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# Self Phase Modulation Reduction for Transmission of Signal using Mach Zehnder Modulator

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**ABSTRACT:** At the high power level the impairment of the signal transmission leads to the nonlinear effects.Here Concentrate On the Self Phase Modulation that induces the degradation of system performance.For this reason, SPM is reduced with the help of the Mach Zehnder Modulator for Error Free transmission of signal.This technique is suitable for 50Km, above this distance SPM is reduced but Eye Height is narrow compared with 50Km.Because Narrow Eye Height justifies more Crosstalk and vice versa.Eye Height decreases with increase in input power.SPM is reduced after that with the help of MZM, Optimum value of input power and varyfiber length such as 50km, 60km, 70km, 80km that produces the different values of BER, Q-factor, Eye Height.These are compared and fixed anyone distance which one is provide better performance than others.This analysis is done with the help of Optisystem12.0 Software.

**KEYWORDS:** Nonlinear Effects, Self Phase Modulation (SPM), Cross Phase Modulation (XPM), Four Wave Mixing(FWM), Stimulated Brillouin Scattering(SBS), Stimulated Raman Scattering(SRS), BER,Q-factor.

## I. INTRODUCTION

Fiber Optic Communication Systems are the light wave systems that employ Optical fibers for information transmission.The most important impairments associated with long distance optical fiber transmission systems that include fiber dispersion, fiber nonlinearities.But here focus on the fiber nonlinear effects on the fiber optic communication system.The nonlinear effects in the optical fiber occurs either due to intensity dependence of refractive index of the medium or due to inelastic scattering phenomenon.The intensity dependence of refractive index canlead to nonlinear phenomenon Such as SPM, XPM and FWM.The inelastic scattering is SBS and SRS[1].Earlier some linear effects were faced like optical attenuation and dispersion in fibers, which can now be easily dealt with using a variety of avoidance, regenerative and cancellation techniques, but nonlinearities like SPM, XPM and FWM need special attention while designing a fiber optic transmission system[6].

All these nonlinear effects reduces the system performance.At high power level an intensity change tends to change in the refractive index due to which velocity get change, this velocity changes produces the phase change and change in phase produced by pulse itself is known as Self Phase Modulation.SPM occurs in signal channel configurations, where it basically converts optical power fluctuations into phase fluctuations in the same wave.Significance of SPM is reduced by low power level and increasing fiber core area.But this is not suitable for the efficient transmission with long distance[4].

Analyze the Quality Factor, Bit Error Rate for different values of dispersion,power, distance.After the transmission signal get distorted by SPM nonlinear effect,so this effect is compensated by comparing the different values ofinput power and Eye Height value[3].

Variation of the optical dispersion from -10ps/nm/km to +10ps/nm/km and obtain that before Self Phase Modulation the constant Quality factor ,but after Self Phase Modulation, Quality factor becomes nonlinear.It can reduce the SPM upto some extent but not able to completely remove these SPM effect[5].

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SPM can significantly increase the pulse broadening effect.So this SPM effect is reduced by proper filtering and Reduction in effective fiber length.But this is suitable for long distance transmission.Then only SPM is reduced by optimizing the fiber core area [2].When SPM is negligible and optical extinction ratio is maximized, the modulator design must be considered carefully in order to increase the transmission distance.When the effects of fiber nonlinearities are negligible, an increase in the dispersion limited transmission distance is obtained for asymmetric Y-branch waveguides.The receiver sensitivity worsens more with increasing fiber length for a preamplified receiver as the dominant source of noise is the signal spontaneous beat noise.The system performance strongly depends on the modulator design, transmitted optical power and modulation conditions [7].
The SPM effect is stronger in the post compensated link than in the precompensated link.A dramatic spectral narrowing effect was observed in the post compensated link [8].

## II. SIMULATION LAYOUT DESIGN

In this paper discuss about the reduction of the Self Phase Modulation effectthatis analyzed with the help of the Optisystem12.0 simulation tool.This simulation layout is given in the Figure1, which consists of three sections.The first section is the transmitter section that contains the Bit Sequence Generator and Pulse Generator. Second section acts as a channel,which contains the Single Mode Fiber.
In general, this channel section induces the some distortion that leadsto impairment of the signal through the transmission of the signal.Last section is the receiver section that contains the Fork, Mach Zehnder Modulator, Photodetector PIN.Low Pass Bessel Filter and Optical Receiver.SomeVisualizer componentsare also used in this simulation such as Optical Spectrum Analyzer, Optical Time Domain Visualizer and BER Analyzer.With the help of this three section Self Phase Modulation effect is reduced.

