

Simulation design and analysis of re modulation structure based on optical network

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Abstract: With the development of information age, the optical fiber communication network has also been greatly developed, and a large number of optical fiber systems should be shipped. Wavelength division multiplexing technology has become the most important technology in optical communication, which has a strong practical significance. The aim of this paper is to design and analyze the digital optical communication system by using the optical system. Using the most suitable configuration, including the optical transmission system at 1310nm and 1550nm wavelength as input power, using single-mode and multi-mode fiber as transmission, using zeroing code and non-zeroing code for modulation and demodulation system to code information, so as to maximize the spectral efficiency of the whole system. There are three evaluation indexes, including signal output power, signal noise spectrum, and transmission rate of two kinds of optical fiber.

Keywords: Optical network; WDM; OTDM; Opti system.

1. Introduction

1.1. Introduction to Optical Network Development

An optical network is an optical fiber-based communication structure that serves as a means of disseminating information. The optical fiber network is not only suitable for the optical fiber transmission line, but also suitable for the transmission line with large capacity, long distance and high reliability, which is ensured by the optical fiber. On this basis, links and connections between multi-node networks are established through photonic and electronic management techniques.

Since the 1970s, the field of optical fiber communication has made breakthroughs in key technologies such as optical fiber destruction, semiconductor lasers, etc., leading to the use of optical fiber communication. After nearly 40 years of development, optical fiber network has become the main source of our information network. At present, the optical fiber network is capable of providing a communication speed of 100 gigabytes per second and data transmission of thousands of kilometers. The evolution of fiber optic networks has been through simple PDH systems in the 1980s, single-mode communication systems in the mid-1990s, and the latest WDM technologies. All this shows that only the network is developing rapidly and will become the center of the future development of the communication network.

Optical communication systems use high frequency media in the visible or near infrared range of the electromagnetic spectrum. Sometimes they are called light waves. They are different from microwave systems. The carrier frequency in the microwave system is usually low, and the optical fiber communication system is an optical system for transmitting information through optical fibers. In fact, lightwave and microelectronics are seen as major factors in the "information age". Optical fiber communication systems have many advantages over metal-based communications. These advantages include: signal transmission line length, bandwidth, small weight, small diameter, strong conductivity,

safety. With the society fully entering the Internet era, the amount of data transmission on the network has increased dramatically. The use of optical fiber communication technology has become a major feature of modern communication technology, and optical networks have become the most important infrastructure in the new generation of information networks.

1.2. Brief Introduction to Optical Network Structure

The basic fiber optic system consists of three components, as shown in the figure below.

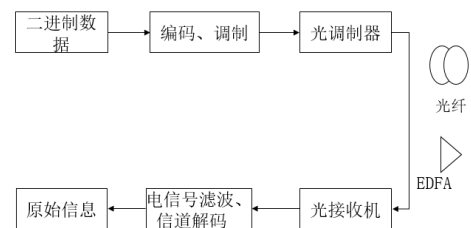


Figure 1. Optical Network Structure

First, the transmitter on the launch site converts the electrical signal into a light signal. Most of the light sources used in fibers emit at one of three wavelengths: 850 nm, 1300 nm, and 1550 nm, which is the ideal wavelength. They show the smallest drop. The two main types of light sources currently in use are LEDs, LEDs and laser diodes, LDs. The actual choice of source and other sources depends on the type of application, cost, desired conclusions, and temperature factors. LDs have a nonlinear output, typically measured in milliwatts, and the output of LDs is extremely narrow, with a spectral spread between 1 nm and 10 nm, although the diffusivity of LEDs may be as high as 100 nm. Due to the high export potential and communication efficiency of LD, Therefore, it is well suited for long-distance transfers. Typically, the code is input directly to the light source or to an external modulator by modulating the output light source, such as a semiconductor laser. There are two options for

optical bit rate modulation.

The second part of the fiber optic system is the optical fiber, which is the actual carrier of the optical fiber made of glass or plastic. A typical fib optic fiber consist of a core, a sheath, and a housing, and is primarily composed of two fiber optic fiber type: step index and progressive index. There are three types of fiber optics: single mode and multimode. As we can see, Multimode step-index propagation, while single-mode fiber only allows the propagation of a single ray. LD is usually used for fiber optic communication because the fiber diameter is as small as ± 6 . The third part is that optical detectors, like light sources, are semiconductors used in almost all fiber optic instruments. An instrument for detecting PIN diodes and avalanche photodiodes. The main optical components include: Optical transmitter, optical receiver, optical fiber, optical amplifier and other devices.

