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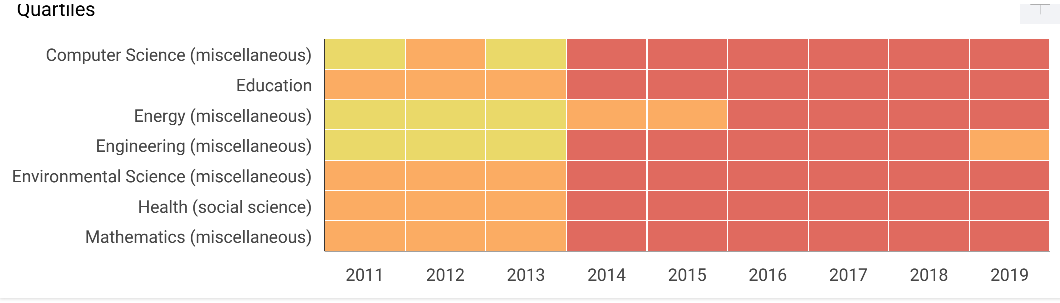

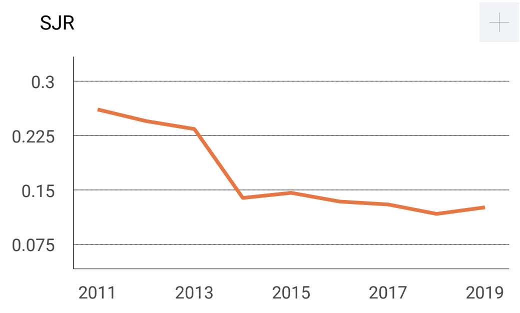

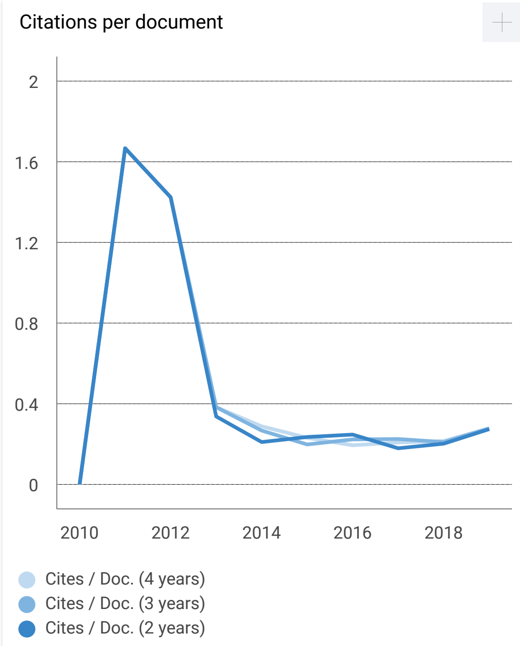

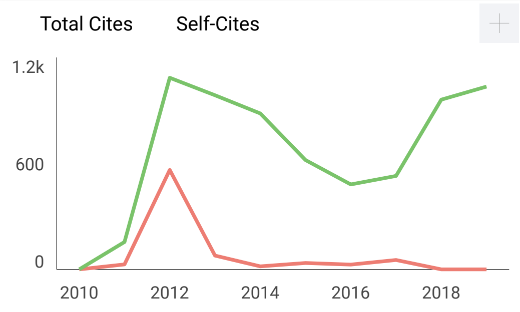

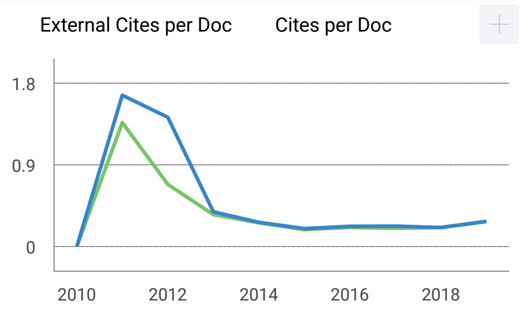

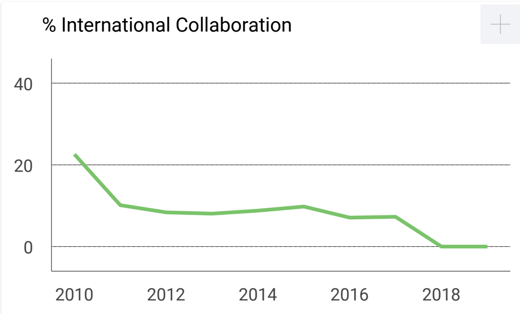

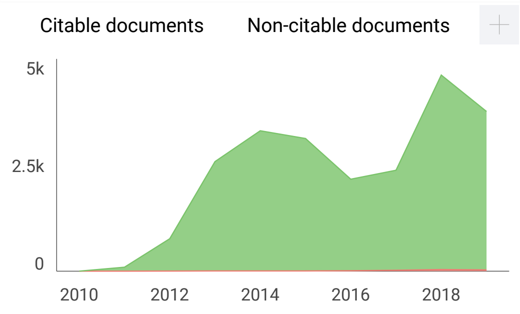

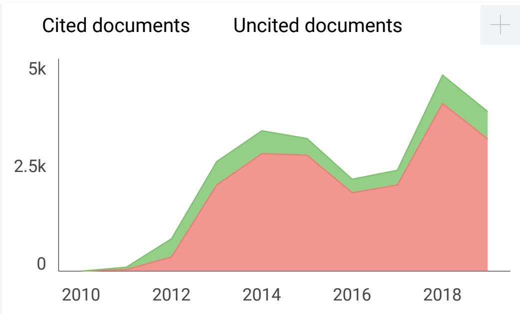

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Characterization of L Band Erbium Doped Fiber Amplifier

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Erbium doped fiber amplifiers (EDFA) have become major key components for dense wavelength division multiplexing (DWDM) in optical fiber communication systems. Recently, an L-band EDFA have gain popularity to extend optical bandwidth level in such a system. It operates in a relatively low population inversion that a total positive gain can be achieved in L-band signals level while energy absorption occurs at the conventional band. Therefore, pump power efficiency has become major issues in L band EDFA to obtain high gain and low noise figure (NF). In this research we have developed high stability and accuracy circuits using high end technology components to maximize power pumping level that is used for laser diode pumping and power meter. We used forward pumping scheme by using simple single pump structure with 980 nm pump laser into short length L band EDFA. In this experiment we have used L band EDFA with the length of 13.5 meters, the purpose is to get short length L band with efficient pumping power and to get good gain output at several pumping and signal power. The experimental results then fitted with theoretical analysis to determine performances of overall EDFA system. The performance parameter such as gain, NF and output power was taken at L band ITU wavelength standard with four different laser diode pumping powers of 53.6 mW, 61.1 mW, 64.83 mW and 68.25 mW respectively. An input signal power ranging was of −20 dBm, −15 dBm, −10 dBm and −5 dBm respectively.

