LOSSES FIBER OPTIC SPLICING, AN ANALYSIS AND CALCULATION

NURUL HUDA BINTI MOHD

This report is submitted in partial fulfillment of the requirements for the award of Bachelor of Electronic Engineering (Computer Engineering) With Honours

Faculty of Electronic and Computer Engineering
Universiti Teknikal Malaysia Melaka

May 2008

UNIVERSTI TEKNIKAL MALAYSIA MELAKA
FAKULTI KEJURUTERAAN ELEKTRONIK DAN KEJURUTERAAN KOMPUTER

BORANG PENGESAHAN STATUS LAPORAN
PROJEK SARJANA MUDA II

Tajuk Projek : LOSSES FIBER OPTIC SPLICING, AN ANALYSIS AND CALCULATION

Sesi Pengajian : 2004-2008

Saya NURUL HUDA BINTI MOHD

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 (v) :

☐	**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:

(TANDATANGAN PENULIS)

(COP DAN TANDATANGAN PENYELIA)

Alamat Tetap: 875 KG. ALUR TEMBESU,
23000 DUNGUN,
TERENGGANU

CHAIRULSYAH WASLI
Lecturer
Faculty Electronics and Computer Engineering (FKEKK)
Universiti Teknikal Malaysia Melaka (UTeM),
Locked Bag 1200,
Ayer Keroh, 75450 Melaka

Tarikh: 28.04.08

Tarikh: 28/4/08

DECLARATION

"I hereby declare that this report is result of my own effort except for works that have been cited clearly in the references."

Signature : ....

Name : Nurul Huda Binti Mohd

Date : 28-04-08..

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

Signature : ....

Supervisor's Name : Mr. Chairulsyah Wasli

Date : 28/4/08

To

My parents

Mohd & Norhayati

My siblings,

Mohd Hilmi Faisal, Nabila and Danial Hafiz

For your infinite and unfading love, sacrifice, patience, encouragement and Best wishes

ACKNOWLEDGEMENT

Praise to the Eternal One, Allah S.W.T for blessing and guiding me through this entire project and for showing me the path so that can complete his project. Million thanks to my parents, Mr. Mohd bin Abu Bakar and Mrs. Norhayati Binti Kamarudin which have been giving non-stop of support in whatever from they can provide. Not to forget Mr. Chairulsyah Wasli for being tolerant with my problems and attitude while guiding me the way to complete this project and thank you again for providing me materials, ideas and suggestion. To my friends who have always been there whenever I am troubled and helped me in my darkest day. Last but not least, to anyone who contributed heir help and time in this project whether they are lecturers, persons and everyone direct or indirectly involved in this project.

ABSTRAK

"Losses Fiber Optic Splicing, An Analysis and Calculation" merupakan sistem dalam program computer yang bertujuan untuk membantu proses pengajaran bagi pelajar Elektronik Komunikasi. Kalkulator ini menggunakan program computer yang berasaskan Matlab dan GUI yang juga merupakan kalkulator yang mudah digunakan berbanding dengan kalkulator lain kerana ianya digunakan oleh pelajar. Pemfokusan lain bagi membangunkan program computer ini adalah bagi menjimatkan kos dan masa tanpa melakukan pengiraan menggunakan kalkulator manual.

ABSTRACT

"Losses Fiber Optic Splicing, An Analysis and Calculation" is a software system that is proposes for helping in teaching matter for Electronic of Communication's students. This calculator is using Matlab and GUI software that are also one of friendly calculator compare of another calculator because it easy to use besides suitable for students status. Another focusing of developing this software is saving cost and time without doing manual calculation.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDIX

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

This project is focus to software calculator. The formula in this calculator involved fusion splices. So, it will be helpful software to support fiber optic learning process. Besides that, this calculator is easier to use by inserting angle, distance and offset value between joining cores of fiber optic. After that, the results will display automatically. This project will use Matlab and GUI software for display and calculating support. The task of this project is to study literature, software design, and test.

1.2 OBJECTIVE

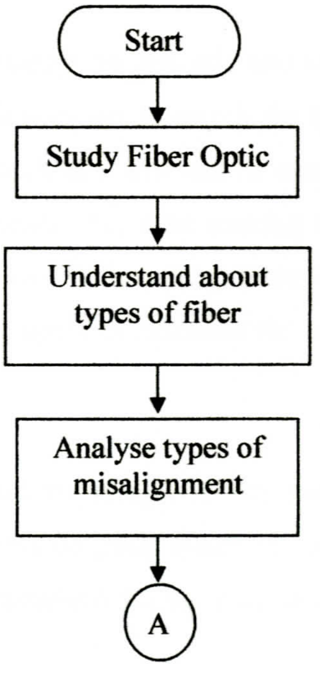
The objective of this project is to design software calculator using Matlab and GUI software. This software will help in learning process for Electronic of Communication's students. The calculator also can save the time without doing manual calculation to get the result and saving cost that is suitable for student status. Besides that, this software calculator is easy to use compare of another calculator.

