Don Bosco Institute of Technology

Optical Communication

Dispersion in Optical Fiber using OptiSystem

A Group Project Report submitted to Don Bosco Institute of Technology

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In

Electronics & Telecommunication

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ABSTRACT

Fiber optic communication technologies are constantly evolving and face many challenges that limit their long transmission capacity over large volumes. One of these challenges is the destructive nature that occurs when optical signals pass through the fiber. There are two causes of degradation - reduced energy and distribution. Reducing these effects will help the system to support long-distance transmission with greater force.

Dispersion is one of the very important factors in the optical fibers that distort every limited bandwidth signals and cause problems for detecting the signal in the receiver.

INTRODUCTION

Dispersion is the temporal spread of light pulse in time. The effect of dispersion is slowing down of the data rate and in extreme case bit overlapping or ISI (inter-symbol interference) which restrict to recover the original data.

$$\boxed{\text{Dispersion, } \triangle\tau = \text{L. D.} \triangle\lambda}$$

L = Length of the Link, D = Dispersion Parameters, $\triangle\lambda$ = Spectral Width

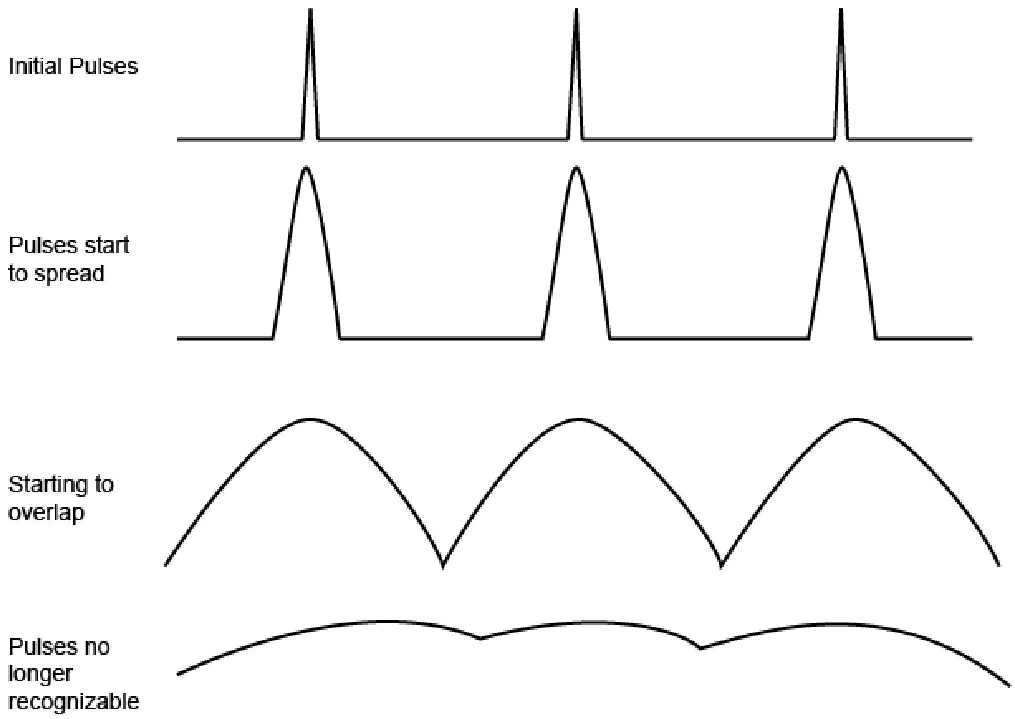


Figure 1: Dispersion and its Effect

In Fiber optic communication there are 4 types of dispersion. They are:

- Modal/Intermodal Dispersion
- Material/Chromatic Dispersion
- Waveguide Dispersion
- Polarization Mode Dispersion

