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Design and comparative performance analysis of different chirping profiles of tanh apodized fiber Bragg grating and comparison with the dispersion compensation fiber for long-haul transmission system

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ABSTRACT

Various dispersion compensation units are presented and evaluated in this paper. These dispersion compensation units include dispersion compensation fiber (DCF), DCF merged with fiber Bragg grating (FBG) (joint technique), and linear, square root, and cube root chirped tanh apodized FBG. For the performance evaluation 10 Gb/s NRZ transmission system over 100-km-long single-mode fiber is used. The three chirped FBGs are optimized individually to yield pulse width reduction percentage (PWRP) of 86.66, 79.96, 62.42% for linear, square root, and cube root, respectively. The DCF and Joint technique both provide a remarkable PWRP of 94.45 and 96.96%, respectively. The performance of optimized linear chirped tanh apodized FBG and DCF is compared for long-haul transmission system on the basis of quality factor of received signal. For both the systems maximum transmission distance is calculated such that quality factor is ≥ 6 at the receiver and result shows that performance of FBG is comparable to that of DCF with advantages of very low cost, small size and reduced nonlinear effects.

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1. Introduction

With the tremendous increase in bandwidth-hungry applications, we need to explore the new methods and techniques for communication to meet such demands. Currently, optical fiber communication is one of the most important members among the high-speed communication technologies (*1*). Wavelength-division-multiplexed systems in optical communication provide the highest bandwidth and speed of all the modern communication networks (*2, 3*). In general, there are three main obstacles to the fiber communications: attenuation, dispersion, and nonlinear effects. Erbium-doped fiber amplifier (EDFA) can be introduced to compensate for the transmission loss due to fiber attenuation loss and other losses. Nonlinear effects can also be avoided by working at suitable power levels. For long-haul and high-speed transmission, dispersion acts as the major limiting factor because it limits ability to achieve both the remarkable transmission link length and data rate (*4*).

A number of techniques have been proposed and can be broadly divided into: Predistortion compensation used at transmitter side, Postdetection compensation used at receiver side, and Inline-compensation done along the channel (*5*). Among these Inline compensation is the main method while both the Predistortion and Postdetection compensation methods are usually used to enhance the dispersion mitigating performance of inline techniques. The inline techniques roughly include techniques such as DCF (*6*), HOM-DCF (*7*), FBG (*8*), optical phase conjugation (OPC) (*9*), and photonic crystal fibers (PCF) (*10*); for mitigating dispersion effects.

Among all the dispersion mitigating techniques, FBG has gained a huge interest because of compactness, low cost and insertion loss, passiveness, and above all the compatibility with present optical communication systems. It must be noted here that FBGs are used in a number of applications like filters, signal shaping and generation, tunable optical delay, and sensors. Side lobe reflectivity and group delay ripple (GDR) are reduced by using apodization profiles (*11*). There are numerous apodization profiles, like Gauss, Hamming, Tanh, cosine, Sinc and Cauchy, which could be selected based on the type of application. Uniform FBGs reflect a single wavelength, but for dispersion compensation we need to chirp the grating period

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