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On the Optimization of Channel Spacing in the Hybrid WDM-COOFDM System

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Abstract

Orthogonal frequency division multiplexing (OFDM) can accomplish high use effectiveness. In this paper, the authors consolidate OFDM with wavelength division multiplexing (WDM) to examine the optical fiber transmission characteristics of a WDM-OFDM hybrid system that can accomplish high usage effectiveness even when the quantity of channels is high. The outline and simulative examination of the Integrated WDM-COOFDM framework is done at different estimations of the channel spacing. Hence all the info channels have been put directly at different values like 50GHz, 100 GHz and 150 GHz. The most extreme transmission separation accomplished is 600km. Simulation results reveal that with the increase in the channel spacing, the interference decreases and thus the performance is improved. The enhanced Q element and BER acquired with the 150 GHz channel dispersing is 33.4db and 9E-12.

Keywords*: CO-OFDM, WDM, Q factor, BER*

1. Introduction

Orthogonal frequency division rising as another and promising method in a large portion of wired and remote correspondence frameworks [1]. In OFDM the subcarrier frequencies are so picked such that the signal ought to be scientifically orthogonal over more than one OFDM symbol period. By utilizing an inverse fast Fourier transform (IFFT), both modulation and multiplexing can be achieved digitally and as an after effect of this, the required orthogonal signal can be produced in a computationally effective manner. In recent years, optical OFDM has risen as a predominant innovative work field in the fast optical communication frameworks [2].

However, there exist various key reasonable and hypothetical contrasts amongst OFDM and the ordinary frameworks. In routine remote frameworks, when frequency division multiplexing (FDM) is utilized, or in optical frameworks, when wavelength division multiplexing (WDM) is utilized, the data is additionally transmitted at the same time on various distinctive frequencies [3]. But in OFDM systems, the carriers are densely packed and are orthogonal to the other carriers. In FDM system carriers are not orthogonal to each other and are separated by guard intervals. Along these lines, OFDM framework is more data transfer capacity effective than FDM framework [4].

Numerous key benefits of the OFDM frameworks have been concentrated and analyzed in the communication field. Firstly, the OFDM system has high spectral efficiency because the OFDM subcarriers have partially overlapped frequency spectra. Secondly, it is easy to estimate and remove the channel dispersion of the transmission system and thirdly, the signal processing in OFDM transceiver has an advantage of the efficient algorithm of FFT/IFFT with the less complexity [3]. The main disadvantages of CO-OFDM are the coherent detection of OFDM systems is polarization dependent and the OFDM is sensitive to phase noise of the local oscillator. Therefore, CO-OFDM is developing as a promising regulation method in the field of the correspondence [5].

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The introduction Hybrid OFDM system has gained a lot of interest in recent years. This paper proposes an incorporated CO-OFDM with WDM configuration to achieve an information rate of 40 Gbps over Single Mode Fiber (SMF). The 40 Gbps signal is produced by multiplexing four OFDM with 10 Gbps for each OFDM. The simulative examination has been finished by differing the channel spacing. Three diverse channel spacing has been viewed that is 50 GHz, 100GHz, and 150GHz. It is analyzed that on expanding the channel separation, the obstruction between the info frequencies diminishes and as an aftereffect of this, the four wave mixing diminishes. In this manner with the expansion in channel spacing, the Q variable enhances and BER likewise improves.

2. System Description

A 40 Gbps WDM-COOFDM framework is composed in optisystem version 13 appeared in Figure 1. The 40 Gbps signal is created by multiplexing four OFDM signals with 10 Gbps for each OFDM The framework comprises of three segments transmitter area, optical fiber connection and recipient segment.