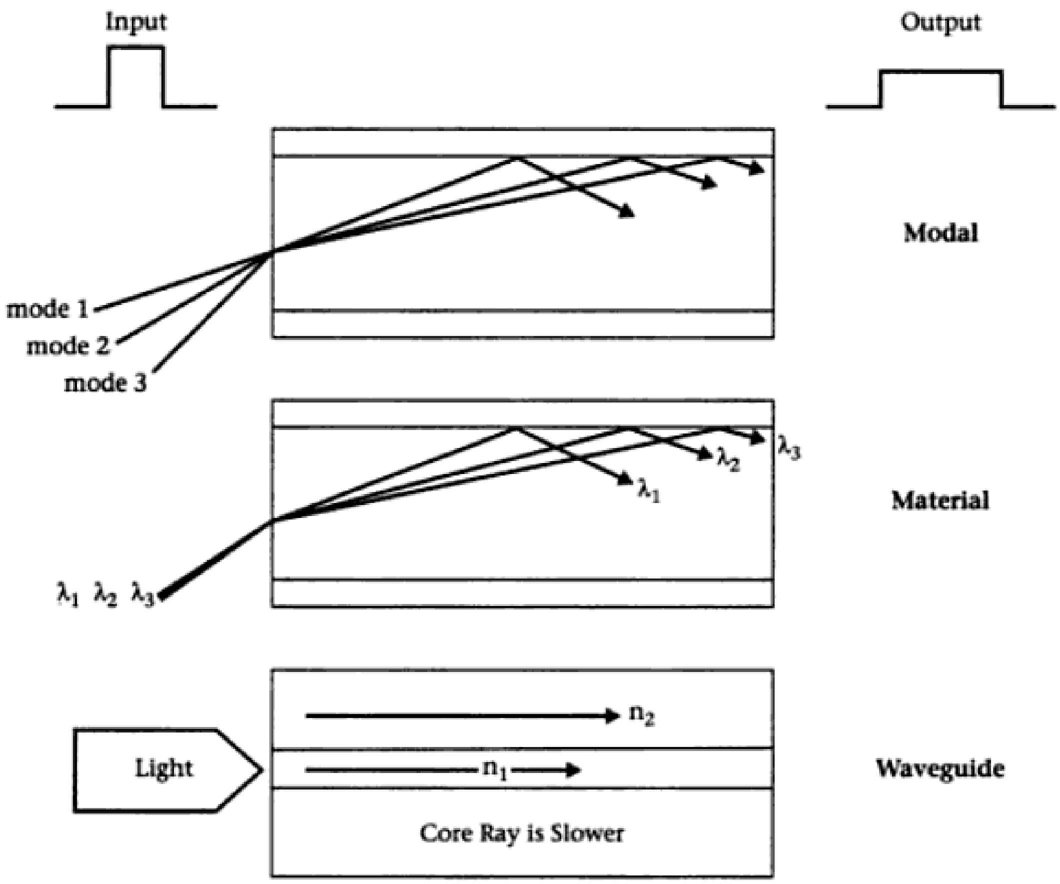


Figure 2: Intermodal, Material and Waveguide Dispersion

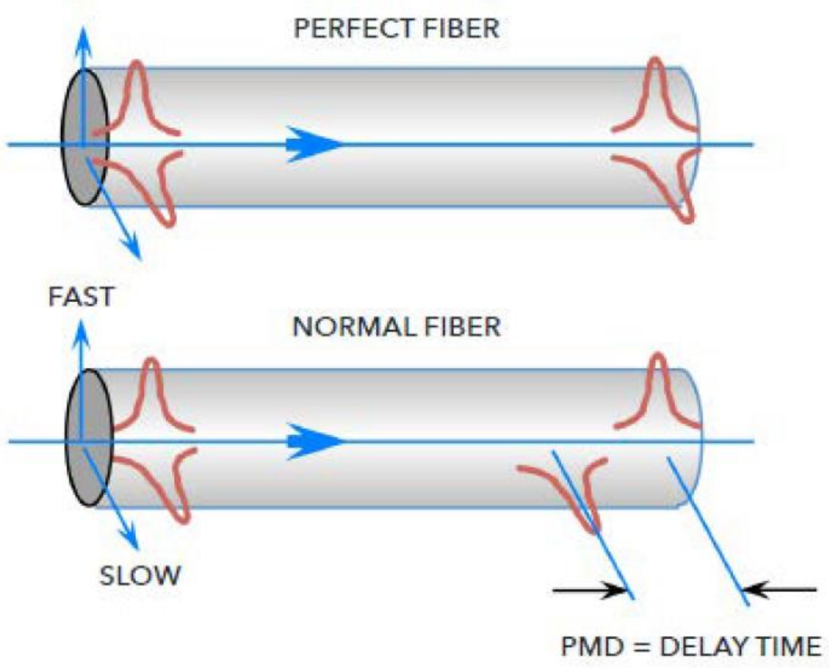
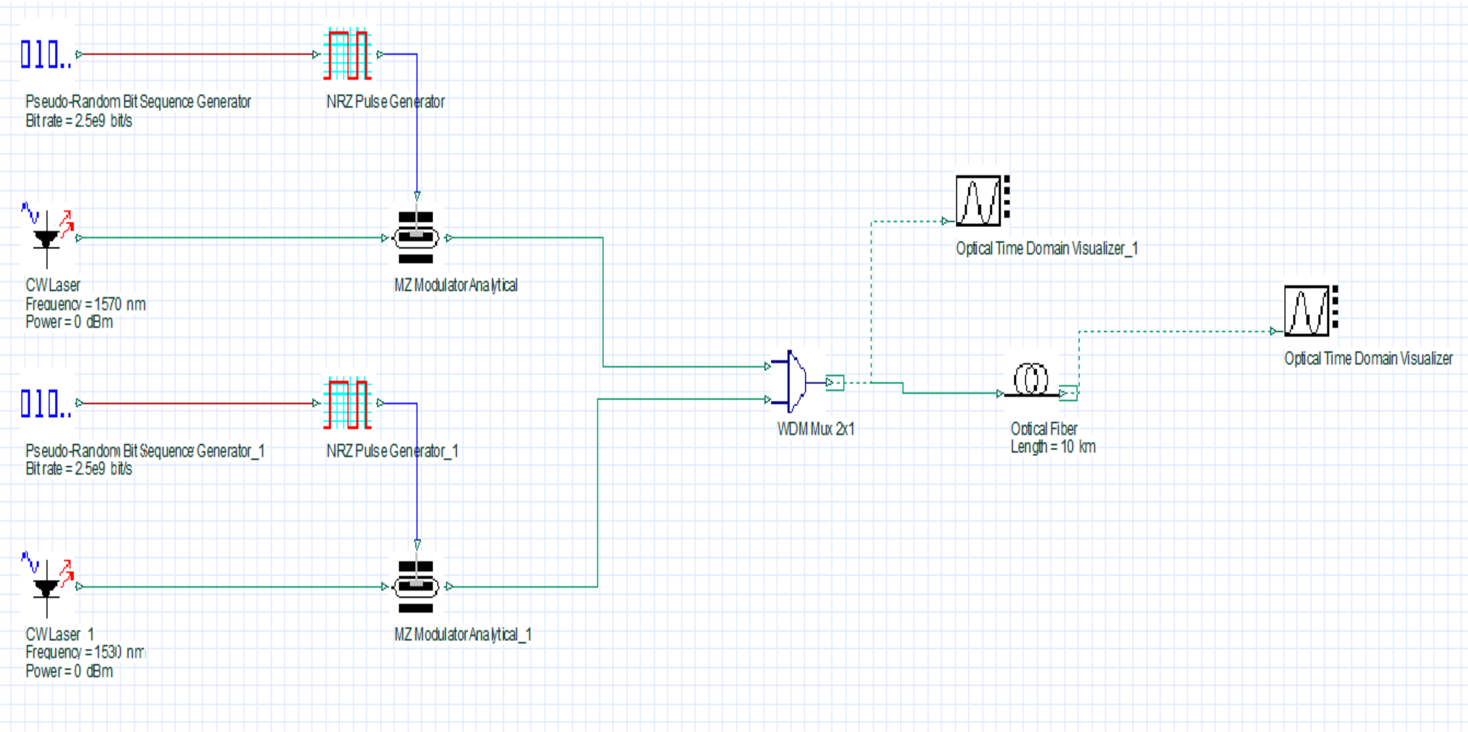


