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# DPSK Modulation OTDM System - A Survey

Darshan N
Student, Dept. of ECE
N I E Institute of Technology
Mysuru, Karnataka, India

Dilip Kumar
Student, Dept. of ECE
N I E Institute of Technology
Mysuru, Karnataka, India

Harish S V
Assistant Professor, Dept. of ECE
N I E Institute of Technology
Mysuru, Karnataka, India

***Abstract*– Optical fiber is the trending technology which drags major attention on multiple data multiplexed transmission. There is a congestion in sending data over a shared channel. OTDM (Optical Time–Division Multiplexing) is an important technique to overcome the electronic bottleneck and achieve a single channel system. In this paper we suggest a point to point communication using OTDM system and that uses one of the PSK modulation scheme for high transmission rate.**

***Keywords*– *Optical fiber communication; Mach–Zehnder Modulator; Optical Time–Division Multiplexing (OTDM); Phase Shift Keying (PSK);***

## I. INTRODUCTION

The optical fibers are next generation future in Physical layer of computer networks and telecommunication. The range of usage of optical fiber in communication changes the speed of transmission over cannel. Signals are multiplexed and sent over the single channel. But use of optical fiber as core or at the back bone of the network leads to poor efficiency and low bit rate. So this leads to optical modulation techniques and Phase Shift Keying (PSK) Modulations.

To multiplex signal simple technique is Time–Division Multiplexing (TDM). Time–Division Multiplexing is a system in which each signal appears at the shared medium only a fraction time in alternating pattern by the means of synchronized switches [1].

A special electro–optical used to modulate optical signal with electrical signal. Mach–Zehnder is a special kind of electro–optical modulator which is used in this paper. An optical signal's intensity is modulated accordance with the input electrical signal [2][4].

Phase Shift Keying is one of the effective way of modulation. Compared to on–off keying(OOK) and Amplitude shift keying (ASK), PSK modulation exhibits high efficient modulation. Differential Phase Shift Keying (DPSK) is used in this paper for good performance.

In this paper we suggest an Optical Time–Division Multiplexing and optical modulation called Mach–Zehnder Modulation along with PSK, specifically Differential PSK.

## II. METHODOLOGY

The different users send the data in bits. These bits are transmitted over the single shared, medium optical fiber. These data are recovered at receiver. Figure 1 shows block diagram of the OTDM System along with Mach–Zehnder modulator and DPSK modulator.

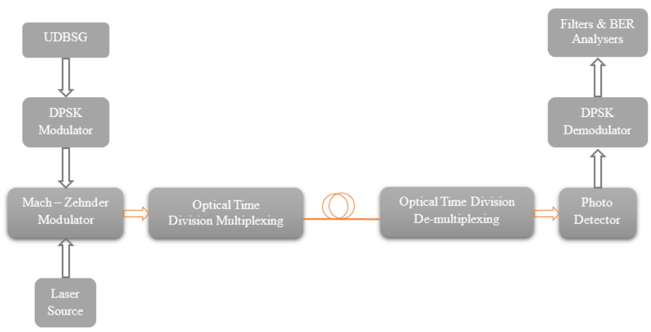


Figure 1 – Block Diagram of OTDM System.

### A. *DPSK Modulation and De–Modulation*

DPSK is a digital modulation technique used to modulate phase of the carrier signal in accordance with the present and previous data. This modulation technique is used at the sender end. When a system receives data bit stream, it modulates with this technique.

DPSK encodes carrier signal's phase with the modulating signal. The serial data input is given to the XOR gate and output is again fed back to the other input through 1–bit delay. The output of the XOR gate along with the carrier

signal is given to the balance modulation, to produce the DPSK modulated signal. Figure 2 shows block diagram of DPSK modulator.

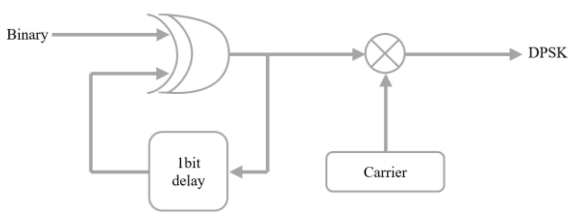


Figure 2 – Block Diagram of DPSK

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The coding rule of differential coder is as below equation.

$$b_n = a_n \oplus b_{n-1}$$

where $b_n$ is current output, $a_n$ is current input and $b_{n-1}$ is previous output. For example, consider the input binary signal 01011001. The TABLE I below shows the phase in the carrier.