Keywords: EDFA L-Band; High Stability Laser Diode Pumping; Noise Figure; Optical Amplifier

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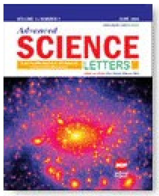

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CHARACTERIZATION OF L BAND ERBIUM DOPED FIBER AMPLIFIER

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Erbium doped fiber amplifiers (EDFA) have become major key components for dense wavelength division multiplexing (DWDM) in optical fiber communication systems. Recently, an L-band EDFA have gain popularity to extend optical bandwidth level in such a system. It operates in a relatively low population inversion that a total positive gain can be achieved in L-band signals level while energy absorption occurs at the conventional band. Therefore, pump power efficiency has become major issues in L band EDFA to obtain high gain and low noise figure (NF). In this research we have developed high stability and accuracy circuits using high end technology components to maximize power pumping level that is used for laser diode pumping and power meter. We used forward pumping scheme by using simple single pump structure with 980 nm pump laser into short length L band EDFA. In this experiment we have used L band EDFA with the length of 13.5 meters, the purpose is to get short length L band with efficient pumping power and to get good gain output at several pumping and signal power. The experimental results then fitted with theoretical analysis to determine performances of overall EDFA system. The performance parameter such as gain, NF and output power was taken at L band ITU wavelength standard with four different laser diode pumping powers of 53.6 mW, 61.1 mW, 64.83 mW and 68.25 mW respectively. An input signal power ranging was of -20 dBm, -15dBm, -10 dBm and -5 dBm respectively.