Optical fiber network is the basis of optical fiber transmission network, because it is the means of transmitting optical signals from the optical source to the receiving end. Due to optical signal attenuation during transmission, optical amplifiers such as EDFAs are required to restore the quality of the signal. However, when the signal is amplified, the system introduces additional noise. The simplest optical fiber communication system has only one wavelength, WDM is an interdependent electrical potential signal modulate by optical carriers of different wavelength, which allows it to propagate through an optical fiber. This technique provides a sufficient bandwidth and can be flexible when transmitting WDM signals, even if they have multiple wavelengths or are scaled down to ensure elastic coupling. To synthesize multiple channels of different wavelengths into a complex channel, multiple modulator wavelengths can be used, A complex WDM channel is divided into multiplexers of different wavelengths. In order to increase the intensity of the source signal, an optical modulator is also required. The main purpose of an optical receiver is to convert the optical signal generated by a single-mode fiber optical fiber into an electrical signal and to recover the source data as much as possible. An input optical signal should be increase in advance during that photoelectric amplification, and then, Use an optical filter to remove amplified spontaneous emission, ASE, or select a specific channel to pass through the Doppler. The optical signal conversion of the electrical wave signal is performed using a broadband detector with subsequent electrical amplification. To reduce the disturbance during the cycle, you can also use an equalizer.

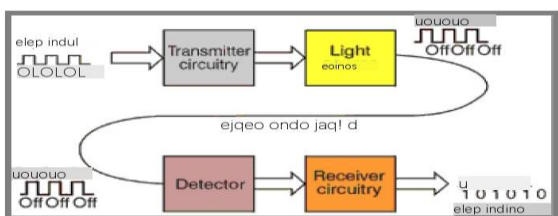


Figure 2. Optical Network Development

Over the past few years, bandwidth issues have arisen on the ground. No matter how quickly or how quickly we increase the availability of the spectrum, new applications suddenly consume all our capabilities. In order to solve this problem, it has become a research topic to exploit the use of our optical system spectrum. It is then possible to introduce various wave frequencies on the same cable and the resulting increase in throughput. We see an increase of 16-30 times that

of the original monogenic fiber. At present, these capabilities have reached the limit, and the expected change will be 128 times that of the existing optical fiber communication technology. This means that in the past, when an object was equipped with optical fibers, it must be replaced with new technology, and the system will be used in the field only to replace the electronics on the line. We can expect that these achievements will provide virtually unrestricted frequency bands without major changes in infrastructure. In the future, we want to reduce costs, improve bandwidth utilization, and simplify implementation to meet our needs for high-speed communications.

2. Optical Network Technology

2.1. Detection of modulation schemes

First, understand the coherent direct control modulation system. The main forms of optical modulation can be divided into the following categories: 1 means that there is a pulse, 0 means that there is no pulse; the signal enters a sinusoidal pulse amplitude, 3 in PSK, information in phase; FSC, information in frequency; V-Polsk, the information enters the polarization state. First, a direct definition of NRZ and RZ modules will be discussed here.

NRZ is considered the simplest modulation, compared to the "periodic signal amplitudes of 1's and 0's" for the RZ bit coal industry. The RZ range is larger than the corresponding NRA.

Then its coherent detection system. Compared with the direct detection method, the correlation test has the following advantages: sensitive control, strong selectivity, and strong selectivity. Use a modulated fixed-amplitude format to facilitate dispersion and other issues.

