UNIVERSITI PUTRA MALAYSIA

DEVELOPMENT OF CLASS 2 AND CLASS 3 SURGE PROTECTION DEVICES FOR LOW VOLTAGE PROTECTION SYSTEMS

AMIZAH MOHD ARIFFEN

DEVELOPMENT OF CLASS 2 AND CLASS 3 SURGE PROTECTION DEVICES FOR LOW VOLTAGE PROTECTION SYSTEMS

By

AMIZAH MOHD ARIFFEN

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia in Fulfillment of the Requirements for the Degree of Master of Science

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Dedication

Especially for Mohamad Shaiful Ashrul, Hannah Athirah and my beloved family members for the loves, perseverance and sacrifices.

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirements for the degree of Master of Science

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Chairman : Assoc. Prof. Mohd Zainal Abidin Abdul Kadir, PhD

Faculty : Engineering

Due to the increased use of sensitive electronics, specifically microelectronics, even modest lightning activity can cause equipment indemnity. Lightning effects can occur at all levels of power systems either directly or indirectly, including transmission, generation, and distribution. Therefore, the use of surge protection can provide a solution to this problem. The International Electrotechnical Commission (IEC) and Institute of Electrical and Electronics Engineers (IEEE) introduced numerous international standards on the specified requirements and applications of low-voltage protection devices, for optimum and reliable protection. Currently, the ability of available surge protection devices is questionable, due to their poor design and unreliable protection of sensitive equipment. This project aims to study those requirement and application guidelines, with the purpose of designing, developing, and analysing, an adequate protective circuit for Class 3 and Class 2 categories. Computational (numerical analysis) and experimental methods have been applied, in addition to the analysis of previously designed devices, where their strengths and

weaknesses have been compared. Next, improvements are proposed, based on the deficiencies of previous designs, which involved the coordination of different components to acquire a lower output voltage. The designed circuit will be simulated to achieve the best results, before PCB fabrication and high voltage laboratory testing. As a result, the output voltage of the Class 2 surge protection device is below 2000 V, and below 600 V for all protection modes of the Class 3 device. Therefore, Class 2 and Class 3 surge protection devices function effectively throughout the analysis and are capable of providing a dependable let-through voltage for end user application.

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

MEMBANGUNKAN PERALATAN PERLINDUNGAN PUSUAN KELAS 2 DAN KELAS 3 BAGI SISTEM PERLINDUNGAN VOLTAN RENDAH

Oleh

Amizah Mohd Ariffen

July 2011

Pengerusi : Prof. Madya Mohd Zainal Abidin Abdul Kadir, PhD

Fakulti : Kejuruteraan

Akibat peningkatan penggunaan peralatan elektronik sensitif khususnya mikroelektronik, hanya dengan aktiviti kilat yang sederhana sahaja boleh menyebabkan ganti rugi untuk peralatan tersebut. Kesan kilat boleh wujud di pelbagai peringkat sistem kuasa secara langsung atau tidak langsung merangkumi bahagian penghantaran, penjanaan, dan pengagihan. Oleh itu, penggunaan pelindung pusuan adalah penyelesaian kepada masalah ini. IEC dan IEEE telah memperkenalkan pelbagai piawai antarabangsa yang menyatakan keperluan dan aplikasi alat perlindungan voltan rendah untuk perlindungan yang optimum dan bolehharap. Kini, kebolehan peralatan perlindungan pusuan sedia ada menimbulkan persoalan kerana kelemahan rekabentuknya dan ketidakbolehharapnya sebagai perlindungan untuk peralatan yang sensitif. Tujuan projek ini ialah mengkaji keperluan dan aplikasi tersebut sebagai panduan dalam merekabentuk, membangunkan dan menganalisis litar perlindungan bagi kategori Kelas 2 dan Kelas 3. Teknik pengiraan (analisis berangka) dan ujikaji diaplikasikan, sebagai tambahan

analisis terhadap rekabentuk peralatan terdahulu, iaitu kebaikan dan kelemahannya dibandingkan antara sama lain. Seterusnya, pembaikan dilakukan berdasarkan kekurangan dalam rekabentuk terdahulu yang mana melibatkan perbezaan koordinasi komponen untuk mendapatkan hasil voltan keluaran yang rendah. Litar yang telah direkabentuk akan disimulasi untuk mendapatkan keputusan paling optimum sebelum fabrikasi PCB dan ujian makmal voltan tinggi. Sebagai hasilnya, keluaran bagi peralatan perlindungan pusuan Kelas 2 adalah dibawah 2000 V dan untuk Kelas 3 adalah dibawah 600 V bagi semua mod perlindungan. Oleh itu, peralatan perlindungan Kelas2 dan Kelas 3 adalah berfungsi dengan efektif dibawah keseluruhan analisis dan mampu menyediakan voltan had keluaran yang bolehharap bagi aplikasi pengguna akhir.

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I certify that a Thesis Examination Committee has met on 28 July 2011 to conduct the final examination of Amizah Md. Ariffen on her thesis entitled "**Development of Class 2 and Class 3 Surge Protection Devices for Low Voltage Protection Systems**" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Master of Science.

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

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DECLARATION

I declare that the thesis is my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or other institutions.

AMIZAH MOHD ARIFFEN

Date: 28 July 2011

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