1.3 SCOPE OF PROJECT

Scope of this project this project is to study the theory of losses in splicing of fiber optic. This project focus to design a calculator for calculation purpose the splicing process in fiber optic and can be flexible calculator for user where is ease using Matlab and GUI software. It also will design a prototype and full system of calculator by the formula collecting.

This includes the study of the misalignment types of losses fiber optic splicing such as lateral, angular and end separation misalignment for single-mode and multimode fiber.

For any physical parameter, it will includes mode field radius, separation between 2 cores, core refractive index, angular misalignment, wavelength of light and numerical aperture with its unit such as millimeter, micrometer, degrees and act. For the output also include with dB unit. It is for learning process and reminds student about the calculation. Figure 1.1 shown about flow chart of this project.



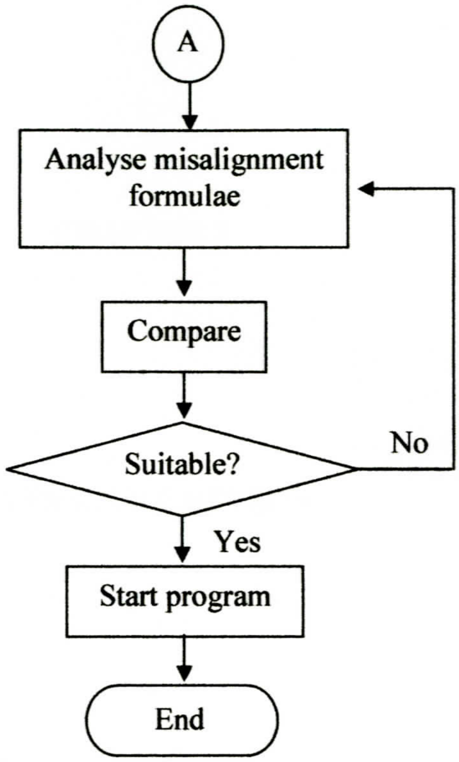


Figure 1.1: Project flow chart

1.4 METHODOLOGY

The Losses Fiber Optic Splicing, an analysis and calculation is a complex and requires a longer reading time. It is because, to search the suitable formulae need a lots of reading by different authors which has different of confuse formulae and different ways expressing for the same formula. So, after making the analysis, I have got the suitable formulae to this calculator. Before this, there are not have any splicing calculator are exist, by this project, user can calculate the misalignment losses by using this calculator.

Besides, this calculator is not including with the 'reset' button because there are have some problem to insert it in this program which effected to other button function. So, when user needs to used this calculator for the second round, they need to exit first and run again this software.

CHAPTER 2

LITERATURE REVIEW

2.1 BACKGROUND STUDY

This is background study on this topics related to the project that is about splicing in fiber optic. This is also about step to splice, characteristic and types of optical fiber. Figure 2.1 illustrates about transmission information through the optical fiber.

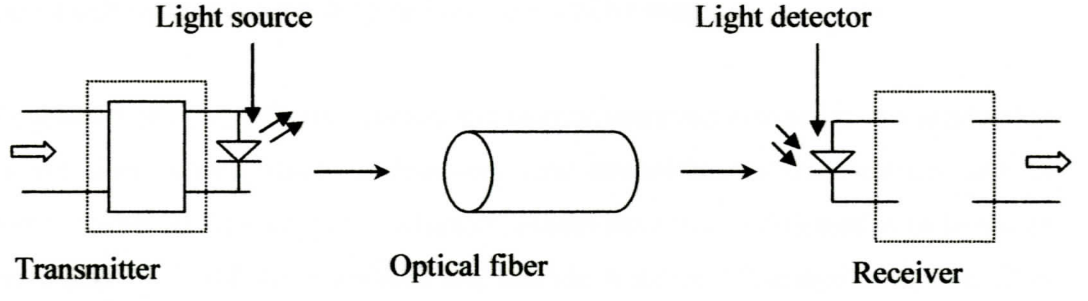


Figure 2.1: Transmission through optical fiber.

2.2 LITERATURE REVIEW

2.2.1 Optical Fiber

Communication using an optical carrier wave guided along a glass fiber has a number of extremely attractive features, several if which was apparent when the technique was originally conceived. Furthermore, the advances in technology to data have surpassed even the most optimistic predictions, creating additional advantages.