The photoelectric signal generated by semiconductor laser must be modulated before it is transmitted by optical fiber. This modulation can be achieved by adjusting the displacement current of the semiconductor laser, and for some specific lasers, this modulation can even be maintained up to 40 gigabytes per second. In practice, however, such modulation is rarely used, because this modulation causes fluctuations in frequency and current, that is, in some cases, this modulation may cause fluctuations in frequency and current. The audio frequency spectrum of broadband light sources limits the performance of the system. Therefore, direct tuning systems are often only suitable for low speed and distance communication networks. When the transmission speed reaches or exceeds 10 GB/s, the bias current of a semiconductor laser diode tends to be constant, requiring an external modulator, often used for external configuration modulation with optoelectronic modulators, such as M-Zender modulators, Mach-Zehnder modulators and electroabsorption modulators. In the case of external modulation, certain parameters of the carrier continuous wave signal are changed as the information is transported differently, for example, when a single-frequency electromagnetic wave is like a carrier wave, its field can be called

$$E(t) = pA \cos(\omega t + \phi)$$

Where A represents the amplitude, ω Denotes frequency, ϕ Represents the phase, p Is the polarization direction. All of these parameters can be used to transmit information, and the information can be a discrete or

continuous signal. If the signal carrying the information is a continuous signal, the corresponding modulation modes are AM, FM, PM, and PolM. If the signal carrying the information is a digital signal, the corresponding modulation modes are ASK, FDK, PSK, and PolSK.

Common modulation formats include return-to-zero, RZ, and non-return-to-zero (NRZ).

2.2. WDM technology

2.2.1. Fundamentals of WDM Technology

In optical fiber communication, WDM is a technical technology of multiplexing multi-frequency optical carrier signals with different wavelengths of an optical fiber. This technology provides single fiber channel bi-directional communication and power multiplication.

The multiplex signal is transmitted through a communication channel such as a cable. Multiplexing divides the capacity of a communication channel into several logical channels, one for each signal or data stream to be transmitted. The reverse process, called the decompression process, takes out the source channel at the end of the receiver. Multiplexing devices are called multiplexers, inverse multiplexers, and IMUXs have an opposite multipurpose object. Divide the data stream into multiple streams while transferring the connection and restoring the original data stream over multiple channels.

Over the past few years, significant progress has been made in the use of fiber-optic means of communication, but the bandwidth problem is growing. There are constant problems not only with bandwidth, but also with our use of all available bandwidth. No matter how quickly or how quickly we increase the availability of the spectrum, new applications suddenly consume all our capabilities. In order to solve this problem, it has become a research topic to exploit the use of our optical system spectrum. It is then possible to introduce various wave frequencies on the same cable and the resulting increase in throughput. We see an increase of 16-30 times that of the original monogenic fiber. At present, these capabilities have reached their limits. The expected change will be 128 times that of the existing optical fiber communication technology. This means that in previous eras, when an object was fitted with optical fibre and had to be replaced with new technology, the system would be used in the field only to replace the electronics on the line. We can expect that these achievements will provide virtually unrestricted frequency bands without major changes in infrastructure. Future, We wanted to reduce costs, improve bandwidth utilization, and simplify implementation to meet our needs for high-speed communications.

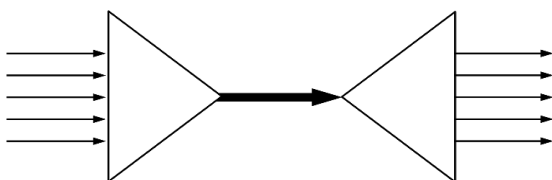


Figure 3. Multiplexing technique

Frequency compression is usually applied to optical carriers, which are usually described by waves, and frequency compression is usually applied to more frequent radio waves, which are described by frequencies. This is pure tradition, because wavelength and frequency convey the same message.

WDM systems use a multiplexer to connect the signals of

multiple transmitters and a multiplexer in the receiver to separate them. The use of fiber optic fiber optic equipment enables simultaneous execution and use of the equipment. As an optical multiplex.

Most WDM systems use single-mode fiber optic cables that are 9 microns in diameter. Some WDM types are also available for 50 or 62.5 micron diameter multimode fiber optic cables, also known as pre-cables. The first WDM systems were expensive and complex. However, recent standardization and a better understanding of the dynamics of WDM systems have reduced the deployment expense of WDM. Compare to a laser source, The optical receive is often a broadband device. Therefore, the speaker must selectively select the wavelength of the receiver in a WDM system.

The WDM system is divided into three different wavelength modes: Normal, WDM, Coarse, and the usual WDM, sometimes referred to as BWDM, uses two normal-wave 1310 and 1550 fiber optic fibers. A coarse WDM provides up to 16 channels in multiple windows of silicate fiber. Compact WDM, DWDM uses C-band, 1530 nm-1565 nm transmission window, but closer spacing. Channel plans vary, But a typical DWDM system will use 40 channels or 80 channels spaced at 50 GHz 100. Some technologies can reach a separation of 12.5 GHz, sometimes referred to as ultra-strong WDM. The new expansion parameter, the addition of Raman, increases the wavelength to the L band between 1,565 nm and 1,625 nm, more or less doubling these numbers.

