LEAKAGE INDUCTANCE CALCULATION OF TOROIDAL TRANSFORMER USING FINITE ELEMENET ANALYSIS

Nuwan Surange Dodampegamage

(09/8655)

Thesis submitted in partial fulfillment of the requirements for the degree Master of Science in Electrical Eng

Department of Electrical Engineering

University of Moratwa

Sri Lanka

September 2012

Declaration

I declare that this is my own work and this dissertation does not incorporate without acknowledgement any material previously submitted for a Degree or Diploma in any other University or institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

Also, I hereby grant to University of Moratuwa the non-exclusive right to reproduce and distribute my thesis/dissertation, in whole or in part in print, electronic or other medium. I retain the right to use this content in whole or part in future works (such as articles or books).

UOM Verified Signature

Nuwan Surange Dodampegamage

Date: .....

The above candidate has carried out research for the Masters under my supervision.

....

Prof. J.R. Lucas Prof. J.P. Karunadasa

Date: ....

Abstract

The researches done on calculating leakage inductance of a toroidal transformer were rare. In this research it is attempted to fill this gap by formulating a method to calculate leakage inductance of a toroidal transformer.
Finite Element Method analysis is used to calculate the leakage inductance value for the horizontal plane of the toroidal toroidal transformer and estimate the leakage inductance of toroidal transformer. Open source magnetic finite element method software FEMM is used to implement the calculation model. The calculated values are compared against different winding methods used in toroidal transformer. Output of the model did show good correlation with normal toroidal transformer winding method which is being used in almost all the toroidal transformers with few exceptions of special winding methods. After introducing a correction factor it was able to achieve maximum error percentage of +/- 20% for the calculated values compared to the values measured from prototype samples. This is a good approximation when considering in a production batch of same transformer design, about +/- 10% variation is observed in measured leakage inductance values due production variations.

Keywords: Toroidal Transformer; Leakage Inductance; FEMM; finite element method

Acknowledgement

It would not have been possible to write this thesis without the help of kind people around me. It is possible to give particular mention to only few of them here.

Above All, I would like to thank my wife Nimali for understanding, motivation and patience and my two sons' Thevindu and Budvin for their patience. My parents and brother has supported me enormously throughout my life, I do not think mere thanks will suffice.

This thesis would not have been possible without the help, support and guidance of my supervisors Prof. J. R Lucas and Prof. J.P. Karunadasa; I thank both of them for guiding me to make this thesis a success. I also would like to thank other staff members of the Electrical Engineering Department for their advice, especially the Msc course coordinator Dr. Asanka Rodrigo for his kind advices and guidance. Sincere gratitude is also extended to the people who serve in the Department of Electrical Engineering office for their support in clarifying various issues.

I would like to acknowledge the support given by Noratel International Pvt. Ltd, with whom I worked as a senior design engineer for past eight years, for providing ample test data and for allowing me to manufacture and test few samples to verify the model developed.

Last but not least I would like to thank my colleagues at Noratel, batch mates in Msc class and all my friends who have supported me in many ways to make this thesis a success.

Contents

List of Figures

List of Figures

List of Tables

List of Appendices

List of Abbreviations

FEMM	Finite Element Methods Magnetics®, Version 4.2 .
FEM	Finite Element Method
HV	High Voltage
LV	Low Voltage
l	Leakage Inductance
M	Mutual Inductance
L	Self Inductance
B	Magnetic Flux Density
Φ	Magnetic Flux
N_1	No. of turns in Primary Winding
N_2	No. of turns in Secondary Winding
R	Resistance
S	Reluctance
Lm	Magnetizing Inductance
V_1	Input Voltage
V_2	Output Voltage
I_1	Input Current
I_2	Output Current.