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Performance analysis of Cascaded optical amplifiers

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Abstract— Laser amplifiers such Semiconductor, Raman and Erbium doped fibres were covered in the article, as well as Ytterbium-Ytterbium and Ytterbium-Ytterbium co doped fibre amplifiers. Amplified 20 dB with very low dispersion and noise, thanks to cascaded optical amplifiers. Using this technique in telecommunications is quite beneficial.

Keywords— All of the above terms are used to describe the power of the optical signal and how it travels via optical fibres.

INTRODUCTION

A. Optical amplifiers' basic idea

It is possible to boost optical signals without the need of repeaters by using optical amplifiers. With respect to the diverse optical amplifiers, there are numerous different types of principles utilised to magnify the optical signal, such as Raman scattering of incoming light with phonons in Semiconductor optical amplifiers (SOA). Stimulated emission with population inversion is used in EDFA (Erbium Doped Fiber Amplifier), EYCDFA (Erbium and Ytterbium co doped Fiber Amplifier) and YDFA (Ytterbium doped Fiber Amplifier). A comparison of individual performance has shown that SOA outperformed all other forms of optical amplifiers [18].

In order to maximise the output amplified optical power while reducing noise, all of the optical amplifiers are linked together in a cascade.

A. EDFA

When employing 980 and 1480nm pump powers, an Erbium Doped Fiber Amplifier (EDFA) is employed to maximise optical power by applying the stimulated emission concept.

EDFA is a fibre amplifier created by doping the fibre core material with trivalent erbium ions and using pumping and population inversion to increase the optical signal. Furthermore, EDFA delivers better performance in telecommunications applications with fibre lengths of up to 10 metres, thanks to its high power transfer efficiency and low noise figure.

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B. EYCDFA

Additionally, EYCDFA is a kind of Erbium Ytterbium Co-Doped Fiber amplifier (EYCDFA). Moreover, the high gain, small size, and low pumping use [19] contribute to superior outcomes.

C. YDFA

Increased optical strength may be achieved by using a Ytterbium doped fibre amplifier Broad gain and great efficiency are best achieved by using YDFA. [12]

D. SOA

As a result of its nonlinear features, the Semiconductor Optical Amplifier may operate at wavelengths of 800, 1300, or 1500nm with better outcomes with lower gain and higher noise figures.

A. RAMAN

An development of EDFA, the Raman amplifier functioned under the principle of Stimulated Raman scattering and generated coherent high intensity levels and dispersion without the requirement for population inversion.

There are six sections to this study. Second, the technique and the intended work are laid forth in this part. Section III shows how the model is simulated. Section IV summarises the findings and offers suggestions for further research. Section V serves as the paper's conclusion.

I. METHODOLOGY

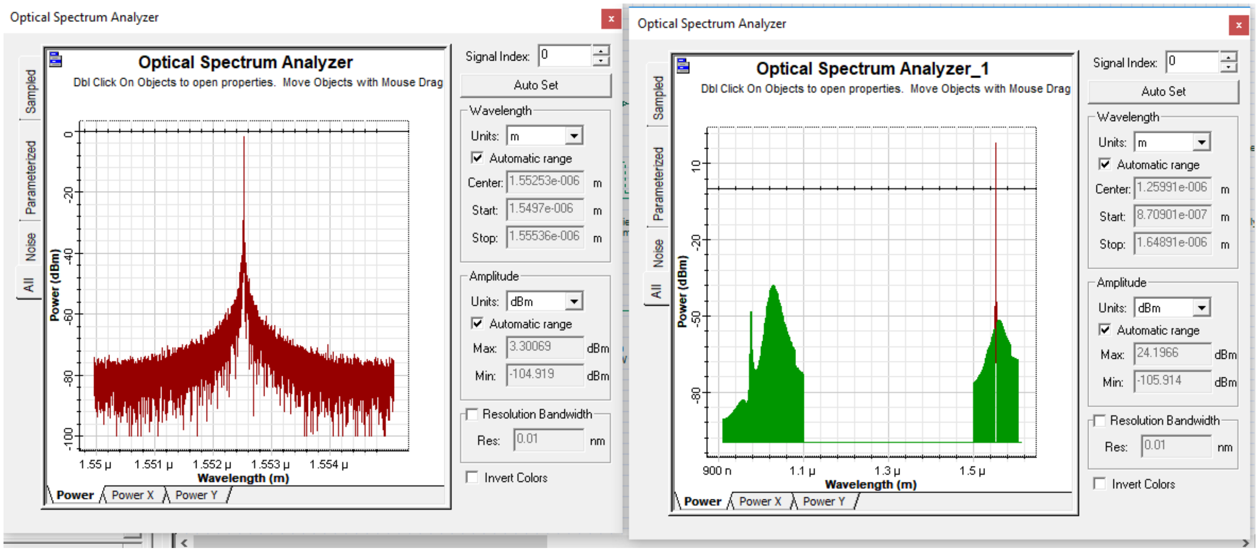
Cascaded amplifiers such as Wideband SOA, Raman amplifier, EYCDFA, and YDFA are used in this study to analyse the output optical power, bandwidth and spectral signal, forward signal output power and noise power, and the simulation model is used to determine the parameters. To do this, a wavelength of 980nm is pumped backward. The transmission impairments can be reduced with the use of EDFAs in such communication systems.

A. Methodology in Use.

A single backward pumping strategy is used in this experiment. It was necessary to model and test each individual component of the design before putting it all together and running simulations to determine parameter (Forward output signal power) values.

2. The Planned Project

A continuous wave optical signal with a wavelength of 193THZ and a power of 1mW was amplified using wideband semiconductor SOA, Raman amplifier, and EDFA. Optical signal strength was improved by reducing noise with EYCDFA. YDFA was employed to boost optical signals. Optimized optical signal is produced by cascading the optical amplifiers together.



