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EDFA Application Research in CATV System

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ABSTRACT
*Characteristics of **EDFA** are researched in this optical for CAT purpose. The performance of EDFA depends on various parameters like doping concentration, active fiber length, pump power, pumping wavelength. EDFA have received much interest for CATV because of their high output power low distortion and low noise capability. Main purpose of this paper is to analyze output signal power with pump power and length variation in cascade EDFA simulation model performance.*

Keywords: CATV; EDFA; EDF; Pump Power

1. INTRODUCTION

EDFA is an optical amplifier that uses a doped optical fiber as a gain medium to amplify an optical signal. The signal which is to be amplified and a pump laser are multiplexed into the doped fiber, and the signal is amplified through interaction with the doping ions. EDFA is the best known and most frequently used optical amplifier suited to low loss optical window of silica based fiber.

A particular attraction of EDFAs is their large gain bandwidth, which is typically tens of nanometers and thus actually it is more than enough to amplify data channels with the highest data rates without introducing any effects of gain narrowing. A single EDFA may be used for simultaneously amplifying many data channels at different wavelengths within the gain region. Before such fiber amplifiers were available, there was no practical method for amplifying all channels between long fiber spans of a fiber-optic link. One had to split all data channels, detect and amplify them electronically, optically resubmit and again combine them. The introduction of fiber amplifiers thus brought an enormous reduction in the complexity, along with a corresponding increase in reliability. In WDM systems by multiplexing, a stream of wavelength channels particularly in C and L-band regimes can simultaneously amplify to a desired power level where the amplification of any particular channel is dependent on the signal wavelength, the number of signals present in the system, the input signal powers and its absorption and emission cross-sections (Yoshida *et al.*, 1995). The gain-flattened Erbium-Doped Fiber Amplifier (EDFA) is a key component in long haul.

Multichannel light wave transmission systems such as the Wave length Division Multiplexing (WDM) (Park *et al.*, 1996). One difficulty in implementing a WDM system including EDFA's is that the EDFA gain spectrum is wavelength dependent. In a WDM system, the EDFA does not necessary amplify the wavelength of the channels equally. EDFA in a WDM system are often required to have equalized gain spectra in order to achieve uniform output powers and similar Signal-Noise Ratios (SNR) (Sun *et al.*, 1999). There are several methods in designing a flat spectral gain EDFA such as by controlling the doped fiber length and the pump power (Park *et al.*, 1996; and Surinder and Kaler, 2006), proper choosing of optical notch filter's characteristic (Tachibana *et al.*, 1991), by using an acousto-optic tunable filter (Su *et al.*, 1993) and by employing an in homogeneously broadened gain medium (Goldstein *et al.*, 1995). This paper achieves gain flatness of EDFA by controlling the doped fiber length and the pump power for a given input power of –26 dBm and a desired output power of more than 8 dBm.

2. OBJECTIVE

Amplify the signal of CATV system.

3. DOPED AMPLIFIER

Doped fiber amplifiers (DFAs) are optical amplifiers that use a doped optical fiber as a gain medium to amplify an optical signal. They are related to fiber lasers. The signal to be amplified and a pump laser are multiplexed into the doped fiber, and the signal is amplified through interaction with the doping ions. The most common example is the Erbium Doped Fiber Amplifier (EDFA), where the core of a silica fiber is doped with trivalent Erbium ions and can be efficiently pumped with a laser at a wavelength of 980 nm or 1,480 nm, and exhibits gain in the 1,550 nm regions.

An erbium-doped waveguide amplifier (EDWA) is an optical amplifier that uses a waveguide to boost an optical signal. Amplification is achieved by stimulated emission of photons from dopant ions in the doped fiber. The pump laser excites ions into a higher energy from where they can decay via stimulated emission of a photon at the signal wavelength back to a lower energy level. The excited ions can also decay spontaneously (spontaneous emission) or even through nonradioactive processes involving interactions with phonons of the glass matrix. These last two decay mechanisms compete with stimulated emission reducing the efficiency of light amplification.

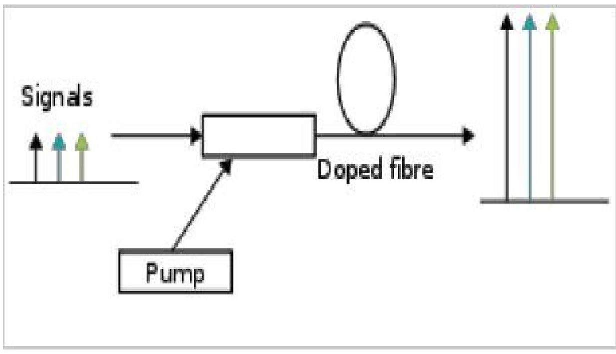

Fig 1. Schematic diagram of a simple Doped Fiber Amplifier

The amplification window of an optical amplifier is the range of optical wavelengths for which the amplifier yields a usable gain. The amplification window is determined by the spectroscopic properties of the dopant ions, the glass structure of the optical fiber, and the wavelength and power of the pump laser signal power are reduced in the output amplified signal: smaller input signal powers experience larger (less saturated) gain, while larger input powers see less gain. The leading edge of the pulse is amplified, until the saturation energy of the gain medium is reached. In some condition, the width (FWHM) of the pulse is reduced.

