International Journal of Current Engineering and Technology
E-ISSN 2277 – 4106, P-ISSN 2347 - 5161
©2014 INPRESSCO®, All Rights Reserved
Available at http://inpressco.com/category/ijcet

General Article

Design and Performance Analysis of Optical Time division Multiplexing for Very High Bit –Rate Transmission

Monika Srivastava[Ȧ*] ,Mukesh Kumar[Ȧ] , A.K.Jaiswal[Ȧ], Anil Kumar[Ȧ] and Rohini Saxena[Ȧ]

[Ȧ]Dept. of Electronics & Communication Engineering, SHIATS, Allahabad,UP,India

Accepted 02 May 2014, Available online 01 June 2014, **Vol.4, No.3 (June 2014)**

Abstract

Optical time division multiplexing (OTDM) extend and expend is well known techniques of Electrical time division multiplexing into optical domain. In OTDM optical streams are constructed by time multiplexing a number of lower bit rate optical streams. In this paper we present an overview of our recent work show the multiplexing and demultiplexing of incoming data. In this lowerbits (10GBits/S)constructed to a higher bits i.e. (40GBits/s) by multiplexing process. The pulses streams are delayed with respect to one another using delay element . The Delay streams in picosecond order. The demultiplexer reconstructs the bit streams at the original bit rate(10 GBits/s) by separating bits in the multiplexed streams. The bits are transmitted over long distance using single fiber . In this paper we verified by the results that at the receiver end each bits are seperated and show their property such as Q factor, Power , Wavelength etc. Also show the Power Penality which show as well as distance is increased power penality decreased meanes at the receiver end the noise is decreased. Data is transmitted 80 KM using singlemode fiber.

Keywords: *A M Modulator, NRZ Pulse, Multiplexer , Demultiplexer, loopcontrol , EDFA, Clock Recovery*

1. Introduction

There are the two main approaches used to optical multiplexing. One is optical wavelength division (frequency division) other one is Optical time division multiplexing . This present paper concentrates on optical time division multiplexing.

In optical time division multiplexing (OTDM) , a high bit rate data streams constructed directly by time multiplexing several lower bit rate optical streams. In the receiver end of the system very high bit rate data streams demultiplexed in to the lower bit streams before detection and conversion to the electrical signals. This approach is used for very high speed data transmission. The time division multiplexing technique is purely digital technique. OTDM offer design flexibility, adjustable bandwidth allocation in different baseband channel and simple architecture. In this paper we describe the multiplexing & demultiplexing of the high data bit using new devices by which losses are decreased. In this we transmit 4 channel 10 Gbits/ s data and receive 40 Gbits/ s.data. A clock recovery is used to provide the synchronization between the bits. In this paper data is transmitted over 80 Km using single mode fiber.

1.1 Optical time division Multiplexing

This paper is totally based on the optical time division multiplexing. Time division multiplexing based on the three sub section: sampling, timing and combining. The sampling function takes sample of the incoming bit. Timing function ensure that the samples are available at the correct time slots on the multiplexed channel. The combining (multiplexing) assembles all the sampled baseband data streams to generate the higher bit rate multiplexed data stream.

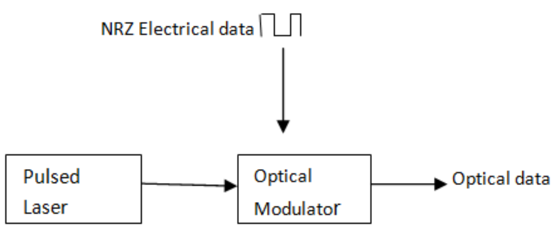

Fig 1 Schematic of an E/O converter that sample input data

Fig shows the electrically to optical converter. Which is used in this paper. In this laser diode used which operate at 1550 nm frequency range with 0dbm power. Signal from Laser diode incident on an Optical Modulator (AM Modulator) . The Electrically data stream i.e. NRZ is also incident in optical modulator. In this paper we used the 10 Gbits/s input data. The optical signal from laser samples the electrical input data via the modulator, thereby converting the optical signal. When the laser and input

*Corresponding author **Monika Srivastava** is PG student; **Mukesh Kumar, Anil Kumar and Rohini Saxena** are working as Asst Prof and **A.K.Jaiswal** as Associate Prof.,