Keywords: High stability laser diode pumping circuitry, optical amplifier, noise figure, EDFA L- band.

1. INTRODUCTION

Dense wavelength division multiplexing (DWDM) technology is a key technology for the future generation of optical network where it is directly connected to high performance network routers. One of the main components is EDFA that play an important role to enhance optical output in optical network performances. Therefore designing of an optical amplifier can directly affect the high performance of an optical system.
Optical amplification using EDFA is quite common on long distance communication systems. Previously long wavelength EDFA i.e. L band EDFA has attracted much intention and played a major role in extending optical bandwidth from previous C band structure. Similar to those C band structures, L band can also be configured using single pump scheme but with more pumping power required to get similar gain as that in C band. Therefore, pumping scheme has become major issues in L band EDFA to obtain high gain and low NF as well as pump power efficiency [1]. In this paper we demonstrate a simple single pump structure with 980 nm pump laser and short L band EDFA.

2. HARDWARE IMPLEMENTATION

In general, there are three setup configurations EDFA pumping namely: forward pumping, backward pumping and bidirectional pumping [2,3]. System design based EDFA optical reinforcement consists of four parts, namely the passive optical component, active optical component, system microcontroller and the high regulated power supply[4].

Figure 1 shows a configuration lay out of EDFA experimental setting.

Figure 1. Configuration layout of EDFA experimental setting.

Figure 2 shows a complete set of L band EDFA with electronics control systems.

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Figure 2. A complate set of L band EDFA with electronics control systems.

For characterization of L band EDFA, we used of single stage forward pumping is shown in schematic diagram in Figure 3 below.

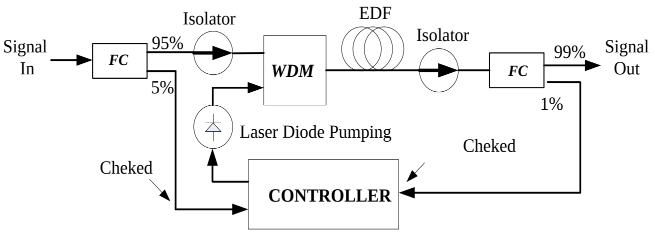


Figure 3. Single stage forward pumping Schematic diagram.

Experiments were conducted without the use of a microcontroller. Controller block in Figure 3 is represent active electronic components (integrated circuit) consists of diode laser pumping and power meter. ADN2830 and AD8304 are high performance active components (integrated circuit) from Analog Device as laser diode pumping and power meter to occupy the controller block. Two ADN2830 Used in parallel current boosting mode to achieve 400 mA current pumping as shown in figure 4 below [5].

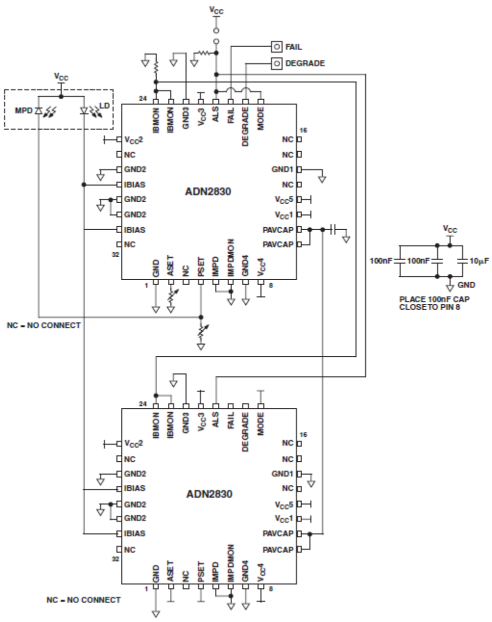


Figure 4. Two ADN2830 in parallel 400 mA current boosting mode [5].

