Flat Gain with Low Noise Figure L-Band Erbium Doped Fiber Amplifiers

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Abstract— **In this paper, we introduce new design high performance flat gain with low noise figure together in L-Band (1570 – 1620 nm) Erbium doped fiber (EDF) by using double pass Erbium doped fiber amplifier (EDFA) with wave selective coupler (WSC) to eliminate the residual pump power. W demonstrated using 980 nm forward pumping scheme in double-pass system Compared to different pump power in this scheme. In this design we show the value for noise figure decreased with increase wavelength until it reached the lowest value of 3.801 dB at the wavelength of 1600 nm, while the best value for the gain was obtained at a wavelength of 1598 nm and reached 29.464 dB, the input power was fixed at -20 dB.**

Index Terms— **L-Band, double pass, Erbium doped amplifier, gain, noise figure.**

I. INTRODUCTION

The beginning of the development in EDFA for the optical signal amplification in the conventional band (C-band) at wavelength (1530-1570 nm)**[1-2]** are now being utilized to expand the wavelength band in the long band wavelength L - band at wavelength (1570-1620 nm) with low noise figure and flat gain. The increase?? EDFA gain in L- band relative to the C band can in principle be increased by using longer length with highly doped active fiber with low pump power. There are two pumps work to EDFA, the pumps work it 980 nm and 1480 nm, EDFA need external pump to works. Doped silica fiber with erbium ions two major components for the productions of EDFA from this product can work in the expand wavelength within 1550 nm in addition the attenuation of silica fiber is minimum, from this specification can get the best result with the optical fiber communication at this broadband **[2].**

Several different amplification methods have been proposed in order to improve the relatively high gain with low noise figure, there are two or more techniques to get it. One technique using double pass EDFA with wave selective coupler (WSC) to eliminate the residual pump power out of the signal and thus enable a higher gain per unit fiber length in the L-band EDFA (LEDFA) . In this structure the higher EDFA gain and lower noise figure relative to be increased pump power with optimal length . Where is other techniques ?

II. GAIN AND NOISE FIGURE:

Gain of an EDFA with a length of L is the ratio of the signal power at the fiber output to the signal power injected at the fiber input as:

$$G = P_s(L) / P_s(0) \quad (1)$$

ASE noise generated during amplification process is added to the signal leading to decrease in signal to noise ratio (SNR) at the amplifier output. SNR reduction ratio from input to output of the amplifier is defined as Noise figure (NF), which is also used for electronic amplifiers:

$$NF = (SNR)_{in} / (SNR)_{out} \quad (2)$$

Noise figure can also be expressed in terms of gain and spontaneous emission factor *(nsp)* (or population inversion factor):**[3]**

$$NF = 2\, nsp\, (G-1) / G \approx 2\, nsp \quad (3)$$

$$nsp = n2 / n2 - n1 \quad (4)$$

n1 and n2 are ionic population in two energy levels.
This section must be expanded!

III. SIMULATION RESULTS

The simulations are performed in order to analyze the pump power dependence of gain and noise figure performance in L band EDFAs using OptiAmplifer 4.0 simulation program. The important parameters of erbium doped fiber (ErFiber.crs EDF) used in the simulations. The numerical aperture 0.31, ion concentration 1.4e25 ion/m^3 , core radius 1 µm , Erbium radius 1 µm the length EDF was 30.5 m and the input power was -20 dB. Figure 1 show double pass EDFA with WSC, this structure consist of multiple laser source used to injected signal light inside fiber. A circulator is used as an isolator and at the same time to separate the input signal from the output signal. A reflector use in double pass and triple pass to reflect the amplified signal back to EDF.

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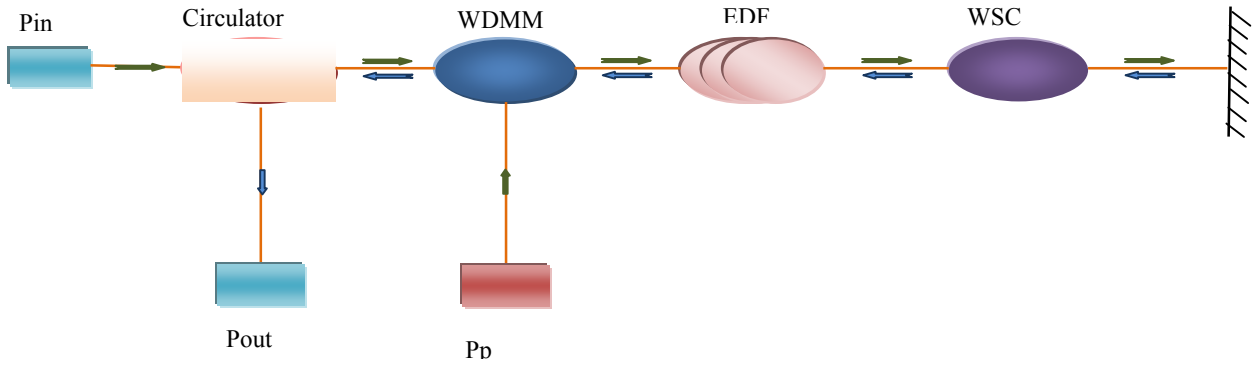


