Performance Evaluation of High Speed Coherent Optical OFDM System

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Abstract—Coherent optical orthogonal frequency division multiplexing (CO-OFDM) is really encouraging and superior technology to achieve high data rate in optical communication. In this paper, the performance of 100Gb/s CO-OFDM system using dual-polarize quadrature phase shift keying (DP-QPSK) modulation format over 360 km standard single mode fiber (SMF) is evaluated. It also evaluates the impact of parameters like fiber non-linearity, chromatic dispersion, laser linewidth and input optical power on the system performance. The use of DP-QPSK modulation format in coherent optical OFDM offers high spectral efficiency at the higher data rate. In this post-dispersion compensation technique is used to compensate dispersion in the optical channel using dispersion compensation fiber (DCF) which also greatly limits the non-linearity in fiber. The simulation result showed that laser linewidth below 1.2 MHz has better Q-factor. In addition, simulation gives BER less than $10^{-5}$ at the launching power below -10 dB. The performance evaluation of CO-OFDM system is a useful direction for the implementation of 1Tb/s Ethernet system.

Keyword—Optical OFDM, SMF, Coherent detection, Dispersion, DP-QPSK

I. INTRODUCTION

The concept of internet broadband services is marvelously growing. In the world of telecommunication, there are subscribers demand for greater speed and lesser cost broadband services. It is a challenge for researchers to provide a higher speed of these services at optimum cost. A typical communication system combining voice data, video, and other multimedia services requires faster transmission capacity and flexibility. Now a day we all are living in the era of “unambiguous connectivity” or “communication anywhere at any time when needed”. Recently, the telecommunication world and its applications like GSM and GPRS (2G system) realized quite low data rates [1]. For 2G data rate is 56Kb/s which uses Global System for Mobile Communication (GSM) technology and for 2.75G data rate is 236.8 Kb/s uses Enhance Data Rate for GSM Evolution (EDGE) technology [2]. In 3G system like WCDMA data rate up to 140 Mbp/s [2] are also not very satisfactory as it has a large number of subscribers using internet broadband services for a variety of applications such as banking, paying electricity bills, mobile dish TV recharges, video conferencing and social communication required fast broadband services.

One of the solution to meet massive expected demand is to improve communication system, evokes a new idea of optical Orthogonal Frequency Division Multiplexing (OFDM) with coherent detection, is referred as coherent optical OFDM or CO-OFDM technique. The optical communication system has numerous advantages like as very high bandwidth, low attenuation loss, immune to electromagnetic induction (EMI)& high flexibility. Coherent optical OFDM is integrated with quadrature phase shift keying (QPSK) which can provide a great spectral efficiency and significantly high data rate [3]. Nowadays using optical OFDM for long haul transmission has proven better than conventional single carrier modulation technique. Coherent optical OFDM is really promising solution to satisfy the huge demand of subscribers for next generation communication systems. Basically increasing the number of users will pose limitations on data communications i.e. speed is reduced due to increasing number of users; as a result, alarge high bandwidth is required. Thus, there is a possibility of Multiple User Interference (MUI) and Inter-
Symbol Interference (ISI), hence system complexity increases. The coherent optical OFDM technique has an objective to eliminate this issue. The performance of optical OFDM system is characterized using the bit error rate (BER); however the general BER for optical communication is $10^{-9}$. In CO-OFDM system fiber nonlinearity, phase noise and chromatic dispersion prominently limit the performance of OFDM signal owing to large peak-to-average power ratio (PAPR). There has a vibrant research on coherent optical OFDM technique to improve tolerance towards fiber nonlinearity [4], transmissions distance in long haul communication system [5] and reduce PAPR.

