International Journal of Research in Advent Technology, Vol.5, No.4, April 2017
E-ISSN: 2321-9637
Available online at www.ijrat.org

Improved Analysis of Hybrid Optical Amplifier in CWDM System

[1]Bandana Mallick ,[2]Reeta Kumari ,[3]Anirban Mukherjee ,[4]Kunwar Parakram
1. Asst Proffesor in Dept. of ECE, GIET Gunupur
2 , 3 ,4. Student in Dept. of ECE, GIET Gunupur
Mail id: bandana.mallick@gmail.com, parakram001@gmail.com

Abstract-We have proposed and demonstrated a hybrid amplifiers SOA-EDFA CWDM transmission system. A new hybrid two-stage in the system of optical fiber amplifier for coarse wavelength division multiplexing (CWDM) network is observed. The hybrid amplifier is a cascaded semiconductor optical amplifier (SOA) and erbium- doped fiber amplifiers (EDFA) which provide a nearly flat gain over 80 nm. The hybrid amplifier has been modeled using a OptiSystem version 14 on a CWDM transmission system which consisting of spans of 100 km. Performance of the system is analyzed by using BER analyser.

Index Terms: Coarse wavelength division multiplexing (CWDM); Semiconductor optical amplifier (SOA); Erbium doped fiber amplifier (EDFA); Optical fiber.

1. INTRODUCTION

In optical communications system carrier signal is output of a light source which is used as a transmitter. Despite frequency division multiplexing (FDM) techniques are used for broadcast systems with high coverage area, mainly optical communication links uses time division multiplexing (TDM) techniques[1]. The components used for transmitting andreceiving the optical signal are generally semiconductors devices. In transmitter generally laser diode (LD) and light emitting diode (LED) are used as optical sources where they have specific properties according to power spectrum and fabrication. Optical receivers consist of PIN photodiode or Avalanche photodiode (APD),which acts as a photo detector and converts the modulated optical signal into an electrical signal. The photodiode current is directly proportional to optical power.

Wavelength Division Multiplexing (WDM) transmits number of signals on a single optical fiber by using distinctive wavelengths to transmit each signal.[2,3] For a given transmission line rate, WDM increases the volume of data which is to be transmitted by the same optical fiber with respect to the number of wavelengths transmitted. WDM technologies have been used and gained popularity after Dense Wavelength Division Multiplexing (DWDM) became standardized. DWDM implement carriers to increase the size of the SONET/SDH rings in the network core, without installing new fiber. As the demand for bandwidth is increasing new development is being made in DWDM technology[4].

While DWDM prevails in long haul network segment, a new WDM technology, Coarse Wavelength Division Multiplexing (CWDM) is now used to aid carriers to enhance their network capacity in different segment i.e. access, metro and regional network. CWDM is used with fewer wavelengths than DWDM, but is cost efficient at a fragment of the cost of DWDM. This makes CWDM interesting for areas with medium traffic growth projections.[5] Proprietary CWDM systems has been used, but carriers have been reluctant to open solutions that were not standardized. With full ITU-T standardization completed in 2003, CWDM deployments will increase dramatically.

2. BASICS OF CWDM

Coarse Wavelength Division Multiplexing (CWDM) implements a cost-effective option to DWDM in many metro and regional networks, and provides increased capacity in the access networks. CWDM is technologically less complex to implement than DWDM, and it provides traffic growth demands without any increase in physical components[6]. For example, a general 8-channel CWDM system, while inexpensive to setup and offers 8 times the amount of bandwidth that can be achieved using a SONET/SDH system, by using same optical fiber at specific transmission line speed.

Coarse WDMs has two functions. Firstly, they filter the light, ensuring only the required wavelengths are used. Secondly, they multiplex or demultiplex multiple wavelengths, which are transmitted using a single fiber link. The difference lies in the wavelengths, which are used. In CWDM space, the 1310-band and the 1550-band are divided into smaller bands, each only 20-nm wide. In the multiplex operation, a single fiber is used in which combined multiple wavelength band are transmitted. In a demultiplex operation, the multiple wavelength bands are separated (i.e. *demuxed*) from a single fiber[7]. The used wavelengths are defined by the International Telecommunications Union; reference ITU G.694.2 for the ITU CWDM Wavelength Grid. Note: as of June 2002, eighteen center wavelengths, from 1270 nm to 1610 nm[8].