Figure 3: Polarization Mode Dispersion

Software Used: OptiSystem 17

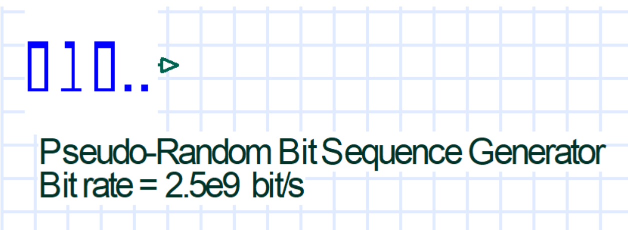
Layout



Components Required for OptiSystem

1. Pseudo-Random Bit Sequence Generator – 2
2. NRZ Pulse Generator – 2
3. CW Laser – 2
4. Mach-Zehnder Modulator – 2
5. WDM Mux 2x1 – 1
6. Optical Fiber – 1
7. Optical Time Domain Visualizer – 2

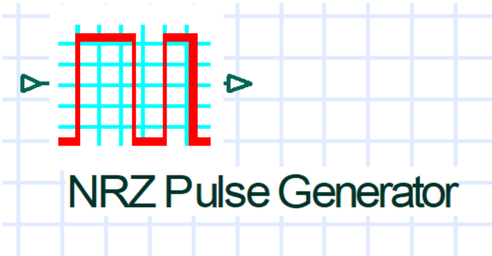
Pseudo-Random Bit Sequence Generator



The Pseudo random bit sequence can be used to generate a binary sequence of pseudo random bits. The bit sequence can be connected to a binary sequence visualizer so that the output bit sequence can be seen.

Double clicking the block shows the main properties. Double clicking beside bit rate we can change the bit rate of the block to base it on other parameters or to make it get it's value from a function. Pressing Evaluate we can see what the current value of bit rate is . If we want to change the value of the bit rate defined for the entire project we can double click on our work space and the global parameters window will pop up. In the global parameters window the bit rate for the project as well as other global parameters may be changed. Now returning to the bit sequence generator and pressing evaluate script we can see that the bit rate has been updated. With the operation mode on probability the bit sequence generator will generate a random output and the probability of generating a 1 will be based on the Mark probability. The length of the sequence generated will be equal to that of the global parameter sequence length.

NRZ Pulse Generator



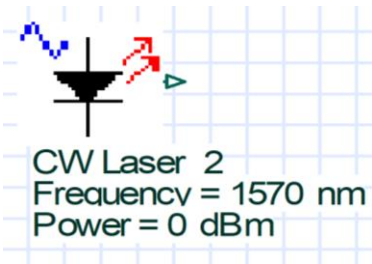
The NRZ Pulse Generator component allows users to create a sequence of non-return to zero pulses that are coded by a digital signal input. This video describes how to setup and modify the NRZ Pulse Generator in OptiSystem.

The NRZ pulse generator generates a Non-Return to Zero coded electrical signal which is dependent on a bit sequence input. Since the pulse generator's output is dependent on a bit sequence, we will connect a user defined bit sequence generator to its input.

The pulse generator outputs an electric signal so we will be using an oscilloscope to visualize it. The bit sequence we should expect at the output is dependent on the bit sequence generator and can be seen here. Calculating the project, we can see the output of the pulse generator in the oscilloscope. As you can see the pulse generator replicates the input bit sequence as the output stays high when the input bit is 1 and goes low when the input bit is 0.

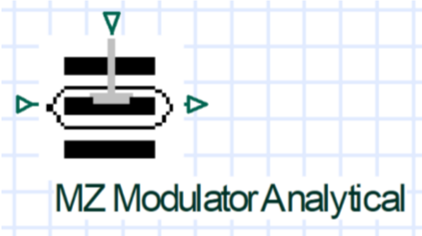
The general properties of the pulse generator can be found by double clicking the block. In the main window we have parameters that alter properties of the pulse.

CW Laser



A CW laser is a continuous output (constant on) type of laser versus a pulsed laser meaning the output turns on and off at a specific rate. CW actual stands for continuous wave. Producing a CW laser output can be accomplished with different types of materials including gas, crystals or semiconductor.