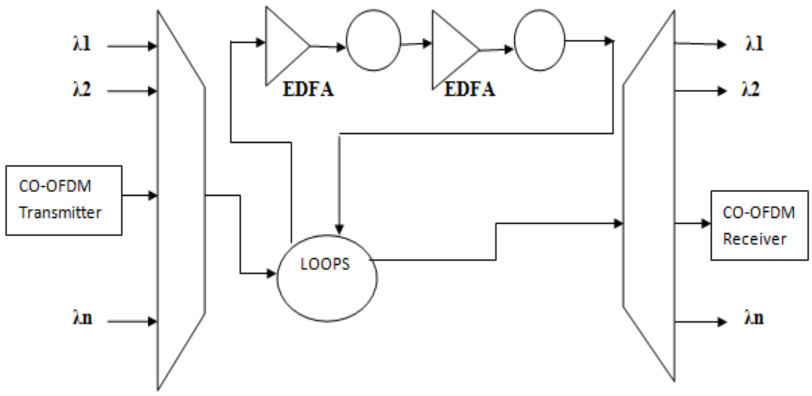

Figure 1. WDM-COOFDM System Design

CO-OFDM Transmitter

Figure 2 demonstrates the framework configuration of CO-OFDM transmitter. The information signal is connected to QAM sequence generator and is then adjusted by OFDM modulator. The different OFDM parameters are appeared in the Table 1. The yield from the OFDM modulator is connected to the Mach-Zehnder modulator and to the power combiner. The subsequent signal is then dispatched into the optical fiber.

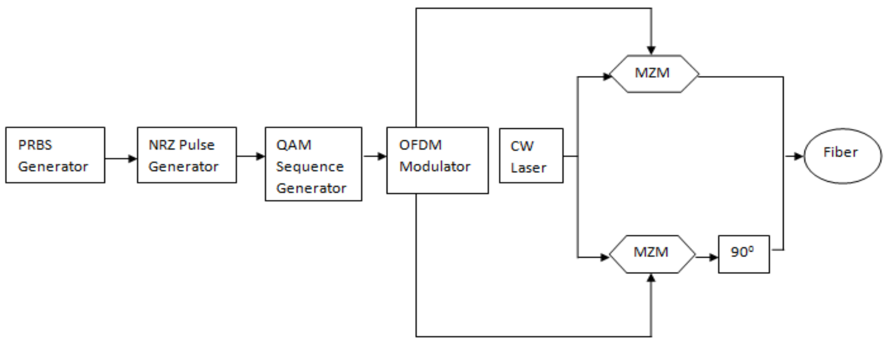

Figure 2. CO-OFDM Transmitter

Optical Fiber Link

Before the optical fiber, the four OFDM signals are multiplexed using WDM multiplexer and then it is transmitted to the optical fiber. The various fiber parameters such as length, attenuation, dispersion and the dispersion slope etc and the various simulation parameters such as data rate, power, gain etc are depicted in the Table2 and Table 3.

Table 1. OFDM Parameters

No of Subcarriers	512
No of FFT points	1024
No of Prefix points	10
Position Array	256

Table 2. Simulation Parameter

Parameters	Specifications
Channel spacing	50GHz,100GHz,150GHZ
Data Rate	40 Gbps
Power	-4 Db
Capacity	4x10Gbps
Electrical gain	-0.008
Gainof amplifier	5dB

Table 3. Fibre Parameters

Parameters	SMF	DCF
Length(Km)	50	10
Attenuation(dB/km)	0.2	0.5
Effective Area(μm^2)	70	22
Dispersion(ps/nm-km)	17	-85
Dispersion slope(ps/km/nm^2)	0.075	-0.3

CO-OFDM Receiver

Figure 3 demonstrates the CO-OFDM recipient. The yield signal from the optical fiber connection is connected to the four PIN Photodetectors to perform the optical to electrical change. The subsequent signal is then connected to the OFDM demodulator and after that to the QAM succession decoder.