Wavelength division optical networks, where specific wavelengths are set on all communication lines. While there may be different bit rate transmissions per wavelength length, these networks do not utilize the spectrum efficiently because of the installation of all optical paths under control. Plane, the frequency bands are the same. Resilient optical networks are more flexible and provide an effective alternative, The system allows the use of spectrum to meet call requirements at different bit rates and modulation circuits. In For these networks, it is defined as the lowest frequency band or spectrum segment, and the conditions required to participate in a particular challenge request may be different from those required for WDM optical networks.

In view of the fact that the quality of the optical signal decreases when it is transmitted through the optical path, it is necessary to increase the optical field of the line in order to enable the generator to be set. Through the presence of these electronic devices, optical networks can be classified as transparent, translucent, and opaque. The first is an optical network without electronic regenerator resources. The second is an optical network in which, Some nodes have the ability to convert optical signals into electronic fields and to modify, switch, and switch electrical signals to electrical and optical. The third is all network nodes with a large number of electronic heat accumulators.

Wave compounding systems can combine a signal with multiple uses and isolate the signal from the decoder. This can be done simultaneously using the appropriate fiber optic cable; also These two devices can be used as separation devices. Previously, this beam filter was used with a standard instrument, called a Fabry-Perot interferometer, using an optical glass film coating. The first WDM technology was conceptualized in the early 1970s and implemented in the laboratory in the late 1970s; however, the two signals were merged, still in use years later. This is very expensive.

As of 2011, WDM systems can handle 160 signals, enabling single-fiber optical conductors, 10 Gbit/s systems to

cover more than 1.6 Gbit/s. C or 1 600 Gbit/s. Typical WDM systems use single-mode fiber, other multimode fiber cable systems, and standardization and extensive research have greatly reduced the cost of the system. WDM systems are classified into wave classes, typically WDM, CWDM, and WDM. CWDM operates on eight channels, eight fiber optic cables, Called the "C-band" or "erbium window," the wavelength is about 1550 nanometers, or 1/1 nanometer. 1550 X 10⁻⁹ m. DWDM also works in C-band, but with 40 channels, 100 channels in the GHz range, and 80 channels in the 50 GHz range. Even the latest technology, called "Raman amplification," the L-band can roughly double these powers, to 1565 nm to 1625 nm.

Fiber-optic cable networks are currently the most important infrastructure of the global information network, as the system is now used as a communications tool in relation to maximum bandwidth. The importance of WDM spectroscopy technology is to make full use of the available beam frequencies in order to meet the broadband needs of traditional networks, especially the broadband needs of major transportation networks provided by the Internet. The so-called wave seal is indeed in the optical fiber transmission of various commercial signals, thus expanding the bandwidth network. WDM systems generally describe the amount of transmission in two dimensions: First, the number of wavelength channels, such as 8 WDM, 16 WDM, 64 WDM, and so on. This is the total capacity of the entire transmission network.

2.2.2. Key components of wavelength division multiplexing

Optical receiver. An optical transmitter is a key element of a WDM system, which requires not only the center wavelength of the laser transmitter, but also the selection of the most appropriate, high dispersion, fiber optic transmitter type and transmission distance. The main functions of the transmitter are mode/signal number conversion, light signal and telecommunication signal conversion, and signal modulation and demodulation. The optical receiver converts the original signal from an optical fiber signal to an optical fiber signal, and because the signal has been transmitted over a long distance, it must be detected, added, shaped, and reproduced from the original signal transmitted. The optical receiver must satisfy the sensitivity to the optical signal and the correct parameters corresponding to the transmitter.

Optical relay amplifiers produce water when transmitting signals over long distances, so it is necessary to periodically amplify the signals in the transmission channel, which requires the enhancement of optical repeaters. Erbium-doped fiber amplifiers are widely used in WDM systems to compensate the power of the water signal. Amplifier noise is typically input during the rebroadcast process, This is also one of the main reasons for the reduction of optical signal to receiver noise ratio and the increase of error frequency. During communication, a channel is selected to allow light to enter a certain wavelength and to block light at another wavelength. In partial wave systems, it is often necessary to select a wavelength range that depends on the front end of the tunable filter.