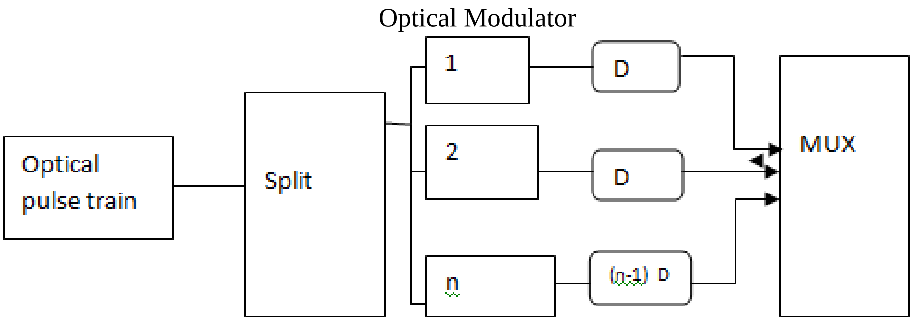

Fig 2 Single optical pulse generator

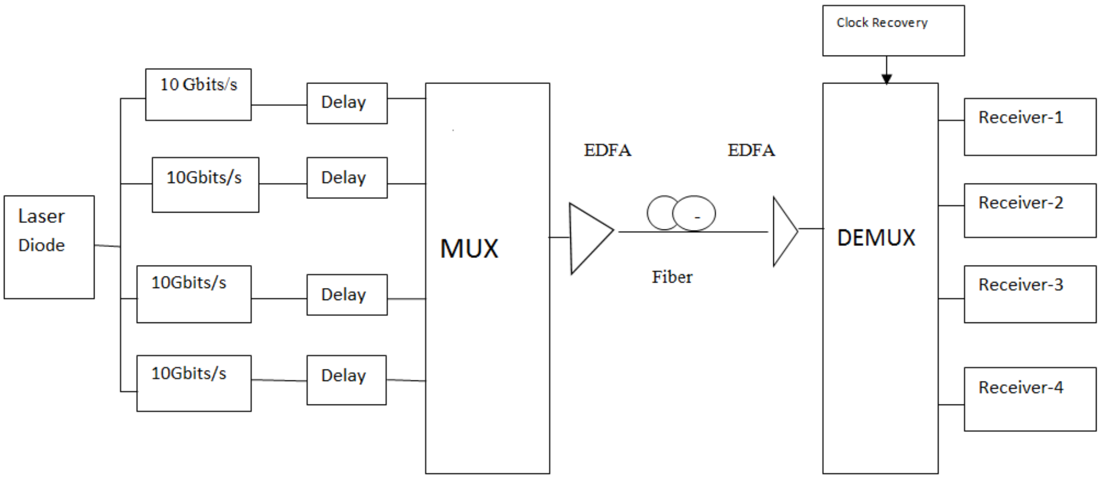

Fig 3 Block Diagram of 4 channel OTDM System

data are correctly timed, the modulator is either fully 'on' or 'off' when optical pulses passes through it.

After this timing function perform. The n optical pulses incident on the multiplexer with the repetition rate B. For n optical pulses the repetition rate may be same or differ. The income.ing bit stream are temporally offset from one another by delays D. In this paper we used the different delay for four channel i.e 25ps, 30ps, 35ps,40ps.

After this multiplexing operation perfome.In this paper we use 4*1 multiplexer. Multiplexer assembles the higher bit stream from the baseband signal .Multiplexer reduce crosstalk

1.2 Demultiplexer

Its purpose is to direct each bit of the arriving multiplexed bit stream to the appropriate O/E converter. Thus the optical demultiplexer should switch the entire bit rather than just sample part of it. In addition, it is important that crosstalk between channel is small. In this paper we used4*1 demultiplexer. Demultiplexers are Two type. One is binary tree and other one is linear tree.

1.3 Timing Recovery

Successful demultiplexing depends on correct timing of the demultiplexer switches. In an OTDM multiplexed system there is generally no electrical signal available at the multiplexed bit rate. So the system using electrically driven demultiplexer switches, to generate an electrical clock signal for demultiplerer. For this purpose recovery circuit used. These circuits provide synchronization between the bits also reduce crosstalk. It is important that timing information contained in pulse position of the incoming multiplexed bits is conveyed without distortion to the timing recovery circuit.