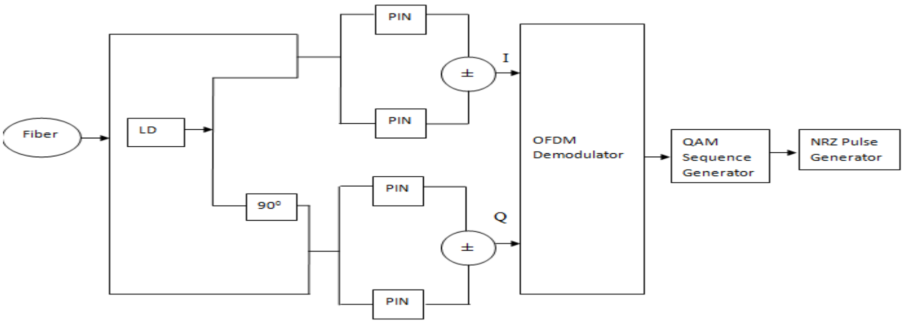

Figure 3. CO-OFDM Receiver

3. Results and Discussions

A 40Gbps WDM-COOFDM system is designed. Simulative investigations have been done by having all the input channels been spaced evenly at various values like 50 GHz, 100GHz and 150GHz.

AT 50GHZ CHANNEL SPACING

With 50GHz channel spacing, the input frequencies of the four channels are 193.05THz, 193.1THz, 193.15THz and 193.2THz. The optical spectrum obtained at the transmitter and at the receiver is shown in Figure 4(a) and Figure 4(b) respectively. The electrical constellation diagram obtained at the receiver is shown in Figure 4(c).

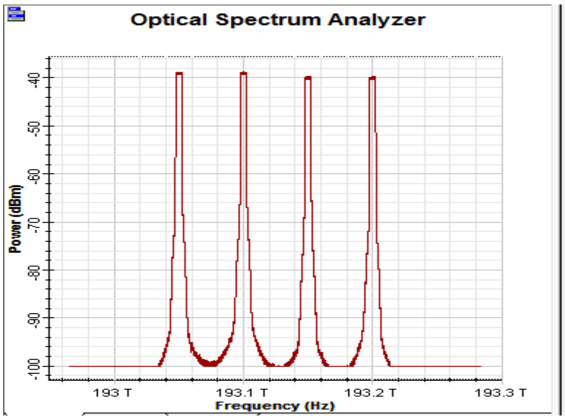

Figure 4 (a). Spectrum at the Transmitting End with 50GHz Channel Spacing

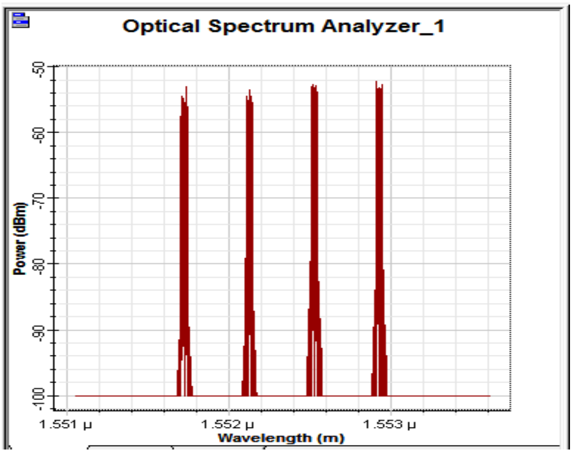

Figure 4 (b).Spectrum at the Receiving End with 50GHz Channel Spacing

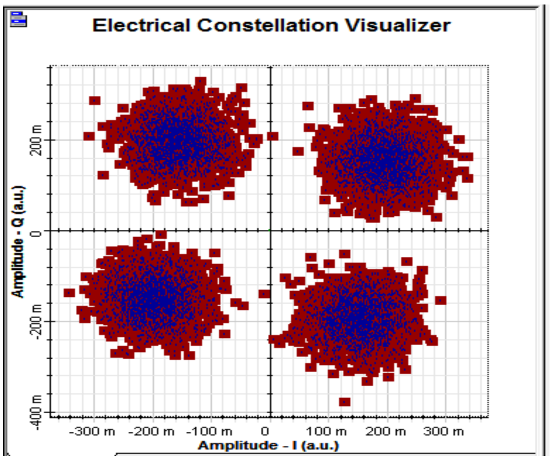

Figure 4 (c).Constellation Diagram of Channel 1 with 50GHz Channel Spacing

AT 100GHZ CHANNEL SPACING

With 100GHz channel spacing, the input frequencies of the four channels are 193.1THz, 193.2THz, 193.3THz and 193.4THz. The optical spectrum obtained at the transmitter and at the receiver is shown in Figure 5(a) and Figure5(b) respectively. The electrical constellation diagram obtained at the receiver is shown in Figure 5(c).

