Volume 2, Issue 2, April 2015 ISSN: 2348-8565 (Online)
International Journal of Modern Engineering and Research Technology
Website: http://www.ijmert.org Email: editor.ijmert@gmail.com

Implementation of DCF Based Optical Communication System for the Analysis of Nonlinear Effects Using Pre, Post, and Combined

Aneera Khan
M.Tech. Research Scholar
All Saint's College of Technology
Bhopal (M.P.), [INDIA]
Email: aneera.enigmatic@gmail.co

Sarwar Raeen
Head of Department
Department of Digital Communication, Electronics & Communication
All Saint's College of Technology
Bhopal (M.P.), [INDIA]
Email: sarwar_79@rediffmail.com

ABSTRACT

Recent trend is the trend of communication because the demand of high speed and bandwidth is increasing day by day. WDM is the best technology available now a day for achieving the greater speed and bandwidth [9]. But the major problem with the WDM is the non linear effects which degrade the signal quality [7, 8, 9, 10]. Dispersion is another cause of degrading the signal. In this paper we work on the dispersion compensation in order to compensate the nonlinear effect also [6, 7]. Dispersion is compensated with the help of DCF (dispersion compensation fiber) [2]. But here we use the various schemes for the dispersion compensation i.e. pre-compensation, post- compensation and pre-post or symmetrical compensation schemes [3,4,5]. The system is designed for various no of channel counts and simulate at various power levels with the help of software optisystem 7.0. And results are analyzed on the basis of Q factor, BER, EYE height and Threshold.

Index Terms:— *Wave Division Multiplexing (WDM), Dispersion compensating fiber (DCF), Q Factor, Bit Error Rate (BER), Optical Signal to Noise Ratio (OSNR).*

I. INTRODUCTION

In order to increase the capacity of optical fiber communication system the most important phenomena is the emergence of wavelength division multiplexing (WDM) [2, 3].Which full fill the demand higher bandwidth for various applications like streaming audio, interactive multimedia, video conferencing. But the non linear effects like four wave mixing (FWM), cross phase modulation (CPM), stimulated brillouns scattering (SBS) [1]. These effects are mostly controlled by controlling the effect of chromatic dispersion [6]. There conventional scheme available for dispersion compensation is DCF [2]. We simulate our model with using the dispersion compensation schemes pre-compensation, pos-compensation, and symmetrical compensation [3, 4, 5, 6]. The dispersion compensation in Pre DCF compensation scheme is achieve by place the DCF before a certain conventional single-mode fiber, or after the optical transmitter. Post -compensation scheme achieve dispersion Compensation by place the DCF after a certain conventional single-mode fiber, or before the optical transmitter. In symmetrical-compensation, we have used EDFA optical amplifiers before and after of optical fiber to compensate the span loss [1]. The main advantage of this technology is the fact that it provides a broadband operation with a smooth dispersion property and good optical characteristics [5]. Very long lengths of dispersion compensating fibers are required to compensate for the dispersion of even modest lengths of transmission.

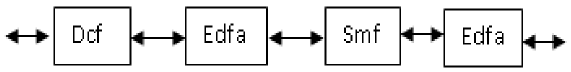

Figure 1: Pre-compensation Scheme

Figure 2: Post-compensation Scheme

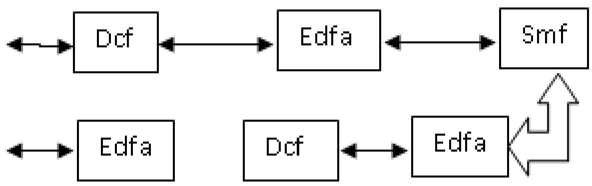

Figure 3: Symmetric-compensation Scheme

II. Simulation Parameters

The various parameters used for the simulation model are given in the table 1. These parameters are input power, transmitting distance, transmitting speed, WDM channel spacing etc.

Table 1: Simulation Parameters

PARAMETER NAME	PARAMETER VALUE
Bit Rate	10 Gbps
Transmission Distance	160 Km
Sequence Length	64
Capacity	26 Channels 10 Gbps
Samples/Bit	256
Input Power	3 dBm,5dBm,11dBm
DWDM Channel Spacing	100 GHz,110GHz

