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Performance Analysis of the Wavelength Converted Signal based on Cross Gain Modulation (XGM) in WDM Transmission System

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***Abstract* – In this paper we focus our attention on the wavelength conversion technologies for photonic networks. A simple method of Cross Gain Modulation (XGM) wavelength conversion employing semiconductor optical amplifiers (SOAs), one of the most attractive and promising wavelength conversion techniques for future all-optical systems. A 10 Gb/s transmission over 100 km for 16 WDM (wavelength division multiplexing) signals was performed using optisys 7.0 software.**

***Index term* – nonlinear signal processing with semiconductor optical amplifier, cross gain modulation (XGM), wavwlwngth division multiplexing (WDM), semiconductor optical amplifier.**

I. INTRODUCTION

Wavelength division multiplexing has been proposed to exploit the huge fiber transmission bandwidth and to allow easy routing and switching in optical networks [1]. Recently much attention is being paid to wavelength conversion technology. If we could convert a signal to a desired wavelength in a transmission bandwidth, it can be used to perform add drop multiplexing and an optical cross connects using the wavelength domain in WDM system. If a coherent nonlinear process could be used for wavelength conversion, a phase conjugate optical wave could be obtained [2]. This can be used for the compensation of the chromatic dispersion and nonlinearity of optical fiber to enable long distance, high bit rate communication [3,4]. To achieve all-optical wavelength conversion, various strategies have been investigated, like cross phase modulation (XPM), cross gain modulation (XGM), and four wave mixing (FWM) in semiconductor optical amplifiers (SOA) and has successfully been demonstrated [5].

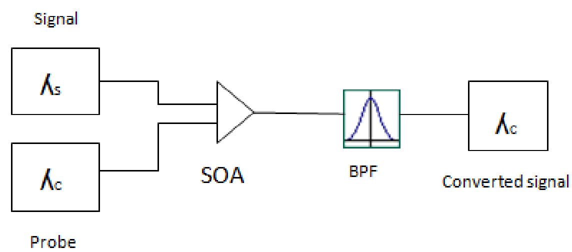

Fig.1: Schematic diagram of XGM wavelength converter.

In this paper, optical wavelength conversion has successfully been demonstrated with semiconductor optical amplifier (SOA) devices exploiting the cross gain modulation (XGM) effect. In the cross gain modulation scheme a strong input sinal is used to saturate the gain of a SOA and thereby to modulate a CW signal carrying the new wavelength [6]. Although XGM is limited by the relatively slow carrier recovery time within the SOA, impressive wavelength conversion of up to 40 Gbits/s [7], has been demonstrated. XGM is accompanied by large chirp and low extinction ratios. Wavelength converter changes the input wavelength to a new wavelength without modifying the data contents of the signal.

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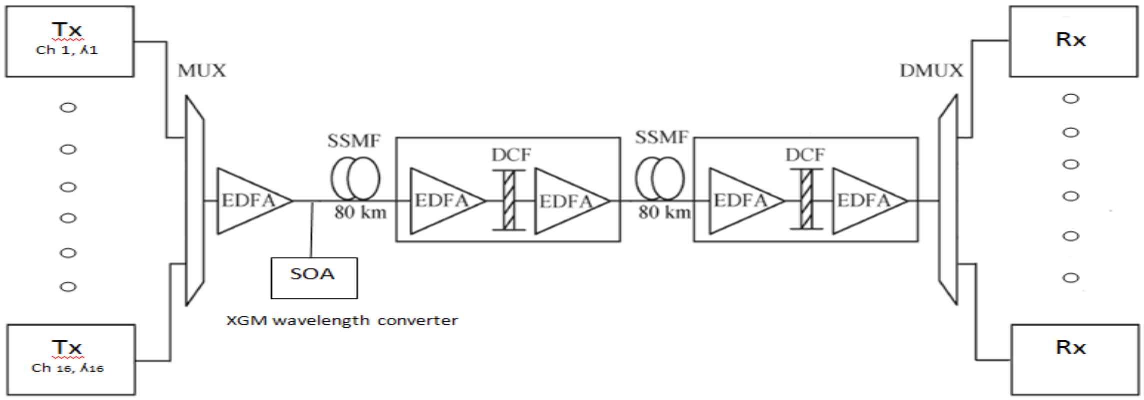

Fig.2: Simulation schematic of the XGM wavelength converter in the 16 channels WDM system.

