INVESTIGATION OF MICROWAVE PHOTONIC (RF-OPTICAL) OPTICAL AMPLIFIER

NUR IDAYU BINTI IBHARIM

This Report Is Submitted In Partial Fulfillment of Requirement for the Bachelor Degree of Electronic Engineering (Telecommunication Engineering)

Fakulti Kejuruteraan Elektronik dan Kejuruteraan Komputer

Universiti Teknikal Malaysia Melaka

JUN 2012

UNIVERSTI TEKNIKAL MALAYSIA MELAKA
FAKULTI KEJURUTERAAN ELEKTRONIK DAN KEJURUTERAAN KOMPUTER

BORANG PENGESAHAN STATUS LAPORAN
PROJEK SARJANA MUDA II

Tajuk Projek	:	**INVESTIGATION OF MICROWAVE PHOTONIC (RF-OPTICAL) OPTICAL AMPLIFIER**
Sesi Pengajian	:	**0 8 / 1 2**

Saya **NUR IDAYU BINTI IBHARIM**

mengaku membenarkan Laporan Projek Sarjana Muda ini disimpan di Perpustakaan dengan syarat-syarat kegunaan seperti berikut:

1. Laporan adalah hakmilik Universiti Teknikal Malaysia Melaka.
2. Perpustakaan dibenarkan membuat salinan untuk tujuan pengajian sahaja.
3. Perpustakaan dibenarkan membuat salinan laporan ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. Sila tandakan (√) :

☐	**SULIT***	*(Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia seperti yang termaktub di dalam AKTA RAHSIA RASMI 1972)
☐	**TERHAD****	**(Mengandungi maklumat terhad yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan)
☒	**TIDAK TERHAD**	

Disahkan oleh:

Idayu .
(TANDATANGAN PENULIS)

(COP DAN TANDATANGAN PENYELIA)

FAUZI B ABDUL WAHAB
Pensyarah
Fakulti Kej Elektronik dan Kej Komputer (FKEKK),
Universiti Teknikal Malaysia Melaka (UTeM),
Karung Berkunci 1200,
Ayer Keroh, 75450 Melaka

Tarikh: 13 JUN 2012

Tarikh: 14/6/2012

"I, hereby declare that this thesis entitled, Investigation of Microwave Photonic (RF-optical) Optical Amplifier is a result of my own research idea concept for works that have been cited clearly in the references."

SIGNATURE: …….

NAME : NUR IDAYU BINTI IBHARIM

DATE : 12 JUN 2012

"I, hereby declare that I have read this report an in my opinion this report is sufficient in terms of scope and quality for the award of Bachelor of Electronic Engineering (Telecommunication Engineering) with Honours".

SIGNATURE **: …….**

SUPERVISOR NAME **: NUR IDAYU BINTI IBHARIM**

DATE **: 12 JUN 2012**

For my lovely father and mother

ACKNOWLEDGEMENT

First and foremost, I would like to express my greatest gratitude to my most dedicated and supportive supervisor, En. Fauzi bin Haji Abdul Wahab for providing his insightful knowledge and valuable assistance throughout the completion and successfully of this project under his guidance.

A special note of appreciation is extended to my parents, for their unfailing encouragement and financial support that they have given to me for over the years. Their supports and encouragement is one of the main causes of the success I gain.

Thanks also to all my friends for their guidance and knowledge they provide to me. My thanks also go to all who support me directly and indirectly in completing this project.

Thank You.

ABSTRACT

In the world of telecommunication, video and data transmission are purpose for the need of higher capacity and speed optical fiber communication systems are being extensively used. Nowadays, almost all the trunk lines of existing networks are using the optical fiber. Optical fiber extensively used because the usable transmission bandwidth on an optical fiber is larger (as much as 50 THz) as a result of which, it is capable of allowing the transmission of many signals over long distances. However, attenuation is the major limitation that imposed by the transmission medium for long distance with high speed optical systems and networks. In the optical communication, transmission rates now growing and highly demands in the field of communication, so it will make the electronic regeneration become more and more expensive. The optical amplifiers came into existence, which is to eliminate the costly of conversions from optical to electrical signal and vice versa. Furthermore, optical amplifier has wide gain spectrum ease of integration with other devices and low cost. This thesis is mainly concerned about the optical amplifier by using Raman amplifier (Distributed Raman Amplifier and Discrete Raman Amplifier) and Erbium doped fiber Amplifier (EDFA). The aim of investigation is to produce a working conversion from RF to optical. The performance of Raman Amplifier and EDFA were used and the performances have been compared based on the various types of configurations of optical amplifiers. Besides that, furthering investigate of the optical amplifier was done by using different parameter of RAMAN and EDFA such as fiber length, pump wavelength, pump power, signal wavelength and also signal power. Based on this investigate, the objective of this project was achieved where to find out, the best optical amplifier according to requirement.