2. Experiments

We proposed and simulate the multiplexing and demultiplexing of high bit data over single mode fiber. Fig shows the block diagram, of 4 channel OTDM. The transmitter section consists of the laser diode with frequency 1550 nm.. This section consists of the four pseudorandom pulses, NRZ, AM Modulators and Optical delay. A laser source produces regular streams of light i.e. 1550nm. Pseorandom generate the 10 Gbits/s. Pulse with there repetition rate. In the transmitter section the electrical signal convert to optical signal by AM

Modulator. Each of these channels can be modulated independently by an electrical tributary data source at a bit rate. The modulated output are delayed individually by different fraction of the clock period and are then interleaved through an multiplexer to produce an aggregate bit rate N*B Where N is the no of channel an B is the repetition rate. The signal is then transmit through the optical fiber. Loop control is used to increase the length of the fiber for the transmission in a very high distance. For amplification two EDFA used. These works as a preamplifier and post amplifier. These are include in the link to compensate for splitting and attenuation losses .Pre EDFA amplified before photo detection so that the signal to noise ratio degradation caused by thermal noise in the receiver . It also provide a larger gain factor and a broader bandwidth. These amplifier also increase the power level of the signal .Both EDFA works on C band i.e. 1530 to 1560nm. The receiver section consists of the Demux and clock recovery. Since in OTDM there is no electrical signal available. It generates the electrical clock signal with the bit rate 10 Gbits/s. This technique provide the low crosstalk .Clock recovery at the receiver to drive and synchronize the demultiplexer. At the receiver end the 40 Gbits/s pulses are demultiplexed in to the original data channel for subsequent electronics signal processing. At the receiver end we see the output in the form of optical spectrum, eye diagram which satisfied that at transmitter and receiver end the signal in combine and split.

3. Simulation and Design consideration

3.1 Design of Transmitter section

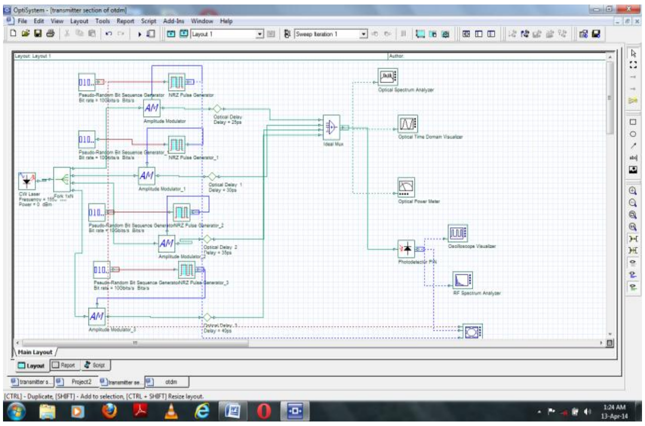

Fig 4 Transmitter section of OTDM

Fig shows the transmitter section We have analyzed the spectrum of these four signal after multiplexing signal . The four data bits i.e.10 GBits/s are modulated with carrier signal whose frequencies 1550 nm.Each transmitted bits are delayed at a particular time period and this time period is picoseconds range. The electrical signal is converted in to the optical signal using AM modulator and this optical signal is repeated at a particular repetition period. The lower bit signal is multiplexed and converted in to the higher bits i.e. 40 Gbits/s.

3.2 Design of Receiver Section

The receiver section consists of the Demux and clock recovery.. The receiver generates a clock from an approximate frequency reference This process is commonly known as **clock and data recovery** (CDR). It is very closely related to the problem of carrier recovery. It generate the electrical clock signal with the bit rate 10 Gbits/s. Clock recovery provide the synchronization between the clock. At the receiver end by the different visualizer like eye diagram, optical spectrum etc we differenceated the each bit.

