SweGRIDS

Distance Protection of Transmission Lines with High Levels of Series Compensation

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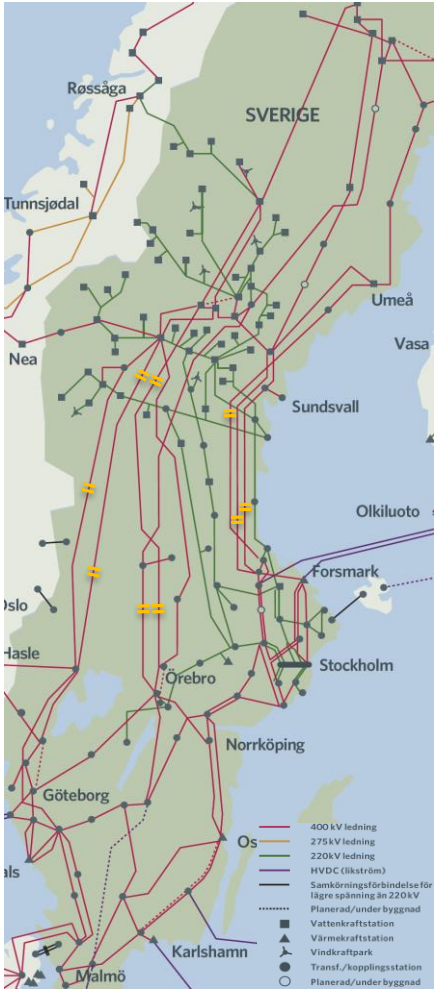
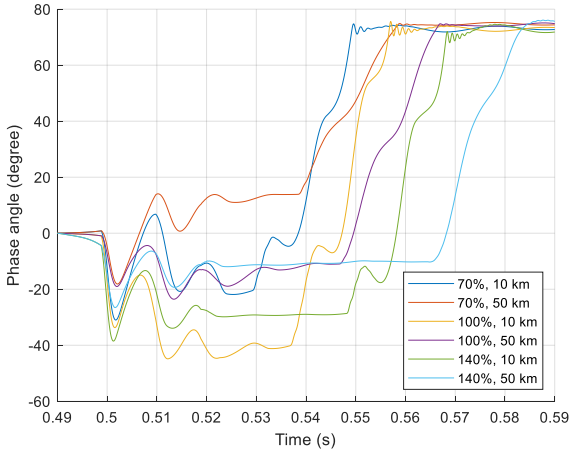
Background

- Transmission Lines
  - Higher voltage levels
  - Connects generation and distribution
  - High investment infrastructure
  - Typically state owned entity
- Why series compensation?
  - Enhanced power transfer
  - Reduced transmission losses
  - Improved voltage profile
  - Improved transient stability of power system

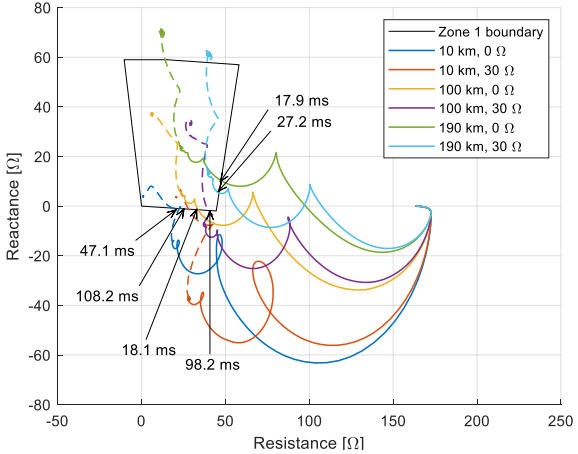


Challenges of Distance Protection

- Understanding the challenges due to high levels of compensation



Evolution of measured fault impedance angle for different compensation levels, for bolted phase-ground fault



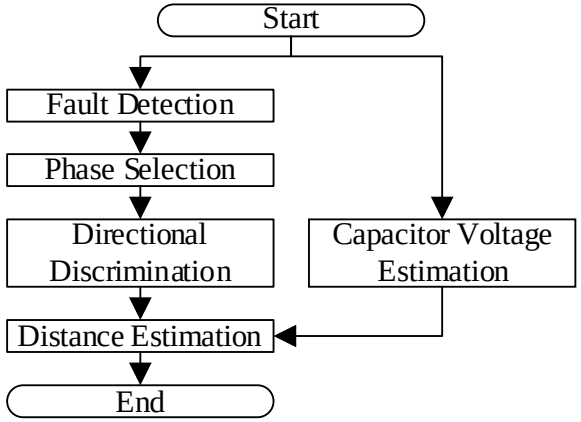
Evolution of measured fault impedance for 100% compensation and 0° inception angle

Incremental Quantity Protection (IQP)

- Incremental Quantity

$$\Delta V = V(t) - V(t - nT)$$
$$\Delta I = I(t) - I(t - nT)$$

- Relay Algorithm



IQP Testing

Test Cases

- Fault angle
- Source impedance
- Compensation level
- Fault resistance
- Fault location
- Fault type
- Capacitor location

Outcome

- Fault detection, phase selection, directional discrimination works in all cases
- Distance estimation works well for low fault resistance
- Operation time is around ¼ cycle

Shortcomings

- Assumption of system linearity
- Issues with higher fault resistance in distance estimation

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Thank You!

Questions and Remarks?

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