III. Simulation Model

In figure 5, 6, 7 the simulation model of WDM network with pre, post and symmetric schemes are shown. In which we generate the (11, 18 & 26) input channels with the help of the WDM transmitter. WE use the modulation format not return to zero (NRZ). Power variation should also be done by changing the power of continuous wave lasser. We have no of channels with the frequency starting from 193.1 THz having frequency spacing of 100Ghz or 110Ghz. After this the information coming from the various channels are multiplexed with the help of the ideal multiplexer and the multiplexed signal is transmitted by using the pre, post and symmetric compensation scheme. In pre compensation scheme firstly the multiplexed signal is passed through the DCF of the length 30Km having dispersion coefficient 0.5dB/Km then passed through the EDFA having gain 0f 15dB. After this the signal is passed through the single mode fiber having attenuation coefficient of 0.2dB/Km and dispersion slope 0.075ps/nm/km and dispersion coefficient of 16 ps/nm/km with the length of 100KM. The SMF is followed by EDFA (Erbium Dopped Fiber Amplifier) having gain and noise figure 20db and 6db or 4 db respectively.

In post compensation scheme the SMF is followed by the DCF which is again followed by the EDFA having the parameter same which are used in pre-compensation scheme.

In symmetric compensation scheme DCF is followed by EDFA then SMF which is followed by the EDFA then DCF is followed by the EDFA and all these components having parameter same as used in pre compensation scheme.

Now if we want to increase the transmitting distance then rotate the signal in the loop and increase the transmitting distance by increasing the number of loops. After travelling the distance of 130Km demultiplexed with the help of the WDM DEMUX in to its various individual channels. After this the optical signal is converted in the electrical signal with the help of the pin photo detector having dark current 10 nA and responsivity 1A/W. Now this electrical signal is passed through the Low pass Bessel filter of order 4 for the removal of noise content from the signal then this signal is send to the bit error rate (BER) analyser for the eye diagram analysis of the signal.

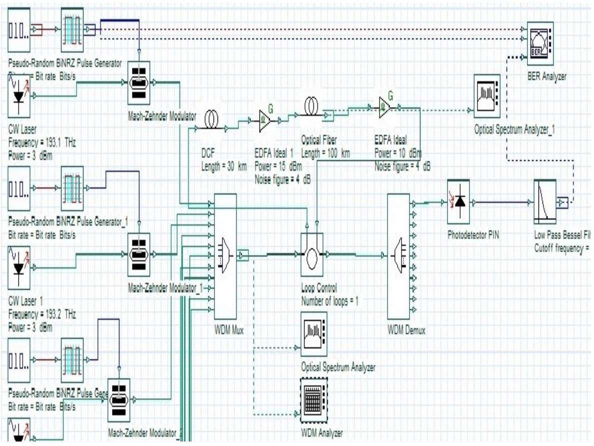

Figure 4: Simulation Model of WDM Network Pre-Compensation

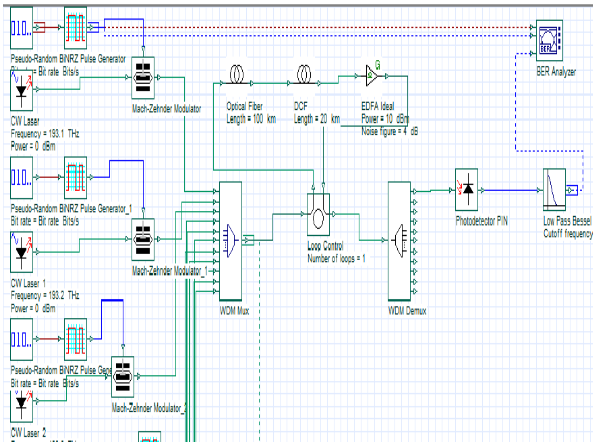

Figure 6: Simulation Model of WDM Network Post-Compensation

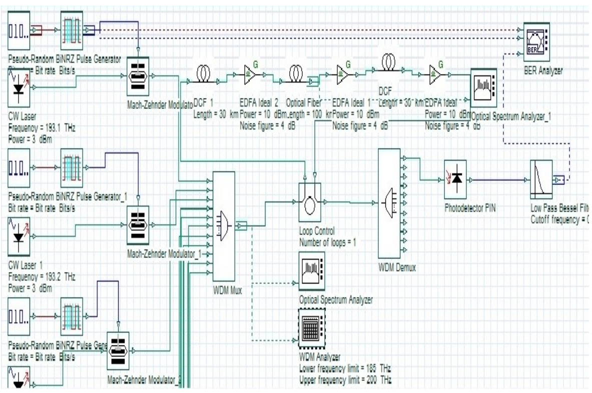

Figure 6: Simulation Model of WDM Network Post-Compensation

IV. Results & Discussion

Analysis of Cross Phase Modulation Using (Pre-Compensation)

Our proposed model is simulated for the 11,18 & 26 DWDM channels having the power of 3dB,5dB & 11dB, for the pre, post and symmetric compensation schemes then the outcomes that are eye diagrams and bit error rate are shown in the figures.

