International Journal of Advance Research in Science and Engineering
Volume No.07, Special Issue No.(02), March 2018
www.ijarse.com
IJARSE
ISSN: 2319-8354

# Design and simulation of digital fibre communication system using (optisystem15.0)

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**ABSTRACT**

*In this paper we are reducing the loss and increase the high spectral efficiency by using optisystem. In which modulation technique are used that are RZ and NRZ technique . By Using the most suitable settings of the system which include laser transmitter with (1310nm) and (1550nm) wavelengths as input power (dBm), optical fiber with both (SM and MM) cable types as channel length (km),(RZ and NRZ) modulation and demodulation schemes to maximize spectral efficiency and power efficiency by encoding information are analyzed in order to evaluate their penalization over the signal quality at the receiver. There are three different parameters will be investigated which are output power (dBm), noise figure (dB), and transmittance for the two types of fibers .*

***KEYWORDS: Digital Fiber Communication,Optisystem15.0.,(RZ and NRZ) modulation, BER and Q-Factor.***

## I. INTRODUCTION

Fibre is an integral part of modern day communication infrastructure and can be found along roads, in buildings, hospitals and machinary. The fibre itself is a strand of silica based glass, it's dimensions similar to those of a human hair, surrounded by a transparent cladding .optical communication fiber technology is the main pillar of modern communication , it has higher frequency. They are sometimes called Lightwave systems to distinguish them from microwave systems, whose carrier frequency is typically smaller by five orders of magnitude (~1 GHz). Optical fiber systems have many advantages over metallic-based communication systems. These advantages include: long-distance signal transmission, large bandwidth, light weight, and small diameter, non conductivity, security.[1]

## II. THEORY

A basic fiber optic system consists of three elements, a transmitting device that converts an electrical signal into a light signal. The majority of light sources used in fiber optics emits light at one of three different wavelengths: 850nm, 1300nm and 1550nm ,these wavelengths are desired because they exhibit the least amount of attenuation in the glass fiber. Of the light sources, there are mainly two types used today: the light emitting diode (LED) and the laser diode (LD). The actual choice of one source over another depends on the type of application, cost, desired output as well as temperature considerations, . LDs have a non linear output, usually measured in milliwatts (mW) ,as well as the output of an LD is very narrow, with a spectral spread on the orderor 1 to 10 nm, compared to an LED that may have a spread as high as 100nm. Because LDs have a higher output potential and coupling efficiency, they are well suited for long distance transmissions[4,5].Normally, the output of an optical source such as a semiconductor laser is modulated by applying the electrical signal either directly to the optical source or toan external modulator. There are two choices for the modulation format of the resulting optical bit stream. These are known as the return-to-zero(RZ) and nonreturn-to-zero(NRZ) formats[2]. The second part of fiber optic system is Optical fibers which are the actual media that guides the light, they can be made of glass or plastic. A typical fiber is made up of a core, cladding and a jacket, there are basically two types of fibers: stepped index and graded index.The stepped index fibers can be broken down into two types: single-mode and multi-mode. The multi-mode stepped index fiber has, as one might guess, multiple paths for the light to travel while the Singlemodefiber only allows a single light ray to propagate and because the core diameter is so small, LDs are usually used to couple light to the fiber . The third part is Optical detectors Like optical sources, the optical detectors used in fiber optics are almost exclusively semiconductor devices in the form of PIN diodes and avalanche photo diode (APD) detectors.

## III. RETURN TO ZERO

Return-to-zero (RZ or RTZ) describes a line code used in telecommunications signals in which the signal drops (returns) to zero between each pulse. This takes place even if a number of consecutive 0s or 1s occur in the signal. The signal is self-clocking. This means that a separate clock does not need to be sent alongside the signal, but suffers from using twice the bandwidth to achieve the same data-rate as compared to non-return-to-zero format.

The "zero" between each bit is a neutral or rest condition, such as a zero amplitude in pulse amplitude modulation (PAM), zero phase shift in phase-shift keying (PSK), or mid-frequency in frequency-shift keying (FSK). That "zero" condition is typically halfway between the significant condition representing a 1 bit and the other significant condition representing a 0 bit.

Although return-to-zero (RZ) contains a provision for synchronization, it still has a DC component resulting in “baseline wander” during long strings of 0 or 1 bits, just like the line code non-return-to-zero.

### RZ IN OPTICAL COMMUNICATION:

Return-to-zero, inverted (RZI) is a method of mapping for transmission. The two-level RZI signal has a pulse (shorter than a clock cycle) if the binary signal is 0, and no pulse if the binary signal is 1. It is used (with a pulse 3/16 of a bit long) by the IrDA serial infrared (SIR) physical layer specification. Required bandwidth for this kind of modulation is: BW = R(data rate).