Figure 4 shows pin out of RPSET as current adjustment laser diode pimping using linear potentiometer.

Experimental setup for characterization of L band with L band EDFA of 13.5 meters long at forward pumping is shown in Figure 5.

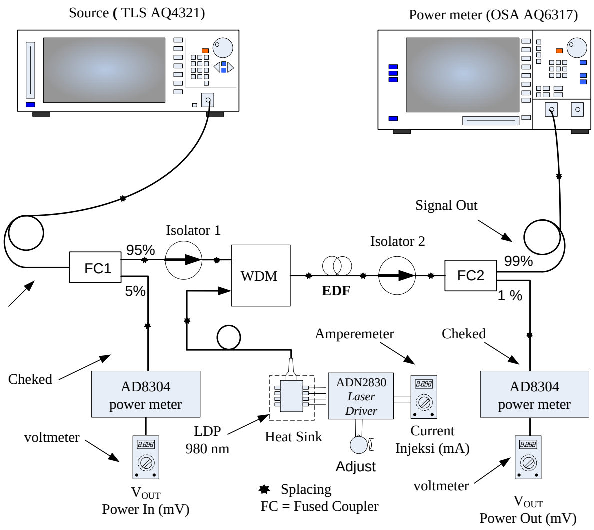


Figure 5. Experiment setup for characterization of Lband EDFA with forward pumping.

Experimental setup in Figure 5 consists of:

a. Isolator 1 and isolator 2 as rectifier signal.
b. One uncooled LDP (LU980) with specifications of 980 nm wavelength and 180 mW output power[6].
c. WDM coupler with specifications of 980 nm and 1550 nm channel input distribution [7].
d. L band EDF 13.5 m long with specification: mode field diameter of 5.5 ± 0.5 µm, @ 1550 nm wavelength, peak absorption 25 ± 2 dB/m near 1530 nm and ≥ 7.0 dB/m near 980 nm, loss of ≤ 15.0 dB/km @ 1200 nm, mode cut-off at 960 ± 50 nm and core numerical aperture is 0.21
e. Tap coupler 1 (FC1) with specification 95% and 5% channel output splitter.
f. Tap coupler 2 (FC2) with specification 99 % and 1% channel output splitter.

FC1 at 5% channel output splitter is selected for minimum limit input signal to power meter AD8304 at the smallest input signal TLS about -30 dBm. FC2 at 1% channel output splitter is selected for maximum of power meter AD8304 at 0 dBM the most output signal EDFA which can still be read.

3. RESEARCH METHODOLOGY

TLS swept in the work area at international telecommunication union (ITU) grid in the wavelength range of L band (1570 nm-1620 nm), then the output signal recorded by OSA in the form of numeric data.

Observation Characterization performance of L band EDFA including:

a. Characterization of the uncooled laser diode pumping (LDP) 980 nm. Observations measurement current injection to LDP toward LDP power.
b. Observation amplified spontaneous emission (ASE) measurement. Observation measurement LDP power toward ASE issued without signal input TLS.
c. Calculated Gain and noise figure (NF). Observation amplification output signal toward variations input signal at LDP power constantly.
d. Characterization EDFA L band for variation input signal toward gain at LDP power constantly.

4. EXPERIMENTAL RESULTS

Graph performance of LDP 980 nm, current injection toward LDP power is shown in figure 6. To avoid LDP damage, RPSET must be tuning slowly using wire wound potentiometer to tuning current injection LDP gradually, especially at lasing point (0 mA to 26 mA current injection).