	CWDM	DWDM
TRANSMISSION DISTANCE	LESS	MORE
COST	Setup cost is 20-25% less than DWDM	Cost is more
WAVELENGTH GRID	Smaller	Larger
NO OF CHANNELS DELIVERED	17-18 atmax	Hundreds
CUSTOMER	Smaller number	Large number

Table I. Difference between CWDM and DWDM

CWDM requires less area because it has smaller size of components. The transmitters of CWDM use approximately 12.5% area of DWDM. The components used in CWDM have less power consumption and thus provide longer battery backups. Because of the lower power dissipation, the components require less air conditioning.CWDM can not only use the legacy fiber laid before but also provide multi-service interface, it can realize IP/Ethernet over SDH, ATM over SDH, and it can provide router and ATM switch with fiber interface.[4]

3. SIMULATION SETUP

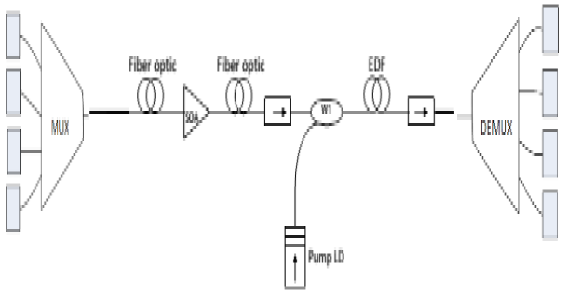

Fig1: Basic Layout of CWDM System

The commercial amplifier SOA is used to compare with EDFA amplifier performance which is used for CWDM system applications. SOA and EDFA used for hybrid amplifiers are useful to present an amplification spectrum covering the S, C, and L band. Due to wide bandwidths and cost-effective multi-channel Semiconductor optical amplifier (SOA) is suitable for CWDM system and also suitable for metro space that is well-suited for some CWDM system[6].

Standard using EDFA amplification band ranging approximately from 1530 nm to 1560 nm or C-b and which is extensively used in the system long-haul fiber optical communications because of the given gain is more than 20 dB[1,3]. According to function of amplifier is one of the elements for increasing performance in the system, three major requirements for amplifier are

(i) high gain
(ii) low noise and
(iii) flat amplification profile .

Based on the proposed use of optical fiber amplifier in the hybrid system is from S to C bands using SOA and EDFA amplifier is designed and modelled using optical network simulator tool namely Opti-System version 14 by Opti-Wave.

This experiment was done using 8 channels CWDM system from 1470 to 1610 nm and uses two optical amplifier SOA and hybrid EDFA when connected in the system. Figure 2 shows the set-up of the SOA and EDFA hybrid amplifiers in two phases for CWDM system using opti-system.

The transmitter subsystem consist of a pseudo random pulse generator which generates the bit sequence with data speed of 10 Gbps from which the output is given to the NRZ pulse generator which is used as a line coding technique in this system. The output from NRZZ pulse generator is now given to the Macg zener modulator aand the second input is taken from a CW laser whose frequencies are set to be 20 nm apart and laser power is set to be zero. The frequencies used by the CW lasers aare from 1470 nm to 1610nm with 20 nm difference between each frequency.

Then the signal is transmitted over a CWDM optical fiber via a WDM mux. The dispersion of the fiber is set to be $16ps/nm^2/km^2$. Then a Wideband travelling SOA is used with injection current od 0.1mA. the output from the Soa is given to another CWDM fiber with 20km length and the EDFA is last stage of the channel with pump power of 50W and gain is 20dB.

The receiver section includes of a optical receiver and a BER analyzer to get the values of Q-factor at the end of the system after transmission of the signal to provide us the data related to the noise in the system and the quality of the signal received at the output end.

The use of amplifiers in the telecommunications system target to get better results, however, to improve the quality of telecommunications system, it is not only to increase the power source but also should be added amplifiers in the system to boost in order to get quality results. In a system that requires an optical amplifier which can improve the quality of results before it is accepted by the user, the signal received by the user can be received well, so that the data or information to avoid mistakes caused by weakness or high noise levels. Adjusted value of the simulator like the real system in the experiments.

