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Gain Flattening Of Hybrid Optical Amplifier for 64×20gbps System Using DWDM Technology

Raghav Vashishth[1,] Sameksha Bhaskar[2]
[1,2] *Dept.of Electronics and Communication, Lovely Professional University, Jalandhar, Punjab*

Abstract- *In this paper the hybrid combination of Erbium doper fiber amplifier and Raman amplifier are projected for dense wavelength division multiplexed (DWDM) 64×20Gbps system. The evaluation of the system has been done in terms of gain and gain flatness at both of the stages using some gain equalization technique the hybrid optical amplifier has gain flatness of 2.5 dB and the maximum gain of 21dB is observed .The gain flattening is also observed for varied input pump power.*

Keywords*:-HOA: Hybrid Optical Amplifier , Gain , Gain flatness , DWDM :Dense Wavelength Division Multiplexing.*

I. Introduction

Optical fiber systems are used as a backbone for sending and receiving the data at ultra high speed and at longer distances. Commercial users demands for the very high speed network for sending and receiving media rich messages in less time and the corporate user demands for ultra high speed so that they can connect their local area network to the internet at high data rate and efficiently. To fulfil the demand of the user the network with high data rates and lower cost is required. Optical Fiber communication systems fulfil these demands because of their higher bandwidth and lower costs over the conventional data transmission systems .Hybrid optical amplifiers (HOAs) are an enabling and promising technology for future dense wavelength-division-multiplexing(DWDM) multiterabit systems, as it has been shown in recent experimental and simulation results [2,3].In optical network the hybrid amplifiers are used to enhance the bandwidth ,to increase the span length and to obtain large gain with lesser gain flatness [2,5].

In the conventional optical systems to amplify the optical signal the optical signals are first converted into electrical signal and then they are amplified in the electrical domain which makes the system quiet complex and time consuming .By the use of optical amplifier the optical signals are directly amplified in optical domain. Optical network the user is assigned with the different wavelengths which are sent over single fiber thread with the help of DWDM process .On the other hand it is required to use more no of fiber threads or to increase the data rate .By decreasing the channel spacing between the channels the optical thread become capable of accessing more wavelengths over it [6].

In order to increase the transmission capacity three different schemes can be performed recently Singh et al [1] demonstrated three schemes which can help to increase the transmission capacity (1) Decreasing the channel spacing, (2) Increasing the bit rate, and (3)Using broadband optical amplification.

Using the first scheme ,the channel spacing between the adjacent channels is reduced in order to increase the number of channels in the system which provides high speed and reduces the dispersion effects in the optical system .Various DWDM systems are implemented using the narrow spacing which provides better results have been studied in literature [7-9].By employing second approach i.e. increasing the bit rate of the system the bit rate can be increased up to 40Gbps or even more of each channel used in the DWDM with the use of high speed digital circuits and optical time division multiplexing by using this scheme the system become complex and there is requirement to decrease dispersion by applying some dispersion compensation techniques .For the broadband application the EDFA are the best choice to increase the capacity[1].The HOAs are mainly implemented to increase the gain bandwidth with higher gain flatness at the output of the Hybrid combination.

All the above schemes discussed above have their own significance of their use in the HOA system. in this system we have used the first and third approach in parallel to get the better gain flatness in the hybrid optical network and it is noticed that systems with narrow channel spacing are the next generation high speed transmission systems .The implemented circuit is shown in Fig 1in this paper the work done in the literature [10-13] has been extended. Also the effect of varied input pump power is also studied in this HOA system in order to measure the gain at the second stage of the circuit.

II. Simulation Setup For HOA

Prior to design HOA for DWDM system it is necessary to analyse the transmission performance. Transmission performances generally evaluated by transmission capacity (C) and transmission distance (L). Transmission capacity is the product of bit rate and number of wavelength N [6].

C = Bit rate × Number of Wavelengths (N) (1)

N = Optical signal Bandwidth × Channel Density (2)
So we can say that from 1 and 2.
C = Bit rate × optical signal bandwidth × channel density (3)

[1].The investigated circuit is shown in Fig 1 showing the effect of decreasing the channel spacing on the gain enhancement and gain flattening of HOA. The simulated system consist of 64 channels spaced at 12GHz the laser used at input sends continuous array of input signals at 20Gbps .First channel is emitted at 185 THz of frequency and the channels are increased up to 64 channels having the spacing of 12 GHz between every adjacent channel after the transmitter part the EDFA and Raman amplifiers are placed in series and their gain media is utilised in order to increase the gain of the implemented circuit.