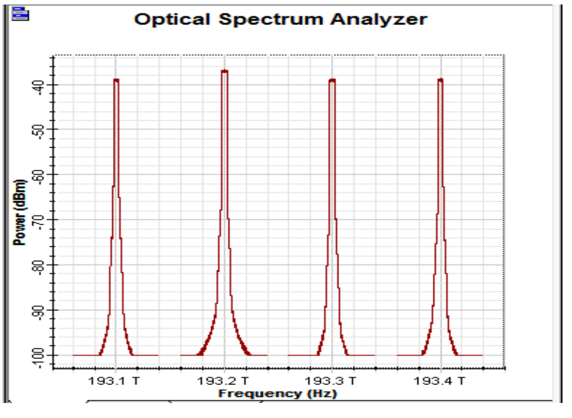

Figure 5(a). Spectrum at the Transmitting End with 100GHz Channel Spacing

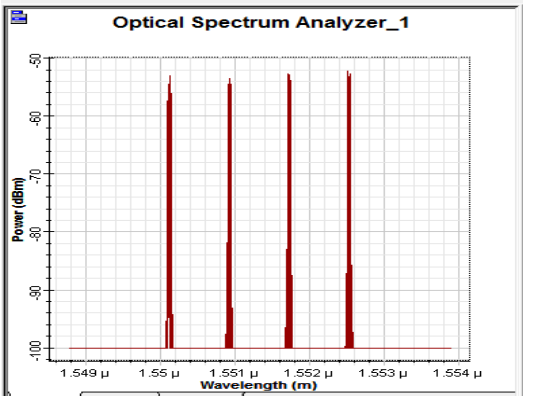

Figure 5(b).Spectrum at the Receiving End with 100GHz Channel Spacing

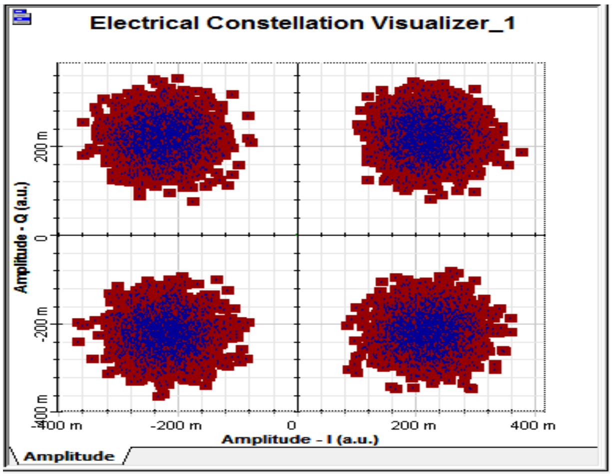

Figure 5 (c).Constellation Diagram of Channel 1 with 100GHz Channel Spacing

AT 150GHZ CHANNEL SPACING

With 150GHz channel spacing, the input frequencies of the four channels are 193.1THz, 193.25THz, 193.4THz and 193.55THz. The optical spectrum obtained at the transmitter and at the receiver is shown in Figure 6 (a) and Figure6(b)respectively. The electrical constellation diagram obtained at the receiver is shown in Figure 6(c).