II. SYSTEM CONFIGURATION

Fig.2 shows the system model used in the simulation. The terminal multiplexer contains one wavelength converting transponder for each 16 channels of WDM system. The wavelength converting transponder receive the input optical signal convert that signal into the electrical domain, and retransmit the signal using a 1548 nm to 1563 nm band channel with an equal channel spacing of 2nm. In this system, EDFA's are inserted in the transmission line every 50 km for compensating the loss in optical power while the signal travels along the fiber. The signal is amplified by an EDFA, which usually consists of several amplifier stages. This is an alternative method of amplification site that amplifies the multi-wavelength signal that may have traverse up to 140 km or more before reaching the receiver part. The terminal demultiplexer breaks the multi-wavelength signal backs into individual signals and outputs them on separate fibers. The receiver design consist of FBG whose output is fed into PIN photo detector having -3dB gain with dark current of 10mA. The electrical signal is fed into Low Pass Bessel filter having bandwidth as same as the 16 channels in the transmitter part and a NRZ pulse generator. User Defined Bit Sequence and NRZ pulse generator can be connected directly to BER analyzer. The output of BER analyzer gives the BER performance and Q-factor for the system.

A typical schematic diagram of a XGM wave-length converter is shown in Fig. 1. The XGM wavelength converters depends on optical input power and bias current to deplete the carrier concentration in the active region of SOA and saturates the SOA. In order to convert the input signal from one wavelength to the desired wavelength, the gain saturation of the SOA can be used.

III. RESULTS AND DISCUSSION

We observe the output waveform and measure Bit Error Rate (BER). Figure 3(a) and 3(b) shows the simulation results from Optical Spectrum Analyzer (OSA).

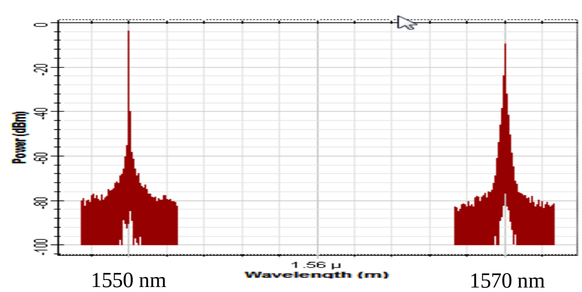

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Fig.3: Input signal before wavelength conversion measured by OSA at the output of the SOA.

Spectra for the pump optical signal and the converted output optical signal are shown in figure below. It can be shown that the wavelength converted signal is 1552nm, which is identical with the probe wavelength. Then it can be concluded that the wavelength up conversion with a 0.5nm span has been achieved.

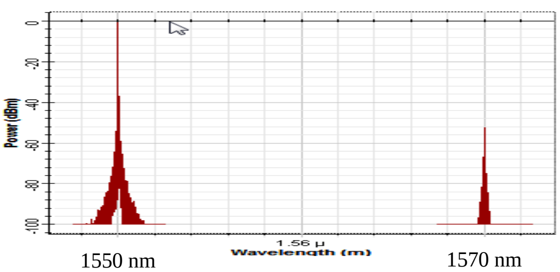

Fig.4: Converted signal

After the SOA, a filter selects CW and drops the other input signal (Fig.4).The speed of operation of XGM wavelength conversion is determined by the carrier dynamics of the SOA, which is districted due to its relatively slow carrier recovery. The modulated signal (ʎs) will saturate the gain of the SOA, so the number of the active porters in the excited state will decrease. So, the CW modulation is proportional to the gain resulting in the decreasing of the gain. As the final result, the output signal will be inverted.

Fig.5 shows the performance of multi-wavelength XGM technique in terms of eye diagram visualizer. According to the results, the Q-factor of the converted signal's drop as the number of probe wavelength increases. The observation initially suggest that this techniques (XGM wavelength conversion)is not feasible in a WDM system.

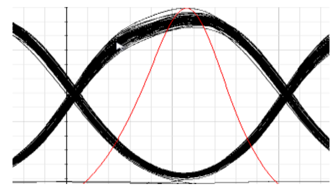

Fig 5: Eye diagram 16 multi-wavelength XGM

IV. CONCLUSION

In summary, an implementation 10 Gbps dispersing compensated WDM system have been investigated. The architecture investigated was based upon a optical Multiwavelength converter using XGM signal and SOA gain saturation, as well as the conventional XGM that will provide full tunability and fast reconfiguration of the optical wavelength path.

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