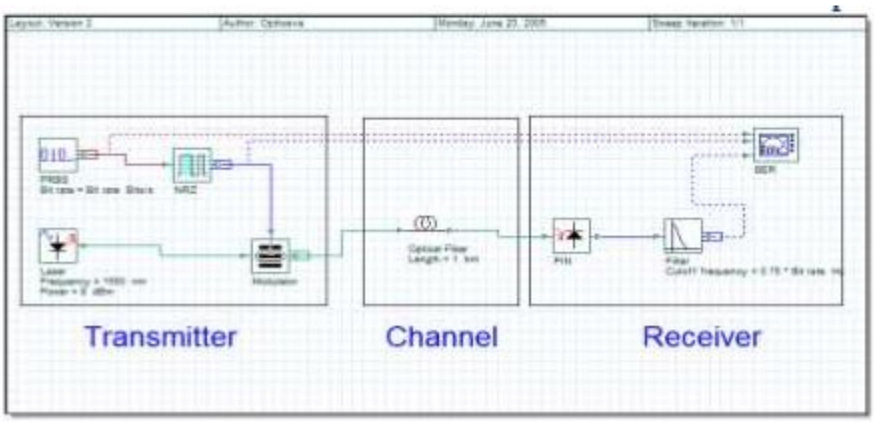
## IV. NON RETURN TO ZERO

In telecommunication, a non-return-to-zero (NRZ) line code is a binary code in which ones are represented by one significant condition, usually a positive voltage, while zeros are represented by some other significant condition, usually a negative voltage, with no other neutral or rest condition. The pulses in NRZ have more energy than a return-to-zero (RZ) code, which also has an additional rest state beside the conditions for ones and zeros. NRZ is not inherently a self-clocking signal, so some additional synchronization technique must be used for avoiding bit slips; examples of such techniques are a run-length-limited constraint and a parallel synchronization signal.NRZ-level itself is not a synchronous system but rather an encoding that can be used in either a synchronous or asynchronous transmission environment, that is, with or without an explicit clock signal involved. Because of this, it is not strictly necessary to discuss how the NRZ-level encoding acts "on a clock edge" or "during a clock cycle", since all transitions happen in the given amount of time representing the actual or implied integral clock cycle. The real question is that of sampling—the high or low state will be received correctly provided the transmission line has stabilized for that bit when the physical line level is sampled at the receiving end.

However, it is helpful to see NRZ transitions as happening on the trailing (falling) clock edge in order to compare NRZ-level to other encoding methods, such as the mentioned Manchester code, which requires clock edge information (is the XOR of the clock and NRZ, actually) see the difference between NRZ-mark and NRZ-inverted

## V. DESIGN CONSIDERATION

The system transmits information using optical carrier wave from transmitter to receiver via optical fiber. The input signal contains electrical data that is represented by 0's and 1's has been generated by pseudo-Random Bit Sequence Generator with non-return-zero (NRZ) once and again to return-zero (RZ) . Then the input signal is modulated with semiconductor laser that is represented by Continuous Wave (CW) laser through Mach-Zehnder modulator. CW laser supplies input signal with 1550nm and 1310 nm wavelengths and input power which is externally modulated at( 2.5e+9) Bits/s with a non-return-zero (NRZ) and return-zero (RZ) pseudorandom binary sequence in a Mach-Zehnder modulator with 10 dB of extinction ratio. The optical fiber used is single mode fiber, because single mode fiber can yield higher data rate, less dispersion and also can operate in a long haul distance, so it is suitable to be used as transmission link ,finally the signal received by PIN detector.




**Design of optical communication in optisystem 14.0**

## VI. MODULATOR

**Mach zender modulator:**

A Mach-Zender modulator is used for controlling the amplitude of an optical wave. The input waveguide is split up into two waveguide interferometer arms. If a voltage is applied across one of the arms, a phase shift is induced for the wave passing through that arm. If a voltage is applied across one of the arms, a phase shift is induced for the wave passing through that arm. When the two arms are recombined, the phase difference between the two waves is converted to an amplitude modulation.

This is a multiphysics model, showing how to combine the Electromagnetic Waves, Beam Envelopes interface with the Electrostatics interface to describe a realistic waveguide device.

