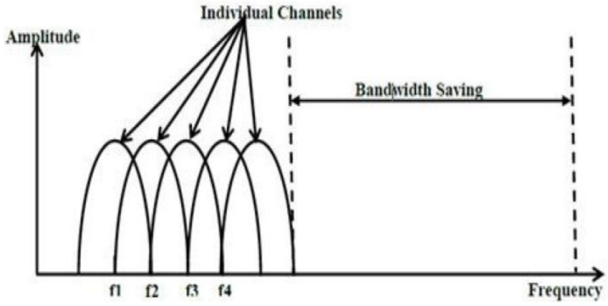

Figure 1: OFDM Spectrum

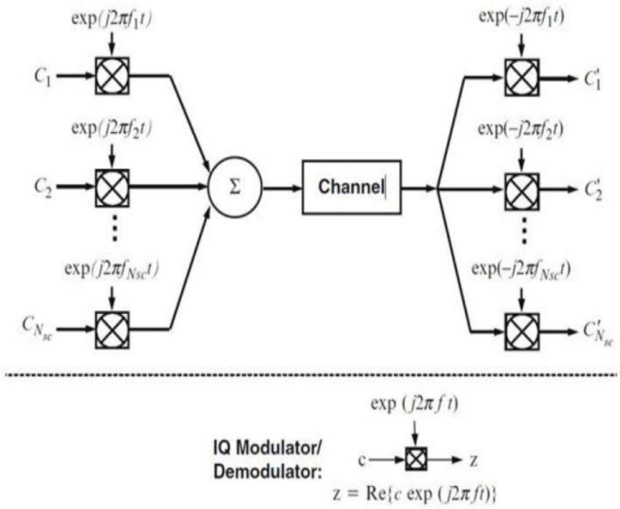

Figure 2: Conceptual diagram for a multi-carrier modulation (MCM) system

OFDM was introduced to optical domain in 2005, and has since been studied and investigated in two main techniques classified according to the detection scheme. The first technique is the direct detection optical OFDM (DD-OOFDM) and the second technique is the coherent optical OFDM (CO-OFDM).

2.3 Direct Detection Optical OFDM

A direct detection optical OFDM aims for simpler transmitter or receiver than CO-OFDMfor lower costs. It has many variants which reflect the different requirements interms of data rates and costs from a broad range of applications. DD-OFDM has anadvantage that it is more immune to impulse clipping noise.Figure 3 shows the block diagram of the DD-OFDM system which consists of a DD-OFDM transmitter, optical fiber link, and DD-OFDM receiver.

2.4 Coherent Detection Optical OFDM

Figure 4 shows the block diagram of CO-OFDM system. As can be seen fromthe figure, the CO-OFDM system is similar to the DD-OFDM system except for thereal/imaginary (I/Q) modulator and the local oscillator. An optical local oscillator is usedin optical coherent systems to generate optical signals at specific wavelengths. Accordingto the frequency of the local oscillator, the optical coherent detection can be classified intotwo categories, heterodyne detection and homodyne detection.

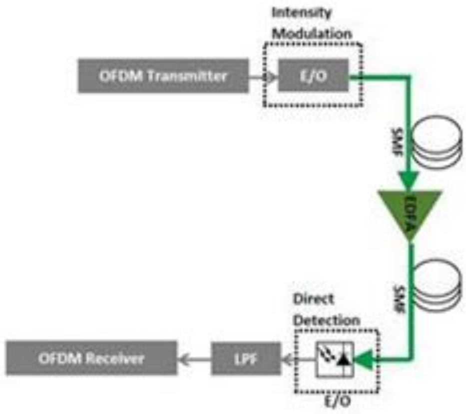

Figure 3: DD-OFDM Block Diagram

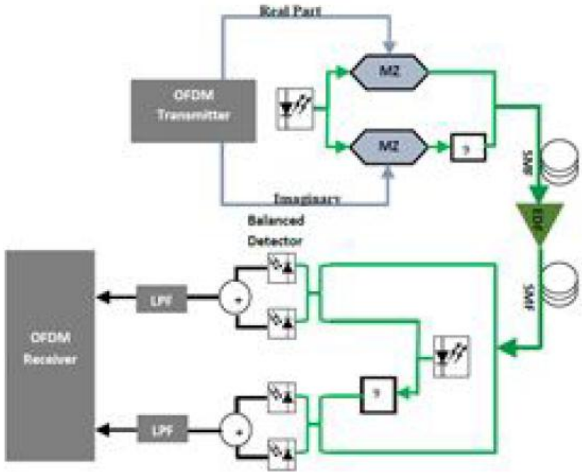

Figure 4: CO-OFDM Block Diagram

3. Simulation using Opti System

3.1 Transmitter

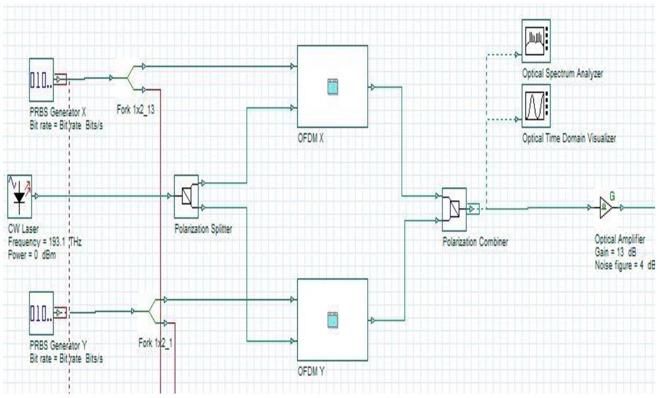

Figure 5: CO-OFDM Transmitter

Figure 5 shows the CO-OFDM transmitter design. The bit stream is generated by a PRBS generator and mapped by a 4-QAM encoder. The resulting signal is modulated by an OFDM modulator. After that, the resulting electrical signal is modulated to the optical signal using a pair of Mach-Zehnder modulators (MZM) which will be fed to the optical link.

