



Optimizing the EDFA gain for WDM lightwave system with temperature dependency

Abdel Hakeim M. Husein^{a,*}, Fady I. El-Nahal^b

^a Al-Aqsa University, Physics Department, P.O. Box 4051, Gaza, Gaza Strip, Occupied Palestinian Territory

^b Islamic University of Gaza, Electrical Engineering Department, Gaza, Gaza Strip, Occupied Palestinian Territory

ARTICLE INFO

Article history:

Received 29 November 2010

Accepted 8 May 2011

Keywords:

EDFA
Gain flatness
Fiber length
Pump power
WDM

ABSTRACT

The gain-flattened erbium-doped fiber amplifier (EDFA) is a key device for wavelength division multiplexing (WDM) modern optical network systems. A flat spectral gain EDFA has been achieved by controlling the doped fiber length and the pump power. The purpose of this paper is to study the variation of gain flattening over the temperature range from -20 to $+60$ °C. The results obtained here indicate that gain flatness increases as temperature increases.

© 2011 Elsevier GmbH. All rights reserved.

1. Introduction

Erbium-doped fiber amplifiers (EDFAs) can be extensively used in optical fiber communication systems due to their compatibility with optical fiber, low insertion loss, low crosstalk, high gain, polarization insensitive, and low noise figure (NF) [1]. EDFAs are attractive devices for single-mode fibers in optical communication systems in the 1530 nm wavelength band, which is known as a third window for fiber optic communication. The gain of EDFAs depends on temperature and this feature is very interesting in the modern optical transmission systems which use wavelength division multiplexing (WDM) [2]. In WDM system, a stream of wavelength channels particularly in C- and L-band regimes can be simultaneously amplified by an EDFA 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 [3]. The gain-flattened EDFA is a key component in long haul multichannel lightwave transmission systems such as the WDM [4]. One complexity 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 necessarily amplify the wavelength of the channels equally. EDFAs 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) [5]. There are several methods in designing a flat spectral gain EDFA such as by controlling the doped fiber length and the pump power [3,5], proper choosing of optical notch filter's characteristic [6], by using an acousto-optic tunable filter [7] and by employing an inhomogeneously broadened gain medium [8]. In this work, the gain-flattening variation with temperature has been studied by including the temperature and cross-section factors for the EDFAs gain pumped at 980 nm for the temperature range from -20 °C to $+60$ °C. The gain flatness of EDFA has been studied by controlling the doped fiber length and the pump power for a given input power of -26 dBm. Moreover, the BER rate variation with temperature and the output power against the wavelength band (1546–1558 nm) have been investigated.

2. Method

The basic configuration of the EDFA in the WDM system consists of 16 input signals (channels), an ideal multiplexer, two isolators, a pump laser, erbium doped fiber and a demultiplexer as shown in Fig. 1. The 16 equalized wavelength multiplexed signals from 1546 nm to 1558 nm with 0.8 nm channels spacing are fed into the system. The power of each channel is -26 dBm. The pumping at 980 nm is used to excite the doped atoms to a higher energy level. An input optical isolator prevents amplified spontaneous emission (ASE) and signals from propagating in backward direction. Otherwise, reflected ASE would reduce the population inversion, hence reducing the gain and increasing the noise figure.

* Corresponding author. Tel.: +970 8 2871829.

E-mail address: hakeim00@yahoo.com (A.H.M. Husein).

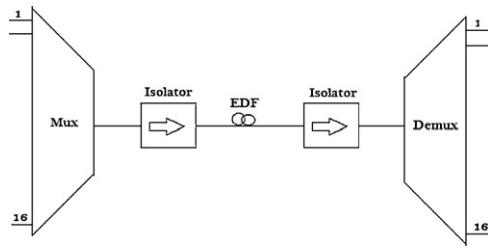


Fig. 1. The block design of EDFA in WDM system.

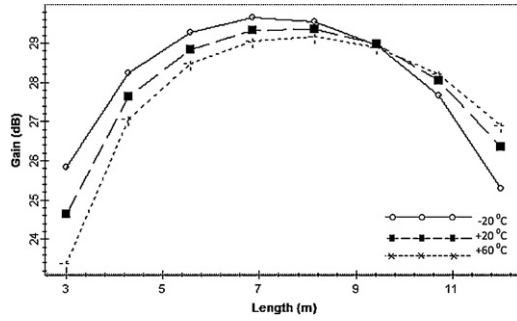


Fig. 2. The variation of gain with fiber length and temperature.