Optical OFDM system using standard single-mode fiber (SMF) is the preeminent way to achieve linearity between input transmitter inverse Fast Fourier Transform (IFFT) and output receiver Fast Fourier Transform (FFT) using linear field modulation [6]. In this radio-frequency(RF) subcarrier is map onto an optical carrier and transmitted over an optical link to facilitate the wireless transmission. At thereceiver,light signal can either be detected directly or coherently. Based on this detection scheme optical OFDM is further classified in two categories, first direct detection optical OFDM is referred as DDO-OFDM and second coherent optical OFDM is referred as CO-OFDM. In DDO-OFDM single sideband field modulation is used to compensate issue regarding chromatic dispersion (CD) [4]. The advantage of DDO-OFDM is simple receiver have low cost, but it needed more transmitted optical power and some of the optical frequencies must be unused result in reduced spectral efficiency [6]. In CO-OFDM system locally generated carrier signal and received signal is mixed while at the receiver local carrier signal is generated using a laser. The main drawback of this system is fiber nonlinearity which affects the sensitivity of CO-FDM system. Non-linearity in optical channel is reduced to acertainextent with the help of Volterra model. In Volterra model the orthogonization techniques in modified Gram-Schmidt method helps in reducing fiber non-linearity [7]. Thus, both systems invoke new research field in optical OFDM and particularly in DDO-OFDM and CO-OFDM techniques to mitigate the disadvantages. In this paper, Simulink model of CO-OFDM system with DP-QPSK modulation format is developed at 100 Gb/s data rate over 360 km optical fiber link using OptiSystem™ simulation software. The performance of CO-OFDM system is analyzed by evaluating parameters like SNR, BER and effect of fiber nonlinearity on the system.

II. COHERENT OPTICAL OFDM

The synergies of a coherent optical communication system with OFDM technique have benefits due to two powerful techniques amalgamation in optical communication. The coherent optical communication system maintains both the signal amplitude and phase, hence bandwidth utilization increases. There is ease of channel and phase estimation due to OFDM technique, nevertheless coherent optical communication system brings linearity needed for OFDM in RF-to-optical up conversion and optical-to-RF down conversion [8]. Both CO-OFDM and RF-OFDM are quietly similar except nature of carrier in this system. In CO-OFDM system, the coherent receiver is used to map optical subcarrier 1:1 with electrical subcarrier [12].

2.1 Principle of coherent optical OFDM.

The crucial assumption CO-OFDM system is linearity in modulation and demodulation while the linear transformation for OFDM implementations is the focal aim of OFDM. Conceptual block diagram of typical CO-OFDM system is shown in Fig.2. The CO-OFDM system is divided into five basic building blocks as follow: (1) RF Modulator (2) RF-to-optical up conversion or I & Q modulator (3) Optical channel (4) Optical-to-RF down conversion or I & Q demodulator (5) RF Demodulator. In RF modulator block first data is converted into serial to a parallel stream. These multiple branches are equal to a number of subcarriers used in OFDM. The modulation formats used are binary phase shift keying (BPSK), quadrature amplitude modulation (QAM), QPSK to mapped converted signal onto this modulation format. The output of the modulator is fed into IFFT block is used to convert the frequency domain signals into the time domain, at the output of this block is a superposition of the entire modulated signal. The cyclic prefix is inserted in this to avoid the channel
dispersion. A pair of adigital-to-analog converter (DAC)is used to convert the signal from digital to analog form; while low pass Gaussian filter (LPF) is used to avoid antialiasing effect in the signal. In RF-to-optical up-conversion laser diode with two Mach-Zender modulators (MZM) and 90° phase shifter is used to mapping RF carrier onto the optical carrier to facilitate transmission. It is impossible to modulate high-frequency signal directly using a laser diode. Therefore, MZM is used for controlling the amplitude of the optical wave. The main advantage of use MZM modulator is avoiding chirp in high-frequency signal.