First stage of the HOA system consists of EDFA having the concentration of Erbium doped fiber of 5 × 10^24m^−3 with 9m of length .it is pumped at the frequency of 1465nm and the pump power of 50mW. After this the signal is employed to the optical isolator .At the second stage of the HOA Raman amplifier with length of 15km is used which is co and counter pumped at the frequency of 1550nm and 1489nm respectively having the pump power at both the coupler laser of 750mW .In this work we have also studied the effect of increasing the input pump power to study the effect of gain the input pump power is varied from -26dB to 0dB in the simulated circuit .At the second stage of setup, the obtained signal is fed into the OSA in order to analyse the optical spectrum .To measure the gain parameter of the HOA system the Dual port WDM analyser is used to study the gain flatness also the optical isolator are used to avoid the backward flow of signal inside the fiber thread so that does not turn the system into oscillations.

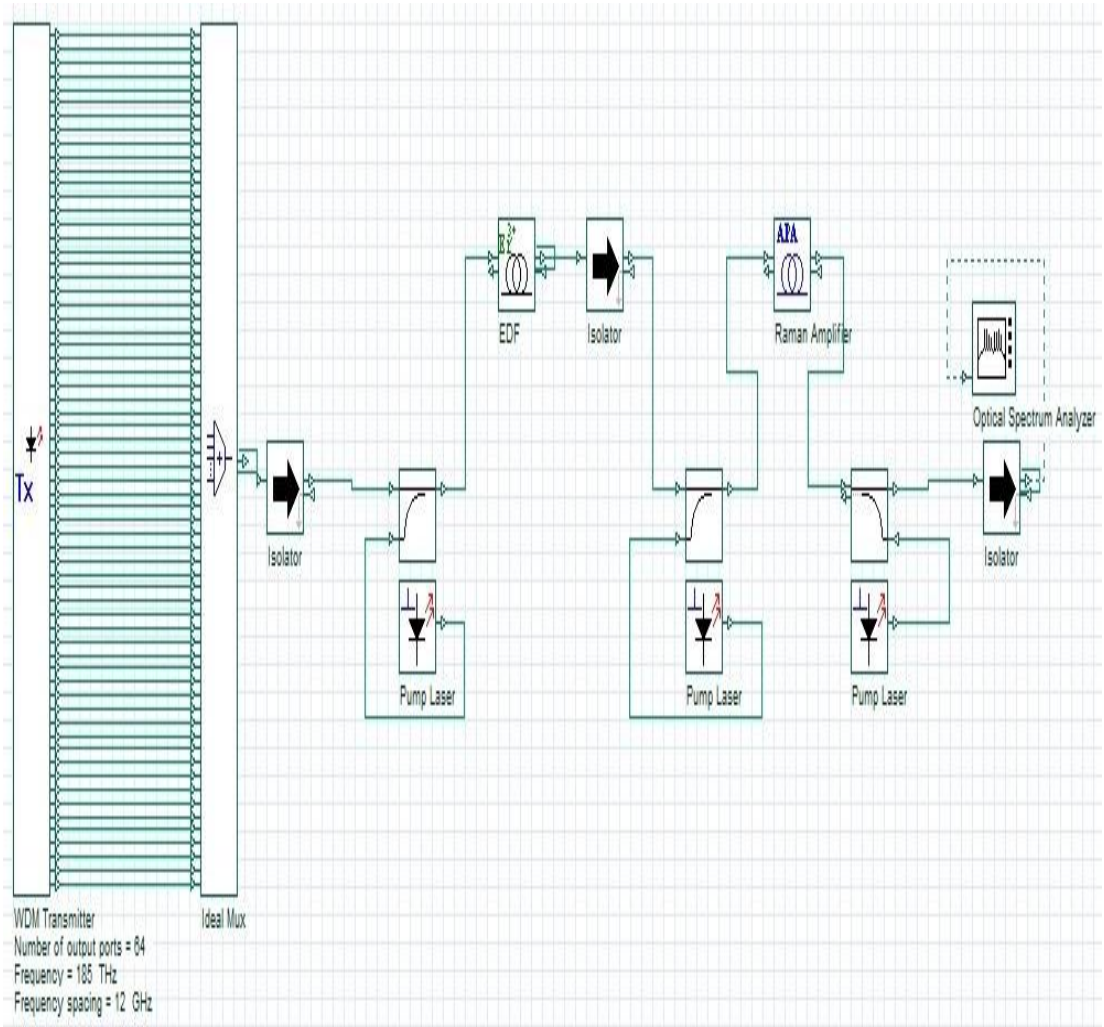

Fig 1 Simulation Setup of 64×20Gbps HOA System.

