PROTECTION OF SHORT TRANSMISSION LINES USING MICROPROCESSOR-BASED DISTANCE RELAY

By

HUSSAIN FADHIL MOHAMMED ALI

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Master of Science
July 2004

DEDICATION

To my Father Fadhil Mohammed Ali (MBUH)

To my beloved Mother (MBUH)

To my Faithful Family (my wife and sons Haider& Jaafer (GKT))

&

To all my brothers, sisters & friends

May Allah S.W.T bless all of you

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

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Chairman: **Nasrullah Khan, PhD**

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Distance protection is used for the protection of transmission or sub-transmission lines, usually 33 KV, 66 KV and 132 KV lines. A distance relay measures the distance between the relay location and the point of fault in terms of impedance, reactance, etc. An impedance relay measures the line impedance between the fault point and relay location; a reactance relay measures reactance, and mho relay measures a component of admittance.

With advances in technology, protective relays have progressed from electromechanical, to solid state to microprocessor-based relays. The increased growth of power systems both in size and complexity has brought about the need for fast and reliable relays to protect major equipment and to maintain system stability.

With the development of economical, powerful and sophisticated microprocessors, there is a growing interest in developing microprocessor-based protective relays which are more

flexible because of being programmable and are superior to conventional electromagnetic and static relays. The main features which have encouraged the design and development of microprocessor-based protective relays are their economy, compactness, reliability, flexibility and improved performance over conventional relays. The distance relays are preferred to over current relays because they are not nearly so much affected by changes in short-circuit-current magnitude as over current relays are, and, hence are much less affected by changes in generating capacity and in system configuration. This is because distance relays achieve selectivity on the basis of impedance rather than current.

This thesis presents the design and operation technique for protection of short transmission lines using microprocessor-based distance relay. The characteristics of a distance relay is realised by comparing voltage and current at the relay location. The ratio of voltage (V) to current (I) gives the impedance of the line section between the relay location and the fault point. The signal will be taken from the transmission line and it will be converted to digital signal then goes to the microprocessor which has a program written in assembly language to estimate the resistance of the protected line, then the decision will be made according to this signal whether it is a fault signal or otherwise, and identify the faulty phases. The faults that have been tested are phase faults and the results have been indicated by giving the indication of the faulty phase at the same time giving signal to trip and isolate the faulty area. Different tests have been made successfully. The thesis presents one of these tests made practically.

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

PERLINDUNGAN PENGHANTARAN TALIAN PENDEK MENGGUNAKAN GEGANTI JARAK JAUH BERASASKAN PEMPROSESAN MIKRO

Oleh

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Perlindungan jarak jauh telah digunakan sebagai perlindungan talian penghantaran atau talian penghantaran tambahan, biasanya untuk talian 33 KV, 66 KV dan 132 KV. Sebuah geganti jarak jauh akan mengukur jarak antara kedudukan geganti dengan tempat berlaku kerosakan dalam bentuk impedan, reaktan dan sebagainya. Manakala geganti impedan akan mengukur nilai impedan talian di antara tempat berlaku kerosakan dengan kedudukan geganti; begitu juga geganti reaktan akan mengukur reaktan dan geganti mho akan mengukur nilai komponan admitan.

Dengan kepesatan perkembangan teknologi, geganti perlindungan telah berkembang maju dari elektromekanikal kepada litar-padu seterusnya geganti berasaskan pemprosesan mikro. Peningkatan yang berlaku dalam sistem kuasa ini adalah dalam bentuk saiz dan komplek kerana geganti yang lebih pantas dan boleh percaya diperlukan untuk melindungi peralatan utama dan mengekalkan kestabilan sistem.

Dengan perkembangan pesat, pemprosesan mikro yang lebih berkuasa, canggih dan berekonomi, perkembangan ini menuju ke arah pembinaan geganti perlindungan berasaskan pemprosesan mikro untuk lebih fleksibel (kerana boleh diprogram) dan lebih bagus dari geganti konvensional elektromagnatik dan statik. Ciri-ciri utama yang menggalakkan pembinaan geganti berasaskan pemprosesan mikro ialah ekonomi, padat, boleh percaya, fleksibel dan peningkatan kebolehan berbanding geganti konvensional.

Geganti jarak jauh adalah disediakan sebagai geganti beban lampau kerana sebagai geganti beban lampau perubahan magnitud arus litar pintas tidak memberi kesan yang begitu ketara kepadanya tambahan pula perubahan dalam kapasiti penjanaan tidak memberi perubahan dalam konfigurasi sistem. Ini kerana pencapaian geganti jarak jauh secara selektif berasaskan impedan berbanding arus.

Tesis ini mengutarakan rekabentuk dan teknik operasi untuk perlindungan penghantaran talian pendek menggunakan geganti jarak jauh berasaskan pemprosesan mikro. Ciri-ciri geganti jarak jauh dapat diketahui dengan membandingkan voltan dan arus pada lokasi geganti. Nisbah voltan (V) kepada arus (I) memberikan nilai impedan talian tertentu di antara lokasi geganti dan titik kerosakan. Isyarat akan diambil daripada talian penghantaran dan kemudian ditukar kepada isyarat digital seterusnya ke pemprosesan mikro yang telah diprogramkan dalam “assembly language” untuk menganggarkan nilai impedan ketara talian yang dilindunggi, selanjutnya keputusan akan diambil berdasarkan isyarat ini samada ia isyarat kerosakan atau tidak, akhirnya mengenalpasti fasa yang rosak.

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2. Prof. Madya Ir. Dr. Norman Mariun my co-supervisor,
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I certify that an Examination Committee met on 21st of July 2004 to conduct the final examination of Hussain Fadhil Mohammed Ali on his Master of Science thesis entitled "Protection of Short Transmission Line Using Microprocessor-based Distance Relay" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

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DECLARATION

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

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TABLE OF CONTENTS