School of Electrical, Computer and Energy Engineering

M.S. Final Oral Defense
Exploring Six-Phase Transmission Line for Increasing Power Transfer With Limited Right Of Way
by
Xianda Deng
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Committee:
Dr. Ravi Gorur (chair)
Dr. Gerald Heydt
Dr. Vijay Vittal

Abstract
In the United States, especially in metropolitan areas, transmission infrastructure is congested due to a combination of increasing load demands, declining investment, and aging facilities. It is anticipated that significant investments will be required for new construction and upgrades in order to serve load demands. This thesis explores higher phase order systems, specifically, six-phase, as a means of increasing power transfer capability, and provides a comparison with conventional three-phase double circuit transmission lines.

In this thesis, the line parameters, electric and magnetic fields, and right of way are the criteria for comparing six-phase and three-phase double circuit lines. The calculations of the criteria were achieved by a program developed using MATLAB. This thesis also presents fault analysis and recommends suitable protection for six-phase transmission lines. This calculation was performed on 4-bus, 9-bus, and 118-bus systems from Powerworld® sample cases. The simulations were performed using Powerworld® and
Line parameters calculations performed in this thesis show that line impedances in six-phase lines have a slight difference, compared to three-phase double circuit line. The shunt capacitance of compacted six phase line is twice of the value in the three-phase double circuit line. As a consequence, the compacted six-phase line provides higher surge impedance loadings.

The electric and magnetic fields calculations show that, ground level electric fields of the six-phase lines decline more rapidly as the distance from center of the lines increase. The six-phase lines have a better performance on ground level magnetic field. Based on the electric and magnetic field results, right of way requirements for the six-phase lines and three-phase double circuit line were calculated. The calculation results of right of way show that six-phase lines provide higher power transfer capability with a given right of way.

Results from transmission line fault analysis, and protection study show that, fault type and protection system in six-phase lines are more complicated, compared to three-phase double circuit line. To clarify the concern about six-phase line protection, a six-phase line protection system was designed. Appropriate protection settings were determined for a six-phase line in the 4-bus system.