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Different Modulation Formats Used In Optical Communication System

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Abstract: *In this paper, the objective is to study the performance of different modulation formats.To choose a right modulation format is the basic key to build a flexible and cost effective high capacity optic-fiber network. The performance of ASK,FSK.PSK and PolSK for the optic-fiber is analyzed.*

Keywords:*Amplitude shift keying (ASK),Frequency shift keying(FSK).Phase shift keying(PSK) and Polarization phase shift keying(PolSK), Non-Return to Zero(NRZ), Return to Zero(RZ), ON-OFF Keying(OOK).*

I. INTRODUCTION

The digital communication brought many advantages over digital that of analog. These advantages can be represented in many features, as easy storage and faster processing. By using this, a huge amount of information can be carried. By using optical fiber, we may improve the transmission fidelity, increase in data rate and increase in transmission distance between transmitter and receiver. Its main advantages are very low attenuation and noise and a large bandwidth. Optical fiber gives higher bit rate in long distance transmission. This strength can be further achieved utilizing the advanced modulation formats.

There are many benefits of using optic-fiber system over electric system and the main advantages of using fiber are its very low losses which allows long distances between repeaters, and its high data carrying capacity. By using single high bandwidth fiber, thousands of electric wires can be replaced. Unlike electrical transmission, optic-fiber experience no cross-talk.

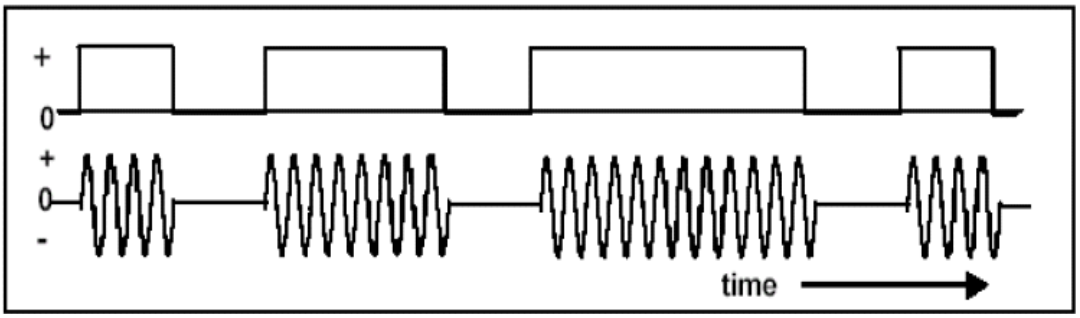
The fiber-optic system gives broadband services and advanced internet applications at high speed because this system has high capacity transport infrastructure. This system also drive for low costs per transmitted bit with high spectral efficiency. The optical-fiber system can have capability to transmit the Tb/s bits over thousands of kilometers. It has been reported that a optical fiber system can have a attenuation coefficient0.2db/km for several T Hz of bandwidth, exceeding the transmission distance than 10,000km and having capacity of more than 10Tb/s.[1] Advance modulation formats improve the channel utilization and capacity. By using different modulation formats,We can achieve better performance of optical fiber. In this paper, we are discussing the ASK, FSK, PSK with RZ and NRZ coding formats and there comparisons.

II. AMPLITUDE SHIFT KEYING

The Amplitude-Shift-Keying (ASK) is a type of intensity modulation of carrier signal also known as ON-OFF-keying. In this, between the on and off states the source is switched. The message signal is modulated onto optical carrier of high frequency. In the ASK technique a carrier frequency signal is imposed onto the message signal thus with binary signal, binary 1 is transmitted with A W and binary 0 with 0 W. For ON state binary 1 means A w is transmitted and for off state binary 0 means 0w is transmitted.[2] The relation between these two state of ON and OFF is characterized for ASK modulation. This relation is known as extinction ratio (ER) whose value depends on signal generation (direct or external modulation of laser source). When using external modulator, the ER of external modulator limits the ER of ASK. The ASK type of modulation formats are simple to generate and detect. At the detection point the demodulation can be easily done by using a photo detector, which coverts optical energy into electrical energy results in original transmitted pattern.

