FAULT LOCATION IDENTIFICATION FOR OVERHEAD RADIAL DISTRIBUTION NETWORKS

By

Mohamed Abd-Alrahman Ibrahim Gabr

A thesis submitted to the

Faculty of Engineering at Cairo University

In Partial Fulfillment of the

Requirements for the Degree of

MASTER OF SCIENCE

In

Electrical Power and Machines Engineering

FACULTY OF ENGINEERING, CAIRO UNIVERSITY

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TITLE OF THESIS: Fault Location Identification for Overhead Radial Distribution Networks

Key Words: Impedance-based Fault Location, Load Variation, Modal Transformation, Radial Distribution Systems.

Summary:

This thesis proposes an analytical impedance-based fault location scheme for distribution systems. The approach is based on voltage and current measurements extracted at only one-end feeding substation. Modal transformation is implemented to decompose the coupled three phase equations due to mutual effects into decoupled ones, and hence directly calculating fault distance in each section without iterative processes. The proposed approach considers various aspects of distribution systems: intermediate loads along the feeder, tapped laterals and sub-laterals at various nodes, time varying loads, and unbalanced operations.

The proposed algorithm is extensively investigated on a real 11 kV distribution system, South Delta electricity sector, Egypt using MATLAB environment. Different cases are studied considering various loading conditions, varied fault resistance values and different fault types. The achieved results ensure the effectiveness of the proposed fault locator irrespective of fault conditions. Besides, the robustness of the proposed scheme against unbalanced loading, network topology change and non-homogenous network sections is also confirmed.

This work is gratefully dedicated to:

My dear parents, my lovely Wife,

and my little son abd-alrahman

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• Symbols

id_s	Current distribution factor
β_s	Current distribution phase angle
d	Distance to the fault point calculated from the beginning of the faulted section
l	Total length of the section
$I_s = [I_a, I_b, I_c]$	Three phase source current
I_o, I_1, I_2	Zero, Positive, Negative sequence current
I_f	Fault current
I_{fm}	Modal fault current
I_m	Modal line current
I_{lm}	Modal load current
V_m	Modal bus voltage
V_{fm}	Modal fault point voltage
V_o, V_1, V_2	Zero, Positive, Negative sequence voltage
R_f	Fault resistance
R_{Fg}	Ground fault resistance
Y_L	Load admittance
X_{app}	Apparent reactance
Z_{app}	Apparent impedance
$Z_{L\ a,b,c}$	Three phase load impedance
Z_{lm}	Modal load impedance
Z_m	Modal section series impedance
Z_{aa}, Z_{bb}, Z_{cc}	Self impedances for phases a, b, c
Z_{ab}, Z_{bc}, Z_{ca}	Mutual impedances between phases a, b, c
Z_0, Z_1, Z_2	Zero, Positive, Negative sequence impedance

Z_{ii} , Z_{ij}	Self and mutual impedances between phases i, j
T	Modal transformation matrix
$D_{estimated}$	Estimated fault distance
D_{actual}	Exact fault distance
S_{ss}	Pre-fault steady state apparent power
S_{rated}	Rated apparent power
γ	Propagation constant of line
Z_C	Characteristic impedance of line
rd	Conductor radius
λ	Flux linkage
D_{ab}, D_{bc}, D_{bc}	Distances between phases a, b, c
ω	Angular frequency
ρ	Soil resistivity