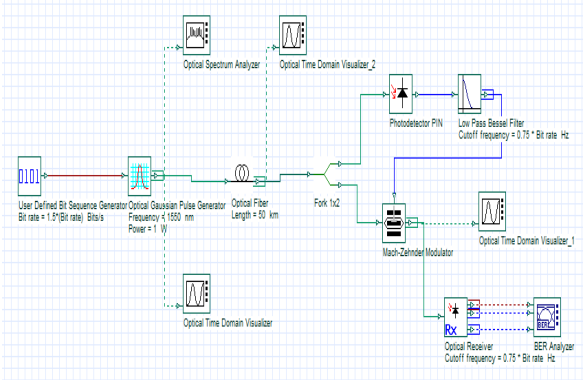

Figure 1.Simulation Layout For reduction of SPM effect.

## III. WORKING PRINCIPLE

In this simulation result a User Defined Bit Sequence Generator provide the data sequence. This data is transferred to the Optical Gaussian Pulse Generator.First section is the transmitter section, whose task is to generate the input data sequence to the optical channel.
An Optical Fiber should contains some parameters such as length, attenuation, dispersion and effective fiber area.In this paper 50km, 60km, 70km, 80km length of the fiber is compared for error free transmission of signal.Above this 80km length of the fiber produces the wide distorted signal compared with these distances.Reference wavelength is 1550nm.
At the receiver section, Fork is like as a splitter but it supports any type of signal that means it can support either electrical or optical signal.Mach Zehnder Modulator also used in this receiver section for reduction of SPM effect.In generally Photodetector APD is used for the high gain.But in this simulation Photodetector PIN is used because it produces the low noise compared with the Photodetector APD.

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Photodetector basically does optical to electrical conversion.Low pass Bessel filter is used for maximally flat delay.Optical Spectrum Analyzer estimates the input spectrum by partitioning the total data sequence into various section.BER analyzer produces the Eye diagram that can be used to effectively analyze the performance of the system. These are the working principle of the reduction of Self Phase Modulation process.

## IV. RESULTS AND DISCUSSION

From the simulation results the input signal is generated without any distortion at before the fiber section.But after the fiber section SPM is introduced by the variation of the refractive index due to the transmitted input optical power and fiber length.In this simulation, SPM is reduced at the 50km length of the fiber after that some different length of fiber is used for the comparison of the Q-factor, BER, and Eye Height.Finally choose the anyone fiber length which one is given the better performance compared with other length of fiber.Figure 2 shows an Input signal at before the transmission of signal.

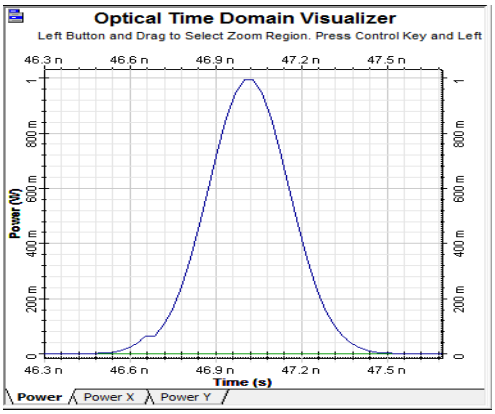


Figure 2.Simulation result for before transmission of signal

The reference wavelength is taken as 1550nm.Fiber effective area is 80um^2.Optical fiber has the 16.75ps/nm/km dispersion value. The 1W of power and 50km length of fiber induces the Self Phase Modulation after the fiber section that shows in the Figure 3.

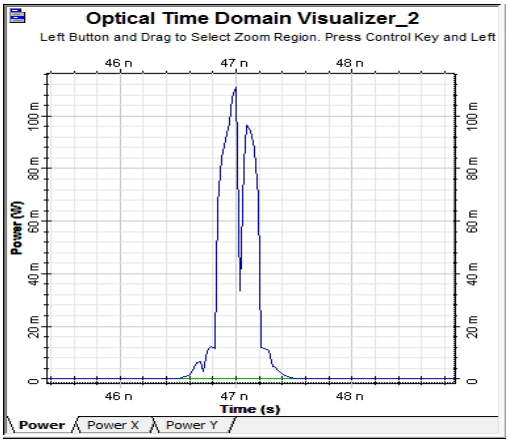


Figure 3.Simulation result for after 50km transmission of signal

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SPM is used for various applications such as Optical Switching, Soliton Formation and also it decreases the performance of the system.For this reason SPM is reduced without degradation of the system performance.SPM is reduced after using Mach Zehnder Modulator that shownin Figure 4 for different length of fiber.