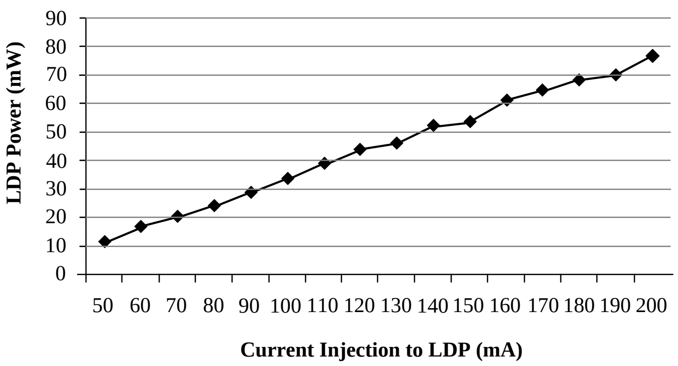


Figure 6. Graph performance of LDP 980 nm, current injection toward LDP power

Figure 7 shows ASE spectrum pattern of L band EDFA with LDP power 53.6 mW (150 mA current injection), resulting in population inversion with ASE average of -37.66 dBm.

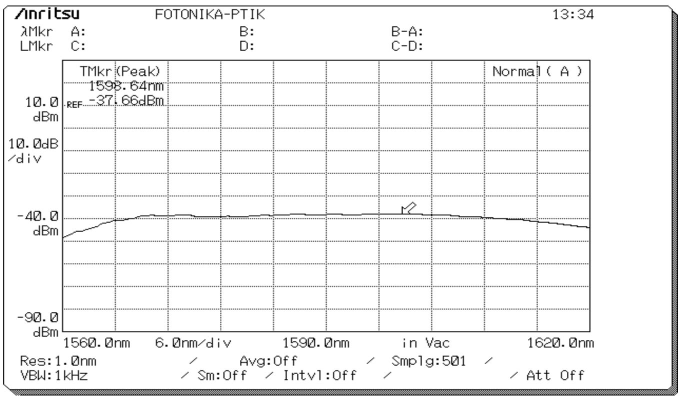


Figure 7. ASE spectrum pattern L band EDFA with pump power 53.6 mW (17.3 dBm) with 150mA current injection

Figure 8 shows the measurement and calculation of the gain and NF at 53.6 mW (17.3 dBm) LDP power for -20dBm input signal with wavelength constant of 1589.52 nm.

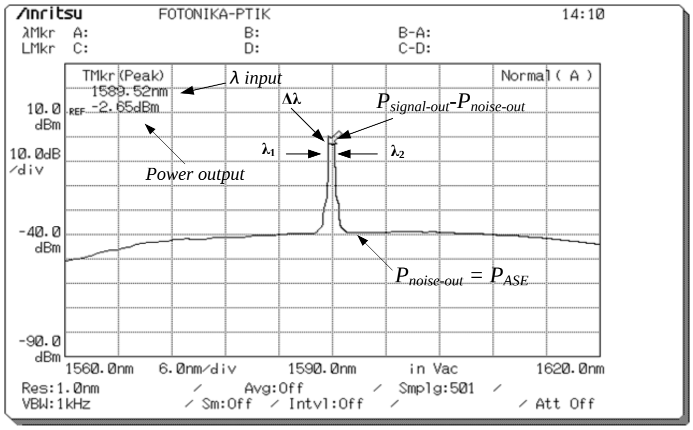


Figure 8. Measurement and calculation of the gain and NF at 53.6 mW (17.3 dBm) LDP power for -20dBm input signal with wavelength constant of 1589.52 nm.

From Figure 8 with input signal of 1589.52 nm and power input signal of (-20 dBm) can be amplified up to -2.65 dBm. *Gain* and *NF* can be calculated by using following Equations [8]:

$$G = \left[\frac{\left(\left(P_{\text{signal out}} + P_{\text{noise out}}\right) - P_{\text{noise out}}\right)}{P_{\text{signal in}}} \right]$$

Figure 9 shows chart of ASE at 53.6 mW (17.3 dBm) LDP power constant with ITU grid L band wavelength without input signal.

