Advancements In Modern Fiber Optical Communication Systems, Modulation Techniques And Its Applications

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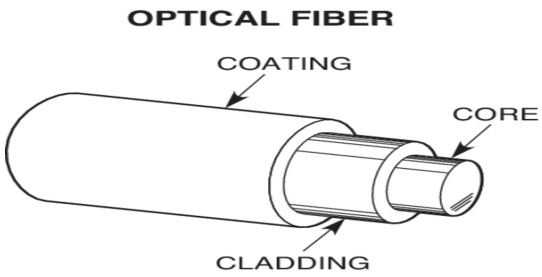
Abstract- *In the modern world of communication, fiber optic communication has witnessed a wide growth in the areas of data communication and in communication engineering. Optical fibers provides means of guided wave propagation which consists of wired components. It provides higher bandwidth efficiency than coaxial cable and twisted pair cable. This paper aims at discussing about the recent advancements in the areas of fibre optic communication, different modulation schemes in the modern system and applications are also about the wireless technology.*

Keywords- optical fiber, LED,WAN,ASK,FSK,PSK,WDM

I. INTRODUCTION

In the modern era, fiber optic communication is one of the widely emerging technologies associated with transmission of data carried using propagating light pulses along with a long fiber usually made of plastic or glass. For the transmission in optical fiber communication, metal wires are used. There are 3 main elements present in fibers namely core, cladding and coating. Light sources in optical fibres are either Light Emitting Diodes(LEDs) or Laser Diodes. The bandwidth is very high for optical fibers than the twisted pair cables and the coaxial cables.

Optical fibers are forms the application for broadband transmission where several channels are handled parallel manner. Free Space communications in optical domain is implemented by transmission of visible and infrared (IR) beams through the atmosphere to obtain optical communications. They are also used in wide area network(WAN).

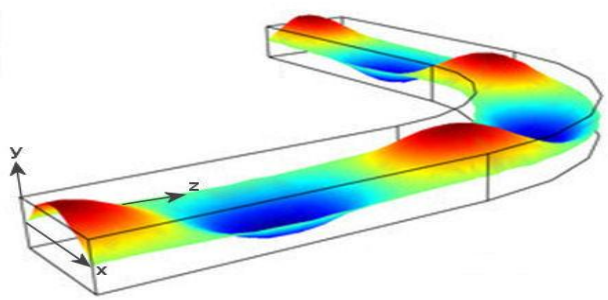


The core part is the light transmission section of the fiber, which is either glass or plastic. The larger the core, the more light would be transmitted into the fiber. Cladding provides lower refractive index at the core interface for reflection to happen inside core in order that light waves are propagated through the fiber. Coatings consists of multi-layers of plastics applied to protect the fiber strength, provide extra fiber protection. These buffer coatings are available from 250 microns to 900 microns. Optical fibers are also unaffected by electric and magnetic interference. Total Internal Reflection is the principle behind the working of optical fibres. Optical fibres are classified on the basis of refractive index, mode of propagation used. Based on refractive index, they are classified into step index and graded index fiber. Based on the propagation modes, fibers are classified as single mode and multimode fibres. Silica materials are used in the fabrication of optical fibers. Optical fibers suffer from attenuation of power. It occurs due to absorption loss, scattering loss, waveguide loss.

II. OPTICAL WAVEGUIDES

A structure that guides a light ray by constraining it to travel along a certain desired path. If the transverse dimensions of the guide are much greater than the wavelength of the guided light, with the help of total internal reflection, the optical guiding of light can be explained.

TIR occurs when light is incident on a dielectric interface at an angle greater than the critical angle θc.

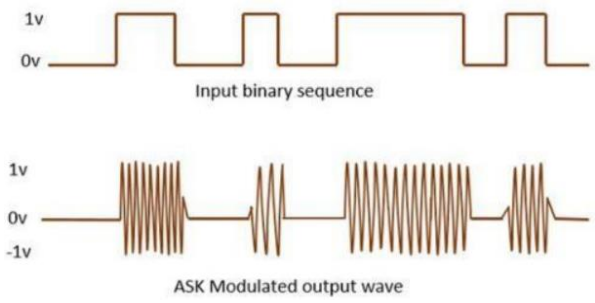


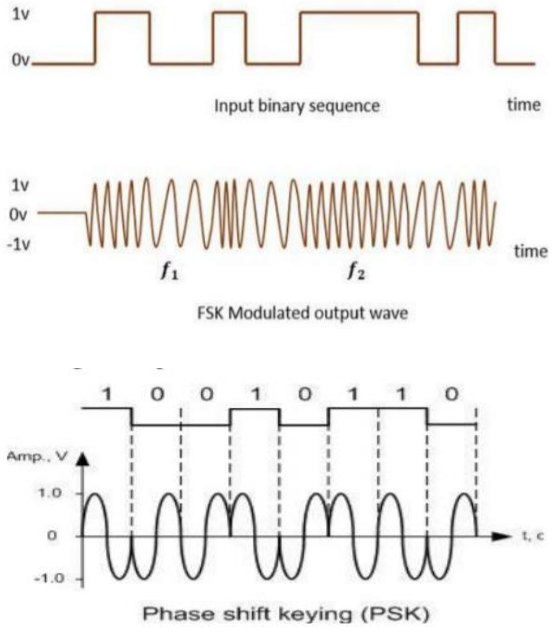
A wave guide detects light by surrounding a guiding region known as the core, made from a material with index of refraction n(core). Most waveguides are non-planar.