Fig. 2. Conceptual block diagram of CO-OFDM system

LD: Laser Diode PD: Photo Diode MZM: Mach-Zender Modulator
DCF: Dispersion Compensation Fiber

In Optical channel, erbium-doped fiber amplifier (EDFA) is widely used for in-line amplification of the signal in optical communication. It provides high power transfer efficiency and independent from data rate. Optical channel use standard single mode fiber (SMF) with dispersion compensation fiber (DCF) to compensation of dispersion in the optical channel. DCF is having negative dispersion with the low positive slope. The coherent detection technique at receiver is capable of reproducing transmitted Inphase (I) and Quadrature (Q) signal at the receiver. The RF down conversion architecture of optical OFDM at receiver use two balanced pairsof opticalhybrids with optical 90° phase shifter to accomplish Inphase (I) and Quadrature (Q) detection as shown in Fig.2. In RF demodulator block the exact reverse process of RF modulation was performed to recover original information or data signal.

2.2 Orthogonality between OFDM subcarriers

In MCM single carrier is divided into multiple subcarriers which are modulated and transmitted in allocated passband. Available bandwidth ‘B’ for communication is divided into ‘Nsc’ number of subcarriers. Thus, transmitted MCM signal \( S(t) \) is given as [8,9],

\[
S(t) = \sum_{\substack{i=-\infty \pm 1}}^{N_{sc} - 1} \sum_{k=-\infty}^{\infty} c_{k} f_{k}(t - iT_{k})
\]  

(1)
Where $s_{kl}$ is the $i^{th}$ number of symbol at data transmitted in $k^{th}$ subcarrier, $f_k = B/N$ is central frequency of subcarrier, $T_s$ is the symbol period and $\prod(t)$ is pulse shaping function.

The classical MCM system uses non-overlap band limited signal and it requires a large number of modulators equally apply to demodulators and filters. The excessive bandwidth required for transmission is a major disadvantage of MCM system, because of this greatly reducing spectral efficiency [8,9]. OFDM overcome this problem. Orthogonality between any two subcarriers from straightforward correlation is given by,

$$
\delta_{kl} = \frac{1}{T_s} \int_0^{T_s} S_k S_l d\tau = \frac{1}{T_s} \int_0^{T_s} \exp(j2\pi (f_k - f_l)\tau) d\tau
$$

(4)

$$
\delta_{kl} = \exp(j2\pi (f_k - f_l)T_s) * \frac{\sin(\pi (f_k - f_l)T_s)}{\pi (f_k - f_l)T_s}
$$

(5)

‘$T_s$’ is symbol period. It can be seen in the following equation,

$$
f_k - f_l = m * \frac{1}{T_s}
$$

(6)

Orthogonality of two subcarriers is concluded when those two satisfies equation (1). It signifies that this orthogonal subcarrier can be recovered with matched filter without inter-carrier interference (ICI) [9].

### 2.3 Implementation of discrete fourier transform in OFDM

We rewrite equation (1) and equation (2) for one OFDM symbol,

$$
S(t) = \sum_{i=0}^{N-1} A_i * e^{(j2\pi (\frac{f}{N})t)}, 0 \leq t \leq T
$$

(7)

equation (3) represent baseband OFDM signal in complex form. Thus, this baseband OFDM signal is sample by sample rate 1/T and normalization factor 1/N, then

$$
S_n = \frac{1}{N} * \sum_{i=0}^{N-1} A_i * e^{(j2\pi (\frac{i}{N})n)}, \quad n = 0, 1, ..., (N - 1)
$$

(8)

Where, $s_n$ is the $n^{th}$ time domain sample. This equation is same as inverse discrete fourier transform (IDFT). Similarly, the original symbol recuperated by discrete fourier transform (DFT) at the receiver side is given as,

$$
A_i = \sum_{n=0}^{N-1} R_n * e^{-j2\pi (\frac{i}{N})n}, \quad n = 0, 1, ..., (N - 1)
$$

(9)
Where $R_n$ is the $n^{th}$ received sample signal and $A_i$ is the received information symbol for the $i^{th}$ subcarrier. The advantage of DFT and IDFT implementation in OFDM is that the implementation using FFT and IFFT algorithm. Therefore, the number of complex multiplications is reduced and computational complexity is also from $\frac{N^2 \log_2 N}{2}$ to $\log_2 N$ [8,9]. There is no need of large number of modulator, demodulator, and filters for modulation and demodulation of number of orthogonal subcarriers at both transmitter and receiver side. Hence there is convenient implementation using IFFT and FFT.