Mach-Zehnder Modulator

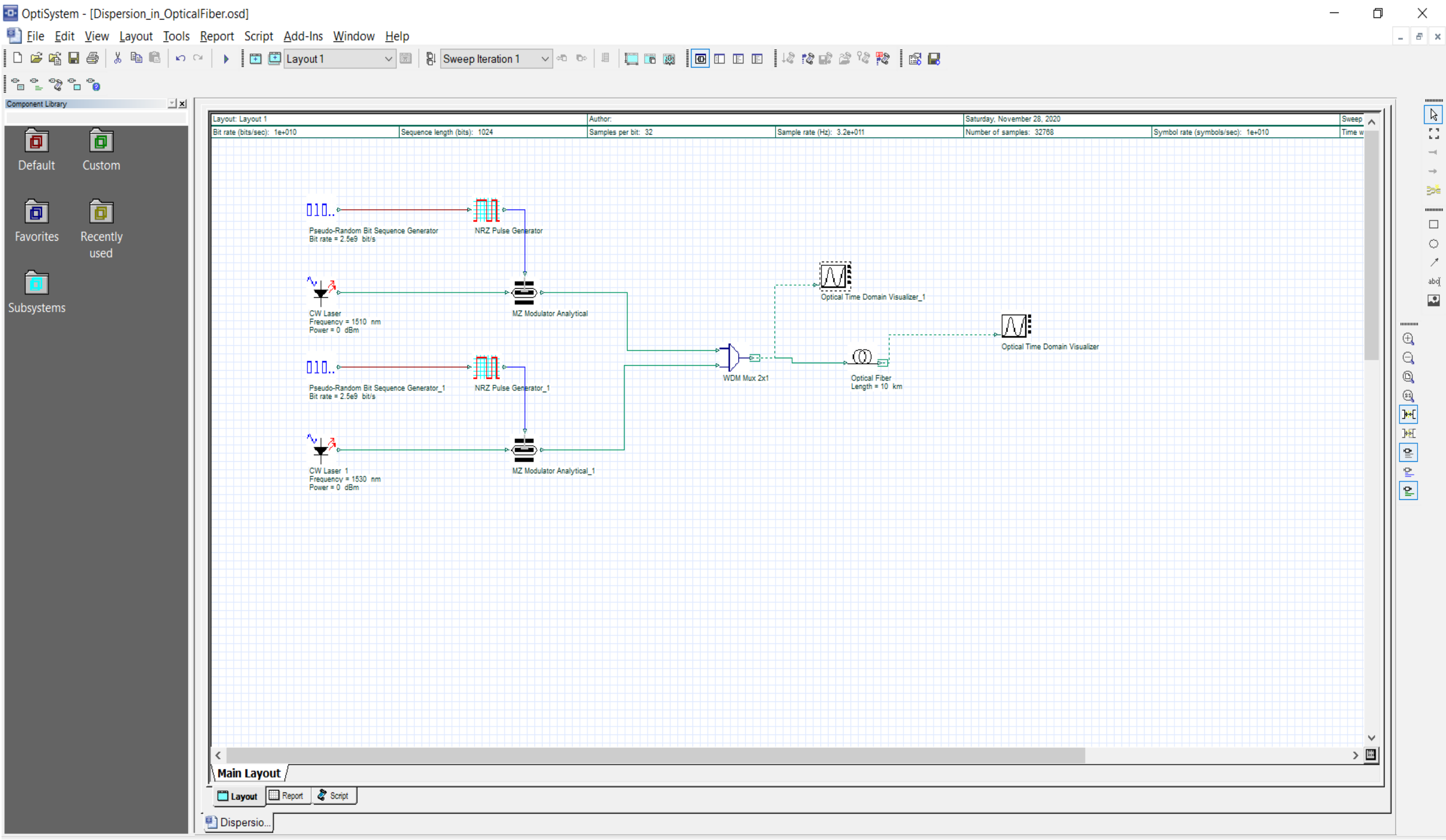


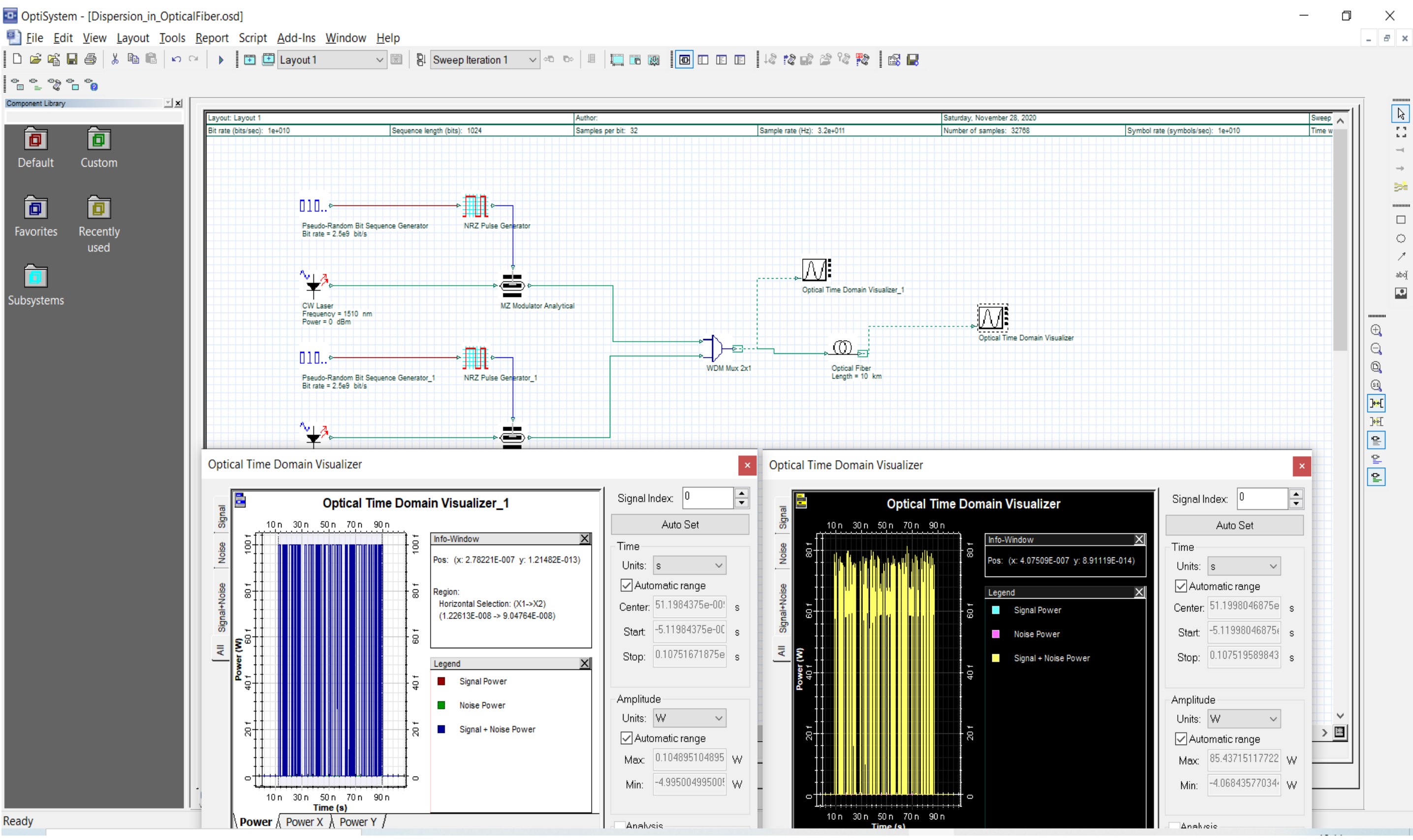
A Mach-Zehnder modulator is used to control the amplitude of an optical wave which is given to it. The input waveguide is split up into two waveguide interferometer arms. If a voltage is applied across one of the arms, a phase shift is induced for the wave passing through that arm.

