Analysis of various dispersion techniques with input bit sequence over Optisystem

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Abstract

With the increasing demand of reliable and low loss telecommunication network the world has entered into optical fiber communication as it provides better quality and a large amount of bandwidth coverage. But due to various parameters like fiber length, refractive index etc. the signal get overlapped and result into a major drawback named "dispersion". In this study various dispersion compensating techniques have been discussed, which have involved DCF(dispersion compensating fiber), EDFA(Erbium dopped fiber amplifier), and two input bit sequence named as FCC and PN sequence. The whole analysis is simulated on Optisystem software and design tool and various parameters have been studied with both the inputs given one at a time.

I. INTRODUCTION

The previous sources like copper wires and coaxial cables are being replaced by optical fiber as it is more sophisticated and better quality providing communication network. The basic need of a communication system is the Quality factor and it should be maximum. The study has proposed three main methods to use dispersion compensating fiber with EDFA in pre, post and mix mode with two different inputs as FCC and PN codes to compare the basic parameters at the receiving end. The PN sequence is very much common but FCC code is the main element of this study which is a tri diagonal matrix format that gives much better result with mix DCF methodology.

II. OPTISYSTEM SOFTWARE

Optisystem is an innovative and powerful software tool plan to test and simulate optical parameters and all the dispersion compensation techniques with both PN sequence and FCC code. It offers transmission layer for optical communication system design and planning from component to system level and visually presents analysis and scenario. It mixes with other Optiwave items and configuration instruments of industry driving electronic outline mechanization programming all add to OptiSystem speeding your item to market and decreasing the payback time frame. OptiSystem enables users to plan, test, and simulate the result.

III. DISPERSION COMPENSATION FIBER

It is generally installed in between EDFA and SMF (single mode fiber) and the position of DCF before SMF, after SMF and at both places (before and after) makes the method as pre DCF, post DCF and mix DCF. For dispersion compensation C and L band at high negative dispersion -70 to -90 ps/nm/km are used. It is the efficient way to optimize dispersion in the presence of single mode fiber. Generally it has low insertion loss, less polarization mode and less nonlinearity. Apart from these characteristics DCF have huge chromatic dispersion coefficient to minimize the size of a DCF module. The net dispersion in the circuit having one DCF with negative dispersion and one SMF with positive dispersion can be calculated as

$$D_{SMF} \times L_{SMF} = - D_{DCF} \times L_{DCF} \qquad (1.1)$$

Where D represents dispersion and L represents length of fiber.

IV. FLEXIBLE CROSS CORRELATION CODE DEVELOPMENT

This the main element of this study which gives all the results better than PN sequence input. This is a tri-diagonal matrix format input bit sequence. Optical codes are group of K (for K clients) bit sequences having length N, code weight W (the number of '1' in each codeword) and the most extreme cross-connection, ∂max. For better correspondence and to recognize every one of the conceivable clients, to decrease channel obstruction and to oblige extensive number of clients, optical codes ought to have huge estimations of W and the size K.

Step 1: The set optical code comprises of (N, W, ∂max) FCC code for K clients. The KxN code matrix A_K^w is here called the tri diagonal code matrix. These arrangements of codes are then given to by;

$$A_K^W = \begin{matrix} a11 & a12 & a13 & 0 & 0 & \ldots & 0 \\ a21 & a22 & a23 & a24 & 0 & \ldots & \vdots \\ 0 & a32 & a33 & a34 & a35 & 0 & \vdots \\ 0 & 0 & a43 & a44 & a45 & a46 & \vdots \\ \vdots & \ddots & \ddots & \ddots & \ddots & \ddots & \vdots \\ 0 & 0 & \ldots & \ldots & \ldots & \ldots & aKN \end{matrix} = \begin{matrix} A1 \\ A2 \\ A3 \\ \vdots \\ \vdots \\ AK \end{matrix} \quad (1.2)$$

Where

$A_1 = a_{11}, a_{12}, a_{13}\ldots\ldots\ldots\ldots a_{1N}$
$A_2 = a_{21}, a_{22}, a_{23}, a_{24}\ldots\ldots\ldots a_{2N}$
$A_3 = a_{31}, a_{32}, a_{33}, a_{34}, a_{35}\ldots\ldots a_{3N}$
$\vdots$
$A_K = a_{k1}, a_{k2}, a_{k3}\ldots\ldots\ldots\ldots a_{KN}$

The rows of A1, A2 and A_k define to the K codeword and it is accepted that, the code weight of every one of the K codeword is to be W.