ABSTRAK

Dalam dunia telekomunikasi, video dan penghantaran data adalah bertujuan untuk keperluan kapasiti yang lebih tinggi dan sistem komunikasi optik gentian sedang digunakan secara meluas. Pada masa kini, hampir semua batang baris rangkaian yang sedia ada menggunakan gentian optik. Fiber optik banyak digunakan kerana penghantaran jalur lebar yang menggunakan gentian optik adalah lebih besar (sebanyak 50 THz) yang mana, ia boleh membenarkan penghantaran isyarat pada jarak yang jauh. Walau bagaimanapun, pengecilan adalah syarat utama yang dikenakan oleh medium penghantaran untuk jarak jauh dengan sistem dan rangkaian optik berkelajuan tinggi. Dalam komunikasi optik, kadar penghantaran kini berkembang dan permintaan tinggi dalam bidang komunikasi, jadi harga untuk komponen barangan elektronik menjadi lebih mahal. Penguat optik wujud untuk menghapuskan penukaran dari optik ke isyarat elektrik dan sebaliknya. Selain itu, penguat optik mempunyai keuntungan yang mudah pelbagai integrasi dengan peranti lain dan kos yang rendah. Perkara utama di dalam tesis ini ialah berkenaan dengan penguat optik yang menggunakan penguat Raman dan EDFA. Tujuan penyiasatan adalah untuk menghasilkan penukaran kerja dari RF kepada optik. Prestasi Penguat EDFA dan Raman telah digunakan dan analisis dibandingkan berdasarkan pelbagai jenis konfigurasi penguat optik. Selain itu, penyiasatan dikukuhkan dengan melakukan perubahan pada Raman dan EDFA seperti panjang gentian, panjang gelombang pam, kuasa pam, panjang gelombang isyarat dan juga isyarat kuasa. Berdasarkan penyiasatan ini, objektif projek telah tercapai di mana untuk mencari, penguat optik yang terbaik mengikut keperluan.

CONTENTS

LIST OF ABBREVIATIONS

EDFA	-	Erbium-Doped Fiber Amplifier
NF	-	Noise Figure
OSNR	-	Output Signal Noise Ratio
RFA	-	Raman Fiber Amplifier
SRS	-	Stimulated Raman Scattering
DRBS	-	Double Rayleigh Backscattering
SM	-	Single Mode
CW	-	Continuous Wave
ASE	-	Amplified Spontaneous Emission
OSA	-	Optical Spectrum Analyzer
MUX	-	Multiplexer
RA	-	Raman Amplifier

LIST OF FIGURE

LIST OF TABLE

LIST OF GRAPH

CHAPTER I

INTRODUCTION

1.1 Project Background

Optical communication has been used for long time ago and greatly used nowadays. Since then, it offers the flexibility to perform well for long-distance communication. There have several types of optical amplifier medium; such as Raman Amplifier and Erbium doped fiber amplifier (EDFA). There are two types of Raman Amplifier: Distributed Raman Amplifier and Discrete Raman Amplifier. For the Raman Amplifier, fiber length was varies from 0km to 100km, for the pump wavelength fixed to 950nm. For the EDFA, fiber length that was varies from 2m to 10m, because the optimum fiber length for EDFA is between 4 to 6m. The value of pump power was fixed at 100mW. The statistic analysis is to compare between Raman amplifier and EDFA are: gain, Noise Figure (NF), Quality, and also OSNR. Distributed Raman Amplifier is one of the best components in the design of the transmission signal to the optical (RF-optical) based on the requirement. The transmission signal that was used in this optical amplifier is microwave signal with frequency of 3G Hz.