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**PROPOSED ADAPTIVE DISTANCE RELAYING
SCHEMES FOR INTERCONNECTED
TRANSMISSION LINES COMPENSATED WITH
THYRISTOR CONTROLLED SERIES
CAPACITOR**

By

Ghada Mahmoud Abo-Hamad Mohamed El-Mahdy

A Thesis Submitted to the
Faculty of Engineering at Cairo University
In Partial Fulfillment of the
Requirements for the Degree of
DOCTOR OF PHILOSOPHY
in
Electrical Power and Machines Engineering

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
GIZA, EGYPT
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Title of Thesis:

**Proposed Adaptive Distance Relaying Schemes For Interconnected Transmission Lines
Compensated With Thyristor Controlled Series Capacitor**

Key Words:

Thyristor Controlled Series Capacitor (TCSC), Distance relays, Interconnected transmission networks, Over-reach and Under-reach, Mho/Quadrilateral characteristics.

Summary:

The thyristor-controlled series capacitor (TCSC) offers many advantages in power systems, such as fast and continuous control of the transmission line series compensation level, suppression of the active power oscillations, eliminating of sub-synchronous oscillations, and voltage support. On the other hand, the presence of TCSC in fault loop affects the impedance measured by distance relay and accordingly leads to under-reach or over-reach problems.

This thesis proposes adaptive dynamic distance relaying schemes for protecting interconnected transmission networks compensated with TCSC. The thesis introduces two different schemes based on comprehensive analysis; one is for Mho relay-based phase comparator scheme, the other is for Quadrilateral relay. Each scheme consists of three different modules; fault detection activation, TCSC zone identification, and implementation of proposed adaptive dynamic distance relay.

To analyze and evaluate the performance of proposed schemes, a series of simulation studies were carried out on IEEE-9 bus system and IEEE-39 bus. The performance has been evaluated for different firing angle; TCSC four modes of operations; different faults types, and fault locations. The achieved results designate the precision of the proposed schemes. Moreover, the results indicate their effectiveness for high fault resistance and close-in three phase faults compared with conventional relays. The proposed schemes are easy in implementation and independent on synchronized data transfer. As well as, the proposed schemes can be applied in conventional relay by just adding a little bit of series calculations.

DISCLAIMER

I hereby declare that this thesis is my own original work and that no part of it has been submitted for a degree qualification at any other university or institute.

I further declare that I have appropriately acknowledged all sources used and have cited them in the references sections.

Name: Ghada Mahmoud Abo-Hamad Mohamed El-Mahdy

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