Dispersion Compensation in Optical Fiber Communication Using Fiber Bragg Grating

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Received: 14 February 2012 Accepted: 29 February 2012 Published: 15 March 2012

Abstract

Optical fiber is one of the most important communications media in communication system.Due to its versatile advantages and negligible transmission loss it is used in high speed data transmission. Although optical fiber communication has a lot of advantages, dispersion is the main performance limiting factor. Dispersion severely degrades the performance of optical fiber. There are various methods for dispersion compensation. Due to some superior advantages Fiber Bragg Grating is a well known hot cake in the field of dispersion compensation in optical fiber communication. Generally Fiber Bragg Grating has a very narrow operating window. An effective method for broadening the window of Fiber Bragg grating is shown in this thesis work, which gives a satisfactory operating window. In this thesis paper a typical MATLAB simulation work is done to compensate dispersion up to a fiber length of 300 Km.

Index terms— Dispersion, Fiber Bragg Grating, Pulse Broadening Characteristics, Window Broadening, Dispersion compensation.

1 INTRODUCTION

ispersion is the main performance limiting factor in optical fiber communication. Dispersion greatly hampers the performance of optical fiber communication. Due to dispersion, broadens optical pulse as they travel in single mode fiber. Limiting the ultimate data rate supported by fiber which causes spreading and overlapping of chips and degrades system performance due to increase inter chip interference and reduced received optical power. So if dispersion can be minimized then a further performance can be obtained from optical fiber communication. There are a lot of methods of dispersion compensation. Fiber Bragg Grating is one of these.

When a pulse travels through an optical fiber due to dispersion it becomes broadened. The dispersion is proportional to the length of the fiber. If the length is increased the width becomes bulk and the magnitude reduces. We tested here for the length up to 700 km using interval of 100 km. For uniform grating period in reflectivity vs. detuning curve the window width increases with increase of coupling constant. In our thesis work we varied the value of coupling constant from one to six with interval one. We tested a Gaussian pulse passing through an optical fiber from one hundred to three hundred km long with an interval of fifty km with Fiber Bragg Grating and without Fiber Bragg Grating at receiving end. The performance we measured as dispersion with lengths when the Gaussian pulse travels through Fiber Bragg Grating and without Fiber Bragg Grating. Fiber Bragg gratings are created by "inscribing" or "writing" the periodic variation of refractive index into the core of a special type of optical fiber using an intense ultraviolet (UV) source such as a UV laser. Two main processes are used: interference and masking. Which is best depends on the type of grating to be manufactured. A special germanium-doped silica fiber is used in the manufacture of fiber Bragg gratings. The germanium-doped fiber is photosensitive, in that the refractive index of the core changes with exposure to UV light, with the amount of the change a function of the intensity and duration of the exposure. The first in-fiber Bragg grating was demonstrated by Hill in 1978. Initially, the gratings were fabricated using a visible laser propagating along the fiber core. In 1989, Meltz and colleagues demonstrated the modern transverse holographic technique from the side of the fiber utilizing the interference pattern of ultraviolet light.

2 II. PULSE BROADENING CHARACTERISTICS

We have used a super-Gaussian pulse whose RMS pulse width after transmission in a dispersive medium is given analytically. Its RMS width c normalized by initial RMS width 00 is given by, shown at the end of this paragraph, where r is the Gamma function. Abstract -Optical fiber is one of the most important communications media in communication system. Due to its versatile advantages and negligible transmission loss it is used in high speed data transmission. Although optical fiber communication has a lot of advantages, dispersion is the main performance limiting factor. Dispersion severely degrades the performance of optical fiber. There are various methods for dispersion compensation. Due to some superior advantages Fiber Bragg Grating is a well known hot cake in the field of dispersion compensation in optical fiber communication. Generally Fiber Bragg Grating has a very narrow operating window. An effective method for broadening the window of Fiber Bragg grating is shown in this thesis work, which gives a satisfactory operating window. In this thesis paper a typical MATLAB simulation work is done to compensate dispersion up to a fiber length of 300 Km. From Fig3.6.2 we see that with the increase of the positive value of ?, the broadening increases. Also with the increase of the negative value of , the broadening also increases. The broadening is minimum when ?= 0.

3 III. EFFECT OF THE LENGTH OF THE FIBER ONLY CONSIDERING THE DISPERSION

The fiber dispersion index is directly proportional to the length of the fiber. With increasing the length of the fiber dispersion index also increases. The effect of the fiber length under transmitted data through the fiber are given below constants KL =1 to 6, as a function of normalized detuning. For KLg=1(green), KLG=2(yellow),KLg=3 (magenta) , kLg=4(cyan) ,KLg=5(red) ,KLg=6(black) .The side-mode structure increases rapidly for stronger gratings.

V.

4 DISPERSION COMPENSATION

5 CONCLUSION

It is shown in this thesis that the recent advances in Fiber Bragg grating technology now allow the realization of a highperformance, high speed optical fibers with good in line dispersion compensation. The characteristic of optical fiber is analyzed. The dispersion is computed by sending a Gaussian pulse as an input. For 200km length of fiber this is observed that dispersion is approximate 75.5ps/nm/km. This is quite impossible to remove but in our thesis we have succeeded to compensate dispersion up to 33. 8 [1]

Figure 1:

212

Figure 2: Fig 2 . 1 :

22 t_0

Figure 3: Fig 2 . 2 :

3141

$$\frac{\sigma}{\sigma_0} = \sqrt{1 - \frac{\Gamma(1/2m)}{\Gamma(3/2m)}\frac{\alpha\beta_2 L}{t_0^2} + \frac{\Gamma(2-1/2m)}{\Gamma(3/2m)}\frac{(1+\alpha^2)(m\beta_2 L)^2}{t_0^4}}$$

Figure 4: Figure 3 . 1 :Figure 4 . 1 :

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$$\sqrt{1 - \frac{\Gamma(1/2m)}{\Gamma(3/2m)}\frac{\alpha\beta_2 L}{t_0^2} + \frac{\Gamma(2-1/2m)}{\Gamma(3/2m)}\frac{(1+\alpha^2)(m\beta_2 L)^2}{t_0^4}}$$

Figure 5: Figure 5 . 1 :Figure 5 . 2 :Figure 5 . 3 :VolumeFigure 5 . 4 :Figure 5 . 5 :Figure 6 . 1 :

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[Note: Simulation Results for the FBG dispersion compensation of uniform grating period receiver VII.]

Figure 6: Table :

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