jointly on both polarizations) is then used to compensate for phase and frequency mismatch between the transmitter and local oscillator (LO). After the digital signal processing is complete, the signal is sent to the detector and decoder, and then to the BER Test Set for direct-error-counting.

Fig. 2(a) shows the optical spectrum of the generated 100 Gbps DP-QPSK signal after the transmitter, and Fig. 2(b) shows the RF spectrum obtained after the Optical Coherent DP-QPSK Receiver.

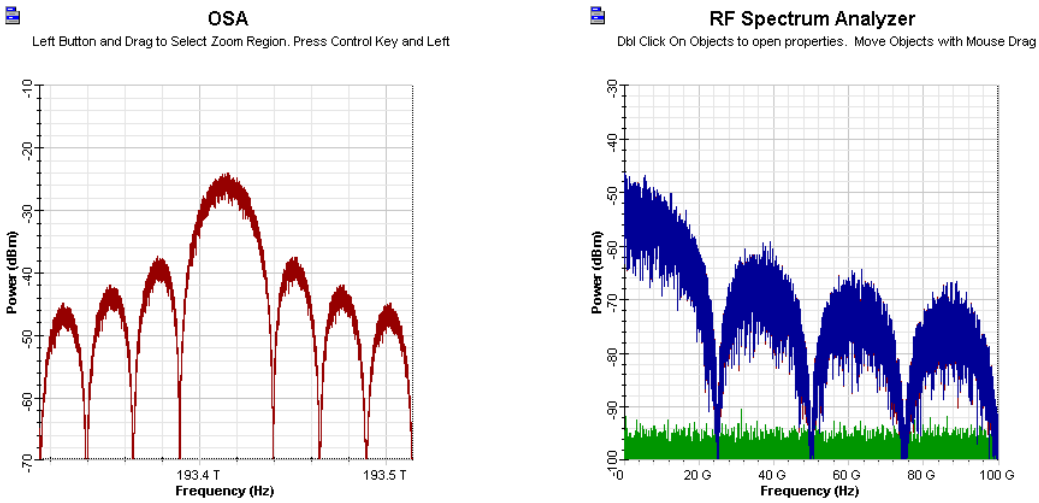

Fig. 2: (a) Optical spectrum after the DP-QPSK Transmitter (b) RF spectrum obtained after the Coherent DP-QPSK Receiver

The inner structure of the DSP module is shown in Fig. 3:

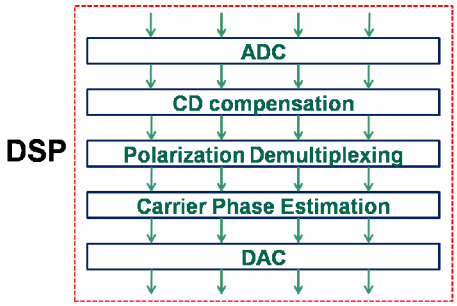

Fig. 3: DSP module (ADC: Analog-to-digital converter, CD: Chromatic dispersion, DAC: Digital-to-analog converter).

The electrical constellation diagrams (for polarization X) before and after the DSP are shown in Fig. 4:

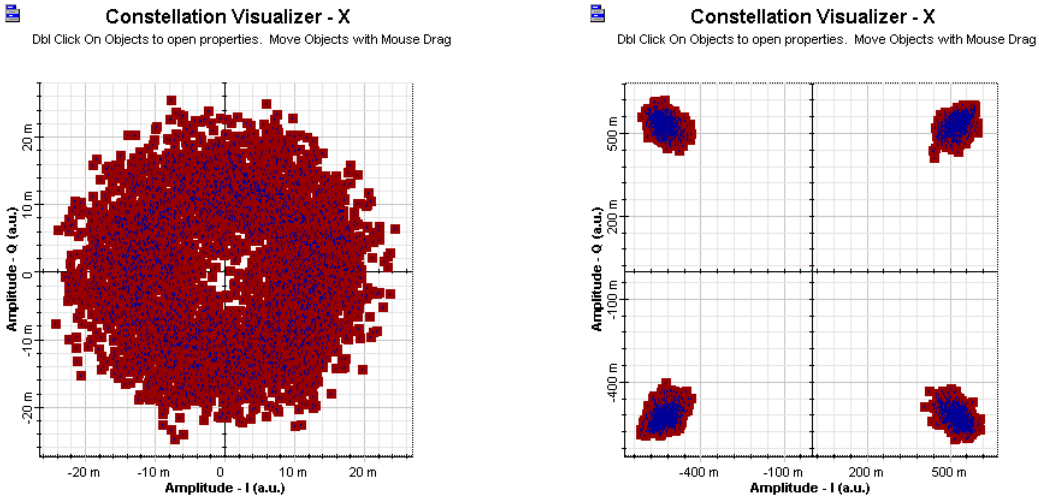

Fig. 4: Electrical constellation diagrams (a) before and (b) after the DSP (for polarization X)

The algorithms used for digital signal processing are implemented through a Matlab component. By setting the Matlab component to debug mode, the generated electrical constellation diagrams after each step (CD compensation, Polarization Demultiplexing, and Carrier Phase Estimation) are shown in Fig. 5.

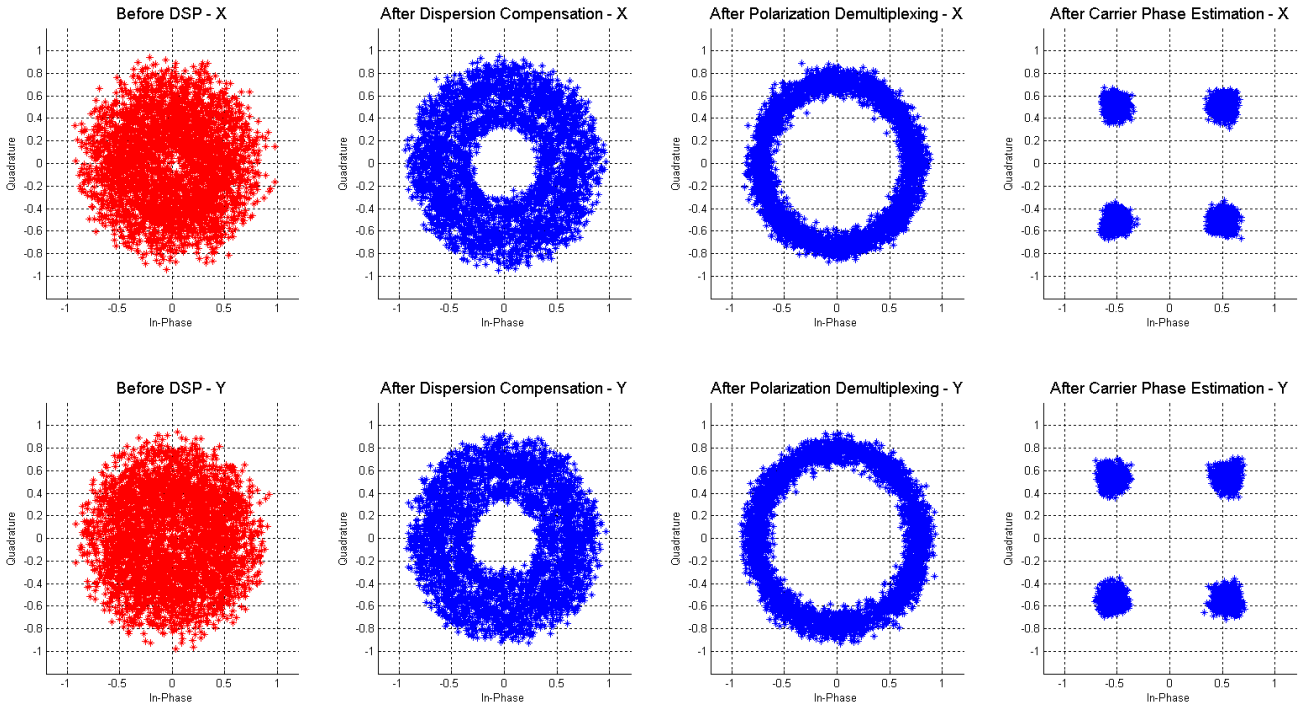

Fig. 5: Electrical constellation diagrams obtained during the calculation of the DSP