### 2.4 Cyclic prefix

The cyclic prefix merely signifies that is the information which periodically repeat itself. In OFDM orthogonal subcarrier is modulated and demodulated via IFFT and DFT, for good performance of optical OFDM it is important to reduced dispersive channel effect such as chromatic dispersion and polarization mode dispersion (PMD). In order to enable this scheme in OFDM technique, cyclic prefix insert in guard interval [8,9]. OFDM has large symbol duration ‘$T_s$’ as compared to the impulse response of channel ‘$\tau_{\text{max}}$’, it causes ISI. Thus, to reduce the amount of ISI addition of guard interval larger than the estimated delay spread ‘$t_d$’. If the guard interval is empty, orthogonality between the OFDM subcarriers is lost. Hence, it caused inter-channel interference (ICI). To prevent the OFDM symbol from ISI and ICI, OFDM symbol is “cyclically extended” into guard interval. The for ISI free transmission of OFDM signal is given by following condition [8,9],

$$t_d < \Delta G$$  \hspace{1cm} (10)

The goal of the cyclic prefix is to eliminate the channel dispersion induced by ISI and ICI. In fig.1 (a) it shows that two OFDM symbol are transmitted without cyclic prefix at the transmitter. In fig.1 (b) represent cyclic prefix inserted into guard interval (\(\Delta G\)) by cyclic extension of OFDM waveform at the transmitter. In cyclic prefix insertion, last few samples or symbol in time domain segment of OFDM symbol is copy and inserted into guard interval is illustrated in fig.1 (b). Time domain representation of OFDM signal is shown in fig.1 (c). It expresses complete one OFDM symbol with cyclic prefix. Frequency domain information of symbol will be recovered using waveperiod in the observation time. Insertion of a cyclic prefix in OFDM reduced asignificant amount of energy loss and multipath are resolved. The addition of cyclic extension in guard interval of CO-OFDM system brought benefits it makes system robust against ISI and PMD.
Fig.1 (a): Transmission of OFDM symbol without cyclic prefix (b): Transmission of OFDM symbol with cyclic prefix (c): OFDM signal for one symbol in time domain

2.5 Spectral efficiency for CO-OFDM

Spectral efficiency of the system describes how many numbers of information bits can be embraced into given bandwidth. The conventional scheme of modulation like single carrier modulation has broad and leaky spectrum. Hence, there is leakage of energy. In CO-OFDM technique owing to its orthogonality property spectrum is rectangular, almost all energy is confined inside the rectangular spectrum and the tiny spectrum is left outside. Occupied spectrum by CO-OFDM is much narrower compared to the spectrum of conventional single carrier modulation. Hence, CO-OFDM has high spectral efficiency. The CO-OFDM system with high spectral efficiency is most efficient to implement higher order QAM modulation to achieve high data rate [14]. Therefore, CO-OFDM emerges as one of the attractive pathways in the direction of the 100 Gb/s and 1 Tb/s Ethernet transport [15].