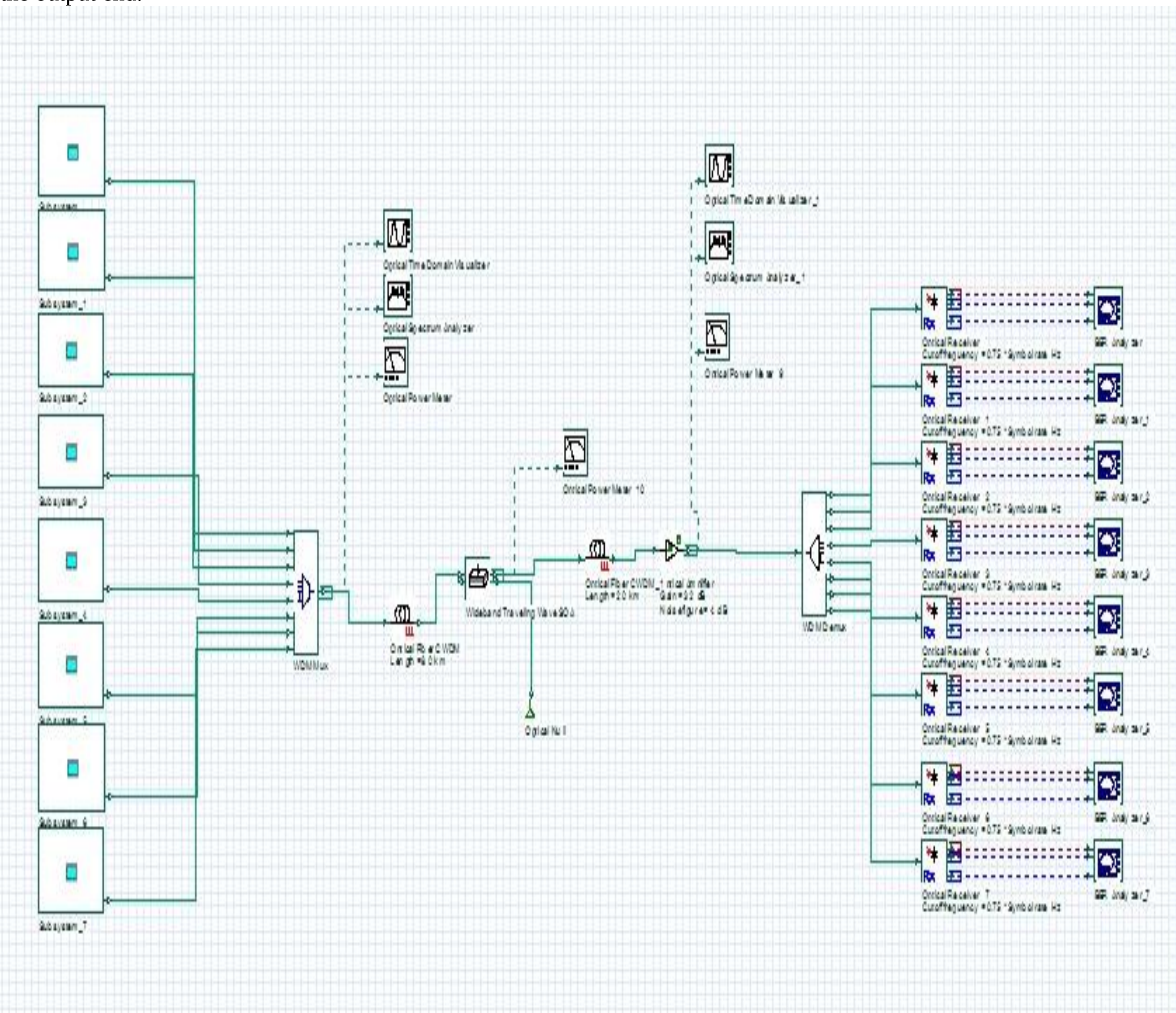

Fig 2: Simulation Setup using optisystem 14

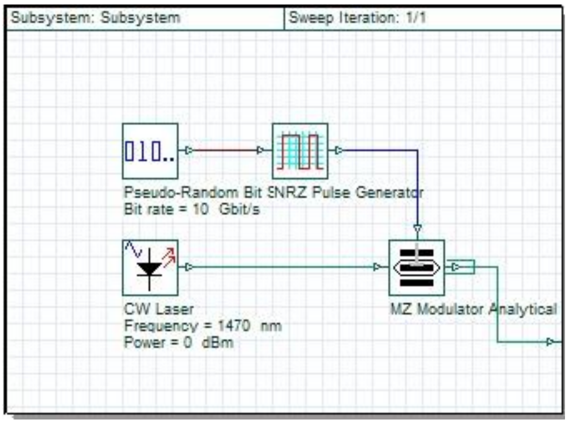

Fig 3: Tansmitter Subsystem

4. RESULTS AND DISCUSSION

From the experiments, we concluded that increased power source or bit rate without the support of network, make saturation point in the system very quick, so that results is not so far away or results generated from the system is not so qualified. So, we try to improve the system by adding amplifiers using a combination of EDFA and SOA where each amplifiers characteristic and way of working are not the same. The receiver can receive input power from system at minimum values -25 dBm. However, in this experiments we try to cover three bands, namely s, c and l bands to provide a good service to the users by increasing the gain and lower noise levels. The use of amplifiers in cascading order is to get improved service gain so that the achievement of service improvement can be done.

