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Analysis of 2-Stage Erbium Doped Fibre Amplifier with Optimum Parameters

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Abstract— The objective is to design an erbium doped fiber amplifier (EDFA) for the speed enhancement. For designing of the EDFA network two software are required to find out the parameters of EDFA optical amplifier. The design evaluates the performance of the network for a given pattern specifies the design accessibility for the speed enhancement. A network planner needs to optimize the various electrical and optical parameters to ensure smooth operations of a wavelength division multiplexing (WDM) network. Most conventional network layer planners do not care about the heuristics of the optical layer. However, such lapses can often be catastrophic. Until the bit rate and the transmission distance is under some bounded constraint (for example, small networks), it is often not important to consider the optical parameters. However, as the bit rate increases and transmission length increases, these optical parameters have the capability of playing important role in the network. A network planner must consider the affecting parameters and build a network that accommodates the impairments caused by the optical parameters.

Keywords— EDFA, WDM,FOSP, GAINMASTER ETC.

I. INTRODUCTION

Optical fiber Raman amplifiers exhibit various merits such as wider amplification bandwidth, flexible center wavelength, and larger amplification capacity [2], [3]. as the optical power of the commercially available pump diodes is limited within 200–300 mw, several pumps are needed to provide enough power for amplifying all the channels. In order to get wide and flat gain bandwidth, the power and wavelength of each pump diode should be carefully chosen [4], [5]. The pioneer research of fiber Raman amplifiers (FRAs) [6] faded out right after the invention of erbium-doped fiber amplifiers (EDFAs) over 15 years ago. However, it has recently made a successful comeback [7], [8]. The renewed interest on FRA is mainly due to the availability of high power compact pump lasers [9] and the superior performance of Raman amplification, such as wide bandwidth, low noise, and suppressed nonlinearities performance in transmission systems.

Nonlinear effects within optical fiber provide optical amplification, this achieved by stimulated Raman scattering, stimulated Brillion scattering or stimulated four photon mixing by injecting a high power laser beam into undoped or doped optical fiber. Raman amplification exhibits advantage of self phase matching between the pump and signal together with a broad gain- bandwidth or high speed response in comparison with the other nonlinear processes[9].There are two types of Raman amplifier discrete (lumped) and distributed Raman amplifier .Distributed type Raman amplifier (DRA) utilizing transmission optical fiber as an active medium[10] if the amplifier is contained in a box at the transmitter or receiver end of the system it is called a discrete Raman amplifier.

A network planner needs to optimize the various electrical and optical parameters to ensure smooth operations of a wavelength division multiplexing (WDM) network. Whether the network topology is that of a point-to-point link, a ring, or a mesh, system design inherently can be considered to be of two separate parts: optical system design and electrical or higher layer system design. To the networking world, the optical layer (WDM layer) appears as a barren physical layer whose function is to transport raw bits at a high bit rate with negligible loss. Most conventional network layer planners do not care about the heuristics of the optical layer. However, such lapses can often be catastrophic. Until the bit rate and the transmission distance is under some bounded constraint (for example, small networks), it is often not important to consider the optical parameters. However, as the bit rate increases and transmission length increases, these optical parameters have the capability of playing important role in the network. A network planner must consider the affecting parameters and build a network that accommodates the impairments caused by the optical parameters.

Optical Amplifier

An optical amplifier is a device that amplifies an optical signal directly, without the need to first convert it to an electrical signal. An optical amplifier may be thought of as a laser without an optical_cavity, or one in which feedback from the cavity is suppressed. Stimulated_emission in the amplifier's gain medium causes amplification of incoming light. Optical amplifiers are important in opticalcommunication and Traditionally,when setting up an optical link,one formulates a power budget & repeaters when path loss exceedes the available power margin. To amplify an optical signal with a conventional repeters,one performs photon to electron conversion,Electrical Amplification ,Retiming,Pulse Shaping, & the electron to photon conversion.althuogh this process works well for moderate speed single wavelength operation,it can be fairly complex & expensive for high speed multiple wavelength systems.Thus a greate deal of effort has been expended to develop all optial amplifiers. These devices completely operate in the optical domain to boost the power levels of the multiple lightwave signals over spectral bands of 30 nm & more.

