ANALYSIS OF PSEUDO-RANDOM BINARY SEQUENCE AND GOLD SEQUENCE TO ACHIEVE HIGH SPEEDIN OPTICAL COMMUNICATION SYSTEM

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***Abstract*:**The rapid growth in network capacity and traffic rates raises the significance of high-speed optical transmission. To achieve the high-speed network, dispersion compensation is amongst the highly required parameters.In this paper, two models of an optical dispersion compensation network have been developed with different input sequences: gold sequence and pseudo random binary sequence. Our main purpose of work is to show that which sequence provides better resultsto attain high-speed optical system. The simulation results such as Q-factor, BER, eye height and threshold are analyzed and compared with respect to 40 km fiber length, for both the models. The gold sequence leads to theresults having high value of Q-factor and reduced BER. All the results are analyzed using OPTISYSTEM simulation at 10 Giga bits per second (Gb/s) transmission system.

***Index Terms* – Gold sequence, pseudo random binary sequence (PRBS), Q-factor, BER, dispersion compensation.**

I. Introduction

Optical communication network offers very high potential bandwidth and flexibility in terms of high bit-rate transmission. However, their performance slows down due to some parameter like dispersion, attenuation, scattering and unsynchronized bit pattern. In long haul application, dispersion is the main parameter which needs to be compensated in order to provide high level of reliability of service.Fiber Bragg Gratings (FBG) is considered to be a key component in optical communication system as, dispersion compensators, filters and flatteners gain. So FBG is added for the design of our model of optical transmission system.
EDFA works in 1550 nm wave band to fulfill the needs of high speed, high bandwidth and high capacity networks. In this paper, we propose a new model to treat chromatic dispersion and signal attenuation.The main area of work is the type of sequence used as an input to the dispersion compensation network. Firstly, we present a study of dispersion compensation network with gold sequence as its input. Then, we compare the transmission system under study using the optimized setting parameters with a previous model proposed by other authors having input pseudo random bit sequence in terms of Q-Factor, bit error ratio(BER), eye height, threshold value and their eye diagrams at the received signal. The simulation results demonstrate the high efficiency of the developed transmission system.

II. PSEUDO RANDOM BINARY SEQUENCE

Pseudo random binary sequences (PRBSs), also known as pseudo noise (PN), linear feedback shift register (LFSR) sequences or maximal length binary sequences (m sequences), are widely used in digital communications, instrumentation and measurements. In a truly random sequence the bit pattern never repeats. A PN sequence is a semi-random sequence in the sense that it appears random within the sequence length, fulfilling the needs of randomness, but the entire sequence repeats indefinitely [1].PN sequence is most commonly adopted as the input sequence to the optical network in previous models proposed by other authors.

A PN sequence is an ideal test signal, as it simulates the random characteristics of a digital signal and can be easily generated. It is a bit stream of '1's and '0's occurring randomly, with some unique properties. The sequence serves as a reference pattern with known random characteristics for the analysis, optimization and performance measurement of communication channels and systems.The OPTISYSTEM component 'pseudo random bit sequence generator' generates a sequence of N bits:

$$N=T_{w.}B_r$$

WhereT_w is the global parameter 'Time window' and B_r is the parameter 'Bit rate'.

$$N_G= N\text{-}n_l\text{-}\ n_t$$

The number of bits generated is N_G .n_l and $n_t$are the Number of leading zeros and the Number of trailing zeros respectively.

III.GOLD SEQUENCE

Communication systems need a set of bit sequence that is easy to generate with hardware or software and have low cross-correlation with other sequences in the set.So it minimally jams other gold codes transmitted by other sources.Gold codes are such a class of 2^{N-1} sequences of length 2^{N-1}. Gold codes are family of pseudo-random noise code sequences, which possess very attractive cross-correlation characteristics, having the characteristics resembling PRBS.

Gold sequences are generated by the modulo-2 operation of two different m-sequences of same length. The two m-sequences are able to generate a family of many non-maximal product codes, but a preferred maximal sequences can only produce Gold codes. Finding preferred pair of m-sequences is necessary in defining set of Gold sequences. Since both m-sequences have equal length N, the generated gold sequence is of length N as well. From a pair of preferred sequences, the Gold sequences are generated by the modulo-2 sum of the first with shifted versions of the second or vice-versa. For a period of $N = 2^n - 1$, there are N possible circular shifts. Thus, one can get N sequences with two preferred m-sequences, and these are called Gold sequences [2].