In advanced optical communication system, to achieve more than one bit per symbol transmits two level binary signals instead of one bit per symbol. This increases the transmission capacity. This is known as multilevel signaling. According to the equation $M=2^N$, M shows the signal level and N is the number of bits per

second and it is called M-ary signaling. For M=4, called 4-ary ASK, is mostly used which doubles the transmission capacity. For tripling the transmission capacity 8-ary ASK has also been reported but as channel

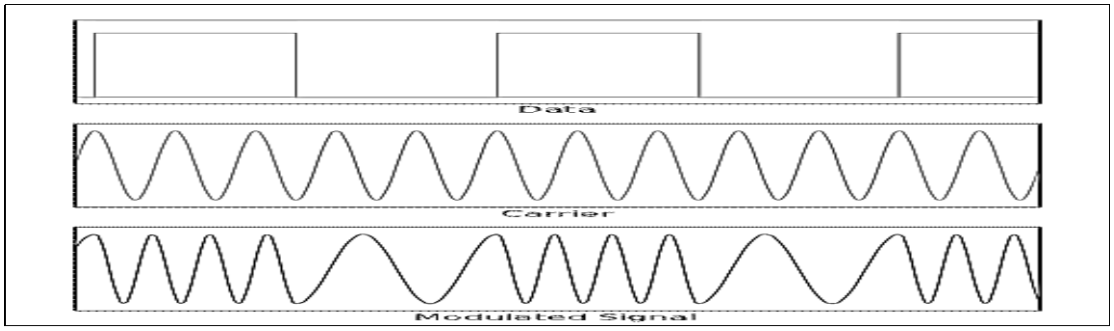


capacity is improved by using 8-ary ASK, the OSNR and receiver sensitivity is degraded.[2]

Figure(1). ASK modulation format, (a) Binary signal, and (b) ASK modulated signal.

III. FREQUENCY SHIFT KEYING

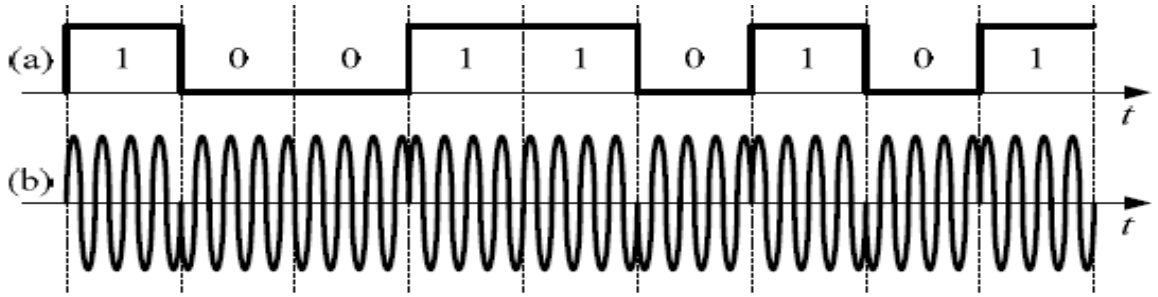
When the frequency of a laser light is switched between the two frequencies is known as the frequency shift keying(FSK). In this modulation technique the envelope of optical signal does not change so in the comparison of ASK the complexity of generating and receiving of the system increases. Modulation index is defined for the FSK system. The different modulation format based on FSK can be defined by changing the value of modulation index. A small change in modulation index results more compact optical spectrum. In already deployed system, a modulation format can not be replaced by FSK based modulation format because of the complexity of the receiving system. In this technique, the parameters of transmission line and the parameters of transmitter and receiver should exactly matched with each other.



Figure(2). FSK modulation format, (a) Binary signal, (b)carrier and (c) FSK modulated signal.