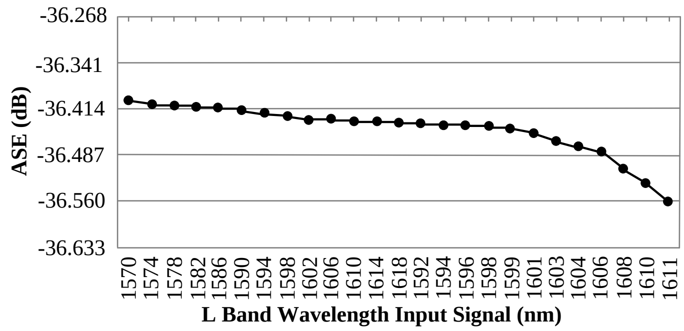


Figure 9. Chart of the Gain and NF at 53.6 mW (17.3 dBm) LDP power constant with ITU grid L band wavelength without input signal.

Figure 10 shows calculation of Gain and NF at 53.6 mW (17.3 dBm) LDP power constant and -20dBm input signal with ITU grid L band wavelength.

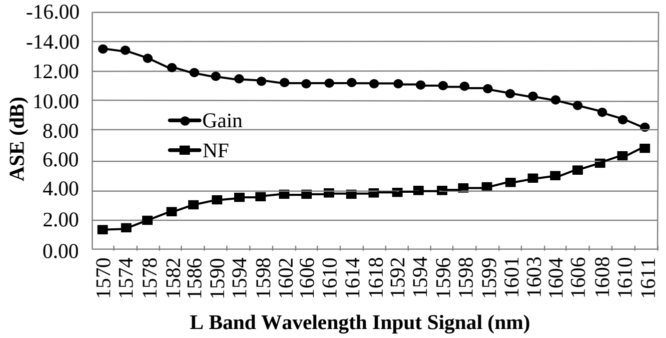
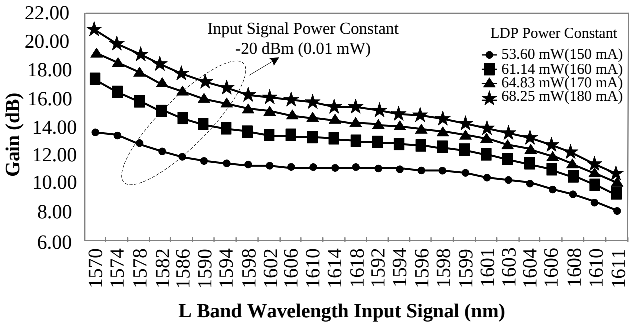


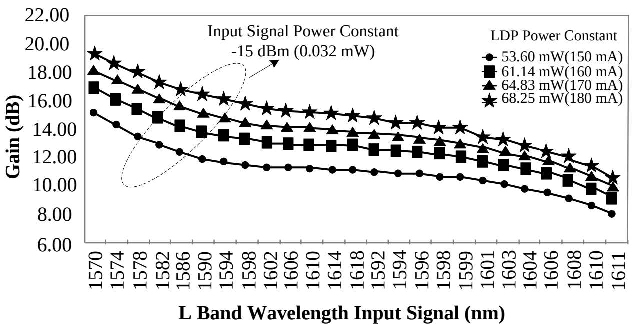
Figure 10.Chart of the Gain and NF at 53.6 mW (17.3 dBm) LDP power constant for -20dBm input signal with ITU L band wavelength.

Figure 10 indicates that the noise figure (NF) is always greater than one, it prove the amplifier always give extra noise during the process of amplification.

Figure 11 (a), (b), (c) and (d) shows chart Gain and output power was taken at L band ITU grid wavelength with four different laser diode pumping powers of 53.6 mW (150 mA), 61.1 mW (160 mA), 64.83 mW (170 mA) and 68.25 mW (180 mA) respectively, toward A input signal power ranging was of -20 dBm (0.01 mW), -15 dBm (0.032 mW), -10 dBm (0.1 mW) and -5 dBm (0.32 mW) respectively.



a)