Consider an m-sequence represented by a binary vector u of length N, and a second sequence $v$obtained by sampling every q^{th}symbol of u. In other words, $v = u[q]$,where $q$is odd and either $q = 2^k + 1$ or $q = 2^{2k} - 2^k + 1$. Two m-sequences u and v are called the preferred pair if

$$m \neq 0 \text{ (mod 4) i.e., } n \text{ is odd or } n = 2 \text{ (mod 4).}$$

It is known that preferred-pairs of m-sequences do not existfor m=4,8,12,16, and it were conjectured that no solutions exist for all m=0 (mod 4).The set of Gold sequences generated with the two preferred pair of m-sequences u and v is given as:

$$G(u, v) = \{u, v, u \oplus v, u \oplus T \cdot v, u \oplus T^{2} \cdot v \ldots u \oplus T^{N-1} \cdot v\}$$

Where$T$ is the cyclic shift operator and $\oplus$ is the XOR operation.

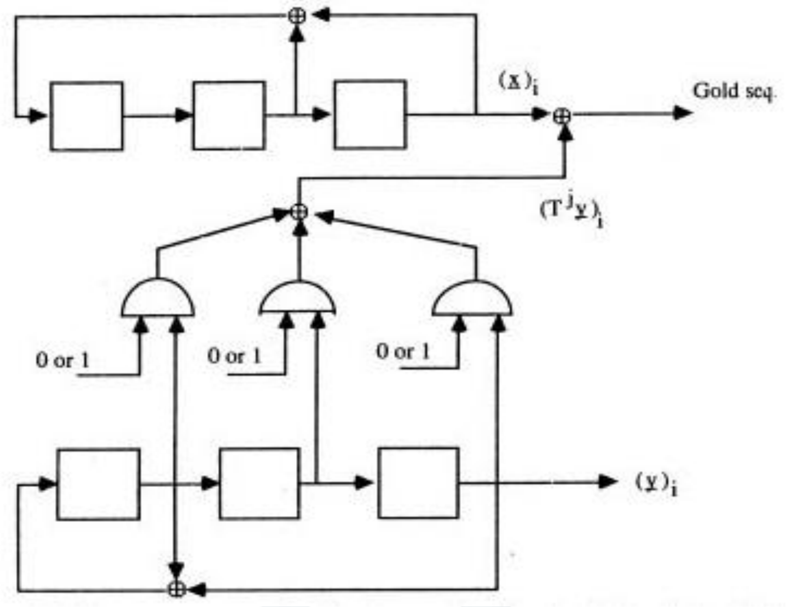

Figure 1: Gold sequence generator

We take an example of generating gold sequence for m=3. Fig. 1 shows the block diagram of a gold sequence generator having two linear feedback shift registers generating two m-sequences of length $N = 2^3-1 = 7$.The preferred pairs used in the generator are $x^3 + x + 1$ and $x^3 + x^2 + 1$.[3]

The major advantage of using gold sequence is that the cross-correlation between its members is guaranteed to be bounded below some arbitrarily small value. For systems where large numbers of coded, high speed signals must share the same frequency band, low cross-correlation values are mandatory if the probability of false synchronization and inter-signal interference is to be reduced to an acceptable level or eliminated altogether. [4]

IV. SIMULATION SETUP

Simulation and designing of the optical transmission system has been done using OPTISYSTEM 15. It helps the users to test and simulate almost all kinds of optical fiber links. All the results are analyzed on the basis of different parameters using OPTISYSTEM simulation at 10 Giga bits per second (Gb/s) transmission systems. Table 1 describes the parameter for the simulation of di spersion compensation systems. All the parameters used in both the models are same except the input sequences.

Table 1: Simulation Parameters

Parameters	Values
C/W Input Power	5dbm
C/W laser Frequency	193.1THZ
Reference Wavelength	1550nm
Mach-Zehnder modulator with of extinction ratio	30 dB
Fiber Length	50km
Attenuation at cable section	0.2db/km
EDFA Length	5m
FBG Length	6mm

