160 Gbps WDM Transmission System using Linearized SOA with 50 GHz Channel Spacing

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ABSTRACT
In a 16 Channel, 10 Gbps WDM System with Linearized SOA using feed forward linearization technique the effect of reduced channel spacing has been investigated. The basic mechanism of crosstalk is completely independent of the amplifier but it depends on the spectral overlap of adjacent channel. However In this paper it has been validated that using linearized SOA the system can be extended to 120 Km length with channel spacing as small as 50 GHz. The achieved Q-Factor was 11 at 100km and 4.2 at 120Km.

Keywords
Feedforward linearization technique, SOA, Channel spacing, WDM system

1. INTRODUCTION
Semiconductor optical amplifiers are amplifiers which use a semiconductor to provide the gain. Semiconductor optical amplifiers are typically made from group III-V. Such amplifiers operating at signal wavelengths between 0.85 µm and 1.6 µm can provide gain up to 30db. It also provides low cost route to providing amplification and also can be used as power booster. However with all these advantages, SOA has one disadvantage of giving non linera outputs. In this research paper it has been validated that the SOA can be lineraized by using feed forward technique and then that lineraized SOA can be evaluated at higher data rate, higher channel system with reduced channel spacing.

Using SOA causes severe problem of intermodulation distortion. It is more severe because this kind of distortion lies more near to pass band and cannot be filtered out easily. Hence various methods and techniques' are used to considerably reduce the worse effect of IMD3 on the performance of light wave link. Therefore because of this the broadband radio demands to be more prevalent due to increases for multiservice operation. In spite of having substantial progress in technology the threat we are facing is increased BER as the link length and data rates increases, as well as increasing harmonic and IMD3 distortion because of multiple channels and when power at the transmitter increases. Various approaches have been done so far to reduce errors. It has been suggested to employ feed forward linearization technique in link to enhance the system performance [1]. There are different methods of linearization [2-5] but feed forward linearization methods gives better results than all. The feed forward technique is better because it gives a large improvement in IMD3 reduction.. An analysis of 16×10 Gbps WDM system was carried out in [6-7] using the feedforward linearization scheme proposed in [1]. In this paper, the 160 Gbps system is analysed to study feasibility of operation when the channel spacing is reduced to 50 GHz. A comparative study of the evaluation and performance of SOA using lineriazation technique has also been studied [6-7].

2. FEED FORWARD APPROACH
In the feed forward linearization circuit the error signal in the amplifier is subsequentlly cancelled. As shown in the figure 2, the first loop is the carrier cancellation loop, which extracts the distortion products, whereas the second loop is the error cancellation loop, which amplifies the distortion products and reduced them by cancelling with the distorted main-amplifier output. The amplifier used in this loop is called the error amplifier [1]. Amplitude, phase, and delay factors are need to consider more precisely in both loops because the mismatches in these parameters effects on the linearization performance of the feed forward, and its efficiency is also limited by the main and error amplifiers, losses of the couplers, and delay compensators [8].

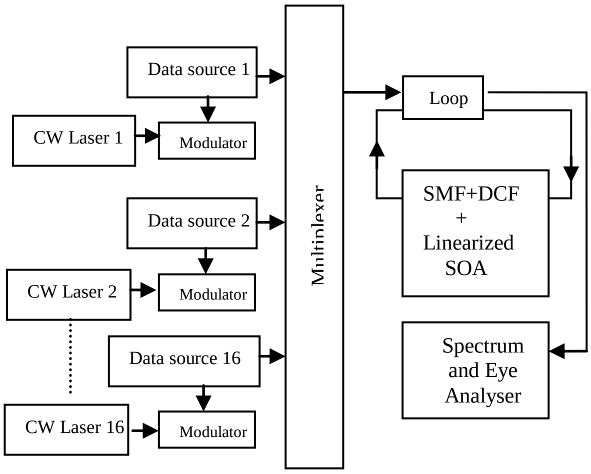

Fig.1: Conceptual diagram of 16 channel WDM Link

The conceptual digram of the simulated model of 16 channel WDM link with SOA linearized using feedforward linearization is shown in figure 1. A sixteen CW laser are connected such that wavelenght of the first channel is 1565.5 nm and the wavelength of sixteenth channel is 1541.35. The ouptut of the CW laser array is externally modulated and applied to 16:1 Mux. The optical signal propagates over a distance of 120 km comprising of SMF and DCF and an adjustable gain amplifier and the system performance parameters are observed in the receiver. The attenuation and disperssive effects introduced by the SMF gets compensated by the DCF . This attenuation is applied by the linearized SOA. The signal is finally observed by using eye diagram and the spectrum analyser.