2.6 Peak to average power ratio (PAPR)

PAPR is less for good optical OFDM system. The high value of PAPR is a major drawback of optical OFDM technique. In CO-OFDM system, OFDM modulation allows transmit data at high data rates through an optical link, nevertheless present of the high signal peak in OFDM causes signal distortion. This effect in optical OFDM system is known as PAPR. IFFT and FFT block in CO-OFDM system is accountable for PAPR. In optical OFDM system having a large number of subcarriers will result in have a large PAPR thus, PAPR is directly proportional to the number of subcarriers used for OFDM system. Therefore, to use a large number of subcarriers in OFDM is extremely difficult due to larger PAPR [10]. In optical systems, there is vivacious research on reduction techniques of PAPR for OFDM system. However, the PAPR still a challenge in optical communication owing to non-linearity in the optical fiber [9]. Signal clipping is most commonly used PAPR reduction technique for OFDM system. But due to clipping technique induced signal distortion cause degradation in system performance. Another technique is Pilot-Assisted PAPR reduction technique which is easier to reduce PAPR value by transmitting average optical power through OFDM system without degradation in system performance [11].
III. EXPERIMENTAL SETUP AND DESCRIPTION

In this paper, the Simulink model of DP-QPSK modulated CO-OFDM is simulated using a commercial optics fiber simulation tool, OptiSystem™. The simulation setup of the polarization multiplexed CO-OFDM system is shown in Fig.3. The simulation model consists two users i.e. user-1 and user-2 which supports to transmit two OFDM signals each of 50Gb/s to reach 100Gb/s data rate. The two OFDM signals for user-1 and user-2 are generated independently using Pseudo Random Bit Sequence (PRBS) generator; each signal is mapped in QPSK modulation format.

IFFT operation was performed to get digital time domain signal. The 128-points IFFT is used having 104 subcarriers and the guard interval is 1/8 of the symbol window. The baseband OFDM signals further process by the roll of cosine filter having roll factor is 0.25 to avoid the antialiasing effect. The laser diode with MZM modulatoris used to map I and Q form of RF OFDM signal onto an optical carrier. The laser diode is operated at 1552.52 nm wavelength (193.1THz central frequency) has linewidth is set at 0.1MHz with optimum launch power. This two RF OFDM signal is combine using polarization combiner and transmit over the optical channel to facilitate wireless transmission. The optical channel uses standard SMF fiber of length 360 km with DCF to compensate dispersion in the optical channel. The SMF and DCF have standard parameter shown in Table.2. The optical channel consists of three spans of 100 km standard SMF with 20 km DCF having dispersion coefficient as 16 ps/nm/km, -80/ps/nm/km and 0.2 dB, 0.6 dB attenuation loss respectively. Global parameters of simulation window have 8192 sequence lengths and 4 samples per bit thus, a total number of the sample is 32768. After the optical channel, Gaussian filter is used to remove the Gaussian optical noise in optical OFDM signal. In optical to RF down-conversion, the coherent detection technique is used to detect the optical signal at the receiver which converts the optical signal into electrical signal. Then RF OFDM demodulator is used to recover the original signal.

<table>
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<tr>
<th>Parameter</th>
<th>SMF</th>
<th>DCF</th>
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<tbody>
<tr>
<td>Dispersion</td>
<td>16 ps/nm/km</td>
<td>-80 ps/nm/km</td>
</tr>
<tr>
<td>Dispersion slope</td>
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<td>-0.45 ps/nm^2/km</td>
</tr>
<tr>
<td>PMD coefficient</td>
<td>0.2 ps/km</td>
<td>0.2 ps/km</td>
</tr>
<tr>
<td>Effective Area</td>
<td>80 um^2</td>
<td>30 um^2</td>
</tr>
<tr>
<td>Nonlinearity Coefficient</td>
<td>2.6 e10^-20</td>
<td>2.6 e10^-20</td>
</tr>
<tr>
<td>Attenuation</td>
<td>0.2 dB/Km</td>
<td>0.6 dB/Km</td>
</tr>
</tbody>
</table>
IV. RESULT AND DISCUSSION