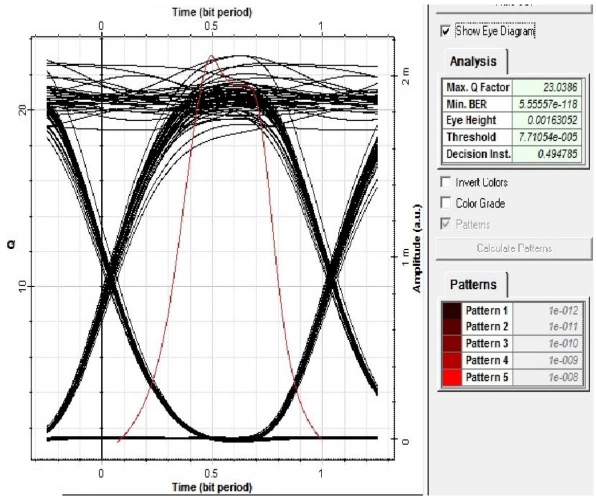

Figure 7: Eye Diagram for WDM having 11 Channels and Power 3dB.

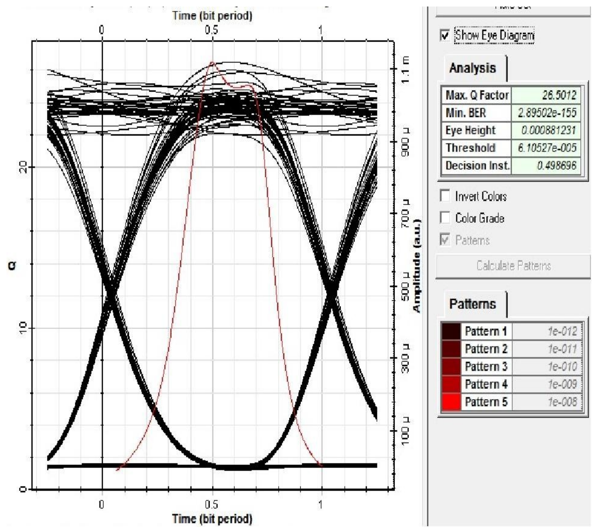

Figure 8: Eye Diagram for WDM having 18 Channels and Power 5dB.

By analyzing the figure 7, 8 & 9 it is observe that when we increase the number of channels from 11 to 18 and power level 3 dB to 5dB then the Q factor decrees from 40.17.03 to 26.50, and we get the quality factor 13.2 for the 26 channel WDM system for the power of 11 dB. From this discussion it is observe that by using pre compensation scheme if we increase the number of channel count and increase the power level then the quality factor of the system reduced because of the cross phase modulation. So we conclude that the cross phase modulation increase if we increase the power level and number of channel counts.

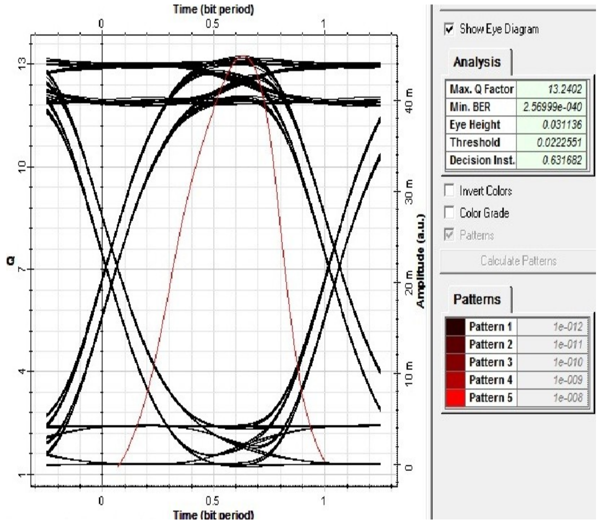

Figure 9: Eye Diagram for WDM having 26 Channels and Power 11dB.