While planning of radio frequency, term channel spacing is commonly used. Channel spacing defines the frequency difference between adjacent allocations in a frequency plan. If the channels are closely spaced, cross talk will be more. The block diagram shown in figure 2 has been used to carry out the analysis in this study. The simulation model of this block diagram was built by using Optisysytem version 9. In order to study the effect of variations in channel spacing over the performance of optical communication system. the channel spacing is reduced from 200 GHz to 50 GHz and the results have been observed. The system performance is analysed from the obtained results and is shown in tabular as well as in graphical modes.

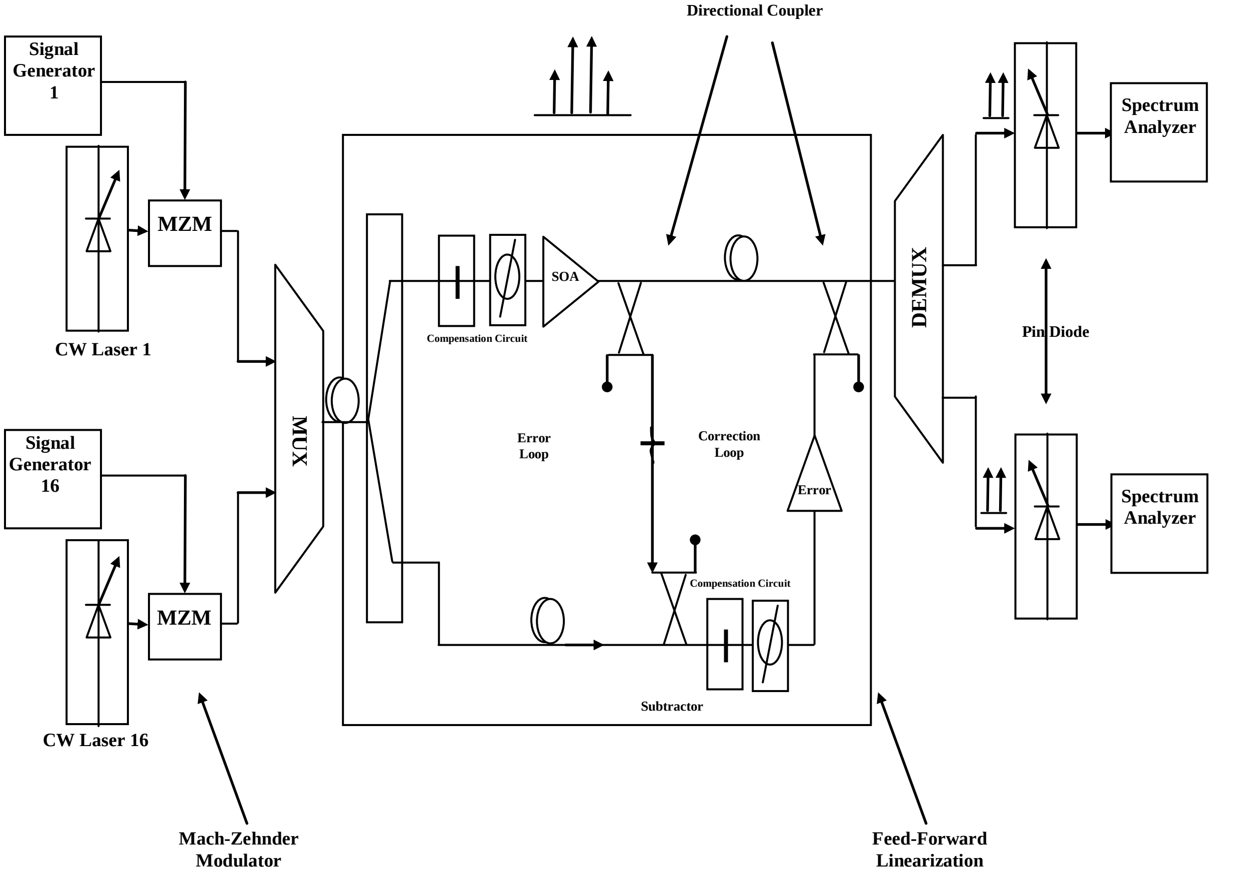

Fig 2: Block diagram of 16 channel WDM link with SOA linearized using feed forward linearization technique based on [6]

3. RESULTS AND DISCUSSION

The fig. 3 shows that the system performance degrades as the link length increases. Q- Factor vs. Channel spacing at different fiber length is also represented in tabular form as in table 4.1.

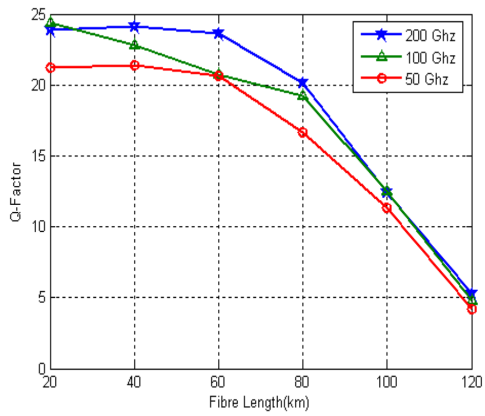

Fig. 3: Q-Factor vs. fiber length at different Channel spacings.

Table 4.1: Q- Factor vs. Channel spacing

Fiber length (km),	Q –Factor at data rate 10 Gbps		
	Channel spacing		