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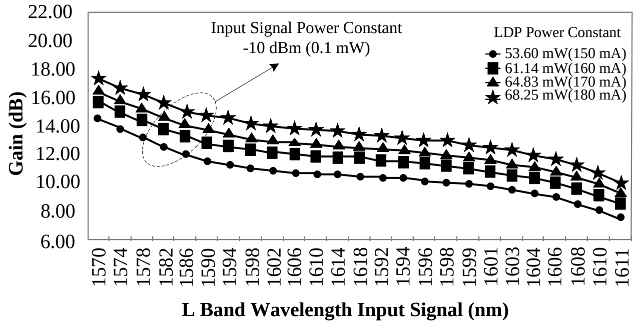
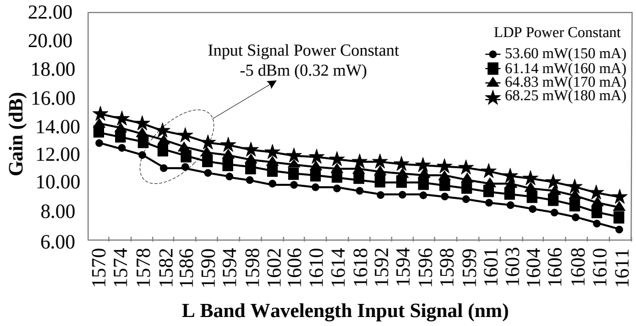


c)



d)

Figure 11. Gain and output power was taken at L band ITU wavelength with four different laser diode pumping powers of a) 53.6 mW (150mA), b) 61.1 mW (160 mA), c) 64.83 mW (170 mA) and d) 68.25 mW (180mA) respectively toward A input signal power constant ranging was of -20 dBm (0.01 mW), -15 dBm (0.032 mW), -10 dBm (0.1mW) and -5 dBm (0.32 mW) respectively.

5. CONCLUSIONS

L band EDFAs spectral gain and noise figure characteristics were analysed through experiments and simulation. By using optimized 13.5 m fibre length at 1580.45 nm and 53.6 mW (150 mA current) pump power to get amplified spontaneous emission (ASE) average of -36.45 dBm.

The performance of gain at L band ITU grid wavelength with four different laser diode pumping powers of 53.6 mW, 61.1 mW, 64.83 mW and 68.25 mW respectively with variation range of different input signal power ranging was used of -20 dBm, -15dBm, -10 dBm and -5 dBm respectively. From the analysis result that increasing current injection LDP every 10 mA, the input signal amplified by 1.76dB .Otherwise the amplification (gain) will be decrease 1.43 dB if increasing input signal power by +5 dBm.

As a result, a high gain 20.64 dB and a moderate noise figure 3.9 dB values were obtained in the small signal regime. In general, with its relatively high NF values, this type of L-EDFA can be used as an optical booster amplifier not requiring very low noise figures.

Future work, in this research needs further developed with bidirectional LDP for increasing the amplification EDFA with the same length of L band EDF.

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REFERENCES

[1] B.Allen, J.Rouse."Optical networking and WDM Lightwave"Cambrian System Corp. pp.47-52, August 1998.

[2] S.Y.Park, et al., "Doped fiber length and pump power of gain- flattened EDFAs", *Elect. Lett*. 32, 2161, 1996

[3] Beker, P.c., Olsson, N.A., & Simpson, J.R. (1999). *Erbium-doped fiber amplifiers fundamentals and technology.* USA: Academic Press

[4] M. Karasek, "The design of L-band EDFA for multiwavelength applications," *J. Opt. A.*, vol.3, pp. 96-102, 2001

[5] Analog Device.(2000). *ADN2830 datasheet*. July 23, 2014. http://www.alldatasheet.com

[6] Technologies, Bookham .(2000). LU980L Mini DIL Uncooled Laser. Maret 21, 2014. http://www.alldatasheet.com.

[7] Jeff, H. (2002). Wavelenght Division Multiplexing. USA: Prentice Hall.

[8] Beker, P.c., Olsson, N.A., & Simpson, J.R. (1999). Erbium-doped fiber amplifiers fundamentals and technology. USA: Academic Press