Analysis of Cross Phase Modulation Using (Post-Compensation)

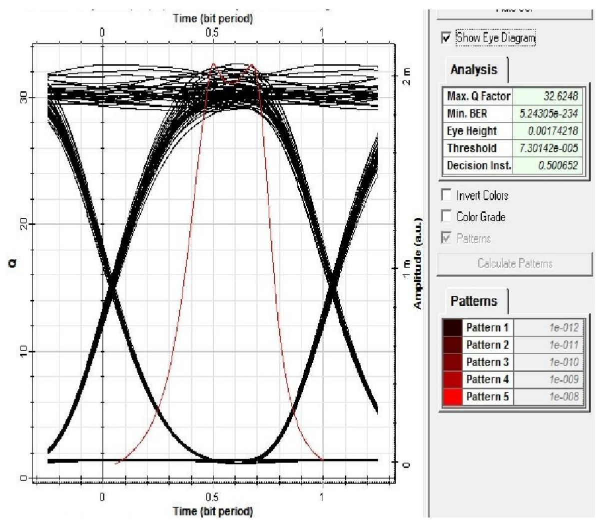

Figure 10: Eye Diagram for WDM having 11 Channels and Power 3dB

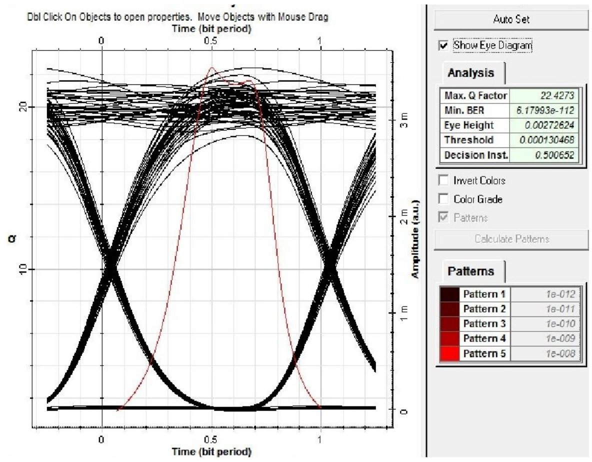

Figure 11: Eye Diagram for WDM having 18 Channels and Power 5dB.

By analyzing the figure 10, 11 & 12 it is observe that when we increase the number of channels from 11 to 18 and power level 3 dB to 5dB then the Q factor decrees from 32.63 to 22.43, and we get the quality factor 13.4 for the 26 channel WDM system for the power of 11 dB. From this discussion it is observe that if we increase the number of channel count and increase the power level then the quality factor of the system reduced because of the cross phase modulation. But we get the better quality factor then that of the pre compensation scheme. So we conclude that post compensation is performing better than that of the pre compensation scheme. The cross phase modulation increase if we increase the power level and number of channel counts.

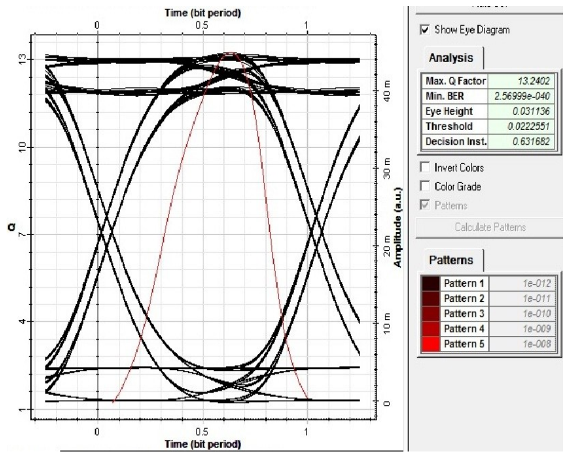

Figure 12: Eye Diagram for WDM having 26 Channels and Power 11dB.

Analysis of Cross Phase Modulation Using (Symmetric-Compensation)

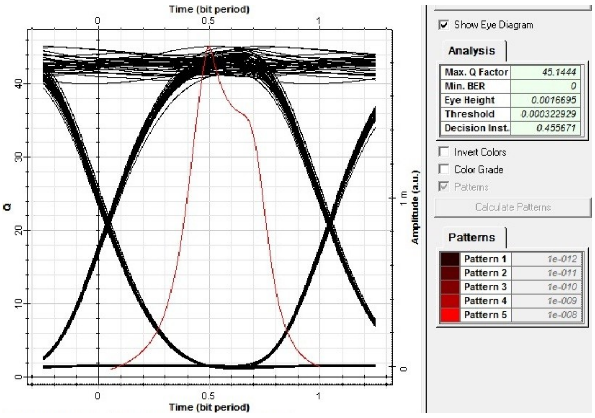

Figure 13: Eye Diagram for WDM having 11 Channels and Power 3dB.

