to track both the phase and polarization of the signal, allowing for a considerable reduction in complexity compared to an optical homodyne receiver. The functionality of the phase and polarization diverse coherent receiver is to map in the optical field into four electrical signals, corresponding to the in-phase and quadrature field components for the two polarizations. This may be achieved practically using a number of options, ranging from more complex options such as the passive quadrature hybrid with balanced detectors to fused fiber couplers with single ended photodiodes as illustrated in Fig. 1.

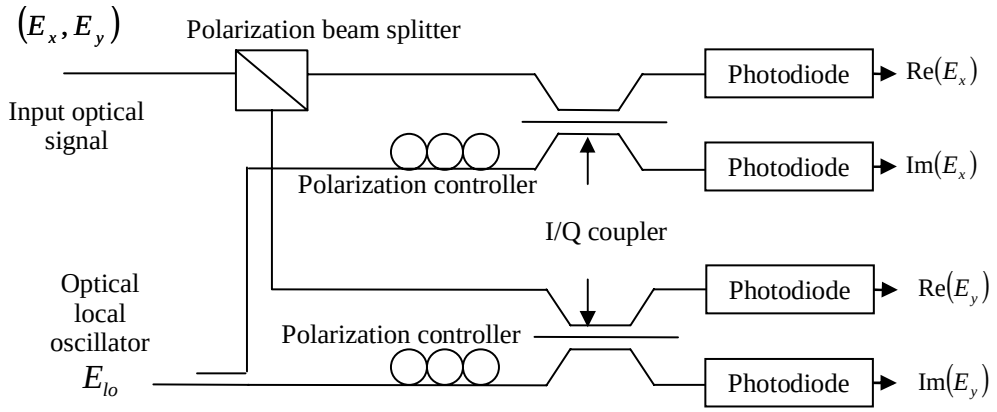

Fig. 1. Schematic of a phase and polarization diverse receiver where E_x, E_y and E_{lo} are the electric fields associated with the horizontal and vertical polarization components of the input optical signal and local oscillator respectively

The exact details of architecture chosen to implement the phase and polarization diverse receiver will have little bearing on the subsequent DSP. Therefore without loss of generality, as in our previous experimental work[8], we consider the architecture illustrated in Fig. 1, in which asymmetric 3x3 fiber couplers are employed as 90° hybrids, such that the four electrical signal are given by

$$\begin{pmatrix} i_1 \\ i_2 \\ i_3 \\ i_4 \end{pmatrix} = \frac{2}{5} \underbrace{\begin{pmatrix} \mathrm{Re}\left(E_x E_{lo}^*\right) \\ \mathrm{Im}\left(E_x E_{lo}^*\right) \\ \mathrm{Re}\left(E_y E_{lo}^*\right) \\ \mathrm{Im}\left(E_y E_{lo}^*\right) \end{pmatrix}}_{\text{coherent terms}} + \frac{1}{10} \underbrace{\begin{pmatrix} 2|E_x|^2 + 2|E_{lo}|^2 \\ 4|E_x|^2 + |E_{lo}|^2 \\ 2|E_y|^2 + 2|E_{lo}|^2 \\ 4|E_y|^2 + |E_{lo}|^2 \end{pmatrix}}_{\text{direct detection terms}} \tag{1}$$

The directly detected local oscillator power may be removed using a DC block, and the remaining terms may be minimized by ensuring that the ratio of the local oscillator to the signal is significantly larger than the signal to noise ratio of interest. In practice for systems which employ forward error correction (FEC) this corresponds to an LO/signal ratio in the region of 20dB.

2.2 Outline of the digital signal processing

The role of the digital signal processing is to reconstruct the transmitted data from the received signal, and has several stages such as those detailed in Fig. 2. The first three blocks for the signal processing, are fundamentally concerned with signal conditioning, such that after these blocks the four channels are synchronized with an integer number of samples per symbol, with the normalization and orthogonalization sub-block compensating for imperfections in the 90° hybrid and the variation of the responsitivity of the four photodiodes.

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