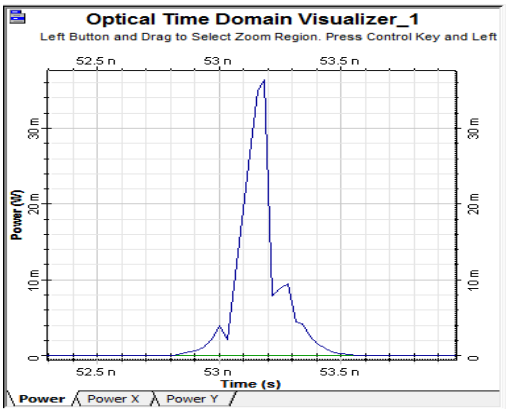


Figure 4(a). Simulation result for reduction of SPM at 50km

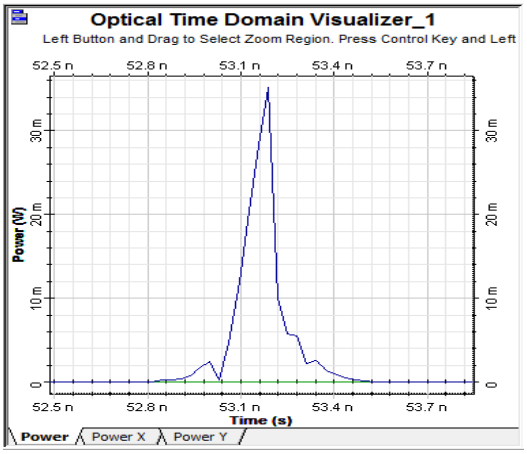


Figure 4(b). Simulation result for reduction of SPM at 60km

From this simulation results, If the length of the fiber is increased that should provide the high level reduction of SPM effect.Because SPM effect is mainly depends on the transmitted power.But this is inversely to the BER and Eye Height.If the length of the fiber is increased, BER reduced that should produce the improvement of the signal quality.Eye Height is high when the minimum length of the fiber compared with remaining fiber.

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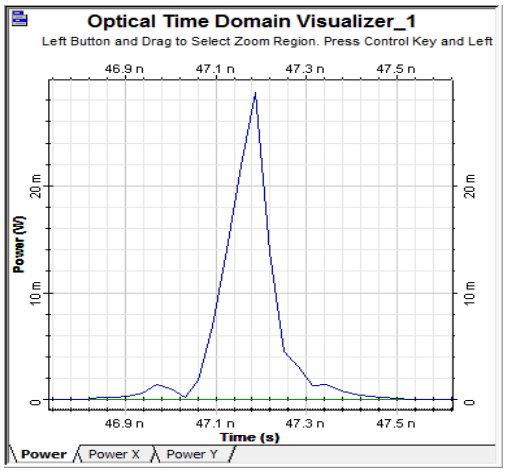


Figure 4(c). Simulation result for reduction of SPM at 70km

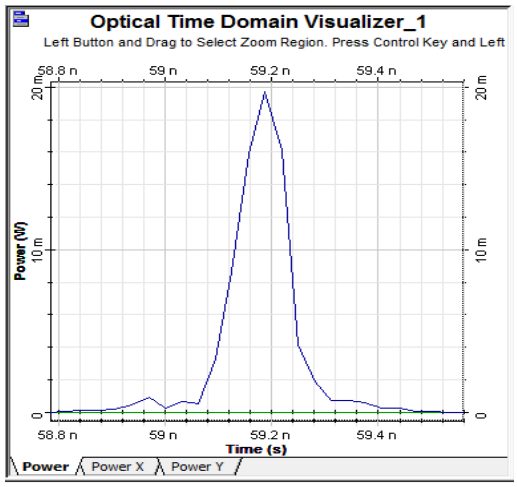


Figure 4(d). Simulation result for reduction of SPM at 80km

In the above simulation result shows the reduction of the Self Phase Modulation.This output is approximately equal to the input signal.In this paper, reduce the Self Phase Modulation upto some extent but still not able to completely remove the Self Phase Modulation.
After this work try to fully eliminate the SPM effect.This reduction of SPM produces the BER, Q-factor and Eye Height for 50km, 60km, 70km and 80km.Eye Diagram result is shown in Figure 5 for 50km, 60km, 70km and 80km.

The reduced Eye Height explains the growth of Selfphase Modulation effect.50km length of fiber provides the maximum Eye Height compared with others.Bur BER is high compared with others.So SPM is reduced in this 50km length of the fiber only.