By analyzing the figure 13, 14 & 52 it is observe that when we increase the number of channels from 11 to 18 and power level 3 dB to 5dB then the Q factor decrees from 45.14 to 26.03, and we get the quality factor 14.03 for the 26 channel WDM system for the power of 11 dB. From this discussion it is observe that if we increase the number of channel count and increase the power level then the quality factor of the system reduced because of the cross phase modulation. But we get the better quality factor then that of pre and post compensation schemes. So we conclude that symmetric compensation is performing better than that of the pre and post compensation scheme. The cross phase modulation increase if we increase the power level and number of channel counts.

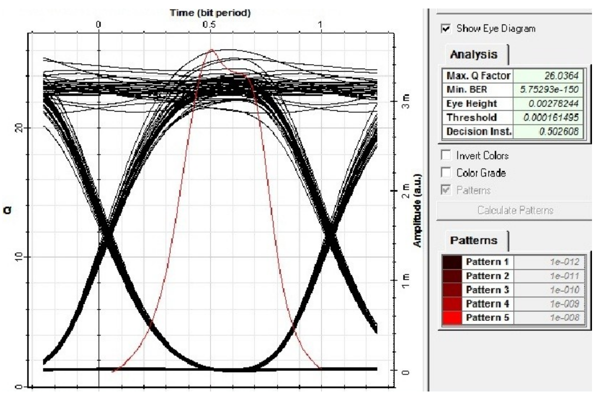

Fig.14: Eye Diagram for WDM having 18 Channels and Power 5dB.

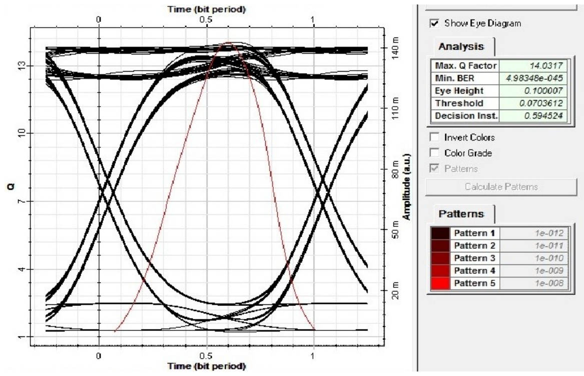

Figure 15: Eye Diagram for WDM having 26 Channels and Power 11dB.

Table 2: Maximum Q Factor with Respect to Various Channel counts & Power Levels for Different compensation schemes

No of Obs	Input Power	Input number of Channels	Pre Comp.	Post Comp.	Symmetric Comp.
1.	3dBm	11	40.17	32.63	45.14
2.	5dBm	18	26.50	22.43	26.03
3.	11dBm	26	13.20	13.40	14.03

By analyzing the table 2 it is observe that when we increase the number of channels from 11 to 18 and 26 powers level 3 dB to 5dB and 11dB then the Q factor decrees. But if we compare the different compensation schemes pre, post and symmetric the symmetric compensation scheme gives the better quality factor which means that the symmetric compensation scheme reduces the effect of cross phase modulation.

Analysis of Four Wave Mixing Effect (Pre-Compensation)

Now we again simulate the same model for the channel counts of 11, 18 and 26 and power of -8dBm, 2dBm and 11dBm using pre, post and symmetric compensation schemes. For the analysis of four wave mixing effect we use the optical spectrum analyzer after the WDM mux and after the optical amplifier. The input and output spectrum of the different models using pre-compensation are as follows:

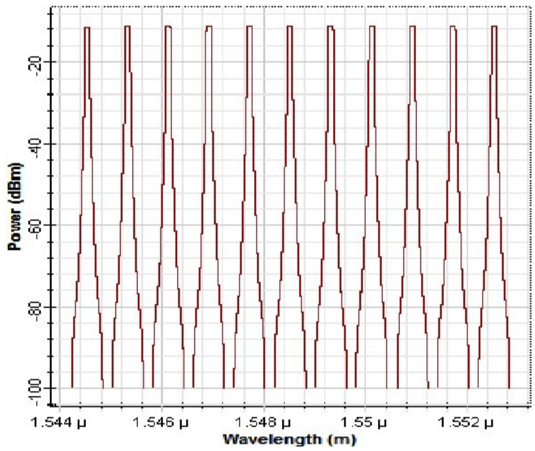

Figure 16: Input Spectrum for 11 Data channels (-8dBm WDM Transmitter Power)