IV. PHASE SHIFT KEYING

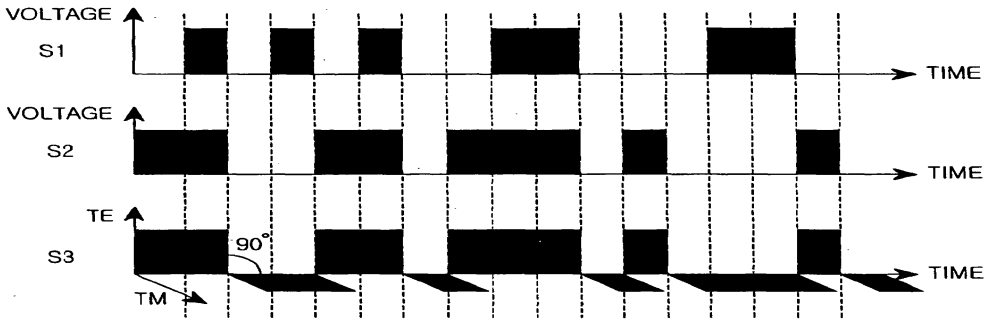
The phase of the signal is used to modulate the signal in the phase shift keying(PSK). The phase of the binary data are modulated according to the phase of carrier signal. A constant signal envelope and a narrow spectrum of PSK optical signal results improve nonlinear tolerance of system. These type of signals are very sensitive about the phase modulation produced by multichannel effects. This produced phase modulation which can enhance the rate of error in decoding the received signal. In comparison of ASK formats, FSK gives a better receiver sensitivity. Because of a complex receiver, PSK did not receive much of interest, so another format of PSK is being used which is known as Differential phase shift keying(DPSK). In this, encoding the signal differentially means phase changes between two successive bits. This encoded data is modulated with optical carrier signal, this is done by using a phase modulator which changes the phase of optical signal.[3] The coherent detection is used at the receiver of PSK .The implementation of PSK system is not capable, rather binary PSK, and DPSK, DQPSK are used. The coding efficiency can be improved by using 4different phase in DQPSK and have half of the signal symbol rate than DPSK format. By using a digital pre-coder, the bit stream is differentially encoded for DQPSK. the MZI interferometer is used for the signal detection in DPSK format which gives a reduced detection complexity then coherent detection.[4] These types of PSK modulation such as DPSK and DQPSK systems are better modulation formats then a complex PSK modulation format for high speed WDM systems.



Figure(3). PSK modulation format, (a) Binary signal, and (b)PSK modulated signal

V. POLARIZATION SHIFT KEYING

The polarization shift keying is the captivating modulation format. There are two orthogonal polarization state between which the polarized signal is switched to generate PolSK signal. A constant signal envelope is identified for PolSK signals which improves the non linear tolerance and sensitivity for a better utilization of the system bandwidth, in this orthogonal polarization is used as a additional degree of freedom PolSK formats also have a complex signal generation and detection system and also very sensitive to polarization disturbances occurs in the transmission lines The effect of this gives a increase in channel data rate. Generally, recent optic-fiber system using DPSK formats but polarization-mode dispersion and fiber non-linearity are the limiting factors of the system. A differential polarization-phase shift keying(DPolPSK) system is introduced.[6] In this system information is encoded in both polarization and phase with multilevel direct detection. In this system the effect of nonlinear polarization scattering is reduced.



Figure(4). PolSK modulation format

VI. Study of performance of optical system with different modulation formats

At 10 Gb/s the performance of NRZ, CSRZ, RZ and duo-binary modulation format is analyzed .The bit error rate versus accumulated dispersion and optical signal to noise ratio is analyzed for the performance assessment. The dispersion tolerance also analyzed for the modulation formats. From the study we observe that maximum dispersion tolerance is given by duo-binary modulation format and CSRZ gives the lowest BER value among all the modulation formats CSRZ also gives best result for long optical communication system.

If we consider the Intensity Modulated Direct Detection system uses two types of modulation formats which are non return-to-zero and return-to-zero formats . In these types of formats for a fraction of bit period the power is transmitted. Generally for commercial use the NRZ types of modulation format is used. The NRZ format is no sensitive to laser phased noise and not requires a high electric band width for transmitting and receiving the signal.[7] At same time the RZ format requires a high electric bandwidth and a complex transmitter and receiver as compared to NRZ. Because of a narrow optical spectrum of NRZ pulses the dispersion tolerance is improved but results in inter-symbol interference and RZ pulses has a broad spectrum so the RZ pulses results increased robustness to fiber non linear effect and a decreased dispersion tolerance and spectral efficiency. According to the application we use modulation format and every modulation format has its own merits and de-merits.

VII. CONCLUSION

To transmit maximum possible information in minimum bandwidth and low cost is the main goal of a communication system. We try to improve the channel capacity by using the different modulation formats. These modulation formats are ASK, M-ary ASK,PSK,DPSK,DQPSK FSK and PolSK, which are used to improve the channel capacity of the system and modulation format has its own merits and de-merits. According

to their merits and de-merits a particular format is chosen for a particular application. If using multilevel signaling than more than one bit per symbol can be transmitted by using M-ary ASK modulation format and if using multiple phases than more than one bit per symbol can be transmitted by using M-ary PSK modulation format. In M-ary PSK the QPSK with differential phase gives the best result among all PSK formats. All the modulation formats improves the channel capacity of the system.

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