PERFORMANCE ANALYSIS OF FIBER OPTIC CURRENT SENSOR USING SAGNAC INTERFEROMETER

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This report is submitted in partial fulfilment of the requirements for the degree of Bachelor of Electronic Engineering with Honours

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APPROVAL

I hereby declare that I have read this thesis and in my opinion this thesis is sufficient in terms of scope and quality for the award of Bachelor of Electronic Engineering with Honours.

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DEDICATION

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ABSTRACT

Conventional current sensor has several limitation and disadvantage, particularly to work for high power applications. The most notable weakness is against a phenomenon called Electromagnetic Interference (EMI). Therefore, crucial aspect such as accuracy, sensitivity, reliability and safety are greatly affected and the result is unreliable. The advancement of the fiber optic technology in recent years opened up a better solution to this conventional problem. The motivation of this project is to implement and enhance fiber optic as current sensor. In this research, a fiber optic interferometer is applied to receive inputs from a modulator, which resemble the presence of electromagnetic field around a conductor carrying an electrical current. The purpose of this research are to design and demonstrate a fiber optic current sensor using Sagnac interferometric scheme. The design is simulated using Optisystem software. The performance of the fiber optic current sensor was observed and analyzed. Analysis has focused on the output waveform, transmission losses, power consumption, and sensitivity of the device. In terms of stability, Sagnac interferometer with CW mode laser as light source provided the best result. However, configuration with pulse mode laser gave another advantage over CW mode, which are low transmission loss, low power consumption and better sensitivity.

ABSTRAK

Sensor arus konvensional mempunyai beberapa batasan dan kelemahan, terutamanya untuk berfungsi dalam aplikasi berkuasa tinggi. Kelemahan paling ketara adalah fenomena yang dipanggil gangguan elektromagnetik (EMI). Oleh itu, aspek penting seperti ketepatan, kepekaan, kebolehpercayaan dan keselamatan terjejas dan hasilnya diragui. Kemajuan teknologi gentian optik beberapa tahun yang lalu memangkinkan penyelesaian lebih baik untuk mengatasi masalah ini. Motivasi projek adalah untuk melaksanakan dan memperbaiki gentian optik sebagai sensor arus. Dalam kajian ini, interferometer gentian optik digunakan untuk menerima input dari modulator, mewakili kehadiran medan elektromagnetik di sekeliling konduktor yang membawa arus elektrik. Tujuan penyelidikan ini adalah untuk merekabentuk dan memperagakan sensor arus gentian optik menggunakan skema interferometrik Sagnac. Reka bentuk disimulasikan melalui perisian Optisystem. Prestasi sensor arus gentian optik telah diperhatikan dan dianalisis. Analisis menumpukan pada bentuk gelombang pengeluaran, kehilangan penghantaran, penggunaan kuasa, dan sensitiviti peranti. Dari segi kestabilan, interferometer Sagnac interferometer dengan laser mod CW sebagai sumber cahaya memberi hasil terbaik. Walaubagaimanapun, konfigurasi dengan laser mod denyut memiliki kelebihan lain berbanding mod CW iaitu kehilangan penghantaran yang rendah, penggunaan kuasa yang rendah serta memiliki sensitiviti yang lebih baik.

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LIST OF ABBREVIATIONS

EMI	:	Electromagnetic Interference
AC	:	Alternate Current
DC	:	Direct Current / Directional Coupler
PCS	:	Plastic Coated Silica
SI	:	Step-Index
GI	:	Graded-Index
PMF	:	Polarization Maintaining Fiber
PCF	:	Photonic Crystal Fiber
TE	:	Transverse Electric
TEM	:	Transverse Electromagnetic
LPG	:	Long Period Grating
FBG	:	Fiber Bragg Grating
LASER	:	Light Amplification by Stimulated Emission Radiation
LED	:	Light Emitting Diode
FOCS	:	Fiber Optic Current Sensor
APD	:	Avalanche Photo Diode
HNLF	:	Highly Non-Linear Fiber
Hz	:	Hertz

BBS	:	Broad Band Source
OSA	:	Optical Spectrum Analyzer
TIA	:	Trans-Impedance Amplifier
NRZ	:	Non Return Zero
CW	:	Continuous-Wave

LIST OF SYMBOLS

A	:	Area
V	:	Voltage / Verdet Constant
B	:	Magnetic field
e	:	Electron charge
k	:	Constant
m	:	Mass of electron / Integer
c	:	Velocity of light
I	:	Current
R	:	Resistor / Radius of circular
J	:	Summation of conduction current and convection current
$\frac{\partial D}{\partial t}$	:	Displacement current
N	:	Number of turns
I_{enc}	:	Total current flows
dB	:	Decibel
Ω	:	Rate of angular velocity
S	:	Sensitivity
λ	:	Wavelength
$\Delta\emptyset$	:	Phase difference

F	:	Frequency
Δt	:	Time differences
P_{in}	:	Input power
P_{out}	:	Output power
Δn	:	Refractive index difference
L	:	Length

LIST OF APPENDICES

Appendix A:

Comparison of different input sine frequencies with output waveform 78