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Comparison of wavelength conversion using phase modulation at 10 Gb/s of 5 km DSF and 100 km of fiber using 3R regenerator

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Abstract: In today's era, wavelength conversion is a key component in optical fiber communication. The modernization in semiconductor devices and fabrication techniques has completely revolutionized the optical world. Despite this, different types of modulation techniques and fiber doped elements are used for long haul transmission to get better response with small degradation of signal. Further, this paper represents a comparison and analysis of wavelength conversion using cross phase modulation at 10Gb/s bit rate over 5 kilometer dispersion shifted fiber and cross phase modulation at 10Gb/s bit rate over 100 kilometer with 3R regenerator. Meanwhile, concluded results are shown in manner of Quality factor and Bit error response.

Keywords: Bit error rate (BER), inferometric cross phase modulation (XPM), need of wavelength converter, 3R-regenerator, and optical fiber communication.

I. INTRODUCTION

The basic need of optical communication is a major need of human beings. For optical communication certain channels are required to transfer a light signal from one point to another. Optical Fibers are thin long strands of ultra-pure glass or plastic that can transfer light from one end to another without much attenuation or loss [1][2]. Optical fiber communication consists of number of key elements as shown in fig.1.The first fiber-optic communication systems was developed in 1978 were capable of transmit signals at high bitrate [3] of 100 Mb/s using multimode fibers working near 0.85 μm [4]. Further for long transmission several systems were developed with reduced dispersion which can operate at 10 Gb/s with repeater and distance spacing as large as 100 km [5].

Firstly, information which consists of input pulse or data in form of codes is provided to electrical transmitter.Electrical transmitter transforms the desired signal into electrical form and provides it to optical source, which is further provided to optical medium.An optical medium consist of desired length of fiber having different refractive indexes

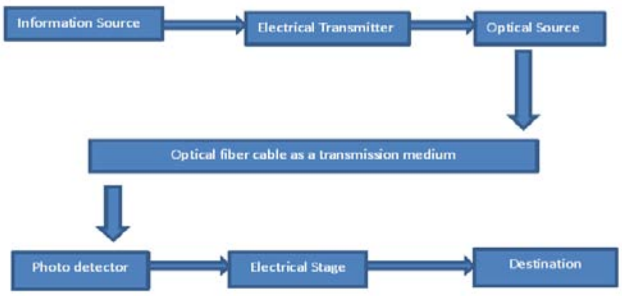

Fig.1 Block diagram of optical communication

Further a photo detector is used to extract and study different output signal parameters.Moreover, to get desired signal at destination, signal has to be pass by electrical stage where optical to electrical conversion takes place.

II. NEED OF WAVELENGTH CONVERTER

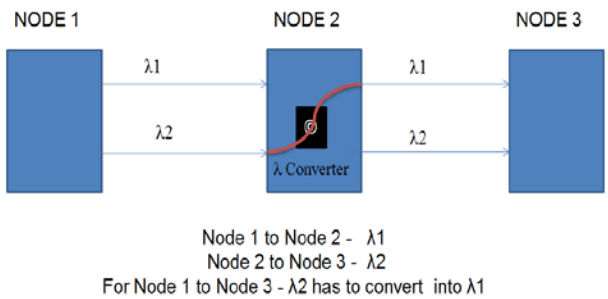

Fig .2 wavelength converter

In WDM system [6], wavelength routed network which carries data from one access station to another without any intermediate optical to electrical conversion is referred to as an all-optical wavelength routed network. Fig.2 illustrates a wavelength converter at Node 2 is employed to convert data from λ2 to λ1. A new light path between Node 1 and Node 3 can now be established by using wavelength λ2 on the link from Node 1 to Node 2 and then by using wavelength λ1 to reach Node 3 from Node 2.Notice that a single light path is such a wavelength convertible network can use a different wavelength along each of the links in its light path. Thus converter may improve the efficiency in the network by resolving the wavelength conflicts of the light paths [7].

III. EXPERIMENTAL SETUP OF WAVELENGTH CONVERTER OVER 5KM DSF

The schematic experimental setup is shown in Fig 3[8], here parameters and equipment's used for experiment are following a 12m erbium-doped fiber as the gain medium. A wavelength division multiplexer to couple the 980-nm pump laser to the EDF. An isolator to ensure the unidirectional operation of the laser.An amplitude modulator driven by a tunable RF source, Polarization controller and Cavity frequency of the ring. By adjusting and varying these parameters wavelength conversion is achieved.