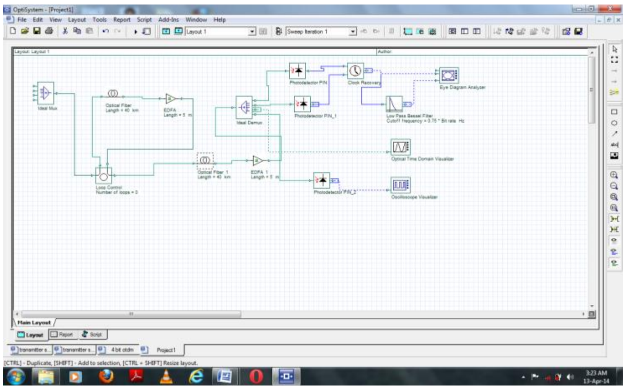

Fig 5 Receiver Section of OTDM

4. Result and Discussion

4.1 Wave Length Spectrum Of Multiplexed Signal

The spectrum of the multiplexed signal shown in the fig. the graph is drawn between the Wavelength(in m) versus power (in dbm).From the figure we observe the peak power of the multiplexed signal obtained at wavelength 1550 nm. In this spectrum all the lower bits are muxed which is shown in fig. Small lines show the presence of other signal.

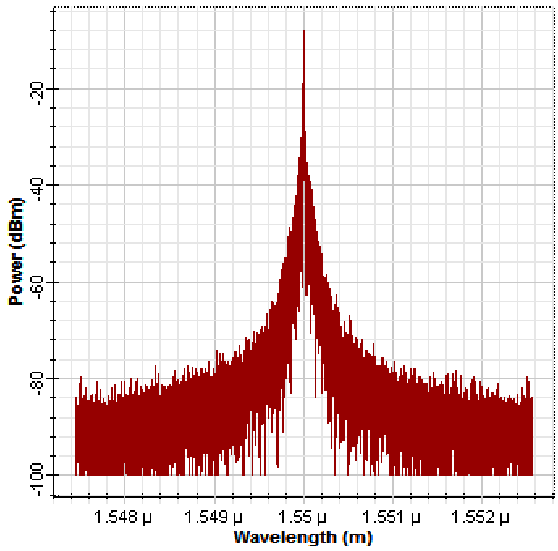

Fig 6 Spectrum of multiplexed signal

4.2 Wave Length Spectrum of Demultiplexed Signal

From the spectrum it is clear there is very little noise is generated . The frequency is obtained at a1550 nm. In the multiplexer side optical spectrum show the noise. Fig shows that at the receiver side bit is demultiplexed with the peak power obtained at 1550 nm which is laser frequency.

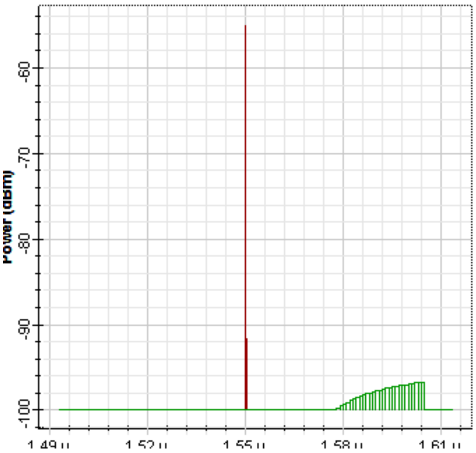

Fig 7 Spectrum of demultiplexed signal

4.3 Eye Diagram of Multiplexed Signal

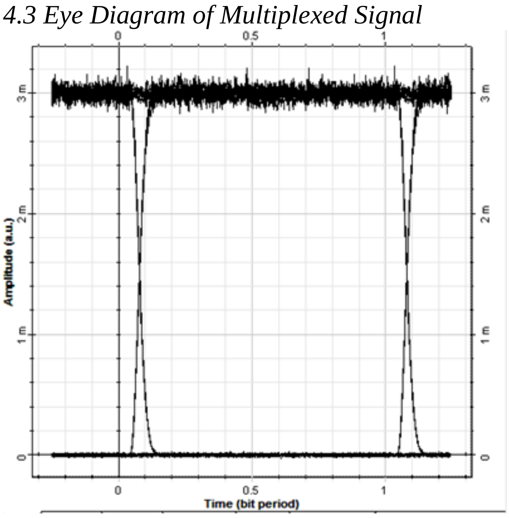

Fig 8 Eye diagram of multiplexed Signal

Fig .shows the eye diagram of multiplexed signal. From figure we conclude that eye height is good but at the upper side signal in distorted. Jitter is good & quality factor is also very good i.e 98.54.