Optical Time Domain Visualizer

Displays the modulated optical signal in the time domain

Output





Output for 5km Optical Fiber Cable

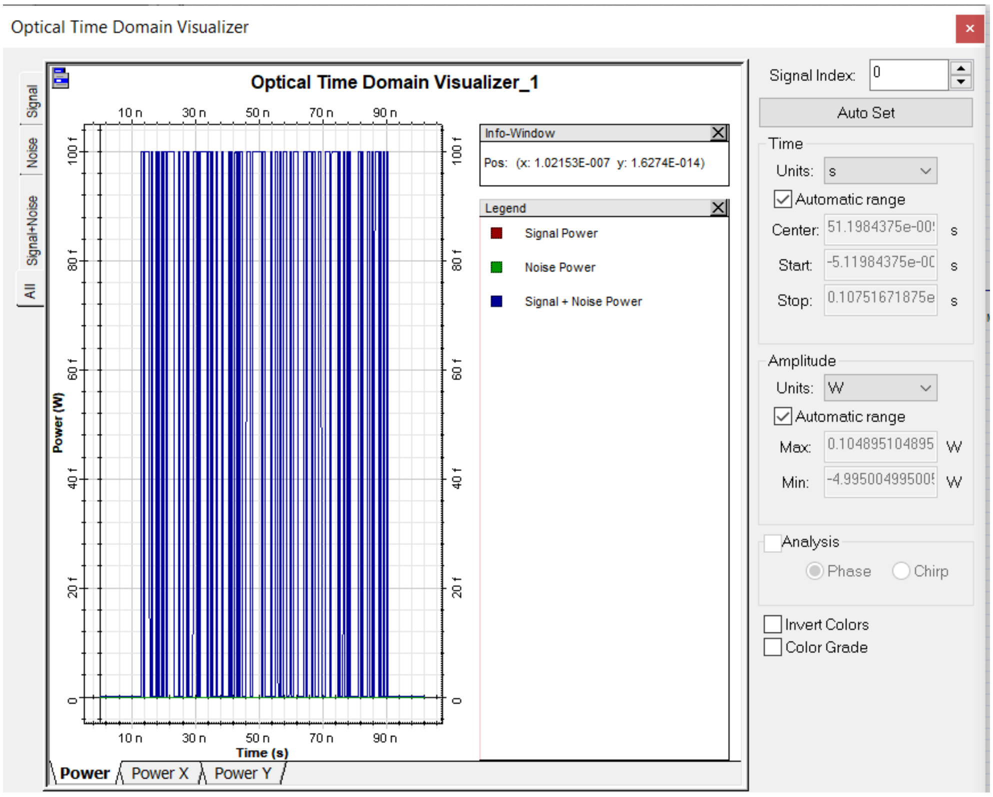


Figure 4: No dispersion before optical fiber

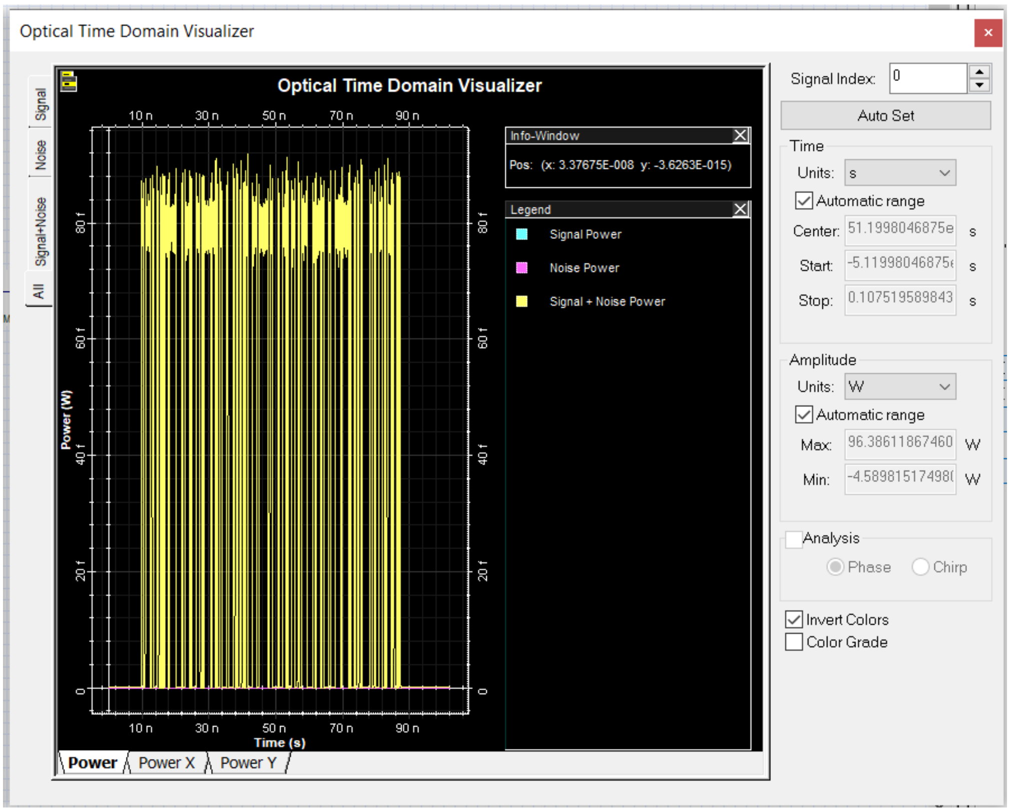
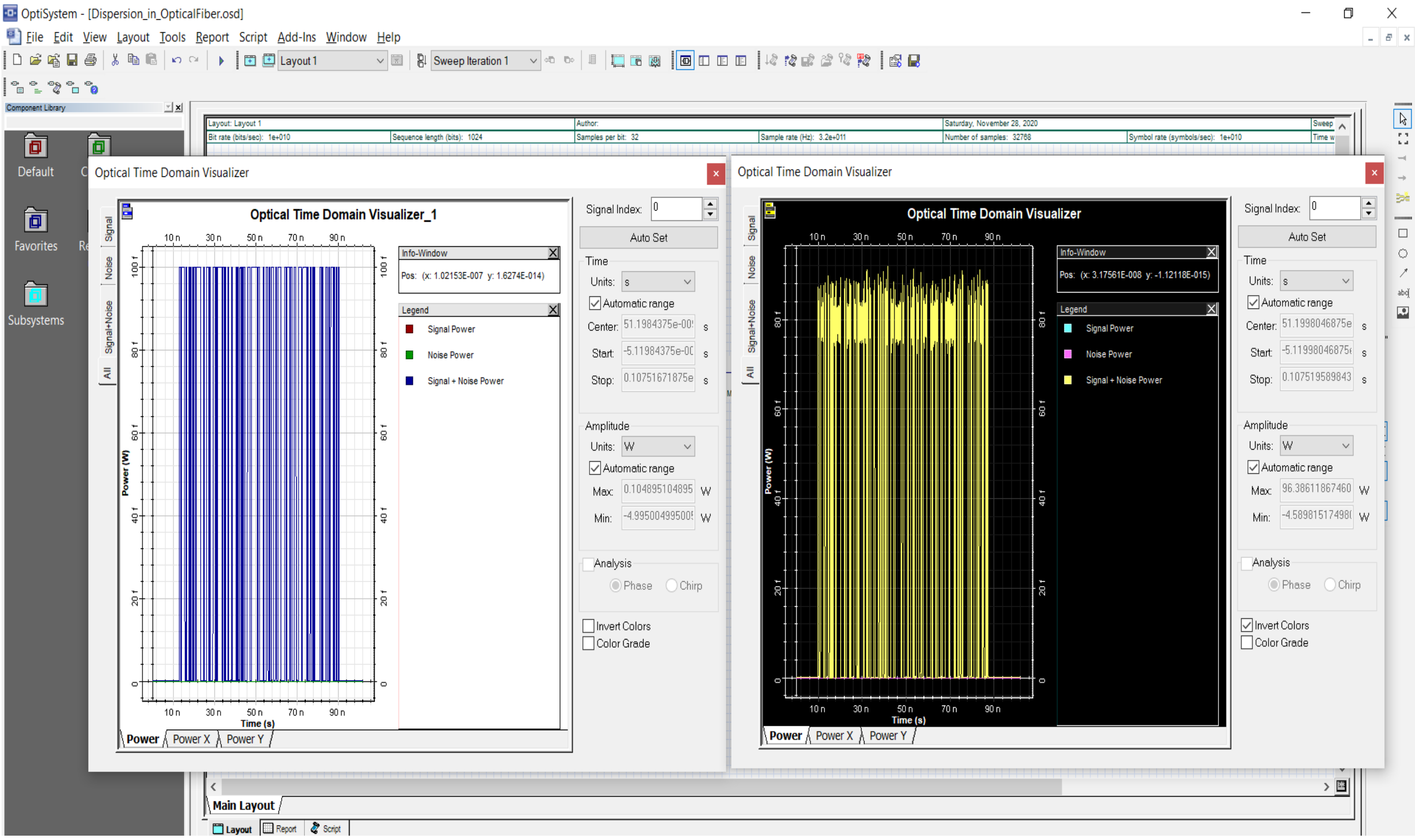