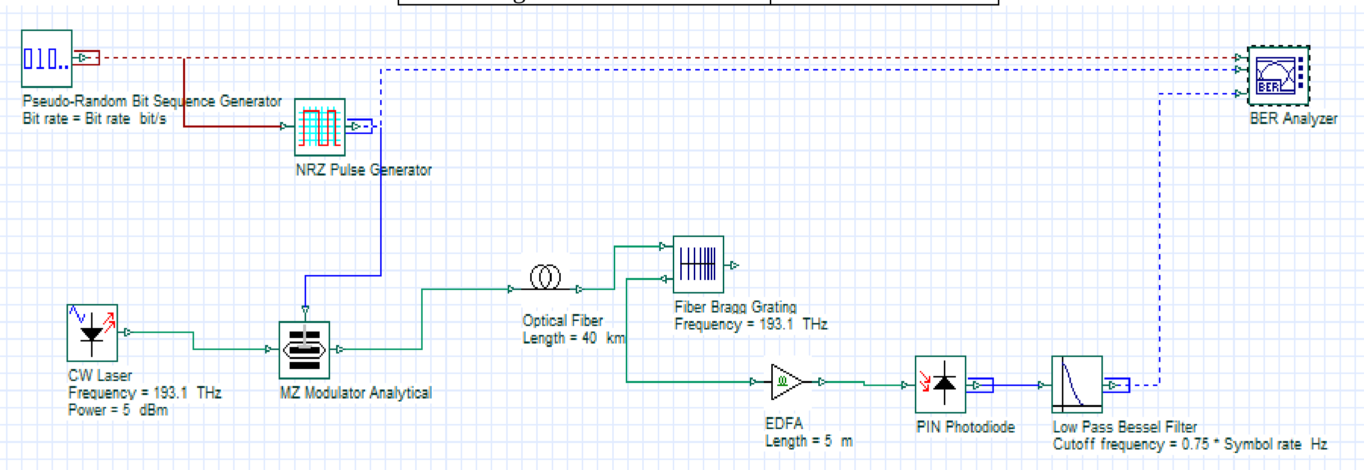

Figure 2:Simulation model for pseudo random binary sequence

In our first model of dispersion compensation network, a pseudo random sequence of bits is produced by data source.For second simulation network, we took the sequence generator with the gold sequence '0000101', chosen from the set of gold sequences generated by the generator mentioned in Fig. 1.In both the models,a 10 Gb/s Non Return To Zero (NRZ) signal is launched onto 40 km long optical fiber.

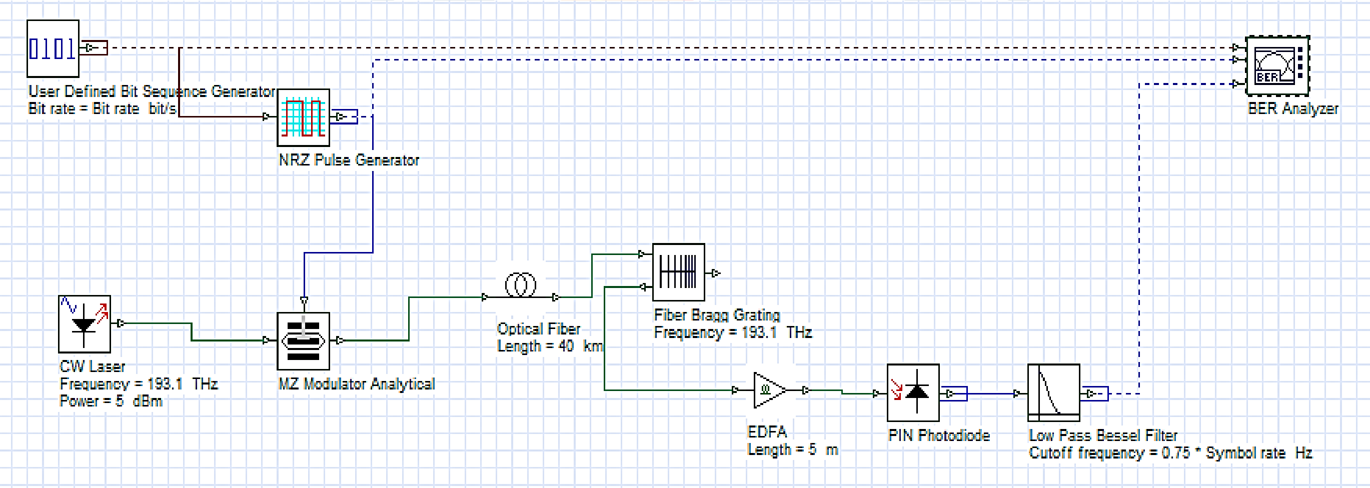

Figure 3: Simulation model for gold sequence

V. RESULTSAND DISCUSSION

In this section we will perform a comparative study of the results obtained by simulating both the models.The complete work represents the method to establish a high-speed network by recovering the lossesdue to dispersion. In this system design, evaluation has been done on the performance of Fiber Bragg Grating in order to compensate dispersion depending upon the types of input data used.Fig. 4 and Fig. 5 showsthe eye diagrams of Q-factor, min. BER, eye height and threshold for PRBS and gold sequence, received at BER Analyzer by taking the simulation parameters mentioned in table 1.