TABLE I. THE THEORITICAL RESULT OF DIFFERENTIAL CODER

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| $a_k$ | | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 1 |
| $b_k$ | (1) | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| Phase | (π) | π | 0 | 0 | π | 0 | 0 | 0 | π |

At receiver end the same data is de–modulated to retrieve the bit stream sent by the sender. The below figure 3 shows block diagram of the DPSK De–Modulation. The input electrical signal is split into two and this are multiplied with carrier and inverse of carrier which is carrier phase shifted by $90^0$ as shown in figure 3. These signals are compressed and change to M–ary format using. These signals are compared and coded using DPSK Decoder.

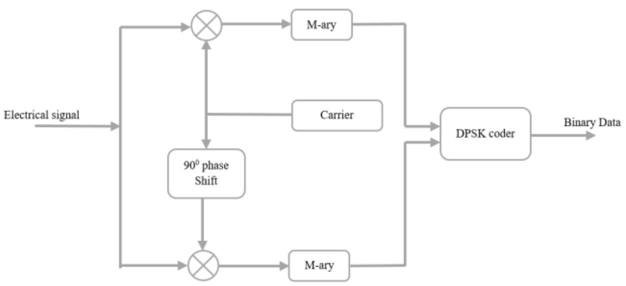


Figure 3 – Block Diagram of DPSK De–modulation

*B. Mach–Zehnder Modulator*

Mach–Zehnder is a special find of electro–optical modulator. There are several electro–optical modulators such as Electro Absorption Modulator (EAM), Amplitude Modulator, Phase Modulator and etc. in which Mach–Zehnder is one of the kind. Waveguide LiNbO3 or Mach–Zehnder modulator which accepts optical carrier and electrical modulation signal and gives modulated optical signal.

The Mach–Zehnder has an input optical branch which splits the incoming optical signal in to two arms. These two arms have the signal out of phase to each other. These arms contain electrodes as shown in figure 4. These electrodes are applied with electrical input signal. Application of electric signal to one or both of the optical arms through electrodes controls the degree of interference. Then the output optical signal is intensity varied input in accordance with electrical signal. Figure 4 shows the Schematic diagram of Mach–Zehnder Modulator.

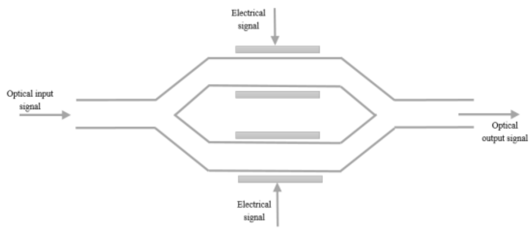


Figure 4 – Schematic Diagram of Mach–Zehnder

*C. Optical Time–Division Multiplecing (OTDM)*

The Time–Division Multiplexing technique in which the inputs and output will be of optical signal. N number of optical signals are fed to the OTDM and all signals are combined to a single optical signal. This process is called Optical Time–Division Multiplexing. Figure 4 shows the simple timing diagram of four input channel OTDM system [5].

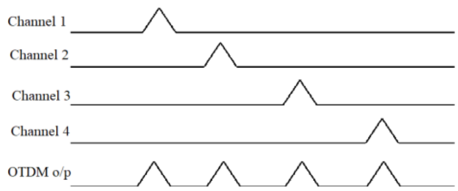


Figure 4 – Simple Timing Diagram.

OTDM is made up of time delayer and power combiner. Delay for each channel is varied. If there are N channels to be multiplexed, then the delay of nth channel (Δd) is given by below formula.

$$\Delta d = 1/\,((\text{Bit rate})) \times (\text{nth channel} - 1)/\,N$$

Time delayer adds time component to the optical signal. For example, let us consider four input channel. Let's consider the bit rate of the system is 500Mbps. So for first channel there will be no delay, that is 0s. For second channel there will be delay of 0.5ns. For third channel there will be delay of 1ns. For fourth channel there will be delay of 1.5ns.