4. SOFTWARE USED

Simulation of EDFA amplifier was done with the help of Gain Master Software.

5. EDFA DESIGN

EDFA optical amplifier designing is done with help of the Fiber propagation of signal, pump and the Gain Master. Design tools are used .In this design we show that the optical amplifier gives all the parameter of the erbium fiber & that gives the idea how the signal is to be transfer from one location to the other location. In this design we find the gain, wavelength & noise parameter. The software allows for schematic representations of an optical amplifier to be input via a graphical user interface which mimics the symbolic language

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often used by engineers to outline a design on paper. The program tracks the optical power through the design, integrating the differential equations to solve the propagation of signal, pump, and amplified spontaneous emission (ASE) bands through all erbium fiber sections. Once a simulation is complete, the user may look inside the design by graphing the power propagating through any fiber in the design, as well as through the length of all erbium fiber sections. . Also, by use of the probe component, the user may make common two-point measurements of interest, such as gain, noise figure, conversion efficiencies, etc. Optical parameters of any component may be changed and the simulation re-run to observe the effects on amplifier performance.

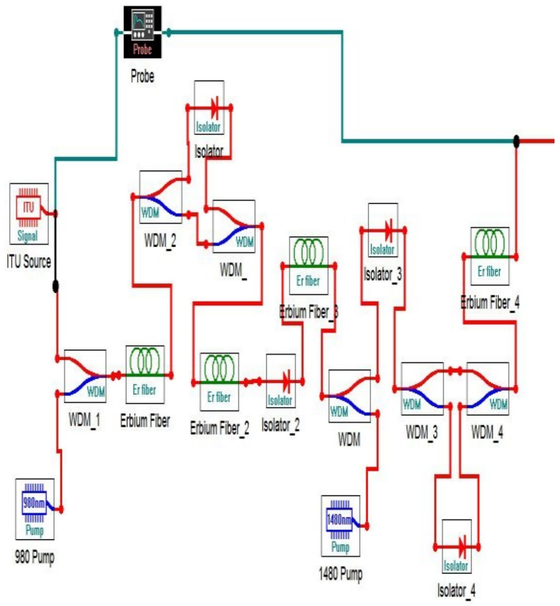

Fig 2. Four- stages EDF Optical amplifier design

6. RESULT ANALYSIS, GAIN & NOICE

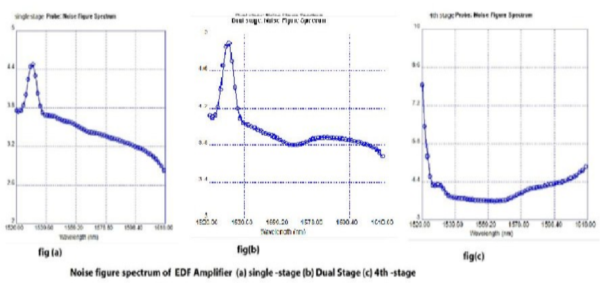

Fig 3. Noise figure spectrum of EDF Optical amplifier
(a) Single-stage (b) Dual –Stages (c) Four-Stages

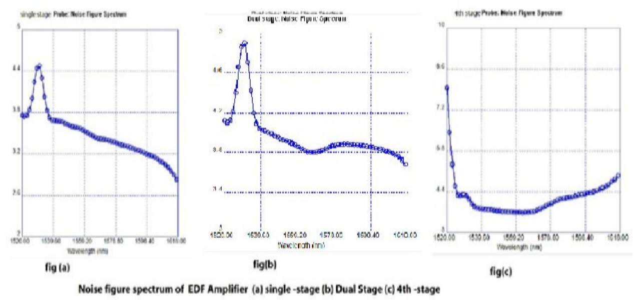

Fig 4. Gain spectrum of EDF Optical amplifier
(a) Single-stage (b) Dual –Stages (c) Four-Stages

SR. NO	EDFA Parameters	Single Stage EDFA	Dual-Stages EDFA	Four-Stages EDFA
1	Average gain	28.091 dB	30.884 dB	31.182 dB
2	Max gain	37.279 dB	36.976 dB	39.253 dB
3	Min gain	3.788 dB	7.130 dB	0.358 dB
4	Gain –Flatness (P-P)	33.491 dB	39.846 dB	39.611 dB
5	Gain-Flatness (RMS)	10.589 dB	10.098 dB	10.837 dB
6	Gain Tilt	17.824 dB	9.846 dB	5.844 dB

Table 5. Analysis of EDFA gain, noise figure with singlestage, dual-stage & four-stage EDF optical amplifier.

7. CONCLUSION

This paper shows that the optical amplifier is to be used for amplify the signal and basically designed an optical amplifier to increase the level of the input signal. There is always an optimum EDFA length depending on the pumping laser power. If the fiber is short then the whole potential of the amplifier would not be realize. If EDF fiber is longer than the erbium conversion level will be less that 50% and fiber will start to absorb the signal.

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