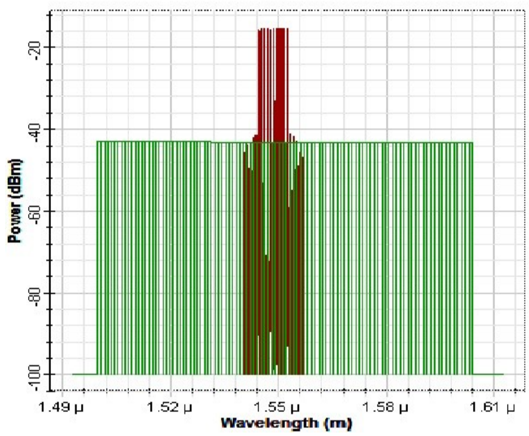

Figure 17: Output Spectrum for 11 Data channels (-8dBm WDM Transmitter Power)

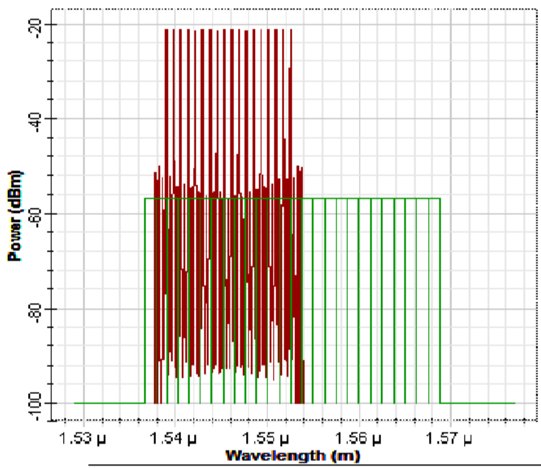

Figure 18: Output Spectrum for 18 Data channels (2dBm WDM Transmitter Power)

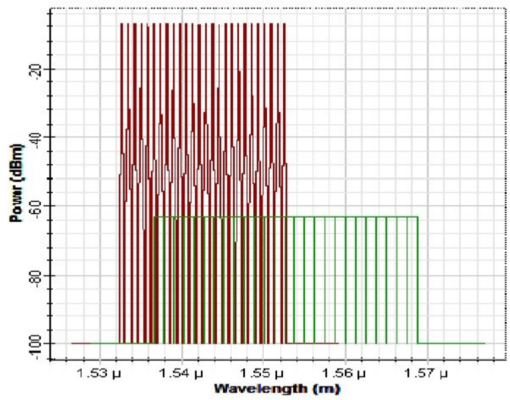

Figure 19: Output Spectrum for 26 Data channels (11dBm WDM Transmitter Power)

Analysis of Four Wave Mixing Effect (Post-Compensation)

The post –compensation scheme is used here for the analysis of four wave mixing effect. The output spectrum for different channel counts and power levels are as follows:

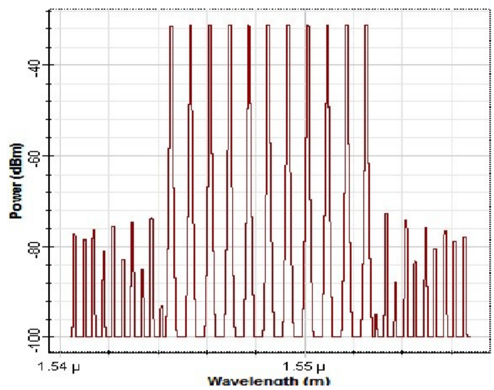

Figure 20: Output Spectrum for 11 Data channels (-8dBm WDM Transmitter Power)

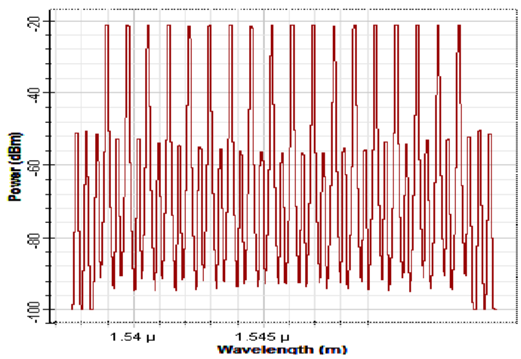

Figure 21: Output Spectrum for 18 Data channels

2dBm WDM Transmitter Power

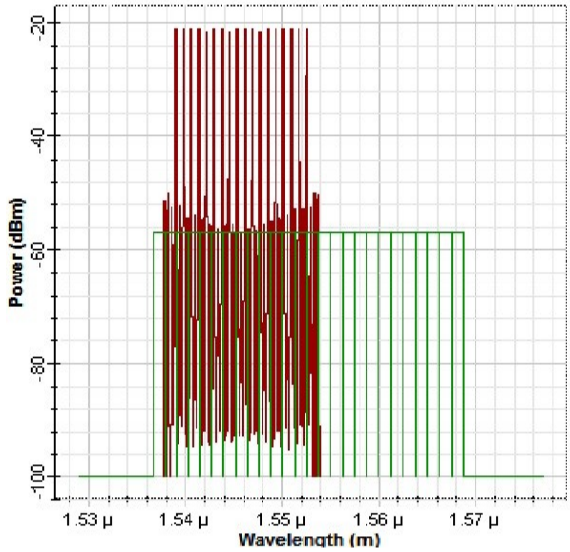

Figure 22: Output Spectrum for 18 Data channels (2dBm WDM Transmitter Power)

Analysis of Four Wave Mixing Effect (Symmetric-Compensation)

The model is again simulated using symmetrical- compensation for the analysis of four wave mixing effect by analysis of the spectrum originated by optical spectrum analyser.