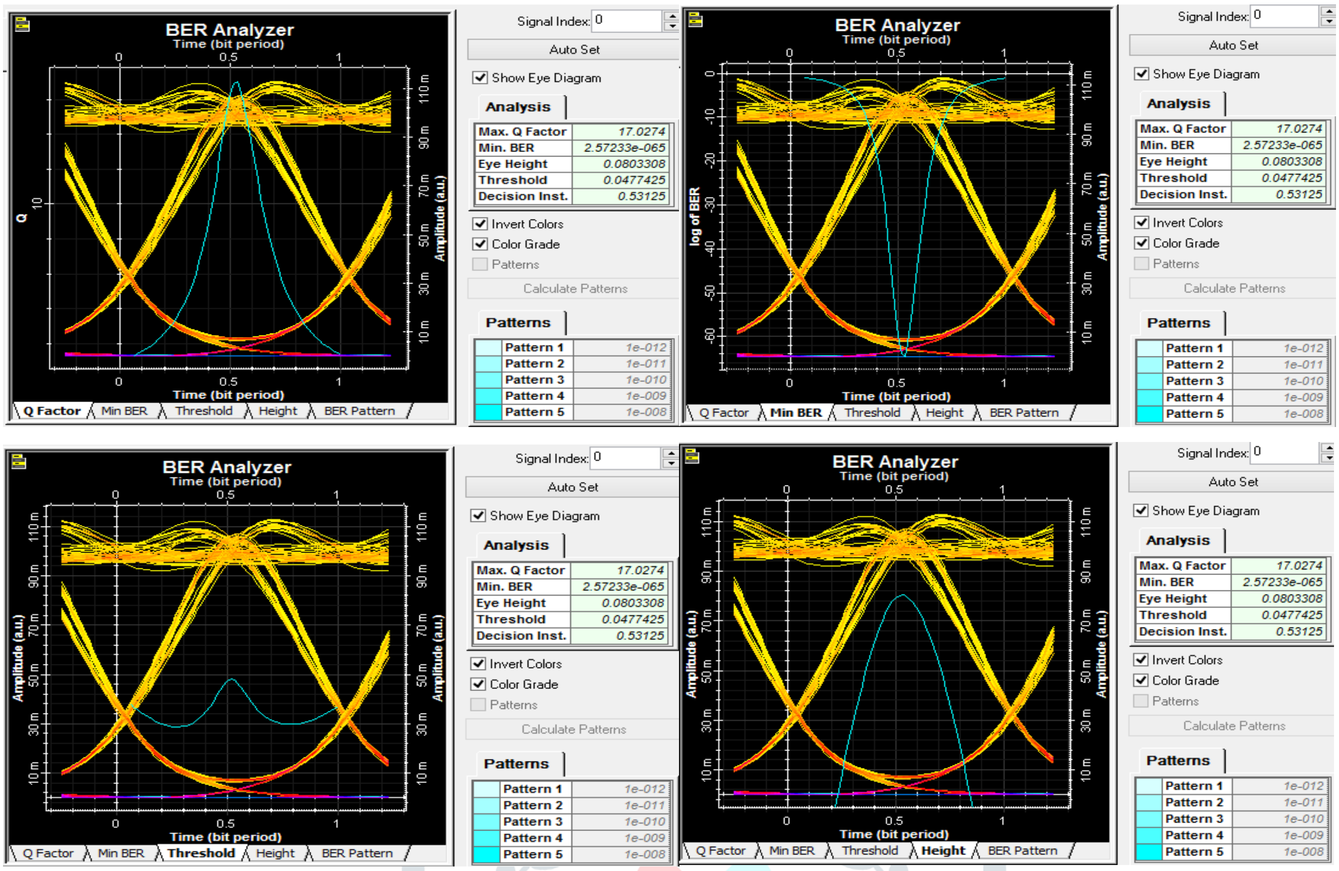

Figure 4: BER analysis for pseudo random binary sequence

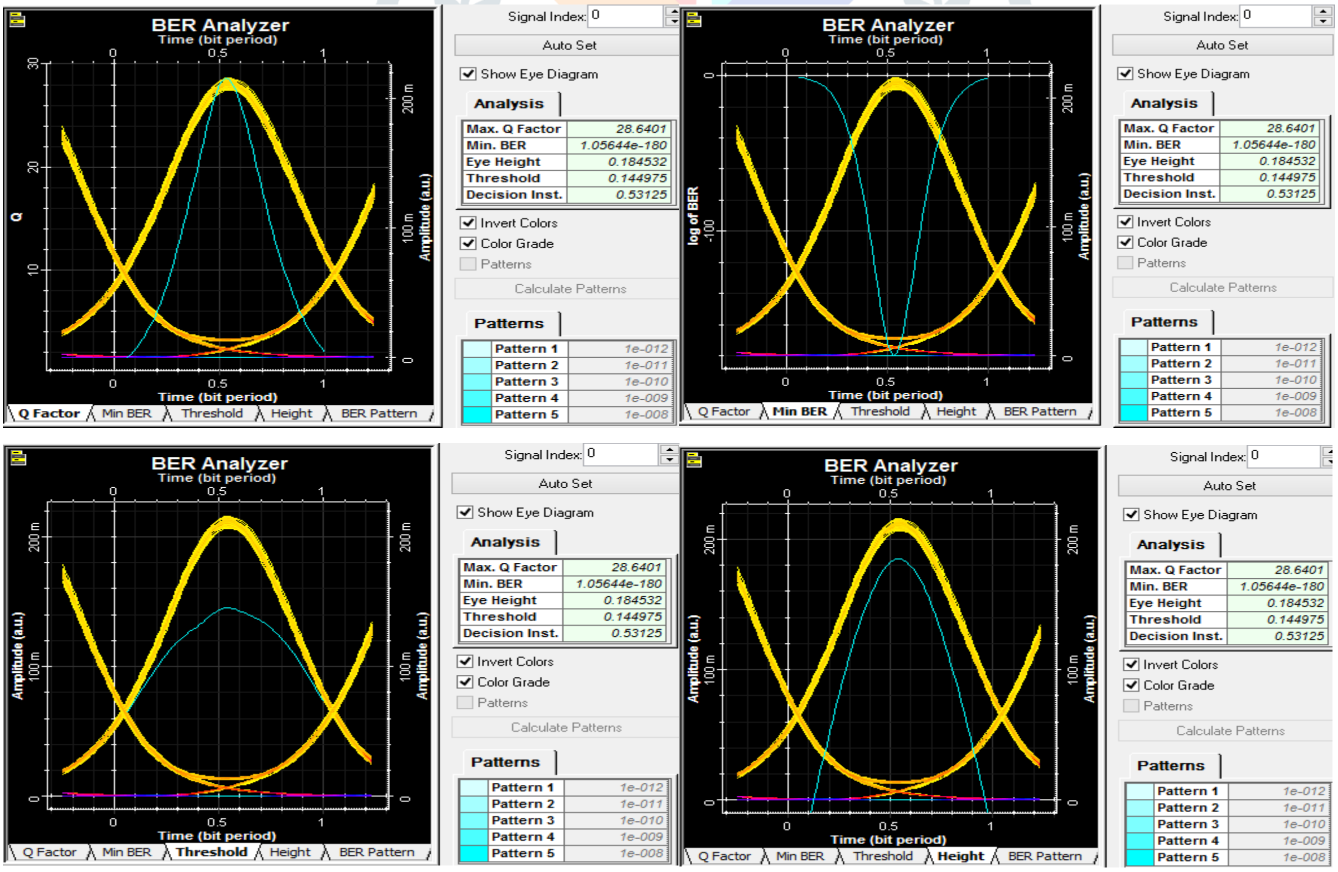

Figure 5: BER analysis for gold sequence

Table 2: Comparison of simulated values

Input sequence	Max. Q-factor	Min. BER	Eye Height	Threshold value
PRBS	17.0274	2.57233e-065	0.0803308	0.0477425
Gold sequence	28.6401	1.05644e-180	0.184532	0.144975

VI. CONCLUSION

Simulation results have been analyzed for 40 km long fiber.In this simulation, we observe that the value of Q-factor for gold sequence i.e. 28.6401is very impressive as compared to the Q-factor of PRBS i.e. 17.0274. The result of min. BER and eye height also comes out better for gold sequence.SinceQ-factor is taken as one of the most important features to measure the performance of the system, so it is shown that the results of the simulation model with gold sequence provides a high performance and high speed optical communication network.The proposed system can be modified in future days for further development using similar devices with different parameters.

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