Light can be guided using different types of waveguides like rectangular, planar or circular. In optical wave guiding, light does not escape through the sides of the fiber.

III. DIGITAL MODULATION SCHEMES FOR OPTICAL FIBRES

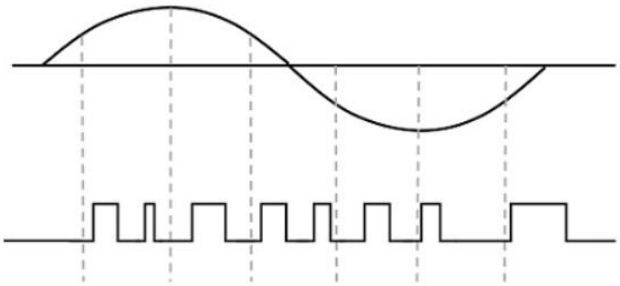
Modulation is the process of varying the characteristics of a modulating signal like amplitude, frequency and phase with respect to the carrier signal. Modulation can be implemented both in analog as well as in the digital domains. In the analog communication, the signal is highly attenuated, suffers from distortion and less data security. In digital communication, we obtain less attenuated, less distorted, high information capacity, high data rates. In digital communication, we have techniques like ASK,FSK,PSK which are analogues to AM,FM,PM in analog communication. In the case of Amplitude Shift Keying(ASK), according to the information present, we vary the carrier amplitude with respect to the information bit. Similarly, in Frequency shift keying, the frequency of the output signal varies either as high or low depending upon the information bits present. In phase shift keying, we have different types like 2-PSK,QPSK,8-PSK,16-PSK**.**

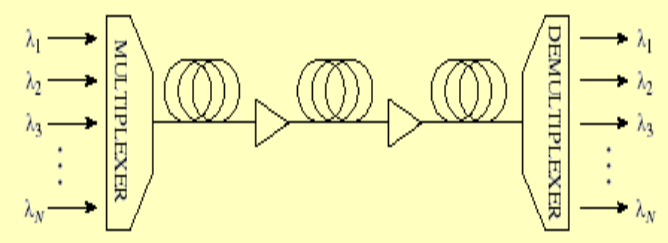




In optical modulation, the commonly used modulation technique is the ON-OFF keying technique. It has a rectangular pulse duration of (1/R where R = bit rate) and the intensity level is = 2*P (P= transmitting power). This implies that 1= High intensity level and 0= No bits present. An alternative approach to pulse position modulation, we have a technique known as digital pulse interval modulation. Here, high transmission capability is performed followed by eradication of all the unused slots. In this technique, there is no necessity for synchronization since each symbol is initiated with a pulse. Data is encoded in discrete intervals of time.

Pulse code modulation is used in optical fibres in which digital pulse coded signal is coupled into a fiber. The end of the fiber is controlled by a connector to maximize the input power. Semiconductor lasers like In GaAsP are used mainly infiber-optic communication system. The commonly used diodes in this modulation include PIN Diode, avalanche diode which are used as optical detectors.





Optical communication of information having data rate higher than 10 Gbit/s is achieved using a popular technique which is known as wavelength division multiplexing (WDM). Several signals with different wavelength are sent through the same optical fiber using this technique.

Here, both the multiplexer and demultiplexer has optical diffraction grating. The wavelengths varies from 2 to over 100. The separation distance between wavelengths, varies between from 0.4 to 3.2 nm.

IV. COMPARISION BETWEEN GUIDED TRANSMISSION MEDIA

Type	Type Sub Type	Maximum Segment Length	Bandwidth Supported	Installation	Cost	Interference
Twisted Pair Cable	UTP	100 mts	100 Mbps	easy	cheapest	high
	STP	100 mts	500 Mbps	moderate	moderate	moderate
Coaxial Cable	Thinnet	185 mts	10 Mbps	easy	cheap	moderate
	Thicknet	500 mts	10 Mbps	hard	moderate	low
Fibre Optic Cable	Multinode	2 kms	100 Mbps	very hard	expensive	none
	Singlenode	100 kms	2 Gbps	very hard	expensive	none

Here, in optical fibers, the data transmission characteristics are better than coaxial cable and twisted pair cables. Optical fibers supports very high bandwidth, suitable for worst environmental conditions, provides secured transmission of data with high capacity. In contrast to this, optical fibers are difficult to install. connection losses, soldering problems, noise immunity are some of the most common demerits which occurs in the case of optical fiber communication. Light can reach the receiver out of phase and quite expensive. Wavelength division multiplexing(WDM) is used in optical fibers which supports data rates greater than 10Gbps.

V. APPLICATIONS OF OPTICAL FIBERS

Optical fibers have major applications in telecommunication, military, metropolitan area networks, satellite communication and Image processing.

Due to its low bit error rates and less weight it is used in aircraft applications. Due to the presence of dielectric inside the fibers, it makes them immune from electromagnetic interferences.

Optical fibers also supports data secured transmission. They also have applications in Rayleigh scattering where the scattering is inversely proportional to the fourth power of wavelength.

Optical fibers are used in wiring of television cables used in our homes. They are used in imaging tools and as lasers for surgeries in hospitals which comes under medical applications.

VI. CONCLUSION

This paper examines about various digital modulation techniques used in modern optical communication system. In our daily life, optical fibers have vast applications like medical, military, networking. LED and LASER are the majorly used in optical fibers. The advantages, disadvantages and comparison between the guided transmission has been studied.

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