**LOW PASS GAUSSIAN FILTER:**

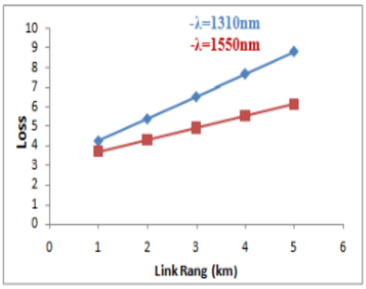
In receiver side, In electronics and signal processing, a **Gaussian filter** is a filter whose impulse response is a Gaussian function (or an approximation to it). Gaussian filters have the properties of having no overshoot to a step function input while minimizing the rise and fall time. This behaviour is closely connected to the fact that the Gaussian filter has the minimum possible group delay. It is considered the ideal time domain filter, just as the sinc is the ideal frequency domain filter. These properties are important in areas such as oscilloscopes and digital telecommunication systems.The Gaussian filter is non-causal which means the filter window is symmetric about the origin in the time-domain. This makes the Gaussian filter physically unrealizable. This is usually of no consequence for applications where the filter bandwidth is much larger than the signal. In real-time systems, a delay is incurred because incoming samples need to fill the filter window before the filter can be applied to the signal. While no amount of delay can make a theoretical Gaussian filter causal (because the Gaussian function is non-zero everywhere), the Gaussian function converges to zero so rapidly that a causal approximation can achieve any required tolerance with a modest delay, even to the accuracy of floating point representation.

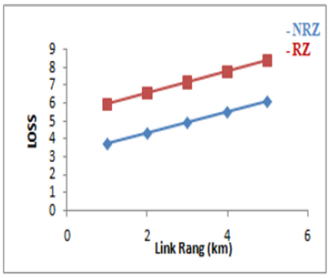
**BIT ERROR RATE:**

The bit error rate (BER) is the number of bit errors per unit time. The bit error ratio (also BER) is the number of bit errors divided by the total number of transferred bits during a studied time interval. Bit error ratio is a unitless performance measure, often expressed as a percentage . the bit error probability $p_e$ is the expectation value of the bit error ratio. The bit error ratio can be considered as an approximate estimate of the bit error probability. This estimate is accurate for a long time interval and a high number of bit errors.**BERT** or **bit error rate test** is a testing method for digital communication circuits that uses predetermined stress patterns consisting of a sequence of logical ones and zeros generated by a test pattern generator.

A BERT typically consists of a test pattern generator and a receiver that can be set to the same pattern. They can be used in pairs, with one at either end of a transmission link, or singularly at one end with a loopback at the remote end. BERTs are typically stand-alone specialised instruments, but can be personal computer–based. In use, the number of errors, if any, are counted and presented as a ratio such as 1 in 1,000,000, or 1 in 1e06.

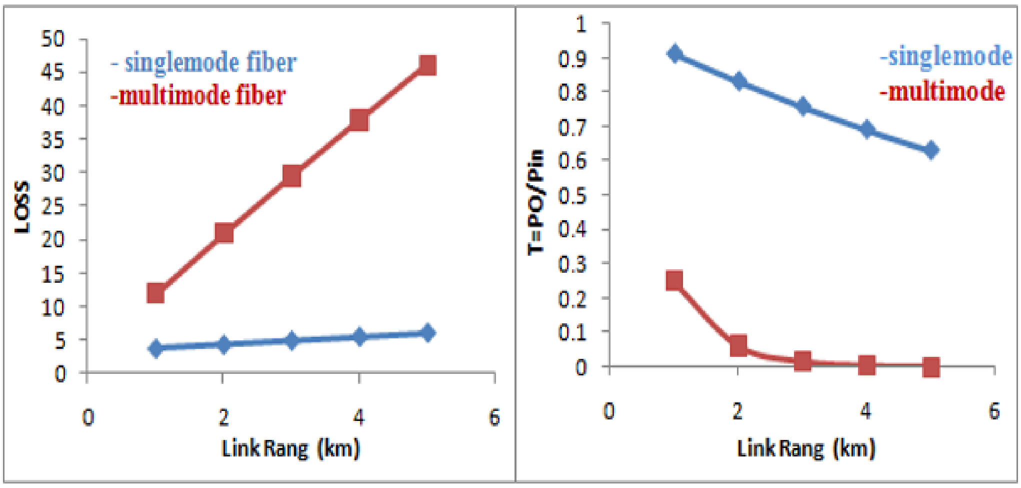
## VII. OUTPUT




outpu1shows loss between two wavelength

output 2 the losses in rz and nrz




Output 3: The loss and transmittance in single mode and multimode fibers

## VIII.RESULT

By using optisystem 14.0 we can predict the values of the input signal contained digital data instead of analog because it needs power very small to transmit the format ,it considered negligent in relation to analog data ,as shown in figure (3), in digital signal, at power of CW laser equal to (-10dBm) , and link range was (1km), the signal after the filter is shown in the figure (3) ,but when you transmit analog signal at this power we will not get the data sent , as shown in (3),it has been obtained on a signal bonus to of the transmitted digital signal at (-10dBm), at a transmission analog signal with power of CW laser equal to (30dBm).

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