Step 2: After the K codes define by the K rows of the KxN code grid in condition (1.2) are to speak to a legitimate arrangement of K codeword with in phase cross relationships A_K^W max and code weight W; it must fulfill the accompanying conditions

1. The elements $\{a_{ij}\}$ of A_K^W must have values '0' or '1'

   a_{ij} = '0'or '1' for i=1,2,..K and j=1, 2,…..N (1.3)

2. In the phase cross-correlation λ_{max}, between any of the K code words (K rows of the matrix, A_K^W) should not surpass code weight W. That is,

   $$X_iX_j^T = \begin{cases} \leq \lambda \max for\ i \neq j \\ = W \quad for\ i = j \end{cases} \quad (1.4)$$

3. The weight of code of each codeword must be equal to W where,

   $$\sum_{j=1}^{N} a_{ij} = W \text{ for } i=1,2,\ldots.K \quad (1.5)$$

4. It is clear from equation (1.4), that the $W = Xi\ Xi^{T}$ is in phase auto-correlation function of codes. The out of phase cross-correlation between the i^{th} code and the j^{th} codes is given as $Xi\ Yj^{T}$. It follows that $Xi\ Xi^{T}$ ought to be more than $Xi\ Yj^{T}$. In other terms, $W > \lambda_{max}$.

5. All K rows of A_K^W ought to be linearly independent so that each codeword must be interestingly unique in relation to other code words. In other words the rank of the KxN matrix, A_K^W should be equal to K. Moreover, for, A_K^W to have rank K, code length N should be greater than or equal to K.

Step 3: The first i^{th} row for the first K user, of the binary matrix sequences as given in step 1 in equation (1.2) by using the all five conditions that are defined in step 2 is;

A_i= 0…..011….10……0 (1.6)

It is clear that the length N is least under the expected conditions. Table 1.1 demonstrates the FCC code for a given number of clients K=4, weight W=3 and adaptable cross connection $\lambda_{max} \leq 1$.

Table 1.1 Generation of FCC Codes

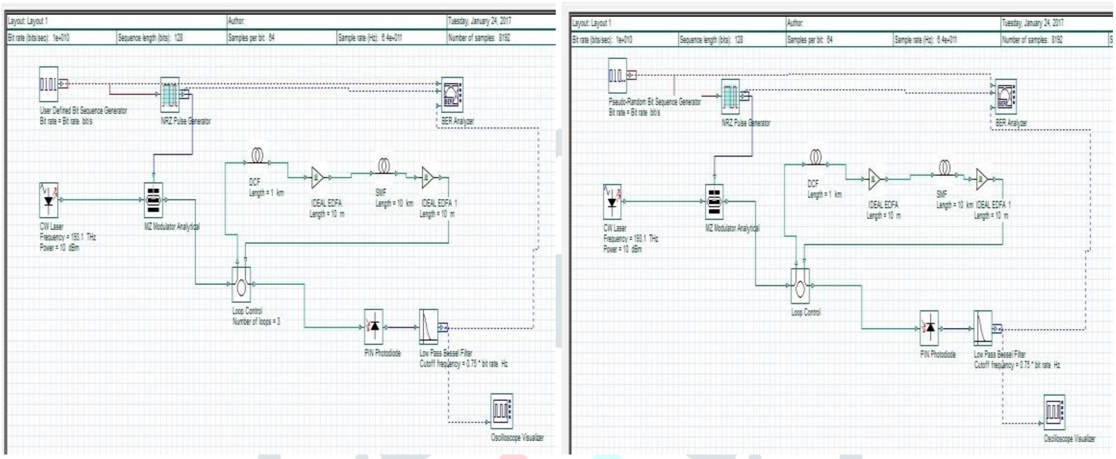
K1	1	1	0	0
K2	1	1	1	0

K3	0	1	1	1
K4	0	0	1	1

V. METHODOLOGY OF COMPONSATION SCHEME SYSTEM SETUP

1. PRE-COMPENSATION

In this scheme DCF will be placed before the universal single mode fiber and EDFA. General design setup of Pre compensation Scheme is given in figure 1.1

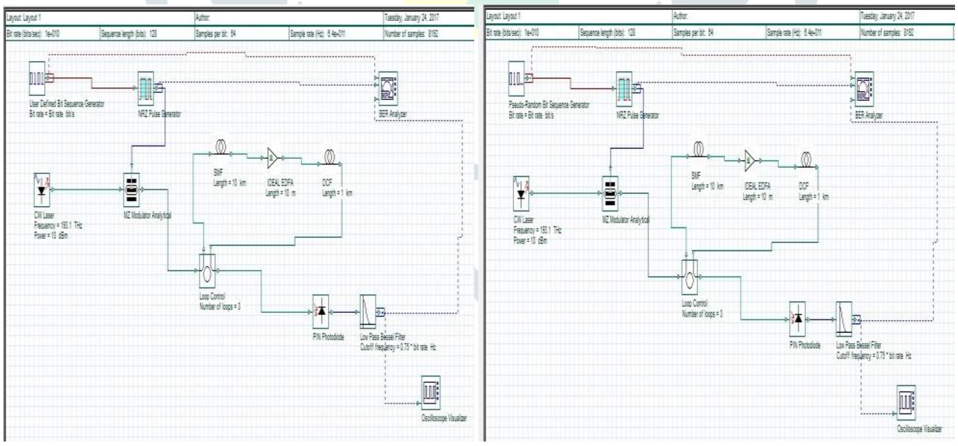


(a) (b)