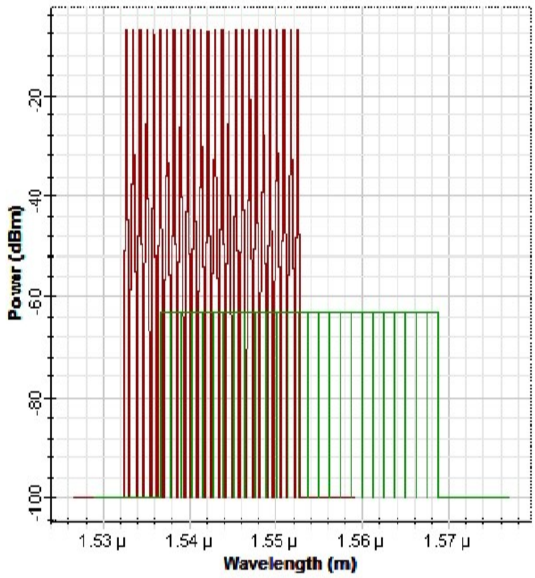

Figure 20: Output Spectrum for 26 Data channels (11dBm WDM Transmitter Power)

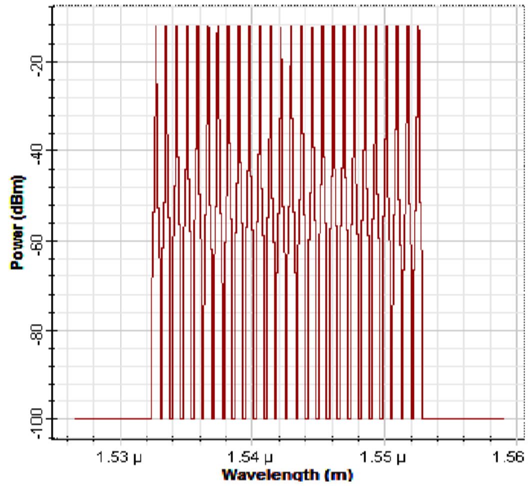

Figure 24: Output Spectrum for 26 Data channels (11dBm WDM Transmitter Power)

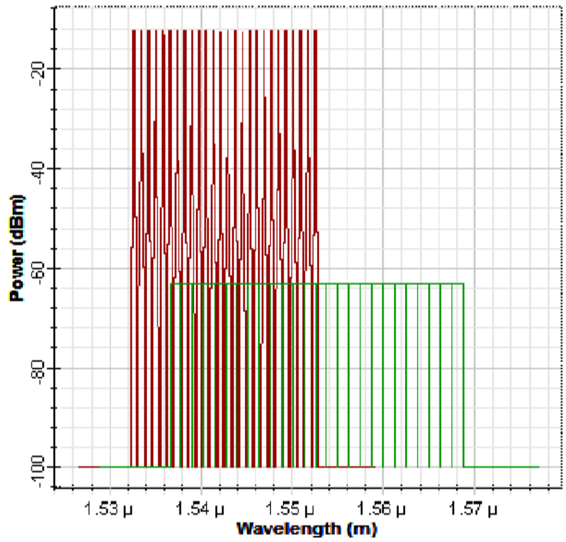

Figure 25: Output Spectrum for 26 Data channels (11dBm WDM Transmitter Power)

It is quite clear by analyzing the above spectrums that if we increase the number of channel count and transmitter power then the four wave mixing effect is increasing. Table 3 shows the various side band power on the basis of different channel counts and the transmitter power using pre, post and symmetric compensation. It is also clear from the table that the symmetric compensation scheme also performs better for the compensation of four wave mixing effect. Another way for reducing the effect of four wave mixing is use of uneven frequency spacing.