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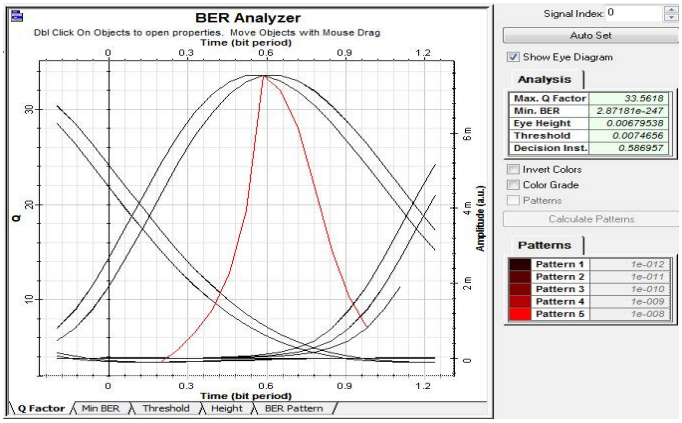


Figure 5(a).Eye diagram results for 50km length of fiber

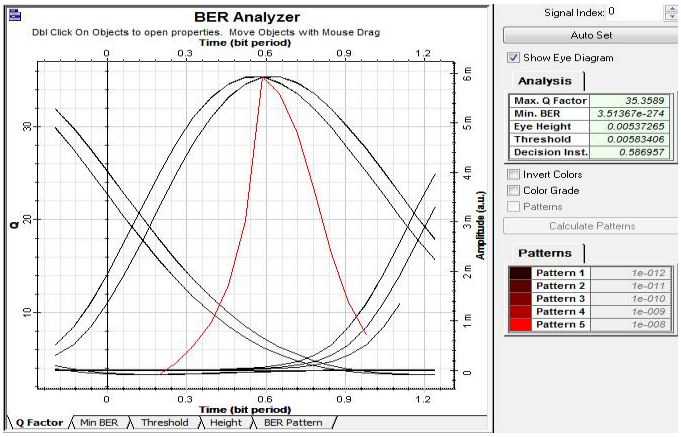


Figure 5(b).Eye diagram results for 60km length of fiber

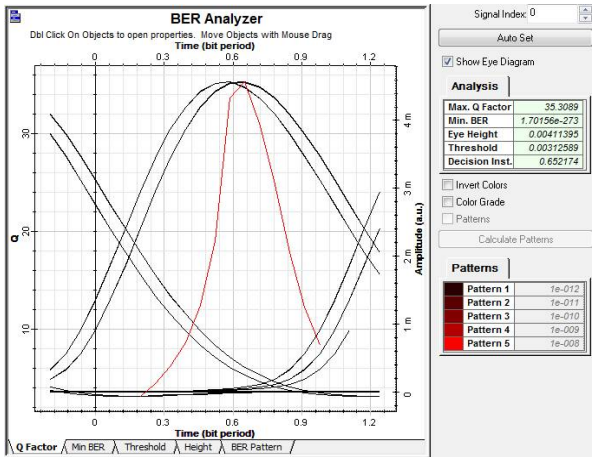


Figure 5(c).Eye diagram results for 70km length of fiber

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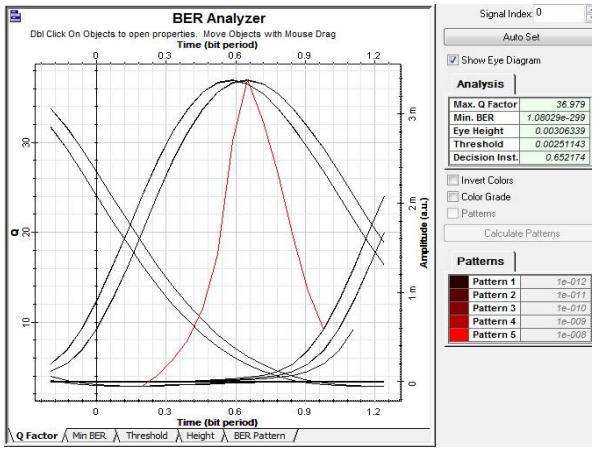


Figure 5(d). Eye diagram results for 80km length of fiber

Minimum BER is achieved in the 80km length of the fiber.But Eye height is narrow compared with others.Maximum Q-factor also achieved in the 80km length of the fiber.

## V. CONCLUSION

The reduction of Self Phase Modulation on the optical fiber is reported in this paper.It was concluded that for the successful transmission, a trade off must be taken between the Optimum condition of the Mach Zehnder Modulator and Eye Height value to reduce the Self Phase Modulation.SPM is reduced after that with the help of MZM, Optimum value of input power and varyfiber length such as 50km, 60km, 70km, 80km that produces the different values of BER, Q-factor, and Eye Height.Finally 50km length of the fiber is suitable for the reduction ofSPM because that length has the Wide Eye Height range.

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