Fig 1.1: Pre DCF Design Scheme (a) DCF with FCC (b) DCF with PN

POST-COMPENSATION

In this Scheme DCF will be placed after the EDFA and SMF. Figure 1.2 shows the design scheme.

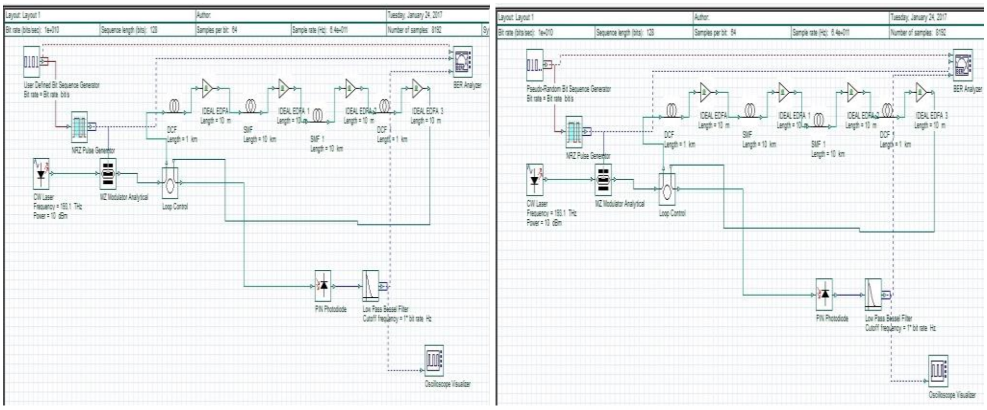


(a) (b)

Fig 1.2: Post DCF Design Scheme (a) DCF with FCC (b) DCF with PN

MIX COMPENSATION

This scheme is basically a combination which is given in Figure 1.3

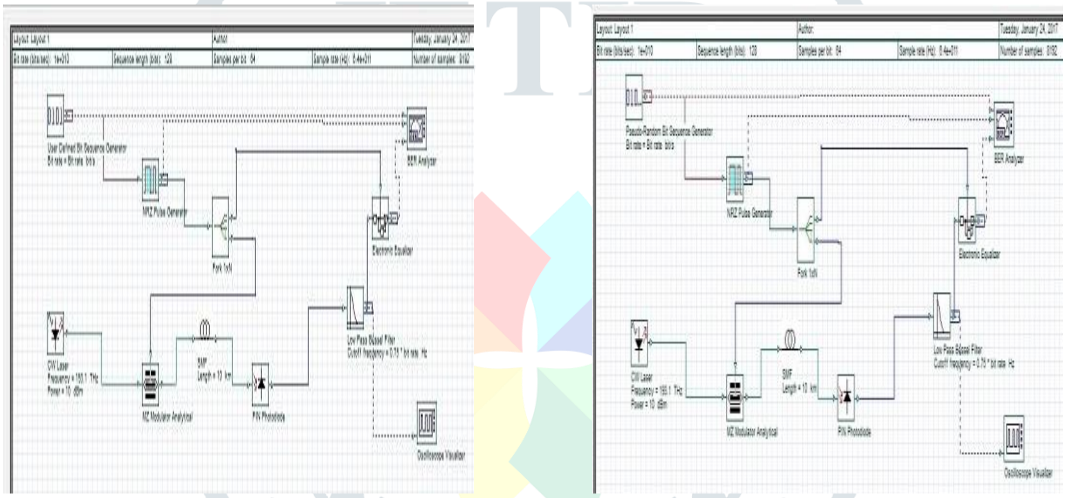


(a) (b)

Fig 1.3: Mix DCF Design Scheme (a) DCF with FCC (b) DCF with PN

ELECRONIC EQUALIATION COMPENSATION

Design setup of this scheme is given in figure 1.4



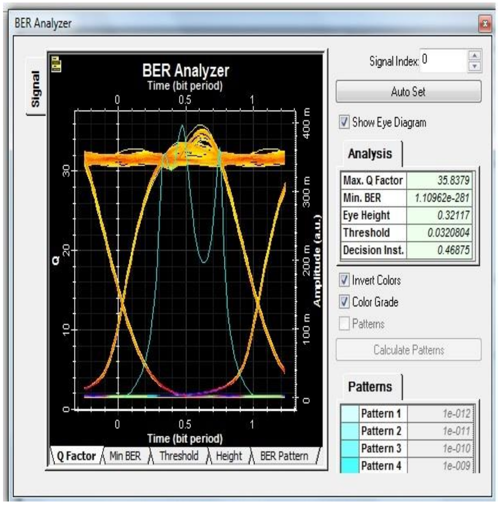
(a) (b)