4.4 Eye Diagram of Demultiplexed Signal

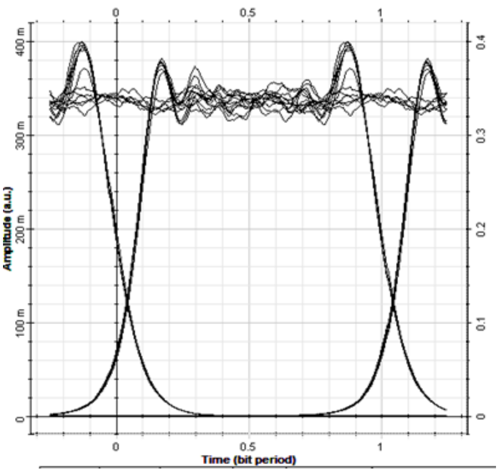

Fig 9 Eye Diagram of Received signal

Fig. shows the eye diagram of demultiplexed signal. From the fig it is clear that there is less distortion created in the receiver side. Fall and rise time clear from the fig . Overshoot is clear but Q factor is reduced i.e 82.78.

4.5 Power Penalty

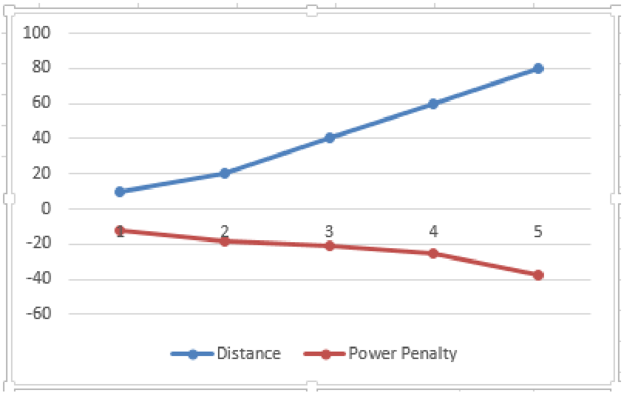

Fig 10 Power penalty Verses distance

The reduction in SNR is known as the power penalty. The optical power falling on the photo detector is a defined of time within the statistical nature of quantum detection process. When any 0f the impairment effects are present in a link, there is a reduction in the signal to noise ratio (SNR. Of the system from the ideal case. The main power penalty are due to the chromatic and polarization mode dispersion, model and speckle noise. From the fig we concluded that as well as distance is increased power penalty reduced means the noise in also reduced in receiver side.

Power Penalty= -10 log$\frac{SNR(Impair)}{SNR(Ideal)}$

Conclusion

OTDM is used for multigigabit per picoseconds point to point transmission system .We have shown that multiplexing ,demultiplexing and timing recovery can be achieved without the need for very wide bandwidth electronics and have demonstrated a transmission bit rate that is higher than in any previous time multiplexed system.

In this paper we describe several theory , different graph and different fig . From this we concluded that

1)In this paper 40 Gbits/s signal is transmitted over 80 KM distance.

2) Optical spectrum is shown that at the multiplexer side signal is combined and noise is generated but at the receiver side multiplexed signal is split and noise is also very less.

3) Eye diagram shown at the multiplexer side there is difficult to see the difference between under and overshoot but at the receiver side it is clear.

4) Power Penalty show as well as distance is increased noise is reduced so this system is useful for high distance.

5) Optical amplifier are also attractive for compensating the accumulated losses in demultiplexes side.

6) Q factor is also reduced as well as distance increased means there is some dispersion produced in the fiber.

Reference

P.R .Prucnal and M.A.Santoro (1987) 12.5 Gbits/s fiber-optic network using all- optical processingElectron Lett The optical power falling on the photodetector is a defined of time within the statistical nature of quantum detection process.vol 23.

D .cotter and D.D. marcenac (1997) Ultra high bit rate networking from the trans continented backbone to the desktop IEEE.

B.Y.Yu (1998) Packed Switched Optical Network

D.J. Blumentha (March 2004) Photonic Packet and all optical label switching technologies and technique invited talk presented at the optical communication conference

K.Uchiyama and T Morioka (2009) All optical time division demultiplexing experiments with simultaneously output of all constituent channel from 100 Gbits/s OTDM Lett 37.

Deepak Behera and Sumit varshney (16 Dec, 2011) reading and drawing Eye Diagram.

Elizabeth K Wilson (10 Marh 2014) Analysis of Electro Optic System.