PHASOR MEASUREMENT UNIT BASED WIDE AREA BACKUP PROTECTION SCHEME FOR TRANSMISSION LINES

By

Eng. Ahmed Saber Abdelbary Refae

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

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Title of Thesis:

Phasor Measurement Unit Based Wide Area Backup Protection Scheme for Transmission Lines

Key Words:

Transmission Line Fault Location, Phasor Measurement Unit, Wide Area Backup Protection, Cross-country Faults.

Summary:

This thesis proposes an innovative wide area backup protection scheme for untransposed single- or double-circuit transmission lines that can be applied as a substitute for third zone function of distance relay. The proposed scheme is derived based on the transmission line theory and Taylor series expansion of distributed line model parameters taking into account the effect of mutual couplings between the adjacent circuits. For large power network, a binary integer linear programming is utilized for determining the minimal number of PMUs to obtain complete fault observability. Synchronized voltage and current measurements obtained from PMUs are utilized for fault detection, faulty line identification, and fault location. Extensive simulation studies are applied to three-terminal untransposed double-circuit transmission lines and New England 39-bus test system and the simulation results prove that the proposed scheme yields acceptable performance for all simulated cases.

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 reference section.

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LIST OF ABBREVIATIONS

abs	Absolute
A/D	Analog to Digital Converter
BZ	Bus Zone
CPU	Central Processing Unit
CT	Current Transformer
DFT	Discrete Fourier Transform
EF	External Fault
EMS	Energy Management System
FACTS	Flexible AC Transmission System
FL	Fault Location
GB	Giga Byte
GPS	Global Positioning System
KCL	Kirchhoff Current Law
LCC	Load Change Condition
LG	Line to Ground
LLG	Double-Line to Ground
LL	Double-Line
LLL	Three-Line
LS-WAMS	Large Scale-Wide Area Monitoring System
max	Maximum
min	Minimum
NERC	North American Electric Reliability Council
PDC	Phasor Data Concentrator
PMU	Phasor Measurement Unit
RAM	Random Access Memory
SCADA	Supervisory Control and Data Acquisition
SIPS	System Integrity Protection Scheme
SPS	System Protection Scheme
SVMC	Support Vector Machine Classifier
TSO	Transmission System Operator
VT	Voltage Transformer
WAMS	Wide Area Monitoring System