An optical fiber is simply a very thin piece of glass which acts as a pipe, through which light can pass down. The light can be turned on and off to represent digital information or it can be gradually changed in amplitude, frequency, or phase to represent analog information. Its are widely used in fiber-optic communication, which permits transmission over longer distances and at higher data rates than other forms of wired and wireless communications.

The term optical fiber covers a range of different designs including graded-index optical fibers, step-index optical fibers and more recently photonic crystal fibers, with the design and the wavelength of the light propagating in the fiber dictating whether or not it will be multi-mode optical fiber or single-mode optical fiber. Fibers are built into different kinds of cables depending on how they will be used.

The developed of optical fibers over the last twenty years has resulted in the production of optical fiber cables which exhibit very low attenuation or transmission loss in comparison with the best copper conductors. Fibers have been fabricated with losses as low as 0.2dB km^{-1} and these features has become a major advantage of optical fiber communications. It facilities the implementation of communication links with extremely wide repeater spacing, thus reducing both system cost and complexity.

2.2.1.1 Construction of an Optical Fiber

An optical fiber consists of a tube of glass constructed of a number of layers of glass, which is when looked at in profile; appear to have a number of concentric rings. This is illustrated in figure 2.2. Each layer (or ring) of glass has a different refractive index. From the previous discussion, it can be seen that to send light down the center of these concentric glass tubes, it is a requirement that total internal reflection occurs. This will duct the light through the fiber. To achieve total internal reflection the outer glass rings require a lower refractive index than the inner glass tube in which the light is traveling. Figure 2.3 illustrates the construction of a typical optical fiber.

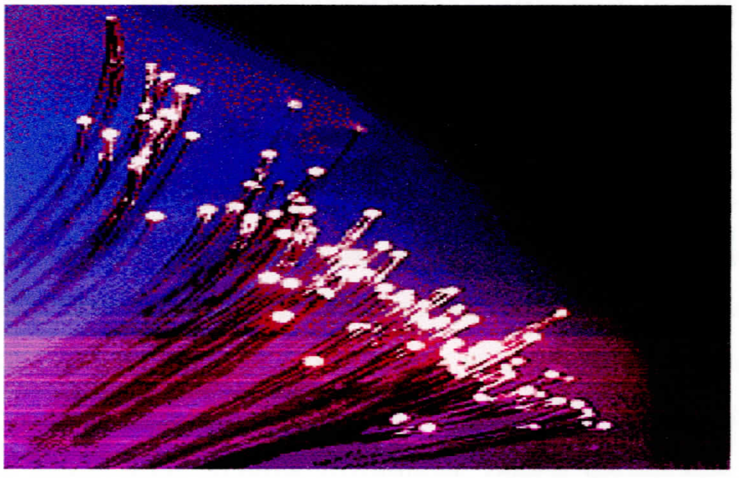


Figure 2.2: Layer of glass

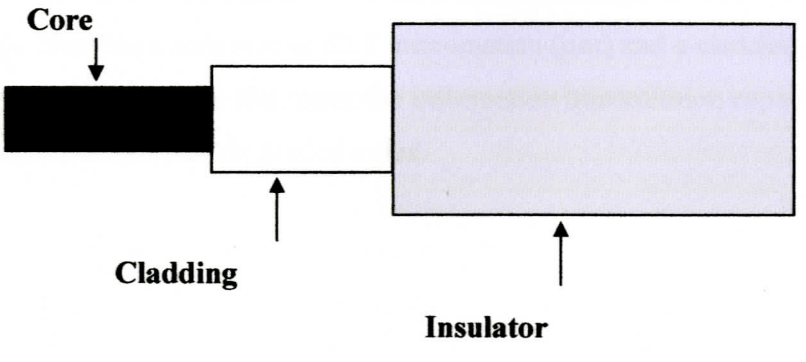


Figure 2.3: Construction of a typical optical fiber

2.2.2 Types of Optical Fiber

There is having three varieties of optical fiber such as single-mode, multi-mode step index and multi-mode step index fibers. There is having their specifications by itself such as multi-mode optical fiber that is a type of optical fiber mostly used for communication over shorter distances, like within a building or on a campus. Multi-mode fibers support applications from 10 Mbit/s to 10 Gbit/s over link lengths of up to 550 meters, more than sufficient for the majority of premises applications.

Typical transmission speeds/distances limits are 100 Mbit/s up to 2 km (100BASE-FX), 1 Gbit/s for distances up to 500-600 meters 1000BASE-SX), and 10 Gbit/s for distances up to 300 meters (10GBASE-SR). Because of its high capacity and reliability, multi-mode optical fiber generally is used for backbone applications in buildings.