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Optical amplifiers have found widespread use in diverse applications ranging from ultra wide long undersea links to short links in acess networks.in long distance undersea & terristial point –to-point links the traffic pattren relatively stable, so that the input power levels to an optical amplifier do not very significantly.However, since many closely spaced wavelength channel are being transported over these link.The amplifier must have a wide spectral response range & be highly reliable.Usually fewer wavelength are carried on metro & acess network links.But the traffic patterns can be bursty & wavelengths an often be added or dropped depending upon the customers demand for services.

Erbium Doped Fiber Amplifiers

The invention of the EDFA in the late eighties was one of the major events in the history of optical communications systems. It is provided new life research of technologies that allow high bit rate transmission over long distances. Higher bit rates are also possible using various dispersion compensations techniques. In general, EDFA has a narrow high gain peak at 1532 nm and a broad peak with a lower gain centered at 1550 nm. In order to take the advantage of the whole amplification band provided by EDFA gain spectrum, equalization techniques have to be applied [39]. The use of increasing number of channels in the present day DWDM optical networks requires a flat gain spectrum requires a flat gain spectrum across the whole usable bandwidth.

The optical fiber can be doped with any of the rare earth element, such as Erbium(Er),Ytterbium(Yb),Neodymium(Nd), or Praseodymium(Pr) .the host fiber material can be either standard silica ,a fluoride based glass or a multi component glass. The operating regions of these devices depend on the host material and doping elements. Fluorozirconate glasses doped with Pr or Nd are used for operation in the 1300 nm window, since neither of these ions can amplify 1300 nm signals when embedded in silica glass. The most popular material for long haul telecommunication applications is a silica fiber doped with Erbium, which is known as a EDFA. In some cases, Yb is added to increase the pumping effiency and the amplifier gain .the operation of an EDFA by itself normally is limited to the l530-1560 nm region. The active medium in an optical fiber amlifier consists of a nominally 10-30-m lenght of optical fiber that has been lightly doped with a rare earth lement ,such as erbium(Er),ytterbium (Yb),thulium (tm).the host fiber material can be standerd silica,a fluoride-based glass,

Optical amplifier design

We design the EDFA optical amplifier with help of WDM using the Fiber Optical Simulation Program & the Gain Master.

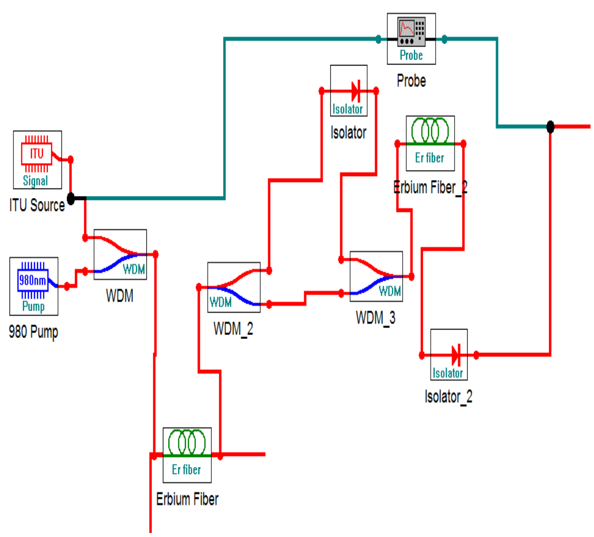

Figure1: Two stage of optical amplifier design.

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 optimum parameter found from the analysis are

The software allows for schematic representations of an optical amplifier to be input via a graphical user interface which mimics the symbolic language 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

Sr.no	Parameter	Range in db(second stage)
1	Average gain	30.099
2	Maximum gain	35.085
3	Minimum gain	24.742
4	Gain flatness(p-p)	10.343
5	Gain flatness(rms)	2.972
6	Gain tilt	10.121

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.