Finally, the multiplexed data stream propagates in fiber link. Figure 5 depicts the input OTDM system.

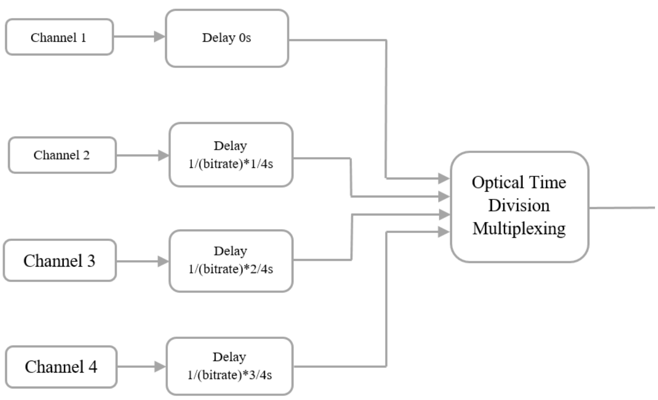


Figure 5 – Block diagram of OTDM System

### *D. Optical Time–Division De–Multiplexing*

Multiplexed signal at the sender end is de–multiplexed at receiver end. This process takes input optical signal from a single shared channel and splits into N channels. The Optical Time–Division De–Multiplexer consists of Power splitter cascaded with Optical Time Delayer and Mach–Zehnder Modulator.

Power splitter splits data stream into identical data stream. These data streams are added with respective optical delay. Delay(Δd) for each arm is calculated by the below formula.

$$\Delta d = 1/((\text{Bit rate})) \times (N - \text{nth channel} - 1) / N$$

These optical signals are fed to input optical branch of Mach–Zehnder Modulator. A high logic Return to Zero format signal is fed to electrodes of Mach–Zehnder Modulator to recover the optical signal sent by the particular user at particular channel. The Figure 6 shows the Block Diagram of Optical Time–Division Multiplexing.

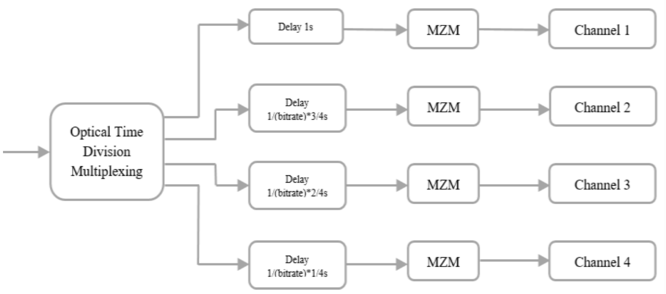


Figure 6 – Block Diagram of Optical Time–Division De–Multiplexing

### *E. Photodetector*

To convert an optical signal into electrical signal Photodetectors are used. These devices have capacity to absorb light and converts the optical energy to electrical energy. The Photodiode is used to convert an optical signal into an electrical current based on the device's Responsivity. When an optical signal strikes the diode, it generates electrical current corresponds to optical intensity by the electron–hole pair formation. This current is called photocurrent. By the means of this device we convert optical signal into corresponding electrical signal.

## III. ADVANTAGES AND SCOPE

The major advantages of this proposal is High bit rate transmission. The data recovery become easy as Mac-Zehnder Modulation is used. As we modulate the user's data with optical signal then these optical signals are multiplexed, this increases bandwidth and efficiency of the system.

This system has lots of scope in Date base, Servers and Date Storage systems where fast transmission is required. In Industrial commercial where the data need to be accurate and fast transmission this system is used. In Broadcasting and HDTV connection these systems are helpful for reliable transmission. It as scope in defense system and sonar vehicle's sensors and actuators.

## IV. CONCLUSION

With the content in this paper, we propose a DPSK Modulation OTDM system. It has large scope in future Optical Communication Systems. As Optical signals from individual channels are multiplexed, the efficiency and Data recovery is high. This system is more useful because it improves bit–rate of transmission and bandwidth of the system.

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