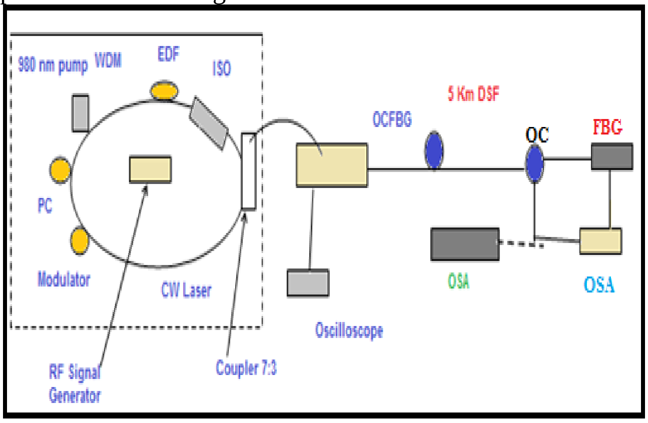

Fig .4 Setup of the wavelength conversion based on the cross-phase modulation

According to wavelength converter setup, a modulator frequency of RF signal is adjusted to integral multiple fundamental cavity response. A pulse is generated through active mode locked using harmonic mode locking method whose pulse train is provided to 7:3 coupler and further, injected to 5Km dispersion shifted fiber (DSF).Furthermore, DSF is spliced with the help of optical circulator (OP) whose one end is connected to FBG with desired wavelength of 1542.9nm whose output will be analyzed using optical spectrum analyzer [9].As shown in Fig 5 when radio frequency is tuned to 58.2 MHz, a pulse of wavelength 1553.185 nm from a continuous wave source EXFO tunable laser having power 1db is injected to 5Km DSF through 50:50 coupler . Further a broader spectrum of continuous wave signal whose one sideband appears beside the wave signal which remains same from 1537nm to 1560nm is observed. Enclose, by introducing a FBG filter a reputation in rate of converted pulse is obtained which was same as injected pulse and modulation frequency. The signal to noise ratio calculated is 25.02dB.

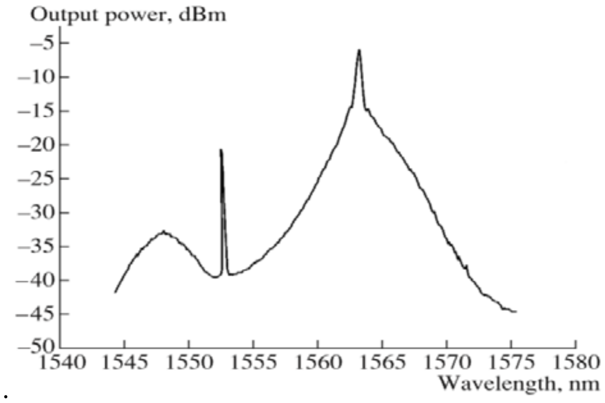

Fig.5 Output spectrum when continuum wave frequency =1553.185 nm.

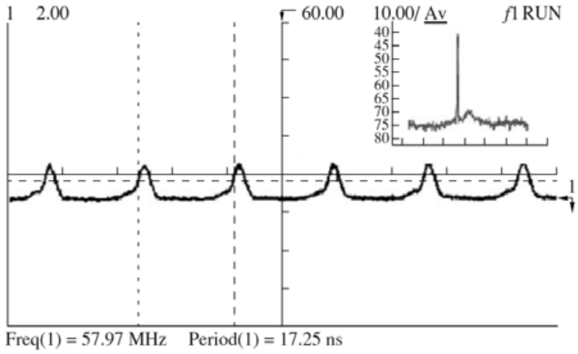

Fig.6 Converted pulse train with the FBG filtering

EXPERIMENTAL SETUP OF WAVELENGTH CONVERTER USING XPM OF 100 KILOMETER FIBER

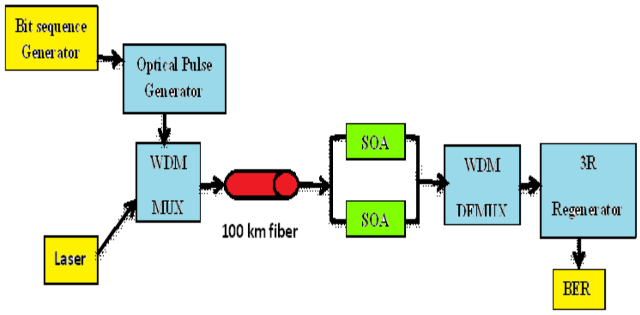

Fig.7 Experimental setup of cross phase modulation technique using 3R generator at bit rate of 10Gb/s

Fig.7 illustrates the experimental setup of wavelength converter in WDM system using cross phase modulation [10]-[14] (XPM)technique having 100 Km of fixed fiber length at bitrate of 10Gb/s. In this setup 10Gb/s bit sequence or bit rate of 10Gb/s is provided to optical Gaussian pulse generator having input frequency of 1550 nm and power of 0.000316 W is provided to WDM MUX. Simultaneously, an optical pump signal in the form of Laser having parameters frequency of 1540 nm and laser power of -10dBm W is provided to WDM MUX. Further, input optical signal from 2:1 WDM MUX passes through a fixed optical fiber length of 100 Km.