Multiplexer plays an important role in the whole WDM system. The function of the optical comparator is to separate multiple lightwave signals from a single lightwave signal, which is processed by an optical fiber and then transmitted by an optical fiber, while the large wave is combined and decomposed, which is the opposite of the optical multiplexer,

a signal fiber optic fiber system. The two instruments can be converted using one of the multiple signals. The main performance specifications of photomultiplier and lightwave resolving comparators are the resulting loss and serial interference. Frequency offset and interpolation errors may be small when choosing a lightwave comparator. While these two conditions are met, if the code sequence between different wavelength signals is reduced, The quality of network communication can be guaranteed. At present, WDM systems use lightwave comparators, which mainly include two types: dielectric thin film photomultiplier tubes and grating photomultiplier tubes.

2.3. Channel Impairments in Optical Communications

Due to the scattering, absorption and other internal attenuation of the material itself, as well as scattering, nonlinear scattering and other internal attenuation, fibers with different frequencies and corresponding optical wavelength lengths have different transmission windows, corresponding to different loss coefficients.

Noise source description. The total noise is a random process that includes a multiplier and an additive component that is input only when there is a signal, while the additive component is a random process. The multiplier includes a modular noise distribution, a relative noise intensity, a modular noise, etc. The additive noise typically includes dark current noise, amplified spontaneous emission, ase, and recoverable noise. Semiconductor lasers contain relative intensity noise, laser phase noise, and mode assignment noise. Modem noise and reflection noise may also be present on fiber connections. There is also spontaneous ASE radiation noise and noise in the amplifier. Thus, the noise at the receiver accumulates several noise components.

Piping damage. The main physical limitation of optical fiber transmission is loss, which is usually used to measure the loss of optical fiber, dB/km. For example, the attenuation coefficient of optical fiber is 0.3db/km, while the loss of 3db or half a signal is the loss of light. The reason for the dispersion. When the short pulses are transferred to the variance channel, they will be extended to a wider time allocation. Lightsaber dispersion and chromatic dispersion can distort multimode optical fiber signals.

Signal-to-noise ratio OSNR for optical networks.

Due to optical amplification and some inherent noise, the cumulative noise of each noise component will be received at the receiving end, which will result in a reduction of the OSNR, which is defined as follows

$$\begin{aligned} \text{OSNR} &= \frac{P_s}{P_{\text{ASE}}} = \frac{P_s}{S_{\text{SP}}B_{\text{OP}}} \\ &= \frac{P_s}{2N_{\text{SP}}hf(G-1)B_{\text{OP}}} \end{aligned}$$

Among P_s Is the signal light power, P_{ASE} Is the noise power, S_{SP} Is the power spectral density of the spontaneous emission noise, B_{OP} Is the optical filter bandwidth, hf Is the photon energy and G is the gain of the optical preamplifier. Note that this expression is only valid for NRZ modulation formats.

In communication systems, the comparison of signal and noise is often used to evaluate the efficiency of the system, while in optical communication systems, this characteristic cannot be simply evaluated, nor can it be compared in optical networks. Using wave compression, the error rate BER must

be estimated. Also, the quality factor is used to measure the quality of the signal and the error rate in the signal. The Q factor will vary with the size of the eye card. The larger the display of the eye card, the larger the Q factor and the smaller the corresponding error factor.

3. Design of simulation experiment

3.1. Description of simulation software

Optical communication systems are becoming increasingly complex. These systems typically include multiple alarm circuits, various terrain structures, non-linear instrumentation, and non-Gaussian noise sources. This makes the design and analysis very complex and requires intensive work. In this document, OptiSystem software is selected as the simulation analysis tool. OptiSystem is an innovative optical communication system simulation software package. Developed by Optivave to meet the scientific needs of system developers, photographic engineers and researchers. It has great features and works well. It is integrated into the design, testing, and optimization of various broadband optical networks at the physical layer, such as virtual communication of light sources. It has an extensive database of active and passive elements, including power, wavelength, loss and other relevant parameters. This option allows the user to scan and optimize the impact of specific device specifications on system performance. Optissystem has powerful modeling and classification components and systems. The optical fiber communication system model is a practical simulator based on the system level.