II. SIMULATION OF THE MODEL

Fig. 1.1: Cascaded optical amplifier simulation model

The wideband Semiconductor optical amplifier, Raman amplifier, EDFA, Er–Yb co-doped fibre amplifier, Yb doped fibre amplifier were cascaded and coupled using the backward pumping approach to improve the optical strength of the simulation.. Pumping is done at a wavelength of 980 nm with an input power of 100 mw. A mill watt or dBm metre is used to measure the optical power at each amplifier output stage. A spectrum analyzer depicts the dBm output power for each output amplifier stage with relation to wavelength. The signal and noise power is shown by the WDM analyzer

Fig 1.3 Input and Output WDM analyzer

based on the connection type, whether it's at the input stage or the output stage.

Figure 1.2 illustrates the relationship between output power and output wavelenght for an optical spectrum analyzer.

It is shown in Fig. 1.2 that the Input optical spectrum analyzer is on the left side, and the Output optical spectrum analyzer is shown on the right side. On the right side, an optical spectrum analyzer shows a maximum output power amplitude of 24.1966 dBm. It's evident.

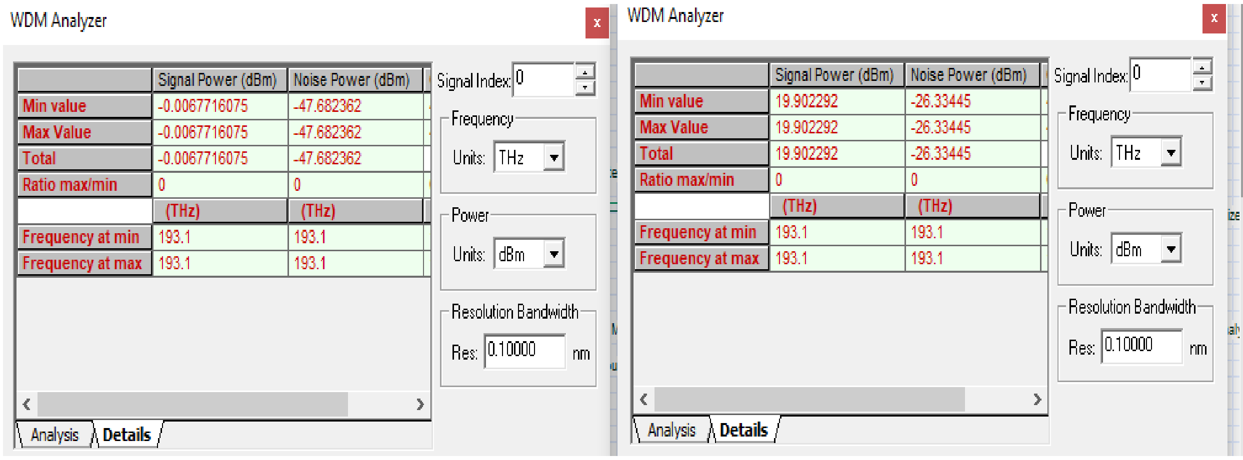


Fig 1.3 Shows the Input and Output Wavelength division multuplexing anlayzer used to display the Input and Output signal and noise power in terms of dBm with frequency range of 193.1Thz.

CW's optical output power is measured by an optical power metre. EDFA amplified the output of the Raman amplifier 61mW, and EYCDFA amplified the output of the EDFA 98.765mW, while SOA amplified the laser input power to 6.16mW and cascaded it to the Raman amplifier. The EYCDFA output was amplified 109.458mW by YDFA.

Fig 1.4.Optical power Meter.

Fig 1.4 shows the Simulated Output of different Optical power meters are displayed from each stage of Cascaded optical

amplifiers.

Table I: The Output Optical power of various optical amplifiers

S.NO	OPTICAL AMPLIFIER	OPTICAL POWER(mw)
1	INPUT/ CW LASER	1.00
2	SAO	3.00
3	RAMAN	6.00
4	EDFA	61.00
5	EYCDFA	98.763
6	YDFA	109.458(20dBm)

Table I shows the simulated output optical power values are tabulated.

The simulation result displays output amplified signal power in watts for the input signal power 0.001mw. Simulation findings reveal that the amplified signal power from the transmitter output grows when pump power increases but amplified signal power drops when EDFA length increases in Dual pumping approach with 980nm indicated in table I.

I. CONCLUSION AND FUTURE ASPECTS

In summary, simulated the Optical amplifiers such SOA, Raman amplifier, EDFA, EYCDFA and YDFA cascaded to forma Cascaded optical amplifiers delivers the optimal performance in telecommunication applications with the input of 1mW and output of cascaded optical amplifiers provided an amplified optical output of 109.458mW. The findings Gain and Forward and Backward ASE noise were compared and assessed. Advancements in EDFA performance have enabled for longer fiber links between regenerators. To lower the cost of regeneration work are underway to increase amplifier performance. Thus, we have proved that the suggested model of a Cascaded EDFA and EYCDFA employing single pumping approach was effectively replicated using optical multiplexer. The researched model is usable in Network reconfiguration and Multi-vendor networks and also addition of new services and wavelengths. The findings have been compared the EDFA output with the usual EYCDFA parameter values.In future study, the model may be changed and refined further by Gain flattening filters(GFF) based on advanced fiber Bragg gratings(FBG) allow amplifier makers to increase gain flatness. Advanced FBGs can be utilized to replace conventional GFF technologies in current- generation amplifier designs as a straightforward approach to increase gain ripple. Similarly, new amplifier designs may take advantage of this technology to help and push the performance of next-generation amplifiers to new heights.

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