4.1 Post-dispersion compensation

Post dispersion compensation technique is used to compensate the dispersion and fiber nonlinearity in the optical channel. In this technique, DCF fiber is used after standard SMF which compensates dispersion in the optical channel. In Fig 4.(a), it prominently shows the effect of chromatic dispersion on CO-OFDM system elaborated in the constellation diagram. The spectral efficiency of OFDM signal is spoiled due to dispersion and fiber nonlinearity in the optical channel. The post-dispersion compensation technique removes nonlinearity in the optical channel and significantly improves system performance. Thus, after nullifying the effect of chromatic dispersion, well-resolved constellation diagram for DP-QPSK modulated CO-OFDM system is achieved. This is illustrated in Fig 4.(b)
4.2 Comparison of modulated spectrum

The calculated power spectrum of QPSK modulated 10 Gb/s and 40 Gb/s OFDM signal compare with 20Gb/s OFDM signal transmitted over 60 km standard SMF at -8dB input optical power are plotted and spectral efficiency of these signal is compared. In Fig.5(a) the optical power spectrum of 10 Gb/s and 20Gb/s signal is compared. Observing these spectra, the optical power spectrum of 20Gb/s signal is two times broad than 10Gb/s signal spectrum and much narrower than optical power spectrum of 40Gb/s signal as shown in Fig.5(b). Hence spectral efficiency of 20 Gb/s signal is less as compared to the 10Gb/s signal and more as compared to the 40 Gb/s signal. The effect of higher data rate on spectral efficiency is elaborated with the help of constellation diagram. Fig.6(a) shows the well-resolved constellation diagram for 10 Gb/s signal with great spectral efficiency. However, the spectral efficiency of 20 Gb/s signal is degraded compared with 10 Gb/s signal as shown in Fig.6(b) constellation. If the data rate increase further spectral efficiency degraded as shown in Fig.6(c) for 40 Gb/s constellation, where spectral efficiency spoiled. Thus increasing data rate results in degraded spectral efficiency in conventional QPSK modulated CO-OFDM system.

This drawback is overcome by using DP-QPSK modulation in CO-OFDM system. Fig.5(c) shows the power spectrum of 100Gb/s DP-QPSK modulated CO-OFDM signal over 360 km standard SMF at same input optical power. Fig.4(b) represent well-resolved constellation diagram of DP-QPSK modulated CO-OFDM signal at 50 Gb/s data rate. Hence, DP-QPSK modulated CO-OFDM system offer high spectral efficiency at a higher data rate as compared to conventional QPSK modulated CO-OFDM system.
Fig. 5 Power spectrum of QPSK modulated (a) 10 Gb/s (Red) and 20 Gb/s (Blue) OFDM signal (b) 20 Gb/s (Blue) and 40 Gb/s (Red) OFDM signal over 360 km SMF (c) Power spectrum of DP-QPSK modulated 100 Gb/s OFDM signal over 360 km SMF.
4.3 Performance Evaluation of Laser linewidth for CO-OFDM

Laser phase noise imposes a limitation on CO-OFDM system. The time domain duration of OFDM symbol restricts laser linewidth in CO-OFDM system. OFDM with longer symbol needed narrower linewidth laser [13]. The phase noise colligates with a linewidth of the laser will cause a loss of orthogonality which leading to inter-carrier interference (ICI). For this reason, CO-OFDM system uses shorter OFDM symbol than DDO-OFDM system. Phase tone with sufficient bandwidth is mixed up with subcarrier band; this mixing helps to extract phase between subcarrier and pilot signal which eliminates the phase error between transmitting laser and local oscillator in CO-OFDM [12]. In Fig 7, it shows the effect of laser linewidth on the quality factor for both user-1 and user-2 at -8 dB input optical power.

Fig 7: Calculated laser linewidth versus Quality factor (Q) for user-1 and user-2, each transmit 50 Gb/s CO-OFDM symbol at -8dB input optical power
The laser linewidth increases from 1.3 MHz to 1.45 MHz quality factor Q is below 30 dB and laser linewidth from 1.5 MHz to 2.2 MHz Q-factor is less than 10 dB which is very poor. Between 1.2 to 1.5 GHz, the performance of user-1 and user-2 is slightly distinct owing to input optical power applied to the laser to both I & Q modulators are not exactly equal, thus this imperfection result fiber nonlinearity and dispersion. Thelaser source of linewidth 1.2 MHz and below result in significantly good Q factor is achieved.