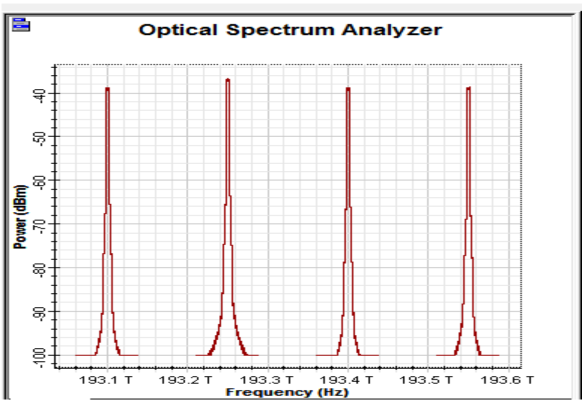

Figure 6 (a).Spectrum at the Transmitting End with 150GHz Channel Spacing

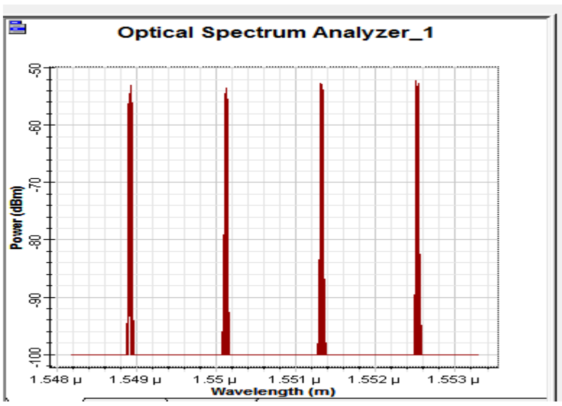

Figure 6.(b). Spectrum at the Receiving End with 150GHz Channel Spacing

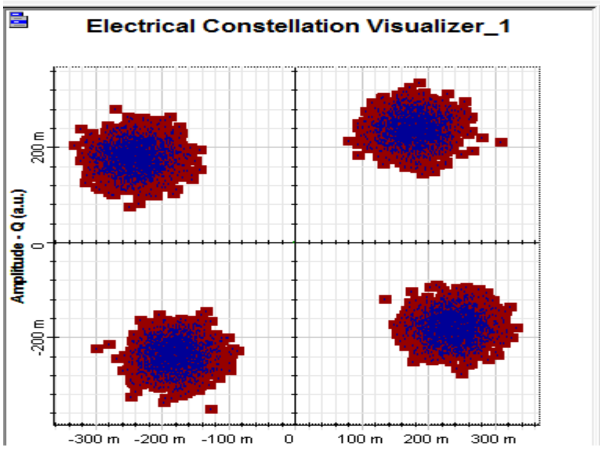

Figure 6(c).Constellation Diagram of Channel 1 with 150GHz Channel Spacing

DISCUSSIONS

The comparison of the three channel spacing is done with the distance on the basis of the quality factor. The plot so obtained is shown in Figure 7.

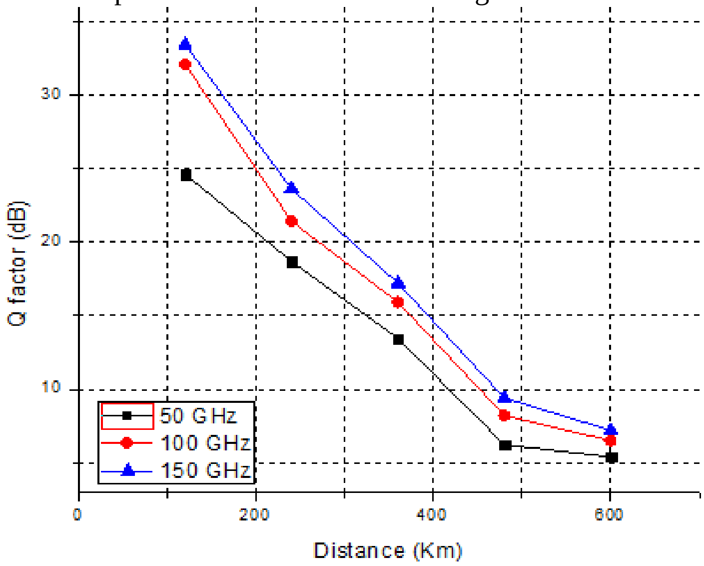

Figure 7. Comparision of Three Channel Spacing on the Basis of Q Factor

Thus, Figure 7 indicates that with the increase in the channel spacing the Q factor increases as the interference decreases and thus the four wave mixing also decreases. The Q factor obtained at 120 km for 50 GHz, 100GHz and 150GHz channel spacing are 24.6dB, 32.06dB, and 33.4dB respectively. Therefore Q factor for 150 GHz is better than 100GHz and 50 GHz

The comparison of the three channel spacing is done with the OSNR on the basis of quality factor and BER. The plot so obtained is shown in Figure 8 and Figure 9.