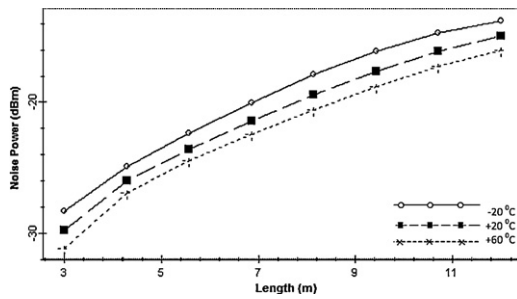


Fig. 3. The variation of the noise power (ASE) with fiber length and temperature.

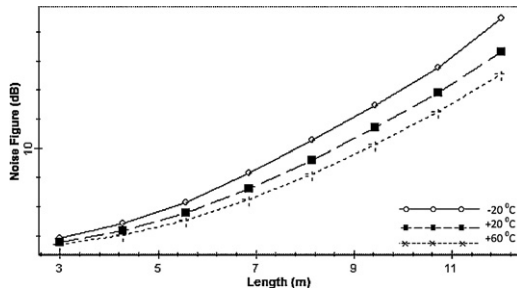


Fig. 4. The variation of the noise figure (NF) with fiber length and temperature.

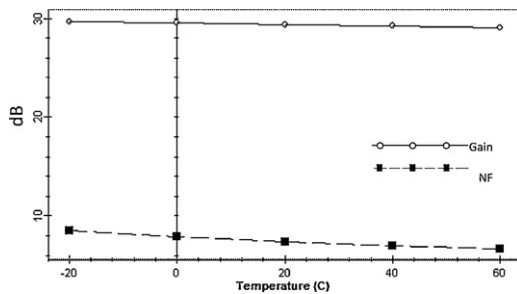
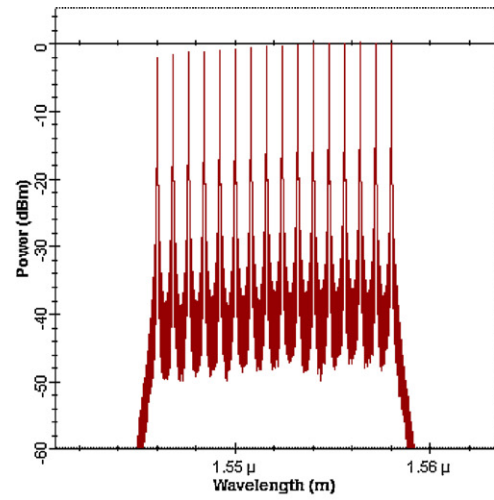
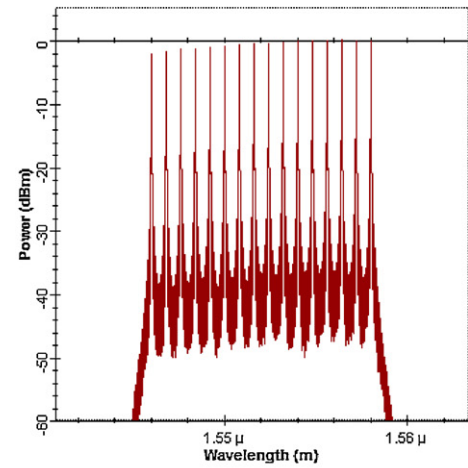


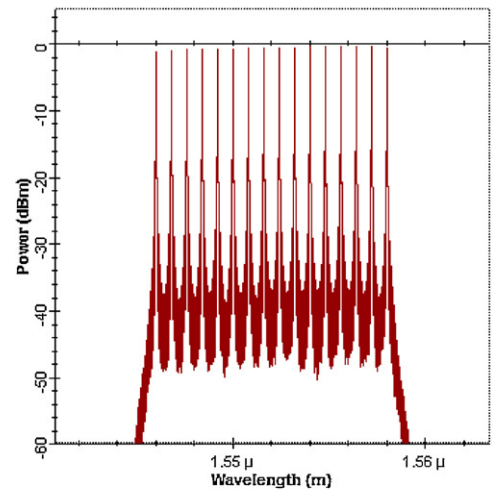
Fig. 5. The variation of the gain and the noise figure (NF) with temperature at the optimum fiber length of 7 m.



(a) Spectra of output power at -20 °C



(b) Spectra of output power at +20



(c) Spectra of output power at +60 °C

Fig. 6. The output power spectra at different temperatures at the optimum fiber length of 7 m and pump power of 50 mW. (a) Spectra of output power at -20 °C. (b) Spectra of output power at +20. (c) Spectra of output power at +60 °C.

Download English Version:

<https://daneshyari.com/en/article/850743>

Download Persian Version:

<https://daneshyari.com/article/850743>

[Daneshyari.com](https://daneshyari.com)