Table 3: Maximum Side Band Power with Respect to Various Channel counts & Power Levels

S. No.	Input power (dBm)	No of Input Chan-nels	Maximum Side Band		
			Pre. Comp.	Post Comp.	Sym-metric Comp.
1.	-8	11	-42	-52	-74
2.	2	18	-36	-50	-50
3.	11	26	-26	-32	-48

V. CONCLUSION

Quality factor and side band power is used in this paper for the various analysis on the FWM, XPM using pre, post and symmetric compensation schemes. From the above analysis it is quite clear that the FWM effect is reduced by increasing the channel spacing, XPM and four wave mixing is also increased by increasing the number of channel counts and the input power. Four wave mixing is also minimize by use of optical rectangular filter. XPM is reduced by using low input power but we cant reduce the power at certain limit because the network should not work below on that limit. From the analysis of the quality factor coming from the different models using pre, post and symmetric compensation scheme is clear that the symmetric compensation scheme is performing better than that of the another two and the use of symmetric compensation scheme is helpful in the reduction of the cross phase modulation effect. And the maximum quality factor coming from the simulation of model having 11 channels and 3dBm power gives the value 45.14 which is greater than that of the previous one. By the analysis of the side band power it is quite clear that the symmetric compensation schemes gives the better result for the reduction of four wave mixing effect. So we can comes on the results which are saying that the symmetric compensation scheme gives better performance for the reduction of cross phase modulation and four wave mixing effects.

REFERENCES:

[1] Iftikhar Rasheed, Muhammad Abdullah, Shahid Mehmood, Mahwish Chaudhary, "Analyzing the Non-linear Effects at various Power Levels and Channel Counts on the Performance of DWDM based Optical Fiber Communication System" IEEE 2012

[2] Bo-ningHU, Wang Jing, Wang Wei and Rui-mei Zhao1, "Analysis on Dispersion Compensation with DCF based on Optisystem", IEEE 2nd International Conference on Industrial and Information Systems,2010

[3] Manjari Sharma, P.K. Raghav "Analysis on Dispersion Compensation in WDM Optical Network using Pre, Post and Symmetrical DCF based on Optisystem." MIT International Journal of Electronics and Communication Engineering Vol. 4, No. 1, Jan. 2014, pp (58-63) 58 ISSN 2230-7672 ©MIT Publications

[4] Ruchi Agarwal and Vivekanand Mishra, "Comparison of Pre, Post and Symmetrical Dispersion Compensation Scheme with 10 Gb/s NRZlink for SCM System" International Conference on Electrical Engineering and Computer Science (ICEECS), May 2012

[5] Shradha Gupta, N. K. Shukla and Shikha Jaiswal, "Pre-Post, Symmetric1 and 2 Compensation

Techniques with RZ Modulation", IEEE 1st Int'l Conf. on Recent Advances in Information Technology, 2012.

[6] G. Ivanovs, and S. Spolitis, "Extending the Reach of DWDM-PON Access Network Using Chromatic Dispersion Compensation," 2011 IEEE Swedish Communication Technologies Workshop (Swe-CTW2011), pp. 29-33, 2011

[7] A.V. Ramprasad, M. Meenakshi, G. Geetha, R. Satheesh Kumar "Suppression of Four Wave Mixing Crosstalk Components in DWDM Optical Systems" 1-4244-0340-5/06/ $20.00 02006 IEEE.

[8] Bijayananda Patnaik, P.K. Sahu "Optimization of Four Wave Mixing Effect in Radio-over-Fiber for a 32-Channel 40-GBPS DWDM System" 978-0-7695-4294-2/10 $26.00 © 2010 IEEE DOI 10.1109/ ISED.2010.31

[9] K. Y. Cho, Y. Takushima, and Y. C. Chung, "Enhanced chromatic dispersion tolerance of 11-Gb/s RSOA-based WDM PON using 4-ary PAM signal," *IET Electronics Letters*, vol. 46, no. 22, pp. 1510-1512, Oct. 2010.

[10] Killy R I, Thiele H J, Mikhailov v, ea al. Reduction of intrachannel nonlinear distortion in 40-Gb/s based WDM transmission over standard fiber [J]. IEEE Photonics Technology Letters, 2000, 12(12): 1642-1626

[11] Eggleton B 1. Dynamic dispersion, compensation devices for high speed transmission systems. Optical Fiber communication conference and exhibit, 2001(3): WHlII-WH1I3.

[12] G. P. Agrawal, Nonlinear Fiber Optics, 3rd Ed, Academic Press, SanDiego, CA, 200 I.

[13] A. R. Chraplyvy, Limitations on lightwave communications imposed by optical-fIber nonlinearities, IEEE 1. lightwave Technology, pp. iw-1557, 1990, vol. 8.

* * * * *