### 4.4 BER Analysis

The BER for two CO-OFDM users was measured from the received CO-OFDM signal. Fig.8. (a) represent the relationship between –log (BER) versus input optical power of CO-OFDM for users-1 and user-2. The input optical power of laser has a significant effect on BER. The BER value of CO-OFDM is calculated for the 1552.52 nm wavelength in the conventional band. The input optical power of laser decreases from -13dB to -24 dB, BER of CO-OFDM system greater than $10^{-4}$. At -10dB input optical power of laser error free transmission of CO-OFDM signals over 360 km with good SNR 55 dB is achieved. In fig 8(b), represents the relationship between –log (BER) versus SNR for user-1 and user-2. This figure illustrates that SNR must be greater than 50 dB for a BER less than $10^{-4}$. Fig 9(a), it shows the constellation diagram of -10 dB input optical power of CO-OFDM signal transmitted over 360 km optical link using standard SMF. If the input power of laser increased beyond the -13 dB, chromatic dispersion in optical channel increases which leads to higher BER. The effect of chromatic dispersion on constellation at 50 Gb/s data rate with -20 dB input optical power is prominently shown in fig 9(b). This figure illustrates the spectral efficiency of CO-OFDM signal is spoiled due to chromatic dispersion.

The BER for both; user-1and user-2 is not precisely same. This is due to the fact that the power delivered by the generated optical multicarrier signal to all optical carriers is not exactly equal [16]. This issue has further combined with fiber nonlinearity of optical channel. Thus, get variation in SNR and BER for the user-1 and user-2. Hence, the input optical power of the laser is decreased beyond the optimum value consequently the power in optical channel decreased this result into dispersion in the optical channel causes inter-channel interference (ICI) in optical channels.
Fig.8. (a) The relationship between $-\log(BER)$ versus input optical power for user-1 and user-2 at 50 Gb/s data rate over 360 km distance (b) The relationship between $-\log(BER)$ versus SNR (dB) for user-1 and user-2 at 50 Gb/s data rate over 360 km distance, the SNR is greater than 50 dB at BER is below $10^{-4}$.

Fig.9. Constellation output (a) at -10 dB input optical power (b) at -20 dB input optical power of 50 Gb/s OFDM signal using 360 km standard SMF.

V. CONCLUSION

This paper has evaluated the performance of dual-polarized QPSK modulated coherent optical OFDM system including the effect of fiber nonlinearity. The system is designed using two OFDM signals each of 50 Gb/s to achieve 100 Gb/s data rate transfer over 360km standard SMF while the effect of chromatic dispersion is compensated using post dispersion compensation technique. Simulation of CO-OFDM system is based on the dual polarization of signal. The result indicates that DP-QPSK modulated CO-OFDM system has high spectral efficiency as compared to conventional QPSK modulated CO-OFDM system at higher data rates. Thus, for higher data rates and long haul communication DP-QPSK-CO-OFDMis a better technique as compared to the conventional QPSK-CO-OFDM modulation technique. The simulation shows that quality factor Q is greater than 60dB for laser linewidth below 1.2 MHz. The selection of laser linewidth should be narrower to get optimum system performance. The BER analysis shows that the input optical power of the laser at -10 dB or below -10 dB get error free CO-OFDM system for which SNR is greater than 55dB. With the help of result, it is concluded that DP-QPSK modulated CO-OFDM system is really promising technology to achieve high data rate in optical communication. The performance evaluation of this CO-OFDM system is helpful to implement Ethernet system of 1 TB/s and radio-over-fiber applications for high data rate.

VI. ACKNOWLEDGMENT

We really appreciate to symbiosis international university which helps to accomplish this work. We would also like to thanks to all researchers for their contribution and research in this domain.

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