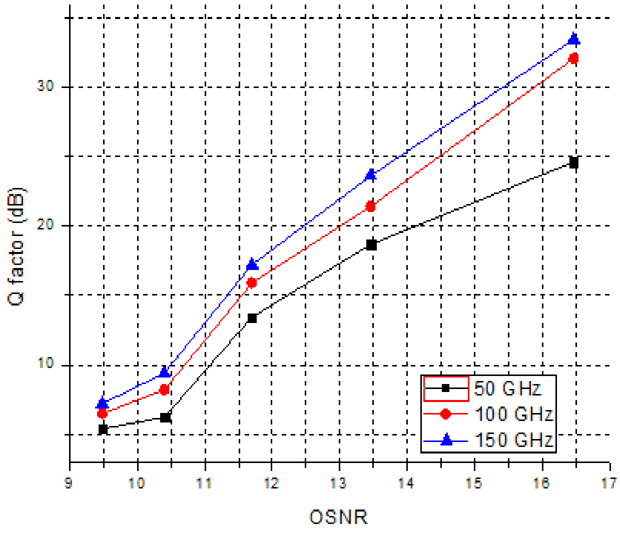

Figure 8. Comparision of Three Channel Spacing with the OSNR on the Basis of Q Factor

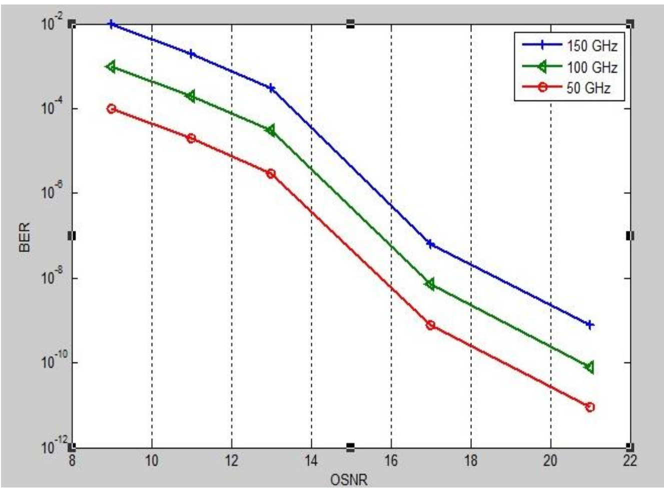

Figure 9. Comparison of BER of the Three Channel Spacing with OSNR

Figure 8 shows that with the extension in the channel separating, the Q factor augments. As can be seen from Figureure 9, expanding the OSNR will keep up BER under 10^{-3}. However, the expanding the OSNR ought to be restricted in light of the fact that high OSNR will build the nonlinear impedances on the framework which will in the end influence the transmission of the signal make it difficult to recover the original signal. The BER acquired at 120 km for 50 GHz, 100GHz and 150GHz channel dividing are 8E-10, 8E-11 and 9E-12.

Table 4. Comparision of Q Factor and BER at Various Channel Spacing

Channel spacing	**Parameters**	
	Q-factor(dB)	**BER**
50 GHz	24.60	8E-10
100 GHz	32.06	8E-11
150 GHz	33.40	9E-12

4. Conclusion

It is reasoned that with the expansion in the channel separating, the Q variable increments and the BER improves. In this manner, a 40 Gbps WDM-COOFDM at expanded channel dividing is progressed. The most extreme transmission separation accomplished is 600km. It is additionally clear from the Table 4, At 150 GHz, the Q variable and the BER is superior to the 100GHz and 50 GHz. The most extreme Q element acquired with 150 GHz channel dispersing is 33.4 dB. Therefore with the increase in the channel spacing the interference decreases, the four-wave mixing diminish and the performance is improved.

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