Synchronous Optical Fiber Code-Division Multiple-Access Networks with Bipolar Capacity

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Abstract

A non-coherent synchronous optical fiber code-division multiple-access (CDMA) network is proposed. In this network, sequence-inversion keying (SIK) of intensity modulated unipolar balanced Walsh code sequences is employed, whereby a code sequence is transmitted for each data '1' bit while the logical complement of that sequence is transmitted for each data '0' bit. At the receiver the received optical signal is correlated with the bipolar form of the reference sequence. Since the code sequences are balanced and the unipolar-bipolar correlation is implemented the same correlation functions as a bipolar system can be obtained. Hence, in the proposed synchronous optical fiber CDMA network, the cross-correlation of the address sequence and the undesired sequences is zero, that is, the interference is completely eliminated. Therefore, a very large number of users can transmit at the same time and very high throughput can be achieved. The novel design of programmable transmitter and receiver for non-coherent synchronous optical fiber CDMA networks using balanced Walsh codes is also presented. The transmitter and receiver are designed based on the use of electro-optical switches and optical delay-lines.

Keywords*: Optical communications, code-division multiple-access, synchronous optical CDMA networks, sequence-inversion keying, Walsh codes.*

Introduction

Code-division multiple-access (CDMA) techniques have been widely used in satellite and mobile radio communication systems (Dinan and Jabbari 1998). In CDMA systems, in order to accommodate many subscribers and a large number of simultaneous users, long sequences or large spreading factors are required. The available bandwidth in radio channels is normally limited by regulatory authorities and the use of long sequences is not possible. Although copper cables are not subject to this restriction, their bandwidth is generally insufficient for large networks. In contrast, single-mode optical fiber provides enormous bandwidths and the limitations of radio and copper-cable CDMA systems are effectively eliminated. In recent years, many authors have proposed to apply CDMA techniques in future very high-speed optical fiber networks. The optical fiber CDMA network can provide a multiple-access environment without employing wavelength sensitive components, which are required in the wavelength-division multiple-access (WDMA) network, and without using very high-speed electronics processing devices, which are needed in the time-division multiple-access (TDMA) network. Depending on the requirement of time synchronization, there are synchronous (Prucnal *et al.* 1986; Shalaby 1999) or asynchronous optical fiber CDMA systems (O'Farrell and Lochmann 1994; Lam 2000). Compared with asynchronous CDMA network, synchronous CDMA requires network access among all users to be synchronized. It can provide higher throughput (i.e. more successful transmission) and accommodate more subscribers (Kwong *et al.* 1991). It follows that synchronous CDMA is suitable for