Multimode fiber has higher "light-gathering" capacity than single-mode optical fiber. However, compared to single-mode fibers, the limit on speed × distance is lower because multi-mode fiber has a larger numerical aperture than single-mode fiber that supports more than one propagation mode; hence it is limited by modal dispersion, where single mode is not. Consequently, multi-mode fiber has higher pulse spreading rates than single mode fiber, limiting multi-mode fiber's information transmission capacity.

Multi-mode fibers are described by their core/cladding diameter. Thus, 62.5/125 μm multimode fiber has a core size of 62.5 micrometers (μm) and a cladding diameter of 125 μm. Figure 2.4 and 2.5 are illustrates the information transmission capacity of multi-mode step index and multi-mode graded index.

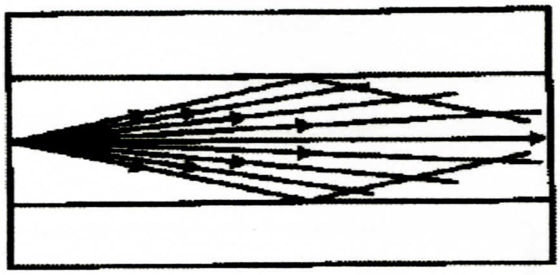


Figure 2.4: Multi-mode step index

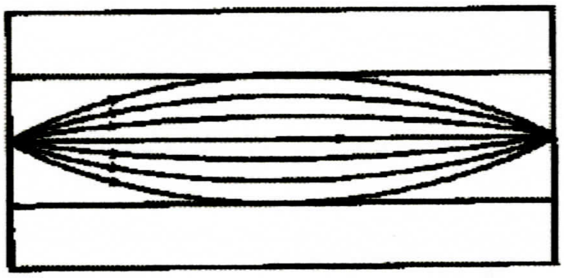


Figure 2.5: Multi-mode graded index

In fiber-optic communication, a single-mode optical fiber is an optical fiber designed to carry only a single ray of light (mode). This ray of light often contains a variety of different wavelengths. Although the ray travels parallel to the length of the fiber, it is often called the transverse mode since its electromagnetic vibrations occurs perpendicular (transverse) to the length of the fiber. Figure 2.6 illustrates the information transmission capacity of single-mode fiber.

Unlike multi-mode optical fibers, single mode fibers do not exhibit dispersion resulting from multiple spatial modes. Single mode fibers are also better at retaining the fidelity of each light pulse over long distances than are multi-mode fibers. For these reasons, single-mode fibers can have a higher bandwidth than multi-mode fibers. Equipment for single mode fiber is more expensive than equipment for multi-mode optical fiber, but the single mode fiber itself is usually cheaper in bulk.

A typical single mode optical fiber has a core radius between 8 and 10 μm and a cladding radius of 125 μm; the wavelength of the light is 1310 or 1550 nm. There are a number of special types of single-mode optical fiber which have been chemically or physically altered to give special properties, such as dispersion-shifted fiber. Data rates are limited by polarization mode dispersion and chromatic dispersion.

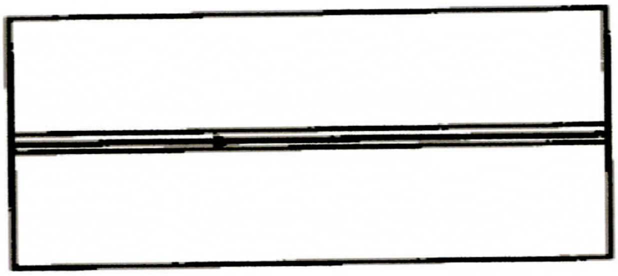


Figure 2.6: Single-mode

Single-mode	**Multi-mode**
i. Carry only a single ray of light	i. Carry for multi ray of light
ii. Core radius between 8 and 10 μm and a cladding radius of 125 μm	ii. Core size of 62.5 μm and a cladding diameter of 125 μm.
iii. Fidelity of each light pulse over long distances	iii. Communication over shorter distances and limit on speed
iv. Higher bandwidth	iv. Transmission speeds/distances limits are 100 Mbit/s up to 2 km
v. Expensive equipment for splicing process	v. Manual splicing
vi. Contains a variety of different wavelengths	vi. Support applications from 10 Mbit/s to 10 Gbit/s
vii. Smaller numerical aperture	vii. Larger numerical aperture
viii. Higher limit on speed × distance	viii. Limiting information transmission capacity

Table 2.1: Characteristic of single-mode and multi-mode fiber