DESIGN AND DEVELOPMENT OF A DUAL-CORE ERBIUM DOPED AMPLIFIER FOR POLARIZATION-MULTIPLEXED SIGNALS

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MASTER OF SCIENCE
UNIVERSITI PUTRA MALAYSIA

2006

DEDICATION

To

My Mother;
Hajah Ramlah Bte Harun

Brothers and Sisters;
Hartati, Roswati, Norliza, Noraini, Haslinda, Hairin, Hairina, Kamarul Rahmat and Mohd Najib

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Master of Science

DESIGN AND DEVELOPMENT OF A DUAL-CORE ERBIUM DOPED AMPLIFIER FOR POLARIZATION-MULTIPLEXED SIGNALS

By

AHMAD SHUKRI BIN MUHAMMAD NOOR

February 2006

Chairman: Associate Professor Mohd Khazani Abdullah, PhD

Faculty: Engineering

The extensive usage of Erbium Doped Fiber Amplifier (EDFA) in fiber optic networks creates many new configurations and technologies. Conventional optical amplifiers based on EDFA can amplify multiple channels at the same time, but within a single fiber optic core. The amplifier can be made to support multiple fibers, however the channels must be at different set of wavelengths, which is impractical since optical channels are standardized at a specific set of wavelengths. Therefore, the application of optical amplifiers are limited for one fiber core only. As an alternative, a design of an EDFA is hereby proposed. With this amplifier, it will make the network management simpler. It also provides flexibility in optical network design.

In this dissertation, the design and development of EDFA is detailed and discussed. The design has made it possible to support two fibers with each one carrying the same set of wavelengths. This is achieved by taking advantage the polarization multiplexing techniques which allow a combination of

lights by setting them linear and orthogonally apart. The signals co-exist in a single core EDF by differentiating both of their polarity using polarization controllers. Then it will combine through in a single core using a 3dB coupler. The combined signals are then amplified by the EDFA simultaneously, doubling the amount of signals carried by the same wavelength.

The amplifier has been successfully tested at the transmission speed as high as 2.5Gbps. Moderate gain and noise figure of the EDFA was achieved at an optimum pump power for the EDF at 40mW. The transmission performance also shows tolerable polarization crosstalk due to unpolarized amplified spontaneous emission with the bit error rate showing little difference compared to that of the conventional amplifier. The results were obtained mainly through experimentation while others are through software simulation.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

REKABENTUK DAN PEMBANGUNAN PENGUAT TERDOP ERBIUM UNTUK ISYARAT TERGABUNG PENGUTUBAN

Oleh

AHMAD SHUKRI BIN MUHAMMAD NOOR

Febuari 2006

Pengerusi: **Profesor Madya Mohd Khazani Abdullah, PhD**

Fakulti: **Kejuruteraan**

Penguat Gentian Terdop Erbium (EDFA) digunakan secara meluas di dalam rangkaian gentian optikal menyebabkan kepelbagaian konfigurasi dan teknologi muncul. Penguat optik konvensional berdasarkan EDFA boleh menguatkan beberapa saliran pada masa yang sama, tetapi didalam satu teras gentian optik sahaja. Penguat optik tersebut boleh menyokong pelbagai saliran jika ia membawa cahaya yang berlainan panjang gelombang. Tetapi ini tidak praktikal kerana panjang gelombang bagi setiap saliran-saliran ini telah ditetapkan mengikut piawainya. Dengan itu, aplikasi penguat optik ini terhad kepada satu teras gentian sahaja. Sebagai alternatif, satu rekabentuk EDFA dicadangkan. Dengan adanya penguat ini, akan membolehkan pengurusan rangkaian lebih senang. Ia juga menyediakan kebolehlenturan didalam rekabentuk rangkaian optik.

Disertasi ini membincangkan secara terperinci rekabentuk dan pembangunan EDFA ini. Rekabentuk ini telah memungkinkan penguat optik untuk menjadi dwi-teras bagi menguatkan dua gentian optik walaupun setiap satunya membawa cahaya yang mempunyai panjang gelombang yang sama. Kejayaan ini dicapai dengan mengguna pakai teknik pemultipleksan kutub yang membenarkan cahaya digabungkan dengan pengesetan linear dan berserenjang antara satu sama lain. Isyarat-isyarat ini boleh wujud bersama di dalam satu teras EDF dengan membezakan pengutuban mereka menggunakan

pengawal pengutuban. Kemudian, kedua-duanya akan digabungkan didalam satu teras menggunakan pengganding 3dB. Cahaya yang telah bergabung ini di kuatkan oleh EDFA serentak, menggandakan jumlah data yang boleh dikuatkan.

Penguat ini telah diuji dengan jayanya pada kelajuan transmisi sehingga 2.5Gbps. Pertambahan dan nombor hingar yang sederhana untuk EDFA ini telah dicapai pada kekuatan optimum laser pam pada 40mW. Kejayaan transmisi ini juga menunjukkan cakap silang pengutuban yang disebabkan oleh pemancaran rawak penguatan yang boleh diterima. Ini terbukti dengan kadar ralat bit tidak terlalu berbeza berbanding dengan penguat konvensional. Keputusan-keputusan didapatkan melalui ujikaji dan selebihnya melalui simulasi perisian komputer.

ACKNOWLEDGEMENTS

Bismillahirrahmanirrahim, In the name of Allah, the Most Beneficent, the Most merciful. Alhamdulillah, all the praises and thanks be to ALLAH the Almighty. All blessing to Prophet Muhammad, Allah blessing be upon him.

First and foremost, it is my duly responsible as a Muslim to thanks Allah the creator on all His givings and blessings throughout this 27 years of my life. My acknowledgement firstly goes to supervisor Associate Professor Dr. Mohd Khazani Abdullah, without his continuous guidance and advice; I will not be able to finish this dissertation. His professional comments and opinion from the very beginning have keeps me on the right lane. I extended my appreciation also to both members of the supervisory committee, Professor Sahbudin Shaari of UKM and Mr. Mohd Hanif Yaacob.

A special acknowledgement to all my friends in Photonic and Fiber Optics System Laboratory, Engineering Faculty, Universiti Putra Malaysia. Your constant support and comments gives additional strength to complete the research. Not to forget as well to all my colleagues at Computer and Communication System Engineering, Faculty of Engineering, Universiti Putra Malaysia.

Last and not least, millions of loves and appreciations are bound for my family, which I dedicated this dissertation and Noor Usratun bte Razali for the love, understanding and support.

I certify that an Examination Committee has met on 2nd February 2006 to conduct the final examination of Ahmad Shukri bin Muhammad Noor on his Master of Science thesis entitled "Design And Development Of A Dual-Core Erbium Doped Amplifier For Polarization-Multiplexed Signals" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

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This thesis submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Master of Science. The members of Supervisory Committee are as follows:

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DECLARATION

I hereby declare that the thesis is based on my original work except for the quotation and citations which have been duly acknowledged. I also declare that it is not been previously or concurrently submitted for any other degree at UPM or other institutions.

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TABLE OF CONTENTS