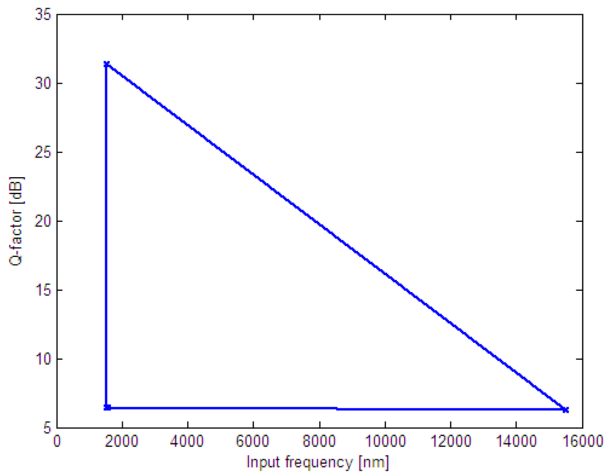

Fig.8 Graphical representation of Q factor with respect to input frequency(nm)

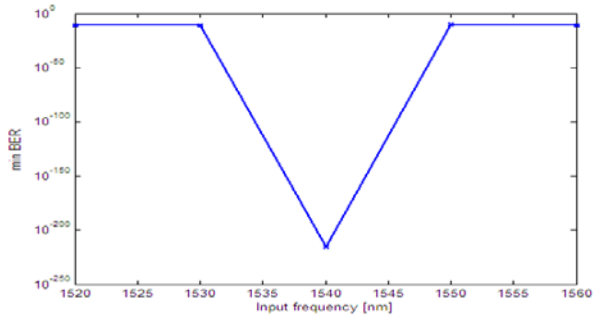

Fig.9 Graphical representation of BER with respect to input frequency (nm)

Furthermore, using cross phase modulation technique, the desired signal is provided to two different semiconductor optical amplifiers (SOA's) by using a splitter. Moreover the optical signal is demuxed by WDM DEMUX and changes to electrical form. Afterward, a photo detector, a low pass Bessel filter of cut of frequency 0.8 Hz are used to evaluate different parameters like Q- factor and BER [15] in future. Results concluded shows that maximum Quality of signal response with minimum bit error rate is observed at 1540nm as shown in Fig.8 and Fig.9.Similarly wavelength conversion at 1540nm is shown in figure Fig.10 and Fig.11. Furthermore Signal to noise power at WDM demultiplexer is concluded as2.41256dBm.

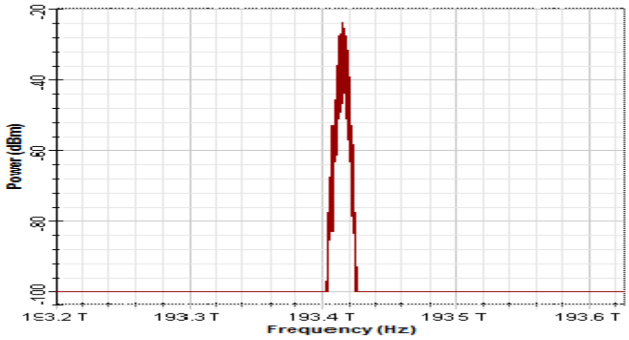

Fig.10 optical spectrum at input 1540nm before wavelength conversion

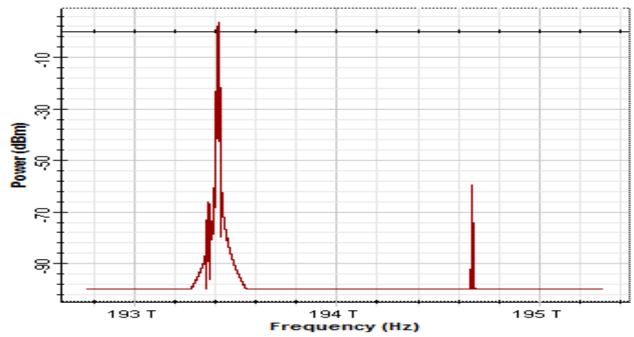

Fig.11 optical spectrum at output 1540nm after wavelength conversion

VI CONCLUSION

The wavelength conversion can be achieved by using both self-phase modulation and cross phase modulation at bit rate of 10Gb/s .this paper illustrates that a maximum wavelength conversion is achieved at frequency 1553.185 nm in the form of optical spectrum analyzer when light travels through a 5Km dispersion shifted laser. Whereas same wavelength conversion and confine results are calculated at frequency 1540 nm using XPM and by increasing the bidirectional fiber length up to 100 Km. It is also concluded that Signal to noise ratio(SNR) in wavelength conversion using DSF was more(25.02db) as compared to wavelength conversion using XPM(2.41256dBm).

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