In this paper we have shown the variation of gain & noise with respect to the wavelength for the second stage of optical amplifier. The range consider the 1550 nm-1620nm.the software use is gain master of erbium doped fiber amplifier optical amplifier up to the threshold value the gain increases after that the gain decreases with wavelength & becomes zero at the peak value of wavelength on the similar pattern the noise also 1st increases & then decreases & finally becomes zero at the peak wavelength.

Graph Measurement & Spectra

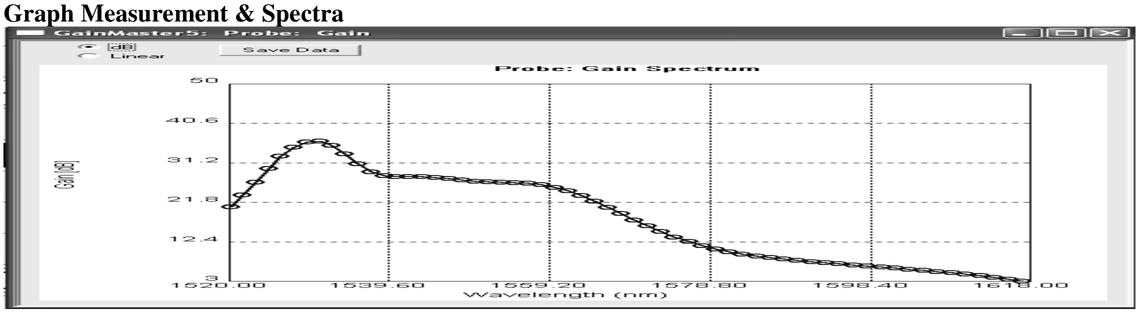

Figure 2: Gain versus Wavelength (second stage)

Noise Measurement & Spectra

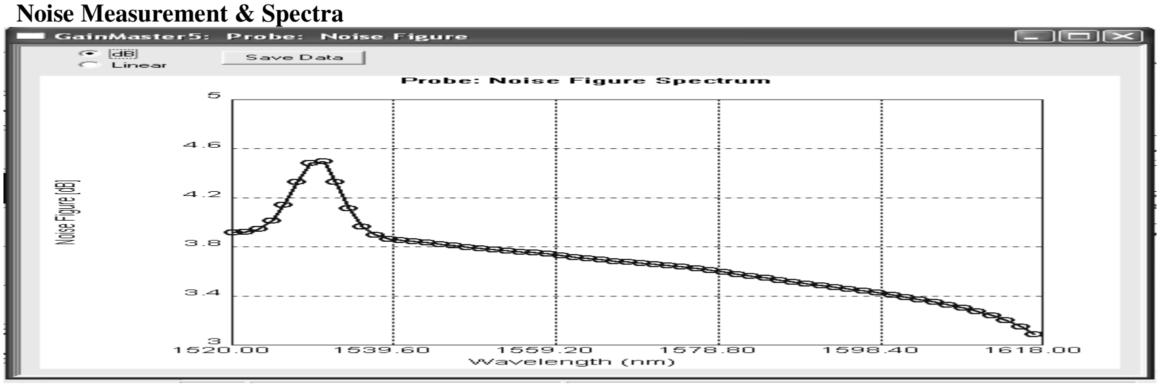

Figure 3: Noise Figure versus Wavelength (second stage)

Performance of the EDFA optical amplifier:

Sr.no	Parameter	Range in(second stage) %
1	Power conversion efficiency	28.243
2	Quantum conversion efficiency	3142

CONCLUSION

This paper shows that the optical amplifier is to be used to amplify the signal and designed, is to increase the level of the input signal and calculate the optimum parameters for the transmission of the data. The input wavelength is taken in between 1520-1617nm. It also depicts the noise spectrum of the erbium doped optical amplifier.

It shows the results of the Two stage of the optical amplifier and the different optimum parameters of the optical amplifiers.

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