Hybrid amplifiers already give effective output gain in the system to increase long haul transmission distances. Figure 5 depicts the result from hybrid amplifiers in simulation, the reduction in power gain because of the different optical gain characteristic for each the amplifiers.

Starting gives gain from wavelength of 1470 nm until 1535 nm, according main terms of flattened ness gain, flattening gain occurs at different points from the total gain at the hybrid amplifiers and the area where service gain of EDFA and SOA amplifiers is overlaps, the gain will be drop according nonlinear characteristic of the amplifiers. However, the gain in the system is not uniform but overall optical amplification in hybrid system can increase the performance of the system in particular for operation up to 100 km.

Table 1: Q-factor and Min BER for distance 100km

Wavelength	Q-factor	Min. BER
1470 nm	2.28883	0.00563913
1490 nm	2.9148	0.00121456
1510 nm	3.51293	0.000212137
1530 nm	3.2094	0.000625961
1550 nm	3.40709	0.00011614
1570 nm	3.23879	0.00044346
1590 nm	2.79586	0.00765469
1610 nm	2.67455	0.00733543

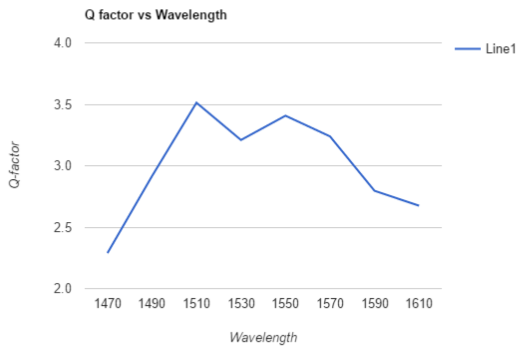

Fig 4: Wavelength vs Q-factor for 100 km distance

5. CONCLUSION

In this experiment we present and demonstrate a CWDM transmission system using hybrid SOA-EDFA amplifiers. The proposed hybrid amplifiers are based on cascaded SOA-EDFA optical amplifier which spans over 100km with uniform performance 0 dBm power penalty in simulation system and 80 km experimental respectively. The proposed of hybrid amplifier enables nearly flat gain over a broad spectrum of the transmission spectrum, with some saturated output power at wavelength of 1550 nm and higher.

REFERENCES

[1] G. P. Agarwal. (2010). Fiber Optic Communication System

[2] J. Downie, M. Sauer, and J. Hurley, "10.7 Gb/s CWDM system transmission with 8 channels 140 nm bandwidth over 120 km using two SOAs," in Optical Fiber Communication Conference and National Fiber Optic Engineers Conference, (OFC2006), pp. JThB80, 2006.

[3] J. B. Rosolem, et al., "Comparative analysis of optical amplifiers for CWDM networks," in International Microwave and Optoelectronics Conference, (IMOC 2007). SBMO/IEEE MTT-S International, pp. 34-37, 2007.

[4] B.C Colling s, et al., “A 1021-channel WDM systems”, *IEEE photonics technology letters*, Vol.12, pp.906-908, 2001

[5] P. Seoijin, et al., "Semiconductor optical amplifier for CWDM operating over 1540-1620 nm," Photonics Technology Letters, IEEE, vol. 17, pp. 980-982, 2005.

[6] CWDM Network Design 8 channel using Hybrid Amplifier SOA-EDFA Muchlis Abdul Muthalib, Norhana Arsad, Abang Anuar Ehsan, Sahbudin Shaari Vol. 3 No. 1 ISSN No. 2356 – 2536 *Scientific Journal of PPI-UKM*

[7] *International Journal of Advanced Research in Computer Engineering & Technology (IJARCET) Volume 4 Issue 5, May 2015* Coarse Wavelength Division Multiplexing Technology – A Review

[8] Analysis of four channel CWDM Transceiver Modules based on Extinction Ratio and with the use of EDFA P.P. Hema[1], Prof. A.Sangeetha[2] International Journal of Engineering and Technology (IJET)