III. Result S And Discussions

As we know that the given system is implemented for the ultra narrow channel spacing using HOA .The effect of gain flatness and increase in gain at second stage of HOA is shown in the fig 2 and the effect of varied input pump power is recorded in Fig 3. As the ultra-low channel spacing is implemented to measure gain at first and second stage of hybrid system. It is observed that the HOA has flat gain at the first stage and higher gain of 21.7 dB is observed at the second stage of the hybrid system with approx. 2.5 dB of gain flatness. Also at the first stage of the amplifier, the gain flatness is 0.51 dB observed with maximum gain of 9.21 dB. The results are also calculated on the bases of varied input pump power. When the input pump power is -26 dB, the maximum gain of 13.06 dB at the second stage of HOA. As we increase the input pump power, we find that the maximum gain of 12.3 dB and 7.99 dB when the pump power is -10 and 0 dB respectively these results are shown graphically in Fig 3.

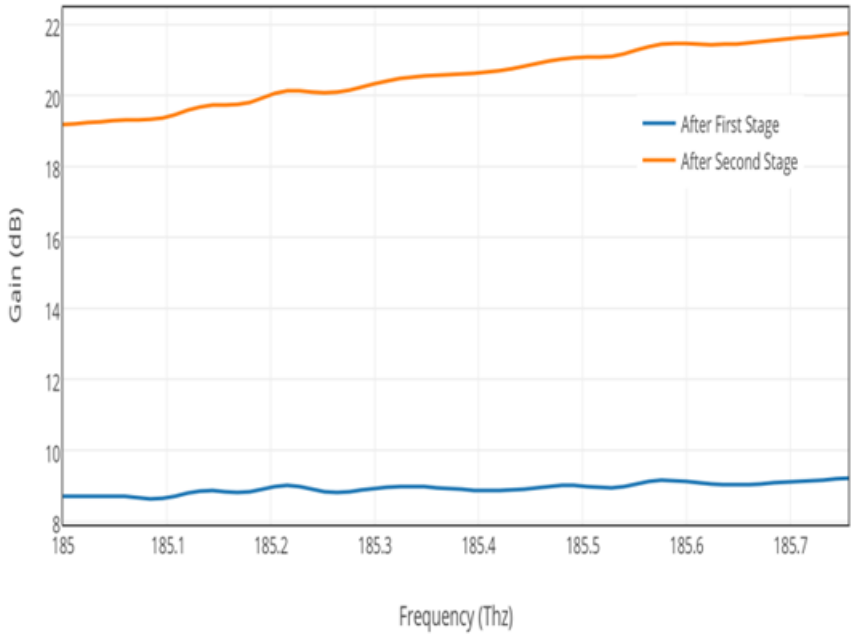

Fig.2 Gain at First and Second stage of HOA

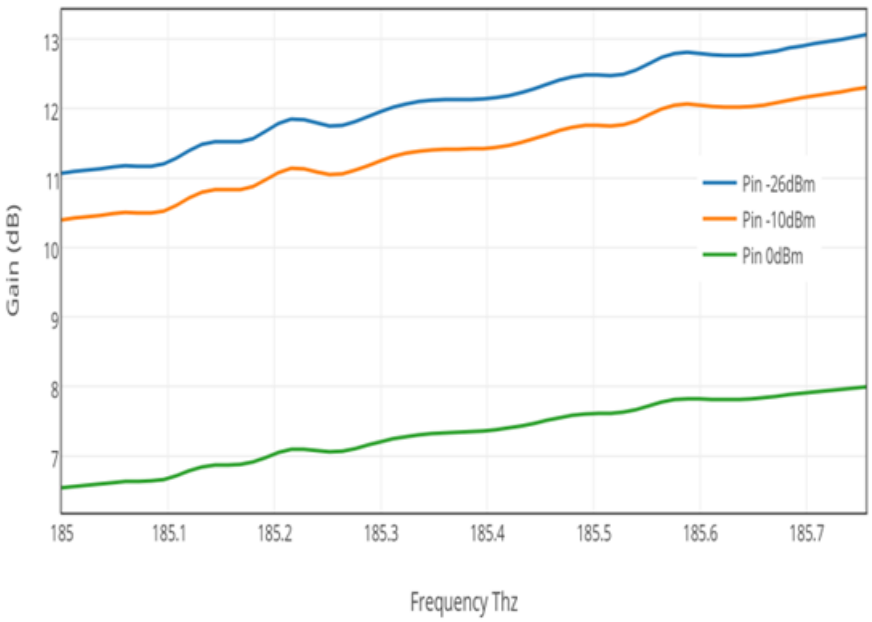

Fig.3 Gain at different Input Pump.

IV. Conclusion

The proposed Hybrid Optical Amplifier is implemented using ultra low channel spacing of 12GHz for 64 channels. Also the system is studied by varying the input pump power .it is observed that the maximum gain of 21.7dB is obtained at the second stage of the hybrid Optical System with the gain flatness of 2.5dB and with increase in the input pump power the gain at the second stage also increases.

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