	200 GHz	100 GHz	50 GHz
20	23.90	24.36	21.18
40	24.11	22.77	21.40
60	23.63	20.74	20.63
80	20.12	19.19	16.68
100	12.41	12.52	11.32
120	5.3	4.74	4.2

Figure 4 shows the eye diagram at channel 1 with channel spacing of 50 GHz. Similarly the eye diagram at 200 GHz channel spacing is shown in figure 5. There comparison shows that a wide opened eye is obtained when the channel spacing has reduced from 200 GHz to 50 GHz.

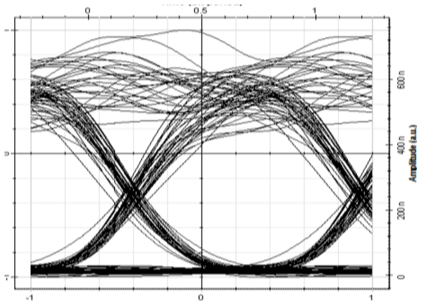

Fig.4. Eye diagram for channel spacing of 50 GHz.

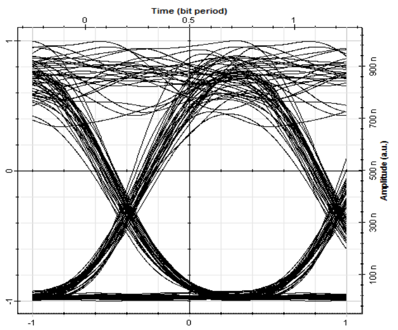

Fig. 5: Eye diagram for channel spacing of 200 GHz.

4. CONCLUSIONS

The linearization of SOA has been done in this work. The evaluation and enhancement in the link length has also been validated in the work done. It has been concluded that the linearized SOA using feed forward linearization technique can carry the data of 16 channels at 120 km long length at the data rate of 10 Gbps. In this, study has been carried out to evaluate the applicability of feedforward technique of linearization of SOA to WDM system when the channel spacing is reduced from 200 GHz to 50 GHz. The results shows that with channel spacing reduced to 50 GHz, the system can still operate with a good system performance.

5. REFERENCES

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