Optissystem has many unique advantages. All the instruments it uses are real and can be designed into systems that can classify systems, such as as a design subsystem, and simulate their powerful simulation environment. If you don't find the detailed information you need in the library, you can enlarge the user database according to the required parameters. Users can easily learn to use the software.

3.2. Description of simulation design

The system uses an optical carrier to transmit information from the emitter to the receiver. The input signal contains electrical data of 0 and the pseudorandom bit sequence generator generates 1 and does not return 0. Again and again. The semiconductor laser signal is then inserted through a Mach-Zehnder modulator, and the semiconductor laser is a continuous wave laser, CW. The wavelengths of the laser input CW signals are 1550 nm and 1310 nm, The input power is externally modulated. In addition, the pseudorandom binary sequence, Zender modulator, has an attenuation factor of 10 dB and a zero reverse sequence, RZ. The fiber used is a single mode fiber because it can reach higher speeds. The data transmission, which is not so dispersed, may also be long-distance and, therefore, may be used for transmission of the communication channel and, ultimately, for receiving the signal of the PIN detector.

Select the light source. When the WDM-PON has an N channel, the corresponding N wavelength is required. The signal source usually uses LED or LD as the light source. However, the LED lamp can only generate a small amount of power, which limits the network transmission distance, and the modulation speed of the LED lamp is very low. Therefore, when the modulation speed exceeds 1 Gbit/s, it is difficult to recover the signal, and it can not meet the needs of modern society for high-speed information transmission. So, LD is a

top-down light source. The absolute fundamental DWDM frequency is 193.1 THZ, the wavelength is 1552.52 nanometers, and the different wavelength ranges are 100 gigahertz. Single-mode fiber is used as the transmission signal, because single-mode fiber has fast transmission speed and low dispersion, which can affect the transmission distance. The attenuation range of single-mode fiber is 0.17-0.25db/km。 For CW laser array, 1MW 0 dbm, 8 channels installed, While the flat hatch range is 193.8 GHz.

Design of signal recovery components. In order to recover the signal, a PIN detector, Photodetector and Bessel low frequency filter are selected to convert the optical signal into an electrical signal. The average PIN frequency is 193.1 THz. The low frequency filter includes a loss of 3Db to 7.5GHz. To recover the code ? Use the 3 R regenerator, which takes a column of binary digits. This is part of the signal restoration plan.

The following is a flow chart of the structure based on the system simulation.

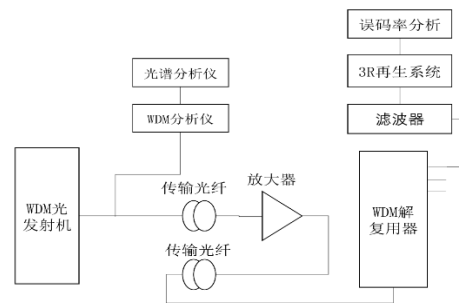


Figure 4. Block diagram of simulation structure

The design diagram in the OptiSystem system is as follows:

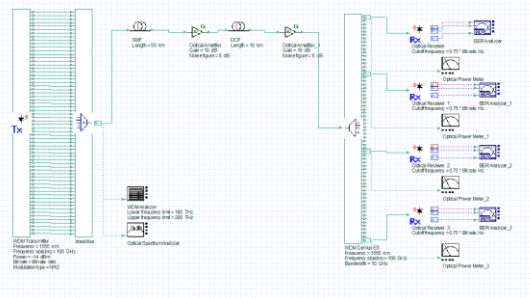


Figure 5. 64 WDM Optical Transmission System

3.3. Experimental result

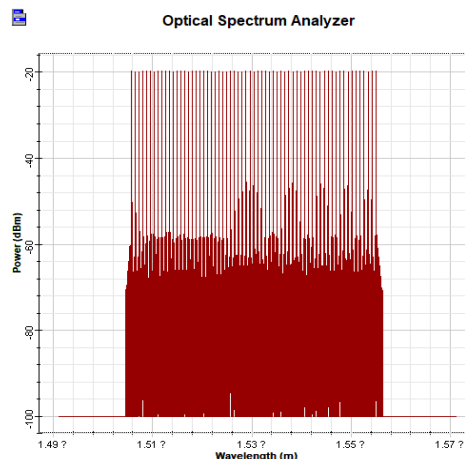


Figure 6. Spectrum at source

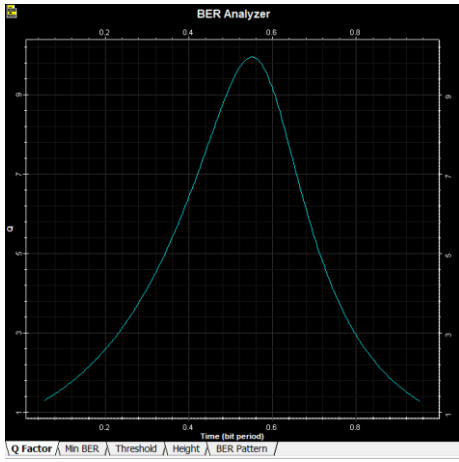


Figure 7. Q factor

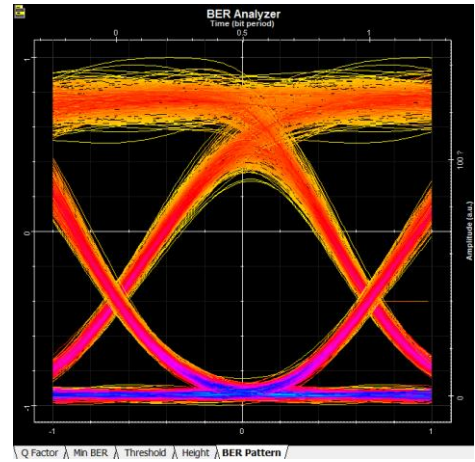


Figure 9. View of eye diagram

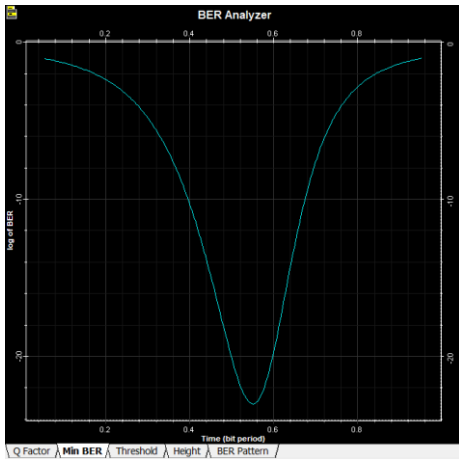


Figure 8. Error rate

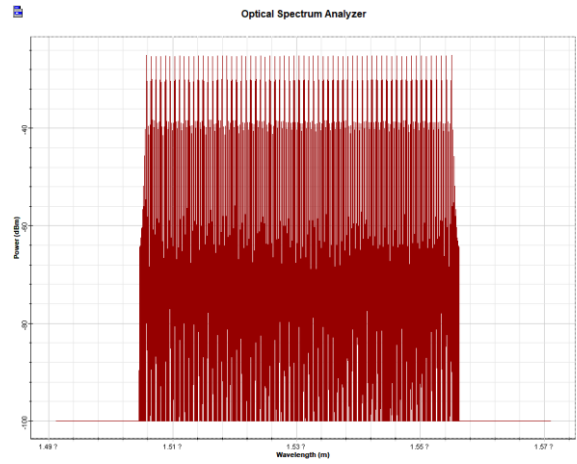


Figure 10. Simulation results of return to zero code modulation

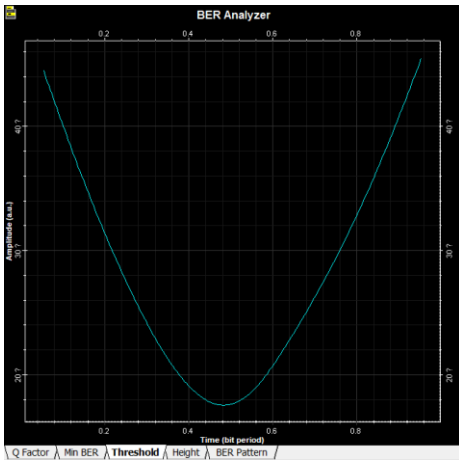


Figure 9. Decision threshold

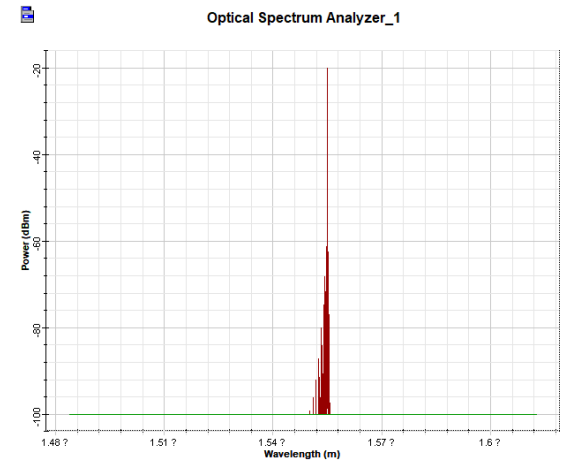


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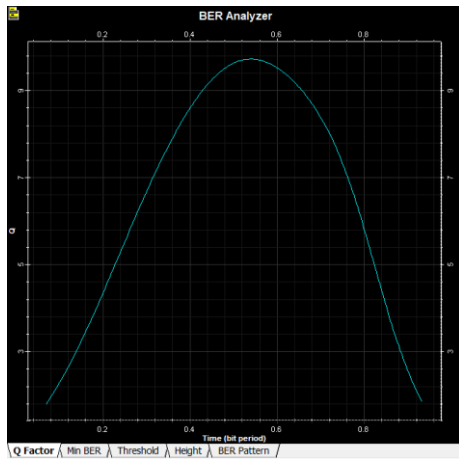


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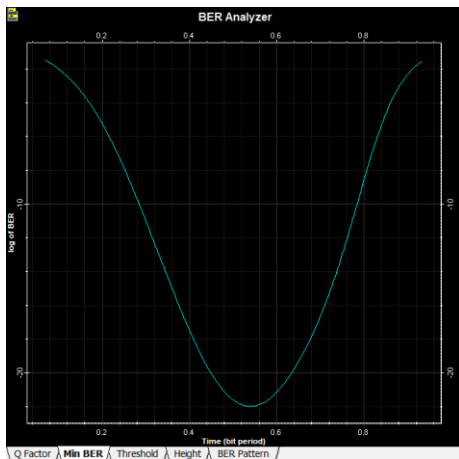


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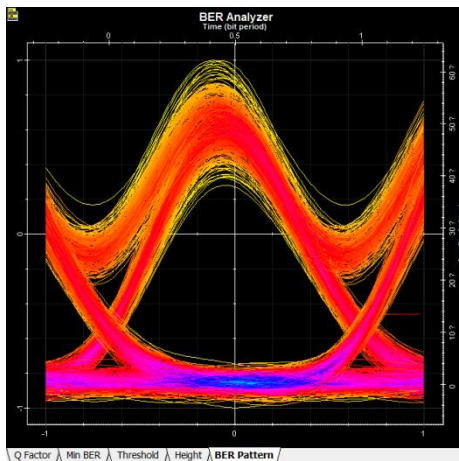


Figure 10. Simulation results of return to zero code modulation

3.4. Analysis of simulation results

The main evaluation system of WDM system is the spectrogram, the Q coefficient representing the error frequency and the eye diagram. The experiment was designed and simulated by the communication system 64WDM, and each parameter was analyzed. The condition of the baseband transmission system can be analyzed based on the nonuniformity of the code shown in the eye diagram. The clearer the image of the eye and the larger the hole, the better the transmission performance. BER is an important measure of the positive and negative effects of an optical transmission network. In general, the quality of a signal depends on the Q factor and the spelling factor and the use of the Q factor to

determine errors in the system.

Two main modulation schemes are analyzed. The simulation results show that under simulated conditions, the zero-code modulation is better when the receiver is Q-switched, which means that modulating the zero-code can improve the performance of the optical network.

4. Summary and outlook

This document reviews and analyzes time compression systems for expanding optical communications due to the increased power of optical communications systems. At the beginning of the paper, the related knowledge of optical network is summarized and analyzed, and the basic structure of optical network is introduced. On this basis, the optical network technology describes the coding type and the modulation circuit. Subsequently, Key technologies related to time and envelope systems are reviewed and discussed. Using optisystem as the experimental part of the simulation platform, the design and simulation are the light wave separation respectively. Finally, the experimental results and analysis are presented.

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