Figure 5: Dispersion in optical Fiber for 5km Length Cable



Output for 10km Optical Fiber Cable

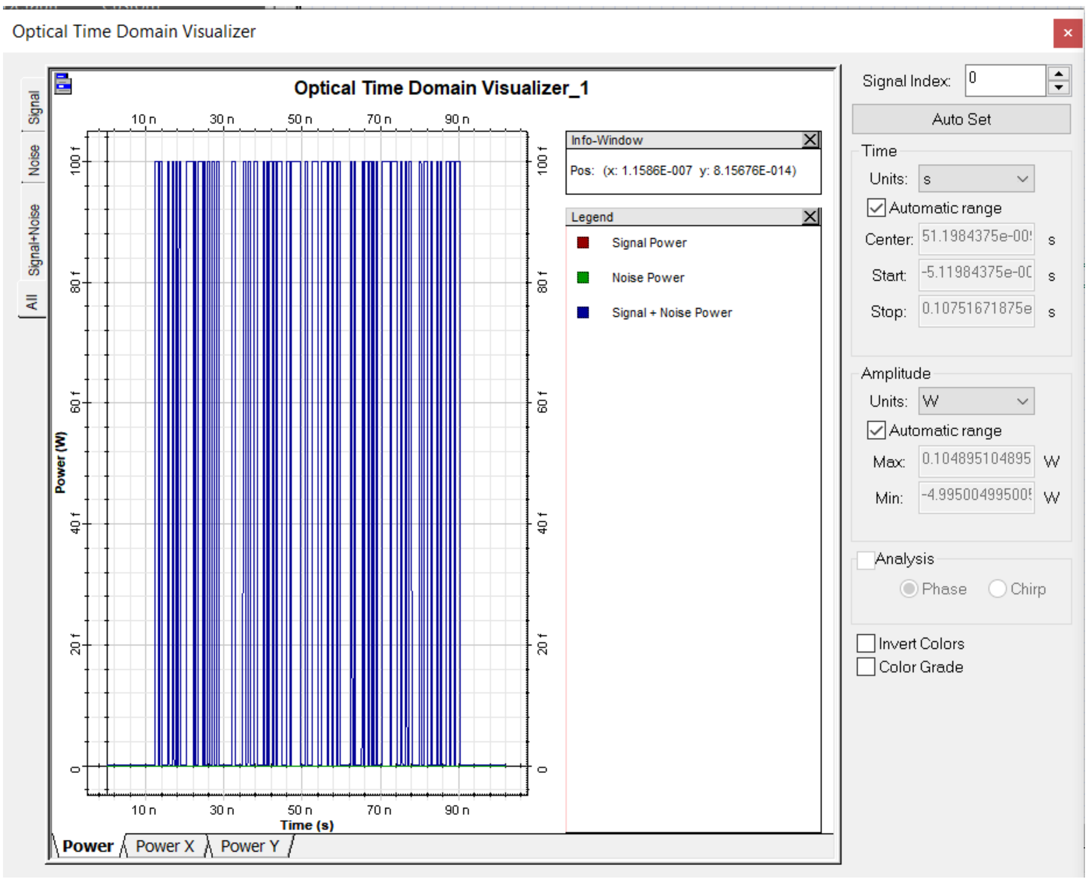


Figure 6: No Dispersion before Optical Fiber

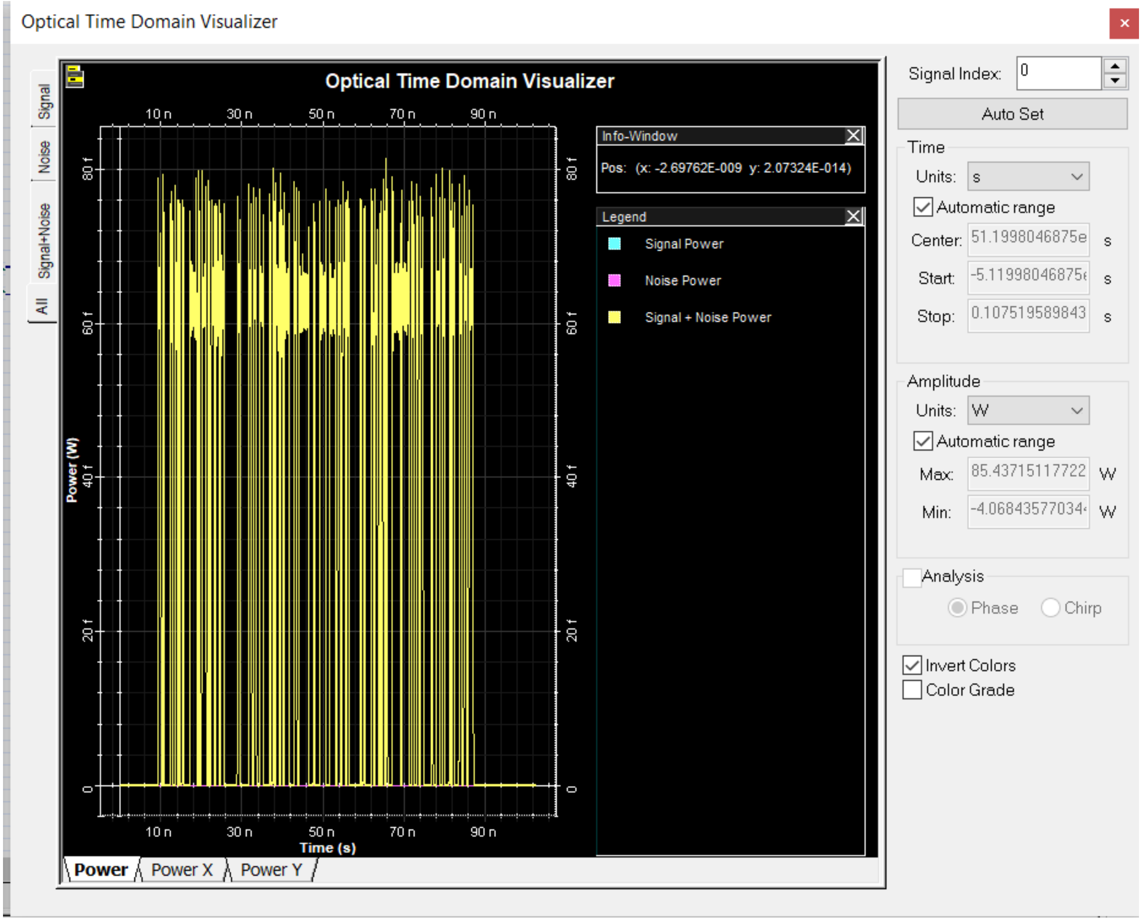
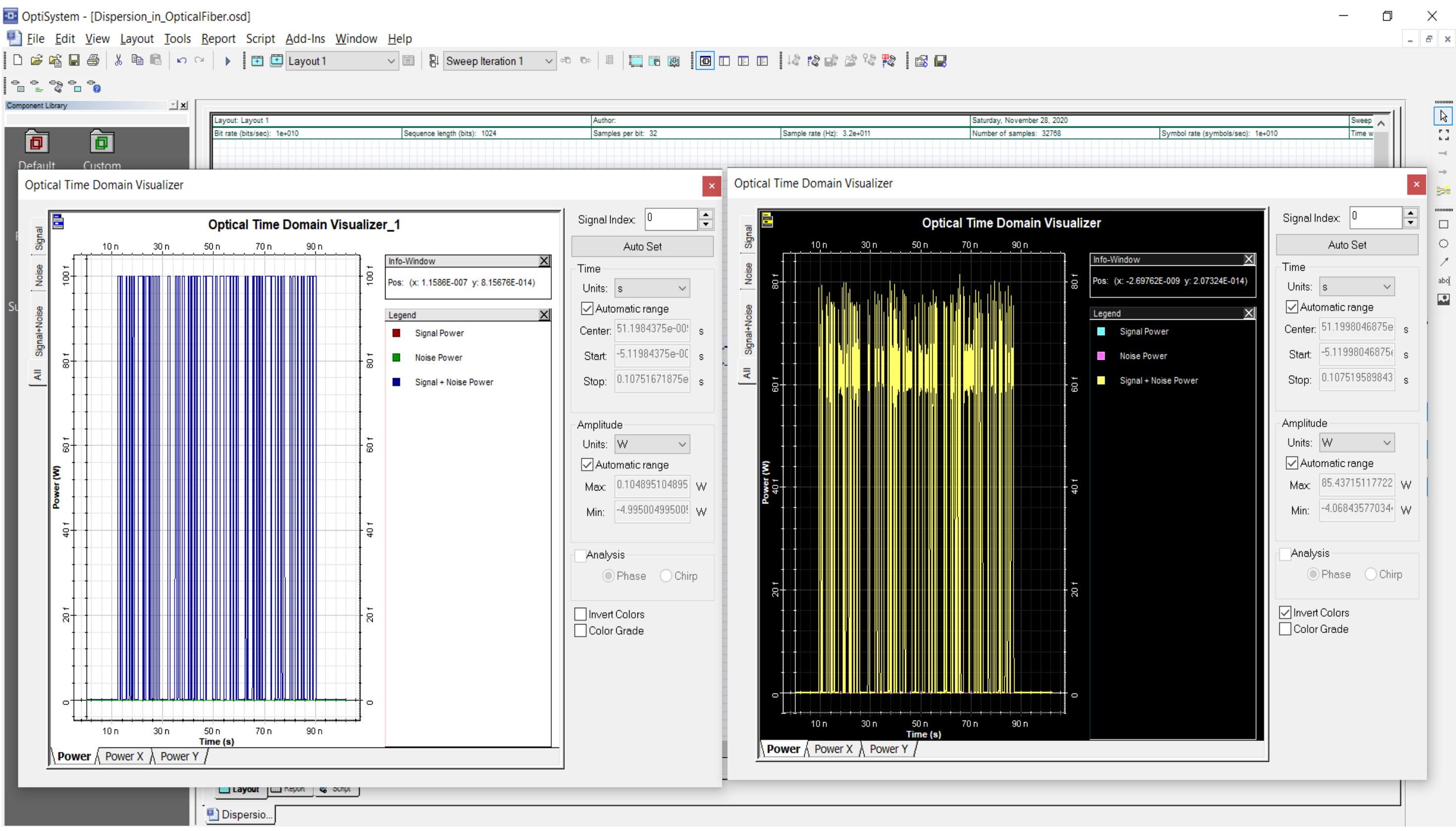


Figure 7: Dispersion in Optical Fiber for 10km Length Cable



Conclusion

We have analysed the dispersion compensation using Mach-Zehnder Modulator at different fiber lengths, The simulated transmission system have been analysed on the basic of different parameters. By simulating a model of communication system and using the most suitable settings of the system which include input power (dBm), fiber cable length (km), FBG Length (mm) and attenuation coefficient (dB/km) at cable section. All the results are analyzed using OPTISYSTEM 17 simulation at 10 Giga bits per second (Gb/s) transmission systems. From the simulation result, it can conclude that for every optical fiber cable of different lengths there would be a little dispersion in optical fiber cable.

References

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