3.2 Receiver

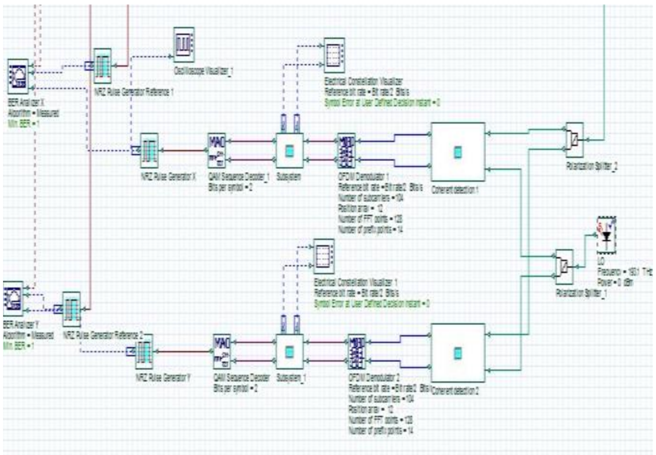

Figure 6: CO-OFDM Receiver

Figure 6 shows the CO-OFDM receiver design. To recover the I/Q component of the OFDM signal, two pairs of balanced PIN photodetectors and LO (Local Oscillator) lasers are used. The balanced detectors perform the I/Q optical to electrical detection and help perform the noise cancellation. Electrical amplifiers are used to adjust the signal intensity. After the balanced detectors the resulting signal is demodulated using the OFDM demodulator with similar parameters as the OFDM modulator, the guard interval is removed. After that the signal is fed into a 4-QAM decoder, and the BER is calculated at the end.

4. Simulation using OptiSystem

Figure 7 shows the variation of received optical power as the fiber length varies from 10 Km to 50 Km. The variation in power is due to the fact that the signal power decreases as it propagates over the fiber due to dispersion and other non-linear effects.

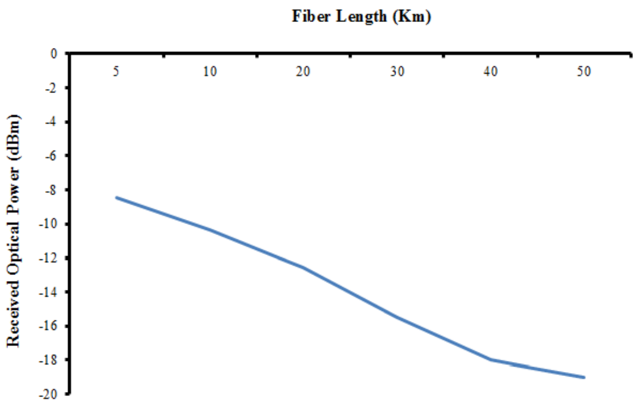

Figure 7: Received Optical Power versus Q-factor

Figure8 demonstrates that when transmission length increases, dispersion increases and the output BER increases. The output BER can be decreased by using an equalizer at the output.

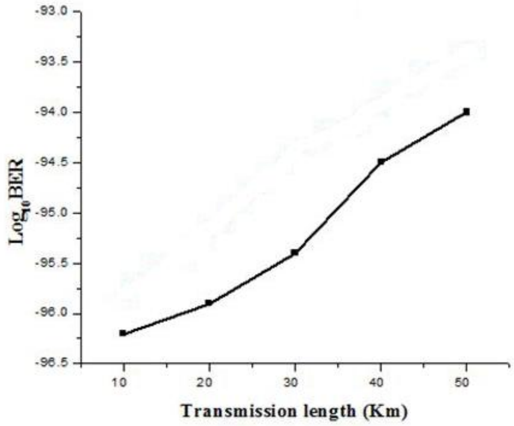

Figure 8: Log BER versus Transmission length

Figure 9 shows the variation of bit rate with Q-factor. As the bit rate increases the bits come close to each other, so the probability of dispersion to occur increases. Thus the value of Q-factor decreases

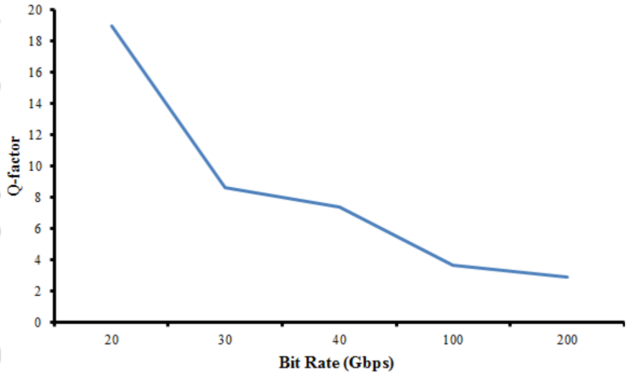

Figure 9: Bit Rate versus Q-factor

The performance of the whole system can be improved by using an equalizer, which can be a phase modulator, before the receiver section. The phase of the phase modulator can be adjusted to achieve better response.

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