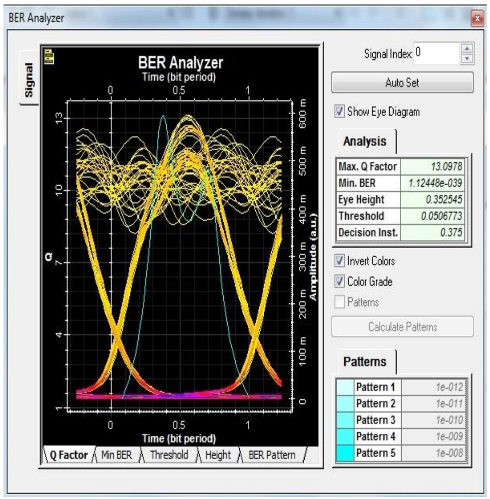
Fig 1.4: Electronic Equalizer DCF Design Scheme (a) DCF with FCC (b) DCF with PN

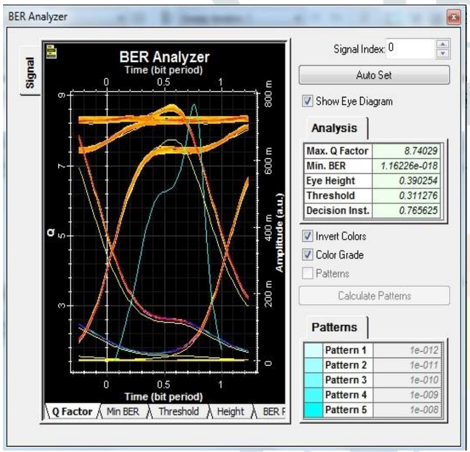
VI. SIMULATION AND RESULT

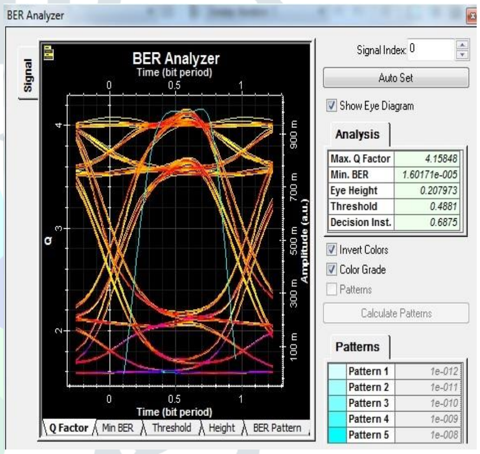
Now the given figure shows various screen shot of simulation results with mix DCF with FCC and PN at input

Comparative Analysis of Q factor		
	FCC Sequence	PN Sequence
	Q = 35.8379	Q = 13.0978

<table>
<tr><td>Mix DCF</td><td>

(a)
Bit rate = 10Gbps</td><td>

(b)
Bit rate = 10Gbps</td></tr>
<tr><td rowspan="2">EQ
DCF</td><td>Q = 8.74029</td><td>Q = 4.15848</td></tr>
<tr><td>

(c)
Bit rate = 10Gbps</td><td>

(d)
Bit rate = 10Gbps</td></tr>
</table>

Table 1.2 Comparison table for different parameters for different techniques

Techniques	**Q- factor**	**Min BER**	**Eye Height**	**Threshold Value**
Pre DCF with FCC	10.9802	1.598e-315	0.13012	0.01113
Pre DCF with PN	09.43010	1.2401e-021	0.14566	0.02321
Post DCF with FCC	13.6024	1.7952e-042	0.147609	0.047971
Post DCF with PN	08.5809	3.90587e-018	0.149801	0.06063

Mix DCF with FCC	**35.8379**	**1.10962e-381**	**0.32117**	**0.03281**
Mix DCF with PN	20.0942	1.1244e-0239	0.35250	0.0506773
Electronic equalizer with FCC	08.740290	1.16220e-018	0.390254	0.311276
Electronic equalizer with PN	4.158580	1.16017e-005	0.2079730	0.48810

table 1.2 is showing comparison results of all implemented DCF techniques in which all values of different parameter are putting together and now we can easily compare the results comes out by simulation that mix DCF with FCC is giving vital result in optical fiber communication in terms of high quality factor and low BER as well as giving good eye height value which is highlighted in above table.

VII. ACKNOWLEDGEMENT

VIII. REFERENCES

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