Figure (1) Double pass Erbium doped fiber amplifier with wave selective coupler

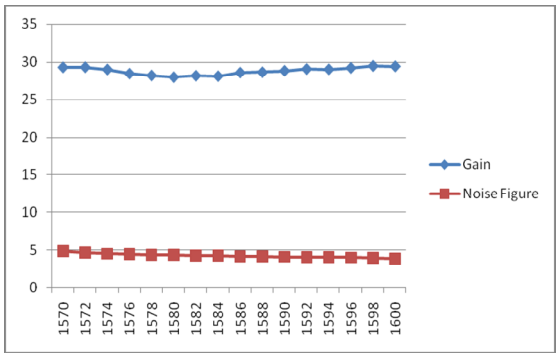


Figure (2) flat gain with low noise figure at 220 mw pump power

power, in this figure the gain is high and flat in the same time and the noise figure is low compare than figure (3&4) . In below figure (3) in this figure shows the decrease gain with increase low figure because of we decrease pump power to 150 mw pump power, in this case the gain increase with increase pump power with decrease noise figure We demonstrated different value of the EDFA pump power have been used (220 mw, 150 mw and 100 mw) with different pump power we can show various result values of the gain and noise figure for this scheme. Figure 2 shows the best result of gain with low noise figure, we used 220 mw pump power at 980 nm with fixed length and input signal

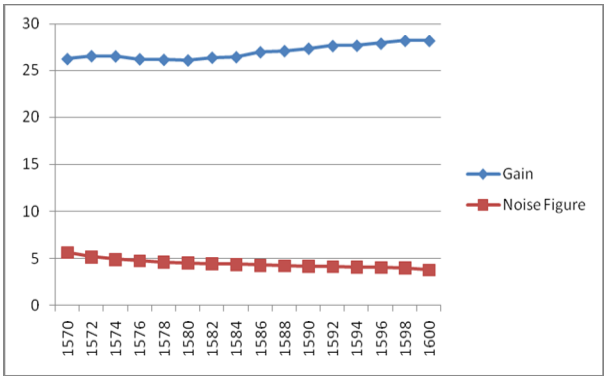


Figure (3) performance gain with noise figure at 150 mw pump power

in figure (4) shows when decrease the pump power until it reached 100 mW we can see increase the noise figure reached 7.108 db with decrease gain.

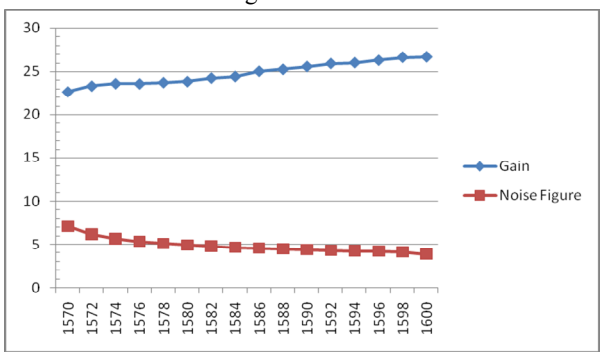
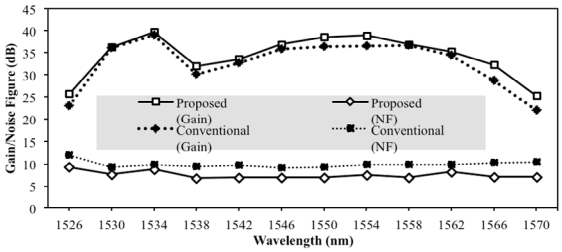


Figure (4) performance gain with noise figure at 100 mw pump power

The figures should be academic! For example:



CONCLUSION

The gain and noise figure improvements in double-pass with wave selective coupler (WSC) L- band EDFA and pump power at 980 nm simulated. The amplified spontaneous emission (ASE) in L- band bigger than compared with the conventional band (C- band), in this paper we have to eliminate the residual power by using wave selective coupler, in addition we get high gain with low noise figure. Our results , it was seen when the increase in the pump power we can see decrease the noise figure with increase the gain. This EDFA improves the gain and noise figure of 1598 nm signal by 29.464 db and 3.8011db at 1600 nm, when the input signal, pump power and length EDFA are fixed at -20 db, 220 mw and 30.5 m respectively. also we can see in the wave length 1570 nm when decrease the pump power to 100 mw the gain become 22.6187 db and the noise figure increase from (4.856

– 7.1086 db) , in same time the input signal and the length are fixed at -20 db and 30.5 m respectively .

REFERENCE

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